Major pitfalls in updating an accident sequence analysis with MELCOR: from 1.8.4 to 1.8.6 YT versions

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OUTLINE

1. **Introductory Remarks**
2. **Scenario Description**
3. **Pitfalls**
4. **Final Remarks**

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1. *Introductory Remarks*

- *AR-PHEBUS project: Analysis of Level – 2 PSA sequences of Spanish NPPs taking into account the recent developments in MELCOR and from the PHEBUS – FP project*

- *This work have been carried out under the sponsorship of Consejo de Seguridad Nuclear (AR-PHEBUS agreement)*

- *The objectives of this project are:*

  - *To asses how relevant MELCOR updates are in terms of severe accident sequences*

  - *To check the effect of including Iodine Chemistry on the MELCOR estimates*

- *Ciemat experience with MELCOR code is limited to:*

  - *PHEBUS – Tests: FPT1 and FPT2 (containment THs, aerosol behaviour and Iodine chemistry)*

  - *Sequence of ASCÓ NPP (full sequence from core degradation to releases to environment)*

- *The objective of this presentation is to report on the problems found when analyzing a full sequence of ASCÓ NPP*
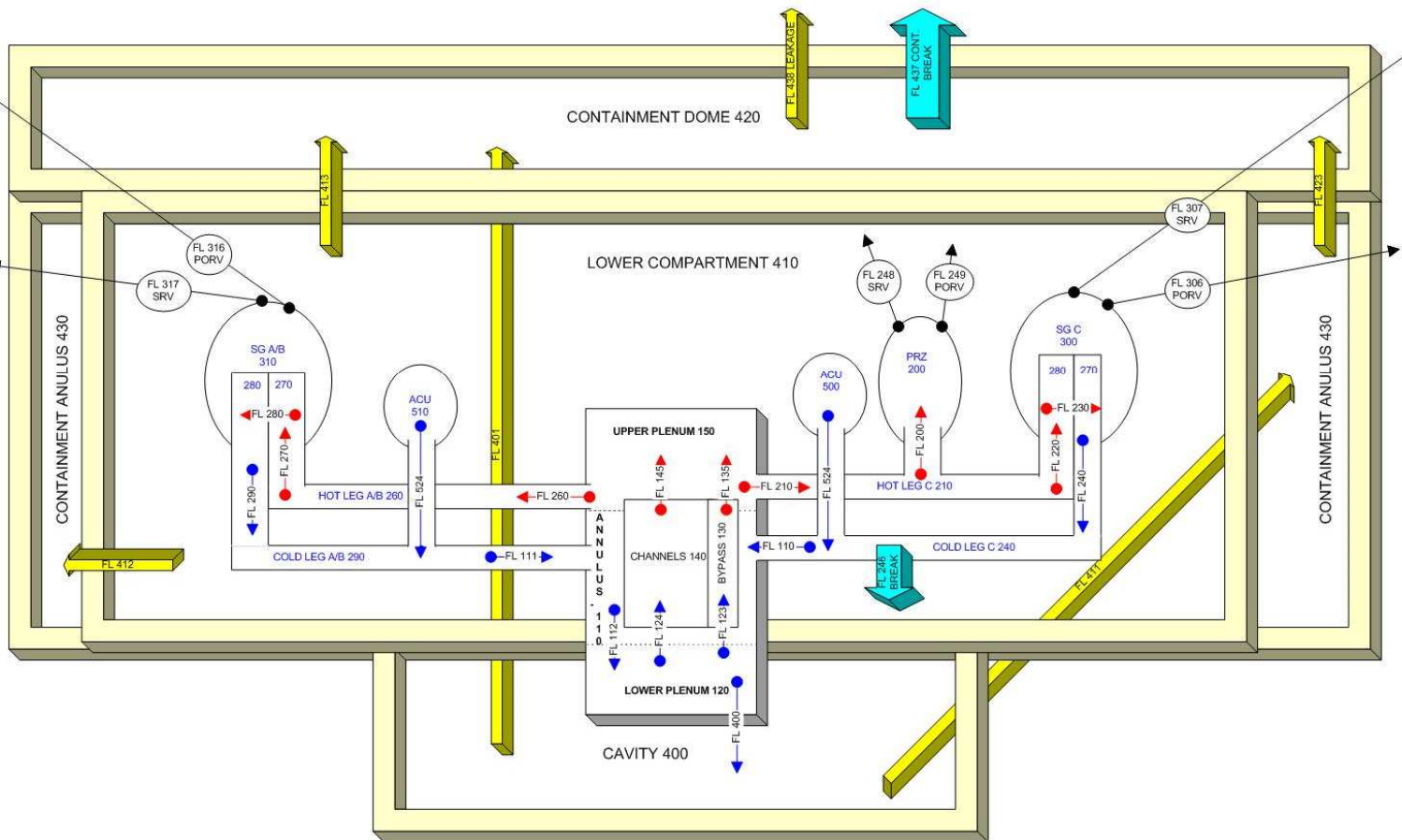
  They should not be necessarily associated to the MELCOR code. But, even if they are not, it could be of some interest to know where "newcomers" find pitfalls in MELCOR applications

