



# Central Gas Installation onboard 10.01.22

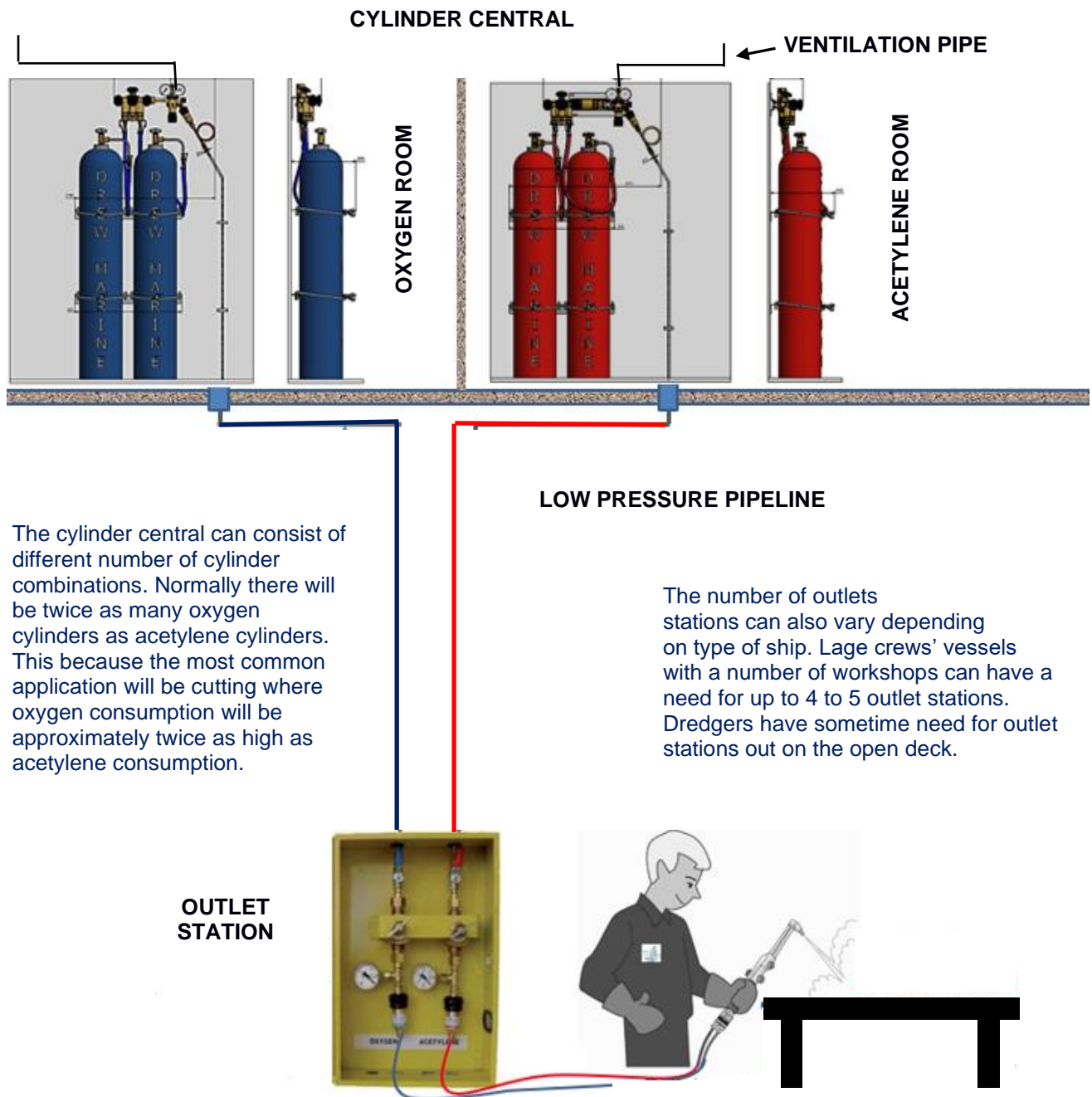
*By Leif Andersen, TE Andersen Consulting.*

High-pressure gas cylinders inside the ship's hull is a safety risk to crew and vessel and should always be avoided. A full oxygen cylinder has a pressure of 150 bar, acetylene 18 bar and filled with a porous mass and highly flammable acetylene gas dissolved in acetone. Neither a good combination if out of control in confined space inside the ship's hull. The Central Gas Installation was developed specifically to improve safety and efficiency onboard. Simply place the cylinders on the uppermost open continuous deck and pipe the gas to outlet stations. If a dangerous situation like fire onboard was to develop the cylinders can be removed and if needed be thrown overboard.

Most classification societies and class flags have legislation covering the use on-board of gas welding systems and equipment. It is implicit that a certain standard of consistency regarding supply and installation is required in order to maximize results in terms of operational efficiency and that safety at all times are enjoyed. The Central Gas Installation (CGI) forms today part of rules and regulations for handling gases on-board ships. The CGI is ideal for use on board most vessels and rigs with a certain consumption of welding gases such as Oxygen, Acetylene and shielding gases.

