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NUCLEAR AND RADIATION SAFETY CENTER

Internal Events Level 1 PSA study of Armenian NPP Spent Fuel Pools

Gurgen Kanetsyan, Armen Amirjanyan, and Zoltan Kovacs

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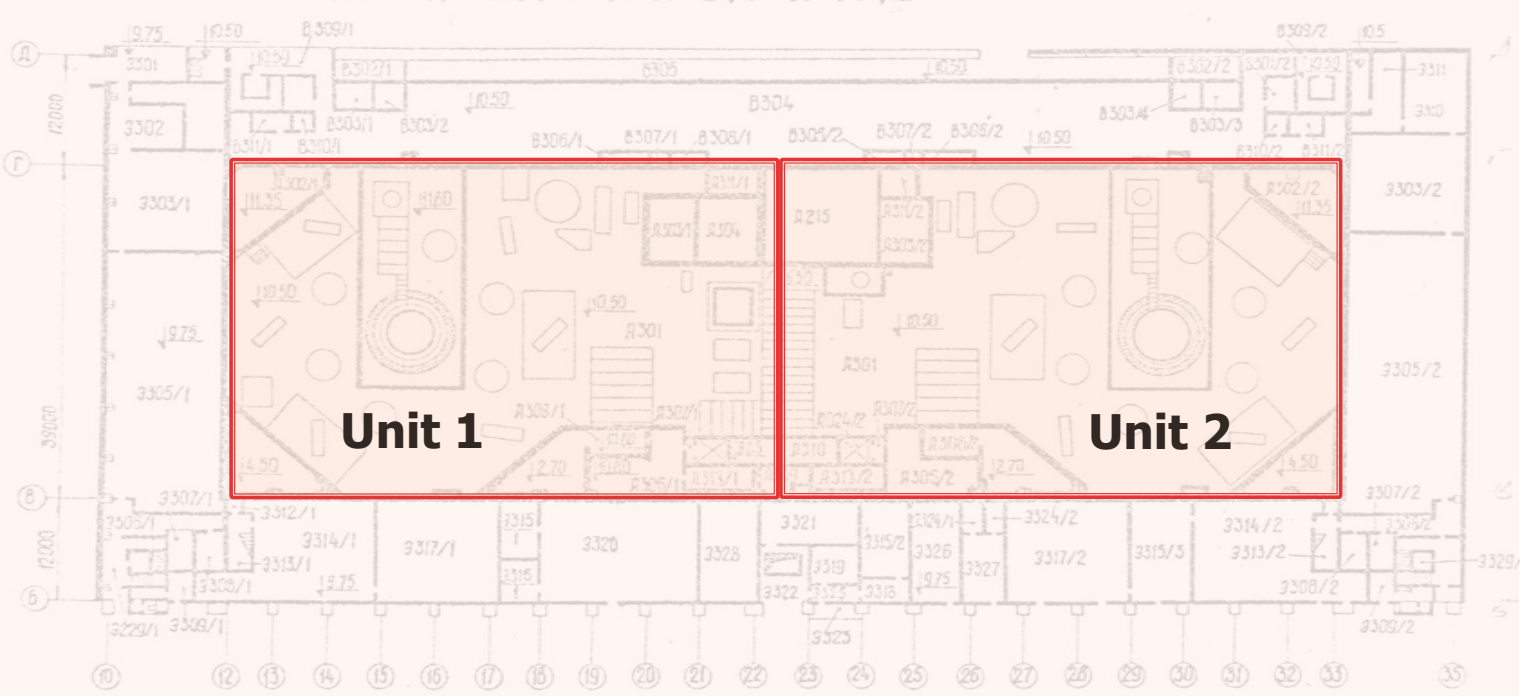
Presenter: **Gurgen Kanetsyan**
Head of Risk Assessment Group
E-mail: **g.kanetsyan@nrsc.am**

Outline

- Background
- Objective and scope of SFP PSA
- Major tasks of the study
- Quantification & Results
- Challenges

