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1 PURPOSE

- 1.1 This document provides detailed work instructions for the tests outlined in the **Design Validation Procedure**.

2 SCOPE

- 2.1 This work instruction applies to all personnel responsible for performing Design Validation tests. Applicable personnel may include the Engineering Test Laboratory technicians, members of the Engineering department, or an external certified test lab.

3 DEFINITIONS

- 3.1 IEC International Electrotechnical Commission
- 3.2 UUT Unit Under Test
- 3.3 Testor Personnel responsible for performing Design Validation tests.
- 3.4 UL Underwriters Laboratories
- 3.5 CSA Canadian Standards Association

4 RESPONSIBILITY AND AUTHORITY:

- 4.1 Design Engineering
- 4.1.1 Provide testor with a detailed test plan specifying the tests to be performed and the numerical quantities of controls to be tested.
- 4.1.2 Test means and interpretation of results will be evaluated jointly by **Quality** and Design Engineering.
- 4.2 Quality Assurance (Engineering/Reliability)
- 4.2.1 Assist Design Engineering in establishing the validation test plan.
- 4.2.2 Evaluate test performance jointly with Design Engineering and recommend design and/or process improvements as deemed necessary.

5 PROCEDURE:

- 5.1 Follow each appropriate individual work instruction as outlined according to the Table of Contents.

6 REFERENCE DOCUMENTS:

- 6.1 Reference documents are indicated in each individual work instruction.

7 DISTRIBUTION:

7.1 Procedures and work instructions referenced are located as "read-only" files on the 'S' drive **SYSTEMS**.

7.2 Forms are located on the "S" DRIVE **FORMS**.

8 RECORDS:

8.1 Records are indicated in each work instruction as "Report"

9 LINE CYCLE DROPOUT TEST PROCEDURE:

9.1 PURPOSE

9.1.1 To evaluate the effects of power line drop-out on control operation, and to determine drop-out duration control can withstand.

9.2 EQUIPMENT

9.2.1 [AC Drop-out Simulator](#), Variac, and Oscilloscope

9.3 PROCEDURE

9.3.1 Record serial numbers of devices to be tested, along with critical to operation information.

9.3.2 Plug the Variac into a power source, plug the Drop-out Simulator into the Variac, and connect the device under test to the Drop-out Simulator.

9.3.3 Set the oscilloscope up to monitor the power-on-reset circuit of the device under test.

9.3.4 Adjust the Variac to the specified low line condition.

9.3.5 Power up the control and verify that it is functioning properly.

9.3.6 Starting with a low number of drop-out cycles and incrementing in half cycle increments, drop-out power to the control.

9.3.7 Observe the response after every drop-out.

9.3.8 Continue to increase drop-out length until control resets, or cancels, a programmed mode.

9.3.9 At this point record number of AC cycles of drop-out, and waveform of power-on-reset circuit.

9.3.10 Repeat this test for all control modes, at low, nominal, and high line voltages.

9.4 REPORT

9.4.1 Lab Report Form

10 TRANSIENT SURGE (RINGWAVE & IMPULSE WAVE) TEST

10.1 PURPOSE

10.1.1 To evaluate the effects of transient energy on control operation.

10.2 REFERENCE

10.2.1 UL858A Second Edition dated 2/22/95.

10.3 EQUIPMENT/SAMPLE SIZE

10.3.1 Transient Surge Generator

10.3.2 A maximum of 8, from E-Build, for each transformer and each vendor to be qualified

10.4 AMBIENT CONDITIONS

10.4.1 Control to tested at Room Temperature ($23^{\circ}\text{C} \pm 3^{\circ}\text{C}$)

10.4.2 Test Voltage - Refer to U.L. Standard 858A, Section: Environmental Stress Tests, General

10.5 PROCEDURE

10.5.1 All relay outputs should be disconnected from their normal loads (open circuited). Connect all neutral conductors of all input and output circuits of the control together. Connect each ungrounded conductor of the same polarity of all line voltage input and output circuits of the control together. Connect the control to the transient be at least 10 seconds. The control shall be tested in a stand-by or all outputs off state and in an operating or outputs on state.

10.5.1.1 Test Connections

10.5.1.1.1 Each line separately to ground. (i.e. L1 to GND and N to GND)

10.5.1.1.2 All lines simultaneously to ground (i.e. L1 & N to GND)

10.5.1.1.3 Line to line (i.e. L1 to N or L1 to L2)

10.5.1.2 Ring Wave Test

10.5.1.2.1 Adjust the transient generator to apply a 6000 V, 500 A, 100 kHz Ring Wave impulse onto the control supply circuit. Apply 20 positive impulses each at 45° , 90° and 270° phase

angles for each of the test connections and 20 negative impulses each at 90°, 225° and 270° angles for each of the test connections.

10.5.1.3 Unidirectional Wave (Surge) Test

10.5.1.3.1 Adjust the transient generator to apply a 6000 V, 3000 A, surge impulse wave onto the control supply circuit. Apply 2 positive impulses each at 45°, 90° and 270° phase angles for each of the test connections and 2 negative impulses each at 90°, 225° and 270° angles for each of the test connections.

10.6 CRITERIA

10.6.1 The protective function of the control shall not be adversely affected and there shall be no physical damage or risk of fire or risk of electrical shock or the control shall shut down without loss of its intended protective function.

10.7 REPORT

10.7.1 Agency Lab Report Form. Include:

10.7.1.1 Transformer part number and vendor information.

10.7.1.2 Any damage to the control as a result of a surge and at which surge the damage occurred.

10.7.1.3 Any other variation which may affect results.

11 LINE VOLTAGE VARIATION TEST

11.1 PURPOSE

11.1.1 To evaluate the effects of different line voltage potentials on control operation.

11.2 EQUIPMENT

11.2.1 A device capable of delivering from 66% to 150% of the specified line voltage for the control, at the specified line frequency.

11.2.2 A calibrated RMS AC voltmeter.

11.3 PROCEDURE

11.3.1 Record serial numbers of devices to be tested, also record the numbers and calibration dates for equipment used.

11.3.2 Power the control up and verify that it is functioning properly.

- 11.3.3 Adjust the line voltage for the specified low line condition and verify that the control functions within specifications. Record results observed.
- 11.3.4 Adjust the line voltage for the specified high line condition and verify that the control functions within specifications. Record results observed.
- 11.3.5 Adjust the line voltage for 66% of nominal line voltage.
- 11.3.6 The control must remain in this condition for a minimum of 1 hour.
- 11.3.7 Verify that the control functions within specifications. Record results observed.
- 11.3.8 Adjust the line voltage for 150% of nominal line voltage.
- 11.3.9 The control must remain in this condition for a minimum of 1 second.
- 11.3.10 Then power the control using nominal line voltage and verify that the control functions within specifications. Record results observed.
- 11.3.11 Repeat the above tests for alternate line voltages, and line frequencies where applicable.

11.4 CRITERIA

- 11.4.1 The component, or assembly, shall meet all specifications of the drawing.

11.5 REPORT

- 11.5.1 Lab Report Form

12 HI-POT TEST

12.1 PURPOSE

- 12.1.1 To assure the control will withstand the application of the specified potentials, without breakdown.

12.2 REFERENCE

- 12.2.1 UL 873 Section 43, Eleventh Edition dated 4/3/96

12.3 SAMPLES

- 12.3.1 As determined by the test plan.

12.4 EQUIPMENT

- 12.4.1 Hi-pot Fixture

12.5 AMBIENT CONDITIONS

- 12.5.1 In most cases the temperature will be determined by the test plan (i.e. immediately following...). This indicates that the test shall be done while the component to be tested is still hot.

12.5.2 If no indication is made, then room temperature ($23^{\circ}\text{C} \pm 3^{\circ}\text{C}$).

12.6 TEST VOLTAGE

12.6.1 The test voltages listed below are applicable for controls which have a test potential (Line input voltage) of 120 VAC.

12.6.2 For controls which have a different test potential, refer to the specification referenced above in subsection 2.

12.7 DEFINITIONS

12.7.1 Line voltage current carrying parts

12.7.1.1 Control terminals which are connected to line voltage.

12.7.1.2 Examples: L1, L2, neutral and relay contact terminals.

12.7.2 Isolated low voltage current-carrying parts:

12.7.2.1 Control terminals which are connected to class II circuitry

12.7.2.2 Examples: Headers, connectors and transformer secondaries.

12.7.3 Grounded metal parts

12.7.3.1 Control ground terminal(s), metal brackets

12.7.4 Adjacent line voltage current-carrying parts which may be at opposite polarity.

12.7.5 Control terminals which are connected to line voltage and may contact line voltage terminals at the opposite polarity.

