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Issue Date:	28 February 2019	Purchase Order:	1021	Line #:	1
Test Start:	26 February 2019	NTS Opportunity:	OP0501545	Line #:	1
Test Complete:	26 February 2019				

EXPLOSIVE ATMOSPHERE TEST REPORT

FOR THE

M/N VJ3 ARTICULATING VIDEO BORESCOPE

TESTING PERFORMED BY:

NATIONAL TECHNICAL SYSTEMS
5325 Old Winter Garden Road
Orlando, Florida 32811-1520

TESTING PERFORMED FOR:

SENECA ENTERPRISES LLC
D/B/A VIEWTECH BORESCOPES
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ABSTRACT

The M/N VJ3 Articulating Video Borescope was subjected to explosive atmosphere testing in accordance with MIL-STD-810G, Method 511.5 Explosive Atmosphere, Procedure I Explosive Atmosphere and in accordance with Seneca Enterprises customer email from Sean O'Connor dated Fri 01 Feb 2019 at 13:19. The test hardware was operated at a simulated altitude of 40,000 feet above site altitude and at site altitude using a 95% n-Hexane fuel-air mixture without igniting the explosive atmosphere in the chamber. A visual examination of the test hardware after application of the test environment did not reveal any notable changes or anomalies. The test hardware functioned properly and no anomalies were observed.

REPORT REVISION RECORD

REV.	DATE	DESCRIPTION OF CHANGE
NA	2019-02-28	ORIGINAL RELEASE

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EXPLOSIVE ATMOSPHERE TEST SUMMARY

Responsible Test Conductor: Jimmy Little

1.0 TEST HARDWARE

- One (1) M/N VJ3 Articulating Video Borescope, S/N C1811091012

2.0 TEST REQUIREMENTS WITH TOLERANCES

The purpose of the explosive atmosphere test is to demonstrate the ability of the test hardware to operate in a fuel-air explosive atmosphere without causing ignition.

The test hardware shall not cause ignition of an ambient, explosive, gaseous mixture when operated in such an atmosphere and the temperature shall not exceed maximum operation temperature (50±2°C).

Conduct explosive atmosphere testing at nominal altitudes of 40,000 feet (12,192 meters) and site elevation using a 95% n-Hexane fuel-air mixture temperature of 50±2°C.

1. Adjust chamber air pressure to a simulated altitude of 2000 meters above test altitude.
2. Introduce the desired stoichiometric fuel-air ratio into the chamber air (3.82%).
3. Adjust the chamber air pressure to 1000 meters above test altitude in ≥3 minutes
4. Ignite a fuel-air sample.
5. Start operating the test hardware per Section 2.1.
6. Adjust chamber air pressure to 1000 meters below test altitude at a rate of ≤100 meters/minute.
7. Stop operating the test hardware.
8. Ignite a fuel-air sample.
9. Repeat Steps 2 through 8, this time at site altitude.

2.1 Test Hardware Operation:

Using remote-controlled actuators, power the test hardware on, operate the joystick (up, down, left, right), press the specified buttons (play, image capture trigger, brightness), and power the test hardware off.

2.2 Tolerance:

- Standard Ambient: 25±10°C, 20 to 80% Relative Humidity, Site Pressure
- Pressure: ±5%

2.3 Test Specification:

- MIL-STD-810G, Method 511.5 Explosive Atmosphere, Procedure I Explosive Atmosphere
- Seneca Enterprises customer email from Sean O'Connor dated Fri 01 Feb 2019 at 13:19
  - Test at 50°C

3.0 TEST SETUP

TABLE 1: NTS ORLANDO–FURNISHED MEASUREMENT & TEST EQUIPMENT

(Measuring instruments used in testing are calibrated per ANSI/NCSL Z540-1 and/or ANSI/NCSL Z540.3, and are NIST traceable)

Asset #	Item	Manufacturer	Model #	Range	Calibration Interval	Calibration Due
WC025946	Data Acquisition	Fluke	2640A/41A	-100 to 400ºC ±0.3ºC; 90 mV to 50 VDC, ±0.01%	12 months	08/24/2019
WC056916	Explosive Chamber 35″ diam. × 45″ length	Qualtest	DCEC1292	Up to 90°C; 40,000 ft	NCR	NCR
WC057023	DC Power Supply	Lambda	LH124FM-391	Max. 40.80 VDC	NCR	NCR
WC057736	Pressure Transducer	Sensotec	TJE/AP122BL	25 psia, ±0.1% FS	12 months	05/16/2019
WC065432	Controller	Research	8630-111-00	N/A	NCR	NCR
WC065489	Thermo/Hygrometer	Extech Instruments	RH30	-10 to 50°C, ±1°C; 1 to 99% RH, ±5%	12 months	01/10/2020
WC067511	Class A Cylinder	Fisherbrand Ertco	08-557D	10 to 100 mL, ±0.5 mL	NCR	NCR

NOTE: Calibration dates are formatted *mm/dd/yyyy*. "NCR" means "No calibration required."

