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Analysis of Factors Determining Shelter Safety within New Safe Confinement

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Introduction

- On 26 April 1986 - the accident occurred at Chornobyl NPP Unit 4

- On 30 November 1986 - the confining building with individual systems– the Shelter – was constructed over the remains of ChNPP Unit 4

The Shelter Implementation Plan

- The Shelter Implementation Plan (SIP) has been implemented since 1998 and provides:
  - top-priority measures on stabilization and increase of safety level of the Shelter
  - long-term measures on transformation of the Shelter

The Shelter Implementation Plan. The top-priority measures

- Stabilization of the most unreliable structures of the Shelter
- Integrated automated monitoring system for the Shelter (IAMS)
- Modernization of the dust suppression system (UDSS)
- Fire protection system
- Modernization of the physical protection system
- Research, assessments, database

New Safe Confinement

The main functions of the NSC, whose service life is at least 100 years, are as follows:

- ensure protection of staff, the public and the environment (including extreme natural events: earthquake, tornado, rain, wind, snow, etc.)
- create conditions for dismantling of Shelter unstable structures and for appropriate management of radioactive waste, for removal of FCM in the future, etc.

New Safe Confinement

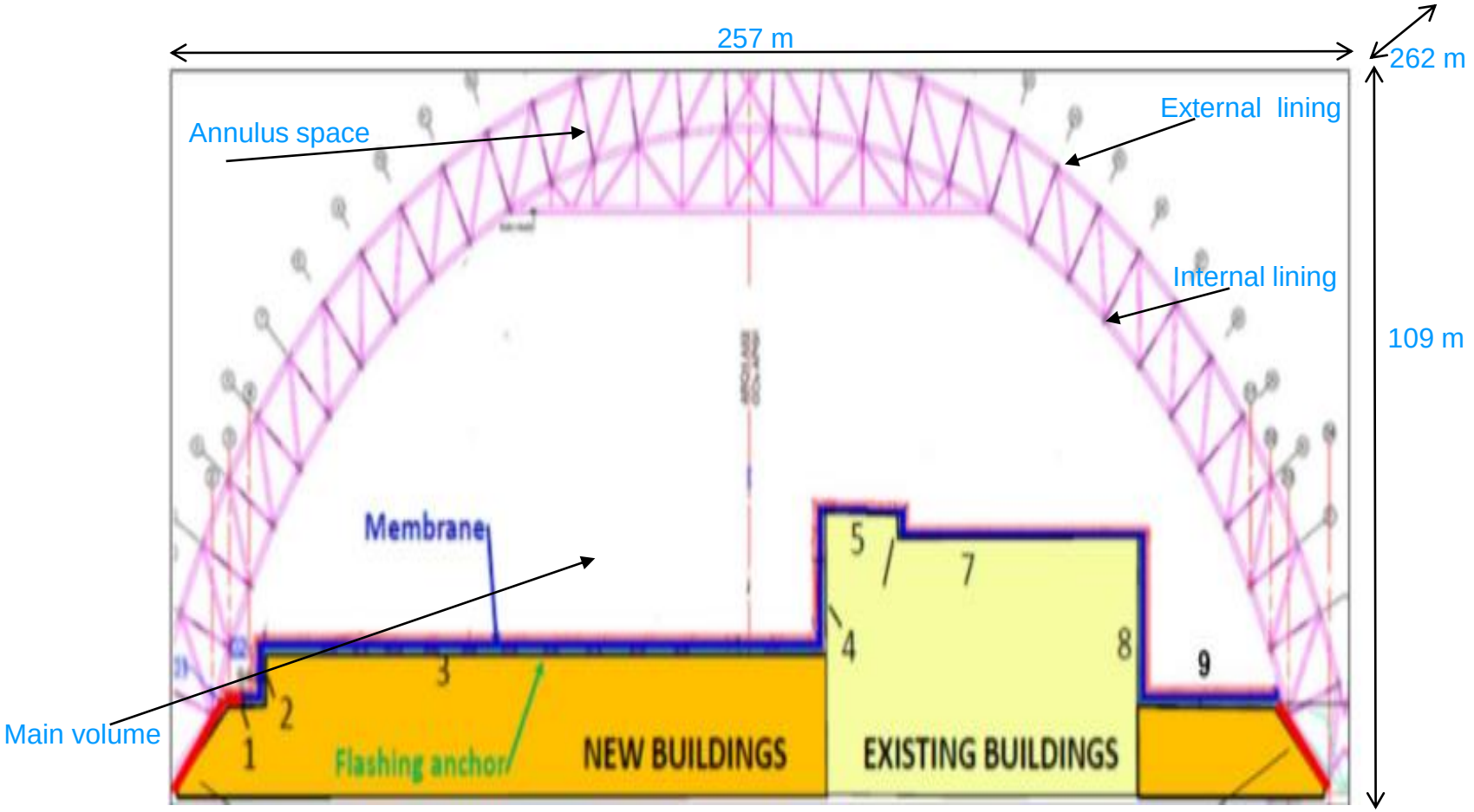
Implementation of NSC design is divided into the following stages:

- protective building with technological systems
- infrastructure for dismantling of unstable structures

NSC SP-1 is planned

to be completed in 2017.

