DUTCH
SAFETY BOARD

Cooperation on nuclear safety

An investigation into the cooperation between the Netherlands, Belgium and Germany concerning the nuclear power plants in the border areas

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The Dutch Safety Board

When accidents or disasters happen, the Dutch Safety Board investigates how it was possible for them to occur, with the aim of learning lessons for the future and, ultimately, improving safety in the Netherlands. The Safety Board is independent and is free to decide which incidents to investigate. In particular, it focuses on situations in which people's personal safety is dependent on third parties, such as the government or companies. In certain cases the Board is under an obligation to carry out an investigation. Its investigations do not address issues of blame or liability.

Dutch Safety Board

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This report is published in the Dutch and English languages. A summary of the report is available in French and German. If there is a difference in interpretation of the reports and the summaries, the Dutch report will prevail.

CONTENT

CONSIDERATION

The risk of a serious accident at a nuclear power plant is small, thanks in part to the expertise of the nuclear sector and the efforts made at an international and national level to achieve a high level of nuclear safety. In the event of a nuclear accident, however, the consequences can be far-reaching, not only in the accident country itself but also beyond its borders. The nuclear accidents at Chernobyl (1986) and Fukushima (2011) serve as a painful reminder in this respect. Therefore, it is vital that the parties responsible for guaranteeing the safety of nuclear power plants and limiting the potential consequences of nuclear accidents pay constant attention to the management of nuclear risks. Due to the transboundary nature of a serious nuclear accident, intensive cooperation between neighbouring countries is important to ensure the safety of nuclear power plants and to prepare for the eventuality of a nuclear crisis.

Nuclear power plants must comply with stringent safety requirements. The responsible national authorities supervise compliance with these requirements. With regard to nuclear safety, there is an international system in place to ensure that countries adequately perform their duties with regard to the safety of their nuclear power plants. This system provides for international safety standards, worldwide exchange of knowledge and experiences and independent reviews. This way, countries with nuclear power plants are not only supported, but also assessed by nuclear specialists from other countries. The Dutch Safety Board has no reason to doubt the functioning of this system. By consequence, the investigation of the Dutch Safety Board did not focus on whether the nuclear power plants in and around the Netherlands are safe, but on how the Netherlands is cooperating with Belgium and with Germany to improve the safety of nuclear power plants and limit the potential consequences of a nuclear accident.

It has become apparent to the Dutch Safety Board that the parties involved have made significant efforts in recent years to improve the safety of nuclear power plants and to limit the consequences of a potential nuclear accident. In the Netherlands, the establishment of the Authority for Nuclear Safety and Radiation Protection (ANVS) has been an important step in this regard. Progress has also been made in terms of cross-border cooperation. As an example, the ANVS and Belgium's Federal Agency for Nuclear Control (FANC) signed an agreement in September 2017 to formalise, expand and substantiate their existing collaboration. However, the Dutch Safety Board also ascertains that improvements can and should be made in a number of areas.

Sensitivity to public concerns

Although nuclear safety experts tend to stress that the risks involved in the production of nuclear energy are small[1], there is public concern about the safety of nuclear power plants. It is imperative that the parties involved recognise these concerns and adjust their decision-making and communication to address them. Given the complexity of the subject matter, that is not an easy task. However, it is necessary that the parties involved urgently take up this task, to ensure that citizens have access to understandable information on issues relevant to them. This can raise the dilemma that providing information can be counter-productive if it causes unnecessary public concern. It is up to the parties involved to consider how they meet the information needs of the public and at the same time prevent the information from leading to unnecessary concerns.

In the experience of the Dutch Safety Board, the nuclear field may be complex, but it is not secretive. In the course of its investigation not only the Dutch parties approached by the Dutch Safety Board (that are obliged to cooperate), but also the parties in Belgium and Germany (that are under no obligation to do so) have contributed to the investigation. In the judgement of the Dutch Safety Board, this reflects an open culture in which parties are prepared to provide an insight into their working processes and explain why they operate the way they do.

At the same time, the Dutch Safety Board observes that the parties involved, especially the government organisations involved, when implementing their (technical, legal and policymaking) duties do not always pay sufficient attention to the societal context within which they implement those duties. That manifests itself, amongst others, in the information they provide to the public. For example, the information they provide on incidents at nuclear power plants is difficult for the public to understand and information on forthcoming licensing procedures does not reach all people living in the vicinity of nuclear power plants for whom that information is relevant. In addition, the responsible parties fail to anticipate optimally to the public concerns that might arise from stories in the media about certain developments at nuclear power plants. These parties would benefit from a more proactive attitude and an increased awareness of public concerns.

Cross-border cooperation with regard to crisis management

Optimal crisis management in the event of a nuclear accident, both within the affected countries and across their national borders, is in everyone's best interest. If the crisis management efforts of the parties involved are successful, the consequences of an accident can be limited as much as possible. Based on its findings, however, the Dutch Safety Board expects that cross-border cooperation with regard to crisis management in the event of a nuclear accident will not be optimal. That conclusion arises first of all from the observation that there are gaps in the current plans for the response to a cross-border nuclear crisis. In addition, the crisis plans have been exercised in practice only to a limited extent, whereas such exercises are important to evaluate the functioning of the plans in practice, but also to experience the working of cross-border cooperation and to get (more) acquainted with the people involved across the border. Furthermore, the parties involved have little practical experience of cross-border crisis management and

1 There is no consensus among experts on the exact level of risk involved.

the specific coordination problems that may result, such as language barriers. Combined with the fact that the multitude of parties involved is likely to hamper coordination in the event of a crisis, the Dutch Safety Board concludes that attention should be paid to improving cross-border cooperation with regard to crisis management.

The challenge in the coming years is to improve cross-border cooperation, while respecting the unavoidable differences between the three countries in terms of language and culture, administrative structures, public attitudes towards nuclear energy, dependency on nuclear energy for energy needs, and so on. The Dutch Safety Board is convinced that intensive cooperation between the Netherlands, Belgium and Germany, with respect for each other's sovereignty, is essential to minimise the risks of the production of nuclear energy and to adequately manage a crisis arising from a nuclear accident.

SUMMARY

The Dutch Safety Board has investigated the manner in which the Netherlands and Belgium and the Netherlands and Germany cooperate to limit the risks involved in the production of nuclear energy. In particular, the investigation focused on cross-border cooperation with regard to licensing, supervision and crisis management. The Dutch Safety Board also investigated how the public are informed about licensing procedures, incidents at nuclear power plants and the measures that need to be taken in response to a nuclear accident.

The investigation focused on the nuclear power plants in operation located in the Dutch-Belgian and Dutch-German border regions. These plants are the Borssele (Netherlands), Doel and Tihange (Belgium) and Emsland (Germany) nuclear power plants. In its investigation, the Dutch Safety Board has assumed that the national and international mechanisms to control and supervise the safety of nuclear power plants function properly. The Dutch Safety Board has treated the current nuclear energy policies of the Netherlands, Belgium and Germany as a given and has not considered the desirability of energy generation by means of nuclear fission.

Cross-border cooperation with regard to licensing
Nuclear power plants must comply with stringent safety requirements. These requirements are, among other things, imposed by the licence by which the government authorises the operation of a nuclear power plant. Such licences are issued by the competent nuclear regulatory authorities. For organisations and persons who want to express their concerns with respect to the licences to be granted, it is of importance that they are kept informed about forthcoming procedures and opportunities to defend their interests (thereby keeping the competent authorities alert).

The investigation reveals that the Dutch and Belgian nuclear regulatory authorities as well as the Dutch and German nuclear regulatory authorities inform each other about the licensing procedures regarding the nuclear power plants in their country. Nevertheless, local authorities in the neighbouring country that may have an interest in licensing procedures, such as municipalities, are not always actively involved in these procedures. The Dutch Safety Board considers it important that at least all municipalities within a 20-kilometre radius from a nuclear power plant are actively informed about licensing procedures, also if those municipalities are located across the border. This is the case for the Doel and Borssele nuclear power plants, which are located within 2.8 and 16 kilometres of the border respectively. In practice, this means that Dutch municipalities near the Doel nuclear power plant and Belgian municipalities near the Borssele nuclear power plant should be informed about licensing procedures more actively than is currently the case, so that they can present their views on forthcoming decisions when they feel the need to do so.

The investigation also revealed differences between the Netherlands, Belgium and Germany as regards the extent to which the public are given access to information about forthcoming licensing procedures. It is easier for residents of Belgium and Germany to obtain information about forthcoming procedures regarding the Borssele nuclear power plant than it is for residents of the Netherlands to obtain information about forthcoming procedures regarding the Doel, Tihange and Emsland nuclear power plants.

Cross-border cooperation with regard to the supervision of nuclear power plants
Regular consultations take place between the Dutch and Belgian and between the Dutch and German nuclear regulatory authorities. Not only do these authorities share information on safety issues regarding the nuclear power plants, they also exchange expertise in order to improve the performance of their own duties. As an example, inspectors from the Dutch and Belgian nuclear regulatory authorities yearly attend a couple of each other's inspections in order to learn from one another. The Netherlands has also entered into agreements with both Belgium and Germany about the exchange of information on incidents at nuclear power plants, although this exchange has not been completely put into practise yet. In all three countries, both the nuclear regulatory authorities and the nuclear power plant operators post information about incidents on their respective websites. It is not easy for the general public to understand or to evaluate this information.

In response to occurrences at and news reports about Belgium's nuclear power plants, the Dutch government regularly requested Belgium to provide information about the safety of its nuclear power plants. The information provided by Belgium strengthened the confidence of the Dutch minister and the Dutch nuclear regulatory authority in the judgement of the Belgian nuclear regulatory authority. The Dutch parties were not very successful in instilling the same confidence among the Dutch public. Part of the reason for this is that the nuclear regulatory authorities exchange information as part of their regulatory duty. The information they share is strongly driven by their professional knowledge. The Board believes that it is important for the nuclear regulatory authorities to also discuss the societal context of their work with each other. In addition, it is essential for the nuclear regulatory authorities to be more sensitive to public concerns and adjust their communications to address these concerns.

Cross-border cooperation with regard to crisis management
If an accident at a nuclear power plant in the Dutch-Belgian border area or the Dutch-German border area were to occur, there is a high probability of transboundary effects, as a consequence of which the Netherlands, Belgium and Germany will have to deal with these effects. In order to ensure an adequate response to such a nuclear accident, it is essential for the Netherlands to make joint preparations with Belgium and Germany. In some areas of crisis management this has already been achieved. Among others, the countries have agreed to alert each other as soon as possible in case of an imminent emergency at a nuclear power plant. The European Commission and the International Atomic Energy Agency have set up international alerting systems for nuclear accidents, so that the Netherlands, Belgium and Germany receive a notification in the event of an actual or imminent nuclear accident in another country. In addition, these countries have access to each other's radiological measurement data for use during an emergency. With respect to the availability of other technical data, such as prognoses, the three countries are able to access each other's systems or are preparing arrangements to make this possible.

However, the Dutch Safety Board also concludes that the cross-border cooperation in a number of areas has to be improved, so that parties are better prepared for the eventuality of a nuclear accident. Firstly, improvements are required with regard to planning. All nuclear crisis plans should reflect the transboundary nature of nuclear accidents. Some existing crisis plans already do so, such as those prepared by the Zeeland and Twente safety regions[2], but others do not or to a much lesser extent. Furthermore, it is important that the Dutch principles for nuclear accident response will be further harmonised with those of Belgium and Germany. Differences between the principles could lead to differences in the measures being taken on either side of the border, which could in turn lead to confusion among the public.

Secondly, the investigation reveals that the number of joint nuclear emergency exercises to test the cooperation between the Netherlands, Belgium and Germany, is limited. In order to ensure an adequate preparation for a nuclear accident, the Dutch parties involved should conduct more frequent and more intensive joint exercises with their partners in Belgium and Germany. This requires a coherent and systematic approach.

Thirdly, it has become clear that the responsible authorities in the Netherlands, Belgium and Germany publish information about the measures to be taken in the event of a nuclear accident on their websites. However, there are differences between the countries regarding the extent to which this information enables the public to form an accurate picture of the potential consequences of a nuclear accident and what action to take in the event of such an accident. In the Netherlands and Germany, this information is more fragmented than it is in Belgium. The Dutch Safety Board considers it remarkable that the Dutch central government has until recently paid very little attention to the provision of information to the public about the potential consequences of a nuclear accident and the government's measures to mitigate those consequences, even though nuclear power plants have been in operation in and around the Netherlands for decades.

Fourthly, the investigation shows that the agreements between the Netherlands and Belgium and between the Netherlands and Germany with respect to crisis communication do not specify how countries align their communications in the event of a transboundary nuclear accident. The countries are not well prepared for dealing with bottlenecks that might result from linguistic and cultural differences and differences in communication tools. In the event of a nuclear accident, alignment of communications between the accident country and its neighbouring countries is paramount to preventing the authorities from providing the public with conflicting information. Unequivocalness in communications from the responsible authorities is vital to provide a counterweight to the spread of divergent information through other channels (like mass media or countries which are not directly involved).

2 The General Emergency response plan for Nuclear and Radiological emergencies (*Algemeen Rampbestrijdingsplan Stralingsincidenten*) was prepared by the Zeeland safety region in close cooperation with the Central and West Brabant safety region. The plan applies to both safety regions. The Emergency response plan Kernkraftwerk Emsland (*Rampbestrijdingsplan Kernkraftwerk Emsland*) was prepared by the Twente safety region in cooperation with the IJsselland and Drenthe safety regions.

Finally, it turns out that the Netherlands has not entered into any agreements with either Belgium or Germany regarding the coordination of decision-making processes in the event of a nuclear accident in the border region. Such agreements are key to being able to effectively mitigate the consequences of a transboundary accident. Although the ability to deploy liaisons has the potential to contribute to cross-border alignment, it is no guarantee for joint decision-making in the event of a crisis.

Recommendations

The Dutch Safety Board's investigation reveals that the Netherlands and Belgium, and the Netherlands and Germany, cooperate well in a number of areas, but that there is room for improvement in others. The Dutch, Belgian and German parties involved have already started implementing some of these improvements. The Dutch Safety Board expects the parties involved to use this investigation report to further improve the cross-border cooperation wherever possible.

The Dutch Safety Board makes two recommendations to improve cross-border cooperation with regard to crisis management. The first recommendation focuses on improving joint preparations for the eventuality of a nuclear crisis. The second recommendation focuses on optimising the decision-making process in the event of a nuclear crisis. In a crisis, the main thing is to act as quickly and effectively as possible. This is why it is important to come to an agreement ahead of time on how the countries involved will arrange their joint decision-making to ensure effective crisis management.

To the Dutch State Secretary for Infrastructure and Water Management the Board recommends the following:

1. Improve - together with the responsible government members in Belgium and Germany - the cross-border cooperation aimed at limiting the potential consequences of a nuclear accident. In particular, pay close attention to:

    - harmonisation of the principles for nuclear accident response;
    - revision of the crisis plans which at the moment take insufficient account of cross-border aspects;
    - joint preparation by means of conducting joint emergency exercises, simulations, et cetera; and
    - harmonisation of crisis communications.

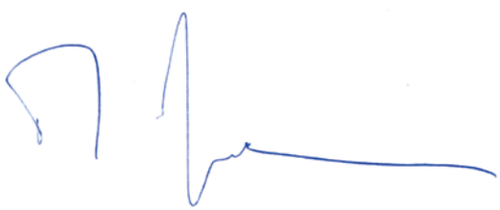
2. Enter into agreements with Belgium and Germany on supranational decision-making in a crisis situation that arises from a cross-border accident at the Borssele, Doel, Tihange or Emsland nuclear power plants. Provide that such decision-making is intended at least to take similar response measures on either side of the border and to communicate unanimously on those measures.

In order to limit the consequences of a nuclear accident when it occurs, it is vital that citizens follow the instructions of the competent authorities. This is only possible if citizens have sufficient confidence in the authorities involved and the protective actions to take. Public concerns indicate that this confidence is not sufficiently widespread at this time. It is of importance that the authorities concerned recognise and address these concerns. They could do so by providing citizens with information that meets their needs and enables them to make their own judgement. Transparency and clear communication can contribute to the public's confidence in the authorities involved.

To the Dutch Authority for Nuclear Safety and Radiation Protection, the Board recommends the following:

3. Recognise the concerns among the Dutch public about the safety of nuclear power plants and address them by:

    - entering into agreements with neighbouring countries about cross-border information provision with regard to licensing procedures, so that residents across the border within a 20-kilometre radius from the nuclear power plant in question are actively informed about these procedures and given the opportunity to participate;
    - communicating about incidents at nuclear power plants in language that is easy for the public to understand; and
    - giving priority to improving communication with regard to the risks of nuclear power plants, among others by setting up a central information point for the public to obtain information about what action to take in the event of a nuclear accident.



T.H.J. Joustra
Chairman Dutch Safety Board

C.A.J.F. Verheij
Secretary Director

LIST OF ABBREVIATIONS

ANVS	Authority for Nuclear Safety and Radiation Protection (Netherlands)
ARBIS	Royal Decree of 20 July 2001 laying down the general regulation for the protection of the public, workers and the environment against the hazards of ionising radiation (Belgium)
ASN	Authority for Nuclear Safety (France)
BBK	Federal Office for Civil Protection and Disaster Assistance (Germany)
BfE	Federal Office for the Safety of Nuclear Waste Management (Germany)
BfS	Federal Office for Radiation Protection (Germany)
BMI	Federal Ministry of the Interior (Germany)
BMUB	Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (Germany)
CalWeb	Calamities Web (Netherlands)
CETsn	Crisis Expert Team radiation and nuclear (Netherlands)
CGCCR	Coordination and Crisis Centre of the Belgian Government (Belgium)
COVRA	Central Organisation for Radioactive Waste (Netherlands)
DCC	Departmental Coordination Centre for Crisis Management (Netherlands)
ECURIE	European Community Urgent Radiological Information Exchange
ELAN	Electronic Situation Display for Emergency Preparedness (Germany)
EMRIC	Euregion Meuse-Rhine Incident Control and Crisis Management
ENSREG	European Nuclear Safety Regulators Group
EPAn	Nuclear Planning and Advice Unit (Netherlands)
EPREV	Emergency Preparedness Review Service
EPZ	Elektriciteits-produktiemaatschappij Zuid-Nederland (Netherlands)
ERH	Energy Resources Holding
EURATOM	European Atomic Energy Community
FANC	Federal Agency for Nuclear Control (Belgium)
GGD	Regional Health Service (Netherlands)
GMLZ	German Joint Information and Situation Centre (Germany)
GRS	Gesellschaft für Anlagen- und Reaktorsicherheit (Germany)
HERCA	Heads of the European Radiological Protection Competent Authorities
IAEA	International Atomic Energy Agency – an autonomous international organisation within the United Nations
ICCb	Interdepartmental Crisis Management Committee (Netherlands)
ICMS	Incident Crisis Management System (Belgium)

ICRP	International Commission on Radiological Protection
IenM	Ministry of Infrastructure and the Environment (Netherlands)
IMIS	Integrated Measuring and Information System for the Monitoring of Environmental Radioactivity (Germany)
INES	International Nuclear and Radiological Event Scale
IPSART	International Probabilistic Safety Assessment Review Team
IRRS	Integrated Regulatory Review Service
JRODOS	Java-based Real-time Online Decision Support System for nuclear emergency management
LCMS	National Crisis Management System (Netherlands)
LTO	Long Term Operation
MCCb	Ministerial Crisis Management Committee (Netherlands)
MW	MegaWatt
NCC	National Crisis Centre (Netherlands)
NCS	National Plan for Nuclear and Radiological Emergencies (Netherlands)
NCTV	National Coordinator for Security and Counterterrorism (Netherlands)
NDKK	Dutch-German Commission for Nuclear Facilities in the Border Region
NEA	Nuclear Energy Agency
NLWKN	Lower Saxony Water Management, Coastal Defence and Nature Conservation Agency (Germany)
NMI	Lower Saxony Ministry of the Interior and Sport (Germany)
NMU	Lower Saxony Ministry of the Environment, Energy and Climate Protection (Germany)
ODL	Gamma dose rate monitoring network (Germany)
OECD	Organisation for Economic Co-operation and Development
OSART	Operational Safety Assessment Review Team
REMIT	Regulation on Wholesale Energy Market Integrity and Transparency
RGEN	Radiology and Health Expertise Network (Netherlands)
RIVM	National Institute for Public Health and the Environment (Netherlands)
RLZ	Federal Radiological Situation Centre (Germany)
RSK	Reactor Safety Commission (Germany)
RWE	Rheinisch-Westfälisches Elekrizitätswerk (Germany)
SALTO	Safety Aspects of Long Term Operation
SCK•CEN	Nuclear Research Centre (Belgium)
SSK	Commission on Radiological Protection (Germany)
TMI	Three Mile Island
UNSCEAR	United Nations Scientific Committee on the Effects of Atomic Radiation
VWS	Ministry of Health, Welfare and Sport (Netherlands)

WANO	World Association of Nuclear Operators
WENRA	Western European Nuclear Regulators Association

LIST OF DEFINITIONS

Crisis communication
Crisis communication is defined as communication with the public in the event of an actual or imminent nuclear accident in order to inform citizens about the situation, its severity, potential consequences and what action to take, and in order to provide citizens with an information point where they can get answers to their questions.

Crisis Expert Team radiation and nuclear
A knowledge and advisory network that reports and issues recommendations to the Dutch national and regional crisis structure on the radiological and health consequences of an actual or imminent nuclear accident or other radiation incidents.

Environmental impact assessment
An environmental impact assessment provides insight into the foreseeable adverse effects on the environment of certain activities, so that those effects can be taken into account in the decision whether to permit these activities.

Incident
In this report, the term "incident" is used to refer to an unusual event that results from a disruption in the processes or installations of a nuclear power plant and has no safety consequences for the surrounding area of the nuclear power plant.

INES
The International Nuclear and Radiological Event Scale (INES for short) is a worldwide tool, developed by the IAEA, for communicating to the public in a consistent way the safety significance of nuclear and radiological events. The scale classifies events from level 1 (deviation) up to level 7 (major accident).

Ionising radiation
Ionising radiation is high-energy radiation that is released when radioactive substances decay causing atomic nuclei to transform into a more stable state (possibly in stages). Ionising radiation is popularly known as "radioactive radiation".

Länder
The Federal Republic of Germany consists of 16 federated states, called Länder in German, each of which has its own government with far-reaching powers. The Länder that border the Netherlands are Lower Saxony and North Rhine-Westphalia. Lower Saxony is particularly relevant for this investigation, because this is the state where the Emsland nuclear power plant is located.

Landkreise
German federated states are divided into regional administrative units known as Landkreise. The Landkreis relevant to this investigation is Landkreis Emsland owing to the presence of the Emsland nuclear power plant.

Level of interference
A level of interference is a fixed dose value or contamination level (or a range of those values or levels) which, if exceeded, requires the authorities to consider taking measures to protect the population.

Long Term Operation (LTO)
Long Term Operation refers to the operation of a nuclear power plant longer than foreseen by its original design. Long Term Operation requires approval by the nuclear regulatory authority, following a safety assessment which demonstrates that continued operation is permissible from a safety perspective. The safety assessment that forms the basis for approval of Long Term Operation is independent from political decision-making regarding the continued production of nuclear energy.

Nuclear accident
In this report, the term "nuclear accident" is used to refer to an unusual event that has safety consequences for the surrounding area of the nuclear power plant. This term also covers an unusual event in a nuclear power plant that has no safety consequences for the surrounding area of the plant but is nevertheless severe, such as an (imminent) meltdown without discharge of radioactive materials.

Nuclear power plant
A nuclear power plant is a power plant that generates electricity using the energy released in nuclear fission. In this report, the term "nuclear power plant" is used to refer to the site that accommodates one or more separate production units, each of which generates electricity using energy released in nuclear fission. The individual production units are called reactors in this report. In this report, the term "reactor" denotes power reactors exclusively.

Planning zone
A planning zone is an area around a nuclear power plant within which countries make preparations for measures to protect the population from exposure to ionising radiation. These preparations concern, among other things, evacuation, providing shelter for the population and the availability of iodine tablets. Measures are prepared in advance of a nuclear accident.

Province
The Netherlands and Belgium are divided into twelve and ten provinces respectively. The executive committee of each province is chaired by the King's Commissioner in the Netherlands, and by the Governor in Belgium. Belgian provinces have a prominent role in the operational response to a nuclear crisis. In the Netherlands that role is assigned to the safety regions. The Belgian provinces with relevance for this investigation are the provinces of East Flanders, Antwerp and Liège.

Radiation sickness
A sickness that may develop in a person who has been exposed to a high dose (with a specified minimum) of ionising radiation for a short period of time.

Reactor
A reactor is the production unit inside a nuclear power plant that generates electricity using the energy released in nuclear fission. The site of a nuclear power plant may accommodate multiple separate production units, as is the case at Doel (four reactors: Doel 1, Doel 2, Doel 3 and Doel 4) and Tihange (three reactors: Tihange 1, Tihange 2 and Tihange 3). The Borssele and Emsland nuclear power plants each have one reactor only.

Safety region
The Netherlands is divided into 25 safety regions. A safety region is a regional collaborative structure in which municipal councils and public services join forces in the fields of firefighting and fire safety, disaster and crisis management, medical assistance, public order and safety. Each safety region has a joint emergency centre. The safety regions of particular relevance to this investigation are the Zeeland, Central and West Brabant, South Limburg and Twente safety regions.

1 INTRODUCTION

1.1 Reason for the investigation

Although severe accidents with nuclear power plants are rare, accidents such as those at Three Mile Island (1979), Chernobyl (1986) and Fukushima (2011) demonstrate that such events cannot be entirely avoided. As the consequences of a severe nuclear accident can be far-reaching, supervising the safety of nuclear power plants at both the national and international level is crucial. If a nuclear accident were to occur, the consequences are unlikely to be restricted to the country in which the accident takes place. By consequence, it is vitally important for countries – particularly those countries with nuclear power plants within or close to their national borders – to cooperate with their neighbouring countries to guarantee the safe operation of nuclear power plants and limit the potential consequences of nuclear accidents. The Dutch Safety Board has investigated the manner in which the Netherlands, Belgium and Germany cooperate in order to improve the safety of nuclear power plants and limit the potential consequences of nuclear accidents.

There are public concerns about the safety of nuclear power plants. The concerns in the Netherlands focus mainly on Belgium's nuclear power plants in Doel and Tihange, due to reports in the press about incidents and "fine cracks"[3] in reactor vessels. In response to these concerns, the Dutch Safety Board has investigated not only the cross-border cooperation between the above three countries, but also the provision of information to the public.

1.2 Dutch Safety Board

The Dutch Safety Board was founded in 2005 with the duty to investigate accidents and incidents. The Safety Board does not only conduct investigations on accidents that have occurred, but also on broader safety issues and unsafe situations that arise gradually. The investigations unravel whether these are caused by structural safety deficiencies. The goal of all investigations is to learn and to issue recommendations to parties where necessary in order to improve safety. The Board's investigations do not address issues of blame or liability.

3 These are not actual cracks, but hydrogen flakes (see section 3.3.2 for more information) which are named cracks in news reports.

The Dutch Safety Board is an independent administrative body. The Board decides for itself what accidents and safety issues it investigates. The Board focuses on those situations in which people's personal safety is dependent on third parties, like the government, companies or organisations. In certain cases the Dutch Safety Board is obliged to carry out an investigation. Internationally the Dutch Safety Board has a role in conducting investigations in accordance with international treaties and European legislation.

The Dutch Safety Board has statutory powers that enable the investigators to obtain all information relevant to the investigation. Those involved are obliged to provide full cooperation to an investigation. The obligation to cooperate does not apply in other countries, like Belgium and Germany, unless (international) legislation points out otherwise.

1.3 Purpose and investigation questions

The purpose of this investigation was to reveal whether, and if so which, improvements can be made to the cross-border cooperation between the Netherlands and its neighbouring countries and to the provision of information to the public, so that people living in the vicinity of nuclear power plants are safe and feel safe.

The investigation addresses the following questions:

1. In what ways does the Netherlands cooperate with Belgium and Germany to improve the safety of nuclear power plants?
2. In what ways does the Netherlands cooperate with Belgium and Germany to limit the potential consequences of nuclear accidents?
3. How is the public kept informed about incidents at nuclear power plants, forthcoming licensing procedures and what action to take in the event of a nuclear accident?

The investigation questions are broken down into the sub-questions listed below.

Re 1. Cross-border cooperation to improve the safety of nuclear power plants

a. To what extent do the Netherlands and Belgium and the Netherlands and Germany involve[4] each other in their decision-making with regard to the safe operation of nuclear power plants?
b. In what ways do these countries cooperate with regard to obtaining insights into and supervising the safe operation of each other's nuclear power plants?
c. How can cross-border cooperation be improved?

4 The Dutch Safety Board defines 'involving' as actively providing information to neighbouring countries about licensing procedures and giving neighbouring countries the opportunity to bring their views forward.

Re 2. Cross-border cooperation with regard to crisis management in the event of a nuclear accident

a. To what extent do the Netherlands and Belgium and the Netherlands and Germany involve each other in their preparations for a nuclear accident (planning, emergency exercises)?
b. In what ways does the Netherlands cooperate with Belgium and Germany to limit the consequences of nuclear accidents (alerts, response)?
c. How can cross-border cooperation be improved?

Re 3. Information provision to the public

a. To what extent do citizens have access to information about forthcoming licensing procedures and opportunities to bring their views forward?
b. How is the public informed about incidents at nuclear power plants?
c. How is the public informed about what action to take in the event of a possible nuclear accident?
d. How can the provision of information to the public be improved?

1.4 Scope of the investigation

With regard to this investigation, the Dutch Safety Board has treated the current nuclear energy policies of the Netherlands, Belgium and Germany as a given. The Board has not considered the desirability of energy generation by means of nuclear fission. The Dutch Safety Board has investigated whether the cross-border cooperation between countries which have opted for nuclear energy includes all reasonable steps necessary to guarantee the safety of the public.

The investigation has been limited to the nuclear power plants in operation in the Dutch-Belgian and Dutch-German border regions, which are the Borssele (Netherlands), Doel and Tihange (Belgium) and Emsland (Germany) nuclear power plants. None of the other nuclear installations in the Netherlands, Belgium and Germany were considered.[5] This also applies to nuclear power plants in other European countries, such as France, whose nuclear power plants at Gravelines and Chooz are the ones nearest to the Dutch border. Of course an accident at any of those power plants could have consequences for the Netherlands and necessitate cross-border collaboration. The lessons learnt in this investigation can also be useful in the event of such an accident. The Dutch Safety Board did not include transportation, storage and processing of radioactive material in its investigation.

As concerns nuclear safety, there is an international system in place to ensure that countries adequately perform their duties with regard to the safety of their nuclear power plants. The Dutch Safety Board has no reason to doubt the effectiveness of this system.

5 These installations concern the research reactors in Petten and Delft, the URENCO enrichment installations in Almelo and Gronau, the radioactive waste processing plants in Borsele and Mol-Dessel, the reactor in the research centre in Mol, the installation for the production of medical isotopes in Fleurus, et cetera. German nuclear power plants at a greater distance from the Dutch border, such as the plants in Brokdorf and Grohnde, were left out as well.

In its investigation, the Board has assumed that the national and international mechanisms to control and supervise the safety of nuclear power plants function properly. By consequence, the investigation did not focus on whether the nuclear power plants in and around the Netherlands are safe, but on how the Netherlands is cooperating with Belgium and with Germany to improve the safety of nuclear power plants and limit the potential consequences of a nuclear accident.

The Dutch Safety Board has not investigated collaboration in crisis management comprehensively, but limited its scope to the first phase of a crisis. The post-accident phase was beyond the scope of this investigation.

In its investigation report, the Dutch Safety Board has attempted to present as accurate a picture as possible of the current legislative framework and the policies in the three countries which are relevant to the investigation. However, the Dutch Safety Board's investigation did not take into account any changes thereto that were implemented after 1 October 2017.

1.5 Investigative approach

The investigation covered a broad range of topics and a multitude of parties in the Netherlands, Belgium and Germany that are involved in these topics. This broad scope had consequences for the investigative approach.

At the start of its investigation, the Dutch Safety Board conducted introductory talks with the directors of the relevant parties. These talks were conducted initially in the Netherlands and Belgium and later also in Germany. During these talks, the Dutch Safety Board explained the purpose of its investigation and its methodology in order to ensure that all interested parties had a clear picture of what to expect from the Dutch Safety Board and of what the Dutch Safety Board expected from them. In addition, the introductory talks in Belgium and Germany helped to get access to individuals and information relevant to the investigation. The Dutch Safety Board Act[6], which governs access to individuals and information in the Netherlands, does not apply to Belgium and Germany. Moreover, parties in those countries are less familiar with the existence and the work of the Dutch Safety Board. The introductory talks contributed to the willingness of parties in Belgium and Germany to cooperate with the Dutch Safety Board's investigation.

In the course of the investigation, the Dutch Safety Board interviewed more than 100 people and studied a large number of documents. Interviewees included employees of public and private parties involved in ensuring the safe operation of nuclear power plants and preparing for the eventuality of a nuclear accident. These parties were also asked to provide relevant information for the purpose of answering the investigation questions. In addition, the Dutch Safety Board consulted several public sources. It also conducted talks with civil-society organisations and border municipalities. Please refer to Appendix A for more information about the interviews and the document research.

6 Dutch Safety Board Act *(Rijkswet Onderzoeksraad voor veiligheid)*, Staatsblad, 23 December 2004, No 677.

In order to gain a better understanding of the workings of a nuclear power plant and the manner in which its safe operation is guaranteed, the project team visited the Borssele nuclear power plant. Members of the project team also visited the Chernobyl nuclear power plant in order to gain insight into the potential long-term effects of a very severe nuclear accident on the environment.

1.6 Frame of reference

Ensuring and supervising the safe operation of nuclear power plants is primarily a State's responsibility. States are free to decide whether they allow the production of nuclear energy within their territory and also have the right to decide autonomously whether to continue such activities. If a nuclear accident were to occur, however, the consequences are likely to be far-reaching and to extend across national borders. Countries in the vicinity of a nuclear power plant therefore have an interest in ensuring the safe operation of nuclear power plants to the greatest possible degree. The Dutch Safety Board considers it important for these countries to have access to information about the safety of the nuclear power plants close to their borders. This will not only help them prepare for any accidents, but also enable them to answer citizens' questions about incidents at these plants. In addition, the Dutch Safety Board considers it vitally important for these countries to cooperate in ensuring they are optimally prepared for the eventuality of a nuclear accident, since accidents leading to an inadvertent discharge of radioactive materials cannot be entirely ruled out.

In order to assess whether cross-border cooperation is as effective as possible and whether the public is being adequately informed, the Dutch Safety Board has established a frame of reference. This frame of reference describes the Board's expectations regarding the collaborative efforts of the Netherlands, Belgium and Germany to improve the safety of nuclear power plants and limit the consequences if a nuclear accident were to take place. It also describes the Board's expectations regarding the provision of information to the public. The Board's frame of reference is based on internationally accepted principles for cross-border cooperation and transparency towards the public with regard to nuclear power plants.[7]

Cross-border cooperation to improve the safety of nuclear power plants
The Dutch Safety Board expects countries with nuclear power plants on their territory to exchange information with neighbouring countries which may have to deal with the consequences of a possible nuclear accident and to cooperate in order to improve the safety of nuclear power plants, while respecting each other's national sovereignty. This is conditional upon the following:

7 These principles are laid down in Euratom guidelines; IAEA Safety Standards Series; international conventions such as the Convention on Nuclear Safety, the Espoo Convention and the Aarhus Convention; and documents issued in an international context to provide guidance to the nuclear sector.

- Countries with nuclear power plants should inform neighbouring countries about forthcoming licensing procedures with regard to the operation of nuclear power plants and about opportunities for participation in those procedures. The neighbouring countries themselves should take the initiative to obtain information about these procedures and take the opportunity to participate if they deem this necessary;
- Countries with nuclear power plants should inform neighbouring countries about incidents and developments which may have consequences for the safety of a particular nuclear power plant. The neighbouring countries themselves should take the initiative to obtain this information;
- Countries with nuclear power plants should involve neighbouring countries in the supervision of the safe operation of the nuclear power plants.

Cross-border cooperation with regard to crisis management in the event of a nuclear accident

Furthermore, the Board expects those parties involved in crisis management (at the national, regional and local level) in the Netherlands, Belgium and Germany to cooperate in ensuring they are optimally prepared for the eventuality of a nuclear accident with transboundary consequences. It is the opinion of the Dutch Safety Board that the borders between these countries should not hinder an effective response. Optimal joint preparation is conditional upon the following:

- Joint or coordinated crisis plans which include cross-border scenarios, are based on coordinated risk analyses and are based on harmonisation of the response measures in the countries involved;
- Agreements about early cross-border emergency notification, the exchange of information, coordination of decision-making in crisis situations and coordination of crisis communications towards the public;
- Joint cross-border emergency exercises to test the effectiveness of crisis plans in practice and to incorporate improvements that arise from the evaluation of such exercises.

Information provision to the public

The Dutch Safety Board expects the relevant authorities in the Netherlands, Belgium and Germany to recognise the safety concerns of citizens[8] and pay attention to these concerns in decision-making procedures and in their communications. It is incumbent on them to keep the public adequately informed about the following:

- Incidents which take place at nuclear power plants in their country or beyond their country's borders;
- Forthcoming licensing procedures for nuclear power plants in their country or beyond their country's borders and opportunities for participation in those procedures;
- Government's measures to prevent a nuclear accident from happening and to limit the consequences of such an accident;
- The action citizens should take in the event of a nuclear accident.

8 Midden, C., *Publieksreacties op energiesystemen, het perspectief van de burger*, 2014.

As this may involve information about nuclear power plants in neighbouring countries, it is important that countries exchange information and that they ensure that the information provided to the public is not contradictory. The Dutch Safety Board defines "adequate information" as information which is reliable and up-to-date and easy for the public to both understand and locate. Such information should enable citizens to make their own judgement with respect to their safety.[9,10]

1.7 Reader's guide

Chapter 2 contains background information about nuclear energy, earlier nuclear accidents, the nuclear power plants that were the subject of this investigation and the incidents at these plants that were reported in the last decade. Chapters 3 and 4 delve deeper into the key topics of this investigation. Both chapters contain a description of the main findings, an analysis of these findings and sub-conclusions. Chapter 3 analyses the licensing and supervision system aimed at the prevention of nuclear accidents. Chapter 4 describes how the Netherlands cooperates with its neighbours to prepare for the eventuality of a nuclear accident. Both chapters also devote attention to the provision of information to the public. Chapter 5 presents the conclusions of this investigation, while chapter 6 lists the Board's recommendations to the parties involved. The appendices contain background information which may prove useful when reading this investigation report.

9 Wetenschappelijke Raad voor het Regeringsbeleid, *Vertrouwen in burgers*, 2012.
10 Bos, K. van den, *Vertrouwen in de overheid. Wanneer hebben burgers het, wanneer hebben ze het niet, en wanneer weten ze niet of de overheid te vertrouwen is?*, 2011.

2 BACKGROUND INFORMATION

This chapter contains a brief explanation of the workings of a nuclear power plant, its safety and of the international context within which supervision of the safety of nuclear power plants is designed and implemented. The causes and consequences of three nuclear accidents that occurred in recent decades are also described in this chapter. In addition, this chapter contains information about the nuclear power plants in the Netherlands, Belgium and Germany that are central to this investigation, and information about the concerns among the public regarding the safety of those plants. Finally, this chapter discusses incidents that have occurred at nuclear power plants, describing the way in which the severity of incidents is classified and the number of incidents that have occurred over the past decade at the four nuclear power plants that are the focus in this investigation.

2.1 Nuclear energy

2.1.1 Nuclear power plants

Nuclear energy is generated by nuclear fission. When atomic nuclei of (usually) uranium are split[11], a large amount of energy is released and converted into electricity. A nuclear power plant contains all of the facilities that are required to do this, including one or more reactors, storage facilities, cooling and conditioning circuits, pumps, valves, heat exchangers, turbines, generators, et cetera.[12] The energy that is released in a nuclear reactor during fission is used to heat water and convert it into steam. At the Borssele, Doel, Tihange and Emsland nuclear power plants this takes place in the nuclear part of the plant, see Figure 1. The steam is then used to drive a turbine which in turn powers an electricity generator to generate electricity. This takes place in the non-nuclear part of the plant.

11 This is a chain reaction that must be kept under control in the reactor. If it is not, heat production will continue unbridled, potentially resulting in a nuclear accident.

12 The Dutch Safety Board has chosen to use the generic terms *nuclear power plant* and *reactor* in this report. The nuclear power plant is the site containing one or more production units – sometimes also called trains or blocks – each of which generates heat from nuclear energy (such as Doel 1 to Doel 4 inclusive). The individual production units are called reactors in this report.

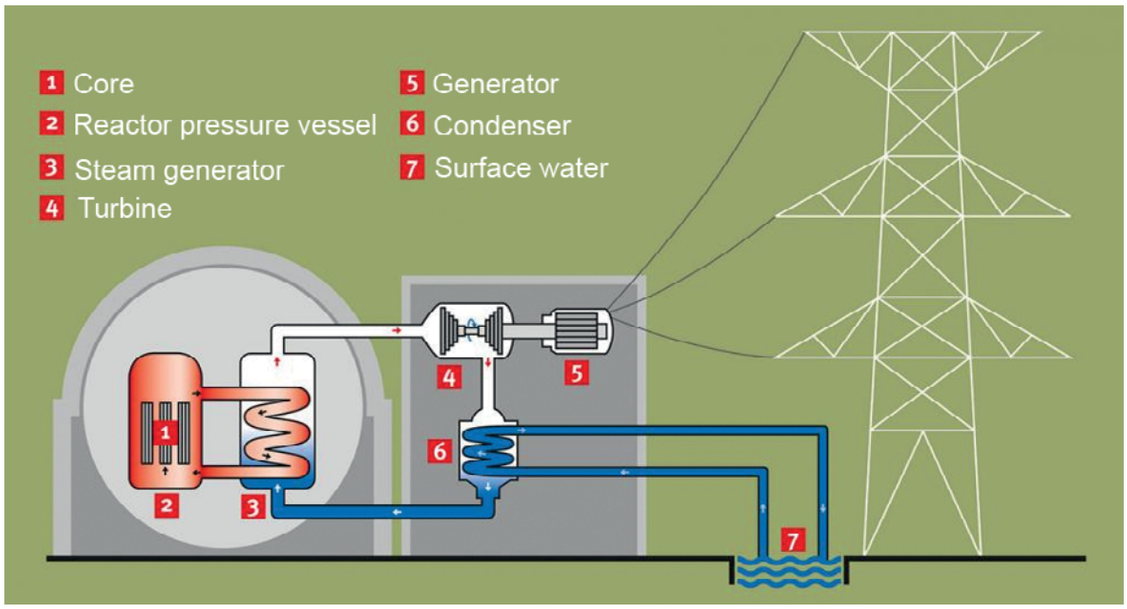


Figure 1: A schematic depiction of a pressurised water reactor, which can be recognised by the three water circuits. The nuclear part is inside the containment, the steel sphere that forms a barrier against emissions. The non-nuclear part is comparable with other types of power plants, such as coal and gas fired plants, and contains the turbine and the generator. (Source: EPZ)

The reactors in the Borssele, Doel, Tihange and Emsland nuclear power plants are all pressurised water reactors[13] with three successive cooling circuits.[14] Water from the Western Scheldt (Borssele and Doel), the Meuse (Tihange) and the Ems (Emsland) is used for cooling in the third cooling circuit. The reactors in the Chernobyl and Fukushima nuclear power plants, where nuclear accidents occurred in 1986 and 2011 respectively, were of a different type.[15]

The most significant safety risk to the environment is the release of a large amount of radioactive material. If this happens, a large area could be contaminated with radioactive materials and the public could be exposed to ionising radiation.[16] To minimise this risk, nuclear power plants must satisfy stringent safety requirements and a number of safety barriers are built into their design. For instance, the parts of the nuclear power plant where radioactive material can be present, are placed inside bunkered, concrete rooms. At the Borssele, Doel, Tihange and Emsland nuclear power plants, the fissile material and fission products are contained within fuel rods. The reactor core contains many of these

13 For more information about pressurised water reactors (including illustrations and pictures), go to https://nucleairnederland.nl/watergekoelde-reactoren.

14 The primary circuit cools the reactor and contains water contaminated by radiation. It passes on its heat through a separated (non-radioactive) secondary steam circuit, which in its turn is cooled by a separated tertiary circuit with river water or through a cooling tower. The radioactive primary circuit is contained in its entirety in the hermetically sealed casing (containment).

15 Water-cooled channel reactors were used in Chernobyl (*Reaktor Bolsjoj Mosjtsjnosty Kanalny*). They are graphite moderated and therefore lack an important safety principle, namely the dual function of water as moderator and coolant. RBMN reactors do have a lower power density though. The reactors used in Fukushima were of the type known as boiling water reactors after a design by General Electric. These reactors are water moderated and have two successive cooling circuits.

16 Ionising radiation is high-energy radiation that is released when radioactive substances decay, transforming the atomic nuclei into a more stable state (possibly in stages). Ionising radiation is commonly known as radioactive radiation.

rods, grouped in fuel elements. The reactor core is surrounded by a reactor vessel made from a special type of steel approximately 20 centimetres thick. The reactor vessel is enclosed in a containment building (sometimes known as the casing or containment) made of steel and concrete, often double-designed. Depending on the type of design, the containment building can be recognised by the dome at the top of the casing.

On 1 September 2017 a total of 448 nuclear reactors were in operation to generate electricity commercially in 30 countries worldwide.[17,18] France has the largest production capacity in Europe with 58 reactors. Only the United States, with 99, has more nuclear reactors. In several countries, nuclear power plants are under construction. According to the IAEA, China is frontrunner with 19 new power plants currently under construction. With a single nuclear power plant and a relatively small capacity, the Netherlands is among the countries with the smallest nuclear energy sector. Seven nuclear reactors are operational in Belgium, three in the Tihange nuclear power plant and four in the Doel nuclear power plant. In Germany, eight nuclear reactors are currently operational.

Figure 2 shows that the reactor of the Borssele nuclear power plant (which was commissioned in 1973) and the Doel 1, Doel 2 and Tihange 1 reactors (which were all commissioned in 1975) are among the world's older generations of reactors. The Emsland reactor is the most recently commissioned (1988) of those that are the focus of this investigation.

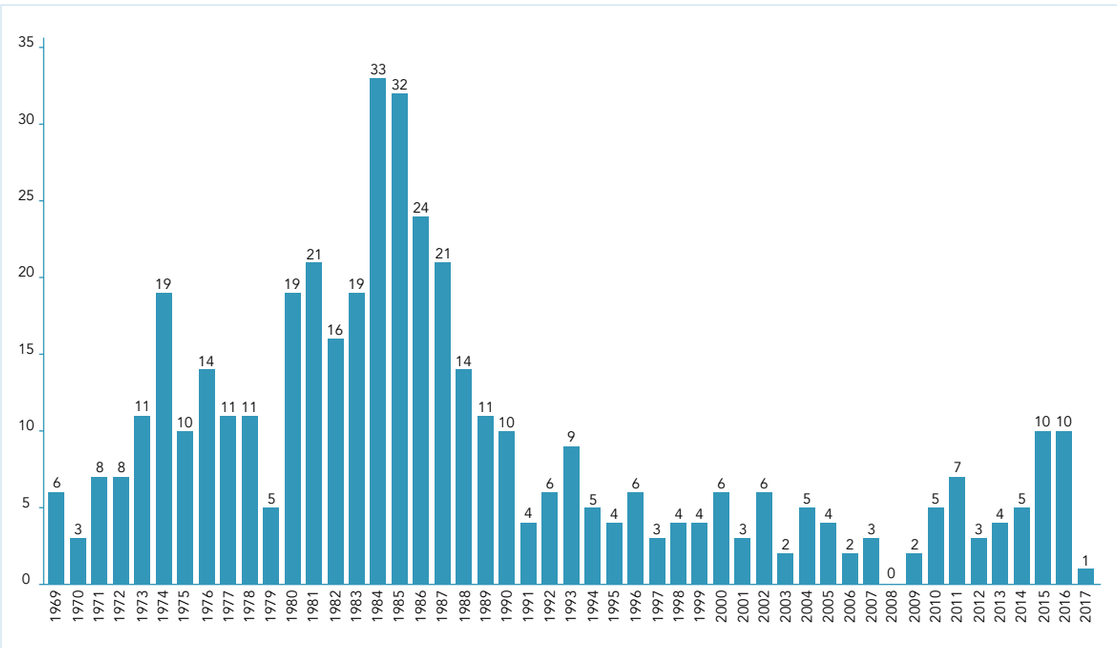


Figure 2: Overview of the years in which the nuclear reactors that in 2017 were operational in commercial electricity production worldwide, were commissioned.[19]

17 See: https://www.iaea.org/PRIS/WorldStatistics/OperationalByAge.aspx
18 Operational is understood to mean: connected to the electricity grid.
19 Data are derived from the IAEA's power reactor information system (database), available at www.iaea.org, accessed in September 2017.

2.1.2 International context

States make their own decisions on whether or not to generate electricity using nuclear energy. The responsibility for ensuring the safety and security of a nuclear power plant in a country rests with the State itself, but it is characterised by the international context within which countries implement that responsibility. Nuclear power plants are subject to national supervision and a comprehensive system of international control and review. The objective is to achieve a high level of safety worldwide. Two organisations play a vital role in this: the International Atomic Energy Agency (IAEA) and the European Atomic Energy Community (Euratom). They formulate principles and guidelines and arrange for the widespread exchange of knowledge and information.

International Atomic Energy Agency (IAEA)

Founded in 1957, the International Atomic Energy Agency is an autonomous organisation within the United Nations; 168 countries[20] are members, including the Netherlands, Belgium and Germany.[21] These countries are bound by the Convention on Nuclear Safety, which was concluded in Vienna in 1994 under the auspices of the IAEA and entered into force in 1996. At that time there was a need for a unifying international framework for countries with nuclear installations.[22] The Convention on Nuclear Safety and the further conventions to which it has given rise, set conditions and provide recommendations for the national system that member states set up to supervise nuclear safety. For instance, member states are obliged to have an independent authority to supervise safety which is functionally segregated from the authority responsible for energy policy. In addition, the member states are obliged to supply information to other member states and to have it assessed by them. Within this framework, member states must report on compliance with the convention every three years. The reports are discussed in peer review sessions during an international convention lasting two weeks.[23] The country reports for the 2017 convention were published in 2016.

All IAEA member states receive an IRRS (Integrated Regulatory Review Service) mission on request. EU member states are obliged to have an IRRS mission conducted every ten years pursuant to EU directives. During such mission the State's regulatory infrastructure for nuclear safety is evaluated and reviewed against IAEA standards. The mission is conducted by an international team of experts from across the globe.[24] There is a follow-up a couple of years after the mission in which the IAEA reviews the extent to which the country concerned has acted on the recommendations and suggestions. In the Netherlands a mission of this type was conducted in November 2014, with a planned follow-up in November 2018. In Belgium a mission was conducted in 2013 with a follow-up in November 2017, and Germany had a mission in September 2008 with a follow-up in September 2011.

20 According to information available from the IAEA, accessed in April 2017.
21 List of member states. Internet: www.iaea.org.
22 The Convention was created in response to problems associated with nuclear safety in the former Eastern Bloc countries, with the Chernobyl accident as an example of the consequences of these problems.
23 A country's report is reviewed by a group of other countries.
24 The EU and the IAEA have specified that at least one third of the team of experts must be from member states outside of the EU.

The IAEA has developed a comprehensive set of standards, known as the Safety Standards, that apply as the international benchmark for nuclear safety and are therefore highly directive. The nuclear regulatory authorities and operators are expected to apply these standards when performing their tasks.

Supplementary to the supervision exercised by the countries themselves, the IAEA gives countries access to international teams of experts who review the safeguards in place to guarantee the safety of a nuclear power plant or the effectiveness of the systems implemented in this respect. These missions are only conducted at the request of the country concerned. There are various types of missions, such as OSART[25] (Operational Safety Assessment Review Team), SALTO[26] (Safety Aspects of Long Term Operation) and EPREV[27] (Emergency Preparedness Review Service). The IAEA puts together the teams of experts and leads and coordinates the missions. Each team comprises experts from different States, with the addition of IAEA observers if necessary. The Netherlands, Belgium and Germany all make use of these expert missions. The IAEA compiles the good practices that emerge from the missions and makes them available to all member states.

European Atomic Energy Community (Euratom)
Within the EU, Euratom ensures a uniform, obligatory framework for nuclear safety. The European Council issues directives under Euratom which contain uniform safety standards. EU member states are bound to implement them. The IAEA and Euratom not only provide a framework to States for ensuring the safety of their nuclear power plants; they increasingly provide guidance to States on how to cooperate with neighbouring countries in doing so. For instance, Euratom[28] stipulates that the authorities in EU member states, if necessary, enter into a cooperation on nuclear safety with States in close proximity to their installations. Among other things, this cooperation comprises information sharing.

Other international collaborations
There are various international associations and cooperatives in which authorities share knowledge and develop guidelines, such as the European Nuclear Safety Regulators Group (ENSREG), the Heads of the European Radiological Protection Competent Authorities (HERCA), the Western European Nuclear Regulators Association (WENRA) and the Nuclear Energy Agency (NEA, part of the OECD). The Dutch, Belgian and German authorities have seats in these associations and cooperatives.

25 OSART missions focus on the operational safety and operational reliability of nuclear power plants. There was an OSART mission to the Doel nuclear power plant in March 2010, with a follow-up in March 2012. An OSART team visited Tihange in May 2007; the follow-up of that mission was in January 2009. Borssele nuclear power plant received an OSART mission in September 2014. The follow-up was in December 2016. Emsland nuclear power plant has not received an OSART mission in recent years.
26 The purpose of SALTO is to subject the Long Term Operation of a nuclear power plant to international review and to provide countries with advice on the safety aspects of Long Term Operation. There was a pre-SALTO mission to Tihange 1 in 2012, the SALTO mission was received in January 2015 and the follow-up was in December 2016. The SALTO mission to Doel 1 and Doel 2 was in February 2017. A SALTO mission visited Borssele in 2012. The follow-up was in February 2014.
27 The aim of EPREV missions is to review the extent to which member states are prepared to respond effectively to a nuclear or radiological accident. Up until now, there have been no EPREV missions to the Netherlands, Belgium and Germany.
28 Council Directive 2014/87/Euratom.

The operators of nuclear installations, including those of the Borssele, Doel, Tihange and Emsland nuclear power plants, have united in the World Association of Nuclear Operators (WANO). WANO is a not-for-profit organisation which aims to maximise the operational safety and reliability of commercial nuclear installations. WANO members are obliged to undergo international peer reviews within a WANO context and to follow up the recommendations from these reviews. These missions are intended to review safety and to identify good practices as well as problems which can then be shared within the sector.