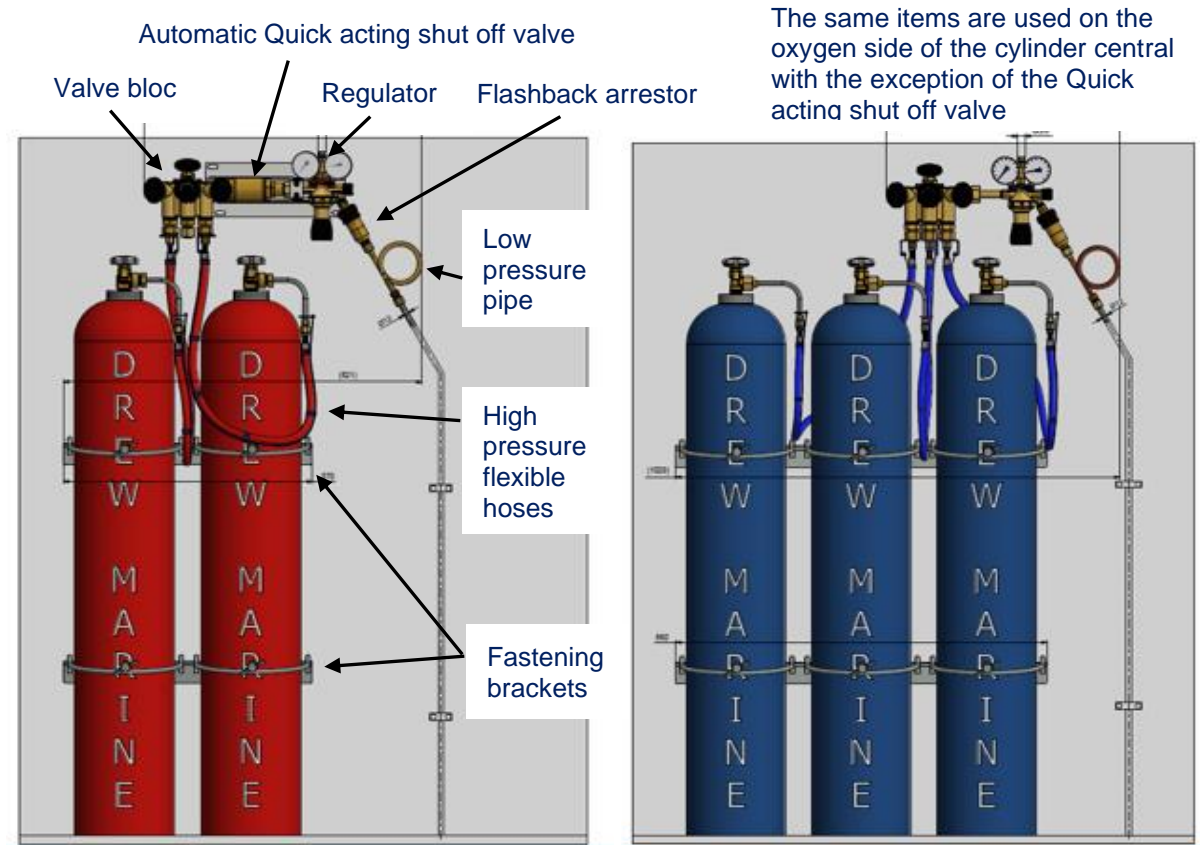


The system consists of the Cylinder Central placed on the uppermost open continuous deck. The cylinders are manifolded together and the pressure reduced from Cylinder pressure to Low pressure pipeline pressure. The system is protected by non-return valves and flashback arrestors to provide outmost safety. The regulators are fitted with safety valves. In case of opening, the gas will ventilate out of the cylinder central. When the total numbers of cylinders exceed eight, oxygen and acetylene shall be kept in separate compartments.





### The Cylinder central



**There are a number of cylinder number combinations available from the suppliers:**

- 1 Acetylene + 1 Oxygen
- 1 Acetylene + 2 Oxygen
- 2 Acetylene + 2 Oxygen
- 3 Acetylene + 3 Oxygen
- 2 Acetylene + 4 Oxygen

In order to deliver a cylinder number according to the customers demand the suppliers can also deliver expansion sets:

Expansion set for 1 Acetylene cylinder.

Expansion set for 1 Oxygen cylinder.

Fastening brackets is to be used in order to secure the cylinders. They should be fast acting type so that the cylinders can be removed from the cylinder storage room without the need of any tools. Ropes and wires must not be used as substitute for fast acting fastening brackets.

Cylinder central shall be a separate compartment, on or above the uppermost continuous deck.

Not to be used for any other purpose than storage of gas cylinders.

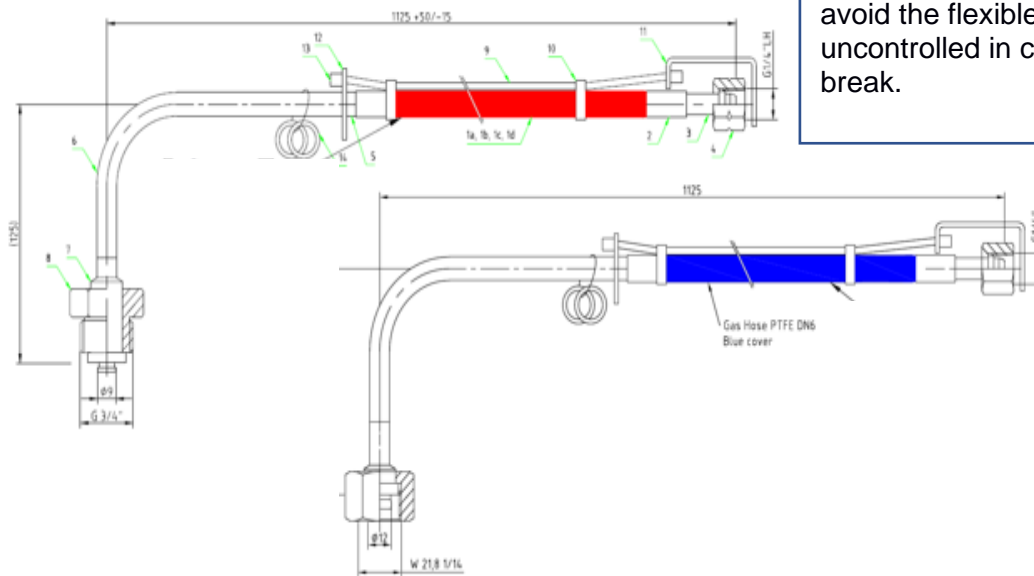
Temperature not to exceed 40°C.

To be clearly marked with signs.



High pressure flexible hoses (also referred to as flexible hose with elbow)

The most vulnerable part of a CGI installation is the high-pressure flexible hoses that runs from the cylinder top valves up to the valve block. Make sure they are fitted with a safety wire to avoid lashing uncontrolled in case of hose break.