Background

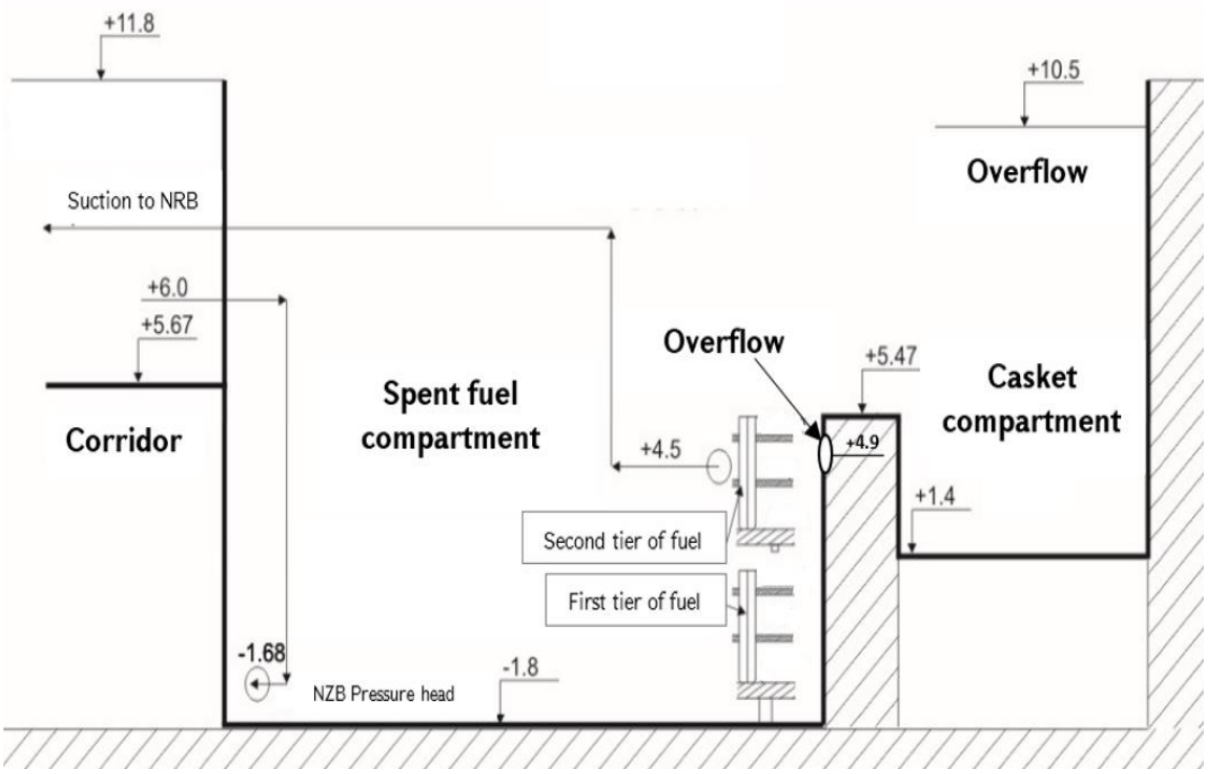
- Insights from Fukushima accident highlighted the importance of safety of the spent fuel pools (SFP)
- SFPs are typically considered within LPSD, not in FP
- Lifetime extension of the ANPP
- SFPs of VVER-440 are located in the reactor hall



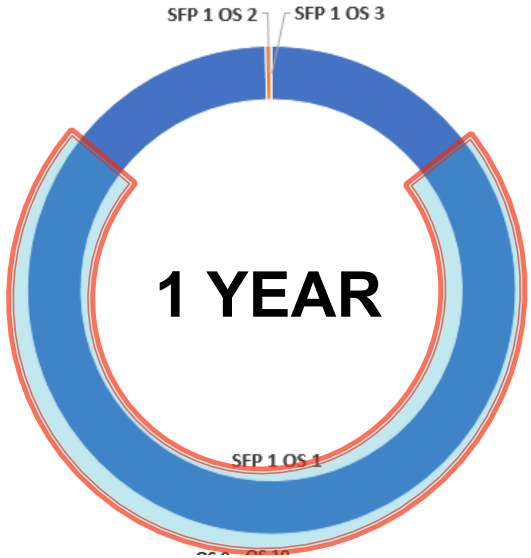
Objective and scope of SFP PSA

- **Objective:** to provide the Regulatory Body (ANRA) with appropriate technical background for decision-making,

