

Title/Subject: Standard Test Procedure – Diesel Power Package Explosion Tests		
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1.0 PURPOSE

This Standard Test Procedure (STP) is to be used by Mechanical & Engineering Safety Division (M&ESD) investigators to evaluate the explosion-proof and flame arresting capabilities of a diesel power package.

2.0 SCOPE

This procedure applies to explosion tests conducted by the Mechanical & Engineering Safety Division on diesel power package components to determine compliance with the requirements of 30 CFR 7.100: "Explosion Tests".

3.0 REFERENCES

- 3.1 30 CFR Part 7, Subpart F, "Diesel Power Packages Intended for Use in Areas of Underground Coal Mines Where Permissible Electric Equipment is Required"
- 3.2 30 CFR Part 36, Subpart C, "Approval Requirements for Permissible Mobile Diesel-Powered Transportation Equipment – Test Requirements"

4.0 DEFINITIONS

- 4.1 **Diesel Power Package** – A diesel engine with an intake system, exhaust system, and a safety shutdown system installed.
- 4.2 **Dry Exhaust Conditioner** – An exhaust conditioner that cools the exhaust gas without direct contact with water.
- 4.3 **Exhaust System** – A system connected to the outlet of the diesel engine which includes, but is not limited to, the exhaust manifold, the exhaust pipe, the exhaust conditioner, the exhaust flame arrester, and any adapters between the exhaust manifold and exhaust flame arrester.
- 4.4 **Fastening** – A bolt, screw, or stud used to secure adjoining parts to prevent the escape of flame from the diesel power package.

- 4.5 **Flame Arrester** – A device so constructed that flame or sparks from the diesel engine cannot propagate an explosion of a flammable mixture through it.
 - 4.6 **Grade** – The slope of an incline expressed as a percent.
 - 4.7 **Intake System** – A system connected to the inlet of the diesel engine which includes, but is not limited to, the intake manifold, the intake flame arrester, the emergency intake air shutoff device, the air cleaner, and all piping and adapters between the intake manifold and air cleaner.
 - 4.8 **Wet Exhaust Conditioner** – An exhaust conditioner that cools the exhaust gas through direct contact with water, commonly called a water scrubber.
- 5.0 TEST EQUIPMENT
- 5.1 Explosion Test Chamber which is large enough to contain the complete diesel power package.
 - 5.2 Auxiliary drive mechanism for motoring the engine.
 - 5.3 Methane analyzer for measuring/monitoring the percent of methane in the engine's intake air.
 - 5.4 Pressure measuring devices/sensors.
 - 5.5 Temperature measuring devices/thermocouples.
 - 5.6 Electric spark ignition source.
- 6.0 PROCEDURE
- 6.1 Prepare to test the diesel power package as follows:
 - 6.1.1 Perform a detailed check of parts against the drawings and specifications submitted under 30 CFR Part 7.97 to determine that the parts and drawings agree.
 - 6.1.2 Remove all parts that do not contribute to the operation or ensure the explosion-proof integrity of the diesel power package such as

the air cleaner and exhaust gas dilution system.

- 6.1.3 Fill coolant system fluid and engine oil to the engine manufacturer's recommended levels.
 - 6.1.4 Interrupt fuel supply to the injector pump.
 - 6.1.5 Establish a preliminary low water level for systems using a wet exhaust conditioner as a flame arrester.
- 6.2 Perform static and dynamic tests of the intake system as follows:
- 6.2.1 Install the diesel power package in an explosion test chamber which is large enough to contain the complete diesel power package. The chamber must be sufficiently darkened and provide viewing capabilities of the flame arresting paths to allow observation during testing of any discharge of flame or ignition of the flammable mixture surrounding the diesel power package. Couple the diesel power package to an auxiliary drive mechanism. Attach a pressure measuring device, a temperature measuring device, and an ignition source to the intake system. The pressure measuring device shall be capable of indicating the peak pressure accurate to +/- 1 pound-per-square inch gauge (psig) at 100 psig static pressure and shall have a frequency response of 40 Hertz or greater. The ignition source shall be an electric spark with a minimum energy of 100 millijoules. The ignition source shall be located immediately adjacent to the intake manifold and the pressure and temperature devices shall be located immediately adjacent to the flame arrester.
 - 6.2.2 For systems using the wet exhaust conditioner as an exhaust flame arrester, fill the exhaust conditioner to the specified high or normal operating water level.
 - 6.2.3 Fill the test chamber with a mixture of natural gas and air or methane and air. If natural gas is used, the content of combustible hydrocarbons shall total at least 98.0 percent, by volume, with the remainder being inert. At least 80.0 percent, by volume, of the gas shall be methane. For all tests, the methane or natural gas concentration shall be 8.5 +/- 1.8 percent, by volume, and the

oxygen concentration shall be no less than 18 percent, by volume.

