

Subpart F—Diesel Power Packages Intended for Use in Areas of Underground Coal Mines Where Permissible Electric Equipment is Required

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§ 7.95 Purpose and effective date.

Part 7, subpart A general provisions apply to subpart F. Subpart F establishes the specific requirements for MSHA approval of diesel power packages intended for use in approved equipment in areas of underground coal mines where electric equipment is required to be permissible. It is effective November 25, 1996.

§ 7.96 Definitions.

In addition to the definitions in subparts A and E of this part, the following definitions apply in this subpart.

Cylindrical joint. A joint comprised of two contiguous, concentric, cylindrical surfaces.

Diesel power package. A diesel engine with an intake system, exhaust system, and a safety shutdown system installed.

Dry exhaust conditioner. An exhaust conditioner that cools the exhaust gas without direct contact with water.

Exhaust conditioner. An enclosure, containing a cooling system, through which the exhaust gases pass.

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.

Fastening. A bolt, screw, or stud used to secure adjoining parts to prevent

the escape of flame from the diesel power package.

Flame arrester. A device so constructed that flame or sparks from the diesel engine cannot propagate an explosion of a flammable mixture through it.

Flame arresting path (explosion-proof joint). Two or more adjoining or adjacent surfaces between which the escape of flame is prevented.

Flammable mixture. A mixture of methane or natural gas with normal air, that will propagate flame or explode when ignited.

Grade. The slope of an incline expressed as a percent.

High idle speed. The maximum no load speed specified by the engine manufacturer.

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.

Plane joint. A joint comprised of two adjoining surfaces in parallel planes.

Safety shutdown system. A system which, in response to signals from various safety sensors, recognizes the existence of a potential hazardous condition and automatically shuts off the fuel supply to the engine.

Step (rabbet) joint. A joint comprised of two adjoining surfaces with a change or changes in direction between its inner and outer edges. A step joint may be composed of a cylindrical portion and a plane portion or of two or more plane portions.

Threaded joint. A joint consisting of a male- and female-threaded member, both of which are the same type and gauge.

Wet exhaust conditioner. An exhaust conditioner that cools the exhaust gas through direct contact with water, commonly called a water scrubber.

§ 7.97 Application requirements.

(a) An application for approval of a diesel power package shall contain sufficient information to document compliance with the technical requirements of this subpart and include:

drawings, specifications, and descriptions with dimensions (including tolerances) demonstrating compliance with the technical requirements of §7.98. The specifications and descriptions shall include the materials of construction and quantity. These shall include the following—

(1) A general arrangement drawing showing the diesel power package and the location and identification of the intake system, exhaust system, safety shutdown system sensors, flame arresters, exhaust conditioner, emergency intake air shutoff device, automatic fuel shutoff device and the engine.

(2) Diesel engine specifications including the MSHA approval number, the engine manufacturer, the engine model number, and the rated speed, rated horsepower, and fuel rate.

(3) A drawing(s) which includes the fan blade material specifications, the location and identification of all water-cooled components, coolant lines, radiator, surge tank, temperature sensors, and orifices; arrows indicating proper flow direction; the height relationship of water-cooled components to the surge tank; and the proper procedure for filling the cooling system.

(4) A drawing(s) showing the relative location, identification of components, and design of the safety shutdown system.

(5) Specific component identification, or specific information including detail drawings that identify the characteristics of the cooling system and safety shutdown system that ensures compliance with the technical requirements.

(6) Detail drawings of gaskets used to form flame-arresting paths.

(7) An assembly drawing showing the location and identification of all intake system components from the air cleaner to the engine head.

(8) An assembly drawing showing the location and identification of all exhaust system components from the engine head to the exhaust outlet.

(9) Detail drawings of those intake and exhaust system components identified in paragraphs (a)(7) and (a)(8) of this section that ensure compliance with the technical requirements. An exhaust conditioner assembly drawing shall be provided showing the location,

dimensions, and identification of all internal parts, exhaust inlet and outlet, sensors, and the exhaust gas path through the exhaust conditioner. If a wet exhaust conditioner is used, the exhaust conditioner assembly drawing must also show the location, dimensions, and identification of the fill port, drain port, low water check port; high or normal operating water level; minimum allowable low water level; and the maximum allowable grade that maintains explosion-proof operations.

(10) A power package checklist which shall consist of a list of specific features that must be checked and tests that must be performed to determine if a previously approved diesel power package is in approved condition. Test procedures shall be specified in sufficient detail to allow the evaluation to be made without reference to other documents. Illustrations shall be used to fully identify the approved configuration of the diesel power package.

