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Title: Calibration of the PT 3845 Electrical Tester, July 13, 2018

Author(s): Mulford, Roberta Nancy
Clark, David Edward

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Roberta N. Mulford and David E. Clark

The PT3845 Electrical Tester, calibration file number 101921, is used to test the electrical properties of components for the Surveillance Program. The unit is located in PF-4 room 214, and is a custom construction provided by Sandia National Laboratory/Primecore. It consists of two environmental chambers that maintain components at 25°C, -55°C or 85°C while their electrical properties are being tested. Test instruments include a HV source meter, Keithley 2410, a current source , Keithley 6221, and a digital multimeter, Fluke 8846A. The calibration file numbers of the instruments currently installed in the PT3845 chassis are summarized in Table 1. The temperature measurement standard is the Fluke 1524 reference thermometer and associated probe.

Table 1. Component instruments and calibration data

Instrument	Calibration file number	Date of last calibration	Calibration due
Keithley 2410 HV source meter	041463	4/24/2018	4/24/2019
Keithley 6221 current source	041464	1/25/2018	1/25/2019
Fluke 8846A digital multimeter	041465	1/25/2018	1/25/2019
Fluke 1524 reference thermometer	110804	6/07/2018	6/07/2019

The PT 3845 is calibrated twice annually under agreement with Sandia National Laboratory, with a calibration registered annually with Standards and Calibration at Los Alamos National Laboratory. Expiration of the current calibration occurs on August 17 2018.

Temperature calibration

Temperature calibration of the PT 3845 Electrical Tester was performed according to PA-DOP-01443, R5. Temperature calibrations were performed for Chambers 1 and 2, using the Fluke 1524 reference thermometer listed in Table 1 as the calibrated measuring device. The temperature of each slot is required to be within 2 degrees of the measuring device at 25°C, and within 5 degrees at -55°C and 85°C. Data measured in chamber 1 are presented graphically in Figures 1 through 5.

