1.0 PURPOSE

The purpose of this document is to provide a procedure used by the Electrical Safety Division to determine if a representative sample of a methane monitoring system meets the requirements for resistance to dust of 30 CFR 27.40.

2.0 SCOPE

This Standard Test Procedure (STP) applies to tests on all methane monitoring systems submitted for certification per 30 CFR Part 27. This STP will apply to tests on systems submitted for extension of certification and RAMPs if the changes would affect the dust resistance of the monitoring system.

3.0 REFERENCES

30 CFR 27.40 *Test to determine resistance to dust.* Components, subassemblies, or assemblies, the normal functioning of which might be affected by dust, such as coal or rock dust, shall be tested in an atmosphere containing an average concentration (50 million (minus 40 micron) particles per cubic foot) of such dust(s) for a continuous period of 4 hours. The component, subassembly, or assembly shall function normally after being subjected to this test.

4.0 DEFINITIONS

4.1. **Methane detector** - A component of a methane monitoring system that functions in a gassy mine, tunnel, or other underground workings to sample the atmosphere continuously and responds to the presence of methane (30 CFR 27.2(d)).

4.2. **Methane monitoring system** - A complete assembly of one or more methane detectors and all other components required for measuring and signaling the presence of methane in the atmosphere of a mine, tunnel, or other underground workings, and shall include a power-shutoff component (30 CFR 27.2(c)).

4.3. **Power shutoff component** - A component of a methane monitoring system, such as a relay, switch, or switching mechanism, that will cause a control circuit to deenergize a machine, equipment, or power circuit when actuated by the methane detector (30 CFR 27.2(e)).

5.0 TEST EQUIPMENT

5.1. Test gases consisting of methane and air.

5.2. Gas mixing/measuring equipment (if not using pre-mixed test gas) with the capability to give mixtures of 1.5(± 0.1) and 2.1 (± 0.1) percent by volume. [Modular Dyna-Blenders Models 8250].

5.3. A dust test chamber able to provide an average concentration (50 million minus 40 micron particles per cubic foot) of dust for a continuous period of 4 hours and sufficiently large enough to enclose the appropriate components, assemblies, and subassemblies of the methane monitoring system[Thermotron Model T-36-D Dust Test Chamber].

5.4. Manufacturer's specified calibration kit (designed for use with the monitor), which may include calibration instructions, a calibration cup, tubing, calibration gas, flow meter set and/or any other required components (IR calibrator, reed switch magnet, etc.). This kit will allow for introduction of the calibration gas and test gas mixtures to the sensor at the manufacturer's specified calibration flow rate.

5.5. Gas analyzer with a range of at least 0 to 10 % volume methane-in-air; a resolution of at least 0.01 % volume methane-in-air, and accuracy of at least ±0.05 % volume methane-in-air [Horiba Model VIA-510].

5.6. Thermometer - Minimum resolution: 0.1°C; minimum accuracy: ±1°C. [Fluke Model 2170A Digital Thermometer]

5.7. DataRAM – a real-time aerosol monitor utilizing light field counting techniques for measurement of the concentration of airborne dust. (See NOTE 1.)

5.8. Dust Pump – a sampling device utilizing filter cartridges to collect a sample of airborne dust for use in calculating the concentration of dust. (See NOTE 1.) [Escort ELF Pump]

5.9. Balance - with the following specifications: Linearity ±0.2 mg/± 0.03mg , and a readability of 0.1 mg / 0.02 mg. [Metter Toledo AG245]

5.10. Relative Humidity Meter – with the following specifications: digital display, range of 5%-99% with an accuracy of ± 5% and a maximum response time of 90 seconds. [Digital Thermo-Hygrometer RH411]

5.11. Stopwatch.

NOTE 1: 30 **CFR Part 27.40 states, "Dust measurements, when necessary, and shall be made by impinger sampling and light-field counting technique."** In the event this equipment is not available, alternate dust monitoring (measurement) instrumentation may be used. The alternate instrumentation must be capable of providing measurement information to determine the average dust concentration in particles per cubic foot present in the dust chamber. Two independent measurement sources should be used for verification. Measurement methods include transmission measurement, gravimetric measurement, and/or scattered light measurement. Other measurement instruments that meet the criteria for providing data to determine dust concentration may be used.

