



Module 5A Explosion and Fire Protection – Basics of Electrical Area Classification

Last Revised – June 2024



PS Bootcamp Modules

- ✓ **Module 1: Introduction**
- ✓ **Module 2: Hazard Identification**
- ✓ **Module 3: Risk Matrix**
- ✓ **Module 4: Safeguard Concepts**
- ✓ **Module 5: Explosion/Fire Protection**
- ☐ **Module 6: Management of Change**
- ☐ **Module 7: Incident Investigation**
- ☐ **Module 8: Facility Siting**

Module 5: Explosions and Fire Agenda

- ✓ **5A – Fire, Combustion and Electrical Area Classification**
- ❑ **5B – Flammable Gas and Vapor Explosions**
- ❑ **5C - Combustible Dust Explosions**

Module 5A: Training Objectives

Increase Recognition of Fire Hazards

Increase general awareness and understanding of Electrical Area Classification

Fire and Combustion

Fire and Combustion

Combustion is a chemical oxidation process

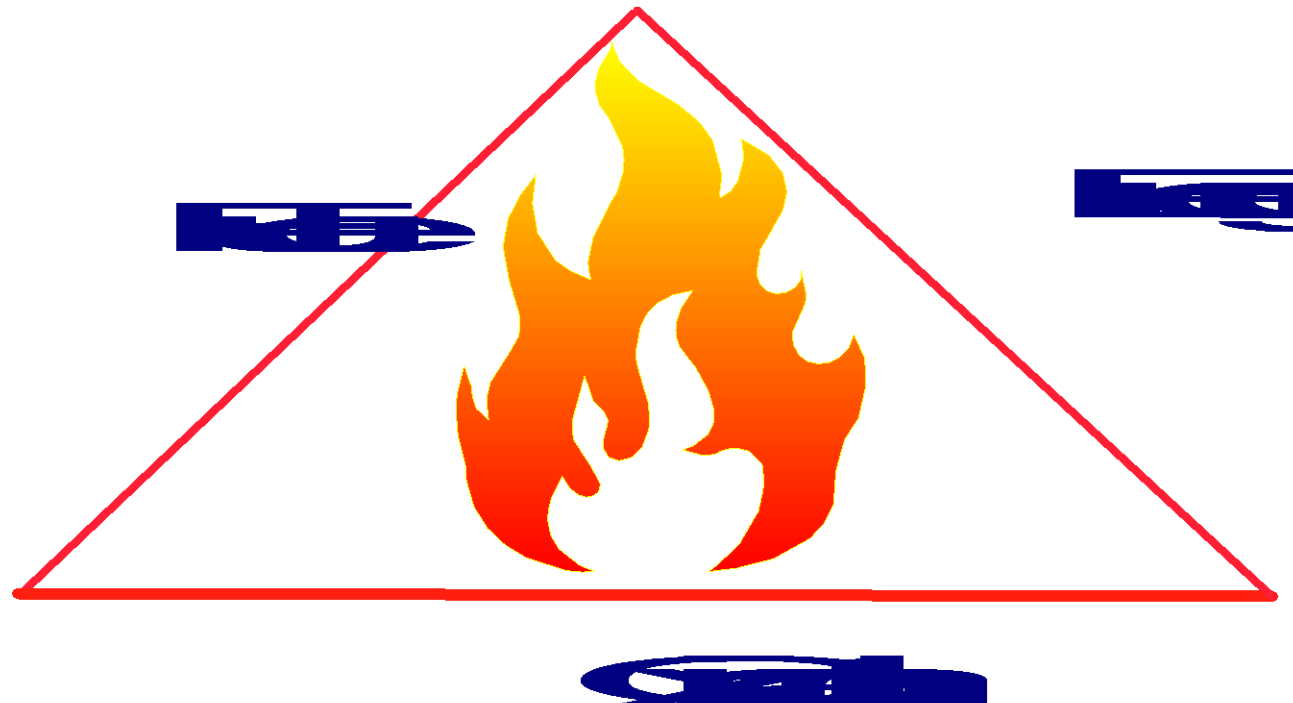
Fire is a self-sustaining combustion process and requires three components - Fuel, Oxidant, and Energy

