



ALL

SERVICE BULLETIN

TOPIC: Lubrication System
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SUBJECT: Waukesha® Lube Oil Recommendations

MODELS AFFECTED: All Waukesha Engines

SUMMARY

The purpose of this bulletin is to identify the lube oil needs of all Waukesha engines. Listing is by current production model and fuel type.

This bulletin revision provides Waukesha's current lubricating oil recommendations as a guideline.

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INFORMATION AND INSTRUCTIONS

Waukesha engines are heavy duty industrial type engines and require heavy duty lubrication oils. The basic requirements are high lubricating quality, high thermal stability, and good control of contaminants.

Waukesha's engine product line consists of industrial engines, from the VSG™ through the 16V-AT27QL spark ignited gas engines. With this wide product line, the lubrication oil requirements and systems change greatly between each model and fuel type.

LUBRICATING OIL PERFORMANCE

CAUTION The performance of a lubricant, like that of any manufactured product, is the responsibility of the refiner and supplier.

Waukesha Engine strongly recommends monitoring the condition of the lube oil through the use of a good oil analysis program.

There are hundreds of commercial crankcase oils marketed today. Engine manufacturers or users cannot completely evaluate the numerous commercial oils. The current edition of the *EMA Engine Fluids Data Book* is available for purchase from:

Engine Manufacturers' Association
Two North LaSalle Street
Chicago, IL 60602
Phone: (312) 827-8700
Fax: (312) 827-8737
Email: ema@enginemanufacturers.org
www.enginemanufacturers.org

This document provides a tabulation of global lubricant producers and marketers, together with the performance classification for which the producers have indicated their products are qualified.

The Waukesha Engine Warranty is limited to the repair or replacement of parts that fail due to defective material or workmanship during the warranty period. The Waukesha Warranty does not include responsibility for lubricating oil performance.

With the exception of cogeneration and special or prototype installations, Waukesha Engine has made it a practice not to recommend oil by brand name.

OIL DESIGNATIONS

Oil is designated in several ways: American Petroleum Institute (API), Society of Automotive Engineers (SAE), American Society for Testing and Materials (ASTM) performance classifications and Military Designation. Since no gas engine industry oil performance designations exist, it is the responsibility of the engine operator to verify with their oil supplier, that the oil they select has proven field performance in their specific engine make and model.

OIL ADDITIVES

Quality oils formulated specifically for natural gas engines have sufficient additives to meet requirements. Waukesha does not recommend the addition of oil additives to these quality oils.

OIL RECOMMENDATIONS

Waukesha recommends the use of oil formulated specifically for gas engines and meeting minimum ash requirements based on engine makes and models (see Table 1). The ash forming constituents in oil formulations provide detergency, corrosion protection, and anti-wear protection. In addition, the ash produced during combustion of these additives will provide protection against valve face and seat recession.



CAUTION Waukesha engines use specifically formulated gas engine oils. Waukesha Engine does not recommend gasoline or diesel oil formulations for use with its engines. Use of gasoline or diesel oil formulations may cause severe engine damage.

CATALYST CONTAMINANTS

The following contaminants are known catalyst deactivators and should be avoided when selecting lubricating oils for installations with catalysts since they contribute to shortened catalyst life: heavy and base metals such as lead, mercury, arsenic, antimony, zinc, copper, tin, iron, nickel, chrome, sulfur, and phosphorus. These individual elements should not exceed 1 ppm or collectively exceed 5 ppm at the catalyst inlet. Specific exceptions: phosphorus or silicon compounds at the catalyst inlet are not to exceed 1 ppm and sulfur compounds at the catalyst inlet are not to exceed 100 ppm.

Do not confuse the concentration of these elements AT THE CATALYST INLET with the concentration of these elements in the lube oil itself.

Table 1. Oil Recommendations By Model

MODEL	SULFATED ASH % ^(1, 2)
VSG SERIES GAS ENGINES	
VSG F11 G, GSI, GSID	0.35 - 1.0
VGF SERIES GAS ENGINES	
VGF F18, H24, L36, P48 G, GL, GLD	0.45 - 0.75
VGF F18, H24, L36, P48 GSID	0.35 - 0.5
VHP SERIES GAS ENGINES	
VHP F2895, F3521, L5790, L7042, P8390 G, GSI, GL	0.35 - 1.0
VHP F3524, L5794, L7044, GSI, L5774, L5794, LT	0.45 - 0.75
AT25/27GL SERIES GAS ENGINES	
AT25/27, 8L, 12V, 16V, GL	0.35 - 1.0

NOTE: (1) Oils must be specifically formulated for gas engines using highly refined mineral oil base stocks. The ash requirements are a percentage by weight with both metallic and ashless additive systems. A maximum of 0.10% zinc is recommended.

