



HOPE INDUSTRIAL SYSTEMS



# 19.5" PANEL MOUNT INDUSTRIAL MONITOR

## REVISION C

### PRODUCT RELIABILITY TEST REPORT

Model No. HIS-ML19.5- \_\_ \_\_ C



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# Test Report Overview

Hope Industrial Systems, Inc.

Environmental Testing Laboratory

Report for: HIS-ML19.5-xxVC

## 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 stored, transported, and operated:

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 **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 **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 storage, transport, 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
<b>Cold, Steady State, Non-operating</b>	68-2-1 Ab, -25°C, 16 hrs			68-2-1 Ab, -25°C, 16 hrs
<b>Cold, Steady State, Operating</b>	68-2-1 Ad, -5°C, 16 hrs	68-2-1 Ad, -5°C, 16 hrs	68-2-1 Ab, -5°C, 16 hrs	
<b>Dry Heat, Steady State, Operating</b>	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
<b>Solar Radiation</b>	dry heat test above	10°C added to dry heat test above	10°C added to dry heat test above	dry heat test above
<b>Thermal Shock, Non-operating</b>	68-2-14 Na, -25°C to ambient, 5 cycles			68-2-14 Na, -25°C to ambient, 5 cycles
<b>Thermal Shock, Operating</b>	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		
<b>Mechanical Shock, Operating</b>	68-2-27 Ea, 150 m/sec <sup>2</sup> , 6 msec half sine, 100 pulses in each of 6 directions	68-2-27 Ea, 150 m/sec <sup>2</sup> , 6 msec half sine, 100 pulses in each of 6 directions		68-2-27 Ea, 100 m/sec <sup>2</sup> , 16 msec half sine, 100 pulses in each of 6 directions
<b>Free Fall</b>	ISO 4180-2, 2 falls, height based on mass			ISO 4180-2, 2 falls, height based on mass
<b>Water from sources not rain</b>	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	
<b>Static Load</b>	ISO 2234		ISO 2234	ISO 2234
<b>Vibration (Broadband), Non-operating</b>	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
<b>Vibration (Sinusoidal), Operating</b>	68-2-6 Fc, 3.5 mm disp to 9 Hz, then 10 m/sec <sup>2</sup> accel, 9-500 Hz, 3 axes, 10 sweep cycles	68-2-6 Fc, 3.5 mm disp to 9 Hz, then 10 m/sec <sup>2</sup> 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 <sup>2</sup> , 9-150 Hz, 3 axes, 10 sweep cycles	68-2-6 Fc, 3.5 mm p-p to 9 Hz, then 10 m/sec <sup>2</sup> , 9-500 Hz, 3 axes, 10 sweep cycles
<b>Damp Heat, Cyclical, Operating</b>	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	
<b>Damp Heat, Steady State, Operating</b>	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 the test, as demonstrated by visibility of a display through the chamber window. The specimen must exhibit no signs of material degradation under visual inspection following the test.

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

**Date of Test:** June 2024

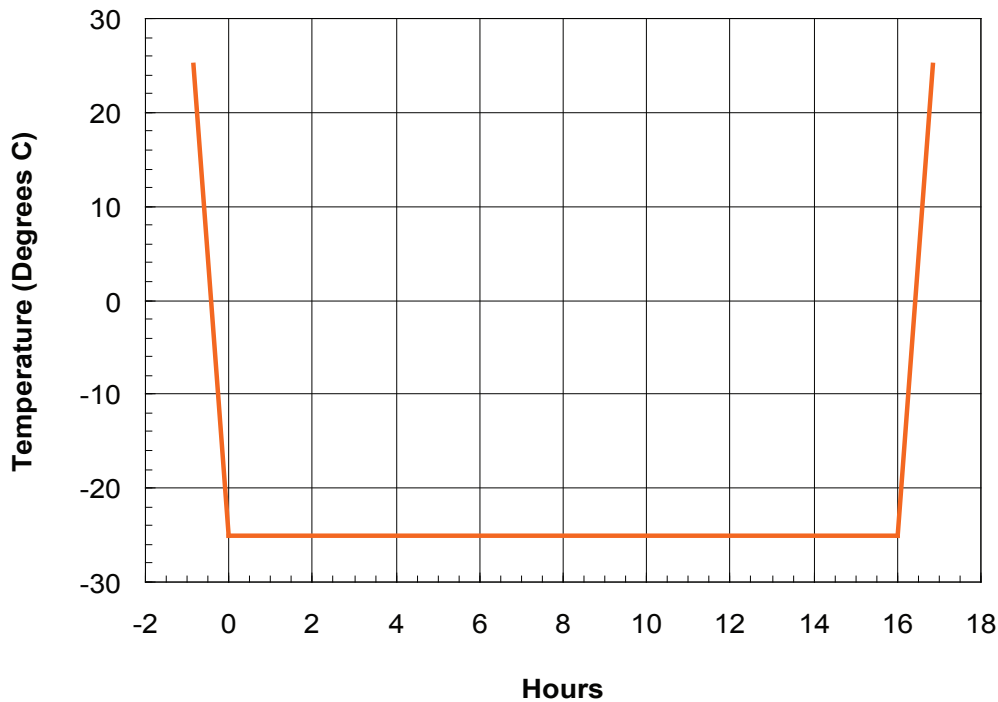
**Test Standard:** IEC 60068-2-1, test Ab

**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.

### Cold, Non-Operating



### Test Equipment

Applied Technical Services, unit ID ATS-08436. Cincinnati Sub-Zero P-64 environmental chamber. Calibrated May 9, 2024.

