
Authority for Nuclear Safety and
Radiation Protection

# TPR II – Country Review Workshops: Fire Protection

National Presentation of The Netherlands

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ANVS (Dutch Regulatory Body)

# Outline

1. List of candidate installations and their regulation
2. NPP Borssele
3. RR HFR (Petten) & RR HOR (TUDelft)
4. Fuel Cycle Facilities – Urenco NL
5. Dedicated Fuel Storage Facility – COVRA

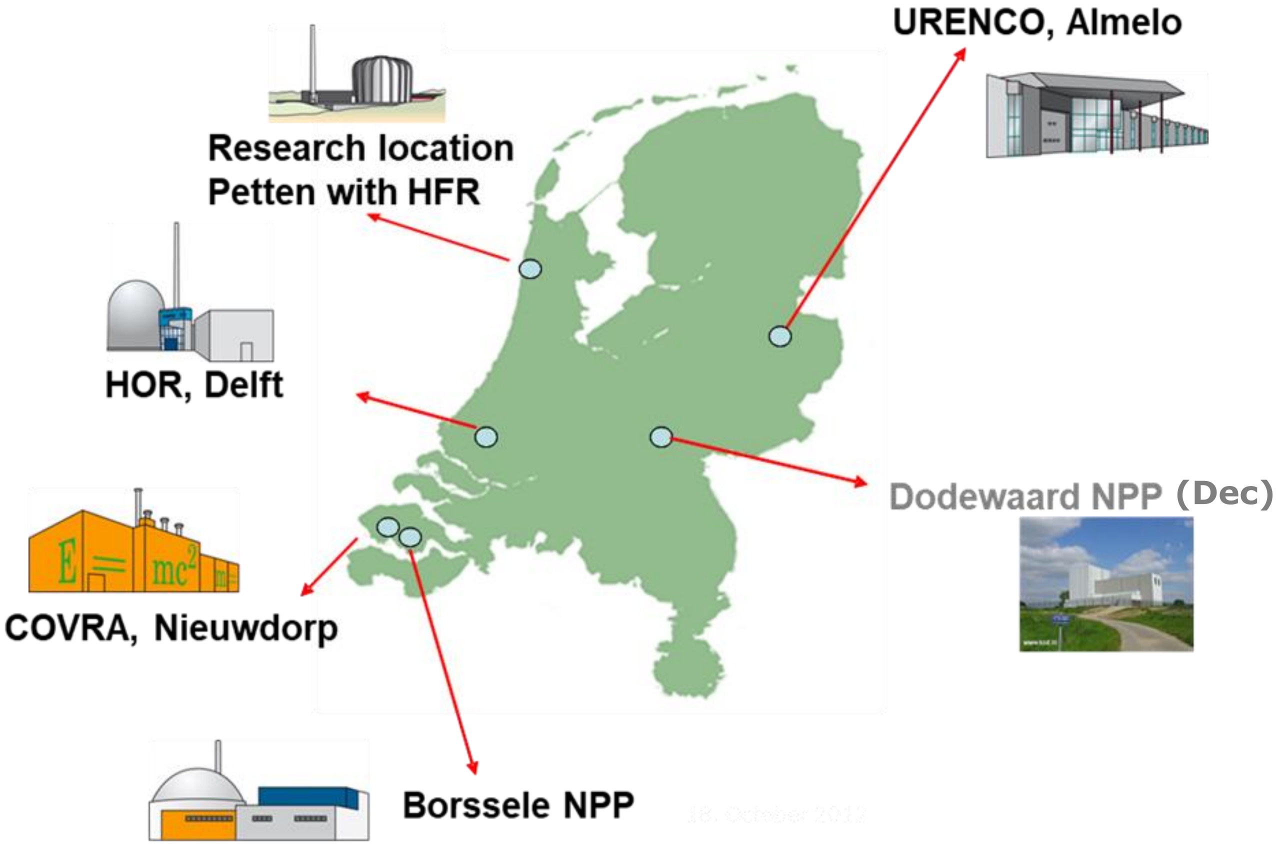
# Sources for this presentation

- National Assessment Report
- Questions and Answer round
- Site visits to HOR
- ENSREG Draft Country report
- Discussions during Technical Workshop in September
- Template shared by ENSREG

