Open front screen

Perkins 400 Series

Models 403C-11, 403C-15, 404C-22 and 404C-22T

WORKSHOP MANUAL

403C-11 Three cylinder naturally aspirated diesel engine

403C-15 Three cylinder naturally aspirated diesel engine

404C-22 Four cylinder naturally aspirated diesel engine

404C-22T Four cylinder turbo charged diesel engine

Perkins Confidential: Green

Publication TPD 1458E, Issue 3.

The information is correct at the time of print.
Published in September 2002 by Technical Publications.

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General information

Introduction

This workshop manual has been written to provide assistance for technicians who service and overhaul the Perkins 403C-11, 403C-15, 404C-22 and the 404C-22T engine. The assumption is made that the engine is removed from the application.

The engine conforms with USA EPA/CARB and EC emissions legislation for agricultural and industrial applications.

Where the information applies only to certain engine types, this is indicated in the text.

Special tools are available and listed in chapter 16. POWERPART recommended consumable products are listed in this chapter. There is a reference to the relevant special tools and consumable products at the beginning of each operation.

Danger is indicated in the text by two methods:

Warning! *This indicates that there is a possible danger to the person.*

Caution: *This indicates that there is a possible danger to the engine.*

Note: Is used where the information is important, but there is not a danger.

Warning! *Read and remember the "Safety precautions". They are given for your protection and must be used at all times.*

Generally, if new joints are to be fitted, it is accepted that the faces for the joint will be cleaned, as this is normal workshop practice. Also, it is understood that during assembly and inspection, all parts are to be thoroughly cleaned and lubricated, and where present, burrs and scale are to be removed.

All open ports of high-precision components e.g. fuel injection equipment must be covered until assembly, to prevent the entry of foreign matter.

When either the "left" or the "right" side of the engine is referred to, it is when viewed from the flywheel end.

When fitting setscrews or studs into holes that enter oil, coolant or air passages, a suitable sealant should be used to prevent leakage.

Micro encapsulated anaerobic sealant (M.E.A.S.) has been applied to the threads instead of jointing compounds or other sealants when the fasteners are fitted in through holes into oil or coolant passages. The identification of these fasteners, as supplied, is by the colour of the sealant.

With M.E.A.S. sealed studs, the sealed end must be fitted into the component. The threaded holes must have a 1,59 mm (0.0625 in) 45° chamfer to ensure that the M.E.A.S. sealant is not removed when the new fasteners are fitted. If the fasteners have to be removed and fitted again, the threads must be cleaned and a suitable sealant used.

Safety precautions

These safety precautions are important. You must refer also to the local regulations in the country of use. Some items only refer to specific applications

- Only use these engines in the type of application for which they have been designed.
- Do not change the specification of the engine.
- Do not smoke when you put fuel in the tank.
- Clean away fuel which has been spilt. Material which has been contaminated by fuel must be moved to a safe place.
- Do not put diesel fuel in the tank during engine operation (unless it is absolutely necessary).
- Do not add lubricating oil, or adjust the engine while it runs (unless you have had the correct training; even then extreme care must be used to prevent injury).
- Do not make adjustments that you do not understand.
- Ensure that the engine does not run in a location where it can cause a concentration of toxic emissions.
- Other persons must be kept at a safe distance while the engine or auxiliary equipment is in operation.
- Do not permit loose clothing or long hair near moving parts.
- Keep away from moving parts during engine operation. ***Warning!*** Some moving parts cannot be seen clearly while the engine runs.
- Do not operate the engine if a safety guard has been removed.
- Do not remove the filler cap or any component of the cooling system while the engine is hot and while the coolant is under pressure, because dangerous hot coolant can be discharged.
- Do not allow sparks or fire near the batteries (especially when the batteries are on charge) because the gases from the electrolyte are highly flammable. The battery fluid is dangerous to the skin and especially to the eyes.
- Disconnect the battery terminals before a repair is made to the electrical system.
- Only one person must control the engine.
- Ensure that the engine is operated only from the control panel or from the operators position.
- If your skin comes into contact with high-pressure fuel, obtain medical assistance immediately.
- Diesel fuel and lubricating oil (especially used lubricating oil) can damage the skin of certain persons. Protect your hands with gloves or a special solution to protect the skin.
- Do not wear clothing which is contaminated by lubricating oil. Do not put material which is contaminated with oil into the pockets of clothing.
- Discard used lubricating oil in accordance with local regulations to prevent contamination.
- Ensure that the control lever of the transmission drive is in the "out-of-drive" position before the engine is started.
- Use extreme care if emergency repairs must be made in adverse conditions.
- The combustible material of some components of the engine (for example certain seals) can become extremely dangerous if it is burned. Never allow this burnt material to come into contact with the skin or with the eyes.
- Always use a safety cage to protect the operator when a component is to be pressure tested in a container of water. Fit safety wires to secure the plugs which seal the hose connections of a component which is to be pressure tested.
- Do not allow compressed air to contact your skin. If compressed air enters your skin, obtain medical help immediately.
- Turbochargers operate at high speed and at high temperatures. Keep fingers, tools and debris away from the inlet and outlet ports of the turbocharger and prevent contact with hot surfaces.
- Do not clean an engine while it runs or while it is hot. If cold cleaning fluids are applied to a hot engine, certain components on the engine could be damaged.
- Fit only genuine Perkins parts.

Viton seals

Warnings!

- *Some seals used in engines and in components fitted to engines are made of Viton. Viton is used by many manufactures and is a safe material under normal conditions of operation. If Viton is burned, a product of this burnt material is an acid which is extremely dangerous. Never allow this burnt material to come into contact with the skin or with the eyes. If it is necessary to come into contact with components which have been burnt, ensure that the precautions which follow are used:*
- *Ensure that the components have cooled.*
- *Use Neoprene gloves and discard the gloves safely after use.*
- *Wash the area with calcium hydroxide solution and then with clean water.*
- *Disposal of components and gloves which are contaminated must be in accordance with local regulations.*

If there is contamination of the skin or eyes, wash the affected area with a continuous supply of clean water or with calcium hydroxide solution for 15 - 60 minutes. **Obtain immediate medical attention**.

Safety cautions when an engine is cleaned

Care should be taken, when an engine is cleaned with a high pressure cleaning system.

***Cautions*:**

- *Do not wash an engine while it runs or while it is hot. If cold cleaning fluids are applied to a hot engine, certain components on the engine could be damaged.*
- *Leave the engine to cool for at least one hour and disconnect the battery connections before cleaning.*
- *Do not wash any part of the fuel injection pump (FIP), cold start device, electrical shut off solenoid (ESOS) or electrical connectors.*
- *Ensure that the alternator, starter motor and any other electrical components are shielded and not directly cleaned by the high pressure cleaning system.*

If these cautions are ignored, the engine or certain components could be damaged, fail to operate and also make the manufacturer’s warranty invalid.

POWERPART recommended consumable products

Perkins have made available the products recommended below in order to assist in the correct operation, service and maintenance of your engine and your machine. The instructions for the use of each product are given on the outside of each container. These products are available from your Perkins distributor.

POWERPART Antifreeze

Protects the cooling system against frost and corrosion.

Part number 21825166.

POWERPART Easy Flush

Cleans the cooling system.

Part number 21825001.

POWERPART Gasket and flange sealant

To seal flat faces of components where no joint is used. Especially suitable for aluminium components.

Part number 21820518.

POWERPART Gasket remover

An aerosol for the removal of sealants and adhesives.

Part number 21820116.

POWERPART Griptite

To improve the grip of worn tools and fasteners.

Part number 21820129.