12.7.5.1 Examples: L1 to L2, neutral to L1 and L1 or L2 to relay contact terminals.

12.8 PROCEDURE

12.8.1 The hi-pot tester is connected to the control according to the tests below.

12.8.2 If it is necessary to isolate areas of the control note the modifications on the report form.

12.8.3 Isolated low-voltage (Class II) current-carrying parts and grounded metal parts.

12.8.3.1 500 VAC for 1 minute (Applies to controls using a metal bracket only)

12.8.4 Line-voltage current-carrying parts and grounded metal parts.

12.8.4.1 1500VAC for 1 minute

12.8.5 Adjacent line-voltage current-carrying parts which may be at opposite polarity.

12.8.5.1 1500VAC for 1 minute

12.8.6 Line and isolated low-voltage (Class II) current-carrying parts.

12.8.6.1 1500VAC for 1 minute

12.9 CRITERIA

12.9.1 The control shall withstand for 1 minute the application of the alternating potential without breakdown.

12.10 REPORT

12.10.1 Agency Lab Report Form

12.10.2 In addition to the report form include the following:

12.10.2.1 Test voltages

12.10.2.2 List the terminal numbers and any other connections under test separately for each test.

12.10.2.3 Transformer part number and vendor information.

12.10.2.4 Modifications made to isolate areas under test.

12.10.2.5 Any other variation which may affect results.

13 OPERATING EXTREMES TEST

13.1 PURPOSE

13.1.1 To verify that the control can operate at the extremes for which the control was designed.

13.2 EQUIPMENT

13.2.1 Programmable environmental chamber suitable for the temperatures and humidity levels required for the test.

13.2.2 Control tester(s) capable of fully exercising the control(s).

13.2.3 A variable power source.

13.3 SAMPLES

13.3.1 Number of controls to be determined by the test plan.

13.4 PROCEDURE

13.4.1 Set the environmental chamber to the maximum specified temperature, maximum specified humidity and apply nominal rated voltage to the control(s). Cycle the controls up to their normal running state and allow them to remain for 3 hours.

13.4.2 After the three hours has elapsed lower the voltage to the lowest rated voltage and switch the control off.

- 13.4.3 Reapply the voltage, at the lowest specified value, and exercise the control(s) through all modes of operation. Record the results.
- 13.4.4 Set the environmental chamber to the maximum specified temperature, maximum specified humidity and apply maximum rated voltage to the control(s). Cycle the control(s) up to their normal running state and allow them to remain for 1 hour.
- 13.4.5 Turn the power off then on, exercise the controls through all modes of operation and record the results.
- 13.4.6 Set the environmental chamber to the minimum specified temperature, minimum specified humidity and apply minimum rated voltage to the control(s). Cycle the controls up to their normal running state and allow them to remain for 3 hours.
- 13.4.7 Turn the power off then on. exercise the controls through all modes of operation and record the results.
- 13.4.8 Set the environmental chamber to the minimum specified temperature, minimum specified humidity and apply maximum rated voltage to the control(s). Cycle the controls up to their normal running state and allow them to remain for 1 hour.
- 13.4.9 Turn the power off then on, exercise the controls through all modes of operation and record the results.

13.5 CRITERIA

- 13.5.1 The control(s) shall meet all specifications and drawings following the testing.

13.6 REPORT

- 13.6.1 Use Lab Report Form

14 SOLDER JOINT STRESS TEST

14.1 PURPOSE

- 14.1.1 To evaluate the effects of temperature changes on a solder joint connecting components with dissimilar temperature coefficients.

14.2 EQUIPMENT/SAMPLES

- 14.2.1 Temperature chamber
- 14.2.2 Microscope equipped with a magnification factor of 30,
- 14.2.3 3 E-Build samples

14.3 CONDITIONS

- 14.3.1 Temperature - 0°C to 105°C

14.4 PROCEDURE

- 14.4.1 Observe the assemblies using the microscope and record any observable flaws previous to testing so they will not be mistaken as flaws created by the test.
- 14.4.2 Program the temperature chamber per the parameters below:
 - 14.4.2.1 1 hour transition period from room ambient to 105°C
 - 14.4.2.2 105°C for 1 hour
 - 14.4.2.3 1 hour transition period to 0°
 - 14.4.2.4 0°C for 1 hour
 - 14.4.2.5 1 hour transition period to 105°C
 - 14.4.2.6 Repeat above sequence 12 times
 - 14.4.2.7 The controls shall remain unpowered throughout the test.
 - 14.4.2.8 Observe the assemblies using the microscope and look for stressed joints at locations where boards are interconnected through jumper wires or other means and where plastic components are in contact with the PCB. Reference the record of pretest observances and record any changes observed (crazing, pitting, cracking, etc.).
 - 14.4.2.9 Power up the controls and verify function.

14.5 CRITERIA

- 14.5.1 The component or assembly shall meet all specifications of the drawing.

14.6 REPORT

- 14.6.1 Lab Report Form. Include the following information:
 - 14.6.1.1 Transformer part number and vendor information.
 - 14.6.1.2 Any other variation which may affect results.

15 TEMPERATURE TEST (THERMAL SURVEY)

15.1 PURPOSE

- 15.1.1 To evaluate the control and its critical components while at the controls rated ambient and maximum loading conditions to assure the various components do not exceed their marked ratings.

15.2 REFERENCE

- 15.2.1 UL873 Eleventh Edition dated 4/3/96.

15.3 EQUIPMENT

15.3.1 Dead Air Space Box

15.3.2 Temperature chamber

15.3.3 Four Wire Ohm Meter(s)

15.3.4 Thermocouple Meter

15.3.5 Clamp On Amp Meter

15.3.6 Load box to supply current or actual loads

15.3.7 Switch Box.

15.4 SAMPLES

15.4.1 1 to 3 as per test plan - minimum 1 for each transformer and vendor to be qualified.

15.5 AMBIENT CONDITIONS

15.5.1 Temperature - $\pm 2^{\circ}\text{C}$ of the control's rated ambient, at the specified UL Ambient Location

15.5.2 Test Voltage - Refer to U.L. Standard 858A, Section: Environmental Stress Tests, General

15.6 PROCEDURE

15.6.1 Temperature Measurement through change of resistance:

15.6.1.1 Connect components to a fixture capable of switching the component between the circuit and a four wire ohm meter. Disconnect the circuit trace from components under test. Attach two wires to one side of the coil to be tested. Attach each of these wires separately to the common of a DPDT switch. Connect the Lo sense of the 4 wire ohm meter to one side of the normally open contacts. Connect the Lo input of the 4 wire ohm meter to the other NO contact. Connect one side of the circuit (only one wire needed) to the NC contacts.

15.6.1.2 Repeat the above process for the other side of the coil, the Hi side of the 4 wire ohm meter and the circuit connection. One Four wire ohm meter is used for each coil or resistance reading to be taken.

15.6.1.3 To calculate change of resistance:

$R1$ = Initial Resistance Reading, $R2$ = Final Resistance Reading, $T1$ = Initial Ambient Temperature Measurement, $T2$ = Final Ambient Temperature Measurement, $k = 234.5$ (Constant for copper wire)

- 15.6.1.4 Formulas: $T\text{-Final} = R2/R1 (T1 + k) - k$
 $T\text{-rise above ambient} = R2/R1 (T1 + k) - (T2 + k)$

15.6.2 Temperature Measurement through thermocouples:

- 15.6.2.1 For components or PCB traces to be measured directly, attach thermocouples. Attach thermocouple wires to the center of a component, the area of a trace or component most likely to be hottest, and at the specified UL Ambient Location of the control.

15.6.3 Control Loading

- 15.6.3.1 Loads capable of delivering the maximum rated loading conditions of the controls outputs are required for this test.

15.6.4 Modes of Operation

- 15.6.4.1 Modes which will energize the various outputs and circuits to be tested.

15.6.5 Test Set-up and Operation

- 15.6.5.1 Place the control, which has been prepared for the test, in a dead air space. Connect the control to the external loads and any other external connections. With no power applied to the control, measure and record coil resistances. Note control ambient temperature.
- 15.6.5.2 Put the control into a specified mode of operation. Adjust the temperature chamber to stabilize at the UL Ambient Temperature of the control. Temperatures are considered constant when three successive readings taken 5 minutes apart indicate less than 1 °C temperature change. Measure and record all thermocouple temperatures including Control Ambient. Measure and record all load currents. Remove power from the control. Immediately measure and record coil resistances. (You may need to obtain help unless a C.A.T. system is automatically taking readings.).

15.7 CRITERIA

- 15.7.1 The control must not attain a temperature at any point sufficiently high to: constitute a risk of fire, damage any materials employed in the equipment or exceed the temperature limits for the components.

15.8 ADDITIONAL TESTING –

- 15.8.1 Immediately following the Temperature Test, the control, while still HOT, must be Hi-Pot Tested. Reference Section 12.8 above.

15.9 REPORT

15.9.1 Agency Lab Report Form.

15.9.2 In addition to the Agency Lab Report Form, also include the following:

15.9.2.1 Transformer part number and vendor information.

15.9.2.2 Relay part number and vendor information.

15.9.2.3 Any other critical component part number and vendor information.

15.9.2.4 Any variation which may affect results.

15.9.2.5 Thermotron set temperature

15.9.2.6 UL Ambient Location

15.9.2.7 Plastic "Hot Spot" Location

15.9.2.8 Load Ratings

15.9.2.9 Loads Measured

15.9.2.10 Coil Resistance before and after measurements with initial temperature measured.

15.9.2.11 Thermocouple temperatures measured.

15.9.2.12 PCB Print or layout with thermocouple locations identified.

16 VIBRATION TEST

16.1 PURPOSE

16.1.1 This test is intended to verify that the product is able to withstand vibration which will be encountered during shipping, handling and normal use in the appliance.