Fire is characterised by Heat, Smoke or Flame



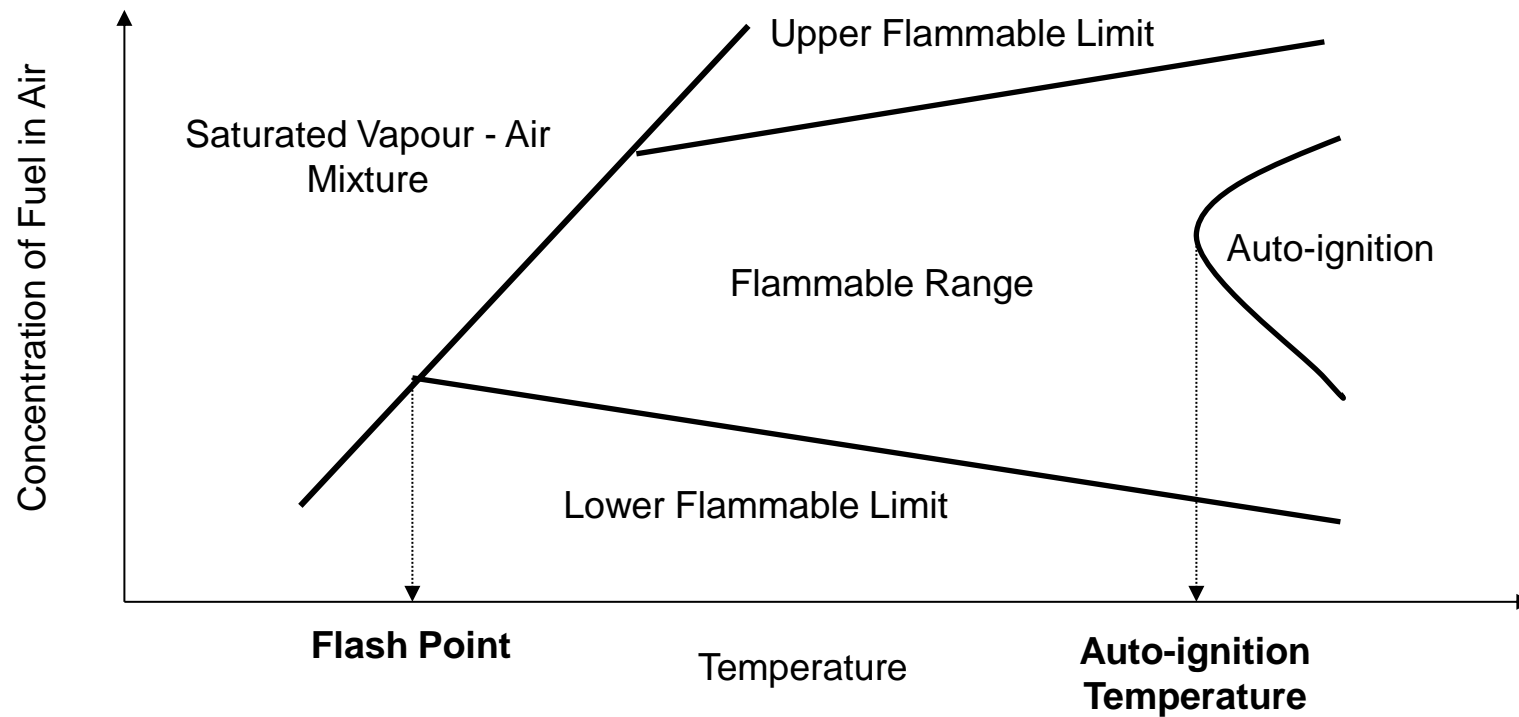
The Fire Triangle

Without all three components the combustion process will be broken, and the fire will be prevented or extinguished



