



Explosion proof

2011. 09. 09





Agenda

- **Define of Explosion Proof**
 - **Zone classified**
 - **Protection Method**
- **ATEX and IECex & NEMA**
 - **To be a inspector**

방폭의 의미 및 목적

- 방폭이란?
 - 폭발 방지의 줄임말.
 - 기본 개념 / 가연성 물질은 적당한 농도에서 점화원을 만나면 폭발하게 되는데, 이중 전기기기 및 전기 설비가 점화원이 되지 못하도록 하는 것

방폭의 의미 및 목적

- Primary explosion protection
 - Preventing the existence of hazardous area
(위험 지역의 존재 예방)
 - ex) 공기 제거, 발화제 교체 및 밀도 조정.
- Secondary explosion protection
 - Preventing an explosion in a hazardous area.
(위험 지역에서의 폭발 예방)
 - ex) 폭발 가능한 지역에서 발화를 피한다.

ATEX Directive



Directive 1999/92/EC, ATEX 137 (user)

- **Obligation of the employer**
- **Directive made for health reasons and safety of the employee**



Directive is applicable 1 July 2006.



Directive 94/9/EC, ATEX 95 (manufacturer)

- **For the manufacturer**
- **Specially to eliminate the barriers for trade on import and export**

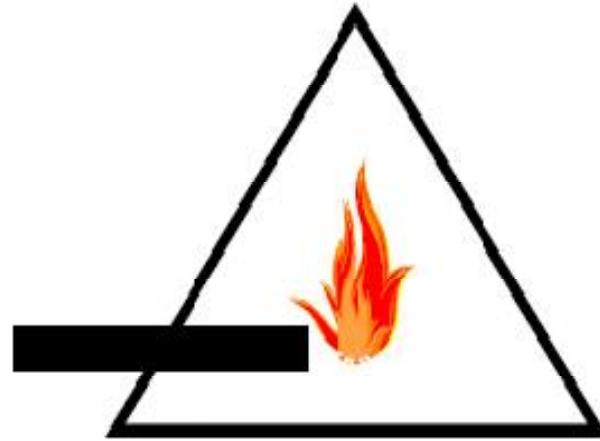


Directive is applicable 1 July 2003.

폭발의 3요소

Oxygen (산 소)

- air
- H_2O_2



Ignition source (발화원)

- sparks
- hot surfaces
- hot gases

Flammable material(발화제)

- gas
- dust
- vapor

폭발성 Gas 의 분류 - IEC - Gap

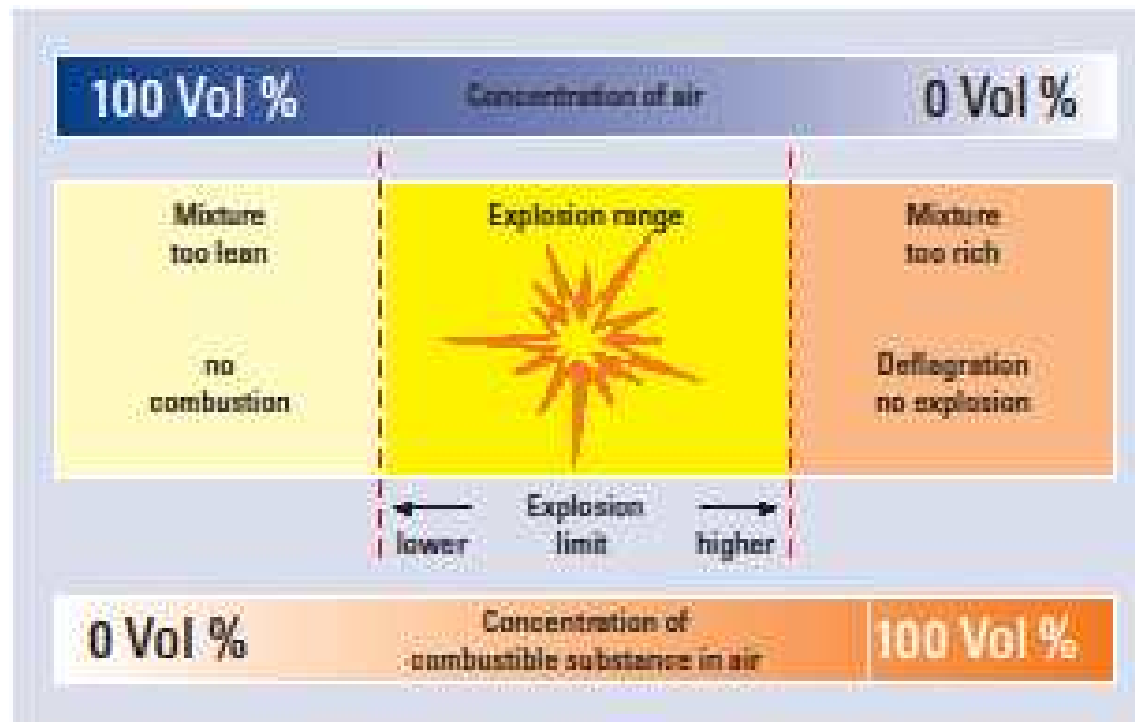
- MESG(Maximum Experimental Safe Gap) 에 의한 Gas 등급
 - II A : 0.9 mm 이상
 - II B : 0.5~0.9 mm
 - II C : 0.5 mm 미만

< 가스별 MESG >

| 인화물질 | 공기와 혼합율 Vol. % | MESG | MESG 의 오차한계 | 폭발등급 (유럽규정의거) |
|-----------------------|-------------------|------|----------------|------------------|
| Methane | 8.2 | 1.14 | 0.11 | I (광산용) |
| Propane | 4.2 | 0.92 | 0.03 | IIA |
| Cyclo hexanol | 3.0 | 0.95 | 0.03 | IIA |
| Methanol | 11.0 | 0.92 | 0.03 | IIA |
| Ethylene | 6.5 | 0.65 | 0.02 | IIB |
| Acetylene | 8.5 | 0.37 | 0.01 | IIC |
| 수소가스(H ₂) | 27.0 | 0.29 | 0.01 | IIC |

공기의 혼합율과 폭발관계(LEL~UEL) Lower Explosive Limit, Upper Explosive Limit

- Acetylene : 1.5% ~ 100% IIC
- Hydrogen : 4.0% ~ 75% IIC
- Propane : 2.0% ~ 9.5% IIA
- Ethylene : 2.7% ~ 34% IIB



