SRG Inc-ASL US

Report of Service, Test, and Calibration
For Accomack County
Fire Service Training

For Work Performed on September 9, 2010
@ Accomack Burn Building
Beacon Drive, Melfa

Kenneth Sloneker

09/16/2010

Signature : Kenneth C. Sloneker Date: 9/28/10

SRG Systems Resource Group Inc.

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Burn Building Temperature Sensor Calibration Procedure

Procedure 10-100
November 5, 2009
Written By: K. C. Sloneker

1.0 Scope:

1.1 Calibration procedures for the temperature monitoring systems in Class A and B burn building are covered in this document. This procedure applies to the sensors, cabling, and instrumentation used to monitor temperature for the purpose of protecting the building structure. These buildings are used specifically for the training of fire fighting personnel. Since no specific National Fire Protection Agency (NFPA) methods for this calibration exist all of the methods are based on principals of thermocouple calibration provided by the American Society of Testing and Materials (ASTM) 14.03 Thermometry. Calibration methodologies and general procedures are taken from ISO, ISA and NCSLI documentation and their accepted calibration principals. Uncertainties of calibration are based on the Guide to Uncertainty in Measurement (GUM) from the National Institute of Standards and Technology (NIST).

Cautionary Note 1: This calibration provides no information about the efficacy of the monitoring system to provide data that can be used to protect personnel during live burn training evolutions.

2.0 General Assessment:

2.1 The general condition of the structure shall be assessed as part of the monitoring system evaluation. Specific evaluations shall be made about the mounting systems for the sensors and instrumentation. Careful attention shall be given to their mounting, protection from water and their location within the structure. These comments shall be detailed in Section 1 of the reports.

3.0 Monitoring System Evaluation:

3.1 The system shall be tested as a monitoring or control loop so that the full system is evaluated at the same time. This ensures that the complete system is tested as it would be used. Each individual component of the system shall also be tested to ensure they are functioning properly independent of the system. Component testing allows a more complete set of tests to be run than are possible during loop testing.

3.1.1 Loop Testing

3.1.1.1 A heated head assembly should be placed onto the sensor while it is installed unless it is too short in which case it can be removed from its mounting assembly.

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3.1.1.2 The temperature should be set to 100 °C on the calibrator; readings can be taken once the system has stabilized. It is recommended to use a remote head calibrator manufactured by EDL Inc. (TEVAL). This device should have a current calibration and that should be verified on site using a suitable and calibrated instrument and sensor.

3.1.1.3 Record this data in the column marked as found loop reading for each individual sensor. Repeat this procedure at room temperature, 100 °C, and at 50% and 90% of the maximum service temperature.

3.1.2 Sensor and Cable Test

3.1.2.1 Disconnect the sensor wire from the instrument and measure the loop resistance at room temperature.

3.1.2.2 Test the sensor to determine if it is grounded or ungrounded and if it is grounded to the structure.

3.1.2.3 Connect the sensor to a thermocouple instrument and repeat the procedure in 3.1.1.1 to 3.1.1.3

3.1.2.4 Record this data in the column marked Sensor and Cable.

3.1.3 Ungrounded Sensor Insulation Resistance Test

3.1.3.1 This test can only be performed on ungrounded sensors when the sensor is disconnected from the monitoring or controlling instrument.

3.1.3.2 Connect the sensor or sensor and cable to one leg of the thermocouple wire and connect the other lead to the sheath of the sensor. Apply 100 volts DC and read the resistance value. It is expected to be greater than 100 Mega Ohms.

3.1.4 Monitoring or Controlling Instrument Test

3.1.4.1 A mV source will be used to simulate a thermocouple in put to the instrument.

3.1.4.2 Connect the leads from the source to the instrument and simulate the same temperatures that were used in section 3.1.1.1 to 3.1.1.3.

3.1.4.3 Record the readings in the column marked monitoring instrument.

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3.2 General Considerations

3.2.1 If at any time during the readings become out of tolerance a decision must be made whether further testing should be conducted or repair and replacement undertaken. The tolerance depends on the accuracy of the components installed and the requirements of the user. It is also driven by the calibration interval, calibration equipment and overall calibration uncertainty.

3.2.2 All equipment found to be out of tolerance shall be rejected and tagged accordingly. It is highly recommended that all rejected equipment be taken out of service until the appropriate repairs or replacements can be made.

