# Element Materials Technology Denver-Longmont A.K.A. NTS Labs, LLC Test Report for Environmental Testing of the Impulse LoRa Modem

**Prepared For**
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## Revision History

| Rev. | Description | Issue Date |
|---|---|---|
| 0 | Initial Release | 07/22/2025 |

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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 at Element Materials Technology Denver-Longmont (hereafter referred to as "Element"). The test program was conducted to assess the ability of the specified Equipment Under Test (EUT) to successfully satisfy the requirements defined in the test specification.

## 2.0 References

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

- Test Specification: IEC 60529 Edition 2.2 2013-08
- KS Technologies, LLC Purchase Order OP0675581-0 dated 06/24/2025
- Element Quotation OP0675581 dated 06/24/2025
- ISO/IEC 17025:2017(E) *General Requirements for the Competence of Testing and Calibration Laboratories*, dated 11/2017

## 3.0 Product Selection and Description

KS Technologies, LLC 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 | 2 | Impulse LoRa Modem | KST5421-US915 | 000010, 000011 |

### 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 Description and Results

**Table 5.0-1: Summary of Test Information & Results**

| Section | Test | Specification | Test Facility | Test Date | Part # | Serial # | Test Result |
|---|---|---|---|---|---|---|---|
| 5.1 | IP6X | IEC 60529 Edition 2.2 2013-08 | Longmont | 07/18/2025 - 07/21/2025 | KST5421-US915 | 000010, 000011 | No dust ingress noted |
| 5.2 | IPX7 | IEC 60529 Edition 2.2 2013-08 | Longmont | 07/17/2025 | KST5421-US915 | 000010, 000011 | No water ingress noted |

## 5.1 IP6X

### 5.1.1 Test Procedure

IEC 60529 Edition 2.2 2013-08

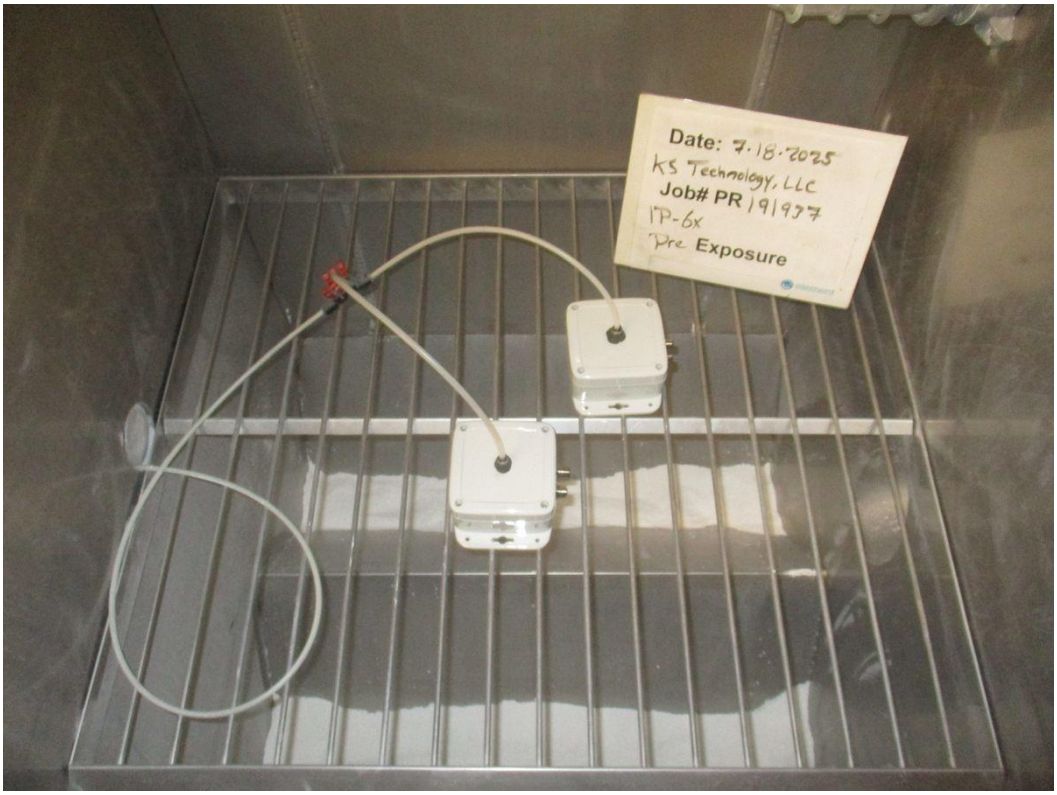
### 5.1.2 Test Result

The EUT showed no dust ingress noted after the test was completed.

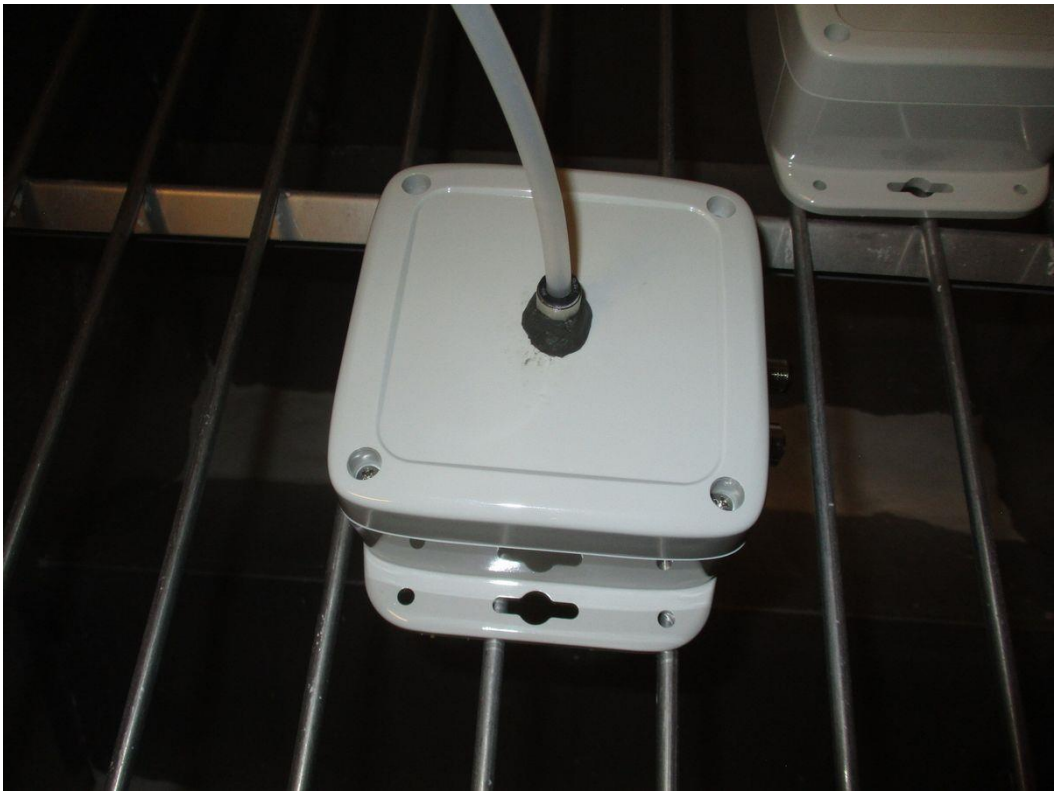
### 5.1.3 Test Datasheets

| CLIMATICS TEST LOG | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Start Date:** | 7/18/2025 | **End Date:** | 7/21/2025 | | **Job No:** | PR191937 | |
| **Customer:** | KS Technologies, LLC | | | **Test Engineer:** | | Cam Storey | |
| **Customer Witness:** | N/A | | | **Lab Temp:** | 71F | **Lab Humidity:** | 59% |
| **Part Name:** | Impulse LoRa Modem (Qty: 2) | | | **Part Number:** | | KST5421-US915<br>KST5421-US915 | |
| **Test Specification:** | IEC 60529 Edition 2.2 2013-08 | | | | **Serial number:** | 000010<br>000011 | |
| **Test Performed:** | IP-6x | | | | | **Lot:** | N/A |
| **Date** | **Time** | **Remarks** | | | | | **Initials** |
| | | **IP Designation: IP-6x Enclosure Category: 1 – Air pressure reduced within the enclosure** | | | | | CS |
| | | **Dust: 2 kg of talcum powder per cubic meter of the test chamber volume** | | | | | CS |
| 7/18/2025 | 900 | Samples (2) were affixed with a hose fitting to allow for pulling a vacuum on the internal cavity of each sample. Each sample was torqued to 8in lbs. | | | | | CS |
| 7/18/2025 | 915 | Samples were set up within the dust chamber | | | | | CS |
| 7/18/2025 | 915 | The customer provided details that the sample internal volume = 560 cm^3 | | | | | CS |
| 7/18/2025 | 915 | Per the IEC specification, the target flow for the test shall be 373.30 to 559.95 CC per minute | | | | | CS |
| 7/18/2025 | 920 | The chamber was sealed. A vacuum of 2kPA within the sample was achieved without reaching the target flow. Additionally, no measurable flow was achieved, therefore the test duration was set at 8 hours | | | | | CS |
| 7/18/2025 | 920 | Began the 8-hour exposure | | | | | CS |
| 7/21/2025 | 900 | The 8-hour exposure was completed. Opened the chamber, cleared away all the dust from the sample, and removed it from the chamber | | | | | CS |
| | | Test Results = Both samples were opened and inspected for signs of dust ingress. No signs of dust ingress was observed within each sample | | | | | CS |
| | | Test complete | | | | | CS |

