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Fuel Deration
Controlling Toxic Gases and Diesel Particulate Matter Emissions

Controlling the fuel to air ratio of a diesel engine is a means to limit the gaseous and diesel particulate matter emissions of the engine. The fuel to air ratio is established during MSHA's engine approval process for all diesel engines used in underground coal mines and for part 36 permissible diesel engines used in underground M/NM mines. One of the purposes of this requirement is to provide a baseline/benchmark to reduce fuel rates to when engines are used at high altitudes. At high altitudes the air density and pressure is lower. With less air available the fuel injection rate must be reduced to keep the same fuel to air ratio. This reduction in fuel is referred to as "fuel deration." Not correcting the maximum fuel delivery for the engine for high altitude operation results in increased emissions. Generally, a 3% fuel reduction for every 1000 ft. above 1000 ft. elevation is needed to maintain the fuel to air ratio at the approved level. The engine manufacturer specifies a fuel setting and a fuel deration curve for the engine during the approval process. The fuel deration curve ensures the fuel rate does not exceed the maximum allowable fuel to air ratio at any altitude.

Fuel rate settings are critical for efficient operation of diesel engines. Over-fueling has the following negative consequences:

- It will not significantly increase power output of the engine since engines can only utilize fuel in relation to the air available. Excess fuel will not be efficiently burned in the combustion chamber of the engine.
- Diesel particulate matter emissions will increase and shorten the useful life of disposable filters or require more frequent active regeneration of ceramic filters.
- Emission of toxic gases, such as carbon monoxide and nitrogen dioxide, will increase.
- Operation of engines at excessive fuel-to-air ratios causes engines to operate at higher temperatures. This will shorten the engine's useful life. For permissible machines with wet exhaust gas conditioners (water scrubbers), higher exhaust gas temperatures will evaporate the scrubber water faster requiring more down time to refill the scrubber.

With increased altitude, a diesel engine has less available horsepower. Due to the decrease in available air for combustion the engine can only efficiently burn *less* fuel. A naturally aspirated (no turbocharger or supercharger) engine operated at altitude will always have less available horsepower than one operated at sea level. Maintaining the fuel to air ratio established in the approval maintains the efficiency of the engine and the emission levels. It does not significantly lower the engine's power. Increasing the fuel rate above the approved fuel to air ratio will significantly increase emissions. This is

not permitted under MSHA's regulations and not worth the unhealthful conditions created or the resulting increase maintenance required.

MSHA has also determined that some engines equipped with turbochargers that force more air into the engine instead of reducing the fuel injection rate may still require deration. Since the turbocharger may only provide increased air to the engine at high power output, emissions can increase above their sea level values at low power levels. This is especially true of high horsepower pickup trucks that normally operate at low power levels. Even at high power output, there may be a need to derate these engines to maintain the fuel to air ratio. The turbocharger is compressing less dense air and is less efficient at doing this. MSHA is in the process of addressing this issue.