Explosion Protection with a focus on Purge + Pressurization

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Overview

1. Effect of Explosions
2. Prerequisites of an Explosion
3. Determination of Explosion Hazardous Areas
4. Basic Principles of the Types of Protection (Electrical)
5. Equipment Protection Level
6. Ex i vs Ex d vs Ex p
7. Purge & Pressurization

Effects of Explosions

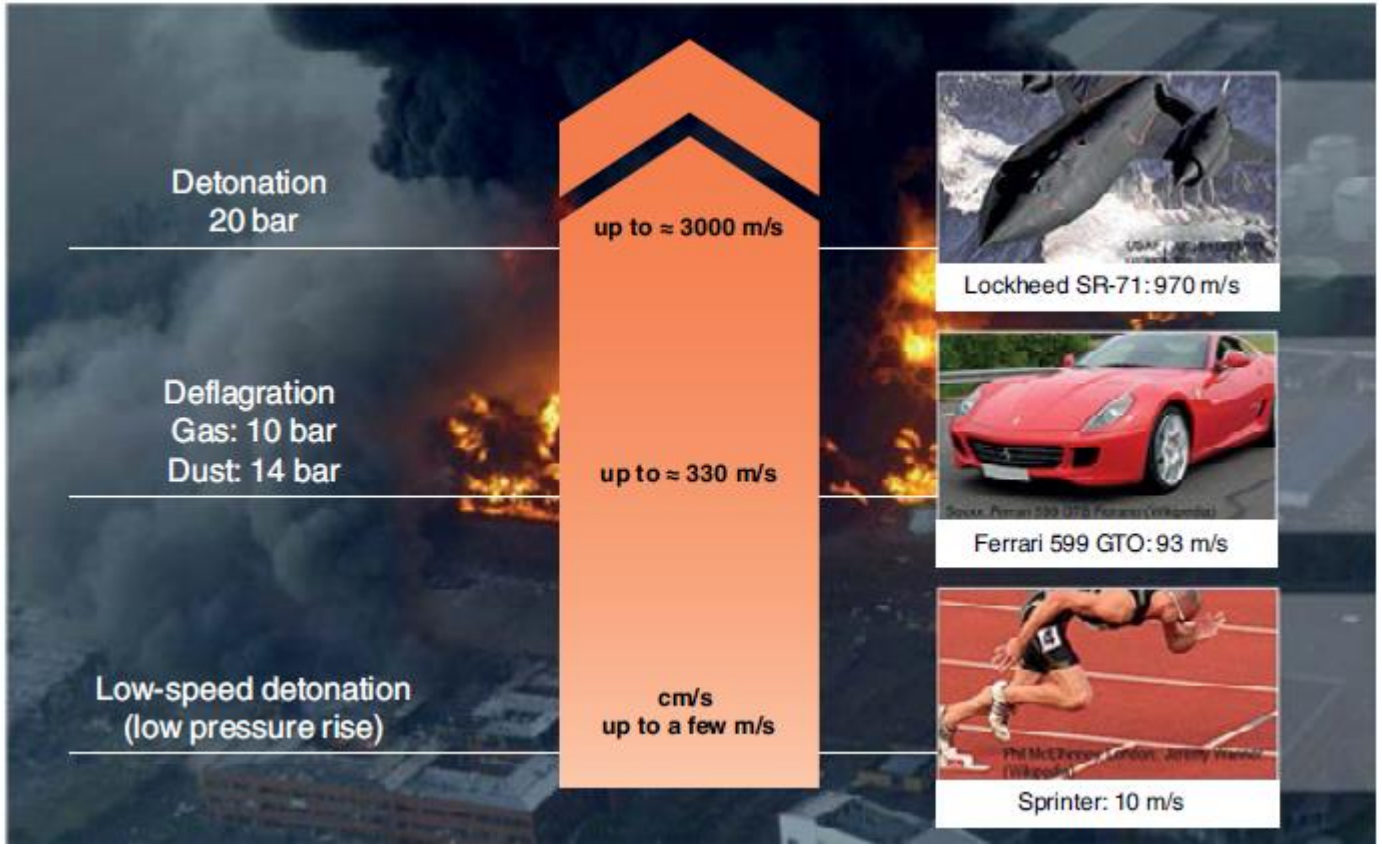
Effects of Explosions

Chiltern Air Support Unit and Hertfordshire County Council

- Effects of explosions are – among other things:
  - damage to persons (e.g. pressure, flames)
  - environmental contamination (e.g. emission of toxic substances in the air or water)
  - damage to property (e.g. destruction of plants, buildings)
  - financial loss (e.g. production downtimes, monetary fines)
  - damage to image (e.g. media coverage)