16.2 SAMPLES

16.2.1 Number of units determined by project engineer.

16.3 EQUIPMENT

16.3.1 [Vibration platform](#)

16.4 PROCEDURE

16.4.1 Mount the UUT's on a vibration platform using the normal means of mounting flanges and screws and secure all cables and contacts as used in the end appliance.

- 16.4.2 Apply 120 VAC to the input of the UUT's and verify that the units are functioning properly then place them in an operate cycle.
- 16.4.3 Subject each control to 5 to 55 Hz of swept vibration of 3 G's peak for 30 minutes in each of the three perpendicular planes (X, Y, and Z). The sweep should be linear with one minute of total time per sweep.

16.5 CRITERIA

- 16.5.1 Following the vibration test each control must not exhibit physical damage and must function per the control specifications.

16.6 REPORT

- 16.6.1 Use Lab Report Form

17 AUDIBLE OUTPUT TEST

17.1 PURPOSE

- 17.1.1 This test is intended to verify that the assembly meets all applicable specifications relating to sound output.

17.2 SAMPLES

- 17.2.1 Number of units to be determined by test plan.

17.3 EQUIPMENT

- 17.3.1 Anechoic chamber
- 17.3.2 dB Meter
- 17.3.3 Device capable of measuring frequency output

17.4 PROCEDURE

- 17.4.1 Record serial numbers of devices to be tested.
- 17.4.2 Place the control in the chamber with the front face of the control facing the input of the sound level meter, 12 inches from the meter input sensor.
- 17.4.3 The control is to be placed into a mode which activates the speaker such that the dB level can be read from the sound meter. Record readings.
- 17.4.4 Measure and record the actual operating frequency of the waveform applied to the speaker.

17.5 CRITERIA

- 17.5.1 The component or assembly shall meet all specifications of the drawing.

17.6 REPORT

17.6.1 Use Lab Report Form.

18 BIT GENERATOR ABUSE TEST

18.1 OBJECTIVE

18.1.1 To determine the ability of the rotary bit generator to withstand customer/user--applied forces without permanent damage.

18.2 EQUIPMENT

18.2.1 One (1) Force gauge - AMETEK (Capital Equip. No. 10307) 0-20 lb. gauge (located in Incoming Inspection Dept.)

18.3 PROCEDURE

18.3.1 Select from given population (lot), five (5) sample control assemblies.

18.3.2 Record serial numbers of devices to be tested, along with critical-to-operation information.

18.3.3 The component(s) and/or assembly(s) shall meet all specifications of the drawing(s).

18.3.4 Mount the control on the force gauge in the orientation of the control assembly.

18.3.5 Subject the bit generator shaft to the following:

18.3.5.1 Apply a twenty-pound (20 lbs) tensile force (pull) axially ($0^\circ \pm 2^\circ$). Inspect the bit generator and PCB(s). Record results and note damage.

18.3.5.2 Apply a twenty-pound (20 lbs) compression force (push) axially ($0^\circ \pm 2^\circ$). Inspect bit generator and PCB(s). Record results and note damage.

18.3.5.3 Apply a ten-pound (10 lbs) compression force (push) radially (perpendicular) ($90^\circ \pm 2^\circ$) to the end of the bit generator shaft. Inspect bit generator and PCB(s). Record results and note damage.

18.4 CRITERIA

18.4.1 The assembly, shall meet all specifications of the drawing.

18.5 REPORT

18.5.1 Use Lab Report Form.

19 CALIBRATION VERIFICATION TEST

19.1 PURPOSE

- 19.1.1 To verify control operating temperatures remain within the specified limits of the control set temperature.

19.2 REFERENCE

- 19.2.1 UL873 Eleventh Edition dated 4/3/96.

19.3 SAMPLES

- 19.3.1 1 to 3 as per test plan.

19.4 CONDITIONS

- 19.4.1 Room Temperature ($23^{\circ}\text{C} \pm 3^{\circ}\text{C}$).
- 19.4.2 Test Voltage: Refer to U.L. Standard 858A, Section: Environmental Stress Tests, General.

19.5 PROCEDURE

- 19.5.1 Confirm the E²PROM of the control is adjusted for maximum operating temperatures of all modes.
- 19.5.2 Note: The User Preference Offset (UPO) shall never be used in place of programming the E²PROM to maximum offsets.
- 19.5.3 Connect the resistive temperature device (RTD) to the sensor terminals. The control shall be checked in each operating mode, at the maximum set temperature.
- 19.5.4 Starting with the RTD set at least 20° below the set temperature, slowly increase the resistance until the relay operates and record the resistance of the RTD. Verify turn off resistance is at or near maximum operating temperature. Slowly decrease the resistance until the relay again operates and record the resistance of the RTD. Repeat for each mode, a total of three times.

19.6 CRITERIA

19.6.1 Calibration:

- 19.6.1.1 The initial operating temperature/sensor resistance was within 3% of the programmed operating temperature. Verify the door locks before the sensor temperature reaches 600°F $\pm 3\%$, if applicable.

19.6.2 Calibration Verification:

- 19.6.2.1 After completion of the Overload and Endurance tests, the operating temperature/sensor resistance did not vary from the as-received temperature

by more than 3% of the set point temperature. After Conditioning, verify the door locks before the sensor temperature reaches 600°F ±3%, if applicable.

19.6.3 ADDITIONAL TESTING

19.6.3.1 The Calibration Test is to be followed by the Overload test (Section 27) and Endurance test (Section 23) with the same control.

19.6.3.2 The Calibration test (Calibration Verification - Section 19) is to be repeated after completion of the Overload (Section 27) and the Endurance tests (Section 23).

19.7 REPORT

19.7.1 Use Agency Lab Report Form.

20 CHATTERING RELAY TEST

20.1 PURPOSE

20.1.1 To evaluate the effects of various types of transient line noise on control operation.

20.2 CONDITIONS

20.2.1 Room Temperature (23°C ±3°C).

20.2.2 Test Voltage: Nominal line input voltage.

20.3 EQUIPMENT

20.3.1 Transient noise generation unit incorporating the following features:

20.3.1.1 Two AC relays interconnected such that the application of power causes the relays to operate continuously at their maximum pull-in and drop-out rates (chatter).

20.3.1.2 Inductive light dimmer.

20.3.1.3 A [spark ignition system](#).

20.3.2 Test unit configuration is quite subjective. Relay types, spark modules used, and wire routing can greatly affect the results. Equipment used for testing must be approved by the responsible engineer and/or conform to customer requirements.

20.4 PROCEDURE

20.4.1 Connect UUT to the transient noise unit.

20.4.2 Operate all combinations, at 5 minutes each, of AC relay chatter, inductive light dimmer, and spark ignitors.

20.4.3 Repeat for all applicable control modes so as to exercise all inputs and outputs.

20.5 CRITERIA

20.5.1 Pass/fail criteria to be determined by the responsible engineer and/or customer requirements. In general, no control failures should occur.

20.6 REPORT

20.6.1 Use Lab Report Form .

21 EMI NOISE TEST

21.1 PURPOSE

21.1.1 To evaluate the effects of the EMI noise input on control operation.

21.2 EQUIPMENT

21.2.1 A noise generator capable of producing 50 nS, and 1uS pulses (Less than 0.4ns rise time), at a repetition rate of 100 Hz, at a variable voltage of 0 to 2kV.

21.3 PROCEDURE

21.3.1 Install control in End Product.

21.3.2 Connect End Product to Noise Generator, running at rated voltage, through the noise generator.

21.3.3 Set up for 50nS Pulse at 100 Hz repeat rate.

21.3.4 Connect noise to L1-N.

21.3.5 Set voltage to +1000V

21.3.6 Power up control

21.3.7 Turn noise on while in Idle mode, for a duration of two minutes, recording any observations.

21.3.8 Turn voltage up 500V at a time, repeating two minutes at each voltage, until 2kV has been reached.

21.3.9 Set noise generator to -1000V and repeat steps 17.3.6 through 17.3.8.

21.3.10 Connect noise to L2-N, and repeat steps 17.3.5 through 17.3.9.

21.3.11 Set noise generator up for 1uS pulse, and repeat steps 17.3.4 through 17.3.10.

21.3.12 Repeat the above steps for all Power On modes. (Bake, Broil, Clean, Etc.)

21.4 CRITERIA

- 21.4.1 At 1000V should have no visible effect on control.
- 21.4.2 At 1500V can have soft failures, but cannot require power down to clear failure.
- 21.4.3 At 2000V can have a soft failure requiring power down, but cannot in any case have a hard (permanent) failure.

21.5 REPORT

- 21.5.1 Lab Report Form.

