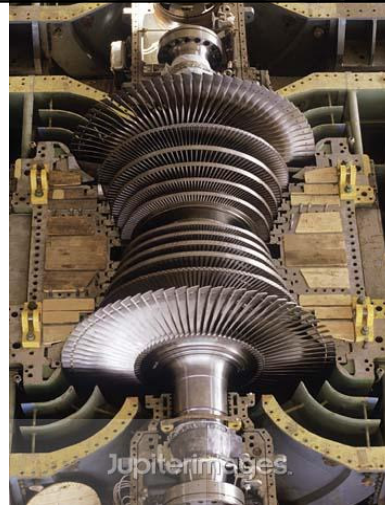


Intrinsic Safety & Hazardous Areas

by

Steve Mackay



Technology Training that works

EIT Micro-Course Series

- Every two weeks we present a 35 to 45 minute interactive course
- Practical, useful with Q & A throughout
- PID loop Tuning / Arc Flash Protection, Functional Safety, Troubleshooting conveyors presented so far
- Upcoming:
 - Electrical Troubleshooting and much much more.....
- Go to <http://www.eit.edu.au/free-courses>
- You get the recording and slides



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Overall Presentation

The focus of this session is the building blocks of electrical engineering, the fundamentals of electrical design and integrating electrical engineering know-how into the other disciplines within an organisation.



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Objectives

The identification of:

- ◆ Terminology
- ◆ Fundamentals of Ex i Protection



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Ex Protection Definition

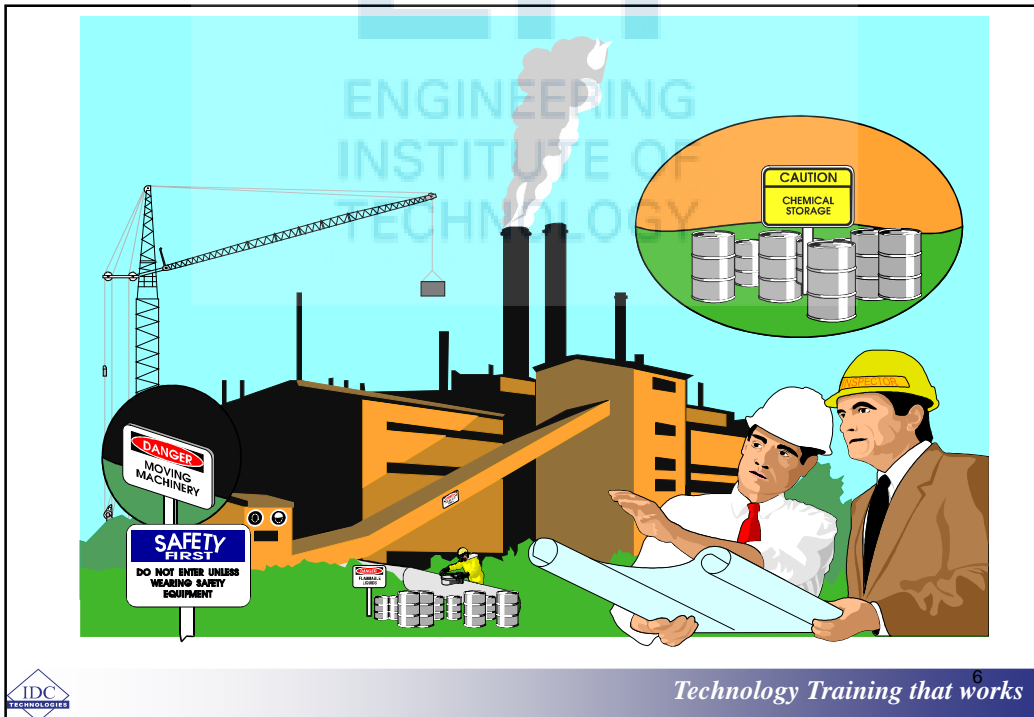
Explosion Protection:

The measures applied in the construction of electrical apparatus to prevent ignition of surrounding explosive atmosphere by such apparatus.

