Jet Propulsion Laboratory

California Institute of Technology

Performing A Launch Depressurization Test on an Inflatable Space Habitat

Patrick Martin

JPL - Environmental Test Laboratory

Pasadena California

Launch Depressurization Test On An Inflatable Space Habitat

WHY DO A LAUNCH DEPRESSURIZATION TEST?

NASA would like to mount an inflatable space habitat on the International Space Station, but was concerned that it might expand during launch and rupture the payload compartment.

The Inflatable habitat is too complicated to answer this question by analysis. So a launch depressurization test was needed.

Launch Depressurization Test On An Inflatable Space Habitat

WHAT DO YOU NEED TO DO THE TEST?

1. A chamber large enough to hold a big test article.
2. A really large capacity pumping system.
3. A means of controlling the rate of depressurization.

Historical note:

JPL's large vacuum chambers used to be connected with the powerful compressors at JPL's wind tunnel with a large vacuum line. The wind tunnel compressors could pump down a chamber fast enough to meet the launch depressurization requirements. But in 1982 the wind tunnel was decommissioned.

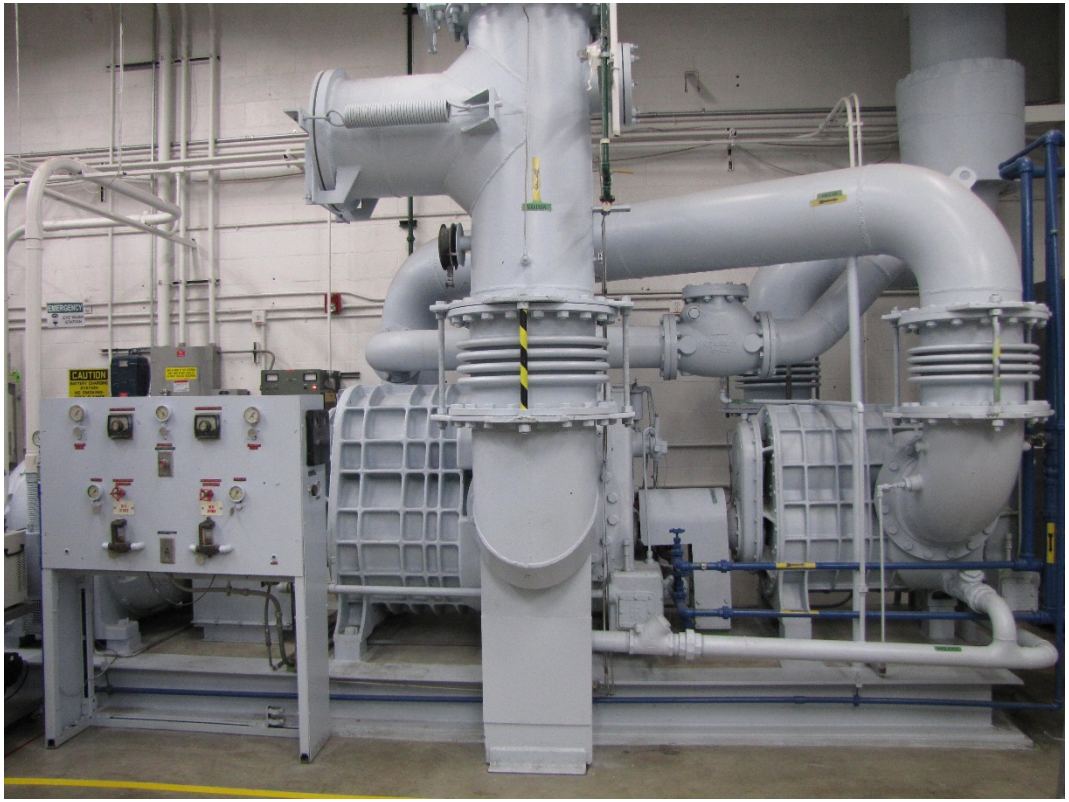
Launch Depressurization Test On An Inflatable Space Habitat

THE PROBLEM:

After the wind tunnel was decommissioned, a rough pumping room was built in Building 150, to support the Space Simulator Chamber.

Though the pumping capacity of the pumps in the rough pumping room was enough to support solar thermal vacuum tests in the Space Simulator chamber, it was not adequate for launch depressurization testing.

