



Recent experience with MELCOR

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MELCOR – main tool for severe accident analyses at VUJE

- Almost exclusively VVER440 models
VVER440 (6-loop, PWR, with BWR like fuel assemblies (fuel canisters), after reactor trip configuration with fuel and also fuel bypass in the lower plenum),
- MELCOR 1.8.3 – two-loop model (single and fivefold loop), up to 2004,
- MELCOR 1.8.5 RK – (2004 – 2020), “happy times”, three-loop model, many successful projects, hundreds of analyses, (6/2004 MELCOR 1.8.5 RK version and model still kept as a life boat),
- MELCOR 2.x (2010 -) – new reactor model developed and “welded” onto 3-loop model translated into 2.x format.

MELCOR – main tool for severe accident analyses at VUJE

- Presently:
- 15254 (10/2019) regularly used with various success, (safety report analyses, using all my faculties and cunning, ultimately successful),
- 18019 (12/2020), 21402 (12/2021) and recent r2023 (3/2023) used sparsely and usually in the mode “we shall watch and pray”,
- MELCOR 2.2 VVER440 model translated by Robert Sanders into MELCOR 1.8.6 to be used in the full scope simulator of Bohunice V2 NPP.

Four crashes of MELCOR (1)

- Nr. 1 – in fact not a real crash. Just a stop of calculation.
- Information is provided that calculation requires some activity that cannot be physically done.
Such as a pump wants to take water out of volume where there is no more pool mass.
- Very helpfull – leads to computational model repair/upgrade.

Four crashes of MELCOR (2)

- Nr. 2 – there is information where there is instability, hinting a solution.
- In shown case usually helps:
- pool/atmosphere heat transfer fraction change,
- time step change,
- turning off of mass transfer at the HS.

```
<Diagnostic Message> Time= 4.5607E+04 Dt= 2.5269E-05 Cycle= 696904 (HS ) L,C= 2,447146
Attempted cycle advancement was unsuccessful / DT reduced to = 1.2634E-05
<Diagnostic Message> Time= 4.5607E+04 Dt= 1.2634E-05 Cycle= 696904 (HS ) L,C= 3,447147
ERROR IN TEMPERATURE ALGORITHM EXCEEDS DESIRED TOLERANCE
FOR HEAT STRUCTURE HS00051
TEMPERATURE ERROR = 3.219E-03, TOLERANCE = 5.000E-04
<Diagnostic Message> Time= 4.5607E+04 Dt= 1.2634E-05 Cycle= 696904 (MEX) L,C= 3,447148
REQUEST FOR FORCED PLOT DUMP SEQUENCE IGNORED. TOO MANY FALLBACKS.
ALL FUTURE REQUEST DURING THIS EXECUTION IGNORED.
<Diagnostic Message> Time= 4.5607E+04 Dt= 2.0023E-05 Cycle= 696905 (MEX) L,C= 3,447149
REQUEST FOR FORCED PLOT DUMP SEQUENCE IGNORED. TOO MANY FALLBACKS.
ALL FUTURE REQUEST DURING THIS EXECUTION IGNORED.
<Diagnostic Message> Time= 4.5607E+04 Dt= 3.1734E-05 Cycle= 696906 (MEX) L,C= 3,447150
REQUEST FOR FORCED PLOT DUMP SEQUENCE IGNORED. TOO MANY FALLBACKS.
ALL FUTURE REQUEST DURING THIS EXECUTION IGNORED.
<Diagnostic Message> Time= 4.5607E+04 Dt= 5.0295E-05 Cycle= 696907 (HS ) L,C= 3,447151
HS PACKAGE TIME STEP CUT
TEMPERATURE CONVERGENCE FAILURE FOR HEAT STRUCTURE HS00051
TEMPERATURE ERROR = 1.031E-02
<Diagnostic Message> Time= 4.5607E+04 Dt= 5.0295E-05 Cycle= 696907 (HS ) L,C= 3,447152
HS PACKAGE CUT TIME STEP
FATAL ERROR FOR HEAT STRUCTURE HS00051
<Diagnostic Message> Time= 4.5607E+04 Dt= 5.0295E-05 Cycle= 696907 (HS ) L,C= 3,447153
HS package requested repeating cycle 696907 with halved timestep
<Diagnostic Message> Time= 4.5607E+04 Dt= 5.0295E-05 Cycle= 696907 (HS ) L,C= 2,447154
Attempted cycle advancement was unsuccessful / DT reduced to = 2.5147E-05
<Diagnostic Message> Time= 4.5607E+04 Dt= 2.5147E-05 Cycle= 696907 (MEX) L,C= 3,447155
REQUEST FOR FORCED PLOT DUMP SEQUENCE IGNORED. TOO MANY FALLBACKS.
ALL FUTURE REQUEST DURING THIS EXECUTION IGNORED.
<Diagnostic Message> Time= 4.5607E+04 Dt= 3.9855E-05 Cycle= 696908 (HS ) L,C= 3,447156
HS PACKAGE TIME STEP CUT
TEMPERATURE CONVERGENCE FAILURE FOR HEAT STRUCTURE HS00051
TEMPERATURE ERROR = 1.034E-02
<Diagnostic Message> Time= 4.5607E+04 Dt= 3.9855E-05 Cycle= 696908 (HS ) L,C= 3,447157
HS PACKAGE CUT TIME STEP
FATAL ERROR FOR HEAT STRUCTURE HS00051
<Diagnostic Message> Time= 4.5607E+04 Dt= 3.9855E-05 Cycle= 696908 (HS ) L,C= 3,447158
HS package requested repeating cycle 696908 with halved timestep
<Diagnostic Message> Time= 4.5607E+04 Dt= 3.9855E-05 Cycle= 696908 (HS ) L,C= 2,447159
Attempted cycle advancement was unsuccessful / DT reduced to = 1.9927E-05
<Diagnostic Message> Time= 4.5607E+04 Dt= 1.9927E-05 Cycle= 696908 (HS ) L,C= 3,447160
HS PACKAGE TIME STEP CUT
TEMPERATURE CONVERGENCE FAILURE FOR HEAT STRUCTURE HS00051
TEMPERATURE ERROR = 5.290E-03
<Diagnostic Message> Time= 4.5607E+04 Dt= 1.9927E-05 Cycle= 696908 (HS ) L,C= 3,447161
HS PACKAGE CUT TIME STEP
FATAL ERROR FOR HEAT STRUCTURE HS00051
<Diagnostic Message> Time= 4.5607E+04 Dt= 1.9927E-05 Cycle= 696908 (HS ) L,C= 3,447162
HS package requested repeating cycle 696908 with halved timestep
<Diagnostic Message> Time= 4.5607E+04 Dt= 1.9927E-05 Cycle= 696908 (HS ) L,C= 0,447163
DT LESS THAN DTMIN - LAST DT ATTEMPTED = 1.99270E-05
<Diagnostic Message> Time= 4.5607E+04 Dt= 1.9927E-05 Cycle= 696908 (HS ) L,C= 0,447164
TRACE TURNED ON AND CYCLE REPEATED BEFORE ABORT
<Diagnostic Message> Time= 4.5607E+04 Dt= 1.9927E-05 Cycle= 696908 (HS ) L,C= 2,447165
Attempted cycle advancement was unsuccessful / DT reduced to = 1.0000E-05
<Diagnostic Message> Time= 4.5607E+04 Dt= 1.0000E-05 Cycle= 696908 (HS ) L,C= 0,447166
MEXLOP fatal error pass - Initialization
DT= 1.0000E-05 IERR= 1 MEXTRC= 1
<Diagnostic Message> Time= 4.5607E+04 Dt= 1.0000E-05 Cycle= 696908 (MEX) L,C= 0,447167
MEXLOP fatal error pass - Communication
DT= 1.0000E-05 IERR= 1 MEXTRC= 1
<Diagnostic Message> Time= 4.5607E+04 Dt= 1.0000E-05 Cycle= 696908 (MEX) L,C= 0,447168
MEXLOP fatal error pass - Advancement
DT= 1.0000E-05 IERR= 1 MEXTRC= 1
```

Four crashes of MELCOR (3)

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Lister - [d:\2021_BS tazka havarie_nas 185 model prepisany do 22 s mojimi reaktorom_test\bohunice_PRISE\VER440.MES]
Súbor Upravit Možnosti Kódovanie Pomocník
100 %
FAILURE WAS BY CONTROL FUNCTION
/SMESAGE/ TIME= 4.11053E+04 CYCLE= 475210
COR0005: MESSAGE FROM CORE PACKAGE
CORE SUPPORT STRUCTURE (POMOCN) HAS FAILED IN CELL IA= 9 IR= 8
FAILURE WAS BY CONTROL FUNCTION
Listing written TIME= 4.11053E+04 CYCLE= 475210
Restart written TIME = 4.110529E+04 CYCLE= 475210
Restart written TIME = 4.300004E+04 CYCLE= 509436
/SMESAGE/ TIME= 4.32815E+04 CYCLE= 513151
COR0007: MESSAGE FROM CORE PACKAGE
END OF DEBRIS QUENCH IN RADIAL RING 7
Listing written TIME= 4.34775E+04 CYCLE= 516913
Restart written TIME = 4.347753E+04 CYCLE= 516913
Calculation terminated by: Executive detected abort signal - see above for reason
TIME= 4.34775E+04 CYCLE= 516913 CPU = 1.21319E+05