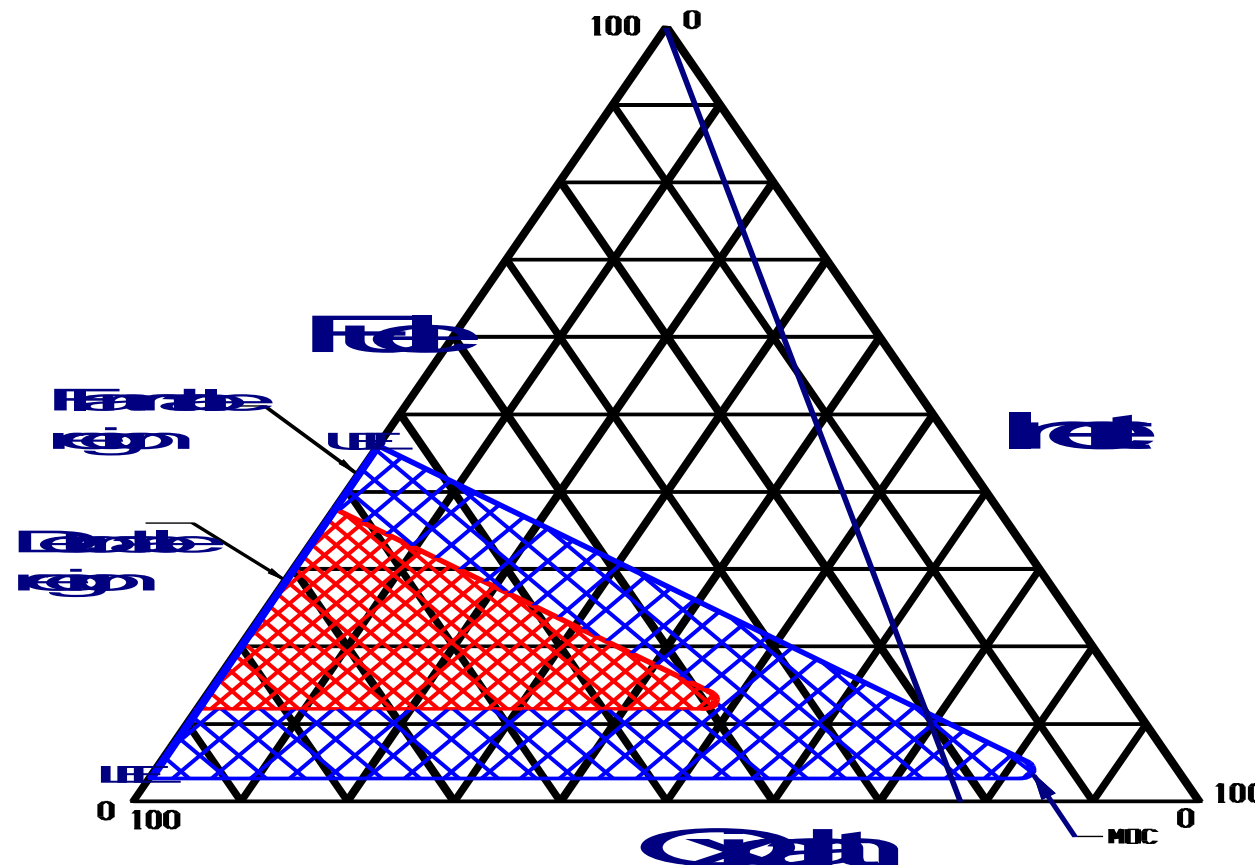
Flammability Limits 1

Fire is predominately a gas/vapor phase process



Flammability Limits 2

Triangular diagram with effects of inerts



Air line normal flammability limits

Flammability Limits 3 - Definitions

Flash point - Temperature at which vapor pressure is sufficient to give concentration (in air) corresponding to the LFL (lower Flammability limit)

Fire point - Minimum temperature at which a liquid gives off sufficient vapors that will ignite and sustain combustion. It is typically several degrees higher than the flash point

Ignition temperature (auto-ignition) - Temperature of a flammable fuel-oxidant mixture at which combustion occurs

Minimum oxidant concentration - Minimum level of oxidant required to sustain a fire

Flammable Or Combustible?

Flammable materials will easily result in a self sustaining fire



Combustible materials will support combustion, but usually require some other process factor to be self sustaining fire, e.g., heat



Ensure combustibles are treated as flammable where appropriate!

Sources Of Ignition

Flames and direct heat

Hot surfaces

Electrical installations and equipment

Static electricity

Lightning

Mechanically generated

Chemical reaction

Non-conductive fluids

Adiabatic compression, shock waves, flowing gases

Optical radiation

High frequency electromagnetic radiation

Ionizing radiation

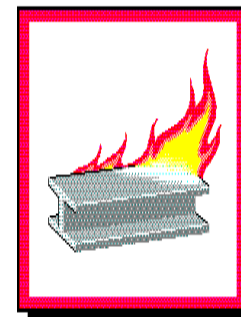
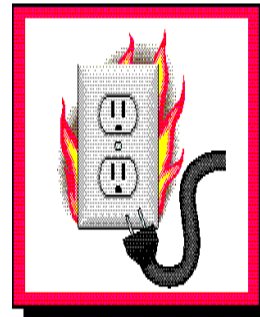
Ultrasound