The United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) is concerned with the effects of ionising radiation on humans and the environment; its aim is to investigate those effects and ensure they are well comprehended. This committee, comprising scientists from 27 countries, has published reports on the consequences of the Chernobyl nuclear accident in 1986 and the consequences of the Fukushima nuclear accident in 2011, among other things. Belgium and Germany participate in UNSCEAR. The Netherlands is not a member, but for many years now two Dutch experts have been members of the Belgian delegation in UNSCEAR.

2.2 Nuclear accidents

Nuclear power plant accidents with off-site consequences are rare. Over the last 40 years there have been a number of nuclear accidents of varying severity at civilian nuclear installations, including the accidents in Three Mile Island (United States, 1979, INES level 5), Chernobyl (former Soviet Union, 1986, INES level 7), Tokai-mura (Japan, 1999, INES level 4) and Fukushima (Japan, 2011, INES level 7).[29,30] This section describes the three most serious accidents at civilian nuclear plants in history, namely the Three Mile Island, Chernobyl and Fukushima accidents. The classification of the severity of the accidents using the INES scale is explained in section 2.4.1.

2.2.1 Three Mile Island

On 28 March 1979 there was a partial meltdown in the Three Mile Island (TMI-2) nuclear power plant in Dauphin County, Pennsylvania, United States. A fairly minor fault in the plant's secondary cooling circuit was the root cause of the accident. This fault caused the temperature of the primary cooling water to rise. As intended, the reactor shut down automatically through an emergency stop. Despite the shutdown, however, the reactor temperature continued to rise. The reactor could not be cooled sufficiently due to a defective safety valve in the cooling system. As a result of this, the reactor core was seriously damaged. The operators in the control room could not see the situation on the control panel and were unable to respond adequately to the unforeseen reactor shutdown.

29 In addition to these four accidents at civilian installations there have been incidents at nuclear installations with an uncontrolled emission of radioactive material, which are associated with nuclear weapons programmes, including the incidents in Mayak (former Soviet Union, 1957) and Windscale (United Kingdom, 1957).

30 UNSCEAR, *Sources and effects of ionizing radiation. UNSCEAR 2008, Report Volume II - Annex C: Radiation exposures in accidents*, 2011.

Insufficient instrumentation and too little training in emergency response proved to be contributory causes to the accident.[31]

The accident resulted in the release of a limited amount of radioactive noble gases from the nuclear reactor and a very limited amount of radioactive iodine. Despite the meltdown of the reactor core, the nuclear reactor's containment largely fulfilled its role and prevented worse. The health effects of exposure to radioactivity are probably limited.[32]

There was considerable economic damage to the installations on the site. After six years the reactor vessel could be opened; the damage appeared to be considerably greater than had been assumed. A large proportion of the reactor fuel was found on the floor of the vessel, molten and mixed with other materials. Cleaning of the reactor vessel was completed in 1993, 24 years after the accident. Demolition of the reactor vessel is envisaged in 2019.

2.2.2 Chernobyl

During the execution of a test on the night of 25 to 26 April 1986, the reactor of the V.I. Lenin Nuclear Power Plant, near Chernobyl in what is now Ukraine, entered an unstable condition after which the reactor overheated. Two large explosions followed[33], as a result of which the reactor building split open due to the lack of a concrete casing.

In addition, a fierce graphite fire started lasting several days. A large quantity of radioactive materials was released as a result of the accident and spread through the air. As a result, radioactive materials were being deposited in many countries in the world, mainly European countries, including the Netherlands, Belgium and Germany. Increased levels of radioactivity were first measured in Finland on 27 April and in Sweden one day later. On 29 April, over three days after the disaster, the press agency of the former Soviet Union ran a report on the Chernobyl accident.

The radioactive cloud reached the Netherlands, Belgium and Germany approximately one week after the disaster, on 2 May 1986. As a result of rainfall in the days subsequent to this, the radioactive material ended up on the soil and in the surface water, including the Rhine and Meuse rivers. There were significant local variations in the level of contamination as a result of different rain shower patterns, causing Germany to be more severely affected than the Netherlands and Belgium.[34] Spinach and other open-field leafy vegetables were contaminated, as was the milk from sheep and cows grazing outdoors.[35]

31 U.S. Government. *Report of The President's Commission on the Accident at Three Mile Island*, 1979 and US General Accounting Office. *Three Mile Island: The Most Studied Nuclear Accident in History*, 1980.
32 Hoge Gezondheidsraad België, *Nucleaire ongevallen, leefmilieu en gezondheid in het post-Fukushimatijdperk: Rampenplanning*, 2016.
33 The first explosion was a steam explosion, the second a chemical explosion resulting from the exothermic reaction with released hydrogen and carbon monoxide.
34 UNSCEAR, *Sources and effects of ionizing radiation. Annex D – Exposures from the Chernobyl accident*, 1988, p. 369.
35 Coördinatiecommissie voor de metingen van radioactiviteit en xenobiotische stoffen, *De radioactieve besmetting in Nederland ten gevolge van het kernreactor ongeval in Tsjernobyl*, 1986.

Deficiencies in the reactor design and in actions by personnel played an important role in the origin and development of the accident. The almost total lack of emergency plans meant that the parties involved on the spot could not adequately respond to the accident.[36] The disaster clearly illustrated how far-reaching the extent of a nuclear accident can be. An area covered by today's Ukraine, Belarus and parts of Russia suffered the greatest contamination by radioactivity and exposure to ionising radiation. Up until the present day, more than 30 years after the disaster, there has been a 30-kilometre habitation exclusion zone around the nuclear power plant. In November 2016 the destroyed reactor of the Chernobyl nuclear power plant was covered by a steel arch to fence it off.

Nuclear power plant Chernobyl

Figure 3: Photograph of the Chernobyl nuclear power plant in 2017, which shows the steel arch that covers the destroyed reactor. (Source: Dutch Safety Board)

Among the fire fighters and rescue workers, 134 were diagnosed with radiation sickness and 28 people died of this within four months after the accident. These emergency workers could incur radiation sickness because they were insufficiently trained and equipped to protect themselves against the radiation to which they were exposed.

36 Hoge Gezondheidsraad België, *Nucleaire ongevallen, leefmilieu en gezondheid in het post-Fukushimatijdperk: Rampenplanning*, 2016.

A large number of recovery workers[37] were exposed to high doses of radiation, usually in a relatively short period of time (an estimated average of 120 millisieverts[38]).[39] This group appears to be at a greater risk of developing leukaemia and cataracts and possibly cardiovascular disorders too. In the months immediately following the disaster, the population was exposed to radioactive iodine through inhalation and the ingestion of contaminated food, such as milk. Among the population no one contracted radiation sickness. It has been demonstrated that a significant proportion of over 6000 recorded cases of thyroid cancer in children in the area surrounding the nuclear power plant were caused by exposure to radioactive iodine. For other health disorders it could not be established if these occur more frequently in the population that was exposed to the radiation. UNSCEAR has decided not to use models to determine the total number of casualties exposed to low levels of radiation because the uncertainties in the numbers anticipated are too high.[40]

It took a while before it emerged that the nuclear accident also had significant psychological effects on the population. The evacuation of residents from the immediate vicinity of the plant started on 27 April 1986, a day and half after the accident. In total, 135,000 residents were evacuated from the vicinity of the nuclear power plant. The evacuated people had to build new lives far from home without any prospect of returning.

Immediately after the Chernobyl disaster there were successful international negotiations on conventions in the field of reporting nuclear and radiological accidents[41] and providing assistance.[42] In the Netherlands, the accident resulted in plans for new nuclear power plants being shelved, among other things. Steps were taken to improve the safety of the Borssele nuclear power plant and to enhance preparations for a nuclear accident.

The Chernobyl accident is the most severe nuclear accident in history to date.

2.2.3 Fukushima Dai-ichi accident

On 11 March 2011 a nuclear accident happened at the Fukushima Dai-ichi nuclear power plant in Japan. This accident was caused by a severe seaquake[43] and a tsunami that hit the east coast of Japan. The seaquake led to the immediate automatic shutdown of the reactors of the nuclear power plant that were operational at that time. The electricity grid in the areas surrounding the nuclear power plant also failed. The cooling system for the

37 This comprises approximately 530,000 individuals over the period 1986–2005. During the initial phase following the accident in particular, the radiation level was so high that employees could only be in the contaminated area for a short period of time. As a result of the short time frame, it was necessary to employ a large number of people one after the other for rescue and repair work.

38 Sievert is a unit used to express the amount of effective radiation absorbed by a human body. For comparison: the maximum permitted average annual dose for a qualified radiographer over a period of five years is 20 millisieverts.

39 UNSCEAR, *Sources and effects of ionizing radiation. UNSCEAR 2008 Report Volume II - Scientific Annex D: Health effects due to radiation from the Chernobyl accident*, 2011.

40 idem.

41 IAEA, *Convention on Early Notification of a Nuclear Accident*, effective date 27 October 1986.

42 IAEA, *Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency*, effective date 26 February 1987.

43 The seaquake had a magnitude of 9.0 on the Richter scale, the highest value ever recorded in Japan. While the height of the tsunami that battered the coast of the stricken nuclear power plant in Fukushima Dai-ichi was exceptional, higher tsunamis had been experienced in Japan before that time.

nuclear reactors was kept working using emergency diesel generators. However, when the nuclear power plant was hit by a tsunami around 45 minutes later, all emergency power supplies were flooded. As a result, they broke down and the cooling system failed. Three reactors overheated, there were a number of hydrogen explosions and radioactive materials were released. The radioactivity released is estimated by the International Atomic Energy Agency (IAEA) to be one tenth of that released at the Chernobyl accident.[44] The nuclear power plant was not designed for a natural disaster of this magnitude.[45]

Nobody died or became ill as a direct result of radiation sickness in the Fukushima accident.[46] Of the employees who were exposed to radiation, 173 received a high dose (more than 100 millisieverts).[47] They have an increased risk of cancer. Exposure of local residents to radiation was limited as a result of the rapid evacuation and because the wind was offshore in the critical periods of the accident. The radiation-related health effects are not expected to be statistically distinguishable.[48] However, there is some uncertainty about the number of children that were exposed to a high dose of radiation. The health of the population in the areas surrounding the nuclear power plant (over two million people) has been monitored since June 2011. Over 50 people died as a consequence of the rapid evacuation during the first days, mainly patients from care institutions who could not be properly cared for during transport or at the reception location. In addition, people died as a result of stress, fatigue, deprivations and depression.[49] According to estimations, this accounted for more than 1000 fatalities.[50]

People in a 20-kilometre zone around the nuclear power plant (78,000 residents) were forced to leave the area in the days of and following the accident. In addition, based on measurements in the period April–June, evacuation was extended in the north-west direction up to a distance of 40 kilometres from the nuclear power plant. Areas indicated as hot spots, up to a 50 kilometre distance from the nuclear power plant, were subject to evacuation as well. Contamination of these zones involves health risks. Together, these areas form the exclusion zone. A number of areas of the exclusion zone have been released since 2014.

The accident in Japan once again placed the safety of nuclear power plants on the agenda across the globe. In May 2011, the European Council announced that the safety of European nuclear power plants was to be reviewed based on a comprehensive and

44 IAEA, *The Fukushima Dai-ichi Accident; Report by the Director General*, 2015
45 The Fukushima Dai-ni nuclear power plant lying approximately 12 kilometres to the south, with four more recent units, emerged from the incident virtually undamaged, which attests to the importance of a suitable design. Crucial shortcomings in Dai-ichi lay in the fact that all emergency power generators could be affected at the same time, they were not set up separately (bunkered) and there were no hydrogen recombiners.
46 The earthquake and the tsunami in particular together resulted in over 18,000 fatalities (almost 16,000 identified victims and 2,500 missing).
47 UNSCEAR. *Sources and effects of ionizing radiation. UNSCEAR 2013 Report Volume I - Scientific Annex A: Levels and effects of radiation exposure due to the nuclear accident after the 2011 great east-Japan earthquake and tsunami*, 2014.
48 Which is not to say that no such effects will occur.
49 UNSCEAR. *Sources and effects of ionizing radiation. UNSCEAR 2013 Report Volume I - Scientific Annex A: Levels and effects of radiation exposure due to the nuclear accident after the 2011 great east-Japan earthquake and tsunami*, 2014.
50 World Nuclear Association, *Fukushima accident*, website: http://www.world-nuclear.org/information-library/safety-and-security/safety-of-plants/fukushima-accident.aspx, 2017.

transparent risk assessment: the stress test. The objective was to assess if nuclear power plants were able to withstand extreme natural occurrences, such as earthquakes, floods, extreme weather conditions and combinations of these. A common review method was established within a European context.[51] The national reports with the results of the stress tests for the European nuclear power plants were published in 2012 and subjected to an international peer review. The results led to a programme to improve the safety of nuclear power plants, among others in the Netherlands[52], Belgium and Germany. The lessons from the Fukushima accident also gave rise to various amendments to the Euratom directive on several topics such as increased transparency on safety issues.

2.3 Nuclear power plants in the Netherlands, Belgium and Germany

2.3.1 Nuclear energy policy in the Netherlands, Belgium and Germany

Current policy in the Netherlands, Belgium and Germany focuses on closing the nuclear power plants that are in operation within specified deadlines.

The Netherlands has a single nuclear power plant in operation: the Borssele nuclear power plant. Dutch legislation stipulates that the Borssele plant will close no later than 31 December 2033. Not so very long ago, the Netherlands was actually planning to expand its production capacity for nuclear energy. The transition to energy production with neither water nor air emissions and the desire to become less dependent on foreign energy suppliers were reasons for the Dutch government to strive for more nuclear energy at the time.[53] There have been two initiatives for the establishment of a second and third nuclear power plant in Zeeland. The plans were shelved in 2012 partly due to the unfavourable investment climate[54] and for commercial reasons. The current policy of the Dutch government does not focus on expanding the production capacity for nuclear energy.[55] In the Netherlands, 3.4 % of electricity production is generated by the Borssele nuclear power plant.[56] This proportion is low compared with other producing countries.[57] The percentage of imported electricity generated by foreign nuclear power plants is also low (less than 5%).

Belgium intends to close its nuclear power plants at the end of 2025. Originally, the exploitation period of the Belgian nuclear power plants was unlimited. This changed on 31 January 2003 with the adoption of an Act on the gradual withdrawal from nuclear energy (*Wet op de kernuitstap*).[58] This Act included a time frame for phasing out the use of nuclear energy for industrial electricity production. It provided for a ban on the establishment of new nuclear reactors and stipulated that production from the existing

51 European Nuclear Safety Regulators Group (ENSREG).
52 Ministerie van Economische Zaken, Landbouw en Innovatie, *Nationaal rapport over de post-Fukushima stress-test. Toelichting, belangrijkste bevindingen en conclusies*, 2012.
53 Coalition agreement of the Netherlands 2010.
54 House of Representatives (*Tweede Kamer*), 2012–2013, 32645, No. 35.
55 Ministerie van Economische Zaken, *Energierapport. Transitie naar duurzaam*, 2016.
56 According to figures from the IAEA's power reactor information system (database) available at www.iaea.org, accessed in July 2017.
57 For comparison: in France nuclear power plants accounted for 72.3% of electricity production in 2016. France has the most nuclear power plants in operation in Europe.
58 *Wet houdende de geleidelijke uitstap uit kernenergie voor industriële elektriciteitsproductie.*

reactors needed to cease 40 years after they were commissioned. A good six years later, on 22 October 2009, the then Belgian government and GDF SUEZ signed an agreement in which the three oldest reactors would be granted a service life of 50 years in exchange for taxing the profits from their electricity production.[59] As a result of the fall of the Belgian federal government at the time, this agreement, which required a change in legislation, was not implemented. However, the Act was amended in 2013 and stipulated that Tihange 1 could remain operational until 2025 and Doel 1 and 2 until 2015. Soon after, the Act was amended once again, in July 2015. According to the latest amendments, the three oldest reactors can remain operational for 50 years, with an envisaged closure date of 2025. The Belgian federal government decided to keep Doel 1 and 2 and Tihange 1 open longer with a view to secure the energy supply. In Belgium, nuclear energy represents a considerably larger proportion of electricity production than it does in the Netherlands. The share of nuclear energy in electricity production was 51.7% in 2016.[60]

German nuclear policy has changed a number of times in recent years. In 2000, the German government reached an agreement in principle to close nuclear power plants in the long term: the *Atomausstieg*. In 2010, the then government reversed this decision: it decided that the nuclear power plants would have to be kept open at least until 2035. Partly as a result of the Fukushima accident and under pressure from public opinion, Germany decided in 2011 to gradually phase out the production of nuclear energy. At the time eight reactors were closed immediately; initially temporarily but later permanently. One more followed in 2015.[61] The latest closing date for the remaining nuclear power plants, including the Emsland nuclear power plant, was set at 31 December 2022. Of the electricity produced in Germany in 2016, 13.1% was generated by the nuclear power plants still in operation.[62]

Table 1 contains an overview of the year commissioned, the year envisaged for closure and the capacity of the reactors of the four nuclear power plants. Of these four plants, the Borssele nuclear power plant is the oldest and, according to current planning, it will remain in operation the longest.

59 This concerns the nuclear interest, which is the difference between what is effectively paid to the nuclear power producers and what would have to be paid in return for their willingness to keep electricity production at its current level.

60 According to figures from the IAEA's power reactor information system (database) available at www.iaea.org, accessed in July 2017.

61 Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety, *Convention on Nuclear Safety, Report by the Government of the Federal Republic of Germany for the Seventh Review Meeting in March/ April 2017*, 2016.

62 Based on data from the IAEA's power reactor information system (database) available at www.iaea.org, accessed in July 2017.

Country	Reactor	Year commissioned	Year envisaged for closure	Current electricity capacity in Megawatts
The Netherlands	Borssele	1973	2033	485 MW
Belgium	Doel 1	1975	2025	433 MW
	Doel 2	1975	2025	433 MW
	Doel 3	1982	2022	1006 MW
	Doel 4	1985	2025	1033 MW
	Tihange 1	1975	2025	962 MW
	Tihange 2	1983	2023	1008 MW
	Tihange 3	1985	2025	1038 MW
Germany	Emsland	1988	2022	1400 MW

Table 1: Reactors of the Borssele, Doel, Tihange and Emsland nuclear power plants.

2.3.2 Borssele nuclear power plant

The Borssele nuclear power plant was commissioned in 1973 to increase the production capacity for nuclear energy in the Netherlands at the time.[63] The Borssele nuclear power plant is in the Zeeland municipality of Borsele that lies on the Western Scheldt, 16 kilometres from the Belgian border. The plant has a single reactor.

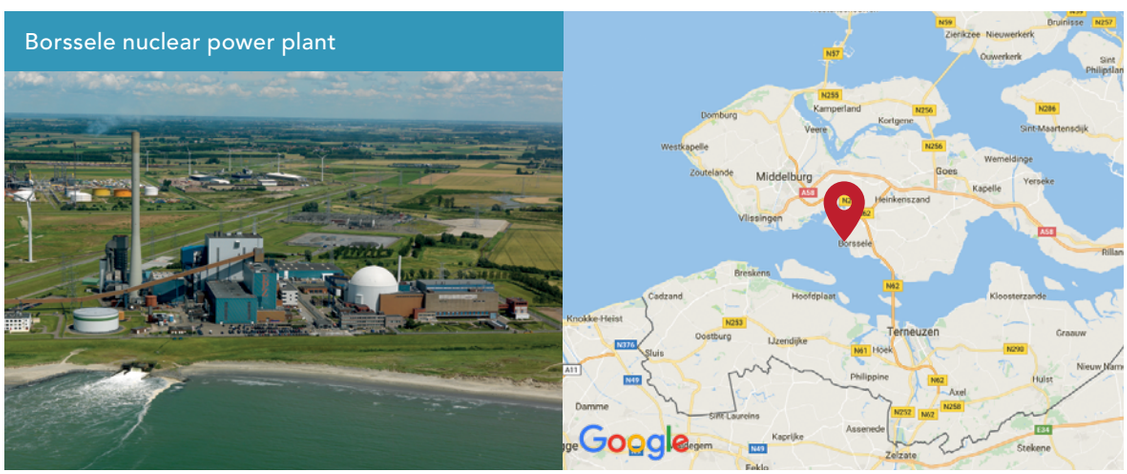


Figure 4: Borssele nuclear power plant. (Source left photograph: EPZ)

In 2006 the Dutch central government, operator EPZ and owners Essent and Delta signed the Borssele Nuclear Power Plant Covenant (*Convenant Kerncentrale Borssele*) with the aim of continuing the service life of the nuclear power plant until 31 December 2033 at the latest under specific conditions. One of the conditions in the covenant is that the operator, EPZ, must ensure that the nuclear power plant remains one of the 25% safest water-cooled and water-modified reactors in the European Union, the United States and Canada.[64] This is supervised by an independent Benchmark Committee.[65] The first and most recent report from this committee was published in 2013.[66]

63 The Netherlands started generating nuclear energy commercially with the opening of the Dodewaard nuclear power plant in 1969.
64 *Convenant Kerncentrale Borssele,* Staatscourant 17 July 2006, No 136.
65 The members of the committee come from the Netherlands, Canada, Germany and Austria.
66 Borssele Benchmark Committee, *The safety of Borssele nuclear power station. First report of the Borssele Benchmark Committee,* 2013.

2.3.3 Doel and Tihange nuclear power plants

Belgium has two locations for producing nuclear energy: the Doel and Tihange nuclear power plants, which have four and three reactors respectively. The Doel nuclear power plant is in the Flemish municipality of Beveren, 2.8 kilometres from the Dutch border. It is located in a densely populated area. The city of Antwerp with over half a million residents is approximately 20 kilometres away. The closest Dutch cities are Bergen op Zoom with over 60,000 residents (at 20 kilometres), Roosendaal with almost 80,000 residents (at 30 kilometres) and Terneuzen with 25,000 residents (at 30 kilometres). There are four reactors on the nuclear power plant site: Doel 1, Doel 2, Doel 3 and Doel 4. Doel 1 and Doel 2 were commissioned in 1975, Doel 3 in 1982 and Doel 4 was commissioned in 1985. Closure is envisaged in 2022 (Doel 3) and in 2025 (Doel 1, 2 and 4).

Doel nuclear power plant

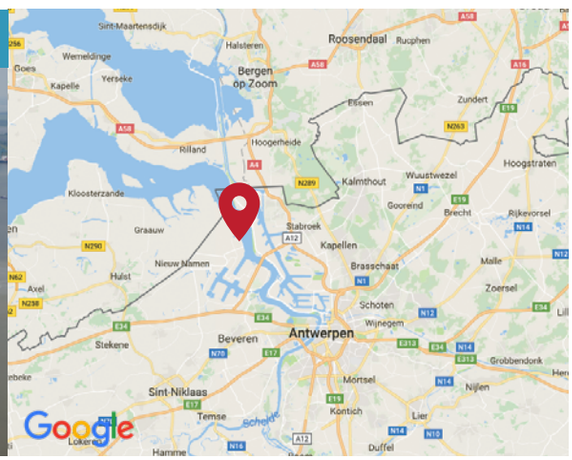


Figure 5: Doel nuclear power plant. (Source left photograph: Electrabel)

The Tihange nuclear power plant is in Wallonia, in the municipality of Huy, on the river Meuse at a distance of 38 kilometres from the Dutch border. Large cities such as Liège with nearly 200,000 residents and Namur with over 110,000 residents are within a 40-kilometre radius of the nuclear power plant. The three reactors of the plant – Tihange 1, Tihange 2 and Tihange 3 – were commissioned in 1975, 1983 and 1985 respectively. Closure is envisaged in 2023 (Tihange 2) and 2025 (Tihange 1 and 3).

Tihange nuclear power plant

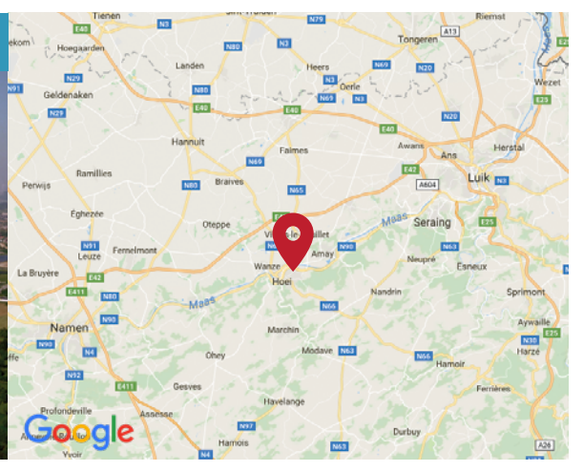


Figure 6: Tihange nuclear power plant. (Source left photograph: Electrabel)

2.3.4 Emsland nuclear power plant

Of the seven operational nuclear power plants in Germany, one is located in an area of Lower Saxony bordering the Netherlands. This is the Emsland nuclear power plant in Lingen, situated at a distance of 20 kilometres from the Dutch border. The plant is operated by Kernkraftwerke Lippe-Ems and is owned by the RWE energy company. The nuclear power plant, which has a single reactor, was commissioned in 1988 and will remain operational up to and including 2022. The area is less densely populated than the areas around the Belgian nuclear power plants. The city of Lingen is approximately 5 kilometres away and has over 50,000 residents. There are no other major cities in Germany close to the power plant. The nearest Dutch towns are Denekamp (24 kilometres, 9000 residents), Oldenzaal (32 kilometres, 32,000 residents) and Enschede (33 kilometres, 160,000 residents).

Figure 7: Emsland nuclear power plant. (Source left photograph: Kernkraftwerke Lippe-Ems)

2.3.5 Concerns about the safety of nuclear power plants

The nuclear accidents described in section 2.2 of this investigation report make it clear that such accidents cannot totally be ruled out and therefore have a negative effect on public perception of the safety of nuclear power plants. A survey among Dutch citizens[67] in 2016 conducted by the National Institute for Public Health and the Environment (*Rijksinstituut voor Volksgezondheid en Milieu - RIVM*) reveals that almost half of the respondents is quite or seriously concerned about the dangers of nuclear power plants in the Netherlands and the rest of Europe. 89% of the respondents believes that there is high health risk in the event of a nuclear accident. At the same time, more than half of the respondents thinks that the risk of a nuclear accident in the Netherlands is very small and almost half of the respondents thinks that the safety measures in the Dutch, German and Belgian nuclear power plants are satisfactory.

A survey conducted by the Authority for Nuclear Safety and Radiation Protection (*Autoriteit Nucleaire Veiligheid en Stralingsbescherming - ANVS*) among Dutch citizens at the start of 2017 presents broadly the same picture. The survey reveals that approximately half of the respondents has concerns about the radiation that is released producing nuclear energy. The ANVS survey, unlike the RIVM survey, specifically asked the

67 RIVM, *Risicocommunicatie over stralingsongevallen en de verspreiding van jodiumtabletten*, 2016.

respondents about their level of confidence in nuclear safety in each of the three countries: the Netherlands, Belgium and Germany. The results of the survey show that the Dutch citizens have more confidence in nuclear safety in the Netherlands and Germany than in nuclear safety in Belgium. In fact, 41% of the respondents believes that nuclear safety in Belgium is not as it should be. With respect to nuclear safety in the Netherlands and in Germany the percentages are much lower; 16 and 14% of the respondents respectively believes it is not as it should be.

The Belgian Nuclear Research Centre (*Belgisch Studiecentrum voor Kernenergie* - SCK•CEN) regularly conducts surveys of public opinion on nuclear energy.[68] Those surveys have revealed that in 2009 44% of respondents believed that the advantages of nuclear energy outweighed the disadvantages. After the Fukushima nuclear accident that proportion fell to 30% and then rose again to 38% in 2013.[69] In 2011 there was a survey of public opinion in Belgium on the safety of nuclear power plants after the Fukushima nuclear accident.[70] It revealed that – as a result of the accident in Japan – 49% of the respondents had concerns about the safety of Belgian nuclear installations. 31% of the respondents indicated that since the accident in Japan they feel the need to explore how they can protect themselves in the event of a nuclear accident. The researchers concluded that, surprisingly, not everyone who had concerns about the safety of nuclear installations was interested in information about protective measures.

2.4 Incidents at nuclear power plants

As with all industrial installations, failures can occur in the operations of a nuclear power plant. Depending on their nature, such unusual events can relate to nuclear safety.

2.4.1 International classification of incidents

Across the world, the International Nuclear and Radiological Event Scale, abbreviated to INES, which was developed by the International Atomic Energy Agency (IAEA), is used to classify the severity of incidents concerning nuclear safety. The INES-classification is intended to allow countries to communicate the severity of events to the public in a uniform manner.[71] INES classifies events from level 1 up to and including level 7 where level 1 indicates an anomaly and level 7 is a major accident with severe consequences, like the Chernobyl accident.

68 http://science.sckcen.be/en/Institutes/EHS/SPS/STS/Risk_perception/Barometer

69 Turcanu, C., en Perko, T., *The SCK•CEN Barometer 2013, Perceptions and attitudes towards nuclear technologies in the Belgian population*, 2014.

70 Perko, T., *Modelling Risk Perception and Risk Communication in Nuclear Emergency Management: An Interdisciplinary Approach*, Universiteit Antwerpen, 2012, p. 136-138.

71 The INES-classification is expressly intended as a tool for informing the public in a consistent way; the organisations involved use their own different systems and terminology to inform each other of anomalies compared with normal operations.

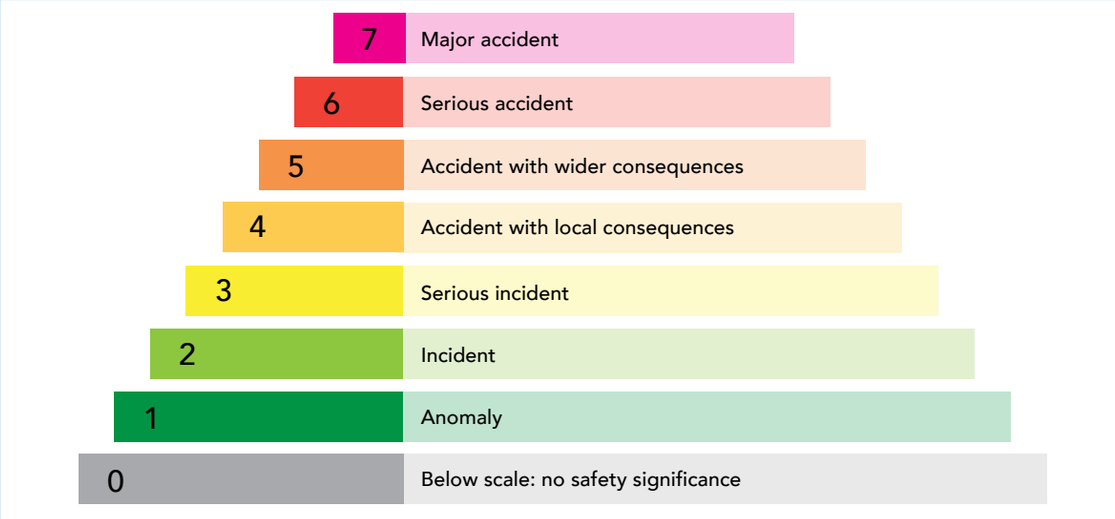


Figure 8: Classification of possible events at a nuclear power plant according to the INES- classification.

INES-classifications level 1 to level 7 only concern events that relate to nuclear safety. In addition, incidents can occur that do relate to nuclear safety but have (almost) no effect on it and do not satisfy the criteria for an INES-classification. The Dutch, Belgian and German nuclear regulatory authorities classify these incidents as INES level 0 or 'below scale'. It is important to know that events below INES level 3 do not have safety consequences for the surrounding area of the nuclear power plant because there are multiple safety barriers that prevent any release of radioactivity outside the nuclear power plant.[72] Appendix G includes examples of incidents and accidents with the corresponding INES levels.

2.4.2 Incidents at the Borssele, Doel, Tihange and Emsland nuclear power plants

Shutdowns

Switching off a nuclear power plant is known as a shutdown. In the case of a shutdown, the energy production is reduced to zero by inhibiting and eventually halting the nuclear fission process. A reactor can be shut down manually or automatically. This happens if the safety systems record deviating measurements or if other anomalies are detected. These could relate to the nuclear part as well as to the non-nuclear part of the nuclear power plant. Shutdowns are not always for safety reasons. For example, the steam turbine that is used to generate electricity may not be functioning optimally or there may be problems in other systems, not related to safety. The reactor can be shut down manually if employees detect unexpected anomalies which they consider significant enough to shut down the reactor. Most reactors undergo a fuel change once each year together with a (major) servicing of the reactors, requiring them to be shut down. This is a planned shutdown.

72 IAEA, *The International Nuclear and Radiological Event Scale User's Manual; 2008 Edition*, 2008.

An overview of the number of unplanned shutdowns in the period from 2007 up to and including 2016 has been created for the four nuclear power plants covered in this investigation (see Figure 9). It is important to note that the criteria for a shutdown can differ from reactor to reactor[73] and that some reactors were put out of operation for a protracted period.[74] Many shutdowns are classified as INES level 0. Planned shutdowns, for example due to scheduled maintenance, are not included in Figure 9.

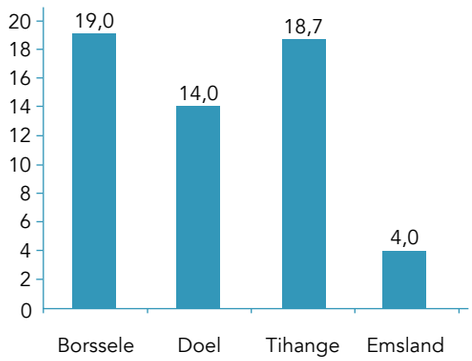


Figure 9: Unscheduled shutdowns (manual and automatic) of the Borssele, Doel, Tihange and Emsland nuclear power plants. The figure shows the average number of shutdowns per reactor in the period from 2007 up to and including 2016. The periods in which a reactor was not operational have not been taken into account in this figure. A more detailed overview can be found in Appendix G.

INES reports

The IAEA points out that the INES classification cannot be used to compare the safety performance of one nuclear power plant with that of another. Mutual comparison of the number of incidents is particularly difficult below INES level 2. The Dutch Safety Board has nevertheless chosen to show the number of INES reports, because the number of incidents can have an effect on public perception of the safety of nuclear power plants.

Figure 10 shows the incidents at the Borssele, Doel, Tihange and Emsland nuclear power plants that are classified as INES level 1 or higher. The figure covers the years 2007 up to and including 2016.[75] There were no incidents above INES level 2 at the four nuclear power plants in that period. This means that over the last decade there have been no events presenting a radiological hazard to the surrounding area at any of the nuclear power plants. Of the total of 89 incidents reported, one has been classified as INES level 2 in the decade concerned. That incident occurred at reactor Doel 4 in 2011 and is described in the text box.

73 The differences in the criteria used depend on, among other things, differences in reactor design.
74 The operators agree that restarting a reactor that has been idle for a protracted period can cause more faults, resulting in shutdowns.
75 For the year 2016 the INES level known at the time of writing this report, was used (either the provisional INES level or the definitive INES level). For some incidents the definitive INES level had not yet been determined. Any differences due to the determination of the definitive INES level are expected to be minimal.

INES level 2 incident at reactor Doel 4 (18 March 2011)

A number of pumps at the reactor Doel 4 were ready to supply water to the steam generators in the event of normal feed water being unavailable. During a check, it turned out that one of the pumps in the auxiliary water circuit would not supply sufficient water in certain emergency situations. The necessary corrective actions were taken to resolve this. This incident was classified as INES level 2. The incident had no consequences for the health of the employees and nearby residents and no consequences for the surrounding area of the nuclear power plant.

The majority of the incidents that occurred over the past decade at the Borssele, Doel, Tihange and Emsland nuclear power plants were classified as INES level 0. These incidents are not included in the overview presented in Figure 10 because the INES level 0 is not an internationally agreed INES level. The figure shows that no incidents at the Emsland nuclear power plant were classified higher than INES level 0.

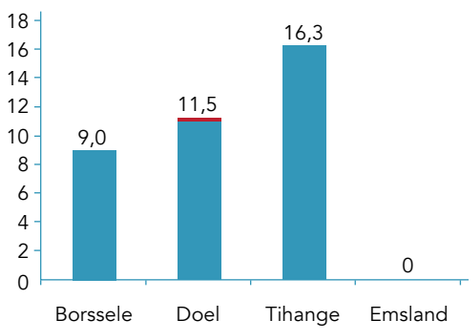


Figure 10: Incidents classified as INES level 1 (blue) or INES level 2 (red) at the Borssele, Doel, Tihange and Emsland nuclear power plants. The figure shows the average number of INES reports per reactor in the period from 2007 up to and including 2016. The periods in which a reactor was not operational have not been taken into account in this figure. A more detailed overview can be found in Appendix G.

In order to place the number of incidents at the Dutch, Belgian and German nuclear power plants into a broader, international perspective, the Dutch Safety Board has also listed the data for INES reports at nuclear power plants in a number of other European countries. Figure 11 shows the average number of incidents per reactor classified as INES level 1 or higher, that occurred in the period from 2007 up to and including 2016.

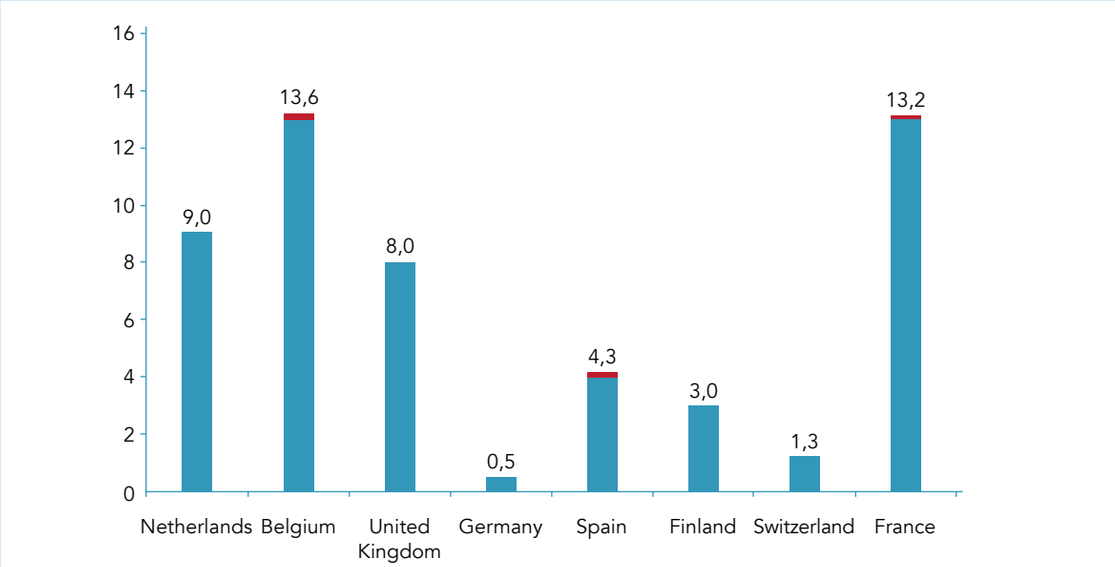


Figure 11: Incidents classified as INES level 1 (blue) or level 2 (red) in various European countries. This figure shows the average number of incidents reported per reactor over the last decade, that occurred at pressurised water reactors in the respective countries. The periods in which a reactor was not operational have not been taken into account in this figure. The specific reactors for which data are included are presented in Appendix G.

None of the nuclear power plants for which data are included in the figure suffered an incident classified higher than INES level 2. The figure shows significant differences between countries. The Dutch Safety Board has not been able to find a definitive explanation for these differences. Various factors could play a role. As a result of differences in the design of the reactors and differences in the way in which countries assess the INES level[76], the same incident at one reactor can be classified as INES level 1 while it can be classified as INES level 0 at another. This is a known phenomenon. On top of this, the designs of newer plants, such as the design of the Emsland nuclear power plant, have more back-up systems to compensate for disruptions in the electricity supply than the designs of older plants, such as the design of the Borssele nuclear power plant.

Figures 9 and 10 show that there are differences between the Borssele, Doel, Tihange and Emsland nuclear power plants in the number of shutdowns and the number of incidents. For the reasons as explained above, no conclusions can be drawn from differences between the nuclear power plants. However, it is clear there has been no

76 The criteria for the classification of events in accordance with the INES-classification are the same for each country. Despite this, mutual differences can arise in the precise classification. The classification method is, after all, complex due to the large number of criteria and factors that have to be taken into account. As a result of this complexity and due to differences between locations and installations, countries will not make precisely the same assessment of the severity of events. Appendix G contains further clarification of the classification method.

increase in the number of incidents and shutdowns that have occurred at the Borssele, Doel, Tihange and Emsland nuclear power plants over the last ten years (see Appendix G). In absolute figures, the number of shutdowns and incidents is much higher for the Belgian nuclear power plants than for the Borssele and Emsland nuclear power plants as a logical consequence of the fact that the Belgian plants have seven reactors while both the Dutch and German plants only have a single reactor each. The consequences of this is that more reports of incidents at the Belgian nuclear power plants appear in the Dutch media than reports of incidents at the Borssele and the Emsland nuclear power plants. This could have contributed to the public perception that Belgian nuclear power plants are not as safe as the Borssele and Emsland nuclear power plants.

3 LICENSING AND SUPERVISION

States are free to decide whether to allow the production of nuclear energy within their territory. Ensuring the safety of nuclear power plants is only a State´s responsibility.[77] However, this autonomy does not entirely exclude other countries to be involved. In order to attain maximum safety levels, international coordination is indispensable.[78] With this in mind, countries with nuclear installations are expected to be open and transparent towards each other, share knowledge and experience and cooperate to improve safety. Cooperation and information sharing become even more important if decisions on a nuclear power plant near a border can have an impact on its surrounding countries.

This chapter describes the extent to which the Netherlands and Belgium, and the Netherlands and Germany, involve each other in their duties to ensure the safety of their nuclear power plants. It devotes attention to both the supervision of the safety of nuclear power plants and the licensing with regard to their operation. "Involvement" is defined in its broadest sense; this means the way countries exchange information and allow each other the opportunity to express any concerns and to be heard.

3.1 Licensing and supervision system

3.1.1 Netherlands, Belgium and Germany

States set up their own national systems for nuclear licensing and supervision within the international system described in chapter 2.

In the Netherlands, the government's duty to supervise the safety of the Borssele nuclear power plant has been assigned to the Authority for Nuclear Safety and Radiation Protection (*Autoriteit Nucleaire Veiligheid en Stralingsbescherming* - ANVS). This authority was established on 1 January 2015. As of 1 August 2017, it is an autonomous administrative body[79] that falls under the responsibility of the Minister of Infrastructure and the Environment (*minister van Infrastructuur en Milieu*).[80] In Belgium, the Federal Agency for Nuclear Control (*Federaal Agentschap voor Nucleaire Controle* - FANC) supervises the safety of Belgium's nuclear power plants. The FANC is a federal public agency that falls under the responsibility of the Minister of Security and the Interior (*minister van Veiligheid en Binnenlandse Zaken*). With regard to its supervisory duties, the FANC relies on the expertise of its technical subsidiary Bel V. In Germany, policymaking and legislation with regard to nuclear safety and radiation protection are

77 The Euratom Convention and Euratom's nuclear safety directives stipulate that nuclear safety is the responsibility of individual member states.
78 IAEA, *Convention on nuclear safety*, effective date 24 October 1996.
79 The ANVS' status as an autonomous administrative body was enshrined in the Nuclear Energy Act by the Decree of 6 July 2017, which entered into force on 1 August 2017.
80 As of October 2017, the ANVS falls under the responsibility of the State Secretary for Infrastructure and Water Management.

the responsibility of the Federal Minister for the Environment, Nature Conservation, Building and Nuclear Safety (*Bundesminister für Umwelt, Naturschutz, Bau und Reaktorsicherheit* - BMUB).[81] In Germany, the execution of policy and legislation is assigned to the Länder; the designated authorities of the Länder are responsible for nuclear licensing and supervision of the nuclear installations, including nuclear power plants, on their territory. The Emsland nuclear power plant is located in Lower Saxony. Within Lower Saxony, the Lower Saxony Ministry of the Environment, Energy and Climate Protection (*Niedersächsisches Ministerium für Umwelt, Energie und Klimaschutz* - NMU) supervises the safety of this nuclear power plant.

There are a number of differences between the scope of the duties of the ANVS, the FANC and the NMU. For example, whereas the nuclear licensing and supervisory duties of the ANVS pertain to the safety of nuclear power plants as a whole, those of the FANC in Belgium are limited to the nuclear parts of Belgium's nuclear power plants; the Flemish and Walloon Regions supervise the other (non-nuclear) parts of the nuclear power plants.[82] The scope of the NMU's nuclear licensing and supervisory duties is comparable to that of the ANVS. Another difference between the nuclear regulatory authorities concerns their role in policymaking and legislation. The ANVS and the FANC have policy preparation duties in addition to their licensing and supervisory duties, but this does not apply to the NMU; in Germany, policy preparation duties are the responsibility of the BMUB and not the responsibility of the NMU.

Compared to the FANC and the NMU, the ANVS is a "young" organisation. It was established on 1 January 2015 following a merger between former organisational units[83] of the Ministry of Economic Affairs[84,85] and the Ministry of Infrastructure and the Environment[86]. The main reason for establishing the ANVS was the requirement in the Convention on Nuclear Safety for an autonomous nuclear licensing and supervisory authority which is functionally segregated from the authority responsible for energy policy. The Dutch system prior to 2015 did not meet this requirement. The FANC was established by law in 1994 and has been fully operational since 1 September 2001. Prior to that date, the federal government's nuclear safety duties in Belgium had been delegated to a number of different organisations. Lower Saxony's nuclear regulatory authority, the NMU, was established in 1986.

81 The regulations will be drafted with contributions from the ministries of the various Länder, including the NMU. For example, guidelines are being prepared within the Länder Committee for Nuclear Energy (*Länderausschuss für Atomkernenergie*) which includes the federal government and the federated states.

82 Please refer to Appendix D (Laws and regulations) for details.

83 Former organisational units were the Ministry of Economic Affairs' Programme Directorate for Nuclear Installations and Safety (*Programmadirectie Nucleaire Installaties en Veiligheid van het Ministerie van Economische Zaken*); the Nuclear Energy Service and the nuclear advisory networks team at the Human Environment and Transport Inspectorate (*Kernfysische Dienst en het Team Adviesnetwerken nucleair van de Inspectie Leefomgeving en Transport*); and the radiation protection team at the Netherlands Enterprise Agency that is part of the Ministry of Economic Affairs (*Team Stralingsbescherming van de Rijksdienst voor Ondernemend Nederland van het Ministerie voor Economische Zaken*).

84 The Dutch Safety Board has opted to use the "old" names of government members and ministries in this report, in view of the fact that the report tends to focus on these parties' actions in the past. Where the report makes recommendations for the future, the names and portfolio allocations are used that have applied since the third Rutte Cabinet came into office in October 2017. The first time an old name is used, the new name is given in a footnote.

85 As of October 2017, the Ministry of Economic Affairs and Climate Policy.

86 As of October 2017, the Ministry of Infrastructure and Water Management.

Figure 12 provides an overview of the main organisations involved in ensuring the safety of nuclear power plants in the Netherlands, Belgium and Germany. See Appendix C of this investigation report for more details about these organisations.

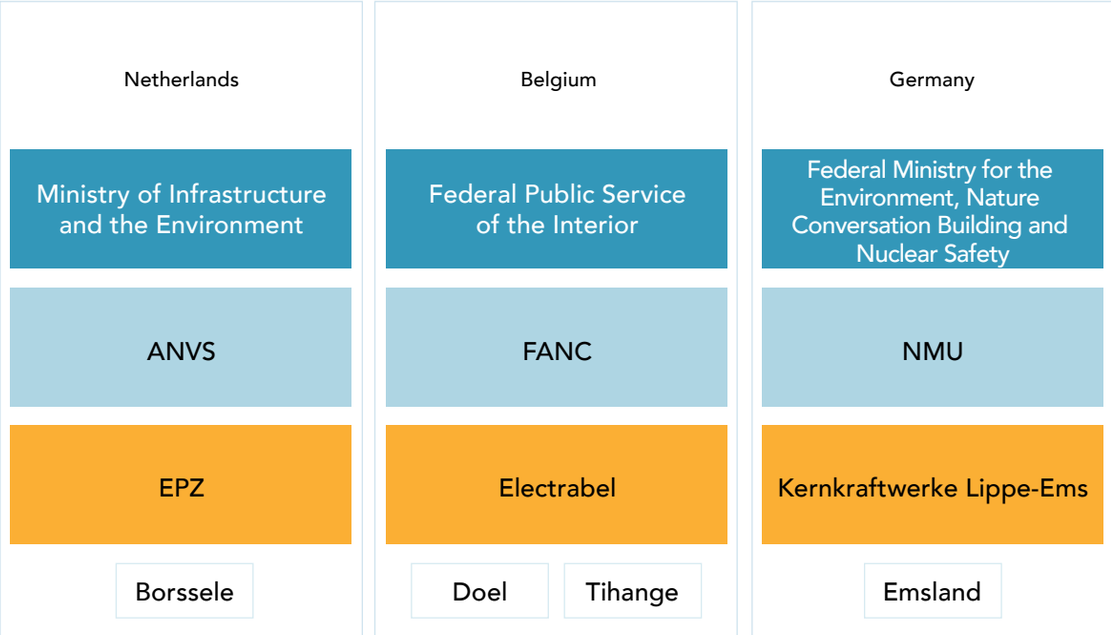


Figure 12: Schematic representation of the most relevant organisations in the Netherlands, Belgium and Germany that are involved in ensuring the safety of the Borssele, Doel, Tihange and Emsland nuclear power plants.

3.2 Information provision on and public participation in nuclear licensing

Countries with a nuclear power plant within or close to their national borders, have an interest in ensuring the safety of this nuclear power plant to the greatest possible degree. The Dutch Safety Board considers it important that countries with nuclear power plants inform neighbouring countries about forthcoming licensing procedures with regard to these nuclear power plants and that neighbouring countries are given the opportunity to express their concerns before a decision is taken.

This section describes the extent to which the Netherlands and Belgium, and the Netherlands and Germany, involve each other in the licensing procedures for the Borssele, Doel, Tihange and Emsland nuclear power plants at an early stage.[87] The Dutch Safety Board studied the licensing procedures (with and without environmental impact assessments) for the aforementioned nuclear power plants in the years 2009 up to and including 2016. For each procedure, the Dutch Safety Board mapped out which authorities in the neighbouring country were involved and to what extent information on these procedures was made available to the public across the border. In particular, this section considers the Long Term Operation of the Borssele, Doel 1, Doel 2 and Tihange 1 reactors.

87 Belgium operates a dual licensing system for nuclear power plants, which means that nuclear power plants require a federal nuclear licence for their nuclear parts and a regional environmental licence for all other parts. This investigation focused exclusively on the federal nuclear licensing procedure.

3.2.1 Licensing procedure

Nuclear power plants must comply with stringent safety requirements. These requirements are, among other things, imposed by the licence by which the government authorises the establishment and operation of a nuclear power plant. Such licences are issued by the competent nuclear regulatory authorities. If the nuclear power plant's activities and installations are modified, the nuclear regulatory authority's permission is required in order to make sure that the modifications are in accordance with the safety regulations. Whether it will be necessary to amend or renew the licence strongly depends on the regulations in force and the nature of the modifications. It is difficult to predict how often amended or renewed licences will be issued. As an example, four licensing procedures were conducted for the Borssele nuclear power plant in the years 2011 up to and including 2016, compared with one procedure for the Emsland nuclear power plant in that same period.

In addition, an environmental impact assessment may need to be carried out for the activities that require a licence (or the amendment of an existing licence). Environmental impact assessments provide an insight into the foreseeable adverse effects on the environment, so that those effects can be taken into account in the decision whether or not to grant a licence. Environmental impact assessments are of interest to the Dutch Safety Board's investigation because international regulations on environmental impact assessment stipulate that neighbouring countries must be involved in the procedure in case of foreseeable transboundary effects.[88]

Appendix D contains further information on the legislation in the three countries that applies to the nuclear licensing and environmental impact assessment regarding nuclear power plants.

3.2.2 Involving neighbouring countries in licensing and environmental impact assessments

The Dutch, Belgian and German regulations to involve their neighbouring countries in the licensing of nuclear power plants, vary from country to country. Furthermore, each country meets its duty in its own way.

Borssele nuclear power plant

Dutch regulations stipulate that the ANVS must involve other authorities within a 10-kilometre radius from the Borssele nuclear power plant in the licensing procedures for the plant.[89] An analysis of the licensing procedures for the Borssele nuclear power plant demonstrates that the ANVS and its legal predecessor interpreted this stipulation quite broadly: in most licensing procedures Dutch authorities within a radius of around 25 kilometres from the plant were involved. In addition, Belgian authorities were involved in the procedures for more "comprehensive" licences, such as for the Long Term Operation, and procedures that concerned an environmental impact assessment. The ANVS has stated to treat any environmental impact assessment for the Borssele nuclear power

88 Convention on Environmental Impact Assessment in a Transboundary Context (the Espoo Convention).
89 These authorities include the province and the municipality in which the nuclear power plant is located, as well as the provinces, municipalities and water quality management bodies within a 10-kilometre radius from the plant. The distance of 10 kilometres is calculated from the perimeter of the nuclear power plant site.

plant as a cross-border environmental impact assessment due to its proximity to the Belgian border. For each procedure, the ANVS used the input from the FANC and submitted requests[90], to determine which Belgian authorities needed to be provided with information. The list of the Belgian authorities that were involved, varied per procedure. According to its own statement, the ANVS does not use a standardised working process in such cases. As a consequence, it may not be clear to Belgian authorities, such as municipalities in the Flemish border region, whether they will be involved in a procedure or not.

In the case of one of these procedures, namely the preliminary stage of the realisation of a second nuclear power plant in the municipality of Borsele[91] (see also chapter 2), several European countries were informed about the start of the procedure, pursuant to European agreements on environmental impact assessments. However, the procedure was aborted when the plans for a second nuclear power plant were shelved.

No German organisations were actively informed about the licensing procedures for the Borssele nuclear power plant, except in one instance. This was done at the request of the German government which had been alerted to the procedure by its citizens. The ANVS' legal predecessor sent the draft licence and the associated announcement to the German government for the purposes of public participation.

Doel and Tihange nuclear power plants

The investigation into Belgium's licensing procedures reveales that the FANC's working methods dovetailed almost seamlessly with the procedure under Belgian legislation. Pursuant to the law, in all licensing procedures authorities within a 5-kilometre radius from the nuclear power plants were involved (the areas are illustrated in figure 13).[92] The municipalities within these areas were required to conduct a "public investigation"[93], which amounts to allowing third parties the opportunity to consult the licence application and accompanying documents and to bring their views forward.