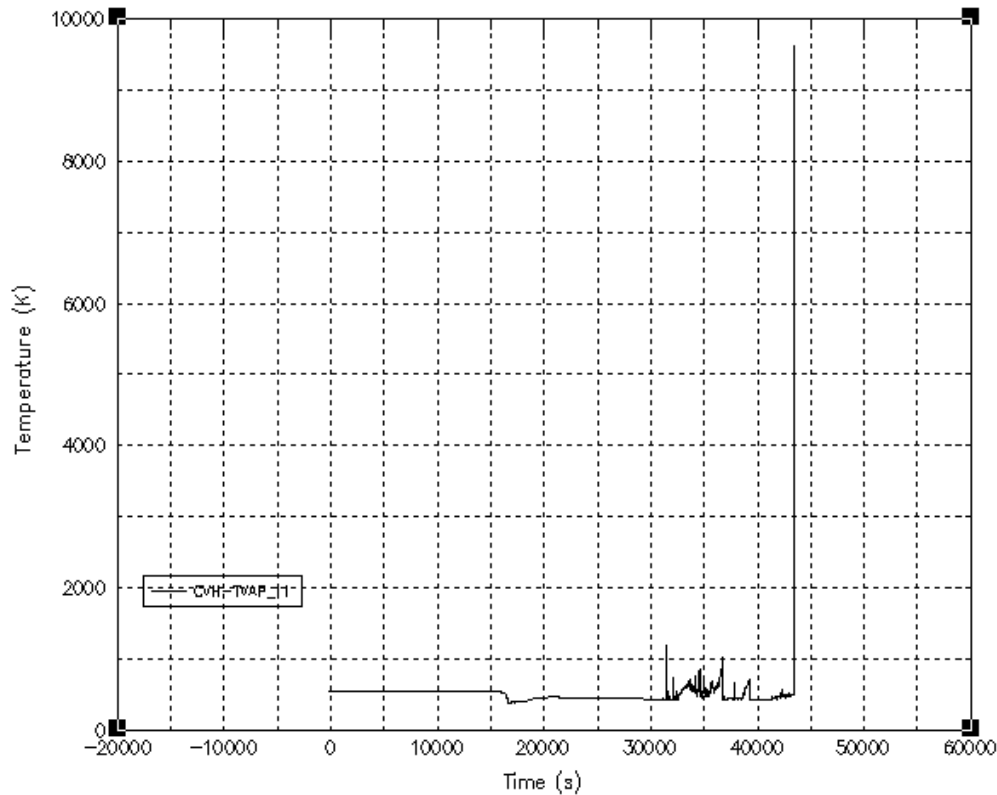
Lister - [d:\2021_BS tazka havarie_nas 185 model prepisany do 22 s mojimi reaktorom_test\bohunice_PRISE\EXTDIA0_VZC01]
Súbor Upravit Možnosti Kódovanie Pomocník
100 %
SUBCYCLE TIME STEP HAS BEEN REDUCED BELOW MINIMUM
CORRM1 (or routine called by it) requested a SYSTEM fallback
SYSTEM TIME STEP REDUCED TO 0.1000E-04
<Diagnostic Message> Time= 4.3478E+04 Dt= 1.2349E-03 Cycle= 516913 (COR) L,C= 3,1267654
COR package requested repeating cycle 516913 with timestep 1.000000E-05
<Diagnostic Message> Time= 4.3478E+04 Dt= 1.2349E-03 Cycle= 516913 (COR) L,C= 2,1267655
Attempted cycle advancement was unsuccessful - DT reduced to = 1.0000E-05
<Diagnostic Message> Time= 4.3478E+04 Dt= 1.0000E-05 Cycle= 516913 (COR) L,C= 1,1267656
ERROR IN CORTSU (DT/D2 MODEL), RESULTS IN INTERNAL FALLBACK IN CORRM1
<Diagnostic Message> Time= 4.3478E+04 Dt= 1.0000E-05 Cycle= 516913 (COR) L,C= 3,1267657
MESSAGE FROM SUBROUTINE CORDBD
CORRM1 (or routine called by it) requested an INTERNAL fallback
<Diagnostic Message> Time= 4.3478E+04 Dt= 1.0000E-05 Cycle= 516913 (COR) L,C= 2,1267658
ERROR IN SUBROUTINE CORDBD
SUBCYCLE TIME STEP HAS BEEN REDUCED BELOW MINIMUM
CORRM1 (or routine called by it) requested a SYSTEM fallback
SYSTEM TIME STEP REDUCED TO 0.5000E-05
<Diagnostic Message> Time= 4.3478E+04 Dt= 1.0000E-05 Cycle= 516913 (COR) L,C= 3,1267659
COR package requested repeating cycle 516913 with timestep 5.000000E-06
<Diagnostic Message> Time= 4.3478E+04 Dt= 1.0000E-05 Cycle= 516913 (COR) L,C= 0,1267660
Attempted cycle advancement was unsuccessful
DT REDUCED BELOW DTMIN FROM PACKAGE COR
DTrequest= 5.000000E-06 DtmIn= 1.000000E-05
<Diagnostic Message> Time= 4.3478E+04 Dt= 1.0000E-05 Cycle= 516913 (COR) L,C= 0,1267661
***** EXECUTION ABORT *****
***** EXECUTION ABORT *****
TRACE TURNED ON AND CYCLE REPEATED BEFORE ABORT
<Diagnostic Message> Time= 4.3478E+04 Dt= 1.0000E-05 Cycle= 516913 (COR) L,C= 2,1267662
Attempted cycle advancement was unsuccessful - DT reduced to = 1.0000E-05
<Diagnostic Message> Time= 4.3478E+04 Dt= 1.0000E-05 Cycle= 516913 (COR) L,C= 0,1267663
MEXLOP fatal error pass - Initialization
DT= 1.00000E-05 IERR= 1 MEXTRC= 1
<Diagnostic Message> Time= 4.3478E+04 Dt= 1.0000E-05 Cycle= 516913 (MEX) L,C= 0,1267664
MEXLOP fatal error pass - Communication
DT= 1.00000E-05 IERR= 1 MEXTRC= 1
<Diagnostic Message> Time= 4.3478E+04 Dt= 1.0000E-05 Cycle= 516913 (MEX) L,C= 0,1267665
MEXLOP fatal error pass - Advancement
DT= 1.00000E-05 IERR= 1 MEXTRC= 1
<Diagnostic Message> Time= 4.3478E+04 Dt= 1.0000E-05 Cycle= 516913 (COR) L,C= 1,1267666
ERROR IN CORTSU (DT/D2 MODEL), RESULTS IN INTERNAL FALLBACK IN CORRM1
<Diagnostic Message> Time= 4.3478E+04 Dt= 1.0000E-05 Cycle= 516913 (COR) L,C= 3,1267667
MESSAGE FROM SUBROUTINE CORDBD
CORRM1 (or routine called by it) requested an INTERNAL fallback
<Diagnostic Message> Time= 4.3478E+04 Dt= 1.0000E-05 Cycle= 516913 (COR) L,C= 2,1267668
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Lister - [d:\2021_BS tazka havarie_nas 185 model prepisany do 22 s mojimi reaktorom_test\bohunice_PRISE\VER440.MES]
Súbor Upravit Možnosti Kódovanie Pomocník
Error in equilibrium thermo routine CUTWGE
Called from CUTNQE for Volume CU00011
<Diagnostic Message> Time= 4.3477E+04 Dt= 9.3294E-03 Cycle= 516906 (CUH)
Error in equilibrium thermo routine CUTWGE
Called from CUTNQE for Volume CU00011
<Diagnostic Message> Time= 4.3477E+04 Dt= 9.3294E-03 Cycle= 516906 (CUH)
Error in equilibrium thermo routine CUTWGE
Called from CUTNQE for Volume CU00011
<Diagnostic Message> Time= 4.3477E+04 Dt= 9.3294E-03 Cycle= 516906 (CUH)
Error in equilibrium thermo routine CUTWGE
Called from CUTNQE for Volume CU00011
<Diagnostic Message> Time= 4.3477E+04 Dt= 9.3294E-03 Cycle= 516906 (CUH)
Error in equilibrium thermo routine CUTWGE
Called from CUTNQE for Volume CU00011
<Diagnostic Message> Time= 4.3477E+04 Dt= 9.3294E-03 Cycle= 516906 (CUH)
Attempted cycle advancement was unsuccessful - DT reduced to = 4.6647E-03
<Diagnostic Message> Time= 4.3478E+04 Dt= 1.2349E-03 Cycle= 516913 (COR)
ERROR IN CORTSU (DT/D2 MODEL), RESULTS IN INTERNAL FALLBACK IN CORRM1
<Diagnostic Message> Time= 4.3478E+04 Dt= 1.2349E-03 Cycle= 516913 (COR)
ERROR IN CORTSU (DT/D2 MODEL), RESULTS IN INTERNAL FALLBACK IN CORRM1
<Diagnostic Message> Time= 4.3478E+04 Dt= 1.2349E-03 Cycle= 516913 (COR)
ERROR IN CORTSU (DT/D2 MODEL), RESULTS IN INTERNAL FALLBACK IN CORRM1
<Diagnostic Message> Time= 4.3478E+04 Dt= 1.2349E-03 Cycle= 516913 (COR)
ERROR IN CORTSU (DT/D2 MODEL), RESULTS IN INTERNAL FALLBACK IN CORRM1
<Diagnostic Message> Time= 4.3478E+04 Dt= 1.2349E-03 Cycle= 516913 (COR)
ERROR IN CORTSU (DT/D2 MODEL), RESULTS IN INTERNAL FALLBACK IN CORRM1
<Diagnostic Message> Time= 4.3478E+04 Dt= 1.2349E-03 Cycle= 516913 (COR)
ERROR IN CORTSU (DT/D2 MODEL), RESULTS IN INTERNAL FALLBACK IN CORRM1
<Diagnostic Message> Time= 4.3478E+04 Dt= 1.2349E-03 Cycle= 516913 (COR)
ERROR IN CORTSU (DT/D2 MODEL), RESULTS IN INTERNAL FALLBACK IN CORRM1
SUBCYCLE TIME STEP HAS BEEN REDUCED BELOW MINIMUM
CORRM1 (or routine called by it) requested a SYSTEM fallback
SYSTEM TIME STEP REDUCED TO 0.1000E-04
<Diagnostic Message> Time= 4.3478E+04 Dt= 1.2349E-03 Cycle= 516913 (COR)
Attempted cycle advancement was unsuccessful - DT reduced to = 1.0000E-05
<Diagnostic Message> Time= 4.3478E+04 Dt= 1.0000E-05 Cycle= 516913 (COR)
ERROR IN CORTSU (DT/D2 MODEL), RESULTS IN INTERNAL FALLBACK IN CORRM1
<Diagnostic Message> Time= 4.3478E+04 Dt= 1.0000E-05 Cycle= 516913 (COR)
ERROR IN SUBROUTINE CORDBD
SUBCYCLE TIME STEP HAS BEEN REDUCED BELOW MINIMUM
CORRM1 (or routine called by it) requested a SYSTEM fallback
SYSTEM TIME STEP REDUCED TO 0.5000E-05
<Diagnostic Message> Time= 4.3478E+04 Dt= 1.0000E-05 Cycle= 516913 (COR)
Attempted cycle advancement was unsuccessful
DT REDUCED BELOW DTMIN FROM PACKAGE COR
DTrequest= 5.000000E-06 DtmIn= 1.000000E-05
<Diagnostic Message> Time= 4.3478E+04 Dt= 1.0000E-05 Cycle= 516913 (COR)
***** EXECUTION ABORT *****
***** EXECUTION ABORT *****
TRACE TURNED ON AND CYCLE REPEATED BEFORE ABORT
<Diagnostic Message> Time= 4.3478E+04 Dt= 1.0000E-05 Cycle= 516913 (COR)
Attempted cycle advancement was unsuccessful - DT reduced to = 1.0000E-05
<Diagnostic Message> Time= 4.3478E+04 Dt= 1.0000E-05 Cycle= 516913 (COR)
MEXLOP fatal error pass - Initialization
DT= 1.00000E-05 IERR= 1 MEXTRC= 1
<Diagnostic Message> Time= 4.3478E+04 Dt= 1.0000E-05 Cycle= 516913 (MEX)
MEXLOP fatal error pass - Communication
DT= 1.00000E-05 IERR= 1 MEXTRC= 1
<Diagnostic Message> Time= 4.3478E+04 Dt= 1.0000E-05 Cycle= 516913 (MEX)
MEXLOP fatal error pass - Advancement
DT= 1.00000E-05 IERR= 1 MEXTRC= 1
<Diagnostic Message> Time= 4.3478E+04 Dt= 1.0000E-05 Cycle= 516913 (COR)
MEXLOP fatal error pass - Communication
DT= 1.00000E-05 IERR= 1 MEXTRC= 1
<Diagnostic Message> Time= 4.3478E+04 Dt= 1.0000E-05 Cycle= 516913 (MEX)
MEXLOP fatal error pass - Advancement
DT= 1.00000E-05 IERR= 1 MEXTRC= 1
<Diagnostic Message> Time= 4.3478E+04 Dt= 1.0000E-05 Cycle= 516913 (COR)
ERROR IN CORTSU (DT/D2 MODEL), RESULTS IN INTERNAL FALLBACK IN CORRM1
```



Four crashes of MELCOR (3)

- Nr. 3 – there is a hint where there can be a problem, no concrete information provided but helpful. (MES, extdiag and MELCOR DIA files) (15254)
Another example in the right picture.



1

Edit MELCOR data

Use File:

/cygdrive/d/2021/119771 Melcor dat

CVH-TVAP_11

Filter:

CVH-TVAP?11

Clear Selections

Clear Current Set

Units Type:

