Temelín PSA Level 2

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Presentation Overview

- Temelín NPP
- Temelín PSA
- Level 2 (1996)
- Level 2 Update (2003)
- Main Results
- Conclusions

Temelín Nuclear Power Plant

- Located in South Bohemia in the Czech Republic
- Construction started in 1987
- Initial Soviet design with four VVER-1000 units
- Standard RCS design, Czech design of BOP
- Decisions made after political changes in 1989:
  - Westinghouse I&C and Fuel
  - Only two units to be completed
  - Number of changes to increase safety
- Unit 1 trial operation started in July 10, 2002
- Unit 2 trial operation started in April 18, 2003

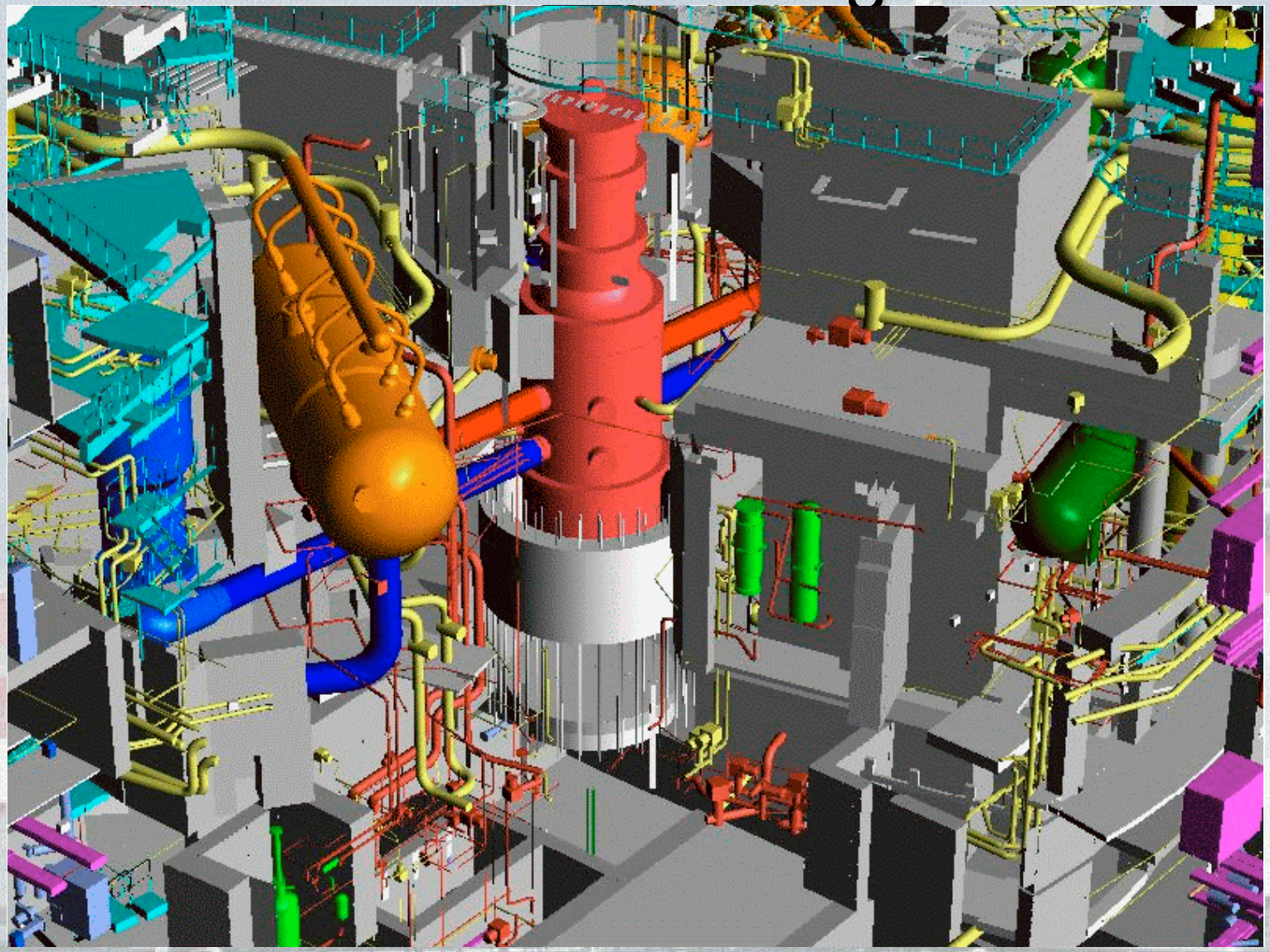
Temelín PSA

- First Temelín PSA performed in 1993-1996 with NUS and Czech subcontractors
- Number of conservative assumptions due to lack of information