POWERPART Hydraulic threadseal

To retain and seal pipe connections with fine threads. Especially suitable for hydraulic and pneumatic systems.
Part number 21820121.

POWERPART Industrial grade super glue

Instant adhesive designed for metals, plastics and rubbers.

Part number 21820125.

POWERPART Lay-Up 1

A diesel fuel additive for protection against corrosion.

Part number 1772204.

POWERPART Lay-Up 2

Protects the inside of the engine and of other closed systems.

Part number 1762811.

POWERPART Lay-Up 3

Protects outside metal parts.

Part number 1734115.

POWERPART Metal repair putty

Designed for external repair of metal and plastic.

Part number 21820126.

POWERPART Pipe sealant and sealant primer

To retain and seal pipe connections with coarse threads. Pressure systems can be used immediately.

Part number 21820122.

POWERPART Radiator stop leak

For the repair of radiator leaks.

Part number 21820127.

POWERPART Retainer (high strength)

To retain components which have an interference fit. Currently Loctite 638.

Part number 21820638.

POWERPART Safety cleaner

General cleaner in an aerosol container.

Part number 21820128.

POWERPART Silicone adhesive

An RTV silicone adhesive for application where low pressure tests occur before the adhesive sets. Used for sealing flange where oil resistance is needed and movement of the joint occurs.

Part number 21826038.

POWERPART Silicone RTV sealing and jointing compound

Silicone rubber sealant which prevents leakage through gaps. Currently Hylosil.

Part number 1861108.

POWERPART Stud and bearing lock

To provide a heavy duty seal to components that have a light interference fit.

Part number 21820119 or 21820120.

POWERPART Threadlock and nutlock

To retain small fasteners where easy removal is necessary.

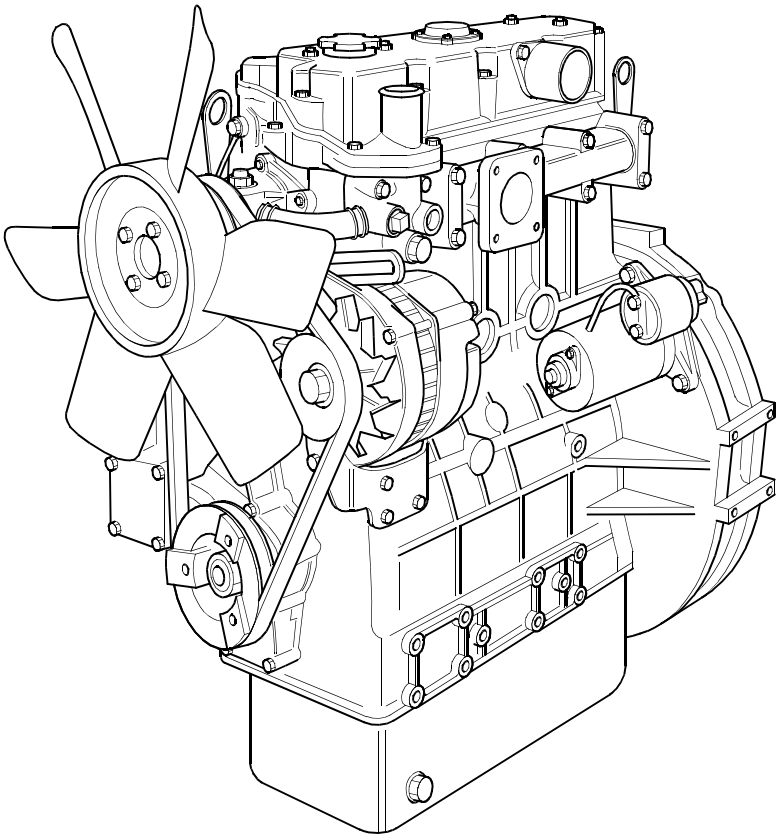
Part number 21820117 or 21820118.

POWERPART Universal jointing compound

Universal jointing compound which seals joints. Currently Hylomar.

Part number 1861117.

Engine views



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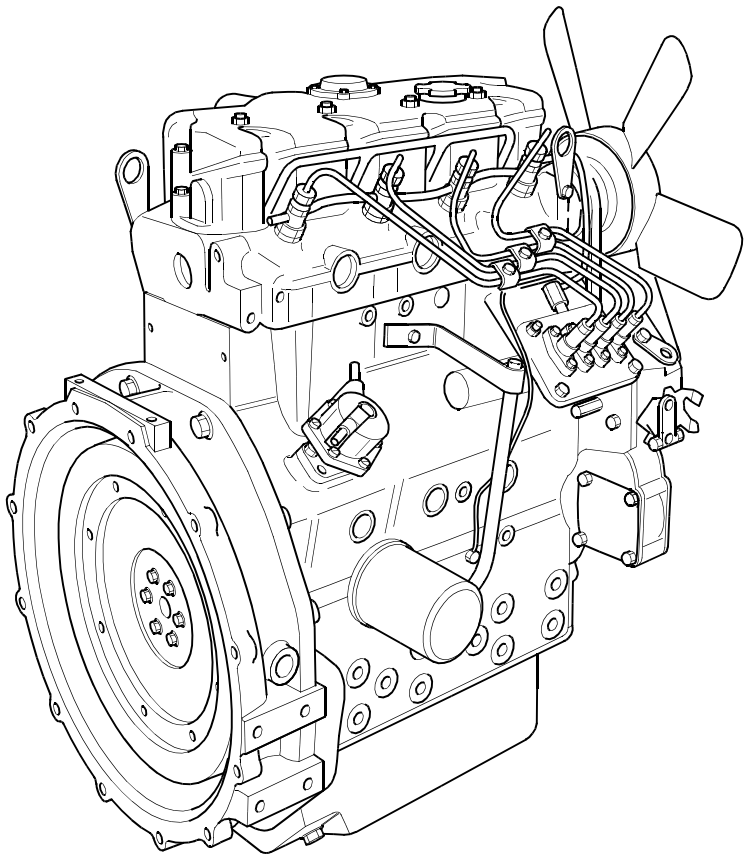

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Engine identification

Engine build lists numbering system

The standard engine build list numbering code is defined as follows:

Code	I	II	III	IV	V
Example	HP	TBA	U	000001	D

Code I Engine build code

Code	HH	HL	HP	HR
Engine	403C-11	403C-15	404C-22	404C-22T

Code II engine build list

The build list increases numerically for both OEMS and distributors.

