Accident analyses for the Cryostat-building interface components

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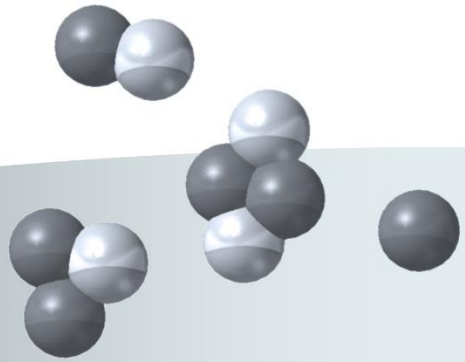

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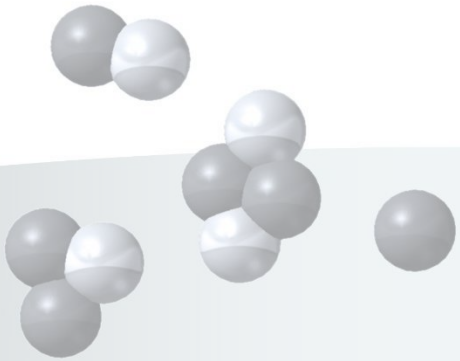
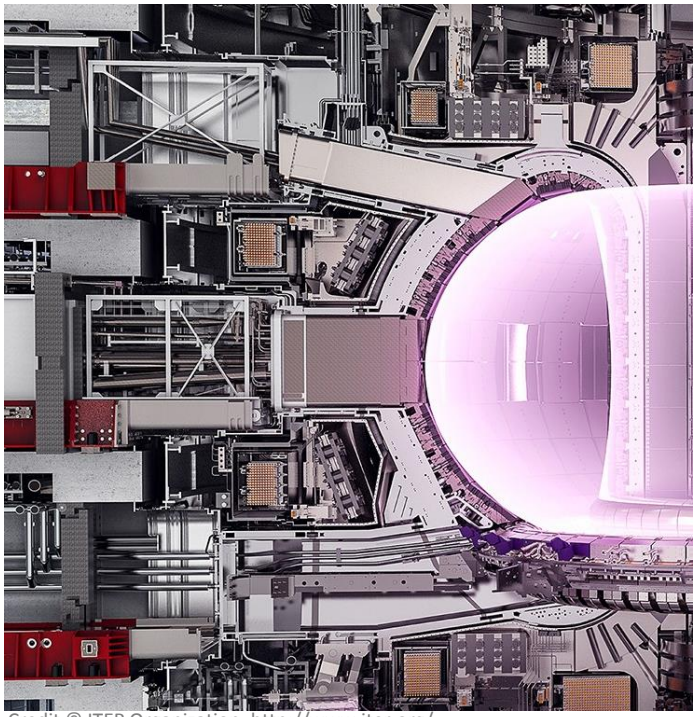


Background

- ITER Cryostat is a metallic structure that maintains a technical vacuum.
- The Cryostat is attached to the building by means of the bellow flanges
- This bellow flanges are air-tight and may be under heavy thermal stress in some tokamak events



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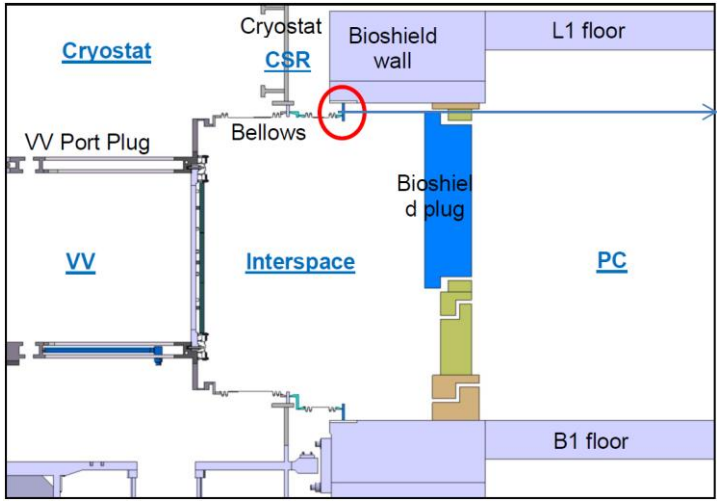
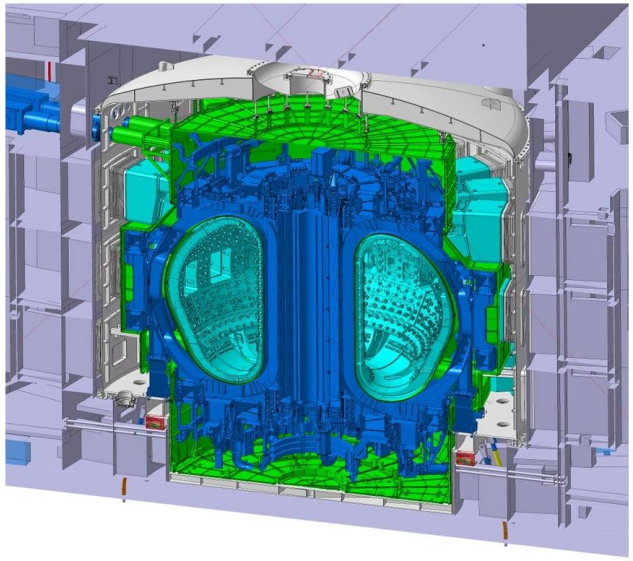
Specifications

- The mechanical performance of the bellow flanges may be compromised due to thermal stress
- The performance is modelized using a FEM model, but detailed boundary conditions are needed for event calculations



Specifications

- To get detailed BC, the MELCOR model of the ITER building, including the tokamak had to be done
- Latest modifications and safety features of the building and tokamak had to be implemented
- Simulation of different scenarios
  - ICE III
  - ICE IV
  - LOCA III
  - HLG
  - Fire in PC



Model developement

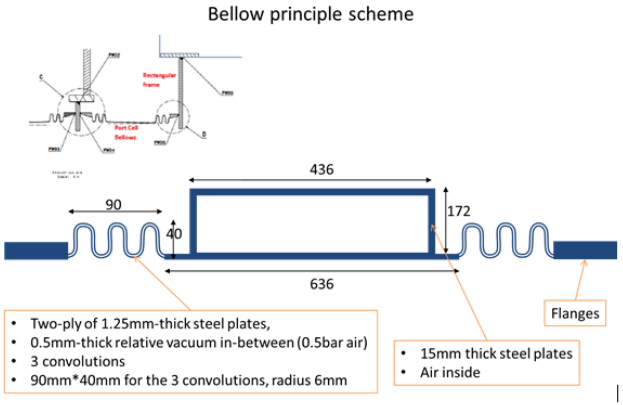
- The model aim is to simulate thermal and pressure transients due to accidental scenarios.
- No RN models needed for this task
- Had to implement several overpressure devices for cryostat and building protection
- New building nodalization developed to include all the involved volumes and flow paths.

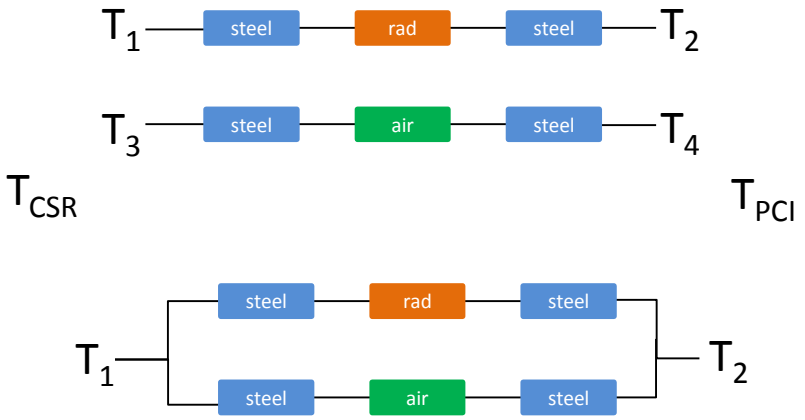
Model developement

- The bellow flanges heat transfer have a important role defining the volumes temperature
- They are thin structures with vacuum inside
- An equivalent thermal conductivity had to be calculated and applied to a made-up material for each bellow.