(11) Information showing that the electrical systems and components meet the requirements of §7.98.

(12) A drawing list consisting of a complete list of those drawings and specifications which show the details of the construction and design of the diesel power package.

(b) Composite drawings specifying the required construction details may be submitted instead of the individual drawings in paragraph (a) of this section.

(c) All documents shall be titled, dated, numbered, and include the latest revision.

(d) When all testing has been completed, the following information shall be submitted and become part of the approval documentation:

(1) The settings of any adjustable devices used to meet the performance requirements of this subpart.

(2) The coolant temperature sensor setting and exhaust gas temperature sensor setting used to meet the performance requirements of this subpart.

(3) The minimum allowable low water level and the low water sensor setting used to meet the performance requirements of this subpart for systems using a wet exhaust conditioner as the exhaust flame arrester.

(4) The maximum grade on which the wet exhaust conditioner can be operated retaining the flame arresting characteristics.

(5) A finalized version of the power package checklist.

§ 7.98 Technical requirements.

(a) The diesel power package shall use a category A diesel engine approved under subpart E of this part with the following additional requirements:

(1) A hydraulic, pneumatic, or other mechanically actuated starting mechanism. Other means of starting shall be evaluated in accordance with the provisions of § 7.107.

(2) If an air compressor is provided, the intake air line shall be connected to the engine intake system between the air cleaner and the flame arrester. If the air compressor's inlet air line is not connected to the engine's intake system, it shall have an integral air filter.

(b) The temperature of any external surface of the diesel power package shall not exceed 302 °F (150 °C).

(1) Diesel power package designs using water jacketing to meet this requirement shall be tested in accordance with § 7.101.

(2) Diesel power packages using other techniques will be evaluated under the provisions of § 7.107.

(3) When using water-jacketed components, provisions shall be made for positive circulation of coolant, venting of the system to prevent the accumulation of air pockets, and effective activation of the safety shutdown system before the temperature of the coolant in the jackets exceeds the manufacturer's specifications or 212 °F (100 °C), whichever is lower.

(c) External rotating parts shall not be constructed of aluminum alloys containing more than 0.6 percent magnesium.

(d) If nonmetallic rotating parts are used, they shall be provided with a means to prevent an accumulation of static electricity. Static conducting materials shall have a total resistance of 1 megohm or less, measured with an applied potential of 500 volts or more. Static conducting materials having a total resistance greater than 1 megohm

will be evaluated under the provisions of § 7.107.

(e) All V-belts shall be static conducting and have a resistance not exceeding 6 megohms, when measured with a direct current potential of 500 volts or more.

(f) The engine crankcase breather shall not be connected to the air intake system of the engine. The discharge from the breather shall be directed away from hot surfaces of the engine and exhaust system.

(g) Electrical components on diesel power packages shall be certified or approved by MSHA under parts 7, 18, 20, and 27 of this chapter.

(h) Electrical systems on diesel power packages consisting of electrical components, interconnecting wiring, and mechanical and electrical protection shall meet the requirements of parts 7, 18, and 27 of this chapter, as applicable.

(i) The diesel power package shall be equipped with a safety shutdown system which will automatically shut off the fuel supply and stop the engine in response to signals from sensors indicating—

(1) The coolant temperature limit specified in paragraph (b) of this section;

(2) The exhaust gas temperature limit specified in paragraph (s)(4) of this section;

(3) The minimum allowable low water level, for a wet exhaust conditioner, as established by tests in § 7.100. Restarting of the engine shall be prevented until the water level in the wet exhaust conditioner has been replenished above the minimum allowable low water level; and

(4) The presence of other safety hazards such as high methane concentration, actuation of the fire suppression system, etc., if such sensors are included in the safety shutdown system.

(j) The safety shutdown system shall have the following features:

(1) A means to automatically disable the starting circuit and prevent engagement of the starting mechanism while the engine is running, or a starting mechanism constructed of non-sparking materials.

(2) If the design of the safety shutdown system requires that the lack of

engine oil pressure must be overridden to start the engine, the override shall not be capable of overriding any of the safety shutdown sensors specified in paragraph (i) of this section.

(k) The diesel power package shall be explosion-proof as determined by the tests set out in §7.100.

