NUOVA FIMA

Industrial instrumentation for Pressure and Temperature

Installation-use-maintenance manual

MGS BOURDON TUBE PRESSURE GAUGES, ATEX VERSIONS 2G1-2D1, ZONES 1, 2, 21, 22

MI-MGS-2D1-2G1-ENG_5 04/2016

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1. Safety notes

- Safety results from the careful selection and installation of the instrument in the pressurised system, as well as from compliance with the maintenance procedures set out by the manufacturer. The user is entirely responsible for ensuring correct installation and maintenance.
- This manual is an integral part of the supply. Carefully read the above instructions before using this product. Keep it in a safe place.
- In order to correctly specify the functional and constructive characteristics of the instruments, it is recommended to consult the most up-to-date version of the catalogue data sheets, available on-line at the website www.nuovafima.com
- Improper use may damage the instrument, resulting in failure and possible injury to persons or damage to the plant.
- The persons charged with the selection, installation and maintenance of the instrument must be able to recognise the conditions that may negatively impact on the instrument's ability to perform its function and which may lead to premature failure. They must therefore be qualified technically and trained, and must carry out the procedures called for in the plant regulations.

2. Directives

The MGS pressure gauges are conform to 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 temperature class.

VERSION	MARKING
2G1 (gases)	**CE Ex II 2G c TX X**
2D1 (gases and dusts)	**CE Ex II 2GD c TX X**

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 **PED 2014/68/EU**, NUOVA FIMA pressure gauges are classified into 2 categories:
- PS <=200 bar these instruments do not have to meet the essential safety requirements, but must only be designed and constructed in accordance with "Sound Engineering Practice" and are not required to bear the CE mark;
- PS > 200 bar these instruments must comply with the essential safety requirements prescribed by the PED, are classified as Category 1 and certified according to Form A. They must bear the CE mark illustrated below.

3. Standards

Nuova Fima instruments are designed and constructed to comply with the safety requirements prescribed by the international regulations in force, extracts of which are given in this manual. A full knowledge of these and complete compliance of the same are necessary for installing and commissioning the instrumentation: **EN837-1, EN837-2, ASME B40.1, UNI EN ISO 13463-1, UNI EN ISO 13463-5, UNI EN ISO 15156/MR0175.**

4. Operative principle

The sensitive bourdon tube element moves linearly in relation to the pressure applied. T he tube is attached to a movement by a tie rod, which transforms this linear movement into a rotary movement by transmitting it to a pinion. The rack on the indicator arm is keyed into the pinion, allowing the pressure to be indicated on a graduated scale on a dial with a range ≥ 270°.

5. Materials

The parts that come into contact with the process fluid are made of AISI 316L stainless steel or Monel 400. The housing is made of AISI 304 stainless steel. The gaskets and vent and filler caps are made of EPDM or Viton. The transparent part is made of glass. The dial and indicator are made of aluminium.

6. Data-sheet

Detailed information on the construction and operating characteristics, as well as drawings showing overall dimensions are available on the catalogue sheets for **MGS** pressure gauges – **2G1** for gas and **2D1** for gas and Powders:

Mod.MGS	*DS*	*Tube material*
18	100-150	AISI316L
19	100-150	AISI316L
36	100-150	Monel400
20	100-150	AISI316L
21	100-150	AISI316L
40	100-150	Monel400

7. Function

The instrument is intended for indicating relative pressure locally, or remotely with a capillary.
This instrument does not pose any risk of causing fires when operating normally or when not in use, and is to be used within the operating limits, avoiding the incorrect uses described below:

8. Intended use limit

Maximum surface temperature – Not due to the instrument working, but only due to the fluid temperature. The temperature produced by a combination of the ambient and process fluid temperatures must be below that for the ATEX temperature class, and must not cause operating problems on the instrument. The process fluid temperature must therefore be kept within the limits indicated in the table:

Classs	*Tmax (°C)*	*Instrument case (°C)*	
		Dry	*Filled*
T6	85	70	65
T5	100	85	
T4	135	120	
T3	200	150	
T2	300		
T1	450		