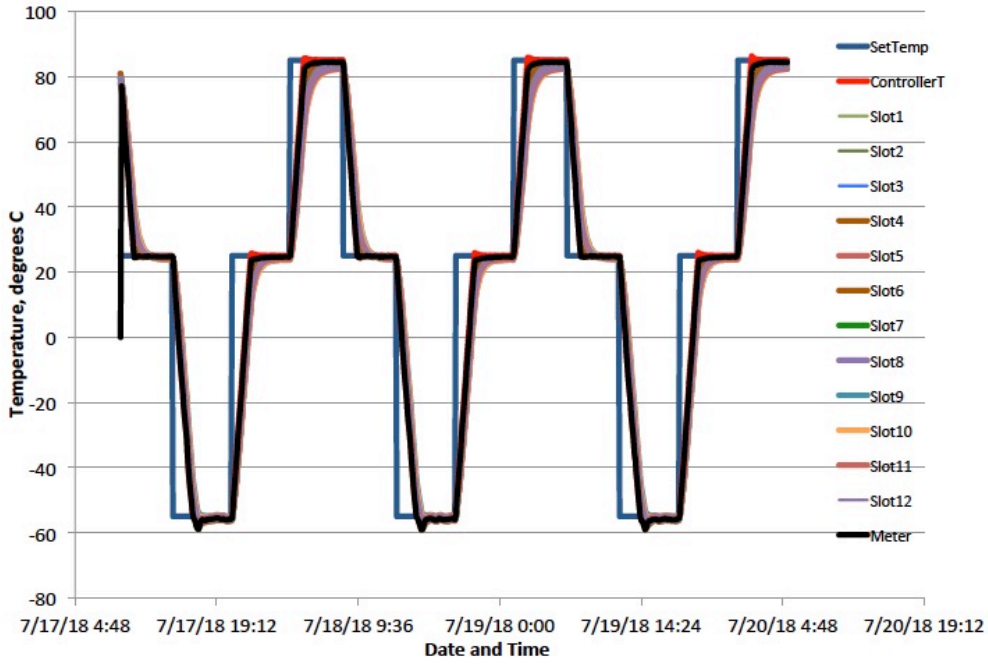

Figure 1. All data measured in Chamber 1

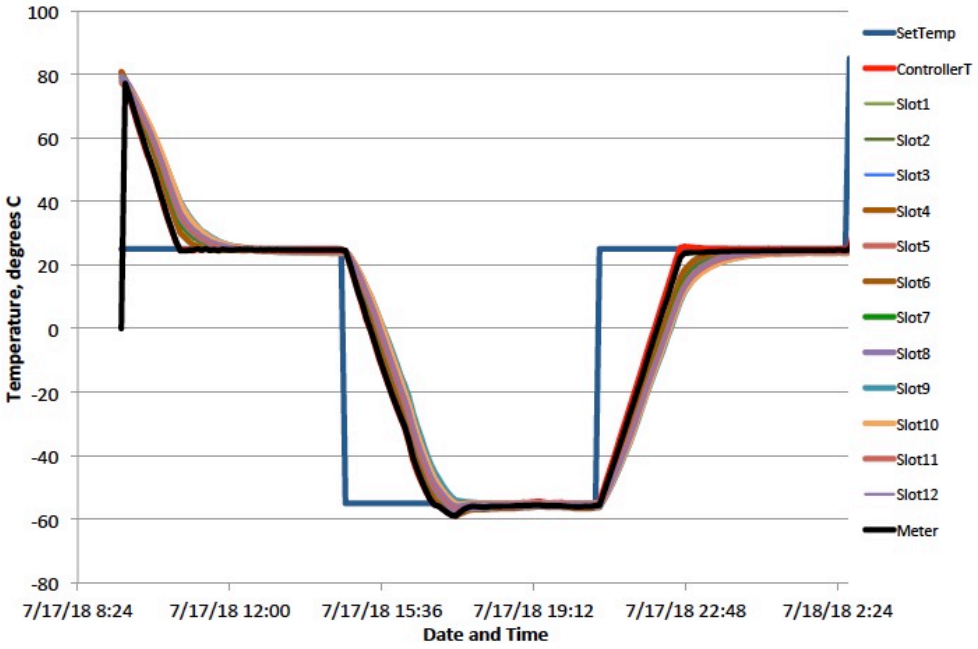

Figure 2. First full thermal cycle measured in Chamber 1

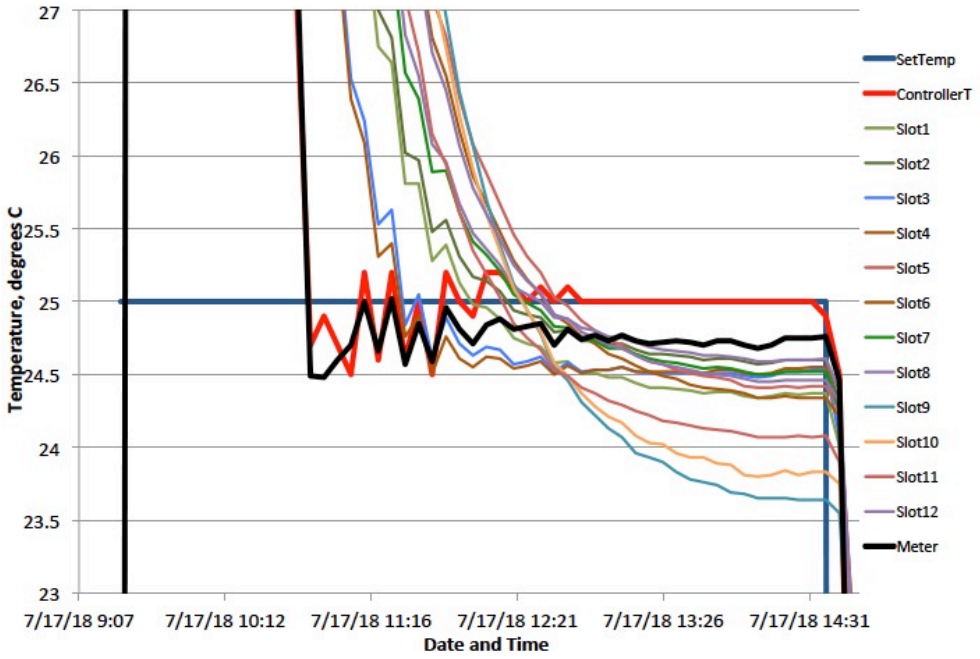

Figure 3. Data measured at 25°C in chamber 1

