Risk Improvement Benchmark (RIB)

Prepared by:

Muhammad Khairi Che Hassim

Sa’aduddin Abdul Wahab

Scope

The risk improvement benchmark will cover compilation of risk improvement based on industry standard and guidelines such as Department of Safety and Health (DOSH), Suruhanjaya Tenaga (ST), Loss Prevention Council (LPC), The National Fire Protection Association (NFPA), Factory Mutual Global (FM Global), etc. This risk improvement recommendation will not cover the firefighting standard.

Objective

The RIB will serve as a documented resource and provide insights for proposing or implementing risk improvements tailored to specific situations and occupations. It will assist risk engineers in enhancing their knowledge of risk improvements and serve as a departmental database. Additionally, it offers clear guidance on meeting regulatory, legal, and industry-specific safety standards, ensuring that the risk improvements provided to clients, help them avoid non-compliance penalties.

These RIB however are not final i.e. can still be subjected to change by risk engineers / surveyor to meet the suitability of the actual recommendations. Any new recommendations are more than welcomed.

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7.14	MS830:2013: Storage, Handling and Transportation of Liquefied Petroleum Gases (LPG)
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7.19	Non-Domestic Electrical Installation Safety Mode (Suruhanjaya Tenaaga, KOD/ST/No.4/2016)
7.20	NFPA 850 Recommended Practice for Fire Protection for Electric Generating Plants and High Voltage Direct Current Converter Stations, 2015 Edition
7.21	Guideline for Electrical Wiring In Residential Buildings, 2008 Edition
7.22	Guideline for The Approval of Electrical Equipment, 2024 Edition
7.23	Risk Control Practice: Occupancy, Renewable Energy Handbook Engineering & Property
7.24	Imia 16-71(98)E, Hydro-Electric Power, Technical and Insurance Development
7.25	MS1979:2007, Electric Installation of Buildings

PERILS

1.1	SUBSIDENCE

Observation

Evidence of subsidence were observed at several areas such as around the M&E rooms of Carpark Building.

Subsidence, which refers to the gradual sinking or settling of the ground, poses significant risks to the structural integrity and operational functionality of the building.

Recommendation

To mitigate these risks and ensure the safety and functionality of the building, the following measures are recommended:

Regular Monitoring of Subsidence Levels
Implement a systematic subsidence monitoring program, with measurements taken monthly to track changes in ground levels.
Utilize tools such as laser levelling, precise digital levelling instruments, or settlement markers to ensure accurate data collection.

Comprehensive Ground Investigation
Conduct a detailed geotechnical survey to determine the underlying cause of the subsidence.
Assess soil conditions, groundwater levels, and other contributing factors to develop a targeted remediation plan.

Preventive Maintenance and Remediation
Based on investigation results, implement remedial actions such as soil stabilization, underpinning foundations, or installing drainage systems to mitigate further ground movement.

Protect M&E Equipment
Temporarily reinforce the M&E rooms to minimize the risk of damage during the monitoring and remediation period.
Ensure waterproofing measures are in place to protect critical systems from potential water ingress.

Record and Report Findings
Maintain a log of all monitoring data, inspections, and remedial actions taken.

Regulation / Guideline

In Malaysia, while there isn't a specific regulation exclusively dedicated to subsidence monitoring, several guidelines and standards address the monitoring of ground movements and structural integrity, which encompass subsidence concerns.

Geotechnical Design Guidelines by JKR (Jabatan Kerja Raya):
These guidelines provide comprehensive procedures for geotechnical analysis, including settlement predictions, calculation of settlement times, and design criteria for settlement analysis. They emphasize the importance of monitoring ground movements to ensure structural safety and integrity.

The Geotechnical Design Guidelines by JKR (Jabatan Kerja Raya) provide a comprehensive framework for managing geotechnical risks, including subsidence. These guidelines emphasize assessing, monitoring, and mitigating ground movement to ensure the safety and stability of structures.

Below is an outline of the relevant sections related to subsidence:

Ground Investigation Requirements

- Conduct thorough soil investigations to identify soil properties, including compressibility, shear strength, and permeability.
- Borehole drilling and sampling should be done at strategic locations to assess subsurface conditions that may influence settlement.
- Lab testing, including consolidation tests, should be conducted to estimate settlement rates and magnitude

Monitoring of Movements

- Regularly monitor settlement and subsidence using geotechnical instruments such as settlement markers and piezometers.

1.2	PIPE BURSTING

Observation

Regular occurrences of pipe bursting in the facility present significant risks, including potential damage to infrastructure, equipment, and inventory. This issue can also disrupt operations, increase maintenance costs, and pose safety hazards such as flooding, electrical hazards, and compromised structural integrity.

Recommendation

To minimize the risk of pipe bursts, which can lead to property damage, operational disruptions, and safety hazards, the following proactive measures are recommended.

- If the piping systems are still under warranty, the installing contractor should be requested to perform a one-time comprehensive inspection of all piping systems, including joints and connections, at no additional cost.
- Ensures that potential installation defects or weaknesses are identified and rectified early.
- Confirms the quality and durability of materials and workmanship under the contractor's responsibility.

- The insured’s maintenance personnel should conduct regular inspections of the piping systems, ideally on a monthly basis. If monthly inspections are not feasible, prioritize high-risk joints and connections for monthly checks.
- Identifies early signs of wear, corrosion, or leaks, reducing the likelihood of pipe failure.
- Prolongs the lifespan of the piping system by ensuring timely maintenance and repairs.

- Train all personnel working on the premises, such as hotel housekeeping staff, to recognize and report signs of water leakage or damaged pipes to the maintenance team promptly.
- Ensures rapid response to emerging issues, preventing further damage or escalation.

Regulation / Guideline

1. **Strata Management Act 2013:**

   This Act addresses maintenance and management issues in strata properties. It includes provisions on the responsibilities of property owners and management bodies concerning maintenance and repair of common facilities, including piping systems, to prevent issues like inter-floor leakages.

2. **The Street, Drainage and Building Act 1974 (Act 133)**

   This Act encompasses several sections pertinent to the construction and maintenance of building infrastructure, impacting the integrity of piping systems. These provisions collectively aim to ensure the proper installation, maintenance, and operation of piping systems within buildings, thereby safeguarding structural integrity and public health.

   Notable sections include:

   1. Section 56: Rain-water pipes not to be used as soil-pipes
      - Prohibits the use of rainwater pipes for carrying soil or drainage from privies or water-closets, ensuring proper segregation of waste and rainwater systems.
   2. Section 57: Water pipes, etc., not to be used as ventilating shafts
      - Restricts the use of water pipes as ventilating shafts to prevent

contamination and ensure proper ventilation of drainage systems.

3. Section 61: Ventilating pipes to sewers
    - Empowers local authorities to install necessary pipes for the proper ventilation of drains and sewers, maintaining the functionality and safety of drainage infrastructure.

3. The Factories and Machinery (Safety, Health, and Welfare) Regulations 1970

Thia Act encompass provisions that, while not explicitly mentioning "pipe bursting," relate to the safety and maintenance of piping systems within industrial settings. Relevant sections include:

1. Regulation 18: Hot Pipes
    - Mandates that all steam pipes and pipes used for heating purposes, which are accessible to personnel during regular operations, must be properly insulated or guarded. This measure prevents accidental contact that could lead to injuries and ensures the safe operation of piping systems.
2. Regulation 20: Stacking of Material
    - Specifies that materials, including pipes and bar stock, should be stored on stable racks or layered with appropriate supports to prevent displacement. Proper storage minimizes the risk of mechanical damage to pipes, which could lead to failures or bursts.
3. Regulation 19: Objects on Inclines
    - Requires that heavy objects, such as large pipes, handled on inclines must be controlled using ropes or other tackle, in addition to necessary chocks or wedges. This regulation aims to prevent uncontrolled movements that could result in damage or hazardous situations.

1.3	LANDSLIDE AND RISK ASSESSMENT

Observation

The risk of landslides is present due to the slightly elevated land with a hill located within the campus. Although no past incidents of landslides have been recorded, the proximity of the hill slope to buildings increases the risk of soil movement which could lead to a landslide, potentially causing structural damage, injury, or operational disruption.

