Empowered *workforce*, Thriving *workplaces*

Driving Excellence in Workplace Safety & Health (WSH)

Ms *Jaime Lim*, MIChemE-PPSE

Director (OSH Specialist Department, Major Hazards Department)

Ministry of Manpower, Singapore

NFEC Seminar, 26 August 2025

Case Study: Stars Engrg Pte Ltd

24 February 2021

Tuas, Singapore

3 fatalities, 7 injuries

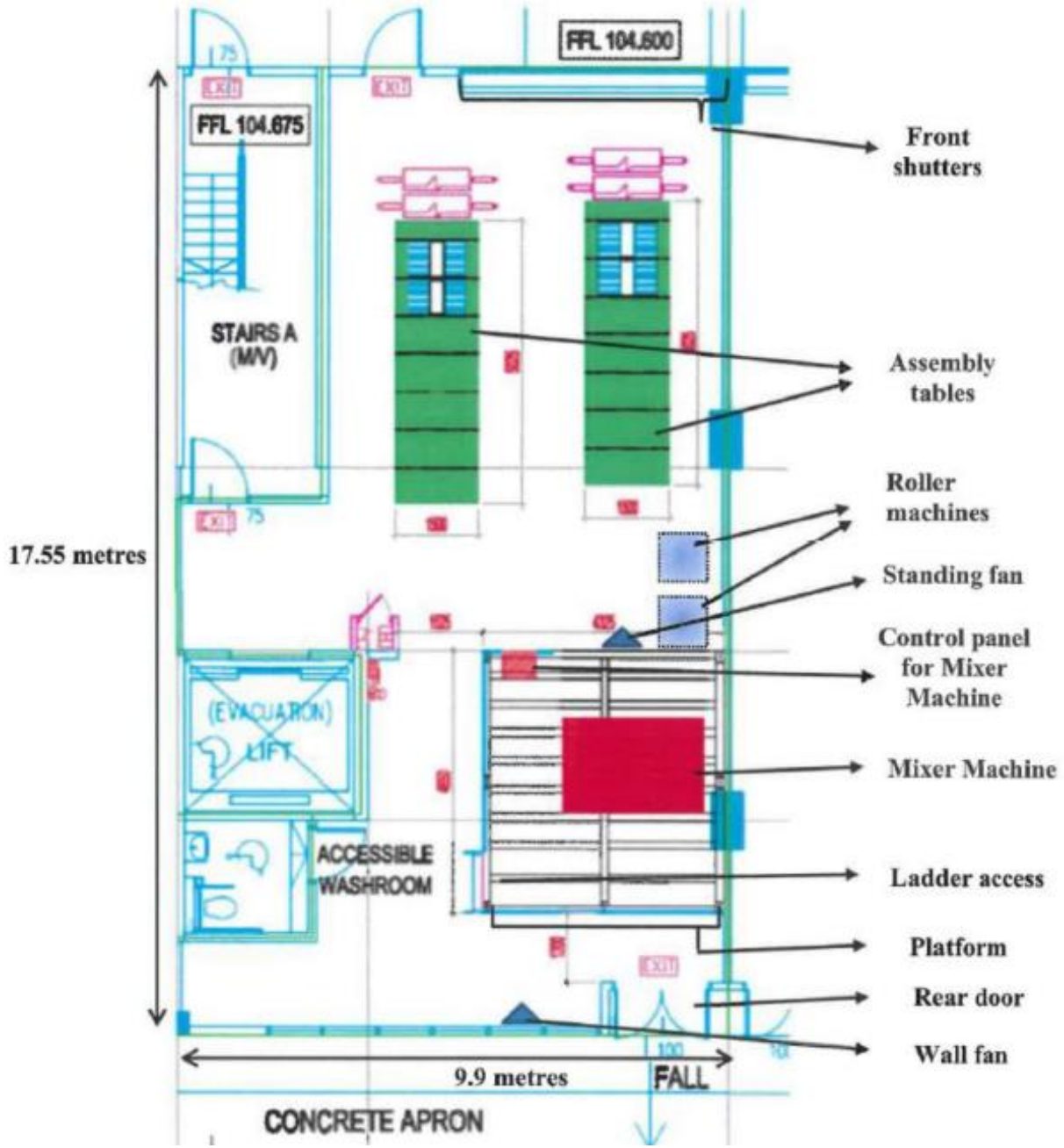
Source**:** Report of the Inquiry Committee for the accident at Stars Engrg Pte Ltd on 24 Feb 2021

