UNIVERSITÀ DI PISA

DIPARTIMENTO DI INGEGNERIA MECCANICA, NUCLEARE E DELLA PRODUZIONE

VIA DIOTISALVI 2, 56100 PISA

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ENLARGEMENT OF THE ASSESSMENT DATABASE FOR ADVANCED COMPUTER CODES IN RELATION TO THE VVER TECHNOLOGY: BENCHMARK ON LB-LOCA TRANSIENT IN PSB-VVER FACILITY

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INTRODUCTORY REMARKS

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- VVER reactors have some unique and specific features (e.g. large primary and secondary side fluid inventory, horizontal steam generators, core design) which require dedicated experimental and analytical analyses
- The predictive capabilities of computer codes used in reactor safety analysis should be validated against relevant test data.
- To this purpose a "VVER code validation matrix" was developed in the framework of the OECD/NEA activities following the experience of the validation matrices for LWR already developed in the '80 and then extended in the '90
- The OECD/NEA PSB-VVER Project (2003-2008) has been set with the objective to obtain the required experimental data not covered by the VVER validation matrix.

FRAMEWORK: THE OCED/NEA PSB-VVER PROJECT

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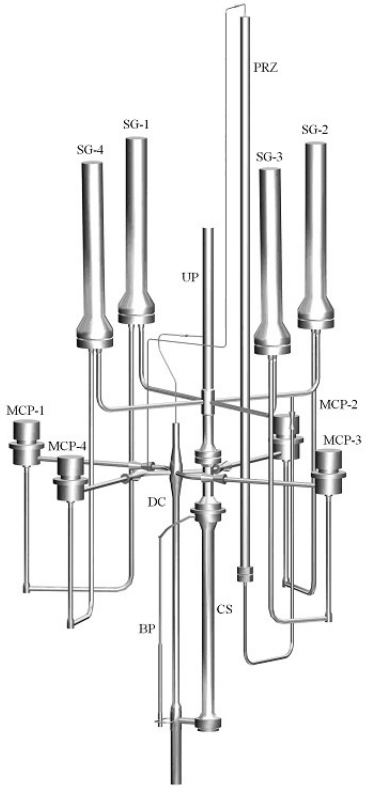
- "In support of validation of thermal-hydraulic codes and of safety assessments for VVER-1000 reactors on the basis of PSB-VVER experiments"
- Project objective: provide unique experimental data that are needed for the validation of thermal-hydraulic codes and to support safety assessments for VVER-1000 reactors.

PSB-VVER experiments constitute a relevant extension of the code validation database and will cover "white spots" in the VVER code validation matrix

No	ID (date)	Test	Note
1	UP-11-08 (2002).	11% Upper Plenum break"	Counter-part of the ISB-VVER test
2	NC-1 (2003)	Natural Circulation	Parametric study
3	CL-4.1-03 (2004)	4.1% cold leg break test	Counter-part of LOBI, BETHSY, SPES and LSTF
4	PSh-1.4-04 (2005)	Primary to secondary leak	Analytical Exercise (Blind test)
5a	CL-2x100-01 (2008)	Large cold leg break @ Low Power	Not in the original TM
5		Large cold leg break	Full power experiment (10MW core bundle will be installed in the facility) TO BE EXECUTED BY JUNE 2008

NOT EXECUTED



OBJECTIVES OF TEST 5a & OF ANALYTICAL EXERCISE

- **The OECD/NEA PSB-VVER Test 5a (CL-2x100-01) simulates a large break LOCA in VVER-1000/320 system**
- **The main objectives of this test are:**
  - to investigate the thermal-hydraulic response of the VVER-1000 primary system to guillotine break of cold leg
  - to obtain experimental data for validation of thermal-hydraulic codes applied to LB-LOCA analysis of VVER-1000
  - to evaluate the capabilities of the PSB-VVER facility to simulate the LB-LOCA in VVER-1000
- **The main objectives of the benchmark are:**
  - to assess the current capabilities of the TH-SYS codes on the domains of interest
  - to develop a common understanding and to promote an exchange of knowledge
  - to draw conclusions on the possible use of the codes for regulatory bodies and the industry

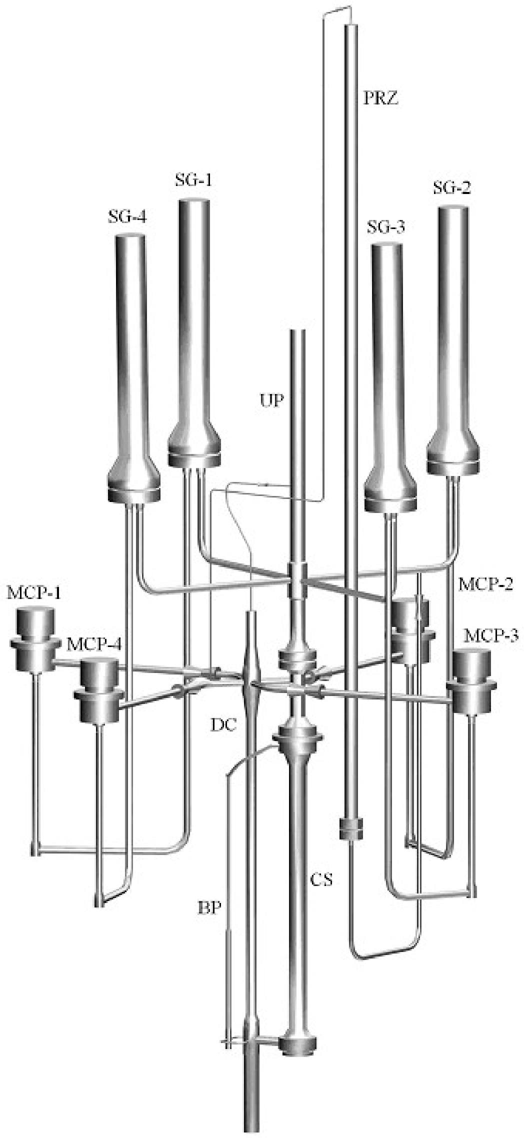
PARTICIPATING ORGANIZATIONS

- **OECD/NEA PSB-VVER Project Test 5a (CL-2x100-01) benchmark**
  - by four participants
  - three different institutions
  - four different thermal-hydraulic system codes

N.	*Participants*	*Organization/Country*	*Email*	*Code/ Version*	*Additional information*
1	**SCHEKOLDIN V. I.** **ZAKUTAEV M. O.**	Gidropress (EDO-GP) RUSSIA	zakutaev@grpress.podolsk.ru	**KORSAR-GP** **V9.027.004** **V9.031.000**	Pre- and post-tests performed
2	**ZAITSEV S.I.**	Gidropress (EDO-GP) RUSSIA	zakutaev@grpress.podolsk.ru	**Tech-M**	Pre- and post-tests performed
3	**BENČÍK M.**	Nuclear Research Institute Řež plc (NRI) CZECH REPUBLIC	ben@ujv.cz	**ATHLET 2.1 Cycle A**	
4	**DEL NEVO A.** **ADORNI M.** **D'AURIA F.**	University of Pisa (UNIPI) ITALY	a.delnevo@ing.unipi.it	**RELAP5-3D© V2.4.2**	

PSB-VVER FACILITY DESCRIPTION

- Simulator of VVER-1000/320
- Full height ITF
- Power and volume are scaled 1:300
- Four separated loops
- ECCS simulated (HPIS, LPIS, Makeup systems)
- 4 Hydro-accumulators
- Separate pipes represent the internals of the VVER (DC, core and UP, core bypass)
- The core is electrical type with indirect heating, hexagonal section simulated by 167 Fuel Rod
  - "low power" (1.5MW = 15% of nom. pow.) core is installed with uniform axial power profile
  - "high power" (10MW = 100% of nom. pow.) core is installed with uniform and non-uniform axial power profiles (to be used in test5)
- The SG consists of a hot and a cold collector and of 34 tubes coiled (the length is the same like the reference NPP)
- The distributor of FW is a ring with several holes placed above the SG tubes
- 4 separated SG are connected to a common steam header via a "low power" SL
- The test facility is equipped with advanced DAS and PCS with about 1000 measuring channels recoarding the measured data with frequencies of 20 Hz, 200Hz and 1000Hz.