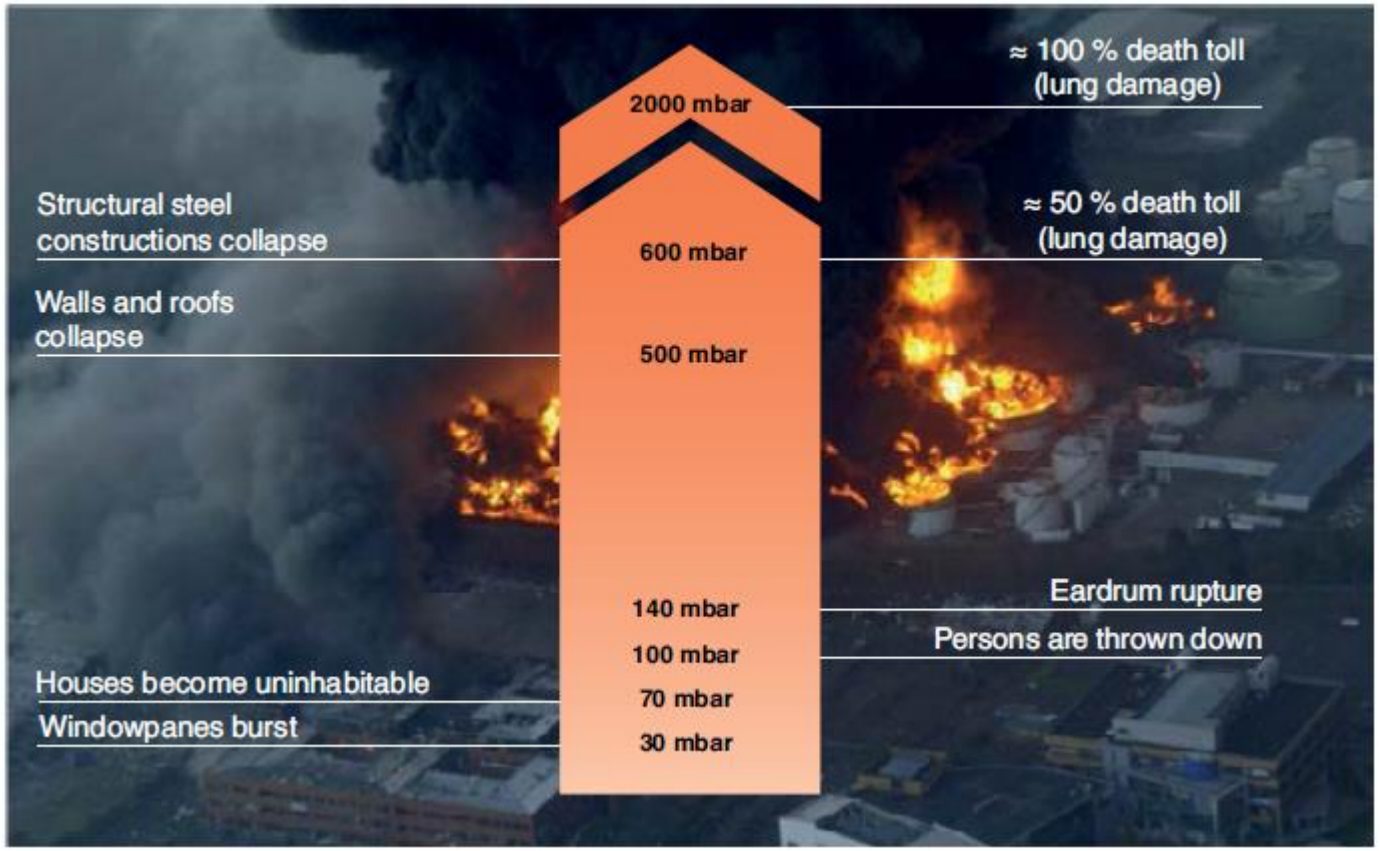
Effects of Explosions

Explosion speed & consequences



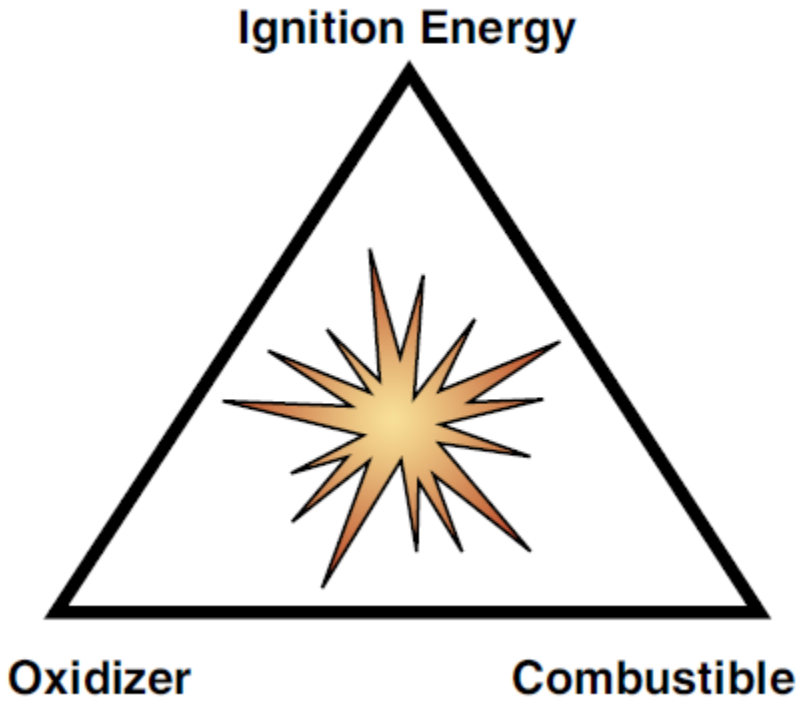
Effects of Explosions

Explosion pressure on buildings & humans



Prerequisites of an Explosion

Ignition Triangle



Prerequisites of an Explosion

Potential Ignition Sources
Hot Surfaces Flames & Hot gases Mechanical sparks Electrical Installations Static Electricity Lightning Electromagnetic Waves Ionising Radiation Ultrasonic sound Adiabatic compression, shock waves Exothermal reactions, auto ignition of dusts

Combustibles					
Gases			Dusts		
IIA	IIB	IIC	IIIA	IIIB	IIIC
Acetone	Ethanol	Hydrogen	Cotton lint	Flour	Magnesium
Propane	Hydrogen Cyanide	Acetylene	Flax	Grain	Graphite Powder
Ammonia	Hydrogen Sulphide	Carbon Disulphide	Saw Dust	Milk Powder	Aluminium Powder
Petrol	Diethyl Ether		Tobacco	Powdered Sugar	

