

Introduction

Northrop Grumman is an American aerospace and defense company that produces many types of rockets. These rockets have nozzles that create a pressure difference and choke flow, allowing propellant to generate an upward force. The interface between the rocket motor and nozzle is a huge silicone O-ring. These O-rings must withstand rigorous atmospheric/space conditions and as such must be tested extensively before they can be used.

Problem

Northrop Grumman is looking for an improved method to leak test their motors that is user friendly, and where only one operator is needed to perform the test. The end product will need to be compact, portable, tamper-proof, and should be automated for the test operator.

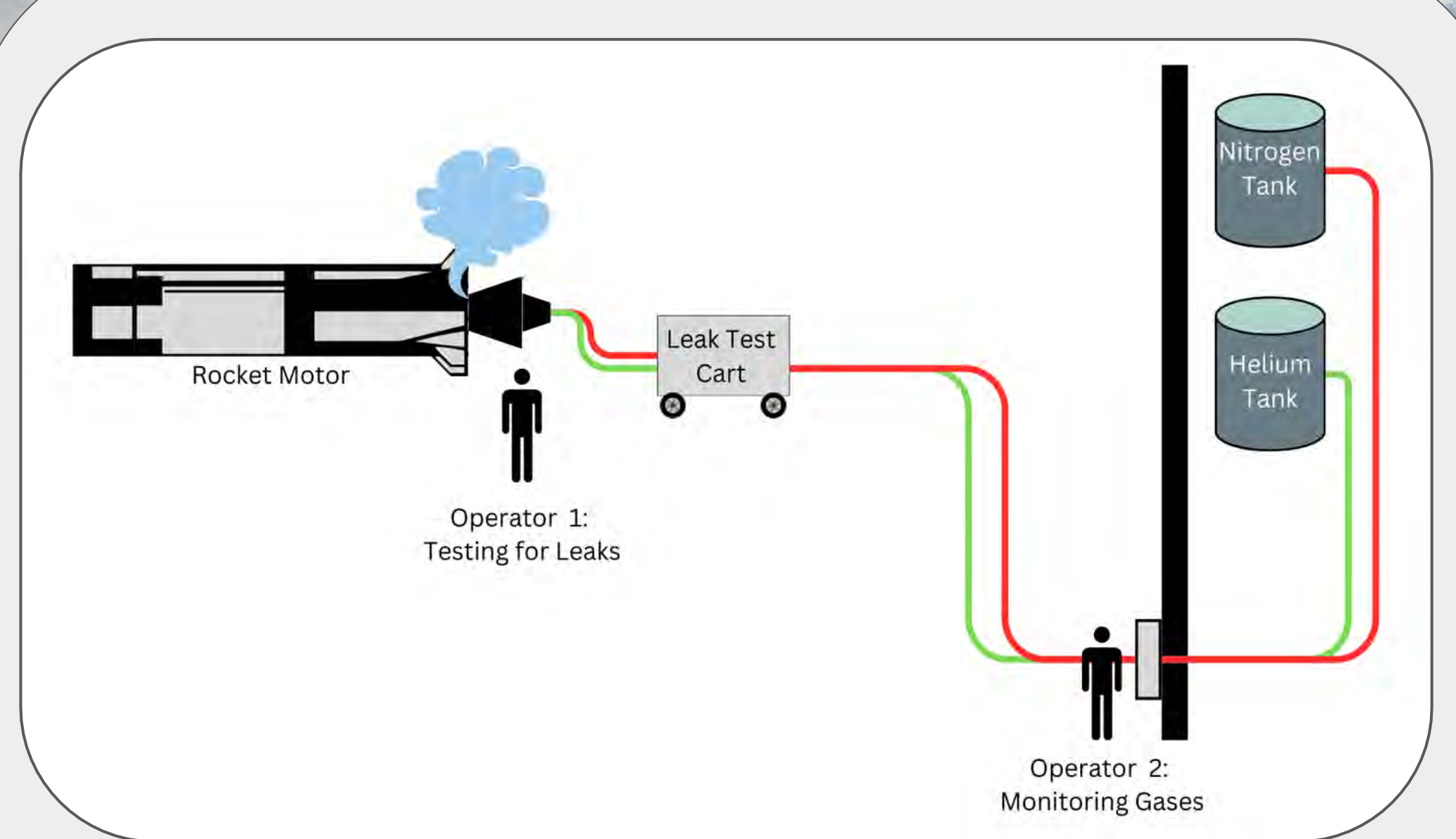


Figure 1: Diagram depicting current leak test methods

Objectives

- Make the test portable between motors
- Keep all components in a compact form factor
- Automate the leak test using LabVIEW
- Pressurize with two gases, Nitrogen and Helium
- Adhere to electrical standards
- Operator controlled HMI
- Display the results of test for operator
- Be accurate within 0.01% of pressure