PSB-VVER FACILITY CONFIGURATION

The facility has been set up as follows:

- The PRZ connected to HL #4
- The break device
  - located CL #3 between the pressure vessel and the MCP
  - rupture opening measure from *0.002 to 0.003s*
  - D scaled with the diameter of the VVER-1000 main pipeline
- 4 MCP in operation and controlled
- FW system: SGs level at 2.25m; FW temp. At 220°C
- The core power is 1.5MW with uniform axial power distribution

- ECCS available are:
  - 3 out of 4 hydroaccumulators
    - ✓ACC #1 and #3 connected to UP
    - ✓ACC #4 is connected to DC
  - 2 out of 3 HPIS systems
    - ✓CL #1 (intact loop w/o PRZ connection
    - ✓ CL #3 (broken loop)
  - 2 out of 3 LPIS systems.
    - ✓1 LPIS pump → two injection points connected through the accumulators lines to UP and DC
    - ✓1 LPIS pump → two injection points connected to the HL and CL (loop #3)

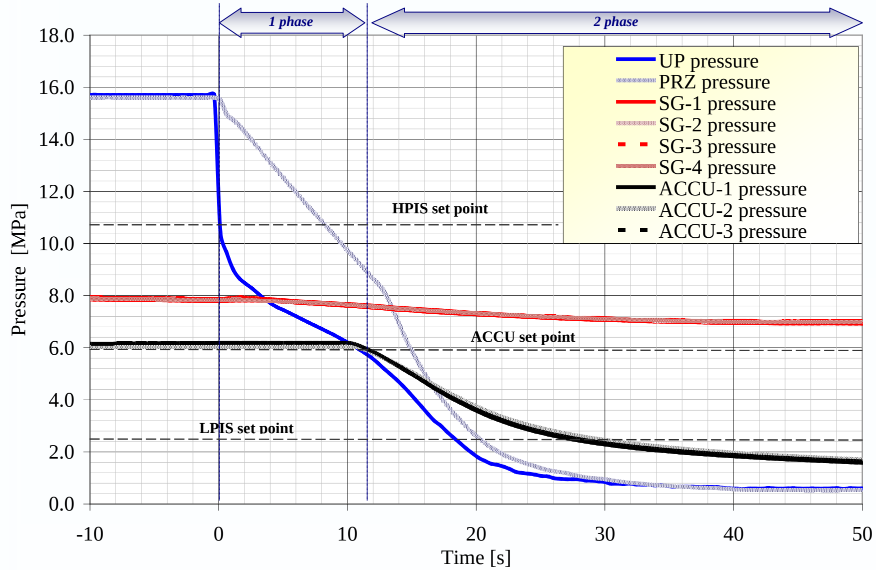
#	INTERFACING SYSTEM	CHARACTERISTICS	STATUS	REMARKS
1	PRZ connection status	Loop #4.	--	
2	Break component	Connected to loop #3. Nozzles: Φ= 50mm; L = 350mm. Break opening time 0.001 - 0.01s	--	
3	Accumulators	3 out of 4 systems available: o 1 ACCUs with the DC. o 2 ACCUs with the UP.	Active 3 of 4 (failure of 1 ACCU connected with the DC)	ACCUs stop when lev < 1.01m.
4	ECCS HPIS	2 out of 3 active systems: o 1 CL of the broken loop. o CL of an intact loop w/o PRZ connection.	Active 2 of 3	Flow rate of a HPIS pump as function of the primary pressure
5	ECCS LPIS	2 out of 3 active systems available: o 1 LPIS connected through the accumulators lines to UP and DC. o 1 LPIS connected to HL and CL of the loop #3.	Active 2 of 3	Flow rate of a LPIS pump as function of the primary pressure
6	MCP	4 MCP in operation	Active	MCP coastdown relative rotation vs. time.
7	AFW /EFW	--	Not operated	
8	FW	The FW system is operated for keeping the level at the nominal value of 2.25m. The FW temperature is 220°C	Active	--

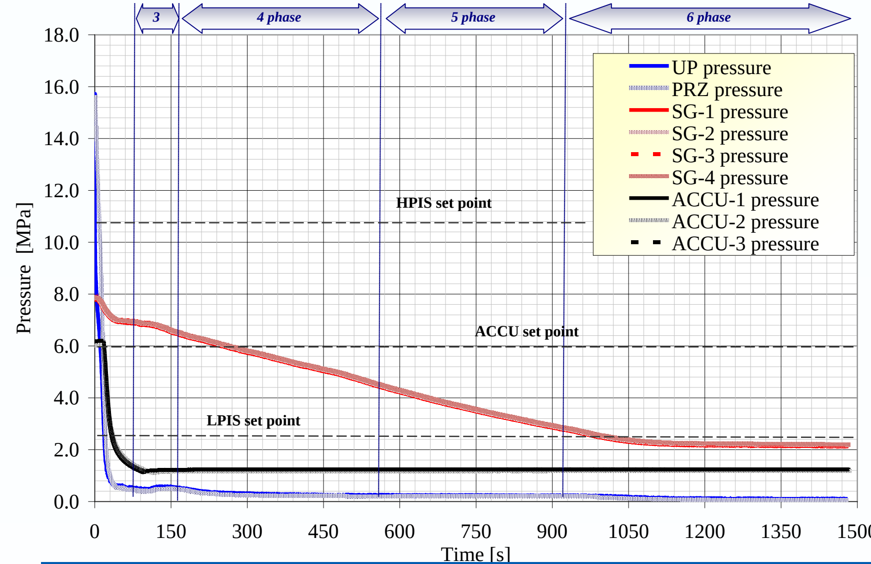
TEST 5A (CL-2X100-01) DESCRIPTION

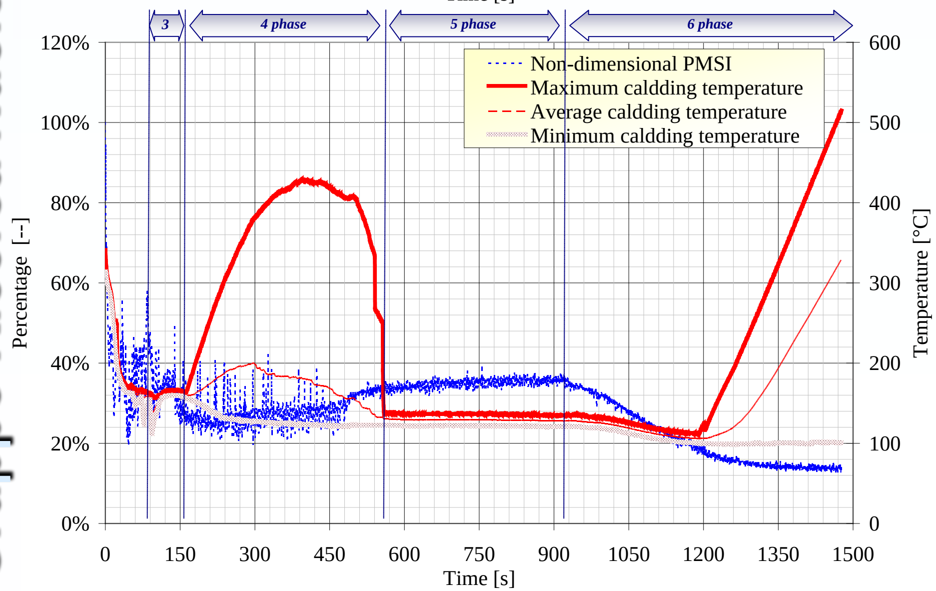
OECD/NEA PSB-VVER CL-2x100-01: imposed sequence of main events

#	IMPOSED EVENT DESCRIPTION	INTERFACING SYSTEM	SIGNAL (TIME OR SET POINT)	REMARKS
1	DEGB occurrence in CL of loop #3	Break component	0 s	--
2	Reactor SCRAM	Core	0.4 s	Power vs. time assigned
3	Trip of the MCP and cosadown	MCP	-0.3 s	Coastdown assigned
4	Stop of FW pumps	FW pumps	FW #1 → 4.7 s FW #2 → 4.1 s FW #3 → 10.8 s FW #4 → 6.5 s	--
5	Turbine valve closure	Main Steam Isolation Valve	0 s	Completed closed at 15.5s
6	ECC accumulator injection start	3 Accumulators	PS pressure < 6.0MPa	--
7	ECC accumulator injection stop	3 Accumulators	Level accumulator tank #1 < 0.68m Level accumulator tank #3 < 0.60m Level accumulator tank #4 < 0.35m	--
8	ECCS connected to an emergence power supply	Active ECCS (HPIS and LPIS)	40.3s	--
9	ECCS HPIS	2 HPIS systems	PS pressure < 10.80MPa and Event #8	Connected
10	ECCS LPIS	2 LPIS systems	PS pressure < 2.50MPa and Event #8	--
11	ECC Systems (LPIS and HPIS) stop	2 HPIS and 2 LPIS systems	Total mass injected > 1830kg	--
12	End of the transient	--	Final core heat up and ECCS systems disabled	No emergency systems available for feeding the primary system (sump empty)