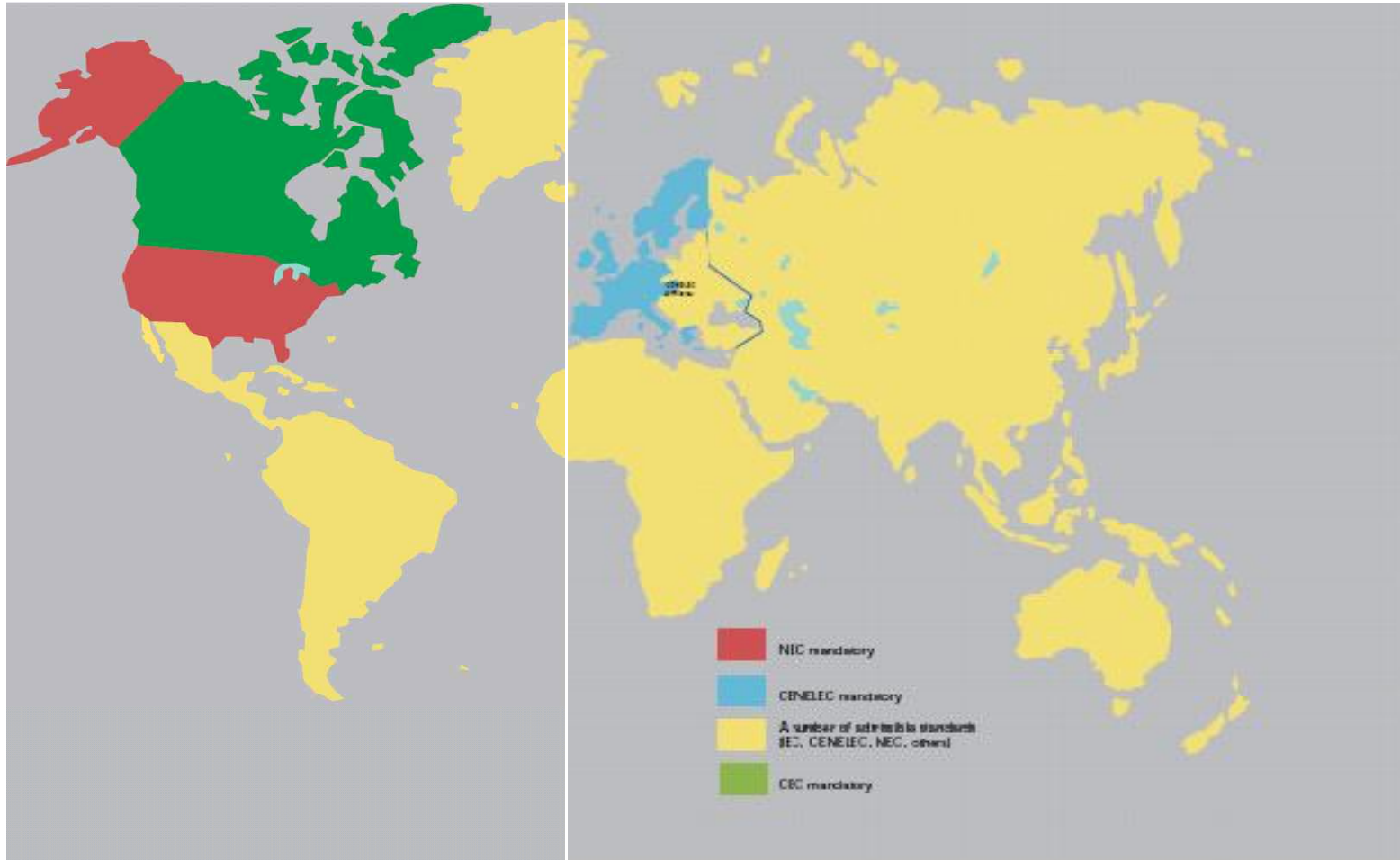
폭발성 Gas 의 분류 – IEC - Energy

- Acetylene : μJ 19 IIC
- Hydrogen : μJ 85 IIB
- Propane : μJ 260 IIA
- Ethylene : μJ 19 IIC

폭발성 Gas 의 분류 – IEC - Current

- Ignition Energy에 의한 Gas 등급
 - Acell A : Current > 0.8 (Ratio Methane (1) MIC)
 - II B : 0.45~0.8
 - II C : < 0.45

대륙별 사용 code






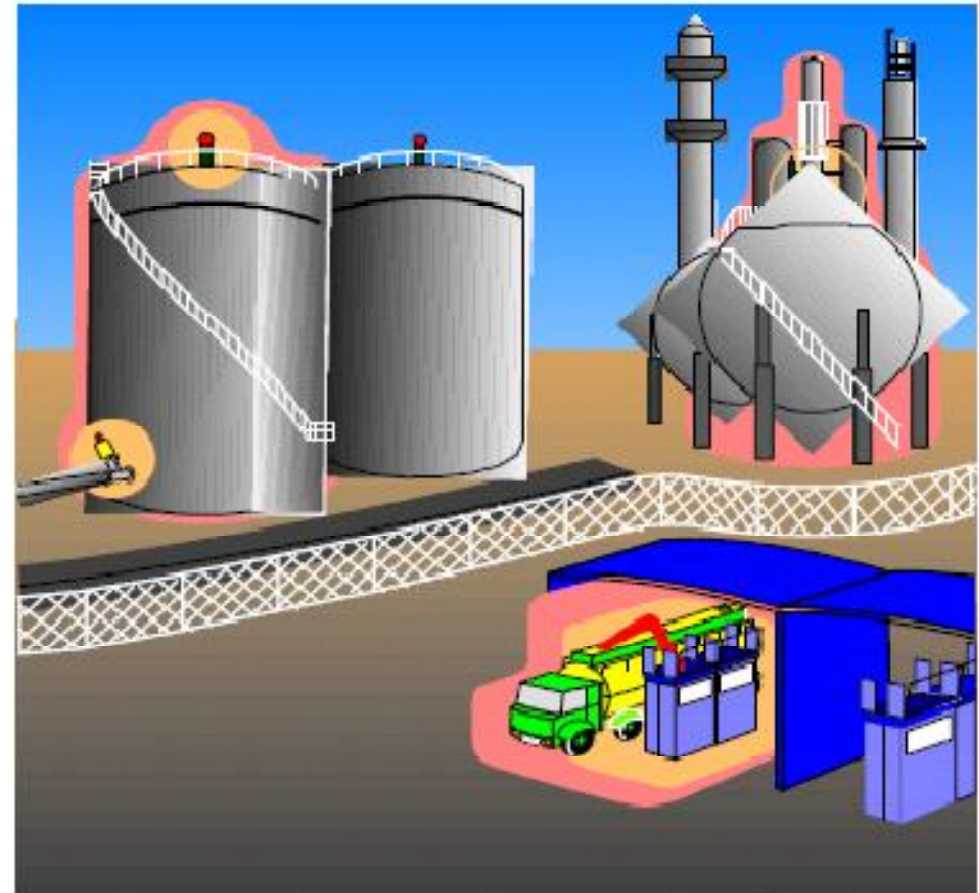
국제 방폭 기준 -IEC

- Group I – Mine (Methane gas)
 - category M1
 - category M2
- Group II – Mine 이외의 지역 (Gas & Dust)
 - category 1G/1D → Zone 0,20
 - category 2G/2D → Zone 1,21
 - category 3G/3D → Zone 2,22