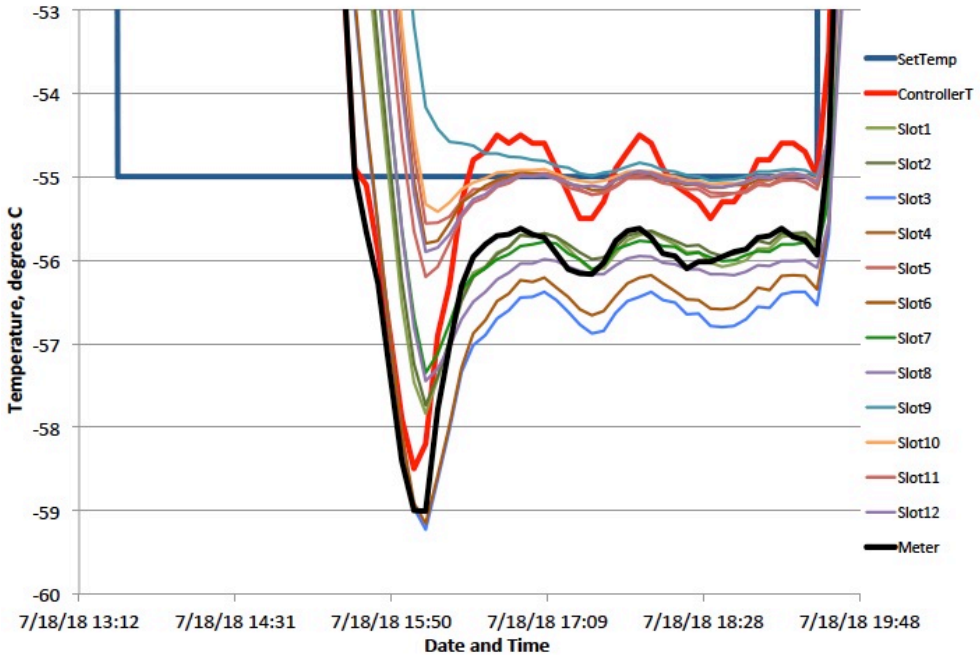

Figure 4. Data measured at -55°C in chamber 1

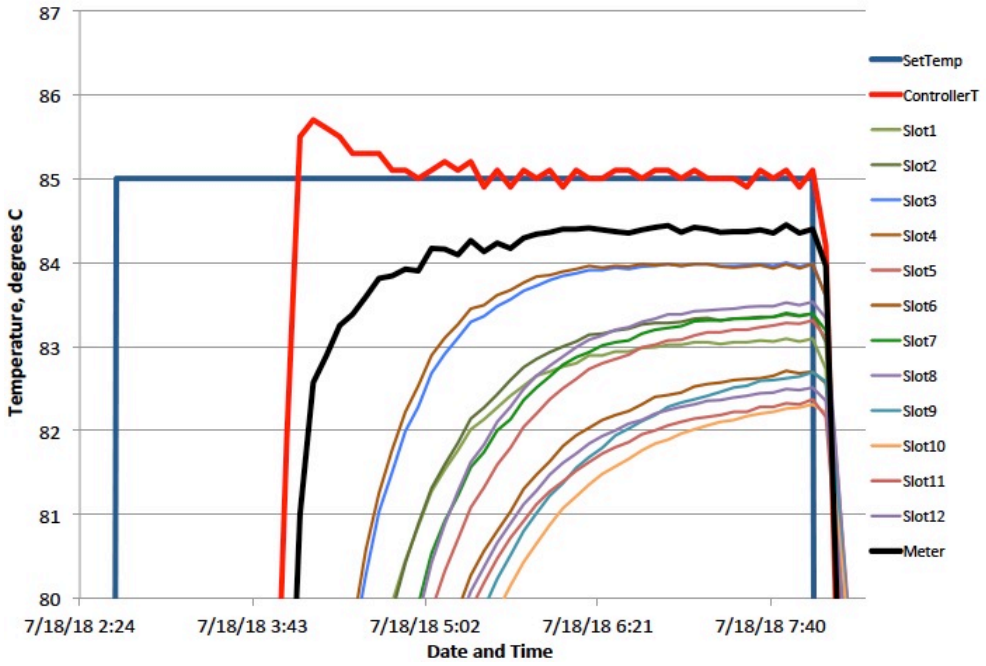

Figure 5. Data measured at 85°C in chamber 1

Data measured in chamber 2 is shown in Figures 6 through 10.

