that it may be cleaned readily. The flame arrester shall be of rugged construc-
tion to withstand the effects of repeated explosions within the intake 
system, and the material of construction shall resist deterioration in serv-
vice. It shall be so mounted in the equip-
ment assembly that it is protected from accidental external damage.

(2) The parts of any flame arrester shall be positively positioned to 
-produce a flame path that will arrest the propagation of an explosion and 
shall be so designed that improper as-
sembly is impossible. In flame arrest-
ers of the spaced-plate type, the thick-
ness of the plates shall be at least 0.125 
inch; spacing between the plates shall 
not exceed 0.018 inch; and the plates 
forming the flame path shall be at 
least 1 inch wide. The unsupported 
length of the plates shall be short 

enough that deformation during the exp-
losion tests shall not exceed 0.002 
inch. Corrosion-resistant metal shall 
be used to construct flame arresters.

(c) Air shutoff valve. The intake sys-

tem shall include a valve, operable 
from the operator’s compartment, to 
shut off the air supply to the engine. 
This valve shall be constructed to per-
mit its operation only after the fuel 
supply to the engine is shut off. In re-
verse operation the valve must open 
fully before fuel can be supplied to the 
engine.

(d) Air cleaner. An air cleaner shall be 

included in the engine intake system and so arranged that only clean air will 
enter the flame arrester. The resistance to airflow shall not increase rap-

idly in dusty atmospheres. Filters of 

the self-cleansing (oil-bath) type will 
be considered satisfactory for this ap-
lication. Provision, satisfactory to 

MSHA, shall be made to prevent over-
filling the oil-bath air cleaner.

(e) Vacuum-gage connection. A connection shall be provided in the intake 
system for temporary attachment of a 
vacuum gage to indicate the pressure 
drop under flow conditions. This open-
ing shall be closed by a plug or other 
suitable device that is sealed or locked 
in place except when a gage is at-
tached.

§ 36.24 Engine joints.

(a) Cylinder head. The joint between 

the cylinder head and block of the en-
gine shall be fitted with a metal or 
metal-clad gasket satisfactory to 

MSHA held securely in position by 
through bolts or other suitable means 
to prevent a change in alignment. This 
joint shall provide an adequate flame 
barrier with the gasket in place.

(b) Valve guides. Valve guides shall be 

long enough to form an adequate flame 
barrier along the valve stem.

(c) Gaskets. All metal or metal-clad 
gaskets shall maintain their tightness 
during repeated explosions within the 
engine and its intake and exhaust sys-
tems to prevent the propagation of 
flame.

§ 36.25 Engine exhaust system.

(a) Construction. The exhaust system 
of the engine shall be designed to with-
stand an internal pressure equal to 4 
times the maximum pressure observed 
in explosion tests, which are described 
in § 36.46, or a pressure of 125 pounds per 
square inch, whichever is the lesser. 
The system shall withstand repeated 
internal explosions without permanent 
deformation or deterioration.

(b) Exhaust flame arrester. (1) The ex-
haut system of the engine shall be 
provided with a flame arrester to pre-
vent propagation of flame or discharge 
of heated particles to a surrounding 
flammable mixture. The flame arrester 
shall be so positioned that only cooled 
exhaust gas will discharge through it 
and shall be so designed and attached 
that it can be removed for inspecting, 
cleaning, or repairing. Its construction 
shall be such that it can be cleaned 
readily. The flame arrester shall be of 
rugged construction to withstand the 
effects of repeated explosions within 
the exhaust system, and the material 
of construction shall resist deteriora-
tion in service. It shall be so mounted 
in the equipment assembly that it is 
protected from accidental external 
damage.

(2) A spaced-plate flame arrester for 
the exhaust system shall meet the 
same requirements as flame arresters 
for the intake system (see §36.23(b)(2)).

(3) In lieu of a space-place flame ar-
rester, an exhaust-gas cooling box or 
conditioner may be used as the exhaust
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flame arrester provided that explosion tests demonstrate that the cooling box will arrest flame. When used as a flame arrester the cooling box shall be equipped with a device to shut off automatically the fuel supply to the engine at a safe minimum water level. A cooling box used as a flame arrester shall withstand repeated explosion tests without permanent deformation. It shall be constructed of material, satisfactory to MSHA, that will resist deterioration in service.

(c) Exhaust cooling system. (1) A cooling system shall be provided for the engine exhaust gas. The heat-dissipation capacity shall be capable of reducing the temperature of the undiluted exhaust gas to less than 170 °F. at the point of discharge from the cooling system under any condition of engine operation acceptable to MSHA. A device shall be provided that will automatically shut off the fuel supply to the engine immediately if the temperature of the exhaust gas exceeds 185 °F. at the point of discharge from the cooling system. Provision shall be made, acceptable to MSHA, to prevent restarting the engine after the fuel supply has been shut off automatically until the water supply in the cooling box has been replenished. When the cooling box is used as a flame arrester, one safety device may be accepted provided it controls a safe minimum water level in the cooling box and also prevents the final exhaust temperature from exceeding 185 °F.

(2) Cooling shall be obtained by passing the exhaust gas through water or a dilute aqueous chemical solution held in a cooling box or conditioner, or by a spray of water or a dilute aqueous chemical solution that will enter the exhaust system near the outlet of the exhaust manifold, or a combination of the two methods. When a spray is used it shall be provided with a filtering device to protect the nozzle from clogging. Provisions shall be made for draining and cleaning all parts of the exhaust cooling system. Openings for draining and cleaning shall be closed and sealed or locked by a method satisfactory to MSHA.