Stray currents

Fire Classes

UK Classification

- Class A - Solid materials
- Class B - Liquids and liquefiable solids
- Class C - Gases
- Class D - Metals



USA Classification

- Class A - Solid
- Class B - Liquid and gaseous fuel fires
- Class C - Electrical
- Class D – Metal

Fire Types

Gas/Vapor phase

- Liquid/Pool
- Falling Liquid Droplets
- Jet (torch)
- Solid (pyrolysis)
- Flash
- Fire Balls

Combustible Dust

Solid (smouldering/self heating)

Metal

Electrical



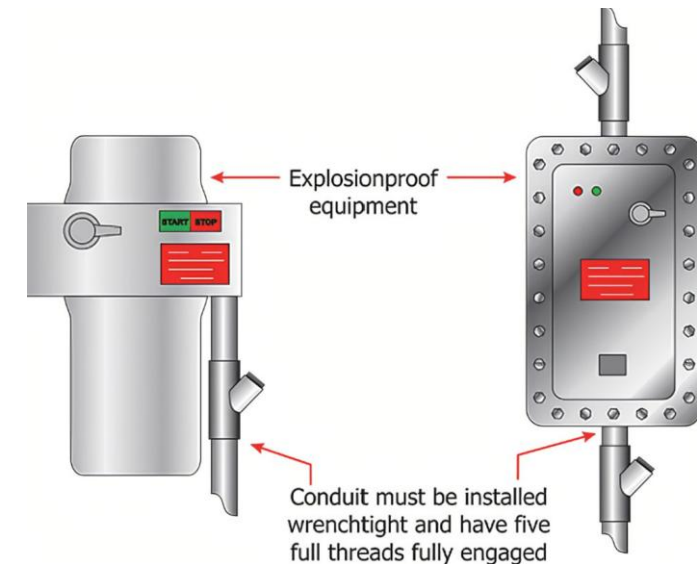
Electrical Area Classification

Electrical Area Classification – Why is it necessary ?

Electrical components can be an ignition source for flammable gases and vapors

Electrical components installed in areas handling flammable materials must be designed to minimize the possibility of introducing a spark that could result in a fire or explosion

Design of electrical components installed in hazardous areas that handle flammable liquids, gases, vapors and combustible dusts and fibers is governed by NFPA 70, the National Electric Code.



How is the Electrical Area Classification determined?

Three aspects of the potential fire / explosion hazard are evaluated:

- Type (Class) of flammable materials involved
- The specific characteristics of these materials
- The likelihood that a fire or explosion hazard will be present

Four terms are used to describe these characteristics:

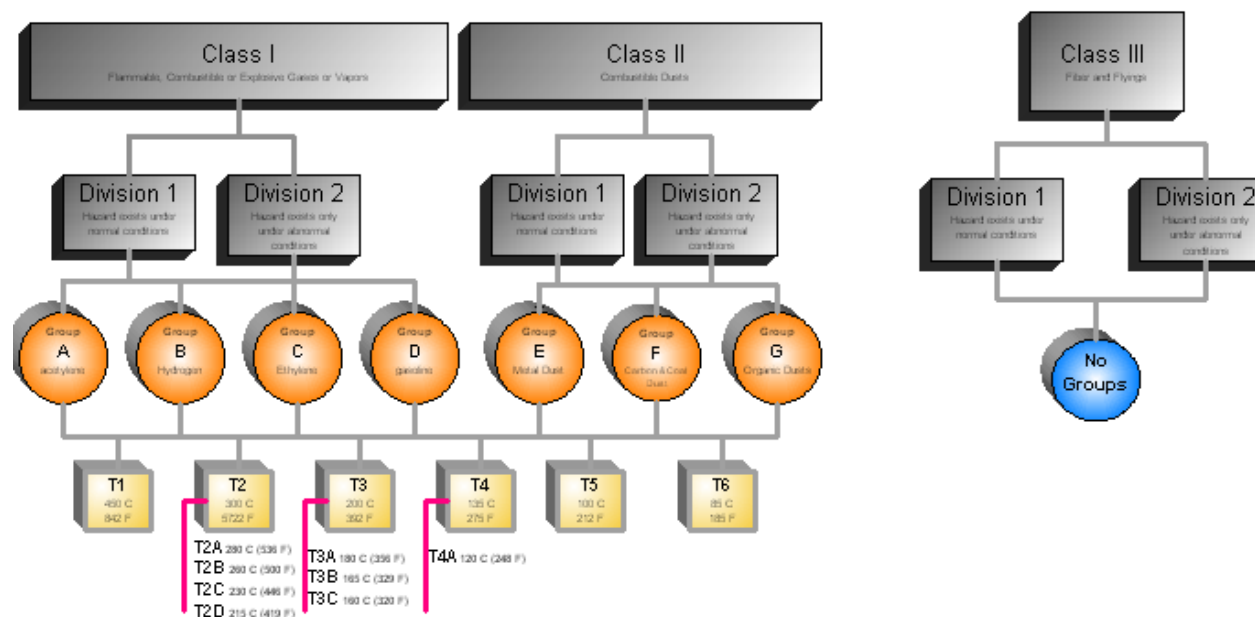
Class__ Division __ Group __ Temperature Rating __