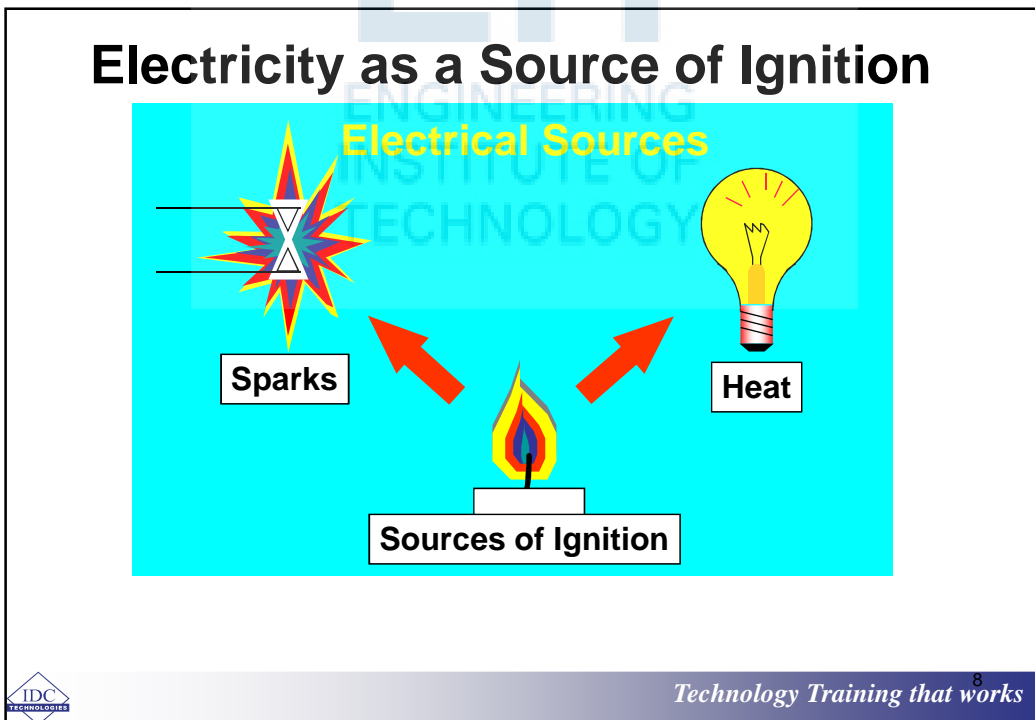
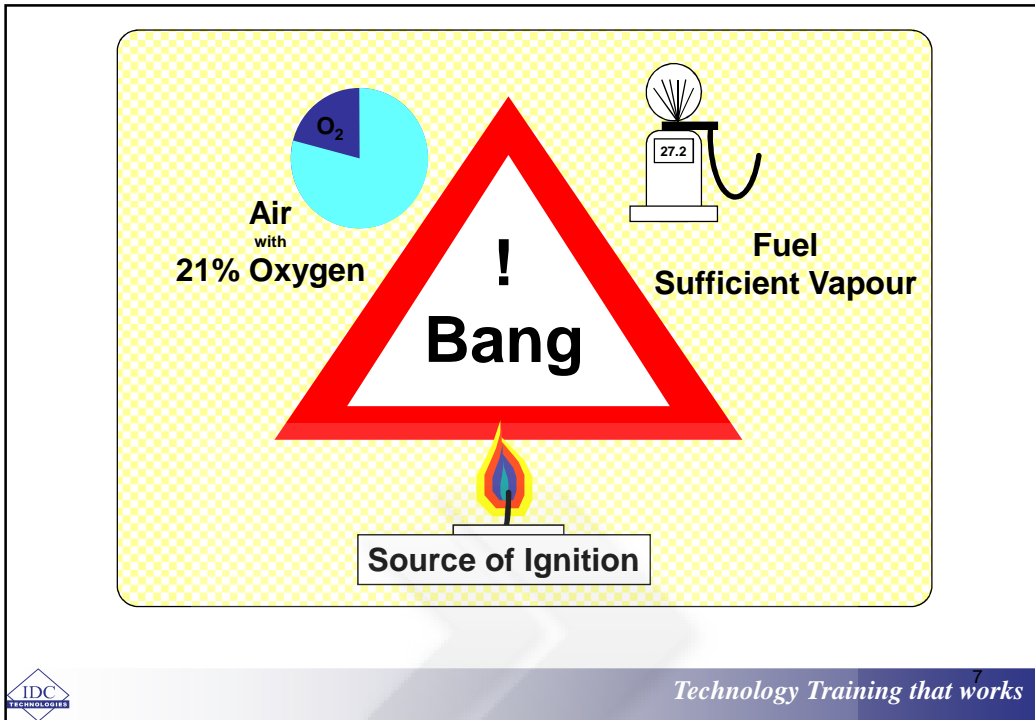
Need: to understand 'ignition'

