



PROTECTING PEOPLE >>>

FHF

■ ■ ■ STANDARDS, DIRECTIVES
& BASICS

Ex



CENELEC

ANSI/NEMA 250

DIN 33404/3

IEC

EN 60529


EN 457

FIBRES

DUST

NEC 500

EN 60849

EXPERIENCE IN  PRODUCTS SINCE 1897

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■ STANDARDS + DIRECTIVES

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EXPLOSION PROTECTION STANDARDS & DIRECTIVES

ZONE CLASSIFICATION

ACCORDING TO CENELEC UND IEC

Substances	Zones	Categories of equipment
Gases Vapours	Zone 0 Areas in which dangerous concentrations of flammable gases/vapours are present constantly or for a long period.	1G
	Zone 1 Areas in which dangerous concentrations of flammable gases/vapours are present from time to time.	2G, 1G
	Zone 2 Areas in which dangerous concentrations of flammable gases/vapours are present in rare and short instances.	3G, 2G, 1G
Dust	Zone 20 Areas in which dangerous concentrations of flammable dust are present constantly or for a long period.	1D
	Zone 21 Areas in which dangerous concentrations of flammable dust are present from time to time.	2D, 1D
	Zone 22 Areas in which dangerous concentrations of flammable dust are present in rare and short instances.	3D, 2D, 1D

In Europe, areas with explosive atmospheres are classified into zones according to the degree of danger.

The equipment is subdivided into categories according to its purpose for use in the different zones.

▶▶▶ Directive 94/9/EG ◀◀◀

The category thus indicates in which zone the respective equipment may be used.

DIVISIONS

ACCORDING TO NEC 500

Substances	Zones
Class I: Gases Vapours	Division 1 Areas in which dangerous concentrations of flammable gases/vapours are present constantly or from time to time under normal operating conditions.
	Division 2 Areas in which dangerous concentrations of flammable gases/vapours are likely not to be present under normal operating conditions.
Class II: Dust	Division 1 Areas in which dangerous concentrations of flammable dust are present constantly or from time to time under normal operating conditions.
	Division 2 Areas in which dangerous concentrations of flammable dust are likely not to be present under normal operating conditions.
Class III: Fibres Fluff	Division 1 Areas in which dangerous concentrations of flammable fibres and fluff are present constantly or from time to time under normal operating conditions.
	Division 2 Areas in which dangerous concentrations of flammable fibres and fluff are likely not to be present under normal operating conditions.

The conventional system in North America according to

▶▶▶ NEC 500 ◀◀◀

classifies the areas with explosive atmospheres into divisions.

The types of substances are subdivided into Class I, II, III.



EXPLOSION PROTECTION STANDARDS & DIRECTIVES

PROTECTION CLASSES

FOR GAS EXPLOSION PROTECTION

Protection class	Code	Description
Increased safety	e	Prevention of ignition sources through special isolation requirements, observance of distances and temperature requirements among other things. Mainly applied for connection areas, motors etc.
Flame-proof enclosure	d	Ignitable parts are encased in a housing which is designed in such a way that an explosion is prevented from penetrating into the environment in the event of ignition.
Pressurised enclosure	p	The penetration of a potentially explosive atmosphere into the equipment is prevented by flushing with inert gas, which is permanently kept slightly under pressure.
Intrinsic safety	i	The ignition of a potentially explosive atmosphere is prevented by limiting electrical tension, current, power and temperature.
Oil immersion	o	The equipment is immersed in oil preventing an explosive atmosphere from entering.
Sand filling	q	The housing of equipment is filled with a fine filling material (usually quartz sand) so that possible sparks cannot get through to the surrounding potentially explosive atmosphere.
Encapsulation	m	Parts which may ignite a potentially explosive atmosphere are embedded in sealing compound.

The protection classes define construction and circuitry measures for equipment for use in explosive areas.

The ignition of a surrounding potentially explosive atmosphere due to sparking or inadmissible heating is prevented by these measures.

