

# Standards of Service

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## Diesel Engines



*Serving Engine Builders, Rebuilders and Installers*

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## **1 – SCOPE**

This Standard applies to the practice of rebuilding and remanufacturing of reciprocating compression ignition automotive and industrial engines which are used in conjunction with standard ancillary components in applications intended by the original manufacturer.

This Standard does not apply to repaired or rebuilt engines which may only be partially repaired with little or no machining, nor does it apply to second-hand exchange engines on which little or no repair work may have been carried out.

## **2 – REFERENCED DOCUMENTS**

The entire Standard is contained in this document.

## **3 – DEFINITIONS**

**NOTE:** These terms may be applied to:

- (a) An engine removed from its chassis to be rebuilt; or
- (b) An exchange engine.

For the purpose of this Standard the definitions below apply.

### **3.1 Fitted block assembly**

A cylinder block containing crankshaft, cylinder liners, piston and connecting rod assemblies and camshaft if in block.

### **3.2 Short block assembly**

A cylinder block and all those internal components contained within the limits of the block deck or decks, the pan rail, the block rear face and the timing cover, where fitted, including the crankshaft. If the fuel pump and oil pump are included.

### **3.3 Cylinder head assembly**

A rebuilt cylinder head fitted with valves and associated springs, retainers, fuel injector tubes or pre-combustion chamber assemblies where fitted.

### **3.4 Long block assembly**

A short block assembly together with a cylinder head assembly and all those components, excluding fuel injector assemblies. The whole fitted as an assembly within the rocker or cam cover, and timing cover. A rebuilt or new balance shaft assembly shall be supplied or fitted as appropriate.

### **3.5 Complete engine ready for Dyno testing or installation.**

A complete long block in addition having fuel system, turbo charger, oil coolers, water pump, flywheel housing and all auxiliary drivers, idlers rebuilt or replaced as necessary per manufacturers specifications.

### **3.6 Rebuilt engine and its synonym remanufactured engine ¾ describes an engine which has been:**

(a) Dismantled, cleaned, inspected, i.e. crack tested, pressure tested or visually inspected, whichever is applicable or appropriate.

(b) The components have been inspected and critical surfaces machined when necessary to achieve the proper dimensions and finishes per acceptable industry standards.

(c) New replacement parts, as defined in this Standard, have been installed as required; and

(d) The engine has been assembled with all critical areas fit to proper clearances or interference and manufacturers' specified fastener-tightening procedures.

### **3.7 Reconditioned component**

A component which has been found to be beyond acceptable industry standards, but which is rendered suitable for normal service by acceptable machining techniques.

### **3.8 Replacement components**

(a) Replacement components are defined as items that are acquired from manufacturers or suppliers who can demonstrate fitness for purpose and who can support their products with written warranty.

(b) Replacement parts defined as those parts not designed for re-use such as gaskets, bearings, piston rings, soft plugs, o-rings and seals.

### **3.9 Shall ¾ indicates that a statement is mandatory.**

### **3.10 Should ¾ indicate a recommendation.**

### **3.11 Inspection ¾ non-destructive testing**

(a) Visual

(b) Measurement

(c) Magnetic particle inspection

(d) Pressure testing

(e) Hardness testing

**(f) Surface finish analysis**

## **4 – REBUILDING A FITTED OR SHORT BLOCK ASSEMBLY**

### **4.1 Cylinder block**

Cylinder block shall be disassembled, all oil and water galley plugs and all bearings removed and thoroughly cleaned inside and out. Where fitted, bolt-on piston cooling nozzles and cylinder liners shall be removed. The cylinder block, including all threaded holes, shall be inspected as appropriate to ensure suitability for reuse.

**(a)** The block deck surface shall be checked for deck height and surface flatness to ensure it meets manufacturers' and replacement part manufacturers specifications.

**(1)** In certain instances, such as engines with removable liners, the surface may not require machining, but in such instances liner recesses shall be checked and trued as required and the sealing surfaces shall be verified to conform to acceptable industry standards.

**(2)** All other gasket or sealing faces on the block shall be checked for reuse or serviceability and corrected if necessary using industry acceptable machining methods.

**(b)** Main bearing housing bore shall be checked for the following:

**(1)** Proper fit of cap to block

**(2)** All housing bores having the correct inside diameter

**(3)** All bores in a straight plane in a proper location

**(4)** Trust location to be checked and verified

**(5)** Complete crankcase check per 3.11

**(c)** All bore type blocks shall have cylinder bores checked for reuse. Either boring to oversize or installing sleeves back to standard can reclaim bores not meeting specification for size, surface finish, and crosshatch as recommended by the manufacturer. All these type of blocks shall be pressure tested.

