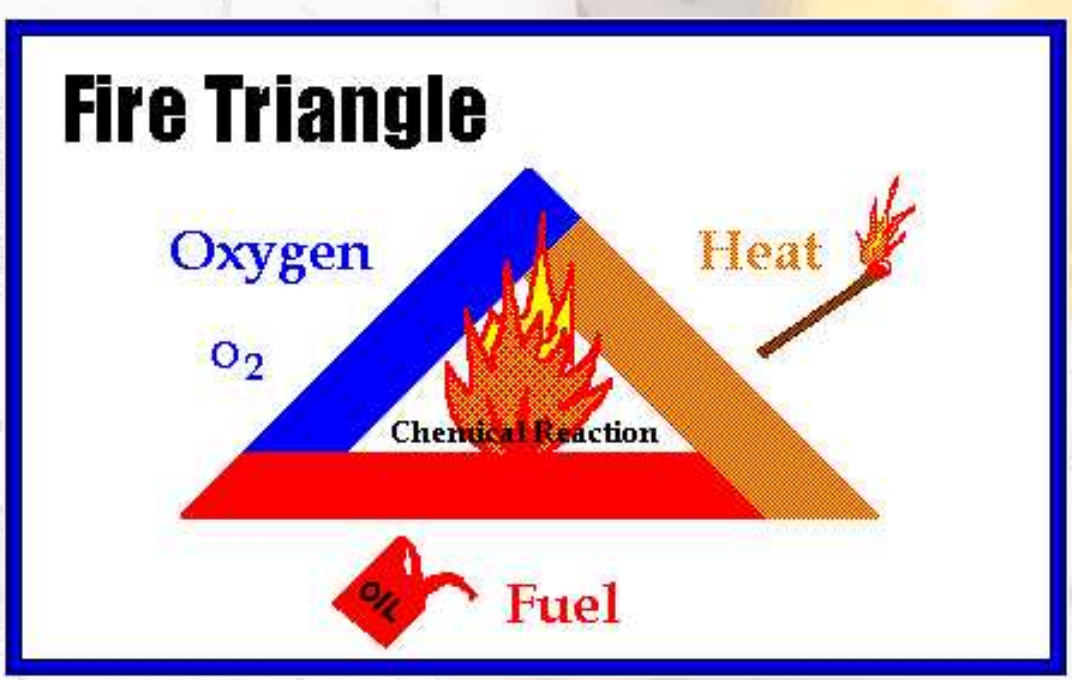
The Fire Triangle



Fire Safety, at its most basic, is based upon the principle of keeping fuel sources and ignition sources separate.

Fire Extinguishment Theory

Three things must be present at the same time to produce fire:

1. **Enough OXYGEN**
2. **Enough HEAT**
3. **Some FUEL**
4. **Together, they produce the CHEMICAL REACTION that is fire**

Take away any of these things and the fire will be extinguished

The Triangle of Fire

Oxygen

Smothering

Heat

Source of ignition

Cooling

Fuel

Starving

EXTINGUISHING METHODS

STARVATION …… TO REMOVAL OF FUEL

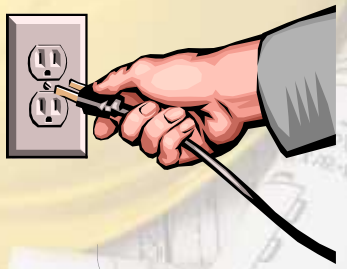
SMOTHERING …… TO REMOVEL OF OXYGEN

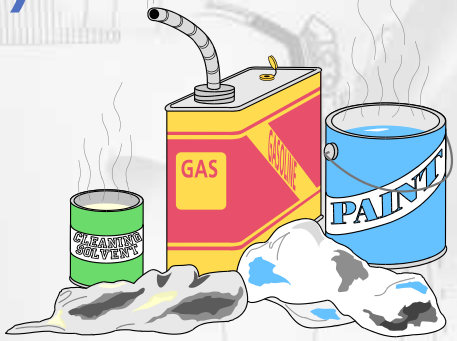
COOLING ….. TO REMOVAL OF HEAT

HAZARDS AND HAZARD MANAGEMENT

SOURCES OF IGNITION

- Naked flames
- Electricity (Overheating/Arcing)
- Smoking materials
- Hot work (Welding, burning)
- Chemical reactions (Giving off heat)
- Heating appliances (Hot surfaces)
- Friction (Inadequate lubrication)
- Static electricity
- Lightning
- Improper storage of flammable materials
- Lack of inspection and supervision





HAZARDS AND HAZARD MANAGEMENT

Harm to persons from fire

Main effects

- Being burnt
- Inhaling toxic fumes
- Effects of smoke inhalation
- Depletion of oxygen supply

Other effects

- Collapse of building
- Crush or other injury sustained while escaping

METHODS OF HEAT TRANSFER

- **CONDUCTION**

HEAT TRANSFER THROUGH A MEDIUM OF SOLID BODY.