6.0 TEST SAMPLES

One representative sample of a complete methane-monitoring system with calibration instructions; this shall be of a quality consistent with that of the final manufactured product. The product must include any documented dust and/or water covers and/or filters. Each cover and/or filter must be tested while connected to the methane-monitoring system.

7.0 PROCEDURES

7.1. Testing shall be conducted in an ambient temperature of 25 ± 10° C. Record the ambient (laboratory) temperature at start of the test and record temperature and on the test sheet in the appropriate section.

7.2. Record the filter cartridge pre-test weight (to be connected in tubing with Dust Pump).

7.3. The dust chamber set-up and controls should be as follows:

7.3.1. Timer – On time: approximately 5 minutes 50 seconds (check with stopwatch). Off time: approximately 10 seconds (check with stopwatch). The combined on/off times should be at or over 6 minutes.

Investigator/Tester must record the on and off times as measured by the stopwatch.

7.3.2. Counter – The counter should be set to 40 cycles. Record the counter setting.

7.3.3. Input Air Pressure – The air pressure regulator should be set at 40 PSI.

7.3.4. Dust – The chamber should contain approximately 150 lbs (3 bags) of rock dust.

7.4. Analyze the pre-mixed calibration gas from the manufacturer's recommended calibration kit with the gas analyzer. Record the reading. Note: Please refer to the user's manual of the gas analyzer [Horiba Model VIA-510] for calibration, which must be performed prior to any analysis.

7.5. Assemble and calibrate the methane monitoring system per the manufacturer's recommendations with the manufacturer's recommended calibration gas kit.

7.6. Bump test the methane monitor. Record the zero gas/fresh air reading, Record the warning reading, the alarm reading and the final reading. After the calibration gas is removed, allow the system to settle for 2 minutes and record the zero/fresh air reading.

7.7. If not using pre-mixed test gas, set the concentration of gas from the gas mixing equipment to 1.5 %(± 0.1) methane-in-air. Record the setting of the gas concentration and flow rate.

7.8. Connect the Calibration cup to the methane monitor and apply the test gas to the methane monitor through the calibration cup at the specified calibration flow rate, start the stopwatch, and record the status of each alarm and warning light and the power shut-off component. Once the display has reached its final reading, record the reading and record the time required for the display reading to increase from its quiescent reading to its final reading. Once the final reading is recorded, disconnect the calibration cup from the device under test.

7.9. If not using pre-mixed test gas, increase the concentration of gas from the gas mixing equipment to 2.1 %(± 0.1) methane-in-air. Record the setting for the gas concentration and flow rate.

7.10. Connect the calibration cup and apply the test gas to the methane monitor through the calibration cup at the specified calibration flow rate, start the stopwatch, and record the status of each alarm and warning light and the power shut-off component. Once the display has reached its final reading, record the reading, stop the stopwatch, and record the time required for the display reading to increase from its quiescent reading to its final reading.

7.11. Decrease the gas mixture to 0.0 percent methane-in-air to the methane detector and record the setting. Record the status of each alarm and warning light and the power shut-off component. If the monitor does not have automatic reset, manually reset the monitor power-shutoff component. Once the final reading is recorded, disconnect the calibration cup from the device under test.

7.12. Place the appropriate dust measurement instrumentation, relative humidity meter and the methane monitoring systems components, subassemblies, and/or assemblies in the dust chamber in their normal operating configuration. The sensor head shall be orientated in such a manner to maximize exposure to the dust normally placed in the vertical down position (Sensor facing down). Cyclones used with the dust sampling equipment must be hanging vertically, so large particles will not be drawn into the filter.

7.13. Energize the dust measurement instrumentation and relative humidity meter. Allow the instruments to warm-up, if necessary, and set the measurement parameters and logging function(s).

7.14. DataRAM – under the Parameters menu, set the flow rate to 1.7 lpm and set data logging on. Under the main menu, zero the system. For complete instruction on set-up and operation, see the manufacturer's instruction manual.

