National Technical Systems Test Report for Environmental Testing of the VJ-4 Boroscope

Prepared For
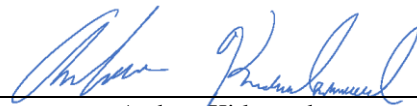
ViewTech Borescopes | 1745 Barlow Street | Traverse City, MI 49686

Performed By

National Technical Systems | 5325 Old Winter Garden Road | Orlando, FL 32811 | 407-293-5844 | www.nts.com

_____
Matthew Matrisciano
Technical Writer

_____
Andrew Kirkwood
Environmental/Dynamic Manager

Revision History

Rev.	Description	Issue Date
0	Initial Release	09/20/2022

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1.0 Introduction

This document presents the test procedures used and the results obtained during the performance of an Environmental test program. The test program was conducted to assess the ability of the specified Equipment Under Test (EUT) to successfully satisfy the requirements listed in Section 2.0.

2.0 References

The following references listed below form a part of this document to the extent specified herein.

- Test Specification: MIL-STD-810G, Method 511.5, Procedure I
- ViewTech Borescopes Purchase Order(s) 1205, dated 09/20/2022
- National Technical Systems (NTS) Quote(s) OP0621789, dated 07/20/2022
- ISO/IEC 17025:2017(E) *General Requirements for the Competence of Testing and Calibration Laboratories,* dated 11/01/2017

3.0 Product Selection and Description

ViewTech Borescopes selected and provided the following test sample(s) to be used as the Equipment Under Test:

Table 3.0-1: Product Identification - Equipment Under Test (EUT)

Item	Qty.	Name/Description	Part Number	Serial Number
1	1	VJ-4 Boroscope	VJ4615FM-WL-XB	QXB2205311650

3.1 Security Classification

Non-classified

4.0 General Test Requirements

4.1 Test Equipment

The instrumentation used in the performance of these tests is periodically calibrated and standardized within manufacturer's rated accuracies and are traceable to the National Institute of Standards and Technology. The calibration procedures and practices are in accordance with ISO 17025:2017. Certification of calibration is on file subject to inspection by authorized personnel.

5.0 **Test Descriptions and Results**

Table 5.0-1: Summary of Test Information & Results

Section	Test	Specification	Test Facility	Test Date	Part #	Serial #	Test Result
5.1	Explosive Atmosphere	MIL-STD-810G, Method 511.5, Procedure I	Orlando	09/07/2022 - 09/07/2022	VJ4615FM-WL-XB	QXB2205311650	Passed

5.1   **Explosive Atmosphere**

5.1.1   **Test Procedure**

The EUT was tested to MIL-STD-810G, Method 511.5, Procedure I.

5.1.2   **Test Result**

Test Result: The EUT passed.

5.1.3   Test Datasheets

Certified Test Materials		
Description	Manufacturer	Lot Number
95% n-Hexane	Sigma-Aldrich	4503752071

Data Recorder Setup				
Asset #	Channel	Type of Sensor	Function/Description	Unit
WC076352	1	Type-T Thermocouple	Chamber Air Temperature	°C
WC076352	2	Type-T Thermocouple	EUT Temperature	°C
WC076352	5	Type-T Thermocouple	Sample Chamber Air Temperature	°C
WC076352	11	Pressure Sensor	Main Chamber Pressure	PSIA
WC076352	12	Pressure Sensor	Sample Chamber Pressure	PSIA

Simulated Altitude (Feet)	Simulated Altitude (Meters)	Presssure (PSIA)
46,562	14,192	1.93
43,281	13,192	2.29
40,000	12,192	2.71
36,719	11,192	3.18
6,562	2,000	11.53
3,281	1,000	13.04
0	0	14.70

Pressure for altitudes was calculated in kPa using the MIL-STD-810G(CH1) Table 520.4-IV formula for altitudes ≤ 20,000 meters:

Pressure (kPa) = 101.33*(((288-(6.5*H))/288)^5.2558)

Pressure calculated in kPa was converted to psia per NIST Special Publication 1038 (May 2006), which lists 6.894757 kPa as equal to 1 psia, using the following formula:

Pressure (psia) = pressure (kPa) * (1 psia / 6.894757 kPa)

Calculating Net Chamber Volume
measured chamber volume (ft3) – estimated test item volume (ft3) = net chamber volume (ft3)

