



NEW HARDWARE CONFIGURATION USED FOR ASME NOZZLE TESTING

NASA's Propulsion Systems Laboratory

TETWoG 111

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HX5 Sierra/NASA GRC

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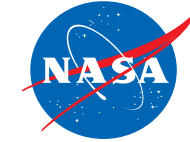




Topics

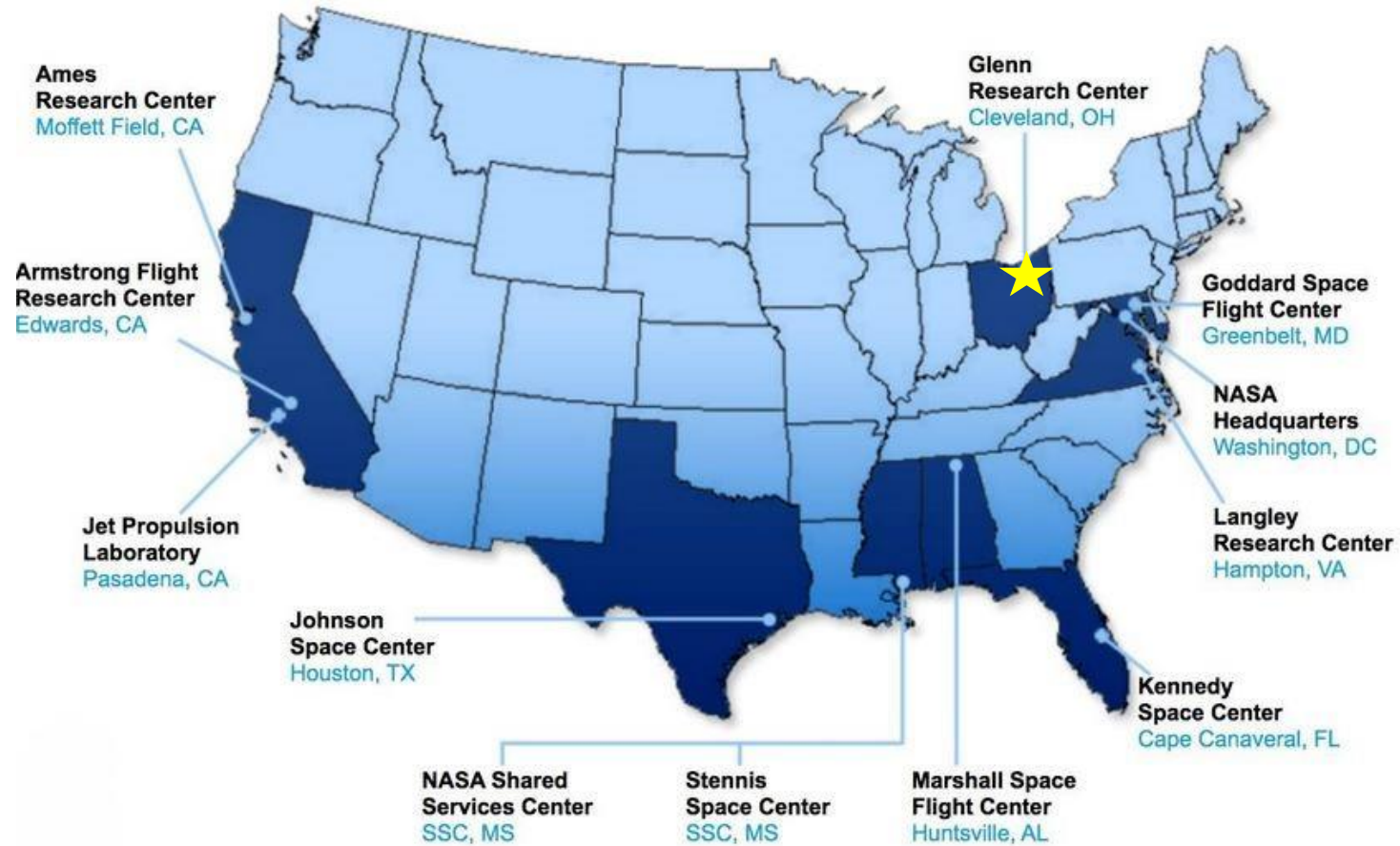
- I. A brief history of the Propulsion Systems Laboratory (PSL)
- II. New hardware configuration design
- III. Hardware manufacture
- IV. Test cell installation

