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PSI

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Conversion of SFP input deck from MELCOR 1.8.6 to 2.1 and back

EMUG, 07.04.2016

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Content

- **Introduction**
- **Modelling**
- **Conversion**
- **Results**
- **Conclusions**

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Introduction

Goal of the work was to check the SNAP convertion routines with a relatively simple SFP inpt deck

A MELCOR 1.8.6 input deck was prepared for the Fukushima unit 4 spent fuel pool

The results of the converted MELCOR 2.1 deck were compared with the results of the original deck

The results of the back converted MELCOR 1.8.6 deck also were compared with the original results

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Accident description

Slow Loss of coolant accident until pool is completly dried out

Remaining pool water heats up during drainage

After start of uncovery fuel heats up and cladding starts to oxidize

Buoancy driven gas flow starts after water level reaches lower end of fuel racks

PSI breakaway model is activated (in steam and air)

Radio nuclide release and MCCI is activated

Cavity will be activated after failure of the steel liner at melting temperature

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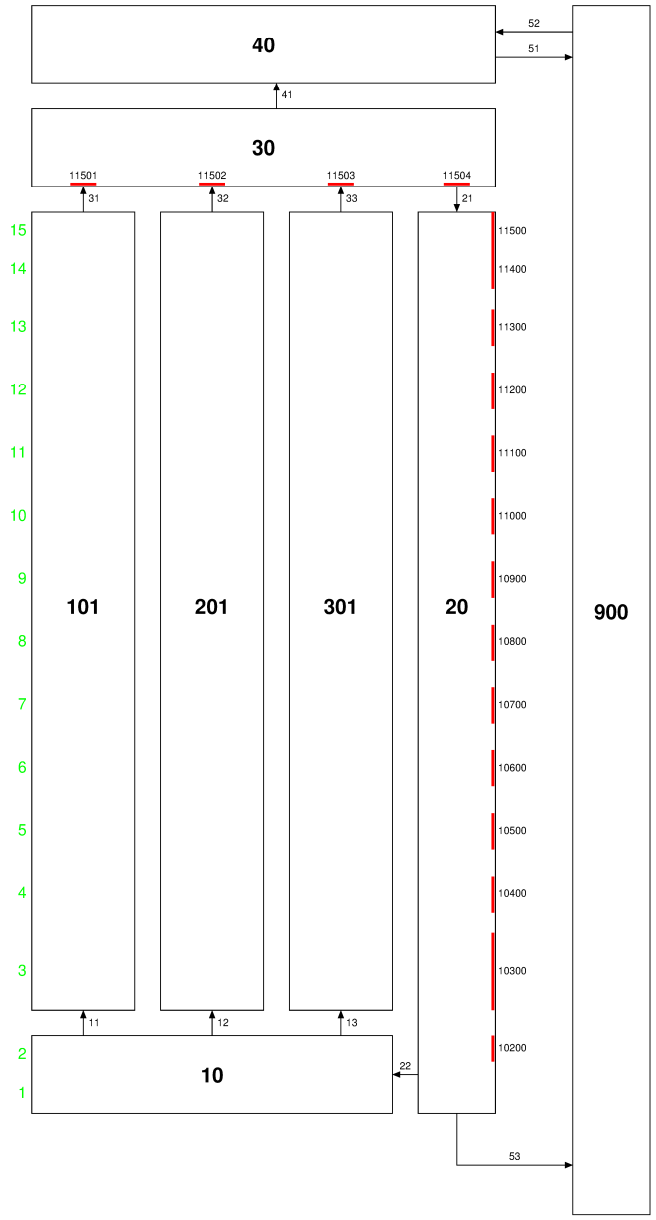
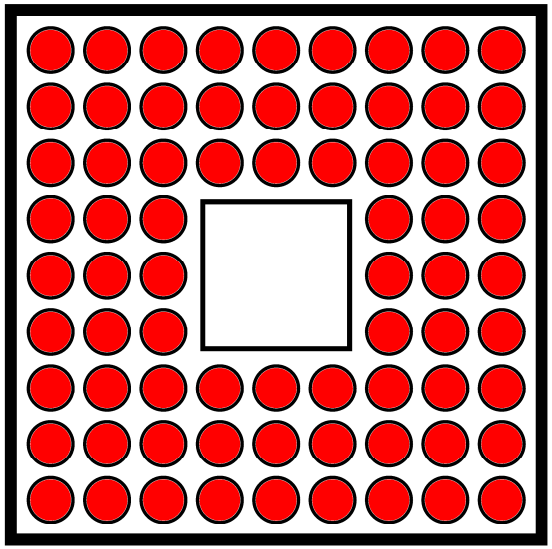
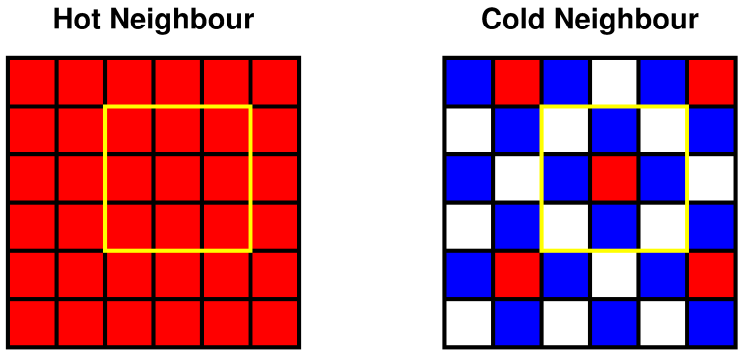
Modeling



