

Technical Information

***ASTM D975 Diesel Fuel
Specification Test***



EXHIBIT F - ASTM D975 DIESEL FUEL SPECIFICATION TEST RESULTS

| TEST METHOD | | TEST PROPERTY | DIESEL FUEL STANDARD ¹ | FUEL TEST | FUEL +ENGINE BOOST 2.0 TEST |
|--------------|----------|--|-----------------------------------|-----------|-----------------------------|
| ASTM | ISO | | | | |
| D93 | 2719 | Flash Point, min | 52°C | 62.8°C | 65°C |
| D2500 | - | Cloud Point, max | - | 8.9°C | 8.9°C |
| D2709 | - | Trace Sediment, %vol, max | <0.05% | <0.005% | <0.005% |
| D445 | 3104 | Kinematic Viscosity, cSt, 40°C, min | 1.9 | 2.67 | 2.66 |
| | | Kinematic Viscosity, cSt, 40°C, max | 4.1 | | |
| D482 | 6245 | Ash, % mass, max | 0.01 | 0.002 | 0.001 |
| D2622, D4294 | EN 24260 | Sulfur, % weight, max | 0.05 | 0.042 | 0.042 |
| D130 | 2160 | Copper Corrosion, 3 hr @ 212°F, max | <No. 3A | No. 1A | No. 1A |
| D613 | 5165 | Cetane Number, min | 40 | 43.9 | 44.8 |
| D976 | 4264 | Cetane Index, min | 40 | 45.5 | 46.8 |
| D287 | - | API Gravity @ 60°F, min | 34 | 34.3 | 34.3 |
| | | API Gravity @ 60°F, max | 38 | | |
| D524 | 10370 | Ramsbottom Carbon Residue on 10% Distillation Residue, % mass, max | 0.35 | 0.15 | 0.15 |
| D86 | 3405 | Distillation, % Volume Recovered, °F | | | |
| | | Initial Boiling Point, Typical | 375°F | 369°F | 368°F |
| | | 10%, Typical | 430°F | 421°F | 420°F |
| | | 50%, Typical | 510°F | 504°F | 506°F |
| | | 90%, Maximum | 625°F | 608°F | 607°F |
| | | 95%, Maximum | 671°F | 634°F | 635°F |
| | | Recovered Volume, % min | 98% | 98% | 98% |

Notes

- 1 Diesel Grade No. 2 On Road
- 2 1:10,000 treatment rate

OTHER DIESEL FUEL TEST RESULTS

| TEST METHOD | | TEST PROPERTY | DIESEL FUEL STANDARD ¹ | FUEL TEST | FUEL +ENGINE BOOST 2.0 TEST |
|--------------|----------|--|-----------------------------------|-----------|-----------------------------|
| ASTM | ISO | | | | |
| D93 | 2719 | Flash Point, min | 52°C | 62.8°C | 65°C |
| D2500 | - | Cloud Point, max | - | 8.9°C | 8.9°C |
| D2709 | - | Trace Sediment, %vol, max | <0.05% | <0.005% | <0.005% |
| D445 | 3104 | Kinematic Viscosity, cSt, 40°C, min | 1.9 | 2.67 | 2.66 |
| | | Kinematic Viscosity, cSt, 40°C, max | 4.1 | | |
| D482 | 6245 | Ash, % mass, max | 0.01 | 0.002 | 0.001 |
| D2622, D4294 | EN 24260 | Sulfur, % weight, max | 0.05 | 0.042 | 0.042 |
| D130 | 2160 | Copper Corrosion, 3 hr @ 212°F, max | <No. 3A | No. 1A | No. 1A |
| D613 | 5165 | Cetane Number, min | 40 | 43.9 | 44.8 |
| D976 | 4264 | Cetane Index, min | 40 | 45.5 | 46.8 |
| D287 | - | API Gravity @ 60°F, min | 34 | 34.3 | 34.3 |
| | | API Gravity @ 60°F, max | 38 | | |
| D524 | 10370 | Ramsbottom Carbon Residue on 10% Distillation Residue, % mass, max | 0.35 | 0.15 | 0.15 |
| D86 | 3405 | Distillation, % Volume Recovered, °F | | | |
| | | Initial Boiling Point, Typical | 375°F | 369°F | 368°F |
| | | 10%, Typical | 430°F | 421°F | 420°F |
| | | 50%, Typical | 510°F | 504°F | 506°F |
| | | 90%, Maximum | 625°F | 608°F | 607°F |
| | | 95%, Maximum | 671°F | 634°F | 635°F |
| | | Recovered Volume, % min | 98% | 98% | 98% |

See following pages for ASTM test definitions.

