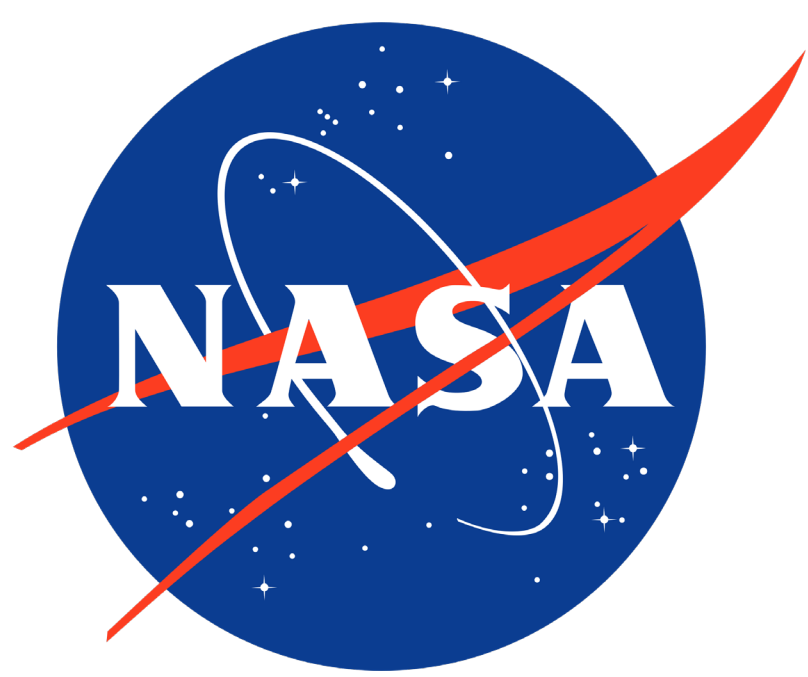


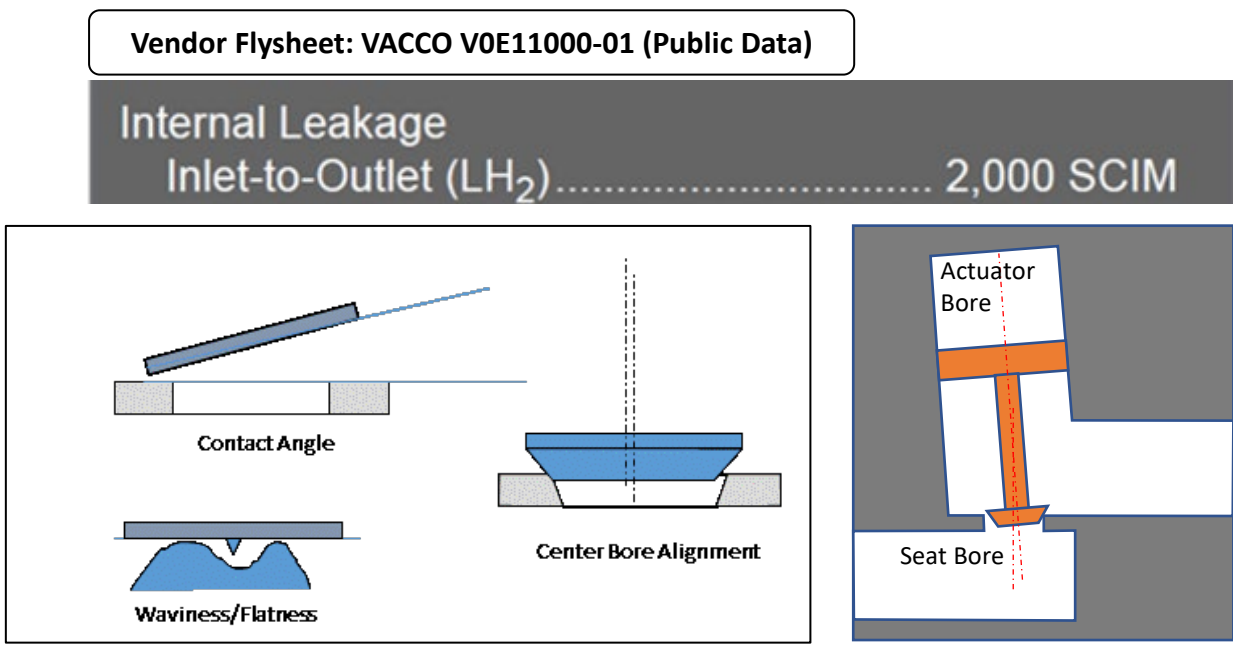
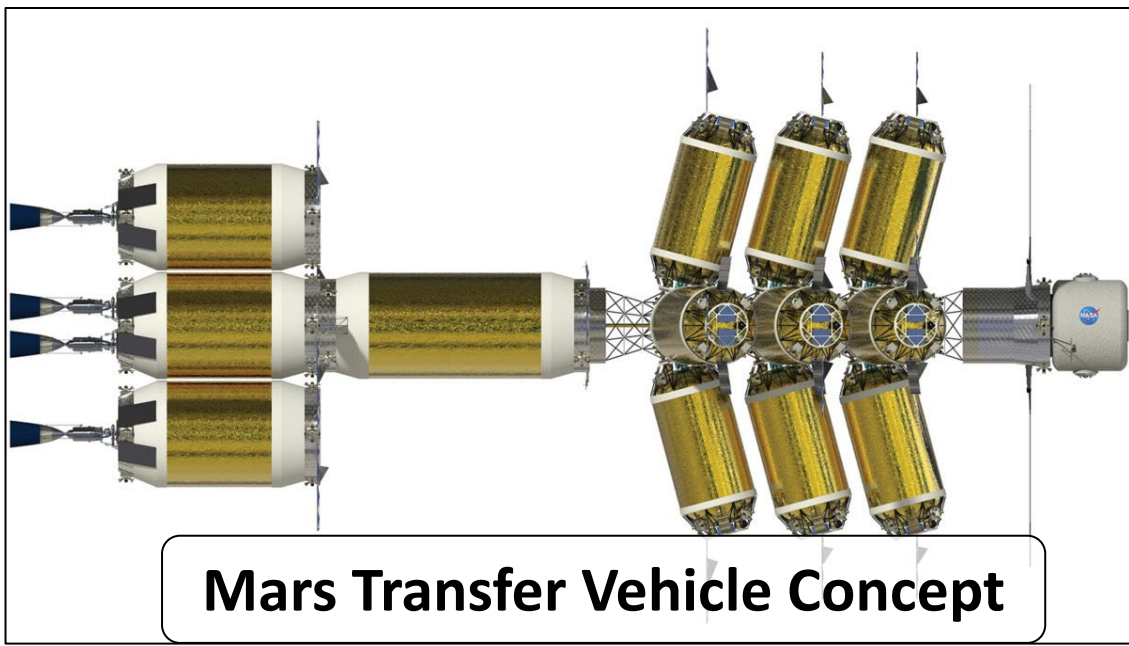


