Country Profile, the Netherlands
30 June 2020

Information about, and Assessment of, the Application of BAT and BEP in Nuclear Facilities

OSPAR Agreement: 2018-01

Section1: Country Profile of the Netherlands

Section 1: Summary document detailing

- Relevant national authorities and responsibilities;

  The ANVS (Authority for Nuclear Safety and Radiation Protection) combines expertise in the fields of nuclear safety and radiation protection, as well as security and safeguards. The ANVS is the national authority responsible for the supervision of discharges of radionuclides into air and water. The ANVS was established on January 1st, 2015 and became an Independent Administrative Body ("ZBO" in Dutch) on August 1st, 2017, and is thereby not directly subject to ministerial authority.

  The ANVS carries out regulatory activities and can implement any measures that are required in the interests of nuclear safety, security and safeguards, or radiation protection. The ANVS issues licences and registrations, and records notifications. It also registers and accredits radiation protection experts and practitioners in medical surveillance of exposed workers. Working with its partners, the ANVS ensures that the Netherlands is as well prepared as possible for radiation safety and security accidents. The ANVS is also contributing to developing nuclear safety, security and safeguards, and radiation protection policies, including radioactive waste and decommissioning policy. At international level, the ANVS coordinates with various foreign agencies, authorities and organizations, such as the International Atomic Energy Agency (IAEA) and OSPAR as far as radioactive substances and nuclear installations are involved.

- National legislation and basis for regulation;

  Policy and national legislation are based on European Commission Directives, international conventions and recommendations of appropriate international bodies like the International Commission on Radiological Protection (ICRP) and the IAEA. Some of the main legislation and regulations are illustrated below.

  Nuclear Energy Act

  The Nuclear Energy Act ('Kernenergiewet' or Kew) and the legislation and licences based on it (including the associated requirements) form the legal guarantee that the Netherlands meets its international obligations in the field of nuclear safety and radiation protection. Through its numerous amendments since its introduction in 1963, the Nuclear Energy Act, in conjunction with its delegation provisions, ensures a broad basis for the implementation of European and international rules. It also includes the general national regulations for protective and preventive measures, radiation protection, disposal of radioactive waste and irradiated fuel elements.

  Decree on Basic Safety Standards for Radiation Protection

  The Decree on Basic Safety Standards for Radiation Protection (in Dutch: "Besluit basisveiligheidsnormen stralingsbescherming") has been in force since 6 February 2018, and replaces the Radiation Protection Decree of 2011. The goal of this Decree is to protect the public, the environment, employees and patients against the adverse effects of ionizing radiation. This complies with the 2013/59/Euratom directive (the Basic Safety Standards or BSS), which in turn is an elaboration of the recommendations of ICRP. The requirements set out in the Decree have been further elaborated, in the form of the associated regulations, notably the Regulation on Basic Safety Standards for Radiation Protection (in Dutch: Ministeriële regeling basisveiligheidsnormen stralingsbescherming) and the ANVS-regulation on Basic Safety Standards for Radiation Protection (in Dutch: ANVS-Verordening basisveiligheidsnormen stralingsbescherming). These Regulations contain rules and appendices with technical and other requirements for implementation, such as administrative requirements, values for exemption and release from regulatory control, core competences and other qualifications for radiation protection experts and radiation protection officers, and the corresponding educational requirements, generic justification for practices and measures.

Nuclear Safety Guidelines

The licences for nuclear facilities make use of the Nuclear Safety Guidelines (Nucleaire Veiligheids Regels, NVR). These are IAEA Safety Requirements and Safety Guides that have been adapted to the Dutch situation. They are linked to a licence, depending on the nuclear facility in question. Through its affiliation with the Western European Nuclear Regulators Association (WENRA), the ANVS has committed itself to implement the Safety Reference Levels. These are important for various reasons, such as promoting the national and international harmonization of legislation, and have for example been implemented in the revision of the licence of the Nuclear Power Plant Borssele of 3 October 2018.

In addition to the NVRs, the DSR ('Guidelines on the Safe Design and Operation of Nuclear Reactors' - Safety Guidelines, or in Dutch 'Veilig Ontwerp en het veilig Bedrijven van Kernreactoren', VOBK) describe a major part of the required processes and regulations for the licensing of new nuclear power plants, and are applicable to existing nuclear power reactors as far as reasonably achievable and in line with the objective of continuous improvement, providing detailed insight into what the ANVS considers to be the best available technology. More information can be found in Appendix 1 of [CNS 2019][1].