Ambient temperature – This instrument is designed to be used safely at ambient temperatures between – 20 and + 60°C.
Model - In systems containing compressed gas, it is advisable to select an instrument equipped with an adequate safety device. In the event of unexpected failure of the measuring element, the safety device allows the compressed gas to escape outside the case, thereby preventing the instrument from fracturing. The safety patterns employed on NUOVA FIMA instruments are designated type S1 when they consist of a release valve which opens when the pressure inside the sealed case exceeds an established safety limit, putting it in communication with the outside, and are designated type S3 when the safety consists of an entire blow-out back and there is an added baffle wall separating the measuring element from the clear solid front, providing further protection to the operator. Select an instrument with an adequate level of protection, consulting the following tables:

Measured fluid LIQUID								
Case filling	Nothing				Damping liquid			
DN	<100		≥100		<100		≥100	
Range (bar)	≤25	>25	≤25	>25	≤25	>25	≤25	>25
Safety	n.a.	n.a.	n.a.	n.a.	S1	S1	S1	S1

Measured fluid GAS or VAPOUR								
Case filling	Nothing				Damping liquid			
DN	<100		≥100		<100		≥100	
Range (bar)	≤25	>25	≤25	>25	≤25	>25	≤25	>25
Safety	n.a.	S2	S1	S3	S1	S2	S1	S3

Operating pressure – This instrument is designed to operate at a static pressure of up to 100% of the scale range. When dynamic or pulsating pressure is involved, 90% of the scale range must not be exceeded. For fields < 1 bar, steps must be taken to prevent a vacuum occurring accidentally that exceeds the absolute value for the instrument's operating range.
When gaseous fluids are involved it is advisable to use a nominal scale range that is double the operating range.
Chemical compatibility – Check the degree of chemical compatibility between the process fluid and the materials of which wet parts are made, and the atmosphere and the materials of which the exposed parts are made. Use an IP65 protection level for better protection. This mechanism can be used with process fluids that are compatible with AISI 316L stainless steel. In all other cases, order pressure gauges fitted with fluid separators with wet parts made of suitable materials.
Overpressure – The maximum overpressure values are shown in the table for each model:

Mod. MGS	*Overpressure % (1)*		
	≤10 bar	*≤100bar*	*≤1000 bar*
18	30	30	30
19	300	200...100	100...60
36	30	30	30
20	30	30	30
21	300	200...100	100...60
40	30	30	30
(1) Referred to the full scale value			

Ambient pressure – This instrument is designed to work at atmospheric pressures between 0,8 and 1,1 barA.
Maximum Allowable Pressure of an Assembly - The maximum allowable pressure (PS) of an Assembly is determined by the PS of every component. To calculate the PS of an assembly, simply select the lesser value of the components. For safe operation, the PS of the assembly should not be exceeded.
To determine the maximum allowable pressure of standard product please consult the data sheet available on the web site www.nuovafima.com. For product not present into the NUOVA FIMA catalogue, please refer to the contractual documents.
Protection level – As for CEI EN 60529 standard. These refer to hermetically sealed ring conditions, with built-in caps located in their seatings. Values shown in the table:

Version	*Case*		
	standard	*fillable*	*filled*
2G1	IP 55	IP 65 (PN≤6bar)	N.D.
2D1	N.D.	IP 65 (PN>6bar)	IP 65

Liquid filled Cases - Liquid filling is generally used to dampen the vibrations of moving parts due to vibrations and/or pulsations. Great care must be taken in choosing the damping liquid for instruments that will be used with oxidising media such as oxygen, chlorine, nitric acid, hydrogen peroxide, etc. In the presence of oxidising agents, there is the possible risk of chemical reaction, ignition and explosion of the instrument.
In this case 20-20HW-40 models must be used, and fluorine or chlorine based filling liquids must be used. In order to contain the damping liquid within the casing, these instruments are made and delivered, sealed and the liquid level must not be lower than 75% of their ND. Particular care must be taken in terms of the nature of the filling liquid used and their use limitations in terms of ambient temperature.

