Qualification Report for S239610 Series
Aerospace Welded Plug-Style Temperature Sensors

Distribution
Public

Justin Biesboer	Craig Odland	*Kristina Quello*
8/22/2025	*8/26/2025*	*8/26/2025*
PREPARED	*CHECKED*	*APPROVED*

Revision History

Revision	Description	Date	ECO	Approval
-	Initial Revision	8/26/2025	N/A	Kristina Quello

Table of Contents

1. Scope

This document presents substantive evidence that the S239610 temperature sensor is suitable for use in applicable airborne applications or environments.

1.1. Applicable Documents

The following documents are referenced:

1. Minco S239610: *Specification drawing*
2. Minco S225302: *Specification drawing*
3. RTCA DO-160G: *Environmental Conditions and Test Procedures for Airborne Equipment*
4. MIL-DTL-38999: *General Specification for Connectors, Electrical, Circular…*
5. MIL-STD-810G: *Environmental Engineering Considerations and Laboratory Tests*
6. MIL-STD-202G: *Test Method Standard, Electronic and Electrical Component Parts*
7. MIL-I-45208A: *Inspection System Requirements*
8. ANSI/NCSL Z540.3-2006: *Requirements for the Calibration of Measuring and Test Equipment*
9. ISO/IEC 17025: 2005: *Testing and calibration laboratories*
10. EIA-364-10: *Fluid Immersion Test Procedure for Electrical Connectors*
11. EIA-364-26: *Salt Spray Testing of Electrical Connectors*
12. EIA-364-31: *Humidity Test Procedure for Connectors and Sockets, Electrical*
13. Minco 2538395: *Robustness and Maturity Test Procedure and Report for S225302*
14. Minco 2681854: *S225302PG QTP – Qualification Test Procedure*
15. Minco 3035981: *S225302PG QTR – Qualification Test Report*
16. Minco 2546500: *Pressure Test of Cases, S225302PG and TS225303*
17. Nickel Development Institute No 9004: *High-Temperature Characteristics of Stainless Steels*
18. Element Materials Technology Minneapolis LLC #55613-1 (Rev 1): *Temperature Test*
19. Element Materials Technology Minneapolis LLC #55613-2 (Rev 2): *Altitude Test*
20. Element Materials Technology Minneapolis LLC #55613-3 (Rev 1): *Temperature Variation Test*
21. Element Materials Technology Minneapolis LLC #55613-4, -5, -7 (Rev 2): *Vibration and Shock Test*
22. Element Materials Technology Minneapolis LLC #55613-6 (Rev -): *Shock – Crash Safety Sustained Test*
23. Element Materials Technology Minneapolis LLC #55613-9 (Rev -): *Magnetic Effect Test*
24. Element Materials Technology Minneapolis LLC #55613-10B (Rev -): *Lightning Induced Transient Susceptibility Test*
25. Element Materials Technology Minneapolis LLC #55613-11 (Rev 1): *Proof and Burst Pressure Test*
26. Element Materials Technology Minneapolis LLC # 61925-1 (Rev -): *Response Time*
27. Minco 3242903: *Verification Test Report for S235021PG*
28. Minco Whitepaper: *Response Time Considerations in Temperature Sensing*
29. ASTM E 644: *Standard Methods for Testing Industrial Resistance Thermometers*

1.2. Derivative Parts

The S239610 [1] is a derivative part. The original design, verification, and qualification was performed under Minco part number S225302 [2], to which the S239610 is identical. The original S225302 test documents include proprietary information. References to the original documents are given for traceability, but all pertinent test results have been reiterated herein.

Other derivative part numbers identifying this document as the qualification record (including but not limited to part numbers S239611 through S239619) share the same basic minimum qualifications identified in this document.

1.3. Requirement Substantiation

The S239610 temperature sensor design has been exposed to a suite of tests and analyses that substantiate its suitability for use in many airborne applications. Some design features or capabilities have been tested against a standardized qualification level defined in RTCA DO-160G [3] and some have been tested to custom (usually more extreme) levels to vet long-term reliability and product maturity.

This sensor was designed to be used in future applications for which it is expected that test classifications and test levels don't exactly align with the specific requirement descriptions or test conditions. Some tests require a rigorous mathematical analysis to compare – namely the *High Temperature Endurance* and *Thermal Cycling* tests. Minco is experienced at this type of analysis can assist in determining whether existing test levels can used to substantiate a requirement.

Table 2.1.1-1: List of Qualification Tests and Analyses

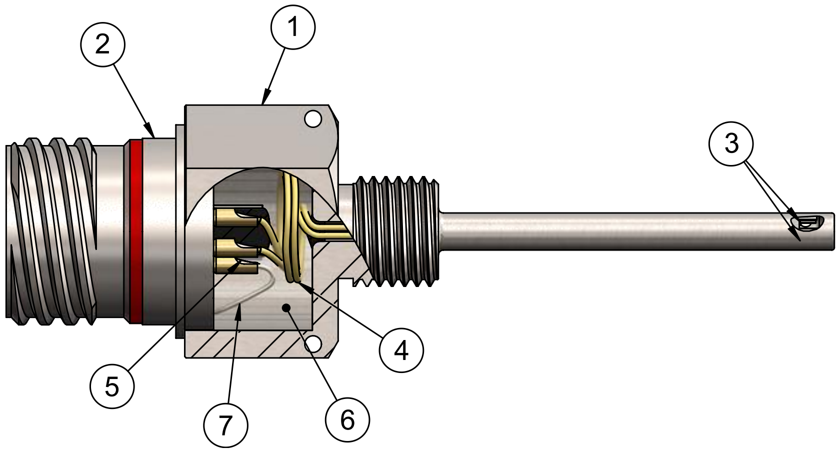
Qualification Requirement	Standard	Cat.	Details	Means	¶
Temperature and Altitude	RTCA DO-160G §4	D3	Temperature (Low): -55°C Temperature (High): 120°C Temperature (High, probe): 260°C Altitude: 15 200 m	Test	2.1 2.2
Temperature Variation	RTCA DO-160G §5	A	Low: -55°C High: +260°C	Test	2.3
Humidity	RTCA DO-160G §6	B	-	Analysis	2.4
Shock, Operational and Crash Safety	RTCA DO-160G §7	B+	• Standard operational shock (6 *g*) • Crash safety (20 *g* impulse, 20 *g* sustained)) • 1.5×Crash safety impulse (30 *g*)	Test	2.5
Vibration, Random	RTCA DO-160G §8	R+	• Greatest of Curve D & E for 10 minutes • Greatest of D1 & E1 for 3 hours	Test	2.6
Vibration, Sinusoidal	RTCA DO-160G §8	H	Curve P	Test	2.7
Explosive Atmosphere	RTCA DO-160G §9	E, H	-	Analysis	2.8
Waterproofness	RTCA DO-160G §10	Y, W, R, S	-	Analysis	2.9
Fluids Susceptibility	RTCA DO-160G §11	F	-	Analysis	2.10
Sand and Dust	RTCA DO-160G §12	D, S	-	Analysis	2.11
Fungus Resistance	RTCA DO-160G §13	F	-	Analysis	2.12
Salt Fog	RTCA DO-160G §14	S	-	Analysis	2.13
Magnetic Effect	RTCA DO-160G §15	Z	≤0.3 m	Test	2.14
Power Input	RTCA DO-160G §16	N/A	Not applicable at component level	Analysis	2.15
Voltage Spike	RTCA DO-160G §17				2.16
Audio Frequency Conducted Susceptibility	RTCA DO-160G §18				2.17
Induced Signal Susceptibility	RTCA DO-160G §19				2.18
Radio Frequency Susceptibility (Radiated and Conducted)	RTCA DO-160G §20				2.19
Emission of Radio Frequency Energy	RTCA DO-160G §21				2.20
Lightning Induced Transient Susceptibility	RTCA DO-160G §22	Z4XXXX	Dielectric test at 1500 $V_{AC, RMS}$ (> 2000 V_{DC})	Analysis, Test	2.21
Icing	RTCA DO-160G §24	A+	Aggravated icing test	Analysis, Test	2.22
Fire and Flammability	RTCA DO-160G §26	C	-	Analysis	2.23
Pressure	-	N/A	Burst: 25°C: 24 MPa, 300°C: 17.92 MPa Proof: 25°C: 11.36 MPa, 300°C: 8.48 MPa	Analysis, Test	2.24
High Temperature Endurance	-	N/A	>1700 h at 300°C, >236 h at 270°C, >1487 h at 260°C	Test	2.25
Low Temperature Endurance	-	N/A	>50 h at -55°C	Test	2.26
Thermal Cycling	-	N/A	>10 000 cycles between 0 and 250°C	Test	2.27
HALT	-	N/A	25C to -94°C to 181°C (during 1 hour) at each 9 *g*, 12 *g*, 15 *g*, 21 *g*, 27 *g*, 33 *g*, 39 *g*, and 45 *g* (8 hours total)	Test	2.28
Response Time	-	N/A	1 second in 1 m/s moving water	Test	2.29