- Application of BAT/BEP in domestic legislation;

  The optimisation principle and/or ALARA (As Low As Reasonably Achievable) is one of the major principles in the national legislation and regulations. Compliance with the ALARA principle is considered sufficient to satisfy the requirements of BAT/BEP in terms of the OSPAR Convention. It embodies the fundamental safety principle of the IAEA of "optimization of protection" in terms of policy and strategy, together with continuous improvement. More relevant information can be found in [ANVS 2018][2].

- Dose limit, constraints and discharge limit setting rationale;

  Major principles in the national legislation and regulations are: justification of exposure, optimisation (As Low As Reasonably Achievable, ALARA) and dose limits. The Decree on Basic Safety Standards for Radiation Protection (in Dutch: "Besluit basisveiligheidsnormen stralingsbescherming") of 2018 elaborates on the principle of dose constraints (dosisbeperking) and dose limits. The contribution to the effective dose to a member of the public, as a result of a facility or practice, should not exceed 0,1 mSv per year (10% of the annual limit of 1 mSv). The rationale for this dose limit is illustrated below.

  The effective dose limit for members of the public is 1 mSv per year (1 mSv/y). This limit is cumulative for all sources an individual is exposed to. The assumption is that a member of the public will be exposed to at most 10 sources. Consequently, a location limit of 0,1 mSv/y is set for individual locations. As there are no specific dose constraints for nuclear installations, a nuclear power plant is not allowed to expose members of the public to more than 0,1 mSv/y, due to normal operation. In addition to the effective dose limit, the equivalent dose limit for members of the public is 15 mSv per year for the lens of the eye (15 mSv/y) and the equivalent dose limit is 50 mSv per year (50 mSv/y) for the skin, where the dose is averaged over any area of 1 cm^2, regardless of the area exposed.

  Moreover, measures for controlling radiation risks must ensure that no individual bears an unacceptable risk of harm: this is implemented through dose limitation in legislation and licences, and it is the embodiment of the IAEA safety principle of "limitation of risks to individuals".

  The nuclear installations are licensed to discharge a limited amount of radionuclides. The operator is required to make a proposal for the discharge limits by applying ALARA, using both specific design options and optimised operational procedures, to the satisfaction of the ANVS. The amount of radionuclides that can be discharged by a nuclear installation differs per installation. In case of discharges to surface water, discharge limits may be given per group of nuclides: beta/gamma emitters (excluding tritium), alpha emitters and tritium. In the licences of the research facilities the

[1] CNS 2019 - Convention on Nuclear Safety (CNS), National Report of the Kingdom of the Netherlands for the Eighth Review Meeting, The Netherlands, 2019

[2] ANVS 2018 - Guide for Readers, National Policy for nuclear safety and radiation protection 2018, ANVS, October 2018, Publication no. 115335

discharge limits may be given in Re_{ing}, radiotoxicity equivalent for ingestion. The radiotoxicity equivalent for ingestion is defined as the radioactivity that, if completely ingested at the discharge source, would cause an effective dose of 1 Sv to reference man.

• Regulation, surveillance and monitoring;

The ANVS is the national authority responsible for the supervison of discharges of radionuclides into air and water. The nuclear installations are inspected, on a risk basis, several times per year by the ANVS. In addition, on behalf of the ANVS, the National Institute for Public Health and the Environment (RIVM) regularly checks the measurements of the quantities and composition of the radioactivity of the discharges of the nuclear installations.

Article 58 of the Nuclear Energy Act gives the basis for entrusting designated officials with the task of performing assessment, inspection and enforcement. The Decree on Supervision ('Besluit aanwijzing en taakvervulling toezichthouders Kernenergiewet', in Dutch) and the Nuclear Energy Act identify the bodies that have responsibilities in this regard. Inspections of nuclear installations are planned and results of these inspections are reported by the ANVS. The function of regulatory inspections is:

- to check that the licence holder is acting in compliance with the regulations and conditions set out in the law, the licence, the safety analysis report, the Technical Specifications and any self-imposed requirements;
- to report any violation of the licence conditions and, if necessary, to initiate enforcement action;
- to check that the licence holder is conducting its activities in accordance with its Quality Assessement system;
- to check that the licence holder is conducting its activities in accordance with the best technical means and/or accepted industry standards.

If the ANVS judges there are serious shortcomings in the actual operation of a nuclear installation, the ANVS is empowered under Article 37b of the Nuclear Energy Act to take all measures as deemed necessary. Article 18a of the Nuclear Energy Act empowers the ANVS to compel the licence holder to cooperate in a process of total revision and updating of the licence. This will be necessary if, for instance, the licence has become outdated in the light of numerous technical advances or if new possibilities to even better protect member of the public have become available since the licence was issued.

