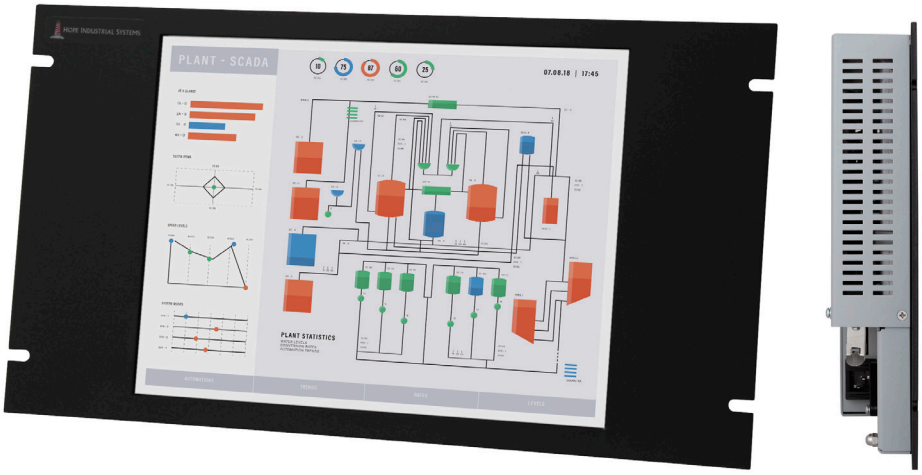
HOPE INDUSTRIAL SYSTEMS



15" RACK MOUNT INDUSTRIAL MONITOR

REVISION I

PRODUCT RELIABILITY TEST REPORT

Model No. HIS-RL15- _ _ _ I

Table of Contents

Test Report Overview

Hope Industrial Systems, Inc.

Environmental Testing Laboratory

Report for: HIS RL15-xxxI, with Elo resistive touch and AC input

Testing Rationale

The environmental classification system set out in IEC 60721-3 is used to determine the conditions to which an HIS product is likely to be exposed, given the way it is intended to be transported, stored, and operated:

The **transport** environment is defined as Set IE21 of Condition Classes from IEC 60721-3-2. This set of conditions typifies the environments to which products are exposed in transport by ground in air-cushioned trailers through areas with normal levels of industrial activity, or by air in heated and pressurized cargo holds.

The **storage** environment is defined as Set IE12 of Condition Classes from IEC 60721-3-1. This set of conditions typifies the environments of weather-protected storage facilities without continuous control of temperature and humidity. The conditions are more severe than those in facilities with continuous temperature and humidity control, and less severe than those in facilities without any heating and cooling. In such environments, temperature can range from -5° to 45°C (23° to 113°F) and humidity can range from 5% to 95%, with condensation and ice formation possible. Stored products can be exposed to solar and heat radiation and to movements of surrounding air.

The **operating** environment is defined generally as Set IE35 of Condition Classes from IEC 60721-3-3. This set of conditions typifies the environments to which products are exposed on process plant floors, where conditions are more severe than those typical of offices, garages, cellars, and workshops, but less severe than those that can be encountered in buildings lacking any protection from daily variations in outdoor climate, especially in geographical areas with very severe outdoor climates. In such environments, temperature can range from -5° to 45°C (23° to 113°F) and humidity can range from 5% to 95% with condensation possible. Products may be subject to heat radiation (near heating equipment), solar radiation (near windows), and moderate movement of air. Significant levels of vibration and shock can be present, as transmitted from machines or passing vehicles.

Once the transport, storage, and operating environments have been characterized, the guidelines and recommendations given in IEC 60721-4 are used to determine the specific tests and test conditions that will adequately simulate these environments in the laboratory.

Test Plan

The specimen is subjected to the tests in the column "HIS Combined Test" in succession. The order of tests is based on IEC recommendations, which take into account the fact that certain tests can affect the outcomes of subsequent tests. The specimen must pass all tests in order to qualify for the prescribed environmental ratings.

Test Type	HIS Combined Test	Test Recommended for IE35 (3K5/3M3), extended to 3M4 and excepting 3Z8 – Operating	Test Recommended for IE12 (1K3/1M2) – Storage	Test Recommended for IE21 (2K2/2M1) – Transport
Cold, Steady State, Non-operating	68-2-1 Ab, -25°C, 16 hrs			68-2-1 Ab, -25°C, 16 hrs
Cold, Steady State, Operating	68-2-1 Ad, -5°C, 16 hrs	68-2-1 Ad, -5°C, 16 hrs	68-2-1 Ab, -5°C, 16 hrs	
Dry Heat, Steady State, Operating	68-2-2 Bd, 55°C, 16 hrs	68-2-2 Bd, 45°C, 16 hrs	68-2-2 Bd, 45°C, 16 hrs	68-2-2 Bd, 55°C, 16 hrs
Solar Radiation	dry heat test above	10°C added to dry heat test above	10°C added to dry heat test above	dry heat test above
Thermal Shock, Non-operating	68-2-14 Na, -25°C to ambient, 5 cycles			68-2-14 Na, -25°C to ambient, 5 cycles
Thermal Shock, Operating	68-2-14 Nb, -5°C to ambient, 2 cycles, 0.5°C/min, 3-hr dwell	68-2-14 Nb, -5°C to ambient, 2 cycles, 0.5°C/min, 3-hr dwell		
Mechanical Shock, Operating	68-2-27 Ea, 150 m/sec^2, 6 msec half sine, 100 pulses in each of 6 directions	68-2-27 Ea, 150 m/sec^2, 6 msec half sine, 100 pulses in each of 6 directions		68-2-27 Ea, 100 m/sec^2, 16 msec half sine, 100 pulses in each of 6 directions
Free Fall	ISO 4180-2, 2 falls, height based on mass			ISO 4180-2, 2 falls, height based on mass
Water from sources not rain	68-2-18 Rb, for dripping water per Ra 2 1-hr 2m drip height, 0° angle	Omitted (see rationale for exclusion of special condition 3Z8)	68-2-18 Rb, for dripping water per Ra 2 1-hr 2m drip height, 0° angle	
Static Load	ISO 2234		ISO 2234	ISO 2234
Vibration (Broadband), Non-operating	68-2-64 Fh, ASD 1.0, 10-100 Hz, -3 db/octave 100-200 Hz, then ASD 0.5, 200-2000 Hz, 3 axes, 30 min/axis			68-2-64 Fh, ASD 1.0, 10-100 Hz, -3 db/octave 100-200 Hz, then ASD 0.5, 200-2000 Hz, 3 axes, 30 min/axis
Vibration (Sinusoidal), Operating	68-2-6 Fc, 3.5 mm disp to 9 Hz, then 10 m/sec^2 accel, 9-500 Hz, 3 axes, 10 sweep cycles	68-2-6 Fc, 3.5 mm disp to 9 Hz, then 10 m/sec^2 accel, 9-150 Hz, 3 axes, 10 sweep cycles	68-2-6 Fc, 0.75 mm p-p to 9 Hz, then 2 m/sec^2, 9-150 Hz, 3 axes, 10 sweep cycles	68-2-6 Fc, 3.5 mm p-p to 9 Hz, then 10 m/sec^2, 9-500 Hz, 3 axes, 10 sweep cycles
Damp Heat, Cyclical, Operating	68-2-30 Db Var 2, 40°C, 90-100% RH, 2 cycles	68-3-30 Db Var 2, 30°C, 90-100% RH, 2 cycles	68-2-30 Db Var 2, 40°C, 90-100% RH, 1 cycle	
Damp Heat, Steady State, Operating	68-2-78 Cab, 40°C, 93% RH, 96 hrs	68-2-78 Cab, 30°C, 93% RH, 96 hrs	68-2-78 Cab, 30°C, 93% RH, 96 hrs	68-2-78 Cab, 40°C, 85% RH, 96 hrs

Criteria for Passage of Test: The specimen must remain operational throughout each test, where applicable, as demonstrated by visibility of a display during testing. Following each test, the specimen must exhibit no signs of material degradation under visual inspection or failures in standard operation.