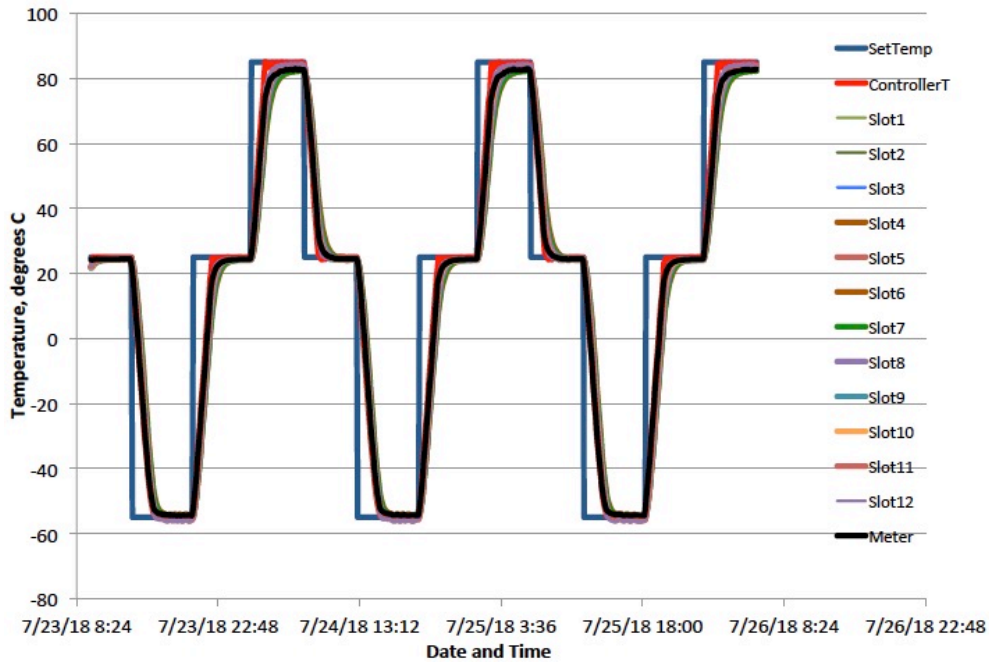

Figure 6. All data measured in chamber 2

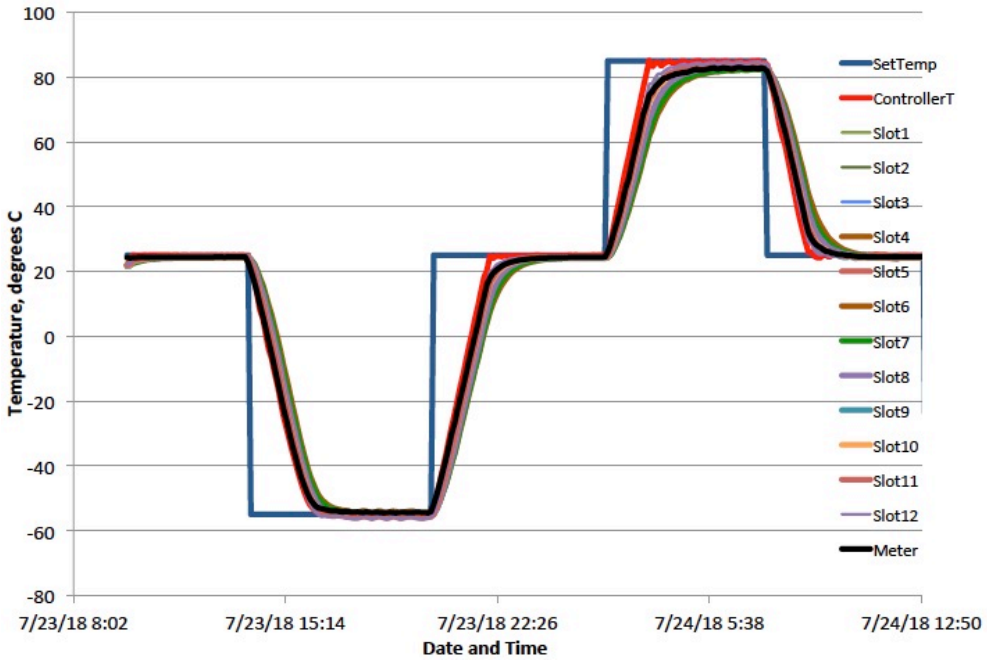

Figure 7. First full thermal cycle measured in chamber 2

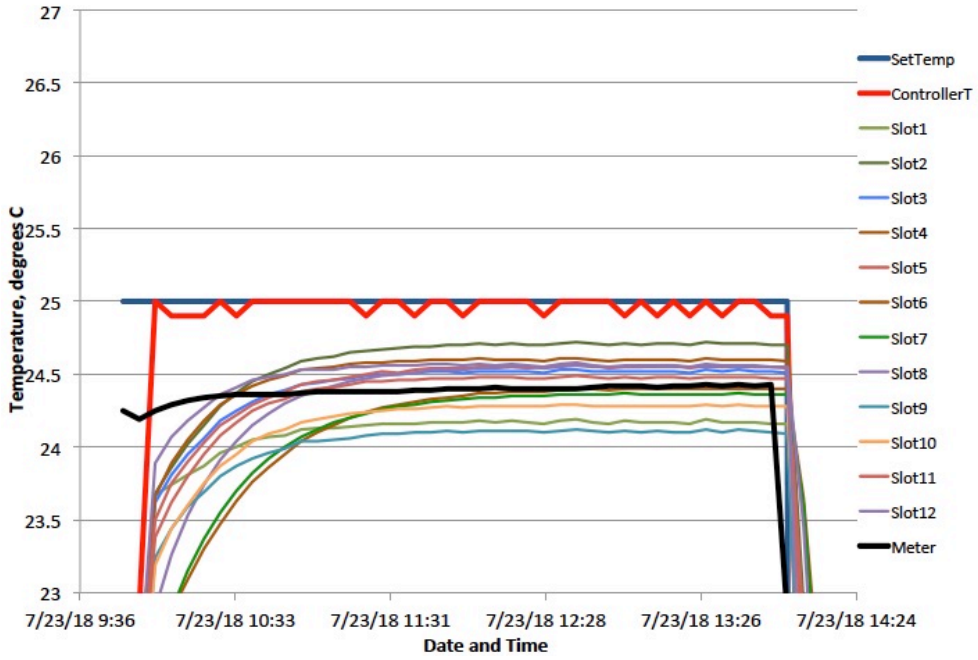

Figure 8. Data measured at 25°C in chamber 2

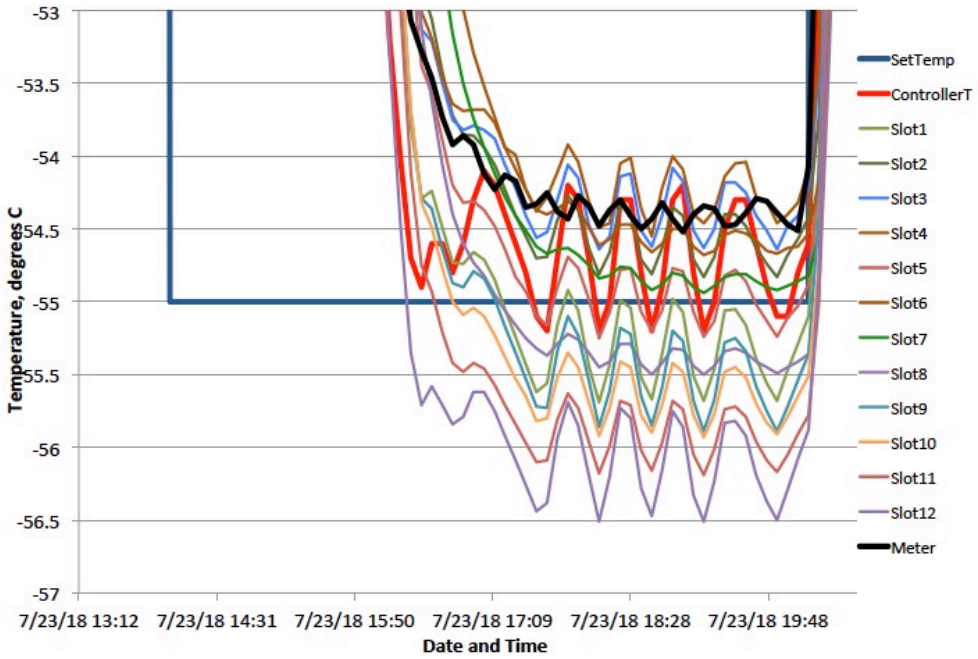

Figure 9. Data measured at -55°C in chamber 2

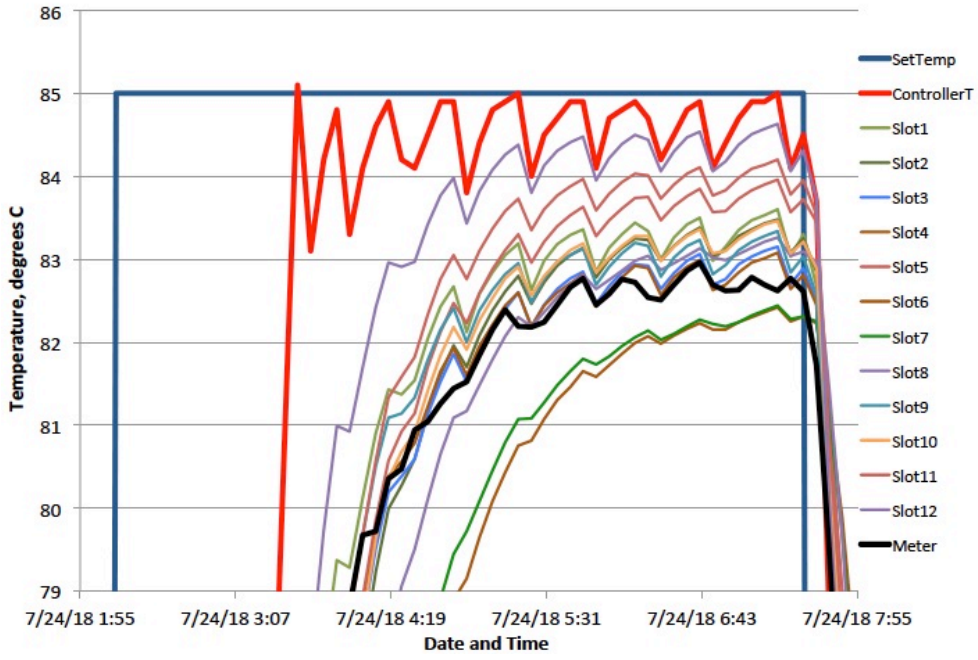

Figure 10. Data measured at 85°C in chamber 2

It can be seen in from the figures that temperature stabilizes to within the required degree of compliance with the standard thermocouple, denoted “Meter.”

Electrical Response

Electrical response of the PT 3845 Electrical Tester was performed according to procedure PA-DOP-01443, R5. Electrical response of the tester is confirmed to be within specification using calibrated test objects, PCBs, which simulate the electrical response of the units to be tested. Estimated