• Environmental monitoring programmes;

Rijkswaterstaat monitors the activity concentrations of a large number of radionuclides in inland waters and the marine environment. It is the executive agency of the Dutch Ministry of Infrastructure and Water Management, dedicated to promote safety, mobility and the quality of life in the Netherlands. A detailed description of the monitoring programme, its underlying strategy and the results of radioactivity measurements in Dutch waters are reported in [de Jong, 2000][3], [Gilde, 1999][4], [MWTL 2016][5], [RWS webpage 2020][6]. The environmental monitoring program of Rijkswaterstaat consists of measuring water samples, suspended particles, sediment and biota. The frequency of sampling is variable per year per nuclide and per location. Figure 1 shows the sampling locations of Rijkswaterstaat. However, it cannot be expected that the environmental monitoring data can be associated to a unique discharge source, as discharges of both Dutch and foreign nuclear installations lead to an increase of the activity concentrations in the environment.

In addition, the licence holders of nuclear installations are required to set up and maintain an adequate off-site monitoring programme. This programme normally includes measurements of possible contamination of grass and soil, airborne radioactivity and radioactivity in the marine environment in the vicinity of the installation. The results are reported to the ANVS where they are regularly evaluated. The Nuclear Research & Consultancy Group (NRG) is commissioned by licence holders to perform monthly measurements on environmental samples taken in the vicinity

[3] de Jong, 2000 - E.J. de Jong and O.C. Swertz, 2000. Radioactieve stoffen in de zoute wateren. RIKZ, The Hague, Report no. RIKZ/2000.041.

[4] Gilde, 1999 - L.J. Gilde, K.H. Prins, C.A.M. van Helmond, 1999. Monitoring zoete rijkswateren. RIZA Lelystad, Report no. 99.004.

[5] MWTL, 2016 - MWTL Meetplan 2016, Monitoring Waterstaatkundige Toestand des Lands, Milieumeetnet Rijkswateren chemie en biologie, 19 augustus 2015.

[6] RWS webpage, 2020 - Web page: https://www.helpdeskwater.nl/onderwerpen/monitoring/gegevensinwinning/chemisch-fysisch/artikel/ (last accessed 15 April 2020).

of the Borssele nuclear power plant and COVRA, the radioactive waste treatment facility. Samples are taken in order to monitor the compartments of air, water and soil; for a more detailed description of the monitoring programme and underlying strategy see [KEMA, 1994][7]. Radionuclides are for example determined in water, suspended solids, seaweed and sediment. The general characteristics of the monitoring programme for environmental samples collected in the vicinity of the Borssele nuclear power plant is outlined in the table below. In addition, on behalf of the ANVS, the National Institute for Public Health and the Environment (RIVM) checks the measurements performed on the environmental sampling program commissioned by the licence holder of the Borssele Nuclear Power Plant.

Table General characteristics of the relevant part of the monitoring programme for environmental samples taken near the Borssele nuclear power plant

Matrix	**Number of locations**	**Parameter**	**Monitoring frequency (per year)**
Water	4	residual β, ^{3}H	12
Suspended solids	4	gross β	12
Seaweed	4	γ-emitters (1)	12 (2)
Sediment	4	γ-emitters (1)	12 (2)

(1) γ-spectroscopic analysis of specific γ-emitting radionuclides: ^{60}Co, ^{131}I and ^{137}Cs.
(2) Analysis is performed on a combined sample of monthly samples taken from all four or five locations

- Radiation dose assessment methods;

The individual effective dose is, as integral part of the licensing process, assessed on the basis of models that take into account the relevant exposure pathways, for example - where applicable - deposition to surface water from emissions to air, and ingestion, based on yearly consumption, of:

- drinking water,
- seafood (mussels, shrimps) and (sea) fish,
- milk and dairy products,
- meat and meat products,
- vegetables.

For the nuclear power plant, the assessment is carried out for the reference group, which is the (hypothetical) homogeneous group from the population for which the individual dose due to the source is the highest. A group of persons is homogeneous when uniform behaviour parameters are applicable and when the individual exposures within the group are more or less equal, and the behaviour includes all habits of living such as working and eating. When the discharge authorizations are being reassessed, the reference group will be reconsidered. For dose estimates adults are considered, in accordance with the Dutch regulation guidelines. The ANVS-regulation on Basic Safety Standards for Radiation Protection of 2018 stipulates that the radiation dose assessment is to be carried out for the representative person.