(3) The cooling system shall be constructed of corrosion-resistant metal suitable for the intended application.

(4) The cooling system shall store enough water or aqueous solution to permit operation of the engine at one-third load factor for eight hours. The minimum quantity of usable water or aqueous solution available for cooling shall equal the consumption for one hour with the engine operating at maximum load and speed multiplied by 8 and this product divided by 3.

(d) Surface temperature of engine and exhaust system. (1) The temperature of any external surface of the engine or exhaust system shall not exceed 400 °F. under any condition of engine operation prescribed by MSHA. Water-jacketed components shall have integral jackets and provision shall be made for positive circulation of water in the jackets and to automatically shut off the engine when the temperature in the cooling jacket(s) exceeds 212 °F. Insulated coverings to control surface temperature are not acceptable.

(2) When a spray is used to reduce the temperature of the exhaust gas, it shall be located as near as practicable to the outlet of the exhaust manifold.

(3) Exterior surfaces of the exhaust system shall be designed to minimize accumulation and lodgement of dust or combustible substances and to permit ready access for cleaning.

(e) Tightness of exhaust system. All joints in the exhaust system shall be tight to prevent the flow of exhaust gas through them under any condition of engine operation prescribed by MSHA. A tight system shall be obtained by the use of ground joints, or thin metal or metal-clad gaskets. All such joints shall be fitted with adequate through bolts and all gaskets shall be aligned and held firmly in position by the bolts or other suitable means. Such joints shall remain tight to prevent passage of flame or propagation of repeated internal explosions to a surrounding flammable mixture.

(f) Dilution of exhaust gas. (1) Provision shall be made to dilute the exhaust gas with and before it is discharged into the surrounding atmosphere. The discharged exhaust gas shall be so diluted with air that the mixture shall not contain more than 0.5 percent, by volume, of carbon dioxide; 0.01
percent, by volume, of carbon monoxide; 0.0025 percent, by volume, of oxides of nitrogen (calculated as equivalent nitrogen dioxide); or 0.0010 percent, by volume, of aldehydes (calculated as equivalent formaldehyde) under any condition of engine operation prescribed by MSHA.

(2) The final diluted exhaust mixture shall be discharged in such a manner that it is directed away from the operator’s compartment and also away from the breathing zones of persons required to be alongside the equipment.

(g) Pressure-gage connection. A connection shall be provided in the exhaust system for convenient, temporary attachment of a pressure gage at a point suitable for measuring the total back pressure in the system. The connection also shall be suitable for temporary attachment of gas-sampling equipment to the exhaust system. This opening shall be closed by a plug or other suitable device that is sealed or locked in place except when a gage or sampling tube is attached.

§ 36.26 Composition of exhaust gas.

(a) Preliminary engine adjustment. The engine shall be submitted to MSHA by the applicant in such condition that it can be tested immediately at full load and speed. The preliminary liquid-fuel-injection rate shall be such that the exhaust will not contain black smoke and the applicant shall adjust the injection rate promptly to correct any adverse conditions disclosed by preliminary tests.

(b) Final engine adjustment. The liquid fuel supply to the engine shall be adjusted so that the undiluted exhaust gas shall contain not more than 0.30 percent, by volume, of carbon monoxide or 0.20 percent, by volume, of oxides of nitrogen (calculated as equivalent nitrogen dioxide, NO\textsubscript{2}) under any conditions of engine operation prescribed by MSHA when the intake air mixture to the engine contains 1.5 ±0.1 percent, by volume, of Pittsburgh natural gas.\textsuperscript{3}

\textsuperscript{3}Investigation has shown that for practical purposes, Pittsburgh natural gas (containing a high percentage of methane) is a satisfactory substitute for pure methane in these tests.

(c) Coupling or adapter. The applicant shall provide the coupling or adapter for connecting the engine to MSHA’s dynamometer.

Note: Preferably this coupling or adapter should be attached to the flywheel of the engine.

Clutches, transmissions, or torque converters ordinarily are not required in the coupling train.

§ 36.27 Fuel-supply system.

(a) Fuel tank. (1) The fuel tank shall not leak and shall be fabricated of metal at least \(\frac{1}{16}\) inch thick, welded at all seams, except that tanks of 5 gallons or less capacity may have thinner walls which shall be formed or reinforced to provide good resistance to deflection. A drain plug (not a valve or petcock) shall be provided and locked in position. A vent opening shall be provided in the fuel filler cap of such design that atmospheric pressure is maintained inside the tank. The size of the vent opening shall be restricted to prevent fuel from splashing through it. The filler opening shall be so arranged that fuel can be added only through a self-closing valve at least 1 foot from the exhaust manifold of the engine, preferably below it. The self-closing valve shall constitute a fuel-tight closure when fuel is not being added. Any part of the self-closing valve that might become detached during the addition of fuel shall be secured to the tank by a chain or other fastening to prevent loss.

(2) The fuel tank shall have a definite position in the equipment assembly, and no provision shall be made for attachment of separate or auxiliary fuel tanks.

(3) Capacity of the fuel tank shall not exceed the amount of fuel necessary to operate the engine continuously at full load for approximately four hours.

(b) Fuel lines. All fuel lines shall be installed to protect them against damage in ordinary use and they shall be designed, fabricated, and secured to resist breakage from vibration.

(c) Valve in fuel line. A shutoff valve shall be provided in the fuel system, installed in a manner acceptable to MSHA.