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2. Scenario description

2.a. ASCÓ NPP

- **Westinghouse design**

- **Power: 940 MW(e)**

- **Dry containment**

2. Scenario description

2.b. Sequence description

- *ALNDRF8 chosen from ASCÓ – PSA LEVEL – 2*

- *Characteristics:*
  - *Large LOCA*
  - *Low pressure (below 13.6 bar)*
  - *Neither the sprays nor the fan coolers available*
  - *Dry cavity*
  - *Low-pressure recirculation failed*

- *Accident progression:*
  - *Large (10 ") break in one of the cold legs of the RCS*
  - *Core damaged at 0.16 hours*
  - *RPV failure at 3 hours*
  - *Containmet pressurized steadily (due to MCCI + absence of fan coolers)*
  - *H_2 deflagration in the short – term (< 10 hours)*

3. Pitfalls

3.a. Input Deck (I): The 185 input deck build up

- *OBJECTIVE: to run ALNDFR8 sequence and compare MELCOR estimates (184 - 185)*

- *Manual modifications in the COR and DCH packages:*

  - *COR package: distinguish between SS and NS and define its temperatures, equivalent diameters and surfaces.*
  - *DCH package: New record (DCHFPOW) to define the total thermal operating power due to fission and decay of U-235, Pu-239 and U-238 nuclides.*

PITFALLS

- *Unavailable graphic tools to extract the information of 184 OUT file*

- *Consistency errors between COR and CVH packages*
- *Cavity errors messages*

SOLUTIONS

- *Hisptlm.exe*

- *Exhaustive revision of the MELCOR 185 user guide.*

DONE!!

3. Pitfalls

3.a. Input Deck (II): The 186 input deck build up

- *OBJECTIVE: to run ALNDFR8 sequence and compare MELCOR estimates (185 - 186)*

- *Modifications with 'MELCOR Input Deck Converter': creation of the LHMP text file.*