NOTE: + indicates testing beyond the standard level or category.

1.4. Component Overview

The temperature sensor consists of the features depicted in Figure 1.4-1. External materials (except for normally-environmentally protected MIL-DTL-38999 [4] connector components) are SAE/AISI 304L or 304 stainless steel. Components of the sensor housing and connector are joined by laser weld to create a hermetic environmental seal.

Figure 1.4-1: Component Overview



No	Part Description
1	Case, SAE/AISI 304L
2	Connector, D38999-25YB5PC
3	Sensing element (2X)
4	Wires
5	Solder, Sn95Sb5
6	Adhesive, cement
7	Ground wire to pin C

2. Test Results and Analyses

This document is a secondary record of the tests performed on the S239610 temperature sensor design. Primary reports may contain proprietary information and are referenced for traceability.

All measurements were made with instruments of verified accuracy in accordance with MIL-I-45208A [7], ANSI/NCSL Z540.3-2006 [8], or ISO/IEC 17025: 2005 [9]. All instruments and test equipment critical to the accurate realization of the tests had calibration traceable to the International System of Units (SI) or the U.S. National Institute of Standards and Technology (NIST).

2.1. Temperature

Temperature requirements ensure that the equipment will either perform within specification or survive without deleterious effect when exposed to the typical environmental conditions (temperature and pressure) of a specified flight altitude.

Category D3 is intended for equipment that will be installed in the powerplant compartment of an aircraft that is operated at altitudes up to 50 000 ft (15 200 m). Category D3 is used to specify alternative high temperature conditions.

2.1.1. Standardized Qualification Details

Standard
RTCA DO-160G

Section
4.0 – Temperature and Altitude

Category
D3

Details

Condition	Cat D3
Ground Survival Low	-55°C
Short-Time Operating Low	-55°C
Operating Low	-55°C
Operating High	260°C (probe stem) / 120°C (body)
Short-Time Operating High	260°C (probe stem) / 120°C (body)
Ground Survival High	260°C (probe stem) / 120°C (body)

NOTE: The high-temperature conditions are specified to allow high-temperature immersion of the sensing end of the probe.

Facility
Element Materials Technology Minneapolis, LLC.

Report
Test Report # 55613-1 (Rev 1) [18]

Result
Pass

2.2. Altitude

The altitude requirements ensure that the equipment will perform within specification at the pressures resulting from flight at a specified altitude.

Category D3 is intended for equipment that will be installed in the powerplant compartment of an aircraft that is operated at altitudes up to 50 000 ft (15 200 m).

2.2.1. Standardized Qualification Details

Standard
RTCA DO-160G

Section
4.0 – Temperature and Altitude

Category
D3

Details

Condition	Cat D3
Altitude	15 200 m [50 000 ft]

Facility
Element Materials Technology Minneapolis, LLC.

Report
Test Report # 55613-2 (Rev 2) [19]

Result
Pass

2.3. Temperature Variation

Temperature variation requirements ensure that the equipment will operate as expected when exposed to temperatures that vary between the expected high and low operating temperature extremes.

2.3.1. Standardized Qualification Details

Standard
RTCA DO-160G

Section
5.0 – Temperature Variation

Category
A

Details

Condition	**Cat A**
Operating Low	-55°C
Operating High	260°C

Facility
Element Materials Technology Minneapolis, LLC.

Report
Test Report # 55613-3 (Rev 2) [20]

Result
Pass

2.4. Humidity

The humidity requirement ensures that the equipment can withstand natural or induced humid atmospheres.

Category B is intended for equipment installed in zones that are not environmentally controlled and will be exposed to the most severe atmospheric humidity levels. Category B exceeds the levels of categories A and C.

2.4.1. Standardized Qualification Details

Standard
RTCA DO-160G

Section
6.0 - Humidity

Category
B

Details
- Severe Humid Environment Test (RTCA DO-160G § 6.3.2)

Facility
N/A

Report
See analysis below.

Result
Pass

2.4.2. Analysis

The body of the S239610 temperature sensor is SAE/AISI 304L stainless steel and is unaffected by prolonged exposure to humid air in the temperature range specified by RTCA DO-160G. All seals used in its construction are permanent and airtight.

The connector, D38999/25YB5PC, utilizes 304 stainless steel and has, per the manufacturer, passed testing for humidity per method IV of EIA-364-31 [12]. The table below compares the key attributes between the EIA and DO-160G test procedures.