- Environmental norms and standards;

Together with a licence application for a nuclear installation, it is compulsory under certain circumstances to conduct an Environmental Impact Assessment or EIA (milieu-effectrapportage, m.e.r.). This is for instance compulsory for all new reactors with a thermal power higher than 1 kW. The Netherlands has a permanent commission, the Commission for the Environmental Assessment (‘Commissie voor de m.e.r.’) that advises the ANVS on the requirements of all EIAs conducted in the Netherlands, including those related to nuclear facilities. The EIA-procedure (chapter 7 of the Environmental Management Act) notably requires that an independent external committee advises on the content of the EIA and offers advice on the environmental report in relation to the memorandum on the scope and level of detail.

- Quality assurance.

The Netherlands relies on IAEA guidance on Quality assurance. This is because it is not cost-effective to develop a specific national programme of Quality assurance rules and guidelines, due to the limited

[7] KEMA, 1994 - Uitgangspunten voor de omgevingsbewakingsprogramma’s van de kerncentrales te Dodewaard en Borssele. KEMA Arnhem, Report no. 40318/40575-NUC 94-5935 (in Dutch)

size of the nuclear industry. For example, the current guide IAEA GS-R-3, "The management system for facilities and activities", has been implemented for the Nuclear power plant Borssele and the radioactive waste treatment facility COVRA. It is anticipated the GS-R-3 will be replaced by another IAEA guide, considering the development of the GSR Part 2 (2017).

The monitoring of all discharges in air and water at Borssele NPP complies with the German regulations 'Sicherheitstechnische Regel des Kerntechnischer Ausschuss (KTA) 1503 and 1504'. These regulations address for example the determination of the detection limits to be attained, and the specification of the nuclide library to be used for analysis.

Section 2: Nuclear Power Plants

- Name of nuclear facility
  Borssele nuclear power plant.
  The common name of the installation is "Kernenergiecentrale Borssele (KCB)".
- Location of nuclear power plant(s)
  The nuclear reactor is located at Borssele in the Province Zeeland (see Figure 2).
  Coordinates 51.4311° N, 3.7175° E
- Year for commissioning/licensing/decommissioning
  The reactor was commissioned and licensed in 1973.
- Receiving waters and catchment area
  The cooling-water is received from the estuary of the Scheldt river, which flows into the North Sea. The North Sea is also the catchment area of the reactor, as the liquid discharges are discharged directly into the estuary of the Scheldt river.
- Other voluntary relevant information that does not tend to change.
  The NPP is a two-loop PWR, Siemens/KWU design. It has a steady thermal power capacity of 1366 MW(th) and an electrical power capacity of 485 MW(e). It started with an electrical power of 450 MW(e) and reached a net electrical output of about 485 MW(e) by means of a turbine upgrade in 2006. It generates approximately 4% of the electricity demand of the Netherlands.

Section 3: Reprocessing facilities

There are no reprocessing facilities in the Netherlands

- ~~Name of reprocessing facility~~
- ~~Location of reprocessing facility~~
- ~~Year for commissioning/licensing/decommissioning~~
- ~~Receiving waters and catchment area~~
- ~~Other voluntary relevant information that does not tend to change.~~

Section 4: Fuel fabrication facilities

- Name of fuel fabrication facility
  URENCO fuel enrichment plant
- Location of fuel fabrication facility
  The fuel enrichment plant is located in Almelo, in the Province Overijssel, see Figure 2.
  Coordinates 52.3354° N, 6.6921° E
- Year for commissioning/licensing/decommissioning
  The first installation was commissioned in 1970, followed by gradual extension with additional production facilities.
- Receiving waters and catchment area
  The installation does not make use of surface water or ground water for cooling purposes. Cooling water systems are of a closed circuit type. Wastewater is treated in the municipal sewage treatment plant.
- ~~Other voluntary relevant information that does not tend to change.~~

Section 5: Radioactive waste treatment facilities

- Name of radioactive waste treatment facility(ies)
  Centrale Organisatie Voor Radioactief Afval (Central Organisation For Radioactive Waste). The common name of the facility is COVRA.
- Location of radioactive waste treatment facility(ies)
  In the South-West of the country, in the municipality of Nieuwdorp, in the province Zeeland, see Figure 2.
  Coordinates: 51.4401° N, 3.7134° E
- Year for commissioning/licensing/decommissioning
  The waste treatment plant was commissioned and licensed for the location in Nieuwdorp in 1989.