```
<Diagnostic Message> Time= 6.4417E+04 Dt= 5.4327E-06 Cycle= 886252 (MEX) L,C= 2,891933
ERROR IN SUBROUTINE MEXDTC
package CVH requested dt ( 5.4327E-06) below dtmin - ignored
<Diagnostic Message> Time= 6.4417E+04 Dt= 1.0000E-05 Cycle= 886252 (MEX) L,C= 3,891934
REQUEST FOR FORCED PLOT DUMP SEQUENCE IGNORED. TOO MANY FALLBACKS.
ALL FUTURE REQUEST DURING THIS EXECUTION IGNORED.
<Diagnostic Message> Time= 6.4417E+04 Dt= 1.7959E-06 Cycle= 886253 (MEX) L,C= 2,891935
ERROR IN SUBROUTINE MEXDTC
package CVH requested dt ( 1.7959E-06) below dtmin - ignored
<Diagnostic Message> Time= 6.4417E+04 Dt= 1.0000E-05 Cycle= 886253 (MEX) L,C= 3,891936
REQUEST FOR FORCED PLOT DUMP SEQUENCE IGNORED. TOO MANY FALLBACKS.
ALL FUTURE REQUEST DURING THIS EXECUTION IGNORED.
<Diagnostic Message> Time= 6.4417E+04 Dt= 1.2975E-06 Cycle= 886254 (MEX) L,C= 2,891937
ERROR IN SUBROUTINE MEXDTC
package CVH requested dt ( 1.2975E-06) below dtmin - ignored
<Diagnostic Message> Time= 6.4417E+04 Dt= 1.0000E-05 Cycle= 886254 (MEX) L,C= 3,891938
REQUEST FOR FORCED PLOT DUMP SEQUENCE IGNORED. TOO MANY FALLBACKS.
ALL FUTURE REQUEST DURING THIS EXECUTION IGNORED.
<Diagnostic Message> Time= 6.4417E+04 Dt= 3.4261E-07 Cycle= 886255 (MEX) L,C= 2,891939
ERROR IN SUBROUTINE MEXDTC
package CVH requested dt ( 3.4261E-07) below dtmin - ignored
<Diagnostic Message> Time= 6.4417E+04 Dt= 1.0000E-05 Cycle= 886255 (HS ) L,C= 3,891940
===== MESSAGE FROM SUBROUTINE HSCUNS =====
CONDENSATION MASS TRANSFER RESULTS IN EXCESSIVELY SMALL
OR NEGATIVE STEAM MASS IN CONTROL VOLUME DOLNE1/6_3
STEAM MASS = 1.94549E-01 CHANGE IN MASS = -2.00756E-01
CUTTING TIME STEP TO ELIMINATE PROBLEM
<Diagnostic Message> Time= 6.4417E+04 Dt= 1.0000E-05 Cycle= 886255 (HS ) L,C= 3,891941
HS package requested repeating cycle 886255 with timestep 7.849542E-06
<Diagnostic Message> Time= 6.4417E+04 Dt= 1.0000E-05 Cycle= 886255 (HS ) L,C= 0,891942
Attempted cycle advancement was unsuccessful
DT REDUCED BELOW DTMIN FROM PACKAGE HS
DTrequest= 7.849542E-06 DTmin= 1.000000E-05
<Diagnostic Message> Time= 6.4417E+04 Dt= 1.0000E-05 Cycle= 886255 (HS ) L,C= 0,891943
***** EXECUTION ABORT *****
***** EXECUTION ABORT *****
TRACE TURNED ON AND CYCLE REPEATED BEFORE ABORT
<Diagnostic Message> Time= 6.4417E+04 Dt= 1.0000E-05 Cycle= 886255 (HS ) L,C= 2,891944
Attempted cycle advancement was unsuccessful - DT reduced to = 1.0000E-05
<Diagnostic Message> Time= 6.4417E+04 Dt= 1.0000E-05 Cycle= 886255 (HS ) L,C= 0,891945
MEXLOP fatal error pass - Initialization
DT= 1.0000E-05 IERR= 1 MEXTRC= 1
<Diagnostic Message> Time= 6.4417E+04 Dt= 1.0000E-05 Cycle= 886255 (MEX) L,C= 0,891946
MEXLOP fatal error pass - Communication
DT= 1.0000E-05 IERR= 1 MEXTRC= 1
<Diagnostic Message> Time= 6.4417E+04 Dt= 1.0000E-05 Cycle= 886255 (MEX) L,C= 0,891947
MEXLOP fatal error pass - Advancement
DT= 1.0000E-05 IERR= 1 MEXTRC= 1
<Diagnostic Message> Time= 6.4417E+04 Dt= 1.0000E-05 Cycle= 886255 (HS ) L,C= 3,891948
===== MESSAGE FROM SUBROUTINE HSCUNS =====
CONDENSATION MASS TRANSFER RESULTS IN EXCESSIVELY SMALL
OR NEGATIVE STEAM MASS IN CONTROL VOLUME DOLNE1/6_3
STEAM MASS = 1.94549E-01 CHANGE IN MASS = -2.00756E-01
CUTTING TIME STEP TO ELIMINATE PROBLEM
<Diagnostic Message> Time= 6.4417E+04 Dt= 1.0000E-05 Cycle= 886255 (HS ) L,C= 3,891949
HS package requested repeating cycle 886255 with timestep 7.849542E-06
```

Four crashes of MELCOR (4)

- Nr. 4 – crash from full time step, no report, all files as if electricity switch turned off.
- OUT file (21402)
- Hoping that such a crash is/will be eliminated.

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CYCLE= 521880 T= 4.626274E+04 DT(MAX)= 1.000000E-01 CPU= 1.642541E+05
CYCLE= 521881 T= 4.626284E+04 DT(MAX)= 1.000000E-01 CPU= 1.642542E+05
CYCLE= 521882 T= 4.626294E+04 DT(MAX)= 1.000000E-01 CPU= 1.642543E+05
CYCLE= 521883 T= 4.626304E+04 DT(MAX)= 1.000000E-01 CPU= 1.642544E+05
CYCLE= 521884 T= 4.626314E+04 DT(MAX)= 1.000000E-01 CPU= 1.642545E+05
CYCLE= 521885 T= 4.626324E+04 DT(MAX)= 1.000000E-01 CPU= 1.642546E+05
CYCLE= 521886 T= 4.626334E+04 DT(MAX)= 1.000000E-01 CPU= 1.642547E+05
CYCLE= 521887 T= 4.626344E+04 DT(MAX)= 1.000000E-01 CPU= 1.642548E+05
CYCLE= 521888 T= 4.626354E+04 DT(MAX)= 1.000000E-01 CPU= 1.642549E+05
CYCLE= 521889 T= 4.626364E+04 DT(MAX)= 1.000000E-01 CPU= 1.642550E+05
CYCLE= 521890 T= 4.626374E+04 DT(MAX)= 1.000000E-01 CPU= 1.642551E+05
CYCLE= 521891 T= 4.626384E+04 DT(MAX)= 1.000000E-01 CPU= 1.642552E+05
CYCLE= 521892 T= 4.626394E+04 DT(MAX)= 1.000000E-01 CPU= 1.642552E+05
CYCLE= 521893 T= 4.626404E+04 DT(MAX)= 1.000000E-01 CPU= 1.642553E+05
CYCLE= 521894 T= 4.626414E+04 DT(MAX)= 1.000000E-01 CPU= 1.642554E+05
CYCLE= 521895 T= 4.626424E+04 DT(MAX)= 1.000000E-01 CPU= 1.642555E+05
CYCLE= 521896 T= 4.626434E+04 DT(MAX)= 1.000000E-01 CPU= 1.642556E+05
CYCLE= 521897 T= 4.626444E+04 DT(MAX)= 1.000000E-01 CPU= 1.642557E+05
CYCLE= 521898 T= 4.626454E+04 DT(MAX)= 1.000000E-01 CPU= 1.642558E+05
CYCLE= 521899 T= 4.626464E+04 DT(MAX)= 1.000000E-01 CPU= 1.642559E+05
CYCLE= 521900 T= 4.626474E+04 DT(MAX)= 1.000000E-01 CPU= 1.642560E+05
CYCLE= 521901 T= 4.626484E+04 DT(MAX)= 1.000000E-01 CPU= 1.642562E+05
CYCLE= 521902 T= 4.626494E+04 DT(MAX)= 1.000000E-01 CPU= 1.642563E+05
CYCLE= 521903 T= 4.626504E+04 DT(MAX)= 1.000000E-01 CPU= 1.642564E+05
CYCLE= 521904 T= 4.626514E+04 DT(MAX)= 1.000000E-01 CPU= 1.642565E+05
CYCLE= 521905 T= 4.626524E+04 DT(MAX)= 1.000000E-01 CPU= 1.642566E+05
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The ultimate crash report

