Deep Water Boosting Design in an Operational Perspective

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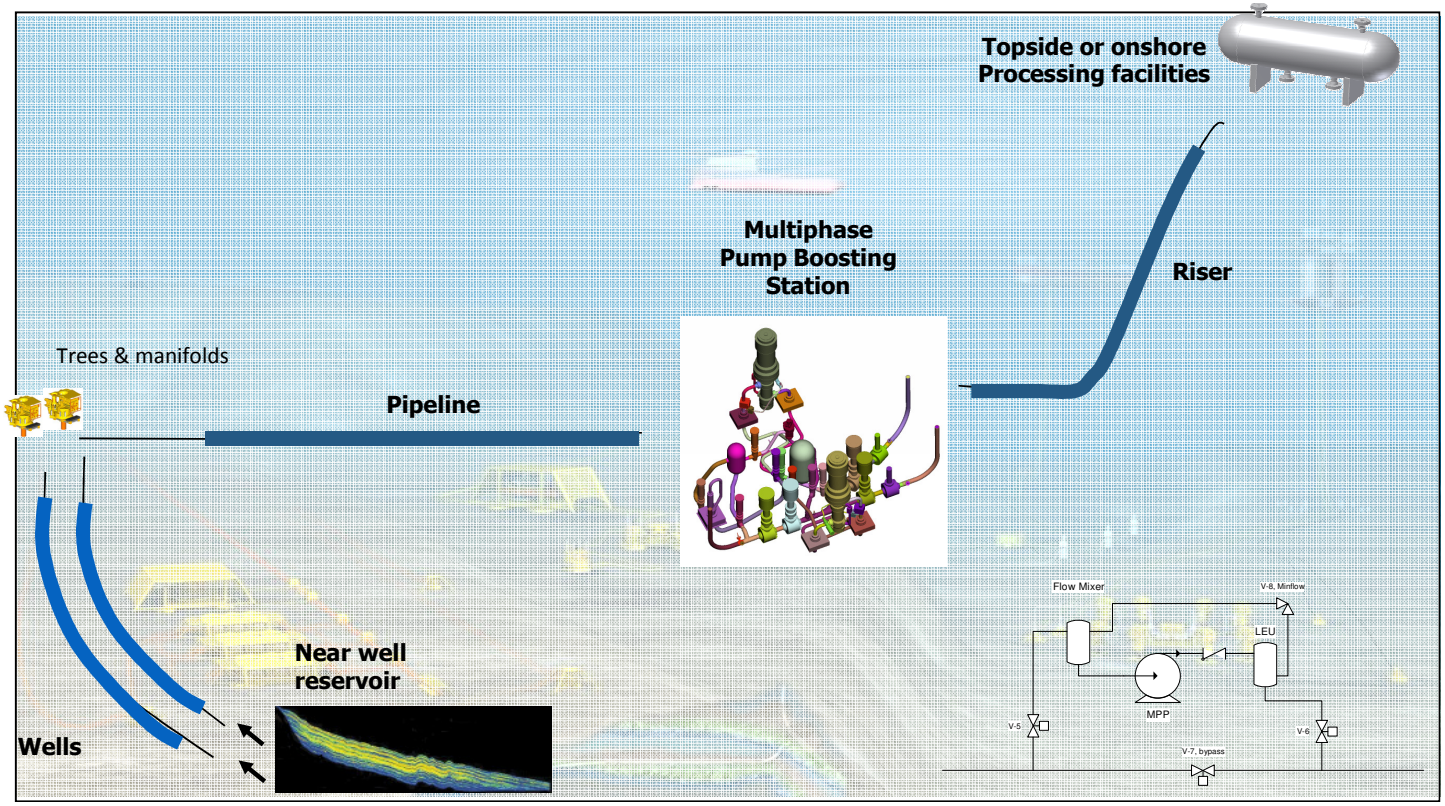
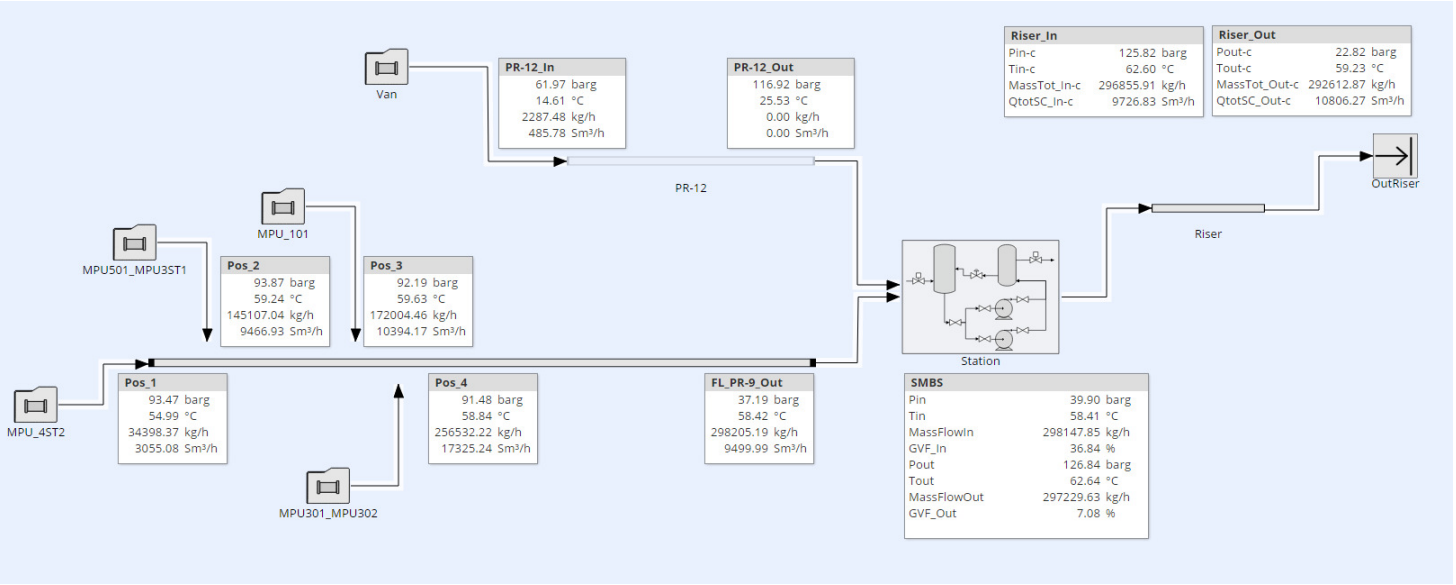
The Multiphase Boosting Station operation in the system