Fuel Assembly Geometry



Modelling



Two phases were planned during the project:

- **Hot neighbour configuration**
- **Cold neighbour configuration**

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Conversion of the input deck with SNAP

1. **Problem was setting of not used hydraulic diameters to 0.0 (needs manual correction)**

Failure of MELGEN, but production of restart file
MELCOR fails with: restart file not found!!!

Conversion MELCOR 1.8.6 to MELCOR 2.1

MELCOR 1.8.6 (YV 3084 PSI)

*	DHYCL	DHYOS	DHYPD	DHYCNC	DHYCNB	DHYSS	DHYNS	DHYPB
COR10204	0.09652	0.09652	0.09652	0.09652	0.09652	0.09652	0.09652	0.09652
*		DHYRK						
COR10204C		0.09652						

MELCOR 2.1 (6342)

COR_EDR	24 ! n	ia	ir	dhycl	dhypd	dhycnc	dhycnb	dhyss	dhyns	dhypb
	2	2	1	0.09652	0.09652	0.0	0.0	0.09652	0.09652	0.09652
COR_RDR	24 ! n	ia	ir	dhyrk						
	2	2	1	0.09652						

Conversion of the input deck with SNAP

2. Problem was reversing the command to store contour data for cavity shape (1 -> exclude)

MELCOR 1.8.6

```
CAV01Z1     SHAPEPLOT     1
```

MELCOR 2.1

```
CAV_U    4 !n      keyword          value[1]     value[2]
             4      SHAPEPLOT        EXCLUDE
```

Calculation with MELCOR 2.1

Problem with MELCOR 2.1:

MELCOR 2.1 fails at restart with PSI breakaway model activated after oxidation has started (breakaway conditions could not be identified)

Conversion MELCOR 2.1 to MELCOR 1.8.6

MELCOR 2.1

```
COR_EDR   24 ! n       ia       ir    dhycl     dhypd     dhycnc  dhycnb  dhyss     dhyns     dhypb
                2        2        1    0.09652   0.09652   0.01    0.01    0.09652   0.09652   0.09652
COR_RDR   24 ! n       ia       ir    dhyrk
                2        2        1    0.09652
```

MELCOR 1.8.6

```
*              dhycl      dhyfm     dhypd      dhycnc   dhycnb   dhyss      dhyns     dhypb
COR10204       0.09652    -1.1      0.09652    0.01     0.01     0.09652    0.09652   0.09652
*              dhyrk
COR10204C      0.09652
```

no problem for MELCOR 1.8.6 here, but...