Filling liquids	*Ambient temperature*
Glycerine 98%	0...+60°C (+32...+140°F)
Silicon oil	-20...+60°C (-4...+140°F)
Fluorurated fluid	-20...+60°C (-4...+140°F)

Temperature application - Regardless of the material with which the unit has been made or welded (connection to the process, Bourdon tube, terminal) it is not advisable to use the pressure gauges at temperatures exceeding 65°C (150°F). It is recommended to use a trap in cases where the pressure gauge is used with steam or liquid media at high temperatures. A trap or similar device should always be fitted near the instrument and filled with condensed fluid before pressurising the system, so as to prevent the hot fluid from reaching the instrument during the initial pressure rise. The fluid should not be allowed to freeze or crystallise inside the measuring element. However, if the instrument is used for measuring points at high temperature, it is recommended to use a hose with inside diameter of at least 6 mm to connect it to the pressure coupling. A hose about 1.5-2 metres long reduces the effective operating temperature to approximately ambient level. If the type of fluid does not permit the use of a small section hose, it is often necessary to insert a separator between the process fluid and the instrument, provided that the transmission fluid is suitable for the temperature of the process fluid.

9. Wrong uses

The following applications must be considered potentially dangerous and carefully specified:

- Systems containing compressed gas (1) (7)
- Systems containing oxygen (2)
- Systems containing corrosive fluids in a liquid or gaseous state (3)
- Systems subject to dynamic or cyclical pressures (4)
- Systems in which overpressures may accidentally be applied or in which low pressure gauges may be installed on high pressure couplings (1)
- Systems in which interchangeable pressure gauges may give rise to dangerous contamination (2)
- Systems containing toxic or radioactive fluids in a liquid or gaseous state (2)
- Systems which produce mechanical vibrations (5)
- Systems containing combustible/inflammable fluids (7)

Overpressure Failure (1) - This is caused by application of internal pressure greater than the rated limits of the measuring element, and can occur when a low-pressure gauge is installed on a high-pressure system. The effects of this type of failure, generally more serious in compressed gas applications, are unpredictable and may result in instrument fragments being projected in all directions. The opening of the safety device on the case does not always guarantee containment of the fragments. It is generally accepted that using an instrument with a solid front and blow-out back reduces the possibility of fragments being projected toward the front of the instrument, where the operator stops to take readings. The clear front alone does not provide adequate protection, and in fact is the most dangerous component in such a case. Overpressure pulses of short duration (spikes) can occur in pneumatic or hydraulic systems, especially when valves are opened or closed. The amplitude of such pulses can be many times the operating pressure, and the great speed at which they occur prevents them from being read out on the instrument, making them invisible to the operator. They can result in definitive breakage of the instrument or a permanent zero error.
Explosive Failure (2) - This occurs as a result of the violent release of thermal energy due to a chemical reaction, such as adiabatic compression of oxygen in the presence of hydrocarbons. It is generally accepted that the effects of this type of failure cannot be anticipated. Even the use of solid-front instruments does not guarantee against the projection of fragments toward the front of the instrument. - Pressure gauges suitable for use with oxygen are marked "Oxygen - Use no Oil" and/or with a crossed out oil can symbol on the dial The instruments are supplied already washed and degreased using appropriate products and packed in polyethylene bags. The user must take the necessary precautions to ensure that the connection and the elastic element are kept clean after the pressure gauge has been unpacked.

Corrosion Failure (3) - This occurs when the material of the measuring element is weakened through attack by the corrosive chemicals present either in the media inside or the environment around it. Failure may occur as a pinhole leakage or early fatigue failure due to stress cracking brought about by the chemical deterioration of the material.
The sensitive element is generally thinner and therefore works under significant mechanical stress. Chemical compatibility with the fluid to be measured must therefore be taken into account. None of the commonly used materials can be considered immune to chemical attack, and various factors can influence the extent of this phenomenon: Concentration, temperature and the

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type of mixture of the various chemical substances.

