NUOVA FIMA

Industrial instrumentation for Pressure and Temperature

Installation, use, and maintenance manual

MGS DIAPHRAGM SEAL and CAPSULE PRESSURE GAUGES, ATEX VERSIONS 2G2-2D2-2D0-2D5 ZONES 1, 2, 21, 22

MI-MN-2G2-2D2-2D0-2D5-ENG_5 03/2021

Contents

1. Safety

- The safest ambient conditions for the instrument to operate properly depend on the correct selection and installation of the it in the system, as well as on the compliance with the maintenance procedures set out by the manufacturer. The user is entirely responsible for a correct installation and maintenance.
- This manual is supplied with the instrument and should be properly kept. It is advisable to read it carefully before using this product.
- In order to specify the functional and constructive characteristics of the instruments, it is advisable to consult the most up-to-date version of the catalogue and data sheets which are available on the website www.nuovafima.com

- Improper use of the instrument may damage the instrument and the operator or the whole plant.
- The managers responsible for the selection, installation and maintenance of the instrument should be aware of the environmental conditions that may negatively affect the instrument's operational activity and that may lead to its premature failure. Therefore, only technically qualified and trained staff should carry out the procedures called for in the plant regulations.

2. Standards

Capsule and diaphragm seal pressure gauges series MGS comply with the essential Health and Safety Requirements laid down in European Directive 2014/34/EU for Group II, Category 2G or 2GD equipment in the T6…T1 temperature class.

EXECUTION	MARKING
2G2 (gas)	CE Ex **II 2G Ex h IIC T6…T1 Gb -20°C ≤ Ta ≤ 60°C**
2D2 (gas and dust)	CE Ex **II 2G Ex h IIC T6…T1 Gb II 2D Ex h IIIC T85°C…T450°C Db -20°C ≤ Ta ≤ 60°C**
2D0 (gas and dust)	CE Ex **II 2G Ex h IIC T6…T1 Gb II 2D Ex h IIIC T85°C…T450°C Db 0°C ≤ Ta ≤ 60°C**
2D5 (gas and dust)	CE Ex **II 2G Ex h IIC T6…T1 Gb II 2D Ex h IIIC T85°C…T450°C Db -53°C ≤ Ta ≤ 60°C**

This instrument is NOT suitable for ZONES 0 and 20

EMC Directive 2014/30/EU on electromagnetic compatibility does not apply to this product.
Under the terms of directive **2014/68/EU (P.E.D.)**, NUOVA FIMA pressure gauges are categorized into 2 categories:
- PS <=0,5 bar N.A.
- PS >0,5 bar these instruments must be designed and manufactured according to a SEP-Sound Engineering Practice.

3. Normative

NUOVA FIMA instruments are designed and manufactured to comply with the safety requirements required by the international regulations in force some of which are reported in this manual. In order to perform installation and commissioning of the instruments, it is necessary to acknowledge and to comply fully with the following standards: **EN837-1, EN837-2, ASME B40.1, UNI CEI EN ISO 80079-36, UNI CEI EN ISO 80079-37, UNI EN 1127-1, UNI EN ISO 15156-3/MR0175.**
All instruments are calibrated with reference to national and/or international samples according to regulations established by the UNI EN ISO 9001:2015 quality management system.

4. Operating principle

Diaphragm seal pressure gauges (MGS18/12 and MGS18/12/ABS models): the diaphragm seal moves linearly according to the pressure applied. An every-angle system and a lever connect the diaphragm seal to a mechanism which transforms the linear movement into a rotating one and transmits the movement to a pinion.
The pointer is fitted on the pinion and indicates the pressure value on a graduated scale which amplitude is 270°, printed on the dial. In the MGS18/12/ABS model the upper face of the diaphragm seal delimits the empty space where the vacuum is produced. A bellow separates the levers from the atmospheric pressure.
Capsule pressure gauges (MGS18 with capsule): the sensing element is represented by two thin, undulated metallic discs which edges are sealed together. One of the two discs is fastened to a rigid support and when pressure is released both discs deform.
The disc opposite to the one receiving the pressure applied is connected to the amplification/indication system which exploits the displacement caused by the deformation.