Table 2.4.2-1: Comparison of humidity test specifications

Step	RTCA DO-160G § 6: Cat B	EIA-364-31, Method IV
Polarize	Not Under Power	100V DC voltage potential across contacts
Stabilize	38°C ±2°C and 85% ±4% relative humidity	25°C ±2°C and 94% ±4% relative humidity
Ramp time to test level	2 hours ±10 minutes	2.5 hours
Maintain test level	65°C ±2°C and 95% ±4% relative humidity for 6 hours	65°C ±2°C and 94% ±4% relative humidity for 3 hours
Decline	16 hours ±15 minutes	2.5 hours
Cycles	10 cycles	10 cycles
Subcycle	None	-10°C ±2°C for 3 hours, completed during any 5 of the first 9 cycles.

Per the EIA specification, the connectors were tested with a polarized load for increased failure detection. The EIA specification also stabilizes at a lower temperature, which introduces a higher level of moisture condensation. The DO-160G specification is tested for a longer duration, however the exposed glass and metal surfaces are non-hygroscopic, so duration is a low risk for failure. The EIA specification also includes 5 cycles below freezing, so any moisture ingress through a crack in the hermetic seal may be stressed and exposed beyond what would be detected by the DO-160G test.

The S239610 meets the requirements of hermetically sealed equipment (RTCA DO-160G § 10.1), a “permanent and airtight” seal. Considering its hermetic nature, moisture in an external, humid atmosphere is unable degrade the internal sensing elements, internal electrical insulation materials, or internal electrical connections. Externally, the 304L stainless steel construction and well-tested D38999 connector are impervious to moisture in the temperature range specified.

2.5. Shock, Operational and Crash Safety

Shock requirements demonstrate the ability of the equipment to operate within normal performance standards after exposure to shocks that are a result of normal aircraft operations (taxiing, landing, gusts of wind, etc.). The crash safety requirements verify that the equipment will not become detached or separate in a hazardous manner during an emergency landing.

2.5.1. Standardized Qualification Details

Standard
RTCA DO-160G

Section
7.0 – Operational Shocks and Crash Safety

Category
B

Details

Shock test	**Cat B**
Standard operational (impulse)	6 *g*, 11 ms
Crash safety (impulse)	20 *g*, 11 ms
Crash safety (sustained)	20 *g, 3 s*

NOTE: Levels applied in both directions on 3 orthogonal axes (6 orientations) to allow aircraft installation in any orientation.

Facility
Element Materials Technology Minneapolis, LLC.

Report
Test Report # 55613-4, -5, -7 (Rev 2) [21]
Test Report # 55613-6 (Rev -) [22]

Result
Pass

2.5.2. Aggravated Testing

Standard
RTCA DO-160G

Section
7.0 – Operational Shocks and Crash Safety

Category
N/A

Details
1.5×(Crash safety impulse test)

Shock test	**Cat B**
Crash safety (impulse)	30 *g*, 11 ms

NOTE: Levels applied in both directions on 3 orthogonal axes (6 orientations) to allow aircraft installation in any orientation.

Facility
Element Materials Technology Minneapolis, LLC.

Report
Test Report # 55613-4, -5, -7 (Rev 2) [21]
Test Report # 55613-6 (Rev -) [22]

Result
Pass

2.6. Vibration, Random

Random vibration requirements ensure that equipment will operate satisfactorily when subjected to vibration.

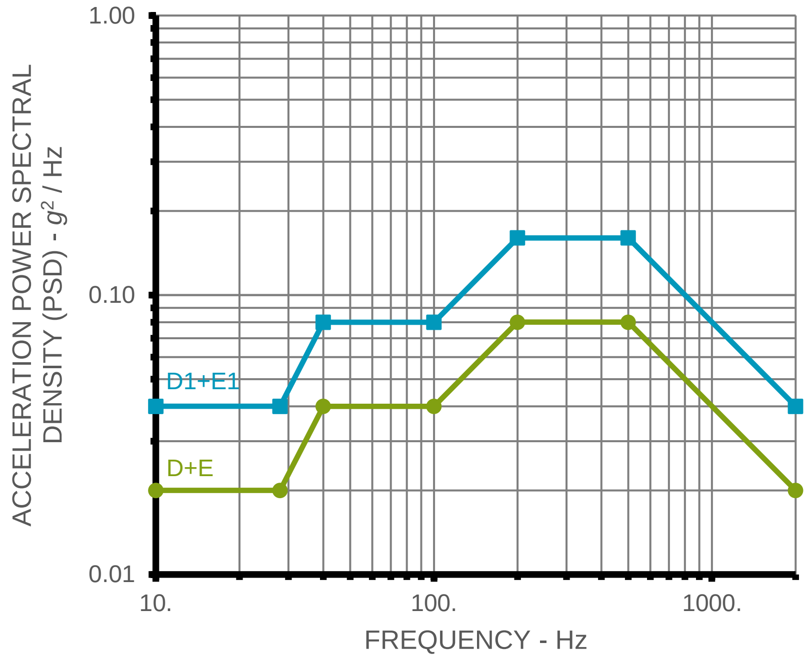
2.6.1. Standardized Qualification Details

Standard
RTCA DO-160G

Section
8.0 - Vibration

Category
R (+)

Details
Greatest of Curve D & E for 10 minutes + Greatest of D1 & E1 for 3 hours
⇒ ~13.3 g_{RMS}



Curve	Test levels at test curve frequency break points						
	10	28	40	100	200	500	2000
D+E	0.02	0.02	0.04	0.04	0.08	0.08	0.02
D1+E1	0.04	0.04	0.08	0.08	0.16	0.16	0.04

Facility
Element Materials Technology Minneapolis, LLC.

Report
Test Report # 55613-4, -5, -7 (Rev 2) [21]

Result
Pass

2.6.2. Aggravated Testing

Standard RTCA DO-160G *Section* 8.0 - Vibration *Category* N/A	*Details* 1.5×(Greatest of Curve D & E + Greatest of Curve D1 & E1) ⇒ ~20 g_{RMS}
Facility Element Materials Technology Minneapolis, LLC. *Report* Test Report # 55613-4, -5, -7 (Rev 2) [21] *Result* **Pass**	

2.7. Vibration, Sinusoidal (Sustained Engine Imbalance / Fan Blade Loss)

Sinusoidal vibration requirements ensure that the equipment continues to function during sustained engine imbalance (due to fan blade-off or other event). These events may cause low-frequency sinusoidal vibration due to windmilling after the engine has been shut down.

Category H is intended for abnormal fixed wing aircraft vibrations conditions that occur during engine fan blade loss in which the performance of the equipment can hazardously affect the aircraft's performance.

