1. GENERAL TECHNICAL INFORMATION

1.1 EXPLOSIVE ATMOSPHERES:

Every time that dangerous quantities and concentration of flammable gas, vapors mixture or dust clouds exists, risk of explosions may arise.
Also, layers of combustible dusty may ignite and act as ignitions sources for explosive atmospheres.
Therefore to minimize these risks measures must be taken by equipment suppliers/installers and respective end users.

WEG has many years in the design and operation of motors to be used in the most severe application regarding Hazardous Areas and special applications under the most severe duty requirements.

1.2 STANDARDS AND CLASSIFICATION OF EXPLOSIVE ATMOSPHERES:

1.2.1 ATEX DIRECTIVES

The ATEX Directives were adopted by the European Union (UE) to facilitate the free trade between the member states by aligning the technical and legal requirements for products intended for use in potentially explosive atmospheres.
There are two main Directives, sharing the responsibilities between the Manufacturer and the End User:

- The ATEX Manufacturers Directive 94/9/EC, also known as ATEX 95, places the responsibilities on the manufacturers: It specifies the Essencial Health and Safety Requirements, that must be met by the equipment intended to be used in potentially explosive atmospheres, and defines two different groups which are subdivided in five equipment groups as indicated in 1.2.3.4 of this catalogue.

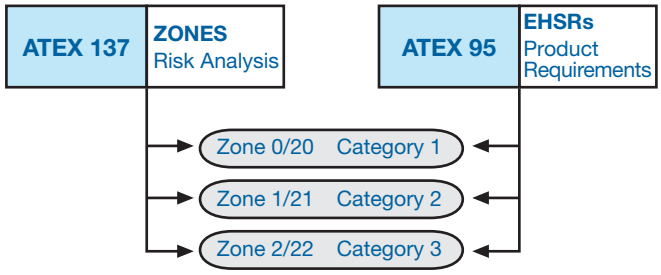
  In order to meet the ATEX Directive products must comply with the Essential Requirements of this Directive and is also required to follow a Conformity Assessment Procedure.

  The ATEX product markings can be easily recognized by the symbol Ex, that indicates the explosion protection and by the CE mark that certifies the conformity with this Directive.

  This assessment procedure involves obtaining the EC Type Examination certificate for products (requires the involvement of a Notified Body except for category 3 products), the Production Quality Assurance (assessed by a Notified Body that issues the QAN – Quality Assessment Notification and periodically makes the audits) and an internal control of production (where the manufacturer carries out the necessary work to guarantee that the products are in compliance with the ATEX Directive).

- The ATEX User Directive 99/92/EC, also known as ATEX 137, describes the minimum requirements for the improvement of the health and safety of workers with relation to potentially explosive atmospheres.
  It classifies the environment into **zones** and outlines which **category** of equipment that can be used in each zone.

This Directive concentrates on the duties of the End User whose responsibilities are mainly:
- The assessment of risks
- Preparation of an Explosion Protection Document
- The provision of suitable warning signs for areas where explosive atmospheres may be formed.
  The safety of an installation in a Hazardous Area is the result of co-operation between the equipment manufacturer, the installer and the end user.



1.2.2 IECEx SCHEME

The objective of the IECEx System is to facilitate international trade in equipment and services for use in explosive atmospheres, while maintaining the required level of safety. IECEx System is accepted in many countries and aims to be the world approval system for electrical equipment to be installed in potentially explosive atmospheres.

The IECEx International Certification System comprises four different schemes:
- The IECEx Certified Equipment Scheme
- The IECEx Certified Service Facilities Scheme
- The IECEx Conformity Mark Licensing System
- The IECEx Certified Persons Scheme

WEG, as a manufacturer of electric motors for potentially explosive atmospheres, introduced a new range of motors - BFG(C)8 and W22XB(C) series - that are in compliance with the IECEx Certified Equipment Scheme.

The IECEx Scheme applies IEC Standards for products design. To achieve IECEx Product Certification is mandatory to involve an ExCB (IECEx Approved Certification Body) to test the products and samples according to the IEC Standards and issue the ExTR (IECEx Test Report).
IECEx Product Certifications also requires the involvement of an ExCB to audit the Quality Assurance System of the manufacturers (that must be previously assessed and in conformity with ISO 9001). From the audit success a QAR (IECEx Quality Assessment Report) is issued.