SPECIAL PROTECTION CLASSES

FOR ZONE 2

Protection class	Code	Description
Non-sparking equipment	nA	Equipment does not produce sparks in normal operation (switch, relay among other things)
Protected sparking equipment	nC	Sparking or hot parts are enclosed or in hermetically-sealed housings
Fume-proof housing	nR	The housing is designed in such a way that a potentially explosive atmosphere can only penetrate to a very limited extent.
Simplified pressurised enclosure	nP/nZ	Similar to pressurised enclosure with certain simplifications Intrinsic safety in the undisturbed operating condition, not considered safety-relevant faults
Energy-limited equipment	nL	Equipment is energy-limited

The protection class type “n” for zone 2 contains several different protection types, of which some are simplifications of the above mentioned types protection.

EXPLOSION PROTECTION STANDARDS & DIRECTIVES

EQUIPMENT GROUPS

FOR EXPLOSIVE ATMOSPHERES

Group	Explanation
Equipment group I	Equipment for use <ul style="list-style-type: none"> ▶ in underground operations ▶ in mines ▶ and in their above-ground plants
Equipment group II	Equipment for use in the remaining areas.

Equipment for explosive atmospheres is classified into two groups.

EXPLOSION GROUPS

FOR THE ELECTRICAL EQUIPMENT IN EQUIPMENT GROUP II

Explosion group	Typical Gas	MESG	MIC	Equipment requirements
II A	Propane	> 0.9 mm	> 0.8	low
II B	Ethylene	0.5 to 0.9 mm	0.45 to 0.8	medium
II C	Hydrogen	< 0.5 mm	< 0.45	high

The further subdividing of the electrical equipment in equipment group II into explosion groups is dependent on the permitted gap MESG and the minimum ignition current MIC.

TEMPERATURE CLASSES

FOR ELECTRICAL EQUIPMENT IN EQUIPMENT GROUP II

Temperature classes acc. to IEC/ CENELEC/NEC 505	Temperature classes acc. to NEC 500	Maximum permissible surface temperature of the equipment in °C	Ignition temperatures of the flammable substances in °C
T1	T1	450	> 450
T2	T2	300	> 300 to 450
	T2A	280	> 280 to 300
	T2B	260	> 260 to 280
	T2C	230	> 230 to 260
	T2D	215	> 215 to 230
T3	T3	200	> 200 to 300
	T3A	180	> 180 to 200
	T3B	165	> 165 to 180
	T3C	160	> 160 to 165
T4	T4	135	> 135 to 200
	T4A	120	> 120 to 135
T5	T5	100	> 100 to 135
T6	T6	85	> 85 to 100

The ignition temperature of a flammable gas/liquid is the lowest temperature of a heated surface at which the ignition of the gas/air or vapour/air mixture occurs: The highest surface temperature of equipment must therefore always be lower than the ignition temperature of the surrounding atmosphere.

The temperature classes T1 to T6 are introduced for electrical equipment in equipment group II. The equipment is assigned to a temperature class on the basis of its maximum surface temperature. Equipment which corresponds to a higher temperature class can also be used for applications with a lower temperature class.



EXPLOSION PROTECTION STANDARDS & DIRECTIVES

EQUIPMENT GROUP II

CATEGORIES, REQUIREMENTS AND AREAS OF APPLICATION

Equipment group II	Requirement	Sufficient safety	Use in		Use in	
			Zone	Atmosphere	Zone	Atmosphere
Category 1	Very high extent of safety	even in rare occurrence equipment malfunctions	Zone 0	G (Gas)	Zone 20	D (Dust)
Category 2	High extent of safety	In case of frequent equipment malfunctions, and in case of error conditions which can usually be expected	Zone 1	G (Gas)	Zone 21	D (Dust)
Category 3	Normal extent of safety	In case of (undisturbed) normal operation	Zone 2	G (Gas)	Zone 22	D (Dust)

EXAMPLES OF MARKING

EXPLOSION-PROTECTED EQUIPMENT

II 2 G Ex d [ib] IIC T4

▶▶▶ FOR EQUIPMENT GROUP II

▶▶▶ EQUIPMENT CATEGORY 2 (ZONE 1)

▶▶▶ GAS EXPLOSION PROTECTION

▶▶▶ EQUIPMENT FOR EXPLOSIVE ATMOSPHERES

▶▶▶ PROTECTION CLASS FLAME-PROOF ENCLOSURE

▶▶▶ ASSOCIATED EQUIPMENT WITH CIRCUITS IN PROTECTION CLASS INTRINSIC SAFE (PROTECTION LEVEL ib)