Launch Depressurization Test On An Inflatable Space Habitat



500 Horse Power Two Stage Axial Compressor

Launch Depressurization Test On An Inflatable Space Habitat

Eight Stokes Mechanical Pumps in Building 150 Pump Room

Launch Depressurization Test On An Inflatable Space Habitat

A NOVEL APPROACH WAS PROPOSED:

Since the large Space Simulator chamber was connected by the underground vacuum line to the 10-ft Vertical Vacuum chamber, we wanted to use the Space Simulator as a vacuum reservoir to augment the pumping capacity of the vacuum pumps while depressurizing the 10-ft chamber.

Launch Depressurization Test On An Inflatable Space Habitat

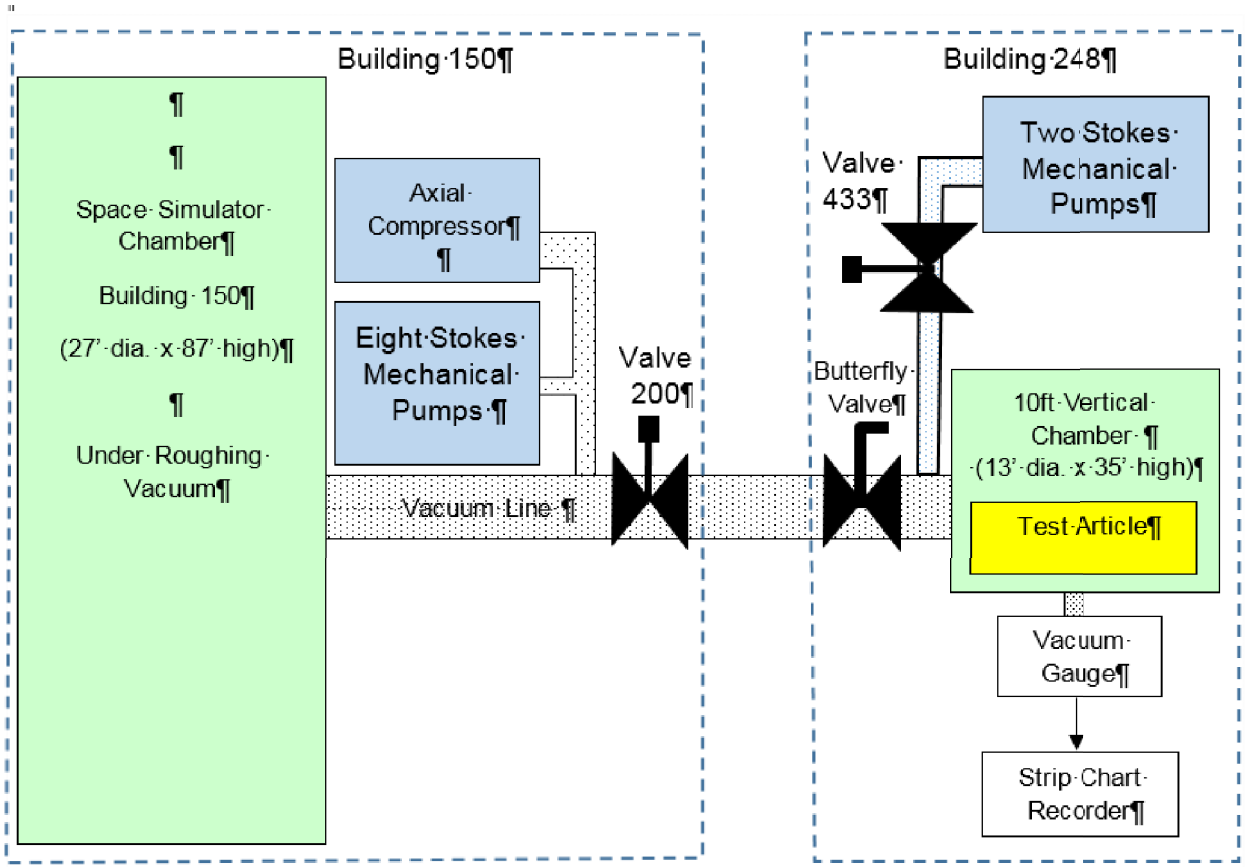


FIGURE 1: TEST SETUP BLOCK DIAGRAM

Launch Depressurization Test On An Inflatable Space Habitat

SOME OF THE CHALLENGES:

- Time: We only had a one month window of opportunity.
- Technical:
  - Modify the setup to bypass the interlocks and open valves.
  - Figure out how run the chambers in tandem.
  - Prove that we can meet the test requirements.
  - Get adequate hands-on training for our “Space Cadet”.
- Contractual: The administrators wanted 30 days to open the contract after confirmation that we could do the test.