2.7.1. Standardized Qualification Details

Standard RTCA DO-160G *Section* 8.0 - Vibration *Category* H	*Details* Curve P (±10 g_{peak} from 10 to 250 Hz at ≤ 0.167 Hz/sec) + Resonance sweeps to identify low frequency resonance
Facility Element Materials Technology Minneapolis, LLC. *Report* Test Report # 55613-4, -5, -7 (Rev 2) [21] *Result* **Pass**	

2.7.1.1. Discussion of results

No low-frequency resonance found. All resonant frequencies (defined as >2×input amplitude) are above 740 Hz.

2.8. Explosive Atmosphere

Explosive atmosphere requirements ensure that there is negligible risk that the equipment will cause an explosion of flammable gas or vapor during flight operations.

Categories E and H ensure that the equipment cannot cause ignition via spark or elevated temperature.

2.8.1. Standardized Qualification Details

Standard RTCA DO-160G *Section* 9.0 – Explosive Atmosphere *Category* E, H *Facility* N/A *Report* See analysis below. *Result* **Pass**	*Details* • Design prevents flame propagation • External surface temperature is ≤ 204°C

2.8.2. Analysis

The design has permanent, airtight seals and is considered "hermetic" per RTCA DO-160G § 10.1. The 304 stainless subcomponents are joined by laser-weld and the connector pins have glass-to-metal seals. The sealed nature of the assembly will prevent any internal spark from propagating outside of its housing.

The surface temperature of the component can be calculated via a worst-case (still air) internal self-heating analysis. The highest resistance (resistive heat-producing) component of the assembly is the temperature sensing element itself. The external temperature of the sensor cannot rise more than the self-heated temperature of sensing element at maximum input current. This self-heating coefficient is a function of the physical element construction and has been measured. The maximum temperature rise can be calculated using this coefficient.

Table 2.8.2-1: Variables and values used in self-heating calculations

Variable	Value	Note
T_{OH}, Temperature, Operating High	120°C	Initial temperature per RTCA DO-160G § 9.6.3.2, Step 1
R_{OH}, Max resistance at T_{OH}	1311.64 Ω	Maximum element resistance at 120°C ("PF" element)
c_{SH},Self-heating coefficient	.195°C/mW	Measured value of qualification unit
I_{MAX}, Maximum supply current	.005 A	Extreme maximum current supply (typical values are usually less than .001 A)

NOTE: Multiple element types are allowed by the S239610 specification. The element resistance and input current values selected for this example depict the most extreme/conservative possibility.

The maximum power dissipation of the element at the "Operating High" condition (120°C) is given by Ohm's Law:

$$P=I^2R= I_{MAX}{}^2R_{OH}=(.005\ \text{A})^2\times 1311.64\ \Omega=.0328\ \text{W}=32.8\ \text{mW}$$

Temperature rise (ΔT) is then the product of the self-heating coefficient and the maximum power dissipation:

$$\Delta T= P\times c_{SH}=32.8\text{mW}\frac{.195°\text{C}}{\text{mW}}=6.40°\text{C}$$

Maximum achievable surface temperature is the sum of T_{OH} and ΔT:

$$T_{MAX}= \Delta T+T_{OH}=120°\text{C}+6.40°\text{C}=126.4°\text{C}$$

The calculated maximum achievable surface temperature of the S239610 (in "Operating High" condition) does not exceed 204°C and therefore meets the requirements of RTCA DO-160G § 9.

2.9. Waterproofness

Waterproofness requirements ensure that the equipment can withstand the effects of liquid water being sprayed or falling on the equipment or the effects of condensation on the equipment.

2.9.1. Standardized Qualification Details

Standard RTCA DO-160G *Section* 10.0 – Waterproofness *Category* Y, W, R, S *Facility* N/A *Report* See analysis below. *Result* ***Pass***	*Details* • Condensing Water Proof Test (RTCA DO-160G § 10.3.1) • Drip Proof Test (RTCA DO-160G § 10.3.2) • Spray Proof Test (RTCA DO-160G § 10.3.3) • Continuous Stream Proof Test (RTCA DO-160G § 10.3.4)

2.9.2. Analysis

RTCA DO-160G §10.1 states that "These tests are not intended to verify performance of hermetically sealed equipment. Therefore, hermetically sealed equipment may be considered to have met all waterproofness requirements without further testing. Equipment shall be considered hermetically sealed when the seal is permanent and airtight."

The S239610 is considered hermetically sealed. Joints between components are laser-welded and the connector pins have glass-to-metal seals. These seals are permanent and airtight. According to RTCA DO-160G §10.1, the equipment has met all waterproof requirements.

2.10. Fluids Susceptibility

The Fluid Susceptibility requirement ensures that materials used in the construction of the equipment can withstand the deleterious effects of the specified fluid contaminants. The fluids are representative of those commonly encountered in airborne and ground operations and have the potential to cause corrosion or degrade the materials they encounter.

2.10.1. Standardized Qualification Details

Standard RTCA DO-160G *Section* 11.0 – Fluids Susceptibility *Category* F *Facility* N/A *Report* See analysis below. *Result* **Pass**	*Details* • Spray Test (RTCA DO-160G § 11.4.1) • Immersion Test (RTCA DO-160G § 11.4.2) Fluids • Hydraulic fluids • Fire extinguishants • Cabin and bay fire extinguishing agents 2-BTP and Halon substitutes • Lubricating oils • De-icing or Anti-icing fluids

2.10.2. Analysis

The S239610 is considered hermetically sealed. Joints between components are laser-welded and the connector pins have glass-to-metal seals. Fluid is therefore unable to cause electrical degradation of the internal sensing element, insulators, or electrical terminations. The external surface of the housing (excluding D38999 connector) is entirely SAE/AISI 304L stainless steel. The specified classes of fluids are all well documented to have excellent chemical compatibility with the 304-stainless steel. All materials have been used extensively in aviation.

The MIL-DTL-38999 connector, which is an integral component of the external housing, utilizes 304 stainless steel and has, per the manufacturer, passed testing for fluid susceptibility in accordance with EIA-364-10 [11], as required by MIL-DTL-38999.

Due to general history of use of both 304 stainless steel and the history and prior testing of the D38999 connector series, no further testing is required to guarantee fluid compatibility.

2.11. Sand and Dust

Sand and dust requirements ensure that the equipment is sufficiently resistant to the effects of blowing sand and dust that are carried by air movement at "moderate" speeds.

2.11.1. Standardized Qualification Details

Standard / Section / Category / Facility / Report / Result	Details
Standard RTCA DO-160G *Section* 12.0 – Sand and Dust *Category* D, S *Facility* N/A *Report* See analysis below. *Result* ***Pass***	• Dust Test (RTCA DO-160G § 12.4) • Sand Test (RTCA DO-160G § 12.5)

2.11.2. Analysis

The S239610 temperature sensor does not include any moving parts that could become fouled or damaged by sand or dust. It is hermetically sealed, preventing sand or dust ingress that could damage or short the electrical components.