All nuclear licensing procedures that were studied by the Dutch Safety Board respected the 5-kilometre radius.[94] As such, the Dutch border municipalities of Hulst and Reimerswaal received requests to conduct a public investigation and to allow opportunities for public participation for each licensing procedure regarding the Doel nuclear power plant. The Dutch municipalities of Woensdrecht (at a distance of 6 kilometres) and Bergen op Zoom (20 kilometres) are outside the 5-kilometre radius. As a result, they were not informed about the procedures and opportunities for public participation.

90 The Flemish border municipalities that had submitted requests were the municipalities of Zelzate, of Assenede and of Sint-Laureins.

91 This concerned a notification of the intent to establish a second nuclear power plant in the municipality of Borsele. There were two initiatives to establish a new power plant for which two procedures were started separately.

92 These authorities include the province and the municipality in which the nuclear power plant is located, as well as the municipalities within a 5-kilometre radius from the plant.

93 A public investigation means that the municipality informs the public about the licence application, including accompanying documents like an environmental impact assessment, carried out by posting an announcement on the notice board at the town hall. The announcement specifies the period during which the documents are available for consultation and the way comments can be submitted. The municipality gathers the comments it has received and incorporates them into an advice to the FANC.

94 Except for the Long Term Operation licence, which was not subject to a public licensing procedure.

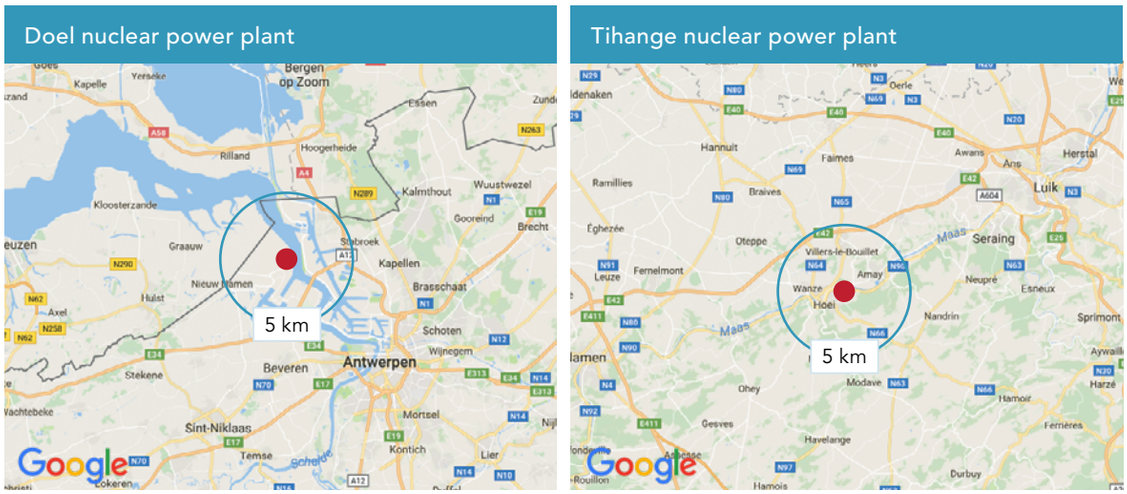


Figure 13: Areas with a 5-kilometre radius around the nuclear power plants at Doel (left) and Tihange (right).

The Long Term Operation licences for the three reactors Doel 1, Doel 2 and Tihange 1 were not subject to public procedures. By consequence, third parties did not have the opportunity to participate in these procedures. This lack of public participation led to dissatisfaction among various Dutch local authorities[95] in the border region. The Dutch nuclear regulatory authority (the ANVS and its legal predecessor) was not actively involved in the Long Term Operation procedures for Belgium's nuclear power plants either. The ANVS took no action to consult with the FANC in order to organise this involvement.

The Dutch Safety Board ascertains that the Belgian legislative framework for the licensing of nuclear power plants leads to working methods which are not entirely in agreement with the interests and expectations of Dutch municipalities in the border areas. If a nuclear accident were to occur, the potential safety risks for the public would extend beyond the 5-kilometre radius. The Dutch Safety Board considers that municipalities in the areas where the public are at the greatest risk in particular have an interest in being involved in licensing procedures. These are the areas around the nuclear power plant with a radius of at least 20 kilometres. This coincides with the distance within which residents are considered interested parties according to Dutch case law.[96] The Tihange nuclear power plant is located at a greater distance from the Dutch border, that is to say 38 kilometres. As regards the Doel nuclear power plant, the distance from the border is so small (2.8 kilometres) that several Dutch municipalities are located within the 20-

95 These included the province of North Brabant and the municipalities of Bergen op Zoom, Woensdrecht, Roosendaal, Steenbergen, Tholen, Maastricht and various smaller municipalities in the Dutch province of Limburg. The province of North Brabant wrote to the Minister of Infrastructure and the Environment stating that public concerns about the dossier had not been addressed. The municipality of Bergen op Zoom, also acting on behalf of the municipalities of Steenbergen and Tholen, turned to the European Commission to raise its concerns about the Long Term Operation of the Doel nuclear power plant. These municipalities wrote to the Commission complaining that they had not been informed and had not been allowed the opportunity to consult the relevant documents or participate in the decision-making process, even though the risks involved extended beyond the Belgian border. The municipality of Maastricht and the German city of Aachen decided to take legal action against the decision to prolong the operation of the Tihange nuclear power plant. This action was joined by more than 60 municipalities in the region, including several municipalities in Germany and Luxembourg.

96 This concerns Decision 201108676/1/A4 of 13 February 2013 by the Administrative Jurisdiction Division of the Council of State (*Afdeling Bestuursrechtspraak van de Raad van State*). Internet: https://www.raadvanstate.nl/uitspraken/zoeken-in-uitspraken/tekst-uitspraak.html?id=72647.

kilometre radius. In the opinion of the Dutch Safety Board, the Minister of Infrastructure and the Environment's point of view, saying that it is up to the municipalities of Hulst and Reimerswaal to decide whether to inform other municipalities about licensing procedures for the Doel nuclear power plant, is not sufficient. With regard to the Borssele nuclear power plant, a number of Belgian border municipalities are located within a 20-kilometre radius of the site. The Dutch Safety Board considers that they should be actively involved in procedures for the Borssele nuclear power plant, like their Dutch counterparts in that area.

The ANVS and the FANC have a duty to ensure that their licensing practices are tailored to the information needs and local interests in both countries. However, there are currently no working arrangements between the ANVS and the FANC about how and when to involve authorities in the neighbouring country in connection with forthcoming procedures. In 2009, the ANVS' legal predecessor and the FANC made an attempt to reach an agreement about mutual involvement in procedures that entail an environmental impact assessment. In spite of their best intentions, the differences between the two countries proved too great to reconcile and no working arrangements were made. The initiative to cooperate was particularly hampered by the differences between regulations, administrative structures and working methods. Furthermore, the proposed arrangement was largely modelled after Dutch working methods. Changes to the Dutch national system of licensing and supervision proved another barrier to take up the cooperation initiatives.

Emsland nuclear power plant
In the past few years, the operating licence for the Emsland nuclear power plant was only once amended with a licensing procedure. This licence amendment was applied for in 2010 and granted in 2011. The NMU informed the Netherlands on the procedure during the annual meetings of the NDKK commission (see also section 3.3.1 in this investigation report). Beyond these meetings, there was no communication to other Dutch authorities. Regarding modifications to the nuclear installation which by their nature did not necessitate a licensing procedure, the NMU also made use of the NDKK meetings to inform its Dutch counterpart.

According to German law, the NMU is obliged to inform the Dutch authorities on licensing procedures for nuclear power plants near the Dutch border that require an environmental impact assessment. These concern modifications of nuclear power plants with potentially significant adverse effects on the environment. The NMU operates on the principle that environmental impact assessments for the Emsland nuclear power plant always have an international character due to the proximity of the site to the Dutch border. Therefore the NMU regards it as its statutory duty to involve the Netherlands actively in all such procedures. No environmental impact assessments were required for the Emsland nuclear power plant in the past few years. Recently, the operator of the Emsland nuclear power plant stated its intention to apply for a dismantling licence. In order to be allowed to dismantle the site, the operator will need to carry out an environmental impact assessment. The NMU has declared that it will actively involve Dutch authorities (including the ANVS) in the procedure from the start, pursuant to the relevant stipulations under German law.

Sub-conclusion

The Dutch nuclear regulatory authority and its counterparts in Belgium and Germany inform each other about their licensing procedures regarding nuclear power plants. Nevertheless, local authorities in the neighbouring country that may have an interest in those licensing procedures, such as border municipalities within a 20-kilometre radius from the nuclear power plant, are not always actively involved in these procedures. Particularly when it comes to procedures regarding the Borssele and Doel nuclear power plants which are located within 2.8 and 16 kilometres of the border respectively, the FANC and the ANVS should take greater account of the local interests on the other side of the border.

3.2.3 Public access to information on licensing procedures in the neighbouring country

Attempts are being made at the international level[97] to enhance the transparency of decision-making processes regarding nuclear power plants. Several standards stipulate that the public should be given the opportunity to participate in the various stages of the licensing procedure and that the participation process should be open, transparent and balanced. As such, nuclear regulatory authorities need to provide easy access to relevant and comprehensive information on safety issues, licensing procedures and licences granted. The information should be published in such a way that it can be easily accessed, such as on the internet and in the mass media. These provisions are based on the assumption that transparency and public participation enhances public confidence in the nuclear regulatory regime.[98]

This section describes how the public have been informed about licensing procedures regarding the Borssele, Doel, Tihange and Emsland nuclear power plants. The underlying question is whether the public have sufficient access to information about topics which are relevant to them and whether they are given the opportunity to defend their interests (thereby keeping the relevant authorities alert).[99] This may also involve public interests across the border.

97 Among other things, this follows from:
- Section 8 Council Directive 2014/87/Euratom;
- ENSREG, *Guidance for National Regulatory Organisations; Principles for Openness and Transparency*, 2011;
- IAEA, *IAEA Safety Standards for protecting people and the environment; Licensing process for nuclear installations*, 2010;
- Nuclear Energy Agency, *The characteristics of an effective nuclear regulator*, 2014.

Moreover, the Convention on Access to Information, Public Participation and Access to Justice in Environmental Matters (Aarhus Convention) also includes transparency and participation requirements.

98 Participatie van de bevolking is niet alleen bij vergunningverlening, maar ook bij andere besluitvormingsprocessen, zoals die voor noodplannen, van belang. In zijn advies van 2016 (*Nucleaire ongevallen, leefmilieu en gezondheid in het post-Fukushimatijdperk: Rampenplanning*) concludeert de Hoge Gezondheidsraad in België dat er nog veel te winnen valt bij een transparant communicatieproces over nucleaire veiligheidskwesties en over noodplanningsprocessen. De Hoge Gezondheidsraad geeft daarbij aan dat zo'n participatieve benadering kwetsbaarheden en zorgen van burgers over nucleaire veiligheid aan het licht brengt.

99 Wetenschappelijke Raad voor het Regeringsbeleid, *Vertrouwen in burgers*, 2012.

Borssele nuclear power plant

In the case of a licensing procedure[100] regarding the Borssele nuclear power plant, the ANVS notifies the public through various (digital) channels about the start of the procedure and opportunities for public participation. This information is publicly available. As an example, the licensing procedures that were analysed as part of the Dutch Safety Board's investigation were announced in various local and national newspapers and on the website www.anvs.nl (previously on www.rijksoverheid.nl). The documents intended for public consultation were made available for consultation for a period of six weeks in The Hague, at the town hall in Borsele and (depending on the procedure) at other locations in the region. They could also be viewed online. The level of information provision targeting Belgium and Germany differed per procedure. With regard to procedures with an environmental impact assessment, notifications were published in various Belgian newspapers. The Belgian public were notified at the initiative of the ANVS (or its legal predecessor), in consultation with the FANC. In a few instances, documents were made available for consultation in Flemish border municipalities. In none of the cases, the ANVS (or its legal predecessor) published notifications in German newspapers or other German media.

As regards the procedures for more "comprehensive" licences, public hearings were organised to provide citizens with information about the initiative and the statutory procedure and to offer them the opportunity to ask questions or present their views. These hearings attracted few attendees. Although there is no longer a statutory requirement to do so, the ANVS continues to organise such hearings in the case of new initiatives or licensing procedures that might give rise to public concerns.

The opportunities for public participation proved particularly popular during the term of the consultation of the draft licence for the Long Term Operation of the Borssele nuclear power plant. The majority of the views that were submitted during that term originated in Germany: of the 638 views submitted, 284 originated in the Netherlands and 354 in Germany. The written views included two petitions, signed by a total of 3,088 persons. None of the views originated in Belgium. The views submitted did not lead to a refusal to issue a licence or to an amendment of the requirements that were laid down in the licence. However, they did lead to a clarification of the rationale for these requirements.

Doel and Tihange nuclear power plants

Opportunities for public participation in the licensing procedures for the Doel and Tihange nuclear power plants are announced locally. These announcements tie in with the public investigations conducted in the municipalities around the nuclear power plant. Public investigations are announced by way of posting notices at the nuclear power plant's site and at the town halls of the municipalities within a 5-kilometre radius from the plant. Licence applications were made available for consultation at the relevant locations for a period of six weeks. No notifications were published online or in the press, in accordance with the FANC's strict interpretation of the Belgian federal law. For all procedures investigated by the Dutch Safety Board, the provision of information to the public was organised as such.

100 This refers to the extended uniform public preparatory procedure laid down in the General Administrative Law Act (*Algemene wet bestuursrecht*). Please refer to Appendix D for details.

As the notices on licensing procedures for the nuclear power plants at Doel and Tihange are posted only locally, their reach is limited.[101] Posting local notices does not bring about an active provision of information to citizens living outside the 5-kilometre radius from the nuclear power plant. The only way for these citizens to find out about procedures that may affect them is to check public notice boards at town halls or at the nuclear power plant's site. The Dutch Safety Board considers that the public's access to opportunities for participation is hampered by the fact that this information is not shared through other channels, such as the press or the Internet.

Whereas the various licensing procedures for the Borssele nuclear power plant in the Netherlands led to the submission of a multitude of views, this was not the case for the licensing procedures for the Doel and Tihange plants. None of those procedures led to a submission of views by third parties. There may be various reasons for this difference between the Dutch and Belgian nuclear power plants, one of which may be the public accessibility of the information on licensing procedures and opportunities for public participation.

Emsland nuclear power plant

Pursuant to German nuclear legislation, the NMU is obliged to publicly announce licensing procedures by publishing notifications in its bulletin and in the local daily newspapers in the region where the nuclear power plant is located. The procedures are also announced in the *Bundesanzeiger*, the federal government's gazette for the publication of official announcements. Licence applications and accompanying documents[102] are made available for consultation at the office of the NMU and at a location near the nuclear power plant for a period of two months. Third parties may view the documents and present their views during this period. At the end of the consultation period a public hearing is held, during which any submitted concerns are discussed. The hearing is attended by the NMU, the operator of the nuclear power plant (Kernkraftwerke Lippe-Ems) and the persons who submitted concerns. There is no hearing if no concerns have been submitted. In some cases, the NMU can decide not to organise an extensive procedure with a public hearing, except in the case of procedures that involve an environmental impact assessment. Even so, all licences must be published after they are issued to allow third parties the opportunity to appeal.

No objections were raised to the nuclear licence that was issued to the Emsland nuclear power plant in 2011.

101 In her investigation report *Engaging with risks. Citizens, science and policy in mobile phone mast siting controversies* (2015), Hermans, M. observed that such channels are often ineffective in reaching the public. Her investigation, which focused on licensing procedures for the erection of mobile phone masts, revealed that the information channels used (such as billboards and notices posted at the town hall) were not always spotted by citizens. In most cases, they obtained information thanks to the alertness of others, and in a few cases they did not find out about the procedure at all until after the licence had been issued.

102 Such as the safety report and the environmental impact report.

Sub-conclusion

There are differences between the three countries as regards the extent to which the public are given access to information about forthcoming licensing procedures. It is easier for residents of Belgium and Germany to obtain information about forthcoming procedures regarding the Borssele nuclear power plant than it is for residents of the Netherlands to obtain information about forthcoming procedures regarding the Doel, Tihange and Emsland nuclear power plants. These differences also affect their opportunities to bring views forward before a decision is taken.

3.3 Cooperation in the supervision of nuclear power plants

The nuclear regulatory authorities – the ANVS in the Netherlands, the FANC in Belgium and the NMU in Germany – have a duty to supervise the safe operation of nuclear power plants. They perform this duty by inspecting the installations and systems that are intended to guarantee safe operation. If there is any indication of a potential safety deficiency, they are tasked with ensuring that the defect is rectified. The Dutch Safety Board expects the authorities to coordinate their activities and cooperate if doing so contributes to safety.

This section describes how the ANVS cooperates with the FANC and the NMU with regard to the supervision of nuclear power plants. This includes their cooperation in inspections, their ways of keeping each other informed about developments and their information sharing with respect to nuclear safety.

3.3.1 Coordination between the Netherlands and Belgium and between the Netherlands and Germany

Coordination between the ANVS and neighbouring countries

The ANVS consults with its counterparts in Belgium and those in Germany on a regular basis.[103] Consultations between the ANVS and the FANC were formalised in 2015 with the establishment of a meeting at board level, which takes place at least once a year. Although the parties consulted each other prior to this point, this was done less frequently and mainly on an ad hoc basis. The parties involved have indicated that contacts between the Dutch and Belgian authorities have intensified in recent years, thanks largely to the formation of the ANVS. This must be attributed to the fact that the Netherlands now has a single central authority similar to the FANC, which makes it easier to enter into agreements.

103 The foundations for the exchange of information between the Netherlands and Belgium about nuclear power plants were laid by the *Memorandum of Understanding between the Kingdom of Belgium and the Kingdom of the Netherlands on early notification of a nuclear accident and the exchange of information about the operation of nuclear installations*, which was signed in 1990. In September 2017, the ANVS and the FANC signed a new cooperation agreement.

As regards the consultations with respect to nuclear installations[104] between the Dutch and German nuclear regulatory authorities, the Dutch-German Commission for Nuclear Facilities in the Border Region (*Niederländisch-Deutsche Kommission für grenznahe kerntechnische Einrichtungen* - NDKK) was established in 1977. The commission has two consultation groups, each of which meets annually. The first group focuses on crisis management, while the second is concerned with all other matters, including licensing and supervision. This second consultation group has as its members not only the ANVS and the NMU, but also the BMUB and the nuclear regulatory authority of North Rhine-Westphalia. Even when Germany will have phased out nuclear energy, Germany and the Netherlands will continue their consultation meetings, since these meetings concern all major nuclear installations in the Netherlands and in the Dutch-German border region and is not limited to nuclear power plants. Germany has established commissions with its other neighbouring countries that are broadly similar to the NDKK.

In the meetings between the Netherlands and Belgium as well as in the meetings between the Netherlands and Germany, the nuclear regulatory authorities share information related to the safety of nuclear power plants and related to their working methods. Its members have stated that there are no barriers to share information. Their main goal is to learn from each other by making use of each other's expertise. Aside from sharing information, the authorities use the meetings to consult with each other and to set up cooperation agreements.

In addition to the existing meeting cycles, the ANVS contacts its Belgian and German counterparts in the interim and vice versa. There may be several reasons for doing so, such as current developments, parliamentary questions or upcoming international conventions.

Although the consultation meetings between the ANVS and the FANC have only existed in their current form for a few years, the Dutch Safety Board regards them as a solid foundation for further developing the cooperation between both nuclear authorities. Future-proof cooperation between the ANVS and the FANC, similar to the cooperation between the Netherlands and Germany as embedded in the NDKK, requires ongoing attention and investment from both the Netherlands and Belgium. Compared to other nuclear regulatory authorities in Europe, the ANVS is a small player with a large portfolio of various types of nuclear installations. As such, the Dutch Safety Board considers it to be in the ANVS' best interest to use the knowledge and experience of neighbouring countries to the full. This dovetails with the ambition of the European Atomic Energy Community (Euratom) to foster close cooperation, coordination and the exchange of information between its member states.[105]

104 These meetings cover all major nuclear installations in the Netherlands and the German nuclear installations that are located near the Dutch border. This includes the URENCO enrichment facility in Almelo, the now-closed Dodewaard nuclear power plant, the Borssele nuclear power plant, the research reactors in Petten and Delft, COVRA, the Emsland nuclear power plant, the now-closed Lingen nuclear power plant, the temporary storage facility in Lingen and the enrichment facility in Gronau.

105 Council Directive 2014/87/Euratom.

Sub-conclusion

Regular consultations take place between the Dutch nuclear regulatory authority and its counterparts in Belgium and Germany regarding nuclear installations in the border regions. They do not only share safety-related information, but they also make use of each other's knowledge and experience in order to learn from one another.

3.3.2 Safety issues regarding nuclear power plants in neighbouring countries

Countries have the right to make autonomous decisions regarding nuclear power plants on their territory. In principle, neighbouring countries have no say in these decisions, not even with regard to nuclear power plants located near their borders. However, they do have a duty to ensure the safety of their residents. As part of their duty of care, they must ascertain that the nuclear power plants near their borders are safe and that they bring their influence to bear, insofar as possible, if they deem it necessary for the actual or perceived safety of the public. In addition to proceedings under administrative law (see section 3.2), various other avenues are open to them to that end, including diplomacy.

This section describes how the Dutch government has met its duty of care in response to reports about hydrogen flakes in the reactor vessels of Doel 3 and Tihange 2 and the existence of warning letters from the FANC. These topics attracted significant attention in the press and contributed to public unrest in the Netherlands about the above-mentioned nuclear power plants. The Emsland nuclear power plant escapes mention here, due to the lack of reports on safety issues causing a similar level of public unrest.

Hydrogen flakes

The reports about hydrogen flakes in the reactor vessels of Doel 3 and Tihange 2 (see text box on the next page) led to concerns in the Netherlands and other countries about the safety of those nuclear plants.

The Dutch Minister of Infrastructure and the Environment (*minister van Infrastructuur en Milieu*) regularly contacted the Belgian minister in order to be informed on the status of the examination of the hydrogen flakes and any possible consequences for the safety of the nuclear power plants.[106] There was also frequent contact between the FANC and the ANVS (and its legal predecessor) on the hydrogen flakes. According to written statements from the Dutch minister to the House of Representatives, the information provided by Belgium reassured the Dutch government that the FANC would not give permission to put the reactors back in operation unless it was satisfied that they were safe. The fact that the German and Luxembourg governments had asked the Belgian federal government in 2016 to put Doel 3 and Tihange 2 out of operation temporarily, partially due to the hydrogen flakes issue, did not alter the Dutch government's position. The

106 At that time, the administrative responsibility for this issue in the Netherlands rested with the Minister of Economic Affairs (*minister van Economische Zaken*). For Belgium, this was the Minister of Home Affairs and Equal Opportunities (*minister van Binnenlandse Zaken en Gelijke Kansen*).

Minister of Infrastructure and the Environment defended this decision by arguing that the FANC had been transparent about its approach and its conclusions and had consulted various international bodies and experts coming to conclusions. Moreover, the ANVS' experts saw no substantial reason to doubt the extensive safety dossier and the conclusions that had been arrived at.[107]

Hydrogen flakes

In 2012, ultrasonic scans indicated a large number of defects in the reactor vessels of Doel 3 and Tihange 2, after which both reactors were put out of operation and a thorough investigation was carried out.[108] The indicated defects pertained to hydrogen flakes in the steel of the reactor vessels, which had been present in the steel since the manufacturing date as a result of early-stage hydrogen inclusion.[109]

In 2013, the FANC gave permission for the reactors to resume operations under certain conditions. Following a FANC-mandated irradiation test on a different steel sample containing similar hydrogen flakes in 2014, which revealed a more rapid embrittlement of the sample than expected, the reactors were put out of operation again as a precaution.[110] Electrabel was ordered to examine the impact of hydrogen flakes on the mechanical properties of the reactor vessels again. Once the structural integrity of the reactor vessels was found to comply with the imposed safety standards, the FANC gave permission on 17 November 2015 to put the reactors back in operation. For its assessment, the FANC called in independent international experts from a variety of countries.[111] Shortly before the reactors were put back in operation, the FANC informed the ANVS on the outcomes of its examinations and the reasoning behind its decision to allow for the restart. This information was also shared with other international partners.[112]

The IAEA designated the FANC's working methods as good practice. This means an approach that may serve as an example to other nuclear regulatory authorities, in the opinion of the IAEA. By way of explanation, the IAEA argued that an in-depth examination was carried out which was conducted within a context of strong international cooperation.

107 House of Representatives (*Tweede Kamer*), 2015 – 2016, 17 May 2016, 32465, No. 67.
108 During routine inspections carried out in August 2012, defects were indicated in the steel wall of the reactor vessel of Doel 3. One month later, the FANC announced that the same defects had been indicated for the reactor vessel of Tihange 2.
109 An excess of hydrogen during the cooling and curing stages of the steel may have resulted in hydrogen bubbles, which were then flattened into hydrogen flakes during the rolling stage.
110 It did not become apparent until later that the sample was not representative of the steel in the reactor vessels. A link between the embrittlement and the presence of hydrogen flakes could not be demonstrated.
111 FANC, file on Doel 3 and Tihange 2 with regard to indications of defects in the steel walls of reactor vessels. Internet: www.fanc.gov.be.
112 In January 2016, the FANC organised an international 2-day workshop on the subject. Nuclear regulatory authorities from a total 15 different countries, including Germany and the Netherlands, took part.

Fire safety studies and safety culture

On 19 November 2016, the Belgian newspaper *La Libre Belgique*[113] reported about the existence of a number of warning letters from the FANC addressed to Electrabel and its mother company, Engie. In the first letter, dated 1 July 2016, the FANC expressed its concern about the outcomes of fire safety studies.[114] The second letter, dated 2 September 2016, addressed the lack of a proactive approach on the part of Electrabel with regard to the development of a proper safety culture. The FANC was particularly concerned about the situation at the Tihange nuclear power plant. The FANC's warning letters were given significant exposure in the Dutch press. A few mayors of Dutch municipalities stated that they were unpleasantly surprised, as they had been unaware of the warning letters and their contents. In addition, the Dutch House of Representatives submitted parliamentary questions to the Minister of Infrastructure and the Environment.

When the issue was reported in the media, the outcomes of the fire safety studies and the contents of the FANC's warning letters were known neither to the Dutch Minister of Infrastructure and the Environment nor to the ANVS, in spite of the fact that they had could have obtained this information. The FANC had raised the problems with the safety culture at the Tihange nuclear power plant and "deficiencies" at Electrabel's head office at the annual meeting between the ANVS and the FANC in 2016. The ANVS took note of this information, but saw no reason to ask for more details.

Shortly after public concern arose in the Netherlands, the FANC provided the ANVS at the latter's request with more information concerning the contents and background of the letters and the fire safety studies. In addition, the Dutch Minster wrote to her Belgian counterpart asking for clarification. He replied that there had never been any actual danger, that the FANC was following the matter closely and that there was no reason to temporarily put the nuclear power plants out of operation from a safety point of view. In a parliamentary debate, the Dutch Minister of Infrastructure and the Environment informed the House of Representatives that it was within the competence of Belgium to make an autonomous decision regarding this matter. In May 2017, the House of Representatives adopted a motion calling upon the Dutch government to follow Germany and Luxembourg's example and make an urgent request to the Belgian federal government to close down the Tihange nuclear power plant. The motion was motivated in part by the FANC's warning letters. While it did not lead to a formal request of the Dutch government to close down the Tihange nuclear power plant, it resulted in the Dutch minister's statement of intent to step up bilateral cooperation with regard to nuclear safety.[115]

113 http://www.lalibre.be/actu/belgique/surete-nucleaire-deux-lettres-accablantes-et-alarmantes-destinees-a-electrabel-582f70d6cd70735194a3ed84

114 These indicated that the likelihood of a fire at the Doel or Tihange nuclear power plants leading to a core meltdown was once per decade. The fact that this conclusion was based on incorrect assumptions and flawed study models was regarded by the FANC as evidence of an insufficiently critical attitude. It summoned Electrabel to redo the fire safety studies and take immediate action to remedy defects.

115 House of Representatives (*Tweede Kamer*), 2016–2017, 32645, No. 83.

Anticipating public concerns

As the examples above show, the Netherlands has been in regular contact with Belgium to obtain information about the condition of Belgium's nuclear power plants. The information provided by Belgium gave the Dutch minister and the Dutch nuclear authority no cause to doubt the FANC's judgement of the safety of the nuclear power plants. However, they were not very successful in instilling the same confidence among the public; in the Dutch-Belgian border region in particular, citizens are concerned about the safety of the Belgian nuclear power plants. The Dutch Safety Board observes that the ANVS and the FANC exchange information as part of their regulatory duty. The information they share is strongly driven by their professional knowledge. It is important for the authorities to recognise that the public perception of safety and the public's need for information may differ from their own.[116] Developments that probably do not influence safety may nevertheless be perceived as such by the public.[117] In the opinion of the Dutch Safety Board, the nuclear regulatory authorities need to be more sensitive to public concerns and need to adjust their communications to address these concerns.

Sub-conclusion

In response to incidents at and news reports about Belgium's nuclear power plants, the Dutch government regularly requested information about the safety of the plants. The information provided by Belgium strengthened the confidence of the Dutch minister and the Dutch nuclear regulatory authority in the judgement of the Belgian nuclear regulatory authority, the FANC. The Dutch parties were not very successful in instilling the same confidence among the Dutch public. It is important for the authorities to be more sensitive to issues that might cause public concerns and to adjust their communications to address these concerns.

3.3.3 Cooperation with regard to inspections

When carrying out inspections, the ANVS, the FANC and the NMU adhere to the standards of the International Atomic Energy Agency (IAEA). Among other things, these standards dictate the areas for inspection, the methodologies to be followed, the inspection schedule (which consists of both announced and unannounced inspections), reporting methods, et cetera. The objective of the inspections is to assess whether the technology and the safety management systems of a nuclear power plant guarantee its safe operation and offer sufficient protection to the public and the environment from the adverse effects of ionising radiation.

Attending inspections in neighbouring countries

The ANVS, the FANC and the NMU involve nuclear authorities from other European countries in some of their inspections by allowing inspectors from those countries to attend these inspections. The objective is to learn from each other and to improve the inspectors' expertise as well as the quality of the inspections. The role of the inspectors from other countries is to observe. They do not take part in communications between the operator and

116 Wetenschappelijke Raad voor het Regeringsbeleid, *Evenwichtskunst*, 2011.
117 Midden, C., *Publieksreacties op energiesystemen, het perspectief van de burger*, 2014.

the lead inspectors, nor do they participate in the assessment and decision-making procedures subsequent to the inspection. Attending inspections in other countries is a key way to maintain knowledge and quality. This is all the more relevant for countries with a small nuclear energy sector, such as the Netherlands. The nature of other countries' involvement in inspections is largely pragmatic. As an example, the ANVS exchanges annual inspection schedules with the countries concerned. The inspectors coordinate amongst themselves which inspections are most suitable to attend. No specific criteria, besides added value, are on the basis for the selection of inspections. A definitive decision to attend an inspection is mostly taken shortly before the inspection takes place.

The ANVS cooperates with the FANC in Belgium and with nuclear authorities in other countries in this fashion, but not (yet) with those in Germany. There is no reason for the absence of cooperation with the German authorities, including the NMU, other than that initiatives to do so have not yet been taken. As a rule, the annual NDKK meetings are combined with a joint visit to a nuclear installation, alternating between the Netherlands and Germany. Although this is not a formal inspection, it provides the authorities with the opportunity to form a picture of the installations in the neighbouring country. In addition, the NDKK meetings between the two countries involve a detailed discussion of incidents at installations and related case reports.

It is the joint ambition of the ANVS and the FANC to involve each other in a number of inspections each year. In 2016, for example, they attended each other's inspections at the Doel and Borssele nuclear power plants, and in 2017, ANVS inspectors attended inspections at both the Doel and the Tihange nuclear power plants.[118] The inspection at the Doel nuclear power plant that took place on 20 January 2016 was the first time that ANVS inspectors attended an inspection of the FANC and Bel V. The inspection focused on the implementation of improvement measures resulting from the European stress test. On this occasion, the inspectors were joined by the Dutch Minister of Infrastructure and the Environment, the Belgian Minister of Security and the Interior and the Belgian Minister of Energy. Their presence generated a significant amount of media attention. The setting presented an image of a joint inspection, which was reinforced by the media reports. However, this event did not actually amount to a joint inspection, which would have involved the inspectors from both countries in a formal role. Formally speaking, the ANVS and the FANC do not supervise each other's nuclear power plants.

Sub-conclusion

Inspectors of the ANVS and the FANC attend each other's inspections in order to learn from one another. Although Dutch inspectors are not involved in inspections at the Emsland nuclear power plant, the Dutch authorities have other opportunities to form a picture of the safety of that installation. The authorities play no formal part in the actual supervision of the safety of nuclear power plants in neighbouring countries.

118 The inspection at Doel took place on 17 October 2017 and the inspection at Tihange on 21 November 2017.

3.3.4 Information on incident reports

Operators of nuclear power plants have a duty to report all incidents that meet pre-established criteria to the relevant nuclear regulatory authority as soon as possible. EPZ reports incidents at the Borssele nuclear power plant to the ANVS, Electrabel reports incidents at the Doel and Tihange nuclear power plants to the FANC and Kernkraftwerke Lippe-Ems reports incidents at the Emsland nuclear power plant to the NMU. This enables the nuclear regulatory authority to check whether the operator is able to resolve the incident and its consequences in an adequate and timely fashion. Any incident at a nuclear power plant, no matter how insignificant, may raise questions among the public. It is therefore important that the authorities tasked with answering questions from citizens have information about the nature and severity of these incidents. This also applies to incidents at nuclear power plants on the other side of the border that may lead to questions or concern among the public.

Appendix F describes how the three countries organised the incident reporting process within their own country. This section focuses exclusively on how the Netherlands and its neighbouring countries Belgium and Germany share information about incidents at each other's nuclear power plants. This applies only to incidents which present no radiological hazard to the surrounding area. If an incident may present a radiological hazard to the surrounding area and, in the worst-case scenario, could lead to a nuclear accident, other agreements between countries apply. These are described in chapter 4 of this investigation report.

Agreements between the Netherlands and Belgium on forwarding incident reports

The ANVS has agreed with the FANC and Belgium's crisis centre (*Coördinatie- en Crisiscentrum van de Regering* – CGCCR) to exchange incident reports from the nuclear power plants. This will put all parties in a better position to answer any questions from the public in their own country about incidents on the other side of the border. The ANVS will inform the FANC about incidents at the Borssele nuclear power plant by telephone. The Zeeland safety region does not actively forward reports about incidents at the Borssele nuclear power plant to the Belgian provinces, in part because those provinces have indicated that they have no need for it. Nonetheless, information about incidents is accessible on the websites of the ANVS and EPZ (see also the next section of this investigation report) and on the ANVS' Twitter account.[119] As soon as EPZ posts information about an incident at the Borssele nuclear power plant on its website, it forwards a link to this information to the Doel nuclear power plant. Due to the geographic proximity of the Doel and Borssele nuclear power plants, their staff keep in regular contact about incidents and other matters. There are no such contacts with the Tihange nuclear power plant.

By contrast, Belgium actively provides information about incidents at the Doel and Tihange nuclear power plants to the Netherlands. The Dutch minister's efforts to reach an agreement with her Belgian counterpart on this subject[120] may be regarded as

119 The ANVS posts a tweet about every reported incident classified as INES level 0 or above. The ANVS' Twitter account has more than 200 followers (as of 1 September 2017).

120 House of Representatives (*Tweede Kamer*), 2015 – 2016, No. 1408 and 32645 No. 64.

indicative of the clear need for information on the Dutch side. This need arises from the public concern about incidents and the need for Dutch safety regions to be able to answer questions about these incidents. The public need for information on incidents is much stronger in the Netherlands than it is in Belgium. As a result, the mutual provision of information is motivated by the degree of concern about the nuclear power plants rather than by reciprocal information as a matter of principle. As such, the ANVS receives reports from the CGCCR about incidents at the Doel and Tihange nuclear power plants. Belgium also forwards incident reports to the Netherlands at the regional level. The regional emergency centre of the province of East Flanders[121] forwards all incident reports from the Doel nuclear power plant to the emergency centre of the Zeeland safety region. This occurs as agreed. Besides, Electrabel itself also forwards incident reports from the Doel nuclear power plant to a number of Dutch municipalities and safety regions.

There are similar agreements between the province of Liège and the South Limburg safety region regarding incident reports from the Tihange nuclear power plant. These include agreements on forwarding reports that have nothing to do with nuclear safety but may nevertheless be a source of public concern. At the time of writing this investigation report, no incident reports from the Tihange nuclear power plant had yet been forwarded to the South Limburg safety region. The safety region had only received a test message in French

Agreements between the Netherlands and Germany on forwarding incident reports
Incidents at nuclear installations are a standing item on the agenda for the annual NDKK meetings between the Netherlands and Germany. Incidents which are extraordinary by nature or offer a learning opportunity for other authorities are discussed in depth. Up to the moment of drafting this investigation report, there has been no active forwarding of reports about incidents at the Emsland nuclear power plant to the Netherlands. Although the authorities of both countries reached agreements on this very recently, these have not yet been put into practice. As part of these agreements, incidents classified as INES level 0 are not shared with the Dutch authorities as a standard procedure. The information provision to the Netherlands in this respect will be limited to the information required in order to warn the public in advance about scheduled shutdowns and provide them with details to counter incorrect information circulating. The Dutch authorities will always be informed about incidents that might cause public concerns or involve a possible discharge of radioactive materials. Information about incidents is publicly accessible on the websites of RWE, the nuclear power plant's owner, and the NMU.

Reports about incidents at the Borssele nuclear power plant are not actively shared with Germany, except during NDKK meetings. Given the nuclear power plant's distance from the German border, this does not stand to reason.

121 Ghent 100/112 emergency centre.

Sub-conclusion

The Netherlands and its neighbouring countries have entered into agreements about the exchange of information on incidents at their nuclear power plants. Some of these agreements are yet to be put into practice. The Netherlands receives incident reports from the Doel nuclear power plant and, as soon as agreements are put into practice, from the Tihange and Emsland nuclear power plants as well. This will then enable the ANVS and the safety regions to inform the public about incidents that are expected to generate concern in the Netherlands.

3.3.5 Access to information on incidents

The Dutch Safety Board considers it important that interested citizens have access to reliable and understandable information about incidents at nuclear power plants. This point of view fits well with the principles for openness and transparency in communications, as drawn up by the European Nuclear Safety Regulators Group (ENSREG). ENSREG advises nuclear regulatory authorities to produce information in plain language that is easy to understand. Where deemed necessary, information should be translated.[122]

This section describes which information on incidents at the Borssele, Doel, Tihange and Emsland nuclear power plants is publicly available.

Availability of information on incidents

EPZ[123], Engie/Electrabel[124] and RWE[125] all publish information about incidents at their nuclear power plants on their websites. They provide a description of the incident in question with an indication of the provisional INES level. In addition, RWE publishes a monthly report about the incidents that took place at the Emsland nuclear power plant during that period. These reports are publicly accessible.

Furthermore, the companies offer the opportunity to track the available production capacity for nuclear energy at their nuclear power plants almost in real time through dedicated websites.[126] Anyone can take out a (free) subscription to this service. Subscribers receive a notification as soon as the production capacity deviates from the usual capacity by more than 100 MW. It follows that nuclear power plant shutdowns are observable this way. By providing access to this service, the energy companies meet the requirements of the European REMIT Regulation.[127] Incidentally, this regulation bears no relation to inform the public about incidents at nuclear power plants, but is designed to expose and discourage the market manipulation of energy prices.

122 ENSREG, *Guidance for National Regulatory Organisations; Principles for Openness and Transparency*, 2011.
123 http://epz.nl/rapportages-aan-de-overheid
124 For the Doel nuclear power plant: http://corporate.engie-electrabel.be/nl/lokaal-producent/kernenergie/doel/doel-publicaties/ and for the Tihange nuclear power plant: http://corporate.engie-electrabel.be/nl/lokaal-producent/kernenergie/tihange/tihange-publications/
125 http://www.rwe.com/web/cms/de/17050/rwe-power-ag/energietraeger/kernkraft/kkw-emsland/presse-betriebsinformationen/
126 For EPZ: https://www.pzem.nl/trading/assets/remit, for Engie: http://transparency.engie.com, for RWE: https://www.rwe.com/web/cms/de/59968/transparenz-offensive/
127 REMIT is short for *Regulation on Wholesale Energy Market Integrity and Transparency*.

It is standard practice for editorial staff at Belgian media (newspapers, television and radio stations) to subscribe to Engie/Electrabel's website. As a result, they are notified automatically as soon as one of Belgium's nuclear power reactors is shut down, which allows them to provide up-to-date information to the public. A potential side effect of the companies' obligation to publish anomalies in the available energy production capacity and the media reports these anomalies will bring about, is that the public might get the impression that the reactors have become less reliable. However, the available data show that there has been no increase in unscheduled shutdowns at Belgium's nuclear power plants. Please refer to Appendix G for more information.

The ANVS[128], the FANC[129] and the NMU[130] also publish information about incidents on their respective websites. This information consists of a description of the incident and an indication of the provisional INES level. In addition, the ANVS posts a tweet with a link to a description of the incident on its website. At the time of writing this investigation report, the FANC and the NMU did not have Twitter accounts. The text box below describes a number of incidents and how they were made public.[131]

Incident at the Borssele nuclear power plant (INES level 0)
At 01:30 on 11 October 2016, there was an automatic shutdown at the Borssele nuclear power plant as a result of a pump failure. This unscheduled shutdown was announced on EPZ's REMIT website one minute later. EPZ's communications department composed a message for publication on the EPZ website. Once notified, the ANVS assessed whether the INES level proposed by the EPZ was correct. At 00:41 on 12 October 2016, the ANVS published a message on its website and posted a tweet.

Incident at the Doel nuclear power plant (INES level 0))
At 13:33 on Tuesday, 10 January 2017, there was a steam leak at Doel 4, as a result of which an employee suffered burns. This incident was announced on Electrabel's website one minute later. Several updates were posted in the days following the incident. On 11 January 2017, the FANC published a message about the incident including an explanation of its cause on its website.[131]

Incident at the Emsland nuclear power plant (INES level 0)
At 13:00 on 3 April 2015, the nuclear power plant was shut down manually following the detection of moisture in the plant's technical area. This shutdown made it possible to carry out a further inspection. The shutdown was announced on RWE's website immediately. Once notified, the NMU published a message on its website the same day.

128 https://www.autoriteitnvs.nl/ongewone-gebeurtenissen/kerncentrale-borssele
129 http://fanc.fgov.be/nl/ongewone-gebeurtenissen/ongewone-gebeurtenissen-belgie/nucleaire-inrichtingen
130 http://www.umwelt.niedersachsen.de/themen/atomaufsicht/kernkraftwerke/emsland/kkw_emsland/
131 http://fanc.fgov.be/nl/content/incident-de-kerncentrale-van-doel-4-geklasseerd-op-ines-niveau-0

The three countries' authorities also publish annual incident reports.[132] In the Netherlands and Belgium, these reports are published by the ANVS and the FANC respectively. The German report is prepared by the Federal Office for the Safety of Nuclear Waste Management (*Bundesamt für kerntechnische Entsorgungssicherheit* - BfE), a federal public service that also publishes monthly incident overview reports.[133] Information about incidents is only available in the language(s) of the country concerned. In Belgium, the information is published in both Dutch and French.

Both the authorities and the operators in the Netherlands, Belgium and Germany communicate actively and through multiple channels about incidents at nuclear power plants. The Dutch Safety Board observes that the public has easy access to information about incidents, even shortly after they have taken place. The parties involved have stated that they struggle to provide understandable information to the public about such incidents, which are often highly technical in nature. Indeed, in the judgement of the Dutch Safety Board, they have not succeeded doing so, as a result of which citizens will probably experience difficulties when they try to understand and evaluate the information about incidents. The Dutch Safety Board is of the opinion that the parties involved should improve the quality of their communications to the public in this regard, so that citizens are able to form an accurate picture of what occurred at the nuclear power plant in question.

Criteria for the types of incidents about which information is made available
There are minor differences in the criteria that each country uses for the types of incidents about which information is made available online. EPZ and the ANVS publish information about all incidents at the Borssele nuclear power plant classified as INES level 0 or above. RWE and the NMU follow the same approach with regard to the Emsland nuclear power plant. Electrabel and the FANC publish information about all incidents classified as INES level 1 or above, and recently also about incidents classified as INES level 0 or without any INES level in sofar these incidents could potentially attract media attention.

In the Board's view, harmonisation of the communication between neighbouring countries can contribute to the avoidance of public concern. This harmonisation would mainly involve a coordination of the criteria for the types of incidents that are published and the kind of information that is provided in the respective countries.

Sub-conclusion

In the Netherlands, Belgium and Germany, both the nuclear regulatory authorities and the nuclear power plant operators post information about incidents on their respective websites. The criteria used by the ANVS and the NMU for the types of incidents about which they communicate do not exactly match those used by the FANC. While it is easy for the public to access information about incidents, the majority will struggle to understand it.

132 In the Netherlands, this information is published in the ANVS report *Ongewone gebeurtenissen in Nederlandse nucleaire inrichtingen*. In Belgium, it is published in the annual report of the FANC and in Germany in the annual report *Meldepflichtige Ereignisse in Anlagen zur Spaltung von Kernbrennstoffen* prepared by the Federal Office for the Safety of Nuclear Waste Management (BfE).
133 http://www.bfe.bund.de/DE/kt/ereignisse/berichte/berichte_node.html

4 CRISIS MANAGEMENT

If a nuclear accident were to occur involving the release of a substantial amount of radioactive materials, the consequences will be widespread and profound.[134] If the nuclear power plant is located close to a national border, the consequences will not be limited to the accident country but will also affect countries on the other side of the border. This cross-border dimension requires the countries affected to cooperate in order to limit the consequences of the nuclear accident.[135]

This chapter describes the way in which the Netherlands cooperates with Belgium and Germany in jointly preparing for a potential nuclear accident at one of the Borssele, Doel, Tihange and Emsland nuclear power plants. The Dutch Safety Board has not investigated the crisis management system comprehensively, but has focused its investigation on a number of aspects for which proper exchange of information and good coordination between countries are essential. This chapter discusses planning, exercises, alerting, the exchange of radiological and technical information, the coordination of the crisis management approach and the provision of information to the public (in preparing for and during a nuclear accident). The investigation covers the first phase of a crisis. The post-accident phase was not a topic of the investigation.

4.1 Managing a crisis arising from a nuclear accident

4.1.1 Consequences and measures to be taken

A nuclear accident makes specific demands on crisis response and crisis management. One of the key aspects of a nuclear accident is that radioactive materials are released that can spread far beyond the nuclear power plant depending on the amount, the way the materials are released and the weather conditions.[136,137] These materials emit ionising radiation during radioactive decay, which means that people in the affected area can be exposed to radiation. Depending on the level and duration of exposure, harmful health

134 In the Dutch National Risk Profile 2016 (*Nationaal Veiligheidsprofiel 2016*), the overall impact of a radiation accident in the Netherlands is classified as very serious. Furthermore, it states that a nuclear accident in the Netherlands in the next five years is very unlikely. The Dutch National Risk Profile 2016 was prepared by the National Network of Safety and Security Analysts, which comprises knowledge institutes and other services coordinated by the National Institute for Public Health and the Environment (*Rijksinstituut voor Volksgezondheid en Milieu* - RIVM).

135 IAEA, IAEA Safety Standards Series, *Emergency preparedness and response for a nuclear and radiological emergency, General Safety Requirements No GSR Part 7*, 2015. HERCA-WENRA *Approach for a better cross-border coordination of protective actions during the early phase of a nuclear accident*, 2014. IAEA, *Convention on Early Notification of a Nuclear Accident*, effective date 27 October 1986.

136 This contrasts with the routine discharges in which a limited (authorised) amount of radioactive isotopes are discharged into the atmosphere.

137 An analysis was conducted in Germany of the risk of the release of radioactive materials from a nuclear power plant. The analysis provides insight into the scale and extent of the potential consequences of a nuclear accident. The analysis resulted in a number of recommendations, including a recommendation to prepare emergency plans jointly with neighbouring countries to ensure a coordinated approach to crisis management.

effects can occur,[138] mainly in the form of an increased risk of cancer in the longer term. It should be noted that particularly the fear of radiation and the socio-economic disruption arising from a nuclear accident contribute to the psychosocial problems citizens experience if they are affected by a nuclear accident. The international organisation UNSCEAR[139] estimates that the psychosocial consequences of the Fukushima accident are larger than the physical health problems.

In the event of a nuclear accident measures must be taken to protect the people living in the vicinity of the nuclear power plant against potential exposure to radiation. Measures should be taken to limit the total effective exposure with the aim of shortening the duration of exposure, fencing off the contaminated environment and preventing or limiting the inhalation (breathing in) and ingestion (intake with food and drink) of radioactive materials. There are two types of measures: direct and indirect measures:

- *Direct measures* aim to minimise and protect the population against the consequences of direct radiation exposure. These measures comprise sheltering or evacuating the population to prevent people from direct exposure to radiation[140], and arranging for people to take stable, non-radioactive, iodine at the right time. Taking iodine tablets during an accident helps to saturate the thyroid gland to protect people against thyroid cancer.
- *Indirect measures* aim to minimise indirect exposure through contaminated food or drinking water for instance. Examples are measures to prevent the contamination of crops, milk and meat, shutting off the drinking water inlet points, announcing a ban on the transport of goods and animals, taking food and goods off the market, checking for contamination, decontamination, et cetera. Indirect measures may even be necessary in the event of an accident abroad at a large distance from the border, as was the case in the Fukushima accident (see the text box on the following page).

In the event of a nuclear accident, direct and indirect measures can be implemented alongside each other. In the event of an actual or imminent nuclear accident, the responsible authorities will need to decide what actions to take to protect the population in certain areas. In order to proceed effectively and efficiently, they will need to estimate what areas will be affected and what radiation levels the population in these areas will be exposed to. In addition to the amount of radioactive materials emitted, the development of the situation over time and the weather conditions are other factors that will determine the action to be taken. In certain circumstances it may make more sense for citizens to take shelter rather than to evacuate the area. Evacuation is only effective if it is coordinated properly, and it should preferably be completed either before any radioactive materials are discharged or in between two more or less controlled discharges. If groups

138 Exposure occurs by inhaling radioactive materials, eating or drinking contaminated food or liquids and by exposure to radiation from the radioactively contaminated area. An important factor in terms of the effects is the total effective exposure that occurs; this is the product of the intensity of the radiation and the time spent in the contaminated area plus the amount of radioactivity inhaled or swallowed. In order to assess the consequences of radiation exposure, it is important to take account of the properties of radioactive substances, the external radiation levels and the degree and nature of the internal physical contamination.

139 UNSCEAR, *Developments since the 2013 UNSCEAR Report on the levels and effects of radiation exposure due to the nuclear accident following the great east-Japan earthquake and tsunami*, 2016.

140 In addition, wearing protective clothing and/or a surgical mask will offer a certain degree of protection.

of people decide to leave an area in a hurry, this could severely disrupt operations to purposefully evacuate the population. If citizens consequently run the risk of unprotected exposure to ionising radiation, it would be preferable for the population to take shelter at that moment.[141]

Especially during the accident phase, it is a matter of whether citizens are willing to be directed by government decisions. For the sake of their own safety, they will need to follow the government's instructions. Citizens who do not trust the government will be less inclined to do so.[142] Moreover, it should be clear to citizens what is expected from them to prevent them from taking the "wrong" actions or from taking no action at all, out of uncertainty or fear. After all, this will make it more difficult for the authorities to ensure the smooth execution of measures aimed explicitly at protecting citizens.

The Netherlands response to the Fukushima accident

The accident in Fukushima, Japan, occurred early in the morning of 11 March 2011. Despite its long distance from Japan, the Netherlands was also affected by the consequences of the accident. This firstly concerned the protection of Dutch nationals living, working or being on holiday in Japan. They were advised not to travel in the region of the affected area. In addition, the Dutch embassy received a supply of iodine tablets for all Dutch nationals who were in Japan at that time although there was no need for them to actually take the tablets. In the absence of an existing protocol, plans had to be made for various operational matters hastily. Goods and food from Japan, for example, were required to undergo inspection for radioactive contamination and radiation measurements had to be taken on aircraft from Japan arriving at Amsterdam Airport Schiphol. The Dutch government provided guidelines for technicians in the Netherlands who carried out maintenance on aircraft from Japan as well as guidelines for inspecting containers from Japan. Information was provided to those who had concerns about possible exposure due to their occupation, such as port employees.

4.1.2 Cross-border cooperation in the event of a nuclear accident.

Not only countries with one or more nuclear power plants but also countries that may have to deal with the consequences of a potential nuclear accident should be prepared for such accidents. The need for countries to cooperate in this regard is greater, the closer the nuclear power plant is to the border between those countries. In order to be able to respond promptly, it is vital that the accident country alerts neighbouring countries as quickly as possible about a nuclear accident. In order to assess the consequences, information must be provided about the nature of the accident, the

141 Depending on the type of building, sheltering can limit the dose by around 50%. However, protection will decrease over time because after several hours indoor exposure will not be much lower than outdoor exposure due to the penetration of contaminated outside air. Source: RIVM, *Technische basisinformatie stralingsongevallenbestrijding*, 2015.

142 Bos, K. van den, *Vertrouwen in de overheid. Wanneer hebben burgers het, wanneer hebben ze het niet, en wanneer weten ze niet of de overheid te vertrouwen is?*, 2011.

potential and expected emission of radioactive materials, the development of the accident and the associated prognoses. This requires the countries concerned to exchange information adequately and frequently.

It is desirable for countries to consult with each other in advance on the basic principles of the approach to be followed when taking protective measures. This will prevent a country on one side of the border from taking measures different from those on the other side of the border, and the population on one side of the border enjoying better protection than the population on the other side. In this respect, the European HERCA-WENRA cooperation[143] promotes harmonisation in the border areas around nuclear power plants. HERCA-WENRA considers this important as different approaches in bordering countries could create implementation problems because confusion may arise among the public. Harmonisation in this respect means that the neighbouring country refrains from taking measures that conflict with or extend beyond those of the accident country.

Apart from technical information and measures, neighbouring countries will need to make agreements on their communications to the public. If communications and messages differ considerably between countries this could lead to uncertainty and confusion among citizens and they may consequently be reluctant to follow instructions. Another factor that comes into play is that all kinds of information can be rapidly and widely disseminated. To reliably counter the contradictory information that reaches citizens through other channels (like mass media or via government channels of other countries that are not directly involved[144]), the responsible authorities should coordinate their communication to the greatest possible extent.