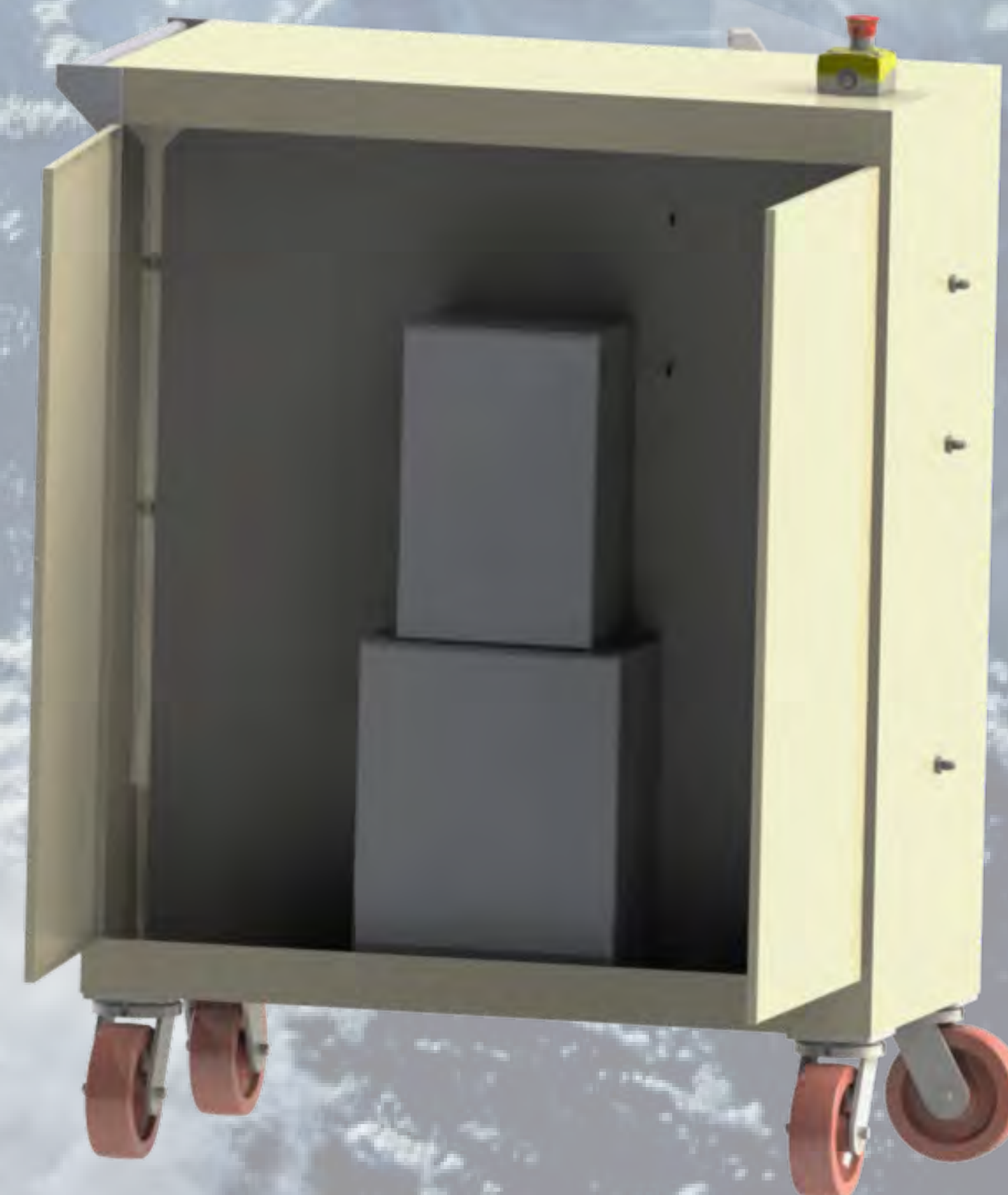


Figure 2: CAD rendering of the front and back side of our new-design Leak Test Cart