(l) Engine joints that directly or indirectly connect the combustion chamber to the surrounding atmosphere shall be explosion-proof in accordance with paragraphs (m) through (q) of this section and §7.100. This paragraph does not apply to the following:

- (1) Pistons to piston rings;
- (2) Pistons to cylinder walls;
- (3) Piston rings to cylinder walls;
- (4) Cylinder head to cylinder block;
- (5) Valve stem to valve guide; or
- (6) Injector body to cylinder head.

(m) Each segment of the intake system and exhaust system required to provide explosion-proof features shall be constructed of metal and designed to withstand a minimum internal pressure equal to four times the maximum pressure observed in that segment in tests under §7.100 or a pressure of 150 psig, whichever is less. Castings shall be free from blowholes.

(n) Welded joints forming the explosion-proof intake and exhaust systems shall be continuous and gas-tight. At a minimum, they shall be made in accordance with American Welding Society Standard D14.4-77 or meet the test requirements of §7.104 with the internal pressure equal to four times the maximum pressure observed in tests under §7.100 or a pressure of 150 psig, whichever is less.

(o) Flexible connections shall be permitted in segments of the intake and exhaust systems required to provide explosion-proof features, provided that failure of the connection activates the safety shutdown system before the explosion-proof characteristics are lost.

(p) Flame-arresting paths in the intake and exhaust systems shall be formed either by—

(1) Flanged metal to metal joints meeting the requirements of paragraph (q) of this section; or

(2) Metal flanges fitted with metal gaskets and meeting the following requirements:

(i) Flat surfaces between bolt holes that form any part of a flame-arresting path shall be planed to within a maximum deviation of one-half the maximum clearance specified in paragraph (q)(7) of this section. All metal surfaces forming a flame-arresting path shall be finished during the manufacturing process to not more than 250 micro-inches.

(ii) A means shall be provided to ensure that fastenings maintain the tightness of joints. The means provided shall not lose its effectiveness through repeated assembly and disassembly.

(iii) Fastenings shall be as uniform in size as practicable to preclude improper assembly.

(iv) Holes for fastenings shall not penetrate to the interior of an intake or exhaust system and shall be threaded to ensure that all specified bolts or screws will not bottom even if the washers are omitted.

(v) Fastenings used for joints of flame-arresting paths on intake or exhaust systems shall be used only for attaching parts that are essential in maintaining the explosion-proof integrity. They shall not be used for attaching brackets or other parts.

(vi) The minimum thickness of material for flanges shall be ½-inch, except that a final thickness of ¼-inch is allowed after machining rolled plate.

(vii) The maximum fastening spacing shall be 6 inches.

(viii) The minimum diameter of fastenings shall be ⅜-inch, except smaller diameter fastenings may be used if the joint first meets the requirements of the static pressure test in §7.104, and the explosion test in §7.100.

(ix) The minimum thread engagement of fastenings shall be equal to or greater than the nominal diameter of the fastenings specified, or the intake or exhaust system must meet the test requirements of the explosion tests in §7.100 and the static pressure test in §7.104.

(x) The minimum contact surface of gaskets forming flame-arresting paths shall be ⅜-inch, and the thickness of the gaskets shall be no greater than ¼-inch. The minimum distance from the interior edge of a gasket to the edge of a fastening hole shall be ⅜-inch. The gaskets shall be positively

positioned, and a means shall be provided to preclude improper installation. When the joint is completely assembled, it shall be impossible to insert a 0.0015-inch thickness gauge to a depth exceeding 1/8-inch between the gasket and mating flanges. Other gasket designs shall be evaluated in accordance with § 7.107.

(q) The following construction requirements shall apply to flame-arresting paths formed without gaskets:

(1) Flat surfaces between fastening holes that form any part of a flame-arresting path shall be planed to within a maximum deviation of one-half the maximum clearance specified in paragraph (q)(7) of this section. All metal surfaces forming a flame-arresting path shall be finished during the manufacturing process to not more than 250 microinches. A thin film of nonhardening preparation to inhibit rusting may be applied to these finished metal surfaces, as long as the final surface can be readily wiped free of any foreign materials.

(2) A means shall be provided to ensure that fastenings maintain the tightness of joints. The means provided shall not lose its effectiveness through repeated assembly and disassembly.

(3) Fastenings shall be as uniform in size as practicable to preclude improper assembly.

(4) Holes for fastenings shall not penetrate to the interior of an intake or exhaust system and shall be threaded to ensure that all specified bolts or screws will not bottom even if the washers are omitted.

(5) Fastenings used for joints of flame-arresting paths on intake or exhaust systems shall be used only for attaching parts that are essential in maintaining the explosion-proof integrity. They shall not be used for attaching brackets or other parts.

