1. Fire Services Part 1

1.1 Fire safety and protection

Ir Dr. Sam C. M. Hui
Department of Mechanical Engineering
The University of Hong Kong
E-mail: cmhui@hku.hk

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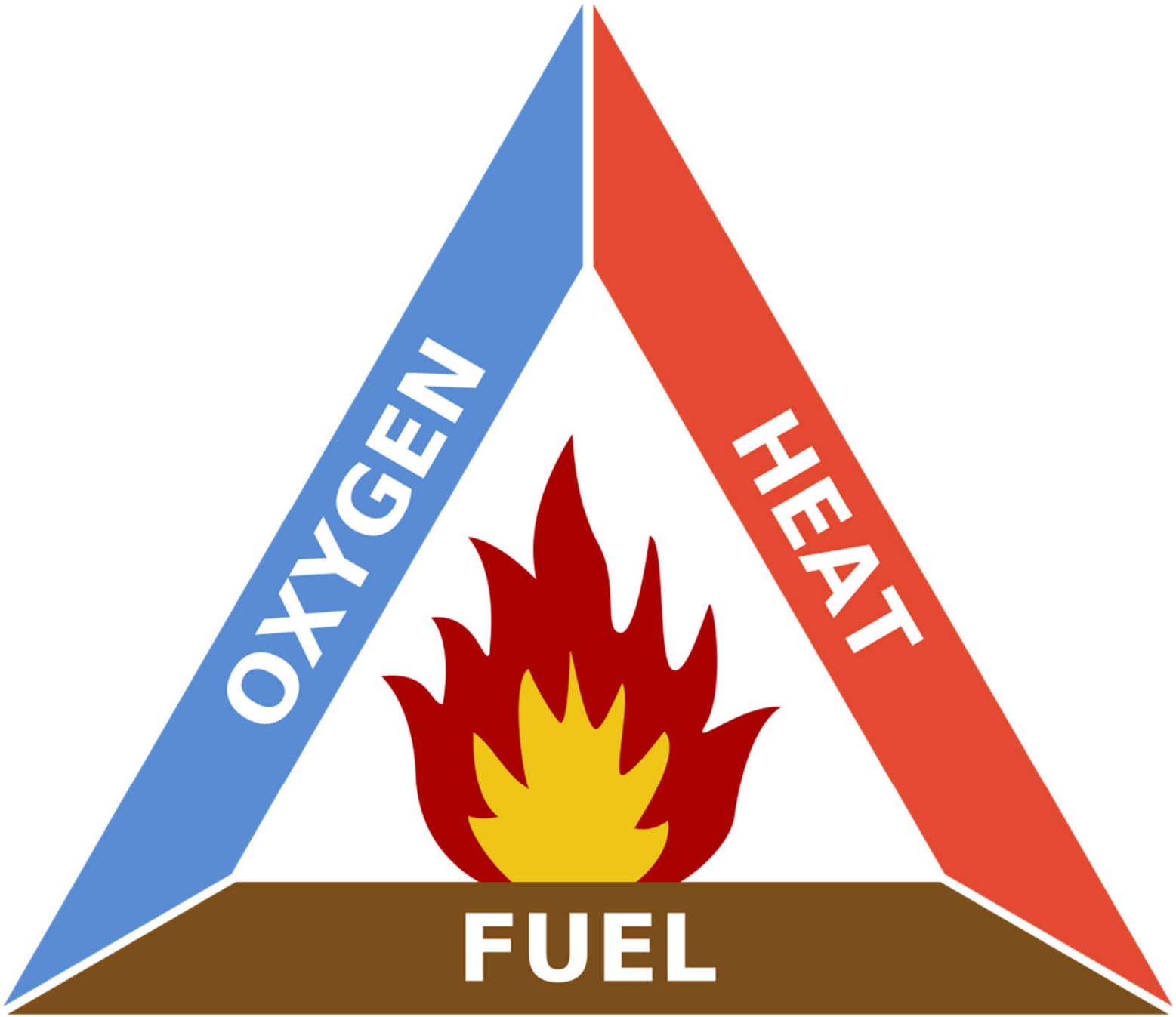
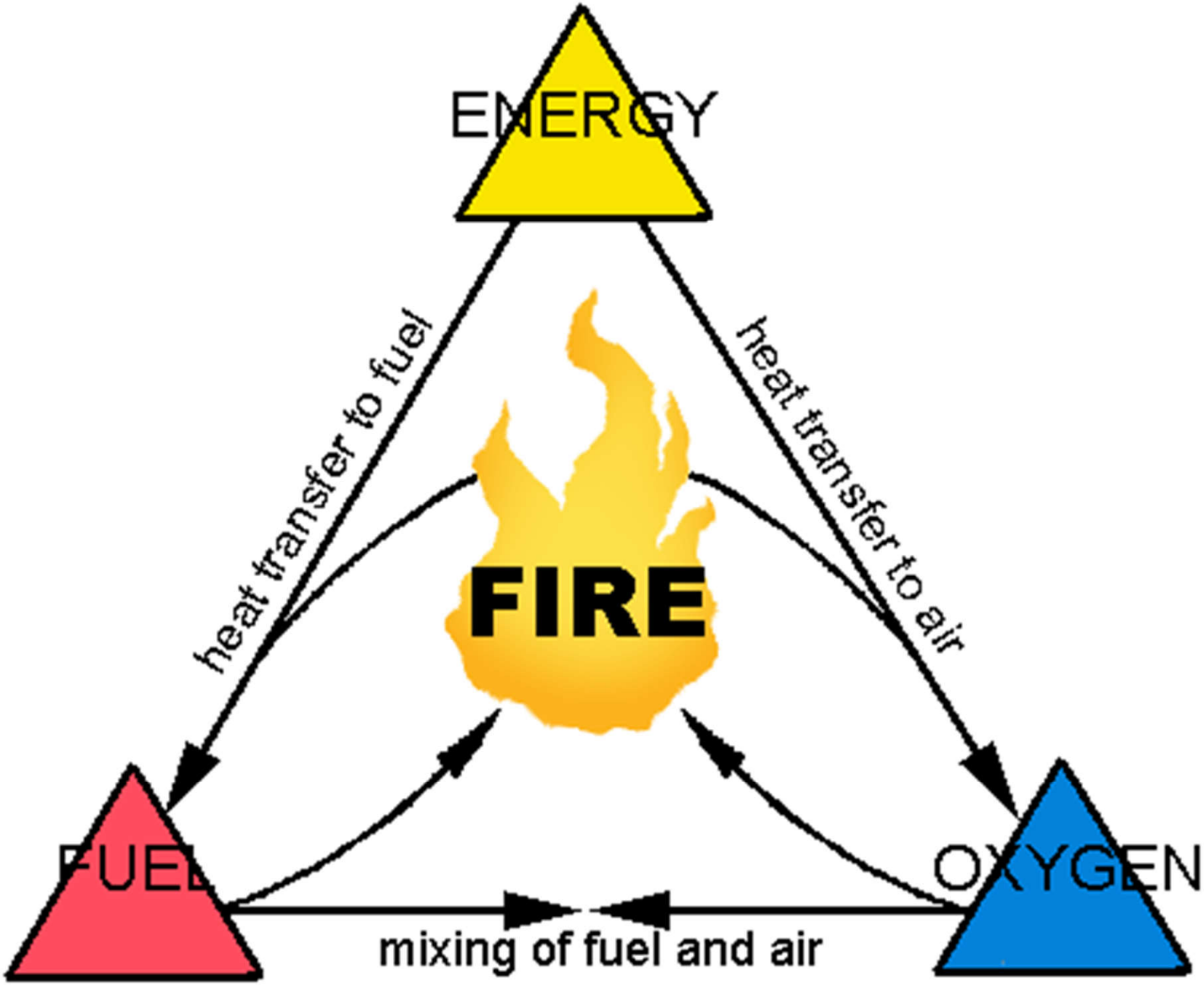
Fire safety concepts

