1.0 PURPOSE

The purpose of this document is to provide a procedure to be used by the Electrical Safety Division to determine if a wire or component, under normal or fault conditions, that exceeded 530° C (986° F) during the Maximum Surface Temperature Test (ASTP2233), is capable of causing ignition of a methane-in-air atmosphere. This procedure is also used for testing exposed wires/filaments, except lamp bulb filaments which are tested according to the Lamp Bulb Safety Test (ASTP2222).

2.0 SCOPE

This STP applies to components of equipment evaluated, approved, or certified under 30 CFR Parts 18, 19, 20, 22, 23, and 27.

3.0 REFERENCES

3.1. ACRI2001 "Criteria for the Evaluation and Test of Intrinsically Safe Apparatus and Associated Apparatus"

3.2. 30 CFR Part 18 “Electric Motor-Driven Mine Equipment and Accessories”

3.3. 30 CFR Part 19 “Electric Cap Lamps”

3.4. 30 CFR Part 20 “Electric Mine Lamps Other Than Standard Cap Lamps”

3.5. 30 CFR Part 22 “Portable Methane Detectors”

3.6. 30 CFR Part 23 “Telephone and Signaling Devices”

3.7. 30 CFR Part 27 “Methane-Monitoring Systems”

3.8. ASTP2233 “Maximum Surface Temperature Test”

4.0 DEFINITIONS

4.1. **Component** - resistors, transistors, voltage regulators, etc.

4.2. **Hot wire** - exposed bead/element of a catalytic type sensor or strand(s) of wire.

4.3. **R_{load}-** resistor connected in series with the component under test to monitor the current through the test circuit.

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

5.0 TEST EQUIPMENT

5.1 A low resistance switch or relay contact for opening and closing the test circuit having adequate voltage and current ratings. If a relay is used, a power supply capable of energizing the relay is required.

5.2 A 0.1 ohm (± 1%) load resistor (R load) with a minimum 50 ampere rating. Note: the value of the load resistor should be less than 10% of the nominal value of the component under test. (Dale RH-250)

5.3 Data recorder having at least 3 channels with sufficient voltage range for the parameters of the test circuit, a resolution of at least 3 significant figures, and an accuracy of at least ±1.5% of the reading. The data recorder must be able to record the voltage of the channels vs. time with a resolution of 1 minute, an accuracy of ±1 second, and a minimum of 1000 data points per test. The parameters to be recorded are: the voltage across the load resistor, the voltage across the component under test, and the temperature of the component under test. [Agilent 34970A Data Acquisition System or Hewlett-Packard 7090A].

5.4 Power Supply (ies) or batteries with adequate capacity.

5.5 Various interconnecting wires, hoses, etc. as necessary.

5.6 Stopwatch.

5.7 Gas mixing equipment with the capability to provide a 7.7 (± 0.2) % (by volume) methane-in-air concentration. [Matheson Multiple Dyna-Blender 8284]

5.8 A source of methane gas having a purity of at least 95%.

5.9 A clean, dry source of air having an oxygen content of 21 (±0.5) % (by volume). [Aadco Model 737 Pure Air Generator]

5.10 CH4 Infrared Methane Gas Analyzer. [Horiba VIA-510 Analyzer Unit]

5.11 A test chamber of sufficient volume to house the component under test. The chamber is fitted with an inlet port with a diffuser to reduce the cooling effect of the flow of the mixed gas into the chamber and a vent port for the mixed gas to vent from the chamber and out of the laboratory. The chamber has internal binding post connections for powering the component under test. The chamber has a loose fitting lid to provide for a secondary means of venting.

5.12 8 mil tungsten wires cut in 2" length pieces.

5.13 Thermometer. Minimum resolution: 0.2° C; minimum accuracy: ± 2° C. The thermocouple junction of the thermometer must consist of wires not larger than No. 24 AWG. [Fluke Model 2170A Digital Thermometer]

6.0 TEST SAMPLES

Ten samples of the component or wire to be tested. If the wire is located in a catalytic type sensor, the samples of the catalytic sensor must be tested with its hot surfaces (wire/bead) exposed to the test gas (i.e., have sintered metal screens removed and beads/elements exposed).

7.0 PROCEDURES

7.1 Test shall be conducted in an ambient temperature of 25° ±10° Celsius.

7.2 Connect the test chamber to the output of the gas mixing equipment and the laboratory vent using hose/tygon tubing. In the test chamber, place a gas flow diffusing device where the test gas mixture enters the chamber.

7.3 Place a piece of 8 mil tungsten wire between the binding posts in the test chamber. The binding posts are to be separated by a distance of 1.5 (± 0.25) inches. Place the lid on the test chamber.

7.4 Connect the power supply through a series circuit of the switch, load resistor, and across the binding posts in the chamber.