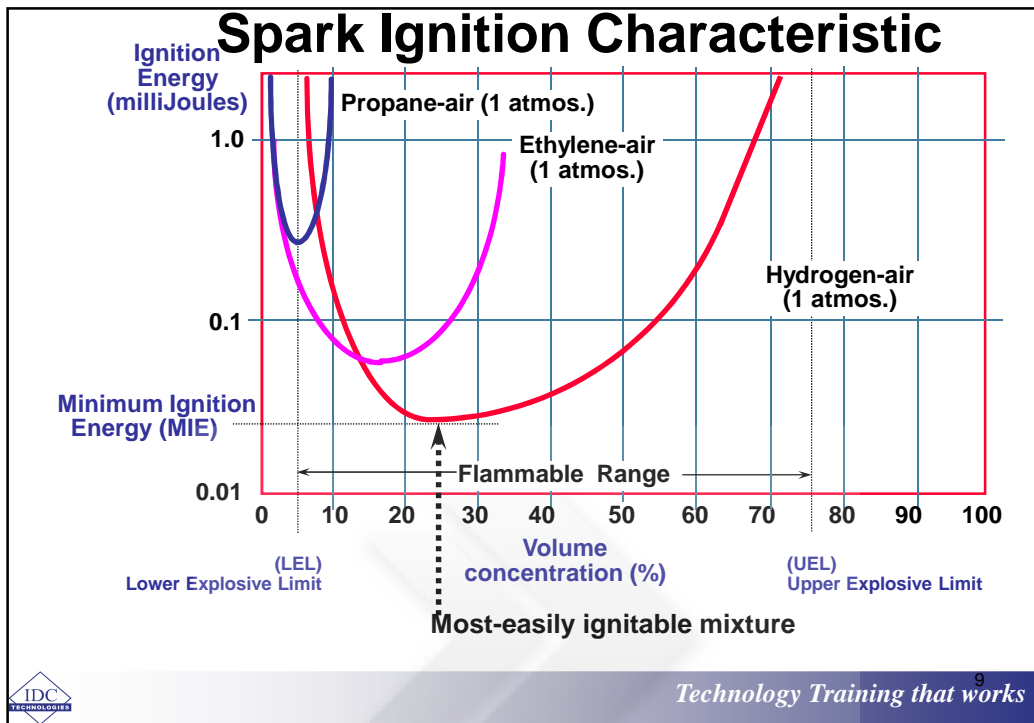


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Explosive limits for materials

Gas/air mixtures are ignitable over a range of concentrations called the "Flammable Range"

Material	Lower Explosive Limit	Upper Explosive Limit	ignition energy*
	Minimum LEL	UEL	
Propane	2 %	9.5 %	180μJ
Ethylene	2.7 %	34 %	60μJ
Hydrogen	4 %	76 %	20μJ

* of most easily ignitable mixture (Note: MESG assessed for Ex d)

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Ignition Temperature Definition

Ignition Temperature

The lowest temperature of a flammable gas or vapour at which ignition occurs.

Sometimes referred to as:-

Auto-ignition temperature
or
Spontaneous ignition temperature



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Flashpoint Definition

Flashpoint

The temperature at which the free surface of a liquid emits sufficient vapour to be ignited by a small flame

Kerosene:
Flashpoint = 38°C; Ignition Temp. = 210°C)

Only liquids have flashpoints

Operation below Flashpoint constitutes no actual hazard



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Personnel Hazards

For Hydrogen Sulphide, H₂S:

a very common danger when dealing with oil products

Property	Volume Concentration
Smell detection level	0.1 ppm
Safe working level	10
Serious health danger level	50
Lower Flammable Limit	40,000 (4%)
Upper Flammable Limit	460,000 (46%)



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Area Classification

- ➔ Nature of the Hazard
- ➔ Locations of hazard
- ➔ Probability of presence



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Requirement for plant classification

Plant and Installations

are classified according to:-

- ➔ The nature of the Hazardous Atmosphere
 - Gas Classification
 - Ignition Temperature