# 1. List of installations and their regulation

# 1.1 Geographical distribution of installations

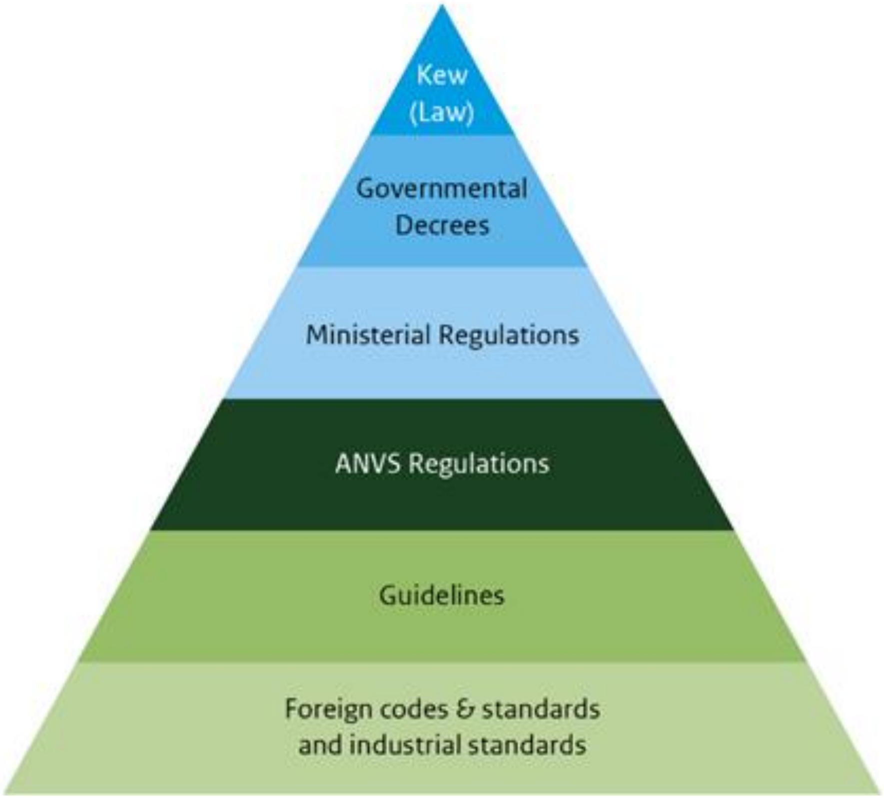
**Installations out of the scope:**
- NPP Dodewaard (BWR, 58 MW) – Decommissioned, no nuclear material remaining inside
- RR PALLAS (Petten) – No Construction Licence by 2022



# 1.2 Dutch Nuclear Legal framework

Legally binding

Not binding




The Nuclear Energy Act (Kew) is the most prominent law.

Governmental Decrees contain additional regulation.

Ministerial Regulations contain additional regulation.

ANVS Regulations give additional rules for certain topics.

Guidelines are safety requirements that are not binding unless referenced in the licence of a nuclear installation.

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

# Additional non- nuclear fire related framework

- Safety Regions Act (Wet Veiligheidsregio’s) + Decree Safety Regions (Besluit veiligheidsregio’s)
  → 25 Safety Regions
- Working Conditions Act (Arbeidsomstandighedenwet)
- Building Decree 2012 (Bouwbesluit 2012)
- Major Accident Hazards Decree 2015 ( Besluit risico's zware ongevallen, Brzo/ EU Directive Seveso-III)

# Additional nuclear guidelines

- ANVS Guide on Level 3 PSA; and approach for the use of a risk analysis/ PSA in Nuclear Installations (web)
- Dutch Safety Requirements (DSR-Handbook for a safe design and safe operation of nuclear reactors), part of ‘Handreiking VOBK’ (web)

# Implementation of WENRA SRLs & IAEA SS

The Netherlands has a non-prescriptive, goal-orientated legal framework, meaning that nuclear installations have to demonstrate that they achieve the legally required safety standards. For this demonstration of compliance with the national legal framework, nuclear codes and standards of other countries are often used.

A long-standing practice has been to apply IAEA Safety Standards in the regulation of nuclear installations. It started at the NPP and gradually extended to other installations. The IAEA Safety Standards are applied in conjunction with the WENRA Safety Reference Levels in several ways:

- Current practice is to make IAEA Requirements <u>legally binding through licence conditions</u> of nuclear installations. Where needed they are <u>adjusted or complemented by WENRA SRLs to ensure the WENRA SRLs are covered</u>. IAEA Safety Guides are generally handled as guidance.
- IAEA Safety Standards and WENRA SRLs are used as reference documents for the evaluation of new licence applications and periodic safety reviews.
- WIDOCS: ANVS' programme where the IAEA and WENRA documents will be systematically considered and allocated, depending on the installation and the potential overlaps with the existing legal framework, as requirement in the individual licenses, or as guidelines for the regulatory oversight.

# Sources for audits and inspections

- Planned inspections by the Safety Regions fire brigades
- Planned inspections by ANVS with the support from the TSO
- Inspections/ audits by Insurance company
- International missions (WANO/ IAEA)
- International experience: OECD NEA Fire database, FINAS, etc
- Update of Fire Risk Analysis report every 2 years
- 10 EVAs (10 year evaluation)

# 1.3 Example of Fire Safety requirements in license

1. The licensee must comply with NS-G-2.1, IAEA Safety Guide Safety Standard Series No. NS-G-2.1, Fire Safety in the operation of NPPs.

2. The provisions from NS-G-1.7, IAEA Safety Guide Safety Standard Series No. NS-G-1.7, Protection Against Internal Fires and Explosions in the Design of NPPs must be met, unless it is justified why this cannot reasonably be expected.

3. The licensee must have a fire risk analysis report in which the fire risks of the nuclear power plant are analyzed and a fire safety strategy document in which the strategy with regard to fire safety is described.

