POWER SOLUTIONS INTERNATIONAL

PSI 8.1L-22L HEAVY-DUTY

OPERATIONS & MAINTENANCE MANUAL

56100038-1

A Product by Power Solutions International Wood Dale, IL
TP-6716 08/20c

Contents

Introduction

PSI is pleased that you have selected our engine for your requirements. PSI Engines takes great pride in our tradition of quality products produced from our line of industrial alternative fuel engines.

Prior to starting the engine at your facility, certain checks should be made. Please read the Initial Start-Up inspection requirements in the Maintenance Section of this manual. If you have further questions please contact your PSI account representative or Customer Support Engineer.

How to Use this Manual

This manual contains instructions on the safe operation and preventive maintenance of your PSI heavy-duty industrial engine. We urge you to read this manual prior to start up or operation of the engine.

The Table of Contents permits you to quickly open the manual to any section.

PSI Engines are built with a variety of standard and/or optional components to suit a broad range of customer requirements. This manual does not identify equipment as standard or optional. All the equipment described in this manual may not be found on your engine or power unit.

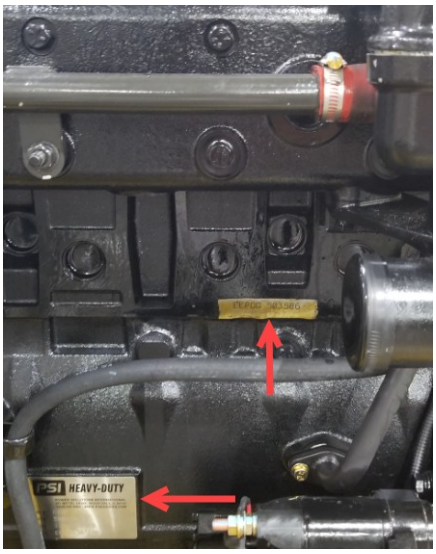
Please pay special attention to the NOTES, CAUTIONS, and WARNINGS. WARNINGS remind you to be careful in areas where carelessness can cause personal injury. CAUTIONS are given to prevent you from error that could cause damage to the equipment. NOTES give you added information designed to help you.

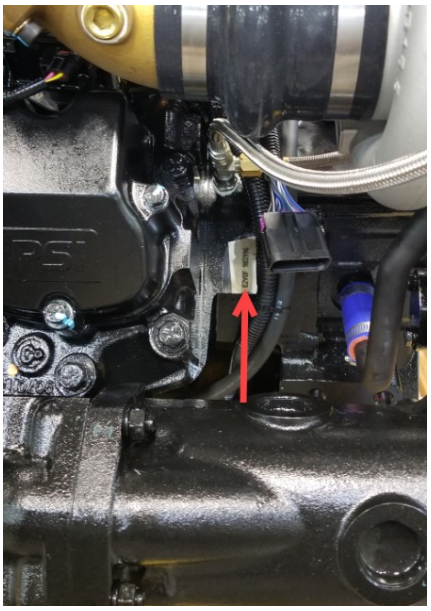
The descriptions and specifications contained in this manual were in effect at the time of publication. PSI Engines reserves the right to discontinue models at any time, or to change specifications or design without notice and without incurring obligation.

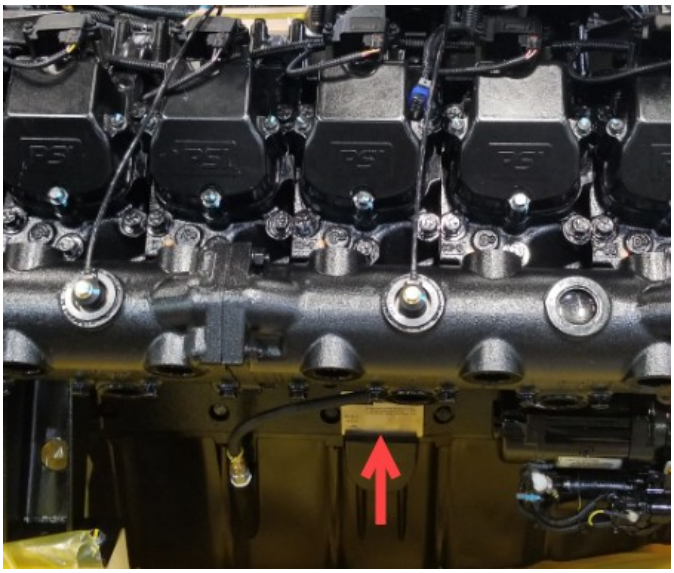
Engine Identification

An identification label is affixed to the left side of the engine block when viewing it from the rear of the engine. The label contains the engine model number, base engine part number, date of build, and PSI heavy-duty serial number. The PSI heavy-duty serial number is a unique number that identifies the engine from other PSI engines. The engine model and serial number are required when seeking information concerning the engine and/or ordering replacement service parts.

The engine is also stamped with the engine model and serial number. The location of the stamped number varies depending on engine size. The pictures to the right show the 3 possible locations of where the engine stamp can be located.







Parts and Service

Replacement parts can be obtained from PSI Engines by calling the Aftermarket Parts Department at 888-331-5769 or parts@psiengines.com. The engine model and serial number will be required when seeking information and/or ordering parts.

Service and technical support for PSI Engines can be obtained by contacting the Service Department at 888-331-5764 or via email at service@psiengines.com.

Service Literature

Additional operator manuals and service manuals for specific PSI Engines can be obtained by contacting the Parts or Service Department at 888-331-5769 or via email at parts@psiengines.com.

Low-Load Engine Operations

Operation of PSI HD engines at low-load conditions should be limited to no more than one (1) hour per twenty-four (24) hour period. If the application requires extended time at light loads, it is recommended that the engine load be increased to at least 70% of mechanical rating for a minimum of two (2) hours per fifty (50) hours of low-load operation, this defines a less than 30% of published prime rate mechanical load.

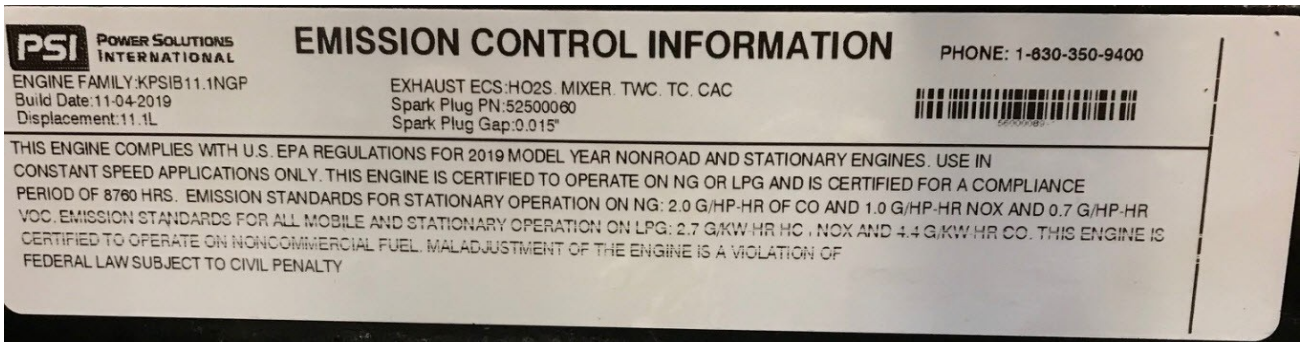
Exceeding the recommendation can result in:

- Abnormal high engine oil consumption
- Degradation in engine oil due to excessive combustion gas blow-by
- Accumulation of carbon deposits in the engine power cylinder, resulting in knock system malfunction
- Reduced life of engine power cylinder

Certified Engine Emissions Information

The engine installed in your equipment is certified by POWER SOLUTIONS, INTERNATIONAL, INC. with the U.S. Environmental Protection Agency and the California Air Resources Board. The engine assembly is certified by PSI and is installed into your equipment by the equipment manufacturer following PSI's installation guidelines. The PSI certified engines have an emission label on or near the valve cover that identifies the engine emission family and the standards the engine is certified to. The label also provides some information regarding the maintenance of your engine.

Example Label:



The engine's emission control system does not require any adjustments, but the engine does require Preventative Maintenance (PM). Your obligation as the owner of the engine/equipment is to follow the engine's PM requirements outlined in this manual and to keep the engine in the proper working order. The equipment your engine is installed in will have a malfunction indicator lamp (MIL) for diagnosis of the engine's emission control system. If this lamp is illuminated it is important to have the engine repaired. Failure to keep the engine in the proper state of repair can affect the performance of the engine's emission control system. Any unapproved modification to the engine's emission control system may potentially violate the engine's emission certification and may be subject to civil penalty.