Potential Risks Associated with the Hill Slope

1. Landslide & Soil Erosion Risks
- Unstable slopes due to natural soil erosion, which may gradually weaken the slope stability.
- Heavy rainfall or poor drainage systems may trigger soil displacement.
- Vegetation overgrowth can cause uneven soil distribution, increasing the chances of slope failure.

2. Infrastructure & Safety Risks
- The proximity of the buildings and walkway to the hill slope means a landslide could damage structures.
- Falling rocks or debris may cause injury to individuals walking along the covered walkway.

Recommendation

Here are some risk mitigation recommendations for improving this potential risk:

1. Regular Monitoring & Inspection
-Conduct frequent visual inspections of the slope for signs of soil movement, including:
  -Cracks in the ground or retaining walls
  -Leaning trees or tilting structures
  -Falling soil, loose rocks, or minor slope failures
  -Drainage blockages that may increase soil saturation
- Schedule geotechnical assessments every six months or after heavy rainfalls to evaluate slope stability.

2. Slope Stabilization Measures
- Install proper drainage systems to prevent excessive water accumulation that weakens soil strength.
- Vegetation control: Maintain appropriate ground cover plants or geotextile matting to prevent excessive soil erosion.
- Construct retaining walls or reinforce slopes using gabions, soil nailing, or erosion control barriers.
- If cracks or soil movement are detected, immediate reinforcement should be undertaken to prevent further deterioration.

3. Safety Measures for Walkways & Buildings
- Install protective barriers along the covered walkway to reduce the risk of debris falling onto pedestrian paths.
- Establish a safe clearance zone near the slope to restrict unauthorized access.
- Ensure emergency evacuation procedures are in place in case of landslide threats

Regulation / Guideline

The safety and stability of slopes fall under several Malaysian laws and guidelines, which include:

1. Guidelines for Slope Safety by the Public Works Department (JKR) & Slope Management Guidelines by JPS Malaysia

- Requires proper slope management, erosion control, and periodic maintenance to prevent landslides.
- Encourages installation of retaining structures and drainage systems to manage slope stability (under item 12 & 13).

2. Street, Drainage and Building Act 1974 (Act 133)

Section 53: Requires Local authority to repair and alter and may discontinue surface and storm water drains. From this section, it may ensure drains and slopes are properly maintained to prevent soil movement.

1.4	DRAINAGE SYSTEM

Observation

During the inspection, several issues were identified within the drainage system that could pose potential risks to the premises.

1. Structural Damage to the Drainage System
Some sections of the drain, particularly those located at the rear-left side of the premises, were observed to be cracked. This could lead to:

- Water stagnation, increasing the risk of flooding and mosquito breeding.
- Soil erosion, which may weaken the surrounding ground structure.
- Blockages and inefficiencies, reducing the drainage system's ability to handle excess water during heavy rainfall

2. Obstruction Due to Overgrown Bushes
Some sections of the drainage system, particularly at the rear side of the premises, were found to be filled with bushes and vegetation, leading to:

- Blockage of water flow, increasing the likelihood of flooding.
- Pest infestations, as stagnant water can attract rodents, mosquitoes, and other harmful organisms.
- Structural damage, as plant roots may penetrate drainage walls, causing cracks and leaks.

Recommendation

Here are some recommendations for improving this potential risk:

- The damaged sections of the drain should be promptly repaired to restore structural integrity and prevent further deterioration.
- Regular inspection and maintenance should be conducted to ensure that the drainage system remains functional and free from defects.
- The bushes and vegetation obstructing the drains should be cleared immediately to ensure the free flow of water.
- A routine maintenance schedule should be established to prevent future blockages.
- The premises management should implement a drainage upkeep plan that includes periodic cleaning and vegetation control.

Regulation / Guideline

The maintenance and management of drainage systems in Malaysia are governed by the following regulations and guidelines:

1. <u>Street, Drainage and Building Act 1974 (Act 133)</u>
Section 53: Requires Local authority to repair and alter and may discontinue surface and storm water drains.
Section 55: Penalty. From this section, it mentions that the authorities have the power to enforce remedial actions if a drainage system is found to be defective or blocked.

2. <u>Environmental Quality Act 1974 (Act 127)</u>
Section 24: Prohibits activities that lead to pollution,
Section 25: Restriction on pollution of inland waters. Note that 'inland water' means of reservoir, pond lake, river, canal, stream, drain etc. which can be translate to improper drainage maintenance that can cause water contamination.

3. <u>Local Authority Guidelines (such as DBKL, MBPJ, MPAJ, etc.)</u>

Mandates regular maintenance of drainage systems within private and commercial premises.

Imposes penalties for failure to maintain drainage systems, leading to public nuisance or environmental hazards.

1.5	FLOOD MITIGATION MEASURE

Observation

The factory recently experienced significant losses due to flooding, resulting in damage to critical equipment, disruption of operations, potential health hazards, and financial losses. The insured acknowledges the need for comprehensive flood mitigation measures to enhance the facility's resilience against future flooding events.

Recommendation

To mitigate flood risk, following recommendation are proposed:

- Elevate Critical Equipment: Install raised metal platforms to protect essential machinery and electrical control panels from floodwater damage.

- Improve Drainage Systems: Install flap water valves at drainage endpoints to ensure water only flows outward, preventing backflow into the facility.

- Install Flood Water Alarm Systems: Implement early warning systems to detect rising water levels and trigger emergency response plans.

- Construct Containment Systems: Build larger containment sum pits equipped with diesel sludge pumps for effective floodwater discharge.

- Build Protective Bund Walls: Erect bund walls around main switch rooms and substations to prevent floodwater intrusion.

- Install Flood Barriers and Gates: Utilize sandbags, automated flood gates, or other barriers for enhanced protection against water ingress.

- Develop and Implement Flood Risk Management Plan (FRMP): Establish a comprehensive plan that includes emergency response procedures, regular maintenance, and training for employees to ensure preparedness and minimize potential damage during flood events.

Regulation / Guideline

Street, Drainage and Building Act 1974 (Act 133): Provides guidance on proper drainage systems to mitigate flooding risks.

Section 58(44): The local authority may require the owner or occupier of any building or land on which is situated any drain, urinal, water-closet, sink, or bathroom to repair or renew it or put it in proper order. If they fail to comply, the local authority may carry out the work and recover the expenses.

Note: this section Mandates owners or occupiers of buildings abutting private streets to clean and maintain their drainage systems.

1.6	LIGHTNING STRIKE

Observation

The area is highly exposed to lightning activity, which poses a significant risk to both personnel safety and operational integrity. The frequent occurrence of lightning strikes increases the likelihood of damage to critical equipment, power disruptions, and potential fire hazards. Furthermore, recent losses recorded due to lightning incidents highlight the inadequacy of current protection measures and the urgent need for improved lightning protection systems.

Lightning arestor and lightning strike counter

Recommendation

1) Lightning Protection System (LPS) Installation:
   Implement a comprehensive Lightning Protection System (LPS) designed to capture and safely dissipate lightning strikes. This should include:
   - Air Terminals (Lightning Rods) strategically installed on all vulnerable structures.
   - Down Conductors to provide a direct path for lightning current to reach the ground.
   - Grounding Systems designed to effectively dissipate the electrical energy into the earth.
   - Surge Protection Devices (SPDs) installed at all critical electrical and electronic equipment to protect against transient overvoltage.
   -

2) Risk Assessment & Analysis:
   Conduct a detailed lightning risk assessment to determine the risk level associated with lightning strikes at the site. This assessment should follow industry standards such as IEC 62305 or NFPA 780 and include factors such as structure size, location, and occupancy type.

3) Regular Maintenance & Inspection:
   Establish a routine inspection and maintenance program for the LPS and SPDs to ensure their functionality and effectiveness. Regular testing of grounding resistance should be performed and recorded.

4) Enhanced Monitoring Systems:
   Install real-time lightning monitoring and detection systems to provide early warning alerts. This will allow timely implementation of emergency procedures to safeguard personnel and sensitive equipment.