32.62	-	0.08	=	32.54

Quantity of Explosive Fuel Calculations

$$(150.41) \frac{(\{\text{net chamber volume [ft3] x chamber pressure [PSIA]}\}}{\{\text{chamber temperature [° Rankine] x relative density of n-Hexane [0.659]}\})} = \text{milliliters (ml) of fuel}$$

(Feet)	(150.41) x	$(\{\dfrac{32.54 \ [ft3] \ x \ 2.71 \ [PSIA]\}}{\{[\ 581.67 \ °R] \ x \ [0.659]\})}$	=	34.60 (mL)

(Feet)	(150.41) x	$(\{\dfrac{32.54 \ [ft3] \ x \ 14.70 \ [PSIA]\}}{\{[\ 581.67 \ °R] \ x \ [0.659]\})}$	=	187.67 (mL)

187.67	-	34.598	=	153.07 (mL) added

Test Witness	
Name	Company
None	

Customer-Supplied Support Equipment			
Qty.	Description	Part/Model No.	Serial No.
	None		

Powered/Operational State of the Test Hardware and by Whom
EUT Operator: Dean Ressler
The test hardware was operated/functionally checked by NTS - Orlando test conductor Dean Ressler during the test. Operation consisted of:
The robot was used to actuate the following controls: power on/off, light switch/on/off, photo trigger, control joystick, left mini joystick, right mini joystick, left control button, right control button.

Test Setup
The test hardware was placed in the chamber and subjected to the explosive atmosphere activities.

Test Conductor:	Dean Ressler	Lab Temperature:	27 °C	Lab Humidity:	55 %RH

Step #	Activity	Date	Start Time	End Time	Duration
1	Adjust the chamber temperature to 50 °C	9/7/2022	7:45	8:30	00:45
2	Stabilized the test hardware at 50 °C	9/7/2022	9:18	10:18	01:00
3	Adjusted to 14,192 meters (1.93 PSIA) (2,000m above nominal)	9/7/2022	10:20	10:50	00:30
4	Injected 34.6 ml of n-Hexane into chamber	9/7/2022	10:50	10:51	00:01
5	Adjusted to 13,192 meters (2.29 PSIA) (1,000m above nominal)	9/7/2022	10:51	11:01	00:10
6	Successfully ignited the sample chamber	9/7/2022	11:01	11:02	00:01
7	Begin test hardware operation	9/7/2022	11:03	11:03	00:00
8	Adjusted to 11,192 meters (3.18 PSIA) (2,000m above nominal)	9/7/2022	11:03	11:21	00:18
9	Stop test hardware operation	9/7/2022	11:21	11:21	00:00
10	Successfully ignited the sample chamber	9/7/2022	11:22	11:23	00:01
11	Adjusted altitude to 2000 meters (11.53 PSIA)	9/7/2022	11:23	11:42	00:19
12	Injected 153 ml of n-Hexane into chamber	9/7/2022	11:42	11:43	00:01
13	Adjusted altitude to 1000 meters (13.04 PSIA) to obtain a homogeneous fuel/air mixture	9/7/2022	11:43	11:53	00:10
14	Successfully ignited the sample chamber	9/7/2022	11:53	11:54	00:01
15	Begin test hardware operation	9/7/2022	11:54	11:54	00:00
16	Adjusted altitude to site ambient (14.7 PSIA)	9/7/2022	11:54	12:04	00:10
17	Stop test hardware operation	9/7/2022	12:04	12:04	00:00
18	Successfully ignited the sample chamber	9/7/2022	12:04	12:05	00:01

Initials	Notes / Limitations / Deviations / Etc.
DR	None

Conclusion
A visual examination of the test hardware after application of the environment did not reveal any notable changes or anomalies.
The test hardware functioned properly and no anomalies were observed.
The EUT was operated at a simulated altitudes 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 main chamber.

