Validation of CFD Model of Spent Fuel Pool at NPP Temelin

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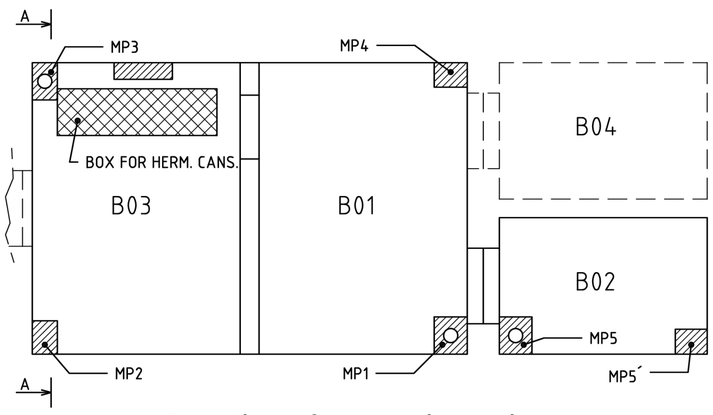
Introduction

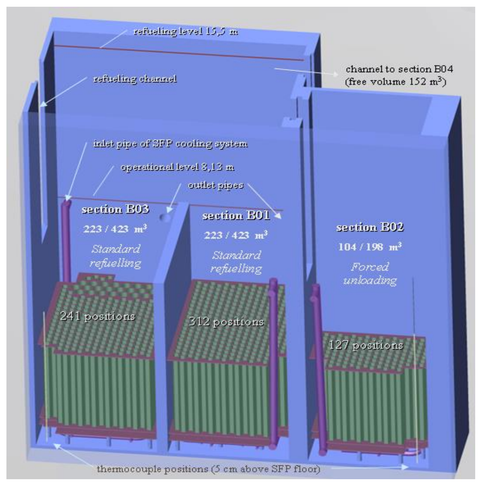
- CFD computational model of spent fuel pool (SFP) of NPP Temelín ⇒ Created for analysis of temperature distribution in spent fuel pool in normal and abnormal operation conditions by company TES s.r.o in cooperation with FME CTU in Prague
- Summer 2011 – measurement of vertical temperatures profiles during shutdown at 1.Unit NPP Temelín by TES s.r.o
- Spring 2012 – validation of CFD model based on measured data by CTU in Prague

Spent fuel pool description

- Overall volume 1050 m^3 (14,5 x 6 x 15,5 m)
- Storage spent fuel in compact storage grid
- Division to three sections – B01, B02, B03



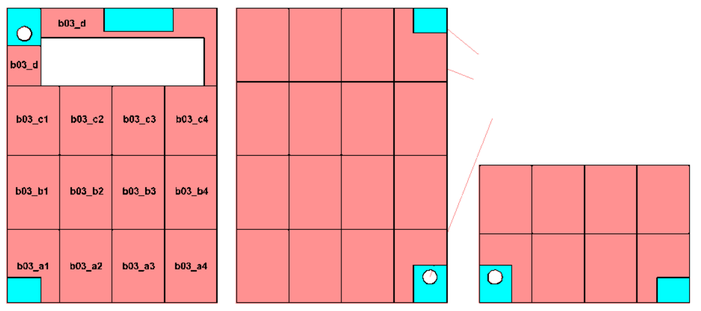
Location of measuring points during validation measurement

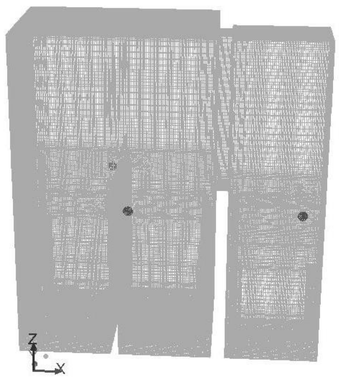


Disposition of NPP Temelin spent fuel pool

Description of CFD model of spent fuel pool

- Number of cells limited to 1 milion – computational time
- Large volumes of cells – average length of edges 100 mm
- Application mostly structured grid
- Heat transfer by walls not considered – adiabatic wall
- Heat transfer by water level – 0,9 kW.m^{-2}
- In upper part set region with laminar flow
- Significant simplification against reality
- Storage grids modeled like porous zone