Conversion MELCOR 2.1 to MELCOR 1.8.6

MELCOR 1.8.6 original

```
*        'IN' TRANSFER PROCESS FROM COR PACKAGE TO TP PKG
*                NMSIN   NTHRM
TPIN10100     6          9
*        'OUT' TRANSFER PROCESS FROM TP PACKAGE TO CAV PKG
*                 NMSOT   NPOTOI     IOTMTX
TPOT10100      5          101          UIN.101
*
TPM1010000    5           6
*
*          TRANSFER PROCESS INPUT - RADIONUCLIDE MASS
*                NMSIN    NTHRM
TPIN60100      16         1
*                NMSOT    NPOTOI    IOTMTX
TPOT60100      16         601         DEF.1
```

MELCOR 2.1

```
!****** Input Transfer Components
!     size
TP_IN      2 !n   nametpin   type direct ip2edf nmsin nthrm
                1   'ITP_1'      COR
                2   'ITP_2'      RNCOR
!****** Output Transfer Components
!      size
TP_OUT    2 !n     nametpot       npotoi       outmtx        nmsot
                1      'OTP_1'        'ITP_1'       'MTX_101'
                2      'OTP_2'        'ITP_2'
```

Problem with TP

MELCOR 1.8.6 back converted

```
*n: ITP_1
*                  nmsin       nthrm
TPIN00100          6           9
*
*n: ITP_2
*                  nmsin       nthrm
TPIN50100          16          1
*
*n: OTP_1
*                 nmsot     npotoi       outmtx
TPOT10100         0         1            UIN.1*
*n: OTP_2
*                 nmsot     npotoi       outmtx
TPOT60100         0         501          DEF.1
*
```

Conversion MELCOR 2.1 to MELCOR 1.8.6

Problem again was reversing the command to store contour data for cavity shape (include -> 0.)

MELCOR 2.1

```
CAV_U   4 !n     keyword        value[1]     value[2]
            4    SHAPEPLOT      INCLUDE
```

MELCOR 1.8.6

```
CAV01U3     SHAPEPLOT     0.
```

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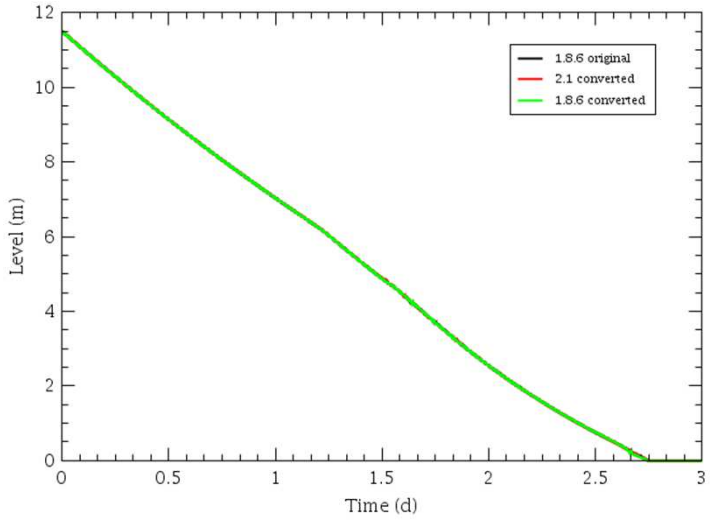
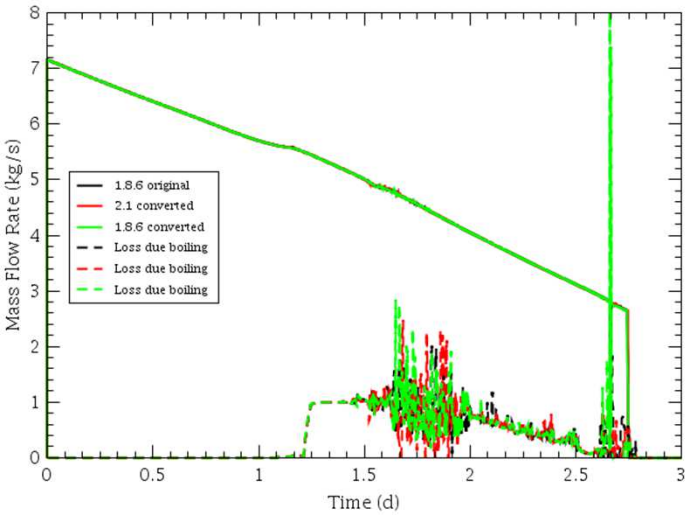
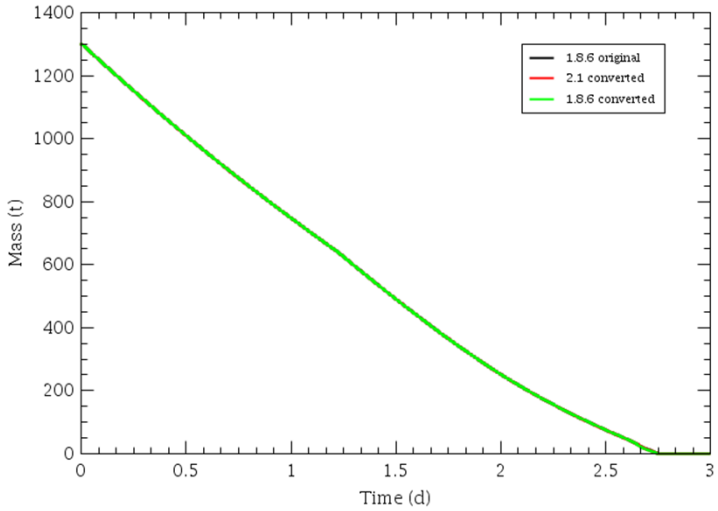
Results