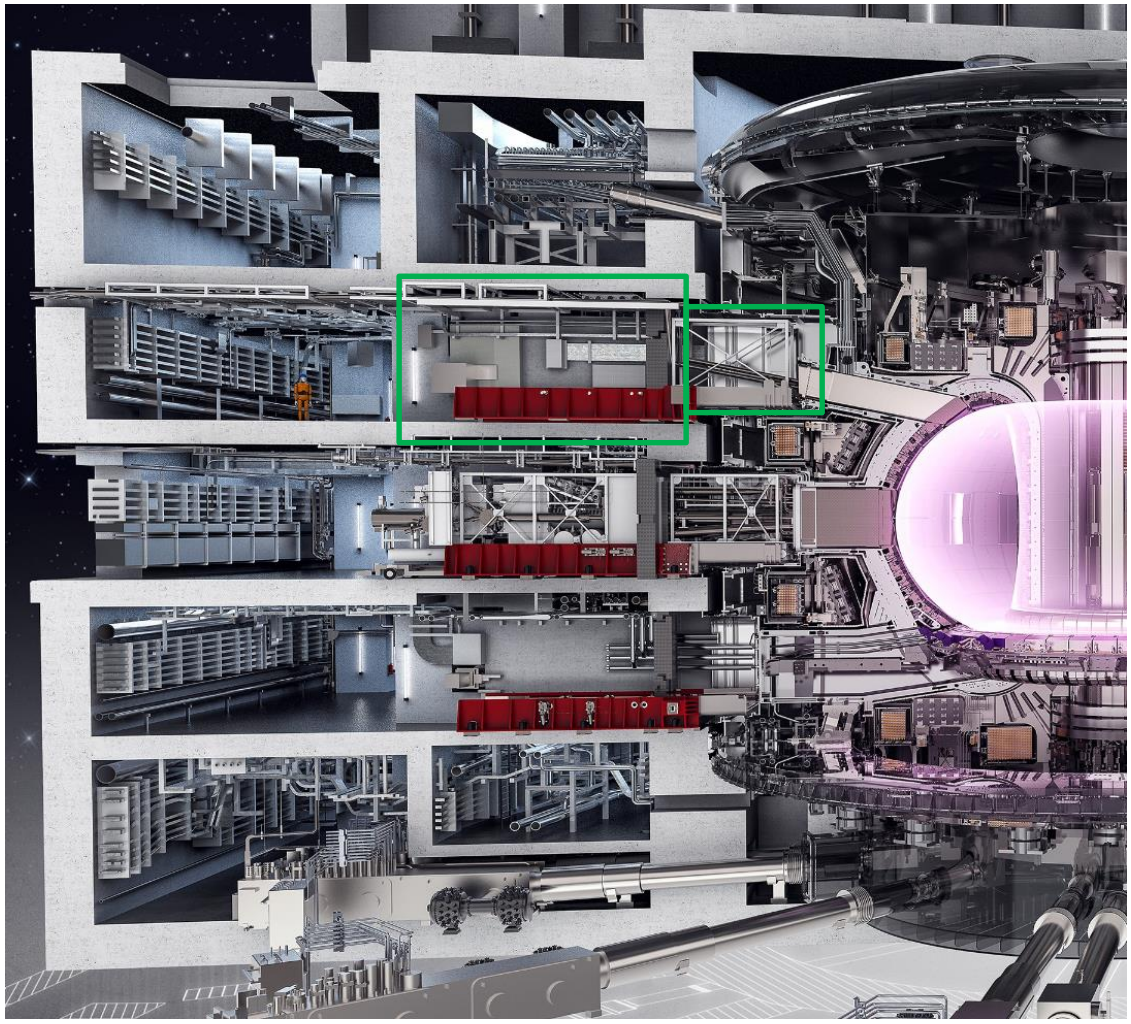
Model developement

- Radiation heat transfer had to be linearized
- Although there are different regions in a bellow, it was modeled as a single HS





