

## 1.0 PURPOSE

- 1.1. This test procedure is used by the Electrical Safety Division (ESD) during the evaluation of intrinsically safe apparatus to determine if a component, which exceeded 150° Celsius (302° Fahrenheit) under normal or fault conditions during surface temperature testing, is capable of causing layered coal dust to ignite.
- 1.2. To provide a person knowledgeable in the appropriate technical field with a written procedure that will assure consistent repeatable test data and results, independent of the person conducting the test.

## 2.0 SCOPE

This Standard Test Procedure (STP) applies to components of equipment evaluated, approved, or certified under 30 CFR Parts 18, 19, 20, 22, 23, and 27 that may be subjected to a coal dust layer, and therefore, does not apply to components located in a dust-tight enclosure or in an MSHA-certified explosion-proof enclosure.

## 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 "Telephones and Signaling Devices"
- 3.7. 30 CFR Part 27 "Methane-Monitoring Systems"

## 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. **Current-Interrupting Device** - A fuse or other device designed to prevent another component from overheating and is effective after applying up to two independent faults to the circuit.
- 4.3. **Maximum Fault Voltage** - The highest voltage that can be applied across the component being tested under the worst case, two fault condition.
- 4.4. **Ignition** - When the heat generated by the coal dust exceeds the heat being supplied by the component under test. This is generally evident when the coal dust temperature (temperature 1/4 inch above the component under test) exceeds the temperature of the component under test either during the test or after power to the component under test is removed.

## 5.0 TEST EQUIPMENT

- 5.1. Data recorder with at least 3 channels, sufficient voltage range for the parameters of the test circuit, a resolution of at least 3 significant figures, an accuracy of at least  $\pm 1.5\%$  of the reading, a minimum of 1000 data points per test, and able to plot voltage of 3 or more channels versus time with a resolution of 1 minute, and an accuracy of  $\pm 1$  minute. [Example, Agilent 34970A Data Acquisition/Switch Unit].
- 5.2. Power supply or batteries with adequate capacity. Fresh or fully charged batteries equivalent to those normally powering the component under test may be used in lieu of a power supply.
- 5.3. Switch rated for the maximum voltage and current of the test circuit, as necessary.
- 5.4. Two digital thermometers with analog or digital output, with a range of at least the maximum permissible surface temperature of the component under test, resolution of at least  $0.2^{\circ}\text{C}$ , and an accuracy of at least  $\pm 1^{\circ}\text{C}$ . The sensing element of these thermometers must not significantly affect the temperature of the component under test. Thermocouple wires must not be larger than No. 24 AWG. [Example, Fluke 2170A].
- 5.5. Series connected resistor, or equivalent device, to measure the current flow through the test circuit that will have a voltage drop of less than or equal to 1% of the voltage drop of the component under test. The power rating of this device shall not be exceeded during this test. [Example, Dale RH-250,  $0.1\Omega$ , 1%, 250 watt resistor].

- 5.6. Various connecting wires, test chamber, etc. as necessary.
- 5.7. An ohmmeter to measure the value of the series connected resistor with a resolution of at least 3 significant figures, and an accuracy of at least  $\pm 1\%$  of reading. [Example, Fluke Model 8842A Multimeter].
- 5.8. An environmental chamber capable of heating the coal dust, component under test, and test chamber to 40 (-0/+5) degrees Celsius. [Example, Tenney Model TH27-3 Environmental Chamber].
- 5.9. Pittsburgh Seam Coal Dust that has been filtered through a 200 mesh screen.

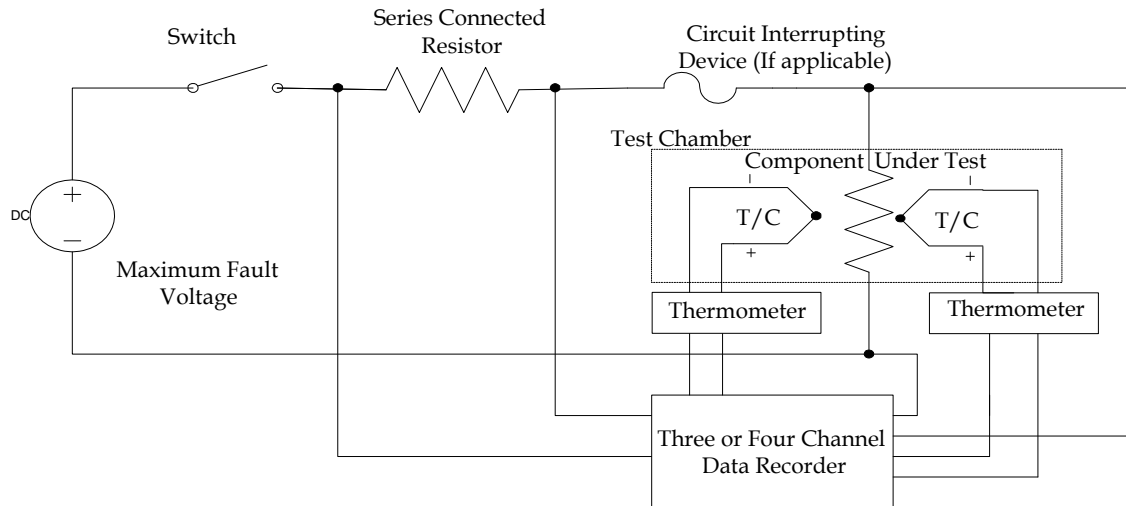
Note: Equipment models listed are acceptable equipment currently used by the ESD to perform the test. Equivalent or more accurate equipment may be used.