### 5.1.4 Test Photographs




Pre-Exposure



Pre-Exposure

Pre-Exposure


Post Exposure

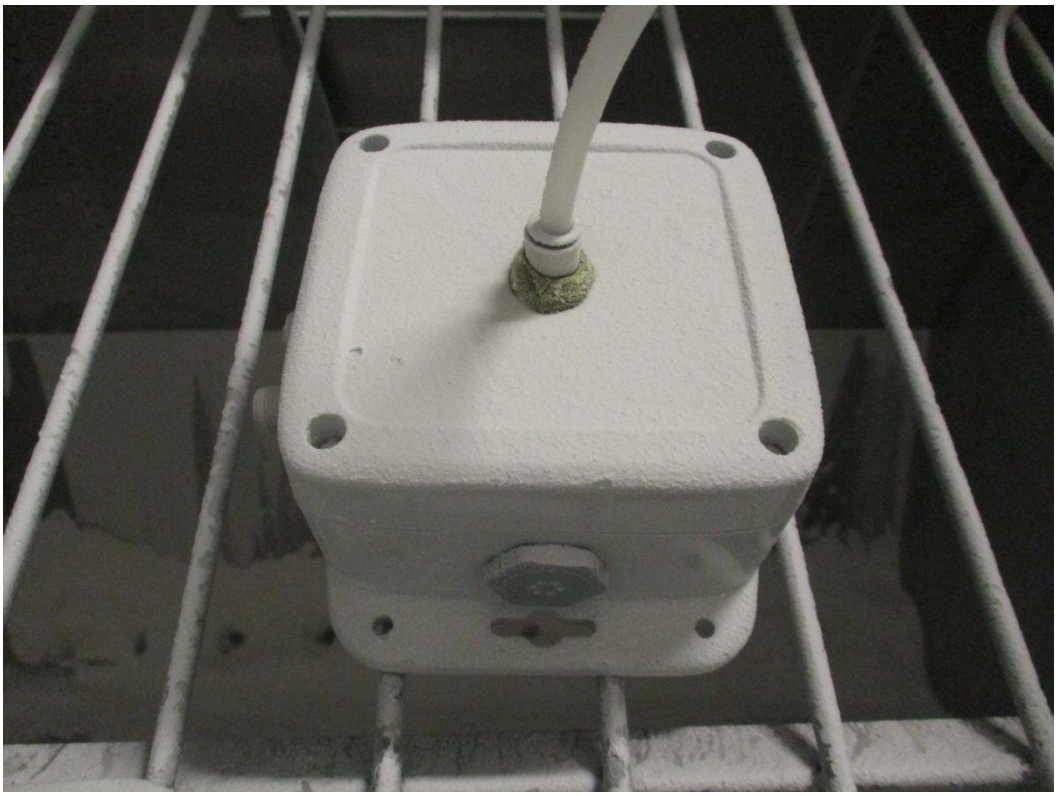
Post Exposure

Post Exposure

Post Exposure

Post Exposure

Post Exposure



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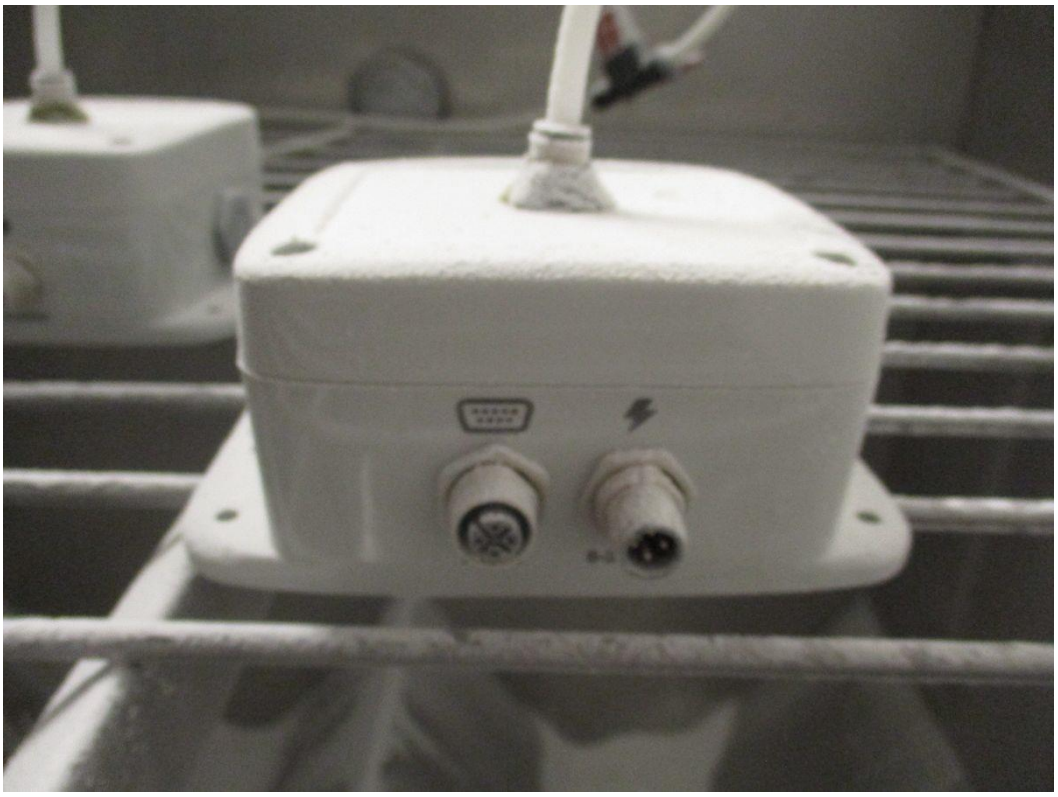

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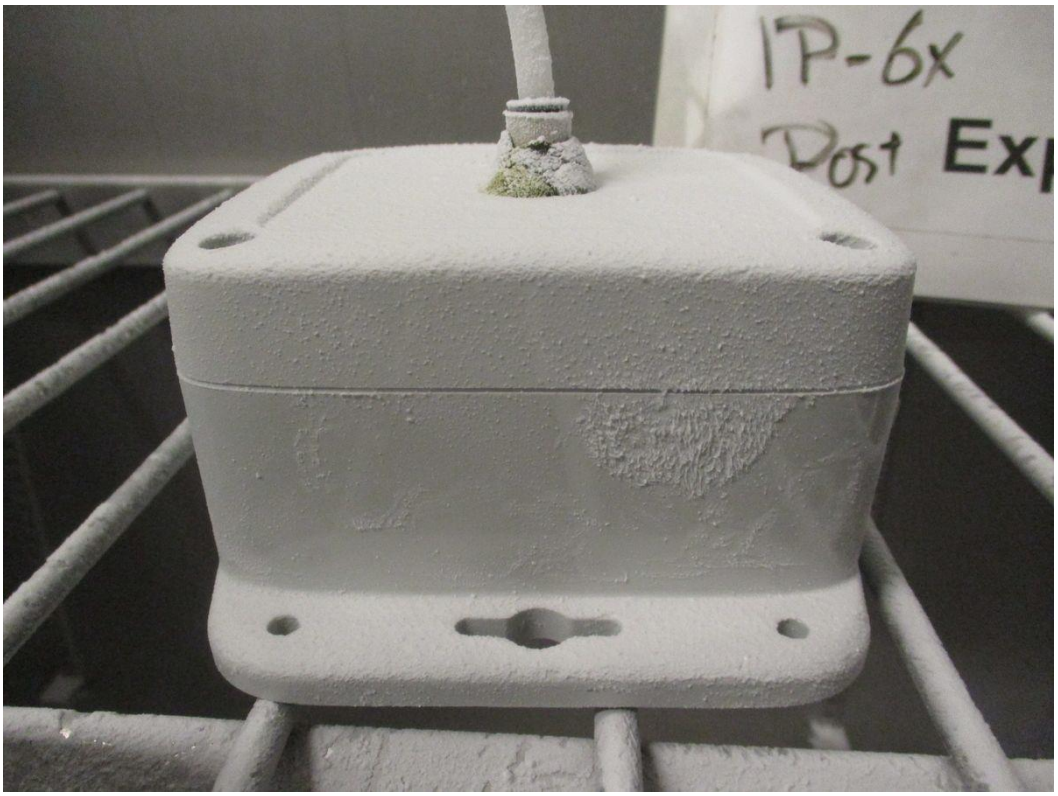


