

30B valve geometry in the DN30 safety assessment

28.02.2024

0023-PRT-2024-012



orano

Meeting agenda

**Overview of the impact of the 30B valve geometry
(this presentation)**

Impact of the valve housing on thermal safety

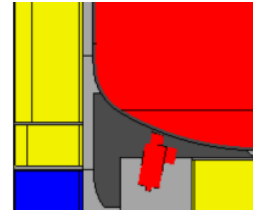
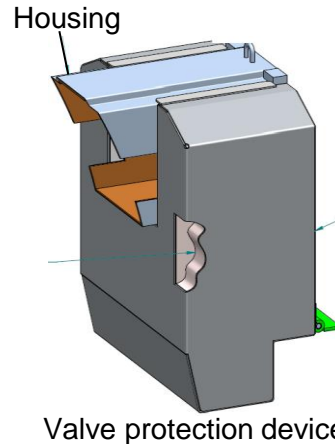
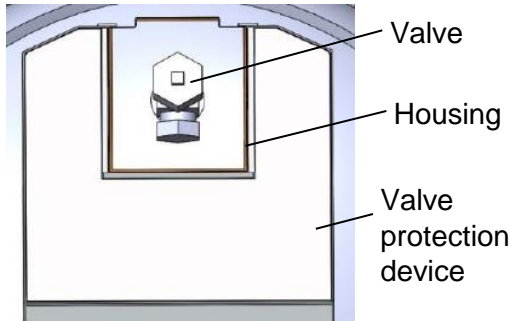
Impact of the valve housing on structural safety

Conclusions and next steps (implementation and schedule)

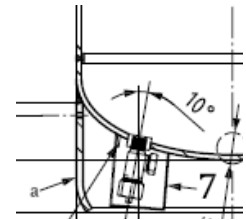
IRSN question on valve geometry

30B valve is modelled too small in DN30 structural model

- Issue was detected during IRSN review for French license extension
- Correct geometry of 30B cylinder for the drop and fire tests, including the geometry of valve and plug
- No issue with the plug geometry in the simulation model
- Central issue is the gap between valve and the valve housing



DN30 model (detail)



ISO/ANSI valve geometry

Overview DN30 drop test program

Drop test program with 5 test sequences (SQ)

Main support for the structural analysis for ACT

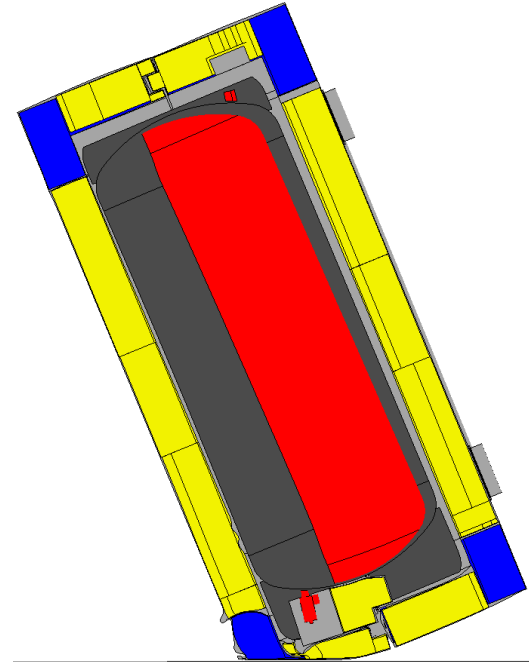
Each SQ: 1.2 m NCT drop → 9 m ACT drop → 1 m ACT bar drop

- SQ 1: Corner drop onto the valve side
Penalizing orientation for valve/housing gap
- SQ 2: Corner drop onto the plug side
- SQ 3: Flat drop onto the valve side
- SQ 4: Drop onto the closure system
- SQ 5: Slap-down drop onto the feet

Pre-damaging drop tests for the three fire tests

SQ 7: Both SQ 1 + 2 with NCT/ACT drop combined into 10.2 m
→ Prototypes with penalizing deformations for fire test

All tests: No contact between valve/plug and any other part



SQ 1 drop test orientation

Introduction of housing around valve

Housing was introduced for the 2nd fire test

Introduction of intumescent material in the cavity to prevent influx of hot gases

Housing designed to position intumescent material around the valve

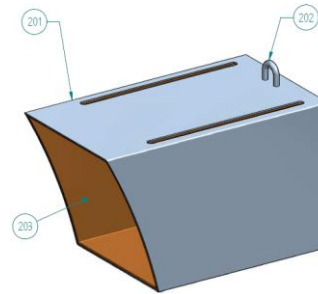
2nd fire test: improved results, but temperatures still too high

