

Title/Subject: Standard Test Procedure – Ground Wire Devices		
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## 1.0 PURPOSE

To establish standard test procedures for ground wire devices.

## 2.0 SCOPE

These procedures apply to all ground wire devices used in conjunction with ground wire monitors or as arc suppression devices.

## 3.0 REFERENCES

This STP does not affect or make change to any other document.

## 4.0 DEFINITIONS

Ground Wire Device - A device placed in series with the ground wire to suppress intermachine arcing and to reduce the effect of interfering parallel paths to the ground wire monitor.

## 5.0 TEST EQUIPMENT

5.1 Ohmmeter

5.2 Voltmeter (2)

5.3 500 or 1000 ampere, 100 millivolt shunt

5.4 Storage oscilloscope

5.5 Thermocouple (2)

5.6 Thermocouple data logger

5.7 Power supply capable of delivering 50, 2500, 20000, and 45000 amperes single phase current at 60 hertz.

5.8 Resistors of various values capable of conducting 50 amperes.

## 6.0 TEST SAMPLES

A total of six samples will be required for these tests.

## 7.0 PROCEDURES

7.1 Three devices will be subjected to the saturation test, transient response test, continuous current test, overcurrent test, and high current test. The parallel device

test will be performed on three untested devices. All tests will be performed by the applicant or by a laboratory chosen by the applicant and witnessed by MSHA. The high current, overcurrent and parallel device tests require a high current testing laboratory. The test procedure and instrument certification will be submitted to MSHA. This information as well as the date and time reserved for the test will be submitted to MSHA at least two weeks in advance.

## 7.2 Saturation Test

- 7.2.1 Measure the DC resistance (both polarities). Record the resistance on Data Sheet 2a.
- 7.2.2 Connect the device between the phase and neutral connections of a power supply capable of supplying 50 amperes AC.
- 7.2.3 Size a resistor to limit current to 50 amperes and connect it in series with the device.
- 7.2.4 Connect a voltmeter across the device terminals.
- 7.2.5 Connect another voltmeter across the terminals of the current limiting resistor.
- 7.2.6 Energize the power supply at its lowest output voltage.
- 7.2.7 Record the voltage across the device and the current (determined from the voltage across the resistor) through the device.
- 7.2.8 Increase the power supply voltage in increments until the voltage across the device no longer increases. Take 30 readings with half of the readings in the region where the current is between 80% and 100% of its final value.
- 7.2.9 Data will be tabulated on Data Sheet 2a and plotted on a linearly scaled graph of amperes versus volts (Data Sheet 2b).
- 7.2.10 Adjust the power supply voltage until current through the device is 25 amperes.
- 7.2.11 De-energize the power supply above.

## 7.3 Transient Response Test

- 7.3.1 Replace the voltmeter across the device with a voltage-measuring device capable of measuring and storing transient response waveforms. Proper range settings and test leads **MUST BE USED**.
- 7.3.2 Set the triggering level of the measuring equipment at 110% of the steady state peak voltage across the device.

- 7.3.3 Set the sweep time of the measuring equipment for three seconds.
  - 7.3.4 Enable the triggering function of the measuring equipment.
  - 7.3.5 Connect (energize) the power supply.
  - 7.3.6 Record and save the transient data as Data Sheet 2c. A photograph of an oscilloscope trace with appropriate scales noted or the plotted trace from a computer will be sufficient for recording the data.
  - 7.3.7 Disconnect (de-energize) the power supply.
  - 7.3.8 Repeat step 7.3.6.
  - 7.3.8 Repeat steps 7.3.5 to 7.3.8 nine times for a total of ten tests.
- 7.4 Continuous Current Test
- 7.4.1 CAUTION SHOULD BE USED TO ENSURE THE CIRCUIT IS DE-ENERGIZED FROM THE PREVIOUS TEST. Disconnect the device from the circuit.
  - 7.4.2 Allow the device to cool to ambient temperature by measuring its DC resistance (both polarities) until the DC resistance is no more than 105% of the resistance measured in 7.2.1. Record the resistance on Data Sheet 2d.
  - 7.4.3 Connect the device in the circuit.
  - 7.4.4 Set up a thermocouple data logger to record temperatures on the device.
  - 7.4.5 Arrange thermocouples on internal and external surfaces of a device. An example of an internal surface is the inside of a coil. No drilling or cutting is required.
  - 7.4.6 Size a grounding resistor to limit the current to 50 amperes continuous.
  - 7.4.7 Connect (energize) the power supply. Start the data logger. Run the test until the temperature is constant for five minutes. Record the maximum temperature on Data Sheet 2d.
  - 7.4.8 Measure voltage across the device during the test. Record the voltage on Data Sheet 2d.
  - 7.4.9 Disconnect (de-energize) the power supply. Allow the device to cool to ambient temperature by measuring the DC resistance (both polarities) until it is no more than 105% of the resistance measured in 7.2.1. Record the resistance on Data Sheet 2d.

