# INSTRUCTION MANUAL FOR USE AND MAINTENANCE

## ORIGINAL INSTRUCTIONS

**Compressor model: 4DA300/110 GASVECTOR**

**Serial number: 1998PG001**

Manufacturer:

Fornovo Gas S.r.l.
Via P.M. Curie 14
42122 Reggio Emilia - Italy
Phone +39 0522 557675
Fax +39 0522 550112
www.fornovogas.it

Technical Support:

Fornovo Gas S.r.l.
Via Ponticelli 5
43029 Traversetolo (Parma) - Italy
Phone +39 0521 1553844
Fax +39 0522 550112
e-mail: service@fornovogas.it

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# 1 GENERAL REMARKS

## 1.1 Warnings and safety instructions

1) This compressor has been designed and built in compliance with the following applicable EU Directives:

| | |
|---|---|
| 06/42 | Machinery (MSD) |
| 97/23 | Pressure Equipment (PED) |
| EMC 2004/108/CE | Electro-Magnetic Compatibility (EMC) |
| 94/9 | Potentially Explosive Atmospheres (ATEX) |

The compressor is suitable for use in Zone 2 as defined by EN60079-10.

Compliance with any further requisites for installation operation in the destination country is the responsibility of the importer and/or user.

2) This manual is intended for operators and skilled personnel and provides instructions about procedures and operations aimed at ensuring correct and functional use of the plant concerned.

3) Read this manual completely before commissioning the compressor. The manual must be kept intact near the compressor, so that all personnel may easily consult it. This manual is an integral part of the machine itself and must be kept updated with any amendments or addenda issued by the manufacturer.

4) FORNOVOGAS reserves the right to perform possible modifications to supplied goods in any form and at any moment, as we constantly work towards further improvement of all machine types and models.

5) It is not possible therefore to claim rights on the basis of data, pictures and descriptions provided by this manual.

6) All operations described in this handbook must be carried out by a trained and qualified staff. Every operation described herein must be performed by the operator considered most suitable for the tasks to be carried out.

7) Tests, drawings and standards issued by this manual are based on the information available at the time of printing.

8) Reprinting, reproduction and translation, even if partial, and under any form, is forbidden without written permission from FORNOVOGAS.

9) All copyrights are reserved by FORNOVOGAS, with conditions of modifications.

10) The conditions of use for the machine and its auxiliaries are explained through this manual. Using the machine in different conditions of pressure, temperature, load, speed, can create conditions of damage to the machine and/or to the operators.

11) The functioning of the machine in such conditions is to be considered incorrect use of the machine, as is its operation after having cut out or removed any safeguarding device.

12) The properties of the treated gas must have characteristics in order to be assumed as "DRY GAS". The presence of liquids in the treated gas can generate conditions of damage to the machine and erosion of its inner parts.

13) The composition of gases treated by FORNOVOGAS' compressor, meaning process and other gases inside the machine, shall be free of explosives mixtures in all the operating conditions.

14) Modifications made in the machine and its control system, without the prior authorization of FORNOVOGAS, can determine hazardous situations for personnel and/or the machine. FORNOVOGAS cannot be held liable for any consequences deriving from incorrect or non-intended use of the machine and its auxiliaries.

15) The compressor must be installed in an adequately lit area, so that its on-board instrumentation is clearly legible.

16) Leave a free space of at least 500 mm all around the machine to facilitate maintenance.

17) Before starting any maintenance work on the compressor, disconnect the electric power and process gas connections and vent off any pressure in the machine. During maintenance, hangs a signboard on the electrical board in a clearly visible location with the warning: "KEEP OFF, MAINTENANCE IN PROGRESS".

18) Do not remove the fixed protective casings and remember that when the operating cycle in is progress, the compressor may start up without warning.

19) Never tamper with or remove any of the safety components.

20) Always verify both, the operating characteristics and the safety devices before starting the compressor. Any damage to persons or things that might result from non-specified or in any case non-reasonably foreseeable operating conditions, or from procedures, inadequate maintenance or the effects of corrosion, erosion, encrustation or gradual deterioration, will be under the customer's responsibility and at his expense.

21) It is prohibited to use the compressor for compressing different types of gas or for operating in an atmosphere other than that of design. The operating parameters are established during the project and cannot be changed for any reason without the intervention of FORNOVOGAS engineers.

22) Failure to observe safety regulations and/or the removal or modification of safeguards will nullify the manufacturer's guarantee and make the user fully liable.

23) The zone surrounding the compressor or acoustic hood (when present) is a danger zone. Limit presences in this zone to the minimum indispensable. Provide adequate supervision to prevent access to non-authorized persons.

24) Any work on the machines and the auxiliary equipment must be carried out buy operators suitably informed of the activities they are to carry out.

25) Do not put the compressor and its auxiliaries in service for the first time before all operators have received adequate training in safety instructions, devices and procedures.

26) Replacing parts with non-original spare parts not only nullifies the warranty but can also create dangerous situations. The manufacturer does not acknowledge any responsibility for possible damage to persons and/or things deriving from the utilization of non-original spare parts.

27) During operation, all parts of the equipment must be in perfect condition; the equipment must not be put in service if any defects or anomalies have been observed.

28) In general, operators must utilize the personal protection devices suitable to the dangers present in the zones to which they accede and to the operations to be carried out. Identification of the specific personal protection devices is the responsibility of the plant manager, also on the basis of the information given in this manual. The operator's clothing must be adequate to the hazards present, and in particular must be such as to avoid any danger of being caught in the machinery.

29) Given the type of operation of the machine and the type of environment in which it operates (presence of gas, high pressures, etc.) it is extremely risky for personnel to carry out operations not specified in this manual (even with the machine switched off). For such operations it is always necessary to consult the assistance service of FORNOVOGAS.

30) Before working on the compressor or on the lines for maintenance procedures, put the machine and its auxiliaries or the line in safe conditions by isolating it from any source of external power (electric, pneumatic, hydraulic power supply, etc.) and discharging any sources of internal power (such as springs, pressure vessels, capacitors, etc.). suitable block external sources of power so that they cannot be accidentally reactivated while working. A procedure prepared by the plant manager must be used.

31) Only operators authorized by the plant manager can carry out command and adjustment operations on the compressor and its auxiliaries with the machines stopped. This I prohibited during normal operation. Any adjustment and control operations for which it is indispensable to have the compressor and its auxiliaries funning, must be reduced to a minimum and previously authorized by the plant manager.

32) It is prohibited to make changes in the operating parameters of the equipment or the calibration of the instruments and fixtures: this could lead to highly dangerous situations.

33) All control and safety devices must be checked, calibrated and tested at regular intervals.

34) Do not cut out nor remove the safety devices and guards installed on the equipment.

35) It is prohibited to start the equipment until all of the required guards heave been installed. Furthermore, it is prohibited to remove them during operation.

36) It is prohibited to use self-constructed equipment (supports, brackets, fixtures, etc.), which has not been explicitly authorized by the technical department of FORNOVOGAS.

37) In the compressor and in some auxiliary systems (lube oil, seal oil, seal gas, cooling water) are fluids which are hot (or cold) and /or under pressure. Special caution must be adopted in operating bleed and vent valves on the systems in question. Prior to beginning any maintenance procedure that involves disassembly, ensure hat the internal fluid has been properly cooled and that it is not under pressure.

38) Immediately clean any oil present and resolve the cause of such immediately, also to avoid the risk of slipping.

39) In the presence of unbalanced loads (such as for example couplings or other accessories) use additional cables to prevent overturning during hoisting. Failure to observe these precautions can cause severe harm to persons. Hoisting and handling operations must be carried out exclusively by specially trained personnel.

40) Maintenance operations on electrical equipment must be carried out by expert, authorized personnel. Note that in circuits, where capacitors are installed, the voltage may remain present for a certain time even after the power supply has been cut off.

41) Inside electric panels and in the vicinity of electrical devices mounted on the machines and its auxiliaries, dangerous voltages are present. Do not remove the guards before having first put the equipment in sage conditions. Remount the guards prior to energizing the equipment again.

42) Never work alone on any electrical equipment. Ensure that personnel assigned to this work are aware of emergency first aid procedures in case of electric shock.

43) Do not climb on or use as rests electric ducts, junction boxes or similar.

44) Always install ground leads for the equipment as specified by the design. Do not remove these connections for any reason.

45) Do not use water to extinguish fires on live electrical equipment. The fire extinguishers to be utilized must be appropriate to the equipment and to the type of fire.

46) Take maximum care to avoid impact while handling the machine and its parts.

47) Prior to put the machine in service, ensure that the covers on inlets, discharges and vents have all been removed and that they remain unobstructed. Carefully observe all of the indications on the monitor and the instrumentation prior to start-up and during operation. The speed of the machine and the pressure and temperature measurements are the best indicators of correct operation of the machine.

48) In case of stopping for malfunction, do not attempt another start before the cause has been found and corrected.

49) Cover for protection all of the ducts opened during maintenance to prevent the entry of extraneous materials into the systems; avoid to use insulating tape.

50) Avoid bending cables. Repeated bending of cables could cause them to break.

51) Ensure that check valves and control valves and control valves are installed according to the correct direction of flow.