- Fire is a form of chemical reaction that involves the rapid oxidation of combustible fuel (material) with the subsequent liberation of heat and light
- Four major elements to produce fire:
  - 1. Enough oxygen to sustain combustion
  - 2. Heat to raise the material to its ignition temp.
  - 3. Some sort of fuel or combustible material
  - 4. The chemical, exothermic reaction that is fire

Fire-triangle: oxygen (air), fuel and heat (ignition source)

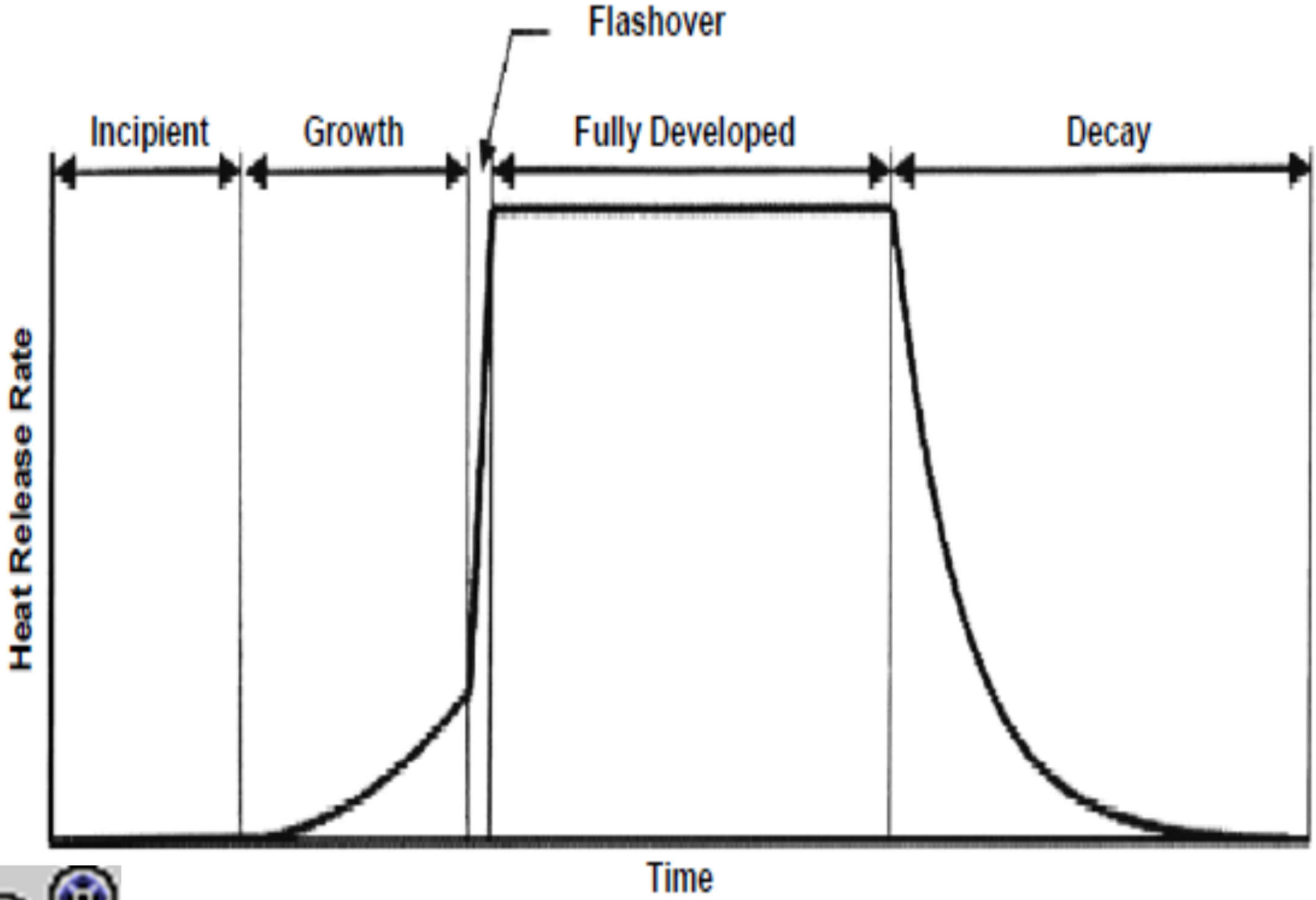


Fire triangle and heat transfer



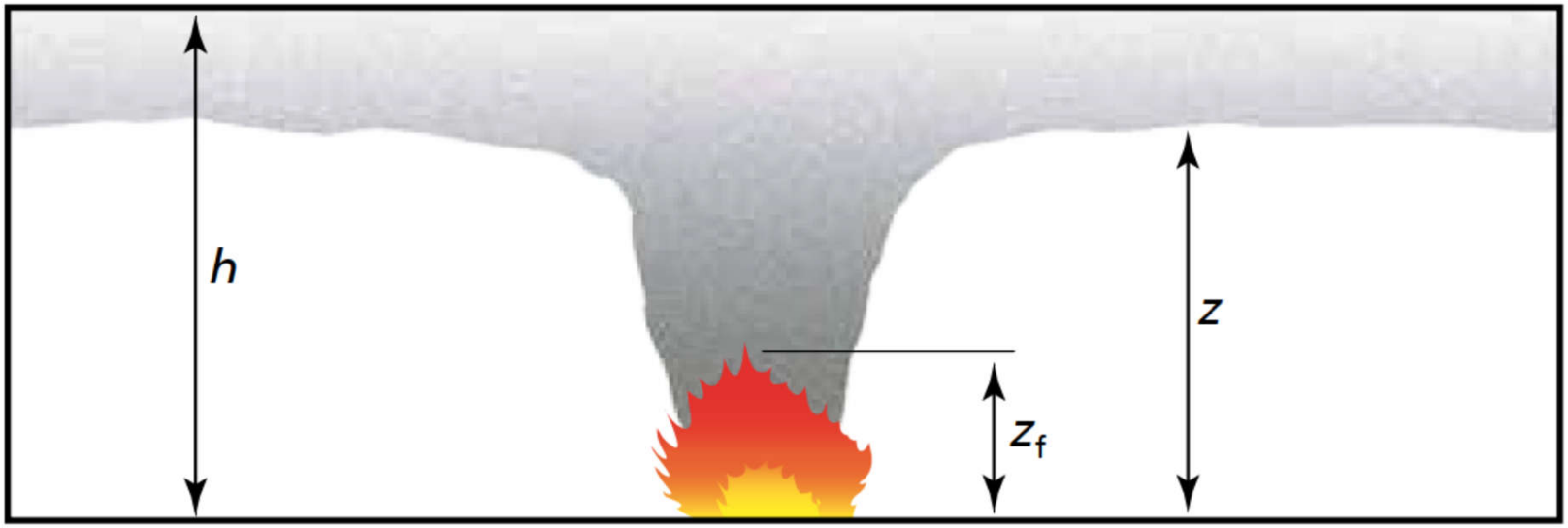
[Source: https://pslc.ws/fire/howwhy/triangle.htm]

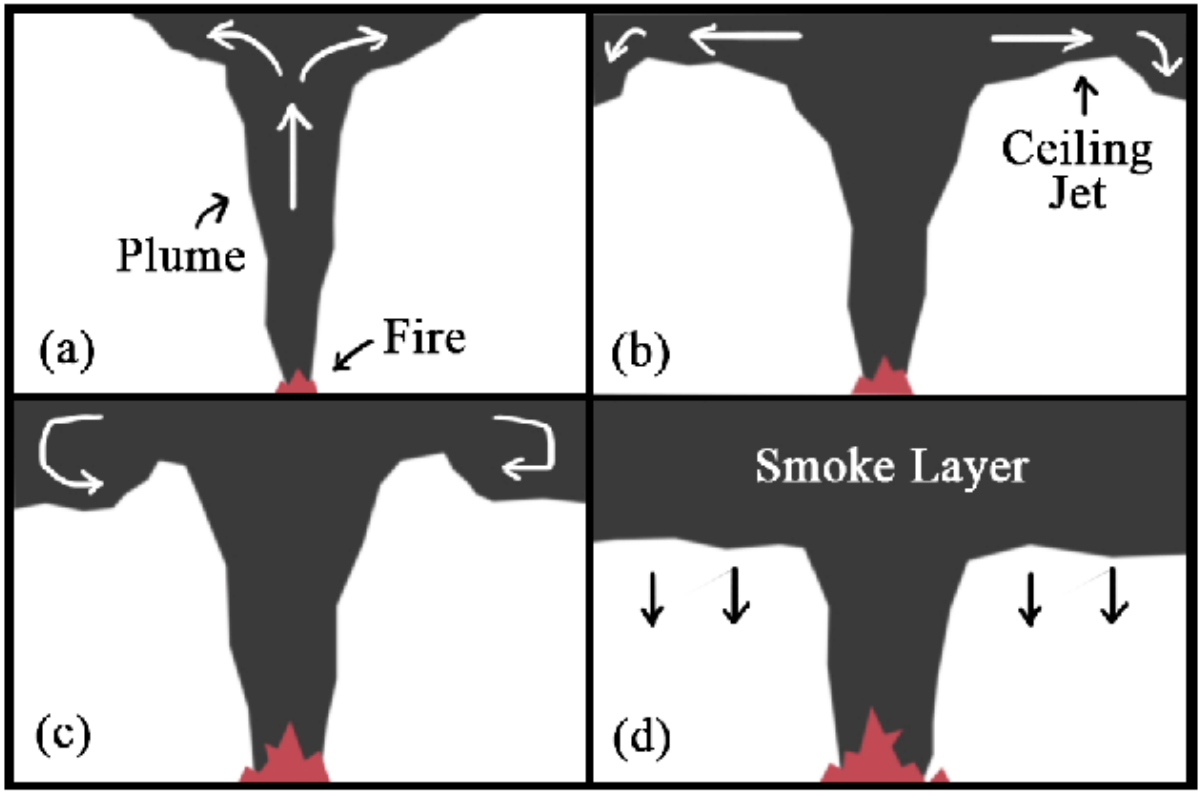
Flashover (閃燃) and typical phases of a fire curve



[Video: NIST Flashover.mpg (4:09) https://youtu.be/w4W82HIzUcc]

Fire smoke plume and the process of smoke distribution in a room





[Source: CIBSE, 2019. *Fire Safety Engineering*, CIBSE Guide E, 4th ed. & https://www.researchgate.net/publication/328651289_Smoke_Models_For_Buildings]

Two types of fire

(a) Controlled (safe) fire

- Good control on the size, duration, temperature, smoke and fumes of fire
- Used in our daily life e.g. cooking, heating (by gas, coal or kerosene), car, aeroplane and rocket engines
- It requires the presence of air (oxygen), fuel and heat (ignition source) [known as the fire-triangle]

(b) Uncontrolled (dangerous) fire

- No control on the size, duration, temperature (1000 ºC or more), smoke and fumes of fire
- Occurs due to the accidental (or due to criminal act) spread of fire to catch combustible materials
- In addition to oxygen, fuel and heat, this type of fire requires an uninhibited chain reaction
- In an uninhibited chain reaction burning continues and may even accelerate
- This chain reaction occurs due to the breakdown and recombination of the molecules that will add to the fuel of the fire

Fire safety concepts

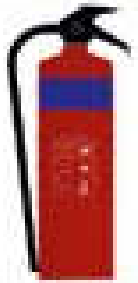
- Effects of uncontrolled fire
  - a) Human loss: burning from extreme heat; suffocation from smoke and fumes and death
  - b) Structural damage: damage to labs, offices and buildings
  - c) Material damage: damage to instruments, equipment, furniture and supplies
  - d) Disruption of work
  - e) Financial losses