With the ExTR, Product Documentation and QAR, the IECEx CoC (Certificate of Conformity) can be issued by the ExCB.

1.2.3 EN/IEC STANDARDS

The implementation of ATEX Directives are supported by the CENELEC (EN) standards regarding the enclosure protections of electric motors to be used in potentially explosive atmospheres, as well as the hazardous areas classification criteria, depending on the presence of Gas and/or Combustible Dusts.

WEG refers below the main applicable EN/IEC recently updated Standards:

EN / IEC 60079 – 0 –	Explosive Atmospheres Equipment – General requirements
EN / IEC 60079 – 1 –	Explosive Atmospheres Equipment protection by flameproof enclosures “d”
EN / IEC 60079 – 7 –	Explosive Atmospheres Equipment protection by increased safety “e”
EN / IEC 60079 – 10 –	Electrical apparatus for explosive gas atmospheres Classification of hazardous areas
EN / IEC 60079 – 14 –	Explosive Atmospheres Electrical installations design, selection and erection
EN / IEC 60079 – 15 –	Electrical apparatus for explosive gas atmospheres Construction, test and marking of type of protection “n” electrical apparatus
EN / IEC 60079 – 17 –	Explosive Atmospheres Electrical installations inspection and maintenance
EN / IEC 60079 – 19 –	Explosive Atmospheres Equipment repair, overhaul and reclamation
EN / IEC 61241 – 0 –	Electrical apparatus for use in the presence of combustible dust General requirements
EN / IEC 61241 – 1 –	Electrical apparatus for use in the presence of combustible dust Protection by enclosures “tD”
EN / IEC 61241 – 10 –	Electrical apparatus for use in the presence of combustible dust Classification of areas where combustible dusts are or may be present
EN / IEC 61241 – 14 –	Electrical apparatus for use in the presence of combustible dust Selection and installation
EN / IEC 61241 – 17 –	Electrical apparatus for use in the presence of combustible dust Inspection and maintenance of electrical installation in hazardous areas (other than mines)
EN / IEC 61241 – 19 –	Electrical apparatus for use in the presence of combustible dust Repair and overhaul of electrical apparatus for combustible dust areas

1.2.3.1 ZONE CLASSIFICATIONS:

The EN/IEC Standards classify the risk areas into **zones** and **groups**:

- The **zones** are of classified according with type of atmosphere Gases or Dusts and the respective to frequency and period of time that the explosive atmosphere is present.
- The division into **groups** is based on the aggressiveness of the environment.

1.2.3.2 CLASSIFICATION OF AREAS - GAS AND VAPOURS

EN/IEC 60079-10 – Classification of Hazardous Areas – Gas Areas

- This standard concerns with hazardous area classification where flammable gas and vapours risks may arise.
- Does not apply to mines susceptible to firedamp neither to areas where ignitable dusts or fibres presence risks may arise.

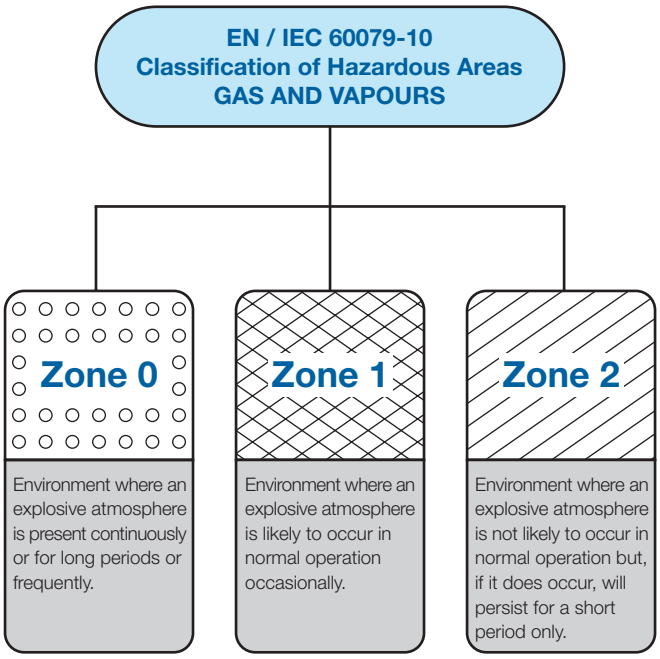
Explosive Gas Atmosphere

Exists where flammable substances in the form of gas, vapours, mist or dust are mixed with air under atmospheric conditions and in case of an ignition combustion spreads throughout the unconsumed mixture.