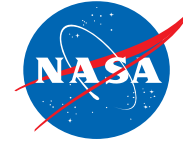




NASA GRC Location

Center Locations

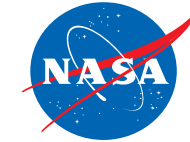




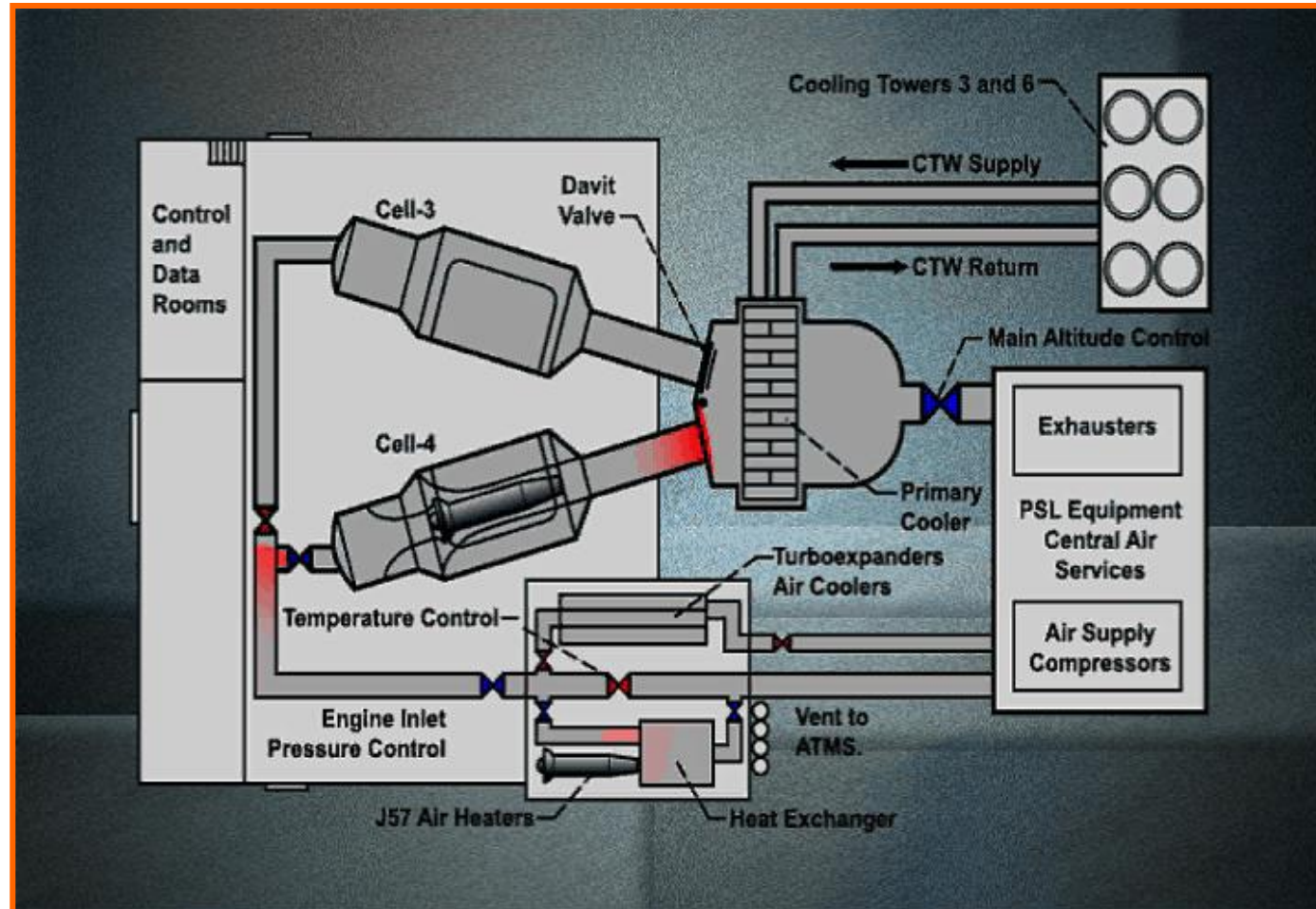
PSL-3 and PSL-4

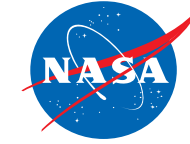
The Propulsion Systems Laboratory (PSL) is located at NASA's Glenn Research Center in Cleveland, OH, USA.