Classification of fires/fuels

A		Ordinary Combustibles	Wood, Paper, Cloth, Etc.
B		Flammable Liquids	Grease, Oil, Paint, Solvents
C		Live Electrical Equipment	Electrical Panel, Motor, Wiring, Etc.
D		Combustible Metal	Magnesium, Aluminum, Etc.
K		Commercial Cooking Equipment	Cooking Oils, Animal Fats, Vegetable Oils

[Source: https://fireprevention.utexas.edu/firesafety/abcs-fire-extinguishers]

Fire Extinguisher Chart

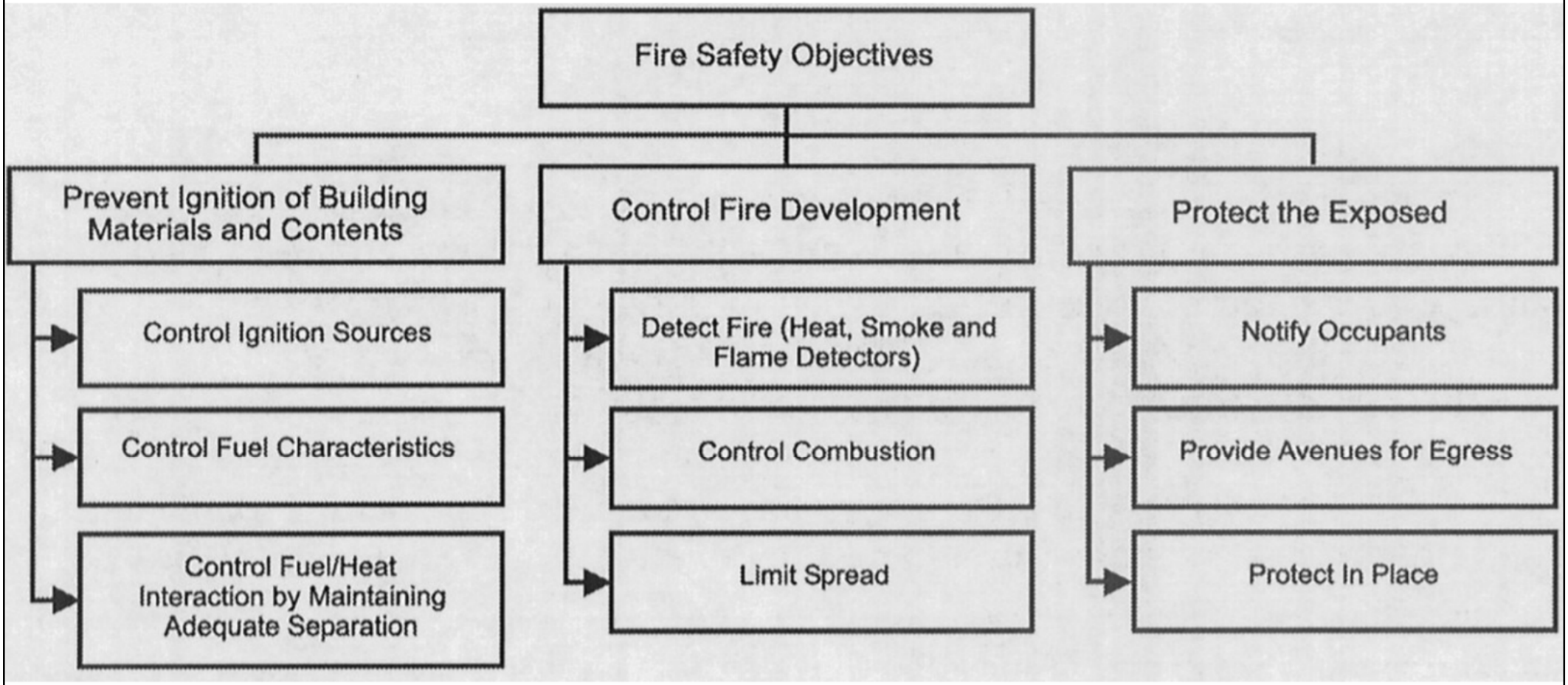
Extinguisher		Type of Fire				
Colour	Type	Solids (wood, paper, cloth, etc)	Flammable Liquids	Flammable Gasses	Electrical Equipment	Cooking Oils & Fats
	Water	✓ Yes	✗ No	✗ No	✗ No	✗ No
	Foam	✓ Yes	✓ Yes	✗ No	✗ No	✓ Yes
	Dry Powder	✓ Yes	✓ Yes	✓ Yes	✓ Yes	✗ No
	Carbon Dioxide (CO2)	✗ No	✓ Yes	✗ No	✓ Yes	✓ Yes

[Source: https://sites.google.com/site/ouhscemergencysafety/fire/types-of-fire-extinguishers]

Fire safety concepts

- Typical fire safety objectives:
  - 1. Prevent the occurrence of fire and explosion
  - 2. Reduce the risk to life caused by fire
  - 3. Reduce the risk of damage caused by fire to the property and the environment
  - 4. Contain, control and suppress fire and explosion in the compartment of origin
  - 5. Provide adequate and readily accessible means of escape for people (e.g. evacuation)

Basic concepts of fire safety objectives



[Source: Watson D., 2000. *Detection Devices, Time-Saver Standards for Building Materials and Systems: Design Criteria and Selection Data*, D4-1-7, McGraw-Hill, New York, NY.]

Fire safety concepts

- Building fire safety issues:
  - 1. Prevention
    - Planning considerations
    - Construction & design considerations (e.g. fire resisting)
  - 2. Suppression
    - Fire alarm system: smoke & heat detectors
    - Fire suppression: fire extinguishers, fire sprinkler systems, hose reels, smoke extractors
  - 3. Evacuation
    - Egress routes & exits, access for firefighters

Fire safety concepts

- The 7 layers of fire safety in buildings:
  - Prevention
  - Detection
  - Early suppression
  - Evacuation
  - Compartmentation
  - Structural safety
  - Firefighting

[Source: https://www.modernbuildingalliance.eu/EU-fire-safety-guide]

Risk management

- Fire risk management procedures:
  - Risk assessment
    - Risk identification: systematic process to understand how, when, and why fire could happen
    - Risk analysis: estimate magnitudes of consequence and probabilities of the adverse effects
    - Risk evaluation: applying the developed risk criteria and making a decision about the level of fire risk
  - Risk treatment
    - Improve existing risk controlling measures, develop new measures & implement them to reduce fire risk

Examples of fire action signs

[Source: http://www.safety.hku.hk/homepage/pdf/FS.pdf]