52) Any damage caused by a period of idleness during which the product has not been put in maintenance conditions, in order to ensure its perfect preservation, will be at the expense of the customer.

53) During the stages of installation and maintenance on the compressor and its auxiliaries, hazards relevant to the specific activity carried out are present.

54) Remember that even if the machine is not running many hazards are still present like:

- gas at high pressures in the process and auxiliary systems
- high voltage
- possible hot surfaces
- slippery surfaces around the machine and its auxiliaries
- dangerous gas

55) External hazardous points created by other equipment not included in the supply should be taken in consideration by the station planner in order to respect and not invalidate the "safe areas" in which the components should be installed.

56) Electrical motors may be supplied through frequency converters (VFD): people who use electro-medical devices must keep at a safe distance.

57) The user shall avoid operating conditions which may cause pressure and temperature limits to be exceeded. Danger of catastrophic failure, injuries or death!

58) Equipment transportation must be accomplished accordingly to what is stated in the manual: danger to equipment integrity and damage to people/things.

59) User is responsible for connections (fluid and electrical) completion: connections dimension and rating must be respected in order to avoid explosions, fires, injuries or death!

60) User is responsible for the correct set up of suitable fire figthing procedure and gas detection systems in the equipment installation area. Danger of injuries/death.

61) Accidental contact with equipment surfaces may cause serious injuries.

62) User is responsible for the correct design and manufacturing of a suitable vent system to convey vent gas to a safe area: if vent gas is not properly conveyed, risk of fire, injuries or death is present.

63) If not otherwise specified, the equipment is not designed to withstand external loads, with the exception of a max 5 meters unsupported tube length (of the same dimension of the connection considered) and a max snow load of 10 cm. Risk of catastrophic failure, injuries or death!

64) User is responsible for correct equipment earthing: risk of sparks, fire, explosions!

65) User shall periodically check equipment external surfaces condition, especially in relation to corrosion: corrosion on pressure equipment surfaces may lead to leakages and fires! User shall periodically clean the equipment.

## 1.2 Notes for reading this manual

We remind you that the name of the Manufacturer, the Technical Assistance contact details and the serial number of the compressor are indicated on the first page of this manual.
The term skid shall mean all components mounted on or supported by the compressor chassis, including the electric motor, the compressor body, the gas-water heat exchangers, etc.
All these components are identified in the photographic annexed to this manual, in the P&ID and in the exploded diagrams.

# 2 INSTRUCTIONS FOR ASSEMBLY, INSTALLATION AND PREPARATION FOR OPERATION

## 2.1 Manoeuvring

Before proceeding with any manoeuver, be sure that the container is completely disconnected and that the used method for manoeuvring is suitable for the dimensions and weight to be moved (see layout GV AS10001768).
The Gasvector™ module is movable in two ways:

### 2.1.1 Moving with crane

Make sure that the used crane is able to lift the indicated weight within the whole manoeuvring range.

1. connect four ropes to the four lifting holes located at each corner of the container;
2. the angle to the ground must be wider than 65°;

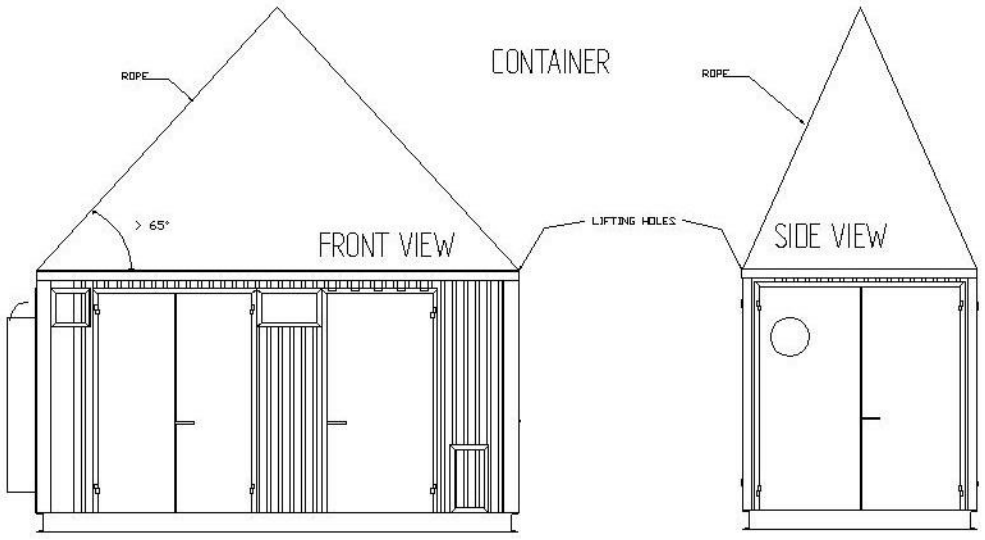


**Fig. 1 Manoeuvring container**

### 2.1.2 Moving with fork lift

Make sure that the used forklift's capacity is suitable to lift the indicated weight within the whole manoeuvring range and that the forks are long enough to sustain the whole construction. You can use the forklift also for unloading the container from a truck, but it is best if it's going to be used only for ground moving and placement. (at the moment of installing the container in it's final working position a crane works better, because there is no space between the ground and the bottom of the container for retiring the forks). Insert the forks centrally on the long side of the container and make sure that they are wide opened at the moment of lifting, for an optimal weight balancing.

**Tab. 1 – Unloading and moving sequence of container with forklift**

| | | |
|---|---|---|
|  |  |  |
| **Fig. 2 Moving with forklift 1** | **Fig. 3 Moving with forklift 2** | **Fig. 4 Moving with forklift 3** |
|  |  |  |
| **Fig. 5 Moving with forklift 4** | **Fig. 6 Moving with forklift 5** | **Fig. 7 Moving with forklift 6** |

Take care to place some logs under the container when only storing or moving temporarily in order to be able to have enough space between the bottom of the container and the ground for inserting/retiring the forks.

## 2.2 Locating container

The container must be located on an appropriate platform, as can be seen in the annexes, drawing PL12000077. At the sides has to be left a free space of at least 1m to facilitate maintenance operations.

### 2.2.1 Gasvector anchorage

**Tab. 2 – Gasvector anchorage preparation**

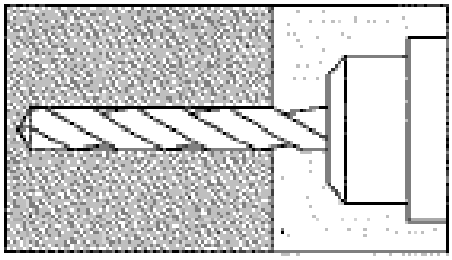

**Fig. 8 Platform hole**

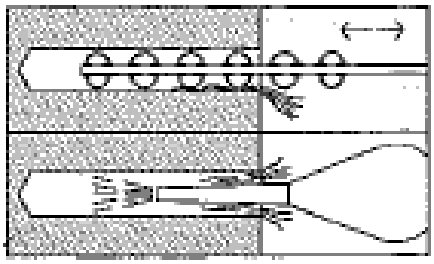

**Fig. 9 Hole cleaning**

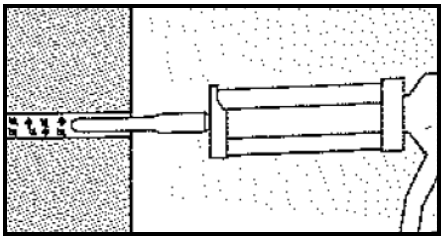

**Fig. 10 Resin insertion**

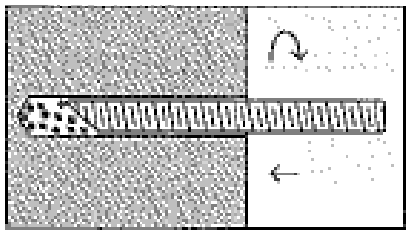

**Fig. 11 Threaded bar insertion**

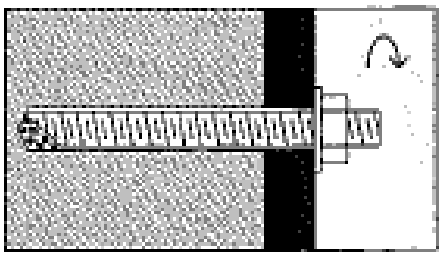

**Fig. 12 Foot tighten**

To perform optimally the Gasvector anchorage on the platform must follow some simple guidelines:

- Boring the platform observing the application data, such as diameter and depth, shown in Tab. 3;
- Accurately Cleaning the hole from the dust and debris using a scraper or compressed air;
- Insert the ampoule of resin into the hole;
- Insert into the hole the threaded rod M12, turning to penetrate the resin in all the cavities;
- Place the foot of Gasvector and tighten.

**Tab. 3 – Chemical anchor**

| **Chemical anchor** | | | | | | | |
|---|---|---|---|---|---|---|---|
| Technical data: | | | | | | | |
| Bar size | | **M8** | **M10** | **M12** | **M16** | **M20** | **M24** |
| Hole diameter | (mm) | 10 | 12 | **14** | 18 | 24 | 28 |
| Hole depth | (mm) | 80 | 90 | **110** | 125 | 170 | 210 |
| Hole total volume | ($cm^3$) | 6,3 | 10,2 | **16,9** | 31,8 | 76,9 | 129,3 |
| Resin Q.ty (2/3 hole vol.) | ($cm^3$) | 4,2 | 6,8 | **11,3** | 21,2 | 51,2 | 86,2 |

Insert between foot and Gasvector the adhesive rubber MUS sp. 0,5 mm, to avoid contact between the two, because it could deteriorate in case of excessive vibration.