- Two IPERS missions reviewed the first PSA (1995 and 1996)
- PSA Update performed in 2001-2003
- IPSART Mission for PSA Update performed in October 2003

PSA Level 2 (1995-1996)

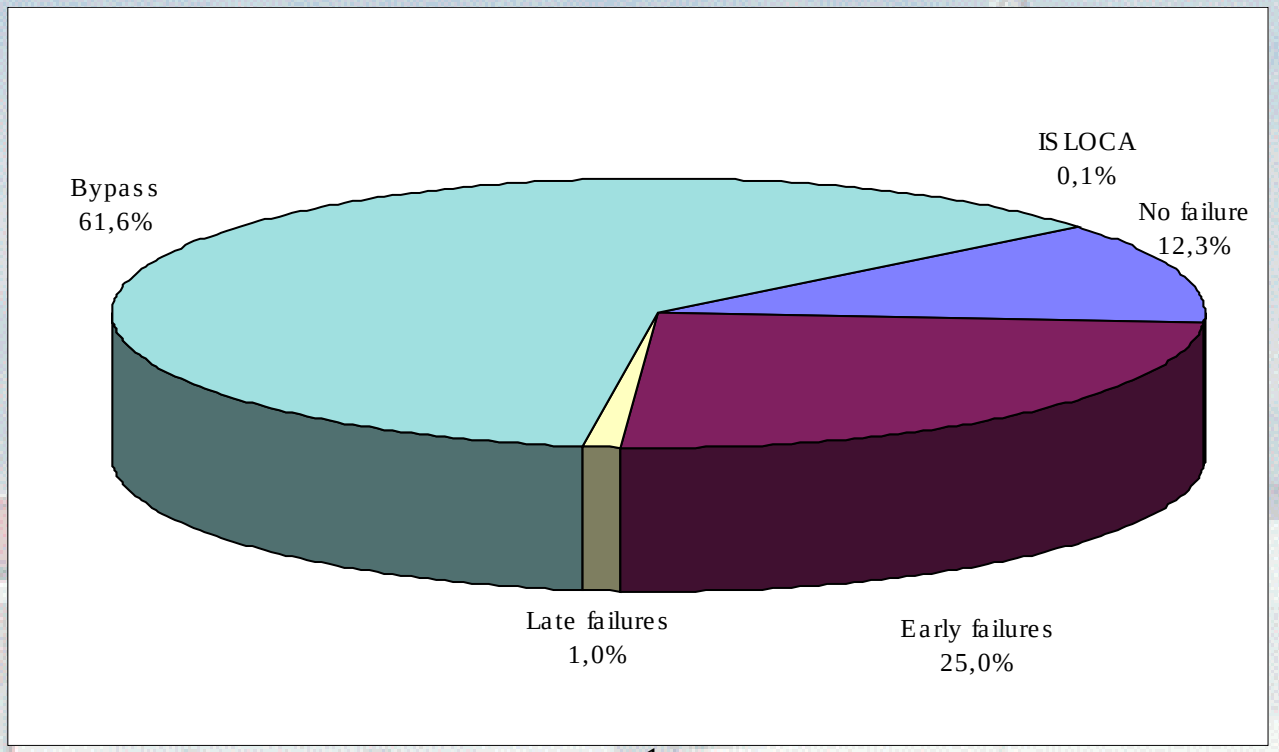
- Level 2 performed by NUS and Temelin staff, with using UJV analyses made by STCP
- Results and conclusions:
  - Robust large containment, resistent to overpressure failures (ultimate strength about 1 MPa)
  - High frequency of Early failures due to:
    - Instrumentation channels through whole thickness of basemat
    - Pipe penetrations and equipment hatch near cavity
  - High frequency of containment bypass given by SGTR frequency in Level 1
  - High RCS pressure in time of vessel failure is beneficial
  - Low frequency of Late failures
  - Hydrogen burns and DCH not important