TABLE 2: CUSTOMER-FURNISHED SUPPORT EQUIPMENT

P/N	S/N	Type of Sensor
N/A	N/A	Bracket/Base

TABLE 3: DATA RECORDER SETUP

Asset #	Channel	Type of Sensor	Function
WC025946	1	Pressure Sensor	Monitor chamber pressure (0 to 15.0 psia)
WC025946	2	Type T Thermocouple	Monitor chamber air temperature (°C)
WC025946	3	Type T Thermocouple	Monitor test hardware temperature (°C)
WC025946	4	Type T Thermocouple	Monitor chamber skin temperature (°C)

TABLE 4: CERTIFIED TEST MATERIALS

Description	Manufacturer	Lot Number
95% n-Hexane	Fisher Scientific	172508

Prior to installing the test hardware in the test chamber, all instrument settings were checked and the altitude profile was validated.

3.1 Altitude Conversions (from the NASA 1976 Table):

Simulated Altitude (ft)	Meters	psia
46,561	14,192	1.8
43,280	13,192	2.0
40,000	12,192	2.7
6561	2000	10.0
3280	1000	13.0
Site	0	14.7

3.2 Calculations for Quantity of Explosive Fuel:

Formula (from MIL-STD-810G)

$$150.41 \times \frac{\text{net chamber volume [ft}^3\text{]} \times \text{chamber pressure [psia]}}{\text{chamber temperature [°Rankine]} \times \text{relative density of n-Hexane [0.655]}} = \text{mL of fuel}$$

40,000 feet

$$150.41 \times \frac{31.15\ [\text{ft}^3] \times 2.72\ [\text{psia}]}{579.87\ [°\text{Rankine}] \times [0.655]} = \textbf{33.3 mL of fuel}$$

Site Pressure

$$150.41 \times \frac{31.15\ [\text{ft}^3] \times 14.7\ [\text{psia}]}{579.87\ [°\text{Rankine}] \times [0.655]} = \textbf{179.9 mL of fuel}$$

For 40,000 feet, 33.3 mL of fuel was added to the chamber. Once the chamber reached site altitude, 146.6 mL of fuel was added to the chamber:

179.9 mL – 33.3 mL = **146.6 mL** of fuel

4.0 TEST DESCRIPTION

4.1 Non–NTS Orlando Personnel, Including Organization, Present for All or Part of the Test:

None.

4.2 Powered/Operational State of the Hardware and by Whom:

The test hardware was operated per Section 2.1 by NTS Orlando test conductor Jimmy Little during the test. Pre- and post-test functional checks were performed. The test item functioned properly and no test item anomalies were observed.

4.3 Test Activities and Resulting Measurements from Observed/Recorded Data:

Initial Ambient Conditions: Temp (°C): 21 Relative Humidity (%): 55 Pressure: Site Ambient

The test hardware was placed in the chamber as shown in Figures 12 and 13 and subjected to the explosive atmosphere activities described in Table 5. Chart 1 (see Appendix) provides the supporting test data.