5. Materials

Components that come into contact with the process fluid are produced in AISI 316 stainless steel. The case is produced in AISI 304 or AISI 316 L stainless steel. Gaskets, vents and filler caps are produced in EPDM or VITON or in SILICONE RUBBER. The window is in safety glass. The dial and the pointer are produced in aluminium.

6. Catalogue sheet

Detailed information about the construction and the operating characteristics, as well as drawings showing the overall dimensions are available in the catalogue sheets regarding the MN pressure gauges – 2G2 version for gas and 2D2, 2D0 version for Gas and Dust:

Mod.	*DN*
MGS 18 with capsule	100-150
MGS 18/12	
MGS 18/12/ABS	

7. Function

This instrument works as a local gauge to measure either a relative pressure value (MGS18 with capsule and MGS18/12) or an absolute pressure value (MGS18/12/ABS).
There are no ignition sources neither during its regular operation nor during malfunction. It should be always used within the intended use avoiding all wrong use as described below.

8. Limits of use

Maximum surface temperature – Only the fluid temperature may develop a high surface temperature. The temperature produced by the combination between the ambient temperature and the process fluid temperature must be below the one intended for the ATEX temperature class and should not affect the instrument operating function.
The process fluid (Pt) temperature must therefore be kept within the limits indicated in the table below:

Class (Tmax)	*Tp(°C)*	
	Type of case: dry	*Type of case: ventilated / filled*
T6 (85°C)	70	65
T5 (100°C)	85	
T4 (135°C)	100	
T3 (200°C)		
T2 (300°C)		
T1 (450°C)		

Ambient temperature – This instrument is designed to work in safe conditions at the following ambient temperatures:
0°C ... + 60°C (2D0)
-20°C…+60°C (2G2 and 2D2)
-53°C…+60°C (2D5)

Model – According to standard EN837-1, it is advisable to select an instrument equipped with an adequate safety device when systems containing compressed gas are involved. In the event of unexpected failure of the measuring element, the safety device allows the compressed gas to escape outside the case, preventing the instrument from cracking. NUOVA FIMA's instruments are designated as type **S1** when they are provided with a blow-out vent when pressure inside the sealed case exceeds the safety limit. An instrument with an adequate level of protection is recommended and should be chosen consulting the following tables taken from standard EN837-2:

Pressure fluid: LIQUID				
Case filling	None		Dampening liquid	
DN	<100	≥100	<100	≥100
Range (bar)	≤25	≤25	≤25	≤25
Safety	0	0	S1	S1

Pressure fluid: GAS or VAPOUR				
Case filling	None		Dampening liquid	
DN	<100	≥100	<100	≥100
range (bar)	≤25	≤25	≤25	≤25
Safety	0	S1	S1	S1

0= gauges not provided with blow-out device
S1= gauges provided with blow-out device

Working pressure – This instrument is designed to work with a static pressure equal to 75% of the full-scale range. When pressure is dynamic it cannot be more than 65% of the full-scale range. For ranges < 1 bar an accidental low pressure which absolute value is higher than the instrument's operating range should be prevented.

Chemical compatibility – The chemical compatibility between the process fluid and the wetted parts material, and between the atmosphere and the exposed parts material, should be verified. An IP65 protection level is recommended for a better protection.
A variety of materials is available other than AISI 316 stainless steel.

Overpressure - 25% of the full-scale range for model MGS18 with capsule and MGS/18/12. As for model MGS18/12/ABS, max 3,5 bar abs for scale ranges ≤400 mbar abs; max 6 bar abs for scale ranges from 0,6 to 1,6 bar abs.

Ambient temperature - models MGS18 with capsule and MGS18/12 are designed to work at atmospheric pressure between 0,8 and 1,1 bar A. Model MGS18/12/ABS can work at any natural atmospheric pressure.
Maximum Permitted Pressure - The maximum permitted pressure (PS) of an Assembly is determined by the PS of every component. To calculate the PS of an assembly, simply select the lowest value of the components. For safe operation, the PS of the assembly should not be exceeded.
To determine the maximum permitted pressure value for a standard product please see the data sheet available on the web site www.nuovafima.com. For product not included in the NUOVA FIMA catalogue, please refer to the contractual documents.