The equipment manufacturer and/or equipment dealer will be your best resource regarding the proper support and information pertaining to the PSI certified engine and the equipment. Please contact the equipment manufacturer or equipment dealer first for questions and further information. You may contact PSI directly if you are unable to reach the equipment manufacturer or dealer. The PSI Service Department can be contacted at 888-331-5764.

Your PSI certified engine is covered by an Emission Control System Warrant (Warranty Statement contained in this section). Your equipment and engine is warranted to you by the equipment manufacturer. In the event you are unable to receive warranty from the equipment manufacturer or equipment dealer you can contact PSI directly for assistance with your PSI certified engine emission control system warranty. The PSI Warranty Department can be contacted at 888-331-5764.

US EPA EMISSION CONTROL WARRANTY STATEMENT

YOUR WARRANTY RIGHTS AND OBLIGATIONS

The **United States Environmental Protection Agency** and **Power Solutions International, Inc.** are pleased to explain the **emission control system warranty** on your 2014 or later model year later large spark-ignition (LSI) engine. New LSI engines must be designed, built and equipped to meet the US EPA's stringent emission standards. Power Solutions International, Inc. must warrant the emission control system on your LSI engine for the periods of time listed below provided there has been no abuse, neglect or improper maintenance of your LSI engine.

Your emission control system may include parts such as the carburetor, regulator or fuel-injection system, ignition system, engine computer unit (ECM), catalytic converter and air induction system. Also included may be sensors, hoses, belts, connectors and other emission-related assemblies.

Where a warrantable condition exists, Power Solutions International, Inc. will repair your LSI engine at no cost to you including diagnosis, parts and labor.

MANUFACTURER'S WARRANTY COVERAGE

The 2015 and later large spark-ignition engines are warranted for **2500 hours** or **three years,** whichever occurs first (**3500 hours** or **five years** for high cost warranty parts). If any emission-related part on your engine is defective, the part will be repaired or replaced by Power Solutions International, Inc.

OWNER'S WARRANTY RESPONSIBILITIES

As the equipment and LSI engine owner, you are responsible for the performance of the **required maintenance listed in your owner's manual**. Power Solutions International, Inc. recommends that you retain all receipts covering maintenance on equipment and LSI engine, but Power Solutions International, Inc. cannot deny warranty solely for the lack of receipts or for your failure to ensure the performance of all scheduled maintenance.

As the equipment or LSI engine owner, you should however be aware that Power Solutions International, Inc. may deny you warranty coverage if equipment or LSI engine or a part has failed due to abuse, neglect, improper maintenance or unapproved modifications.

Your engine is designed to operate on Natural Gas and/or LPG. Use of any other fuel may result in your engine no longer operating in compliance with the US EPA’s emissions requirements.

You are responsible for presenting your equipment or LSI engine to a Power Solutions International, Inc. distribution center as soon as a problem exists. The warranty repairs should be completed by the dealer as expeditiously as possible.

If you have any questions regarding your warranty rights and responsibilities, you should contact Power Solutions International, Inc. via telephone at **1-800-551-2938** or contact Power Solutions International, Inc. in writing at:

Power Solutions International, Inc.
201 Mittel Dr.
Wood Dale, IL 60191

or

Fax: 888-331-5764

DEFECTS WARRANTY REQUIREMENTS:

(a) The warranty period begins on the date the engine or equipment is delivered to an ultimate purchaser.

(b) **General Emissions Warranty Coverage.** Power Solutions International, Inc. must warrant each LSI engine to the ultimate purchaser and each subsequent owner that the engine is:

(1) Designed, built, and equipped so as to conform with all applicable regulations adopted by the US EPA; and

(2) Free from defects in materials and workmanship that causes the failure of a warranted part for a period of 2500 hours or three years, whichever occurs first (3500 hours or five years for high cost warranty parts).

(c) The warranty on emissions-related parts will be interpreted as follows:

(1) Any warranted part that is not scheduled for replacement as required maintenance in the written instructions required by subsection (d) must be warranted for the warranty period defined in Subsection (b)(2). If any such part fails during the period of warranty coverage, it must be repaired or replaced by the manufacturer according to Subsection (4) below. Any such part repaired or replaced under the warranty must be warranted for the remaining warranty period.

(2) Any warranted part that is scheduled only for regular inspection in the written instructions required by subsection (d) must be warranted for the warranty period defined in Subsection (b)(2). A statement in such written instructions to the effect of “repair or replace as necessary” will not reduce the period of warranty coverage. Any such part repaired or replaced under warranty must be warranted for the remaining warranty period.

(3) Any warranted part that is scheduled for replacement as required maintenance in the written instructions required by subsection (d) must be warranted for the period of time prior to the first scheduled replacement point for that part. If the part fails prior to the first scheduled replacement, the part must be repaired or replaced by the engine manufacturer according to Subsection (4) below. Any

such part repaired or replaced under warranty must be warranted for the remainder of the period prior to the first scheduled replacement point for the part.

(4) Repair or replacement of any warranted part under the warranty must be performed at no charge to the owner at a warranty station.

(5) Notwithstanding the provisions of Subsection (4) above, warranty services or repairs must be provided at all manufacturer distribution centers that are franchised to service the subject engines.

(6) The owner must not be charged for diagnostic labor that leads to the determination that a warranted part is in fact defective, provided that such diagnostic work is performed at a warranty station.

(7) The manufacturer is liable for damages to other engine components proximately caused by a failure under warranty of any warranted part.

(8) Throughout the emissions warranty period defined in Subsection (b)(2), the manufacturer must maintain a supply of warranted parts sufficient to meet the expected demand for such parts.

(9) Any replacement part may be used in the performance of any warranty maintenance or repairs and must be provided without charge to the owner. Such use will not reduce the warranty obligations of the manufacturer.

(10) Add-on or modified parts that are not exempted by the US EPA and may not be used. The use of any non-exempted add-on or modified parts will be grounds for disallowing a warranty claim. The manufacturer will not be liable to warrant failures of warranted parts caused by the use of a non-exempted add-on or modified part.

(d) Emission Warranty Parts List.

(1) Fuel Metering System
- (i) Fuel injection system.
- (ii) Air/fuel ratio feedback and control system.
- (iii) Carburetor system (internal parts and/or pressure regulator or fuel mixer or injection system).

(2) Air Induction System
- (i) Intake manifold(s) or air intake system.
- (ii) Turbocharger systems.
- (iii) Air filter

(3) Ignition Control System
- (i) Engine Wire Harness
- (ii) Ignition coil and spark plugs.

(4) Positive Crankcase Ventilation (PCV) System.
- (i) PCV Valve.

(5) Catalyst System
- (i) Exhaust manifold.
- (ii) Catalytic converter. *
- (iii) Engine Control Module (ECM). *
- (iv) Electronic Pressure Regulator (EPR).

(6) Miscellaneous items Used in Above Systems
- (i) Vacuum, temperature, and time sensitive valves and switches.
- (ii) Sensors used for electronic controls.
- (iii) Hoses, belts, connectors, assemblies, clamps, fittings, tubing, sealing gaskets or devices, and mounting hardware.
- (iv) Pulleys, belts and idlers.

* Indicates high cost warranty item

Operating Instructions

Fuel Systems

The fuel system installed on your engine operates with a Direct Electronic Pressure Regulator (DEPR) and a diaphragm style variable venturi mixer. The DEPR will regulate the fuel pressure being delivered to the mixer; these parts are not adjustable and should not be tampered with. Proper inlet fuel pressure is critical to the proper operation of the fuel system and engine; you should the review the pressure, volume, and BTU recommendations prior to commissioning the engine.

Governors

PSI HD Engines have an isochronous governor installed. The governor controls the movement of the throttle via a 0-5 volt signal and a ground provided by the Engine Control Module. The throttle allows the correct amount of air to enter the engine; this movement is monitored by using 2 throttle position sensors located internal to the throttle. The ECM monitors various engine sensors to determine what the correct throttle position should be.

Oil Pressure Reading

The oil pressure reading shows the engine lubrication system pressure in pounds per square inch (psi) and should be checked frequently to ensure that the system is functioning correctly. Should the pressure fluctuate or drop, stop the engine and find the cause. Do not operate the engine at lower than normal oil pressure (see maintenance schedule for minimum engine oil pressure).