TABLE 5: EXPLOSIVE ATMOSPHERE TEST ACTIVITIES

Step #	Activity	End Time HH:MM	Duration HH:MM
1	Adjust the chamber temperature to 50°C.	12:02	01:32
2	Stabilize the test hardware at 50°C.	12:18	00:16
3	Adjust to 14,192 meters (1.8 psia; 2000 meters above test altitude).	12:30	00:12
4	Inject 33.3 mL n-Hexane into the test chamber.	12:30	–
5	Adjust altitude to 13,192 meters (2.0 psia; 1000 meters above test altitude) in ≥3 minutes.	12:45	00:15
6	Successfully ignite the sample chamber.	12:46	–
7	Begin operating the test hardware.	12:47	00:01
8	Adjust altitude to 11,192 meters (3.18 psia; 1000 meters below test altitude) in ≥20 minutes.	13:12	00:28
9	Stop operating the test hardware.	13:12	–
10	Successfully ignite the sample chamber.	13:13	00:01
11	Adjust altitude to 2000 meters (10 psia; 2000 meters above site altitude).	13:18	00:05
12	Inject 146.5 mL n-Hexane into the test chamber.	13:18	–
13	Adjust altitude to 1000 meters (13.03 psia; 1000 meters above site altitude) in ≥3 minutes.	13:29	00:11
14	Successfully ignite the sample chamber.	13:30	00:01
15	Begin operating the test hardware.	13:30	–
16	Adjust altitude to site ambient (14.7 psia) in ≥10 minutes.	13:41	00:11
17	Stop operating test hardware.	13:41	–
18	Successfully ignite the sample chamber.	13:42	00:01

For temperature (°C) and pressure (psia) versus time data, see Appendix.

4.4 Limitations or Departures from the Test Requirements and Authorizing Source:

None.

5.0 CONCLUSION

A visual examination of the test hardware after application of the test environment did not reveal any notable changes or anomalies. The test hardware functioned properly and no anomalies were observed.

Figure 1: Test hardware identification

Figure 2: Test hardware before explosive atmosphere – bottom

Figure 3: Test hardware before explosive atmosphere – handle, screen

Figure 4: Test hardware before explosive atmosphere – handle, screen

Figure 5: Test hardware before explosive atmosphere – joystick

Figure 6: Test hardware before explosive atmosphere – power button, screen

Figure 7: Test hardware before explosive atmosphere – Side 1

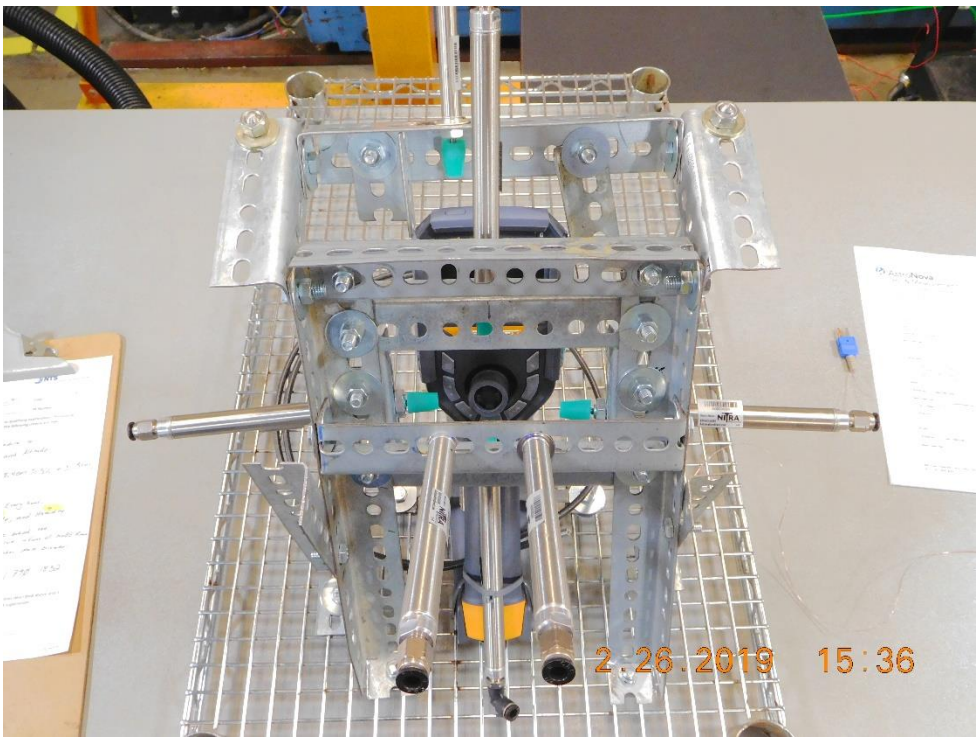

Figure 8: Explosive atmosphere test setup – actuators for test hardware operation