The safety wire is there to avoid the flexible hose lashing uncontrolled in case of hose break.

The high pressure flexible hoses should come with a certificate informing that they have been pressure tested and that they are oxygen- acetylene compatible.

High pressure flexible hose for oxygen and acetylene with elbow & safety cable should be according to ISO14113.

For Beau Veritas Projects they might require to be with BV Product Certificate and according to ISO14113.

The hose itself will be made from PTFE/Hytrel and the ferrule from stainless steel AISI 304.

Manufacturers of high pressure flexible hose for oxygen and acetylene normally test pressure the hoses to 600 bar (water). The bursting pressure will be approximately 1200bar. The test pressures will vary depending on manufacturer. Acetylene high pressure flexible hoses are by some manufacturer also fitted with an antistatic spring woven into the hose in order to prevent the possibility of sparks igniting the acetylene gas.



High pressure flexible hoses must receive visual inspection every time they are in use. To be replaced in case of damage to cover, braid or fittings. Recommended lifetime\*: 5 years.

\*Recommended lifetime is from date of installation. Imprint and labels will inform date of manufacturing.

What makes the high pressure flexible hoses vulnerable to accidents:

The most likely accident handling and operating the central gas installation oxygen side (cylinders and its equipment) is a phenomena called adiabatic compression. Adiabatic compression is also referred to as "gas hammer effect" or "metal fire". Oxygen at 99.5% purity under high pressure of 150 bar (2176 psi) has strange properties. When a valve of an oxygen cylinder is opened quickly, the oxygen will rush into the high-pressure flexible hose and when reaching the end of the hose a phenomena called, adiabatic compression might occur. The effect of this is that local compression heat is generated. The net result is that for a very short time we can see a higher than normal pressure and an increased temperature. This higher oxygen pressure and temperature makes it more critical what products are in contact with the oxygen.

Products that are normally considered as non-flammable can when in contact with high pressure oxygen at higher temperatures become flammable. Any foreign object, organic or a metal particle might ignite and start a metal fire. The high pressure has under those circumstances no problem burning through the high-pressure flexible hose, consuming it. For this reason, oxygen components are specially designed and tested (oxygen surge testing) and cleaned to be fit for oxygen service. When replacing components like hoses and seals, attention must be paid to work "clean" so that possible flammable components (contaminants like dirt, fine particles, oil or grease) are not transferred. If small amounts of contaminants are present and the oxygen surge happens, ignition will occur instantly (explosive) and the hose or regulator stem will fail. Because of the above-mentioned process, the instructions are: No foreign substances to be used, and always slowly open the cylinder top valves.

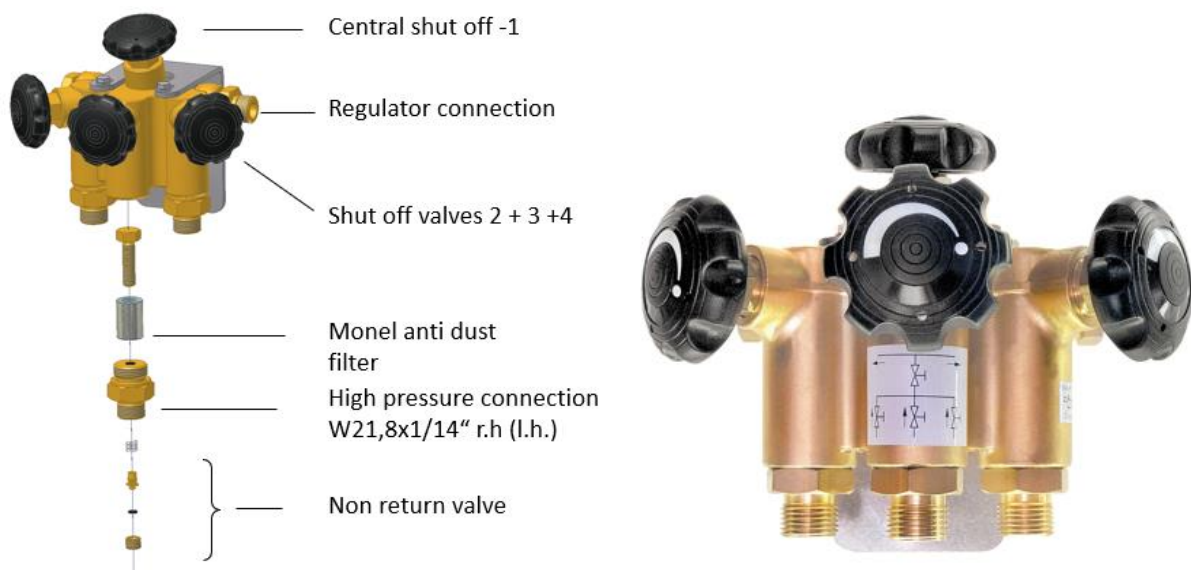
In order to avoid fire or explosion due to Adiabatic compression:

- Use only original equipment and spares when handling/ servicing oxygen equipment.
- Open and close oxygen cylinder top valves before connecting equipment. This in order to remove any foreign items and hence preventing them entering the system.
- Work clean. No oil or impurities must contaminate the parts (your hands, tools etc.).
- Open oxygen cylinder top valves slowly.
- Make sure the safety wire is in place in case of hose break.