4. <u>The fire risk analysis report must be updated at least once every two years</u> and the fire safety strategy document must be updated every year. A fundamental evaluation and updating of both documents should take place every ten years.

5. Changes to the documents referred above must be submitted to the ANVS for information.

6. The site must be laid out in such a way, and the accessibility must be monitored in such a way, that <u>the facility can be reached from at least two directions at all times</u>, except in force majeure situations.

7. The fire alarm installation must be provided with a <u>valid inspection certificate</u> issued on the basis of the CCV Inspection Schedule for Fire Alarm Installations.

8. The permanently installed fire extinguishing systems must be provided with a valid inspection certificate issued on the basis of the CCV inspection scheme Permanently installed Fire Management and Fire Extinguishing Systems (VBB). This certification obligation does not apply to existing installations for which the licensee can demonstrate that certification is impossible or disproportionately expensive.

# Example of Fire Safety requirements in license (cont.)

9. The documents referred to in provision 1, or the implementation documents supporting them, must, at least, describe the following:

- the identification of the hazards: choice of scenario based on a thorough identification of the hazards and associated risk analysis;
- the control/combat tactics for the normative incident scenarios, including a motivation for the chosen tactics and a chronological overview of the measures for control of the normative scenarios;
- the way in which damage from incidents is kept to a minimum, incidents are managed and the measures taken for this purpose;
- the detection of incidents (method, type, availability, reliability, speed of detection, including motivation for the chosen detection method);
- the alarm methods;
- a technical description of the facilities present and resources to be used (stationary extinguishing facilities, availability, inspection/maintenance, reliability, capacity, protection against freezing and irradiation, and collection of any contaminated extinguishing water), including a motivation for the resources chosen;
- a description of the organization for the distinct phases in the management of incidents; - the management of the organization, safeguarding knowledge and skills (practice cycle, process and material knowledge);
- a system description: Plan, Do, Check, Act cycle for the facility (related to emergency management and facilities) and - clear drawings/graphic representations of repressive facilities, road plan.

# 2. NPP Borssele

# NPP Borssele

- PWR: 512 MWe
- Begin of operations: 1973
- License until: 2033
- LTO under consideration
- On the shore of the Westerschelde estuary, main shipping lanes into and out Antwerpen and Ghent
- An oil refinery is located at 4 km.
- COVRA radioactive waste storage located at 1 km.
- Site surrounded by several small and large companies in a radius of a couple of kilometers.
- 8 km to the town of Middelburg, 10 km to the city of Vlissingen and 2 to 4 km to villages Borssele, ‘s-Heerenhoek and Nieuwdorp.

# 2.1 NPP Fire Safety Analysis (FSA): DSA and PSA

**Objective:**

To verify that all the safety systems required to fulfil the three Fundamental Safety Functions are protected before, during and after a fire. This is achieved by the application of the ‘Defence in Depth’ concept, incorporating three main objectives:

(1) To prevent fires from starting (e.g. by control of ignition sources and minimization of combustible material);

(2) To detect and extinguish quickly those fires that do start, thus limiting the damage;

(3) To prevent the spread of those fires that have not been extinguished, thus minimizing their effect on items important to safety.

**Scope:**

FSA covers the nuclear safety systems important for the fulfillment of the three Fundamental Safety Functions. Non-safety systems with a great fire load are also considered in the deterministic fire safety analyses (IAEA NS-G-1.7).

The Fire Hazards Analyses covers all operational states of the KCB: Normal operation, Start-up, Hot stand-by, Hot-subcritical, Cold stand-by, Cold-subcritical, Outage (fuel reshuffling) and Storage in the Spent Fuel Pool.

# Assumptions for DSA (FHA) and PSA

- The scenarios analyzed in the FHA postulate that only one fire at a time will occur.
- For every safety system important to fulfil the Fundamental Safety Functions, it is assumed that a fire will threaten one redundancy.
- The combinations of hazards are dealt with assuming the conservative case (e.g. all non-explosion-resistant buildings are assumed to be completely lost after external explosion, external flooding assumes loss of external grid, etcetera)
- Fire safety scenarios are also combined with external events such as earthquake (design earthquake) and external flooding ( external flooding (7,30 m + NAP) ).
- Fire detection and extinguishing systems are seismic qualified and are available for coping with a fire caused by the earthquake in one of the affected safety systems.
- The PSA does not have an extensive Seismic– PSA. EPZ decided to do a Seismic Margin Assessment (SMA), where consideration was given to fires resulting from a seismic event.

# Results of FHA: Most penalizing scenarios

- The main conclusion of the current FHA-report is that the Borssele NPP is sufficiently protected against fire. That means that every relevant safety function is protected against fire.
- The dominant scenario for the FHA is a fire in the cable spreading room, since it has the greatest fire load. This room contains mainly power cables (6 kV) for supplying motors of safety equipment.
- PSA: The contribution of fires to the overall core damage frequency is 41%.
- The contributions of fires to the level 3 PSA results are: 15% for group risk and 34% for individual risk.

| Event | Clarification |
| --- | --- |
| **Fire in cable room at power** | This room contains cables of components important to safety. |
| **Fire in RPS compartment at power or Cold shutdown** | This room contains redundancy of the RPS.<br><br>Fire will cause RESA. |
| **Fire in specific rooms at Cold shutdown** | Fire induced actuation of RPS signals is assumed possible. |

# 2.2 NPP Fire detection

The fire detection system of the plant is used for timely warning of fire and/or smoke in the plant and initiating actions like:

- closing fire dampers, closing fire doors,
- switch off ventilation,
- starting the heat and smoke removal system in the roof of the turbine building and,
- starting of automatic extinguishing systems (water mist and gaseous).

