

Health and Safety Standard: Explosive atmospheres.

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The following text is a translation of the original document, NT.00061.GN-SP.ESS, Version 1, for the purpose of facilitating comprehension of the content by all Gas Natural Fenosa employees. In the event of any differences of interpretation arising from the translation, the content of the original Spanish version in force will prevail for all purposes.

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Health and Safety Standard: Explosive atmospheres

1. Purpose

Guarantee minimum safety conditions to prevent injury to people and damage to installations that may be exposed to risks caused by the presence of explosive atmospheres in the work area.

2. Scope

This standard applies to all companies in the Gas Natural Fenosa group, to those in which the group is responsible for operation and/or management and to the group's partner companies (contractors) in all the group's installations (and in those in which it is responsible for operation and/or maintenance) in which explosive atmospheres may be produced under normal operating conditions.

The risks inherent in the activities to be carried out in installations that involve modifying the installations or altering their normal operating conditions must also be evaluated.

Group workers or contractors performing work for the group in classified areas in installations owned by third parties must take the necessary preventive measures to ensure that the risk level does not exceed the admissible level defined in this document.

This standard does not apply in:

- opencast or underground extractive industries
- home environments
- catastrophic situations

In any event, all applicable national legislation and the aspects included in this Standard must at least be complied with.

3. Reference standard

PG.00043.GN: General Procedure for Health and Safety Standard Management

NT.00043.GN-SP.ESS: Health and Safety Standard: Work Permits.

NT.00052.GN-SP.ESS: Health and Safety Standard: Confined Spaces.

NT.00053.GN-SP.ESS: Health and Safety Standard: Signposting.

4. Definitions

Explosion: a sudden reaction of oxidation or decomposition that produces an increase in temperature or pressure or both simultaneously.

Explosive atmosphere: a mixture of flammable substances with air –under atmospheric conditions– in the form of gases, vapours, mists or powders in which, after ignition, combustion extends to the entire unburned mixture.

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Ordinary operation: situations that occur when the installations, equipment, protective systems and components perform their intended functions within the scope for which they are designed.

Ordinary conditions are also those under which activities are performed in the installations without increasing the presence of ignition sources or flammable substances.

Dangerous location: three-dimensional area or space in which an explosive atmosphere is or may be present, presumably in amounts that require special precautions.

Areas: hazardous areas into which hazardous locations are classified based on the frequency of appearance and the duration of presence of an explosive atmosphere.

Risk Assessment: a systematic process for identifying and assessing risks that may put the integrity of workers or installations at risk.

Lower explosive limit (LEL): the minimum concentration by volume of a combustible in air that makes it possible for a mixture to be flammable.

Upper explosive limit (UEL): the maximum concentration by volume of a combustible in air that makes it possible for a mixture to be flammable.

5. Responsibilities

Unit responsible for the installation and/or the tasks:

- Develop and maintain explosion prevention documentation.
- Check that the workers have received suitable training.
- Provide the necessary resources for carrying out the activity, ensuring the proper state of repair and maintenance of equipment and tools.
- Halt the activity when the preventive and safety measures do not guarantee an acceptable level of risk.

Workers:

- Act in accordance with the provisions of the work permit and received instructions and training.
- Inform the person in charge of the activity of any anomaly or defect that may increase the level of risk.

Corporate Unit responsible for Prevention:

Collaborate with the units responsible for the installation and/or work to:

- Develop and maintain documentation on explosion protection
- Implement this Standard.

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6. Explosion Risk Assessment

The basic principle for preventing risk of explosion is to eliminate the risk of explosive atmospheres, avoiding the presence of flammable substances or their mixture with air.

If this is not feasible, it will be necessary to assess the risk of explosion, taking into account:

- the likelihood of the formation and duration of the explosive atmosphere
- the probability of the presence and activation of ignition sources
- the foreseeable consequences

Similarly, the activities to be conducted must be taken into account, evaluating the likelihood of their increasing the inherent risk of the installation.

Experienced prevention technicians and/or workers with knowledge of the installations and its activities who have 2 or more years' certified experience and/or specific training in prevention of explosion must assess the level of risk.

Below, (6.1 to 6.6) is a method of risk assessment. Other proven methods may be used to assess risks, and the final classification of the risk of explosion must be incorporated into the classification established in this document (acceptable, monitored, undesirable and unacceptable).