**(d)** All blocks with replaceable type liners shall have liner "o" ring sealing areas checked for pits, including chamfer where crevice seal is used, and bore concentricity compared to the upper 'pilot bore' area. Counter bores are to be checked as per 3.11 including depth and squareness. Parent bores shall be checked for accordance with manufacturer specifications.

All cylinders that dimensions are outside of manufacturer's specifications are to be:

- 1) Replaced with new sleeves manufactured from proper materials and finished to original or ring manufacturers' specification.
- 2) Or resized and finished honed to within the recommended limits of oversized with an appropriate surface finish and crosshatched angle as defined by the piston ring manufacturers' specification.

#### **4.2 Crankshaft**

The crankshaft shall have all galley plugs and gears removed and then be thoroughly cleaned and inspected for damage and specifications. Crankshafts may not need grinding in order to meet acceptable industry standards. In these instances journal roundness, surface finish, taper, diameter, residual magnetism and fillet radii must be verified to be correct to the appropriate manufacturer's specifications.

Crankshaft snouts to be inspected for wear, concentricity, and rectified as required.

Crankshaft alignment will be checked by noting the total indicator runout (TIR) on each main journal when the crankshaft is supported by the front and rear main in a pair of V-blocks.

Keyways, gears, threads, seal areas and flange condition will be inspected and repaired as required.

All crankshafts will be magnetic particle inspected before re-use.

The crankshaft may be reclaimed by:

- (a) Journals that are not within specifications shall be ground to the same relative undersize and finish. If a crankshaft was originally heat treated and surface hardness is reduced below acceptable industry standards, after grinding it shall be re-hardened; and
- (b) One or more crankshaft journals may be built up, reground and finished so as to maintain parity with the other journals on the crankshaft. It is important that any built up journals are restored to the crankshaft's original hardness, flexibility and radius size. Thrust face condition shall be checked and built up and reground, or only reground to a determined oversize, as required. Rear main sealing surfaces shall be checked and refinished as required.

#### **4.3 Camshafts**

The camshaft shall be inspected and if necessary, the camshaft lobes shall be ground to

the camshaft's original profile, rebuilt or the shaft replaced; and

(a) All lobes, journals, gears, key ways, threads, seal areas and other applicable surfaces shall be inspected for wear; and

(b) Auxiliary shaft journals shall be inspected and if necessary be reground, rebuilt or the shaft replaced; and

(c) Hydraulic camshaft followers shall be replaced or rebuilt; and

(d) Mechanical followers shall be resurfaced if applicable or replaced where necessary, according to type.

#### **4.4 Connecting rod assemblies**

All connecting rod assemblies (including bolts) shall be checked as per 3.11 also including center-to-center length, alignment and residual magnetism.

(a) The connecting rod housing bore shall be checked for size, roundness, taper, width and where necessary be resized or replaced.

(b) The piston pin end bore shall be checked as follows:

(1) Fully floating pin types shall have the bushing inspected for specification and replaced where necessary. Connecting rods requiring bushing replacement shall have the bushing removed, the parent bore inspected and a new bushing fitted, using the manufacturer's guidelines and machined to the correct fit for the replacement pin. Connecting rod center-to-center length shall be maintained when applicable, or

(2) Press fit pin types shall be checked for parallelism, size and surface finish.

## **5 – REBUILDING A CYLINDER HEAD ASSEMBLY**

### **5.1 Cylinder head**

The cylinder head shall be disassembled, cleaned both inside and out to remove all foreign matter. The following work shall then be completed on the unit:

(a) The cylinder head shall be inspected and tested to ensure suitability for reuse as per 3.11 also to include minimum head thickness and vacuum testing where applicable. Cracks, which may cause subsequent failure, shall be repaired or the component replaced. Acceptance criteria established by the engine's manufacturer will be used as a guideline when available.

**(b)** Water ports shall be inspected and if corroded outside of gasket-sealing area shall be reclaimed by an appropriate method and machined so that a new gasket seals water ports.

**(c)** The head surface shall be checked to ensure straightness and the surface finish as specified by the engine or replacement gasket manufacturer will be verified. Cylinder heads that are not within specifications must be machined to specifications.