To assure that the fire will be detected as soon as possible, the detectors are set to the kind of fire to be detected, and designed according the environmental conditions they would withstand

In addition, the fire detectors are divided into different groups per compartment. In this way, a fire in a particular compartment will not affect the detectors in the redundant compartment.

# 2.2 NPP Fire Detection

- A great number of manually activated fire alarm switches have been installed all over the plant buildings. When triggered, they (automatic detectors and manual activators) give an alarm in the control room. Based on this alarm, the control room operator will take measures such as directing the fire brigade to the affected room or call for the off-site fire brigade, if deemed necessary. The alarm consists of two levels: an early warning and an actual alarm.
- Approximately 2.000 automatic detectors are present in the plant buildings. Most detectors are of the optical/thermal type.
- The detection system is certified according to the Dutch standard NEN 2535:2009+C1:2010.
- In the reactor building (crane and cooling equipment), annulus building (radioactive solid waste system), turbine building and electric building (marshalling room), smoke aspiration systems have been installed.
- In the charcoal filters of the nuclear ventilation system, temperature detectors have been installed.
- In the turbine building, flame detectors are also present.

# 2.3 NPP Fire suppression

- Design of systems accounts for:
  - the size of the fire to be suppressed and
  - the sort of fire load (oil, cables, electric equipment, etc.).
- Electric and electronic systems have a gaseous suppression system (Inergen).
- For cable fires and oil fires, water mists, fine water spray or micro drops, are the most suitable suppression method.
- In the rooms with the oil systems of the main coolant pumps, $CO_2$ gaseous extinguishing systems used.
- Automatic extinguishing systems are used in rooms with nuclear safety equipment, and in rooms with no safety systems but with a potential for high fire loads.
- In other places, manual extinguishing equipment is always available. The rooms with an automatic extinguishing system are also equipped with manual extinguishing systems.
- Secondary hazards of activation or breakage of fire suppression systems have been considered as well. For example, certain areas in the water network can be isolated by means of valves.

# 2.4 Compartmentation

- The containment approach is the preferred option, for redundant divisions of systems (minimum requirement: F60). In practice (as built) the resistance is higher. Fire doors have a real resistance of at least 90 minutes. The same for fire dampers in ventilation systems.

- Otherwise, redundacies should be at least in different fire cells (influence approach).  A fire cell has a lower fire resistance than F60. In this case, extra fire measures are required ((automatic) extinguishing equipment, detection, etc.).

- A fire cell can consist of a wall or door etc. with a lower resistance than 60 minutes, of a greater distance between the redundancies, of cable coating or of special screens.

- The condition of the fire barrier walls, fire doors and cable and pipes fire resistant penetrations of all fire compartments are annually visually inspected by an external, independent supplier specialized in fire prevention.

**Examples:**

- The fire doors between the compartments of the emergency diesel generators in the building where they are located have a resistance of 180 minutes.

- Redundant fire extinguishing and detection systems and supporting equipment such as ventilation, drainage and smoke extraction are mutually independent.

- Redundant cables in the same compartment (influence approach) that are at a distance of 1.5 m or less, are separated from each other by means of a fire-resistant coating. Cable penetrations through walls are of the type Bratberg.

# 2.5 NPP Ventilation management

- To prevent spreading of smoke from the affected room to another compartment through the ventilation ducts, the isolation between fire compartments is made by automatic operating fire dampers with a fire resistance of at least 60 minutes.

- The dampers are built in the ventilation ducts, directly on the compartmentation walls. In situations where this configuration is not possible the ventilation ducts are cladded with fire resistant material between the fire damper and the wall.

- In case of a fire in staircases, smoke can be removed by the ventilation systems to prevent enough visual sight for members of the fire brigade to reach the affected room.

- In the roof of the turbine building, a heat and smoke removal system is installed. This system consists of 12 ventilation hatches, actuated by the fire detection system. Furthermore, each hatch can be opened by a thermal activated device (temperature is 72 $^0$C).

- The purpose of this ventilation system is to protect the roof construction against collapsing by heat, and to guarantee access for the members of the fire brigade to reach the fire.