Risk management

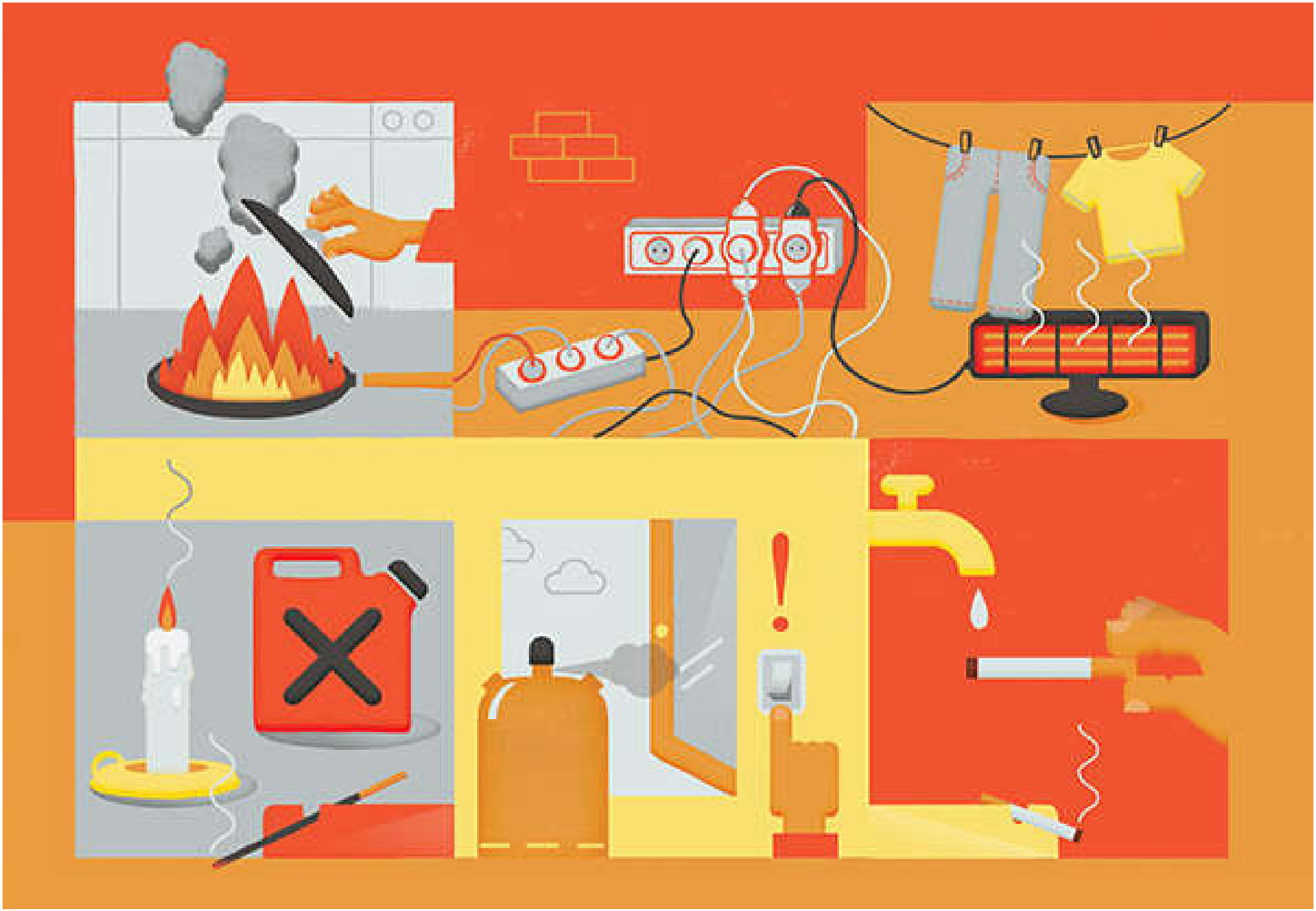
- Fire risk assessment
  - Identifies possible hazards as well as the actions and/or precautions needed to ensure the safety of people using a premises
  - Must be systematic, thorough and up to date
  - Should be reviewed whenever significant alterations are made to the premises
- Understanding of relevant fire safety legislation, principles of fire safety & hazards

Typical steps in the fire risk assessment process

1. Identify all fire hazards	Include sources of ignition, fuel & oxygen
2. Identify people at risk	Include people in & around the premises, and people especially at risk, e.g. elderly, infirm or disabled people
3. Evaluate the risk and decide if existing fire safety measures are adequate -- then remove, reduce and protect people from the risk wherever possible	• Evaluate the risk of a fire occurring • Evaluate the risk to people from fire • Remove or reduce fire hazards • Remove or reduce the risks to people Actions include: detection & warning, fire fighting, escape routes, lighting, signs and notices, maintenance
4. Record, plan, inform, instruct and train	• Record significant findings & actions taken • Prepare an emergency plan • Inform and instruct relevant people and, where necessary, co-operate and co-ordinate with others • Provide training
5. Review	• Keep the assessment under review • Revise it where necessary

[Source: https://app.croneri.co.uk/topics/fire-safety-risk-assessment-and-prevention/indepth?topic=3419]

Examples of fire risks & hazards



[Source: https://www.behance.net/gallery/16610575/Nablus-Fire-Prevention-Campaign]

Common fire hazards

1. Careless disposal of lighted cigarettes or matches
2. Accumulation of rubbish, paper or other materials that can easily catch fire
3. Electrical wiring, plugs and sockets kept in poor conditions or overloaded
4. Electrical equipment left switched on when not in use (unless designed to be permanently connected)
5. Flammable material left close to sources of heat
6. Obstruction of heater, machinery or office equipment ventilation
7. Inadequate cleaning of work areas
8. Exits and exit doors being locked up
9. Careless handling or over storage of dangerous substances
10. Lack of proper maintenance of fire service installations and equipment

Major fire risks in commercial premises

1. Obstruction to means of escape
2. Locked exits and exit doors
3. Wedging of smoke stop door
4. Combustible decorative material used indoors or along means of escape
5. Hindrance to fire fighting due to poor housekeeping
6. Unauthorized alteration of partitions
7. Unauthorized change of use of occupancy
8. Lack of proper maintenance, unauthorized alteration or removal of fire service installations and equipment
9. Floating obstructions which affect the use or operation of fire service installations and equipment

[Source: https://www.hkfsd.gov.hk/eng/source/safety/fs_comm_premises.pdf]