(6) The flame-arresting path of threaded joints shall conform to the requirements of paragraph (q)(7) of this section.

(7) Intake and exhaust systems joints shall meet the specifications set out in Table F-1.

TABLE F-1—DIMENSIONAL REQUIREMENTS FOR EXPLOSION-PROOF INTAKE AND EXHAUST SYSTEM JOINTS

Minimum thickness of material for flanges	1/2" ¹
Minimum width of joint; all in one plane	1"
Maximum clearance; joint all in one plane	0.004"
Minimum width of joint, portions of which are different planes; cylinders or equivalent	3/4" ²
Maximum clearances; joint in two or more planes, cylinders or equivalent:	
Portion perpendicular to plane	0.008" ³
Plane portion	0.006"
Maximum fastening ⁴ spacing; joints all in one plane ⁵	6"
Maximum fastening spacing; joints, portions of which are in different planes	8"
Minimum diameter of fastening (without regard to type of joint) ⁶	3/8"
Minimum thread engagement of fastening ⁷	3/8"
Maximum diametrical clearance between fastening body and unthreaded holes through which it passes ^{8 9 10}	1/16"
Minimum distance from interior of the intake or exhaust system to the edge of a fastening hole: ¹¹	
Joint-minimum width 1"	7/16" ^{8 12}
Shafts centered by ball or roller bearings:	
Minimum length of flame-arresting path	1"
Maximum diametrical clearance	0.030"
Other cylindrical joints:	
Minimum length of flame-arresting path	1"
Maximum diametrical clearance	0.010"

¹ 1/16-inch less is allowable for machining rolled plate.

² If only two planes are involved, neither portion of a joint shall be less than 1/8-inch wide, unless the wider portion conforms to the same requirements as those for a joint that is all in one plane. If more than two planes are involved (as in labyrinths or tongue-in-groove joints), the combined lengths of those portions having prescribed clearances are considered.

³ The allowable diametrical clearance is 0.008-inch when the portion perpendicular to the plane portion is 1/4-inch or greater in length. If the perpendicular portion is more than 1/8-inch but less than 1/4-inch wide, the diametrical clearance shall not exceed 0.006-inch.

⁴ Studs, when provided, shall bottom in blind holes, be completely welded in place, or have the bottom of the hole closed with a plug secured by weld or braze. Fastenings shall be provided at all corners.

⁵The requirements as to diametrical clearance around the fastening and minimum distance from the fastening hole to the inside of the intake or exhaust system apply to steel dowel pins. In addition, when such pins are used, the spacing between centers of the fastenings on either side of the pin shall not exceed 5 inches.

⁶Fastening diameters smaller than specified may be used if the joint or assembly meets the test requirements of § 7.104.

⁷Minimum thread engagement shall be equal to or greater than the nominal diameter of the fastening specified, or the intake or exhaust system must meet the test requirements of § 7.104.

⁸The requirements as to diametrical clearance around the fastening and minimum distance from the fastening hole to the inside of the intake or exhaust system apply to steel dowel pins. In addition, when such pins are used, the spacing between centers of the fastenings on either side of the pin shall not exceed 5 inches.

⁹This maximum clearance only applies when the fastening is located within the flame-arresting path.

¹⁰Threaded holes for fastenings shall be machined to remove burrs or projections that affect planarity of a surface forming a flame-arresting path.

¹¹Edge of the fastening hole shall include any edge of any machining done to the fastening hole, such as chamfering.

¹²If the diametrical clearance for fastenings does not exceed 1/32-inch, then the minimum distance shall be 1/4-inch.

(r) *Intake system.* (1) The intake system shall include a device between the air cleaner and intake flame arrester, operable from the equipment operator's compartment, to shut off the air supply to the engine for emergency purposes. Upon activation, the device must operate immediately and the engine shall stop within 15 seconds.

(2) The intake system shall include a flame arrester that will prevent an explosion within the system from propagating to a surrounding flammable mixture when tested in accordance with the explosion tests in § 7.100. The flame arrester shall be located between the air cleaner and the intake manifold and shall be attached so that it can be removed for inspection or cleaning. The flame arrester shall be constructed of corrosion-resistant metal and meet the following requirements:

(i) Two intake flame arrester designs, the spaced-plate type and the crimped ribbon type, will be tested in accordance with the requirements of § 7.100. Variations to these designs or other intake flame arrester designs will be evaluated under the provisions of § 7.107.

