

Certified Test Report

IEEE 1656-2010 Guide Test Report

HI Standard Solid Wildlife Guard Products

December, 2022



**Routine and Design Tests for
HI Standard Wildlife Guard Products**

CERTIFICATION

Statements made and data shown are correct and within the usual limits of IEEE testing practice to the best of my knowledge and belief.



Anthony Nix
anix@howard-ind.com

11/3/2023

Date

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Howard Industries, Inc.

Tuesday, August 24, 2021

Subject

Testing Howard Industries Wildlife Guarding products in accordance with certain tests within the IEEE 1656-2010 Guide. At the time this document was written, the following wildlife guarding products have been tested:

0060-002163-405, 0060-002163-410, 0060-002163-430, 0060-002163-431, 0060-002163-450, 0060-002163-451, 0060-002163-452, 0060-002163-453, 0060-002163-454, 0060-002163-455, 0060-002163-456, 0060-002163-457, 0060-002163-458, 0060-002163-459, 0060-002163-460, 0060-002163-461, 0060-002163-462, 0060-002163-463, 0060-002163-464, 0060-002163-465, 0060-002163-466, 0060-002163-467, 0060-002163-468, 0060-002163-469

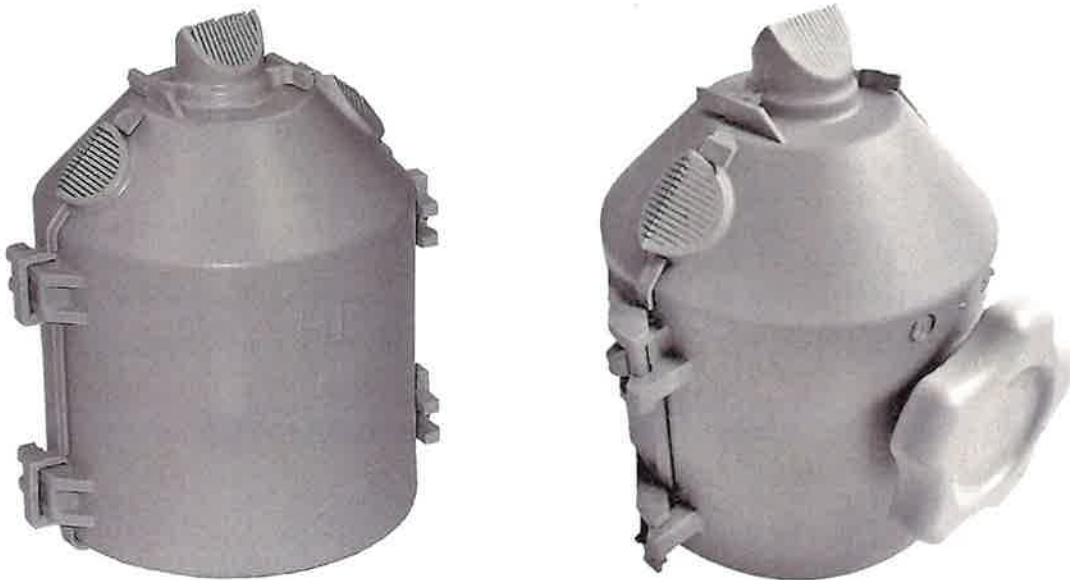


Photo is representative of this style of wildlife guard

Purpose

To verify that the Howard Industries Wildlife Guarding Products listed above pass the following portions of the IEEE 1656-2010 Guide:

- Section 5.2 – Wet Withstand
- Section 5.3 – Wet Power Frequency Flashover
- Section 5.4 – Lightning Impulse Withstand
- Section 5.5 – Cold Temperature Test
- Section 5.6 – Ultraviolet Aging
- Section 5.7 – Salt Fog Aging
- Section 5.8 – Retention Test
- Section 5.9 – Flammability Testing
 - o 5.9.1 – 50 W Vertical Flame Test
 - o 5.9.2 – 50W Horizontal Flame Test
 - o 5.9.3 – High-Current Test (Power Arc)
- Section 5.10 – Radio-Influence Voltage Test

