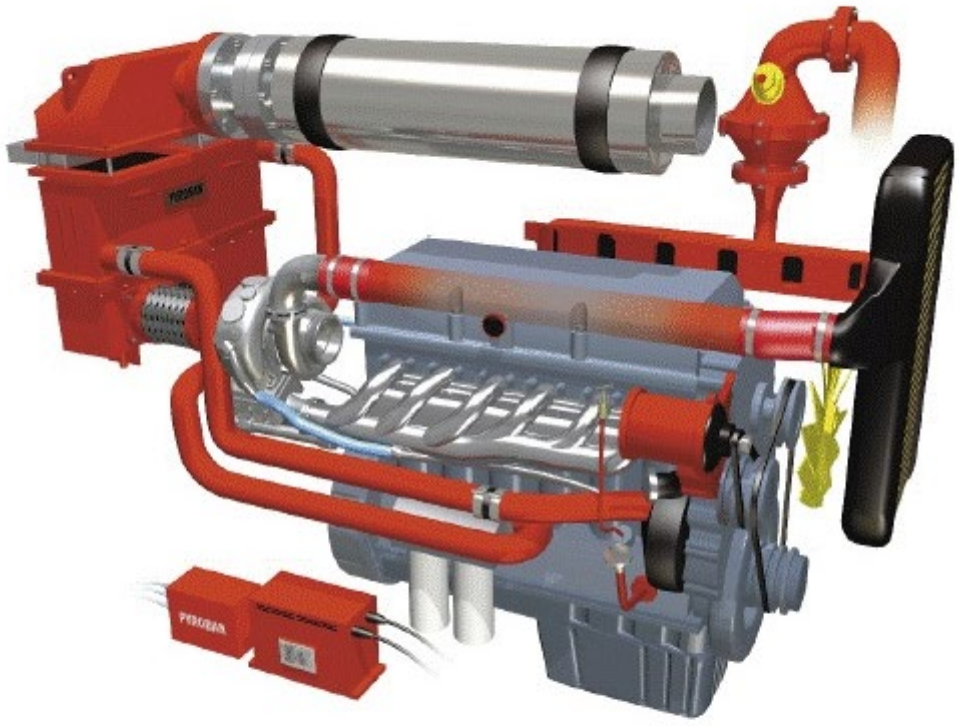
PYROBAN®

EXHAUST SYSTEM

OFFSHORE (KITS AND COMPONENTS) INSTALLATION MANUAL



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REVISION HISTORY

ISSUE	DATE	NATURE OF CHANGE
A	19 October 2008	First Issue
B	10 July 2009	General Update
C	10 August 2010	New flame arrester variant added to table
4	23 October 2013	Section added regarding the application of copper based grease to the flame arrester to cooler/outlet box interfaces. Document issue character changed from C to 4.
5	03 January 2014	Added note regarding potential condensation appearing at the exhaust outlet and on the exhaust side. Added table of contents
6	1 April 2014	Added information on coolant bonnets, pneumatic control schematics, constant tension clamps, updated copyright dates and added figure titles.
7	4 August 2014	Added information on coolant bonnet for C32, Tee piece for 3508 and 3516 and Air shut-off valve for C15.
8	12 December 2015	Addition of back pressure port usage
9	4th April 2016	Modified front sheet layout. Added new 'Warning' graphic. Reworded text in sections 2,3,4,6,7,8,10,37,38,40 Deleted duplicate section 30 – Cooling system. Added table of Pyroban products with references to data sheets Added condensation drain breather flame arrester installation. Added section on the Maintenance of Flameproof Joint Added section on Exhaust T-pieces. Added generic pneumatic schematic. Added text on new standard cooler top flange. Added text regarding inlet air shut off valves on twin manifold engines.
10	23rd May 2016	Amended text regarding inlet air shut off valves on twin manifold engines.
11	26th November 2018	§21 - Updated ATEX directive reference. §'WASTE & DISPOSAL' - COSHH regulation ref. updated §3.1 & 12.5 - Reference to 3GP removed and replaced with a generic description. §1.1 – Added - Air intake & exhaust component conditions of use §46 - Removed whole section §49 - Added ExSCS to table of manuals
12	10th January 2022	Added Section 47 'Option of Ever Clear exhaust flame traps'
13	17th December 2022	Ever Clear arrester information added to section 47
14	22nd March 2023	Ever Clear Arrester Information re-written and added as section 9 (replacing previous section 47)
15	02nd January 2024	'Turbogard' was replaced with 'turboguard' section 24

This manual must be read in association with the original manufacturer's instructions.
If in any doubt, operators must contact the Person in Authority for guidance.

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GENERAL

Only suitably trained and competent personnel may carry out installations, maintenance, or repair work on Pyroban equipment.

The component parts supplied must be installed correctly and the complete installation approved by the Person in Authority before the equipment is used in a hazardous area.

The units are suitable for use in hazardous areas when selected, installed, and maintained in accordance with all the relevant standards. Parts must only be used as described in this manual.

⚠ WARNING

DO NOT MODIFY ANY PART WITHOUT AUTHORISATION FROM PYROBAN. TO DO SO AND FAILURE TO OBSERVE ANY INSTRUCTIONS IN THIS MANUAL MAY INVALIDATE ANY CERTIFICATE OF WARRANTY AGREEMENT.

Most of the components described in this manual are of special manufacture either in duty or specification, but for specific applications consult Pyroban Customer Services Department.

Only genuine Pyroban parts should be used for replacements.

PERSON IN AUTHORITY

Person taking full responsibility for safety procedures and supervision of safety for employees under their control.

SAFETY POINTS

All personnel are expected to use safe practices and to observe all relevant safety requirements and regulations, relevant to the country or locality in which the equipment is being used.

The following safety precautions must be observed, where applicable:

- Read and understand all warning, caution, prohibition and mandatory notices and labels on the equipment before operating or carrying out any maintenance or servicing.
- Do not operate the equipment until you have read and understand the instructions in the “Operating Instructions” sections of this manual.
- Do not perform any servicing or maintenance on this equipment until you have read and understood the instructions in the “Maintenance” sections of this manual.
- When safety equipment has been installed or serviced it must be checked and passed by the Person in Authority before placing it in service.
- When using any non-Pyroban supplied product in the operation, installation, servicing, or maintenance of the Pyroban Safety System, ensure that the product manufacturers warning recommendations are strictly adhered to. This information should be held by your safety department.
- Ensure that all operators, maintenance, and service personnel are adequately trained, have the relevant experience or are under supervision of someone qualified for the job. Pyroban offer servicing and operator training.
- Pressure systems must be installed, tested, and maintained in accordance with applicable regulations specific to the country or locality the equipment is operated in.

- Protection devices must be periodically tested to determine that they are in good operating condition. Pyroban operates a component service exchange scheme.

WASTE AND DISPOSAL

The careful disposal of hazardous materials is a public responsibility to prevent damage to humans, animals, and the environment. The Authorised Person is responsible to ensure that all potentially hazardous wastes produced during cleaning processes are correctly identified at each stage of the process and that appropriate measures are taken to protect the health of employees and those who are contracted to transport or dispose of waste substances. These provisions are built into UK law under the *Health and Safety at Work Act 1974* and the *Control of Substances Hazardous to Health Regulations (COSHH) 2002 (SI 2002 No. 437)*. For non-UK applications the Authorised Person is responsible to ensure compliance with legislation and regulations applicable in the country of use. A list of hazardous wastes can be obtained from the Consolidated TEXT produced by the CONSLEG system of the Office for Official Publications of the European Communities (CONSLEG: 2000D0532 – 01/01/2002). Relevant sections would cover:

- Wastes from thermal processes.
- Wastes from chemical surface treatment and coating of metals and other materials, non-ferrous metallurgy.
- Oil wastes and wastes of liquid fuels.
- Waste organic solvents, refrigerant, and propellants.

ORDERING SPARES AND REPLACEMENT PARTS

Spare parts should be ordered directly from Pyroban Limited parts@pyroban.com quoting the part number and the item description. Parts not listed should be ordered from the original equipment manufacturer.

Manufacturers name label, part number and serial numbers are stamped on the component.

MAINTENANCE OF SAFETY EQUIPMENT

The preventative and protective measures described in this manual will not provide the required level of safety and protection unless the equipment is operated and maintained in accordance with the original manufacturers recommendations and is operated and maintained within its intended use as stated by PYROBAN LIMITED.

Maintenance must be carried out in accordance with the maintenance charts in this manual, for example EXHAUST SYSTEM (page 18) and INLET SYSTEM (page 34) etc.

Continue to observe the original equipment manufacturers (OEM) instructions except where otherwise stated.

Keep a record of all maintenance, repair work and servicing. The frequency and nature of repairs can reveal item deterioration which may lead to unsafe conditions.

After maintenance or repair work, the Person in Authority must inspect and approve the equipment before being returned to service.

OPERATING

DO NOT ATTEMPT TO RESTART EQUIPMENT IF THE ENGINE SAFETY SYSTEMS TRIPS WHILST IN A HAZARDOUS AREA. ADVICE FROM THE PERSON IN AUTHORITY MUST BE OBTAINED AND THE CAUSE OF THE SHUTDOWN IDENTIFIED AND CORRECTED BEFORE RE-STARTING THE EQUIPMENT.

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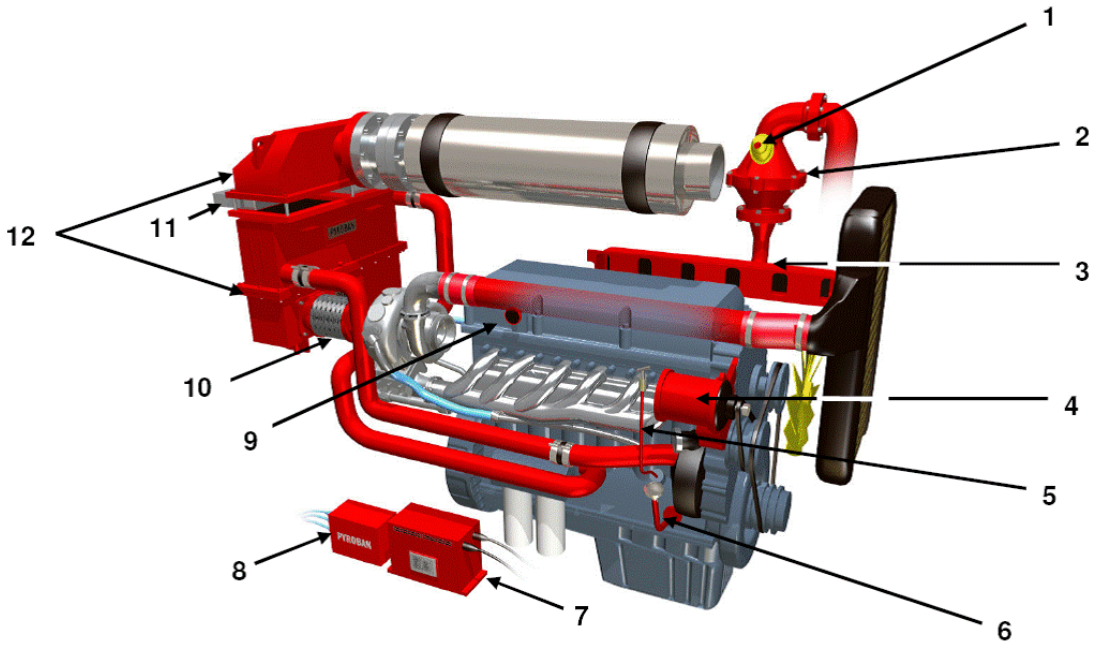
1 ZONE 2 KEY FLAME PROOFING COMPONENTS GUIDE

A guide to Zone 2
Key Flame Proofing Components



1) Combustion **air inlet shutdown valve**
2) Combustion **air inlet flame arrester**
3) Combustion **air inlet manifold**
4) Charging **Ex alternator**
5) Positively retained **oil filler dipstick**
6) Screw fitting **oil filler cap**
7) Ex **battery assembly**
8) Engine **safety control system,** designed to safely shut down the engine in the event of (as a minimum).

i. High coolant temperature
ii. High exhaust temperature
iii. Engine over speed

9) **Crank Case breather flame arrester**
10) **A water cooled flexible section.** This takes exhaust gas from the turbo to the exhaust gas cooler.
11) Removable exhaust gas **flame arresters** prevent any flame transmissions through the exhaust cooler and into the atmosphere. Alternative long life Ever Clear exhaust flame traps (refer section 9)
12) **Exhaust gas cooler** to cool the exhaust gas and skin temperatures to below the T class limitation.

⚠ WARNING

ALWAYS REFER TO SPECIFIC WARNINGS FOR COMPONENTS

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1.1 Engine Exhaust & Air intake – 'Conditions of Use'

Pyroban has developed a range of pre-defined and tested explosion protection safety kits for diesel engines, to help the installer meet the requirements of EN1834:2000. If in doubt regarding how to meet the conditions below, please contact Pyroban Ltd.

1.1.1 Exhaust Components – Conditions of use

The following conditions apply to these components:

Exhaust gas cooler.
Exhaust gas plenum.
Exhaust pipe work (pre-flame arrester).
Outlet box (if fitted pre-flame arrester).
Exhaust water cooled flexible.

- The component is intended to be used as part of a diesel engine exhaust system only.
- The end user shall ensure all exposed metallic parts are electrically bonded to the engine cylinder block. (ref EN 1834-1:2000, §5.13.2).
- The end user / installer shall ensure that any joints connecting the *component* with the rest of the exhaust system meet the requirements of EN1834-1:2000, §5.5 and or EN1834-3:2000, §5.4 (Zone 22).
- When assembled as part of a complete exhaust system, the required test to determine the maximum surface temperature of the component shall be performed. (ref. EN 1834-1:2000,§5.3, EN 1834-3:2000,§5.1). If this exceeds the auto-ignition temperature of the explosive atmosphere the assembled system cannot be put into service.
- When assembled as a complete exhaust system, it must be verified that the requirements of EN 1834-1:2000,§5.7.1 and or EN 1834-3:2000,§5.4, have been met.
- The *component* must not be put into service without the installation of a flame arrester & spark arrester unless it has been verified that the fitting of a flame arrester is not necessary. Either through the application of a 'PYROBAN Flammable Gas Detection Solution' or through following the flame arrester elimination procedure ref. EN 1834-1:2000,§5.7.2.

1.1.2 Air Intake Components – Conditions of use

The following conditions apply to these components:

Air inlet manifold
Charge air cooler
Turbocharger (if post-flame arrester)
Air inlet pipework (if post flame arrester)

- The component is intended to be used as part of a diesel engine air intake system only.
- The end user shall ensure all exposed metallic parts are electrically bonded to the engine cylinder block. (ref EN 1834-1:2000, §5.13.2).
- The end user / installer shall ensure that any joints connecting the component with the rest of the air intake system meet the requirements of EN1834-1:2000, §5.6 and or EN1834-3:2000, §5.3.
- When assembled as part of a complete air intake system, the required test to determine the maximum surface temperature of the component shall be performed. (ref. EN 1834-1:2000,§5.3, EN 1834-3:2000,§5.1). If this exceeds the auto-ignition temperature of the explosive atmosphere the assembled system cannot be put into service.
- When assembled as a complete air intake system, it must be verified that the requirements of EN 1834-1:2000,§5.6 and or EN 1834-3:2000,§5.3 have been met.

2 EXHAUST GAS COOLER, EXHAUST PLENUM AND OUTLET BOX

2.1 Description

'Gas to liquid heat exchangers' are fabricated structures utilizing radial, serrated finned tubes for maximum heat transfer rate. Their primary purpose is to reduce engine exhaust gas and exhaust system surface temperatures to the specified 'T' class temperature limit. Exhaust gas coolers also function as explosion proof enclosures intended to contain an exhaust system detonation and, as such are designed and tested according to the requirements of EN1834:2000. The exhaust system is designed to suit each installation and application. The heat exchanger may be bolted directly to the engine or may be remote mounted, connected to engine by water cooled exhaust plenum and flexible(s). The cooler is typically connected in series with the engine coolant system, although other configurations are accepted.
Refer to the application specific cooling circuit P & ID for more information.

The exhaust plenum acts as an interface between the exhaust gas cooler and the water-cooled exhaust flexible.

The outlet box acts as an interface between the flame arresters and remaining exhaust system.

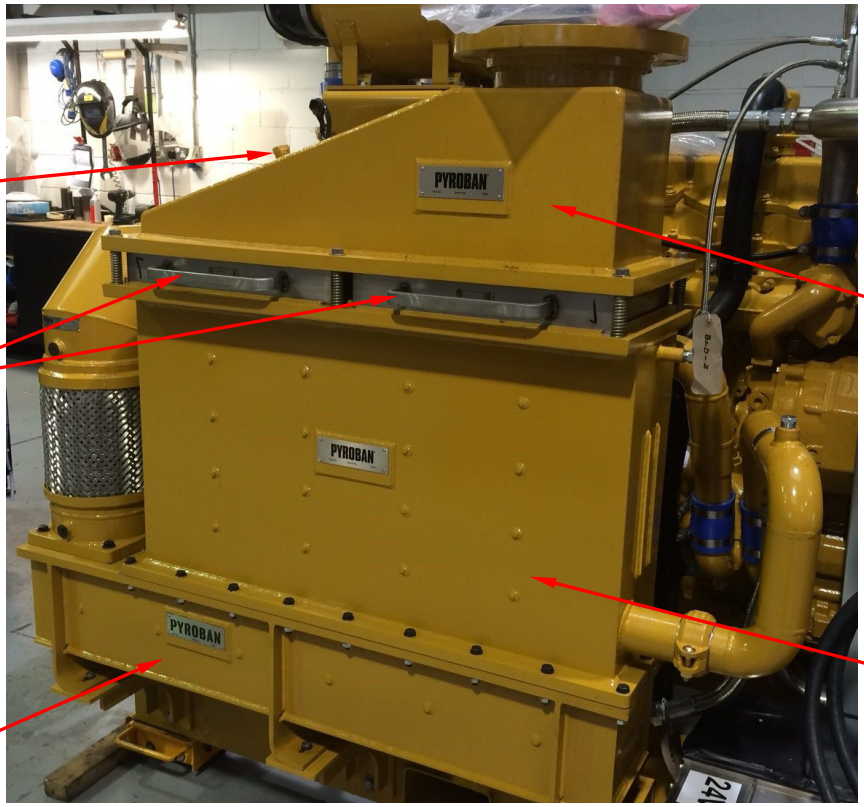

Figure 1 – Typical Exhaust System Installation

3 TEMPERATURE MONITORING

IMPORTANT: Exhaust gas temperature monitoring is a mandatory element of the Pyroban protection system. There are 2 forms of exhaust gas temperature sensor – mechanical and electrical. Both sensor types require periodic inspection to ensure the integrity of the protection system is maintained. Refer to the control system section of this manual for specific installation, maintenance, and operation information.

3.1 Installation

The exhaust gas cooler, exhaust plenum and outlet box are heavy items and appropriate lifting equipment should be used to handle them. Before installation, ensure all packing material is removed. During installation, refer to the application specific layout drawing and parts list.

Secure the exhaust plenum to the exhaust gas cooler using the gasket and fixings supplied. Tighten to the correct torque setting (Refer to the Technical Data Section of the manual). Using the lifting eyes provided, mount the exhaust gas cooler and plenum assembly onto a suitable support framework. Position the outlet box to the outlet of the exhaust gas cooler and loosely secure using the fixing kit supplied.

Coolant connections, flame arresters (non 'flame arrester elimination' installations), spark arrester and temperature monitoring components complete the exhaust system. Refer to the applicable sections in this manual.

⚠ WARNING

HOT SURFACES ARE PRESENT ON THE COMPLETE EXHAUST SYSTEM (EXHAUST GAS COOLER, EXHAUST PLENUM, OUTLET BOX, COOLANT CONNECTIONS, FLAME ARRESTERS, SPARK ARRESTER AND TEMPERATURE MONITORING COMPONENTS.

3.2 Maintenance

On major overhauls or in the event of shutdown due to excessive exhaust gas temperature clean the exhaust gas cooler and exhaust plenum interior with a carbon removing solvent. It is essential to clean the exhaust gas cooler and exhaust plenum whenever excessive carbon build-up occurs. This will be indicated by a tendency to shut down on high exhaust gas temperature. The frequency of cleaning is dependent on local operating conditions, but where regular idling occurs, cleaning may need to be more frequent. When washing parts in or with a cleaning solvent, provide adequate ventilation, safety equipment and protection, as stated in the product safety data sheets.

Note – High backpressure is a direct cause for high exhaust temperatures. Consider fitting a backpressure gauge to monitor operating engine exhaust pressures. (See 'Backpressure Port' section in this manual).

Remove the exhaust gas cooler from the engine and blank off the gas inlet ports. Fill the exhaust gas cooler with solvent and allow to 'soak' for four hours. Remove the exhaust plenum and wash through by steam cleaning. Empty and thoroughly hose out the interior. Remove all the fluid from the exhaust gas cooler and exhaust plenum and repeat the cleaning process if necessary.

Blow out the exhaust gas cooler 'gas-ways' with compressed air and then refit the unit. Run the engine until warm, top up the coolant system and check the coolant and gas connections for leaks. After cleaning, subject to the method and thoroughness of cleaning, loose carbon particles will be released during the initial period of operation. These particles may cause additional fouling of the flame arrester (if fitted) which will require more frequent cleaning until the deposits have stabilized. Normal exhaust flame arrester service life will be resumed.