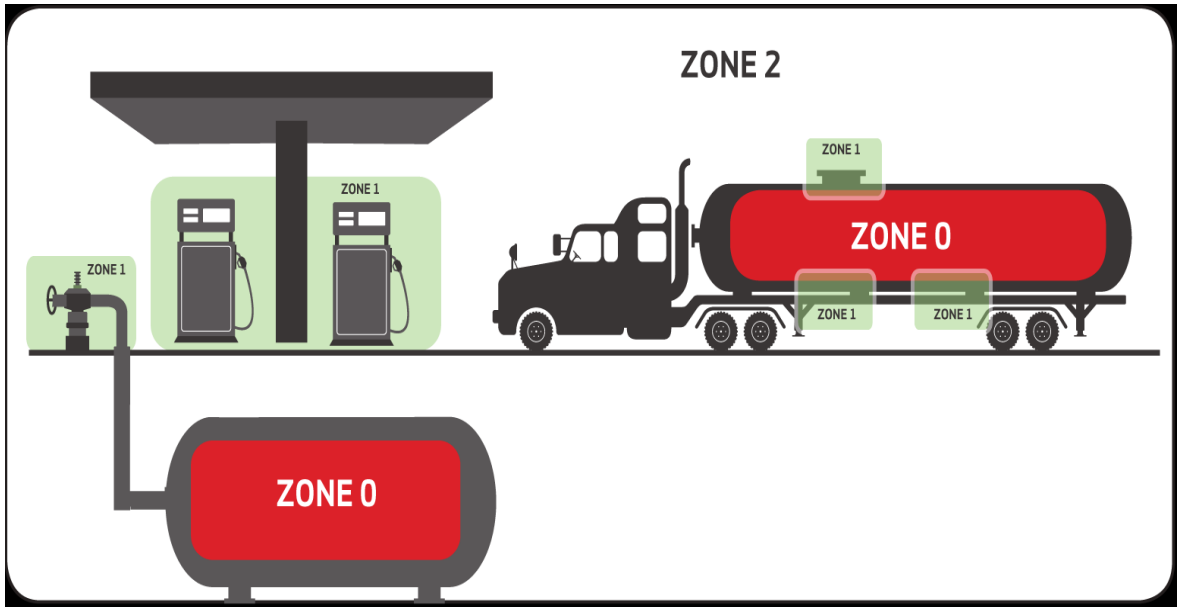
Group I: Methane

Determination of Explosion Hazardous Areas

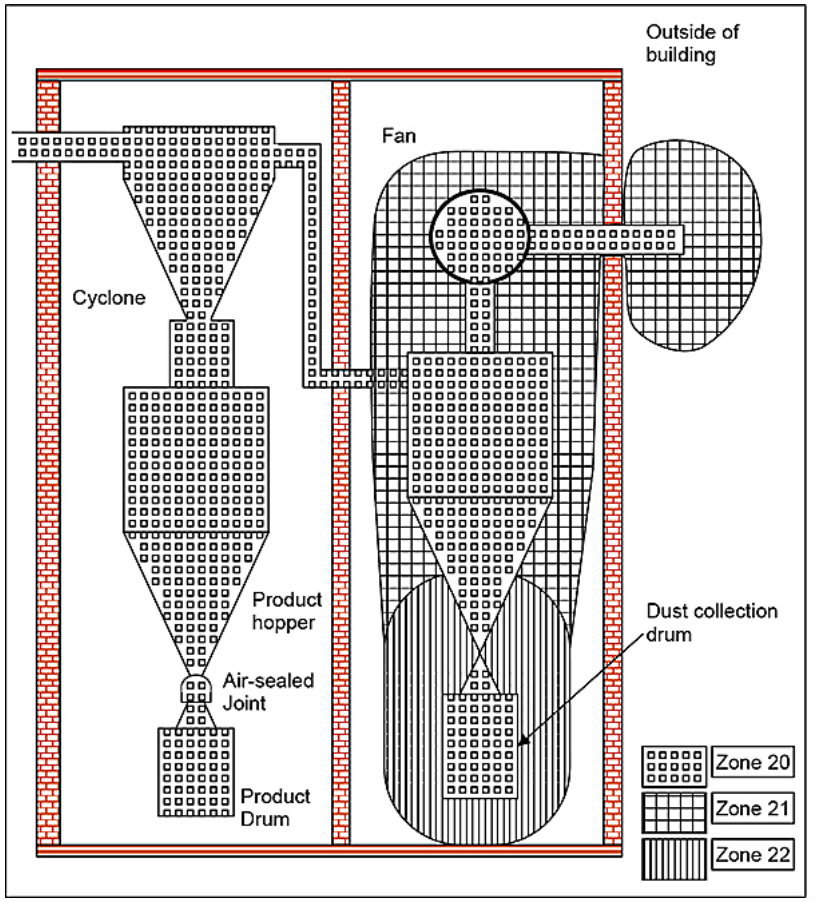
Zone	Type of fuel	
0	Gases, vapours, mists	Permanent, frequent, over long periods of time
20	Dust clouds	
1	Gases, vapours, mists	Occasional during normal operation
21	Dust Clouds	
2	Gases, vapours, mists	Not to be expected during normal operation. Possible short-term occurrences when deviating from standard operation
22	Dust clouds	