5) Safety Procedures & Training:

Develop and implement safety procedures for personnel during lightning storms. Provide training on lightning safety, including protocols for seeking shelter, equipment shutdown, and response to lightning-related emergencies

Regulation / Guideline

In Malaysia, lightning protection system (LPS) design and related regulations are primarily governed by the **MS IEC 62305** standard, which aligns with the international IEC 62305 standard. This standard provides comprehensive guidelines on the design, installation, maintenance, and testing of LPS to safeguard structures and their occupants from lightning-related hazards

Part 1: General Principles
This section introduces the fundamental concepts of lightning protection, including definitions, lightning characteristics, and general protective measures.

Part 2: Risk Management
It outlines methodologies for assessing the risk posed by lightning to structures and services, helping determine the necessity and extent of protection measures required.

Part 3: Physical Damage to Structures and Life Hazard
This part provides detailed guidance on protecting structures and individuals from physical damage and injury due to lightning strikes. It covers the design considerations for external and internal LPS components.

Part 4: Electrical and Electronic Systems within Structures
It focuses on safeguarding internal electrical and electronic systems from lightning-induced surges, emphasizing the importance of surge protective devices and proper system design.

1.7	FALLING TREES

Observation

The presence of large, mature trees within a developed area poses significant risks that must be addressed to ensure safety and prevent potential losses. Trees provide essential benefits such as shade, aesthetic value, and environmental enhancement. However, their size, age, and structural condition can also pose hazards if not properly managed. This may pose to following risks:

1) Dead Trees:
- Trees that have died due to diseases, pest infestations (such as termites or beetles), or natural decay are at a high risk of falling. Dead trees are structurally weak and can collapse suddenly, causing injury, property damage, or even fatalities.

2) Broken or Hanging Branches:
- Detached or partially broken branches, especially those hanging from significant heights, may fall unexpectedly. This can be hazardous to pedestrians, vehicles, and nearby structures.

3) Material Fall from Trees:
- Objects such as nests, fruits, or broken branches can fall without warning, posing a threat to people and property below.

4) Signs of Disease or Structural Weakness:
- Presence of fungi, mushrooms, or perennial fruiting bodies on the trunk or branches indicates internal decay and structural weakness.
- Disease symptoms such as leaf discoloration, premature shedding, or cankers can also signal compromised health and stability.

5) Leaning Trees:
- Trees with a tilt greater than 10 degrees from the vertical pose a higher potential for failure, especially during heavy rains, strong winds, or seismic activity.

6) Cracks in Trunks and Branches:
- Visible cracks are clear signs of compromised structural integrity, increasing the likelihood of collapse during storms or high wind events.

7) Soil Heaving or Uplift:
- Disturbances around tree roots, such as soil heaving or uplift, indicate potential root failure. Such trees may be ready to fall at any moment, particularly under adverse weather conditions

Recommendation

It is advised that the participant examine, identify and appropriately maintain the trees by either pruning or eliminating the impacted trees in order to lessen the risks of a tree collapsing. Following are among risk mitigation that could be done:

1) Tree Risk Assessment and Inspection:
- Regularly inspect all trees within the area, especially those located near high-traffic zones, parking lots, and structures.
- Engage certified arborists or tree risk assessment experts to evaluate tree health and structural integrity using standardized assessment tools.

2) Pruning and Removal:
- Remove dead trees immediately to prevent accidental falls.

- Prune damaged or diseased branches to eliminate weak points and improve overall tree health.
- Implement preventive pruning to enhance structural stability and prevent the likelihood of large branches breaking off during extreme weather conditions.

3) Disease Management:
- Monitor trees for signs of disease and take appropriate action to control or eliminate the disease spread.
- Implement pest control measures where necessary to prevent infestations that may compromise tree health.

4) Proactive Monitoring:
- Install monitoring devices where necessary to detect early signs of instability, such as tilting sensors or soil movement indicators.

5) Tree Support Systems:
- Where appropriate, install cabling, bracing, or guying systems to support structurally weakened trees and minimize the risk of failure.

Regulation / Guideline

1) The Town and Country Planning Act 1976 (Act 172) addresses the **preservation and management of trees** under **Part VA – Tree Preservation Order**, particularly in **Sections 35A to 35H**. Here's a summary of the relevant parts (35A and 35E):

1.1) Section 35A (Tree Preservation Order):
- The local planning authority can issue a tree preservation order if it's necessary to preserve trees for amenity purposes.
- The order can prohibit the felling of trees without written permission from the local planning authority.
- It can also require the planting or replanting of trees as directed by the authority.

Exemptions include trees that are dying, dead, or present an imminent danger

1.2) Section 35E (Replacement of trees):
- Any person found guilty of unauthorized felling must replace the tree with another of appropriate size and species at a specified location

2) Occupational Safety and Health Act 1994 (OSHA):
While not exclusively focused on tree management, OSHA mandates that employers ensure the safety, health, and welfare of their workers. This includes implementing safety measures during tree maintenance activities, such as pruning or removal, to protect workers from potential hazards

1.8	WINDSTORM

Observation

The Administration, Academic, and Library Building (1 OP) has experienced multiple incidents of wind damage to the strip ceilings at the roof level. In September 2023, a significant wind event caused one strip ceiling to be blown away and damaged several others. According to the participant, similar incidents have occurred on multiple occasions previously but were not reported to the takaful operator. After each event, the damaged strip ceiling was replaced without further investigation or mitigation measures.

This repetitive pattern of damage highlights the inadequacy of current construction and maintenance practices, suggesting the need for a more comprehensive and proactive approach to managing wind-induced risks.

The following risk assessments should be carried out to identify any possible and inherent causes arises from the event:

1) Vulnerability to Strong Winds:
   - The building's roof and strip ceiling structures are highly exposed to strong wind forces, especially during stormy weather conditions.
   - The design and construction of the strip ceilings may not be adequate to withstand high wind pressures, leading to repeated failures.
   -
2) Potential Consequences:
   - Structural damage to the building due to compromised ceilings.
   - Potential safety hazards to occupants and pedestrians due to falling debris.
   - Increased financial losses from repeated repairs and replacements.
   - Potential reputational damage and increased insurance premiums if incidents persist.

Recommendation

We recommend that a more comprehensive and proactive approach be taken instead of merely replacing the damaged strip ceilings after each incident. The followings mitigation plans shall be explored:

1. Proactive Maintenance and Inspection:
   - Quarterly Inspections:
     - Conduct scheduled inspections of the strip ceilings at least every three months, focusing on areas most exposed to prevailing wind directions.
   - Post-Event Inspections:
     - Perform immediate inspections after each windstorm or strong wind event to assess damage and identify any weakened areas.
   - Inspection Records:
     - Maintain detailed records of all inspections, including observations, identified issues, and remedial actions taken.
   - Professional Assessment:
     - Engage a professional roofing inspector or structural engineer to evaluate the adequacy of the current installation and recommend improvements.

2. Enhanced Roof Strengthening Measures:
   - Strengthening the Roof Structure:
     - Implement structural enhancements, such as:
       - Installing gable bracing to support roof ends and reduce lateral

movement.
        - Utilizing roof nailing techniques that secure the roof deck more effectively to the supporting structures.
        - Applying hurricane clips or straps to secure roof components.
- Reinforced Materials:
    - Upgrade the quality and durability of strip ceilings with materials that have higher wind resistance.
    - Use weather-resistant fasteners and adhesives to secure the ceilings more firmly.

3. Design and Construction Improvements:
- Wind Load Assessment:
    - Conduct a thorough analysis of the wind loads expected at the site, considering factors such as wind speed, wind direction, and building geometry.
- Structural Integrity Enhancement:
    - Evaluate the connection points and support systems of the strip ceilings to ensure they can withstand anticipated wind forces.
- Aerodynamic Considerations:
    - Redesign the strip ceiling profiles to reduce wind resistance and minimize the likelihood of being lifted or blown away.