The lockwire hole may become filled with sand particles, but the test particles are smaller than 0.85 mm (compared to the hole size of 1.7 mm) and can be removed (per the requirement) by brushing, wiping, or shaking.

The D38999 connector has passed sand and dust testing per MIL-STD-202 [6] procedure 110, for which the differences are identified below. Most notable is the omission of sand testing – however, the S239610 has no moving parts to become fouled, so the larger particle size of the sand test is not necessary.

Table 2.11.2-1: D38999 Sand and Dust Testing (MIL-STD-202) vs RTCA DO-160G

Attribute	RTCA DO-160G §12: Cat D, S	MIL-STD-202-110 (18 April 2015)
Dust particle size	140 mesh silica flour	140 mesh silica flour
Dust concentration	8.8 g/m^3	10.3 g/m^3
Dust velocity	0.5 to 2.4 m/s (2 hours)	8.9 m/s (6 hours) 1.5 m/s (16 hours) 8.9 m/s (6 hours)
Sand particle size	0.15 to 0.85 mm	N/A
Sand concentration	2.2 g/m^3	N/A
Sand velocity	18 to 29 m/s	N/A

The S239610 has no moving parts or exposed electronics that can become clogged or fouled by sand or dust. It therefore meets the requirements of RTCA DO-160G §12.

2.12. Fungus Resistance

The Fungus Resistance requirement ensures that materials used are not affected by fungi under conditions favorable to their development, namely, high humidity, warm atmosphere, and the presence of inorganic salts.

2.12.1. Standardized Qualification Details

Standard	Details
RTCA DO-160G	• Salt Fog Test (RTCA DO-160G § 14.3.6.6) ○ 2x 24 hour exposure; ○ operation after drying ○ inspection for corrosion • Severe Salt Fog Test (RTCA DO-160G § 14.3.6.7) ○ 2x 48 hour exposure; ○ operation before drying is complete ○ inspection for corrosion
Section 13.0 – Fungus Resistance	
Category F	
Facility N/A	
Report See analysis below.	
Result **Pass**	

2.12.2. Analysis

RTCA DO-160G §13.3 states that "If all materials used in the construction of the equipment can be shown to be non-nutrients for the growth of the fungi, either through their composition or through previous testing, this test is not required."

The exposed portion of the sensor is fabricated of hermetically sealed 304 stainless steel. SAE/AISI 304L stainless steel is non-nutrient.

The connector utilizes 304 stainless steel and has, per the manufacturer, passed testing for fungus per method 508 of MIL-STD-810 [5], as specified by MIL-DTL-38999. The pertinent test attributes specified in MIL-STD-810 are identical to DO-160G §13.5. Furthermore, Table I in section 508.6 of MIL-STD-810 identifies all metals and glass as materials that are fungus inert.

All external materials are either fungal non-nutrient (inert) or have been previously tested per MIL-STD-810.

2.13. Salt Fog

Salt fog requirements ensure that there are no deleterious effects from prolonged exposure to a salt atmosphere or to salt fog experienced in normal operations.

Category S is for normal exposure.

Category T is for equipment exposed directly to unfiltered air while parked near the sea.

2.13.1. Standardized Qualification Details

Standard	Details
RTCA DO-160G	• Severe Salt Fog Test (RTCA DO-160G § 14.3.6.7)
Section	
14.0 – Salt Fog	
Category	
S, T	
Facility	
N/A	
Report	
See analysis below.	
Result	
Pass	

2.13.2. Analysis

The S239610 temperature sensor is hermetically sealed, composed of resilient and corrosion resistant 304L stainless steel, and has no moving parts. Salt solution or salt deposits are therefore unable to cause electrical shorting to the internal sensing element, insulators, or electrical terminations.

The connector utilizes 304 stainless steel and meets, per the manufacturer, series III classes F, G, N, and R per EIA—364-26 [11]. The table below compares the key attributes between the EIA and DO-160G test procedure.

Table 2.13.2-1: Salt Fog/Mist Test Comparison

Test Parameter	RTCA DO-160G § 14: Cat T	EIA-364-26, Series III
Salt solution	5% NaCl	5% NaCl
Test temperature	35°C	35°C
Connector	New (no gasket wear) Sealed/mated (out of scope)	Temporarily Sealed (partially protected mating connector)
Total duration	48 hours	452 hours sealed/mated 48 hours unmated

The process steps for the two procedures consist of the same conditions, however the EIA specification is more extreme as the duration is considerably longer and the connector is also tested “exposed” for 48 hours.

Considering the materials (304 stainless) and prior testing of the D38999 connector, the S239610 is compliant with the salt fog requirements of RTCA DO-160G §14.

2.14. Magnetic Effect

The magnetic effect requirements determine the safe distance that equipment can operate near onboard compass or compass sensors (flux gates) without interfering with those systems.

Category Z is intended for equipment that that will be installed ≥0.3 m from magnetic compasses or flux gates.

2.14.1. Standardized Qualification Details

Standard RTCA DO-160G *Section* 15.0 – Magnetic Effect *Category* Z	*Details* • Magnetic Effect Test (RTCA DO-160G § 15.2) – Operational equipment moved toward compass until 1° of deflection achieved.
Facility Element Materials Technology Minneapolis, LLC. *Report* Test Report # 55613-9 (Rev -) [23] *Result* ***Pass: ≤0.07 m***	

2.14.1.1. Discussion of Results

In all 6 orthogonal test orientations, the S239610 was found to have a 1° deflection distance of less than 7 cm (the radius of the compass). The temperature sensor could not be moved closer to the compass due to the radius of the compass.

2.15. Power Input

The power input requirements ensure that the equipment is compatible with aircraft power supply characteristics including voltage spikes.

2.15.1. Standardized Qualification Details

Standard RTCA DO-160G *Section* 16.0 – Power Input *Category* N/A	*Details* N/A
Facility N/A *Report* See analysis below. *Result* ***Pass: N/A***	

2.15.2. Analysis

Power input test requirements are often incorrectly flowed down to the S239610 component level. This justification is provided for such circumstances.

Power input tests are intended for equipment with power inputs that are connected directly to aircraft AC or DC power sources. The S239610 is not connected directly to aircraft power and does not have power leads or terminals. It consists of purely passive electrical components and is dependent upon a controlling device. The controller is responsible for driving the passive elements, managing power line disturbances, and for signal filtering.

The power input test is not applicable at the S239610 component level.

2.16. Voltage Spike

The voltage spike requirement ensures that equipment can withstand the effects of voltage spikes arriving at the equipment on its power leads, either AC or DC.

2.16.1. Standardized Qualification Details

Standard RTCA DO-160G	*Details* N/A
Section 17.0 – Voltage Spike	
Category N/A	
Facility N/A	
Report See analysis below.	
Result ***Pass: N/A***	

2.16.2. Analysis

Test requirements that require power input leads are often incorrectly flowed down to the S239610 component level. This justification is provided for such circumstances.