Determination of Explosion Hazardous Areas

Gas Example

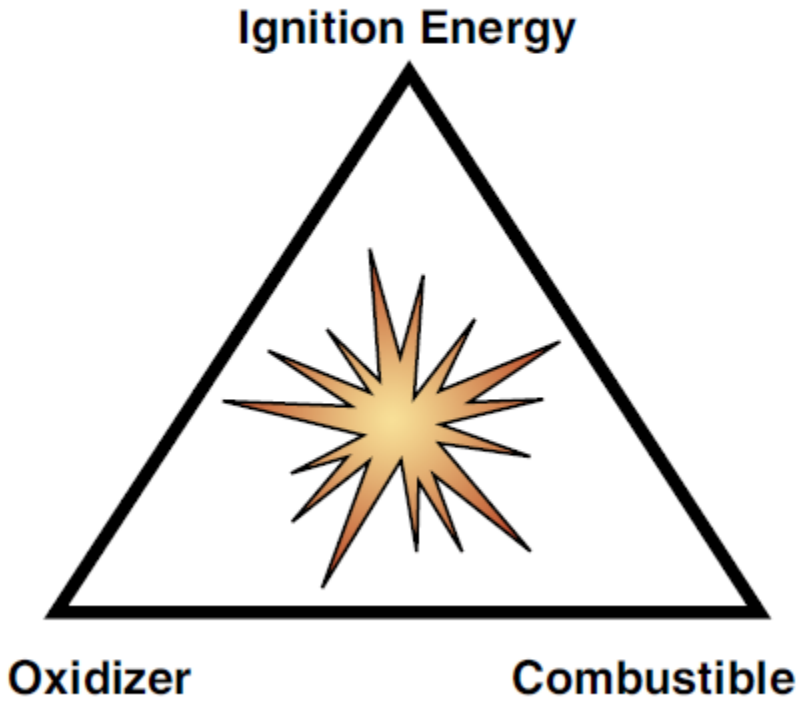


Dust Example



Prerequisites of an Explosion

Ignition Triangle

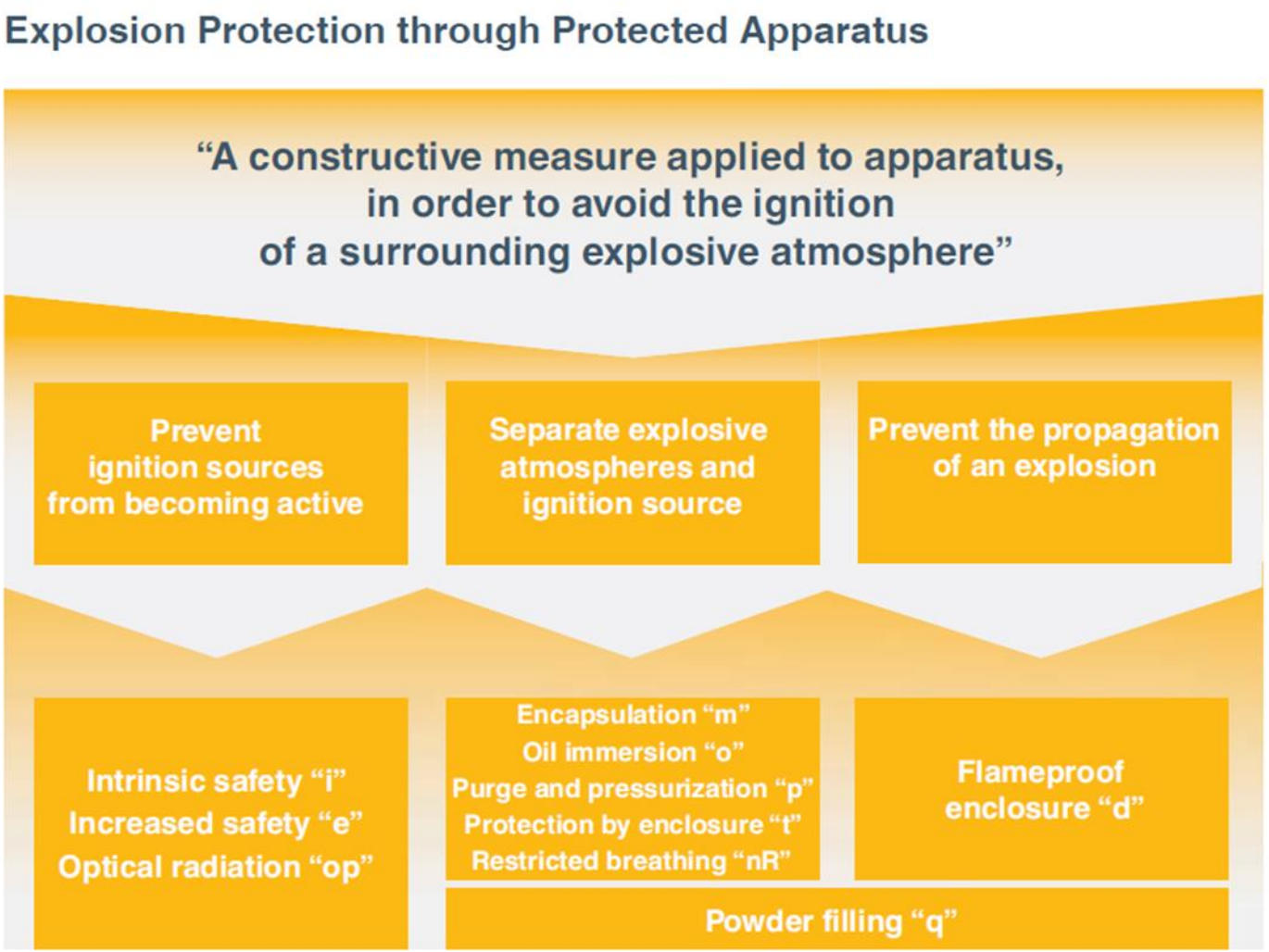


Basic Principles of the Types of Protection

Fundamental Measures:

- Prevention of explosion by containment
- Spatial separation between the ignition source and potentially explosive atmosphere
- Prevention of an effective ignition source

Basic Principles of the Types of Protection



Basic Principles of the Types of Protection

Marking Code	Type of protection	Zone
Ex d	Flameproof equipment	1,2
Ex e	Increased Safety	1,2
Ex i	Intrinsic Safety	0,1,2; 20,21,22
Ex m	Moulded Encapsulation	0,1,2; 20,21,22
Ex n (nA, nR)	Non incendive	2
Ex op	Optical Radiation	0,1,2; 20,21,22
Ex p	Pressurized enclosure	1,2; 21,22
Ex q	Powder filling (Quartz encapsulation)	1,2; 21,22
Ex t	Protection by enclosure	20,21,22
Ex o	Liquid Immersion	1,2

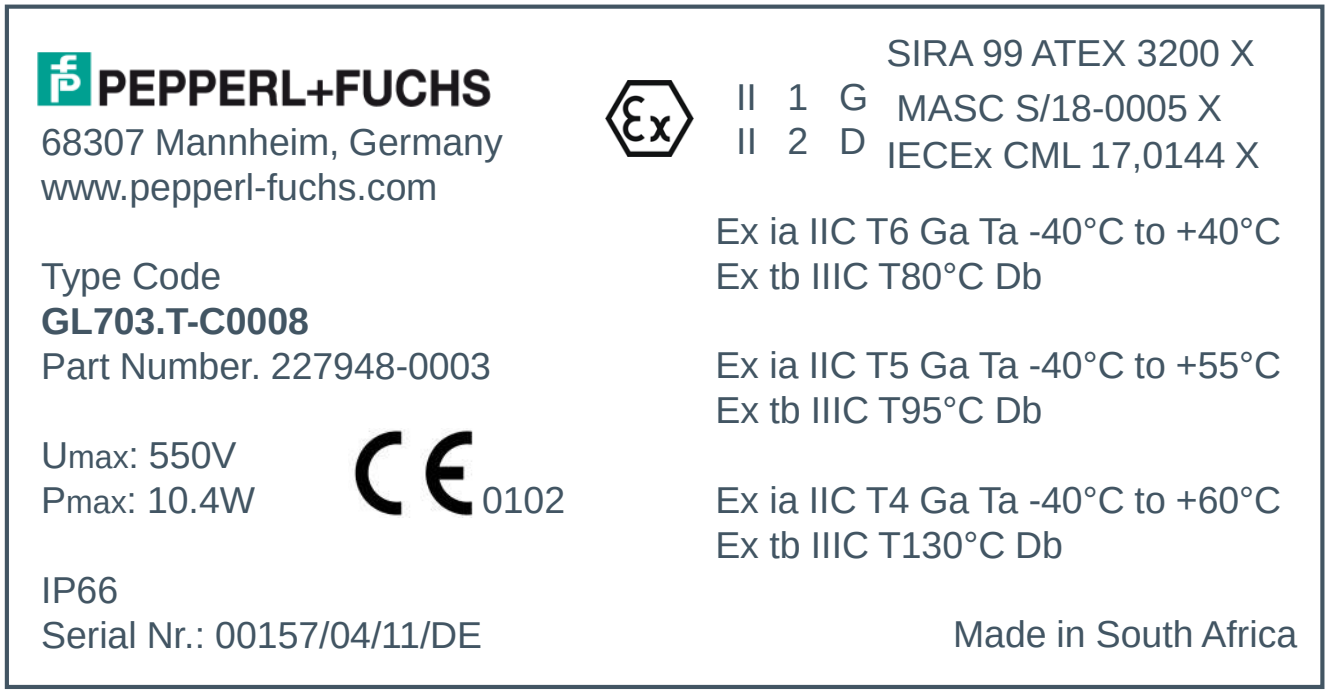
Equipment Protection Level (EPL)