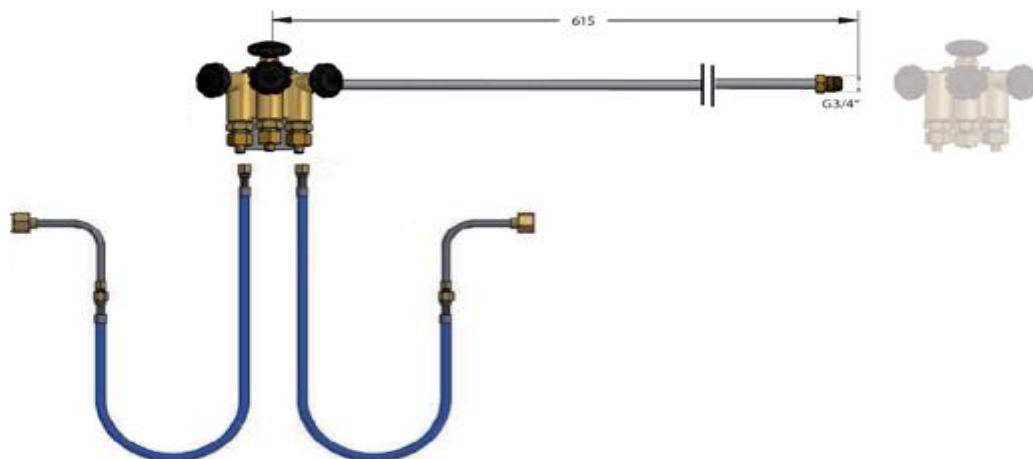


### The Valve block.

The valve block drastically reduces the number of screw connection that some systems are depending on. Every screw connection represents a possible leak location. It caters for up to 3 cylinders and have one central closing valve. Testing of Valve block for Burn-Out Safety to Gaseous Oxygen Pressure Shocks: BAM approval Ref.-No: 2.1/50 781. Oxygen shock tested to 300 bar at 60°C. The non-return valves are integrated into the block itself avoiding gas from one cylinder accidentally entering into another cylinder.



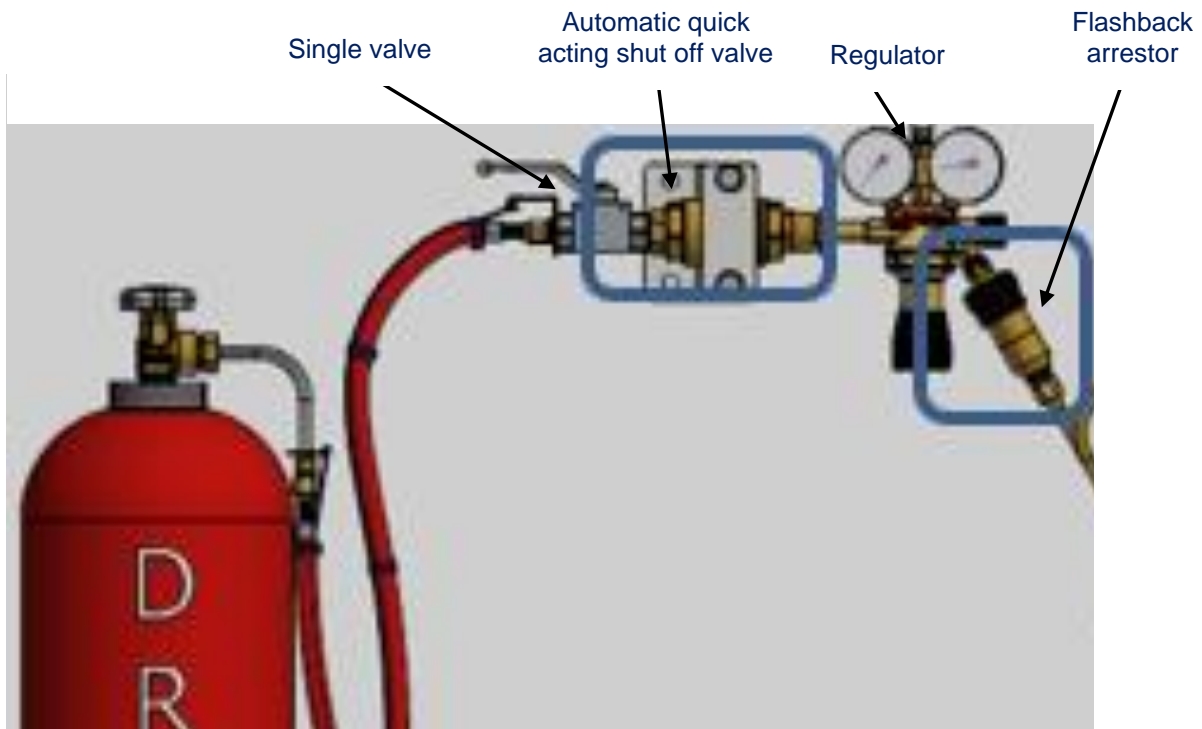
If there is a need for more than 3 cylinders additional valve blocks can be added by a connection pipe.



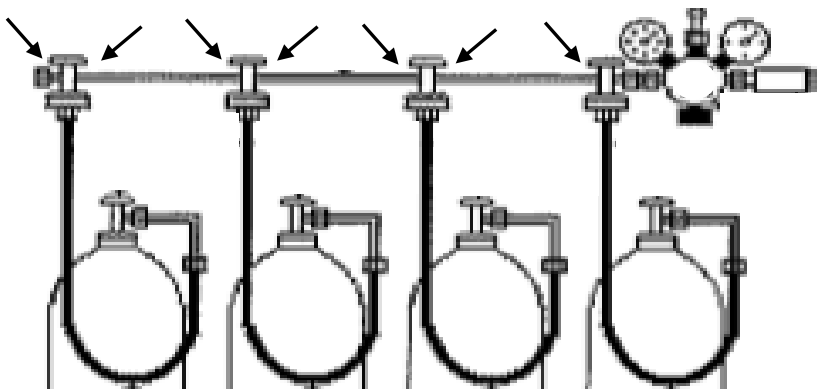




If only one acetylene or one oxygen cylinder is required there is no need for the valve block. The oxygen high pressure flexible hose is then connected directly to a single valve and regulator. For acetylene high pressure flexible hose, it is connected to a single valve with regulator, automatic quick acting shut off valve and then the regulator. For both oxygen and acetylene, a flashback arrestor is mounted on the regulators.



