

# Repair Time Schedule / Warranty Repair Time Guide

## Schedules, by engine type

Section 1
400 Series
850 Series
900 Series
1100 Series
1200 Series
1300 Series
1600 Series

Section 2
2300 Series
2500 Series
2800 Series

Section 3
4006 Series
4008 Series
4012 Series
4016 Series

The following repairs include all "start-by" components, as outlined in the Disassembly & Assembly (D&A) Manual.

Times do not include removal of after treatment unless stated otherwise.

If draining of the coolant is required to carry out a procedure, it is not included in this document as the time required will be application specific.

If draining of the engine oil is required to carry out a procedure, it is not included in this document as the time required will be application specific.

Repair Times are in hours : minutes by Engine Family / Type

## Section 1

Operation Description	900 Series	1200 Series	850 Series	400 Series	1100 Series	1300 Series	1600 Series
<p align="center"><b>Major overhaul</b></p> <p>Steam clean and completely dismantle, clean all parts, flush all oil and water passages and replace plugs, check crankshaft for size and wear and inspect all parts.</p> <p>Hone or replace liners or rebore as required</p> <p>Replace, or renew where necessary camshaft and auxiliary drive bushes, main and big end bearings and thrust washers Inspect and replace timing gears as necessary.</p> <p>Inspect and renew as required water pump, oil pump, turbochargers, and any cylinder head components</p> <p>Re-assemble engine completely using new gaskets and seals and tighten to specifications. Set valve clearances. Run engine and check for leaks.</p> <p>Re-tighten head and re-set valve clearances.</p>	X	X	X	X	X	34:30	34:30

<b>Operation Description</b>	<b>900 Series</b>	<b>1200 Series</b>	<b>850 Series</b>	<b>400 Series</b>	<b>1100 Series</b>	<b>1300 Series</b>	<b>1600 Series</b>
<p align="center"><b>Minor overhaul</b></p> <p>Steam clean engine, dismantle, clean and inspect parts            Replace or renew pistons and check height.            Hone liners, fit new main and big end bearings and thrust washers</p> <p>Check and rework/renew valves as necessary</p> <p>Completely re-assemble and tighten to specification using new gaskets and seals</p> <p>Run engine and check for leaks</p> <p>Re-tighten head and re-set valve clearances</p>	<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>	17:30 hours	17:30 hours
<p align="center"><b>Top overhaul (cylinder or gasket)</b></p> <p>Remove cylinder head and gasket Remove all traces of jointing compound and old gasket Check cylinder head and re-seat valves.</p> <p>Fit new gasket and replace head.            Note: Do not use gasket cement with dry type gasket.</p> <p>Check atomisers and service as necessary.</p> <p>Tighten head and set valve clearances.</p> <p>Run engine, check for leaks.</p> <p>Re-tighten head and re-set valve clearances.</p>	<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>	12:30 hours	12:30 hours
Additional time - turbocharged engine	<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>	30 mins	30 mins

Operation Description	900 Series	1200 Series	850 Series	400 Series	1100 Series	1300 Series	1600 Series
<b>Oil consumption rectification</b>							
Remove cylinder head, lube oil sump and oil pump							
Remove all pistons and con rods Deglaze all cylinder bores using 'Flexi hone' or similar tool							
Clean and check pistons for wear, renewing as necessary and replace all piston rings							
Strip and clean cylinder head							
Re-seat valves and service atomisers							
Check condition of oil pump and renew if necessary							
Re-assemble all parts using new gaskets and seals. Set valve clearances and tighten head to specification							
Run engine and check for leaks							
Re-tighten head and re-set valve clearances							
	<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>	21:00 hours	21:00 hours

Operation Description	900 Series	1200 Series	850 Series	400 Series	1100 Series	1300 Series	1600 Series
Replace bare block Steam clean complete engine, dismantle, clean and inspect all component parts Re-assemble engine complete into new bare block with same or new pistons using new rings, main and big end bearings and thrust washers, gaskets and seals, and tighten to correct specifications Run engine and check for leaks Re-tighten head and reset valve clearances	X	X	X	X	X	25:00 hours	25:00 hours
Cylinder block liner – Remove and Install Replacing one piston and connecting rod	X	X	X	X	X	11:30 hours	11:30 hours
Cylinder block liner – Remove and Install Replacing all pistons and connecting rods	X	X	X	X	X	13:00 hours	13:00 hours
Crankshaft Rear Seal - Remove	X	31 mins	X	X	31 mins	X	X
Crankshaft Rear Seal - Remove Equipped with Rear Power Take-Off remove	X	1:53 hours	X	X	1:53 hours	X	X
Crankshaft Rear Seal - Remove Wet Back End	X	44 mins	X	X	44 mins	X	X
Crankshaft Rear Seal – Install (Installation Procedure With Oil Pan in Position)	X	44 mins	X	X	44 mins	X	X
Crankshaft Rear Seal – Install Equipped with Rear Power Take-Off remove	X	3:15 hours	X	X	3:15 hours	X	X
Crankshaft Rear Seal – Install Wet Back End	X	46 mins	X	X	46 mins	X	X
Crankshaft Rear Seal – Remove and Install	37 mins	X	48 mins	47 mins	46 mins	1:30 hour	1:30 hour
Piston Cooling Jets – Remove and Install	45 mins	1:14 hours	4:10 hours	X	1:14 hours	X	X
Engine Oil Line - Remove and Install	X	X	X	13 mins	X	X	X

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Valve Mechanism Cover - Remove and Install	1:13 hours	30 mins	44 mins	X	16 mins	1:15 hours	1:15 hours
Valve Mechanism Cover - Remove and Install (Valve Mechanism Cover for 404-22 Engines)	X	X	X	18 mins	X	X	X
Valve Mechanism Cover - Remove and Install (Valve Mechanism Cover for 403-15 Engines)	X	X	X	23 mins	X	X	X
Valve Mechanism Cover Base – Remove and install	X	X	X	X	1:48 hours	X	X
Rocker Shaft and Pushrod - Remove	39 mins	44 mins	34 mins	39 mins	44 mins	45 mins	45 mins
Rocker Shaft – Disassemble	3 mins	18 mins	5 mins	13 mins	18 mins	30 mins	30 mins
Rocker Shaft – Assemble	4 mins	21 mins	7 mins	13 mins	21 mins	30 mins	30 mins
Rocker Shaft and Pushrod – Install	55 mins	36 mins	38 mins	42 mins	36 mins	1:00 hours	1:00 hours
Engine Valve Lash - Inspect/Adjust	X	X	X	39 mins	X	1:30 hours	1:30 hours
Check valve clearances only	X	X	X	26 mins	X	1:15 hours	1:15 hours
Cylinder head - Remove (Add 13 minutes if primary & secondary fuel filters are installed to the cylinder head)	1:46 hours	5:27 hours	1:15 hours	3:01 hours	5:27 hours	3:30 hours	3:30 hours
Cylinder head – Install (Add 13 minutes if primary & secondary fuel filters are installed to the cylinder head)	2:45 hours	6:13 hours	1:43 hours	3:03 hours	6:13 hours	4:45 hours	4:45 hours
Inlet and Exhaust Valves - Remove Reseat and replace or renew all valves Add 59 mins per valve seat replacement	X	X	X	X	X	10:30 hours	10:30 hours
Inlet and Exhaust Valve Guides - Remove and Install (Time includes cutting the valve seat and reaming the valve guides)	X	X	5:15 hours	X	7:55 hours	7:30 hours	7:30 hours
Lifter Group - Remove and Install (Hydraulic Lifter Group)	1:31 hours	6:56 hours	X	X	6:56 hours	X	X

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Electronic Unit Injector Sleeve – Remove and Install	X	X	X	X	X	1:30 hours	1:30 hours
All Electronic Unit Injector Sleeves – Remove and Install	X	X	X	X	X	3:00 hours	3:00 hours
Inlet and Exhaust Valve Spring – Remove and Install (Time for one spring, add 3 minutes for each additional spring)	X	1:04 hours	46 mins	X	1:01 hours	X	X
Inlet and Exhaust Valve Spring – Remove and Install	X	X	X	2:09 hours	X	1:45 hours	1:45 hours
Inlet and Exhaust Valve Springs – Remove and Install Replace all valve springs	1:50 hours	X	X	X	X	3:30 hours	3:30 hours
Inlet and Exhaust Valve – Remove and Install (Add 13 minutes per cylinder for valve removal)	X	2:41 hours	X	X	2:41 hours	X	X
Inlet and Exhaust Valve – Remove and Install (Add 10 minutes per cylinder for valve removal)	X	X	2:49 hours	X	X	X	X
Inlet and Exhaust Valve – Remove and Install (Add 5 minutes per cylinder for valve removal)	X	X	X	X	4:16 hours	X	X
Inlet and Exhaust Valve – Remove and Install	X	X	X	2:43 hours	X	X	X
Lifter Group - Remove and Install (If Balancer removal is necessary add 12 mins)	X	X	2:31 hours	5:43 hours	4:20 hours	X	X
Ream integral valve guides	X	X	X	X	X	X	X
Inlet Manifold - Remove and Install	X	X	1:27 hours	44 mins	1:31 hours	2:00 hours	2:00 hours
Exhaust manifold - Remove and Install	1:16 hours	2:48 hours	1:05 hours	X	34 mins	3:15 hours	3:15 hours
Exhaust manifold (403-15) - Remove and Install	X	X	X	55 mins	X	X	X
Exhaust manifold (404-22) - Remove and Install	X	X	X	1:26 hours	X	X	X
Exhaust Elbow - Remove and Install (Exhaust Elbow between the Turbocharger and the Aftertreatment Regeneration Device (ARD))	X	X	X	16 mins	X	X	X

