



## Engine and Component Remanufacturing Process

- Each engine is disassembled down to the last nut and bolt. Specific oil gallery and water core plugs are removed from the crankshaft and cylinder block. This provides a thorough cleaning; enabling contaminants to be removed more efficiently. Any engine failure found during disassembly is noted. This ensures that the technician performing the remanufacturing process will give the area of failure special attention. This ensures a higher quality of repair.
- Cylinder blocks, crankshafts and camshafts are sent in house to the machine shop.
  - Each cylinder block is first magnafluxed for cracks in the main saddle, main cap and bolt hole areas. The main saddle area is then inspected for alignment; this measurement must be no more than .0015 of an inch. Main caps are then lightly filed to remove small burrs. The main caps are next checked for a snug fit to the block. Proper oil or torque compound is used on the main cap bolts to ensure correct torque is reached. The main bearing journals are then measured using a dial bore gauge. The block deck is then magnafluxed and measured with a straight edge; this specification will differ depending on engine manufacture and model. The deck height is then measured and compared to OEM (Original Equipment Manufacturer) specifications. Next, the counterbore area is measured to ensure correct depth and lack of variation in circumference. Each cylinder bore is then inspected at the specified areas for proper specification (i.e. taper, out-of-round, etc.). All necessary machine work is performed to make certain the cylinder block is within OEM specifications. After all necessary machine work is performed the cylinder block is pressure tested at a minimum of 35 psi to provide positive proof that all water core plugs and block casting are dependable. Each above process is monitored by a QC (Quality Control) Inspector, then logged with each process and technicians name to eliminate possibility for error.
  - Each crankshaft is magnafluxed for cracks on a liquid particle machine for maximum efficiency. Next, crankshafts are checked to be within OEM specifications for straightness. Crankshaft main and rod journals are then measured with micrometers to ensure journals are within OEM specifications. Crankshafts are then demagnetized. Once journals are verified to be within OEM guidelines the crankshaft is then polished to a very fine finish and measured again. Final measurement is performed by a QC inspector and the crankshaft is then logged with the technicians name to eliminate possibility for error. If journals are not in specification, crankshafts are then ground to OEM undersize specifications.
  - Each camshaft is magnafluxed for cracks on a liquid particle machine for maximum efficiency. Main journals are then measured with micrometers to ensure journals are within OEM specifications. Once journals are verified to be within OEM guidelines the camshaft lobes are ground to OEM specifications. For instances where the OEM does not recommend camshaft grinding, a new camshaft is purchased.

- Engine subassemblies: cylinder heads, water pumps, fuel pumps, oil pumps, connecting rods, blowers, governors, injectors, blower drive supports, regulator and relief valves, etc. are sent to their respective remanufacturing area.
  - Each cylinder head is stamped with its individual ID number which is logged in a record book. Next the head is completely disassembled all fuel, water and oil galley plugs are removed. All copper tubes or prechambers along with the valve guides are removed. The head is then magnafluxed to ensure maximum efficiency. Every bolt hole and threaded plug hole is inspected and repaired as necessary. The head is then measured for proper thickness and is recorded. All cam follower/lifter bores are measured and inspected for proper specification. Each cylinder head is then resurfaced. The head is then measured again for proper thickness, and then recorded again. All cross/bridge guides are then inspected and measured for proper diameter. Each head receives new copper tubes or a new/requalified prechamber with new gaskets/o-rings. The head is then pressure checked at 35 psi and inspected for leaks. This ensures the tubes/prechambers and head casting are completely reliable. Valves are then inspected for wear or fatigue, then measured with a micrometer to ensure proper valve stem diameter. Valve and stem faces are then ground to a very fine finish. Afterwards valve head thickness is measured so that the remanufactured valve meets or exceeds manufacturers' guidelines. Any valve not meeting guidelines and specification is discarded and replaced with a new valve. New valve guides are then installed and reamed to OEM guidelines. Next valve seats are machined using a three angle relief system. Valves are then installed, checked for proper seat location and measured for proper recession or protrusion. Valves are then vacuum tested to 10 in. Hg to verify seating. New valve stem seals are installed; where applicable. Valve springs are then inspected and measured for proper height and pressure as per OEM specifications. Any valve spring not meeting manufacturers' guidelines, or which is recommended not to be put into service again, is discarded and new valve springs installed. Push rods, when applicable, are inspected, tested and replaced as necessary. New or remanufactured cam followers are installed. All rocker arms are inspected and measured with a micrometer; rocker arms which do not meet OEM guidelines are replaced with remanufactured rocker arms. When application calls for a rocker arm which has a roller assembly, the roller and pin are always replaced with new. All rocker arm shafts are inspected, polished and then measured with a micrometer to ensure proper specification. Valve bridges are inspected and remanufactured. Final assembly is performed and the cylinder head is stamped with a remanufactured subassembly number and a QC inspector performs a final inspection of component, and then stamps it for approval.
  - Each water pump is completely disassembled. The housing is shot peen blasted and inspected for cracks and wear. Every bolt hole and threaded plug hole is inspected and repaired as necessary. Water pump main drive shafts are replaced with new as recommended by OEM or as needed. New seals and bearings are installed. Impellers are then inspected and measured for wear. A new ceramic seal is installed in the impeller and baked at recommended temperature and time. Drive gears are demagnetized and inspected for wear. The water pump is then assembled and slipped checked at OEM specifications. The QC inspector performs a final inspection of component, and then stamps it for approval.
  - Each fuel pump (positive displacement gear-type) is completely disassembled and cleaned. The housing is inspected for cracks and measured for wear. Every bolt hole and threaded plug hole is inspected and repaired as necessary. All seals and