Some suppliers of central gas installations, instead of using the valve block, depend on using high pressure connectors between individual single closing valves. These systems will however increase the number of screw connections thereby increasing the chances for leaks developing.



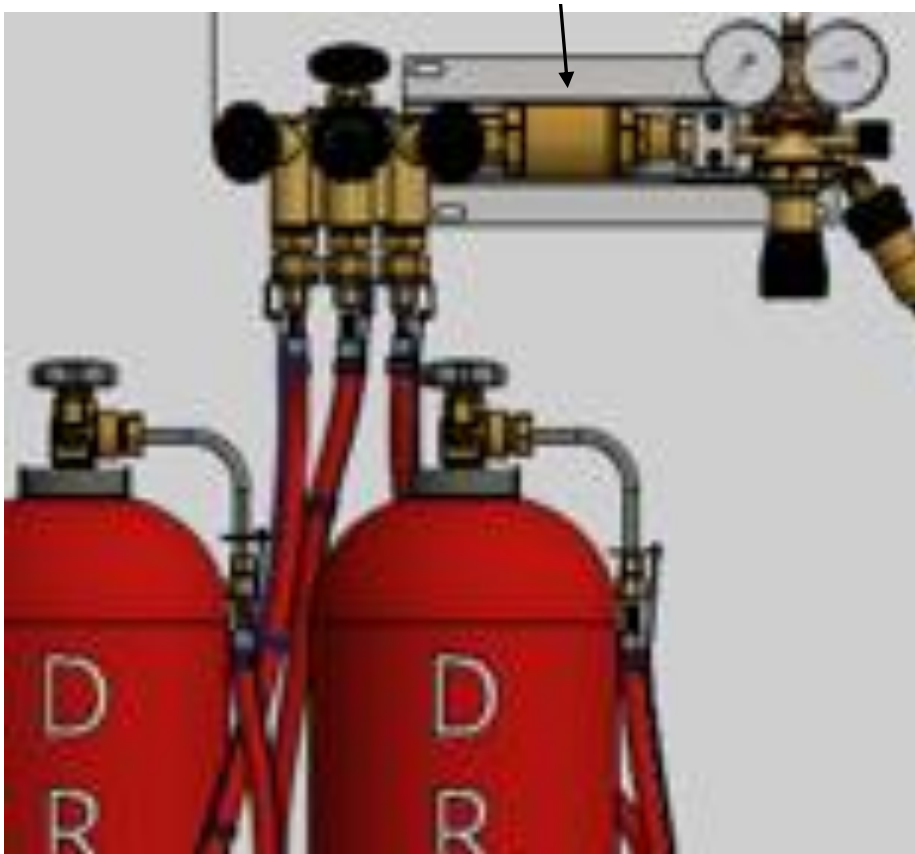
If pipes between individual single closing valves are used, they should be made from seamless stainless steel and be hydraulically pressure tested to 300 bar. They should preferably have expansion loops in order to take up strain and vibration.



### Automatic quick acting shut off valve

The quick action shut off valve is only to be fitted to the valve block on the acetylene side. The purpose is to stop an incoming acetylene decomposition from cylinder side and thereby protect gas supply equipment installed downstream towards the outlet station of the CGI system. The Automatic quick acting shut off valve must be according to ISO14114. This standard allows only for automatic valves simply because the cylinder central will be an unmanned location.

### Automatic quick acting shut off valve



To be replaced in case of damage. Recommended lifetime: 5 years.





### Cylinder central regulator

The cylinder central regulator for oxygen and acetylene should be according to ISO7291, this in order to meet the requirement of 300 bar testing flow line.

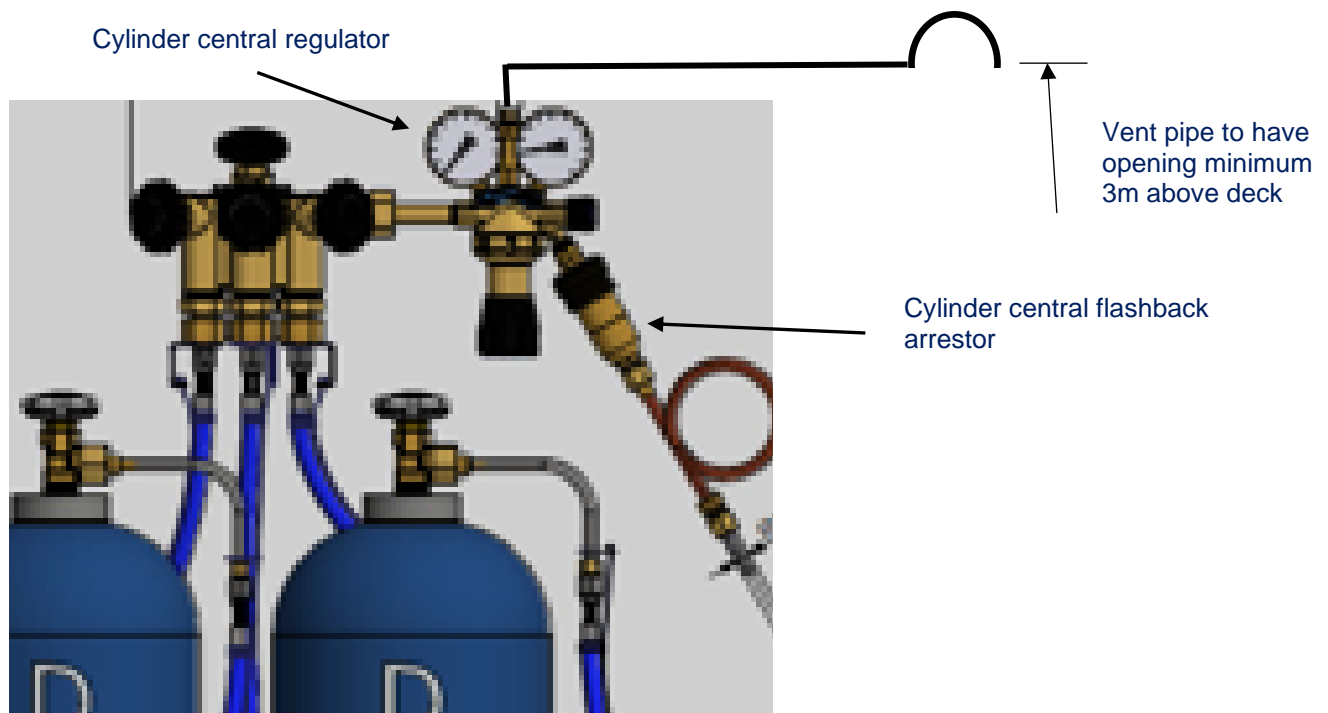
The cylinder pressure for oxygen is reduced by the regulator from 150 bar to 8 bar on the low-pressure side.