22 ELECTROMIGRATION TEST

22.1 PURPOSE

- 22.1.1 This test is performed to verify the immunity of the control to the effects of hot and humid environments. AC power is cycled on and off during the test to allow moisture to penetrate during off periods and electrolysis to occur during on periods if conditions for these processes exist in the product.

22.2 QUANTITY

- 22.2.1 5 Units

22.3 EQUIPMENT

- 22.3.1 Temperature/Humidity Environmental Chamber

22.4 PROCEDURE

- 22.4.1 Place the controls in an environmental chamber set to the maximum rated operating temperature of the UUT and 90% +/- 5% relative humidity.
- 22.4.2 Operate the controls in the standby state without actual loads. Cycle power to the controls 30 minutes ON followed by 30 minutes OFF for a total of 500 hours.
- 22.4.3 Allow the controls to dry and stabilize at room temperature for 24 hours prior to retesting.

22.5 CRITERIA

- 22.5.1 The controls shall not malfunction, exhibit corrosive mechanisms or fail due to dendrite growth following this test.

22.6 REPORT

- 22.6.1 General Lab Report Form 4040502.

23 ENDURANCE TEST

23.1 PURPOSE

- 23.1.1 To exercise the control and its components, to verify operation over an extended period.

23.2 REFERENCE

- 23.2.1 UL873 Eleventh Edition dated 4/3/96.

23.3 SAMPLES

- 23.3.1 1 to 3 as per test plan (The same sample(s) as used for the Overload Test Section 27).

23.4 EQUIPMENT

- 23.4.1 Temperature chamber
- 23.4.2 Dead Air Space Box
- 23.4.3 Device capable of automatically cycling between 2 resistances
- 23.4.4 Device capable of counting relay on/off cycles
- 23.4.5 Thermocouple meter
- 23.4.6 Current meter
- 23.4.7 Actual loads at the rated voltage.

23.5 CONDITIONS

- 23.5.1 Temperature - $\pm 2^{\circ}$ C of the control's maximum rated ambient, measured at the specified UL Ambient Location.
- 23.5.2 Test Voltage - Refer to UL Standard 858A Section Environmental Stress Tests, General
- 23.5.3 Relay loads to be in accordance with the table shown in Appendix B.

23.6 PROCEDURE

- 23.6.1 Set the RTD Cycler such that the control output will cycle 1 second ON and 9 seconds OFF, or the shortest cycle time the design will allow.
- 23.6.2 Place the control in the dead air space, inside the temperature chamber.
- 23.6.3 Earth Ground is to be connected through a 3A 250V non-delay fuse to; the control's ground terminal or aluminum foil which has been placed on the control relays in such a way to cover all relays.
- 23.6.4 Connect the cycle counter and the actual loads to the control.
- 23.6.5 NOTE: This test does not require a load on the relay contacts if the relays have been previously qualified and meet the load requirements of the control.

- 23.6.6 Allow the control to stabilize at the maximum rated ambient temperature.
- 23.6.7 After the temperature is stable, put the control into the specified mode of operation.
- 23.6.8 The control shall complete 100,000 cycles at a rate no greater than 6 cycles per minute (10 seconds per cycle) unless the control design will allow a greater cycle rate.

23.7 CRITERIA

- 23.7.1 There shall be no electrical breakdown or malfunction of the device,
- 23.7.2 No undue burning, pitting or welding of the contacts or printed circuit board traces.

23.8 ADDITIONAL TESTING

- 23.8.1 Immediately following the Endurance Test and while still hot, the control must be tested for dielectric breakdown. (See Section 12).
- 23.8.2 The control shall be operationally tested following the Operational Verification Test Procedure Section 39 after completion of the dielectric test.
- 23.8.3 Calibration Verification (Section 19) is to be repeated after completion of the Endurance Test (Section 23).

23.9 REPORT

- 23.9.1 Agency Lab Report Form.
- 23.9.2 In addition to UL report include the following information:
 - 23.9.2.1 Load current measured.
 - 23.9.2.2 Relay part number and vendor information.

24 HIGH TEMPERATURE OPERATION TEST

24.1 PURPOSE

- 24.1.1 To determine the affect of maximum operating temperature on the control.

24.2 EQUIPMENT

- 24.2.1 Heating chamber

24.3 SAMPLES

- 24.3.1 The number of units to be determined by the responsible engineer.

24.4 PROCEDURE

- 24.4.1 Set heating chamber for the control's maximum rated operating temperature.
- 24.4.2 Apply nominal line voltage to the control(s).

- 24.4.3 Place control(s) into the heating chamber
- 24.4.4 Allow the control(s) to soak for 96 hours
- 24.4.5 Remove the control(s) and allow them, to stabilize for 1 hour at room ambient temperature.
- 24.4.6 Perform the Operational Verification Test (Section 39) on all samples.
- 24.4.7 Inspect the control(s) for mechanical damage

24.5 CRITERIA

- 24.5.1 The control shall not fail in its primary functions
- 24.5.2 The control(s) shall meet all specifications and drawings following the test.

24.6 REPORT

- 24.6.1 Lab Report Form.

25 LOW TEMPERATURE OPERATE TEST

25.1 PURPOSE

- 25.1.1 To determine the affect of minimum operating temperature on the control.

25.2 EQUIPMENT

- 25.2.1 Environmental Chamber

25.3 SAMPLES

- 25.3.1 The number of controls to be determined by the responsible engineer.

25.4 PROCEDURE

- 25.4.1 Set temperature chamber for the controls minimum rated operating temperature.
- 25.4.2 Apply nominal line voltage to the control(s).
- 25.4.3 Place control(s) into the temperature chamber
- 25.4.4 Allow the control(s) to soak for 96 hours
- 25.4.5 Remove the control(s) and allow them to stabilize for 1 hour at room ambient temperature.
- 25.4.6 Perform the Operational Verification Test (Section 39) on all samples.

25.4.7 Inspect the control(s) for mechanical damage

25.5 CRITERIA

25.5.1 The control(s) shall meet all specifications and drawings following the test.

25.6 REPORT

25.6.1 Use report form..

26 MOLD (PLASTIC CHASSIS) STRESS RELIEF TEST

26.1 PURPOSE

26.1.1 To evaluate the plastic retainer material after stress and determine if an unsafe condition exists.

26.2 REFERENCE

26.2.1 UL746C Fourth Edition dated 3/14/96.

26.3 SAMPLES

26.3.1 UL requires 3 from soft tool or hard tool from each plastic vendor and each color to be qualified.

26.4 CONDITIONS

26.4.1 Temperature - +/- 2° C of the controls rated maximum plus 10°C. In any case the temperature is not to be less than 70°C. The plastic will be retested, if during the Temperature Test (Section 15) the plastic hot spot temperature is found to be greater than the control ambient. Consequently, the test would then be 10°C above the plastic hot spot temperature.

26.5 EQUIPMENT

26.5.1 Temperature chamber

26.5.2 Thermocouple meter

26.5.3 Calipers

26.6 PROCEDURE

26.6.1 Measure and record the plastic wall thickness.

26.6.2 Place a thermocouple in the center of the temperature chamber to monitor the chamber temperature.

26.6.3 Place the three control assemblies into a temperature chamber which has been set to the required temperature.

- 26.6.4 Allow the controls to remain at the required temperature for a period of 7 hours.
- 26.6.5 At the end of seven hours check for compliance with the criteria listed below.
- 26.6.6 Measure the plastic retainer wall thickness.

26.7 CRITERIA

- 26.7.1 Immediately after removal from the conditioning environment, the plastic material shall not exhibit softening as determined by handling.
- 26.7.2 After cooling to room temperature, the material shall not warp, shrink or distort to the extent of resulting in any of the following:
 - 26.7.2.1 Reduction of spacings between uninsulated live parts of opposite polarity.
 - 26.7.2.2 Uninsulated live parts and accessible dead metal or grounded material.
 - 26.7.2.3 Uninsulated live parts with the enclosure below minimum acceptable values.
 - 26.7.2.4 Making uninsulated live parts or internal wiring accessible to contact or defeating the integrity of the enclosure so that acceptable mechanical protection to internal parts of the equipment is affected.
 - 26.7.2.5 Causing a condition that results in the equipment not complying with the power-supply cord strain relief requirements, if applicable.
 - 26.7.2.6 Causing interference with the intended operation or servicing of the equipment.

26.8 REPORT

- 26.8.1 Agency Lab Report Form.
- 26.8.2 In addition to the General Lab Report Form, also include the following:
 - 26.8.2.1 Copy of the plastic print (This will show the version of plastic tested),
 - 26.8.2.2 Note wall thickness before and after testing.
 - 26.8.2.3 Any damage to the plastic as a result of the thermal stress noted on a copy of the plastic print and noted in detailed written form in the report.

27.1 PURPOSE

- 27.1.1 To assure the control and its components will perform acceptably under overload conditions.

27.2 REFERENCE

- 27.2.1 UL873 Eleventh Edition dated 4/3/96.

27.3 SAMPLES

- 27.3.1 1 to 3 as per test plan. (The same sample(s) used for the Calibration Verification Test.)

