Ingersoll-Rand
Revised (10-12)

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INGERSOLL RAND TECHNICAL SERVICE BULLETIN

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Bulletin #: **GEN-006**
Date: **24 August 2005**
Product: **GENERATORS**
Subject: **Biodiesel**

MODELS	SERIAL NUMBER
All generators with a John Deere engine	
All generators with a Volvo engine	

Customers come more and more with the question in how far the engines of our generators can handle BIODIESEL.

Therefore we made this file, which is no more then a copy of internal Bulletins of John Deere and Volvo.

Not all the information in this files in related to the biodiesel, but it is interesting info, so we kept it in the file.

In short:

- John Deere allows 5% biodiesel in there engines.
- Volvo allows also 5% biodiesel but recommends that the oil change interval gets reduced to 50%.

In case you have a customer who wants to use the biodiesel, you can give him a copy of these files. But always insist that they give us the exact specs of the fuel, the exact environmental conditions of the machines and the type of engine he wants to use the diesel on.
This way we can give him a more specific and detailed advise!

Fuels, Alternative

Contents / Notes

Page

RECOMMENDED FUEL SPECIFICATIONS

John Deere engines are designed to operate on #2 Diesel Fuels which meet U.S. Military Specification VV-F-800E, ASTM D975 or EN 590 Standard Specifications for Diesel Fuel Oils. Fuel specifications recommended for use in John Deere Diesel Engines follow:

- Fuel Specific Gravity @ API 35 .....0.850
- Kinematic Viscosity @ 40 °C.....2.50 cSt
- Fuel Lower Heating Value ..... 42,765 kJ/kg
  ..... (18,385 Btu/lb)
- Fuel Temperature at Pump Inlet.....40 °C (104 °F)
- Cetane Number ..... 40 minimum
  Cetane number greater than 50 is preferred for temperatures below -4°F (-20°C) or elevations above 5000 feet (1500 m).
- Cold Filter Plugging Point (CFFP) below the expected low temperature or Cloud Point at least 9°F (5°C) below the expected low temperature.
- Sulfur Content.....< 0.5%
  - Sulfur content between 0.05% and 0.5% is preferred.
  - If diesel fuel with sulfur content greater than 0.5% is used, reduce service interval for engine oil and filter changes by 50%.
  - **DO NOT** use diesel fuel with sulfur content greater than 1.0%

IMPORTANT:

Low sulfur fuels (less than 0.05% sulfur) may not provide adequate lubricity. Fuel lubricity should pass the ASTM D5001 BOCLE (Ball On Cylinder Lubricity Evaluation) method. If fuel of low or unknown lubricity is used, add John Deere ALL-SEASON FUEL CONDITIONER or equivalent at the specified concentration.

Biodiesel fuels meeting DIN 51606 or equivalent specification may be used in concentrations up to 5% on a volume basis. Biodiesel by definition is biodegradable so the higher the concentration of biodiesel in a fuel blend, the more susceptible the fuel is to degradation and water absorption. Concentrations of no more than 5% biodiesel are approved to minimize the potential problems associated with fuel degradation. Concentrations beyond 5% by volume could adversely effect engine performance and fuel system durability. Use of biodiesel fuels may result in a 1%-9% reduction in engine power dependent on fuel mixture concentration. 100% biodiesel concentration may result in a 7%-9% power loss. A 20% biodiesel/80% petroleum diesel mixture may result in a 1%-1.5% reduction in engine power.

John Deere engines will also operate on lower viscosity fuels. However, with rotary pumps, as fuel viscosity decreases, fuel flow to the engine decreases resulting in lower power. Engine response, load recovery, and starting time are adversely affected. The reduced lubricating properties of lower viscosity fuels may also reduce pump life unless special internal parts are used.

Engines which use in-line pumps are also sensitive to lower viscosity fuels, resulting in reduced power. In-line pump components are not as sensitive to wear as rotary pump components since in-line parts are lubricated by engine oil.

