Low Voltage
Hazardous Area Motors

1 EXPLOSIVE ATMOSPHERE

An atmosphere is considered as explosive when the amount of gas, vapor, dust or fibers is such that a spark originated from an electric circuit or an overheating from an equipment may cause an explosion.
In reference to surrounding equipment, preventive construction measures are taken so as to avoid that the area around them is flamed.

2 EUROPEAN STANDARDS FOR EXPLOSIVE ATMOSPHERE DESIGNED MOTORS

In Europe, all motors designed for explosive atmospheres must meet IEC and CENELEC Standards and ATEX Directive 94/9/EC, which is mandatory since July 2003.

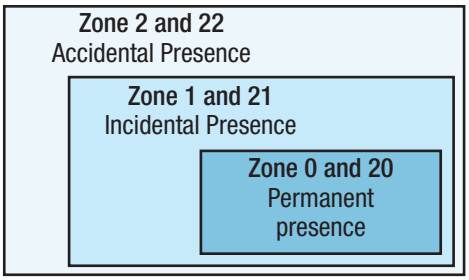
2.1 IEC STANDARDS

The IEC Standard classifies the risk areas into zones and groups:
- The zones are classified according to frequency and period of time that the explosive atmosphere is present.
- The division into groups is based on the aggressiveness of the environment.

Zone classification:

Gases and Vapours	Zone 0	Environment where the explosive atmosphere is present continuously or for long periods of time.
	Zone 1	Environment where the probability of existing an explosive atmosphere is associated with normal operation of the equipment.
	Zone 2	Environment where an explosive atmosphere will probably not be present under normal operating conditions and, if any, this will be for short periods of time.

Dusts	Zone 20	Environment where flammable dust is present continuously or frequently under normal operating conditions in enough amount to generate an explosive concentration of mixed dust with air and/or areas where may occur excessive amount of dust with no further control.
	Zone 21	Area that is not classified as Zone 20. However, where flammable dusts may occur under normal operating conditions in enough amount to generate an explosive concentration of dust mixed with the air.
	Zone 22	Areas that are not classified as Zone 21. However, where flammable dust may occur frequently and is present for short periods of time, or where the amount of dust may occur just under abnormal operating conditions causing an explosive mixture.



Group classification:

GROUPS	Mines	Equipment manufactured for underground operation mines	I	Methane may be present (grisu)
	Other Explosive Atmospheres	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, ethyl acetate, gasoline, hepthanes, hexanes, natural gas, methanol, naphtha, propane, propanol, toluene, esthirene, solvents in general
			IIB	acetaldeide, cyclopropane, diethylic ether, ethene, carbon monoxide
			IIC	acetylene, butadiene, ethene oxide, hydrogen, propylene oxide, gases containing over 30% of hydrogen

2.2 CENELEC STANDARDS

CENELEC Standard provides criteria to determine the classification of the equipment into groups and categories:

Group classification:

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

GROUP II* (Surface Industry)			
Categories			Zone
1	Equipment with high level 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 level of protection. Explosive atmosphere may occur occasionally.	2G (gas) 2D (dust)	1 (gas) 21 (dust)
3	Equipment with normal level 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 IEC Standards.*

2.3 ATEX DIRECTIVE 94/9/EC

Valid since March of 1996, this European Directive is mandatory since July 2003. If provides a classification for motors into areas containing explosive atmospheres. More than product specification, the present Directive gives special attention to the production process including design, production itself and sale.
The certification for the system is provided together with the product certification. ATEX Directive 94/9/EC also classifies the equipment to operate in explosive atmospheres into groups and categories following the same classification bases used by CENELEC.

3 CLASSES OF TEMPERATURE

The minimum temperature causing 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 checked to avoid ignition of an explosive mixture. So the equipment is classified into classes of temperature, as per table below:

Class of Temperature (ºC) GGROUP II* (Surface Industry) IEC / CENELEC	Maximum motor surface temperature (ºC)	Ignition temperature of the explosive mixture (ºC)
T1	450	>450
T2	300	>300
T3	200	>200
T4	135	>135
T5	100	>100
T6	85	>85

4 MOTORS FED BY VARIABLE FREQUENCY DRIVES

Notes: Ex e motor line fed by VFD requires additional certification.

