FIRE RISKS ASSOCIATED WITH WASTE MANAGEMENT FACILITIES

Speaker: Annie Choi
Technical Director of
WSP (Asia) Ltd.

Waste Management Facilities (WMF)

- Storage, treatment and handling of combustible wastes such as mixed wastes from domestic and commercial sources
- Recycling plants
- Incineration plants

South China Morning Post 南華早報

Third-alarm blaze at Hong Kong recycling plant takes 130 firefighters four hours to put out

PUBLISHED : Wednesday, 13 September, 2017, 1:00pm
UPDATED : Wednesday, 20 September, 2017, 1:19pm
News › Hong Kong › Law & Crime

Clifford Lo clifford.lo@scmp.com

No casualties reported as burning plastic generates giant cloud of black smoke in Yuen Long

About 130 firefighters took more than four hours to put out a predawn blaze at a recycling plant in Yuen Long on Wednesday.

Emergency crews were called in when the fire broke out at the 17,000 sq ft site at Shan Ha Tsuen on Shan Ha Road at 5.40am. The used plastic stored at the plant went up in flames, spewing out a large cloud of black smoke and lighting up the early morning sky.

The fire was upgraded to a third-alarm blaze at 6.35am. Fires in the city are rated on a scale of one to five according to seriousness.

Four ambulances and 35 fire engines were sent to the scene, according to the Fire Services Department.

When asked why it was upgraded to a third-alarm fire, the department's acting New Territories West divisional officer Wu Man-to said: "The fire scene covered a large area, and the site stored a large quantity of plastic. The fire was so fierce."

He said firefighters also had to lay hoses up to 600 metres long to reach the water source.

The crews battled the blaze with four water jets, bringing it under control at 9.35am and finally putting it out at about 10am.

Massive fire engulfs waste management plant in Singapore

SOCIAL By Huang Zhengzheng

2017-02-23 15:00:55 4488km to Beijing

A huge fire that engulfed a waste management plant in Tuas, Singapore, on Thursday morning has been extinguished after four hours' battle.

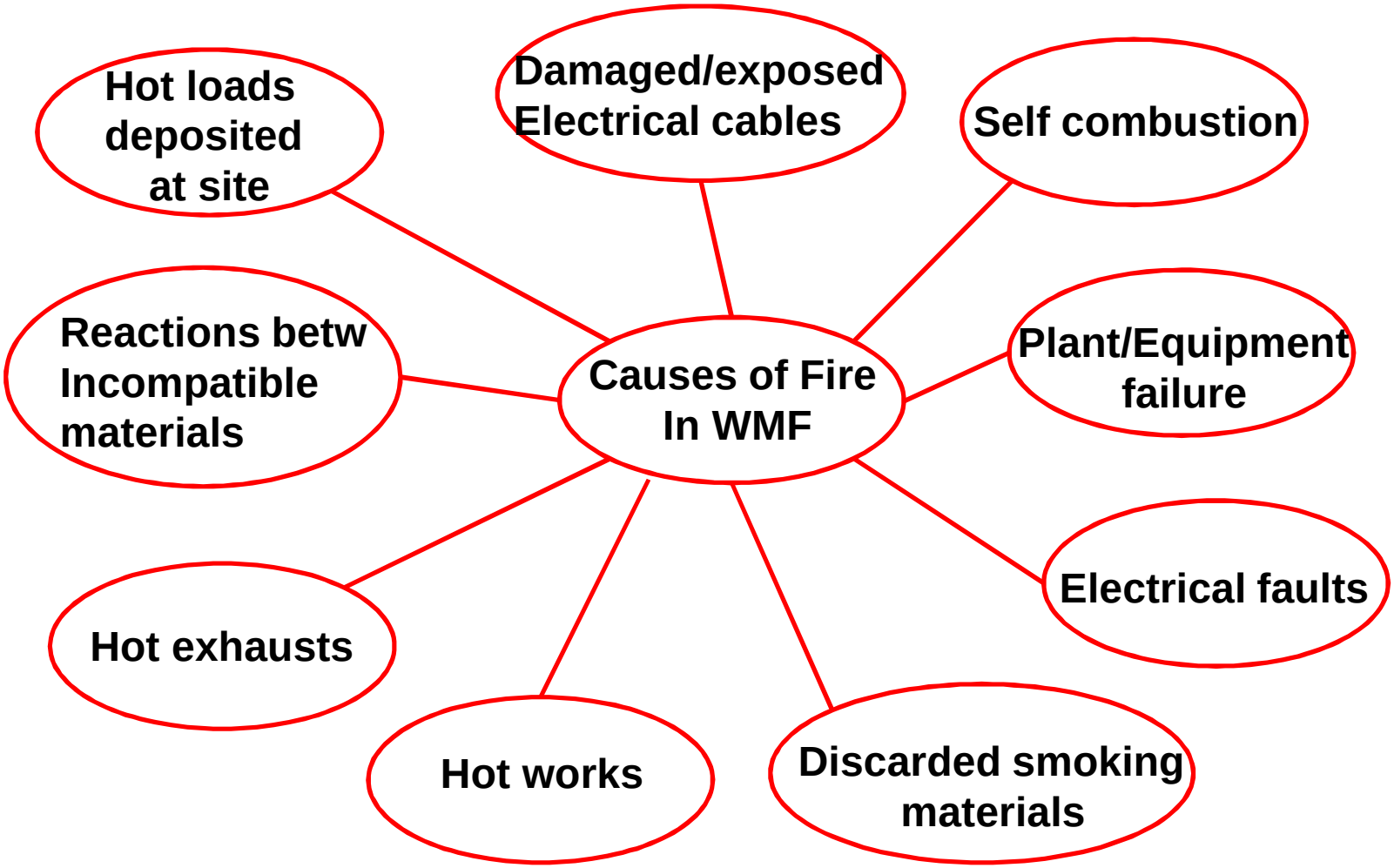
Nine fire engines, 38 support vehicles, an ambulance, and 200 firefighters were sent to the scene by the Singapore Civil Defence Force (SCDF). One firefighter who sustained heat exhaustion during the operation was taken to a local hospital.

By 11.21 a.m., SCDF reported that the fire was "well under control" as firefighters were dousing pockets of fire within the premises with foam.

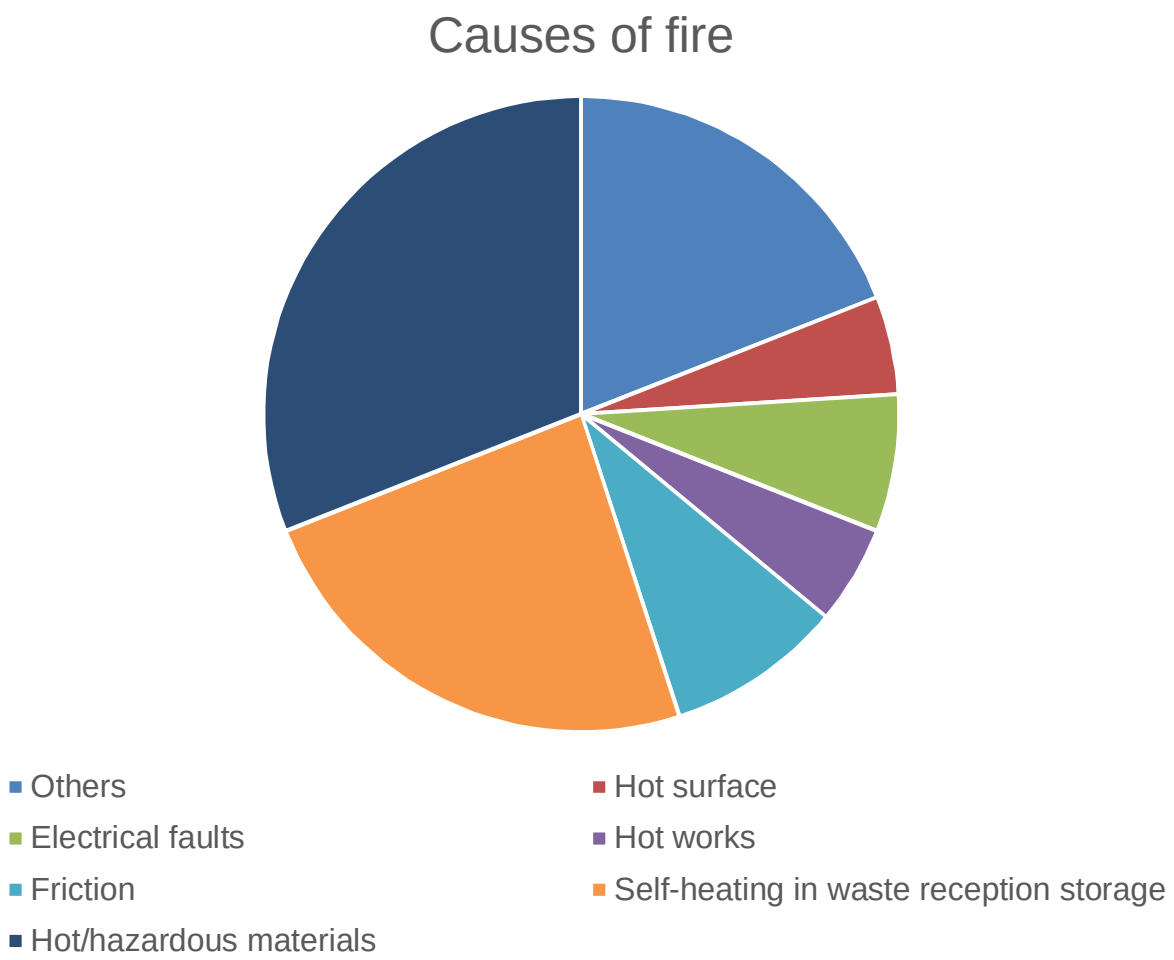
Photo: Singapore Civil Defence Force (SCDF) / Facebook

The fire involved chemical waste and flammable materials, as "periodic explosions could be heard."