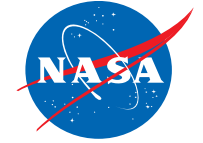
PSL-3 and PSL-4





PSL-3 and PSL-4 Capabilities Overview

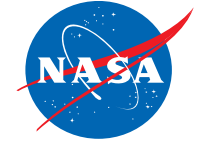
	PSL-3	PSL-4
Diameter, ft	24	
Length, ft	39	
Engine centerline above thrust bed, ft	6	
Mach number range	0 – 3.0	0 – 4.0
Altitude range, ft	0 – 90,000	
Inlet air supply, Pressure range, PSIA	0 – 55	0 – 165
Inlet air supply, Temperature range, °F	-50 – +800	-90 – +1200 (1800 planned)
Inlet air supply, mass flow range lbm/sec (a)	0 – 480	
Exhaust capability, pressure range, PSIA	Atmosphere – 0.4	
Exhaust capability, mass flow range at sea level, lbm/sec (b)	750	
Test cell cooling air, pressure range, PSIA (c)	55 – 165	
Test cell cooling air, mass flow range, lbm/sec	0 – 100	
Model cooling air, pressure range, PSIA	0 – 465	
Model cooling air, mass flow range, lbm/sec	0 – 100	
Fuel Supply, flow rate, Gal/Min	0-200	
Fuel supply, pressure range, PSIA	0-65	
Thrust measurement capability, multi-axis, lbm	40,000/50,000 Horizontal 15,000 Vertical and Lateral	
Thrust measurement capability, single-axis, lbm	10,000/40,000/50,000	



PSL History

- PSL 1 and 2 operated for 27 years from 1952 until 1979.
- PSL construction was completed in 1972.
- First engine test completed in 1973.
- 450# heated air capability at Mach 4 temps added in late 1990s.
- Engine icing capability added in 2011.
- PSL 3 and 4 are in their 53rd year of operation.
- No current plans for PSL 5 and 6.





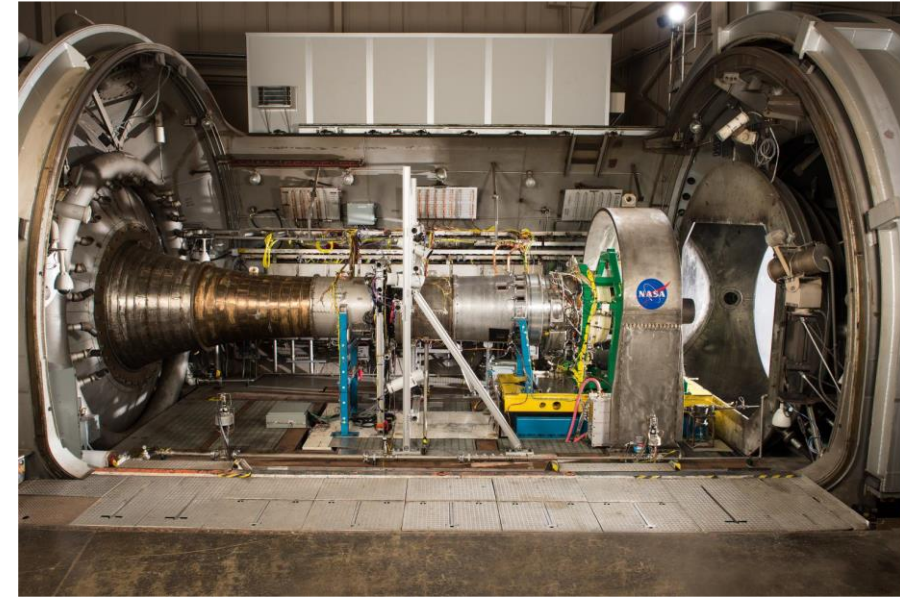
PSL History



1973: Pratt & Whitney F100



1998: General Electric J85

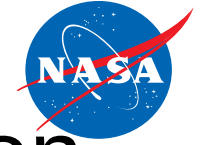


2015: Honeywell ALF502



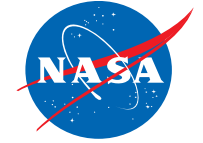
New Inlet Hardware

- Problem Statement: A PSL customer wishes to run a jet engine with an inlet diameter of 52". PSL typically runs engine inlets of 36" diameter or smaller. The new hardware needs to be characterized before running the customer engine. This will be accomplished using an ASME nozzle.
- Process: PSL worked with the NASA design group to coordinate a design and build effort for approximately 15 pieces of new hardware. The total cost of the hardware design and build was approximately 1.75 million USD.
- Results: PSL has received all of the necessary hardware and is in the process of installing this hardware into PSL-3 for characterization. Testing is scheduled to begin in early June 2024.

