

SAFE MANAGEMENT OF WASTE MATERIALS

Background

1 Waste management is an essential service that ensures Singapore remains clean and sustainable. The National Environment Agency (NEA) views safe management of waste materials as an important aspect for waste management companies and their workers.

2 Since the start of 2022, the Singapore Civil Defence Force (SCDF) and NEA have observed a spike in the number of fire incidents at waste management facilities. Major fire incidents at waste management facilities can take days to fully extinguish due to deep seated hot spots. Such incidents not only compromise the safety of workers and incur financial losses to businesses, but they could also cause environmental pollution. It is therefore important for waste management companies to review their operations regularly and adopt industry best practices to minimise workplace/fire risks to ensure a safe working environment. Companies should also take stringent fire and safety precautions and educate workers on the importance of early identification of possible workplace hazards that can lead to a fire.

3 This advisory aims to provide general guidance on practical fire risk control measures (see **Annex A**) that can be implemented at waste management facilities to prevent or minimise the occurrence of fire incidents at the workplace. The general guidance provided in this advisory may not comprehensively address all aspects of waste management operations. As required by the Workplace Safety and Health (Risk Management) Regulations, waste management companies must conduct regular risk assessments to identify the source of risks arising from their operations and take steps to eliminate or minimise the risk.

Roles of NEA licensees

4 In accordance with the Environmental Public Health Act, waste management facilities will be required to obtain the relevant licence(s) for waste management operations at the facilities (i.e. General Waste Disposal Facility (GWDF) and/or a Toxic Industrial Waste Collector (TIWC) licence).

5 GWDF and/or TIWC licensees are required to ensure that the maintenance and operations of the licensed premises do not endanger public health and cause pollution to the environment. The licensees are required to install, operate and maintain pollution control equipment, and also take effective measures to minimise or mitigate any pollution and/or nuisance issues during their operations. This would help to ensure a clean and safe working environment for everyone.

6 To ensure fire and workplace safety within waste management facilities, waste management companies shall review their risk assessments regularly to identify new potential hazards that may arise from their operations, implement appropriate risk control measures, and adopt industry best practices to minimise workplace or fire incidents.

7 Waste management facilities are required to comply with the licensing conditions and only receive/handle wastes that are approved under the respective licence(s), identify and account for all potential hazards associated with the handling/recycling activities of such waste and ensure that the storage of waste does not exceed the maximum storage capacity stipulated in the respective licences. To reduce safety risk to as low as reasonably practicable, appropriate risk reduction measures shall be implemented to effectively address the specific nature of hazard arising from the waste handling operations. For example, when handling waste aerosol cans, local exhaust ventilation shall be provided to capture flammable gases emitted from the emptying and puncturing of the waste aerosol cans.

8 The licensees are also obliged to keep proper records of wastes collected, stored, treated and disposed of, and submit the relevant records to NEA as required under the respective licences.

9 In the event of a workplace or fire incident at GWDF/TIWC facility, the licensee shall notify SCDF at 995 and NEA Call Centre at 1800 2255 632 immediately and provide information on the time, location and nature of the incident, waste types involved and casualties (if any).

10 The licensee shall, as soon as practicable and/or in any event within two working days, furnish to NEA a detailed report in writing, indicating:

- a) The findings on the cause of incident;
- b) The immediate actions and mitigating measures taken by the owner/operator of the facility to prevent further environmental and public health issues; and
- c) The measures taken by the owner/operator of the facility to restore affected premises back to normalcy and prevent recurrence of similar incidents.

11 Companies are also required to report any work-related incident via the Ministry of Manpower (MOM) WSH Incident Reporting eService. For details, please refer to MOM's website at <https://www.mom.gov.sg/eservices/services/wsh-incident-reporting>.



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Guidelines for Safe Management of Waste Materials

Waste management companies handle various types of waste generated on a day-to-day basis. Such wastes differ in characteristics and material composition and may result in biological or chemical reaction when exposed to the surrounding or mixed with other incompatible types of waste.

It is therefore imperative to understand the nature of waste collected and put in place the necessary measures to minimise or eliminate the associated risk when handling/recycling different waste streams.

Risk Assessment

The conduct of a comprehensive risk assessment is key to safe management of waste materials. With participation from managerial staffs and line workers, risk assessment provides a systematic approach to identify potential hazards, evaluate associated risks and select appropriate control measures.