(2) Oil with 0.35% ash or less may be used in naturally aspirated and catalyst equipped naturally aspirated or turbocharged engines with the understanding that valve recession may occur, thus shortening the normally expected valve and seat life.

OIL FILTRATION REQUIREMENTS

The quality of oil filtration will directly affect engine component life.

Waukesha's basic filtration requirement is 90% efficient at 15 microns for all full flow sock and paper elements, and 98% efficient at 25 microns for cleanable full flow metal mesh elements. Mesh or screen sizes larger than 25 microns are not acceptable.

Lube oil filter elements should be changed when the lube oil is changed or when the pressure drop across the lube oil filter exceeds 24 psi (165 kPa).

Waukesha's complete oil filter performance specification is shown in Waukesha specification sheets S08486 and S08486-1.

EXTENDED OIL DRAIN INTERVALS

Extended oil drain intervals are not recommended unless a Waukesha Microspin® centrifuge as well as Waukesha supplied oil filtration components are installed. The Microspin centrifuge, in conjunction with Waukesha supplied oil filtration components, will remove by-products of combustion, allowing an increase in scheduled oil drain and oil filter element change intervals. See Table 9 for the maximum number of hours between normal and extended oil drain and oil filter element change intervals.

It is recommended that oil analysis be used to determine when condemning limits are reached.

WAUKESHA COGENERATION INSTALLATIONS

Waukesha Engine does not ordinarily recommend lube oils by brand name. However, based on actual field experience, the oils listed in Table 2 are specified for cogeneration installations with forced hot water cooling systems 212° F - 265° F (100° C - 129° C) or ebullient cooling 250° F (121° C).

Table 2. Recommended Lube Oils For Cogeneration Applications (Using Pipeline Quality Gas)

BRAND	TYPE	PERCENT OF SULFATED ASH
Chevron HDAX Low Ash	SAE 40	0.50
Estor Super	SAE 40	0.45
Estor Elite (Synthetic)	SAE 20 W40	0.45
Estor Select 40	SAE 40	0.95
Mobil Pegasus 1 (Synthetic)	SAE 15 W40	0.48
Mobil Pegasus 805	SAE 40	0.48
Mobil Pegasus 710 (89)	SAE 40	0.99
Petro Canada, CG40	SAE 40	0.92
Q8 Mahler HA (Europe only)	SAE 40	0.90
Q8 Mahler MA (Europe Only)	SAE 40	0.55
Shell Mysella MA SIPC (Outside USA only)	SAE 40	0.90

It is especially important that the lube oils used in cogeneration applications use base stocks with good thermal stability. With a minimum of 4000+ hours of experience, the lube oils listed in Table 2 are known to give satisfactory performance in high temperature cooling systems' applications.

Additions to the list of approved oils may be made if substantiating data is provided for an oil meeting the following criteria:

- Used in similar applications 212° F (100° C) to 265° F (129° C) jacket water temperatures.
- Minimum of 6 months operation. Documented with engine inspection data.
- No signs of oil degradation or lacquering problems (based on normal oil change interval, the engine should be clean).

SOUR GAS, DIGESTER GAS, AND LANDFILL GAS RECOMMENDATIONS

WARNING

Waukesha Engine assumes no liability or responsibility for damage to the environment or severe personal injury caused by using landfill gases or sour gases. It is the customer's sole responsibility to carefully analyze any gases they choose to use. Use of these gases is at the customer's own risk.

Alternate fuel sources are attracting increasing interest today as a low cost fuel or because of environmental concerns. Waukesha, being the leader in developing engine systems to accommodate these alternate fuels, is aware of problems due to sulfur compounds (H₂S, etc.), siloxanes, and halide constituents in these fuels. Hydrogen sulfide (H₂S), siloxanes, and total organic halide as chloride (TOH/Cl) bring with them totally different problems to the engine and lubricating oils.