The voltage spike test is intended for equipment with power inputs that are connected directly to aircraft AC or DC power sources. The S239610 is not connected directly to aircraft power and does not have power leads or terminals. It consists of purely passive electrical components and is dependent upon a controlling device. The controller is responsible for driving the passive elements, managing power line disturbances, and for signal filtering.

The voltage spike test is not applicable at the S239610 component level.

2.17. Audio Frequency Conducted Susceptibility

The audio frequency conducted susceptibility requirements ensure that the equipment will function acceptably when exposed to power-line frequency components that are normally harmonically related to the power source fundamental frequency.

2.17.1. Standardized Qualification Details

Standard RTCA DO-160G	*Details* N/A
Section 18.0 – Audio Frequency Conducted Susceptibility	
Category N/A	
Facility N/A	
Report See analysis below.	
Result ***Pass: N/A***	

2.17.2. Analysis

Test requirements that require power input leads are often incorrectly flowed down to the S239610 component level. This justification is provided for such circumstances.

The audio frequency conducted susceptibility tests are intended for equipment with power inputs that are connected directly to aircraft AC or DC power sources. The S239610 is not connected directly to aircraft power and does not have power leads or terminals. It consists of purely passive electrical components and is dependent upon a controlling device. The controller is responsible for driving the passive elements, managing power line disturbances, and for signal filtering.

The audio frequency conducted susceptibility test is not applicable at the S239610 component level.

2.18. Induced Signal Susceptibility

The induced signal susceptibility requirements ensure that the equipment interconnect circuit configuration will accept a level of induced voltages caused by the installation environment. This section relates specifically to interfering signals related to the power frequency and its harmonics, audio frequency signals, and electrical transients that are generated by other on-board equipment or systems and coupled to sensitive circuits within the equipment through its interconnecting wiring.

2.18.1. Standardized Qualification Details

Standard RTCA DO-160G	*Details* N/A
Section 19.0 – Induced Signal Susceptibility	
Category N/A	
Facility N/A	
Report See analysis below.	
Result ***Pass: N/A***	

2.18.2. Analysis

Test requirements that heavily involve the computer/controller to which the S239610 is attached are often incorrectly flowed down to the S239610 component level. This justification is provided for such circumstances.

The S239610 has a sensing element with a non-inductive resistance pattern, is fully enclosed in a metallic (304 stainless steel) sheath, and does not have an integrated wire interconnect that might enhance a coupling effect. It consists of purely passive electrical components and is dependent upon a controlling device. The controller is responsible for driving the passive elements, managing power line disturbances, and for signal filtering. The controller is responsible for preventing or mitigating any induced signal associated with its electronic system as a whole, or that the non-inductive and shielded nature of the S239610 may allow.

The induced signal susceptibility test is not applicable at the S239610 component level.

2.19. Radio Frequency Susceptibility (Radiated and Conducted)

The radio frequency susceptibility requirements ensure that the equipment will operate acceptably when subjected to RF modulated power and will not emit an unacceptable level of RF noise.

2.19.1. Standardized Qualification Details

Standard RTCA DO-160G	*Details* N/A
Section 20.0 – Radio Frequency Susceptibility (Radiated and Conducted)	
Category N/A	
Facility N/A	
Report See analysis below.	
Result ***Pass: N/A***	

2.19.2. Analysis

Test requirements that heavily involve the computer/controller to which the S239610 is attached are often incorrectly flowed down to the S239610 component level. This justification is provided for such circumstances.

The S239610 has a sensing element with a non-inductive resistance pattern, is fully enclosed in a metallic (304 stainless steel) sheath, and does not have an integrated wire interconnect that might enhance a coupling effect. It consists of purely passive electrical components and is dependent upon a controlling device. The controller is responsible for preventing the generation of radio frequency emissions as it drives the passive elements. The controller is responsible for preventing or mitigating any induced signal (radiated or conducted), or that the non-inductive and shielded nature of the S239610 may allow.

The radio frequency susceptibility test is not applicable at the S239610 component level.

2.20. Emission of Radio Frequency Energy

The emission of radio frequency energy requirements ensure that the equipment does not emit undesired RF noise in excess of the specified levels.

2.20.1. Standardized Qualification Details

Standard RTCA DO-160G	*Details* N/A
Section 21.0 – Emission of Radio Frequency Energy	
Category N/A	
Facility N/A	
Report See analysis below.	
Result ***Pass: N/A***	

2.20.2. Analysis

Test requirements that heavily involve the computer/controller to which the S239610 is attached are often incorrectly flowed down to the S239610 component level. This justification is provided for such circumstances.

The S239610 has a sensing element with a non-inductive resistance pattern, is fully enclosed in a metallic (304 stainless steel) sheath, and does not have an integrated wire interconnect that might enhance a coupling effect. It consists of purely passive electrical components and is dependent upon a controlling device. The controller is responsible for preventing the generation of radio frequency emissions as it drives the passive elements.

The emission of radio frequency energy test is not applicable at the S239610 component level.

2.21. Lightning Induced Transient Susceptibility

The lightning induced transient susceptibility requirements ensure that the equipment will not experience a functional upset when exposed to lightning induced transients applied via induction or ground injection.

2.21.1. Standardized Qualification Details

Standard RTCA DO-160G	*Details* Pin injection test waveforms A or B are substituted by a dielectric withstand test of equal or greater magnitude (level 4 = 1500 $V_{AC, RMS}$). **NOTE**: 1500 $V_{AC, RMS}$ = 2121 V_{PEAK} ≈ 2121 V_{DC}
Section 22.0 – Lightning Induced Transient Susceptibility	
Category Z4XXXX	
Facility Element Materials Technology Minneapolis, LLC.	
Report Test Report # 55613-10B (Rev -) [24]	
Result ***Pass***	

2.21.2. Analysis

2.21.2.1. Pin Injection

RTCA DO-160G §22.5.1.a permits a dielectric withstand test to be conducted in lieu of a pin injection test for passive devices like the S239610. The replacement dielectric withstand test must meet or exceed the highest voltage specified by the pin injection test level. The specified "Z" in the first position is applicable to any waveform set (A or B).

2.21.2.2. Cable Bundle

Cable bundle test requirements (the XXXX portion of the category) are often incorrectly flowed down to the S239610 component level (and are not applicable). The S239610 is composed of purely passive (resistive) electrical components and is (by definition) not susceptible to functional upset.

2.22. Icing

The icing requirement ensures acceptable performance characteristics for equipment that must operate when exposed to icing conditions that would be encountered under conditions of rapid changes in temperature, altitude and humidity.

Category A is intended for equipment that may be mounted externally or in non-temperature-controlled areas of the aircraft, where ice or frost may form due to condensation.