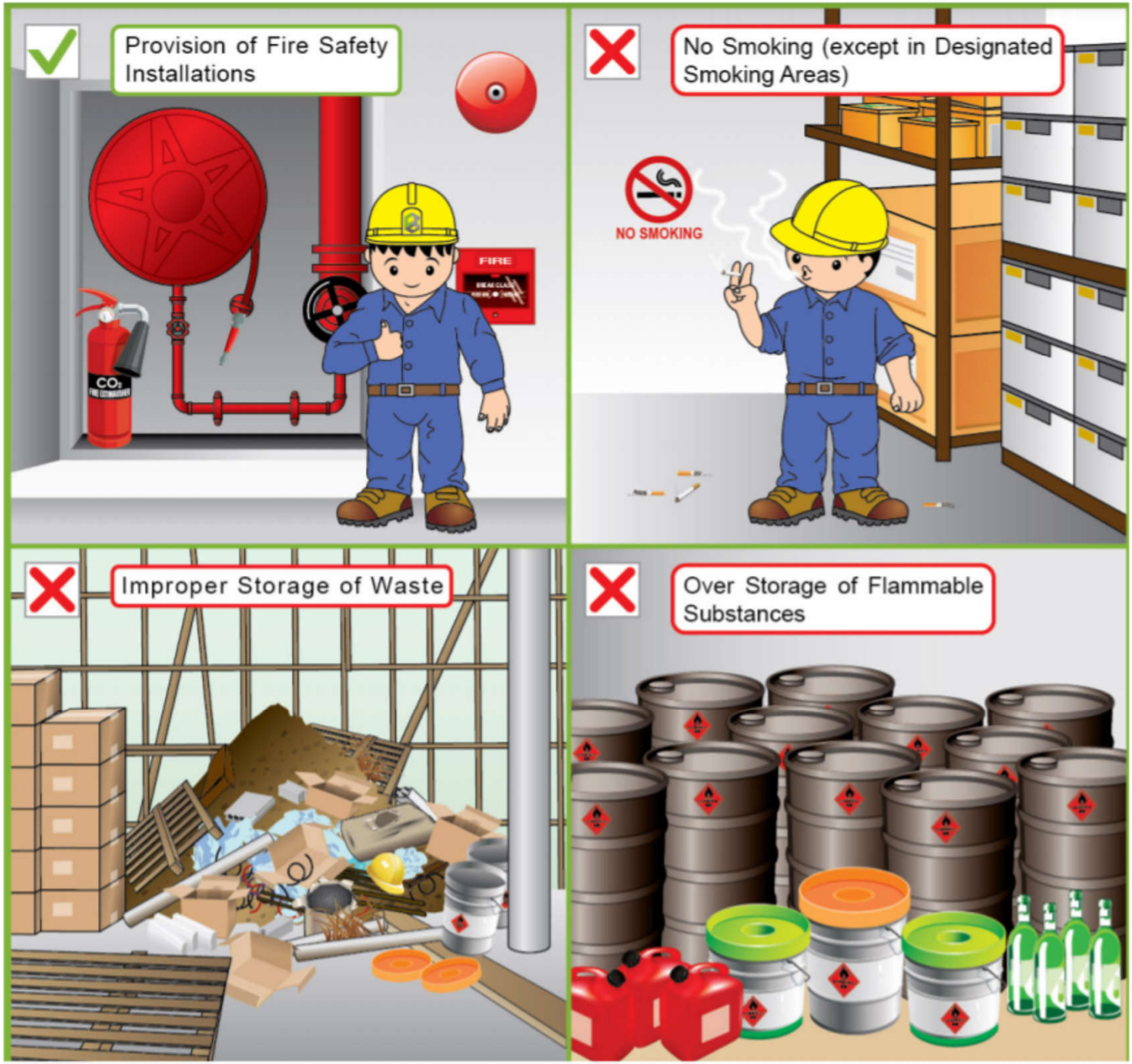
Fire safety escape plan

[Source: https://www.pscpen.com/workshops/fire-safety-begins-with-you-campaign/]

Risk management

- Common risk controlling measures:
  - Fire prevention & good housekeeping
  - Emergency action during fire incident
  - Fire alarm & summon FSD or police
  - Fire fighting equipment
  - Means of escape & evacuation procedure
  - Smoke control
  - Fire drill, training & education
  - Fire precautions

Fire safety on construction sites



[Source: http://www.cic.hk/files/page/52/Fire%20Safety%20on%20Construction%20Sites.pdf]

Fire protection requirements

- Fire safety requirements for building owners, occupants & employers
  - Purpose: To provide better protection from the risk of fire for occupants, users, and visitors to, different kinds of buildings
- A fire safety direction (消防安全指示) may be given by the enforcement authorities, e.g.
  - Buildings Department (BD)
  - Fire Services Department (FSD)

屋宇署
BUILDINGS DEPARTMENT

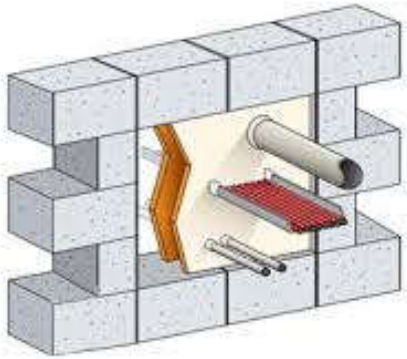
FIRE SERVICES HONG KONG

Common fire safety provisions found in buildings

- Fire rated door

- Fixed Light

- Enclosures to Non-emergency Services



[Source: https://www.bd.gov.hk/en/safety-inspection/fire-safety/]

[Source: HKFSD]

Fire protection requirements

- Fire safety legislation: statutory requirements
  - Provisions of means of escape in case of fire
  - Ability for a building to resist the effects of fire and to minimize the spread of fire & smoke
  - Provision of means of access to enable firefighters to effect rescue and fight fire
- Technical & management issues
  - Testing of the fire properties of building elements and components; fire safety management of buildings; fire service installations & equipment

Fire safety construction in buildings

Fire Safety Construction in relation to / Premises/Building		Non-domestic portion of composite building	Domestic portion of composite building and domestic building
		Responsible Person: Owner	Owner
	*Means of escape*	✓	✓
	*Fire resisting construction*	✓	✓
	*Means of access for firefighting and rescue*	✓	✓

[Source: https://www.bd.gov.hk/doc/en/resources/pamphlets-and-videos/fso572_e.pdf]

Fire protection requirements

- Professionals involved in statutory requirement:
  - Authorized Person (AP) to sign on 'General Building Plans' (GBP) and 'Fire Service Layout Plans' for approval by Buildings Department
    - Registered Architects/Structural Engineers/Surveyor
  - Registered Professional Engineer (RPE) to sign on specific design plans of mechanical systems in fire service installations, e.g. smoke extraction system
  - Registered Contractor to submit necessary forms involving completion of fire service installation (FSI) or annual maintenance of FSI
    - Registered Fire Service Installation Contractors (RFSIC)