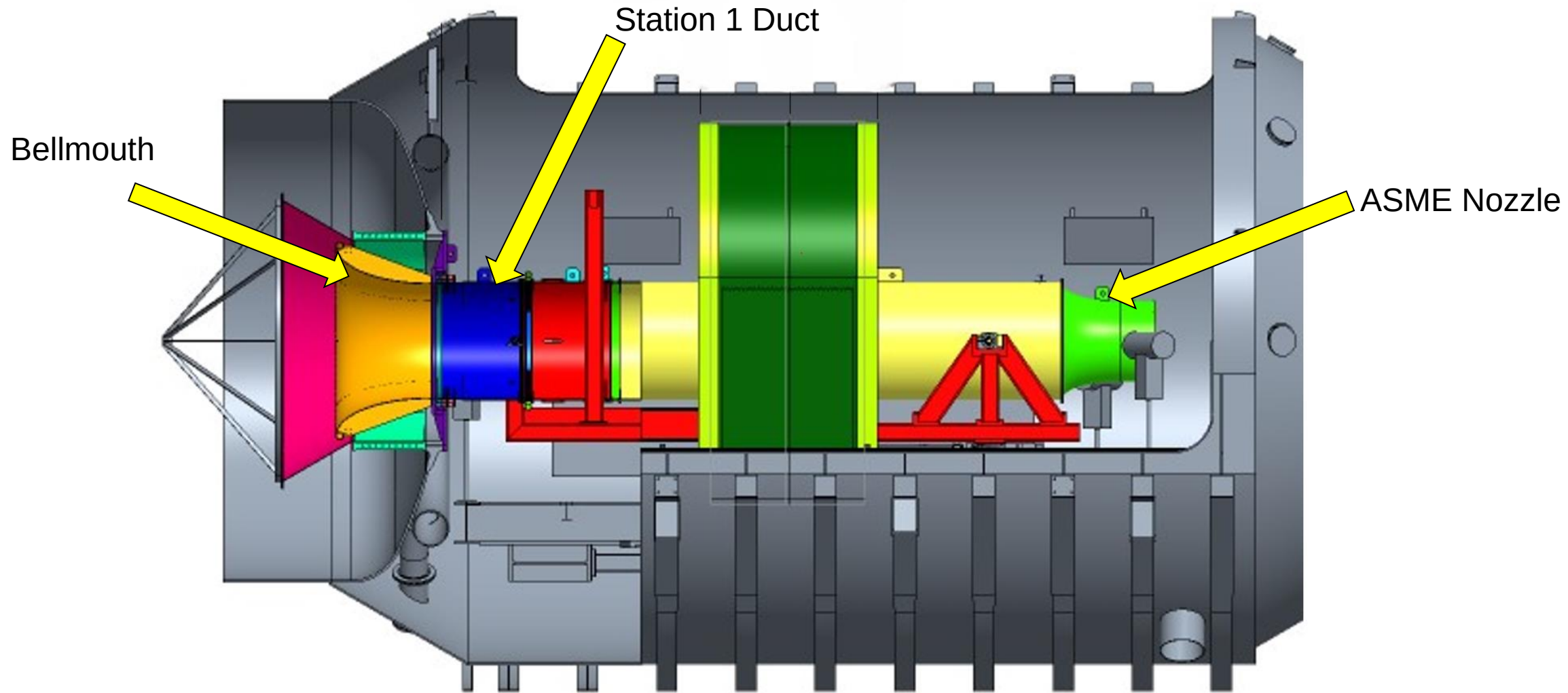


Typical PSL ASME Nozzle Configuration





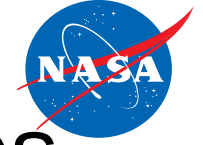
New Inlet Hardware Configuration





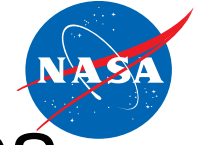
New Inlet Hardware Manufacturing

- Most of the hardware was contracted out in 2 bid packages. 2 different companies won these bids.
- With 2 notable exceptions, the hardware passed inspection and was delivered to NASA GRC to be test fit before installation into the PSL-3 cell.
- The inlet bellmouth and the facility interface plate both required significant effort and rework to provide an acceptable product for ASME testing.