4.1.1 Temperature class

Ex d and Ex de motor line fed by VFD are suitable to operate at temperature class T4.
Note: For Ex nA motor line, please considerer page 23

4.1.2 Application of filters

- Motors with voltages up to 575V do not require application of filters if the criteria below are followed accordingly:

Rated Voltage	Insulation System	TECHNICAL CRITERIA FOR VFD APPLICATION			
		Voltage Spikes motor terminals (maximum)	dV/dt inverter terminals (maximum)	Rise Time(*) inverter terminals (minimum)	MTBP(*) Minimum Time Between Pulse
Vrated ≤ 460V	Standard Insulation	≤ 1430V	≤ 5200 V/µs	≥ 0,1 µs	≥ 6 µs
460V < Vrated ≤ 575V	Reinforced Insulation	≤ 1780V	≤ 6500 V/µs		

(*) Informed by the converter manufacturer.

Note: Nameplate showing voltage 380-415V / 660-690V – 50Hz and 440-480V – 60Hz, and fed by VFD on voltage

660-690V – 50Hz or 480V – 60Hz require filters.

- Motors fed by VFD with voltage range of 575V up to 690V require filters.

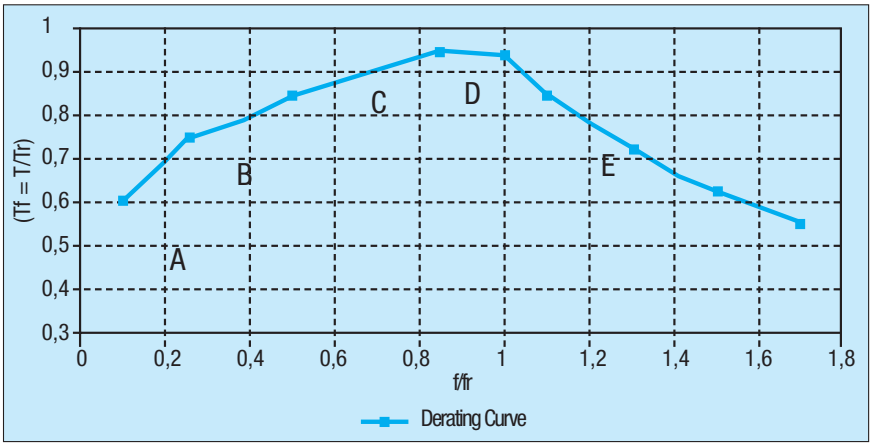
4.1.3 Switching Frequency

The minimum switching frequency is 2.5 kHz.

4.1.4 Type of load torque

For load with quadratic torque, motor can be operated at frequency range from 10% up to 100% of the rated frequency if the load torque at the rated frequency is 95% of the motor rated torque.
For load with constant torque, motor can be worked at frequency range of 10% up to 100% of the rated frequency if the load torque is lower than motor torque derating curve as showing below.
To operate at frequency above the rated frequency, use the derating curve and check if breakdown torque is appropriate for the application in the maximum run speed.

Note: For maximum motor speed selection, item 4.2.1. showing mechanical speed limits must be considered.



PART	DERATING CURVE	
	FREQUENCY RANGE	DERATING
A	0.1 ≤ f/fr < 0.25	Tf = (f/fr) + 0.50
B	0.25 ≤ f/fr < 0.50	Tf = 0.4(f/fr) + 0.65
C	0.50 ≤ f/fr < 0.83	Tf = 0.3(f/fr) + 0.70
D	0.83 ≤ f/fr ≤1.0	Tf = 0.95
E	f/fr > 1.0	Tf = 0.95 / (f/fr)

4.2 Mechanical Characteristics

4.2.1 Mechanical Limit Speed:

The mechanical limit speeds of the motor are indicated on the table below:

MOTOR	SPEED (RPM)			
	2 pole	4 pole	6 pole	8 pole
90 – 100	7000	7000	7000	7000
112	7000	6000	6000	6000
132	6000	5500	5500	5500
160	5000	5000	5000	5000
180	4500	4000	4000	4000
200	4000	3800	3800	3800
225	3600	3600	3600	3600
250	3600	3600	3600	3600
280	3600	3000	3000	3000
315	3600	2500	2500	2500
355	3600	1800	1800	1800

Note: For maximum motor speed selection, the derating curve of item 4.1.4 must be considered.