Test 1 – Cold (Steady State), Non-Operating

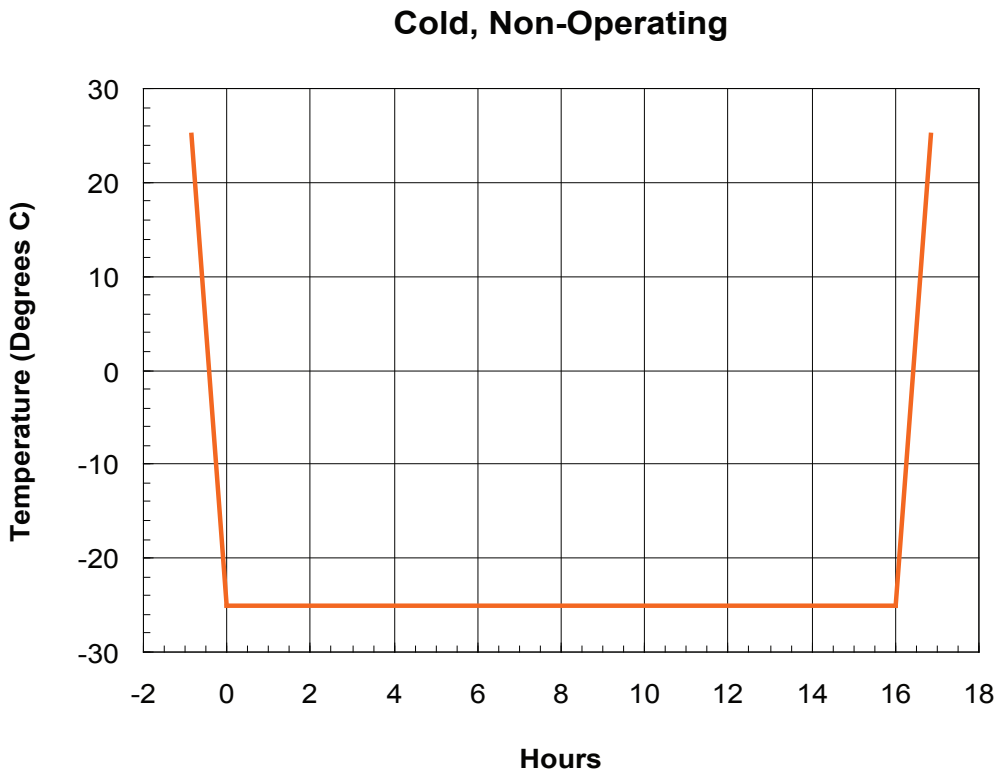
Date of Test: July 2019

Test Standard: IEC 60068-2-1, test Ab

Test Conditions: -25°C (+/- 3°), 16 hours, specimen not energized, specimen packaged

Purpose of Test: To demonstrate that the specimen can be transported in conditions where the ambient air temperature can fall to -25°C, as recommended in IEC 60721-4-2 to qualify the specimen for transport in Class 2K2 Climate as defined in IEC 60721-3-2.

This test also demonstrates that the specimen can be stored in conditions where the ambient air temperature can fall to -5°C, as recommended in IEC 60721-4-1 to qualify the specimen for storage in Class 1K3 Climate as defined in IEC 60721-3-1.



Test Equipment

Thermotron SM-16 climatic chamber, with 4800 controller and 2 input channels for temperature and humidity monitoring (calibrated by Southern Instrument Service, Certificate #12813 – June 2019)

Test Procedure

Unless otherwise noted, the procedure followed was the procedure described in Test 1, "HIS Monitor Testing," V0.94, June 2019, which in turn follows the recommendations of IEC 60068-2-1 for test Ab.

Test parameters were entered into the Thermotron controller as Program #1.

Results

Specimen was found to be in good working order following the test.

Testing Pictures

The photo below shows how specimens were installed in the chamber.

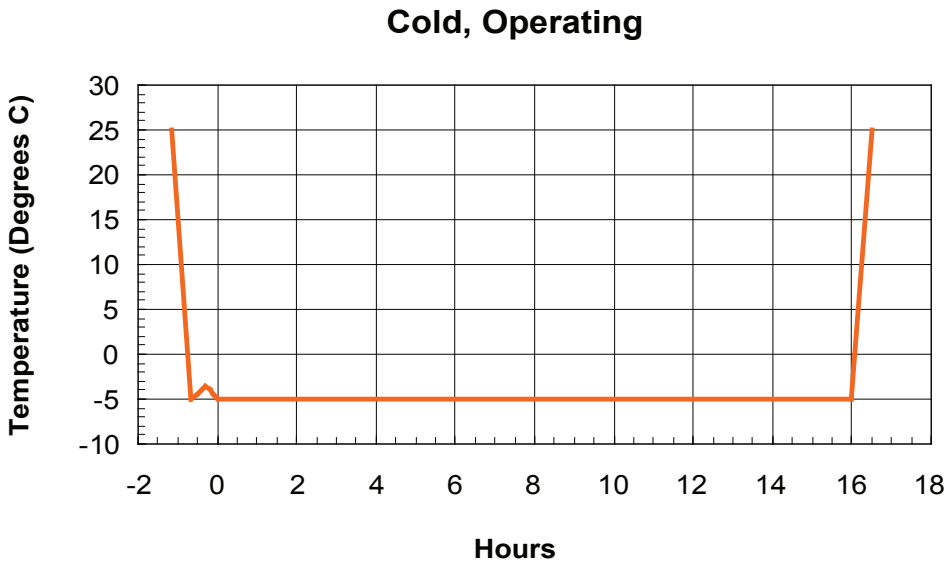
Test 2 – Cold (Steady State), Operating

Date of Test: July 2019

Test Standard: IEC 60068-2-1, test Ad for heat-dissipating specimens

Test Conditions: -5°C, 16 hours, specimen operating

Purpose of Test: To demonstrate that the specimen can be operated in a location in which the ambient air temperature can fall to -5°C, as recommended in IEC 60721-4-3 to qualify the specimen for operation in Class 3K5 Climate as defined in IEC 60721-3-3.



Test Equipment

Thermotron SM-16 climatic chamber, with 4800 controller and 2 input channels for temperature and humidity monitoring (calibrated by Southern Instrument Service, Certificate #12813 – June 2019)

PC and video splitter used to supply video to specimens

Test Procedure

Unless otherwise noted, the procedure followed was the procedure described in Test 2, "HIS Monitor Testing," V0.94, June 2019, which in turn follows the recommendations of IEC 60068-2-1 for test Ad.

NOTE: The period of exposure at -5°C was extended from 16 hours to 22 hours to facilitate management of the test.