TEST 5A DESCRIPTION







❑ Six phases are distinguished:

- Blowdown ph. (0s – 11.4s): from the SoT up to RPV level increase
- Refill ph. (11.4s – 84s): up to the ACCUs effectiveness
- PMI reduction ph. (84s – 159s): up to the onset of core heatup
- Dryout ph. (159s – 559s): up to core quenching
- Stable safe condition ph. (559s – 921s): up to the active ECCS tanks emptying
- PMI depletion ph. and EoT (921s – 1477s)

COMPARISON AMONG PARTICIPANTS INPUT DECKS

General information of the nodalization and the code options

#	QUANTITY	Unit	EDO-GP Pretest KORSAR	EDO-GP Posttest KORSAR	EDO-GP Pretest TECH-M	EDO-GP Posttest TECH-M	NRI Posttest ATHLET	UNIPI Posttest R5-3D
1	**ADOPTED CODE RESOURCES**							
1-1	Tot. No. of hydr. components PS	--	--	--	--	--	142	482
1-2	Tot. No. of hydr. components	--	185	193	--	--	164	620
1-3	Tot. No. of hydr. nodes (meshes) PS	--	--	--	76+36	76+36	693	--
1-4	Tot. No. of hydr. nodes (meshes)	--	858	825	81+36	81+36	820	2474
1-5	Tot. No. of heat structures	--	52	65	81+36	81+36	90	2171
1-6	Tot. No. of mesh points in the heat structures	--	509	629	4	4	2108	11263
1-7	Tot. No. of core active structures	--	10	10	30	30	20	20
1-8	Tot. No. of core radial meshes in the active structures	--	--	--	7	7	3	13
2	**NODALIZATION FEATURES**							
2-1	No. of modeled loops	--	4	4	4	4	4	4
2-2	No. of horizontal tubes per SG	--	4	4	1	1	5	17
2-3	Core model (3-D or 1-D)	--	1-D	1-D	1-D	1-D	1-D	1D
2-4	No. of hydr. channels in core region	--	1	1	3	3	2	2
2-5	Crossflow junctions between parallel channels in the core	--	YES	YES	No	No	NO	YES
3	**CODE OPTIONS**							
3-1	Reflood model TOP-DOWN	--	--	YES	YES	YES	NO	YES
3-2	Reflood model BOTTOM-UP	--	--	YES	YES	YES	NO	YES
3-3	CCFL model	--	--	NO	YES	YES	WALLIS	NO

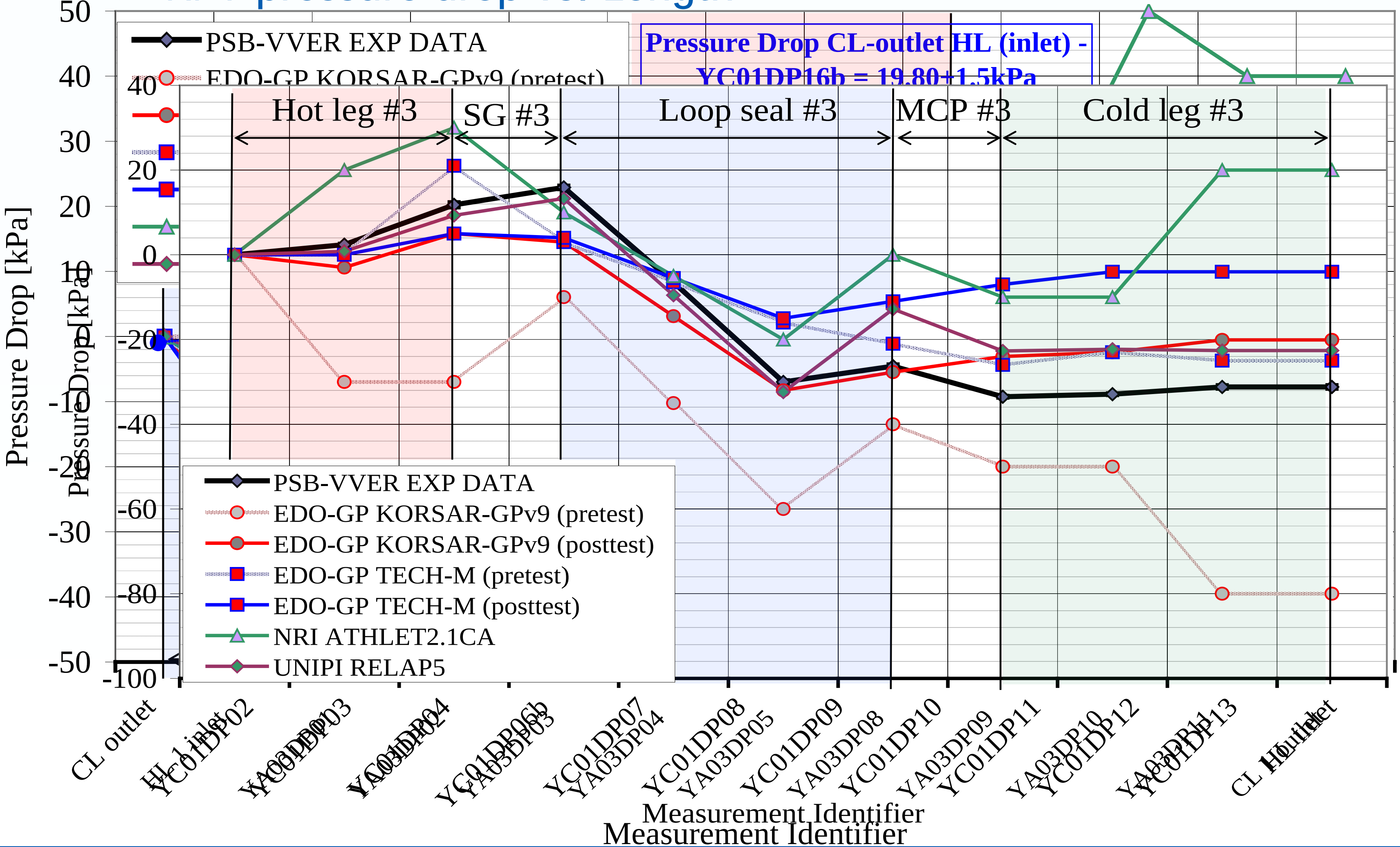
COMPARISON AND EVALUATION OF STEADY STATE RESULTS

- **The step includes two main tasks:**
  - **1** → the verification and evaluation of the geometrical fidelity of the model developed, also called the "nodalization development phase"
    - ✓ It consists in a systematic comparison between the volumes, the surfaces and the absolute and the relative vertical positions between the system to be modeled and the nodalization
  - **2** → the capability of the analytical model to achieve stable steady state with the correct initial conditions as in the experiment to be simulated. This step is "the steady state qualification"
    - ✓ The steady state qualification (step two) deals with the comparisons between the experimental measurements and the calculated results at the Start of Transient (SoT)

COMPARISON AND EVALUATION OF STEADY STATE RESULTS

STEADY STATE RESULTS: sample results

- RPV pressure drop vs. Length



COMPARISON AND EVALUATION OF REFERENCE RESULTS

TABLE OF RESULTING SEQUENCE OF MAIN EVENTS (part 1 of 2)

