



S4



Standup



**Service Manual
2007**



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1 GENERAL INFORMATION



1. General Information

Model information, Identification number, Engine number, safety warning

1.1. 2007 HSR personal watercraft Identification Numbers

The engine I.D. number and hull I.D. number are used to register the watercraft. They are unique numbers that distinguish each watercraft from others of the same model.

If the watercraft is ever stolen these numbers will help identify it. The owner should keep a record of these numbers in a place other than the watercraft. A second hull number is hidden inside the Hull, only the manufacturer knows where is this number on each ski.

1.2. HIN number



AT : Manufacturing Country

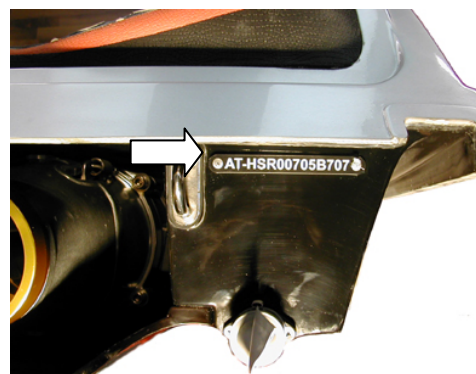
HSR : HydroSpace Racing Manufacture

000608 : Sequential Serial Numbers

Production Month : **K** (Month code : **A** January, **B** February)

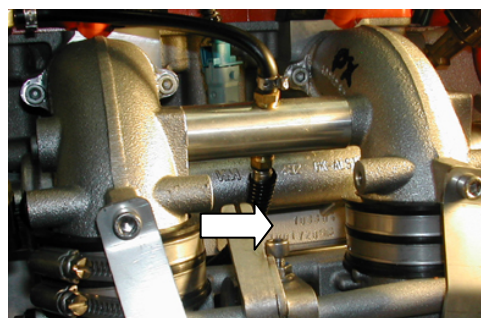
Production Year : **6**

Model Year : **06** (Model year : **6** = 2006)



1.3. Engine number

Number is above the starter motor
Engine Number : #10017203



1.4. Three stars – ultra low emission

The three-star label identifies engines that meet the Air Resources Board's Personal Watercraft and Outboard marine engine 2008 exhaust emission standards. Engines meeting these standards have 65% lower emissions than One Star – Low Emission Engines



1.5. Safety instructions

Under the handpole



1.6. CE Sticker

Under the handpole bracket





1.7. Service Guidelines - Safety Warnings

Clean inside and outside of watercraft prior to servicing.

Clean all parts before installing.

Always use a service apron to prevent damage to foot well and top- deck fiberglass.

Watch for sharp edges which can cause personal injury.

Protect hands and arms when working with sharp components.

Always use a soft- faced hammer and extreme care when removing difficult or stuck components.

Some fasteners are installed with locking agents or lubricants. Use of impact drivers will aid in fastener removal.

Always follow torques specifications located throughout manual.

Fasteners secured with either too little or too much torque may fail and cause severe property damage, injury or death.

Always follow torque sequence patterns when founding this manual.

Tighten each fastener evenly and to the specified torque value, and with specified locking agent.

Always use new gaskets, o- rings and seals, clips, cir- clips, and snap rings when assembling components.

Never reuse Nylokt or Flex Lockt nuts when assembling components.

Never reuse Oetikert clamps when removed from fuel lines. Replace with small gear clamps.

Always use Hydrospace authorized lubricants, greases, and locking agents when assembling components. Failure to do so may cause severe engine or vehicle damage.

Always disconnect the black (-) negative cable first from the battery when removing the battery. When installing the battery, attach the red (+) positive cable first, then the black (-) negative cable.

Wear appropriate clothing, eye protection, and rubber gloves when working with batteries.

Battery acid contains sulphuric acid and is extremely poisonous. Serious burns can result when in contact with skin, clothing, eyes or internal body components. If battery acid is ingested, drink large quantities of water or milk. Follow with milk of magnesia, beaten egg or vegetable oil. Call a physician immediately. Flush eyes for 15 minutes with water and seek prompt medical attention if acid comes in contact with eyes. Thoroughly wash affected external body parts that come in contact with battery acid with water.

Keep hands, arms, legs, feet and hair away from rotating parts, hot engine and exhaust components, drive pump and impeller and engine induction when engine is running.





Never attempt engine or driveline inspections and/or repairs without first removing lanyard and battery cables.

Gasoline is highly flammable and explosive under certain conditions.

Always exercise extreme care when handling gasoline.

Do not smoke or allow open flames in or near the area where refueling is performed or where gasoline is stored.

Always refuel the watercraft outdoors and in a well- ventilated area.

Do not fill the tank to the fuel cap.

If you get gasoline or oil on your skin or clothing, wash it off immediately with soap and water and change clothing.

The engine exhaust from this product contains chemicals known to cause cancer, birth defects or other reproductive harm.

Only run engine outdoors or in a well- ventilated area.

Never run the engine for more than 15 seconds without cooling water supply.





1.8. General data

2007 Hydrospace S4 Turbocharged

Length: 2,29 m (90,15 in.)
 Width:..... 0,74 m (29,13 in.)
 Height:..... N/A
 Dry Weight:..... 168kg (370,16 in.)
 Category: Stand-up
 Riders:..... 1
 Fuel Capacity: 18 liters 4,75 US Gal
 Emission Certification: Three Star - Ultra Low Emission

ENGINE	
Emission control system	SFI (Sequential Fuel Injection)
FUEL	Unleaded Gasoline 91/95/98 Octane R+M/2
SPARK PLUG	Champion RC7PYCB Platinum
SPARK PLUG GAP	0,7 – 0,8 mm (0.0028 – 0.032 in.)
HORSEPOWER	82Kw (110 HP)
ENGINE DISPLACEMENT	749cc
NUMBER OF CYLINDER	2
CYLINDER Lining Material	Nicasil
BORE x STROKE	85 x 66 mm
COMPRESSION RATIO	9.0:1
CYLINDER COMPRESSION	9,6 +/- 1 bar (140 +/- 14,5 psi)
Cooling System	Open loop with intercooler and thermostat
THERMOSTAT	70°C
OVER HEATING WARNING	Exhaust Manifold Overheat switch – RPM limit
OVER HEATING Cooling	Cooling manifold Sensor – 90° cut engine
INDUCTION TYPE	Intercooler / Turbo charged
LUBRIFICATION	Dry Sump
OIL REQUIREMENT	Hydrospace 100% Synthetic 10w60
RPM LIMITER	7800 to 8400 RPM – Determined by ECU
Exhaust System	Turbo exhaust manifold / Waterbox with water injector
ENGINE MANAGEMENT SYSTEM	
FUEL DELIVERY	WALBRO Multi-point fuel injection
IDLE SPEED	1450 +/- 50 rpm
MAGNETO GENERATOR OUTPUT	25A / 350 W @ 3000 rpm
BATTERY	12 Volts / 20A
FUSES	30A – Alternator, 15A – Fuel Pump, 7,5A – Stop switch, 30A - Main
STARTING	Electric motor 12V – 800w
PROPULSION	
JET PUMP TYPE	Solas – Axial Flow – 12 Veins – Steel stator





IMPELLER	12/17 Stainless steel – 3 blade – 140 mm
COUPLING TYPE	Six piece coupler + Damper
MINIMUM DEPTH FOR OPERATION	60cm (2 Ft)
HULL / BODY	
Hull material	Fiberglass texalium reinforced Carbon elements

1.8.1. Standard Torque Specifications

The following torque specifications are to be used as a general guideline.
Use standard torque values for the appropriate size fastener when torque values are not specified.

Always consult the specific manual section for torque values of fasteners and use of locking agent.

RECOMMENDED TORQUE SPECIFICATION STAINLESS STEEL FASTENERS (METRIC)	
4 mm	40–42 in.lbs.
5 mm	45-52 in.lbs.
6 mm	66-78 in.lbs.
7 mm	13-16 ft.lbs.
10 mm	26-30 ft.lbs.
12 mm	40-44 ft.lbs.

1.8.2. Conversion Chart

ft. lbs.	x 12	= in. lbs.
in. lbs.	x 0,0833	= ft. lbs.
ft. lbs.	x 1,356	= Nm
in. lbs.	x 0,115	= kg-m
Nm	x 0,7376	= ft. lbs.
kg-m	x 7,233	= ft. lbs.
kg-m	x 86,796	= in. lbs.
kg-m	x 10	= Nm
in.	x 25,4	= mm
mm	x 0,03937	= in.
in.	x 2,54	= cm
mile (mi.)	x 1,6	= km





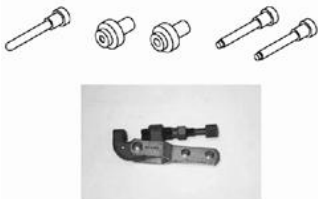
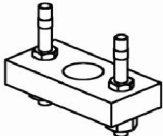
Km	x 0,6214	= mile (mi.)
Ounces (oz.)	x 28,35	= Grams (g)
Grams (g)	x 0,035	= Ounces (oz.)
lb.	x 0,454	= kg
kg	x 2,2046	= lb.
Cubic inches (cu in)	x 16,387	= Cubic centimeters (cc)
Cubic centimeters (cc)	x 0,061	= Cubic inches (cu in)
Imperial pints (Imp pt)	x 0,568	= liters (l)
Liters (l)	x 1,76	= Imperial pints (imp pt)
Imperial quarts (Imp qt.)	x 1,137	= liters (l)
Liters (l)	x 0,88	= Imperial quarts (Imp qt)
Imperial quarts (Imp qt.)	x 1,201	= US quarts (US qt)
Liters (l)	x 1,057	= US quarts (US qt)
US gallons (US gal)	x 3,785	= Liters (l)
Liters (l)	x 0,264	= US gallons (US gal)
Pounds – force per square inch (psi)	x 6,895	= Kilopascals (kPa)
Kilopascals (kPa)	x 0,145	= Pounds – force per square inch (psi)
Kilopascals (kPa)	x 0,01	= Kilograms- force per square cm
Kilograms- force per square cm	x 98,1	= Kilopascals (kPa)

°C to °F: $9 (°C + 40) \mid 5 - 40 = °F$

°F to °C: $5 (°F + 40) \mid 9 - 40 = °C$



1.9. Service Tools

	HR00_99_20_002 Diagnostic cable and Software
	HSR00_9920_003 Impeller tool
	HSR00_99_01_076 Flywheel removal tool
	HSR00 Torx 50 for Head cylinder
	Chain Remover tool Not Available
	Balance Shaft Remover tool Not Available

	Oil removing tool Not Available
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1.10. Operating materials



The use of other operating materials causes damage to the engine and the voiding of the warranty.

1.11. Fuel

Unleaded gasoline according to DIN 51607 („superunleaded“), with an octane rating of at least 95 ROZ [RON] or 85 MOZ [MON]. In case of emergency, unleaded fuel with 91 ROZ [RON] or 82.5 MOZ [MON] may be used for a short time.



Lower-quality fuels should only be used in case of emergency. If used regularly, they cause decreases in performance and possibly damage to the engine.

1.12. Lubricant

Oil specification	Recommendation: HSR oil 10w60, ACEA, A3/B3/B4, API SL
Filling quantity	Initial filling 3.3liters[3.5qt(US)] Oil change with filter 2.4-2.6 liters [2.5-2.7qt(US)]

1.13. Running the Engine

HSR recommends that during the first five hours of operation, you should not operate the engine over 6,000 U/min [RPM]. This protective running-in has a positive effect on the engine's lifespan.

1.14. Operating the engine without sea water

If it is necessary to operate the engine longer than 30 seconds without sea water, the vehicle's rinsing equipment must be used.

See chapter **Maintenance - Rinse sea water cooling circuit after driving**.



The engine may only be operated at idle speed for a maximum of 30 seconds without sea water. Engine damage due to overheating.



2 MAINTENANCE





2. Maintenance

The table in chapter **Maintenance intervals** provides the manufacturer's recommended intervals for maintenance work. If you follow the maintenance recommendations, a long lifespan of the engine can be achieved and unnecessary environmental damage prevented. The Maintenance intervals specified in the table should not be exceeded by more than 10%.

If not stated otherwise, all activities on the engine described in this manual must be carried out by trained service personnel.

During the warranty period, maintenance and repair work may only be carried out in Weber Motor service stations or in associated shops. If necessary, contact your vehicle dealer.

Weber Motor AG reserves the right to demand that proof of warranty be provided in writing for warranty service. See **Proof of maintenance for work carried out**.



The vehicle owner or user is responsible adhering to the maintenance intervals. HSR assumes no liability for damage that arises due to maintenance not carried out.





2.1. Maintenance work by the user of the vehicle

2.1.1. Regular checks before driving

Always check the oil level before driving. See Chapter **Oil level check**.



Under running and exceeding the motor oil fill level Specified in this manual can cause damage to the Engine.

2.1.2. Rinse sea water cooling circuit after driving

In order to protect the sea water cooling circuit against soiling, calcium deposits, and such, the sea water cooling circuit must be rinsed after each use.

See the vehicle manufacturer's service manual.



Soiling in the sea water cooling circuit can cause severe engine damage.





2.2. Maintenance intervals

Activities on the engine must be carried out by trained service personnel.

Activity	Procedure		1 st maintenance h ¹ after 10 - 12	Maintenance interval h ¹		At end of season
				Every 25	Every 100	
Motor oil and oil filter	Change		■ 2)	■ 2)		■ 4)
Spark plugs	Check/Clean					■ 4)
	Change				■ 3)	
Valve play	Check/Set		■ 3)		■ 3)	

1) h = hours of operation

2) or at least once a year if the hours of operation specified above are not reached before that.

3) or at least every two years if the hours of operation specified above are not reached before that.

4) See chapter Decommissioning at the end of the season.

2.3. Decommissioning at the end of the season

The decommissioning of the vehicle is necessary ...

- at the end of the season if the vehicle will be decommissioned during the winter months.
- if the vehicle will not be used for more than 30 days.

In addition to the maintenance work described in the maintenance interval table under **end of the season**, various other service work is also required.

- **Conserve the cylinders**
Check spark plugs. See Chapter Checking the spark plugs.





Fill approx. 10 ml [0.34 oz (US)] of clean motor oil directly through the spark plug holes. Before you replace the spark plugs, crank up the motor briefly with the starter. Replace the spark plugs.



Never fill more motor oil than specified into the spark plug holes. Too much motor oil can cause engine damage.

- **Fill the fuel tank all the way**

A full fuel tank prevents the formation of condensation inside the tank.

- **Add fuel stabilizer**

After approx. 30 days, fuel begins to decompose. You can use any common fuel stabilizer in order to maintain the fuel quality.

2.4. Motor oil and oil filter

2.4.1. Oil level check

IMPORTANT!!!

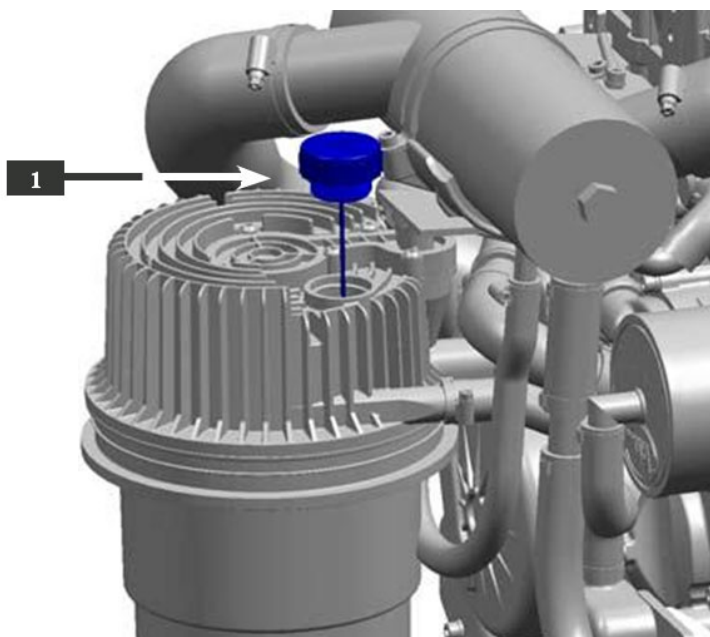
Use a clean, lint-free cloth

The oil level must be measured with oil warm from operation (approx. 80 °C [176 °F]) and with the motor at a standstill. Measurements with cold oil are not meaningful. The desired motor temperature is achieved after a driving time of approx. 10 minutes at 4000 - 4500 U/min [RPM]. Measurement with a motor warm from operation is necessary, because the oil volume changes depending on the temperature. To avoid mistaken measurements, the vehicle must be level. If the motor is operated for a longer time under extreme conditions, the oil level may reach the MAX marking.

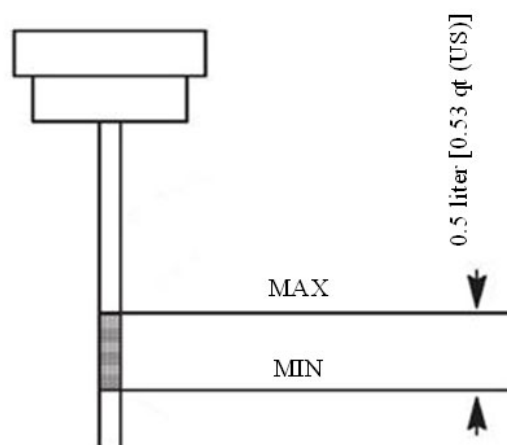


1) Unscrew the **oil dipstick** (1) from the oil tank and wipe it clean with a cloth.

2) Replace the oil dipstick in the oil tank. **Do not screw it in.** Then remove it again and read the oil level.



With a motor warm from operation, the oil level must be just below the MAX marking. The difference between MIN and MAX is approx. 0.5 liter [0.53 qt (US)].



Under running the MIN marking and exceeding the MAX marking can cause severe and, under some circumstances, irreparable damage to the engine.

2.4.2. Changing the motor oil and oil filter

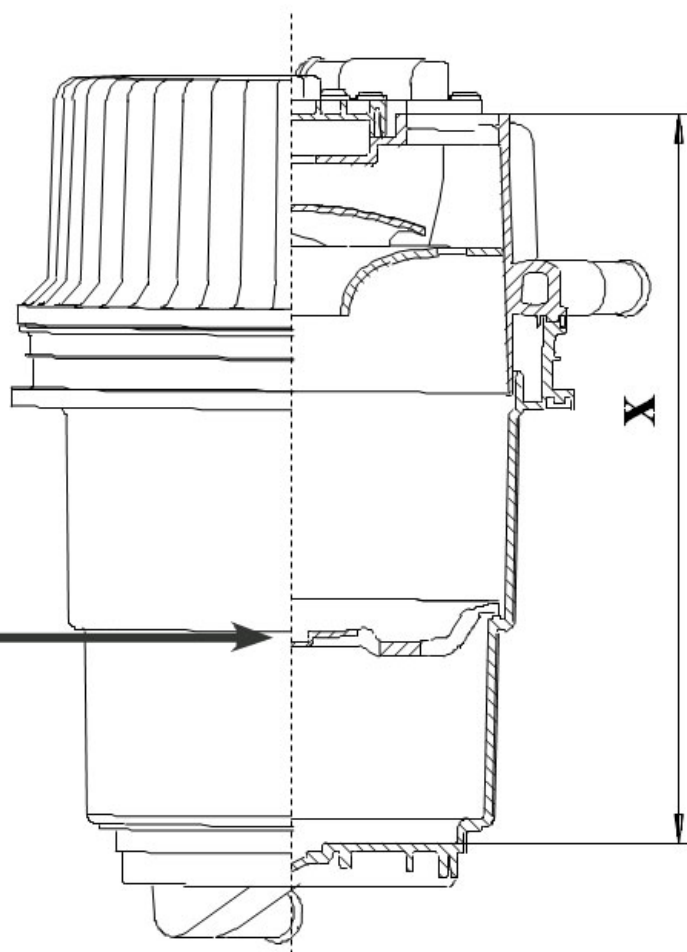
- Oil extraction pump
- Catch basin for old oil, fill volume at least 4liters[4.3qt(US)]
- Flathead screwdriver or wrench to open the screw clamps
- Torque wrench to close the screw clamps
- TorquewrenchSW27[11/16"] for oil filter cover
- Possible hose extension for oil feed hose with screw clamps
- Funnel tube for motor oil
- Motor oil, see chapter Operating materials
- Oilfilter, see spareparts catalogue

2.4.3. Draining the motor oil

IMPORTANT!!!

With a motor warm from operation, the greatest oil volume is sucked out of the motor.

1. Unscrew the oil dipstick from the oil tank. See Chapter **Oil level check**.
2. Insert the suction hose of the oil extraction pump into the oil tank through an opening in the cover (1) until it reaches the bottom of the oil tank. X = 260 mm [10.25 in.].
3. Pump all the motor oil out.
4. Remove the suction hose and insert the oil dipstick again.

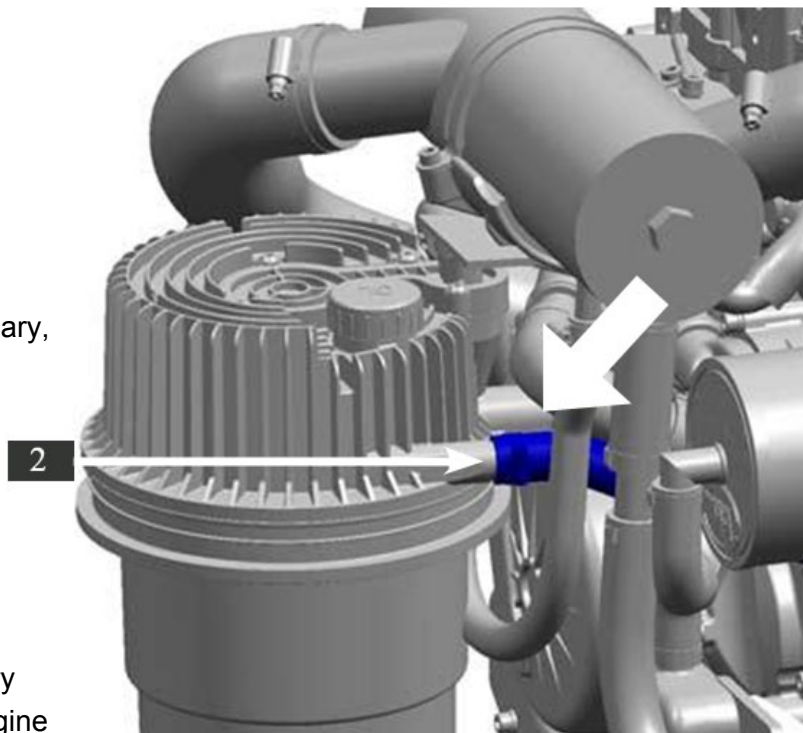


The motor oil in the dry sump tank is pumped out with the help of the engine dry sump pump.

5. Remove the cable harness from the spark plugs and the injection valves. See Chapter Removing the spark plugs.
6. Remove the oil feed hose (2) on one side of the oil tank. If necessary, extend the oil feed hose.

→ **Tightening torque:**
3 Nm $\pm$ 10 % [2.2 ft. lb.]

7. Activate the engine's starter every 10 seconds in order to let the engine crank and wait 30 seconds.
8. Repeat this procedure until the motor oil is pumped completely out.



ATTENTION

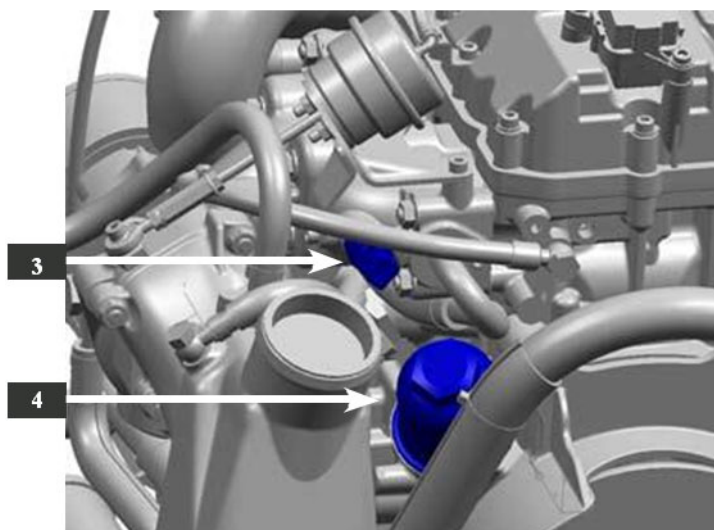
Do not let engine crank longer than necessary. To prevent damage due to insufficient lubrication and overloading of the starter.

2.4.4. Changing the oil filter

9. Unplug the plug from switch 70/65°C (3).

10. Unscrew the oilfiltercover(4).

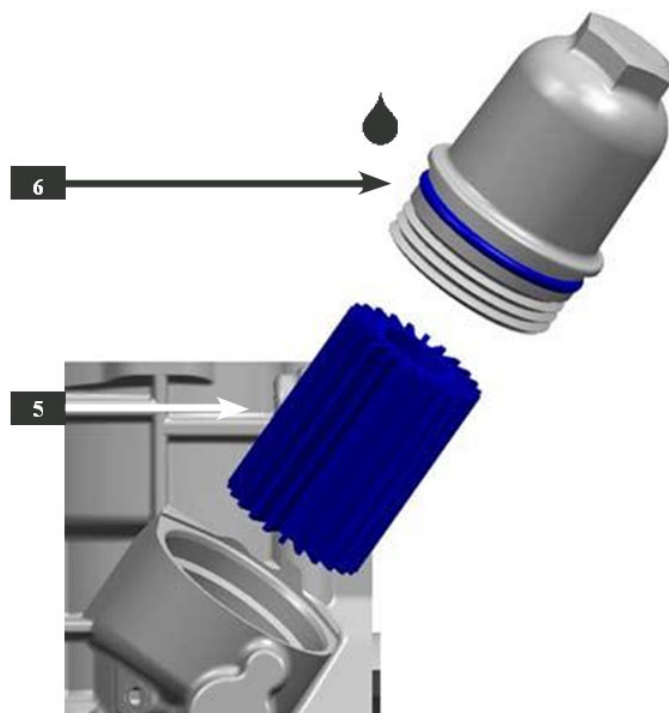
→ **Tightening torque:**
24 Nm $\pm$ 10 % [17.7 ft. lb.]



11. Replace the oilfilter(5) and O-ring (6).

12. Coat the O-ring (6) lightly with motor oil.

→ **During reassembly, make sure that the oil filter snaps in.**



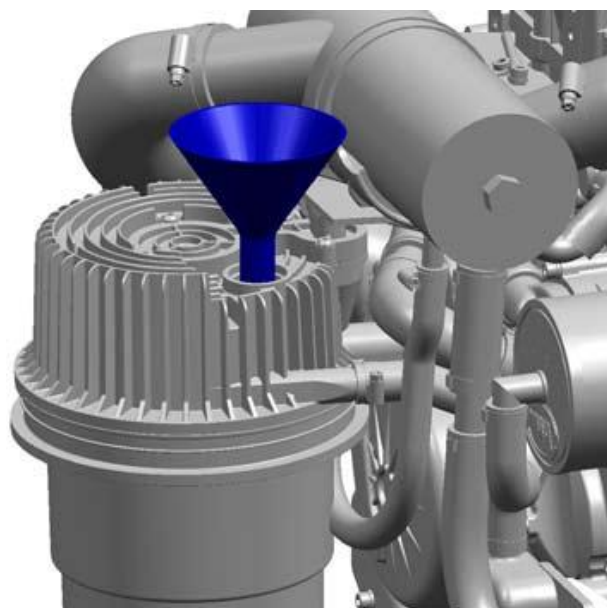
IMPORTANT!!!

Assembly occurs in reverse order.

Please note instructions after this symbol →

2.4.5. Refilling the motoroil

13. Fill oil tank with 2.5 liters of motoroil.
14. Close the oil tank with the oil dipstick.
15. Warm up the motor in a body of water for approx. 10 minutes at 4000 - 4500 U/min.
16. Fill up the oil level with a motor warm from operation until just below the MAX marking.



2.5. Spark Plugs

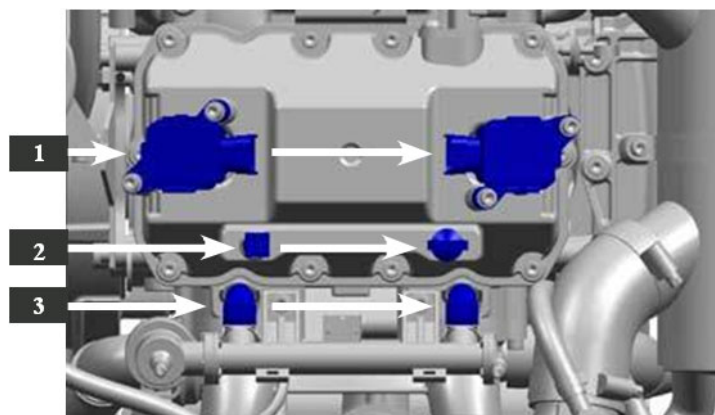
2.5.1. Checking the spark plugs

IMPORTANT!!!

- Socket wrench 16mm [5/8 "]
- Feeler gauge, measurement range 0.69 mm – 0.84 mm [0.0272 - 0.0331 in.]
- Torque wrench
- 2x spark plugs

2.5.2. Removing the spark plugs

1. Remove cable harness on the ignition coils (1).
2. Loosen the cable harness on the cable holders (2).
3. Remove the cable harness on the injection valves (3).



→ Before disassembling, make sure that the plugs of the ignition coils and the injection valves are not switched during assembly.

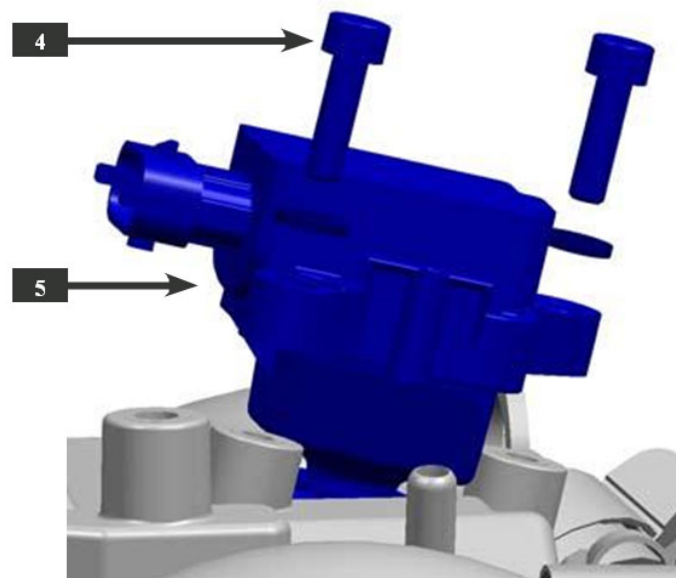
4. Remove the screws and washers (4).

5. Remove the ignition coils (5)

→ Install the spark plugs only in a cold engine.

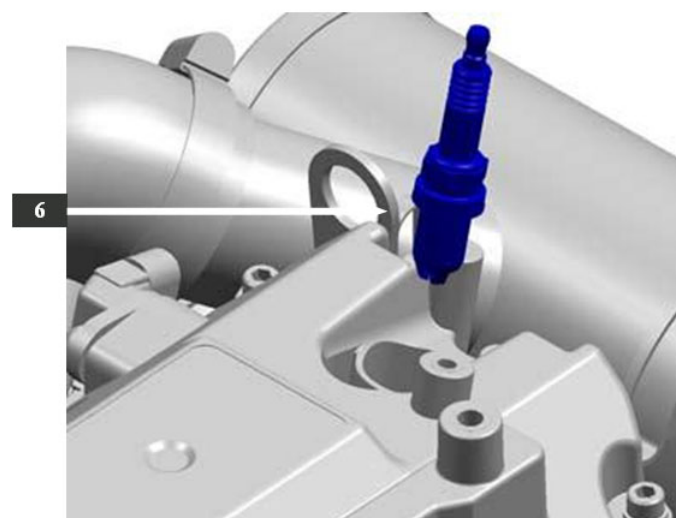
→ Grease the threads of the spark plugs with commercial graphite grease.

→ Tightening torque:
10 Nm $\pm$ 10 % [7.4 ft. lb.]



6. Unscrew the spark plugs (6).

→ Tightening torque:
27 Nm $\pm$ 20 % [19.9 ft. lb.]

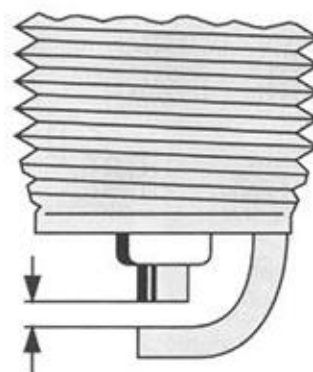


Assembly occurs in reverse order. Please note instructions after this symbol →

2.5.3. Checking the spark plugs

7. Check the electrode distance of the spark plugs with the help of the feeler gauge.

0,69 - 0,84 mm
[0.0272 - 0.0331 in.]



2.6. Valve play

2.6.1. Checking and setting the valve play

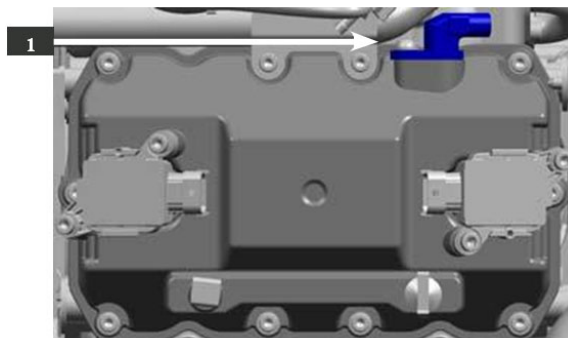
IMPORTANT!!!