7.15. Dust Pump – Set the flow rate for 1.7 lpm. Record the dust cartridge serial number and the pre-weight measurement. For instructions on set-up and operation, see the manufacturer's instruction manual.

7.16. Record the dust chambers relative humidity for pre-test humidity on the test sheet.

7.17. Start the dust measurement instruments and the dust chamber. Allow the methane monitor to run in the chamber for at least four (4) hours (40 cycles).

7.18. When the dust chamber completes the last cycle, it will shut off. Record the elapsed time (ET) and time-weighted average (TWA) recorded on the light field counter (DataRAM). Allow the dust in the chamber to settle prior to opening the lid. This should require typically 15-30 minutes.

7.19. If not using pre-mixed test gas, set the concentration of gas from the gas mixing equipment to 1.5 %(± 0.1) methane-in-air. Record the setting of the gas concentration and flow rate.

7.20. Connect the calibration cup to the methane detector, start the stopwatch, and apply the gas to the methane detector while still in the dust chamber. Note: Tester should minimize any shaking, movement, and/or vibrating the sensor as this may affect the placement of the dust on the device under test. Record the display reading and the status of each alarm and warning light and the power shut-off component. Record the time required for the display reading to increase from its quiescent reading to its final reading. Once the final reading is recorded, disconnect either the calibration cup from the device under test or the tubing from the calibration cup. The tester should determine which method will allow the least amount of disturbance to the methane monitor.

7.21. Increase the concentration of gas from the gas mixing equipment to 2.1 %(± 0.1) methane -in-air and record the setting. Reconnect the calibration cup or the tubing to the calibration cup, and start the stopwatch. Note: Tester should minimize any shaking, movement, and/or vibrating the sensor as this may affect the placement of the dust on the device under test. Apply the test gas to the methane monitor through the calibration cup at the specified calibration flow rate and record the status of each alarm and warning light and the power shut-off component. Once the display has reached its final reading, record the reading and the time required for the display reading to increase from its quiescent reading to its final reading. Disconnect the calibration cup from the device under test. The tester should determine which method will allow the least amount of disturbance to the methane monitor.

7.22. Decrease the gas mixture to 0.0 percent methane in air to the methane detector, start the stopwatch, and record the setting. Record the display

reading and the status of each alarm and warning light and the power shut-off component. Record the time required for the display reading to decrease from the value recorded in Section 7.21 to its final reading.

7.23. Record the ambient (laboratory) temperature for post-test temperature on the test sheet.

7.24. Record the relative humidity inside the dust chamber for post-test humidity on the test sheet.

7.25. Record the filter cartridge post-test weight (located in Dust Pump tubing).

8.0 TEST DATA

8.1. Time- weighted average concentration number of dust throughout the course of the test.

8.2. Pre- and post-test weight of the filter cartridge from Dust Pump tubing.

8.3. Warning indicator status during Sections 7.8 through 7.10 and Sections 7.19 through 7.22.

8.4. Alarm indicator status during Sections 7.8 through 7.10 and Sections 7.19 through 7.22.

8.5. Response times recorded during Sections 7.8 through 7.10 and Sections 7.19 through 7.19.

8.6. Fresh air/zero readings of the monitor.

8.7. Final pre- and post-test readings of the monitor.

8.8. Test equipment manufacturer and part number with calibration due dates.

8.9. Description of methane monitoring system including position and orientation of the sensor during the test.

8.10. Test gas concentration. Minimum precision: 0.1%; minimum accuracy: ± 0.1%.

8.11. Reference to the manufacturer's calibration procedure and installation instructions (document number, section, revision date, etc.).

8.12. The analyzed reading of the calibration gas.

8.13. The ambient temperature and relative humidity at start and finish of testing.

8.14. The manufacturer, part number and serial number of the monitoring system to include the manufacturer, part number and serial numbers (as appropriate) of any dust/water cap/filters tested with the monitoring system.

