
EMPIR CALL 2020

Metrology infrastructure for high-pressure gas and liquified hydrogen flows

Hydrogen Primary flow standards

Authors:

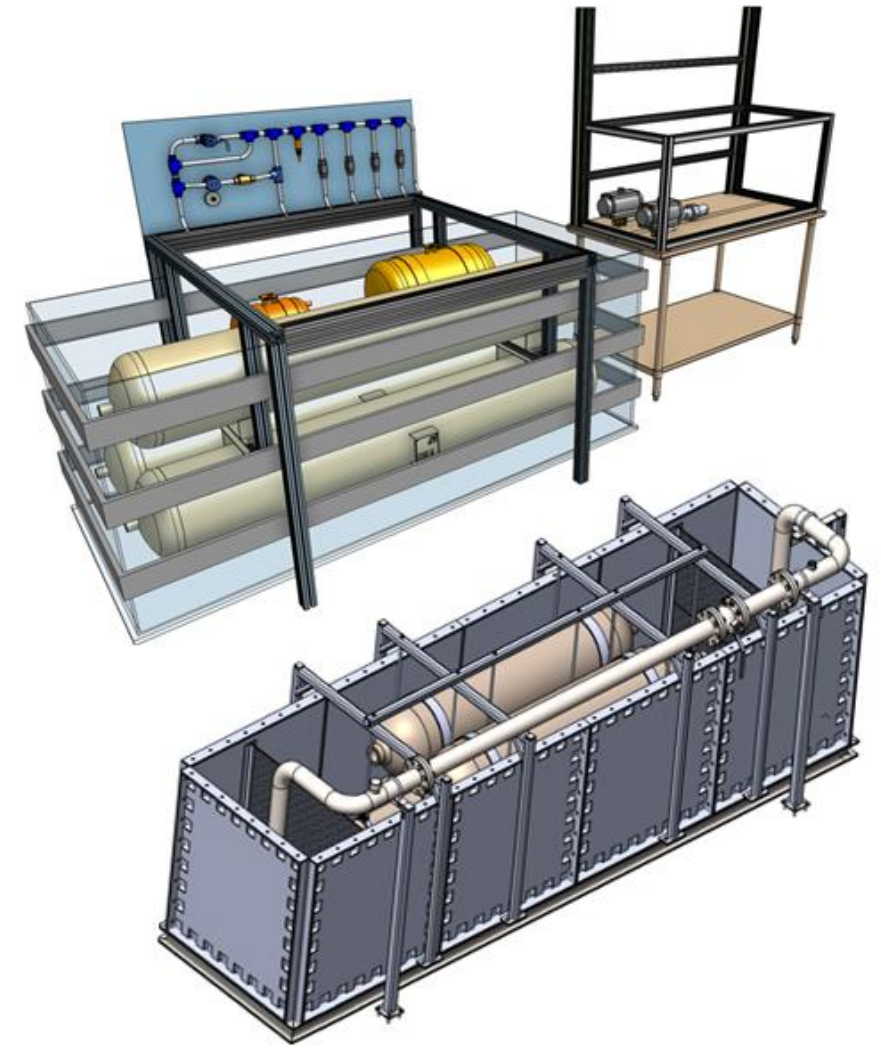
Marc MacDonald (NEL)