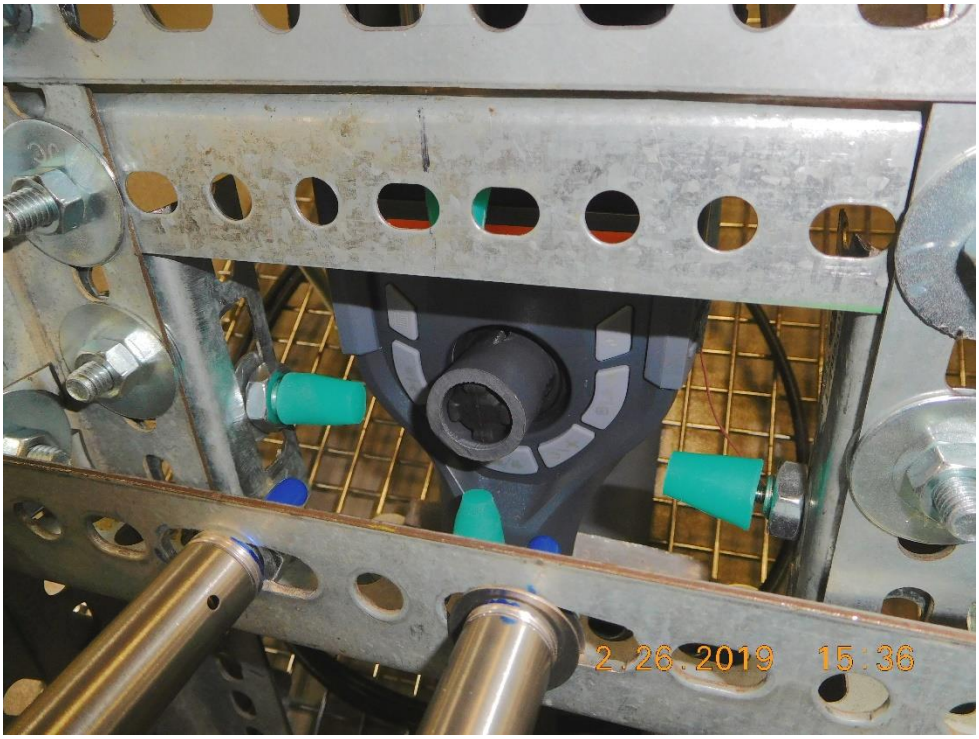

Figure 9: Explosive atmosphere test setup – actuators for test hardware operation

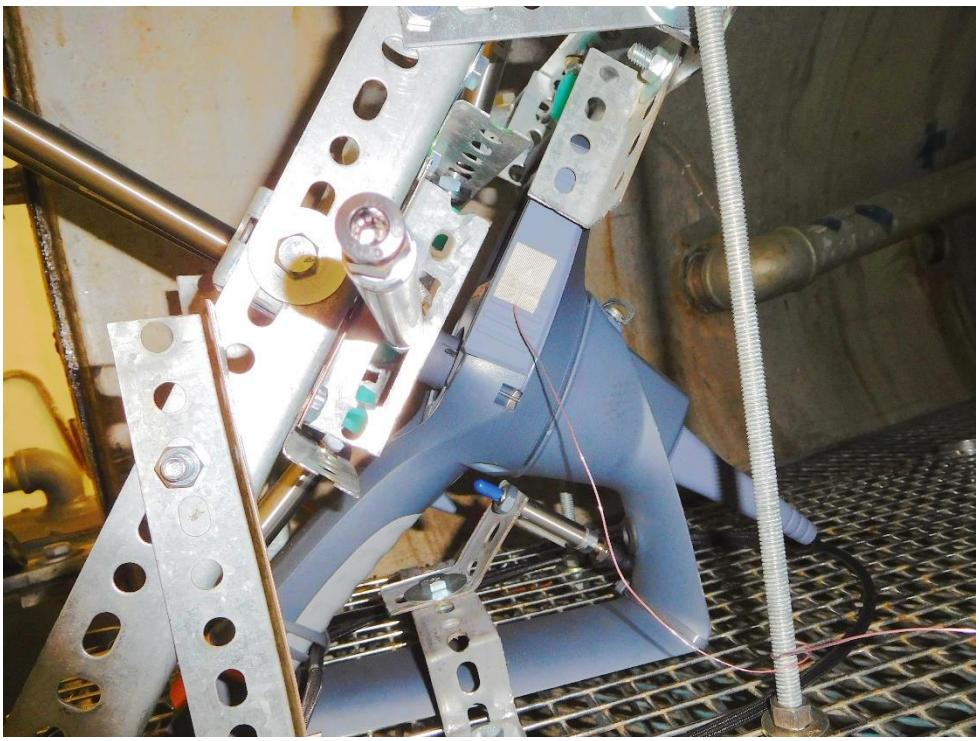

Figure 10: Explosive atmosphere test setup – actuators for test hardware operation