Launch Depressurization Test On An Inflatable Space Habitat

PRE-TEST:

- Eight dry runs were performed.
- Per direction of the JSC Project Chief Engineer, the profile was modified so that the transonic period happened sooner.

Launch Depressurization Test On An Inflatable Space Habitat

THE TEST METHOD:

1. Pump down the Space Simulator with the axial compressor and eight Stokes pumps in Building 150.
2. Turn on the two Stokes mechanical pumps in Building 248, but keep them off-line.
3. Start the strip chart recorder and manually open the butterfly valve to follow the launch depressurization profile.
4. As pressure in the two chambers approaches equilibrium, open the isolation valve for the two Stokes pumps in Building 248, then close the isolation valves on the vacuum line to Space Simulator facility.

Launch Depressurization Test On An Inflatable Space Habitat

PERFORMING THE TEST:

- The contract was opened on the morning as the test article was being installed in the chamber.
- Test Run # 1 was conducted. But our customer's DAS hung up.
- The Test Article was inspected, and no signs of expansion or damage were observed.
- A request was made to repeat the test.
- Test Run # 2 was conducted successfully, all requirements were met, and our customer's DAS worked.
- The Test Article was inspected and no signs of expansion or damage were observed.

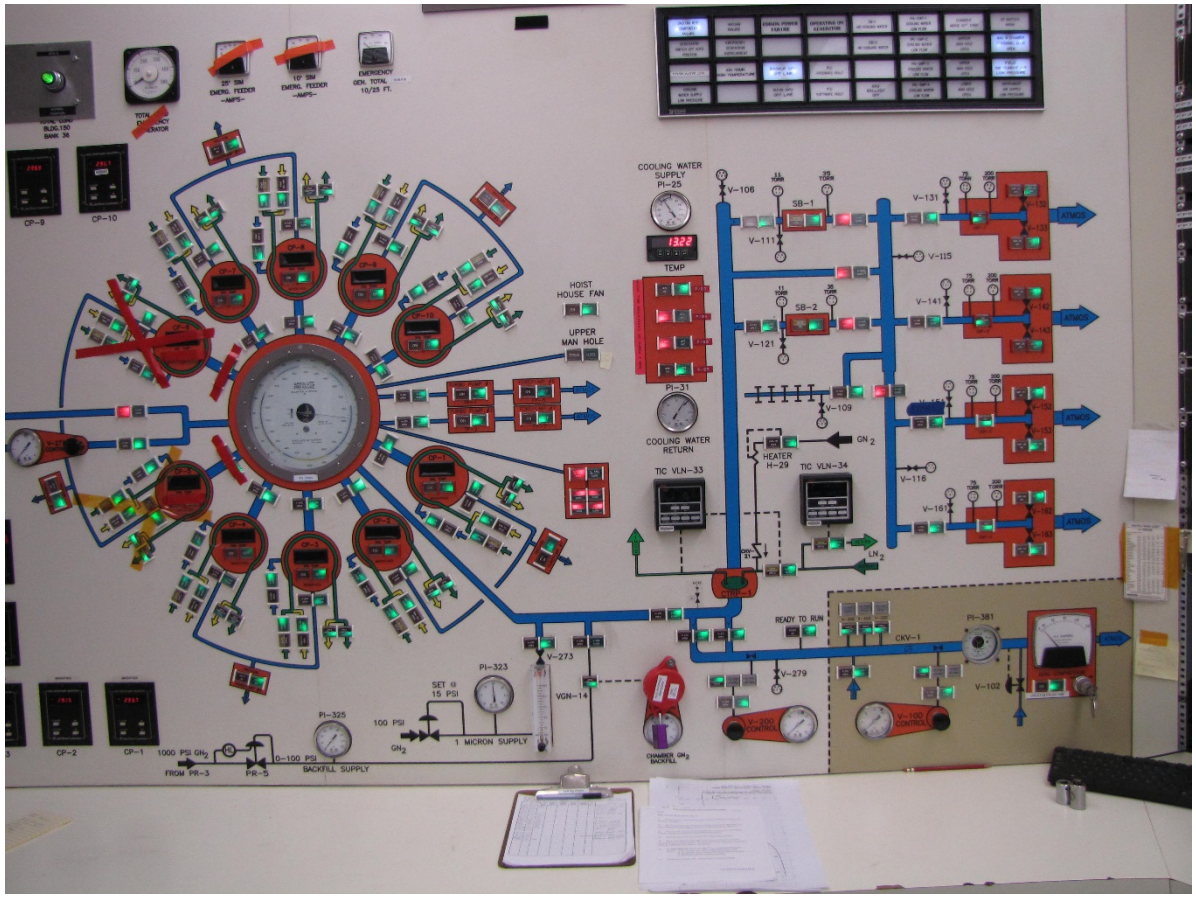
Launch Depressurization Test On An Inflatable Space Habitat