Operation Description	900 Series	1200 Series	850 Series	400 Series	1100 Series	1300 Series	1600 Series
Exhaust Elbow - Remove and Install (Exhaust Elbow between the (Aftertreatment Regeneration Device (ARD) and the Clean Emission Module (CEM))	X	X	X	36 mins	X	X	X
Exhaust Elbow - Remove and Install	X	X	X	X	10 mins	X	X
Exhaust Clamps - Remove and Install	42 mins	X	X	X	X	X	
Crankshaft Front Seal - Remove and Install (403-15/404-22 - Add 13 minutes if equipped with ARD Air Pump)	X	38 mins	35 mins	42 mins	55 mins	45 mins	45 mins
Crankshaft Front Seal - Remove and Install (Alternative procedure if the front housing must be removed to carry out the procedure)	X	X	X	3:05 hours	X	X	X
Crankshaft Front Seal - Remove and Install	16 mins	43 mins	X	X	43 mins	X	X
Inlet Air Control – Remove (NRS Inlet Air Mixer)	X	16 mins	X	X	X	X	X
Inlet Air Control – Install (NRS Inlet Air Mixer)	X	26 mins	X	X	X	X	X
Exhaust Cooler (NRS) – Remove & Install	32 mins	2:24 hours	10 mins	16 mins	X	1:35 hours	1:35 hours
Throttle Valve (Air Intake) - Remove	6 mins	16 mins	8 mins	X	X	X	X
Throttle Valve (Air Intake) - Install	8 mins	18 mins	9 mins	X	X	X	X
Air Control Valve (Clean Emissions Module) – Remove and Install	X	16 mins	X	X	X	X	X
ARD Spark Plug - Remove and Install	X	8 mins	X	X	X	X	X
Ignition Coil (Clean Emissions Module) – Remove & Install	X	20 mins	X	X	X	X	X
Combustion Head Group (ARD) - Remove and Install (Pilot Only System)	X	52 mins	X	X	X	X	X
Relay (ARD Nozzle Heater) - Remove and Install (Clean Emissions Module)	X	12 mins	X	X	X	X	X



Operation Description	900 Series	1200 Series	850 Series	400 Series	1100 Series	1300 Series	1600 Series
Heated Nozzle - Remove and Install (Heated Nozzle Connection)	X	18 mins	X	X	X	X	X
Catalyst - Remove and Install (Diesel Oxidation Catalyst (DOC))	X	2:36 hours	X	X	X	X	X
Flexible Exhaust Pipe - Remove and Install	X	1:31 hours	26 mins	16 mins	X	X	X
Diesel Particulate Filter - Remove	X	1:57 hours	31 mins	29 mins	X	X	X
Diesel Particulate Filter - Disassemble	X	1:18 hours	X	X	X	X	X
Diesel Particulate Filter - Assemble	X	1:38 hours	X	X	X	X	X
Diesel Particulate Filter - Install	X	2:36 hours	42 mins	30 mins	X	X	X
Support and Mounting (Clean Emissions Module (CEM)) – Remove and Install	X	X	52 mins	22 mins	X	X	X
Support and Mounting (Clean Emissions Module (CEM)) – Remove and Install (Support and Mounting for Rear mounted Clean Emission Module (CEM))	X	X	X	48 mins	X	X	X
Support and Mounting (Clean Emissions Module (CEM)) – Remove and Install Diesel Oxidation Catalyst and Diesel Particulate Filter	1:06 hours	X	X	X	X	X	
Support and Mounting (Clean Emissions Module (CEM)) – Remove and Install Selective Catalyst Reduction	37 mins	X	X	X	X	X	
Check Valve (ARD Air Supply) - Remove and Install	X	X	X	8 mins	X	X	X
Diesel Exhaust Fluid Module - Disassemble	X	1:16 hours	X	X	X	X	X
Diesel Exhaust Fluid Module - Assemble	X	1:46 hours	X	X	X	X	X
Diesel Exhaust Fluid Lines - Remove and Install	X	52 mins	X	X	X	X	X
Diesel Exhaust Fluid Pump - Remove and Install	X	1:44 hours	X	X	X	X	X
DEF Injector and Mounting - Remove and Install	25 mins	39 mins	X	X	X	X	X
Electronic Control (Diesel Exhaust Fluid) - Remove and Install	X	13 mins	X	X	X	X	X

Operation Description	900 Series	1200 Series	850 Series	400 Series	1100 Series	1300 Series	1600 Series
Diesel Exhaust Fluid Tank - Remove and Install	X	52 mins	X	X	X	X	X
Manifold (DEF Heater) - Remove and Install	X	26 mins	X	X	X	X	X
Solenoid Valve (DEF Heater Coolant) - Remove and Install	X	16 mins	X	X	X	X	X
Voltage Load Protection Module – Remove and Install	X	10 mins	X	X	X	X	X
Connecting Rod Replace one	X	X	X	X	X	11:00 hours	11:00 hours
Small end bush Remove, replace one and ream one	X	X	X	X	X	11:30 hours	11:30 hours
Pistons and Connecting Rods – Remove	2:06 hours	X	X	3:24 hours	X	X	X
Pistons and Connecting Rods – Remove Add 6 minutes for each piston & connecting rod that is removed.	X	X	X	X	X	X	X
Pistons and Connecting Rods – Remove Add 8 minutes for each piston & connecting rod that is removed. (If Balancer removal is necessary add 4 mins)	X	X	1:23 hours	X	X	X	X
Pistons and Connecting Rods – Remove Add 13 minutes for each piston & connecting rod that is removed. (Add 13 minutes if primary & secondary fuel filters are installed to the cylinder head)	X	5:51 hours	X	X	5:51 hours	X	X
Pistons and Connecting Rods – Disassemble (per cylinder)	6 mins	7 mins	7 mins	4 mins	7 mins	X	X
Pistons and Connecting Rods - Assemble (per cylinder)	6 mins	10 mins	8 mins	5 mins	10 mins	X	X
Pistons and Connecting Rods – Install	3:25 hours	X	X	3:48 hours	X	X	X
Pistons and Connecting Rods – Install Add 10 minutes for each piston & connecting rod that is installed. (If Balancer Installation is necessary add 7 mins)	X	X	1:56 hours	X	X	X	X

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Pistons and Connecting Rods – Install Add 16 minutes for each piston & connecting rod that is installed. (Add 13 minutes if primary & secondary fuel filters are installed to the cylinder head)	X	6:26 hours	X	X	6:26 hours	X	X
Connecting Rod Bearings - Remove (Connecting rods in position) Add 7 minutes per Connecting Rod (If Balancer removal is necessary add 4 mins)	X	X	8 mins	X	X	X	X
Connecting Rod Bearings - Install (Connecting rods in position) Add 8 minutes per Connecting Rod (If Balancer installation is necessary add 7 mins)	X	X	13 mins	X	X	X	X
Connecting Rod Bearings - Remove (Connecting rods in position)	X	47 mins	X	34 mins	47 mins	1:45 hours	1:45 hours
Connecting Rod Bearings - Install (Connecting rods in position)	X	1:09 hours	X	39 mins	1:09 hours	2:15 hours	2:15 hours
Piston Replace one, checking piston height	X	X	X	X	X	11 :00 hours	11 :00 hours
Replace all pistons, checking heights	X	X	X	X	X	15:30 hours	15:30 hours
Re-ring all pistons	X	X	X	X	X	15:30 hours	15:30 hours