7.4.10 Note the physical condition of the device after the test on Data Sheet 2d.  
A photograph of the device may be used for this purpose.

## 7.5 High Current Test

7.5.1 Data may be collected in the form of oscillographic traces, magnetic storage media, or plotted graphs. Data will be tabulated on Data Sheet 2d.

7.5.2 Measure the DC resistance of the device (both polarities), to check for continuity. Record the resistance on Data Sheet 2d.

7.5.3 A test current of at least 20000 amperes symmetrical will be passed through the device for at least .334 seconds. Record the actual test current and duration on Data Sheet 2d.

7.5.4 Measure the voltage across the device during the test. Record the voltage on Data Sheet 2d.

7.5.5 Allow the device to cool to ambient temperature by measuring the DC resistance (both polarities) until it is no more than 105% of the resistance measured in 7.2.1. Record the resistance on Data Sheet 2d.

7.5.6 Note the physical condition of the device after the test on Data Sheet 2d.  
A photograph of the device may be used for this purpose.

## 7.6 Overcurrent Test

7.6.1 Data may be in the form of oscillographic traces, magnetic storage media, or plotted graphs. Data will be tabulated on Data Sheet 2d.

7.6.2 Measure the DC resistance of the device (both polarities), to check for continuity. Record the resistance on Data Sheet 2d.

7.6.3 A test current of at least 2500 amperes symmetrical will be passed through the device for at least ten seconds. Record the actual test current and duration on Data Sheet 2d.

7.6.4 Measure the voltage across the device during the test. Record the voltage on Data Sheet 2d.

7.6.5 Allow the device to cool to ambient temperature by measuring the DC resistance (both polarities) until it is no more than 105% of the resistance measured in 7.2.1. Record the resistance on Data Sheet 2d.

7.6.6 Note the physical condition of the device after the test on Data Sheet 2d.  
A photograph of the device may be used for this purpose.