Temelín Reactor Building



PSA Level 2 (1996) (continued)

Basic Containment Failure Modes



CDF = 1.07E-04 reactor-year^{-1}(including Fire and Flood sequences)
LERF = 9.30E-05 reactor-year^{-1}

PSA Level 2 Update (2002-2003)

- New MELCOR analyses available for Level 2 (phenomena, source terms, hydrogen recombiners)
- IPERS 1996 comments incorporated (DDT, door strenght, containment isolation failure)
- SAMG measures assumed in Level 2 analysis:
  - Basemat penetration plugs
  - Corium barriers
- More detailed source terms evaluation
- RTARC calculations used for risk measure

Main Results of Level 2 Update

- Lower frequency of Early failures due to:
  - Basemat penetration plugs
  - Corium barriers
- Higher frequency of No failure and Late failures
- Numerical fractions of source terms developed for all STCs
- Integral dose for each STC calculated by RTARC code

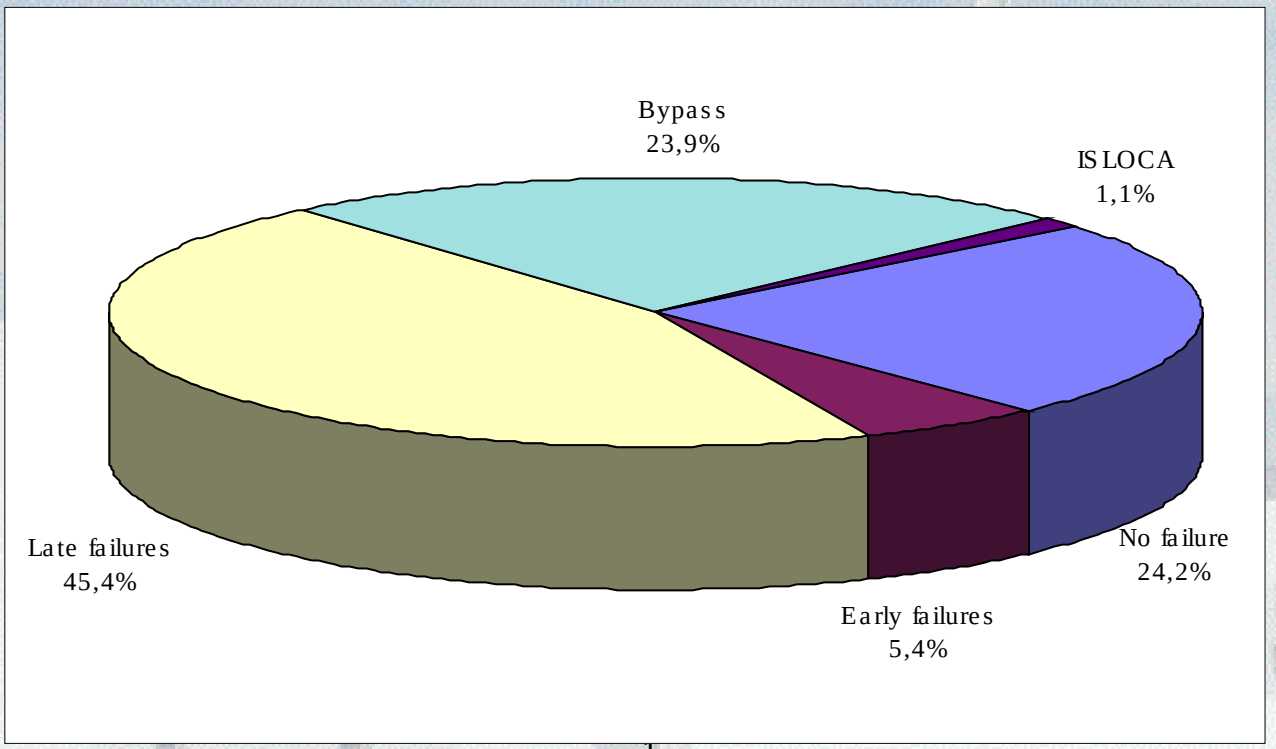
Main Results of Level 2 (continued)