The cylinder pressure for acetylene is reduced by the regulator from 18 bar to 0,8 bar on the low-pressure side.

The cylinder central regulators are to have their safety valves connected to ventilation pipes that have outlet to open deck at a height of minimum 3m above deck.

Oxygen regulators safety valves opens at 12-14 bar. Acetylene regulators safety valve opens at 3-4 bar.

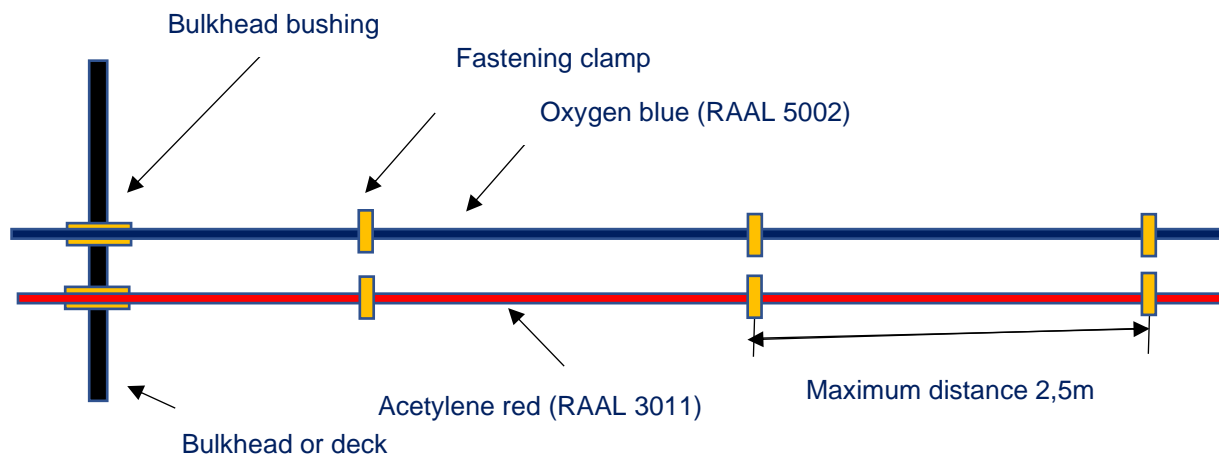
Regulators to be replaced in case of damage to regulator body, gauges or fittings. Recommended lifetime: 5 years.



The Flashback arrestors at the cylinder storage room serves as a backup for the one at the outlet station in case of this failing. Failing can be because of being clogged up or being tampered with. The acetylene flashback arrestor at the cylinder storage room are also there in case the low-pressure pipeline is accidentally being punctured and the gas ignited. The flashback arrestors should be according to EN 730-1/ISO 5175-1 and have a BAM approval BAM/ZBA/007/03 and UL approval. The flashback arrestor should contain the following functions: Non-return valve, Flame arrestor, and Temperature sensitive cut-off valve. It must not be fitted with a pressure relief valve. Flashback arrestors to be replaced in case of damage to body or fittings. Recommended lifetime: 5 years.



### Low pressure pipeline



The low-pressure pipes are to be seamless steel pipes according to DIN 2441 or equivalent. Pipe diameter is to be 19 to 23 mm and wall thickness minimum 2,0 mm. Out on the open deck this is to be increased to 2,5mm. Make sure that pipes have been cleaned for grease and oil before being welded together. Pipes can be ordered degreased and phosphatized. No galvanized pipes to be used. All pipe bends should be expertly made (not flattened or have reduction in diameter). The pipeline should not have any negative loops where liquids can accumulate. No unions, muffs, flanges to be used, only welding. Pipes to preferably be welded end to end (I-butt weld). Gas welding is to be preferred welding method.

Acetylene pipeline to be painted red (RAAL 3011).

Oxygen pipeline to be painted blue (RAAL 5002).



Distance between fastening clamps shall not exceed 2,5 m. Distance between pipes centrelines should be approx. 100 mm.



Pipes carried through deck or bulkheads shall be shielded in protection tubes. Not to be welded to it, but allowed to move freely.