Conceptually, a fire-specific risk assessment involves:

- Understand the combustibility and flammability properties of waste materials;
- Ascertain the quantities of combustible and flammable waste materials present at the premises;
- Identify foreseeable circumstances under which a workplace safety and health or fire incident could happen;
- Determine the potential consequences of bodily injuries, ill-health effects, property damage and environmental impact;
- Develop reasonably practicable fire prevention and mitigating measures;
- Evaluate the residual risk level based on severity of the consequences and likelihood of its occurrence; and
- Ensure no high-risk level work is being carried out.

Waste management companies are required to provide their workers with adequate information, instruction, training and resources to perform their work safely. Supervision shall be carried out to ensure control measures are duly implemented, and safe work procedures are adhered to.

Regular monitoring shall be in place to ensure the effectiveness and relevance of existing safety measures. Means of monitoring include periodic physical inspections, robust maintenance regime of equipment and regular consultations with workers to address any feedback on operational issues.

Risk assessment shall be revised at least once every three years or under such conditions as are necessary, including upon the occurrence of any workplace incident, where there is significant change in work practices and when new information is made known. In particular, staying abreast of emerging fire risks and current developments in fire safety practices fosters a continuous cycle of improvement in managing the evolving risk of fire at work.

For more information on the conduct of risk assessment, you may visit the Workplace Safety and Health Council's website at <https://www.tal.sg/wshc/topics/risk-management/conducting-risk-assessments>.

Identification of Fire Causes

It is important to understand the various elements that contribute to a fire incident. The identification of the potential fuel sources onsite is important as it is one of the elements contributing to a fire triangle. For waste management companies, the fuel can be in the form of combustible recyclable and/or waste materials. It is therefore important to identify the types of combustible recyclable and waste materials, and its associated fire risks to implement effective measures to manage it.



Fig 1: Oxygen, heat, and fuel are frequently referred to as the "Fire Triangle." There is also a fourth element, which is chemical reaction.

Common causes of fire at waste management facilities:

- **Embers**
When embers such as lit cigarette butt, lit incense sticks, burned charcoal or hot incineration ashes are not extinguished completely, the heat from the embers could transfer and heats up nearby combustibles such as papers and plastics. The transition from smouldering embers to flame could be triggered by a combination of increasing airflow, oxygen concentration and external heat. The time taken for fire to erupt is unpredictable and it could take minutes to days.
- **Spontaneous combustion**
Spontaneous combustion can occur due to self-heating, arising from an internal chemical or biological reaction of the material, which allows heat to build up to the point of ignition. Ambient weather conditions, density of waste, particle size of waste and other factors such as processing and storage practices can also pose a risk to spontaneous combustion. Wood waste could be subjected to thermal degradation while oily rags from renovations or construction sites could undergo spontaneous combustion without any sparks.
- **Electrical Origin**
Batteries from electronic devices e.g. laptop batteries, lithium-ion batteries, are commonly discarded as general waste and this can be an ignition source. Thermal runaway, inherent defects, mechanical damage, or deterioration over time of such batteries could result in a fire. Electrostatic electricity is another source of ignition which can lead to fires and explosions in a flammable or combustible atmosphere, and they are generated by contact and separation surfaces of dissimilar materials. There are many kinds of operations in chemical waste management facilities that create static electricity such as transferring of solvents, discharging powders, and mixing processes.
- **Cross Reaction of incompatible chemicals/materials**
Improper disposal of dangerous goods/hot loads such as household bleach, flammable substances like paint, thinner, automotive fluids including oil and antifreeze, marine flares, spent aerosol cans or gas canisters etc. that is incompatible with other materials could cause fire.

- *Other ignition sources*

The operation of machineries (e.g. baler, shredder etc.) themselves may pose an ignition risk through friction, sparks from metal-on-metal contact and blunt blades. Sparks/embers from hot works can be a potential source of ignition too.

Preventive Measures

Preventive control measures at waste management facilities include (but are not limited to) the following types of engineering and administrative controls.

(a) Site Management

Separation of activities

- Activities involving hot work and heat generation should not be performed within close proximity to flammable or combustible sources.
- A permit-to-work system can assist in the management of hot work activities by providing a formal authorisation system to ensure safe execution of work onsite.

Segregation of waste materials

- The storage or mixing of waste should be in accordance with basic chemical compatibility. Incompatible waste should be properly segregated to prevent inadvertent mixing which can result in unintended chemical reactions and risk of spontaneous combustion.
- The arrangement of different materials can increase combustion risk or cause the spread of fire throughout the storage heaps. Some materials may have a low risk of spontaneous combustion when stored separately but become combustible when improperly stored and cross reaction of incompatible chemicals/materials happens.