9.0 PASS/FAIL CRITERIA

The methane monitoring system shall:

9.1. Have a final reading at or within 0.2% of the measured gas used for calibration and testing and remain at or within 0.2% of zero. For example:

9.1.1. 1.4% gas applied, methane monitor system shall display (1.2% -1.6%)

9.1.2. 1.5% gas applied, methane monitor system shall display (1.3% - 1.7%)

9.1.3. 1.6% gas applied, methane monitor system shall display (1.4% - 1.8%)

9.2. Actuate a warning device when 1.5 percent methane-in-air is applied to the methane detector;

9.3. Actuate a warning device and power shutoff component when 2.1 percent methane-in-air is applied to the methane detector;

9.4. Not actuate these devices in fresh air before, after or during test when not appropriate.

Enclosure A

Sample Test Sheets

Data Sheet No. _____

File No. _____ PAR No. _____

Company _____

Date _____ STP No. _____

Test Sheet No. ____ of ____ Investigator _____

Test Results: Pass ☐ Fail ☐

EQUIPMENT UNDER TEST:

TEST EQUIPMENT:

Test Conditions	Actual Applied Test Gas _____%			Actual Applied Test Gas _____%		
Sensor No. 1	Warn	Max	Horiba reading	Trip	Max	Horiba reading
Pre-Test Fresh Air						
Pre-Test CH_4						
Post-Test Fresh Air						
Post-Test CH_4						
Sensor No. 2	Warn	Max	Horiba reading	Trip	Max	Horiba reading
Pre-Test Fresh Air						
Pre-Test CH4						
Post-Test Fresh Air						
Post-Test CH4						

Note: Additional configurations (with splash guards, dust covers) may require additional sensor blocks (i.e... Sensor No. 3, etc.)

Enclosure A

Sample Test Sheets

Data Sheet No. _____

File No. _____ PAR No. _____

Company _____

Date _____ STP No. _____

Test Sheet No. ___ of ___ Investigator _____

Test Results: Pass ☐ Fail ☐

TEST COMMENTS:

Ambient temperature: °C

DUST MEASUREMENTS AND METHANE MONITOR READINGS DURING THE TEST

TIME hrs:mins	DUST MONITOR	Sensor No. 1 Reading	Sensor No. 2 Reading	Sensor No. 3 Reading	Sensor No. 4 Reading
Start (fresh air)	000.0 µg/m³	0.0	0.0	0.0	0.0
Start (dust concentration)	mg/m³	0.0	0.0	0.0	0.0
00:15	mg/m³	0.0	0.0	0.0	0.0
00:30	mg/m³	0.0	0.0	0.0	0.0
00:45	mg/m³	0.0	0.0	0.0	0.0
1:00	mg/m³	0.0	0.0	0.0	0.0
1:15	mg/m³	0.0	0.0	0.0	0.0
1:30	mg/m³	0.0	0.0	0.0	0.0
1:45	mg/m³	0.0	0.0	0.0	0.0
2:00	mg/m³	0.0	0.0	0.0	0.0
2:15	mg/m³	0.0	0.0	0.0	0.0
*2:40	mg/m³	0.0	0.0	0.0	0.0
2:45	mg/m³	0.0	0.0	0.0	0.0
3:00	mg/m³	0.0	0.0	0.0	0.0
3:15	mg/m³	0.0	0.0	0.0	0.0
3:30	mg/m³	0.0	0.0	0.0	0.0
3:45	mg/m³	0.0	0.0	0.0	0.0
4:00	mg/m³	0.0	0.0	0.0	0.0

***dust circulated in chamber**

TWA of dust during the test: ___mg/m³

TEST CONCLUSION: The Model Methane Monitoring System (meets/does not meet) the requirements of 30 CFR 27.40.

Enclosure A

Sample Test Sheets

Data Sheet No. _____

File No. _____ PAR No. _____

Company _____

Date _____ STP No. _____

Test Sheet No. ___ of ___ Investigator _____

Test Results: Pass ☐ Fail ☐

Subject: Methane Monitor Dust Resistance Test

Model:

Test Circuit:

Dust Chamber

Notes:

Filter Cartridge Weights:

Pre-Test	Post-Test

Elapsed Time

Applied Gas	1.4% - 1.6%	2.0% - 2.2%
Pre		
Post		

Humidity

Pre-Test	Post-Test

Enclosure B

Sample Test Sheets

Company: ABC Corporation							
Date: 6 June 2014				STP No. 2248			
Test Sheet No. 1 of 3				Investigator John Smith			
Test Results:		Pass	x		Fail		

EQUIPMENT UNDER TEST: Model ABC Methane Monitoring System with the P/N 1234 Dust Guard only and also with the optional P/N 1234 Splash Guard Filter installed on the Dust Guard.