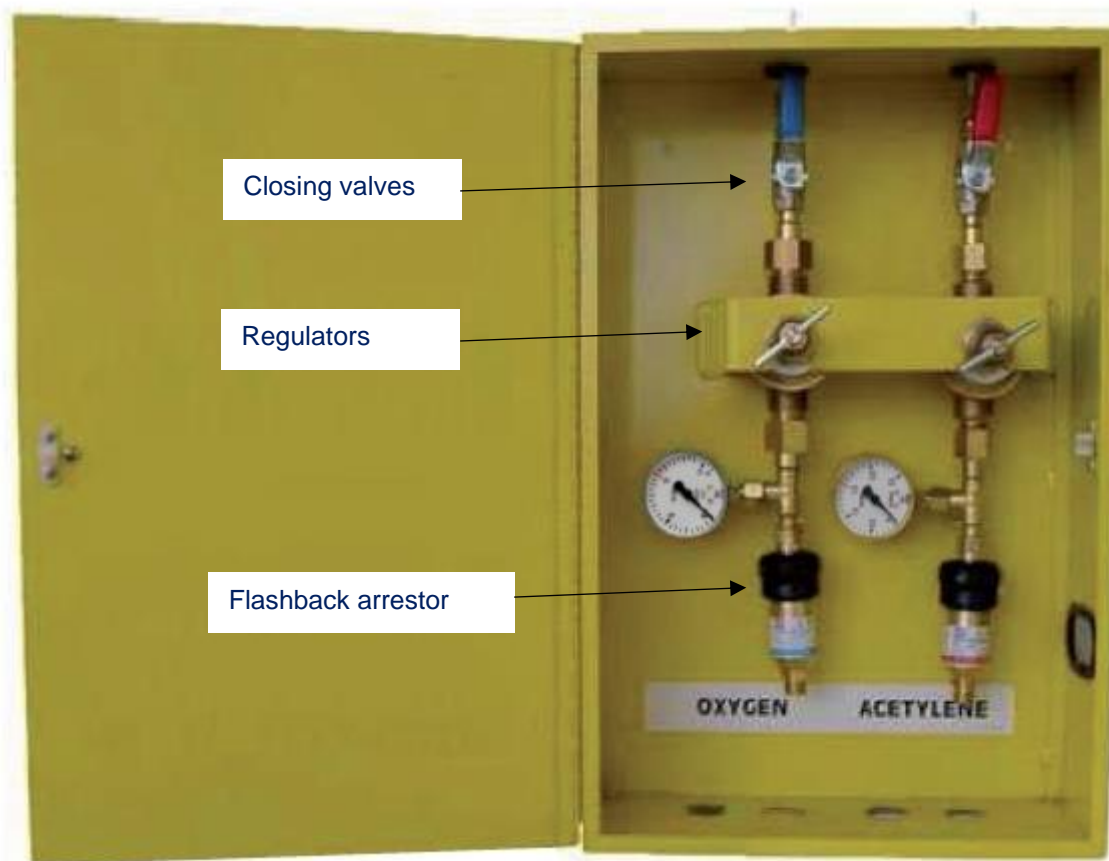
Pipelines must not go through accommodation spaces for crew or passengers. All rooms where piping is running should be ventilated.



Avoid negative loops on the low-pressure pipeline where liquids can accumulate.



### Outlet station



Normally two outlet stations are permitted, in engine room and workshop.

The purpose of the regulators in the outlet station is to bring pipeline pressure down to suitable working pressure and to keep the working pressure constant despite emptying the cylinder(s). Regulators for outlet stations should be according to EN ISO 2503 Oxygen class 3, Acetylene class 2. Regulators to be replaced in case of damage to regulator body, gauges or fittings. Recommended lifetime: 5 years.

The Flashback arrestors at the outlet station is there to stop the flashback as early as possible. According to manufacturer there is a 90% possibility that a flashback will run in the acetylene hose and pipeline. It is therefore advisable, in order to be 100% sure, to have flashback arrestors on both gases. A full flashback consists of a pressure front, a flame front, and the gases back feeding into one of the lines. It is therefore self-sufficient and can burn its way into the oxygen line even if oxygen itself is not a combustible gas. Flashback arrestors for the outlet station should be according to EN 730-1/ISO 5175-1 and have a BAM approval BAM/ZBA/007/03 and UL approval. Flashback arrestors to be replaced in case of damage to body or fittings. Recommended lifetime: 5 years.





### Systems signs

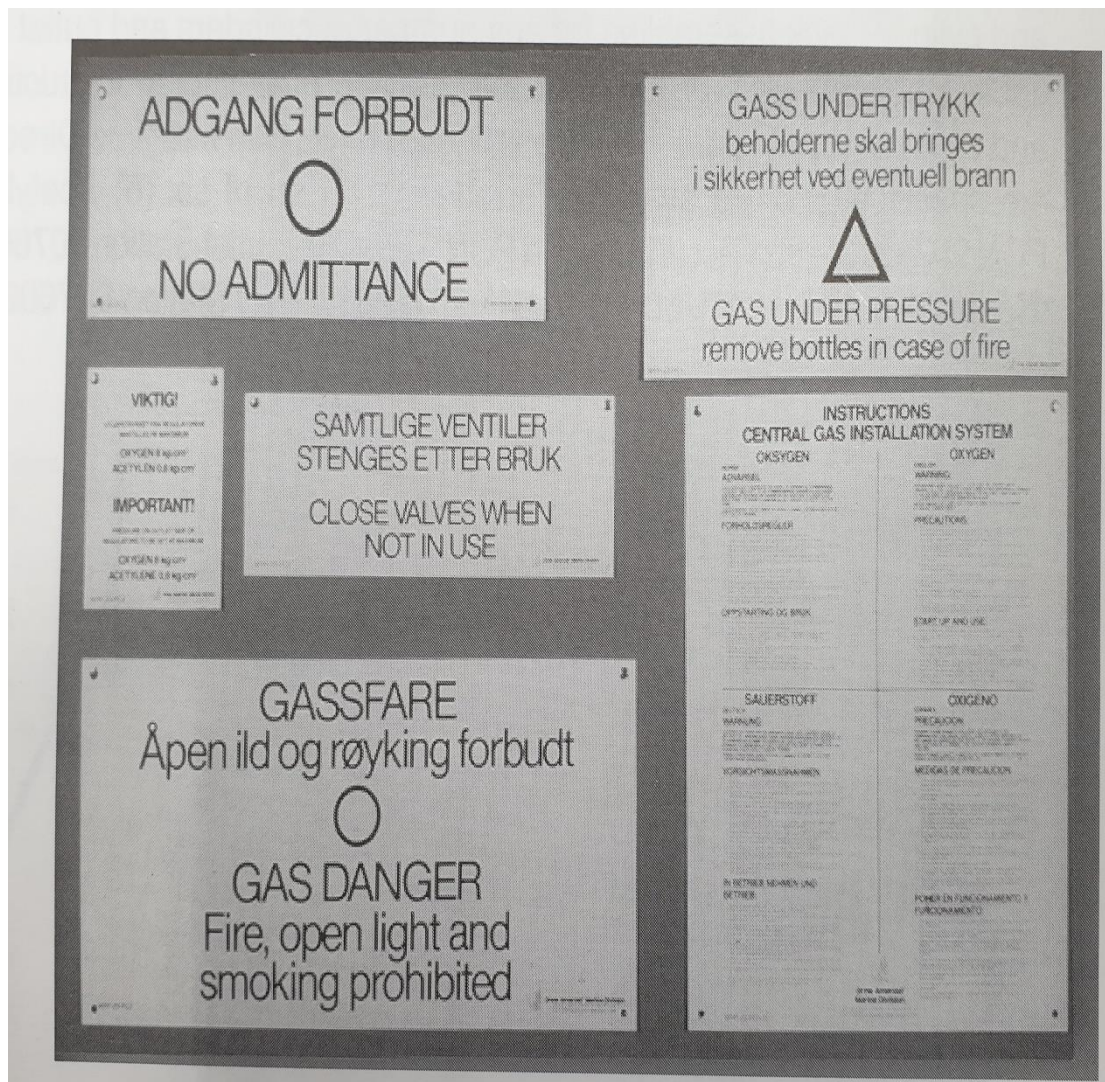
A number of signs are to be in placed in a central gas installation. There are signs for the:  
Entrance doors to the cylinder central.

