



In order to meet much higher emission standards and improvements in combustion efficiency, diesel engine manufactures have adopted fuel injection equipment (F.I.E.) that operates at considerably higher pressures to achieve greater atomization of the diesel fuel. Greater pressures require a much higher manufacturing precision within F.I.E. componentry and lower tolerance to less than very clean diesel fuel. This Information Sheet discusses the importance of maintaining a clean supply of fuel to your diesel generator system with particular emphasis on engines incorporating the higher fuel injection pressures.

1.0 HIGHER PRESSURE FUEL INJECTION EQUIPMENT:

Latest EPA compliant Tier diesels now incorporate injection pressures within common rail systems that can generate peak pressures of 43,000 psi (2965 bar). Injector design now dictates manufacturing tolerances as close a 2 microns. At these pressures very small contaminate particles within the fuel can scar surfaces of the fuel delivery system, and result in increased wear, loss of performance, and potential failure of components within the F.I.E. A system designer has to ensure the fuel delivered to the F.I.E. is very clean to avoid an unacceptable increase in operational and maintenance costs.

Ensuring Clean Diesel Fuel Supply to Low Emission Diesel Generator Systems

| ISO 4406 CODE LEVELS | | |
|----------------------|----------------------------|--------------------|
| ISO Code | Number of Particles per ML | |
| | Minimum (Included) | Maximum (Included) |
| 28 | 1,300,000 | 2,500,000 |
| 27 | 640,000 | 1,300,000 |
| 26 | 320,000 | 640,000 |
| 25 | 160,000 | 320,000 |
| 24 | 80,000 | 160,000 |
| 23 | 40,000 | 80,000 |
| 22 | 20,000 | 40,000 |
| 21 | 10,000 | 20,000 |
| 20 | 5,000 | 10,000 |
| 19 | 2,500 | 5,000 |
| 18 | 1,300 | 2,500 |
| 17 | 640 | 1,300 |
| 16 | 320 | 640 |
| 15 | 160 | 320 |
| 14 | 80 | 160 |
| 13 | 40 | 80 |
| 12 | 20 | 40 |
| 11 | 10 | 20 |
| 10 | 5.0 | 10 |
| 9 | 2.5 | 5.0 |
| 8 | 1.3 | 2.5 |
| 7 | 0.64 | 1.3 |
| 6 | 0.32 | 0.64 |
| 5 | 0.16 | 0.32 |
| 4 | 0.08 | 0.16 |
| 3 | 0.04 | 0.08 |
| 2 | 0.02 | 0.04 |
| 1 | 0.01 | 0.02 |

Methods to Ensure Clean Diesel Fuel for Latest EPA Tier Engines

- 1) Install additional filters with water separator between engine filter and fuel tank
- 2) Grounding and bonding of tank and delivery system using ultra low sulfur diesel
- 3) Include fuel polishing as part of the generator's Planned Maintenance Program
- 4) Install protective caps over filler and vents to prevent dust contamination
- 5) Wipe surfaces around filler when fueling



The installation information provided in this information sheet is informational in nature only, and should not be considered the advice of a properly licensed and qualified electrician or used in place of a detailed review of the applicable National Electric Codes and local codes. Specific questions about how this information may affect any particular situation should be addressed to a licensed and qualified electrician.

2.0 DIESEL FUEL FILLING:

A primary cause of on-site stored fuel contamination is entry of dust, water, and dirt through the fuel tank's filler cap. Prior to filling the tank, the area around the filler cap should be wiped clean before the filler nozzle is inserted. A planned maintenance visit can include fuel top-off. An experienced service technician will ensure no contamination of the generator system's stored fuel.

When operating in dusty conditions, plastic protectors can be used to prevent airborne particles from entering via the filler.

3.0 DIESEL FUEL SOURCE:

Diesel fuel should be sourced from a reliable supply to ensure contamination by particulates and water is kept to a minimum. If the source of the fuel is not known, additional filtration should be added between the filler and fuel source during delivery.