Hazardous Area (Gas)

Area in wich an explosive gas atmosphere is present, or may be expected to be present, in quantities such as to require special precautions for the constructions, installations and use of apparatus.

Hazardous Areas are classified into zones (Gases on the frequency of the occurrence and duration of on explosive gas atmosphere).



1.2.3.3 CLASSIFICATION OF AREAS - COMBUSTIBLE DUSTS

EN/IEC 61241-10 – Classifications of areas where combustible dusts are or may be present

Combustible dust

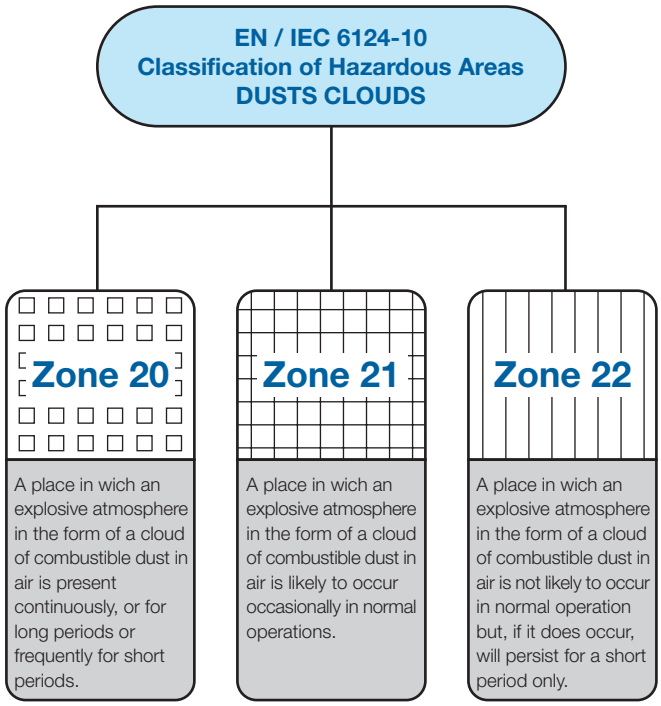
Dust, fibres or flyings that can burns or glow in air and could form explosive mixtures with air at atmosphere pressure and normal temperatures.

Explosive dust atmosphere

Mixture with air, under atmospheric conditions, of flammable substances in the form of dust, fibres or flyings in wich, after ignition, combustion spreads throughout the unconsumed mixture.

Hazardous Area (Dust)

Area in wich combustible dust in cloud form is, or can be expected to be, present in quantities such as to require special precautions for the constructions and use of equipment in order to present ignition of explosive dust/air mixtures.
Based on the likelihood of the formation of potentially explosive dust/air mixtures, the areas can be designated according to diagram below.



For dust layers the nature of house keeping assures an essential control to their thickness.

For a “good” level of house keeping dust layers are kept to negligible thickeness and the risk of the occurrence of explosive dust clouds from layers and the risk of fire due to layers has been removed.