- ➔ The probability that the Hazardous Atmosphere will be present
 - Area Classification



Requirement for equipment classification

Equipment

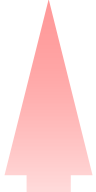
is classified according to:-

- ➔ The maximum spark energy it can produce
 - Apparatus Group

- ➔ Its maximum surface temperature
 - Temperature Classification



Gas classification: the two main systems

Representative (Test) gas	Gas classification		Ignitability
	IEC countries (including Europe)	USA & Canada	
Acetylene Hydrogen Ethylene Propane	Group IIC Group IIC Group IIB Group IIA	Class I, Group A Class I, Group B Class I, Group C Class I, Group D	 More easily ignited
Methane	Group I (Mining)	(No classification)	
Metal dust Carbon dust Flour, starch, Grain	(IEC 1241)	Class II, Group E Class II, Group F Class II, Group G	
Fibres & Flyings	(No classification)	Class III	



Temperature classification (IEC/European)

Temperature classification	Maximum surface temperature
450°C	T1
300°C	T2
200°C	T3
135°C	T4
100°C	T5
85°C	T6

$T_{amb} = 40^{\circ}\text{C}$
unless otherwise stated

Operation above stated T_{amb} may de-rate T Class



Temperature classification in North America

T class	°C
T1	450
T2	300
T2A	280
T2B	260
T2C	230
T2D	215
T3	200
T3A	180
T3B	165
T3C	160
T4	135
T4A	120
T5	100
T6	85

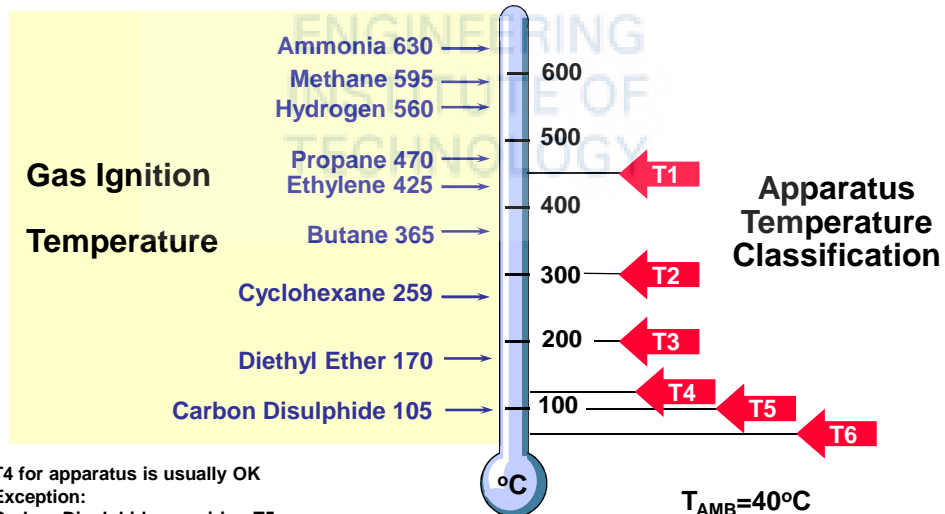
Apparatus is marked with either T rating or maximum surface temperature

User has responsibility to ensure that the T-rating is below the Spontaneous Ignition Temperature (SIT)

$$T_{amb} = 40^{\circ}\text{C}$$



Gas/Apparatus compatibility



T4 for apparatus is usually OK
 Exception:
 Carbon Disulphide, requiring T5
 Don't confuse T Class with maximum operating temperature!



Properties of Gases

Compound	Vapour Density	LFL	UFL	Ignition Temp °C	T Class	Apparatus Group
Acetone	2.00	2.0	13	535	T1	IIA
Ammonia	0.59	15	28	630	T1	IIA
Butane	2.05	1.5	8.5	365	T2	IIA
Carbon Disulphide	2.64	1.0	60	100	T5	IIC
Cyclohexane	2.90	1.2	7.8	259	T3	IIA
Diethyl Ether	2.55	1.7	36	170	T4	IIB
Ethylene	0.97	2.7	34	425	T2	IIB
Hydrogen	0.07	4.0	75.6	560	T1	IIC
Kerosene		0.7	5	210	T3	IIA
Methane	0.55	5.0	15	595	T1	I / IIA
Propane	1.56	2.0	9.5	470	T1	IIA