국제 방폭 기준 -IEC

Three categories for hazardous areas:

-  Zone 0 : Continuously present (during long periods) 1000 hours/year
-  Zone 1 : Not likely to be present (regular services) > 10 – 1000 hours/year
-  Zone 2 : Accidentally present (short-time-service-never in regular service) < 10 hours/year



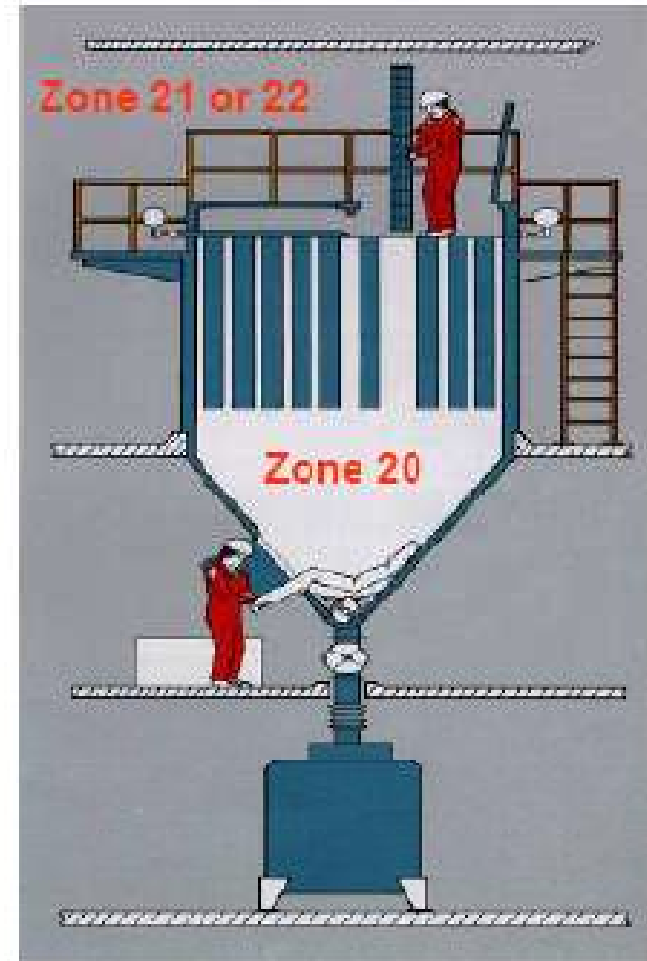
국제 방폭 기준 -IEC

Three categories for hazardous areas:

Zone 20 : Continuously present (during long periods), > 1000 hours/year

Zone 21 : Not likely to be present (regular services) > 10 – 1000 hours/year

Zone 22 : Accidentally present (short-time-service- never in regular service) < 10 hours/year



국제 방폭 기준 – NEC(2002)

- Class I (Gas)
 - Division 1
 - Division 2 } Group A,B,C,D
- Class II (Dust)
 - Division 1
 - Division 2 } Group E,F,G
- Class III (Fiber)

국제 방폭 기준 – IEC vs NEC

| | Europe Cenelec & IEC | North America |
|---|-------------------------|------------------|
| Explosive gas/Air mixture present continuously or for long period. | ZONE 0 | Division 1 |
| Explosive gas/Air mixture are likely to occur during normal operation. | ZONE 1 | |
| Explosive gas/Air mixture are likely to occur. If it does then it will exist only for a short time. | ZONE 2 | Division 2 |

ZONE 0 : 폭발가스가 존재 하거나 장시간 정체되는 지역 (1년에 1000시간 이상)

ZONE 1 : 정상 작동시 폭발가스가 존재하는 지역 (1년에 10~1000시간)

ZONE 2 : 정상적인 사용시 폭발 가능성이 없으나, 단지 이상 상태에서 극히 짧은 시간 동안 폭발가스가 존재하는 지역 (1년에 10시간 이내)

국제 방폭 기준 – IEC vs NEC

| | Europe Cenelec & IEC | North America |
|---|-------------------------|------------------|
| Combustible dust cloud present continuously or for long period. | ZONE 20 | Division 1 |
| Combustible dust cloud is likely to occur during normal operation. | ZONE 21 | |
| Combustible dust cloud is likely to occur. If it does then it will exist only for a short time. | ZONE 22 | Division 2 |

ZONE 20 : 가연성 먼지가 존재 하거나 장시간 정체되는 지역 (1년에 1000시간 이상)

ZONE 21 : 정상 작동시 가연성 먼지가 존재하는 지역 (1년에 10~1000시간)

ZONE 22 : 정상적인 사용시 폭발 가능성이 없으나, 단지 이상 상태하에서 극히 짧은 시간 동안 가연성 먼지가 존재하는 지역 (1년에 10시간 이내)

Gas Group

| Gas Group | Gas 종류 |
|-----------|--|
| IIA | Acetone, Ammonia, Amyl acetate, Aniline, Benzene, n-Butanol, n-Butyl acetate, Carbon monoxide, Cumene, Cyclohexane, Cyclohexanol, Cyclohexanone, p-Cymene, o-Dichlorobenzene, 1,2-Dichloroethylene, Diethylamine, Diethylaminoethanol, Dimethylamine, Ethane, Ethanol, Ethyl Acrylate, Ethyl Formate, n-Heptane, n-Hexane, Hexanol, Kerosene, Methane, Methanol, Methyl Methacrylate, Methylamine, Monoethanolamine, Naphtha, Nitroethane, Nitromethane, n-Nonane, Nonyl Alcohol, n-Octyl Alcohol, 1-Pentanol, Propane, 1-Propanol, Pyridine, Styrene, Toluene, Triethylamine, Vinyl Acetate, Xylene |
| IIB | Acrolein, Acrylonitrile, 1,3-Butadiene, Crotonaldehyde, Cyclopropane, Diethyl ether, 1,4-Dioxane, Ethylene, Ethylene oxide, Hydrogen Cyanide, Methyl Acetate, Tetrahydrofuran, Town gas, Coke-oven gas |
| IIC | Acetylene, Carbon Disulfide, Hydrogen |