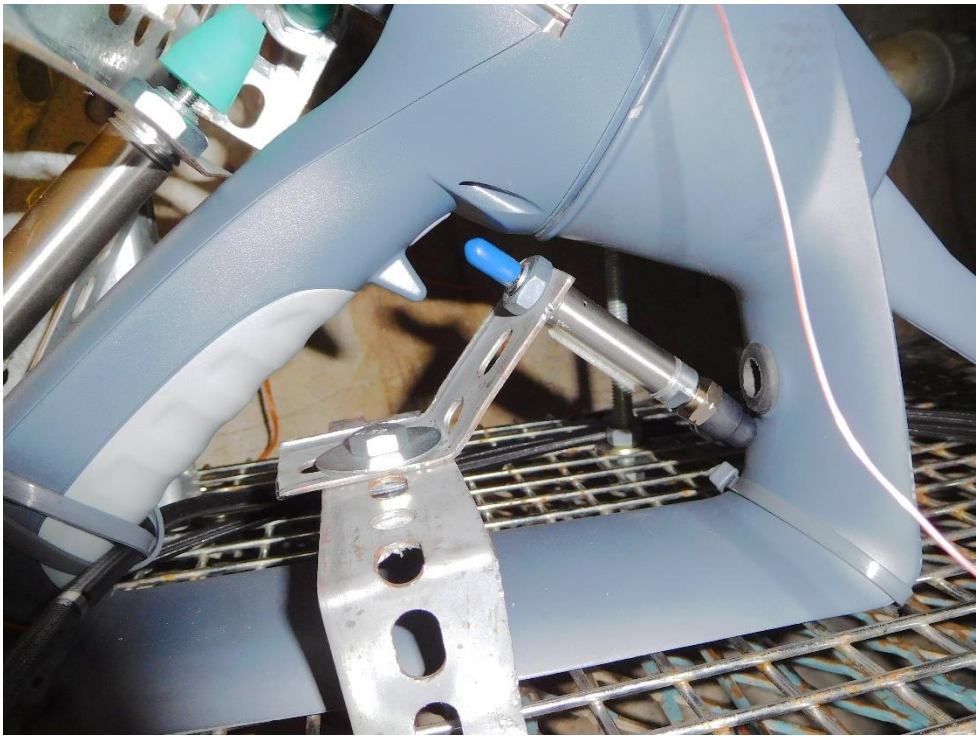

Figure 11: Explosive atmosphere test setup – actuators for test hardware operation

Figure 12: Explosive atmosphere test setup – test hardware installed in test chamber