PITFALLS

- *Many code crashes*
- *Warnings in .GDIA file:*

"Warnings from subroutine CORICV altitudes in CVH volume altitude tables do not match COR cell elevations"
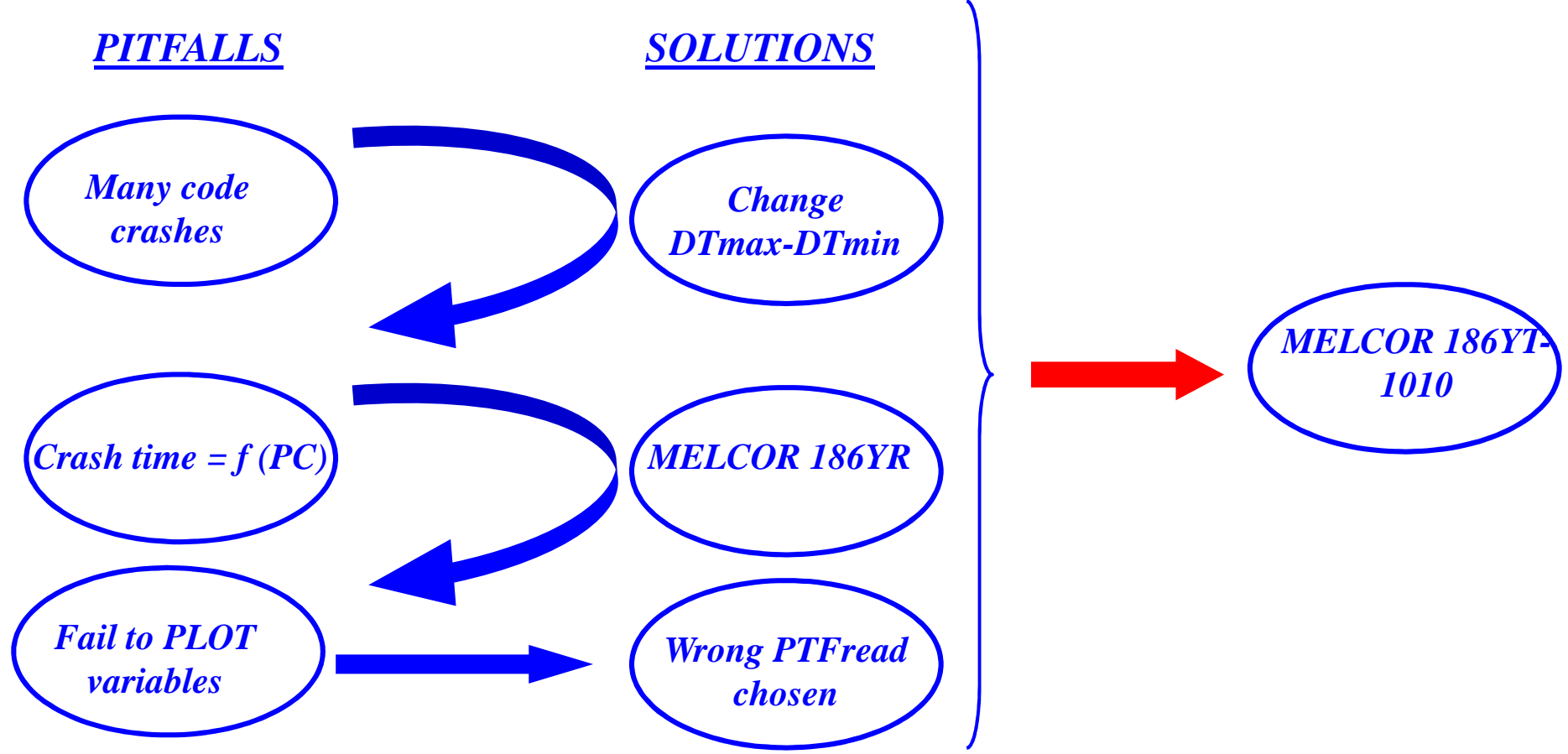
SOLUTIONS