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Crankshaft – Remove and Install	X	X	X	X	X	11:15 hours	11:15 hours
Crankshaft – Remove (Add 13 minutes if primary & secondary fuel filters are installed to the cylinder head)	X	5:07 hours	X	2:53 hours	5:07 hours	X	X
Crankshaft – Install (Add 13 minutes if primary & secondary fuel filters are installed to the cylinder head)	X	6:11 hours	X	2:58 hours	6:11 hours	X	X
Crankshaft – Remove (If Balancer removal is necessary add 5 mins)	X	X	1:43 hours	X	X	X	X
Crankshaft – Install (If Balancer installation is necessary add 7 mins)	X	X	2:35 hours	X	X	X	X
Crankshaft Timing Ring - Remove and Install Add 20 minutes for heavy duty front gear group	X	5:15 hours	X	X	5:15 hours	X	X
Crankshaft Timing Ring - Remove and Install (If Balancer removal is necessary add 12 mins)	X	X	4:50 hours	X	X	X	X
Crankshaft Gear - Remove and Install (Add 18 minutes for heavy duty front housing)	X	6:07 hours	X	3:18 hours	6:07 hours	X	X
Refrigerant Compressor - Remove and Install	X	38 mins	X	X	38 mins	X	X
Replace damper and pulley	X	35 mins	X	X	35 mins	2:30 hours	2:30 hours
Crankshaft Main Bearings - Remove and Install (Crankshaft in position)	X	2:22 hours	X	X	2:22 hours	4:15 hours	4:15 hours
Crankshaft Main Bearings - Remove and Install (Crankshaft in position) (If Balancer removal is necessary add 12 mins)	X	X	1:00 hour	X	X	X	X
Thrust washers Replace	X	X	X	X	X	3:15 hours	3:15 hours
Crankshaft Wear Sleeve - Remove and Install	X	X	X	1:06 hours	X	X	X
Crankshaft Main Bearings - Remove	X	X	X	3:22 hours	X	X	X
Crankshaft Main Bearings - Install	X	X	X	3:12 hours	X	X	X
Crankshaft Gear (Balancer Drive) - Remove and Install	X	X	X	6:26 hours	X	X	X

Operation Description	900 Series	1200 Series	850 Series	400 Series	1100 Series	1300 Series	1600 Series
Camshaft - Remove and Install (If Balancer removal is necessary add 12 mins)	1:01 hours	6:40 hours	2:31 hours	8:13 hours	6:40 hours	14:45 hours	14:45 hours
Camshaft – Disassemble	X	X	X	7 mins	X	X	X
Camshaft – Assemble	X	X	X	8 mins	X	X	X
Camshaft Bearings – Remove and Install (Add 18 minutes for heavy duty front housing)	X	2:53 hours	2:46 hours	X	3:45 hours	X	X
Camshaft Gear - Remove and Install (Add 5 minutes for heavy duty front cover)	X	2:19 hours	2:00 hours	X	3:44 hours	X	X
Camshaft Followers – Remove and Install	X	X	X	X	X	7:45 hours	7:45 hours
Fuel Injection Pump Gear - Remove and Install	1:29 hours	X	X	X	X	8:45 hours	8:45 hours
Fuel Injection Pump Gear - Remove	X	1:25 hours	22 mins	X	1:02 hours	X	X
Fuel Injection Pump Gear - Install	X	1:28 hours	27 mins	X	1:39 hours	X	X
Idler Gear – Remove	X	1:10 hours	44 mins	X	1:10 hours	X	X
Idler Gear – Install	X	1:12 hours	57 mins	X	1:34 hours	X	X
Idler Gear – Remove (Heavy Duty Front Cover)	X	1:27 hours	X	X	1:27 hours	X	X
Idler Gear – Install (Heavy Duty Front Cover)	X	1:53 hours	X	X	1:53 hours	X	X
Housing (Front) – Remove and Install	X	X	X	X	X	6:00 hours	6:00 hours
Housing (Front) - Remove	X	X	1:06 hours	1:38 hours	2:05 hours	X	X

Operation Description	900 Series	1200 Series	850 Series	400 Series	1100 Series	1300 Series	1600 Series
Housing (Front) - Disassemble	X	X	X	16 mins	X	X	X
Housing (Front) – Assemble (403-15/404-22 only - New housing assemble add 70 minutes for Governor adjustments)	X	X	X	21 mins	X	X	X
Housing (Front) – Install (Add 21 minutes if equipped with an accessory drive)	X	2:43 hours	X	X	2:43 hours	X	X
Housing (Front) - Install (Heavy Duty Housing (Front))	X	2:46 hours	X	X	2:46 hours	X	X
Front Cover - Remove and Install	X	1:57 hours	1:21 hours	X	2:22 hours	45 mins	45 mins
Front Cover - Remove and Install (Heavy Duty Front Cover)	X	1:48 hours	X	X	2:45 hours		
Valve Timing Check Remove cylinder head cover Set Number 1 inlet valve to specified clearance Turn engine to 'nip' push rod Reset valve clearance. Refit top cover Run engine and test	X	X	X	X	X	1:15 hours	1:15 hours
Gear Group (Front) – Remove and Install	X	2:43 hours	X	X	3:23 hours	X	X
Gear Group (Front) – Remove and Install (Heavy Duty Gear Group (Front))	X	3:07 hours	X	X	3:07 hours	X	X
Housing (Front) - Install	X	X	2:36 hours	1:22 hours	3:01 hours	X	X
Housing (Front) – Remove (Add 13 minutes if equipped with an accessory drive)	X	1:57 hours	X	X	1:57 hours	X	X
Housing (Front) - Remove (Heavy Duty Housing (Front))	X	2:04 hours	X	X	2:04 hours	X	X
Gear Group (Rear) - Remove and Install	1:16 hours	X	X	X	X	X	X

Operation Description	900 Series	1200 Series	850 Series	400 Series	1100 Series	1300 Series	1600 Series
Engine Oil Pan - Remove (Aluminium Oil Pan)	X	18 mins	X	8 mins	18 mins	X	X
Engine Oil Pan - Install (Aluminium Oil Pan)	X	25 mins	X	8 mins	25 mins	X	X
Engine Oil Pan Plate – Remove and Install (Aluminium Oil Pan)	X	21 mins	X	X	X	X	X
Engine Oil Pan – Remove and Install (Pressed steel Oil Pan)	X	X	21 mins	X	X	X	X
Engine Oil Pan - Remove and Install (Cast Iron Engine Oil Pan)	X	X	21 mins	X	43 mins	1:45 hours	1:45 hours
Engine Oil Pan – Remove and Install (Composite Oil Pan)	25 mins	X	X	X	X	X	X
Suction pipe Remove and replace (oil pump on bench)	X	X	X	X	X	15 mins	15 mins
Engine Oil Pump - Remove (403-15/404-22 - Add 7 minutes if equipped with ARD Air Pump)	X	21 mins	38 mins	1:40 hours	21 mins	1:30 hours	1:30 hours
Engine Oil Pump - Remove and Install	1:02 hours						
Engine Oil Pump - Install (403-15/404-22 - Add 7 minutes if equipped with ARD Air Pump)	X	30 mins	43 mins	1:40 hours	30 mins	2:00 hours	2:00 hours
Engine Oil Pump – Disassemble, check, clean and assemble (On bench)	X	X	X	X	X	30 mins	30 mins
Relief valve – Remove and Install	14 mins	X	7 mins	16 mins	X	X	X
Relief valve Strip, check, clean and re-assemble (oil pump on bench)	X	X	X	X	X	30 mins	30 mins
Balancer - Remove and Install	X	X	33 mins	34 mins	X	X	X
Engine Centrifugal Oil Filter - Remove and Install (Includes disassembly, clean and assembly)	X	X	X	X	X	1:00 hours	1:00 hours

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HP Fuel Injection Pump - Remove	X	1:12 hours	35 mins	35 mins	1:28 hours	30 mins	30 mins
HP Fuel Injection Pump - Install	X	1:18 hour	1:01 hours	36 mins	2:09 hours	40 mins	40 mins
HP Fuel Injection Pump – Remove and Install	1:09 hours	X	X	X	X	X	X
Fuel Priming Pump – Remove and Install (Electric Fuel Lift Pump (ELFP))	X	20 mins	X	10 mins	20 mins	X	X
Fuel Priming Pump – Remove and Install (Mechanical Priming Pump)	X	X	20 mins	X	20 mins	45 mins	45 mins
Fuel Priming Pump - Disassemble, check, clean and assemble	X	X	X	X	X	1:15 hours	1:15 hours
High pressure fuel lines – Remove	4 mins	49 mins	16 mins	8 mins	49 mins	X	X
High pressure fuel lines – Install	10 mins	1:57 hours	17 mins	12 mins	1:57 hours	X	X
Fuel Lines - Remove and Install	30 mins	X	X	X	X	X	X
Bleeding the fuel system	X	X	X	X	X	15 mins	15 mins
Electronic Unit Injector - Remove Time for one Injector	X	1:09 hours	20 mins	20 mins	1:09 hours	45 mins	45 mins
Electronic Unit Injector – Remove Time for each additional Injector	X	13 mins	5 mins	5 mins	13 mins	10 mins	10 mins
Electronic Unit Injector – Install Time for one Injector	X	2:09 hours	22 mins	22 mins	2:09 hours	45 mins	45 mins
Electronic Unit Injector – Install Time for each additional Injector	X	18 mins	7 mins	5 mins	18 mins	11 mins	11 mins
Fuel Injector - Remove Time for one injector	X	X	X	20 mins	X	X	X
Electronic Unit Injector – Remove Time for a pair of injectors	10 mins	X	X	X	X	X	X
Electronic Unit Injector – Install Time for a pair of injectors	14mins	X	X	X	X	X	X