- Hex wrench SW5 [3/16 “]
- Feeler gauge, measurement range 0.08 mm - 0.25 mm [0.0031 - 0.0098 in.]
- Valve adjustment tool, see spare parts catalogue
- Combination wrench 24mm [15/16 “]
- Bar magnet
- Measurement tool for adjustment plate, reading 0.01mm [0.0003 in.]
- Adjustment plates from 2.5 - 3.7 mm [0.0984 - 0.1457 in.], see spare parts catalogue
- Valve cover seals, see spare parts catalogue
- 2x O-rings, see spare parts catalogue

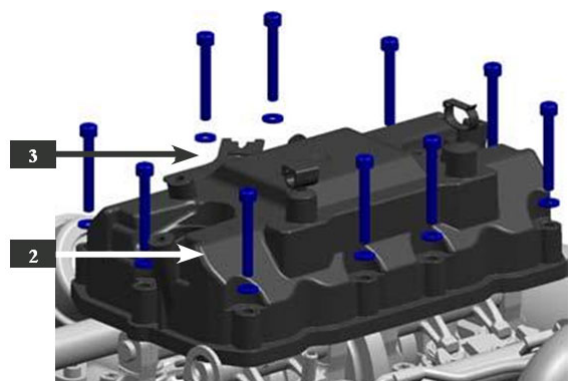
To get correct measurement values, check and adjust valve play with a cold engine.

2.6.2. Removing the valve cover

1. Removing the cable harness on the cam shaft sensor (1).
2. Remove the spark plugs.
See Chapter **Removing the spark plugs**.



3. Unscrew the valve cover (2) along with bracket and valve (3).

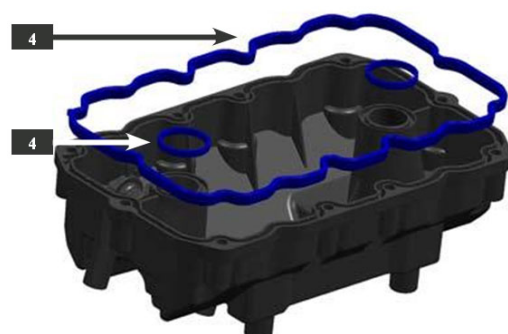


→ **Tightening torque:**
10 Nm $\pm$ 10 % [7.4 ft. lb.]

→ **The sequence of the connection**
Occurs according figure.



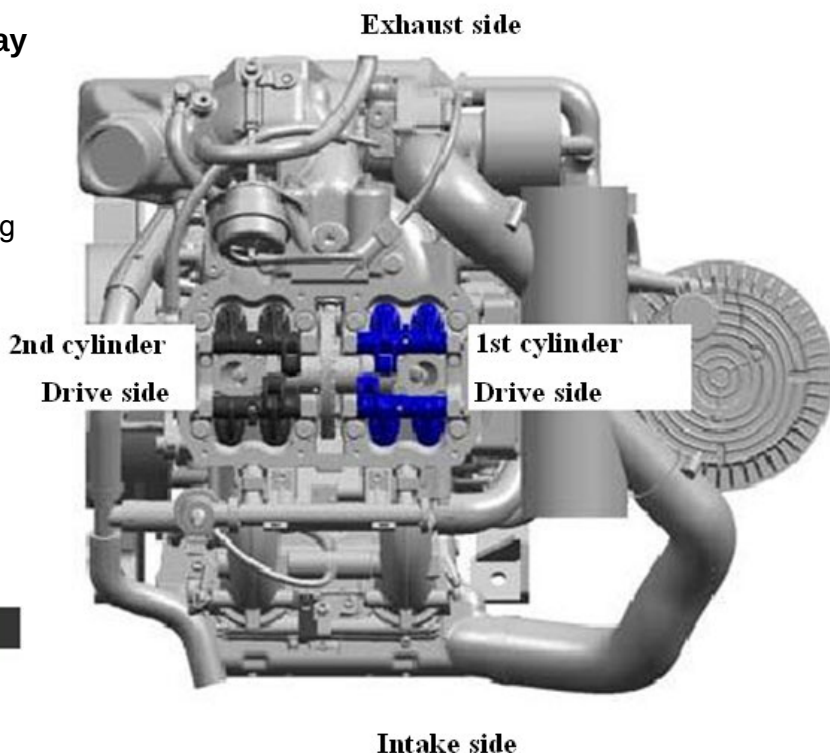
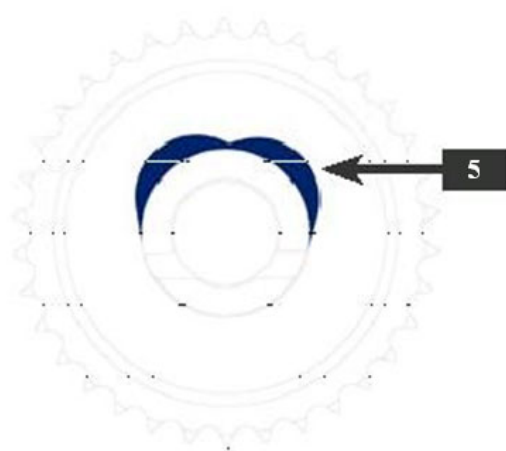
- Replace the valve cover seals (4).
- Clean seal areas of the valve cover and cylinder head.



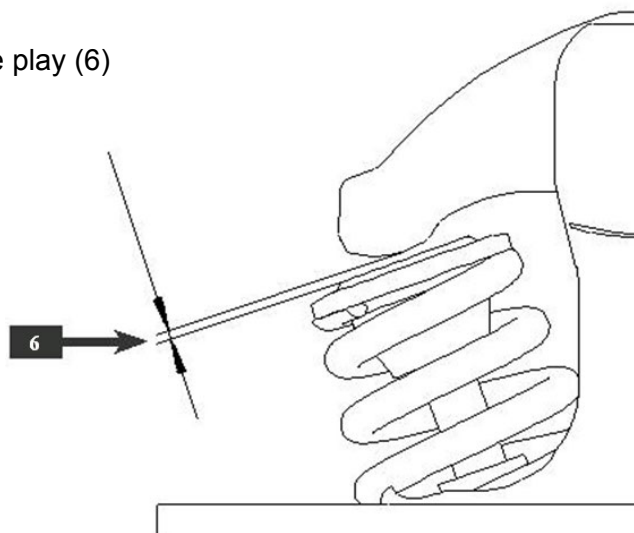
Assembly occurs in reverse order.
Please note instructions after this symbol →

2.6.3. Checking the valve play

4. Start the vehicle's starter and let the engine crank until both cams of the second cylinder are pointing upwards.
The rocker of the first cylinder demonstrates a little play.

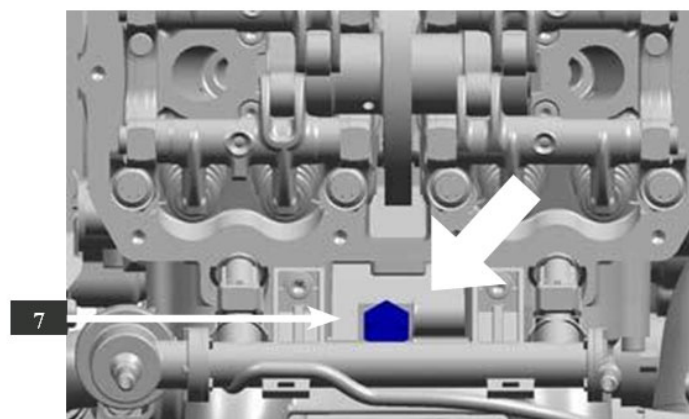


5. Using a feeler gauge, measure the valve play (6) of all four valves of the first cylinder between the adjustment plates and the rockers.
Permissible valve play:
Intake side 0,08 - 0,15 mm
[0.0031 - 0.0059 in.]
Exhaust side 0,18 - 0,25 mm
[0.0071 - 0.0098 in.]



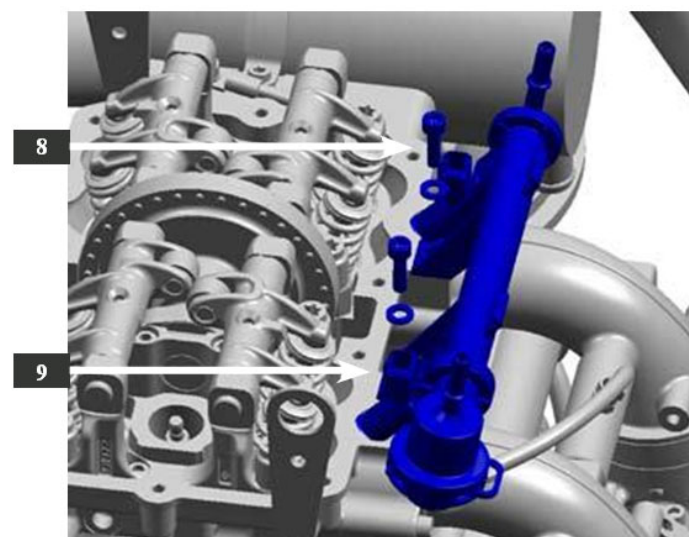
2.6.4. Adjusting the valve play

6. To adjust the valve play on the intake side, it is necessary to remove the fuel distributor rail. Remove the cable harness on the coolant sensor (7).

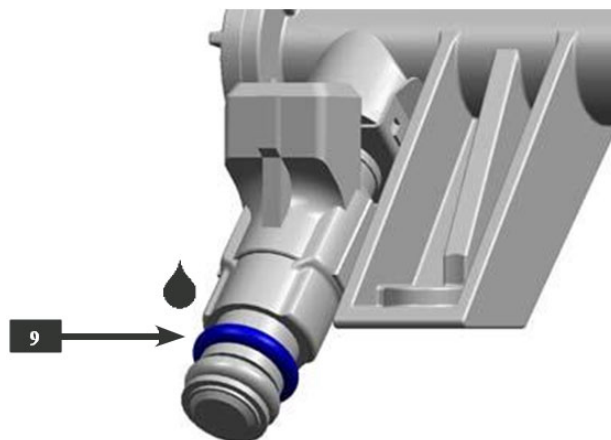


7. Loosen the screws and washers (8) and remove the fuel distributor rail (9).

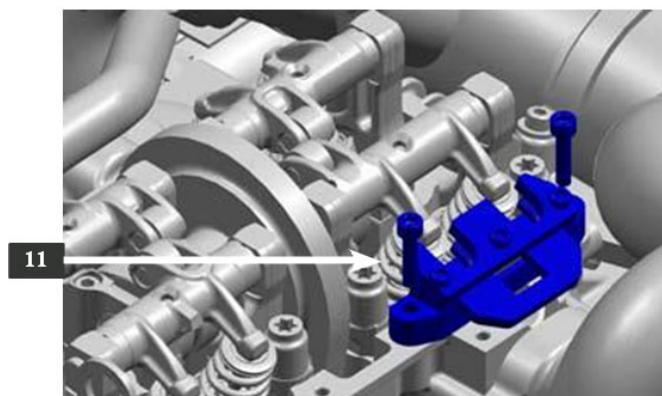
→ **Tightening torque:**
10 Nm $\pm$ 10 % [7.4 ft. lb.]



- Replace the O-rings (9) on the injector valves. Coat the O-rings lightly with motor oil.

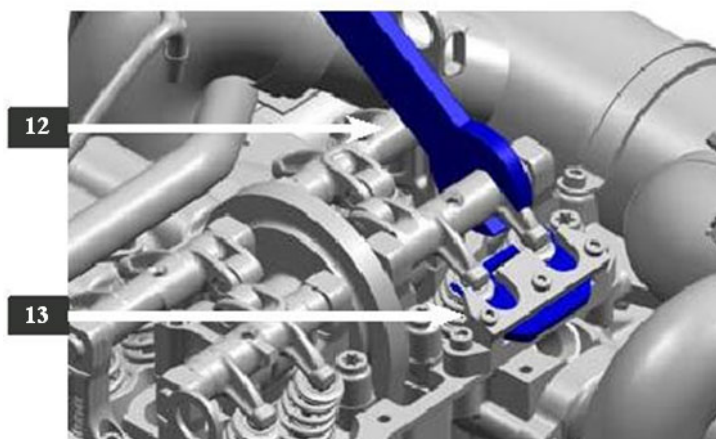


8. Mount the valve adjustment tool (11) with two screws.
Tightening torque:
10 Nm $\pm$ 10 % [7.4 ft. lb.]



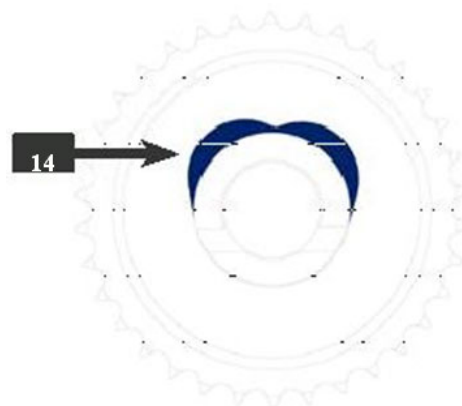
The engine may not be turned over until all valve Plays of the first cylinder are adjusted.

9. Press the rocker downwards with a 24 combination wrench (12).
10. Clamp both valves by pressing in the sliding piece (13).
11. Remove the adjustment plate with the bar magnet.
12. Measure the strength of the adjustment plate and replace with an adjustment plate with which the permissible tolerance is adhered to.
13. Replace the adjustment plate in the spring seat.
14. Remove the sliding piece (13) and, to check the valve play, measure again.
15. Repeat this procedure with all Valves of the first cylinder.



2.6.5. Checking the valve of the 2nd cylinder

16. Start the vehicle's starter and let the engine crank until both cams of the first cylinder are pointing upwards. The rocker of the second cylinder demonstrates a little play.
17. Check the valve play of the second cylinder in the same way you did the first cylinder.



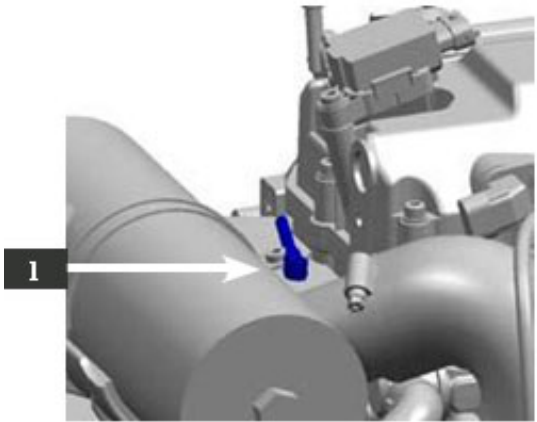
2.7. Malfunctions

If you cannot correct a malfunction yourself using the table below, contact your vehicle dealer's customer service.

In case of improperly-made repairs, the warranty is voided and HSR is not liable for any resulting subsequent damage.

2.7.1. Engine does not crank

Possible cause	Remedy
Main power switch not plugged in.	Plug in main power switch.

Battery voltage too low. - Open-circuit voltage < 12 volts. - During activation of the starter < 10.5 volts.	Remove soiling and corrosion on the battery poles and connect battery connections correctly. With non maintenance-free batteries, check water level. Charge battery with external battery charger
Engine mass point (1) not connected or not connected properly.	Check connection. 
Defective fuse.	Check the fuses in the cable harness.
Drive or jet pump blocked.	Remove blockage.
Cable harness plug connections not plugged in or not plugged in correctly.	Check plug connections.



2.7.2. Engine cranks but does not start

Possible cause	Remedy
Lanyard not plugged in.	Plug in lanyard.
Defective fuse.	Check the fuses in the cable harness.
Too little or no fuel in the tank.	Fill up fuel. Check the engine for signs of leaky fuel lines and, if necessary, have it checked by a professional shop.
Cable harness plug connections not plugged in or not plugged in correctly.	Check plug connections.
Spark plugs defective.	Check the spark plugs and, if necessary, replace them. See Chapter Spark plugs .





2.7.3. Engine stalls but can be started again

Possible cause	Remedy
Too little or no fuel in the tank.	Fill up fuel. Check the engine for signs of leaky fuel lines and, if necessary, have it checked by a professional shop.
Too much motor oil.	Check the oil level. See Chapter Oil level check . Excessive motor oil must be pumped out as quickly as possible.

2.7.4. Engine stalls and cannot be started again

Possible cause	Remedy
Lanyard not plugged in.	Plug in lanyard.
Defective fuse.	Check the fuses in the cable harness.
Too little or no fuel in the tank.	Fill up fuel. Check the engine for signs of leaky fuel lines and, if necessary, have it checked by a professional shop.
Cable harness plug connections not	Check plug connections.





plugged in or not plugged in correctly.	
Spark plugs defective.	Check the spark plugs and, if necessary, replace them. See Chapter Spark plugs .

2.7.5. Engine loses power (speed limitations)

Fault	Possible cause	Remedy
Engine speed limited to 1800 U/Min [RPM] and the water temperature warning lamp lights up.	Overheating of exhaust manifold.	DO NOT LET THE ENGINE RUN LONGER THAN 30 SECONDS. Rinse and check the sea water cooling circuit. See Chapter Rinse sea water cooling circuit after driving . Check the sea water pump.





3

**REMOVAL, INSTALLATION
ENGINE**





3.Engine Removal and Installation

3.1. Engine Removal

Several subsystems must be removed before the engine can be extracted from the engine bay. These systems are:

- Oil, see chapter 2.4.3
- Intercooler, support and hoses.
- Engine electrical harness, and earth cable
- Oil storage tank assembly.
- Battery and his support
- Throttle cable, Exhaust hose, fuel rail, cooling hose
- Air intake and throttle body assembly. (will come out all in one, do not disconnect the intake bracket)
- Starter motor, will avoid you to disconnect the wires on the start relay
- Cut the cable tie over the oil cooler
- 4 Engine mounts bolts

The use of an engine hoist or overhead crane system is required to both remove and install the engine assembly.



Always disconnect the positive (RED) and negative (BLACK) battery cables from the battery after removing the engine oil and prior to performing any engine work. Failure to do so may cause severe injury or death.

NOTE: The use of an engine hoist is strongly recommended for working on and removing the engine from the engine compartment. Place masking tape around the engine compartment. Doing so will prevent nicking and scratching of the hull when the engine is removed.





NOTE: Not all electrical connections can be disconnected without removing hoses, pipes or sub-systems. As components are removed, disconnect any electrical connections.

1. Locate the fuel hose quick disconnect on top of the fuel rail. Wrap a shop towel around the disconnect and press the two tabs in while pulling up on the connector.
2. Remove the fuel supply and fuel return hoses from the fuel rail. (Identify hoses for re-assembly.)
3. Remove all of the hoses connected to the oil storage tank. Identify each hose and its location during removal.
4. Lift the oil storage tank up and out of the cradle.
5. Remove the two lower tank hose connections. Identify each hose and its location during removal.
6. Carefully lift the oil storage tank out of the engine compartment.
7. Locate and remove the four engine mounting nuts and washers

NOTE: The hoist chains must allow the engine to be moved in any direction and at any pitch.

CAUTION: The lifting hoist must be able to lift at least 250 lbs. (113 kg.)

3.2. Engine Installation

The installation of the engine and engine subsystems is the reverse of their removal. During engine installation, several important notes must be made.

- Always verify the correct number of engine mounting strap shims are installed on each engine mounting post. Remove the pump to check driveshaft alignment, add shims to upper or lower the engine.
- Always verify that the engine does not interfere with critical routings such as the steering cable, cooling hoses, and main wiring harness.
- Steering cable must be fix on the front left motor mounts to avoid damage from engine





4

DISASSEMBLY INSPECTION AND RE-ASSEMBLY ENGINE





4. Engine Disassembly/Assembly

4.1. Engine Specifications

Component	Specification
Engine Model Number	Weber 110HP = HSR00_05_00_000
Maximum Engine Horsepower	110 HP
Maximum Engine Torque	108 @ 6700 rpm
Engine Type	8 Valve SOHC Parallel Twin Cylinder w/Balance Shaft-Four Stroke
Displacement	749cc
Bore X Stroke	85 x 66mm (3.346" x 2.598")
Compression Ratio	9.0:1
Cylinder Compression @ Sea Level	140 ± 14 psi (9.6 ± 1 bar) @ Sea Level
Recommended Fuel	Premium Unleaded 91, 92, 93 Octane
Engine Oil Requirement	HSR 100% Synthetic Four Stroke Engine Oil
Oil Grade Requirement	10W- 60 Synthetic API A3/B3
Engine Oil Capacity With Oil Filter Replacement Dry Engine (After Rebuild)	3.4 - 3.7 US Quarts (3.3 - 3.5 Liters) 3.9 - 4.2 US Quarts (3.7 - 4.0 Liters)





Cooling System Requirement	OPEN cooling system with Thermostat
Thermostat Opening Temperature	158 F (70°C)
Valve Timing (1mm Valve Lift) EV OPENS EV CLOSES IV OPENS IV CLOSES	52_ BBDC 2_ ATDC 14_ BTDC 50_ ABDC
Valve Diameter Exhaust Valves Intake Valves	29.5mm (1.161") 32.5mm (1.279")
Valve Seat Contact Width IV EV	1.1mm - 1.2mm (.043" - .047") 1.3mm - 1.4mm (.051" - .055")
Valve Face Width IV EV	2.0mm 2.0mm
Valve Margin Thickness IV EV	5.472mm (.2154") 5.463mm (.2150")
Valve Seat Angle	45°
Valve Outer Correction Angle	30°
Valve Inner Correction Angle	75°
Valve Clearance (COLD) IV	0.08 – 0.15mm (.003" – .006")





EV	0.18 – 0.25mm (.007" - .010")
Valve Stem Diameter	
IV	5.465 – 5.479mm (.2151" – .2157")
EV	5.456 – 5.470mm (.2148" - .2153")
Valve Guide Inside Diameter	
IV	5.5mm – 5.507mm (.216")
EV	5.5mm – 5.509mm (.216")
Valve Stem Run out	.03mm (.001")
Valve Stem-To-Guide Clearance	
IV	.021mm - .044mm (.0008 - .0017")
EV	.030mm - .053mm (.0011 - .0020")
Valve Spring Free Length	
INTAKE	38.2mm (1.5")
EXHAUST	38.2mm (1.5")
Valve Spring Installed Length	
INTAKE	32mm (1.26")
EXHAUST	32mm (1.26")
Cylinder Head Warpage Limit	.04mm (.001")
Cylinder Specifications	
BORE SIZE	85.00 - 85.01mm (3.34")
TAPER LIMIT	.008mm (.0003")
OUT--OF--ROUND LIMIT	.008mm (.0003")
WEAR LIMIT	N/A
Camshaft Specifications	
CAMSHAFT WIDTH	108.85mm - 109.00mm (4.28" - 4.29")
IN CAM LOBE HEIGHT	48.553mm (1.911")
EX CAM LOBE HEIGHT	48.209mm (1.897")
MAXIMUM CAMSHAFT RUNOUT	.05mm @ Sprocket / .02mm @ Base. (.001")
RADIAL PLAY	.020mm - .050mm (.001")
	25.972mm - 25.988mm (1.02")





BEARING HOLE I.D. CAMSHAFT AXLE O.D. CAMSHAFT CLAMP I.D.	19.991mm - 20mm (.787") 19.90mm - 19.98mm (.783")
Rocker Arm Specifications BEARING AXIAL PLAY ROCKER ARM I.D. ROCKER ARM SHAFT O.D. ROCKER ARM HOLDER BORE I.D. ROCKER ARM AXIAL PLAY	.013mm - .025mm (.0005" - .0009") 13.980mm - 13.991mm (.55") 9.994mm - 10mm (.393") 10mm - 10.009mm (.393") .16mm - .26mm (.006" - .010")
Crankshaft Specifications CRANKSHAFT DEFLECTION MAIN BEARING CLEARANCE BEARING CODES	.02mm - .04mm (.0007" - .0015") .03mm - .04mm (.0011" - .0015") YELLOW : 1,995 – 2,000mm BLUE : 2,000 – 2,005mm GREEN : 2,005 – 2,010mm
Balance Shaft Specifications AXIAL PLAY RADIAL PLAY BEARING DIAMETER RUN OUT	.15mm - .25mm (.005" - .009") .014mm - .066mm (.0005" - .002") 24.975mm - 24.990mm (.983") .014mm - .066mm (.0005" - .002")
Piston Specifications PISTON- TO- CYL CLEARANCE PISTON DIAMETER WEAR LIMIT PISTON PIN BOSS I.D. PIN O.D. PIN WEAR LIMIT TOP RING INSTALLED RING GAP	.041mm - .059mm (.0016" - .0023") 84.961mm - 84.979mm (Measured 15mm from bottom, 90° from pin. (3.34" - 3.345") .04mm (.001") 21.004mm - 21.009mm (.826" - .827") 20.995mm - 21.000mm (.826") .05mm (.001")
Piston Ring Specifications TOP RING INSTALLED RING GAP TOP RING GROOVE CLEARANCE MIDDLE RING INSTALLED RING GAP MIDDLE RING GROOVE CLEARANCE	.2mm - .4mm (.07" - .015") .65mm - .955mm (.025" - .037") .2mm - .4mm (.007" - .015") .50mm - .805mm (.019" - .031") .2mm - .7mm (.007" - .027")





OIL RING INSTALLED END GAP OIL RING GROVE CLEARANCE	.50mm - .910mm (.019" - .035")
Oil Pump Specifications OIL PUMP TYPES OIL PRESSURE RELIEF VALVE OIL PRESSURE	Trochoid SPRING FREE LENGTH = 2.7" (69mm) / PISTON O.D. = .43" (10.9mm) / PISTON LENGTH = 1.10" (27.7 - 28mm) 21 @ IDLE - 80 @ MAX PSI (1.5 - 5.5 BAR)

4.1.1. Engine Fastener Torque Specifications

Standard Torque Guide (mm)	FT. LBS.	Nm
5	1.5 – 3-6	3.4 – 4.9
6	4.3 – 5.7	5.9 – 7.8
8	10 – 14	14 – 19
10	18 – 25	25 – 34
12	322 – 45	44 – 61
14	54 – 72	73 – 98
16	85 – 114	115 – 155
18	122 – 166	165 – 225
20	166 – 240	225 – 325





4.1.2. Engine Specific Fastener Torque Specifications

Component	FT. LBS.	Nm	Notes	Fastener(s)
Cylinder Head Nuts	15	20	Apply Engine Oil to Threads.	M10 x 1.25
Step 1	30	40		
Step 2	180°	180°		M8 x 50
Step 3				M8 x 70 M8 x 90
Lower Crankcase Bolts				
Step 1	12	16 24 –		
Step 3	18	25		
Gearcover – to – Engine Block	7	10		M6 x 20
Plug Elbow Connector	11	15		M12 x 1.5
Hose Connector in Lower Crankcase	30	40	Loctite 577	M18 x 1.5
Oil Filter Cover Cap	17	24		
Dry Sump Oil Filter Screen	7	10	Loctite 243	M6 x 20
Dry Sump Cover – to – Lower Crankcase	7	10		M6 x 20 M6 x 35 M6 x 60
Dry Sump Pump Gear	28	38	Loctite 272	M8 x 25
Dry Sump Pump – to Cover	7	10		M6 x 20 M6 x 25
Dry Sump Hose Connector	7	10		M6 x 16
Balance Shaft Drive Gear Nut	51	70	Loctite 272	M10
Connecting Rod Bolts				
Step 1	7	10		M10 x 1.32
Step 2	14	20		
Step 3	90°	90°		
Camshaft Clamps	7	10		M6 x 40
Rocker Arm Holders	9	13		M6 x 20
Exhaust Manifold Studs				
Short	13	18	Copper Crease	M8 x 69
Long	13	18		M8 x 118
Exhaust Manifold Nuts	17	24	Copper Grease	M8 Flange
Valve Cover	7	10		M6 x 45





Tensioner Rail Fastener	17	24	Loctite 243	M8 x 25
Chain Guide Rail Fastener	7	10	Loctite 243	M6 x 25
Chain Tensioner Plug Bolt	51	70		

4.1.3. Engine Specific Fastener Torque Specifications

Component	FT. LBS.	Nm	Notes	Fastener(s)
Water Pump Cover	7	10	Loctite 577	M6 x 20 M6 x 30 M6 x 35

4.1.4. Turbocharger Specific Fastener Torque Specifications

Component	FT. LBS.	Nm	Notes	Fastener(s)
Segments	7	10		M6 x 16
Compressor Housing Clamping	7	10		M6 x 12
Oil Return Flange	7	10		M6 x 16
Turbocharger Lower Crankcase Bracket	17	24		M8 x 40
Turbocharger Bracket – to Manifold	17	24		M8 x 50
Wastegate Actuator Locknut	7	10		
Wastegate Bracket – to – Manifold	7	10		Torx E8
Wastegate – to – Bracket	7	10		M6
Actuator Arm – to – Lever	7	10		M6 x 20
Intercooler Mounting Fasteners	7	10		M6 x 35





4.1.5. Intake Manifold Specific Fastener Torque Specifications

Component	FT. LBS.	Nm	Notes	Fastener(s)
Manifold – to – Cylinder Head	7	10		M6 x 30
Lower Bracket – to – Lower Crankcase	22	30		M8 x 30

4.1.6. Alternator Assembly Specific Fastener Torque Specifications

Component	FT. LBS.	Nm	Notes	Fastener(s)
Magnet Rotor Fastener	73	100		M12 x 90
Cable Clamp	3	4	Loctite 272	M4 x 6
Sprague Clutch	7	10	Loctite 2752	M6 x 16
Stator Fasteners	7	10		M6 x 35
Stator Cover	7	10		M6 x 20 M6 x 25 M6 x 65

4.1.7. Fuel Rail Specific Fastener Torque Specifications

Component	FT. LBS.	Nm	Notes	Fastener(s)
Fuel Rail Fasteners	7	10	Loctite 243	M6 x 20





4.1.8. Engine Management Components/ Sensor Specific Fastener Torque Specifications

Component	FT. LBS.	Nm	Notes	Fastener(s)
Temperature/ Pressure Sensor (MAP)	4	5		M6 x 10
Temperature / Pressure Sensor (Intake Manifold)	5	7		M6 x 10
Crank Position/ Speed Sensor	7	10		M6 x 10
Coolant Manifold Temp. Sensor	13	18		
Ignition Coil Fasteners	7	10		M6 x 20
Spark Plugs	20	27	Dielectric Grease	
Starter Motor Fasteners	7	10	Nyogel	M6 x 50

4.1.9. Balance Plate/ PTO Specific Fastener Torque Specifications

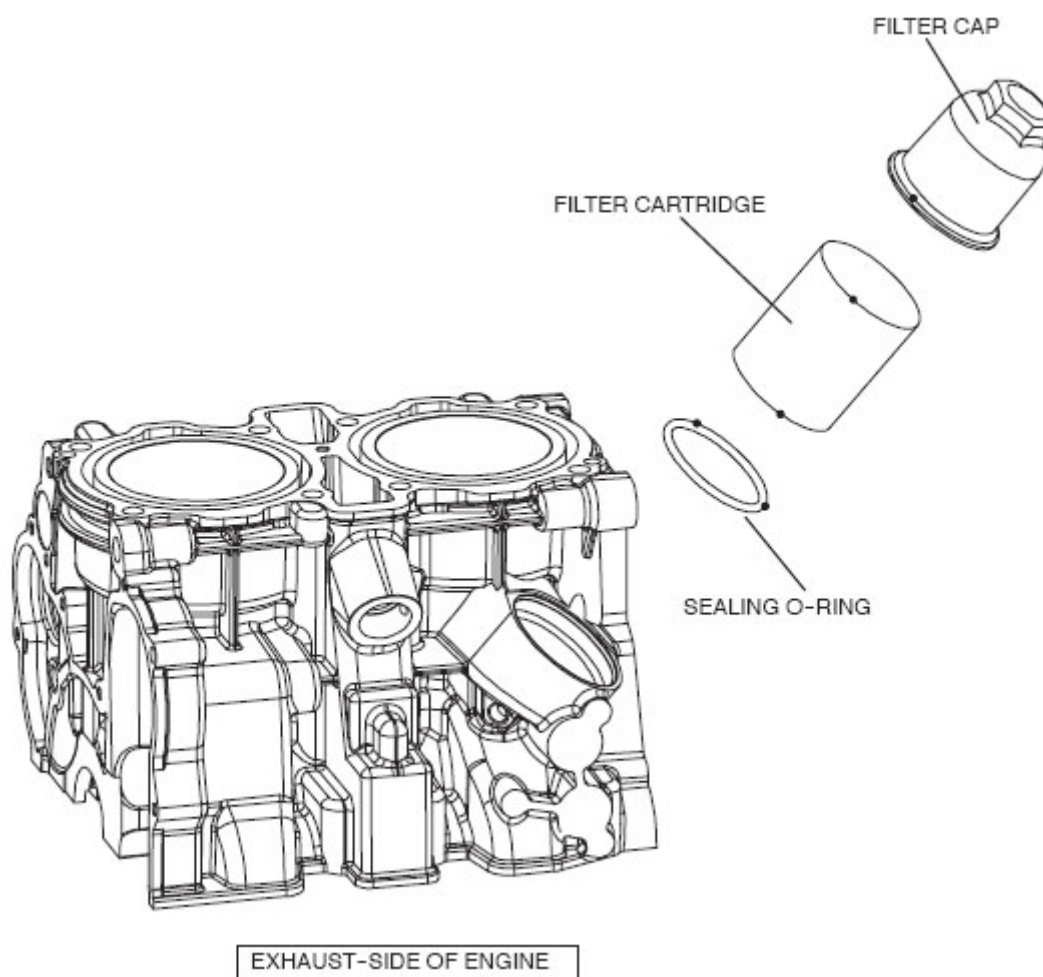
Component	FT. LBS.	Nm	Notes	Fastener(s)
Balance Plate – to – Crankshaft	51	70	Loctite 577	M10 x 1 x 45

4.1.10. Engine Mounts Specific Fastener Torque Specifications

Component	FT. LBS.	Nm	Notes	Fastener(s)
Front Engine Mount – to – Lower Crankcase	40	55	Loctite 243	M10 x 80
Rear Engine Mount – to – Crankcase and Lower Crankcase	40	55		M10 x 40