Low Leakage Cryogenic Valves

David Eddleman, Scott Kramer, Andrew Smith, Robert Walker / ER14

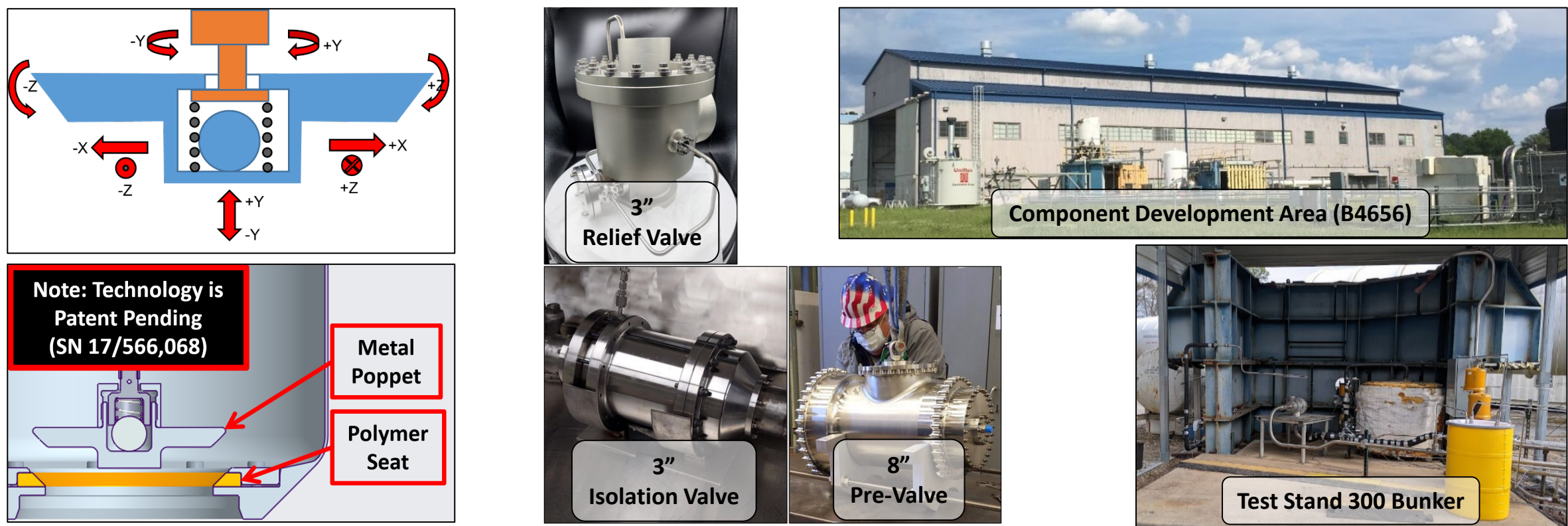
Background:

- Internal leakage poses a significant challenge for aerospace cryogenic valves in meeting the demands of future long-duration missions utilizing cryogenic propellants.
- Large vehicles for long-duration missions are projected to require valve sizes ranging from 3 inches to 10 inches. Current cryogenic valves are typically used on launch vehicles and have internal leakage rates up to 2,000 SCIM for 10-inch valves.
- Surface imperfections and misalignments can create leak paths for cryogenic fluids, which are more prone to permeating between (or even through) components due to their small molecule size.
- Activity Goal:** Create large valves with significantly improved internal leakage rates (ideally below 1.0 SCIM) while at liquid hydrogen temperatures.



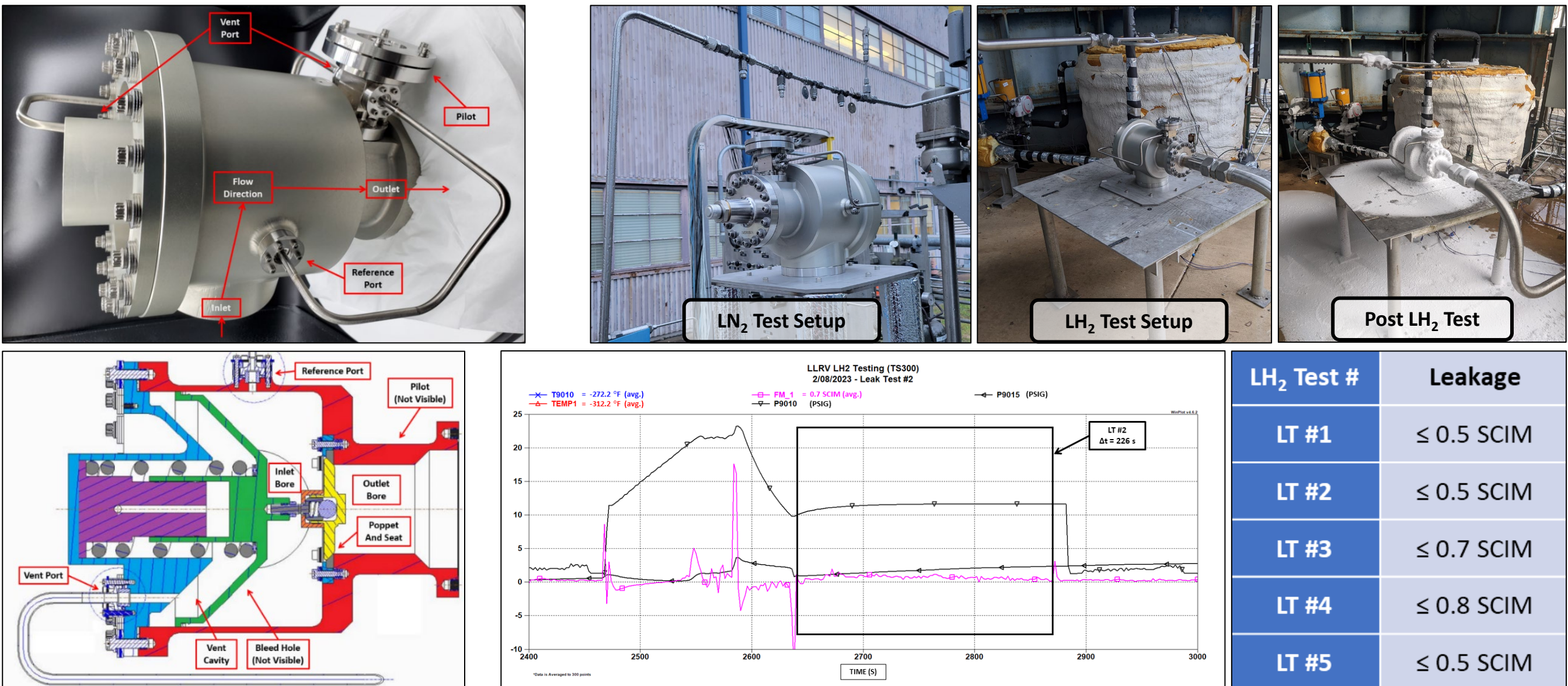
Concept:

- ER14's design incorporates a self-aligning spherical poppet and conical seat, allowing 5 degrees of freedom through a spring-loaded ball joint. This configuration minimizes non-uniform seat stress and potential misalignments between the metal poppet and polymer seat.
- Three test valves (relief, isolation, and pre-valve) were developed to demonstrate the technology in various sizes, environments, and applications.
- LN₂ Testing performed at the Component Development Area (CDA) to establish baseline performance and implement required changes prior to LH₂ testing.
- LH₂ Testing performed at Test Stand 300 (TS300) in the East Test Area.



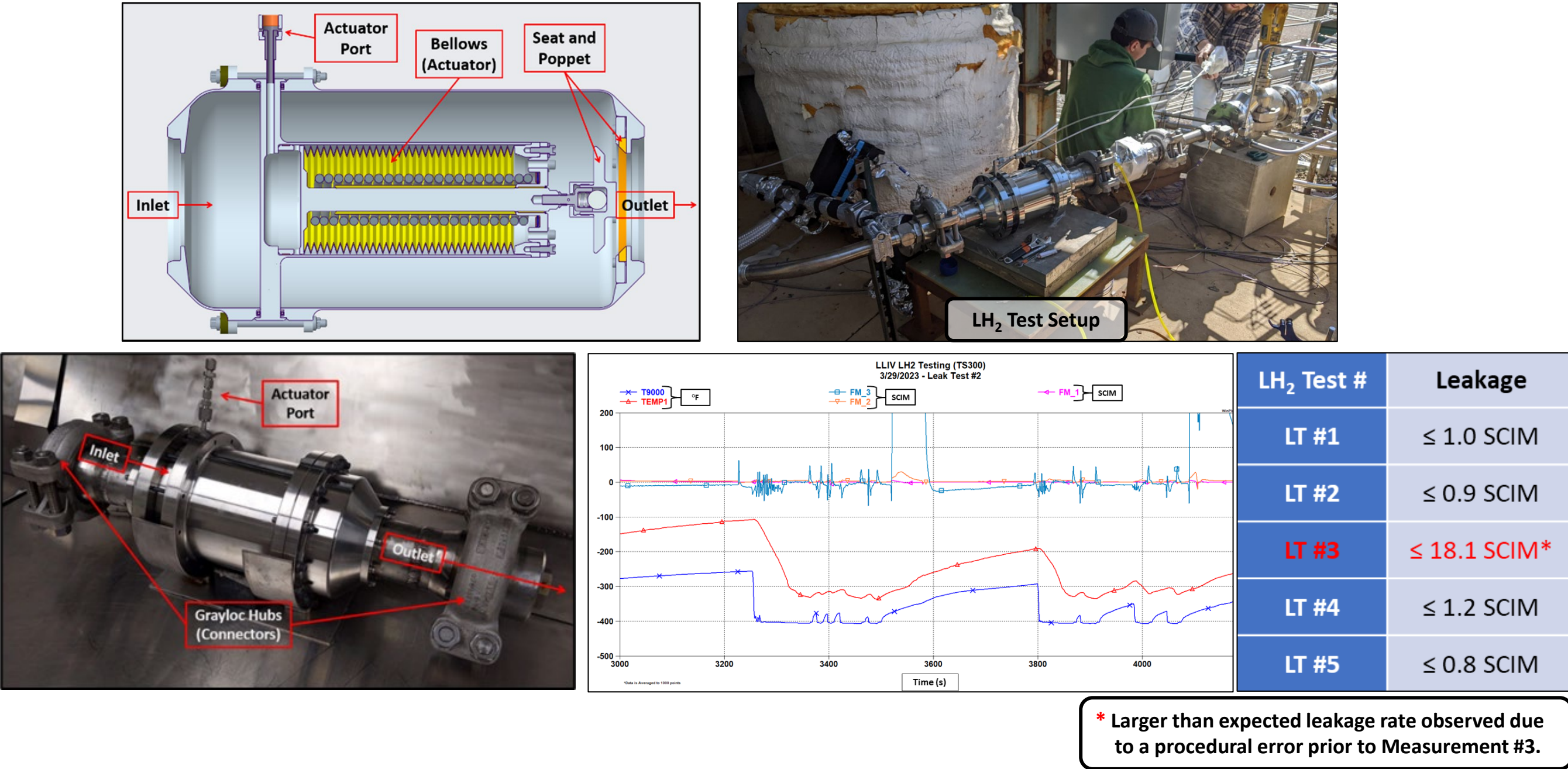
Low Leakage Relief Valve (LLRV):