#	EVENT DESCRIPTION	EXP (sec)	EDO-GP Pretest KORSAR	EDO-GP Posttest KORSAR	EDO-GP Pretest TECH-M	EDO-GP Posttest TECH-M	NRI Posttest ATHLET	UNIPI Posttest R5-3D	Note
1	DEGB occurrence	**0.0**	0.0	0.0	0.0	0. .0	0.0	0.0	Imposed event
2	Reactor SCRAM	**0.0**	0.2	0.2	0.2	0.2	0.0	0.0	Imposed event
3	MCP trip and coastdown	**0.0**	0.0	0.0	0.4	0.4	0.0	0.0	Imposed event
4	Turbine valve closure begins	**0.0**	0.0	0.0	0.1	0.1	0.0	0.0	Imposed event
5	Flashing of coolant at the outlet of core model	**0.4**	0.4	1.0	1.0	0.2	0.4	0.2	
6	UP Pressure < 10.8 MPa	**0.54**	0.4	0.8	0.8	0.9	0.35	0.2	
7	Coolant reaching saturation in CLs SGs outlet - Loop #1 - Loop #2 - Loop #3 - Loop #4	 **2.8** **2.3** **0.03** **3.1**	 -- -- -- --	 -- -- -- --	 -- -- -- --	 -- -- -- --	 -- -- -- --	 5.0 4.9 2.0 4.7	
8	Coolant reached saturation at core inlet	**1.0**	1.0	1.0	1.0	0.6	1.4	1.3	
9	Primary pres. below secondary pressure	**4.0-4.3**	7.7	6.5	9.0	6.0	6.5	5.2	
10	Stop of FW pumps	**4.1-8.7**	5.2	4.0	0.4.0	0.4	0.0	0.0	
11	ECC Acc injection start	**10.2-10.7**	9.2	11	10.0	12.0	10.9	11.1	
12	PRZ emptied (level < 0.1m)	**11**	6.3	7.0	9.7.0	12.4	8.6	11.9	
13	Turbine valve fully closed	**15.5**	16.0	15.0	--	--	--	15.7	Imposed
14	Pressure in UP < 2.5 MPa	**18.6**	14.7	19	18.0	19.8	18.0	17.9	

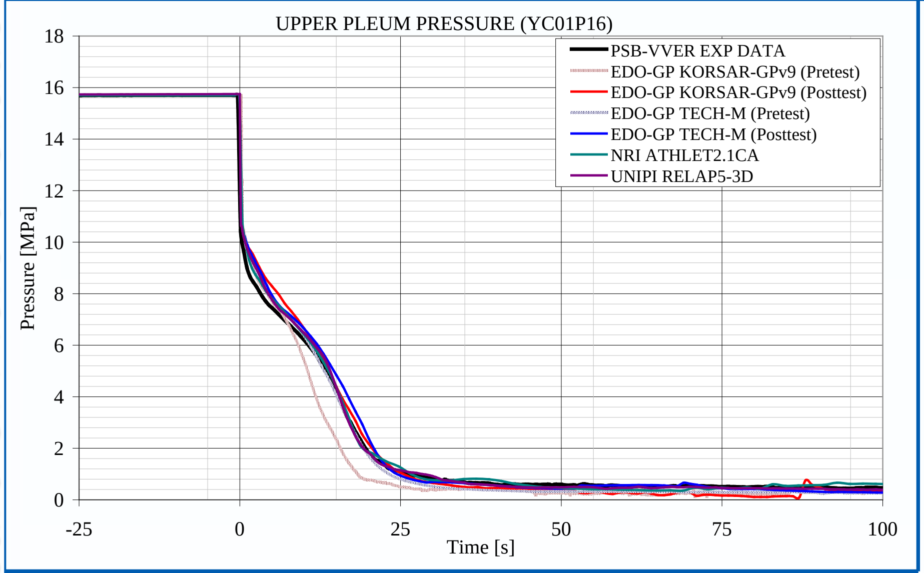
COMPARISON AND EVALUATION OF REFERENCE RESULTS

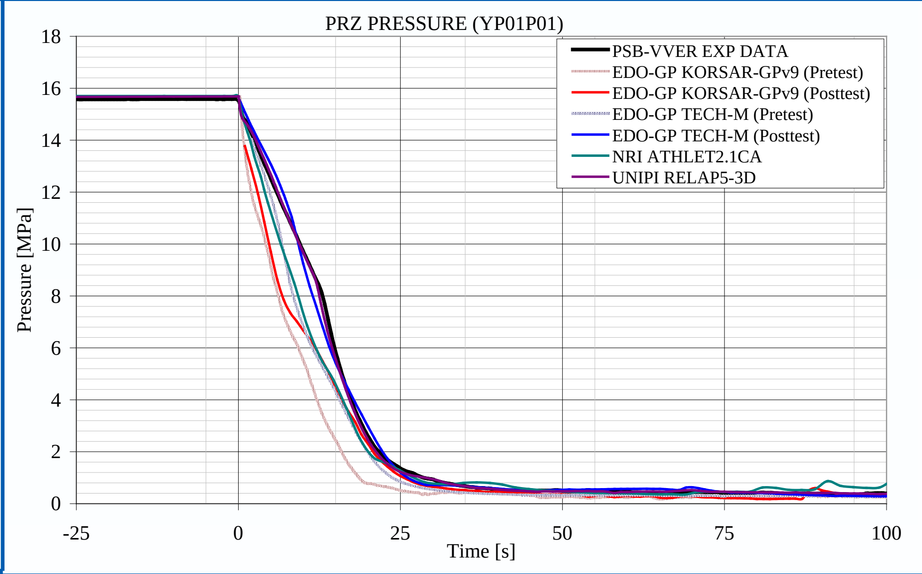
❑ TABLE OF RESULTING SEQUENCE OF MAIN EVENTS (part 2 of 2)

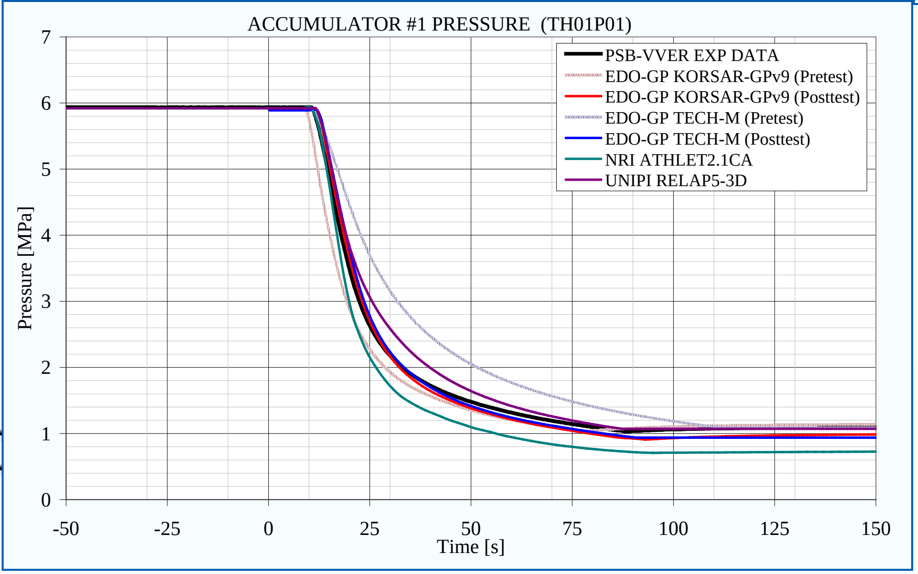
#	EVENT DESCRIPTION	EXP (sec)	EDO-GP Pretest KORSAR	EDO-GP Posttest KORSAR	EDO-GP Pretest TECH-M	EDO-GP Posttest TECH-M	NRI Posttest ATHLET	UNIPI Posttest R5-3D	Note
14	Pressure in UP < 2.5 MPa	**18.6**	14.7	19	18.0	19.8	18.0	17.9	
15	UP and PRZ pressures equalization	**31**	8	8	28	30	21	36.8	
16	ECCS connected to an emergence power supply	**40**	40	40	40	40	40.3	40	Imposed event
17	ECCS HPIS injection	**40**	40	40	40	40	40	40	
18	ECCS LPIS injection	**40**	40	40	40	40	40	40	
19	ECC Acc. injection stop - Acc #1 - Acc #3 - Acc #4	 **89** **107** **92**	 77 77 77	 93 100 96	113	104	95	 88 91 94	
20	First dry out occurrence	**159**	94*	150	177	134	43	153	
21	End of MCP coastdown	**231**	232	231	217	231	232	232	
22	Max. PCT in the core	**395**	109*	339	232	476**	296	385	
23	Overall quenching	**559**	117*	462	--	559	487	493	
24	All ECCS stop	**921**	862	872	898	884	903	923	
25	Second dry out occurrence	**1187**	106	1258	911	904	1148	1072	Top of the core
26	End of calc. (Max Tcl=516°C)	**1477**	1100	1566	1241	1230	1500 ***	1360	