IEC / SANS
Zone
0/20
1/21
2/22

IEC/SANS	
Suitable group	Suitable EPL
II (A, B, C)	Ga
	Ga or Gb
	Ga, Gb or Gc

IEC/SANS	
Suitable group	Suitable category
III (A, B, C)	Da
	Da or Db
	Da or Db or Dc

Example: Junction Box Label

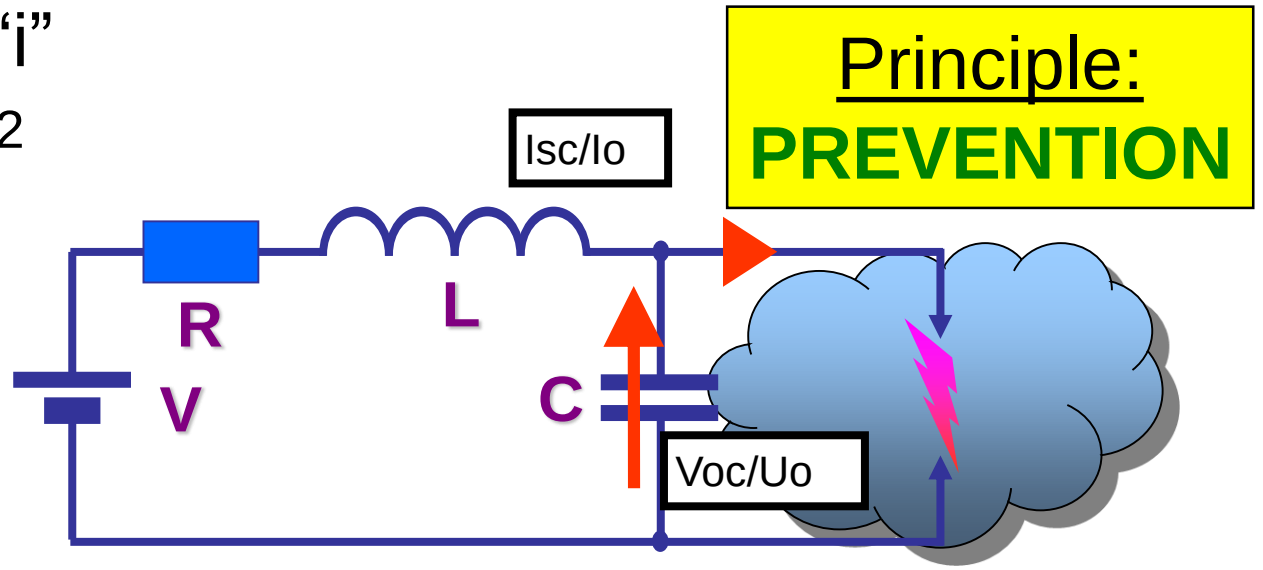


Ex i vs Ex d vs Ex p

Methods of Protection

- Intrinsic Safety “i”

  Zones 0,1,2; 20, 21, 22



- CHARACTERISTICS
  - Low power technique to limit voltage, current and stored energy to a level below the minimum required for ignition

- ADVANTAGES
  - No special cables are required
  - Safe for personnel
  - Hot permits not required
  - Suitable for all area classifications – Zones 0,1,2 ; 20, 21, 22

- DISADVANTAGES
  - **Not suitable for high power equipment**
  - Requires front loaded engineering work and documentation

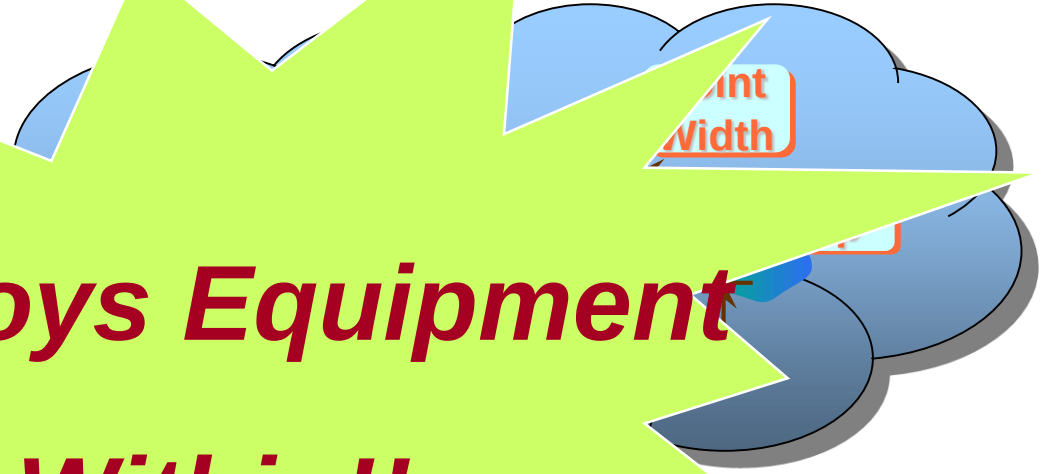
Ex i vs Ex d vs Ex p

Methods of Protection

- "Explosion-Proof" or flame-proof "d"

  Zones 1,2

Principle:
CONTAINMENT



Destroys Equipment Within!!