Causes of Fires in WMF



Likely Cause of fire in a waste management site in UK



Assessment of Fire Risks at the Plant/Site

IDENTIFY

Where are the combustible And/or flammable materials

Where are the potential Ignition sources

FIRE SAFETY PLAN (CONTROLS & MEASURES IN REDUCING FIRE RISKS)

Operation of Waste Management Facilities

Typically, most WMF have 3 main areas of operation:

Waste Reception

Typical areas	Common causes of fires	Control measures	Appropriate detection system	Appropriate suppression /extinguishing system
Enclosed tipping halls Reception pits External reception areas	- Hot loads - Loads with hazardous materials such as gas cylinders, batteries or containers of flammable liquids	- Robust acceptance that prevent acceptance of unauthorized wastes - Not accept higher-risk loads late in the working day - Instruct mobile plant operators to spread wastes out to identify smoulders / hazardous items - Provision of an 'emergency quarantine area' for suspect loads	Camera type detectors in external areas *stop transfer plant operation when fire is detected to prevent fire spread by mechanical transfer means	- Deluge system - Water monitors - Automatic suppression system on conveyors to processing areas - Water deluge system at the shredder - Automatic smoke vents

Waste Treatment & Processing

Typical areas/ processes	Common causes of fire/risks	Control measures	Appropriate detection system	Appropirate fire suppression/ extinguishing system
Shredders, bag openers etc.	- Ignition from friction and/or metal-on-metal contact - Hazardous items in wastes such as gas cylinders or battery which causes ruptures		IR / triple IR detectors (fast acting)	- Water deluge or sprinkler system above shredder feed hoppers, permanent housings etc.

Waste Treatment & Processing

Typical areas/ processes	Common causes of fire/risks	Control measures	Appropriate detection system	Appropirate fire suppression/ extinguishing system
Trommel screens, air-separators etc.	May not pose a high ignition risk but can aerate wastes resulting in a smoulder turning into a full fire			Water deluge or sprinkler system at trommel screen housings, and/or at conveyor outputs from the trommel screen etc. to prevent spread of fire

Waste Treatment & Processing

Typical areas/ processes	Common causes of fire/risks	Control measures	Appropriate detection system	Appropriate fire suppression/ extinguishing system
Mechanical handling systems, conveyors etc.	- May carry a fire rapidly through the plant - An ignition source themselves as a result of friction	Install slip sensors on conveyors to determine if a conveyor is slipping on its drive roller – friction caused by slippage may cause ignition	- IR / triple IR detectors (fast acting) - Stop conveyor movement upon activation of fire alarm	- Water deluge or sprinkler system under and over-conveyor

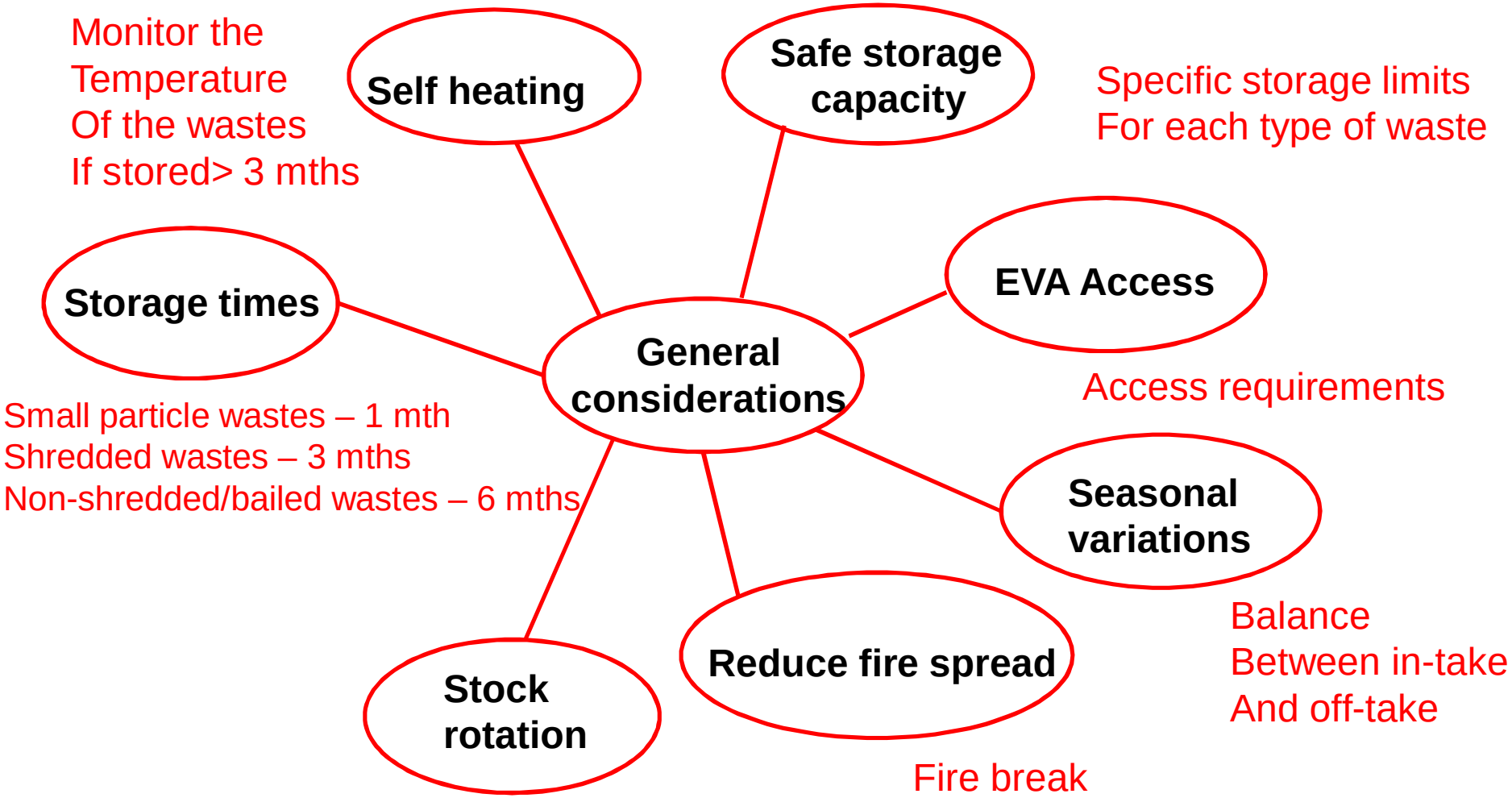
Waste Treatment & Processing

Typical areas/ processes	Common causes of fire/risks	Control measures	Appropriate detection system	Appropriate fire suppression/ extinguishing system
Bailers and similar	Rupture of gas cylinders, aerosols in balers			Sprinklers at bailer feed chutes and hoppers
De-dusting systems, cyclones etc.	Dust explosion risks	Subject to an assessment requiring hazardous area classification (ATEX zoning)		

Waste Storage

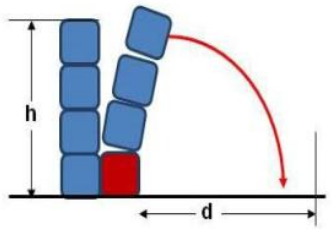
- External Storage
- Internal Storage

Waste Storage

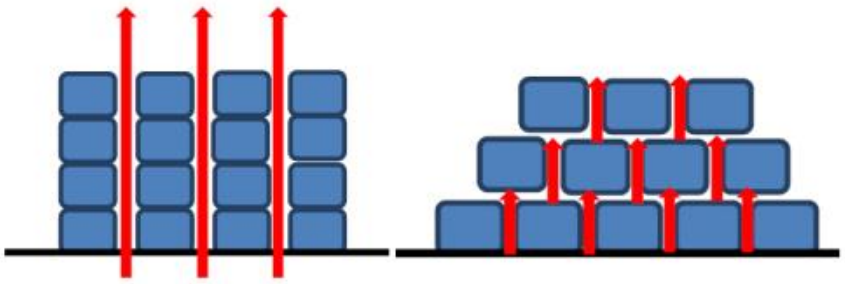


External Waste Storage

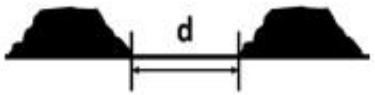
- Volume of waste stored are much higher than internally stored wastes
- Consider stack size and separation distance between stacks
  - Rule of thumb: Maximum stack height = 4m
    maximum width = 20m