### 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.

### 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.



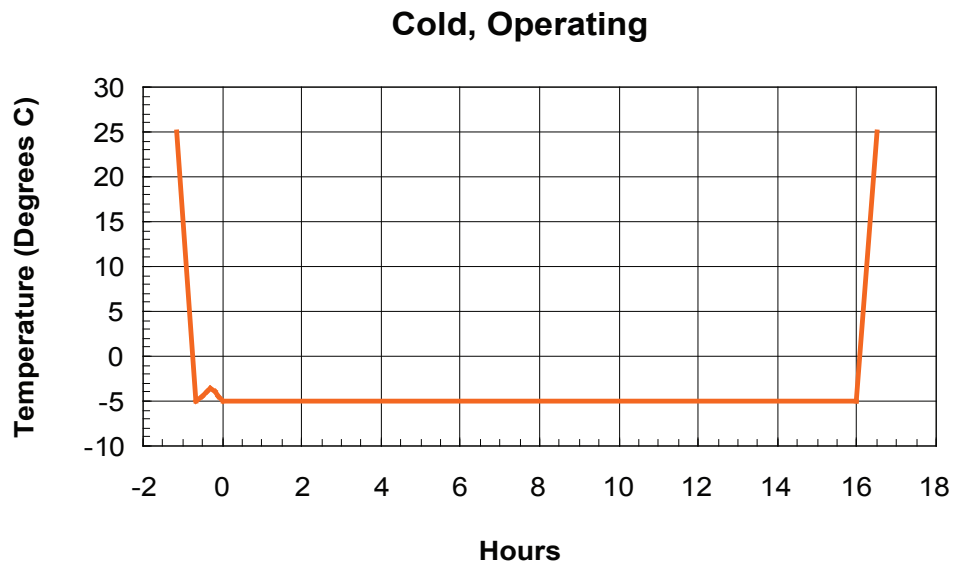
## Test 2 – Cold (Steady State), Operating

**Date of Test:** June 2024

**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

Applied Technical Services, unit ID ATS-08436. Cincinnati Sub-Zero P-64 environmental chamber. Calibrated May 9, 2024.

PC with dual video output 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.

### 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:** June 2024

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

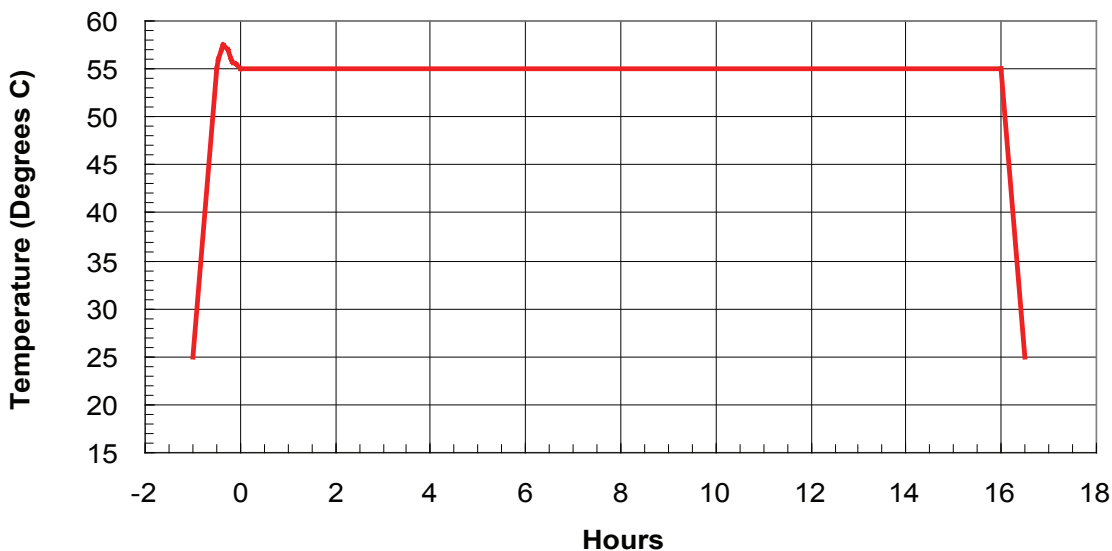
**Test Conditions:** 55°C (+/- 3°), 16 hours, specimen operating

**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.

### Dry Heat, Operating



### Test Equipment

Applied Technical Services, unit ID ATS-08436. Cincinnati Sub-Zero P-64 environmental chamber. Calibrated May 9, 2024.

PC with dual video output used to supply video to specimens.