- CHARACTERIS
- Enclosure mu
  pressure o
  explosion and be desig
  to "cool" the flame befor
  reaches the external
  explosive environment (ie
  small joints and gaps)

or hig
powe d equipment

SADVANTAGES
- ge enclosures, high cost seals and conduit
- Live electrical work not possible
- Installation/ maintenance errors are dangerous!
- Not suitable for all hazardous areas

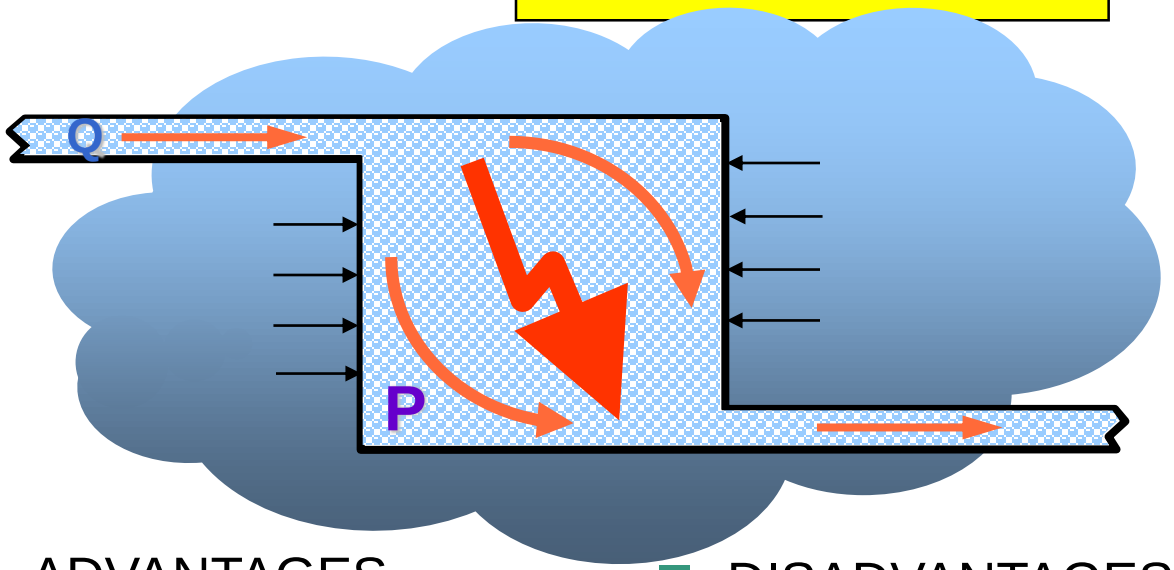
Ex i vs Ex d vs Ex p

Methods of Protection

- Purge/ Pressurization

  Zones 1,2; 21,22

Principle:
SEGREGATION



- CHARACTERISTICS
  - Clean or Inert gas at greater pressure than outside allows internal equipment to operate inside a safe zone with interlock to turn off power before purging and at loss of pressure
- ADVANTAGES
  - May be only solution especially for large equipment (i.e. High Energy Equipment)
- DISADVANTAGES
  - Requires protective gas supply
  - Requires other protection methods to operate
  - Powered maintenance is not permitted

Purge & Pressurization

Purge + Pressurization: Definition

Pressurization

„Technique of guarding against the ingress of the external atmosphere into an enclosure by maintaining a protective gas therein at a pressure above that of the external atmosphere.“

Purge

„in a pressurized enclosure, the operation of passing a quantity of protective gas through the enclosure and ducts, so that the concentration of the explosive atmosphere is brought to a safe level

SANS 60079-2:2015

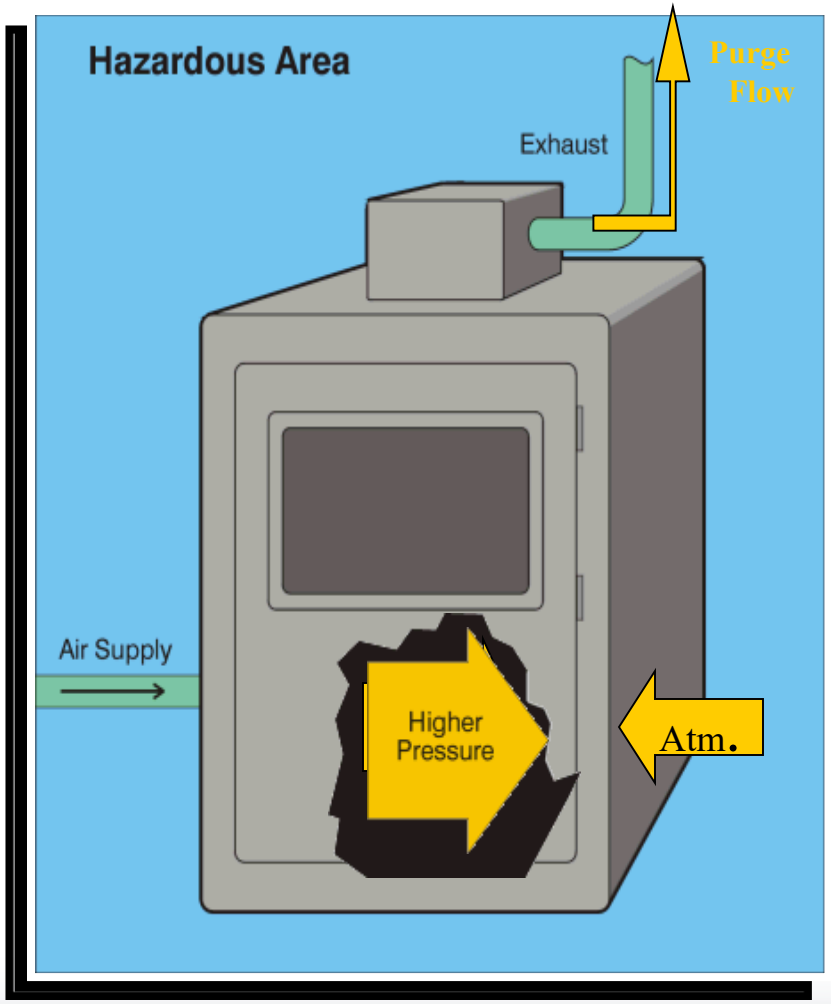
Purge + Pressurization System Selection

Four Primary factors that determines which appropriate system is appropriate for a particular application

1. Classification of the area
2. Ratings of the equipment inside the enclosure
3. Type of enclosure, and any specifics regarding doors, windows and any accessories
4. Power requirement to the equipment inside the enclosure