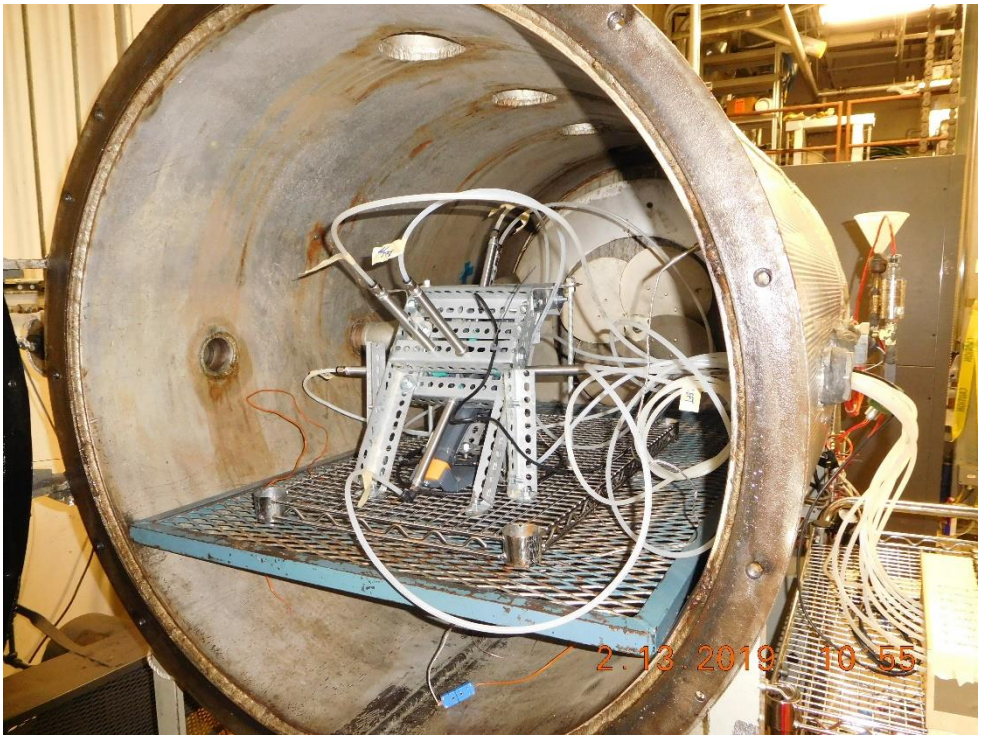

Figure 13: Explosive atmosphere test setup – test hardware installed in test chamber