6.1. The likelihood of the formation and duration of the explosive atmosphere

The likelihood of an explosive atmosphere being formed is determined according to the classification of hazardous areas.

In existing installations, the basic classification method in the table described below must be applied (consisting of a direct comparison between the dangerous location in question and the established definitions):

Type of area	Definition
0 (gas, vapour, mist) 20 (powder)	A work area in which an explosive atmosphere consisting of a mixture of air and flammable substances are continuously or frequently present, or present for prolonged periods.
1 (gas, vapour, mist) 21 (powder)	Work area in which the formation of an explosive atmosphere is likely to occur occasionally under normal operating conditions.
2 (gas, vapour, mist) 22 (powder)	Work area in which the formation of an explosive atmosphere consisting of a mixture of air and flammable substances is not likely to occur under normal operating conditions but, if it does occur, it will persist only for a short period.

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Type of area	Definition
<p><u>Comments:</u></p> <ul style="list-style-type: none"> - If there are several dangerous leaks in the same location, the classification of the area must take into account their potential accumulation. - Closed premises will be classified as hazardous sites in their entirety, except where a study justifies reducing the size of the area (when the volume of a possible explosive mixture is evaluated as being well below the volume of the closed premises or the existing ventilation is sufficient) - Area classifications must take into account places that are or may be connected through openings to places where explosive atmospheres may be created. 	

The design of new installations included within the scope of this Standard shall include the classification of areas described in the above table and the measures taken in the preliminary design to eliminate or reduce the risk of explosive atmospheres.

Before using the installations with hazardous locations for the first time, experienced prevention technicians and/or workers with knowledge of the installations and its activities and who have 2 or more years' certified experience and/or specific training in prevention of explosion, must assess the overall safety levels. The Gas Natural Fenosa units responsible for the installation must require that this check is made before commissioning it.

Before commissioning the installation, an approved inspection body must inspect the electrical installation in classified areas.

6.2. The probability of the presence and activation of ignition sources

All ignition sources that may become present during normal operation must be taken into account. The probability of presence of ignition sources is evaluated according to the following table:

Probability	Definition
Low	Situation in which in normal operation is unlikely to present a source of ignition, except in the event of malfunctioning or failure caused by improper use of the system
High	Situation in which under normal operating conditions it is quite likely that a source of ignition may become present

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Probability	Definition
<p>Comments:</p> <ul style="list-style-type: none"> - We must estimate the likelihood of effective appearance of ignition sources, taking into account that they may become present during the normal operation of the installation. - The classification according to the probability of each ignition source present in an explosive atmosphere shall be determined by taking into account the type of installation and/or process, the frequency and type of operations that may be performed in the installation and the characteristics of said source, among others. - The effect of a fault in the equipment in an unclassified area that is necessary for, or contributes to, the safe operation of the equipment in classified areas must also be taken into account. - If the degree of probability of whether or not ignition sources may become present cannot be estimated, we must assume that the ignition source is always present. Similarly, when there are doubts among the levels of probability, we must always assume the highest probability. - Third-party ignition sources that may be present in the vicinity of the installation must be taken into account (mobile phones, cigarettes, heat, flames, etc.) as well as those installations or electrical equipment, which, despite being equipped with enhanced security measures, might not fulfil their protective function because of poor maintenance. 	

Potential ignition sources are (non-exhaustive list):

- hot surfaces, flames and hot gases
- mechanically generated sparks
- electrical material
- parasitic, induced electrical currents or cathodic protection
- static electricity
- lightning
- electromagnetic fields, electromagnetic radiation
- ionising radiation
- ultrasounds
- adiabatic compression, shock waves, circulating gases
- chemical reactions

6.3. Determining the likelihood of explosion

The value of the likelihood of explosion is expressed by the following formula:

$$\text{Probability of explosion} = \text{Probability of explosive atm.} \times \text{Probability of ignition sources}$$

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The following table defines the probability of explosion:

Likelihood of formation of the explosive atmosphere (Classification by area)	Probability of presence and activation of ignition sources	
	Low	High
Areas 2 and 22	Unlikely	Possible
Areas 1 and 21	Possible	Likely
Areas 0 and 20	Likely	Inevitable

6.4. Degree of consequences

This is the severity of injury to people and damage to installations if an accident occurs as a result of the risk of explosive atmosphere (explosion). The foreseeable damage and the levels defined below are directly compared:

Level	Definition	
	Personal injury	Property damage
Minor	Minor injuries not requiring hospitalisation	Repairable without stopping the process or activity
Serious	Injuries causing temporary disability	The process or activity must be stopped for repairs to be made
Very Serious	Serious injuries that may be irreparable	Partial destruction of the system (complex and costly repair)
Fatal or Catastrophic	Serious disability or death	Irreparable and involving the total destruction of the installation

Note: When assessing damage, we must take into account the possibility of a domino effect in which given material damage may in turn generate more serious damage to property and personal injury (for example, an explosion on the valve rack of a tank may rupture the tank, which may subsequently explode).

6.5. Assessment of risks of explosion in the installations:

The risk level is determined from the analysis of two factors:

$$\text{Risk level} = \text{Probability of explosion} \times \text{Consequences of the explosion}$$

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The table that defines the probability of explosion is:

Probability of explosion	Degree of Consequences			
	Minor	Serious	Very Serious	Fatal or Catastrophic
Unlikely	Acceptable	Monitored	Undesirable	Intolerable
Possible	Monitored	Undesirable		
Likely	Undesirable			
Inevitable				

6.6. Assessment of risk of explosion by activity

The activities carried out within an installation with potential risk of explosive atmospheres must be assessed to determine whether they increase the intrinsic risk of the installation by altering normal operating conditions:

- increase of potential ignition sources because of the equipment and tools entering the area.
- increased presence of flammable substances (leak to be repaired, action taken on the installation, purges, etc.).

The explosion risk analysis must include the following:

- name of the activity
- affected installation(s)
- description of the activity, including relevant information on the tools and equipment used.
- description of preventive measures to be adopted for carrying out the activity (individual protection, collective protection, training, organisation, etc.).
- Determination of the risk level.

The risk assessment must take into account the reasonably foreseeable malfunctions of the equipment and the human factor.

The cumulative risk level will be determined by jointly assessing the explosion risk of the installation and the activity and this will determine the security measures to be adopted.

7. Determining the level of actions taken in installations

In cases where risk analysis determines an unacceptable risk level, additional preventive measures to reduce it must be taken before the activity begins.

Below are descriptions of the levels of action to be taken when allocating preventive measures based on risk classification:

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Classification of risk	Level of action
Acceptable	The existing checks are sufficient, no measures need to be taken.
Monitored	Define the necessary checks to verify that the preventive measures established for the installation and activities are complied with.
Undesirable	<ul style="list-style-type: none"> - Periodically check the effectiveness of the preventive measures. - Improve the preventive action in the medium term. - A specific work permit is required.
Intolerable	<ul style="list-style-type: none"> - Work must not start or continue until the risk has been reduced. - If it is not possible to reduce the risk, work must be prohibited. - The risk must be re-assessed after the measures have been taken.

Preventive measures taken against the risk of explosion must aim to prevent explosive atmospheres from forming and, if this is not possible, to prevent them from igniting.

If preventive measures have not been able to completely eliminate the risk, protective measures must be taken to mitigate the effects of a possible explosion. Systems to limit the effects of the explosion must be designed to prevent them from spreading and/or to ensure that the pressure wave does not reach a dangerous level. The choice and design of these systems must be based on a specific study of each installation.

Annex 01 lists a number of possible technical measures for preventing explosive atmospheres from forming (Section A), preventing ignition (B) and mitigating the effects of a possible explosion (C).

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8. Documentation on preventing explosions.

Every business must keep its explosion prevention documentation up to date for installations at risk of explosive atmospheres. This must contain:

- the explosive atmosphere risk-assessment methodology.
- the identification of classified areas (according to Section 6.1.).
- the identification of risk levels (according to Section 6.5.).
- the preventive measures to be adopted and their implementation plan.
- the validation of these measures in terms of their efficacy, possible residual risks, etc.
- the content and planning of the training the workers involved must receive.
- monitoring and periodic review of the assessment and the adopted preventive measures, in accordance with possible changes in activity, modifications to the workplace, the incorporation of new workers, the development of technology, etc.
- work procedures to be applied for certain activities in classified areas.
- activities that require specific work permits before they can be conducted in classified areas.