4.2. Oil filter assembly

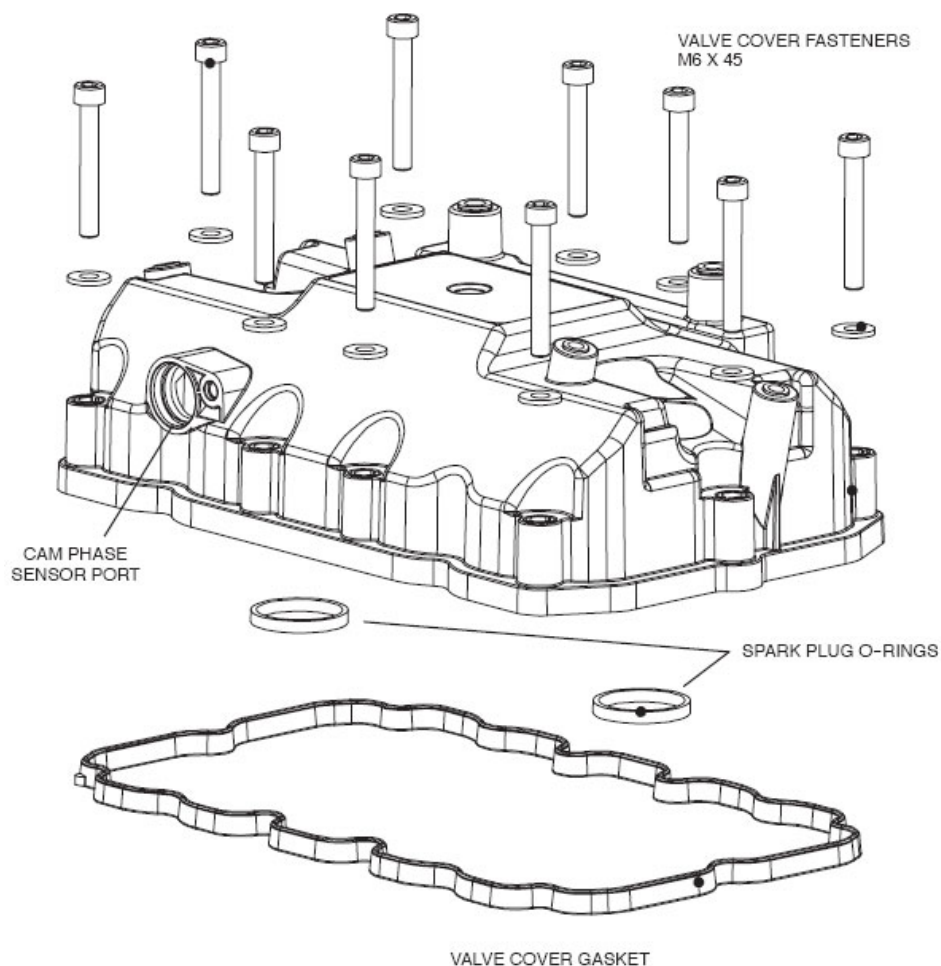


Assembly Notes:

Filter Cap Torque 18 ft.lbs. (25 Nm)

Apply a light film of engine oil to sealing o- ring and filter cap threads during installation.
OIL FILTER CHANGE INTERVAL: BREAK IN = 10 TO 12 HOURS / EVERY 25 HOURS
THEREAFTER

4.3. Valve cover assembly



Assembly Notes:

Valve Cover Fastener Torque 7 ft.lbs. (10 Nm)

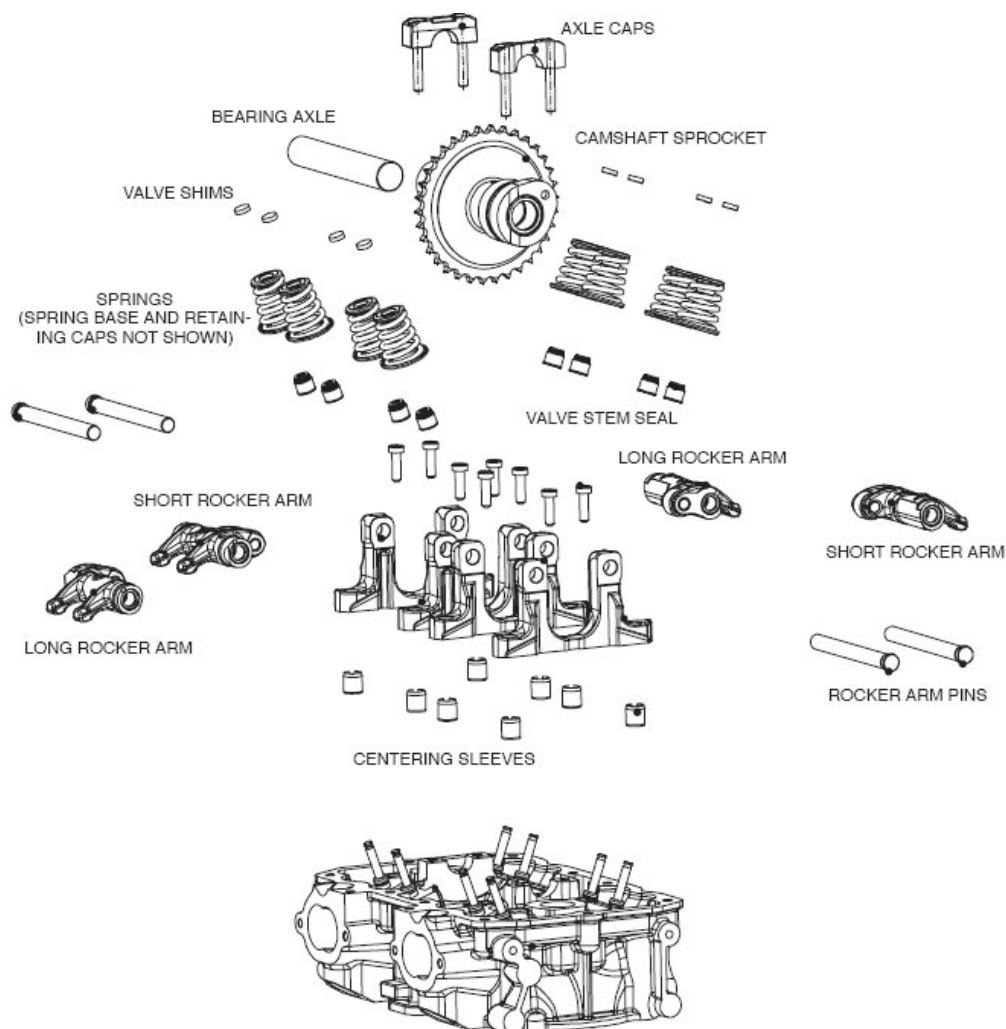
Cam Phase Sensor Fastener Torque 6.6 ft.lbs. (9 Nm)

Always use new gaskets and o- rings when removing or replacing parts.

Torque valve cover fasteners in a criss- cross pattern beginning with the four inside fasteners. Cam phase sensor port faces exhaust- side of engine.

Verify valve cover sealing surface is dry and clean from containments.

4.4. Valve train assembly



Assembly Notes:

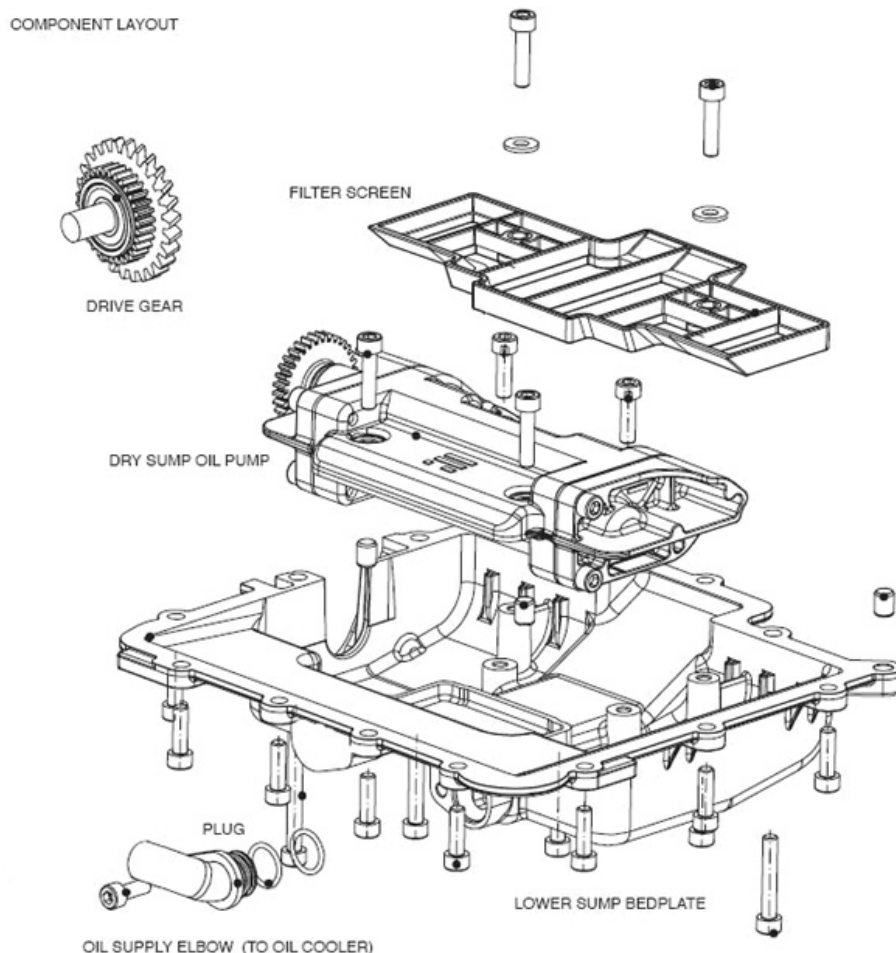
Camshaft Bearing Fastener Torque: 7 ft.lbs. (10 Nm)

Rocker Arm Tower Fastener Torque: 9 ft.lbs. (13 Nm)

VALVE CLEARANCE (COLD) IN: .08 - 0.15MM (.003 - .006IN.) / EX: .18 - .25MM (.007 - .010IN.)

Verify camshaft orientation during installation. Hole in camshaft is located on the PTO side of engine. Always replace camshaft sprocket and timing chain together.

4.5. Dry sump oil pump assembly



Assembly Notes:

Screen Fastener Torque: 7 ft.lbs. (10 Nm) Apply Loctitet 243 to threads.

Oil Pump Fastener Torque: 7 ft.lbs. (10 Nm) Apply Loctitet 243 to threads.

Oil Pump Drive Gear Nut Torque: 28 ft.lbs. (38 Nm) Apply Loctitet 272 to threads.

Plug Fastener Torque: 11 ft.lbs. (15 Nm)

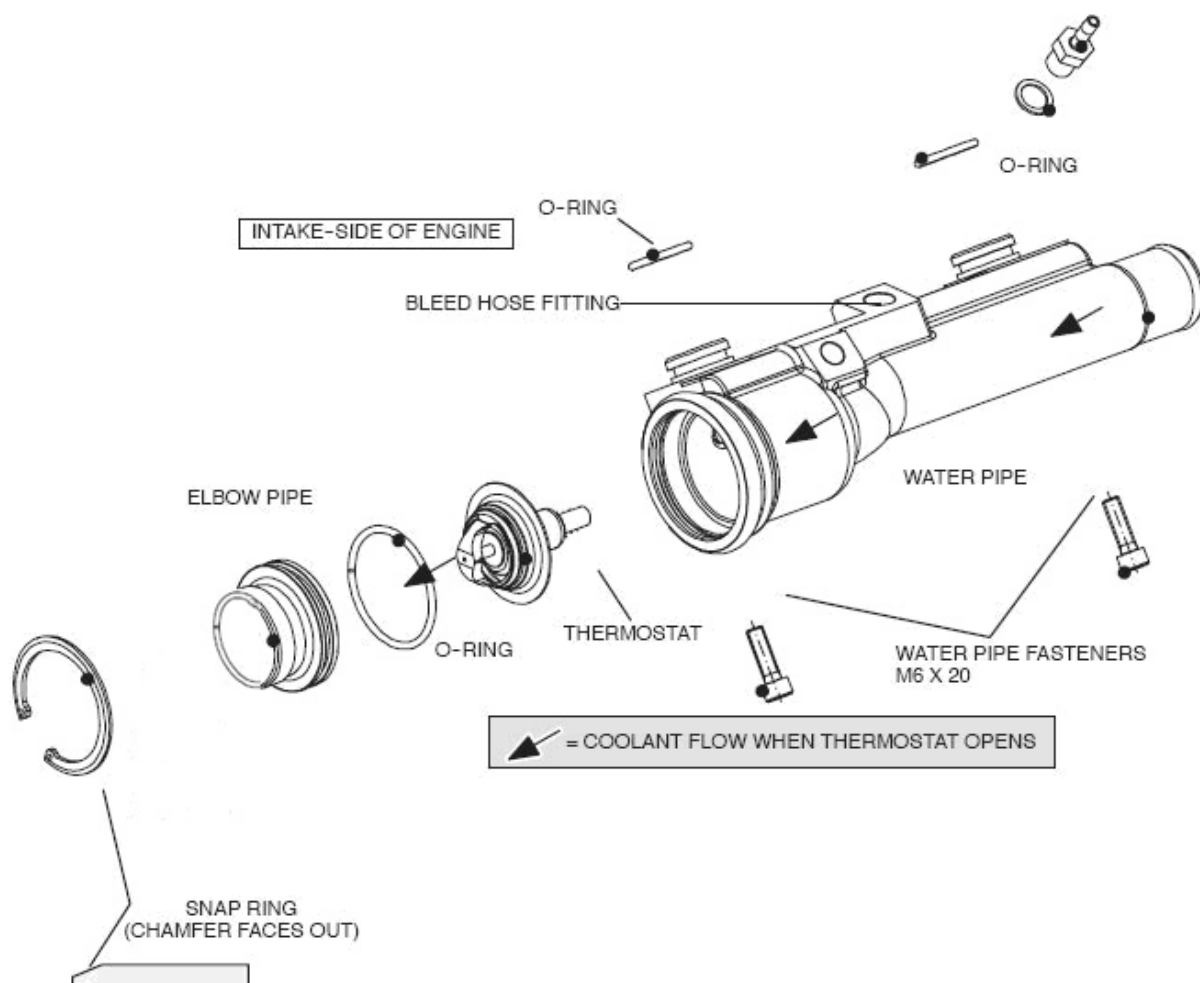
Oil Supply Elbow Fastener Torque: 7 ft.lbs. (10 Nm)

Clean bedplate and lower crankcase mating surfaces prior to apply silicone. Verify surfaces are free from any oil residue.

Apply a thin bead of Three Bondt 1215 to mating surfaces of bedplate and lower crankcase.

Dry sump oil pump is not serviceable. Replace component if operation is suspect.

4.6. Thermostat housing assembly



Assembly Notes:

Water Pipe Fastener Torque: 7 ft.lbs. (10 Nm)

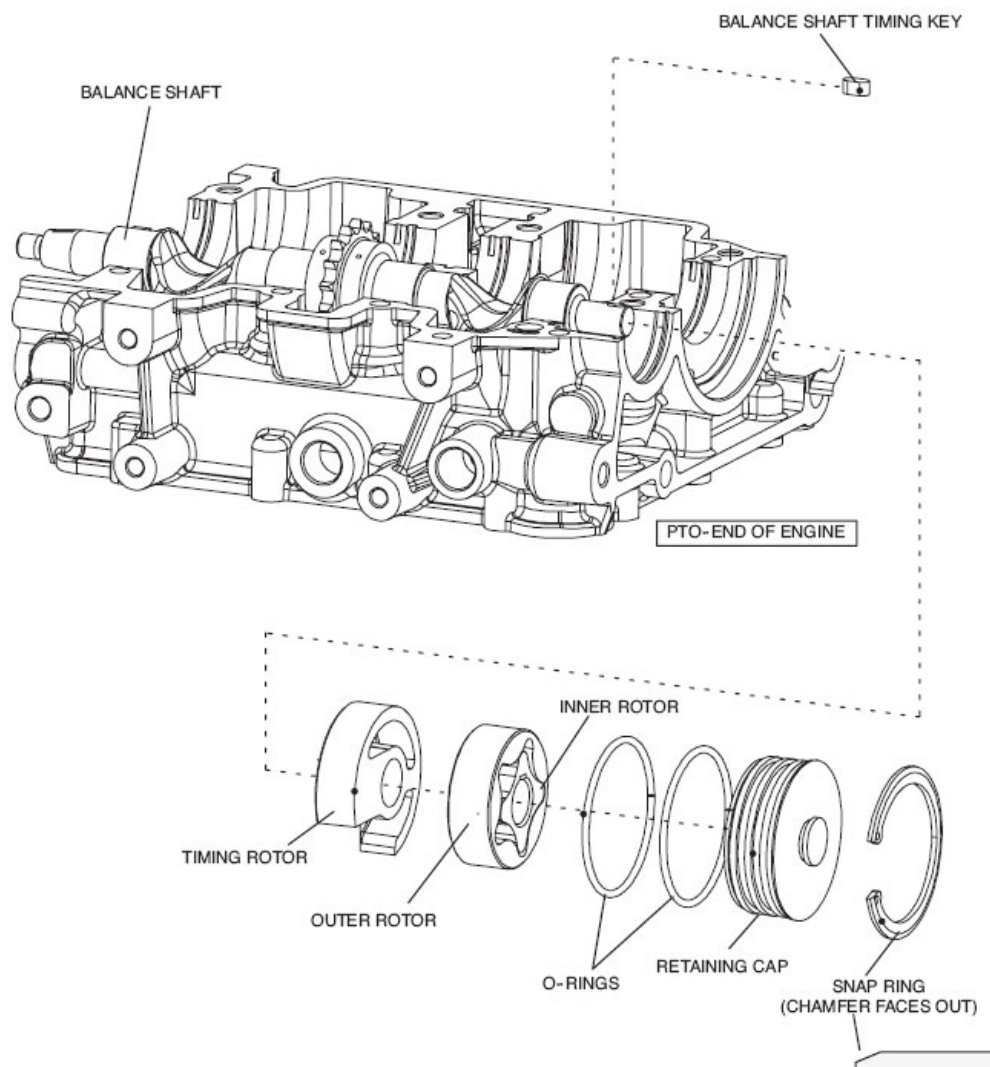
Thermostat Opening Temperature: 158_F / 70_C

Snap ring chamfer faces outward, towards rear of engine.

Always use new o- rings during installation and reassembly.

Elbow pipe points down and toward the heat exchanger.

4.7. High pressure oil pump assembly



Assembly Notes:

Use LIBERAL amounts of engine oil on timing rotor, inner and outer rotors, I.D. of retaining cap, and retaining cap o- rings during oil pump assembly.

Snap ring chamfer must face outwards, towards rear of engine when installed.

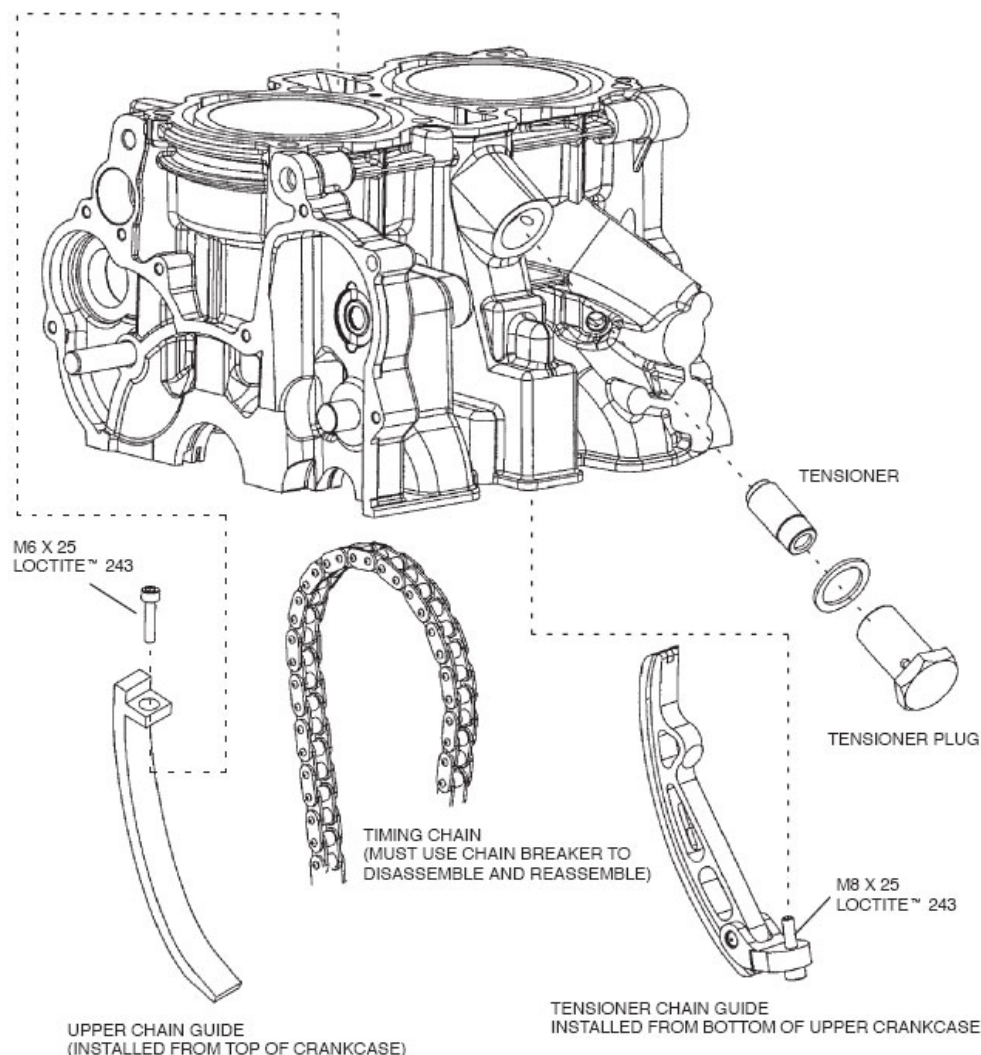
Verify retaining cap does not move when snap ring is installed.

An audible “click” must be heard and alignment pin must be inserted properly into engine case when installing the timing rotor into the oil pump bore.

Verify balance shaft timing key is oriented properly inside shaft keyway.

4.8. Exhaust-side chain guide/tensioner assembly

COMPONENT LAYOUT



Assembly Notes:

Timing Chain Tensioner Plug Bolt Torque: 51 ft.lbs. (70Nm)

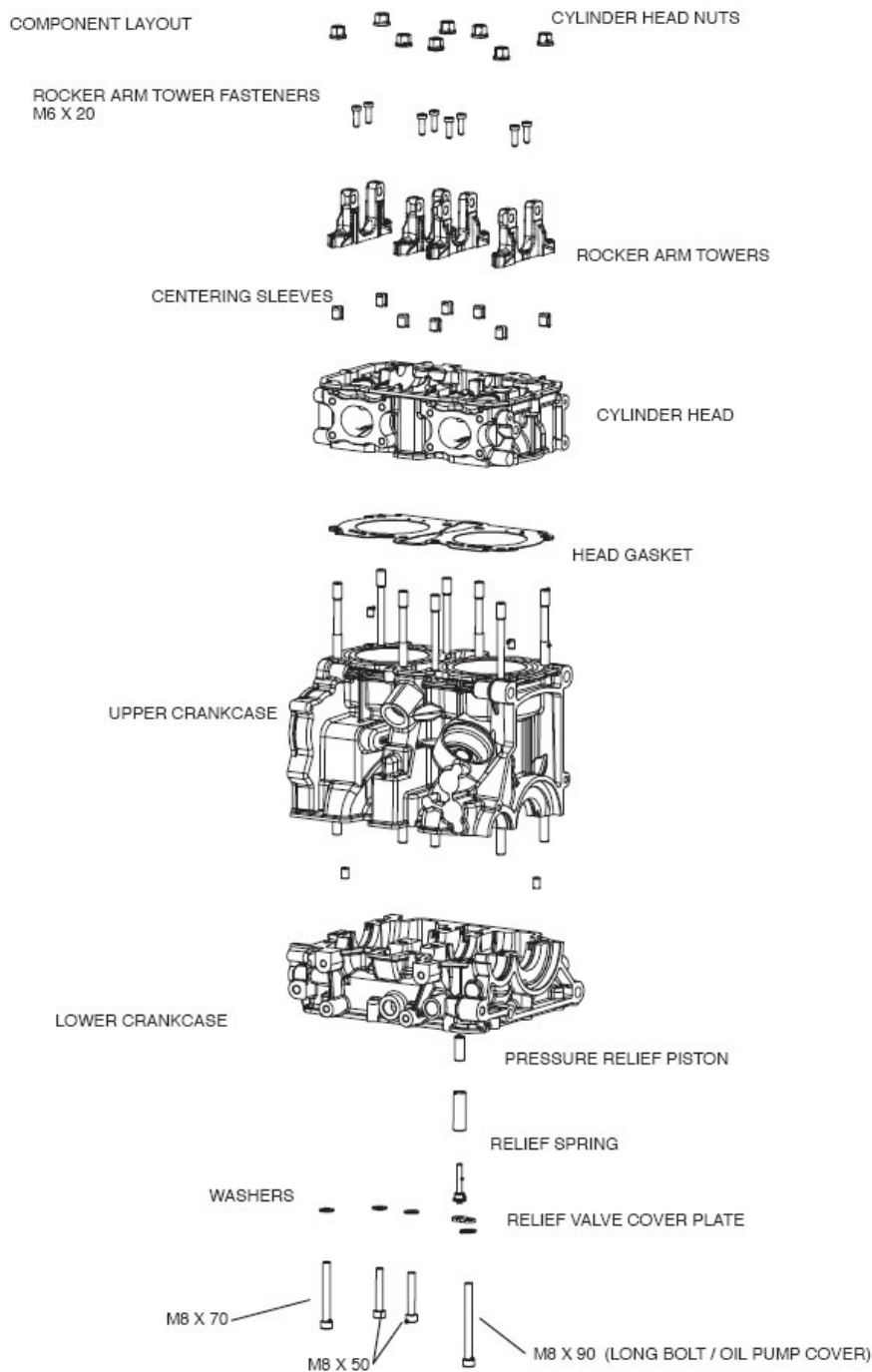
INSTALLED FROM BOTTOM OF UPPER CRANKCASE

Tensioner Guide Fastener Torque: 17 ft.lbs. (24 Nm) Apply Loctitet 243 to threads.

Replace replace tensioner rail if damaged, or unevenly worn.

Press tensioner into housing until flush with plug to set tensioner. Tensioner should remain in locked position. Activate tensioner by pushing tensioner in and past flush. Tensioner should activate and extend outwards. Replace if function is incorrect

4.9. Engine case/cylinder head assembly



Assembly Notes:

CYLINDER HEAD - TO - CRANKCASE TORQUE SEQUENCE SPECIFICATIONS

Apply engine oil to bolt threads.

1st STEP: Torque cylinder head nuts in sequence.

15 ft.lbs. (20 Nm)

Torque crankcase fasteners in sequence.

12 ft.lbs. (16 Nm)

2nd STEP: Torque cylinder head nuts in sequence

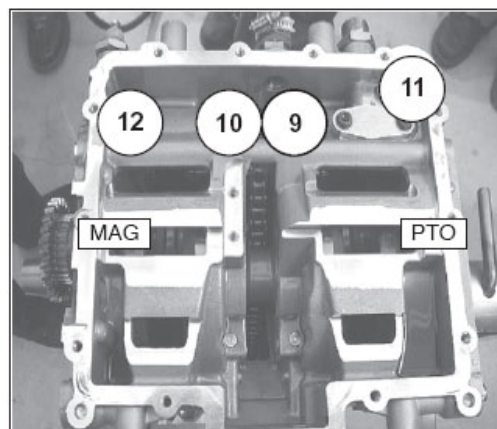
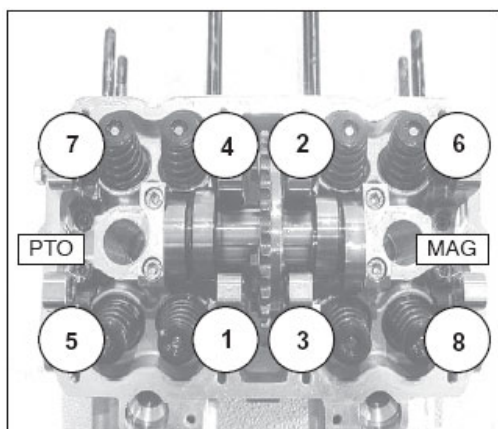
30 ft.lbs. (40 Nm)

3rd STEP: Torque cylinder head nuts in sequence.

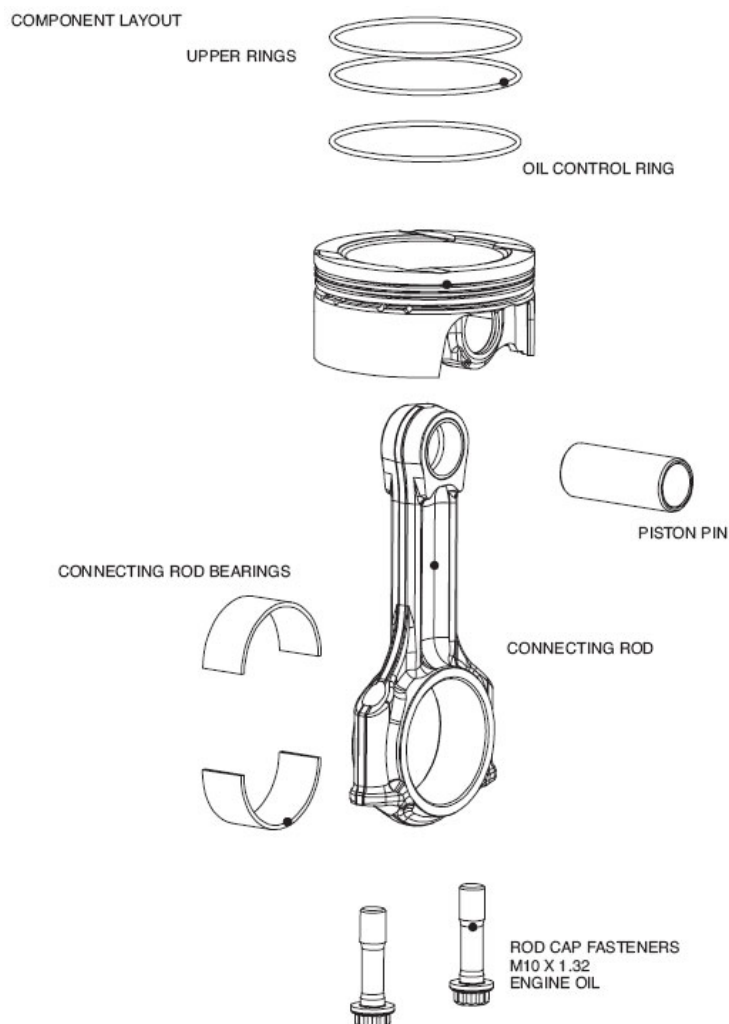
180°

Torque crankcase fasteners in sequence.

18 ft.lbs. (24 - 25 Nm)



4.10. Piston assembly



Assembly Notes:

AVAILABLE BEARINGS: 1. RED .0783 - .0785IN. (1.990 - 1.995mm)

2. YELLOW .0785 - .0787IN. (1.995 - 2.000mm)

3. BLUE .0787 - .0789IN. (2.000 - 2.005mm)

Rod Cap Fastener Torque: 1st Step: 7 ft.lbs. (**10 Nm**)

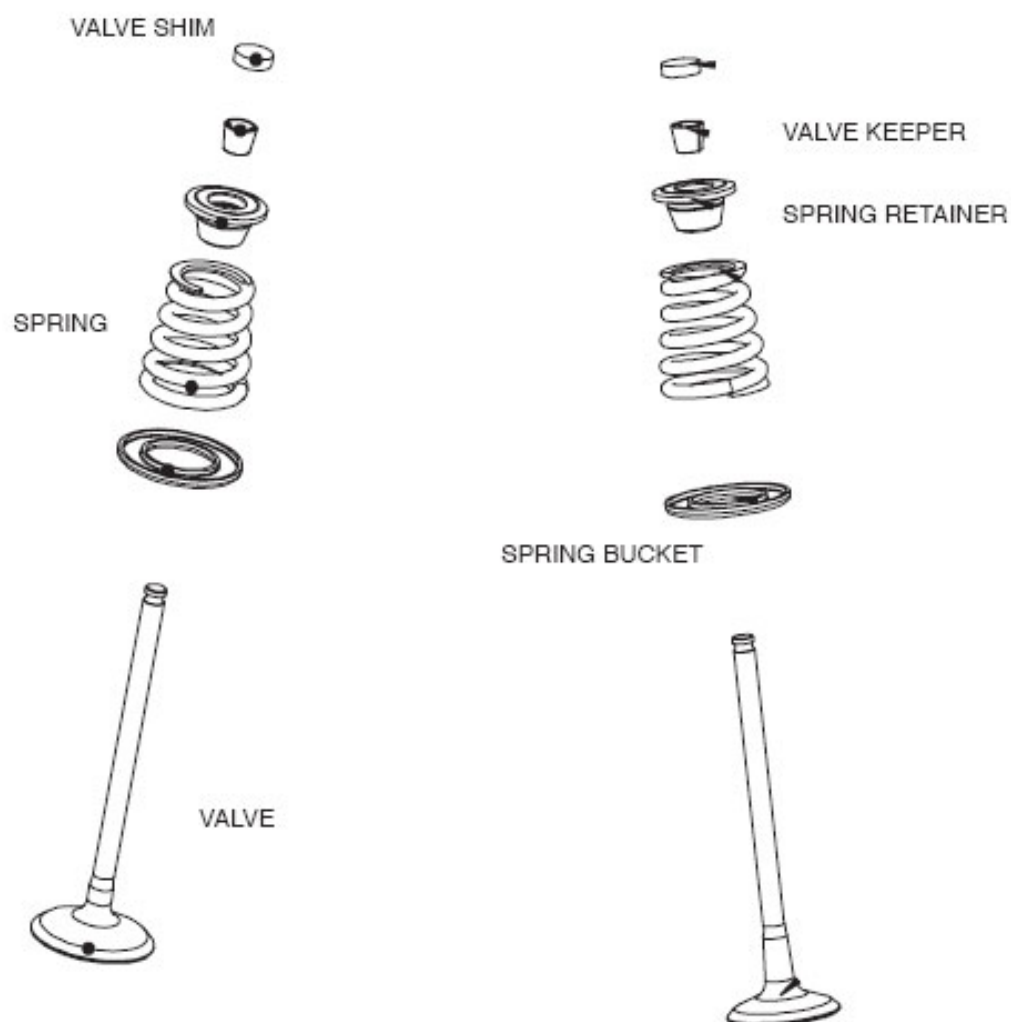
2nd Step: 14 ft.lbs. (**20 Nm**)

3rd Step: **Turn 90°** _

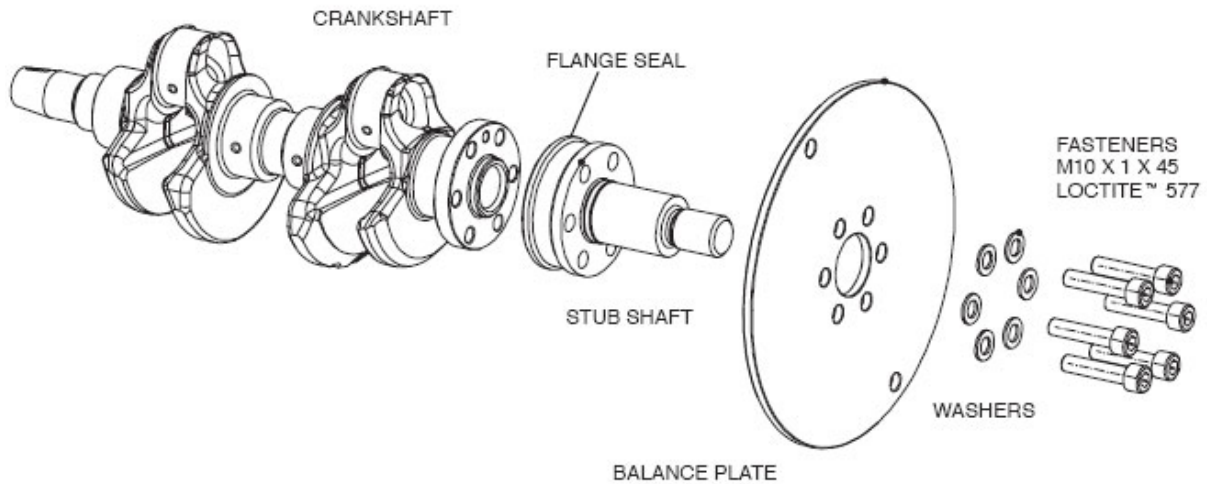
APPLY ENGINE OIL TO FASTENER THREADS PRIOR TO INSTALLATION.