Code III country of manufacture

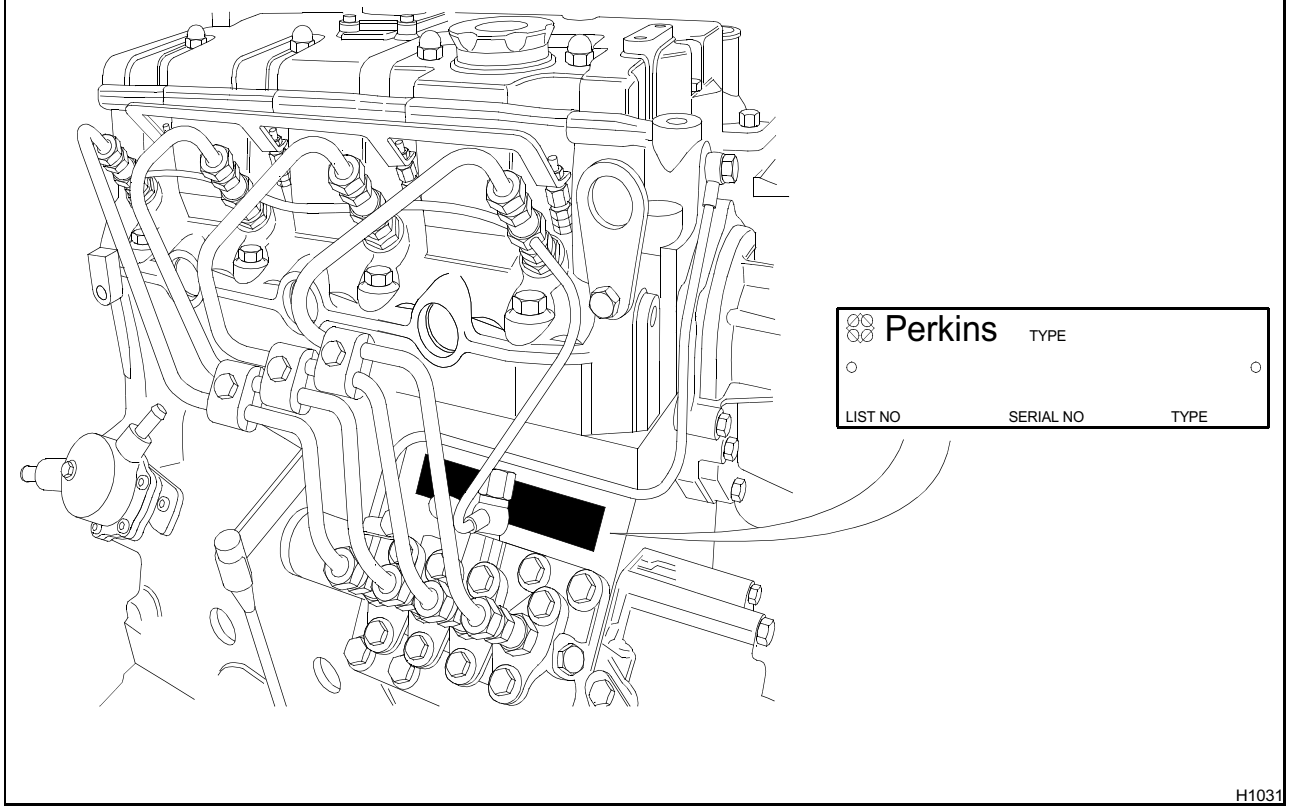
Code	J	U
Country of manufacture	Made in Japan	Made in U.K.

Code IV engine serial number

Individual serial number commencing with 000001 increasing numerically.

Code V year of manufacture

Code	H	J
Year	2001	2002



Engine lift equipment

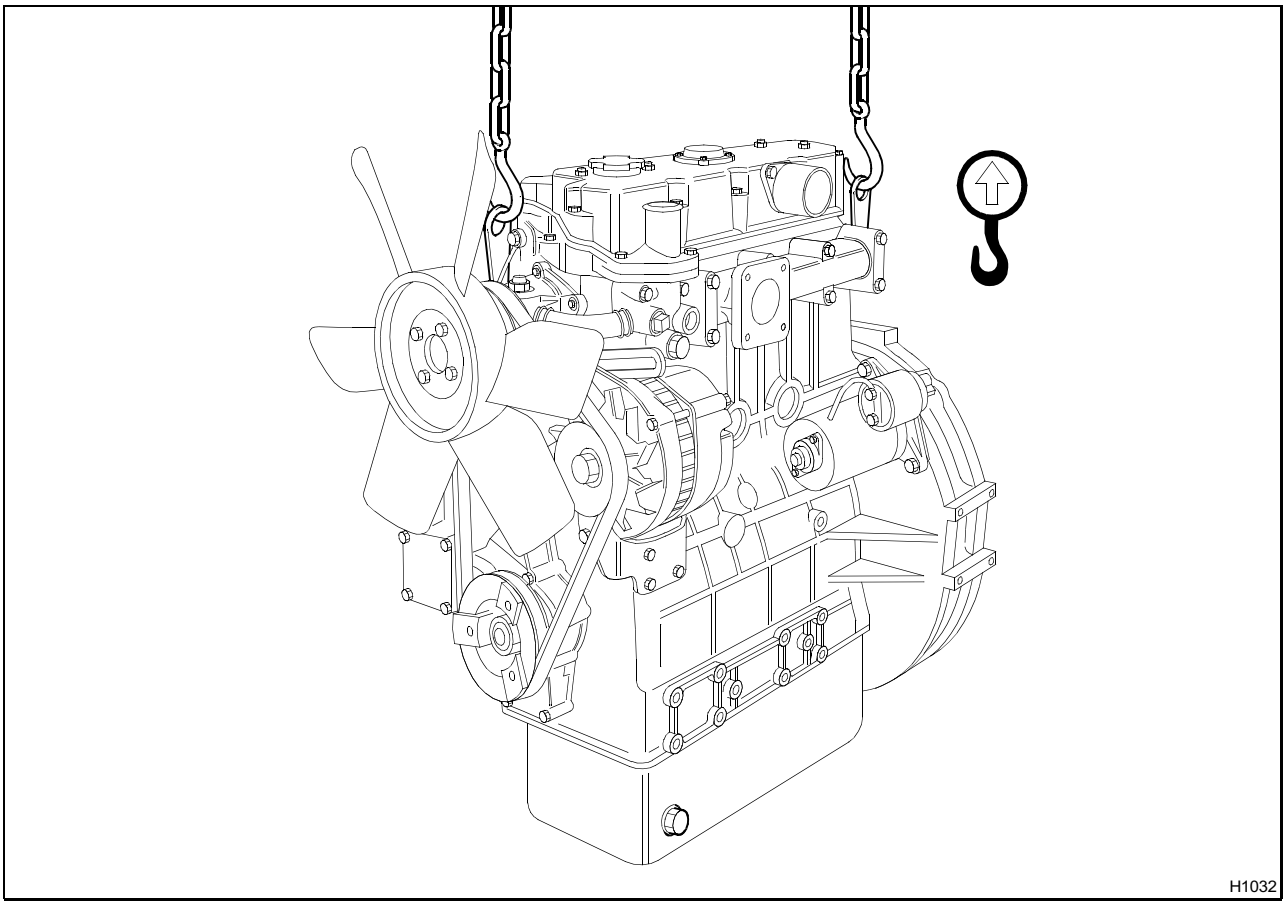
Recommended torque: lifting eye bolts

Engine	Nm (lbf ft) kgf m
All models	26 (19) 2,6

Maximum engine weights

Engine	Engine specification	Maximum engine weights (dry) (1)
403C-11	Long flywheel housing specification	114 kg
	Short flywheel housing specification	96 kg
	Backplate specification	87 kg
403C-15	Long flywheel housing specification	176 kg
	Short flywheel housing specification	154 kg
	Backplate specification	150 kg
404C-22	Long flywheel housing specification	220 kg
	Short flywheel housing specification	196 kg
	Backplate specification	184 kg
404C-22T	Long flywheel housing specification	230 kg
	Short flywheel housing specification	206 kg
	Backplate specification	194 kg

(1) Engine may alter with final specification.