Waukesha has limited fuel trace gases to the following:

- Sulfur bearing compounds (H₂S, etc.) content in fuel gas to 0.1%, (1000 ppm) by volume. However, it is not unusual to encounter biomass gas or field gas with much higher percentages of sulfur bearing compounds (H₂S, etc.). Gas exceeding 0.1% sulfur bearing compounds must be treated.
- Maximum organic halide content, expressed as chloride, (TOH/Cl) in landfill gas is limited to 150 micrograms per liter (µg/l).
- Maximum liquid fuel hydrocarbons at the coldest expected engine mounted regulator fuel outlet temperature are limited to 2% total by gaseous volume.
- Maximum permissible free hydrogen content is 12% by volume.
- Maximum total siloxanes for engine models with a prechamber fuel system is 25 µg/l. If greater than 25 µg/l total siloxanes are present at the inlet to the engine mounted fuel regulator, clean commercial quality natural gas must be supplied to the prechamber fuel system. Waukesha currently does not limit total siloxane content in the fuel gas to engines which do not have a prechamber fuel system.

When dealing with halogens or halogen compounds in landfill gas, the subject becomes far too complicated to address here as it relates to the selection of a lubricating oil, used oil analysis, and drain interval. It follows that those customers operating on landfill gas review Waukesha Engine's Fuel Specification S7884-7 (or current revision) to fully understand the ramifications of operating an engine on landfill gas. This document (as well as Service Bulletin 9-2701) prescribes specific fuel gas sampling techniques, fuel gas analysis, handling of abrasive fuel constituents, and limitations on total organic halide as chloride, to achieve reasonable engine life. Lubricating oil requirements change as the TOH/CI increases.

RECOMMENDED LUBE OILS FOR LANDFILL GAS APPLICATIONS

Table 3. Recommended Lube Oils Landfill Gas Applications

BRAND	TYPE	PERCENT OF SULFATED ASH
Mobil Pegasus 610 (446)	SAE 40	0.68
Mobil Pegasus 605 (426)	SAE 40	0.48
Chevron HDAX LFG	SAE 40	0.71

Waukesha recommends lubricating oils specifically formulated for landfill gas. However, care must be taken that oils formulated for a particular fuel type not be used beyond their recommendations. When used outside of their recommendations, some landfill gas formulated lube oils can cause excessive build-up of abnormal ash deposits in the combustion chamber. Landfill gas engine oils should only be used for engines applied to landfill gas operation, not digester gas operation.

The best approach would be to filter or absorb corrosives in the fuel gas before they reach the engine. There are increasing claims for filtration and absorption by various companies manufacturing and promoting these types of products. Waukesha makes no endorsement of these products or service. Their performance is solely the responsibility of the manufacturers.

RECOMMENDATIONS FOR FUEL GAS FILTRATION OF SOLIDS AND LIQUIDS

Solid Particulate Removal:

Coalescer shall have an absolute rating of 5 microns (0.3 microns for landfill applications) for solid particulate removal.

Liquid and Aerosol Removal From Fuel Gas:

Coalescer shall remove entrained liquid and aerosol contaminants of 0.3 μm (micron) or larger.

- Fuel gas compressor lubricating oil carryover must be removed from the fuel stream. A coalescing filter with a 0.3 micron rating is adequate in most cases. Even though this oil is hydrocarbon based and combustible, it contains an additive package with calcium and other undesirable elements and compounds. Failure to remove this carryover oil can lead to fuel regulator problems, excessive spark plug and combustion chamber deposits, cylinder varnish, ring sticking, and other problems.

- Liquid water is not allowed in the fuel because it frequently results in fouling and corrosion. Particular attention must be paid to landfill and digester gases since these gases are commonly received saturated with water. Due to extremely small clearances in the admission and check valves, absolutely no water can be tolerated in a prechamber fuel system. To insure that no liquid water forms in the fuel system, Waukesha specifies that the dew point of the fuel gas should be at least 20° F (11° C) below the measured temperature of the gas before all engine mounted regulators and engine remote regulator pilot valves (if so equipped). On engines without prechamber fuel systems, saturated, (100% relative humidity) fuel gas at the carburetor inlet is acceptable. A 0.3 micron coalescing filter will remove any liquid water droplets being carried along with the fuel stream. The water content of the gas can then be reduced to an acceptable level by several methods.