# 2.6 NPP KCB Conclusions - Strengths

- Through license conditions, the FHA is required to be developed based on the IAEA guidelines, while the (living) PSA follows the USA-NRC guidelines for Fire PSA as well. ( IAEA NS-G-1.7; IAEA SRS No. 8; IAEA SS 50-P-9)
- The FHA must be updated every 2 years and sent to the regulator.
- KCB internal fire brigade is involved in approving work permits.
- The KCB has developed procedures for the maintenance and improvement of all fire protection related aspects, covering from design modifications, to organization, and the certification of systems.
- The most important measures that are based on the FHA and have been implemented in 2003 and 2013 are:
    - (2003) Exchange of many fire dampers in the plant; Replacing fire doors; Replacing the Halon systems by Inergen gaseous extinguishing systems;
    - (2013) Smoke and heat removal system in the roof of the turbine building; Extinguishing systems for coal filters of the nuclear ventilation system; Making the high- pressure extinguishing system earthquake resistant; Purchasing of diverse mobile systems.

# 2.6 NPP Conclusions - Weaknesses

- Given the operational lifetime of the KCB, not all the systems can be easily modified to accommodate the findings from the Fire Safety Analysis, inspections, lessons learned or the newest standards.
- Certification of already installed systems can be difficult or impossible.
- The fire detection alarms are not simulated in the control room simulator.

# 2.7 NPP Conclusions – Lessons learned

- Recommended to consider the potential HEAF (High Energy Arcing Fault) events in the FHA and PSA, in particular for electrical rooms with medium of high voltage electrical cabinets. This activity is ongoing at the time of this NAR.
- The communication equipment of the fire brigade has been renewed to improve the communication in the plant, especially in the controlled area.
- An IAEA OSART mission in 2023 recognized a good performance in the Fire prevention and protection program: All rooms of the plant have been assessed for fire loading and baselined accordingly.

# 3. Research Reactors HFR and HOR

Note: Not everything applicable to both reactors

# RR HFR

- 45 MW
- Begin of op: 1961
- Located on a site by the sea in the North
- Holland dunes
- Organisations on site:
  - GCO-IE (the Institute for Energy of the JRC),
  - the R&D organisation TNO,
  - Curium Pharma producing medical isotopes and the
  - Foundation Preparation PALLAS reactor
  - Hot Cell laboratories (HCL), R&D labs

# RR HOR – TU Delft
## (Site visits location)

- 2- 3 MW
- Begin of op: 1969 (lic)
- Located on university campus next to the city of Delft

# 3.1 RR Fire Safety Analysis (FSA): DSA and PSA

**Objectives:**

To establish, verify and document the qualitative identification of safety systems and the (fire) hazards against which they should be protected. The objectives of the fire analysis are as follows:

- Identification of deficiencies concerning the fire protection design requirements;
- Identification of internal fire scenarios that could lead to any of the plant damage states (including core damage) that are considered in the PSA;
- Calculation of the contributions of the internal fire scenarios to the total frequencies of these plant damage states.

**Scope:**

The approach to the development of the Fire Safety Analysis is a combination of deterministic and probabilistic assessments. The PSA covers PSA level 1, PSA level 2 and PSA level 3.

This Fire Safety Analysis is performed for all the plant operating states as considered for the full-scope PSA (full power and shutdown). This full-scope HFR-PSA includes the assessments of the Spent Fuel Pool, experiments and production facilities, and considers internal events, internal hazards and external hazards, as well as combination of hazards.

# FSA: Modelling assumptions

Some of the adopted conservative assumptions are listed below **:**

- Upon ignition of a fire in a fire cell, it is assumed that this space is not accessible and therefore all local operator recovery actions to be performed from this location are unavailable;
- Upon ignition of a fire in a fire cell, the reactor shall be shut down either automatically or, eventually, manually. In case of failure of both, core damage and experiment damage are assumed;
- (HFR) Following a successful reactor shutdown, the removal of decay heat shall be ensured by the proper functioning of a decay heat removal system and its back-up systems. If all these systems fail, core damage and experiment damage are assumed (eventually);
- In case a fire is neither automatically nor manually (and timely) detected, it is assumed that the fire will spread to the adjacent cell;
- In case a fire is not timely suppressed, it is assumed that the fire will spread to the adjacent cell; otherwise, the fire is assumed to be contained within the fire cell in which it ignited.

# 3.2 Fire detection

- Is used for timely warning of fire and/or smoke in the plant and initiating actions. Equipped with both automatic and manual alarms that signal to the company's central alarm station.
- If a detectors or alarm is activated, the signals will be relayed to the reactor control room, the security lodge and the QRT. Every employee is allowed and able to initiate a fire alarm.
- When a signal is triggered, a number of doors in the reactor auxiliary building will automatically close, even though they can still be used.
- If necessary, in addition to automated actions, manual actions are taken aimed at a controlled shut-down of the reactor.
- The fire detectors are fed by an emergency power supply.
- Full fire surveillance is used in accordance with NEN 2535. Full monitoring is applied to buildings where fissile and radioactive materials are handled: manual call points and automatic detectors.
- The cabling (from the alarms) is installed where necessary to maintain its function for at least 30 minutes in case of fire complying with NEN NPR 2576.