Engine operation using extremely low viscosity fuels such as JP-4 and Jet B is **not** recommended. Significant fuel injection equipment wear results from use of fuels with viscosities below 2.0 centistokes. If JP-4 is used, viscosity must be raised by adding 10%-20% new lube oil by volume and 0.2%-1% cetane improver such as hexyl nitrate. Even with these additives to raise viscosity and cetane number, a performance loss should be expected.

The use of high specific gravity fuels (lower API) could result in power levels exceeding the engines approved power rating. Operation above the approved engine power level will result in reduced engine life and increased operating costs.

In general, 'light' fuels may give poor low-load / high-speed performance, poor injection system lubrication, lower power, and poorer startability. 'Heavy' fuels may cause fuel filter plugging at low temperature, poor starting, additional combustion zone deposits and higher wear due to higher sulfur levels. Pretreatment of 'heavy' fuels may be required, such as prefiltering, water separation, and heating. Contact Sales Engineering if use of other than recommended fuels is anticipated.

The following tables summarize various fuels, comments concerning modifications required to maintain pump and engine life, and performance effects that may be encountered.

ALTERNATIVE FUEL CAPABILITY FOR MECHANICAL ROTARY AND DE10 ELECTRONIC FUEL INJECTION PUMPS (2.9 L / 4.5 L / 6.8 L)

DESCRIPTION	TYPE	COMMENTS
Diesel Fuels	No. 2-D	Recommended fuel for ambients above 40 °F (5 °C).
	No. 1-D	Recommended for ambients below 40 °F (5 °C). Power loss up to 5% can be expected due to lower viscosity.
	DF-2	U.S. Federal Specification, regular grade. See No. 2-D comments.
	DF-1	U.S. Federal Specification, winter grade. See No. 1-D comments. Power loss up to 5% can be expected.
	DF-A	U.S. Federal Specification, arctic grade. Power loss up to 6% can be expected. Injection pumps may exhibit increased component wear with extended use of this fuel due to high dewaxing and low viscosity. Special transfer pump and drive component parts are required for Stanadyne injection pumps. Stanadyne mechanical gen-set pumps also require special governor components. Stanadyne mechanical fuel injection pump options identified as "Jet A, JP5/JP8 Fuel Capable" are equipped with the required parts. Standard Stanadyne mechanical pumps can be converted by installing a Stanadyne Arctic conversion kit. Special components are not required for Lucas-CAV injection pumps. All DE10 electronic fuel injection pumps are jet-alternative-fuel capable as described below with no component changes.
Burner Fuels	No. 2	Higher density and specific gravity than base fuel No. 2-D. A power increase up to 3% can be expected.
	No.1	Lower viscosity than base fuel No. 2-D. A power loss up to 2% can be expected.
Aviation Fuels	Jet A	Lower viscosity and density than base fuel No. 2-D. Power loss up to 10% can be expected. Injection pumps may exhibit increased component wear with extended use of this fuel. Special transfer pump and drive component parts are required for Stanadyne mechanical injection pumps. Special components are not required for Lucas-CAV injection pumps. See DF-A comments for details.
	Jet A-1	See Jet A and DF-A comments. Power loss up to 10% can be expected.
	Jet B	Not Recommended. Lower density and extremely low viscosity compared to base fuel No. 2-D will result in greatly accelerated injection pump wear, poor starting, and a power loss of up to 14%. Jet B may be used on pumps with Stanadyne injection pumps with special hardened parts for up to 300 hours as an emergency fuel only. Hot starting could be extremely difficult or impossible without priming. Lucas-CAV injection pumps should not be used with Jet-B fuel, even for emergency operation.
	JP-4	Not Recommended. Military equivalent of Jet B. See Jet B comments. Power loss up to 14% can be expected. JP-4 may be used on Stanadyne pumps with special hardened parts up to 300 hours as an emergency fuel only. Lucas-CAV injection pumps should not be used with JP-4 fuel, even for emergency operation.
	JP-5	See Jet A and DF-A comments. Power loss up to 10% can be expected.
	JP-7	See Jet A and DF-A comments. Power loss up to 10% can be expected.
	JP-8	See Jet A and DF-A comments. Power loss up to 10% can be expected.