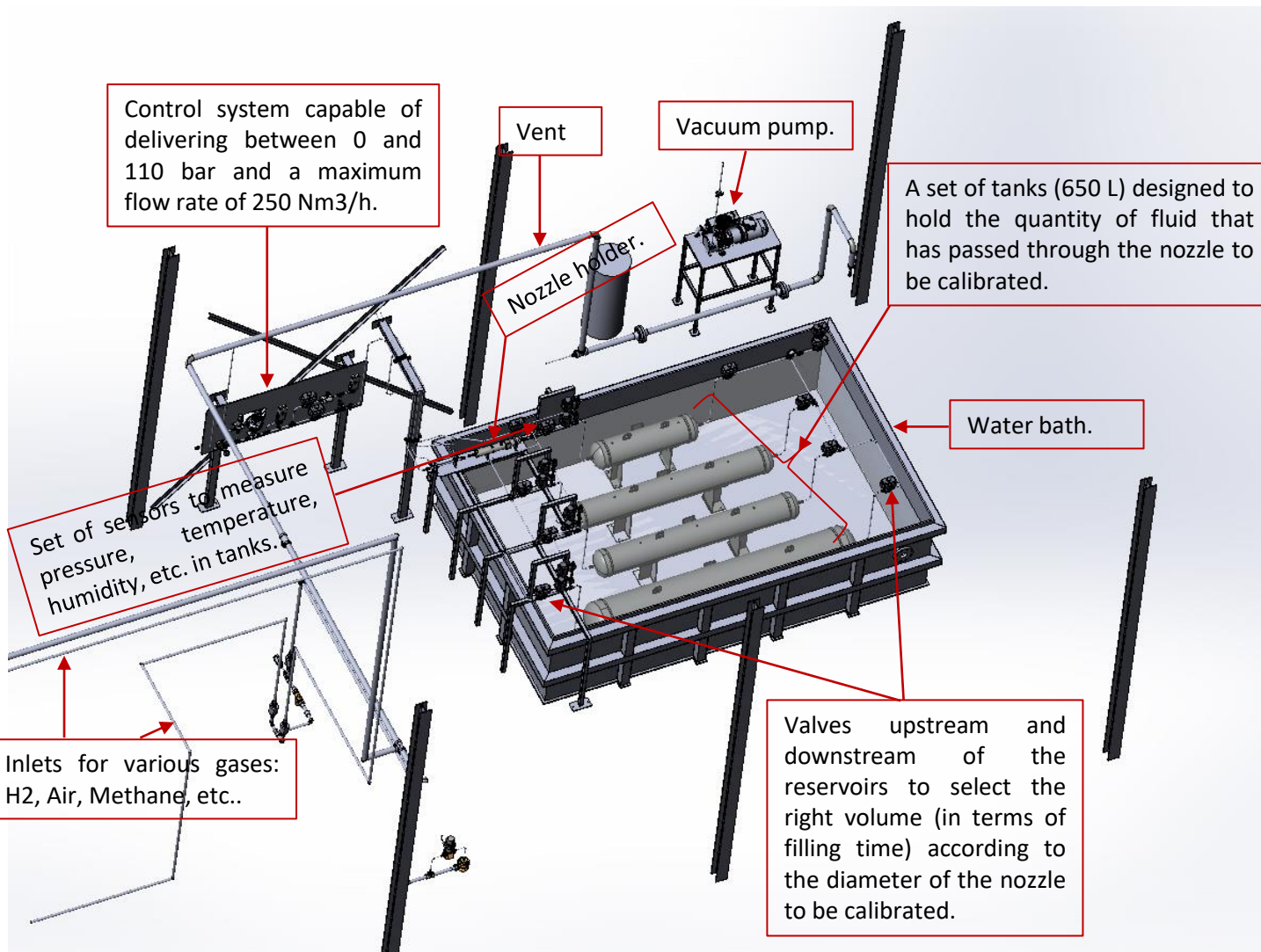
Hydrogen primary flow standards

A4.1.2 M18	Cesame, JV, METAS and NEL will develop at least 2 primary standards for critical nozzle calibration with LP hydrogen. Primary standards will be based on, at least, the pVTt method (other methods include gravimetric or provers). The targeted flow rates for the primary standards will be, at least, $Q_{max} = 4 \text{ kg/h}$ and calibration pressures of, at least, $p_{max} = 3 \text{ MPa}$.	Cesame , JV, METAS, NEL
A4.2.2 M25	JV, with the support of Cesame, METAS and NEL, will calibrate the medium pressure critical nozzle set from A4.2.1 with their own primary standards that were developed in A4.1.2 using the flow rates defined in the A4.2.1 test protocol. An inter-comparison of critical nozzle calibration results will be made for at least 1 critical nozzle and a report summarising the results will be written. The critical nozzle set will then be transferred to the test rig from A4.1.3 at NEL in order to provide SI-traceability.	JV , Cesame, METAS, NEL