### Test Procedure

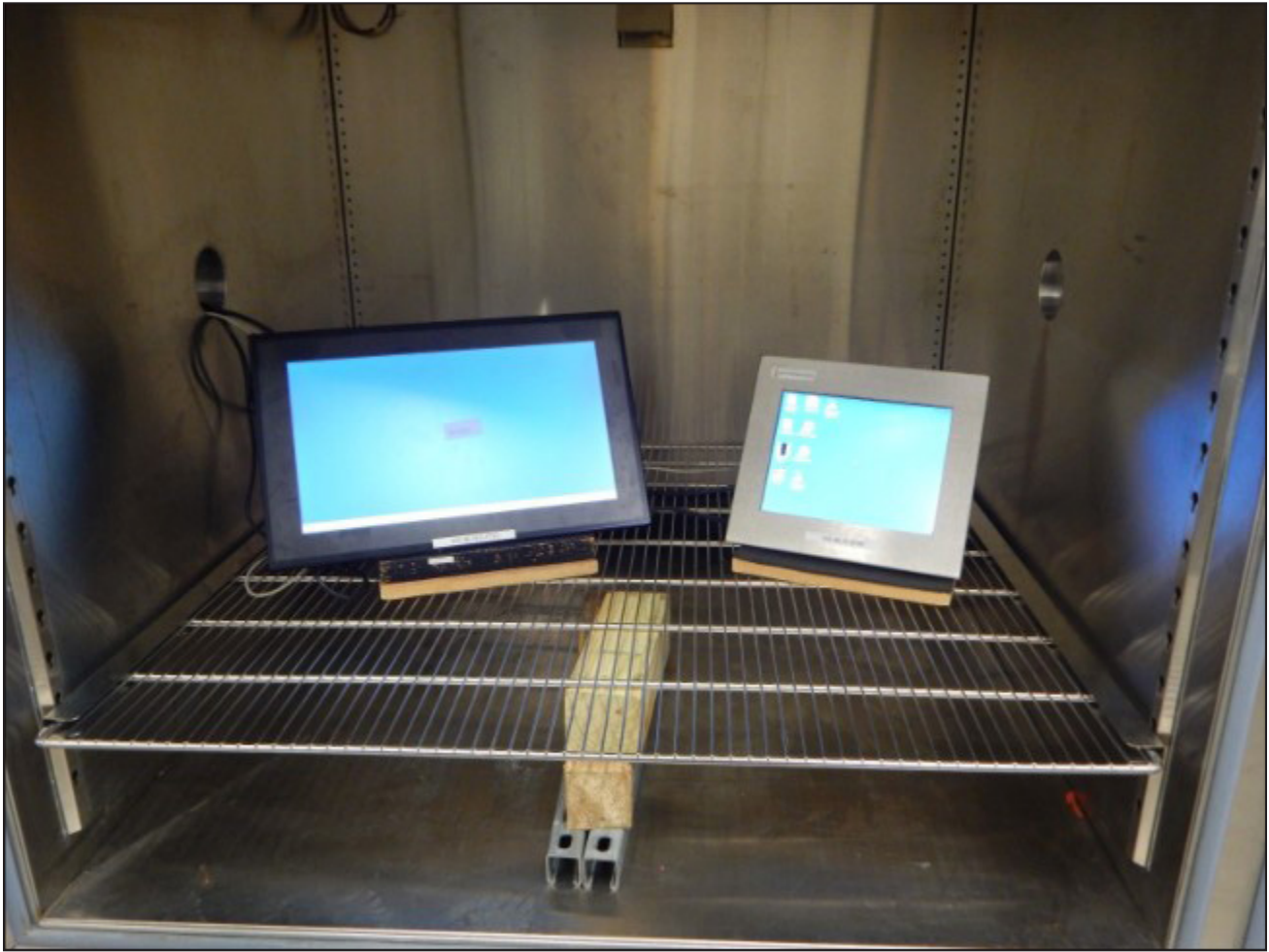
Unless otherwise noted, the procedure followed was the procedure described in Test 3, "HIS Monitor Testing," V0.94, June 2019, which in turn follows the recommendations of IEC 60068-2-2 for test Bd.

### 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

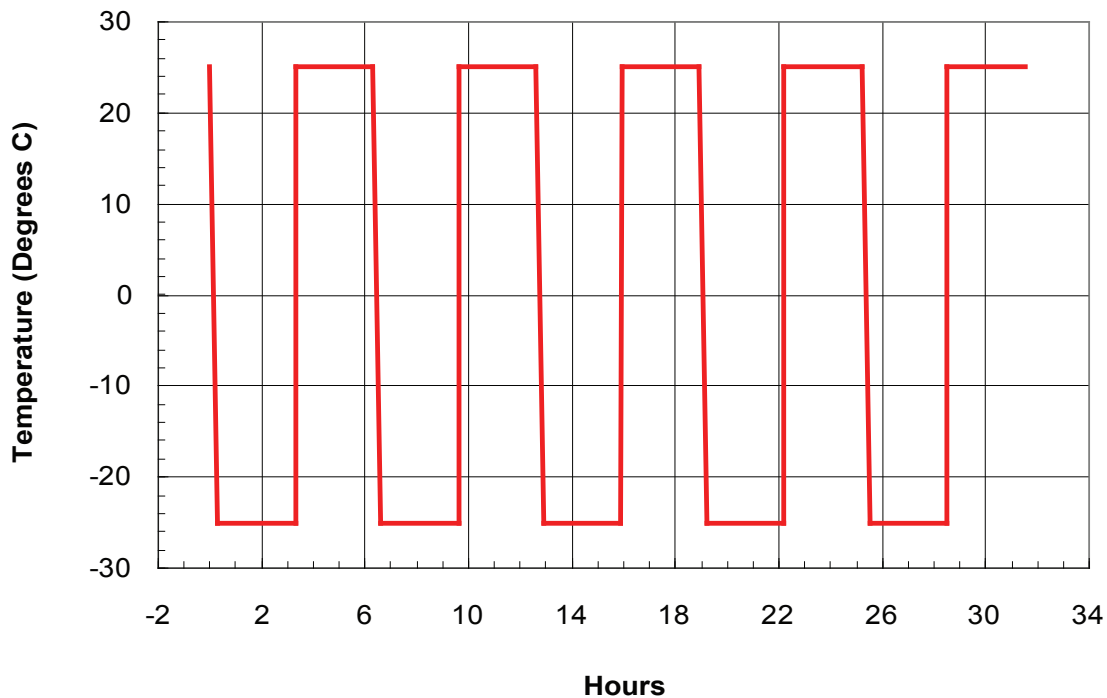
**Date of Test:** June 2024

**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.

### Thermal Shock, Non-Operating



### Test Equipment

Applied Technical Services, unit ID ATS-08436. Cincinnati Sub-Zero P-64 environmental chamber. Calibrated May 9, 2024.