# 3.3 Fire suppression

- Fixed manually operated firefighting system is available; no automatic firefighting system is used.
- The fixed firefighting system consist of fire hoses and plugs that are supplied by a low- and high-pressure system.
- Adjustments were made over the years, in consultation with the company fire brigade, to ensure that reels are available at all relevant locations.
- This system supplies the hydrants outside the buildings and hoses inside the buildings of the plant. A high-pressure water extinguishing system is available as well.
- All buildings are equipped with portable fire extinguishers tailored to the fire classes relevant to the building. These extinguishers can be used to fight small (starting) fires. In most cases these are filled with $CO_2$.

# 3.4 RR Compartmentation

- The HFR reactor building (RB) consists of five fire compartments, subdivided in fire cells.
- The HOR reactor hall is one fire compartment. The Control room is in separate compartment.
- The fire cells are screened on several aspects, like type of components, location of safe shutdown equipment, plant trip initiators, fire load inventory, ignition sources, propagation potential, etc

# 3.5 RR Ventilation management

**HFR:**

- In the ventilation systems (nuclear as well as conventional), the isolation between fire compartments is made by fire dampers with a fire resistance of at least 60 minutes. These dampers are built in the ventilation ducts directly on the compartmentation walls. In situations where this configuration is not possible, the ventilation ducts are cladded with fire resistant material between the fire damper and the wall.

- In case smoke is moving into the direction of the control room, the smoke will be detected in the inlet and the control room ventilation system will switch to recirculation mode (with an emergency filter installation).

**HOR:**

- The ventilation system forms a part of the reactor containment system. The reactor containment system is gas-tight and is usually in open, filtered connection with the environment, via the intake and outlet of the ventilation system.

- The ventilation system has two isolation valves (no separate fire-dampers are installed) in series in the inlet duct and two isolation valves in series in the outlet duct.

- These are controlled valves with an electrically fail-safe configuration which provide gas-tight isolation. If the settings of process variables (such as off-gas activity) are exceeded, the connection with the environment and containment penetrations are closed by means of isolation valves.

# 3.6 RR Conclusions - Strengths

- For most scenarios, the low power of the reactor(s) allows it to remove the decay heat after a SCRAM by natural circulation of water in the reactor pool. In this sense, the reactor(s) does not rely on any system that may be affected by fires to ensure heat removal (e.g. electric systems).
- The development of a full scope PSA (levels 1, 2 and 3), accounting for internal and external hazards, including fires. The contribution of the fire scenarios to the TCDF is very low.
- Fire safety is regularly subject to both internal and external inspections, nuclear risk evaluation, generic fire safety measures, external auditing from insurers.
- For experimental assemblies, no specific extinguisher equipment would be needed, the design of is within the scope of the present provisions installed in the fire compartments/cells.

# RR Conclusions – Weaknesses

- Reactors not fully divided in fire compartments (even though a sufficient safety level is achieved)

# 3.6 RR Conclusions – Lessons learned

- Improved fire separation (done): Replacement of non-fire-retardant signal cables to the reactor protection system (interlock) by fire retardant ones; installation of a fire door between the two cooling water pumps.
- Removal, replacement and minimization of fire loads (e.g. furniture in reactor halls; isolation panels).

## From ENSREG Site Visits (HOR):

- Well-structured programme in place to promote and strengthen safety culture.
- Conducted full level 1, 2, and 3 PSA, including a FHA, is unique for a research reactor.
- Some possible improvements in fire detection in ventilation systems and organisational arrangements.

# 4.Fuel Cycle Facility - UNL

# FCF Urenco Nl

- In operation since early ‘70s
- Expansions in ‘80s en ’00s
- Surrounded by a business park
- City of Almelo > 1 km

# 4.1 FCF Fire Safety Analysis (FSA): DSA and PSA

## Objective:

To ensure the achievement of the main safety functions ‘Confinement to protect against internal exposure and chemical hazards , ‘Prevention of criticality’ and ‘Protection against external exposure’ by protecting the integrity of the safety relevant SSCs (from fires) through:

- The prevention of fires and/or incidents resulting in fire;
- Controlling incidents that nevertheless occur;
- The prevention of casualties due to fire and fire symptoms, like smouldering or smoke.

## Scope:

Related to the identified main hazards:

- The potential release of UF6;
- A criticallity hazard
- External exposure is a concern in the handling of recently emptied cylinders

A level 3 Probabilistic Safety Assessment is performed, in accordance with the ANVS Guide for Level-3 PSA

# Scenarios - Fire-related PIEs

- Internal fires or explosions
- Ignition of accumulated hydrogen
- External explosions
- Aircraft crashes
- External fires
- Accidents on transport routes

The assessment framework for the Fire Hazard Analysis (FHA) is a combination of several IAEA and national guidelines and documents.

IAEA Safety Reports Series No. 8, 'Preparation of Fire Hazard Analyses for Nuclear Power Plants', the Graded Approach of IAEA SSG-25 'Periodic Safety Review for Nuclear Power Plants' and the guideline 'Model Integrale Brandveiligheid Bouwwerken' (i.e. 'Model integral fire safety of buildings') based on the 'Bouwbesluit 2012', together with IAEA SSG-5 Rev.1: 'Safety of Conversion Facilities and Uranium Enrichment Facilities'

# 4.2 Compartmentation

- Fire compartments and fire cells are assessed based on several criteria in the FHA
- All building are constructed with fire resistant material (fire barrier) and equipped with fire detection systems.
- In all rooms, a minimum of combustible materials and ignition sources are maintained.
- A maximum fire compartment size of 1,000 m2 applies to areas with offices and the Control Room, since more fire load is present in these areas.
- Fire barriers are part of UNL's maintenance program and are inspected periodically.
- There is no scenario where an entire fire compartment could burn down, taking into account the development of fire under unfavourable conditions.