In detailed design the station is prepared for operation

Dynamic Model of the Multiphase Boosting Station

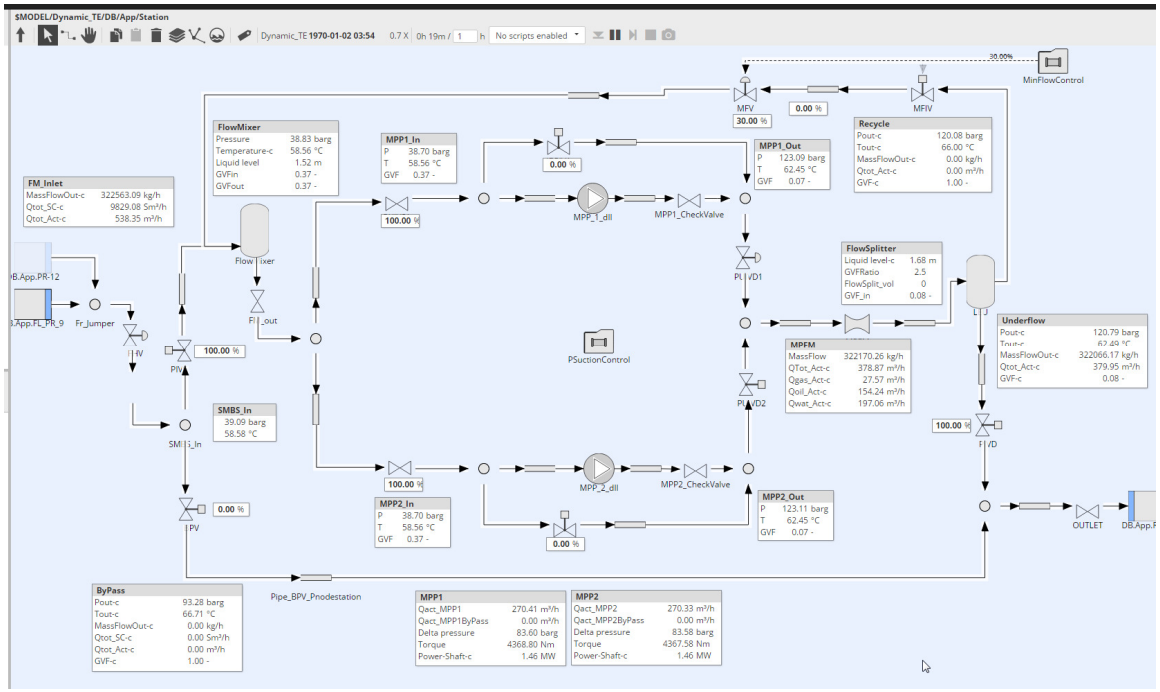
Preparation of operation in design phase is done by dynamic simulations of total system including the detailed boosting station.
All disciplines are linked together, including limitations in power, pressures, temperatures, equipment operating envelopes, wells, valve handling, etc.