EXHIBIT F - DIESEL FUEL PROPERTIES AND ASTM TEST EXPLANATIONS

Pour Point - The lowest temperature at which a petroleum product will just flow when tested under standard conditions. **ASTM D97.**

Cloud Point - The temperature at which a petroleum product just shows a cloud or haze of wax crystals when it is cooled under standard test conditions. **ASTM D2500.**

Flash Point - The lowest temperature at which petroleum vapours will ignite under a low flame; important for safe handling and storage. **ASTM D93.**

Volatility - The property of a liquid that defines its evaporation characteristics; important for complete combustion. Volatility is expressed in terms of the temperature at which successive portions are distilled from a sample of the fuel under controlled heating. Volatility will effect viscosity, flash point, cetane number, density, and smoking (exhaust). Too high, or too low, volatility negatively impacts these factors. **ASTM D86.**

Cetane number - The measure of the ignition quality of diesel fuel based on ignition delay in an engine (readiness to spontaneously combust under the temperature and pressure conditions in the combustion chamber of the engine). The higher the cetane number, the shorter the ignition delay and the better the ignition quality. Important for ease of ignition, better starting in cold temperature, reduced engine noise, and to control legislated emissions. **ASTM D613.**

Cetane Index (CI) - An approximation of Cetane number based on an empirical relationship with density and volatility parameters. **ASTM D976.**

Sulfur - Sulfur content (ppm); important to minimize engine wear and to meet legislation. Forms acidic by-products that are harmful to the environment, and eat away the engine (SO, SO₂, SO₃). **ASTM D2622** and **ASTM D4294.**

Viscosity - The measure of resistance to flow of a liquid; important for consistency, injector flow, and good atomization. An **upper limit** on viscosity ensures that fuel will flow readily during cold starting, and a **minimum limit** is often specified to avoid the possibility of a serious power loss at high temperatures. **ASTM D445.**

Density - Mass of a substance per unit volume; important for consistency and good fuel economy. Higher density produces more power and more smoke. **ASTM D287** or **ASTM D1298.**

Colour - The colour of the fuel before and after aging can be determined by **ASTM D1500.** This helps in predicting fuel quality, and fuel stability.

Water and Sediment Content - Amount of sediment and water in fuel is measured by **ASTM D1796.** The amount of water can be measured by **ASTM D1744,** and the amount of sediment can be measured by **ASTM D2709.**

Ash Content - Diesel Fuels may contain small amount of ash forming material, such as suspended solids and soluble organometallic compounds. Can cause damage to close tolerances of fuel injection system, and abrasive wear on engine components (piston rings). **ASTM D 482**.

Carbon Residue - Indicates the tendency of the fuel to form carbonaceous deposits. There are two recognized test methods: **ASTM D189** or **ASTM D524**.

Corrosivity - **ASTM D130** is the copper corrosion and tarnish test. To minimize attack on metals in the distribution and storage network, and in the engine fuel system.

Neutralization Number - **ASTM D974** is another corrosion test.

Heating Value - Measure of the energy available from a fuel when it is burned. **ASTM D240**.

Aromatics Content - Reducing aromatic hydrocarbon composition will reduce emissions. **ASTM D1319**.

Fuel Stability - **ASTM D1500** Colour Test (see above), **ASTM D2274** Oxidation Stability, and **ASTM D4625** Long-Term Storage Stability.

Lubricity - Sometime called film strength, is the ability of a liquid to lubricate. This is extremely important to the satisfactory operation of diesel engines. Low viscosity fuel, low sulfur fuel, and non-petroleum fuels put some injection equipment at risk. Not part of fuel standard, but tests recognized by the EMA are

- 1) Ball on Cylinder Lubricity Evaluator (BOCLE) - **ASTM D5001**
- 2) Ball on Three Seats Method (BOTS)
- 3) High Frequency Reciprocating Wear Rig (HFRR).