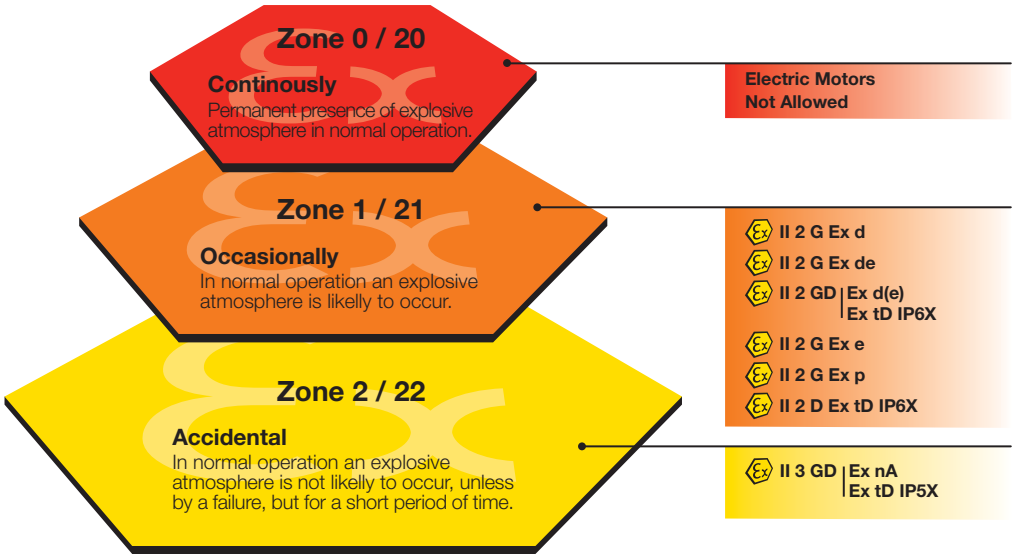
The max surface temperature, for dust layers up to 5mm is:

$$T_{max} = T_5mm - 75\ ºC$$

Where T_5mm is the minimum ignition temperature of a 5mm dust layers.

For higher dust layer other rules must be applied according with EN/IEC 61241-10

In summary the Hazardous Areas are classified as follows:



1.2.3.4 CLASSIFICATION OF GROUPS

CENELEC / IEC Standards provide a criteria which determine the classification of the equipment into groups and categories according to EN / IEC 60079-0:

Group Classification:

GROUP I (Mines)	
Categories	
M1	Equipment designed to operate on environments where the explosive atmosphere is present frequently.
M2	Equipment that must be powered off if there is any risk of explosion. Explosive atmosphere is present frequently.

Category Classification:

GROUP II* (Surface Industry)			
Categories			Zone
1	Equipment with high degree of protection. Explosive atmosphere is present continuously or for long periods of time.	1G (gas) 1D (dust)	0 (gas) 20 (dust)
2	Equipment with high degree of protection. Explosive atmosphere may occur occasionally.	2G (gas) 2D (dust)	1 (gas) 21 (dust)
3	Equipment with normal degree of protection. The explosive atmosphere will probably not occur.	3G (gas) 3D (dust)	2 (gas) 22 (dust)

* Gases are subdivided into IIA, IIB and IIC, as per EN / IEC Standards.

Sub-Group Classification for Gases of Explosive Atmospheres:

GROUPS	Underground Explosive Atmospheres	Equipment manufactured for underground operation mines	I	Methane may be present (firedamp)
	Other Explosive Atmosphere	Equipment manufactured for other types of industry (surface industry), being subdivided based on the characteristics of the materials present	IIA	acetone, ammonia, benzene, butane, butanol, alcohol butylic, ethane, ethanol, acetate of ethyl, gasoline, hepthanes, hexanes, natural gas, methanol, naphtha, propane, propanol, toluene, esthirene, solvents in general
			IIB	acetaldeide, cyclopropane, diethylic ether, ethene, monoxide of carbon
			IIC	acetylene, butadiene, oxide of ethene, hydrogen, oxide ofpropylene, gases containing over 30% of hydrogen

Note: For a better understanding of a complete identification of Areas and Groups, please see the markings on paragraph 2.2

1.2.3.5 CLASSES OF TEMPERATURE

The minimum temperature that causes an explosion of a gas, vapour of explosive mixture is called ignition temperature. To avoid any risk of explosion, the motor surface temperature must always stay below the ignition temperature of the explosive mixture.