A. Condensation of excess moisture by refrigerating the fuel gas to no higher than 40° F (4° C) followed by filtering to remove the liquids and reheating of the gas to 85° - 95° F (29° - 35° C). This process will also remove significant amounts of halogenated and heavy hydrocarbons and volatile siloxanes.

B. Selective stripping with a chemical process.

C. By heating: If the gas is 30° F (17° C) or more above the ambient temperature, it can be cooled by passing it through a heat exchanger or refrigeration system, then reheated, in a manner similar to Step A. If the gas is 20° F (11° C) or more below the ambient temperature, it can be heated. In both cases, the fuel system after the heating operation should be insulated. Heating of the fuel gas is limited to the maximum allowable temperature of 140° F (60° C).

- Glycol is not permitted in fuel gas because it can affect the engine in adverse ways. The lubricating qualities of the oil may be reduced, resulting in bearing failure, piston ring sticking, excessive wear, and other problems. A 0.3 micron rated coalescing filter will remove liquid glycol from the fuel stream.

Design Criteria:

Coalescer Filter Housing is to be of the cylindrical type, vertically mounted. The housing shall contain two sump chambers, such that the lower sump collects heavier liquid dropouts immediately downstream of the gas inlet, while the upper sump collects liquids draining off the coalescer cartridge(s).

The coalescer design shall use an inside to outside gas flow path through the coalescer cartridge.

Recommended Coalescing Filter:

Pall Process Filtration Company
Model CC3LG7A

The following recommendations will minimize corrosion problems normally encountered with fuel gas containing H_2S and TOH/CI:

- **Recommendation #1**

Select a gas engine lubricating oil with a high alkalinity reserve, 7 to 13 TBN (Total Base Number). Alkalinity reserve in the lube oil is measured in TBN. The higher the TBN, the more reserve.

Contact your oil supplier or consult the *EMA Engine Fluids Data Book* for an appropriate choice. Also follow the appropriate ash content percent by weight for the specific engine model.

- **Recommendation #2**

Used oil analysis is mandatory for alternate fuel applications. Lube oil change periods are determined by TBN, TAN (Total Acid Number), oxidation, and nitration level in the used oil samples. The user must change the oil when the TBN level falls to 30% of the new oil value or TAN increases by 2.5 – 3.0 above the new oil value. The method of measuring TBN in used oil must be ASTM-D2896.

DEXSIL® Corporation has developed the Q2000 field test kit as a test for chlorine contamination of engine oil exposed to chlorine containing fuels, as in landfill gas. This field test kit is highly accurate and allows the operator to obtain timely test results in the field. The oil must be sampled every 50 hours, in order to establish a "trend." Waukesha has experienced good results with this kit. Order information may be obtained from DEXSIL® Corporation, One Hamden Park Drive, Hamden, CT 06517.

CAUTION TOH/CI does not affect TBN levels the same as sulfur compounds. Therefore, the 70% depletion as an indicator of a change interval only applies to the applications where fuel gas does not contain halides. Disregarding this information could result in product damage and/or personal injury.

- **Recommendation #3**

Increase the jacket water temperature to 210° – 235° F (99° – 113° C) and lube oil temperatures to 185° – 200° F (85° – 93° C). ATGL series engines are limited to a maximum of 180° F (82° C) lube oil temperature. Increased temperatures will reduce condensation, which will reduce the concentration of acids within the crankcase. High temperature thermostats are available for most models.

If you have any question on lubricants to be used with alternate fuel gases, contact the Field Service Department or Sales Engineering Department prior to selecting a lubricating oil.

LUBE OIL CONDEMNING LIMITS**WARNING**

Engine oil is extremely hot and is under pressure. Use caution when sampling engine oil for analysis. Failure to follow proper procedures could cause severe personal injury or death.

Lubricating oil condemning limits are established by the engine manufacturer's experience and/or used oil testing.

Laboratory testing will determine the used oil's suitability for continued use. Used oil testing should cover the data shown in Table 4.