Nodalization



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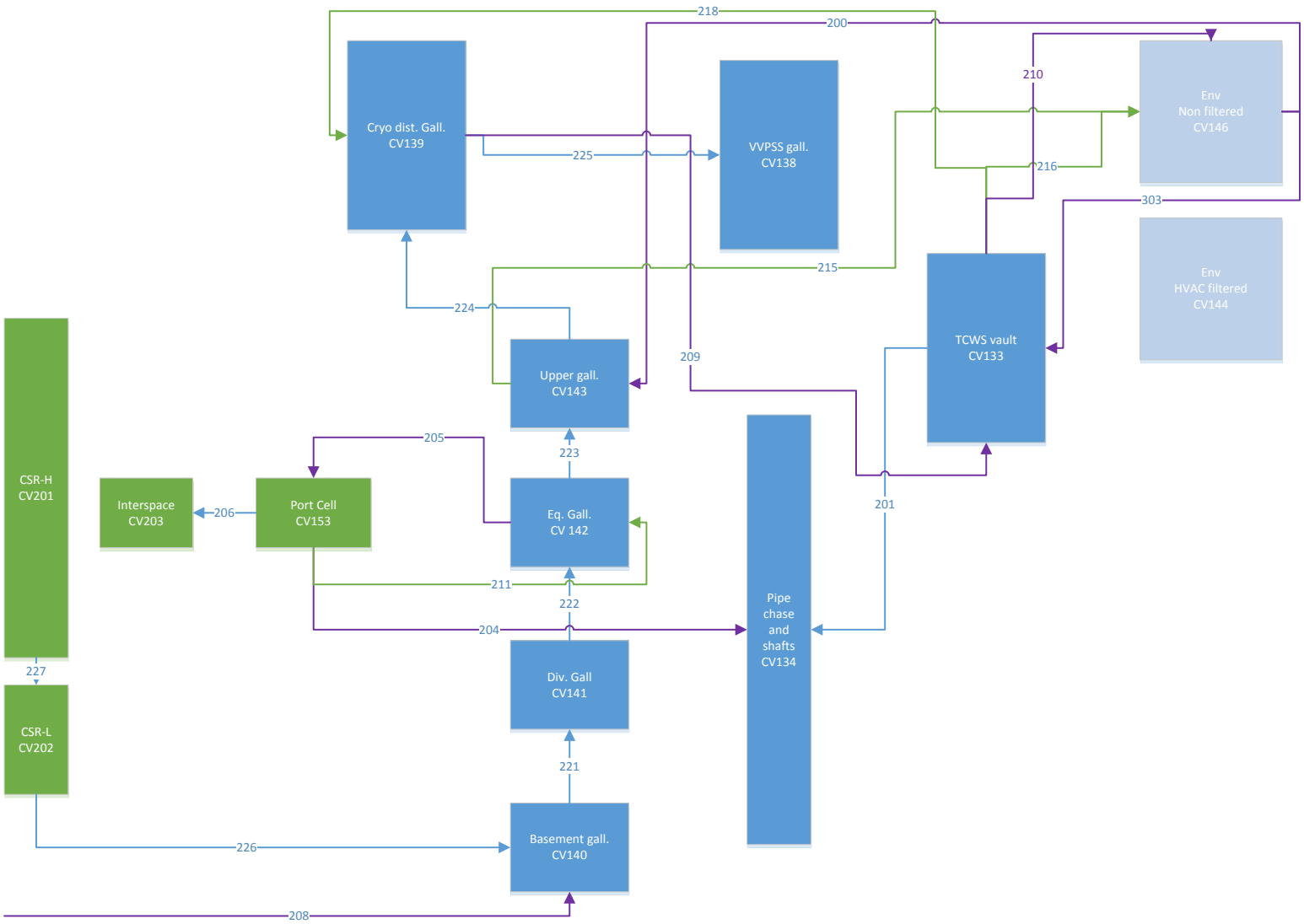
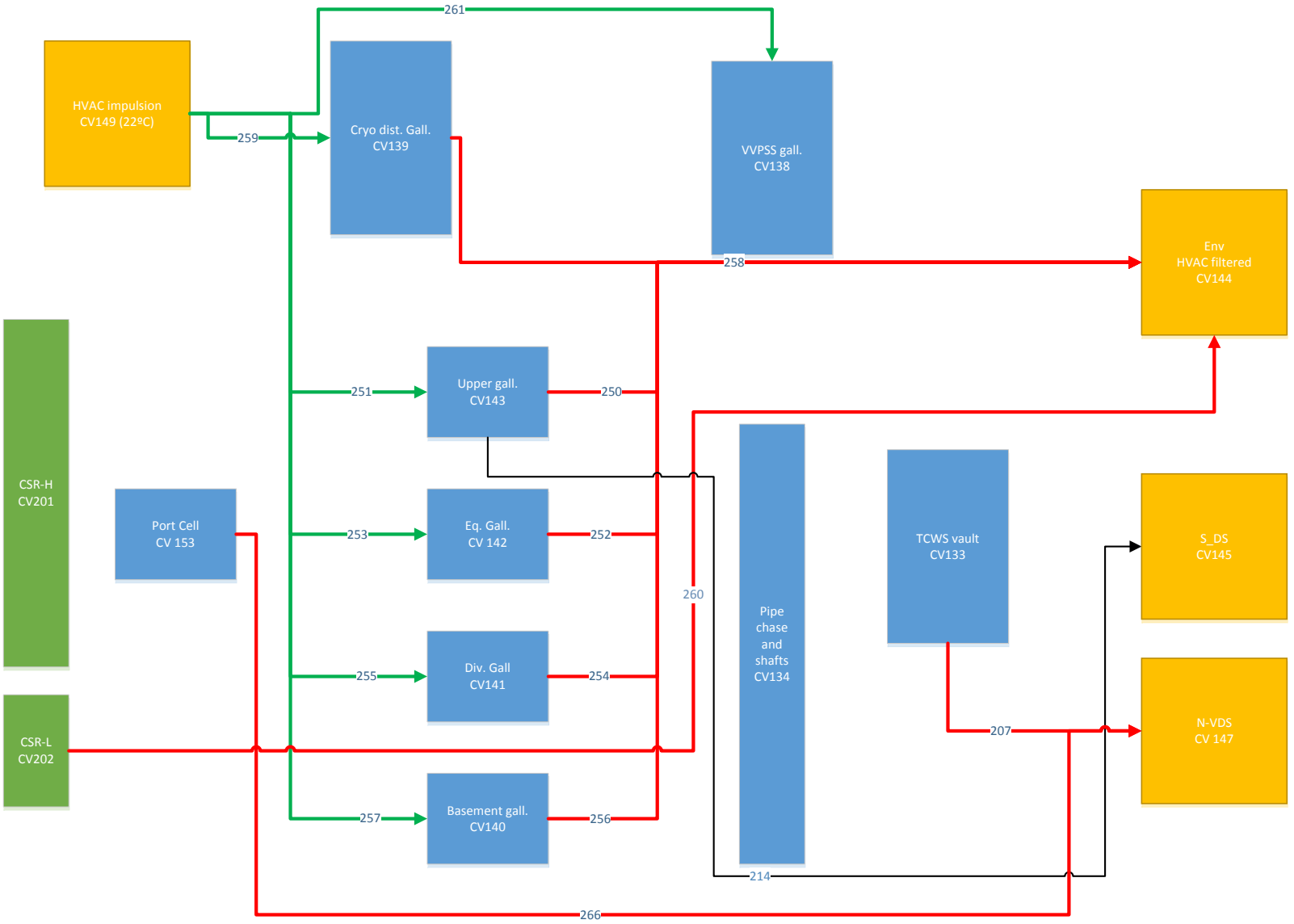
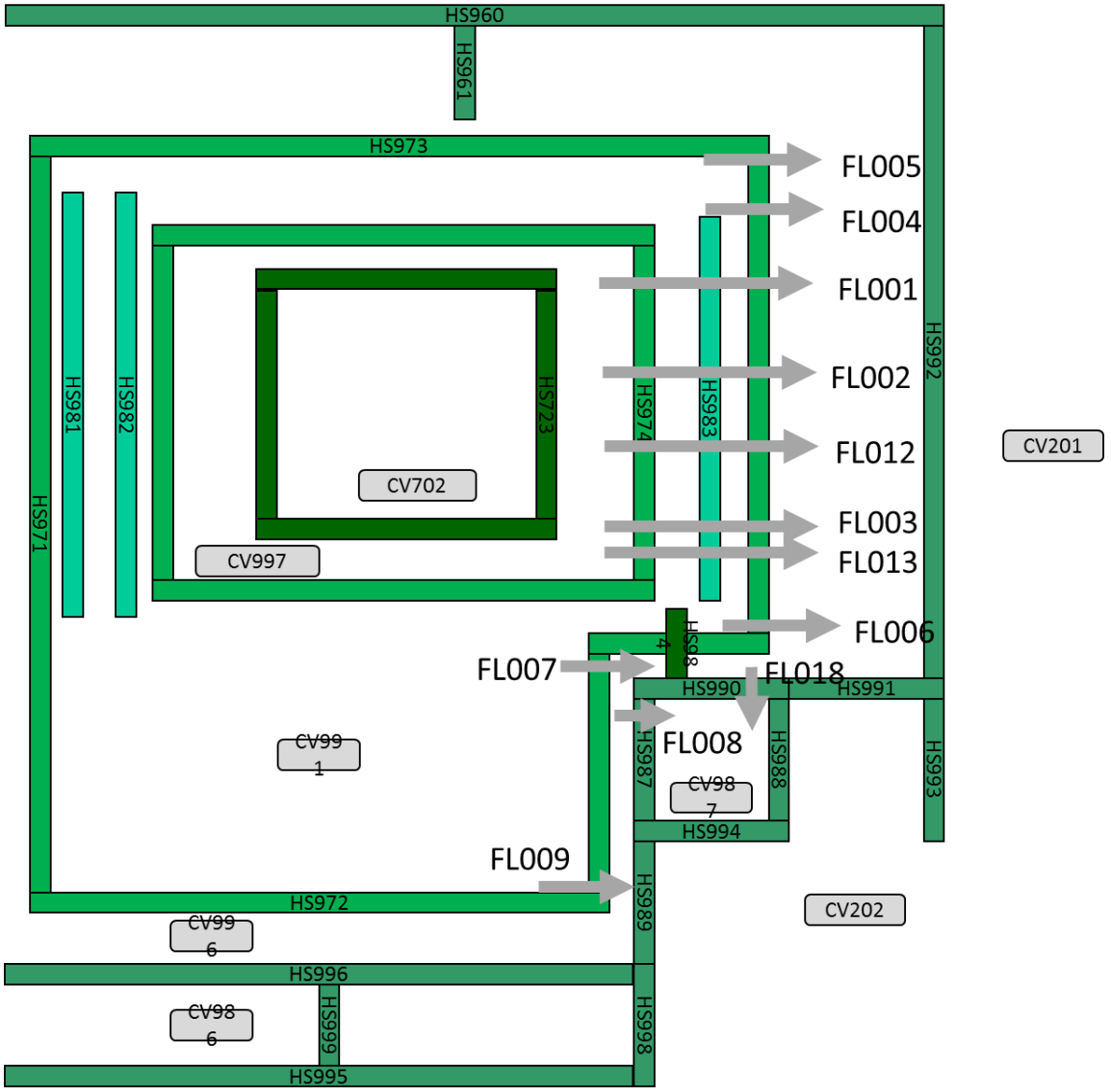
Nodalization