TEST EQUIPMENT:

1. Horiba VIA 510 Analyzer Unit
2. Matheson Model 8250 Modular Dyna-Blender, Serial No. 1234, (Air)
3. Matheson Model 8250 Modular Dyna-Blender, Serial No. 1234, (Methane)
4. Thermotron Model T-36-D, S/N 1234 Dust Chamber
5. MIE Dataram Model DR-2000 Dust Monitor
6. Metter Toledo Model AG245 Balance
7. Escort ELF Pump

Test Conditions	Actual Applied Test Gas 1.5%			Actual Applied Test Gas 2.1%		
Sensor No. 1	Warn	Max	Horiba reading	Trip	Max	Horiba reading
Pre-test Fresh Air	0.0	0.0	0.00	--------	0.0	0.00
Pre-Test CH_4	1.0	1.51	1.51	2.0	2.1	2.08
Post test Fresh Air	0.0	0.0	0.00	-------	0.0	0.00
Post Test CH_4	1.0	1.5	1.51	2.0	2.1	2.09
Sensor No. 2	Warn	Max	Horiba reading	Trip	Max	Horiba reading
Pre-test Fresh Air	0.0	0.0	0.00	-------	0.0	0.00
Pre-Test CH4	1.0	1.5	1.50	2.0	2.2	2.00
Post-Test Fresh Air	0.0	0.0	0.00	-------	0.0	0.00
Post-Test CH4	1.0	1.5	1.51	2.0	2.3	2.01
Sensor No. 3	Warn	Max	Horiba reading	Trip	Max	Horiba reading
Pre-test Fresh Air	0.0	0.0	0.00	-------	0.0	0.00
Pre-Test CH4	1.0	1.5	1.51	2.0	2.1	2.08
Post-Test Fresh Air	0.0	0.0	0.00	-------	0.0	0.00
Post-Test CH4	1.0	1.5	1.51	2.0	2.1	2.09
Sensor No. 4	Warn	Max	Horiba reading	Trip	Max	Horiba reading
Pre-Test Fresh Air	0.0	0.0	0.00	------	0.0	0.00
Pre-Test CH4	1.0	1.5	1.51	2.0	2.1	2.08
Post-Test Fresh	0.0	0.0	0.00	----------	0.0	0.00
Post Test CH4	1.0	1.5	1.50	2.0	2.1	2.08

Enclosure B

Example Test Sheets

Company: ABC Corporation							
Date: 6 June 2014				STP No. 2248			
Test Sheet No 1 of 3				Investigator John Smith			
Test Results:		Pass	x		Fail		

Gas readings above are the Horiba Gas Analyzer reading

TEST COMMENTS: Gas Concentrations were mixed with the Dyna-Blenders and applied to the sensor before and after the test via the ABC P/N 1234-1, Rev. A, calibration cup at a flow rate of 0.5 LPM. System was calibrated before the test with the ABC Purge Calibrator kit. Sensors Nos. 1 and 4 had the dust guard only and Sensors Nos. 2 and 3 had the complete splash guard filter assy. (Ref. Drawing No. 1001). At 1.0% the display backlight flashes amber with the Warning indication. At 2% the display backlight flashes red with the Alarm indication and relays open.