For other applications, please contact WEG.

4.2.2 Bearing insulation

For “Ex d” and “Ex de” motors, on frames 315S/M and 355M/L* when used with VFD’s must use insulated bearings.

(*) Other frame sizes, on request.

5 PROTECTION CATEGORIES FOR ELECTRIC MOTORS

5.1 TYPE Ex d – EXPLOSION PROOF

It is a type of protection where the parts that may ignite an explosive atmosphere are closed into enclosures which are capable to withstand a pressure during an internal explosion of an explosive mixture and to avoid that explosion leaves this enclosure and reaches an external explosive atmosphere.
An induction electric motor (of any protection) is not totally sealed, that is, air goes in and out. While in operation, it becomes heated 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 on the motor. 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 that the motor is physically suitable to withstand an internal explosion without transmitting 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.

The main characteristics of Ex d motors are as follows:

- Reinforced frame, terminal box and endbells
- Greater contact surface between motor components
- Reduced clearance between motor shaft and bearing cap to avoid transmission of sparks and the external environment
- Water pressure test on all components (frames, endbells, terminal box, terminal box covers)

Application:
Environments containing flammable gases or vapour continuously, intermittently or periodically in enough amount to generate explosive or flammable mixtures arising out of repairs or maintenance services.
The most common locations of Zone 1 and 2, group IIA and IIB are those where the following gases are found present: oil, naphtha, benzene, ammonia, propane, diethylic ether, acetone, alcohol, industrial methane, natural gas.
The main applications include fans, blowers, crushers, conveyor systems, mills, cranes and other applications located in areas that require explosion proof motors.

5.2 TYPE Ex de – EXPLOSION PROOF WITH INCREASED SAFETY TERMINAL BOX

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

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 to avoid arcs and sparks and standardized distance between terminals (increased safety terminal block)
- Double grounding must be provided (one on the foot and the other on terminal box covers)

Application:
Same as described for Ex d motors.

5.3 TYPE Ex e – INCREASED SAFETY

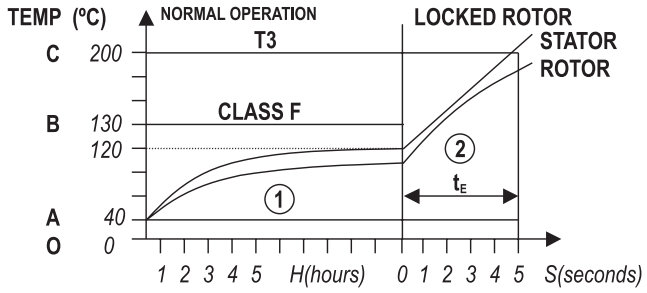
This is an electric equipment which under normal operating conditions will not cause arcs, sparks or overheating enough to cause ignition of an explosive atmosphere which it has been designed to. These motors are similar to standard motors.

However, they are fitted with special features as follows:

- Temperature rise 10K below the maximum temperature allowed for the insulation class
- Commitment with “time tE” (maximum time for switching off through protection device)
- Terminal box components as well as connection cables must be firmly fastened (without allowing any movement)
- External grounding on the frame is mandatory
- Frame grounding must be connected with terminal box grounding
- Drip cover must be applied on vertical applications
- Reduced output x frame ratio
- Special care when manufacturing the winding along with applying double impregnation layer (frames 63 up to 200)
- For frames 225S/M and above resin continuous flow impregnation
- Special terminal block to avoid arcs and sparks and standardized distance between terminals (increased safety terminal block)
- Drain holes on endbells

5.3.1 TIME tE

It is the time required for the motor winding, when starting current goes through it, to reach the limit temperature, starting from the achieved temperature under normal service duty and considering the ambient temperature on its maximum value.
The protection device must be designed so as to avoid any risk under all operating conditions. This protection device must operate, without fault, not only on overload cases, but also on locked rotor conditions. On this way, the value of time tE must be such that, when rotor is locked, motor must be switched off by a protection device that depends on the current, before time tE gets to the end.