3.2.3 Service tolerances should be established prior to testing through discussion with the user and by evaluating the equipment used to control or monitor.

3.2.4 Due to the harsh operating conditions of this equipment it is highly recommended that users self verify the temperature monitoring system at more frequent interval depending on the number and frequency of evolutions.

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As Found Data

Test Description (Units)	FLR1	FLR1 B	FLR2	FLR1 W	FLR2 B	FLR2 W	Attic	
100 C	99.4	98.9	98.9	98.9	98.9	98.9	98.9	
300 C	297.8	298.3	296.7	298.3	298.3	298.3	298.3	
500 C	500	495	496.7	500	498.9	496.7	497.8	
Cable Ground Test (Pass Fail)	P	P	P	P	P	P	P	
IR Test Ungrounded Only (MOhms)	25	22	8	7.5	4.0	40	30	
Loop Resistance	2.4	14.7	3.2	26.2	43.6	40.6	43.8	

Table1, 10-100 Rev 1

Signed: ______________________ Date: ____________________

Signed: ______________________ Date: ____________________

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General Notes

Rooms are approximately 10 x 10 x 8 feet high

Sensor Part Number K24U-006-00-15HT F1008-4, MC, R24U-006

Description: 1/8 dia. x 6" Long Sensor with 12" GL/GL Lead and Standard Plug, Type K and Type R in Ceiling

Yokogowa DR 210-1 #12BC18747 with 20 Channel Inputs Thermocouple

Sensors protruded about 2 inches from the wall and ceiling

Monitor System is mounted in the utility garage area attached to the burn building. It is well protected from the elements and is also inside an electrical enclosure.

The box is internally heated and cooled with an internal box temperature control device

All of the boxes and insulation in the ceiling were in generally good shape and they were dry.

Upon arrival 5 sensors were working, at departure all seven sensors were functional.

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Photographs:

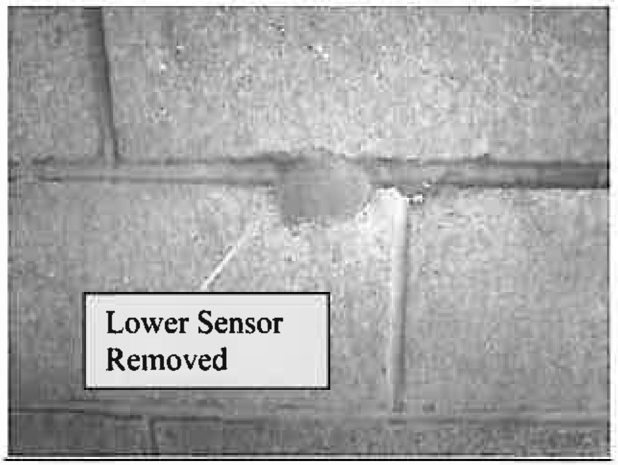

Figure 1, Original Low Sensor Location

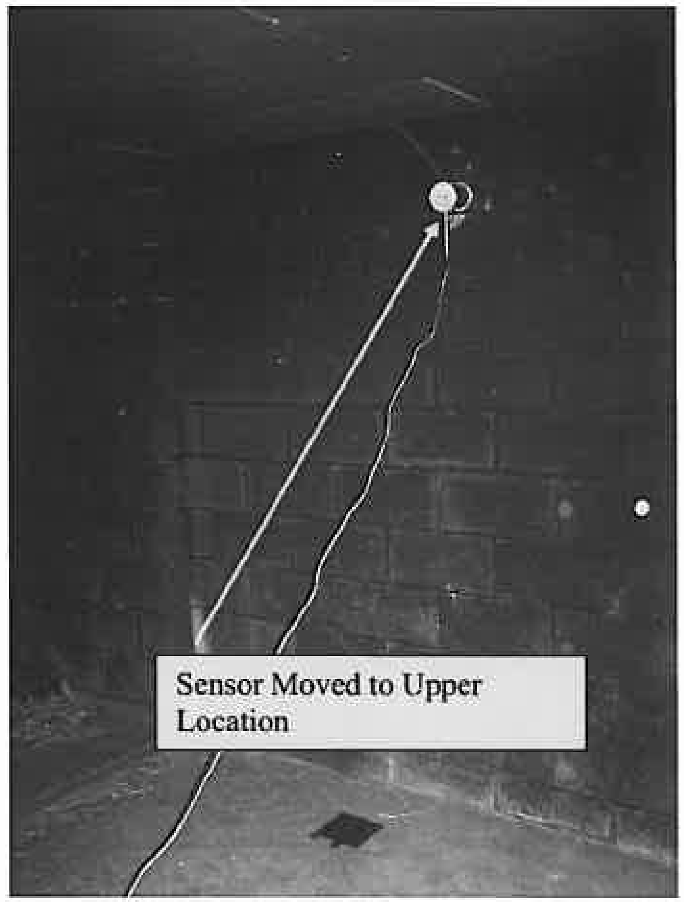

Figure 2, New Upper Sensor Location

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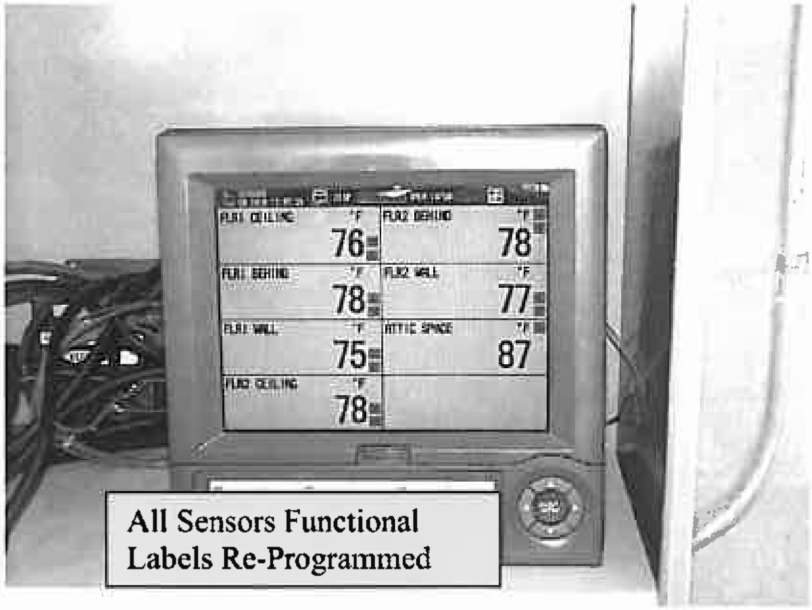