ALTERNATIVE FUEL CAPABILITY FOR UNIT PUMPS (2.4 L / 3.0 L)

DESCRIPTION	TYPE	COMMENTS
Diesel Fuels	No. 2-D	Recommended fuel for ambients above 40 °F (5 °C).
	No. 1-D	Recommended for ambients below 40 °F (5 °C). Power loss up to 5% can be expected due to lower viscosity.
	DF-2	U.S. Federal Specification, regular grade. See No. 2-D comments.
	DF-1	U.S. Federal Specification, winter grade. See No. 1-D comments. Power loss up to 5% can be expected.
	DF-A	U.S. Federal Specification, arctic grade. Power loss up to 6% can be expected. Injection pumps may exhibit increased component wear with extended use of this fuel due to high dewaxing and low viscosity.
Burner Fuels	No. 2	Higher density and specific gravity than base fuel No. 2-D. A power increase up to 3% can be expected.
	No.1	Lower viscosity than base fuel No. 2-D. A power loss up to 2% can be expected.
Aviation Fuels*	Jet A	Lower viscosity and density than base fuel No. 2-D. Power loss up to 10% can be expected.
	Jet A-1	See Jet A comments. Power loss up to 10% can be expected.
	Jet B	Not Recommended. Lower density and extremely low viscosity compared to base fuel No. 2-D. Power loss up to 12% can be expected. Jet B may be used as an emergency fuel with the addition of 10 to 20% clean lube oil by volume and 0.2 to 1% cetane improver such as hexyl nitrate.
	JP-4	Not Recommended. See Jet B comments. Power loss up to 12% can be expected. JP-4 may be used as an emergency fuel with the addition of 10 to 20% clean lube oil by volume and 0.2 to 1% cetane improver such as hexyl nitrate.
	JP-5	See Jet A comments. Power loss up to 10% can be expected.
	JP-7	See Jet A comments. Power loss up to 10% can be expected.
	JP-8	See Jet A comments. Power loss up to 10% can be expected.

* Emissions will increase, however the engine will remain in emissions compliance for its useful life if it is operated on commercially available jet fuel.

ALTERNATIVE FUEL CAPABILITY FOR IN-LINE FUEL INJECTION PUMPS (6.8 L / 8.1 L)

DESCRIPTION	TYPE	COMMENTS
Diesel Fuels	No. 2-D	Recommended fuel for ambients above 40 °F (5 °C).
	No. 1-D	Recommended for ambients below 40 °F (5 °C). Power loss up to 4% can be expected due to lower viscosity.
	DF-2	U.S. Federal Specification, regular grade. See No. 2-D comments.
	DF-1	U.S. Federal Specification, winter grade. See No. 1-D comments. Power loss up to 4% can be expected.
	DF-A	U.S. Federal Specification, arctic grade. Highly dewaxed and low viscosity. Power loss up to 5.5% can be expected.
Burner Fuels	No. 2	Higher density and specific gravity than base fuel No. 2-D. A power increase up to 2.5% can be expected.
	No. 1	Lower viscosity than base fuel No. 2-D. A power loss up to 1.5% can be expected.
Aviation Fuels	Jet A	Lower viscosity and density than base fuel No. 2-D. Power loss up to 10% can be expected.
	Jet A-1	See Jet A comments. Power loss up to 10% can be expected.
	Jet B	Not Recommended. Lower density and extremely low viscosity compared to base fuel No. 2-D. Power loss up to 12% can be expected. Jet B may be used as an emergency fuel with the addition of 10 to 20% clean lube oil by volume and 0.2 to 1% cetane improver such as hexyl nitrate.
	JP-4	Not Recommended. See Jet B comments. Power loss up to 12% can be expected. JP-4 may be used as an emergency fuel with the addition of 10 to 20% clean lube oil by volume and 0.2 to 1% cetane improver such as hexyl nitrate.
	JP-5	See Jet A comments. Power loss up to 10% can be expected.
	JP-7	See Jet A comments. Power loss up to 10% can be expected.
	JP-8	See Jet A comments. Power loss up to 10% can be expected.