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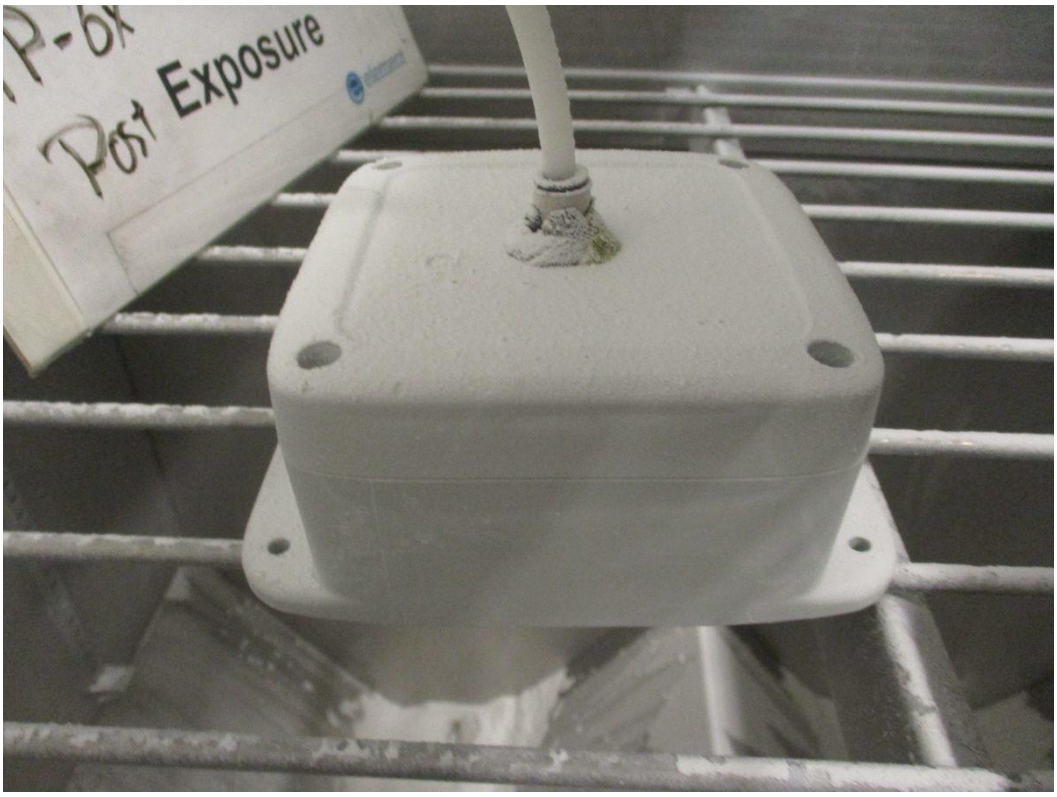


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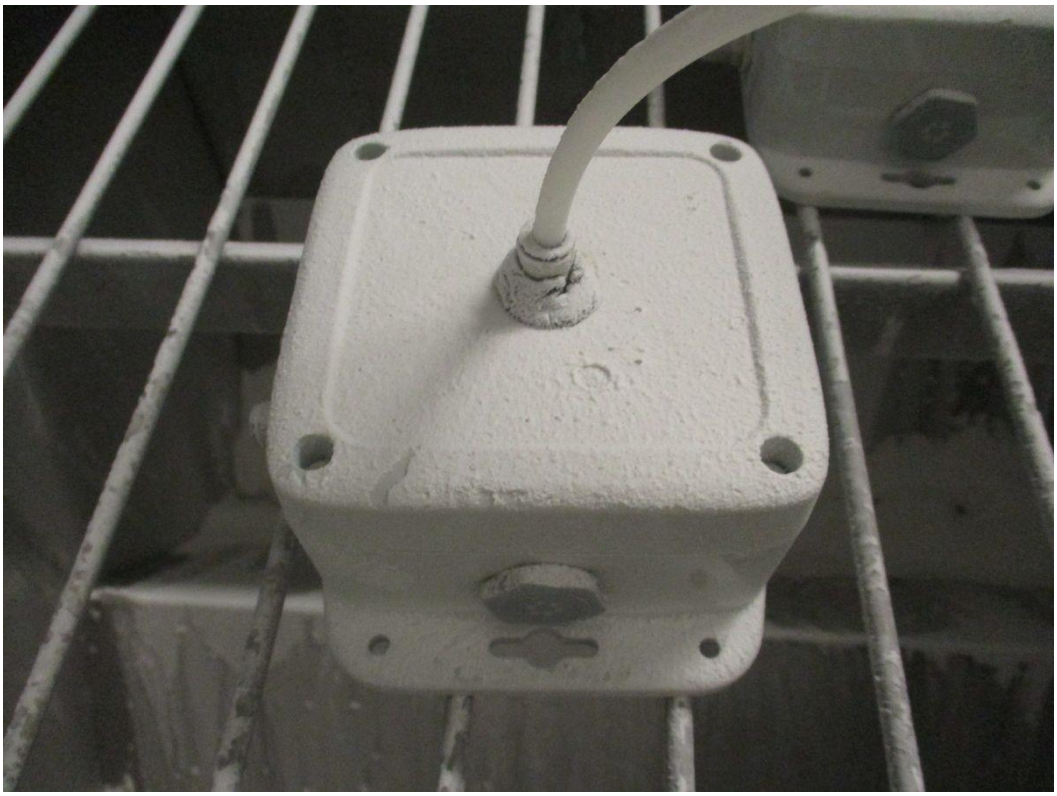