- Equipment Design Verification
- Start-up/Shut-down
- Dead-oil preservation
- Ramp-up/Turn-down
- Slugging
- Failure scenarios
- Establish process control and operational philosophy
- Identify operational risks that cannot be solved by design

From offline Engineering tool to online Operation supporting tool

The dynamic model used during design can easily be converted to an online supporting tool, by linking tags to real sensors. During commissioning and first start-up, the Operation supporting tool can be benchmarked towards the real system, and operational philosophies verified. The Operation supporting tool for deep water boosting is ready for use.



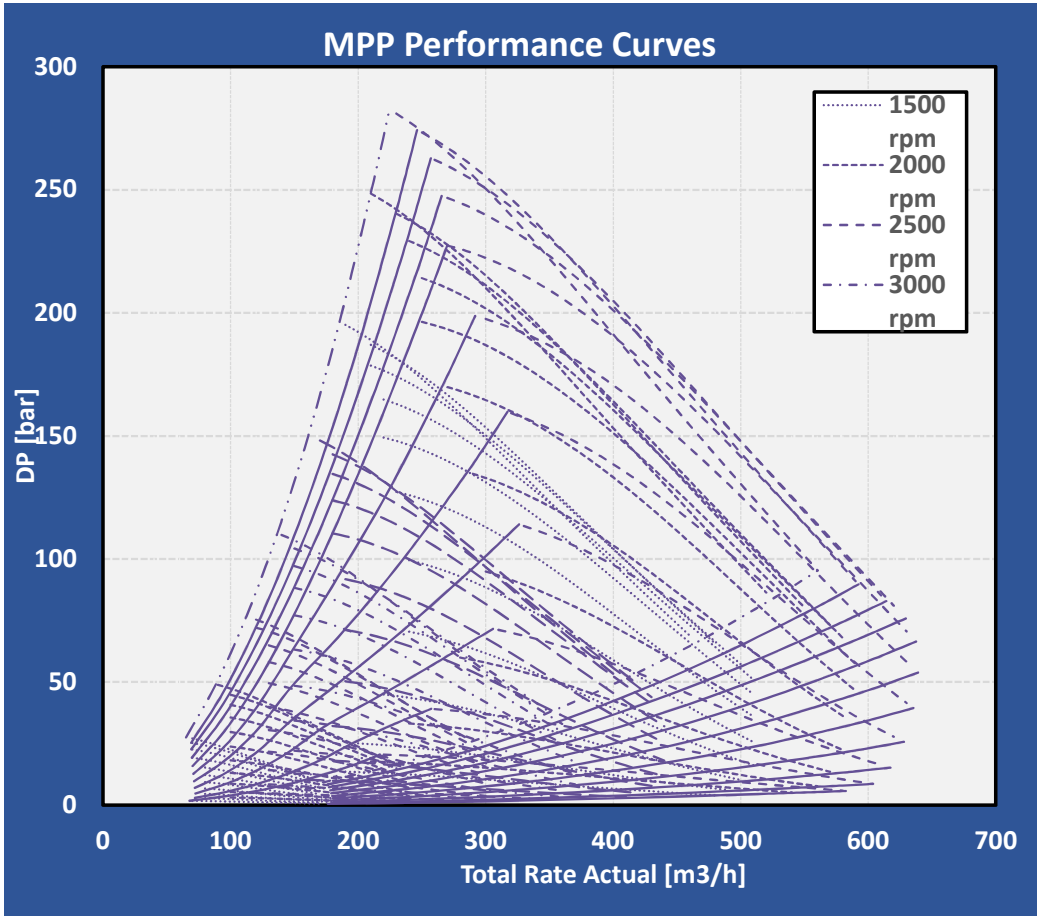
- Look-a-head production/flow/process performance
- Verification of operational scenarios
- Operational point optimization
- Operability risk/challenge prediction and warning
- Disturbance caused by upstream/downstream system to the MPP
- Disturbance to upstream/downstream system caused by MPP