<b>Operation Description</b>	<b>900 Series</b>	<b>1200 Series</b>	<b>850 Series</b>	<b>400 Series</b>	<b>1100 Series</b>	<b>1300 Series</b>	<b>1600 Series</b>
Dismantle, clean and assemble one atomiser (Atomiser previously removed)	X	X	X	X	X	15 mins	15 mins
Fuel filter element – Remove and Install	15 mins	X	X	X	X	15 mins	15 mins
Position Sensor (Governor Control) - Remove and Install (Fuel Rack Solenoid)	X	X	X	16 mins	X	X	X
Fuel Filter Base (Primary) Remove & Install	20 mins	29 mins	20 mins	16 mins	20 mins	X	X
Injection Actuation Pressure Control Valve - Remove and Install	X	X	X	X	X	15 mins	15 mins
Fuel Filter Base (Secondary) Remove & Install	20 mins	36 mins	X	X	20 mins	X	X
Fuel Manifold (Rail) – Remove & Install	15 mins	3:05 hours	52 mins	X	3:05 hours	X	X
Relief Valve (Fuel) – Remove and Install	14 mins	20 mins	X	X	20 mins	X	X
Fuel Pump (ARD) – Remove and Install	X	46 mins	X	X	X	X	X
Fuel Control Manifold (Pilot Solenoid Only) – Remove and Install	X	59 mins	X	X	X	X	X
Water Separator and Fuel Filter (Primary) - Remove and Install	X	29 mins	20 mins	X	29 mins	X	X
Fuel Injector - Remove and Install (Aftertreatment Regeneration Device (ARD) Secondary Fuel Injector)	X	X	X	1:39 hours	X	X	X
Fuel Injector - Remove and Install (Aftertreatment Regeneration Device (ARD) Primary Fuel Injector)	X	X	X	1:39 hours	X	X	X
Air Cleaner – Remove and Install	X	X	X	16 mins	X	X	X
Flow Control Valve – Remove and Install	11 mins	20 mins	12 mins	X	20 mins	X	X

<b>Operation Description</b>	<b>900 Series</b>	<b>1200 Series</b>	<b>850 Series</b>	<b>400 Series</b>	<b>1100 Series</b>	<b>1300 Series</b>	<b>1600 Series</b>
Alternator – Remove	4 mins	25 mins	21 mins	20 mins	25 mins	15 mins	15 mins
Alternator – Install	6 mins	34 mins	23 mins	20 mins	35 mins	15 mins	15 mins
Alternator Bracket – Remove and Install	4 mins	<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>
Alternator Pulley – Remove and Install	5 mins	<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>
Idler Pulley - Remove and Install (Grooved Idler Pulley)	2 mins	23 mins	20 mins	<b>X</b>	23 mins	<b>X</b>	<b>X</b>
Idler Pulley - Remove and Install (Flat Idler Pulley)	2 mins	12 mins	<b>X</b>	<b>X</b>	12 mins	<b>X</b>	<b>X</b>
Belt Tensioner - Remove and Install	2 mins	17 mins	<b>X</b>	<b>X</b>	17 mins	<b>X</b>	<b>X</b>
Air Compressor - Remove and Install (Twin Cylinder Compressor)	<b>X</b>	1:12 hours	<b>X</b>	<b>X</b>	1:12 hours	<b>X</b>	<b>X</b>
Air Compressor - Remove and Install (Single Cylinder)	<b>X</b>	1:12 hours	<b>X</b>	<b>X</b>	1:12 hours	<b>X</b>	<b>X</b>
Electric Starting Motor - Remove and Install	7 mins	18 mins	18 mins	13 mins	18 mins	1:45 hours	1:45 hours
Flywheel – Remove	9 mins	14 mins	14 mins	12 mins	14 mins	40 mins	40 mins
Flywheel - Remove (Equipped with Rear Power Take-Off)	<b>X</b>	18 mins	<b>X</b>	<b>X</b>	18 mins	<b>X</b>	<b>X</b>
Flywheel – Install	14 mins	20 mins	17 mins	12 mins	20 mins	50 mins	50 mins
Flywheel – Install (Equipped with Rear Power Take-Off)	<b>X</b>	23 mins	<b>X</b>	<b>X</b>	23 mins	<b>X</b>	<b>X</b>
Flywheel Housing – Remove and Install	57 mins	1:13 hours	1:25 hour	1:48 hour	1:02 hours	<b>X</b>	<b>X</b>
Flywheel Housing– Remove and Install (Wet Back End Housing)	<b>X</b>	1:13 hours	<b>X</b>	<b>X</b>	1:13 hours	<b>X</b>	<b>X</b>

Operation Description	900 Series	1200 Series	850 Series	400 Series	1100 Series	1300 Series	1600 Series
Flywheel Housing – Remove and Install (Engines with Flywheel Housing and Back Plate)	X	X	X	1:52 hours	X	X	X
Flywheel Housing– Remove and Install (Flywheel Housing Equipped with Rear Power Take-Off)	X	3:31 hours	X	X	X	X	X
Ring Gear – Remove and Install	X	X	X	X	X	2:00 hours	2:00 hours
Accessory Drive - Remove and Install (Accessory Drive SAE "A")	X	34 mins	12 mins	X	34 mins	X	X
Accessory Drive - Remove and Install (Accessory Drive SAE "B")	X	34 mins	X	X	34 mins	X	X
Crankshaft Pulley – Remove and Install (Add 13 minutes if equipped with ARD Air Pump)	7 mins	X	22 mins	29 mins	X	X	X
Vibration Damper and Pulley - Remove	X	16 mins	X	X	16 mins	X	X
Vibration Damper and Pulley - Install	X	22 mins	X	X	22 mins	X	X
Turbocharger (First Stage) – Remove	X	30 mins	X	X	X	X	X
Turbocharger (Second Stage) – Remove	X	1:09 hours	X	X	X	X	X
Turbocharger (First Stage) - Install	X	30 mins	X	X	X	X	X
Turbocharger (Second Stage) – Install	X	1:47 hours	X	X	X	X	X
Turbocharger (Top Mounted) – Remove	X	X	39 mins	X	30 mins	39 mins	39 mins
Turbocharger (Top Mounted) – Install	X	X	44 mins	X	30 mins	45 mins	45 mins
Turbocharger (Side Mounted) – Remove	20 mins	X	34 mins	26 mins	30 mins	30 mins	30 mins
Turbocharger (Side Mounted) – Install	32 mins	X	44 mins	29 mins	30 mins	45 mins	45 mins
Wastegate Solenoid – Remove & Install	X	47 mins	13 mins	X	47 mins	X	X
Nitrogen Oxide Sensor - Remove and Install	3 mins	X	X	X	X	X	X

Operation Description	900 Series	1200 Series	850 Series	400 Series	1100 Series	1300 Series	1600 Series
Engine Oil Filter Base – Remove and Install	10 mins	16 mins	10 mins	X	16 mins	X	X
Exhaust Gas Recirculation Valve - Remove and Install	37 mins	X	22 mins	16 mins	X	X	X
Glow Plugs - Remove and Install	42 mins	59 mins	1:27 hours	8 mins	17 mins	X	X
Power Take-Off Drive – Remove and Install	X	X	18 mins	X	X	X	X
Crankcase Breather – Remove, disassemble, clean, assemble and install	X	X	X	X	X	1:15 hours	1:15 hours
Crankcase Breather – Remove (Filtered Breather)	X	9 mins	7 mins	X	9 mins	X	X
Crankcase Breather – Remove (Unfiltered Breather)	X	X	X	X	4 mins	X	X
Crankcase Breather – Install (Filtered Breather)	X	13 mins	7 mins	X	13 mins	X	X
Crankcase Breather – Install (Unfiltered Breather)	X	X	X	X	5 mins	X	X
Crankcase Breather – Remove and Install (For Turbocharged 404-22 Engine)	X	X	X	22 mins	X	X	X
Crankcase Breather – Remove and Install (Naturally Aspirated 404-22 Engine)	X	X	X	10 mins	X	X	X
Crankcase Breather – Remove and Install (For 403-15 Engines)	X	X	X	22 mins	X	X	X
Crankcase Breather – Remove and Install	7 mins	X	X	X	X	X	X
Engine Oil Pressure Switch - Remove and Install (Engine Oil Pressure Switch in Valve Mechanism Cover)	X	X	X	5 mins	X	X	X
Engine Oil Pressure Sensor - Remove and Install	3 mins	8 mins	5 mins	8 mins	8 mins	X	X
Inlet Manifold Temperature Sensor - Remove and Install	3 mins	8 mins	X	4 mins	X	X	X
Atmospheric Pressure Sensor - Remove and Install	X	8 mins	X	X	X	X	X