Fatigue Failure (4) - This is caused by mechanical stress resulting from the pressure and takes the form of a small crack from the inside to the outside, generally along an edge. Such failures are more dangerous when the measured medium is a compressed gas rather than a liquid. Fatigue failures release the fluid gradually, and therefore the case pressure build-up is indicated by the opening of the relief valve. When measuring high pressures, the process operating pressure is close to the maximum permissible stress limit, and can therefore result in an explosive failure.

Vibration Failure (5) - The most common mode of vibration failure is that where the movement parts wear because of high cyclic loading caused by vibration, resulting in a gradual loss of accuracy and, ultimately, failure of the pointer to indicate a pressure change.

Vibration-Induced Fatigue Failure (5) – Large amplitude vibrations may in some instances cause fatigue cracks in the structure of the measuring element. In this case the pressure build-up may be slow or fast, or even explosive.

Cracked Failure (6) – When use is found to be incorrect or the sensitive element is cracked or broken, if the fluid measured is combustible or inflammable and measuring is continuous, an explosive atmosphere may be generated inside and around the instrument casing. In cases such as this it is vitally important that an appropriate maintenance program is activated to replace worn parts on the instrument before any leaks occur.

Temperature (7) – The temperature inside and on the surface of the instrument may increase significantly due to rapid compression of a gas measured, or an impact wave in a liquid measured. Internal overheating caused by adiabatic compression or by an impact wave can lead to spontaneous combustion of fluids measured, or ignition of explosive atmospheric conditions outside the casing. The surface temperature must not exceed the limit set for the temperature class required in the area in which the instrument is installed.

10. Transport

The characteristics of the instruments may be affected during transport, despite adequate packing, and must be checked before use. Correct calibration can be checked by excluding the instrument from the process by means of the shut-off valve and checking that the pointer returns to the zero mark (unless the temperature varies greatly from 20°C). Failure of the pointer to return to zero indicates serious damage to the instrument and requires maintenance to be carried out on the instrument.

11. Storage

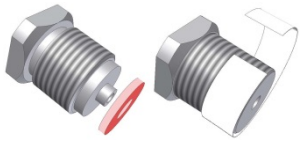
Instruments must be kept in their original standard packaging until they are installed, and must be located in closed spaces that are free of any damp. If the instruments come with special packaging (in wooden boxers lined with tar paper or in barrier bags), it is always best to keep them in closed spaces wherever possible, and always where they are protected from the weather. The state of packaging materials must be checked every 3-4 months, especially if the boxes are exposed to the weather. The temperature of the storage area should be between –20 and +70 °C, except where otherwise specified in the catalogue data sheets.

12. Installation

2G1 and 2D1 version MGS pressure gauges must be installed in compliance with European Standard EN 837-2, and special care must be taken to avoid any loose mechanical connections.

Install the instrument in a position in which magnetic and electromagnetic induction, ionising radiation, ultrasound and exposure to sunlight will not increase the instrument's surface temperature.

To facilitate removal for maintenance purposes, a shut-off valve can be installed between the pressure gauge and the plant. The pressure connection must be watertight. If the pressure connection has a cylindrical thread, the seal is achieved 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 seal is achieved by simply screwing the connection onto the coupling, through the mating of the 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 use the case as a means of tightening as this may cause damage to the instrument.

When pressurising the system for the first time, check the tightness of the connection seal. All instruments must be mounted in such a way that the dial is vertical, unless otherwise indicated on the dial itself. When the instrument includes a safety device, this must be at least 20 mm from any other object. - For wall or panel mount instruments, make sure that the pipe conveying the pressurised fluid is connected to the instrument coupling without exerting torsion or force.

Effect of liquid columns - The installer must be aware that, if the instrument is subjected to the load of a liquid column, it must be calibrated to compensate for this effect. This occurs when the instrument is fitted above or below the pressure connection to which it is connected. When dealing with gas or steam this does not occur. In this case, we recommend installing the instrument above the pressure connection.

Ventilation – The casing must be ventilated as indicated in the instructions shown on the sticker supplied with the instrument.

