Workplace Safety and Health Guidelines

Preparing for Adverse Weather

WSHCOUNCIL

Tripartite Alliance for
Workplace Safety and Health

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1. Introduction

1.1 Adverse Weather and Its Impact

Climate change has led to more frequent adverse weather patterns. Warmer oceans have resulted in more tropical cyclones, bringing stronger winds and heavier rainfall to land masses.

While Singapore's geographical location protects us from tropical cyclones, the example[1] of a strong gust of wind blowing a container office off its supports and killing a worker within, proves the need to plan for unforeseen possibilities. When adverse weather occur, they disrupt work, damage properties and equipment, and can cause injuries.

1.2 Objectives

This guidelines aim to raise awareness on possible adverse weather conditions in Singapore and guides companies to prepare their workplaces for such conditions to minimise injuries to persons and damages to properties.

1.3 Scope

The following adverse weather conditions are covered in this guidelines:

- Strong winds
- Heavy rainfall/flooding
- Lightning
- Heatwaves
- Haze

The guidelines cover the following phases:

- Assessing the impact of an adverse weather condition, and planning the responses to the adverse weather condition.
- Executing preparation works and responses when an impending adverse weather condition is detected.
- Recovering of workplaces and conducting inspections/checks to safely resume work.

The scenarios, hazards and measures shared in this guidelines are non-exhaustive. Companies should monitor the weather and conduct site-specific risk assessments for all relevant work activities impacted by adverse weather. For equipment and structures, companies can work with relevant stakeholders, including designers, manufacturers, and suppliers, to develop appropriate control measures.

Emphasis is placed on temporary structures and equipment at workplaces as they pose the greatest hazards should they dislodge or topple during adverse weather.

[1]Source: https://www.tal.sg/wshc/-/media/tal/wshc/resources/newsletters/wsh-bulletins/files/20220629-wsh-alert.ashx

2. The WSH Act and its Subsidiary Legislation

The Workplace Safety and Health (WSH) Act covers the safety, health and welfare of persons at work in a workplace. It requires stakeholders to take reasonably practicable steps for the safety and health of workers and others affected by the work undertaken in the workplace.

In particular:

- Occupiers of workplaces have a duty to ensure that the workplace, pathways to and from work, and any machinery, equipment, plant, article or substance kept on the workplace does not pose a risk to anyone within your premises.
- Employers have a duty to protect the safety and health of employees or workers working under their direction, as well as persons who may be affected by their work, which include developing and implementing procedures for managing emergencies.
- Principals have a duty to ensure the safety and health of any contractors engaged and their employees when at work, which include developing and implementing emergency response procedures.
- Persons at work have a duty to follow the WSH system, safe work procedures or safety rules implemented at the workplace.

For occupiers and their contractors, communication of the adverse weather response plan is critical to ensure the effectiveness of any response. Occupiers should ensure that the adverse weather response plan is shared with their contractors. Their employees and contractors should adhere to the adverse weather response plan when it is triggered. During the development of the adverse weather response plan, occupiers should involve major stakeholders, including their contractors, to ensure the effectiveness of the response plan.

3. Recommendations for Strong Winds, Heavy Rainfall and Flooding

In the event of adverse weather, the following may occur:

- **Strong winds**
  Strong winds with speeds of 60 km/hr and above can dislodge unsecured materials, and tip over heavy objects. Flying debris and falling objects can injure people and damage property.

- **Heavy rainfall and flooding**
  During stormy conditions, strong winds typically accompany heavy rain. The resulting floodwaters can damage structures and equipment and sweep away workers, objects and debris in an uncontrolled manner.

3.1 Preparing an Adverse Weather Response Plan

Workplaces should assess the risk and impact of adverse weather to their worksite and work activities, and establish a response plan to take necessary precautions and promptly get operations back on track in a safe manner.

The response plan should be a risk-based approach after taking into consideration the specific nature of their business activities and operations. This includes:

- Identify the potential impact an adverse weather condition will have on the workplace, and plan for the resources required, including materials and manpower (such as specialised contractors e.g. Approved Crane Contractors). Appoint the relevant persons involved and familiarise them with their roles before activation.
- Identify vulnerable and at-risk workers and ensure provisions are available for their safety (e.g. accessibility considerations for safe evacuation).
- Establish procedures to notify persons within the workplace about the impending adverse weather and the actions to take. Maintain communication channels to receive information and updates from emergency services and government agencies, such as the Singapore Civil Defence Force and Ministry of Manpower.
- Plan and maintain the required response equipment, including first-aid kits, automated external defibrillators, firefighting and rescue equipment. Ensure the response equipment are easily accessible and are in working condition for adverse weather.
- Establish clear communication channels as existing communication systems may be damaged during adverse weather. For example, prepare wireless communication equipment such as walkie-talkies and loudspeakers to maintain communications between the command post and emergency response team.