Ambient temperature: 23°C

DUST/METHANE MONITORS READINGS DURING THE TEST

TIME hrs:mins	DUST MONITOR	Sensor No. 1 Reading	Sensor No. 2 Reading	Sensor No. 3 Reading	Sensor No. 4 Reading
Start (fresh air)	000.0 µg/m³	0.0	0.0	0.0	0.0
Start (dust concentration)	390.0 mg/m³	0.0	0.0	0.0	0.0
00:15	230.4 mg/m³	0.0	0.0	0.0	0.0
00:30	150.1 mg/m³	0.0	0.0	0.0	0.0
00:45	99.0 mg/m³	0.0	0.0	0.0	0.0
1:00	86.5 mg/m³	0.0	0.0	0.0	0.0
1:15	63.5 mg/m³	0.0	0.0	0.0	0.0
1:30	55.9 mg/m³	0.0	0.0	0.0	0.0
1:45	47.0 mg/m³	0.0	0.0	0.0	0.0
2:00	39.2 mg/m³	0.0	0.0	0.0	0.0
2:15	33.3 mg/m³	0.0	0.0	0.0	0.0
2:40	28.99 mg/m³	0.0	0.0	0.0	0.0
2:45	24.35 mg/m³	0.0	0.0	0.0	0.0
*3:00	285.9 mg/m³	0.0	0.0	0.0	0.0
3:15	158.9 mg/m³	0.0	0.0	0.0	0.0
3:30	98.8 mg/m³	0.0	0.0	0.0	0.0
3:45	73.9 mg/m³	0.0	0.0	0.0	0.0
4:00	54.9 mg/m³	0.0	0.0	0.0	0.0

***dust circulated in chamber**

TWA of dust during the test: 93.5 mg/m³

TEST CONCLUSION: The ABC Methane Monitoring System meets the requirements of 30 CFR 27.40.

Enclosure B

Example Test Sheets

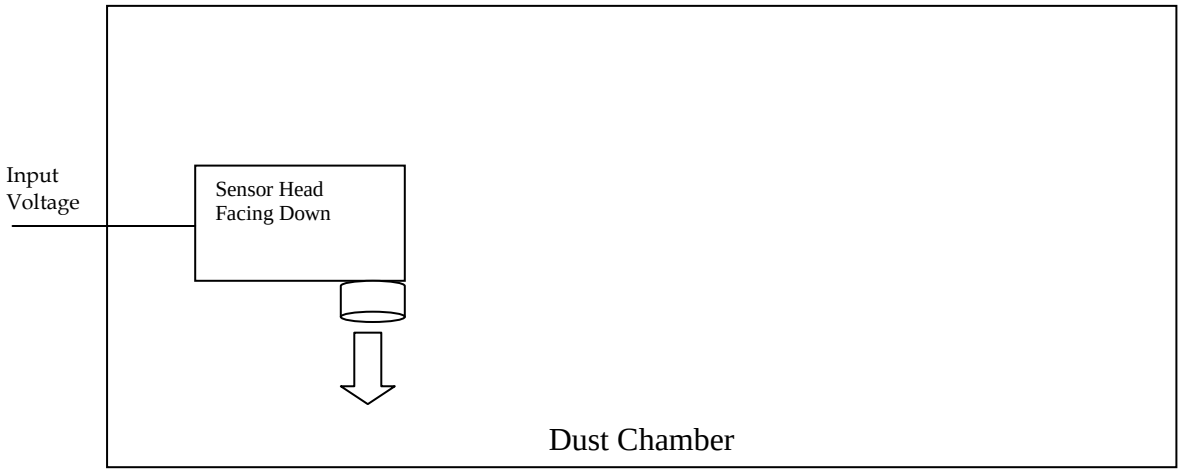
Company: ABC Corporation							
Date: 6 June 2014 STP No. 2248							
Test Sheet No 1 of 3 Investigator John Smith							
Test Results:		Pass	x		Fail		

Subject: Methane Monitor Dust Resistance Test

Model: ABC Methane Monitoring System

Test Circuit:

Sensor P/N: 1 IR sensor



Notes: The sensor subject to testing is defined in Drawing No. 1002, and included the optional splash guard.

Filter Cartridge Weights:

Pre-Test	Post-Test
12.0054g	12.0055g

Elapsed Time

Applied Gas	1.4% -1.6%	2.0% - 2.2%
Pre	1:30 minutes	1:30 minutes
Post	2 minutes	2 minutes

Humidity

Pre-Test	Post-Test
52% RH	51% RH