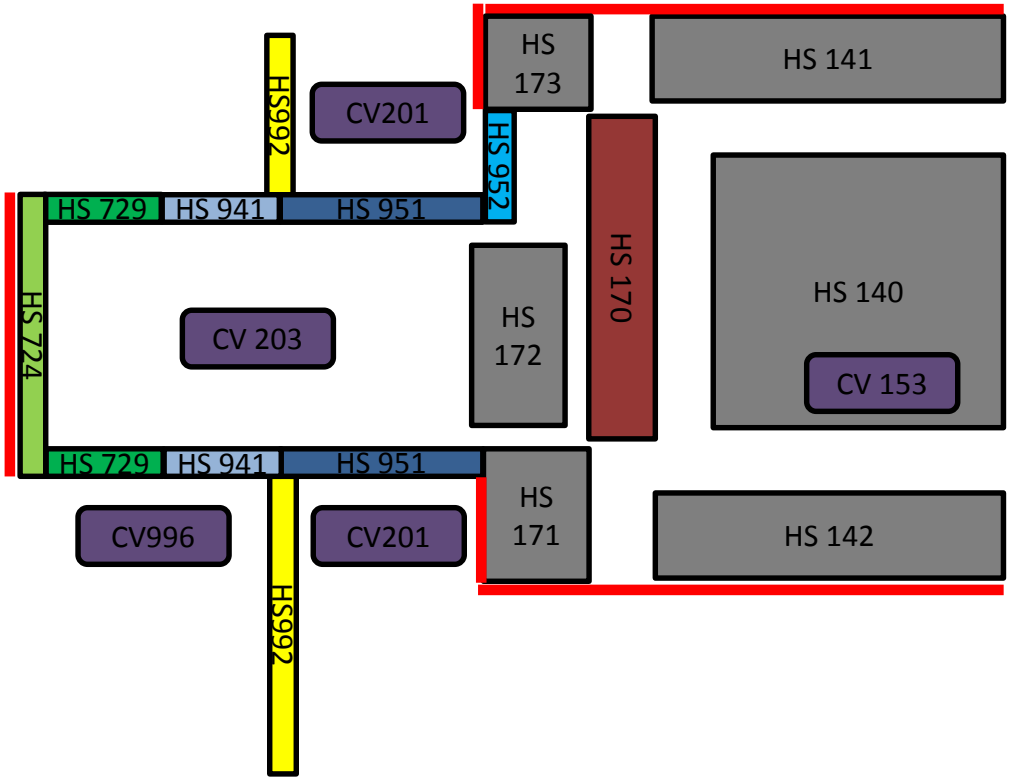
Nodalization



Nodalization



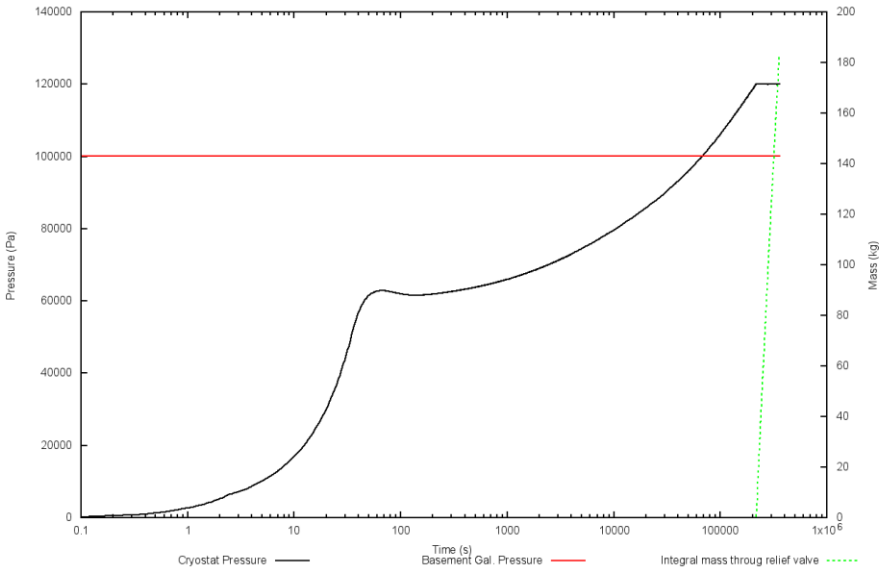
Nodalization

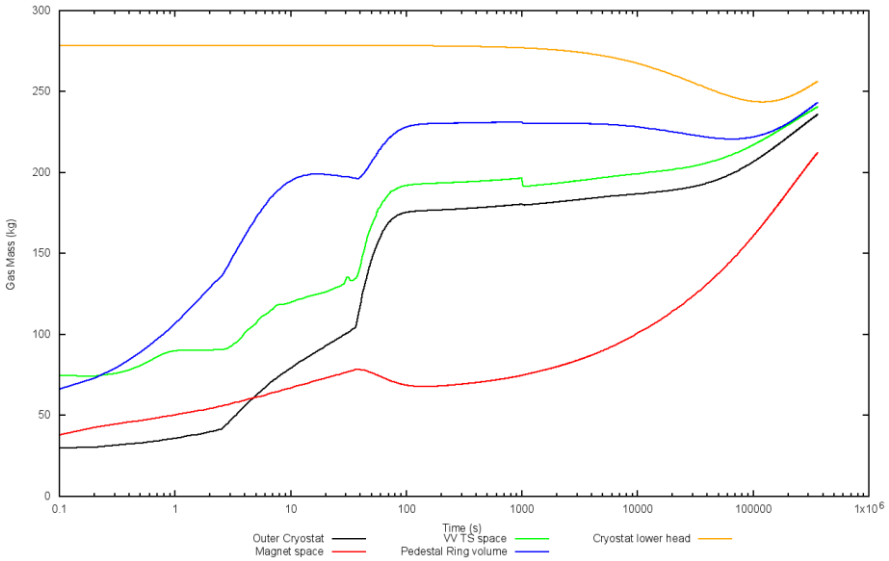


Case definition

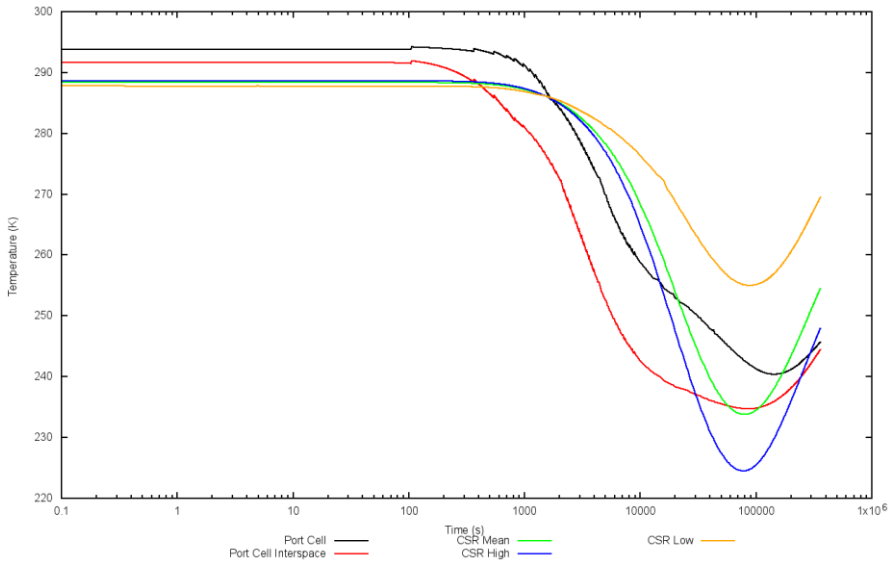
- ICE III: 2600 Kg of cryogenic He in the cryostat
  - Mass source of NCG
- ICE IV: 4000 Kg of cryogenic He in the cryostat
  - Mass source of NCG
- LOCA III: 98000 kg of water at 513K in PC
  - Simulation as mass and energy source. Pipe system is not explicitly modeled in this task
- HLG: 2600 kg of cryogenic He in the building
  - Mass source of NCG
- Fire in PC: 4500 kW for 2h
  - Simulated as mass and energy source