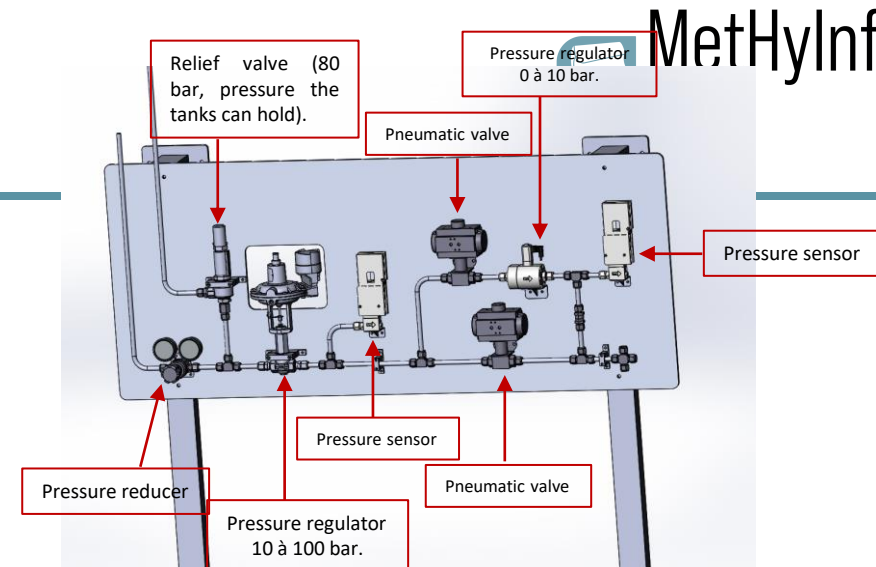
PVTt

- All 4 partners decided to build PVTt primary standards
- CESAME, METAS, NEL have completed their designs, started procurement and construction
- Collection volumes 600 - 800 L, immersed in recirculating water baths
- $q_{\max} > 8 \text{ kg/h}$, $P_{\max} > 100 \text{ bar}$
- Initially aiming for $<0.2\%$ ($k=2$) measurement uncertainty
- Delays and cost escalation due to global supply chain problems, but at least 2 should be primary standards should be available in 2023.

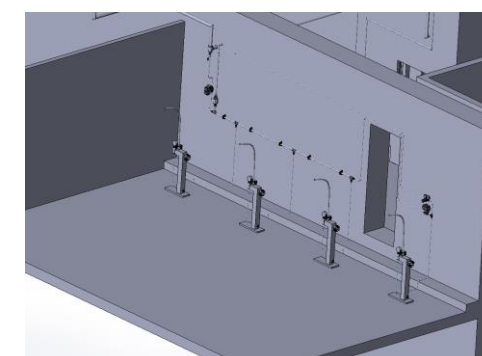
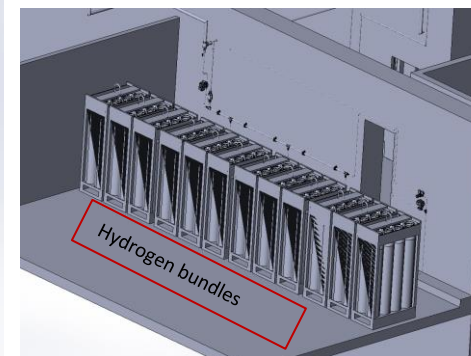




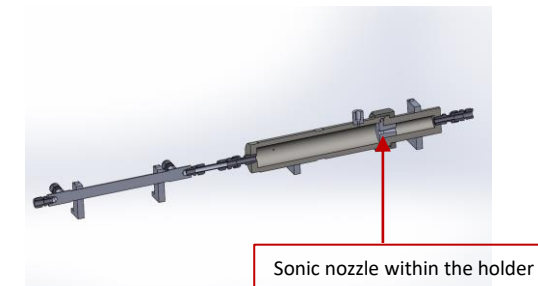
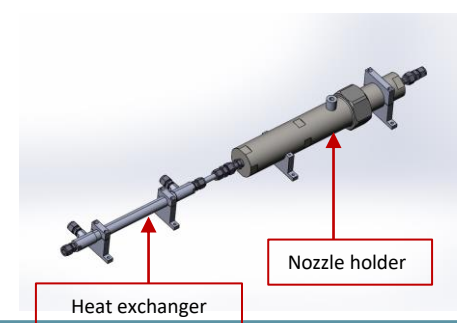
PVTt system (H₂, CH₄, blending, Air)