```
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ALL FUTURE REQUEST DURING THIS EXECUTION IGNORED.
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LOGIC ERROR IN CORSTR
APPARENT LOAD ON SS IN CELL IA= 9 IR= 8 WHICH DOESN'T EXIST
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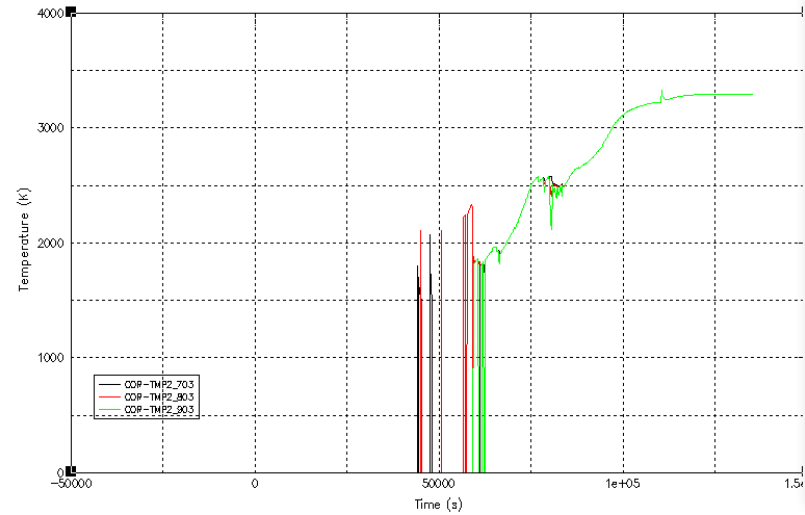
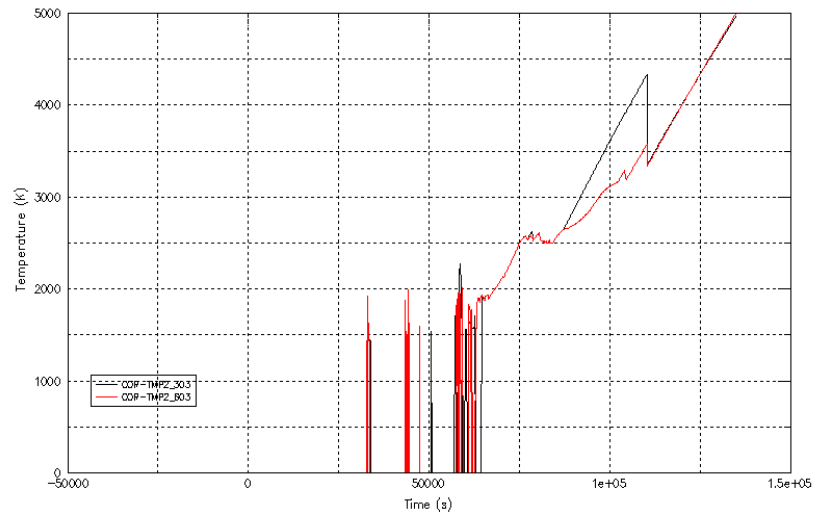
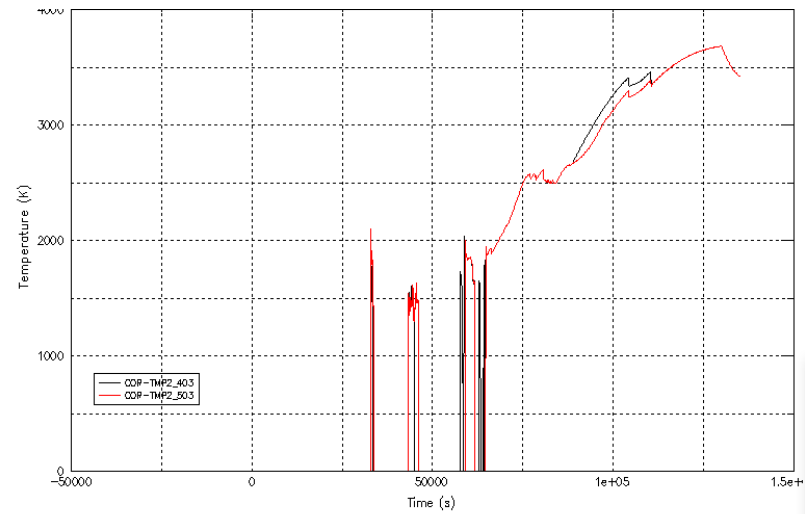
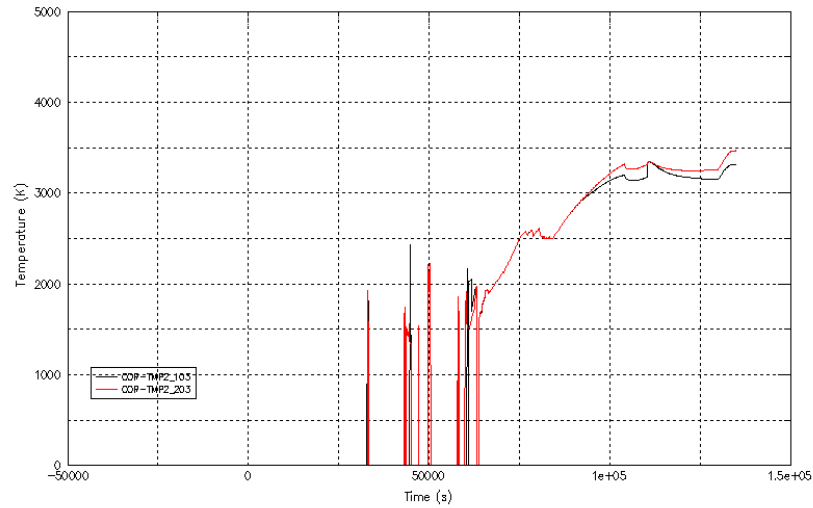
```
00000077 MESSAGE FROM CORE FUNCTION
CORE SUPPORT STRUCTURE (POMOEN) HAS FAILED IN CELL IA= 9 IR= 8
FAILURE WAS BY CONTROL FUNCTION
Listing written TIME= 1.15027E+05 CYCLE= 1440268
Restart written TIME = 1.150271E+05 CYCLE= 1440268
Listing written TIME= 1.15061E+05 CYCLE= 1440340
Restart written TIME = 1.150613E+05 CYCLE= 1440340
Calculation terminated by: SUPPORT MODEL LOGIC ERROR
TIME= 1.15061E+05 CYCLE= 1440340 CPU = 2.58496E+05

<Diagnostic Message> Time= 1.1497E+05 Dt= 5.0000E-01 Cycle= 1440149 (CUH)
Attempted cycle advancement was unsuccessful - DT reduced to = 2.5000E-01
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<Diagnostic Message> Time= 1.1497E+05 Dt= 5.0000E-01 Cycle= 1440157 (CUH)
Attempted cycle advancement was unsuccessful - DT reduced to = 2.5000E-01
CUHMON: ERROR IN SOLUTION OF FLOW EQUATIONS
SPARSE MATRIX SOLVER RETURNED ERROR 2: FAILED TO CONVERGE in 500 steps
<Diagnostic Message> Time= 1.1498E+05 Dt= 5.0000E-01 Cycle= 1440165 (CUH)
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Attempted cycle advancement was unsuccessful - DT reduced to = 2.5000E-01
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Attempted cycle advancement was unsuccessful - DT reduced to = 2.5000E-01
<Diagnostic Message> Time= 1.1504E+05 Dt= 5.0000E-01 Cycle= 1440304 (CUH)
Attempted cycle advancement was unsuccessful - DT reduced to = 2.5000E-01
<Diagnostic Message> Time= 1.1505E+05 Dt= 5.0000E-01 Cycle= 1440306 (CUH)
Attempted cycle advancement was unsuccessful - DT reduced to = 2.5000E-01
<Diagnostic Message> Time= 1.1505E+05 Dt= 5.0000E-01 Cycle= 1440316 (CUH)
Attempted cycle advancement was unsuccessful - DT reduced to = 2.5000E-01
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Attempted cycle advancement was unsuccessful - DT reduced to = 2.5000E-01
<Diagnostic Message> Time= 1.1506E+05 Dt= 5.0000E-01 Cycle= 1440340 (COR)
LOGIC ERROR IN CORSTR
APPARENT LOAD ON SS IN CELL IA= 9 IR= 8 WHICH DOESN'T EXIST
Calculation terminated by: SUPPORT MODEL LOGIC ERROR
```

- load on a non-existing support structure ...

MELCOR lower plenum molten pool

- MP2 temperature increase up to crash...



MELCOR lower plenum molten pool

- MP2 temperature increase up to crash...
 - Axial level 03 contains no fuel, no cladding but does contain canister mass (also supporting and non-supporting structure mass),
 - Molten pool consists of steel and zirconium (mostly steel),
 - Will be analysed...
-
- For the time being heat transfer from the component used.