The internal and external temperature of the electrical equipment must be strictly followed to avoid ignition of an explosive mixture. The equipment is classified into classes of temperature, as per table below:

Class of Temperature (C)		Maximum motor surface temperature (C)	Ignition temperature of the explosive mixture (C)
EN / IEC 60079-0	NEC		
T1	T1	450	>450
T2	T2	300	>300
	T2A	280	>280
	12B	260	>260
	T2C	230	>230
	T2D	215	>215
T3	T3	200	>200
	T3A	180	>180
	T3B	165	>165
	T3C	160	>160
T4	T4	135	>135
	T4A	120	>120
T5	T5	100	>100
T6	T6	85	>85

1.3 PROTECTION CATEGORIES FOR ELECTRIC MOTORS

1.3.1 TYPE Ex d – FLAMEPROOF (according to EN/IEC 60079-1)

It is a type of protection where the parts that may flame an explosive atmosphere are closed into enclosures which are capable to withstand a pressure during an internal explosion of an explosive mixture and it avoids such explosion to go out from this enclosure to an external explosive atmosphere. An induction electric motor (of any protection) is not totally sealed, that is, air flows in and out.

While the motor is in operation, it heats up and the internal air gets to a higher pressure compared to the external pressure (air is blown out); when motor is switched-off, the internal pressure decreases, allowing in this way entrance of air (which in this case is contaminated).

The motor surfaces do not need to be totally enclosed to avoid flame propagation. The minimum opening required to avoid passage of flames depends on the gas or vapour that is present. Therefore, there will always be flame passages through the motor enclosure. The safety level on an explosion proof motor is on the fact that it must ensure that all flame passages never exceed the standardized dimensions and that the motor is physically suitable to withstand an internal explosion without transmitting it to the external environment.

Ex d protection will not allow that an internal explosion propagates to the external environment. To ensure safety to the system, WEG provides a control of the openings and the finishing of joints once these are responsible for the volume of gases exchanged between inside and outside of the motor.

Flame propagation between motor interior and external atmosphere is guaranteed by constructive joints and gaps. Internal pressure that can result of an explosion in the interior of the motor is guaranteed by the enclosure resistance (frame, endshields, internal bearing covers, terminal boxes and some adaptors).

The main characteristics of **Ex d** motors are as follows:

- Reinforced frame, terminal box and endshields
- Greater contact surface (interference) between motor components
- Reduced clearance between motor shaft and bearing cap to avoid transmission of sparks and the external environment
- All components (frames, endshields, terminal box and terminal box lids) are submitted to overpressure test in factory.
- Guaranty of external surface temperature of the motor according with the correspondent Class of temperature (ex. T4 – 135ºC). The tests on WEG prototypes comprehend a full evaluation of the external surface temperatures with motor supplied with electrical limit conditions.

Applications:

- Environments containing flammables gas or vapour continuously, intermittently or periodically in enough amounts to generate explosive or flammable mixtures arising out of repairs or maintenance services.
- The locations defined as **Zones 1** and **2**, **Groups IIA**, **IIB** and **IIC** are those where the following gases are found present: oil, naphtha, benzene, ammonia, propane, diethylic ether, acetone, alcohol, industrial methane, natural gas, as well hydrogen and acetylene.
- The main applications including pumps, fans, blowers, crushers, conveyor systems, mills, cranes and other applications located in areas that require explosion proof motors.

1.3.2 TYPE Ex de – FLAMEPROOF MOTORS WITH INCREASED SAFETY TERMINAL BOX (according to EN/IEC 60079-1 and EN/IEC 60079-7)

Ex de motors differ from **Ex d** motors only on the configuration of terminals and terminal box. The terminal box with increased safety terminals prevents from any ignition source that may occur such as sparks, excessive heating, etc.

Motors with flameproof enclosures “d” with Increased Safety terminal boxes “e” can be used also in zone 1. The protection principle of increased safety terminal boxes is acting in the causes that can start an ignition (ex. Sparks, materials overheating, cables movements, etc) and not in preventing that an internal explosion is sustained inside the enclosure (like flameproof enclosures “d”). Most of WEG increased safety terminal boxes have the constructive principles of flameproof enclosures “d” with additional Increased Safety requirements.