4.1.3 Organisations in the Netherlands, Belgium and Germany involved in nuclear crisis management.

In the phase of preparation
In the Netherlands, the central government is responsible for crisis coordination in the event of an accident at a nuclear power plant irrespective of whether the accident occurs at a nuclear power plant in the Netherlands or abroad. As such, the Minister of Infrastructure and the Environment (*minister van Infrastructuur en Milieu*) and the ministers concerned[145] are responsible for the preparedness for a crisis arising from an accident at a nuclear power plant (in the Netherlands or abroad). The Minister of Infrastructure and the Environment has delegated this task to the Ministry's Departmental Crisis and Coordination Centre (*Departementaal Coördinatiecentrum Crisisbeheersing* - DCC IenM). The DCC IenM arranges for, among other things, the development of nuclear crisis plans at a national level and for organising exercises based on those plans. The Authority for Nuclear Safety and Radiation Protection (*Autoriteit Nucleaire Veiligheid en Stralingsbescherming* - ANVS) is closely involved in these matters because of its expertise

143 HERCA-WENRA, *HERCA-WENRA Approach for a better cross-border coordination of protective actions during the early phase of a nuclear accident*, 2014.
144 For example, shortly after the nuclear emergency at Fukushima the US government advised its nationals to stay at a distance of at least 80 kilometres from the nuclear power plant. This advice caused several local residents to leave the area even though the instructions issued by the Japanese authorities were different.
145 In the event of a nuclear accident, this includes the Minister of Security and Justice, the Minister of Health, Welfare and Sport, the Minister of Foreign Affairs (in the event of an accident abroad) and the Minister of Defence.

in nuclear safety and radiation protection. The Minister of Security and Justice (*minister van Veiligheid en Justitie*) also has a key role in preparing for the eventuality of a nuclear accident in view of his overall responsibility for crisis management in the Netherlands. The National Coordinator for Security and Counterterrorism (*Nationaal Coördinator Terrorismebestrijding en Veiligheid* - NCTV) fulfils the minister's preparatory duty. The responsibility for the execution of nuclear accident response operations lies with the safety regions, even though the central government is responsible for coordinating crisis management. In the event of a nuclear accident in the border region, a number of safety regions play a key role due to their location: these are the Zeeland safety region (due to Borssele and Doel), the Central and West Brabant safety region (due to Borssele and Doel as well), the South Limburg safety region (due to Tihange) and the Twente safety region (due to Emsland). They prepare operational plans and arrange for coordination with the neighbouring safety regions that are involved in such plans. Notwithstanding the coordination, the neighbouring safety regions still have their own competences and responsibilities.

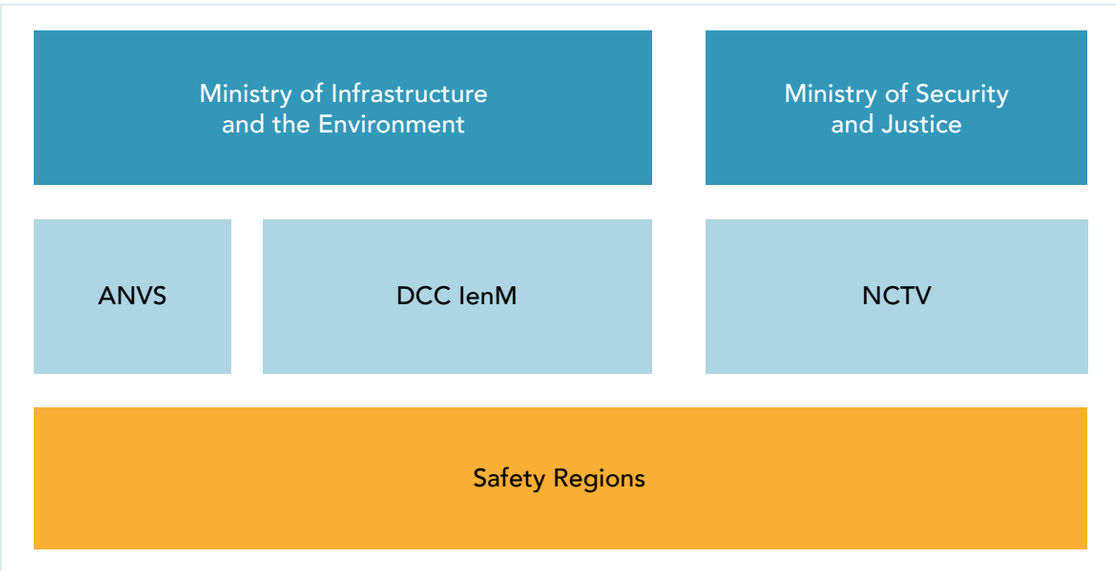


Figure 14: Schematic overview of the most relevant organisations in the Netherlands involved in the preparedness for a nuclear accident.

In Belgium, the Minister of Security and the Interior (*minister van Veiligheid en Binnenlandse Zaken*) is primarily responsible for the preparedness for crises, including a crisis arising from a nuclear accident. The minister has delegated the duty to prepare for such an accident to the Directorate-General Crisis Centre of the Federal Public Service of the Interior (*Federale Overheidsdienst Binnenlandse Zaken*). Within the Directorate-General, the Coordination and Crisis Centre of the Government (*Coördinatie- en Crisiscentrum van de Regering* - CGCCR) operates as the federal crisis centre. The CGCCR has a pivotal role in nuclear crisis planning. It is responsible for managing the nuclear crisis plan at federal level. The Federal Agency for Nuclear Control (*Federaal Agentschap voor Nucleaire Controle* - FANC) fulfils a supporting role in formulating the nuclear crisis plans. In Belgium the provinces (in conjunction with the municipalities) coordinate the execution of response operations. In the event of an accident at the Borssele, Doel or Tihange nuclear power plants, the provinces of East Flanders, Antwerp and Liège coordinate the response operations.

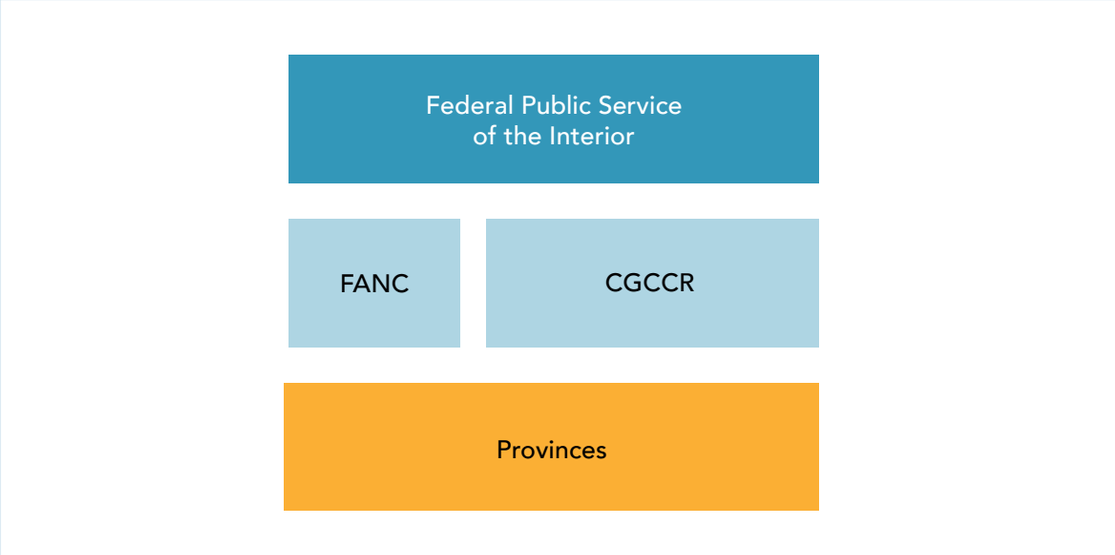


Figure 15: Schematic overview of the most relevant organisations in Belgium involved in the preparedness for a possible nuclear accident.

In Germany the individual Länder are responsible for crisis management. This is Lower Saxony for the Emsland region. In Lower Saxony, the Lower Saxony Ministry of the Interior and Sport (*Niedersächsisches Ministerium für Inneres und Sport* - NMI) is responsible for crisis management. The federal government of Germany is responsible for liaising with other countries in preparing for crises with transboundary consequences. In case it involves nuclear crises, the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (*Bundesministerium für Umwelt*, Naturschutz, Bau und Reaktorsicherheit - BMUB) is responsible for doing so. The Federal Office for Civil Protection and Disaster Assistance (*Bundesamt für Bevolkerungsschutz und Katastrophenhilfe* - BBK), part of the Federal Ministry of the Interior (*Bundesministerium des Innern* - BMI), facilitates the Länder with crisis management. Within the BBK, Germany has a central centre for civil safety, the German Joint Information and Situation Centre (*Gemeinsames Melde- und Lagezentrum von Bund und Ländern* - GMLZ).

Landkreis Emsland prepares the execution of nuclear accident response operations. The operational coordination of the crisis management lies with the Osnabrück police department (*Polizeidirektion Osnabrück*). Landkreis Emsland has drawn up an emergency response plan for the response to a nuclear emergency at the Emsland nuclear power plant. At Länder and federal government level there are no nuclear crisis plans like in the Netherlands and Belgium. On 1 October 2017 legislation entered into force introducing a stacked system for nuclear crisis planning. Under the new legislation, the federal government is required to provide for an overarching crisis plan, on the basis of which the Länder are required to draw up their own crisis plans. The BMUB provides guidance on the content of the nuclear crisis plans: the German Commission on Radiological Protection (*Strahlenschutzkommission*), a commission within the BMUB, has set out national guidelines that serve as a framework to ensure that nuclear crisis management for the whole of Germany is set out according to a consistent framework.

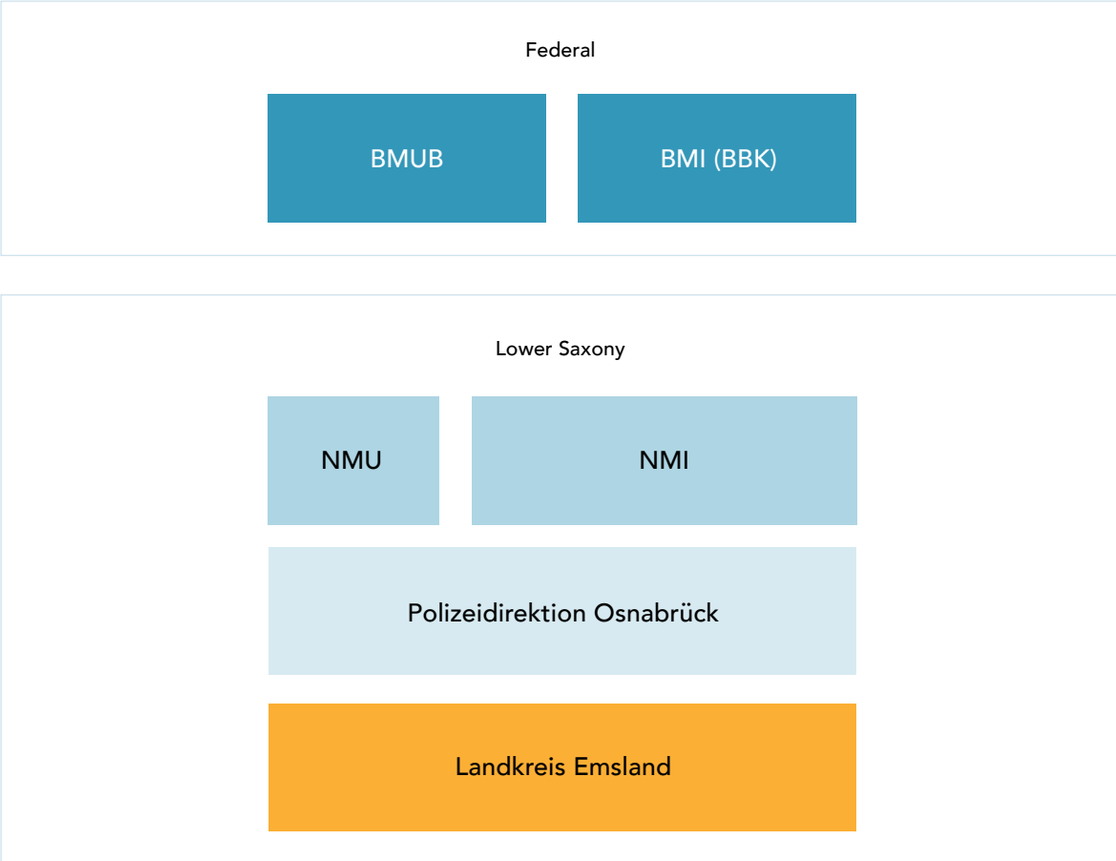


Figure 16: Schematic overview of the most relevant organisations in Germany (of the federal government and the Land Lower Saxony) involved in the preparedness for a nuclear accident at the Emsland nuclear power plant.

Appendix C contains an overview of the main organisations, their responsibilities and their role in nuclear accident preparedness and response. Appendix F provides information on the crisis organisation that will be activated in the event of an actual of imminent nuclear accident.

4.2 Planning

This section describes the way in which the Netherlands has jointly undertaken preparations with Belgium and Germany for cross-border cooperation to manage a crisis arising from an accident at one of the nuclear power plants in the border region. The question is not only to what extent countries take the transboundary nature of such accidents into account in their plans, but also how they align their basic principles for response as well as the plans with those on the other side of the border.[146] The Chernobyl accident showed that the Dutch government was not prepared for such an event, which prompted the government to draw up a national plan (see text box).

146 In its advisory report on nuclear planning in Belgium (*Nucleaire ongevallen, leefmilieu en gezondheid in het post-Fukushimatijdperk: Rampenplanning*), the Superior Health Council of Belgium stated that the emergency plans lacked sufficient cross-border coordination.

Planning in the Netherlands after the Chernobyl disaster

The Chernobyl disaster in 1986 revealed that the nuclear alerting arrangements were far from complete and that the Dutch government had not made any preparations for several aspects, such as the provision of information to the public and the potential role of the local authorities. It not only became apparent how widespread the consequences of a nuclear accident could be, but it also became clear what measures would be necessary should a nuclear accident occur in or near the Netherlands. The action taken by the central government in response to the Chernobyl accident was evaluated. The evaluation prompted the Dutch government to improve preparedness for a nuclear accident. This resulted in the National Nuclear Emergency Plan in 1989, followed by the National Nuclear Emergency Plan Revitalisation Project that was initiated in 1999 to improve nuclear crisis planning. The National Nuclear Emergency Plan has since been superseded by the National Plan for Nuclear and Radiological Emergencies.

4.2.1 Measures to protect the population against radiation exposure

The Netherlands, Belgium and Germany apply the internationally adopted radiation protection policy issued by the International Commission on Radiological Protection (ICRP).[147] The commission's recommendations are set out in the Euratom directives.

The Netherlands, Belgium and Germany have each determined planning zones in order to prepare direct protective measures. Planning zones are circular areas around nuclear power plants within which preparations are made for sheltering or evacuating the population and for ensuring the availability of stable iodine. Countries autonomously decide on the size of the planning zones. This may result in mutual differences (see text box).

Harmonisation of planning zones

A review[148] commissioned by the European Commission in 2013 brought to light that the planning zones in European countries vary considerably. The researchers concluded that even though the countries apply the same principles for radiation protection, they make different assumptions in the underlying calculations for the distances used. These assumptions relate to the severity of the accident, the outreach of the consequences and possible weather influences. The review resulted in a recommendation to improve harmonisation in Europe. The researchers recommended adopting a political approach for this purpose because, in their view, a discussion on the technical background to this issue would not achieve the desired results.

147 The members of the commission are scientists and policymakers from different countries and continents.
148 ENCO, *Review of Current Off-site Nuclear Emergency Preparedness and Response Arrangements in EU Member States and Neighbouring Countries*, 2013.

The size of the zones is determined in part on the basis of the estimated scale and extent of the consequences, the dose values[149] above which protection of the population is required and the political choice with respect to the preferred level of preparedness.

The area where measures should be considered when a nuclear accident occurs, may differ from the zone that has been prepared, depending on the actual situation that has arisen. The crisis organisation will assess, based on an analysis of the situation in the nuclear power plant and the potential emission of radioactive material, to what extent the public in the surrounding areas may be exposed to radiation. The uncertainty about the course of the accident inside the nuclear power plant, changing weather conditions and suchlike mean that assessments have limited tenability. This variability and the numerous factors[150] influencing the decision on where to take specific measures compound the decision-making process.

Harmonisation

Partly on account of the Fukushima accident and the approach set out at the European level for better cross-border cooperation in responding to a nuclear accident[151], the Netherlands, Belgium and Germany have formulated policies to prepare similar protective measures in the event of a nuclear accident. In 2014 the Dutch government decided to harmonise the planning zones and intervention levels with those in Germany and Belgium.[152] In practice, the implementation of this decision entailed that the Netherlands should prepare for a larger scale evacuation and wider availability of iodine tablets than prior to the decision. Figure 17 shows the size of the areas within which protective measures are prepared in the Netherlands.

The implementation of the harmonisation policy comprises, among other activities, the adjustment of crisis plans and the underlying documents at national and regional level, the distribution of iodine tablets and the associated communication to the public. The Ministry of Health, Welfare and Sport (*Ministerie van Volksgezondheid, Welzijn en Sport*) has set out the policy on the distribution of iodine tablets. The Ministry is also responsible for the execution of the pre-distribution, which is the advance provision of iodine tablets to the public.[153] The objective of pre-distribution is to reduce acute demand for iodine tablets in the event of an accident.

149 Dose values are referred to as intervention levels and are linked to the type of measure. The countries also individually determine the intervention levels.

150 Such as the time available, the availability of equipment and emergency services, the feasibility at that moment, the possible consequences of measures, et cetera.

151 HERCA-WENRA, *HERCA-WENRA Approach for a better cross-border cooperation of protective actions protective actions during the early phase of a nuclear accident*, 2014.

152 House of Representatives (*Tweede Kamer*), 2013–2014, 32645 No. 60. The intervention levels in the Netherlands were higher in the past (and therefore less stringent) than the Belgian, German and internationally accepted values.

153 Pre-distribution has taken place in October 2017. The iodine tablets were posted to people belonging to the target group. For the nuclear power plants, the target group comprises the following Dutch residents: everyone up to and including 40 years of age and pregnant women within a radius of 20 kilometres and young people up to and including 18 years of age and pregnant women, within a radius of 100 kilometres from the Borssele, Doel, Tihange and Emsland nuclear power plants. Iodine tablets will be made available to pregnant women within a radius of 100 kilometres by pharmacies and chemist's shops.

Figure 17: Visualisation of the zones around the Borssele, Doel, Tihange and Emsland nuclear power plants applied by the Netherlands for the preparation of protective measures. The preparation by the Netherlands is restricted to the sections of the zones on Dutch territory.

The safety regions located in the zones around nuclear power plants are responsible for preparations for sheltering or evacuating the population and for the emergency distribution of iodine tablets. The emergency distribution of iodine tablets entails distribution of iodine tablets in the event of an actual or imminent nuclear accident with a possible release of radioactive materials. Emergency distribution covers an area within a 100-kilometre radius around the nuclear power plant. All safety regions located within that distance were required to have an operational plan available for emergency distribution by the end of 2017. Out of the 25 safety regions, 20 are located within the 100-kilometre zones[154] around the Borssele, Doel, Tihange and Emsland nuclear power plants.

154 In addition to the Zeeland, Central and West Brabant, South Limburg and Twente safety regions, the zones around the Borssele, Doel, Tihange and Emsland nuclear power plants include the Southern South Holland, Rotterdam-Rijnmond, Haaglanden, Central Holland, Utrecht, South-East Brabant, North Limburg, IJsselland, Drenthe, Flevoland, Central Gelderland, North and East Gelderland, Friesland and Groningen safety regions.

An analysis of the risk profiles of the safety regions concerned shows that the regions assess the risk of a nuclear accident quite differently.[155] Various safety regions have not included the risk of a nuclear accident in their risk profile, even though they are situated (at least in part) within a 100-kilometre radius from a nuclear power plant.

Coordination of the basic principles between the Netherlands and its neighbouring countries
For the purpose of the harmonisation process in 2014, the Netherlands aligned its policy with the policies applicable in Belgium and Germany at that time. Both Belgium and Germany later adjusted their basic principles concerning the preparation of protective measures.[156] Although both countries have adopted the adjusted basic principles, they have not yet incorporated them into their plans. Belgium will implement the changes in the plans during the course of 2018. Germany will do so in 2019.

Table 2 shows the distances determined by the three countries based on the most recent basic principles for the zones within which protective measures are prepared.

155 In the Dutch National Risk Profile 2016 (*Nationaal Veiligheidsprofiel 2016*), the overall impact of a radiation accident in the Netherlands is classified as very serious. Furthermore, it states that a nuclear accident in the Netherlands in the next five years is very unlikely. The Dutch National Risk Profile 2016 was prepared by the National Network of Safety and Security Analysts, which comprises knowledge institutes and other services coordinated by the National Institute for Public Health and the Environment (*Rijksinstituut voor Volksgezondheid en Milieu* - RIVM).

156 In Belgium this concerns the *Advies m.b.t. noodplanning*, drawn up by the Scientific Council for Ionising Radiation (*Wetenschappelijke Raad voor Ioniserende Straling*) in January 2016. In Germany this concerns the recommendation by the German Commission on Radiological Protection (*Strahlenschutzkommisssion, planning areas for emergency response near nuclear power plants; Recommendation by the German Commission on Radiological Protection)* in 2014.

Borssele, Doel and Tihange nuclear power plants			
Policy in the Netherlands		Policy in Belgium[157]	
		Reflex zone[158]	3,5
Evacuation[159]	10	Evacuation	10 - 20
Shelter	20	Shelter	20 - 100
Iodine target groups - up to and including 40 years of age, and pregnant women - up to and including 18 years of age, and pregnant women	20 100	Iodine target groups[160] - up to and including 40 years of age, and pregnant women - up to and including 18 years of age, and pregnant women	20 - 100 België
Emsland nuclear power plant			
Policy in the Netherlands		Policy in Germany	
Evacuation	10	Evacuation	20
Shelter	25	Shelter	100
Iodine target groups - up to and including 40 years of age, and pregnant women - up to and including 18 years of age, and pregnant women	25 100	Iodine target groups - up to and including 45 years of age, and pregnant women - up to and including 18 years of age, and pregnant women	100 Germany

Table 2: The planning zones determined by the Netherlands, Belgium and Germany (radius in kilometres) around the nuclear power plants for direct protective measures in the event of a nuclear emergency situation

These basic principles, listed in Table 2, have not yet been implemented in all crisis plans. For further details, see Appendix E. The table shows various differences between the countries that suggest different underlying assumptions. The following observations can be made on the differences between the Netherlands and Belgium, and between the Netherlands and Germany:

157 The values in the table are subject to adoption of the updated Nuclear and Radiological Emergency Plan for the Belgian Territory (*Nucleair en Radiologisch Noodplan voor het Belgische Grondgebied*). The plan had not yet been formally adopted when this report was written. The plan classifies the planning zones either as emergency planning zones or extension zones. The emergency planning zones cover by far the majority of all emergencies. If necessary, emergency planning zones may be widened to extension zones in accordance with a strategy whose basic principles are laid down in the emergency plan. The zone expansion is up to 20 kilometres for evacuation and up to 100 kilometres for sheltering and the availability of stable iodine tablets for the public. This is indicated in the table by means of a range of emergency planning zone (number on the left) to extension zone (number on the right).

158 Belgium applies a reflex zone, for the special case of an emergency that requires immediate protection of the public. This concerns specific accident scenarios in which measures to protect the public must be taken within four hours of the initial event. This entails warning the public, the advice to take shelter and the advice to listen to the media, pending activation of the federal crisis organisation.

159 The population in the 5-kilometre circle around the nuclear power plant is given priority in an evacuation.

160 In Belgium, boxes containing iodine tablets are distributed to families and collectives (schools, hospitals, day care centres, factories, emergency services et cetera) within a radius of 20 kilometres from the nuclear power plant. Outside these zones, boxes containing iodine tables are made available all over the Belgian territory to children (under age 18), pregnant women, breast-feeding women and collectives associated with these target groups. In the event of extremely high exposure levels, the Belgian authorities may also decide to advise persons over age 40 to take iodine tablets.

- The recent changes in German federal policy have not yet been included in the Dutch harmonisation policy. For its policy, the Netherlands has copied the zones around the Emsland power plant as stated in the emergency response plan of Landkreis Emsland (2012) in force at that time. That plan has not yet been updated. Harmonisation between the Netherlands and Germany has been discussed frequently by the members of the NDKK. These discussions included wider zoning in Germany due to the change in policy. In a recent NDKK meeting, the members agreed that the authorities concerned in the two countries should prepare a joint proposal for the implementation of German policy so that both countries again have the same planning zones around the Emsland nuclear power plant. As stated in the meeting report, both countries consider this process a "challenge".
- If a nuclear accident in a neighbouring country were to occur, in principle, the Belgian government will adopt the approach of the accident country but will leave the option open of working with its own intervention levels if they differ from those of the neighbouring country.[161]
- Germany applies an age limit that differs from the age limit applied by the Netherlands and Belgium for people who should receive iodine tablets in the first circle around the nuclear power plant. The German policy is based on the age limit of 45 years instead of 40.
- Belgium and Germany prepare the distribution of iodine tablets for people up to and including the age of 18 years and for pregnant women throughout the whole country whereas the Netherlands applies 100-kilometre zones. Belgium's reason for doing so is mainly pragmatic; the aim is to provide just one clear and basic guideline for the whole of Belgium. In addition, in Belgium the use of zones with a 100-kilometre radius will cause almost the entire country to be covered. The German decision follows from calculations made by the German Commission on Radiological Protection (*Strahlenschutzkommission* – SSK), which show that an INES level 7 nuclear accident may require the intake of iodine up to a distance of 200 kilometres.[162] The application of such distances led to the choice for distribution across the whole of Germany. According to its harmonisation policy, the Netherlands can opt to widen the area for emergency distribution to beyond the 100-kilometre radius, when applicable. However, the policy does not explicit how, in such case, the acute need for iodine tablets is to be met in areas where no emergency distribution was prepared.
- There are also differences between the countries in terms of the manner in which they ensure the availability of iodine tablets in the event of a nuclear accident. For example, in the Netherlands the tablets are made available in advance via door-to-door distribution, whereas Germany largely depends on an emergency distribution effort.

161 Federale Overheidsdienst Binnenlandse Zaken, *Nucleair en Radiologisch Noodplan voor het Belgische Grondgebied*, draft version September 2017.

162 SSK, *Planning areas for emergency response near nuclear power plants; Recommendation by the German Commission on Radiological Protection*, 2014.

- The Netherlands prepares evacuation of the population in a 10-kilometre zone around the nuclear power plant. Germany has opted for a zone of double that distance. In Belgium, preparations for evacuation using extension zones cover an area of up to 20 kilometres around a nuclear power plant. This goes to show that the countries make different assumptions.[163] One lesson learned from the Fukushima accident is that the actual evacuation zone in the event of a nuclear accident may be larger. During that accident, an initial evacuation was necessary within a radius of 20 kilometres around the plant. In the aftermath, evacuations took place beyond this zone (up to a distance of 50 kilometres). If a nuclear accident with a similar impact were to occur, the authorities in the Netherlands, Belgium and Germany will have to be able to evacuate larger zones than those for which they are prepared for. Depending on the areas considered, this may involve considerable numbers of people that need to be evacuated.

The aim of harmonisation is that the neighbouring country refrains from taking measures around the nuclear power plant that conflict with or extend beyond those of the measures declared by the accident country. This may relate to both the size of areas and the associated conditions (such as defined target groups, operational requirements such as evacuation times, et cetera). Although the Netherlands, Belgium and Germany are committed to the international appeal with regard to harmonisation, the Dutch Safety Board observes that the Netherlands has not yet entirely achieved the desired level of harmonisation with its neighbouring countries. The basic principles differ partly because the neighbouring countries' policies are in a state of flux.

The Dutch Safety Board has questioned how differences would turn out during a nuclear accident in the border region. If neighbouring countries adhere to the principle that they should follow the accident country, they will take the same measures. However, it is not certain that this will happen. Given the fact that countries yet are facing difficulties in reaching agreement, it is less likely that they will adopt each other's measures in the event of a nuclear accident. If citizens on one side of the border are faced with measures that differ from those on the other side of the border, this may compound citizen protection, according to the Dutch Safety Board. Differences between countries can create confusion among the public, which will not contribute to the smooth execution of crisis response operations. There is a possibility that citizens will opt for a measure that fails to provide them with the best protection at that moment.

Sub-conclusion

Partly because policy in the three countries is in a state of flux, the basic principles for preparing a response to a nuclear accident in the Netherlands are not fully harmonised with those of Belgium and Germany. In the event of a nuclear accident, this may imply that measures taken one side of the border will differ from those on the other side of the border. Differences between countries can create confusion among citizens.

163 There are no international standards governing the extent of the areas within which countries are required to prepare for a potential nuclear accident. Views on ideal standards in this regard differ among experts.

4.2.2 Nuclear crisis plans

The parties involved in crisis management set out their respective tasks, responsibilities, competences and their crisis management approach in crisis plans. In the event of a nuclear accident with transboundary consequences, the multitude of countries in crisis management constitutes a compounding factor. The cooperation between those countries should be well prepared and should be incorporated in the various crisis plans.[164] It is of importance that the crisis plans are aligned with each other in order to achieve a joint and decisive crisis management approach.

The crisis management approach adopted in the Netherlands, Belgium and Germany is based on a universal framework for all kinds of crises, and a specific framework tailored to a specific type of crisis, such as a crisis arising from a potential nuclear accident. The three countries have set out their approach for the response to a nuclear accident in various crisis plans and response plans. For the purpose of this investigation, the Dutch Safety Board studied the plans describing the crisis management approach in response to an accident at the Borssele, Doel, Tihange or Emsland nuclear power plants. The analysis of the plans focused on the extent to which the plans cover cooperation with the neighbouring country, consider cross-border scenarios and are aligned with each other. Various plans were being updated at the time of writing this report. Appendix E contains a detailed description of the plans studied.

Cross-border scenarios and cooperation with neighbouring countries

The extent to which the nuclear crisis plans pay attention to cross-border cooperation in the event of a nuclear accident varies considerably. The General Emergency Response Plan for Nuclear and Radiological Emergencies[165] (*Algemeen Rampbestrijdingsplan Stralingsincidenten*) by the Zeeland safety region provides the most comprehensive information on this aspect. This plan considers accidents at both the Borssele and Doel nuclear plants and has been drawn up almost entirely from a cross-border perspective. This equally applies to the Twente safety region's emergency response plan relating to a nuclear accident at the Emsland nuclear power plant (*Rampbestrijdingsplan Kernkraftwerk Emsland*).[166] Both plans describe the crisis organisation in the Netherlands and in the neighbouring country and the associated tasks and responsibilities. The plans also express how the Netherlands cooperates with its neighbouring countries with respect to notifying, alerting and upscaling processes.

164 Under the Council Directive 2013/59/Euratom, member states are obliged to develop a crisis management system that includes plans for the various types of potential emergency nuclear and radiological situations that have been identified. These plans must contain various elements, including, in particular, regulations for prompt coordination with all other member states that could potentially be involved in, or impacted by, an accident.

165 The General Emergency Response Plan for Nuclear and Radiological Emergencies (*Algemeen Rampbestrijdingsplan Stralingsincidenten*) is drawn up by the Zeeland safety region, in cooperation with the Central and West Brabant safety region and is applicable in both safety regions.

166 This plan is drawn up with cooperation of the Drenthe and IJsselland safety regions and is also applicable in these safety regions.

Malicious intent

The Dutch Response Plan NCS (*Responsplan Nationaal Crisisplan Stralingsincidenten*) describes a number of possible emergency situations arising from malicious intent where the public is intentionally exposed to ionising radiation, such as sabotage at a nuclear installation. The response to such emergencies described in the Response Plan NCS is based on the expectation that the "regular" direct and indirect measures will offer sufficient protection.[167] The Dutch authorities make the assumption that it will make little difference for the protection of the public against ionising radiation whether the radiological consequences arise from an accident or an intentional act.

The allocation of roles in the crisis organisation in the event of an act of terrorism or sabotage will probably differ from that in the case of an accident at a nuclear power plant. Depending on the nature of the crisis, overall control will tend to be vested with the Ministry of Security and Justice[168], with the explicit involvement of the National Coordinator for Security and Counterterrorism (NCTV), the Public Prosecution Service and the Police. For example, the National Manual on Decision-making in Crisis Situations (*Nationaal Handboek Crisisbesluitvorming*) states that in the event of an urgent terror threat the Minister of Security and Justice[169] can exercise his extended powers. In addition to the nuclear crisis plans, other plans will also come into operation, such as the external security plan of the police. Based on the latter plans, measures that are necessary at that time from a security point of view will be implemented in the vicinity of the nuclear power plant. These security measures could affect the possible response measures, although the authorities involved have stated that they do not expect the security and response measures to counteract. Appendix H contains further information on nuclear installation security.

In Belgium, the Nuclear and Radiological Emergency Plan for the Belgian territory (*Nucleair en Radiologisch Noodplan voor het Belgische Grondgebied*) constitutes the basis for cooperation with the neighbouring countries in the event of accidents originating in Belgium or the surrounding countries. The plan comprises the aspects on which cooperation with the neighbouring country is required. According to the plan, the actual cooperation on those aspects will be implemented in procedures as well as in the provincial response plans of the governors concerned, such as the Governors of East Flanders, Antwerp and Liège. However, in their current form the response plans of the Belgian Governors are not tailored to cooperation with the Netherlands. The plans are limited to the area within the Governors' own administrative boundaries. Apart from a few general provisions concerning alerts, the plans state nothing about cooperation with the neighbouring country.

167 Ministerie van Infrastructuur en Milieu, *Responsplan Nationaal Crisisplan Stralingsincidenten*, 2017.
168 As of October 2017, the Ministry of Justice and Security.
169 As of October 2017, the Minister of Justice and Security.

Given the fact that the Doel nuclear power plant is less than 3 kilometres from the Dutch border, there is a high probability that – if a nuclear accident were to occur – not only Belgium but also the Netherlands will be affected. In this case both countries will need to warn their residents and take direct measures, including sheltering and evacuation. Effective crisis management requires both countries to cooperate. The possibility of an accident at the Borssele nuclear plant, which requires the same type of cooperation, has not been considered either in the plans of the Governors of East Flanders and Antwerp. The plans are due to be revised upon completion of the update of the Belgian federal nuclear crisis plan.[170] Pending these revisions, the plans do not reveal what action the provinces will take if an accident at the Borssele nuclear power plant were to occur. Nor do the plans reveal how the coordination of response operations, of measures and the information exchange with the Dutch safety regions is provided for.

The emergency response plan of Landkreis Emsland states that the emergency centre of the Twente safety region will be notified if an accident occurs or is imminent at the Emsland nuclear power plant. The plan does not provide any further details of cooperation with the Dutch crisis organisation, such as the coordination of response operations or the way information is exchanged between Landkreis Emsland and the Twente safety region.

In view of the need to prepare for a large-scale accident, especially if it occurs close to the border, the Dutch Safety Board considers it essential that the plans on both sides of the border take account of cross-border scenarios and cross-border cooperation. The investigation revealed that a number of plans scarcely pay any attention to both aspects or none at all. The Board concludes that the cross-border nature of a nuclear accident requires further attention in nuclear crisis planning.

Sub-conclusion

The degree to which the cross-border nature of a nuclear accident is reflected in the current Dutch, Belgian and German nuclear crisis plans varies considerably. The plans prepared by the Zeeland and Twente safety regions pay the most attention to this aspect, but there also are plans that do not or to a much lesser extent take account of cross-border scenarios and cross-border cooperation.

Alignment of crisis plans between countries

The Dutch, Belgian and German organisations that are responsible for managing a potential nuclear crisis participate in various bilateral consultative structures, at both national and regional level. As part of these consultations, the countries inform each other about the crisis planning and share the plans they have prepared. In most cases the crisis plans are drawn up without any mutual involvement, which means that their contents have not been coordinated on both sides of the border.

170 When writing this investigation report, the final version of the federal plan had not been determined yet. In all probability, the revision of the provincial plans will be initiated in the course of 2018.

Furthermore, when writing this investigation report, various crisis plans were subject to revision. Due to the stacked structure of the planning process, crisis plans are firstly updated at national level and subsequently at regional level. As a result of the ongoing revision process a situation has arisen in which both current crisis plans and crisis plans under development exist for nuclear accident response in the border region. These plans are based on either old or new principles, for instance with respect to the planning zones around the nuclear power plants. As a result, even within countries plans are not entirely in line with each other (see also Appendix E). This situation has, although it will be temporary, created an incoherent set of crisis plans and basic principles. In the view of the Dutch Safety Board, if a nuclear accident were to occur in the short-term, it is not clear both within and among countries which basic principles serve as the guiding principles for this accident. In a crisis situation, which in itself brings uncertainty and chaos, any matters of this nature that are unclear can cause additional delays in decision-making on the measures to be taken.

Sub-conclusion

The crisis plans for the response to a nuclear accident have not been coordinated between the Netherlands and Belgium nor between the Netherlands and Germany. Various plans are subject to revision, which contributes to a lack of coherence among plans and basic principles. If a nuclear accident were to occur in the short-term, it is not clear both within and among countries which basic principles serve as the guiding principles for the accident.

4.3 Information to citizens on measures in the event of a nuclear accident

After the Chernobyl accident, it became clear that radiation awareness should be promoted in the Netherlands and that information was needed on this aspect to better prepare citizens for the eventuality of a nuclear accident.[171] A survey conducted by the RIVM in 2016 revealed that while Dutch citizens are familiar with the protective measures that are required to be taken in the event of a nuclear accident, they are largely unaware of the applicable criteria.[172] The RIVM researchers concluded that many citizens thought that in the event of a nuclear accident a very large area would be evacuated. For the citizens it was not clear why there is an age limit for taking iodine tablets and why the distribution of iodine tablets only takes place within a 100-kilometre zone around a central location.[173] Citizens were also under the impression that immediate departure to a safe area is the best way to protect themselves, whereas - depending on the circumstances - it may be better to take shelter first (see also section 4.1).

171 Berenschot, *Evaluatieonderzoek "Tsjernobyl"; Rapport inzake het optreden van de rijksoverheid naar aanleiding van het ongeval in Tsjernobyl*, USSR, 1986.
172 RIVM, *Risk communication on radiation accidents and the distribution of iodine tablets*, 2016, p. 60
173 Idem.

In order to limit the consequences of a potential nuclear accident, it is essential to ensure that citizens in the Netherlands, Belgium and Germany are properly informed in advance. Although the Dutch Safety Board is aware that various channels and senders are engaged in informing the public, this investigation focused solely on communication by the government. Ultimately, the responsibility for effective information services to the public concerning the potential consequences of a nuclear accident and the government's measures to mitigate those consequences, rests with the government.

4.3.1 Provision of information to the public in the Netherlands, Belgium and Germany

The Netherlands
In the Netherlands, the Authority for Nuclear Safety and Radiation Protection (*Autoriteit Nucleaire Veiligheid en Stralingsbescherming* - ANVS) is responsible for providing information to the public about the potential consequences and the measures to be taken in the event of a nuclear accident.[174] In early 2017 the ANVS commissioned a survey among the public on the most effective strategy for informing citizens in the Netherlands about nuclear safety and radiation protection. The results of that survey revealed that Dutch citizens mainly have a need for reliable and practical information that is up-to-date and immediately accessible, especially in the event of an actual or imminent nuclear accident. They expect to receive information on nuclear safety and radiation protection from the central government.

The ANVS is preparing a communications strategy which had not yet been completed by the time this investigation report was written; the definitive strategy is expected in the course of 2018 at the earliest. The ANVS has informed the Dutch Safety Board that the process is slow because priority has been given to developing a set of communication instruments. In 2017, the ANVS added infographics and animations to the information on its website with regard to the consequences and the actions to take if a nuclear accident were to occur. The intention is for the safety regions to adopt these infographics and animations in their communications with the public.

The Ministry of Health, Welfare and Sport (*Ministerie van Volksgezondheid, Welzijn en Sport* - VWS) is responsible for the information to the public on iodine tablets. The Ministry compiled a brochure entitled "Iodine Prophylaxis", which describes the target groups, explains the effects and indicates the designated planning zones for the pre-distribution and emergency distribution of iodine tablets. The document is available on the central government's website.[175] On this website questions and answers concerning the distribution of iodine tablets in the Netherlands can be found. In addition, citizens can check whether they are eligible for tablets. The website can be consulted in Dutch as well as in English. The national distribution of iodine tablets in October 2017 prompted the government to provide detailed information on this topic to citizens. The Ministry of Health, Welfare and Sport had originally planned to distribute the tablets one month earlier but decided to postpone distribution following a letter from the Zeeland safety

174 Section 43, Nuclear Energy Act (*Kernenergiewet*).
175 www.rijksoverheid.nl/onderwerpen/jodiumtabletten, which can also be accessed via www.waaromkrijgikjodiumtabletten.nl

region expressing concern about the lack of adequate information to the public on iodine distribution and the potential concern this could cause.[176]

The central government website www.crisis.nl provides general advice on disasters, emergencies and crisis situations, including a nuclear accident. The information available on this website about nuclear accidents is minimal and gives citizens little insight in what to expect of a nuclear accident. The website mostly links to other websites. The information on the website is only available in Dutch.

In addition to the central government, the safety regions concerned, namely the Central and West Brabant safety region, the Zeeland safety region, the South Limburg safety region and the Twente safety region, also provide information on their respective websites about the consequences of, and the measures to take in the event of a nuclear accident. The information on the websites of the safety regions is similar and explains, among other things, how citizens can prepare themselves, what they should do, what the government is doing and for whom the iodine tablets are intended. In addition, citizens can watch the animations developed by the ANVS on the safety regions' websites. The Zeeland and Central and West Brabant safety regions work jointly on information services to the public on the potential consequences of a nuclear accident and the government's measures to mitigate those consequences.

Experiences with the pre-distribution of iodine tablets in Zeeland

The Zeeland safety region and the municipalities concerned distributed iodine tablets in the spring of 2013. The tablets were distributed door-to-door together with an information leaflet and a package leaflet. The target group comprised households composed of one or more persons up to and including 40 years of age in several municipalities in Zeeland and West Brabant.[177] The results of the evaluation of the distribution in the municipalities of Borsele, Middelburg and Vlissingen, conducted by the Zeeland Regional Health Service (GGD Zeeland) and published in October 2015, showed that the majority of respondents were positive about the campaign (pre-distribution and the information material). 62% of the respondents stated that they had received the tablets, almost everyone of them (99.6%) stored the tablets and 73% of the respondents were aware that iodine tablets may be taken only on the government's advice.

Belgium

The Minister of Security and the Interior (*minister van Veiligheid en Binnenlandse Zaken*) is responsible for informing "potentially affected population in radiological emergencies" about the measures for health protection that will apply to them. The content of the

176 http://nos.nl/artikel/2182805-verspreiding-jodiumtabletten-uitgesteld-na-brief-veiligheidsregio.html

177 This concerned the following municipalities: Bergen op Zoom, Borsele, Goes ('s-Heer Arendskerke), Hulst, Middelburg, Reimerswaal, Sluis (village of Hoofdplaat), Roosendaal (Wouwse Plantage), Terneuzen (area around the village of Biervliet), Vlissingen (the villages of Oost-Souburg and Ritthem plus the section of the city of Vlissingen within the 10-kilometre iodine prophylaxis zone) and Woensdrecht.

information is determined in consultation with the Federal Public Service of Health, Food Chain Safety and the Environment (*Federale Overheidsdienst Volksgezondheid, Veiligheid van de Voedselketen en Leefmilieu*) and with the Federal Agency for Nuclear Control (*Federaal Agentschap voor Nucleaire Controle* - FANC). The FANC is responsible for information of a more technical nature concerning radiation protection and nuclear safety.

In practice the Coordination and Crisis Centre of the Belgian Government (*Coördinatie- en Crisiscentrum van de Regering* - CGCCR) takes care of the provision of nuclear information to the public. The latest information campaign dates from 2011 and was jointly conducted with the FANC. A new information campaign will be provided for in view of the entry into force of the new federal nuclear crisis plan. The CGCCR and the FANC jointly manage the website www.nucleairrisico.be (www.risquenucleaire.be), which provides comprehensive information on nuclear risks and subjects related to it. The website provides practical information to the public on what to do in the event of a nuclear accident, distinguishing between government tasks, on what citizens themselves can do and on iodine tablets. Additionally, background information can be found on the dangers of radiation, the radiation sources in Belgium and the preparations by the government for a possible nuclear accident. The website is available in different languages, namely in Dutch, French, German and English.

Unlike the Dutch safety regions, the Belgian provinces are not obliged to undertake activities to inform the public about the potential consequences of a nuclear accident and the government's measures to mitigate those consequences. The websites of the Governors of the provinces of Antwerp and Liège refer visitors to www.nucleairrisico.be. The website of the province of East Flanders has no such link.

Germany

In Germany public communication to citizens with respect to the potential consequences of a nuclear accident and the protective measures is assigned to authorities at various levels. With respect to the eventuality of an accident at the Emsland nuclear power plant, the Landkreis Emsland and Landkreis Grafschaft Bentheim, among other parties, provide information to the public. In association with the operator of this power plant, they published and distributed a brochure in 2011 to all households within a 10-kilometre radius from the nuclear power plant. The brochure is also available online on the websites of the two Landkreise.[178] In Germany the nuclear power plant's operator is responsible for providing general information to local residents in the immediate vicinity of the power plant about the nuclear risks and the preparations they can make.

At federal level, the Federal Office for Civil Protection and Disaster Assistance (*Bundesamt für Bevolkerungsschutz und Katastrophenhilfe* - BBK) and the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (*Bundesministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit* - BMUB) arrange for the provision of information to citizens about potential consequences and measures in the event of an accident. The BBK addresses all kinds of crises. With regard to iodine tablets, information

178 Landkreis Emsland, Landkreis Grafschaft Bentheim and Kernkraftwerke Lippe-Ems GmbH, *Notfallschutz; An alle Haushalte. Information für die Bevölkerung in der Umgebung des Kernkraftwerkes Emsland*, 2010.

can be found on BMUB's website www.jodblockade.de which provides information on the availability of tablets in Germany and the intake of iodine tablets in the event of a nuclear accident. Along with detailed information about iodine, the website provides concise information about related subjects. The website also contains links to scientific information issued by the German Commission on Radiological Protection (*Strahlenschutzkommission* - SSK), an advisory commission within the BMUB. The website is available in German as well as in English.

The Ministries of Lower Saxony do not provide any specific information on their websites about what is expected from citizens in the event of a nuclear accident.

4.3.2 Public access to information on measures in the event of a nuclear accident

The Netherlands, Belgium and Germany provide information to the public on the potential consequences of and the measures to be taken in the event of a nuclear accident. This effort primarily targets the population of the country concerned. Information is largely provided through websites, which residents of neighbouring countries can also consult although not all websites provide information in these countries' languages.

The accessibility of the information varies by country. The Belgian federal government, for instance, provides a dedicated public website focusing entirely on nuclear risks, whereas in the Netherlands and Germany the same information is more fragmented across various sources. It is important for citizens to be able to form an accurate picture of the potential consequences of an accident and what action they should take in such an event. The Dutch Safety Board believes that the information they need for this purpose should be easy to find and to access. The ANVS, in the Netherland being responsible for gathering this fragmented information, has only started this effort relatively recently. This is partly due to the fact that the Dutch central government, until recently, scarcely paid any attention to this topic. The Dutch Safety Board finds this remarkable considering that the nuclear power plants in and around the Netherlands have been in operation for decades and considering that the Chernobyl accident in 1986 already showed that adequate information provided to the public is of great importance.

No coordination has taken place between the Netherlands and Belgium, nor between the Netherlands and Germany on the content of information to the public about the measures to be taken. Nevertheless, various parties, such as the Belgian provinces and the Dutch safety regions[179], have set out their intention to do so in writing or are engaged in talks on this matter. The Dutch Safety Board considers coordination between countries advisable, because any inconsistencies in the information communicated may cause confusion among citizens in the border regions.

179 This concerns the government organisations in the Western Scheldt delta region, including the Zeeland safety region, the province of Zeeland and the provinces of East Flanders, Antwerp and West Flanders.

Sub-conclusion

The Netherlands, Belgium and Germany publish information on websites regarding the potential consequences of and measures to be taken in the event of a nuclear accident. The accessibility of the information to citizens varies by country. In the Netherlands and Germany, this information is more fragmented than it is in Belgium. The Dutch Safety Board considers it remarkable that the Dutch central government has so far paid very little attention to the provision of information to the public about the potential consequences of a nuclear accident and the government's measures to mitigate those consequences, even though nuclear power plants have been in operation in and around the Netherlands for decades.

4.4 Exercises

Exercising crisis situations is essential for gaining experience in crisis management, obtaining insight into potential problem areas and for improving plans and agreements arising from such insight. Exercises are particularly important in preparing the parties concerned for a crisis with a low probability of ever occurring, such as a nuclear accident. After all, it is impossible for them to gain any practical experience in managing such a crisis. The fact that numerous parties are involved, both within the Netherlands and abroad, constitutes a complicating factor and provides all the more reason for conducting exercises. Moreover, joint exercises present an opportunity for the parties to get to know each other better. Good interpersonal relationships between the members of the various organisations involved contribute to effective crisis management.

This section describes to what extent the Netherlands and its neighbouring countries exercise the cross-border cooperation in managing a crisis arising from a nuclear accident in the border region. By way of illustration, the results of a number of exercises are included in the following sections of this report. Training and education too are important in acquiring the requisite knowledge and skills. This investigation focused on exercises[180] since exercising is the most appropriate way of testing cross-border cooperation.

4.4.1 Nuclear emergency exercises in the Netherlands, Belgium and Germany.

Partly pursuant to the provisions of national and international laws, regulations and plans, the Netherlands, Belgium and Germany organise nuclear emergency exercises with some regularity. In addition to the major national nuclear emergency exercises[181] organised

180 In this context, the Dutch Safety Board refers to exercises in the broadest sense, such as major staff exercises, operational exercises, table-top exercises, simulations, et cetera.

181 An example of a major exercise is "Indian Summer", organised in the Netherlands in 2011. The exercise yielded a considerable number of learning points. The following conclusions were drawn from the exercise: there were too many links in the crisis management system; this system was insufficiently linked to normal practice; the various bodies took too much time to get operations up and running due to a lack of routine; citizens received information either too late or not at all from the government (communication by the government lagged considerably behind that of the media).

once every four to seven years[182], smaller-scale exercises are held in the intervening period focusing on specific sub-aspects of nuclear crisis management. Examples are the alert procedure for an (imminent) nuclear accident, the process of scaling up and activating the crisis organisation, the operation of technical systems, exchanging radiological and technical information, decision-making on the measures to be taken and suchlike. Both the operators of the nuclear power plants and the authorities that have a role in crisis management conduct exercises. Depending on the sub-aspect of the exercise, they either hold their own exercises or jointly conduct exercises with other organisations.

International organisations also organise exercises for sub-aspects of nuclear crisis management. These exercises focus on the alerting of other EU member states or countries within the IAEA (via ECURIE and USIE, see also section 4.5.1). The Netherlands, Belgium and Germany take part in these exercises. Furthermore, the OECD's Nuclear Energy Agency organises international exercises (known as International Nuclear Emergency Exercises - INEX), of which five have taken place, each focusing on a different aspect of crisis management. The latest exercise cycle, INEX 5, focused specifically on the alert and communication procedures both within and among countries. In 2016 Germany and the Netherlands jointly conducted this exercise. Belgium individually participated in the INEX 5 exercise cycle. Earlier INEX exercises did not include a cross-border component. An international report is issued on each INEX exercise cycle containing the results and experiences of all countries participating in the exercise. The reports do not specify the lessons for the individual countries; it is left to the countries themselves to interpret the results and to decide on the next steps.

4.4.2 Joint nuclear emergency exercises in the Netherlands, Belgium and Germany

The nuclear emergency exercises conducted in the Netherlands, Belgium and Germany in recent years relating to one of the nuclear power plants in the border region generally focused on crisis management in their own country. Some of these exercises encompassed the scenario of a nuclear accident outside the border.

Cooperation between the Netherlands and Belgium

The cooperation between the Dutch and Belgian crisis organisations in case of a nuclear accident have been exercised to a limited extent. Some larger-scale exercises were conducted in Belgium, which include the sharing of information with the Netherlands. The ANVS, the Dutch expertise network[183], the National Crisis Centre (*Nationaal Crisiscentrum* – NCC) and the South Limburg safety region took part in an exercise focusing on an accident scenario at the Tihange nuclear power plant in 2016.[184] The Dutch organisations were asked to test the transfer of information from Belgium to the Netherlands. This concerned the alert procedure, the exchange of radiological information and the possibility for the Netherlands to obtain information from the Belgian parties. The exercise focusing on an accident scenario at the Belgian Nuclear Research

182 The average frequency differs from country to country.
183 The Nuclear Planning and Advice Unit (EPAn) and the Crisis Expert Team Radiation and Nuclear (CETsn).
184 The exercise is called TIHEX 2016.

Centre (*Belgisch Studiecentrum voor Kernenergie* - SCK•CEN) in Mol[185] in 2015 also included practising the provision of information to the Netherlands.[186] No Belgian parties were involved in the exercises organised by the Netherlands centring on the Borssele power plant. Nor have any Dutch organisations participated in the Belgian exercises relating to the Doel nuclear power plant in the past few years.[187] However, representatives from the neighbouring country have occasionally been invited to attend an exercise as observers.

The Netherlands and Belgium intend to involve each other in the major national exercises centring on their nuclear power plants. The upcoming exercise centring on the Borssele nuclear power plant comprises a "regional" exercise, scheduled for 7 February 2018, and a "central government" exercise for which a date yet needs to be determined in March 2018. The CGCCR, the FANC, Bel V and the provinces of East Flanders and Antwerp plan to participate.[188] The Belgian nuclear exercise centring on the Doel nuclear power plant was held on 21 November 2017. Representatives from the province of Zeeland and the Zeeland safety region took part on behalf of the Netherlands.[189] In August 2017 the Netherlands organised a table-top exercise on crisis communication to prepare for the Dutch national exercise centring on the Borssele nuclear power plant. The FANC and the CGCCR participated in the table-top exercise on behalf of Belgium.

Up till now the Dutch safety regions and the Belgian provinces have not conducted any joint operational exercises relating to a nuclear accident. However, they do conduct operational exercises to practise cooperation in generic emergency situations (of a non-nuclear nature),[190] although such joint exercises are limited. Participants acquire the necessary operational skills to deal with radiological consequences partly through training. An initiative by the Belgian provinces of West Flanders, East Flanders and Antwerp to meet with the Zeeland safety region to discuss nuclear emergency exercising and the related techniques several times a year, was aborted due to incompatible agendas.