Post Exposure

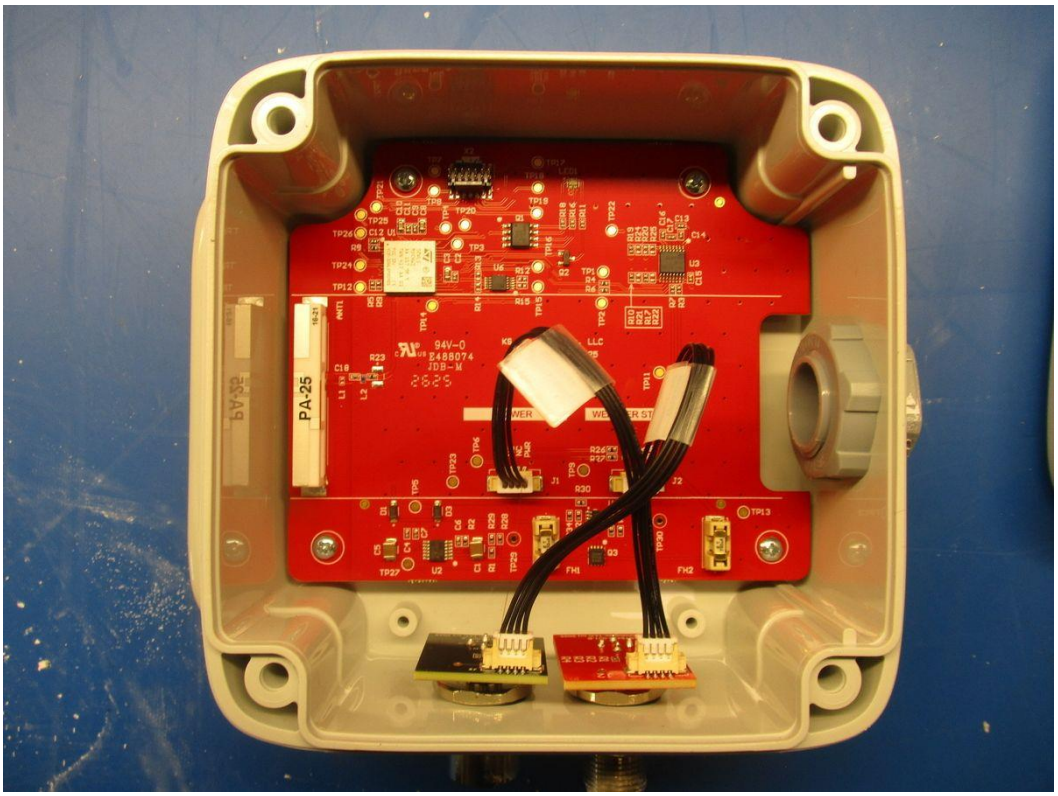
Post Exposure Inspection

Post Exposure Inspection

Post Exposure Inspection

Post Exposure Inspection

Post Exposure Inspection

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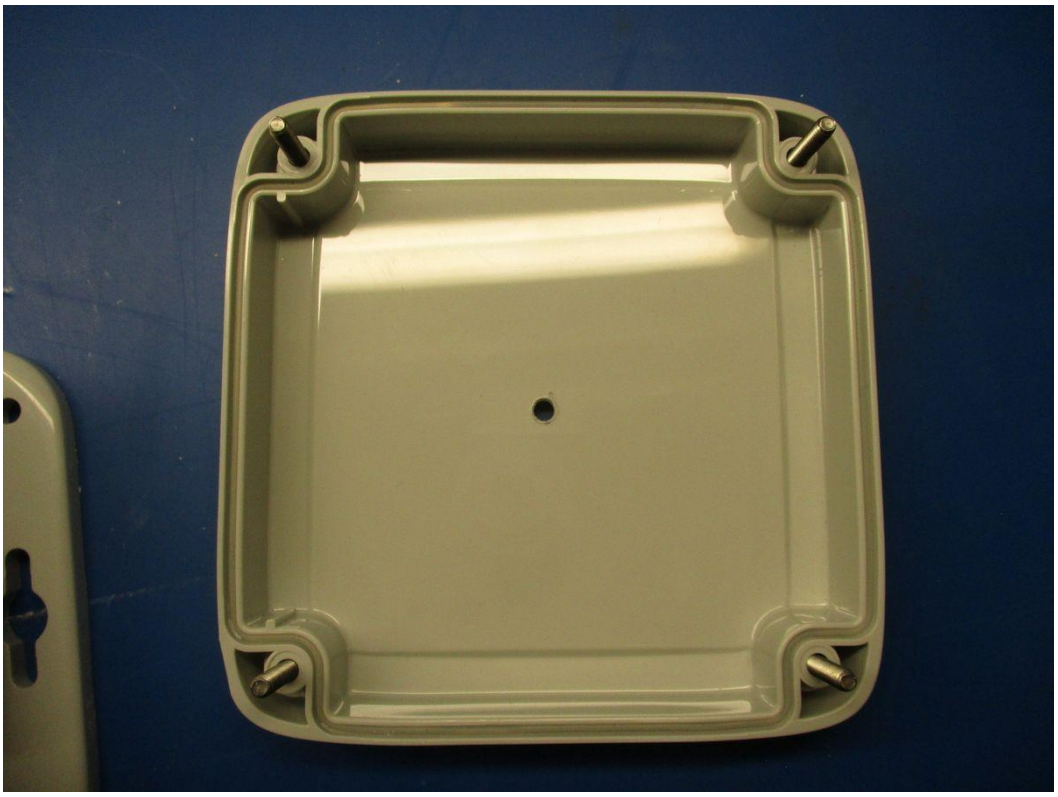

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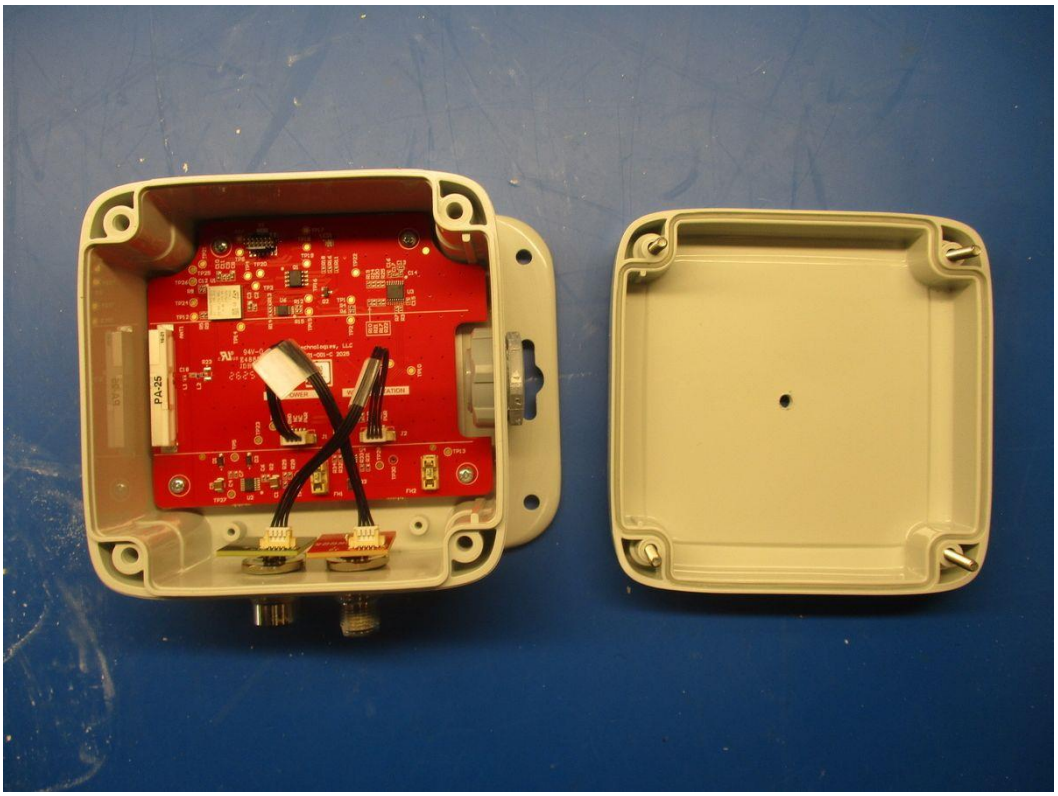

Post Exposure Inspection

Post Exposure Inspection

Post Exposure Inspection

Post Exposure Inspection

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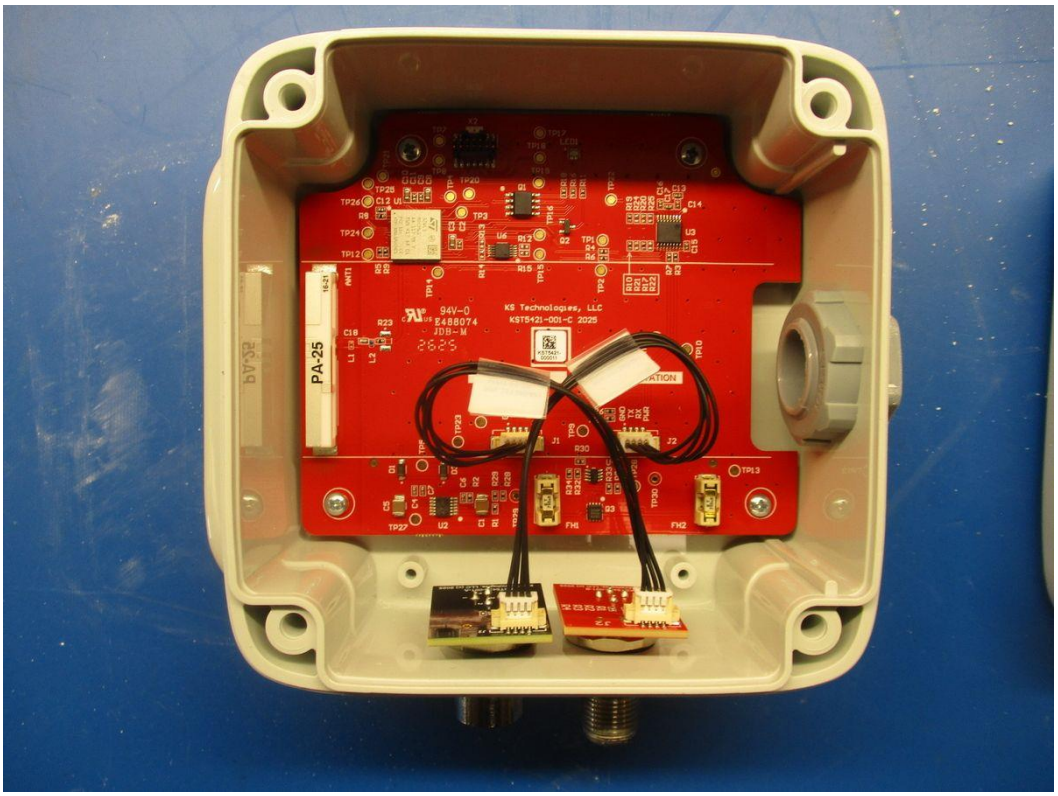
Post Exposure Inspection