ALTERNATIVE FUEL CAPABILITY FOR UNIT INJECTORS (10.5 L / 12.5 L)

DESCRIPTION	TYPE	COMMENTS
Diesel Fuels	No. 2-D	Recommended fuel for ambients above 40 °F (5 °C).
	No. 1-D	Recommended for ambients below 40 °F (5 °C). Power loss up to 4% can be expected due to lower viscosity.
	DF-2	U.S. Federal Specification, regular grade. See No. 2-D comments.
	DF-1	U.S. Federal Specification, winter grade. See No. 1-D comments. Power loss up to 4% can be expected.
	DF-A	U.S. Federal Specification, arctic grade. Highly dewaxed and low viscosity. Power loss up to 5.5% can be expected.
Burner Fuels	No. 2	Higher density and specific gravity than base fuel No. 2-D. A power increase up to 2.5% can be expected.
	No. 1	Lower viscosity than base fuel No. 2-D. A power loss up to 1.5% can be expected.
Aviation Fuels	Jet A	Lower viscosity and density than base fuel No. 2-D. Power loss up to 10% can be expected.
	Jet A-1	See Jet A comments. Power loss up to 10% can be expected.
	Jet B	Not Recommended. Lower density and extremely low viscosity compared to base fuel No. 2-D. Power loss up to 12% can be expected. Jet B may be used as an emergency fuel with the addition of 10 to 20% clean lube oil by volume and 0.2 to 1% cetane improver such as hexyl nitrate.
	JP-4	Not Recommended. See Jet B comments. Power loss up to 12% can be expected. JP-4 may be used as an emergency fuel with the addition of 10 to 20% clean lube oil by volume and 0.2 to 1% cetane improver such as hexyl nitrate.
	JP-5	See Jet A comments. Power loss up to 10% can be expected.
	JP-7	See Jet A comments. Power loss up to 10% can be expected.
	JP-8	See Jet A comments. Power loss up to 10% can be expected.

MILITARY APPLICATIONS

Aviation fuel usage only comprises one requirement for military contract applications. All military contracts should be reviewed carefully to confirm that all requested performance and application component requirements have been previously demonstrated on the fuel system and engine model being quoted. If the performance capability or availability of required application components for the engine are unknown or in doubt, the military contract product description information should be forwarded to your John Deere Power Systems Regional Sales Manager or Sales Engineer for review and comment prior to quotation of the engine package.

VOLVO PENTA

AB Volvo Penta
SE-405 08 Göteborg, Sweden

Service Bulletin

Group	Number	Version
18–8	**3**	**01**

Dieselfuel - quality and function

Dieselfuel

Distribution: Date: 05-2000 Binder: **A B D E I**

GENERAL QUALITY REQUIREMENTS
The fuel consumption plays an important role in the engines function, service life, and emission characteristics. To achieve specified power and fuel economy as well as emission requirements, only fuel that meets local requirements (if applicable) as well as national and international standards should be used. These standards are the minimum requirements for diesel fuel and often are developed with cooperation between the oil and automotive industries. Examples:

- EN 590
- ASTM D 975 No. 1-D, 2-D
- JIS KK 2204

For environmental reasons some countries have more stringent requirements than the minimum requirements. Examples:

- Environment class 1 and 2
- So called “City Diesel”
- Special requirements for buses and distribution vehicles

These fuels produce less exhaust emissions and can, therefore, be recommended. They may produce a slightly lower power and increased fuel consumption.