New Safe Confinement



New Safe Confinement

- The main crane system
- Integrated control and monitoring system
- Technological and other buildings
- Other systems

Safe State of the Shelter under the NSC

The NSC is designed on the basis of the limiting conditions related to current and potential Shelter impacts on the environment in the NSC main volume:

- release of radioactive substances from the Shelter to the NSC
- direct ionizing radiation at workplaces in the NSC main volume
- temperature and humidity influence
- hazard of criticality incident
- hazard of collapse of structures
- hazards of fire and explosion

Safe State of the Shelter under the NSC. Release of Radioactive Substances from the Shelter

- The limiting value of the average monthly activity in air – 30 Bq/m^3 - ventilation works without filters (210 Bq/m^3 for activities with dust rising, ventilation works with filters).
- The total boundary release from the Shelter ≈ 30 Bq/m^3 x 147442 m^3/hr ≈ 4.4 MBq/hr.
- Dust formation inside the Shelter due to the degradation of FCM.
- Drying-out of surfaces in the Shelter.

Safe State of the Shelter under the NSC. Level of Ionizing Radiation

- Permissible dose values depending on staff working time at the workplace in the NSC main volume.
- Shielding is envisaged in the NSC.
- After erection of the NSC over the Shelter, it is necessary to measure the dose rate and analyze the adequacy of shielding.

Safe State of the Shelter under the NSC. Temperature and Humidity Influence

- To prevent moisture concentration on internal linings of the NSC Arch, it is envisaged to warm up air in the NSC annulus space.
- The design parameter is 380 t/year of water evaporation from the Shelter.

Safe State of the Shelter under the NSC. Water Accumulations in the Shelter

- It is necessary to analyze conditions of water accumulations in the Shelter, dynamics of their changes, condensation processes and condensate movement routes, etc.
- It is necessary to determine a criterion for limitation of water accumulations in the Shelter, in particular, for preventing water flow from the Shelter to Unit 3.

Safe State of the Shelter under the NSC. Prevention of Criticality

The conditions for the Shelter safe state and for ensuring FCM subcriticality are:

- prevention of water ingress in FCM accumulations due to water condensation (it is necessary to establish acceptable criteria and to monitor their compliance)
- prevention of inundation of FCM accumulations with water (from technological systems, in case of fire extinguishing)
- preventive periodic supply of neutron-absorbing solutions to FCM accumulations

Current state of FCM accumulations is monitored by the IAMS.

Safe State of the Shelter under the NSC. Prevention of Collapse of Shelter

- The probability for collapse of insufficiently stable structures of the Shelter is estimated as $P \approx 10^{-3}$/year. The permissible probability is estimated as $P < 10^{-4}$/year if staff exposure doses are higher than 100 mSv.
- It is necessary to perform risk assessments, establish criteria and take measures to limit collapse of internal structures of the Shelter.
- Current state of Shelter structures is monitored by the IAMS.

Safe State of the Shelter under the NSC. Prevention of Fire

- To avoid exceeding permissible radiation impacts, it is necessary to extinguish the maximum possible fire within 18 minutes.
- Automated fire alarm and foam extinguishing systems are envisaged in NSC.
- Risks related to fire in the Shelter areas with high level of contamination require further study.

Safe State of the Shelter under the NSC. Prevention of Explosion

- Hydrogen concentration over the reactor vault and in the central hall is monitored at the Shelter.
- The issues related to formation and possible hydrogen accumulation in the Shelter premises with water accumulations require further study.

Conclusions

- The new safe confinement ensures protection of staff, the public and the environment, provided that the Shelter is maintained in the state that limits risks associated with: the degradation of fuel-containing materials, rise of dust, accumulation of water, collapse of structures, fire, explosion.
- It is necessary to define systematic criteria for the safe state of the Shelter under the NSC, implement measures for dismantling unstable structures and monitoring of negative processes in the Shelter, and carry out additional risk assessments.

Thank you
for attention!