## 6.0 TEST SAMPLES

- 6.1. Ten samples of the component under test.
- 6.2. Ten samples of the current-interrupting device (if applicable).

## 7.0 PROCEDURES

- 7.1. Calibrate the coal dust according to ASTM E2021-01 standard titled "Standard Test Method for Hot-Surface Ignition Temperature of Dust Layers". If the ignition temperature of the coal dust is greater than 240 degrees Celsius, then newer coal dust must be obtained. Note: Coal dust that has been initially calibrated when received, and is stored in a sealed container for less than one year does not require a calibration.
- 7.2. Measure and record the resistance of the series connected resistor. The voltage drop across the sensing resistor must be less than or equal to 1% of the voltage drop of the component under test. If not, change to a lower value series connected resistor, and repeat this step.
- 7.3. Connect the test circuit (see the following diagram) using wiring methods that will minimize the resistance and heat-sinking affects of the test circuit. If applicable, connect a sample of the current-interrupting device in series with the component to be tested. If only using a three channel data recorder, the voltage across the component may be omitted and substituted with a verbal description of the applied voltage.



- 7.4. Mount the component under test in its normal position inside the test chamber.
- 7.5. Place one thermocouple junction in secure contact with the surface of the component under test at a point on the component most likely to be the hottest. If no specific location on the component can be considered the hottest, place the thermocouple near the top center of the component.
- 7.6. Place the other thermocouple junction  $\frac{1}{4}$  inch above the component under test.
- 7.7. Cover the component with Pittsburgh Seam coal dust filtered by a 200 - mesh screen to a depth of at least 12 mm (0.48 inches), but no more than 18 mm (0.71 inches).  
  
Note: Do not place a cover over the test chamber since this may restrict oxygen to the coal dust preventing it from igniting.
- 7.8. Heat the component under test, coal dust, and test chamber until it reaches a constant temperature of 40 (- 0/ + 5) degrees Celsius.
- 7.9. Set the open circuit voltage of the power supply to the maximum fault voltage. Record the test voltage.
- 7.10. Set the short-circuit current of the power supply to a value that will ensure it does not limit the current to the component under test.

- 7.11. Apply the maximum fault voltage to the component under test by closing the switch.
- 7.12. Observe on the data recorder or thermometers a steady increase in both the surface temperature of the component under test and the temperature  $\frac{1}{4}$  inch above the component under test. Observe for ignition of the coal dust. Ignition will be evident if the temperature  $\frac{1}{4}$  inch above the component under test exceeds the component temperature.
- 7.13. Continue the test until either an ignition is observed, the temperature  $\frac{1}{4}$  inch above the component under test reaches a constant surface temperature or the temperature  $\frac{1}{4}$  inch above the component is decreasing. During the test, record the voltage across the component under test, the voltage across the series connected resistor, and the temperature of the component versus time.
- 7.14. Repeat the test described in 7.1 through 7.13 on four additional samples of the component under test.
- 7.15. If during the test described in section 7.11 through 7.13, the component under test or the current interrupting device fails in the open condition then the test described in Section 7.1 to 7.13 should be repeated with a new sample of the component and/or the current interrupting device at a reduced voltage. The voltage applied should be increased in steps until the maximum constant temperature of the component is achieved without the component or the current interrupting devices failing open circuited. One way to accomplish this is to use one of the samples to experimentally determine the fuse or resistor opening voltage or current by slowly increasing the test voltage. After determining the fuse opening voltage, increase the test voltage in 10 equal steps from 0 volts to the experimentally determined voltage. Repeat this test on four more samples of the component.

## 8.0 TEST DATA

- 8.1. Ignition temperature of the coal dust when tested according to ASTM E2021-01, date of the calibration test, and age of the coal dust (in months).
- 8.2. Resistance of the series connected resistor, and its specified power rating.

- 8.3. Continuous recording of the voltage versus time across the component under test for each test conducted. May be omitted and substituted with a verbal description of the applied voltage if only using a three channel data recorder.
- 8.4. Continuous recording of the current versus time through the component under test for each test conducted.
- 8.5. Continuous recording of the surface temperature versus time of the component under test and the temperature  $\frac{1}{4}$  inch above the component under test for each test conducted.
- 8.6. Manufacturer, model, serial number or other identification number and calibration due date (if applicable) for each piece of test equipment.
- 8.7. Description of the component under test including manufacturer, manufacturer's part number, type of component, and general specifications for each sample tested.
- 8.8. Description of the current-interrupting device (if applicable) including manufacturer, type of device (fuse, PTC, etc.), nominal current rating, maximum operating time versus current curve (if necessary), and any other relevant manufacturer's specifications.
- 8.9. Observations made during the test (e.g. point at which the component or coal dust began smoking, glowing red, and/or flaming).
- 8.10. Description or circuit diagram of test being conducted.

Note: Photographs may be included as an alternate to the description of the test setup or observations made during the test.

## 9.0 PASS/FAIL CRITERIA

The component under test fails if there is evidence of ignition of the coal dust.