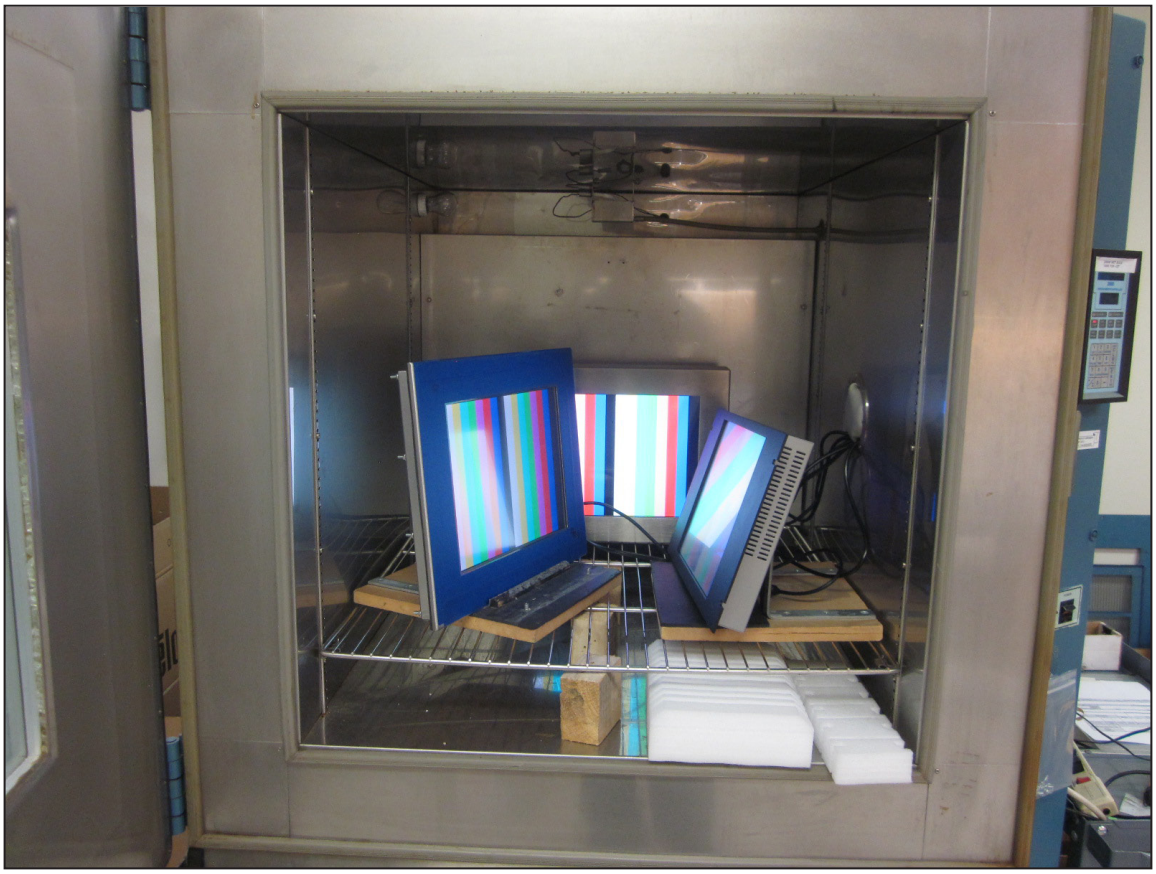
Test parameters were entered into the Thermotron controller as Program #2.

Results

Specimen was found to be in good working order following the test.

Testing Pictures

The photo below shows how specimens were installed in the chamber.



Test 3 – Dry Heat (Steady State), Operating

Date of Test: July 2019

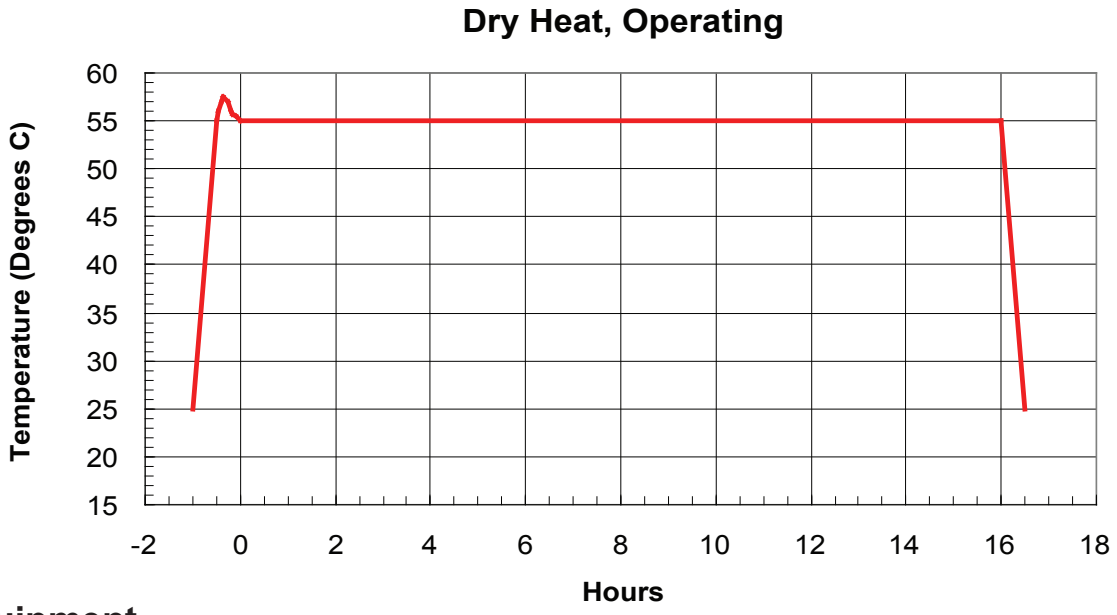
Test Standard: IEC 60068-2-2, test Bd for heat-dissipating specimens

Test Conditions: 55°C (+/- 3°), 16 hours, specimen operating

Purpose of Test: To demonstrate that the specimen can be operated in a location where the ambient air temperature can rise to 45°C, and where combined effects of solar radiation, movement of air, and thermal radiation on the specimen can produce a rise of up to 10°C over ambient, as recommended by IEC 60721-4-3 to qualify the specimen for operation in a Class 3K5 Climate as defined in IEC 60721-3-3.

This test also demonstrates that the specimen can be transported in unventilated conditions where the ambient air temperature can rise to 55°C, or in ventilated conditions where the ambient air temperature can rise to 40°C, as recommended in IEC 60721-4-2 to qualify the specimen for transport in a Class 2K2 Climate as defined in IEC 60721-3-2.

This test also demonstrates that the specimen can be stored in conditions where the ambient air temperature can rise to 55°C, as recommended in IEC 60721-4-1 to qualify the specimen for storage in a Class 1K3 Climate as defined in IEC 60721-3-1.



Test Equipment

Thermotron SM-16 climatic chamber, with 4800 controller and 2 input channels for temperature and humidity monitoring (calibrated by Southern Instrument Service, Certificate #12813 – June 2019)

PC and video splitter used to supply video to specimens

Test Procedure

Unless otherwise noted, the procedure followed was the procedure described in Test 3, "HIS Monitor Testing," V0.94, June 2019, which in turn follows the recommendations of IEC 60068-2-2 for test Bd.

NOTE: The period of exposure at 55°C was extended from 16 hours to 22 hours to facilitate management of the test.