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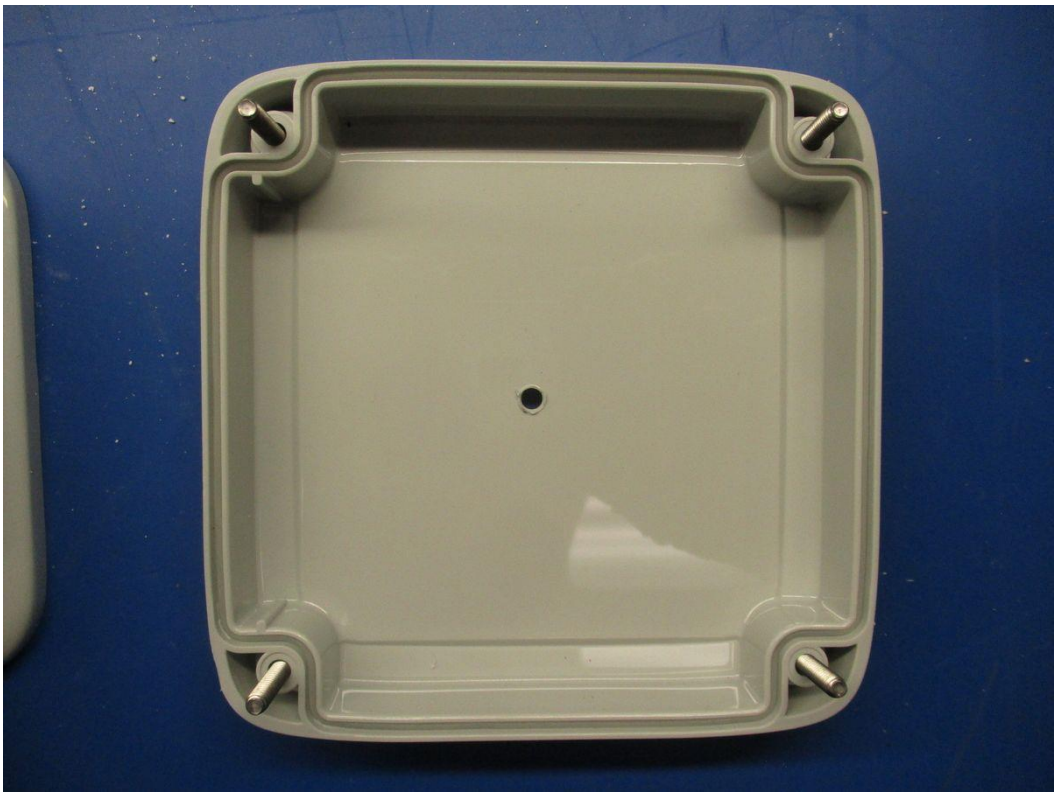
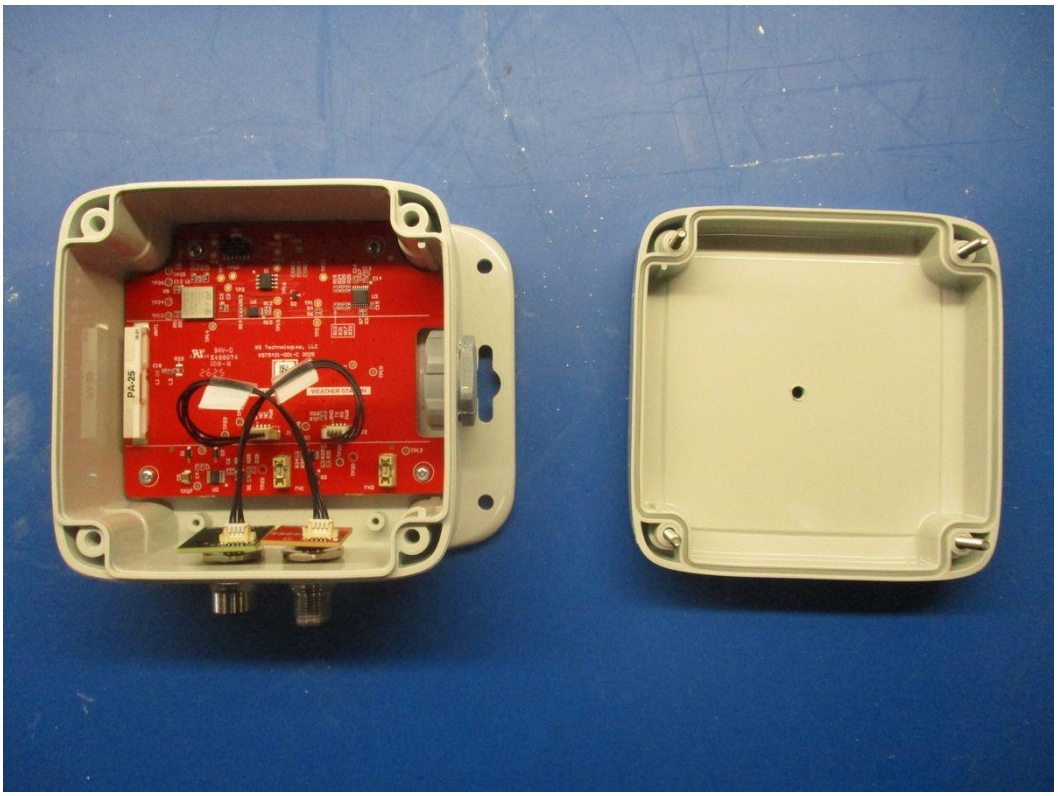


Post Exposure Inspection



Post Exposure Inspection


Post Exposure

### 5.1.5 Test Equipment List

**Table 5.1-1: IP6X Test Equipment List**

| Asset Number | Asset Type | Manufacturer | Model | Calibrated | Due |
|---|---|---|---|---|---|
| WC080871 | Chamber (Dust, Settling) | Thermotron | D27 | NCR | NCR |
| WC070466 | Meter (Hygrometer) | Fluke | 971 | 07/09/2025 | 07/09/2026 |
| WC080896 | Wrench (Torque) | Proto Tool | J6169NMF | 02/12/2025 | 02/12/2026 |
| WC084344 | Scale (Digital) | Mettler Toledo | PBA655-BC120 | 02/25/2025 | 02/25/2026 |
| WC084362 | Gauge (Vacuum) | Dwyer Instruments | 2000-10KPA | 06/18/2025 | 06/18/2026 |
| WC084369 | IP Test Dust | Powder Technology Inc | TALC (#399) | NCR | NCR |
| WC084448 | Meter (Flow) | Dwyer Instruments | RMA-13_TMV | NCR | NCR |

**Calibration Abbreviations**
CAL: Calibration
NCR: No Calibration Required

## 5.2 IPX7

### 5.2.1 Test Procedure

IEC 60529 Edition 2.2 2013-08

### 5.2.2 Test Result

The EUT showed no water ingress noted after the test was completed.

### 5.2.3 Test Datasheets

| CLIMATICS TEST LOG | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Start Date:** | 7/17/2025 | **End Date:** | 7/17/2025 | | **Job No:** | PR191937 | |
| **Customer:** | KS Technology, LLC | | | **Test Engineer:** | | Cam Storey | |
| **Customer Witness:** | N/A | | | **Lab Temp:** | 73F | **Lab Humidity:** | 60% |
| **Part Name:** | Impulse LoRa Modem (Qty: 2) | | | **Part Number:** | | KST5421-US915<br>KST5421-US915 | |
| **Test Specification:** | IEC 60529 Edition 2.2 2013-08 | | | | **Serial number:** | 000010<br>000011 | |
| **Test Performed:** | IP-x7 | | | | | **Lot:** | N/A |
| **Date** | **Time** | **Remarks** | | | | | **Initials** |
| | | **IP Designation: IP-x7** | | | | | CS |
| | | **Test Means: Immersion tank water-level on enclosure 0.15 m above top, 1 m above bottom** | | | | | CS |
| | | **Water Temperature: The water temperature does not differ from that of the specimen by more than 5 K** | | | | | CS |
| | | **Test Duration: 30 minutes** | | | | | CS |
| 7/17/2025 | 1115 | Samples were placed in a cage with a rope that measures out to 1 meter | | | | | CS |
| 7/17/2025 | 1124 | Samples were then placed in a chamber to condition so the samples temperature is within 5 K of the water temperature. Water temperature = +23C | | | | | CS |
| 7/17/2025 | 1431 | Samples were then exposed to water immersion at 1 meter for a duration of 30 minutes | | | | | CS |
| 7/17/2025 | 1501 | Samples have completed the exposure and were removed from the tank | | | | | CS |
| | | Test Results = Both samples were opened and inspected for signs of water intrusion. No signs of water intrusion were found within either sample | | | | | CS |
| | | Test complete | | | | | CS |