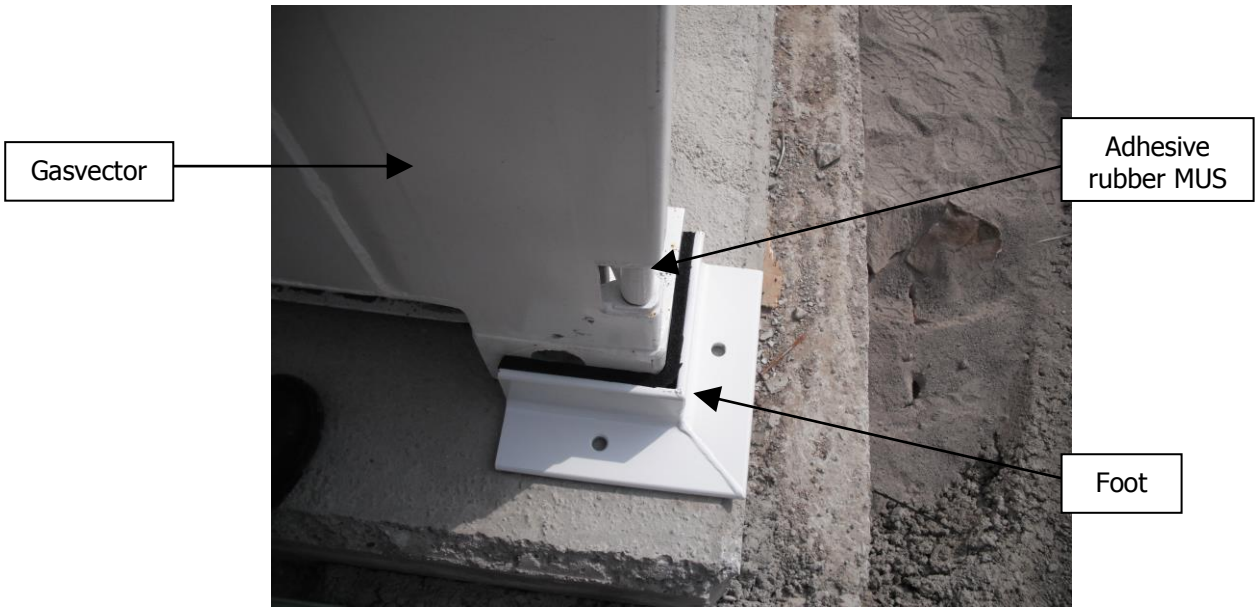


**Fig. 13 Gasvector fixing in platform**

## 2.3 Compressor's module constructive description

The Gasvector™ module is supplied as a preassembled station in which all the components are enclosed in a single prefabricated metallic cabin. The cabin is usually divided in two sections (compressor room and power/control panel room) through a metallic panel. The power/control panel is installed on a short side of the cabin, in an area classified as safe area according to the European standards for electric equipment.

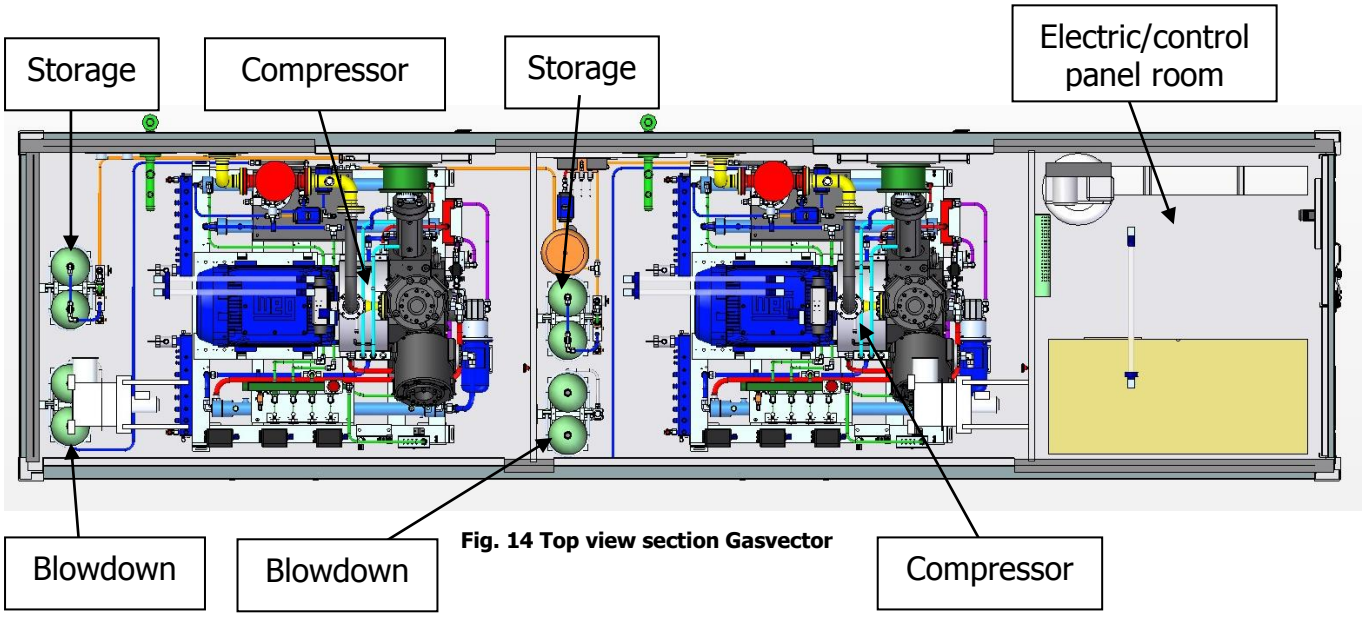


**Fig. 14 Top view section Gasvector**

## 2.4 Moving the compressor

In case of necessity to move only the compressor for extraordinary maintenance or for special replacements, the compressor may be maneuverer with fork lift equipment, using at least 2 meters long forks, inserted between the chassis and the ground;

**NOTE:** Before removing the compressor make sure to have emptied all the pressurized and hydraulic circuits that have connections with outstanding parts of the compressor's skid itself (water and gas circuits). For doing this see the chapters regarding the maintenance for each circuit along in this manual. Also make sure to have removed all pneumatic (air), hydraulic (water, gas) electrical and structural connection (fixing screws to the ground of the cabinet).

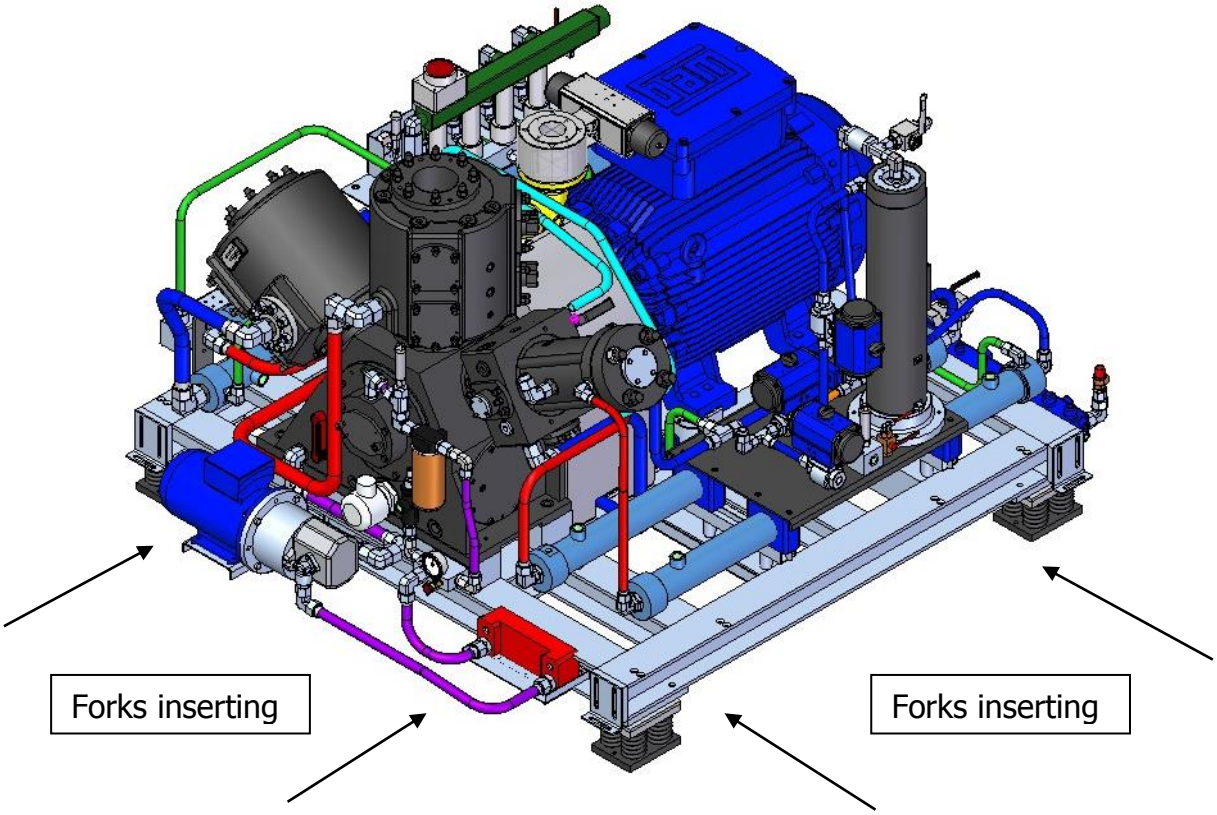


**Fig. 15 Compressor's skid**

While inserting the forks pay attention to the lower holders. You may find their position in the annexed footprint.