Inside the central cabinet.

Ventilation pipe outlets.

Outlet station(s).

They are to inform type of gas, operating instructions, pressure setting and safety warnings.





### Regulations to be followed

Only a few authorities (Canada, Norway, The Netherlands) have own regulations for cylinder-based CGI.

Some Class Societies have own design rules to be followed and shall then (except for NOR & NIS ships) approve the system and endorse the testing.

When issuing Installation certificates for NOR and NIS flagged ships a supplier Installation Certificate is issued.

The Class Societies that all have the requirement for leak testing every 5 years are: ABS, BV, DNV/GL, LR, RINA.

Original Installation Certificate shall be posted in the CGI central, and a copy shall be kept for at least 6 years by the person who issued it.

The CGI supplier's role with regards to a CGI approval is: INSPECTING & REPORTING & (in case of NOR/NIS) also APPROVE.

The surveyor from the classification society can also do the above and he can always: APPROVE.

### Testing and approvals of Central Gas Installations

All personnel from supplier/service company involved in testing the CGI shall have received appropriate training and be aware of the danger involved with high pressures and the possible harmful effects of the strong degreasing liquids used. Make sure that they before inspection and pressure testing are familiar with the regulations of class and/or flag for the respective vessel/new building before installing and testing. Special precautions must be taken that all acetylene and oxygen gas is to be ventilated and removed from all pipelines and components before pressure testing. This in order to avoid the danger of acetylene decomposition.

New installations or modified installations:

#### Low pressure piping to receive:

Cleansing/ Degreasing using required cleaning agent.

Blow through N2 at 10 bar.

Acetylene and Oxygen Pressure testing N2 at 12 bar for 8 hours.

Pressure drop max 0,4 bar.

#### High pressure piping to receive:

Leak testing using N2:

Acetylene 25 bar and leak testing spray.

Oxygen 200 bar and leak testing spray.

Visual examination of complete CGI.

5-year testing:

#### Low pressure piping to receive:

Blow through N2 at 10 bar.

Acetylene and Oxygen Pressure testing N2 at 12 bar for 8 hours.

Pressure drop max 0,4 bar.

#### High pressure piping to receive:

Leak testing using N2:

Acetylene 25 bar and leak testing spray.

Oxygen 200 bar and leak testing spray.

Visual examination of complete CGI.





The supplier/service company is responsible for issuing certificate of inspection.

Every once a year the C/E onboard is responsible for a leak testing of the CGI. This consist of setting the installation under pressure and observe if any pressure drops. This is done using the oxygen and acetylene gas in the installation under normal pressure settings. If no pressure drops the leak test is confirmed on the certificate of inspection. If any pressure drop is observed the responsible supplier/service company should be called upon to rectify the leak.

### Suppliers and service companies delivering/servicing Central Gas Installations

Supplier	Type	Service responsible
Marigas/Marichem	Marigases Central Gas Supply System (CGSS)	Marigas/Marichem
Drew Marine	Drew Marine Central Gas Installation (CGI)	Viking
Survitec Wilhelmsen Ship Service	Unitor Gas Distribution System (GDS)	Survitec Survitec

There are also shore based suppliers of CGI installations that can deliver to ships (Linde Central Gas System). One must however make sure that the equipment is according to maritime regulations and in compliance. If a new building, the low-pressure pipeline will in majority of cases be installed by the yard. The high-pressure equipment and outlet station(s) will be delivered and installed by a supplier. If agreed with yard this can also be installed by yard. Testing, approval and issuing of certificate will be done by supplier/service company.

### The benefit of a Central Gas Installation

#### **SAFETY**

Easy access to cylinders. The cylinders are stored safely in ventilated spaces.

No need to move cylinders around.

Easier to remove cylinders in event of fire on-board.

#### **ECONOMY**

Equipment like regulators is less exposed to damage.

More economical use of gases. A Central Gas Installation with multiple cylinders ensures sufficient gas flow for all welding, cutting and heating purposes. Large flow of oxygen is for example needed when cutting thick steel plates. An acetylene gas cylinder has a limited discharge rate. Acetylene drawn from a single cylinder may register as empty even if the cylinder is half-full due to the slow process of acetone to release acetylene gas. By drawing from two or more cylinders at the same time, the gas will have more time to form and be ready for continuous use.

#### **EFFICIENCY**

Greatly reduced set-up time. Changing or moving cylinders. Hoses to be laid. The system can be operated with several outlet stations as the gas pressure is adjusted in the outlet station to suit the type of activity. The outlet station also reduces the need for long hoses.