Separation distance

- Examples include separating loading/unloading bays, processing and storage areas by an appropriate distance and/or barriers (e.g. containment walls), creating appropriate buffer spaces or barriers between waste storage to prevent risk of contamination and exposure of hot loads to the storage area.

Outdoor heap storage

- Companies may refer to **Annex B** for SCDF's guideline "Fire safety guidelines for outdoor heap storage development involving combustible materials".

(b) Waste Pile Management

First in first out

- This will ensure that older stocks of combustible recyclables and waste materials, which are more prone to self-ignite, are not kept for long periods of time.

Baling wastes

- Baling of combustible recyclables may reduce the likelihood of fires starting. However, the material should be screened prior to baling so that incompatible wastes/contaminants can be removed beforehand.

(c) Fixed Installations*Early detection devices*

- Devices such as thermal probes, thermographic cameras, heat detecting systems (to monitor temperature of combustible heaps), gas monitoring devices, smoke and flame detectors can be deployed to detect smouldering and indicate the presence of flammable gases or fire in the early stages.
- This will help to provide early tell-tale signs of potential fire, and intervention can be rendered in time to prevent the start of a fire. This is especially the case for organic storage or for long term storage (which is not recommended) of self-heating materials.

Avoid flammable and combustible dust conditions

- This can be achieved through better ventilation/dilution to prevent the accumulation of flammable vapours, and local exhaust ventilation to capture and control the dispersion of combustible dusts.
- For waste management companies, such as toxic industrial waste collectors, which store or process flammable solvents, the use of inert gas blanketing can displace and dilute oxygen in the headspace of a storage vessel so that flammable atmosphere could be prevented from forming.

Grounding and Bonding

- Grounding of equipment should be provided in operations where combustible products are handled and processed as it is the most effective way of mitigating the accumulation of static electricity.

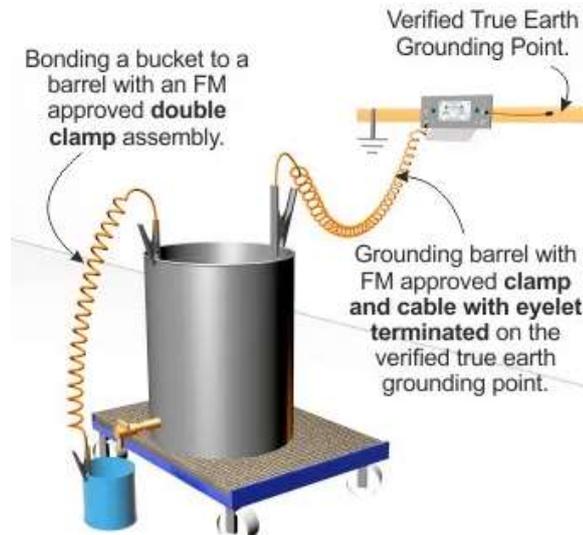


Fig 2: The process of bonding and grounding eliminates the build-up of static electricity by allowing it to safely dissipate into the ground.

(d) Administrative and Training measures*Communication with waste generator*

- Address fire risk at source by establishing common understanding and binding agreement with waste generator on the type of waste to be collected so as to minimise the entry of incompatible waste into waste management facility.

- Engage with waste generator on the implementation of proper waste segregation at source to facilitate waste collection process.

Training and Education

- Identification of wastes/materials through proper labelling and conduct of analytical testing for mixed chemical wastes to verify its composition will help operators identify the types of waste so that safe and appropriate measures can be adopted during the handling and processing of it.
- Staff should be trained to read warning labels that are affixed on containers containing hazardous substances/wastes. Labels are an important means of hazard communication. This will assist staff to better segregate hazardous substances/wastes from the other wastes and isolate the materials/waste accordingly.
- If you do discover hazardous substances/wastes or load containing materials that your company is not licensed to receive or your facility is not equipped to handle safely, you should attempt to trace this back to the customer and take appropriate action to avoid collecting these hazardous wastes/materials. These waste/materials should be stored separately and disposed of at the appropriate licenced facilities.