The center of gravity is located approximately between the electric motor and the compressor body, under the flywheel.

**Manoeuvre the compressor with extreme caution, avoiding brusque movements or knocks.**

## 2.5 Process gas connections - Instrument air connections - Electrical connections

### 2.5.1 Process gas on Gasvector

Methane based Natural Gas, max $CO_2$ 3% by vol., max $H_2S$ 5ppm, no liquid particulate. The gas dew point must be lower than the minimum air temperature. No liquid residue in the gas.

We suggest to install one manually operated valve at the compressor's outlet, outside the container, to allow easy removal or bypass during maintenance.

For all connections to Gasvector always refer to P&ID SG15000134 and layout AS10001768.

### 2.5.2 Process gas – Skid's connections

The skid is already installed inside the cabinet, but in case of extraordinary maintenance or if needed to remove for any case you may find described here below the gas connections on the skid (compressor module).

See SG15000132 and AS10001767 for all the connection within compressor skid and cabinet.

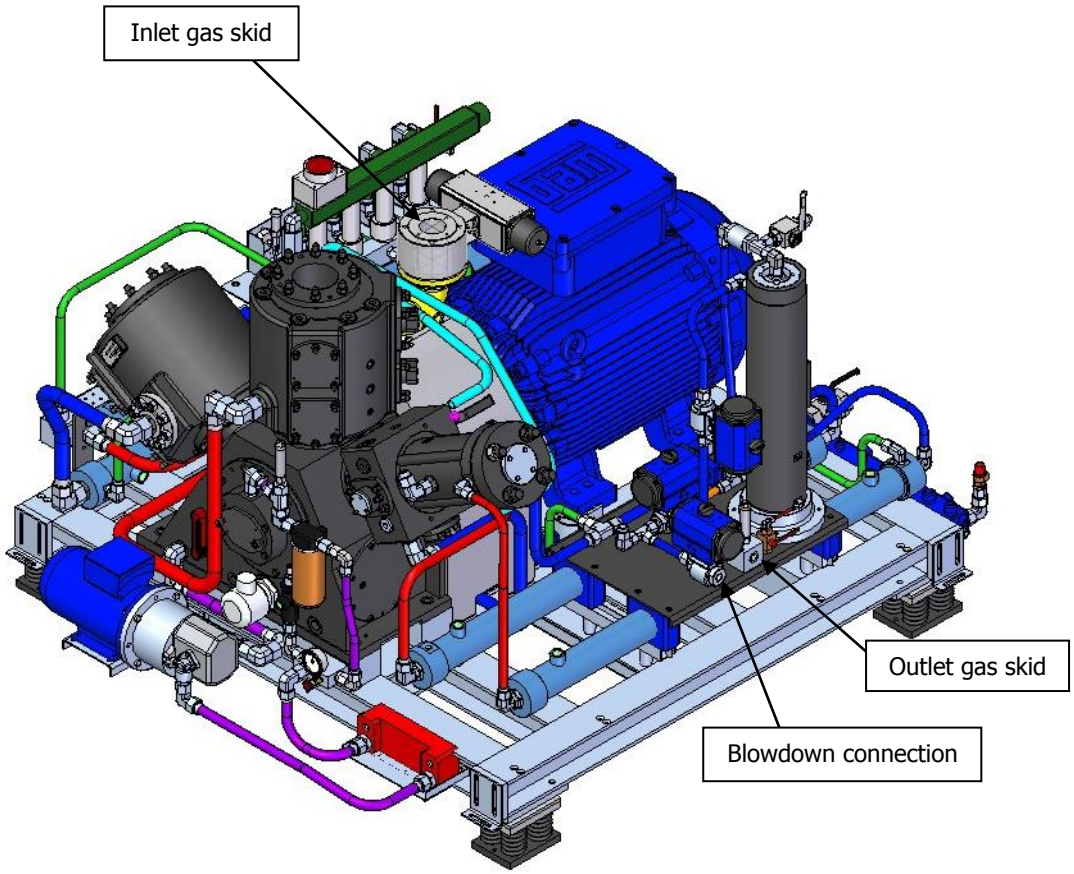


**Fig. 16 Inlet/Outlet gas connections on skid**

**FAILING TO COMPLY WITH THE REQUISITES FOR THE PROCESS GAS MAY RESULT IN SERIOUS DAMAGE TO THE COMPRESSOR**

### 2.5.3 Instrument air on Gasvector

Dehydrated, filtered atmospheric air. Normal supply pressure 6-8 bar(g).

Connect dispenser compressed air inlet line to the Gasvector compressed air outlet line

See also P&ID no. SG15000134 and layout AS10001768 for connection references.

### 2.5.4 Instrument air on Skid

Dehydrated, filtered atmospheric air. Normal supply pressure 7-10 bar(g).

Connect the pneumatic plate (on board the skid unit) to the solenoid valves in the electrical board using 6x1 (external diam. x thickness in mm) Rilsan tubing. See P&ID no. SG15000132 for a schematic of air connections.

### 2.5.5 Electrical connections on Gasvector

For all electrical connections see the annexed electrical diagram, SE15000075 and SE15000076.

### 2.5.5.1 Grounding

Grounding is predisposed on the backside of Gasvector through a threaded rod that connects the ground wire and it is tightened with a bolt M12.


**Fig. 17 Backside Gasvector**

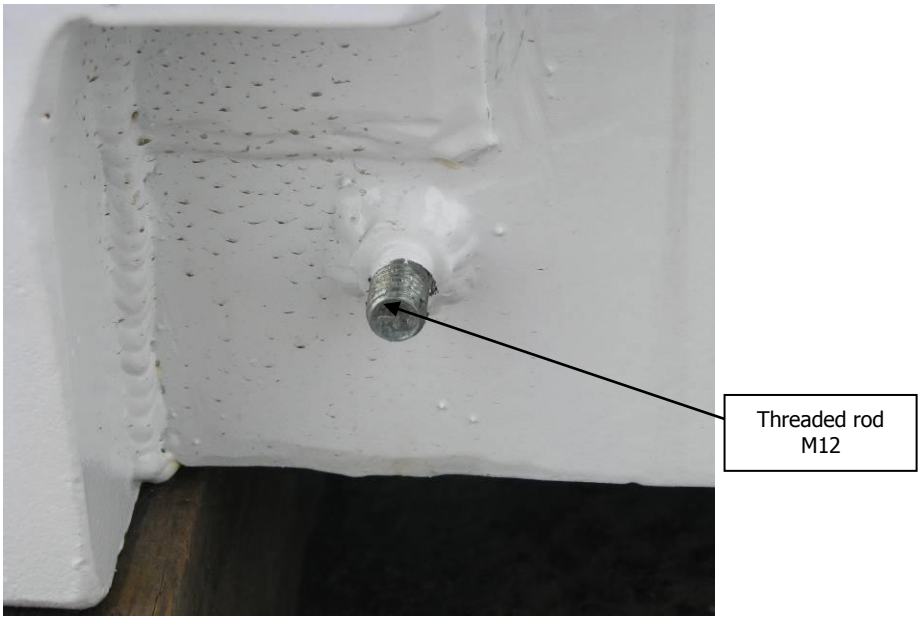


**Fig. 18 Grounding connection**

### 2.5.6 Electrical connections on Skid

For all electrical connections and wiring between the board and skid unit (electrical junction boxes), see the annexed electrical diagram, SE15000075.

### 2.5.7 Electrical power

For information regarding the electrical power to refer to the wiring diagram SE15000075 and SE15000076.

Direction of rotation, main motor: anticlockwise from fan (rear) side.

**VERY IMPORTANT: BEFORE STARTING THE COMPRESSOR FOR THE FIRST TIME, VERIFY DIRECTION OF ROTATION, GIVING A SHORT TIME (1 SECOND) IMPULSE TO THE MOTOR.**

### 2.5.8 Vent gas on Gasvector

Low-pressure gas recovery from compressor, storages manual discharges and safety valves discharges are collected to a vent pipe that conveys to a safe area.

Vent pipe exhaust (delivered with the supply) must be connected to the vent pipe connection flange outside of the Gasvector module.

For any connection refer to P&ID GV in annexes SG15000134 and layout GV AS10001768.

### 2.5.9 Vent gas on Skid

Vent pipe exhaust must be conveyed to a safe area.