Alternative description:

Zones

European & IEC Classification	Definition of Zone or Division	North American Classification
Zone0 (gasses)	An area in which an explosive mixture is continuously present or present for long periods	Class I Division 1 (gases)
Zone 20 (dusts)		Class II Division 1 (dusts)
Zone1 (gases)	An area in which an explosive mixture is likely to occur in normal operation	Class I Division 1 (gases)
Zone 21 (dusts)		Class II Division 1 (dusts)
Zone2 (gases)	An area in which an explosive mixture is not likely to occur in normal operation and if it occurs it will exist only for a short time	Class I Division 2 (gases)
Zone 22 (dusts)		Class II Division 1 (dusts)
		Class III Division 1 (fibres)
		Class III Division 2 (fibres)

Electrical Area Classification Schematic



Class

Class denotes the generic nature of flammable material.

- There are three Classes of flammable material:
 - Class I Flammable gases & vapors
 - Class II Combustible dust
 - Class III Ignitable fibers & flyings



Division - Defines the Probability that a Fire / Explosion Hazard Exists

Division 1	<ul style="list-style-type: none">■ Fire & explosion hazard exists under normal conditions.■ Fire & explosion hazard may exist because of maintenance / repair operations or leakage due to:<ul style="list-style-type: none">● equipment or process breakdown● faulty equipment operation● faulty process operation which causes simultaneous electrical equipment failure
Division 2	<ul style="list-style-type: none">■ Hazard does not exist under normal conditions.■ Hazardous materials normally contained within closed containers / systems■ Areas immediately adjacent to a Division 1 location.■ Hazard is only present in accidental or unusual cases.

Some General Guidelines for Electrical Area Classification

Division 1 Locations

- Vents, relief valves, fittings, packaging glands, and seals, sampling valves, open manways
- Equipment requiring frequent maintenance
- Flammable liquid dispensing areas
- Below grade areas such as pits or vaults
- Ceilings or roofs that can trap lighter than air vapors

Division 2 Locations

- Areas that are neither non-hazardous nor Division 1, generally thought of as a transition zone

Group

Group is a sub-classification of the nature of the hazard.

Materials with same general hazard are included in the same Group.

Seven Groups, A through G.

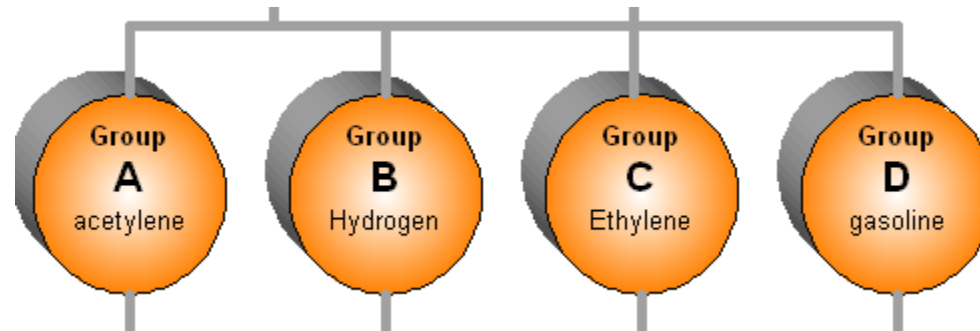
Groups A, B, C, & D - Class I materials (flammable gases and vapors)