Suggested Cleaning Fluids:

Product	Manufacturer	Contact Details
Jumbo	Unicorn Chemicals Limited.	+44 (0)1282 831251
Combat	Servo-Chem Limited.	+44 (0)1934 713999
Powerwash Regular	DEB Limited.	+44 (0)1773 855100

4 MANICOOLER AND OUTLET BOX

4.1 Description

'Gas to liquid heat exchangers' are fabricated structures utilizing radial, serrated finned tubes for maximum heat transfer rate. Their primary purpose is to reduce engine exhaust gas and exhaust system surface temperatures to below the specified 'T' class temperature limit. Manicoolers also function as explosion proof enclosures intended to contain an exhaust system detonation and, as such are designed and tested according to the requirements of EN1834:2000. They are designed to suit individual installation/duty situations by incorporating a water cooled manifold and are fixed directly to the engine cylinder head. The manicooler is typically connected in series with the engine coolant system, although other configurations are accepted.
Refer to the application specific cooling circuit P & ID for more information.

The outlet box acts as an interface between the flame arresters and remaining exhaust system.

Figure 2 – Typical Manicooler Installation

5 TEMPERATURE MONITORING

IMPORTANT: Exhaust gas temperature monitoring is a mandatory element of the protection system. There are two forms of exhaust gas temperature sensor – mechanical and electrical. Both sensor types require periodic inspection to ensure the integrity of the protection system is maintained. Refer to the control system section of this manual for specific installation, maintenance, and operation information.

5.1 Installation

The manicooler and outlet box are heavy items and appropriate lifting equipment should be used to handle them. Before installation, ensure all packing material is removed. During installation, refer to the application specific layout drawing and parts list.

Drain the engine of coolant and remove the existing manifold, studs, and gaskets. Clean the exposed cylinder head face thoroughly. Fit the cylinder head plugs into the unused central stud holes in the cylinder head using thread sealant to block off the coolant passage. Fit the studs into the remaining stud fixing holes with the ½" thread length end of each stud located into the cylinder head. Slide the gasket supplied and the Pyroban manicooler over the studs into position. Using the washers and hex nuts supplied, tighten the manicooler to the cylinder head. The customer must supply suitable support brackets from the side of the engine block to the manicooler gusset. Drill the manicooler gussets as required but do not drill or weld any other part of the manicooler body. Fit the exhaust flame arrester (or DUMMY exhaust flame arrester) and the exhaust outlet box on to the top flange face of the manicooler using the fixing kit supplied. The system must not be used in a hazardous area without a standard exhaust flame arrester fitted.

⚠ WARNING

HOT SURFACES ARE PRESENT ON THE COMPLETE EXHAUST SYSTEM (EXHAUST GAS COOLER, EXHAUST PLENUM, OUTLET BOX, COOLANT CONNECTIONS, FLAME ARRESTERS, SPARK ARRESTER AND TEMPERATURE MONITORING COMPONENTS.

5.2 Maintenance

On major overhauls or in the event of shutdown due to excessive exhaust temperature not reconciled by other checks, clean the manicooler interior with a carbon removing solvent. Clean the manicooler whenever the carbon built-up inside exceeds a thin layering of surfaces in the exhaust gas flow. The frequency of cleaning is dependent on local operating conditions, but where regular idling occurs cleaning may be needed more frequently. When washing parts in or with a cleaning solvent, provide adequate ventilation, safety equipment and protection, as stated in the product safety data sheets.

Note – High backpressure is a direct cause for high exhaust temperatures. Consider fitting a backpressure gauge to monitor operating engine exhaust pressures. (See 'Backpressure Port' section in this manual).

Remove the manicooler from the engine, discard the existing gasket and blank off the exhaust outlet of the engine. With the outlet uppermost, fill the casing with the solvent and allow to 'soak' for 4-5 hours. Empty and thoroughly hose out the interior. Remove all fluid from the manicooler and repeat the cleaning process, if necessary, with clean solvent, empty again and thoroughly hose out. Blow out the manicooler gas away with an airline and then refit the manicooler to the engine using a new gasket. Run the engine until warm, top up the coolant system and check the coolant and gas connection for leaks.

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After cleaning, subject to the method and thoroughness of cleaning, loose carbon particles will be released during the initial period of operation. These particles may cause additional failing of the flame arrester which will require more frequent cleaning until the deposits have stabilized. Normal exhaust flame arrester service life will be resumed.
Suggested Cleaning Fluids:

Product	Manufacturer	Contact Details
Jumbo	Unicorn Chemicals Limited.	+44 (0)1282 831251
Combat	Servo-Chem Limited.	+44 (0)1934 713999
Powerwash Regular	DEB Limited.	+44 (0)1773 855100

6 WATER COOLED EXHAUST FLEXIBLE

6.1 Description

Duplex water cooled exhaust flexible assemblies are constructed from braided stainless steel corrugated hose and mild steel connections/flanges to suit application.
They are used on the interface between the turbocharger outlet and plenum chamber.

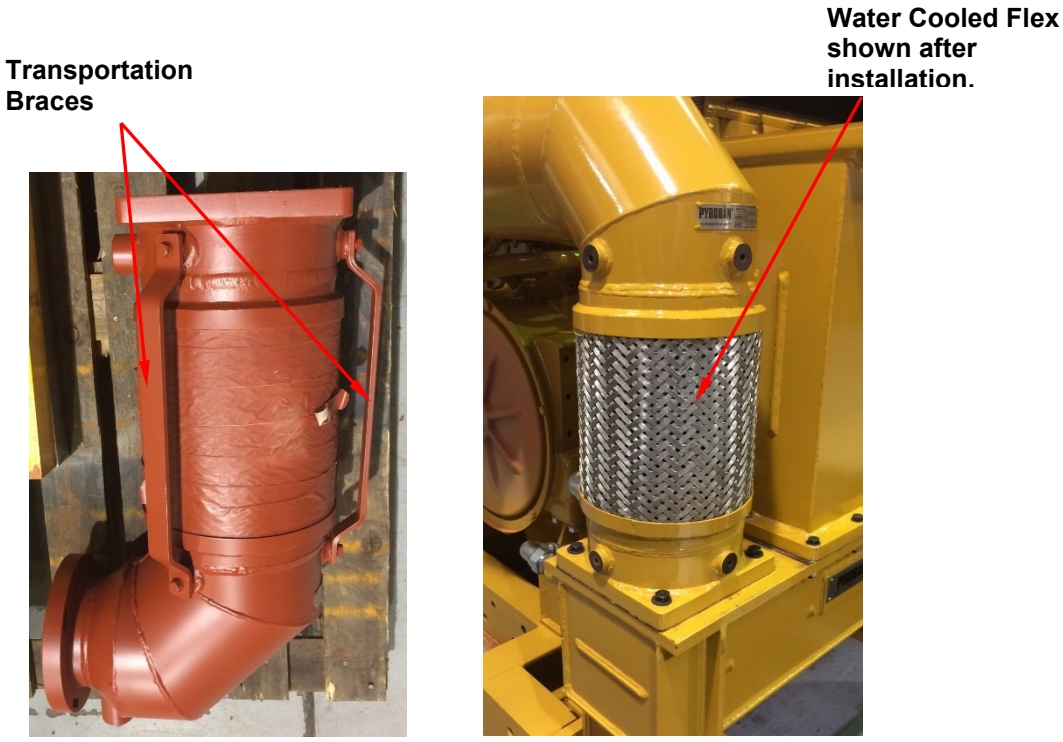

Figure 3 – Examples of a Water Cooled Exhaust Flexible Connection

⚠ WARNING

HOT SURFACES ARE PRESENT ON THE WATER COOLED EXHAUST FLEXIBLE.

6.2 Installation

During installation, refer to the appropriate general arrangement drawing for your specific configuration.

Install with suitable gaskets and fixings, then tighten to appropriate torque values. Ensure that no undue strain or torque loading is imposed on the water cooled exhaust flexible assembly during assembly or when tightening the fixings. Ensure that all water connections are securely connected to the engine cooling system.

The water cooled exhaust flexible assembly is designed to accommodate thermal expansion on rigid installations and some vibration. It is not suitable for applications involving axial compression/extension. It is typically supplied with transportation braces that shall be removed before starting up.

Position the water cooled exhaust flexible to the exhaust plenum/manicooler outlet. Fit gasket and firmly secure using the fixings supplied. Tighten to the correct torque.

When the fasteners are tightened, remove the ‘transport braces’ at the two ends by loosening retaining bolts (bolted arrangements) or by using an angle grinder (welded arrangements). Note that grinding through the strap centre can lead to damage to the braided/flexible section. Following removal, touch-up the paintwork as appropriate.

Ensure that the water cooled exhaust flexible assembly is not exposed to any cleaning fluids containing carcinogenic solvents such as trichloroethylene during cleaning.

6.3 Maintenance

Before commencing any maintenance operations make sure that the correct procedure has been obtained from the person in authority. A record must be kept of all maintenance and repair in line with BS EN1834-1:2000, clause 7.2.

After maintenance and before use, the water cooled exhaust flexible assembly must be checked and approved by the person in authority. Ensure new gaskets are fitted (where applicable) and that fixings are secure when re-fitting the flexible assembly.

7 DRY EXHAUST FLEXIBLE

7.1 Description

Dry exhaust flexible assemblies are constructed from braided or unbraided steel corrugated hose to and typically mild steel collars and flanges to suit application.

7.2 Installation

During installation, refer to the general arrangement drawing for your configuration.

The dry exhaust flexible should be fitted as close as possible to the outlet from the exhaust gas cooler/manicooler. Fit the dry exhaust flexible to the outlet flange on the exhaust outlet box using the gasket and fixings supplied. Ensure that no undue strain or torque loading is imposed on the dry exhaust flexible assembly during assembly or when tightening fixings.

When refitting, ensure that all fixings are secure and new gaskets are used on all flange connections.

The dry exhaust flexible assembly is designed to accommodate thermal expansion on rigid installations and some vibration. It is not suitable for applications involving axial compression/extension.

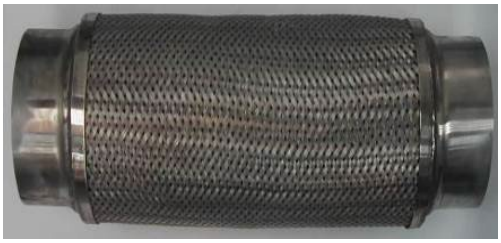

Figure 4 – Dry Exhaust Flexible

Figure 5 – Flanged Exhaust Flexible

⚠ WARNING

HOT SURFACES ARE PRESENT ON THE DRY EXHAUST FLEXIBLE.

7.3 Maintenance

Before commencing any maintenance operations make sure that the correct procedure has been obtained from the person in authority. A record must be kept of all maintenance and repair in line with BS EN1834-1:2000, clause 7.2.

After maintenance and before use, the dry exhaust flexible assembly must be checked and approved by the person in authority. Ensure new gaskets are fitted (where applicable) and that fixings are secure when re-fitting the dry exhaust flexible assembly.

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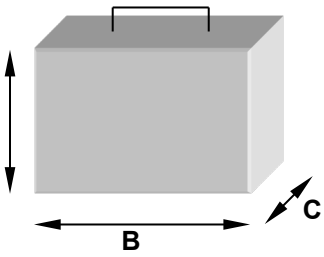
8 EXHAUST FLAME ARRESTERS

8.1 Description

Exhaust flame arresters are designed and tested to extinguish explosions created in the exhaust system. The flame arrester is sized to operate within the back-pressure limit of the engine. All Pyroban plate type exhaust flame arresters are constructed from stainless steel. Exhaust flame arresters supplied can be close tolerance (CT) type or standard. The CT designates that the thickness is machined to a close tolerance limit. CT flame arresters are used where more than 1 flame arrester is fitted on the exhaust system by a common outlet box, not individual outlet boxes. CT exhaust flame arresters are identified by handles of flat rather than round section. CT exhaust flame arresters must not be interchanged with standard (i.e., round handled) exhaust flame arresters used elsewhere. The engine must not be used in a hazardous area without exhaust flame arresters fitted. The Person in Authority must be consulted before fitting a dummy exhaust flame arrester to the system. Dummy exhaust flame arresters may only be used if the system is being used in a safe area.



Dummy Flame Arrester

⚠ WARNING

DUMMY EXHAUST FLAME ARRESTERS SHOULD ONLY BE USED IN A SAFE AREA

Pyroban introduced a unique design called the Ever Clear Flame Arrester in 2021. This flame arrester has different installation and maintenance requirements from that of the plate type flame arrester. See the **Exhaust Ever Clear** section for further details.

Low load conditions and bad fuel quality can cause the arrester to block more quickly. Long periods of idle or low load should be avoided where possible.

8.2 Installation

Exhaust flame arresters sit either between the guide rail or in a machined pocket on the cooler top face. The flame arresters are heavy items and appropriate lifting equipment should be used to handle them. Ensure cooler, flame arrester and outlet box flanges are clean and free from damage or rust. Slide the exhaust flame arresters (or DUMMY flame arresters) between the exhaust gas cooler and the outlet box. Do not use sealant or gaskets between the joints (refer to flange face protection section regarding corrosion protection). The exhaust flame arrester fixing kit includes heavy duty springs. These are designed to push the outlet box away from the exhaust gas cooler when the bolts are released thereby allowing the exhaust flame arrester to be removed for cleaning purposes. After installation and cleaning, tighten the fixings to the correct torque.

8.3 Maintenance

No gaskets are required on the mating faces with the exhaust gas cooler body or outlet box. No maintenance is required on a DUMMY exhaust flame arrester (if fitted/supplied). Exhaust flame arresters must be cleaned every 12 hours or more frequently if required. To remove the exhaust flame arrester, slacken the retaining bolts (fixing kit) then carefully slide the exhaust flame arrester out using the handle. Clean the exhaust flame arrester by soaking in carbon removing solvent. Never clean the exhaust flame arrester by inserting probes as the fine passages could be enlarged thereby impairing the flame arrester performance. Check mating surfaces, they should be free from damage, and rust. Refit in reverse order. No gaskets are fitted. When washing parts in or with a cleaning solvent, provide adequate ventilation, safety equipment and protection, as stated in the product safety data sheets. Ensure the unit is completely dry before refitting.

Suggested Cleaning Fluids:

Product	Manufacturer	Contact Details
Jumbo	Unicorn Chemicals Limited.	+44 (0)1282 831251
Combat	Servo-Chem Limited.	+44 (0)1934 713999
Powerwash Regular	DEB Limited.	+44 (0)1773 855100

Consult PYROBAN Ltd. for available exhaust flame arrester elimination technology.

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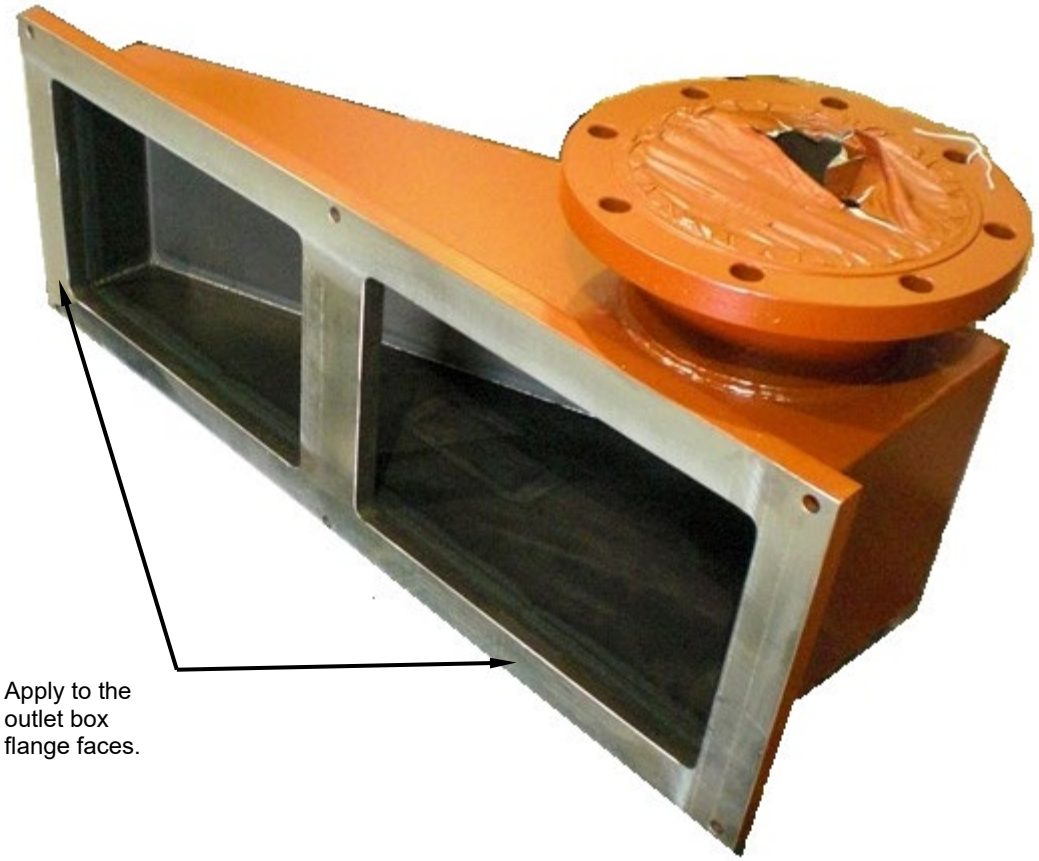
8.4 Flange Face Corrosion Protection

To protect the cooler, outlet box and flame arrester open flange faces from corrosion after installation, a copper based grease can be applied. Copper based grease has a high melting temperature and can therefore withstand the high operating temperatures of the exhaust system.
Pyroban recommends the use of “COPPERGREASE” manufactured by Chemodex, as this is approved by Baseefa UK for use in Ex applications. This grease can be supplied by Pyroban if required.

The following photograph shows the application area on the cooler.

The copper grease can be applied to any other unpainted surfaces to protect them from corrosion.

The copper grease should also be applied to the outlet box faces as shown on the following image.



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8.5 Exhaust Plate Type Flame Arresters Weight and Dimensions

All weights and dimensions quoted are approximate. If a suitable exhaust flame arrester is not shown on the table below, please contact Pyroban Customer Services department for advice.

Please note that dimension 'A' refers to height, 'B' length and 'C' width.