(ii) In flame arresters of the spaced-plate type, the thickness of the plates shall be at least 0.125-inch; spacing between the plates shall not exceed 0.018-inch; and the flame-arresting path formed by the plates shall be at least 1 inch wide. The unsupported length of the plates shall be short enough that permanent deformation resulting from explosion tests shall not exceed 0.002-inch. The plates and flame arrester housing shall be an integral unit which cannot be disassembled.

(iii) In flame arresters of the crimped ribbon type, the dimensions of the core openings shall be such that a plug gauge 0.018-inch in diameter shall not pass through, and the flame-arresting

path core thickness shall be at least 1 inch. The core and flame arrester housing shall be an integral unit which cannot be disassembled.

(3) The intake system shall be designed so that improper installation of the flame arrester is impossible.

(4) The intake system shall include an air cleaner service indicator. The air cleaner shall be installed so that only filtered air will enter the flame arrester. The air cleaner shall be sized and the service indicator set in accordance with the engine manufacturer's recommendations. Unless the service indicator is explosion-proof, it shall be located between the air cleaner and flame arrester, and the service indicator setting shall be reduced to account for the additional restriction imposed by the flame arrester.

(5) The intake system shall include a connection between the intake flame arrester and the engine head for temporary attachment of a device to indicate the total vacuum in the system. This opening shall be closed by a plug or other suitable device that is sealed or locked in place except when in use.

(s) *Exhaust system.* (1) The exhaust system shall include a flame arrester that will prevent propagation of flame or discharge of glowing particles to a surrounding flammable mixture. The flame arrester shall be constructed of corrosion-resistant metal.

(i) If a mechanical flame arrester is used, it shall be positioned so that only cooled exhaust gas at a maximum temperature of 302 °F (150 °C) will be discharged through it.

(ii) If a mechanical flame arrester of the spaced-plate type is used, it must meet the requirements of paragraph (r)(2)(ii) of this section and the test requirements of § 7.100. Variations to the spaced-plate flame arrester design and

other mechanical flame arrester designs shall be evaluated under the provisions of § 7.107. The flame arrester shall be designed and attached so that it can be removed for inspection and cleaning.

(2) The exhaust system shall allow a wet exhaust conditioner to be used as the exhaust flame arrester provided that the explosion tests of § 7.100 demonstrate that the wet exhaust conditioner will arrest flame. When used as a flame arrester, the wet exhaust conditioner shall be equipped with a sensor to automatically activate the safety shutdown system at or above the minimum allowable low water level established by § 7.100. Restarting of the engine shall be prevented until the water supply in the wet exhaust conditioner has been replenished above the minimum allowable low water level. All parts of the wet exhaust conditioner and associated components that come in contact with contaminated exhaust conditioner water shall be constructed of corrosion-resistant material. The wet exhaust conditioner shall include a means for verifying that the safety shutdown system operates at the proper water level. A means shall be provided for draining and cleaning the wet exhaust conditioner. The final exhaust gas temperature at discharge from the wet exhaust conditioner shall not exceed 170 °F (76 °C) under test conditions specified in § 7.102. A sensor shall be provided that activates the safety shutdown system before the exhaust gas temperature at discharge from the wet exhaust conditioner exceeds 185 °F (85 °C) under test conditions specified in § 7.103(a)(4).

(3) The exhaust system shall be designed so that improper installation of the flame arrester is impossible.

(4) The exhaust system shall provide a means to cool the exhaust gas and prevent discharge of glowing particles.

(i) When a wet exhaust conditioner is used to cool the exhaust gas and prevent the discharge of glowing particles, the temperature of the exhaust gas at the discharge from the exhaust conditioner shall not exceed 170 °F (76 °C) when tested in accordance with the exhaust gas cooling efficiency test in § 7.102. A sensor shall be provided that activates the safety shutdown system

before the exhaust gas temperature at discharge from the wet exhaust conditioner exceeds 185 °F (85 °C) when tested in accordance with the safety system controls test in § 7.103. All parts of the wet exhaust conditioner and associated components that come in contact with contaminated exhaust conditioner water shall be constructed of corrosion-resistant material.

(ii) When a dry exhaust conditioner is used to cool the exhaust gas, the temperature of the exhaust gas at discharge from the diesel power package shall not exceed 302 °F (150 °C) when tested in accordance with the exhaust gas cooling efficiency test of § 7.102. A sensor shall be provided that activates the safety shutdown system before the exhaust gas exceeds 302 °F (150 °C) when tested in accordance with the safety system control test in § 7.103. A means shall be provided to prevent the discharge of glowing particles, and it shall be evaluated under the provisions of § 7.107.