Figure 3, Display on Completion

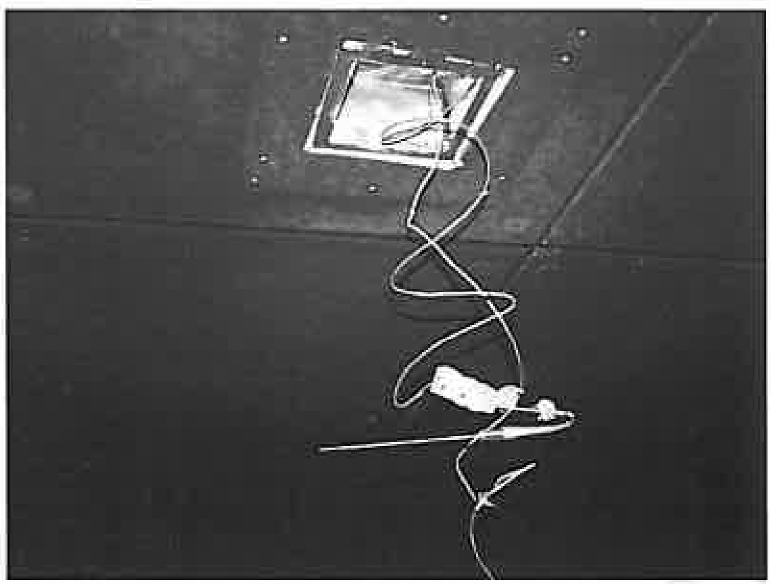

Figure 4, Box Assemblies Dry and Properly Insulated on Inspection

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Closing Report

1. General Assessment and Comments
   a. The building structure is 20' x 49' 2 ½ story cement and fire brick in generally good condition. All of the sensor wires are PFA/PFA parallel run in standard conduit protected from the weather. Each sensor is mounted using compression fittings in the center of two separate burn rooms. Each room is 10' x 10' with 8' ceilings, the sensors are mounted center ceiling, behind the ceiling and on the wall. The sensors protruded about 2" on average from the compression fitting. All but one channel was reading and appeared to be in working order upon our arrival. The sensor readings were indicated by a recording system mounted on the inside of the building in a weather proof heated/cooled enclosure. The enclosure temperature was measured in the enclosure and found to be about 78 °F during the testing process. Each sensor loop and individual sensor was calibrated and tested to verify that it is performing as expected. Test results tabulation can be found in section 2. In this report front means the sensor protruding from the compression fitting and back means the sensor mounted behind the insulating material. Type R sensors are well suited for high temperature measurement but the copper wire connections in the lead wire are not well suited for wet or high temperature applications, some evidence of corrosion due to heat was present on these wires. It may be desirable to convert these sensors to more robust type K sensors. In the procedure attached loop temperature tests are performed but due to time constraints and problems with the protrusion length an optional calibration was performed. When the sensors are replaced and repairs performed this test should also be performed. Three channels on the recorder were mislabeled and two showed the sensor as removed. In addition the FLR1 Wall sensor was damaged and would not fit into the calibrator head so it was replaced. The ceiling sensor on floor 1 was reading low and so it was replaced. The attic sensor had been removed and it was installed. All of the sensors were supplied by the customer and all of the test results are for the newly installed sensors. The old sensors were tagged and returned to the customer. The monitoring system was re-programmed to reflect the proper labeling. It should be noted that the wall sensors are located very high but if located in their original location breakage is likely. The rooms are small and the sensor was mounted very near the door where entry is made. Additionally, it is likely the sensor would read incorrectly due to the door opening. Moving the sensor to another opposite wall would require some investment.

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2. Data Tabulation
    a. Different measuring instruments were used to calibrate and test the sensors. The actual data and reduced data are shown in the table, graphs and attached spread sheets.

3. Measurement Uncertainty
    a. The measurement uncertainty represents both the calibration equipment and worst case values for all sensors. This affects the reference junction compensation of the calibration and measuring instrumentations. The uncertainty analysis is included in section 2.

4. Pass Fail Analysis
   Based on the data collected and the test conditions the sensors and instrumentation will be considered acceptable for use in the training center. It should be noted that the insulation resistance values of all of the sensors is lower than expected, 100 Mega Ohms. Even the new sensors exhibited low IR values; most likely due to the long term absorption of moisture.

5. Calibration Equipment Traceability Statement
   Calibration Reports for the Temperature monitoring equipment used on site is attached.

6. Recommendations outside of Pass Fail Criteria
    a. Immediate replacement of the sensors is not required but all of the reported values should be compared to new values obtained at the next calibration interval. Ungrounded sensors should typically be above 10 and ideally 100 Mega Ohms at ambient temperature, Ref: ASTM 14.03. Many of the sensors in this building read far below the expected values.

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References:

1. ASTM, Principles of Thermoelectric Thermometry, Manual on the Use of Thermocouples in Temperature Measurement, MNL12, ASTM Philadelphia PA, 1993, pg.8-21.

2. NIST Monograph 175, National Institute of Standards and Technology, Washington D.C., 1990

3. ASTM, (2009). Annual Book of ASTM Standards. (Vol. 14.03). West Conshohocken, PA. ASTM, Philadelphia PA, 1999

4. NIST Technical Note 1297 (1994) Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results. Gaithersburg, MD. NIST

5. Virginia Department of Fire Programs- VDFP Website, Schedule of Burn Building Prop Inspections.

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Instrument F to C Conversion

Inst Test	Temp F	Temp C	Temp F	Temp C	Temp F	Temp C	
FLR1 Ceiling	211.0	99.4	568.0	297.8	932.0	500.0	FLR1 Ceiling
FLR1 Behind	210.0	98.9	569.0	298.3	923.0	495.0	FLR1 Behind
FlR2 Ceiling	210.0	98.9	566.0	296.7	926.0	496.7	FlR2 Ceiling
FLR1 Wall	210.0	98.9	569.0	298.3	932.0	500.0	FLR1 Wall
FLR2 Behind	210.0	98.9	569.0	298.3	930.0	498.9	FLR2 Behind
FLR2 Wall	210.0	98.9	569.0	298.3	926.0	496.7	FLR2 Wall
Attic Space	210.0	98.9	569.0	298.3	928.0	497.8	Attic Space