### 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 this test. Instead of holding the chamber at -25°C and physically moving the specimen into and out of the chamber every three hours, the specimen was left in the chamber for the duration of the test and the chamber was programmed as follows, from ATS Test report, DE425547:

**Table 9: Thermal Shock Non-Operational Profile**

Step	Initial Temperature	Final Temperature	Ramp/Dwell	Duration/Ramp Rate
1	Ambient	-25°C	Ramp	5°C/Min
2	-25°C	-25°C	Dwell	3 hours
3	-25°C	25°C	Ramp	5°C/Min
4	25°C	25°C	Dwell	3 hours
5	25°C	-25°C	Ramp	5°C/Min
6	Repeat Steps 2-5 for a Total of 7 Cycles			
7	-25°C	Ambient	Ramp	5°C/Min

It was decided that the ability of the chamber to transition from 25°C to -25°C in 10 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

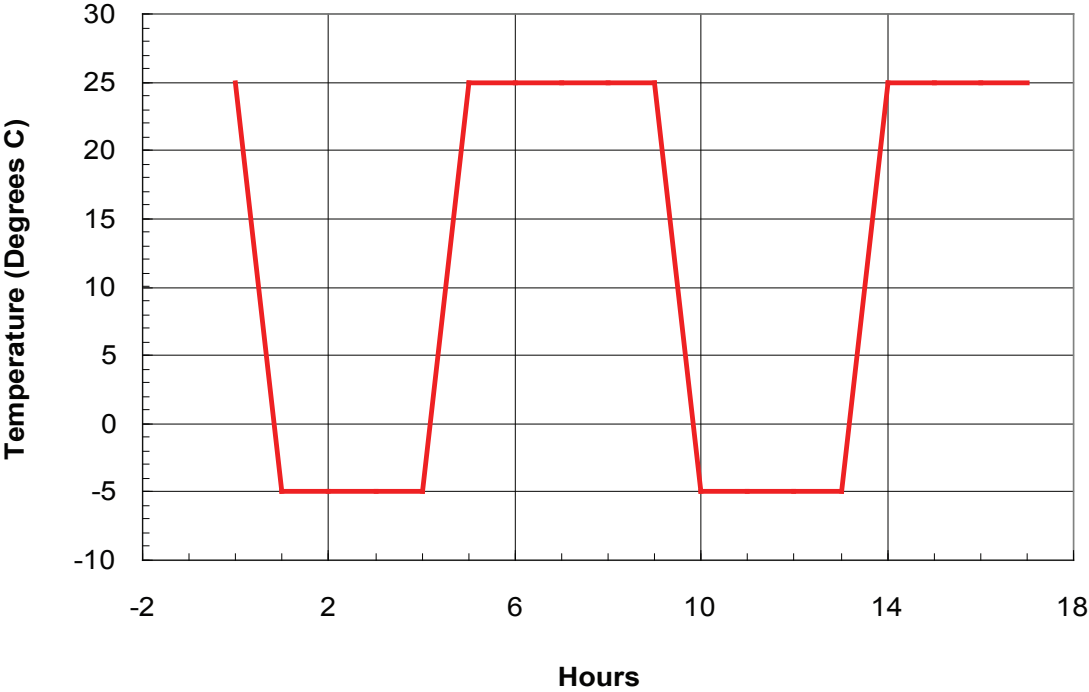
**Date of Test:** June 2024

**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.

**Thermal Shock, Operating**



## Test Equipment

Applied Technical Services, unit ID ATS-08436. Cincinnati Sub-Zero P-64 environmental chamber. Calibrated May 9, 2024.

PC with dual video output 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.

## 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:** June 2024

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

**Test Conditions:** 150 m/sec<sup>2</sup>, 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 #425547, dated July 8, 2024, is incorporated by reference. For the complete report, please visit:

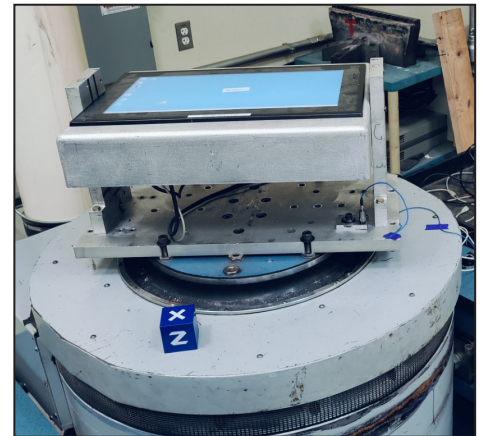
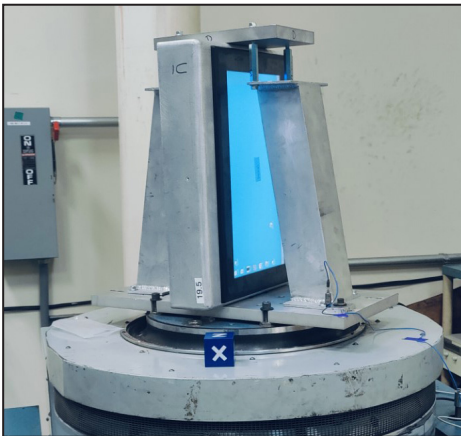
<https://www.HopeIndustrial.com/docs/425547>

### Results

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

### Testing Pictures

Below are pictures from the test.