▶▶▶ EXPLOSION GROUP IIC

▶▶▶ TEMPERATURE CLASS T4

EXPLOSION PROTECTION STANDARDS & DIRECTIVES

IP PROTECTION TYPES

(INGRESS PROTECTION)
ACCORDING TO EN 60529 (IEC 529)

Protection against foreign matter	IP		Protection against water
	Number 1	Number 2	
No protection	0	0	no protection
Foreign matter > 50 mm	1	1	vertically dripping water
Foreign matter > 12 mm	2	2	diagonally dripping water
Foreign matter > 2.5 mm	3	3	Spray water
Foreign matter > 1 mm	4	4	Splash water
Dust-protected	5	5	Jet water
Dust-proof	6	6	strong jet water
		7	temporary submersion
		8	prolonged submersion

The classification of housing protection in accordance with the IP system is the most used worldwide.

It meets the European and the international IEC standard.

The IP system differentiates between protection from foreign matter (number 1) and protection from water (number 2)



HOUSING PROTECTION TYPES

ACCORDING TO ANSI/NEMA 250 (USA)

Provides a Degree of Protection against the following Environmental conditions	Type of Enclosure						
	3	3R	3S	4	4X	6	6P
Incidental contact with enclosed equipment	x	x	x	x	x	x	x
Rain, snow, sleet	x	x	x	x	x	x	x
Sleet - ice covered			x				
Windblown dust	x		x	x	x	x	x
Hosedown				x	x	x	x
Corrosive agents (salt water)					x		x
Occasional temporary submersion						x	x
Occasional prolonged submersion							x

The US-American classification scheme for housing protection in accordance with NEMA is substantially different from the IP scheme used in Europe and also by the IEC.

The standard differentiates between three application classes in principle:

- ▶▶▶ Housings for indoor nonhazardous locations
- ▶▶▶ Housings for outdoor nonhazardous locations
- ▶▶▶ Housings for hazardous locations

The housing protection types for potentially explosive atmospheres (**hazardous locations - types 7, 8, 9, 10**) build on those for nonhazardous locations, through special explosion requirements (e.g. pressure test for "explosion proof enclosures") being tested in addition.

In the USA however, it has now become a largely established practice to only use the nonhazardous types, since the explosion protection must be tested and certified by an authorised testing centre anyway (e.g. FM, UL, CSA).

The most common housing types today are therefore (including for explosion-protected field devices) **Outdoor enclosure types 4, 4X, 6 und 6P** if used appropriately in combination with an explosion protection certification.



ACOUSTICS

PRINCIPLES OF ACOUSTICS

BASIC VALUES

FOR UNDERSTANDING THE BASICS OF ACOUSTICS BETTER

Lowest hearing threshold of the human ear	10 dB(A)
Absolute pain threshold	130 dB(A)
Increase for the doubling of the volume	plus 6 dB(A)
Subjective perception, doubling of the volume	10 dB(A)
Smallest perception of a rise in volume	3 dB(A)

▶▶▶ The greater the difference between the frequencies of interference noise level and those of the sound generator is, the better the alarm signal can be heard.

SPECIFIC VALUES

FOR AMBIENT NOISES

Pain threshold	> 130 dB (A)
Aeroplane, fireworks	120 dB(A)
Pneumatic hammer	110 dB(A)
Passing lorry	100 dB(A)
Car	90 dB(A)
Telephone, loud workplace	80 dB(A)
Office	60 - 70 dB(A)
Entertainment	40 - 50 dB(A)
Wall clock	30 dB(A)
Forest	20 dB(A)
Lower hearing threshold	< 10 dB(A)

RANGES OF AUDIBILITY

OF ACOUSTIC SIGNALLING DEVICES

Distance	Volume of sound generator				
	100 dB(A)	106 dB(A)	110 dB(A)	120 dB(A)	126 dB(A)
1 m	100	106	110	120	126
2 m	94	100	104	114	120
4 m (~50m²)	88	94	98	108	114
8 m (~200m²)	82	88	92	102	108
16 m (~800m²)	76	82	86	96	102
32 m (~3200m²)	70	76	80	90	96
64 m (~13000m²)	64	70	74	84	90
128 m (~51000m²)		64	68	78	84
1024 m				60	66

RULE OF THUMB:

▶▶▶ If the distance is doubled the signal decreases by approx. 6 dB(A).