→ •*Manual modifications following the MELCOR 186 user guide*

DONE!!
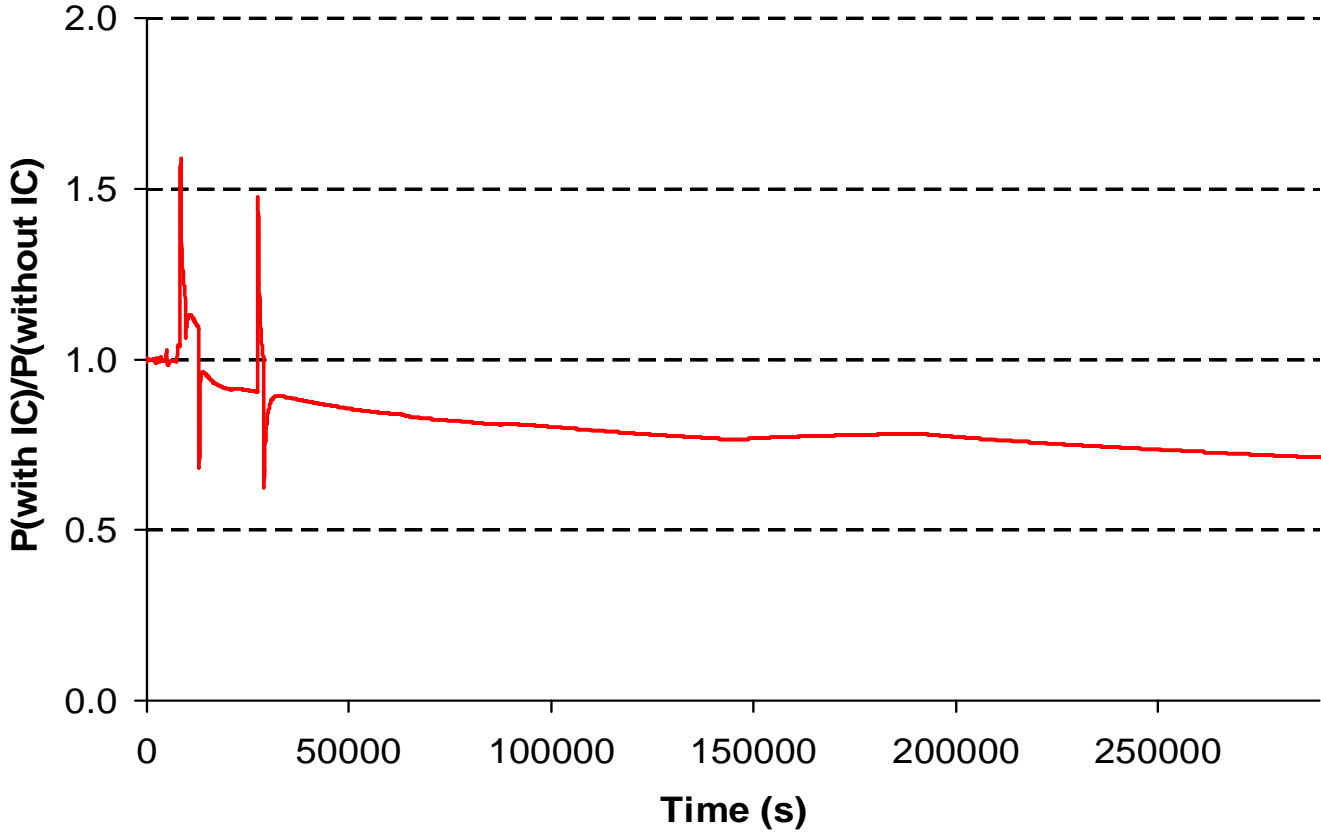
3. Pitfalls

3.b. Activation of Iodine Chemistry

- *Introduce new records to activate the Iodine Chemistry Model*
- *Define new necessary radionuclide classes with this model*

<u>PITFALLS</u>   <u>SOLUTIONS</u>

Many code crashes

Change DTmax-DTmin

MELCOR 186YT-1010

Crash time = f (PC)

MELCOR 186YR

Fail to PLOT variables

Wrong PTFread chosen

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3. Pitfalls

3.c. Results Analysis (I)
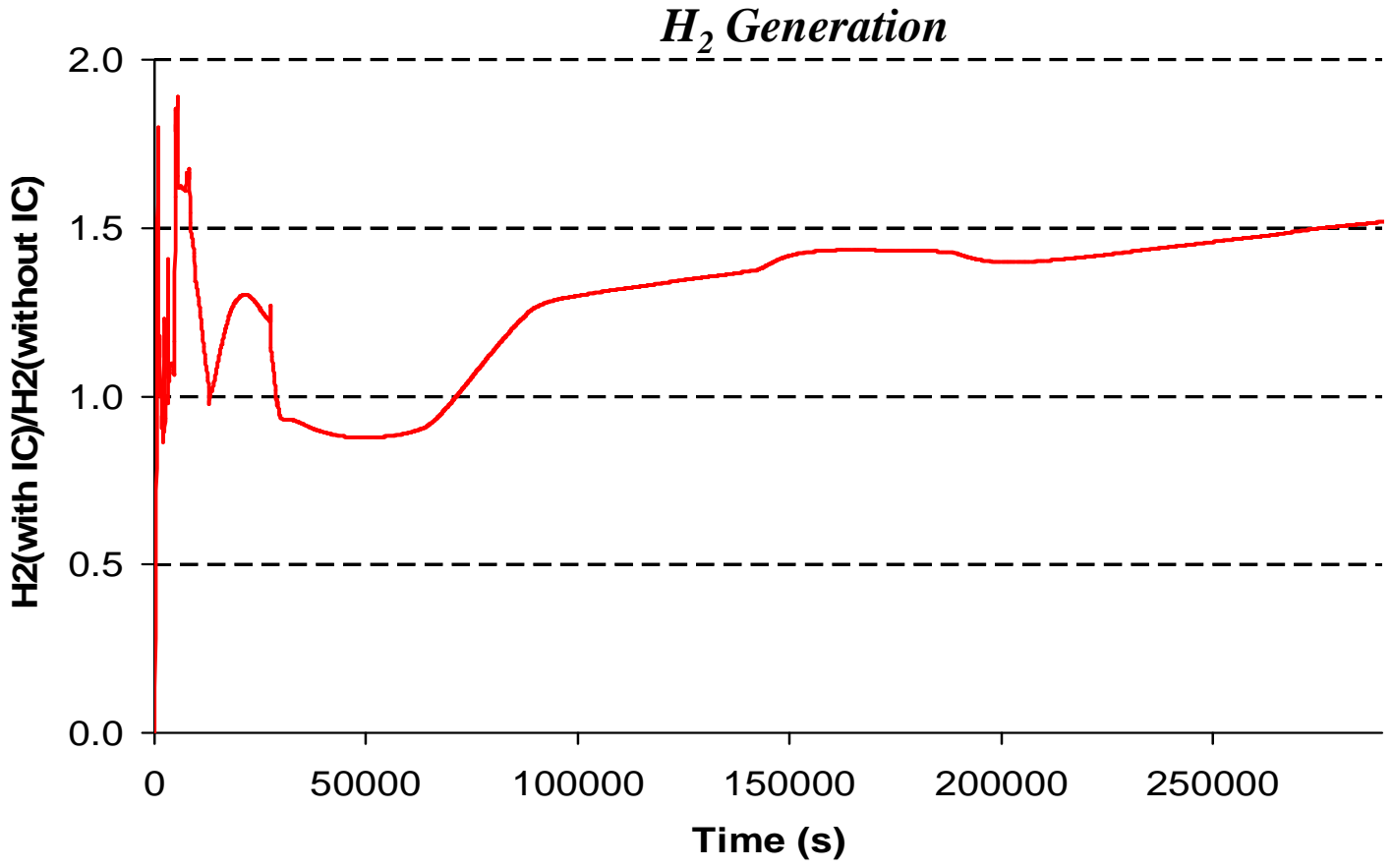
Containment Pressure