Certain types of cylinder heads may have insufficient allowance for machining in which case the flatness and surface finish shall be verified to conform to acceptable industry standards. Machining the cylinder head for and installation of a cylinder head shim, or thicker cylinder head gasket, where appropriate within acceptable industry standards, is an acceptable procedure taking special consideration of valve protrusion or recession specification.

**(d)** In the case of overhead camshaft configurations, the camshaft bores shall be measured for size and checked for roundness, taper and alignment. Machining, line boring or straightening is acceptable practices for restoration of alignment and straightness. In some instances the fitting of replacement bearing shells, oversized components, or metal build up may be carried out.

**(e)** Valve guides shall be inspected for wear and fit in the cylinder head, where appropriate, and restored to original clearances. Guides, which do not meet these clearances, shall be replaced, remachined or sleeved. Knurling is not an acceptable repair.

**(f)** Valve seats shall be machined in such a manner as to retain the correct seat angles, widths, finish, valve heights and valve seating face concentric with the centerline of the valve guide bore.

**(g)** Where valve seat recession has occurred beyond acceptable limits, valve seat inserts shall be fitted. If this procedure is necessary in heads, which previously did not have removable seats, the procedure will include pressure testing the cylinder head before re-use.

**(h)** All defective valve seats shall be replaced. Replacement seats shall be fitted with the appropriate interference fit.

**(i)** Fuel injector sleeves shall be cleaned and checked for specifications, replaced if required and machined to specifications. Pressure testing the cylinder head after installation will be included as part of the procedure.

**(j)** Lifter bores shall be checked for specifications and repaired as necessary.

## **5.2 Valve and injector operating components and assemblies**



Valve and injector operating components and assemblies shall be completely dismantled, cleaned and inspected for wear and other defects. Components shall be machined or replaced as necessary.

### **5.3 Valve**

The valve face shall be remachined and inspecting stems, keeper grooves, tips and valve margin inspected for wear and conformance with specifications and dimensions or the valve will be replaced. In all cases correct valve train geometry must be maintained.

### **5.4 Valve caps and valve spring retainers**

All valve retaining components, i.e. collets, keepers, retainers, rotators, etc. shall be inspected for serviceability and replaced where necessary.

### **5.5 Valve spring**

All valve springs shall be tested for squareness, free height and spring pressures at installed height and valve open height and replace as necessary.

## **6 – MISCELLANEOUS COMPONENTS**

Miscellaneous components shall be checked as follows:

**(a)** The oil pump shall be disassembled, cleaned, inspected and parts remachined to restore correct clearances and finishes, and reassembled with suitable priming lubricant or replaced with new or remanufactured unit. The pressure relief valve assembly shall be disassembled and checked or replaced with a new or remanufactured unit. The oil pump drive shall be inspected and replaced when necessary.

**(b)** All push rods shall be inspected for straightness, damage and wear and replaced as necessary.

**(c)** The following shall be replaced:

- (1)** Timing belt
- (2)** Timing chains
- (3)** Unhardened chain sprockets
- (4)** Rocker assemblies

**(d)** The following may be reused, if in good condition, replace or rebuild if considered necessary:

- (1)** Hardened chain sprockets
- (2)** Timing chain guides and chain tensioners

- (3) Timing belt sprockets
- (4) Timing and drive gears
- (5) Timing gear hub and/or assemblies

(e) All other rotating or wearing components, the condition of which may influence engine noise, performance, emission performance or durability, shall be removed, inspected and rebuilt or replaced as required.

(f) All bolts, screws, nuts and mating threads shall be checked for suitability for reuse. Torque to yield bolts should be checked or replaced in accordance with manufacturer's recommendations and specifications.

(g) Vibration damper assemblies should be checked for specifications and reused or replaced in accordance with manufacturer's recommendations.

## **7 – ASSEMBLY PROCEDURES**

### **7.1 Engine assembly**

During assembly of the short block the following procedures shall be observed:

- (a) All components shall be thoroughly cleaned.
- (b) All expansive plugs shall be replaced. All other plugs may be reused if qualified by inspection.
- (c) All applicable mating surfaces shall be lubricated with an appropriate lubricant and surfaces susceptible to storage corrosion shall be treated with suitable rust inhibitor.
- (d) Cylinder block shall be reassembled using the following new or reconditioned parts as determined in Sections 3.6, 3.7 and 3.8.
  - (1) Main, connecting rod, camshaft and auxiliary shaft bearings and bushings.
  - (2) Pistons, pins and rings
  - (3) Gaskets, expansion plugs and seals.