Table 4. Used Oil Testing And Condemnation

TEST	CONDEMNING LIMIT
Viscosity	-20/+30% Change
Flash Point	Below 356° F (180° C)
Total Base Number (TBN) (ASTM-D2896)	30% of New Oil Value (Not applicable to TOH/CI)
Total Acid Number (TAN)	2.5 – 3.0 Rise Above New Oil Value
Oxidation (Abs/Cm)	25
Nitration (Abs/Cm)	25
Water Content	Above 0.10% Wt.
Glycol	Any Detectable Amount
Wear Metals	Trend Analysis
Chlorine	900 ppm

**CAUTION**

Actual oil change intervals to be determined by engine inspection and oil analysis in conjunction with the condemning limits. Disregarding this information could result in product damage.

In the interest of developing a reasonable life expectancy for Waukesha engines operating on fuel gas laden with some level of halogens, our experience dictates the following:

- To achieve the life expectancy of an engine operating on pipeline quality natural gas, remove all halogen compounds and abrasives from the fuel gas.
- Reasonable life can be expected if Total Organic Halide as Chloride Concentration (TOH/Cl) of the fuel does not exceed 150 micrograms per liter ($\mu\text{g/l}$). Total Organic Halide as Chloride (TOH/Cl) equals the sum of all halogenated compounds expressed as chloride in micrograms/litre as chloride ($\mu\text{Cl/L}$) at STP (Standard Temperature and Pressure). Reasonable life can also be expected with increased maintenance and operating adjustments to the engine.
- Typical changes in maintenance and operation at this level are:
 - Decreased oil change interval (150 hours to start)
 - Condemn oil when 900 ppm chlorine level in used oil is reached. This will aid in establishing an oil change interval.
 - Lubricating oil analysis every 50 hours maximum
 - Elevated jacket water temperature $212^{\circ}\text{F} - 235^{\circ}\text{F}$ ($100^{\circ}\text{C} - 113^{\circ}\text{C}$)
 - Elevated lube oil temperature to $185^{\circ}\text{F} - 200^{\circ}\text{F}$ ($85^{\circ}\text{C} - 93^{\circ}\text{C}$); ATGL series engines are limited to a maximum of 180°F (82°C) lube oil temperature.
 - Use of high TBN oil (7.0 - 13.0)
 - Bypass lubrication oil filtration. Waukesha Engine has introduced the Microspin cleanable lube oil filtering system. The Microspin system uses the cleaning capabilities of a centrifuge, coupled with cleanable filter elements. The Microspin system uses Waukesha's current lube oil filtration canister for the cleanable elements. The centrifuge is installed as a bypass system, working in conjunction with the cleanable filter elements. The Microspin centrifuge can also be used with standard filter elements.

- TOH/Cl above 150 micrograms chloride/litre require pre-treatment of the fuel in order to make it suitable for use in a reciprocating engine.

DEXSIL® Corporation has developed the Q2000 field test kit, as a test for chlorine contamination of engine oil exposed to chlorine containing fuels, as in landfill gas. This field test kit is highly accurate and allows the operator to obtain timely test results in the field. The oil must be sampled every 50 hours, in order to establish a "trend." Waukesha has experienced good results with this kit. Order information may be obtained from DEXSIL® Corporation, One Hamden Park Drive, Hamden, CT 06517.

OIL VISCOSITY SELECTION

The operating temperature of the oil in the sump or header is the best guide for selecting the proper SAE grade of oil. When the oil temperature is unknown, add 120°F (67°C) to the ambient temperature to obtain the estimated sump oil temperature.

Table 5. VSG Sump Temperature And SAE Number

SUMP TEMPERATURES	SAE NUMBER
$210^{\circ} - 250^{\circ}\text{F}$ ($99^{\circ} - 121^{\circ}\text{C}$)	40
$160^{\circ} - 210^{\circ}\text{F}$ ($71^{\circ} - 99^{\circ}\text{C}$)	30

Table 6. VGF/VHP Sump And Header Temperatures And SAE Number

SUMP TEMPERATURES	HEADER TEMPERATURE	SAE NUMBER
$180^{\circ} - 230^{\circ}\text{F}$ ($71^{\circ} - 110^{\circ}\text{C}$)	$180^{\circ} - 195^{\circ}\text{F}$ ($71^{\circ} - 91^{\circ}\text{C}$)	40
Below 180° (71°)	Below 180° (71°)	30

Table 7. ATGL Sump And Header Temperatures And SAE Number

SUMP TEMPERATURES	HEADER TEMPERATURE	SAE NUMBER
$180^{\circ} - 230^{\circ}\text{F}$ ($71^{\circ} - 110^{\circ}\text{C}$)	$180^{\circ} - 180^{\circ}\text{F}$ ($71^{\circ} - 82^{\circ}\text{C}$)	40

NOTE: Do not operate engines with an oil header temperature below 140°F (60°C). Engines that exceed 195°F (91°C) header temperature or 215°F (102°C) sump temperature should have reduced oil change intervals.