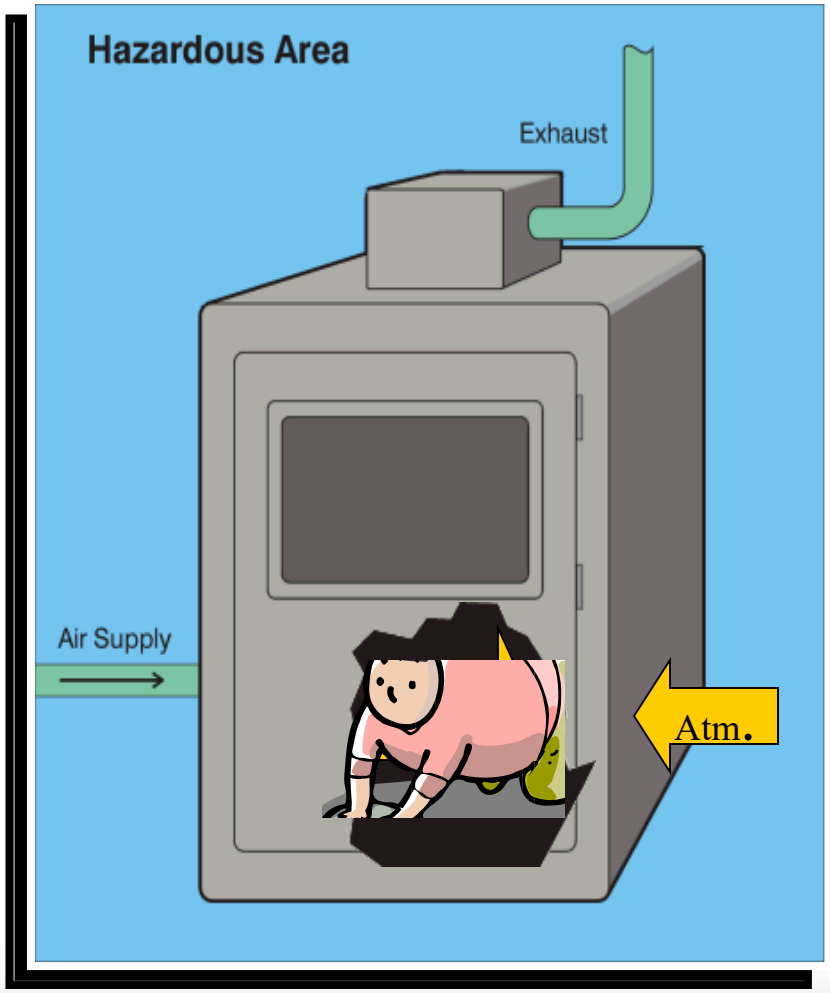
Purge + Pressurization: Concept (gas)

- **Electrical equipment operated in an enclosure**
- **Hazardous gas is removed (Purging)**
- **Positive (higher) pressure maintained (Overpressure)**
- **The lower pressure hazardous atmosphere outside can not penetrate**



Purge + Pressurization: Concept (dust)

- **Electrical equipment operated in an enclosure**
- **Hazardous dust is physically removed**
- **Positive (higher) pressure maintained (Overpressure)**
- **The lower pressure hazardous atmosphere outside can not penetrate**



Types of Purge+Pressurization Systems

- Ex ‘px’ – Reduces classification within an enclosure from Zone 1 to non-hazardous
- Ex ‘py’ – Reduces classification within an enclosure from Zone 1 to Zone 2
- Ex ‘pz’ – Reduces classification within an enclosure from Zone 2 to non-hazardous

Important Considerations

- Enclosure Type & Size: IP 4X (SANS 60079-2:2015)
- All Cable Entry points must be sealed (incl. conduits)
- Clean and reliable gas/air supply
- Doors and cover must be fully secured

Purge + Pressurization: Design Criteria

Design criteria	Type px	Type py	Type pz with indicator	Type pz with alarm
Degree of enclosure Protection	IP4X minimum			IP3X minimum
Enclosure impact resistance	IEC 60079-0, Table 8			IEC 60079-0, half the value in Table 8
Verifying purge period	Time, pressure and flow monitoring	Time and flow marked		
Prevent incandescent particles from exiting a normally closed relief vent into an area requiring EPL Gb or Mb	Spark and particle barrier required, unless incandescent particles not normally produced	No requirement, see Note 1	Spark and particle barrier required, unless incandescent particles not normally produced	
Prevent incandescent particles from exiting a normally closed relief vent into an area requiring EPL Gc	No requirement, see Note 2			
Preventing incandescent particles from exiting a vent that opens during normal operation, to an area requiring EPL Gb or Mb	Spark and particle barrier required, see 5.8			
Prevent incandescent particles from exiting a vent that opens during normal operation to an area requiring EPL Gc	Spark and particle barrier required, unless incandescent particles not normally produced	No requirement, see Note 1	Spark and particle barrier required, unless incandescent particles not normally produced	
Door or cover removable only with use of a tool	Warning, see 5.3 and 6.2 b) ii)	Warning, see 5.3.6 and Note 1	Warning, see 5.3.6 and Note 3	
Door or cover removable without use of a tool	Interlock, see 7.12 (no internal hot parts)			
Internal hot parts that require a cool-down period before opening enclosure	Comply with 6.2 b) ii)	No requirement, see Note 1	Warning, see 5.3.6	
NOTE 1 Subclause 6.2 b) ii) is not applicable for type py since neither hot internal parts nor normally created incandescent particles are permitted. NOTE 2 There is no requirement for spark and particle barriers since in abnormal operation, where the relief vent opens, it is unlikely that the external atmosphere is within the explosive limits. NOTE 3 There is no requirement for tool accessibility on a type of protection pz enclosure since in normal operation the enclosure is pressurized with all covers and doors in place. If a cover or door is removed, it is unlikely that the atmosphere is within the explosive limits.				

Components of a Purge+Pressurization system

Target: Use of standard Equipment in hazardous area

Vent

- maintain the overpressure inside enclosure
- opens if overpressure is too high
- Flow and Pressure measurement (Zone 1)

Control Unit

- regulates pressure via selenoid valve
  (e.g. during purging)
- Pressure measurement (Zone 2)
- De-energize cabinet in case of a failure (Zone 1)
- Create an alarm signal in case of a failure (Zone 2)