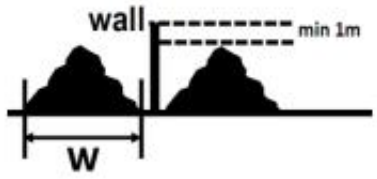
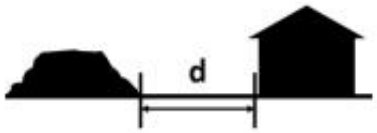
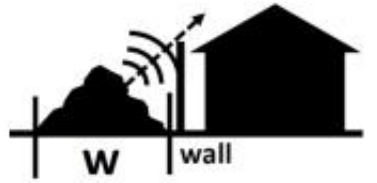
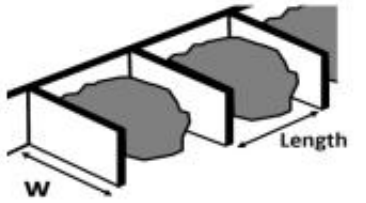
- Use of fire walls / bunkers
- Camera type detection system for external storage areas
- Need on-site fire hydrants, drencher, deluge systems etc.



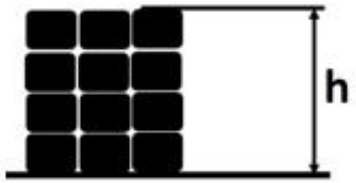
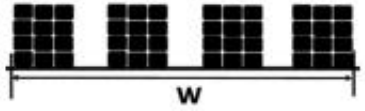
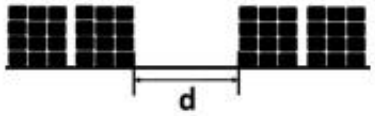
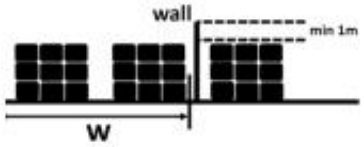
Summary tables of standard stack separation distances and stack sizes (Source: WISH)

A. General combustible wastes (typical max burn 950 °C), EXCLUDING plastics/rubber	
Parameter and standard	**Commentary**
Note: *The graphics used below are indicative only and should not be considered as being to scale or a guide to stack layout or configuration, number of bales suggested in a stack etc. They are for illustrative purposes only and should be treated as such. The terms length and width are used, but these are interchangeable and* ***ALL*** *sides of a stack need to be considered.*	
1. Loose waste stacks: General wastes (typical max burn 950 °C), EXCLUDING plastics/rubber	
 **Max height (h) of stack = 4 metres**	Maximum height (h) of 4 metres is based on practical ability to fight fires using manual means such as standard hoses, and stability of stack to reduce the risk of fire spread from falling/rolling wastes.
 **Max width (w) stack = 20 metres (10 if access one side only)**	Maximum width (w) of 20 metres is based on practical ability to fight fires using manual means such as standard hoses. **NOTE** – 20 metres assumes good access from all sides of the stack to fight fires (minimum 5 metres). If this is not the case then maximum width = **10 metres**.
 **Min 'free-air' separation distance between stacks (d) = See graph 1**	Separation distance will depend on stack length (or at their ends width – consider all sides of your stack) – the longer (or wider) the stack the wider the separation distance required. See graph 1, **blue** line to calculate separation distance for your stacks.

Summary tables of standard stack separation distances and stack sizes (Source: WISH)

	**Alternative fire wall between stacks. Max stack width (w) = 10 metres**	Walls must be of suitable construction, and a minimum freeboard of **1 metre** left between waste and wall height to account for flame height. Stacks could be 'butt' against walls, but access to rear of stacks may be required for stock rotation and similar – this is a matter for site specific assessment. **NOTE** – access for fire-fighting will not be from both sides. This means maximum stack width = **10 metres**
Note: *Readers may look at the option above and ask: "Why would I do this as stack width is reduced to 10 metres and I might as well just have one 20 metre wide stack". When considered as a fire wall between the length-sides of stacks this is a valid point. However, use of fire walls between the width-sides of stacks may have benefits. See the example stack layouts in section 6 below.*		
	**Min distance to buildings (d) = See graph 1**	Separation distance will depend on stack length (or at their ends width) – the longer the stack the wider the separation distance required. See graph 1, **red** line to calculate separation distance for your stack to buildings.
	**Alternative wall between stacks and buildings. Max stack width (w) = 10 metres**	Heat does not only travel horizontally. A wall height which is too low may result in heat radiated upwards and outwards travelling to an exposed upper portion of a building. Wall height should be sufficient to avoid this. A gap between wall and building should be left for general access. Unless this gap is substantive, access for fire-fighting will be from one side only and max stack width = **10 metres**.
Note: *Buildings can be on-site (such as a recycling plant waste hall) or off-site (such as a nearby industrial unit). The separation distances and/or fire wall information given above applies in both cases, including at site boundaries (heat does not stop at a site boundary).*		
	**Bunkered wastes. Max width (w) of bunker = 10 metres**	Maximum width (w) of bunkers = 10 metres (for reasons of practical fire-fighting as access is unlikely to be from both sides). Length of bunker is for site specific assessment based on stock rotation etc. A minimum of 1 metre freeboard should be left between waste and bunker height. **NOTE** - if open (length) side of bunker/s faces a building/other waste stack then see graph 1 for separation distance.

Summary tables of standard stack separation distances and stack sizes (Source: WISH)

2. Baled waste stacks: General wastes (typical max burn 950 °C), EXCLUDING plastics/rubber		
	**Max height (h) = 4 metres or no more than four bales high, whichever is lower**	Maximum height (h) of 4 metres, or four bales high whichever is the lowest, is based on practical ability to fight fires using manual means such as standard hoses, and stability of bale stack to reduce the risk of fire spread from falling/rolling waste bales.
	**Max width of stack (w) = 20 metres (10 if access one side only)**	Maximum width (w) of 20 metres is based on practical ability to fight fires using manual means such as standard hoses. **NOTE** – 20 metres assumes good access from all sides of the stack to fight fires (minimum 5 metres). If this is not the case then maximum width = **10 metres**. **NOTE** – within an individual bale stack gaps for access for stock rotation should be left between rows of bales. The gaps shown in the diagram left are illustrative only – you need to ensure adequate access, including use of forklifts or other plant for stock rotation
	**Min 'free-air' separation distance between stacks (d) = See graph 1**	Separation distance will depend on stack length (or at their ends width) – the longer the stack the wider the separation distance required. See graph 1, **brown** line to calculate separation distance for your stacks.
	**Alternative fire wall between stacks. Max stack width (w) = 10 metres**	Walls must be of suitable construction, and a minimum freeboard of **1 metre** left between waste and wall height to account for flame height. Stacks could be 'butt' against walls, but access to rear of stacks may be required for stock rotation and similar – this is a matter for site specific assessment. **NOTE** – access for fire-fighting will not be from both sides. This means maximum stack width = **10 metres**
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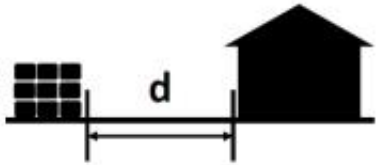
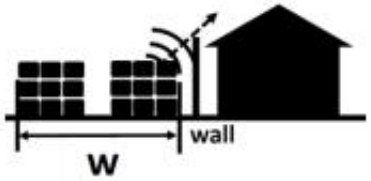
	**Min distance to buildings (d) = See graph 1**	Separation distance will depend on stack length – the longer the stack the wider the separation distance required. See graph 1, **purple** line to calculate separation distance for your bale stack to buildings.
	**Alternative wall between stacks and buildings. Max stack width (w) = 10 metres**	Heat does not only travel horizontally. A wall height which is too low may result in heat radiated upwards and outwards travelling to an exposed upper portion of a building. Wall height should be sufficient to avoid this. A gap between wall and building should be left for general access. Unless this gap is substantive, access for fire-fighting will be from one side only and max stack width = **10 metres**.
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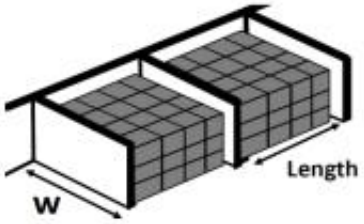	**Bunkered wastes. Max width (w) of bunker = 10 metres**	Maximum width (w) of bunkers = 10 metres (for reasons of practical fire-fighting as access is unlikely to be from both sides). Length of bunker is for site specific assessment based on stock rotation etc. A minimum of 1 metre freeboard should be left between waste and bunker height. **NOTE** - if open (length) side of bunker/s faces a building/other waste stack then see graph 1 for separation distance.