Fire protection requirements

- Typical requirements:
  - 1. Fire alarm/warning systems: give warning in case of fire and call fire services department or police
  - 2. Fire fighting/suppression: e.g. fire extinguishers, fire hydrant & hose reel, sprinklers
  - 3. Means of escape (MOE): adequate means of escape/exit by which all are able to reach a safe place without becoming overcome by smoke, toxic gases, heat or fire

Fire service installations and equipment

Fire Service Installations and Equipment / Premises/Building		Non-domestic portion of composite building		Domestic portion of composite building and domestic building
	Responsible Person	Owner	Occupier	Owner
	*Automatic sprinkler system*	✓*		
	*Fire hydrant and hose reel system*	✓		✓
	*Manual fire alarm system*	✓		✓
	*Emergency lighting (common areas)*	✓		✓#
	Emergency lighting (non-common areas)		✓	
	*Automatic cut-off device for the mechanical ventilating system (common areas)*	✓		
	Automatic cut-off device for the mechanical ventilating system (non-common areas)		✓	

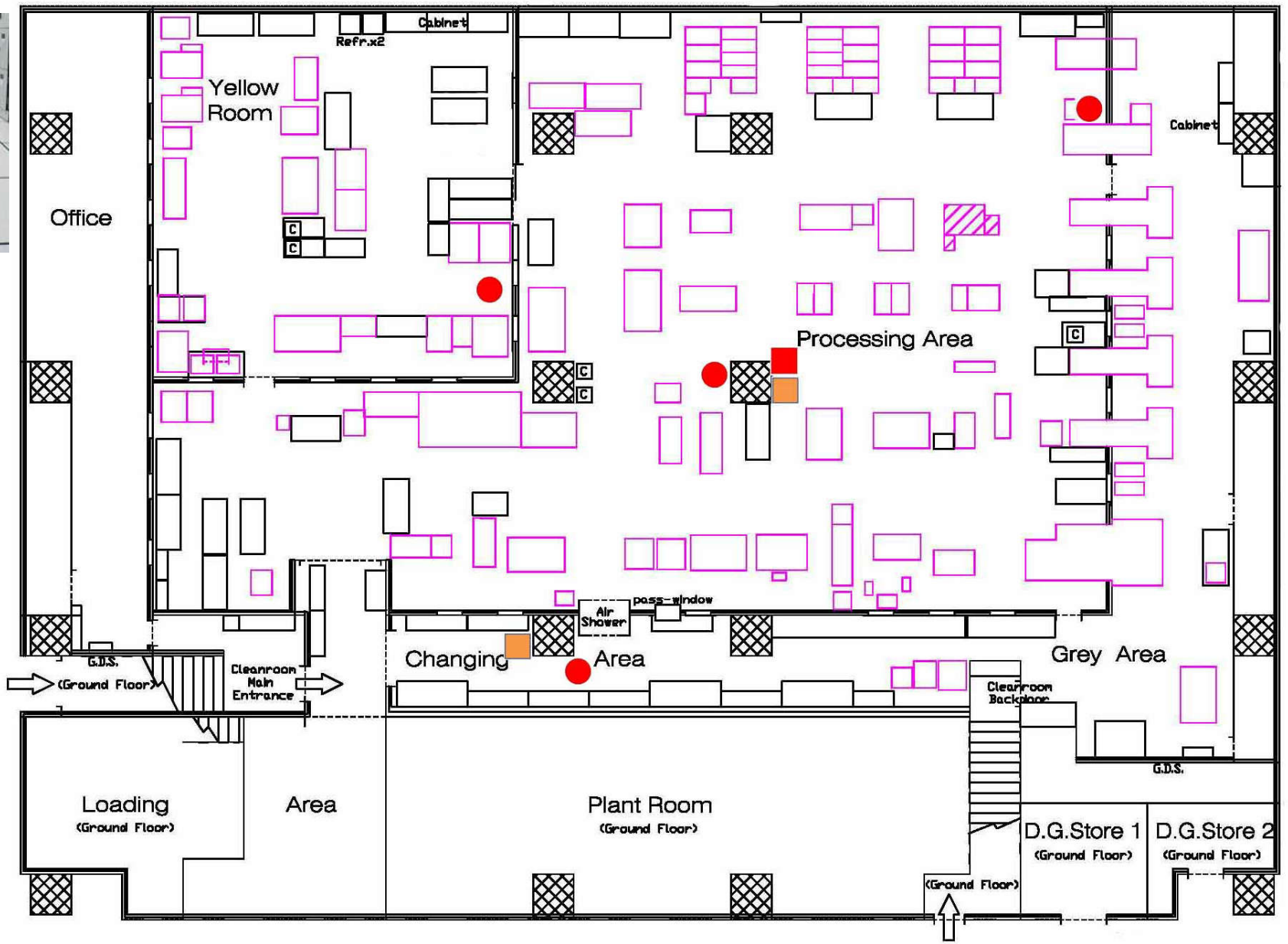
Note: * *applicable to a composite building in which the total floor areas of the non-domestic portion exceeds 230 m²*

\# *applicable to a building where the uppermost storey exceeds 30 m above ground floor level*

[Source: https://www.bd.gov.hk/doc/en/resources/pamphlets-and-videos/fso572_e.pdf]