Groups E, F, & G - Class II materials (combustible dusts)

Class III materials (ignitable fiber & flyings) – No Group Classification

IEC Systems IIA, IIB, IIC correlate to NEC/CEC Groups D, C and A/B

Grouping of Flammable and Combustible Gases or Vapors



Grouping of Flammable and Combustible Gases or Vapors

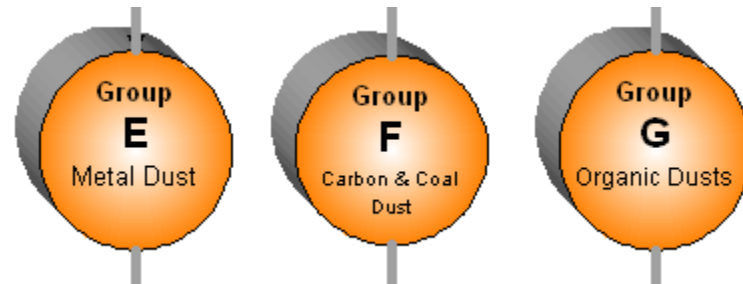
Class I materials are divided into four groups based on:

- Maximum explosive pressures.
- Maximum safe clearance between parts in an enclosure.
- Grouping by chemical families – certain chemicals create higher explosive pressures and heat when ignited.

Group A gas creates the greatest pressure during an explosion – Group D creates the least.

There is no consistent relationship between Group A, B, C, or D classification and flash point, ignition temperature, or explosive limits.

Grouping of Combustible Dusts

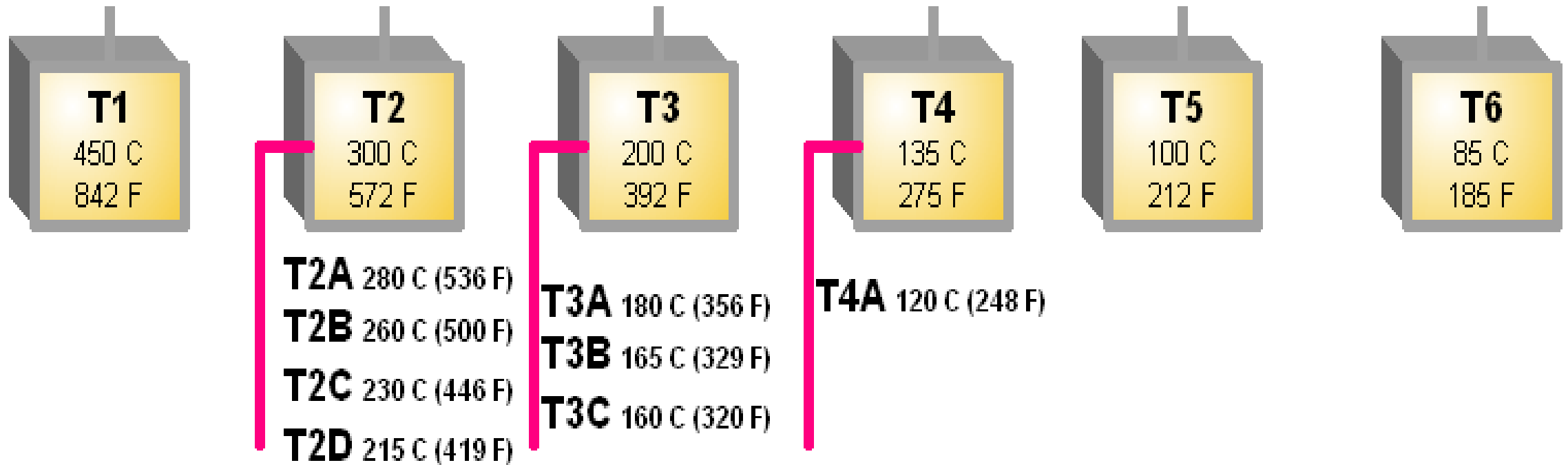


Grouping of Combustible Dusts

The grouping of Class II materials is more straightforward. Each dust Group represents materials of similar hazard:

- **Group E** Includes metallic materials that are not only combustible but are also conductive. Accumulation of metallic dusts may cause arcing between live parts that could ignite a metallic dust layer.
- **Group F** Includes carbonaceous materials of more than 8% volatile content.
- **Group G** Combustible dusts not included in Group E or F, such as, foodstuffs, grain, wood, plastic, and chemicals.