### 5.2.4 Test Photographs

Pre-Exposure

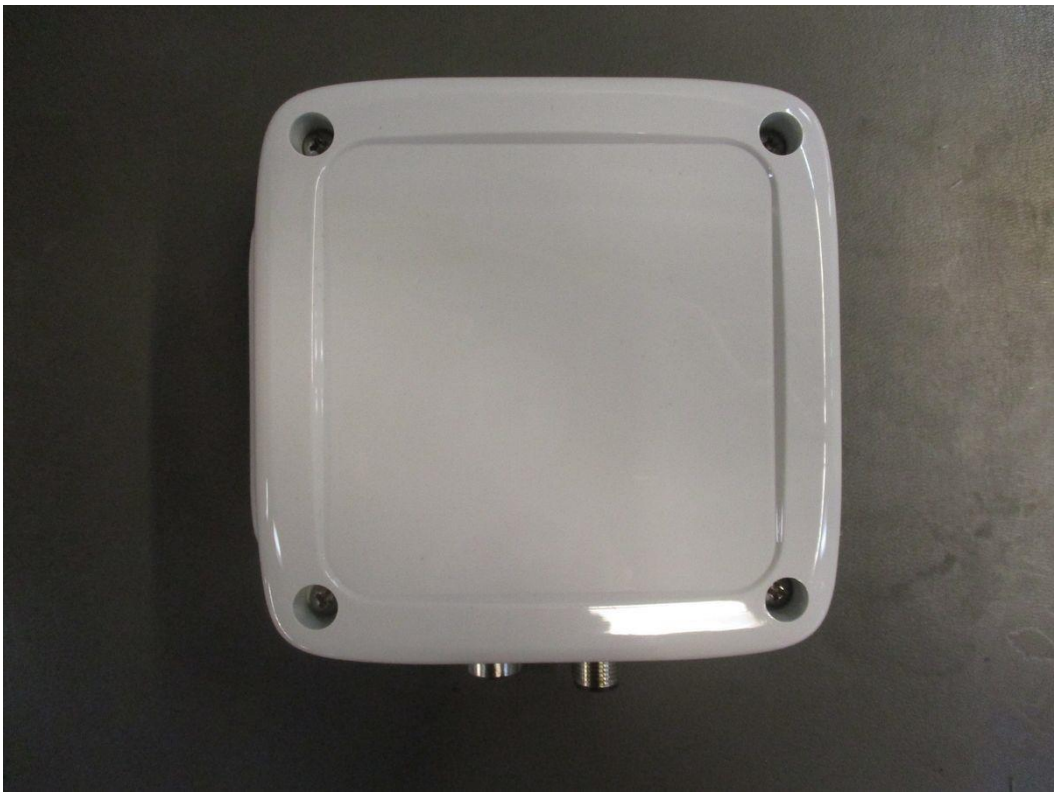
Pre-Exposure

Pre-Exposure

Pre-Exposure

Pre-Exposure


Pre-Exposure



Pre-Exposure

Pre-Exposure

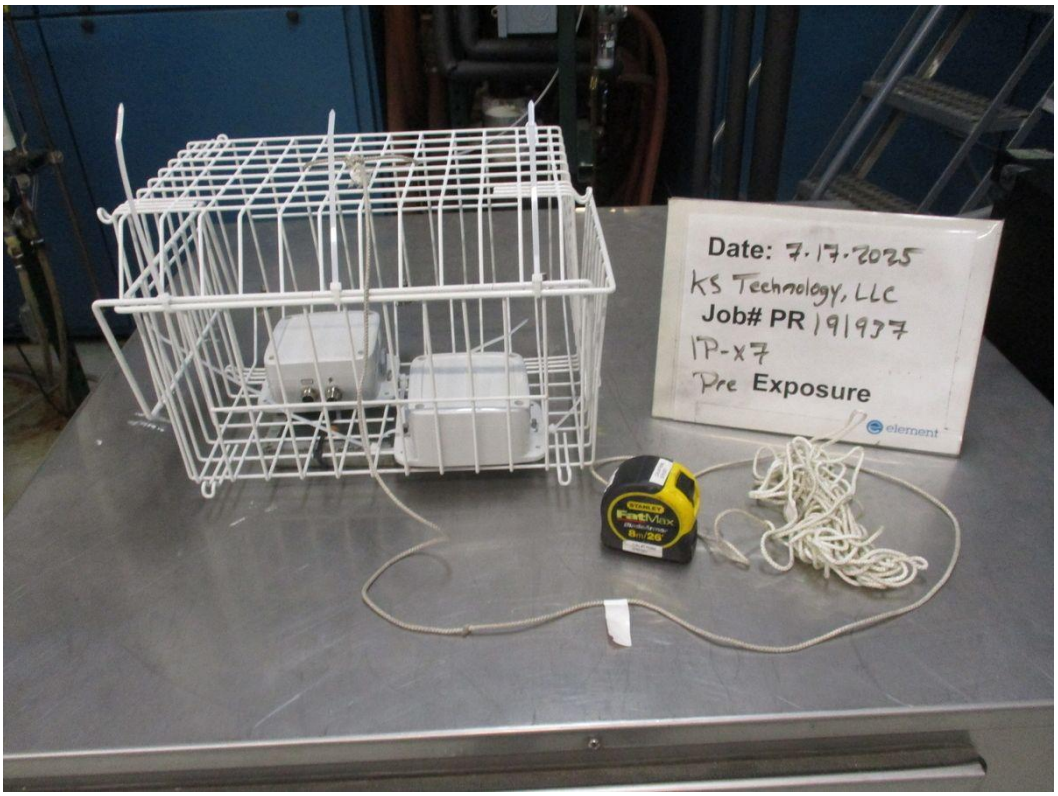
Pre-Exposure

Pre-Exposure

Pre-Exposure


Pre-Exposure

Setup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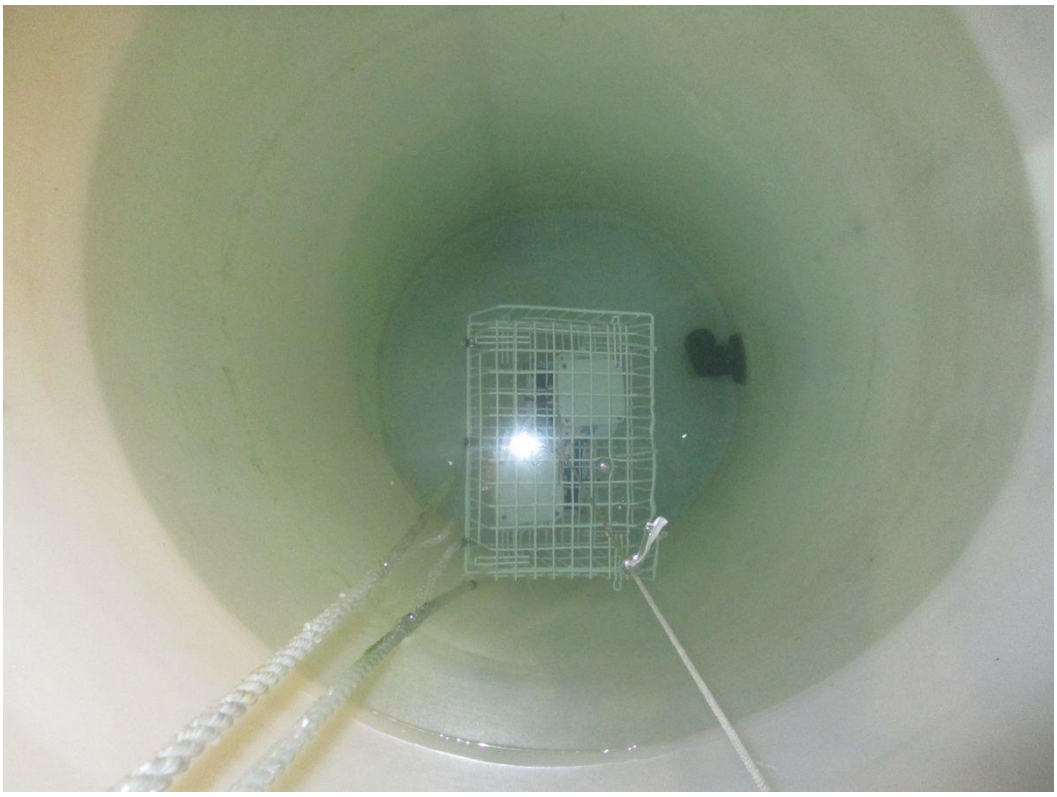
KS Technology, LLC
Job# PR 191937
IP-x7
Pre Exposure
element