(5) Other means for cooling the exhaust gas and preventing the propagation of flame or discharge of glowing particles shall be evaluated under the provisions of § 7.107.

(6) There shall be a connection in the exhaust system for temporary attachment of a device to indicate the total backpressure in the system and collection of exhaust gas samples. This opening shall be closed by a plug or other suitable device that is sealed or locked in place except when in use.

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§ 7.99 Critical characteristics.

The following critical characteristics shall be inspected or tested on each diesel power package to which an approval marking is affixed:

(a) Finish, width, planarity, and clearances of surfaces that form any part of a flame-arresting path.

(b) Thickness of walls and flanges that are essential in maintaining the explosion-proof integrity of the diesel power package.

(c) Size, spacing, and tightness of fastenings.

(d) The means provided to maintain tightness of fastenings.

(e) Length of thread engagement on fastenings and threaded parts that ensure the explosion-proof integrity of the diesel power package.

(f) Diesel engine approval marking.

(g) Fuel rate setting to ensure that it is appropriate for the intended application, or a warning tag shall be affixed to the fuel system notifying the purchaser of the need to make proper adjustments.

(h) Material and dimensions of gaskets that are essential in maintaining the explosion-proof integrity of the diesel power package.

(i) Dimensions and assembly of flame arresters.

(j) Materials of construction to ensure that the intake system, exhaust system, cooling fans, and belts have been fabricated from the required material.

(k) Proper interconnection of the coolant system components and use of specified components.

(l) Proper interconnection of the safety shutdown system components and use of specified components.

(m) All plugs and covers to ensure that they are tightly installed.

(n) The inspections and tests described in the diesel power package checklist shall be performed and all requirements shall be met.

§ 7.100 Explosion tests.

(a) *Test procedures.* (1) Prepare to test the diesel power package as follows:

(i) Perform a detailed check of parts against the drawings and specifications submitted under § 7.97 to determine that the parts and drawings agree.

(ii) 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.

(iii) Fill coolant system fluid and engine oil to the engine manufacturer's recommended levels.

(iv) Interrupt fuel supply to the injector pump.

(v) Establish a preliminary low water level for systems using the wet exhaust conditioner as a flame arrester.

(2) Perform static and dynamic tests of the intake system as follows:

(i) 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.

(ii) 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.

(iii) 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.

(iv) 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.

(v) 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 § 7.104 with the pressure parameter replaced with a static pressure of twice the highest value recorded.

(vi) 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.

(vii) 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.

(3) Perform static and dynamic tests of the exhaust system as follows:

(i) Prepare the diesel power package for explosion tests according to § 7.100(a)(2)(i) as follows:

(A) Install the ignition source immediately adjacent to the exhaust manifold.

(B) 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.

(C) Install a temperature device immediately adjacent to the exhaust conditioner inlet.

(ii) 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.

(iii) 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:

(A) 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.

(B) 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.

(C) 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.

(D) 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.

(iv) 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

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inches to the lowest water level that passed the explosion tests.

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

(b) *Acceptable performance.* The explosion tests shall not result in any of the following—

(1) Discharge of flame or glowing particles.

(2) Visible discharge of gas through gasketed joints.

(3) Ignition of the flammable mixture in the test chamber.

(4) Rupture of any part that affects the explosion-proof integrity.

(5) Clearances, in excess of those specified in this subpart, along accessible flame-arresting paths, following any necessary retightening of fastenings.

(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 §7.104.

(7) Permanent distortion of any planar surface of the diesel power package exceeding 0.04-inches/linear foot.

(8) Permanent deformation exceeding 0.002-inch between the plates of spaced-plate flame arrester designs.

[61 FR 55518, Oct. 25, 1996; 62 FR 34641, June 27, 1997]

§7.101 Surface temperature tests.

The test for determination of exhaust gas cooling efficiency described in §7.102 may be done simultaneously with this test.

(a) *Test procedures.* (1) Prepare to test the diesel power package as follows:

(i) Perform a detailed check of parts against the drawings and specifications submitted to MSHA under compliance with §7.97 to determine that the parts and drawings agree.

(ii) Fill the coolant system with a mixture of equal parts of antifreeze and water, following the procedures specified in the application, §7.97(a)(3).

(iii) If a wet exhaust conditioner is used to cool the exhaust gas, fill the exhaust conditioner to the high or nor-

mal operating water level and have a reserve water supply available, if applicable.