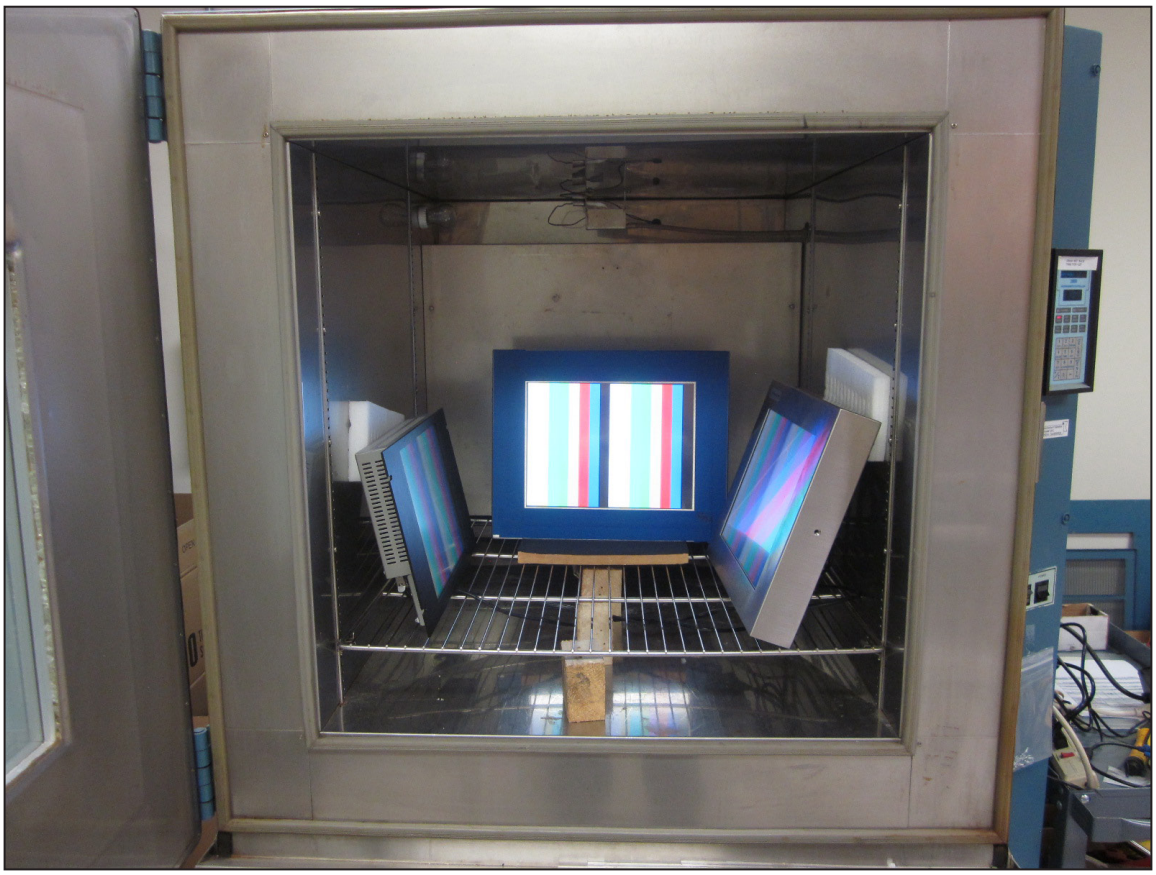
Test parameters were entered into the Thermotron controller as Program #3.

Results

Specimen was found to be in good working order following the test.

Testing Pictures

The photo below shows how specimens were installed in the chamber.



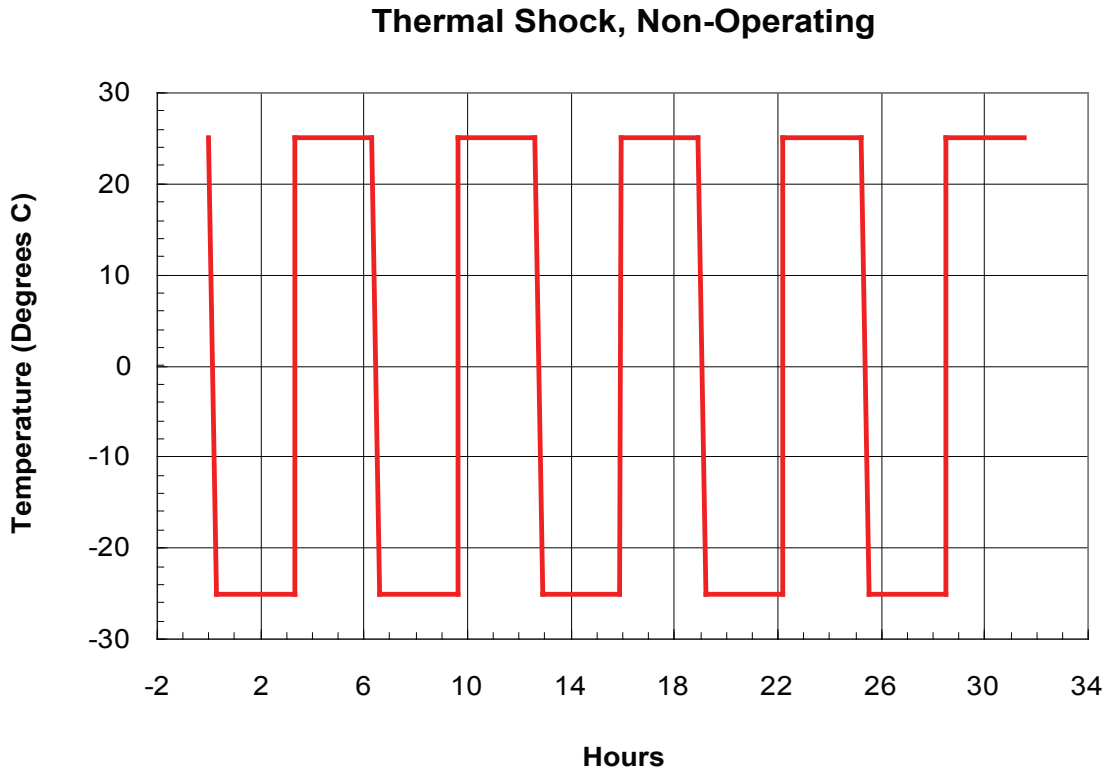
Test 4 – Thermal Shock, Non-Operating

Date of Test: July 2019

Test Standard: IEC 60068-2-14, test Na

Test Conditions: -25°C to ambient, 5 cycles, specimen not energized, specimen packaged

Purpose of Test: To demonstrate that the specimen can be transported in conditions where the ambient air temperature can vary rapidly over a considerable range, as recommended in IEC 60721-4-2 to qualify the specimen for transport in a Class 2K2 Climate as defined in IEC 60721-3-2.



Test Equipment

Thermotron SM-16 climatic chamber, with 4800 controller and 2 input channels for temperature and humidity monitoring (calibrated by Southern Instrument Service, Certificate #12813 – June 2019)

Test Procedure

Unless otherwise noted, the procedure followed was the procedure described in Test 13, "HIS Monitor Testing," V0.94, June 2019, which in turn follows the recommendations of IEC 60068-2-14 for test Na.