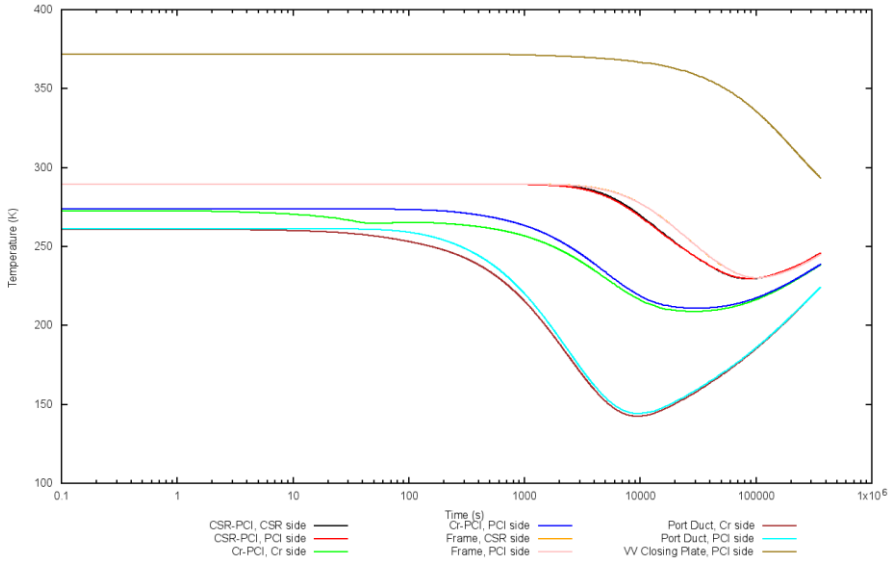
Case simulation: ICE III



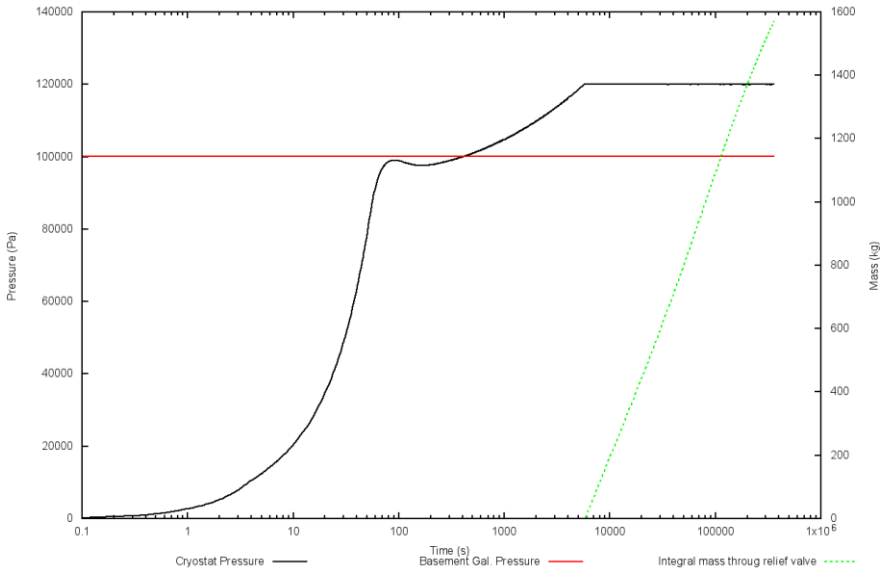


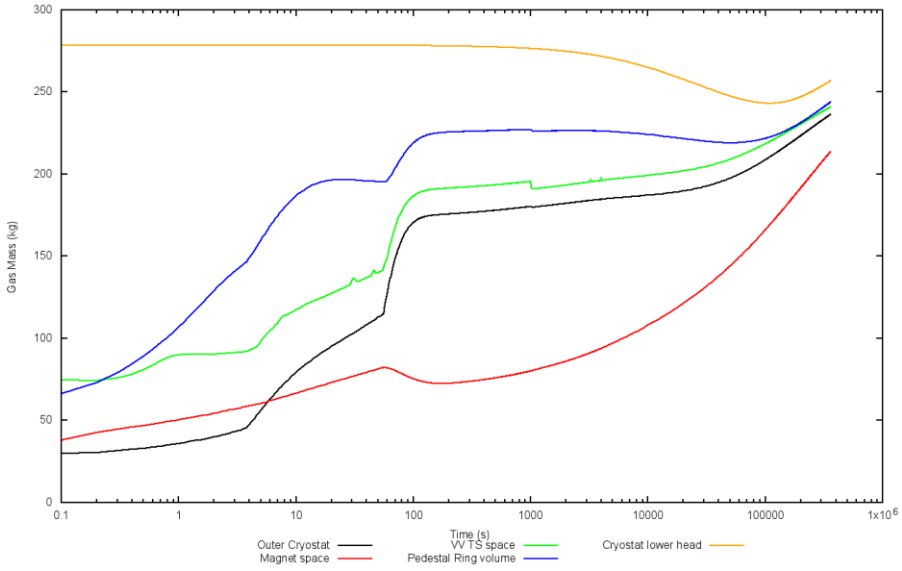
Case simulation: ICE III



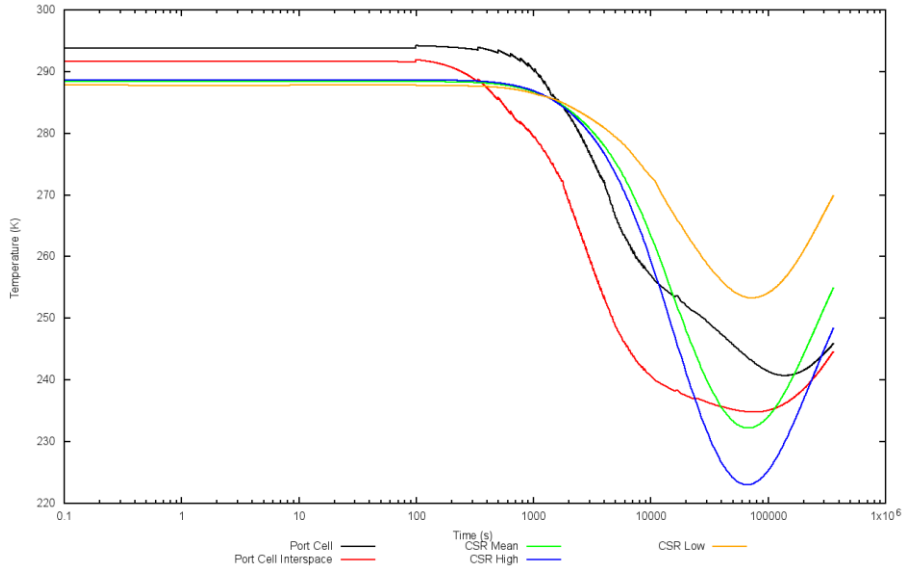


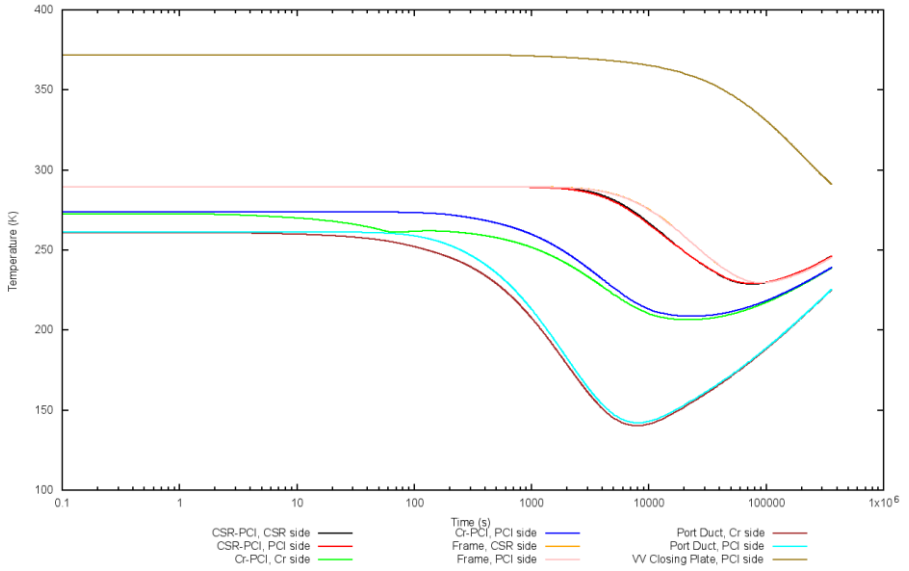
Case simulation: ICE IV



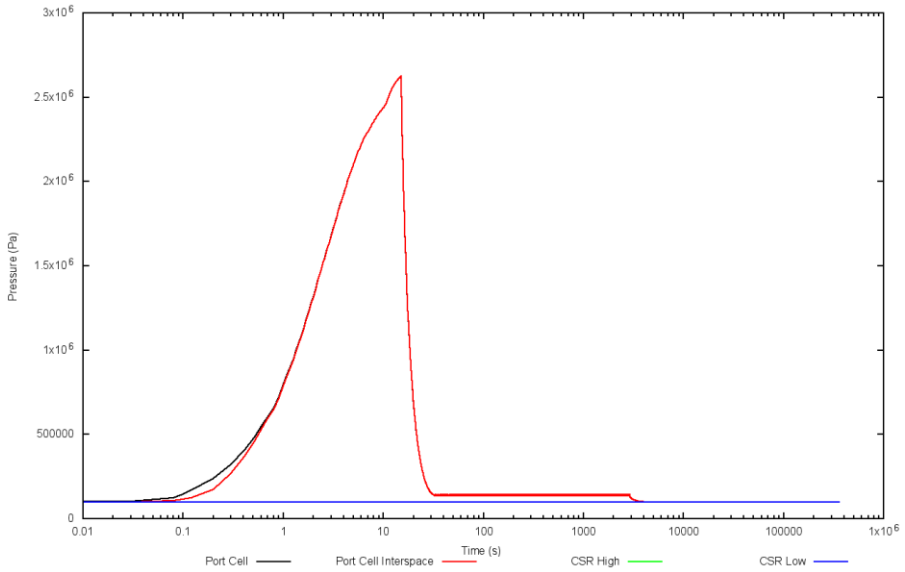