uncertainties are not pertinent to these measurements, since measurements are required only to fall within tolerance bounds. The 4:1 ratio requirement is similarly not pertinent to the case at hand.

Environmental conditions within the chamber are controlled to within 2°C at 25°C, as discussed under "Temperature Calibration."

Calibration of the tester itself is achieved by annual calibration of the component voltmeters, ohmmeters, and current generators. Component instrument currently installed and calibration information is summarized in Table 1. The test objects are calibrated annually. Test object used in these tests and their calibration data is tabulated in Table 2.

Table 2. Test objects (PCBs) and calibration data

Tester Location, Slot #	Calibration ID	PCB ID	Measured value 100 Ohms	Measured value 1000 MOhms	Measured value 100 MOhms	Expiration date	Calibration date
			Ohms	Ohms	Ohms		
Slot# 1	41729	1	100.173	1007.735	99.49	3/5/19	3/5/18
Slot# 2	41730	2	100.138	1005.866	100.21	3/1/19	3/1/19
Slot# 3	41731	3	100.185	1000.469	99.82	3/5/19	3/5/18
Slot# 4	41732	4	100.131	1005.918	99.83	3/5/19	3/5/18
Slot# 5	41733	5	100.182	1006.444	99.31	3/5/19	3/5/18
Slot# 6	41734	6	100.102	1000.165	99.98	3/1/19	3/1/19
Slot# 7	41735	7	100.133	1001.550	99.82	3/5/19	3/5/18
Slot# 8	41736	8	100.198	1002.085	99.50	3/5/19	3/5/18
Slot# 9	41737	9	100.137	999.658	99.14	3/5/19	3/5/18
Slot# 10	41738	10	100.140	999.206	99.35	3/6/19	3/6/18
Slot# 11	41741	13	100.158	996.382	99.57	3/5/19	3/5/18
Slot# 12	41740	12	100.138	995.104	99.64	3/6/19	3/6/18

Tests performed include Voltage Calibration, Cable Impedance, Device Impedance, and Base Isolation at 300 V and 500V. Results for each test are presented in tables. Tests were performed on both chambers 1 and 2 of the Electrical Tester. Results of the tests are presented in Tables 3 through 7 below.

