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National Aeronautics and
Space Administration
John C. Stennis Space Center

Stennis Space Center, MS
39529-6000

Instrument Specification

For

A-3 Test Stand

Platinum Resistance Temperature Detectors

(PRTDs)

Used in non-corrosive fluids including

Hydrogen and Oxygen

National Aeronautics and Space Administration
John C. Stennis Space Center
Stennis Space Center, MS 39529-6000

SIGNATURE RECORD

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DOCUMENT HISTORY LOG

Status (Baseline / Revision/ Canceled)	**Document Revision**	**Effective Date**	**Description**
Initial Release for Procurement (Baseline)	0	June 10, 2011	Initial Release for Procurement
Modification for clarification	1	July 15, 2011	Clarification of paragraph 3.3.11. Changed "When vibration qualification is specified by purchase order, the following shall apply." to "The vendor shall perform vibration qualification of a representative sample of the quantity ordered per the following"

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1.0 Scope

This specification designates the requirements for Platinum Resistance Temperature Detector (PRTD) intended for use in liquid or gaseous hydrogen, oxygen and kerosene. These are intended for quick, precise measurement of predominately cryogenic fluids under a range of temperatures, pressures and flow rates.

2.0 Classification

The transducers (PRTD) will carry the manufactures sensor number followed by "TR" designation along with the sensor insertion length noted in eights of an inch. The available lengths shall range from 16 (2") to 80 (10"). Insertion length is noted on Figure 1 of this specification as length "A".

Example: A 4" insertion length shall be defined as part number

xxxTR32

3.0 Requirements

3.1 General

3.1.1 Configuration:

The transducers shall conform to the physical drawing depicted in Figure 1.

3.1.2 Mounting:

The transducer shall mate and seal to an MS 33649-4 boss.

3.1.3 Electrical Connector:

The electrical connector shall mate with an MS 3106-10SL-3S connector.

3.1.4 Schematic:

The transducer shall be wired per the schematic noted on Figure 1. No pins shall be connected to the case.

3.1.5 Shield:

The sensing element shall be surrounded by a perforated 304 SS shield to provide protection from mechanical damage while allowing limited exposure of the sensor to the fluid flow. The shield and transducer housing shall be joined by welding if not integral to the device.

3.1.6 Identification:

The following minimum information shall be electro-etched, stamped or otherwise made a permanent and integral part of the transducer in the position shown on Figure 1. In addition the unique serial number shall be stamped into on flat of the hexagonal fastening section.

- Model and Type
- Unique Serial Number

3.2 Physical

3.2.1 Sensor:

The sensor shall consist of reference grade platinum wire mounted on a strain free support and protected by a ceramic insulation. The Callandar-Van Dusen alpha constant of the sensor shall be 0.00391 or greater.

3.2.2 Materials:

All materials in contact with the test fluid shall be compatible with liquid or gaseous hydrogen, oxygen and kerosene over a range of temperatures and pressures. The transducer shall not be damaged by exposure to Freon TF, acetone, trichloroethylene and gaseous or liquid helium and nitrogen. The housing, extension, element mount and shield shall be of 304L SS. The end retainer ring shall be 308L or 308ELC CRES. The end bushing shall be certified as constructed from Chem Fluor TFE Virgin Extruded Rod tested per White Sands Test # BT-WS-014A.

3.2.3 Finish:

No pits or scratches shall be present. The sealing surface shall be per Figure 1.

3.2.4 Passivation:

Parts shall be passivated to resist corrosion.

3.3 Design and Performance

3.3.1 Repeatability:

At any temperature in the use range, the resistance of the transducer shall be repeatable within the ohmic equivalent of +/- 0.1°F from the average value of resistance at that temperature.

3.3.2 Use Range:

The transducer shall be capable of operating within specifications over a range of -440 to +500°F.

3.3.3 Thermal EMF:

When the transducer is quickly immersed in liquid nitrogen up to the attaching threads from room temperature conditions the EMF between pins A and B of the electrical connector shall not exceed 100 µV and shall be <25 µV within one minute.

3.3.4 Self Heating:

A power input of 150 mW shall cause an indicated sensor error of ≤ 1°F in Dow Corning #200 oil flowing transverse to the sensor at 3 fps at 75°F.

3.3.5 Time Constant:

When a sensor is quickly immersed in the 170°F Dow Corning #200 oil flowing transverse to the sensor at 3 fps, 63% of the total sensor response shall occur within 500 mSec.

3.3.6 Current:

A continuous current of 20 mA RMS shall not damage the sensor.

3.3.7 Insulation Resistance:

At room temperature and dry internal surfaces, the insulation resistance between pins A or B to the case shall exceed 10 MΩ at 100 VDC.