- 6.2.4 Using the auxiliary drive mechanism, motor the engine to fill the intake and exhaust systems with the flammable mixture. The intake system, exhaust system, and test chamber gas concentration shall not differ by more than +/- 0.3 percent, by volume, at the time of ignition.
- 6.2.5 For static tests, stop the engine, actuate the ignition source, and observe the peak pressure. The peak pressure shall not exceed 110 psig. If the peak pressure exceeds 110 psig, construction changes shall be made that result in a reduction of pressure to 110 psig or less, or the system shall be tested in accordance with the static pressure test of Part 7.104 with the pressure parameter replaced with a static pressure of twice the highest value recorded.
- 6.2.6 If the peak pressure does not exceed 110 psig or if the system meets the static pressure test requirements of this section and there is no discharge of visible flames or glowing particles or ignition of the flammable mixture in the chamber, a total of 20 tests shall be conducted in accordance with the explosion test specified above.
- 6.2.7 For dynamic tests, follow the same procedures for static tests, except actuate the ignition source while motoring the engine. Forty dynamic tests shall be conducted at two speeds, twenty at 1800 +/- 200 RPM and twenty at 1000 +/- 200 RPM. Under some circumstances, during dynamic testing the flammable mixture may continue to burn within the diesel power package after ignition. This condition can be recognized by the presence of a rumbling noise and a rapid increase in temperature. This can cause the flame-arrester to reach temperatures which can ignite the surrounding flammable mixture. Ignition of the flammable mixture in the test chamber under these circumstances does not constitute failure of the flame arrester. However; if this condition is observed, the test operator should immediately stop the engine and allow components to cool to prevent damage to the components.

- 6.3 Perform static and dynamic tests of the exhaust system as follows:

- 6.3.1 Prepare the diesel power package for explosion tests according to Part 7.100(a)(2)(i) as follows:
 - 6.3.1.1 Install the ignition source immediately adjacent to the exhaust manifold.
 - 6.3.1.2 Install pressure measuring devices in each segment as follows: immediately adjacent to the exhaust conditioner inlet; in the exhaust conditioner; and immediately adjacent to the flame arrester, if applicable.
 - 6.3.1.3 Install a temperature device immediately adjacent to the exhaust conditioner inlet.
- 6.3.2 If the exhaust system is provided with a spaced-plate flame arrester in addition to an exhaust conditioner, explosion tests of the exhaust system shall be performed as described for the intake system in accordance with this section. Water shall not be present in a wet exhaust conditioner for the tests.
- 6.3.3 If the wet exhaust conditioner is used as the exhaust flame arrester, explosion testing of this type of system shall be performed as described for the intake system in accordance with this section with the following modifications:
 - 6.3.3.1 Twenty static tests, twenty dynamic tests at 1800 +/- 200 RPM, and twenty dynamic tests at 1000 +/- 200 RPM shall be conducted at 2 inches below the minimum allowable low water level. All entrances in the wet exhaust conditioner which do not form explosion-proof joints shall be opened. These openings may include lines which connect the reserve water supply to the wet exhaust conditioner, insert flanges, float flanges, and cover plates. These entrances are opened during this test to verify that they are not flame paths.
 - 6.3.3.2 Twenty static tests, twenty dynamic tests at 1800 +/- 200 RPM, and twenty dynamic tests at 1000 +/- 200 RPM shall be conducted at 2 inches below the minimum allowable low water level. All entrances in the wet exhaust conditioner (except the exhaust conditioner

outlet) which do not form explosion-proof joints shall be closed. These openings are closed to simulate normal operation.

6.3.3.3 Twenty static tests, twenty dynamic tests at 1800 +/- 200 RPM, and twenty dynamic tests at 1000 +/- 200 RPM shall be conducted at the specified high or normal operating water level. All entrances in the wet exhaust conditioner which do not form explosion-proof joints shall be opened.

6.3.3.4 Twenty static tests, twenty dynamic tests at 1800 +/- 200 RPM, and twenty dynamic tests at 1000 +/- 200 RPM shall be conducted at the specified high or normal operating water level. All entrances in the wet exhaust conditioner (except the exhaust conditioner outlet) which do not form explosion-proof joints shall be closed.

6.3.4 After successful completion of the explosion tests of the exhaust system, the minimum allowable low water level, for a wet exhaust conditioner used as the exhaust flame arrester, shall be determined by adding two inches to the lowest water level that passed the explosion tests.

6.3.5 A determination shall be made of the maximum grade on which the wet exhaust conditioner can be operated retaining the flame-arresting characteristics.

7.0 ACCEPTABLE PERFORMANCE

7.1 The explosion tests shall not result in any of the following:

7.1.1 Discharge of flame or glowing particles.

7.1.2 Visible discharge of gas through gasketed joints.

7.1.3 Ignition of the flammable mixture in the test chamber.

7.1.4 Rupture of any part that affects the explosion-proof integrity.

- 7.1.5 Clearances, in excess of those specified in this subpart, along accessible flame-arresting paths, following any necessary retightening of fastenings.
- 7.1.6 Pressure exceeding 110 psig, unless the intake system or exhaust system has withstood a static pressure of twice the highest value recorded in the explosion tests of this section following the static pressure test procedures of Part 7.104.
- 7.1.7 Permanent distortion of any planar surface of the diesel power package exceeding 0.04-inches/linear foot.
- 7.1.8 Permanent deformation exceeding 0.002-inch between the plates of spaced-plate flame arrester designs.