2.22.1. Standardized Qualification Details

Standard RTCA DO-160G	*Details* Icing Category A Test (RTCA DO-160G § 24.4.2)
Section 24.0 – Icing	
Category A	
Facility N/A	
Report See analysis below.	
Result ***Pass: N/A***	

2.22.2. Analysis

The temperature sensor meets the requirements of hermetically sealed equipment, therefore there is no danger of ice or water ingress. The design does not include any moving parts, and the sensing element is encapsulated in a stainless-steel enclosure that is chemically and physically robust against repeated ice formation

The S239610 has been specifically designed with ice accumulation in mind. The stem wall has been thickened to resist cantilever bending and permanent deformation in high-flow conditions after a significant amount of ice has accumulated on the temperature probe.

2.22.3. Custom Development Testing

Standard	Details
Standard N/A *Section* N/A *Category* N/A *Facility* Customer	Ice allowed to accumulate at -5°C and Mach 0.1 air velocity (~1 bar atmosphere). After significant buildup (many times the volume of the probe itself), the air velocity is increased to Mach 0.4, at which point the ice detaches and slides toward the cantilevered tip of the probe.
Report Customer Report – See 2.22.3.1. Discussion of results	
Result **Pass**	

2.22.3.1. Discussion of results

The development test was devised to prevent a specific real-world icing scenario that was known to be problematic. The S239610 was designed for this scenario and is confirmed to survive this extreme icing scenario without deformation.

2.23. Fire and Flammability

The fire and flammability requirements ensure the operational characteristics (when exposed to flame), resistance to flame, and flame non-propagative properties of equipment.

Category C flammability tests are intended to test the non-propagation of flames originating within or external to the equipment.

2.23.1. Standardized Qualification Details

Standard	Details
Standard RTCA DO-160G *Section* 26.0 – Fire and Flammability *Category* C *Facility* N/A *Report* See analysis below. *Result* **Pass**	• Flammability Test (RTCA DO-160G § 26.6)

2.23.2. Analysis

The S239610 sensor is exempt from testing. RTCA DO-160G §26.3.3 states that testing is not required when “The enclosure is constructed of metal…on all sides, and has no vent holes.” The S239610 meets this exemption requirement.

It also has an exemption for small parts, for which all polymeric (and glass/ceramic) components of the D38999 connector would comply.

The S239610 meets the DO-160G flammability requirements by exemption. Its metallic construction and small size preclude it from contributing to flame propagation.

2.24. Pressure

The S239610 has been designed for use in various aircraft air handling systems and is also capable of fluid temperature measurement. The pressure requirement ensures that the probe-end of the S239610 is physically capable of handling the pressures utilized in the system for which it is specified.

NOTE: See section *2.2. Altitude* regarding ambient (connector-end included) environmental pressure tests.

2.24.1. Qualification Details

Standard N/A *Section* N/A *Category* N/A *Facility* Minco Products, Inc. *Report* Test Report # 2546500 [16] *Result* ***Pass: ≥ 24 MPa at 25°C***	*Details* • Externally pressurize to 22.75 MPa [3300 psi] (gauge) followed by output verification at 0°C. • Pressurize to failure.

2.24.1.1. Burst pressure

When pressurize to failure, the S239610 failed between 48.26 and 52.40 MPa [7000 and 7600 psi] (gauge).

The S239610 has been pressure tested to failure at room temperature and shown to be ultimately capable of ≥ 48 MPa. Most aircraft requirements will assume some required factor of safety, often the requirement is ≤ 2 for this type of equipment.

⇒ Utilizing a safety factor of 2, the S239610 has a *burst pressure* capability of **≥ 24 MPa [3480 psi]** (gauge) at room temperature (25°C).

2.24.1.2. Proof pressure

Proof pressure does not have a single, accepted definition. It can mean one of several possibilities:

- a multiple of the design or normal operating pressure (e.g. “1.5x maximum normal operating pressure” per US Code of Federal Regulations 14 CFR 15.1438),
- a factor of the burst pressure,
- yield level
- an operational performance threshold (performance is guaranteed below proof pressure),

In lieu of a specific requirement, the qualified proof pressure shall utilize the last definition. Minco Test Report # 2546500 [16] inspected operational output after exposure to 22.75 MPa, so this value meets the intent of that definition.

⇒ Utilizing a safety factor of 2 (as in 2.24.1.1), the S239610 has a *proof pressure* capability of **≥ 11.36 MPa [1650 psi]** (gauge) at room temperature (25°C).

2.24.2. Analysis for Elevated Temperatures

Proof and burst pressure requirements are often specified at the operational temperature extreme. The S239610 is capable of continuous operation to 300°C per 2.25 *High Temperature Endurance*.

To consider the pressure capability at the high temperature extreme, the ratio of tensile strength at 300°C to the tensile strength at 25°C can be used:

Equation 2.24-1: Pressure capability at 300°C

$$p_{300°C} = p_{25°C} \times \frac{S_{300°C}}{S_{25°C}}$$

Table 2.24.2-1: Properties of SAE/AISI 304 stainless steel [17]

Property	Value						Units
	27°C [80°F]	149°C [300°F]	260°C [500°F]	371°C [700°F]	482°C [900°F]	593°C [1100°F]	
Yield strength, S_y	2.90×10^8	1.82×10^8	1.50×10^8	1.34×10^8	1.25×10^8	1.13×10^8	N/m²
	4.20×10^4	2.64×10^4	2.18×10^4	1.95×10^4	1.81×10^4	1.64×10^4	psi
Ultimate tensile strength, S_u	5.79×10^8	4.72×10^8	4.42×10^8	4.27×10^8	4.14×10^8	3.67×10^8	N/m²
	8.40×10^4	6.84×10^4	6.41×10^4	6.19×10^4	6.00×10^4	5.32×10^4	psi

2.24.2.1. Burst pressure at 300°C

Per Table 2.24.2-1 (interpolated):

- $S_{u,\,300°C} = 4.337 \times 10^8$ Pa
- $S_{u,\,25°C} = 5.810 \times 10^8$ Pa

Utilizing Equation 2.24-1:

$$p_{burst,\,300°C} = p_{burst,\,25°C} \times \frac{S_{u,\,300°C}}{S_{u,\,25°C}} = 24\text{ MPa} \times \frac{4.337 \times 10^8\text{ Pa}}{5.810 \times 10^8\text{ Pa}} = \mathbf{17.92\ MPa\ [2600\ psi]}$$

2.24.2.2. Proof pressure at 300°C

See 2.24.1.2 regarding the definition of “proof pressure”.