For any connection refer to P&ID skid in annexes SG15000132 and layout skid AS10001767.

## 2.6 Other fluids (Coolant, Oil)

### 2.6.1 Coolant manoeuvring

Before to proceed with the movement to ensure that the Aircooler is completely disconnected and that the method used is appropriate in accordance with the size and weight to be moved.

For dimensions and weights see the layout attached.

### 2.6.2 Coolant fluid on Gasvector

Demineralized water and antifreeze liquid* in order to avoid solution freezing at minimum ambient temperature.

See layout attached to the required amount of liquid.

Liquid level in the expansion tank shall be kept at tank half height.

Indicatively, antifreeze percentage are as per following table:

**Tab. 4 Antifreeze percentage**

| %vol. antifreeze liquid | Min. temperature °C |
|---|---|
| 35 | -20 |
| 50 | -40 |

* As antifreeze liquid, use the product "Ferrogel Green" by ICL Water Solutions, equipped with corrosion inhibitors. Alternatively, use an equivalent product (equipped with corrosion inhibitors) of primary manufacturer.

In addition to antifreeze liquid, use also a biocidal product, like "Ferrocid 8580" by ICL Water Solutions (40 g every 1 m3 of cooling liquid) or, alternatively, an equivalent product of a primary manufacturer.

To protect effectively against corrosion, it is strongly suggested to keep cooling liquid pH between 7 and 9: if needed, increase pH by using the product "Ferrodo 211" by ICL Water Solutions or an equivalent product of primary manufacturer.

**ATTENTION: Fornovogas does not bear any responsibility for corrosion damages caused by a cooling liquid not withstanding the above requisites.**

## NOTES ON WATER CIRCUIT FILLING

Before starting the compressor, it is necessary to remove all the air present in the circuit itself.

Start water pump manually and let the air go out to atmosphere through the apposite valve usually located in the expansion volume of the water circuit. Expansion volume must be placed above the highest point of water circuit, to have all the circuit pressurized even when the pump doesn't run. Special procedures are applicable for the disposal of coolant containing ethylene glycol. See procedures of the country where the machine is installed.

Note: in case that the cooling unit should be supplied dismounted refer to its assembling instructions in the annexes.

**VERY IMPORTANT!!!!**

1. **Cooling water circuit shutoff valves (skid mounted, aircooler mounted or others) shall be kept open (locked) in every operating conditions. FAILURE TO DO SO MAY RESULT IN COOLING CIRCUIT OVERPRESSURE AND POTENTIAL EXPLOSIONS DUE TO AIRCOOLER EXPANSION TANK NO LONGER CONNECTED TO COOLING CIRCUIT. It is also necessary to check that expansion tank atmospheric vent is free. If it is equipped with safety valve, it is necessary to check its proper functioning once a year.**
2. **Prior to perform any kind of maintenance on cooling water circuit (except cooling water replenishment), it is necessary to shutoff inlet and outlet gas valves (or storage shutoff valves if present) and blowdown any gas contained between them through relevant skid mounted manual blowdown valves. These valves shall be kept open during the entire maintenance operation.**
3. **The same operations described in point 2 above must be accomplished also if a cooling water leakage is detected in any point of the circuit, or when an alarm related to water circuit (low pressure, high pressure, water pump thermic relay, etc.) is noted on the operator panel. In both situation the plant shall be put out of schedule as described in point 2.**

### 2.6.3 Oil

For the oil circuit see the annexed compressor manual ST14000015.

# 3 COMMISSIONING

## 3.1 Compressor's functional characteristics

The compressor is designed to compress methane-based natural gas from intake pressure, within the limits specified below, to the filling pressure.

### 3.1.1 Process gas operation limits and nominal values

In the annexed "compressor datasheet" ST15000108 are reported other functional parameters, specifically interstage pressures when the two stage functioning mode is active (suction pressure less than 60 barg)

**Lubrication circuit pressure**: 3-10 barg (read from PI301 or PT301)
**Coolant circuit pressure**: 1.5-2.5 barg (read from PI401 or PT401)
**Instrument air pressure**: 6-8 barg (read from PT201)

### 3.1.2 Environmental temperature operation limits

Compressor: min -20°C max +40 °C

### 3.1.3 Priority panel

The priority panel is installed downstream the compressor skid, to allow two-line refuelling of the storages and the vehicles with a two line dispenser. The control of the sequence is commanded by the control panel's logic.

## 3.2 Safety devices

In the annexed "Cause & Effect chart" ST15000119 is reported a list of electric safety devices (alarms), and their maximum and minimum values (together with *never-exceed* values).

If one of operating conditions is not verified, relative alarm MUST trigger the machine emergency stop.

**VERY IMPORTANT!!!!**

- **Do not alter the calibration settings of the electric safety devices, or tamper with, remove or bypass the devices themselves**

- **Do not alter the calibration settings of the safety valves (mechanical safety devices), or tamper with, remove or bypass the valves themselves**

## 3.3 Machine use

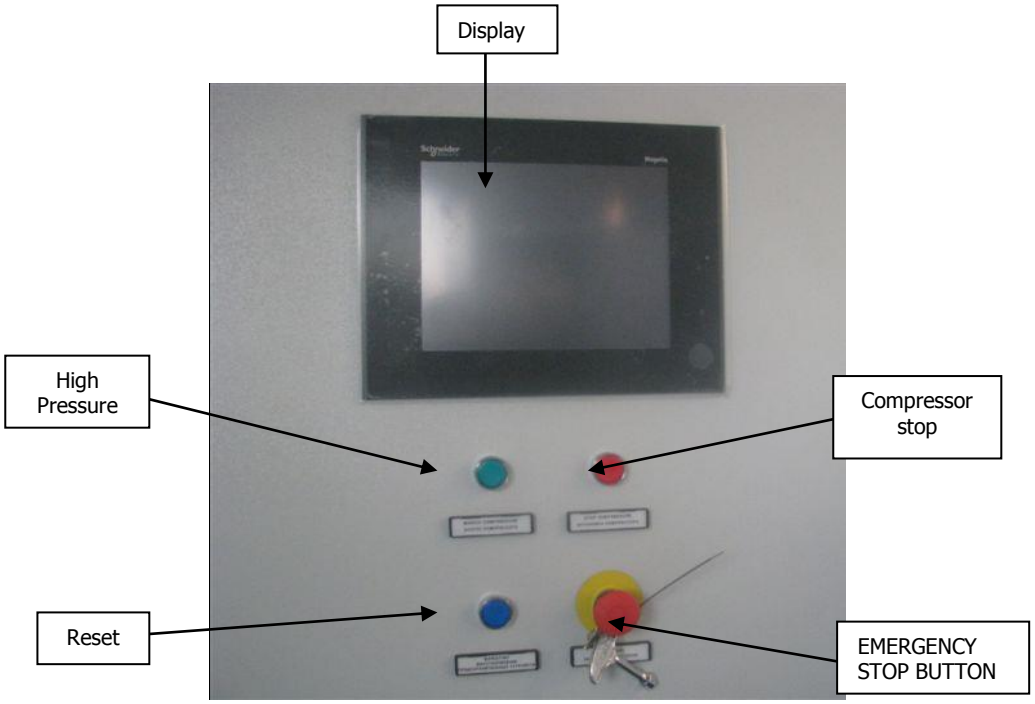


**Fig. 19 Control panel's commands**

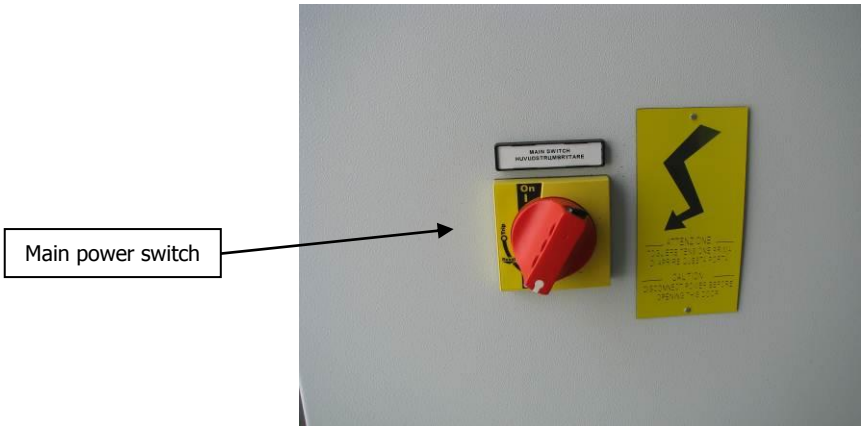


**Fig. 20 Main power switch**

## 3.4 Starting for the first time

Before starting for the first time, check that all instructions given in the chapter "Installation" has been followed correctly. In particular, remember to:

1) drain the intake line – there must be no residual liquid particulate left over from hydraulic testing;
2) read this manual and its annexes completely;
3) clearly identify the location of the emergency buttons;

## 3.5 Daily functioning

Daily starting (cycle switch on)

1. turn the key in the set command to "ON";
2. make sure the air compressor is switched on; if not, switch it on and wait till the air pressure reaches the set pressure before proceeding with the next step;
3. push the "Start Compressor" button for at least 3 seconds. The siren, while pushing the button, indicates the start of the compressor;

The electric motor starts and activates the compressor body through a joint, as soon as the stock pressure lowers, due to the refuelling.