Temperature – If the process fluid temperature exceeds the upper limit, a trap or similar device should always be fitted near the instrument and filled with condensed fluid before pressurising the system, so as to prevent the hot fluid from reaching the instrument during the initial pressure rise. No fluid that is to be frozen or crystallised is to be allowed into the sensitive element. However, if the instrument is used for measuring points at high temperature, we recommend using a hose with an inside diameter of at least 6 mm for the connection to the pressure coupling. A pipe about 1,5 – 2 mt long, reduces the actual operating temperature to approximately the same as the ambient temperature. If the type of fluid does not permit the use of a small section hose, it is often necessary to insert a separator between the process fluid and the instrument, provided that the transmission fluid is suitable for the temperature of the process fluid.

Adiabatic compression – For gaseous fluids that are compressed rapidly, the rate of pressure variation must be lowered until the maximum surface temperature falls to within the range permitted. When working with gaseous fluids the pressure must increase as slowly as possible. Suitably sized bottlenecks or shock-absorbers must be installed until the raise time 1 sec. is reached through pressure steps 80% of the full range value. If there is a possibility of great fluctuations in the pressure on the line, a suitable pressure limiting device must be installed upstream of the pressure gauge.

Mechanical stress - Pressure gauges must not be subjected to mechanical stress. If the installation points are subject to mechanical stresses, the instrument must be installed at a distance and connected using flexible hoses. - The instruments selected must be of the surface, wall or panel mount type.

Vibrations - When the pressure gauge support is subject to vibrations, various solutions may be considered, such as:

a) the use of liquid-filled gauges; b) if the vibrations are strong or irregular, the instruments must be mounted at a distance and connected using a flexible hose or tubing. The presence of vibrations is indicated by continuous, often irregular fluctuations of the pointer.

Dynamic and cyclical pressures – These generally occur when the instruments are fitted on pumps and/or when working with gaseous fluids, and significantly reduce the lifespan of the sensitive element, the pressure gauge's amplification movement, and excessively high surface temperatures. These pressures are generally indicated by the indicator oscillating widely. These pulsating pressures must be reduced by fitting shock-absorbers or bottlenecks between the source of the pressure and instrument, especially when working with combustible or inflammable fluids. Filling the case with a damper liquid can also reduce the harmful effect of pulsations on the moving parts of the pressure gauge. If there is a possibility of large fluctuations in pressure on the line, fit a pressure limiting device between the shut-off valve and the pressure gauge.

Overpressure - Any overpressures subject the measuring element to stress, with a consequent reduction in its lifespan and accuracy. It is therefore always advisable to choose an instrument whose full scale pressure is greater than the maximum operating pressure, so that it is better able to withstand overpressures and pressure surges. Pressure surges can be handled in the same way as pulsating pressures. Overpressures of longer duration can be handled by installing a pressure-reducing valve on the pressure gauge line. The occurrence of even a single overpressure event can result in an overpressure failure.

Equipotentiality – The instrument is made equipotent with the plant it is fitted on by means of an Ohmic contact between the threaded process connection and the pressure connection.

13. Accessories

Diaphragm seals - These are required for transmitting the pressure exerted by corrosive, hot, high viscosity or crystallisable process fluids. See the relevant instruction manual: MGS9.

Adjustable overload protection device - These are useful on systems that may generate high excess pressures, as they automatically exclude the pressure gauge at a preset pressure, and automatically include them in the circuit again once the process pressure has been normalised. Valves, loops, blow-out vents, and pipe fittings and connection piping, and pressure stabilisers: See the relevant instruction manual: MP.

14. Use

The user must be aware of the risks related to the chemical and physical characteristics of the gases, vapours, and/or powders in the system, and carry out a thorough preliminary check before putting into service.

Putting into service - The instrument must always be put into service with care, to avoid pressure surges or sudden changes in temperature. **Shut-off valves must therefore be opened slowly.**

Intermittent measuring – It is advisable to measure when necessary by slowly opening the shut-off valve and then closing it again once the reading has been taken. This will ensure a long lifespan and safe operation of the instruments.