4. Expert Consultation and Mitigation Measures:
- If incidents continue to occur despite the above measures, it is recommended to:
    - Engage a qualified structural consultant or wind engineering expert to conduct an in-depth assessment.
    - Identify the root causes of failure and explore alternative construction techniques or materials.
    - Implement wind mitigation strategies that are proven effective in similar environments

Regulation / Guideline

The primary standard governing wind loading for building structures in Malaysia is **MS 1553:2002 - Code of Practice on Wind Loading for Building Structure**. This standard outlines the procedures to determine wind speeds and the resulting wind actions that structures must withstand. Wind load specified as per MS1553 with a minimum basic wind speed of 33.5m/s for Zone I while 32.5m/s for Zone II.

Figure 3.1 Basic Wind Speed for Peninsular Malaysia (Simplified Procedures)

According to Wind Load Consideration in Structural Design (by Ir. Dr. Justin Lai Woon Fatt), the minimum wind forces the main structural system must resist should be at least 0.65 kN/m², multiplied by the area of the building or structure as seen in a vertical plane perpendicular to the wind direction.

1. Billboard

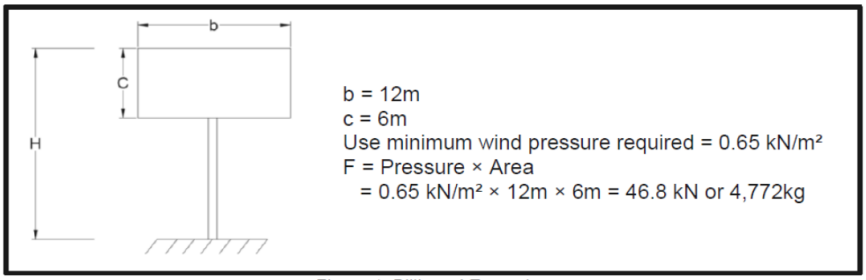


Figure 1: Billboard Example

2. High rise building

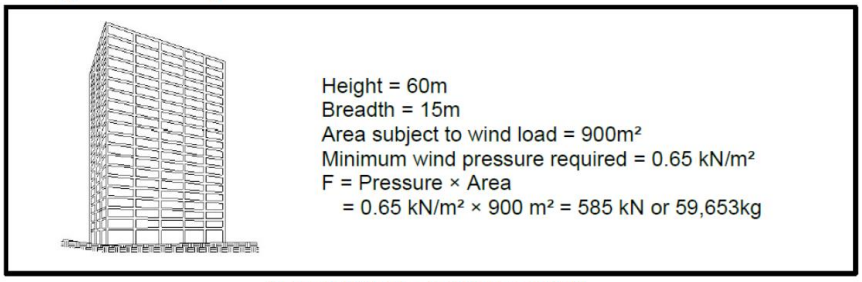


Figure 3: High Rise Building Example [2]

1.9	IMPACT DAMAGE FROM LIFTING ACTIVITIES

Observation

There is evidence of impact damage to the walls and roof of the factory resulting from lifting activities carried out by lorries and other large vehicles. These damages may occur due to poor manoeuvring, inadequate clearance, or improper handling of heavy materials during loading and unloading operations.

The continued occurrence of such incidents could result in structural damage, compromising the integrity of the building and potentially causing safety hazards to personnel and equipment within the factory premises.

The risk assessment on caused of damage and potential consequences from this kind of risk/hazard shall be carried out as follows.

1. Causes of Damage:
    - Inadequate clearance between vehicles and factory walls/roof during lifting operations.
    - Poorly designed loading/unloading areas that do not account for the size and height of lorries and large vehicles.
    - Insufficient guidance systems or markings for safe manoeuvring.
    - Lack of proper training for vehicle operators on safe lifting and maneuvering procedures.
    - Absence of barriers or protective structures to prevent accidental impact.

2. Potential Consequences:
    - Structural damage to the factory's walls and roof, leading to expensive repairs or reconstruction.
    - Increased risk of injury to workers and visitors due to falling debris or compromised structures.
    - Disruption of operations and potential downtime if critical areas are damaged.
    - Insurance claims or increased premiums due to repeated incidents of damage.
    - Loss of reputation and credibility for failing to implement adequate safety measures.

Recommendation

To mitigate the risks associated with impact damage, the following measures are strongly recommended:

1. Physical Barriers and Protective Structures:
    - Install protective barriers, bollards, or railings at strategic points to prevent vehicles from making direct contact with factory walls and roofs.
    - Construct roof guards or height restrictors where applicable, especially where vehicles may inadvertently hit overhead structures.

2. Clear Markings and Guidance Systems:
    - Mark all loading/unloading zones with high-visibility paint or reflective tape to delineate safe paths for vehicles.
    - Install warning signs and height restriction indicators to alert drivers to potential collision points.
    - Consider installing mirrors or visual aids to enhance visibility for drivers when manoeuvring in tight spaces.

3. Improved Loading/Unloading Area Design:

- Review and redesign the layout of loading/unloading areas to ensure sufficient clearance for lorries and other large vehicles.
- Provide dedicated zones for lifting activities, separated from pedestrian pathways and vulnerable structures.

4. Operator Training and Safe Operating Procedures:
- Implement regular training programs for vehicle operators focusing on safe lifting and manoeuvring procedures.
- Provide training on proper vehicle positioning, safe speed limits, and lifting techniques to minimize the risk of impact.

By implementing these recommendations, the risk of structural damage from lifting activities by lorries and large vehicles can be significantly reduced. Enhanced safety measures will protect both the physical infrastructure of the factory and the safety of personnel, ultimately resulting in cost savings and improved operational efficiency.

Regulation / Guideline

Safety and Health Act 1994 (OSHA 1994)

Section 15: General Duties of Employers
- Employers are required to ensure, as far as is practicable, the safety, health, and welfare at work of all their employees.

Note: This includes providing and maintaining a safe working environment and ensuring that plant and machinery are safe and without health risks.

Section 24: General Duties of Employee
- to take reasonable care for the safety and health of himself and of other persons who may be affected by his acts or omissions at work.

Note: Employees are obligated to take reasonable care for their own safety and health, as well as that of others who may be affected by their actions at work. They must also cooperate with their employers in adhering to safety and health regulations

1.10	ENHANCING IMPACT PROTECTION FOR NATURAL GAS REDUCING AND METERING STATION

Observation

The natural gas reducing and metering station is located within a yard that also serves as a car parking area. It is protected by a chain-link fence and plastic impact barriers positioned along the side most exposed to vehicle traffic from the parking bays. However, the current use of plastic barriers is considered inadequate to prevent significant vehicle impact, especially from larger vehicles or high-speed collisions. If compromised, this station poses a severe risk of natural gas leaks, explosions, and subsequent fire hazards.

The hazard identified from this are as follows:

- Potential impact damage from vehicles due to inadequate barrier strength.
- Risk of gas leaks from damaged piping or control systems following a vehicle collision.
- Increased likelihood of ignition sources in case of gas leaks due to the proximity of vehicles.

Recommendation

To mitigate the risks associated with impact damage, the following measures are strongly recommended:

1. Replace Plastic Impact Barriers with Reinforced Concrete Barriers:
   - Install reinforced concrete impact barriers permanently along the side of the natural gas reducing and metering station that is exposed to the car parking bays.
   - Ensure that the barriers are constructed to withstand high-impact forces, providing robust protection against accidental vehicle collisions.
   - The design should adhere to relevant standards, ensuring barriers are tall and wide enough to provide effective coverage

2. Enhanced Perimeter Protection:
   - In addition to concrete barriers, consider enhancing the chain-link fence with impact-resistant guardrails or steel bollards for added security.
   - The installation should cover all sides that may be exposed to vehicle movement, not just the most vulnerable side

3. Improved Signage and Markings:
   - Clearly mark the protected area with warning signs and reflective markings to enhance visibility for drivers.
   - Install speed limit signs within the parking area to reduce the likelihood of high-speed collisions

Regulation / Guideline

1. **Occupational Safety and Health Act 1994 (OSHA 1994):**
   - Employers must provide a safe working environment by identifying and mitigating potential hazards, including impact damage to critical installations.
   - This includes implementing appropriate physical barriers to protect gas stations from accidental impact.