<b>Operation Description</b>	<b>900 Series</b>	<b>1200 Series</b>	<b>850 Series</b>	<b>400 Series</b>	<b>1100 Series</b>	<b>1300 Series</b>	<b>1600 Series</b>
Camshaft Position Sensor -Remove and Install	4 mins	8 mins	5 mins	X	8 mins	X	X
Crankshaft Position Sensor - Remove and Install	4 mins	8 mins	5 mins	X	8 mins	X	X
Fuel Temperature Sensor - Remove and Install	4 mins	10 mins	5 mins	X	X	X	X
Flame Detection Temperature Sensor - Remove and Install(Flame Detection Temperature Sensor for the ARD)	X	29 mins	X	4 mins	X	X	X
Soot Antenna - Remove and Install	X	10 mins	X	X	X	X	X
Temperature Sensor (DPF) - Remove and Install (Temperature Sensor (DPF) and Flame Detection sensor)	X	29 mins	X	X	X	X	X
Temperature Sensor (Exhaust) DOC, DPF & SCR - Remove and Install	8 mins	X	X	X	X	X	X
Pressure Sensor (DPF) - Remove and Install (Clean Emissions Module)	X	13 mins	10 mins	7 mins	X	X	X
Temperature Sensor (Cooled Exhaust Gas) - Remove and Install	5 mins	16 mins	X	X	X	45 mins	45 mins
Pressure Sensor (Cooled Exhaust Gas) - Remove and Install (Differential Pressure Sensor)	X	46 mins	X	X	X	X	X
Pressure Sensor (DPF) - Remove and Install (Differential Pressure Sensor and Tube Assemblies)	38 mins	X	X	X	X	X	X
Boost Pressure Sensor - Remove and Install	X	8 mins	X	4 mins	8 mins	X	X
Secondary Engine Speed/Timing Sensor - Remove and Install	X	X	X	5 mins	X	X	X
Primary Engine Speed/Timing Sensor - Remove and Install	X	X	X	5 mins	X	X	X
Temperature Sensor (DPF) - Remove and Install (Temperature Sensor for the DPF Outlet)	X	X	X	4 mins	X	X	X
Temperature Sensor (DPF) - Remove and Install (Temperature Sensor for the DPF Inlet)	X	X	7 mins	4 mins	X	X	X
Temperature Sensor (Catalyst Inlet) - Remove and Install	X	X	X	4 mins	X	X	X
Turbocharger Inlet Temperature Sensor - Remove and Install	X	X	X	4 mins	X	X	X
Glow Plug - Remove and Install (Aftertreatment Regeneration Device (ARD) Glow Plug)	X	X	X	4 mins	X	X	X

<b>Operation Description</b>	<b>900 Series</b>	<b>1200 Series</b>	<b>850 Series</b>	<b>400 Series</b>	<b>1100 Series</b>	<b>1300 Series</b>	<b>1600 Series</b>
Oxygen Sensor - Remove and Install (Catalytic Converter)	X	X	9 mins	X	X	X	X
Temperature Sensor (Exhaust) - Remove and Install	9 mins	X	9 mins	X	X	X	X
Pressure Sensor (Exhaust Back Pressure) - Remove and Install	X	X	5 mins	X	X	X	X
Pressure Sensor (Exhaust Manifold Pressure) - Remove and Install	X	X	X	X	X	15 mins	15 mins
Inlet Manifold Temperature and Pressure Sensor - Remove and Install	X	X	8 mins	X	X	X	X
Fuel Pressure Sensor - Remove and Install	X	X	X	X	8 mins	X	X
Inlet Air Temperature Sensor - Remove and Install	X	X	X	X	8 mins	X	X
Coolant Temperature Sensor - Remove and Install	4 mins	8 mins	5 mins	5 mins	8 mins	X	X
Electronic Control Module - Remove and Install (Electronic Control Module With Banjo Bolt Connections)	X	51 mins	X	X	X	X	X
Electronic Control Module - Remove and Install (Electronic Control Module With Quick Coupler Connections)	X	51 mins	X	X	X	X	X
Electronic Control Module - Remove and Install	X	X	X	X	39 mins	X	X
ECM Mounting Bracket - Remove and Install	X	1:06 hours	X	X	51 mins	X	X
Rear Power Take-Off (RPTO) - Remove	X	56 mins	X	X	56 mins	X	X
Rear Power Take-Off (RPTO) - Install	X	1:18 hours	X	X	1:18 hours	X	X
Aftertreatment Regeneration Device (ARD) - Remove and Install	X	X	X	38 mins	X	X	X
Pump (ARD Air) - Remove and Install (Low Mounted Pump (ARD Air))	X	X	X	39 mins	X	X	X
Pump (ARD Air) - Remove and Install (High Mounted Pump (ARD Air))	X	X	X	1:02 hours	X	X	X
Belt (ARD Air Pump) – Remove and Install	X	X	X	13 mins	X	X	X

<b>Operation Description</b>	<b>900 Series</b>	<b>1200 Series</b>	<b>850 Series</b>	<b>400 Series</b>	<b>1100 Series</b>	<b>1300 Series</b>	<b>1600 Series</b>
Air Inlet Heater – Remove and Install	X	X	X	X	X	45 mins	45 mins
Engine Lifting Bracket – Remove	2 mins	X	5 mins	X	X	X	X
Engine Lifting Bracket – Install	2 mins	X	9 mins	X	X	X	X
Ridge Reaming (per cylinder)	6 mins	X	X	X	X	X	X
Engine Oil Cooler - Remove and Install	6 mins	X	1:30 hours	13 mins	56 mins	2:45 hours	2:45 hours
Engine Oil Cooler - Remove (Engine Oil Cooler with a Low Mounted Filter Base)	X	56 mins	X	X	56 mins	X	X
Engine Oil Cooler - Remove (Engine Oil Cooler with a High Mounted Filter Base)	X	59 mins	X	X	59 mins	X	X
Engine Oil Cooler - Install (Engine Oil Cooler with a Low Mounted Filter Base)	X	1:21 hours	X	X	1:21 hours	X	X
Engine Oil Cooler - Install (Engine Oil Cooler with a High Mounted Filter Base)	X	1:23 hours	X	X	1:23 hours	X	X
Fan - Remove and Install (Add 13 minutes if an ARD Air Pump is installed (400 Series only))	4 mins	27 mins	27 mins	26 mins	27 mins	1:15 hours	1:15 hours
Alternator Belt - Remove and Install	2 mins	12 mins	12 mins	13 mins	13 mins	15 mins	15 mins
Water Temperature Regulator - Remove and Install	7 mins	5 mins	13 mins	X	5 mins	45 mins	45 mins
Water Temperature Regulator Housing - Remove and Install	X	X	X	20 mins	X	X	X
Water Pump - Remove	6 mins	17 mins	13 mins	X	17 mins	40 mins	40 mins
Water Pump - Install	10 mins	22 mins	14 mins	X	22 mins	50 mins	50 mins
Water Pump – Remove and Install (Add 49 minutes if equipped with ARD high mounted air pump)	X	X	X	1:05 hours	X	X	X

<b>Operation Description</b>	<b>900 Series</b>	<b>1200 Series</b>	<b>850 Series</b>	<b>400 Series</b>	<b>1100 Series</b>	<b>1300 Series</b>	<b>1600 Series</b>
Fan Drive - Remove and Install	10 mins	40 mins	47 mins	X	42 mins	X	X
Water Pump Pulley – Remove and Install	X	X	X	X	X	45 mins	45 mins
Jacket Water Heater – Remove and Install	X	X	X	X	X	20 mins	20 mins



## Section 2

Op No	Comp Code	Operation Description	Repair times (hr:min) by engine family / type		
			2300	2500	2800
A1	-	<p><b>Major overhaul (engine in workshop)</b></p> <p>Steam clean and completely dismantle, clean all parts, flush all oil and water passages and replace plugs, check crankshaft for size and wear and inspect all parts.</p> <p>Hone or replace liners or rebore as required</p> <p>Replace, or renew where necessary camshaft and auxiliary drive bushes, main and big end bearings and thrust washers</p> <p>Inspect and replace timing gears as necessary.</p> <p>Inspect and renew as required water pump, oil pump, turbochargers, and any cylinder head components</p> <p>Re-assemble engine completely using new gaskets and seals and tighten to specifications. Set valve clearances. Run engine and check for leaks.</p> <p>Re-tighten head and re-set valve clearances.</p>	53:00	53:00	53:00
A2	-	Additional time, per piston, if necessary to 'top'	0:45	0:45	0:45
A3	-	<p><b>Minor overhaul (intermediate - installed)</b></p> <p>Steam clean engine, dismantle, clean and inspect parts</p> <p>Replace or renew pistons and check height.</p> <p>Hone liners, fit new main and big end bearings and thrust washers Check and rework/renew valves as necessary</p> <p>Completely re-assemble and tighten to specification using new gaskets and seals Run engine and check for leaks</p> <p>Re-tighten head and re-set valve clearances</p>	45:00	45:00	45:00