MultiPhasePump Performance Curves

Example of operational support tool use

- MPP curve is changing with
  - GasVolumeFraction (GVF)
  - Suction Pressure
  - Suction Temperature

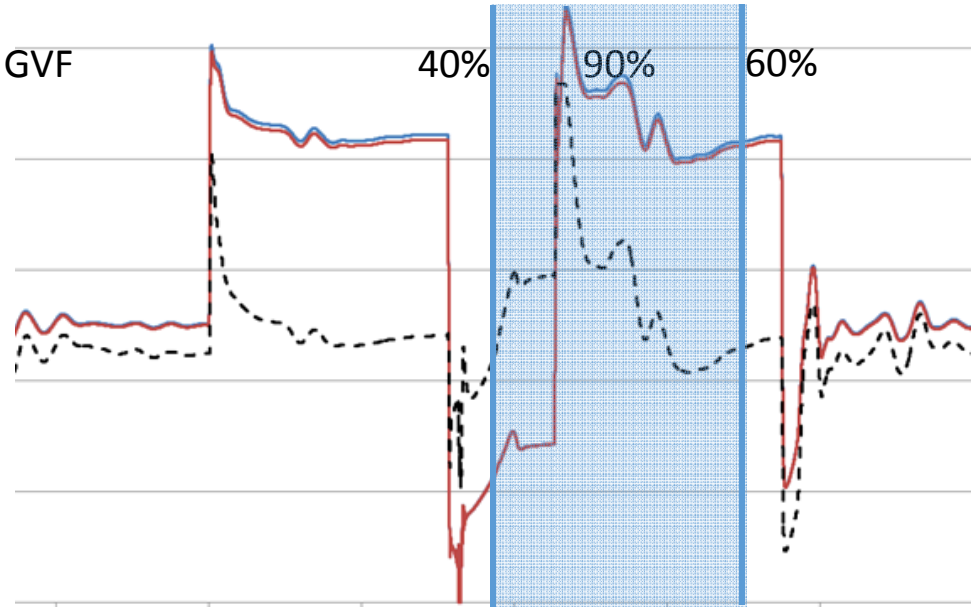
- For low GVF the pump performance approaches single phase
- For high GVF the pump approaches gas compression