DIMENSION 'A' (mm)	DIMENSION 'B' (mm)	DIMENSION 'C' (mm)	SPACER THICKNESS (mm)	HANDLE POSITION	WEIGHT (kg)	PART NUMBER STANDARD TYPE	PART NUMBER CLOSE TOLERANCE
179.5	129	42.5	0.5	LONG SIDE	8	802507/1	802779/1
179.5	129	42.5	0.5	SHORT SIDE	8	802507/2	802779/2
179.5	129	42.5	0.7	LONG SIDE	8	802507/3	802779/3
179.5	129	42.5	0.7	SHORT SIDE	8	802507/4	802779/4
179.5	129	58.5	0.5	LONG SIDE	8	802507/5	802779/5
179.5	129	58.5	0.5	SHORT SIDE	8	802507/6	802779/6
179.5	129	58.5	0.7	LONG SIDE	8	802507/7	802779/7
179.5	129	58.5	0.7	SHORT SIDE	8	802507/8	802779/8
228	129	42.5	0.5	LONG SIDE	10	802507/9	802779/9
228	129	42.5	0.5	SHORT SIDE	10	802507/10	802779/10
228	129	42.5	0.7	LONG SIDE	10	802507/11	802779/11
228	129	42.5	0.7	SHORT SIDE	10	802507/12	802779/12
228	129	58.5	0.5	LONG SIDE	10	802507/13	802779/13
228	129	58.5	0.5	SHORT SIDE	10	802507/14	802779/14
228	129	58.5	0.7	LONG SIDE	10	802507/15	802779/15
228	129	58.5	0.7	SHORT SIDE	10	802507/16	802779/16
179.5	195	42.5	0.5	LONG SIDE	10	802507/17	802779/17
179.5	195	42.5	0.5	SHORT SIDE	10	802507/18	802779/18
179.5	195	42.5	0.7	LONG SIDE	10	802507/19	802779/19
179.5	195	42.5	0.7	SHORT SIDE	10	802507/20	802779/20
179.5	195	58.5	0.5	LONG SIDE	10	802507/21	802779/21
179.5	195	58.5	0.5	SHORT SIDE	10	802507/22	802779/22
179.5	195	58.5	0.7	LONG SIDE	10	802507/23	802779/23
179.5	195	58.5	0.7	SHORT SIDE	10	802507/24	802779/24
179.5	248	42.5	0.5	LONG SIDE	13	802507/25	802779/25
179.5	248	42.5	0.5	SHORT SIDE	13	802507/26	802779/26
179.5	248	42.5	0.7	LONG SIDE	13	802507/27	802779/27
179.5	248	42.5	0.7	SHORT SIDE	13	802507/28	802779/28
179.5	248	58.5	0.5	LONG SIDE	13	802507/29	802779/29
179.5	248	58.5	0.5	SHORT SIDE	13	802507/30	802779/30

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DIMENSION 'A' (mm)	DIMENSION 'B' (mm)	DIMENSION 'C' (mm)	SPACER THICKNESS (mm)	HANDLE POSITION	WEIGHT (kg)	PART NUMBER STANDARD TYPE	PART NUMBER CLOSE TOLERANCE
179.5	248	58.5	0.7	LONG SIDE	13	802507/31	802779/31
179.5	248	58.5	0.7	SHORT SIDE	13	802507/32	802779/32
179.5	301	42.5	0.5	LONG SIDE	18	802507/33	802779/33
179.5	301	42.5	0.5	SHORT SIDE	18	802507/34	802779/34
179.5	301	42.5	0.7	LONG SIDE	18	802507/35	802779/35
179.5	301	42.5	0.7	SHORT SIDE	18	802507/36	802779/36
179.5	301	58.5	0.5	LONG SIDE	18	802507/37	802779/37
179.5	301	58.5	0.5	SHORT SIDE	18	802507/38	802779/38
179.5	301	58.5	0.7	LONG SIDE	18	802507/39	802779/39
179.5	301	58.5	0.7	SHORT SIDE	18	802507/40	802779/40
250	301	42.5	0.5	LONG SIDE	26	802507/41	802779/41
250	301	42.5	0.5	SHORT SIDE	26	802507/42	802779/42
250	301	42.5	0.7	LONG SIDE	26	802507/43	802779/43
250	301	42.5	0.7	SHORT SIDE	26	802507/44	802779/44
250	301	58.5	0.5	LONG SIDE	26	802507/45	802779/45
250	301	58.5	0.5	SHORT SIDE	26	802507/46	802779/46
250	301	58.5	0.7	LONG SIDE	26	802507/47	802779/47
250	301	58.5	0.7	SHORT SIDE	26	802507/48	802779/48
322	301	42.5	0.5	LONG SIDE	34	802507/49	802779/49
322	301	42.5	0.5	SHORT SIDE	34	802507/50	802779/50
322	301	42.5	0.7	LONG SIDE	34	802507/51	802779/51
322	301	42.5	0.7	SHORT SIDE	34	802507/52	802779/52
322	301	58.5	0.5	LONG SIDE	34	802507/53	802779/53
322	301	58.5	0.5	SHORT SIDE	34	802507/54	802779/54
322	301	58.5	0.7	LONG SIDE	34	802507/55	802779/55
322	301	58.5	0.7	SHORT SIDE	34	802507/56	802779/56
425	301	42.5	0.5	LONG SIDE	44	802507/57	802779/57
425	301	42.5	0.5	SHORT SIDE	44	802507/58	802779/58
425	301	42.5	0.7	LONG SIDE	44	802507/59	802779/59
425	301	42.5	0.7	SHORT SIDE	44	802507/60	802779/60
425	301	58.5	0.5	LONG SIDE	44	802507/61	802779/61
425	301	58.5	0.5	SHORT SIDE	44	802507/62	802779/62
425	301	58.5	0.7	LONG SIDE	44	802507/63	802779/63
425	301	58.5	0.7	SHORT SIDE	44	802507/64	802779/64
425	301	58.5	0.4	SHORT SIDE	44	-	802779/65
308	263	58.5	0.5	LONG SIDE	28	-	802779/66

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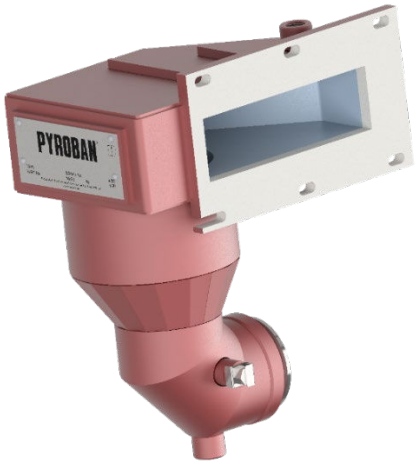
9 EVER CLEAR EXHAUST ARRESTERS

9.1 Description

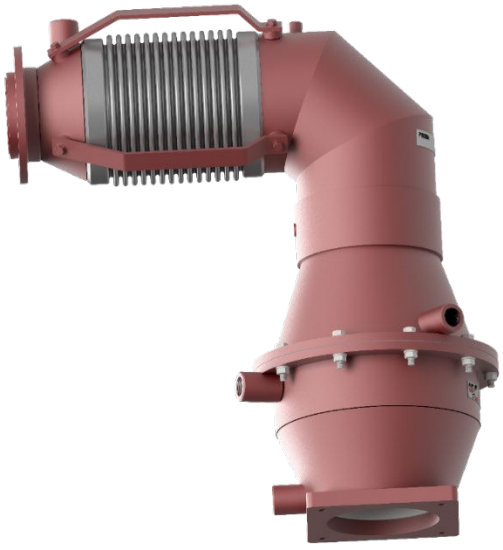
The Ever Clear flame arrester has been designed and tested to extinguish explosions created in the exhaust system. The flame arrester is designed to run for extended periods without cleaning. The flame arrester section is tailored to the application and sized to operate within the back-pressure limit of the engine. The arrester section can be a separate boltable part or part of the water cooled exhaust flexible assembly. There are many applications where the Ever Clear arrester can replace an existing water cooled flexible and the plate type arresters. (Dummy flame arresters will permanently replace the plate type arresters in this case).

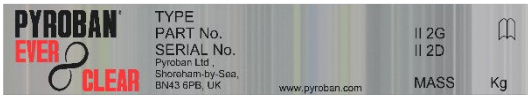
Low load conditions and bad fuel quality can cause the arrester to block more quickly. Long periods of idle or low load should be avoided where possible.

Ever Clear Combined Example Assemblies:



Ever Clear Removable Example Assembly:





⚠ WARNING

HOT SURFACES ARE PRESENT ON THE EXTERNAL SURFACES OF THE ASSEMBLY.

9.2 Installation

The Ever Clear flame arrester is fitted between the engine turbocharger and the exhaust plenum / gas cooler. During installation, refer to the appropriate general arrangement drawing (G.A.) for your specific configuration.

Install with the gaskets and fasteners (detailed on the G.A.), then tighten to appropriate torque values. Ensure that no undue stress or torque loading is imposed on the water cooled exhaust flexible assembly or turbocharger during assembly or when tightening the fixings.

The Ever Clear arrester is normally supplied already assembled to the flexible section (where used). If you are refitting the arrester assembly, then secure to the plenum or cooler / manicooler using the fasteners provided. New gaskets are to be used whenever the assembly is fitted.

Sockets are provided for coolant inlet and coolant outlet. For coolant circuit and socket sizes refer to the appropriate general arrangement drawing for your specific configuration. Hoses should be the same bore as the plenum hoses where possible. The flow should be in series from the plenum.
It may be useful to install a drain valve on the inlet socket to assist during the maintenance cleaning period. A back pressure port is fitted between the turbocharger and the Ever Clear arrester. It is highly recommended this port have a gauge or pressure sensor fitted to monitor the state of blockage build up on the arrester's element.

9.3 Maintenance

Replace all gaskets during cleaning procedure. The Ever Clear flame arresters must be cleaned periodically at a point where the exhaust backpressure is approaching the engine limit (See engine data sheet for actual limit).

To remove, drain the coolant from the Ever Clear Assembly and remove the coolant connection. Depending on the cooling circuit installed it may require partial or total plenum drainage. If isolation valves can be installed in the connection sockets this may reduce the drain down time and coolant storage during the cleaning process. If the coolant is to be re-used on re-install, ensure the containers to capture said coolant are clean and suitable for the fluid. If isolation valves are to be installed, ensure there are processes in place to stop them being inadvertently left in the closed position after re-installing the Ever Clear arrester.

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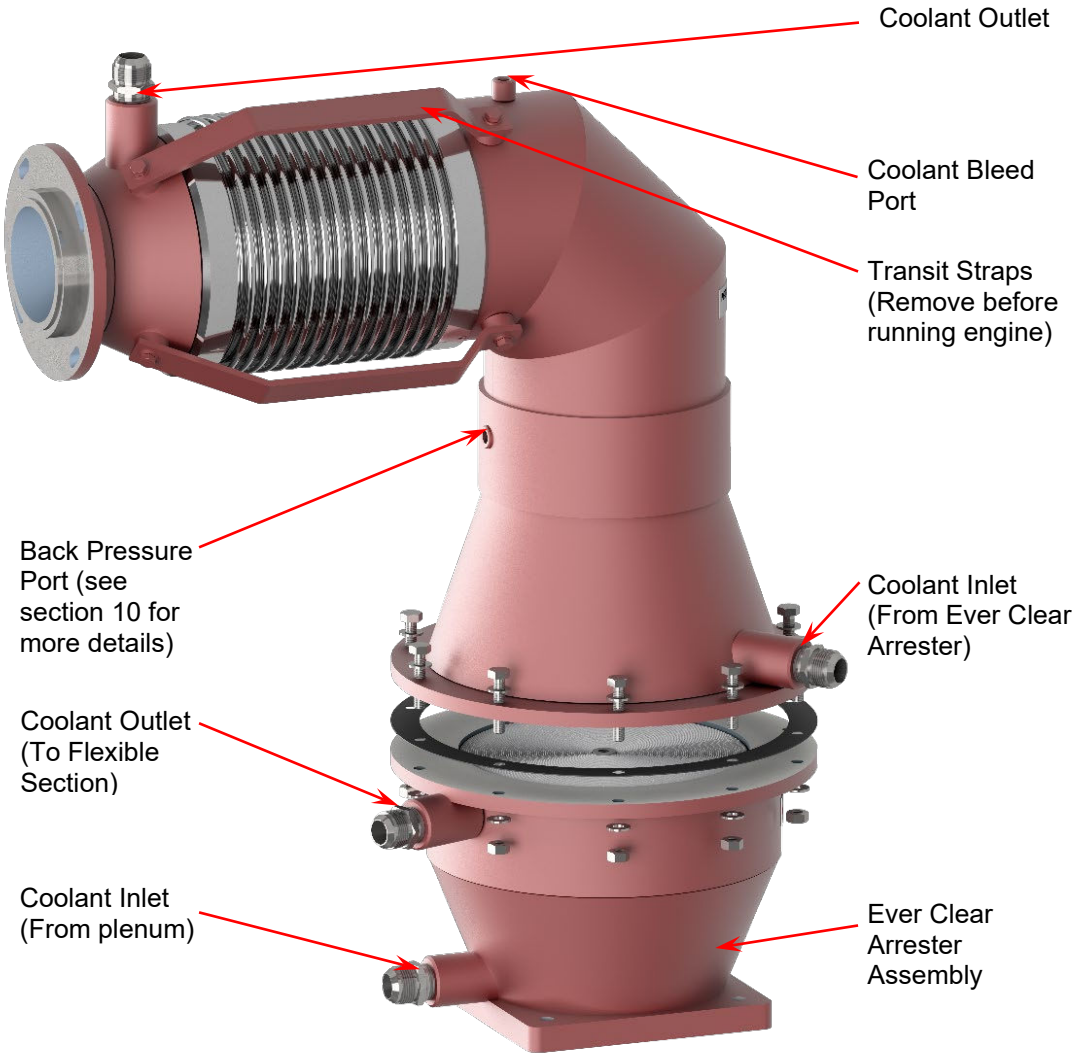
If the flexible section cannot be supported without placing load on the turbocharger during the cleaning process then remove the whole assembly. If the flexible section is supported or the assembly does not have one then the Ever Clear arrester can be removed on its own.



Typical Ever Clear Arrangement (Shown Above)

Slacken and remove the retaining fasteners and then carefully slide out the assembly. With a blanking flange and rubber gasket covering one exhaust flange clean the assembly by soaking the exhaust path in carbon removing solvent. Never clean the exhaust flame arrester by inserting probes as the fine passages could be damaged, thereby impairing the flame arrester performance. Check mating surfaces, they should be free from damage, and rust. Refit in reverse order. Fit new gaskets. When washing parts in or with a cleaning solvent, provide adequate ventilation, safety equipment and protection, as stated in the product safety data sheets. Ensure the unit is completely dry before refitting.

Suggested Cleaning Fluids:

Product	Manufacturer	Contact Details
Jumbo	Unicorn Chemicals Limited.	+44 (0)1282 831251
Combat	Servo-Chem Limited.	+44 (0)1934 713999
Powerwash Regular	DEB Limited.	+44 (0)1773 855100

10 BACK PRESSURE PORTS

10.1 Description

The back pressure port is used for connecting pressure measuring equipment, such as a back pressure gauge via an in-line flame arrester. Back pressure ports are usually located on the plenum in the case of a separate exhaust gas cooler or located near the exhaust inlet in the case of a manicooler arrangement. With the new Ever Clear Arrester the port will be located between the engine outlet and Ever Clear arrester element (normally in the flexible assembly). Refer to the kit GA drawing of your specific application for further guidance on the location of the back pressure port, if available.

⚠ WARNING

WHEN THE BACK PRESSURE PORT PLUG IS REMOVED TO INSTALL A PRESSURE GAUGE, OR ANY PRESSURE MEASURING DEVICE, IT IS MANDATORY TO FULFIL THE REQUIREMENTS OF EN 1834:2000. PYROBAN RECOMMENDS THE USE OF A SUITABLE INLINE FLAME ARRESTER. IF THE BACKPRESSURE PORT IS LEFT UNUSED, IT IS RECOMMENDED TO MAINTAIN THE INTEGRITY OF THE SECURITY TAB WHEN OPERATING IN A HAZARDOUS ENVIRONMENT.

10.2 Installation

Upon removal of the back pressure port connect an in-line flame arrester, such as the one shown below, to maintain flame proofing integrity. Then attach the hose to be connected to the pressure measuring device.

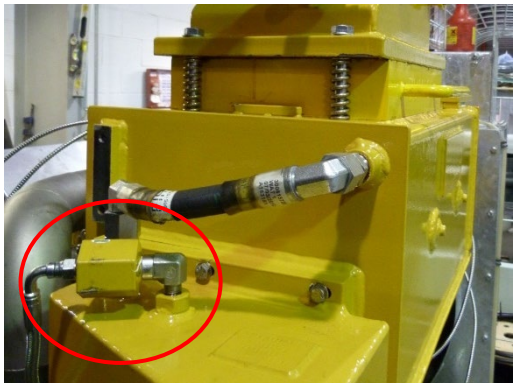


Figure 6 – Manicooler Fitted with In-line Flame Arrester to Back Pressure Port

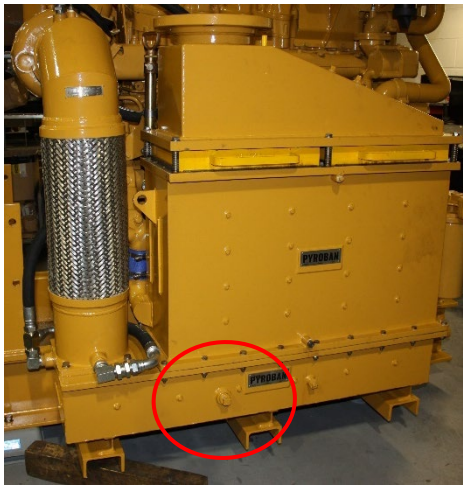


Figure 7 – Plenum with Back Pressure Port Security Tab Maintained

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11 ILX EXHAUST FLAME ARRESTER

11.1 Installation

The ILX exhaust flame arrester is a heavy item of equipment, and this should be considered during installation or removal. Do not run the engine in a hazardous area without an exhaust flame arrester fitted. Ensure that the air flow direction on the ILX exhaust flame arrester unit is strictly adhered to taking care to renew all gaskets and ensure that all fixings are secure.

11.2 Maintenance

A clean ILX exhaust flame arrester should be fitted to the exhaust system when necessary. The cleaning interval may vary on each application but can only be established by monitoring site operational conditions. Providing idling of the engine is kept to a minimum, the cleaning period may be extended. Long idling periods result in low exhaust gas temperature and premature fouling.

It is essential that the exhaust flame arrester is cleaned at the first signs of dirty exhaust or sluggish engine performances.

To remove the ILX exhaust flame arrester, remove the fixings from each of the flanges clean the ILX exhaust flame arrester by soaking in carbon removing solvent ensuring that the flame arrester element is completely covered. Never clean the ILX exhaust flame arrester by inserting probes, as the passages could be enlarged thereby impairing the flame arrester performance.

After cleaning, wash the solvent off with water and blow the ILX exhaust flame arrester element through with compressed air. Ensure the unit is completely dry before refitting. Hold one end of the ILX exhaust flame arrester to a light and check visually that the passages are clear. Before refitting, ensure that the casing and flanges are not damaged or corroded. When refitting the ILX exhaust flame arrester, ensure that the air flow direction on the ILX exhaust flame arrester unit is strictly adhered to taking care to use new gaskets and ensure that all fixings are secure.

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12 STAINLESS STEEL EXHAUST SPARK ARRESTER

12.1 Description

Designed for fitting into and suppressing sparks emitted by a diesel engine exhaust system (engine configurations with a nominal inlet velocity of 55 to 75 m/s). Made from stainless steel, it is designed as a cylindrical 'can' with inlet and outlet pipe stubs containing serrated and louvered inner tube welded to it.

12.2 Installation

During installation, refer to the appropriate installation drawing.

The direction of the flow of gases is indicated on the exhaust spark arrester and must be strictly adhered to. Fit the exhaust spark arrester to the outlet flange on the dry exhaust flexible using the gasket and fixings supplied being tightened to the correct torque. Ensure that the gas enters the exhaust spark arrester via the port marked 'inlet'.

Figure 8 – Typical Example of a Spark Arrester

Although the item is of stainless steel construction for long life, the following points should be observed:

When an exhaust gas cooler is fitted, operation at low power can cause exhaust gas temperatures to fall below the dew point. This will lead to warm acid condensate collecting, particularly in the exhaust spark arrester, leading eventually to corrosion. To alleviate this problem, it is advisable to remove the exhaust spark arrester if mounted in the horizontal position and empty the condensate which has collected. After long periods of idling, run on load before shutting down the engine, even if the engine is warm. If the exhaust appears 'steamy', continue running on load until the exhaust clears before shutting down the engine. If extended periods of engine 'idling' are unavoidable it is particularly important to use low-sulphur fuels.

In an offshore environment, condensates may contain chlorides, increasing the risk of corrosion. To minimise this risk: -

- The induction air intake should be positioned and/or protected to reduce the ingestion of marine spray or mist when the engine is running.
- The exhaust outlet should be positioned and/or protected to reduce the ingress of marine spray or mist when the engine is not running. Rain caps should always be fitted to the exhaust outlet if there is a danger of this occurring.

12.3 Maintenance

Check the exterior of the exhaust spark arrester for damage or distress and check the pipework and joints for leaks. Remove the exhaust spark arrester and lightly tap with a soft mallet to loosen deposits, then shake out all loose particles. Visually examine the interior of the exhaust spark arrester via the inlet and outlet ports.

13 TURBOCHARGER

13.1 Description

The turbocharger is a device composed of two sealed chambers containing fan blades, also known as turbines, which are connected by a shaft.

The greater the load on the engine, the higher the volume of exhaust and thus the more air and by extension, fuel—that is pumped into the engine thereby increasing output.

The unit supplied for hazardous area use includes a water-cooled exhaust housing to minimise the surface temperature. The oil bearing housing may also be water-cooled.

Figure 9 – Turbocharger with Water Cooled Exhaust Housing

13.2 Installation

Ensure the turbocharger is clean and free from any packing material. Fit gaskets (not supplied) to the turbocharger.

Align the water cooled exhaust flexible with the turbocharger. Mark out the position of the required fixing holes on the flange of the water cooled exhaust flexible with the fixings on the turbocharger (if required). Drill the required number of holes in the flange of the water cooled exhaust flexible (if required).

Secure the water cooled exhaust flexible to the turbocharger using suitable fixings (not supplied) in accordance with standard torque values. Once the water cooled exhaust flexible has been secured to the turbocharger, firmly secure the exhaust gas cooler/exhaust plenum assembly to the mounting frame ensuring that no undue strain is placed on the water cooled exhaust flexible or the turbocharger when the fixings are tightened.

13.3 Maintenance

Routinely check seals and gaskets.

Ensure air cleaner is maintained and not damaged. Once a month check blades on both sides for damage or scoring.

Strip down and rebuild with new bearings and seals every 50000 hours.

It is important to remember that the turbocharger uses the same oil as the engine and therefore regular oil and filter changes will enhance turbo life. Only have the turbo removed and attended to when the cause of a problem has been isolated to the turbocharger by someone competent to do so. The occasional dynamometer test to check that all settings are correct can be worthwhile.

13.4 Servicing

The following table defines the servicing requirements for the Pyroban system (where applicable). Only competent and suitably trained staff may operate, service and maintain the equipment. The Person in Authority is responsible to authorize personnel to undertake service work.

- Items marked ✓are to be carried out by the Service provider.

Items listed in this schedule may not be supplied or fitted. Refer to parts list to identify installed parts. A record of servicing and maintenance should be maintained.

Task-In addition to original requirements	Daily 8-12 hrs	Weekly 50 hrs	1 Month 200 hrs	3 Months 500 hrs	6 months 1000 hrs	2 Years 4000 hrs
Exhaust Flame arrester: clean element.	✓					
Exhaust Flexible (Water-Cooled): check exterior for damages or distress, check pipework and joints for leaks.			✓		✓	
Exhaust System: check the mechanical integrity of all pipework/components and joints.				✓		
Exhaust Gas Cooler: remove carbon.						✓
Exhaust Manicooler: remove carbon.						✓
Exhaust Flexible (Dry): check exterior for damages or distress, check pipework and joints for leaks.				✓	✓	
Temperature Monitoring Device: check exterior for damage.			✓		✓	✓
Spark Arrester: check exterior for damages or distress, check pipework and joints for leaks, clean interior, perform visual check of interior via inlet and outlet ports.				✓	✓	

13.5 Operating Instructions

If the system is not protected by Pyroban 'flame arrester elimination' system, then ensure clean exhaust flame arresters are fitted.