Case Study: The Production Process

Fire Clay Making	• Mixer machine to heat up water in mixing chamber. • Add potato starch and other ingredients with heated water in mixing chamber till pasty consistency is achieve
Fire Clay Processing	• Pour out fire clay from mixer machine and laid out on the platform and subsequently transfer to ground floor • Workers at flatten fire clay to 10mm with roller machine • Passed to next roller machine to further flatten fire clay to 5mm
Fire Wrap Assembly	• Two sheets of aluminum roll are cut and taped to create a width of 1.1m for fire wrap • Layers of fire clay and other ingredients are placed on the aluminum sheet • The layers are enfolded with the plastic sheet and shrink-wrapped with heat

Case Study: The Layout

- The worksite measured about 17.55m by 9.90m
- Mixer machine and its control panel was placed on a raised platform
- 2 roller machines were located between the assembly tables and the platform
- 2 assembly tables were placed near the front shutters



Case Study: Sequence of Events

Heating coil fault observed (glowing flange)

- Employer contacted
- Employer gave instruction to shut down machine to replace faulty heating coil

- 1st Explosion and Flash Fire occurred
- Minutes later, explosions and pockets of flash fire occurred

- SCDF arrived
- Fire extinguished

24 Feb 2021

0900hrs

0930hrs

1100hrs

Case Study: Incident Analysis

- Mixer machine was used in overheated conditions as a closed system, leading to mechanical rupture

- Oil vapour was expelled and subsequently ignited due to the sudden rupture, leading to the **primary explosion** and the **subsequent secondary flash fires.**

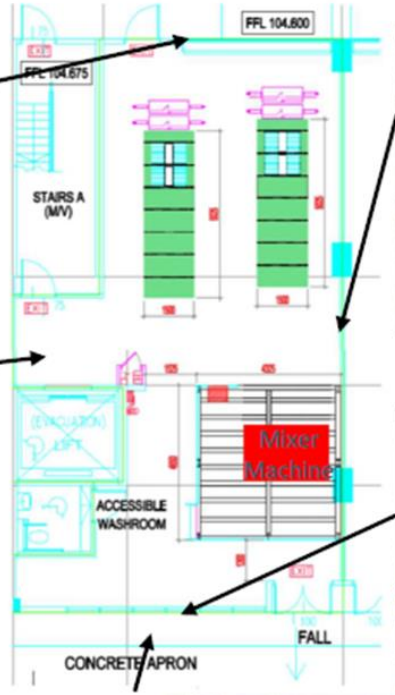
- Secondary flash fires were most likely due to the ***combustion of potato starch powders***.

Source: Report of the Inquiry Committee for the accident at Stars Engrg Pte Ltd on 24 Feb 2021

Case Study: Aftermath of Incident

damaged front shutters

collapsed false ceiling in lift lobby



hole blasted out on side wall

rear wall blasted outwards

debris outside rear wall

Source: Report of the Inquiry Committee for the accident at Stars Engrg Pte Ltd on 24 Feb 2021

Explosion caused by unsafe use of mixer machine

1. **Temperature within oil jacket was not monitored**
   Temperature sensors that came with machine to specifically measure and regulate temperature within the oil jacket not properly used

2. **Insufficient thermic oil used in mixer machine's oil jacket**
   This caused inefficient heat transfer & overheating of the thermic oil. Temperature of thermic oil went beyond its safe operating temperature, leading to thermal degradation, thus reducing its flash point

3. **Mixer machine used as a closed system**
   Sealing off two vents and no monitoring of pressure within oil jacket led pressure to build up beyond safe levels in the oil jacket

4. **Oil jacket's integrity compromised by poor welding repairs**
   The repeated heating and cooling cycles with each operation stressed the oil jacket's integrity, causing it to lose its mechanical strength. Poor quality repair welds resulted in welds fracturing and the oil jacket ruptured outwards at weak points