27.4 EQUIPMENT

- 27.4.1 Temperature chamber
- 27.4.2 Dead Air Space Box
- 27.4.3 [Device capable of automatically cycling between 2 resistances](#)
- 27.4.4 Device capable of counting relay on/off cycles
- 27.4.5 Loads having the same characteristics as the actual application supplying 150% of the rated current at the rated voltage
- 27.4.6 Current meter
- 27.4.7 Thermocouple meter

27.5 CONDITIONS

- 27.5.1 Temperature - $\pm 2^{\circ}\text{C}$ of the controls rated ambient, at the specified UL Ambient Location.
- 27.5.2 Test Voltage - Refer to U.L. Standard 858A, Section: Environmental Stress Tests, General
- 27.5.3 Relay loads shall be in accordance with the table specified in appendix B.

27.6 PROCEDURE

- 27.6.1 Monitor Control Ambient through a thermocouple placed in the specified UL Ambient Location.
- 27.6.2 Set the RTD Cyler such that the control output will cycle 1 second ON and 9 seconds OFF, or the shortest cycle time the design will allow.
- 27.6.3 Place the control in the dead air space box, inside the temperature chamber.

- 27.6.4 Earth Ground is to be connected through a 3A 250V non-delay fuse to the control's ground terminal or aluminum foil which has been placed on the control relays in such a way to cover all relays.
- 27.6.5 Connect the cycle counter and the loads to the control.
- 27.6.6 NOTE: This test does not require a load on the relay contacts if the relays have been previously qualified and meet the load requirements of the control.
- 27.6.7 Allow the control to stabilize at the ambient temperature.
- 27.6.8 After the temperature is stable, put the control into the specified mode of operation.
- 27.6.9 The control shall complete 50 cycles of operation (10 seconds per cycle).

27.7 CRITERIA

- 27.7.1 There shall be no electrical breakdown or malfunction of the device and no undue burning, pitting or welding of the contacts or printed circuit board traces.

27.8 ADDITIONAL TESTING

- 27.8.1 The Overload Test is to be followed by the Endurance Test (Section 23) with the same control.
- 27.8.2 The Calibration Verification Test (Section 19) is to be repeated after completion of the Endurance Test.

27.9 REPORT

- 27.9.1 Agency Report Form
- 27.9.2 In addition to the Agency Lab Report Form, also include the following
 - 27.9.2.1 Load current measured.
 - 27.9.2.2 Relay part number and vendor information

28 OVERVOLTAGE & UNDERVOLTAGE TEST

28.1 PURPOSE

- 28.1.1 To evaluate the effects of maximum and minimum line voltage potentials on control operation.

28.2 REFERENCE

- 28.2.1 UL858A Section 10 Second Edition dated 2/22/95.
- 28.2.2 NOTE: Supplemental testing was also added to check relay pull-in at a worst case temperature/voltage condition.

28.3 SAMPLES

28.3.1 1 to 3, as determined by the Test Plan.

28.4 EQUIPMENT

28.4.1 Dead Air Space Box

28.4.2 Temperature chamber

28.4.3 Variable AC power supply

28.4.4 TRMS AC voltmeter

28.4.5 Thermocouple meter

28.5 CONDITIONS

28.5.1 Temperature - $\pm 2^{\circ}\text{C}$ of the controls maximum rated ambient, at the specified UL Ambient Location.

28.5.2 Test Voltage - As specified below.

28.6 PROCEDURE

28.6.1 Place the control in a dead air space, inside the temperature chamber.

28.6.2 Monitor ambient temperature using a thermocouple placed at the specified UL Ambient Location.

28.6.3 Voltage supplies should be measured under the following conditions:

28.6.3.1 No outputs on,

28.6.3.2 One output on,

28.6.3.3 All outputs on.

28.6.4 Nominal Voltage Test

28.6.4.1 Set the variac to 100% of the test potential.

28.6.4.2 When the control has stabilized at the Ambient Temperature, measure and record all voltage supplies, in each of the conditions stated above.

28.6.4.3 Verify operation of the control through use of the Operational Verification Test Procedure (Section 39).

28.6.4.4 Follow Immediately with the Overvoltage test.

28.6.5 Overvoltage Test

- 28.6.5.1 Set the variac to 110% of the test potential.
- 28.6.5.2 When the temperature of the thermocouple stabilizes at the controls rated ambient or after 7 hours, confirm that the control is still operating safely.
- 28.6.5.3 When the control has stabilized at the Ambient Temperature, measure and record all voltage supplies, in each of the conditions stated above.
- 28.6.5.4 Verify operation of the control through use of the Operational Verification Test Procedure (Section 39).
- 28.6.5.5 Follow Immediately with the Undervoltage test.

28.6.6 Undervoltage Test

- 28.6.6.1 Set the variac to 85% of the test potential.
- 28.6.6.2 Immediately put the control into a mode which causes the maximum number of outputs to turn on at one time under normal operating conditions.
- 28.6.6.3 Monitor the control for 1 minute and assure the outputs come on and remain on. Note any failure.
- 28.6.6.4 When the temperature of the thermocouple stabilizes at the controls rated ambient or after 7 hours, confirm the control is still operating safely.
- 28.6.6.5 Verify operation of the control through use of the Operational Verification Test Procedure (Section 39).
- 28.6.6.6 Measure and record all voltage supplies, in each of the conditions stated above.

28.7 CRITERIA

- 28.7.1 The control shall continue to perform its intended protective function and shall remain functional.
- 28.7.2 There shall be no increase in the risk of fire, electric shock or injury to persons.

28.8 REPORT

- 28.8.1 Agency Report Form
- 28.8.2 In addition to the Agency Report Form, also include the following:

28.8.2.1 All voltage measurements.

28.8.2.2 Any variation which may affect results.

29 POWER INPUT TEST

29.1 PURPOSE

29.1.1 To verify the input power to a control does not exceed the marked rating of the control by more than 10%.

29.2 REFERENCE

29.2.1 UL873 Eleventh Edition dated 4/3/96

29.3 SAMPLES

29.3.1 prototype, for each transformer vendor to be qualified

29.4 EQUIPMENT

29.4.1 Current Meter

29.4.2 Voltage Meter

29.4.3 Alternate: [A true RMS power meter may be substituted for the above.](#)

29.5 CONDITIONS

29.5.1 Temperature - Room Ambient ($23^{\circ}\text{C} \pm 3^{\circ}\text{C}$)

29.5.2 Test Voltage - Refer to U.L. Standard 858A, Section: Environmental Stress Tests, General

29.6 PROCEDURE

29.6.1 The current meter is connected in series with one side of the AC line and the control.

29.6.2 The opposite side of the line is connected directly to the control.

29.6.3 Power input is to be measured under:

29.6.3.1 Full load conditions

29.6.3.2 Greatest unbalanced condition.

29.6.4 All outputs and accessories must be considered (Fans, lights, etc.).

29.6.5 Measure the voltage and current.

29.6.6 Calculate the power using the measurements taken.

29.7 CRITERIA

29.7.1 The power input shall not exceed 100% of the marked rating.

29.8 REPORT

29.8.1 Agency Report Form

29.8.2 In addition to the UL Report Form, also include the following:

29.8.2.1 Any variation which may affect results.

29.8.2.2 Input Power rating of the control.

29.8.2.3 Voltage and Current Measurements.

29.8.2.4 Calculated power

30 SHIPPING & STORAGE TEMPERATURE TEST

30.1 PURPOSE

30.1.1 To evaluate the effects shipping and storage temperatures on control operation.

30.2 REFERENCE

30.2.1 UL858A Section 18, Second Edition dated 2/22/95

30.3 SAMPLES

30.3.1 5 samples from prototype or E-build

30.4 EQUIPMENT

30.4.1 Temperature chamber

30.4.2 Thermocouple meter

30.5 CONDITIONS

30.5.1 Temperature - 105°C, 23°C and -40°C (UL specifies 70°C, 23°C and -30°C respectively. TruHeat has extended the parameters and has increased the time at the specified parameters. See PROCEDURE below.)

30.5.2 Test Voltage - Refer to UL Standard 858A, Section: Environmental Stress Tests, General

30.6 PROCEDURE

30.6.1 Program the temperature chamber to following temperatures and times:

30.6.1.1 105°C for 24 hours (UL is 70°C for 24 Hrs)

30.6.1.2 30 minute transition period to 23°C (Thermotron required transition period)

- 30.6.1.3 23°C for 1 hour (UL specs at least 1 hour of room temp)
 - 30.6.1.4 30 minute transition period to -40°C (Thermotron required transition period)
 - 30.6.1.5 -40°C for 24 hours (UL is -30 for at least 3 hours)
 - 30.6.1.6 30 minute transition period to 23°C (Thermotron required transition period)
 - 30.6.1.7 23°C for 3 hours (The UL specification ends here)
- 30.6.2 Monitor Thermotron temperature using a thermocouple meter. Following exposure to the above temperature extremes the control is to be operationally tested following the Operational Verification Test Procedure (Section 39).
- 30.6.3 Repeat the above procedure for a total of five complete cycles.
- 30.7 CRITERIA
 - 30.7.1 The control shall continue to perform its intended protective function following the exposure to the above temperature extremes.
- 30.8 REPORT
 - 30.8.1 Agency Lab Report Form.
 - 30.8.2 In addition to the General Lab Report Form, also include the following:
 - 30.8.2.1 Any other variation which may affect results.
- 31 RAMP VOLTAGE
 - 31.1 PURPOSE
 - 31.1.1 To evaluate the effects of instantaneous line variations on control operation.
 - 31.2 REFERENCE
 - 31.2.1 UL 858A, Section 13, Second Edition dated 2/22/95
 - 31.3 SAMPLES
 - 31.3.1 To be determined by test plan.
 - 31.4 EQUIPMENT
 - 31.4.1 Variable AC power supply
 - 31.4.2 RMS voltmeter

31.5 PROCEDURE

31.5.1 The following tests can be done simultaneously.

31.5.2 The tests shall be conducted in the maximum output condition.

31.5.3 The voltage is to be increased or decreased, depending on which test is being done, at the rate of 40% of the test potential per second.