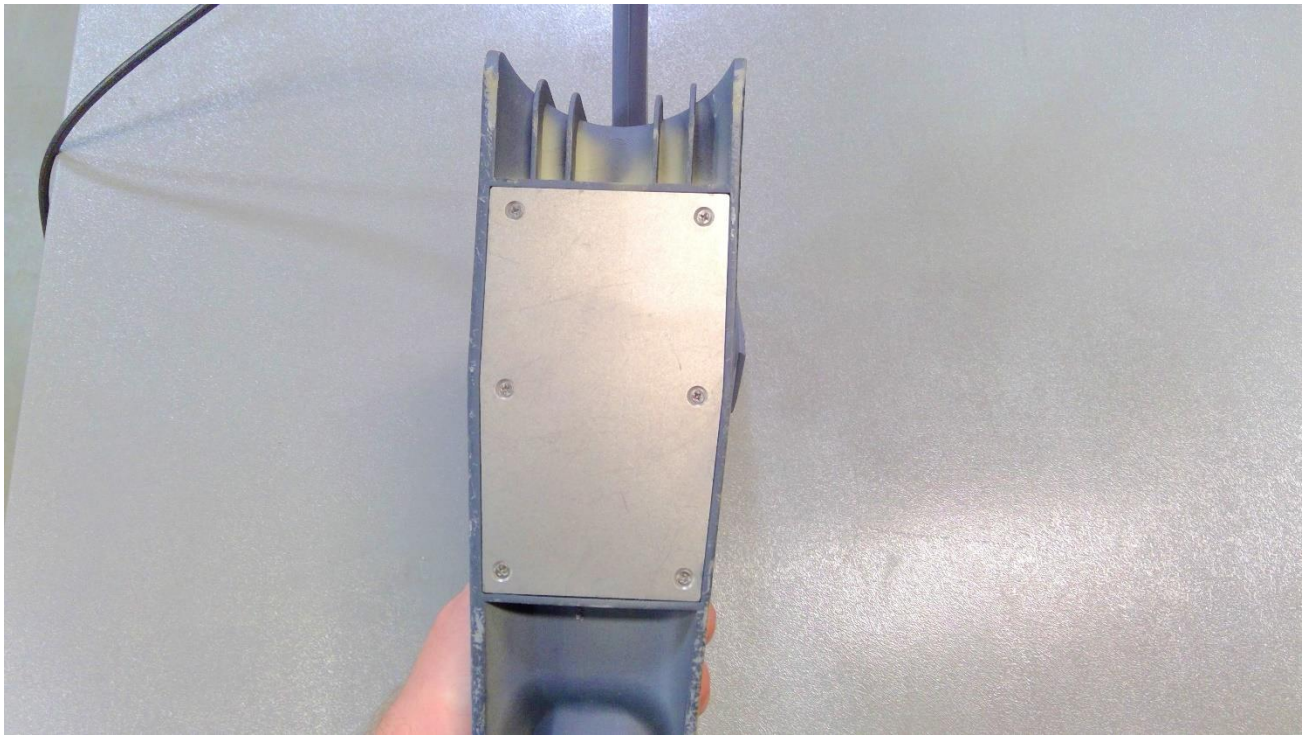

Figure 14: Test hardware after explosive atmosphere – bottom

Figure 15: Test hardware after explosive atmosphere – handle, screen

Figure 16: Test hardware after explosive atmosphere – handle

Figure 17: Test hardware after explosive atmosphere – screen, joystick

Figure 18: Test hardware after explosive atmosphere – Side 1

Figure 19: Test hardware after explosive atmosphere – Side 2

Appendix: Explosive Atmosphere Data Chart

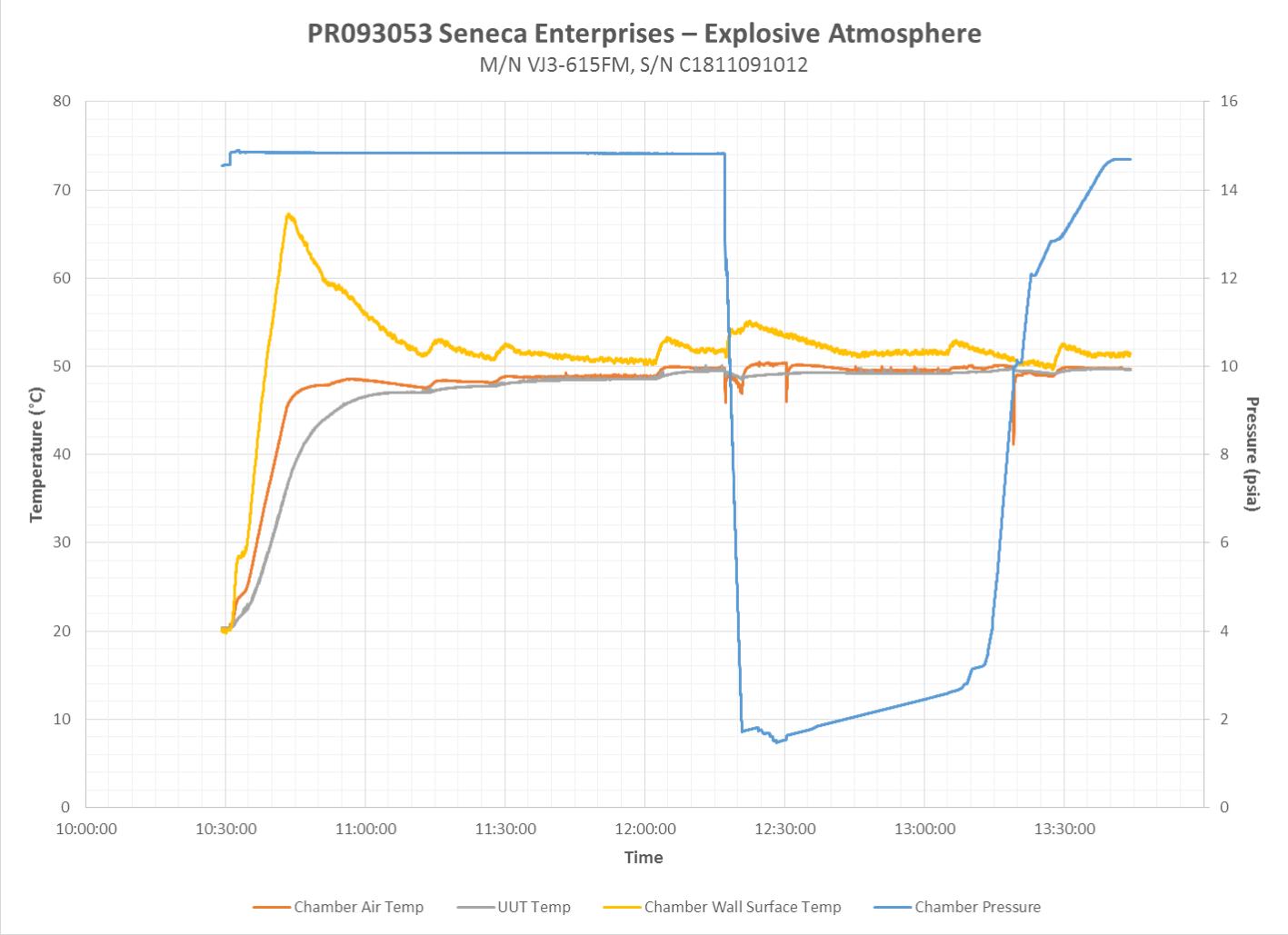

Chart 1: Temperature (°C) and pressure (psia)