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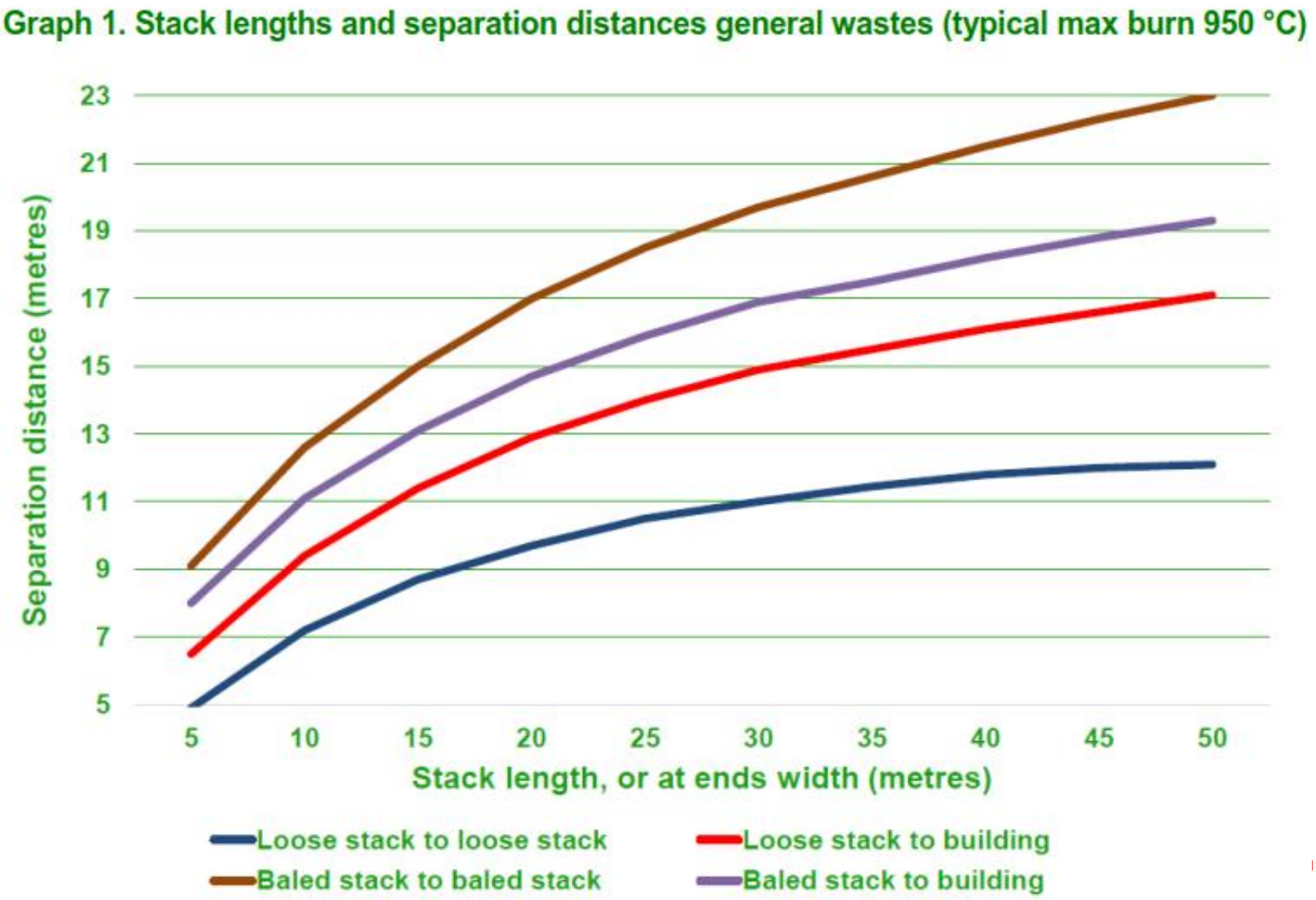
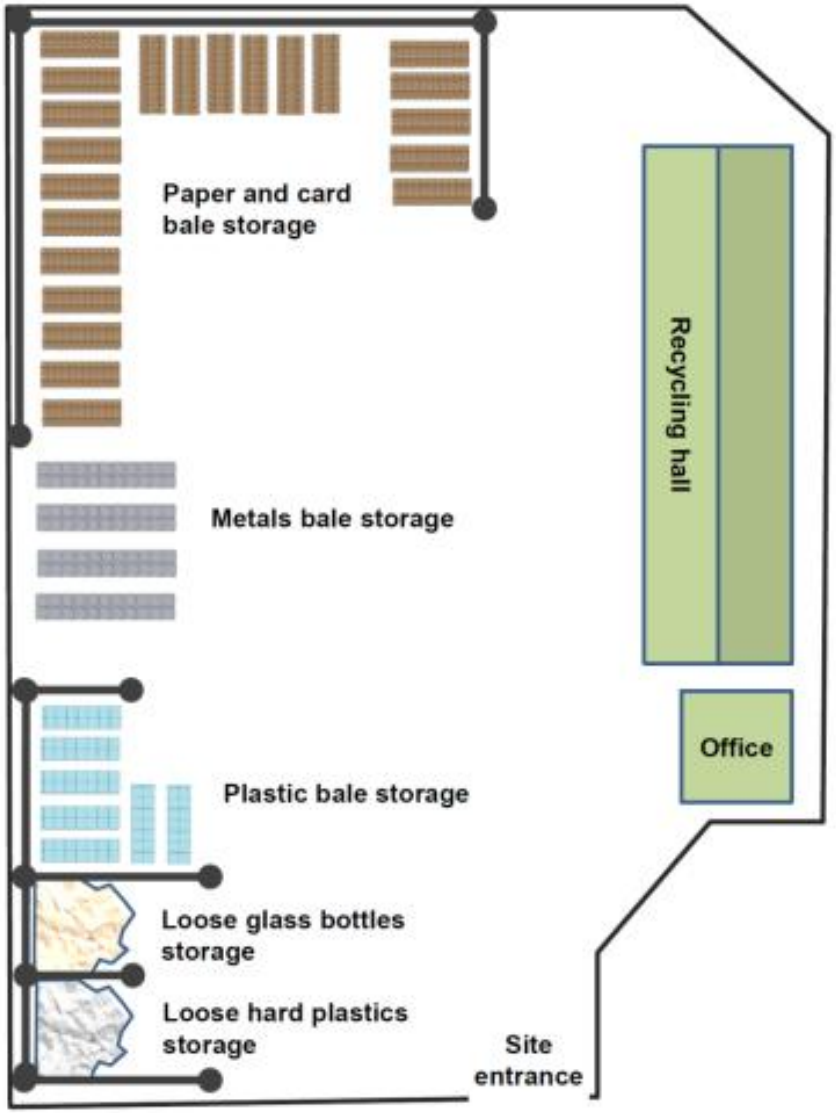


Internal Waste Storage

- Consider stack size and separation distance between stacks
- Use fire walls / bunkers
- Provide smoke venting to storage areas
- Provide fire suppression system such as sprinklers / deluge system
- Oscillating water monitors

Overall Site Storage Example



Paper and board bales are partially bunkered to preserve separation distances, but not on one side as distance is not an issue to the bunkered baled plastics bunker or baled metals, which are themselves not bunkered. Plastics bales are bunkered, with adequate free separation distance at the open side of the bunker. Loose glass (non-combustible), stored in a bunker for non-fire reasons has been placed between the plastic bales bunker and loose plastics bunker as a further precaution.

Design of Fire System in WMF

Detector robustness and example application

Detector type	Robustness in waste management application	Speed of response	Potential example applications
Standard smoke detectors	Very unlikely to be robust enough for operational areas	Medium	Offices, control rooms and welfare facilities
Beam detectors	Can be affected by dust/moisture and experience is that often not robust in operational areas	Medium	Internal waste storage areas where dust and moisture is not an issue
Aspirating systems	Likely need to be harsh environment systems, and not placed in dead-air areas or where air flow such as from roller doors could prevent or delay activation	Medium	Internal waste reception areas, general detection in processing areas, internal storage areas, but only if dead-air or air flow issues are not relevant
Visual IR/UV/triple IR type detectors	May need protection such as air-shields in operational areas, and beware of their 'view' being blocked by obstructions	Fast	In process areas to activate deluges over conveyors, shredders and other specific items of plant etc, or above storage bunkers
Heat sensing/thermal camera type systems	'View' may be blocked by obstructions and often require 'programming' to specific situations. May not be accepted by insurers	Medium to fast	Internal waste reception and storage areas, such as bunkers and pits

Design of Fire System in WMF

Detector robustness and example application

Heat sensitive wires	Prone to damage and unlikely suitable for general detection	Medium to fast	Conveyor and similar, but speed of reaction may be an issue
Video smoke and similar detectors	Fairly new to waste management	Medium to fast	Potentially waste halls
Gas (carbon monoxide etc) sensing systems	Specialised and require specific assessment	Medium to slow	Storage silos used for treated wastes, enclosed waste treatment systems and similar

Left to right: Aspirating detector (red pipework) at a waste recovery site, visual type detector in external use overlooking a waste storage bunker, specialised gas detector at a wood chip storage silo, flame detector set in a waste bunker wall