A change was made in the procedure to allow automating the test, to ensure the ambient temperature would be appropriate. Instead of holding the chamber at -25°C and physically moving the specimens into the chamber or from the chamber into normal ambient conditions every three hours, the specimens were left in the chamber for the duration of the test and the chamber was programmed as follows (Program #7):

Interval	Channel 1 Start	Channel 1 End	Channel 2 Start	Channel 2 End	Time
1	25°C	-25°C	50%	50%	15 minutes
2	-25°C	-25°C	50%	50%	3 hours
3	-25°C	25°C	50%	50%	15 minutes
4	25°C	25°C	50%	50%	3 hours
Loop back to interval #1 seven times					

It was decided that the ability of the Thermotron to transition back and forth from 25°C to -25°C in 15 minutes was enough to simulate the desired thermal shock. Although the test plan calls for only 5 cycles, 7 cycles were run in order to better manage testing.

Results

Specimen was found to be in good working order following the test.

Testing Pictures

The photo below shows how specimens were installed in the chamber.

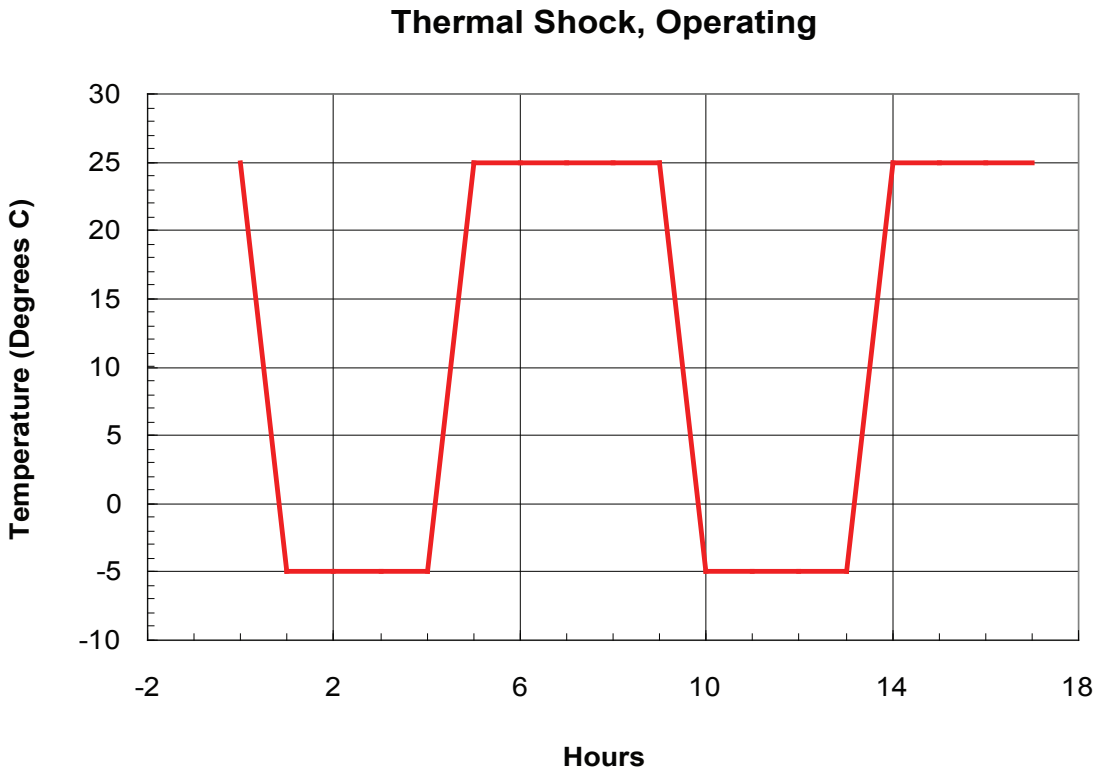
Test 5 – Thermal Shock, Operating

Date of Test: August 2019

Test Standard: IEC 60068-2-14, test Nb

Test Conditions: -5°C to ambient, 2 cycles, specimen energized, 0.5°C/min rate of temperature change

Purpose of Test: To demonstrate that the specimen can be operated in conditions where the ambient air temperature can vary rapidly over a considerable range, as recommended in IEC 60721-4-3 to qualify the specimen for operation in a Class 3K5 Climate as defined in IEC 60721-3-3.



Test Equipment

Thermotron SM-16 climatic chamber, with 4800 controller and 2 input channels for temperature and humidity monitoring (calibrated by Southern Instrument Service, Certificate #12813 – June 2019)

PC and video splitter used to supply video to specimens

Test Procedure

Unless otherwise noted, the procedure followed was the procedure described in Test 5, "HIS Monitor Testing," V0.94, June 2019, which in turn follows the recommendations of IEC 60068-2-14 for test Nb.

NOTE: The number of temperature cycles was extended from 2 to 3 to facilitate management of the test.

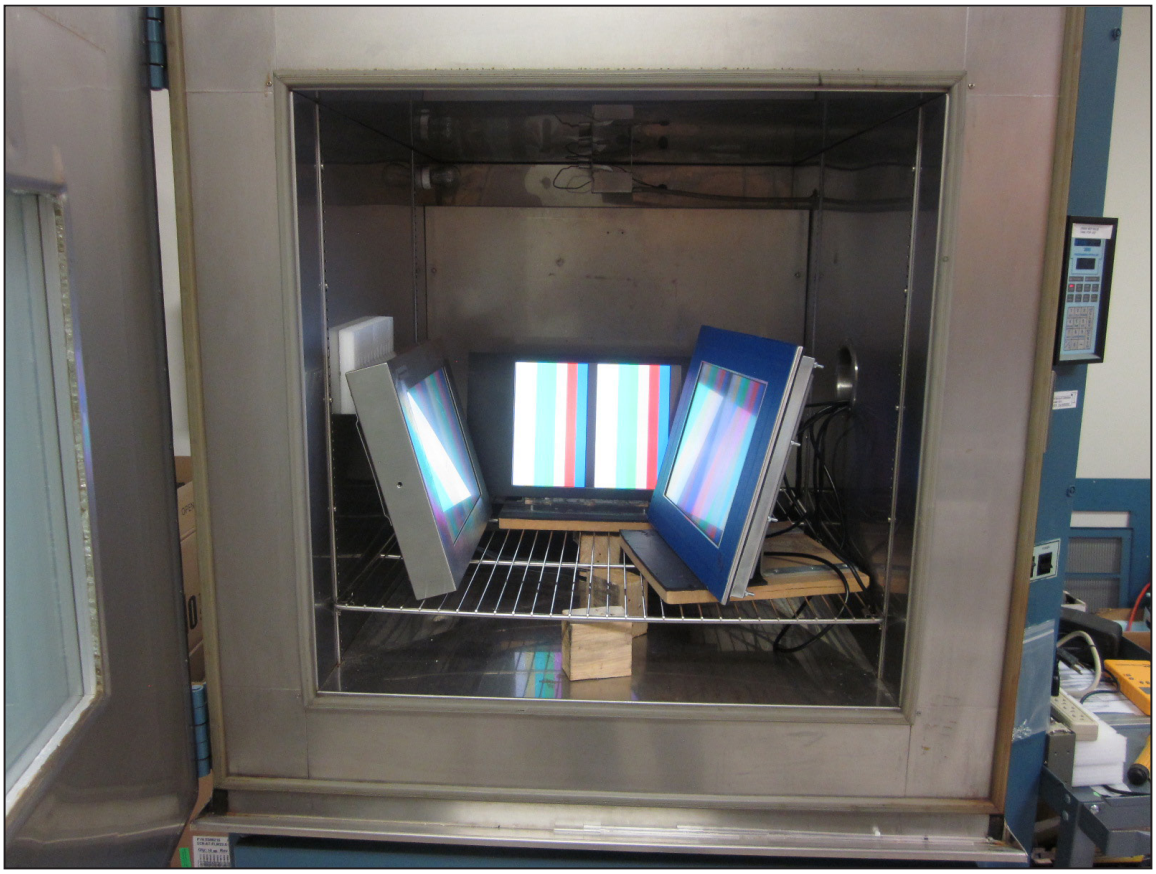
Test parameters were entered into the Thermotron controller as Program #4.