MULTI-VISCOSITY OILS

Use multi-viscosity oils only for engines in cold starting applications. Multi-viscosity oil may deteriorate in continuous operation, allowing the oil to lose viscosity through shearing. In this state, the oil may not supply sufficient lubricating films and/or pressure. Therefore, use an oil analysis program to determine the oil change intervals.

SYNTHETIC OILS

Based on developments by Exxon Mobil Corporation and the release of their synthetic lubricating oils, Waukesha Engine now recognizes these products as being suitable for all Waukesha stoichiometric and lean burn gas engines. Table 2 lists the synthetic oils available.

When synthetic lubricating oils are selected, it is suggested that you contact Waukesha Engine for change interval recommendations. Typically, synthetic oil change intervals are 3 to 5 times longer than those of mineral oils. Actual change intervals must be established through oil analysis and visual inspection of engine components. Typical areas to look for oil breakdown are: exhaust valve stems, piston ring area, and piston undercrown. Oil filter change intervals remain at 1000 to 1500 hours of operation.

Synthetic oils are not recommended for digester or landfill gas applications.

LOW AMBIENT TEMPERATURE OPERATION

At low ambient temperatures, use an oil which will provide proper lubrication when the engine is hot and working. For engines of 1000 cu. in. (16.4 L) and above, operating at ambients below 50° F (10° C) lube oil and jacket water heaters are required to warm oil and water for fast starting and loading of engines. Waukesha Engine will supply information on these starting devices upon request.

LUBE OIL CONSUMPTION GUIDELINES

Typical lube oil consumption rates have been updated for all Waukesha engines.

Table 8. Oil Consumption

MODEL	LBS/ HP-HR	GRAMS/ HP-HR	GRAMS/ kWb-HR
All	0.0002- 0.002	0.091 - 0.910	0.121 - 1.22

NOTE: Lube oil consumption rates given above are a general guide and not meant to be used for Condemning Limits or determining overhaul requirements.

FORMULAS FOR DETERMINING OIL CONSUMPTION RATES

The following formulas may be useful in determining whether the oil consumption rate of the engine is normal. ☐

$$\frac{\text{LBS}}{\text{HP} - \text{HR}} = \frac{7.3 \times \text{Number of Gallons of Oil Used}}{\text{HP} \times \text{Hours of Operation}}$$

$$\frac{\text{LBS}}{\text{HP} - \text{HR}} = \frac{1.82 \times \text{Number of Quarts of Oil Used}}{\text{HP} \times \text{Hours of Operation}}$$

$$\frac{\text{Grams}}{\text{HP} - \text{HR}} = \frac{875 \times \text{Number of Litres of Oil Used}}{\text{HP} \times \text{Hours of Operation}}$$

$$\frac{\text{Grams}}{\text{kWb} - \text{HR}} = \frac{875 \times \text{Number of Litres of Oil Used}}{\text{kWb}(\text{corrected}) \times \text{Hours of Operation}}$$

RECOMMENDED OIL CHANGE INTERVALS



CAUTION The use of some types of oil, as well as dusty environment, marginal installation, internal engine condition and/or operating the engine with malfunctioning carburetion equipment may require more frequent oil changes. Waukesha Engine recommends that the lubricating oil be monitored with a professional oil analysis program. Extended oil change intervals may cause varnish deposits, oil oxidation, or sludge conditions to appear in the engine, which an oil analysis cannot detect. Disregarding this information could result in engine damage. Contact your local Waukesha Distributor for periodic engine maintenance.