Good housekeeping and regular maintenance and update of safety documents

- Good housekeeping at site can reduce dust, litter and other combustible materials building up around the premises.
- Regular equipment maintenance can reduce the likelihood of overheating or for it to become an ignition source.
- These efforts would also help to identify new or changing hazards and respond to them before they cause problems.
- Review and update safety documents, including safe work procedures, in a timely manner/when introducing new equipment or tasks to the site.
- Ensure risk assessments are accurate, reflect the up-to-date operations on-site and cascaded down to all relevant personnel.

Develop and enforce no-smoking policy

- Allocate proper smoking areas away from combustible materials and/or designate no-smoking zones near combustible materials to avoid introducing an ignition source.

Emergency response plan

- Staff should be briefed, trained, and made aware of their roles during an emergency.
- Ensure first response team are competent to respond to incipient fires, and follow emergency procedures including alerting authorities of the fire incident and carrying out emergency evacuation.

Proper Personal Protective Equipment (PPE)

- Ensure that proper PPE are worn by operational staff. The PPE should be made available to staff who have undergone training and (where necessary) accreditation to use them.

- Provide appropriate fire-fighting kit to reduce the risk of harm to staff who are engaged in firefighting or related activities.

Mitigation Measures

As fires may still happen in facilities handling combustible recyclables and waste materials despite taking all reasonably practicable steps to prevent them, it is therefore important to implement mitigating controls that detect and suppress the fire, thereby reducing the impact to human health and the environment. Mitigating controls can include but not limited to the following.

- (a) Train staff to mitigate incipient fires
- (b) Rectify existing fire hazards to facilitate swift evacuation of occupants and firefighting
- (c) Put in place a regime for proper maintenance of fire protection and warning systems
 - Ensure fire safety measures such as exit lights, fire sprinklers, hosereel and fire extinguishers are properly maintained and in working order at all times.

Do	Don't
Fire extinguisher to be inspected and maintained regularly. 	Expired fire extinguisher. 

Do	Don't
Illuminated "Exit" sign to facilitate evacuation in the event of fire or emergency. 	"Exit" signage not in working order 

<p>Well maintained manual call point.</p> 	<p>Damaged manual call point.</p> 
<p>Fire Alarm Panel in working order.</p> 	<p>Fire Alarm Panel disabled/isolated/faulty.</p> 

- (d) Proper fire engine access and unobstructed access to firefighting equipment
- Ensure fire engine accessway/access road is kept unobstructed at all times.

Do	Don't
<p>Fire engine access kept clear at all times.</p> 	<p>Fire engine access obstructed by goods.</p> 

<p>Fire access panel to be kept clear at all times.</p> 	<p>Obstructed fire access panel</p> 
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- Ensure unobstructed access to exit doors or fire safety measures such as hosereel.

<p>Do</p> <p>Exit doors to be kept unobstructed at all times.</p> 	<p>Don't</p> <p>Exit door obstructed by items</p> 
<p>Escape route to be kept clear of items at all times.</p> 	<p>Escape route obstructed by items</p> 

Fire safety measures to be accessible at all times.



Fire safety measures obstructed by items.



FIRE SAFETY GUIDELINES FOR OUTDOOR HEAP STORAGE DEVELOPMENT

- 1 The size of storage heap shall not be more than 40m in length and 40m in width. The heap height shall be limited to maximum of 9m.
- 2 Each heap with maximum size of 40m x 40m shall be surrounded by 4m wide fire engine access road and the heap shall be placed minimally 10m away from boundary line (it includes the imaginary extension of the border up to the centre of an abutting public road or canal / river). This is to prevent fire spread between heaps or fire spread to neighbouring premises, as well as to form an island wide fire engine access road to facilitate SCDF fire-fighting operations (please refer to Appendix 1 for illustration).
- 3 The 4m wide fire engine access road (which can be on suspended slabs, metalled/non-metalled roads, paved/non-paved surfaces, ground laid with strengthened perforated slabs etc) shall be designed to withstand both stationary and axle loading capacity of firefighting appliances respectively, as stipulated in the Fire Code 2018. Other specific requirements such as gradients and turning facilities etc for fire engine access road shall fulfil relevant clauses stipulated in the Fire Code 2018.
- 4 These fire engine access roads shall be kept clear at all times.
- 5 Fire hydrant shall be provided to adequately cover the entire heap storage area. Fire hydrant shall be located along the fire engine access road such that every part of the fire engine access road is within an unobstructed distance of 50m from any fire hydrant. The general provisions of fire hydrant shall comply with SS 575 except that it shall be in a form of header integrated with 2 number of landing valves*. These fire hydrants shall be sited at least 3m away from the heap area (but to keep at least 3m away from heap area for accessibility purpose). Adequate isolation valves shall be incorporated in the event when such isolation is necessary to shut off the water supply to any one of these fire hydrants should it be affected / damaged.
- 6 Water supply for the fire hydrant system shall be in the form of water storage with pumping arrangements (pump feed system) capable of delivering minimum 4,000 L/min (litre per minute) with minimum running pressure of 8 bars.
- 7 On site, operator shall be equipped with at least 4 number of 64mm fire hoses (20 m or 30m in length depends on the overall coverage of fire hydrant and storage heap locations) and 2 portable / mobile water monitors (able to delivery water capacity of minimum 1,000 L/min with coverage distance of minimum 60m water throw when water monitor nozzle is tilted at 45 degree). The required pump fed fire water supply shall have a capacity to serve 4 of such portable / mobile water monitors effectively.
- 8 For hosereels shall also be provided and be located along the fire engine access road such that every part of the heap storage is covered.
- 9 The provision of fire hosereel system shall be in the form of water storage with pumping arrangements (pump feed system) capable of delivering minimum 4 L/s (litre per second) with the required running pressure to throw water up to a ranged of 15m. The actual provision is depending on hose length and water throw based on the established mitigation plan (under para 13).