Ensure all water cooled components are full of coolant with appropriate bleeds attached. It is not advised to run the water cooled system without coolant.

Ensure all exhaust system temperature monitoring devices are installed and connected to control system. Carry out pre-start checks as defined by the engine manufacturer.

A consequence of exhaust gas cooling is the formation of exhaust condensate.

When the engine is run up from cold, the system sees a transition period where exhaust gas temperature difference between the gas and the exhaust system steel work will precipitate condensation. This precipitation period is at its longest when the engine is run up from cold and at its shortest when the engine is directly put on to full load - full speed.

When the engine and exhaust system have heated up beyond the dew point of the gas, the precipitation of condensate will stop and any residue in the system will be cleared by the hot exhaust gas.

If what appears to be condensate continue to form, check the coolant system for leaks.

Operation at low power can cause exhaust gas temperatures to fall below the dew point. This will lead to warm acidic condensate collecting in the exhaust system, with possible failure due to corrosion.

To reduce this problem, it is important to avoid shutting an engine down before it is fully warmed, and to minimise long periods of idling.

If extended idling is unavoidable, it is particularly important to operate on a low sulphur fuel.

After long periods of idling, run the engine on load before shutting down the engine, even if the engine is warm.

In an offshore environment, condensates may contain chlorides, increasing the rate of corrosion.

To minimise the risk:

- The induction air intake should be positioned and/or protected to reduce the ingestion of marine spray or mist when the engine is running.

- The exhaust outlet should be positioned and/or protected to reduce the ingress of marine spray or mist when the engine is not running. Rain caps should always be fitted to the exhaust outlet if there is a danger of this occurring.

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14 EXHAUST SYSTEM CONDENSATION

On initial engine start up, the operator could experience water vapour in the exhaust system. This can be visible at the exhaust outlet and can seep past the exhaust flame arresters.
Also, when the engine is idling, or when a lower than the rated power is being extracted from the engine, there is the potential for condensation to form on the exhaust side of the system,

In both cases, any sign of condensation at the exhaust flame arresters does not indicate a leak and the condensation will clear once the exhaust system reaches operating temperature.

Figure 10 – Condensation Seeping Past the Flame Arresters on Start Up

15 INLET MANIFOLD

15.1 Description

The inlet hydrostatic manifold forms part of the flameproof protection system and is designed and tested in accordance with the requirements of BS EN 1834:2000. Pyroban manufactured manifolds to replace the original engine manufacturer's manifold, if it cannot withstand the test pressure or, is not suitable for adaptation to the flame protection installation.

Additional Technical Data:-

Material: Mild steel FE430A or aluminium alloy depending on the application.

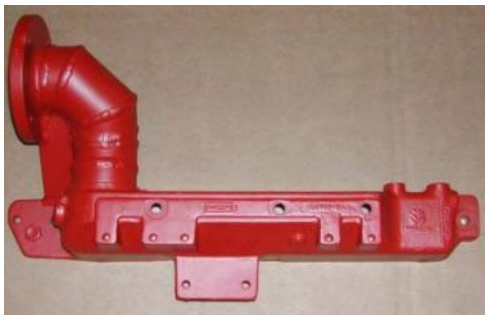

Figure 11 – Typical Inlet Manifold

15.2 Installation

Before installation, ensure any packing material is removed. Also, ensure that the inside of the manifold is free from swarf, grit, or weld residue, etc. before assembly to the engine. Serious valve and cylinder damage could result if any abrasive particles enter the engine.

Fit the inlet manifold to the cylinder head using new gaskets and tighten all fixings to the recommended torque figures. A Pyroban Supplied adapter may be required.

15.3 Maintenance

Periodically inspect exterior surface for any damage or cracks and check that all fixings are secure.

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16 INLET AIR SHUT-OFF VALVES

16.1 Description

Pyroban uses three types of inlet air shut off valves SV-D, SV-G and SV-H. These valves should be installed upstream of the flame arrester.

⚠ WARNING

NOTE THAT THE SVH VALVE HAS TEMPERATURE LIMITATION OF 150°C.

The SV-G and SV-H inlet air shut-off valves use a rotating 'butterfly' type valve to provide intake air shut-off and employ a free-flow design which provides very low pressure drop, to avoid any loss in engine shaft horsepower.

The SV-D inlet air shut-off valve uses a flat plate which blocks the valve intake orifice once activated, closing the air intake.

The inlet air shut off valves are described in more detail in the next sections.

16.2 Twin Intake Manifold Engine

Where an engine has twin intake manifolds each fitted with an air shut-off (ASO) valve, there is a risk of catastrophic turbo damage if one valve shuts down while the other is open.

SVH valves with a position switch indicator should be used in this configuration. In the event the position switches show that a single valve is shut, the control system (e.g. Programmable Logic Device (PLC)) should shut both valves immediately.

⚠ WARNING

TURBO DAMAGE MAY RESULT FROM THE SHUT DOWN OF IN A SINGLE INLET AIR VALVE ON A TWIN INTAKE MANIFOLD ENGINE

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17 SVD INLET SHUT-OFF VALVE

17.1 Description

Two alternative types of control cable and lever are used on these valves (short length cables and longer cables). It is important that the ball joint on the SVD valve end of the cable inner is screwed into the appropriate tapped hole in the start/reset/emergency stop lever. The SVD valve operating gear is manufactured from stainless steel and must not be painted.

The start/reset/emergency stop lever and cable mechanism allows the SVD valve to be held open to start or closed for emergency stop. The control cylinder is retained in the open position by an oil operated plunger. The plunger holds the trip lever until lack of oil pressure allows it to release. The trip lever also allows the SVD valve to close with the plunger up: this is the 'over speed condition'. To reset the SVD valve, select the 'reset' position with the start/reset/emergency stop lever and hold until maximum oil pressure is achieved. Then return the start/reset/emergency stop lever to the neutral position.

It may not be possible to reset the lever within approximately 30 seconds after the engine vacuum. Do not try and reset the lever until the vacuum level has fallen.

17.2 Setting the SVD Inlet Shutdown Valve Over Speed Spring

Assemble the complete inlet system from engine to air filter before attempting to set the SVD inlet shutdown valve over speed spring. This is very important, as an accurate setting cannot otherwise be achieved.
Fully warm up engine (some initial adjustment of the SVD inlet shutdown valve may be necessary to enable the engine to run at a suitable speed).
Use the control arm to reset the SVD inlet shutdown valve. It may not be possible to reset the SVD inlet shutdown valve until approximately 30 seconds after a shutdown due to the high engine inlet system vacuum. Do no attempt to reset the SVD inlet shutdown valve against this vacuum.

When fully warmed up, adjust the over speed spring as follows:

a) If the existing setting gives shut down below engine high idle (i.e., max. throttle/min. load) turn the adjuster screw one turn clockwise and rechecked. Continue this with finer adjustments, if necessary, until the SVD inlet shutdown valve gives shutdown at or just below high idle. If the existing setting does not give shutdown, turn the adjuster screw two or more turns anti-clockwise as necessary to give shut down below high idle and then adjust as above.
b) After completing (a) turn the adjuster screw one full turn clockwise.
c) Rapidly accelerate the engine up to high idle three or four times. If there is any tendency for the SVD inlet shutdown valve to actuate, repeat operations (a) and (b) above.
d) Tighten the locknut and wire-lock (always use new stainless steel wire).
e) Check the emergency stop by operating with engine running.

The over speed setting operation should be checked after 100 hours (or two weeks, whichever sooner) to allow for bedding in, and thereafter at 500 hours (or 3 months whichever is sooner) intervals.

17.3 Maintenance

Every week (50 hours) inspect the control mechanism and ensure that the roller on the trip lever is free to spin. Lubricate the valve spindle and all pivot points with a thin layer of oil. Carry out an emergency stop test by selecting 'Emergency Stop' with the start/reset/emergency stop control. Ensure that the control mechanism moves freely, closes correctly, and shuts down the engine. If operation of the SVD valve appears satisfactory but the engine does not stop within a few seconds, then the inlet system including manifold should be checked for leaks. Recheck the over speed setting every 3 months (500 hours).

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18 SVG INLET AIR SHUT-OFF VALVE

INCORPORATING INLET FLAME ARRESTER & BUTTERFLY VALVE (SVG-12, SVG-9.5, SVG-4)

18.1 Description

The inlet air shut-off valve uses a rotating disc 'butterfly' valve to provide intake air shut-off. The valve employs a free flow design which provides very low pressure drop to minimise losses in engine shaft horsepower. The valve is equipped with a pneumatic actuator, pressurized to run, spring return to close. The recommended actuation pressure is 60 psi to 80 psi (414 kPa to 552 kPa), with minimum actuation pressure of 35 psi (241 kPa) and maximum actuation pressure of 100 psi (690 kPa). The working temperature range.

The red plastic indicator on the end of the actuator spindle must not be used to turn the butterfly; it is for position indication only. Check that it aligns with the direction of the butterfly plate.

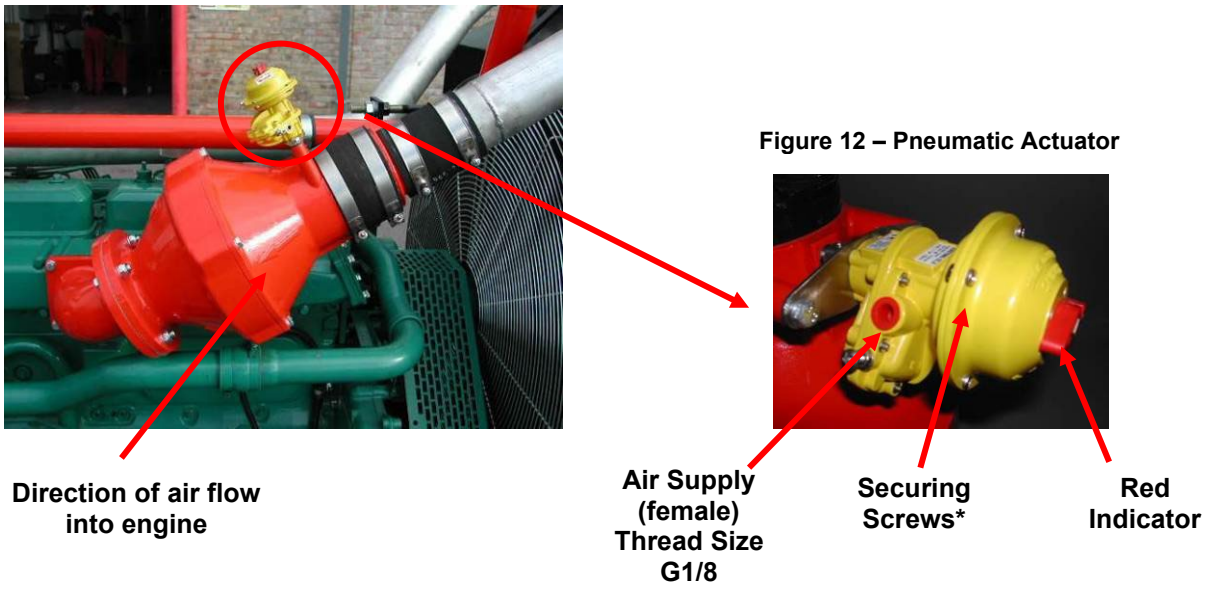


Figure 12 – Pneumatic Actuator

Figure 13 – SVG Inlet Air Shut-Off Valve Installation

18.2 Installation

Refer to assembly drawing for installation details.

Before installing the SVG inlet air shut-off valve, ensure any packing material is removed. The SVG inlet air shut-off valve may be assembled in any orientation.

Fit with the inlet flame arrester element on the engine side of the SVG inlet air shut-off valve. Refer to the air flow direction arrow.

The entire inlet system between the SVG inlet air shut-off valve and the engine must be tested and withstand 10 bar hydrostatic pressure. All other air inlets between the SVG inlet air shut-off valve and the engine must be closed or rerouted to prevent ingress of air or gases after shutdown.

An efficient 'dry type' air filter must be fitted upstream of the SVG inlet air shut-off valve. Regular servicing to the air filter will minimise fouling of the valve's flame arrester.

The control system pipework connection on the valve actuator is made with pipe thread fittings.

Any scale, dirt, etc. must be removed from the fittings and tubing before they are connected to the valve. Apply a quality thread sealant to the threaded pipe connections which must not be permitted to enter the valve actuator passages.

Alternatively, P.T.F.E. thread sealing tape may be used: but the tape must not be applied in a manner that enables shreds of tape to enter the valve actuator.

18.3 Maintenance

The air shut-off valve should be checked monthly for correct operation. Inspect the control mechanism and ensure that it functions correctly.

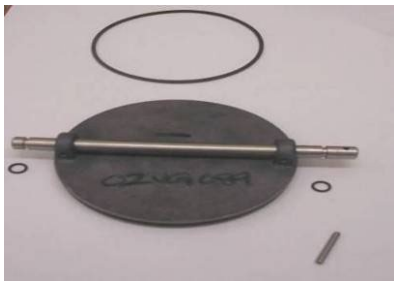
Carry out an emergency stop test by cracking a pipe fitting to reduce system pressure below the set trip pressure.

Ensure the SVG inlet air shut-off valve closes correctly and shuts down the engine.

If operation of the SVG inlet air shut-off valve appears to be satisfactory but the engine does not stop within a few seconds, then the inlet system including the inlet manifold should be checked for leaks.

The valve shafts are permanently lubricated by the manufacturer. The 'O' rings within the valve are used to seal in the lubricant and need not be serviced. If it is necessary to replace the 'O' ring on the periphery of the butterfly plate, remove the two screws (see ***** on picture) securing the mounting plate of the valve operator and rotate the disc 180° from its normal closed position.

Remove the 'O' ring and replace. When the SVG inlet air shut-off valve is downstream of a turbocharger the replacement 'O' ring must be Viton. Reverse the above sequence to reassemble.



Mark the plate for correct positioning. Make sure the plate is clean from dust and dirt. Apply silicone grease (DOW Corning DC4) and fit large ‘O’ ring to the plate.

Slide shaft through and fit the smaller ‘O’ rings in the same way (these act as dust seals) until they sit within the housing.

Tip plate up (vertical position), rotate shaft carefully whilst maintaining ‘O’ ring in housing. Previous marks should line up. Fit new stainless steel pin through plate and shaft. Repeat process for tother hole.

The actuator with its bracket is then positioned on to the shaft. Finally, fit the coil pin through the hole back into shaft and fit fixing screws.

18.4 Lubrication

Periodically, apply suitable light grease (e.g., Dow Corning MS4 or equivalent) to the 'O' ring in the periphery of the butterfly plate and to the mating conical surface inside the casting.

Note that the SVG inlet air shut-off valve shafts are permanently lubricated by the manufacturer.

18.5 Cleaning the Exhaust Flame arrester Inlet Flame Arrester Element:

Do not attempt to remove the flame arrester element from the SVG valve.

Do not clean by inserting probes as the fine passages could be enlarged thereby impairing the flame arrester performance.

Provided the maintenance and servicing of the induction air filter is carried out regularly, the inlet flame arrester should not require cleaning. However, if engine performance deteriorates due to a partially blocked inlet flame arrester, the inlet flame arrester can be washed with mild solvent and blown through with compressed air. Ensure the element is dry before re-assembling on engine.

Air supply should be clean and dry filtered to 25 microns.

18.6 Operating Instructions

To Start the Engine:

Carry out operator checks as defined in the Servicing section.

Ensure that the clean air supply is applied to the Pyroban SVG inlet air shut-off valve. If the safety control system has not actuated, the SVG inlet shut-off valve will open, the red indicator will show the plate orientation. Carry out pre-start checks as defined by engine manufacturer. Start engine in accordance with installer's instructions.

To Stop the Engine:

Stop the engine in accordance with the original engine manufacturer's instructions. Only shut down the engine on the SVG inlet air shut-off valve an emergency or for test purposes.

Stopping the engine using the SVG inlet shutdown valve will create a vacuum with the inlet system. This vacuum must dissipate before the inlet valve can be opened. Allow minimum 5 minutes before attempting to open valve.

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19 SVH INLET AIR SHUT-OFF VALVE

The SVH Valve is a series of air inlet shut-off valves – an integral safety component for diesel engines. Its primary use is to shut off the air supply to an engine to prevent a potential explosion.

Pyroban SVH valves are available with full ATEX certification making them safe for use in Zone 1, Zone 2, and Zones 21/22 areas for both gas and dust applications. The SVH Valve also carries IEXEx and NEC505 certification for its electrically actuated variants. There is also a non-certified electrical variant with screw terminal connections suitable for use in Added Safety applications.

The SVH Valve is used in diesel engine applications to shut off the air supply to an engine to prevent a potential explosion. Its primary use is to stop engine over speed but can also be used in the event of exhaust and coolant over-temperature or low oil pressure.

The design includes a metal to metal plate seal and high temperature bearings for turbo-charged or intercooled engines. The slim butterfly design has a low pressure drop avoiding loss in engine power.

There are numerous build configurations to suit a wide range of hazardous and non-hazardous applications including a choice of 3”, 5”, 8” SVH Valve sizes, and electric, pneumatic, or hydraulic actuation. SVH Valves can be supplied in their basic form, with hose ends or with an integral flame trap for the 3” and 5” versions. There are also several other options which are available including fail open/closed, flying leads, screw terminals, junction box, manual activation, and a wide range of tube ends.

Further information on the valve can be found in the SVH inlet Air Shut Off Valve manual COM001.

Figure 14 – SVH Inlet Air Shut-Off Valve

20 C15 AIR SHUT-OFF SYSTEM

The C15 Hazardous Location Engine is provided with an OEM inlet shut-off valve which is hydraulically controlled via the engine ECU. To interface one of the Pyroban electrical shut-down systems, a solenoid valve kit can be provided. The Solenoid valve can be either 12V or 24V depending on the application.

The solenoid valve kit is illustrated in the figure below. Refer to Work Instruction – **WI 364** for detailed installation guide.

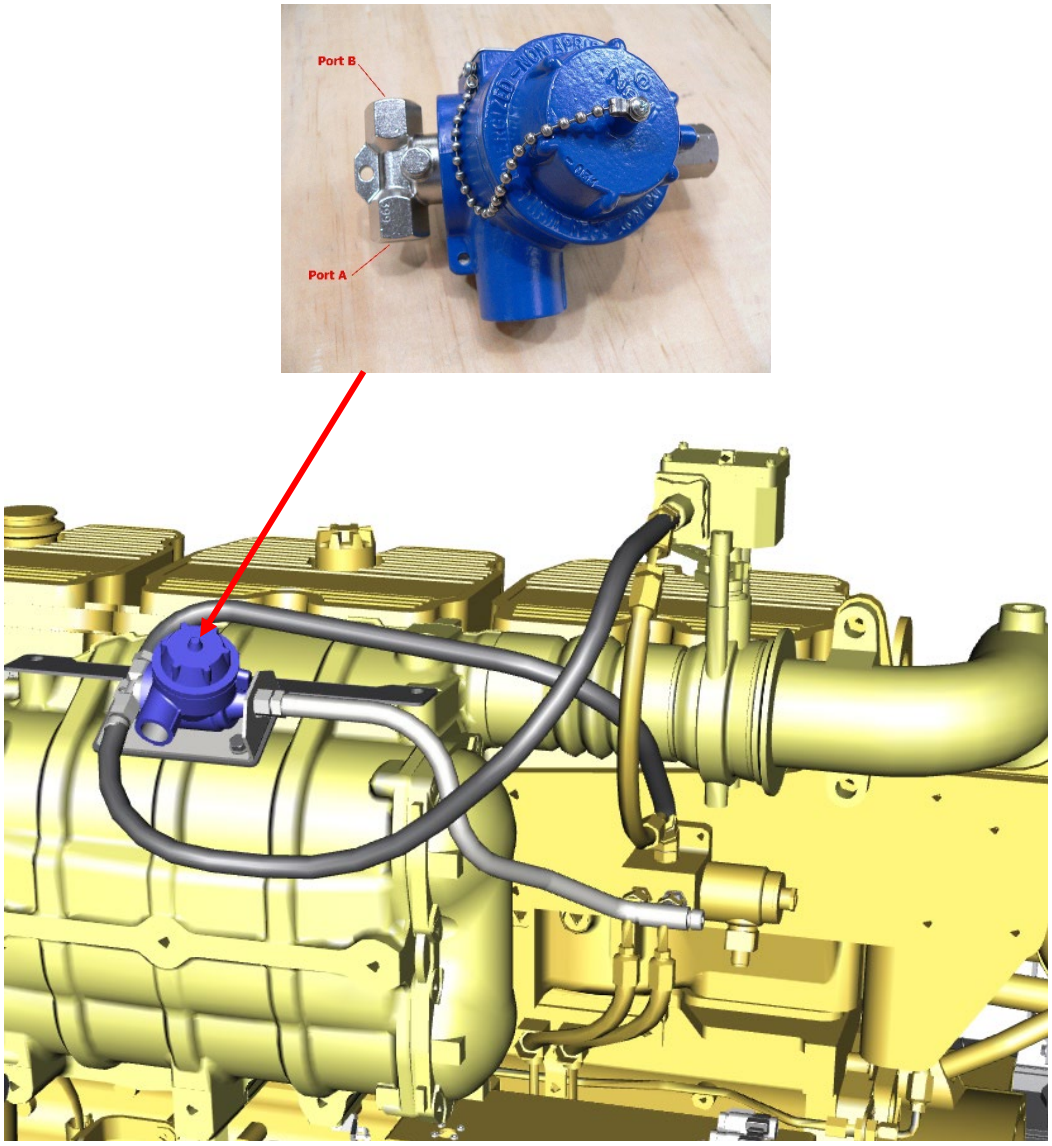

Figure 15 – Air Shut-Off Valve Solenoid

21 ILS INLET FLAME ARRESTER

21.1 Description

The ILS Flame arrester is mounted in the engine air intake system. The flame arrester is an in line flame arrester which is designed and tested to extinguish explosions created in the engine inlet system.