Note: Any adjustment to the fuel injection pump to compensate for any power loss is not approved.

SULFUR CONTENT

The sulfur content in diesel fuel should be as low as possible. During combustion, the sulfur is converted to sulfur dioxide which in turn is converted to sulfuric acid in the atmosphere. Particle emissions also increase with increased sulfur content. Should the sulfur content exceed 0.5%, recommended time between oil changes must be reduced by half. Diesel fuel with extremely low sulfur content does not allow for extended oil change intervals. See appropriate owners manual for oil change intervals.

Viscosity and Density

Viscosity and density are directly connected to the engines performance, emissions, and service life. Low viscosity and density reduce engine power. Extremely high viscosity and density have a negative impact on emissions and can reduce the service life of the fuel system components.
Recommendations:

- Viscosity – 1,5cSt – 4,5 cSt at 40°C/104°F
- Density – 810 – 860 kg/m^{3}/50.6–53.7 pound/foot^{3} at 15°C/59°F

Expected power reduction and increase in fuel consumption compared with standard fuel (Density – 840 kg/m^{3}/52.4 pound/foot^{3}; Viscosity 2.5 cSt at 40°C/104°F)

	Power reduction	Increased fuel consumption
Winter fuel	approximately 4%	approximately 2%
Environment		
Class 1	approximately 5%	approximately 2 – 3%
Class 2	approximately 5%	approximately 2 – 3%

Lubricants
Volvo Penta recommends a maximum of 460µm at 60°C/140°F according to HFRR test (ISO12156).

Cetane Number
A high cetane number is important in order to achieve low emissions. Fuel with low cetane numbers (40 – 43) increases hydro carbon, nitric oxides, particles and engine noise. The ease of ignition is also reduced with a low cetane number. From a technical standpoint, Volvo Penta recommends a minimum cetane number of 45. From an environmental standpoint, Volvo Penta recommends a minimum cetane number of 53.

Water and Particles
Water and particles should not be present in the fuel or the fuel system since this causes corrosion and wear on the fuel system components. Water also promotes bacteria and fungi growth in the fuel system. Under cold conditions, suspended water will freeze and block fuel supply. A pre-filter with water separator is always recommended.

Cloud point and cold filter block a point (CFPP)
International standards specify the requirements for diesel fuel in different geographical regions and different seasons. The oil companies are required to meet these specifications.

Additives
The oil companies are always responsible for the proper additives to ensure correct ignition, lubricity, and cold climate operation. Volvo Penta does not approve additives that are mixed directly in the fuel tank. The only exception is kerosene; see recommendations below.

Kerosene
Kerosene should only be used to improve the cold climate operation. Adding kerosene should be done after consulting with the supplier of the diesel fuel. Adding kerosene will reduce the viscosity, density, and cetane number. This in turn reduces power output, ignition ease, and the emissions **increase**. The maximum allowed kerosene content is 20%.

Note 1: The maximum lubricity level of 460µm at 60°C/140°F cannot be exceeded.
Note 2: It is forbidden to mix kerosene in Swedish environment class fuels.

Gasoline and Alcohol

Diesel Boosters
Volvo Penta does not approve the use of diesel boosters.

Biodiesel/RME
Volvo Penta does not approve more than 5% RME contents in the diesel fuel. All biodiesel or RME content must be pre-mixed by the fuel supplier. Volvo Penta also recommends that when these types of fuel are used the oil change interval be reduced 50%.

Used engine oil or two-stroke oil
Volvo Penta does not approve used engine oil or two-stroke oil for use with diesel fuel.

Aviation and Military Fuel are rated for use as follows:
Jet A-1 – ok to use
JP-4 is unsuitable as diesel fuel
JP-5 – ok to use
JP-8 – ok to use
NATO F-34, F-35, and F-54 – ok to use