- **Scope:**
  - **IEs**: Internal
  - **OS**: Full power operation + other OSs with 1 tier in operation
  - **Undesired event**: FD (uncovery + mechanical)

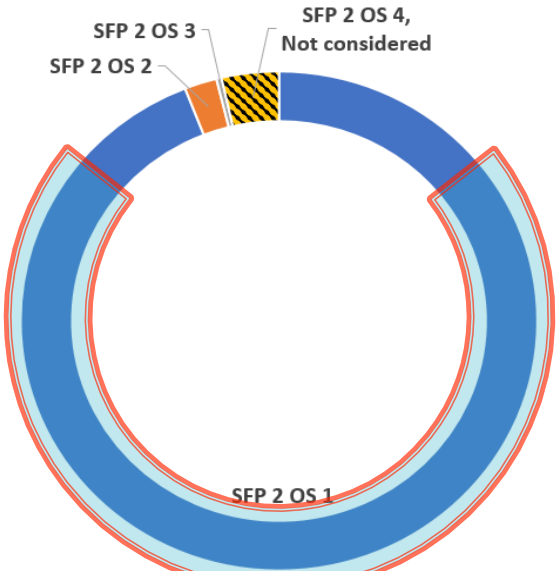


The objective and scope of the SFP PSA



Considered SFP 1 OSs

ID	Description	Duration [hour]	Conditional probability of the SFPOS
SFPOS 1	In SFP the coolant level is in the range 4.6÷4.9 m, transportation is not permitted	8725.06	9.960E-1
SFPOS 2	In SFP the coolant level is in the range 10.2÷10.5 m, transportation of the spent fuel is not practiced	34.316	3.92E-3
SFPOS 3	In SFP the coolant level is in the range 10.2÷10.5 m, transportation of the spent fuel	0.625	7.14E-5



Considered SFP 2 OSs

POS	Description	Temperature [°C]	Layers in the SFP	Coolant Level in the SFP [m]	Duration [h]
POS 0	Plant at full power	260 ÷ 267	1	4.6 ÷ 4.9	6122.86
POS 1	Plant at low power	260 ÷ 264	1	4.6 ÷ 4.9	724.46
POS 2	Plant at "hot" shutdown state	245 ÷ 260	1	4.6 ÷ 10.5	14.92
POS 3	Plant at "semi-hot" shutdown state	240 ÷ 140	1	4.6 ÷ 10.5	36.17