Connecting rod caps feature a "cracked" mating surface. Cap must be marked during removal and installed correctly.

4.11. Valve assemblies



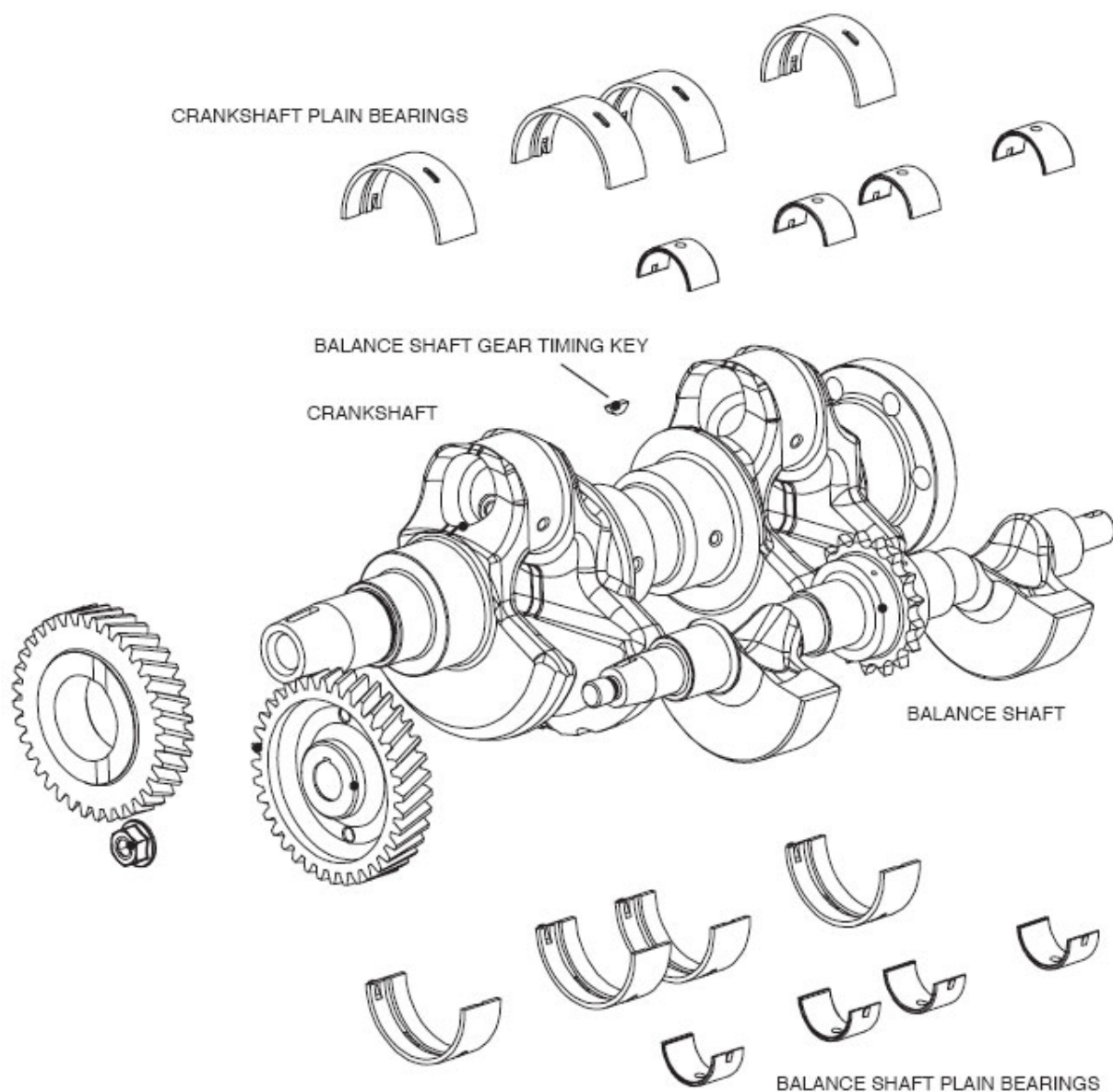
4.12. Balance plate/PTO assembly



Assembly Notes:

Balance Plate Fastener Torque: 51 ft.lbs. (70 Nm) Apply Loctite 577 to threads.

4.13. Crankshaft/Counter balancer assemblies



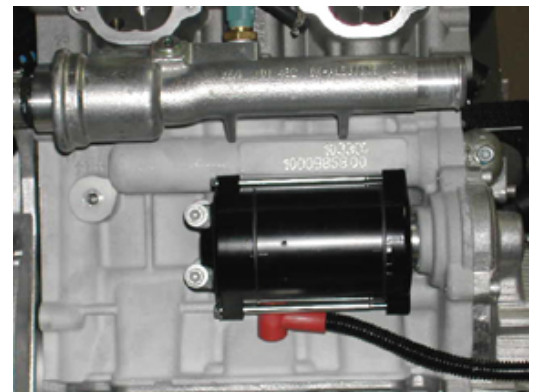


4.14. Engine Disassembly Process

1. Remove valve cover from engine.



2. Remove the coolant outlet manifold, oil filter cover, and electric starter motor from engine case

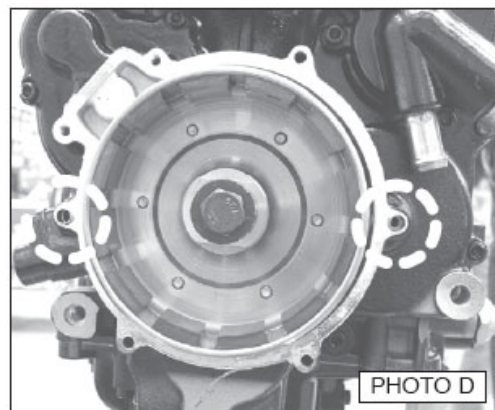


3. Remove the two high pressure oil feed hose banjo bolts from the cylinder head exhaust- side rear mounting location.

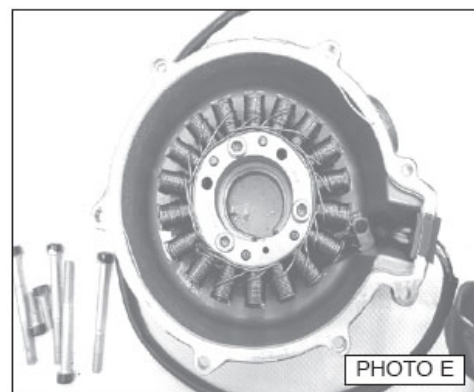


4. Remove the stator cover from the flywheel housing. (Photo D)

NOTE: The stator is attached to the inside of the cover. Note the two alignment dowels as circled in photo.

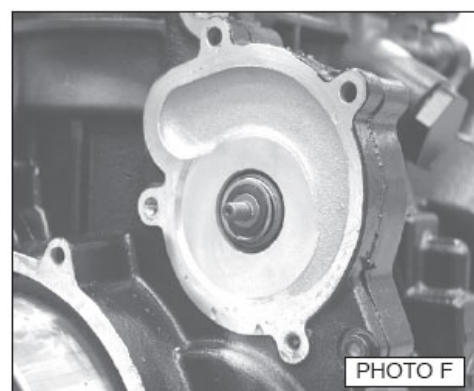


5. Photo of stator inside of cover. (Photo E)



6. Remove the water pump cover and impeller. (Photo F)

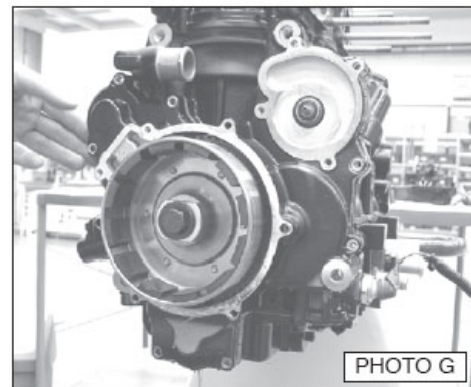
NOTE: The impeller can be removed by turning the nut counter-clockwise. Hold the flywheel stationary while removing the impeller.



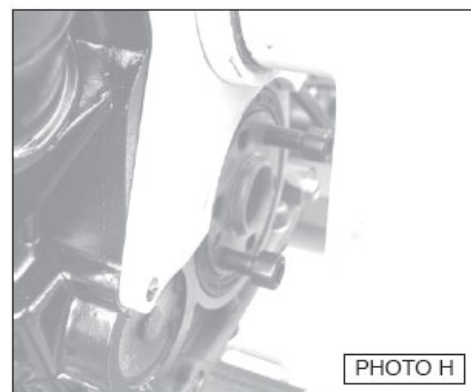


7. Remove the front engine gear cover. (*Photo G*)

NOTE: Place drain pan underneath cover to catch oil.



8. Install two of the PTO coupler bolts into the PTO- end of the crankshaft. Have an assistant place a pry bar across these two bolts to prevent the crankshaft from rotating. (*Photo H*)



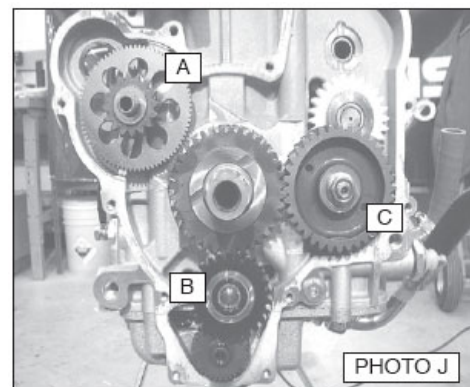
9. Remove the flywheel bolt and washer from the front of the engine. Install flywheel puller bolt into flywheel HSR00_99_01_076. Carefully tighten puller bolt until flywheel comes off of crankshaft nose. (*Photo I*)

10. Remove the flywheel timing key and roller bearings from crankshaft.



11. Photo of front of engine. Remove the starter motor drive gear assembly (A) and oil pump drive gear (B).

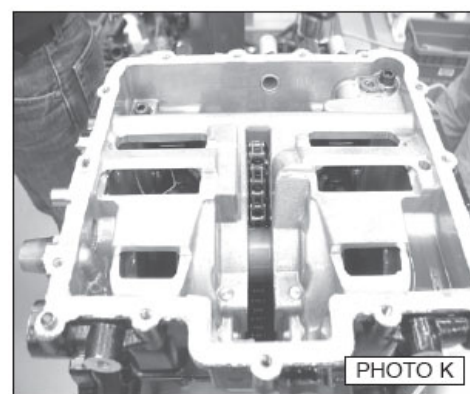
(Photo J)



12. Remove lock pin and rotate engine 180°. Remove the sump cover. (Photo K)

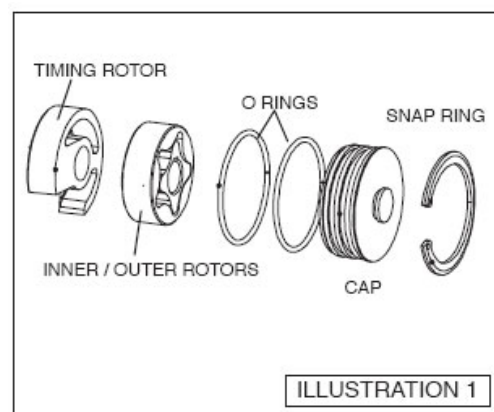
NOTE: The sump oil pump is attached to the inside of the sump cover.

13. Install crankshaft hand crank, PN PW- 46981 into nose of crankshaft. Tighten lock nut against crankshaft.



14. The high pressure oil pump is located on the PTO side of the engine. It is connected to the balance shaft.

Remove the snap ring from the high pressure oil pump cover. Carefully extract the cap, outer and inner rotors, timing key and timing rotor from engine. (Illustration 1)



15. Rotate the engine assembly 180° so that the valve train is up. Using the hand crank, crank the engine until the PTO piston is at TDC on the compression stroke.

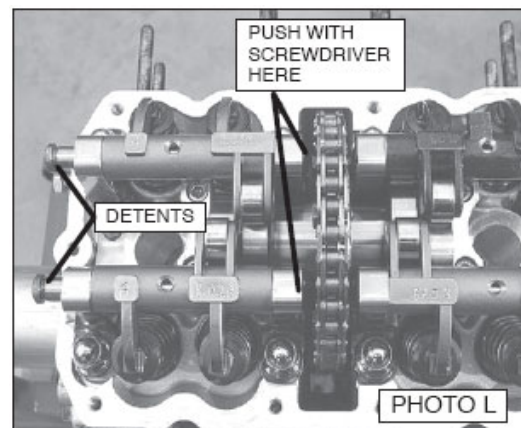
BOTH PTO ROCKER ARMS WILL BE LOOSE.

16. Using a flat-head screwdriver, push the rocker arm pins out enough to expose the detents on the pins.

Remove the pins from the cylinder head. (Photo L)

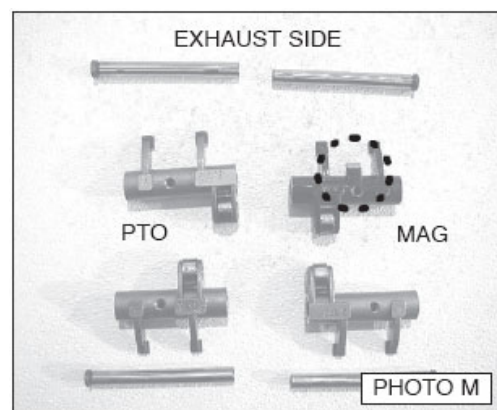
17. Rotate the engine 360° counter-clockwise. Perform steps 15 and 16 on the MAG cylinder valve train.

NOTE: A piston is at TDC on the compression stroke when the piston is up and there is axial free-play in each of the rocker arms.



18. Place rocker arm assemblies and rocker arm pins on a clean towel or piece of paper. Identify each part for use during assembly. (Photo M)

NOTE: The MAG, exhaust-side rocker arm features a cam phase sensor pickup nose as circled in photo M.



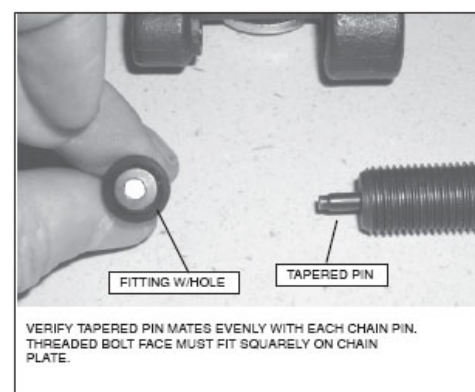
19. Remove the valve shims. Place valve shims with corresponding rocker arm and location.

20. Remove the chain tensioner bolt located next to the oil filter location.

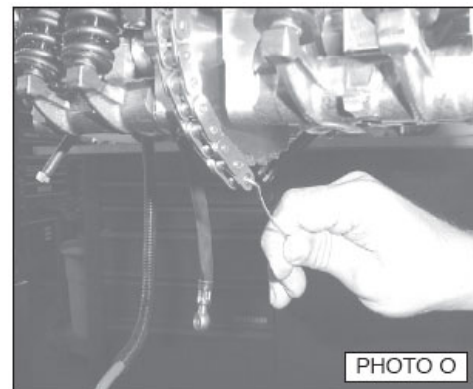
21. Attach the chain breaker tool,.

22. Using the chain breaker tool, carefully press the pin out of the link plate. Once outer plate is loose, disconnect the tool and remove the last pin.

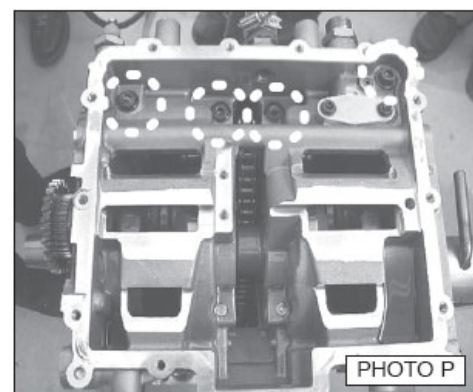
23. Remove the two pins from the chain, but do not pull the chain away from the cam sprocket.



24. Rotate the engine assembly 180° so that the valve train is down, facing the floor. Using the hand crank, crank the timing chain out of the engine.

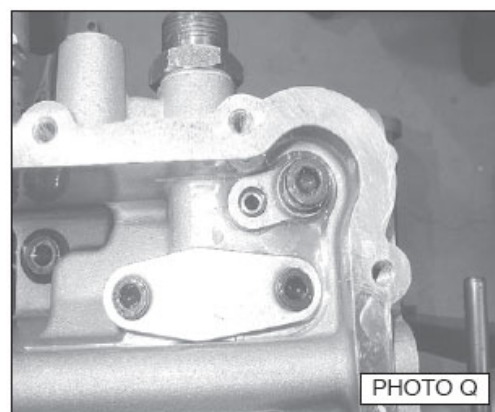


25. With the timing chain removed from the engine, the crankcase can be split in two. To begin, loosen and remove the four case bolts located in the oil sump gallery. (*Photo O*)



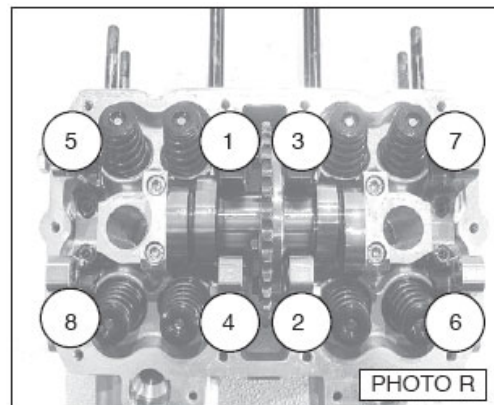
26. The lower case bolt located on the PTO side also holds the oil pump relief piston cover in place. (*Photo P*)

27. Once the plate is removed, use a magnet to remove the spring and piston from inside the bore.

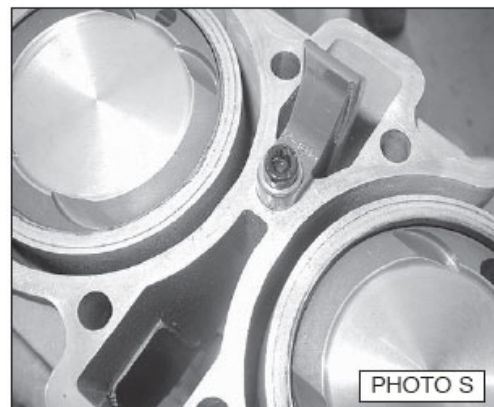


28. Rotate the engine assembly 180° so that the valve train is up. Evenly loosen and remove the cylinder head nuts. *(Photo R)*

29. Carefully pull the cylinder head assembly up and off of the crankcase.

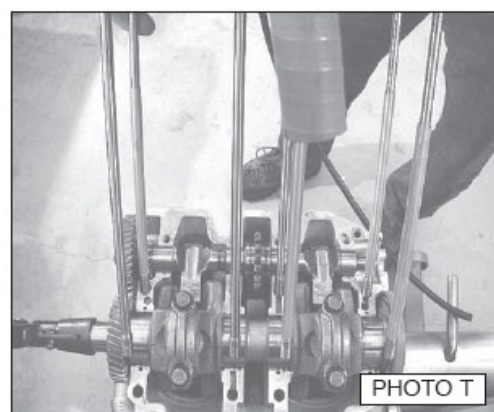


30. Remove the chain guide fastener and chain guide. *(Photo S)*



31. Rotate the engine assembly 180°. Remove the tensioner chain guide from the crankcase.

32. Using a soft-faced hammer, carefully tap the lower section of the crankcase loose from upper crankcase. Once loose, pull the lower crankcase up and away from the upper case. *(Photo T)*





33. Remove the balance shaft from the crankcase.

Remove the PTO crankshaft case seal and discard.

Remove the piston lower rod cap bolts. (*Photo R*)

34. Carefully push each piston through and out of the crankcase. Match each rod cap with its corresponding connecting rod. (*Photo U*)

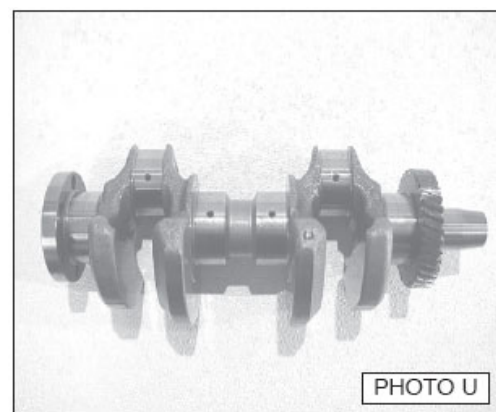
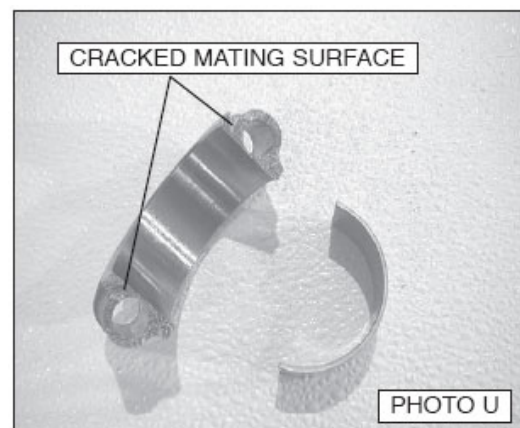
NOTE: The connecting rod caps are “cracked” during manufacture creating a unique mating surface between the connecting rod and cap. Always verify that the lower cap matches the connecting rod.

35. Always keep the connecting rod plain bearings, rod caps, and bolts with the piston assembly the engine was manufactured with.

36. Remove the crankshaft assembly from the crankcase.

Remove each crankshaft plain bearing from both crankcase halves and place with its original crankshaft journal.

NOTE: Always mark the bearings for identification during assembly and oil clearance measuring procedures.



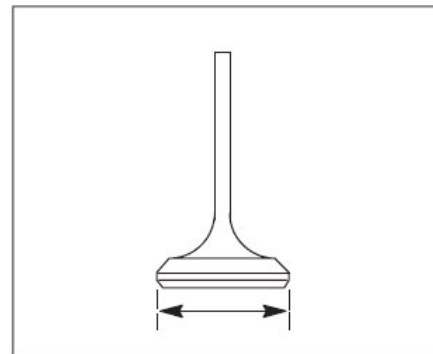
4.15. Engine inspection procedures

4.15.1. Valve Inspection

NOTE: Valves cannot be replaced. If valve face is burned or excessively worn, replace valve.

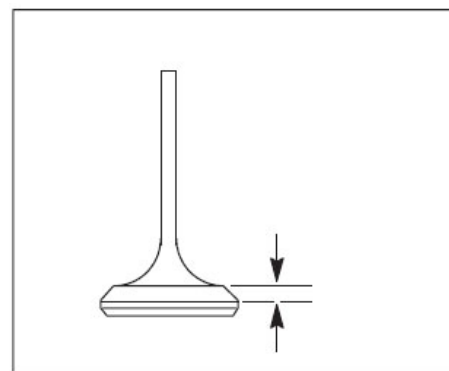
Measure diameter of valve.

- Out of specification: Replace



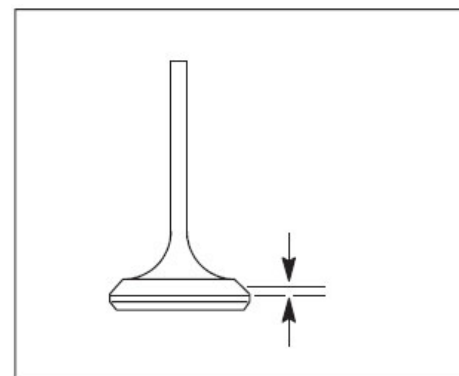
Measure valve face width.

- Out of specification: Replace valve



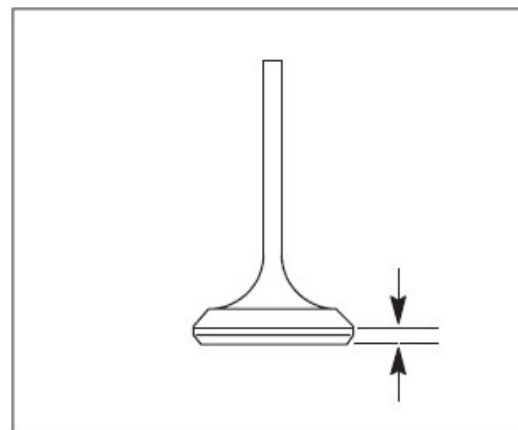
Measure valve seat contact width.

1. Apply light coating of Prussian Blue or similar dye compound to valve face.
2. Install valve into valve guide.
3. Tap valve several times to make a clear impression on the valve face. Do not rotate valve.
4. Remove valve and measure valve seat width.
 - Out of specification: Recondition or re-place cylinder head.



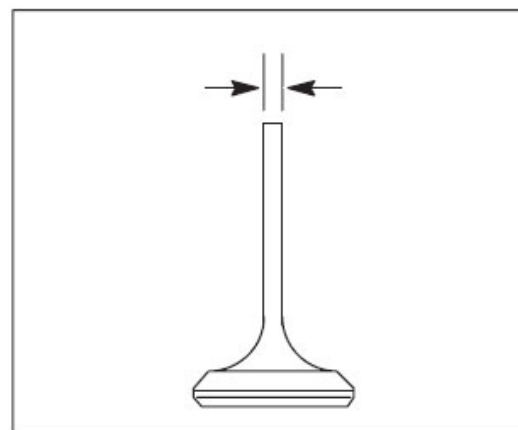
Measure valve margin thickness.

- Out of specification: Replace valve



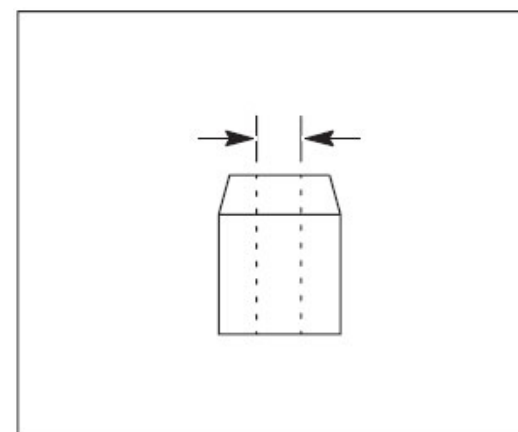
Measure valve stem diameter.

- Out of specification: Replace valve



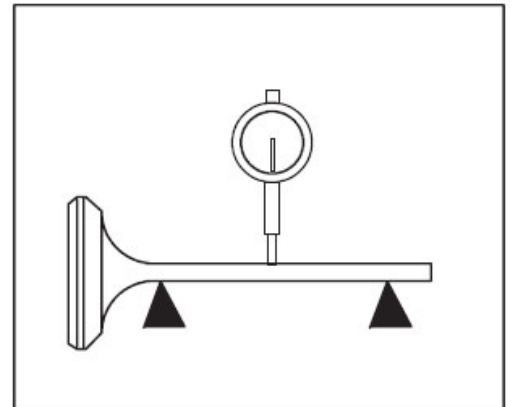
Measure valve guide inside diameter.

- Out of specification: Replace valve guide



Measure valve stem run out.

- Out of specification: Replace valve



Measure valve spring free and installed length.

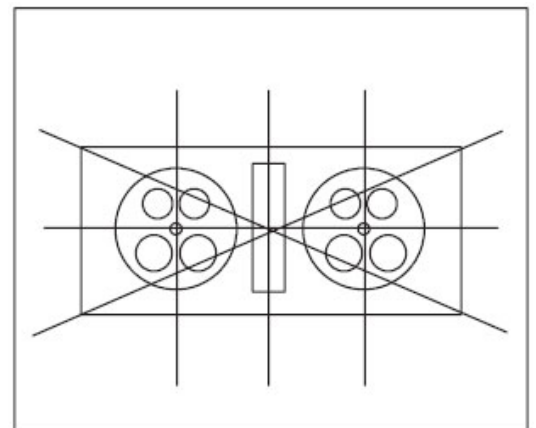
- Out of specification: Replace spring



4.15.2. Cylinder Head Inspection

Measure cylinder head warpage.

- Out of specification: Replace cylinder head

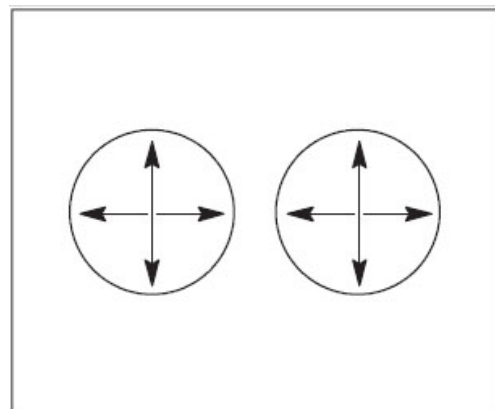


4.15.3. Cylinder Block Inspection

Measure cylinder bore size.

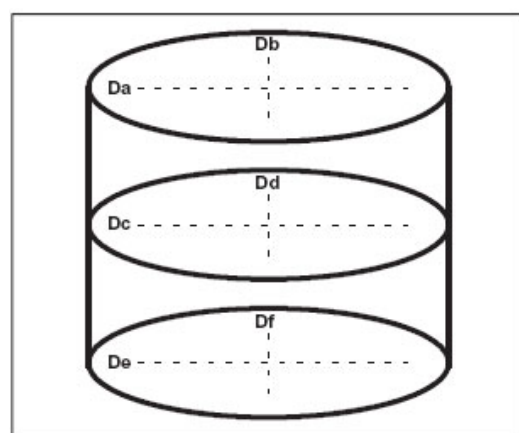
- Out of specification: Replace cylinder block

NOTE: Cylinders are plated with NiCaSil.



Measure cylinder for taper and out- of- round limits.

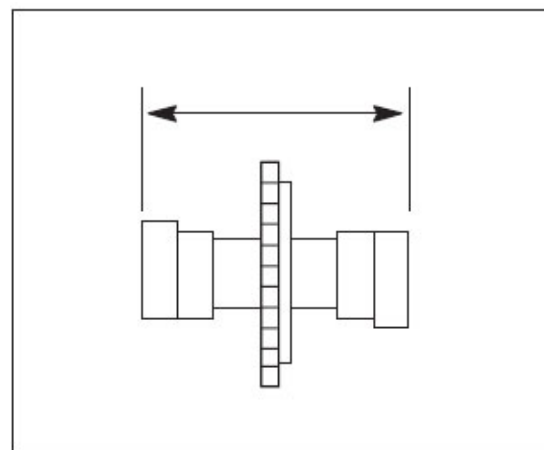
1. BORE = Maximum diameter of Da - Df.
 2. TAPER = Maximum of Da - De and Db - Df.
 3. Out- of- Round = Maximum of Da - Db and De - Df.
- Out of specification: Replace cylinder block



4.15.4. Camshaft Inspection

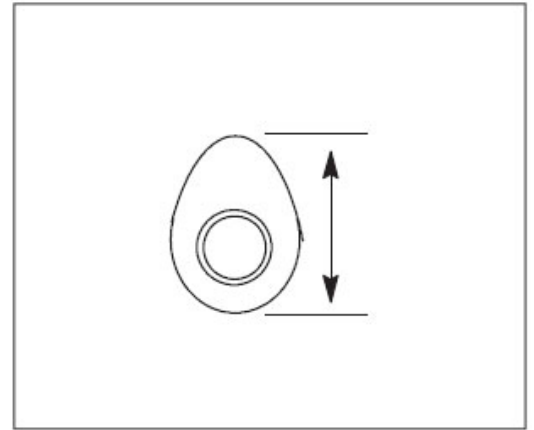
Measure camshaft width.