5.1.4   Test Photographs

Receiving

EUT Label
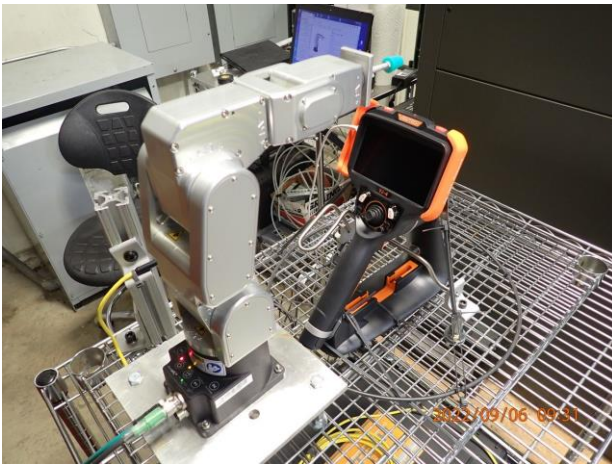
Setup for EUT Operation

Setup for EUT Operation

Setup for EUT Operation
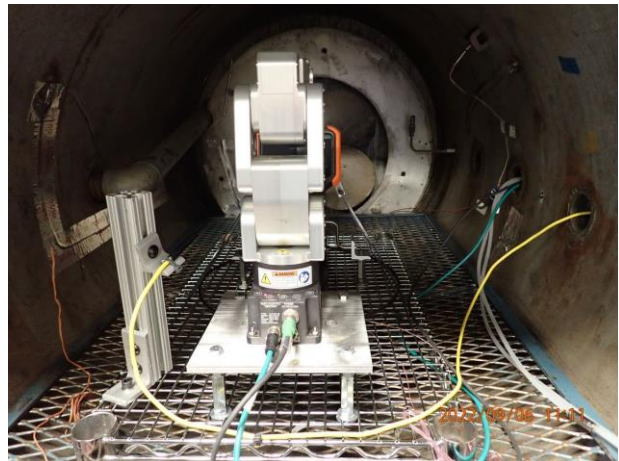

Setup for EUT Operation

EUT Thermocouple Placement

Explosive Atmosphere Setup

Explosive Atmosphere Setup

Explosive Atmosphere Setup

EUT in Test Chamber After Explosive Atmosphere Test

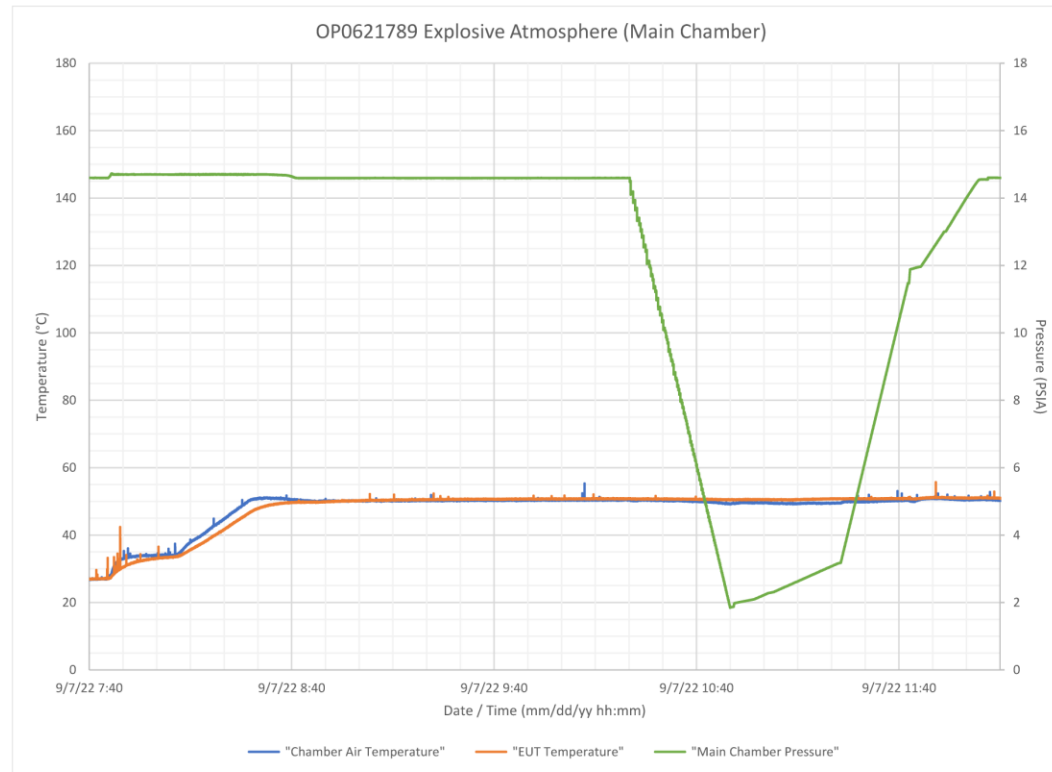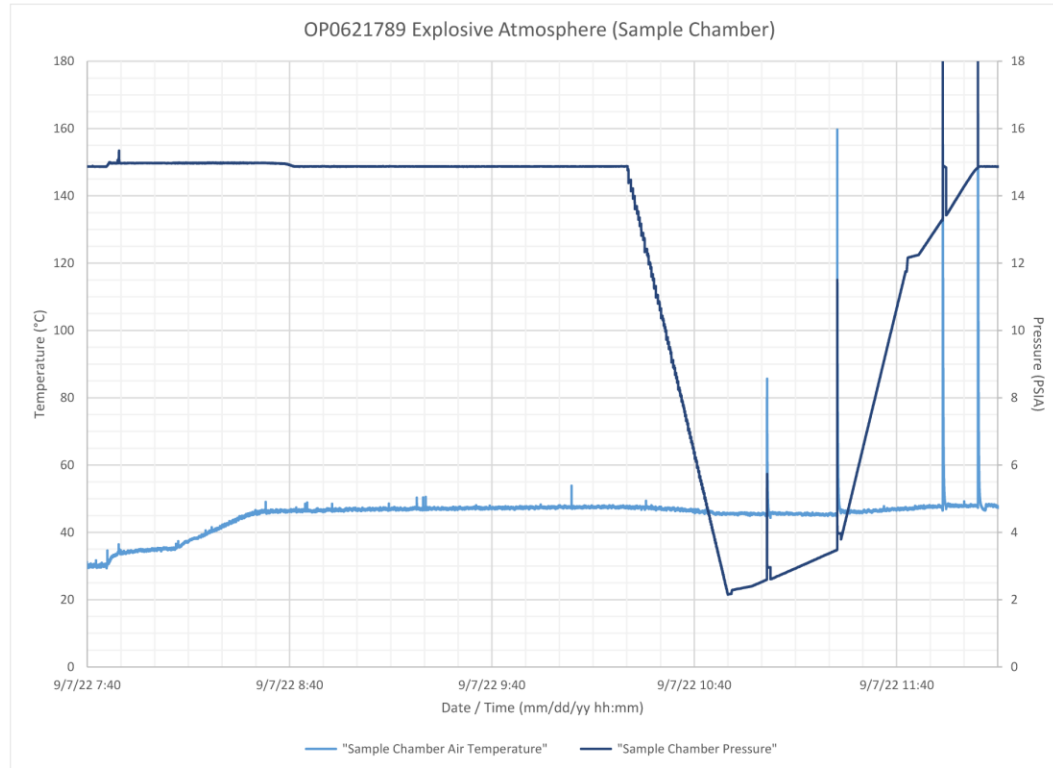EUT in Test Chamber After Explosive Atmosphere Test