Design of Fire System in WMF

Summary table automatic fire systems, issues and example applications

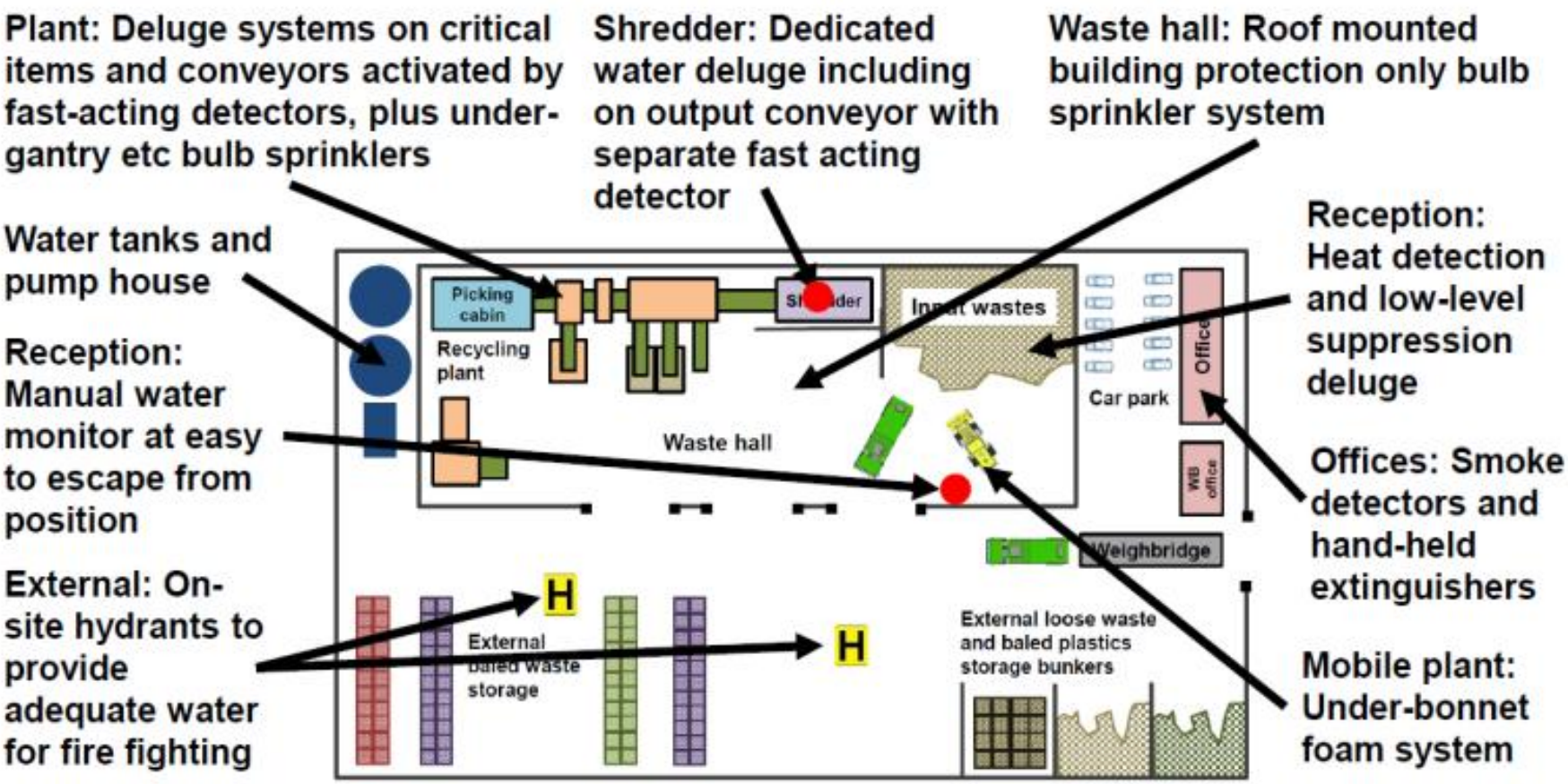
Automatic system	Comments/issues	Example waste management applications
Roof level sprinklers	Robust and reliable, but if vertical distance between wastes and sprinklers is circa >6-7 metres may suffer delayed or no activation in high waste halls	Lower waste buildings where vertical distance wastes to sprinklers is less of an issue, above plant/equipment systems (where distance to sprinkler head is not an issue) and as building protection
Gantry level sprinklers	Removes problem of shaded areas under plant (conveyors, gantries etc) which water from roof level systems may not reach. May be prone to physical damage and may need protection	Under conveyors, access gantries, screens and similar which may block water from roof level systems

Left to right: Large foam system under test at a waste recovery plant, sprinklers in action at a recycling plant, manual-use water monitor at a waste site, under-gantry sprinkler head and pipework at a recycling plant

Design of Fire System in WMF

Roof level deluges	As for roof mounted sprinklers, but activated by detector. Delayed or no activation less of an issue. But, water demand can be high (sometimes very high) leading to multiple deluges zones to reduce water demand and complex multiple detector systems to activate individual zones	General use waste halls, above wastes stored internally, waste bunkers etc
Dedicated deluges	Deliver water direct to where it is needed, but can be difficult to arrange in some plant, and higher water demand may result in complex, multi-leg systems. Typically require fast detector systems to be effective	Above shredder input chutes, in conveyor systems, in/above trommel and other screens
Oscillating or fixed water monitors	May have lower water supply needs than equivalent deluge systems, but must be capable of covering whole of area within their operating arc. Obstructions (plant, gantries etc) may block water stream from monitors, and nozzle type may need careful selection to avoid burning wastes being 'blasted' about promoting fire spread	Larger waste reception, treatment or storage halls/areas where roof sprinklers may not be effective and where obstructions from plant and walls is not an issue. Note – some oscillating water monitor systems are in use in outside applications and may be an option for external storage of wastes

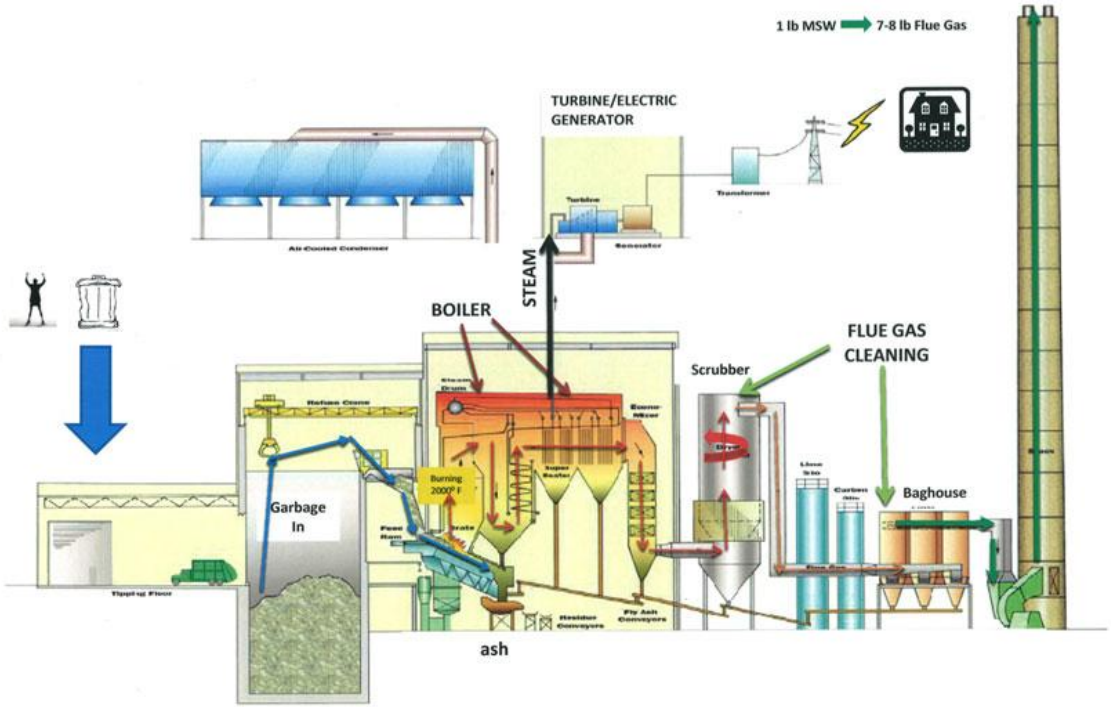
Example Application of Fire Service System in WMF