CAUTION: Do not continue to operate your engine below the normal operating range. Severe engine damage could occur.

Coolant Temperature

The coolant temperature reading will indicate overheating which may arise from low coolant level, plugged radiator, loose fan belt or faulty thermostat. Coolant level should be checked daily.

CAUTION: If the engine continues to overheat, have the cooling system checked and serviced.

Voltage Reading

The PSI HD product operates on a 24 volt electrical system. The voltage reading indicates the battery charging voltage. If the meter consistently indicates less than 26 volts or more than 31 volts under normal operating conditions, you should have the engine electrical system checked by a qualified service technician.

Tachometer/Hourmeter

The tachometer indicates the engine speed in hundreds of revolutions per minute (rpm). It serves, as a guide to ensure that engine speed is set correctly.

The hour meter records the hours of operation and is used to determine when periodic maintenance is required.

Starting the Engine

WARNING: All internal combustion engines give off various fumes and gases while running. Do not start or run the engine in a closed or poorly ventilated building where exhaust gases can accumulate. Avoid breathing these gases as they may contain poisonous carbon monoxide, which can endanger your health or life if inhaled steadily for even a few minutes.

If the engine is equipped with a manual clutch it must be disengaged prior to starting the engine. Starting the engine with the clutch engaged imposes unnecessary strain on the battery, starter, and driven components.

CAUTION: If the engine stalls or falters during starting, wait 3 to 4 seconds before re-engaging the starter. This will prevent possible damage to the starter and the engine. DO NOT operate the starter for periods longer than 30 seconds at a time. An interval of at least 1-minute should be observed between cranking periods to protect the starter from overheating.

NG Fuel Systems

Turn on the gas supply to the engine. Turn the ignition key to the START position. After the engine starts return the key to the ON position.

Stopping the Engine

Return the engine to idle speed. If the machine is equipped with a clutch, move the clutch lever to the disengaged position. Run engine for a few minutes at idle to allow the coolant and oil systems to cool down before turning the ignition switch to the OFF position.

WARNING: Avoid injury when checking a Hot Engine. Allow the engine to cool down before removing the radiator cap.

CAUTION: Before restarting the engine ensure that both the coolant system and the engine oil level have been checked and re-filled if necessary.

Fuel Recommendations

Fuel Quality

For more information on fuel quality please consult PSI Energy Technical Standard 56100019-Fuel Standard. LPG engines and fuel systems are designed to operate on HD-5 or HD-10 specification LPG fuel. Fuel other than HD-5 or HD-10 may cause harm to the engine's emission control system and a warranty claim may be denied on this basis if operators can readily find the proper fuel. Use of any other fuel may result in your engine no longer operating in compliance with CARB or EPA emissions requirements.

Spark plugs

Always use the recommended spark plugs for your engine. Hotter or colder plugs, or similar plugs that are not exact equivalents to the recommended plugs, can cause permanent engine damage, reduce the engines useful life, and cause many other problems such as hard starting, spark knock and run-on. Installing new spark plugs regularly is one of the best ways to keep your engine at peak performance.

Power Loss at Higher Elevations & Temperatures

All engines will experience power loss when operated at elevations above sea level or at temperatures above 77 degrees Fahrenheit. For more information please consult PSI Energy Technical Standard 56100020.

MAINTENANCE INSTRUCTIONS

Initial Start Up Maintenance

The initial start-up checks must be made before putting the engine into service. Please refer to the Maintenance Schedule and perform the initial start-up operations in the sequence shown in column 1.

Routine Maintenance

Routine maintenance provides the best solution for making sure that the engine is ready when you are. The following are some routine service points:

- Make daily checks of the engine oil and coolant levels
- Repair any oil or coolant leaks immediately
- Check battery condition and cables frequently
- Keep the engine air filter clean
- Monitor engine coolant temperature
- Monitor engine oil pressure
- Check voltmeter and charging system

Scheduled Preventive Maintenance

Refer to the Maintenance Schedule to ensure that all of the maintenance items listed are checked and replaced as recommended at the hours shown.

Engine Oil Level Check

The engine oil level should be checked daily. It is recommended that the oil be checked just before the engine is started for the first time for that day. The oil level should be between the ‘Add’ and the ‘Full’ marks on the dipstick.

CAUTION: Do not operate the engine with the oil level below the bottom or ‘Add’ mark on the dipstick, or above the top or ‘Full’ mark on the dipstick.

Adding Engine Oil

It is normal to add some oil in the period of time between oil changes. The amount will vary with the severity of operation. When adding or replacing engine oil, be sure the oil meets or exceeds the recommended specification.

Changing Engine Oil and Filter

The first oil and filter change should occur after 50 hours of operation.

The oil and filter should be changed more often if the engine is operating in dusty or extremely dirty areas, or during cold weather. No oil additives or break-in oil change is required.

Engine Oil Quality

To achieve proper engine performance and durability, it is important that you use only engine lubricating oils of the correct quality in your engine. Proper quality oils also provide maximum efficiency for crankcase ventilation systems, which reduces pollution.

A multi-viscosity, low-ash gas engine oil should be used. Straight weight engine oils are not recommended. Do not use oils that are formulated only for use in diesel engines.

SAE No.	Sulfated Ash Content by Weight	Recommended Oil
15w-40	0.25 - 0.5%	Chevron HDAX 5200 Low Ash Gas Engine Oil

Engine Oil Recommendation

Multi-viscosity oil is recommended. SAE 15W-40 is recommended for your PSI heavy-duty industrial product. Synthetic oils are not recommended for industrial or stationary engines. The ash content should be less than 0.5% ash content, the use of a median ash content will void the catalyst warranty.

Oil Filter

The filter protects your engine from harmful, abrasive, or sludge particles without blocking the flow of oil to vital engine parts.

To replace the filter, use a proper filter wrench to remove the filter.

Clean the filter mounting base and lightly coat the gasket surface of the new filter with engine oil. Hand tighten the filter until the gasket contacts the base, then tighten another ½ turn. Fill the engine with the correct amount of oil and run the engine. Verify oil pressure is okay and check for oil leaks at the drain plug and oil filter gasket. Tighten as necessary to stop any oil leakage noted.

Engine Air Cleaner

The engine air cleaner filters air entering the engine intake system and acts as a silencer and flame arrester when assembled to the intake system. Air that contains dirt and grit produces an abrasive fuel mixture and can cause severe damage to the cylinder walls and piston rings. Damage to the cylinder walls and piston rings will cause high oil consumption and shorten engine life. Thus, it is extremely important that the air cleaner be serviced properly at the recommended intervals. PSI recommends using only UL recognized filter elements to ensure backfire suppression.

CAUTION: Service the air cleaner more frequently under severe dusty or dirty conditions.

Remove the primary air cleaner element from the air cleaner assembly and inspect the element for foreign material restrictions or signs of excessive wear or damage. Replace the element if necessary. Remove all dust and foreign matter from the air cleaner housing. Reinstall the air cleaner element. Reinstall the air cleaner cup, and securely fasten the retaining clips.

Cooling System

Coolant Level

Check the coolant level of the radiator daily and only when the engine is cool. Do this just prior to starting the engine for the first time each day.

Maintain the coolant level at ¾ to 1½ inches below the filler neck seat of the radiator when the coolant is cold. Whenever coolant level checks are made inspect the condition of the radiator cap rubber seal. Make sure it is clean and free of any dirt particles which would keep it from seating on the filler neck seat. Rinse off with clean water if necessary. Also make sure that the filler neck seat is free of any dirt particles.

WARNING: Never remove the radiator cap under any conditions while the engine is operating or hot. Failure to follow these instructions could result in damage to the cooling system, engine, or cause personal injury. To avoid having scalding hot coolant or steam blow out of the radiator, use extreme caution when removing the radiator cap from a hot radiator. If possible, wait until the engine has cooled, then wrap a thick cloth around the radiator cap and turn slowly to the first stop. Step back while the pressure is released from the cooling system. When all the pressure has been released, press down on the cap and remove it slowly.

DO NOT add coolant to any engine that has become overheated until the engine cools. Adding coolant to an extremely hot engine can result in a cracked block or cylinder head.

The engine manufacturer recommends the cooling system be filled with a 50/50 mixture of antifreeze and water. A NAPS-free coolant (free from nitrates, amines, phosphates and silicates) should be used.