EUT in Test Chamber After Explosive Atmosphere Test

Shipping

5.1.5   Test Data

OP0621789 Explosive Atmosphere (Main Chamber)

OP0621789 Explosive Atmosphere (Sample Chamber)

5.1.6   Test Equipment List

Table 5.1-1: Explosive Atmosphere Test Equipment List

Asset Number	Asset Type	Manufacturer	Model	Calibrated	Due
WC056916	Chamber (Explosive Atmosphere)	Qualtest	DCEC1292	NCR	NCR
WC071987	Arm (Robot)	Mecademic	MECA500-R3	NCR	NCR
WC057023	Power Supply (DC)	Lambda	LH124FM-391	NCR	NCR
WC057057	Pump (Vacuum)	Bachmann Industries	50-WS	NCR	NCR
WC065432	Controller (Temperature)	Research	8630-111-00	NCR	NCR
WC067415	Controller (Temperature)	Love Controls	4B-33	NCR	NCR
WC067511	Cylinder (Graduated)	Fisherbrand Ertco	08-557D	NCR	NCR
WC067519	Computer (Laptop)	Hewlett Packard	Laptop	NCR	NCR
WC067552	Module (Input)	Fluke	2680A-180	NCR	NCR
WC071859	Controller (System)	JC Systems	600A-RTD/LIN	NCR	NCR
WC071940	Meter (Hygrometer)	Extech Instruments	445814	04/08/2022	04/08/2023
WC076352	System (Data Acquisition)	Fluke	2640A	11/18/2021	11/18/2022
WC076508	Power Supply (DC)	VOLTEQ	HY3020D	NCR	NCR

Calibration Abbreviations
CAL: Calibration
NCR: No Calibration Required

End of Test Report