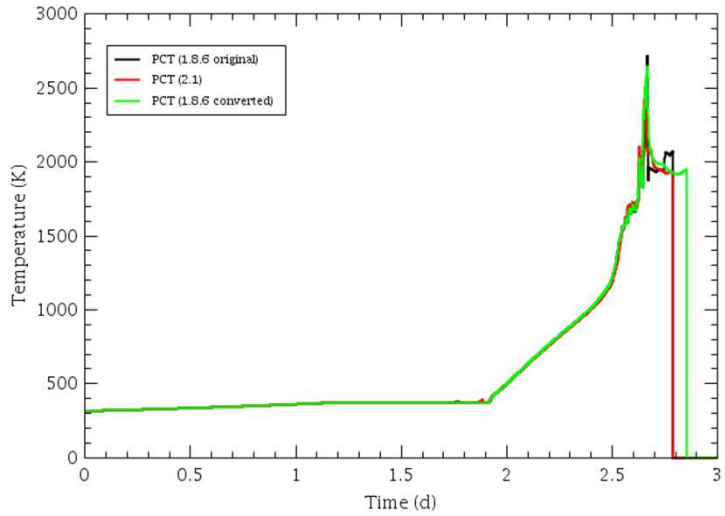


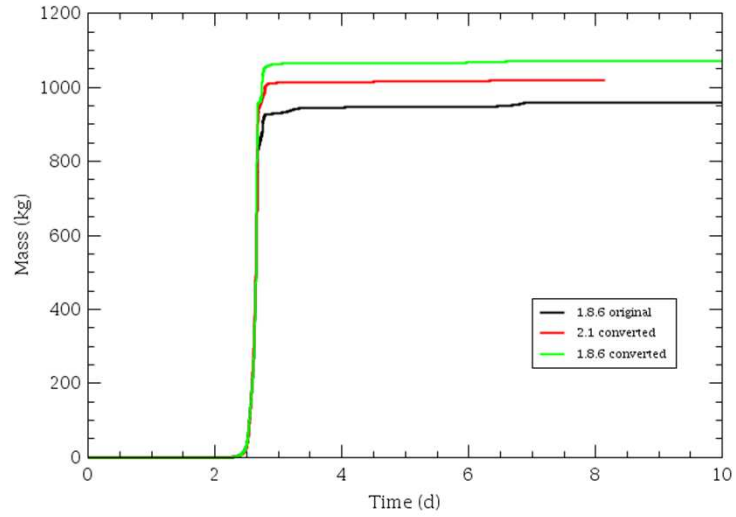




Identical results until beginning of fuel uncovery.
numerical instable behavior of the code leads to slightly different calculation.