**NOTE:** To protect the transmission of electric motor / compressor body there is a housing.

Daily stop

1. push the "Stop Compressor" button;
2. turn the key in the set command to "OFF";

During the regular daily functionality, it is recommended to not switch off the power panel, but to leave it always powered, to prevent the formation of condense.

## 3.6 Daily functioning during Winter Period

**For "Winter Period" is meant, when the minimum night temperature is expected to fall lower than 0°C.**

In that case, it is recommended to let the compressor switched on, to keep the thermal protections active.

## 3.7 If it's foreseen an inactivity of the compressor for over one week

Stop sequence

1. push the "Stop Compressor" button;
2. turn the key in the set command to "OFF";
3. turn the main power switch to position "OFF"

Start sequence

1. turn the key in the main power switch to position "1"
2. the siren starts beeping, push the "Switch Off Siren"
3. push the "Reset alarms"
4. turn the key in the "Set Command" to "ON"
5. make sure the air compressor is switched on; if not, switch it on and wait till the air pressure reaches the set pressure before proceeding with the next step;
6. push the "Run Compressor" button for at least 3 seconds. The siren, while pushing the button, indicates the start of the compressor;

The compressor will start automatically, as soon as the stock pressure lowers, due to the refuelling.

## 3.8 Emergency stop

The machine is fitted with at least two emergency buttons, on board the skid unit and another one on electric board. Pressing these buttons immediately cut off power to the compressor and set it to safety mode.

The compressor automatically performs an emergency stop in the event of an alarm.

## 3.9 In case of alarms

In the case that one of the set limit values should be exceeded:

1. the compressor stops in safe mode;
2. the siren beeps for 5 minutes;
3. the control light "Compressor Blocked" turns on;

consequently:

1. push the "Switch Off Siren" button;
2. LOOK ON THE DISPLAY THE MARKED ALARM MESSAGE;
3. resolve the cause of the alarm;
4. press the "Reset Alarms" button;
5. push the "Run Compressor" button for at least 3 seconds. The siren, while pushing the button, indicates the start of the compressor;

In case that the FORNOVOGAS technical service should be called, which numbers are on the first page of this manual, you must COMMUNICATE THE SHOWN ALARM MESSAGE ON THE DISPLAY.

The compressor could not be reset as the cause of the alarm has not been removed.

## 3.10 Warnings

For a correctly use would be recommended, in agreement with the Fornovogas Srl, a training, in our office, on the operation of the machine in all its aspects;
In addition, according to the normative in force on safety at work, the operator is required to play a fire-fighting training.

# 4 LOW VOLTAGE SWITCHBOARD

## 4.1 Preliminary checks

Every part of the entire unit was completed and has been checked in the factory to ensure that operation can be started immediately. However before turning on the electrical power supply it is important to check that no damage has occurred during transport. To do this, carry out the following procedure:

- Perform a careful visual inspection to ensure that there is no oxidation on the bars, neither any sign of condense. If any traces of humidity are found, they must be removed, especially around the isolators bar support, using a completely dry jet of hot air (max. 80 °C).

Oxidation traces must also be removed accurately. This for see chapter 0 Maintenance on page 36.

- Check that the bolts are tight. This must be done for all bolts, whether they are part of the electrical or of the mechanical connections. In particular check that the connections are tight on the earth bus bar.

- Accurately reassemble all the segregation sheet metal of the bars spaces.

- Carry out the same checks as above also on terminal boards where the auxiliary connections are foreseen

- On the front part of the control panel check that the doors open correctly and that the handles with corresponding lock and key are working properly. If necessary, lubricate the revolving plugs on the lock with a drop of oil, try the locks a few times and remove any excess oil with a clean cloth

- Verify the extraction of the sectional switches.
  The switches must be extracted completely and a visual check has to be performed to ensure that no damage has occurred during the transport on fixed and mobile parts. Broken parts must be immediately replaced. Also check that extraction and inserting of the switches happens easily and so for their translation on the bars. If translation should result difficult, it means that the guide bars have moved from their normal operating position and have to be realigned.

- Remember that a relevant power has to be used only in the moment when the mobile contacts are inserted on the fixed contacts, because contact pressures have to be exceeded for a correct insertion of the switch.

- Verify the integrity of socket and plug connectors for auxiliary connections of sectional and removable interrupters.

- Verify that there is no oxidations on start contacts, fixed and mobile, neither on auxiliary connection contacts, socket and plug. If there should be, proceed to their elimination as described in chapter 0
- Maintenance on page 36.

- Check the internal control and measuring buckets; visually control that all the devices and relays are properly fixed to their correct mounting position and eliminate with the usual procedure eventually presences of humidity and oxidation.

- Inspect by opening, the integrity of all fusers and proceed with reinsertion. Particularly check that the contact surfaces of fuser and its holder are perfectly clean.

- Check that there are no traces of humidity on the switches. If there are, remove them using a completely dry jet of hot air (max. 80 °C). If the switches show a considerable degree of humidity, remove the front lid by loosening the four fixing screws and use a jet of hot dry air to dry out perfectly the internal part of the switch. Any trace of salt deposit or mould must be removed using a stiff bristled brush

## 4.2 Maintenance

The described LVS, once correctly installed and used, doesn't have particular maintenance problems. Anyway it's advisable to proceed periodically with some check as described as follows; the times between the check may be opportunely reduced depending on the status of the switchboard after the first checks.

### 4.2.1 Visual control of internal dust backlog (every 6 months)

An eventual dust backlog can be eliminated with a normal vacuum cleaner by switched off electric panel.

Do not use compressed air to remove dust, because most of it would return into the case and could also penetrate the single components.

It is absolutely not allowed any deposit of conductive dust, like graphite or similar, or flammable dust, like wooden or cereals powder and similar.

### 4.2.2 Visual check for oxidation of start connections with mechanical bolt clenching between cupper bars and cables endings (every 12 months)

Search for the causes responsible for oxidation, so that it can be eliminated.

The most usual causes are:

- Loosen of mechanical clenching (screws and bolts) with consequently junctions overheating.
- Contamination by aggressive chemical agents brought from outside either by air in the checking stage or by the use of tools, which had chemicals on them.
- Presence of humidity.

Any oxidation should be removed by opening the connection, cleaning the contact surfaces carefully using lightly abrasive paper and perfectly clean cloths and brushes.

All powder residues must be removed completely from the control panel.

Do not use chemical products for cleaning, unless you are entirely sure they can be neutralized.

Once you have cleaned the connection, tighten the connection, and tighten the bolts again After this it is a good idea to apply a thin film of electrical contact grease (grease which has had graphite and/or silver powder added to it to make it conduct) to the outside of the connection. Remove any excess with a perfectly clean cloth.

### 4.2.3 Visual check of start connections between fixed and removable parts of sectional interrupters (every 12 months)

The eventually present oxidation must be removed by an accurately cleaning with a rough fibres cloth, eventually moisten with alcohol, o with strong brushes. Do not use abrasive devices, like powders or sandpaper, which could damage the silver cover of the contacts. After that proceed with greasing the contacts, fixed and removable, with special electric contacts grease. The eventually excess of grease has always to be removed. By checking the above described, also look for the correct mechanical functionality of interrupters removing and insertion.

### 4.2.4 Check the bolt connections are tight (every 12 months)

Disconnect the control panel completely from the electrical power supply and check that the bolt connections on all the copper bars, between copper bars and cables and between terminals in general and input and/or output cables are tight.
Obviously this check should be extended to all the earth connections including the secondary connections of the current transformers.

### 4.2.5 Check the auxiliary connections (every 12 months)

This involves checking that the screws, which make electrical connections and the fasteners that hold electrical equipment in general, are tight.
Remove any trace of oxidation by means of a light abrasive action and after tightening the connection again apply a thin film of conducting grease to protect it.
If the connection shows a high degree of oxidation, it should be replaced. Change the support equipment and the terminal and rebut the cable again from scratch after removing the end of the cable where the copper showed signs of being oxidized.

### 4.2.6 Check the protection fuses for the power supply to the auxiliary services and voltmeter measuring circuits (every 6 months)

Open the equipment and check the fuses.

If no signs of oxidation or overheating are to be seen, the equipment can be reassembled.

If not, the entire unit should be replaced, since once the fuse holder has been overheated it can no longer guarantee a good electrical contact with the fuse.

### 4.2.7 Check the protection relay of the starting line (every 12 months)

With the electrical power supply connected, check this by pressing the "test" button located on the switches.

### 4.2.8 Check the connections of the grounding system (every 12 months)

After checking the internal connections of the control panel with the earth bus bar as described above, check that the bus bar is connected perfectly with the grounding system.

It's a good idea, however, to open the connections both on the earth bus bar and on the earth plate itself to check the effectiveness of the contact surfaces.

Clean them if necessary, re-establish the contact and grease the outside of the connection with Vaseline or conducting grease.

The above check is obviously entirely valid only if you can be entirely sure of the complete effectiveness of the grounding system, which you are legally required to check at least once every two years.