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Specifications

Basic engine data

Engine model	403C-11	403C-15	404C-22	404C-22T
Engine build code	HH	HL	HP	HR
Number of cylinders	3	3	4	4
Cylinder arrangement	Vertical in line			
Cycle	Four stroke			
Direction of rotation	Clockwise from the front			
Induction system	Naturally aspirated			Turbo charged
Combustion system	Indirect injection			
Nominal bore	77 mm (3.03 in)	84 mm (3.3 in)		
Stroke	81 mm (3.19 in)	90 mm (3.5 in)	100 mm (3.9 in)	
Compression ratio	23: 1	22.5: 1	23.3: 1	
Cubic capacity	1,131 litres (69 in³)	1,496 litres (91 in³)	2,216 litres (135.2 in³)	
Firing order	1, 2, 3	1, 2, 3	1, 3, 4, 2	
Valve tip clearance (cold)				
Inlet	0,2 mm (0.0078 in)			
Exhaust	0,2 mm (0.0078 in)			
Governor	Mechanical all speed			
Fuel injection	Cassette type fuel injection pump			
Electrical system	12 Volt			
Lubricating oil pressure relief valve	304 - 500 kPa	262 - 359 kPa	352 - 448 kPa	
Lubricating oil pressure switch located on top cover	49,0 kPa	29,4 kPa		
Lubricating oil pressure switch located on cylinder block oil rail	49,0 kPa	98,0 kPa		

Standard torques

Most of the torque tensions on the engine are standard. Special torque tensions are listed in the separate specific torque tables. The standard torque tensions listed in the tables below can be used when a specific torque is not necessary.

The torque tensions below apply to components lubricated lightly with clean engine oil before they are fitted.

Standard torques for setscrews and nuts

Thread size	Strength	Coarse thread				Fine thread			
		Pitch mm	Torque Nm	Torque lbf ft	Torque kgf m	Pitch mm	Torque Nm	Torque lbf ft	Torque kgf m
M 4	8.8 11T	0,7	3 4	2 3	0,3 0,4	-	-	-	-
M5	8.8 11T	0,8	6 8	4 6	0,6 0,8	-	-	-	-
M6	8.8 11T	1,0	10 14	7 10	1,0 1,4	-	-	-	-
M8	8.8 11T	1,25	26 32	19 24	2,7 3,3	1,0	30 35	22 26	3,0 3,6
M10	8.8 11T	1,5	50 62	37 46	5,1 6,3	1,25	56 66	41 49	5,7 6,7
M12	8.8 11T	1,75	75 104	55 77	7,6 10,6	1,25	84 113	62 83	8,6 11,5
M14	8.8 11T	2,0	118 157	87 116	12,0 16,0	1,5	132 167	97 123	13,5 17,0
M16	8.8 11T	2,0	167 230	123 170	17,0 23,4	1,5	175 245	129 181	17,8 25,0

Bolt strength	Examples of applicable material
8.8 11T	S45C SCM435

Special torques

	Torque Nm (lbf ft) kgf m
Angleich	5 (3.6) 0,5
Atomiser	64 (47.2) 6,4
Atomiser pipes	23 (16.9) 2,3
Blanking plug rear of cylinder block	7 (5.1) 0,7
Crankshaft carrier to block	27 (19.9) 2,7
Connecting rod nuts	52 (38.3) 5,2
Crankshaft nut	303 (223.5) 30,3
Crankshaft sub assembly	52 (38.3) 5,2
Exhaust manifold	25 (18.4) 2,5
Flywheel	74 (54.5) 7,4
Fuel injection pump	15 (11) 1,5
Fuel injection pump leak off rail	7 (5.1) 0,7
Glow plug	18 (13.2) 1,8
Head setscrew	101 (74.5) 10,3
Leak off rail	27 (19.9) 2,7
Lift pump banjo	12 (8.8) 1,2
Lift pump mounting setscrew	6 (4.4) 0,6
Oil pipe	12 (8.8) 1,2
Oil strainer	10 (7.3) 1,0
Relief valve	64 (47.2) 6,4
Timing case	10 (7.3) 1,0
Rocker assembly nuts	33 (24.3) 3,3
Rocker cover	14 (10.3) 1,4
Electrical shut off solenoid	18 (13.2) 1,8
Sump drain plug	35 (25.8) 3,5
Temperature switch	27 (19.9) 2,7
Thermostat setscrew	14 (10.3) 1,4

Compression test data

Many factors affect compression pressures, the battery, starter motor condition, ambient conditions and the type of gauge used can give a wide variation of results for a given engine.

Standard value	To be repaired
>2940 kPa (426.6 lbf / in²) @ 250 rpm	<2450 kPa (355.5 lbf / in²) @ 250 rpm

Compression tests should only be used to compare between cylinders of an engine. If one or more cylinders vary by more than 350 kPa (50 lbf / in²) then those cylinders may be faulty.

Compression tests should not be the only method used to show the condition of an engine, but they should be used together with other symptoms and tests.

How to do a compression test

Note: Before the compression test, ensure that the battery is in good condition and fully charged. Also ensure the starter motor is in good condition.

1 Ensure that the valve tip clearances are set correctly.

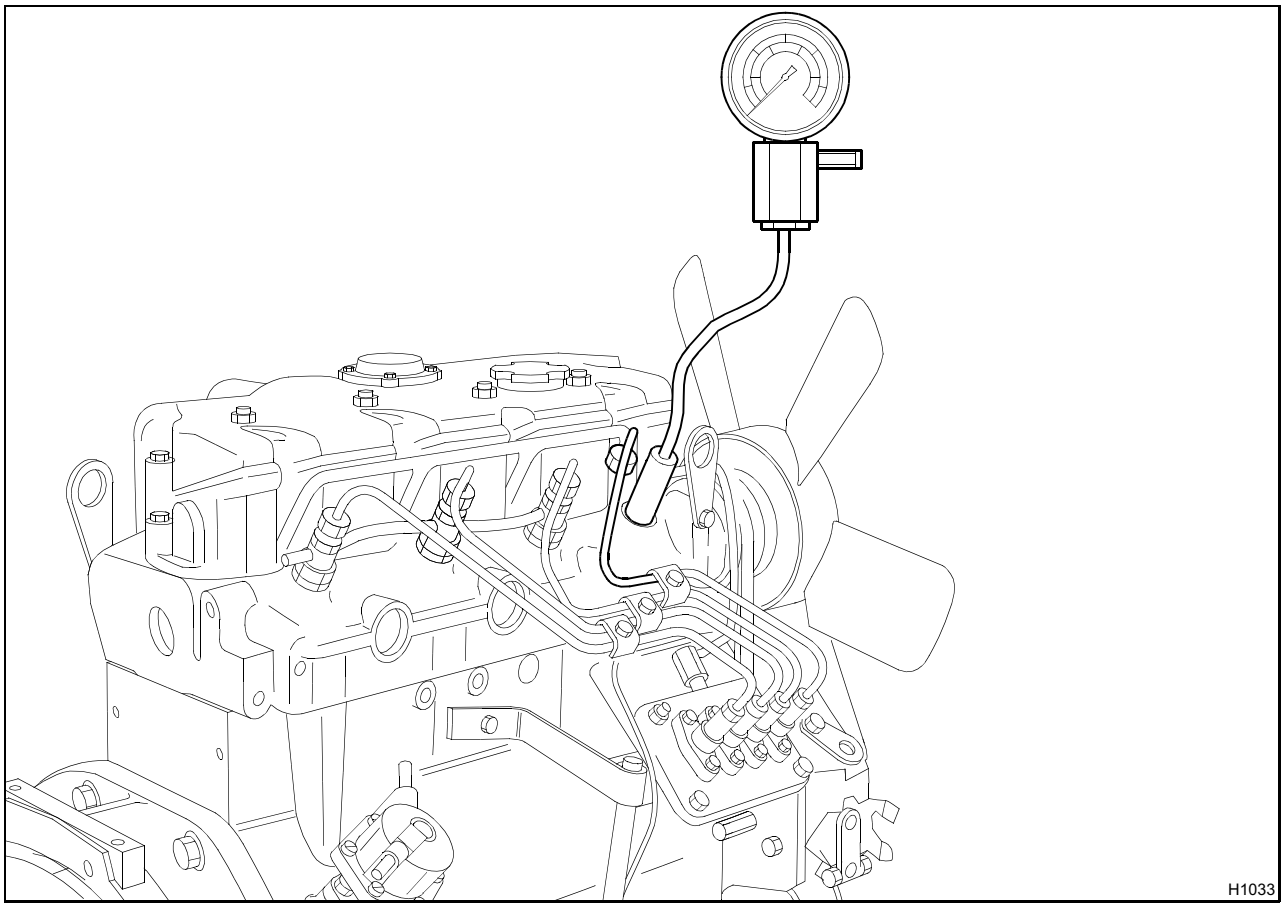
2 Remove the atomisers, see Operation 11-1.