- Out of specification: Replace camshaft



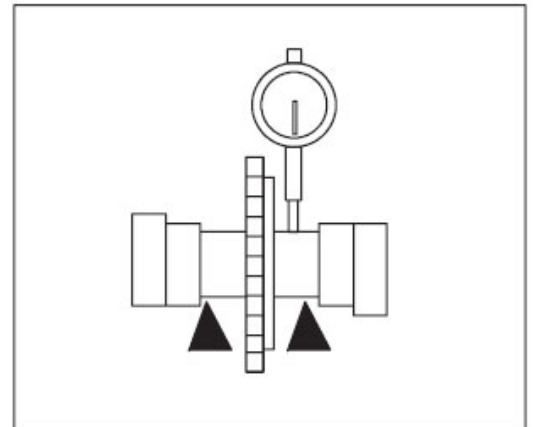
Measure cam lobe height.

- Out of specification: Replace camshaft



Measure camshaft run out.

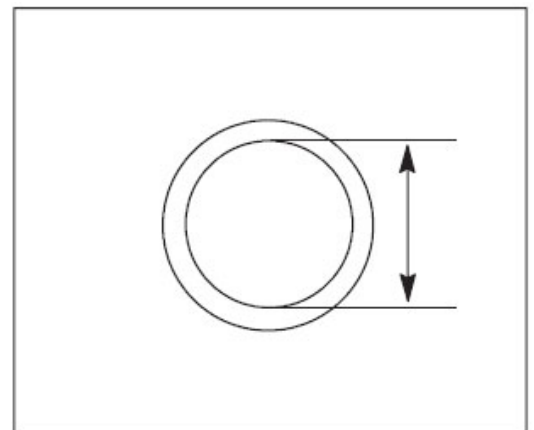
- Out of specification: Replace camshaft



Measure camshaft bearing hole inside diameter.

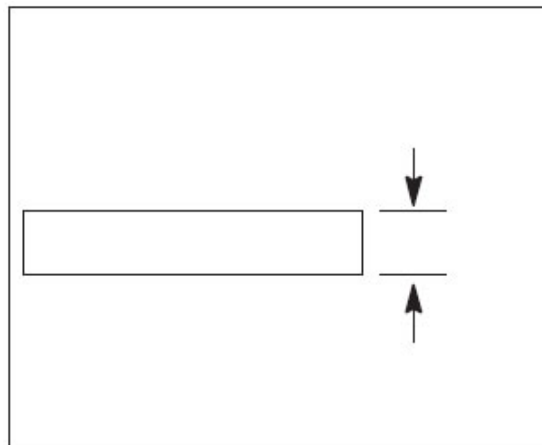
- Out of specification: Replace camshaft

NOTE: Bearings must be removed to measure I.D.



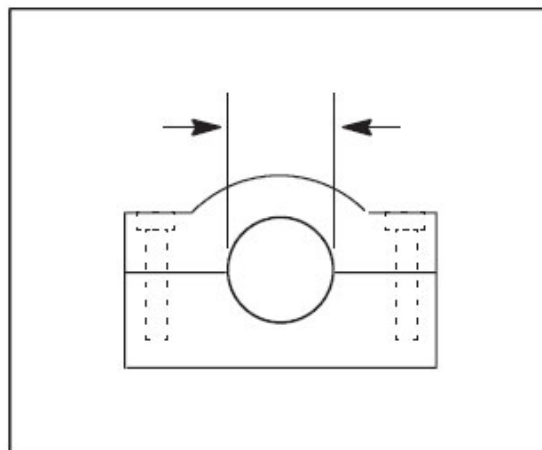
Measure camshaft axle outside diameter.

- Out of specification: Replace axle



Measure camshaft axle clamp inside diameter.

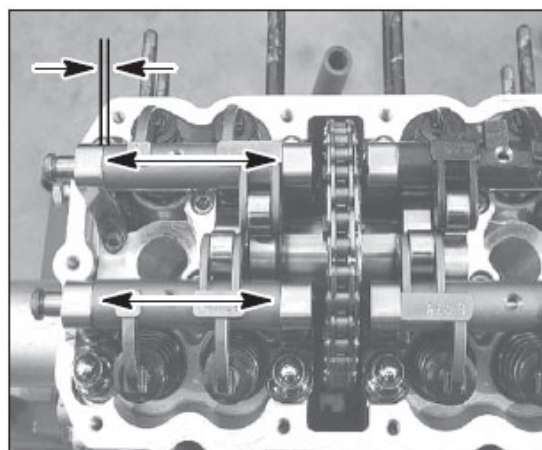
- Out of specification: Replace cylinder head



4.15.5. Rocker Arm Inspection

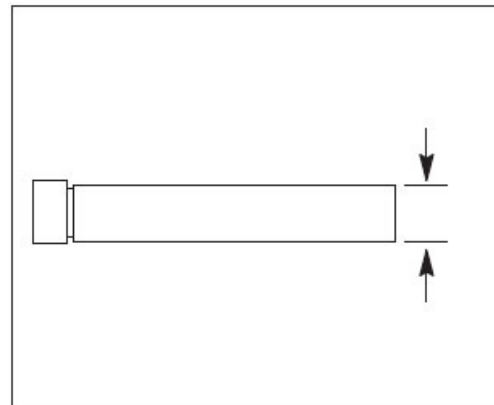
Measure rocker arm axial play.

- Out of specification: Replace rocker arm



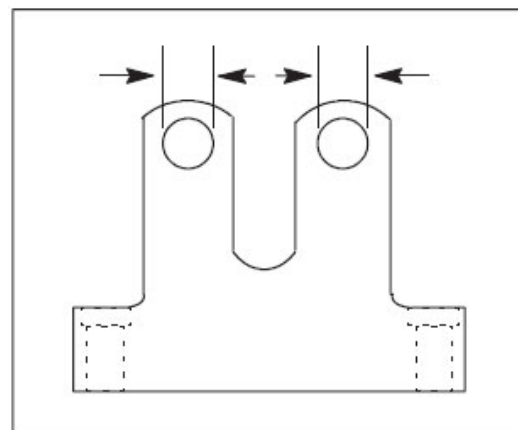
Measure rocker arm shaft outside diameter.

- Out of specification: Replace rocker arm shaft



Measure rocker arm post bore inside diameter.

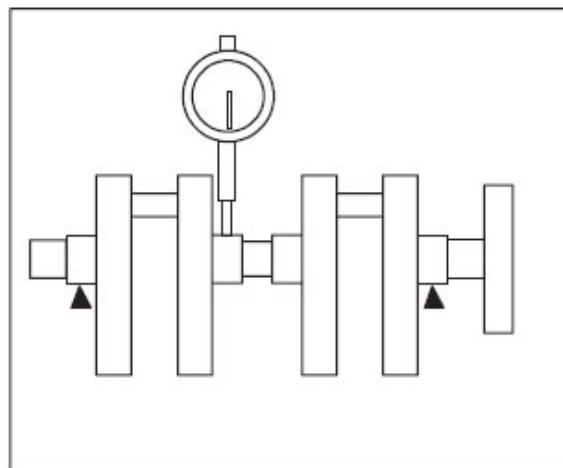
- Out of specification: Replace rocker arm post



4.15.6. Crankshaft Inspection

Measure crankshaft deflection.

- Out of specification: Replace crankshaft

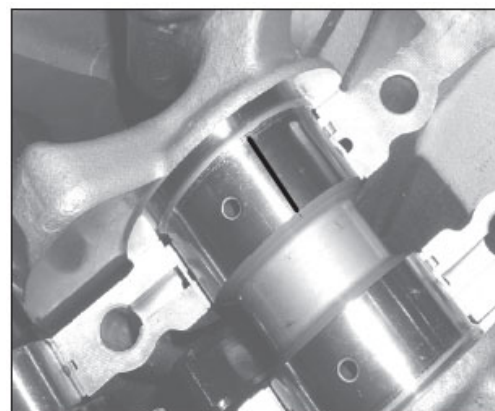




NOTE: Do not move crankshaft until measurement process is completed. Do not place on oil holes.

Measure crankshaft main bearing clearance.

1. Place upper journal bearings into upper casehalf.
2. Install crankshaft. Place a piece of Plastigauge across the journal surface. Install lower crankcase half with journal bearings installed.
3. Loosely install lower crankcase bolts, turn engine up on stand.
4. Install old cylinder head gasket, cylinder, and the cylinder head nuts. Torque nuts and bolts to specified torque and tightening sequence.
5. Carefully remove components and measure each compressed piece of Plastigauge.
6. Reference bearing replacement guide if bearing oil clearance is out of specification.
 - Out of specification: Replace main bearings, crankcase, or crankshaft.



Crankshaft Main Bearing Replacement Guide

Replacement of the crankshaft main bearings is required when the bearing oil clearance is out of specification. Use this guide to select new bearings.

NOTE: Bearing color code is imprinted on the side of each bearing.

REPLACEMENT BEARING THICKNESS

YELLOW	.0679" - .0681" (1.726 - 1.731mm)
BLUE	.0681" - .0683" (1.731 - 1.736mm)
GREEN	.0683" - .0685" (1.736 - 1.741mm)

If the measured clearance is within specification, replace with new bearings with the same color code.

If the oil clearance is outside of specification, install the BLUE color- coded bearings and re-measure oil clearance. If the measured clearance is too small, install a YELLOW bearing.

If the measured clearance is too large, install a GREEN bearing.

If the used bearings reveal an oil clearance of .04 and .05mm, install new bearings with the same color code.

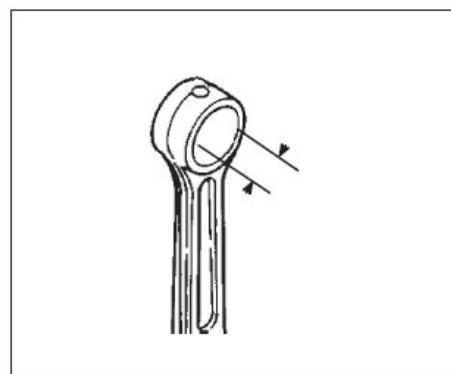
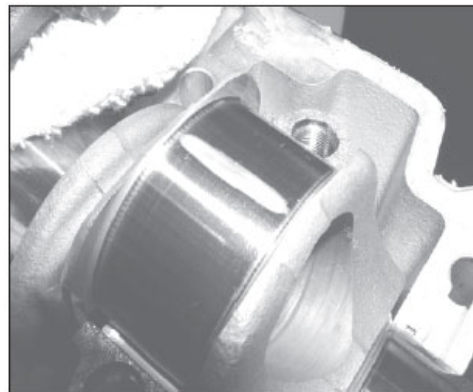


4.15.7. Connection Rod Inspection

Measure big end oil clearance.

NOTE: Do not move crankshaft or connecting rods until measurement process is completed.

1. Remove lower connecting rod caps.
 2. Place a piece of Plastigauge across the journal surface. Install lower rod caps with journal bearings installed.
 3. Torque rod bolts to specified torque.
 4. Remove caps and measure each compressed piece of Plastigauge .
 5. Reference bearing replacement guide if bearing oil clearance is out of specification.
 - Out of specification: Replace connecting rod bearings
- Measure small end inside diameter.
- Out of specification: Replace connecting rod



Connecting Rod Bearing Replacement Guide

Replacement of the connecting rod bearings is required when the bearing oil clearance is out of specification. Use this guide to select new bearings.

NOTE: Bearing color code is imprinted on the side of each bearing.

REPLACEMENT BEARING THICKNESS

RED	.0783 - .0785 (1.990 - 1.995mm)
YELLOW	.0785 - .0787 (1.995 - 2.000mm)
BLUE	.0787 - .0789 (2.000 - 2.005mm)

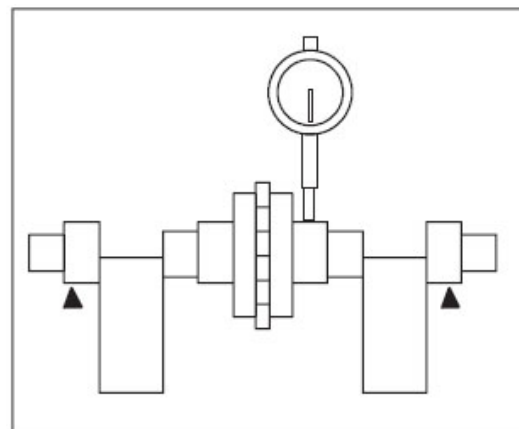
If the measured clearance is within specification, replace with new bearings with the same color code.

If the used bearings reveal an oil clearance of .04 and .05mm, install new bearings with the same color code.

4.15.8. Balance Shaft Inspection

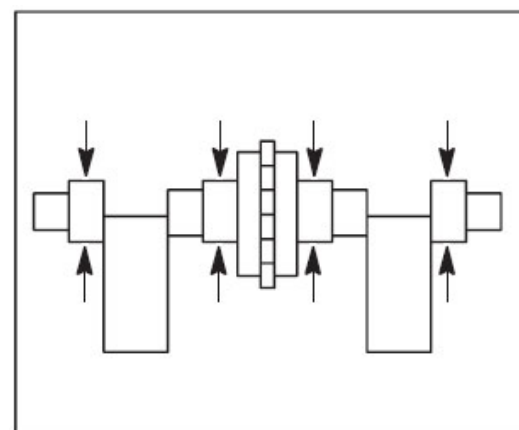
Measure balance shaft run out at several locations.

- Out of specification: Replace balance shaft



Measure bearing diameter.

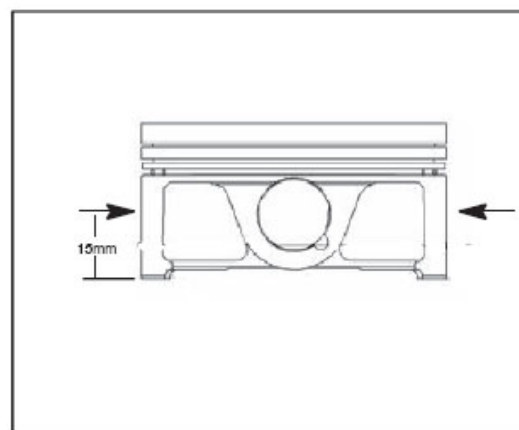
- Out of specification: Replace balance shaft



4.15.9. Piston Inspection

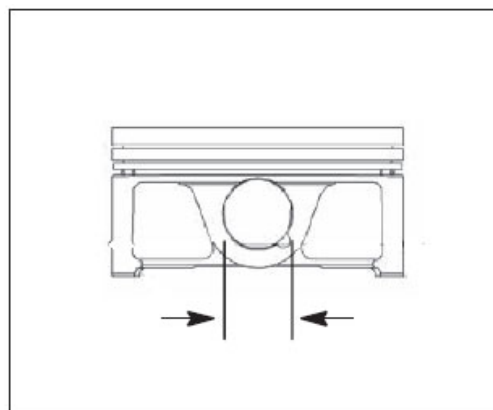
Measure piston diameter.

- Out of specification: Replace piston



Measure piston pin boss inside diameter.

- Out of specification: Replace piston

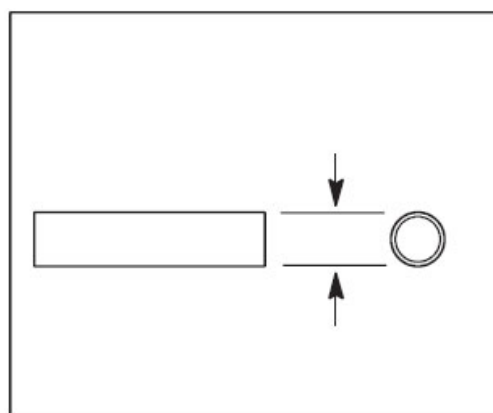


Measure piston pin outside diameter.

- Out of specification: Replace piston pin

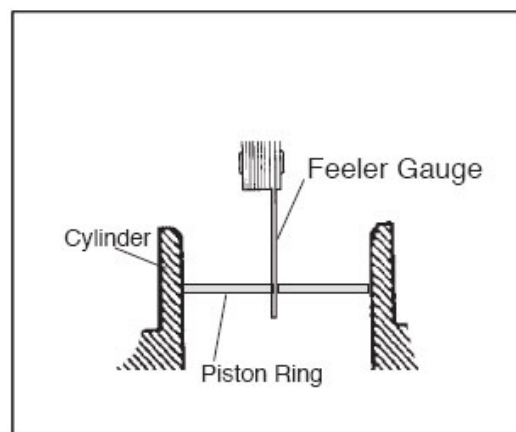
Confirm piston- to- cylinder clearance specification.

- Out of specification: Replace piston pin



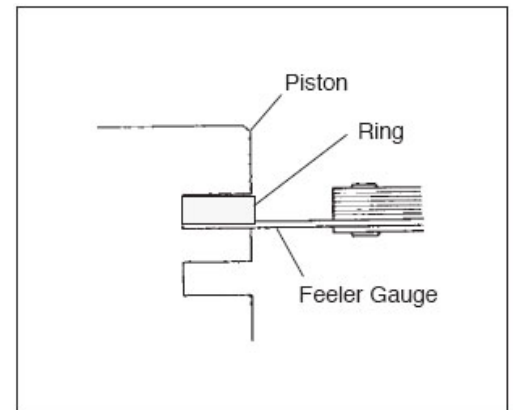
Measure installed ring end gap.

- Out of specification: Replace rings or cylinder block



Measure piston ring groove clearance.

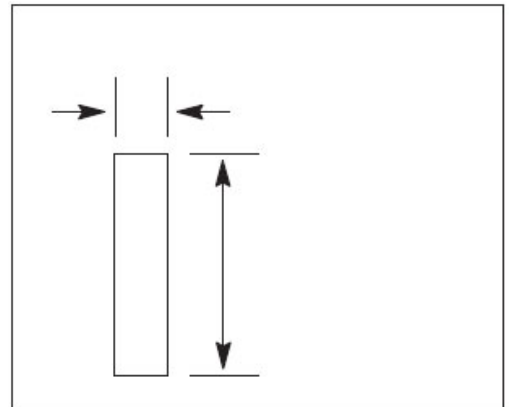
- Out of specification: Replace piston ring or piston



4.15.10. High Pressure Oil Pump Inspection

Measure relief spring free length and piston dimensions.

- Out of specification: Replace spring and piston



4.15.11. Chain Tensioner

Verify chain tensioner function.

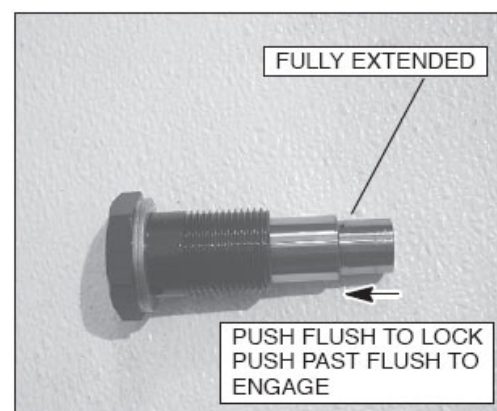
1. Push tensioner into housing until flush with threaded housing. Tensioner should lock into place. (6 audible clicks should be heard when tensioner is pushed in from fully extended position.)
2. Once locked, push tensioner inward. Tensioner should activate and spring outwards.
 - Replace tensioner assembly if tensioner will not lock, then engage when pushed inward from locked position.

Chain Tensioner Guides

Visually inspect both chain guides.

- Replace guides if any cracking or abnormal wear and tear is found.

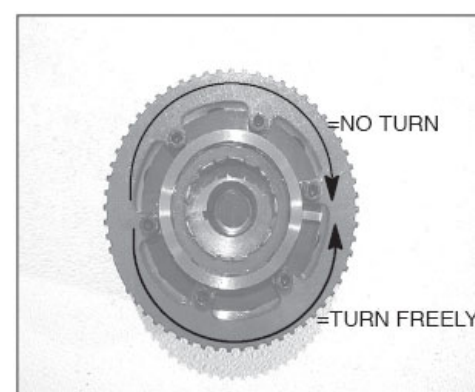
NOTE: Tensioner chain guide shown.



4.15.12. Starter Motor Clutch

Inspect clutch function.

- Clutch should move freely when rotated clockwise.
- Clutch should not rotate freely when rotated counter clockwise.
- Inspect rollers for wear and tear. Replace assembly if found.
-



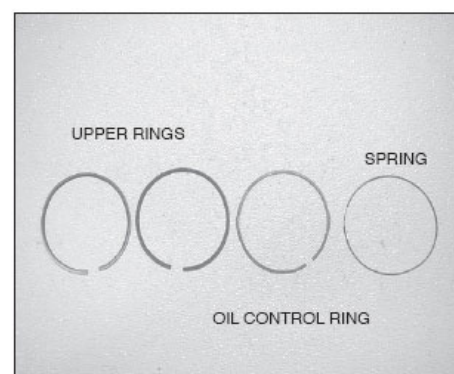
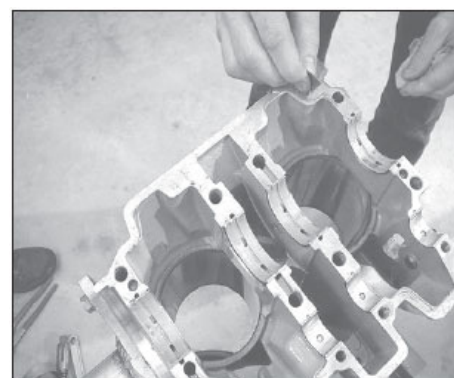
4.15.13. Timing Chain

Inspect timing chain.

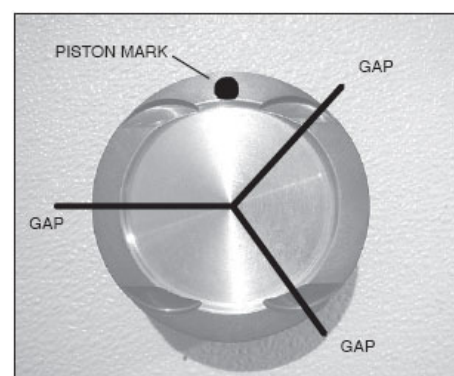
- Replace timing chain if any damage, obvious wear and tear, or broken / mis-shaped plates are found.

4.16. Engine Assembly

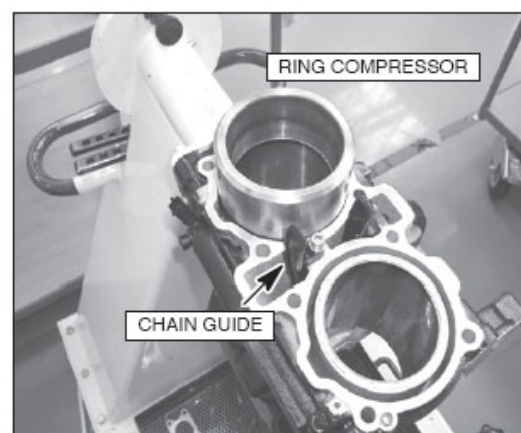
1. Remove any remaining gasket material from the upper and lower crankcase mating surfaces.
2. Remove gasket material from bedplate mating surface.
3. Clean the following parts with engine cleaning solvent:
 - Upper / Lower Crankcase
 - Cylinder Head
 - Bedplate
 - Lower Sump
 - Crankshaft / Balance Shaft
4. After cleaning parts, blow dry with compressed air.
5. With the engine facing up on stand, lubricate cylinders with engine oil.
6. Obtain both piston assemblies. Lubricate piston assemblies with engine oil.
7. Install the upper and oil control rings with the markings facing upwards.



8. Place ring compressor tool on top of one cylinder.
9. Align the ring end gaps as outlined in the photo. The piston mark will face the INTAKE SIDE of the engine once installed into the cylinder.

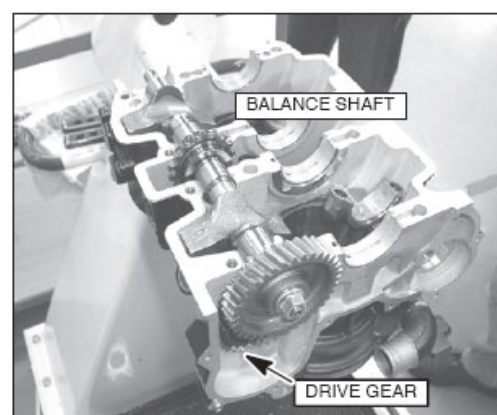


9. Carefully install each piston assembly into the cylinders. Take care in not scratching the cylinder bore.
10. Install the intake- side chain guide. Tighten fastener to specification.
11. Carefully rotate engine 180° Do not allow the pistons to fall out of cylinders.
12. Select and install the connecting rod, crankshaft main bearings, and balance shaft bearings. (Selection is made using bearing selection process described in this chapter.)
13. Coat all bearings and journals with engine oil. Install water pump drive gear into crankcase.
14. Install the chain tensioner guide into the exhaust- side of the crankcase. Tighten fastener to specification.



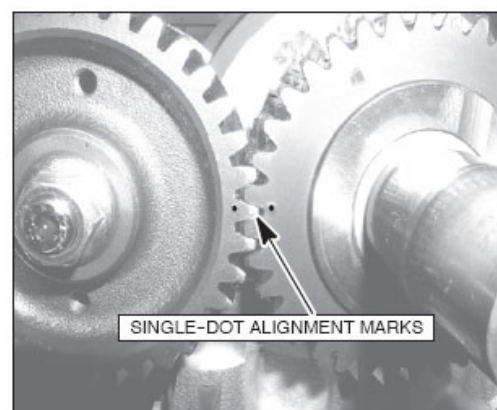
15. Install the balance shaft with the gear facing the front of the engine.

NOTE: Verify bearing surfaces are centered within journals.



16. Install crankshaft so that the two single- dot alignment marks located on the balance shaft gear and crankshaft gear face each other.

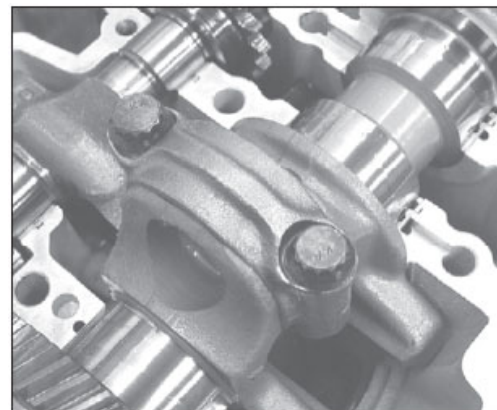
NOTE: Verify bearing surfaces are centered within journals.



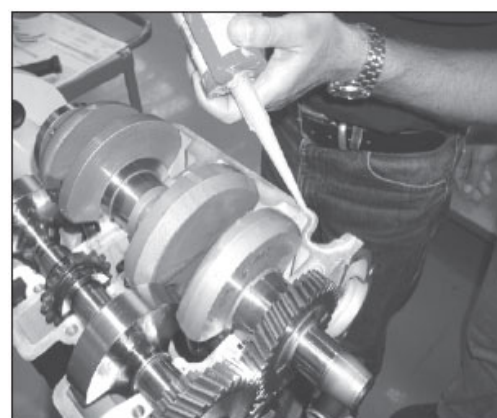
17. Coat bearing surfaces with engine oil.



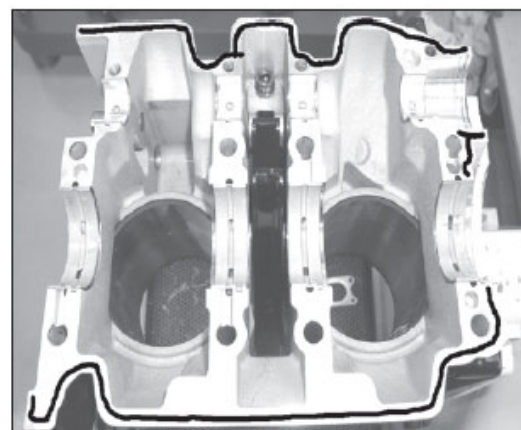
18. Push pistons so the connecting rods engage the crankshaft. Obtain the two con-rod caps with bearings installed. Apply engine oil to connecting rod bearings.
19. Match each unique cap mating surface with the appropriate connecting rod. Loosely install each fastener, then tighten evenly.
20. Torque connecting rod cap bolts to specification.



21. Verify the lower and upper crankcase mating surfaces are free from engine oil or foreign material.
22. Apply a thin, even bead of Three Bond 1213t case sealant to the upper crankcase mating surface.

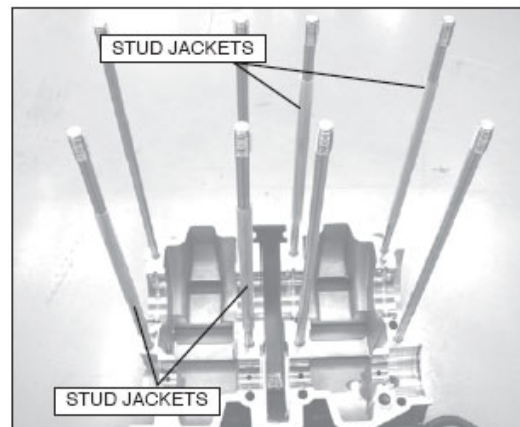


23. Apply sealant as outlined in photo.

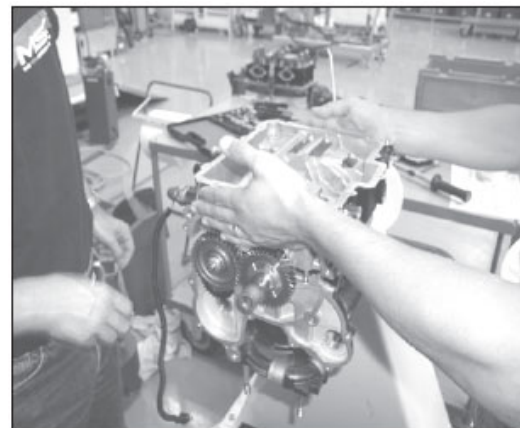


24. Verify the crankcase stud oil jackets are installed on the four studs as outlined in the photo.

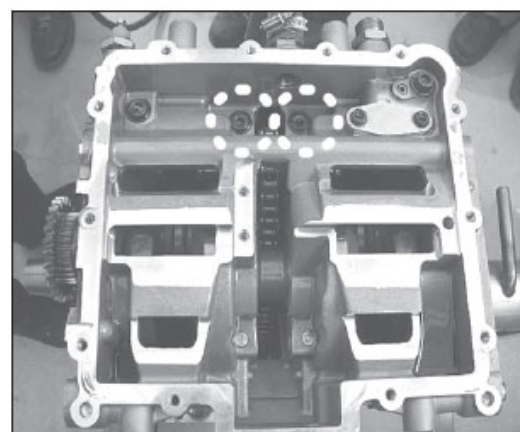
NOTE: Verify stud jackets are installed in the middle of each stud.



25. Carefully install the lower crankcase on to the upper crankcase.



26. Loosely install two of the four lower crankcase fasteners.





27. Apply a light film of grease to the crankshaft seal. Install the seal around the flange. Evenly press seal into crankcase.

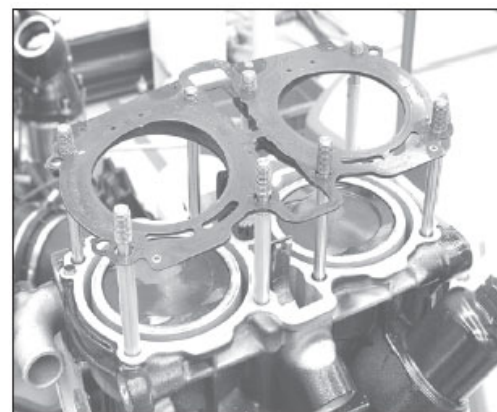
CAUTION!: Use extreme care when installing seal. Do not fold seal lips over when pressing around flange.

28. Rotate the engine 180° so the pistons face upwards.



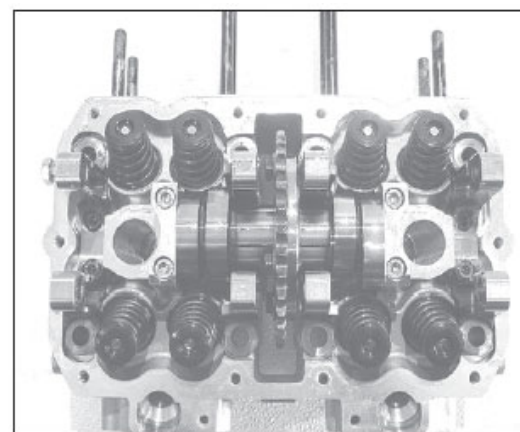
29. Clean the cylinder head mating surface free from oil and foreign material. Install a new cylinder head gasket with the part numbers and markings facing up and the larger coolant slots located on the exhaust- side of the engine.

NOTE: Always use a new cylinder head gasket, regardless of original condition.



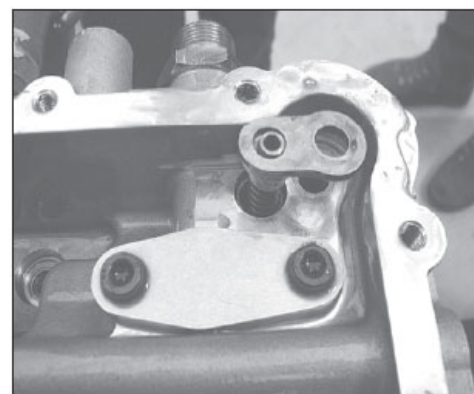
30. Install the cylinder head over the stud bolts with the exhaust manifold studs facing the oil filter side of the engine.

31. Apply engine oil to stud threads and loosely install the cylinder head nuts.





32. Rotate the engine 180°. (Cylinder Head Down)
33. Install the oil pump relief valve piston and spring. Place cover over spring and insert fastener. Hand- tighten fastener.
34. Install the remaining lower crankcase fastener.
35. Rotate the engine 180°. (Cylinder Head Up)
36. Tighten cylinder head nuts and lower crankcase fasteners to specification as outlined on page 61.
37. Rotate the engine 180°. (Cylinder Head Down)
38. Proceed with the TIMING CHAIN INSTALLATION / TDC PROCEDURE.