The main characteristics of **Ex de** motors are:

- Terminal box components as well as connection cables must be firmly fastened (without allowing any movement)
- Special terminal block / bushings to avoid arcs and sparks and higher air and surface distances between to conductive parts (clearances and creepages)
- Double grounding must be provided (one on the frame and the other inside the terminal box)

Applications:

- Same as described for Ex d motors.

1.3.3 TYPE Ex nA – NON SPARKING MOTORS (according to EN/IEC 60079-15)

This type of protection is applied to electric equipment which do not cause ignition of an explosive atmosphere under normal operating conditions and in certain abnormal conditions.

The design and constructive principles for these apparatus must guarantee that in normal operation a spark or arc is prevented from causing ignition in a surrounding explosive atmosphere and that the internal and external surfaces temperatures do not overpass the maximum surface temperature certified.

Ex nA motors don’t require certification by a third party Notified Body (a manufactures conformity declaration is sufficient). Nevertheless the **Ex nA** motors manufactured by WEG have certification by Ex NB BASEEFA.

Assessment risk

For **Ex nA** motors with output power exceeding 100kW **an assessment risk for rotors** must be made for possible air gap sparking (motors with service duties S1 and S2 with an average starting frequency in normal operation not exceeding 1 start per week are excluded from this assessment risk). The assessment risk consists in a punctuation table where a score is calculated based in rotor construction and some application characteristics. If the score exceeds 5, special measures must be made to guarantee that the apparatus will not contain explosive gas atmosphere at the time of starting. WEG equips the motors that exceed the score of 5 with provision for a pre-start ventilation system (this system is customer’s responsibility).

For **Ex nA** motors with rated voltage greater than 1kV **an assessment risk for stators** must be made for possible incendivity of winding insulation system. The assessment risk consists also in a punctuation table where a score is calculated based in the application and site conditions. If the score exceeds 6, special measures must be made to guarantee that the apparatus will not contain explosive gas atmosphere at the time of starting. WEG equips its motors that exceed the score of 6 with space heaters and also with a provision for pre-start ventilation system (this system is customers responsibility).
The assessment risk is a subject that must have the responsibility of the customer and manufacturer. It’s a combined work that is mandatory according with the present standard. WEG always makes the assessment risk in the enquiry stage.

The **Ex nA** motor enclosure is built identically to a safe TEFC motor.

The main characteristics of **Ex nA** motors are as follows:

- Terminal box components as well as connection cables must be firmly fastened (without allowing any movement)
- T3 classification as per maximum internal and external surface temperature
- Increased safety terminal blocks / bushings to avoid arcs and sparks and higher air and surface distances between to conductive parts (clearances and creepages)
- Construction particularities to avoid arcs or sparks between static and rotating parts during normal operation:
  - specific air gaps
  - rubbing seals materials
  - rotor construction
  - fans material and peripherical speeds

Applications:

Environment where an explosive atmosphere will probably not be present under normal operating conditions and, if any, this will be for short period of time, that is, an explosive atmosphere may be present accidentally.
The environments are classified as Zone 2, groups IIA, IIB and IIC. The most common gases included in this classification are: acetone, ammonia, benzene, butane, butanol, buthylic alcohol, ethane, ethanol, acetate of ethyl, gasoline, heptanes, hexanes, natural gas, methanol, oil naphtha, propane, propanol, toluene, esthyrene, solvents in general, acetaldehyde, cyclopropane, diethylic ether, ethane, monoxide of carbon, acetylene, butadiene, oxide of ethane, hydrogen, oxide of propylene and gases containing over 30% of hydrogen.

1.4 GENERAL CONSTRUCTION STANDARDS

Beyond the particular requirements for Hazardous Areas, the WEG electric motors are manufactured in compliance with General EN/IEC and equivalent National Standards related with construction and performance. The main applicable Standards are described below:

EN / IEC 60034-1	Rating and performance
EN 50347 and IEC 60072	Outputs and Dimensions
EN / IEC 60034-5	Mechanical protection
EN / IEC 60034-6	Cooling method
EN / IEC 60034-7	Mounting arrangements
EN / IEC 60085	Insulation class
EN / IEC 60034-8	Terminals identification and rotation
EN / IEC 60034-9	Noise limits
EN / IEC 60034-14	Balancing and vibration limits