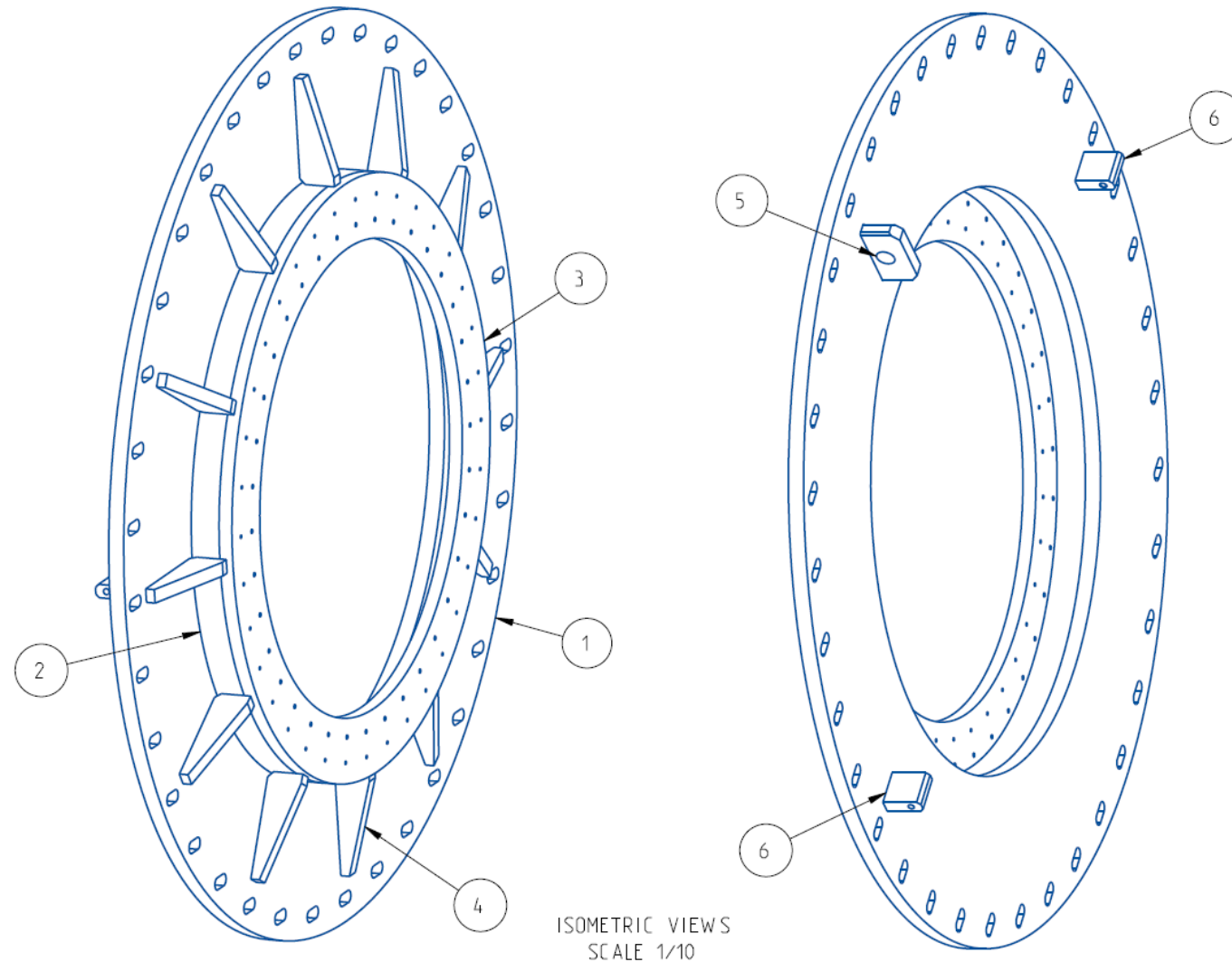


Interface Plate Manufacturing Challenges

- The interface plate between the facility and the inlet ducting was awarded to a company that typically builds larger weldments for fuel tanks.
- After award, the contractor wanted to make changes to our design for easier manufacturing.
- After PSL denied the changes, we were informed that they were not capable of hitting our tolerances as specified on our drawings.
- This caused additional engineering effort and cost as the contractor's first attempt at the interface plate had to be scrapped.