2. **Gas Supply Act 1993 (Act 501) (38)(f):**
   - Govern the measures to be taken and the equipment to be supplied and used in connection with pipelines and installations in order to secure public and private safety;

Electrical

2.1	NO INSPECTION ON TRANSFORMER

Observation

There has been no inspection conducted on the transformers, or such inspections are entirely absent. Regular inspection and maintenance of transformers are critical for ensuring their operational reliability and preventing potential hazards. The lack of inspections increases the risk of undetected faults, such as insulation degradation, oil leaks, overheating, or other mechanical and electrical issues. These faults could lead to equipment failure, fire hazards, or even extensive downtime, posing significant safety, operational, and financial risks.

Recommendation

To improve risk management and enhance safety, it is recommended to implement a structured inspection schedule in line with industry standards. This should include periodic visual inspections, thermographic scanning, oil analysis, and electrical testing to detect and address issues early, thereby mitigating the likelihood of failures and ensuring compliance with safety and performance standards.

Regulation / Guideline

The Electricity Supply Act 1990 and the Electricity Regulations 1994 serve as key legislative frameworks in Malaysia governing the generation, distribution, and maintenance of electrical installations, including transformers.

1. Electricity Supply Act 1990

The Electricity Supply Act 1990 outlines the legal requirements for the safe operation and maintenance of electrical installations. Key provisions relevant to transformer maintenance include:

Safe Operation (Section 33a.)

(1) A licensee who operates and maintains any electricity supply infrastructure shall comply with any regulations made under this Act, the electrical infrastructure safety code or in the absence of such regulations or code, with standards and prudent utility practices as may be determined by the Commission.

Note: This section mandates that electrical installations, including transformers, must be maintained in a condition that prevents danger to individuals or property.
Owners or operators of transformers are responsible for ensuring that the equipment operates safely and complies with applicable safety standards.

Competency Requirements (Section 33c)

This section state only qualified personnel, such as competent engineers certified under the Energy Commission, are authorized to conduct inspections, maintenance, and repairs on electrical installations.

Offences and Penalty (Part IX)

This section describes the failure to maintain electrical equipment in accordance with the Act can result in penalties, including fines and imprisonment, particularly if non-compliance leads to injury, death, or property damage.

2. Electricity Regulations 1994

The Electricity Regulations 1994 provide detailed guidelines for the maintenance, inspection, and testing of electrical installations, including transformers. Key regulations include:

Regulation 110: Part IV Maintenance
All installation shall be maintained in good and working order and safety precautions ahll be observed at all times to prevent danger.

Electrical installations must be inspected and tested by a competent person at least once every five years. For transformers, this may involve:
Checking for overheating or load imbalances.
Inspecting insulation, connections, and oil levels.
Testing electrical parameters to ensure compliance with performance standards.

Regulation 70: Part III – Operation – Duty to inform and to make goof defects
Any Electrical Services Engineer, Competent Electrical Engineer or Electrical Supervisor inspecting and installation referred to in sub regulation 67(2), and being aware of any defect in the installation or any equipment therein which is likely to cause danger shall forthwith inform the owner, management or licensee of the installation to make good or remove the defects and make a report immediately to the Commission.

Note: This highlighted that if defects are discovered during maintenance or inspection, they must be reported to the Energy Commission. Operators must take immediate steps to rectify the issues to avoid potential hazards.

Regulation 111: Part IV Maintenance – Competency person to undertake maintenance work
No person, except a competent person or a person acting under the control of a competent person, shall undertake to carry out any repair, replacement, servicing or cleaning of any equipment which forms part of an installation.

Note: Maintenance and inspection must be conducted by a competent person, as defined under the Electricity Regulations. This ensures that the personnel handling transformers have the required knowledge and certifications.

2.2	ELECTRICAL INSPECTION

Observation

There is no schedule inspection carried out to date.

The lack of scheduled inspections for electrical installations poses significant operational, safety, and legal risks, including:

Electrical Failures & Unexpected Downtime
- Without periodic testing, electrical components may deteriorate, leading to unplanned power outages and operational disruptions.
- Overloaded circuits, loose connections, and insulation breakdowns increase the probability of sudden equipment failure.

Fire & Explosion Hazards
- Lack of inspection may cause unnoticed faults in wiring, switchgear, and transformers, which can overheat and ignite nearby materials.
- Accumulated dust, moisture, and worn-out insulation can lead to short circuits and arc flash incidents, causing severe damage to equipment and personnel.

Failure of Protective Relays & Devices
- Protective relays and circuit breakers require periodic testing and calibration to ensure proper functioning in fault conditions.
- If these devices fail to operate correctly, it could lead to extensive damage to electrical systems and increased fire risks.

Regulatory Non-Compliance & Legal Consequences
- Failure to perform scheduled inspections violates the Electricity Supply Act 1990, potentially leading to penalties, legal liability, and revocation of operating licenses.
- Non-compliance with safety regulations may invalidate insurance claims in the event of an electrical accident or fire.

Recommendation

To mitigate the risks associated with the absence of scheduled inspections, the following corrective actions should be taken:

1. Implement a Preventive Maintenance & Inspection Program
- Develop a structured maintenance schedule in compliance with regulatory requirements.
- Assign a competent electrical engineer or technician to conduct inspections.
- Create inspection checklists to cover:
  - Visual inspection of wiring, panels, and terminations.
  - Testing of circuit breakers, relays, and transformers.
  - Earth resistance, insulation resistance, and thermographic analysis.

2. Regulatory Compliance – Scheduled Inspections Per Voltage Level
- Ensure compliance with Electricity Supply Act 1990, Regulation 67 & 110:
- General electrical installations → Checked & tested every 5 years by a competent person.
- Protective relays & devices → Checked, tested, and calibrated every 2 years.
- Routine inspections based on voltage levels:
  - ≤ 600V → At least once per month
  - 600V – 11kV → At least twice per month
  - 11kV – 132kV → At least four times per month

3. Perform Advanced Testing & Condition Monitoring
- Conduct thermographic scanning to detect overheating components.
- Perform Partial Discharge (PD) testing to identify insulation failures.
- Implement power quality monitoring to detect voltage fluctuations and harmonics.

4. Proper Documentation & Compliance Reporting
- Maintain detailed inspection records for audits and regulatory compliance.
- Keep logs of maintenance activities, test results, and calibration certificates.
- Submit inspection reports to Suruhanjaya Tenaga (Energy Commission) as required.

5. Competency & Training for Electrical Personnel
- Ensure all inspections are performed by a competent person registered with Suruhanjaya Tenaga.
- Provide periodic training on fault detection, testing procedures, and arc flash hazards.

Regulation / Guideline

1. Electricity Supply Act 1990 (Malaysia)
- Regulation 110(3) – Mandates electrical installations (excluding domestic) to be tested at least once every five years by a competent person.
- Regulation 110(4) – Requires protective relays and devices to be tested and calibrated at least every two years.
- Regulation 67 – Specifies routine inspection frequency based on voltage level:
    - ≤ 600V → At least once per month
    - 600V – 11kV → At least twice per month
    - 11kV – 132kV → At least four times per month

2. MS IEC 60364 (Electrical Installations for Buildings)
- Provides guidelines for electrical system maintenance, grounding, and protective device inspections.

3. NFPA 70B (Recommended Practice for Electrical Equipment Maintenance)
- Establishes best practices for preventive maintenance of electrical systems.

4. OSHA 1994 (Malaysia – Occupational Safety and Health Act)
- Requires identification, assessment, and control of electrical hazards through periodic inspections.

2.3	ACCUMULATION OF COMBUSTIBLE MATERIAL AT ELECTRICAL BOARD

Observation

During the site visit, we found that combustible materials were stored too close to the electrical systems, such as the electrical board and utilities in the switchboard room. Flying sparks from an electrical short circuit could cause a smouldering fire, which may remain undetected for hours before an open flame breaks out, possibly during off-hours. This could escalate into a large fire.

Recommendation

Electrical fires due to failures of electrical connection are the causes of many equipment or building fires. Many of these electrical fires result from improper terminations, poor workmanship, different characteristics of dissimilar metals, improper binding screw or splicing devices, environmental and atmospheric condition present at the facility.