3 Fit a suitable gauge into the atomiser hole of the cylinder to be tested.

4 Disconnect the stop solenoid or put the stop solenoid in the no fuel position. Operate the starter motor and record the pressure indicated on the gauge.

Caution: *Do not remove the stop solenoid as this will allow the engine to start.*

5 Repeat for each cylinder.



3

Cylinder head assembly

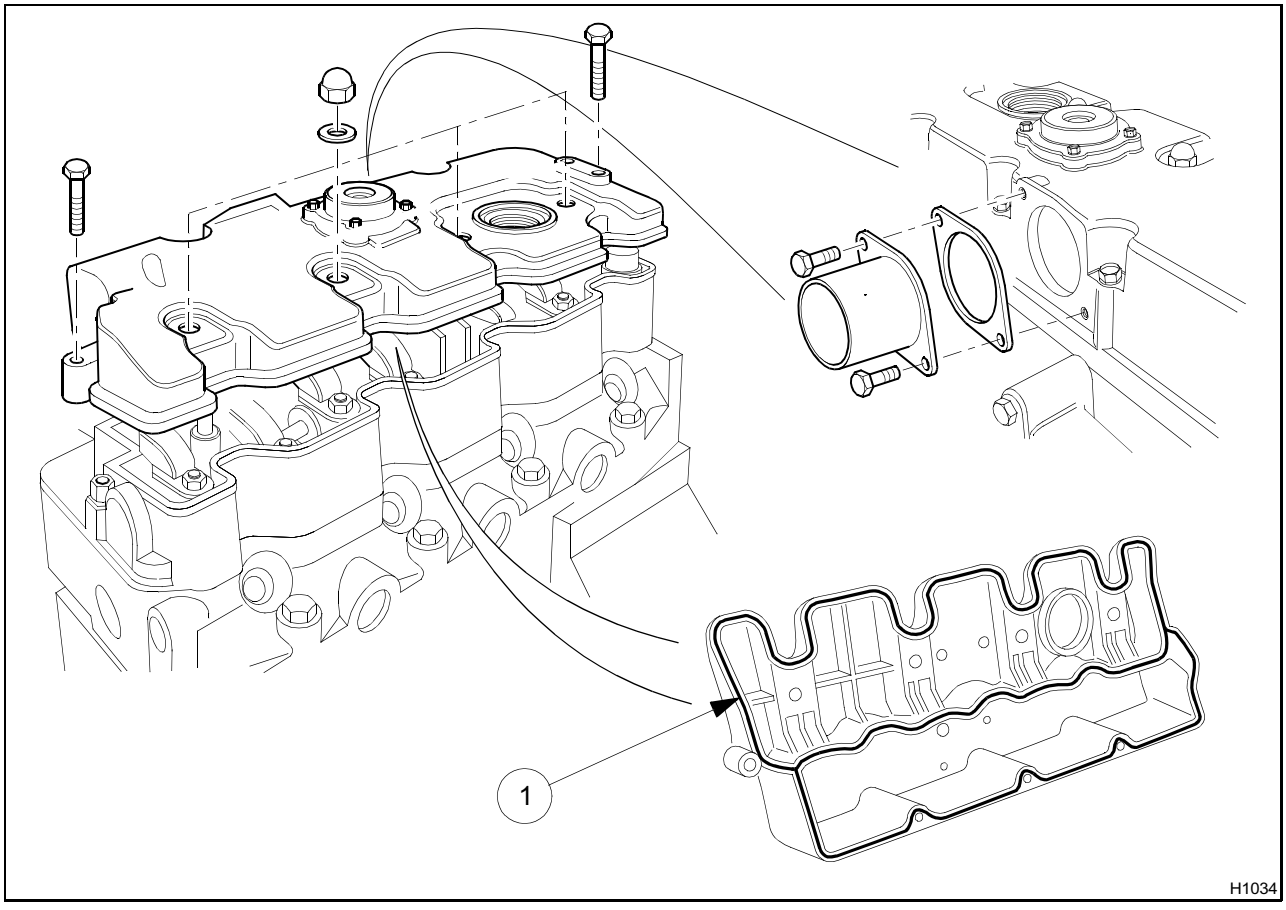
Rocker cover and inlet manifold

To remove and to fit **Operation 3-1**

Engine	Torque Nm (lbf ft) kgf m	
403C-11	Cap nut	11 (8.1) 1,1
	Setscrew	11 (8.1) 1,1
403C-15 404C-22 404C-22T	Cap nut	14 (10.3) 1,4
	Setscrew	14 (10.3) 1,4

Notes:

- An ‘O’ ring (1) is fitted in the groove in the rocker cover.
- Inspect the ‘O’ ring and renew if necessary.