Figure 16 – ILS Inlet Flame arrester

21.2 Installation

Before installation, ensure that any packing material is blown well clear of all components.

The air flow direction is marked with an arrow on the ILS inlet flame arrester label and must be strictly adhered to.

Remove the air shutdown flap assembly, if fitted. Position the ILS unit in correct location for application, if in doubt contact Pyroban. Complete seal with fixings and gasket for flanges, or hose or hose and clamps for pipe end and adapters.

Re-site the air shutdown flap directly on top of the ILS unit and secure using a suitable gasket and fixings. Make good all pipework connections from the ILS unit to the inlet air cleaner.

21.3 Maintenance

Do not clean the ILS inlet flame arrester by inserting probes as the fine passages could be enlarged thereby impairing the flame arrester performance.

If necessary, the ILS inlet flame arrester should be washed in a suitable solvent. When washing parts in or with a cleaning solution provide adequate ventilation, safety equipment and protection as stated in the product data sheet. The flame arrester should then be blown through using compressed air. Ensure eye protection is worn during this operation.

Visually examine inside the ILS inlet flame arrester via the inlet and outlet ports by holding up to a light, ensuring that the passages are clear. Before refitting, ensure that the ILS inlet flame arrester casing and flanges are not damaged or corroded.

When assemblies with flanged connections are dismantled, new gaskets must always be used when refitting. Do not use sealer.

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Suggested Cleaning Fluids:

Product	Manufacturer	Contact Details
Jumbo	Unicorn Chemicals Limited.	+44 (0)1282 831251
Combat	Servo-Chem Limited.	+44 (0)1934 713999
Powerwash Regular	DEB Limited.	+44 (0)1773 855100

22 MAINTENANCE OF TURBO COMPRESSOR TO CHARGE AIR PIPE (WITH SCTB) FLAMEPROOF JOINT

This section describes the procedure for reassembling the charge air pipe (coated with soft compound thermal barrier) to the turbocharger compressor joint following disassembly. The instructions within this section must be followed explicitly to ensure continued compliance.

⚠ WARNING

THE JOINT BETWEEN THE TURBOCHARGER COMPRESSOR AND THE CHARGE AIR PIPE IS OF SPECIAL MANUFACTURE AND IS ESSENTIAL FOR COMPLIANCE WITH ATEX DIRECTIVE 2014/34/EU. FOR FURTHER GUIDANCE, CONTACT PYROBAN LTD.

Figure 17 – Charge Air Pipe (coated with SCTB) Flameproof Joint

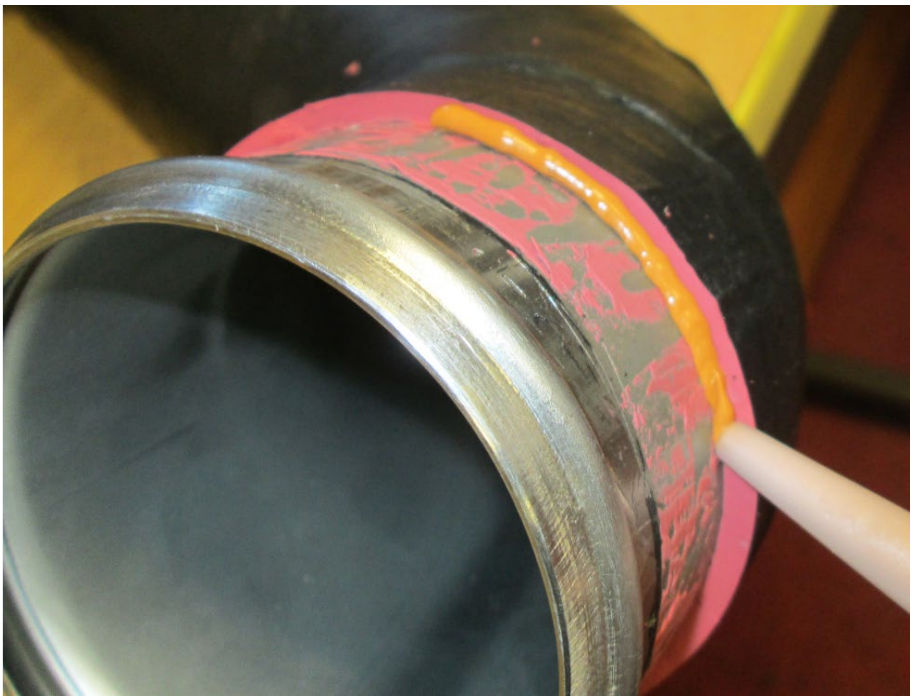

Figure 18 – Application of High Temperature Silicon

1. Run a small bead of hi-temperature silicon sealant (Pyroban part no. 300520125) along the exposed edge of SCTB (Figure 18).

Figure 19 – Appearance of High Temperature Silicon after Smoothing

2. Use a damp lint free cloth to smooth the silicon off so it appears as shown below:

Note: In the following sections, the orientation of the turbo charger and cross over pipe and the lengths of the silicon cuff and braiding are purely representative of what is installed.

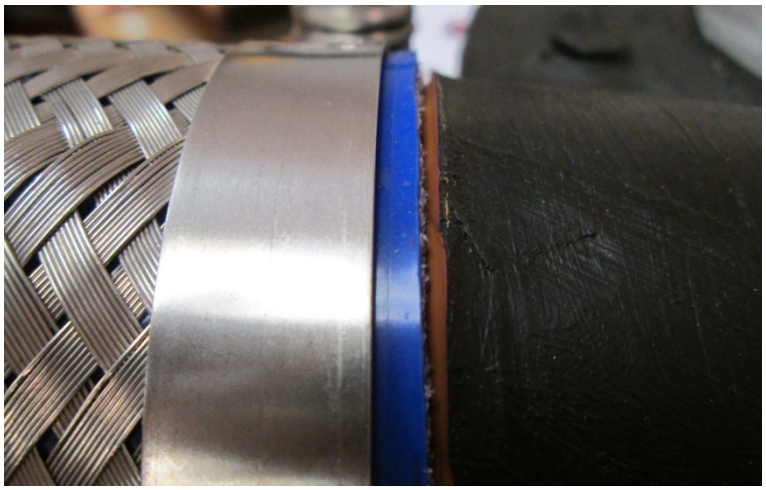

Figure 20 – Silicon Hose and Stainless Braiding after Installation

3. Install the silicon cuff and stainless steel braiding as shown above. On installation , a small gap will be present between the SCTB and cuff.

23 CONSTANT TENSION CLAMPS

23.1 Description

Constant tension clamps should be used to clamp the hoses and cuffing on your installation. The spring loading within the clamp provides superior clamping over a wide temperature range when compared to standard band clamp.

23.2 Installation

The constant tension clamp may be used to assemble the inlet system components including air filter, inlet shutdown valve, inlet adapter and coolant system where applicable and may also be used to assemble spark arresters on smaller applications.

Below is a table of constant tension clamps available. When ordering, ensure the outside diameter of the hose to be clamped is approximately in the mid-range of the clamp size selected.

PYROBAN PART NO	SAE SIZE	TRIDON FLEX-GEAR HD 45 SERIES PART NO	CLAMPING RANGE						IMAGE
			English (in.)		Metric (mm)		Fits Hose I.D.		
			Min. Dia.	Max. Dia.	Min. Dia.	Max. Dia.	Min. Dia.	Max. Dia.	
3010005116	175	45175	1	1 3/4	25	45	7/8	1 1/8	
3010005117	212	45200	1 1/4	2 1/8	32	54	1	1 1/2	
3010005118	262	45250	1 3/4	2 5/8	45	67	1 1/2	2	
3010005119	312	45300	2 1/4	3 1/8	57	79	2	2 1/2	
3010005120	362	45350	2 3/4	3 5/8	70	92	2 1/2	3	
3010005121	412	45400	3 1/4	4 1/8	83	105	3	3 1/2	
3010005122	462	45450	3 3/4	4 5/8	95	117	3 1/2	4	
3010005123	512	45500	4 1/4	5 1/8	108	130	4	4 1/2	
3010005124	562	45550	4 3/4	5 5/8	121	143	4 1/2	5	
3010005125	612	45600	5 1/4	6 1/8	133	155	5	5 1/2	
3010005126	662	45650	5 3/4	6 5/8	146	168	5 1/2	6	
3010005127	712	45700	6 1/4	7 1/8	159	181	6	6 1/2	
3010005128	762	45750	6 3/4	7 5/8	172	193	6 1/2	7	
3010005129	812	45800	7 1/4	8 1/8	184	206	7	7 1/2	
3010005130	862	45850	7 3/4	8 5/8	197	219	7 1/2	8	
3010005131	912	45900	8 1/4	9 1/8	210	232	8	8 1/2	

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24 'TURBOGUARD' INLET FLAME ARRESTER

24.1 Description

A crimped ribbon flame arrester designed to prevent flame transmission between engine inlet system and turbocharger.

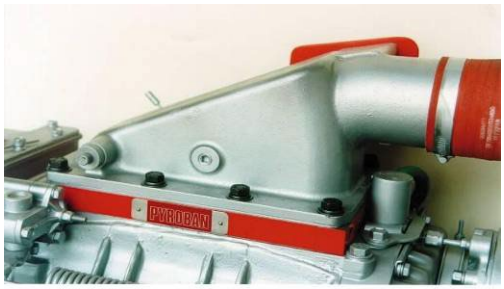

Figure 21 – Typical Turboguard Inlet Flame arrester

24.2 Installation

Before installation, ensure that any packing material is blown well clear of the component.

Do not clean the 'Turboguard' inlet flame arrester by inserting probes, as the fine passages could be enlarged thereby impairing the flame arrester performance.

Secure using suitable gaskets and fixings. Do not use sealer.

24.3 Maintenance

If necessary, the 'Turboguard' inlet flame arrester should be removed from the engine and washed in a suitable solvent. The flame arrester elements should then be blown through using compressed air.

Visually examine the crimped element by holding up to light, ensuring that the passages are clear.

Before refitting, ensure that the flame arrester mating faces are not damaged or corroded.

The 'Turboguard' inlet flame arrester should be handled with care. Do not drop.

Ensure new gaskets are always used when refitting. Do not use sealer.

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24.4 Servicing

The following table defines the servicing requirements for the Pyroban system (where applicable). Only competent and suitably trained staff may operate, service and maintain the equipment. The Person in Authority is responsible to authorize personnel to undertake service work.

- Items marked ✓ are to be carried out by the Service provider.

Items listed in this schedule may not be supplied or fitted. Refer to parts list to identify installed parts. A record of servicing and maintenance should be maintained.

Task-In addition to original requirements	Daily 8-12 hrs	Weekly 50 hrs	1 Month 200 hrs	3 Months 500 hrs	6 months 1000 hrs	2 Years 4000 hrs
Inlet Flame arrester: check exterior for damages or distress, check pipework and joints for leaks.	✓					
Inlet Manifold: inspect exterior surface for damage or cracks, check that all fixings are secure.			✓			
SVG Inlet Shut-Off Valve: check for correct operation.			✓			
SVD Inlet Shutdown Valve with Oil Control: inspect the control mechanism and ensure that the roller on the trip lever is free to spin. Recheck the over speed setting		✓		✓		
Inlet Air Shut-Off Valve: visual inspection. Engine shut-down test.				✓		

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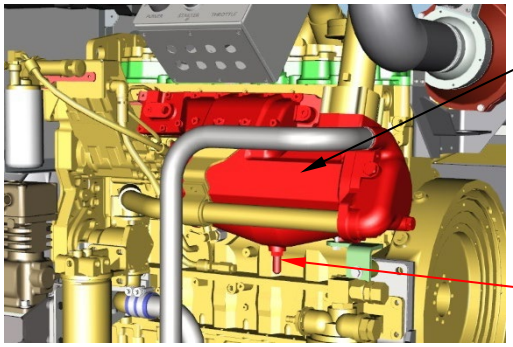
25 AFTER COOLER CONDENSATION DRAIN FLAME ARRESTER INSTALLATION

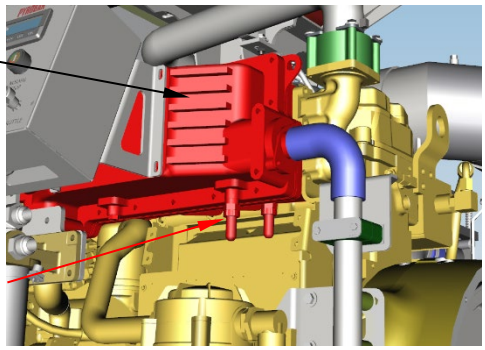
The Caterpillar hazardous location engines C32, C9 and C7 are provided with Separate Circuit After Cooler (SCAC) condensation drain valve. These drain valves are not certified to be flameproof.

To fulfil the requirement of EN 1834-1 and comply with the Applications and Installations guide (LEBW0003); the drains should be installed with an end of line flame arrester.

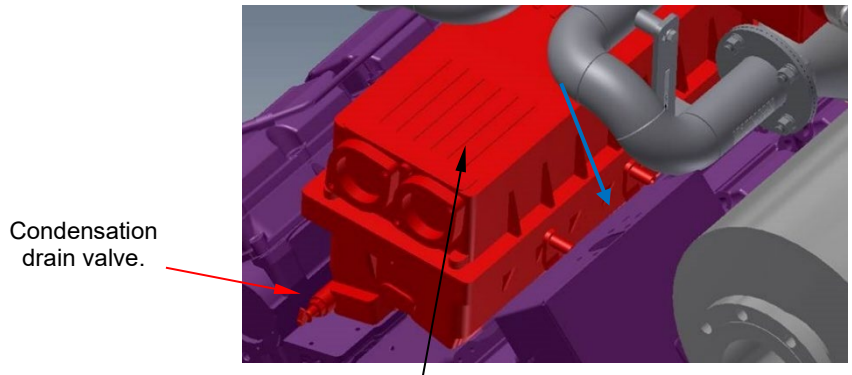
Compliance with this requirement is compulsory to maintain the integrity of the flameproof enclosure. **Pyroban can be consulted for a suitable solution**.



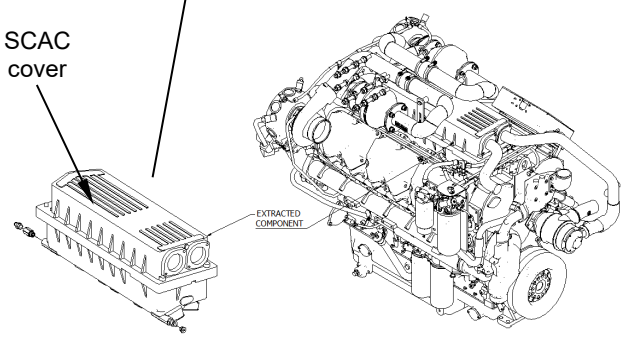
C7 Engine - SCAC drain valve as installed from the factory.



C9 Engine - SCAC drain valve as installed from the



C32 Engine - SCAC drain valve as installed from the factory.



26 3 WAY STOP VALVE

26.1 Description

This valve was developed for use in manual and automatic hydraulic or pneumatic control systems. It is a precision item made from cast and machined aluminium that is versatile operating over a wide pressure range. This valve incorporates a manual reset latch which automatically drops out on introduction of pilot pressure.

3-way stop valves feature modular construction and incorporate a sliding spool. The standard spool has a small centre dead spot position and no valve port overlap. With the spool fully to the left (rest position), port 2 is connected to Port 3 with Port 1 closed. With the spool moved to the right (actuated position), Port 2 is connected to Port 1 with Port 3 closed.

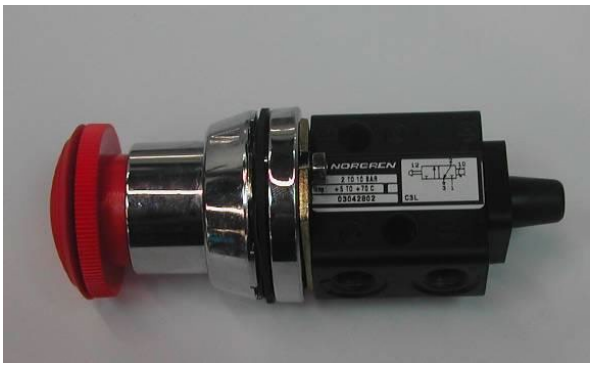


Figure 22 – Manually Operated Valve

Note: All connections 1/8” NPT Thread

26.2 Installation

Use a thread sealant (e.g., ‘Loctite’ pipe sealant) to the pipe thread connections without allowing any sealant to enter the valve passages. PTFE thread sealing tape may be used but must be applied so that shreds of tape do not enter the valve. Avoid over tightening the fittings on the valve port bosses as they can be cracked, especially when thread sealing tape is used.

Care should be taken to prevent dirt from entering the ports.

26.3 Maintenance

The condition of the valve can be monitored by checking for leakage. Inspect for wear at monthly intervals and clean as required.

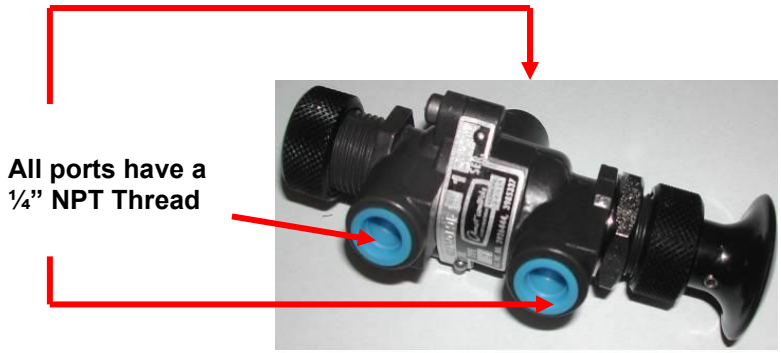
If it is necessary to replace the seal rings in the valve due to wear, damage, or seal hardness, removing the end cap allows the spool to be removed. Remove the old seal rings, thoroughly clean the grooves, and fill with Dow Corning No. 33 grease.

Lightly coat the new seal rings with grease. Insert the thin tall section of the ring into one side of the groove. Work around the ring until it is uniformly positioned. Remove any excess grease and re-install the piston.

27 3 x 2 WAY VALVE

27.1 Description

3 x 2 way valves are of modular construction and incorporate a sliding spool. The standard spool has a small centre dead spot position and no valve port overlap. With the spool fully to the left (rest position), Port 2 is connected to Port 3 with Port 1 closed. With the spool moved to the right (actuated position), Port 2 is connected to Port 1 with Port 3 closed.



27.2 Installation

Apply a good quality thread sealant such as 'Loctite' pipe sealant to the pipe thread connections without allowing any sealant to enter the valve passages.

Thread sealing tape may be used but must be applied so that shreds of tape do not enter the valve.

Avoid over tightening the fittings on the valve port bosses as they can be cracked, especially when thread sealing tape is used.

Care should be taken to prevent the ingress of dirt from entering the ports.

27.3 Maintenance

Wear can be observed by checking for leakage which will increase as there is more wear in the valve. Inspect at monthly intervals to detect any wear and clean as required.

If it is necessary to replace the seal rings in the valve due to wear, damage, and hardness, remove the valve spool by removing the end cap and pull out the spool. Remove the old seal rings, thoroughly clean the grooves, and fill the grooves with Dow Corning No. 33 grease.

Lightly coat the new seal rings with grease. Insert the thin tall section of the ring into one side of the groove. Work around the ring until it is uniformly positioned. Remove any excess grease and re-install the piston.

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28 TOGGLE VALVE

28.1 Description

This valve is developed for use in manual and automatic hydraulic or pneumatic control systems. It offers versatility in operating requirements and allowable pressure limits. Made from precision cast and machined aluminium parts, this valve has a manual reset latch which automatically will drop out on introduction of pilot pressure and returns automatically on loss of pilot pressure.

Toggle valves feature modular construction and incorporate a sliding spool. The standard spool has a small centre dead spot position and no valve port overlap. With the spool fully to the left (rest position), port 2 is open to Port 3 and Port 1 is closed. With the spool moved it the right (actuated position), Port 2 is open to Port 1 and Port 3 is closed.