Case simulation: ICE IV

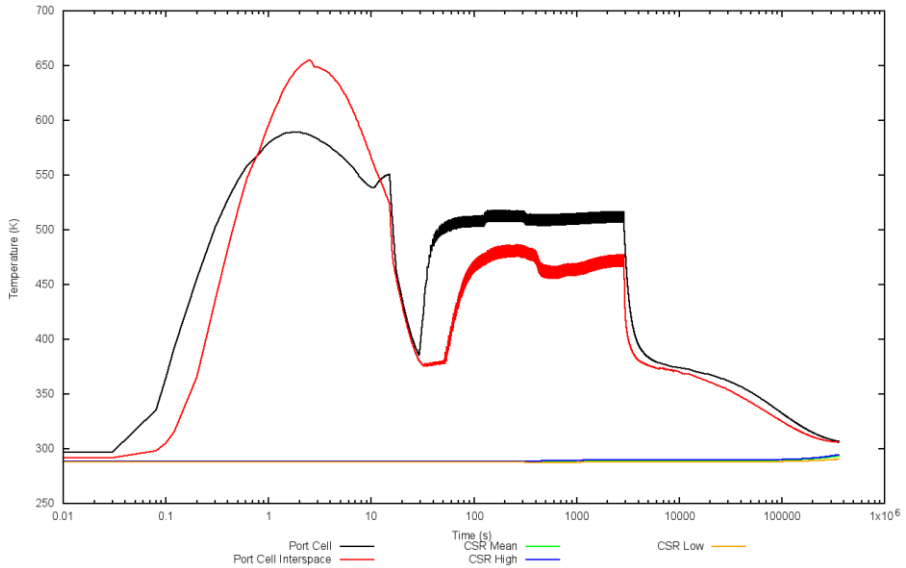




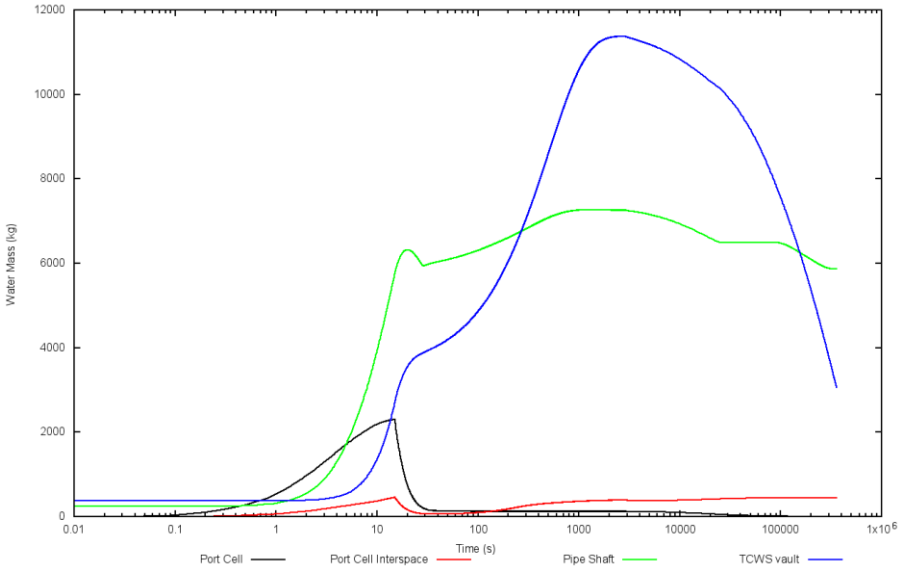
Case simulation: LOCA

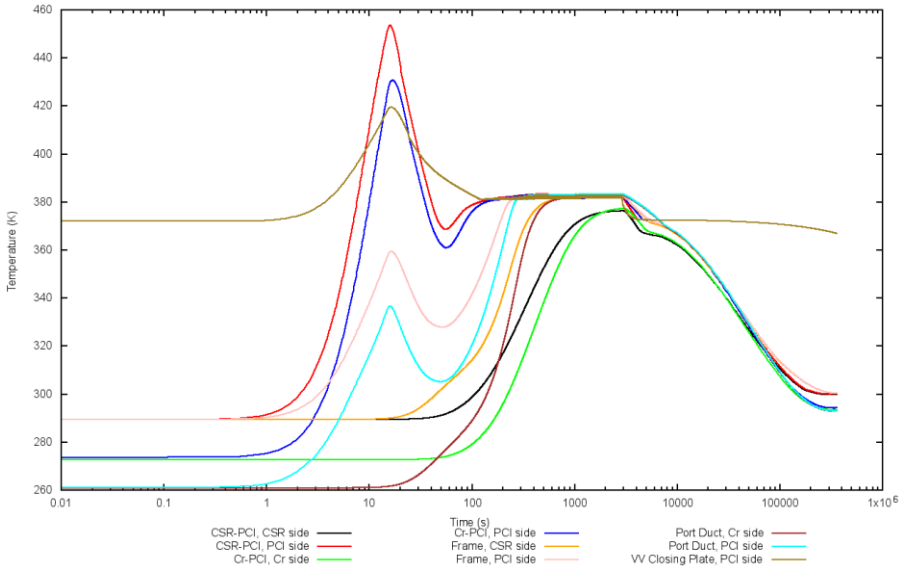


- Overpressure due to very conservative leak definition (much more flow than in AAR)
- Leak conditions defined in time independent volumen, imposing flow rate