Op No	Comp Code	Operation Description	Repair times (hr:min) by engine family / type		
			2300	2500	2800
A4	-	Additional time for marine only	X	X	X
A5	-	Additional time, per piston, if necessary to 'top'	0:45	0:45	0:45
A6	-	<b>Top overhaul (cylinder or gasket)</b>			
		Remove cylinder head and gasket			
		Remove all traces of jointing compound and old gasket. Check cylinder head and re-seat valves.			
		Fit new gasket and replace head Note: Do not use gasket cement with dry type gasket. Check atomisers and service as necessary.	27:00	27:00	27:00
		Tighten head and set valve clearances. Run engine, check for leaks.			
		Re-tighten head and re-set valve clearances.			
A7	-	Additional time - turbocharged engine	X	X	X
A8	-	<b>Oil consumption rectification</b>			
		Remove cylinder head, lube oil sump and oil pump. Remove all pistons and con rods			
		Deglaze all cylinder bores using 'Flexihone' or similar tool (C1 liners and bores only – not silicon carbide liners)			
		Clean and check pistons for wear, renewing as necessary and replace all piston rings. Strip and clean cylinder head			
		Re-set valves and service atomisers	38:00	38:00	38:00
		Check condition of oil pump and renew if necessary. Re-assemble all parts using new gaskets and seals. Set valve clearances and tighten head to specification. Run engine and check for leaks.			
		Re-tighten head and re-set valve clearances			
A9	-	Additional time - turbocharged engine	X	X	X

Op No	Comp Code	Operation Description	Repair times (hr:min) by engine family / type		
			2300	2500	2800
B1	1102	<b>Replace auxiliary drive shaft bushes</b> (Includes F2 and J3)	X	X	X
B2	1106	<b>Replace bare block</b> Steam clean complete engine, dismantle, clean and inspect all component parts Re-assemble engine complete into new bare block with same or new pistons, using new rings, main and big end bearings and thrust washers, gaskets and seals and tighten to correct specifications Run engine and check for leaks Re-tighten head and reset valve clearances	48:00	48:00	48:00
B3		Additional time - turbocharged engine	X	X	X
B4	1108	<b>Replace one interference fit cast iron liner</b> Bore and finish, hone to size if required (includes D1)	X	X	X
B5	1108	Additional time - turbocharged engine	X	X	X
B6	1108	<b>Replace set of interference fit cast iron liners</b> Bore and finish, hone to size if required (includes D3 and D14)	X	X	X
B7	1108	Additional time - turbocharged engine	X	X	X
B8	1108	<b>Replace one wet or pre-finished liner</b> (includes D1)	14:00	14:00	14:00
B9	1108	Additional time - turbocharged engine	X	X	X
B10	1108	<b>Replace set of wet or pre-finished liners</b> (includes D3 and D14)	24:00	24:00	24:00
B11	1108	Additional time - turbocharged engine	X	X	X
B12	1112	<b>Replace rear main oil seal assembly (Split and positive seal)</b> Includes removal and refitting of standard gearbox or driven equipment (additional operations may be added when justified)	9:00	9:00	9:00
B13	1112	<b>Replace rear main lip seal</b> (Additional operations may be added when justified)	X	X	X

Op No	Comp Code	Operation Description	Repair times (hr:min) by engine family / type		
			2300	2500	2800
C1	1219	<b>Cylinder head cover (engine set)</b> Remove and replace	0:30	0:30	0:30
C2	1219	Additional time - high mounted turbocharged engine	X	X	X
C3	1210	<b>Rocker shaft assembly</b> Remove and replace (includes C1 and C5)	1:00	1:00	1:00
C4	1207	Dismantle and clean, fitting new levers where necessary (includes C3)	1:30	1:30	1:30
C5	1211/ 1268	Check / adjust valve clearances (includes C1) per cylinder	0:15	0:15	0:15
C5/1	1211/ 1268	Check valve clearances only (includes C1)	X	X	X
C6	1203	<b>Cylinder head(s)</b> Remove and replace, fitting new gasket(s) (includes C3 and C5)	12:00	12:00	12:00
C7	1203	Additional time - turbocharged engine	X	X	X
C8	1203	Remove, and either reseal and replace or renew all valves (includes C6)	14:00	14:00	14:00
C9	1212/ 27	Additional time - cut one valve seat	0:20	0:20	0:20
C10	1212/ 27	Additional time - turbocharged engine	X	X	X
C11	1212/ 27	Additional time - replace each valve seat insert as necessary	0:30	0:30	0:30
C12	1215	Remove and replace valve guides (includes C6)	25:30	25:30	25:30
C13	1215	Additional time - turbocharged engine	X	X	X

Op No	Comp Code	Operation Description	Repair times (hr:min) by engine family / type		
			2300	2500	2800
C14	1215	Ream integral valve guides (includes C6)	X	X	X
C15	1226	Replace end covers, fitting new gaskets	X	X	X
C16	1232	Fit one injector sleeves in situ	1:30	1:30	1:30
C17	1232	Fit all injector sleeves in situ	3:00	3:00	3:00
C18	1214	<b>Valve spring</b> Change one - head not removed (includes C1)	2:00	2:00	2:00
C19	1214	Change complete set of valve springs - head not removed (includes C1)	9:00	9:00	9:00
C20	1206	<b>Inlet manifold</b> Remove and refit, renewing gaskets	0:30	0:30	0:30
C21	1206	Additional time - turbocharged engine	X	X	X
C22	1205	<b>Exhaust manifold</b> Remove and refit, renewing gaskets	1:00	1:00	1:00
C23	1205	Additional time - turbocharged engine	X	X	X
C24	-	Replace front camshaft oil seal (includes F18 and F13)	X	X	X
C25	-	Replace rear camshaft oil seal	X	X	X

Op No	Comp Code	Operation Description	Repair times (hr:min) by engine family / type		
			2300	2500	2800
		<b>Connecting rod</b>			
D1	1301	Replace one (includes C6 and G1)	12:00	12:00	12:00
D2	1301	Additional time - turbocharged engine	X	X	X
D3	1301	Replace all connecting rods (includes C6 and G1)	24:00	24:00	24:00
D4	1301	Additional time - turbocharged engine	X	X	X
		<b>Small end bush</b>			
D5	1304	Remove, replace and ream one (includes D1)	11:30	11:30	11:30
D6	1304	Additional time - turbocharged engine	X	X	X
D7	1304	Replace and ream all small end bushes (includes D3)	X	X	X
D8	1304	Additional time - turbocharged engine	X	X	X
		<b>Big end bearings</b>			
D9	1305	Replace one pair (includes G1)	3:00	3:00	3:00
D10	1305	Replace all big end bearings (not removing oil gallery) (includes G1)	4:30	4:30	4:30
		<b>Piston</b>			
D11	1308	Replace one, checking piston height (includes C6 and G1)	12:00	12:00	12:00
D12	1308	Additional time - turbocharged engine	X	X	X
D13	1308	Additional time if necessary to 'top' piston	0:45	0:45	0:45
D14	1308	Replace all pistons, checking heights (includes C6 and G1)	18:00	18:00	18:00
D15	1308	Additional time - turbocharged engine	X	X	X
D16	1308	Additional time if necessary to 'top' piston	X	X	X
D17	1309 /10	Re-ring all pistons (includes D14 and cleaning pistons and liner bores)	22:15	22:15	22:15
D18	1309 /10	Additional time - turbocharged engine	X	X	X

Op No	Comp Code	Operation Description	Repair times (hr:min) by engine family / type		
			2300	2500	2800
E1	1400	<b>Replace crankshaft</b> (Includes B12/B13, E2, E5, G1 and J6)	16:00	16:00	16:00
E2	1406 /08	Replace damper and pulley as a separate operation from E1	1:00	1:00	1:00
E3	1407	<b>Main bearings</b> Replace all (includes G1) Note: Removal of front and rear main bearings in situ is not advocated	X	X	X
F1	1501	<b>Auxiliary drive oil seal</b> Remove and replace (Certain types may require additional operations to be added)	X	X	X
F2	1502	<b>Auxiliary drive shaft</b> Remove and replace (include J3) (Additional operations may require to be added)	X	X	X
F3	1503	<b>Auxiliary drive worm wheel</b> Remove and replace (includes H1 and F2)	X	X	X
F4	1504	<b>Auxiliary drive thrust washers</b> Remove and replace (includes H1 and F12)	X	X	X
F5	1505	<b>Camshaft</b> Remove and replace (includes C3, C5, G1 and F7)	9:00	9:00	9:00
F6	1505	Additional time - turbocharged engine	X	X	X
F7	1506	<b>Camshaft gear</b> Remove and replace (includes F13 on all but type 'T' engines)	4:00	4:00	4:00
F8	1510	<b>Tappets (Do Not Remove Camshaft)</b> Remove and replace all	X	X	X
F9	1511	Remove and replace (Includes F13)	X	X	X
F10	1512	<b>Fuel pump timing gear</b> Remove and replace (includes F13 except when driven through compressor on Eagle engines)	4:00	4:00	4:00
F11	1513	<b>Timing gear idler (main idler)</b> Remove and replace	5:00	5:00	5:00
F12	1516	<b>Timing case</b> Remove and replace	3:00	3:00	3:00
F13	1516	<b>Timing gear cover</b> Remove and replace (includes E2)	6:00	6:00	6:00
F14	1516	<b>Timing case front seal</b> Remove and replace (Additional to F13)	9:00	9:00	9:00