Results

Specimen was found to be in good working order following the test.

Testing Pictures

The photo below shows how specimens were installed in the chamber.



Test 6 – Mechanical Shock, Operating

Date of Test: August 2019

Test Standard: IEC 60068-2-27, test Ea

Test Conditions: 150 m/sec^2, 6 msec half-sine pulses (nominal), 6 directions, 100 pulses per direction, specimen energized, specimen unpackaged

Purpose of Test: To demonstrate that the specimen can be operated in conditions where it can be subjected to moderate shock, as recommended in IEC 60721-4-3 to qualify the specimen for operation in a Class 3M5 mechanical environment as defined in IEC 60721-3-3.

This test also demonstrates that the specimen can be transported in conditions where it can be subjected to moderate shock, as recommended in IEC 60721-4-2 to qualify the specimen for operation in a Class 2M1 environment as defined in IEC 60721-3-2.

Test Procedure

Applied Technical Services report "Shock and Vibration Testing of LCD Monitors," Job #319281, Purchase Order #76667, Dated August 23, 2019, is incorporated by reference. For the complete report, please visit:

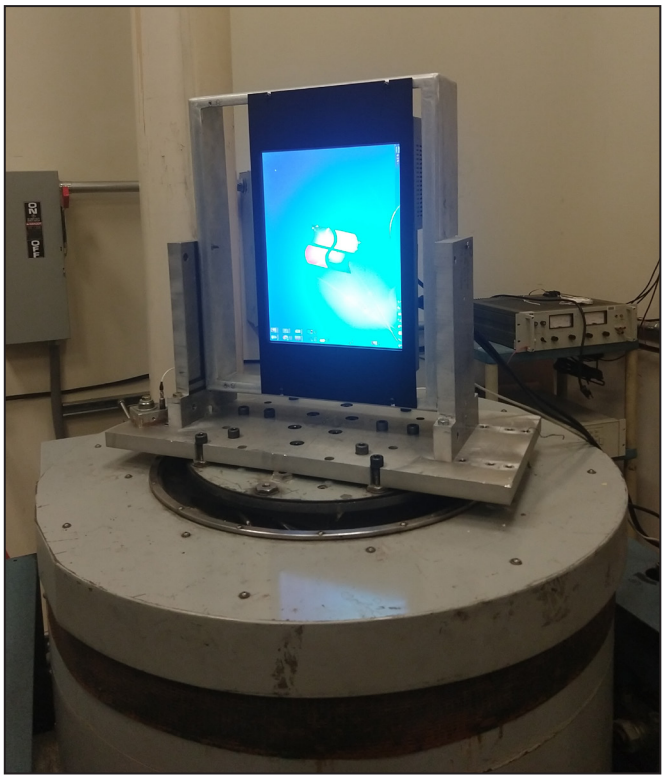
https://www.HopeIndustrial.com/docs/319281

A video signal was applied to the monitors during the exposure. 100 shocks per axis per direction were applied. Each shock had an amplitude of 15G, a pulse duration of 6 msec and half-sine time waveform.

Results

Specimens were found to be in good working order following the test.

Below are pictures from the test.



Test 7 – Free Fall

Date of Test: September 2010 (Test not redone due to no changes in packaging)

Test Standard: ISO 4180-2 (ISO 2248)

Test Conditions: 2 falls at each specified altitude, height based on mass, specimen not energized, specimen packaged, laboratory ambient

Purpose of Test: To demonstrate that the specimen can withstand moderately rough handling that could involve dropping, as recommended in IEC 60721-4-2 to qualify the specimen for transport in Class 2M1 conditions as defined in IEC 60721-3-2.

This test also demonstrates that the specimen can withstand moderately rough handling that could involve dropping as recommended in IEC 60721-4-1 to qualify the specimen for storage in Class 1M2 conditions as defined in IEC 60721-3-1.

NOTE: Test was not repeated since no packaging changes were made since the last revision.

Test Procedure

Applied Technical Services report "Shock and Vibration Testing of LCD Monitors," Job #D157097, Purchase Order #59955, Dated September 21, 2010, is incorporated by reference. For the complete report, please visit:

https://www.HopeIndustrial.com/docs/ATS4

Results

Specimen was found to be in good working order following the test.

Test 8 – Exposure to Water

Test waived due to product being packaged and taped in a plastic bag.

Test 9 – Static Load

Date of Test: January 2009 (Test not redone due to no changes in packaging)

Test Standard: ISO 2234

Test Conditions: Laboratory ambient conditions, stack height 2.5 m

Purpose of Test: To demonstrate that the specimen (packaged) can withstand static loads that might be imposed when items are stacked on it in transport or storage, as recommended in IEC 60721-4-1/2 to qualify the specimen for transport and storage in Class 1M2/2M1 conditions as defined in IEC 60721-3-1/2.

NOTE: Test was not repeated since no packaging changes were made since the last revision.

Test Equipment

Concrete Floor

Test Procedure

1. This test requires multiple identical specimens. Each specimen shall be a monitor in its normal packaging. Packaging shall be sealed in the normal way for storage and transport.

2. The number of specimens required for the test shall be determined from the specified stack height. The required number of specimens shall be weighed to determine the static load.

3. Prior to the test, one of the specimens shall be selected at random as the specimen under test. Its overall outside dimensions shall be measured to within 1 mm.

4. The required number of specimens shall be stacked vertically on a concrete floor that is level to within +/- 2 mm over the relevant area. The specimen selected as the specimen under test and previously measured shall be placed at the bottom of the stack.

5. The specimens shall remain stacked at laboratory ambient for a period of 24 hours, or until collapse of the specimen under test.

6. The specimens shall be unstacked, and the specimen under test shall be measured to within +/- 1 mm.

Criteria for Passage of Test: Following exposure to the specified conditions, the dimensions of the specimen under test shall be within 5% of its pre-test dimensions, and the package shall exhibit no buckling.

Results

Pass – total dimensional change of the specimen was 3% of its pre-test dimensions.

Test 10 – Vibration (Broadband), Non-Operating

Date of Test: August 2019

Test Standard: IEC 60068-2-64, test Fh

Test Conditions: ASD 1.0 from 10-100 Hz, -3 db/octave 100-200 Hz, then ASD 0.5, 200-2000 Hz, 3 axes, 30 min/axis, specimen not energized, specimen may be packaged

Purpose of Test: To demonstrate that the specimen can withstand moderate levels of random vibration, as recommended in IEC 60721-4-2 to qualify the specimen for transport in Class 2M1 conditions as defined in IEC 60721-3-2.

Test Procedure

Applied Technical Services report "Shock and Vibration Testing of LCD Monitors," Job #319281, Purchase Order #76667, Dated August 23, 2019, is incorporated by reference. For the complete report, please visit:

https://www.HopeIndustrial.com/docs/319281

The displays were tested in a packaged configuration. The packages were placed into a fixture to simulate a shipping environment. A random vibration was applied for a duration of 30 minutes per axis over three mutually perpendicular axes.