Protection degree – CEI EN 60529 standard. This refers to hermetically sealed rings, built-in caps positioned properly. Values are shown in the table below:

Execution	**IP degree** *(type of case)*
2G2	IP 55 *(dry)*
2D2 – 2D0	IP65/67 *(dry) (filled)*
2D5	IP65/67 *(ventilated)*

Liquid filled Cases (only for model MGS18/12)– The dampening liquid is generally used to prevent vibrations of the parts in motion caused by vibrations and/or pulsations. The dampening liquid should be selected very attentively when oxidant fluids, such as oxygen, nitric acid, hydrogen peroxide or chlorine, are involved in the system. A potential risk of chemical reaction, ignition or explosion of the instrument exists when oxidant agents are involved in the system. Instruments are manufactured and shipped as a sealed execution in order to prevent the liquid filling the case from leaking. The filling liquid type should be selected very attentively considering the dampening liquid's nature and limits of use according to the ambient temperature.

Filling liquid	*Ambient temperature*
Glicerine 98%	0°C ...+60°C
Silicone oil	-20°C…+60°C
Fluorurate oil	-20°C…+60°C

Use with high temperatures – The use of this instrument is not recommended when temperature exceeds 65°C. The use of a siphon is recommended when the pressure gauge is employed in a system involving vapours or high temperature liquids. A syphon or a similar device, should always be placed next to the instrument and filled with condensate fluid before pressurizing the system in order to prevent that the hot fluid reaches the instrument during the first pressure rise. The fluid should not neither freeze nor crystalize inside the sensing element. However, if the instrument is used to measure high temperatures peaks it is advisable to employ a small tube which internal diameter should be no less than 6mm, to connect the instrument to the pressure source. A 1,5-2 Mt.- long tube can decrease the actual working temperature to the ambient one**. The capsule MGS18 model is not intended to work in the above-mentioned applications.**

9. Wrong uses

The following applications may be potentially dangerous and must be considered carefully:
- Systems containing compressed gas (1) (7)
- Systems containing oxygen (2)
- Systems containing corrosive, liquid or gaseous fluids (3)
- Systems subject to dynamic or cyclical pressures (4)
- Systems subject to accidental overpressure or where low pressure instruments may be mounted on high pressure (1)
- Systems where the instruments interchangeability may produce dangerous contaminations (2)
- Systems containing liquid or gaseous toxic or radioactive fluids (2)
- Systems containing combustible /flammable fluids (6)
- Systems producing vibrations (5)
- Systems with vapour under pressure (6)

Overpressure failure (1)
Overpressure might damage the product unexpectedly and even more seriously when compressed gas is involved. An explosion of the instrument may develop with the projection of the instrument's fragments in any direction. The fact that the safety device opens does not always prevent the fragments from being spread around. If the risk of breakage for overpressure is real, we recommend using a solid front blow-out back instrument. This model prevents the operator from being hit by the instrument's fragments. The glass alone does not guarantee proper protection, on the contrary, it represents the most dangerous component. Short overpressure pulsations could develop in pneumatic or hydraulic systems, especially after the valve opening or closing. The amplitude of these pulsations can often be higher than the working pressure and their high velocity affects the instrument reading so that the operator cannot be aware of them. These pulsations can bring to complete breakage of the instrument or to a permanent zero error.

Failure for explosion (2) –
When thermal energy is released violently due to a chemical reaction such as the one involving the adiabatic compression of oxygen in the presence of hydrocarbon or oils, the instrument may explode. Generally, the unpredictability of this event is accepted. Instruments suitable to work with oxygen are marked with the following notice "Oxygen- Use no Oil" and/or with a crossed oiler printed on the dial. Instruments are supplied cleaned and degreased properly using adequate products and packaged in polyethene bags. The user should keep the elastic element and the connection clean after the instrument has been unpacked.