Op No	Comp Code	Operation Description	Repair times (hr:min) by engine family / type		
			2300	2500	2800
F15	1520	<b>Valve timing check</b> Remove cylinder head cover Set Number 1 inlet valve to specified clearance (see Workshop Manual) Turn engine to 'nip' push rod. Reset valve clearance, Refit top cover Run engine and test	2:00	2:00	2:00
F16	-	<b>Fuel pump drive shaft coupling</b> Remove and replace	X	X	X
F17	-	<b>Fuel pump drive shaft bush</b> Remove and replace (includes F16)	X	X	X
F18	-	<b>Timing belt, idler and adjuster</b> Remove, replace and re-tension belt	X	X	X
F19	-	<b>Front oil seal - oil pump</b> Remove and replace (includes H3, F13 and F18)	X	X	X
F20	1527	<b>Timing belt tension</b> Check and reset	X	X	X
F21	-	<b>Timing gear assembly</b> Remove and replace (includes F13)	X	X	X
G1	1601	<b>Sump and strainer</b> Remove, clean and re-assemble with new gaskets and corks and replace	3:00	3:00	3:00
G2	1603	<b>Suction pipe</b> Remove and replace (oil pump on bench)	X	X	X
G3	1604	<b>Delivery pipe</b> Remove and replace (oil pump on bench)	X	X	X
G4	1606	<b>Oil pump</b> Remove and replace (includes G1) (includes H3, F13 and F18 on 'B' engines)	3:30	3:30	3:30
G5	1606	Strip, check, clean and re-assemble oil pump (Oil pump on bench)	1:00	1:00	1:00
G6	1607	<b>Relief valve</b> Strip, check, clean and re-assemble (oil pump on bench)	1:00	1:00	1:00
G7	1610	<b>Scavenger oil pump</b> Remove and replace (includes G1)	X	X	X
G8	1610	Strip, check, clean and re-assemble scavenger pump (Pump on bench)	X	X	X



Op No	Comp Code	Operation Description	Repair times (hr:min) by engine family / type		
			2300	2500	2800
G9	1610	<b>Scavenger pump drive gear</b> Remove and replace (Pump on bench)	X	X	X
G10	1611	<b>Balancer unit</b> Remove and replace (includes G1)	X	X	X
G11	-	Strip, clean, check and re-assemble balancer unit assembly (Balancer on bench)	X	X	X
H1	1701	<b>Fuel pump</b> Remove and replace (includes H3 and H9)	0:30	0:30	0:30
H2	1701	<b>Distributor (gasoline engine)</b> Remove and replace	X	X	X
H3	1701	<b>Fuel pump timing</b> Check and adjust	X	X	X
H4	1701	<b>Governor</b> Adjust on running engine	X	X	X
H5	1701	Replace mechanical governor spring (includes H3 and H9)	X	X	X
H6	1702	<b>Lift pump</b> Remove and replace	X	X	X
H7	1702	Strip and clean, fit new diaphragm and / or valves (includes H6)	X	X	X
H8	1703	<b>High pressure pipes</b> Remove and replace one	0:15	0:15	0:15
H9	1703	Remove and replace set	1:00	1:00	1:00
H10	-	<b>Bleed fuel system</b>	0:15	0:15	0:15
H11	1707	<b>Atomiser</b> Remove and replace one (includes H8)	1:30	1:30	1:30
H12	1707	Remove, test and replace all (includes H9)	5:00	5:00	5:00
H13	1707	Dismantle and clean one atomiser (includes H11)	X	X	X
H14	1707	Dismantle and clean all atomisers (includes H12)	X	X	X

Op No	Comp Code	Operation Description	Repair times (hr:min) by engine family / type		
			2300	2500	2800
H15	1713	Remove, adjust and replace <b>Relief valve</b>	0:15	0:15	0:15
H16	1717	Change (includes H10) <b>Fuel filter element</b>	0:30	0:30	0:30
H17	1727	Remove and replace <b>Fuel pump stop solenoid</b>	X	X	X
J1	1801 /21	Remove and replace <b>Alternator</b>	0:30	0:30	0:30
J2	1802	Remove and replace <b>Alternator pulley</b>	0:15	0:15	0:15
J3	1805 /34	Remove and replace <b>Compressor</b>	X	X	X
J4	1806	Remove and replace <b>Oil filter</b>	0:30	0:30	0:30
J5	1807	Remove and replace <b>Starter motor</b>	1:00	1:00	1:00
J6	1810	Remove, replace and align (Includes removal and refitting of standard gearbox or driven) <b>Flywheel and flywheel housing</b>	1:30	1:30	1:30
J7	1817	Remove, check and replace <b>Thermostart unit</b>	X	X	X
J8	1818	Remove and replace <b>Power steering pump</b>	X	X	X
J9	1823	Remove and replace <b>Flywheel lipseal (wet back-end)</b>	X	X	X
J10	1826	Remove and replace <b>Turbocharger</b>	2:00	2:00	2:00
J11	1836	Remove and replace (includes removal and refitting of flywheel and standard gearbox) <b>Starter ring</b>	8:00	8:00	8:00
J12	1842	Remove and replace <b>Oil breather</b>	0:15	0:15	0:15
J13	-	Remove and replace <b>Flexible pipes between filter head and oil cooler</b>	X	X	X

Op No	Comp Code	Operation Description	Repair times (hr:min) by engine family / type		
			2300	2500	2800
J14	-	<b>Glow plugs</b> Remove and replace set	X	X	X
J15	-	<b>Starter solenoid</b> Remove and replace	X	X	X
J16	-	<b>Voltage regulator</b> Remove and replace	X	X	X
J17	1867	<b>Air actuator</b> Remove and replace	X	X	X
J18	2031	<b>Wiring harness</b> Remove and replace	1:00	1:00	1:00
K1	1901	<b>Oil cooler</b> Remove and replace	3:00	3:00	3:00
K2	1901	<b>Oil cooler transfer pipes</b> Remove and replace (includes K1)	0:30	0:30	0:30
K3	1906	<b>Fan (normal access)</b> Remove and replace	1:30	1:30	1:30
K4	1907	<b>Fan belt</b> Remove and replace	2:00	2:00	2:00
K5	1916	<b>Thermostart</b> Remove and replace	1:00	1:00	1:00
K6	-	<b>Water outlet connection</b> Remove and replace	0:30	0:30	0:30
K7	1919	<b>Coolant pump</b> Remove and replace	2:30	2:30	2:30
K8	1919	Dismantle, clean, recondition and re-assemble (includes K7)	6:00	6:00	6:00
K9	1919	Fit seal kit (includes K7)	5:00	5:00	5:00
K10	1922	<b>Water pump pulley</b> Remove and replace (Includes K7 except for types B, G and H)	X	X	X
K11	-	<b>Fan drive assembly</b> Remove and replace	X	X	X

Op No	Comp Code	Operation Description	Repair times (hr:min) by engine family / type		
			2300	2500	2800
R1	-	<b>Radiator (normal access)</b> Remove and replace	4:00	4:00	4:00
R2	-	<b>Servex short engine</b> To fit. (Includes engine removal and installation, re-tightening cylinder heads and re-setting valve clearances)	45:00	45:00	45:00

### Section 3

Op No	Comp Code	Operation Description	Repair times (hr:min) by engine family / type			
			4006	4008	4012	4016
A1	-	<b>Major overhaul</b> Completely disassemble, clean and inspect all parts to schedule of wear and renewal limits, rework or renew as necessary, rebuild to the disassembly and assembly manual, test run	122:00	147:00	203:00	229:00
A2	-	<b>Intermediate overhaul</b> Top overhaul. Inspect/de-glaze or change cylinder liners. Inspect piston, replace rings or change complete assembly. Inspect big end journal. Change big end bearings and bolts. Inspect piston cooling jets. Fit service exchange turbochargers, water pumps, unit injectors. Inspect oil pump. Test run	92:00	117:00	163:00	189:00
A3 Sub A		<b>Cylinder head removal / gasket seal replacement</b>	X	X	X	X
1	1704	Remove and refit fuel/oil rail and associated pipe work	0:48	0:55	1:25	1:45
2	1206	Remove and refit inlet manifolds 'T' build engines	0:30	0:40	1:00	1:20
3	1206	Remove and refit inlet manifolds TW, TE and TA build engines	0:40	0:50	1:20	2:00
4	1205	Remove and refit air cooled exhaust manifolds plus water rail	0:49	0:56	1:53	2:28
5	1205	Remove and refit water cooled exhaust manifolds and associated pipe work (sub Section 4 and 5), these operations may require turbocharger removal, refer to Section 'J'	0:56	1:08	2:17	2:43
6	1219	Remove and refit rocker box covers and replace joints	0:30	0:40	1:00	1:20
-	1220	Diesel	X	X	X	X
6a	1250	Remove and refit rocker box covers and replace joints / 'O' rings	0:36	0:48	1:12	1:36
-	1701	Gas	X	X	X	X
7	1250	Remove and refit rockers, bridge pieces and push rods	0:22	0:28	0:45	0:57
8	1701	Remove and refit unit pump injectors (for times refer to Section 'H')	X	X	X	X
9	1831	Remove and refit control rods, fuel rack to brake-back lever	0:34	0:40	1:06	1:22