Notes

- The tests outlined in this report were performed by the testing sequences outlined in the section 7 and Table 1 of the IEEE 1656-2010 Guide.
- Three (3) samples of each Wildlife Guard were tested where full guards were required per testing clause.
- Flammability samples tested were strips of the polymer compounds used in the guards prepared to the 125mm long x 13.0mm wide called for in the vertical and horizontal flame test clause.
- The Arrester Bracket guard is guarding a non-energized area of the transformer components, so many of the test in the IEEE1656-2010 Guide may not be applicable. Howard Industries has chosen to test HiPot, Ultraviolet Aging, and Flammability.

Executive Summary

All testing performed with calibrated test equipment either at Howard Industries or at certified independent laboratories in accordance to IEEE 1656-2010.

IEEE 1656-2010 Testing	HI Standard Solid Guard and Variations of this Guard	HI Standard FR Solid Guard and Variations of this Guard
5.2 Wet Withstand (5.2.1)	Pass	Pass
5.3 Wet Power Frequency Flashover	Pass	Pass
5.4 Lightning Impulse Withstand	Pass	Pass
5.5 Cold Temperature Test	Pass	Pass
5.6 Ultraviolet Aging	Pass	Pass
5.7 Salt Fog Aging	35 days	35 days
5.8 Retention Testing	Pass	Pass
5.9 Flammability Testing - 5.9.1 Vertical Burn - 5.9.2 Horizontal Burn - 5.9.3 Power Arc	N/A	5.9.1 Vertical Burn = Pass - VO Rating 5.9.2 Horizontal Burn = Pass - HB Rating 5.9.3 Power Arc = Pass
5.10 Radio-Influence Voltage Test	Pass	Pass

Continue below for detailed test setup and result specifics.

5.2 Wet Withstand

Test Setup:

- Howard Industries chose to perform the Option 1 moving electrode in IEEE 1656-2010 Section 5.2.1.
- See pictures below of the testing setup at an independent high voltage testing laboratory. Three specimens of each sample were tested via the procedure outlined in IEEE 1656-2010 Section 5.2.1, the moving electrode consisted of a live-line tool with a grounded probe at the tip.
- The grounded probe was formed with a 2-3cm diameter rounded end of No. 6 AWG wire. The test fixture phase conductor was connected to a Hipotronics AC Dielectric Test Set, 100 step-up transformer. A voltage of 23kV was applied to all samples and while the samples were energized, the ground stick was moved by the operator on the surface of the wildlife guard.
- Precipitation and preparation of test samples was in accordance with IEEE 4-2013 Section 11. The vertical precipitation component was measured as 1.5 mm/min and the horizontal component was measured as 2.0 mm/min. Ambient temperature was 23.2C and Resistivity was 91.74 $\mu\text{S}/\text{cm}$. The test samples conditioned and pre-wetted for 15 minutes prior to the test. The precipitation levels described above were maintained throughout the entire test duration.
- The electrode was moved across all surfaces of the wildlife guard approaching to within 5 cm of the exposed energized conductor at the end of the sample. If a flashover occurs with the probe at 5 cm, the distance can be extended and should be reported in the test report. If a bare energized conductor is not exposed at the end of a sample such as a bushing guard, the moving electrode can be passed over the end of the sample and onto the adjacent insulating surface. The motion should be such that the electrode is moved continuously across the surface, but at a rate not greater than 15 cm/s. This test is complete when all exterior surfaces have been swept by the probe.



Wet Withstand Testing Moving Electrode



Wet Withstand – Precipitation Equipment

Test Results:

- All wildlife guard samples flashed over only near the top of the guard at or very near to 5 cm from the energized conductor. No other areas of the samples flashed over covering all of the surface area of the guards.
- Once the grounded probe was moved further than 5 cm of the energized conductor, no additional instances of flash over occurred on any of the samples.
- Based on the criteria outlined in IEEE 1656-2010 Section 5.2.1 all samples represented in this report Pass the Wet Withstand Test.