Results



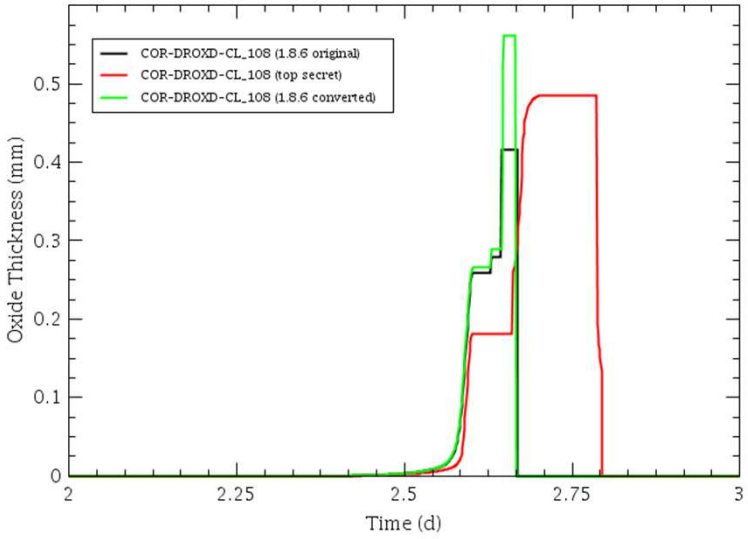


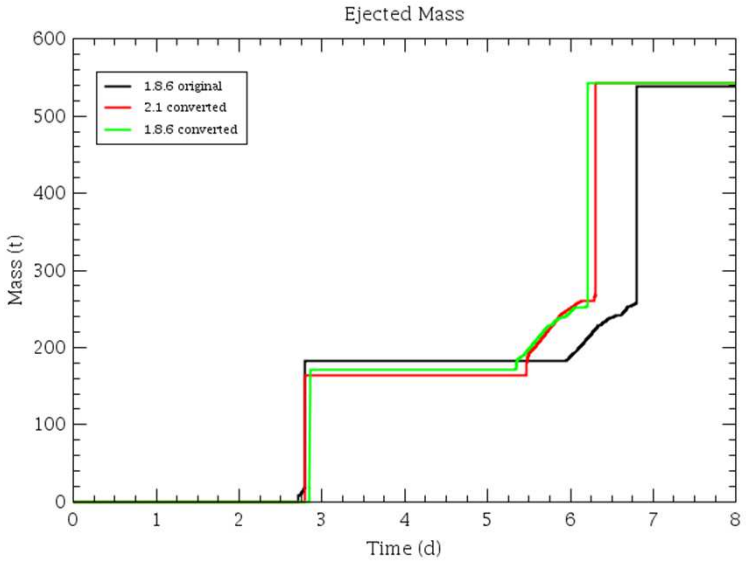
The results of the converted input decks start to differ more significantly after begin of relocation.

The peak cladding temperature (above) shows differences after the first peak and also at the last cladding relocation.

The hydrogen production in the core (below) stops at different levels and the later hydrogen production after fuel relocation can be explained by oxidation of non-relocated rack materials (steel).

Results





The oxide thickness of the cladding is a very useful variable and is used since several years. Surprisingly it was notified that it is not available in 2.1.

It is also not mentioned in the user guide of 1.8.6.

Recommendation:
Include the variable in 2.1 version.

The ejected mass is almost identical except of the timing.