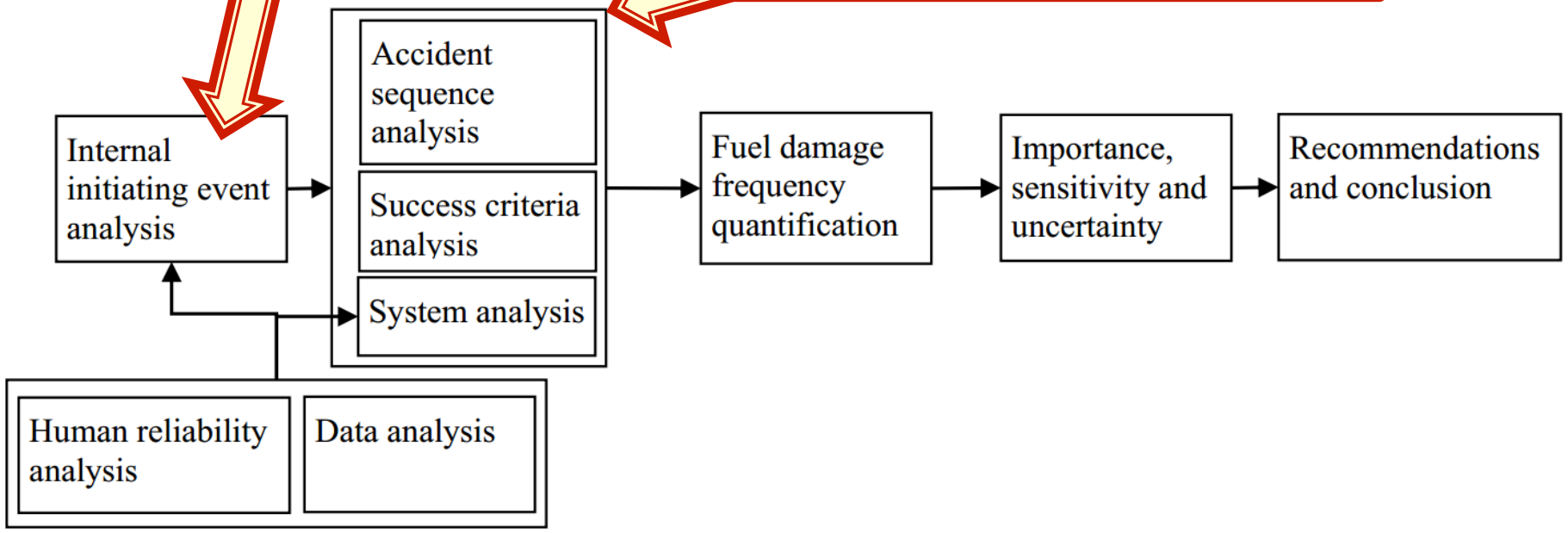
ID	Description	Duration [hour]	Conditional probability of the SFPOS
SFPOS 1	In SFP the coolant level is in the range 4.6÷4.9 m, transportation is not permitted	8241.23	9.41E-1
SFPOS 2	In SFP the coolant level is in the range 10.2÷10.5 m, transportation of the spent fuel is not practiced	177.055	2.02E-2
SFPOS 3	In SFP the coolant level is in the range 10.2÷10.5 m, transportation of the spent fuel	27.965	3.19E-3

POS 11	Hydrotest of primary circuit	150	1	4.6 ÷ 10.5	4.11
POS 12	Primary circuit heat-up to nominal state	260	1	4.6 ÷ 10.5	33.71
POS 13	Driving reactor into criticality	260	1	4.6 ÷ 4.9	25.10

Major tasks of the study

- Generalized list of the IEs
- Operational experience
- List of IEs for LPSD study
- System investigation
- MLD

Thermohydraulic calculations:
- Loss of coolant due to evaporation
- Loss of coolant due to penetration