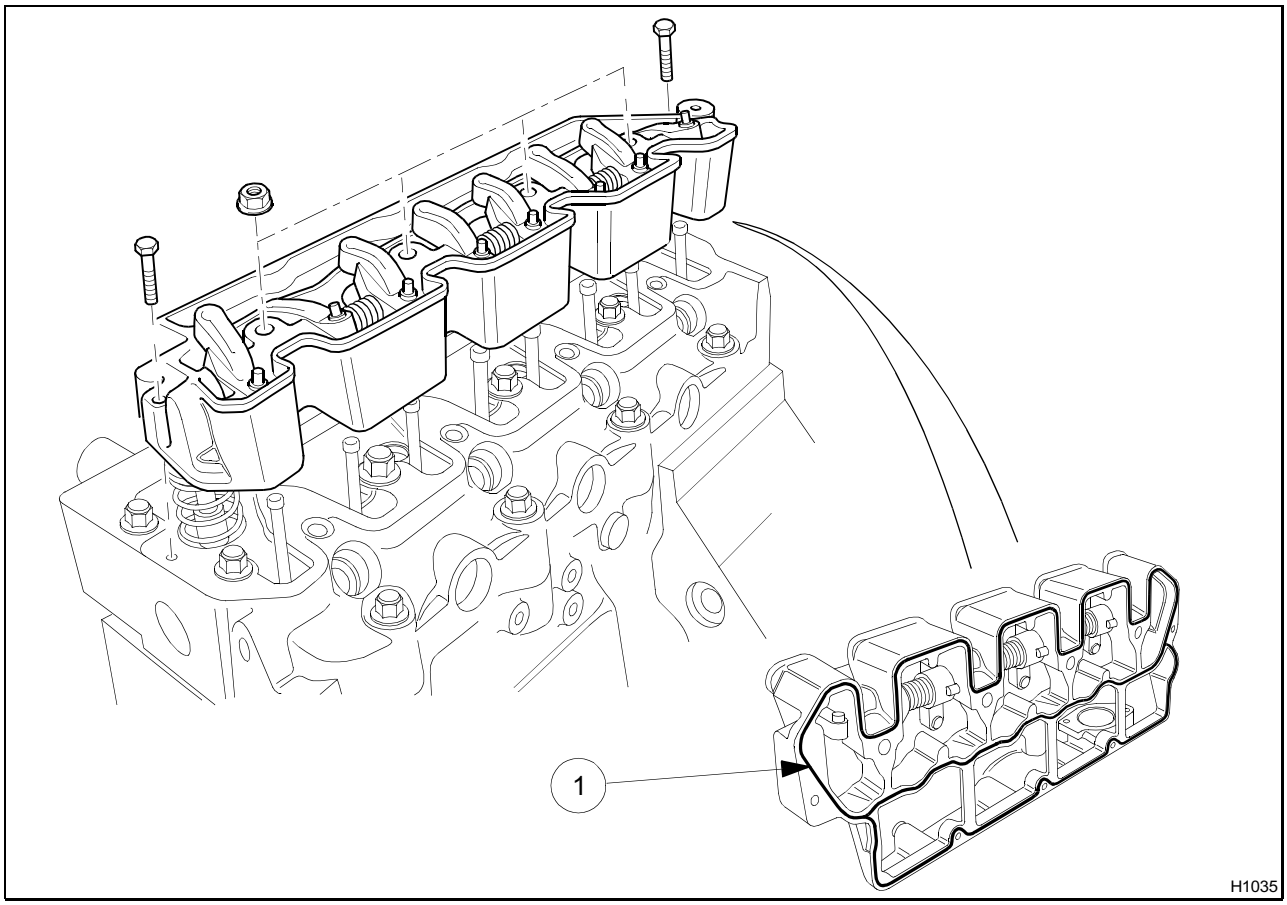
Rocker assembly

To remove and to fit **Operation 3-2**

Engine	Torque Nm (lbf ft) kgf m	
403C-11	Rocker assembly nuts	23 (17.0) 2,3
403C-15 404C-22 404C-22T	Rocker assembly nuts	33 (24.3) 3,3

Caution: *Ensure that the valve stem caps are on the valve stems and the pushrods are located in the rockers after assembly.*

Note: An ‘O’ ring (1) is fitted in the groove in the rocker assembly.

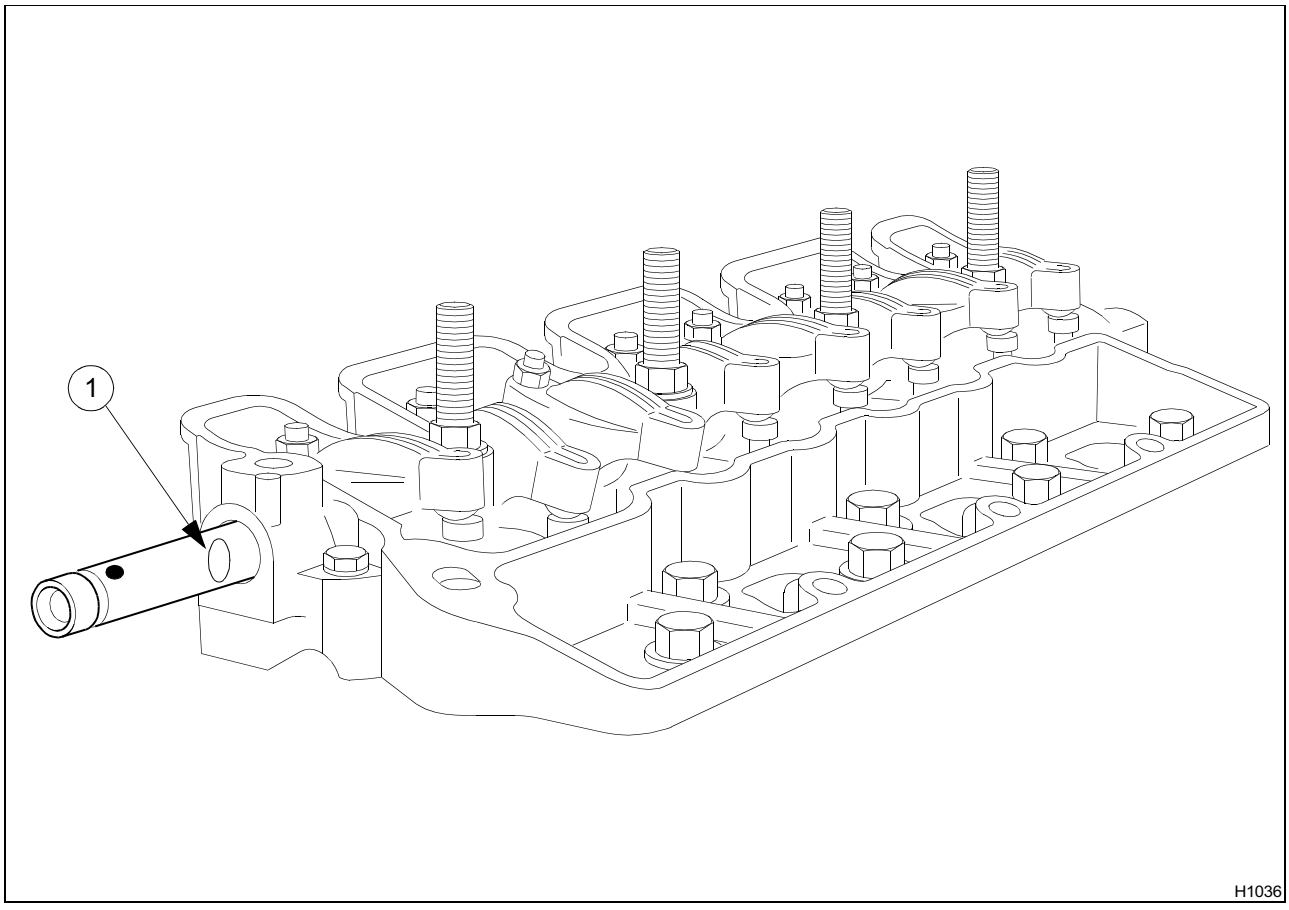


To dismantle and to assemble **Operation 3-3**

Engine	Torque Nm (lbf ft) kgf m	
All models	Tappet adjustment nut	14 (10.3) 1,4

Use a suitable puller to extract the rocker shaft.

Note: Remember the position of the recess (1) for assembly.