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Data Reduction

Burn Building Calibration Data Analysis

Accomack Fire

Tval	Ref Sensor	Ref Sen Cor			Tval Corrected		Std Tol	
100.0	99.0	0.5			99.5		100.0	1.1
300.0	296.9	2.9			299.8		300.0	2.3
500.0	496.7	2.9			499.6		500.0	3.8
	Nominal	Nominal	Nominal					
Temp Test	100.0	300.0	500.0					
	Actual	Actual	Actual					
Corrected	99.5	299.8	499.6				100 VDC	Res Ohms
Sensor	100.0	DEV	300.0	DEV	500.0	Dev	IR Mega Ohms	Sensor Loop
FLR1 Ceiling	99.4	-0.1	297.8	-2.0	500.0	0.4	25.0	2.4
FLR1 Behind	98.9	-0.6	298.3	-1.5	495.0	-4.6	22.0	14.7
FIR2 Ceiling	98.9	-0.6	296.7	-3.1	496.7	-2.9	8.0	3.2
FLR1 Wall	98.9	-0.6	298.3	-1.5	500.0	0.4	7.5	26.2
FLR2 Behind	98.9	-0.6	298.3	-1.5	498.9	-0.7	4.0	43.6
FLR2 Wall	98.9	-0.6	298.3	-1.5	496.7	-2.9	40.0	40.6
Attic Space	98.9	-0.6	298.3	-1.5	497.8	-1.8	30.0	43.8
Instrument	100.0	Dev Corr	300.0	Dev Corr	500.0	Dev Corr		
FLR1 Ceiling	100.0	0.0	300.6	0.6	500.0	0.0		
FLR1 Behind	99.4	-0.6	300.6	200.6	500.0	0.0		
FIR2 Ceiling	100.0	0.0	300.6	200.6	500.0	0.0		
FLR1 Wall	100.6	0.6	300.0	200.0	500.6	0.6		
FLR2 Behind	100.0	0.0	299.4	199.4	500.6	0.0		
FLR2 Wall	100.0	0.0	300.6	200.6	500.0	-0.6		
Attic Space	100.0	0.0	300.0	200.0	500.0	0.0		

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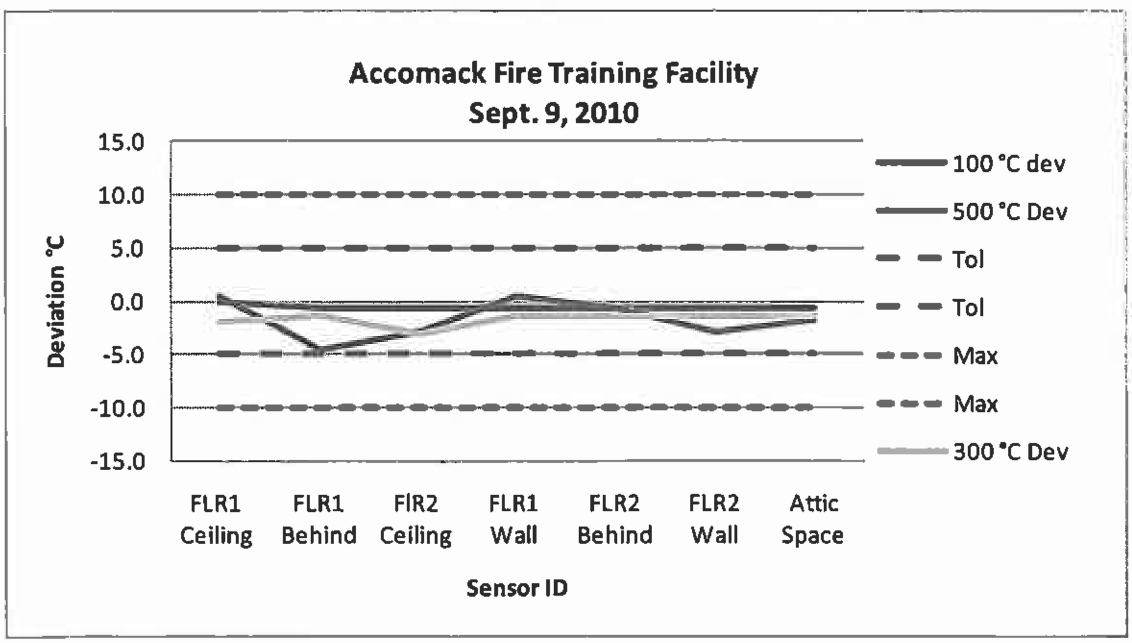
Uncertainty Analysis