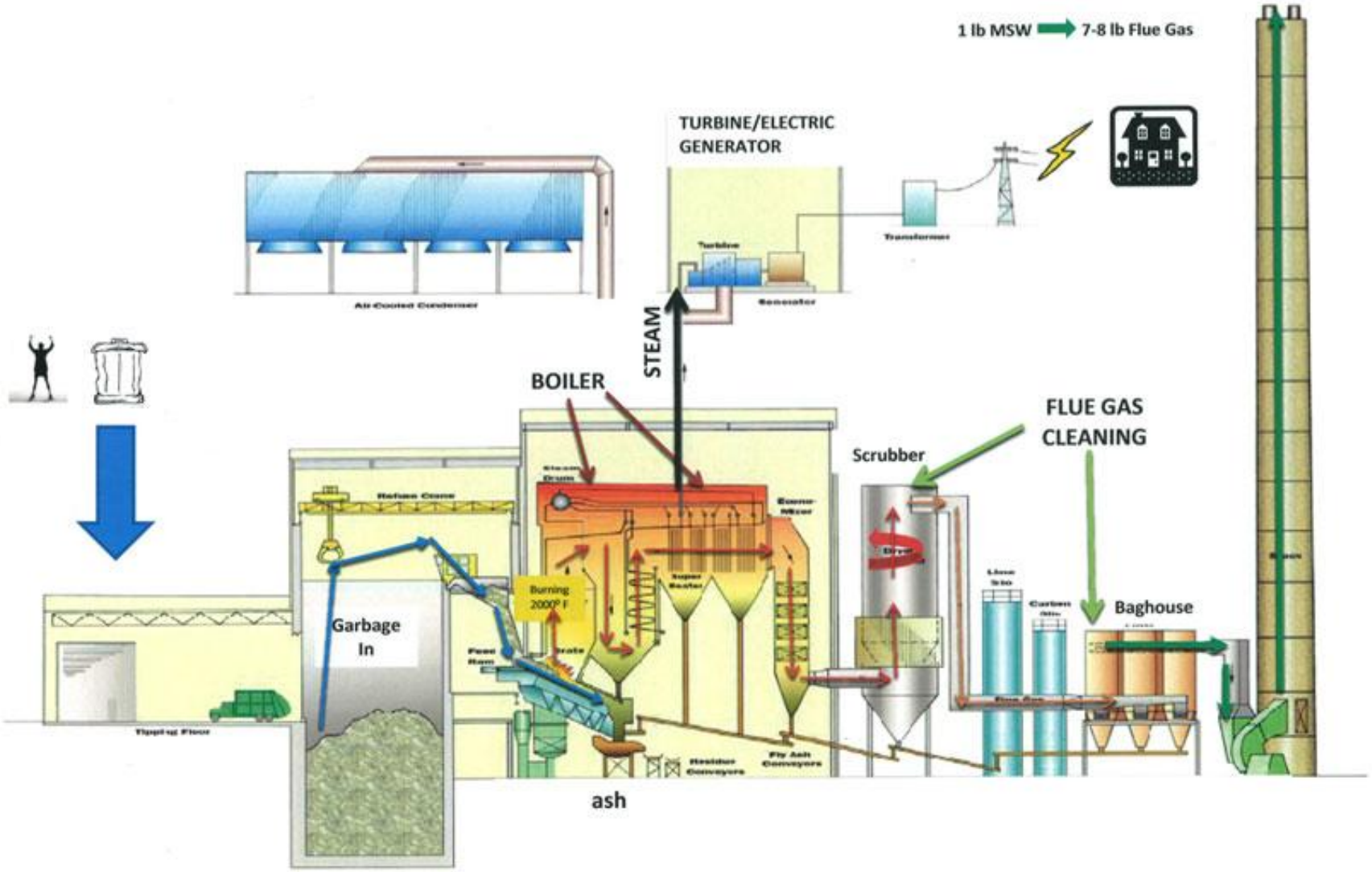
Case Study - WMF

Features of the Site

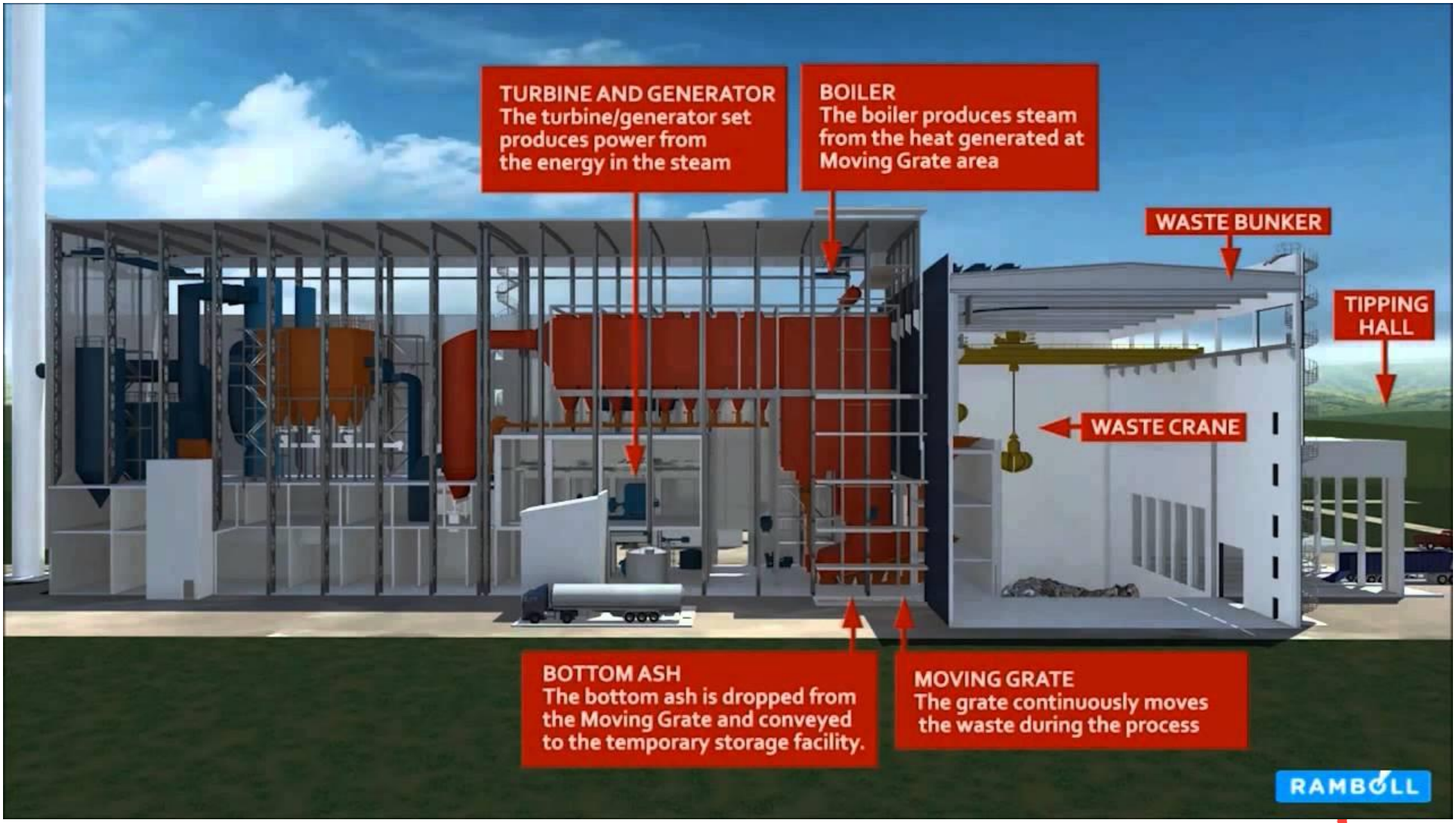
- Located at a remote island with large site area
- Consisted of various plant buildings
- WMF adopting incineration as waste