The capsule MGS18 model is not intended to work in any of the above-mentioned applications.

Failure for corrosion (3) - This event may develop when

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the sensing element materials are attacked by the chemical substances composing the fluid to be measured or from the atmosphere surrounding the pressure system. When this kind of failure occurs, fluid starts leaking locally in spots or a fatigue crack starts developing because of the material weakening. The sensing element is subject to a strong mechanical stress because it is usually thin. Therefore, it should be chemically compatible with the media to measure. None of the most common materials is immune from a chemical attack which power can be influenced by concentration, temperature and by the type of mix of chemical substances.

Fatigue failure (4) - When pressure causes a mechanical stress a small crack from the inside to the outside, generally along the edge of the instrument, develops. Such a failure is more dangerous when the medium is a compressed gas rather than a liquid. Fatigue failures release the fluid gradually. Therefore, the increase of pressure inside the case is indicated by the opening of the blow-out vent. When measuring high pressures, the process operating pressure is close to the maximum permissible stress limit and an explosion may occur.

Failure for vibrations (5) – Vibrations most commonly wear the movement components out because of high cyclic loading resulting in a gradual loss of accuracy and, eventually, in the failure of the pointer in indicating a pressure change.

Fatigue failure due to vibrations (5) – Wide amplitude vibrations may also produce cracks due to fatigue on the sensitive element structure. In this case the fluid may leak slowly as much as quickly becoming even explosive.

Crack failure (6) - When the instrument is used unproperly or the sensing element is cracked or broken, when the process fluid is combustible or flammable and the type of measuring is continuous, an explosive atmosphere may develop inside and around the instrument case. Therefore, it is extremely important that the worn-out parts of the instrument are replaced to prevent the fluid from leaking.

Temperature (7) - The temperature inside the instrument and on its surface may increase significantly because of rapid compression of the gas in the process, or of an impact wave in the process liquid. Internal overheating caused by the adiabatic compression or by an impact wave can lead to spontaneous combustion of the fluids measured, or to the ignition of the explosive atmospheric conditions outside the case. The surface temperature should not exceed the correct limit set for the temperature class required in the area in which the instrument is operating.

10. Transport

The characteristics of the instruments may be affected during transport, despite adequate packaging, and must be verified before use. Calibration can be checked by isolating the instrument from the process by means of the shut-off valve and by checking that the pointer returns to the zero mark correctly (unless the temperature is far from 20°C). If the pointer doesn't return to zero it means that the instrument is seriously damaged and must be repaired

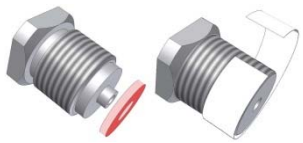
11. Storage

Instruments should remain packaged in their original standard box until installation and stored in dry, indoor spaces. If instruments are supplied with special packaging (in wooden boxes lined with tar paper or in barrier bags), it is always best to keep them indoor, and always protected from atmospheric agents. The condition of the packaging materials must be checked every 3-4 months, especially if the boxes are exposed to the weather. The storage area temperature should range between –20°C and 65 °C, except if otherwise specified in the catalogue data sheets.

12. Installation

MGS pressure gauges 2G2, 2D2, 2D0 and 2D5 executions, **must be installed in compliance with European Standard EN 837-2, and special care must be taken to prevent the mechanical connections from being loose.**
The instrument should be installed far from magnetic and electromagnetic induction, ionizing radiation, ultrasound and exposure to sunlight to prevent the instrument's surface temperature from rising.

A shut-off valve between the instrument and the system should be added to facilitate the removal of the instrument (root valve). All instruments should be mounted in such a way that the dial is in a vertical position unless different recommendations are reported on the tag. A minimum distance of 20mm. should be guaranteed from any object to allow the blow out vent to operate. The pressure connection must be airtight. If the pressure connection is provided with a cylindrical thread, tightness is produced using an O-ring clamped between the two flat sealing surfaces, one on the pressure connection and the other on the instrument's process connection. If the pressure connection has a tapered thread the tightness is performed by screwing the connection on the pressure source for at least 5 full threads. It is common practice to wrap PTFE tape around the male thread before coupling (see Fig).