# 4.3 Ventilation

- All penetrations of the ventilation systems through fire-resistant compartments are provided with automatically operating fire valves. The fire valves have at least the same fire-resistant capacity as the fire compartment.
- In case of fire, fire valves in the ventilation systems are automatically closed so that fire compartmentation remains intact. No supplementary provisions are needed.

# 4.4. Conclusions - Strengths

- Fire Hazards Analyses and a (PSA level 3) risk assessment have been developed, accounting for internal hazards and external hazards, including fires.
- The inherent risks are very low: low radioactive inventory and low fire loads in buildings with sufficient fire protection means.
- The installation is subjected to several inspections by national organisations.
- UNL has a rapid intervention at its disposal by the emergency response team.
- Urenco has similar installations in different countries, and these installations are all individually subjected to different national regulations and inspections. Experience and design improvements can be gathered and shared between operators of the various installations.

# 4.4 Conclusions - Weaknesses

- Fires have been accounted for in different reports, mainly those about the Safety Analyses and Fire Hazard Analysis. These are elaborated following different requirements and guidelines. These reports have been developed by different experts, and show no obvious connection, since scenarios differ.
- UNL has several fire stations on site with personal equipment. Occasionally, team members are not provided with their own size.
- Due to the large buildings, most built up in concrete, walky-talky contact can be difficult.

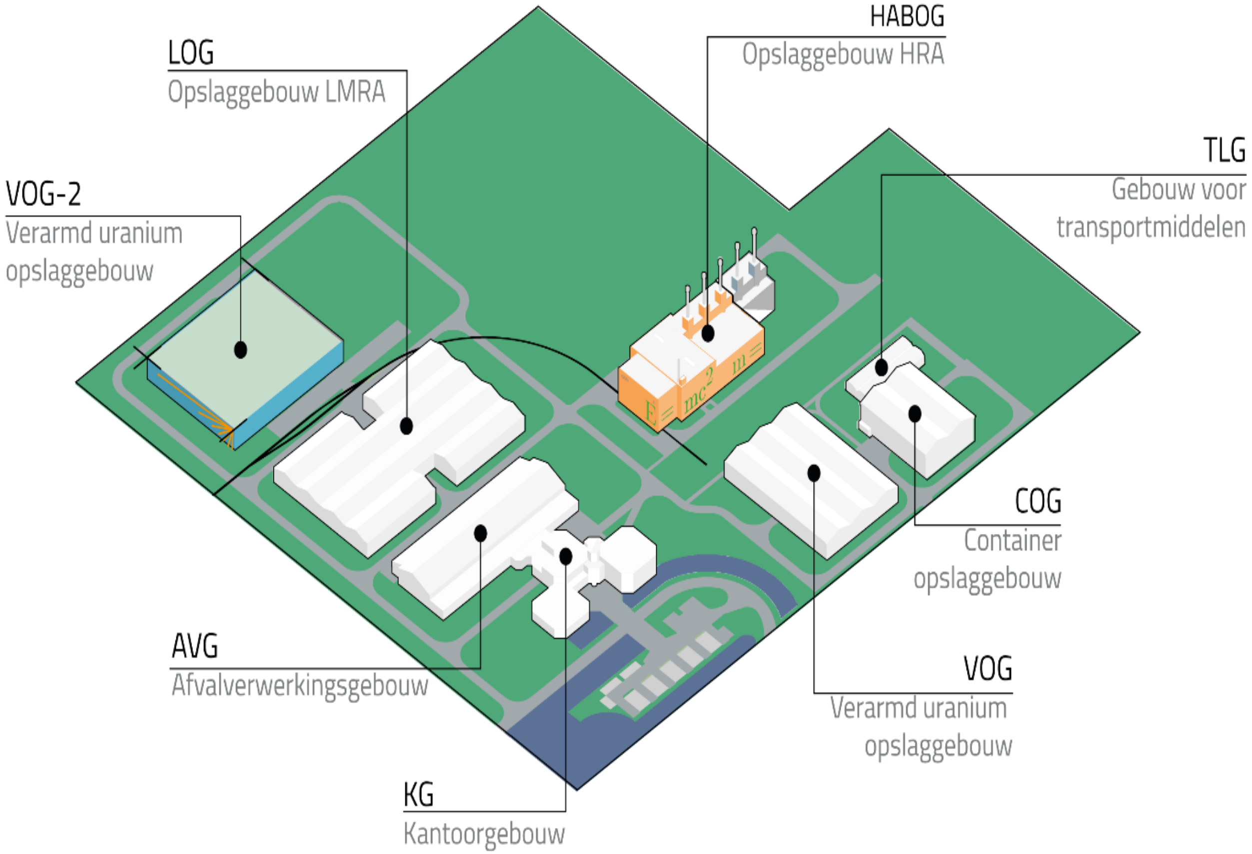
# Conclusions – Lessons Learned

- In the past six years, there have been nine true fire alarms. Seven of these true fire alarms were caused by an electrical hazard and two by human activity.
- UNL is regularly audited by the fire insurance company ‘Atoompool’.
- A quarterly report with external incidents is shared across the organization. External incidents are collected from news websites and nuclear authorities, including the Fuel Incident Notification and Analysis System (FINAS) database.