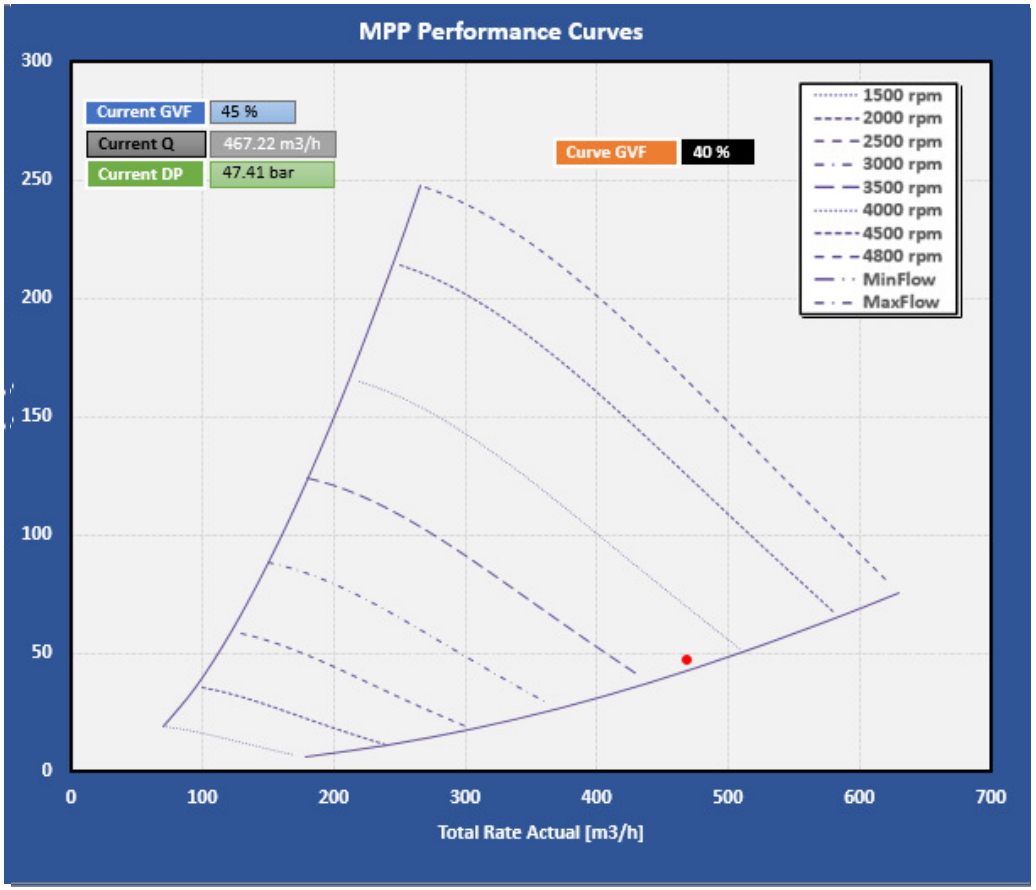


MPP Performance during flow instabilities

Example of operational support tool use

If the operator is aware of a flow instability, as in this case, a gas pocket coming into the station, he can adjust the pump speed accordingly.