Temperature (“T”) Rating



Temperature (“T”) Rating

The “T” Rating is related to the temperature at which the flammable materials will self-ignite.

- For gases and vapors, it is based on the auto-ignition temperature of the material
- For combustible dusts and ignitable fibers and flyings, it is based the ignition temperature of a dust cloud and the minimum ignition temperature of a dust layer.

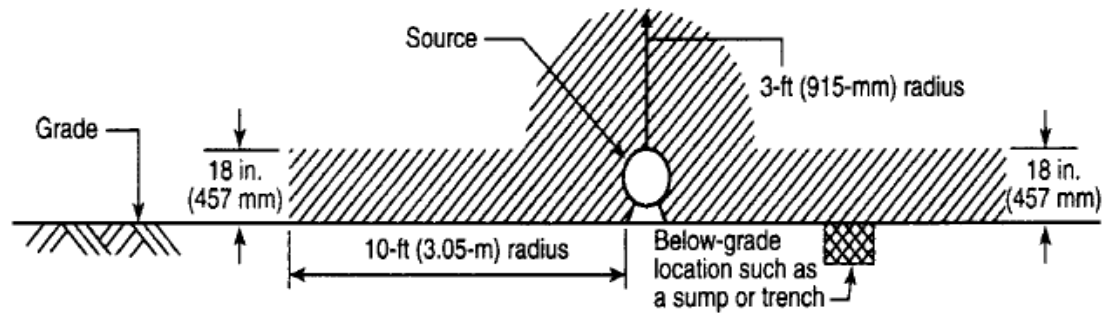
All electrical components in a classified area must be designed to meet the “T” rating, which is determined by the flammable materials being handled in that area.

When new materials are introduced to an area, the suitability of the area’s “T” rating must be verified.

Determining the Area Classification

1. Determine flammability characteristics of the materials being handled.
2. Determine probable location, rate, and quantity of release from P&IDs, PFDs, and layout drawings
3. Determine considerations such as elevation or depression relative to grade and the degree of ventilation.
4. Specify NEC group classification of the material at point of release.
5. Specify division classification and distance that classification extends from the source (bubble concept).