Dimensions:

- Chamber:
  - 27-ft diameter
  - 87-ft high
- Shrouds:
  - 25-ft diameter
  - 74-ft high

Space Simulator Chamber in Building 150

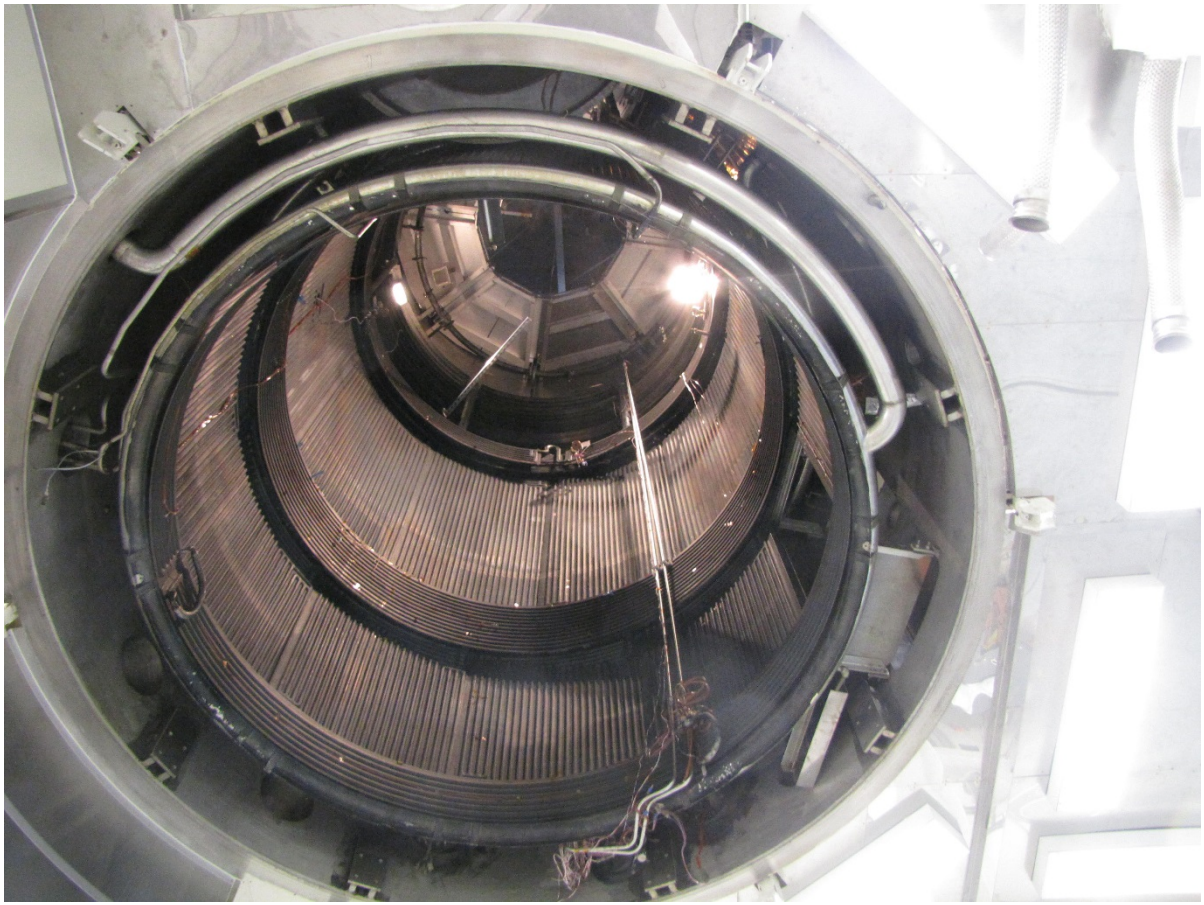
Launch Depressurization Test On An Inflatable Space Habitat



Only the eight Stokes mechanical pumps and axial compressor were used. The Roots blowers and cryo pumps were not needed for this test.