- **CONVECTION**

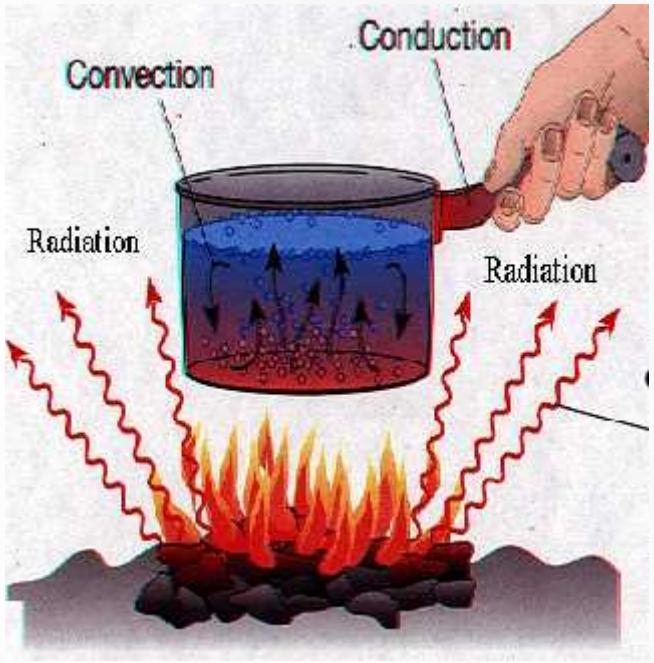
HEAT TRANSFER THROUGH UPWORD MOTION OF HEATED MATTERS.

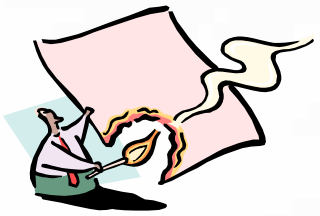
- **RADIATION**

HEAT TRANSFER THROUGH AIR HEAT WAVE.

- **DIRECT BURNING**

COMBUSTIBLE MATERIALS IN CONTACT WITH NAKED FLAME





HAZARDS AND HAZARD MANAGEMENT

CAUSES OF FIRE

- Deliberate (Arson)
- Electrical faults
- Misuse of electrical equipment
- Smokers materials
- Smoking in prohibited areas
- Loss of control burning rubbish
- Heating equipment
- Unsafe storage of materials
- Flammable liquids/gases
- Welding/hot work
- Mechanical heat (Friction)

Classification of Fires

Class	Type of fuel	Examples
A	Combustible solids	Paper, Wood
B	Flammable liquids	Petrol, Diesel
C	Flammable gases	LPG, Acetylene
D	Flammable metals	Sodium, Potassium
F	Combustible cooking media	Kitchen Fire
electrical equipment	Electrical - classified according to the source of ignition rather than fuel source	Electrical equipment

Hazards and hazard management

Extinguishing Agents

Class	Type of Extinguisher
A	Water, Dry powder
B	Foam, CO2 , Dry powder
C	Dry Powder,CO2
D	Special type DCP
F	The foam congeals on the top of the oil
Electrical	CO2, Dry Powder

Outline key stage of Fire Risk Assessment?

1) **Identify hazards:**

   The three elements of the triangle of fire

   Fuel, Oxygen and Heat

2) **Identify who could be harmed:**

   Persons at risk particularly the disabled etc.

3) **Evaluate the risks and adequacy of precautions:-**

   Considering prevention, protection and precautions

4) **Record findings:**

   Prepare an emergency plan

5) **Review:**

   Annually , changes in process, Equipment's

HAZARDS AND HAZARD MANAGEMENT

Factors To Consider In Fire Risk Assessment

- Construction and use of building
- Flammable materials
- Sources of ignition
- Work activities generating heat
- Methods of control
- Means of fire detection
- Means of raising the alarm
- Means of fighting fire/maintenance of equipment
- Evacuation routes/Protection of routes
- Numbers of persons at risk
- Fire prevention training/fire drills

HAZARDS AND HAZARD MANAGEMENT

Identify the factors that should be addressed in the fire plan.

Factors that should be addressed in the fire plan include:

- The action workers should take if they discover a fire;
- The system for raising the alarm
- The system of notifying the fire service;
- The escape routes and travel distances
- The provision of fire exit route signs;
- The provision of emergency lighting;
- The provision and siting of fire fighting equipment;
- The identification of an assembly point and the procedures for taking a roll call;
- The appointment of and delegation of specific responsibilities to marshals and wardens;
- The arrangements for workers with disabilities and for non-workers;
- The location of service shut down switches and valves
- The arrangements for stopping and isolating machinery and plant in the event of a fire;
- The training required for all workers and that for those with special responsibilities
- Coordination and cooperation with other employers who might be affected if a fire occurred.