gaskets are replaced with new. Drive, driven shafts and gears are replaced as necessary. Final assembly is performed; the fuel pump is then mounted to a bench test stand and test for proper fuel pressure and the absence of leaks. This ensures every fuel pump is problem free right out of the box. The QC Inspector performs a final inspection of component, and then stamps it for approval.

- Each oil pump is completely disassembled, cleaned and flushed. The housing is inspected for cracks and measured for wear. Rotor type assemblies are replaced with a new rotor assembly. Gear type assemblies are inspected for wear and fatigue, and then replaced as necessary. All shafts and bushings are measured with micrometers to ensure OEM specifications. Those not within specification are replaced and reamed or honed to OEM specifications. Final assembly is performed and the QC Inspector performs a final inspection of component, and then stamps it for approval.
  - All bushings and bearings are removed from connecting rods, steam cleaned, shot blasted and inspected for irregular wear and fatigue. Cross-head type rods are then checked to ensure that bend and twist limits do not exceed OEM specifications. Rods are demagnetized. The crank pin end of the connecting rod is then resized to OEM specifications. New bushings are installed on trunk-type rods. They are then set up on a precision boring machine to ensure proper center to center length between crank and piston pin; also eliminating bend and twist. A final cleaning is performed, then new rod nuts are installed and the QC Inspector performs a final inspection of component, and then stamps it for approval.
  - Blowers are completely disassembled, run through a jet wash cabinet to remove all grease, oil and grime. They are then steam cleaned, dried and shot blasted. Every bolt hole and threaded plug hole is inspected and repaired as necessary. Housings, end plates, rotors and gears are then carefully inspected for defects, wear and fatigue. All components are refinished, then new bearings, seals and sleeves are installed. Final assembly is performed and technician verifies all clearances, stamps it with a remanufactured subassembly number and test runs component. The QC Inspector performs a final inspection of component checking all clearances and then stamps it for approval.
  - Governors are completely disassembled, run through a jet wash cabinet to remove all grease, oil and grime. The housing is inspected for cracks and inspected for wear. Every bolt hole and threaded plug hole is inspected and repaired as necessary. **All** normal wear items are discarded and replaced with new. Final assembly is performed by technician and it is stamped with a remanufactured subassembly number. The QC Inspector performs a final inspection of component checking proper assembly and overall quality; and then stamps it for approval.
  - Injectors, blower drive supports, regulator and relief valves, etc. are all remanufactured using OEM guidelines. Careful consideration is given to ensure a high quality remanufactured item.
- Engines are assembled **always** using all the following new components: overhaul gasket set, rod bearings, main bearings, camshaft intermediate bearings, thrust bearings/washers, idler gear bearings/bushings, front and rear crankshaft seals and sleeves, camshaft seals and sleeves, liners, pistons, rings, liner seal rings, fuel jumper lines and valve cover gaskets. The subassemblies which are installed on the engine, listed previously above, are **always** remanufactured.

- All other engine components have been hot tanked, steam cleaned, all gaskets are scraped and each casting, housing or component has been critically inspected for cracks, defects, etc. Any repairs needed have been performed. Substandard components are discarded.
- Final engine assembly is performed by top qualified engine technicians, with each bolt being torqued using a calibrated torque wrench. All critical procedures are inspected by a QC Inspector and recorded on an engine build sheet. All critical bolts and assemblies inside of the engine are torqued and marked with a colored marker one-at-a-time. This procedure ensures that no mistakes are made, which could cause critical failure. All measurements such as crankshaft endplay, gear backlashes, camshaft endplay, liner protrusion/recession, bearing sizes, liner sizes, engine timing, oil pump backlash, valve lash clearances, and other tune-up settings are recorded on an engine build sheet. Upon completion of engine assembly the fuel system and the cooling system is pressure tested to eliminate any leaks or problems. The engine is then pre-lubed to avoid a dry startup.
- All engines are then dynamometer tested by top qualified engine technicians under the following procedure: Engine is warmed up for 15 minutes while setting all speeds, checking fuel and oil pressure, water temperature and checking for external fuel, water and oil leaks. Any problems found are repaired at this time. Engine is then run for 30 minutes under a full load while monitoring all pressures, temperatures, horsepower and torque. Afterwards, a hot tune-up and inspection is performed. The engine is run again for a full hour without interruption. All critical information is observed and recorded on an engine dynamometer test report.
- Engines are then drained of all fluids, steam cleaned, taped, rust proofed and painted.