Subsequent flash fires caused by accumulation of combustible dust powders

1

Lack of Local Exhaust Ventilation system to capture residual powders

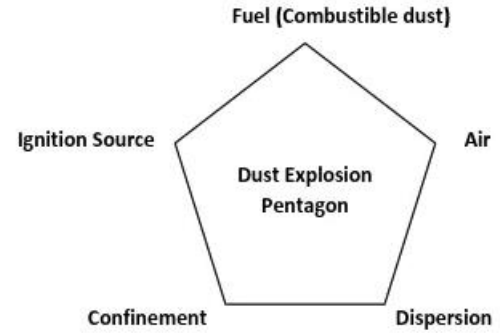
Combustible dust powders were not removed and accumulated within worksite

2

Inadequate housekeeping

Without adequate housekeeping to keep workplace dust-free, combustible potato starch powder could disperse and accumulate within the worksite; such as on ducting, beams and floor.

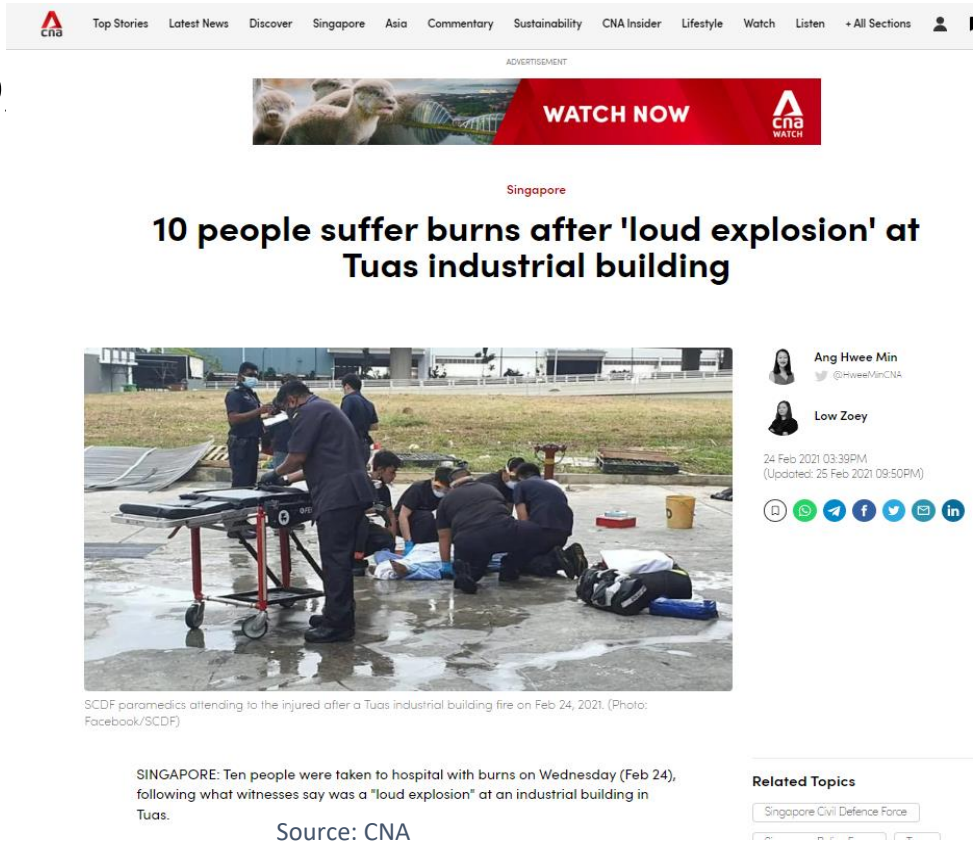
Learning from the catastrophic incident



- The 24 Feb 2021 accident resulted in three deaths, five major injuries, two minor injuries, and severe property damage
- The explosion of the mixer machine ignited combustible potato starch powders in the workshop leading to secondary flash fires

Source: CNA

Source: The Straits Times



Source: CNA

Tuas Inquiry Committee recommendations

MINISTRY OF MANPOWER

About us

MENU 2022 Search

Government Accepts Recommendations by the Tuas Explosion Inquiry Committee

25 March 2022 | Workplace safety and health

1. The Inquiry Committee (IC) appointed to look into the fatal explosion and fire at 32E Tuas Avenue 11 on 24 February 2021 has submitted its report to the Minister for Manpower. After carefully reviewing the IC's recommendations, the Government has accepted all of them.