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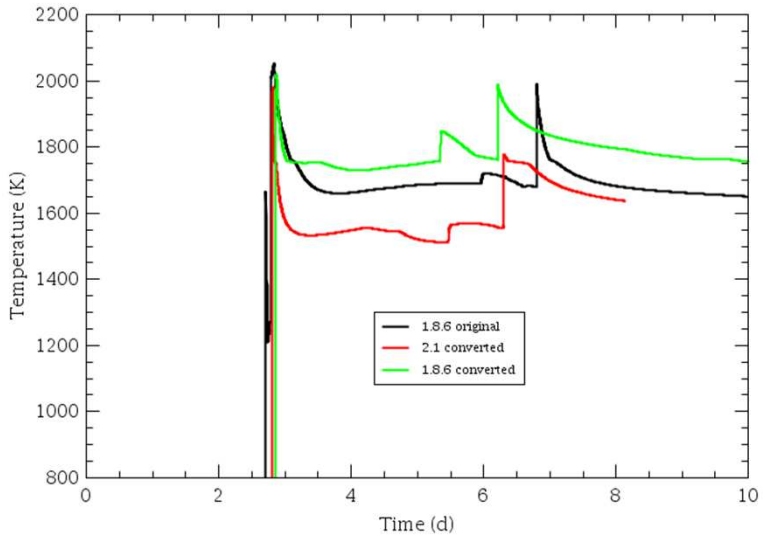
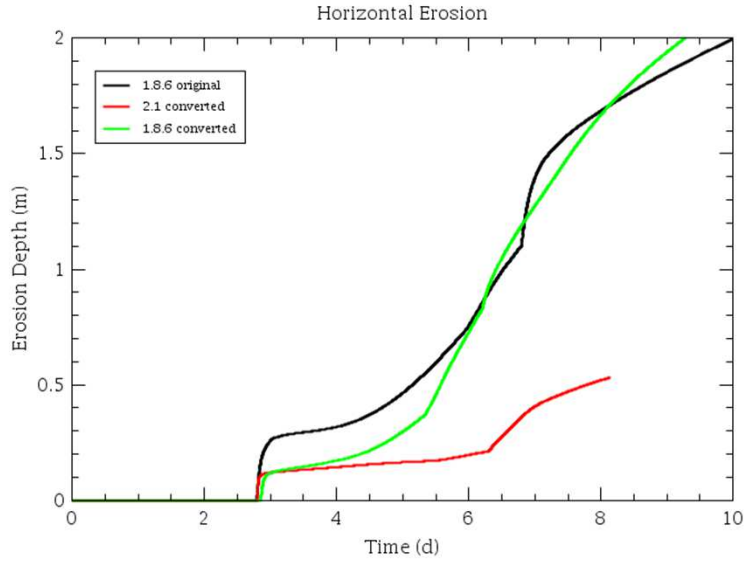
Results





A Problem with 2.1 is a larger instability of the program during MCCI. It was not possible to drive the code for the further calculation of the accident sequence.

The melt temperatures (above) are differing strongly between 2.1 and 1.8.6.

Also the horizontal concrete ablation is strongly different between MELCOR 1.8.6 and MELCOR 2.1.

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Results

MELCOR 2.1 failed during the MCCI calculation with following error message:

<Diagnostic Message> Time= 9.3320E+06 Dt= 1.2000E+00 Cycle= 3957380 (COR)
VIEW FACTOR ERROR IN CORVF
SUM OF VIEW FACTORS EXCEEDS UNITY FOR SURFACE PRT.DBR IN CORE CELL 303
FURTHER MESSAGES SUPPRESSED

<Diagnostic Message> Time= 9.3442E+06 Dt= 8.3435E-10 Cycle= 3968860 (CVH)
Error in equilibrium thermo routine CVTWGE
Called from CVTNQE for Volume Building

MELDIA_v2-0 and MELOUT_v2-0 filesize increased over 85 GB each before run was stopped manually.

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Conclusions

The code conversion with SNAP is working with some problems (TH diameters, MCCI contour data, TP).

The code calculates in rather good agreement at the beginning of the transient. Diversivities are growing with time as usual.

Attention! MELCOR 2.1 produces restart file even if MELGEN fails.

Thank you for your attention