Test Methods

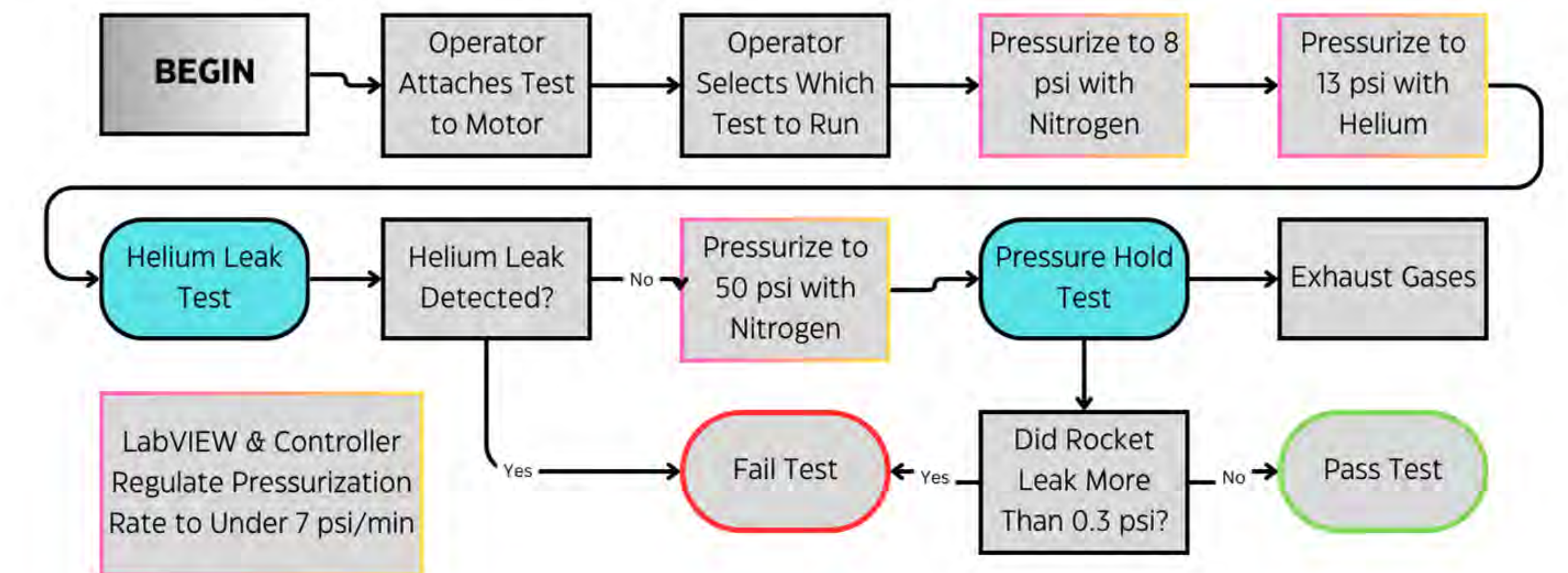


Figure 3: Steps in a Rocket Motor Leak Test

Final Site Testing Results

| Test # | Test Type | Test Data | | Test Metrics | | |
|--------|-----------|-------------------------|------------------------------|------------------------------|------------------------------|------------------------|
| | | Correct Assesment Given | Intentional Results Achieved | Stabalization Duration (min) | Pressure Test Duration (min) | Leak Criteria (15 psi) |
| 1 | pass | yes | yes | 5 | 10 | 0.3 |
| 2 | pass | yes | yes | 2 | 4 | 0.3 |
| 3 | pass | yes | yes | 2 | 4 | 0.3 |
| 4 | fail | yes | yes | 2 | 4 | 0.3 |
| 5 | fail | yes | yes | 2 | 4 | 0.3 |
| 6 | pass | yes | yes | 2 | 4 | 0.3 |

Figure 4: Leak test results taken on site

Results

The results shown in Figure 4 prove the cart can run a successful leak test. All tests were run using Nitrogen gas and a 30 gallon tank at Northrop's testing site. 6 tests were performed, with the expected results in the 'Test Type' column, and actual results in the 'Correct Assesment Given' column.

Conclusion

Our test is successful in performing an automated test that fits all given specifications. The test consistently passes and fails the pressure hold test as expected. Helium does not leak from the cart in the process, and can be detected from the pressure vessel given an intentional leak. All gases successfully flow into the rocket motor at a rate under 7 psi/min, and flow out of the facility in a controlled manner.