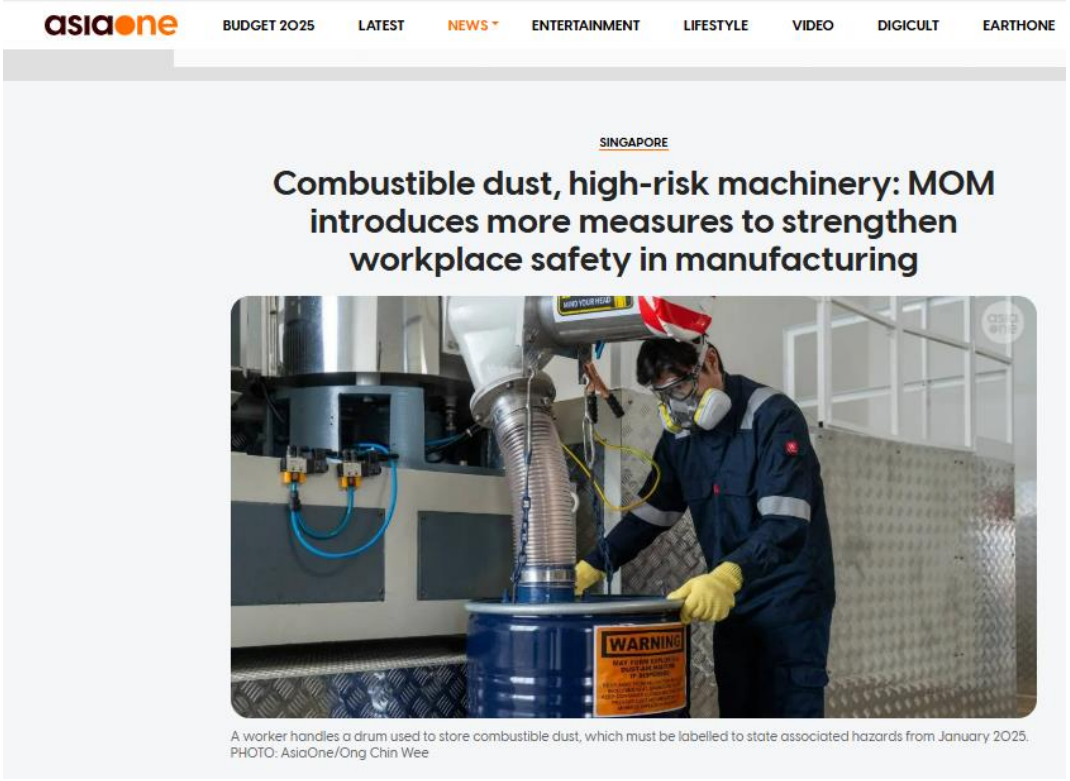
Background

2. On 24 February 2021, eight workers at manufacturing company Stars Engrg Pte Ltd ("Stars Engrg") were preparing a mixer machine to mix potato starch powder with heated water, in order to produce a compound to manufacture fire retardant sheets. An explosion occurred in the process, killing three workers, injuring seven others, and causing severe damage to the building structure.

Annex

Recommendations by the IC

a) Encourage buyers of industrial equipment to certify their equipment to the machinery safety standard SS 537-1[1];
b) Review and expand the Fifth Schedule of the Workplace Safety and Health Act[2] to include higher-risk machineries, such as those powered by mechanical, electrical, hydraulic or pneumatic energy;
c) Require suppliers of materials that pose a defined level of combustible dust hazard to include a label explicitly informing others of the hazard before selling or redistributing those materials;
d) Require companies that handle prescribed amounts of specified combustible powders to register or notify the authorities;
e) Require occupiers to inform building owners or landlords about the use of combustible powders; and
f) Put in place more outreach and guidance efforts for Small and Medium Enterprises, as well as workers who may be at risk.