4.0 DIESEL ENGINE STANDARD FUEL FILTRATION EQUIPMENT:

Diesel engine manufacturers supply fuel filtration as a standard accessory. The primary fuel filters now being fitted have been upgraded to meet higher fuel filtration requirements. Standard filters will remove "normal" contaminants for a reasonable operating period. A system designer will have to evaluate whether the system is operating in a normal environment. Many engines are also fitted with filters that include water separators with a visual bowl to view any water contamination.

5.0 ADDITIONAL FUEL FILTRATION EQUIPMENT-MOUNTED DEVICES:

Generator manufacturers and authorized distributors will add additional fuel filtration devices if the application requires above-standard levels of fuel filtration. Secondary fuel filtration is fitted to the fuel supply system before fuel enters the primary fuel filter. Any additional fuel filter added should be sized to allow an adequate flow the flow rate to the primary filter. Restrictions in flow will reduce engine performance.

Additional water-traps are also fitted up stream to remove any potential large quantity of water contamination.

6.0 BULK FUEL HANDLING:

Bulk storage fuel tanks need to be protected from factors that can contaminate previously clean diesel fuel. Also, emissions codes have led to the use of Ultra Low Sulfur Diesel (ULSD). Removal of sulfur and other compounds to produce ULSD decreases the fuel's conductivity and, in turn, increases the potential for stored static energy. Static electricity building up in ULSD has the potential to produce a spark within combustible vapors leading to fire or an explosion. It is important that the entire fuel system - fuel supply tank, transfer pump, hoses, nozzles and other components - are properly grounded and bonded to prevent any buildup of a static charge.

The following should be verified on installation of the generator system's fuel supply:

- **Bonding** – To properly bond the fuel delivery system, electrical conductive with no unbroken connection has to connect all the components within the fuel delivery system. In addition to bonding the components, a wire connection from the fuel delivery system to the generator chassis will equalize the potential static electrical buildup between the generator system and its fuel supply.
- **Grounding** – Having bonded all the components within the fuel delivery system, the entire system, and especially the generator and fuel tank, should be grounded to earth to enable dissipation to earth of any static electrical charge buildup.

7.0 ADDITIONAL FUEL CONDITIONING OF STORED FUEL:

If equipment operators need to ensure fuel entering the generator system is clean, they can utilize fuel-cleaning processes that ensure clean fuel delivered from the refinery has not been contaminated by water and particulates during delivery and storage.

Fuel cleaning and polishing can be incorporated into your generator system's planned maintenance program. A service technician will bring to site a portable stationary base clean-fuel cart equipped with filtration and water separators to remove any contamination of the stored diesel fuel. A full-flow analyzer can be incorporated into the delivery system to constantly check fuel is within the required standard of cleanliness.

8.0 ISO CLEANLINESS 3-DIGIT CODE TO SPECIFY ENGINE MANUFACTURERS FUEL FILTRATION REQUIREMENTS:

The ISO Cleanliness Code for particle counting is expressed as a three-digit code with each number (1 to 28) separated by a slash. Each number represents particle counts from 0.01 particles per milliliter of fluid to 2,500,000 particles per milliliter. The first number represents greater than 4-microns, the second number greater than 6-microns and the third number greater than 14-microns.

For example in a code of 13/11/9, the first number 13 signifies 40 to 80 particles greater than 4 microns per milliliter is permitted, the second number 11 signifies 10 to 20 particles greater than 6 microns per milliliter is permitted, and the third number 9 signifies 2.5 to 5 particles larger than 14 microns per milliliter that is permitted. (See chart on front page)

A micron is a very microscopic particle; a 4-micron particle only measures 0.000157480315 inches.

Diesel engine manufacturers more frequently specify the level of fuel cleanliness required for latest emission compliant engines. Only filters complying with the manufacturer's specification should be used for service changes.

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