Implementation of SSR2/1 requirements for Nuclear Power Plant Design in Polish regulation.

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Overview

1. Introduction:
   - PAA’s mission and function
   - Nuclear infrastructure

2. Legal framework: Polish and International law

3. Most important topic from SSR-2/1 and Polish Law implementation.
   - Design Extension Condition (DEC)
   - Defence in Depth
   - Internal and External Hazards
   - Emergency Power Supply

4. Conclusion
ABOUT THE NATIONAL ATOMIC ENERGY AGENCY (PAA)

Mission:

The National Atomic Energy Agency through its regulatory and supervisory activities aims to ensure that activities involving exposure to ionizing radiation are conducted safely both for workers and the general public.
ABOUT THE NATIONAL ATOMIC ENERGY AGENCY (PAA)

Functions:
Regulatory oversight of activities involving nuclear materials and ionizing radiation sources constitutes the key element of nuclear safety and radiological protection system. This supervision is exercised by means of:

• **issuance of decisions** on licenses concerning the performance of these activities or their **registration**, based on regulatory verification of **safety analysis** performed by the applicant

• **issuance of authorizations of persons** to be employed in positions important from the viewpoint of nuclear safety and radiological protection,

• **control over the manner** in which activities are performed, using regulatory **assessment** tools, **inspection** and, if necessary, **enforcement** measures,

• **participation in development of legal acts** and recommendations regulating these activities.
>3600 ionising radiation users in medical, industrial and scientific applications


SWIERK SITE

Two spent fuel storages (wet and dry)


Warsaw

Stage I until 28.01.2014 preparation and approval the Polish Nuclear Power Program by the Council of Ministers

Stage II 2014 – 2016 NPP site selection and conclusion of a contract for construction of the first NPP

Stage III 2017 – 2018 Preparation of technical design and obtaining all required decisions and permits

Stage IV 2019 – 2024 Construction of the first NPP
Division of responsibilities

**Council of Ministers**

Ministry of Economy
- Activities connected with the peaceful use of nuclear energy
- Rule making, safety assessment, licensing, inspection and enforcement, EP

Ministry of Environment
  - Regulating of nuclear, radiation, waste and transport safety, security and safeguards in Poland

Government Commissioner for Nuclear Power (2009)
- NPPs
- PGE Energia Jądrowa SA

Council of Ministers
- Radioactive Waste Management Plant
- National Radioactive Waste Repository
- National Nuclear Research Centre
- Research Reactor MARIA
- Utilization of nuclear energy & waste management

**Other Institutions**
- National Radioactive Waste Management Plant
- Research Reactor MARIANP
- Radioactive Waste Management Plant
- National Radioactive Waste Repository
- National Nuclear Research Centre
- Research Reactor MARIANP
- Utilization of nuclear energy & waste management
LEGAL FRAMEWORK

Main Polish Laws which implemented of SSR-2/1 regulation

• „Atomic Law” - Act of Parliament of 29 November 2000 on the Atomic Law

Secondary legislation to the Atomic Law

• REGULATION OF THE COUNCIL OF MINISTERS of 31 August 2012 on nuclear safety and radiological protection requirements which must be fulfilled by a nuclear facility design

(Regulation of Design)

• REGULATION OF THE COUNCIL OF MINISTERS of 31 August 2012 on the scope and method for the performance of safety analyses prior to the submission of an application requesting the issue of a license for the construction of a nuclear facility and the scope of the preliminary safety report for a nuclear facility

(Regulation of Safety Analyses)
Conditions potentially leading to early or large releases of radioactivity – Categories of plant states

**Requirement 13: Categories of plant states**

Plant states shall be identified and shall be grouped into, a limited number of categories primarily on the basis of their frequency of occurrence at the NPP.

