




NEBOSH Certificate in Fire Safety and Risk Management

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
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Element 2

Principles of fire and explosion

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Principles of fire and explosion

Overall aims of element

- Combustion processes
- Ignition of solids, liquids and gases
- Fire growth and spread
- Explosion and explosive combustion

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Principles of fire and explosion

Contents of element

- Combustion process
- Ignition
- Fire growth
- Explosion

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Principles of fire and explosion

Contents of element

- Combustion process
 - Ignition
 - Fire growth
 - Explosion


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Principles of fire and explosion


Combustion process

Concept of the fire triangle



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Principles of fire and explosion

Combustion process

Combustion

- Chemistry of combustion
- Conditions for the maintenance of combustion
- Combustion as a complex dynamic process

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Principles of fire and explosion


Combustion process

Combustion

Chemistry of combustion

“Combustion is defined as being a chemical reaction during which heat energy and light energy are emitted”

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Principles of fire and explosion

Combustion process


Combustion

Conditions for the maintenance of combustion

- Fuel
 - The fuel dictates all aspects of fire. The type of fuel, the format the fuel is in, or how much is present in the air will control its susceptibility to fire
- Heat
 - The level of heat required to cause ignition is dictated by the format (solid, liquid, vapour or gas) and type of fuel
- Oxygen
 - This is provided from the air around us. Other than in specialised industrial applications it is always present

For the combustion process to be maintained all three of the component parts above must remain present

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Principles of fire and explosion

Combustion process


Combustion

Conditions for the maintenance of combustion

If one or more of these parts of the fire is removed, the fire will be extinguished. This can be done by:

1. **COOLING** the fire to remove the heat, e.g. water or foam extinguisher
2. **STARVING** the fire of fuel, e.g. isolation of gas supply.
3. **SMOTHERING** the fire by limiting its oxygen supply, e.g. foam extinguisher
4. **CHEMICAL INTERFERENCE** of the flame reactions, e.g. method by which some extinguishing media works

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Principles of fire and explosion

Combustion process

Combustion

Combustion as a complex dynamic process

Chemical reactions in the combustion process


- happening very quickly
- at very high temperatures
- and in very small volumes

Tiny reactions are exothermic - give out sufficient excess heat to initiate the next chemical reaction

Combustion is therefore a chain reaction

All flame reactions depend on 'free radicals'

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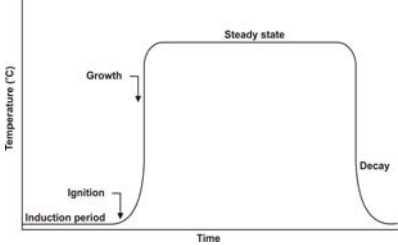


Principles of fire and explosion


Combustion process

Description of the stages of combustion

- Induction
- Growth
- Decay



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Principles of fire and explosion


Combustion process

Description of the stages of combustion

Induction

- Represents the early stages of a fire
- May often be a slow process such as in a smouldering fire

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Principles of fire and explosion

Combustion process

Description of the stages of combustion


Induction

- Represents the early stages of a fire
- May often be a slow process such as in a smouldering fire

Growth

- This phase will often grow very quickly
- Only limited by the availability of oxygen

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Principles of fire and explosion

Combustion process

Description of the stages of combustion

Induction

- Represents the early stages of a fire
- May often be a slow process such as in a smouldering fire


Growth

- This phase will often grow very quickly
- Only limited by the availability of oxygen

Decay

- This is the final stages of a fire
- As the fuel runs out the combustion process will quickly slow down, and eventually come to a stop

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Principles of fire and explosion

Combustion process

Outline of the chemical reactivity

- Endothermic
- Exothermic

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Principles of fire and explosion


Combustion process

Outline of the chemical reactivity

Endothermic

- Chemical reactions that must absorb energy in order to proceed are called endothermic reactions
- Endothermic reactions cannot occur spontaneously
- When endothermic reactions absorb energy, a temperature drop is measured during the reaction

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Principles of fire and explosion


Combustion process

Outline of the chemical reactivity

Exothermic

- Many chemical reactions release energy in the form of heat, light, or sound. These are exothermic reactions
- Exothermic reactions may occur spontaneously
- Some exothermic reactions produce heat very quickly resulting in an explosion

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Principles of fire and explosion

Contents of element

- Combustion process
- Ignition
- Fire growth
- Explosion

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Principles of fire and explosion

Ignition

- Identification of ignition sources
- Ignition of solid materials
- Ignition of liquids and gases

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Principles of fire and explosion

Ignition

Identification of ignition sources

- The majority of fires need an ignition source to enable them to start
- An assessment should be made in the workplace to identify all ignition sources likely to be present
- Then the surrounding areas can be checked for combustible materials or gases that are normally, or are likely, to be present
- A study can be made to assess the viability of separating the ignition source and combustible material from each other

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Principles of fire and explosion


Ignition

Identification of ignition sources

- Smokers' materials
- Sparks from welding equipment
- Sparks from electrical motors
- Sparks from grinding equipment
- Oxy-acetylene welding equipment
- Fixed or portable heaters
- Cooking equipment
- Bitumen boilers

continued

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Principles of fire and explosion

Ignition

Identification of ignition sources

- Electrical faults and overloaded electrical circuits
- Steam pipes
- Overheating equipment
- Static electricity
- Non-intrinsically safe equipment used in a flammable atmosphere
- Radiated heat from a legitimate source such as a light bulb
- Hot surfaces such as soldering irons or hot glue guns
- People with the intent to cause harm or deliberate acts of ignition

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Principles of fire and explosion

Ignition

Identification of solid materials

- 'the smaller the particles of material, the easier it is to ignite'
- It first chemically decomposes and produces carbon products in the form of a vapour
- It is these that ignite when mixed with the oxygen from the air

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Principles of fire and explosion

Ignition

Identification of liquids and gases

- A flammable liquid gives off vapours and it is these vapours that ignite
- The influence of the temperature of a flammable liquid on ease of ignition is important and when measured is called the '*flashpoint*' of a flammable liquid
- Flammable gases behave differently to liquids as they are already in the gaseous state
- These small gaseous particles readily mix with the available oxygen and are easily ignited by an ignition source

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Principles of fire and explosion

Ignition

Definitions

- Flashpoint
- Auto ignition temperature
- Vapour density
- Vapour pressure
- Flammable limits

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Principles of fire and explosion


Ignition

Definitions

Flashpoint

'Flash Point' is defined as the lowest temperature at which, in a specific test apparatus, sufficient vapour is produced from a liquid sample for momentary or flash ignition to occur

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Principles of fire and explosion

Ignition

Definitions

Auto ignition temperature

- 'Auto Ignition Temperature' is the lowest temperature at which a substance will ignite spontaneously
- Will burn without a flame or other ignition source
- Is sometimes called 'Spontaneous-Ignition Temperature'

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