31.5.4 Voltage Rise

31.5.4.1 Increase the voltage from 20% of the test potential to 100% of the test potential.

31.5.4.2 Repeat the test 10 times.

31.5.5 Voltage Fall

31.5.5.1 Decrease the voltage from 100% of the test potential to 20% of the test potential.

31.5.5.2 Note at what voltages the following occur:

31.5.5.2.1 Mode relays dropout

31.5.5.2.2 Mode drops

31.5.5.2.3 Time of day can not be read

31.5.5.2.4 Repeat the test 10 times.

31.6 CRITERIA

31.6.1 At the 20% value the control shall not increase the risk of:

31.6.1.1 Fire, electric shock or injury to persons and shall cease to operate.

31.6.2 At the 100% value the control shall continue to perform its intended protective function.

31.7 REPORT

31.7.1 Agency Lab Report Form

32 RESISTANCE TO IMPACT (BALL IMPACT) TEST

32.1 PURPOSE

32.1.1 To evaluate the strength of an enclosure or plastic bracket and determine if damage results in an unsafe condition.

32.2 REFERENCE

32.2.1 UL746C Fourth Edition dated 3/14/96

32.3 SAMPLES

32.3.1 Agency requires a maximum of 3 from soft tool or hard tool each plastic vendor and each color to be qualified. TruHeat will test both versions to assure compliance.

32.4 EQUIPMENT

32.4.1 Temperature chamber

32.4.2 Ball Impact Fixture employing a 2 in. diameter, 1.18 lb. steel sphere

32.4.3 Calipers

32.5 CONDITIONS

32.5.1 Equipment intended for indoor use - Room Temperature ($23^{\circ}\text{C} \pm 3^{\circ}\text{C}$).

32.5.2 Equipment intended for use in unheated indoor applications such as a Garage or warehouse - $0^{\circ}\text{C} \pm 2^{\circ}\text{C}$.

32.5.3 Equipment intended for Outdoor use - $35^{\circ}\text{C} \pm 2^{\circ}\text{C}$

32.5.4 For controls which are intended for indoor unheated indoor applications or outdoor use –

32.5.4.1 Place the controls into the temperature chamber which has been set to the required temperature.

32.5.4.2 Allow the controls to remain at the specified temperature for a period of three hours.

32.5.4.3 Immediately following conditioning, the controls shall be tested

32.6 PROCEDURE

32.6.1 One to Three plastic samples may be used for this test.

32.6.2 If a series of impacts to a control assembly does not cause damage to the enclosure as outlined in the criteria, the enclosure sample may be subjected to an additional impact, until a series of three impacts have been applied or damage has been sustained.

32.6.3 If damage is sustained to the plastic, note any damage in the test report and on the print.

- 32.6.4 If damage is sustained to the plastic, repeat the impact which produced a failure on a new plastic piece.
- 32.6.5 Impact is accomplished by dropping the steel sphere through a vertical distance of 51 inches.
- 32.6.6 Hold sphere at a 90° angle from its mount.
- 32.6.7 Allow sphere to free fall until impact takes place.
- 32.6.8 Do not allow the sphere to impact the control more than once, after the initial impact takes place.
- 32.6.9 Follow the test procedure below.
 - 32.6.9.1 Measure wall thickness using the calipers.
 - 32.6.9.2 Mount the control assembly to the ball impact fixture.
 - 32.6.9.3 Adjust the height of the pendulum to apply an impact from the center point of the sphere to the central location of the area under test.
 - 32.6.9.4 Three impacts to the enclosure are to be applied to the left, center and right of the control face.

32.7 CRITERIA

- 32.7.1 The enclosure shall not sustain damage caused by the impact which would:
 - 32.7.1.1 Make uninsulated live parts accessible.
 - 32.7.1.2 Produce a condition which would affect the mechanical performance or produce a condition which would increase risk of electrical shock.
 - 32.7.1.3 If the risk of electric shock has increased or is in question the control is to be subjected to the dielectric voltage withstand test (Section 12).
 - 32.7.1.4 Cracking or denting of the enclosure can not: Affect the safety functions of the control or affect constructional features such as strain relief, water seals, overload protective devices or thermostats.
 - 32.7.1.5 Result in accessibility of moving parts which could cause injury.

32.8 REPORT

- 32.8.1 Agency Lab Report Form
- 32.8.2 In addition to the General Lab Report Form, also include the following:

- 32.8.2.1 Plastic part number and vendor information.
- 32.8.2.2 Note wall thickness.
- 32.8.2.3 Any damage to the plastic as a result of each impact marked clearly on a print copy.
- 32.8.2.4 Damage noted in detailed written form in the report.
- 32.8.2.5 Location of each impact marked clearly on a print copy.

33 SPARK INTERFERENCE TEST

33.1 PURPOSE

- 33.1.1 To test the controls sensitivity to spark interference.

33.2 SAMPLES

- 33.2.1 3 or as determined by test plan.

33.3 EQUIPMENT

33.3.1 Spark Plate Fixture

- 33.3.2 Test fixture configuration is quite subjective. All aspects of fixture construction can greatly affect the results. Equipment used for testing must be approved by the responsible engineer and/or conform to customer requirements

33.4 CONDITIONS

- 33.4.1 Temperature - Room Temperature ($23^{\circ}\text{C} \pm 3^{\circ}\text{C}$).
- 33.4.2 Nominal rated input voltage.

33.5 PROCEDURE

33.5.1 Test Plate and Control Configuration:

- 33.5.1.1 Wires connecting the spark plate and the control must be 18 gauge appliance wire.
- 33.5.1.2 The intended mounting plate or backguard should be used to mount the control to the spark plate to simulate the actual control environment, but is not necessary.
- 33.5.1.3 Mount the control face up, to the spark plate, keeping a distance of at least 3/4 inch between the transformer and the metal sheet.

- 33.5.1.4 Connect a 6 inch ground wire between the metal plate and the control.
- 33.5.1.5 Sensor harness shall be 42 inches.
- 33.5.1.6 Door Switch Harness shall be 53 inches.
- 33.5.1.7 Level 1:
 - 33.5.1.7.1 Spark Plate ground wire = 3 inches.
 - 33.5.1.7.2 Door Switch Harness bundled and laying loosely on the Spark Plate.
 - 33.5.1.7.3 Spark gaps #1 and #2 = .156".
 - 33.5.1.7.4 1.05 k resistor assembly between the AC line and spark module.
- 33.5.1.8 Level 2:
 - 33.5.1.8.1 Spark Plate ground wire = 10 inches.
 - 33.5.1.8.2 Door Switch Harness bundled and laying loosely on the Spark Plate.
 - 33.5.1.8.3 Spark gaps #1 and #2 = .156".
- 33.5.1.9 Level 3:
 - 33.5.1.9.1 Spark Plate ground wire = 1 Meter or 39.37 inches.
 - 33.5.1.9.2 Door Switch Harness bundled and suspended 1/2" above the Spark Plate, not bundled with AC line voltage.
 - 33.5.1.9.3 Spark gap #1 = .219" and #2 = .187".
- 33.5.2 Start With Level 1 configuration.
- 33.5.3 At the conclusion of each test mode; note displayed time, remove power for 10 seconds, apply power and note the displayed time. If the noted times differ this should be recorded as a failure.
- 33.5.4 Spark Tests:
 - 33.5.4.1 100 Sparks Test:
 - 33.5.4.1.1 Start the 100 sparks test with the control powered, without user input (Power on Display).

33.5.4.1.2 Allow the test to run until 100 sparks have discharged or a failure occurs.

33.5.4.1.3 Repeat the above test in the following modes of operation: Timer set for 10 minutes, Time Of Day Clock, Bake Mode set to 350°F - Relay ON, Bake Mode set to 350°F - Relay OFF, Delayed Bake, Hi Broil and Clean.

33.5.4.1.4 Repeat the entire 100 sparks test using reverse polarity - Switch L1 and Neutral at the Spark Module.

33.5.4.2 Four Hour Test:

33.5.4.2.1 This test is to be performed at the highest test level which produced no failures.

33.5.4.2.2 The control shall be put into the Time of Day mode, with the Time of Day clock synchronized to a known accurate one.