Table 3. Results of Voltage Calibration Test

Chamber 1 Voltage Calibration				
7/10/18 10:42				
Slot#	2.5 V Value, Volts	Pass	5.0 V Value, Volts	Pass
Slot #1	2.5001	1	5.0004	1
Slot #2	2.5001	1	5.0004	1
Slot #3	2.5001	1	5.0004	1
Slot #4	2.5001	1	5.0004	1
Slot #5	2.5001	1	5.0004	1
Slot #6	2.5001	1	5.0004	1
Slot #7	2.5001	1	5.0004	1
Slot #8	2.5001	1	5.0004	1
Slot #9	2.5001	1	5.0004	1
Slot #10	2.5001	1	5.0004	1
Slot #11	2.5001	1	5.0004	1
Slot #12	2.5001	1	5.0004	1

Chamber 2 Voltage Calibration				
7/10/18 11:49	2.5 V Value, Volts	Pass	5.0 V Value, Volts	Pass
Slot #1	0.0015	0	0.0014	0
Slot #2	2.5001	1	5.0004	1
Slot #3	2.5001	1	5.0004	1
Slot #4	2.5001	1	5.0004	1
Slot #5	2.5001	1	5.0004	1
Slot #6	2.5001	1	5.0004	1
Slot #7	2.5001	1	5.0004	1
Slot #8	2.5001	1	5.0004	1
Slot #9	2.5001	1	5.0004	1
Slot #10	2.5001	1	5.0004	1
Slot #11	2.5001	1	5.0004	1
Slot #12	2.5001	1	5.0005	1

Voltage values fall within 0.5% of the required 2.5 V or 5.0 V.

Table 4. Results of Cable Impedance Test

Chamber 1 Cable Impedance Calibration	Impedance, Ohms	pass	Chamber 2 Cable Impedance Calibration	Impedance, Ohms	pass
7/10/18 11:14			7/10/18 12:05		
Slot #1	4.0473	1	Slot #1	3.3903	1
Slot #2	4.3852	1	Slot #2	4.7579	1
Slot #3	3.6936	1	Slot #3	4.4685	1
Slot #4	4.1966	1	Slot #4	4.5354	1
Slot #5	3.5313	1	Slot #5	3.5981	1
Slot #6	5.2061	1	Slot #6	4.7945	1
Slot #7	4.6717	1	Slot #7	5.0507	1
Slot #8	6.2004	1	Slot #8	3.3224	1
Slot #9	3.4682	1	Slot #9	4.9041	1
Slot #10	5.5632	1	Slot #10	4.1317	1
Slot #11	5.9923	1	Slot #11	4.3854	1
Slot #12	4.761	1	Slot #12	4.7052	1

Table 5. Results of Device Impedance Test

Chamber 1 Device Impedance Calibration	Volts	pass	Deviation, %	Chamber 2 Device Impedance Calibration	Volts	pass	Deviation, %
7/10/18 11:17				7/10/18 12:08			
Slot #1	100.9377	0	0.94	Slot #1	99.9273	1	0.07
Slot #2	100.0889	1	0.09	Slot #2	101.6001	0	1.60
Slot #3	99.9421	1	0.06	Slot #3	99.9187	1	0.08
Slot #4	99.9131	1	0.09	Slot #4	99.9541	1	0.05
Slot #5	99.9379	1	0.06	Slot #5	99.9271	1	0.07
Slot #6	99.6985	1	0.30	Slot #6	99.8989	1	0.10
Slot #7	99.9617	1	0.04	Slot #7	99.914	1	0.09
Slot #8	100.0645	1	0.06	Slot #8	99.9391	1	0.06
Slot #9	99.8909	1	0.11	Slot #9	99.5628	1	0.44
Slot #10	99.9284	1	0.07	Slot #10	101.6596	0	1.66
Slot #11	99.8784	1	0.12	Slot #11	99.8209	1	0.18
Slot #12	99.9413	1	0.06	Slot #12	99.9244	1	0.08

Device impedance values fall within 2% of 100. As seen in the listing of deviations, all

slots in both chambers meet the criterion.