# 5. Spent Fuel & RW storage – COVRA HABOG

# Spent Fuel & Radioactive Waste Storage

- Aboveground storage
- In operation since 1993
- Designed to last more than 100 years
- Surrounded by several small and large companies in the industrial area (r < 400m)
- NPP Bossele at 1 km



# 5.1 FCF Fire Safety Analysis (FSA): DSA and PSA

**Objective:**

The safety systems shall be protected against the consequences of fires, so that their safety functions are preserved: to stop the operations in a safe way, to remove residual (decay) heat, to contain radioactive material and to ensure radiological protection.

To provide protection against fire risks following the Defence-in-Depth concept:

- to prevent fires from starting, achieved by the quality of the design and safe operations,
- to ensure surveillance, quickly detecting fires and enable fire-fighting,
- to minimize the consequences in case a fire does start, by preventing the spread of those fires.

**Methodology according to IAEA and WENRA:**


- IAEA Safety Standards: General Safety Requirement, GSR-part 4, Safety Assessment for facilities and activities. Vienna, 2009.
- WENRA Waste and spent fuel storage safety reference levels report, version 2.1, WENRA Working Group on Waste and Decommissioning (WGWD), Stockholm, February 2011
- IAEA Safety Standards: draft safety standard series No DS284, The Safety Case and Safety Assessment for Predisposal Management of Radioactive Waste, Vienna, 2011.
- IAEA Safety Standards: Specific Safety Guide, SSG-2, Deterministic Safety Analysis for Nuclear Power Plants, Vienna, 2009.

# 5.1 Main Scenarios

Various scenarios have been studied.

- For example, two scenarios have been considered regarding the gas explosion safety of the HABOG: The first scenario assumes the explosion of an external gas cloud of which the blast wave enters the storage room via the ventilation inlet. The second scenario considers the case in which a flammable mixture enters the storage room via the ventilation system. The results has been used to design the floor of the room as well as the equipment inside the room.

- Earthquakes and floodings have been considered in the design basis. In areas with very low seismic activity, the available data are often not sufficient for a probabilistic approach. In such cases, reference is often made to the maximum earthquake effect observed in the location and its intensity plus 1 is used as the design basis (as per IAEA and KTA guidance).

- The effect of an aircraft fuel fire (fireball) following an aircraft impact event has been analyzed as well.

Regarding criticality risks related to fires events, it has been concluded that no criticality issues can arise from the presence of water coming from the fire extinguishing systems.

Heat removal of waste is ensured by passive principles:

  - by convection and conduction through the walls in the handling areas and in the bunkers, and

  - by natural convection in the vaults

# 5.2 Fire detection

- The fire alarm installation is designed, constructed and maintained complying with NEN 2535 and equivalent solutions. An inspection certificate is issued.

- The fire detection system entails sound and visual signals. These signals are visualized in the control room of the HABOG and by the entrance of the building. A general alarm is given to the control room located in an adjacent building.

- The HABOG is equipped with a fire alarm system with full surveillance.  The fire detection means are automatic (systematically implemented in fire compartments), and manual.

- Different measures assure that the systems can withstand the relevant ambient and hazard conditions. For example, in case of loss of normal and emergency power supply, the fire detection system performs its function during approximately 12 hours with batteries.

- All areas containing a fire load density higher than 400 MJ/m2 are classified as fire compartments. The required resistance of the fire barriers is 90 minutes at least.

# 5.2 Fire suppression

- The equipment in the HABOG building consists of standard firefighting extinguishers (foam and $CO_2$).
- The room with the emergency diesel tank is equipped with a sprinkler system. These systems start (and stop) automatically in case of occurring fire but can also be operated manually.
- COVRA does not have its own internal fire brigade. In case of a fire that cannot be extinguished with a small extinguishing equipment by the company emergency response team (BHV), the fire brigade will be called in.

# 5.3 Conclusions - Strenghts

- One of the most important strengths in terms of fire safety is that the buildings and their contents represent a very low potential fire load, decreasing the risk of fire.

- A Fire Hazards Analysis and a risk assessment have been developed. This assessment complies with the ANVS PSA level 3 guidelines, and several IAEA / WENRA guidelines.

# Conclusions – Lessons Learned

- COVRA is regularly audited by the insurance company (‘Nederlandse Atoompool’), usually every 5 years.

- Preventive igniters to ignite a flammable mixture outside the HABOG have been installed by a certified company, as a result of the studied scenarios.


Thanks for your kind attention