Accomack Fire
9-Sep-10
Measurement Uncertainty

All Contributors are Treated as Rectangular Distributions

	Type A		Type B				
	Data Spread	Temp Source	Yokogowa Accuracy	1.5	0.866025	0.75	
100	1	0.5	Cold End Yokogowa	2	1.154701	1.333333333	
			Thermocouple Type K	4.5	2.598076	6.75	
300	3.1	0.5	Cold End Ref Inst	0.3	0.173205	0.03	
			Ref Inst	0.1	0.057735	0.003333333	
500	4.6	0.5	Ref TC	2	1.154701	1.333333333	
			Ground Loops	0	0	0	
	2.655811238	0.288675135	EMI/RFI	0	0	0	
	x/SQRT(3)						
					Type B	10.2	
	7.053333333	0.083333333			Type A	7.136666667	
						K=1	K=2
				RSS	°C	4.1637323	8.327465
				RSS	°F	7.49471814	14.98944

Graph of Sensor Error



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CUSTOMER SERVICE REPORT

CSR NO.		DATE: 9/9/10	
Customer Name: ACCOMACK FIRE.			
Address: 28598 BEACON Rd.			
City: Melfa / Gloucester		State: VA	ZIP Code:
Status of Call: Warranty/ Service/ Evaluation (Please circle) Calibration Test.		Instruction From: Charles Pruitt. On	
NATURE OF PROBLEM			
Problem Reported: Calibration test system			
System Down: Yes/ No (Please circle)			Equipment Type:
Make: Block / MASON		Model	Serial No.
Call Reported by: Bldg. 20x49' 2 Story.		Date:	Time:
Location of Installation:			
SERVICE DETAILS			
Service Rendered: wall sensor Removed 1st Floor - At Door? Replaced @ High level.			
Engineer's Remarks: All sensors Replaced were supplied By Customer. Install attic sensor TYPE K.		Status after Service: (Please circle) Complete/ Incomplete/ Pending for spares/ Under Observation/ Working solution provided	
Defects found on inspection: Replaced TYPE K Ceiling 1st Floor Replaced TYPE K High wall 1st Floor.			
Events: (Date & Time)	Start of Service: 0530	End of service: 1400	
ESTIMATED COMPLETION			
Labor	Date Required 9/9/10	Date Agreed 9/9/10	Annoyed
PARTS AND MATERIALS			
Remarks: Report will be EMAILED & Hard Copy Deliver. - Flowers			
Travel In/Out		Miles Traveled 250 M	Odometer Readings 29,397 M - 29,678
Email: Tech@ESLS.Com			
Signature: [signature]		Date: 9/9/10.	Place:

29.397
-0R
250 Miles

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Electronic Development Laboratories Inc.
Temperature Calibration Laboratory
244 Oakland Drive
Danville, VA 24540

Report of Calibration
Report # 3000378

Description: Type "K" MGO
Manufacturer: Idaho Labs
Instrument Model # n/a Serial # n/a
Sensor Model # TWH-K30250SPP Serial # 3000378

Requestor
SRG
250 Oakland Drive
Danville, VA 24540

This instrument and/or thermocouple were calibrated by comparison to a PRT device and a digital indicating instrument. All reference readings were made in degrees centigrade to better than or equal to the nearest one tenth of a degree. This procedure follows in principle the information provided in NIST 250-35 and ASTM Standard E220-86 (1996). This calibration is traceable to NIST and the International Temperature Scale of 1990. Uncertainties as expressed on this report include a (k=2) coverage factor.

Tolerance ±1% Lab Uncertainty ± 0.27°C Cold Junction Temp. 0.0°C
Visual inspection: Okay Pass Immersion Depth 12"

As Found and As Left data ....