COMPARISON AND EVALUATION OF REFERENCE RESULTS

QUALITATIVE ACCURACY EVALUATION





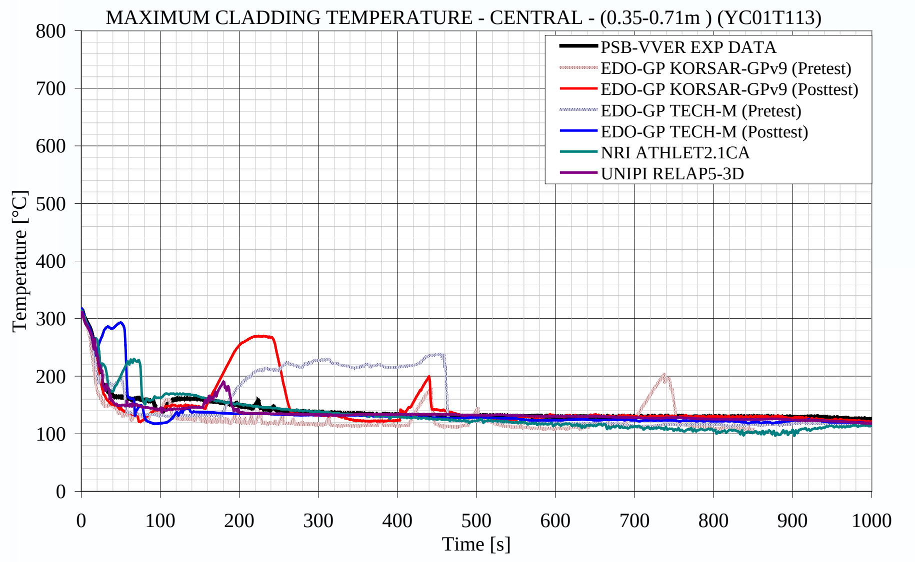


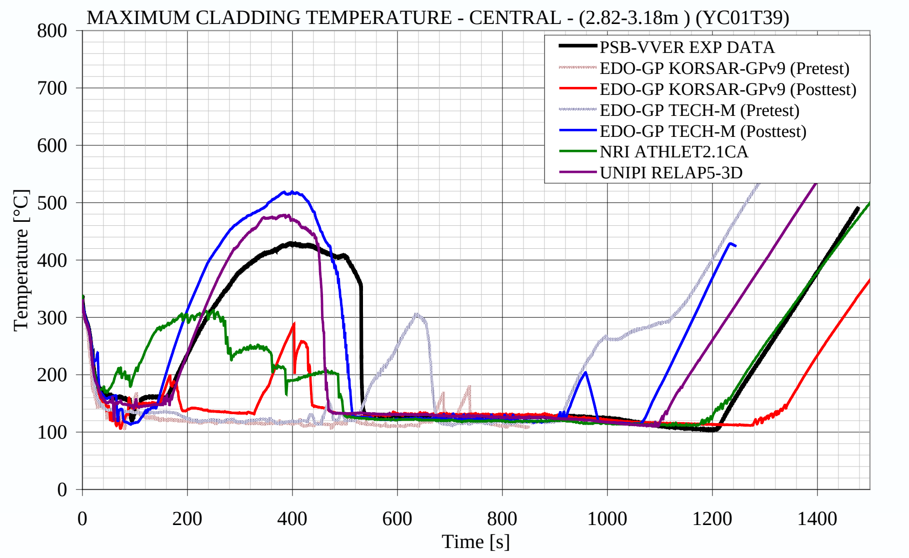
❑ **SELECTED TIME TRENDS**

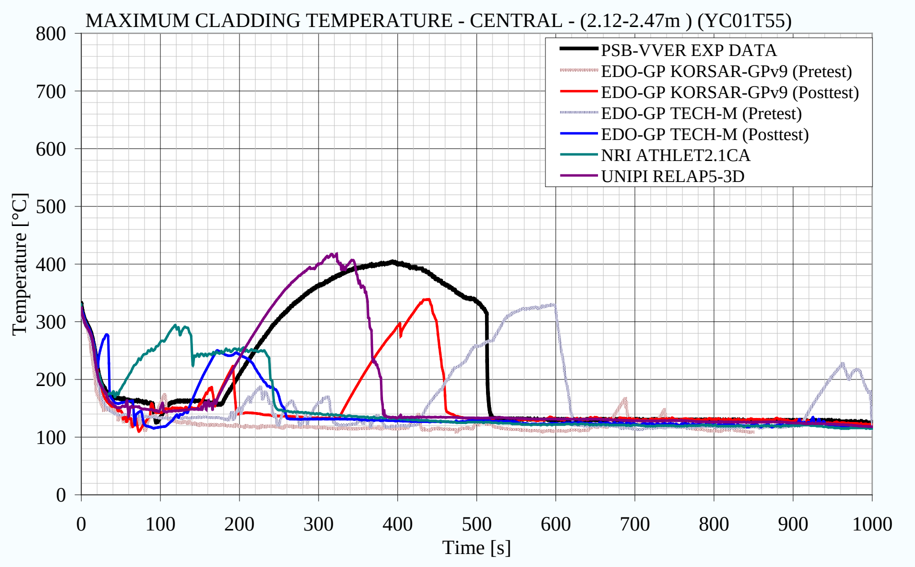
- Upper plenum pressure
- PRZ pressure
- ACC pressure

COMPARISON AND EVALUATION OF REFERENCE RESULTS

QUALITATIVE ACCURACY EVALUATION







❑ SELECTED TIME TRENDS

- Max clad temp trends
  - ✓ between 0.35 and 0.71m
  - ✓ between 2.12 and 2.47m
  - ✓ between 2.82 and 3.18m

❑ QUALITATIVE ACCURACY EVALUATION OF THE RTA (part 1 of 2)

#	PARAMETER	TYPE	UNIT	EXP	EDO-GP Pretest KORSAR		EDO-GP Posttest KORSAR		EDO-GP Pretest TECH-M		EDO-GP Posttest TECH-M		NRI Posttest ATHLET		UNIPI Posttest R5-3D	
					Value	J	Value	J	Value	J	Value	J	Value	J	Value	J
1	**RTA: BREAK FLOW RATE BEHAVIOR**															
1-1	Sub-cooled BRK flow ended	TSE	s	**1.1-1.7**	1.8	E	2	E	–	–	0.2	R	1.3	E	3.3	R
1-2	Int. BRK flowrate at ACC inject. time	IPA	kg	**441**	410	E	744	M	–	–	626	M	676.2	M	715	M
1-3	Int. BRK flowrate at ECCS active inject. time	IPA	kg	**708**	820	R	983	M	–	–	881	R	956.1	M	989	M
1-4	Int. BRK flowrate at 1st dryout time	IPA	kg	**1279**	1234	E	1477	R	–	–	1291	E	971.3	M	1479	R
1-5	Int. BRK flowrate at core quenching time	IPA	kg	**2086**	2754	R	2183	E	–	–	2181	E	2088.0	E	2145	E
1-6	Int. BRK flowrate at final dryout time	IPA	kg	**2993**	3000	E	3088	E	–	–	2893	E	3050.0	E	3106	E
2	**RTA: PRZ BEHAVIOR**															
2-1	Time of emptying (lev. < 0.1 m)	TSE	s	**11**	8	R	6.8	R	–	–	12.5	E	8.6	R	11.9	E
2-2	PRZ press./Prim. press. at 5 s	NDP	–	**1.67**	1.19	R	1.17	R	–	–	1.65	E	1.44	R	1.63	E
2-3	PRZ press./Prim. press. at 10 s	NDP	–	**1.55**	1	M	1	M	–	–	1.40	E	1.14	R	1.50	E
2-4	PRZ press./Prim. press. at emptying time	NDP	–	**1.54**	1	M	1.04	M	–	–	1.23	R	1.25	R	1.46	E
2-5	Time of PRZ- Prim. press equalization	TSE	s	**33.6**	30	E	8	M	–	–	53	M	20.7	M	36.8	E
3	**RTA: FIRST DRYOUT OCCURRENCE**															
3-1	Time of dryout	TSE	s	**159**	81	M	150	R	–	–	134	E	42.8	M	153	E
3-2	PS mass / Initial mass at dryout occurrence	NDP	–	**0.3**	–	–	0.13	R	–	–	–	–	0.11	R	0.1	R
3-3	Core collapsed lev. (with reference to BAF) at dryout occurrence $	SVP	m	**0.0**	–	–	1.77	M	–	–	0.94	M	0.226	R	0.0	E
3-4	Time of PCT	TSE	s	**395**	737	M	440	R	–	–	475	R	296	R	385	E
3-5	PCT	SVP	°C	**428**	217	M	339	R	–	–	521	R	398	E	478	R
3-6	Minimum core collapsed lev. $	SVP	m	**0.0**	1.6	M	0.84	M	–	–	0.27	R	0.187	R	0.0	E
3-7	Time of core recovering	TSE	s	**559**	757	R	462	R	–	–	551	E	528	E	493	R
4	**RTA: UP PRESSURE BEHAVIOR**															
3-1	Press. at 10 s	SVP	MPa	**6.2**	5.41	R	6.63	R	–	–	6.64	R	6.41	E	6.5	E
3-2	Press. at 20 s	SVP	MPa	**1.84**	0.78	M	2.2	M	–	–	2.4	M	1.86	E	1.84	E
3-3	Press. at dry out time	SVP	MPa	**0.52**	0.23	M	0.4	R	–	–	0.34	M	0.62		0.43	R
3-4	Press. at core quenching time	SVP	MPa	**0.23**	0.18	E	0.345	M	–	–	0.2	E	0.19		0.28	R
3-5	Press. at final dryout time s	SVP	MPa	**0.10**	0.12	E	0.136	R	–	–	0.18	M	0.11		0.15	R

$ Value derived by the measure of the RPV level.