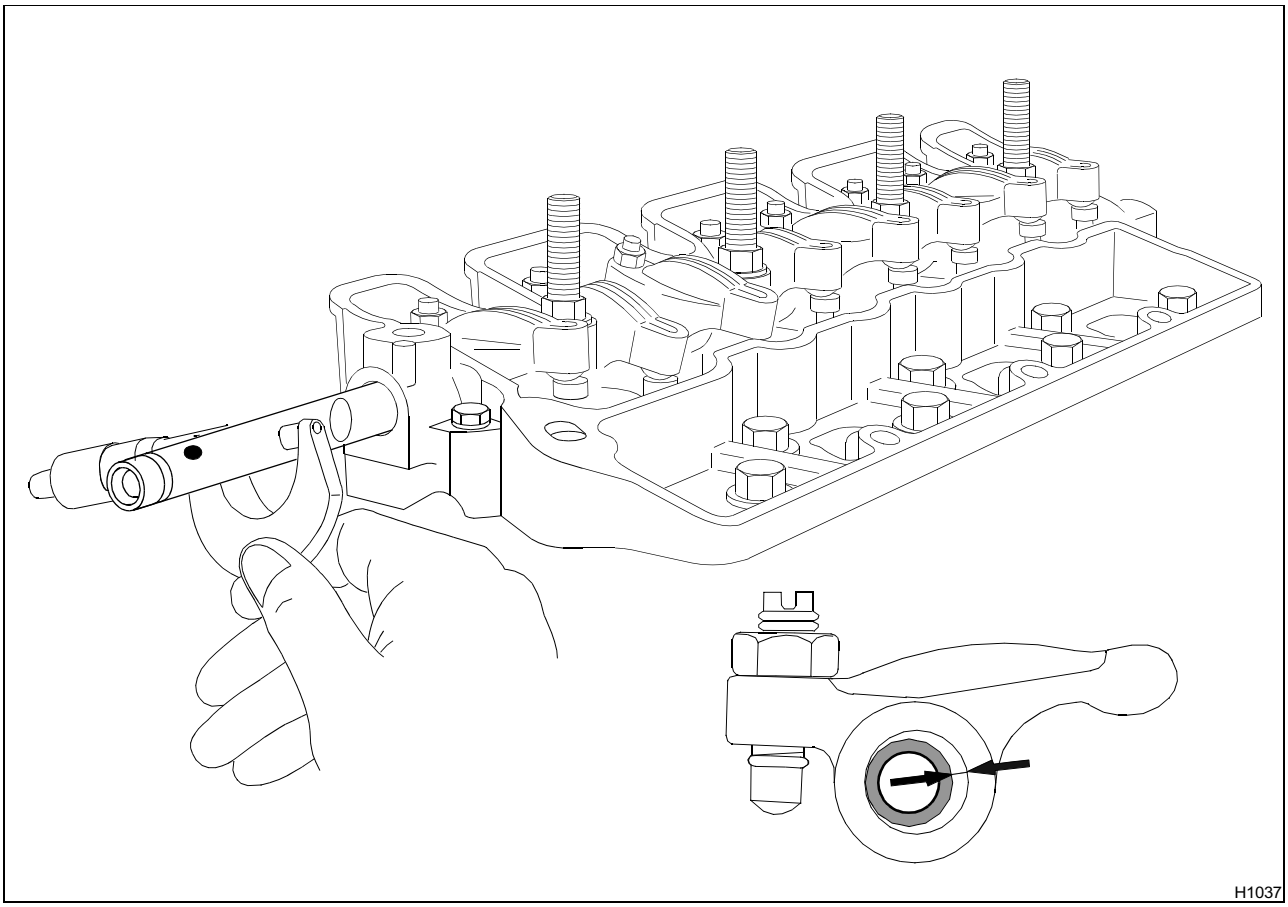
To inspect **Operation 3-4**

Rockershaft diameter

Engine	Diameter mm (in)	
	Standard	Service limit
403C-11 403C-15	11,65 - 11,67 (0.4587 - 0.4595)	11,57 (0.4555)
404C-22 404C-22T	14,95 - 14,97 (0.5886 - 0.5894)	14,87 (0.5854)

Rocker shaft to rocker lever clearance

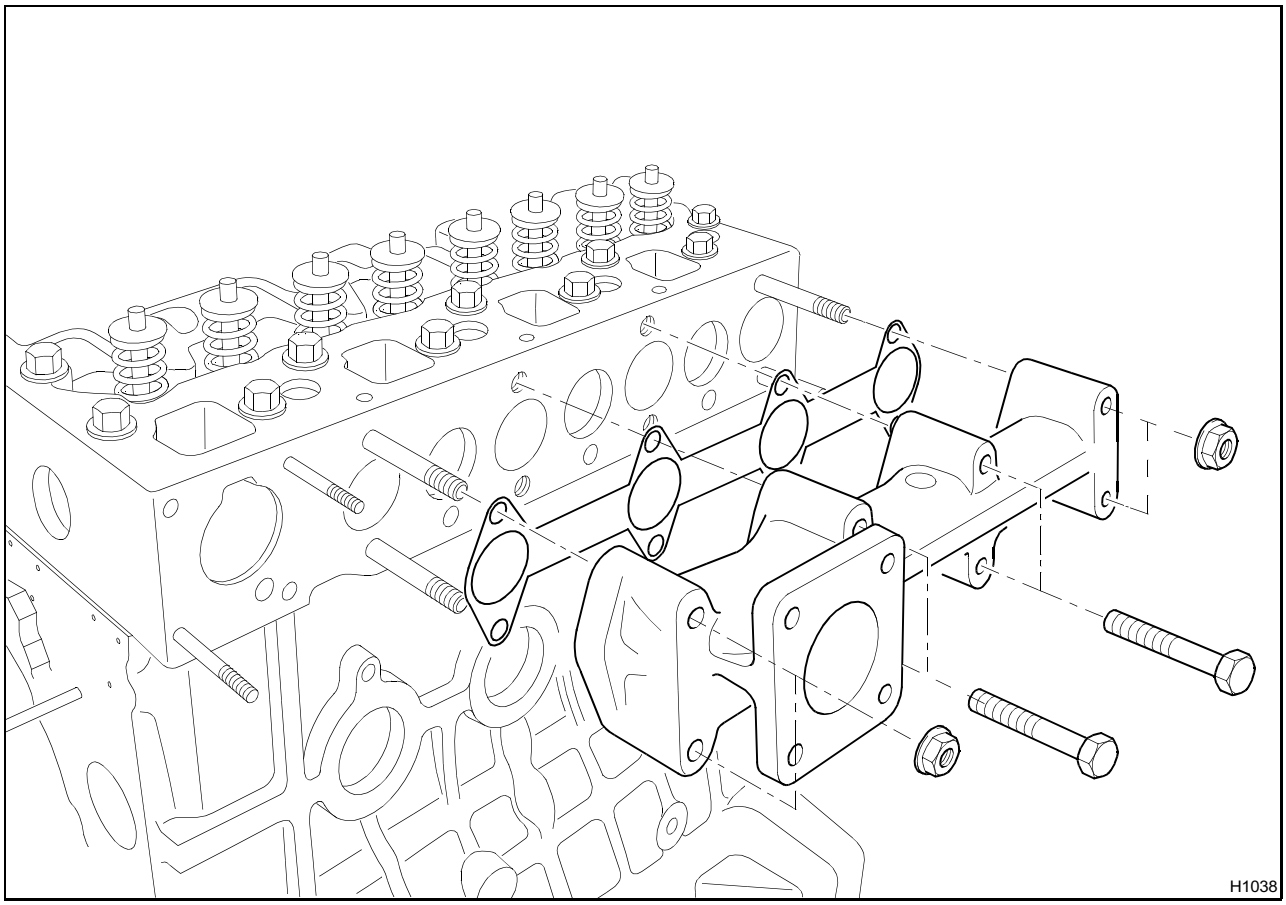
Engine	Clearance mm (in)	
	Standard	Service limit
403C-11 403C-15	0,032 - 0,068 (0.00126 - 0.00268)	0,2 (0.008)
404C-22 404C-22T	0,030 - 0,093 (0.00120 - 0.00366)	0,2 (0.008)



