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Selection of Diesel Engines for Underground Mining Applications.



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MSHA Diesel Engine Requirements for M/NM Underground Mines

§ 57.5067 (a) Engines

- ◆ Any Diesel Engine Introduced Underground
 - (a)(1) Have Affixed A Plate Evidencing Approval Under Subpart E of Part 7, Or Under Part 36
 - (a)(2) Meet Or Exceed The Applicable PM Emission Requirements Of The U.S. EPA Listed In Table 57.5067-1

MSHA Approved Engines

Approval Number

- ◆ Permissible Engines:
7E-A001 or 07-EPA030001
- ◆ Non-permissible Engines
7E-B001 or 07-ENA030001

Information on Approval Plate

- ◆ Approval Number
- ◆ Ventilation Rate
- ◆ Rated Power
- ◆ Rated Speed
- ◆ High Idle Speed
- ◆ Maximum Altitude before Fuel Deration
- ◆ Engine Model Number

Internet Link to MSHA Approved Engines

◆ <https://lakegovprod1.msha.gov/ReportView.aspx?ReportCategory=EngineAppNumbers>

or

◆ www.msha.gov then click on "Approved Products", then click on "Part 7 Diesel Engines"

MSHA Approved Diesel Engines

<i>Approval Number</i>	<i>Engine Manufacturer</i>	<i>Model</i>	<i>HP @ RPM at 1000ft Elevation</i>	<i>DPM grams/-hp- hr weighted</i>	<i>Exhaust BP Max Limit, in.H2O</i>
<i>07-ENA040001</i>	<i>CUMMINS</i>	<i>QSB-155C</i>	<i>155 @ 2500</i>	<i>0.11</i>	<i>41</i>
<i>07-ENA040018</i>	<i>DEUTZ</i>	<i>F6L 914</i>	<i>117 @ 2300</i>	<i>0.09</i>	<i>40</i>
<i>07-ENA050001</i>	<i>MITSUBISHI</i>	<i>S4S-DT</i>	<i>77 @ 2500</i>	<i>0.18</i>	<i>32</i>
<i>7E-B001</i>	<i>DEUTZ</i>	<i>MWM 916</i>	<i>94 @ 2300</i>	<i>0.42</i>	<i>40</i>
<i>7E-B003</i>	<i>CATERPILLAR</i>	<i>3306 PCNA</i>	<i>150 @2200</i>	<i>0.49</i>	<i>34</i>
<i>7E-B035</i>	<i>DEUTZ</i>	<i>F8L 413FW</i>	<i>182 @ 2300</i>	<i>0.16</i>	<i>30</i>
<i>7E-B063</i>	<i>CATERPILLAR</i>	<i>3306PCTA</i>	<i>215 @ 2200</i>	<i>0.45</i>	<i>27</i>

EPA DPM Limits

MSHA Table 57.5067-1

- | | | | |
|-----------------------|---------------|--------|--------|
| ◆ Hp < 11 | 0.75 g/bhp-hr | Tier 1 | MY2000 |
| ◆ $11 \leq HP < 25$ | 0.60 g/bhp-hr | Tier 1 | MY2000 |
| ◆ $25 \leq HP < 50$ | 0.60 g/bhp-hr | Tier 1 | MY1999 |
| ◆ $50 \leq HP < 100$ | 0.30 g/bhp-hr | Tier 2 | MY2004 |
| ◆ $100 \leq HP < 175$ | 0.22 g/bhp-hr | Tier 2 | MY2003 |
| ◆ $175 \leq HP < 750$ | 0.40 g/bhp-hr | Tier 1 | MY1996 |
| ◆ Hp ≥ 750 | 0.40 g/bhp-hr | Tier 1 | MY2000 |
- ◆ On highway diesel vehicles such as pickup trucks from 1994 vehicle model year

Engine's Diesel Particulate Matter (DPM) Emissions

The background is a solid teal color. In the bottom right corner, there is a dark teal silhouette of a mountain range.

Engine Combustion Design

- ◆ Pre 1993 Direct Injection Engines
 - 0.5 – 1.0 gm/hp-hr.
- ◆ Indirect Injection (Pre Chamber) Engines
 - 0.3 – 0.5 gm/hp-hr.
- ◆ Post 1993 Direct Injection Engines
 - High Pressure Fuel Direct Injection
 - Turbocharged
 - Computerized Electronic Fuel Injection
 - 0.05 – 0.2 gm/hp-hr for the higher horsepower engines

Engine Emissions

◆ Total Emissions =

Hp specific emissions x

Horsepower x

Hours of use.

Total Engine Out Emissions

Emissions x Horsepower x Hours = DPM

◆ Loader:

$$0.1 \quad \times \quad 275 \quad \times \quad 8 = 220 \text{ grams}$$

◆ Haul Truck:

$$0.1 \quad \times \quad 350 \quad \times \quad 8 = 280 \text{ grams}$$

◆ Haul Truck:

$$0.3 \quad \times \quad 350 \quad \times \quad 8 = 840 \text{ grams}$$

◆ Drill:

$$0.5 \quad \times \quad 150 \quad \times \quad 4 = 300 \text{ grams}$$

Three Strikes and It's Out

◆ Strikes:

- High horsepower (greater than 150),
- High emissions (greater than 0.3 gm/hp-hr),
- High use (greater than 6 hours per shift).

◆ Target Equipment:

- Production Loaders and Trucks (primary),
- Drills and Scalers (secondary)
- PC engines (specialty mining equipment).

◆ One bad engine can spoil the entire fleet.

Clean Engines vs. Ventilation

- ◆ Clean engines reduce emissions by 80 to 90%.
 - Fuel savings pay for engine in 2 to 3 years.
- ◆ Estimate that 80% of engines are currently Tier 1 or better.
- ◆ Ventilation is important, it can be expensive unless improvements are made by improved distribution.
 - 25% increase in mine air flow doubles the ventilation cost.

EPA Tier 3

- ◆ $50 \leq \text{HP} < 100$ Tier 3 MY2008
 - ◆ $100 \leq \text{HP} < 175$ Tier 3 MY2007
 - ◆ $175 \leq \text{HP} < 750$ Tier 3 MY2006
-
- ◆ NOX reductions only, no change in DPM

EPA Tier 4

- ◆ Hp < 25 Tier 4 MY2008
 - ◆ $25 \leq HP < 75$ Tier 4 MY2008 & 2013
 - ◆ $75 \leq HP < 175$ Tier 4 MY2012 - 2014
 - ◆ $175 \leq HP < 750$ Tier 4 MY2011 - 2014
 - ◆ $HP \geq 750$ Tier 4 MY2011 - 2015
-
- ◆ Substantial DPM reductions above 25 hp
 - ◆ Substantial NOX reductions above 75 hp

Diesel Fuel

- ◆ MSHA §57.5065 requires diesel fuel with a sulfur content of less than 0.05 percent (500 ppm)
- ◆ EPA requirement for on-highway diesel fuel to be at 0.0015 percent (15 ppm) sulfur by mid – 2006
- ◆ EPA requirement for non-road diesel fuel to be at 0.0015 percent (15 ppm) sulfur by 2010

QUESTIONS?