### **7.2 Cylinder head assembly**

During cylinder head assembly the following procedures shall be observed:

- (a) All components shall be thoroughly cleaned.
- (b) All applicable mating surfaces shall be lubricated with an appropriate lubricant and

surfaces susceptible to storage corrosion shall be treated with a suitable rust inhibitor.

(c) All overhead camshaft and auxiliary shaft bearings/bushings shall be replaced as required to restore correct clearance.

(d) All seals and gaskets shall be replaced.

### **7.3 Long Block Assembly**

A long block assembly is a combination of a short block as described in 3.2 and assembled as in 5.1 and a cylinder head as described in 3.3, and assembled as in 5.0.

#### **NOTE:**

(a) All relevant bolts, nuts and screws, etc. shall be tightened to specifications as determined by the manufacturer.

(b) All running clearances shall be checked and corrected during assembly.

## **8 – ENGINE REMOVAL, PREPARATION AND RE-INSTALLATION**

The engine shall be removed from and re-installed in the vehicle in accordance with approved service procedures. Care should be taken to recover all fluids and gasses from the engine prior to removal. All fluids and gasses shall be stored or disposed of in accordance with Federal, State and local EPA and municipal regulations.

Confirm proper operation and integrity of all engine controls, sensors, emission controls, operating systems, ignition systems, fuel systems and cooling systems.

Consult the Original Engine Manufacturer's guidelines or AERA's Break-In-Procedure and Engine Installation brochures for additional guidelines on engine re-installation.

## **9 – WARRANTY**

An engine as described by this Standard shall be accompanied by a written warranty statement pursuant with the individual company's policies.

## 10 – QUALITY ASSURANCE

These Standards for quality and test procedures embrace every kind of repair of internal combustion compression ignition engines ¾ from the repair of individual engine parts to a rebuilt engine with the goal of restoring the established properties and characteristics of the engine.

### 10.1 Technical prerequisites

The following equipment must be available for the proper execution of quality-assured engine repairs:

- Cleaning equipment capable of cleaning all areas of the engine parts.
- Cylinder sizing machinery for oversizing and honing of cylinders and the installation of cylinder sleeves.
- Crankshaft grinders and polishing surface finishing equipment.
- Align boring or line honing equipment for the treatment of main and cam bearing bores.
- Connecting rod equipment for the treatment of the connecting rods, including equipment to accurately gage bore diameter, roundness and taper. (honing, boring, straightening, etc.)
- Surface grinder or milling machine.
- Crankshaft straightening press.
- Head straightening equipment.
- Hydraulic press.
- Valve seat & guide equipment.
- Valve seat finishing equipment to include accurate gauging, designed for this purpose, to determine valve seat concentricity. Vacuum testing may be used in conjunction with, but not exclusively to determine machining accuracy of the finished seat.
- Equipment for the treatment of engine valves.
- Thermal equipment for fitting of parts.
- Non-destructive test equipment, i.e. magnetic particle inspection, liquid penetrant

testing, etc.

- Hardness testing equipment in Rockwell C or Skelgraf.
- Spring pressure test equipment.
- Precision measuring instruments for inside and outside diameters and depths with a minimum accuracy of  $\pm 0.0001$ " or .0025mm, i.e. micrometers, dial indicators, cylinder bore gauges.
- Radius gauges, straight edge, surface analyzer, torque wrenches.

### **10.2 Technical resources**

Reference materials to establish and verify manufacturers' engine specifications. As published by the Original Engine Manufacturer, the replacement parts manufacturer or the AERA's Technical Committee.

## **11 – STANDARDS ADDENDUM (FTC GUIDELINES)**

### **Federal Trade Commission guides for the rebuilt, reconditioned and other used automobile parts industry**

#### **DEFINITIONS**

**Industry Member** - Any person, firm, corporation or organization engaged in the sale of distribution of any industry product as defined below.

**Industry Products** - Industry products are automotive parts and automotive assemblies which have been used or which contain used parts, whether such parts or assemblies have been rebuilt, remanufactured, reconditioned, relined, or otherwise. The term "automotive assemblies" as herein used mean any part or assembly designed for an automobile, truck, motorcycle, tractor or similar self-propelled vehicle. Industry products include, but are not limited to, armatures, generators, starters, carburetors, clutches, distributors, connecting rods, crankshafts, cylinder blocks, engine assemblies, fuel pumps, brakes, master and wheel brake cylinders, power brakes, shock absorbers, starter drives, solenoids, automatic transmissions, regulators, spark plugs, springs, windshield wiper motors and water pumps. Automobile tires are not products of the industry.