## Test 7 – Free Fall

**Date of Test:** August 2022

**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

**Altitudes:** Each of faces 1, 2, 3. Each of edges 1-2 and 2-3. Corner 1-2-3



Package Mass (kg)	Drop Height (m)
< 10	0.8
10 to 30	0.6
20 to 30	0.5
30 to 40	0.4
40 to 50	0.3
50 to 100	0.2
> 100	0.1

**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.

### Test Equipment

Concrete Floor  
Drop Tester

### Test Procedure

1. The packaged specimen shall be at laboratory ambient and shall be verified to be in working condition.
2. The mass and dimensions of the packaged specimen shall be noted.
3. The following procedure shall be repeated twice for each of the specified attitudes:
  - a.) The specimen's center of gravity shall be raised to the specified height (+/- 2%) over a solid concrete floor and

held at that height in the specified attitude (+/- 5 degrees).

- b.) The specimen shall be released in such a way that its fall is not obstructed by any part of the holding apparatus.
4. Following the specified number of drops from all attitudes, the packaged specimen shall be measured and visually examined for deformities. Any serious deformities shall be noted. The specimen shall then be unpackaged and subjected to a visual inspection and operational test.

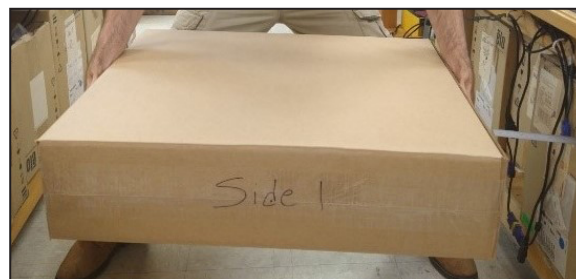
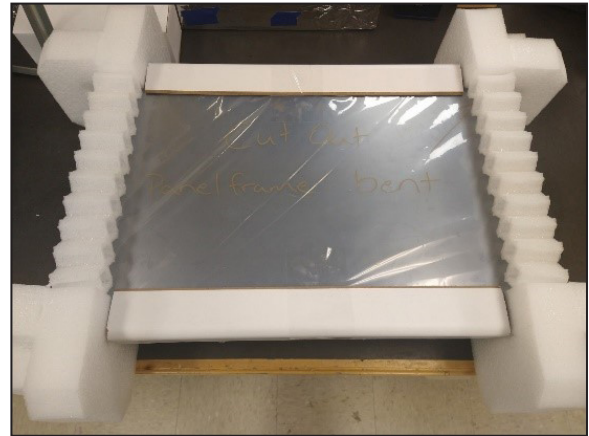
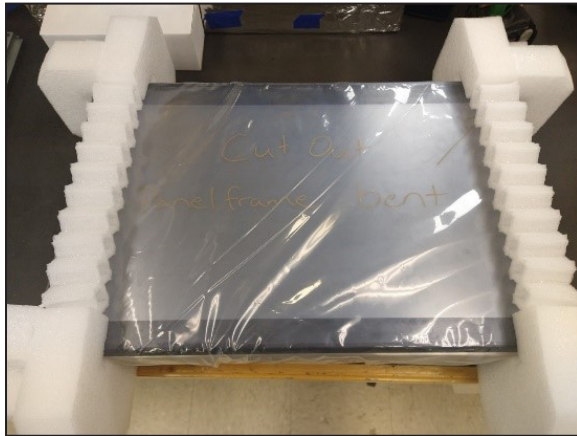
**Criteria for Passage of Test:** Deformations of the package are allowed, provided they do not compromise the overall integrity of the package, i.e. its continued ability to enclose and protect the specimen. The unpackaged specimen shall itself exhibit no deformations or material imperfections following the test and shall be verified to be fully operational.

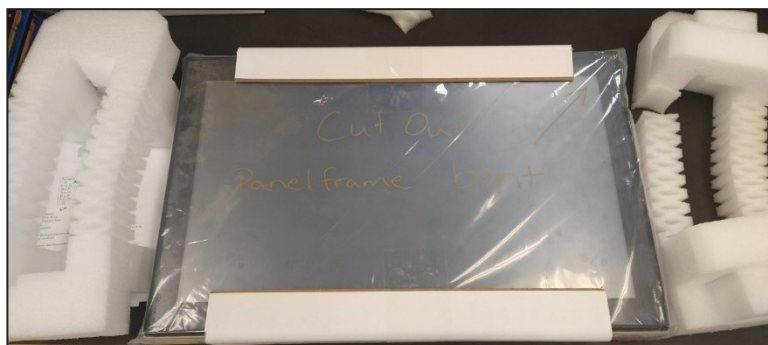
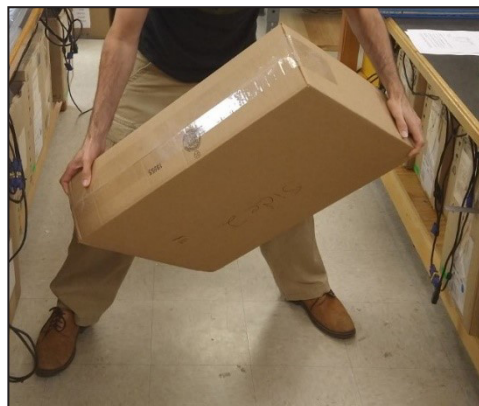
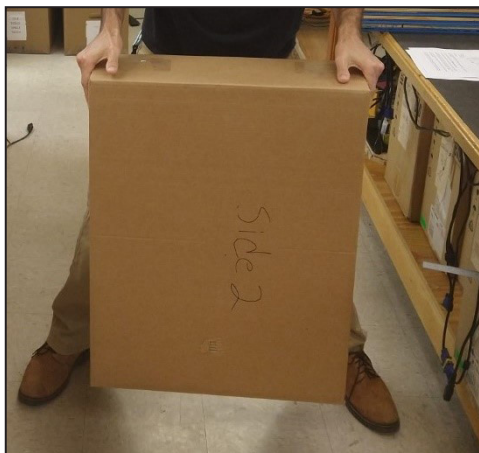
## Results

Specimens were found to be in good working order and without any cosmetic defects at the end of the tests.