Setup

Conditioning


Exposure

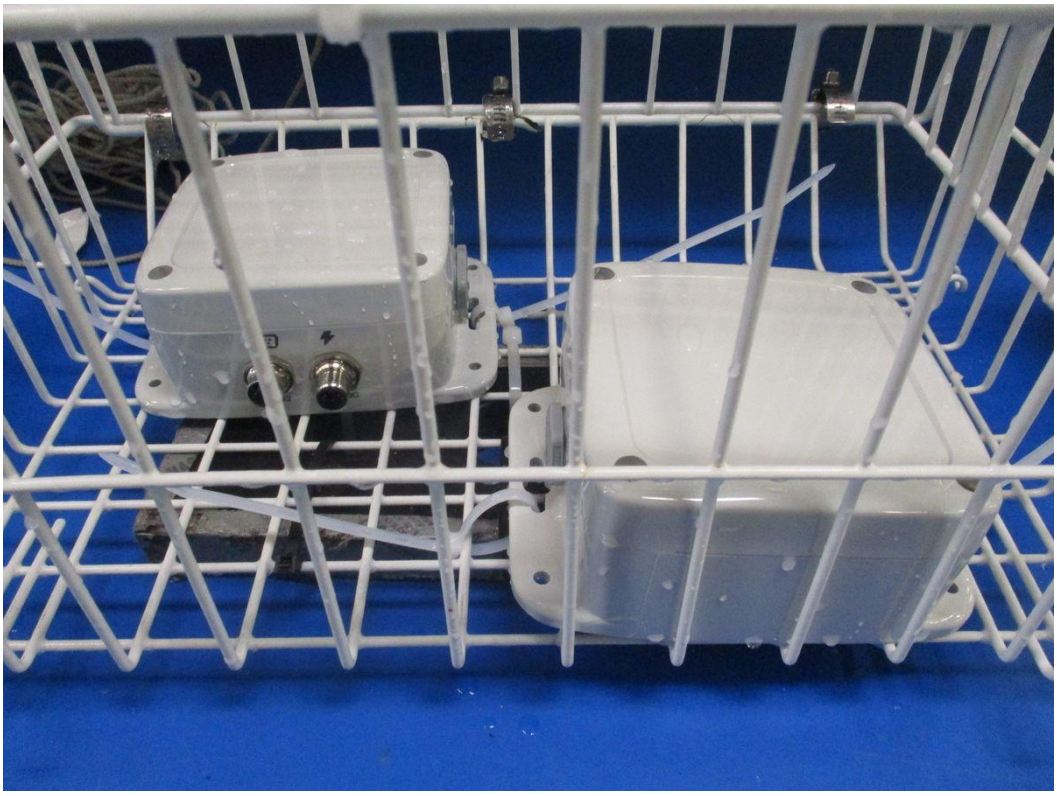


Exposure

Exposure


Timer

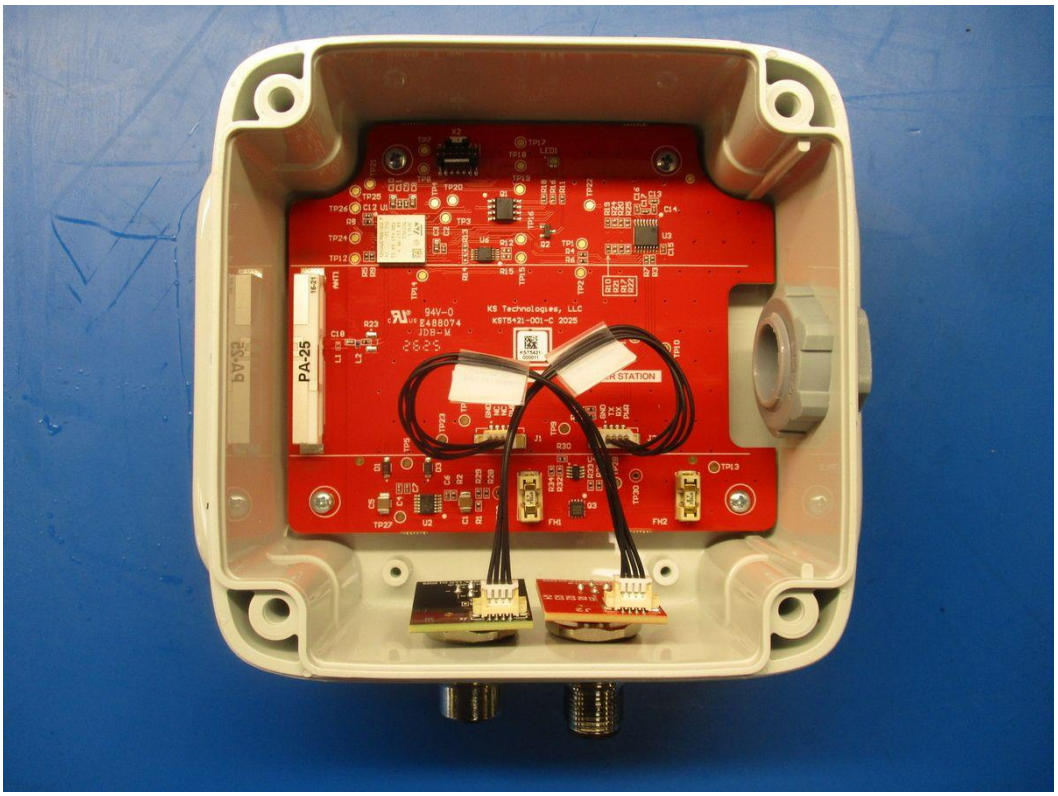

Post Exposure



Post Exposure

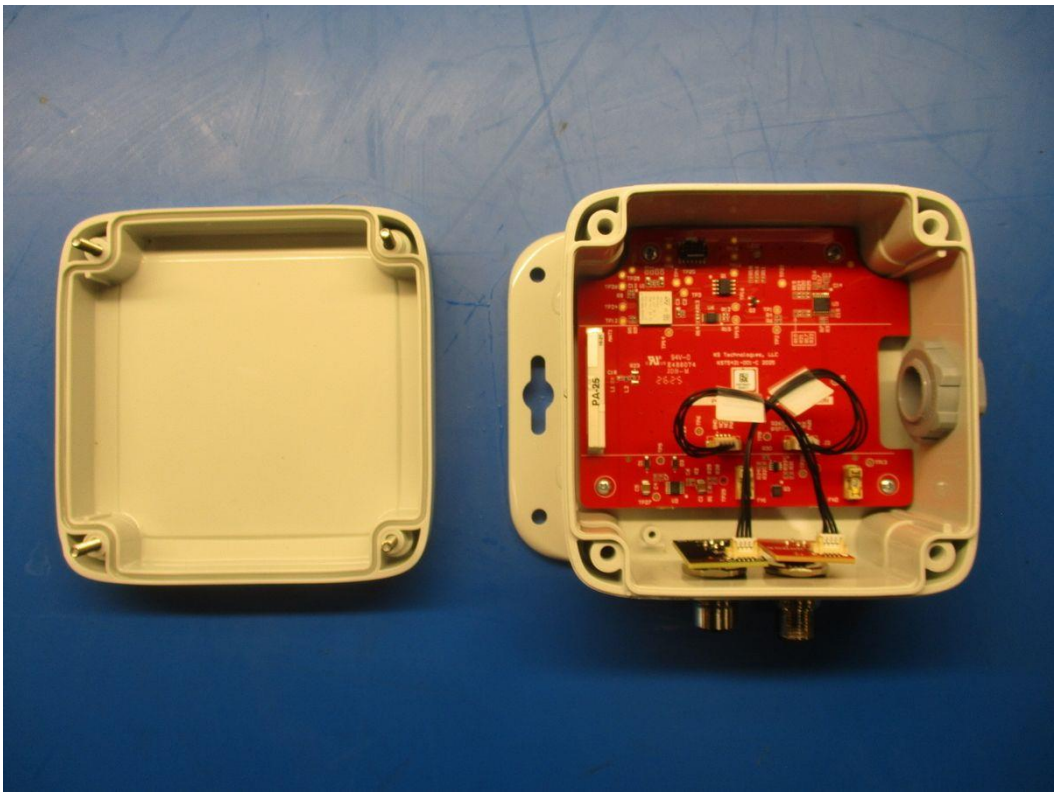
Post Exposure

Post Exposure Inspection



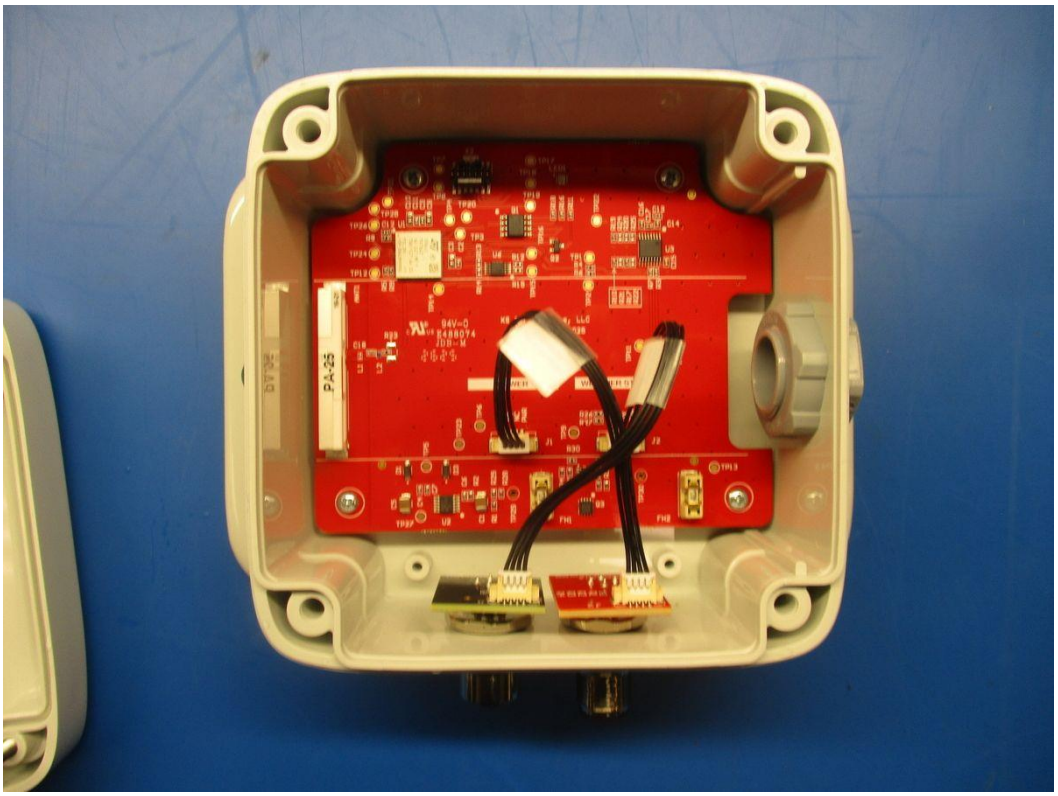

Post Exposure Inspection

Post Exposure Inspection



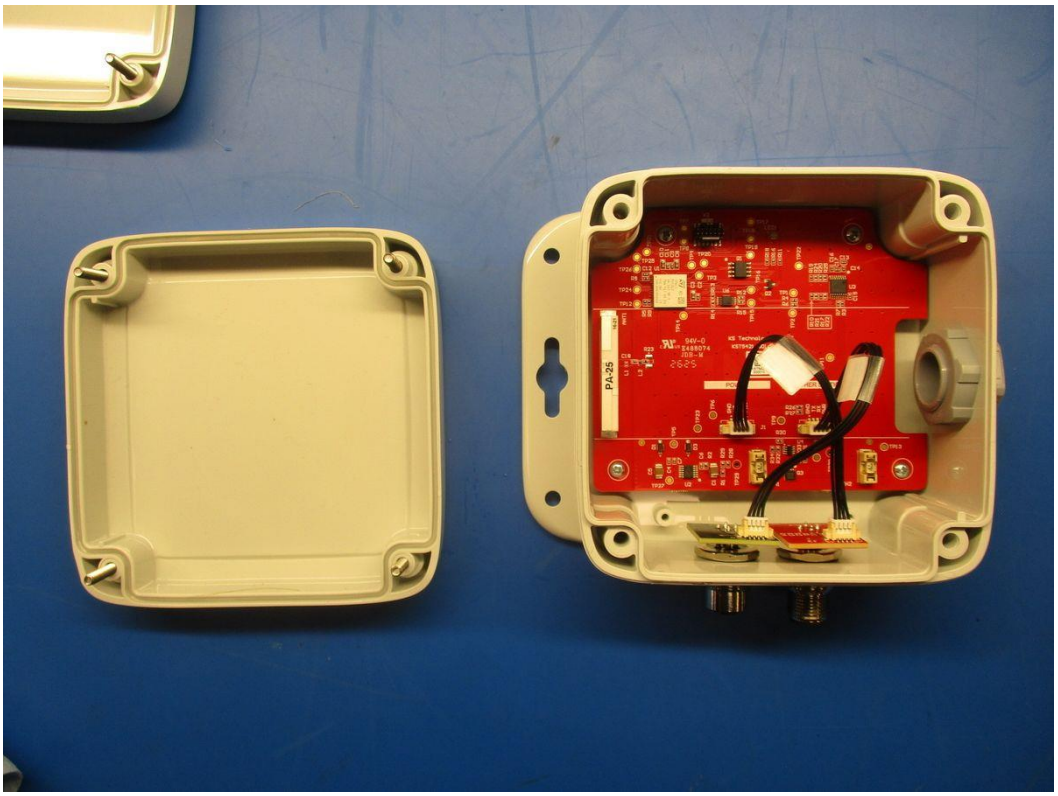
Post Exposure Inspection

Post Exposure Inspection



Post Exposure Inspection

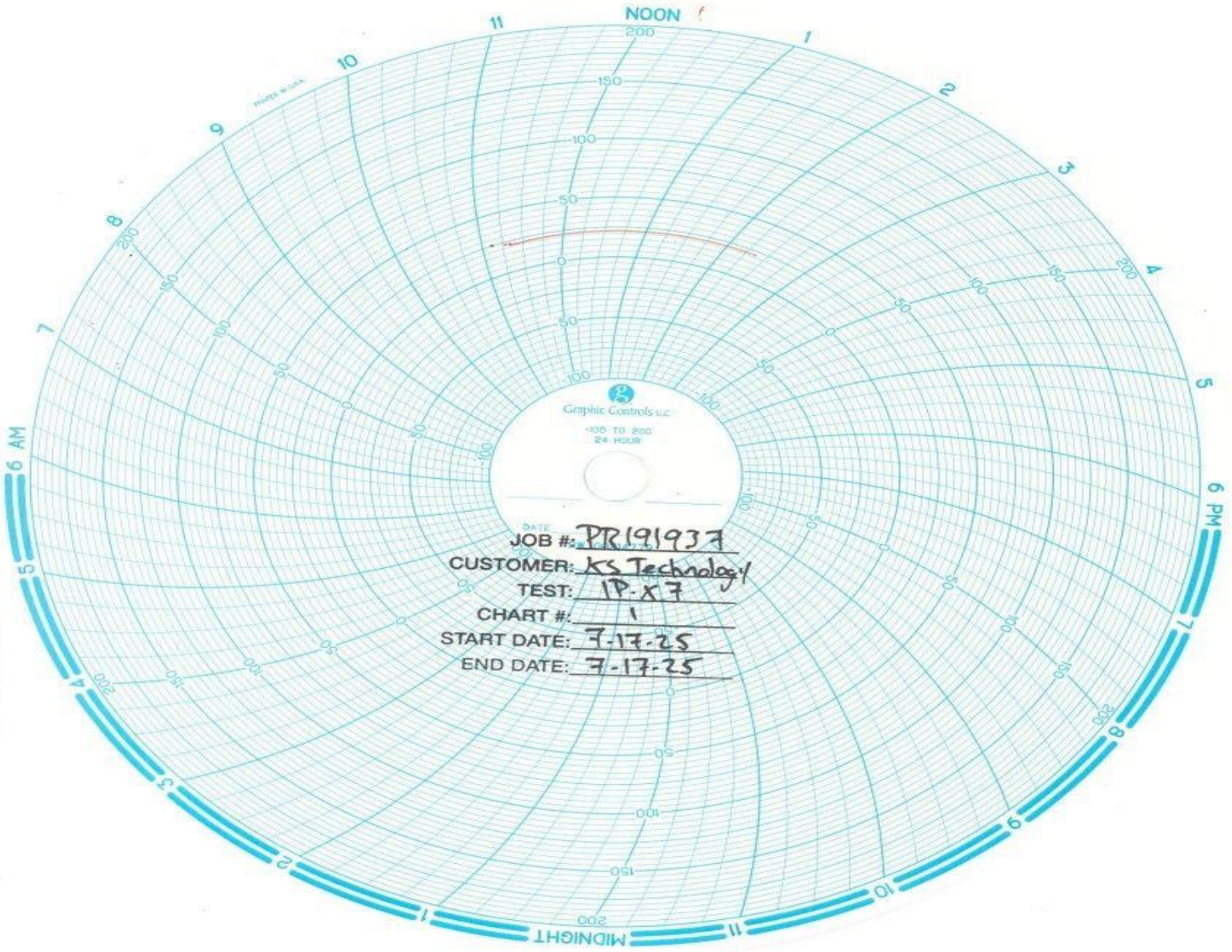
Post Exposure Inspection



Post Exposure Inspection


Post Exposure

### 5.2.5 Test Data



### 5.2.6 Test Equipment List

**Table 5.2-1: IPX7 Test Equipment List**

| Asset Number | Asset Type | Manufacturer | Model | Calibrated | Due |
|---|---|---|---|---|---|
| WC084345 | Chamber (Temperature) | Cincinnati Sub-Zero (CSZ) | Z-32-2-2-H/WC | 11/08/2024 | 11/08/2025 |
| WC061417 | Calibrator (Thermocouple) | Omega Engineering | CL27 | 11/21/2024 | 11/21/2025 |
| WC070466 | Meter (Hygrometer) | Fluke | 971 | 07/09/2025 | 07/09/2026 |
| WC080932 | Stopwatch (Digital) | Digi | 94460-28 | 03/21/2024 | 03/21/2026 |
| WC084240 | Measurement Tools (Tape Measure) | Stanley | 33-726 | 07/03/2025 | 07/03/2026 |
| WC084400 | Tank (Immersion) | Element | 01 | NCR | NCR |

**Calibration Abbreviations**
CAL: Calibration
NCR: No Calibration Required

# End of Test Report