3rd fire test successful due to additional microporous insulation material (Microtherm)

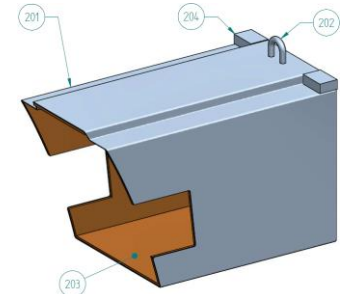
SQ 7 is the only drop test with housing

Performed 2x (before 2nd and 3rd fire test) with initial housing design

Series design without 10 mm extension on top
10.2 m drop showed no contact valve / housing



Initial housing design



Series housing design
with 10 mm extension

Conclusion from tests: gap of at least 10 mm for series design

Calculational analysis

Housing is not modelled explicitly in the calculation models

Thermal: 2D model, housing considered via benchmarked heat transfer mechanisms

Structural: Not represented, valve/housing gaps determined from geometry

Complex challenge to represent housing explicitly in the structural model

- Housing: buckling behavior and weld deformations
- Significant influence from the modeling of the UF_6 contents
- Detailed investigation of valve/housing gap was not necessary because the geometry approach was sufficient

With corrected valve geometry, small valve/housing gap estimated

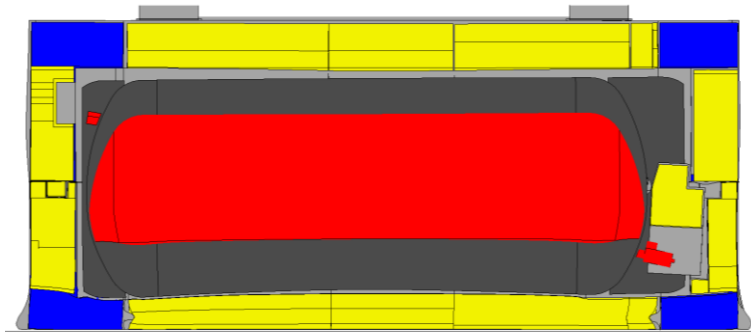
Penalizing drop test orientation for valve gap is now drop sequence SQ8

Valve/housing for SQ8

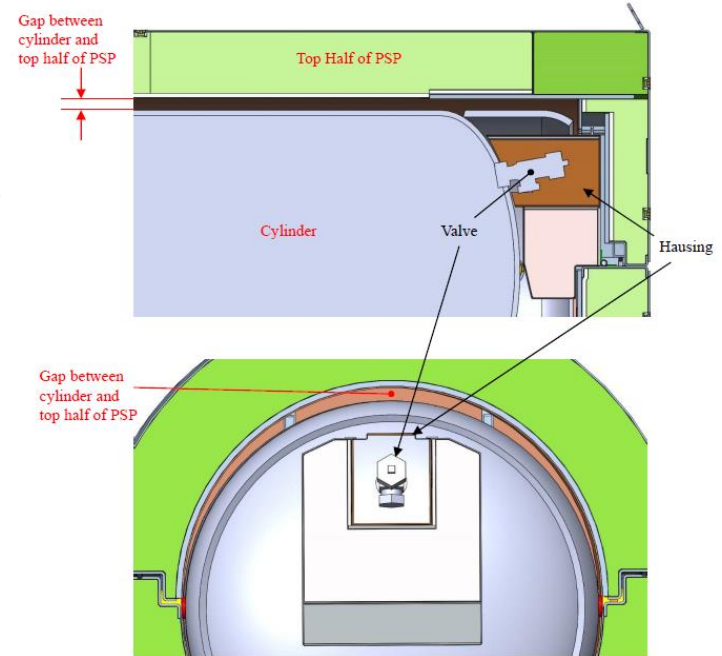
Flat drop onto the top half

Initial goal: Investigate max. thickness reduction of the DN30 PSP under NCT and ACT for thermal and dose rate analysis

Corrected valve geometry leads to narrow margin for the valve/housing distance



SQ 8 drop test orientation



Summary and conclusion

Summary of valve geometry impact

No issue for the experimental drop test results (valve/housing gap of >10 mm)
However, penalizing SQ8 was not investigated in the drop test program

Decreases margin for the valve/housing gap in the numerical simulations

Investigation of fire test results demonstrates that the housing does not provide a significant safety benefit (see next presentation)

Solution: removal of the housing

- Increases global safety margins so that valve contact is not an issue anymore
 - Thermal safety: only small effect due to efficiency of thermal insulation
 - Structural safety: removes any risk of valve contact, no other consequences
-
- Also needs to be implemented for the DN30-X package (USA/9388/AF-96)



orano

Giving nuclear energy its full value