- 10 The provision of pump fed fire water supply for both fire hydrant and fire hose reel can be shared under one pumping system, but adequate isolation valves shall be incorporated in the event when such isolation is necessary to shut off the water supply to the fire hose reel system should it be affected / damaged.
- 11 The provision of such fire hose reel system could be replaced by providing 2 x 38mm (30m long) fire hose complete with 2 x handheld nozzles capable of delivering 500 L/min (litre per minute).
- 12 Fire water storage tank (in two equal size compartments) for at least 90 minutes shall be provided on site. A 4-way breeching inlet shall be provided at the main entrance of the premises and be connected to the fire water tank. This is to facilitate SCDF with the sufficient fire water supply as well as for any prolonged operational needs.
- 13 The operator shall be responsible to establish the followings:
 - a. an effective monitoring and mitigation plan to ensure that there is adequate apparatus (or system) and manpower to monitor all combustible heaps to prevent the risk of possible ignition (e.g. spontaneous combustion);
 - b. to maintain an adequate in-house emergency response team to initiate first-aid and/or initial fire-fighting procedures for incipient or smothering fires. This is to eliminate any possible fire escalation by control or even extinguish the fire using fire hose reel and portable / mobile water monitors.
- 14 The area / earth underneath heap shall be flatted and compact (nonperforated) and be able to withstand the load of the heap. Metal plate or concrete / cement flooring shall be considered for the entire pile area.
- 15 If a fire occurs, all activities shall cease immediately and focus on the implementation of all mitigation measures including assisting SCDF to remove certain levels of pile to facilitate the firefighting operations.
- 16 To consider keeping pile of sand to mitigate deep-seated fire and a dedicated empty space on site in order to accommodate operation procedures as stated in para 15.
- 17 The operator shall be responsible to maintain good housekeeping and site management at all times.
- 18 SCDF shall be consulted if there are any doubts or queries regarding the fire safety requirements, the operator together with the QP shall visit the FSD at SCDF Headquarters, 91 Ubi Ave 4, for a walk-in consultation.
- 19 In situations where certain provisions of the above cannot be fully adhered to, the operator together with the QP may consult FSD and propose suitable alternatives.

Note:

- (a) All fire safety and fire-fighting systems shall be well-maintained.
- (b) Waste management and recycling premises involved in processing of flammable liquid waste, please refer to clause 9.6.6 of the Fire Code via the following link:

<https://www.scdf.gov.sg/firecode/table-of-content/chapter-9-additional-requirements-for-each-purpose-group/clause-9.6>