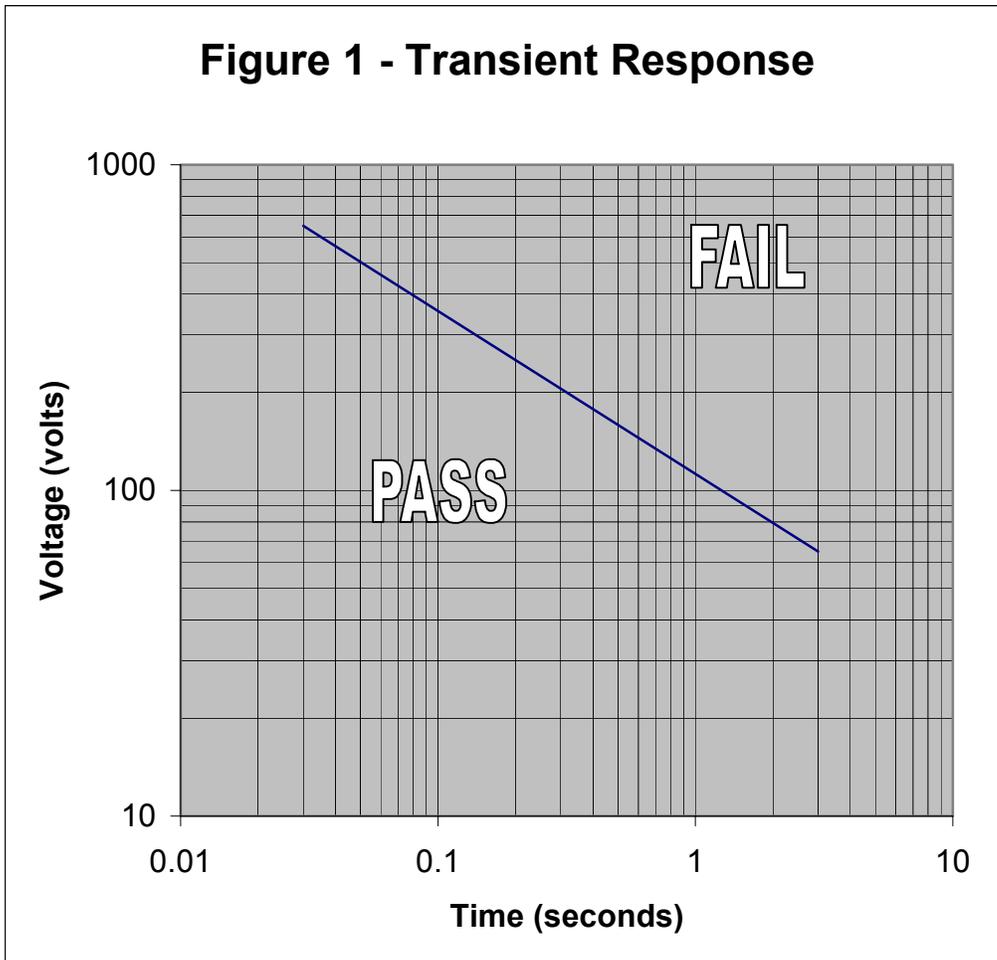
## 7.7 Parallel Device Test

- 7.7.1 Data may be collected in the form of oscillographic traces, magnetic storage media, or plotted graphs. Data will be tabulated on Data Sheet 2d.
- 7.7.2 Measure the DC resistance of three devices (not previously tested) (both polarities), to check for continuity. Record the resistances on Data Sheet 2d.
- 7.7.3 Connect the three devices in parallel with a parallel connection kit and connect the parallel arrangement in the power circuit.
- 7.7.4 A test current of at least 45000 amperes symmetrical will be passed through the three-device arrangement for at least 0.167 seconds. Record the actual test current and duration on Data Sheet 2d.
- 7.7.5 Measure the voltage across the devices during the test. Record the voltage on Data Sheet 2d.
- 7.7.6 Disassemble the parallel arrangement.
- 7.7.7 Allow the devices to cool to ambient temperature by measuring the DC resistances (both polarities) until they are no more than 105% of the resistance measured in 7.7.2. Record the resistances on Data Sheet 2d.
- 7.7.8 Note the physical condition of each device after the test on Data Sheet 2d. A photograph of the device may be used for this purpose.

## 8 PASS / FAIL CRITERIA

- 8.3 A device will fail if it exhibits failure in any of the following modes during any test in this STP:
  - 8.3.2 Deteriorates electrical joints.
  - 8.3.3 Fails in an open mode. (DC resistance increases 10% above the value measured before the continuous current test for the continuous current test, overcurrent test, and high current tests or 10% above the value measured before the parallel device test for the parallel device test).
  - 8.3.4 Emits flames, burns, or melts.
  - 8.3.5 Expels particles.
  - 8.3.6 Exhibits structural damage.
  - 8.3.7 Exhibits split or cracked external potting.
  - 8.3.8 Heats the external surface to the auto ignition temperature of coal dust (302 degrees F).

- 8.4 For a device to pass, its transient response voltage level and time measured in the transient response test must be in the pass region of Figure 1.
- 8.5 The voltage across a device will not exceed 29 volts when 25 amperes or more is passed through the device during any test in this standard test procedure.



Data Sheet 2a  
PAR Number: \_\_\_\_\_  
Test Device: \_\_\_\_\_  
Date of Test: \_\_\_\_\_

GROUND WIRE DEVICE  
SATURATION TEST

Company Name: \_\_\_\_\_ MSHA Investigator: \_\_\_\_\_  
Device Model Number: \_\_\_\_\_ Other Witness: \_\_\_\_\_

Initial DC Resistance (5.2.1) (ohms)  
Positive Polarity \_\_\_\_\_ Negative Polarity \_\_\_\_\_

Test Number	Current (amperes)	Voltage (volts)	Test Number	Current (amperes)	Voltage (volts)
1			16		
2			17		
3			18		
4			19		
5			20		
6			21		
7			22		
8			23		
9			24		
10			25		
11			26		
12			27		
13			28		
14			29		
15			30		

Data Sheet 2d  
 PAR Number: \_\_\_\_\_  
 Test Device: \_\_\_\_\_  
 Date of Test: \_\_\_\_\_

**GROUND WIRE DEVICE  
 CURRENT TEST**

Company Name: \_\_\_\_\_ MSHA Investigator: \_\_\_\_\_  
 Device Model Number: \_\_\_\_\_ Other Witness: \_\_\_\_\_

	Continuous Current	High Current	Overcurrent	Parallel Device
DC Resistance before Test + polarity (ohms)				D _____ E _____ F _____
DC Resistance before Test - polarity (ohms)				D _____ E _____ F _____
DC Resistance after Test + polarity (ohms)				D _____ E _____ F _____
DC Resistance after Test - polarity (ohms)				D _____ E _____ F _____
Voltage Across Device (volts)				
Test Current (amperes)				
Actual Duration (seconds)				
Maximum Temperature of external surface (°F)				

Physical condition of device after Continuous Current Test

Physical condition of device after High Current Test

Physical condition of device after Overcurrent Test

Physical condition of device after Parallel Test

Other Observations during Test