Per Table 2.24.2-1 (interpolated):

- $S_{u,\,300°C} = 4.337 \times 10^8$ Pa
- $S_{u,\,25°C} = 5.810 \times 10^8$ Pa

Utilizing Equation 2.24-1:

$$p_{proof,\,300°C} = p_{proof,\,25°C} \times \frac{S_{u,\,300°C}}{S_{u,\,25°C}} = 11.36\text{ MPa} \times \frac{4.337 \times 10^8\text{ Pa}}{5.810 \times 10^8\text{ Pa}} = \mathbf{8.48\ MPa\ [1230\ psi]}$$

2.24.3. Third-Party Verification Details

Standard N/A	*Details* Apply external pressure of 488 psig for 1 minute.
Section N/A	
Category N/A	
Facility Element Materials Technology Minneapolis, LLC.	
Report Test Report # 55613-9 (Rev -) [23]	
Result **Pass**	

2.25. High Temperature Endurance

High temperature endurance requirements ensure that the equipment is capable of a lifetime of exposure to elevated temperatures. Accurate application requires knowledge of the aircraft mission profiles (expected temperature exposure probability over the life of the aircraft).

2.25.1. Qualification Details

Standard N/A *Section* N/A *Category* N/A	*Details* • >1700 h at 300°C, • >236 h at 270°C, • >1487 h at 260°C
Facility Minco Products, Inc. *Report* Test Report # 2538395 [13] *Result* ***Pass***	

2.25.1.1. Discussion of results

The temperature and duration combination used to test the high temperature endurance of the S239610 was selected for a particular flight profile (demonstrating >80 000 flight cycles). The Arrhenius Equation can be used to estimate an equivalent cycle count for other flight profiles.

2.26. Low Temperature Endurance

Low temperature endurance requirements ensure that the equipment is capable of a lifetime of exposure to depressed temperatures. Accurate application requires knowledge of the aircraft mission profiles (expected temperature exposure probability over the life of the aircraft).

2.26.1. Qualification Details

Standard N/A *Section* N/A *Category* N/A	*Details* • >50 h at -55°C
Facility Minco Products, Inc. *Report* Test Report # 2538395 [13] *Result* ***Pass***	

2.27. Thermal Cycling

Thermal cycling requirements ensure that the equipment can meet or exceed the specified number of flight cycles expected during the service life of the aircraft. Accurate application requires knowledge of the aircraft mission profiles (expected temperature exposure probability over the life of the aircraft).

2.27.1. Qualification Details

Standard N/A *Section* N/A *Category* N/A *Facility* Minco Products, Inc. *Report* Test Report # 2538395 [13] *Result* **Pass**	*Details* • >10 000 cycles between 0 and 250°C

2.27.1.1. Discussion of results

The temperature delta and cycle count used to test the S239610 temperature sensor design was selected to demonstrate a specific distribution of mission profiles over the entire life of an aircraft. The Coffin-Manson Equation can be used to estimate the test coverage with respect to other mission profiles or distributions.

2.28. HALT

HALT (Highly Accelerated Life Testing) is a method for stressing equipment to failure. It is designed to stress the equipment beyond what is expected in field environments and uncover design or construction weaknesses.

2.28.1. Qualification Details

Standard
N/A
Section
N/A
Category
N/A
 	
Facility
Element Materials Technology Minneapolis, LLC.
Report
Test Report # 2538395 [13]
Result
Pass
	Details
	• Cycle from 25°C to -94°C to 181°C (during 1 hour) while exposed to eight increasingly severe vibration conditions (sinusoidal, *g*-peak)
	  ○ 9 *g*, 12 *g*, 15 *g*, 21 *g*, 27 *g*, 33 *g*, 39 *g*, 45 *g*
	  ⇒ 8 hours total

2.28.1.1. Discussion of results

There were no failures during HALT testing. After HALT testing, two units were CT scanned and dissected. No anomalies or premature deterioration were observed in either the CT scan or the dissection.

HALT testing was performed to the maximum level possible with available equipment. Significantly higher levels are required to truly meet the intent of HALT testing and cause failure in the S239610.

2.29. Response Time

Response time requirements ensure that the temperature sensor is compatible with the expected temperature rate of change or the predictive characteristics of the system.

Response time is particularly important when replacing a legacy sensor or sourcing the temperature sensor from multiple vendors. Care must be taken to ensure that the temperature sensors, which are likely of different designs (and therefore response characteristics), behave the same in the systems in which they'll be installed.

2.29.1. Qualification Details

Standard	Details
N/A	• Fully characterize temperature response time ○ Measure time constant in multiple instrumented flow conditions: ▪ Air, 5 m/s (ambient pressure, ≥40°C) ▪ Air, 40 m/s (ambient pressure, ≥40°C) ▪ Air, 60 m/s (ambient pressure, ≥40°C) ▪ Air, 80 m/s (ambient pressure, ≥40°C) ▪ Air, 100 m/s (ambient pressure, ≥40°C) ▪ Air, 110 m/s (ambient pressure, ≥40°C) ▪ Water, 1 m/s (60°C) ○ Convert conditions to convection coefficient and fit to characteristic curve
Section N/A	
Category N/A	

Facility
Element Materials Technology Minneapolis, LLC.
Minco Products, Inc.

Report
Test Report # 61925-1 (Rev -) [26]
Test Report # 3242903 [27]

Result
Pass: 1 s in 1 m/s moving water

2.29.1.1. Discussion of results

The time constant of a temperature sensor is a function of the convection coefficient, h ($W\cdot m^{-2}\cdot K^{-1}$), of the fluid flow condition that it is measuring. The convection coefficient encapsulates the thermophysical and convective properties of the fluid or gas mixture into a single variable.

The S239610 was measured at several flow conditions at ambient pressure (~98 kPa). Convection coefficients were calculated for each flow condition, then a characteristic curve was fitted using the methodology described in Minco white paper "Response Time Considerations in Temperature Sensing" [28]. The resulting equation is of the form $\tau(h)=ah^b+c+\bar{\tau}_0$, where $\bar{\tau}_0$ is the average 63.2% time constant in 1 m/s moving water (as described in ASTM E 644 [29]).

Equation 2.29-1: Response time characteristic equation

$$\tau_{0.632}\ (\text{seconds})=910\times h\ \left(W\cdot m^{-2}\cdot K^{-1}\right)^{-0.87}+0.75$$

Table 2.29.1-1: Reference values

Time constant (63.2%, 1 m/s water), $\bar{\tau}_0$	1.0 s
Variation (standard deviation, part-part) (approx., any flow condition)	0.21 s

2.29.1.2. Notes on application of characteristic curve

1. The data collected in Test Report # 61925-1 (Rev -) [26] is sufficient calculate response time for most flow conditions (gas or fluid), except that *still* gasses are outside of the characterized regime.
2. In multi-source situations, the S239610 may need to match the performance of a sensor from another vendor. The characteristic curve can be recalculated for better comparison to another product (such as presenting it with respect to velocity or at other time constant step change percentages).