QUALITATIVE ACCURACY EVALUATION OF THE RTA (part 2 of 2)

#	PARAMETER	TYPE	UNIT	EXP	EDO-GP Pretest KORSAR		EDO-GP Posttest KORSAR		EDO-GP Pretest TECH-M		EDO-GP Posttest TECH-M		NRI Posttest ATHLET		UNIPI Posttest R5-3D	
					Value	J	Value	J	Value	J	Value	J	Value	J	Value	J
5	**RTA: ACCUMULATOR BEHAVIOR**															
5-1	ACCs intervention time	TSE	s	**10.2-10.7**	9.2	E	11.0	E	–	–	12	E	10.9	E	11.1	E
5-2	ACC1 press. 10 s after inject. time initiation	TSE	s	**3.3-3.4**	3.02	R	3.63	E	–	–	3.3	E	2.77	R	3.8	R
5-3	ACC1 press. 20 s after injection initiation	TSE	s	**2.1-2.3**	1.98	E	2.16	E	–	–	2.1	E	1.67	R	2.5	E
5-4	ACC1 press. at ACCs isolation	TSE	s	**1.03**	1.03	E	0.915	E	–	–	0.945	E	0.72	R	1.01	E
6	**RTA: ECCS (HPIS AND LPIS) BEHAVIOR**															
6-1	Total int. ECCS flowrate at first core dryout	SVP	kg	**234**	90	M	696*	–	–	–	662*	–	–	–	219	E
6-2	Total int. ECCS flowrate at first core quenching time	SVP	kg	**1086**	1592	M	1382*	R	–	–	1570*	–	–	–	939	R
6-3	Total int. ECCS flowrate at final core dryout	SVP	kg	**1858**	1823	E	2283*	–	–	–	2299*	–	–	–	1853	E
7	**RTA: PS MASS BEHAVIOR**															
7-1	Minimum mass / initial mass	NDP	–	**0.13**	0.033	M	0.04	M	–	–	0.06	M	0.08	R	0.06	M
7-2	Primary mass / initial mass at core quench. time	NDP	–	**0.33**	–	–	0.13	M	–	–	0.22	R	0.17	M	0.18	M
7-3	Primary mass / initial mass at final core dryout	NDP	–	**0.19**	–	–	0.11	R	–	–	0.25	R	0.13	R	0.12	R
8	**RTA: FINAL DRYOUT OCCURRENCE**															
8-1	Time of dryout	TSE	s	**1187**	886	M	1256	R	–	–	904	M	1148	E	1072	R
8-3	Core collapsed lev. (with reference to BAF) at dryout occurrence	SVP	m	–	1.8	–	2.7	–	–	–	1.2	–	1.65	–	1.47	–
8-4	Cladding temperature reaches 516°C (end of the transient)	TSE	s	**1477**	1100	M	1566	R	–	–	1230	R	1446	E	1360	R

* The value include the mass injected by the accumulator systems

COMPARISON AND EVALUATION OF REFERENCE RESULTS

QUANTITATIVE ACCURACY EVALUATION

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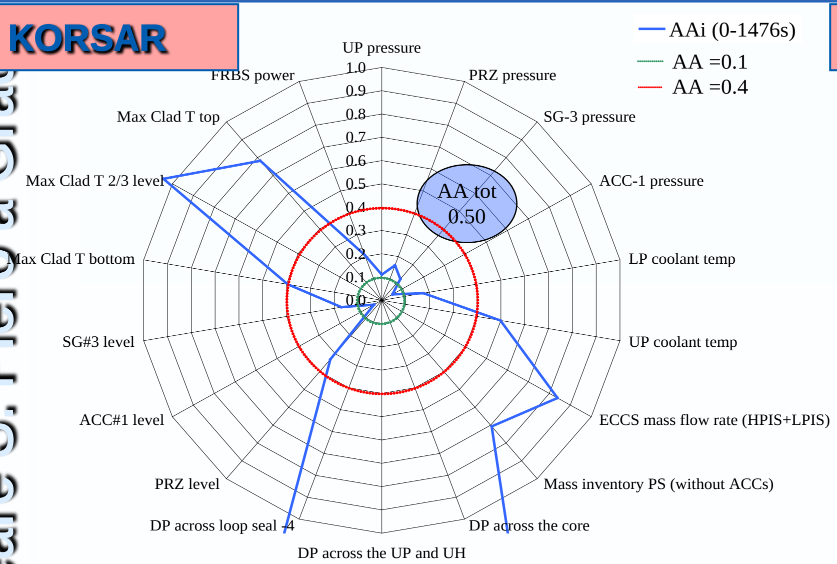
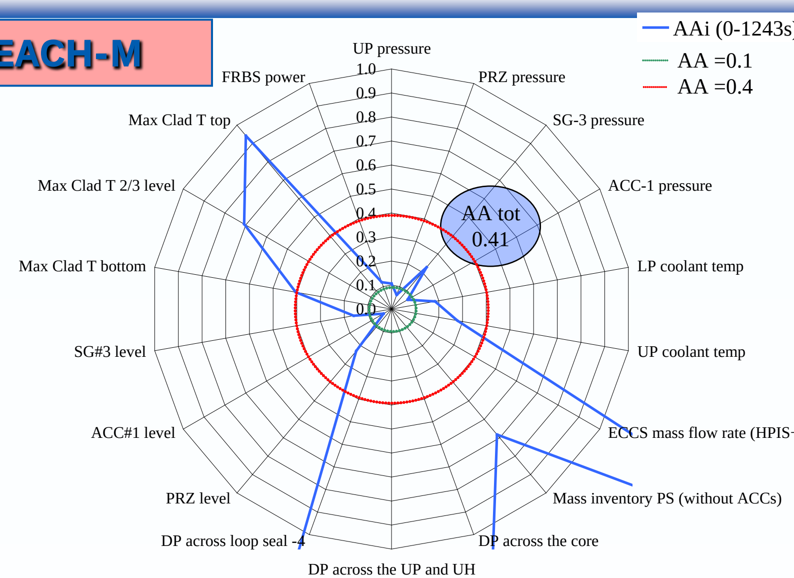
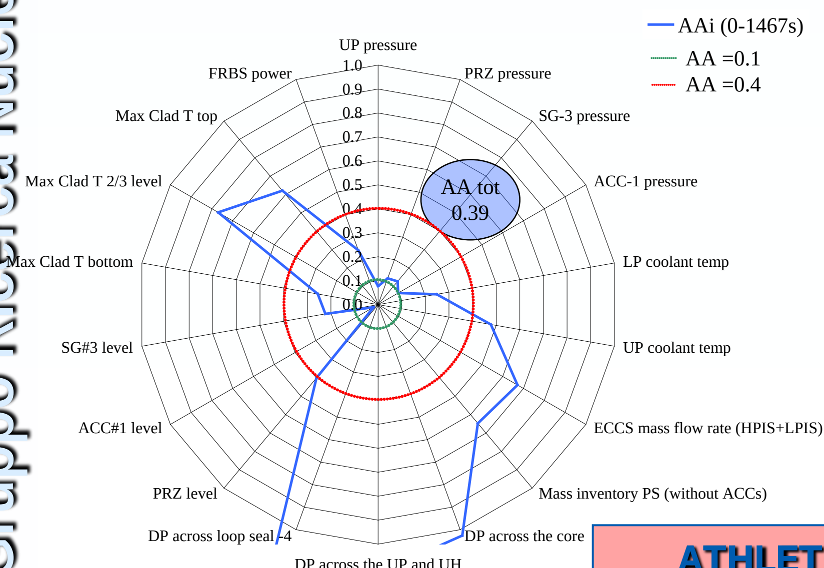
FFTBM POSTTEST RESULTS