5.3 Wet Power Frequency Flashover

Test Setup:

- Wet power frequency flashover test was performed in accordance to IEEE 1656-2010 5.3
- See pictures of the testing setup at an independent high voltage testing laboratory. Three specimens of each product were tested via the procedure outlined in IEEE 1656-2010 Section 5.3 in accordance with ANSI/NEMA C29.1-1988 (R2002, R2012) Clause 4.3 Low-Frequency Wet Flashover Tests mounted on a bushing fixture.
- AC-voltage was generated using a Hipotronics AC Dielectric Test Set, 100 kV, and step-up transformer.
- Precipitation and preparation of test samples was in accordance with IEEE 4-2013 Section 11. The vertical precipitation component was measured as 1.5 mm/min and the horizontal component was measures as 2.0 mm/min. Ambient temperature was 23.1C and Resistivity was 97 $\mu\text{S}/\text{cm}$. The test samples conditioned and pre-wetted for 15 minutes prior to the test.
- Voltage was applied at a steadily increasing ramp until flashover occurs across the test sample.
- The wet flashover voltage value of a test specimen is the arithmetic mean of five individual flashovers taken consecutively. The period between consecutive flashovers was either one or two minutes depending on the magnitude of the flashover voltage. Wet flashover voltage values were corrected in accordance with IEEE 4-2013 Clause 13.2.1 Atmospheric Corrections using Method 1, and the humidity correction factor was not applied.
- The sample passes the wet power frequency flashover test if the average flashover value of all three samples is not less than 90% of the value obtained on the test fixture alone with no wildlife guard installed.



Wet Power Frequency Flashover Test



Wet Power Frequency Flashover Conditioning

Test Results:

- The average flashover without a wildlife guard for this setup was 95.79 kV
- Therefore the acceptance threshold (90% U_f) was 86.21 kV
- The measured average flashover with the guard samples installed was 100.96
- All samples passed the acceptance threshold and therefore passed the Wet Power Frequency Flashover test.

5.4 Lightning Impulse Withstand

Test Setup:

- Samples of each wildlife guard were tested in accordance to IEEE 1656-2010 Section 5.4 at 150 BIL levels.
- Three samples of each wildlife guard were subjected to three positive and three negative 150 kV impulse waves in accordance to IEEE 1656-2010 Section 5.4 while mounted on a pole type transformer bushing fixture in accordance to clause 6.1 of IEEE 1656-2010.
- The impulses used in this test were in accordance to IEEE Standard 4-1995 section 7.8.2.3.
- According to IEEE Standard 4-1995 7.8.2.3, the acceptance criteria for Lighting Impulse Withstand is as follows: "If no disruptive discharge occurs, the test object has passed the test. If more than one disruptive discharge occurs, the test object has failed to pass the test. If one disruptive discharge occurs in the self-restoring part of the insulation, then nine additional impulses are applied; and if no disruptive discharge occurs, the test object has passed the test."

Test Results:

- All samples tested passed three positive and three negative 150kV impulse waves and no disruptive discharges occurred for this entire class of wildlife guards.
- All samples covered in this document therefore passed the IEEE 1656-2015 Section 5.4 Lighting Impulse Withstand test.

5.5 Cold Temperature Test

Test Setup:

- Three (3) samples of each wildlife guard model were tested at the Howard Industries Components Division Test Laboratory.
- The samples were placed in a calibrated thermo-cycle chamber set at -25C for 4 hours in accordance to IEEE 1656-2010 Section 5.5.
- After the 4 hour cycle, the samples were removed and then opened and closed 5 times in less than 1 minute, and then analyzed for any potential damage.

Test Results:

- All wildlife guards covered in this reports passed the cold temperature test.
- There were no cracks, splits, or breakage of any kind on the samples tested during the five opening and closings after cold temperature conditioning.
- Based on the "no damage occurring upon cold temperature cycling", all wildlife guards covered in this report pass the cold temperature test IEEE 1656-2010 Section 5.5.