Based on the adverse weather response plan, companies should:

- Prepare an adverse weather kit consisting of emergency response tools, communications equipment and emergency rescue equipment. (a non-exhaustive list of recommended items can be found in Annex A). Check the expiry and refresh expendables regularly.
- Familiarise and prepare workers with the response procedures in the event of adverse weather. The response plan should be continually reviewed, updated, and communicated to all workers.
- Develop and implement a training programme and conduct regular drills to familiarise workers with the appropriate response and evacuation.

Table 1 lists a summary of the key recommendations when responding to adverse weather and are explained further in the subsequent sections.

Table 1: Recommendations for responding to adverse weather conditions

Indoor Activities	Prepare for disruptions to electricity and water supplies
	Remain indoors until weather conditions improve
	Stay away from windows, skylights, glass doors and panels
Outdoor Activities	Monitor wind speed and adjust outdoor work activities accordingly
	Stow or secure loose/unsecured materials
	Provide additional PPE such as safety goggles
Underground or Low Ground Activities	Protect low-lying areas from flooding
	Stop work and evacuate
Temporary Structures and Equipment	Dismantle and remove
	Lower and secure
	Communicate response plan and evacuate

Workplaces should adopt a proactive approach and initiate their response plans accordingly before weather conditions exceed the established threshold criteria (indicated in Table 2). When weather conditions at any point in time pose significant risks to workers, suspend all preparation works and stop outdoor activities immediately.

Once the preparations are completed, everyone should evacuate and seek suitable shelter immediately. Workplaces may perform a final check to establish that the response plan had been adequately executed to prepare the workplace for the impending impact.

3.2 Indoor Activities

Exercise caution when working or seeking shelter indoors during adverse weather conditions. Some measures (non-exhaustive) to take include:

- Prepare for disruptions to electrical, water and telecommunication utilities.
- Remain indoors until weather conditions improve.
- Stay away from windows, skylights or glass doors and panels as these may shatter.

Temporary buildings and shelters may not be designed and built to withstand certain adverse weather conditions. When unsure about the structural soundness of buildings and shelters, evacuate to somewhere safe before weather conditions worsen.

3.3 Outdoor Activities

Workers in outdoor environments face escalating risks as weather conditions can worsen quickly. Various objects may be lifted by strong winds and become projectile hazards. Table 2 highlights how various wind speeds may affect workplaces.

Table 2: Potential effects at various wind speeds (modified from the Beaufort Wind Scale)

Beaufort Scale	Wind Speed (km/hr)	Effects
0-3	<2-19	Objects are not moved
4	20-28	Dust and loose paper can be lifted
5	29-38	Scrap metal can be lifted
6	39-49	Workers may be thrown off balance with increased risk of falls. Empty plastic bins can be toppled, while flat materials can catch the wind and act as a sail.
7	50-61	Trees start moving
8	62-74	Wind is strong enough to break twigs and blow over signs and barricades
9	75-88	Minor damage to buildings
10	89-102	Trees are uprooted
11	103-117	Widespread damage
12	>118	Catastrophic damage

[2] The Beaufort wind force scale was developed in 1805 by Sir Francis Beaufort to standardise the qualitative effects of various wind speeds. Present day meteorologists use km/h, mph and knots for expressing wind speed, but the Beaufort scale remains in use for adverse weather warnings for the qualitative effects of various wind speeds.

Some measures (non-exhaustive) to take include:

- Adjust outdoor work activities as the wind speed increases, paying particular attention to workers working at height.
- Stow or secure any loose and unsecured materials.
- Provide additional personal protective equipment (PPE), such as safety glasses, to guard against wind-borne debris.
- Stop all outdoor work once wind speeds exceed 60 km/hr.

3.4 Activities Underground or on Low Ground

Underground structures (e.g. tunnels, basements) may flood during heavy rain. Excavation pits may collapse from heavy rain or rapid water infiltration, which can weaken soil structures. Unless these work areas are adequately protected against flooding, stop work and evacuate all workers in these areas immediately.

3.5 Temporary Structures and Equipment

In adverse weather, temporary structures and equipment can cause serious and widespread injury and damage:

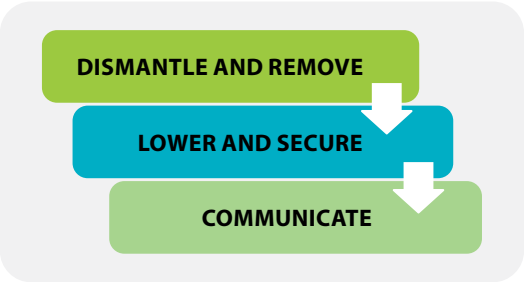
- Temporary structures (e.g. scaffolds, formwork) and their components may be dislodged and swept away.
- Equipment (e.g. cranes, mobile elevating work platforms or MEWPs, gondolas, mast climbing work platforms or MCWPs, lifts and hoists) may fail and collapse.