4.17. Timing Chain Installation/TDC Procedure

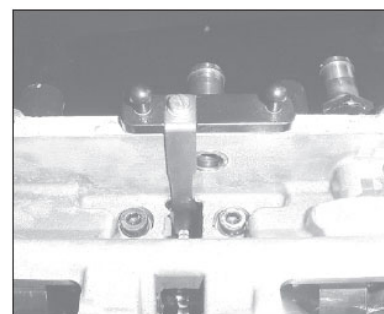
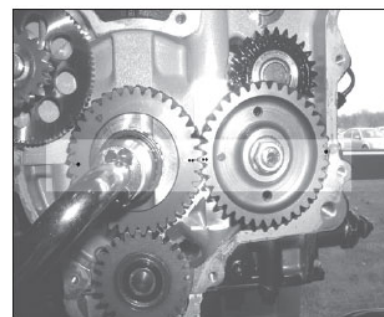
A special procedure is required for installing the timing chain into the engine. Four service tools are required when

installing the timing chain and setting the engine timing. They are:

- Timing Chain Installation Guide PN- PW- 47079
- Timing Chain Hook / Stuffer PN- PW- 47108
- Crankshaft Turning Hand Crank PN- PW- 46981
- Camshaft Alignment Tool PN- PW- 47077

4.17.1. Timing Chain Installation

1. Remove the rocker arm pins and rocker arms from the cylinder head.
2. Install the Crankshaft Hand Crank Tool into the nose of the crankshaft. Set the jam nut so the crankshaft can be turned left or right.
3. Rotate the crankshaft until double- dot alignment marks on each gear face each other. (The engine will be set to BDC when the two sets of double dots face each other.)
4. Install the the Timing Chain Installation Guide,

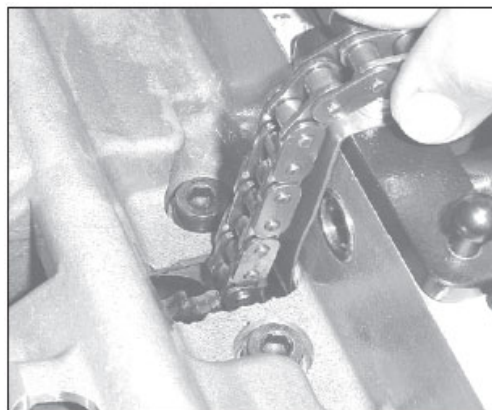


PN- PW- 47079, into the two bedplate fastener bores.

NOTE: The Timing Chain Installation Guide tool will guide the chain around the crankcase bends while preventing the chain from catching on the balance shaft sprocket.

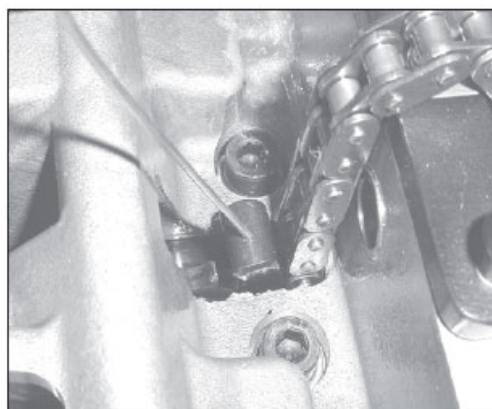
5. Slowly insert the chain into chain gallery. Wiggle the chain slightly until it falls down through the engine and protrudes from the bottom of the cylinder head.

CAUTION!: Do not drop the chain into the engine.



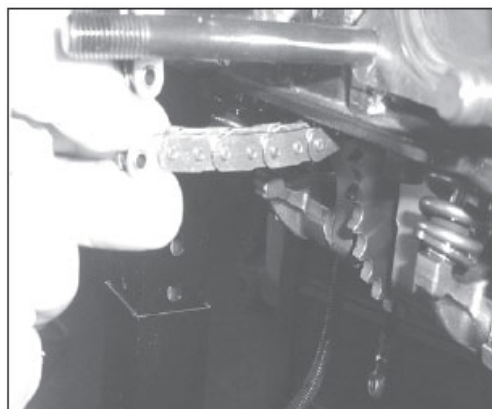
6. Insert the stuffer end of the Timing Chain Hook / Stuffer, PN- PW- 47108, tool into the chain gallery.

NOTE: The stuffer wedge will prevent the chain from catching on the sprocket.

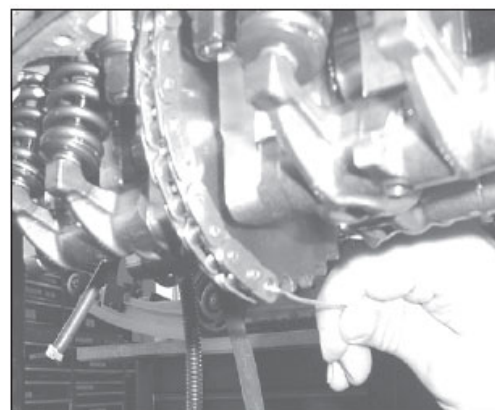


7. Allow three to four chain links to fall past the cylinder head parting line.

NOTE: Verify the chain is not caught on the balance shaft sprocket and that the marks on the gears are still in alignment!

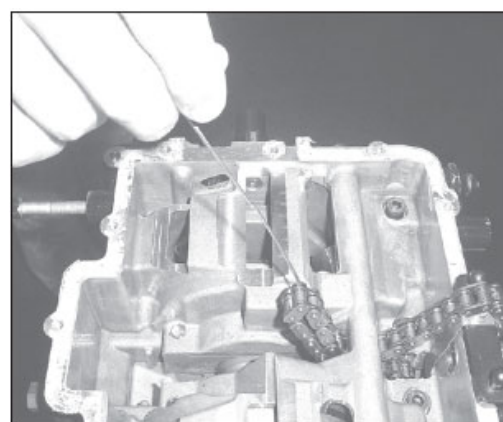


8. Wrap the chain around the camshaft sprocket.



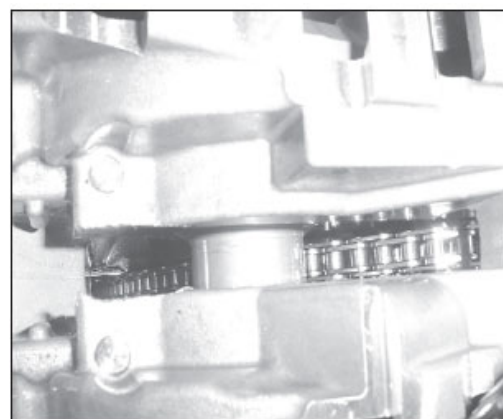
9. While firmly holding the chain against the camshaft sprocket, remove the stuffer, and wrap the chain around the balance shaft sprocket and under the crankcase support member.

NOTE: The hooked- end of the Timing Chain Hook / Stuffer Tool will simplify pulling the chain around the sprocket.



10. Carefully drop the chain UNDERNEATH the crankshaft and around the chain guide.

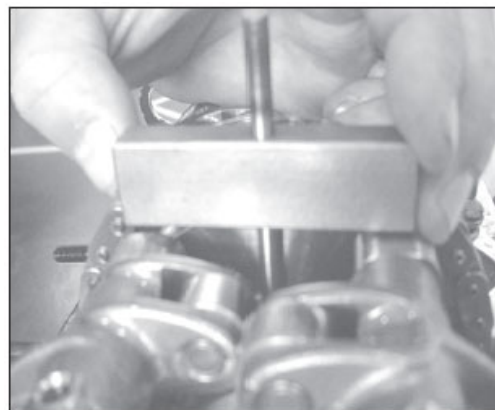
NOTE: Do not drop the chain around the OUTSIDE of the crankshaft. When performed properly, the chain should drop easily through the engine and protrude from the cylinder head.



11. Rotate the camshaft until one of the holes in the PTO- end points to the floor.

12. Install the Camshaft Alignment Tool, PN- PW- 47077, into the hole, press against the rocker arm towers.

NOTE: The Camshaft Alignment Tool will lock the camshaft into the correct timing position in relation to the crankshaft and balance shaft.

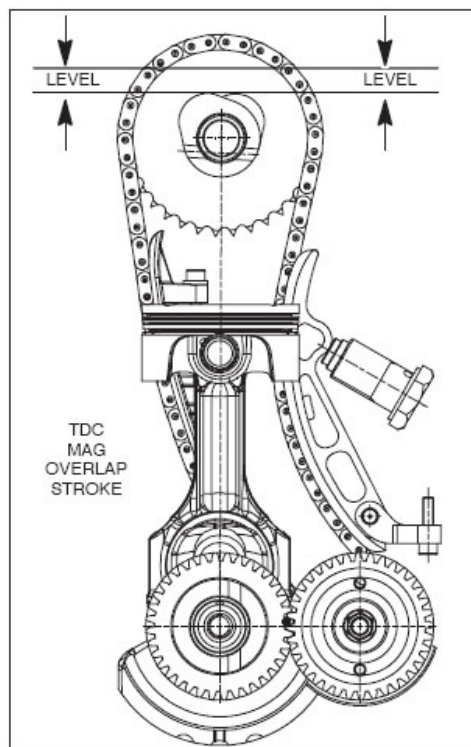
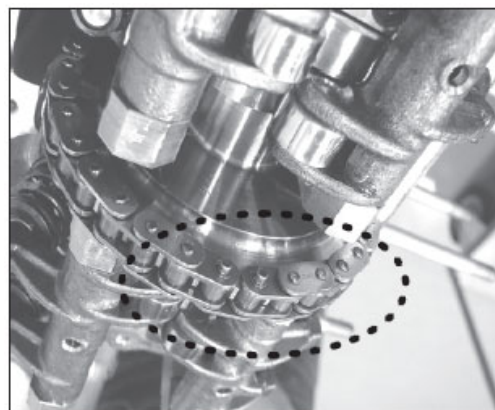


13. Wrap chain around camshaft sprocket and secure links with new pins and plate assembly.

NOTE: Do not use the chain crimper to assemble chain links at this time.

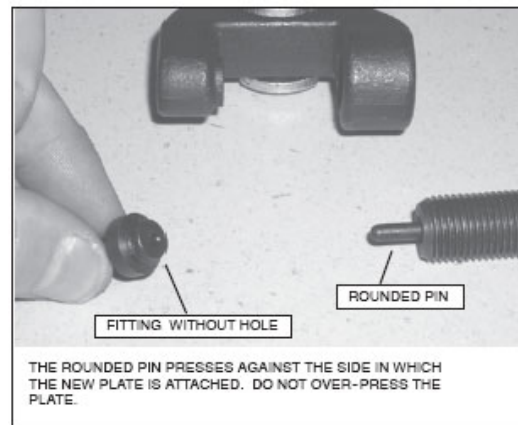
14. Rotate the engine 180°. (Cylinder Head Up)

15. Carefully rotate the crankshaft until the timing marks on the gears are pointing at each other. The valve train should resemble the illustration below



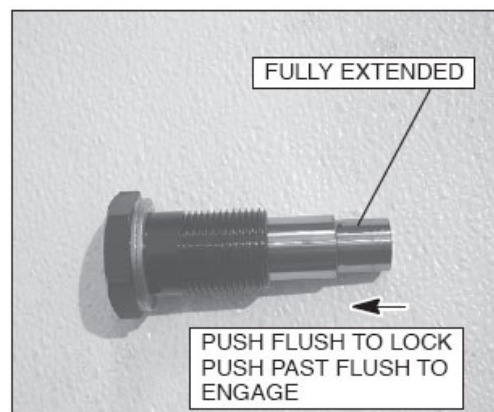
4.17.2. Engine Assembly

1. Reassemble the timing chain with a new plate. Crimp the new chain pins and plates together using the Chain Breaker Tool, PN- PW- 46985.



2. Verify the chain tensioner is set in the locked position. To set the chain tensioner, grasp end in palm of hand, and press assembly down on a hard surface. The tensioner is set in the locked position when it is flush with the tensioner housing.

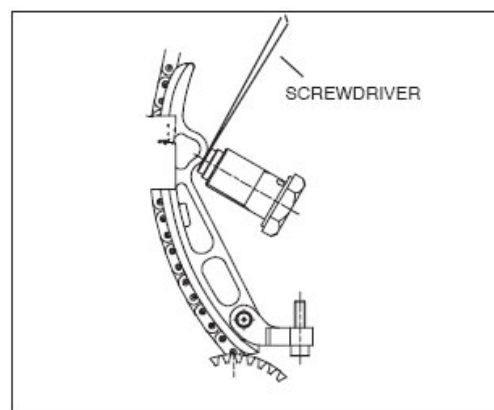
3. Install the chain tensioner into the crankcase. Tighten housing cap to specification.



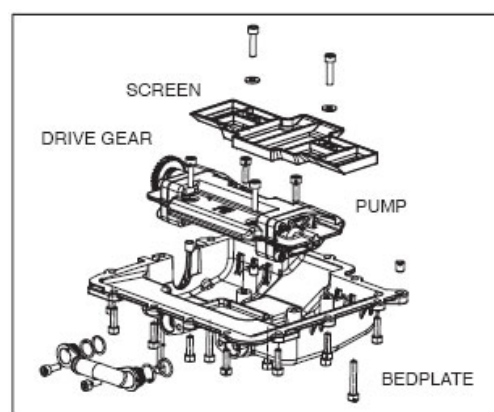
4. Insert the blade of a flat head screwdriver between the tensioner and the tensioner rail guide.



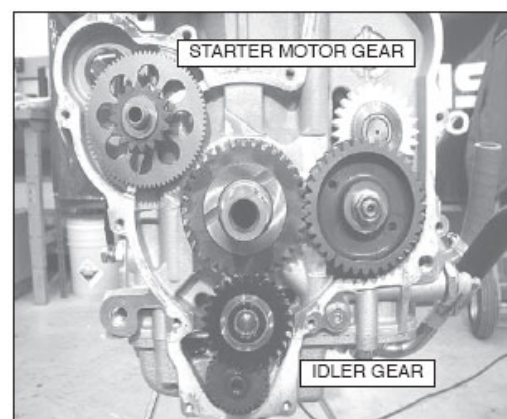
5. Verify the blade of the screwdriver contacts the face of the tensioner.
6. Push the blade of the screwdriver against the tensioner face and twist. Do this until the tensioner goes in past flush and activates.
7. Once activated, there should be no slack present in the timing chain.



8. Install low pressure pump and screen into bedplate. Clean bedplate and lower crankcase mating surfaces.
9. Apply a thin bead of Three Bond 1215t to the mating surface and Install the bedplate. Tighten fasteners to specification.
10. Install the high pressure oil pump assembly as outlined on page 4.12.
11. Rotate the engine 180°. (Cylinder Head Up)

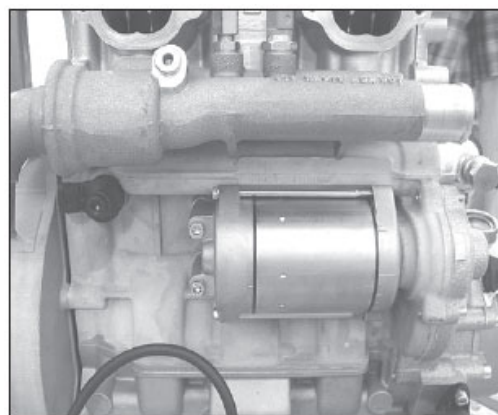


12. Coat the gears located at the front of the engine with engine oil.
13. Install the starter motor gear, low pressure oil pump idler gear.



14. If the starter motor was removed, reinstall and tighten fasteners to specification.

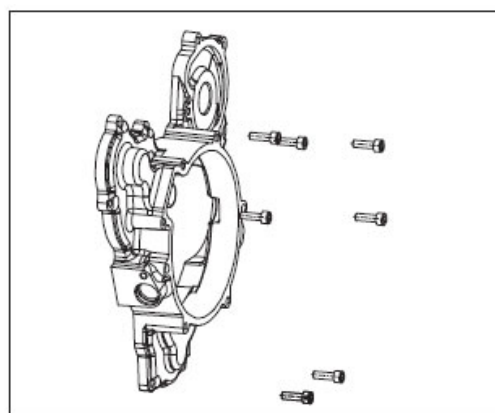
15. Attach the starter motor battery cable to the motor at this time.



16. Press the water pump shaft into the mechanical seal.

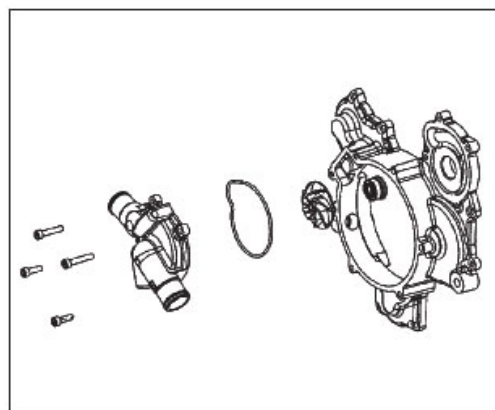
17. Apply a thin bead of Three Bond 1215t to the front gear cover mating surface.

18. Install the front gear cover. Tighten fasteners to specification.

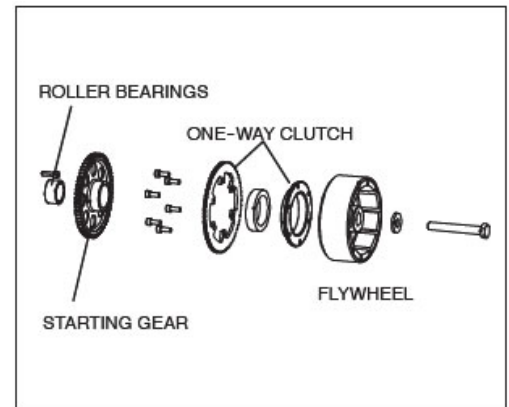


19. Install the water pump impeller. Tighten impeller nut to specification.

20. Install water pump housing and coolant hose. Tighten fasteners to specification.



21. Apply a generous amount of engine oil to the crankshaft end and roller bearings.
22. Install the roller bearing, starting gear, and flywheel key into end of crankshaft.
23. Install the flywheel on to the crankshaft. Verify flywheel fits over key.
24. Apply Loctite 262 to flywheel bolt, and install.



25. Install two of the PTO coupler bolts into the PTO- end of the crankshaft. Have an assistant place a pry bar across these two bolts to prevent the crankshaft from rotating.

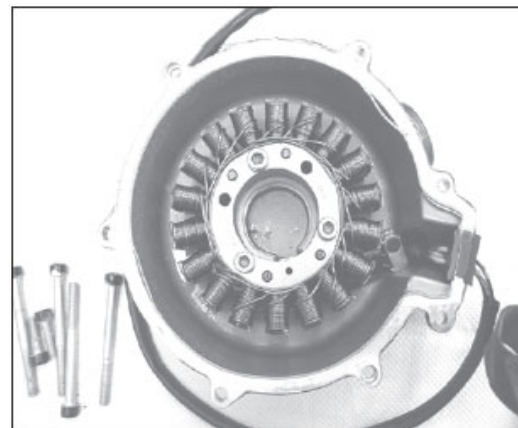


26. Tighten flywheel bolt to specification.





27. Apply a thin bead of Three Bond 1215t sealant to stator cover mating surface.
28. Install stator cover with stator mounted inside of cover. Route harness as not to pinch or cut wires.



29. Reinstall the high- pressure oil supply hoses and banjo bolt to the top of the cylinder head.
30. Tighten banjo bolt to specification.



NOTE: Before installing the valve cover and gaskets, the valve clearance must be checked. Follow the procedure outlined in chapter . Replace any valve clearance shims that are out of specification or worn.

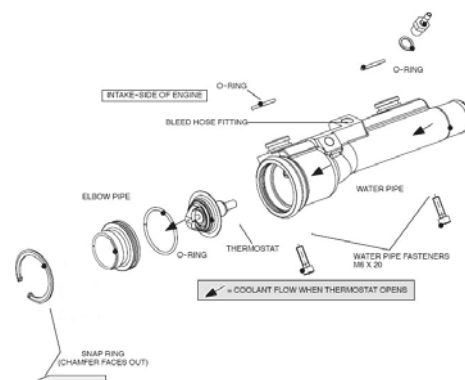
After completing the valve clearance adjustment, reinstall the valve cover using new gaskets and o rings.



4.18. Thermostat Removal/Installation

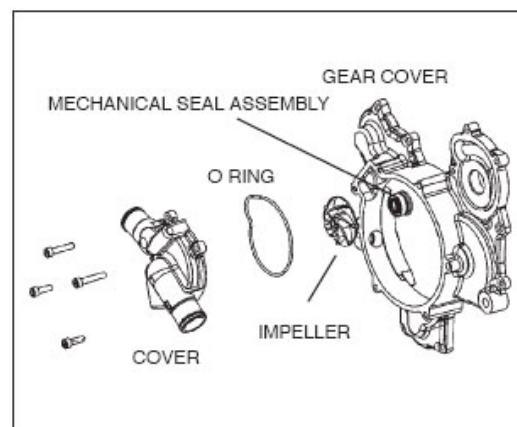
NOTE: Coolant will flow out of the cylinder head into the bilge when the outlet rail elbow is removed. Tilt the bow down to prevent coolant from escaping outlet rail.

1. Remove the snap ring using a snap ring pliers.
2. Carefully twist and pull the elbow out of the rail.
3. Inspect the o rings. Replace if found worn or damaged.
4. Remove and replace thermostat.
5. Insert thermostat with bleed hole up.
6. Reinstall the elbow. Reinstall the snap ring. Verify the snap ring chamfer faces out when installing.



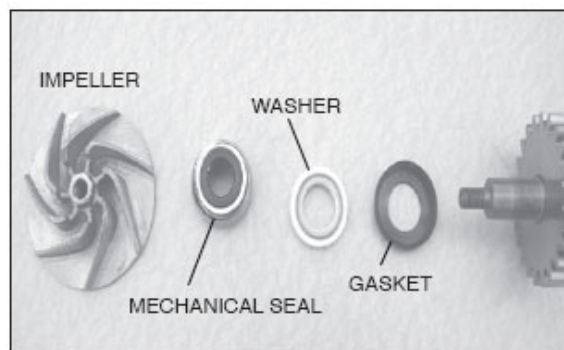
4.19. Water Pump Removal/Installation

1. The water pump cover can be removed by 4 fasteners that mount the cover to the front gear cover.
2. Always replace the o ring with new during reassembly.
3. The impeller can be removed by holding the crankshaft. Stationary while turning the impeller nut counter-clockwise.
4. Tighten fasteners to specified torque outlined at beginning of chapter.





1. To replace the impeller shaft and mechanical seal, remove the front gear cover.
2. Carefully extract mechanical seal components out of the gear cover.
3. Press new gasket with washer recess facing out, washer with grooves facing gasket, and new mechanical seal, with spring- end facing outward into cover using light and even force.
4. The impeller shaft sits inside crankcase bore. Replace shaft if worn or damaged.
5. Tighten fasteners to specified torque outlined at beginning of chapter.



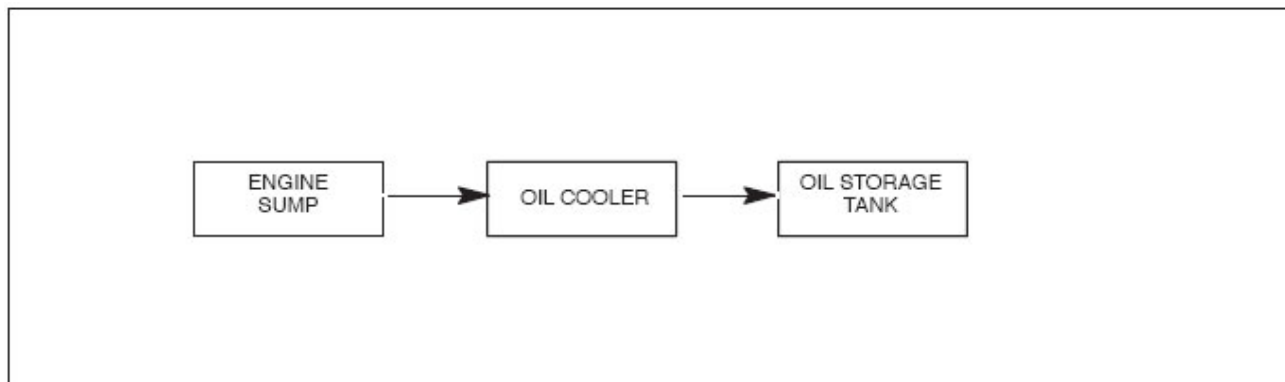
4.20. Oil Lubrication System

The lubrication system features two oil pumps. The first pump is the low pressure pump that pumps oil to the oil cooler, and then on to the oil storage tank. The second pump, high pressure, is located on the PTO end of the engine crankcase. The high pressure pump draws oil in from the oil storage tank, and supplies oil to all of the internal engine components. The low pressure pump supplies approximately twice the amount of oil to the oil storage tank than what the high pressure pump requires. This ensures a constant supply of oil.

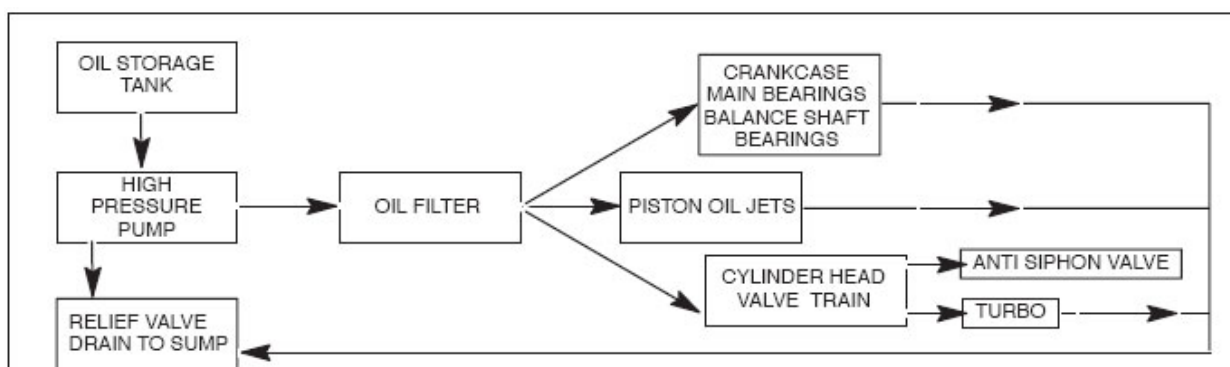
A small amount of pressurized oil is supplied to the turbocharger bearing house and oil storage tank antisiphon valve. The anti- siphon valve is located on top of the oil storage tank. The valve works by preventing oil from the tank to back- feed into the engine in the even that oil pressure is lost. (Watercraft Rollover)



4.20.1. Low Pressure Oil Circuit

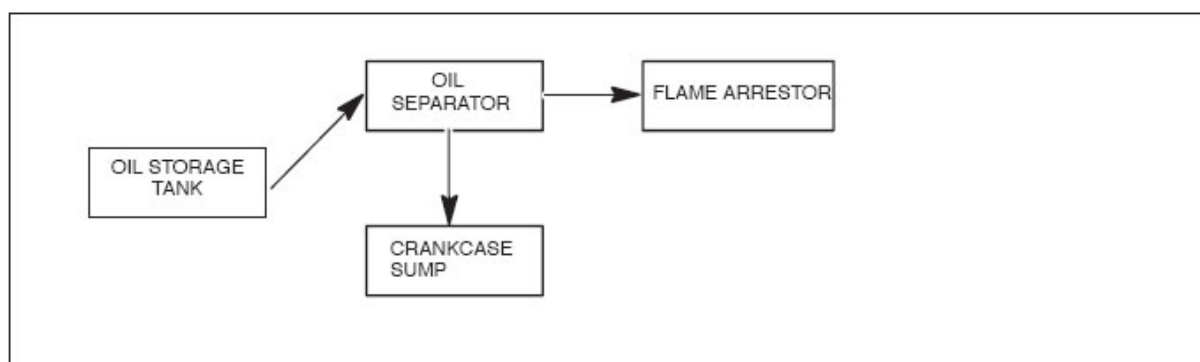


4.20.2. High Pressure Circuit



4.20.3. Crankcase Ventillation

Engine blow- by is recovered via the oil separator or cyclone. The oil separator is located on the oil storage tank. Engine oil and fuel vapors are collected in the top housing of the oil storage tank. These vapors are routed to the separator. Heavy elements such as oil and unburned fuel are collected at the bottom of the separator and are routed back to the crankcase sump. The remaining vapors are collected at the top of the separator and routed to the air intake flame arrestor where they are drawn into the intake air stream and burned.

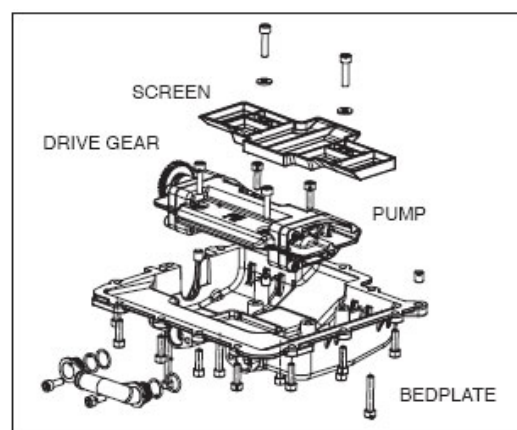


4.20.4. Low Pressure Pump Removal/Installation

NOTE: The engine must be removed to access the low pressure pump.

1. Remove the crankcase bedplate from the lower crankcase.
2. Remove the fasteners securing the screen to the bedplate and pump.
3. Remove the pump from the bedplate.

NOTE: The low pressure pump is not serviceable and must be replaced as one component is when operation is suspect.



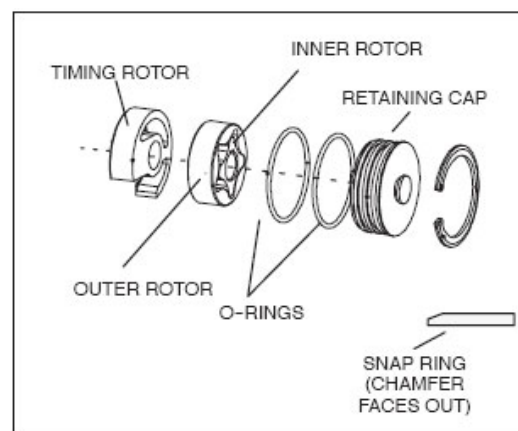
4.20.5. High Pressure Pump Removal/Installation

NOTE: The engine must be removed to access the high pressure pump.

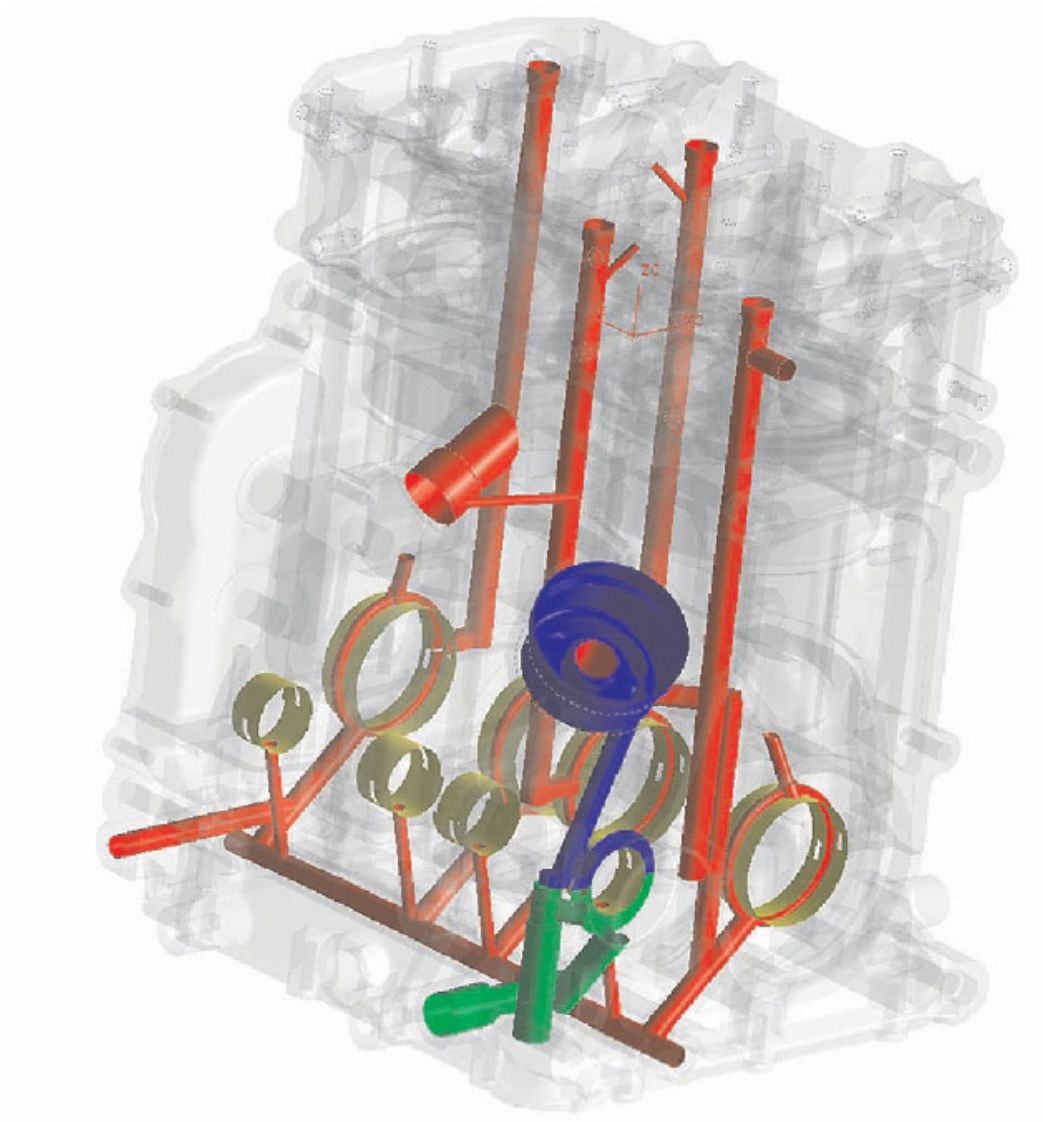
1. Remove snap ring. Carefully extract rotor cover from crankcase.
2. Extract outer and inner rotors from bore. Remove timing rotor from shaft.
3. Carefully remove timing key.

NOTE: Always use a new timing key and o rings during pump assembly.

NOTE: Verify snap ring bevel faces outward.