Variety	Freezing/Boiling Point (°F)	Recommended Type
OAT Long-Life Engine Coolant	-34 / 265	Chevron Delo XLC Antifreeze/ Coolant 50/50 Mix

Plain water may be used in an emergency (except in freezing temperatures) but replace it with the specified coolant as quickly as possible to avoid damage to the system.

Radiator

Inspect the exterior of the radiator for obstructions. Remove all bugs, dirt or foreign material with a soft brush or cloth. Use care to avoid damaging the core fins. If available, use low pressure compressed air or a stream of water in the opposite direction of the normal air flow. Check all hoses and connections for leaks. If any of the hoses are cracked, frayed, or feel spongy, they must be replaced.

Fan Belts

The water pump is belt driven. The same belt may also drive the fan and/or the alternator. The drive belts should be properly adjusted at all times. A loose belt can cause improper alternator, fan and water pump operation, in addition to overheating.

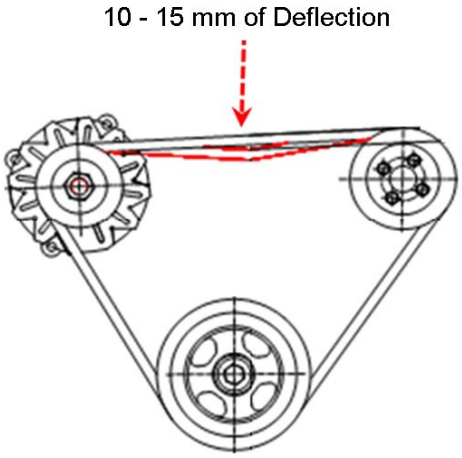
Serpentine Belt

Some PSI HD engines utilize serpentine belts on the front of the engine. This type of belt system incorporates a belt tensioning device which keeps the belt at the proper tension.

This belt should be checked routinely for cracks or 'checking' on the groove side of the belt. If cracks or 'checking' are apparent the belt must be changed.

V-Type Belt

V-Type belts are generally tensioned by adjusting the alternator, or through a mechanical belt tensioner. The belt is generally correctly tensioned when there is 10-15 mm of deflection when pressed down with your thumb.



Fuel Filter

LPG Engines

LP, fuel like all other motor fuels is subject to contamination from outside sources. Refueling of the equipment tank and removal of the tank from the equipment can inadvertently introduce dirt and other foreign matter into the fuel system. It is therefore necessary to filter the fuel prior to entering the fuel system components down stream of the tank. Install a inline fuel filter to remove the dirt and foreign matter from the fuel, which is replaceable as a unit only. Maintenance of the filter is critical to proper operation of the fuel system and should be replaced according to the maintenance schedule or more frequently under severe operating conditions.

Fuel Shut-Off

LPG and NG engines are equipped with a fuel shut-off. The fuel shut-off is located between the fuel supply and the IEPR/DEPR. The purpose of the fuel shut off is to prevent or allow fuel flow from the supply source to the engine fuel system. The shut off is a 24-volt solenoid (Normally closed) that is controlled by the engine ECM.

Ignition Systems

Types of Ignition Systems

PSI heavy-duty engines utilize an ECU controlled, distributor less, 24V ignition system. Using coil-on-plug ignition, timing wheels and magnetic pick-up sensors mounted on the crank and cam shafts, allows the ECU to adjust ignition timing automatically. The coils, crank position and cam position sensors are standard for the entire engine family.

Ignition Timing

Proper adjustment of the ignition timing must be obtained to provide the optimum engine power output and economy. Ignition timing is controlled by the ECU and is not adjustable. The ignition coils are driven by the ECU using a table-based variable ignition timing strategy.

NOTE: Do not attempt to adjust timing on the ignition systems. Timing is not adjustable.

Spark Plugs

Spark plugs should be replaced at the recommended intervals described in the Maintenance Schedule. Use only the recommended spark plug or an equivalent as described in the General Specifications.

Spark plugs are gapped to .016" by the manufacturer and should not be adjusted. Attempting to adjust the gap could damage the spark plug and result in undesirable engine operation.

When removing spark plugs, always note which cylinder each plug came out of. Look at the porcelain around the center electrode of each plug. You can detect many engine problems from the color and type of deposits that have built up on the white porcelain. For example, if the deposits are a glossy brown, that cylinder is burning excess oil. If the deposits are a very dark gray or sooty black color, your engine is running rich, and you are burning excess fuel. The optimum color of the deposits on the porcelain is light tan or light brown. This shows optimum fuel mixture and proper engine running conditions. If the deposits are almost white, the engine may be running excessively lean.

Lean running is very detrimental to your engine life and should be corrected immediately. If one or more cylinders are burning oil, the smoke from the engine will be a blue-gray color. Most common causes are piston rings (worn out or not broken in) and valve stem seals (cut, nicked, or worn out). If the engine is running rich, the exhaust smoke will be a sooty black color and it will smell like raw fuel.

Storage

One to Six Months

If the engine or machine is to be placed in storage for a period of one to six months it is recommended that the following steps be followed:

- Store indoors with a consistent temperature and low humidity, if possible.
- Protect the air cleaner inlet from water entry.
- Protect the exhaust outlet or muffler outlet from water entry.
- Check the coolant strength and top off radiator.
- Use a weather proof storage bag, with desiccant bag inside, for extra protection.

At the end of each and every three months storage periods:

- Carefully check all drive belts, paying particular attention to the point where the straight run of the belt starts to bend around the pulley. Check the vee groove in the pulley for corrosion
- Check the level of coolant (must be anti-freeze inhibited).
- Check the level of oil in the sump on the dipstick.
- Rotate crankshaft by hand to re-distribute load on the valve train and to keep seals from becoming stuck. Be sure engine rests in a different position (~180 degrees).
- If battery is still installed in unit, slowly recharge battery. This can be done every month to extend the service life of the battery.

Storing an engine over six months:

Storage preparation:

- Drain the engine crankcase and refill with recommended oil.
- Change the oil filter.
- Disconnect and remove the battery.
- Clean exterior surface of the engine.
- If the engine is equipped with an automotive type clutch or PTO clutch, make sure that the clutch is disengaged.

STORAGE - continued

Storing an engine over Six months:

At the end of each and every six month storage period:

- Check that existing preservation of all external surfaces is sound and complete, paying particular attention to crankshaft lip seal surfaces, re-preserve as necessary.
- Ensure that all open aperture protective covers (air intake, exhaust manifolds, etc) are securely positioned.
- Perform all 3-month inspections previously listed.

Note: The lubricating oil and fully primed filter must be replaced with oil to the listed specification every twelve months, even though the oil has not been used. Oil left standing in an engine will oxidize and can be contaminated by condensation within the crankcase.

Removing an engine from storage

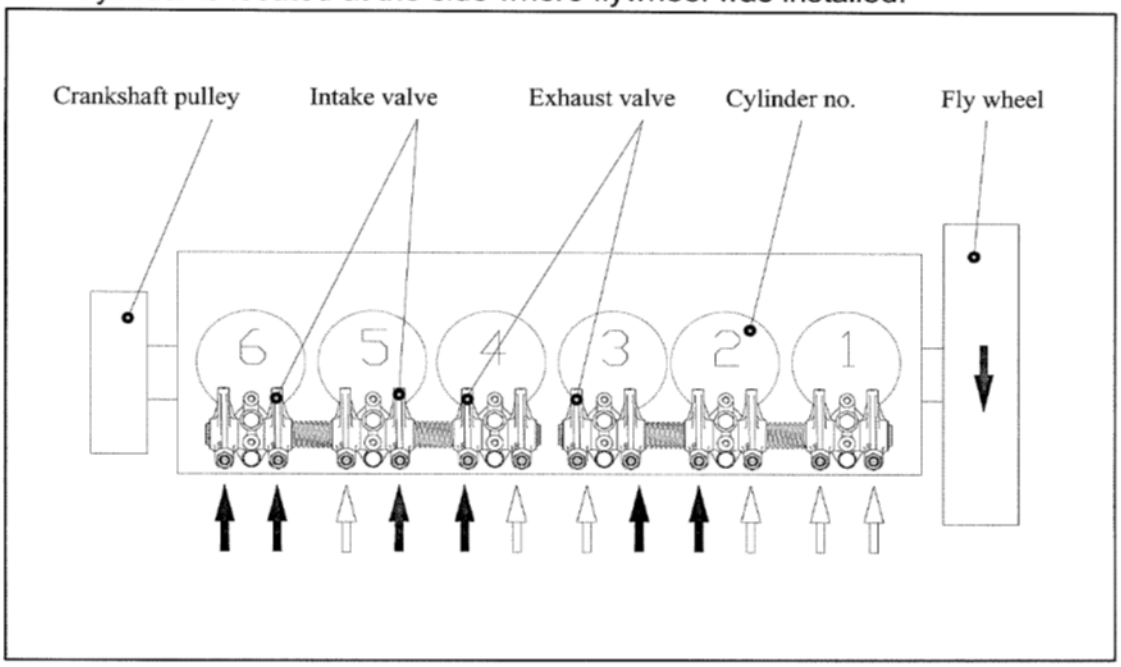
When removing an engine or machine from storage, the following steps should be taken to be sure the engine is in proper operating condition:

- Remove all protective storage coverings from engine / machine.
- Check engine oil level. If engine has been dormant for over 12 months change engine oil and filter.
- Check engine coolant level. If engine has been dormant for over 12 months, drain and refill with fresh coolant.
- Inspect drive belt system. Check for cracks in belt and corrosion on pulleys. Replace and clean as needed. If applicable grease pulley bearings.
- Install a new or fully charged battery. If installing a used battery check electrolyte levels.
- Inspect all engine systems thoroughly for leaks, tears, broken wires, etc.
- Rotate engine by hand at least 360 degrees before attempting to start to be sure engine rotates smoothly.
- When starting engine watch all gauges closely. Be sure engine oil pressure rises within 10 seconds of engine run time. If no oil pressure shut down engine.
- Allow engine to run at idle for approximately 5 minutes, then raise engine to a ‘high idle’, 1000-1500 rpm and bring to full operating temperature. Watch all gauges closely, if any system is out of specification shut down engine immediately and find cause.
- After engine has successfully reached operating temperature shut down and re-check all fluid levels and systems.

Valve Lash Adjustment

8.1L & 11L Valve Lash Adjustment

1. Remove all valve covers from the engine.
2. Rotate the crankshaft until the engine is at TDC #1. Use the markings on the flywheel to determine when the engine is at TDC. Check the rocker arms on cylinder #1, which is the cylinder closest to the **flywheel**. If the rocker arms are slightly loose and can be moved around a little, the camshaft is in the correct spot to begin checking and setting valve lash. If the rocker arms feel tight, rotate the crankshaft 360 degrees until it is at TDC #1 again, then check the rockers on cylinder #1 – they should now move slightly.
    a. Another way to verify that the camshaft is in the correct position is to watch the rockers on cylinder #1 as the crankshaft is rotated. If the rockers are moving as the crankshaft approaches TDC #1, the crank will need to be rotated 360 degrees to set the engine for timing. If the rockers on cylinder #1 do not move as you approach TDC #1, the timing is correct, and you may begin checking valve lash.
3. Start with the valves indicated on the picture below with a **WHITE ARROW**.
    - No. 1 Cylinder is located at the side where flywheel was installed.



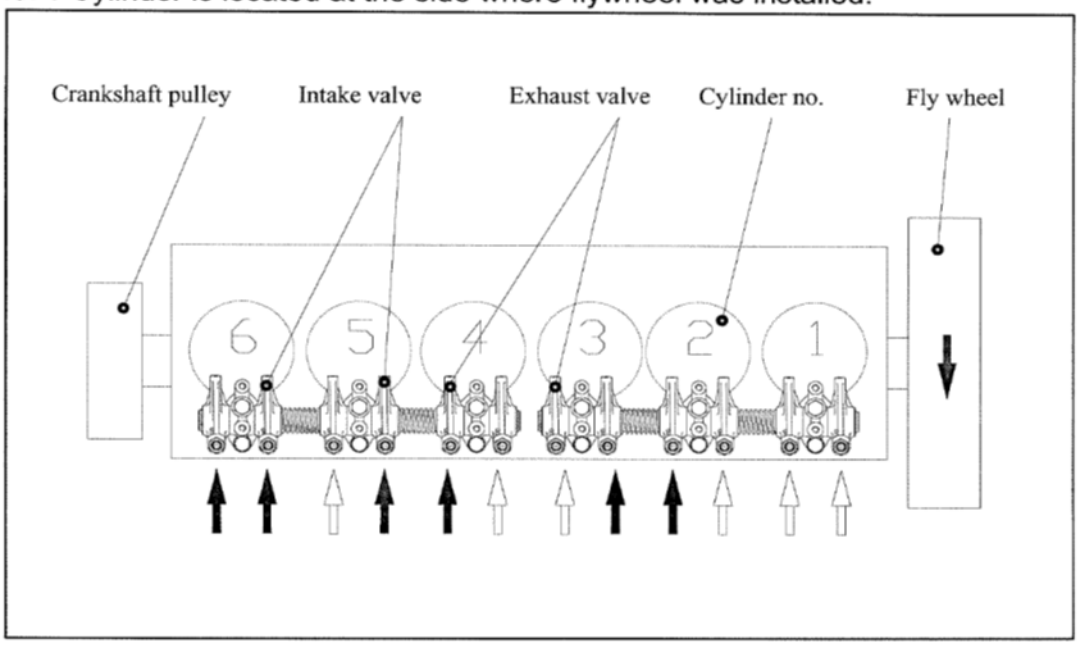
4. Use a 17mm wrench to loosen the nut around the lash adjuster you are going to set. Use a screwdriver to set the valve lash adjuster so that the feeler gauge of your desired thickness fits into the gap between the rocker arm and the valve tip. The gauge should fit snugly but should still slide in and out – don't clamp the rocker arm onto the feeler gauge.
    a. 8.1 Engines: .30MM (.012")
    b. 11L Engines: .40MM (.016")

Note:

- The same measurement is used on both intake and exhaust valves

5. Once the proper angle is set, use the screwdriver to hold the adjuster in place while tightening the locking nut to 36 ft/lbs with a 17MM wrench.
    a. Repeat this procedure on all the valves marked with a white arrow.
6. Once all six valves have been measured, adjusted, and marked, rotate the crankshaft around once fully so that it comes back to the TDC#1 mark on the flywheel. The rockers on cylinder #6, which is the cylinder closest to the crank pulley, should now move slightly when you pull on them.

- No. 1 Cylinder is located at the side where flywheel was installed.

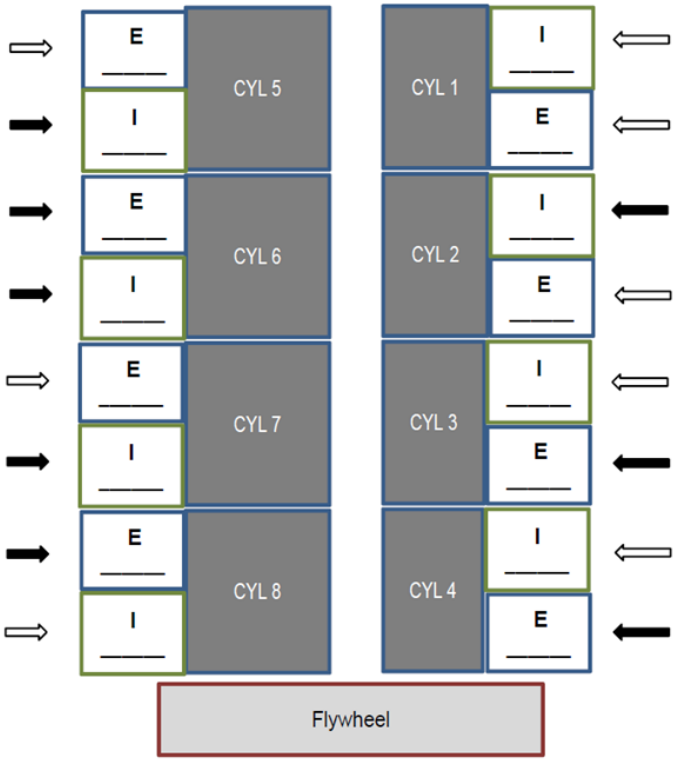


7. Go back to step 3 and repeat the procedures for adjusting and marking the six valves indicated on the drawing above with the black arrow.
    a. Check to make sure all valves have been adjusted to the proper clearance and all jamnuts have been tightened.