폭발성 Gas 의 분류 - NEC

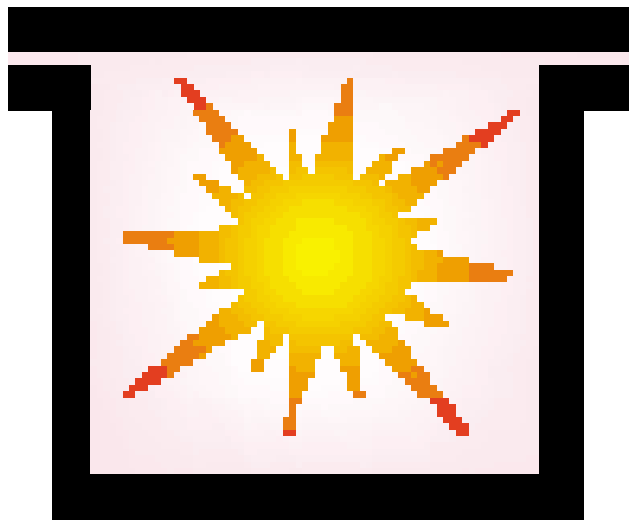
| Gas Group | 대상 가스 분류기 |
|-----------|---|
| Group D | Acetone, Alcohol Ammonia, Benzene, Gasoline, Solvent, Butane, Heptane |
| Group C | Ethylene, Cyclopropane, Ethyl Ether, Acetaldehyde, Isoprene |
| Group B | Butadiene, Ethylene Oxide, Propylene Oxide, Acrolein, H ₂ , 30% 이상의 수소를 포함한 제조가스 |
| Group A | Acetylene |

Temperature

| Maximum Surface Temperature | IEC/Europe | North America | Examples (EU) |
|-----------------------------|------------|---------------|---|
| 450 | T1 | T1 | Acetone, Ammonia, Benzole Methanol, Propane, Hydrogen, Natural Gas (City Gas) |
| 300 | T2 | T2 | Ethyl-alcohol, Ethylene, Acetylene, N-butane |
| 280 | | T2A | |
| 260 | | T2B | |
| 230 | | T2C | |
| 215 | | T2D | |
| 200 | T3 | T3 | Gasoline, Diesel, Fuel, Heating oil, Hydrogen, Sulphide |
| 180 | | T3A | |
| 165 | | T3B | |
| 160 | | T3C | |
| 135 | T4 | T4 | Acetaldehyde, ether, diethyl ether |
| 120 | | T4A | |
| 100 | T5 | T5 | |
| 85 | T6 | T6 | Carbon disulphide |

방폭 구조

- 내압 방폭 “d” (Flameproof enclosure)

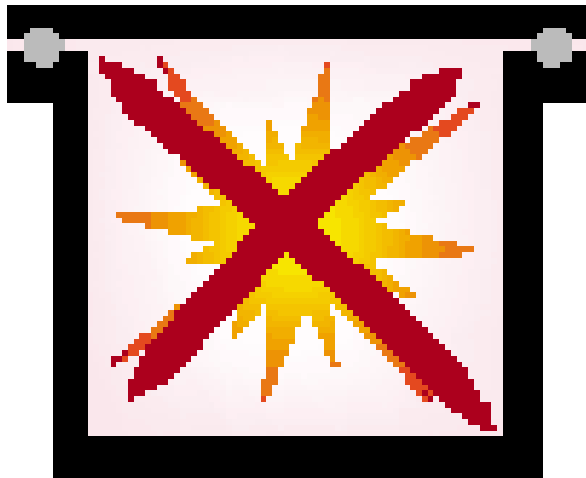


점화원이 될 우려가 있는 부분 즉 불꽃 아아크 또는 과열이 생길 우려가 있는 부분을 밀폐구조인 용기에 넣어 만일 외부의 폭발성 가스가 내부로 침입해서 폭발을 하였을 때 용기가 그 압력에 견디어 파손되지 않고 폭발한 고열가스가 용기의 접합부 틈으로 부터 외부로 유출되는 일이 있어도 그 동안에 냉각되어 외부의 폭발성 가스에 점화가 파급될 우려가 없도록 하는 구조.

1. Spark and arcs in Normal condition
2. 6 threads provided

방폭 구조

- 안전증 방폭 “e” (Increased Safety)

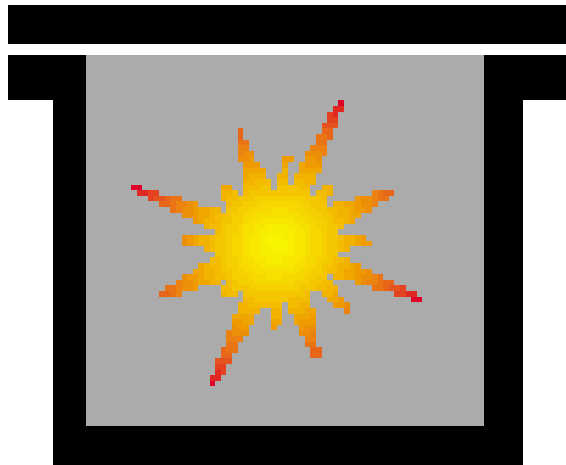


정상적인 운동중 불꽃 또는 과열이 생겨선 안될 부분에 이러한 것들의 발생을 방지 하기 위해 구조와 온도 상승에 대해 특히 안전도를 증가시킨 구조

1. Reducing Current
2. Enhanced Insulation
3. Creepage and Clearance
4. No spark & arcs in Normal Condition
5. Max. 11 Kv Concept
6. Do not self loosening conductor connection
7. Keep stability up to at least 20K for Insulation material
8. Enclosure min. IP54. IP66 & 67 has drainage
9. Cable entry min. IP54 Plastic cable gland EC certified

방폭 구조

- 몰딩 “m” (Encapsulation)

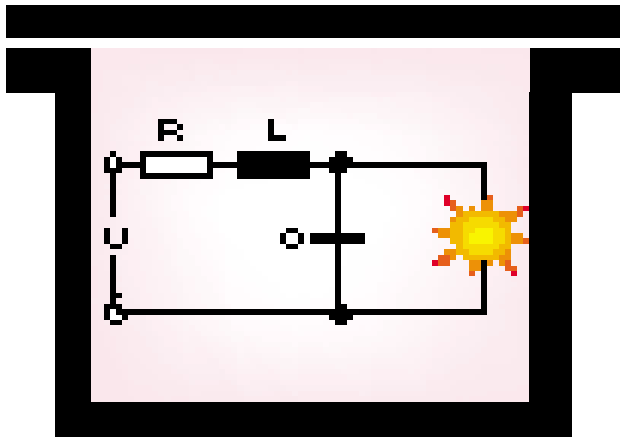


전기 기기나 부품을 주위 환경의 영향에 충분히 견디는 수지로 몰딩시켜 그 수지 내부에서 발생하는 스파크나 열에 의해 점화가 일어나지 않도록 만든 구조