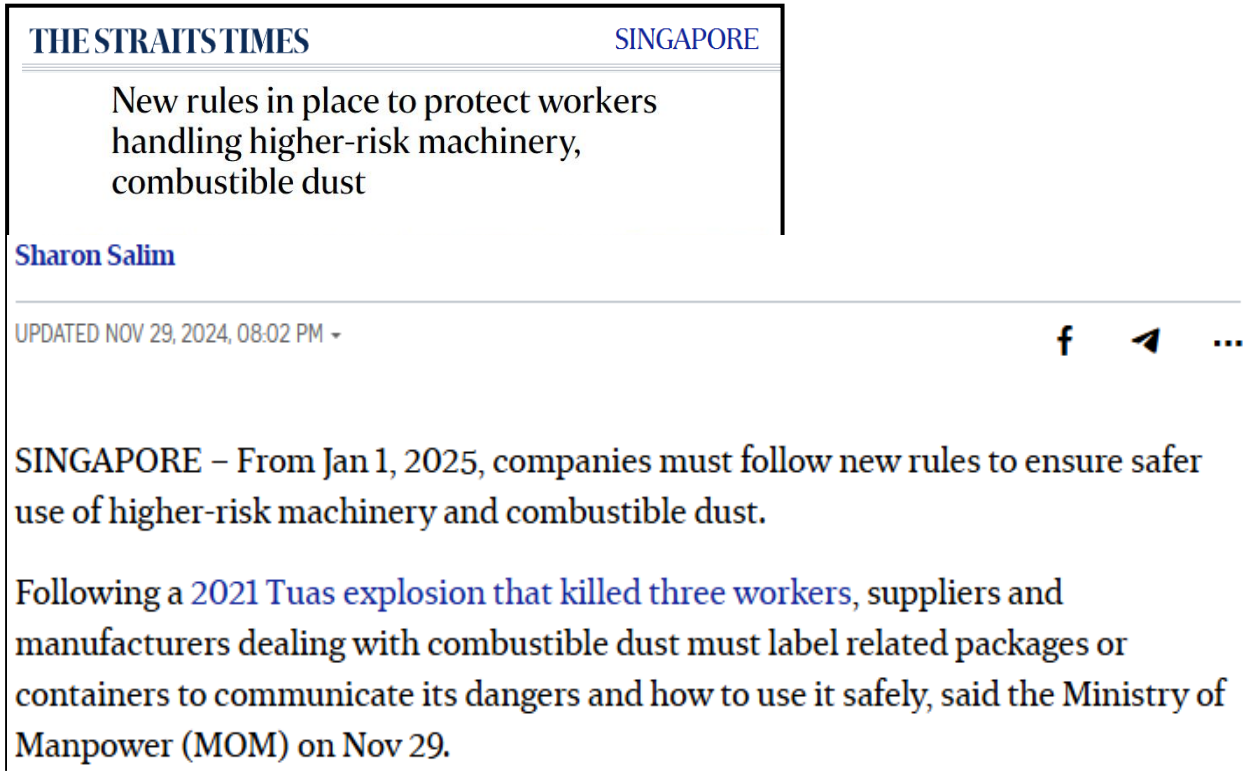


asiaone BUDGET 2025 LATEST NEWS ENTERTAINMENT LIFESTYLE VIDEO DIGICULT EARTHONE

SINGAPORE

Combustible dust, high-risk machinery: MOM introduces more measures to strengthen workplace safety in manufacturing

A worker handles a drum used to store combustible dust, which must be labelled to state associated hazards from January 2025. PHOTO: AsiaOne/Ong Chin Wee



THE STRAITS TIMES SINGAPORE

New rules in place to protect workers handling higher-risk machinery, combustible dust

Sharon Salim

UPDATED NOV 29, 2024, 08:02 PM

SINGAPORE – From Jan 1, 2025, companies must follow new rules to ensure safer use of higher-risk machinery and combustible dust.

Following a 2021 Tuas explosion that killed three workers, suppliers and manufacturers dealing with combustible dust must label related packages or containers to communicate its dangers and how to use it safely, said the Ministry of Manpower (MOM) on Nov 29.

From 1 January 2025, the list of hazardous substances in the Fifth Schedule of the WSH Act is expanded to include combustible dust. Duties of manufacturers and suppliers will also be extended to include combustible dust.