KORSAR



TEACH-M





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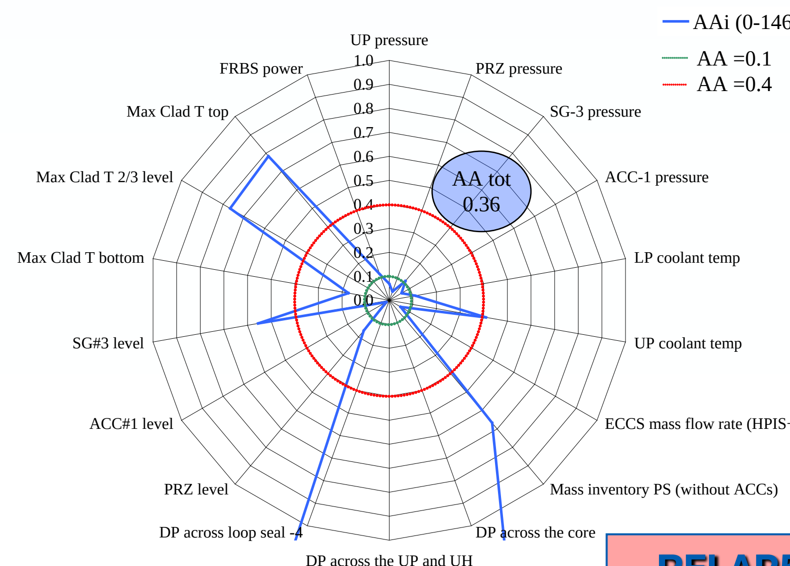

RELAP5-3D

COMPARISON AND EVALUATION OF REFERENCE RESULTS

QUANTITATIVE ACCURACY EVALUATION

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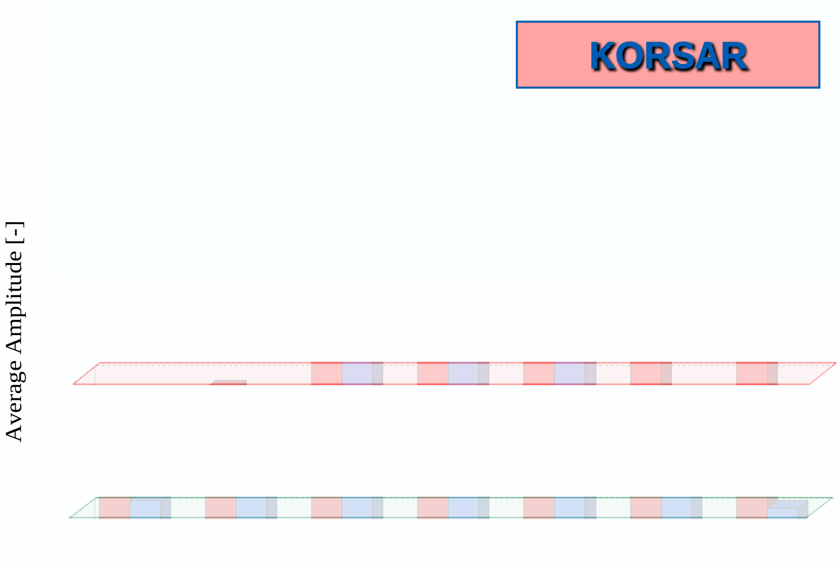
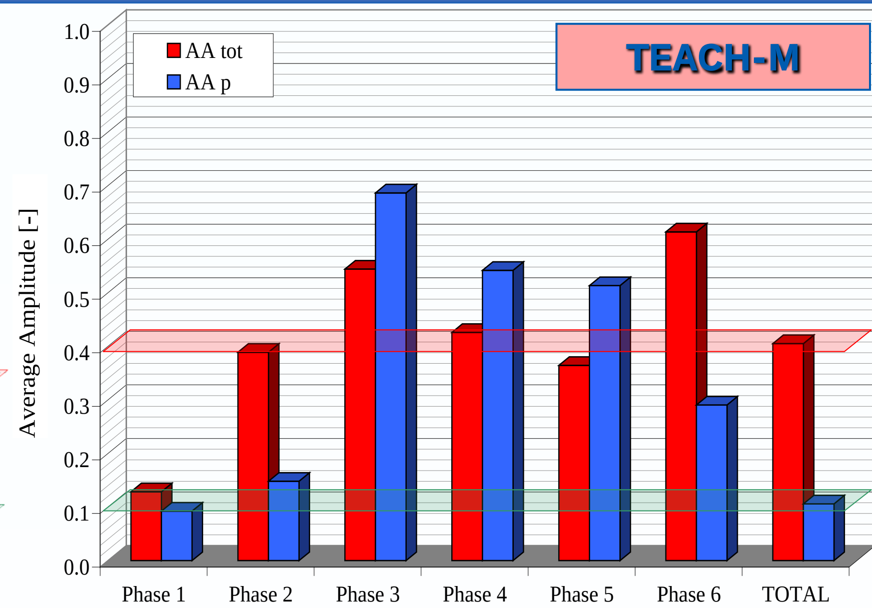
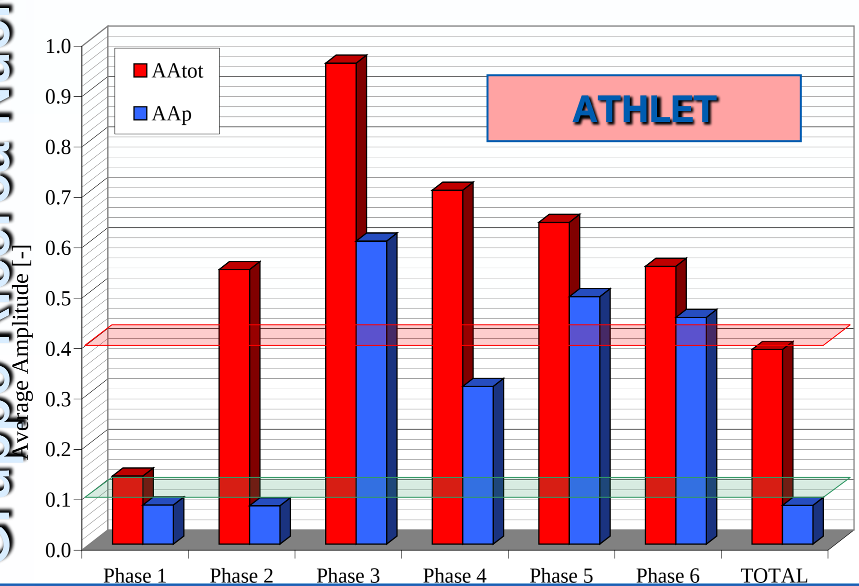
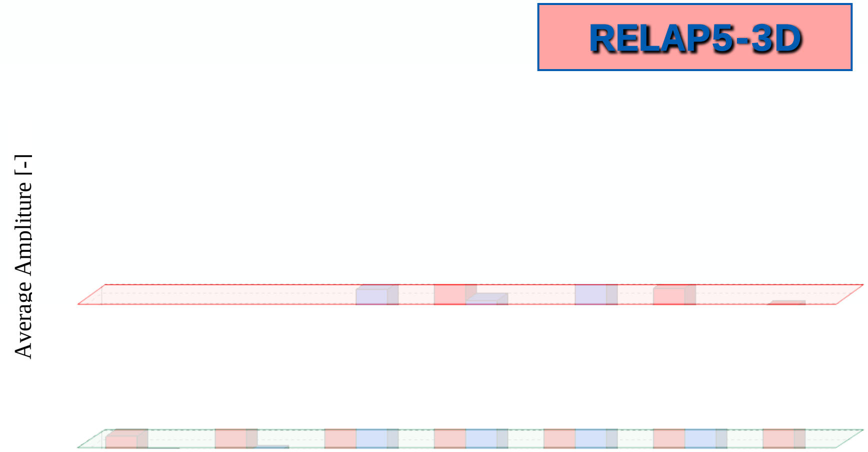
FFTBM POSTTEST RESULTS









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QUANTITATIVE ACCURACY EVALUATION