Table 9. Recommended Oil Change Intervals For Engines Receiving Normal Maintenance

ENGINE MODEL	ISO STANDARD OR CONTINUOUS POWER RATING	ENGINES OPERATED IN EXCESS OF ISO STD POWER	LIGHT LOAD OPERATION	EBULLIENT COOLED OR HOT WATER SYSTEM WITH ENGINE WATER TEMPERATURE 200° F (93° C) OR ABOVE	STANDBY DUTY
FOR ENGINES OPERATING WITH OIL SUMP TEMPERATURE OF 230° F (110° C) OR BELOW.					
VSG SERIES F11 Natural Gas, HD-5 Propane	Normal 720 hours*	300 hours	720 hours	N/A	300 hours or annually
FOR ENGINES OPERATING WITH OIL HEADER TEMPERATURES 195° F (91° C) OR BELOW.					
VGF G, GL, QLD Natural Gas, HD-5 Propane	Normal 1000 hours (Extended 1250 hours**)	500 hours	1000 hours	720 hours	500 hours or annually
VGF GS1D Natural Gas, HD-5 Propane	Normal 720 hours (Extended 900 hours**)	500 hours	720 hours	500 hours	500 hours or annually
VHP SERIES Natural Gas, HD-5 Propane	Normal 1500 hours (Extended 2100 hours**)	500 hours	1500 hours	500 hours	250 hours or annually
ATGL SERIES Natural Gas	Normal 4000 hours (Extended 5000 hours**) or sooner by analysis. Sample every 1000 hours.			See page 5 for condemning limits.	

NOTE: Change lube oil filter elements when lube oil is changed.

* Attainable with 15.5:1 air/fuel ratio (carburetor adjusted to 1.15% CO in the exhaust). If best economy carburetor setting is used, 17.0:1 - 17.7:1 air/fuel ratio (1.4% - 2.1% O₂ in the exhaust), lube oil change hours should be reduced to 300 operating hours.

** Extended oil drain intervals listed, are acceptable, if a Microspin® centrifuge, in conjunction with a Waukesha supplied oil filtration system is used, and an oil analysis program is followed.

Table 10. Recommended Oil Change Intervals For Engines Receiving Normal Maintenance And Using Gaseous Fuel Containing H₂S.

ENGINE MODEL	ISO STANDARD OR PRIME POWER RATING	ENGINES OPERATED IN EXCESS OF ISO STD POWER	LIGHT LOAD OPERATION	EBULLIENT COOLED OR HOT WATER SYSTEM WITH ENGINE WATER TEMPERATURE 200° F (93° C) OR ABOVE	STANDBY DUTY
FOR ENGINES OPERATING WITH ELEVATED OIL SUMP TEMPERATURE.					
VSG SERIES	360 hours*	250 hours	360 hours	N/A	250 hours or annually
VGF SERIES	360 hours	250 hours	360 hours	360 hours	250 hours
VHP SERIES	360 hours	250 hours	360 hours	360 hours	250 hours or annually
ATGL SERIES**	500 hours or sooner by analysis. Sample every 100 hours.			See page 5 for condemning limits	

NOTE: Change lube oil filter elements when lube oil is changed.

* Attainable with 15.5:1 air/fuel ratio (carburetor adjusted to 1.15% CO in the exhaust). If best economy carburetor setting is used, 17.0:1 - 17.7:1 air/fuel ratio (1.4% - 2.1% O₂ in the exhaust), lube oil change hours should be reduced to 300 operating hours.

** ATGL series engines are limited to a maximum of 180° F (82° C) lube oil temperature.

Table 11. Duty Cycle Definitions

ISO STANDARD OR CONTINUOUS POWER RATING:	The highest load and speed which can be applied 24 hours a day, 7 days a week, 365 days per year, except for normal maintenance. It is permissible to operate the engine at up to 10% overload or maximum load indicated by the intermittent rating, whichever is lower, for two hours in each 24 hour period.
GENERATOR STANDBY POWER RATING:	In a system used as a backup or secondary source of electrical power, this rating is the output the engine will produce continuously (no overload), 24 hours per day, for the duration of the prime power source outage.
INTERMITTENT POWER RATING:	This rating is the highest load and speed that can be applied in variable speed mechanical system application only. Operation at this rating is limited to a maximum of 3500 hours per year.
GENERATOR PEAK SHAVING:	Peak shaving is operation of an engine for a limited time to meet short term peak power requirements. Speed, loading, and hours per year of operation will affect the recommended oil change interval.
LIGHT LOAD OPERATION:	Power levels less than 50% of the maximum continuous power rating.