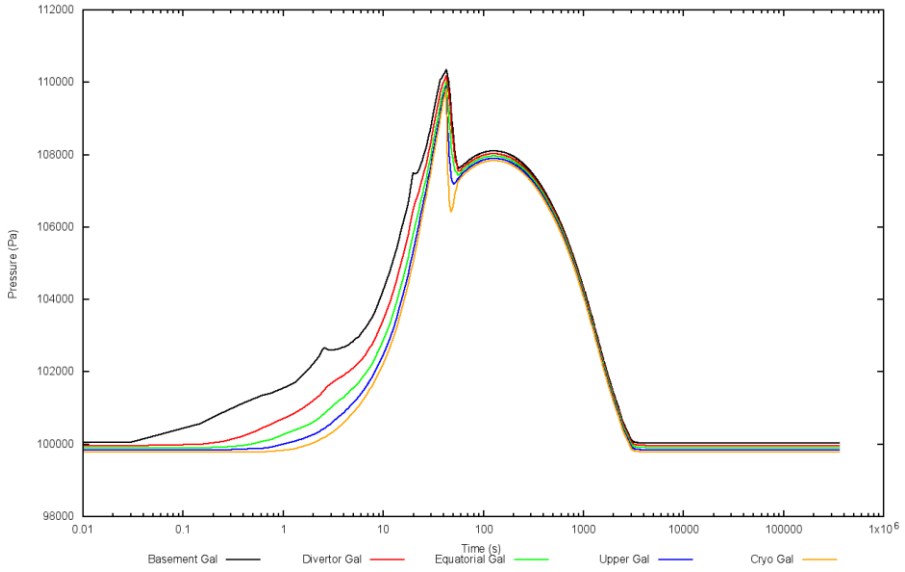


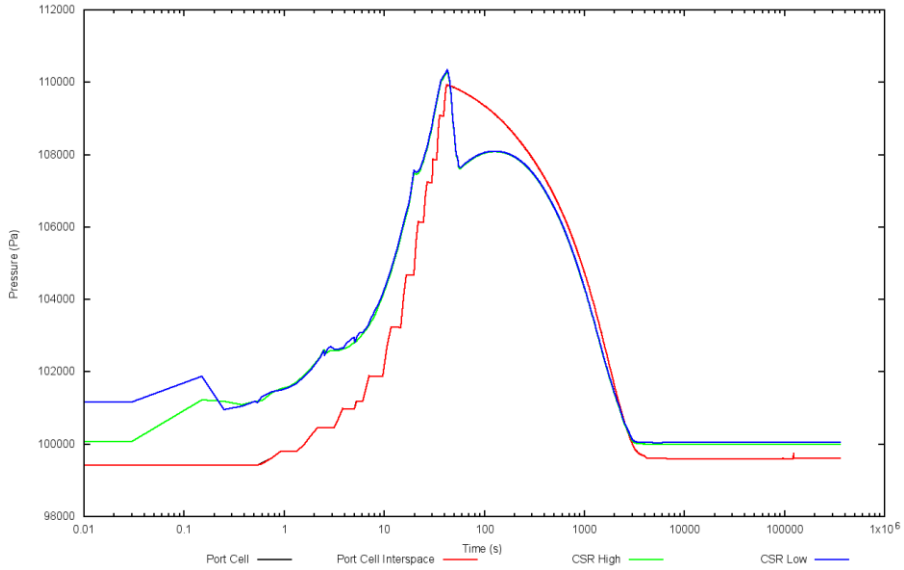
Case simulation: LOCA



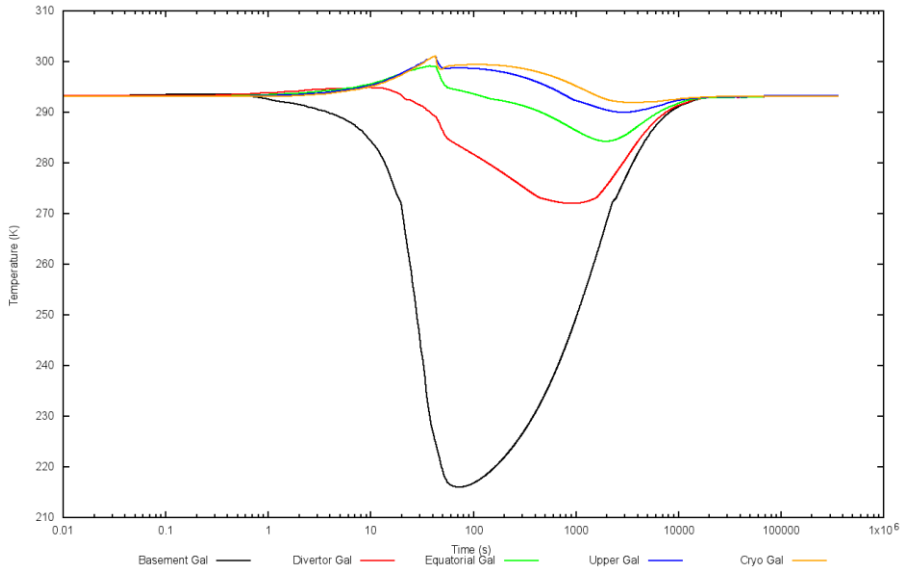


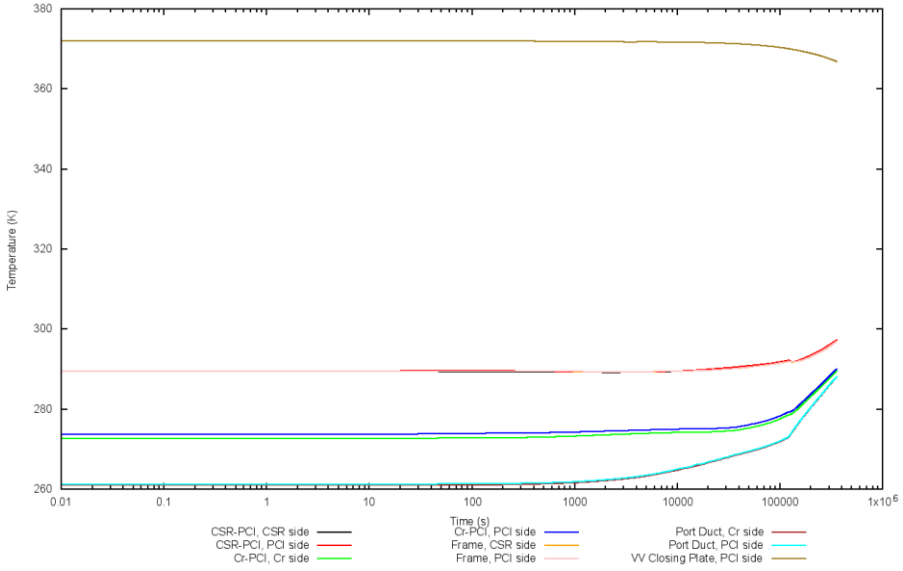
Case simulation: HLG



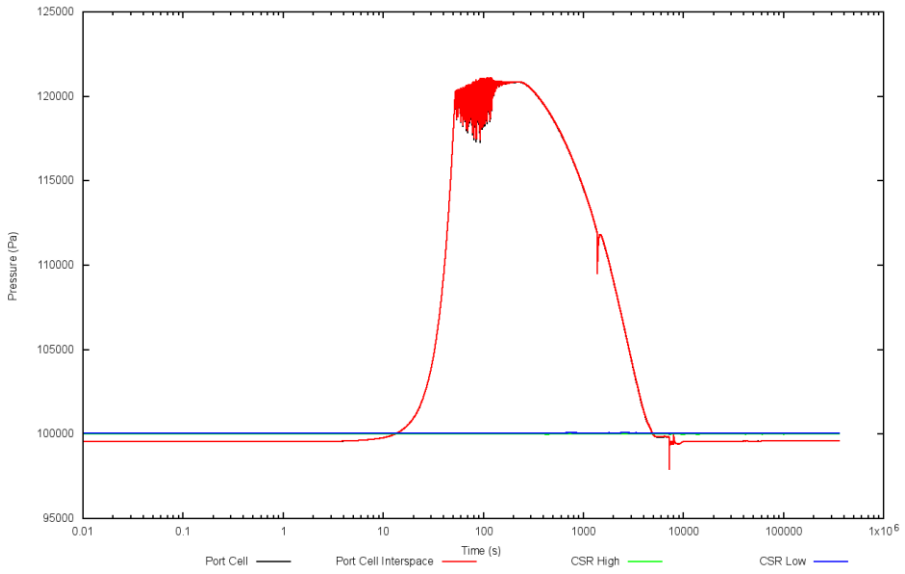


Case simulation: HLG

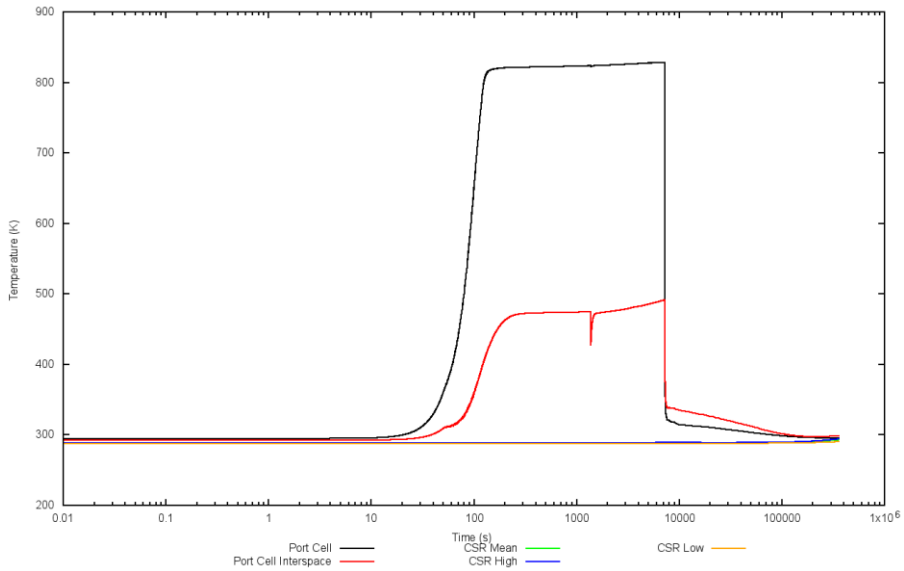