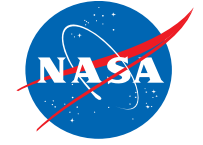
Interface Plate Manufacturing Challenges



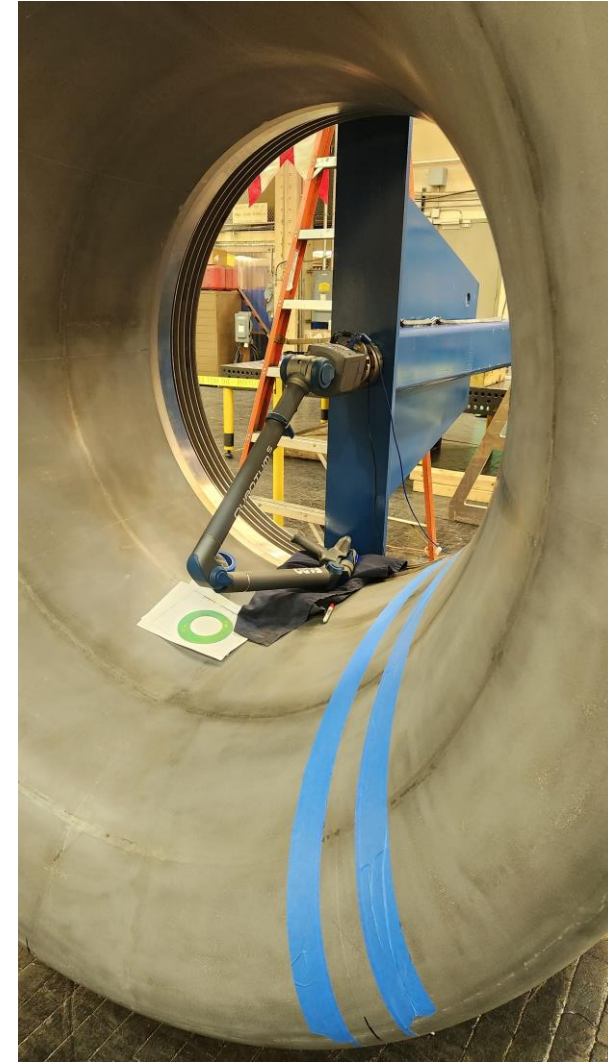


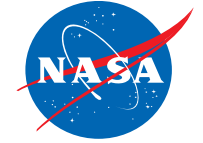
Bellmouth Manufacturing Challenges

- The inlet bellmouth was awarded a contractor who canceled the job approximately 2 months after contract award. This caused a re-award to our second contractor and delayed receipt of the hardware by several months.
- Progress proceeded on the new bellmouth, but was not scheduled to be ready in time to meet NASA schedules.
- To meet deadlines, PSL chose to skip anodizing and paint the interior of the bellmouth. PSL planned to rework the bellmouth after the ASME nozzle test and have it anodized before use in front of an engine. This decision was made during PSL testing when not all the technical experts were available to make the best decision.
- Due to changes in test schedule after receipt of the bellmouth, PSL decided to send out the bellmouth before ASME testing for paint stripping and anodization.
- The sandblasting process damaged the bellmouth and will prevent it from being used for engine testing. A new bellmouth will be made for engine testing.



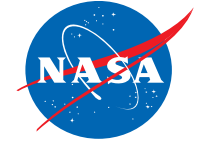
Bellmouth Manufacturing Challenges





Lessons Learned

- Interface plate:
 - Verify that a company has expertise in your specific application before award.
 - The lowest bid is not always the best bid.
- Bellmouth:
 - Take the time to get stakeholder buy-in on key decisions regardless of schedule pressure.
 - Don't let poor decisions compound. Keep the big picture in mind.



Test Cell Installation

- To help with a smooth installation in PSL-3, the NASA GRC manufacturing facility pre-built the hardware from multiple vendors to ensure connections fit together properly.
- This has helped to reduce issues and installation time in PSL-3.





Questions?