33.5.4.2.3 Monitor the control every half hour. Allow test to run 4 hours or until a failure occurs.

33.5.4.2.4 Repeat test using reverse polarity - Switch L1 and Neutral at the Spark Module.

33.5.4.3 Level 2 Repeat Section 29.5.4.1.

33.5.4.4 Level 3 Repeat Section 29.5.4.1.

33.6 CRITERIA

33.6.1 Failure Types:

33.6.1.1 Soft Failure - Any malfunction of the unit which can be cleared from the user interface (key panel, tactile keys, etc.).

33.6.1.2 Hard Failure - Any malfunction of the unit which cannot be cleared from the user interface (Power connections are not considered user interface). EXAMPLE: A Corrupted E²PROM.

33.6.2 All controls must pass level 1. No failures allowed.

33.6.3 All controls are expected to pass level 2. No hard failures allowed.

33.6.4 No controls are expected to pass level 3. Level 3 is used mainly as a measurement.

33.7 REPORT

- 33.7.1 Lab Report Form 4040502.
- 33.7.2 Include also the following information:
 - 33.7.2.1 Actual room temperature AND humidity.
 - 33.7.2.2 Any other variation which may affect results.

34 STORAGE HUMIDITY TEST

34.1 PURPOSE

- 34.1.1 To evaluate the effects of a condensing type of environment such as could occur in a state bordering the Gulf of Mexico.

34.2 EQUIPMENT

- 34.2.1 A device capable of supplying a 95% Relative Humidity @ 40°C environment for 96 hours.

34.3 PROCEDURE

- 34.3.1 Record serial numbers of devices to be tested, also record the numbers and calibration dates for equipment used.
- 34.3.2 Power the control(s) up and verify that it is functioning properly.
- 34.3.3 Place the assembly in the chamber set to 95% Relative Humidity @ 40°C unpowered for 96 hours, then remove the control(s) and allow them to remain at room conditions unpowered for 12 hours.
- 34.3.4 Power the control(s) up and verify that it is functioning properly.

34.4 CRITERIA

- 34.4.1 The component, or assembly, shall meet all specifications of the drawing.

34.5 REPORT

- 34.5.1 Lab Report Form

35 TERMINAL/CONNECTOR ABUSE

35.1 PURPOSE

- 35.1.1 To evaluate the effects of both radial and axial forces on customer accessible straight terminals and/or connectors.

35.2 EQUIPMENT

35.2.1 One (1) Force gauge - AMETEK (Capital Equip. No. 10307) 0-20 lb. gauge (located in Incoming Inspection Dept.)

35.3 SAMPLES

35.3.1 5 sample control assemblies.

35.3.2 Record serial numbers of devices to be tested, along with critical-to-operation information.

35.4 PROCEDURE

35.4.1 Mount control assembly onto the force gauge in the orientation of said control assemblies.

35.4.2 Apply tensile force (pull) to all customer accessible terminals and/or connectors axially ($0^\circ \pm 2^\circ$). For "ganged" connectors, i.e. .100" or .156" pitch, apply force simultaneously to all pins of the connector. Gradually apply 20 lbs., or as otherwise specified force.

35.4.3 Inspect terminals and/or connectors and PCB. Record results and note all damage.

35.4.4 Apply compression force (push) to all customer accessible terminals and/or connectors axially ($0^\circ \pm 2^\circ$). For "ganged" connectors, i.e. .100" or .156" pitch, apply force simultaneously to all pins of the connector. Gradually apply 20 lbs., or as otherwise specified force.

35.4.5 Inspect terminals and/or connectors and PCB. Record results and note all damage.

35.4.6 Apply compression force at an oblique angle of $+45^\circ$ or -45° to all customer accessible terminals and/or connectors at the tip of the terminals and/or pins. For "ganged" connectors, i.e. .100" or .156" pitch, apply force simultaneously to all pins of the connector. Gradually apply 20 lbs., or as otherwise specified force.

35.4.7 Inspect terminals and/or connectors and PCB. Record results and note all damage.

35.5 CRITERIA

35.5.1 The terminals and/or connectors must not permanently deflect and PCB(s) must remain seated in the assembly without sustaining any permanent damage following the procedure described above.

35.6 REPORT

35.6.1 Lab Report Form.

36 UNPACKAGED DROP TEST

36.1 PURPOSE:

36.1.1 To determine the control's resistance to shocks absorbed upon accidental dropping and/or mishandling. This procedure applies to controls having a generally rectangular or cubic shape.

36.2 EQUIPMENT:

36.2.1 Equipment or process suitable to repeatedly drop control onto a firm, flat surface such as steel, concrete, etc.

36.3 PROCEDURE:

36.3.1 Record serial numbers of devices to be tested, along with critical-to-operation information.

36.3.2 Inspect and test the component(s) and/or assembly(s), to certify conformance to all associated engineering drawing(s) and/or specification (s) preceding the following procedure.

36.3.3 Drop the component and/or assembly once each, on all corners (with associated edges forming a $45^{\circ} \pm 30^{\circ}$ angle incident with surface), front and back from a height of forty (40" $\pm$.25") inches onto a smooth, non-yielding surface (i.e.: concrete, steel, etc.)

36.3.4 Inspect the interior and exterior of the component and/or assembly, and record all damage: unlatched brackets etc.

36.4 CRITERIA:

36.4.1 "Critical-to-operation information" is defined as customer, agency TruHeat engineering required functions and operations which cannot be compromised upon completion of this test.

36.5 REPORT

36.5.1 Lab Report Form

37 ELECTROSTATIC DISCHARGE (AIR OR CONTACT DISCHARGE)

37.1 PURPOSE

37.1.1 To evaluate the effects of static energy discharge on control operation.

37.2 REFERENCE

37.2.1 UL858A Second Edition dated 2/22/95

37.3 CONDITIONS

37.3.1 Preconditioning of Controls

37.3.1.1 Controls shall be conditioned prior to testing for a minimum of 24 hours at the following parameters:

37.3.1.2 Temperature - $23^{\circ}\text{C} \pm 3^{\circ}\text{C}$

37.3.1.3 Humidity - $20\% \pm 5\%$

37.3.2 Test Conditions:

37.3.2.1 The test may be completed outside of the preconditioning environment provided the test is completed within 45 minutes after removal from conditioning environment and room air conditions are as follows:

37.3.2.1.1 Temperature - $23^{\circ}\text{C} \pm 3^{\circ}\text{C}$

37.3.2.1.2 Humidity - 25% - 50%

37.3.3 Test Voltage - Refer to UL Standard 885A, Section: Environmental Stress Tests, General.

37.3.4 Post Test Conditions:

37.3.4.1 Controls shall be energized in a stand by or time of day mode for a minimum of 72 hours at $23^{\circ}\text{C} \pm 3^{\circ}\text{C}$. The controls shall be operationally tested following the 72 hours through use of the Operational Verification test procedure (Section 39).

37.4 SAMPLES

37.4.1 As determined by test plan.

37.5 EQUIPMENT

37.5.1 Temperature/Humidity Chamber

37.5.2 [Electrostatic Discharge Probe](#) with the following characteristics:

37.5.2.1 100pF ($\pm 10\%$) storage capacitor

37.5.2.2 1500W ($\pm 5\%$) discharge resistor

37.5.2.3 4kV - 20kV variable output

37.5.2.4 8mm ($\pm 0.05\text{mm}$) diameter discharge tip

37.5.2.5 The ability to produce positive and negative discharges

37.6 PROCEDURE

37.6.1 The control shall be tested with and without the overlay, if the control uses an overlay.

- 37.6.2 Separate test results shall be recorded and clearly noted on the test form when using an overlay.
- 37.6.3 The control to be tested shall be located on a non-conductive surface, 1 foot away from metal bench parts.
- 37.6.4 The non-conductive surface shall be located above a 4 foot by 8 foot galvanized steel ground plane.
- 37.6.5 The return conductor of the discharge probe and the control ground shall be electrically connected to the ground plane. At the conclusion of the test, energize the control(s) according to the post test conditions.
- 37.6.6 Air Discharge Test:
- 37.6.6.1 Identify all user accessible areas to be tested i.e.; keys, display, switches, retainer etc.
- 37.6.6.2 The Air Discharge test shall be conducted between 4 - 20 kV, in 2 kV increments. After each set of discharges, record the results using the appropriate letter and number combinations as shown below.
- 37.6.6.2.1 Discharge Simulator action:
- 37.6.6.2.1.1 A = Discharge did not occur
- 37.6.6.2.1.2 B = Discharge
- 37.6.6.2.2 Control Reaction
- 37.6.6.2.2.1 1 = Normal operation - No failure occurred.
- 37.6.6.2.2.2 2 = Soft Failure - Any malfunction of the unit which can be cleared from the user interface and is not considered an unsafe failure.
- 37.6.6.2.2.3 3 = Hard Failure - Any malfunction of the unit which can not be cleared from the user interface. Describe failure in detail in the data section of the report.
- 37.6.7 Unpowered and Unconnected Configuration:
- 37.6.7.1 Begin the test with the discharge simulator charged in free air to 4 kV. Bring the probe to the predetermined test point until an air discharge occurs or the probe tip is touching the test point.
- 37.6.7.2 The control shall be subjected to five discharges at each polarity.
- 37.6.7.3 Control operation shall be checked after each set of five discharges.