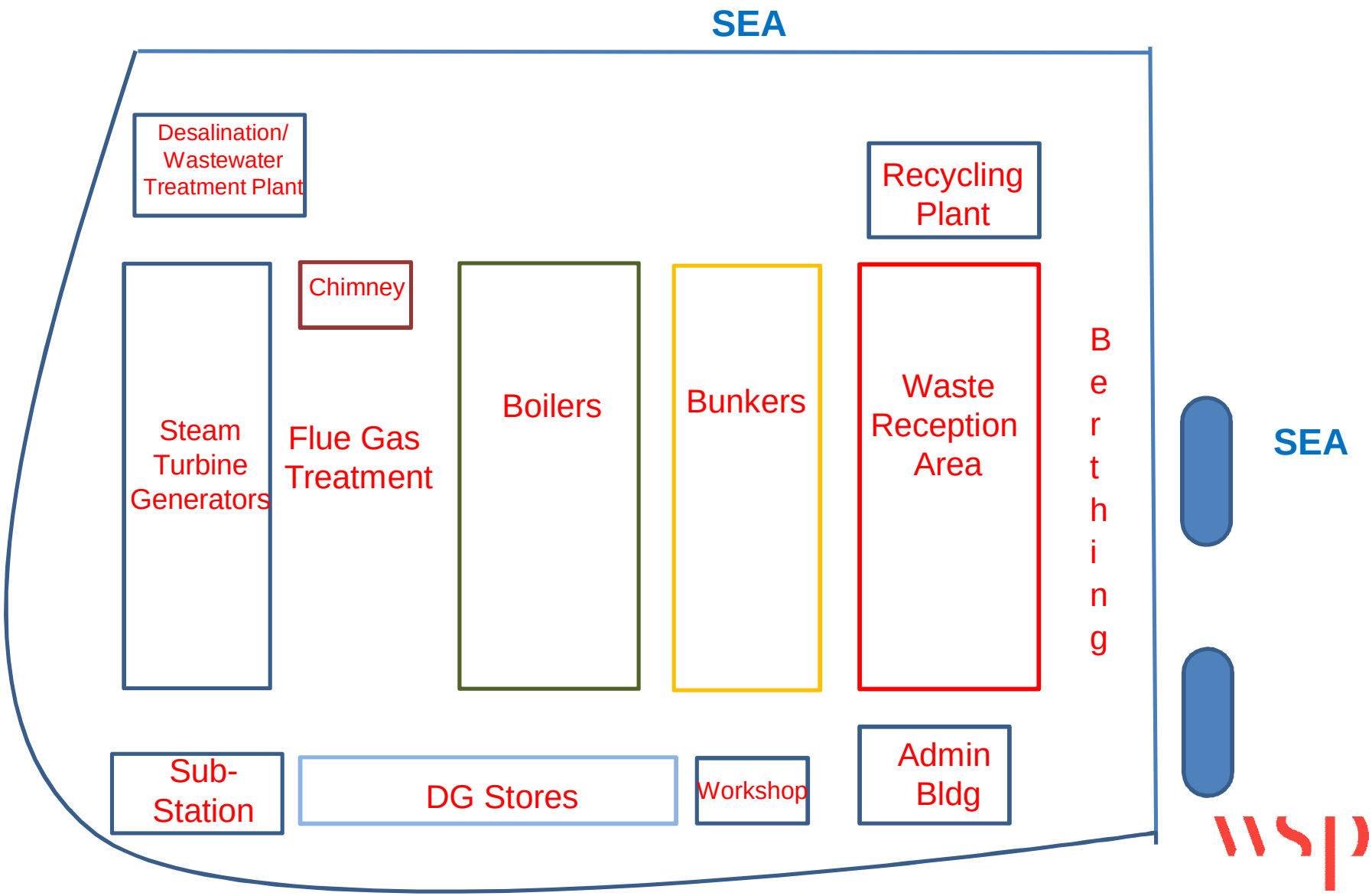
WMF


1 lb MSW
7-8 lb Flue Gas
TURBINE/ELECTRIC GENERATOR
STEAM
BOILER
FLUE GAS CLEANING
Scrubber
Baghouse
Garbage In
Burning 2000° F
ash

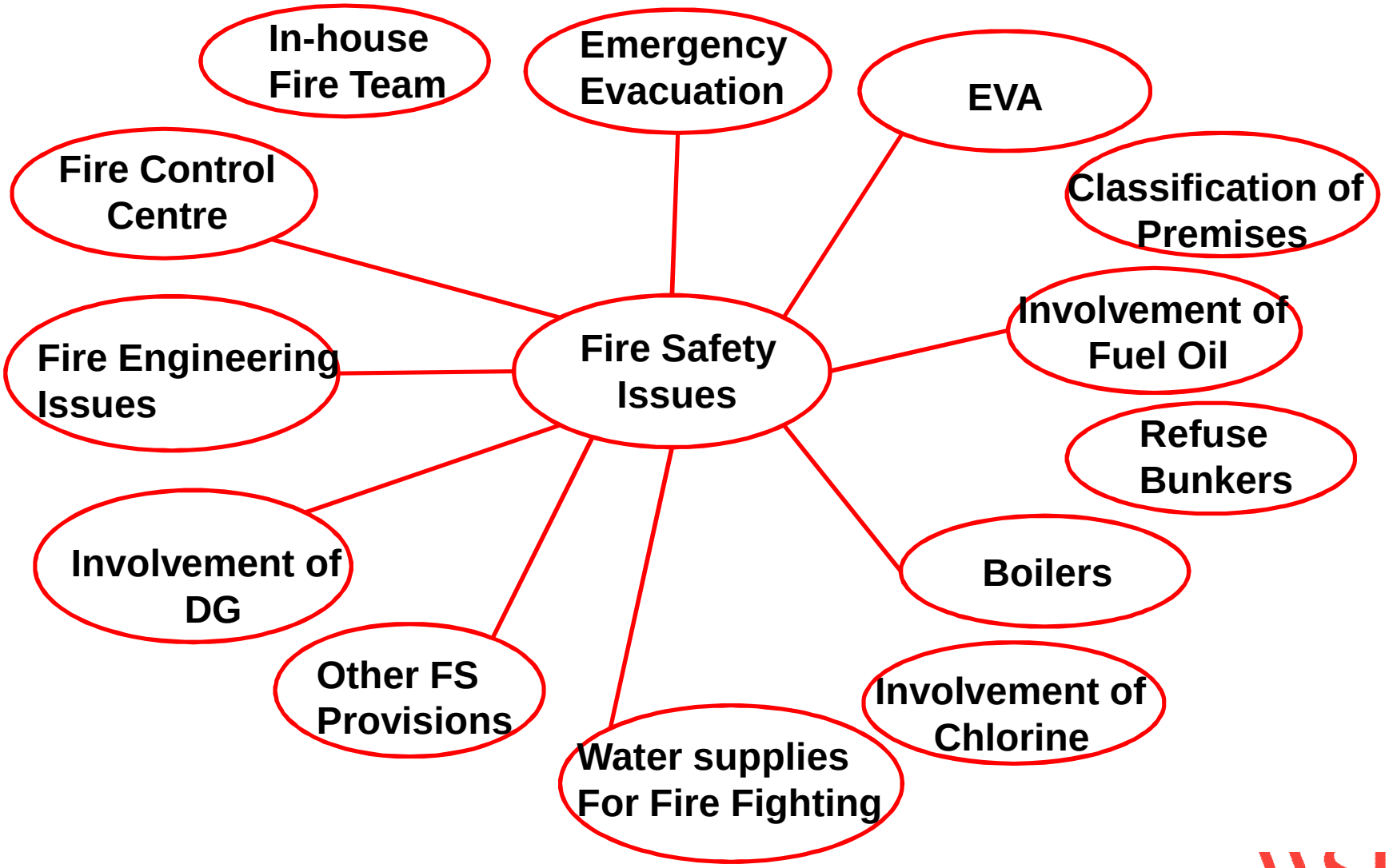
WMF


TURBINE AND GENERATOR
The turbine/generator set produces power from the energy in the steam
BOILER
The boiler produces steam from the heat generated at Moving Grate area
WASTE BUNKER
TIPPING HALL
WASTE CRANE
BOTTOM ASH
The bottom ash is dropped from the Moving Grate and conveyed to the temporary storage facility.
MOVING GRATE
The grate continuously moves the waste during the process
RAMBØLL

Case Study - WMF



Causes of Fires in WMF



Emergency Vehicular Access

- Fireman access to island by fire boat
- Major fire boat location and travelling time to fire scene
- FS requirements for berthing of the major fire boat and protection of the jetty
- EVA deficiency
- Remote area

Classification of Premises

- The WMF is a designated area of special hazard Para 3.2) Gp II
- Design of FSI systems to cope with the intended purpose of each building

Classification of Premises

3.2 Special and other risks

Group II: A building, group of buildings or complex considered to present special hazard(s) i.e.:

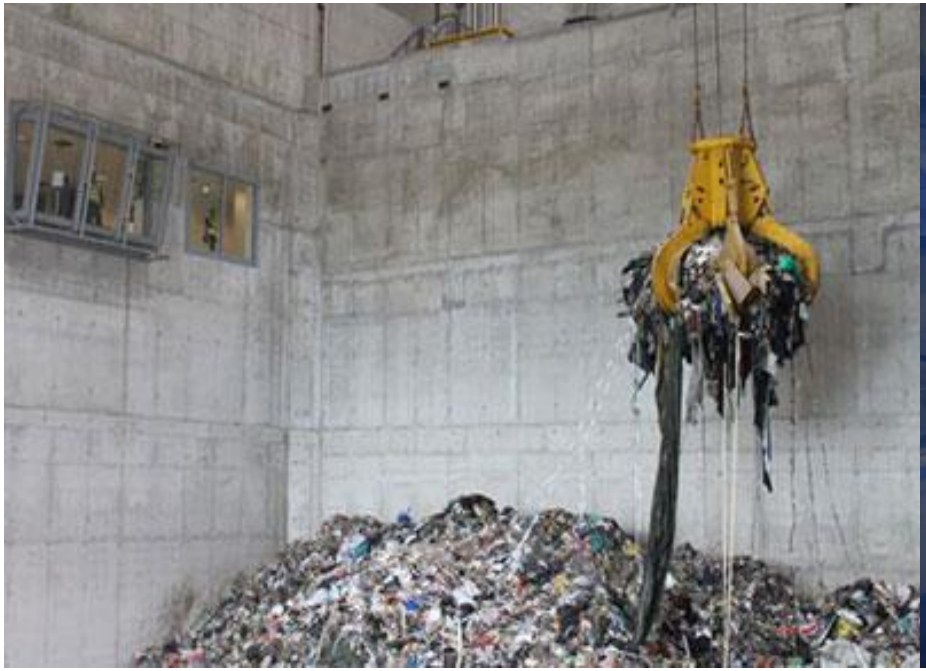
- Aircraft maintenance and repair facilities
- Audio/visual production facilities (Building(s) devoted to this purpose)
- Bulk fuel storages
- Chemical manufacturing/processing plants
- Cold storage areas (Building(s) devoted to this purpose)
- Container terminals, yards and freight stations
- Curtain walled buildings
- Dangerous goods stores (Range of DG stores in an area devoted to this purpose)
- Explosive production and/or storages
- Mechanical plant rooms (Building(s) devoted to this purpose)
- Open sites of public assembly
- Petro-chemical complexes
- Railway marshalling yards
- Road tunnels
- Shipyards
- Substation/switchgear buildings

Involvement of Fuel Oil

- FS requirements for the jetty, berthing facilities, loading & unloading areas etc.
- FS requirements of the plant / equipment using fuel oil
- FS requirements for the fuel oil storage tanks (U/G)
- Means of conveyance of fuel oil to U/G storage tanks (U/G oil pipe?)