It is not advisable to use the instruments for measuring pressures near zero, as in that range the accuracy tolerance can represent a significant percentage of the applied pressure. For this reason, these instruments should not to be used for measuring residual pressures inside large volume containers such as tanks, surge tanks, and the like. In fact, such containers may retain pressures that are dangerous for the operator, even when the instrument indicates a zero pressure. It is recommended to install a ventilation device on tanks in order to achieve zero pressure before removing covers or connections, or performing similar tasks.

It is not advisable to successively install instruments on systems with different operating media, to avoid initiating chemical reactions that may cause explosions resulting from contamination of the wetted parts.

Caps – The filling and vent caps must not be removed while the system is working.

15. Possible malfunctions

- **No indication** (pointer on zero): Initial valve closed.
- **Indication steady on the same value**: Pressure pipes clogged. Initial valve closed.
- **Indication steady outside the graduated scale**: Excess pressure – temporary or permanent reading error.
- **Indication error exceeds that stated for the instrument**: Calibration altered.
- **Pointer oscillating 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

Maintenance of the initial mechanical and construction characteristics must be ensured by means of a specific maintenance programme, drawn up and managed by qualified technicians. Mechanical parts must be maintained in such a way as to avoid the dangers associated with high temperatures, and the risk of fire and explosion due to any abnormality that arises when they are working.

Thorough check – The window must not show any crack. Filling plug and blow out vent must be placed in the right position. The pointer must be within the graduated scale.

As for the liquid filled instrument, they must be refilled when the level is 85%. Use Nuova Fima liquids only.

Routine check - Instruments used on plants subject to demanding conditions (vibrations, pulsating pressures, corrosive or combustible / inflammable fluids) must be replaced at the time intervals indicated in the maintenance programme. Where not covered by the **maintenance programme**, the state of the sensitive element should be checked every 3/6 months, as well as the indicating precision, degree of corrosion on the sensitive element (for fluid separators), the seal on the gaskets, and the presence of condensate inside the casing. If the instrument malfunctions, an unscheduled check must be carried out.

Check from time to time that dust deposits on the instrument are not thicker than 5 mm. Where this occurs the instrument must be cleaned. Use a cloth soaked in a water and soap solution.

Removal – The instruments must be cut off from the system by closing the initial valve, and the pressure inside the instrument must be reduced to zero by opening the vent in the system. The process fluid left in the instrument's process connection must not be disposed of in the environment, so as not to cause pollution or harm people. Dangerous and toxic fluids must be handled with care.

Detailed check - The testing fluid must be compatible with the fluid to be measured in the pressurised system. Fluids containing hydrocarbons must not be used when the fluids to be measured are oxygen or any other oxidising substance. To check the integrity of the sensitive element, fit the instrument on a pressure generator, with a shut-off valve between the two. Submit the instrument to the maximum pressure allowed and disconnect it from the pressure source by closing the shut-off valve. If there are any leaks on the sensitive element, the pointer will slowly return to zero. In order to check indication precision, a stable pressure must be generated in a laboratory and applied to the instrument being checked and to a pressure sample or primary pressure. The precision of the latter must be 4 times higher than the nominal precision for the instrument being checked. The values indicated by the two instruments as the pressure rises and falls a number of times makes it possible to establish non-linearity, hysteresis, and repeatability for the instrument being checked.

Check the soundness of the gaskets and the consequent IP protection level.

Recalibration – If the calibration check produces measured values that differ from the nominal values indicated in the catalogue, the instrument must be recalibrated. We recommend returning the instrument to NUOVA FIMA for recalibration using the service **Product Return**.

NUOVA FIMA does not accept any responsibility for instruments used that are subject to work not expressly authorised by them, and such work shall cause the CE Declaration of Conformity and Contractual Guarantee to be null and void.

17. Demolition

We recommend removing transparent parts and caps and disposing of them as aluminium and stainless steel. The fluid left in the instrument may be dangerous or toxic.

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