## Testing Pictures

Below are pictures from 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 8, 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:** June 2024

**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 #425547, dated July 8, 2024, is incorporated by reference. For the complete report, please visit:

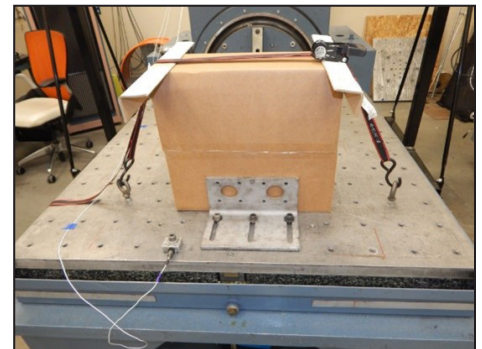
<https://www.HopeIndustrial.com/docs/425547>

## Results

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

## Testing Pictures

Below are pictures from the test.



# Test 11 – Vibration (Sinusoidal), Operating

**Date of Test:** June 2024

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

**Test Conditions:** 3.5 mm peak acceleration to 9 Hz, then 1 g (10 m/sec<sup>2</sup>) 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 #425547, dated July 8, 2024, is incorporated by reference. For the complete report, please visit:

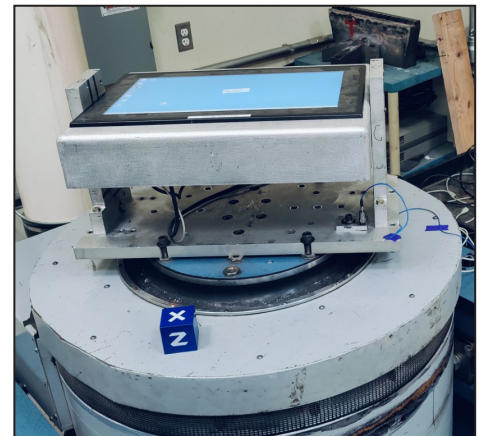
<https://www.HopeIndustrial.com/docs/425547>

## Results

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

## Testing Pictures

Below are pictures from the test.



## Test 12 – Damp Heat (Cyclical), Operating

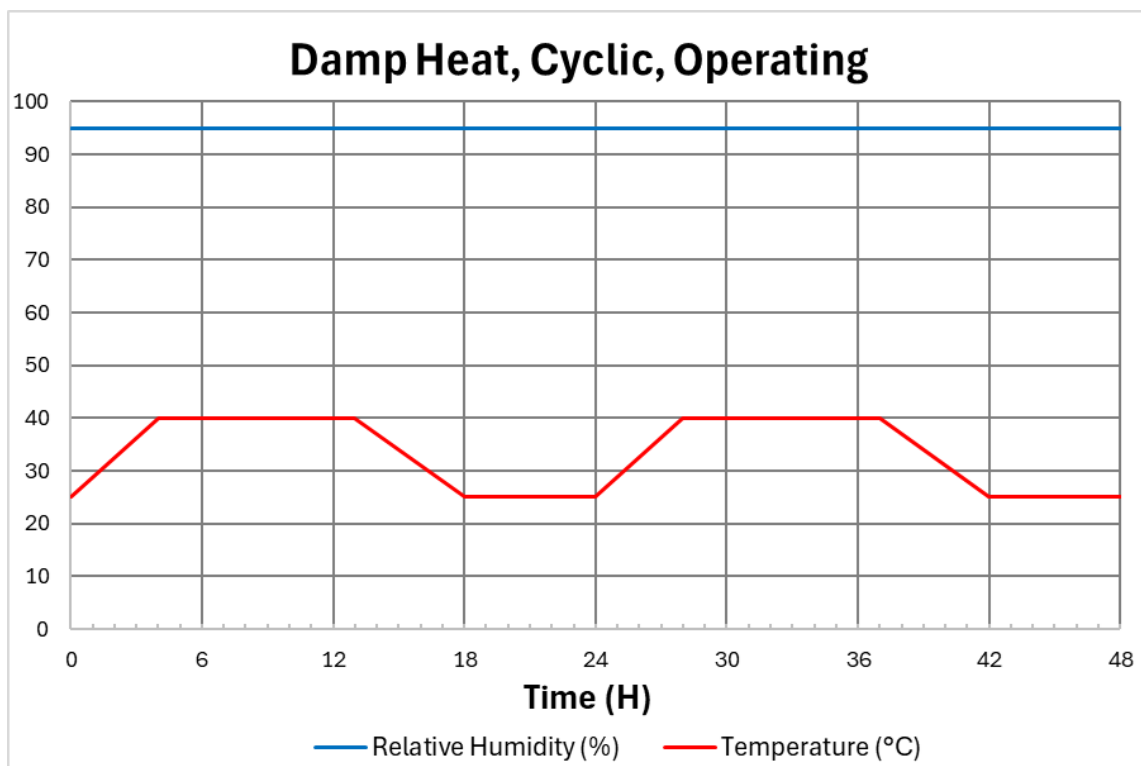
**Date of Test:** June 2024

**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

Applied Technical Services, unit ID ATS-08436. Cincinnati Sub-Zero P-64 environmental chamber. Calibrated May 9, 2024.

PC with dual video output used to supply video to specimens.