185 This is a research reactor and not a nuclear power plant. This exercise is included here due to the insights obtained regarding the exchange of information between Belgium and the Netherlands during a nuclear accident.
186 The South-East Brabant safety region, the NCC and the ANVS were involved in this exercise. The safety region delegated a liaison to join the provincial crisis unit. The role of the NCC and the ANVS consisted of remote role play: this concerned the receipt of the alert notification by the NCC and the ANVS's interaction with the Belgian crisis response team about radiological and technical information. On the Dutch side the exercise was also used to test the functioning of the EPAn in practice.
187 In 2009 an exercise was conducted centring on the nuclear power plant in Doel in which several Dutch municipalities took part.
188 The staff exercise has a national character. The exercises focus mainly on coordination and cooperation within the Dutch crisis response structure, such as coordination between the regional and central government authorities. The aim of participation by the Belgian organisations is to practise cross-border sharing of information but only during the "central government" exercise. The exercise scenario has yet to be developed.
189 The purpose of this exercise was to test the bilateral and international alert procedures.
190 This relates, for instance, to a traffic accident, an accident at a chemical company or a shipping accident. However, the Dutch and Belgian emergency services conducted a joint traffic accident exercise in Baarle-Nassau that included a nuclear component. The accident involved a vehicle transporting radioactive material.

The question arises as to what the implications are of choosing generic exercises over nuclear-specific exercises. In its investigation into the external security of nuclear installations in the Netherlands in September 2017, the Dutch Security and Justice Inspectorate[191] concluded that the Dutch safety regions' necessary familiarity with the nuclear installations could be compromised as a result of that choice.[192]

Cooperation between the Netherlands and Germany

The most recent nuclear emergency exercise between the Netherlands and Germany was INEX 5, conducted in May 2016. This table-top exercise related to an emergency at the Emsland nuclear power plant with potential consequences for the Netherlands. The scenario was based on an earthquake near the power plant. The exercise focused on the bilateral cooperation between the Netherlands and Germany and included attention to the harmonisation of response measures and consistency in communications. In addition to various German organisations, the ANVS, the Twente safety region, the RIVM, the National Crisis Centre and the crisis coordination centres from the Ministry of Infrastructure and the Environment (*Ministerie van Infrastructuur en Milieu*)[193] and the Ministry of Health, Welfare and Sport (*Ministerie van Volksgezondheid, Welzijn en Sport*) took part on behalf of the Netherlands. Neither the Dutch nor the German reports on the results of the exercise provide much clarity on the main insights and the lessons drawn from the exercise. The significance of the exercise for cross-border cooperation in general will get further clarification in the international evaluation report of the Nuclear Energy Agency, which had not yet been published by the time this investigation report was written.

A joint exercise, the German Dutch Emergency Exercise (GDEX), is scheduled to be held in 2019. In this exercise the crisis organisations in both Germany and the Netherlands will be activated. Communications between the various parties in the two countries will be practised. The Lower Saxony Ministry of the Interior and Sport (*Niedersächsisches Ministerium für Inneres und Sport* - NMI), the BMUB and the ANVS will jointly organise this exercise, which focuses primarily on the cooperation between the Netherlands and Germany. No date has yet been set.

To date, the Netherlands has not been involved in nuclear emergency exercises initiated with regard to the emergency response plan of Landkreis Emsland.

Organisation of cross-border exercises

The above findings show that the number of joint nuclear emergency exercises in which cooperation has been practised between the Netherlands and Belgium and between the Netherlands and Germany, is limited. According to the parties concerned this is due, among other things, to the low exercise capacity, full exercise agendas and the numerous parties involved. They declare that, as a result, it is difficult to find a date appropriate for all parties and to organise a representative group of participants. Doubts about the educational effects and the lack of interest due to the unique and exceptional nature of a nuclear accident additionally contribute to the fact that hardly any joint nuclear emergency

191 As of October 2017, the Justice and Security Inspectorate.
192 Inspectie Veiligheid en Justitie, *Onderzoek Externe beveiliging nucleaire inrichtingen; Onderzoek naar het plan Externe Beveiligingsorganisatie (EBO) van de politie*, 2017.
193 As of October 2017, the Ministry of Infrastructure and Water Management.

exercises are conducted. It is not uncommon that plans for joint exercises end up being shelved or cancelled. The border regions deal with the above dilemmas pragmatically by conducting all-hazard (generic) exercises rather than nuclear-specific exercises to practise cross-border cooperation.

Although the exercise programmes between the Netherlands and its neighbouring countries are shared, they are not coordinated with each other. Due to the lack of cohesion in the programmes, the organisation of a bilateral exercise essentially comes down to initiatives and ad hoc agreements among the parties themselves. In the Netherlands there is no clear overview of the various exercises (themes, frequencies, types of exercises and participating organisations) that shows to what extent the parties in the Netherlands have been trained to manage a cross-border crisis arising from a nuclear accident. The puzzle cannot be pieced together with the various isolated exercises. It is the task of the Ministry of Infrastructure and the Environment (DCC IenM) to coordinate the planning and organisation of exercises. In this respect, it is the Ministry's duty to ensure that exercises are conducted systematically. Especially the interfaces between organisations and between countries may raise difficulties in crisis management. It is essential to improve the effective cooperation with regard to those interfaces by conducting joint exercises, simulation sessions and suchlike.

The relevant parties have stated they have the intention to conduct more exercises with their partners in the neighbouring countries. Even though the Dutch Safety Board believes these intentions are a step in the right direction, it observes the lack of a systematic approach. Establishing this approach is a key priority for the period ahead.

Sub-conclusion

The number of joint nuclear emergency exercises to test the cooperation between the Netherlands and Belgium and between the Netherlands and Germany is limited. In order to ensure that the parties in the Netherlands are well prepared for a nuclear accident, they should conduct more frequent and more intensive joint exercises with their partners in the neighbouring countries. This requires a coherent and systematic approach.

4.5 Alert procedure and activating the crisis organisation

The Netherlands, Belgium and Germany clearly respond differently to an incident at a nuclear power plant without any safety consequences for the surrounding area, than to an actual or imminent nuclear accident. In the event of an incident without any safety consequences for the surrounding area, the operator of the nuclear power plant is required to analyse the problem and to resolve it as quickly as possible. The nuclear regulatory authority supervises the adequate problem resolution. An actual or imminent nuclear accident requires a more extensive approach on the part of both the power plant's operator and the authorities involved. As soon as there are indications that an incident is so serious that it may have consequences outside the nuclear power plant or

threatens to turn into a nuclear accident, the power plant's operator is required to notify the authorities as quickly as possible. In line with the protocols applicable, the organisations that have a role in the initial response and that are responsible for crisis management will be notified. Appendix F describes how the Netherlands, Belgium and Germany have organised that the authorities within their respective countries are notified and how they have arranged for the crisis organisation to be activated.

This section focuses exclusively on the agreements the Netherlands has made with Belgium and Germany on the way they notify each other in the event of an actual or imminent nuclear accident in their respective countries. The second part of this section describes the cross-border coordination between the crisis organisations once they have been activated.

4.5.1 Alerting other countries in the event of an actual or imminent nuclear accident

If a nuclear accident occurs or is imminent, it is vital to notify other countries without delay and to provide them with relevant information so that they can take the appropriate protective measures should they be faced with the consequences of the accident.[194]

International agreements

Pursuant to international requirements,[195] the national competent authorities are required to notify the International Atomic Energy Agency (IAEA), the EU and the national warning points in the neighbouring countries of an actual or imminent nuclear accident.[196] In the Netherlands, Belgium and Germany, the national warning points are the ANVS, the Coordination and Crisis Centre of the Belgian Government (CGCCR) and the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) respectively.

The notification to the EU runs through the European Community Urgent Radiological Information Exchange (ECURIE) system. The countries connected to this system will receive a notification immediately after the accident has been reported in the system.[197] The notification to the IAEA runs through the IAEA Incident and Emergency Centre by means of registration in the Unified System for Information Exchange in Incidents and Emergencies (USIE), which is similar to the ECURIE system.[198] The IAEA Incident and Emergency Centre will notify other member states through their respective contact persons. The IAEA points out that countries that have reported an accident or emergency situation also have a duty to notify other member states of the situation. To date, the Netherlands, Belgium and Germany have not made any notifications regarding nuclear power plants through ECURIE and USIE because no situations at the nuclear power plants requiring such notification have occurred. However, notifications from other countries have been received through these systems. For example, the ANVS received notifications through USIE and ECURIE of a marginal radioactive emission at a research reactor in Norway in October 2016.

194 Council Directive 2014/87/Euratom.
195 87/600/Euratom: *Council Decision of 14 December 1987 on Community arrangements for the early exchange of information in the event of a radiological emergency* and IAEA, *Convention on Early Notification of a Nuclear Accident*, effective since 27 October 1986.
196 Ministerie van Infrastructuur en Milieu, *Nationaal Crisisplan Stralingsincidenten*, 2017.
197 The EU member states, Switzerland and Croatia. Internet: https://rem.jrc.ec.europa.eu/RemWeb/activities/Ecurie.aspx
198 IAEA, *Operations Manual for Incident and Emergency Communication*, 2012.

Sub-conclusion

The European Commission and the IAEA have set up systems for issuing international alerts in the event of a nuclear accident. The Netherlands, Belgium and Germany will receive a notification through these systems if a nuclear accident occurs abroad, even if it is at a considerable distance from their national borders.

Agreements between the Netherlands and Belgium

Supplementary to the above international obligations, the Netherlands and Belgium have agreed that the nuclear regulatory authorities in both countries (the ANVS and FANC) and the national crisis centres (the National Crisis Centre (NCC) in the Netherlands and the Coordination and Crisis Centre of the Belgian Government (CGCCR) in Belgium) will notify each other as soon as an emergency is imminent. The notification is made by telephone and subsequently confirmed by fax or email.

The ANVS and the CGCCR have set out the agreements on cross-border alerts in detail and laid down that this procedure applies to situations for which the national crisis plans come into effect. Whether these events actually have or will have transboundary consequences is not decisive; the determining factor is whether the crisis plan comes into effect.

Figure 18 shows how the Belgian national authorities are notified of a nuclear accident in the Netherlands and vice versa.

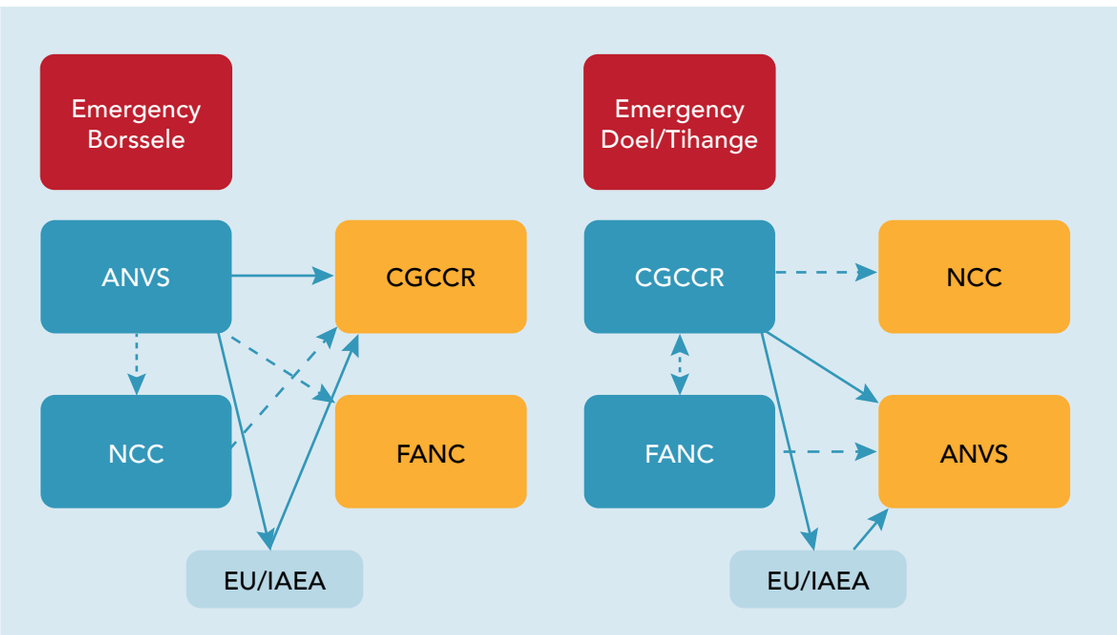


Figure 18: Flow chart showing the bilateral and international alert procedure. The left-hand side shows notification by the Netherlands to Belgium and EU/IAEA, and the right-hand side notification by Belgium to the Netherlands and EU/IAEA. The dotted lines indicate the agreements the parties have made supplementary to the international agreements.

Apart from the international and national lines of communication, the notification of an emergency situation at one of the nuclear power plants in the border region will be forwarded at the regional level. The safety regions in the Netherlands and the provinces in Belgium have jointly made agreements on this procedure. The Ghent 100/112 emergency centre will forward the notification of an actual or imminent nuclear accident at the Doel nuclear power plant to the Zeeland safety region's emergency centre and vice versa in the event of an actual or imminent accident at the Borssele nuclear power plant. The Zeeland safety region's emergency centre will notify the Central and West Brabant safety region's emergency centre.[199] The Liège 100/112 emergency centre will forward the notification of an actual or imminent nuclear accident at the Tihange nuclear power plant to the South Limburg safety region's emergency centre.[200] As the South Limburg and North Limburg safety regions have a joint emergency centre, the latter region will also be alerted. The notification route for the other safety regions in the Netherlands runs through the NCC. Upon receipt of the notification from the CGCCR, the EU or the IAEA, the NCC has the task to inform the other safety regions.

Impression from a Tihange exercise on the cross-border alert procedure

The evaluation of the table-top exercise in Tihange in 2016 revealed that the notification by the Liège 100/112 emergency centre to the South Limburg safety region's emergency centre was made one and a half hours earlier than the CGCCR's notification to the NCC. Likewise, during the further course of the exercise communications between regional parties proceeded faster than between the parties at national level.

Agreements between the Netherlands and Germany

At national level, the ANVS and the BMUB notify each other of an actual or imminent nuclear accident in their own country. As national crisis coordination centres, the German Joint Information and Situation Centre of the Federal Government and the Länder (*Gemeinsames Melde- und Lagezentrum von Bund und Ländern* - GMLZ) and the Dutch National Crisis Centre (NCC) will contact each other if a nuclear accident were to occur.

In the event of a nuclear accident in Lower Saxony, the Lower Saxony Ministries have direct lines of communication with the Netherlands. The German nuclear regulatory authority (NMU) will notify the ANVS whereas the Lower Saxony Ministry of the Interior and Sport (NMI) will notify the NCC.

199 Veiligheidsregio Zeeland, *Algemeen Rampbestrijdingsplan Stralingsincidenten*, 2017.
200 Veiligheidsregio Zuid-Limburg, *Multidisciplinaire informatiekaart (dreiging) Stralingsincident Tihange (en Doel)*, 2016.

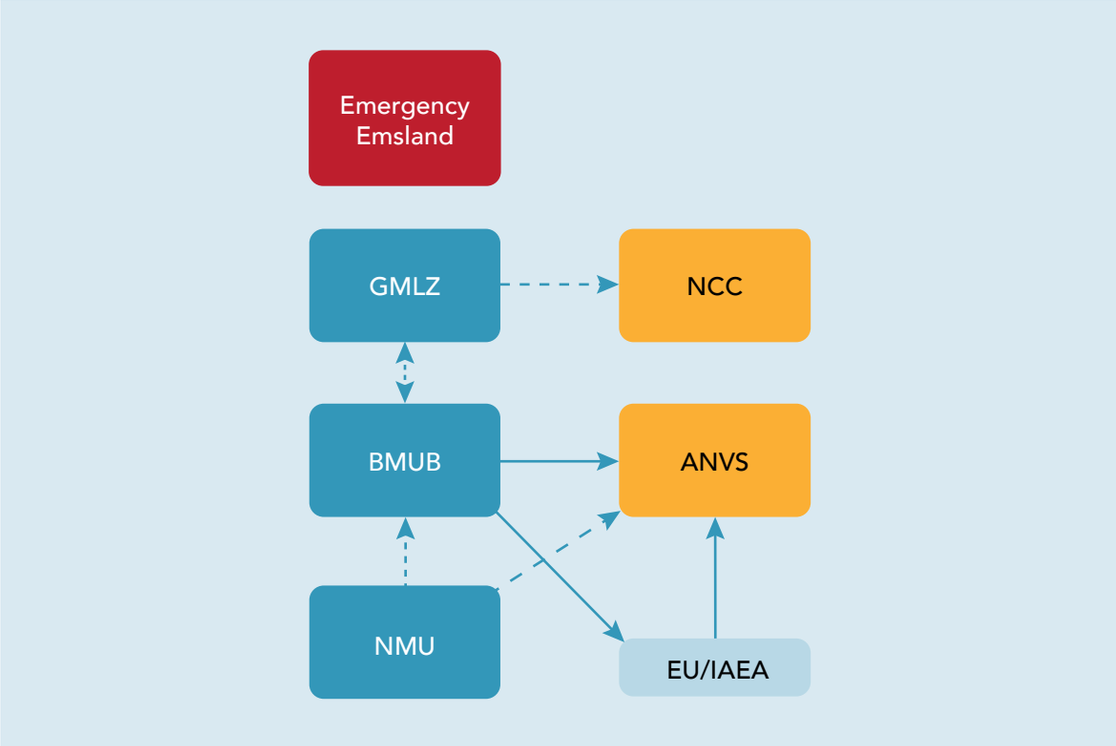


Figure 19: Flow chart showing the bilateral and international alert procedure for an emergency at the Emsland nuclear power plant. The dotted lines indicate the agreements the parties have made supplementary to the international agreements.

If there is an accident at the Emsland nuclear power plant, both the German police (*Polizeiinspektion Emsland*) and Landkreis Emsland will notify the Twente safety region's emergency centre, which will subsequently verify the notification with the NCC.

Sub-conclusion

The Netherlands has agreed with Belgium and with Germany that they will notify each other as quickly as possible should an emergency situation occur or threaten to occur at one of their nuclear power plants. They have agreed that both the national and regional contacts will forward the alert notification to the neighbouring country.

4.5.2 Activation of the crisis organisation and cross-border coordination

The notification of an actual or imminent nuclear accident in the Netherlands or in a neighbouring country will activate the crisis organisation. Even a nuclear accident at a long distance can be cause to (partially) activate the crisis organisation, such as was the case with the Fukushima accident (see text box on the next page).

The crisis structures that will be activated in the Netherlands, Belgium and Germany in the event of a nuclear accident are explained in Appendix F. This section describes to what extent the Netherlands has entered into agreements with Belgium and Germany on coordination of the crisis management approach.

Coordination between the Netherlands and Belgium

The 1 June 2006 Benelux memorandum constitutes the basis for cooperation between the Netherlands and Belgium during the course of a crisis.[201] The memorandum sets out, among other aspects, that the crisis centres – supplementary to the broader international frameworks – are required to exchange information. It does not specify what kind of information this should be and in what specific areas coordination should take place. It also states that the parties may deploy liaisons. To interact effectively, a liaison should have knowledge of the crisis organisation in the neighbouring country and should be able to speak the neighbouring country's language in order to avoid communication problems. An evaluation of a nuclear emergency exercise centring on the Tihange nuclear power plant showed the importance of a Dutch liaison being able to speak French.

Agreements on sharing information and deploying liaisons have been made at regional level between (1) the province of Antwerp and the Central and West-Brabant safety region[202] and (2) the province of East Flanders, the province of Zeeland and the Zeeland safety region.[203] The South Limburg safety region and the province of Liège have entered into similar agreements.[204]

The relevant agreements between the Netherlands and Belgium relate to crises in general and are not geared towards a crisis arising from a nuclear accident.

201 *Memorandum of Understanding between the Kingdom of Belgium, the Kingdom of the Netherlands and the Grand Duchy of Luxembourg concerning cooperation with regard to the management of crises with potential transboundary consequences*, 1 June 2006. Amended version, Treaty Series, Year of Publication 2009 No. 58.
202 *Crisis management convenant between the Central and West Brabant safety region and the province of Antwerp*, February 2017.
203 *GROS Protocol for crisis management and emergency planning in the Western Scheldt delta* (draft version, May 2017).
204 Euregional EMRIC collaboration, *Afspraken betreffende informatie-uitwisseling tussen Euregionale partners ten tijde van een ramp of crisis*, 2016.

Activation of the Dutch crisis organisation during the Fukushima accident (2011)

Based on the news coverage on the Japan earthquake and the consequences for the nuclear power plants in Fukushima, the then nuclear regulatory authority in the Netherlands began to gather information on the problems at the affected nuclear power plants shortly after the earthquake.[205] At that time, it was clear that the problems at the Dai-ichi nuclear power plant were the most serious and that a meltdown could occur. It was also announced that local residents living within a 3-kilometre radius from the power plant were being evacuated. A day later, the expertise network in the Netherlands was partially scaled up. The expertise network carried out assessments of the radiological situation, issued advice and provided information to the Dutch authorities involved in crisis management. Communication from the Ministry of Foreign Affairs was particularly important for the Dutch nationals who were in Japan at that time. The same day *Nucleair Nederland*[206] arranged a location at the Hilversum Media Park where the press could ask questions. The government mainly communicated to the public by means of questions and answers on the central government's website. It took a few days to make the questions and answers available.[207] The Dutch government continued to monitor the media so that it could quickly respond to questions from citizens and from the press. The RIVM also provided substantive information on the actual situation in Japan. The constant workload of radiation experts and communication staff became so heavy that they suffered from sleep deprivation as time passed.

Coordination between the Netherlands and Germany

General coordination between the Netherlands and Germany during crises with transboundary consequences formally takes place between the NCC and the German crisis centre of the Federal Ministry of the Interior (*Bundesministerium des Innern* - BMI). If the crisis arises from an accident at the Emsland nuclear power plant, parallel coordination will also take place with the crisis centre of the Lower Saxony Ministry of the Interior and Sport (*Niedersächsisches Ministerium für Inneres und Sport* - NMI). The Dutch Ministry of Security and Justice and the NMI have signed a declaration on cooperation with regard to the exchange of information during cross-border crisis situations. These agreements, too, relate to crisis situations in general.

The Twente safety region and Landkreis Emsland have agreed that in the event of a nuclear accident at the Emsland nuclear power plant, a liaison from the Twenty safety region will join the crisis organisation of Landkreis Emsland. The Dutch liaison must have German language proficiency, knowledge of nuclear crisis management and must be familiar with the Twente safety region's procedures. An investigation has shown that the

205 The Dai-ichi nuclear power plant was not the only nuclear energy facility affected by the earthquake and the tsunami, but it was the only one where the situation was not under control.
206 A cooperation between URENCO, EPZ, NRG, Reactor Institute Delft, COVRA and the recent member PALLAS.
207 The Dutch government only began to communicate more actively a few days after the accident. In the initial phase the safety regions were unclear about which government department to contact with questions they had received from citizens. No Q&As were available in advance. Q&As were subsequently compiled and published several days later.

safety region has limited capacity in this regard. The German and Dutch organisations do not have access to each other's crisis management systems. Consequently, additional efforts must be undertaken to ensure an effective exchange of information.

Cross-border decision-making
The Dutch Safety Board observes that the agreements made by the Netherlands with Belgium and with Germany provide for the exchange of information and a certain degree of harmonisation, but not for the coordinated cross-border decision-making. However, in the Dutch Safety Board's view, such coordination is required in the event of a nuclear accident in the border region where both countries will face the consequences of the accident. In order to limit the consequences as much as possible, but equally to allay any unnecessary concerns among the public, crisis management decision-making must be properly coordinated between the countries. Even though the deployment of liaisons certainly contributes to harmonisation, in the Dutch Safety Board's view, it offers no guarantee for a joint decision-making process. Liaisons act as a link between parties and have no coordinating role.

Sub-conclusion

The Netherlands has not made any agreements with Belgium nor with Germany on the coordination of decision-making in the event of a nuclear accident in the border region. While the possibility of deploying liaisons contributes to harmonisation between the countries, it offers no guarantee for a joint decision-making process.

4.6 Exchanging radiological and technical information

In order to determine whether measures need to be taken in the event of a nuclear accident (and if so, which ones, when and where), information is required about both the existing radiological situation and its predicted development. This information forms the basis for decisions concerning the protective measures to be taken. The information is also relevant to neighbouring countries, as it allows them to form a more accurate picture of the accident, its potential consequences and what action to take.

To find out how the Netherlands, Belgium and Germany have made provision for sharing radiological and technical information, the Dutch Safety Board focused its investigation on the most relevant information systems that countries rely on during a nuclear accident.

The Netherlands came to realise the need to invest in the availability of radiological and technical information after the Chernobyl accident in 1986 (see text box).

Radiation monitoring in the post-Chernobyl era

When news emerged about a nuclear accident at Chernobyl in 1986, the Netherlands had to organise ad hoc that measurements were taken. This required the collaboration of multiple institutes, the coordination of measurement protocols and the acquisition of new equipment. Similarly, there were no known dose value limits or models to predict the spread of radioactive materials. One of the recommendations of the Chernobyl evaluation report[208] was to invest in the availability of radiological and technical data. As a result, the RIVM established the National Radiation Monitoring Network (*Nationaal Meetnet Radioactiviteit*). The RIVM also acquired mobile measuring equipment capable of monitoring all types of radiation and suitable for the inspection of radioactive contaminated products in situ. The same period, the Information and Documentation Centre for nuclear emergency response was established. The models and information systems provided by this centre enable authorities to assess a radiological situation and its development as accurately as possible.

4.6.1 Exchanging data through monitoring networks

The Netherlands, Belgium and Germany have a monitoring infrastructure to detect radiation. Among other things, this infrastructure in each of the three countries consists of intricate monitoring networks.[209] One of the objectives of these monitoring networks is to detect any radiation hazard. In the event that ionising radiation is released as a result of a nuclear accident, the monitoring networks provide insight into the amount and spread of the ionising radiation. The monitoring network in the Netherlands, the National Radiation Monitoring Network, is managed by the RIVM. The National Radiation Monitoring Network measures the radiation level continuously[210] at more than 165 fixed locations, and transmits the measured values every ten minutes.[211] The measurement data are gathered and analysed by the RIVM. Belgium's FANC and Germany's Federal Office for Radiation Protection (*Bundesamt für Strahlenschutz* – BfS) have access to the National Radiation Monitoring Network's latest measurement data (taken every 10 minutes). The measurement data are made available without delay.

Belgium's national radiation monitoring network, TELERAD, is managed by the FANC. It consists of more than 230 measuring stations throughout Belgium. Belgium's crisis centre CGCCR has permanent access to TELERAD's measurement data. Up-to-date measurement data in TELERAD are made available to the RIVM in the Netherlands to a

208 Berenschot, *Evaluatieonderzoek Tsjernobyl; Report on the action taken by the central government in response to the Chernobyl accident in the USSR*, 1986.
209 RIVM, *Het Nationaal Meetnet Radioactiviteit*, 2012.
210 The level of gamma radiation is measured at 165 locations, the levels of alpha and beta radiation are measured at 14 locations and the concentration of radioactive particles in the air is measured at one location. In addition, measurements may be taken by mobile crews (of the RIVM, the safety region or the Ministry of Defence).
211 Supplementary to the National Radiation Monitoring Network, the Netherlands has a number of specialist measuring facilities, including two mobile radiological measuring stations, which make it possible for measurements to be taken anywhere.

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limited extent[212] RIVM has reached an agreement with the Belgian authorities for improving the availability of the measurement data.

In Germany, radiation levels are measured by the ODL monitoring network (*Ortsdosisleistungs-Messnetz*).[213] This network consists of around 1,800 measuring stations and is managed by the Federal Office for Radiation Protection (BfS). It forms part of Germany's Integrated Measuring and Information System (*Integrierte Mess- und Informationssystem* - IMIS), which also provides prognoses and supports the decision-making process.[214] The RIVM in the Netherlands has direct access to Germany's radiological measurement data. The Federal Office for Radiation Protection also provides measurement data from the Emsland region.[215] The operator of the Emsland nuclear power plant issues monthly overviews of the values registered by the monitoring network in relation to the accepted level of radiation in the vicinity of the nuclear power plant.[216] These communications are aimed at informing the public rather than at supporting the decision-making process with regard to a nuclear accident.

At the European level, radiological measurement data are exchanged through the European Radiological Data Exchange Platform. The measurements taken by the Dutch National Radiation Monitoring Network, by TELERAD and by the ODL network are transmitted to this European data platform automatically, thus ensuring that the data are available to other countries with access to the platform. Countries are obliged to update their data once per hour. National data are visible on the platform almost immediately after transmission. Europe-wide data are visible on the platform at most one hour later.[217] So as not to be solely reliant on the European data exchange platform, the Netherlands would like to have direct access to the measurement data of its neighbours. With Germany, mutual access to measurement data has already been agreed. The Netherlands is currently working with Belgium to gain better access to the Belgian data, as previously described.

Sub-conclusion

The Netherlands, Belgium and Germany each have a national radiation monitoring network that enables them to detect radiation hazards. The countries have access to each other's radiological measurement data either directly or through a European data exchange platform.

212 Gamma radiation measurements are shared with the Netherlands straight away. As for nuclide-specific measurements, these are expected to be shared with the Netherlands in short-term. Measurements of the concentration of radioactive particles in the air are not available.
213 http://www.bfs.de/DE/themen/ion/umwelt/luft-boden/odl/odl.html
214 Bundesamt für Strahlenschutz, *Das Deutsche Messnetz für Radioaktivität*, 2013.
215 As a back-up resource, the RIVM also has access to measurements taken around the Emsland nuclear power plant by the Lower Saxony Water Management, Coastal Defence and Nature Conservation Agency (NLWKN).
216 https://www.rwe.com/web/cms/de/17066/rwe-power-ag/energietraeger/kernkraft/kkw-emsland/links-und-downloads/
217 In an emergency, the data are updated more frequently and are therefore likely to be available sooner.

4.6.2 Exchanging data about a nuclear accident through decision support systems

Prognoses and model calculations
In the Netherlands, the RIVM uses JRODOS[218], a system designed to support the decision-making process during nuclear and radiological emergencies. JRODOS gathers data and makes prognoses based on model calculations. The system can be used at various stages of a nuclear accident to make predictions about the consequences of the accident and the effect of protective measures. These predictions relate to the exposure of both the public and food (crops, dairy, meat). Germany also uses JRODOS. The RIVM has access to Germany's federal JRODOS system.[219] Belgium uses a different system and does not have access to JRODOS. Belgian and Dutch experts from the expertise network have made arrangements to exchange their prognoses.

Technical information and situation reports
In the event of a nuclear accident in the Netherlands, technical information about the nuclear power plant, situation reports and recommended measures will be published on Calamities Web (*Calamiteitenweb* - CalWeb), a restricted network. CalWeb can be accessed by the Belgian authorities, the German Federal Office for Radiation Protection and the Lower Saxony Water Management, Coastal Defence and Nature Conservation Agency (*Niedersächsischer Landesbetrieb für Wasserwirtshaft, Küsten- und Naturschutz*-NLWKN).

The Belgian equivalent of CalWeb is called WAPITI. In the event of a nuclear accident in Belgium, information about the technical condition of the nuclear power plant, situation reports and an overview of proposed response measures will be made available there. The system also shows which measures are actually implemented. No Dutch authorities have access to this network, although the CGCCR and the RIVM are in contact to make the network accessible for the Dutch authorities.

Germany uses the ELAN system (*Elektronische Lagedarstellung für den Notfallschutz*). It is used by both the federal government and the state of Lower Saxony. Dutch authorities have access to this system.

218 JRODOS: Java-based Real-time Online Decision Support System for nuclear emergency management. JRODOS has been developed since 1990 by 40 institutions from 20 EU member states plus Belarus, Russia, Ukraine, Poland, Hungary, Czech Republic, Slovakia and Romania.
219 The RIVM also has access to the model calculations of the Lower Saxony Water Management, Coastal Defence and Nature Conservation Agency (NLWKN).

Impression from exercises on the exchange of radiological/technical information

The evaluation report following the exercise centring on the research reactor at the Belgian Nuclear Research Centre in Mol in 2015 describes how the FANC and the ANVS kept in touch regularly to exchange radiological and technical information. The ANVS valued this exchange as positive. On the other hand, the members of the Dutch expertise network indicated that, since they had been provided with little explanation about why certain protective measures were implemented, they could not understand the reasoning behind them. According to the Dutch assessment of the exercise, such background information proved difficult to obtain.

During the nuclear exercise centring on the Tihange nuclear power plant in 2012[220], the CGCCR had provided regular situation reports. In spite of the Dutch access to Belgium's crisis management platform and the presence of liaisons, these situation reports and the platform itself were of little use to the Dutch authorities due to the fact that they were in French. As a result, the evaluation report following the exercise states that any future liaisons sent by the NCC to the CGCCR must be fluent in French. In addition, the Dutch parties regarded the situation reports as inadequate and incomplete, as a lot of information was missing.

Crisis management information

The Dutch and Belgian authorities responsible for crisis management at the regional level have access to each other's crisis management systems (these are the national crisis management system LCMS in the Netherlands and the Incident & Crisis Management System ICMS in Belgium). Among other things, these systems contain plans, maps and situation reports about accidents.[221] If the information is only available in the language of the accident country, foreigners may face difficulties accessing the information (see the text box above). The Belgian provinces in the vicinity of the Borssele nuclear power plant prefer the use of a liaison to exchange information. The German and Dutch crisis management teams do not have access to each other's national crisis management systems. Nevertheless, the Dutch Minister of Security and Justice (*minister van Veiligheid en Justitie*) and Lower Saxony's Minister of the Interior and Sport (*Niedersächsisches Minister für Inneres und Sport*) have signed a memorandum of intent[222] to set up a joint Internet platform to improve the exchange of information.

220 The national nuclear exercise Pegase took place in Belgium in 2012. Pursuant to one of the agreements in the Benelux memorandum of 2006, the NCC had been invited to attend this exercise as an observer.

221 Both are restricted digital platforms with the objective of maintaining an up-to-date and shared overview of the crisis and the crisis management efforts. Users of the LCMS include all 25 Dutch safety regions and the National Crisis Centre (NCC). Various crisis management actors, such as the RIVM and hospitals, are able to log onto the system. Belgium's ICMS is intended for all crisis management actors.

222 Joint declaration by the Dutch Minister of Justice and Security and Lower Saxony's Minister of the Interior and Sport regarding cross-border cooperation in the event of disasters and large-scale accidents, signed 28 August 2014.

Sub-conclusion

The Netherlands has entered into arrangements with both Belgium and Germany on the accessibility of each other's digital systems, so that each country has access to the information in these systems in the event of a nuclear accident in a border region. Where such access has not yet been realised, the countries are preparing arrangements to allow mutual access to the relevant information in the near future. Whereas the Netherlands and Belgium exchange information through crisis management systems, no such arrangement exists between the Netherlands and Germany.

4.7 Crisis communication

Crisis communication relates to the provision of information to the public in the event of an actual or imminent nuclear accident with the objective to inform citizens about the situation, its severity, its potential consequences and what action to take. Crisis communication is different from the provision of information to the public discussed in section 4.3 of this investigation report.

In the event of a nuclear accident, it is essential that the public know in good time what they need to do in order to stay safe. The effectiveness of crisis communication depends on the extent to which the crisis organisation is able to provide the public with correct and consistent information, quickly. In order to do so, the organisations responsible for crisis communication will need to harmonise their messages. The Chernobyl accident already made clear that organisations should coordinate their communications to prevent confusion among the public (see text box).

In the event of a cross-border nuclear accident, the accident country and its neighbour will also need to coordinate their crisis communications in order to prevent the public from receiving conflicting information from the responsible authorities. This section describes what steps the Netherlands has taken to coordinate its crisis communications with Belgium and Germany in the event of a nuclear accident.

Crisis communication in the Netherlands at the time of the Chernobyl disaster

A few days after the Chernobyl disaster (1986), the Dutch government announced a number of precautionary measures to protect the food chain (including a prohibition on the grazing of livestock, and the destruction of leafy vegetables). These measures led to a level of disquiet among the public that was unforeseen by the crisis organisation. By keeping communications low-key and limiting them to press releases (instead of organising press conferences to answer questions), the government had hoped to prevent concerns. In practice, however, the one-way communication of information had the opposite effect. A lack of coordination between the various departments involved regarding the provision of information and a lack of consideration given to media reports from abroad contributed to the circulation of conflicting messages, which exacerbated public unrest. The provision of information was further complicated by a lack of expertise about radiation. The report of the evaluation, carried out in the Netherlands with respect to the Dutch government's response to the Chernobyl accident, raised a number of recommendations. These related to preparing a communication strategy, improving cooperation between the departmental information services and educating the public on radiation.

4.7.1 Bilateral coordination of crisis communication during a nuclear accident

Agreements between the Netherlands and Belgium
In the Netherlands, nuclear crisis communication is based on the Crisis Communication Plan for Nuclear and Radiological Emergencies (*Crisiscommunicatieplan Stralingsincidenten* (2017)). According to this plan, the National Core Team for Crisis Communication (*Nationaal Kernteam Crisiscommunicatie* - NKC) is responsible for the coordination and organisation of crisis communication during an actual or imminent nuclear accident.[223] Among other things, the NKC defines communication frameworks and core messages. The safety regions involved implement the communication strategy at the regional level by informing the public about the response measures that will be taken in line with national communication guidelines. Until the NKC has been activated, the responsibility for communication rests exclusively with the safety region. There is no coordination at the national level during this initial phase, as a result of which there is a risk of conflicting messages reaching the public.

Belgium has developed a crisis communication strategy at the national level for nuclear crises. This provides the basis for communication to the public during an actual or imminent nuclear accident. An information cell[224] within the CGCCR determines the communication strategy to be pursued and is responsible at national level for providing information to the public. During the phase preceding the activation of the national crisis organisation[225], however, the responsibility for communication rests with the governors of the provinces and with the municipalities.

223 Ministerie van Infrastructuur en Milieu, *Crisiscommunicatieplan Stralingsincidenten*, 2017.
224 Please refer to Appendix F under F2.
225 This is the reflex phase.

The Netherlands and Belgium have entered into agreements about the coordination of crisis communications at both the national and the regional level. In the event of a cross-border crisis leading to the activation of the national crisis structures in both countries, the CGCCR in Belgium and the NKC in the Netherlands will be in contact regarding crisis communication.[226] They have agreed to keep each other informed about communication initiatives and send each other press releases for consideration, parallel to their external dissemination. For the content of the messages to be communicated, they have agreed to tune the content in the case of communication issues, rumours or distorted perceptions. These are general agreements with regard to cross-border crises and do not address nuclear crises specifically. The national crisis communication plans for the Netherlands and Belgium that deal specifically with nuclear crises refer to the general agreements between the two countries. These plans do not specify in what way the two countries should harmonise communications on nuclear emergencies.

The Zeeland and Central and West Brabant safety regions in the Netherlands and the provinces of Antwerp and East Flanders in Belgium have included contact details for each other's communication staff in their general crisis communication plans. There is a standing agreement that Dutch and Belgian communication staff will contact each other in the event of a cross-border crisis in the region. In addition, the province of Antwerp and the Central and West Brabant safety region have signed a cooperation agreement with regard to crisis management, which includes a statement of intent to align their crisis communications. The authorities in the Western Scheldt delta region, including the Zeeland safety region, the province of Zeeland and the provinces of East Flanders, Antwerp and West Flanders, are in the process of drawing up a cooperation protocol with regard to crisis management and planning.[227] Pursuant to this protocol, the parties will enter into agreements about the alignment of crisis communications. How alignment of communications is to be achieved in practice, is not specified. All agreements are generic in nature, meaning that they are not geared towards a nuclear crisis.

The South Limburg safety region and the province of Liège have entered into similar agreements regarding the coordination of crisis communication. Again, these agreements are generic and provide no details as to how the parties will coordinate their information efforts.[228]

226 Pursuant to the *Memorandum of Understanding between the Kingdom of Belgium, the Kingdom of the Netherlands and the Grand Duchy of Luxembourg on cooperation with regard to the management of crises with potential transboundary consequences*, 1 June 2006.
227 *Protocol GROS Crisisbeheersing en noodplanning Westerscheldedelta (*draft version, May 2017*).*
228 Euregionaal EMRIC-samenwerkingsverband, *Afspraken betreffende informatie-uitwisseling tussen Euregionale partners ten tijde van een ramp of crisis*, 2016.

Differences in communication between countries

The containment of a large fire on the Kalmthoutse Heide, a nature reserve in the Dutch-Belgian border region, brought to light that Dutch and Belgian citizens experienced the message to "close all doors and windows" differently. Belgian citizens interpreted the consequences of the fire as much more severe, compared to Dutch citizens, who were much less impressed by the message.

During the INEX 5 exercise (see section 4.4 of this investigation report) the Dutch participants found that the German authorities were inclined to perform more verifications than their Dutch counterparts before providing information to the public. While the German authorities do not issue communications until an event has been formally confirmed, the Dutch authorities are used to releasing information at an early stage, and to make use of social media. If the Dutch authorities were to wait for the German authorities to communicate about a nuclear accident at the Emsland nuclear power plant, this could lead to the Dutch public receiving information at a later stage than they are used to. On the other hand, if the Dutch authorities were to communicate before the German authorities are ready to do so, this could lead to diverging messages.

Agreements between the Netherlands and Germany

In the event of a nuclear crisis with supraregional consequences, the BMUB is responsible for providing information to the public about the nuclear emergency, its potential radiological consequences (exposure) and the steps to be taken. The responsibility for the actual crisis communication rests with the competent authorities in the Länder, in consultation with the BMUB. In Lower Saxony, the NMI and Landkreis Emsland will use the available warning systems to alert the public. The German Commission on Radiological Protection (*Strahlenschutzkommission*) has prepared communication guidelines for the provision of information to the public during a nuclear crisis. The guidelines specify the communication tools to be used and the methodologies to be followed and provide suggestions for the content of the messages to be communicated.

At the regional level, the Landkreis Emsland, the Osnabrück police department and the Twente safety region have entered into agreements regarding the coordination of communications. In the event of an accident at the Emsland nuclear power plant, the Twente safety region will align its messages to the public with Germany's communication strategy. The safety region's emergency response plan for the Emsland nuclear power plant (*Rampbestrijdingsplan Kernkraftwerk Emsland*) specifies that the measures taken in the Netherlands may differ from those taken in Germany, due to the different principles in these two countries for protecting the public (see also section 4.2 of this report). This may raise questions among the public in the border region. The plan provides a number of default messages to the public that specifically address potential differences in measures and are based on Germany's standard crisis communication messages.[229]

229 Veiligheidsregio Twente, *Rampbestrijdingsplan Kernkraftwerk Emsland*, Appendix 9, 2015.

Neither this plan nor the Landkreis Emsland response plan (*Katastrophenschutz Sonderplan Kernkraftwerk Emsland*) give any further details about how the authorities supplementary will align the information they provide to the public.

At recent NDKK meetings, the German and Dutch representatives considered the cultural differences[230] between the Netherlands and Germany in order to gain a better understanding of each other. To know and understand these differences is a benefit to effective crisis communication.

Coordinating crisis communication following a nuclear accident in the border region
The Netherlands and its neighbouring countries have signed a number of agreements in which they have documented how they coordinate crisis communication. In general, these agreements state that communication staff at the relevant crisis organisations will contact each other during a crisis. For the most part, however, the agreements do not specify how and to what extent the countries shall align the content and method of their communications.

In addition, most of the agreements between the countries are not geared towards nuclear accidents. This can be a handicap, as the unique circumstances of nuclear accidents call for a different communication style compared to generic cross-border crises. Nuclear accidents pose multiple demanding challenges to the crisis communication effort. Aside from the need to quickly inform citizens in the area affected by a nuclear accident about what action to take, there will be a strong need by the public for reliable information from the government. There will be considerable pressure from the media in the event of a nuclear accident. The crisis organisation must be in a position to anticipate these factors. This is only possible if the parties involved have made adequate crisis communication preparations. The coordination between countries of their crisis communication is an essential part of these preparations.

The coordination of crisis communication between countries can be hampered by differences in language[231], culture, communication tools, et cetera. For example, there may be differences in the timing of the information provision, as illustrated in the text box in this section. For the benefit of similarity, it would be preferable if the parties involved coordinated best communication practices in advance. The issue is complicated further by the number of different parties. The Dutch Safety Board observes that the existing plans and agreements have not been elaborated sufficiently to establish whether the crisis organisations will be able to overcome these obstacles. A harmonisation of default messages, some of which are already included in a number of crisis communication plans, is a potential first step.

230 Germany is an "industrial nation" with a focus on reliable, structured and predictable working practices. The Netherlands is a "mercantile nation" with a focus on flexibility and pragmatism.
231 This may involve not only a difference in language, but also differences in phrasing.

Sub-conclusion

The crisis communication agreements the Netherlands has entered into with Belgium and Germany do not specify in what way the countries will harmonise communications in practice. The countries are not well prepared for dealing with bottlenecks that might result from linguistic and cultural differences and differences in communication tools.

5 CONCLUSIONS

The Dutch Safety Board has investigated how the Netherlands and Belgium and the Netherlands and Germany cooperate:

- in the field of licensing and supervision in order to improve the safety of nuclear power plants; and
- in the field of crisis management in order to limit the consequences of a nuclear accident if it were to occur.

The way in which the public are informed about licensing procedures, incidents at nuclear power plants and what action to take in the event of a nuclear accident, was also subject to investigation.

The Dutch Safety Board has reached the following conclusions based on the investigation conducted.

Conclusion 1

If a nuclear accident in the Dutch-Belgian or Dutch-German border region were to occur, at least two of these three countries are likely to be affected by its consequences. The preparations made by the Netherlands and its neighbouring countries with regard to cross-border cooperation in crisis management could be improved in a number of areas. Points for improvement particularly relate to planning, information provision to the public, crisis communication, exercises and cross-border decision-making.

If an accident were to occur at a nuclear power plant close to the Dutch border, there is a high probability of transboundary effects. In order to ensure an adequate response to such a nuclear accident, it is essential for the Netherlands to make joint preparations with Belgium and Germany. In some areas, this has already been achieved. As such, countries have agreed to alert each other as soon as possible in case of an imminent emergency at a nuclear power plant. The European Commission and the International Atomic Energy Agency have set up systems which ensure that countries receive a notification in the event of an actual or imminent nuclear accident in another country. In addition, the Netherlands, Belgium and Germany have access to each other's radiological measurement data so that they can make use of it in the event of a nuclear accident. They also have access to each other's digital systems containing other technical information, such as prognoses, or agreements are being prepared to allow mutual access to this information.

It is difficult to predict how the approach to a nuclear emergency would function in practice. In addition to plans and agreements, mutual relationships, the ability to

improvise and effective leadership are significant factors in determining the extent to which parties will be able to take proper action in practice and deal with the consequences of a nuclear accident. Nevertheless, the Dutch Safety Board has established that the cooperation between the Netherlands and its neighbouring countries and the provision of information to the public require more preparation. The points for improvement mainly concern planning, information on measures to the public, emergency exercises, crisis communication and decision-making:

- **Planning.** The degree to which the cross-border nature of a nuclear accident is reflected in the current nuclear crisis plans varies considerably. The plans prepared by the Zeeland and Twenty safety regions[232], devote most attention to this aspect but there are also plans that do not or to a much lesser extent. In addition, the nuclear crisis plans have not been coordinated between the Netherlands and Belgium nor between the Netherlands and Germany. Moreover, a number of plans are being revised. The Dutch basic principles for preparing the response to a nuclear accident are not fully harmonised with those of Belgium and Germany. In the event of a nuclear accident, this may imply that measures taken one side of the border will differ from those on the other side of the border, giving rise to confusion among the public.
- **Exercises.** The number of joint nuclear emergency exercises to test the cooperation between the Netherlands and Belgium and between the Netherlands and Germany is limited. In order to ensure that the parties in the Netherland are well prepared for a nuclear accident, they should conduct more frequent and more intensive joint exercises with their partners in Belgium and Germany. This requires a coherent and systematic approach.
- **Information on measures to the public.** The Netherlands, Belgium and Germany publish information on websites regarding the potential consequences of and measures to be taken in the event of a nuclear accident. The accessibility of the information to citizens varies by country. In the Netherlands and Germany, this information is more fragmented than it is in Belgium. The Dutch Safety Board considers it remarkable that the Dutch central government has so far paid very little attention to the provision of information to the public about the potential consequences of a nuclear accident and the government's measures to mitigate those consequences, even though nuclear power plants have been in operation in and around the Netherlands for decades.
- **Crisis communication.** The crisis communication agreements the Netherlands has entered into with Belgium and Germany do not specify in what way the countries will harmonise communications in practice. The countries are not well prepared for dealing with bottlenecks that might result from linguistic and cultural differences and differences in communication tools.

232 The General Emergency response plan for Nuclear and Radiological emergencies (*Algemeen Rampbestrijdingsplan Stralingsincidenten*) was prepared by the Zeeland safety region in close cooperation with the Central and West Brabant safety region. The plan applies to both safety regions. The Emergency response plan Kernkraftwerk Emsland (*Rampbestrijdingsplan Kernkraftwerk Emsland*) was prepared by the Twente safety region in cooperation with the IJsselland and Drenthe safety regions.

- **Cross-border decision-making.** Cross-border decision-making is necessary to effectively combat a major, cross-border accident. The Netherlands has not made any agreements with Belgium and Germany on the coordination of decision-making in the event of a nuclear accident in the border region. While the possibility of deploying liaisons contributes to harmonisation between countries, it offers no guarantee for a joint decision-making process.

Previous experiences of crisis management at national level have revealed that the multitude of parties involved can hamper coordinated crisis management.[233] The number of parties involved will only increase for a nuclear accident with transboundary consequences. Moreover, differences in language and culture can obstruct harmonisation. These complicating factors strengthen the need for the parties involved to address the points for improvement and improve their joint preparedness for the eventuality of a crisis arising from a nuclear accident.

Conclusion 2

The Dutch nuclear regulatory authority and its counterparts in Belgium and Germany share information and use each other's expertise to ensure the safety of the nuclear power plants and to be able to inform the public on incidents. It is important for the nuclear regulatory authorities to be more sensitive to issues that could contribute to social concerns and adjust their communications to address these concerns.

Regular consultations take place between the ANVS and its counterparts in Belgium and Germany. They not only share relevant safety information about the nuclear power plants, they also use each other's knowledge and experience to learn from one another:

- Inspectors of the ANVS and the FANC attend each other´s inspections in order to learn from one another. Although Dutch inspectors are not involved in inspections at the Emsland nuclear power plant, the Dutch authorities have other opportunities to form a picture of the safety of that installation. The authorities play no formal part in the actual supervision of the safety of nuclear power plants in neighbouring countries.
- The Netherlands and its neighbouring countries have entered into agreements about the exchange of information on incidents at nuclear power plants. Some of these agreements are yet to be put into practice. The Netherlands receives incident reports from the Doel nuclear power plant and, as soon as agreements are put into practice, from the Tihange and Emsland nuclear power plants as well. This will then enable the ANVS and the safety regions to inform the public about incidents that are expected to generate concern in the Netherlands.

233 Dutch Safety Board, *MH17 Passenger Information*, 2015; Dutch Safety Board, *Fire at Chemie-Pack in Moerdijk*, 2012; and Dutch Safety Board, *Assistance following the Turkish Airlines accident*, 2010.

- In the Netherlands, Belgium and Germany, both the nuclear regulatory authorities and the nuclear power plant operators post information about incidents on their respective websites. The criteria used by the ANVS and the NMU for the types of incidents about which they communicate do not exactly match those used by the FANC. While it is easy for the public to access information about incidents, the majority will struggle to understand it.
- In response to incidents at and news reports about Belgium's nuclear power plants, the Dutch government regularly requested information about the safety of the nuclear power plants. Although the information provided by Belgium strengthened the confidence of the Dutch minister and the Dutch nuclear regulatory authority in the judgement of the Belgian nuclear regulatory authority, the FANC, Dutch parties were not very successful in instilling the same confidence among the Dutch public. It is important for the authorities to be more sensitive to issues that might cause public concerns and to adjust their communications to address these concerns.

Conclusion 3

The Dutch nuclear regulatory authority and its counterparts in Belgium and Germany also inform each other about their licensing procedures regarding nuclear power plants. However, local authorities in a neighbouring country that may have a significant interest in the licensing procedure are not always actively involved in it. The opportunities to engage in public participation for Dutch, Belgian and German residents prior to the actual decision-making vary by country.

The Dutch nuclear regulatory authority and its counterparts in Belgium and Germany inform each other about their licensing procedures regarding nuclear power plants. Nevertheless, local authorities in the neighbouring country that may have an interest in those licensing procedures are not always actively involved in these procedures. Particularly when it comes to procedures regarding the Borssele and Doel nuclear power plants, with a distance to the land border of less than 20 kilometres (namely 16 and 2.8 kilometres respectively), the Dutch and Belgian nuclear regulatory authorities should take greater account of the local interests on the other side of the border.

Partly due to differences in legislation, public access to information about forthcoming licensing procedures varies between the three countries. It is easier for residents of Belgium and Germany to obtain information about forthcoming procedures regarding the Borssele nuclear power plant than it is for residents of the Netherlands to obtain information about forthcoming procedures regarding the Doel, Tihange and Emsland nuclear power plants. These differences also affect their opportunities to bring their views forward before a decision is taken.

6 RECOMMENDATIONS

The Dutch Safety Board's investigation reveals that the Netherlands and Belgium, and the Netherlands and Germany, cooperate well in a number of areas, but that there is room for improvement in others. The Dutch, Belgian and German parties involved have already started implementing some of these improvements. The Dutch Safety Board expects the parties involved to use this investigation report to further improve the cross-border cooperation wherever possible.

The Dutch Safety Board makes two recommendations to improve cross-border cooperation with regard to crisis management. The first recommendation focuses on improving joint preparations for the eventuality of a nuclear crisis. The second recommendation focuses on optimising the decision-making process in the event of a nuclear crisis. In a crisis, the main thing is to act as quickly and effectively as possible. For this reason, it is important to come to an agreement ahead of time on how the countries involved will arrange their joint decision-making to ensure effective crisis management.

To the Dutch State Secretary for Infrastructure and Water Management the Board recommends the following:

1. Improve – together with the responsible government members in Belgium and Germany – the cross-border cooperation aimed at limiting the potential consequences of a nuclear accident. In particular, pay close attention to:

   - harmonisation of the principles for nuclear accident response;
   - revision of the crisis plans which at the moment take insufficient account of cross-border aspects;
   - joint preparation by means of conducting joint emergency exercises, simulations, et cetera; and
   - harmonisation of crisis communications.

2. Enter into agreements with Belgium and Germany on supranational decision-making in a crisis situation that arises from a cross-border accident at the Borssele, Doel, Tihange or Emsland nuclear power plants. Provide that such decision-making is intended at least to take similar response measures on either side of the border and to communicate unanimously on those measures.

In order to limit the consequences of a nuclear accident when it occurs, it is vital that citizens follow the instructions of the competent authorities. This is only possible if citizens have sufficient confidence in the authorities involved and the protective actions to take. Public concerns indicate that this confidence is not sufficiently widespread at this time. It is of importance that the authorities concerned recognise and address these concerns. They could do so by providing citizens with information that meets their needs and enables them to make their own judgement. Transparency and clear communication can contribute to the public's confidence in the authorities involved.