In both cases the torque must be applied using two hexagonal spanners, one on the flat faces of the instrument/process coupling and the other on the pressure connection.
Do not tighten with force on the case as the instrument could be damaged.
When pressurising the system for the first time, check the tightness of the connection tight. Also, it is advisable to check if the accessories are installed and fastened correctly.

Effect of liquid columns - If the instrument is loaded by a liquid column calibration is required to compensate this effect. This may occur when the instrument is fitted above or below the pressure connection. This is not the case of a system involving vapour or gas. Therefore, installing the instrument above the pressure connection is advisable.

Ventilation – The case must be ventilated following the instructions reported on the instrument adhesive tag.
Temperature – If the process fluid temperature is higher than the permitted one, a siphon or a similar device, should always be added to the instrument and it should be filled with condensate fluid before pressurizing the system in order to prevent the hot fluid from reaching the instrument during the first pressure rise. The fluid must not freeze or crystalise inside the sensitive element.
The capsule MGS18 model is not intended to work in any of the above-mentioned applications.
Adiabatic compression – When rapid compression gaseous fluids are involved, pressure variation should be slowed down in order to decrease the maximum surface temperature within the permitted range. The gaseous fluid pressure should be increased as slowly as possible: suitably sized dampeners should be installed.
Mechanical shocks – Instruments shouldn't be affected by mechanical shocks. If the intended points of installation are affected by mechanical shocks, instruments should be mounted remotely and connected by means of a flexible tube. Instruments should be selected among those provided with support for wall or panel mounting.
Vibrations – When the instrument support is affected by vibrations various solutions may be considered: a) use of liquid-filled instruments and b) instruments installed remotely and connected by means of a flexible tube suitable for strong or irregular vibrations.
Vibrations can be detected by the continuous and irregular fluctuations of the pointer.
Dynamic and cyclic pressures – This kind of pressures may occur when instruments are installed on pumps or/and gaseous fluids are involved in the system. The sensing element and the pressure gauge's amplifying movement may be affected negatively and surface high temperatures may develop.
When this event occurs, the pointer starts to fluctuate significantly. Therefore, it is necessary to add a dampener between the pressure source and the instrument especially when fluids are flammable or combustible. The harmful effect of pulsating pressure on the parts in motion of the pressure gauge may be reduced by filling the case with a viscous liquid (for the MGS18/12 model). If significant variations in pressure on the line are expected, a restrictor should be installed between the pressure gauge and the shut-off valve.
Overpressure – Overpressure affects negatively the sensing element reducing its life and accuracy. Therefore, it is always advisable to choose an instrument able to absorb overpressure and pressure spikes more easily and provided with a full scale range which is larger than the maximum working pressure and.
Pressure spikes and pulsating pressure can be treated in the same way. Long-lasting overpressures can be overcome by installing a restrictor calibrated on the instrument's range. However, the fact that just one overpressure event can damage the instrument permanently should be taken into account.

Equipotentiality – **The instrument must be made equipotential to the plant on which it is installed through the ohmic contact between the threaded process connection and the plant socket. The latter must be metallic and connected to earth.**

13. Accessories

Adjustable restrictor: this device is useful on plants where high overpressure may develop. An adjustable restrictor is able to isolate the pressure gauge automatically from the pre-fixed pressure and to put it back automatically on the circuit when pressure is normalized. Please refer to the relevant instruction manual.
Valves, pig tails, siphons, fittings and connection tubes are also available.