MELCOR lower plenum molten pool

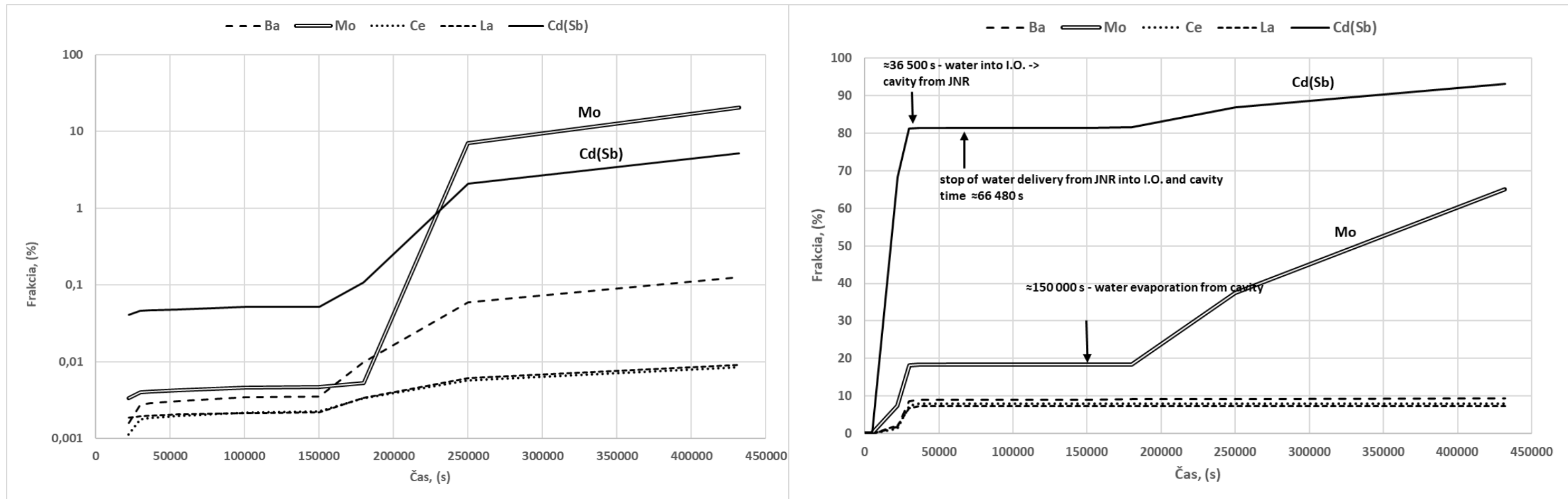
- MP2 temperature increase up to crash...

```
COR_QHS 13
1 3 9 MP2 CF00605 !jja toto je z kraja do vody v sachte reaktora
2 3 3 MP2 CF00615
3 3 4 MP2 CF00616
4 3 6 MP2 CF00625
5 3 7 MP2 CF00626
6 3 4 MP2 CF00635
7 3 5 MP2 CF00636
8 3 5 MP2 CF00645
9 3 6 MP2 CF00646
10 3 7 MP2 CF00655
11 3 8 MP2 CF00656
12 3 8 MP2 CF00665
13 3 9 MP2 CF00666
```

```
COR_QHS 9
1 3 9 MP2 CF00695 !jja do vody v sachte reaktora z kazdeho MP2
2 3 8 MP2 CF00685
3 3 7 MP2 CF00675
4 3 6 MP2 CF00665
5 3 5 MP2 CF00655
6 3 4 MP2 CF00645
7 3 3 MP2 CF00635
8 3 2 MP2 CF00625
9 3 1 MP2 CF00615
```

MELCOR molybdenum surge

- EXVES scenario (STC11) experienced significant increase of Mo group release



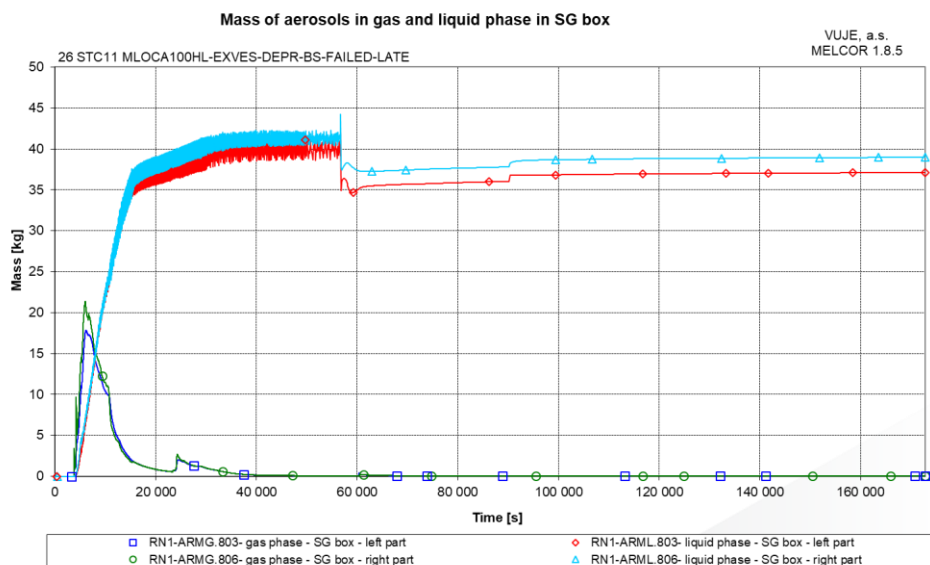
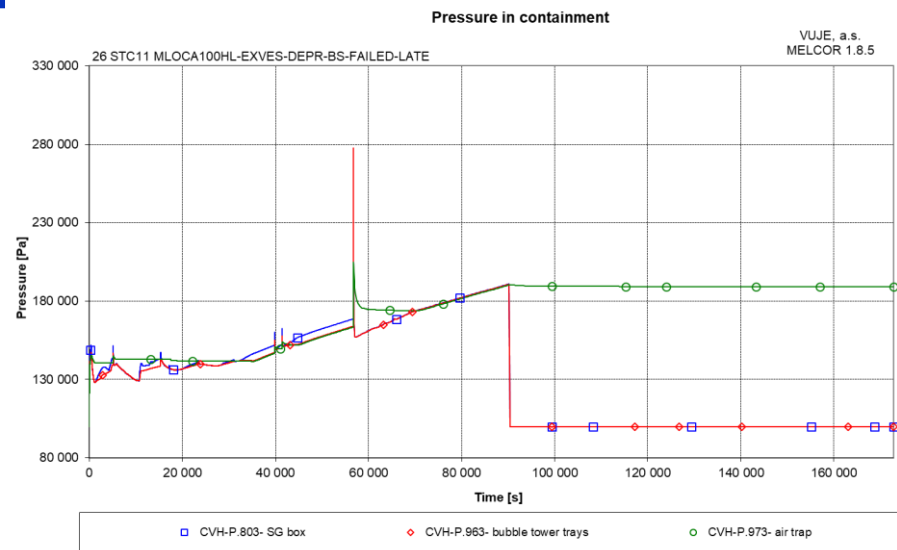
MELCOR RN retention and resuspension

- STC11 vs. STC9 – only different time of containment failure

Zdrojový člen (STC)	Popis STC	Frekvencia [1/rok]	Príspevok k celkovej frekvencii [1/rok]	Únik do okolia, [%]		
				Xe	I	Cs
Režim 1 - Plný výkon reaktora						
STC1	Celistvosť HZ zachovaná, sprchovanie HZ, neporušená tlaková nádoba	1,12E-06	50,99	0,04	0,02	0,02
STC2	Celistvosť HZ zachovaná, bez sprchovania HZ, neporušená tlaková nádoba	7,26E-07	33,05	2,09	0,06	0,07
STC11	Neskoré porušenie HZ po porušení tlakovej nádoby, neobnovenie chladenia poškodenej AZ mimo tlakovej nádoby (bez sprchovania HZ)	1,31E-07	5,96	65,77	0,36	0,26
STC9	Veľmi skoré porušenie HZ s porušením tlakovej nádoby, neobnovenie chladenia poškodenej AZ mimo tlakovej nádoby (bez sprchovania HZ)	7,18E-08	3,27	97,25	33,21	32,66
STC12S	Neskoré porušenie HZ bez porušenia tlakovej nádoby (so sprchovaním HZ)	3,92E-08	1,78	42,84	0,28	0,02

STC9-MLOCA100HL-EXVES-DEPR-BS-FAILED-EARLY (4 800 s)
 STC11-MLOCA100HL-EXVES-DEPR-BS-FAILED-LATE (90 000 s)

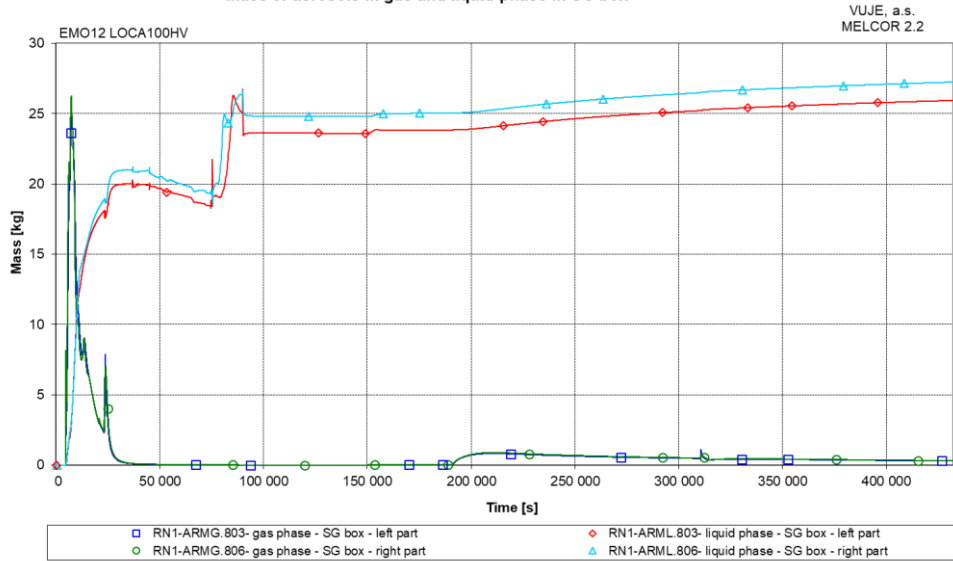
Two orders of magnitude difference.



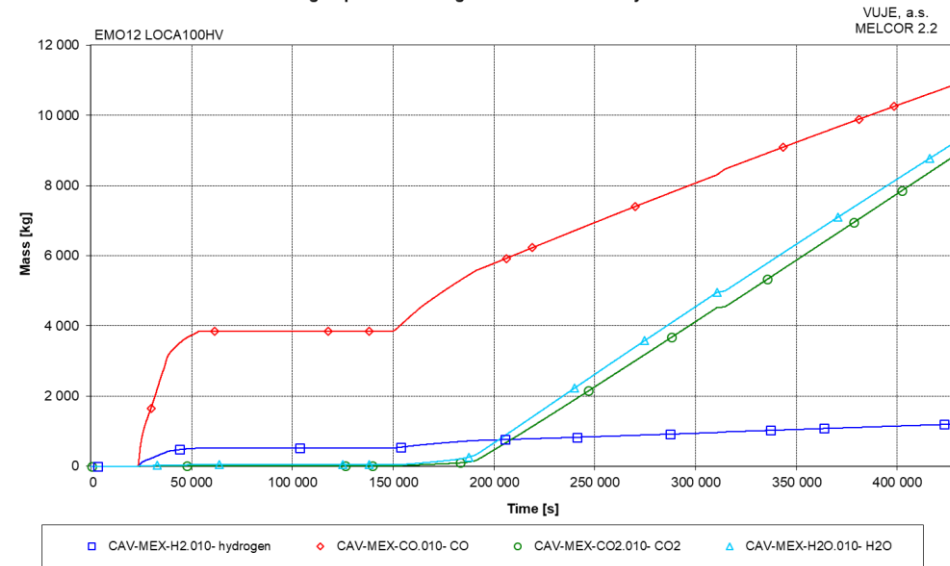
MELCOR RN retention and resuspension

■ STC11 – MELCOR 2.2 (15254)