Operation of a Purge+Pressurization system

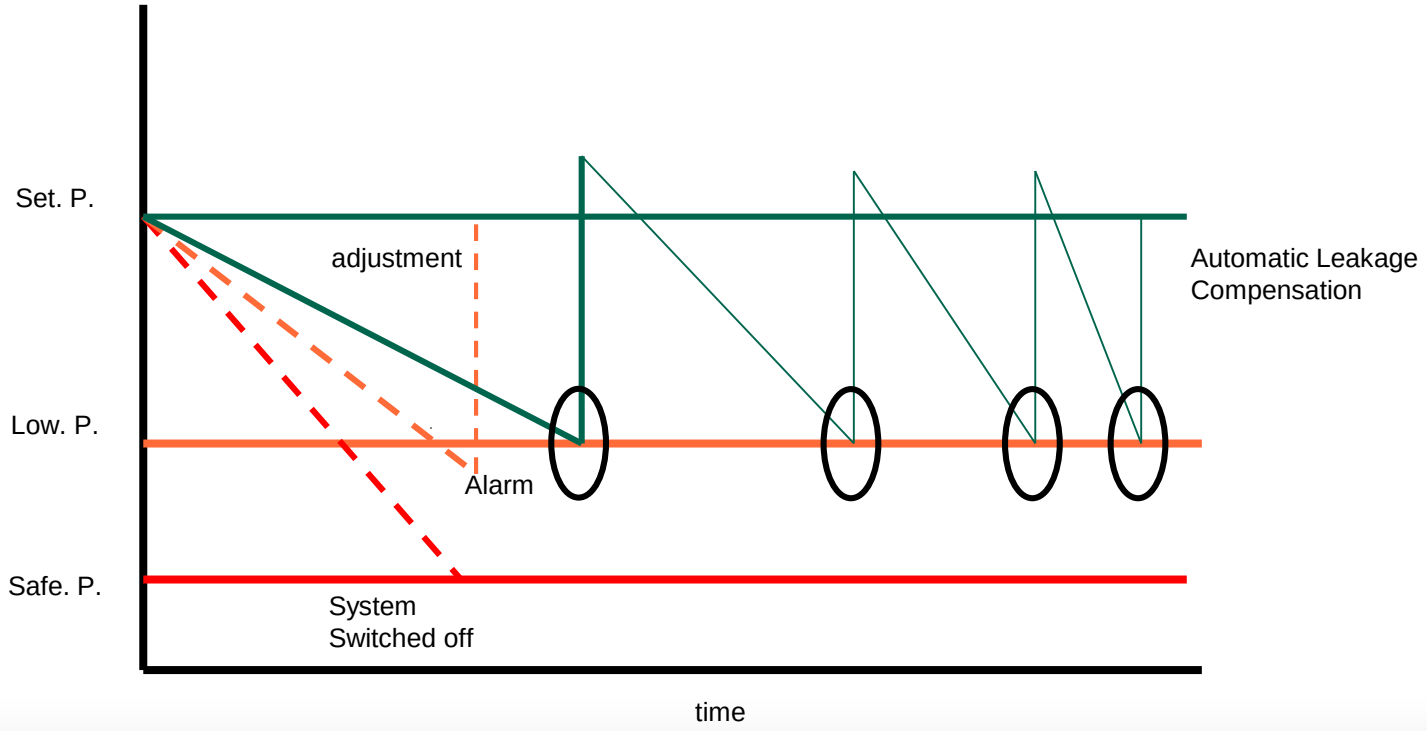
1. Equipment is de-energised, no overpressure, enclosure unsafe conditions
2. Gas-Zone: Enclosure purged
   Dust-Zone: Enclosure inside has to be cleaned manually
3. Enclosure is sealed, Overpressure is revised, safe conditions
4. Equipment will be energized
5. Failure, Overpressure decreases under safe pressure

   Zone 1,21: Equipment is de-energised

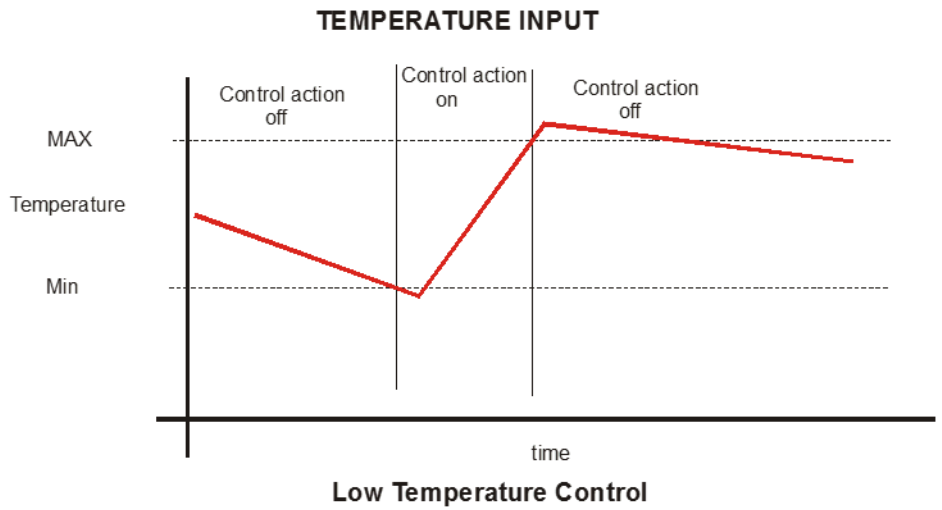
   Zone 2,22: Alarm is generated and immediate action has to be taken

Automatic Leakage Compensation

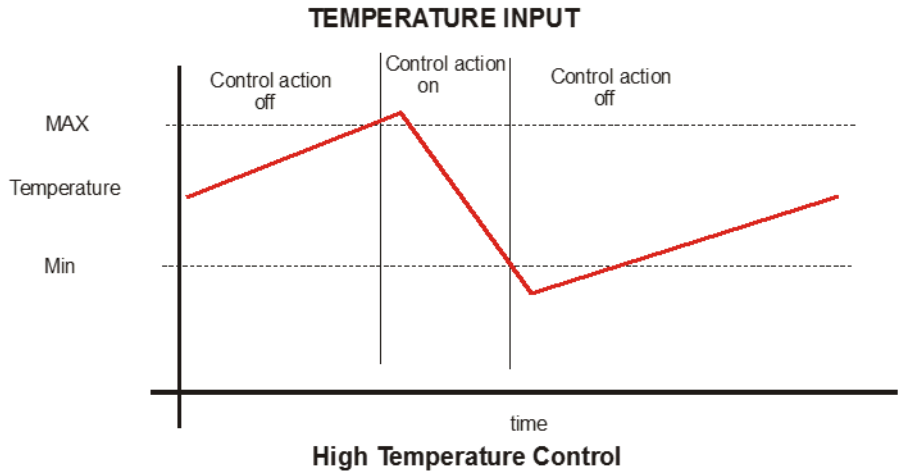
In case of an additional leakage of the enclosure the pressure drops down under the set alarm pressure. The controller opens the purge valve as long as the pressure increase 0,5-2 mbar over the set alarm pressure.



Temperature Monitoring and Control



Low Temperature Control



High Temperature Control

Low temperature control can be used for heating

High temperature control can be used for cooling

Questions?