ACOUSTICS

ACOUSTIC ALERTING

IMPORTANT STANDARDS FOR ACOUSTIC ALERTING

EN 457	
Min. sound level	65 dB(A)
Min. difference from the interference level	> 15 dB(A)

EN 457

The document specifies safety related, ergonomic and the appropriate testing procedures for acoustic danger signals and contains notes on the formation of the signals for clear recognition and differentiation according to the requirement in accordance with 5.3 of DIN EN 292 part 2.

It does not apply for hazard notes as part of voice communication (e.g. calls and loudspeaker announcements).

The terms acoustic danger signal, acoustic warning signal and acoustic emergency signal for evacuation, signal reception area, ambient noise and masked threshold are defined.

DIN 33 404/3	
Min. sound level	75 dB(A)
Min. difference from the interference level	> 10 dB(A)

DIN 33404/3

The course of the danger signal is specified in DIN 33404, part 3. It must be possible to emit acoustic danger signals for at least 30 sec., but they may be interrupted during this time for voice announcements in accordance with section 3.2 by the respective safety activation point (e.g. fire-brigade intercom station). Particularly in the standard DIN/EN 457 (replacement for DIN 33404 part 1), important statements are made about the perceptibility i.e. audibility, distinctness and clarity of the danger signal.

The sound level of the acoustic danger signal emitted must reach at least 75 dBA, measured in the time weighting "Slow". Moreover, it depends on the volume of the environment (interference signal) in each case and must be at least 10 dB above this. If necessary, an automatic regulation is recommended in order to adhere to this value. In the case of ambient noise levels over 110 dB, optical danger signals (e.g. yellow flashing light – in accordance with DIN/EN 842 (replacement for DIN 33 404 part 2) are to be used in addition to support the acoustic emergency signal.

EN 60849	
Min. sound level	65 dB(A)
Min. difference from the interference level	6 to 20 dB(A)

EN 60849

The document applies to sound reinforcement and sound distribution systems which are used in emergency situations in order to get persons in an area and/or outside a building to vacate this area quickly and in an orderly manner.



OPTICS

OPTICAL ALERTING

AREAS OF APPLICATION

OF OPTICAL SIGNALLING DEVICES

The use of optical signalling devices can be for the most varied of reasons.

- >>> Indication of a dangerous situation
- >>> Occurrence of a predefined condition
- >>> Reinforcement of an acoustic signal in a loud environment

COLOUR DEFINITION

OF OPTICAL SIGNALLING DEVICES ACCORDING TO IEC 73

Colour	Explanation	
Red	Danger	Mortal danger, act immediately
Yellow	Warning	Work carefully
Green	Safety	Everything OK
Blue	System-dependant	No classification
Clear	Free	

EFFECTS

OF LENS CAP COLOUR ON THE BRIGHTNESS OF THE SIGNAL

RULE OF THUMB:

Origin	Colour					
	Clear	Yellow	Orange	Red	Blue	Green
Flash light	100 %	93 %	70 %	23 %	24 %	25 %
Lamp	100 %	95 %	70 %	30 %	17 %	12 %

▶▶▶ If the distance to the signal is doubled, luminosity is reduced by 75%

APPROXIMATE VALUES

FOR THE PERCEPTION OF OPTICAL SIGNAL GENERATORS (FLASHLIGHTS)

RULE OF THUMB:

Execution	Radius of direct and indirect perception	Radius only of direct visual contact to light
2.5 joule	1.5 m	5 m
5 joule	2.5 m	10 m
10 joule	5.0 m	20 m
15 joule	7.5 m	30 m

▶▶▶ Due to the complexity of observing optical signalling, it is recommended to examine the alerting effectiveness onsite with representative persons. This should always be a “worst case” observation.