4.20.6. High Pressure Oil Supply



GREEN = LOW PRESSURE / PRE FILTRATION
BLUE = HIGH PRESSURE / PRE FILTRATION
RED = HIGH PRESSURE / POST FILTRATION



5

DIAGNOSTIC SOFTWARE, SENSORS, ACTUATORS
ELECTRICAL SYSTEM

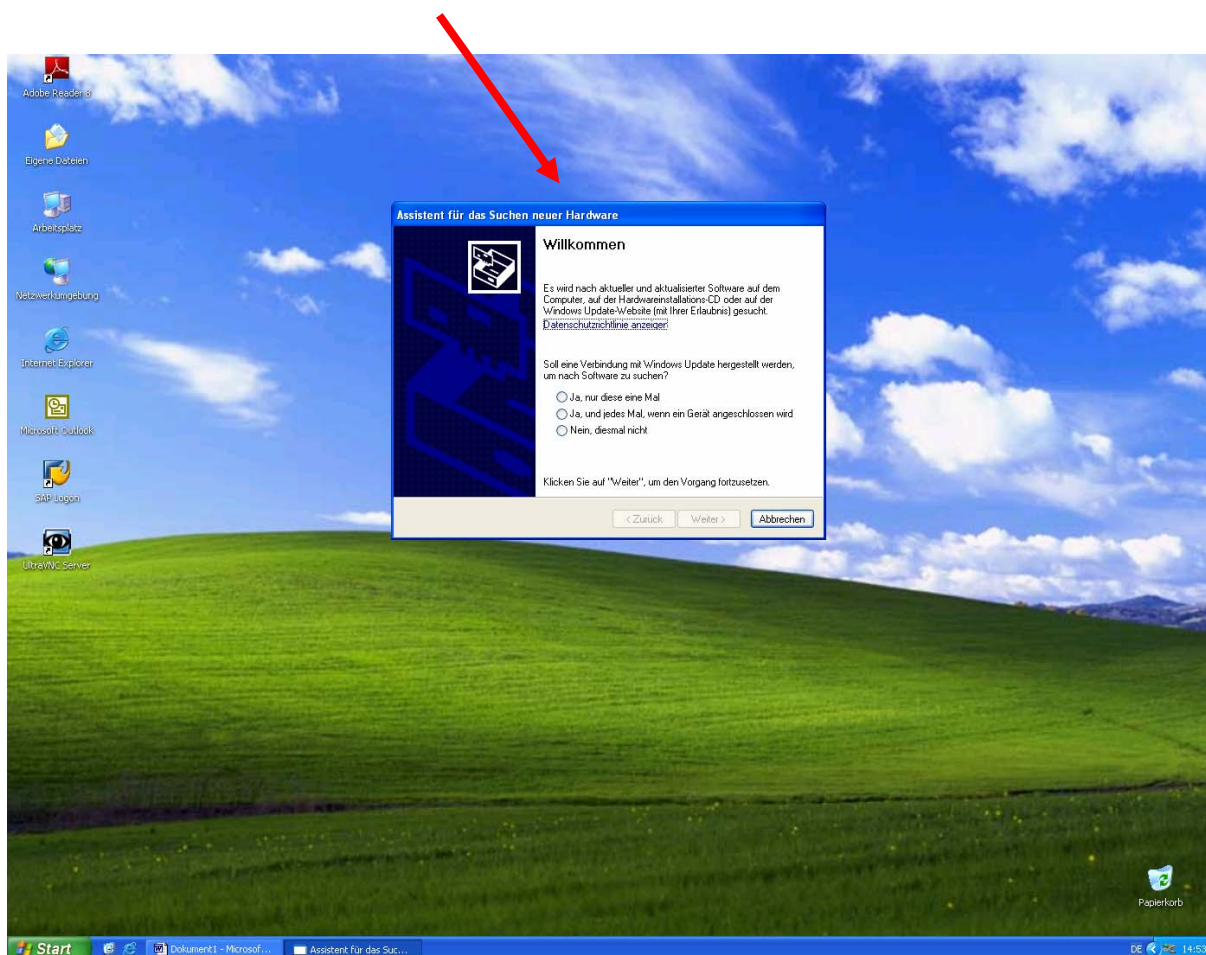


5. Electrical System

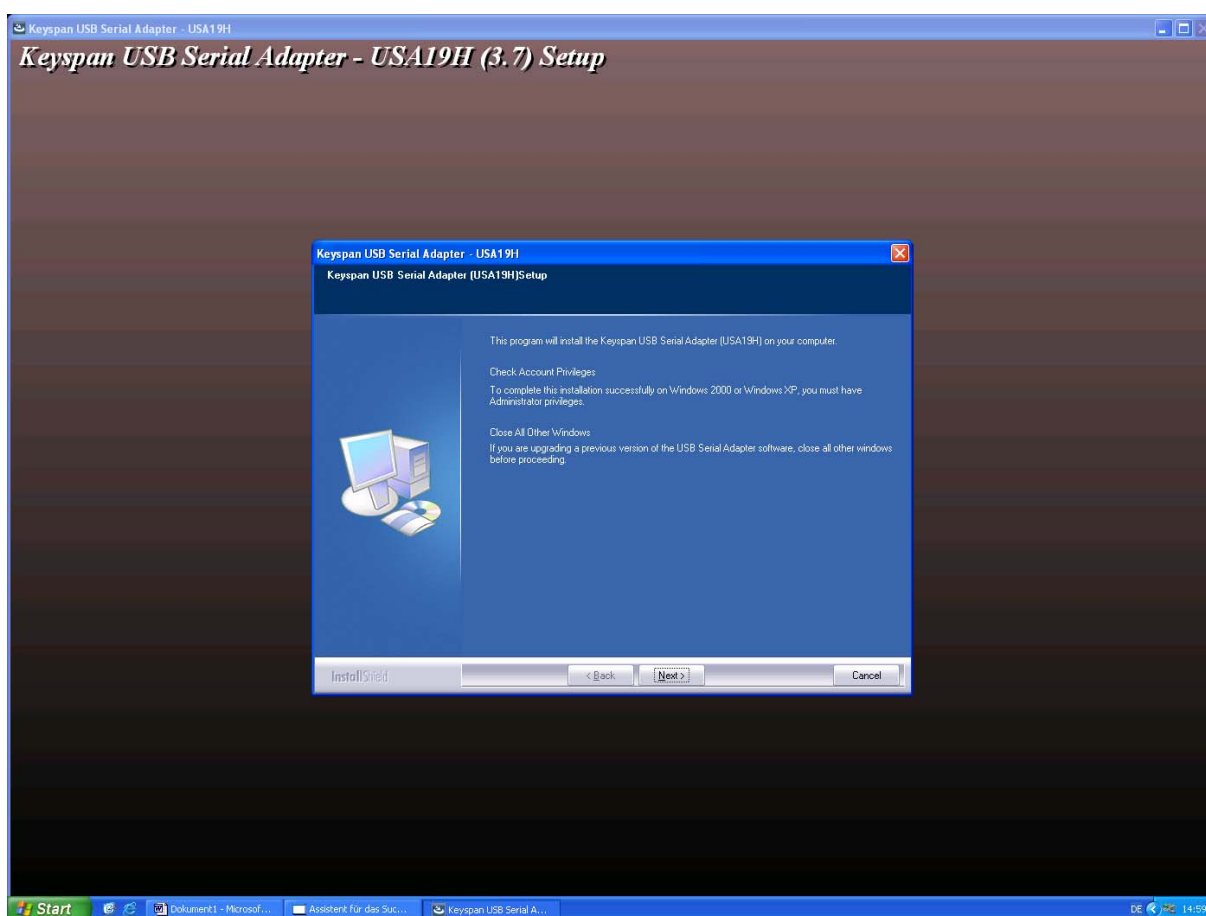
5.1. Installing the Keyspan USB to RS-232 Adapter

The following steps are explained by using Windows XP Service Pack 2 !! If you are using an older version of Windows please contact our support.

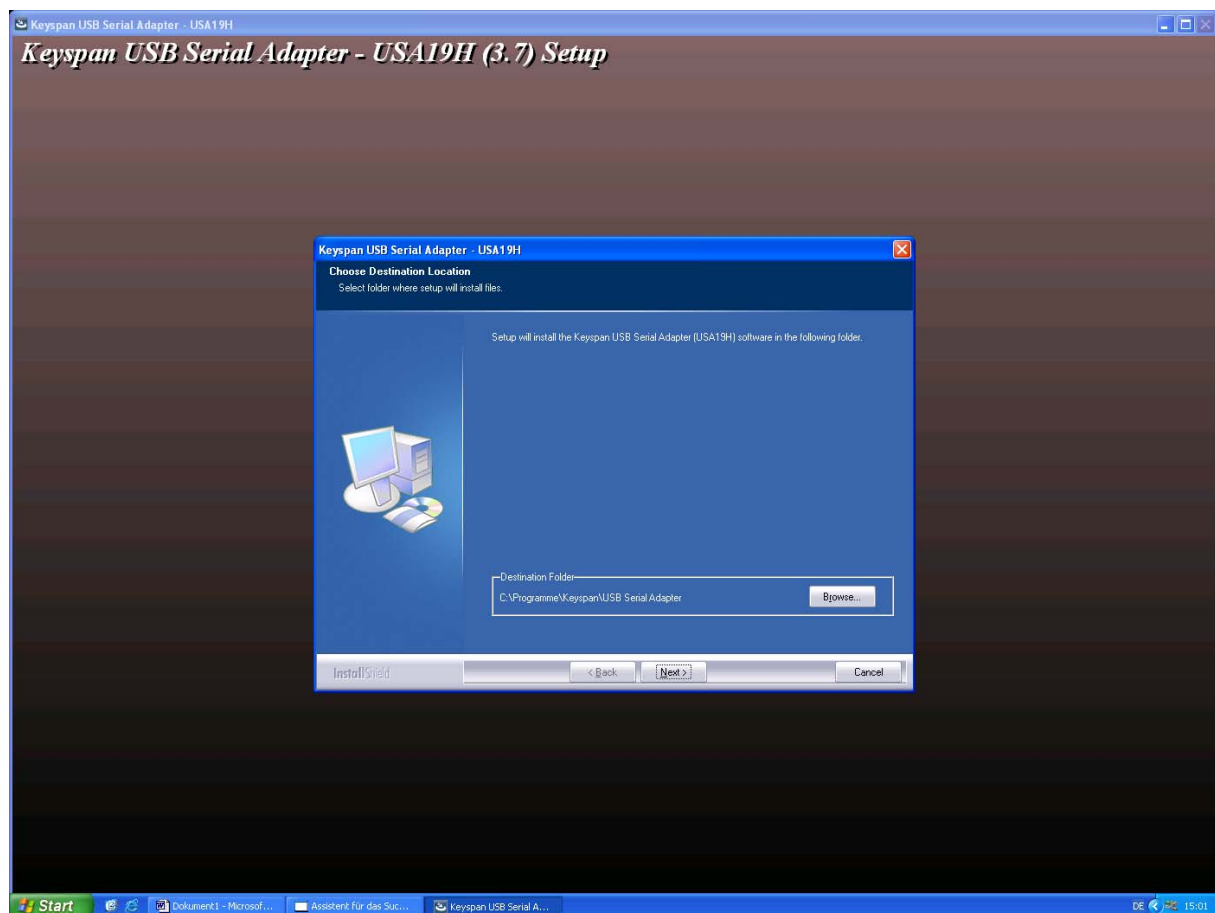
- Plug in the **Keyspan Adapter** in a free USB-Port.
- After a short time windows will start the manager for installing new software like in the following picture. Please ignore this window it will disappear later automatically. Please click cancel.



- Now you have to open the **Keyspan Install File** named “*KeyspanUSA19hsWinV37.exe*” !! You can download the file (driver) under <http://www.keyspan.com/>
- Sometimes Windows will ask you if you trust the publisher of the product. You confirm by clicking on the button “ok”.
- After this there should appear the install assistant from the **Keyspan Software** as in the picture followed.



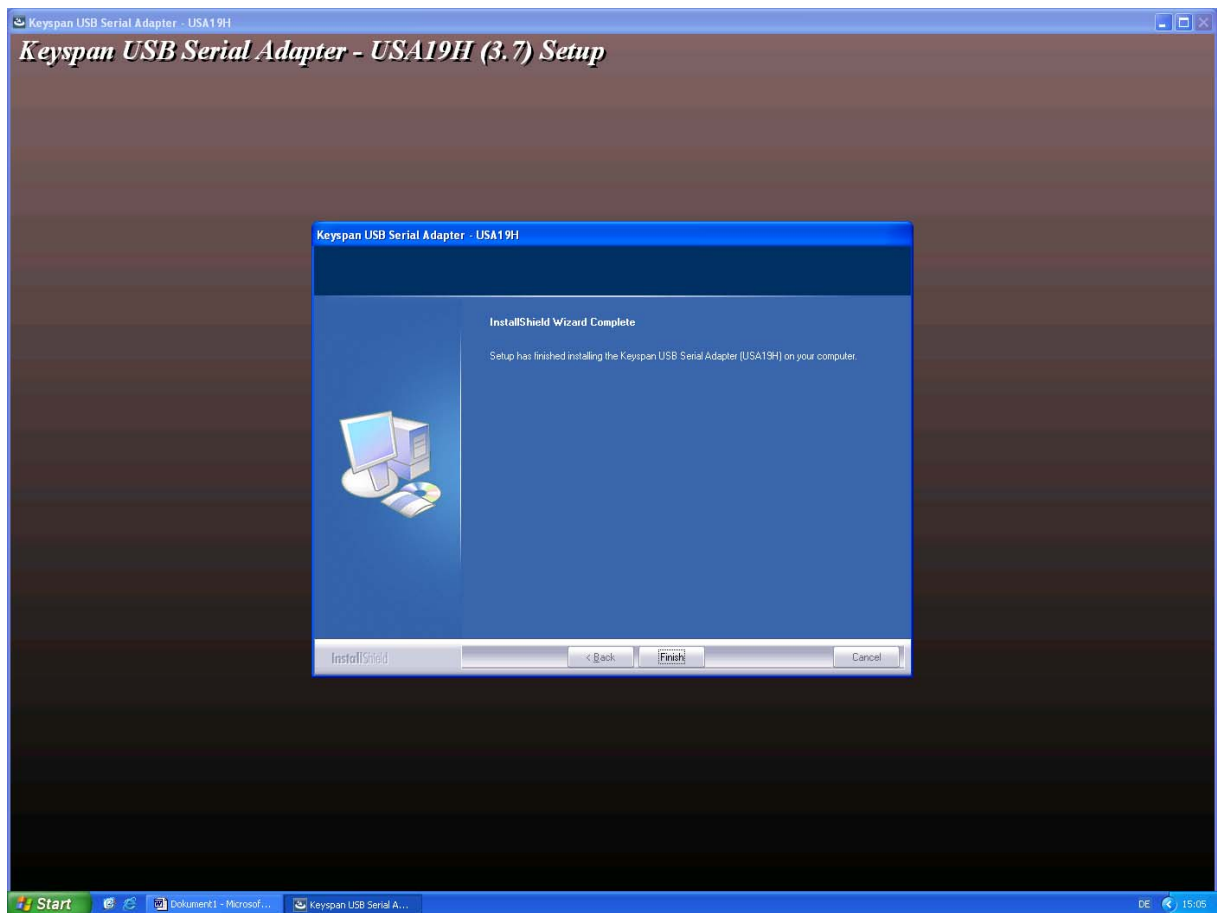
- Now you have to click “**next**”. In the next window you confirm the licence with “**yes**”.
- In the next window please select the directory where to install the files for the **Keyspan Adapter** and click “**next**” !



- Now the program will start with installing the **Keyspan Adapter**. It takes several minutes to finish the installation, depending on the hardware configuration of your PC.

Note: If Windows call you that the program hasn't pass the Windows Logo Test select "continue installation" !!

- If everything has completed you should see this window (next site). Please click "**finish**" to complete the installation.



- Please reboot the PC, restart the computer.

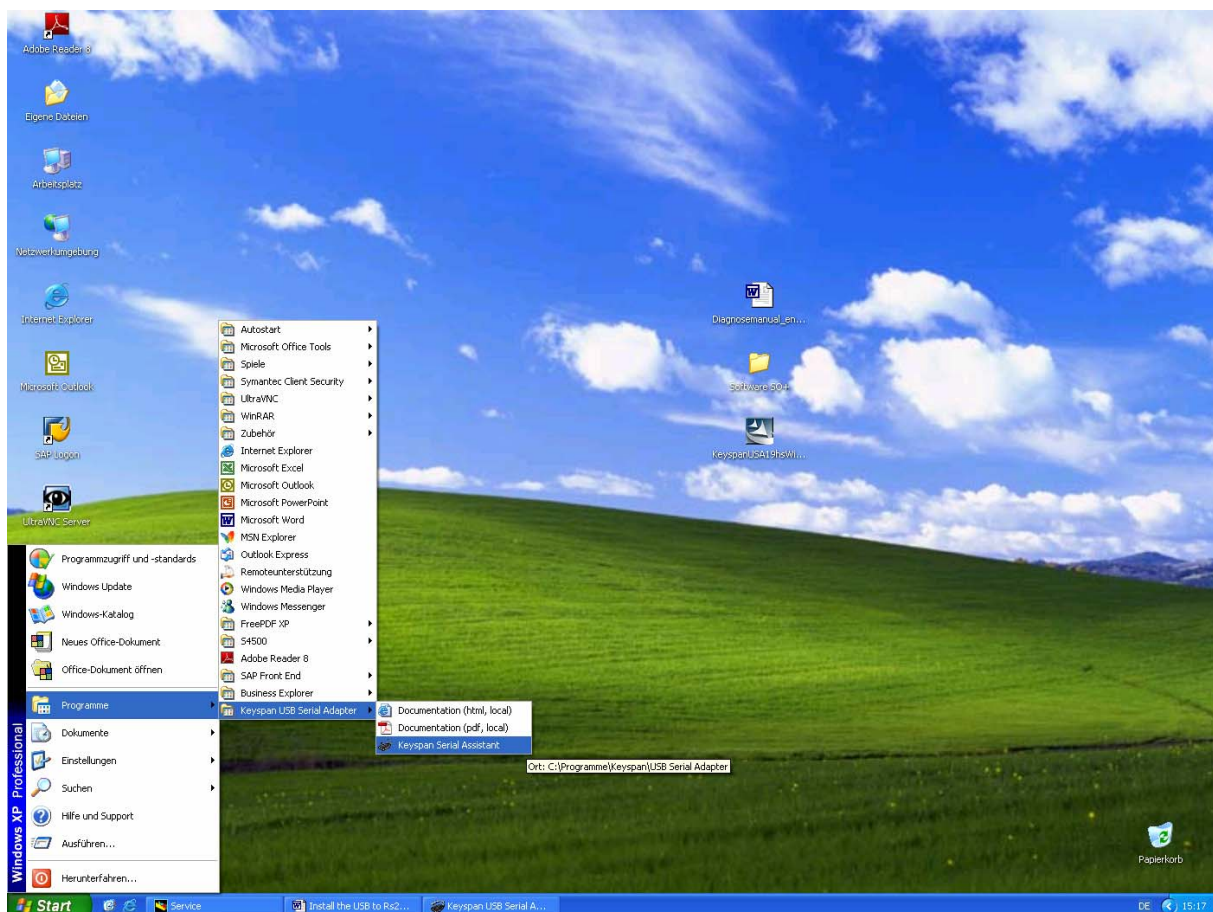


5.2. Configure the Keyspan Adapter

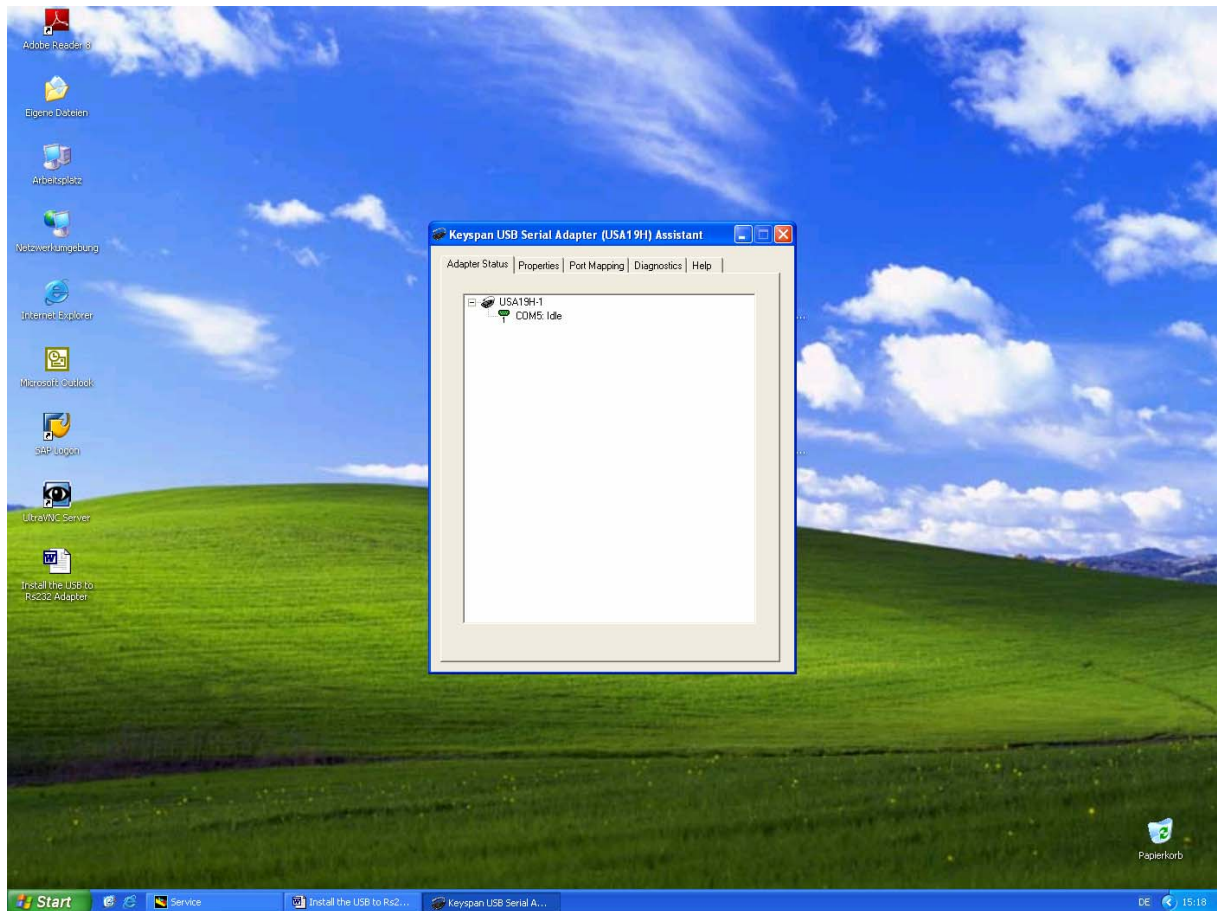
- Please connect the **HSR Diagnostic cable** with the **Keyspan Adapter**.

That everything works the **Keyspan Adapter** has to configure on a Port between 1-4 as shown in the following steps!

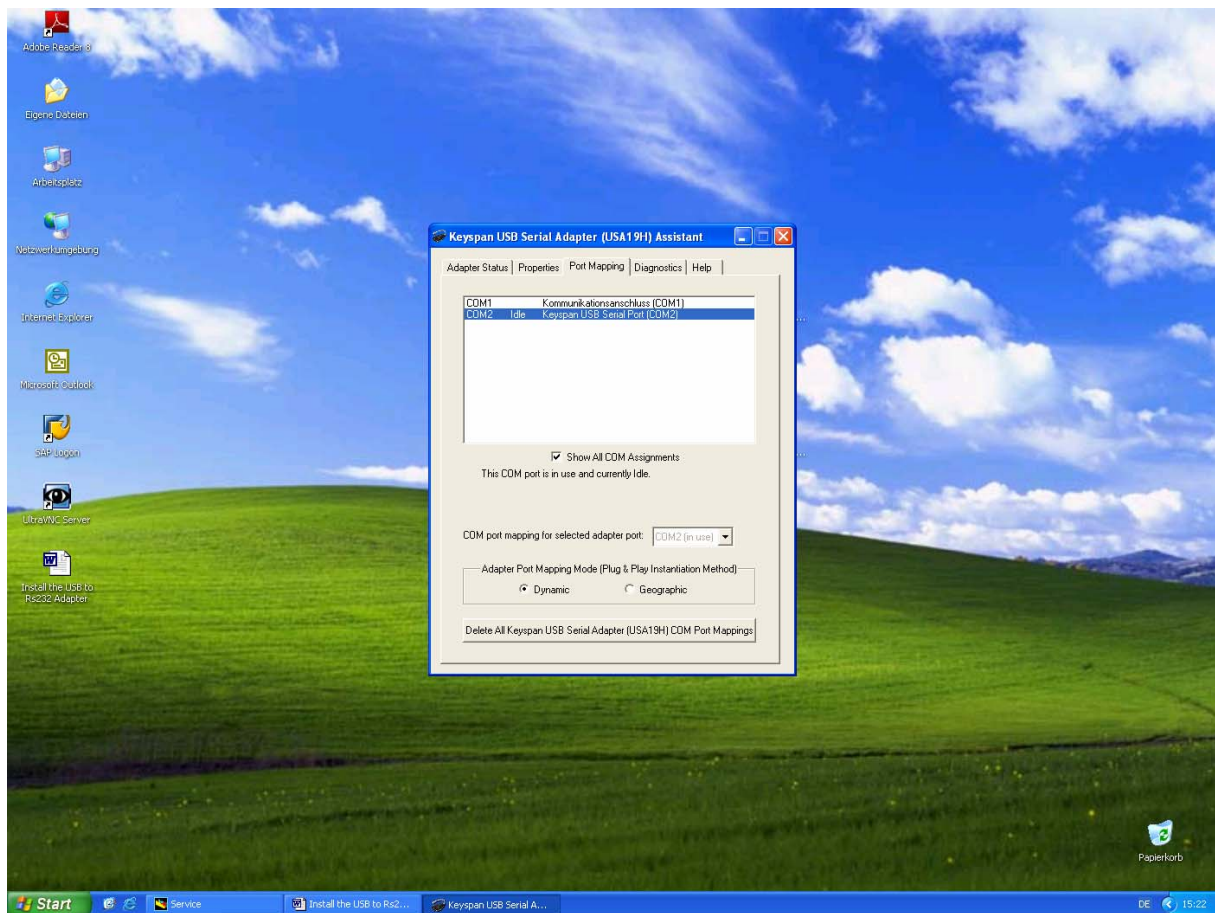
- Click on the **Windows Start-Button** and select "Programs". Then select the entry "**Keyspan Usb Serial Adapter**" and click "**Serial Keyspan Assistant**".



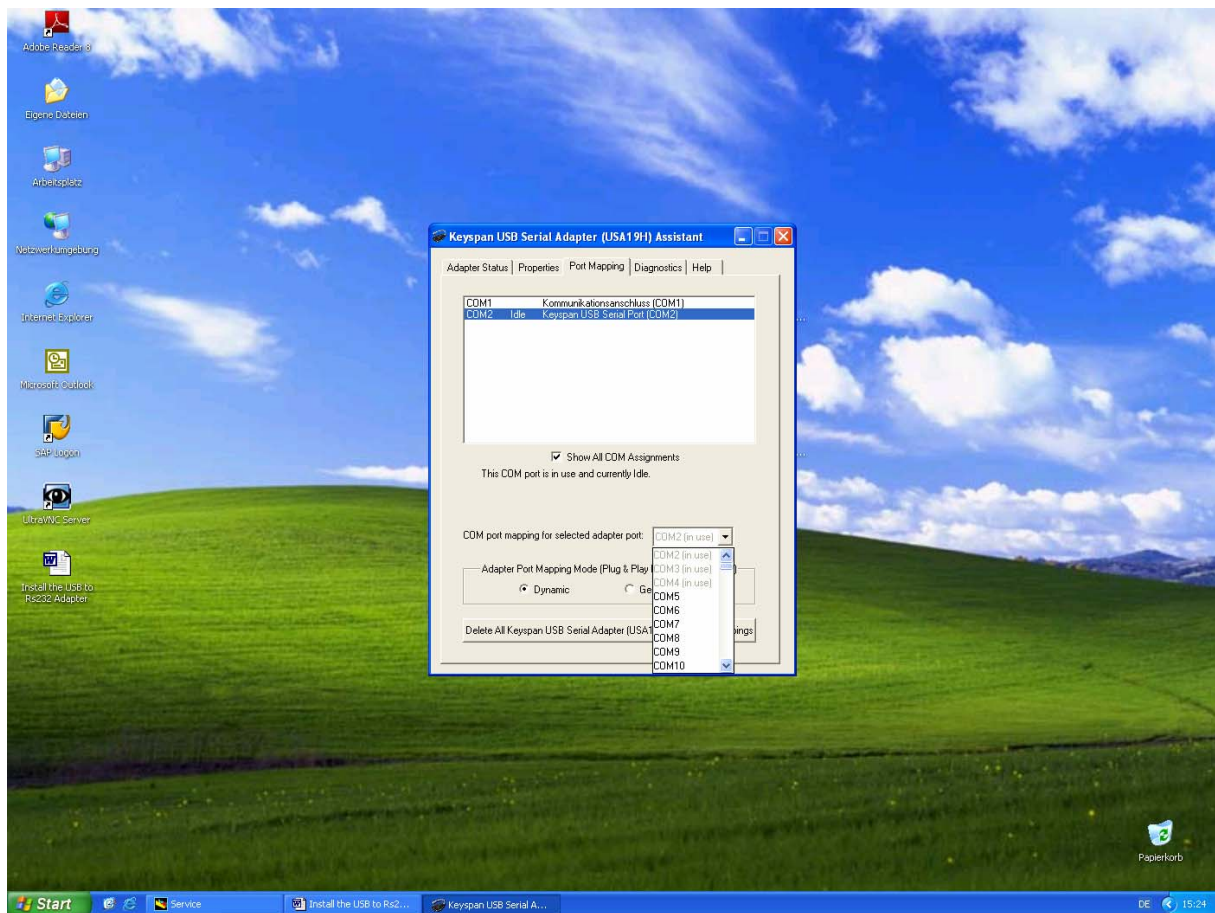
- Then the **Keyspan USB Serial Assistant** window should appear.



- Now in the main view you can see which port the **Keyspan Adapter** is using.
- If the Port is between 1-4 you can close the **Keyspan Assistant** and you have to start the HSR Diagnostic Tool
- Other case please click on the department (submenu) "**Port Mapping**".



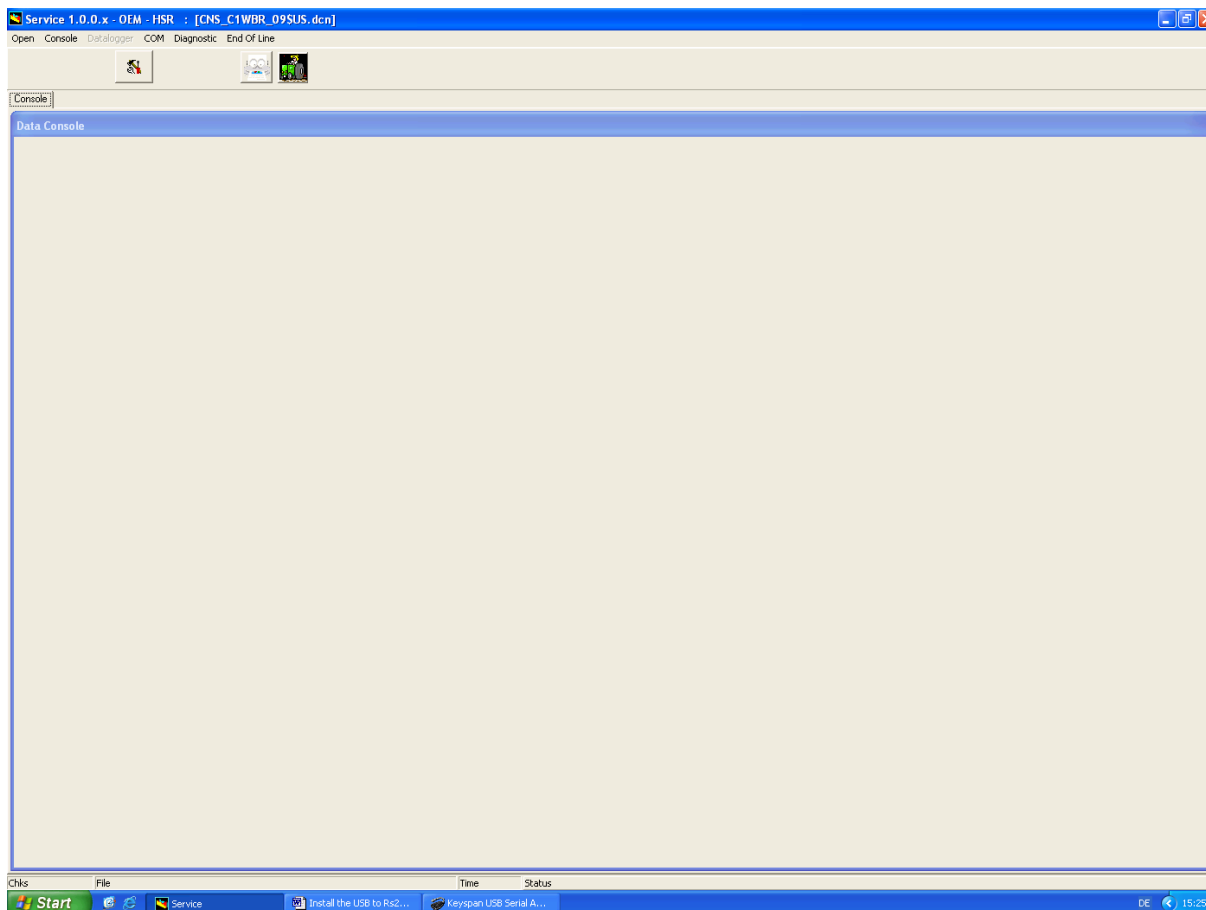
- In the middle of the window there you can select which port should be used. Please select a free one between 1-4 ! After that wait about 30 seconds that the program can change your settings.