To the Dutch Authority for Nuclear Safety and Radiation Protection, the Board recommends the following:

3. Recognise the concerns among the Dutch public about the safety of nuclear power plants and address them by:

    - entering into agreements with neighbouring countries about cross-border information provision with regard to licensing procedures, so that residents across the border within a 20-kilometre radius from the nuclear power plant in question are actively informed about these procedures and given the opportunity to participate;
    - communicating about incidents at nuclear power plants in language that is easy for the public to understand; and
    - giving priority to improving communication with regard to the risks of nuclear power plants, among others by setting up a central information point for the public to obtain information about what action to take in the event of a nuclear accident.

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APPENDIX A

EXPLANATION OF THE INVESTIGATION

A.1 Purpose and investigation questions

The purpose of this investigation was to reveal whether, and if so which, improvements can be made to the cross-border cooperation between the Netherlands and its neighbouring countries and to the provision of information to the public, so that people living in the vicinity of nuclear power plants are safe and feel safe.

The investigation addresses the following questions:

1. In what ways does the Netherlands cooperate with Belgium and Germany to improve the safety of nuclear power plants?
2. In what ways does the Netherlands cooperate with Belgium and Germany to limit the potential consequences of nuclear accidents?
3. How is the public kept informed about incidents at nuclear power plants, forthcoming licensing procedures and what action to take in the event of a nuclear accident?

The investigation questions are broken down into the sub-questions listed below.

Re 1. Cross-border cooperation to improve the safety of nuclear power plants

a. To what extent do the Netherlands and Belgium and the Netherlands and Germany involve[234] each other in their decision-making with regard to the safe operation of nuclear power plants?
b. In what ways do these countries cooperate with regard to obtaining insights into and supervising the safe operation of each other's nuclear power plants?
c. How can cross-border cooperation be improved?

234 The Dutch Safety Board defines "involving" as actively providing information to neighbouring countries about licensing procedures and giving neighbouring countries the opportunity to bring their views forward.

Re 2. Cross-border cooperation with regard to crisis management in the event of a nuclear accident

a. To what extent do the Netherlands and Belgium and the Netherlands and Germany involve each other in their preparations for a nuclear accident (planning, emergency exercises)?
b. In what ways does the Netherlands cooperate with Belgium and Germany to limit the consequences of nuclear accidents (alerts, response)?
c. How can cross-border cooperation be improved?

Re 3. Information provision to the public

a. To what extent do citizens have access to information about forthcoming licensing procedures and opportunities to bring their views forward?
b. How is the public informed about incidents at nuclear power plants?
c. How is the public informed about what action to take in the event of a possible nuclear accident?
d. How can the provision of information to the public be improved?

A.2 Scope of the investigation

With regard to this investigation, the Dutch Safety Board has treated the current nuclear energy policies of the Netherlands, Belgium and Germany as a given. The Board has not considered the desirability of energy generation by means of nuclear fission. The Dutch Safety Board has investigated whether the cross-border cooperation between countries which have opted for nuclear energy includes all reasonable steps necessary to guarantee the safety of the public.

The investigation has been limited to the nuclear power plants in operation in the Dutch-Belgian and Dutch-German border regions, which are the Borssele (Netherlands), Doel and Tihange (Belgium) and Emsland (Germany) nuclear power plants. None of the other nuclear installations in the Netherlands, Belgium and Germany were considered.[235] This also applies to nuclear power plants in other European countries, such as France, whose nuclear power plants at Gravelines and Chooz are the ones nearest to the Dutch border. Of course an accident at any of those power plants could have consequences for the Netherlands and necessitate cross-border collaboration. The lessons learnt in this investigation can also be useful in the event of such an accident. The Dutch Safety Board did not include transportation, storage and processing of radioactive material in its investigation.

As concerns nuclear safety, there is an international system in place to ensure that countries adequately perform their duties with regard to the safety of their nuclear power plants. The Dutch Safety Board has no reason to doubt the effectiveness of this system.

235 These installations concern the research reactors in Petten and Delft, the URENCO enrichment installations in Almelo and Gronau, the radioactive waste processing plants in Borsele and Mol-Dessel, the reactor in the research centre in Mol, the installation for the production of medical isotopes in Fleurus, et cetera. German nuclear power plants at a greater distance from the Dutch border, such as the plants in Brokdorf and Grohnde, were left out as well.

In its investigation, the Board has assumed that the national and international mechanisms to control and supervise the safety of nuclear power plants function properly. By consequence, the investigation did not focus on whether the nuclear power plants in and around the Netherlands are safe, but on how the Netherlands is cooperating with Belgium and with Germany to improve the safety of nuclear power plants and limit the potential consequences of a nuclear accident.

The Dutch Safety Board has not investigated collaboration in crisis management comprehensively, but limited its scope to the first phase of a crisis. The post-accident phase was beyond the scope of this investigation.

In its investigation report, the Dutch Safety Board has attempted to present as accurate a picture as possible of the current legislative framework and the policies in the three countries which are relevant to the investigation. However, the Dutch Safety Board's investigation did not take into account any changes thereto that were implemented after 1 October 2017.

A.3 Investigative approach

The investigation covered a broad range of topics and a multitude of parties in the Netherlands, Belgium and Germany that are involved in these topics. This broad scope had consequences for the investigative approach.

At the start of its investigation, the Dutch Safety Board conducted introductory talks with the directors of the relevant parties. These talks were conducted initially in the Netherlands and Belgium and later also in Germany. During these talks, the Dutch Safety Board explained the purpose of its investigation and its methodology in order to ensure that all interested parties had a clear picture of what to expect from the Dutch Safety Board and of what the Dutch Safety Board expected from them. In addition, the introductory talks in Belgium and Germany helped to get access to individuals and information relevant to the investigation. The Dutch Safety Board Act[236], which governs access to individuals and information in the Netherlands, does not apply to Belgium and Germany. Moreover, parties in those countries are less familiar with the existence and the work of the Dutch Safety Board. The introductory talks contributed to the willingness of parties in Belgium and Germany to cooperate with the Dutch Safety Board's investigation.

As part of its investigation, the Dutch Safety Board established a frame of reference describing what the Board expects from the parties involved. This frame of reference was based on the international, European, Dutch, Belgian and German legislative frameworks with regard to the investigation. In addition, the Dutch Safety Board itself formulated an additional number of principles for its investigation. These are outlined in paragraph 1.6.

In the course of the investigation, the Dutch Safety Board interviewed more than 100 people. The majority of the interviews were conducted in the Netherlands and Belgium.

236 Dutch Safety Board Act (*Rijkswet Onderzoeksraad voor veiligheid*), Staatsblad, 23 December 2004, No 677.

In the concluding phase of the investigation, organisations in Germany were requested to answer questions in order to assess whether the cooperation between the Netherlands and Germany differed from the cooperation between the Netherlands and Belgium. Interviewees included representatives of parties involved in ensuring the safe operation of nuclear power plants and of parties involved in preparing for the eventuality of a nuclear accident. The former group included policymakers, nuclear regulatory authorities and operators of nuclear power plants. The latter group mainly included parties involved at the national, regional and local level in preparing for the eventuality of a nuclear accident. The Dutch Safety Board also conducted talks with Greenpeace, representatives of a number of local authorities in the Dutch-Belgian border region and a number of scientific experts from such institutions as the University of Twente, Delft University of Technology and Eindhoven University of Technology. The main objective to consult these experts was to gain insight into public perceptions of the safety of nuclear power plants.

In addition to the interviews conducted, the investigation team studied a large number of documents. The team made use of public sources, such as parliamentary proceedings, policy documents, crisis plans, manuals, et cetera and requested the parties involved to provide all information relevant for the purpose of answering the investigation questions. Furthermore, the Dutch Safety Board commissioned a media analysis in order to obtain insight into how the media reports about safety at nuclear power plants.

Lastly, the project team visited the Borssele nuclear power plant in order to gain a better understanding of the workings of a nuclear power plant and the manner in which its safe operation is guaranteed. Members of the project team also visited the Chernobyl nuclear power plant in order to gain insight into the potential long-term effects of a very serious nuclear accident on the environment.

A.4 Quality assurance

The Dutch Safety Board carried out a number of activities to assure the quality of the investigation. These included the organisation at various stages of the investigation of round-table sessions with colleagues who were not involved in the investigation. The objective of these sessions was to encourage a critical evaluation of the interim findings of the investigation team. In addition, the Dutch Safety Board convened a guidance committee composed of external experts to assess the contents of the report (please see paragraph A.5 for more information). Finally, the draft investigation report was submitted to the parties involved for consultation with a request to check the contents for factual inaccuracies and ambiguities (please refer to Appendix B for more information).

A.5 Role and composition of the guidance committee

The Dutch Safety Board convened a guidance committee for the purpose of this investigation. This committee comprised external members with expertise relevant to the investigation and was chaired by a member of the Dutch Safety Board. The external members sat on the guidance committee in a personal capacity. The guidance committee comprised the following people (academic degrees and titles are listed in Dutch):

prof. mr. dr. E.R. (Erwin) Muller (chairman)	Vice-chairman of the Dutch Safety Board
ir. J. (Hans) van der Vlist	Associate Member of the Dutch Safety Board
H.F.J. (Herman) de Croo	Minister of State, former President and serving Member of the Belgian Chamber of Representatives
drs. P.L.B.A. (Pieter) van Geel	Managing Director of Pieter van Geel Consultancy and former State Secretary at the Ministry of Housing, Spatial Planning and the Environment
prof. dr. ir. W. (William) D'haeseleer	Professor of energy conversion at the Catholic University of Leuven and Chairman of the Scientific Council for Ionising Radiation
drs. H.G. (Henk) Geveke	Managing Director of Defence, Safety and Security at the Netherlands Organisation for Applied Scientific Research (TNO)
prof. dr. ir. J. L. (Jan Leen) Kloosterman	Professor of nuclear reactor physics at Delft University of Technology
prof. dr. ir. G.L.L. (Genserik) Reniers	Professor of safety of hazardous materials at Delft University of Technology, the Catholic University of Leuven and the University of Antwerp
prof. dr. W.C. (Wim) Turkenburg	Emeritus Professor of Science, Technology and Society at Utrecht University and former Director of the Copernicus Institute (Utrecht University) and the Utrecht Centre for Energy Research
J.P. (Jean-Paul) Samain	Superior Health Council of Belgium

The guidance committee convened on three occasions during the investigation to exchange views with the members of the Dutch Safety Board and the project team on the approach and results of the investigation. The committee acted in an advisory capacity during the investigation. The Dutch Safety Board bears final responsibility for the report and the recommendations.

A.6 Project team

The project team comprised the following people (academic degrees and titles are listed in Dutch):

dr. E.K. (Ellen) Verolme	Investigation manager
ir. J.J.C. (Annemiek) van der Zande MBA	Project manager
dr. Ir. E.M. (Ellen) Berends	Investigator
R.J.H. (Ron) Damstra	Investigator (until 1 February 2017)
F. (Floris) Gisolf Msc	Investigator
drs. M. (Mirjam) van het Loo	Investigator
H.T.M. (Hetty) van Rooij	Liaison officer Brussels
drs. S. (Seija) Pijnse van der Aa	Advisor (until 1 April 2017)
drs. E.J. (Elsabé) Willeboordse	Advisor (until 1 April 2017)

To carry out the investigation, the Dutch Safety Board contracted the following external investigators: drs. V. (Vincent) Sabee, mr. E.M.J. (Evelien) Verberne (COT), drs. P. (Paul) van Beers MBA (Twynstra Gudde) and R. (Robin) Liefferinckx.

The Dutch Safety Board was supported by the following external experts during the investigation: dr. H. (Harry) Slaper, radiation protection expert; drs. D.J. (Dirk) Stolk, crisis management expert; and mr. W.J.N. (Willem-Jan) Langenbach, legal expert.

APPENDIX B

RESPONSES RECEIVED FOLLOWING REVIEW OF THE DRAFT REPORT

As required under the Dutch Safety Board Kingdom Act (Rijkswet Onderzoeksraad voor veiligheid), a draft version of this report has been submitted to the parties directly involved. The following parties have been requested to check the report for any factual inaccuracies and ambiguities, and to present their views on the findings of the investigation.

In the Netherlands:

- ANVS
- Ministry of Infrastructure and the Environment (*Ministerie van Infrastructuur en Milieu*)
- Ministry of Security and Justice (*Ministerie van Veiligheid en Justitie*)
- NCTV
- Ministry of Health, Welfare and Sport (*Ministerie van Volksgezondheid, Welzijn en Sport*)
- RIVM
- Zeeland safety region (*Veiligheidsregio Zeeland*)
- Central and West Brabant safety region (*Veiligheidsregio Midden- en West-Brabant*)
- South Limburg safety region (*Veiligheidsregio Zuid-Limburg*)
- Twente safety region (*Veiligheidsregio Twente*)
- Province of Zeeland (*Provincie Zeeland*)
- Province of Limburg (*Provincie Limburg*)
- Province of North Brabant (*Provincie Noord-Brabant*)
- Municipality of Bergen op Zoom (*Gemeente Bergen op Zoom*)
- Municipality of Borsele (*Gemeente Borsele*)
- EPZ

In Belgium:

- FANC
- Federal Public Service of the Interior (*Federale Overheidsdienst Binnenlandse Zaken*)
- Directorate-General Crisis Centre, CGCCR (*Algemene Directie Crisiscentrum, CGCCR*)
- Superior Health Council of Belgium (*Hoge Gezondheidsraad*)
- Province of Antwerp (*Provincie Antwerpen*)
- Province of East Flanders (*Provincie Oost-Vlaanderen*)
- Province of Liège (*Province de Liège*)
- Engie Electrabel
- Municipality of Beveren (*Gemeente Beveren*)

In Germany:

- Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (*Bundesministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit*)
- Federal Office for Civil Protection and Disaster Assistance (*Bundesamt für Bevölkerungsschutz und Katastrophenhilfe*)
- Lower Saxony Ministry of the Environment, Energy and Climate Protection (*Niedersächsisches Ministerium für Umwelt, Energie und Klimaschutz*)
- Lower Saxony Ministry of the Interior and Sport (*Niedersächsisches Ministerium für Inneres und Sport*)
- Osnabrück police department (*Polizeidirektion Osnabrück*)
- Kernkraftwerke Lippe-Ems

International:

- International Atomic Energy Agency (*IAEA*)

The Dutch Safety Board has assessed the responses received and has made adjustments to the draft investigation report where necessary. The Dutch Safety Board has incorporated corrections of inaccuracies, clarifications as well as editorial comments, where relevant. The relevant passages were amended in the final report. These responses are not mentioned separately. The responses that were not incorporated are listed in a table with the reasons for their non-inclusion. That table was published on the Dutch Safety Board website at the same time as this report (www.onderzoeksraad.nl/en).

APPENDIX C

PARTIES INVOLVED: THE NETHERLANDS, BELGIUM AND GERMANY

C.1 The Netherlands

Elektriciteits Productiemaatschappij Zuid-Nederland (EPZ)
EPZ is the operator of the Borssele nuclear power plant. The plant is owned by the energy companies DELTA (70%) and RWE Essent (30%).

Authority for Nuclear Safety and Radiation Protection (Autoriteit Nucleaire Veiligheid en Stralingsbescherming - ANVS)
The Dutch government has delegated its nuclear safety and radiation protection tasks to the ANVS. The ANVS was established on 1 January 2015 following a merger between former organisational units of the Ministry of Economic Affairs and the Ministry of Infrastructure and the Environment.[237] It prepares and/or provides advice about policy and legislation, issues licences to nuclear installations and supervises compliance with the regulatory framework. In addition, the ANVS has the statutory duty to provide information to third parties, to participate in international networks and to cooperate with its counterparts in neighbouring countries, among others by exchanging and sharing information. As part of its information provision duties, the ANVS provides information to the public about the potential consequences of nuclear accidents and possible measures.[238] Furthermore, the ANVS plays a substantive part in managing the National Plan for Nuclear and Radiological Emergencies as well as the corresponding response plan.

In the event of an actual or imminent nuclear accident, the ANVS' knowledge and expertise with regard to nuclear safety and radiation protection is used as input for the decision-making in crisis situations.[239] As an example, the Crisis Expert Team radiation and nuclear (CETsn), which plays an important substantive and advisory role in the crisis organisation during an actual or imminent nuclear accident, is staffed by the ANVS. The CETsn is supported by a Radiology and Health Expertise Network (RGEN). The RGEN is

237 Former organisational units were the Ministry of Economic Affairs' Programme Directorate for Nuclear Installations and Safety (*Programmadirectie Nucleaire Installaties en Veiligheid van het Ministerie van Economische Zaken*); the Nuclear Energy Service and the nuclear advisory networks team at the Human Environment and Transport Inspectorate (*Kernfysische Dienst en het Team Adviesnetwerken nucleair van de Inspectie Leefomgeving en Transport*); and the radiation protection team at the Netherlands Enterprise Agency that is part of the Ministry of Economic Affairs (*Team Stralingsbescherming van de Rijksdienst voor Ondernemend Nederland van het Ministerie van Economische Zaken*).
238 Section 43 Nuclear Energy Act (*Kernenergiewet*).
239 Ministerie van Infrastructuur en Milieu, *Nationaal Crisisplan Stralingsincidenten*, 2017.

an expertise network formed by a number of Dutch knowledge institutes[240], which provides reports and advice about the radiological and health consequences of the accident.

Ministry of Infrastructure and the Environment (Ministerie van Infrastructuur en Milieu)[241]
At the central governmental level, responsibility for nuclear safety rests with the Minister of Infrastructure and the Environment.[242] On 1 May 2015, this responsibility was transferred from the Minister of Economic Affairs to the Minister of Infrastructure and the Environment by virtue of legislation concerning departmental reorganisation.[243] The policy preparation duties with respect to nuclear safety and radiation protection policy rest mainly with the ANVS. A liaison position has been created to ensure the desired level of coordination between the ANVS and the Ministry.

The Minister of Infrastructure and the Environment is responsible for coordinating the preparation for and response to an actual or imminent nuclear accident.[244] The performance of this coordinative duty has been delegated to the Ministry's Departmental Coordination Centre for Crisis Management (DCC IenM). As a consequence, the DCC IenM is ultimately responsible for the Ministry's crisis response. Among other things, the DCC IenM manages the National Plan for Nuclear and Radiological Emergencies and the general education, training and exercise efforts for crisis management as based on this plan.[245]

One of the roles of the DCC IenM during a crisis caused by a nuclear accident is to coordinate requests for information. This means that the DCC ensures that the substantive recommendations from the CETsn are communicated to the national crisis structure and are taken into account in the national decision-making process. The DCC also ensures that the safety regions that have to deal with the consequences of the accident are informed of these recommendations and that questions from the safety regions and ministries reach the CETsn. In addition, during a crisis the CETsn and the safety regions are in direct contact with each other.

Ministry of Security and Justice (Ministerie van Veiligheid en Justitie)[246]
The Minister of Security and Justice[247] has general responsibilities with regard to disaster and crisis management, particularly with regard to the crisis coordination between the various ministers and authorities involved in the event of a crisis which constitutes a threat to national safety or security. If the cause of the crisis is an intentional act the Minister of Security and Justice has extended powers in his capacity as the minister in charge of counterterrorism coordination.

240 These include the National Institute for Public Health and the Environment, the Royal Netherlands Meteorological Institute, RIKILT, the Defence Coordination Centre for Expertise on Working Conditions and Health, KWR, the National Poisons Information Centre and the Directorate-General for Public Works and Water Management.
241 As of October 2017, Ministry of Infrastructure and Water Management (*Ministerie van Infrastructuur en Waterstaat*).
242 As of October 2017, State Secretary of Infrastructure and Water Management (*staatssecretaris van Infrastructuur en Waterstaat*).
243 *Besluit houdende departementale herindeling met betrekking tot nucleaire veiligheid en stralingsbescherming*), no 2015000645 of 10 April 2015.
244 Ministerie van Infrastructuur en Milieu, *Nationaal Crisisplan Stralingsincidenten*, 2017.
245 Ministerie van Infrastructuur en Milieu, *Nationaal Crisisplan Stralingsincidenten*, 2017.
246 As of October 2017, Ministry of Justice and Security (*Ministerie van Justitie en Veiligheid*).
247 As of October 2017, Minister of Justice and Security (*minister van Justitie en Veiligheid*).

National Coordinator for Security and Counterterrorism (Nationaal Coördinator Terrorismebestrijding en Veiligheid - NCTV)
The NCTV falls under the responsibility of the Minister of Security and Justice and assumes the minister's coordinative duties with regard to the preparation for and response to a crisis.[248] In addition, the NCTV is in charge of the National Crisis Centre (NCC). The NCC serves as a 24/7 crisis centre for the Netherlands as a whole. The NCC plays a pivotal role during a national crisis; it organises and coordinates all of the government's crisis response processes. These include detection, information gathering, preparation, crisis communication and supporting the interdepartmental decision-making process.

Ministry of Health, Welfare and Sport (Ministerie van Volksgezondheid, Welzijn en Sport - VWS)
Subject to coordination by the Ministry of Infrastructure and the Environment, the Minister of Health, Welfare and Sport is responsible for measures and decisions in the field of public health in the event of an accident or long-term exposure. As regards preparedness for a nuclear accident, the Ministry arranges (preparations for) the distribution of iodine tablets in particular. For example, the Ministry of Health, Welfare and Sport arranges the pre-distribution of iodine tablets among residents of the Netherlands who live within a certain distance from nuclear installations. The objective of pre-distribution is to reduce the acute demand for iodine tablets in the event of an accident. The execution of the emergency distribution of iodine tablets, which entails the distribution of iodine tablets during an actual or imminent release of radioactive materials, is a matter for the Dutch safety regions.

National Institute for Public Health and the Environment (Rijksinstituut voor Volksgezondheid en Milieu - RIVM)
The RIVM is an agency of the Ministry of Health, Welfare and Sport. As a knowledge institute, the RIVM supports the government in taking care of the health of the population and the quality of the environment. This includes protecting the public, employees and patients against the harmful effects of radiation. The RIVM manages the National Radiation Monitoring Network[249], which continuously measures the amount of radiation in the Netherlands, as well as a model infrastructure and a system that supports the decision-making process. In addition, the RIVM coordinates and manages the expertise network RGEN.[250] During a nuclear accident, this network gathers details on the accident, its progress, its potential consequences (in terms of radiation) and the current weather conditions. Based on this information, the expertise network makes dispersion calculations and summarises the outcomes in a situation report. These situation reports form the basis for substantive advice regarding effective measures to mitigate the consequences of the accident, which is subsequently drafted by the CETsn.

248 NCTV, *Nationaal Handboek Crisisbesluitvorming*, September 2016. Internet: www.nctv.nl.
249 The monitoring network functions as an early warning system for nuclear accidents. Its measurement data are gathered and analysed by the RIVM.
250 Which consists of the National Institute for Public Health and the Environment, the Royal Netherlands Meteorological Institute, RIKILT, the Defence Coordination Centre for Expertise on Working Conditions and Health, KWR, the National Poisons Information Centre and the Directorate-General for Public Works and Water Management.

Safety regions (veiligheidsregio's)
The safety regions are responsible for executing the operational response to a nuclear accident. They take care of the execution of the measures within the affected region(s) that are decided upon by the central government in response to a nuclear accident. This may include a wide range of measures, such as regulating access to the contaminated area, distributing iodine tablets, evacuating residents, decontaminating and protecting surface waters and drinking water supplies, broadcasting calls to seek shelter, et cetera. In a practical sense, all safety regions in the Netherlands may be affected by the consequences of a nuclear accident. Out of the 25 safety regions, 20[251] are responsible for preparing measures to ensure the immediate protection of the Dutch population (evacuation, shelter, iodine tablets) in the event of an accident at one of the Borssele, Doel, Tihange or Emsland nuclear power plants. As a result of their location, four safety regions play a primary role. These are the Zeeland and Central and West Brabant safety regions (both because they are near Borssele as well as Doel), the South Limburg safety region (near Tihange) and the Twente safety region (near Emsland). They prepare operational plans and arrange for coordination with the neighbouring safety regions that are involved in such plans. Notwithstanding the coordination, the neighbouring safety regions still have their own competences and responsibilities.

The affected safety regions also play a role in informing the public about disasters and crises that may affect the region (like nuclear accidents), the protective measures that may be taken as a result and what action the people themselves should take in such case.

C.2 Belgium

Electrabel
Electrabel is the operator of the nuclear power plants in Doel and Tihange. As Belgium's main energy supplier, Electrabel owns various production facilities, which include both nuclear power plants. Electrabel is a subsidiary of the international Engie group.

Federal Agency for Nuclear Control (Federaal Agentschap voor Nucleaire Controle - FANC)
The FANC is the Belgian federal government's regulatory authority for nuclear installations and is in that sense comparable to the ANVS in the Netherlands, although their statutory duties differ to some extent. The FANC is under the jurisdiction of the Federal Public Service of the Interior. It is responsible for the licensing[252] and supervision of nuclear installations in Belgium with the aim of protecting the public, employees and the environment against the dangers of ionising radiation.[253] For the supervision of nuclear installations, including nuclear power plants, the FANC relies on the technical

251 In addition to the Zeeland, Central and West Brabant, South Limburg and Twente safety regions, the zones around the Borssele, Doel, Tihange and Emsland nuclear power plants include the Southern South Holland, Rotterdam-Rijnmond, Haaglanden, Central Holland, Utrecht, South-East Brabant, North Limburg, IJsselland, Drenthe, Flevoland, Central Gelderland, North and East Gelderland, Friesland and Groningen safety regions.
252 Only the King of Belgium has the authority to license nuclear power plants. The FANC is responsible for making the necessary preparations for licensing.
253 The Special Act on Institutional Reform (*de Bijzondere Wet tot hervorming der instellingen*) defines the jurisdictions of Belgium's federal and regional governments. This Act stipulates that nuclear energy is under the jurisdiction of the federal government. The federal government is authorised to issue licences for the nuclear part of nuclear power plants.

expertise of Bel V, a company which carries out routine inspections commissioned by the FANC. Bel V also contributes specialist expertise. In addition, the FANC and Bel V carry out inspections together. The FANC also manages Belgium's national monitoring network TELERAD, which continuously measures the amount of ionising radiation in Belgium. Furthermore, the FANC supports the implementation of the nuclear crisis plans drawn up by the Minister of Security and the Interior by contributing scientific and technical information with regard to nuclear safety.[254]

In a nuclear crisis situation, such as a crisis arising from a nuclear accident, the FANC provides the decision-making process at federal level with radiological and technical advice concerning the protective measures to be taken.

Scientific Council for Ionising Radiation (Wetenschappelijke Raad voor Ioniserende Straling)
The Scientific Council for Ionising Radiation is a scientific advisory body responsible for providing substantive advice with regard to licensing. The advice of the Scientific Council is formally solicited for new nuclear installations, significant modifications to existing installations, additional licence requirements or modifications to existing licence requirements, the revocation of licences and applications for licences to dismantle installations. Each licence application must be submitted to the Scientific Council twice. Its advice is binding. In the first session, the Scientific Council provides advice about, among others, the research that is required in order to guarantee safety and radiation protection. In the second session, the Scientific Council focuses on the outcomes of the aforementioned research, objections raised and advice received, as a result of which it issues formal advice about whether to grant the licence.

Federal Public Service of the Interior (Federale Overheidsdienst Binnenlandse Zaken)
At the governmental level, responsibility for nuclear safety rests with the Federal Public Service of the Interior. In addition, the Minister of Security and the Interior is primarily responsible for Belgium's crisis response preparations. As such, he draws up the federal nuclear crisis plan. This plan sets out the responsibilities and competences of the federal government and other governments with regard to managing a crisis arising from a nuclear accident. The minister has delegated the duty to prepare for a nuclear accident to the Directorate-General Crisis Centre of the Federal Public Service of the Interior. This Directorate-General coordinates the mutual alignment of the nuclear safety policies of the various governments, authorities and services. In addition to crisis planning, the Directorate-General is responsible for the information provision to the public. For this purpose, it has developed the website www.nucleairrisico.be (www.risquenucleaire.be).

Coordination and Crisis Centre of the Belgian Government (Coördinatie- en Crisiscentrum van de Regering - CGCCR)
The CGCCR is an operational service within the Directorate-General Crisis Centre of the Federal Public Service of the Interior and acts as a federal crisis centre. Its duty is to

254 Sections 22 and 23 of the Act of 15 April 1994 concerning the protection of the public and the environment against the hazards of ionising radiation and concerning the FANC (*Wet betreffende de bescherming van de bevolking en van het leefmilieu tegen de uit ioniserende stralingen voortspruitende gevaren en betreffende het FANC*).

monitor the chain of events both day and night, identify potential crisis situations and alert the responsible authorities in the event of an actual or imminent crisis.

During a crisis, the CGCCR plays a central role in the federal crisis organisation. Among other things, it organises logistics and communication resources and activates the various crisis organisation units, also known as "cells".

Federal Public Service of Public Health, Food Chain Safety and Environment (Federale Overheidsdienst Volksgezondheid, Veiligheid van de Voedselketen en Leefmilieu)
The Minister of Public Health is responsible for policy decisions regarding the availability of iodine tablets in the event of a nuclear accident. When preparing policies (including the policy for the protection of the public against ionising radiation), the Federal Public Service draws on the advice of the Superior Health Council.

Superior Health Council of Belgium (Hoge Gezondheidsraad)
The Superior Health Council of Belgium is the scientific advisory body of the Federal Public Service of Health, Food Chain Safety and Environment (*Federale Overheidsdienst Volksgezondheid, Veiligheid van de Voedselketen en Leefmilieu*). The Superior Health Council serves as a link between the Belgian government and the academic community within several public health-related domains. The Council provides both solicited and unsolicited advice. The Belgian government is obliged to ask the Superior Health Council for advice on every legal amendment or Royal Decree in connection with the protection against ionising radiation. Several years after the Fukushima accident, the Superior Health Council of Belgium launched an advisory procedure on its own initiative. In 2016 the Council issued a report on nuclear planning in Belgium.

Provinces
The provinces of Belgium have a duty to prepare general as well as special emergency response plans in order to safeguard civil safety on their territories. Regarding crisis management, the provinces play a largely operational role. In the special case where an accident requires immediate measures to protect the public, the governor can take reflexive action in response to an alert on his or her own authority, pending activation of the federal crisis response organisation. The reflex phase ends as soon as the federal crisis organisation is activated. From that moment, the decision-making on response measures lies at the federal level. The execution of these measures is managed by the governor(s) of the province(s) involved. For the nuclear power plants in the Dutch-Belgian border region covered by this investigation, the Governors of the provinces of East Flanders (Doel), Antwerp (Doel) and Liège (Tihange) play a primary role.

C.3 Germany

Kernkraftwerke Lippe-Ems
The Emsland nuclear power plant is operated by Kernkraftwerke Lippe-Ems GmbH and owned by the energy company RWE.

Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (Bundesministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit - BMUB)
The BMUB is responsible at the federal level for Germany's nuclear safety policy and nuclear legislation. In addition to its policymaking and legislative duties, the ministry plays an important role in the agreements and coordination with neighbouring countries. It participates in international alliances as a signatory party on Germany's behalf.

The responsibility for implementing laws and regulations rests with the German Länder. The federal government and the Länder cooperate on nuclear safety and radiation protection through the Länder Committee for Nuclear Energy (*Landerauschuss für Atomkernenergie*). The objective of this cooperation is to continue to develop regulations in Germany and harmonise licensing and supervision across the Länder. The BMUB contributes knowledge from international working groups, specialist literature, et cetera. The competent ministries of the Länder, including that of Lower Saxony, contribute practical knowledge about the actual performance of their nuclear installations.

With respect to crisis management, the BMUB is tasked with the coordination of crisis response measures with Germany's neighbouring countries, the provision of information to the public and all matters related to radiation protection. In the event of a nuclear crisis, the BMUB is responsible for alerting other countries, the IAEA and the EU. In addition, the federal ministry has the duty to assess the radiological situation. Germany's Radiation Protection Act (*Strahlenschutzgesetz*), which entered into force on 1 October 2017, makes provisions for a radiological centre (*Radiologisches Lagezentrum des Bundes* - RLZ) under the jurisdiction of the BMUB. During a crisis, this centre will analyse the radiological situation for the whole of Germany and make recommendations for protective measures and follow-up actions. In addition, the BMUB can make recommendations to the Länder regarding the crisis communications to the public.

Technical advisory committees and federal agencies
The BMUB is supported by a number of committees, including the Reactor Safety Commission (*Reaktorsicherheitskommission*) and the Commission on Radiological Protection (*Strahlenschutzkommission*), which provide technical and substantive advice on their own initiative or when solicited by the BMUB. The Commission on Radiological Protection provides advice about protection against ionising and non-ionising radiation, the risks of radiation and crisis management. The Reactor Safety Commission provides advice about safety-related issues and the physical protection of nuclear installations. In addition, the BMUB uses the services of the *Gesellschaft für Anlagen- und Reaktorsicherheit* (GRS), a technical support organisation. The GRS performs research and analyses in the field of reactor safety, radioactive waste management and the protection of the environment against radiation.

The Federal Office for Radiation Protection (*Bundesamt für Strahlenschutz* - BfS) is an independent federal agency concerned with radiation protection. The agency is under the jurisdiction of the BMUB. The BfS manages the ODL monitoring network (*Ortsdosisleistungs-Messnetz*)[255], which is the network that measures gamma radiation

255 Bundesamt für Strahlenschutz, *Das Deutsche Messnetz für Radioaktivität*, 2013.

on German territory. This network forms part of Germany's Integrated Measuring and Information System (IMIS), which also provides prognoses and supports the decision-making process[256] This network forms part of Germany's Integrated Measuring and Information System (IMIS), which also provides prognoses and supports the decision-making process.[257] In July 2016, a number of duties of the Federal Office for Radiation Protection, such as the compilation of monthly reports about incidents at Germany's nuclear installations, were transferred to the Federal Office for the Safety of Nuclear Waste Management (*Bundesamt für kerntechnische Entsorgungssicherheit* – BfE). The BfE is also tasked with the registration of incident reports in the German registration system *Störfallmeldestelle*.

Lower Saxony Ministry of the Environment, Energy and Climate Protection (Niedersächsisches Ministerium für Umwelt, Energie und Klimaschutz - NMU)
The implementation of federal legislation is the responsibility of the German Länder. This includes the licensing of nuclear power plants and the supervision of their safety. For the Emsland nuclear power plant, which is located in Lower Saxony, licensing and supervision is the responsibility of the NMU.[258]

In the event of a crisis arising from a nuclear accident in Lower Saxony, the NMU will contribute nuclear and radiological knowledge to the crisis organisation and will provide substantive advice in the crisis decision-making process.

Lower Saxony Water Management, Coastal Defence and Nature Conservation Agency (Niedersächsischer Landesbetrieb für Wasserwirtshaft, Küsten- und Naturschutz - NLWKN)
In Lower Saxony, the NLWKN has the duty to measure and monitor the radiological situation. The NLWKN collates information from various systems in order to make prognoses and recommendations which the crisis organisation can use in deciding which measures should be implemented, and where.

Federal Office for Civil Protection and Disaster Assistance (Bundesamt für Bevölkerungsschutz und Katastrophenhilfe - BBK)
The BBK is a federal agency within the Federal Ministry of the Interior and plays a facilitating and supporting role in crisis management. For instance, the BBK manages the German Joint Information and Situation Centre (*Gemeinsames Melde- und Lagezentrum von Bund und Ländern* - GMLZ), which serves as the national crisis centre and is comparable to the NCC in the Netherlands. The GMLZ pools information resources during a major disaster or crisis. It can be contacted 24 hours per day.

Lower Saxony Ministry of the Interior and Sport (Niedersächsisches Ministerium für Inneres und Sport - NMI)
In principle, the responsibility for managing a crisis rests with the Länder. It is up to the individual Länder to decide whether to organise crisis management at their own level or at the level of the Landkreise. At the Land level, crisis management in Lower Saxony is

256 Bundesamt für Strahlenschutz, *Strahlenthemen*, 2012.
257 Bundesamt für Strahlenschutz, *Strahlenthemen*, 2012.
258 The division of tasks and responsibilities among the BMUB and the Länder is described in the Manual for the cooperation between the federal government and the Länder regarding nuclear law (*Handbuch über die Zusammenarbeit zwischen Bund und Ländern im Atomrecht*), 2016.

the responsibility of the Lower Saxony Ministry of the Interior and Sport. Depending on the nature of the crisis, however, it may need to cooperate with other ministries. If the crisis is the result of a nuclear accident, the ministry will need to work closely with the NMU. The Osnabrück police department (*Polizeidirektion Osnabrück*), under responsibility of the NMI, is one of the organisations contributing to crisis management. This police department has a coordinating role with respect to the operational response to a nuclear accident at the Emsland nuclear power plant.

Landkreis Emsland
The Landkreise are responsible for the execution of the response operations in Germany. With respect to a crisis arising from an accident at the Emsland nuclear power plant the responsible Landkreis for the operational response to this accident is Landkreis Emsland. Landkreis Emsland is tasked with emergency response planning at the regional level and thus plays a role comparable to the one of the safety regions in the Netherlands and the provinces in Belgium. During an accident at the Emsland nuclear power plant, Landkreis Emsland has an important role in the direct information exchange with the operator of the nuclear power plant, as well as in the coordination with neighbouring municipalities and safety regions in the Netherlands.

C.4 International

International Atomic Energy Agency (IAEA)
Nuclear power plants are subject to national supervision and a comprehensive system of international guidance and review. The objective is to achieve a high level of safety worldwide. The International Atomic Energy Agency plays a vital role in achieving this objective. The IAEA is an autonomous organisation within the United Nations; 168 countries are members.[259] These countries are bound by the Convention on Nuclear Safety, which was concluded in Vienna in 1994 under the auspices of the IAEA and came into force in 1996. At that time a need arose for a unifying international framework for countries with nuclear installations. The Convention on Nuclear Safety and the further conventions to which it has given rise, set conditions and provide recommendations for the national system that member states set up to supervise nuclear safety. For instance, member states are obliged to have an independent authority to supervise safety which is functionally segregated from the authority responsible for energy policy. In addition, the member states are obliged to supply information to other member states and have it assessed by them.

The IAEA has developed a comprehensive set of standards, known as the Safety Standards, that apply as the international benchmark for nuclear safety and are therefore highly directive. The nuclear regulatory authorities and operators are expected to apply these standards when performing their tasks. The IAEA standards are also tested through peer review sessions. Supplementary to the supervision exercised by the countries themselves, the IAEA gives countries access to international teams of experts who review the safeguards in place to guarantee the safety of a nuclear power plant or the

259 List of member states. Internet: www.iaea.org.

effectiveness of the systems implemented in this respect. These missions are only conducted at the request of the country concerned.

European Atomic Energy Community (Euratom)
Euratom consists of EU member states and was founded in 1957. Euratom is an independent organisation that uses EU institutes for decision-making. The Euratom Convention aims to promote the peaceful application of nuclear energy. Euratom has several tasks in order to achieve this goal. This includes establishing and implementing uniform safety standards for the protection of the health of the general public and workers. The European Council issues directives under Euratom which contain uniform safety standards. EU member states are bound to implement them.

European Nuclear Safety Regulator Group (ENSREG)
The ENSREG is an independent advisory group, consisting of experts from the 28 EU member states and the European Commission. ENSREG aims to improve cooperation and openness between member states (and openness in general) regarding nuclear safety, and to advise the European Commission about safety regulations for nuclear installations. There are four working groups in which countries cooperate on implementing new regulations, strengthening openness and transparency, monitoring, et cetera. ENSREG has taken a guiding role in implementing the stress tests of the European nuclear power plants, has arranged for the international peer review process and has set up an action plan for its follow-up.

Other international collaborations
At international level, there are various associations and cooperatives in which authorities share knowledge and develop guidelines, such as the Western European Nuclear Regulators Association (WENRA), the Heads of the European Radiological Protection Competent Authorities (HERCA) and the Nuclear Energy Agency (NEA, part of the OECD). These guidelines are supplemental to the applicable obligations and frameworks from the IAEA and Euratom. Dutch, Belgian and German authorities have seats in the associations and cooperatives mentioned.

The operators of nuclear installations, including those of the Borssele, Doel, Tihange and Emsland nuclear power plants, have united in the World Association of Nuclear Operators (WANO). WANO is a not-for-profit organisation which aims to maximise the operational safety and reliability of commercial nuclear installations. WANO members are obliged to undergo international peer reviews within a WANO context and to follow up the recommendations from these reviews. These missions, too, are intended to review safety and to identify good practices which can then be shared within the sector.

The United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) is concerned with the effects of ionising radiation on humans and the environment; its aim is to investigate those effects and ensure they are well comprehended. This committee, comprising scientists from 27 countries, has published reports on the consequences of the Chernobyl nuclear accident in 1986 and the consequences of the Fukushima nuclear accident in 2011, among other things. Belgium and Germany participate in UNSCEAR. The Netherlands is not a member but for many years now two Dutch experts have been members of the Belgian delegation in UNSCEAR.

APPENDIX D

LAWS AND REGULATIONS

This appendix contains an overview of the national and international laws and regulations relevant to this investigation. The international framework has been taken from the International Atomic Energy Agency (IAEA) and Euratom, and is set out in the Convention on Nuclear Safety and the Euratom directives (among other places). Additionally, this appendix devotes attention to the obligations arising from national laws and legislation in the Netherlands, Belgium and Germany.

The IAEA standards that are not mandatory but qualify as recommendatory are not covered by this appendix. The same applies to all international guidelines and supporting documents drawn up for the purposes of nuclear safety and radiation protection, and to agreements between countries.

D.1 Licensing and supervision

D.1.1 International

The Council Directive 2014/87/Euratom includes stipulations concerning the licensing procedure for nuclear installations. Section 8 of the Directive stipulates that member states must ensure that necessary information in relation to the nuclear safety of nuclear installations and its regulation is made available to workers and the general public, with specific consideration to local authorities, population and stakeholders in the vicinity of the installation in question. The Directive does not specify exactly how this is to be achieved.

Regarding participation of neighbouring countries in licensing, international legislation is limited primarily to environmental impact assessments. These assessments must accompany any decisions regarding initiatives and activities that may have significant adverse effects on the environment, such as the establishment or dismantling of a nuclear power plant. Major changes must also be accompanied by an environmental impact assessment. The Convention on Environmental Impact Assessment in a Transboundary Context (the Espoo Convention) states that contracting countries must involve the public and authorities in neighbouring countries in transboundary impact assessments in the same way and subject to the same timelines as those in their own country. The agreements from the Convention have been included in the Council Directive 2011/92/EU on environmental impact assessment and amendments thereto under the Council Directive 2014/52/EU.

Among other things, the Convention on Access to Information, Public Participation and Access to Justice in Environmental Matters (the Aarhus Convention) regulates public participation in decision-making on environmental activities. Nuclear power plants are included among the activities covered by these public participation regulations.[260] The opportunity for public participation offered must satisfy various requirements under the Convention. Essentially, these boil down to informing the public in an adequate and effective manner during the various stages of the procedure; facilitating public participation at an early stage; and taking account of the views brought forward in the decision-making process.

D.1.2 The Netherlands

The Nuclear Energy Act (*Kernenergiewet*)[261] stipulates that operators of nuclear power plants must have a licence under the Act in order to operate plants. The licensing procedure is set out in the General Administrative Law Act (*Algemene wet bestuursrecht*). The Minister of Infrastructure and the Environment is authorised to issue licences, and has mandated the ANVS to do so. The ANVS is also responsible to supervise compliance with the licence. If the nuclear power plant's activities and installations are modified, the ANVS' permission is required in order to make sure that the modifications are in accordance with the safety regulations. Whether it will be necessary to amend or renew the licence strongly depends on the nature of the modifications.

As a rule, licensing with regard to the Borssele nuclear power plant will be subject to the extended uniform preparatory procedure under the General Administrative Law Act.[262] The regular preparatory procedure will be used for minor changes.[263] Licences under the Nuclear Energy Act are issued for an indefinite period.

Participation of neighbouring countries

The procedure for issuing or altering a licence under the Nuclear Energy Act neither expressly requires nor excludes the involvement of neighbouring countries. The ANVS must involve the advisers and administrative bodies in the licensing procedure that are specified by law.[264] As regards the administrative bodies, the Nuclear Installations, Fissionable Materials and Ores Decree (*Besluit kerninstallaties, splijtstoffen en ertsen*) states that provincial and municipal authorities where the nuclear power plant is located and the provincial and municipal authorities and water quality management authorities within a radius of 10 kilometres of the power plant, must be involved in a role other than an advisory role. The authorities involved are to receive the draft licence and accompanying documentation.

260 Annex I to the Aarhus Convention.
261 Section 15 Nuclear Energy Act (*Kernenergiewet*).
262 Section 17 of the Nuclear Energy Act (*Kernenergiewet*) stipulates that the extended procedure need not be followed if the licence under preparation for an activity or initiative does not lead to adverse environmental effects other/greater than those permitted under the current licence, and that does not necessitate an environmental impact assessment and does not lead to restructuring of the plant.
263 There are two key differences between the extended and regular procedures. Firstly, no draft licence is required under the regular procedure. The second difference relates to appealing the results of the licensing application. Under the regular procedure, objections can be submitted to the licensing authority, after which an appeal can be filed with the Council of State. Under the extended procedure, decisions can only be appealed with the Council of State. However, the extended procedure also gives third parties the right to bring their views on the draft licence forward.
264 The role of advisers is to supply the competent authorities with relevant expertise that the authorities themselves are missing. The General Administrative Law Act (*Algemene Wet bestuursrecht*) states that the administrative bodies involved are to represent the interests with which they have been entrusted.

In case of a licence application that also requires an environmental impact assessment,[265] the involvement of neighbouring countries is provided for by the regulations, if the activity or initiative can lead to transboundary environmental effects. In the case of a transboundary environmental impact assessment, the ANVS must inform the competent authorities[266] in the countries that may face the adverse effects of the initiative as soon as possible. They must receive the licence application, draft licence, environmental impact report and its accompanying advice at the same time as these documents are made available for consultation in the Netherlands.[267] The ANVS must also send any announcements as part of the procedure to the relevant national authorities abroad. If the other country itself believes that potential adverse effects can be expected in its territory, the competent authority in that country may submit a request to be involved in the procedure.[268]

Access to information on licensing procedures

There are various times during the procedure at which the ANVS is required to provide information to the public. Firstly, the ANVS must publish an announcement before the draft licence is made available for public consultation.[269] This announcement must state where and when the documents can be consulted, who may bring views forward and how, and the term within which the authority will decide on the licence. There is no obligation to publish this announcement in other countries. Once it has been published, the authority must make the draft licence and accompanying documentation[270] available for consultation for a period of six weeks.[271] There is no obligation to make documents available for consultation in other countries. Once the consultation period has expired, the authority will draw up a final version of the licence, a notification of which must be published in the government's gazette (*Staatscourant*), in a national and a regional daily newspaper, and in a local newspaper. The final version of the licence must also be made available for consultation, to allow third parties to appeal.

If the nuclear power plant operator wishes to undertake an activity that may require an environmental impact assessment, announcements must be published at various times. This starts with notifying the ANVS about the intention to conduct the activity. Within two weeks of receiving this notification, the ANVS must publish an announcement in the government's gazette and in a number of national and regional newspapers. Citizens will then have the opportunity to bring their views forward. To ensure that the information on the procedure regarding a transboundary environmental impact assessment can also be

265 The Environmental Impact Assessment Decree (*Besluit milieueffectrapportage*) stipulates when an environmental impact report is necessary. A deciding factor is whether significant adverse environmental effects can be expected. This is not always evident at the outset. In that case, the obligation for an environmental impact assessment will first need to be determined. One option is always to skip this determination phase and decide to conduct the assessment anyway. Even if there is no obligation to conduct an assessment, it may be desirable to do so from a social point of view. An environmental impact assessment concludes with a report outlining the effects on the environment, which the operator must submit along with the licence application.

266 These are the authorities with specific environmental responsibilities.

267 Section 7.38(a)(3) Environmental Management Act (*Wet milieubeheer*).

268 Section 7.38(d) Environmental Management Act (*Wet milieubeheer*).

269 Section 3.12 General Administrative Law Act (*Algemene wet bestuursrecht*). The draft licence is only made available for consultation under the extended uniform preparatory procedure. Consultation under the regular preparatory procedure is only possible by appeal against the licence.

270 This concerns the draft licence, with the relevant accompanying documentation considered reasonably necessary to evaluate the subject matter.

271 Section 3.11 General Administrative Law Act (*Algemene wet bestuursrecht*).

accessed and understood by citizens in other countries, Dutch legislation stipulates that public announcements must also be issued in neighbouring/other countries that may experience adverse environmental effects,[272] in the language of the country concerned.[273]

The law stipulates that anybody may bring views forward as part of the licensing procedure for nuclear installations, which include nuclear power plants.[274] This also applies to people and organisations outside the Netherlands. Views from other countries must be treated in the same manner as those from inside the Netherlands.

D.1.3 Belgium

Belgium operates a dual licensing system for nuclear power plants. Under the General Regulation on the protection of the population, the workers and the environment against the danger of ionising radiation (ARBIS), nuclear power plants must have a licence for establishment and operation.[275] The King is authorised to issue licences to nuclear power plants. The Federal Agency for Nuclear Control (FANC) has been tasked with the execution of nuclear licensing. Licences under ARBIS ensure protection from ionising radiation, and therefore only concern those parts of the power plant that necessitate such protection. Other parts[276] do not fall under ARBIS, and are regulated by environmental legislation at regional level. The competence to issue regional environmental licences in Flanders has been granted to the provincial authorities. The Doel nuclear power plant is in the province of East Flanders. In Wallonia, this competence lies with the *Service Public de Wallonie*, a department of the Walloon government. The duality of the Belgian licensing system also applies to the environmental impact assessment. The nuclear part, for example, is regulated at federal level under ARBIS, while the non-nuclear part falls under regional environmental legislation.[277]

Given that the procedural stipulations in Belgium are not universal but are specific to each decree, they may differ from decree to decree. The opportunities for other countries to be involved may also vary in this manner. The dual licensing system results in the following three regimes:

a. Federal legislation for the nuclear part of nuclear power plants (ARBIS);
b. Environmental legislation by the Flemish Region governing the non-nuclear part of the Doel nuclear power plant; and
c. Environmental legislation by the Walloon Region governing the non-nuclear part of the Tihange nuclear power plant.

This investigation is only concerned with the legislation applicable to the nuclear part of the nuclear power plants under a).

272 Sections 7.9, 7.17 and 7.27 Environmental Management Act (*Wet milieubeheer*).
273 Section 7.29 Environmental Management Act (*Wet milieubeheer).*
274 Section 17(1) Nuclear Energy Act (*Kernenergiewet*).
275 Section 5.1 ARBIS.
276 This includes matters such as storage of non-nuclear hazardous substances, waste water treatment, et cetera.
277 Alterations to the nuclear power plant that concern both the nuclear and non-nuclear parts may therefore require two environmental impact reports to be drawn up. Legislation does not provide for any obligation to coordinate procedures in this regard. In 2010 the federal and Flemish governments did draw up a protocol under which both authorities endeavour to produce a single environmental impact report. However, this protocol does not cover coordination of procedures concerning the involvement of third parties. No comparable protocol exists with regard to the Walloon government.

The licensing procedure concerning the nuclear part of the nuclear power plant is regulated entirely under ARBIS, which also includes the regulations governing the environmental impact assessment. As such, the assessment therefore only relates to the potential radiation-related environmental effects of nuclear installations in nuclear power plants.[278] Licences for the establishment as well as for the dismantling of a nuclear power plant impose a direct obligation to include an environmental impact assessment.[279] The operator of the nuclear power plant must notify the FANC in the event of any modifications or expansions. The FANC will then decide whether the modification/expansion must be included in the licence and whether an environmental impact assessment is required. The FANC takes the criteria into consideration that are listed in the European directive concerning the environmental impact assessment.

ARBIS prescribes that the FANC must consult the municipality in which the nuclear power plant is located and any municipalities within a radius of 5 kilometres of the power plant regarding the licence application.[280] For the Doel nuclear power plant, this 5-kilometre radius extends just beyond the Dutch border; this is not the case for the Tihange nuclear power plant. The municipalities involved must arrange for a "public investigation". They must give third parties the opportunity to access documentation for a certain period of time, and to bring their views forward to the relevant municipality. The municipalities must publicise the licence application (accompanied by an environmental impact report if necessary) by posting a notice at the town hall. The municipality in which the nuclear power plant is located must also post a notice at the company itself (the place of business). The notice must state the subject of the application including the environmental impact report, the consultation period and the options for bringing views forward. ARBIS does not specify who is allowed to bring views forward. However, the legislation does not seem to stipulate any criteria in this regard.

The municipal college of alderman gives advice based on the public investigation results. The municipality sends the investigation results and its advice to the FANC.[281] Unlike the Netherlands, no draft licence is drawn up in Belgium. Third parties may only respond to the application and the environmental impact report and not – as in the Netherlands – to a provisional version of the licence.[282] The municipalities that have publicised the licence application will receive a copy of the announcement of the decision made with regard to the licence.[283] Provincial authorities do not need to conduct any public investigation; they will only send their advice to the FANC.

The Scientific Council for Ionising Radiation (*Wetenschappelijke Raad voor Ioniserende Straling*) is charged with the task of advising the FANC on licensing. All licence applications must be submitted to the Scientific Council twice. Upon reception of the application, the FANC will send it to the Council, who will then issue a provisional advice. In order to give a proper advice, the Scientific Council may demand that the operator

278 Section 6.2.9 ARBIS.
279 Sections 6 and 17 ARBIS.
280 Section 6.4 ARBIS.
281 Section 6.4 ARBIS.
282 In the Netherlands, the draft licence is only made available for consultation under the extended preparatory procedure.
283 Section 6.8 ARBIS.

submits the views from national or international experts or institutions regarding the safety of the nuclear power plant or the impact on the environment. The Council may also consult these experts/institutions directly.[284] The advice by the Scientific Council is final. If it believes that other countries may experience serious adverse environmental effects, the Council may also require the FANC to send the environmental impact report to these countries. The FANC must do the same if these countries ask to see the report themselves. These countries will receive the documentation at the same time as it is sent to the municipalities and the province. The exact rights of neighbouring countries are not specified in ARBIS.

D.1.4 Germany

German nuclear power plants are required to have a licence under the Atomic Energy Act (*Atomgesetz*). The licence covers the establishment and operation of a nuclear power plant. The dismantling of a nuclear power plant also requires a licence. Major modifications or expansions will need authorisation by means of amending of renewing the nuclear licence. Minor modifications do not require a licence. These must be reported to the nuclear regulatory authority within the framework of nuclear supervision. In Germany, the Länder are responsible for nuclear licencing and supervising the nuclear power plants located within their borders. The Emsland nuclear power plant is located in Lower Saxony, where the Lower Saxony Ministry of the Environment, Energy and Climate Protection (*Niedersächsisches Ministerium für Umwelt, Energie und Klimaschutz* - NMU) supervises the safety of the power plant.