Quantification & Results

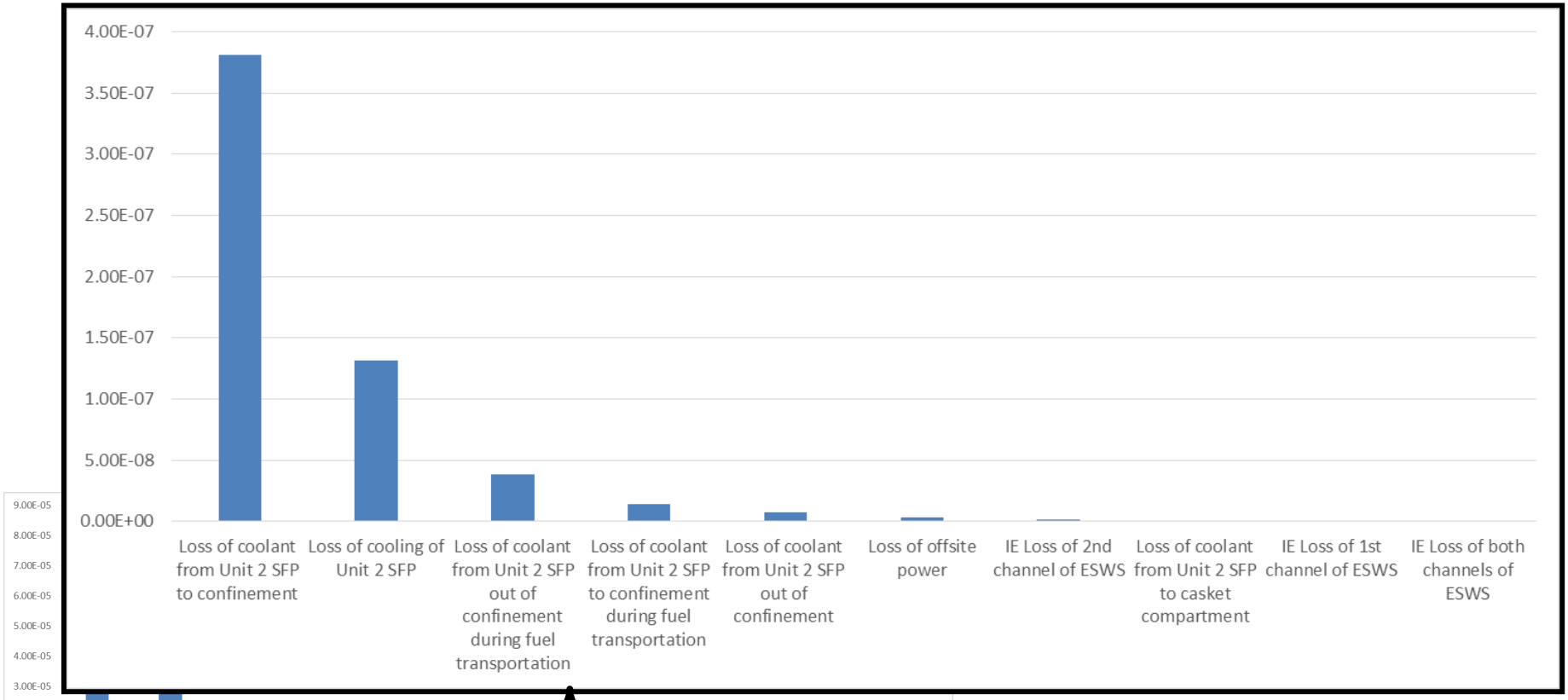
Results of SFP PSA model quantification:

	Mechanical fuel damage[1] [1/y]			Fuel damage due to uncovery [1/y]		
	5th percentile	Mean	95th percentile	5th percentile	Mean	95th percentile
Unit 1 SFP	1.37E-06	3.26E-05	1.19E-04	3.73E-08	5.74E-07	1.80E-06
Unit 2 SFP	1.36E-06	3.67E-05	1.61E-04	2.16E-05	7.71E-05	1.95E-04
Unit 1 SFP and Unit 2 SFP	6.89E-06	6.93E-05	2.31E-04	2.16E-05	7.77E-05	1.72E-04

Dominant risk contributors are:

- High importance of mechanical damage
- For Unit 2 SFP human induced LOCA importance is extremely high.

Quantification & Results



The fuel damage risk profile of Unit 2 SFP

Quantification & Results

Risk important items:

•Human actions aimed at configuring feeding lines for refilling Unit 1 SFP and Unit 2 SFP, and cooling Unit 2 SFP

•1NB0-1, 1NZB and 2NZB pumps

•2NB0-1 and 2NB0-2 pumps

Results are sensitive to the following assumptions and data:

•HEPs (all front-line systems of are operated manually)

•Assumption related to the mission time for LOCAs (72 hours)

•Crediting possibility to supply and overflow of Unit 2 SFP using Unit 1 SFP systems

Challenges

- Definition of undesired event
- Mission time
- Aggregating risks of reactor core damage and spent fuel damage
- Integrated PSA model for reactor and SFP
- SFP / L2 PSA

Thank you