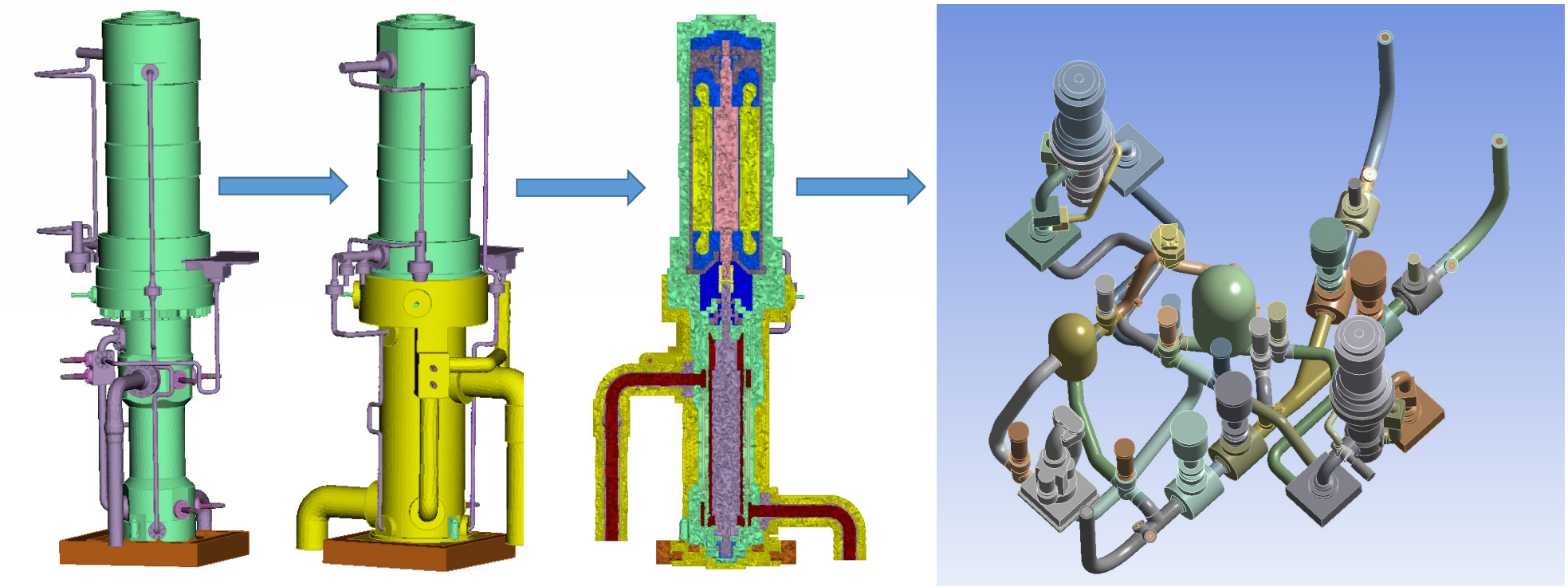




Insulation design of boosting station

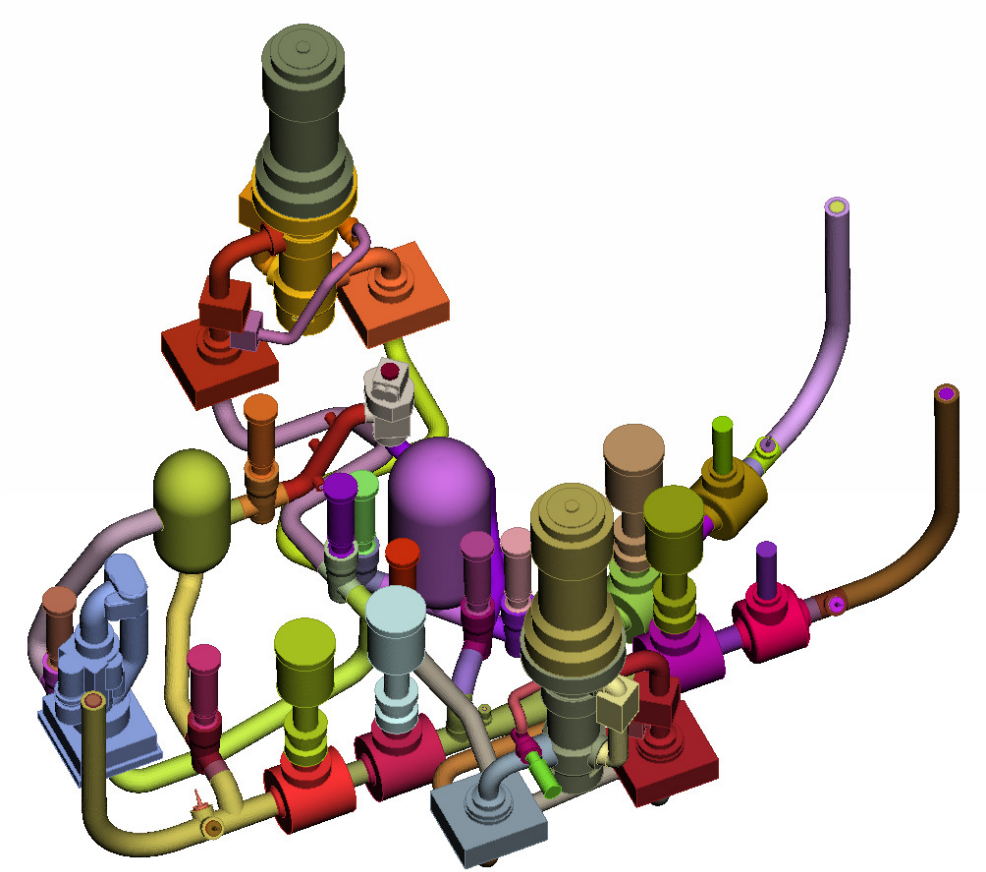
Example of operational support tool use

From single component to system analysis

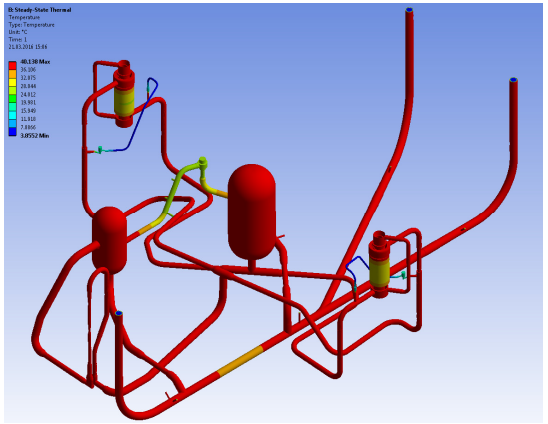


Cool-down analysis and testing during design

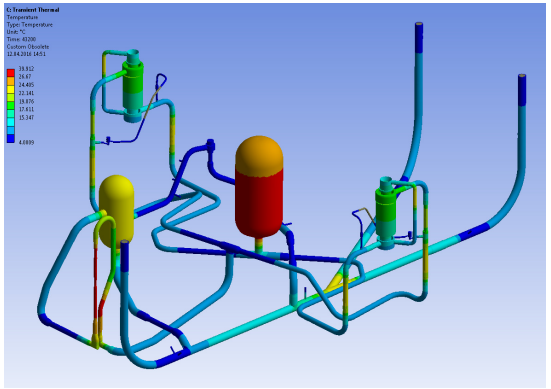
Example of operational support tool use



Steady state temperature analysis



Cool-down analysis



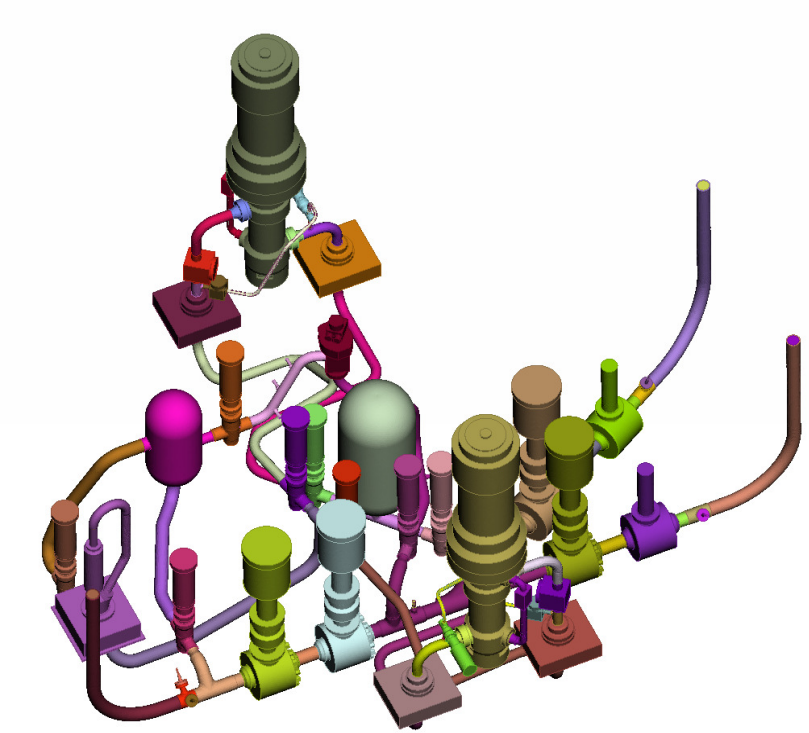
From offline Thermal design to online Operation supporting tool

Example of operational support tool use

The thermal design specifications are conservative, hence during operation the real cool-down time is most of the time much longer than designed.

Merging the Thermal system model with the Online operation support tool have several potential added values:

- Increased no-touch/cool-down time during operation
- Reduced thermal insulation, (cut cost and weight)



Summary

The offline dynamic model converted to an online supporting tool serve several purposes:

- During commissioning and first start-up, the Operation supporting tool is important to
  - Understand how the real system is operating
  - Benchmarking models towards the real system
  - Verify operational philosophies

- During Operation the support tool for deep water boosting give valuable support and advice for the operators and flow assurance experts

- Merging the Thermal system model with the Online operation support tool have several potential added values:
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  - Reduced thermal insulation (cost and weight reduction)