9. Preventive measures on classified sites

9.1. Organisational measures

- Work permit:
The corresponding work permit is required for work to begin in hazardous areas. If the risk is of "undesirable" level, a specific work permit is needed; it must include at least the following requirements:
 - precise location of the place where the work must be done
 - description the work to be performed
 - personnel involved
 - specific and indirect risks (interaction with other operations) and preventive and protective measures
 - when and how to perform environmental supervision
 - personal protective equipment to be used
 - rescue and evacuation plan in case of emergency
- Written standards and procedures
Written policies and procedures must be available for carrying out activities involving special risk or aggravating an existing risk. Checks must be made to ensure that the workers who receive these instructions understand them theoretically and practically and understand the requirements.

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- Suitably and sufficiently qualified workers
All workers who have access to a classified area must receive training and information on:
 - results of risk evaluation, preventive measures and protective measures
 - work clothes, personal protective equipment, collective protection equipment, tools and work equipment permitted and prohibited in the area
 - activities prohibited in the area
 - correct handling of substances that can cause hazards.
 - signposting of risk areas, evacuation signs and routes to follow
 - emergency and evacuation plan in case of fire or explosion.
- Coordination of activities
When workers from several companies are present at hazardous sites located on group premises, Gas Natural Fenosa will be responsible for coordinating activities.
- Checking, supervising and monitoring of work and/or risk areas
Checks must be made to ensure that the activities planned for the task in the explosion protection documentation are followed.

9.2. General measures

- Before starting work:
 - Obtain the work permit: the work manager must verify that all the conditions indicated in the work permit for performing the work are present.
 - When work is carried out in confined spaces with risk of explosive atmosphere, the provisions of standard NT.00052.GN-SP.ESS must be complied with.
 - Properly signal and define (if applicable) the risk area, as established in NT.00053.GN-SP.ESS
 - In cases where an area classified as hazardous has more than one access, one of them must be designated as an emergency exit to allow workers to leave the danger zone quickly and safely.
 - Check that the measuring equipment and work tools to be used are suitable for use in the classified area and are in good condition and state of repair. The use of equipment that does not have certificates of its suitability for use in classified areas will only be allowed if approved during the risk assessment, and this must be expressly authorised in the work permit.
 - The electrical installations must be disconnected in classified hazardous locations before any electrical work is carried out.

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- All equipment and lines installed within the classified areas must be properly grounded, including buried pipes and metal tanks.
- All workers in the classified work area must wear anti-static footwear and fireproof, anti-static work clothes. Metallic elements must not be introduced into classified areas (watches, chains, rings, etc.)
- If an explosive atmosphere contains several types of gases, vapours, mists or combustible or flammable powders, the preventive measures to be taken must be suited to the greatest potential risk.
- The condition of all rescue and evacuation equipment must be checked, and it must be located near the work area.
- During work
 - Always follow the rules and work procedures established for each operation and the specific safety measures detailed in them.
 - Avoid triggering sources of ignition in classified locations. Where unavoidable, work can only be performed after adopting the preventive measures necessary to guarantee an acceptable level of risk.
 - Bear in mind that workers or the work area may act as charge generators or carriers and take into account the possible electrostatic discharges they may cause.
 - If an explosive atmosphere may come in contact with a hot surface, a safety margin between the maximum surface temperature and ignition temperature of the explosive atmosphere must be maintained at all times.
 - Whenever activities involving the use of chemical products are performed, the specifications on the safety data sheets of those products will be followed, which indicate the risks and the necessary control measures.
 - Venting operations must be performed using methods and procedures that direct the released fuel to a safe area.
- After completion of work
 - Remove equipment and materials used and any waste generated
 - Make sure that all personnel have left the area.
 - Close access points and remove signs and markings, where applicable.
 - Report the completion of the work.

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9.2.1. Specific preventive measures in areas classified by flammable gases

- Before accessing a hazardous site, use appropriate detection equipment to check for the possible presence of an explosive atmosphere, moving forward gradually and checking corners and dead areas. Do not access the site until the conditions are safe (below 20% LEL and oxygen concentration within the 19.5% -23.5% range).
- Once inside the site, continually check the atmosphere. If an alarm is triggered, evacuate the site immediately and notify your colleagues.
- Ensure the ventilation of the classified area during the course of the work.