Combustibles materials stored close to electrical panel and incoming electrical board could be ignited by electrical fault/flashover in the event of electrical malfunction or short circuiting. Spark or ignition source will land on the nearby carton boxes/combustible material and start the fire in the storage area.

To minimize the fire risk, we recommend that all electrical panels be kept clear of combustible materials. A yellow square marking should be drawn on the floor, and a barricade should be placed within a 1.5-meter radius around the electrical panel to indicate that no materials are to be stored near the panel

Regulation / Guideline

In Malaysia, the use of **combustible materials** around electrical switchboards is regulated under several standards, including **MS 1933** (Code of Practice for Electrical Installations), **MS 1979** (Code of Practice for Electrical Installations of Buildings), and **the Uniform Building By-Laws (UBBL)**. These guidelines aim to ensure that electrical installations are safe, reduce the risk of fire, and protect both property and lives.

MS 1933: Code of Practice for Electrical Installations

- Section 3: General Requirements for Electrical Installations
  - Clause 3.3.4 (Safety of electrical equipment): It specifies that all electrical installations should be designed, installed, and maintained to ensure safety under normal operating conditions. This includes protecting against fire hazards, which can be caused by combustible materials in proximity to

electrical equipment such as switchboards, panel boards, or distribution boards.

-

MS 1979: Code of Practice for Electrical Installations - Low Voltage Installations

1. Clause 4.4 - Location of Electrical Equipment
   This clause states that electrical equipment, including switchboards, should be installed in locations that minimize the risk of fire or damage. It emphasizes that electrical installations should not be placed near combustible materials that could catch fire in the event of an electrical fault, overheating, or short circuit.

- Clause 4.6 - Clearances Around Electrical Equipment
  Electrical switchboards must maintain a certain clearance from combustible materials to ensure safe operation and ease of maintenance. This clearance also allows heat dissipation and minimizes the risk of fire hazards due to overheating of electrical components.

- Clause 5.1 - General Installation Requirements
  This clause specifies that all installations should be properly maintained and kept clear of any potential hazards, including combustible materials. The area around electrical switchboards must be free from storage of flammable or combustible substances to reduce the risk of fire or electric shock.

2.4	ELECTRICAL BOARD IS NOT PROPERLY CLOSED

Observation

We noted that most of the electrical board panel is not properly closed, exposing the live wire.

Recommendation

Open electrical panels expose live wires, posing risks such as fatal electric shocks, short circuits, fires from sparks or overheating, environmental damage caused by dust, moisture, or pests, and violations of safety standards, thereby increasing liability and endangering personnel and property.

Therefore, it is recommended that all electrical panels be properly closed. If the panel has missing or broken covers, replace them with properly fitted, non-conductive, and fire-resistant covers. Use panels with IP-rated enclosures (e.g., IP44 or higher) for dusty or humid environments.

Ensure that all covers are securely fastened with screws or latches to prevent accidental removal, as loose covers are ineffective and pose additional safety risks

Regulation / Guideline

The standards and guidelines governing the safety of electrical installations, including open electrical panels, focus on mitigating risks such as electrical shocks, short circuits, and fire hazards while ensuring compliance with statutory regulations, includes:

1. **Malaysian Standards (MS 1979:2007)**
   The Malaysian Standard (MS) for electrical installations specifies that all electrical panels must be enclosed to prevent direct contact with live wires, thus reducing the risk of electric shocks. Missing or damaged covers are considered violations of safety requirements, and panels must comply with IP ratings appropriate for the environment (e.g., IP44 for protection against dust and moisture)

2. **Electricity Supply Act (ESA) 1990 & Regulations 1994**
   The ESA 1990 and Electricity Supply (Safety) Regulations 1994 mandate that electrical installations be safe and well-maintained. This includes:
   - Ensuring electrical panels have proper enclosures to avoid exposure to live wires.
   - Routine inspections and maintenance to prevent hazards caused by loose connections, overheating, or environmental contamination.
   - Installation and maintenance work must be carried out by licensed or competent persons to prevent risks

3. **Suruhanjaya Tenaga (Energy Commission) Guidelines**
   Suruhanjaya Tenaga, the Malaysian Energy Commission, provides guidelines for managing electrical safety. These guidelines emphasize:
   - A written electrical safety policy and management system to ensure compliance with ESA 1990 and related standards.
   - Risk assessments to identify potential hazards, such as open panels, and implement preventive measures like installing proper covers.
   - Regular performance monitoring, inspections, and audits to ensure electrical installations remain safe.

2.5	EXPOSED WIRING

Observation

It is observed that there is a lot of exposed wiring in the showroom.

Recommendation

All exposed wires pose an electrical safety hazard, but exposed wiring within the structure of the building is of particular concern because it represents a hidden danger. When exposed wiring occurs in the structure of a building, it can easily be in close proximity to flammable materials, posing an increased risk of an electrical fire.

Fires caused by exposed wires can spread rapidly, especially if they occur in enclosed spaces or areas with a high concentration of flammable materials. It is essential to understand that even a small spark from an exposed wire can quickly escalate into a full-blown fire. This is because the heat generated by the spark can ignite nearby materials, and the resulting fire can be fuelled by the electricity flowing through the wire. Therefore, it is crucial to address exposed wires promptly to prevent fire hazards.

To ensure safety, it's essential to properly cover any exposed wiring with electrical insulation or enclosures to avoid accidental contact. All wiring connections must be provided with an approved junction box, especially for connections that are intended to be made later.

Sample of approved junction box as below.

Regulation / Guideline

Suruhanjaya Tenaga (Energy Commission of Malaysia) and **Malaysian Standards (MS)** provide guidelines and regulations to ensure electrical safety and standards in

various electrical installations, including for exposed wiring. These regulations cover various aspects such as wiring installation, safety measures, equipment, and inspection procedures to ensure the safety of users and to minimize the risks associated with electrical hazards.

1. MS 1933: 2015 – Code of Practice for the Electrical Wiring of Buildings

- General Wiring Safety: MS 1933 outlines the minimum requirements for the design, installation, and maintenance of electrical wiring in buildings. This includes guidelines for exposed wiring, which should be installed in such a way as to prevent electrical hazards and allow for future maintenance.
- Exposed Wiring Requirements: The standard includes specific requirements regarding exposed wiring in different areas of buildings. Wiring should be protected by conduits or enclosures, particularly in areas that are more prone to physical damage. For example:
    - Indoor wiring should be securely fastened and protected with conduit if exposed.
    - Outdoor or external wiring should use weather-resistant materials and be enclosed in durable conduit to protect against the elements.
- Fire Safety Measures: Wiring systems must be installed with consideration to fire safety. Exposed wiring should be insulated and installed in a way that minimizes the risk of overheating or sparking, especially near combustible materials.
- Electrical Equipment Enclosures: MS 1933 also specifies that electrical equipment, such as junction boxes, must be securely mounted and properly enclosed to avoid electrical shock hazards.

2. MS IEC 60364 – Electrical Installations of Buildings

This is an internationally recognized standard that has been adapted into Malaysian standards, which outlines the general rules for the electrical installations in buildings.

- Wiring Systems: Exposed wiring should be installed according to the proper classifications. For example, Class I, II, and III protection methods may be used depending on the environment.
- Fire Hazard Prevention: The standard emphasizes the need to minimize fire hazards by using correct cable types, ensuring adequate grounding, and securing cables away from flammable materials.

3. Suruhanjaya Tenaga (Energy Commission) Guidelines – Guidelines for Electrical Installations (GEI)

The GEI is based on and is a part of the Electricity Supply Act 1990 and the Electricity Regulations 1994. These pieces of legislation set out the legal framework within which electrical installations in Malaysia must be carried out. The GEI sets the requirements for safe electrical installations in buildings, ensuring that electrical wiring is installed, maintained, and used in a way that prevents risks such as electrical fires or electric shocks.