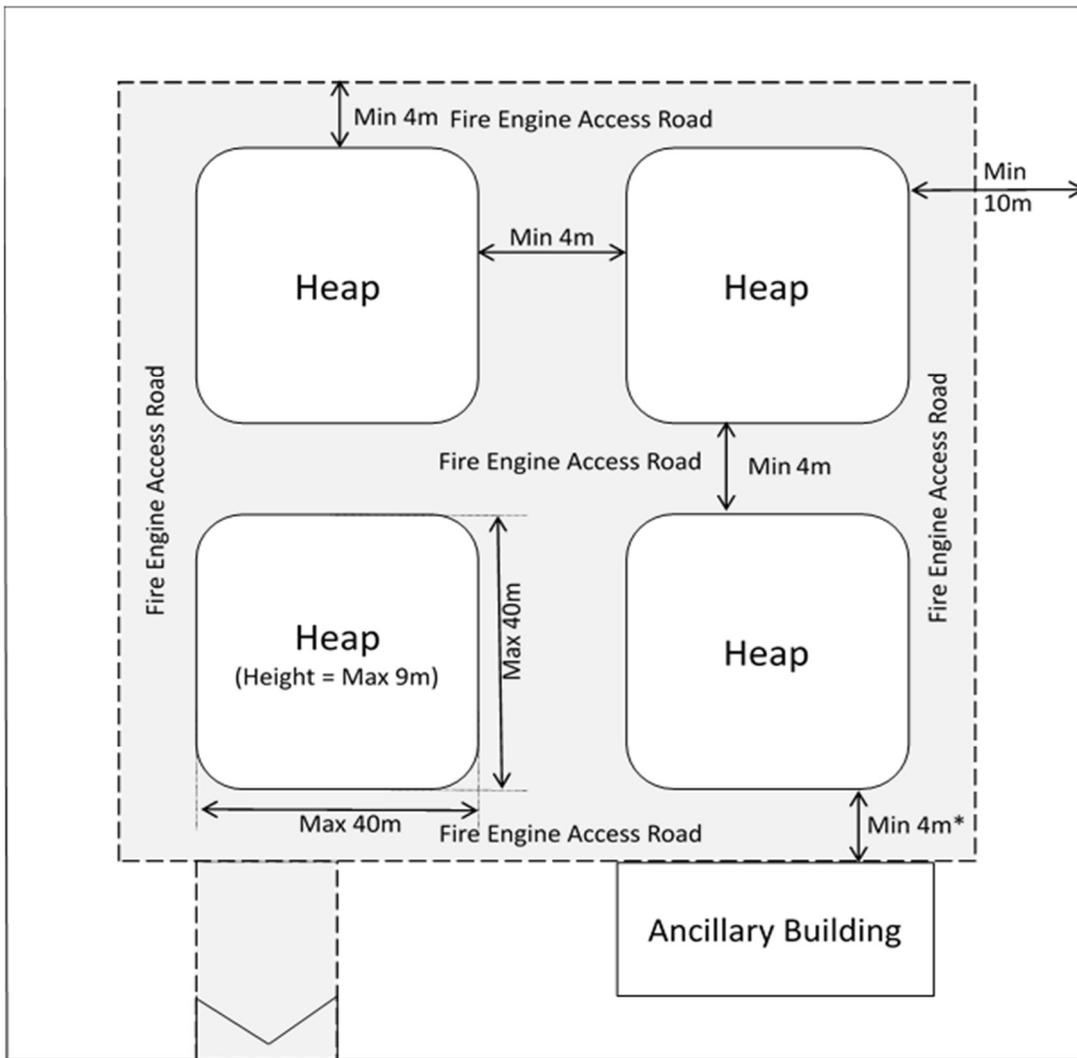
- (c) For general waste management facilities, the building shall comply with factory (Purpose Group VI) requirements of Fire Code. Where storage space is located within the building, it may be subjected to general warehouse requirements under PG VIII buildings. Please refer to CI 9.6.1.c. of the Fire Code and relevant circular on indication of storage space in building plans for PG VI buildings:

[https://www.scdf.gov.sg/docs/default-source/scdf-library/fssd-downloads/circulars/circular--advisory-on-indication-of-storage-space-in-building-plans-for-purpose-group-vi-buildings-\(1\).pdf](https://www.scdf.gov.sg/docs/default-source/scdf-library/fssd-downloads/circulars/circular--advisory-on-indication-of-storage-space-in-building-plans-for-purpose-group-vi-buildings-(1).pdf)

- (d) For details on hazards and controls of combustible dusts, please refer to the circular available via the following link:

<https://safe.menlosecurity.com/https://www.mom.gov.sg/-/media/mom/documents/safety-health/circulars/2015/circular-20150723-hazards-and-controls-of-combustible-dusts.pdf>

* Gasket to be replaced regularly to prevent leakage.



Legend

- Boundary Line
- ⌞ Entrance
- ⌚ Fire Engine Access Road

*Distance between ancillary building and heap to observe building setback (unprotected opening) but minimum 4m.

Note: This diagram is for illustration purpose only.