1. EEx ma : Zone 0,1,2
2. EEx mb : Zone 1,2

방폭 구조

- 본질 안전 “i” (Intrinsically Safety)

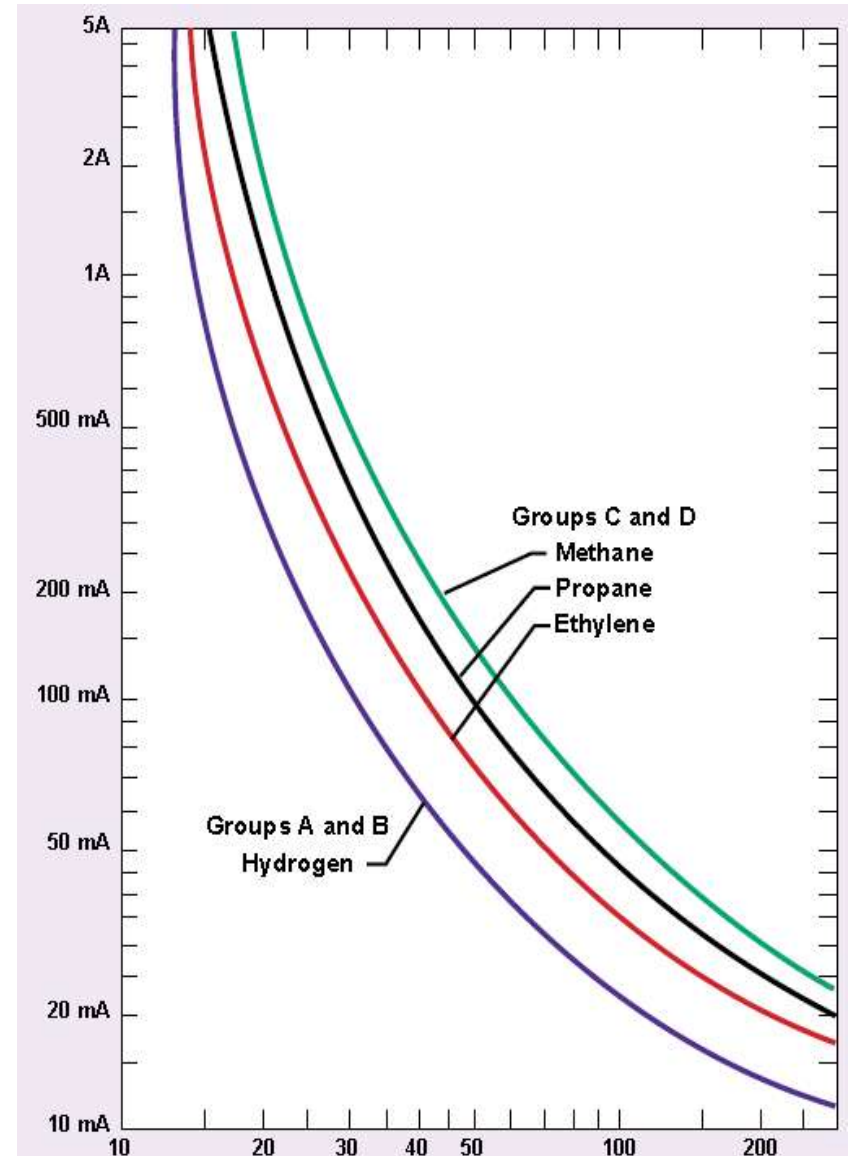


잠재적인 폭발 환경에서의 점화를 야기시키는 정상 또는 비정상 상태에서 전기적 에너지나 열적효과를 제한하도록 한 구조

1. Low voltage & Current
2. Nominal volt : 24VDC
3. Current : less than 100mA

방폭 구조

- 본질 안전 “i” (Intrinsically)
 1. Simple device(Not exceed 1.2volts, 0.1amps, 25mW or 20 μ J) : No need approval : Switch, LED, thermocouples
 2. Complex device : Need approval by 3th party : Transmitters, Solenoid valve – Store energy
 3. Barrier : Limit current by resistor, Limit voltage with zener diode
 4. Keep energy level below ignition curves when fault condition
 5. 1 Resistor + 2 Zener diode + 1 fuse (protect burning Zener diode)
 6. Keep below 30V combination 150mA (Can reach Hydrogen gas)
 7. Light Blue Coding for Terminal Blocks

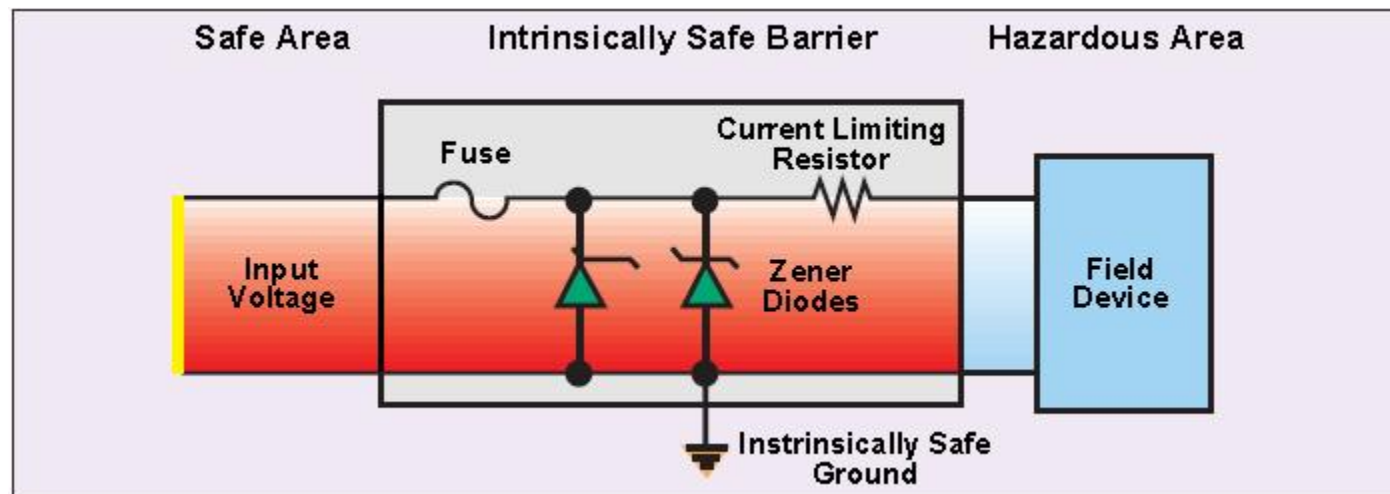


방폭 구조

- Intrinsically Safety - Barrier

| Associated Apparatus (barrier) | | Apparatus (field device) |
|--------------------------------|--------|--------------------------|
| Open circuit voltage V_{oc} | \leq | V_{max} |
| Short circuit current I_{sc} | \leq | I_{max} |
| Allowed capacitance C_a | \geq | C_i |
| Allowed inductance L_a | \geq | L_i |