- The Low Leakage Relief Valve is a normally-closed, piloted relief valve with a 3-inch nominal seat diameter. The LLRV is configured in a right angle (inlet to outlet). The pilot valve cracks at 20 psid, and the main valve will open fully before 25 psid.
- The LLRV is intended to demonstrate the application of the self-aligning seat and poppet to pilot operated relief valves, with vent valve fluid conditions (gas).
- Demonstrated internal leakage rates ≤ 1.0 SCIM during LN₂ testing and LH₂ testing.



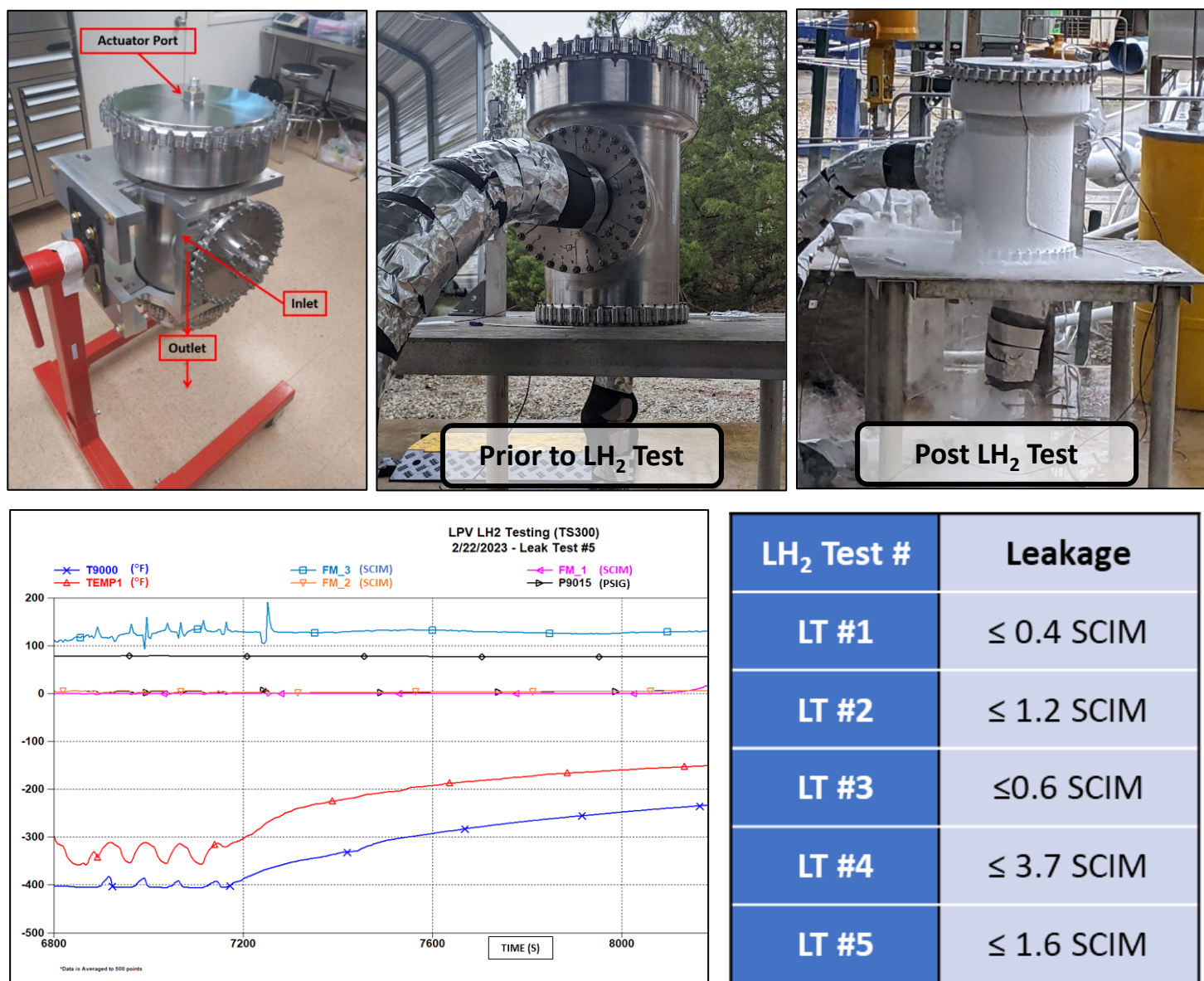
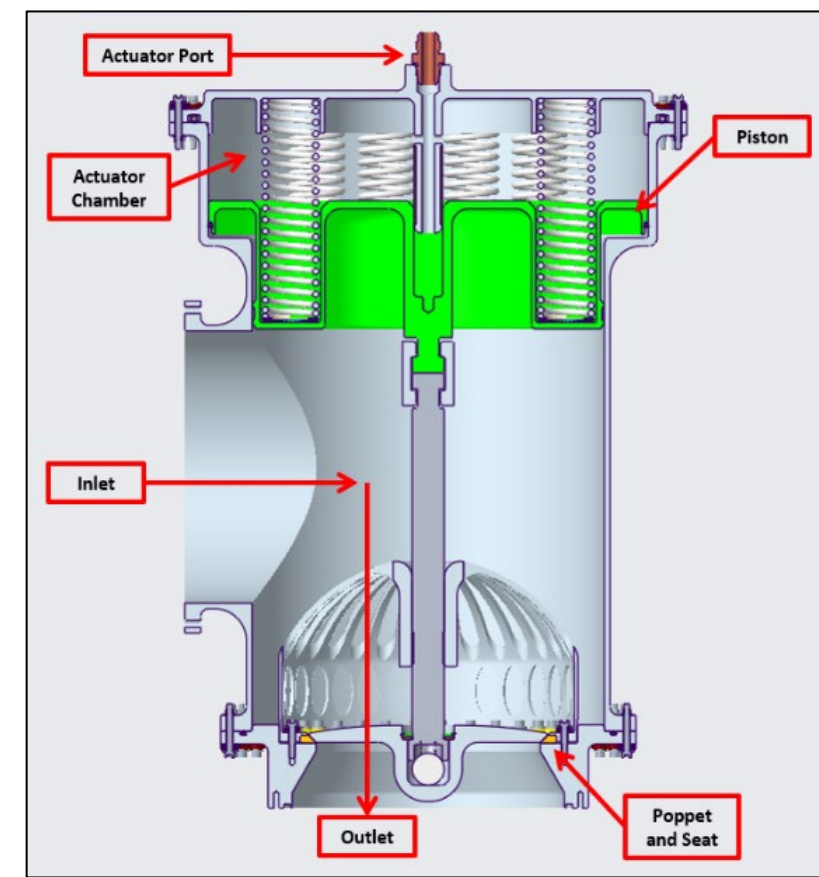
Low Leakage Isolation Valve (LLIV):

- The Low Leakage Isolation Valve is a normally-open, bellows-actuated isolation valve with a 3-inch nominal seat diameter. The inline configuration with pneumatic actuator allows sealing force to vary by changing actuator pressure.
- The LLIV is intended to demonstrate the application of the self-aligning seat and poppet to fill-and-drain style valves in high flow, liquid environments.
- High internal leakage rates were initially observed during LN₂ testing but were subsequently resolved. Demonstrated internal leakage rates ≤ 1.5 SCIM during LH₂ testing.