- Receiving waters and catchment area
  COVRA does not use any cooling water. The liquid discharges are discharged directly into the estuary of the Scheldt river, which flows into the North Sea.
- Other voluntary relevant information that does not tend to change
  COVRA also stores solid waste, e.g. from NPP Borssele, in the High level waste Treatment and Storage Building (Hoogradioactief Afval Behandelings- en Opslag Gebouw, HABOG), which opened in 2003.

Section 6: Research reactors

- Name of research reactor
  HFR ("High Flux Reactor") in Petten
- Location of research reactor
  The reactor is located in Petten in the province North-Holland, see Figure 2.
  Coordinates 52.7839° N, 4.6740° E
- Year for commissioning/licensing/decommissioning
  The research reactor was commissioned and licensed in 1961.
- Receiving waters and catchment area
  The North Sea functions as receiving water for and catchment area of the facility.
- Other voluntary relevant information that does not tend to change.
  The reactor type is a tank in pool reactor, with an installed capacity of 45 MW(th). The HFR is used not only as a neutron source for applied and scientific research, but also for the production of isotopes for medical and industrial applications. Waste water is collected and treated in a specially designed waste water treatment building. Direct connections exist from the HFR to this building.

- Name of research reactor
  The common name of the research reactor in Delft is the HOR: "Hoger Onderwijs Reactor", owned by the Interfaculty Reactor Institute, Delft University of Technology.
- Location of research reactor
  The reactor is located in Delft, in the province Zuid-Holland, see Figure 2.
  Coordinates 51.9905° N, 4.3806° E
- Year for commissioning/licensing/decommissioning
  The research reactor was commissioned and licensed in 1963.
- Receiving waters and catchment area
  Liquid waste is discharged into the municipal sewage system and treated in the sewage treatment plant of the city Den Haag. Radionuclides, which pass the sewage treatment plant, proceed to the North Sea.
- Other voluntary relevant information that does not tend to change.
  The installed capacity for the HOR is 2,3 MW(th). The HOR is an open pool-type research reactor, using MTR-fuel (material testing reactor) assemblies and low-enriched Uranium-235 (< 20%) as fuel. The core is composed of 20 fuel assemblies and 4 control assemblies. It is equipped at three sides with a row of Be-reflector assemblies acting as neutron reflectors. The reactor provides neutron radiation to a variety of facilities for radioisotope production and neutron activation analysis.

Section 7: Decommissioning activities

There are currently no decommissioning activities of nuclear installations in the Netherlands. For completeness, the following text addresses an installation in 'Safe Enclosure' and the completed decommissioning of a nuclear reactor.

In Dodewaard, near Arnhem, in the province of Gelderland, see Figure 2 (coordinates 51.89972°N, 5.68611°E), a small prototype reactor was put into operation in 1968 and shut down on 26 March 1997. It was a General Electric (Mark I) Boiling Water Reactor with a steady thermal power capacity of 183 MW(th), and 60 MW(e). In April 2003, all the spent fuel had been removed from the site and has been shipped to Sellafield for reprocessing, and, in 2009, all vitrified waste from reprocessing was shipped to the radioactive waste treatment facility COVRA.
The Dodewaard plant is in so-called 'Safe enclosure', has discharged no radionuclides to water since July 2005, and liquid emissions of radioactive material are not permitted. In 2005 the owner of this NPP was granted a licence for a 'Safe enclosure' state for a period of 40 years, after which final dismantling shall commence. Decommissioning is planned for 2045.
The licence for 'Safe enclosure' of the NPP Dodewaard requires its operator to appoint a radiological expert for this period, who is responsible for all radiation protection issues.
These responsibilities include:

- to assess the results of routine monitoring procedures on locations where external radiation levels and/or contamination levels are likely to be encountered.

• to be immediately available for any information request regarding radiation protection by the ANVS.
• to take appropriate action in case of unplanned events.
• to ensure that radiation monitoring equipment is well maintained or replaced in case of dysfunction.
• to ensure that radioactive waste is managed in accordance with relevant safety Standards [Predisposal Management of Radioactive Waste, IAEA Safety Standards Series No. GSR Part 5, IAEA, Vienna (2009)] and is transferred at regular intervals to COVRA.
• to report periodically to the ANVS on radiation protection matters and general site conditions.