Table 6. Results of Base Isolation Tests for Chamber 1

Chamber 1 Base Isol 300V Calibration					
Temperature = 25					
7/10/18 11:24					
Slot #	Calibrated Resistance, Ohms	Measured Resistance, Ohms	Compensated Resistance, Ohms	Pass	Deviation %
Slot #1	99490000	99417396.7	99490000	1	0.07%
Slot #2	100210000	100119666	100210000	1	0.09%
Slot #3	99820000	99742418.2	99820000	1	0.08%
Slot #4	99830000	99760695.1	99830000	1	0.07%
Slot #5	99310000	99232558	99310000	1	0.08%
Slot #6	99980000	99904685.2	99980000	1	0.08%
Slot #7	99820000	99743176	99820000	1	0.08%
Slot #8	99500000	99433508.8	99500000	1	0.07%
Slot #9	99140000	99064785	99140000	1	0.08%
Slot #10	99350000	99270063.8	99350000	1	0.08%
Slot #11	99900000	99821588.3	99900000	1	0.08%
Slot #12	99570000	99500602.1	99570000	1	0.07%

Chamber 1 Base Isol 500V Calibration					
Temperature = 25					
7/10/18 11:33					
Slot #	Calibrated Resistance, Ohms	Measured Resistance, Ohms	Compensated Resistance, Ohms	Pass	Deviation %
Slot #1	1007734976	1002698574	1007734976	1	0.50%
Slot #2	1005865984	999384369.6	1005865984	0	0.64%
Slot #3	1000468992	996195281.2	1000468992	1	0.43%
Slot #4	1005918016	1001468888	1005918016	1	0.44%
Slot #5	1006444032	1002170951	1006444032	1	0.42%
Slot #6	1000164992	995925029.7	1000164992	1	0.42%
Slot #7	1001550016	997589979.5	1001550016	1	0.40%
Slot #8	1002084992	998086343.1	1002084992	1	0.40%
Slot #9	999657984	995552490.1	999657984	1	0.41%
Slot #10	999206016	994916492.2	999206016	1	0.43%
Slot #11	995692992	991771073.1	995692992	1	0.39%
Slot #12	996382016	992215043.3	996382016	1	0.42%

Table 7. Results of Base Isolation Tests for Chamber 2

Chamber 2 Base Isol 300V Calibration					
Temperature = 25					
7/10/2018 12:12:00 PM					
Slot #	Calibrated Resistance	Measured Resistance	Compensated Resistance	Pass	Deviation %
Slot #1	99490000	99409052.3	99490000	1	0.08%
Slot #2	100210000	100132115.7	100210000	1	0.08%
Slot #3	99820000	99739824.5	99820000	1	0.08%
Slot #4	99830000	99747428.9	99830000	1	0.08%
Slot #5	99310000	99231837.8	99310000	1	0.08%
Slot #6	99980000	99900271.4	99980000	1	0.08%
Slot #7	99820000	99741517.2	99820000	1	0.08%
Slot #8	99500000	99426956.2	99500000	1	0.07%
Slot #9	99140000	99062665.2	99140000	1	0.08%
Slot #10	99350000	99267244.3	99350000	1	0.08%
Slot #11	99900000	99817106.3	99900000	1	0.08%
Slot #12	99570000	99496385.3	99570000	1	0.07%

Chamber 2 Base Isol 500V Calibration					
Temperature = 25					
7/10/18 12:20					
Slot #	Calibrated Resistance	Measured Resistance	Compensated Resistance	Pass	Deviation %
Slot #1	1007734976	2599031312	1007734976	0	-157.91%
Slot #2	1005865984	1000843189	1005865984	1	0.50%
Slot #3	1000468992	996089351.3	1000468992	1	0.44%
Slot #4	1005918016	1000167491	1005918016	0	0.57%
Slot #5	1006444032	1002040117	1006444032	1	0.44%
Slot #6	1000164992	995782180.5	1000164992	1	0.44%
Slot #7	1001550016	997380262.9	1001550016	1	0.42%
Slot #8	1002084992	997637896.3	1002084992	1	0.44%
Slot #9	999657984	995388739.8	999657984	1	0.43%
Slot #10	999206016	994734614.4	999206016	1	0.45%
Slot #11	995692992	991603981.1	995692992	1	0.41%
Slot #12	996382016	991781528.7	996382016	1	0.46%

Resistances are within 2% of the resistance being measured, as seen from the percent deviation, except for slot 1 in Chamber 2, which has never functioned satisfactorily.