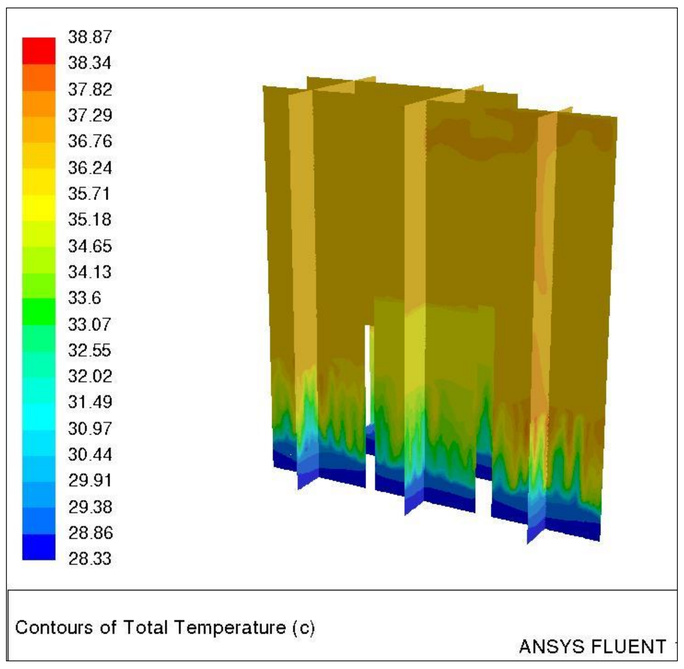




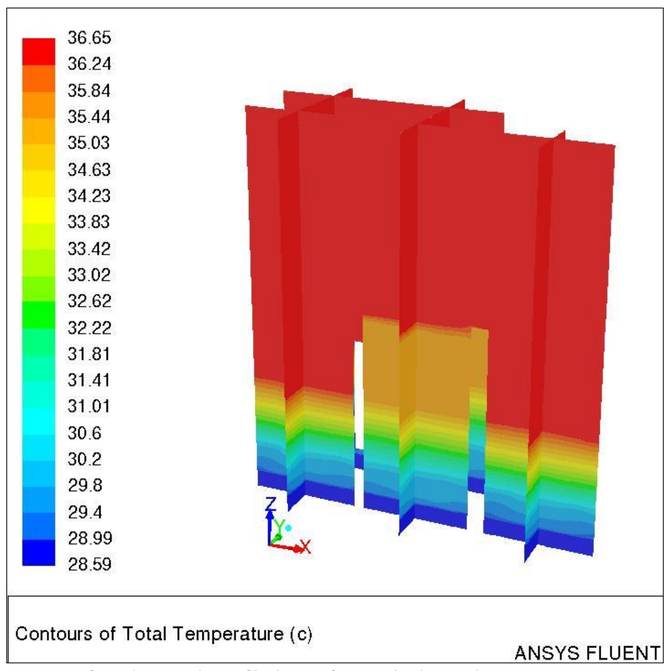
CFD model nodalization

Validation calculation

- Problem wit divergence of calculation ⇒ calculation in stages with different set of solver and settings laminar flow in upper region



Results from segregated solver („pressure based“) – pre calculation



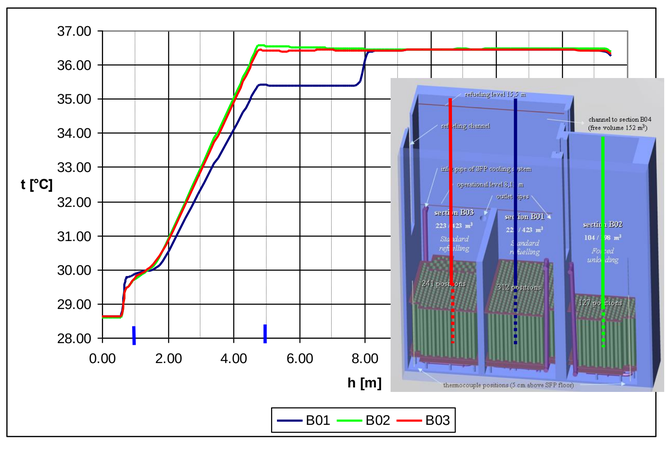
Results from implicit solver („density based“) – final calculation

Final computation strategy

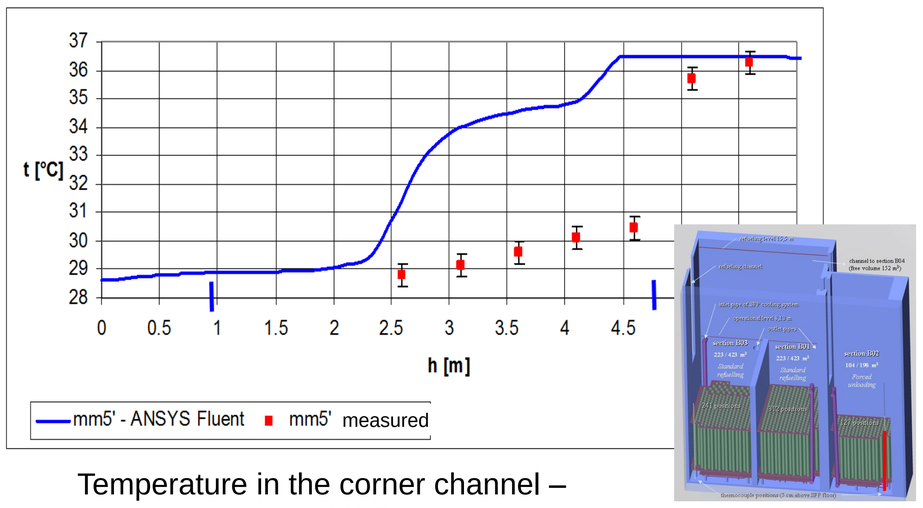
iteration interval	accuracy of computation	turbulence solver	„courant number“
0 – 5 000	**normal**	**„pressure based“**	**-**
5 000 – 50 000	**„double precision“**	**„pressure based“**	**-**
50 000 – 100 000	**„double precision“**	**„density based“**	**0,5**
100 000 – 130 000	**„double precision“**	**„density based“**	**2**

Computation was provide on 8 quad-core processors AMD Opteron 8354 – 2,2 GHz. Time of computation 1040 hours machine time

Results of validation computation of CFD model



Temperature in the center of pool sections



Temperature in the corner channel – measuring point mMP5‘ – measuring point with worst accordance model and measured data

Conclusion to existing CFD model:

- In area of corner channel is model described insufficiently.
- In area of storage grid is assume good accordance model with reality.
- In area up the storage grid was confirm good accordance model wit reality

Conclusion to improve the CFD model:

- Better settings heat transfer between corner channel and storage grid
- Refining the CFD grid in corner channel area
- Searching a use better model of turbulences which better describe flow conditions in spent fuel pool

Acknowledgment

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