Workplaces with temporary structures or equipment onsite should make additional considerations to mitigate the potential impact. Some measures (non-exhaustive) to take include:

- Be aware of the temporary structures and equipment's in-service and out-of-service limits (wind speed, forces, etc). These limits are based on engineering standards, manufacturer's recommendations and/or industry best practices.
- Stop the operation of MEWPs such as boom lifts or scissor lifts when wind speeds exceed 45 km/hr or their operational limits (whichever is lower). Operators should refer to the manufacturer's recommendations on model-specific in-service wind speed limits. Park equipment in a pre-designated safe parking spot before the wind speed limit is exceeded.
- Stop the operation of non-guided gondolas when wind speeds exceed 50 km/hr or their operational limits (whichever is lower). Operators should refer to the manufacturer's recommendations on model-specific in-service wind speed limits. Ground and secure all gondolas before the wind speed limit is exceeded.
- For tower cranes, follow the manufacturer's recommendations on the model-specific in-service and out-of-service limits, and the necessary precautions accordingly. Tower cranes are typically designed with wind speed limits of 72 km/hr (while in-service) and 151 km/hr (when out-of-service).
- Establish a response plan to manage temporary structures and equipment, taking into consideration the method and resources required to dismantle or modify temporary structures and equipment in preparation for adverse weather conditions. Figure 1 provides

a guide on eliminating, minimising and mitigating the risk posed by temporary structures and equipment during adverse weather conditions.

Figure 1: Emergency response framework for adverse weather conditions



Dismantle and Remove

Dismantling and removing temporary structures and equipment can eliminate their potential to cause harm. Workplaces should:

- Dismantle and stow away temporary structures and equipment before their service limits are exceeded. Refer to the manufacturer's recommendations on the proper storage of equipment during adverse weather.
- Identify and remove attachments (e.g. banners and posters) that may catch winds and impose additional loading on the equipment.
- Relocate unsecured materials to their designated storage area to prevent them from being blown or washed away.

Figure 2: Workers dismantling a scaffold

Lower and Secure

For temporary structures and equipment that cannot be dismantled and stowed away safely, lower and secure them to reduce their likelihood of collapse. Workplaces should:

- Identify the temporary structures and equipment that need to be lowered or secured.
- Plan and establish the responses (according to the manufacturer's and/or supplier's recommendations) to lower or secure the temporary structures and equipment (e.g. installing additional tie-backs, props or storm anchoring devices).
- Ensure the required materials and resources are always available.

Figure 3: Examples of additional tie-backs for scaffolds

Communicate

Temporary structures and equipment that cannot be dismantled or secured may fail during adverse weather. Companies must make adequate preparations to mitigate the risks to workers and properties, for example:

- Identify the potential collapse zones of temporary structures and equipment.
- Develop plans for the evacuation or restriction of persons from these zones.
- Protect critical properties within the safety collapse zone from the impact of falling equipment or collapsing structures.
- Inform persons within the collapse zones on the response plan during adverse weather conditions, and evacuate them safely.

3.6 Notifications to Adverse Weather

In the event of impending adverse weather, the Ministry of Manpower will inform workplaces before its onset as early as possible. Once alerted, workplaces should:

- Execute their adverse weather response plans proactively.
- Stay updated on the prevailing weather conditions.
- Monitor wind speeds to determine whether the service-limits for equipment have been exceeded.

4. Post-Emergency Recovery

After the adverse weather has subsided, work areas, structures and equipment may have been damaged by the wind and/or rain. Workplaces should make sure that it is safe to resume work before doing so. Some measures (non-exhaustive) to take include:

- Do not operate any machinery or equipment that are damaged or in poor condition.
- Assess if the equipment in the affected area is safe for operations. Equipment owners and users can approach the supplier or manufacturer for a checklist.
- Drain away waterlogged areas.
- Re-assess the stability of ground conditions.

Workplaces should not resume work if conditions are suspected to be unstable or unsafe. Workers should report any unsafe conditions or situations to their supervisors immediately.

5. Recommendations for Other Adverse Weather Conditions

Although less destructive than strong winds and heavy rainfall, lightning strikes, heat waves and haze are other adverse weather conditions that companies should keep in mind when developing their adverse weather response plan.