37.6.7.4 Increment the test voltage after all test points have been subjected to a total of ten discharges for the positive and negative polarities.

37.6.8 Magnetic Field Test:

37.6.8.1 The conditioned control shall be positioned and supported as described above.

37.6.8.2 Attach the magnetic field loop.

37.6.8.3 Apply power to the control.

37.6.8.4 Charge the test probe to 20 kV and discharge through the loop.

37.6.8.5 The loop should be first placed on a parallel plane with respect to the control surface being tested, then in two other mutually perpendicular planes.

37.6.8.6 A portion of the loop should be positioned within 2 inches of the control.

37.6.8.7 Repeat the test on all control surfaces for each polarity and each loop position.

37.6.8.8 If the control can fit in the loop, it is to be tested within the loop.

37.6.8.9 In this configuration, only three loop positions at each polarity need to be tested, not each control surface.

37.6.8.10 Six discharges are sufficient in this configuration.

37.7 CRITERIA

37.7.1 During the post test conditioning, the control shall perform its protective function or shut down without the loss of its protective function.

37.8 REPORT

37.8.1 Agency Lab Report Form

37.9 See Appendix A for an example of the data that needs to be collected for the Lab Report.

38 SHOWERING ARC TEST

38.1 PURPOSE

38.1.1 To evaluate the effects of fast transient energy on control operation.

38.2 REFERENCE

38.2.1 UL858A Second Edition dated 2/22/95 - Fast Transient Test.

38.3 EQUIPMENT/SAMPLE SIZE

38.3.1 Showering arc Generator constructed as directed in UL 858A, Fast Transient Test.

38.3.2 Samples from each transformer and vendor to be qualified, as determined by test plan.

38.3.3 Oscilloscope equipped with high voltage probe.

38.4 AMBIENT CONDITIONS

38.4.1 Control to tested at Room Temperature ($23^{\circ}\text{C} \pm 3^{\circ}\text{C}$)

38.4.2 Test Voltage - Refer to UL Standard 858A, Section: Environmental Stress Tests, General

38.5 PROCEDURE

38.5.1 Test apparatus shall be constructed and calibrated in accordance with the procedures specified in UL 858A, fast transient test.

38.5.2 The connections to the control are to be in accordance with the procedures specified in UL 858A, fast transient test.

38.5.3 Test Sequence:

38.5.3.1 Connect all circuits as appropriate to their function.

38.5.3.2 Energize the control.

38.5.3.3 Energize the fast transient generator.

38.5.3.4 Exercise all functions of the control.

38.5.3.5 Repeat for all controls to be tested.

38.6 CRITERIA

38.6.1 The protective function of the control shall not be adversely affected and there shall be no physical damage or risk of fire or risk of electrical shock or the control shall shut down without loss of its intended protective function.

38.7 REPORT

38.7.1 Agency Lab Report Form Include:

38.7.1.1 Transformer part number and vendor information.

38.7.1.2 Any damage to the control as a result of testing.

38.7.1.3 Any other variation which may affect results.

39 OPERATIONAL VERIFICATION

39.1 PURPOSE

39.1.1 To verify the operation of controls either before, during, or after testing.

39.2 SAMPLES

39.2.1 As required by the test specification.

39.3 EQUIPMENT

39.3.1 As required to confirm operation.

39.4 CONDITIONS

39.4.1 As specified OR Room Temperature ($23^{\circ}\text{C} \pm 3^{\circ}\text{C}$).

39.4.2 Test voltage - Refer to UL Standard 858A, Section: Environmental Stress Tests, General.

39.5 PROCEDURE

39.5.1 The control shall be connected to inputs and outputs which simulate or indicate intended operation. The actual test procedure will be determined by the responsible engineer. The Lab Form may be used as a worksheet to define operational verification test procedure.

39.6 CRITERIA

39.6.1 The control shall meet the criteria of the test specification and/or shall operate as intended.

39.7 REPORT

39.7.1 Lab Report Form - or Agency Report Form

39.7.2 In addition to one of the Report Forms, also include any modifications which may affect results.

40 CONTACT BOUNCE SIMULATION

40.1 PURPOSE

40.1.1 To simulate the arcing and contact bounce associated with making and breaking a switch, either the switch contacts of a manual switch or the contacts of a relay, or from a TCO, ect.

40.2 SAMPLES

40.2.1 As determined from the test plan, one with each alternative component.

40.3 EQUIPMENT

40.3.1 A conducting metal probe about 9 to 12 inches long, well insulated on one end so that it may be safely handled, with the other end having about 1" of conducting material exposed.

40.3.2 An exposed metal plate approximately 30 sq. in. with some rust on it.

40.4 CONDITIONS

40.4.1 All currents and voltages of all inputs and outputs as in normal operation in room temperature, or as otherwise specified by engineering.

40.5 PROCEDURE

40.5.1 For the node that leads to a device that switches contacts through open air, open the current path to one lead of the switching device.

40.5.2 Connect one side of the opened node to the probe through at most a 2ft. long wire of at least one gauge larger than being used by that node.

40.5.3 Connect the other side of the opened node to the plate through at most a 2ft. long wire of at least one gauge larger than being used by that node.

40.5.4 With the probe and plate positioned so that they can not potentially touch each other or other metal or persons, power up the control and put it into a mode in which the switching device would normally be closed.

40.5.5 Using much caution and using an insulating glove, grab the probe by the insulated handle and commence to drag the exposed metal tip of the probe across the metal plate to produce sparks if the potential is high enough. Continue to scratch the plate with the metal probe, producing sparks, for 10 to 15 minutes.

40.5.6 Repeat for each mode of operation so that each input and output is exercised.

40.5.7 Re-connect the opened node so that the control functions as it would before opening that node.

40.5.8 Repeat 40.5.1 through 40.5.6 for each lead connected to an open-air switching device.

40.6 CRITERIA

40.6.1 The control shall continue to function as normal throughout the test and afterwards.

40.6.2 No components will burn open or short, and no sparking will be observed or heard on the control.

40.7 REPORT

40.7.1 Note all results in the Lap Report.

41 REFERENCE DOCUMENTS

41.1 Design Validation Procedure

41.2 UL858A Second Edition dated 2/22/95

41.3 UL873 Eleventh Edition dated 4/3/96.

41.4 UL746C Fourth Edition dated 3/14/96.

42 DISTRIBUTION

42.1 All Engineering personnel and Quality/Reliability supervisors

43 RECORDS

43.1 Records shall be maintained in accordance with the methods specified in the Design Validation Procedure.

APPENDIX A

Air Discharge

Unpowered & Unconnected																
Areas Under Test																
kV	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-
4																
6																
8																
10																
12																
14																
16																
18																
20																

De-Energized (Stand-By or Time of Day Operation)																
Areas Under Test																
kV	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-
4																
6																
8																
10																
12																
14																
16																
18																
20																

LETTER CODE + NUMBER CODE = Discharge Simulator Action + Control Reaction	
A = Discharge did not occur B = Discharge occurred	1 = Normal Operation - No failures occurred 2 = Soft failure - Can be reset from user interface. No unsafe failures occurred. 3 = Hard Failure - Can not be reset from user interface. (Detailed description of failure is included in the data section of the Lab Report.)

Example of data table for Electrostatic Discharge Test

APPENDIX B

UL RELAY CONTACT TEST CRITERIA

LOAD TYPE	OVLD/PF	OVLD/I	OVLD/V	OVLD/C	EDR/PF	EDR/I	EDR/V	EDR/C	NOTES **
RESISTIVE	1.0	1.5 X R	R	50	1.0	R	R	*	
MOTOR	.4-.5	LRA	R	50	.75-.80	FLA	R	*	AIR CORE LOADS USED
HORSEPOWER	.4-.5	6 X FLA	R	50	.75-.80	FLA	R	*	AIR CORE LOADS USED
PILOT DUTY	<.35	1.1 X R	1.1 X R	50	<.35	R	R	*	AIR CORE LOADS USED
GENERAL PURPOSE	.78-.80	1.5 X R	R	50	.75-.80	R	R	*	AIR CORE LOADS USED
TUNGSTEN	1.0	1.5 X R	R	50	1.0	R	R	*	INCANDESCENT LAMPS ARE USED FOR LOADS
BALLAST	.4-.5	3 X R	R	50	.4-.5	2 X R	R	*	AIR CORE LOADS USED

* - 6K, 10K, 30K, 100K, 250K – depending on application.

** - Actual loads can be used in lieu of using artificial loads.

OVLD - OVERLOAD
EDR - ENDURANCE
PF - POWER FACTOR
V - VOLTAGE
I - CURRENT
C - CYCLES
R - RATED