Results

Specimen was found to be in good working order following the test.

Test 11 – Vibration (Sinusoidal), Operating

Date of Test: August 2019

Test Standard: IEC 60068-2-6, test Fc

Test Conditions: 3.5 mm peak acceleration to 9 Hz, then 1 g (10 m/sec^2) 9-500 Hz, 3 axes, 10 sweeps per axis at 1 octave/min, specimen energized

Purpose of Test: To demonstrate that the specimen can withstand moderate levels of vibration while operating, as recommended in IEC 60721-4-3 to qualify the specimen for transport in Class 3M4 conditions as defined in IEC 60721-3-3.

This test also demonstrates (by extension of the vibrational frequency range to 500 Hz) that the specimen can withstand moderate levels of vibration, as recommended in IEC 60721-4-2 to qualify the specimen for transport in Class 2M1 conditions as defined in IEC 60721-3-2.

This test will also demonstrate that the specimen can withstand moderate levels of vibration as recommended in IEC 60721-4-1 to qualify the specimen for storage in Class 1M2 conditions as defined in IEC 60721-3-1.

Test Procedure

Applied Technical Services report "Shock and Vibration Testing of LCD Monitors," Job #319281, Purchase Order #76667, Dated August 23, 2019, is incorporated by reference. For the complete report, please visit:

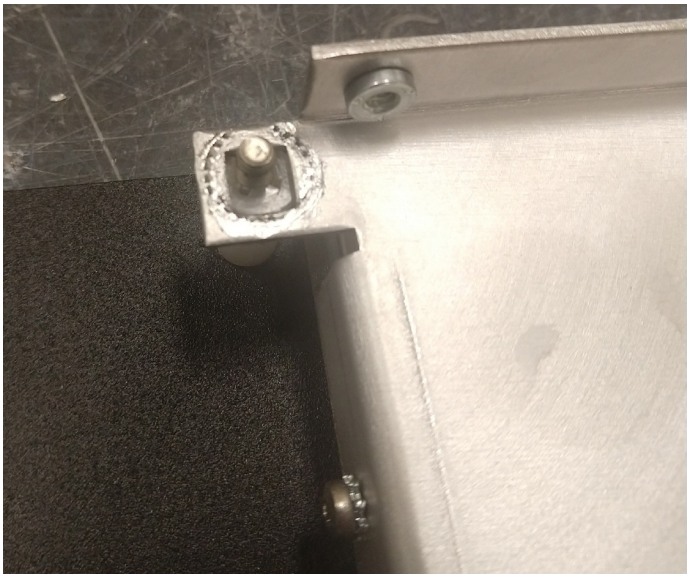
https://www.HopeIndustrial.com/docs/319281

The setup was identical to the setup used for Test 6 (Mechanical Shock). A sinusoidal sweep was applied to the displays along three mutually perpendicular axes. A total of 10 sweeps per axis were performed.

Results

Specimen was found to be perfectly functional following the test. However, a nut was found to have worked itself loose. As a corrective action, it was decided to change the build procedure and add a loctite compound to this and similar nuts to prevent this in the future.

The photo below shows the missing nut.



Test 12 – Damp Heat (Cyclical), Operating

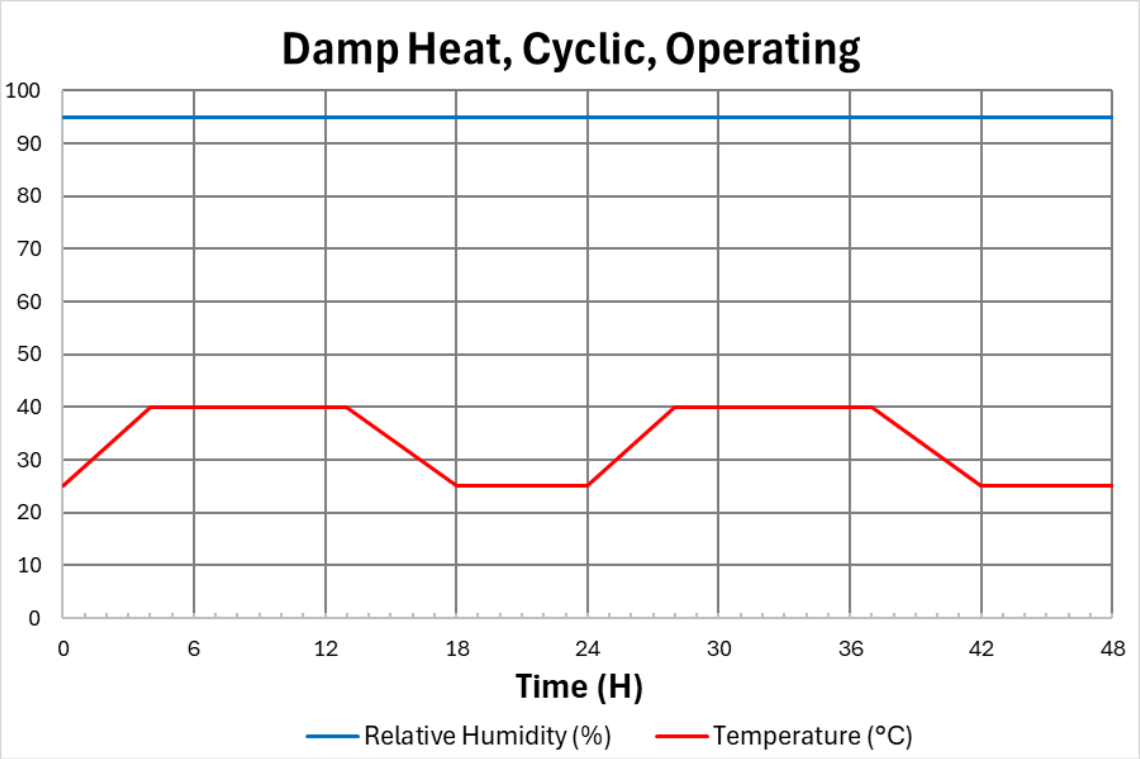
Date of Test: September 2019

Test Standard: IEC 60068-2-30, test Db, variant 2

Test Conditions: Ambient to 40°C, 90-100% RH, 2 24-hour cycles, specimen operating

Purpose of Test: To demonstrate that the specimen can be operated in a location with high humidity combined with moderate changes in temperature that could produce condensation, as recommended by IEC 60721-4-3 to qualify the specimen for operation in a Class 3K5 Climate as defined in IEC 60721-3-3.

This test also demonstrates (by extension of the temperature to 40°C) that the specimen can be stored in conditions of high humidity combined with moderate changes in temperature that could produce condensation, as recommended by IEC 60721-4-1 to qualify the specimen for storage in a Class 1K3 Climate as defined in IEC 60721-3-1.



Test Equipment

Thermotron SM-16 climatic chamber, with 4800 controller and 2 input channels for temperature and humidity monitoring (calibrated by Southern Instrument Service, Certificate #12813 – June 2019)

PC and video splitter used to supply video to specimens

Test Procedure

Unless otherwise noted, the procedure followed was the procedure described in Test 12, "HIS Monitor Testing," V0.94, June 2019, which in turn follows the recommendations of IEC 60068-2-30 for test Db, variant 2.