5.1 Lightning Strikes

Singapore has the highest lightning density in the world, averaging 175 thunderstorm days[3] each year. Lightning strikes can cause fatal injuries, and companies should implement the following measures (non-exhaustive):

- Subscribe to lightning activity alerts.
- Set up portable lightning detectors or lightning protection devices.
- Establish a communication system to notify workers of possible lightning activity.
- Stop outdoor work during flash-bang weather conditions.
- Move workers to the nearest lightning-protected shelter.

For more information on protecting workers from lightning strikes, refer to the WSH Advisory on Workplace Fatal Injuries due to Environmental Factors in 2H2023 or the US Occupational Safety and Health Administration's Factsheet on Lightning Safety When Working Outdoors.

For more information on protecting structures against lightning, refer to the SS 555:2018 Protection against lightning.

5.2 Heat Stress

Singapore's hot and humid weather increases the risks of heat-related illnesses. When the body is unable to remove excess heat, heat stress-related illnesses such as heat stroke may occur. As heat stroke can be fatal, companies should take adequate measures to protect workers from heat-related illnesses.

Employers are required to monitor the wet bulb globe temperature (WBGT), and implement the required heat stress measures at varying WBGT bands focusing on the four aspects of "Acclimatise, Drink, Rest, Shade" to reduce heat stress risks for outdoor workers. More information on the WBGT bands and corresponding measures can be found on the Ministry of Manpower's Guidance on heat stress measures for outdoor work.

[3]Source:https://www.straitstimes.com/singapore/environment/st-explains-will-climate-change-increase-the-likelihood-of-lightning-in-singapore

Some examples of these measures (non-exhaustive) include:

- **Acclimatise:** Acclimatise new workers by gradually increasing their exposure to heat over at least seven consecutive days.
- **Drink:** Remind workers to rehydrate regularly.
- **Rest:** Provide hourly rest breaks of a minimum of 10 mins for heavy physical work activity when WBGT reaches 32°C and above.
- **Shade:** Provide adequate rest in shaded areas with air coolers, such as fans.
- **Educate:** Inform workers on the signs of heat injury and how to address them.

For more information on heat stress, refer to the WSH Guidelines on Managing Heat Stress in the Workplace.

For more information on WBGT monitoring, refer to the Guidelines on Wet Bulb Globe Temperature (WBGT) Monitoring for Outdoor Work.

5.3 Haze

Singapore occasionally experiences haze, which can cause respiratory distress and other adverse health effects. The severity of smoke haze is measured by the 24-hour Pollutant Standards Index (PSI) reading and is used as the benchmark for the measures that companies should take to protect their workers.

Some measures (non-exhaustive) to take include:

- Identify employees who are vulnerable to haze.
- Determine outdoor work activities that need to be adjusted, depending on the 24-hour PSI reading.
- Prepare sufficient personal protective equipment (e.g. N95 masks, respirators, goggles, etc). Ensure at least a week's supply of N95 masks is available as part of the haze-related business continuity plans.
- Establish a communication system to ensure workers are familiar with the measures put in place to protect them.
- Monitor workers' health and encourage them to report any symptoms they are experiencing.

For more information on haze, refer to the Ministry of Manpower's Guidelines for employers on protecting employees from the effect of haze and Haze guidelines and advisory for work.

6. References

Regulations

- Workplace Safety and Health Act and subsidiary legislations
    - Workplace Safety and Health (Risk Management) Regulations
    - Workplace Safety and Health (Design for Safety) Regulations

Guidance Materials

- Ministry of Manpower's Haze guidelines and advisory for work guidelines and advisory for work
- SS 555:2018 Protection against lightning
- SS 559:2022 Code of practice for tower cranes
- SS 598:2014 Code of practice for suspended scaffolds
- SS 616:2016 Code of practice for safe use of mobile elevating work platforms
- SS 659:2020 Code of practice for scaffolds
- Ministry of Manpower's Guidelines on Wet Bulb Globe Temperature (WBGT) Monitoring for Outdoor Work
- Code of Practice on Workplace Safety and Health (WSH) Risk Management
- WSH Guidelines on Managing Heat Stress in the Workplace
- Public Utilities Board's Code of Practice on Surface Water Drainage
- Public Utilities Board's Erosion & Sediment Control at Construction Sites Guidebook

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Annex A - Sample List of Items in an Adverse Weather Kit

Adverse Weather Kit	
Flashlight with dry spare batteries	
Portable lights	
Rain suits	
Rubber boots	

Toolkits	 
Water buckets	
First-aid kit	 

Life buoy	
Life vest	
6m x 6m plastic tarpaulin	
Water pump with hose	

Circuit breaker lock-out tags	
Duct tape and warning tape	
Sandbags	
Rope	

Clean drinking water	
Backup generator	
Fire extinguisher	

Backup communication equipment	
Cellular telephone	
Radio communication equipment	
Wireless radio with charger	

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