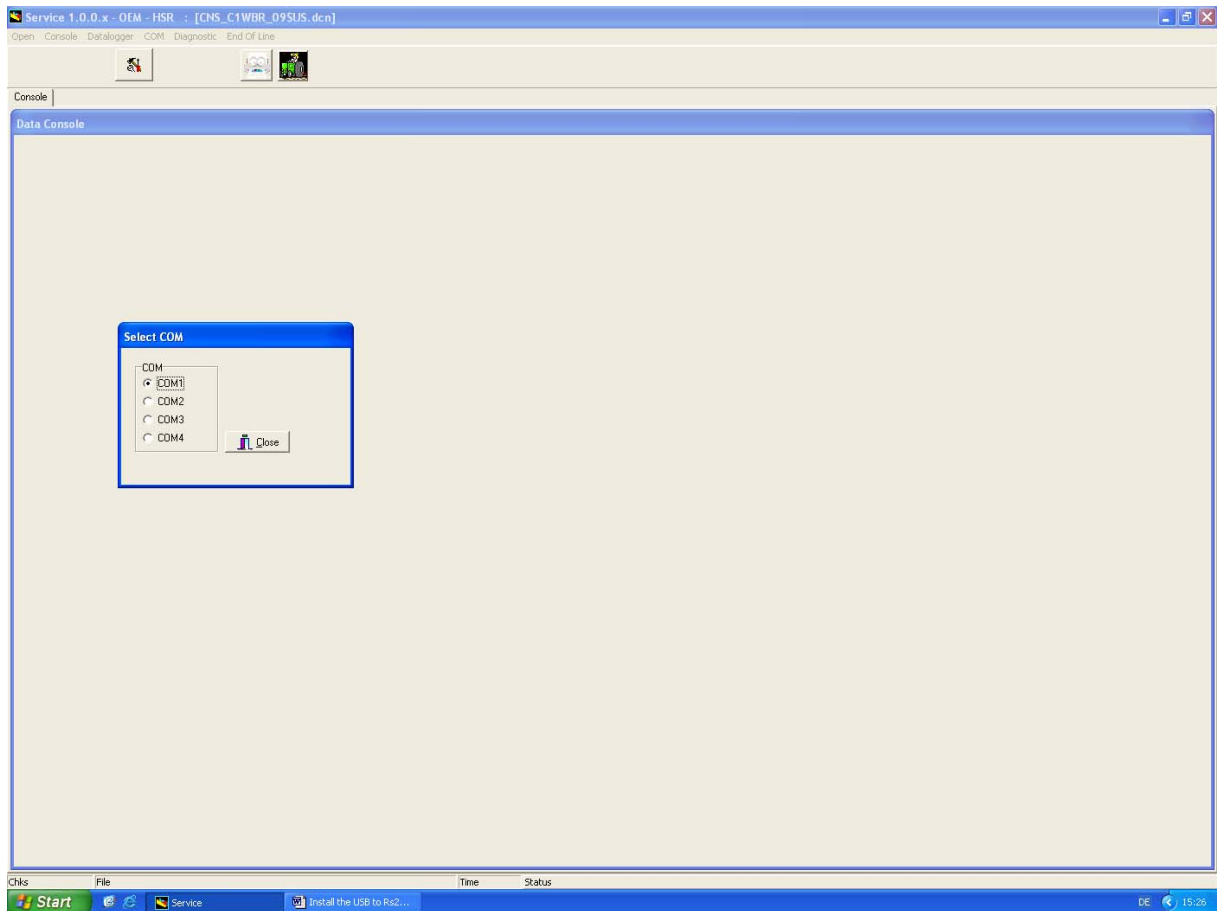
- When you have chosen a right port please close the **Keyspan Assistant** and open the **HSR Diagnostic tool** !

5.3. Configure the HSR Diagnostic Tool

To open the diagnostic manual, refer to the diagnostic manual installation



- In the menu of the **HSR Diagnostic Tool** you can see a submenu named “**COM**”, please click on it.
- After that you see the entry “**COM Port**”, please select this one.



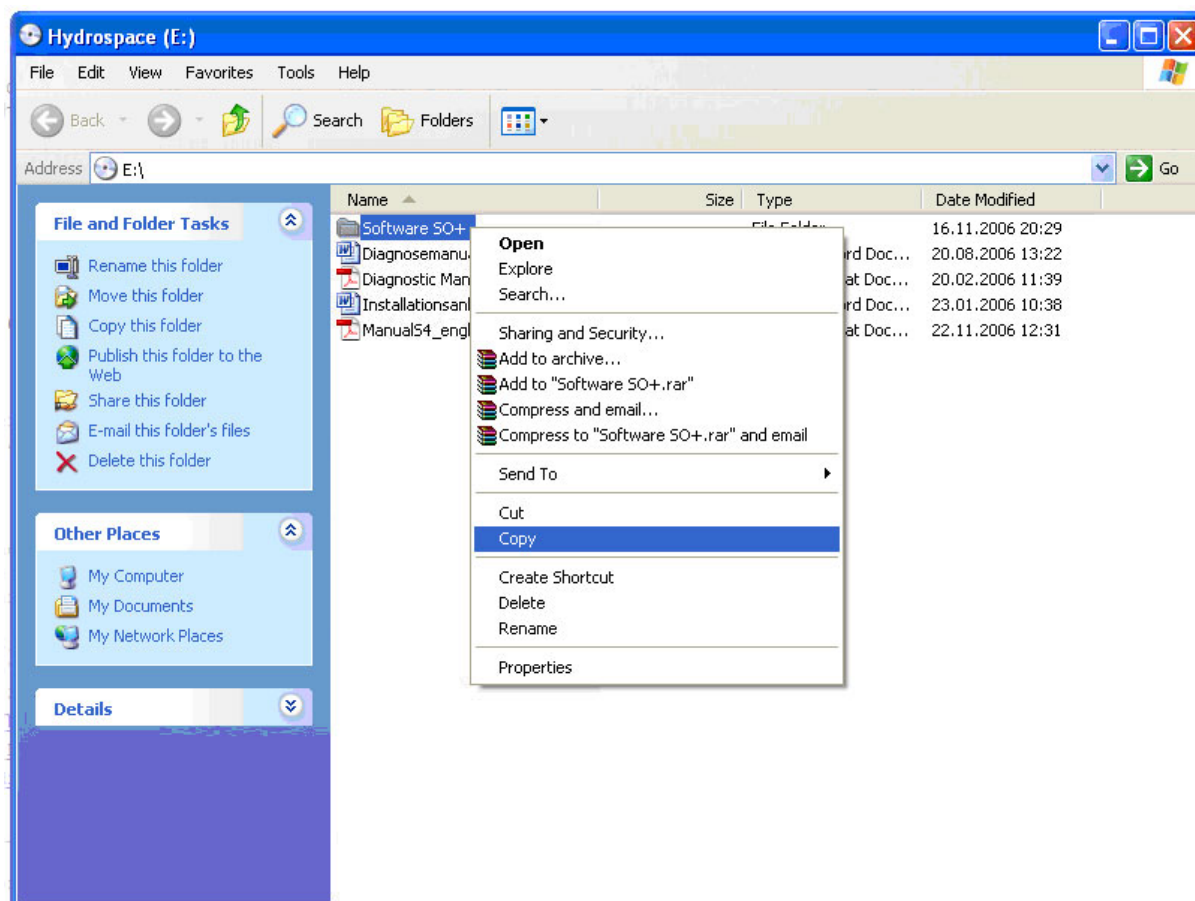
- Now a new little window has appeared. Please select the same port as you have chosen into the **Keyspan Assistant** and press the Button “**Close**”.
- Now the **HSR Diagnostic Tool** should work correctly! If there are any problems please contact our Administrators.



5.4. Diagnostics

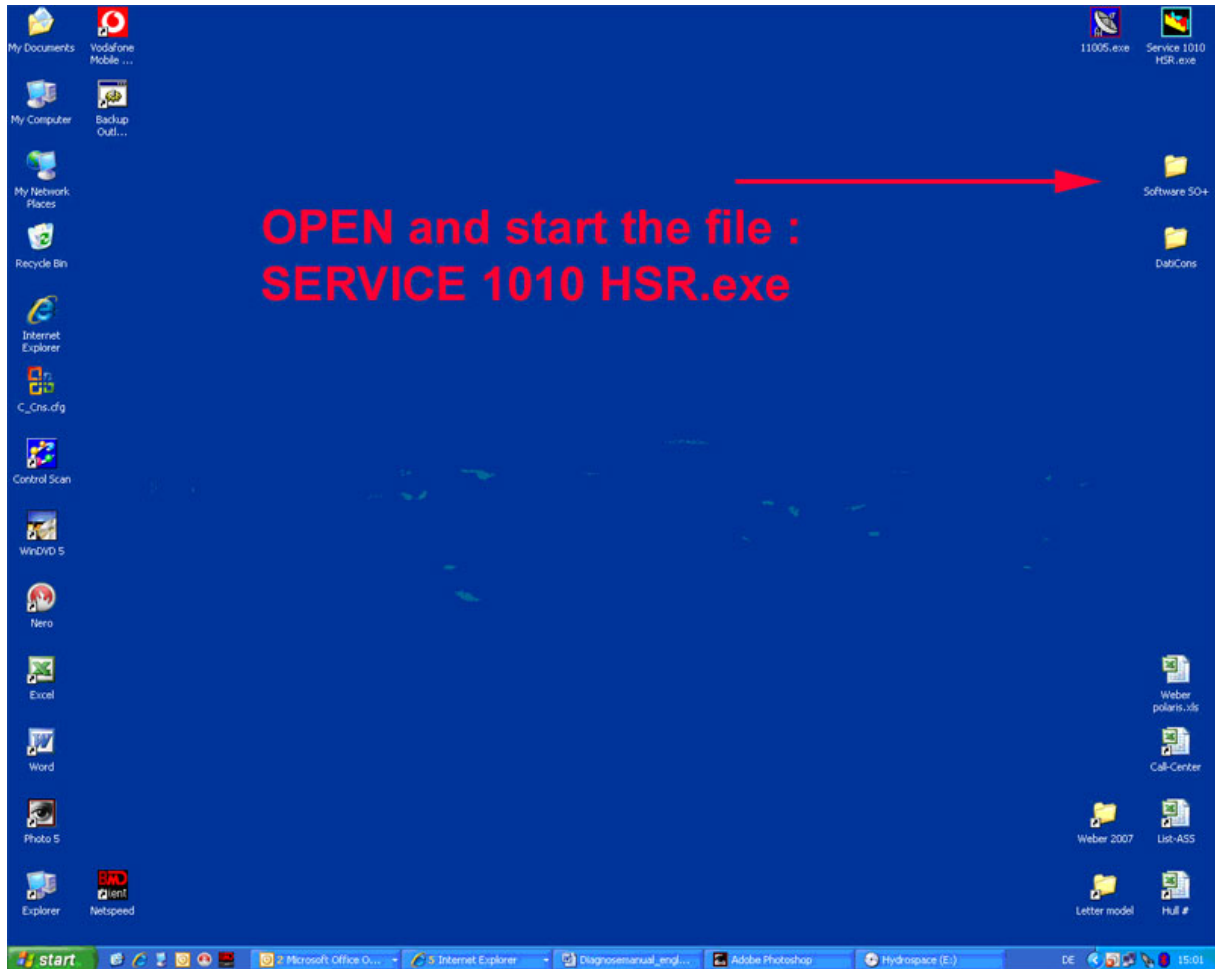
5.4.1. Installation

Move the folder “software S0+” to your hard disk or desktop



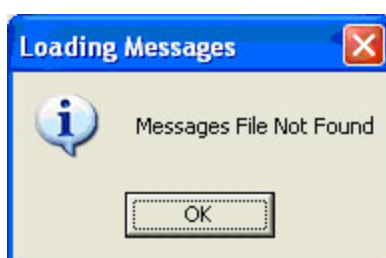


Start the program :” **SERVICE 1010 HSR.exe**”



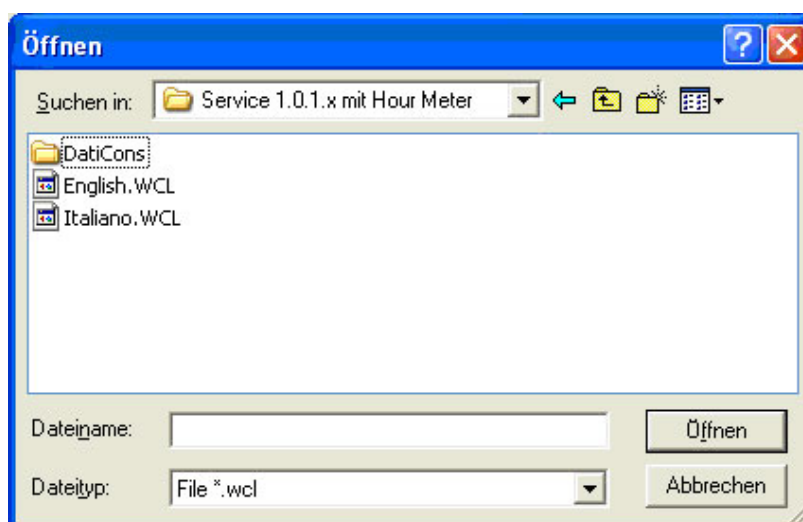
5.4.2. Starting the diagnostic program for the first time

If you start the diagnostic program (Service 1010 HSR.exe) for the first time, it could be that the following error is shown:



Message File Not Found

After a click on the button „OK“, the following dialogue window will open:

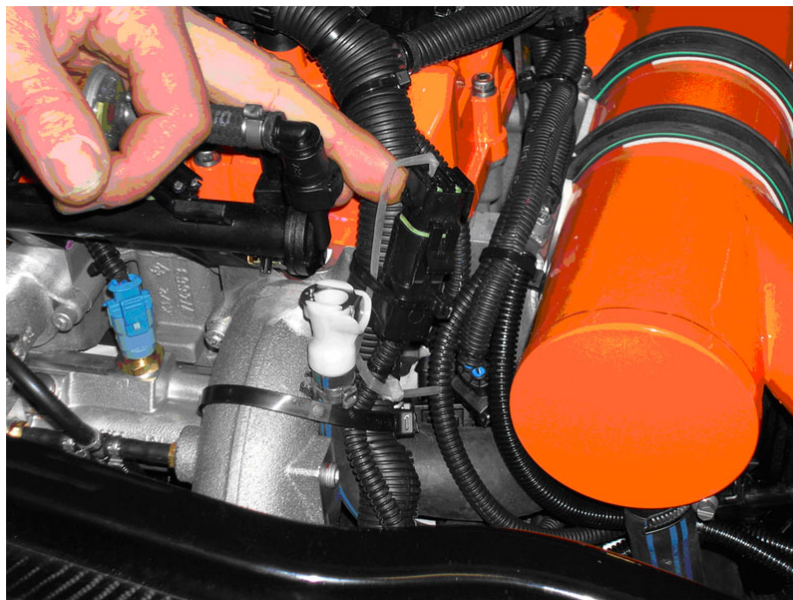


Selecting the Message File

Here you can select the language of your Message file (at the present English and Italian). The language-files are in the same folder like the diagnostic program. After that you are asked for the saving path for the device file. This is saved in the folder „Datensätze SO+“.

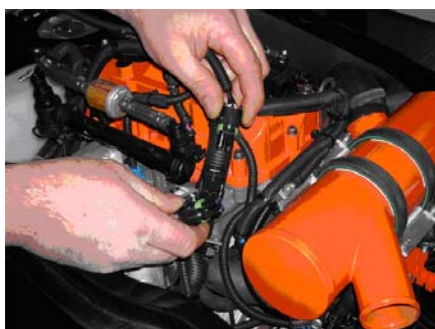
5.4.3. Diagnostic

1. Plug off the cover cap of the multipoint diagnostic connector which is on the wiring harness.



Multipoint diagnostic connector

2. Connect the HSR diagnostic cable with the push-pull plug.



Connecting the diagnostic cable (1)



Connecting the diagnostic cable (2)

3. Now attach the other side of the diagnostic cable to the serial interface (RS232, COM1) of your computer/laptop.



Serial interface

4. Switch on the ignition with the lanyard.

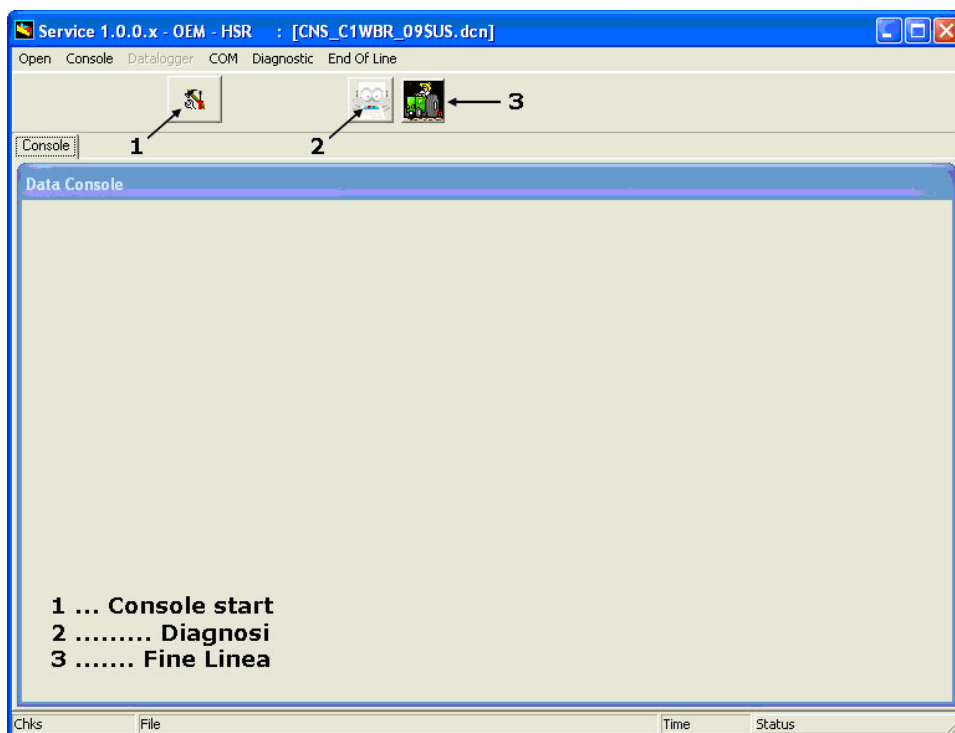


Connecting the lanyard (1)



Connecting the lanyard (2)

5. Start the diagnostic program (**Service 1010 HSR.exe**) with a double click on the icon.



Service 1010 HSR.exe

Should there be problems when you start the program for the first time, so you could find a solution in chapter **Starting the diagnostic program for the first time**.

6. Click on the button „Console Start“ [1]. Afterwards the following window will appear with the current values read out from the ECU:



Service 1.0.0.x - OEM : [CNS_C1WBR_09SUS.dcn]

Open Console Datalogger COM Diagnostic End Of Line

Console

Data Console

ERCOUNTER	0	DELTA_TPS	81
RPM	0	AIR_T	8,1
BAP	977	ENGINE_T	4,4
MAP	984	BATT_V	12,6
TARGET_MAP	0	LAMBDA	0,90
KLAMBDA	1,0000	LAMBDA_REF	0,00
INJ1	7509,0	IDLE	0,0
INJ2	7509,0	GEAR_VALUE	232
SPARK1	-3,0	OTS_SWITCH	0
SPARK2	-3,0	KILL_SWITCH	0
PHASE	350,7	DUTY_BOOST	0,0
TPS	0,5	BLOCK	0
		FREE	0

Errors Chks: 0 File Time Logging

Start Service DE 08:41

Data Console

The values shown in the illustration above correspond approximately with the standard values of the non-running engine at the ambient temperature about 10°C (50°F).

It's advisable to set the following parameter in this console:

RPM | SPARK1

BAP | SPARK2

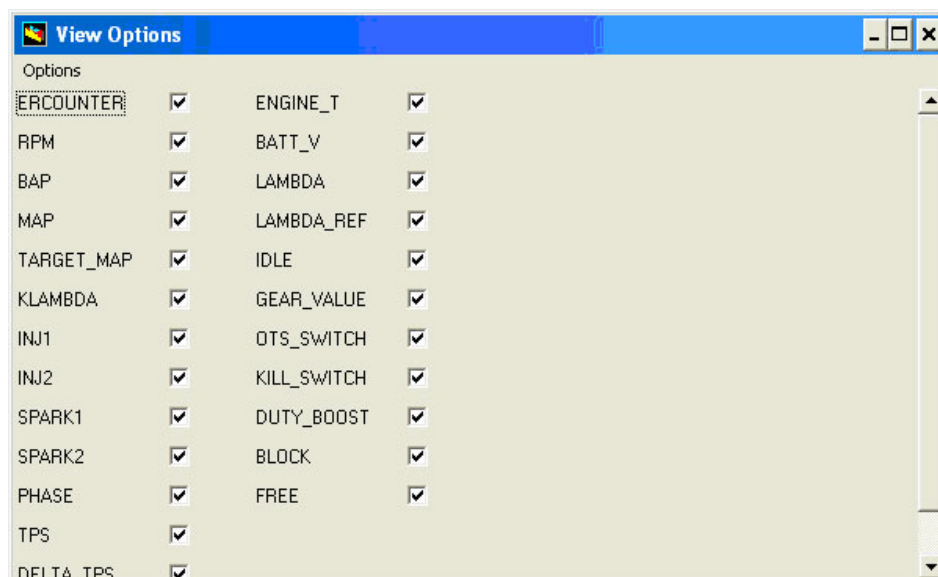
MAP | TPS

INJ1 | AIR_T

INJ2 | ENGINE_T, BATT_V



In order to change the indicated parameter, click the button „Open“ and afterwards “Options...” in the menu bar. Then following window will open:



Selecting the parameters

Select the parameter which you want to have. With a click on the button „Close“  you take over the settings.

To select all parameters, you have to click on “Options” in the menu bar and then on “Select All”. To select no one of the parameters, you have to click on “Options” in the menu bar and then on “Disable All”.

The meanings of the abbreviations are:

ERCOUNTER.....	ignition counter
RPM	engine speed
BAP	atmospherically pressure in [mbar] and/or [hPa]
MAP.....	manifold pressure in [mbar] and/or [hPa]
TARGET_MAP	<i>not required</i>
KLAMBDA	<i>not required</i>
INJ1	injection time for cylinder 1 in [ms]
INJ2	injection time for cylinder 1 in [ms]
SPARK1	ignition timing for spark plug 1 in [degree]
SPARK2	ignition timing for spark plug 2 in [degree]
PHASE	<i>not required</i>
TPS	throttle body position in [%]
DELTA_TPS.....	<i>not required</i>



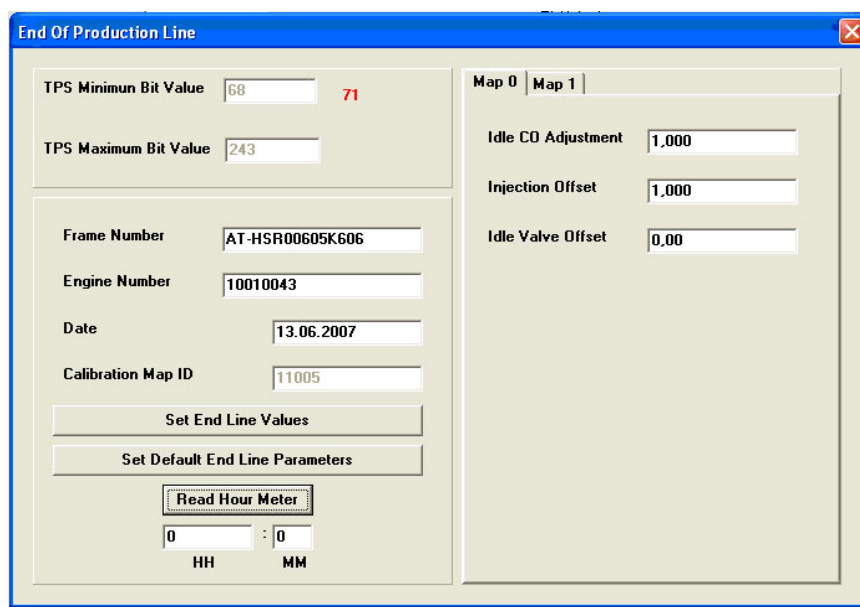
AIR_Tinlet manifold temperature sensor in [°C]
ENGINE_Tengine temperature in [°C]
BATT_Vbattery voltage in [V]
LAMBDA.....*not required*
LAMBDA_REF*not required*
IDLE*not required*
GEAR_VALUE*not required*
OTS_SWITCH.....*not required*
KILL_SWITCH.....*not required*
DUTY_BOOST*not required*
BLOCK*not required*
FREE*not required*

To abort the diagnosis, click the button .



5.4.4. ECU Setup

To start the window for the ECU-Setup, click the button „Fine Linea“ (see Illustraton “**Service 1010 HSR.exe**”).



ECU-Setup

TPS Minimum Bit Value.....	throttle body minimum position
TPS Maximum Bit Value.....	throttle body maximum position
Frame Number	hull serial number
Engine Number	engine serial number
Date	date of the last ECU-Setup
	A double click into the field will insert the actual date
Calibration Map ID	Mapping version number (at present the actually version is 11005)
Set End Line Values	saves the values in the ECU
Set Default End Line Parameters	reset to default values and saves it in the ECU
Read Hour Meter	reads the engine total running time
Idle CO Adjustment	<i>not required</i>
Injection Offset	<i>not required</i>
Idle Valve Offset	<i>not required</i>



5.4.5. Control the throttle body attitude

1. The computer must be connected by the diagnostic cable with the engine and the ignition must be switched on with the lanyard.
2. Start the diagnostic program (**Service 1010 HSR.exe**) and start the ECU-Setup window.
3. Give full power and hold. Then double-click with the mouse on the value right of the input field of "TPS Maximum Bit Value". So the value will be transferred into the input field. (**Be sure it's full on throttle body**)
4. Release the throttle trigger and with a double-click you have to take over the value for "TPS Minimum Bit Value".
5. If the bolt has been touched before by the rider, the best would be to unscrew it until the TPS mini does not move, turn the screw clockwise, and when the bit starts to move then make ½ turn more.
6. The idle should be between 1400-1500 rpm, if you have 100 rpm and you wish to adjust higher, do not forget to reset the minimum value inside the ECU.

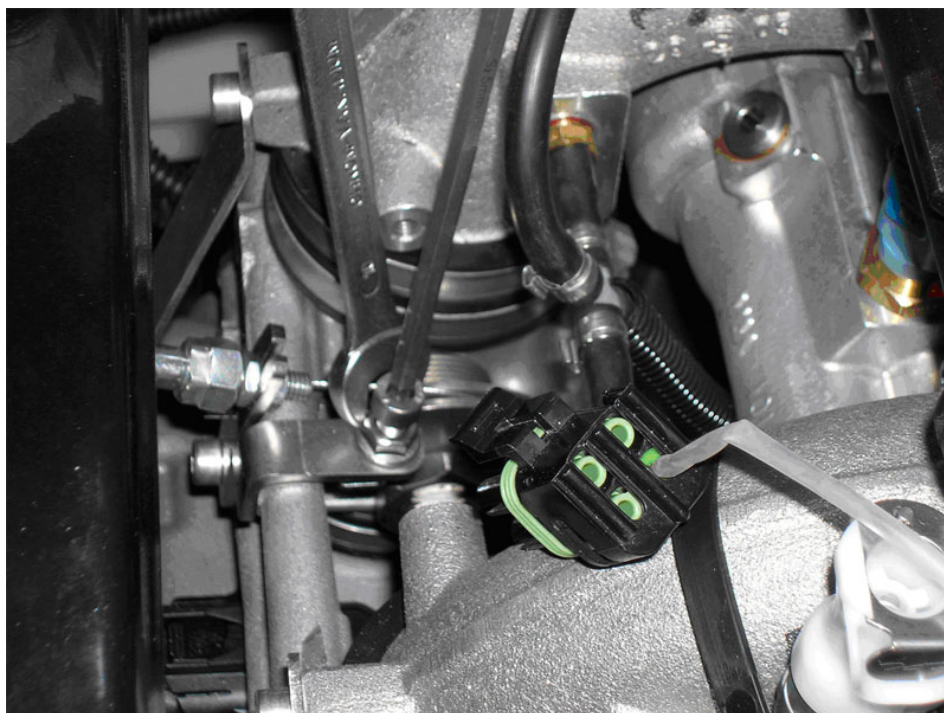
Example:

TPS Minimum between : 72 to 82 bits (never the same from 1 ski to the other one)

TPS Maximum between : 235 to 245 bits (never the same from 1 ski to the other one)

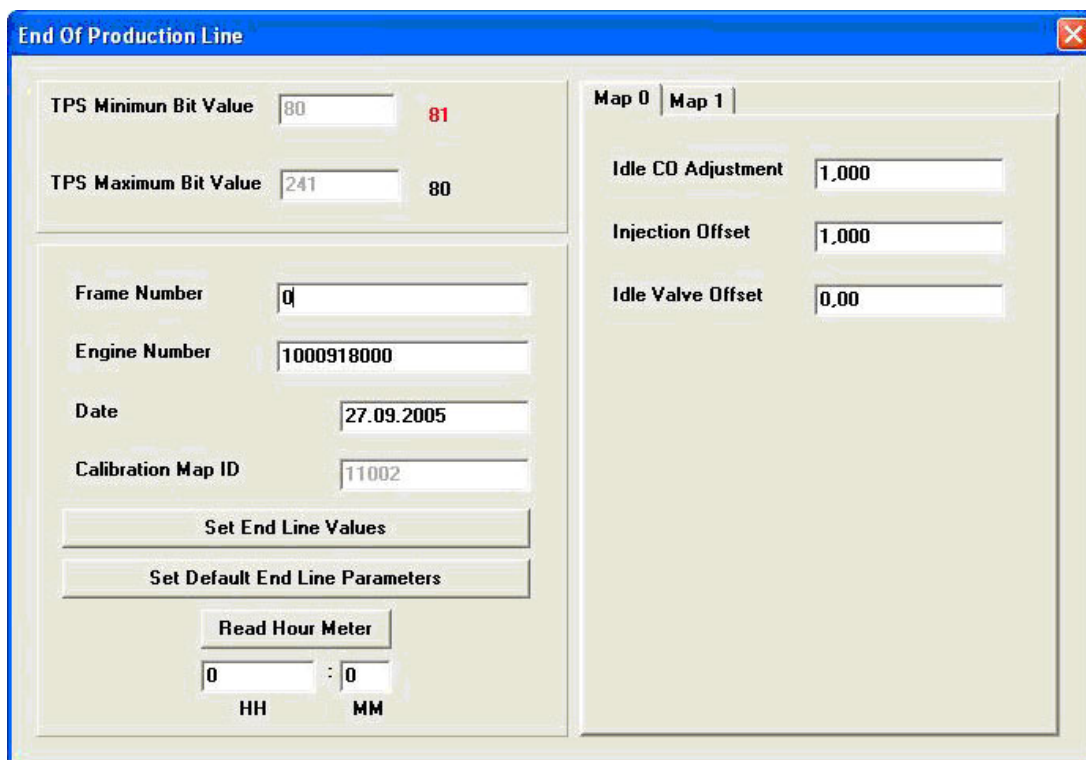
7. To unlock the nut use a bended 10mm fork wrench.
8. Adjust with a 5mm allen key.





Adjusting throttle body minimum position

9. Double-click on the value right of the input field of "TPS Minimum Bit Value" to transfer the value into the input field.
10. Then turn the allen screw until the value increases by 1. In our example above, this would be the value of 81. Now the correct idle setting is done.



The screenshot shows a software window titled "End Of Production Line" with a blue title bar and a close button (X) in the top right corner. The window is divided into two main sections. The left section contains input fields for "TPS Minimum Bit Value" (80), "TPS Maximum Bit Value" (241), "Frame Number" (0), "Engine Number" (1000918000), "Date" (27.09.2005), and "Calibration Map ID" (11002). Below these fields are three buttons: "Set End Line Values", "Set Default End Line Parameters", and "Read Hour Meter". The "Read Hour Meter" button is followed by two input fields for hours (HH) and minutes (MM), both showing 0. The right section has a tabbed interface with "Map 0" and "Map 1" tabs. Under the "Map 1" tab, there are three input fields: "Idle CO Adjustment" (1.000), "Injection Offset" (1.000), and "Idle Valve Offset" (0.00).

Example for correct idle settings

11. Now snug down the lock nut.
12. Click on the button „**Set End Line Values**“ saves the values into the ECU.
13. With a click on the button „Close“  you quit the ECU-Setup.

To start the diagnostic you have to click on the button „Diagnosi“

A click on the button „Read Diagnostic“ reads out the error memory from the ECU. With the register cards „Sensors“, „Actuators“, „Injection“ and „Ignition“ you can browse between the individual engine building groups. Any error will be indicated with the value „ERROR“.

[illegible]



6 APPENDIX





6. Appendix

6.1. General Data

Company	Hydrospace Handels und Produktions GmbH & Co KG
Address	Wiener Straße 71 3380 Pöchlarn Austria
Internet	www.hsr-benelli.com
E-Mail	office@hydrospace.at

6.2. Directives

Hydrospace thus confirms that the construction of the engine corresponds to the following pertinent conditions:

- EU directive about sport boats 94/25/EG with addendum 2003/44/EG
- USA EPA Federal Register 40 CFR Part 91
- USA CARB 13 California Code of Regulation Article 4.7 Spark Ignition Marine Engines





6.3. Proof of maintenance for work carried out

Date: Status: Hours of operation: Company seal, signature:	Work carried out: Motor oil change Oilfilter change Spark plug change Valve play checked Valve play adjusted
---	---

Date: Status: Hours of operation: Company seal, signature:	Work carried out: Motor oil change Oilfilter change Spark plug change Valve play checked Valve play adjusted
---	---





Date: Status: Hours of operation: Company seal, signature:	Work carried out: Motor oil change Oilfilter change Spark plug change Valve play checked Valve play adjusted
	
	
	

Date: Status: Hours of operation: Company seal, signature:	Work carried out: Motor oil change Oilfilter change Spark plug change Valve play checked Valve play adjusted
	
	
	