The Atomic Energy Act specifies *kerntechnische Anlagen*, or "nuclear facilities". The federal legislation does not clearly specify the extent to which the non-nuclear parts of nuclear power plants (office buildings, canteens, workstations, et cetera) are also included in the licence under the Atomic Energy Act.

The Ordinance Concerning Procedures according to the Atomic Energy Act (*Atomrechtliche Verfahrensverordnung*) sets out more detailed procedural and other regulations concerning the licensing of nuclear power plants, including the participation of authorities in other countries in the nuclear licensing procedure. With regard to the Emsland nuclear power plant, the NMU only has an obligation to involve Dutch authorities in case an environmental impact assessment is required and the environmental effects in potential are transboundary. In Germany, environmental impact assessments are regulated under the Environmental Impact Assessment Act (*Gesetz über die Umweltverträglichkeitsprüfung*). The appendix to this federal Act lists nuclear power plants as projects for which an environmental impact assessment is necessary. The Act regulates the obligation to inform neighbouring countries of transboundary environmental impacts, which includes providing information to the population (publication of announcements) as well as to the authorities in neighbouring countries. Legislation concerning transboundary environmental impact assessments in Germany is virtually the same as in the Netherlands.

284 Section 6.3.1 ARBIS.

For licensing procedures without environmental impact assessment legislation does not require participation of authorities in neighbouring countries. Legislation neither stipulates which local authorities (for example, municipalities located within a certain distance from a German nuclear power plant) must be involved in a licensing procedure.

Information accessible to citizens
Each nuclear regulatory authority in Germany is obliged to publicly announce licensing procedures by publishing notifications in its bulletin and in the local daily newspapers in the region where the nuclear power plant is located. The procedures are also announced in the *Bundesanzeiger*, the federal government's gazette for the publication of official announcements. The licence application (including the accompanying safety report and any other documentation, such as the environmental impact report) must be made available for consultation for a period of two months at the authority offices and at a location near the nuclear power plant. Third parties may consult the documents and present their views during this period. After this time (at least one month later) a public hearing will be held, during which any submitted concerns will be discussed.

Under the Nuclear Licensing Procedure Ordinance (*Atomrechtliche Verfahrungsverordnung*), third parties in the Netherlands have the same opportunity to participate in the licensing procedure as the German stakeholders. The NMU must ensure that the Dutch authorities announce the application correctly in the Netherlands, and arrange for Dutch citizens to have access to information on the application. Dutch citizens have two months after the application announcement to bring their views forward. The documentation can be consulted in the Netherlands. Third parties in the Netherlands can also appeal against the German decision to refuse or grant a licence. The NMU may request the licence applicant to provide a summary of the application in Dutch, which must also address the transboundary effects of the project.

D.2 Reporting incidents

D.2.1 International

Among other things, the Council Directive 2014/87/Euratom stipulates that, in the event of an incident, the competent authority and the operator must provide information to the competent authorities in other countries located in the vicinity of the nuclear power plant. The Directive defines an incident as "any unintended event, the consequences or potential consequences of which are not negligible from the point of view of radiation protection or nuclear safety". This definition is broad, and also covers unintended events with safety consequences for the surrounding area of a nuclear power plant.

The IAEA has produced an agreement[285] stating that member states must forward INES reports of level 2 or higher to the IAEA. Under this reporting system, other member states are notified of the incidents by the IAEA via email. Incidents classified as INES level 1 or lower are generally considered not to offer any safety lessons, and therefore do not need to be reported to the IAEA.

285 IAEA, *The International Nuclear and Radiological Event Scale User's Manual; 2008 Edition*, 2008.

D.2.2 The Netherlands

Under the Radiation Protection Decree (*Besluit stralingsbescherming*), EPZ, the operator of the Borssele nuclear power plant, must report incidents to the ANVS. The same decree also stipulates that the Dutch government must have set up a contact centre for this purpose. This contact centre is managed by the ANVS.[286] All radiation incidents, accidents or emergency situations must be reported immediately to the ANVS' contact centre and, in certain cases, also to the radiation physician.[287] The Borssele nuclear power plant's nuclear licence specifies the reporting criteria in greater detail. These criteria state that serious incidents must be reported as soon as possible, but within 8 hours at the latest (by telephone or fax, and in writing within 14 days). Such incidents include those involving:

- individual exposure to an amount of radiation exceeding the permissible limit under the Radiation Protection Decree;
- automatic or manual activation of specific safety systems;
- the discovery that one or more specific safety systems have not worked upon activation;
- exceeding the permissible limit for discharge of radioactive substances.

Less serious incidents must be reported in writing as soon as possible, but within a maximum limit of 30 days. Examples include those incidents that, if no intervening action had been taken, could have resulted in exceeding the permissible limit for discharge of radioactive substances, or incidents that are not subject to mandatory reporting but which may still relate to nuclear safety. Incidents that bear no relation to safety (such as exceeding maximum noise limits within the facility premises) must be reported within 24 hours.

The legislation does not impose any obligation to forward incident reports to authorities in neighbouring countries.

D.2.3 Belgium

Under the federal Royal Decree Concerning Safety Regulations for Nuclear Installations (*Koninklijk besluit houdende veiligheidsvoorschriften voor de kerninstallaties*), nuclear power plant operators are obliged to implement a system that allows for all significant incidents (in accordance with the established modalities and criteria) to be reported to the authorities. Belgium must have established a system for receiving such reports.

ARBIS[288] states that the federal nuclear crisis plan must include reporting and alarm procedures for unusual events. In this context, the new updated Nuclear and Radiological Emergency Plan for the Belgian Territory (*Nucleair en Radiologisch Noodplan voor het Belgische Grondgebied*) draws a distinction between significant events for which the crisis plan does not come into effect, and those for which it does. In the former case, the crisis plan speaks of reporting to the government; in the latter case, of notifying the government. Operators must inform the FANC verbally of an incident, followed by a

286 Section 12a Radiation Protection Decree (*Besluit stralingsbescherming*).
287 A radiation physician is engaged in cases of excessive exposure to radiation or contamination of an employee.
288 Section 72 ARBIS.

written confirmation by email (or fax) using a predetermined standard template. This template is to include a short description of the events and the situation, as well as a brief description of the potential consequences. In addition to the FANC and Bel V, various other organisations will also be informed. The provisions do not require the authorities in neighbouring countries to be informed as well.

D.2.4 Germany

Pursuant to the Nuclear Safety Officer and Reporting Ordinance (*Atomrechtliche Sicherheitsbeauftragten- und Meldeverordnung*), which is based on the Atomic Energy Act (*Atomgesetz*), nuclear power plant operators must report unusual events to the nuclear regulatory authority. This includes any events relevant to nuclear safety. The Ordinance stipulates that a written notification using a standard template must be sent to the authority, including a description of the event, the causes and consequences, measures taken to mitigate the consequences, and measures to prevent reoccurrence. Appendix I to the Ordinance lists a large number of events and criteria applicable to reporting, which specifies which type of report is required for each incident type. The Ordinance identifies the following categories with regard to reporting terms:

- Category S: immediate, without delay;
- Category E: within 24 hours;
- Category N: within 5 working days; and
- Category V: within 10 working days.

Category V incidents are those that occur before the installation commences operations. This category is no longer relevant, given that no more nuclear power plants will be put into operation Germany.

D.3 Providing information to citizens regarding incidents

D.3.1 International

The Council Directive 2014/87/Euratom covers, to a large extent, the provision of incident information to the public. Section 8 of the Directive stipulates that the public[289] must have access to necessary information in relation to the nuclear safety of nuclear power plants and its regulation. This obligation states that the competent regulatory authority and the operators must:

a. provide information on normal operating conditions of nuclear installations, and
b. in the case of incidents or accidents, provide prompt information to workers and the public, as well as to the competent regulatory authorities of other member states in the vicinity of a nuclear installation.

289 With specific consideration to local authorities, population and stakeholders in the vicinity of a nuclear installation.

Nuclear power plants are subject to the obligation under the European Regulation on Wholesale Energy Market Integrity and Transparency (REMIT)[290] to make information that may have significant impact on energy prices accessible to the public. This includes information on production and reductions to capacity, including disruptions. Given that it is a European Regulation, it is directly applicable in all EU member states, who must ensure that the provisions of the Regulation are complied with by the energy companies.

D.3.2 The Netherlands

In the Netherlands, the provisions concerning public information on incidents are contained in the Nuclear Energy Act (*Kernenergiewet*). Under the Act,[291] ANVS must ensure that the Dutch population is informed of unusual events at nuclear installations in the Netherlands in an appropriate manner, which must include generally accessible electronic means. Insofar as there is information available, unusual events at similar establishments in other countries close to the Netherlands must also be reported to the Dutch population in the same manner (in any case electronically, through generally accessible means).

The operator of the nuclear power plant, too, is obliged to inform the public about incidents. The Regulation on the Safety of Nuclear Power Plants (*Regeling nucleaire veiligheid kerninstallaties*) requires that the population, local authorities and interested parties in the vicinity of a nuclear power plant be informed about the nuclear safety of the plant. Among other things, this concerns the immediate provision of information about incidents that have occurred. Energy suppliers, in this case EPZ, must also fulfil the obligations under the above-mentioned REMIT Regulation.

D.3.3 Belgium

The legislation studied does not contain any obligations concerning the active public announcement of incidents at nuclear power plants. Energy companies, in this case Engie/Electrabel, however, must fulfil the obligations under the REMIT Regulation.

D.3.4 Germany

The legislation studied does not contain any obligations concerning the active public announcement of incidents at nuclear power plants. Energy suppliers, in this case RWE, however, must fulfil the obligations under the REMIT Regulation.

290 Regulation on Wholesale Energy Market Integrity and Transparency.
291 Section 43b Nuclear Energy Act (*Kernenergiewet*).

D.4 Crisis plans

D.4.1 International

The IAEA Convention on Nuclear Safety stipulates that all contracting countries must take appropriate measures to ensure the existence and regular testing of internal and external emergency response plans for nuclear power plants in their territory. These plans must provide for all activities to be carried out in the event of accidents.[292]

Under the Council Directive 2013/59/Euratom, member states are obliged to develop a crisis management system that includes plans for the various types of potential nuclear and radiological emergency situations that have been identified. These plans must contain various elements,[293] including, in particular, regulations for prompt coordination with all other member states that could potentially be involved in, or impacted by, an accident.

D.4.2 The Netherlands

The Nuclear Energy Act (*Kernenergiewet*)[294] stipulates that the Minister of Infrastructure and the Environment and any other ministers concerned are responsible for preparing, coordinating and executing the response to a crisis arising from a nuclear accident, either in the Netherlands or abroad. The "ministers concerned" include primarily the Minister of Security and Justice, due to his overall responsibility for crisis management in the Netherlands.

Under the Act, the safety regions are responsible for preparing for incidents and accidents, including those at nuclear power plants. The Nuclear Energy Act[295] stipulates that the safety region must prepare for accidents with a nuclear power plant in accordance with the provisions in the Safety Regions Act (*Wet veiligheidsregio's*). The safety regions are under no obligation to draw up nuclear emergency response plans, however the Dutch government does intend to include such an obligation in the Safety Regions Decree (*Besluit veiligheidsregio's*).[296]

The Basic Safety Standards for Radation Protection Decree (*Besluit basisveiligheidsnormen stralingsbescherming*) has been drafted in the Netherlands for the purposes of implementing the Council Directive 2013/59/Euratom, and will come into effect in 2018. The Dutch government has stated that the crisis management system prescribed by this Directive (as outlined above in D.4.1) has already been catered for in an administrative, legal and organisational sense via the Decree establishing the Ministerial Crisis Management Committee (*Instellingsbesluit Ministeriële Commissie Crisisbeheersing*), the National Manual on Decision-making in Crisis situations (*Nationaal Handboek Crisisbesluitvorming*), the National Plan for Nuclear and Radiological Emergencies (*Nationaal Crisisplan Stralingsincidenten*), the Safety Regions Act (*Wet veiligheidsregio's*) and the Radiation Protection Decree (*Besluit stralingsbescherming*).[297]

292 Section 16(1) Convention on Nuclear Safety.
293 As stated in Annex XI to the Directive, under B.
294 Sections 38 and 40 Nuclear Energy Act (*Kernenergiewet*).
295 Section 41 Nuclear Energy Act (*Kernenergiewet*).
296 Explanatory memorandum to the Basic Safety Standards for Radiation Protection Decree (*Besluit basisveiligheidsnormen stralingsbescherming*).
297 Explanatory memorandum to the Basic Safety Standards for Radiation Protection Decree (*Besluit basisveiligheidsnormen stralingsbescherming*).

Current Dutch legislation does not include specific provisions governing coordination of crisis plans with those of surrounding countries. Under the future Basic Safety Standards for Radiation Protection Decree (*Besluit basisveiligheidsnormen stralingsbescherming*), the responsible ministers will seek collaboration with other countries with a view to the management of potential radiological emergencies (in the Netherlands or elsewhere) that may affect those countries.

The Safety Regions Decree (*Besluit veiligheidsregio's*) includes a summary of the details that any emergency response plan must contain in a generic sense (this means: plans that are not tailored to specific crises). These include measures and provisions for informing emergency services in another country, if the population or environment in that country could be affected or threatened by a disaster.[298]

The responsibility of operators in crisis management is limited to the premises of the nuclear power plant (on-site). EPZ is obliged to draw up and regularly test an internal emergency plan.[299]

D.4.3 Belgium

In terms of implementing the Civil Protection Act (*Wet betreffende de civiele bescherming*), the Minister of Security and the Interior retains ultimate responsibility for the preparation of crisis management in Belgium. As part of these activities, the minister establishes the Nuclear and Radiological Emergency Plan for the Belgian Territory (*Nucleair en Radiologisch Noodplan voor het Belgische Grondgebied),*[300] which sets out the responsibilities and competences of the federal government and other authorities with regard to managing a crisis that arises from an accident at a nuclear power plant. ARBIS sets out the substantive conditions applicable to the federal crisis plan.

The provincial governors and municipalities are obliged to draw up both general and specific emergency response plans in order to ensure civil safety in their territories.[301] Specific plans have been drawn up for nuclear power plants in Belgium by the provincial governors.

Current Belgian legislation does not stipulate any specific requirements for the content of the plans concerning accidents with transboundary consequences, or relevant coordination between countries on planning. The implementation of the Council Directive 2013/59/Euratom, which stipulates that crisis plans should contain regulations for the prompt coordination between the countries that are potentially involved in a nuclear accident, in Belgium is provided for under the federal Nuclear and Radiological Emergency Plan for the Belgian Territory.

298 Section 6.1.3 Safety Regions Decree (*Besluit veiligheidsregio's*).
299 Section 115 Radiation Protection Decree (*Besluit stralingsbescherming*).
300 Section 72 ARBIS.
301 Civil Protection Act (*Wet betreffende de civiele bescherming)* and the Emergency and Intervention Plan Decree *(Besluit betreffende de nood- en interventieplannen*) of 16 February 2006.

Operators of nuclear power plants are responsible only for managing the effects of potential accidents on the premises of the power plant. Electrabel is under obligation to draw up an emergency response plan for this purpose.

D.4.4 Germany

There are a number of laws governing generic emergency response and crisis management at federal level (*Grundgesetz, Gesetz über den Zivilschutz und Katastrophenhilfe des Bundes, Gesetz über die Bundespolizei, Gesetz über das Technische Hilfswerk*). The Länder all also have their own legislation governing crisis management. In 2009, a stipulation was included in the Federal Civil Protection and Disaster Assistance Act (*Gesetz über den Zivilschutz und Katastrophenhilfe des Bundes*) outlining a joint responsibility among the Länder and the federal government in crises of national scope. The focus of the crisis management effort lies with the individual Länder (Lower Saxony in the case of Emsland). The Lower Saxony Disaster Protection Act (*Niedersächsisches Katastrophenschutzgesetz*) sets out the emergency response legislation applicable in Lower Saxony. It specifies that the Landkreise in Lower Saxony are responsible for crisis response, and that each Landkreis must draw up an emergency response plan. The Act imposes no obligation to also draw up a specific nuclear plan. Landkreis Emsland does have a specific plan, however, focusing on emergency situations at the Emsland nuclear power plant. At the time of this investigation, an amendment to the Lower Saxony Disaster Protection Act[302] was underway, introducing an obligation for the Landkreise to also include specific plans for nuclear power plants in Lower Saxony.

The federal Radiation Protection Act (*Strahlenschutzgesetz*) entered into force on 1 October 2017 implementing the Council Directive 2013/59/Euratom.[303] Among other things, the new Act has introduced a new system of nuclear planning in Germany.[304] This includes an obligation for the federal government to draw up an overarching national crisis plan, to be detailed further in special federal plans drawn up for more specific aspects (such as food chain protection). The Länder must then draw up emergency response plans for the implementation and specification of the overarching and special federal government plans. The authorities charged with emergency response must also draw up external emergency response plans for the high-risk nuclear installations, such as nuclear power plants. All the federal and other government authorities involved must prepare their plans in accordance with uniform guidelines and those plans must be mutually harmonised.

The federal government has the option of issuing instructions to the Länder concerning the content of their plans. The emergency response and crisis plans must also fit in with plans by the member states of the EU, Euratom, and any relevant third countries.

302 Draft Amendment to the Lower Saxony Disaster Protection Act (*Entwurf Gesetz zur Änderung des Niedersächsischen Katastrophenschutzgesetzes, Niedersächsischer Landtag. Wahlperiode Drucksache 17/6435*).
303 Radiation Protection Act (*Strahlenschutzgesetz*). The Act will be phased in gradually. The provisions concerning emergency plans entered into force on 1 October 2017, and the remaining aspects will follow on 31 December 2018.
304 Paragraphs 97-101 Radiation Protection Act (*Strahlenschutzgesetz*).

Germany has set out national guidelines for nuclear crisis management,[305] that serve as a framework to ensure that nuclear crisis management throughout Germany follows the same model as much as possible. These guidelines were drawn up by the Commission on Radiological Protection (*Strahlenschutzkommission*) and presented to the Ministers of the Interior of the Länder in 2015. Appendix 4 to the federal Radiation Protection Act contains a list of documents designated as "key elements" of nuclear planning.[306] These form the basis for the zones being prepared in Germany for the protection of the public in the event of a nuclear accident.

Federal legislation and legislation in Lower Saxony do not set any substantive criteria for the emergency response plans and crisis plans in connection with potential transboundary consequences of an accident at a nuclear power plant. The national guidelines also lack any recommendations concerning the transboundary nature of any such accident.

D.5 Providing information to citizens regarding response measures

D.5.1 International

The Convention on Nuclear Safety stipulates that all contracting states must take appropriate measures to ensure that their own populations in the vicinity of nuclear installations (which would be affected by radiation in the event of an accident) receive good-quality information on emergency preparedness and response.[307]

Under the Council Directive 2013/59/Euratom, member states must ensure that citizens at risk of being affected in emergency situations must be informed of the protective measures applicable to them, as well as of what actions to take in the event of an emergency. The information provided must cover the following aspects in any case:

a. basic facts about radioactivity and its effects on human beings and on the environment;
b. the various types of emergency situations covered and their consequences for the population and the environment;
c. emergency measures envisaged to alert, protect and assist the population in the event of an emergency; and
d. appropriate information on the action to be taken by the population in the event of an emergency.

The information must be issued to citizens actively, that is without them needing to request for it. Member states must ensure that the information is updated and distributed at regular intervals and whenever significant changes take place. This information shall be permanently available to the public.

305 *Rahmenempfehlungen für den Katastrophenschutz in der Umgebung kerntechnischer Anlagen.*
306 This includes the following documents by the Commission Radiation Protection: *Rahmenempfehlungen für den Katastrophenschutz in der Umgebung kerntechnischer Anlagen, Radiologische Grundlagen für Entscheidungen über Maßnahmen zum Schutz der Bevölkerung bei Ereignissen mit Freisetzungen von Radionukliden) and Planungsgebiete für den Notfallschutz in der Umgebung von Kernkraftwerken.*
307 Section 16(2) Convention on Nuclear Safety.

D.5.2 The Netherlands

Under the Nuclear Energy Act (*Kernenergiewet*), the Minister of Infrastructure and the Environment must ensure that the public is informed about radiation-related risks. This information must in any case cover the following aspects:

a. basic facts about radioactivity and its consequences for human beings and the environment;
b. the dangers and consequences of an accident;
c. the way the population will be alerted, kept informed and protected in the event of an accident;
d. the way the population can recognise potential dangers;
e. actions to be taken by the population and the measures to take in the event of an accident in order to limit the negative consequences as much as possible.

The information under c), d) and e) must be issued at least once per year, and the information under a) and b) at least once every five years, or as frequently as required in connection with changes.[308]

Safety regions must inform the public in advance of all types of emergencies and crises that may affect them. This includes information on the origin, scope and anticipated consequences of an emergency or crisis, the way the public will be alerted and the measures the population needs to take.[309]

D.5.3 Belgium

Under ARBIS, the Minister of Security and the Interior is responsible for informing the population potentially at risk of being affected by radiological emergency situations on protective health measures, as well as on the action to be taken in the event of a radiological emergency. The information must be provided in advance, at least every five years. Regarding the nature of the information, the ARBIS criteria are entirely consistent with those in the Council Directive 2013/59/Euratom.

The Belgian provinces are not subject to any legal obligation to inform the public about the potential consequences of a nuclear accident and about the government's measures to mitigate those consequences.

308 Section 43 Nuclear Energy Act (*Kernenergiewet*).
309 Section 46 Safety Regions Act (*Wet veiligheidsregio's*) and Section 5 Disasters and Crises Information Decree (*Besluit informatie rampen en crises*).

D.5.4 Germany

The federal Radiation Protection Act (*Strahlenschutzgesetz*) stipulates that the federal government authorities responsible for nuclear planning must inform the population on the basic principles of radioactivity and how it can affect human beings and the environment, on the accident scenarios covered by the crisis plans and their consequences for the public, and on the way the population will be kept informed of radiological hazard. They must also issue recommendations to the population regarding the action to take in the event of an accident.[310] The above-mentioned information and recommendations must also be provided by the Länder, subject to further detailing of the recommendations. The information and recommendations must be updated and made publicly available at regular intervals, and whenever significant changes are made.

D.6 Exercises

D.6.1 International

The Council Directive 2013/59/Euratom stipulates that member states must ensure the regular testing, evaluation and (where necessary) improvement of the nuclear crisis plans, incorporating the knowledge gained from previous exposure in emergency situations and the results of participation in emergency exercises at national and international level.[311] There are no international provisions under which countries are obliged to conduct nuclear emergency exercises with other countries.

D.6.2 The Netherlands

The Dutch government has regulated the implementation of the above-mentioned provision under the Council Directive 2013/59/Euratom via the Basic Safety Standards for Radiation Protection Decree (*Besluit basisveiligheidsnormen stralingsbescherming*), which will come into effect in 2018. This decree states that the national nuclear crisis plan must be regularly tested, evaluated and - as indicated by the results - improved. Insights and experiences gained from previous exposure in emergency situations should also be taken into consideration, along with the results of national and international accident and emergency exercises.[312]

The National Plan for Nuclear and Radiological Emergencies (*Nationaal Crisisplan Stralingsincidenten*) states that the manager of this plan, which is the Ministry of Infrastructure and the Environment, is responsible for regularly testing the entire crisis management system as set out in the crisis plan.

Safety regions must ensure that the emergency response in the region is exercised at least once a year involving all authorities that have a role in regional emergency response and crisis management.[313] The nuclear emergency response plan of the Zeeland safety

310 Paragraph 112 Radiation Protection Act (*Strahlenschutzgesetz*).
311 Section 98 Council Directive 2013/59/Euratom.
312 Section 6.5(6) Basic Radiation Protection Safety Standards Decree (*Besluit basisveiligheidsnormen stralingsbescherming*).
313 Section 2.5.1 Safety Regions Decree (*Besluit veiligheidsregio's*).

region[314] states that the main structural components of emergency response and crisis management are to be exercised jointly at least once every three years, testing the plan for correctness, completeness and feasibility. Operators are also subject to a statutory obligation to conduct exercises.

Dutch legislation does not impose any obligations to conduct joint exercises with neighbouring countries.

D.6.3 Belgium

The federal Emergency and Intervention Plans Decree of 16 February 2006 (*Besluit betreffende de nood- en interventieplannen*) states that each municipality and province must establish a safety unit responsible for organising exercises, and evaluating both exercises and emergency situations.[315] There are no legal obligations imposing cross-border exercises for nuclear plans.

The draft version of the federal Nuclear and Radiological Emergency Plan for the Belgian Territory (*Nucleair en Radiologisch Noodplan voor het Belgische Grondgebied*) states that the general coordination of the preparations is to be performed by the CGCCR (in close collaboration with the FANC), mandated by the Minister of Security and the Interior. The CGCCR is also responsible for organising nuclear emergency exercises and their follow-up.[316] Based on the plan and in conjunction with the relevant partners, the CGCCR must develop an annual and/or multi-annual programme, which is also to include (among other things) Belgium's participation in exercises in neighbouring countries that concern bordering nuclear installations. The federal nuclear crisis plan also stipulates that annual exercises are to be held for the Doel and Tihange nuclear power plants.[317]

D.6.4 Duitsland

The Radiation Protection Act (*Strahlenschutzgesetz*) stipulates that regular exercises must be conducted in order to test the effectiveness of the federal and local nuclear crisis plans. This Act contains no stipulations that concern the execution of exercises with other countries.[318]

The Lower Saxony Disaster Protection Act (*Niedersächsisches Katastrophenschutzgesetz*) prescribes emergency exercises in a general sense, for the purposes of testing management, the deployment of relevant services, and collaboration. The Act contains no regulations on cross-border exercises that are conducted with neighbouring countries.

The national guidelines for preparing for the response to a nuclear accident recommend making agreements with neighbouring countries on the organisation of joint cross-border exercises.

314 The General Emergency Response Plan for Nuclear and Radiological Emergencies (*Algemeen Rampbestrijdingsplan Stralingsincidenten*) was prepared by the Zeeland safety region in cooperation with the Central and West Brabant safety region.
315 Section 29 Federal Emergency and Intervention Plans Decree (*Besluit betreffende de nood- en interventieplannen*).
316 Federale Overheidsdienst Binnenlandse Zaken, *Nucleair en Radiologisch Noodplan voor het Belgische Grondgebied*, conceptversie september 2017.
317 Federale Overheidsdienst Binnenlandse Zaken, *Nucleair en Radiologisch Noodplan voor het Belgische Grondgebied*, draft version September 2017.
318 Paragraph 102 Radiation Protection Ordinance (*Strahlenschutzverordnung*).

D.7 Alerts and information exchange between countries

D.7.1 International

Under the IAEA Convention on Early Notification of a Nuclear Accident or Radiological Emergency, member states are required to directly notify the International Atomic Energy Agency (IAEA), the EU and the national warning points in the neighbouring countries of an actual or imminent nuclear accident. The notification must provide information on the location and time of the accident, the installation involved, the possible cause of the accident, the anticipated progression of the situation and the volume and nature of the radioactive materials released.[319]

The 87/600/Euratom Council Decision[320] stipulates that member states must provide information to other member states whenever they decide to take protective measures due to emergencies involving radioactive substances.[321] Such information must include the following details:[322]

a. the nature and time of the event, its exact location and the facility or activity involved;
b. the assumed or established cause and the foreseeable development of the accident relevant to the release of the radioactive materials;
c. the general characteristics of the radioactive release, including the nature, probable physical and chemical form and the quantity, composition and effective height of the radioactive release;
d. information on current and forecast meteorological and hydrological conditions, necessary for forecasting the distribution of the radioactive release;
e. the results of environmental monitoring;
f. the results of measurements of foodstuffs, feeding-stuffs and drinking water;
g. the protective measures taken or planned;
h. the actions taken, or planned, for informing the population;
i. the predicted behaviour over time of the radioactive release.

This European Council Decision is directly applicable to the Netherlands, Belgium and Germany. No exception to the Decision is possible, therefore.

In order to efficiently address an emergency with transboundary consequences, under the Council Directive 2013/59/Euratom member states must cooperate on this aspect.[323] For example, the Directive states explicitly that in the event of an emergency occurring on its territory or likely to have radiological consequences on its territory, a member state promptly establishes contact with all other member states and with third countries which may be involved[324] or are likely to be affected. The provision aims for countries to jointly assess the potential exposure situation and to coordinate the protective measures they take and to harmonise their crisis communications to the public. The Directive also

319 Section 5 Convention on Early Notification of a Nuclear Accident or Radiological Emergency.
320 Council Decision of 14 December 1987 on community arrangements for the early exchange of information in the event of a radiological emergency (87/600/Euratom).
321 Section 2 of the Council Decision.
322 Section 5 of the Council Decision.
323 Section 99 Directive 2013/59/Euratom.
324 Countries affected or otherwise influenced by the consequences of the accident.

stipulates that the above must involve the use, as appropriate, of bilateral or international information exchange and coordination systems. These coordination activities shall not prevent or delay any necessary actions to be taken on a national level. Under Council Directive 2014/87/Euratom, nuclear regulatory authorities and operators must immediately provide information to countries in the vicinity of a nuclear power plant in the event of an incident or accident.

D.7.2 The Netherlands

The Nuclear Energy Act (*Kernenergiewet*) states that anybody who knows or can be reasonably expected to know that a nuclear accident occurs, is obliged to report it immediately to the mayor of the relevant municipality and to the nuclear regulatory authority (de ANVS).[325] The nuclear power plant operator must provide all necessary information immediately to the ANVS, and to the mayor of the municipality where the nuclear power plant is located. The Regulation on Nuclear Power Plant Safety (*Regeling nucleaire veiligheid kerninstallaties*) provides for the exchange of information with other countries. For example, the Regulation stipulates that in the event of an accident the ANVS, with reference to its role in emergency preparedness, and the minister, with reference to its role in crisis management, shall immediately inform the competent authorities of other countries in the vicinity of the nuclear power plant concerned.[326] The future Basic Safety Standards for Radiation Protection Decree (*Besluit basisveiligheidsnormen stralingsbescherming*) contains provisions of a similar nature. In the event of a radiological emergency, the responsible ministers are required to ensure that the countries affected are informed forthwith. They must be contacted in order to jointly assess the exposure situation and to coordinate the protective measures and communications to the public. In addition, there are various bilateral agreements between the Netherlands and its neighbours, stipulating that the countries are to alert each other of any accidents and provide adequate information.

The way the Netherlands is to inform its neighbours and international bodies of an actual or imminent nuclear accident, is outlined in the National Plan for Nuclear and Radiological Emergencies (*Nationaal Crisisplan Stralingsincidenten*). The ANVS will inform the IAEA, the EU and neighbouring countries in the event of an actual or imminent nuclear accident.

Under the Safety Regions Act (*Wet veiligheidsregio's*), the Minister of Security and Justice must ensure that all countries affected by an accident in Dutch territory are informed of the origin, scope and consequences thereof.[327] This information includes the specific details of the emergency or crisis, particularly concerning its origin, scope and consequences for the public or the environment, the anticipated progression of the situation, details on how the public will be kept informed, and a description of the measures for mitigating the harmful effects as much as possible, along with the action to be taken.

325 Section 39 Nuclear Energy Act (*Kernenergiewet*).
326 Section 17 Nuclear Power Plant Safety Regulations (Regeling nucleaire veiligheid kerninstallaties).
327 Section 47 Safety Regions Decree (*Besluit veiligheidsregio's*).

D.7.3 Belgium

The ARBIS states that the federal nuclear crisis plan must include reporting and alarm procedures for unusual events at nuclear power plants. It also specifies the information that must be shared with the European Commission, and with any member states that are or may be affected.[328] The Nuclear and Radiological Emergency Plan for the Belgian Territory (*Nucleair en Radiologisch Noodplan voor het Belgische Grondgebied*)[329] states that, in the event of a radiological emergency in Belgium necessitating the plan to come into effect, the CGCCR will alert the national crisis centres and the international contact points in neighbouring countries. The CGCCR must also alert the EU via the ECURIE system, and the IAEA via the USIE system. The subsequent information to be sent to international bodies must cover, among other things, the evolution of the emergency situation, technical radiological details and the announced direct or indirect protective measures. Alerts and information to international authorities must be sent using the channels set up for this purpose. When sending information to international authorities, copies are automatically provided to the contact points in the neighbouring countries.

The legislation contains no additional provisions concerning the supply of information to Belgium's neighbouring countries in the event of a nuclear accident.

D.7.4 Germany

The Nuclear Safety Officer and Reporting Ordinance (*Atomrechtliche Sicherheitsbeauftragten- und Meldeverordnung*) states that operators must notify an actual or imminent nuclear accident immediately to the competent nuclear regulatory authority. In the case of the Emsland nuclear power plant, this authority is the Lower Saxony Ministry for the Environment, Energy and Climate Protection (NMU), which will forward the notification to the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB), the Federal Office for Radiation Protection (BfS) and the GRS (*Gesellschaft für Anlage- und Reaktorsicherheit*). The notification must also be issued to the authorities responsible for public order and emergency response. The BMUB is responsible for informing the IAEA, the EU and other countries.

The legislation contains no additional provisions concerning information exchange with other countries in the event of an accident at a nuclear power plant.

D.8 Crisis communication

D.8.1 International

Under the Council Directive 2013/59/Euratom, member states must ensure that, when a nuclear emergency occurs, the citizens actually affected are informed without delay about the facts of the emergency, the actions to take and, as appropriate, the measures for health protection applicable to these citizens. The citizens actually affected by the emergency must rapidly and regularly receive information on the type of emergency that

328 Section 72 ARBIS.
329 Federale Overheidsdienst Binnenlandse Zaken, *Nucleair en Radiologisch Noodplan voor het Belgische Grondgebied*, conceptversie september 2017.

has occurred and its characteristics (origin, extent, development), the instructions to protect themselves, et cetera.

D.8.2 The Netherlands

In the event of an actual or imminent accident at a nuclear power plant, the Minister of Infrastructure and the Environment must ensure that the population is informed rapidly and regularly.[330] The information provided to the population during an emergency must, in any case, cover the aspects listed in the Council Directive 2013/59/Euratom (as mentioned under D.8.1). Under the future Basic Safety Standards Decree for Radiation Protection (*Besluit basisveiligheidsnormen stralingsbescherming*), in the event of a radiological emergency the responsible ministers are required to contact other countries involved in order to coordinate, among other things, the communications to the public.[331]

D.8.3 Belgium

The ARBIS states that the Nuclear and Radiological Emergency Plan for the Belgian Territory (*Nucleair en Radiologisch Noodplan voor het Belgische Grondgebied*) must specify how the public will be informed promptly in the event of a radiological emergency, the actions to take and the measures for health protection applicable to them in their specific case.[332] This information must also be shared with other member states that are or may be affected.[333] The legislation stipulates that the manner in which local authorities must inform their populations in a radiological emergency, must be set out in the Nuclear and Radiological Emergency Plan for the Belgian Territory, as well as in the general and specific emergency response plans drawn up by the provinces and municipalities.[334]

D.8.4 Germany

The Radiation Protection Act (*Strahlenschutzgesetz*) stipulates that, depending on the scale of a radiological emergency, the BMUB, the Länder authorities with responsibilities concerning radiation protection, the regional and local authorities must immediately inform the population about the accident and provide information on the measures to be taken.[335] An appendix to the Act details the information that must be provided to the population,[336] which includes information on the emergency situation, on protective measures, such as a possible evacuation.

330 Section 43a Nuclear Energy Act (*Kernenergiewet*).
331 Section 6.6(3) Basic Safety Standards for Radiation Protection Decree (*Besluit basisveiligheidsnormen stralingsbescherming*).
332 Section 72(1) ARBIS.
333 Section 72 ARBIS
334 Section 27 Emergency and Intervention Plan Decree (*Besluit betreffende de nood- en interventieplannen*) of 16 February 2006.
335 Paragraph 112 Radiation Protection Act (*Strahlenschutzgesetz*).
336 Appendix XII, Informing the public and recommendations on what to do in an emergency (*Information der Bevölkerung und Empfehlungen für das Verhalten bei Notfalle*).

NUCLEAR CRISIS PLANS

E.1 The Netherlands

The Dutch Nuclear Energy Act makes a distinction between what is known as A-objects and B-objects.[337] Nuclear power plants, including nuclear power plants abroad with possible consequences for the Netherlands, are designated as A-objects. Due to the potentially far-reaching consequences of an accident involving an A-object, it has been decided that crisis coordination should take place at central government level.[338] An accident involving a B-object usually only has local consequences; crisis coordination then takes place at regional level. B-objects have not been considered in this investigation.

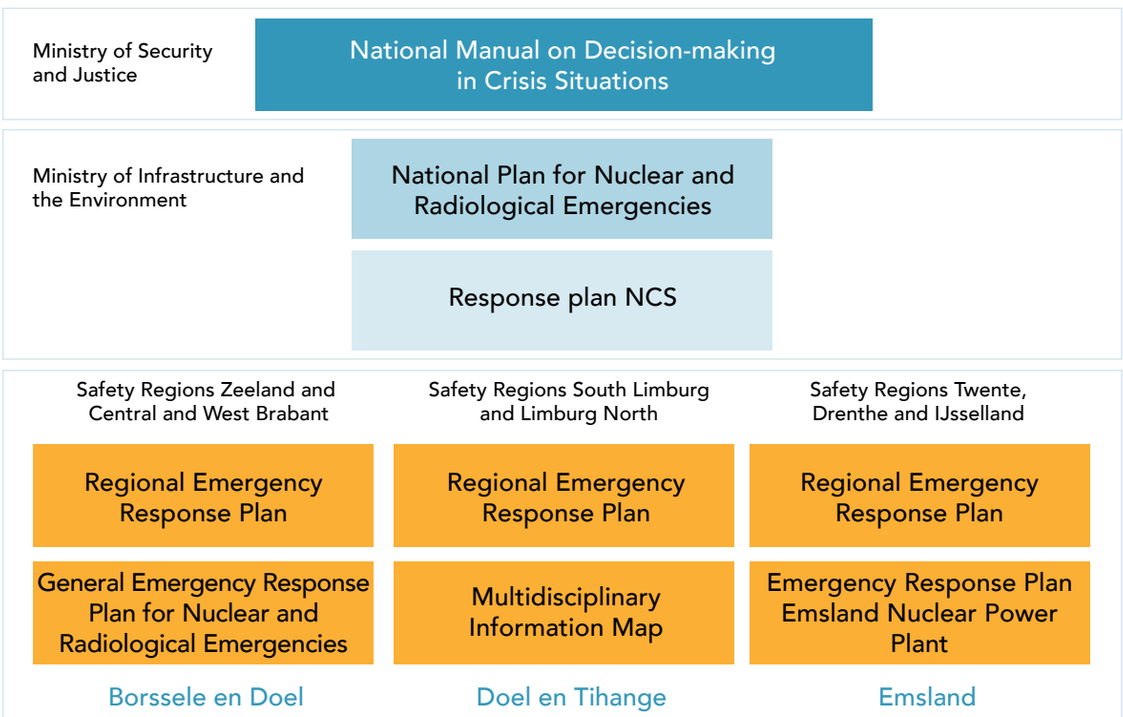


Figure 20: Overview of the Dutch national and regional plans that lay down the frameworks for the response to a nuclear accident at the Borssele, Doel, Tihange and Emsland nuclear power plants.

337 Nuclear Energy Act (*Kernenergiewet*): A-objects are primarily nuclear power plants, ships and spacecraft that use nuclear energy, transport of highly radioactive waste, et cetera. B-objects include all other objects with radioactive substances.

338 Nationaal Coördinator Terrorismebestrijding en Veiligheid van het Ministerie van Veiligheid en Justitie, *Nationaal Handboek Crisisbesluitvorming*, september 2016 en Ministerie van Infrastructuur en Milieu, *Nationaal Crisisplan Stralingsincidenten*, november 2016.

The Netherlands employs a crisis management policy for the response to a nuclear accident based on a generic framework that applies to all sorts of crises and a specific framework for nuclear crises. Figure 20 illustrates the entirety of Dutch crisis plans which lay down the frameworks for the response to a nuclear accident.

National Manual on Decision-making in Crisis Situations (Nationaal Handboek Crisisbesluitvorming - final version, September 2016)
In the event of a nuclear accident at one of the nuclear power plants in the border region, the national crisis structure will be activated in line with relevant agreements in the National Manual on Decision-making in Crisis Situations. The general basic principles in a crisis of nationwide significance[339], such as a crisis arising from a nuclear accident, are laid down in this manual. Depending on the nature and scale of the national crisis and how it develops, the central government can fulfil three roles (either in combination or separately): it can facilitate, provide guidance or control. The manual designates an accident at a nuclear power plant as one of the situations that require control by the central government. The manual sets out the competences, responsibilities and key tasks of the main actors at central government level within the national crisis structure. The specific nuclear crisis plans will have to be in line with this.

The manual does not consider the cooperation between the Netherlands and other countries during a crisis of a cross-border nature. The manual does mention situations abroad with possible consequences for the Netherlands for which the national crisis organisation will be activated. A nuclear accident abroad is one of the examples addressed in this respect. In addition, the manual mentions the possibility of Dutch nationals living, working or being on holiday in the accident country in which case the government will provide assistance in the form of repatriation, reception, advice and suchlike.

National Plan for Nuclear and Radiological Emergencies (Nationaal Crisisplan Stralingsincidenten - final version, November 2016)
The Ministry of Infrastructure and the Environment's National Plan for Nuclear and Radiological Emergencies broadly describes the basic principles for managing a crisis that arises from a nuclear accident, the crisis organisation which is activated in such an event and the associated responsibilities assigned to the parties involved. Underlying sub-plans have been drawn up for a number of topics, such as the Response Plan NCS (*Responsplan NCS*), which sets out the conceptual principles for the response, and a communications plan for the provision of information to the public during a nuclear accident. For the operational and technical principles, the NCS and its response plan refer to the RIVM report entitled "*Technische basisinformatie stralingsongevallenbestrijding*" and the knowledge documents that are entitled "*Stralingsincidenten veiligheidsregio's*" from the Institute for Safety (*Instituut Fysieke Veiligheid*) that serve as operational guidelines for the approach to radiological accidents.

339 This concerns situations where national safety could be at stake or which otherwise have a major social impact. This is for example the case in a crisis resulting from an accident at one of the nuclear power plants in the border region.

The NCS and its response plan consider both nuclear accidents in the Netherlands as well as abroad. They consider the international and bilateral agreements on alerts for nuclear emergencies and the provision of information in this regard. The NCS also mentions the agreements that the Netherlands has specifically entered into with Belgium and Germany about the exchange of technical measurement and monitoring data needed for a technical analysis of the situation. The execution of the response operations in the regions is not part of the plans. For cross-border cooperation in the execution of the response operations, the NCS refers to the agreements that the safety regions have made with the neighbouring regional authorities in this regard.

According to the Response Plan NCS, the protective measures for the population should be prepared in zones around the nuclear power plants at the following distances:

Measures	Borssele	Doel (2,8 kilometres from NL)	Tihange (38 kilometres from NL)	Emsland (20 kilometres from NL)
Evacuation[340]	10	10	10	10
Shelter*	20	20	20	25
Iodine target groups - up to and including 40 years old, and pregnant women - up to and including 18 years old, and pregnant women	20 100	20 100	20 100	25 100

Table 3: The planning zones (radius of circles in kilometres) around the nuclear power plants for direct protective measures in the event of a nuclear accident, as taken up in the Response Plan NCS.
** The planning zone for shelter was set at 10 kilometres in the Dutch government's decision to harmonise the zones with Belgium and Germany. For practical reasons the distance has been increased to 20 kilometres. This way, the same distances are used for shelter and for the distribution of iodine (for individuals up to and including 40 years of age, and pregnant women).*

General Emergency Response Plan for Nuclear and Radiological Emergencies, Zeeland safety region (Algemeen Rampbestrijdingsplan Stralingsincidenten - final version, June 2017)
The Zeeland safety region has, in close cooperation with the Central and West Brabant safety region, drawn up a joint emergency response plan for an actual or imminent accident at the Borssele or the Doel nuclear power plants. The plan has been revised in 2017.

The plan was conceived in collaboration with various Dutch and Belgian parties, including the province of East Flanders and the operator of the Doel nuclear power plant, Electrabel. The plan has been formulated almost entirely from a cross-border perspective. Both the Dutch and the Belgian crisis organisations and the associated tasks and responsibilities are set out at national and regional levels. The plan considers cooperation between the Netherlands and Belgium for the reporting, alerting and upscaling processes. The plan mirrors the Dutch and Belgian terms, classification levels and

340 The population in the 5-kilometre circle around the nuclear power plant is given priority in an evacuation.

upscaling criteria so that the similarities and the differences between them is clear. The planning zones for protective measures that are taken up in the plan, are presented in table 4.

Measures	Borssele	Doel (2.8 kilometres from NL)
Evacuation[341]	10	10
Shelter	20	20
Iodine target groups - up to and including 40 years old, and pregnant women - up to and including 18 years old, and pregnant women	20 100	20 100

Table 4: The planning zones (radius in kilometres) around the Borssele and Doel nuclear power plants for direct protective measures in the event of a nuclear accident, as taken up in the General Emergency Response Plan for Nuclear and Radiological Emergencies.

Multidisciplinary Information Map, Limburg region (Multidisciplinaire Informatiekaart - final version, October 2016)

The South Limburg safety region, in cooperation with the North Limburg safety region, has drawn up a Multidisciplinary Information Map for an actual or imminent accident at the Tihange and Doel nuclear power plants. The map provides a brief overview of aspects that could play a role in a nuclear accident. Due to the distance to Tihange and Doel, the map only considers the distribution of iodine tablets within a radius of 100 kilometres for protection of the population of Limburg. The map contains very little information about cooperation with the neighbouring countries. As such, the information is limited to mentioning the most relevant crisis response teams in Belgium and Germany.

The planning zones for protective measures that are taken up in the map, are presented in table 5.

Measures	Tihange (38 kilometres from NL)
Evacuation	N/A
Shelter	N/A
Iodine target groups - up to and including 40 years old, and pregnant women - up to and including 18 years old, and pregnant women	 N/A 100

Table 5: The planning zones (radius in kilometres) around the Tihange nuclear power plant for direct protective measures in the event of a nuclear accident, that are taken up in the Multidisciplinary Information Map.

341 The population in the 5-kilometre circle around the nuclear power plant is given priority in an evacuation.

Emergency Response Plan for the Emsland nuclear power plant, Twente region (Rampbestrijdingsplan Kernkraftwerk Emsland - final version 2015)
This emergency response plan set up by the Twente safety region, in cooperation with the IJsselland and Drenthe safety regions, specifically focuses on an accident at the Emsland nuclear power plant. The plan considers the response to a nuclear accident in detail as well as the crisis organisations to be activated for this purpose in the Netherlands and in Germany. It also describes the way in which the Netherlands is alerted by Germany in the event of an actual or imminent nuclear accident. The plan contains a number of appendices that further elaborate specific sub-aspects, including crisis communications.

The planning zones for protective measures that are taken up in the plan, are presented in table 6.

Measures	Emsland (20 kilometres from NL)
Evacuation	10
Shelter	10 (flexible, depending on scenario)
Iodine target groups - up to and including 40 years old, and pregnant women - up to and including 18 years old, and pregnant women	 25 100

Table 6: The planning zones (radius in kilometres) around the Emsland nuclear power plant for direct protective measures in the event of a nuclear accident, as taken up in the Emergency Response Plan for the Emsland nuclear power plant.

Other plans and cooperation agreements
Apart from the aforementioned plans, there are various generic plans, protocols and agreements that could relate in part to cross-border cooperation during crises. They do not specifically focus on nuclear crises and are therefore not discussed in further detail in this investigation report. Where relevant, the investigation report includes a reference to the document concerned.

E.2 Belgium

Management of a crisis that results from an accident at one of the nuclear power plants is controlled at federal level from the Coordination and Crisis Centre of the Belgian Government (*Coördinatie- en Crisiscentrum van de Regering* - CGCCR), that is part of the Federal Public Service of the Interior (*Federale Overheidsdienst Binnenlandse Zaken*). This predefined approach is based on the following considerations and choices:

- the central availability of radiological-technical expertise at federal level that is required to analyse the emergency and its possible consequences;
- the (potentially) cross-border nature of the consequences;
- the need for coherent information to the population.

Belgium has a generic framework for crises that require coordination at national level.[342] A separate federal nuclear crisis plan, which is in line with the generic framework, has been drawn up for the management of crises that arise from nuclear emergencies, such as a nuclear accident. The provinces and municipalities are obliged to draw up generic and specific emergency response plans. This investigation is limited to planning at federal and provincial level.

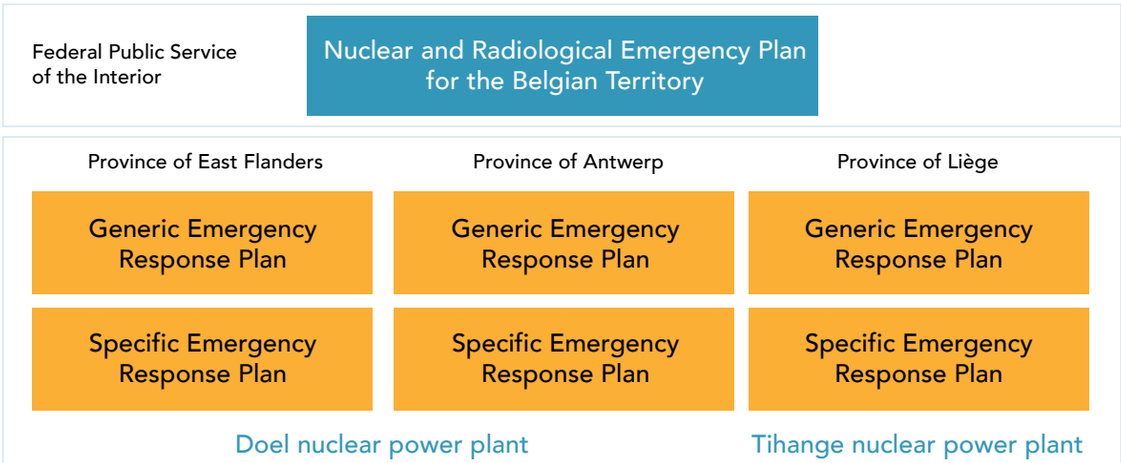


Figure 21: Overview of the crisis plans in Belgium in preparation for a nuclear accident.

Nuclear and Radiological Emergency Plan for the Belgian Territory (Nucleair en Radiologisch Noodplan voor het Belgische Grondgebied - draft version, September 2017)
This federal crisis plan focuses on nuclear emergencies with potential consequences for Belgium that occur in Category I nuclear installations.[343] This includes, among others, the Doel and Tihange nuclear power plants and the foreign nuclear power plants close to the Belgian border, such as the French nuclear power plants at Chooz, Gravelines and Cattenom and the Dutch Borssele nuclear power plant. The plan also considers nuclear accidents that occur at a distance of 100 kilometres or more from the Belgian border as well as nuclear accidents abroad that could have consequences for Belgian nationals living, working or being on holiday in the accident country.

The response approach is based on the planning of protective measures in defined zones. The emergency plan classifies the planning zones either as emergency planning zones or extension zones. The emergency planning zones cover by far the majority of all emergencies. If necessary, emergency planning zones may be widened to extension zones in accordance with a strategy whose basic principles are laid down in the federal plan. The zone expansion is up to 20 kilometres for evacuation and up to 100 kilometres for sheltering and the availability of stable iodine among the public. This is indicated in the table by means of a range of emergency planning zone (number of kilometres on the left) to extension zone (number of kilometres on the right).

342 Royal Decree establishing the emergency plan for crisis events and crisis situations that require coordination or management at national level (*Koninklijk besluit tot vaststelling van het noodplan voor de crisisgebeurtenissen en -situaties die een coördinatie of een beheer op nationaal niveau vereisen*), 31 January 2003.

343 As defined in the Decree of 20 July 2001 laying down the General Regulation for the protection of the public, workers and the environment against the hazards of ionising radiation (ARBIS).

Measure	Doel	Tihange	Borssele (16 kilometres from Belgium)
Reflex zone	3,5	3,5	nvt
Evacuation	10 - 20	10 - 20	10 - 20
Shelter	20 - 100	20 - 100	20 - 100
Iodine target groups[344] - up to and including 40 years old, and pregnant women - up to and including 18 years old, and pregnant women	20 - 100 Belgium	20 - 100 Belgium	20 - 100 Belgium

Table 7: The planning zones around the nuclear power plants for direct protective measures in the event of a nuclear accident, as included in the federal nuclear emergency plan (draft). The data show the radius of the circles in kilometres, and are subject to the adoption of the federal nuclear emergency plan (expected in early 2018).

The federal plan sets out the approach in the event of a nuclear emergency in detail, and contains specific information about direct and indirect protective measures (and related response processes). In the event of a nuclear accident in a neighbouring country, in principle, the Belgian government will adopt the approach of the accident country but will leave the option open of working with its own intervention levels, as specified in the federal nuclear plan, if they differ from those of the neighbouring country.

The plan considers the cooperation with neighbouring countries, which is based on the principle of cooperation between organisations with a comparable role in crisis response and crisis management ("homologous organisations"). In this regard, the plan mentions cross-border alerting, the exchange of information and the provision of assistance. The intention is to further elaborate on bilateral cooperation on these components in specific procedures as well as in the specific emergency response plans of the provincial governors concerned.

Specific emergency response plans for Doel nuclear power plant (bijzondere nood- en interventieplannen kerncentrale Doel van gouverneurs Oost-Vlaanderen en Antwerpen - final versions, April 2014 and February 2014 respectively)
The specific emergency response plans of the Governors of East Flanders and Antwerp for the Doel nuclear power plant set out the response to an accident at the Doel nuclear power plant. The plans have been elaborated to the operational level comprehensively. Both plans are limited by their own administrative provincial boundaries. The plans do not consider the consequences of an accident for the Netherlands, nor do they cover the possibility of an accident at the Borssele nuclear power plant or preparations for such an event. The plans are very limited regarding the cooperation with the Netherlands. They contain a few general provisions concerning alerting.

344 In Belgium, boxes containing iodine tablets are distributed to families and collectives (schools, hospitals, day care centres, factories, emergency services etc.) within a radius of 20 kilometres from each nuclear power plant. Outside these zones, boxes containing iodine tables are made available all over Belgian territory to children (under age 18), pregnant women, breast-feeding women and collectives associated with these target groups.

Specific emergency response plan for Tihange nuclear power plant (Plan particulier d'Urgence et d'Intervention Centrale nucléaire de Tihange, gouvernement provincial de Liège - final version, November 2016)
The Governor of the province of Liège has drawn up an emergency response plan for managing a crisis arising from an accident at the Tihange nuclear power plant. This plan is similar in structure to the plans of the Governors of the provinces of Antwerp and East Flanders for Doel nuclear power plant. The plan does not include any cross-border scenarios and does not consider cooperation with the Netherlands.