Extract from IEC79-18



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Area classification in IEC/European countries

Areas classification:

The probability of a potentially explosive atmosphere being present
and
The length of time for which it is likely to exist

Zone 0: in which an explosive gas-air mixture is continuously present or present for long periods

Zone 1: in which an explosive gas-air mixture is likely to occur in normal operation

Zone 2: in which an explosive gas-air mixture is not likely occur in normal operation, and if it occurs it will exist only for a short time



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Area classification in North America

Zone 0:

Division 1

Zone 1:

Hazardous atmosphere is likely to be present in normal operation

Zone 2:

Division 2

Hazardous atmosphere is unlikely to be present in normal operation

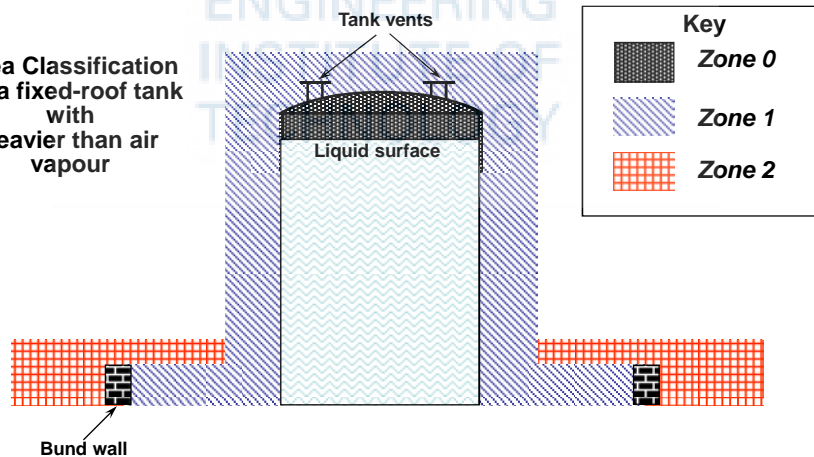
Div.1 Zone 0 sometimes specified



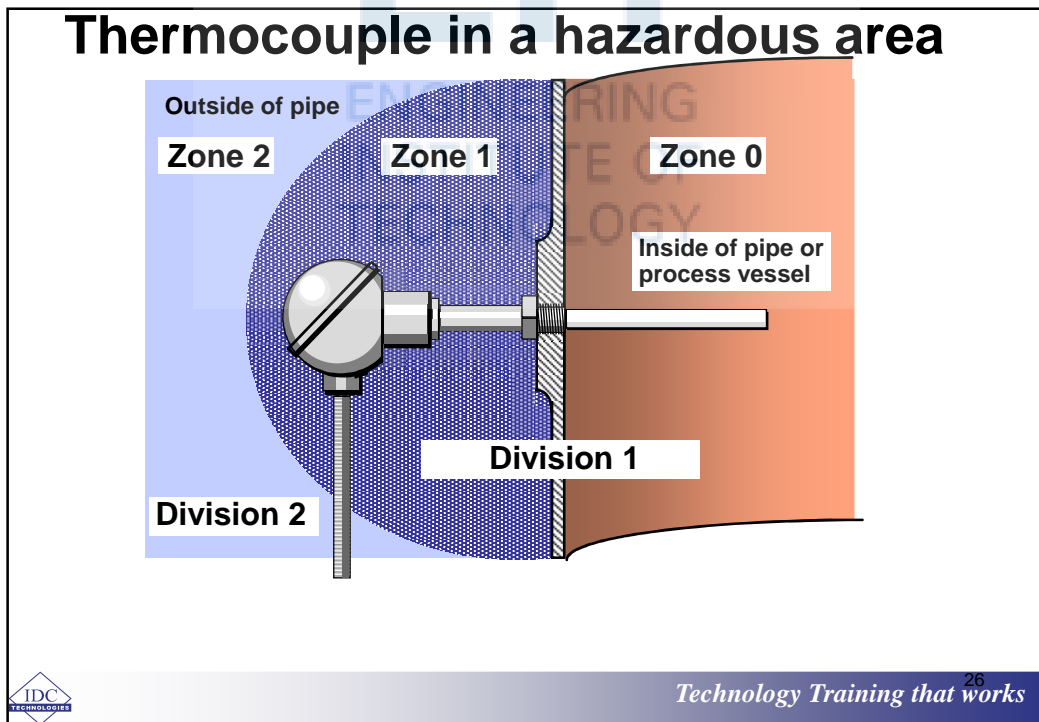
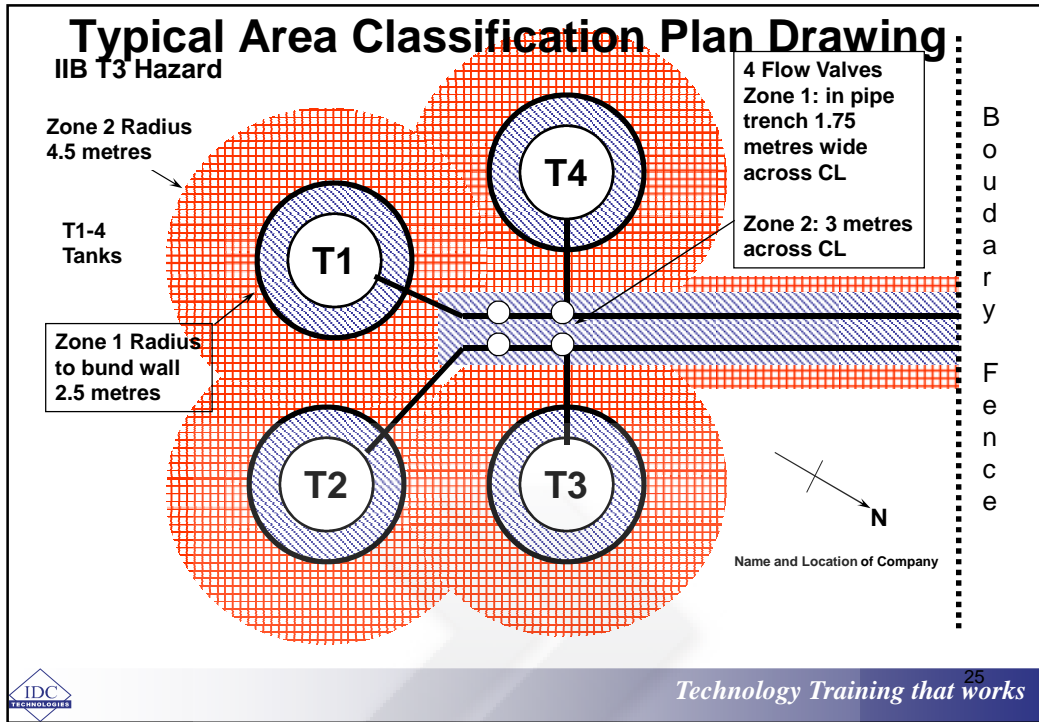
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Area Classification Example

Area Classification for a fixed-roof tank with heavier than air vapour



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Why Area Classify?

Probability of Gas/Air Mixture being present

Zone 0,1,2

X


Probability of Source of Ignition

Matched to Type of Protection
d, i, q, o, p, m, e, n, s

=

Acceptable Risk

Nothing is 100% Safe




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Methods of Explosion Protection

E x	Technique:	IEC 79-	Description:	Zone:	Application:
p o q m	Separation (Gas)	2	Pressurisation	1,2	Control rooms, analysers
	(Liquid)	6	Oil-filling	2	Transformers switchgear
	(Semi-solid)	5	Quartz/Sand	2	Instrumentation
	(Solid)	18	Encapsulation	1,2	Instrumentation, control gear
n e	Construction	15	Non-incendive	2	Transformers, switchgear
	Construction	7	Increased Safety	1,2	Motors, lighting, boxes (Draft)
d	Containment	1	Flameproof	1,2	Switchgear, motors, pumps
i	Electrical design	11	Intrinsic Safety	0,1,2	Instrumentation, control gear
s	Special		Special	0,1,2	Gas detection
		0	General Requirements		

Ex s Not adopted
 Zones are 'permitted Zone of use'



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Intrinsic Safety

Ex i



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Definition of 'intrinsic'
Intrinsic:
“in-built”
or
“of its nature”