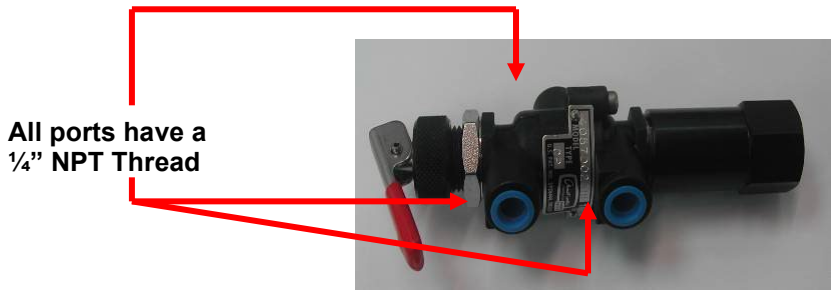


Figure 23 – Manually Latched or Pressure Operated Toggle Valve

28.2 Installation

Apply a good quality thread sealant such as 'Loctite' pipe sealant to the pipe thread connections without allowing any sealant to enter the valve passages.

Thread sealing tape may be used but must be applied so that shreds of tape do not enter the valve.

Avoid over tightening the fittings on the valve port bosses as they can be cracked, especially when thread sealing tape is used.

Care should be taken to prevent the ingress of dirt from entering the ports.

28.3 Maintenance

Wear can be observed by checking for leakage, which will increase as there is more wear in the valve. Inspect at monthly intervals to detect any wear and clean as required.

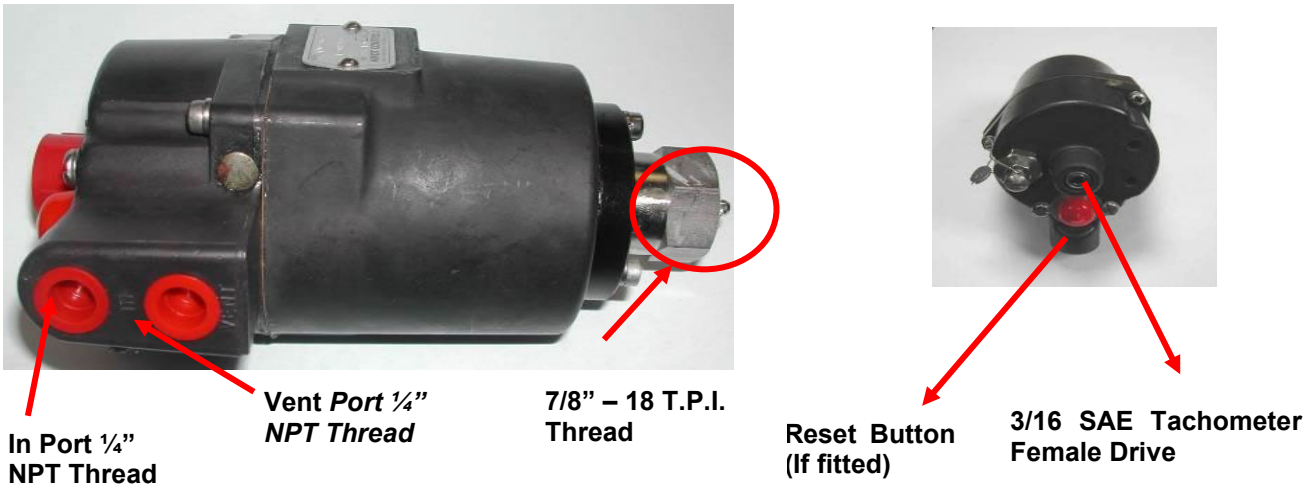
If it is necessary to replace the seal rings in the valve due to wear, damage, and hardness, remove the valve spool by removing the end cap and pull out the spool. Remove the old seal rings, thoroughly clean the grooves, and fill the grooves with Dow Corning No. 33 grease.

Lightly coat the new seal rings with grease. Insert the thin tall section of the ring into one side of the groove. Work around the ring until it is uniformly positioned. Remove any excess grease and re-install the piston.

29 OVER SPEED VALVE

29.1 Description

The over speed valve is a sensor that provides a pneumatic or hydraulic signal when the engine runs faster than a pre-set speed. Its mountings allow for fitment of original engine tachometer if required. Within the selected speed range, the 'trip point' is readily adjustable by loosening the locknut and turning the adjusting screw clockwise to increase and counter-clockwise to decrease the over speed value.



For general over-speed protection, the engine should be shut down when the crankshaft speed reaches 10% above the maximum intended operating speed of the engine. For example, an engine with operating speed for the application of 2100 rpm should be shut down if the engine reaches 2300 rpm.

29.2 Typical Installation

Care must be taken to assure that the SAE drive tang is properly located in the mating slot of the engine tachometer drive. If applicable, the original engine tachometer can then be attached to the free end of the unit provided it is equipped with a standard 3/16" SAE tachometer female drive with a 7/8" – 18 SAE mounting. Check the drive shafts are properly located before tightening the fastenings. The body is provided with 2 off ¼" - 20 NC x ½" deep mounting holes for the attachment of a stiffening bracket.

All tubing and hose connections should be tightened securely to avoid leakage and thread sealant applied to thread connections. The output signal should not be piped to a common vent header. Avoid introducing contaminants into the system. If over speed occurs, the reset button (if fitted) must be depressed before restart.

⚠ WARNING

THE SPEED RATIO OF THE DRIVE SYSTEM USED TO DRIVE THE SPEED VALVE MUST BE TAKEN INTO CONSIDERATION WHEN SELECTING THE SPEED VALVE TRIP POINT.

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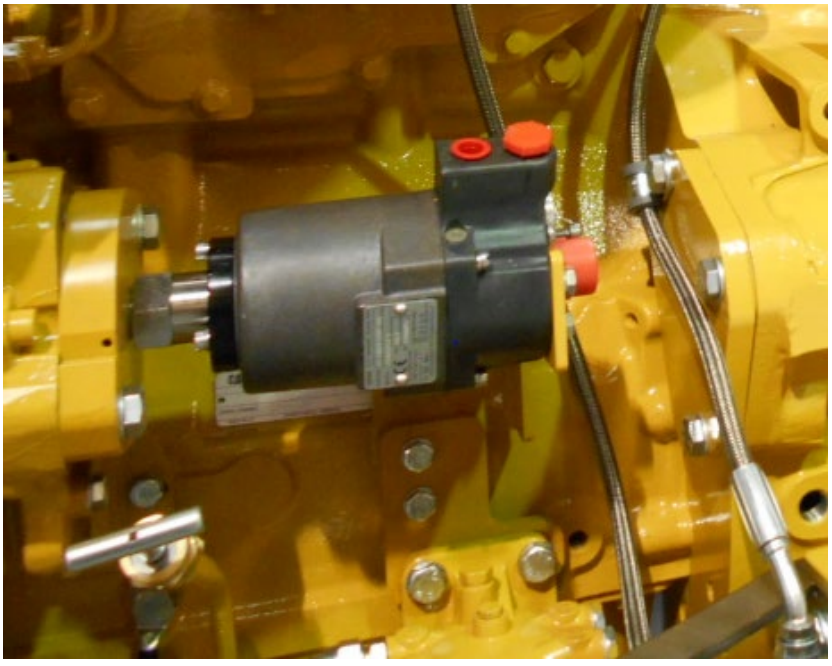
For example, if a Power Take Off drive has a 1:2 ratio compared to crankshaft speed i.e., the PTO output shaft rotates at 50% of the crankshaft speed, then the speed valve trip point must be set accordingly. When this is the case; an engine with maximum operating speed of 2100 rpm requires the engine to be shut down at 2300 rpm using a speed valve with trip point set to 1150 rpm **NOT** 2300 rpm. The following images give typical examples of the over speed valve installation:



29.3 Maintenance

Properly installed ‘Speed Valves’ require practically no maintenance other than a 12 monthly check to detect for any wear. It is recommended that the inspection and cleaning be incorporated into a normal preventive maintenance program. Seals and ‘O’ rings should be checked for wear, damage and hardness and be replaced, as necessary. Lightly coat the seals and/or ‘O’ rings with appropriate grease before installation. Other Internal parts should be inspected for excessive wear or damage and replaced, as necessary. The over speed trip function of the speed valve should be checked every 6 months by over speeding the engine.

30 FUEL SHUT-OFF VALVE

30.1 Description

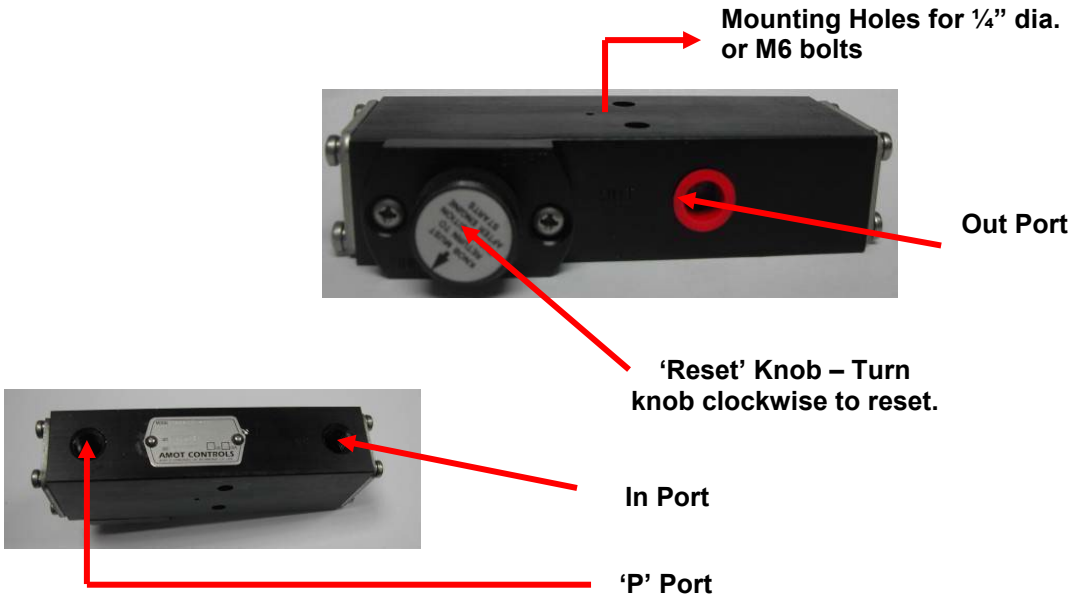
The diesel fuel shut-off valve intended for fitting into the ¼" inside diameter fuel line typically fitted to engines up to 300-400 HP range. The valve completely shuts-off the fuel supply and does not, therefore, provide a pilot facility to enable an engine to run at idle speed. It can be used to stop an engine by shutting-off the fuel supply or, when an engine is stopped by other means, the valve isolates the fuel supply automatically, providing additional safety in case of fire risk. It is completely mechanical in operation controlled by either pneumatic or hydraulic pressure, usually lubricating oil.

When the valve is fitted upstream of the lift pump (see "Installation"), then in the absence of other information, the depression at the lift pump inlet at full load rated speed should not exceed 4 inches (100mm) Hg or 5 inches (127mm) Hg in the case of other applications. Any figures quoted by the engine manufacturer for fuel line restriction must be complied with.

The fuel shut-off valve is of the normally closed type, where the fuel supply is always shut-off except:

i) When the fuel shut-off valve is manually latched into the 'Start' position.
ii) When the fuel shut-off valve is maintained in the 'Run' condition by control system pressure.

When the fuel shut-off valve is latched in condition (i), application of control system pressure will unlatch the valve and cause it to be armed, ready to shut down as soon as control pressure is lost. Hence the system is essentially 'fail-safe'.



Note: All connections ¼" NPT Thread

Fuel Shut-Off Valve Technical Data

Maximum working pressure:	Fuel 'IN' port = 200 psi (13.8 bar) Pressure 'P' port = 150 psi (10.34 bar)
Trip setting (falling pressure):	5 ± 2 psi (non-adjustable)
Rise of trip setting per 100 psi of fuel pressure:	2 psi
Flow coefficient:	C_v = 1.7
Dimensions:	6 x 1¼ x 2 7/8 inches (153 x 32 x 73 mm)
Approximate weight:	3 lbs (1.4 kg)

Nylon Tubing Technical Data

Maximum working pressure (-40°C to +20°C):	264 psi (8.2 bar)
Working pressure factors at other temperatures:	+30°C x 0.83 +40°C x 0.75 +50°C x 0.64
Minimum centre-line band radius	2½ inches (64 mm)

30.2 Operation

With a pneumatically controlled fuel shut-off valve, pneumatic pressure must be supplied to the unit before attempting to start the engine.

With a lubricating oil controlled fuel shut-off valve, rotate the knurled 'Reset' knob approximately half-a-turn clockwise until it latches into position with the arrow pointing to 'Start'. The fuel shut-off valve is then open, and the engine may be started. Once the engine is running and oil pressure becomes established, the fuel shut-off valve will automatically become armed being held open by the oil pressure. This will be indicated by the 'Reset' knob rotating anti-clockwise so that the arrow points to 'Run'.

30.3 Installation

The fuel shut-off valve must be mounted on a suitable bracket or panel using 1/4 inch diameter or M6 bolts located through the mounting holes provided. These mounting holes are pitched at 1 inch (25.4mm) centres. It should be located in a protected area, free from possible damage and positioned so as to ensure the most direct fuel pipe run.

The knurled 'Reset' knob must be easily accessible when the fuel shut-off valve is fitted in position. The fuel line to the engine must be interrupted and connected to the 'IN' and 'OUT' ports on the fuel shut-off valve.

Pyroban Limited's normal recommendation is to install the fuel shut-off valve between the final filter and the injector pump or the unit injectors (except on Cummins engines where the fuel shut-off valve should be in the line from the PT fuel pump to the injectors).

The area safety authority must be consulted before the fuel shut-off valve position is finalised as there may be a requirement to position the valve further upstream. If this is the case, any risk of air leakage into the fuel system is reduced when the same control medium operates a Pyroban SVD inlet shutdown valve. The SVD inlet shutdown valve trips at a higher pressure, giving shutdown on induction air with fuel shut-off as an additional safety feature.

Control system pressure is connected to the 'P' port on the fuel shut-off valve. Where lubricating oil pressure is used, this must be taken from the engine via an orifice and routed to any sensing devices (e.g., temperature valves, speed valve) as described elsewhere.

Control pressure must be taken from an inlet port tee of the sensor which is furthest downstream from the orifice. This minimizes the effect of pressure gradient in the pipework when a sensor operates and discharges via the vent line.

The fuel shut-off valve has taper threaded ports for fuel in, fuel out and control pressure connections. A 2 metre length of nylon tubing and a selection of suitable compression fittings are provided, both straight and right-angled types. The straight connectors must be used where possible to minimize restriction.

The following points should be noted when assembling these couplings:

a) Tubing must be cut-off square and deburred.
b) Place the tubing nut and sleeve on tube.
c) Fit the tubing to the coupling and ensure it is pushed fully home.
d) Hold the tubing square to the coupling and tighten the tubing nut finger-tight so that the sleeve is trapped between the nut and the counter bore.
e) While holding the tube firmly in contact with the tubing stop, screw the tubing nut down (between 1 and 1¾ full turns).
f) Slacken off the assembly and then re-tighten.

Recommended torques:

- Nylon 8 N-m (70 lb-in)
- Bundy 11.3 N-m (100 lb-in)

30.4 Maintenance

Weekly (or every 50 operating hours) turn the ‘Reset’ knob clockwise and check that it remains latched in the ‘Start’ position with no control system pressure applied. Then apply control system pressure and check that the ‘Reset’ knob automatically rotates back to the ‘Run’ position.

Every six months (or every 1000 operating hours) check the fuel shut-off valve for closure on falling pressure at the correct trip point setting. In case of difficulty, a service exchange unit should be obtained from Pyroban Limited.

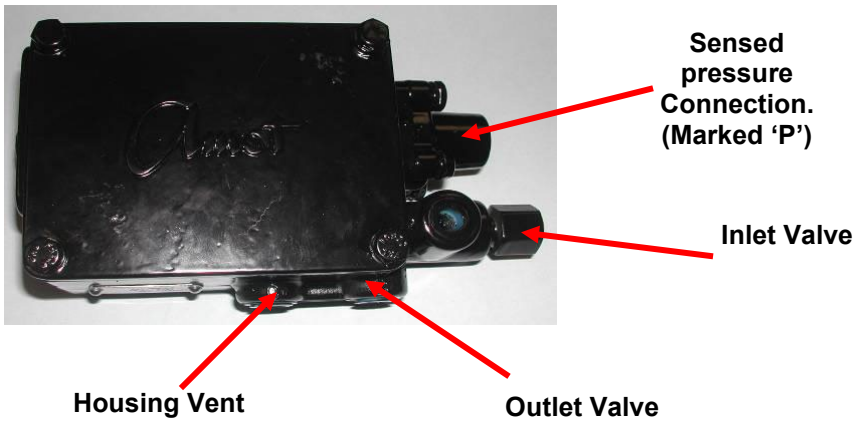
Do not attempt to dismantle or repair the fuel shut-off valve as this may invalidate the Pyroban warranty.

31 OIL PRESSURE VALVE

31.1 Description

Oil Pressure Valves are 2-way open sensors (closed under satisfied operating conditions) which are opened by the sensed pressure decreasing or increasing past the trip point. This dual purpose construction provides a wide latitude of application and permits easy field adjustment. They are essentially snap-acting, and the valves are suitable for use on hydraulic or gas control systems up to 80 psi maximum control pressure. The case is made of aluminium and all the internal valve parts are made of aluminium or stainless steel, providing corrosion resistance to most control fluid.

The operation of the Oil Pressure Valve is simple and straightforward. The sensed pressure moves the diaphragm or piston operator against the larger adjusting spring. The motion is transmitted to the valve through a lever and fulcrum pin which operates the valve pushrod.



Note: All connections ¼" NPT Thread

31.2 Installation

Oil pressure valves can be mounted in any position (two 3/8" – 16NC tapped holes through the back of the case).

All tubing and hose connections should be tightened securely to avoid leakage and thread sealant applied to thread connections. ¼" O.D. tubing is the minimum size recommended for air or gas. 5/16" O.D. is the recommended minimum for short lengths of lube oil line, while 3/8" O.D. may be required for longer lengths, especially in cold weather conditions.

Do not allow sealant to enter the valve passages. Care should be taken to prevent the ingress of dirt from entering the ports.

The valve should be secured against vibration and not be supported by the piping. When checking an oil pressured system, be sure all trapped air is bled from the connecting tubing. If this is necessary, start at the first connection after the restricting orifice and bleed each connection in turn until all air is purged. The most critical point is at the master safety control.

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31.3 Maintenance

Properly applied and installed, Oil Pressure Valves require practically no maintenance. Inspect at 12 months intervals to detect any wear and clean as required.

Seals and 'O' rings should be checked for wear, damage and hardness and replaced, as necessary. Lightly coat the seals and/or 'O' rings with appropriate grease before installation.

Other internal parts should be inspected for excessive wear or damage and replaced, as necessary.

The Oil Pressure Valve should be checked monthly for proper function by simulating an unsafe condition.

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32 PNEUMATIC SINGLE ACTING CYLINDER

32.1 Description

For engines fitted with mechanical fuel cut off, the pneumatic actuator will be fitted in place of the original cable mechanism.

The pneumatic actuator forms part of the protection control system, providing fuel shut off in event of high temperature (coolant, exhaust), engine over speed (in addition to air intake shut off) and emergency stop situations.

The pneumatic cylinder opens to the 'RUN' position when the system reset control on the control panel is actuated in the 'up' position. This opens the fuel rack, and the engine can be started.

The system reset control returns to the run (downward) position when the correct oil pressure is reached.

The pneumatic cylinder returns to the 'STOP' position, closing the fuel rack when the 'Engine Stop Button' is pushed in for five seconds and then released or on emergency stop, high exhaust temperature, high water temperature and engine over speed situations.

32.2 Installation

Pyroban supplies the pneumatic single acting cylinder of the correct length and travel to achieve correct fuel stop operation.

Ensure the actuator linkage does not induce side load.

32.3 Maintenance

Check exterior for signs of damage or distress. Check the mechanical integrity of all components and joints. Perform visual check of interior via inlet and outlet ports.

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33 EXHAUST TEMPERATURE PROBE

33.1 Description

Exhaust temperature probes are devices responsible for the gas temperature monitoring of the protection system. This is a normally closed, two-way valve opening at 150°C to 200°C (rising) suitable for use with oil/air control systems with a restricted supply. The maximum pressure that can be applied to the inlet port is 9 bar (125 psi).

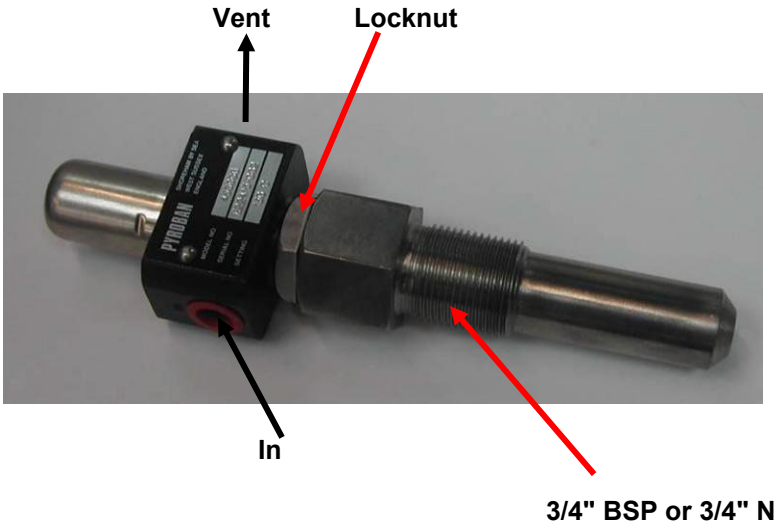
33.2 Installation

In the event of this component being tampered with in any way, Pyroban Limited will not accept any responsibility and any warranty agreement will be invalidated.