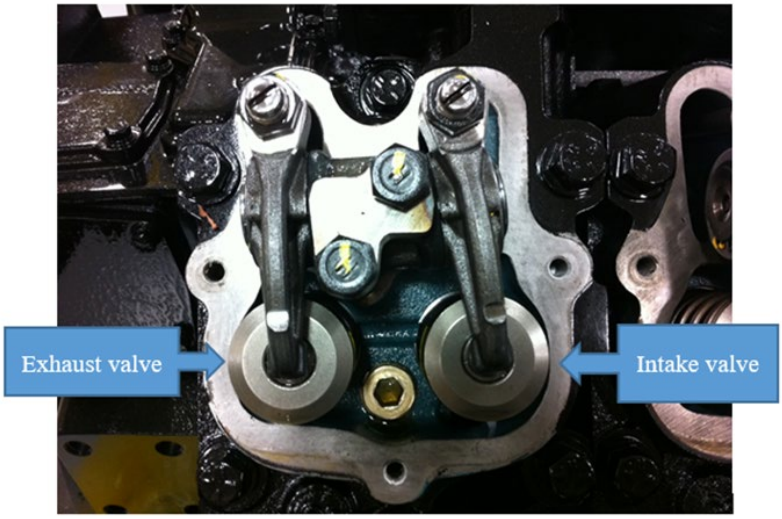
14L Valve Lash Adjustment

1. Remove all valve covers from the engine.
2. Rotate the crankshaft until the engine is at TDC #1 using the reference marks on the flywheel. Check the rocker arms on cylinder #1, which is the cylinder at the front right corner of the engine. If the rocker arms are slightly loose and can be moved around a little, the camshaft is in the correct spot to begin checking and setting valve lash. If the rocker arms feel tight, rotate the crankshaft 360 degrees until it is at TDC #1 again, then check the rockers on cylinder #1 – they should now move slightly.
    a. Another way to verify that the camshaft is in the correct position is to watch the rockers on cylinder #1 as the crankshaft is rotated. If the rockers are moving as the crankshaft approaches TDC #1, the crank will need to be rotated 360 degrees to set the engine for timing. If the rockers on cylinder #1 do not move as you approach TDC #1, the timing is correct, and you may begin checking valve lash.

3. Start with the valves indicated on the picture below with a **WHITE ARROW**.

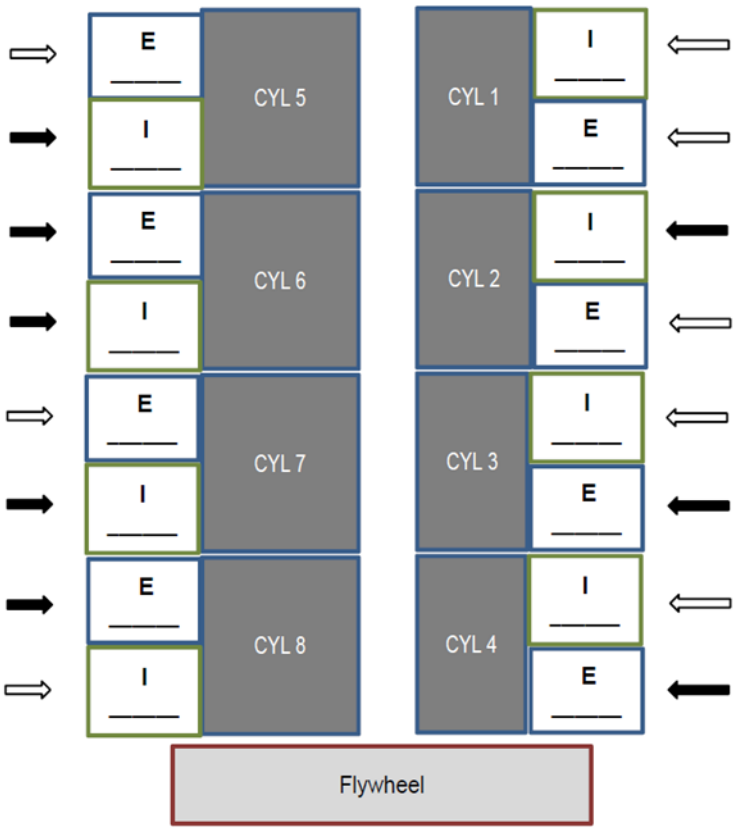


4. Use a 17mm wrench to loosen the nut around the lash adjuster you are going to set. Use a screwdriver to set the valve lash adjuster so that the feeler gauge of your desired thickness fits into the gap between the rocker arm and the valve tip. The gauge should fit snugly, but should still slide in and out – don't clamp the rocker arm onto the feeler gauge.
    a. Exhaust Valves: .40MM (.016")
    b. Intake Valves: .03MM (.012")



5. Once the proper angle is set, use the screwdriver to hold the adjuster in place while tightening the locking nut to 36 lb/ft with a 17mm wrench.
    a. Repeat this procedure on all the valves marked in the drawing with a white arrow.

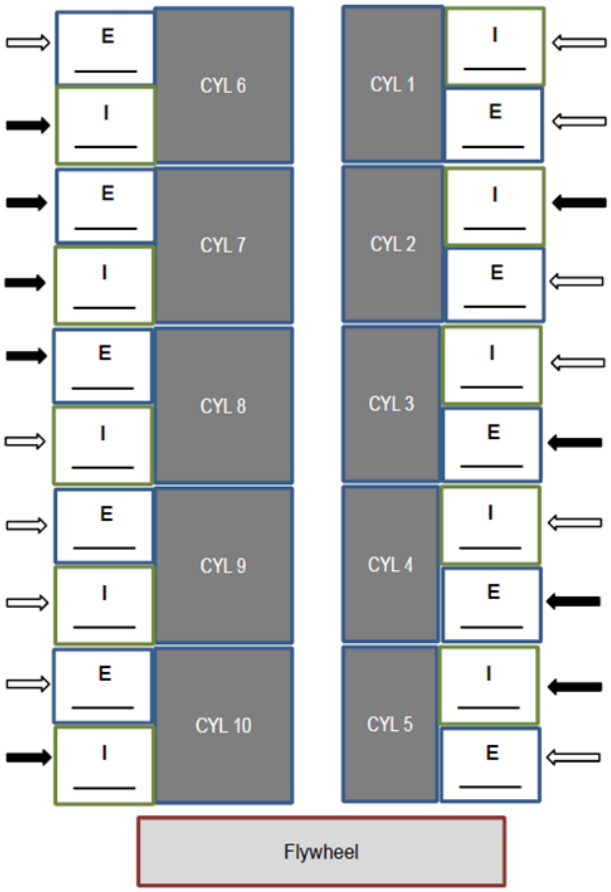
6. Once all eight valves have been measured, adjusted, and marked, rotate the crankshaft around once fully so that it comes back to the TDC#1 mark on the flywheel. The rockers on cylinder #6, which is the second cylinder from the front on the left side of the engine, should now move slightly when you pull on them.



7. Go back to step 3 and repeat the procedures for measuring, adjusting, and marking the eight valves marked on the drawing above with a black arrow.
    a. Check to make sure all valves have been adjusted to the proper clearance, and all jamnuts are tight.

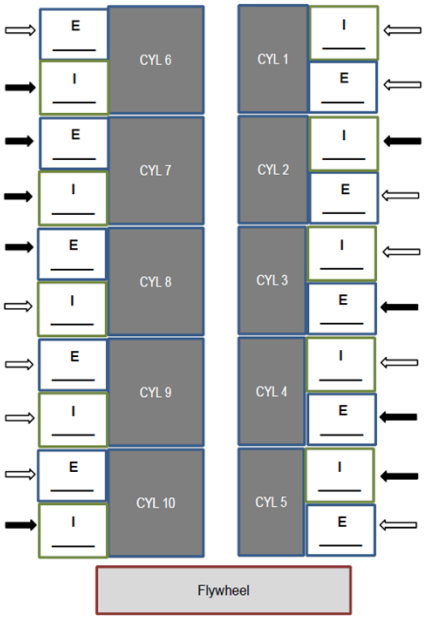
18L Vale Lash Adjustment

1. Remove all valve covers from the engine.
2. Rotate the crankshaft until the engine is at TDC #1 using the reference marks on the flywheel. Check the rocker arms on cylinder #1, which is the cylinder at the front right corner of the engine. If the rocker arms are slightly loose and can be moved around a little, the camshaft is in the correct spot to begin checking and setting valve lash. If the rocker arms feel tight, rotate the crankshaft 360 degrees until it is at TDC #1 again, then check the rockers on cylinder #1 – they should now move slightly.
    a. Another way to verify that the camshaft is in the correct position is to watch the rockers on cylinder #1 as the crankshaft is rotated. If the rockers are moving as the crankshaft approaches TDC #1, the crank will need to be rotated 360 degrees to set the engine for timing. If the rockers on cylinder #1 do not move as you approach TDC #1, the timing is correct, and you may begin checking valve lash.
3. Start with the valves indicated on the picture below with a **WHITE ARROW**.