Control system



Storage system



Current Status

NEL

- Received most equipment now. Large pressure vessels expected in July
- Laboratory modifications complete – ATEX enclosure and non-ATEX control cabin
- Currently installing gas supply pipework, fabrication of main test facility piping soon
- Completion of build by Oct 2023
- Commissioning in Nov, incl. determination of tank volumes and measurement uncertainty



Current Status (CESAME)



Part of the piping inside the test room that has been installed.

Water bath where the tanks will be installed



Vent and hydrogen pipes: one will be connected to the hydrogen and the other to a flare that will burn the gas as it leaves the bench.

The slab that will house the hydrogen bundles

Zoom on the point where the pipes pass through the wall of the CESAME buildings



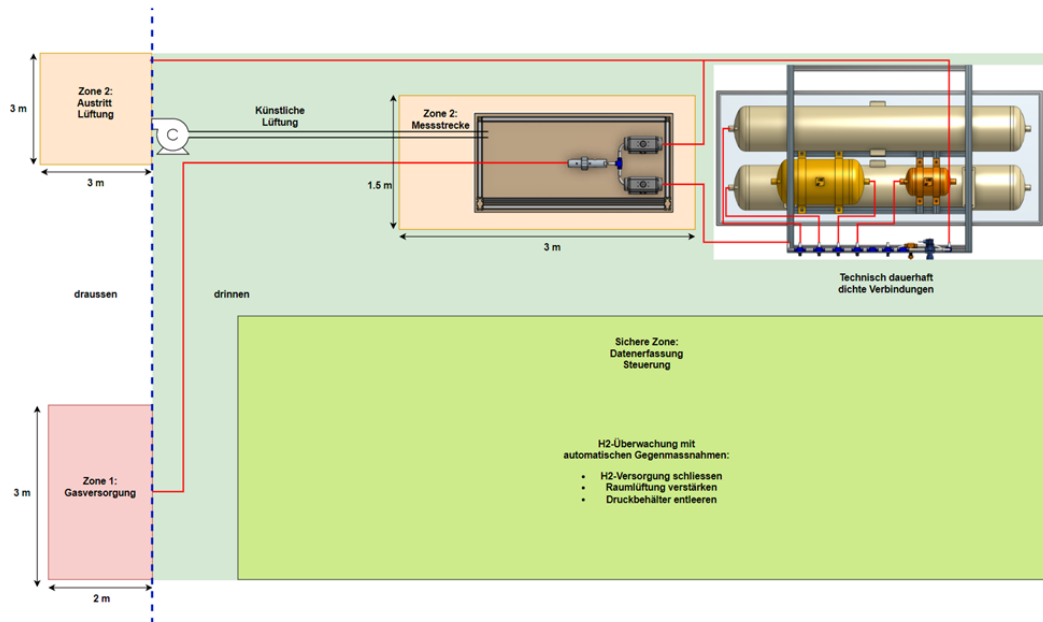
The route taken by the pipes to the test room.

- ✓ Construction of a slab for gas cylinders.
- ✓ Assembly of piping from the source to the test bench (**finishing: probably in July**).
- ✓ Installation of the bath tank.
- ✓ Connection to air storage system (200 bar).
- ✓ Test bench assembly (**ongoing**).
- ✓ Storage system assembly (**in the following months**).
- ✓ Software/LABVIEW development (**specifications in studies by specialized companies**).
- ✓ Optimistic date of end : end of September 2023

Current Status

METAS

- Procurement in progress, received pressure vessels and vacuum pump recently
- Safety concept approved by insurer
- Fabrication of piping starting soon
- Completion of build by Dec 2023



Internal



National Engineering Laboratory



external



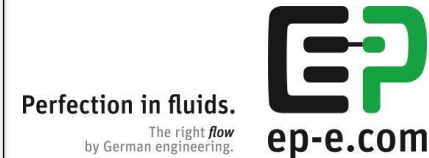
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