The probe is equipped with a ¾" BSP/NPT (depending on the component selected) hexagon for tightening into the manicooler or cooler exhaust outlet adaptor. Rotate it to the desired position and tighten the locknut. Do not use a wrench on the aluminium valve body.

Pipe the pressure source to the 'In' port and use apply small amount of pipe sealant to the fitting.

The 2 ports are threaded ¼" BSP.



33.3 Maintenance

Visually check the cables for damage or deterioration. Check that all fixings are secure and inspect the unit for mechanical damage. Check tightness in pockets.

34 COOLANT TEMPERATURE PROBE

34.1 Description

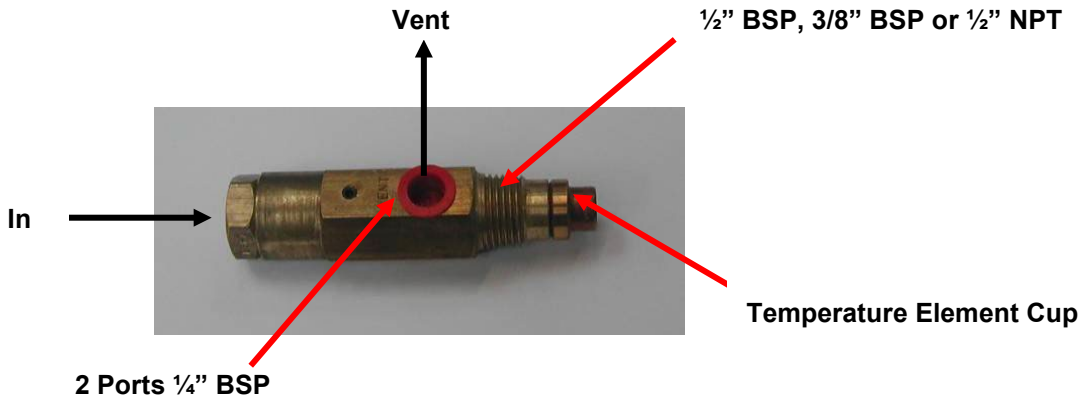
This is a normally closed, two-way valve, opening at 100°C to 110°C (rising) and suitable for use with oil/air control systems with a restricted supply. The maximum pressure at the 'In' port is 125 psi (8.6 bar).

34.2 Installation

The probe is provided with a ½" BSP, 3/8" BSP or ½" NPT (depending on the application, refer to parts list) thread for mounting into one of the thermostat outlets. If a suitable tapping is not available, one will have to be made as close to the thermostat bypass as possible.

Before installing the probe, it is advisable to run a 23/32" diameter tap drill through the taping in which the unit will be placed. Some commercial fittings etc. are not tapped deeply enough and the threads may cause damage to the temperature element cup.

Pipe the pressure source to the 'In' port using a small amount of pipe sealant on the fitting.



34.3 Maintenance

Visually check the cables for damage or deterioration. Check that all fixings are secure and inspect the unit for mechanical damage. Check tightness in pockets.

35 PNEUMATIC CONTROL SCHEMATIC

The following page contains a generic schematic diagram of the pneumatic control systems typically used for the starting system and the safety shutdown system.

The system uses a variety of pneumatic valves and cylinders which are described in other sections of this document, as well as tubing and hoses.

GENERIC PNEUMATIC CONTROL SCHEMATIC

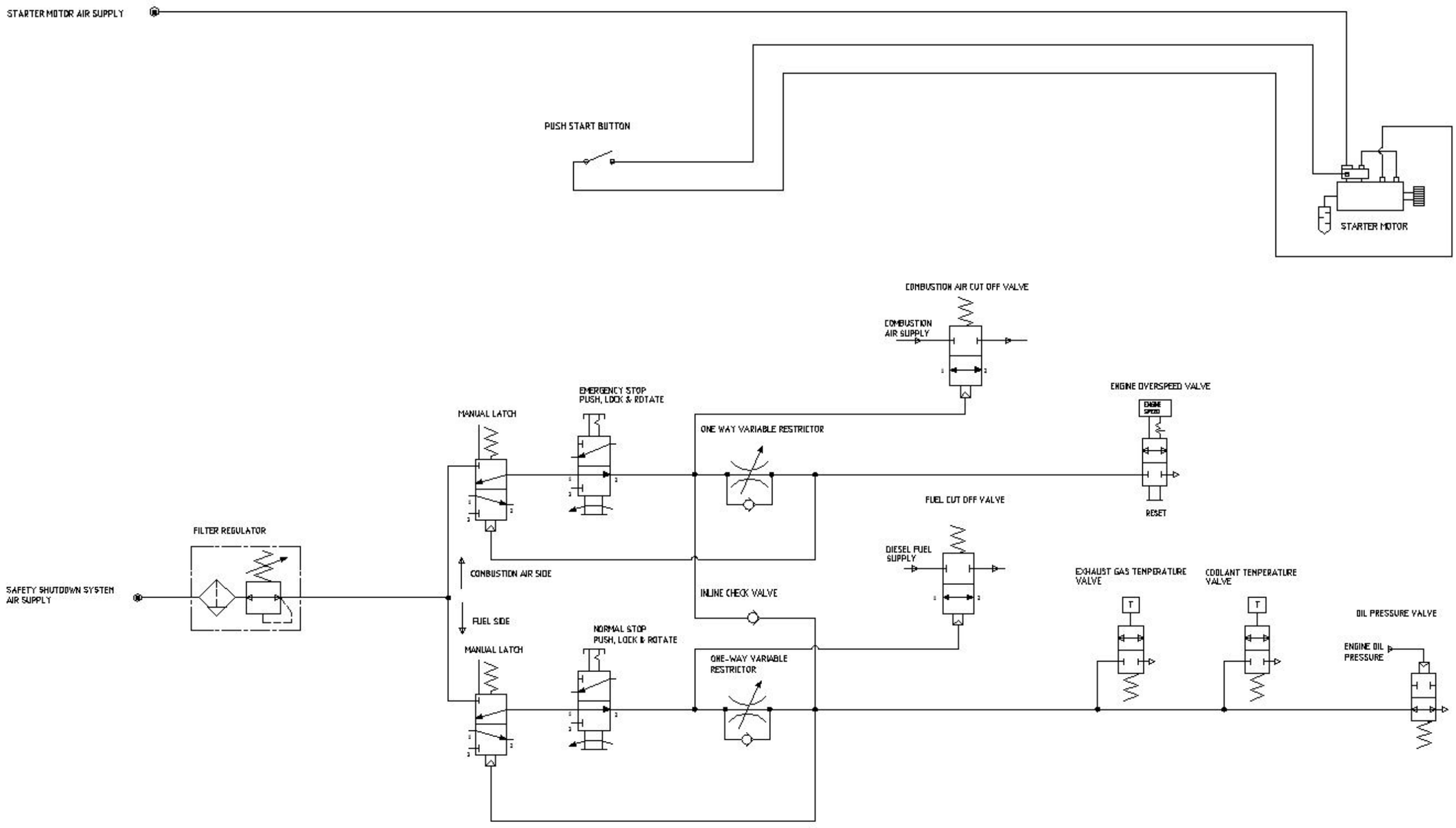


Figure 24 – Generic Pneumatic Control Schematic

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36 SERVICING OF PNEUMATIC & HYDRAULIC CONTROLS

The following table defines the servicing requirements for the Pyroban system (where applicable). Only competent and suitably trained staff may operate, service and maintain the equipment. The Person in Authority is responsible to authorize personnel to undertake service work.

- Items marked ✓ are to be carried out by the Service provider.

Items listed in this schedule may not be supplied or fitted. Refer to parts list to identify installed parts. A record of servicing and maintenance should be maintained.

Task-In addition to original requirements	Daily 8-12 hrs	Weekly 50 hrs	1 Month 200 hrs	3 Months 500 hrs	6 months 1000 hrs	12 Months 2000 hrs
3-Way Stop Valve: inspect at monthly intervals to detect any wear and clean as required.			✓			
3 x 2 Way Valve and Solenoid Valves: inspect at monthly intervals to detect any wear and clean as required.			✓			
Toggle Valve: inspect at monthly intervals to detect any wear and clean as required.			✓			
Fuel Shut-Off Valve: turn the 'Reset' knob clockwise and check that it remains latched in the 'Start' position with no control system pressure applied. Check the fuel shut-off valve for closure.		✓			✓	
Speed Valve: inspect at 12 months intervals to detect any wear and clean as required. It is recommended that the inspection and cleaning be incorporated as a normal preventive maintenance program.					✓	✓
Oil Pressure Valve: inspect at 12 months intervals to detect any wear and clean as required. The Oil Pressure Valve should be checked monthly for proper function by simulating an unsafe condition.			✓			✓
Pneumatic Cylinder: inspect at monthly intervals to detect any wear and clean as required.			✓			
Exhaust Temperature Probe: Visually check the cables for damage or deterioration. Check that all fixings are secure and inspect the unit for mechanical damage. Check tightness in pockets.			✓			
Coolant Temperature Probe: Visually check the cables for damage or deterioration. Check that all fixings are secure and inspect the unit for mechanical damage. Check tightness in pockets.			✓			

37 COOLING SYSTEM

⚠ WARNING

Please refer to the cooling circuit layout appropriate to the installation.

37.1 Installation

Cooling systems are designed to suit the application specific requirements and heat rejection (kW) of the exhaust gas cooler. The heat rejection from the exhaust cooler and other components is in addition to the normal heat rejection from the engine coolant and any other water cooled items such as transmission oil coolers. The exhaust gas cooler is typically connected in series with engine cooling circuit.

A permanent vent line of approximately ¼" bore should be connected to the vent socket provided on the exhaust gas cooler, and slope continually upwards to the expansion tank. These circuits should be connected to suitable tapping's on the engine with sufficient pressure differential between them to ensure adequate flow.

Permanent vent lines should be connected to the highest point in the cooling system. Air vent lines must be taken back to the radiator top tank or expansion tank, from any point on components or pipes in the coolant system likely to trap air (use 3/16" or 1/4" i/d max.).

Ensure that the radiator top tank volume is suitably sized to accommodate the extra cooling system volume and operate normally right up to the maximum coolant temperature.

Keep all pipe runs to a minimum and use long radius bends where possible.

The expansion tank is not supplied by Pyroban Limited.

Coolant bonnets can be used to divert flow from the engine cooling circuit into the exhaust gas cooler (refer to the following sections of this manual).

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38 COOLANT BONNET AND BONNET DIVERTER CATERPILLAR C9

⚠ WARNING

Please refer to the cooling circuit layout appropriate to the installation.

38.1 Description

The coolant bonnet is used on certain engines to divert coolant from the engine cylinder block and into the Pyroban coolant circuit. The Caterpillar C9 requires the assembly of a coolant bonnet and bonnet diverter for this purpose.

38.2 Installation

The following figure illustrates the assembly; note the bonnet diverter is inserted into the right-hand side of the two coolant ports and the orientation of the bonnet diverter is with the side hole facing the front of the engine (away from the flywheel).

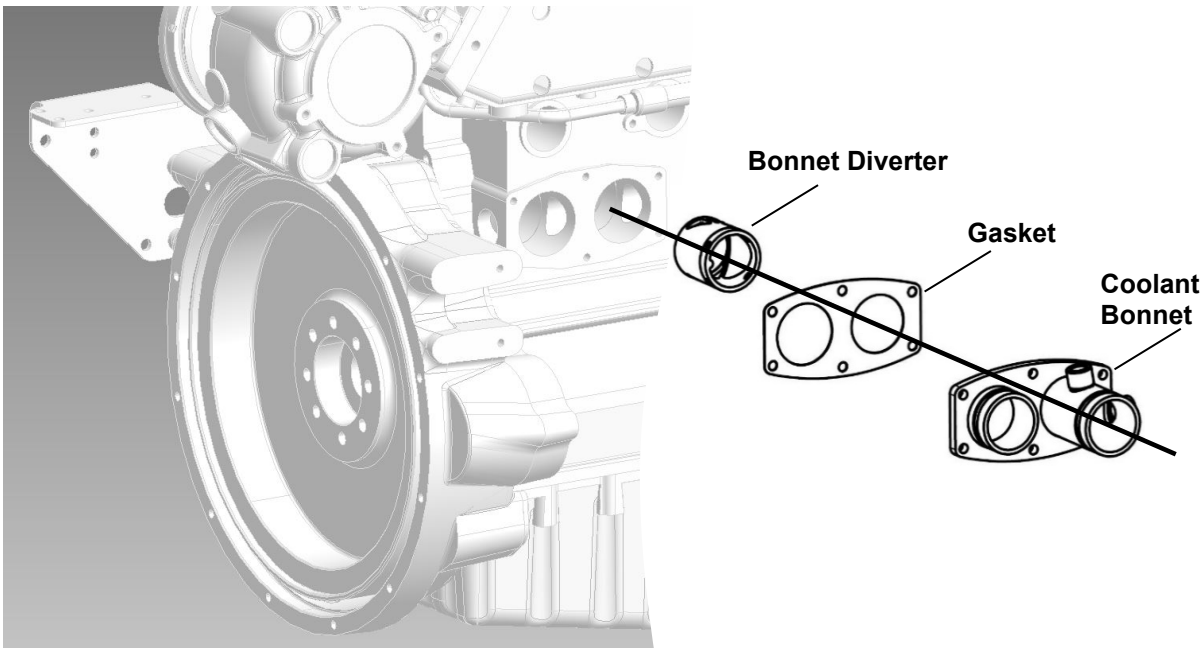


Figure 25 – Coolant Bonnet, Gasket and Bonnet Diverter Installation

39 COOLANT BONNET ADAPTER CATERPILLAR C32

39.1.1 Description

The C32 engine also cab use a coolant diverting bonnet and adapter to feed the Pyroban exhaust gas cooler.

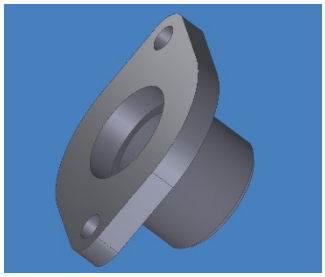
39.1.2 Installation

There are two typical applications:-

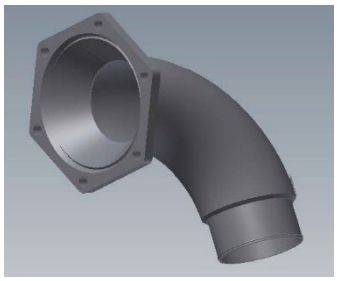
- Application with Transmission Oil Cooler
- Application without Transmission Oil Cooler.

A. Application with transmission oil cooler

The figure below illustrates the installation of the coolant bonnet/adapters. In this case, transmission oil cooler is mounted remotely to facilitate the connection of the coolant bonnet. The coolant feed is from engine to transmission oil cooler via the coolant bonnet/adapter and from the transmission oil cooler to the Pyroban system. The following adapters are required for this application; 300812172 (4 off as numbered below) and 300812185 (2 off).



300812185



300812172

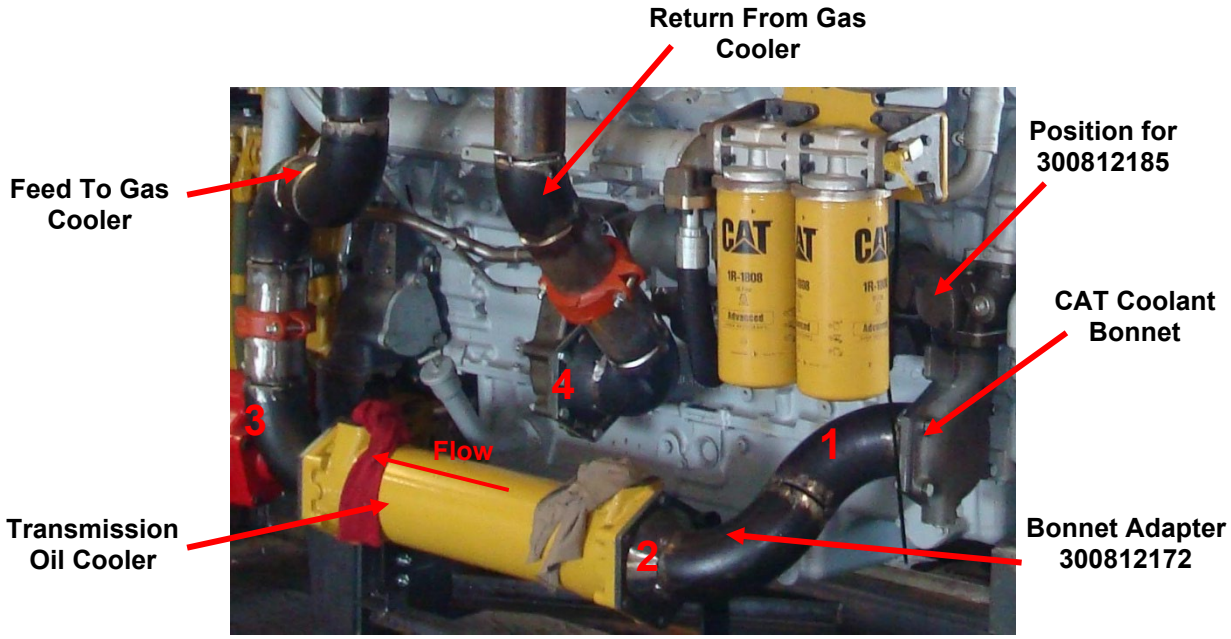


Figure 26 – Coolant Bonnet Application with Transmission Oil Cooler

B. Application without transmission oil cooler

In this application, the feed to the Pyroban Cooler can be provided via the CAT coolant bonnet. This employs the use of a different CAT coolant bonnet from the one in A above.

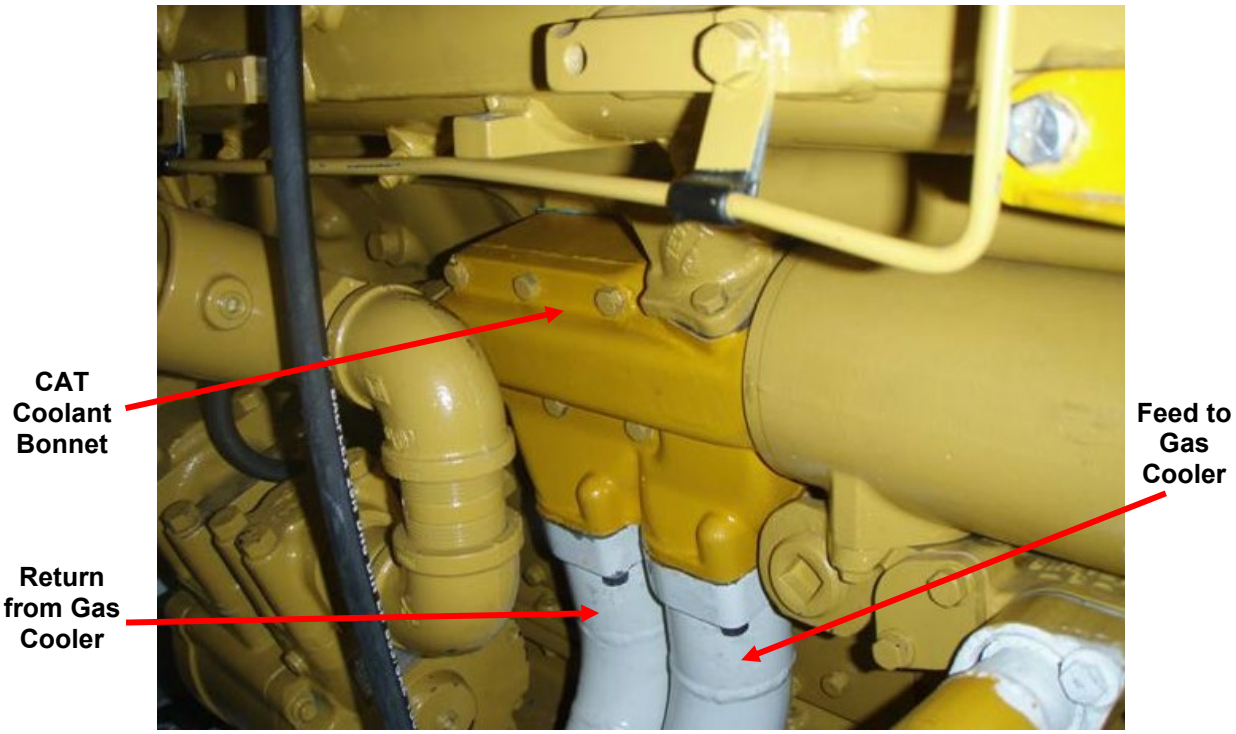


Figure 27 – Coolant Bonnet Application without Transmission Oil Cooler

⚠ WARNING

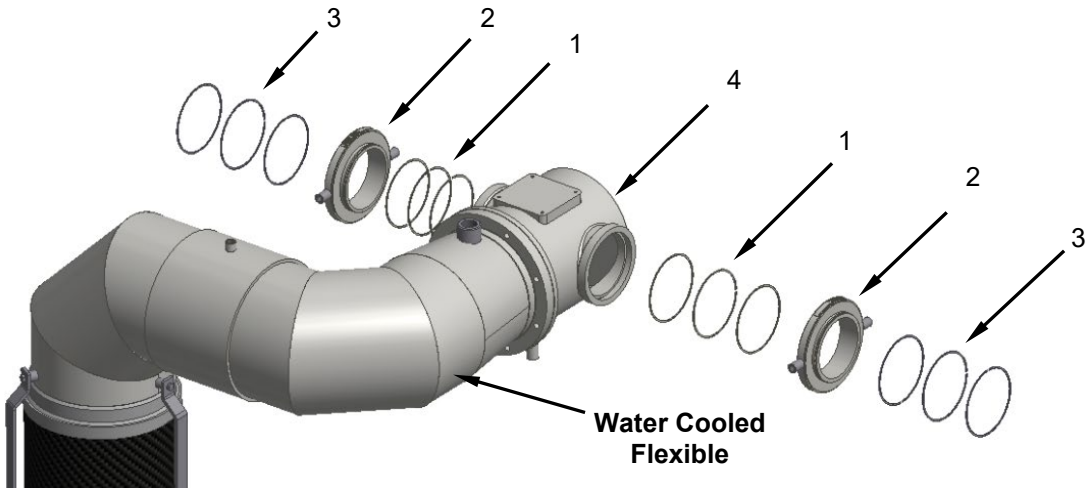
- CONSULT YOUR ENGINE DEALER FOR INFORMATION REGARDING CAT COOLANT BONNETS.
- IT IS RECOMMENDED TO ALWAYS VERIFY COMPATIBILITY OF THE COMPONENTS WITH TH ENGINE ARRANGEMENT USED IN YOUR APPLICATION.