4. Use a 17mm wrench to loosen the nut around the lash adjuster you are going to set. Use a screwdriver to set the valve lash adjuster so that the feeler gauge of your desired thickness fits into the gap between the rocker arm and the valve tip. The gauge should fit snugly but should still slide in and out – don't clamp the rocker arm onto the feeler gauge.
    a. Exhaust Valves: .40MM (.016")
    b. Intake Valves: .30MM (.012")

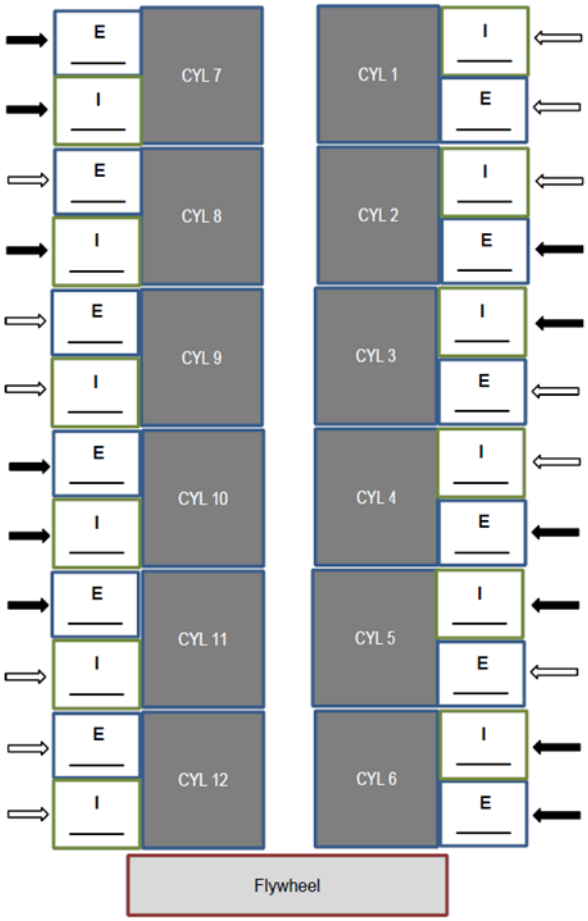
5. Once the proper angle is set, use the screwdriver to hold the adjuster in place while tightening the locking nut to 36 lb/ft with a 17mm wrench.
    a. Repeat this procedure on all the valves marked with a white arrow.
6. Once all 11 valves have been measured, adjusted, and marked, rotate the crankshaft around once fully so that it comes back to the TDC#1 mark on the flywheel. The rockers on cylinder #7, which is the second cylinder from the front on the left side of the engine, should now move slightly when you pull on them.



7. Go back to step 3 and repeat the procedures for measuring, adjusting, and marking the nine valves marked on the drawing above with a black arrow.
    a. Check to make sure all valves have been adjusted to the proper clearance, and all jamnuts are tight.

22L Valve Lash Adjustment

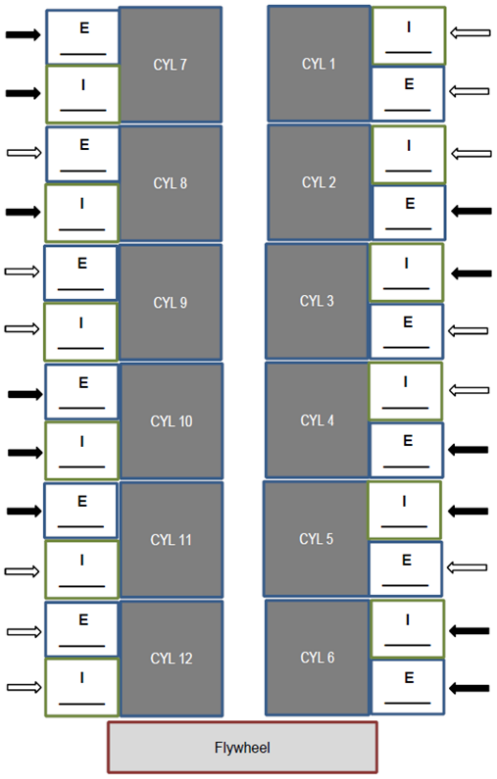
1. Remove all valve covers from the engine.
2. Rotate the crankshaft until the engine is at TDC #1 using the reference marks on the flywheel. Check the rocker arms on cylinder #1, which is the cylinder at the front right corner of the engine. If the rocker arms are slightly loose and can be moved around a little, the camshaft is in the correct spot to begin checking and setting valve lash. If the rocker arms feel tight, rotate the crankshaft 360 degrees until it is at TDC #1 again, then check the rockers on cylinder #1 – they should now move slightly.
    a. Another way to verify that the camshaft is in the correct position is to watch the rockers on cylinder #1 as the crankshaft is rotated. If the rockers are moving as the crankshaft approaches TDC #1, the crank will need to be rotated 360 degrees to set the engine for timing. If the rockers on cylinder #1 do not move as you approach TDC #1, the timing is correct, and you may begin checking valve lash.
3. Start with the valves indicated on the picture below with a WHITE ARROW.



4. Use a 17mm wrench to loosen the nut around the lash adjuster you are going to set. Use a screwdriver to set the valve lash adjuster so that the feeler gauge of your desired thickness fits into the gap between the rocker arm and the valve tip. The gauge should fit snugly, but should still slide in and out – don't clamp the rocker arm onto the feeler gauge.
    a. Exhaust Valves: .40MM (.016")
    b. Intake Valves: .30MM (0.12")

5. Once the proper angle is set, use the screwdriver to hold the adjuster in place while tightening the locking nut to 36 lb/ft with a 17mm wrench. Torque the nut to 36 lb/ft.
    a. Repeat this procedure on all the valves marked with a white arrow.

6. Once all 12 valves have been measured, adjusted, and marked, rotate the crankshaft around once fully so that it comes back to the TDC#1 mark on the flywheel. The rockers on cylinder #6, which is the **cylinder closest to the flywheel on the right side of the engine**, should now move slightly when you pull on them.



7. Go back to step 3 and repeat the procedures for measuring, adjusting, and marking the 12 valves marked on the drawing above with a black arrow.
    a. Check to make sure all valves have been adjusted to the proper clearance, and all jamnuts are tight.

Engine Maintenance Requirements

PSI ENERGY STANDBY ENGINE MAINTENANCE GUIDELINES			
56100027 Revision: 3	Service Intervals		
8.1L NA, 8.1L Turbo, 11L, 14L, 18L, 22L	**Initial 50 Hour Service[1]**	**Annual Service**	**Every Two Years**
Check for fluid leaks	X	X	
Check engine oil level	X	X	
Check coolant level	X	X	
Inspect drive belts for tension, cracks, splits, or glazing	X	X	
Inspect air cleaner filter element, replace as needed	X	X	
Inspect electrical system and harnesses for cuts, abrasions or wear	X	X	
Inspect all vacuum lines and fittings for cracks, breaks or hardening	X	X	
Inspect coolant hoses for cracks, swelling or deterioration	X	X	
Inspect Fuel Shut-off Valves for leaks and proper operation	X	X	
Inspect gas piping and hoses for leaks or damage	X	X	
Check air induction piping for leaks	X	X	
Inspect automatic belt tensioners, replace if necessary	X	X	
Check intake manifold for vacuum leaks	X	X	
Inspect exhaust manifold for leaks	X	X	
Inspect exhaust piping for leaks	X	X	
Inspect O_2 sensors and harness for damage/performance	X	X	
Inspect catalyst for mechanical damage and performance	X	X	
Sample engine oil as needed	X	X	
Change engine oil and filter[2]	X	X	
Adjust intake and exhaust valve clearance	X	X	
Clean debris from radiator core	X	X	
Tighten all hose clamps on CAC piping boots	X	X	
Drain LPL vaporizer oil build up (if LP fuel system is installed)	X	X	
Inspect ignition coils and harness		X	
Check crankcase ventilation filter, **Replace** if necessary[3]		X	
Replace spark plugs			X
Drain, flush, and replace engine coolant[2]			X
Replace fan and water pump belts			X
Replace ignition coils			X
Replace throttle body			X

