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Simultaneous SFP and open reactor calculations for VVER-1200

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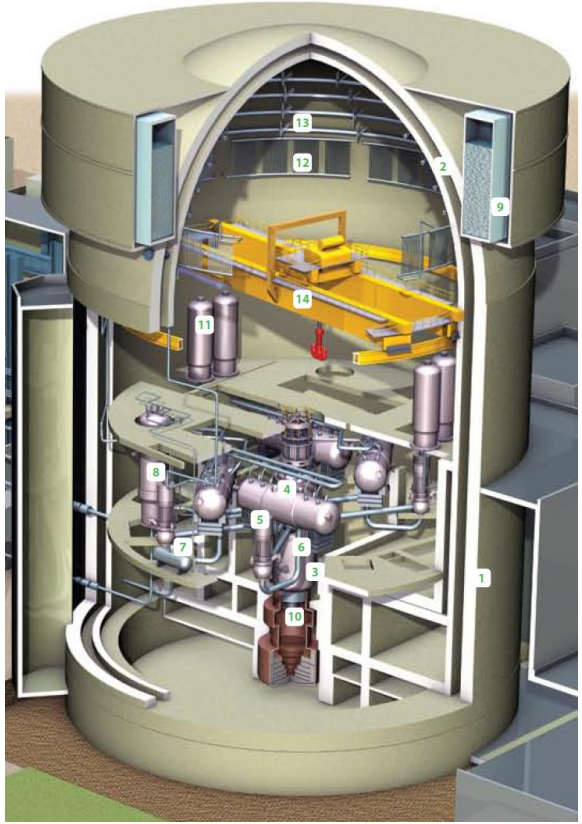
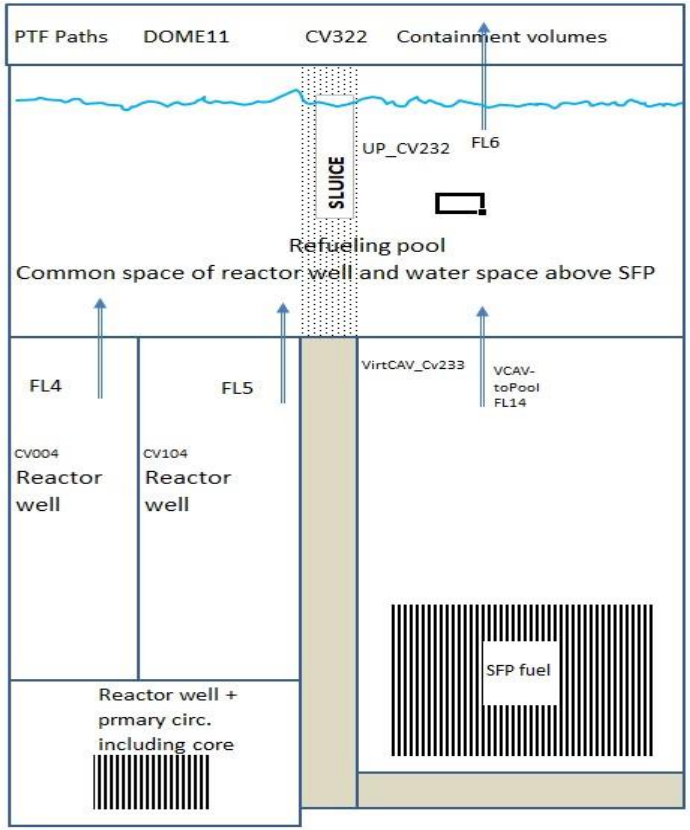
Introduction – VVER1200



Present status of VVER-1200 in Hungary:

- Soil-foundation work ongoing
- Safety analysis report still in PSAR status
- Lot of analyses and calculations still needed before final safety analysis report will be issued
- Current global politics and economy bring large uncertainty into the whole project
- Even if the project is stopped, the analyses could still be helpful and the expertise is maintained

Task of simultaneous SBO on Reactor + SFP



Reactor and SFP simultaneous SBO has not been analysed so far anywhere

Main goal is to find out whether:

- Can the pressure be limited by the Containment Passive Heat Removal System (CPHR) and how long?
- Release of hydrogen is overlapping for in-reactor and in-SFP processes. Are recombiners able to cope with the rate and mass of hydrogen?
- Is activity release increasing or not?