The response to a nuclear accident in the three plans of the governors regarding the Doel and Tihange nuclear power plants is based on "old" planning zones. Due to the stacked structure of the planning process, the governors are awaiting the implementation of the new federal crisis plan before revising their own nuclear emergency response plans. The revision will include an update of the planning zones in the plans, in line with the federal plan. The planning zones for protective measures that are taken up in the governor's emergency response plans, are presented in table 8.

Measure	Doel	Tihange
Reflex zone	3,5	3,5
Evacuation	10	10
Shelter	10	10
Iodine tablets	20	20

Table 8: Planning zones around the nuclear power plants for direct protective measures in the event of a nuclear accident, as included in the current nuclear emergency response plans of the Governors of the provinces of East Flanders, Antwerp and Liège. The figures show the radius of the circles in kilometres. The emergency response plans will be reviewed in the course of 2018, as a result of which their zones will be harmonised with those in the federal nuclear emergency plan (see Table 7).

E.3 Germany

At Länder and federal government level there are no nuclear crisis plans like in the Netherlands and Belgium. On 1 October 2017 legislation entered into force introducing a stacked system for nuclear crisis planning. Under the new legislation, the federal government is required to provide for an overarching crisis plan, on the basis of which the Länder are required to draw up their own crisis plans. In addition, under the new legislation the authorities that are tasked with emergency response for the high-risk nuclear installations, such as nuclear power plants, are required to draw up a specific external emergency response plan. All the federal and other government authorities involved must prepare their plans in accordance with uniform guidelines and those plans must be mutually harmonised.

The Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (*Bundesministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit* – BMUB) provides guidance on the content of the nuclear crisis plans: the German Commission on Radiological Protection (*Strahlenschutzkommission* - SSK), a commission within the BMUB, has set out national guidelines that serve as a framework to ensure that nuclear crisis management for the whole of Germany is set out according to a consistent framework. As such, the SSK published the following documents, among others: *Rahmenempfehlungen für den Katastrophenschutz in der Umgebung kerntechnischer Anlagen, Radiologische Grundlagen für Entscheidungen über Maßnahmen zum Schutz der Bevölkerung bei Ereignissen mit Freisetzungen von Radionukliden and Planungsgebiete für den Notfallschutz in der Umgebung von Kernkraftwerken*. These form the basis for the zones that are prepared in Germany to protect the public in the event of a nuclear accident.

Emergency response plan Emsland nuclear power plant (Katastrophenschutz Sonderplan Kernkraftwerk Emsland - final version July 2012)
Landkreis Emsland has drawn up an operational emergency response plan for a nuclear accident at the Emsland nuclear power plant. Among other things, this plan considers the organisation, alerting and the measures that can be taken during a nuclear accident. Pursuant to the plan, the emergency centre of Twente safety region is to be informed of an actual or imminent accident. The plan does not consider cooperation with the Netherlands in any more detail.

Measure	Emsland
Evacuation	10
Shelter	10
Iodine target groups - up to and including 45 years old, and pregnant women - up to and including 18 years old, and pregnant women	 25 100

Table 9: Planning zones around the Emsland nuclear power plant for direct protective measures in the event of a nuclear accident, as included in Landkreis Emsland's emergency response plan (Katastrophenschutz Sonderplan Kernkraftwerk Emsland).

APPENDIX F

REPORTING, ALERTING AND ACTIVATING THE CRISIS ORGANISATION

F.1 The Netherlands

Reporting an incident at the Borssele nuclear power plant
The nuclear licence for the Borssele nuclear power plant makes it mandatory for the operator (EPZ) to report incidents that satisfy set criteria to the nuclear regulatory authority (ANVS). Certain events must be reported by telephone or fax as quickly as possible, but always within eight hours after the event (and within 14 days in writing). Other events must be reported to the ANVS in writing within 30 days after the event. The steps to be taken then depend on the nature of the incident. EPZ will assign a provisional INES level to the incident in its report. In any event, upon receipt of the report the ANVS assesses if the provisional level is correct and publishes the incident report with the corresponding INES level on its website and on Twitter. Following notification, EPZ has to draft an analysis report which subsequently is assessed by the ANVS. When the incident is complex, it can take up to several months to complete the report. After the completion of the analysis report, the ANVS will determine the definitive INES level.[345] The analysis report itself is not publicly available.

If the incident merely concerns a technical disruption, the ANVS will focus on publishing information about the incident on the website and on Twitter. If it is an event that requires immediate emergency assistance, such as the radioactive contamination of a nuclear power plant employee, attention will first of all be on emergency assistance and identifying the cause of the contamination. Publication of the incident report on the website will follow later.

EPZ maintains a record of all incidents, including those that do not satisfy the reporting criteria. Once every year, the ANVS inspects the list of incidents to see if EPZ's decision not to report was correct.

Notification of an imminent nuclear accident at the Borssele nuclear power plant (alerting)
If an accident occurs or is imminent at the Borssele nuclear power plant, the nuclear power plant operator (EPZ) notifies the ANVS as quickly as possible through the crisis desk, which can be contacted 24/7. If it concerns an actual or imminent intentional act this is to be stated explicitly.

345 If necessary, the information about the incident will also be posted on the website.

In addition to notifying the ANVS, EPZ notifies the Zeeland safety region, the King's Commissioner for the province of Zeeland, the Mayor of the municipality of Borsele, operators of other nuclear installations in the Netherlands and the Doel nuclear power plant.

If the population needs to be alerted, the authorities will use the standard warning systems (including NL-Alert[346]) to do so. Here, the procedures do not differ from those in other emergency situations. There is no separate alert protocol for specific target groups, such as Seveso companies which may encounter additional risks or vulnerable groups such as people in care institutions.[347]

Activation of the crisis organisation when a nuclear accident is imminent
The ANVS's crisis desk forwards the notification of an imminent nuclear accident to the chair of the Crisis Expert Team radiation and nuclear (CETsn). Based on that notification, the chair will make a decision on activating the CETsn. This will certainly be the case if the notification has been assigned an accident category. Activating the CETsn may also be considered if an incident that has not been assigned an accident category is presumed to worsen or may possibly have safety consequences for the surrounding area. In addition, the CETsn can also be activated in case of incidents that give rise to social concern or which gain considerable media attention, and if the government requests for it. For example, the latter happened when news emerged about the Fukushima nuclear accident.

The ANVS will forward the alert notification for an imminent nuclear accident to the Ministry of Infrastructure and the Environment's Departmental Coordination Centre for Crisis Management (DCC IenM). The DCC IenM will then inform the Minister of Infrastructure and the Environment and the National Crisis Centre (NCC). Next, the national crisis structure will be activated in line with the relevant provisions in the National Manual on Decision-making in Crisis Situations (*Nationaal Handboek Crisisbesluitvorming*).

The National Manual on Decision-making in Crisis Situations defines nuclear accidents as situations that require control by the central government. The decision-making takes place at central government level in the Ministerial Crisis Management Committee (MCCb), where the Prime Minister, the Minister of Security and Justice (chair) and the relevant ministers, including the Minister of Infrastructure and the Environment have a seat.[348] The Minister of Security and Justice coordinates national crisis management and decision-making with respect to the general measures, while the Minister of Infrastructure and the Environment coordinates preparation of the decision-making on and the implementation of radiation-related measures. The MCCb receives official-level advice from the Interdepartmental Crisis Management Committee (ICCb), chaired by the National Coordinator for Security and Counterterrorism. The NCC supports the national

346 In situations that pose a threat to life and health, the Dutch government will send a text message to mobile phones in the immediate vicinity of the emergency. NL-Alert works on the basis of mobile-phone broadcasting. This technique is used to send messages to mobile phones via the transmission masts of all providers.
347 A pilot project (Alert4omgevingen) is running in Zeeland and elsewhere. This project is specifically intended for in-company emergency response staff. (http://www.centric.eu/NL/Default/Software-Solutions/Standaardsoftware/Calamiteiten-alerteringssysteem)
348 Decree establishing the Ministerial Crisis Management Committee (*Instellingsbesluit MCCb*).

crisis structure and handles the provision of information within this structure. The NCC is the central government's main point of contact for all other parties. Once the national crisis structure has been activated, the chair of the safety region concerned is responsible for executing the response measures decided by the MCCb.

The CETsn fulfils an important substantive and advisory role within the crisis organisation. The CETsn is staffed by experts from the ANVS. The Radiology and Health Expertise Network (*Radiologisch en Gezondheidskundig Expertise Netwerk* - RGEN) is an integral component of the CETsn. This network will gather information on how the accident occurred, its progress, its potential consequences (in terms of radiation) and current weather conditions. Based on this information, the RGEN makes dispersion calculations and summarises the outcomes in a situation report. In addition to making dispersion calculations, the RGEN issues advice in the fields of health, water quality, agriculture and products and goods. These form the basis for the CETsn recommendations regarding effective measures to mitigate the consequences of the accident. The Departmental Coordination Centre for Crisis Management of the Ministry of Infrastructure and the Environment (DCC IenM) arranges that the recommendations are taken into account in the national decision-making process, that the safety regions concerned are informed of these recommendations and that questions from the safety regions and ministries reach the CETsn. The CETsn and the safety regions are also in direct contact with each other.

F.2 Belgium

Reporting an incident at the Doel and Tihange nuclear power plants
The process for reporting incidents in Belgium is broadly comparable with that in the Netherlands. Electrabel and the Belgian government have made agreements on which incidents will be reported when, and to whom. The reporting criteria are included in legislation and further specified in the safety report for the nuclear power plant concerned. Pursuant to those criteria, Electrabel must inform Bel V verbally within one hour of detecting an incident. A written confirmation follows within two hours of this verbal alert.

Currently, there are differences in the reporting criteria for incidents at the Doel nuclear power plant and the Tihange nuclear power plant. As a result of these differences, in practice Tihange reports more incidents than Doel because the criteria for the Tihange facility are more stringent that those for the Doel nuclear power plant.[349] The differences mainly concern the reporting criteria for minor incidents that do not relate to nuclear safety.

If there is an incident at the Doel or Tihange nuclear power plants, the operator (Electrabel) first reports to Bel V. If the incident satisfies certain criteria, the FANC is then notified as well. Next, the 100/112 emergency centre and the federal crisis centre (CGCCR) are informed, as are the mayor of the municipality and the governor of the

349 This is partly due to the emergency services not being located on the site of Tihange nuclear power plant; they are located in the vicinity and consequently a notification is required to allow those services to access the site.

province in which the nuclear power plant is located. Incident reports concerning the Tihange nuclear power plant are sent to the Mayor of the Huy municipality and the Governor of the province of Liège. Incident reports concerning the Doel nuclear power plant are sent to the Mayor of the Beveren municipality and the Governor of the province of East Flanders. In addition to this, it has been agreed that the Governor of the province of Antwerp will also be notified of incidents at the Doel nuclear power plant.

Belgium uses the INES-classification to categorise the severity of incidents and to inform the public. The nuclear power plant operator, Electrabel makes a provisional proposal for the INES level of an incident; the FANC sets the definitive level. In the case of an irresponsible repetition of a violation (recidivism, which could indicate a poor safety culture) or a situation that requires the federal nuclear crisis plan to come into effect due to the possible safety consequences for the surrounding area of the nuclear power plant, an INES evaluation is performed and the incident can be classified at a higher INES level. In the case of recidivism, the increased INES level can serve as a warning. To date, the federal plan came only once into effect, for an incident at reactor Doel 4 on 10 January 2017. During a planned escape of steam some of the steam unintentionally ended up in the machine room due to ventilation grids that had been left open, injuring an employee who was working at a height in the machine room. Electrabel assigned an INES level to the notification. However, further analysis proved that the situation was under control and activation of the Belgian federal nuclear emergency plan was unnecessary.

Notification of an imminent accident at the Doel or Tihange nuclear power plants (alerting)
In the event of an actual or imminent nuclear accident at the Doel nuclear power plant, Electrabel notifies the Governor of the province of East Flanders, the Ghent 100/112 emergency centre, the on-site fire department, the CGCCR, the Mayor of the municipality of Doel, the FANC and Bel V by telephone of the accident and its corresponding notification level. The Ghent 100/112 emergency centre in its turn informs the Governors of the provinces of East Flanders and Antwerp and the various emergency services. In the particular case of a situation where the population requires immediate protection, the provincial Governors implement the "reflex measures" that are provided for in their emergency plan. The process at the Tihange nuclear power plant is almost identical, but in this case the Governor of the province of Liège and the Liège 100/112 emergency centre are notified. In Belgium, the FANC and Bel V must be notified of both an incident and an (imminent) nuclear accident within one hour. The notification is assigned a notification level.

The Belgian government mainly uses BE-Alert to alert the population.[350] No specific measures have been agreed for alerting specific target groups, including Seveso companies, in Belgium either. These companies' internal emergency plans should take account of external risks such as an accident at one of the nuclear power plants and should provide for the immediate shutdown of installations in such an event.

350 The Belgian government can send out a message to all mobile phones in the vicinity via BE-Alert. Residents must register with the system in advance to be able to receive such messages. In a major emergency, the government can send messages to citizens, even those who have not registered in advance.

Activation of the crisis organisation in Belgium
Once the operator has notified the various bodies, an actual or imminent nuclear accident in Belgium results in upscaling at federal level. The Coordination and Crisis Centre of the Belgian Government (CGCCR) activates a number of crisis units, also known as cells. The policy cell (*beleidscel*), which comprises the ministers and state secretaries with direct responsibilities for emergencies, decides on the measures that need to be taken. The policy cell is chaired by the Minister for Security and the Interior.[351] The federal Coordinating Committee (*federaal coördinatiecomité*), chaired by the director-general of the FANC, prepares the decision-making in the policy cell. The evaluation cell (*evaluatiecel*) makes recommendations on measures to be taken in the radiological and technical field to the federal Coordinating Committee. This cell is staffed by experts and scientists from the various competent authorities or services and is chaired by the FANC. The evaluation cell is supported by the measurement cell (*meetcel*), which provides the necessary expertise and resources to measure the radiation and radioactive contamination in the area. The measurement cell comprises representatives from the government services and institutions that have the principal measuring tools and the necessary competences and expertise with regard to nuclear measurements.

During the first phase of an accident (the reflex phase), upon receipt of an alert the governor may take reflexive action on his or her own authority if required by the accident scenario, pending activation of the federal crisis organisation. The reflex phase covers alerting the population, any recommendation to take shelter and continuously informing the population in the area subject to immediate danger. Evacuation and taking iodine are not included in these initial, urgent measures. The reflex phase applies as long as the federal crisis organisation has not yet been activated.

F.3 Germany

Reporting an incident at the Emsland nuclear power
Under the Nuclear Safety Officer and Reporting Ordinance (*Atomrechtliche Sicherheitsbeauftragten- und Meldeverordnung*), a nuclear power plant operator must report incidents to the nuclear regulatory authority. This concerns any incident that is relevant to nuclear safety. The operator of the Emsland nuclear power plant, Kernkraftwerke Lippe-Ems, reports incidents to the Lower Saxony nuclear regulatory authority, which is the Lower Saxony Ministry of the Environment, Energy and Climate Protection (NMU). The NMU forwards the incident report to the federal government. It is customary that the nuclear regulatory authority is first informed of an incident by telephone and then in writing. The written incident report is made using a standard form which must specify the cause, the consequences and the measures taken (to mitigate the consequences and to prevent reoccurrence). The reporting criteria and procedure are described in detail in the operations manual (*Betriebshandbuch*). The period within which incidents must be reported depends on the category of the incident:

351 Federale *Overheidsdienst Binnenlandse Zaken, Nucleair en Radiologisch Noodplan voor het Belgische Grondgebied*, conceptversie september 2017.

- Category S: immediately, without delay;
- Category E: within 24 hours;
- Category N: within 5 working days;
- Category V: within 10 working days.

Category V incidents are those that occur before the installation commences operations. This category is no longer relevant, given that no more nuclear power plants will be put into operation Germany.

RWE, the energy company that owns the Emsland nuclear power plant, will analyse and evaluate the incident. All incidents, even those incidents where there is no obligation to report to the government, are recorded using an internal reporting system. This enables all of RWE's nuclear power plants to learn from each other's experiences. In addition to the immediate incident report, RWE provides monthly summaries to the government. The reporting procedure aims at both the provision of timely information to the nuclear regulatory authority and the prevention of repeated or similar faults.

Notification of an imminent nuclear accident at Emsland nuclear power plant (alerting)
Pursuant to the Nuclear Safety Officer and Reporting Ordinance, the nuclear power plant operator, Kernkraftwerke Lippe-Ems, must report an actual or imminent nuclear accident at the Emsland nuclear power plant to the nuclear regulatory authority as quickly as possible. The ordinance includes a number of categories with corresponding notification periods for various types of events. Category S concerns events that must be reported without delay and which could lead to activation of the crisis organisation. The nuclear power plant immediately informs the NMU and Landkreis Emsland. The Emsland nuclear power plant informs the parties both by phone and by fax using a nuclear accident (*Kerntechnischer Unfall*) form. The information on the form includes the provisional INES level, a brief description of the event and of the weather conditions (wind direction, chance of precipitation). The nuclear power plant also informs Kerntechnische Hilfsdienst Gmb., a service that is responsible for, among other things, decontamination of personnel and helping to stabilise the situation.

The population will be alarmed through the appropriate warning systems, such as sirens and sound trucks. Unlike the Netherlands and Belgium, Germany does not have an alerting system where citizens receive a message on their mobile phone automatically and without prior approval.

Activation of the crisis organisation in Germany
In the event of an actual or imminent accident at the Emsland nuclear power plant, the crisis organisation is activated at the local level by Landkreis Emsland, where a crisis staff is formed for the response within the Emsland district. The initial crisis response measures and communications with citizens take place under the responsibility of the Landkreis. The crisis organisation of the Osnabrück police department (*Polizeidirektion Osnabrück*) is also activated. In the event of an actual or imminent accident, the police, in its turn, informs the Lower Saxony Ministry of the Interior and Sport (NMI), which subsequently informs the Federal Ministry of the Interior (BMI) so it can arrange support and coordination with other Länder and with neighbouring countries. For instance, within the BBK, Germany has a central centre for civil safety, the German Joint Information and

Situation Centre (*Gemeinsames Melde- und Lagezentrum von Bund und Ländern* - GMLZ). The GMLZ pools information resources across the various ministries from the federal government and from the Länder during a major disaster or crisis. In addition, the ministries concerned have a permanent Joint Situation Centre (*Lagezentrum*) that functions as a crisis coordination centre.

Crisis coordination in Lower Saxony is assigned to the NMI. In the event of a nuclear accident, a task force will be set up, which includes besides representatives from the NMI, representatives from other ministries, such as the NMU. Decision-making and coordination will take place within the task force.

In Lower Saxony, the NLWKN has the task to measure and monitor the radiological situation. The NLWKN collates information from various systems in order to make prognoses and recommendations which the crisis organisation can use in deciding which measures should be implemented, and where. The Radiation Protection Act (*Strahlenschutzgesetz*) that came into force recently, namely on 1 October 2017, provides for a Federal Radiology Situation Centre (R*adiologisches Lagezentrum des Bundes* - RLZ) at federal level. In the event of a nuclear accident, the RLZ will have a prominent role in interpreting the radiological situation and formulating prognoses on how the situation will develop. The RLZ will also make recommendations on protective measures to the Länder concerned. Previously, the Länder and the federal government had to conduct their own analyses. Vesting this task with the RLZ will help to achieve greater clarity and a more coordinated joint approach within Germany.

SHUTDOWNS AND INES REPORTS

G.1 Shutdowns

Figures 22 to 25 show the number of unscheduled shutdowns at the Borssele, Doel, Tihange and Emsland nuclear power plants in the period from 2007 up to and including 2016. The periods in which a reactor was not operational have not been taken into account in these figures.

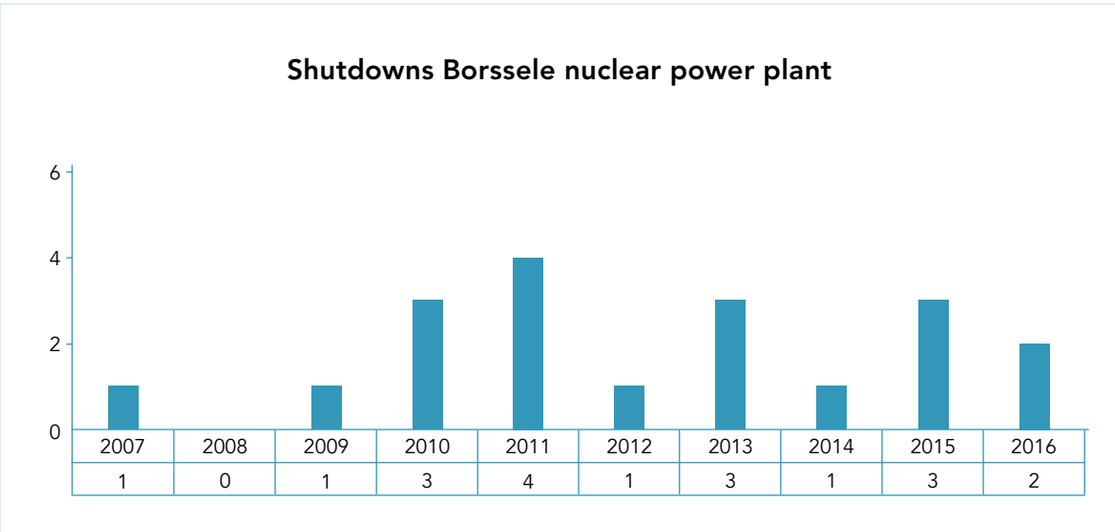
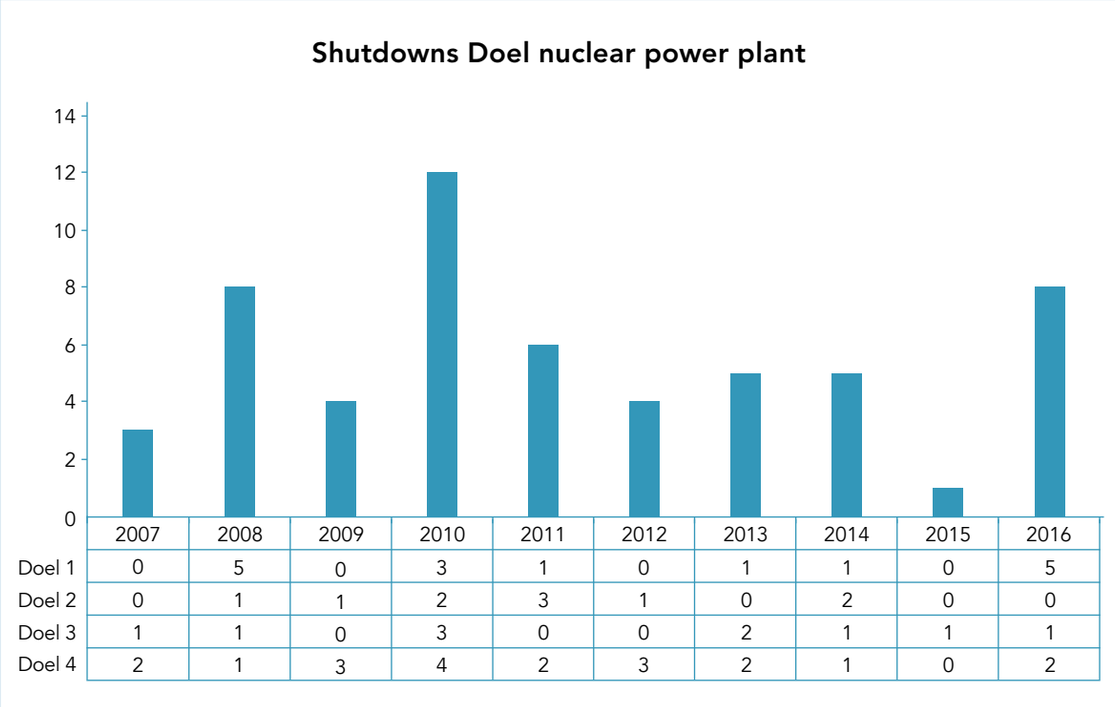
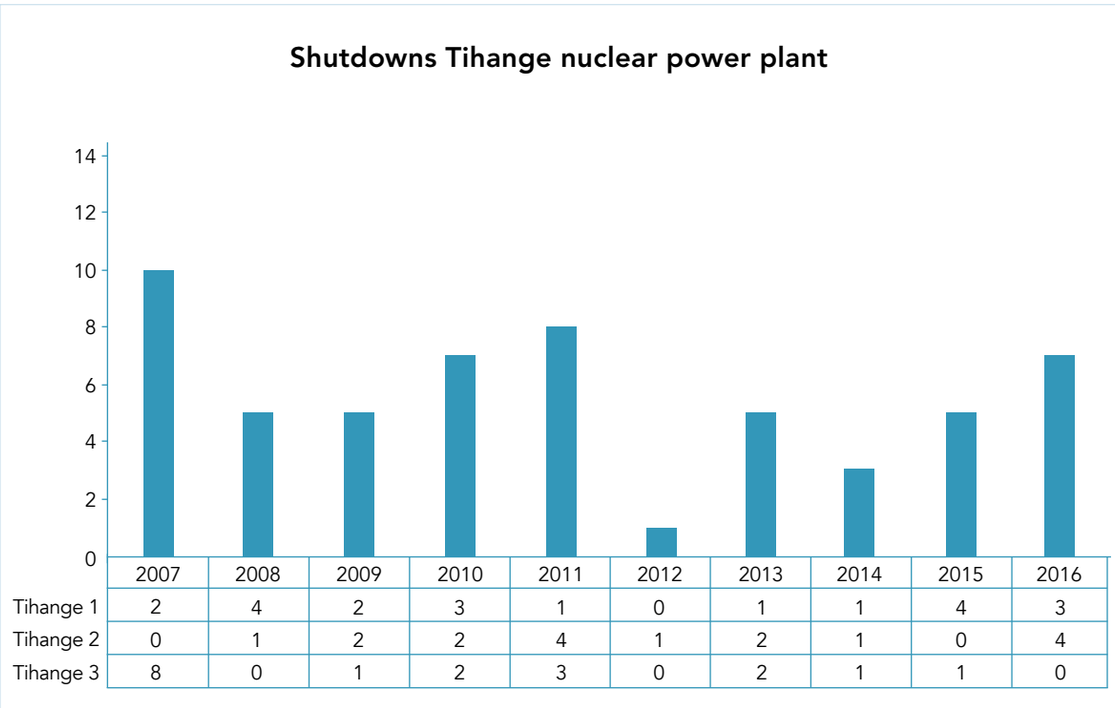


Figure 22: Unscheduled manual and automatic shutdowns at the Borssele nuclear power plant.



	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Doel 1	0	5	0	3	1	0	1	1	0	5
Doel 2	0	1	1	2	3	1	0	2	0	0
Doel 3	1	1	0	3	0	0	2	1	1	1
Doel 4	2	1	3	4	2	3	2	1	0	2

Figure 23: Unscheduled manual and automatic shutdowns at the Doel nuclear power plant (Doel 1, Doel 2, Doel 3 and Doel 4).



	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Tihange 1	2	4	2	3	1	0	1	1	4	3
Tihange 2	0	1	2	2	4	1	2	1	0	4
Tihange 3	8	0	1	2	3	0	2	1	1	0

Figure 24: Unscheduled manual and automatic shutdowns at the Tihange nuclear power plant (Tihange 1, Tihange 2 and Tihange 3).

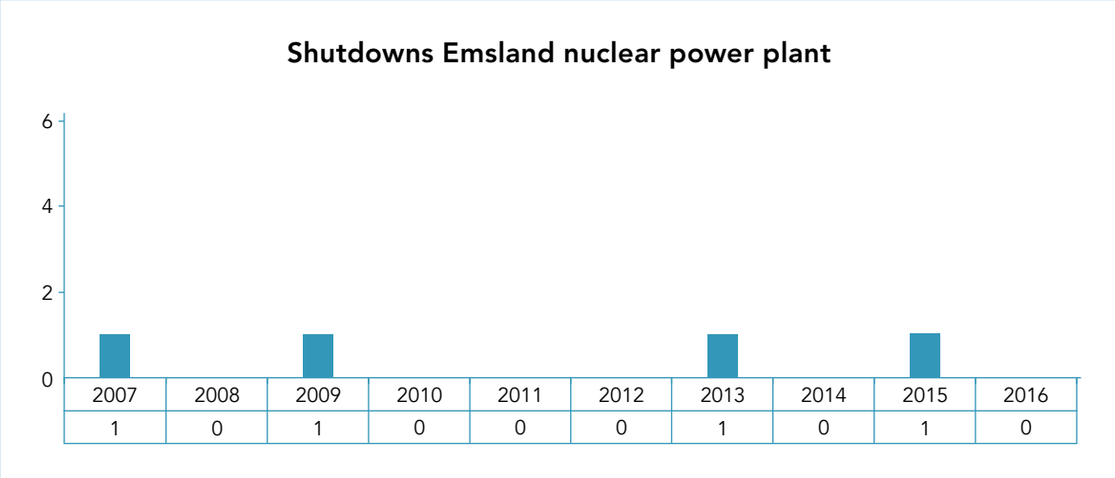


Figure 25: Unscheduled manual and automatic shutdowns at the Emsland nuclear power plant.

G.2 INES reports

Figures 26 to 29 show the number of incidents classified as INES level 1 or level 2 at the Borssele, Doel, Tihange and Emsland nuclear power plants in the period from 2007 up to and including 2016. The periods in which a reactor was not operational have not been taken into account in this figure.

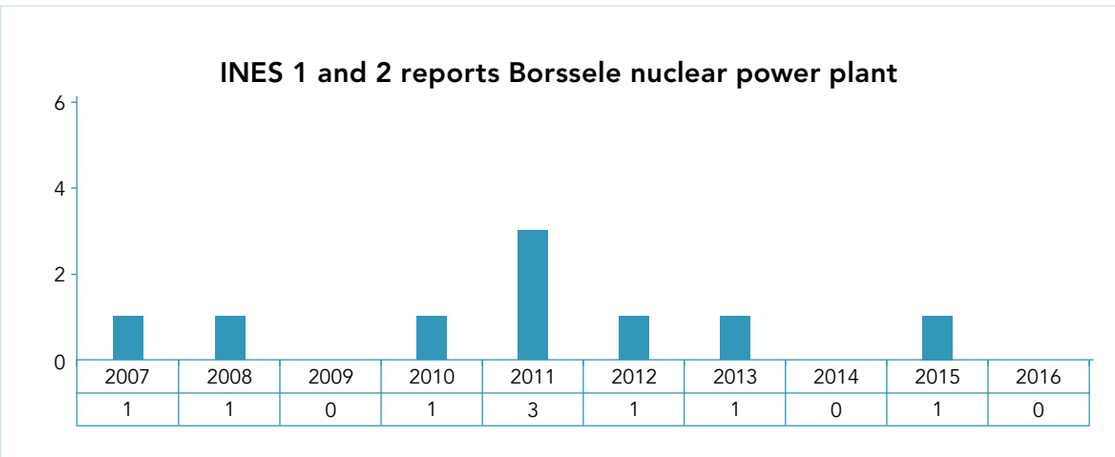
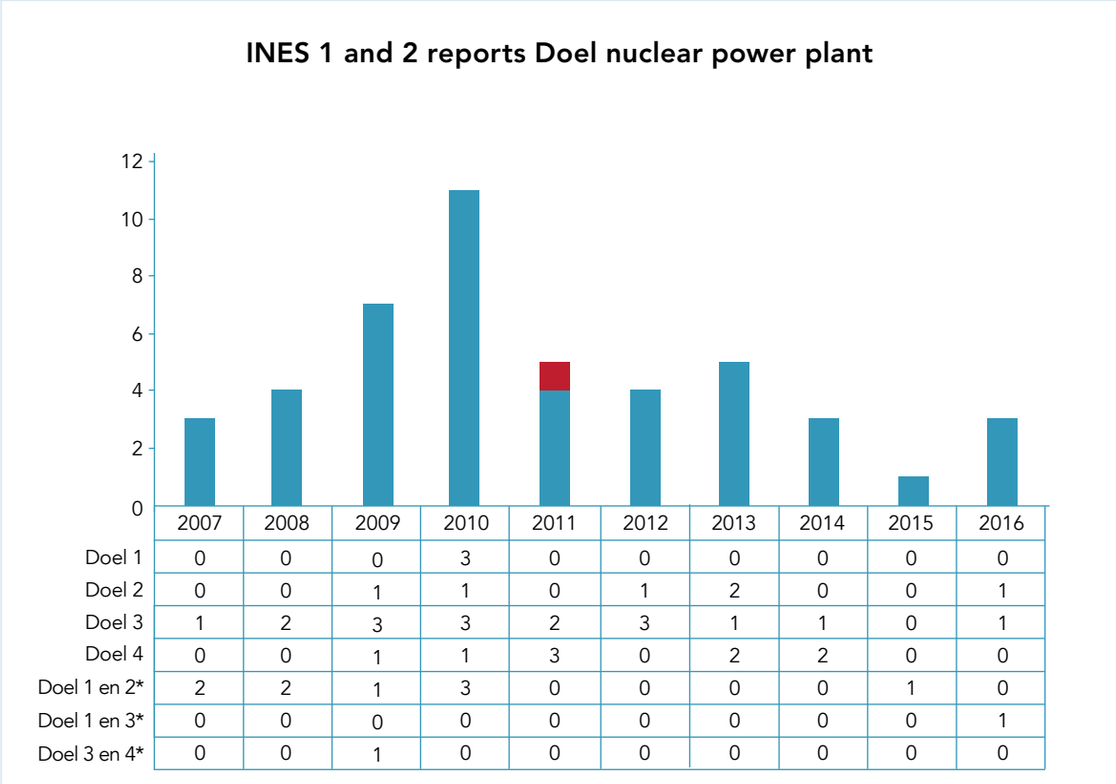
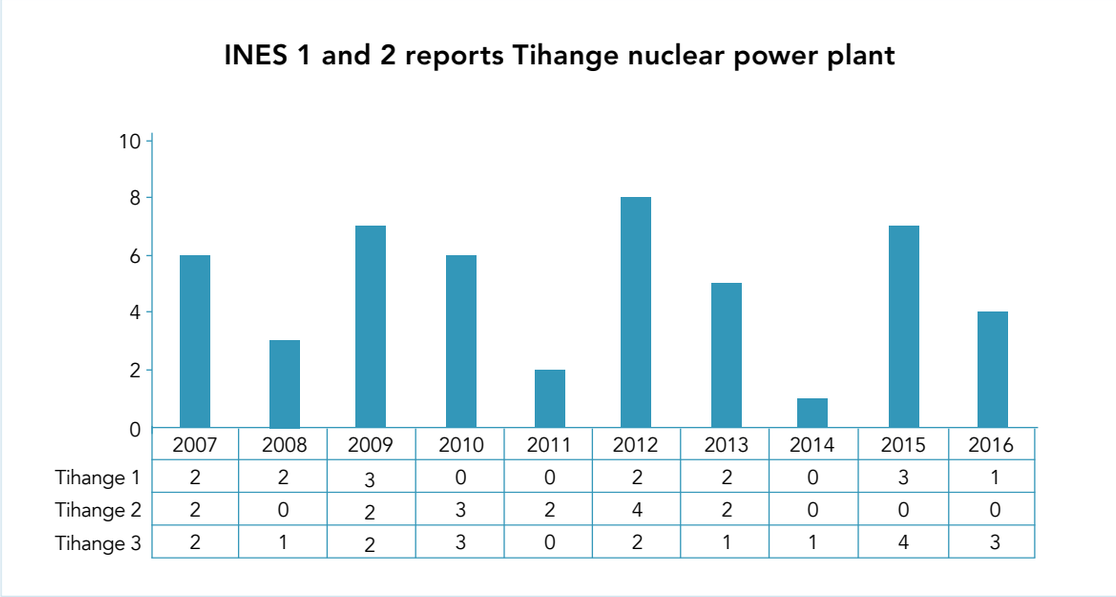


Figure 26: Incidents classified as INES level 1 or level 2 at the Borssele nuclear power plant. None of the incidents were classified as INES level 2.



	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Doel 1	0	0	0	3	0	0	0	0	0	0
Doel 2	0	0	1	1	0	1	2	0	0	1
Doel 3	1	2	3	3	2	3	1	1	0	1
Doel 4	0	0	1	1	3	0	2	2	0	0
Doel 1 en 2*	2	2	1	3	0	0	0	0	1	0
Doel 1 en 3*	0	0	0	0	0	0	0	0	0	1
Doel 3 en 4*	0	0	1	0	0	0	0	0	0	0

*Figure 27: Incidents classified as INES level 1 or level 2 at the Doel nuclear power plant (Doel 1, Doel 2, Doel 3 and Doel 4). One of the incidents was classified as INES level 2. This incident occurred at Doel 4 in 2011. *Some INES reports concern systems that are used by multiple reactors.*



	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Tihange 1	2	2	3	0	0	2	2	0	3	1
Tihange 2	2	0	2	3	2	4	2	0	0	0
Tihange 3	2	1	2	3	0	2	1	1	4	3

Figure 28: Incidents classified as INES level 1 or level 2 at the Tihange nuclear power plant (Tihange 1, Tihange 2 and Tihange 3). None of the incidents were classified as INES level 2.

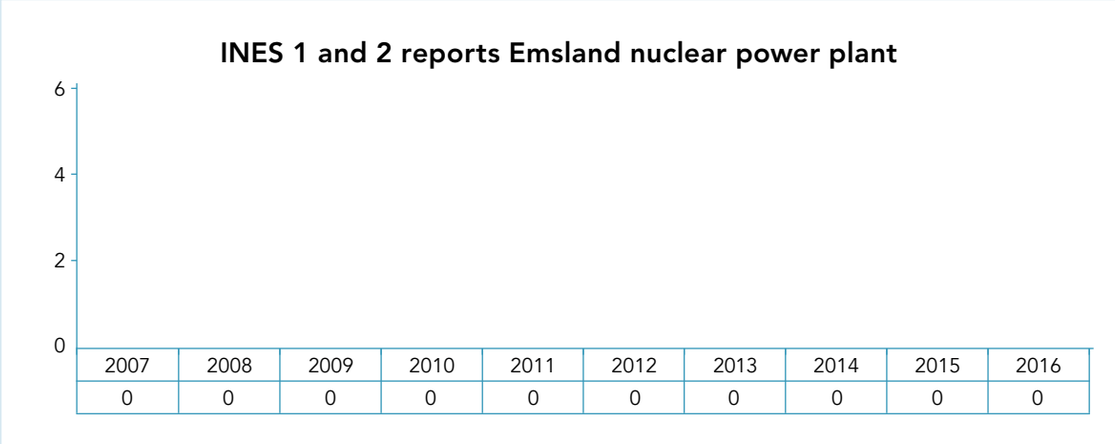


Figure 29: Incidents classified as INES level 1 or level 2 at the Emsland nuclear power plant. There were no incidents classified as INES level 1 or 2.

G.3 INES reports in European countries

Figure 30 shows all incidents classified as INES level 1 or level 2 that occurred in various European countries. This figure shows the average number of incidents reported per reactor over the last decade, that occurred at pressurised water reactors in the respective countries. The specific reactors for which data are included, are listed in Table 10.

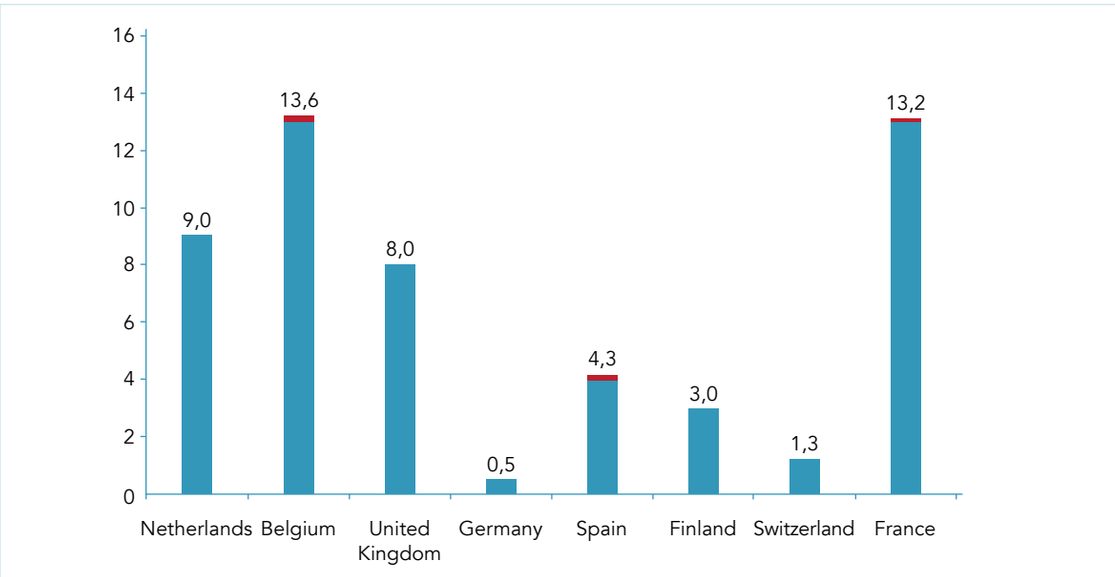


Figure 30: Incidents classified as INES level 1 (blue) and level 2 (red) in various European countries. This figure shows the average number of incidents reported per reactor over the last decade, that occurred at pressurised water reactors in the respective countries. The periods in which a reactor was not operational have not been taken into account in this figure.

The Netherlands	Belgium	Germany	Finland	Spain
Borssele	Doel 1	Neckar 2	Loviisan 1	Asco
	Doel 2	Isar 2	Loviisan 2	Asco II
	Doel 3	Philippsburg 2		Almaraz I
	Doel 4	Grohnde		Almaraz II
	Tihange 1	Brokdorf		Vandelos II
	Tihange 2	Emsland		Trillo
	Tihange 3			
United Kingdom	**Switzerland**	**France**		
Sizewell B	Beznau 1	Blayais 1	Gravelines 1	Saint-Laurent B1
	Beznau 2	Blayais 2	Gravelines 2	Saint-Laurent B2
	Gösgen	Blayais 3	Gravelines 3	Dampierre 1
		Blayais 4	Gravelines 4	Dampierre 2
		Golfech 1	Gravelines 5	Dampierre 3
		Golfech 2	Gravelines 6	Dampierre 4
		Civaux 1	Bugey 2	Chinon B1
		Civaux 2	Bugey 3	Chinon B2
		Paluel 1	Bugey 4	Chinon B3
		Paluel 2	Bugey 5	Chinon B4
		Paluel 3	Nogent 1	Flamanville 1
		Paluel 4	Nogent 2	Flamanville 2
		Penly 1	Chooz B 1	Cattenom 1
		Penly 2	Chooz B 2	Cattenom 2
		Tricastin 1	Cruas 1	Cattenom 3
		Tricastin 2	Cruas 2	Cattenom 4
		Tricastin 3	Cruas 3	Belleville 1
		Tricastin 4	Cruas 4	Belleville 2
		Saint-Alban 1	Fessenheim 1	
		Saint-Alban 2	Fessenheim 2	

Table 10: Pressurised water reactors in European countries that the data in Figure 30 refer to.

G.4 Determining the INES level

The INES-classification is used to rate the significance of all types of incidents and accidents involving sources of ionising radiation (nuclear power plants, hospitals, the transportation of nuclear materials, etc.) which have or may have an impact on the safety of people and the environment. A large number of factors must be taken into account when determining the INES level.[352, 353] The INES level is determined on the basis of the following three main categories:

1. People and environment (INES 1-7)
2. Defence in depth (INES 1-3)
3. Radiological barriers and controls (INES 2-5)

For every main category, there is a lower and an upper INES level. The INES levels within each main category are defined by a large number of criteria.

The first category concerns events that have caused damage to people and/or the environment due to the discharge of radioactive materials or the exposure of a person to radiation. In the case of a discharge of radioactive materials, the INES level will be between 4 and 7, depending on the type and the amount of radioactive materials released. If one or more persons have been exposed to radiation, but there has been no discharge outside the nuclear power plant site, the INES level will be between 1 and 4. The second and third categories concern events where the safety barriers of the nuclear power plant were activated successfully, thus preventing damage to people and/or the environment. The INES levels within the main category of "Defence in depth" are between 1 and 3. The main category of "Radiological barriers and controls" (INES 2-5) relates to serious accidents at nuclear installations which potentially could involve a sufficiently large discharge of radioactive materials to be rated as INES level 5 or above, but where the safety barriers were successfully in preventing a discharge. As an example, a core meltdown with no discharge of radioactive materials outside the nuclear power plant site, such as happened at Three Mile Island, would fall under this category.

All persons responsible for determining the INES level of events have undergone training to that end by the IAEA. Nevertheless, countries may still assess the scale of an event differently due to the many criteria that must be taken into account when determining the scale of an event and the way these criteria are applied to different locations and installations. This applies to lower-level events (below INES level 2) in particular. For this reason, the IAEA stresses that the number of INES reports as such is not an adequate tool for comparing the safety performance of different nuclear power plants.

352 IAEA, *The International Nuclear and Radiological Event Scale User's Manual*, 2008
353 IAEA, *INES Rating Interactive Learning Tool*, website: https://iec.iaea.org/inesrilt/, 2017.

G.5 Examples of events and the related INES level

The following table shows various examples of actual events that occurred in the past and were rated on the INES scale.

INES level 7 major accident	**People and environment**
	• Chernobyl (Ukraine, 1986) and Fukushima (Japan, 2011) accidents.
INES level 6 serious accident	**People and environment**
	• Large explosion in storage tank with liquid radioactive waste at enrichment facility near Kyshtym (USSR, 1957).
INES level 5 accident with wider consequences	**Radiological barriers and controls**
	• Three Mile Island accident (Harrisburg, USA, 1979) involving a partial nuclear core meltdown, but only a limited release of radioactive material.
	People and environment
	• Fire in a reactor at Windscale (now Sellafield, UK, 1957) resulting in a discharge into the environment. • Unsupervised abandonment of a high-activity source in Goiânia (Brazil, 1987) resulting in four fatalities.
INES level 4 accident with local consequences	**Radiological barriers and controls**
	• Meltdown of a number of fuel elements in a nuclear reactor at Saint-Laurent (France, 1980) as a result of a blockage in the cooling system for those elements. No radioactive materials were released into the environment.
	People and environment
	• Tokaimura accident (Japan, 1999) due to an uncontrolled chain reaction in a tank containing uraniferous liquid. • Sterigenics accident (Fleurus, Belgium, 2006) in which an employee was exposed to a high-activity source.
INES level 3 serious incident	**Radiological barriers and controls**
	• Failure of a pipeline at an enrichment facility at Sellafield (UK, 2005) resulting in the release of a large amount of radioactive liquid into a sealed room.
	Defence in depth
	• Loss of safety barriers due to a fire at the Vandellos nuclear power plant (Spain, 1989).
	People and environment
	• Yanago incident (Peru, 1999); a welder suffered grievous injuries after contact with unshielded radioactive source.

INES level 2 incident	**Radiological barriers and controls**
	• Contamination of installation at Cadarache (France, 1993) due to overflow of storage tank with radioactive liquid.
	Defence in depth
	• Failure of emergency power systems at the Forsmark nuclear power plant (Sweden, 2006). • Failure of access control system to a room with high radiation level in nuclear accelerator facility (France, 1995).
	Mens en milieu
	• Overexposure to radiation of a medical technician in a hospital in Phoenix (USA, 2015).
INES level 1 anomaly	**Defence in depth**
	• Accelerated deterioration of emergency power batteries at the Borssele nuclear power plant, resulting in reduced usability (The Netherlands, 2015).
	People and environment
	• Exposure of employee to high level of radiation during maintenance of gammagraphy installation (Belgium, 2016).
INES level 0 no safety significance	**Defence in depth**
	• Automatic activation of backup diesel generators at the Borssele nuclear power plant (The Netherlands, 2013) due to an external power grid failure.

Table 11: Examples of events that were given an INES-classification.

NUCLEAR SECURITY IN THE NETHERLANDS

H.1 Security of nuclear installations

The operator of a nuclear power plant in the Netherlands has a legal obligation to ensure the security of the power plant. The way in which security is implemented should be included in an internal security plan (plan for the internal security organisation) which is part of the nuclear licence issued under the Nuclear Energy Act (*Kernenergiewet*). In the Netherlands, security plans are supervised by the Authority for Nuclear Safety and Radiation Protection (*Autoriteit Nucleaire Veiligheid en Stralingsbescherming* - ANVS). The measures set out in this plan must be exercised regularly. The security plan needs to be evaluated annually, and there should be a report on whether or not the internal security plan is still closely aligned with the external security plan (the plan for the governments' external security organisation). The external security plan sets out the action to be taken by the chief of police, the mayor and the public prosecutor if a situation were to arise in which the security of the nuclear installation is threatened.

The results of a study by the Security and Justice Inspectorate (*Inspectie Veiligheid en Justitie*) into the external security of nuclear installations in the Netherlands were published in September 2017.[354] The Inspectorate concluded that the police takes a thoughtful approach to ensuring the security of nuclear establishments and that the external safety plans meet the statutory requirements. Coordination between the operator of the installation and the police and the way in which the external security organisation is exercised could be improved. The emergency centres of the safety regions are not, or hardly, involved in those exercises. Due to busy exercise schedules and exercise obligations, safety regions choose generic exercises over object-specific ones, as a result of which those involved may not acquire the necessary familiarity with the design and layout of the nuclear power plant concerned.

Design basis threats

The internal security plan for the nuclear power plant should set out how design basis threats are managed. The government conducts a threat assessment which sets out possible events, which are included in the design basis threat (known as the *referentiedreiging* in Dutch). The scenarios in the design basis threat can concern external demonstrators, the actions of insiders and terrorist attacks. Parties involved in the

354 Inspectie Veiligheid en Justitie, *Onderzoek externe beveiliging nucleaire inrichtingen; Onderzoek naar het plan Externe Beveiligingsorganisatie (EBO) van de politie*, 2017.

formulation of the design basis threat include the National Coordinator for Security and Counterterrorism (*Nationaal Coördinator Terrorismebestrijding en Veiligheid* - NCTV), the National Police, the General Intelligence and Security Service (*Algemene Inlichtingen- en Veiligheidsdienst* - AIVD) and the plant security managers of the nuclear installations in the Netherlands.[355]

A design basis threat has been established for both the physical security and cyber security of the nuclear sector in the Netherlands. The design basis threat for physical security was formulated in 2010 and updated in 2015. The design basis threat for cyber security was formulated in 2014, making the Netherlands one of the first countries with a design basis threat for cyber security. It is updated every two years. Both design basis threats can be amended in the interim should there be reason to do so.

H.2 International coordination and exchange of information

The IAEA makes recommendations for countries on nuclear security through what is known as the Nuclear Security Series. These recommendations also concern cyber security. In addition, the IAEA provides missions that relate to the security of nuclear installations. These are known as International Physical Protection Advisory Service (IPPAS) missions. The Borssele nuclear power plant was subject to an IPPAS mission in 2005. In the years subsequent to this, other nuclear installations in the Netherlands have also been subject to IPPAS missions.[356]

European countries exchange information about the security of nuclear installations in the European Nuclear Security Regulators Association (ENSRA). This mainly involves sharing experiences and developing best practices. The Western European Nuclear Regulators Association (WENRA) and the World Association of Nuclear Operators (WANO), in which the Netherlands, Belgium and Germany are represented, are also occupied with nuclear security. Their engagement broadly relates to the interface between safety and security and possible conflicting requirements. For instance, WENRA has taken the initiative to elaborate the further integration of nuclear safety and security.

Within the Netherlands, consultative groups have been set up for the physical security of nuclear installations and for the cyber security of nuclear installations, with representation from the sector and the government. Both forums discuss matters including establishing the design basis threats and the way in which security can be improved.

The countries do not discuss the security measures that they actually employ in nuclear installations due to the limitations imposed by the confidentiality of the information, among other things. This does not, however, mean that there is no international exchange of information; as stated above, there are international channels within which information is shared.

355 https://zoek.officielebekendmakingen.nl/kst-32645-66.html
356 COVRA, the now-closed Dodewaard nuclear power plant, the research reactors in Petten and in Delft and the enrichment facility URENCO.

H.3 Detection and alerting

The Counterterrorism Alert System (*Alerteringssysteem Terrorismebestrijding*) has been set up to warn the government and the business community in the event of danger or threats to a specific sector. Its objective is to ensure that critical and vulnerable sectors can continue to function responsibly, even in the event of a threat. The government and the business community can decide to implement measures based on the system. A Counterterrorism Alert System has been set up for critical infrastructure.[357] As the nuclear sector is part of the vital infrastructure, it is connected to the Alert System. Participation in the Counterterrorism Alert System by companies in the sector is voluntary, but does require certain commitments. If the threat level increases, companies have to implement agreed measures. All nuclear installations in the Netherlands, including the Borssele nuclear power plant, participate in the system.

Information about concrete threats abroad is received in the Netherlands through the NCTV or the Dutch national intelligence services. The former ensures selective dissemination of the information in such a way that security measures can be adjusted where necessary, for example by amending the threat level in the Counterterrorism Alert System.

H.4 Crisis management

The Dutch nuclear crisis plans set out a number of possible emergency situations that result from malicious intent and where the population is intentionally exposed to ionising radiation. This could be sabotage at a nuclear installation, a "dirty bomb" or the intentional contamination of food and drinking water for instance. The response to such situations provided for in the Dutch Response Plan NCS is based on the expectation that the "regular" direct and indirect measures will offer sufficient protection. The Dutch authorities make the assumption that the protection of the public against ionising radiation will differ very little whether the radiological consequences result from an accident or an intentional act.

The allocation of roles in the crisis organisation managing a nuclear crisis involving terrorism or sabotage will almost certainly differ from that managing a crisis arising from an accident at a nuclear power plant. Depending on the nature of the crisis, control will tend to be vested with the Ministry of Security and Justice, with the explicit involvement of the NCTV, the Public Prosecution Service and the police. For example, the National Manual on Decision-making in Crisis Situations (*Nationaal Handboek Crisisbesluitvorming*) states that in the event of an urgent terror threat the Minister of Security and Justice can exercise his extended powers.[358] Under such circumstances this extended powers are exercised along the regular (existing) lines as far as possible. Beyond that, management of a crisis arising from terrorist activity or sabotage (with a possible discharge of

357 https://www.nctv.nl/organisatie/nationale_veiligheid/vitale_infrastructuur/index.aspx
358 If speed is of the essence due to a fatal time line, the Minister of Security and Justice can exercise his extended powers even if the Ministerial Crisis Management Committee has convened. However, the minister is bound by the decisions of the Committee.

radioactive materials) is assigned to the same parties as those involved in managing a crisis arising from a nuclear accident.

In addition to the nuclear security plans, other plans will also come into effect, such as the external security organisation's plan. Based on those latter plans, measures concerning the nuclear power plant that are necessary at that time from a security point of view will be implemented. These could affect the possible response measures, although parties agree that they do not expect that the security and response measures will counteract.

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