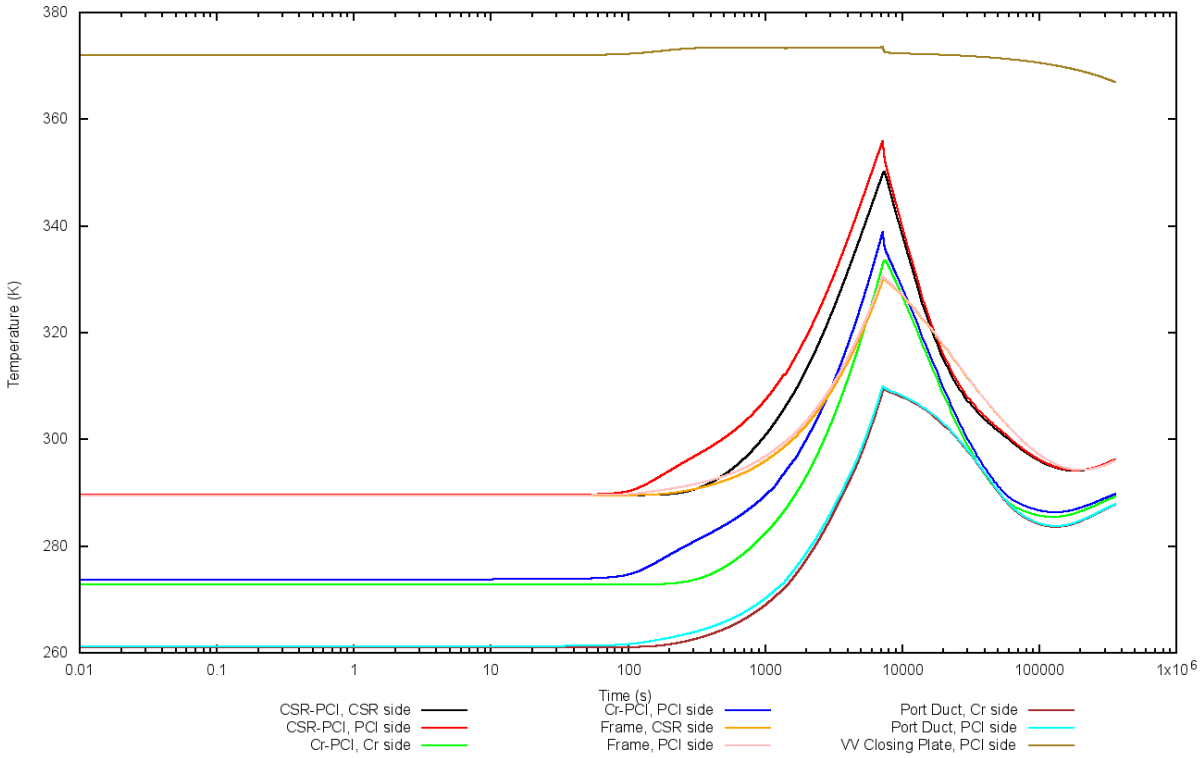
Case simulation: Fire



- Very conservative fire power and duration
- A lot of numerical instabilities, very dependent on walls BC



Case simulation: Fire



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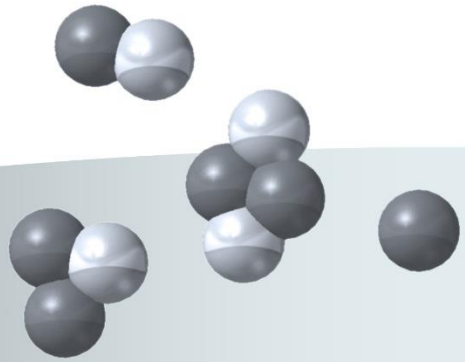

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