Vacuum Control Console for Space Simulator Chamber

Launch Depressurization Test On An Inflatable Space Habitat



Dimensions:

Chamber:

13-ft diameter

35-ft high

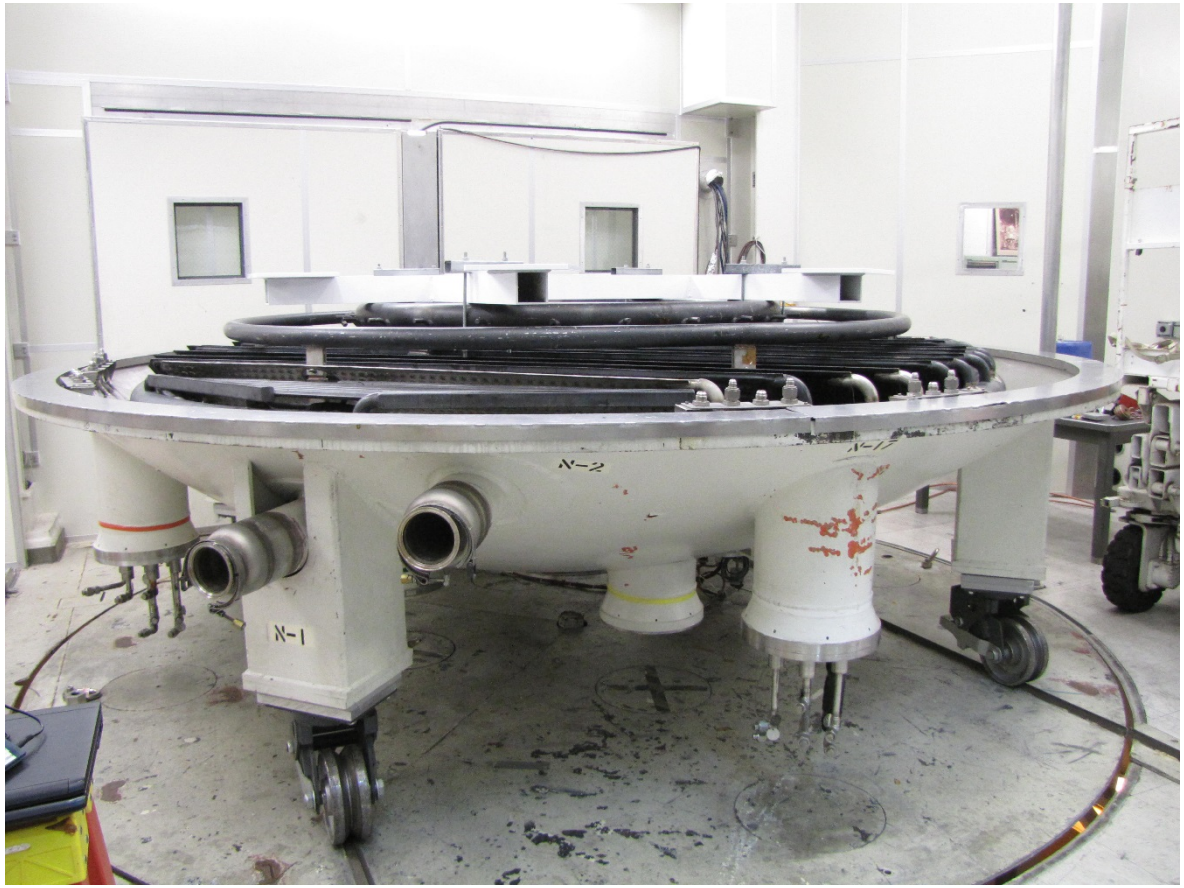
Shrouds:

10-ft diameter

22-ft high

Bottom View of 10-ft Vertical Vacuum Chamber in Building 248

Launch Depressurization Test On An Inflatable Space Habitat

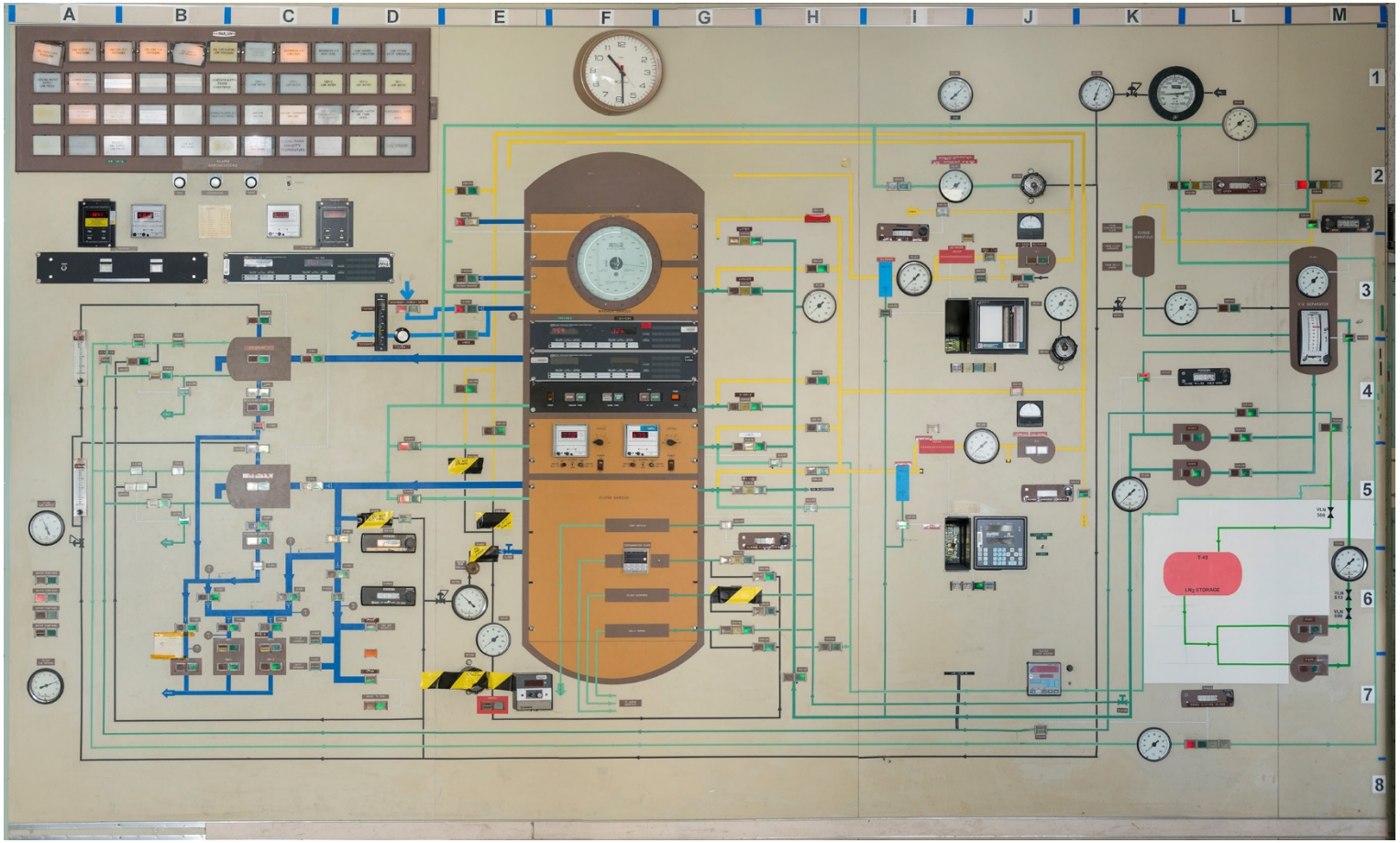


The test article was mounted on top of the end bell.

The end bell was raised to the chamber with a hydraulic lift.