Nominal Value	Standard Read	UUT Degrees	Deviation
100°C	100.0°C	100.7°C	+0.7°C
300°C	300.0°C	303.7°C	+3.7°C
600°C	600.0°C	603.7°C	+3.7°C

Standards Recall:

Description	Manufacturer	Model #	Serial#	Due Date
SPRT Thermometer	Hart Scientific	1590	A02063	03/11/10
SPRT Probe	ASP	SSP670	631203	09/21/10
Type S Sensor	NIST	Wire	262159	10/04/10
DC Voltage Source	Fluke	5440B	3765011	12/22/10
Standard Resistor	L&N	4030-B	389876	08/12/10

Laboratory conditions:
R.H. %35 ±5%
Temperature 23.5°C ±0.5°C
Remarks:

Calibration Date: 12/16/09

Calibration Performed by Angelia M. Piper Date 12/14/09

Calibration Approved by [signature] Date 12/14/09

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Electronic Development Laboratories Inc.
Temperature Calibration Laboratory
244 Oakland Drive
Danville, VA 24540
Report of Calibration
Report # 3000426

Description: Digital Calibrator
Manufacturer: Promac
Instrument Model # DHT620 Serial # XDB4504

Requestor
SRG
250 Oakland Drive
Danville, VA 24540

This instrument and/or sensor were calibrated by comparison to a digital indicating instrument and/or PRT device. All reference readings were made in degrees centigrade to better than or equal to the nearest one tenth of a degree. This procedure follows in principle the information provided in NIST 250-35 and ASTM Standard E220-86 (1996). This calibration is traceable to NIST and the International Temperature Scale of 1990. Uncertainties as expressed on this report include a (k=2) coverage factor.

Tolerance ±1°F — Uncertainty ± 0.5°F
Cold Junction Temperature 32.0°F — Visual inspection: Okay Pass

As Found and As Left data..................

Nominal Value	Standard Read	Deviation	Nominal Value	Standard Read	Deviation
100.0°C	100.7°C	+0.7°C	300.0°C	301.1°C	+1.1°C
600.0°C	601.0°C	+1.0°C			

Standards Recall:

Description	Manufacturer	Model #	Serial#	Due Date
SPRT Thermometer	Hart Scientific	1590	A02063	03/11/10
SPRT Probe	ASP	SSP670	631203	09/21/10
Type S Sensor	NIST	Wire	262159	10/04/10
DC Voltage Source	Fluke	5440B	3765011	12/22/10
Standard Resistor	L&N	4030-B	389876	08/12/10

Laboratory conditions:
R.H. %35 ±5%
Temperature 24.8°C ±0.5°C
Remarks:

Calibration Date: 12/14/09

Calibration Performed by *Angelia M. Piper* Date 12/14/09

Calibration Approved by [signature] Date 12/14/09

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Electronic Development Laboratories Inc.
Temperature Calibration Laboratory
244 Oakland Drive
Danville, VA 24540

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Report of Calibration
Report # 3000425

Description: Thermocouple Reference Meter
Manufacturer: EDL
Instrument Model # LT-100 Serial # LT1010
Sensor Model # n/a Serial # n/a

Requestor
SRG
250 Oakland Drive
Danville, VA 24540

This instrument and/or thermocouple were calibrated by comparison to a PRT device and a digital indicating instrument. All reference readings were made in degrees centigrade to better than or equal to the nearest one tenth of a degree. This procedure follows in principle the information provided in NIST 250-35 and ASTM Standard E220-86 (1996). This calibration is traceable to NIST and the International Temperature Scale of 1990. Uncertainties as expressed on this report include a (k=2) coverage factor.

Tolerance ± 1% Lab Uncertainty ± 0.27°C Cold Junction Temp. 0.0°C
Visual inspection: Okay Pass Immersion Depth n/a

As Found and As Left data ....

Nominal Value	Standard Read	UUT Degrees	Deviation
100°C	100.0°C	100.1°C	+0.1°C
300°C	300.0°C	300.1°C	+0.1°C
600°C	600.0°C	600.1°C	+0.1°C

Standards Recall:

Description	Manufacturer	Model #	Serial#	Due Date
SPRT Thermometer	Hart Scientific	1590	A02063	03/11/10
SPRT Probe	ASP	SSP670	631203	09/21/10
Type S Sensor	NIST	Wire	262159	10/04/10
DC Voltage Source	Fluke	5440B	3765011	12/22/10
Standard Resistor	L&N	4030-B	389876	08/12/10

Laboratory conditions:
R.H. %35 ±5%
Temperature 24.8°C ±0.5°C
Remarks:

Calibration Date: 12/14/09

Calibration Performed by Angelia M. Piper Date 12/14/09

Calibration Approved by [signature] Date 12/14/09