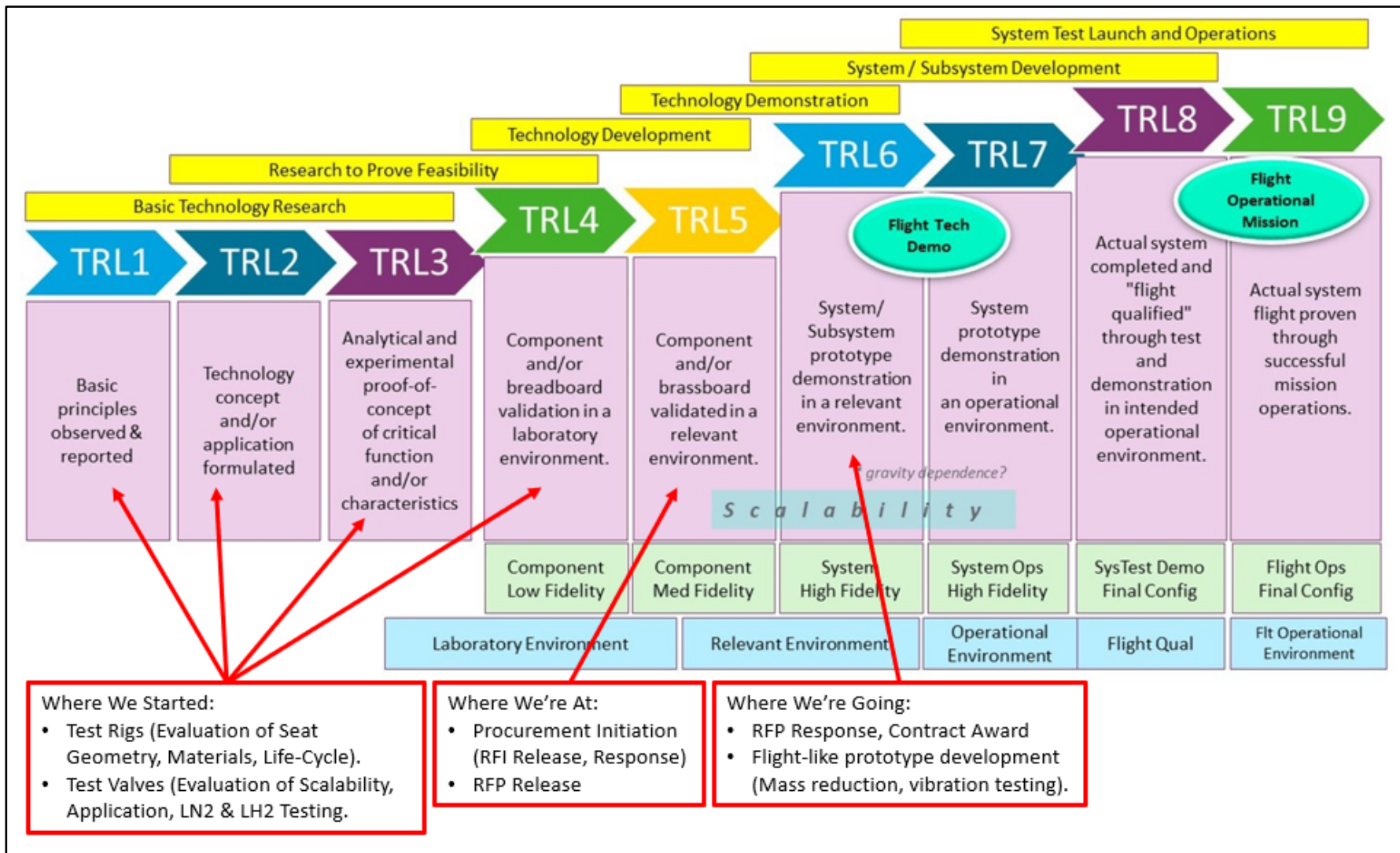
Low Leakage Large Pre-Valve (LPV):

- The Low Leakage Large Pre-Valve is a normally-closed, hydraulically actuated isolation valve, with an 8-inch nominal seat diameter. The LPV is configured in a right angle (inlet to outlet), with the actuator port located at the top of the valve.
- The LPV is intended to demonstrate the application of the self-aligning seat and poppet to large, main propulsion system pre-valves.
- Demonstrated internal leakage rates ≤ 1.5 SCIM during LN₂ testing and ≤ 5.0 SCIM during LH₂ testing.



Current Status / Future Work:

- Request For Information released, using feedback to develop acquisition strategy.
- RFP release scheduled for Q4 FY23. Contract award anticipated in Q1 FY24.
- Development activities for procurement valve(s) anticipated in FY24 – FY25.



Acknowledgements:

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