## 4.3 Exercise

### 4.3.1 Preamble

Access to the switchboard must be allowed only to trained personal, because the LVS contains terminals and distribution bars, which are normally protected for direct contacts, but still under tension.

### 4.3.2 Closing interrupters

Before closing the sectional, removable or fixed, interrupters, ensure they are perfectly fixed on the wall (if sectional or extractable) or correctly placed on the metal sheet support (if fixed).

Anyway there are no particular conditions to observe for proceeding with the interrupters closing.

## 4.4 First start up

- Unscrew the rear protection of the single modules, so to allow the access to the terminals of the interrupters;
- Connect the incoming wires;
- Connect the outgoing wires;
- Regulate the surge suppressor;
- Set the foreseen values, based on loads and selectivity demands;
  - The magnetic surge suppressors of the principal (incoming) interrupters, can temporally be set on minimal values, to obtain a rapid power cut in case of a short cut during the start up.
- Control the current transformers;
  - Control that the secondary circuit of all current transformers is closed (connected load). If no load is used, the circuit's terminals must be placed in short circuit;
- Control of the power and neutral bars;
  - Perform a visual control to ensure that all the connections screws of the bars are correctly tighten between the sections;
- Control the sequence end identification of the phases;
- Control the panels connections between the sections;
- Carry out an isolation test;
  - Control that the incoming power supply is cut off. Verify that all the control supplies are disconnected. Check that all the relays are disconnected. Control that all the big interrupters units (incoming) are sectioned.

- Control the isolating of the principal bars system using a Megger to 1kV or 0.5kV. The isolating resistance must result bigger than 1Mohm. Reconnect all relays, control the tensions and circuits that have been disconnected during the isolation test.

- Power up tension
  - Control that the incoming and outgoing units interrupters are in open condition.
  - Ensure that all the doors and panels of the switchboard are closed. Close the main switch of the LVS and connect, if possible, on switch at time.
  - Control the sequence of the phases.
- Control the single starts one by one:
  - Close the interrupter
  - Control the main circuit connected to user
  - Control all the important interconnection circuits (if present) following the LVS' annexed schemes.
- Final control
  - Control that all the electronic devices are working. During the start up, set all the magnetic surge suppressors with their relative working value. Control that bars don't generate any noise or vibration.

## ATTENTION!

The short circuit level of a low-tension device is usually very high. Depending on the set interruption time, the selectivity, etc., in the operating unit can be generated elevate level currents also for a relatively long time. An accidental short circuit may cause serious damages to the persons and devices. This for it's very important to use isolated tools and fuse protected instruments during the start up procedure.

# 5 MAINTENANCE

Only specially trained and authorized personnel is authorized to perform maintenance operations. Always use proper individual protections for a safety operating.

## 5.1 Ordinary Controls

### 5.1.1 Daily jobs:

*Intake and inter-stage gas pressure*

To verify the correct values, see functional characteristics table on compressor datasheet ST15000034 to have referral parameters to compare with the values displayed at the operators panel on the compressor's electric power/control panel; for more details about the use of the operator's panel see the relative attached instruction's manual.

*Gas or fluid leaks*

Perform a visual and auditory check to detect eventual gas or fluid leaks.

*Alarms signalled on the board*

Check and clear alarms signalled on the operator's panel.

### 5.1.2 Weekly jobs:

*Oil level*

Make sure that the oil level seen in the level indicator is over the minimum (see annex ST14000015)

Further there is a double electronic control for the oil level;

- A forewarning that advises with a message on the display, the approaching of the oil quantity to the minimum allowed level.
- By reaching of the minimum level, found by the level switch, the machine is going to be blocked under alarm condition.

In case of low oil level, fill until the level reaches half between the minimum and maximum signs on the level indicator.

*Coolant level*

The coolant liquid level must be controlled by running machine, or better by running water pump. Make sure that in this conditions the coolant level in the pan positioned over the air cooling system is higher than the minimum level indication. If necessary, refill.

*Fluids drainage;*

For the drainages of fluids refer to their relative paragraphs: 5.3 at page 44

### 5.1.3 Monthly jobs:

*Air cooling unit cleaning*

Check periodically (at least once a month) air-cooling system, especially that there is no obstruction behind the fans. If there should be found e.g. leafs or similar, they have to be manually removed by hold machine.

If there should be present too much dust cumulating, plants and/or other things that do not allow a satisfying cleaning by hand, automatic-cleaning auxiliaries may be used.

### 5.1.4 Annual jobs:

*Instruments check*

Check that all on board instruments work properly.

*Vibrations check*

The machine was designed and built to remove the risks relating to the vibrations. Properly installed, as described in the manual, present no risk to human health or to the level of whole body or to the level hand / arm system.

In any case, for greater security, visually check for unconventional vibrations on tubes, valves, plant components and on the compressor itself. If affirmative, proceed with special instruments for a more specific control. If so, proceed with appropriate instrumentation to a more rigorous control.

**Note:** Upon request, be installed vibration sensors that control the vibrational state in time of the machine.

*Relevant operating temperatures check*

- Gas circuit: control the temperatures on suction line and on discharge lines of 1st and 2nd stage before and after each refrigeration circuit.
- Oil circuit: check the oil temperature on inlet and outlet of the oil heat exchanger.
- Cooling circuit: check the water temperature at he inlet and the outlet of the air cooling unit

*Nuts and bolts tightness check*

Check that the main nuts and bolts on the machine and important connections on the plant are still tight.

## 5.2 Electro Motor

Respect the ball bearings lubrication intervals reported on the label on the electro motor.

## 5.3 Drainages

### 5.3.1 Draining liquid from Filter on suction line

1) Press the stop button on electric board;
2) Close the inlet gas line;
3) **<u>Unscrew the valve at the bottom of filter very slowly (may be under pressure);</u>**
4) Empty the filter from the liquid eventually present inside;
5) Close valve on filters;
6) Open the inlet gas line;
7) Press start button on electric board.

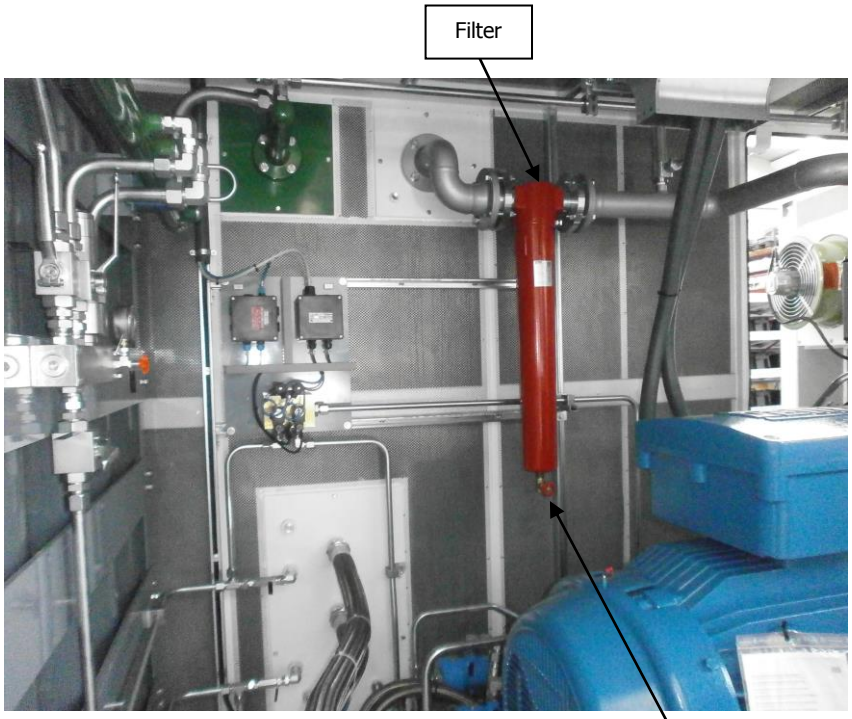


**Fig. 21 Filter On Suction Line**

### 5.3.2 Draining liquid from wiper (weekly):

1) Press the stop button on electric board;
2) Open valve on the drain storage tank on compressor skid,
3) Empty it from the liquid eventually present inside;
4) Close valve.
5) Press start button on electric board.