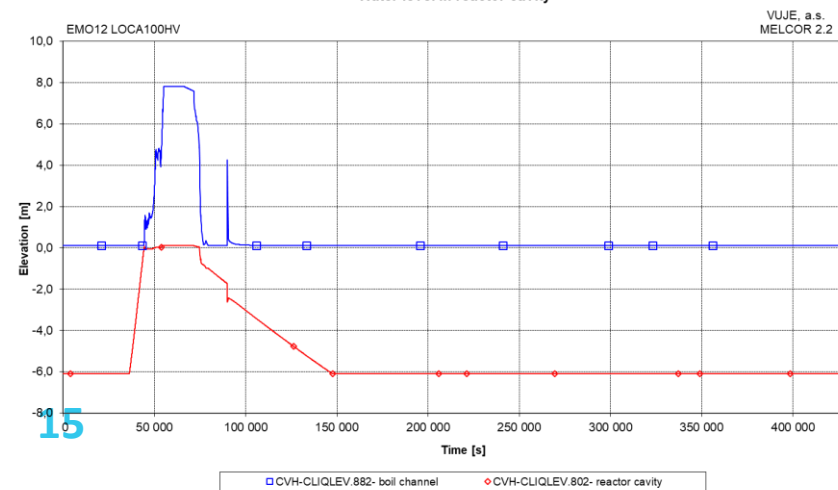
Mass of aerosols in gas and liquid phase in SG box



Integral production of gasses in reactor cavity



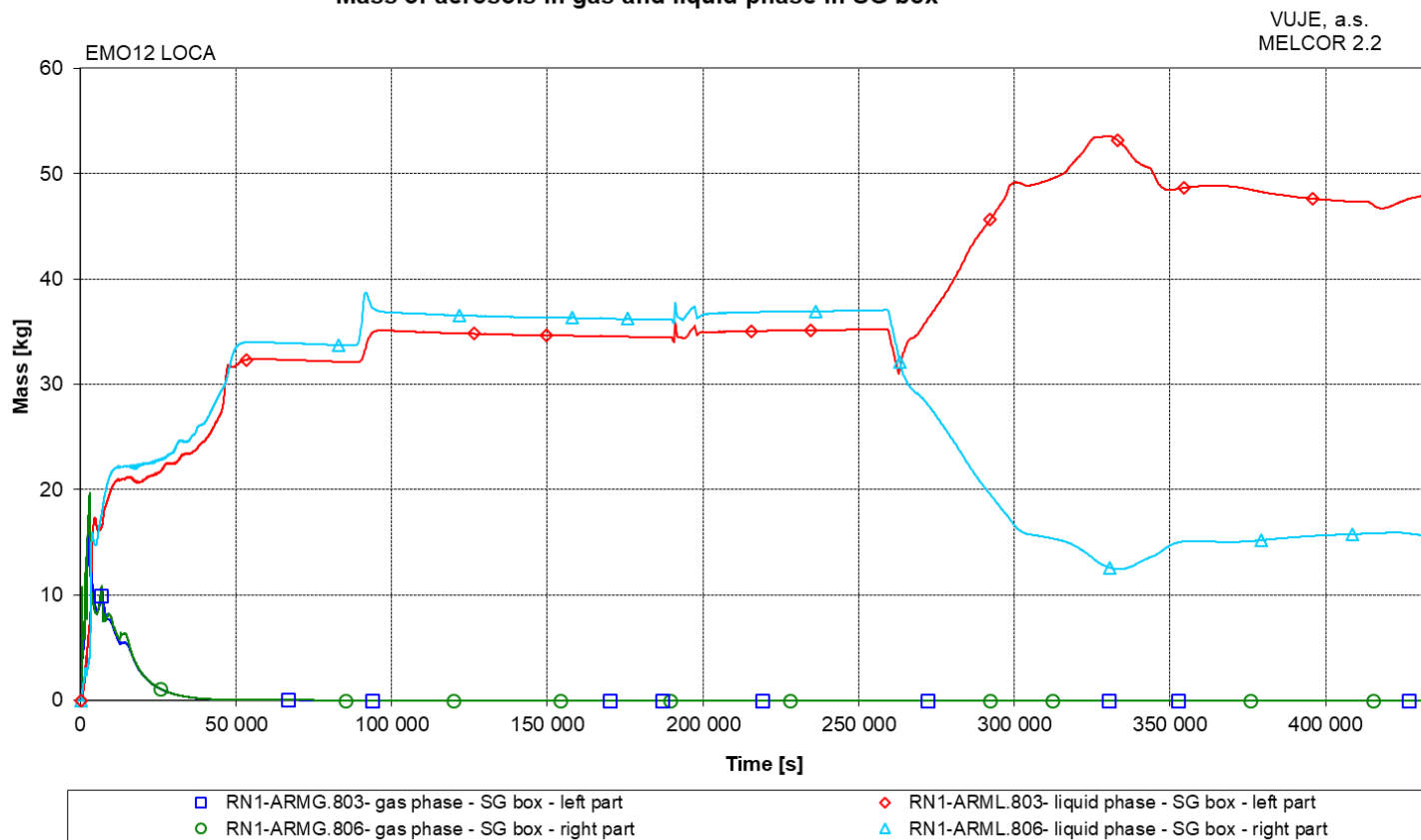
Water level in reactor cavity



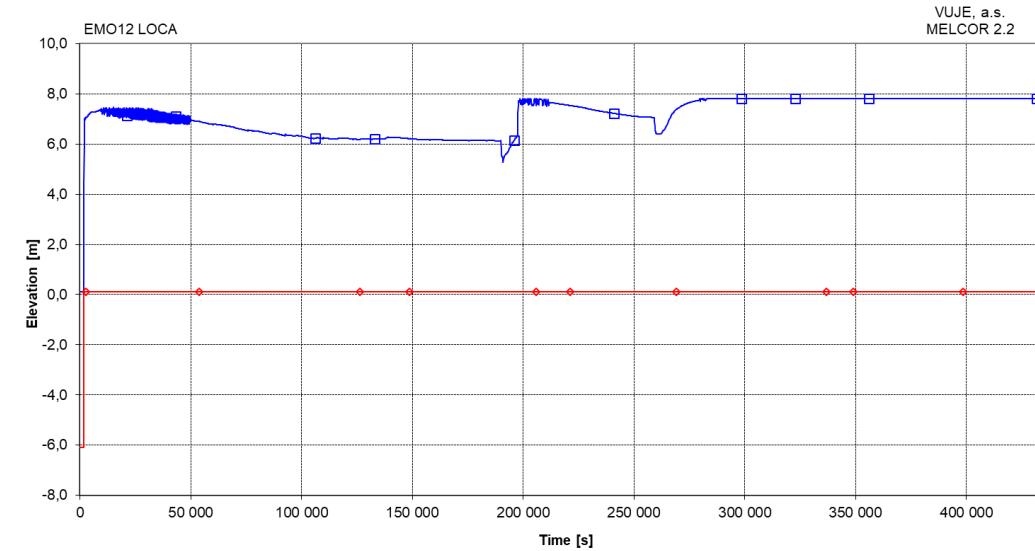
MELCOR RN retention and resuspension

LOCA 2x496 – IMVES – MELCOR 2.2 (15254)

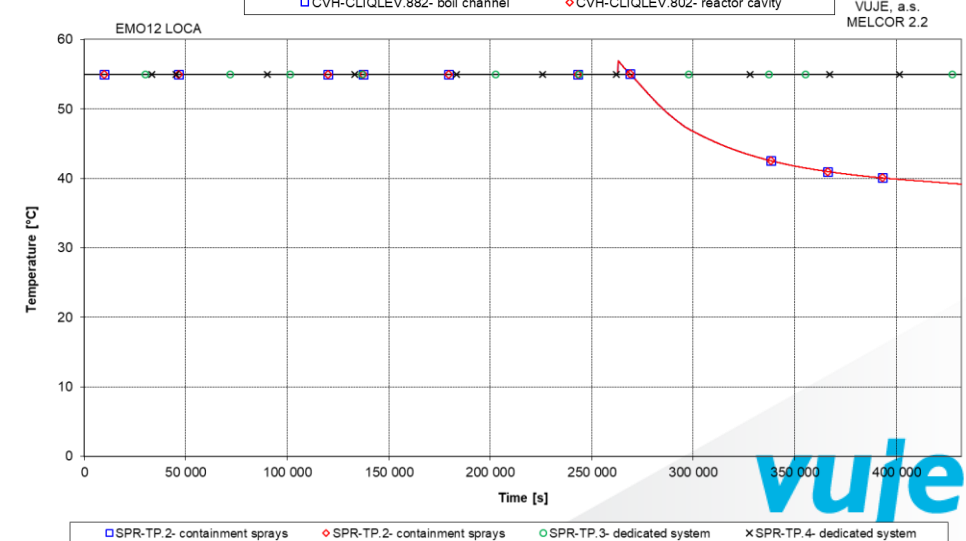
Mass of aerosols in gas and liquid phase in SG box



Water level in reactor cavity



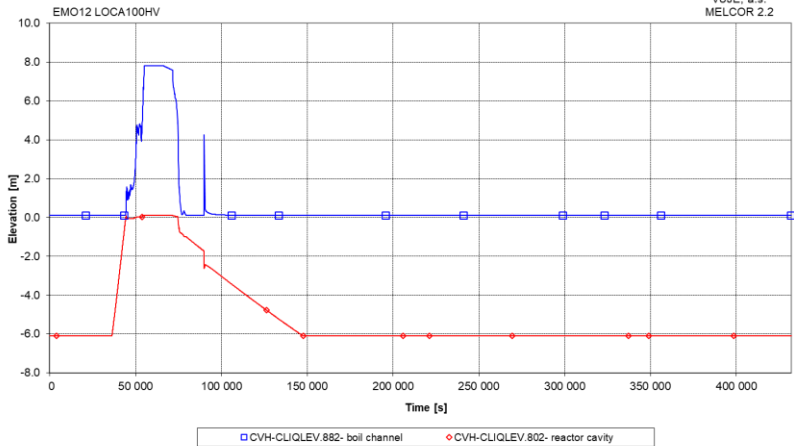
Spray water temperature



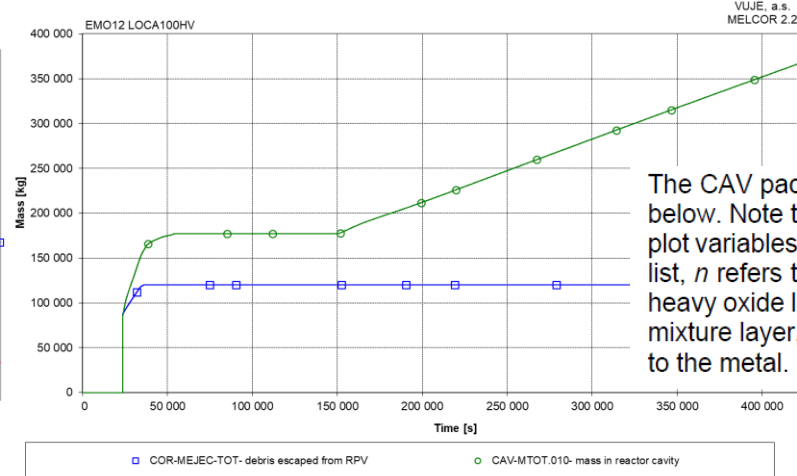
MCCI temperatures and components

The CAV package variables that may be used for plot variables are listed and described below. Note that control function arguments (some that are identical in definition to these plot variables but different in format) are described in the following section. In the following list, *n* refers to the cavity index, lay refers to the desired layer, with HOX referring to the heavy oxide layer, LOX to the light oxide layer, MET to the metal layer, HMX to the heavy mixture layer, and LMX to the light mixture layer. Here heavy and light are in comparison to the metal. Finally, gas refers to one of the four gases (H₂, H₂O, CO, or CO₂).