3.3.8 Use Pressure:

The transducer shall be operable within specification over a pressure range of 9,000 psi. The sensor ice-point resistance shall exhibit a maximum shift of 3 Ω (equivalent to 1 degree F) at this pressure. No detectable leakage shall occur at 6,000 psi.

3.3.9 Proof Pressure:

The transducer shall not be damaged by proof pressure testing to 13,500 psi.

3.3.10 Flow:

The sensor of the transducer shall operate at flow-rates having a dynamic pressure:

$$\frac{\rho V^2}{2} = \frac{150}{x(L - x/2)}$$

Where,

ρ= fluid density, $lb_f \cdot s^2/in^4$
V= fluid velocity, in/s
x= length exposed to impinging flow, in
L= length from tip to threaded fitting, in

3.3.11 Vibration – Qualification

The vendor shall perform vibration qualification of a representative sample of the quantity ordered per the following:

- Sensors, grouped into length categories, shall be undamaged by superimposed sine on random vibration for each category as shown in Table 1 - Table 6.
- The duration of the vibration tests shall be 6,000 seconds per axis.

3.3.11.1 Random:

A random PSD has been specified for each length category as shown in Table 1 - Table 5 for the frequency range 20Hz-2000Hz.

134TR -16 to -24 53.85 Grms

Frequency [Hz]	**Amplitude [G^2/Hz]**	**Slope [dB / Octave]**
20	0.060	6.021
100	1.000	0.000
2000	1.000	

Table 1 : Qualification Screening for 134TR -16 through -24

134TR -26 to -30 43.97 Grms

Frequency [Hz]	**Amplitude [G^2/Hz]**	**Slope [dB / Octave]**
20	0.040	6.021
100	1.500	0.000
2000	1.500	

Table 2 : Qualification Screening for 134TR -26 through -30

134TR -32 to -36 32.61 Grms

Frequency [Hz]	**Amplitude [G^2/Hz]**	**Slope [dB / Octave]**
20	0.022	6.021
100	0.550	0.000
2000	0.550	

Table 3 : Qualification Screening for 134TR -32 through -36

134TR -40 to -53 21.98 Grms

Frequency [Hz]	Amplitude [G^2/Hz]	Slope [dB / Octave]
20	0.010	6.021
100	0.250	0.000
2000	0.250	

Table 4 : Qualification Screening for 134TR -40 through -53

134TR -68 to -72 9.83 Grms

Frequency [Hz]	Amplitude [G^2/Hz]	Slope [dB / Octave]
20	0.002	6.021
100	0.005	0.000
2000	0.005	

Table 5 : Qualification Screening for 134TR -68 through -72

3.3.11.2 Sinusoidal:

Two sines are to be superimposed on the random vibration environment with the amplitude specified in Table 6. One sine will be swept over the frequency range 130 Hz – 1,065 Hz and the other over the range of 1,065 Hz to 2,000 Hz. A total of ten linear sine sweeps for the two sine sweep bands is specified over the test duration (1 sweep in 600 seconds). For each sine sweep band this corresponds to a sweep rate of approximately 1.56 Hz/sec.

134TR Length Categories

	-16 to -24	-26 to -30	-32 to -36	-40 to -53	-68 to -72
Amplitude [Gpk]	23.99	12.81	8.54	4.44	2.04

Table 6 : Sine Amplitudes for Each Sine Band

3.3.11.3 Shock:

The sensor shall meet all the requirements herein after exposure to the environment defined in Table 7 for each axis. Apply 60 shocks per axis in 3 mutually perpendicular axes for the total of 180 shocks. The duration of the first 30 shocks shall be 3.0 seconds each and the duration of second 30 shocks shall be 1.5 seconds each.

Transient Shock	
Freq (Hz)	SRS (G)
10	8
30	20
100	120
600	120
1300	240
2000	280

Table 7 : Shock Spectrum

3.3.12 Base Resistance:

The sensor of the transducer shall have an ice-point resistance of 1257 ± 3 Ω.

3.3.13 LHe Resistance:

The resistance of the sensor at the boiling point of helium shall not exceed 0.12% of the ice point resistance.

3.3.14 Calibration:

Each sensor shall be calibrated at three points; helium boiling, nitrogen boiling and ice point. Calibration reports for each transducer shall be submitted with the devices including the three point resistances.

4.0 Tests

4.1 Acceptance Tests

These tests may be performed at SSC or our appointed location on an individual or sampling basis. Failure of a PRTD to pass any acceptance test may be cause for rejection of the device.

4.1.1 Individual Tests:

Each PRTD shall be subjected to the following tests:

(a) Repeatability:

The Ro (Ice Point) calibration shall be performed as the baseline test of the device. Conditioning the PRTD will be performed with 5 dips in liquid nitrogen. The PRTD shall then be calibrated at three points; helium boiling, nitrogen boiling and ice point. At the final ice point the Ro value will not shift by more than 0.1°F from the initial test.