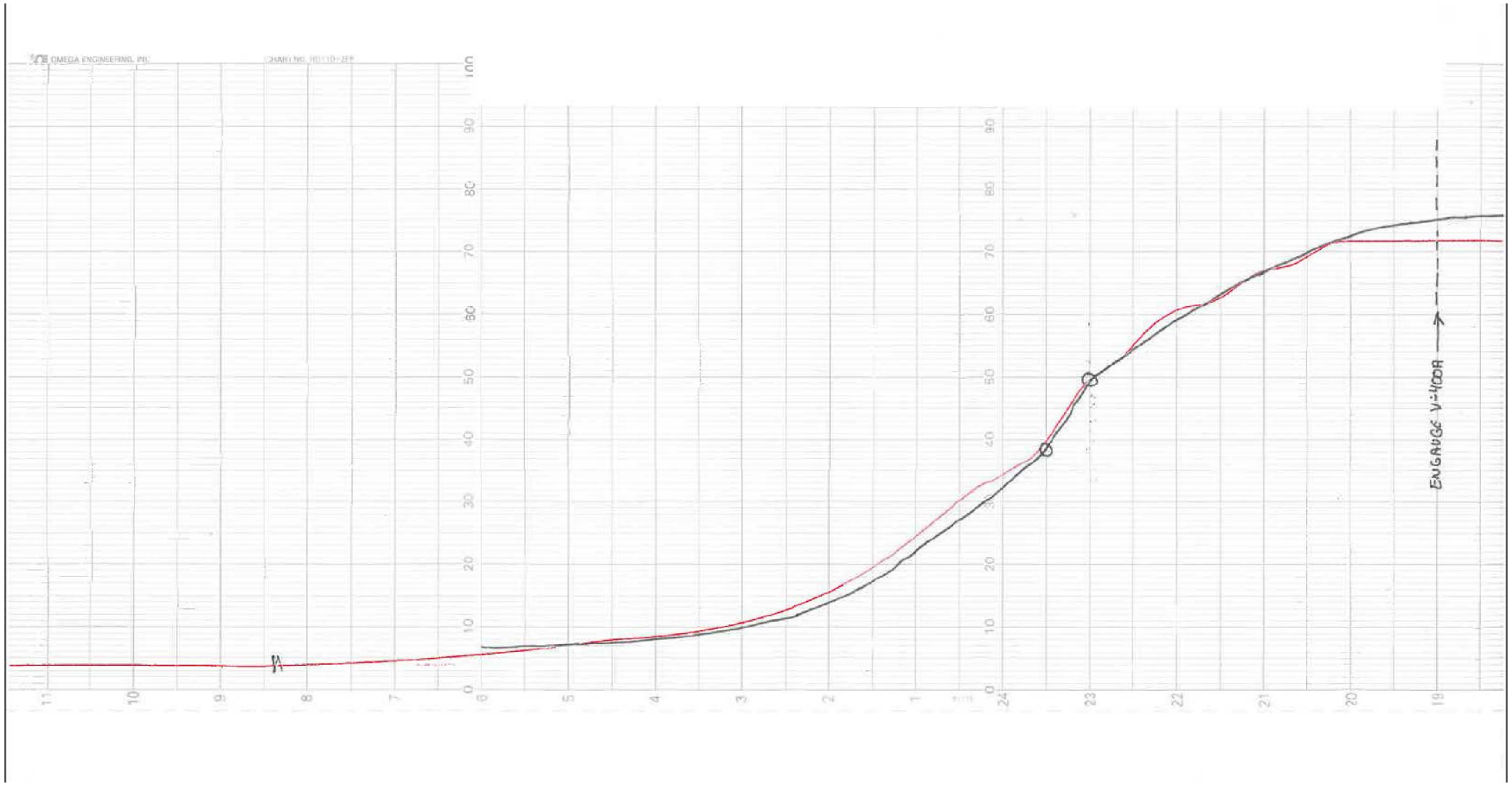
End Bell for 10-ft Vertical Vacuum Chamber

Launch Depressurization Test On An Inflatable Space Habitat



Control Console for 10-ft Vertical Vacuum Chamber

Launch Depressurization Test On An Inflatable Space Habitat



Strip Chart Data for Test Run # 2

Launch Depressurization Test On An Inflatable Space Habitat

CONCLUSIONS:

- The launch depressurization test was successfully completed on time, within tolerance, and within budget.
- The test demonstrated that the Inflatable Space Habitat should not pose a risk of expansion during the launch.
- The test also demonstrated JPL's capability of using the tandem chamber method of performing a launch depressurization test on a large test article.
- Doing something that had not been done before, under narrow schedule constraints, inspired a lot of creativity from all our team members.
- We really enjoyed performing this test.

NASA