1. Zener Barrier : Passive device – Grounding
2. Isolation Barrier : No need grounding : additional electronics – Has function switching Temp. measurement or 4~20mA reading
3. Remote I/O : Combining Intrinsically safe barrier + I/O – Reducing cost and cable loss – Can use Bus system



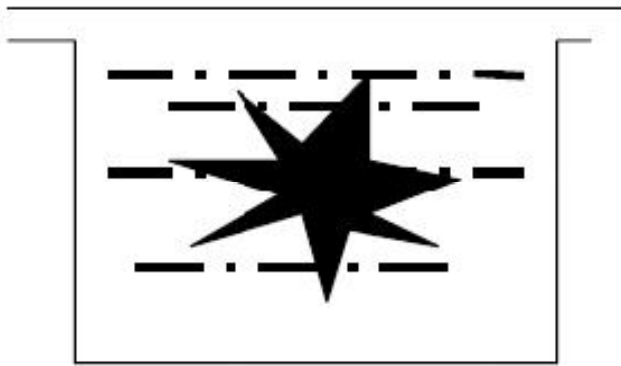
방폭 구조

- Intrinsically Safety – NAMUR (German-DIN19234, EN60947-5-6)
 1. Proximity switch with Amplifier
 2. 2 wire system, 8.2V
 3. Operating proximity switch 1.2mA ~ 2.1mA (Normally 1.55mA)
 4. Amplifier provide 8.2V and 8mA Loop power

| Switch Amplifiers | |
|---|--|
| Advantages <ul style="list-style-type: none">Simple applicationNo ground requiredNo internal resistanceLEDs to indicate power and monitor operationsSensitive to detect closed contacts in corrosive areas | Disadvantages <ul style="list-style-type: none">Needs power supplyLarger in size |

방폭 구조

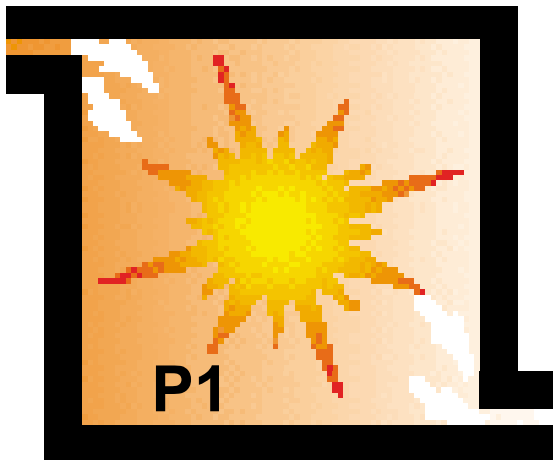
- 유입방폭 “o” (Immersion)



스위치 기어나 트랜스포머에 사용되는 기술로 위험의 원인이 될 수 있는 장비를 무기질의 Oil에 잠기게 함으로써 폭발 가능한 환경을 제거하도록 한 구조.

방폭 구조

- 압력방폭 “P” (Pressurised Enclosure)



점화의 원인이 될 우려가 있는 부분을 용기내에 넣고 보호기체를 용기 내부에 주입하여 내부의 압력을 유지하여 폭발성 가스가 침입하지 않도록 한 구조.

P2

$P1 > P2$ 이면 외부의 폭발성 가스가 침입할 수 없다.

방폭 구조 (*Zone 2 apparatus*)

- 비점화 방폭 “n” (Non-sparking enclosure)
- No need certified by 3th party
- nC : Hermetically sealed, Enclosed-Break, Non-incentive device

Free internal volume $\leq 20 \text{ cm}^3$

The encapsulation must permit a permanent temperature of $\geq 10 \text{ K}$ compared to the maximum operating temperature

The combination of the parts is tightly sealed or

The design of the contacts will extinguish any incipient flame

Limited to AC 254 V and 16 A.

L and C are part of the test.



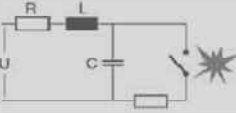
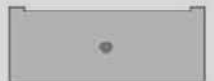
Explosion hazard subgroups II A, II B and II C are to be treated differently

- nL(Energy Limited) : Similar to intrinsic safety
- nR(Restricted-breathing enclosure) : Keep 3mbar & IP54 min. Inside of enclosure not exceed outside Temp. over 10K
- nP(Simplified pressurization)









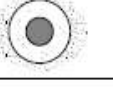




참고 사항

- 일반적으로 현장에서는 내압방폭 “d” 와 본질 안전 방폭 “I” 를 사용.
- 본질 안전 방폭의 이점.
 - 최소 비용.(SOV 자체는 비싸지만 plant 전체적으로는 저렴해 진다.)
 - 전원 “ON” 상태에서도 보수가 가능하다.
 - 낮은 전압과 전류값으로 인해 작업자가 안전하다.

방폭 구조 별 Cover range

| Protection symbol | Zones | | | Description | Drawing |
|-------------------|-------|---|---|---|---|
| | 0 | 1 | 2 | | |
| "d" | | ● | ● | Type of protection in which the parts which can ignite an explosive atmosphere are placed in an enclosure which can withstand the pressure developed during an internal explosion of an explosive mixture and which prevents the transmission of the explosion to the explosive atmospheres surrounding the enclosure. |  |
| "e" | | ● | ● | Type of protection in which measures are applied so as to prevent with a higher degree of safety the possibility of excessive temperatures and of the occurrence of arcs or sparks in the interior and on the external parts of electrical apparatus, which does not produce them in normal service. |  |
| "i" | "ia" | ● | ● | Type of protection when no spark or any thermal effect in the circuit, produced in the test conditions prescribed in the standard (which include normal operation and specific fault conditions), is capable of causing ignition. |  |
| | "ib" | | ● | | |
| "m" | | ● | ● | Type of protection in which the parts which can ignite an explosive atmosphere are enclosed in a resin sufficiently resistant to the environmental influences in such a way that this explosive atmosphere cannot be ignited by either sparking or heating which may occur within the encapsulation. |  |
| "n" | | | ● | Method of protection for electrical equipment designed so that it will not ignite the surrounding explosive atmosphere in normal operation and under certain fault conditions specified in the standard. There are 5 categories of equipment: nA (non-sparking), nC (hermetically sealed), nR (restricted breathing), nL (limited energy) and nP (simplified pressurisation). | |
| "o" | | ● | ● | Type of protection in which the electrical apparatus is immersed in oil. | |
| "p" | | ● | ● | Type of protection in which the protective inert gas inside the enclosure is maintained at a higher pressure than that of the surrounding atmosphere. | |
| "q" | | ● | ● | Type of protection in which the enclosure is filled with a material in a finely granulated state. | |