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Definition

Intrinsically Safe Circuit

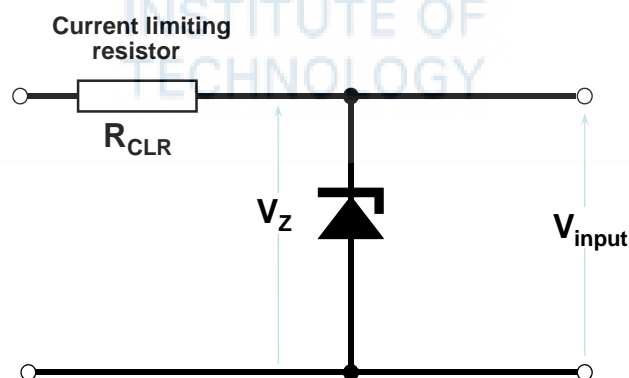
“A circuit in which no spark or thermal effect in any part of the circuit intended for use in a hazardous area is capable of causing ignition.”

IEC79-11



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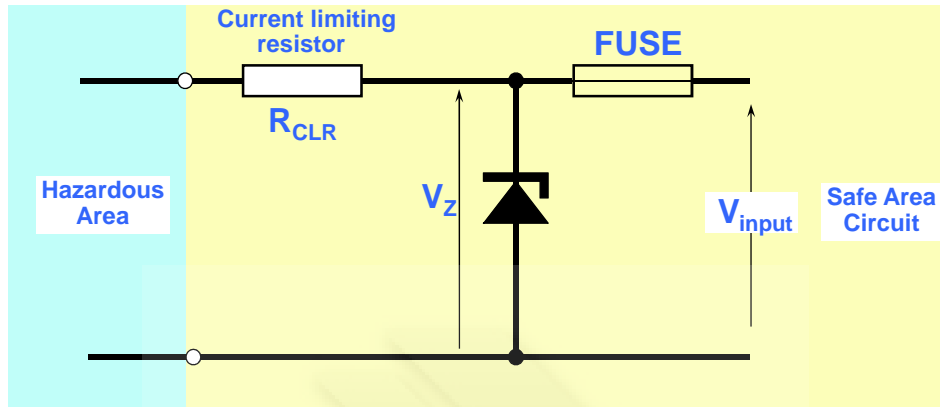
V & I Limiting Network