1: First 50 hours only

2: Oil and coolant change intervals can be extended only with a regularly scheduled sampling program

3: On units with replacable crankcase ventilation filter elements: Filter should be changed and the inside of the canister should be wiped clean when the engine oil is changed

PSI ENERGY PRIME POWER AND CONTINUOUS DUTY ENGINE MAINTENANCE GUIDELINES							
56100027 Revision: 3	Service Intervals						
8.1L NA, 8.1L Turbo, 11L, 14L, 18L, 22L	**Initial 50 Hour Service[1]**	**Daily**	**Every 250 Hrs**	**Every 750 hrs**	**Every 8760 hrs or annually**	**Every 24,000 hrs (Top End)**	**Every 48,000 hrs (Overhaul)**
Check for fluid leaks	X	X					
Check engine oil level	X	X					
Check coolant level	X	X					
Inspect drive belts for tension, cracks, splits, or glazing	X		X				
Inspect air cleaner filter element, replace as needed	X		X				
Sample engine oil as needed	X		X				
Change engine oil and filter[2]	X		X				
Inspect electrical system and harnesses for cuts, abrasions or wear	X			X			
Inspect all vacuum lines and fittings for cracks, breaks or hardening	X			X			
Inspect automatic belt tensioners, replace if necessary	X			X			
Inspect coolant hoses for cracks, swelling or deterioration	X			X			
Inspect Fuel Shut-off Valves for leaks and proper operation	X			X			
Inspect gas piping and hoses for leaks or damage	X			X			
Inspect air induction piping for leaks	X			X			
Inspect intake manifold for vacuum leaks	X			X			
Inspect exhaust manifold for leaks	X			X			
Inspect exhaust piping for leaks	X			X			
Inspect O_2 sensors and harness for damage/performance	X			X			
Inspect catalyst for mechanical damage and performance	X			X			
Clean debris from radiator core	X			X			
Measure intake and exhaust valve clearance, reset as necessary	X			X			
Tighten all hose clamps on CAC piping boots	X			X			
Drain LPL vaporizer oil build up (if LP fuel system is installed)	X			X			
Inspect ignition coils, coil boots, and harness				X			
Replace spark plugs				X			
Check crankcase ventilation filter, **Replace** if necessary[3]				X			
Drain, flush, and replace engine coolant[2]					X		
Inspect O_2 sensor performance, replace if necessary					X		
Inspect catalyst performance, replace if necessary[4]					X		
Replace fan and water pump belts					X		
Replace ignition coils and boots					X		
Replace throttle bodies					X		
Replace crankcase ventilation impactor (11L only)					X		
Replace coolant pumps						X	
Replace thermostats, gaskets and O-rings						X	
Replace fuel mixers						X	
Replace EPRs						X	
Replace fuel lock-off valves						X	
Replace cylinder heads						X	
Replace rocker arm assemblies						X	
Replace turbocharger assembly						X	
Replace crankcase ventilation assembly						X	
Replace piston and connecting rod assemblies and cylinder liners							X
Replace crankshaft assembly, bearings and seals							X
Replace camshaft, bearings, seals, lifters, pushrods, and timing gears							X
Replace oil pump							X
Replace exhaust manifold assembly and gaskets							X
Replace front accessory drive pulleys, idlers and seals							X

1: First 50 hours only
2: Oil and coolant change intervals can be extended only with a regularly scheduled sampling program
3: On units with replacable crankcase ventilation filter elements: Filter should be changed and the inside of the canister should be wiped clean when the engine oil is changed
4: Expected catalyst life is 8760 hours

GENERAL SPECIFICATIONS CHART
PSI HEAVY DUTY Industrial Engines

GE Series Engines

Engine	D081L	D111L
Type	In-Line 6 Cylinder	In-Line 6 Cylinder
Displacement cc (c.i.d.)	8071 (492.5)	11051 (674.5)
Compression Ratio	10.5:1	10.5:1
Valve Configuration	Push Rod Actuated Overhead Valve	Push Rod Actuated Overhead Valve
Valve Lifters	Flat Follower	Flat Follower
Bore x Stroke mm (inches)	111 (4.37) X 139 (5.47) mm(in.)	123 (4.84) X 155 (6.1) mm(in.)
Main Bearing Caps	2 Bolt	2 Bolt
Balance Method	External	External
Intake Manifold	Mixer	Mixer
Firing Order	1-5-3-6-2-4	1-5-3-6-2-4
Oil Capacity With Oil Filter	17L (4.49 Gal.) Min - 23L (6.08 Gal) Max 26L (6.9 Gal)	19L (5.02 Gal) Min - 25L (6.60 Gal) Max 28L (7.4 Gal)
Minimum Oil Pressure (Hot)	ECU Controlled	ECU Controlled
Coolant Capacity (Engine)	18L (4.76 Gal.)	22L (5.55 Gal.)
Fuel Type	NG / LPG	NG / LPG
Engine Rotation (Flywheel End)	CCW	CCW
Ignition System	24v, Distributor-less, Coil On Plug	24v, Distributor-less, Coil On Plug
Ignition Timing	ECM Controlled - Variable Not Adjustable	ECM Controlled - Variable Not Adjustable
Spark Plugs	NGK IFR7B-D	NGK IFR7B-D
Spark Plug Gap	0.4mm	0.4mm
Valve Clearance (Cold) Intake Exhaust	 0.30mm 0.30mm	 0.4 mm 0.4 mm

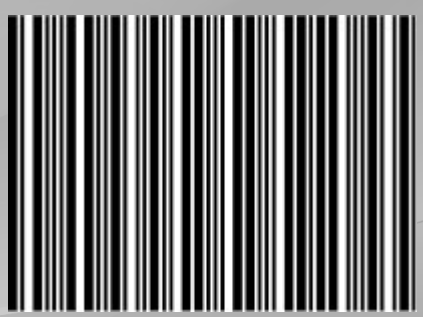
GENERAL SPECIFICATIONS CHART
PSI HEAVY DUTY Industrial Engines

GV Series Engines

Engine	D146L	D183L	D219L
Type	V8	V10	V12
Displacement cc (c.i.d.)	14618 (892)	18273 (1,115)	21927 (1,338)
Compression Ratio	10.5:1	10.5:1	10.5:1
Valve Configuration	Push Rod Actuated Overhead Valve	Push Rod Actuated Overhead Valve	Push Rod Actuated Overhead Valve
Valve Lifters	Flat Follower	Flat Follower	Flat Follower
Bore x Stroke mm (inches)	128 (5.04) X 142 (5.59) mm(in.)	128 (5.04) X 142 (5.59) mm(in.)	128 (5.04) X 142 (5.59) mm(in.)
Main Bearing Caps	2 Bolt	2 Bolt	2 Bolt
Balance Method	External	External	External
Intake Manifold	Mixer	Mixer	Mixer
Firing Order	1-5-7-2-6-3-4-8-1	1-6-5-10-2-7-3-8-4-9	1-12-5-8-3-10-6-7-2-11-4-9
Oil Capacity	26L (6.9 Gal) Min - 28L (7.4 Gal) Max	28L (7.4 Gal) Min - 35L (9.2 Gal) Max	33L Min (8.7 Gal) - 40L (10.6 Gal) Max
With Oil Filter	31L (8.2 Gal)	38L (10 Gal)	43L (11.4 Gal)
Minimum Oil Pressure (Hot)	ECU Controlled	ECU Controlled	ECU Controlled
Coolant Capacity (Engine)	36L (9.51 Gal.)	42L (11.1 Gal.)	44L (11.62 Gal.)
Fuel Type	NG / LPG	NG / LPG	NG / LPG
Engine Rotation (Flywheel End)	CCW	CCW	CCW
Ignition System	24v, Distributor-less, Coil On Plug	24v, Distributor-less, Coil On Plug	24v, Distributor-less, Coil On Plug
Ignition Timing	ECM Controlled - Variable Not Adjustable	ECM Controlled - Variable Not Adjustable	ECM Controlled - Variable Not Adjustable
Spark Plugs	NGK IFR7B-D	NGK IFR7B-D	NGK IFR7B-D
Spark Plug Gap	0.4mm	0.4mm	0.4mm
Valve Clearance (Cold)			
Intake	0.30mm	0.30mm	0.30mm
Exhaust	0.40mm	0.40mm	0.40mm

POWER SOLUTIONS INTERNATIONAL

Power Solutions International, Inc (PSI)
201 Mittel Drive
Wood Dale, IL 60191
USA
630-350-9400



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