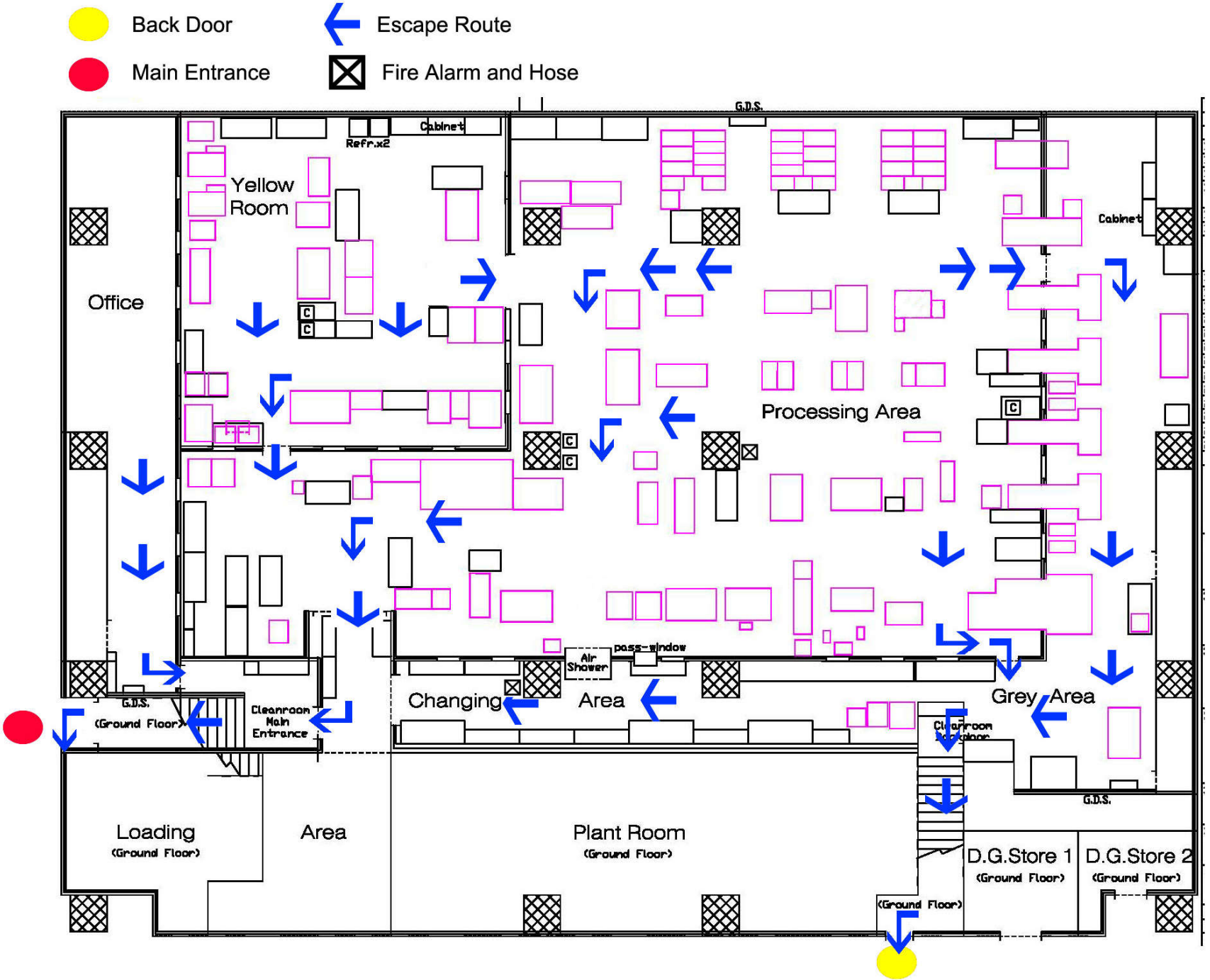
A map to show the fire service installations

Fire Alarm and Hose Fire Extinguishers Hose Reels



[Source: http://www.nff.ust.hk/en/about-nff/safety/fire-service-installation.html]

A map to show the fire escape route



[Source: http://www.nff.ust.hk/en/about-nff/safety/fire-service-installation.html]

Fire service installations

- List of accepted/approved equipment https://www.hkfsd.gov.hk/eng/fire_protection/accep_eq/
  - Fire service installations & equipment
  - Fire extinguishers & fire blankets
  - Fire retardant solution
  - Cylinders or other containers
  - Materials & equipment for ventilating system

Fire service installations

- Fire service installation (FSI) contractors https://www.hkfsd.gov.hk/eng/fire_protection/cert/fsi_contractors.html
  - Three classes for registration
  - Companies with “Qualified Persons” (written exam & practical test) with suitable academic/professional qualifications
  - Manufacturer, designer or an authorized agent of approved equipment
  - Equipment, tools & workshop

Classes of registered fire service installation contractor (RFSIC)

Class 1	Registered contractors who are fit to install, maintain, repair and inspect any fire service installation or equipment (other than portable equipment) which contains an electrical circuit or other apparatus for the detection and warning, by alarm or otherwise, of smoke or fire.
Class 2	Registered contractors who are fit to install, maintain, repair and inspect any fire service installation or equipment (other than portable equipment) which contains :- a) pipes and fittings designed or adapted to carry water or some other fire extinguishing medium; or b) any type of electrical apparatus other than those specified in class 1.
Class 3	Registered contractors who are fit to maintain, repair and inspect portable equipment.

[Source: https://www.hkfsd.gov.hk/eng/fire_protection/cert/fsi_contractors.html]

Fire service installations

- Registration of Class 3 FSI Contractors: syllabus for written examination
  - (1) Functions & maintenance of portable equipment
  - (2) Regulations relating to registered FSI contractors
  - (3) Professional ethics standard of FSI contractors

Fire service installations

- Certificate of Fire Service Installations and Equipment (FS 251) 消防裝置及設備證書
  - FSI contractor to submit within 14 days after completion of the work with
    - Certificate of Compliance (FSI/314A or FSI/314B)
  - Online Submission System https://www.hkfsd.gov.hk/eng/fire_protection/cert/fs251/

FIRE SERVICE (INSTALLATIONS AND EQUIPMENT) REGULATIONS
消防（裝置及設備）規例
(Regulation 9(1))
（第九條(1)款）
CERTIFICATE OF FIRE SERVICE INSTALLATIONS AND EQUIPMENT
消防裝置及設備證書

Appendix C
A 5521901

FSD Ref.:

Name of Client: Tai Man International
Name of Building: Tai Man House
Street No./Town Lot: 4-8
Street/Road/Estate Name: Tai Man Street
Block: 2
District: Tsuen Wan
Area: HK K NT
Type of Building: Industrial Commercial Domestic Composite Licensed premises Institutional

Part 1 Annual Maintenance ONLY
第一部 只適用於年檢事項

Code	Type of FSI	Location(s)	Comment on Condition	Completion Date	Next Due Date

Fire service installations

- Related associations:
  - Association of Registered Fire Services Installation Contractors of Hong Kong (FSICA) 香港註冊消防工程公司商會
    http://www.fsica.org.hk/
  - Hong Kong Institution of Engineers (HKIE) Fire Division 香港工程師學會 消防分部
    http://fe.hkie.org.hk/
  - Institution of Fire Engineers (Hong Kong Branch)
    http://www.hkife.org/

Fire service installations

- Useful reference document:
  - General Specification for Fire Service Installation https://www.archsd.gov.hk/en/publications-publicity/general-specification-for-fire-service-installation.aspx
    - Technical requirements of materials & equipment
    - Standards of workmanship
    - Requirements on testing & commissioning
    - Operation and maintenance
    - Requirements on document submissions