Concept of simultaneous SBO model of Reactor + SFP

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Reactor and SFP both need to contain 2 distinct core models by the COR package

however

Simultaneous calculation of Reactor + SFP containing 2 COR packages is not possible by MELCOR

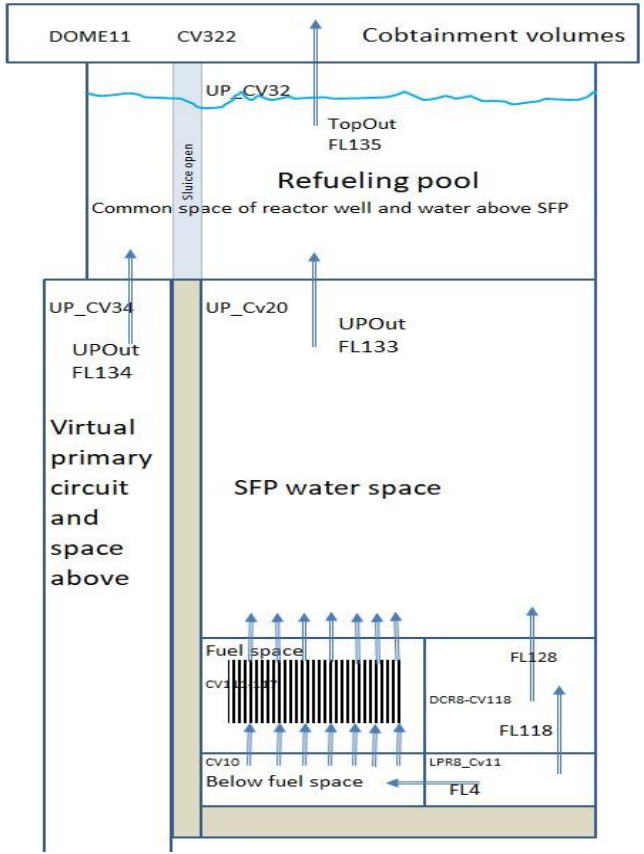
Solutions of the problem:
1st option: perform 2 separate calculations and add the results afterwards

- Disadvantage:
  - Containment boundary conditions will be different in the 2 calculations
  - Some parameters can not be added/averaged – requires a lot of work

2nd option: 2 calculations but creating similar containment boundary conditions

How to achieve the 2nd option?

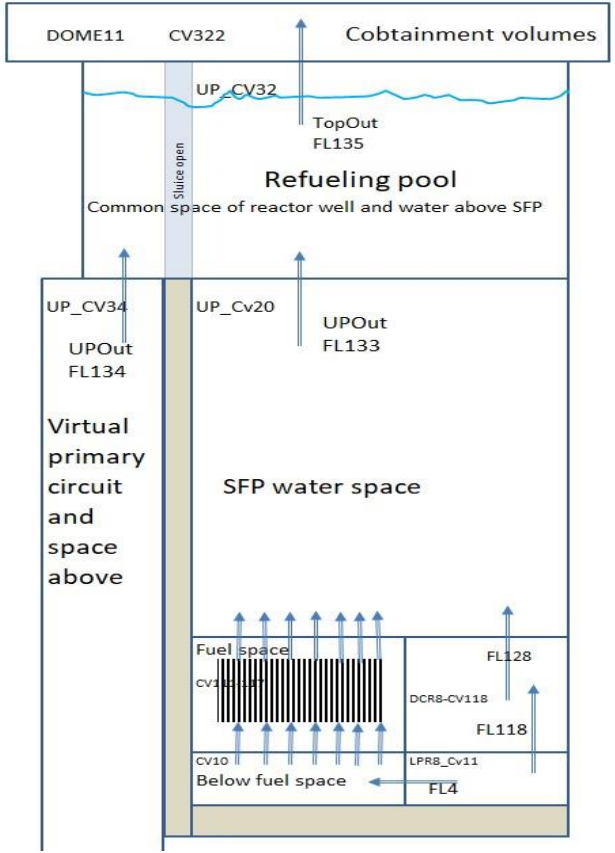
Simult. SBO on Reactor + SFP – 1st Stage: SFP - 1



1st Stage calculation:

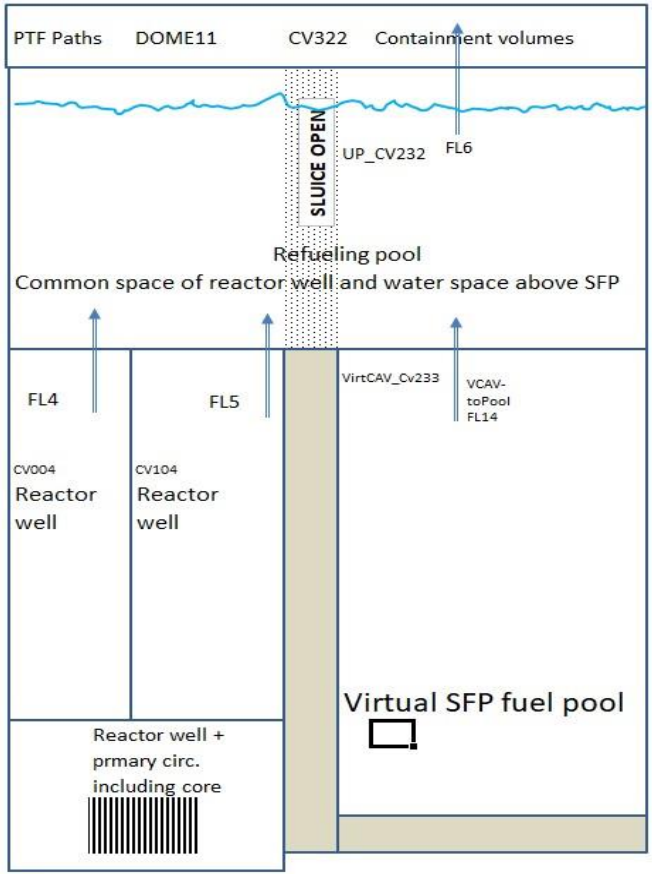
- Use a full SFP COR model with SFP + Refueling-pool + Virtual-reactor-pool filled with water
- Residual heat in the reactor vessel is added via TAB-FUN
- Record SFP exit flow at SFP top (sluice bottom=UpOut133) after Refuelling-Pool level is at sluice bottom:
  - FL133 - steam, H_2, atmospheric energy
- Transfer COR fuel to a virtual CAVITY at SFP bottom failure
- Record CORCON flows:
  - CAV-MEX('VirtCAV',H_2O)
  - CAV-MEX('VirtCAV',H_2)
  - CAV-MEX('VirtCAV',CO)
  - CAV-MEX('VirtCAV',CO_2)
  - CAV-TSURF('VirtCAV')

Simult. SBO on Reactor + SFP – 1st Stage: SFP - 2



- Record Fission Product flow at SFP top (sluice bottom=UpOut133) after Refuelling-pool level is at sluice bottom:
  - (CORSOR) MACCS-M-RE('RN_FL133','XE',TOT) + 16 more FP classes;
- Transfer COR fuel to a virtual CAVITY at SFP bottom failure:
  - Record CORCON Fission Product flows MACCS-M-RE('RN_FL399','XE',TOT) + 16 more FP classes;
- RN package accepts only a single set of 17 FP sources so – CORSOR and CORCON FP source has to be summed up

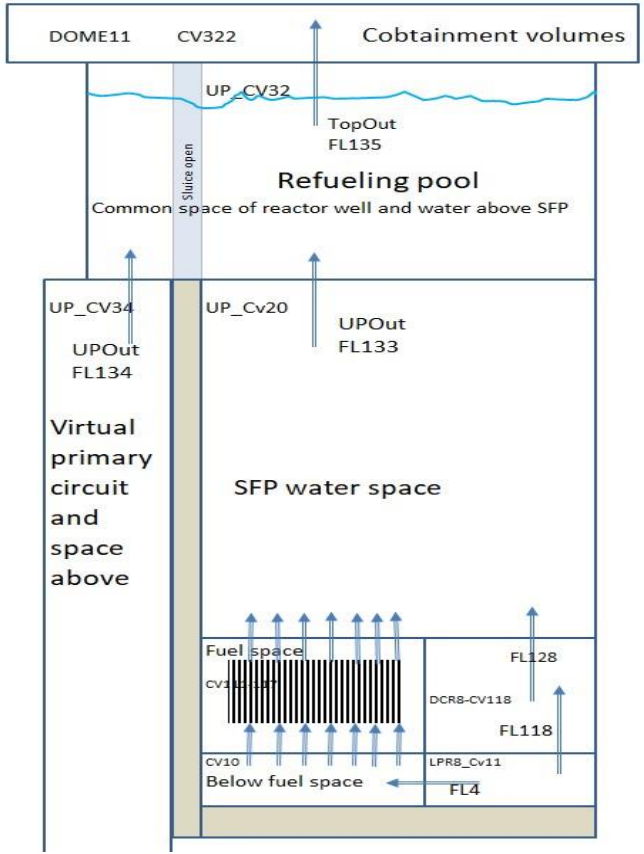
Simult. SBO Reactor + SFP – 2nd Stage: RPV/Primary