Exhaust manifold and gasket

To remove and to fit **Operation 3-5**

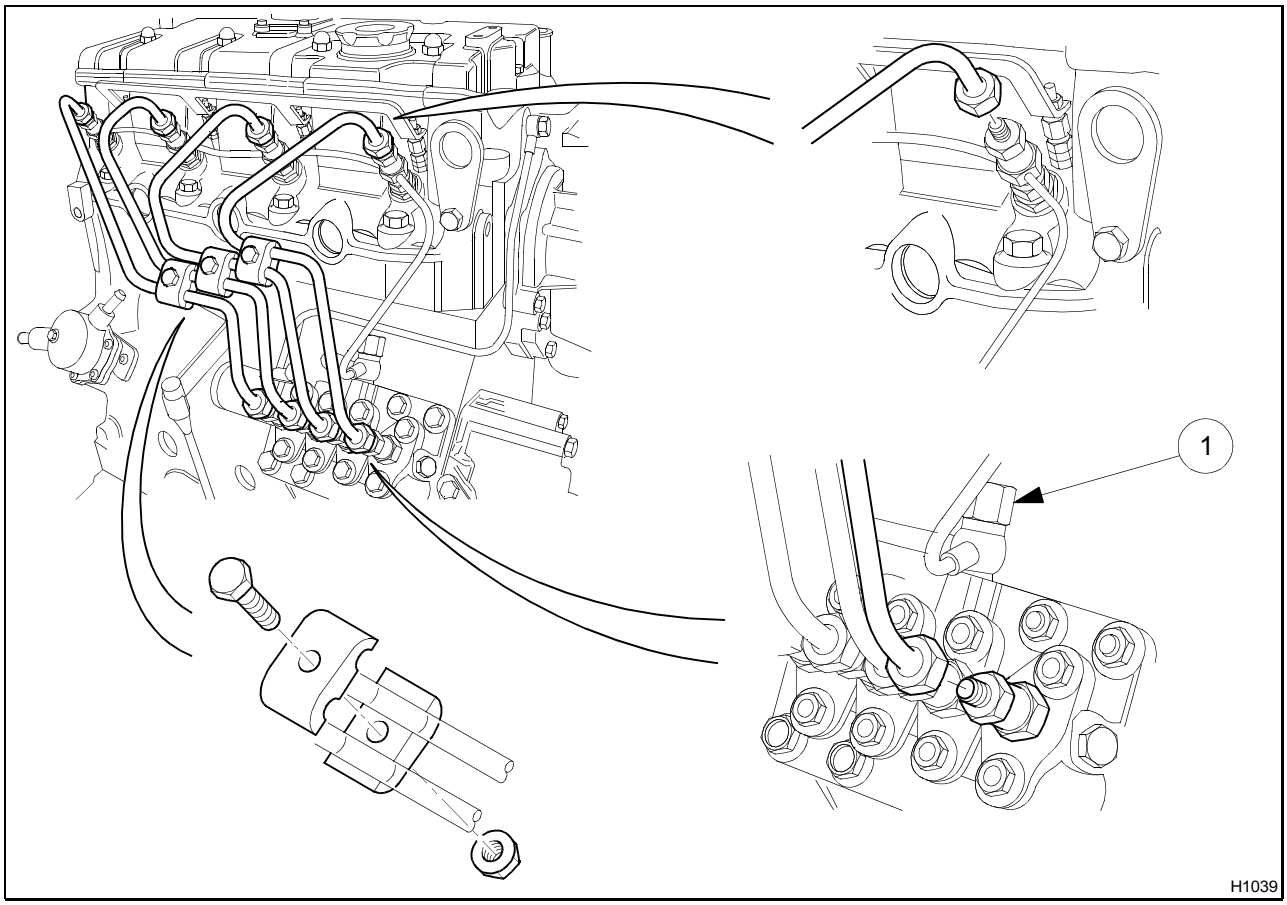
Engine	Torque Nm (lbf ft) kgf m	
403C-11	Setscrew	9,8 (7.2) 0,9
	Nuts	9,8 (7.2) 0,9
403C-15 404C-22 404C-22T	Setscrew	25 (18.4) 2,5
	Nuts	25 (18.4) 2,5



Fuel injection pipes / fuel return pipes

To remove and to fit **Operation 3-6**

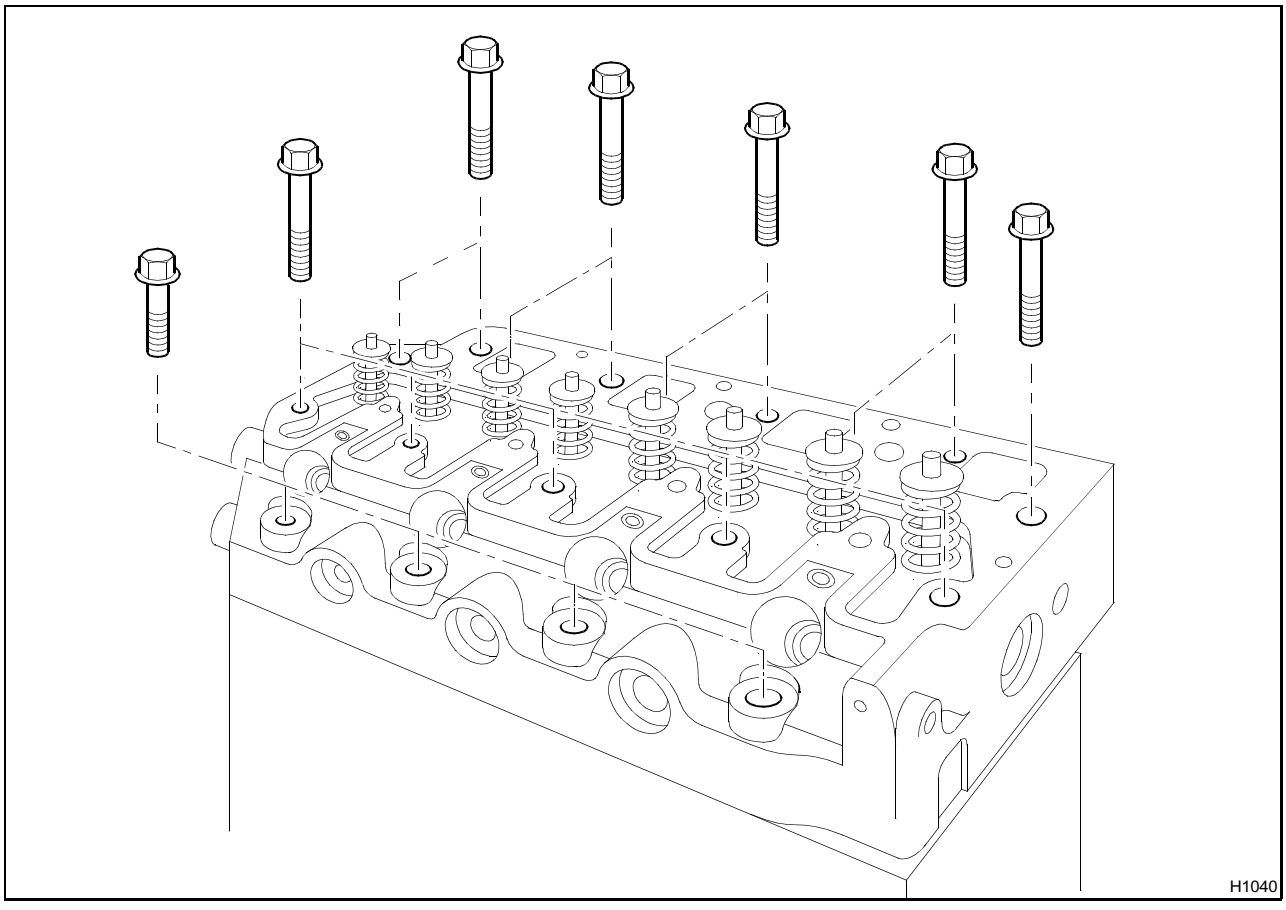
Engine	Torque Nm (lbf ft) kgf m	
All models	Fuel injection pipe	23 (16.9) 2,3
	Banjo bolt (1)	2,5 (3.2) 0,25



Cylinder head setscrews

To remove and to fit **Operation 3-7**

Note: If it is necessary to replace the cylinder head the fuel adjustment screw must not be altered from the original setting. The maximum no load speed must be checked after assembly.



Tightening sequence 403C-11 and 403C-15 **Operation 3-8**

Engine	Torque Nm (lbf ft) kgf m	
403C-11	Cylinder head setscrews	51 (37.6) 5,2
403C-15	Cylinder head setscrews	101 (74.5) 10,3

Notes:

- All torques should be checked again after tightening.
- On assembly lubricate cylinder head setscrews with clean oil.