Water level in reactor cavity

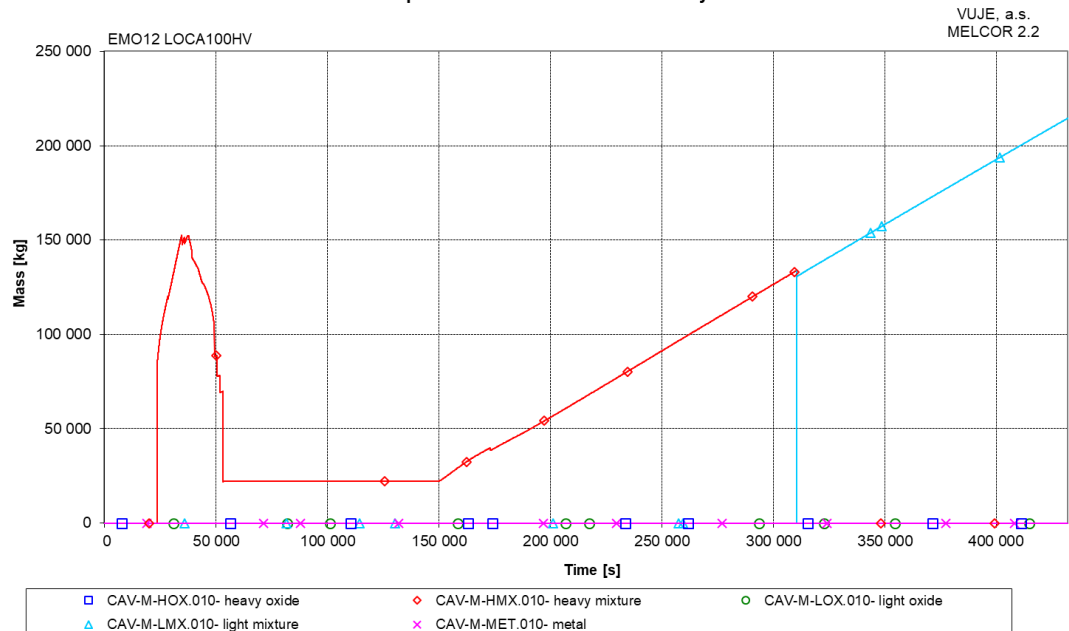


Total mass of debris escaping from RPV and total mass in reactor cavity

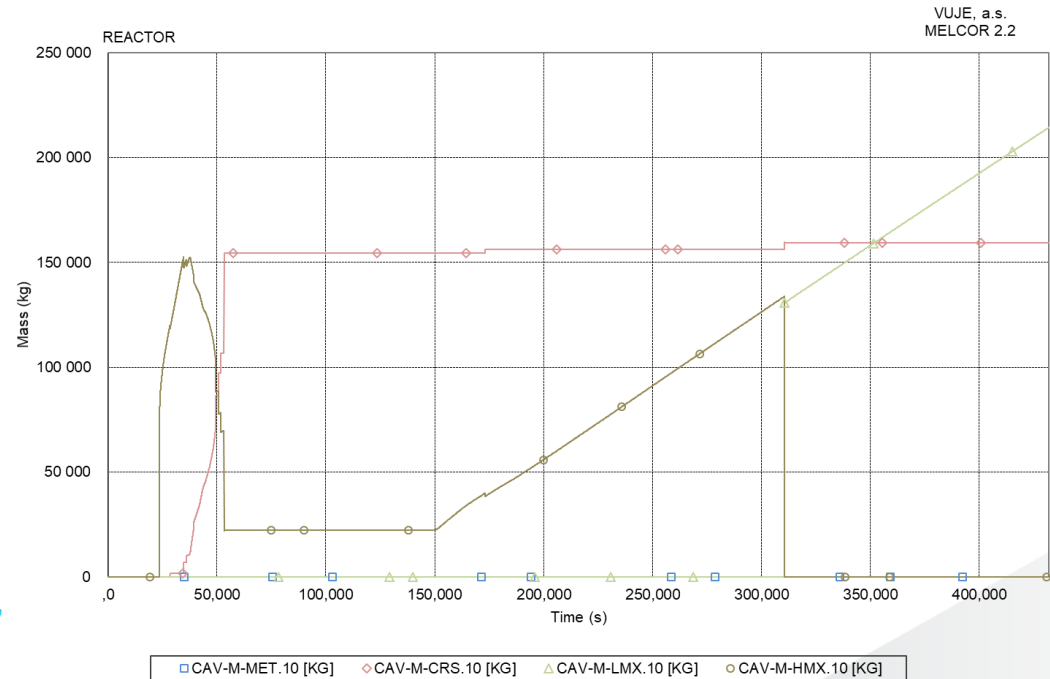


The CAV package variables that may be used for plot variables are listed and described below. Note that control function arguments (some that are identical in definition to these plot variables but different in format) are described in the following section. In the following list, *n* refers to the cavity index, lay refers to the desired layer, with HOX referring to the heavy oxide layer, LOX to the light oxide layer, MET to the metal layer, HMX to the heavy mixture layer, and LMX to the light mixture layer. Here heavy and light are in comparison to the metal. Finally, gas refers to one of the four gases (H₂, H₂O, CO, or CO₂).

Mass of components of debris in reactor cavity

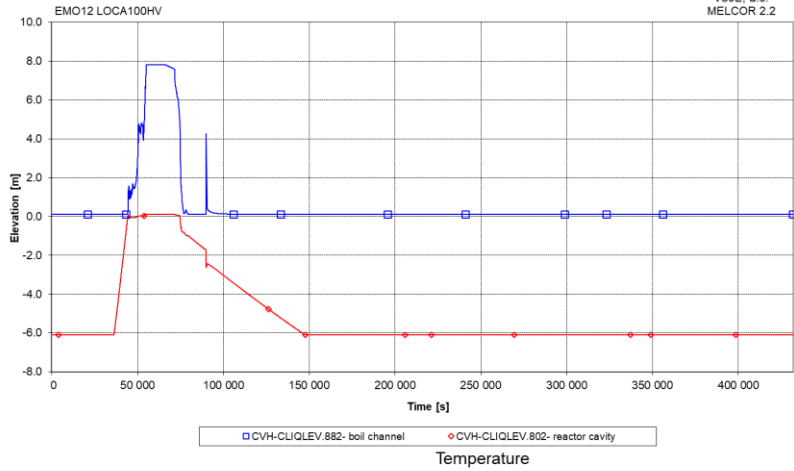


Cavity - mass

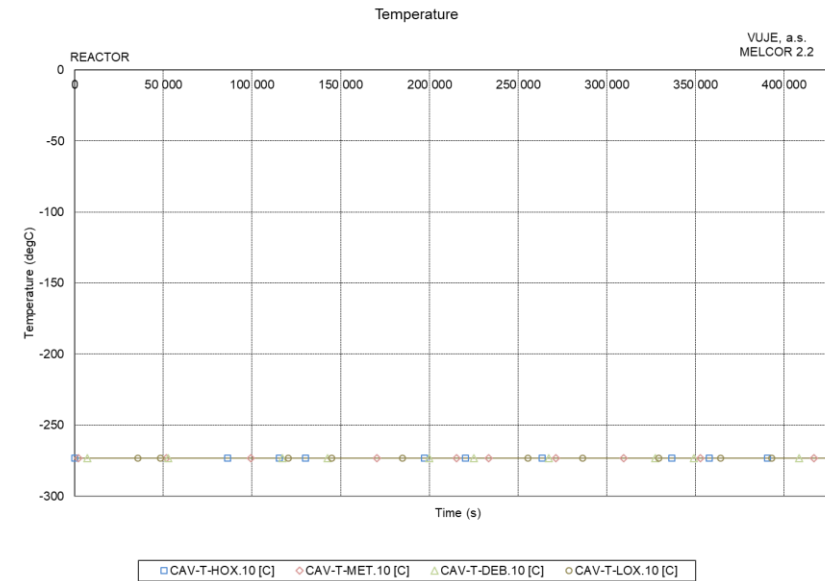
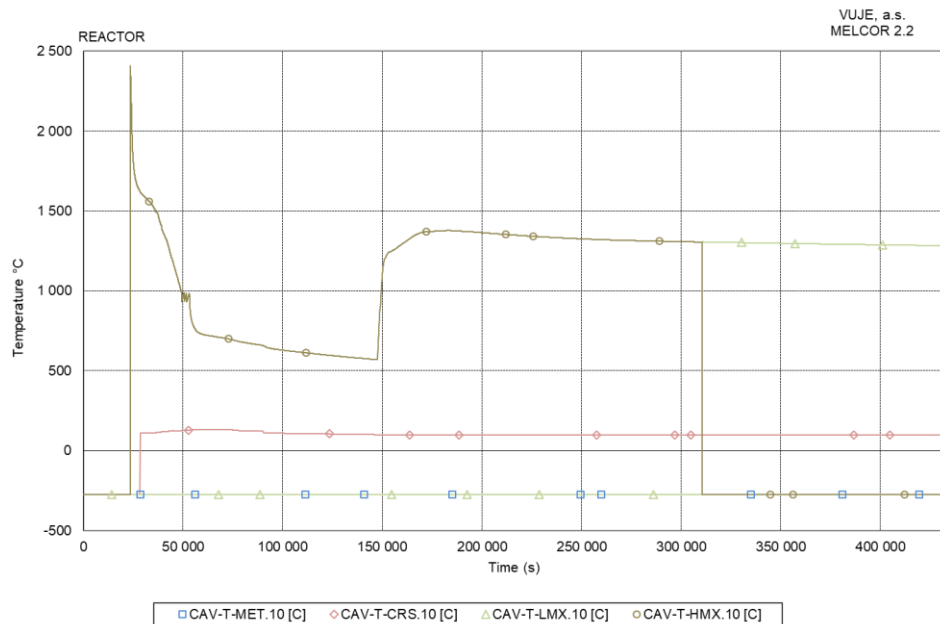
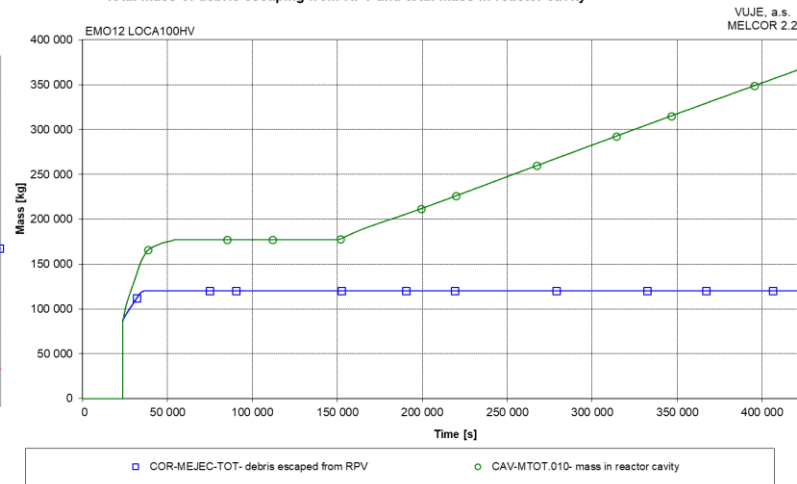