5.1. Plant states shall typically cover:

- a) Normal operation;
- b) Anticipated operational occurrences, which are expected to occur over the operating lifetime of the plant;
- c) Design basis accidents;
- **d) Design extension conditions**, including accidents with significant degradation of the reactor core.
- e) Severe accidents beyond DEC

All categories were listed in *Regulation of Design § 14*
Design Extension Conditions (DEC) – Objective

Requirement 20: Design Extension Conditions DEC

A set of design extension conditions shall be derived on the basis of engineering judgement, deterministic assessments and probabilistic assessments for the purpose of further improving the safety of the NPP by enhancing the plant’s capabilities to withstand, without unacceptable radiological consequences, accidents that are either more severe than design basis accidents or that involve additional failures. These design extension conditions shall be used to identify the additional accident scenarios to be addressed in the design and to plan practicable provisions for the prevention of such accidents or mitigation of their consequences if they do occur.

It was implemented in Regulation of Design § 1, 9, Regulation of Safety Analyses annex 2,
Defence in Depth (DiD) - Objective

According SSR-2/1 concept of **defence in depth (DiD)** is the primary means of **preventing** accidents in a NPP and **mitigating** the consequences of accidents if they occur.

4.13. The design shall be such as to ensure, as far as is practicable, that the **first**, or at most the **second**, level of defence is capable of **preventing an escalation** to accident conditions for all failures or deviations from normal operation that are likely to occur over the operating lifetime of the NPP.

2.13. Application of the concept of DiD in the design of a NPP provides several levels of defence (inherent features, equipment and procedures) aimed at **preventing** harmful effects of radiation on people and the environment, and ensuring adequate **protection** from harmful effects and **mitigation** of the consequences in the event that prevention fails. The **independent** effectiveness of each of the different levels of defence is an essential element of DiD at the plant and this is achieved by incorporating measures to avoid the failure of one level of defence causing the failure of other levels.....

It was implemented in **Regulation of Design § 3, Atomic Law art. 36c**
Defence in Depth (DiD) – 5 levels

There are five levels of defence (briefly):

1. **Prevent deviations from normal operation.**
2. **Detect and control deviations from normal operational.**
3. **Escalation** of certain anticipated operational occurrences or postulated initiating events might not be controlled.
4. **Mitigate the consequences** of accidents that result from failure of the third level of DiD.
5. **Mitigate the radiological consequences** of radioactive releases that could potentially result from accident conditions.

It was implemented in **Regulation of Design § 3**.
Defence in Depth (DiD) – design

4.11.

The design shall:

a) provide for **multiple physical barriers** to the release of radioactive material to the environment;

b) be **conservative** and the construction be of **high quality**, so as to provide assurance that failures and deviations from normal operation are **minimized**, that accidents are prevented as far as is practicable and that a small deviation in a plant parameter **does not lead to a cliff edge effect**;

c) provide for the control of plant behaviour by means of **inherent** and **engineered features**, such that failures and deviations from normal operation requiring actuation of safety systems are minimized or excluded by design, to the extent possible;

It was implemented in **Regulation of Design § 4**.
4.11.

The design shall:

d) provide for supplementing the control of the plant by means of **automatic actuation of safety systems**, such that failures and deviations from normal operation that exceed the capability of control systems can be controlled with a high level of confidence, and the need for operator actions in the early phase of these failures or deviations from normal operation is minimized;

e) provide for **systems, structures and components and procedures** to control the course of and, as far as practicable, to limit the consequences of failures and deviations from normal operation that exceed the capability of safety systems;

f) provide **multiple means** for ensuring that each of the fundamental safety functions is performed, thereby ensuring the effectiveness of the barriers and mitigating the consequences of any failure or deviation from normal operation.

It was implemented in **Regulation of Design § 4.**
5.30. In particular, the containment and its safety features shall be able to withstand extreme scenarios that include, among other things, melting of the reactor core. These scenarios shall be selected using engineering judgment and input from probabilistic safety assessments.

**Requirement 55: Control of radioactive releases from the containment**

The design of the containment shall be such as to ensure that any release of radioactive material from the NPP to the environment is as low as reasonably achievable, is below the authorized limits on discharges in operational states and is below acceptable limits in accident conditions.