14. Use

The user must be aware of the risks related to the chemical and physical characteristics of gas, vapours, and/or powders in the system, and should carry out a thorough preliminary check putting into service.
Commissioning- The instrument should always be put into service very carefully to prevent pressure spikes or sudden changes in temperature. **Therefore, the shut-off valves should be closed extremely slowly.**

Intermittent measuring - It is advisable to perform the measuring by opening the shut-off valve slowly and then closing it again once the reading has been performed. This procedure ensures a long life of the instrument and safety during operation.
It is not advisable to use the instruments for measuring pressures close to zero, as in that range, the accuracy tolerance may represent a significant percentage of the applied pressure. For this reason, these instruments should not to be used for measuring residual pressure inside huge containers such as tanks, surge tanks, and alike. In fact, such containers may retain pressure that could be dangerous for the operator, even when the instrument indicates a zero pressure. The installation of a ventilation device on tanks is recommended to achieve pressure zero before removing covers or connections, or performing similar tasks.
It is not advisable to install new instruments on systems working with different operating media, in order to prevent chemical reactions that may cause explosion because of contamination of the wetted parts.
Caps – The filling and vent caps must not be removed during operation of the system.

15. Dysfunctions

- **Indication failure (pointer on zero):** filling up system is empty.
- **Pointer remains on the same value:** Pressure pipes clogged. Initial valve closed.
- **Pointer remains outside the graduated scale:** pressure too high – temporary or permanent reading error.
- **Error of indication exceeding the one stated for the instrument:** Calibration altered.
- **Pointer fluctuating rapidly:** Harmful pulsations in the process fluid. Harmful mechanical vibrations.
- **Ejection of the safety cap**: Excess Temperature: Breaking/cracking of the sensitive element probable.

16. Maintenance

A specific maintenance programme should be drawn up in order to perform proper maintenance of the instrument and preserve its original features. The mechanical components must be maintained and protected from high temperatures. The risk of fire and explosion due to any malfunction should be prevented.

Close check – The window should not be cracked. The blow-out vents and filling caps should be positioned correctly in the intended seats. The pointer should be positioned within the graduated scale.

Regular check –
Instruments employed on plants operating in severe working conditions (vibrations, pulsating pressures, corrosive or combustible/inflammable fluids) should be replaced according to the maintenance programme. The condition of the sensing element should be checked every 3/6 months irrespective of the maintenance program, as well as the indication accuracy, the degree of corrosion on the sensing element (for fluid diaphragm) the gaskets' tightness and the presence of condensation inside the case. If the instrument does not operate properly, an extra check is advisable.
Dust deposits on the instrument should not be thicker than 5mm otherwise they must be removed and the instrument cleaned by means of a wet cloth with water and soap solution .
Instruments must be isolated from the system by closing the root valve. Pressure inside the instrument must be brought to zero by opening the blow out vents of the system. The process fluid remaining inside the process connection should not be dispersed in the environment in order to prevent pollution and risk of danger to people. Should the process fluid be toxic or harmful, it must be handled with extreme care.

Detailed check – The test fluid should be compatible with the process fluid to measure. To check the integrity of the sensing element, fit the instrument on a pressure generator adding a shut-off valve between the two devices. Submit the instrument to the maximum pressure allowed and disconnect it from the pressure source by closing the shut-off valve. If the sensing element leaks, the pointer returns to zero slowly. In order to check the accuracy in indication, a stable pressure should be developed in laboratory and applied to the instrument which is under test and to a laboratory pressure gauge or primary pressure gauge. The accuracy of the latter must be 4 times better than the nominal accuracy for the instrument being verified. The values indicated by the two instruments during the pressure rise and fall allow to establish the non-linearity, the hysteresis, and the repeatability for the instrument under test.
The condition of the gaskets and of the IP protection level must be verified.

Recalibration – If the calibration check produces values which are different from the nominal values shown in the catalogue, the instrument should be recalibrated. It is advisable to return the instrument to NUOVA FIMA for recalibration through the service **Product Return**.

The use of an instrument subject to interventions not explicitly authorized by NUOVA FIMA excludes any liability of the same, and will cause the invalidation of the relevant EC Declaration of Conformity and the contractual guarantee.

17. Disposal

Before disposal, the instrument and the diaphragm seal should be disassembled and the filling circuit should be empty. Window and vents should be disposed of as aluminium and stainless steel. The fluid remaining inside the instrument may be harmful and toxic.

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