- Exposed Wiring and Safety: The Energy Commission mandates that exposed wiring should be properly insulated and protected, using appropriate conduits and enclosures, to prevent accidental contact, damage, or fire.
- Risk Mitigation: Installations must be carried out by qualified electricians, and all work must meet prescribed safety standards. Exposed wiring should be minimized or covered wherever possible to reduce the risk of fire or shock.
- Regulation on Overhead and Underground Wiring
  The Energy Commission provides specific guidelines on overhead and underground wiring installations. Exposed wiring should be properly secured and protected to avoid environmental damage, especially in high-risk areas where there could be exposure to physical damage, moisture, or other hazards.

2.6	BURN MARK AT THE CIRCUIT BREAKER

Observation

It was noted that one of the circuit breakers has an obvious burn mark.

Recommendation

Burn marks on a circuit breaker indicate electrical problems within the system. They are the result of localized overheating within the breaker panel or box. Typically, these marks occur due to loose or corroded components and connections, which introduce resistance and cause excessive heat generation. Burn marks aren't just a cosmetic issue; they are a warning of impending danger. These marks can be a precursor to electrical shorts, potentially leading to electrical fires or even electric shocks if left unattended.
As such, it is recommended that the circuit breaker:

1. **Tighten all wire connections** to the circuit breaker. Loose electrical connections at the breaker or on the wires connected to it can create resistance. This resistance in the circuit leads to heat buildup, which can cause burning or charring at the connection points.
2. **Replace faulty breakers** with new, properly rated ones. A malfunctioning or aged circuit breaker might fail to trip during an overload or short circuit, causing heat to accumulate and burn marks to appear.
3. **Investigate the circuit** to identify and fix any short circuits. This may involve checking wiring and outlets for faults, replacing damaged wires, or inspecting appliances that may have caused the short. A large current surge can generate significant heat, causing the circuit breaker to overheat and resulting in burn marks or charring around the breaker area.
4. **Ensure that the total electrical load** on the circuit does not exceed the breaker's rating. If necessary, redistribute the load across other circuits or upgrade to a higher-rated breaker. An overloaded circuit occurs when too many electrical devices or appliances are connected to the same circuit, drawing more current than the breaker is rated for.

Regulation / Guideline

Suruhanjaya Tenaga (Energy Commission) and **Malaysian Standards (MS)** provide comprehensive guidelines and regulations that cover electrical safety, including addressing issues like overloaded circuits, damaged circuit breakers, and burn marks at circuit breakers. These regulations aim to ensure that electrical systems are safe and reliable, preventing hazards such as fires, electric shocks, and electrical failures.

1. **Suruhanjaya Tenaga (Energy Commission) Guidelines – Guidelines for Electrical Installations (GEI)**

The GEI is based on and is a part of the **Electricity Supply Act 1990** and the **Electricity Regulations 1994**. These pieces of legislation set out the legal framework within which electrical installations in Malaysia must be carried out. The **GEI** issued by Suruhanjaya Tenaga provides detailed instructions on how electrical systems, including circuit breakers, should be installed, maintained, and inspected:

- Circuit Breakers & Overload Protection: Circuit breakers should be correctly sized according to the load requirements and should protect the system from overloads or short circuits. If the breaker is under-sized for the circuit, it will not trip properly during an overload or short circuit, which may lead to overheating or burn marks.
- Faulty Circuit Breaker Protection: If a circuit breaker shows signs of burning or charring, it could be a sign that it is faulty or that there has been a prolonged overcurrent event. The guidelines recommend replacing faulty breakers immediately to maintain safety and to avoid electrical fires.
- Inspection & Testing: The Energy Commission mandates regular inspections of electrical installations, including breakers, to ensure that they are functioning properly and are safe to use.

2. MS 1933: 2015 – Code of Practice for the Electrical Wiring of Buildings

This standard outlines the requirements for electrical wiring in buildings, including the proper installation of circuit breakers:

- Proper Sizing of Circuit Breakers: MS 1933 emphasizes the importance of correctly sizing the circuit breakers based on the wire gauge and expected load to prevent overheating, overloading, or tripping issues.
- Exposed Wires and Circuit Breaker Protection: In the case of burn marks, this standard recommends ensuring that all circuit breakers are protected from environmental damage (e.g., water, heat) and that exposed wiring is securely mounted and insulated.

3. MS IEC 60364 – Electrical Installations of Buildings

This standard is based on the International Electrotechnical Commission (IEC 60364) and outlines safety requirements for electrical installations:

- Overload Protection: MS IEC 60364 mandates that circuit breakers must be sized appropriately to protect against both overloads and short circuits. If a breaker is too small for the circuit or too large to trip in time, it can cause serious issues such as overheating and burn marks.
- Electrical Faults & Protection: The standard provides detailed requirements on the protection devices such as circuit breakers, fuses, and earth leakage circuit breakers (ELCBs), which must be installed to prevent fire risks due to overheating of wiring or failure of the circuit protection devices.

4. MS 1571: 2016 – Electrical Installation Safety Standards

This standard covers the general safety requirements for electrical installations, including protection against electrical faults that could lead to burn marks:

- Circuit Breaker Safety: MS 1571 stipulates that circuit breakers should be installed and maintained in accordance with the manufacturer's instructions. The breaker must be designed to protect against overcurrent and fault conditions, and if it fails to do so, it should be replaced immediately.
- Routine Maintenance: Regular maintenance and inspections are mandated to ensure that the circuit breaker and entire electrical system function safely. Any signs of burn marks or damage should be inspected by a qualified professional and repaired promptly.

2.7	KILL SWITCH

Observation

Based on discussions with the insured representative, the insured has provided a kill switch to cut off the electrical supply to each shop unit. However, we noted that the kill switch is not locked, which could allow unauthorized personnel to access it.

Recommendation

The kill switch for each individual shop unit is located at the rear of the unit. It is installed to cut off the power supply to each unit and is turned off after operating hours, typically between 11 pm and 12 am every day by the insured personnel stationed at the site. However, the kill switch is not properly locked, which could allow unauthorized access.

We recommend that the kill switch be properly locked to prevent unauthorized access. Alternatively, the kill switch can be installed in a centralized location within a single enclosure and securely locked, as implemented at the Shah Alam branch (refer photo below).

Regulation / Guideline

Not applicable

HOUSEKEEPING

3.1	FLOOR AREA COVERED WITH GREASE AND GRIME

Observation

Many floors and machinery within the Mill were observed to be covered with grease and grime. This condition not only compromises the cleanliness and overall housekeeping standards but also poses significant safety and operational risks. it may pose risks as follows:

Slips, Trips, and Falls:
- Greasy floors increase the likelihood of accidents, leading to potential injuries to personnel.

Operational Inefficiencies:
- Greasy machinery may experience reduced efficiency and increased wear and tear, potentially leading to mechanical failures and unplanned downtime.

Fire Hazards:
- The accumulation of grease and oil can act as a fuel source, increasing the risk of fire, especially in areas where machinery operates at high temperatures.

Recommendation

It is recommended that the followings:

Thorough Cleaning:
- Implement a regular and comprehensive cleaning schedule to remove grease from floors and machinery. Use appropriate cleaning agents and tools suitable for the Mill's operations to ensure effective grease removal.

Preventive Maintenance:
- Establish a preventive maintenance program to regularly inspect and clean machinery. Ensure that oil leaks or spills from machinery are promptly identified and rectified.

Housekeeping Standards:
- Train staff on the importance of maintaining high housekeeping standards. Introduce workplace cleanliness policies, ensuring that all employees contribute to maintaining a clean and safe working environment.

Non-Slip Flooring:
- Consider installing non-slip flooring or mats in high-risk areas to minimize the risk of slips and falls.

Regulation / Guideline

1. Occupational Safety and Health Act 1994 (Act 514)

General Duties of Employers and Self-Employed Persons to Their Employees (Section 15)

- This section mandates that employers and self-employed individuals ensure, as far as practicable, the safety, health, and welfare of their employees at work. This includes providing and maintaining a work environment that is safe and without health risks, which implicitly covers good housekeeping practices

Duty to Formulate Safety and Health Policy (Section 16)

Employers are required to prepare and revise a written statement of their general policy

concerning the safety and health at work of their employees.