Does the Iodine Chemistry Model CONDITION the integration time intervals ?

3. Pitfalls

3.c. Results Analysis (II)

H_2 Generation

3. Pitfalls

3.c. Results Analysis (III)

Without IC	With IC (t = 0 s)	With IC (t = 9000 s)
/SMESSAGE/ TIME= 3.63963E+00 CYCLE= 82	**/SMESSAGE/ TIME= 3.68026E+00 CYCLE= 68**	**/SMESSAGE/ TIME= 3.68026E+00 CYCLE= 68**
CF0500 - MESSAGE FROM CONTROL FUNCTION PACKAGE **CONTROL FUNCTION 500 - RPS-PPZR BECAME .TRUE.**	CF0500 - MESSAGE FROM CONTROL FUNCTION PACKAGE **CONTROL FUNCTION 500 - RPS-PPZR BECAME .TRUE.**	CF0500 - MESSAGE FROM CONTROL FUNCTION PACKAGE **CONTROL FUNCTION 500 - RPS-PPZR BECAME .TRUE.**
/SMESSAGE/ TIME= 8.15162E+03 CYCLE= 25931	**/SMESSAGE/ TIME= 7.40969E+03 CYCLE= 27728**	**/SMESSAGE/ TIME= 7.80817E+03 CYCLE= 26797**
COR0002: MESSAGE FROM CORE PACKAGE **BEGINNING OF DEBRIS EJECTION TO CAVITY**	COR0002: MESSAGE FROM CORE PACKAGE **BEGINNING OF DEBRIS EJECTION TO CAVITY**	COR0002: MESSAGE FROM CORE PACKAGE **BEGINNING OF DEBRIS EJECTION TO CAVITY**

3. Pitfalls

3.c. Results Analysis (IV)

- *Fission products classes – Iodine chemistry speciation – Unclear match*

  - *IM ("pool iodine bound in chemical species other than I_2 or CsI"*

    - *Adding – up all the iodine species other than I_2 or CsI is hard to get the same IM figure*

  - *CH_3I origin*

    - *No organics added in the system or cable/coatings defined*

    - *A noticiable fraction of CH_3I found*

    - *Where does it come from? (Is it a default amount?)*

4. Final Remarks

- *More user-friendly tools to make MELCOR new versions compatible with previous versions input decks would be welcome*

- *Intricate procedure to make Iodine pool model run, a more straightforward way would be recommendable (i.e., extra – RN and deposition classes defined out of the IPM records)*

- *Link between IC activation and MELCOR running unclear*

- *Efforts have been made to make IPM easier to use by MELCOR developers; nevertheless, the analysis of IPM results is not simple*

"Thanks to the MELCOR development team for their technical support during this work"

THANK YOU FOR YOUR ATTENTION