The Low Flux Reactor in Petten in the province of North-Holland, see Figure 2, (coordinates 52.7839° N, 4.6740° E) was an argonaut low flux reactor with 30 kW(th), which is no longer in use; it stopped operations in December 2010, and has been decommissioned. The spent fuel has been removed in 2012 and has been transferred to the Waste Treatment Management Facility COVRA in December 2013. The consumption of fuel in the LFR in Petten was very low; the original fuel elements were still in use till the permanent shut-down of the reactor in 2010. Its decommissioning was completed in 2018 and the decommissioning licence was revoked in the beginning of 2019.

FIGURES

Fig. 1 Map showing the sampling locations of Rijkswaterstaat

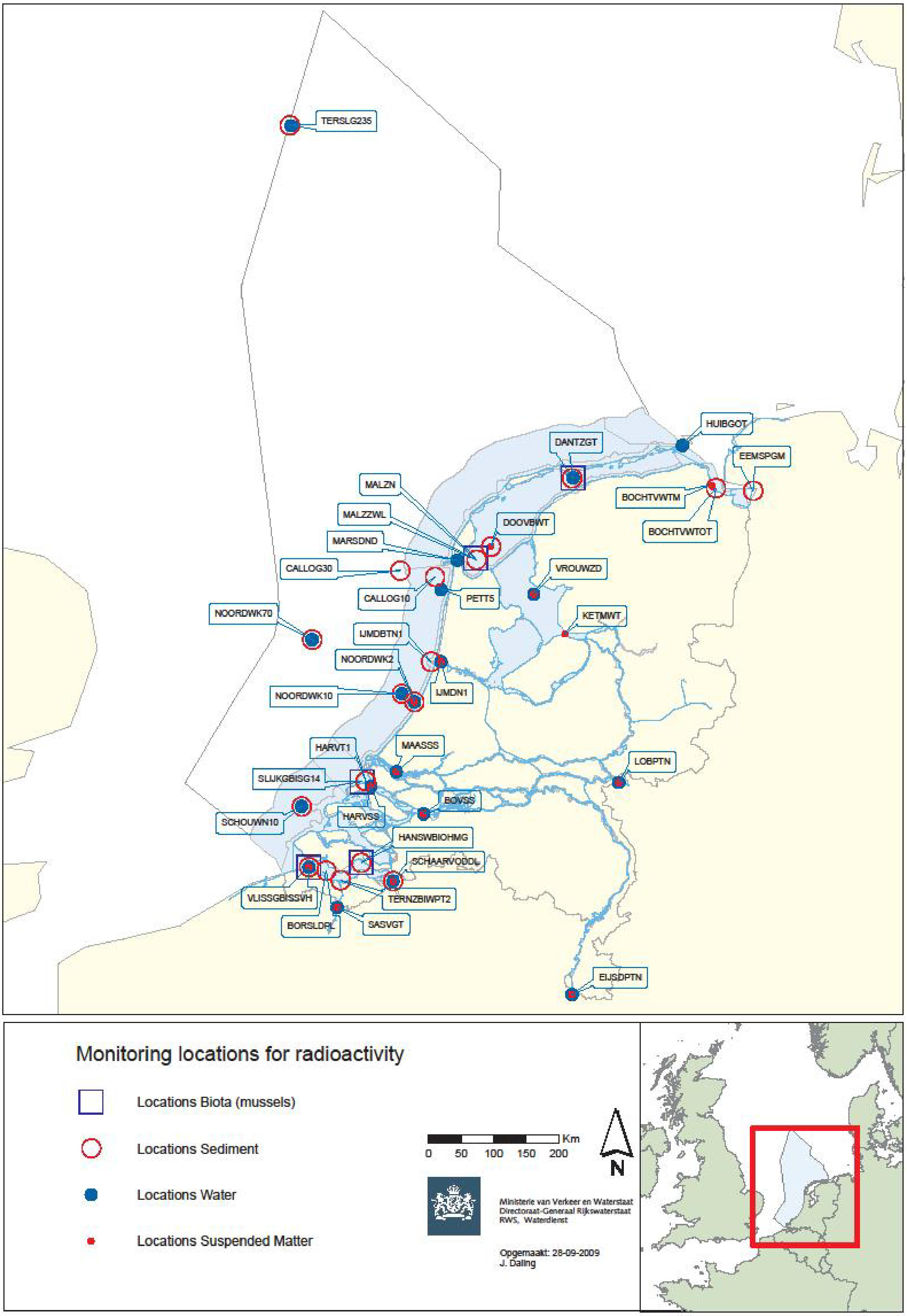

Fig. 2 Maps showing the location of nuclear installations in the Netherlands