*It was implemented in Regulation of Design § 9, 29*
Defence in Depth (DiD) – Containment design

6.20. The containment structure and the systems and components affecting the leaktightness of the containment system shall be designed and constructed so that the leak rate can be tested after all penetrations through the containment have been installed and, if necessary, during the operating lifetime of the plant, so that the leak rate can be tested at the containment design pressure.

6.21. The number of penetrations through the containment shall be kept to a practical minimum and all penetrations shall meet the same design requirements as the containment structure itself. The penetrations shall be protected against reaction forces caused by pipe movement or accidental loads such as those due to missiles caused by external or internal events, jet forces and pipe whip.

It was implemented in Regulation of Design § 69 point 2 and 4
Requirement 17: All foreseeable internal hazards and external hazards, including the potential for human induced events directly or indirectly to affect the safety of the nuclear power plant, shall be identified and their effects shall be evaluated. Hazards shall be considered for determination of the postulated initiating events and generated loadings for use in the design of relevant items important to safety for the plant.

5.16. The design shall take due account of internal hazards such as fire, explosion, flooding, missile generation, collapse of structures and falling objects, pipe whip, jet impact and release of fluid from failed systems or from other installations on the site. Appropriate features for prevention and mitigation shall be provided to ensure that safety is not compromised.

It was implemented in Regulation of Safety Analyses § 7
External Hazards – Design Basis

External hazards – design

5.17.

**natural** - meteorological, hydrological, geological and seismic events.

**human** - from nearby industries, transport routes,

....In the short term, the safety of the plant shall not be permitted to be dependent on the availability of **off-site services** such as electricity supply and fire fighting services. The design shall take due account of site specific conditions to determine the **maximum delay time by which off-site services need to be available**.

5.18. **Items important to safety** shall be designed and located to **minimize, consistent with other safety requirements**, the likelihood of external events and their possible harmful consequences.

It was implemented in **Regulation of Safety Analyses § 8, Regulation of Design § 110**
5.19. Features shall be provided to minimize any interactions between buildings containing items important to safety (including power cabling and control cabling) and any other plant structure as a result of external events considered in the design.

5.20. The design shall be such as to ensure that items important to safety are capable of withstanding the effects of external events considered in the design, and if not, other features such as passive barriers shall be provided to protect the plant and to ensure that the required safety function will be performed.

5.21. The seismic design of the plant shall provide for a sufficient safety margin to protect against seismic events and to avoid cliff edge effects.

5.22. For multiple unit plant sites, the design shall take due account of the potential for specific hazards giving rise to simultaneous impacts on several units on the site.

It was implemented in Regulation of Design § 16, 19, 22
Emergency Power Supply– Design Basis

**Requirement 68:** The emergency power supply at the NPP shall be **capable of supplying** the necessary power in anticipated operational occurrences and accident conditions, in the event of the loss of off-site power (LOOP).

6.43. In the design basis for the emergency power supply at the NPP, due account shall be taken of the postulated initiating events and the associated safety functions to be performed, to determine the requirements for

- capability,
- availability,
- duration of the required power supply
- capacity and continuity.

It was implemented in **Regulation of Design § 93, 98, 99**
Emergency Power Supply– Design Basis

6.45. The design basis for any diesel engine or other prime mover (motor, solenoid operator or pneumatic operator) that provides an emergency power supply to items important to safety shall include:

a) The capability of the associated fuel oil storage and supply systems to satisfy the demand within the specified time period;

b) The capability of the prime mover to start and to function successfully under all specified conditions and at the required time;

c) Auxiliary systems of the prime mover, such as coolant systems.

It was implemented in Regulation of Design § 100, 101,
Conclusion

Polish Law has implemented all important IAEA requirements regarding DEC

- **Defence in Depth** (inherent features, equipment and procedure);
  - preventing accidents,(independent, reliability of safety systems);
  - protection from harmful effects (capability and integrity of containment);
  - mitigating radiological consequences;
- Identification and evaluation of internal and external hazards;
- Emergency power supply.
Thank you for your attention!