7.5 Set the gas mixing equipment to provide a carrier (air) flow rate of 2.0 (± 0.5) liters/minute.

7.6 Adjust the gas mixing equipment to provide a component flow rate to achieve a 7.7 (± 0.2) % (by volume) methane-in-air concentration in the chamber. The gas analyzer may be used to verify the proper test gas

concentration. Allow the test gas to flow through the test chamber for at least two minutes before performing the following pre-test calibration.

7.7 Set the power supply to provide an open circuit voltage of 5.0 volts and a short circuit current of 4.8 amps.

WARNING: BURN HAZARD.
YOU MUST EXERCISE CAUTION WHEN CONDUCTING THIS TEST. AN IGNITION IN THE TEST CHAMBER MAY CAUSE THE LID TO DISPLACE ALLOWING HOT GASES TO ESCAPE THAT MAY CAUSE BURNS. STAY CLEAR OF THE CHAMBER WHILE CONDUCTING THE TEST.

7.8 Close the switch and start the stop watch.

7.9 Open the switch immediately after ignition of the test gas occurs. Note the elapsed time until ignition occurs. The test gas must ignite within 60 seconds for a valid calibration. If the test gas did not ignite within 60 seconds, corrective action must be taken to achieve calibration.

7.10 Vent the test gas flow by connecting the hose/tygon tubing from the gas mixing equipment to the lab exhaust vent.

Note: Do not interrupt the gas flow from the gas mixing equipment after a successful calibration is achieved.

7.11 Open the chamber and check that the electrode is still intact. An open electrode invalidates the calibration. Remove the tungsten electrode from the binding posts.

7.12 Mount the test component in its normal position and connect to the binding posts inside the test chamber.

7.13 Connect the component power source through a series circuit of the switch, load resistor, and across the binding posts in the chamber.

7.14 Connect the data recorder to monitor the voltage across the load resistor, voltage of the component under test, and the temperature of the component under test (temperature data is not used with "Hot Wire" testing).

Note: Follow Section 7.15 through 7.20 for testing of components and Section 7.21 through 7.24 for testing of "Hot Wire" then continue with Section 7.25.

7.15 Place the thermocouple junction in secure contact with the surface of the small component under test.

7.16 Place the lid on the test chamber. Re-connect the test chamber to the output of the gas mixing equipment and the laboratory vent using hose/tygon tubing. Allow the test gas to flow through the test chamber for at least two minutes before energizing the circuit. Note: Do not allow the test gas to blow directly toward the hot surface. The gas flow will have a cooling effect on the component.

7.17 Subject the component to the same test conditions that caused the component to exceed 530° C (986° F) during the previously conducted surface temperature testing.

7.18 Monitor the temperature of the component under test to determine that the steady state surface temperature is approximately the same as the temperatures observed during previous surface temperature testing of the component.

7.19 Carefully remove the thermocouple from direct contact with the component, if possible without removing the lid on the test chamber. If not possible, test two samples with the thermocouple, and three samples without the thermocouple.

7.20 Apply the test voltage to the component until a constant temperature is obtained and then continue for an additional 10 minutes or until an ignition of the test gas occurs.

Note: If an ignition of the test gas occurs, the component has failed the test (reference Section 9.0) and testing is terminated.

7.21 Place the lid on the test chamber. Re-connect the test chamber to the output of the gas mixing equipment and the laboratory vent using hose/tygon tubing. Allow the test gas to flow through the test chamber for at least two minutes before energizing the circuit. Note: Do not allow the test gas to blow directly toward the hot surface. The gas flow will have a cooling effect on the wire.

7.22 Apply the test voltage to the wire. If the wire fails (e.g., open-circuits), the test described in Section 7.12 to Section 7.21 must be repeated with a new sample of the wire at a reduced voltage. The voltage shall be reduced until the wire does not burn open for the duration of the test.

7.23 Observe the wire to determine if it is glowing red.

7.24 Apply the test voltage to the wire for 20 minutes or until an ignition of the test gas occurs.

Note: If an ignition of the test gas occurs, the wire has failed the test (reference Section 9.0) and testing is terminated.

7.25 Repeat Section 7.12 through 7.14 on four additional samples of the component/wire under test (5 total samples tested).

7.26 If no ignition of the test gas occurs during the hot wire testing, perform a post-test calibration repeating Section 7.3 through 7.11.

8.0 TEST DATA

8.1 The manufacturer, part number, and type of component for each sample tested.

8.2 The voltage vs. time across the component during the test.

8.3 The current vs. time through the component during the test.

8.4 The temperature vs. time of the component under test.

8.5 The voltage, current, and elapsed time during the calibrations of the test chamber.

8.6 Observations made during the test (e.g. if the test gas did or did not ignite; visible red glowing of the component under test).

8.7 Equipment used for testing. This should include manufacturer, model number, and calibration due date for each piece of equipment.

8.8 Ambient temperature.

9.0 PASS/FAIL CRITERIA

The component under test fails if there is an ignition of the test gas during either component or hot wire testing.