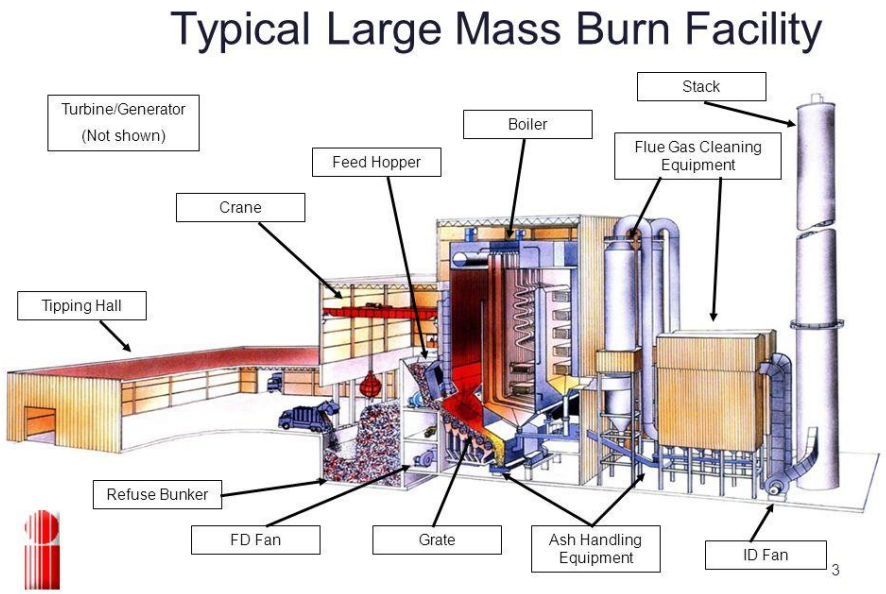
Refuse Bunkers

- Large compartmentation
- Classification according to Building Code requirements
- FS requirements



Boilers

- Classifications according to Building Code requirements
- Means of Escape (Staircase provision and travel distance)
- FS requirements especially fuel oil pipe



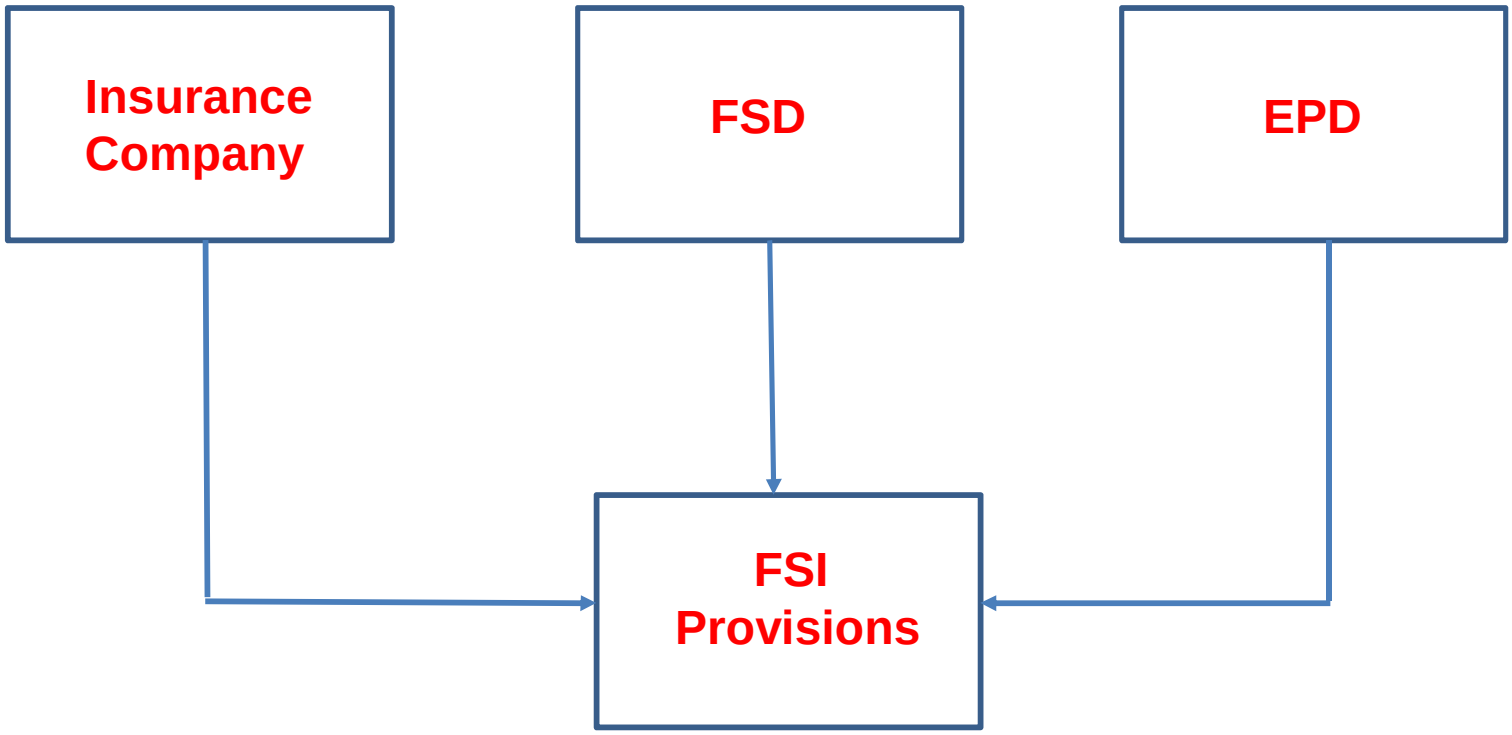
Involvement of Chlorine

- Waste water treatment plant involving chlorine is considered as potential hazardous installations
- FS requirements

Water supplies for fire fighting and strategy of Fire Service tanks arrangements

- Centralized / Decentralized FS tank
- Duration of storage and other requirements
- Design of storage capacity (Aggregate vs single fire scenario)
- Reliability of water storage
- Potable / sea water

Other Fire Safety Provisions



Maintaining a suitable balance between FSD/EPD/Insurance Company requirements

Involvement of DG

- Siting Requirements
- Fire Service Requirements
- DG Classifications
- Compatibility of DG chemicals
- Application of DG licenses

FIRE SAFETY REQUIREMENTS FOR STORAGE OF CATEGORY 3 DANGEROUS GOODS (CORROSIVE SUBSTANCES)
貯存第 3 類危險品（腐蝕性物質）之消防安全規定

1. The dangerous goods store constructed of fire resisting materials throughout shall be provided in accordance with plans approved by the Director of Fire Services.
須依照消防處處長所批准的圖則設置全部用抗火材料建造之危險品倉庫。

2. The actual layout of the installation shall be in accordance with plans approved by the Director of Fire Services.
該設備的實際佈置必須符合消防處處長所批准的圖則。

3. Plans of the store shall be approved by the Building Authority and the Director of Fire Services before construction work is commenced.
倉庫圖則須經建築事務監督及消防處處長審批。如圖則未經批准，建築工程不得動工。

4. The ultimate licensee shall confirm in writing to the Director of Fire Services the receipt of the approved plans and the set of fire safety requirements (Applicable to applications submitted by agents).
持牌人必須以書面向消防處處長証實已收到有關批准圖則及消防安全規定(此項規定只適用於經代理人的申請)。

5. Door openings of the store shall be fitted with self-closing doors having a fire resisting period of not less than one hour.
該倉庫須設有不少於 1 小時抗火時效的自掩門。

Fire Engineering Issues

Fire engineering may be required to address issues on building code non-compliances such as:

- Large compartmentation (e.g Bunkers) or other plant rooms
- MOE in large plant buildings

In-house Fire Team and Rescue Facilities during Operation

- Fire fighting squad
- Emergency fire fighting and rescue facilities

Emergency Evacuation

- Evacuation procedures for each of the building or plant area under emergency condition
- Duties and roles of different management staff and parties
- Deployment of staff under emergency