### Test Procedure

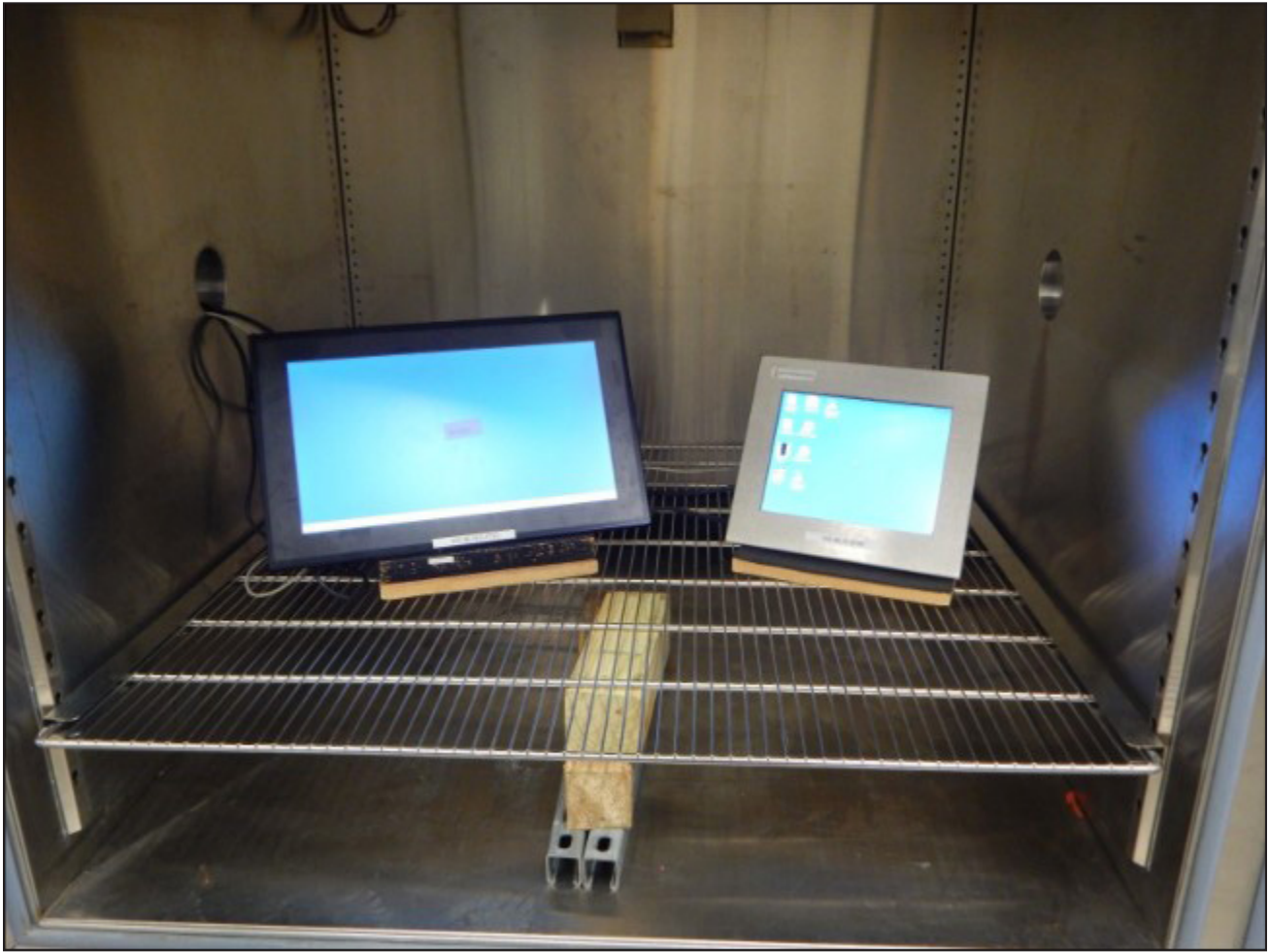
Unless otherwise noted, the procedure followed was the procedure described in Test 12, "HIS Monitor Testing," V0.94, June 2019, which in turn follows the recommendations of IEC 60068-2-30 for test Db, variant 2.

### 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:** June 2024

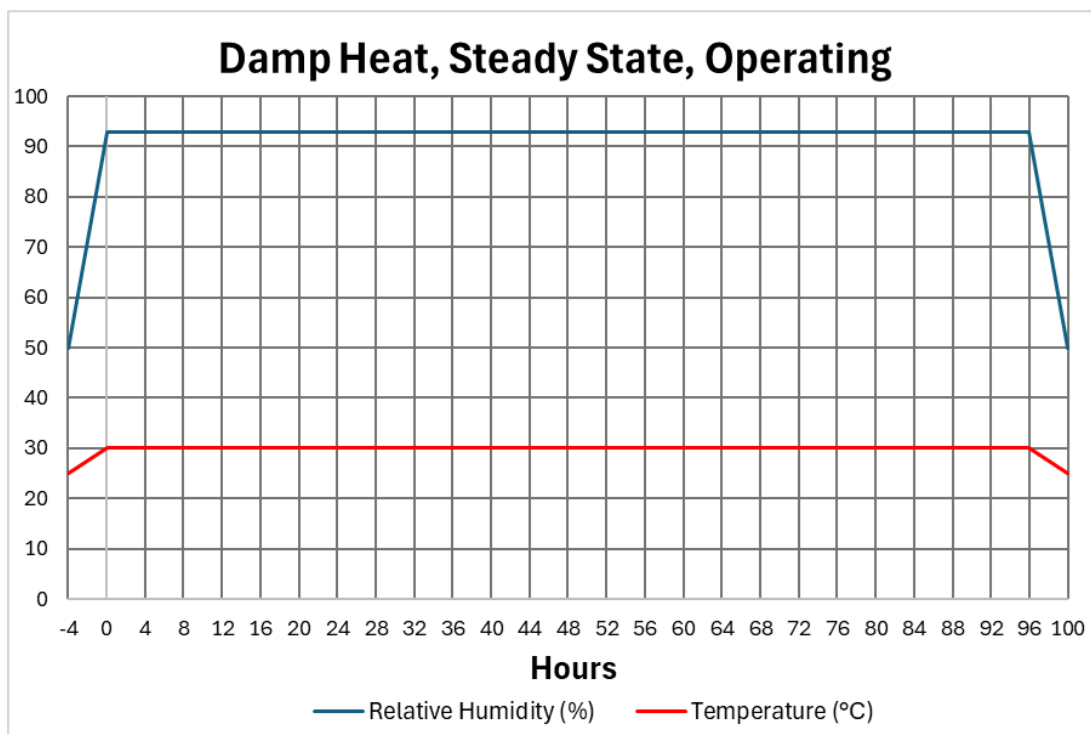
**Test Standard:** IEC 60068-2-78, test Cab