PROTECTION - IP code

| 1st NUMERAL | | Test | 2nd NUMERAL | | Test |
|-------------|--|--|-------------|---|---|
| | Abridged definition | | | Abridged definition | |
| 0 | Non-protected | | 0 | Non-protected | |
| 1 | Protected against solid foreign objects Ø 50 mm (eg accidental contact with the hand) |  | 1 | Protected against vertically falling water drops (condensation) |  |
| 2 | Protected against solid foreign objects Ø 12,5 mm (eg finger) |  | 2 | Protected against vertically falling water drops when enclosure tilted up to 15° |  |
| 3 | Protected against solid foreign objects Ø 2,5 mm (eg tools, wires) |  | 3 | Protected against spraying water up to 60° on either side of the vertical |  |
| 4 | Protected against solid bodies Ø 1 mm (eg fine tools and small wires) |  | 4 | Protected against splashing water from any direction |  |
| 5 | Dust-protected (no harmful deposit) |  | 5 | Protected against water jets from any direction |  |
| 6 | Dust-tight |  | 6 | Protected against powerful water jets from any direction |  |
| | | | 7 | Protected against the effects of temporary immersion in water |  |

The degree of protection of each product is indicated in its appropriate leaflet, usually IP 65.

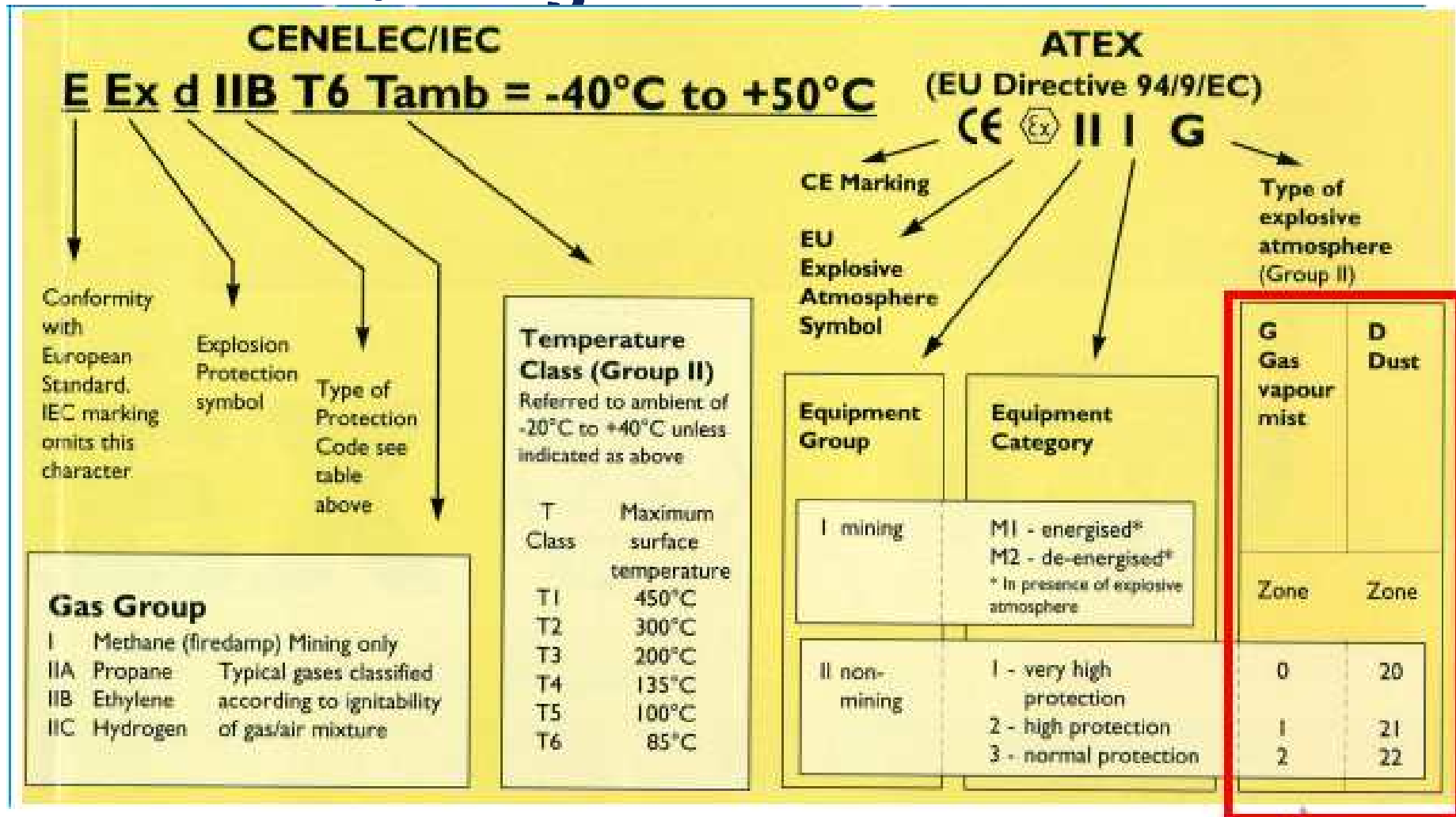
PROTECTION - NEMA standrd

| NEMA TYPE | ENCLOSURE TYPE |
|-----------|--|
| Type 1 | <u>General Purpose</u> - For indoor use where oil, dust or water is not a problem. Primarily intended to prevent accidental contact by personnel with the enclosed equipment. |
| Type 2 | <u>Drip-proof/Drip-Tight</u> - Similar to Type 1 with drip shields added to protect the enclosed equipment against falling noncorrosive liquids and dirt. |
| Type 3 | <u>Dust-Tight, Raintight, and Sleet-/Ice-Resistant</u> - For outdoor use protects against windblown dust and water no dust - and snowproof. Has provisions for watertight connection in conduit entrance and provisions for locking. |
| Type 3R | <u>Rain-Resistant and Sleet-Ice-/Resistant</u> - For outdoor use. Protects against rain, prevents entrance of rain at a level higher than lowest live part. Not dust-, snow-, or sleet-/ice-proof. Has provisions for drainage and locking. |
| Type 3S | <u>Dust-Tight, Raintight and Sleet-/Ice-proof</u> - For outdoor use. Protects against windblown dust and water, permits operation when enclosure is covered by external ice, does not protect equipment from internal icing. Has provisions for locking and watertight connections at conduit entrance. |
| Type 4 | <u>Watertight and Dust-Tight</u> - For indoor and outdoor use. Protects against water splash, water seepage, water from hoses, and severe external condensation. In sleet-resistant but not sleet-proof. |
| Type 4X | <u>Watertight, Dust-Tight, and Corrosion-Resistant</u> - Has same provisions as Type 4 enclosures ; in addition, is corrosion-resistant. |
| Type 5 | Type 5 enclosures are deleted ; superseded by Type 12 for control apparatus. |