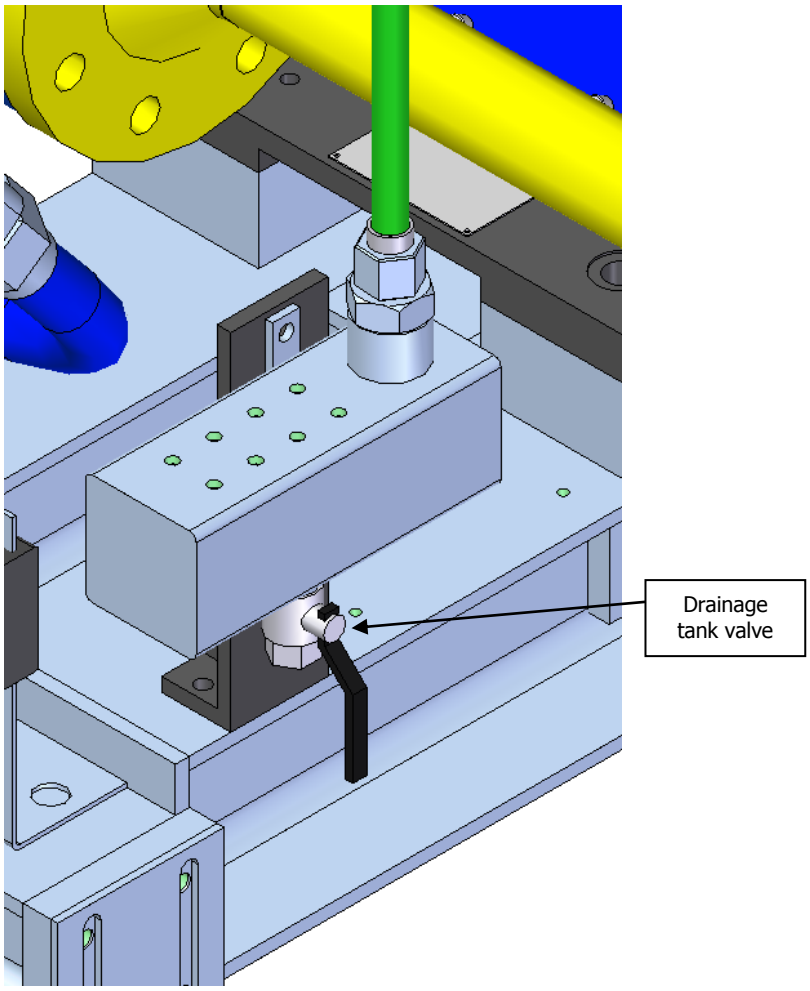


**Fig. 22 Drainage Wiper**

## 5.4 Removing and refitting pumping elements

For removing and refitting pumping elements see the annex ST14000015.

## 5.5 Ordering spare parts

Spare parts may be ordered:

1) for the compressor body, referring to the exploded diagrams and specifying the component position and diagram number;
2) for skid unit components, specifying the position of the component in the annexed photographs;
3) always specify the serial number given on the compressor identification plate;

## 5.6 Replace oil filter cartridge

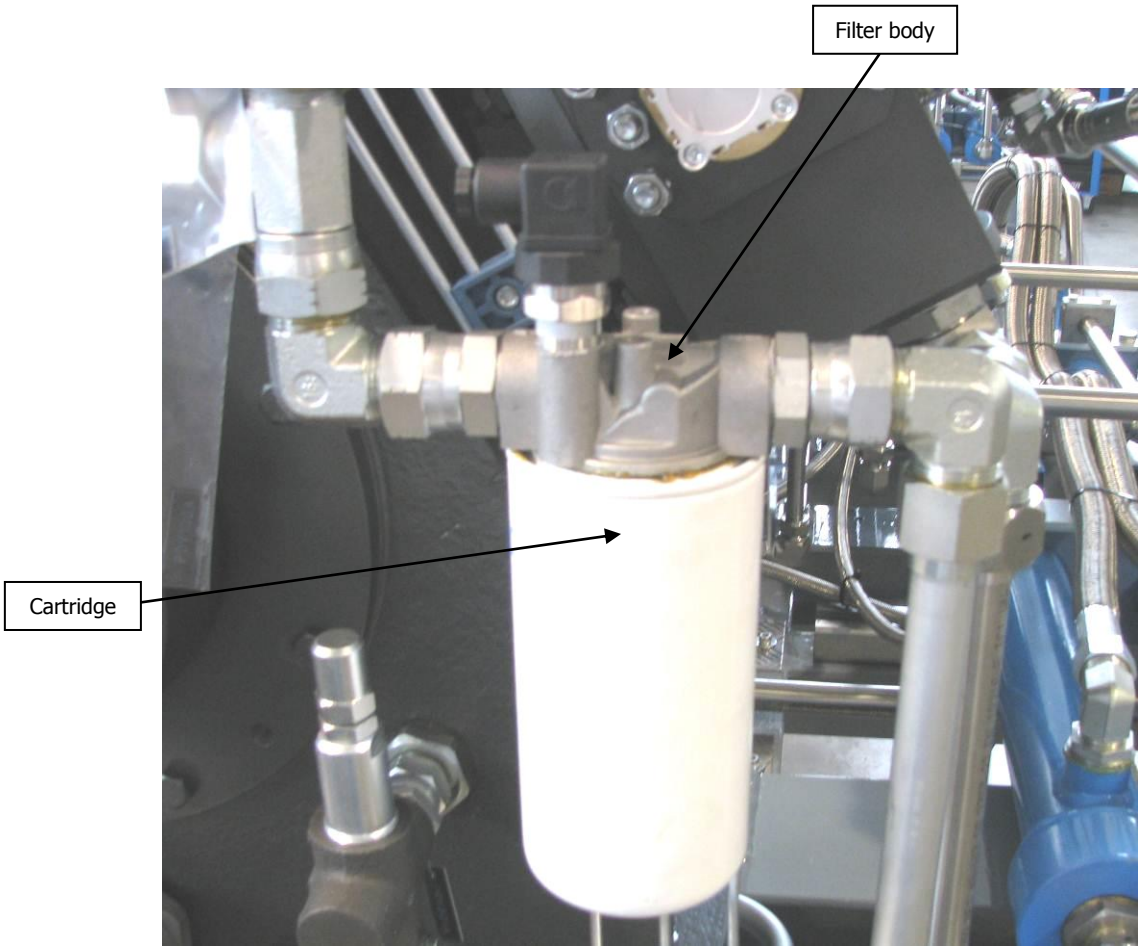


**Fig. 23 Oil filter**

To replace the oil filter cartridge takes a few and simple steps:

1) Make sure that the machine is stopped and that the voltage to the electrical panel is removed;

2) Predispose, under the filter, a cloth to contain any oil spills that could be encountered during the replacement;

3) Grasp the cartridge and turn it counter clockwise until you completely remove from the body;

4) Insert the new cartridge on the body and turn it clockwise until the completely screwing.

# 6 WARNING TO USERS

The following table (Tab. 5) describes the list of "Individual protective equipment" (DPI), and their average duration, that the maintainer or anyone working on the machine must ensure that you have.

**Tab. 5 Individual protective equipment**

| Individual protective equipment (DPI) | Average duration |
|---|---|
| Protection helmet | Three-year |
| Cap | At wear |
| Protecting cover | Three-year |
| Earplug | Disposable |
| Safety glasses for protection from impacts | Three-year |
| Safety glasses for physical agents | Three-year |
| Face shield | At wear |
| Solder mask | At wear |
| Dust mask | Disposable |
| Half mask with filter | According to the notification |
| Mask with filter | According to the notification |
| Protective gloves against the dangerous chemical agents | At wear |
| Protective gloves against cold burns | At wear |
| Protective gloves against hot burns | At wear |
| High shoes | Annual |
| Low shoes | Annual |
| Boots | Three-year |
| Knee-pad | At wear |
| Safety belt | Five-year |
| Slinging of load | Five-year |
| Special clothes | At wear |
| Raincoat (*) | At wear |
| Work clothes (*) | Annual |

Upon receipt of these devices, the employee must:

- Do a formation and training course organized by the owner;
- Use the DPI provided in accordance with information and training received;
- Adequately preserved the DPI provided;
- Not make changes on their own initiative;
- Immediately report to the employer, manager or person in charge of any discrepancies or problems found in DPI provided;
- Follow company procedures established for the return of the material.

## 6.1 DPI to be used during the assembly and disassembly pumping elements

- Work clothes
- Low shoes
- High shoes
- Protective gloves against hot burns
- Protective gloves against cold burns
- Protective gloves against the dangerous chemical agents

## 6.2 DPI to be used during the oil filling

- Work clothes
- Protective gloves against the dangerous chemical agents
- Safety glasses for physical agents
- Low shoes
- High shoes

# 7 DIRECTIONS ABOUT THE INCORRECT USING REASONABLY FORESEEABLE

If you make an incorrect use of the machine and its specific the risks that you can go against are:

- Explosion
- Fire
- Projection of the machine's parts
- Burns
- Crushing

**For the correct use of the machine, see the annex ST10000011**

# 8 ANNEXES

| | |
|---|---|
| Layout GV | AS10001768 |
| Layout Skid | AS10001767 |
| P&ID Gas GV | SG15000134 |
| P&ID Gas skid | SG15000132 |
| P&ID Cooling | SG15000133 |
| P&ID Lubrication | BD00000409 |
| P&ID Priority Panel 3 lines | BD00000396 |
| P&ID Storage | BD00000760 |
| P&ID External storage | BD00000366 |
| Electric wiring diagram | SE15000075 |
| Control panel diagram | SE15000076 |
| Touchscreen manual | |
| Placing platform | PL12000077 |
| Static and dynamic loads | AS10304 |
| Electric motor alignment instructions | AS10434 |
| Assembling instructions for external cooling unit | ST15000160 |
| Risk analysis | ST10000011 |
| Compressor manual | ST14000015 |
| Compressor datasheet | ST15000108 |
| Cause and effect chart | ST15000119 |
| Storage manual | ST13000051 |
| High pressure CNG filter manual | ST13000142 |
| Heat exchangers manual | ST13000044 |
| Blowdown manual | ST14000120 |
| Layout cooler | |