Op No	Comp Code	Operation Description	Repair times (hr:min) by engine family / type			
			4006	4008	4012	4016
10	1219	<b>Cylinder head removal / gasket seal replacement continued</b> Remove and refit rocker boxes	0:18	0:24	0:36	0:48
11	1203	Remove and refit cylinder heads 'O' rings and flame rings	1:12	1:36	2:24	3:12
12	1203	Remove sandwich plates and 'O' rings, clean plates, replace 'O' rings and refit	N/A	N/A	1:48	2:25
13	-	Clean crankcase top deck face	0:33	0:45	1:07	1:31
14	-	Clean and inspect cylinder head (any rework refer to Section 'C')	0:33	0:43	1:07	1:31
15	1520	Reset bridge piece and recheck valve clearances (setting of bridge and valve clearances will have been carried out during the pump timing procedure. Section 'H')	0:26	0:37	0:55	1:15
A4		<b>Section A Oil consumption rectification</b>	<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>
1	1203	Remove and refit cylinder heads. (refer to Section 'A' 3)	0:12	2:14	<b>X</b>	<b>X</b>
-	-	Remove and refit inspection doors	<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>
2	1853	Remove and refit oil pump, filter head, oil cooler one starter motor and inspection doors 'A' bank	<b>X</b>	<b>X</b>	2:06	2:14
3	1853	Remove and refit filter head, oil cooler, pipe-work and inspection doors 'B' bank	<b>X</b>	<b>X</b>	1:27	1:34
4	2025	Remove and refit raw water pump	0:17	0:17	0:22	0:22
5	1120	Remove piston cooling jets, inspect and refit	0:24	0:32	0:48	1:04
6	1301	Remove pistons and connecting rods, clean and inspect	<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>
-	1308	Replace as necessary, change piston rings	<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>
7	1108	De-glaze liners using flexi-hone and clean all parts	1:18	1:44	1:57	3:19
8	1108	Remove and refit liners	1:44	2:17	3:30	4:35

Op No	Comp Code	Operation Description	Repair times (hr:min) by engine family / type			
			4006	4008	4012	4016
		<b>Section B cylinder block</b>	<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>
1	-	Replace bare block (as major overhaul) (refer to Section 'A' 1)	<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>
2	-	Strip and rebuild onto short block	9:30	11:00	28:30	32:20
3	-	Strip and rebuild onto long block	8:00	9:30	17:20	21:00
A5		<b>Section C Cylinder head</b>	<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>
1	1203	Remove and replace cylinder head (refer to Section 'A' 3)	2:30	3:20	5:00	6:40
-	-	Remove, re-seat and replace or renew and re-seat all valves, re-seat valve seat inserts (all heads)	<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>
2	1213	Replace valve seat inserts (all heads)	1:48	2:24	3:36	4:48
3	1215	Remove and replace valve guides (all heads)	0:54	1:12	1:48	2:24
4	1264	Remove and replace bridge guides (all heads)	1:18	1:44	2:36	3:28
5	-	Remove and refit injector tube or spark plug adaptor (all heads)	1:30	2:00	3:00	4:00
6	-	Pressure test one cylinder head	0:15	0:15	0:15	0:15
7	1202	Replace one core plug	0:04	0:04	0:04	0:04
8	-	Clean one cylinder head	0:20	0:20	0:20	0:20
9	1203	Overhaul one cylinder head complete	2:35	2:35	2:35	2:35
		<b>Section D Piston assembly</b>	<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>
1	1301	Renew connecting rod or piston (all) (Refer to Sections 'A'3 and 'A'4 removal from engine)	0:24	0:32	0:48	1:04

Op No	Comp Code	Operation Description	Repair times (hr:min) by engine family / type			
			4006	4008	4012	4016
		<b>Section E Crankshaft</b>	X	X	X	X
1	1401	Replace crankshaft Refer to appropriate sections for the times to remove components to facilitate removal of crankshaft. Do not attempt to remove the crankshaft with the con rods in place, this will require the removal of the balance weights which is not recommended.	0:50	1:05	1:32	1:37
		<b>Section F Camshaft, gear case and gear train</b>	X	X	X	X
1	1131	Cam follower removal and refitting	0:21	0:26	1:02	1:25
2	1517	Gearcase cover removal and refitting	0:34	0:34	0:39	0:39
3	1505/ 1506	Camshaft gear, thrust plate and camshaft removal and refitting	0:47	0:47	1:11	X
4	1521	Camshaft bearing, removal and refitting (one bearing)	0:20	0:20	0:20	0:20
5	1525	Removal, inspection and replace timing gears (excluding crank gear)	0:19	0:19	0:20	0:20
6	1511	Remove and replace crank gear (including heating)	0:49	0:49	1:14	1:14
		<b>Section G Sump assembly</b>	X	X	X	X
1	1601	Remove and refit	1:10	1:15	1:37	1:45
2	1662	Remove and refit with stiffening plate	X	X	X	2:05
		<b>Section H Fuel system</b>	X	X	X	X
1	1701	Remove and replace unit pump injectors and calibrate	0:42	0:56	1:24	1:52
2	1701	Set unit pump timing/datum pins, bridge and valve clearances	0:57	1:15	1:53	2:34
-	-	Set unit pump timing	X	X	X	X



Op No	Comp Code	Operation Description	Repair times (hr:min) by engine family / type			
			4006	4008	4012	4016
		<b>Section H Fuel system - continued</b>	<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>
3	1702	Remove and replace fuel lift pump	0:12	0:12	0:18	0:18
4	1718	Remove replace lift pump drive dog (oil pump shaft) oil pump removal will be necessary to refer to Section 'J'	0:43	0:43	0:43	0:43
5	-	Replace fuel pressure control valves	0:06	0:06	0:12	0:12
6	-	Vent / bleed fuel system	0:08	0:08	0:13	0:13
7	1831	Replace control rods actuator to fuel racks	<b>X</b>	<b>X</b>	0:33	0:33
8	1867	Replace electronic governor control box	0:18	0:18	0:18	0:18
9	1867	Replace electronic governor actuator	0:35	0:35	0:20	0:20
10	-	Check governor settings using simulator, final adjustments when running	0:15	0:15	0:15	0:15
11	1867	Replace governor support bracket	0:25	0:25	0:30	0:30
12	1727	Change stop solenoids	0:13	0:13	0:27	0:27
		<b>Section J Auxiliary equipment</b>	<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>
1	1803	Remove and replace battery charging alternator and guard	0:17	0:17	0:16	0:16
2	1802	Remove and replace battery charging alternator drive pulley	0:06	0:06	0:06	0:06
3	1826	Remove and replace turbocharger X1	1:15	1:15	<b>X</b>	<b>X</b>
4	1826	Remove and replace turbocharger X2	2:04	2:04	2:32	2:32
5	1826	Remove and replace turbocharger X4	<b>X</b>	<b>X</b>	6:14	6:14
6	2025	Remove and refit raw water pump	1:08	1:08	1:24	1:24
7	1925	Remove and refit air to water intercooler (one)	1:26	1:26	1:26	1:26

Op No	Comp Code	Operation Description	Repair times (hr:min) by engine family / type			
			4006	4008	4012	4016
		<b>Section J Auxiliary equipment - continued</b>	<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>
8	1807	Remove and replace starter motor(s)	0:16	0:16	0:21	0:21
9	1810	Remove and replace flywheel	0:28	0:28	0:32	0:32
10	1836	Remove and replace flywheel ring gear (plus heating)	0:55	0:55	0:55	0:55
11	1825	Remove and replace flywheel housing	0:37	0:37	0:45	0:45
12	1112	Remove and replace rear crankshaft oil seal	0:18	0:18	0:18	0:18
13	1406	Remove and replace TV dampers and crank adaptor	0:42	0:42	0:46	0:46
14	1518	Remove and replace front crankshaft seal	0:18	0:18	0:18	0:18
15	1606	Remove and replace oil pump	0:26	0:26	0:33	0:33
16	1501	Remove and replace oil pump/water pump shaft oil seals, battery alternator drive	0:14	0:14	0:14	0:14
17	1903	Remove and replace breather assembly (closed circuit)	1:21	1:21	3:07	3:07
18	1870	Remove and replace air filter assembly plus pipes to turbo	0:18	0:18	0:18	0:18
19	-	Remove and replace gas pipe work zero pressure regulator to gas mixer	0:37	0:37	0:49	0:49
		<b>Section K Cooling System</b>	<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>
1	1913	Remove and replace oil cooler pipe work (oil and water pipes)	0:56	0:56	2:51	2:51
2	1901	Remove and replace oil cooler (one)	0:21	0:21	0:21	0:21
3	-	Pressure test oil cooler	0:15	0:15	0:15	0:15
4	1919	Remove and replace fresh water pump(s)	0:15	0:15	0:30	0:30
5	1916	Remove and replace thermostat elements (one housing)	0:33	0:33	0:33	0:33