- **Labelling for combustible dust**: Statement "Warning: May form explosible dust-air mixture if dispersed" needs to be explicitly stated on the label.
- **Notification on use of combustible dust:** Factories that handle, sort, pack, store, process, manufacture or use combustible dust specified in the Fourth Schedule of the WSH (General Provisions) Regulations at or above the prescribed threshold quantity will be required to notify MOM and the owner of the factory such as the building owner or landlord.

Other gaps that contributed to the accident or worsened the injuries sustained by the workers

Competency

Lack of competent personnel to:

- Commission and operate mixer machine,
- Identify the problems with it
- Understand and remedy the issues appropriately

Inadequate risk assessment for operation of mixer machine

Not learning the right lessons from, nor adequately addressing, the numerous warning signs and incidents which clearly indicated that there was something wrong with how the mixer machine was being used

Emergency response plan

Lack of a comprehensive emergency response plan which could, in the case of an incident such as fire, indicate:

- Escape route
- Response procedure

Personal Protective Equipment

Not providing or ensuring the donning of suitable Personal Protective Equipment such as fire retardant clothing

Series of red flags were not properly addressed

#	Red flags	Implications	What should have been done
1	Blackened oil drained from the oil jacket	Oil has been overheated leading to degradation.	Use the temperature sensor to measure and regulate the oil jacket temperature within 200°C. Use sufficient oil (240L) to heat the machine.
2	Boiling sounds heard during operation of the machine		
3	White smoke coming out of the oil jacket	Pressure is building up within the oil jacket	Operate the machine as an open system
4	Visible cracks seen on the oil jacket	Integrity of the oil jacket has been compromised	
5	Heaters melted / glowed red / caught fire	Heater has overheated (expert: the heaters must have been at temperature above 700°C over a long time)	Use the temperature sensor to measure and regulate the oil jacket temperature within 200°C

Business uncertainties

AI AGI

Climate Change

Health

WSH Culture

What can you do?

Know the way
Show the way
Go the way

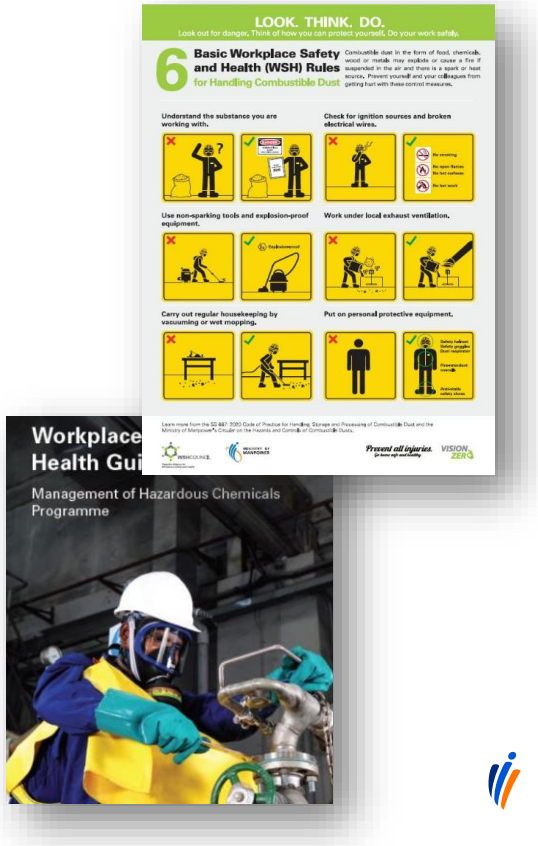
Resources

- MOM webpage on safe use of machineries and combustible dust

- List of FAQs on machinery safety and combustible dust

Other Resources

- Approved Codes of Practice
  - *SS 667 - Code of Practice for handling, storage and processing of combustible dust*
  - *SS 658 - Code of Practice for design, operation, testing, and maintenance of local exhaust ventilation systems*
  - *SS 537 - Code of Practice for safe use of machinery*
  - *SS 586 – Specification for Hazard Communication for hazardous chemicals and dangerous goods*
  - *Code of practice on Workplace Safety and Health (WSH) Risk Management*
- WSH Guidelines on Management of Hazardous Chemicals Programme
- MOM Circular on Hazards and Controls of Combustible Dusts
- WSH Council Publication on 6 Basic WSH Rules for Handling Combustible Dust



Thank you

Ministry of Manpower