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

4.1. Constant Temperature – The equilibrium temperature of the device with the prescribed test parameters. This temperature is obtained whenever three consecutive temperature readings taken at intervals of no less than 5 minutes indicate a total change of less than 3%.

4.2. Ground Wire Device - A device placed in series with the ground wire to suppress intermachine arcing or 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 continuously variable voltage power supply capable of supplying 50 amperes AC.

7.2.3. Size a resistor to limit current to 50 amperes at the maximum output of the power supply 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 slope of the saturation curve (device voltage versus device current) decreases to 10% of its maximum value. 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 to zero. When the current through the device reaches zero, de-energize the power supply.

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. 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. De-energize the power supply.

7.3.8. Repeat step 7.3.6.

7.3.9. 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 110% 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 or permitted.

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 a constant temperature is reached. 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. De-energize the power supply. Note the physical condition of the device and note any defects on Data Sheet 2d. A photograph of the device may be used for this purpose. Allow the device to cool to ambient temperature by measuring the DC resistance (both polarities) until it is no more than 110% 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 cooling and note any defects 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 0.334 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. De-energize the power supply. Note the physical condition of the device and note any defects on Data Sheet 2d. A photograph of the device may be used for this purpose. Allow the device to cool to ambient temperature by measuring the DC resistance (both polarities) until it is no more than 110% 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 cooling and note any defects 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. De-energize the power supply. Note the physical condition of the device and note any defects on Data Sheet 2d. A photograph of the device may be used for this purpose. Allow the device to cool to ambient temperature by measuring the DC resistance (both polarities) until it is no more than 110% 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 cooling and note any defects 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 supplied by the applicant. 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. De-energize the power supply. Note the physical condition of each device and note any defects on Data Sheet 2d. A photograph of the device may be used for this purpose. Allow the devices to cool to ambient temperature by measuring the DC resistance (both polarities) until they are no more than 110% of the resistances measured in 7.2.1. Record the resistances on Data Sheet 2d.

7.7.8. Note the physical condition of each device after cooling and note any defects on Data Sheet 2d. A photograph of the device may be used for this purpose.

8.0 TEST DATA

8.1. Data from the saturation test will be tabulated on Data Sheet 2a.

8.2. Data from the saturation test will be plotted on a linearly scaled graph of amperes versus volts. This graph will be saved as Data Sheet 2b.

8.3. The transient data will be recorded and saved 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.

8.4. Data from the continuous current, high current, overcurrent, and parallel device tests will be tabulated on Data Sheet 2d.

9.0 PASS/FAIL CRITERIA

9.1. A device will fail if it exhibits failure in any of the following modes during any test in this STP:

9.1.1. 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).

9.1.2. Emits flames, burns, or melts.

9.1.3. Expels particles.

9.1.4. Exhibits structural damage.

9.1.5. Exhibits split or cracked external potting.

9.1.6. Heats an internal surface above the temperature rating of the insulation.

9.1.7. Heats the external surface to the auto ignition temperature of coal dust (302 degrees F).

9.2. 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.

9.3. 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.

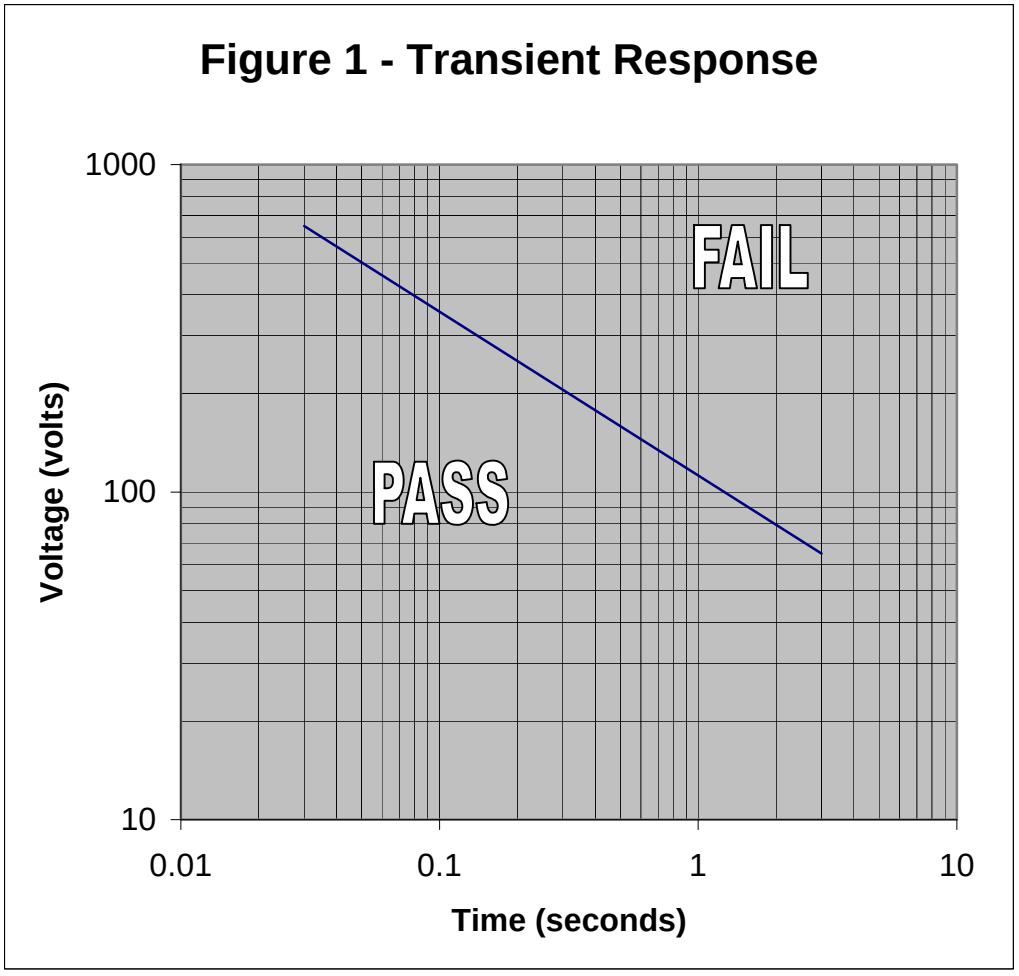
Figure 1 - Transient Response
1000
100
10
Voltage (volts)
FAIL
PASS
0.01
0.1
1
10
Time (seconds)

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 (7.2.1) (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)				
Maximum Temperature of internal 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

_____