(2) Tests shall be conducted as follows:

(i) The engine shall be set to the rated horsepower specified in §7.97(a)(2).

(ii) Install sufficient temperature measuring devices to determine the location of the highest coolant temperature. The temperature measuring devices shall be accurate to ± 4 °F (± 2 °C).

(iii) Operate the engine at rated horsepower and with 0.5 \pm 0.1 percent, by volume, of methane in the intake air mixture until all parts of the engine, exhaust coolant system, and other components reach their respective equilibrium temperatures. The liquid fuel temperature into the engine shall be maintained at 100 °F (38 °C) \pm 10 °F (6 °C) and the intake air temperature shall be maintained at 70 °F (21 °C) \pm 5 °F (3 °C).

(iv) Increase the coolant system temperatures until the highest coolant temperature is 205 °F to 212 °F (96 °C to 100 °C), or to the maximum temperature specified by the applicant, if lower.

(v) After all coolant system temperatures stabilize, operate the engine for 1 hour.

(vi) The ambient temperature shall be between 50 °F (10 °C) and 104 °F (40 °C) throughout the tests.

(b) *Acceptable performance.* The surface temperature of any external surface of the diesel power package shall not exceed 302 °F (150 °C) during the test.

§7.102 Exhaust gas cooling efficiency test.

(a) *Test procedures.* (1) Follow the procedures specified in §7.101(a).

(2) Install a temperature measuring device to measure the exhaust gas temperature at discharge from the exhaust conditioner. The temperature measuring device shall be accurate to ± 4 °F (± 2 °C).

(3) Determine the exhaust gas temperature at discharge from the exhaust conditioner before the exhaust gas is diluted with air.

(b) *Acceptable performance.* (1) The exhaust gas temperature at discharge

from a wet exhaust conditioner before the exhaust gas is diluted with air shall not exceed 170 °F (76 °C).

(2) The exhaust gas temperature at discharge from a dry exhaust conditioner before the gas is diluted with air shall not exceed 302 °F (150 °C).

§ 7.103 Safety system control test.

(a) *Test procedures.* (1) Prior to testing, perform the tasks specified in § 7.101(a)(1) and install sufficient temperature measuring devices to measure the highest coolant temperature and exhaust gas temperature at discharge from the exhaust conditioner. The temperature measuring devices shall be accurate to ± 4 °F (± 2 °C).

(2) Determine the effectiveness of the coolant system temperature shutdown sensors which will automatically activate the safety shutdown system and stop the engine before the coolant temperature in the cooling jackets exceeds manufacturer's specifications or 212 °F (100 °C), whichever is lower, by operating the engine and causing the coolant in the cooling jackets to exceed the specified temperature.

(3) For systems using a dry exhaust gas conditioner, determine the effectiveness of the temperature sensor in the exhaust gas stream which will automatically activate the safety shutdown system and stop the engine before the cooled exhaust gas temperature exceeds 302 °F (150 °C), by operating the engine and causing the cooled exhaust gas to exceed the specified temperature.

(4) For systems using a wet exhaust conditioner, determine the effectiveness of the temperature sensor in the exhaust gas stream which will automatically activate the safety shutdown system and stop the engine before the cooled exhaust gas temperature exceeds 185 °F (85 °C), with the engine operating at a high idle speed condition. Temporarily disable the reserve water supply, if applicable, and any safety shutdown system control that might interfere with the evaluation of the operation of the exhaust gas temperature sensor. Prior to testing, set the water level in the wet exhaust conditioner to a level just above the minimum allowable low water level. Run the engine until the exhaust gas temperature sen-

sor activates the safety shutdown system and stops the engine.

(5) For systems using a wet exhaust conditioner as an exhaust flame arrester, determine the effectiveness of the low water sensor which will automatically activate the safety shutdown system and stop the engine at or above the minimum allowable low water level established from results of the explosion tests in § 7.100 with the engine operating at a high idle speed condition. Temporarily disable the reserve water supply, if applicable, and any safety shutdown system control that might interfere with the evaluation of the operation of the low water sensor. Prior to testing, set the water level in the wet exhaust conditioner to a level just above the minimum allowable low water level. Run the engine until the low water sensor activates the safety shutdown system and stops the engine. Measure the low water level. Attempt to restart the engine.

(6) Determine the effectiveness of the device in the intake system which is designed to shut off the air supply and stop the engine for emergency purposes with the engine operating at both a high idle speed condition and a low idle speed condition. Run the engine and activate the emergency intake air shutoff device.