5.6 Ultraviolet Aging

Test Setup:

- Three Specimens of each Howard Industries wildlife guard were tested for exposure to UV-A ultraviolet light energy per ASTM D4329 and IEEE 1656-2010 Section 5.6.
- The test samples were placed in a calibrated QUV ultraviolet light aging Weatherometer per the requirements in ASTM D4329.
- Samples are aged for a period of 1000 hours using UV-A type lamps having a peak emission at 340 nm.
- Conditions in the test chamber follow a repeating cycle consisting of 8 hours of UV exposure at 60oC followed by 4 hours of condensation exposure at 50oC.

Test Results:

- Upon completion of the Ultraviolet Aging test, all wildlife guard samples were removed and visually inspected in a part inspection area with optimal lighting and compared to guards that had no exposure.
- None of the guarding samples had any signs of significant degradation, cracking, breaking, or significant discoloration.
- While there is no specific pass / fail criteria for this test, the fact that there was no significant change in the condition of the samples after exposure constitutes a passing test in the view of Howard Industries, Inc.

5.7 Salt Fog Aging

Test Setup:

- Three samples of each product to be tested were mounted on a pole type transformer bushing fixture per IEEE 1656-2010 Section 6.
- All samples were placed in a salt fog chamber per the instructions given in IEEE 1656-2010 Section 5.7 containing a salt spray mist having a conductivity of 370 Ω -cm to 400 Ω -cm.
- During the salt fog aging process, the samples were exposed to a fixed voltage applied to the high-voltage terminal of the test fixture.
- The fixed voltage was set at the nominal voltage of the system for which the sample is rated.
- Test parameters:
 - o Continuous application of voltage with a tolerance of $\pm 3\%$
 - o The test circuit when loaded with a resistive current of 250 mA on the high-voltage side shall experience a maximum voltage drop of 5%
 - o Application of salt fog mist for 4 hours, followed by 4 hours with no salt fog.
- Total test period is 1000 hours (42 days) or until flashover occurs and voltage cannot be restored. If flashover occurs, record the number of hours the sample withstood before flashover.
- This is a very demanding test and the tank wall / bushing often will flashover with no guard installed at all.

Test Results:

- The samples in this class of parts began flashing over at 35 days.
- At that point the voltage was unable to be restored due to the conductivity of the salt that was built up on the bushing fixture, tank wall, and wildlife guard.
- The samples of wildlife guards in this class of parts passed 35 days of salt fog aging.
- One determination that was made during this test is the test fixture with no guarding installed would flashover at essentially identical timing as the fixture with a guard installed.
- Based on the test results, it appears that these samples of wildlife guarding make no difference in when the conductive salt flashed over. It appears that the wildlife guarding samples do not increase or decrease the amount of time for a flash over in this test setup.

5.8 Retention Testing

Test Setup:

- These flammability tests are only applicable to the Flame Retardant (FR) line of Howard Industries Wildlife Guards.
- The 50W Vertical Flame Test and the 50W Horizontal Flame Test were performed at an independent UL certified test laboratory and at the main QC lab at the Howard Industries facility in Laurel, MS.
- Vertically mounted samples 4" x 0.5" x 0.090" were tested in accordance with the 50W Vertical Flame Test (IEEE 1656-2010 Section 5.9.1)
- Horizontal mounted samples 4" x 0.5" x 0.090" were tested in accordance with the 50W Horizontal Flame Test (IEEE 1656-2010 Section 5.9.2)
- Actual guarding samples exactly as used in the field were tested in accordance with the High-current test (power arc) (IEEE 1656-2010 Section 5.9.3)

Test Results:

- All samples representing this class of product passed the retention test.
- All samples remained properly installed and exhibited no damage to guard itself.
- This class of Howard Industries wildlife guarding passes the IEEE 1656 – 2010 Section 5.8 Retention test

5.9 Flammability Testing

Test Setup:

- These flammability test are only applicable to the Flame Retardant (FR) line of Howard Industries Wildlife Guards.
- The 50W Vertical Flame Test and the 50W Horizontal Flame Test were performed at an independent UL certified test laboratory and at the main QC lab at the Howard Industries facility in laurel MS
- Vertically mounted samples 4" x 0.5" x 0.090" were tested in accordance to the 50W Vertical Flame Test (IEEE 1656-2010 Section 5.9.1)
- Horizontal mounted samples 4" x 0.5" x 0.090" were tested in accordance to the 50W Horizontal Flame Test (IEEE 1656-2010 Section 5.9.2)

Test Results:

- 50W Vertical Flame Test (IEEE 1656-2010 Section 5.9.1)
 - o All twenty (20) vertical samples were exposed to a Bunsen burner flame for 10 seconds, removed until self-extinguished, and then immediately re-exposed to the flame for 10 additional seconds.
 - o All twenty (20) samples quickly self-extinguished upon being removed from the 1st 10 second flame exposure.
 - o All twenty (20) samples quickly self-extinguished upon being removed from the 2nd 10 second flame exposure.
 - o Time from removal of the flame to self-extinguish on the first flame exposure averaged 1.48 seconds or well below the required less than or equal to 10 seconds requirement for the most stringent V-0 Rating.
 - o Time from removal of the flame to self-extinguish on the second flame exposure averaged 1.25 seconds or well below the ≤ 10 seconds requirement for the most stringent V-0 Rating.
 - o The flame retardant polymer compound used to make all Howard Industries FR wildlife Guards passes the 50W Vertical Flame Test (IEEE 1656-2010 Section 5.9.1) with a V-0 Rating.

- 50W Horizontal Flame Test (IEEE 1656-2010 Section 5.9.2)
 - o All six horizontal samples were exposed to a Bunsen burner flame for 30 seconds.
 - o After the 30 seconds of flame exposure, all six samples immediately self- extinguished and failed to propagate any burning or flames to the initial 1" mark on the test samples. Since the samples self-extinguish with no measureable burn rate, they meet the most stringent criteria of HB.
 - o Since all six samples self-extinguished immediately, the samples passed with a HB ratings.
 - o The flame retardant polymer compound used to make all Howard Industries FR wildlife Guards passed the 50W Vertical Flame Test (IEEE 1656-2010 Section 5.9.2) with a HB Rating.
- High-current test (power arc) (IEEE 1656-2010 Section 5.9.3)
 - o All 3 samples for each guard represented in this report were tested in accordance to IEEE 1656-2010 Section 5.9.3.
 - o All samples were tested with ten cycles at 10kA phase conductor to an ac voltage source with a near symmetrical waveform using the nominal phase-to-ground voltage for the system rating.
 - o None the guards listed in this report exhibited the presence of flame propagation or signs of melting.
 - o Since all samples tested did not have the presence of flames, burning, or melting, these products pass and meet the requirements for IEEE 1656-2010 5.9.3 High-current test (power arc).



5.10 Radio-Influenced Voltage Test

Test Setup:

- Three (3) samples were tested of each part covered in this report in accordance with IEEE 1656-2010 Section 5.10.
- The pole transformer bushing mounting fixture was first tested without any guarding to establish the radio-influence voltage (RIV) baseline, to compare all tested samples against.
- All three (3) samples were mounted on a pole type transformer bushing mount and subjected to a radio-influence voltage test at 26kV @ 12mA and compared to the same test fixture with no guarding installed.
- A sample is seen as passing the RIV test if the average of all three (3) samples tested for that product does not exceed 100 μ V.

Test Results:

- All three (3) samples covered in this report subjected to the RIV test were measured at less than 100 μ V, therefore all samples pass the test.
- The average reading for the products covered in this test report is 85 μ V.
- The products covered in this test report pass the IEEE 1656-2010 Section 5.10 Radio-Influence Voltage Test with a reading of less than 100 μ V.