Prevention, Protection & Precautions

1) **Fire Prevention**
   Control measures to reduce the risk of fire
   Starting

2) **Fire Protection**
   Structural measures to reduce the risk of fire
   Spreading

3) **Fire Precautions**
   Measures taken to reduce the risk in the
   Event of fire

HAZARDS AND HAZARD MANAGEMENT

Fire Prevention

Aim to keep the three sides of the fire triangle apart:

- Eliminate or reduce the storage of flammable materials
- Control of ignition sources
- Control smoking materials
- Good housekeeping
- Lubrication of machinery to prevent friction
- No overloading of electrical systems
- Regular inspections of electrical systems
- Ventilation outlets not obstructed
- Controlling hot work with permits etc.
- Proper storage of flammable materials
- Segregation of incompatible chemicals
- Security to prevent arson
- Regular Inspection and supervision

FIRE PROTECTION

Compartmentation

Splitting a building into separate sealed areas made of fire-resisting materials

Restricts the spread of fire and smoke within a building

Depends upon:

- **the use of the building**
- **building height**
- **floor area**
- **compartment volume**

Hazards and hazard management

Fire Protection

Fire resistant materials

- Primary construction: the main “fabric” of the building – walls, floors , roofs and internal walls
- Secondary construction: internal partitioning
- internal walls & Ceiling lines
- Bricks
- Concrete
- Structural steel

Hazards and hazard management

Fire Precautions

a) Fire/smoke detection

b) Fire alarms

c) Means of escape

d) Means of fighting the fire

e) Emergency evacuation procedures

Fire Detection and Alarm Systems

- Simple with more noise
  - hand bell, whistle or air horn
- Manually-operated fire alarm
  - manual call points
- Automatic fire detection and alarm
  - automatic detectors, manual call points, linked to sounders/lights

Fire Detection

- Smoke detectors
  - Detect small smoke particles
  - Two main types: ionising and optical
  - Can give rise to false alarms
- Heat detectors
  - Detect excess heat generated by a fire
  - Usually less sensitive and give later warning
  - May not detect fires that are giving off smoke but not much heat

Limitation of Extinguishers

- MUST use the correct extinguisher on the fire
  - Water conducts electricity so **NEVER** use on electrical fires
  - Powder is effective but may destroy electrical equipment

Other Fire-Fighting Equipment

- Fire blankets
  - physically smothers fires, e.g. fat fires in kitchens
- Hose reels
  - used in large buildings for fire teams
- Sprinkler systems
  - sited in buildings and warehouses
  - automatically dowses the fire

Means of Escape (safe Evacuation)

- Available to every person in the workplace
- No use of lifts
- Two or more separate routes may be required
- Travel distance should be short
- Adequate width
- Clearly signed
- Appropriately lit
- Emergency lighting
- No obstructions
- Suitable assembly point
- Exit to safe place
- Fire resistance of structure
- Adequate size for numbers
- Clearly marked exits

Provision for Infirm and Disabled

- Staff with disabilities may need personal evacuation plans
  - Assist with travel downstairs
  - Alert those with hearing impairment
- May need to consider temporary disabilities, e.g. use of crutches
- Consider also evacuation of young/elderly

Fixed Fire Fighting Equipment

Hose Reel

Sprinkler

Hose Reels

Permanently connected to the mains water supply. Should be sited in a location which covers the whole area.

Advantages	Disadvantages
Inexpensive, Effective	Only suitable for class A fires
Harmless to health	Poor siting may cause inadequate coverage
Unlimited supply of water at good pressure	Hose could be damaged
Greater force than sprinkler	May create trip hazards
Operators need not be too close to the fire	

HAZARDS AND HAZARD MANAGEMENT

Automatic Sprinkler Systems

A network of water pipes with spray heads normally at ceiling height is installed in vulnerable areas

Advantages	Disadvantages
Large coverage of water to prevent the spread of fire in large open plan buildings where. Less manpower	Only suitable for Class A fires Causes damage to equipment and furnishings

HAZARDS AND HAZARD MANAGEMENT

Inspection & Maintenance of Fire Extinguishers

Inspection

Routine (perhaps monthly) visual checks to ensure extinguishers are in place, not been discharged or damaged

Maintenance

Involves an annual examination by a competent person with the removal and replacement of equipment found faulty and the date of the inspection recorded

HAZARDS AND HAZARD MANAGEMENT

Siting of Fire Extinguishers

- Accessibility
- Proximity to exits/Escape routes
- Visibility and signage
- Located off ground with adequate support
- Suitable type
- Protection against damage and weather

HAZARDS AND HAZARD MANAGEMENT

Practice Drills

Practice drills should be undertaken to:

- Checking alarm can be heard throughout the premises
- Testing the effectiveness of the evacuation procedure
- Familiarising employees with the alarms etc.
- Giving fire wardens to practice their roles
- Satisfy a legal requirement e.g. fire certificate and to provide instruction to employees on action to be taken