On the chart above, the interval OA represents the maximum ambient temperature, and OB is the temperature reached under normal operating duty. In case there is any failure with further rotor locking, the condition is represented on the interval 2 of the chart. The motor temperature increases fastly up to interval OC which must be shorter than motor classification temperature T. So, care must be taken to ensure motor is switched-off within time tE.

Application:

Environments where the probability of existing an explosive atmosphere is associated with normal operation of the equipment in amount enough to cause an explosion.
The environments are classified as Zone 1 and 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, esthirene, solvents in general, acetaldehyde, cyclopropane, diethylic ether, ethane, carbon monoxide, acetylene, butadiene, ethane oxide, hydrogen, propylene oxide and gases containing over 30% of hydrogen.

5.4 TYPE Ex n – NON-SPARKING

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

The Ex n motor is built identically to a normal TEFC motor, with the following characteristics:

- Terminal box components as well as connection cables must be firmly fastened (without allowing any movement)
- Increased safety terminal block to avoid arcs and sparks, along with standardized distance between terminals

Application:
Environment where an explosive atmosphere will probably not be present under normal operating conditions and, if any, this will be for short periods 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, acetane 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.

5.5 Cast Iron Motor for Zone 21

These motors are designed to avoid that sparks, arcs or external superficial heat produced, cause the ignition of the dust (cloud or layer). WEG Zone 21 motors are standard motors with special degree of protection that not allow the ingress of dust.

The main characteristics of a Cast Iron Motor for Zone 21 are:

- Degree of protection: IP6X
- Temperature classification: Zone 21: maximum motor guarantee external surface Temperature T125°C – Temperature limitation because of the presence of dust clouds (for materials with ignition temperature above 125°C) and presence of dust layers (up to 5mm).

Application:
These motors are designed to operate in areas that can release flammable dust or in atmospheres where explosions can occur due to a mixture of air and dust. The main applications include sugar refining plants, breweries, cement works, textiles and pharmaceutical, chemical and agricultural process industries.

6 GENERAL INFORMATION

Type of Protection	Ex d	Ex de	Ex e	Ex n	Cast Iron for Zone 21
Designation	Explosion Proof	Explosion Proof with Increased Safety Terminal Box	Increased Safety	Non-sparking	DIP
Objective	Keep an internal explosion not allowing to propagate to the external environment	Explosion not allowing to propagate to the external environment, with special attention to terminal box	Ensure non occurrence of arcs, sparks or overheating under normal operationor on starting	Ensure non occurrence of arcs, sparks or overheating under normal operation	Avoid that sparks, arcs or external superficial heat produced, cause the ignition of the dust
Time t_E	Not applied	Not applied	Applied	Not applied	Not applied
Construction	Rugged frame	Rugged frame, with special characteristics on the terminal box	Similar to standard motor, with special characteristics on the terminal box	Similar to standard motor, with special characteristics on the terminal box	Similar to standard motors, with degree of protection IP 66
Output/frame ratio	Standard	Standard	Reduced	Standard	Standard

Terminal box	Explosion Proof	Explosion proof with increased safety terminal block	Increased safety terminal block	Increased safety terminal block	

7 WEG MOTORS NAMEPLATE IDENTIFICATION

- Type EEx d – Explosion Proof / Explosion Proof with Brake

CE 0102 Ex II 2 G Ex d II B T4 CESI 01 ATEX XXXX

- Type EEx de – Explosion Proof with Increased Safety Terminal Box

CE 0102 Ex II 2 G Ex de II B T4 CESI 01 ATEX XXXX

- Type EEx e – Increased Safety

CE 0102 Ex II 2 G Ex e II C T1,T2,T3 PTB 01 ATEX XXXX

- Type EEx nA – Non Sparking

CE 0102 Ex II 3 G Ex nA II T3 / CE 0102 Ex II 3 D T 125°C

- Cast Iron for Zone 21

CE 0102 Ex II 2 D tD A21 IP 6X T 125°C

Caption:
Identification code of the notified body
Group for the equipment
Category for the equipment
G - Gas / D - Dust
Type of protection against explosion
Protection by enclosure
A21 Level of protection
Group of the equipment
Gas subdivision
Class of Temperature
Certifying Entity
Year
ATEX directive
Certificate Number

For Ex nA motors, the letter A means that all motor components are non-sparking.