(7) Determine the total air inlet restriction of the complete intake system, including the air cleaner, as measured between the intake flame arrester and the engine head with the engine operating at maximum air flow.

(8) Determine the total exhaust backpressure with the engine operating at rated horsepower as specified in § 7.103(a)(7). If a wet exhaust conditioner is used, it must be filled to the high or normal operating water level during this test.

(9) The starting mechanism shall be tested to ensure that engagement is not possible while the engine is running. Operate the engine and attempt to engage the starting mechanism.

(10) Where the lack of engine oil pressure must be overridden in order to start the engine, test the override to ensure that it does not override any of the safety shutdown sensors specified in § 7.98(i). After each safety shutdown sensor test specified in paragraphs

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(a)(2) through (a)(5) of this section, immediately override the engine oil pressure and attempt to restart the engine.

(b) *Acceptable performance.* Tests of the safety system controls shall result in the following:

(1) The coolant system temperature shutdown sensor shall automatically activate the safety shutdown system and stop the engine before the water temperature in the cooling jackets exceeds manufacturer's specifications or 212 °F (100 °C), whichever is lower.

(2) The temperature sensor in the exhaust gas stream of a system using a dry exhaust conditioner shall automatically activate the safety shutdown system and stop the engine before the cooled exhaust gas exceeds 302 °F (150 °C).

(3) The temperature sensor in the exhaust gas stream of a system using a wet exhaust conditioner shall automatically activate the safety shutdown system and stop the engine before the cooled exhaust gas exceeds 185 °F (85 °C).

(4) The low water sensor for systems using a wet exhaust conditioner shall automatically activate the safety shutdown system and stop the engine at or above the minimum allowable low water level and prevent restarting of the engine.

(5) The emergency intake air shutoff device shall operate immediately when activated and stop the engine within 15 seconds.

(6) The total intake air inlet restriction and the total exhaust backpressure shall not exceed the engine manufacturer's specifications.

(7) It shall not be possible to engage the starting mechanism while the engine is running, unless the starting mechanism is constructed of non-sparking material.

(8) The engine oil pressure override shall not override any of the shutdown sensors.

§ 7.104 Internal static pressure test.

(a) *Test procedures.* (1) Isolate and seal each segment of the intake system or exhaust system to allow pressurization.

(2) Internally pressurize each segment of the intake system or exhaust system to four times the maximum

pressure observed in each segment during the tests of § 7.100, or 150 psig \pm 5 psig, whichever is less. Maintain the pressure for a minimum of 10 seconds.

(3) Following the pressure hold, the pressure shall be removed and the pressurizing agent removed from the intake system or exhaust system.

(b) *Acceptable performance.* (1) The intake system or exhaust system, during pressurization, shall not exhibit—

(i) Leakage through welds and gasketed joints; or

(ii) Leakage other than along joints meeting the explosion-proof requirements of § 7.98(q).

(2) Following removal of the pressurizing agent, the intake system or exhaust system shall not exhibit any—

(i) Changes in fastening torque;

(ii) Visible cracks in welds;

(iii) Permanent deformation affecting the length or gap of any flame-arresting paths;

(iv) Stretched or bent fastenings;

(v) Damaged threads of parts affecting the explosion-proof integrity of the intake system or exhaust system; or

(vi) Permanent distortion of any planar surface of the diesel power package exceeding 0.04-inches/linear foot.

§ 7.105 Approval marking.

Each approved diesel power package shall be identified by a legible and permanent approval plate inscribed with the assigned MSHA approval number and securely attached to the diesel power package in a manner that does not impair any explosion-proof characteristics. The grade limitation of a wet exhaust conditioner used as an exhaust flame arrester shall be included on the approval marking.

§ 7.106 Post-approval product audit.

Upon request by MSHA, but not more than once a year except for cause, the approval-holder shall make an approved diesel power package available for audit at no cost to MSHA.

§ 7.107 New technology.

MSHA may approve a diesel power package that incorporates technology for which the requirements of this subpart are not applicable if MSHA determines that the diesel power package is

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as safe as those which meet the requirements of this subpart.

§ 7.108 Power package checklist.

Each diesel power package bearing an MSHA approval plate shall be accompanied by a power package checklist. The power package checklist shall consist of a list of specific features that must be checked and tests that must be performed to determine if a previously approved diesel power package is in approved condition. Test procedures shall be specified in sufficient detail to allow evaluation to be made without reference to other documents. Illustrations shall be used to fully identify the approved configuration of the diesel power package.