40 TEE PIECE (CAT 3508, 3512 AND 3516)

The tee piece is used on twin turbo engines where a common outlet is required. The tee piece takes the exhaust gas from the turbo outlets into the water cooled flexible of the Pyroban kit. This is applicable to CAT 3508, 3512 and 3516 engines.

40.1 Cat 3508 & 3512 Engines

The OEM tee piece (CAT P/N: 1N-4490) is removed from the engine and modified to allow for the incorporation of a water-cooled turbo adaptor (item 2 in the figure below). There are CAT tee-pieces other than 1N-4490 which are backward compatible with 1N-4490. If the tee-piece on the engine is different from 1N-4490, the customer needs to check backward compatibility between 1N-4490 and the tee-piece on the engine and let Pyroban know if the tee-piece modification is required and compatible with the engine exhaust in question.



Item 1 – Stainless Steel Spring Ring (P/N: 300403362)
Item 2 – Water Cooled Turbo Adaptor (P/N: 300812414)
Item 3 – Stainless Steel Spring Ring (P/N: 300403363)
Item 4 – Tee Piece (P/N: 300807178)

Figure 28 – Tee Piece, Water Cooled Turbo Adaptor and Spring Ring Installation

Ensure the Water Cooled Turbo Adapter is installed the correct way around, as per Figure 29.

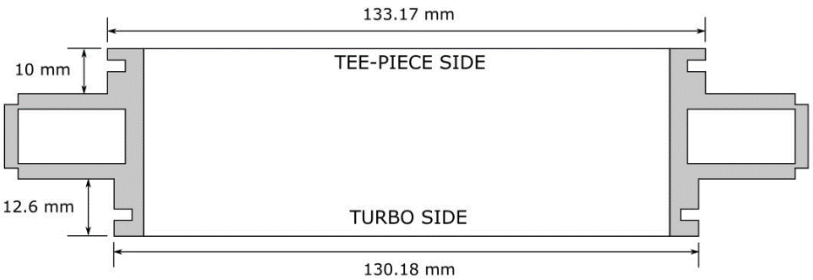


Figure 29 – Water Cooled Turbo Adapter 300812414

40.2 Cat 3516

The OEM tee piece is removed from the engine and replaced with a water cooled unit. Refer to Work Instruction - **WI 372** for detailed installation guide.

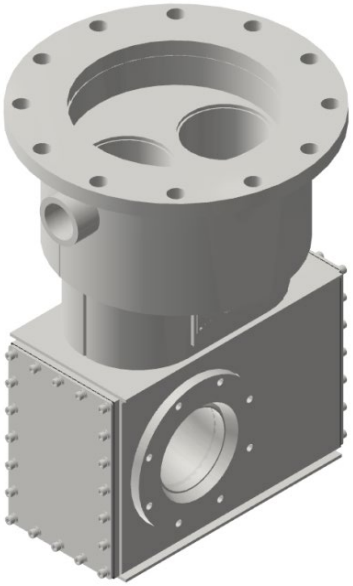


Figure 30 – Water Cooled Tee Piece: CAT 3516

⚠ WARNING

IT IS RECOMMENDED TO ALWAYS VERIFY COMPATIBILITY OF THE COMPONENTS WITH THE ENGINE ARRANGEMENT USED IN YOUR APPLICATION.

41 SCREW SECURED ENGINE OIL FILLER CAP

41.1 Description

A screw secured oil filler cap designed to replace the standard engine oil filler cap.

41.2 Installation

These are two different types of screw secured engine oil filler cap assembly available.

The filler cap body of type ‘A’ is secured to the engine oil filler inlet using ‘Loctite’. Remove the existing filler cap but retaining the drain. Ensure that the non-threaded section of the filler cap body is secured into the engine oil filler to a depth of between 35mm and 40mm with the threaded section protruding upwards.

Type ‘A’

The filler cap body of type ‘B’ is secured to the engine valve cover using a locking nut and gasket. Remove the valve cover from the engine. Place the gasket over the filler cap body, then push the threaded section of the body through the underside of the engine valve cover. Secure the filler cap body to the engine valve cover using the locking nut supplied and secure using ‘Loctite’.

Type ‘B’

For each type of filler cap assembly, push the gasket into the filler cap and screw the cap onto the filler cap body.

41.3 Maintenance

During assembly ensure that the threads are clean and undamaged and new that gaskets are always fitted.

42 SCREW SECURED DIPSTICK

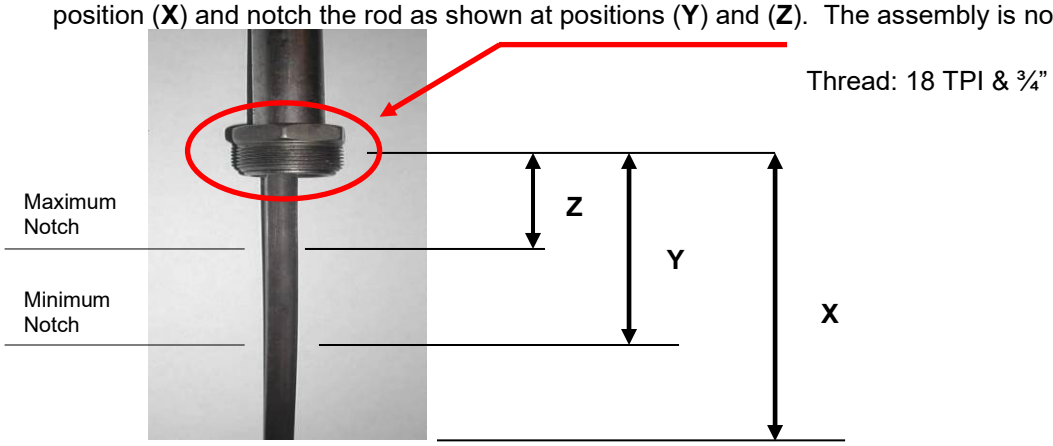
42.1 Description

A screw secured dipstick designed to replace the original engine component.

42.2 Installation

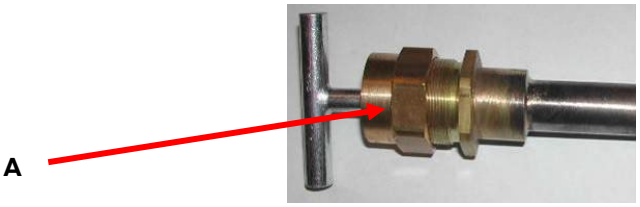
Remove the existing engine dipstick assembly and measure the length of the dipstick (**X**), then measure the distance from the screw fitting to the minimum mark on the dipstick (**Y**) and the distance from the screw fitting to the maximum mark on the dipstick (**Z**).

With the dipstick fully secured mark off positions (**X**), (**Y**) and (**Z**) on the dipstick rod. Cut the rod at position (**X**) and notch the rod as shown at positions (**Y**) and (**Z**). The assembly is now ready to fit.



To access the oil level reading of the engine, loosen nut (**A**) while holding the pull handle and body assembly firmly so it does not move. It should only be necessary to tighten the nut **(A)** by hand. When nut (**A**) has been screwed back, use the dipstick in the normal manner.

To replace the dipstick, assemble in the reverse order.



42.3 Maintenance

During assembly ensure that the threads are clean and undamaged.

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43 CRANKCASE BREATHER FLAME ARRESTER

43.1 Description

A small flame arrester designed to fit onto the end of the crankcase engine breather pipe. It is designed to prevent any flame front originating from inside the crankcase reaching the possible explosive atmosphere outside.

The element is manufactured from stainless steel to provide resistance to corrosion.

43.2 Installation

Fit engine breather pipe with small flame arrester element to gear train cover. Bracket pipe to engine. Ensure all joints are satisfactory sealed.

Examples of End of Line Arresters

43.3 Maintenance

It is recommended that the flame arrester element is inspected at 6 monthly intervals, or if excessive pressure drop is experienced. In the event of a flashback occurring immediate inspection should be made. If the element is found to be damaged or distorted a new replacement unit should be fitted. Elements are sealed into the housing and cannot be removed for cleaning. To clean the element, remove the unit from the line, wash the complete flame arrester in a suitable solvent, then blow through thoroughly with compressed air.

Never attempt to clean the engine breather flame arrester by inserting probes as the fine passages could be enlarged, thereby impairing the engine breather flame arrester performance.

When refitting onto the line, always use a new gasket of the correct size and of the type suitable for that application.

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44 COOLANT TEMPERATURE GAUGE

44.1 Installation

This gauge is supplied as a loose item.

Remove the 3/8” adaptor. The 5/8” UNF thread should be mounted directly into the thermostat housing. The indicator head should be panel mounted at a convenient location.

The capillary line must be adequately protected against external damage and free from twisting and buckling.

Excess line length must be accommodated by coiling, not cutting off the surplus. Do not place the line past hold or cold sources.

When installing the probe, ensure that it is not forced against any obstruction when tightening the nut. This can lead to an increase in pressure within the probe and cause incorrect readings. If the probe is touching any obstruction, withdraw approximately 3mm before tightening the nut.

Vibration acting on the casing of the gauge affects the function and working life of the instrument. Therefore, the gauge should be installed in vibration free situations where possible.

45 EXHAUST GAS TEMPERATURE GAUGE

45.1 Description

A temperature gauge designed to be directly mounted into the exhaust pipe, downstream of the exhaust spark arrester, to provide passive measurement of the exhaust temperature before the gases are released into the atmosphere.

45.2 Installation

The exhaust gas temperature gauge is supplied as a loose item. Mount the 1/2" NPT fitting on the exhaust pipe, after the exhaust spark arrester, with the probe protruding into the exhaust gas.

Care must be taken when installing the probe in the system to ensure that it is not forced against any obstruction when tightening the nut. This can lead to an increase in pressure within the probe, causing incorrect readings. If the probe is touching any obstruction, withdraw approximately 3mm before tightening the nut.

The instrument is calibrated with the length of fixed capillary lines (3 metres). Excess line length must be accommodated by coiling, not by cutting off the surplus. Do not place the line near hot or cold sources. The capillary line must be adequately protected against external damage and be installed free from twisting and buckling.

Panel mount the indicating head at a convenient location.

Vibration acting on the casing of the gauge affects the function and working life of the instrument. Therefore, the gauge should be isolated from vibration wherever possible.

45.3 Maintenance

Visually check the capillary line for damage or deterioration. Check that all fixings are secure and inspect the unit for mechanical damage.

The function of the gauge does not require any special maintenance procedure, but frequent checks must be made to ensure the instrument is working correctly and accurately.

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46 OIL PRESSURE GAUGE AND PIPE KIT

46.1 Installation

The indicator head should be panel mounted at a convenient location.

The capillary lines should be adequately protected against external damage and be installed free from twisting and buckling.

Excess line length must be accommodated by coiling, not by cutting off the surplus. Do not place the line past hold or cold sources.

Vibration acting on the casing of the gauge affects function and working life; therefore, the gauge should be isolated from vibration wherever possible.

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47 START PILOT COLD START AID

47.1 Engine Starting

Operate the pump for 2 or 3 strokes before starting the engine. In very cold conditions and to attain a quick engine warm-up and even running it may be necessary to operate the pump for a further 1 or 2 strokes. Do not make use of cylinder or manifold heater plugs to assist cold starting.

47.2 Charging Reservoir with Fluid

Recharge the reservoir using type 'F' refill fluid obtainable from Pyroban Limited. Lift the hinged cover on the reservoir and present the canister head down on to the filler valve. Press down firmly and squarely so that the fluid flows into the transparent bowl. The fluid must not rise above the maximum level indicated by the arrow markings on the bowl. A special 'arctic' fluid is available which is especially suitable at temperatures of between –20°C and –40°C.

When recharging the start pilot reservoir please follow the safety instructions printed on the canister.

47.3 Maintenance

In time the spray nozzle may become partially blocked by dirt from the incoming air, although this should not happen if the air cleaner is attended to at the correct service intervals. Wash the nozzle in petrol, when necessary, dry thoroughly and replace. Ensure that the reservoir is kept topped up. At monthly intervals check all fasteners for tightness and inspect all tubing for signs of chafing. Every six months, remove the nozzle from the inlet system, operate the pump and visually check the start pilot functions properly. After checking re-fit the nozzle and top up the reservoir.

Once a year (or more often in dirty conditions) dismantle the pump and clean the filter. Lubricate the piston rod with thin oil; either every 30 or 40 strokes or every 10 engine starts in which the start pilot system is used.

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48 TORQUE SETTINGS (Tightening Torques for Nuts, Bolts and Studs)

Because of variations in frictional conditions, torque figures can give wide variance in bolt tension. The main precaution that can be taken is to calibrate the torque wrench for each batch of bolts. As this is usually impracticable, the figures in the following tables may be taken as a guide. They are for unlubricated threads and do not take account of the effect of hard or smooth mating surfaces or hardened washers, etc. in case of doubt, lower values should be used.

IMPERIAL SIZES-STEEL GRADES R, S & T									
THREAD FORM:		BSW		BSF		UNF		UNF	
MATERIAL GRADE:		R	T	R	T	S	T	S	T
1 / 4"	Lb.ft.	8.2	10	9.1	12	11	12	9.8	10
	Nm	11	14	12	16	15	16	13	14
5 /16 "	Lb.ft.	17	21	18	23	22	24	20	22
	Nm	23	29	24	31	30	33	27	30
3 / 8"	Lb.ft.	30	38	32	41	40	43	36	38
	Nm	41	52	44	56	54	59	49	52
7 / 16"	Lb.ft.	48	60	50	65	65	70	55	60
	Nm	65	82	68	88	88	95	75	82
1 / 2"	Lb.ft.	70	90	80	100	95	105	90	95
	Nm	95	122	109	136	129	143	122	129
5 / 8"	Lb.ft.	145	185	155	200	195	200	175	185
	Nm	197	252	211	272	265	272	238	252
3 / 4"	Lb.ft.	260	320	270	340	340	360	310	320
	Nm	354	435	367	463	463	490	422	435
7 / 8"	Lb.ft.	415	520	435	560	540	580	490	540
	Nm	565	707	592	762	735	789	667	735
1"	Lb.ft.	620	800	660	840	800	860	740	800
	Nm	844	1088	898	1143	1088	1170	1007	1088

The minimum ultimate tensile strengths of the grades of steel referred to are:

Grade R 45 tons / sq. in. (70.9 kg/mm^2, 695 N/mm^2)
Grade T 55 tons / sq. in. (86.6 kg/mm^2, 849 N/mm^2)

Grade S 50 tons / sq. in. (78.7 kg/mm^2, 772 N/mm^2)
Grade 8.8 50 tons / sq. in. (80.0 kg/mm^2, 785 N/mm^2)

SIZE	METRIC SIZES-STEEL GRADE 8.8				METRIC SIZES-STAINLESS STEEL			
	COARSE		FINE		COARSE		FINE	
	PITCH (mm)	TORQUE	PITCH (mm)	TORQUE	PITCH (mm)	TORQUE	PITCH (mm)	TORQUE
M5	0.8	5.1 Lb.ft 6.9 Nm	0.50	5.7 Lb.ft 7.8 Nm	0.8	3.6 Lb.ft 4.8 Nm	0.50	4.0 Lb.ft 5.5 Nm
M6	1.00	8.6 Lb.ft 12 Nm	0.75	9.5 Lb.ft 13 Nm	1.00	6.0 Lb.ft 8.4 Nm	0.75	6.7 Lb.ft 9 Nm
M8	1.25	21 Lb.ft 28 Nm	1.00	22 Lb.ft 30 Nm	1.25	14.7lb.ft 19.6 Nm	1.00	15.4lb.ft 21 Nm
M10	1.50	42 Lb.ft 56 Nm	1.25	44 Lb.ft 59 Nm	1.50	29.4 Lb.ft 39.2 Nm	1.25	31 Lb.ft 41 Nm
M12	1.75	72 Lb.ft 98 Nm	1.25	79 Lb.ft 107 Nm	1.75	50 Lb.ft 69 Nm	1.25	55 Lb.ft 75 Nm
M16	2.00	180 Lb.ft 244 Nm	1.50	190 Lb.ft 259 Nm	2.00	126 Lb.ft 171 Nm	1.50	133 Lb.ft 181 Nm
M20	2.50	350 Lb.ft 476 Nm	1.50	390 Lb.ft 528 Nm	2.50	245 Lb.ft 333 Nm	1.50	273 Lb.ft 370 Nm
M24	3.00	610 Lb.ft 822 Nm	2.00	660 Lb.ft 894 Nm	3.00	427 Lb.ft 575 Nm	2.00	462 Lb.ft 626 Nm

Note – The stainless steel torque figures given in the table above are based on 70% of the equivalent Grade 8.8 values.

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49 TABLE OF PYROBAN PRODUCTS

The following table lists some of the Pyroban products along with the appropriate manual references.

Pyroban Product	Description	Document
SVH Inlet Air Shut off Valves	The SVH range of butterfly Valves is designed for diesel engine shutdown preventing “over-speeding” should the engine ingests flammable gasses.	COM001
ESB Battery Offshore	This equipment is design specifically for use in hazardous areas and is corrosion resistant with a 316 stainless casing.	PDS7114
Flameproof Alternator FPA Range	This equipment is design specifically for use in hazardous areas and has anodised aluminium housing with a red polyester point finish.	PDS7066
SVD-S Inlet Shutdown Valve	This valve has an automatic over speed facility, a built in flame arrester and a manual emergency stop facility.	PDS7060
SVG-4 Inlet Air Shut off Valve	The SVG-4 inlet air shut-off valve uses a rotating disc 'butterfly' valve to provide intake air shut-off and employs a free flow design which provides very low pressure drop to avoid any loss in engine shaft horsepower.	PDS7043
SVG-9.5 Inlet Air Shut off Valve	The SVG-9.5 inlet air shut-off valve uses a rotating disc 'butterfly' valve to provide intake air shut-off and employs a free flow design which provides very low pressure drop to avoid any loss in engine shaft horsepower.	PDS7044
SVG-9.5/2800 Inlet Air Shut off Valve	The inlet air shut-off valve uses a rotating disc 'butterfly' valve to provide intake air shut-off. The valve employs a free flow design which provides very low pressure drop to avoid any loss in engine power. A version of the model 2800 hydromechanical safety control is used to actuate the air shut-off valve.	PDS7045
SVG-12 Inlet Air Shut off Valve	The air shut-off valve uses a rotating disc 'butterfly' valve to provide intake air shut-off. The valve employs a free design which provides very low pressure drop to avoid any loss in engine shaft horsepower.	PDS7046
SVG-12 Inlet Air Shut off Valve 802326	The inlet air shut-off valve uses a rotating disc 'butterfly' valve to provide intake air shut-off. The valve employs a free flow design which provides very low pressure drop to avoid any loss in engine power.	PDS7047
Flameproof Starter Motor FPS23	The starter motor is designed for use on diesel engines up to 6 litres. The unit is a ‘pre-engaged’ type starter motor which is contained within a fabricated steel and cast iron flameproof enclosure and is supplied with suitable cables connected via Exd cable glands for fitting to the vehicle battery and switch connections.	PDS7026
PCS2 Compact Control Unit	The PCS2 Control unit forms part of a safety shutdown system which is added to a diesel engine to render it safe for use in potentially flammable atmospheres according to BS EN 1834-1-2000 Reciprocating internal combustion engines -Safety requirements for design and construction of engines for use in potentially explosives atmospheres-Part 1: Group II engines for use in flammable gas and vapour atmospheres.	MAN-GPD0009-01
ExSCS	ExSCS is a configurable PLC based gas detection shutdown system for the protection of diesel engines operating in zone 2 hazardous areas.	POM114ENG POM115ENG POM116ENG