(b) Proof Pressure:

The PRTD shall be proof pressure tested at 13,500 psi in GN2. No leakage, damage or permanent calibration shift shall occur.

(c) Insulation Resistance:

The dry PRTD insulation resistance shall be measured between pin A and the case and shall exceed 10 MΩ at 100 VDC.

(d) Visual:

The PRTD shall be visually inspected for identification per paragraph 3.1.6 along with configuration and sealing surfaces per Figure 1. In addition the electrical connector will show no evidence of glass seal cracking surrounding the pins of this connector.

(e) Helium Leak:

The PRTD shall have less than 10^{-7} SCC/S of Helium leak rate through the connector with a differential pressure of 15 psi.

4.1.2 Lot Tests:

The following tests will be performed on a sample basis:

(a) Pressure Effect:

The PRTD shall be mounted in a test fixture and filled with oil and stabilized at the ice point. The pressure shall be increased to 9,000 psi and the ice point again stabilized. The difference between the pressurized and non-pressurized ice points shall be < 1°F.

(b) Thermal EMF:

Thermal EMF shall be measured per paragraph 3.3.3.

(c) Self Heating:

Self heating shall be measured per paragraph 3.3.4.

(d) Time Constant:

Time constant shall be measured per paragraph 3.3.5.

(e) Flow:

The PRTD shall be mounted in a boss perpendicular to a flow of water equivalent to the dynamic forces of paragraph 3.3.10 for a period of five minutes. No damage shall occur.

(f) Vibration:

The PRTD shall be subjected to the vibration requirements of paragraph 3.3.11. No damage shall occur.

(g) Shock:

The PRTD shall be subjected to the shock requirements of paragraph 3.3.11.3. No damage shall occur.

5.0 Packaging

Each PRTD shall be shipped with a protective metal sleeve around the sensor to prevent damage. The sleeve shall be attached by the transducer mounting threads.

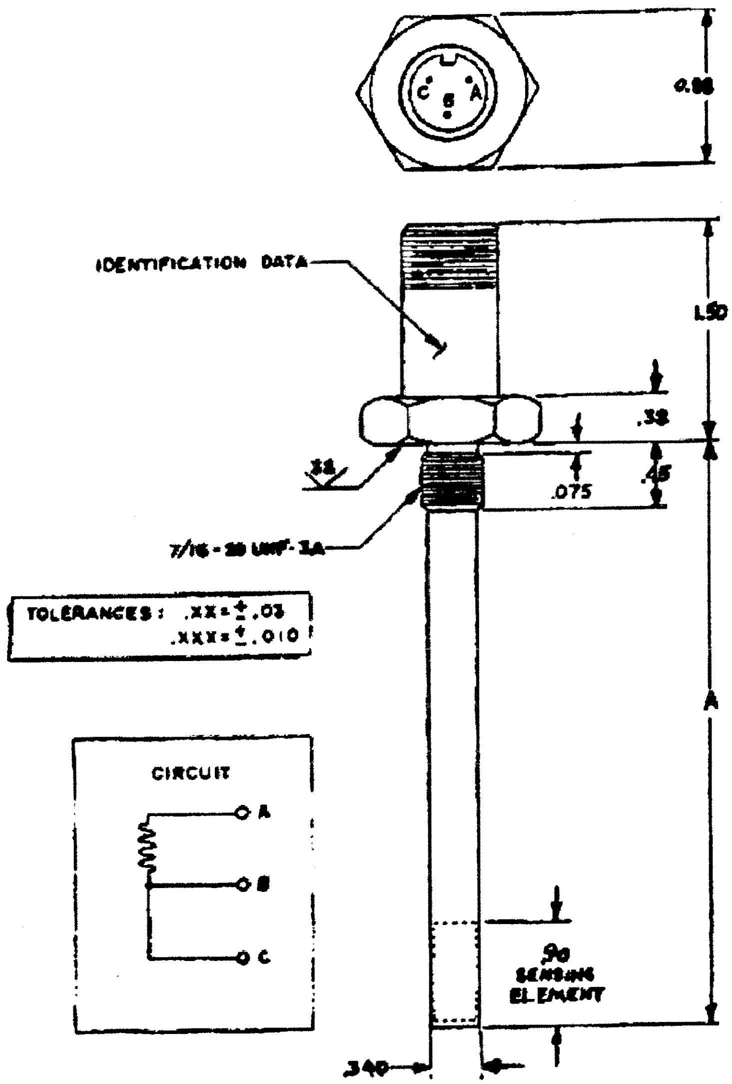

FIGURE 1

Figure 1 : PRTD Construction