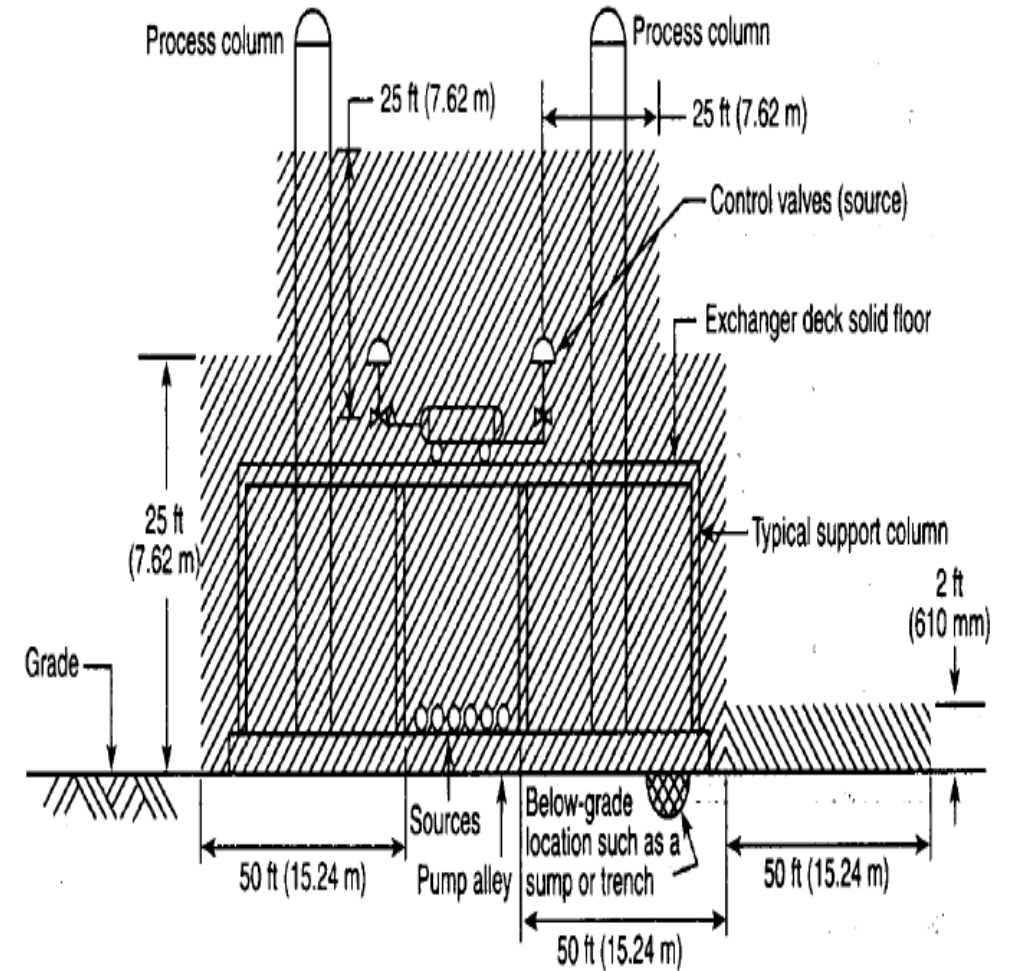
Two Examples of the “Bubble” Concept



	Small/low	Moderate	Large/high
Process equipment size	X	X	
Pressure	X	X	
Flow rate	X	X	

Division 1

Division 2



Area Classification Considerations

Gases & vapors lighter than air disperse rapidly & seldom produce hazardous mixtures at grade.

Liquids of low vapor pressure seldom render an area of any significant size hazardous.

Vapors heavier than air stay close to grade – the hazard does not exist long at elevated locations but may exist close to grade for great distances.

Air currents, ventilation, and topography are important in determining area classification.

Compressed liquefied flammable gases released as liquids readily pick up heat and vaporize producing a volume of gas much larger than the volume of liquid spilled.

IVL EHS-408 Area Classification and Management

An Area Classification Study shall be performed to classify hazardous areas where flammable liquids, gases, vapors and dust risks may arise to ensure the proper selection and installation of equipment in use.

Electrical Area Classification Diagram required for the OSHA PSM regulated areas.

**Flammable / Combustible
Liquid, Gas, Vapor or Dust**

Forms a

**Flammable or Explosive
Atmosphere**

Which finds an

Ignition Source

Resulting in a

Fire or Explosion

Minimum Requirements

Area Classification Study shall be performed in accordance with the process and methodologies within IVL EHS-408

Team of competent persons and led by an Area Classification Assessment Leader.

Full documentation of results managed as controlled documents; revalidated every 5 years or when changes occur or per regulatory requirements; and maintained for the life of the asset.

**Documentation considered PSI to be maintained through Management of Change, IVL-EHS-204.
Actions managed per Management of Actions, IVL-EHS-107.**

More stringent local or national regulatory codes take precedence.

Minimum Requirements

All equipment installed in hazardous areas which has been identified as a potential source of ignition shall be:

- Field labelled, registered, and assessed to ensure its suitability.
- Where there is documentation on file as to the suitability of equipment for use in the hazardous area and programs in place to maintain the integrity of this equipment, it is acceptable to register and label only the unique or non-standard ignition sources.
- Shall be included in an inspection, replacement and maintenance program to ensure the integrity with records retained for the life of the equipment.

The atmosphere within a hazardous (classified) location, around any instrument or electrical enclosure, shall be checked to see that it is free from concentrations of flammable or combustible materials **before the enclosure is opened.**

More stringent local or national regulatory codes take precedence.

Minimum Requirements

Management of any work activity **which could introduce an ignition source**, including hot-work zoned areas, shall be per facility's safe work permitting program (IVL EHS-301, Work Permits).

Training of operating and maintenance personnel on zoned areas and the requirements for:

- Activities within hazardous areas
- Control of ignition sources
- Management of the area

More stringent local or national regulatory codes take precedence.

Take Aways

- ❑ **Area Classification Study is required per IVL EHS-408, US OSHA PSM/RMP, and National/International Regulatory Standards**
- ❑ **Area Classifications shall be prepared with reference to RAGAGEP (NEC/CEC/IEC)**
- ❑ **All potential ignition sources and their controls must be field labelled, registered, assessed to ensure suitability, and maintained to ensure integrity**
- ❑ **Safe work practices must be in place to control ignition sources in classified areas**
- ❑ **Operations and maintenance personnel shall be trained on Area Classifications and their requirements**

Questions/Comments