| Type 6 | <u>Submersible, Watertight, Dust-Tight, and Sleet-/Ice-Resistant</u> - For indoor and outdoor use where occasional submersion is encountered. Protects against static head of 6 feet of water for 30 minutes, dust, splashing or external condensation of noncorrosive liquids, water, lint, and seepage. |
| Type 7 | <u>Hazardous Areas (Groups A-B-C-D)</u> - For indoor Class I locations containing hazardous gases or vapor ; air-break contacts. |
| Type 8 | <u>Hazardous Areas (Groups A-B-C-D)</u> - For indoor Class I location containing hazardous gases or vapor ; oil-immersed contacts. |
| Type 9 | <u>Hazardous Areas (Group E-F-G)</u> - For Class II locations containing hazardous dusts. Prevents entrance of explosive amounts of hazardous dust. |
| Type 10 | <u>Bureau of Mines</u> - Designed to meet requirements of U.S. Bureau of Mines ; suitable for application in coal mines. |
| Type 11 | <u>Corrosion-Resistant and Drip-proof</u> - For indoor use. Protects against dripping, seepage, external condensation of corrosive liquids, and corrosive effects of fumes and gases by providing for immersion of equipment in oil. |
| Type 12 | <u>Industrial - Dust-Tight and Drip-Tight</u> - For indoor use. Protects against fibers, lint, dust, and dirt and light splashing, dripping, and external condensation of noncorrosive liquids. Has no holes, conduit knockouts, or openings, except when provision is made for oil-tight or dust-tight mechanisms with oil-resistant gaskets. (Type-13) |


NEMA standard vs IP code

| NEMA standard | Enclosure Classification Designation |
|----------------------|---|
| 1 | IP10 |
| 2 | IP11 |
| 3 | IP54 |
| 3R | IP14 |
| 3S | IP54 |
| 4 and 4X | IP65 |
| 5 | IP52 |
| 6 | IP67 |

ATEX Marking



Example

| T. amb./T cable °C | | T | T °C | YEAR | SOL. TYPE | |
|---|-----|---|------|-------------|-----------|--|
| -20/+25 | | 6 | 85 | 2002 | NK | |
| -20/+40 | | 5 | 100 | VOLTS Hz | | |
| -20/+60 | 100 | 4 | 135 | 24 | DC | |
| MEDIUM | | | bar | ORF. | WATTS | |
| AIR | | | 10 | 2.7 | 11.2 | |
| TS MEDIUM=T amb | | | | PIPE | | |
| | | | | G1/4 | | |
| CATALOGUE N° | | | | | T.P.L | |
| NK E370A017A1 | | | | | | |
| DO NOT OPEN WHEN ENERGIZED | | | | SERIAL No. | | |
| DELAY OPENING FOR 35 MINUTES | | | | 1304963/001 | | |
|  SCHERPENZEEL - THE NETHERLANDS | | | | | | |



LCIE 00ATEX 6050X
II2G/D EEx d IIB H2 IP65

0081



Inspection

| Apparatus | EEx d | EEx e | EEx N |
|--|--------------|--------------|--------------|
| Appropriate Area Classification | X | X | X |
| Gas Group | X | X | X |
| Temp. Class | X | X | X |
| Enclosure gaskets | | X | X |
| Electrical Connection tightness | | X | X |
| Electrical insulation clean & dry | | X | X |
| Enclosed break hermetically sealed undamaged | | | X |
| Breathing enclosure | | | X |

Certification code

CSA certification code

- Class I, Group A,B,C and D;
Class II, Group E, F and G
Class III
Type 3, 3S, 4, 4X, 6 or 6P

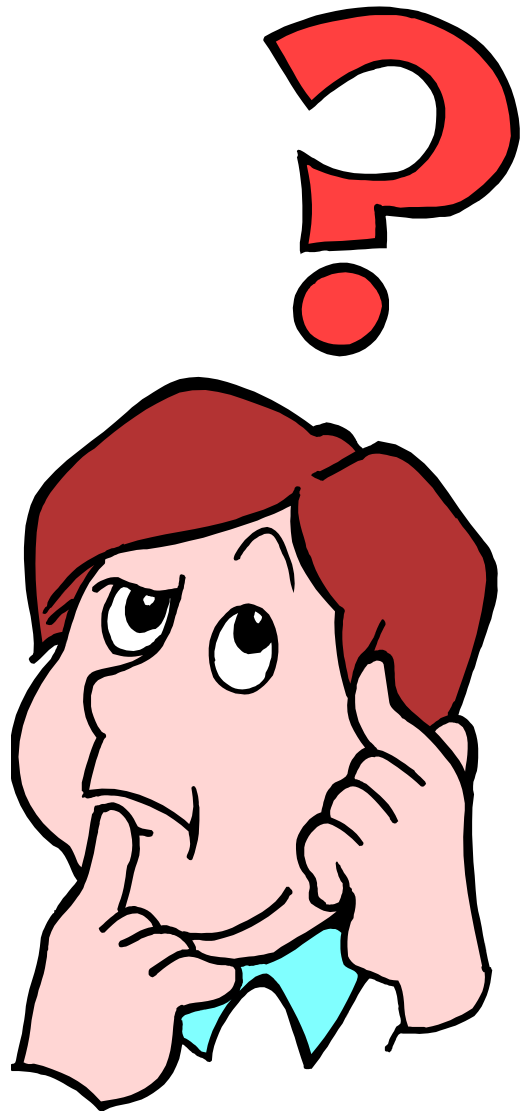
ATEX certification code

- Ex d II C T6 IP65



II 2 G/D

EEx d IIB + H₂ T6 to T4



QUESTIONS ?