Conditions:

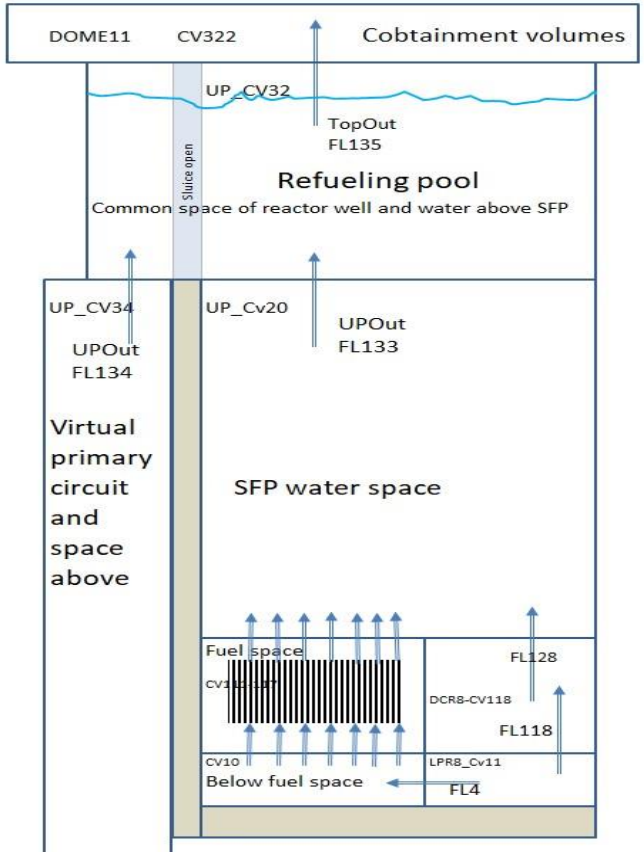
- Use a Primary Circuit COR model with SFP + Refuelling-pool + Virtual-reactor-pool filled with water
- Calculate reactor and primary circuit with COR package describing the reactor core
- Use previously recorded SFP exit flow at SFP top (sluice bottom=UpOut133) after Refuelling-Pool level is at sluice bottom and CORCON sources as TAB-FUN functions as additional input

Simult. SBO on Reactor + SFP – Limitations of the model



- Virtual primary circuit contains structural elements and heat losses interfacing the containment which are not taken into account in the calculation (only relevant in the 1st stage)
- These however can be included, but might need iterative calculations
- For a more precise definition of decay and reaction heat from the two ‘cores’, iterative calculations could be made

Simultaneous SBO Reactor + SFP – Results



- Containment Passive Heat Removal (CPHR) is able to restrict pressure within prescribed limits up to late stage of SFP CORCON reaction
- In our cases the hydrogen produced during the degradation of the two 'cores' were not overlapping, i.e. hydrogen production in the SFP starts much later
- The H_2 recombiners consume most of the oxygen in the containment during the degradation of the in-vessel core so no oxygen is left for H_2 recombination at later stages, thus the atmosphere mixture is not flammable (however mostly because of oxygen starvation)

Simultaneous SBO Reactor + SFP – Conclusions

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The combined model gives reasonable results and eliminates some MELCOR restrictions

Precision of the used method is sufficient for such low-power, long transients

Iterative calculations could improve precision of the calculations, however the uncertainties during a severe accident (calculation) might likely outweigh the need for a more precise definition of boundary conditions

Connecting two MELCOR calculations directly might give better results, but the difficulties in doing so might make it not feasible

Bonus slide

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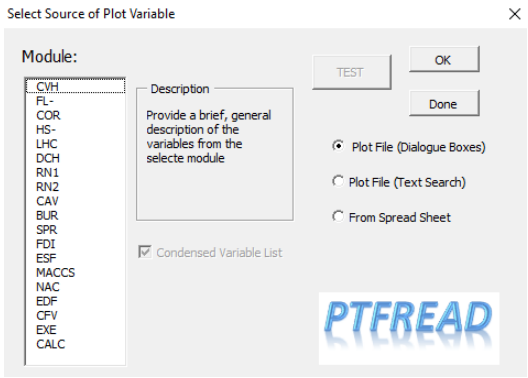
We had a problem with PTFREAD for years now (already mentioned two years ago at EMUG):

- Using the dialogue boxes option does not work
- Crashing after couple of plots
- Update sheets from PTF does not work
- …



We found the solution:

The operating system (ie. Windows in our case), or more precisely the user account has to be set to English language. Setting the input language and Excel is not enough.

Thank you for your kind attention