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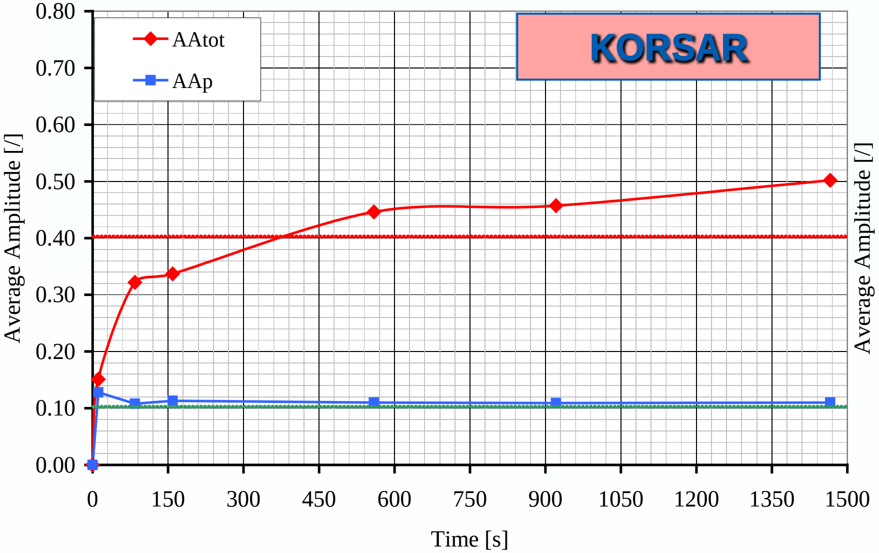

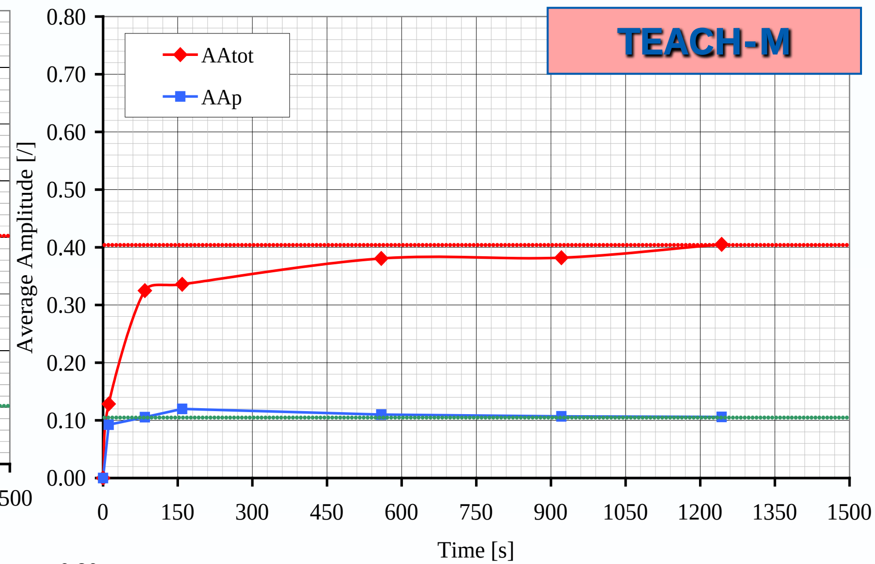

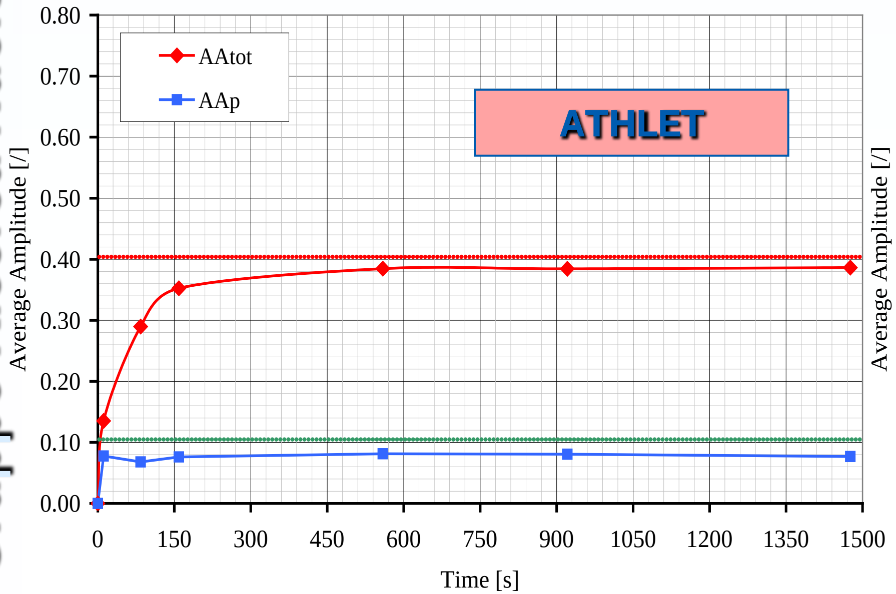

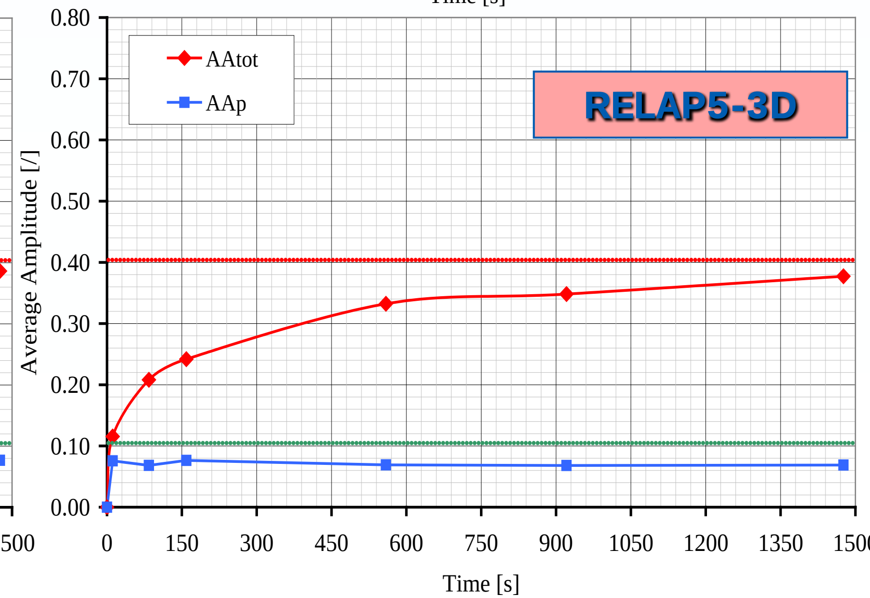

FFTBM POSTTEST RESULTS

CONCLUSIVE REMARKS

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- **The OECD/NEA PSB-VVER project provided unique and useful experimental data for code validation by the scaled down test facility PSB-VVER.**
- **A benchmark activity has been carried out using the data of the experiments test #5a (identification CL-2x100-01: four participants and three different institutions were involved. The Western (i.e. ATHLET and RELAP5-3D©) and Eastern (KORSAR and TECH-M) advanced computer codes are appleid.**
- **This benchmark activity is conducted through comprehensive comparisons based on the following steps:**
  - comparison of the features of the analytical models applied;
  - verification of the code performance “at steady state level”;
  - assessment of the code performance at “on transient level” based on a qualitative and quantitative (FFTBM) accuracy evaluations of the results.

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BENCHMARK ON
OECD/NEA PSB-VVER PROJECT TEST 5A:
LB-LOCA TRANSIENT IN PSB-VVER FACILITY

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NRI (Czech Republic): M. Benčik

Pisa, April 2009 DIMNP NT 638(08) Rev. 2

OECD/NEA PSB-VVER Project

CONCLUSIVE REMARKS

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- **Specific outcomes from the analyses.**
  - All codes runs predict the primary pressure trend with satisfactory results
  - The maximum cladding temperature is overestimated (posttest) with the exception of the ATHLET simulation that highlighted an excellent accuracy
  - The primary mass inventories predicted resulted in general lower than the experimental (indirect) measure
- **Outcomes from the application of the FFTBM (quantification of the accuracy) are:**
  - The average accuracy of primary pressure is < 0.1 or very close to this threshold
  - All code simulations showed a "very good" prediction of the experiment (AAtot < 0.4) or a "good" prediction (0.4<AAtot<0.5)
- **The benchmarking activity and the availability of the experimental data brought to the following technological advancement.**
  - The TEST 5a, executed in the largest and most qualified ITF currently available for VVER-1000 type reactors, represents an enlargement of the "VVER code validation matrix"
  - The benchmark is also an enlargement of the validation activity for the TH-SYS codes. The comparison of western and eastern computer codes represent a further valuable achievement

FUTURE ACTIVITIES

- Next Int. benchmarks in which GRNSPG/UNIPI is involved
  - OECD ISP ATLAS
  - OECD PKL-2
  - IAEA ISCP MASLWR