MCCI temperatures and components

Water level in reactor cavity



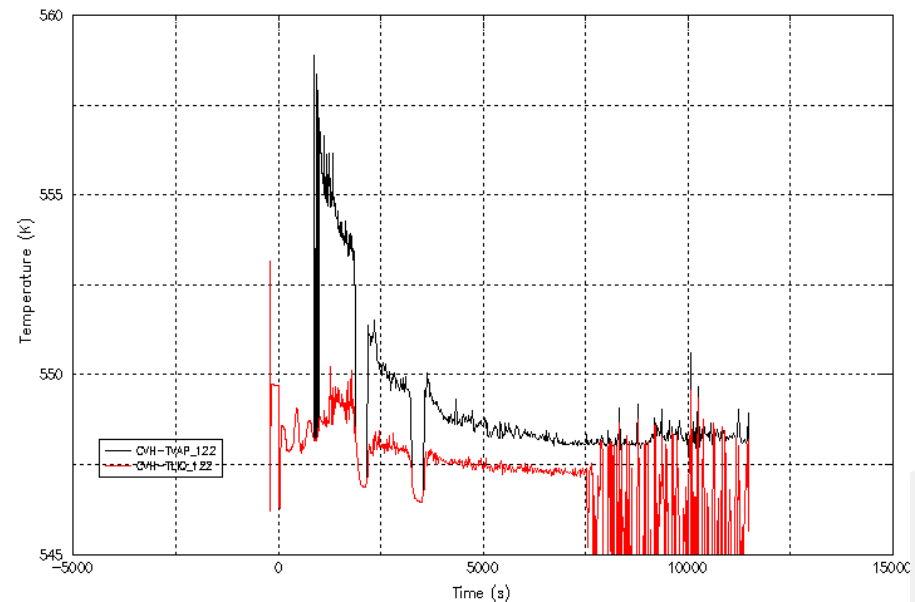
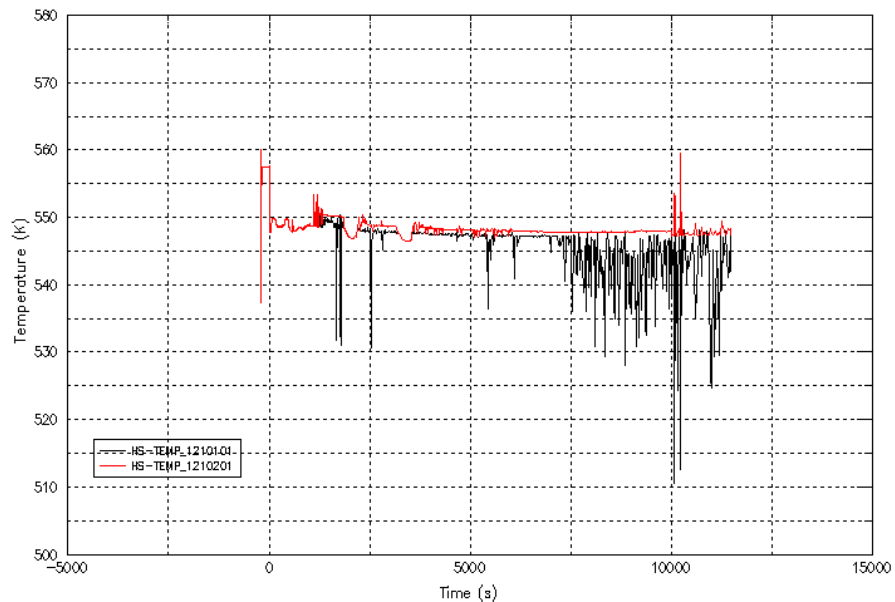
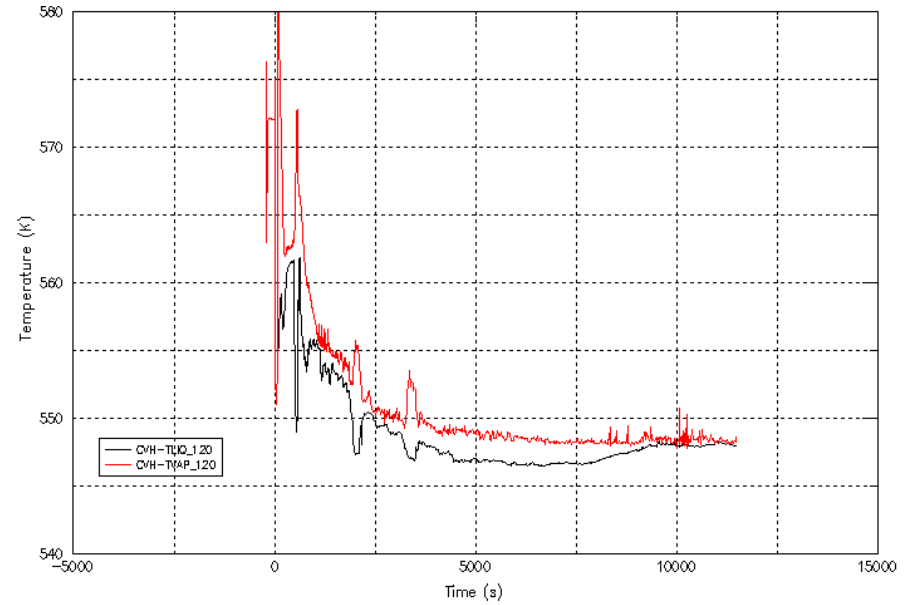
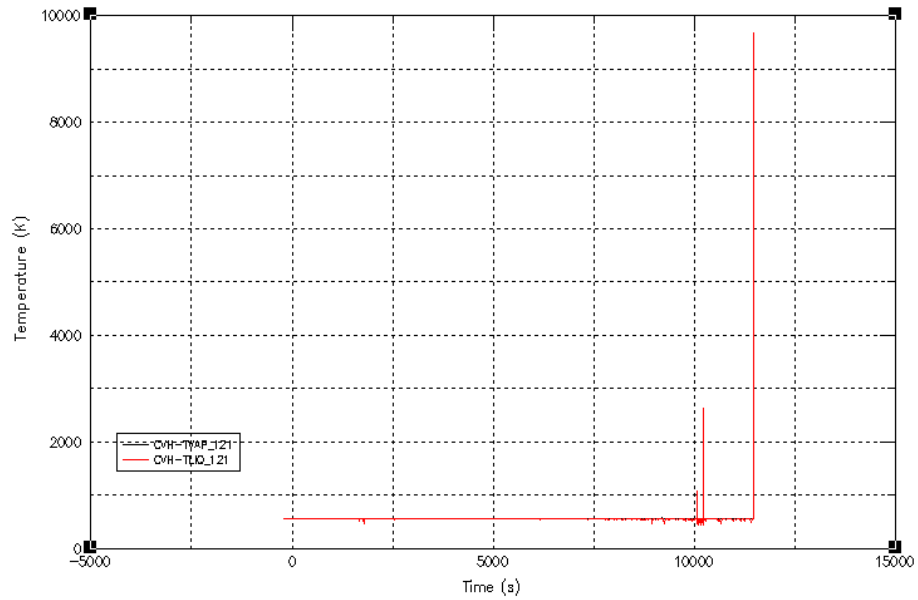
Total mass of debris escaping from RPV and total mass in reactor cavity



Code usage overview – STC11, LOCA100-EXVES

- Calculated up to 5 days (432 000 s), using 15254,
- Crashed at 697 s, no report, using 18019,
- Crashed at 20 313 s, ERROR IN CORE LOWER HEAD MODEL, ONE-DIMENSIONAL MECHANICAL MODEL FAILED TO CONVERGE, time step changing and different restart times did not help, using 21402
- Crashed at 7 091 s, POOL VOID NOT CONVERGED, TOO LARGE A MASS OR ENERGY SINK GENERATED FOR CVH, TIME STEP REDUCED TO 0.0000E+00, using r2023.0

Code usage overview – PRISE scenario, crash even before core damage (15254)



Conclusion

- MELCOR is nowadays exclusively used for severe accident analyses as capacity and capability (both financial and personal) for other codes in severe accident area are diminishing.
- “The first step of avoiding a trap is knowing of its existence.” Thufir Hawat
- The first step of finding the cause of a crash is knowing where the instability happened.
- The most important area of MELCOR 2.2 code upgrade is in crash reporting.



Thank you for your attention.

Feel free to ask questions.

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Fax: + 421 33 599 1200