Source Term Categories

STC	Description	Frequency
1.	No containment failure	3.67E-06
2.	Large early containment failure; sprays OK	1.86E-07
3.	Large early containment failure; no sprays	1.17E-07
4.	Early containment leak; sprays OK	7.52E-08
5.	Early containment leak; no sprays	1.88E-08
6.	Early basemat meltthrough, penetration failure; sprays OK	8.68E-09
7.	Early basemat meltthrough, penetration failure; no sprays	1.72E-07
8.	Containment not isolated; sprays OK	1.53E-07
9.	Containment not isolated; no sprays	8.28E-08
10.	Late containment failure due to overpressure; sprays OK	4.26E-09
11.	Late containment failure due to overpressure; no sprays	4.35E-07
12.	Late containment failure due to overtemperature	4.12E-07
13.	Late basemat meltthrough; sprays OK	2.84E-06
14.	Late basemat meltthrough; no sprays	3.20E-06
15.	SGTR with relief valves normally cycling	2.72E-07
16.	SGTR with relief valves stuck in open position	1.83E-07
17.	SGTR 40 - 100 mm with relief valves normally cycling	3.14E-06
18.	SGTR 40 - 100 mm with relief valves stuck in open position	1.74E-08
19.	ISLOCA 300 mm with aux. building effective	3.52E-09
20.	ISLOCA 300 mm; aux. building ineffective	1.57E-07

Main Results of Level 2 (continued)

Basic Containment Failure Modes



CDF = 1.51E-05 reactor-year^{-1} (without Fire and Flood sequences)

LERF = 4.04E-06 reactor-year^{-1}

Main Results of Level 2 (continued)

- Dose calculations by RTARC showed up three most serious scenarios:
  - STC 7 - Early basemat failure through instrumentation channels, no sprays
  - STC 16 - SGTR with stuck relief valve
  - STC 20 - ISLOCA

STC	Frequency year $^{-1}$	Dose Sv	Relative Risk
1	3.67E-06	1.46E-03	0.00%
2	1.86E-07	4.95E+01	7.57%
3	1.17E-07	5.36E+01	5.16%
4	7.52E-08	1.04E-01	0.01%
5	1.88E-08	1.90E+01	0.29%
6	8.68E-09	4.65E+01	0.33%
7	**1.72E-07**	**1.60E+02**	**22.63%**
8	1.53E-07	4.22E+01	5.31%
9	8.28E-08	5.87E+01	4.00%
10	4.26E-09	9.39E-03	0.00%
11	4.35E-07	3.24E-02	0.01%
12	4.12E-07	2.61E-02	0.01%
13	2.84E-06	2.57E-02	0.06%
14	3.20E-06	3.39E-02	0.09%
15	2.72E-07	2.09E-01	0.05%
16	**1.83E-07**	**1.62E+02**	**24.38%**
17	3.14E-06	1.79E+00	4.62%
18	1.74E-08	2.13E+02	3.05%
19	3.52E-09	3.49E+01	0.10%
20	**1.57E-07**	**1.73E+02**	**22.33%**

Conclusions of Level 2

- Containment failures „moved“ from „Early“ to „Late“ categories thanks to SAMG measures (penetration plugs, corium barriers)
- Low frequency of overpressure failures
- Hydrogen recombiners important both for Early and Late containment failures
- Uncertainty of source terms due to insufficient and inconsistent analyses data
- One early failure and two bypass scenarios found to be most important from frequency/radiological consequences viewpoint