9.2.2. Specific preventive measures in areas classified by flammable powders

- As far as possible, avoid spreading powder particles. Clean up any powder deposits frequently.
- Where necessary, use localised extraction, directing the extracted powder to risk-free areas.
- If the work requires the use of tools that continually generate sparks (drills, grinders) or arcs (blow torches, welding units), or equipment that gets hot when used (vulcanising equipment), then the following measures must also be taken:
 - cordon off the work area if possible.
 - remove the dust from the work area either using suction devices or brushes. Alternatively, dampen it with water so that it cannot disperse in the air. If the work area cannot be cordoned off, the above measures must be extended to the surrounding area, to avoid projections beyond the safe area.
 - avoid the presence of combustible materials within a 10m radius. If this is not possible, cover the combustible material or surround the work area with fireproof material to prevent projections reaching the hazardous zone.

10. List of appendices

APPENDIX 01. Technical measures for explosion protection

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Appendix 01. Technical measures for explosion protection

A. Prevention of formation of explosive atmospheres

- Avoid or reduce the use of flammable substances. In the case of powders, it is sometimes possible to increase the particle size of the substances used or to dampen them.
- Keep the concentration of flammable substances outside its explosive range.
- Inerting: dilute the oxygen in the air inside the installation or the combustible material using inert substances.
- Prevent or reduce the formation of explosive atmospheres in the vicinity of the installation: use of closed facilities with suitable ventilation.
- Remove dust deposits. Clean-up plans must be drawn up detailing the type, extent and frequency of cleaning operations and the corresponding responsibilities. Wet cleaning and vacuum cleaning of dust are suitable methods; dust removal by blowing must be avoided.
- Monitor the concentration around the installation using detectors/gas warning devices. This means knowing beforehand what substances will probably be found, the location of their sources, the maximum intensity of emission and their propagation conditions.

B. Prevention of the appearance of ignition sources

- If an explosive atmosphere may come in contact with a hot surface, a safety margin between the maximum surface temperature and ignition temperature of the explosive atmosphere must be maintained at all times.
- Flames must be totally excluded in areas classified as 0 or 20; in Areas 1, 2, 21 and 22 only safely confined flames are acceptable.
- Sparking by friction and impact can be limited by choosing a suitable combination of materials.
- In the case of exothermic chemical reactions that may lead to ignition sources, the following may be appropriate protective measures:
 - inerting
 - stabilising
 - improving heat extraction
 - controlling the temperature of the installation
 - storage at lower ambient temperatures
 - limiting the time the substance is present to less than that necessary to induce the ignition of the powder

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- The measuring equipment and work tools to be used must be suitable for use in the classified area and be in good condition and state of repair.
- To prevent static electricity discharges that cause ignition, the following measures are effective:
 - earthing of conductive objects and installations.
 - use of appropriate footwear depending on the type of ground.
 - avoid materials and objects with low electrical conductivity.
 - reduce non-conductive surfaces.
 - in powder transport and filling processes, avoid conductive metal containers and tubes coated with interior electrical insulation.

C. Limiting the effects of explosions

- Explosion-resistant construction: parts of facilities such as containers, vessels and piping are constructed in such a way that, in case of internal explosion, they do not rupture.
- Explosion relief: when an explosion begins or when it has reached a certain stage, and if it reaches the trigger pressure of the discharge device, the initially closed installation where the explosion occurs momentarily or permanently opens in a safe direction.
- Explosion suppression: in an explosion, the explosion suppression devices act by rapidly injecting extinguishing agents into containers and facilities to prevent the maximum explosion pressure being reached; apparatus and installations so protected must be designed only for a low explosion pressure.
- Prevention of explosion propagation: by isolating and interrupting them (disconnection) possible explosions can be limited to isolated parts of the installation. For disconnecting parts of the installation, the following systems among others are available:
 - rapid mechanical isolation
 - flame extinction in narrow gaps or by injecting extinguishing agents
 - arresting of flame by high counterflow
 - hydraulic interception
 - gates

Flame arresters for gases, vapours and mists are essentially based on one or more of the following mechanisms:

- flame extinction in narrow gaps and channels
- stopping a flame front by discharging the unburned mixtures at suitable speed (high-speed valves)
- stopping a flame front by liquid interception.

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To prevent the spread of dust explosions through communication piping, transportation facilities or the like, as well as the flame reaching the outside of the installations, devices such as the following are used:

- extinguishing barriers
- instant-closing sliding gates, double sliding gates, quick-closing gates
- quick-closing valves (anti-explosion safety valves)
- explosion diverting devices

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