**Test Conditions:** 30°C (+/- 3°), 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

Applied Technical Services, unit ID ATS-08436. Cincinnati Sub-Zero P-64 environmental chamber. Calibrated May 9, 2024.

PC with dual video output used to supply video to specimens.

### Test Procedure

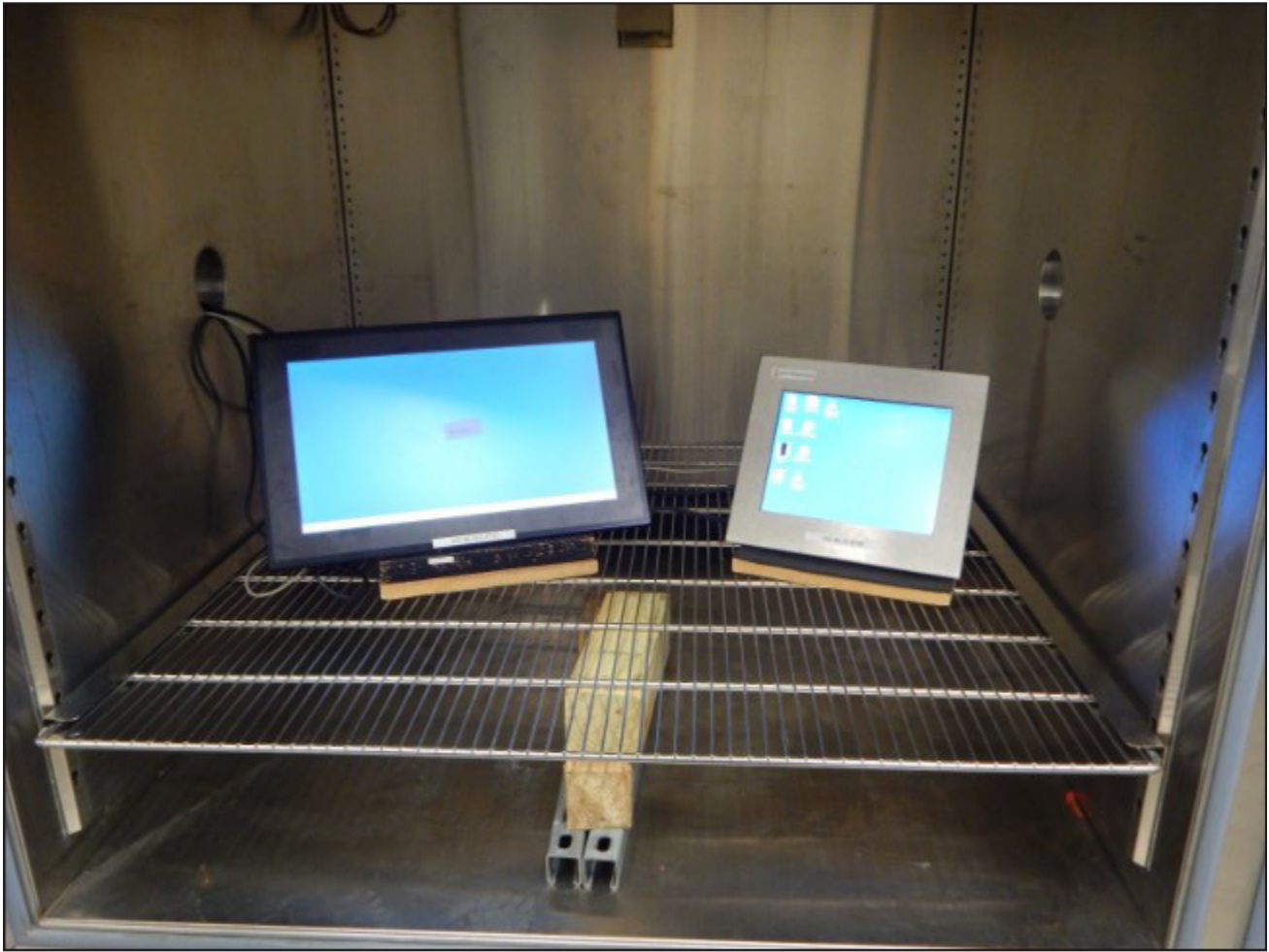
Unless otherwise noted, the procedure followed was the procedure described in Test 13, "HIS Monitor Testing," V0.94, June 2019, which in turn follows the recommendations of IEC 60068-2-78, test Cab.

### 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.



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