EXAMPLES FROM THE FHF PROGRAM

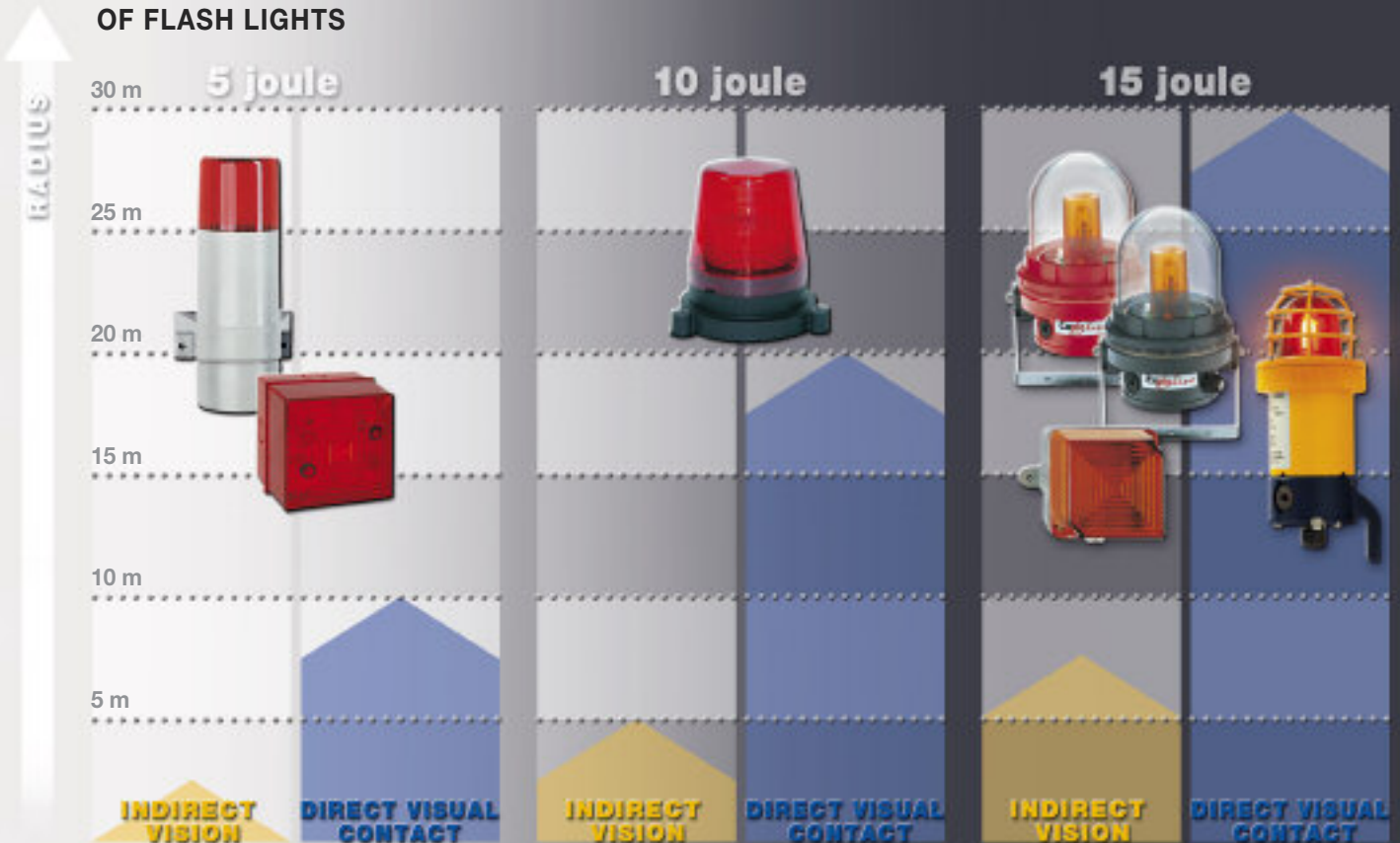
VOLUME

OF ACOUSTIC SIGNALLING DEVICES



VISIBILITY

OF FLASH LIGHTS





PROTECTING PEOPLE >>>



- ▶▶▶ THIS HANDOUT IS INTENDED TO PROVIDE SOME INFORMATION AND GIVE AN OUTLINE OF THE CONTENTS OF THE STANDARDS AND REGULATIONS IN THE RELEVANT AREAS.
- ▶▶▶ FOR THIS PURPOSE, THE HANDOUT SHOWS THE FUNDAMENTAL CONTENTS OF THE RELEVANT STANDARDS AND DIRECTIVES.
- ▶▶▶ NO CLAIM OF COMPLETENESS IS MADE. THE CONTENT IS SUBJECT TO A DIFFERENT INTERPRETATION BY THE COURTS AND LAW ENFORCEMENT AGENCIES AND IS NOT LEGALLY BINDING. THE LEGAL STANDARDS AND REGULATIONS ARE TO BE CONSIDERED IN EACH CASE.

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