#### **DECEPTION AS TO PREVIOUS USE OF PRODUCTS**

It is an unfair trade practice to represent, directly or by implication, that any industry product is new or unused, or that any part of an industry product is new or unused when

such is not the fact, or to misrepresent the extent of previous use thereof.

It is an unfair trade practice for an industry member to offer for sale or sell any industry product unless a clear and conspicuous disclosure that such product has been used or contains used parts is made in all the industry member's advertising, sales promotional literature and invoices concerning the product, on the container in which the product is packed and if the product has been rebuilt, remanufactured, reconditioned or has the appearance of being new, on the product with sufficient permanency to remain thereon after installation for a reasonable period of time under ordinary conditions of use, and in such manner that said disclosure cannot be easily removed or obliterated.

**Form of Disclosure** - The disclosure that an industry product has been used or contains used parts as required by this section may be made by use of a word such as, but not limited to, "Used," "Second-hand," "Repaired," "Remanufactured," "Reconditioned," "Rebuilt," "Relined," whichever is applicable to the product involved. On invoices to the trade only the disclosure required by this section may be made by use of any number, mark, or other symbol which is clearly understood by all purchasers receiving such invoices are meaning that the products, or parts thereof, identified on the invoices have been used.

**Conspicuousness of Disclosure** - The disclosure required by this section shall be of such size or color contrast and so placed as to be readily noticeable to purchasers or prospective purchasers reading advertising, sales promotional literature, or invoices containing same, or reading any representation as to content on the container in which an industry product is packed, or inspecting an industry product before installation, or with a minimum of disassembly after installation.

It is unfair trade practice to place any means or instrumentality in the hands of others whereby they may mislead purchasers or prospective purchasers as to the previous use of industry products or parts thereof.

**DESCRIPTION AS TO IDENTITY OF REBUILDER, REMANUFACTURER, RECONDITIONER OR RELINER:**

It is an unfair trade practice to misrepresent the identity of the rebuilder, remanufacturer, reconditioner or reliner of an industry product.

In connection with the sale or offering for sale of an industry product if the identity of the original manufacturer of the product, or the identity of the manufacturer for which the product was originally made, is revealed and the product was rebuilt, remanufactured, reconditioned or relined by other than the manufacturer so identified, it is an unfair trade practice to fail to disclose such fact wherever either of said manufacturers is identified in advertising and sales promotional literature concerning the product, on the container in which the product is packed, and on the product, in close conjunction with, and of the same permanency and conspicuousness as, the disclosure of previous use of the

product required by this section. Examples of disclosures considered to be in compliance with the requirements of this section are as follows:

Disclosure of the identity of the rebuilder as, for example:  
*Rebuilt by John Doe Co.*

Disclosure that the product was rebuilt by an independent rebuilder as, for example:  
*Rebuilt by an Independent Rebuilder*

Disclosure that the product was rebuilt by other than the manufacturer so identified as, for example: *Rebuilt by other than XYZ Motors*

Disclosure that the product was rebuilt for the identified manufacturer, if such is the case, as, for example: *Rebuilt for XYZ Motors*

#### **MISREPRESENTATION AS TO CONDITION OF PRODUCTS AND MISUSE OF THE TERMS "REBUILT," "FACTORY REBUILT," "REMANUFACTURED," ETC.:**

It is an unfair trade practice to use, or cause or promote the use of, any statement or representation in advertising, on containers, on industry products, or elsewhere, which has the capacity and tendency or effect of misleading or deceiving purchasers or prospective purchasers as to the condition of an industry product, or the extent that an industry product has been repaired or reconstructed.

It is an unfair trade practice to use the words "Rebuilt," "Remanufactured," or words of similar import, as descriptive of an industry product which, since it was subjected to any use, has not been dismantled and reconstructed as necessary, all of its internal and external parts cleaned and made free from rust and corrosion, all impaired, defective or substantially worn parts restored to a sound condition or replaced with new, rebuilt, or unimpaired used parts, all missing parts replaced with new, rebuilt or unimpaired used parts, and such rewinding or machining and other operations performed as are necessary to put the industry product in sound working condition.

It is an unfair trade practice to represent an industry product as "Factory Rebuilt" unless the product was rebuilt as described in paragraph (b) of this section as a factory generally engaged in the rebuilding of such products.