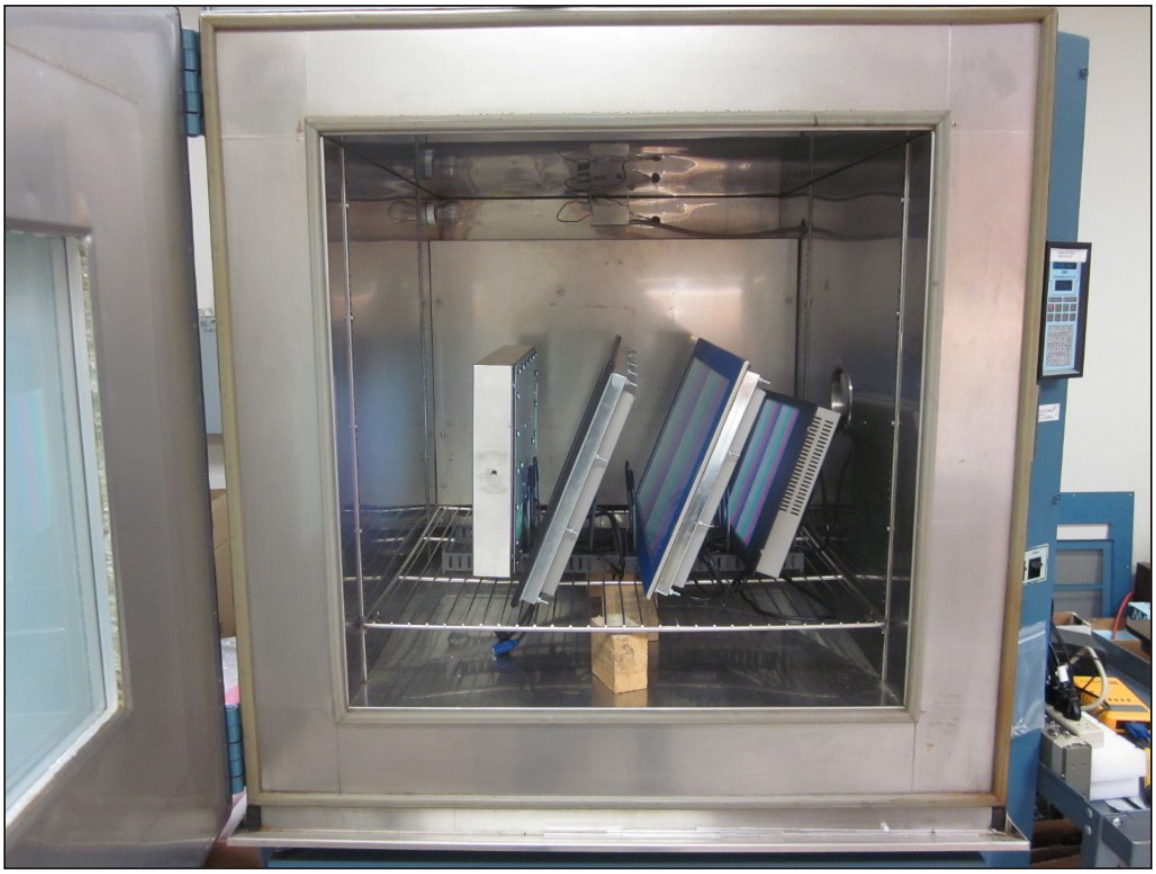
Test parameters were entered into the Thermotron controller as Program #5.

Results

Specimen was found to be in good working order following the test.

Testing Pictures

The photo below shows how specimens were installed in the chamber.



Test 13 – Damp Heat (Steady State), Operating

Date of Test: September 2019

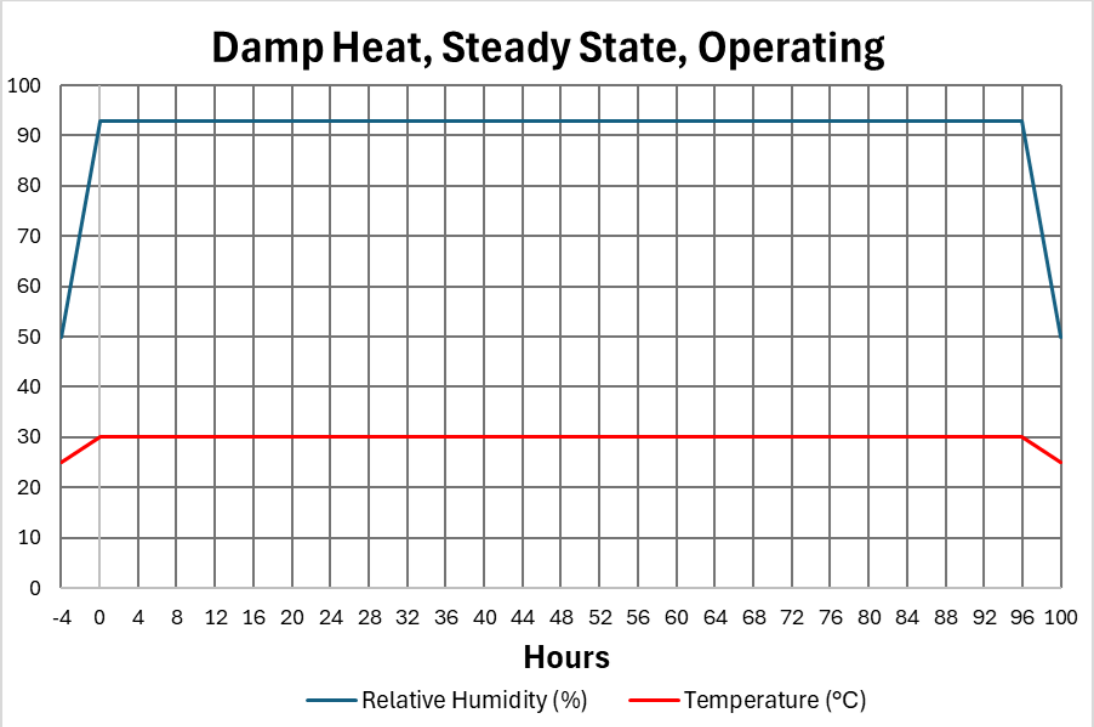
Test Standard: IEC 60068-2-78, test Cab

Test Conditions: 30°C (+/- 2°), 93% RH, 96 hours, no condensation, specimen operating

Purpose of Test: To demonstrate that the specimen can be operated in a location with high humidity, as recommended in IEC 60721-4-3 to qualify the specimen for operation in a Class 3K5 Climate as defined in IEC 60721-3-3.

This test also demonstrates that the specimen can be transported in conditions of high humidity, as recommended in IEC 60721-4-2 to qualify the specimen for transport in a Class 2K2 Climate as defined in IEC 60721-3-2.

This test also demonstrates that the specimen can be stored in conditions of high humidity as recommended in IEC 60721-4-1 to qualify the specimen for storage in a Class 1K3 environment as defined in IEC 60721-3-1.



Test Equipment

Thermotron SM-16 climatic chamber, with 4800 controller and 2 input channels for temperature and humidity monitoring (calibrated by Southern Instrument Service, Certificate #12813 – June 2019)

PC and video splitter used to supply video to specimens

Test Procedure

Unless otherwise noted, the procedure followed was the procedure described in Test 13, "HIS Monitor Testing," V0.94, June 2019, which in turn follows the recommendations of IEC 60068-2-78, test Cab.

Test parameters were entered into the Thermotron controller as Program #6.

Results

Specimen was found to be in good working order following the test.

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