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Energy limiting arrangement

Infallible Components



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Intrinsic safety categories

Countable Faults: Faults in *infallible* components

Intrinsically safe with two countable faults

Zones 0, 1 and 2

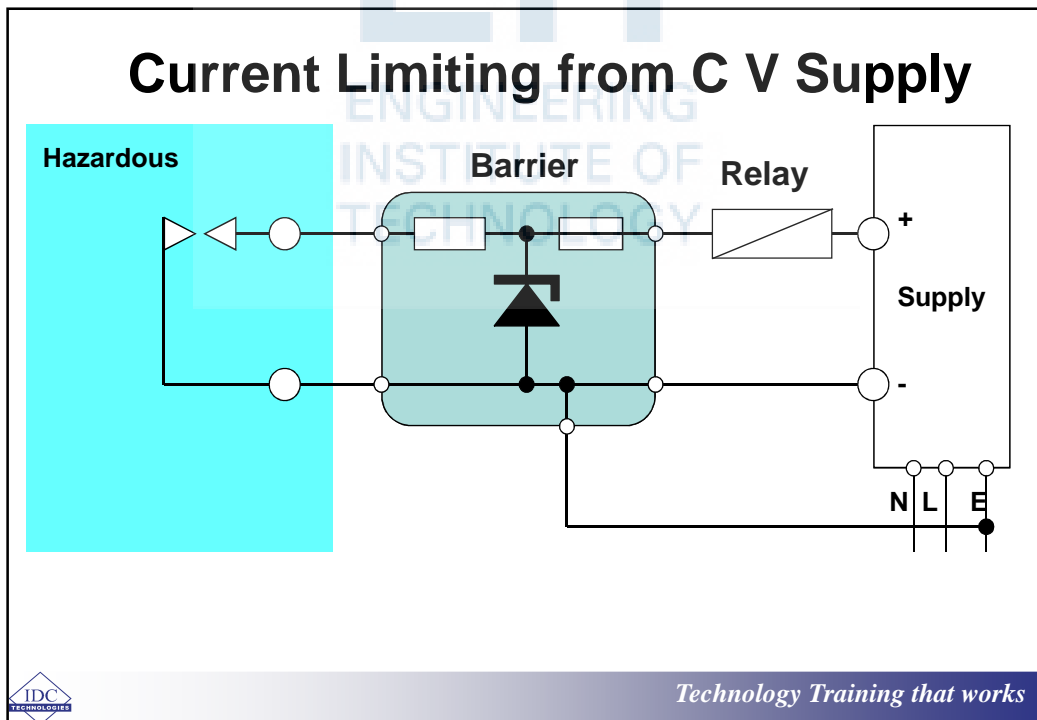
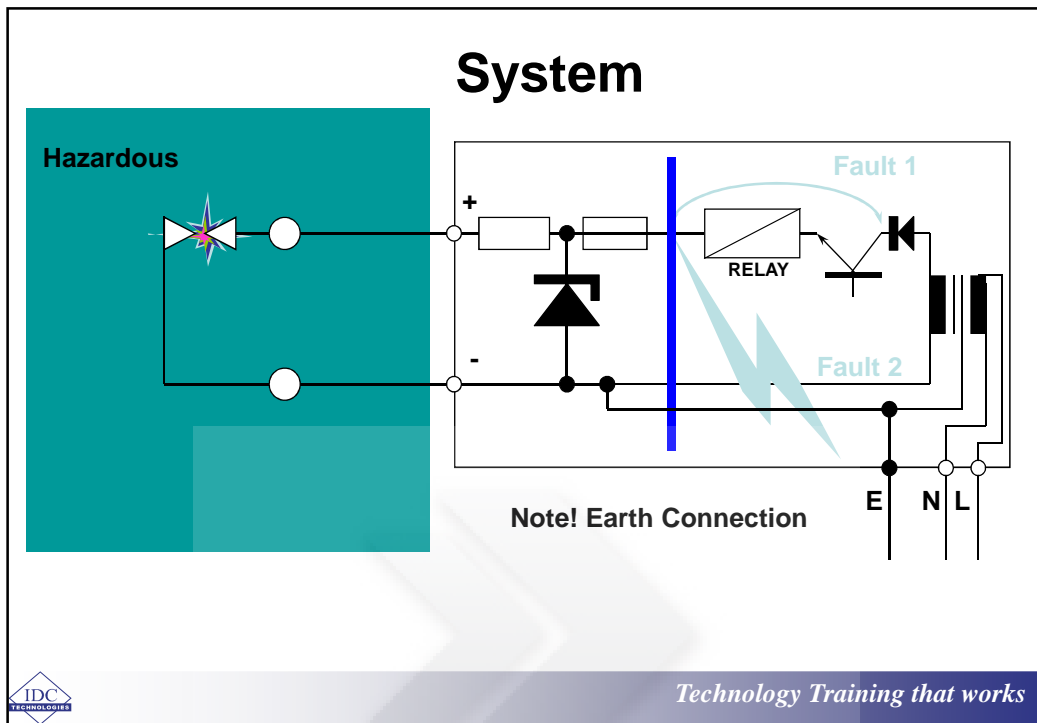
Intrinsically safe with one countable fault

Zones 1 and 2

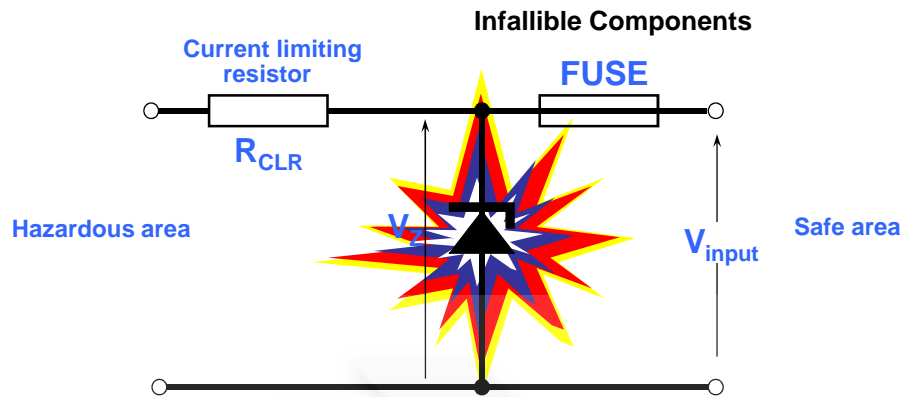
Intrinsic safety is the only protection concept which considers failure of the field wiring



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Component Failure



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Thank You For Your Interest

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