Note: This policy should include arrangements for maintaining a safe working environment, which would involve proper housekeeping measures

3.2	STORAGE OF UNUSED METAL

Observation

Unused metals were observed stored in multiple locations within the premises, including the right side of the Mill. This not only detracts from the overall housekeeping standards but also introduces various safety and operational risks. it may pose risks as follows:

Obstruction Hazards:
- Improperly stored metals can block walkways, create tripping hazards, and hinder efficient movement within the Mill.

Fire Risks:
- Stacked or scattered metals may become an obstruction during an emergency evacuation and, in some cases, may contribute to fire hazards, particularly if stored near heat sources.

Inefficient Space Utilization:
- Random storage of materials reduces the effective utilization of available space, impacting overall operational efficiency.

Recommendation

It is recommended that as follows:

Designated Storage Areas:
- Establish clearly defined storage areas for unused metals, located far from the Mill and operational areas. These areas should be secure, organized, and labelled to facilitate easy identification and retrieval of materials.

Regular Removal of Unused Materials:
- Develop a material management policy to regularly remove unused metals from operational spaces to designated storage or disposal areas.

Housekeeping Procedure:
- Enhance housekeeping standards by introducing systematic inspections to identify and address cluttered or improperly stored materials promptly.

Safety Signage and Training:
- Install clear signage to indicate storage rules and provide training to employees on proper material handling and storage practices to prevent clutter and ensure safety

Regulation / Guideline

1. Occupational Safety and Health Act 1994 (OSHA 1994)

General Duties of Employers (Section 15):
- Employers are required to ensure the safety, health, and welfare of employees by maintaining a clean and organized workplace.

Note: Improper storage of materials, such as unused metals, increases risks of tripping, obstruction, and potential injuries, violating this duty. This also related to establish designated storage areas for unused metals aligns with this requirement.

2. Factories and Machinery (Safety, Health, and Welfare) Regulations 1970

Regulation 6: Floor
- Requires that every part of any floor where any person is likely to pass shall be

maintained in a level, good, and non-slippery condition to afford safe walking and, where necessary, safe trucking or handling of materials.

Note: This also can be related that the requirements of all materials, including unused metals, to be stored in an organized manner to prevent hazards such as tripping and falling.

Regulation 7: Access of place of work.:
- Clear and unobstructed space shall be provided and maintained at all machinery to enable any work thereat to be performed without unnecessary risk, and to permit of free and ready access to any part necessitating regular operation, inspection, maintenance or removal.
- Where materials or goods or other articles are necessarily stacked between any machines or workbenches, clear aisles or gangways to such machines or workbenches shall be provided and maintained, and such aisles or gangways shall be clearly marked on the floor and no materials or goods, or other articles shall be stacked on such aisles or gangways.

3.3	STORAGE OF LPG GAS CYLINDER

Observation

There is an LPG gas cylinder storage area located at the rear side of the Production building.

Recommendation

Here are some recommendations for improving the safety and organization of the LPG storage area:

1. Secure and Properly Lock the Enclosure
Ensure that the storage cage remains locked at all times to prevent unauthorized access and potential tampering.
The locking mechanism should be robust to withstand external interference.

2. Fire Safety Enhancements
Fire Extinguisher Placement: While a fire extinguisher is available, it should be an ABC dry powder or CO_2 type suitable for flammable gas fires.
Install a Fire-Rated Barrier: Compliance with MS 830:2013 requires LPG storage areas to have a 4-hour fire-rated wall to contain potential fire hazards.

3. Signage and Emergency Instructions
Improve existing signage by including:
“Flammable Gas - No Smoking or Open Flames”
“LPG Storage - Authorized Personnel Only”
Emergency contact details and immediate action steps in case of leaks or fire.

4. Proper Cylinder Storage
Ensure all LPG cylinders are stored upright and secured with chains or brackets to prevent them from falling, in line with MS 830:2013.
Maintain a minimum separation distance from any potential ignition sources as per OSHA 1994 (Occupational Safety and Health Act).

5. Adequate Ventilation and Drainage

Ensure the storage area is well-ventilated to prevent gas accumulation.
Install proper drainage to avoid water accumulation around cylinders, which can cause rust and weaken the integrity of the cylinders.

Regulation / Guideline

1. Compliance with MS 830:2013 - Storage, Handling, and Transportation of LPG
- Proper Cylinder Orientation: LPG cylinders must always be stored upright and secured using chains or brackets to prevent accidental falls or tipping.
- Fire Separation Distance: LPG storage should be at least 3 meters away from ignition sources, heat-producing equipment, or direct sunlight exposure.
- Enclosure Requirements: The storage area must be fenced or enclosed with non-combustible materials and have adequate ventilation to prevent gas accumulation.

Signage & Labelling: The area must be clearly marked with warning signs such as:
"Flammable Gas - No Smoking or Open Flames"
"LPG Storage - Authorized Personnel Only"
- Emergency procedures for leaks or fires must also be displayed.

5. Occupational Safety and Health Act 1994 (OSHA 1994)

Section 15: General duties of employer, self-employed persons and occupier
- Stipulate the duties and responsibilities of the employer, self-employed or occupier to ensure the use of plant or substance are safe and without risks to health or their employees and persons other than his employees at workplace.

Section 20: General duties of designers, manufacturers and suppliers
- Requires designers, manufacturers, importers, and suppliers of any plant for use at work to ensure, as far as practicable, that the plant is safe and without risks to health when properly used.

Section 21: General duties of designers, manufacturers and suppliers
- Imposes similar duties on those who formulate, manufacture, import, or supply any substance for use at work, ensuring that the substance is safe and without risks to health when properly used.
- Note that substances in this Act means any natural or artificial substance, whether in solid or liquid form or in the form of a gas or vapour or any combination.

Section 24: General duties of employees
Stipulates the duties of the employee while at work to take reasonable care for the safety and health of himself and any other person, to comply with any instruction or measure on occupational safety and health instituted by his employer and to wear any protective equipment to prevent risks to his safety and health.

3. Compliance with Factories and Machinery Act 1967 (FMA 1967)

Safe Installation & Maintenance: All LPG cylinders, piping, and equipment must be periodically inspected to prevent leaks and deterioration.
Structural Integrity: The storage area should have a stable foundation to prevent cylinder movement due to vibration or impact.
Permit to Operate: If the storage exceeds a certain volume, an operating permit may be required under the FMA regulations.

4. Energy Commission Gas Supply Regulations 1997

Section 39: Power to make regulations
Stipulate the regulations on method by which gas may be stored and the measures to be taken and the equipment to be supplied and used in connection with pipeline and installations in order to secure public and private safety.

3.4	STORAGE OF LIQUID DRUMS WITHOUT CONTAINMENT

Observation

There are metal drums containing liquids (unknown liquid) being stored inside the chiller plant. These storage drums present potential risks related to chemical spills, leaks and contamination, which could lead to safety hazards, environmental harm and operational disruption.

or

The presence of metal drums containing unknown liquids inside the chiller plant presents several potential hazards, including:

Chemical spills & leaks – leading to environmental contamination and workplace exposure.
Fire & explosion risk – if flammable or reactive substances are stored improperly.
Health hazards – exposure to hazardous chemicals due to vapor release or direct contact.
Operational disruption – spills or leaks can damage surrounding equipment and cause system downtime

Metal drums storage

Recommendation

To address the risk associated with drum storage, effective spill containment measures are essential to prevent leaks or spills from causing safety hazards. The following steps should be implemented to ensure robust spill containment.

1) Use of Spill Containment Systems

• Chemical drums should be stored on spill containment trays or secondary containment pallets specifically designed to capture and contain any leaks, spills, or overflows. These systems provide a physical barrier that prevents hazardous substances from spreading to the surrounding environment.

• Each containment unit must have the capacity to hold at least 110% of the largest drum's volume stored on it, ensuring sufficient space for potential leaks, even in the event of a complete drum failure.

2) Compatibility of Containment Materials

• The materials used in spill containment trays or pallets must be chemically compatible with the substances being stored. For example:

o Polyethylene pallets should be used for most corrosive chemicals, such as acids and bases, as they are resistant to corrosion.

o Steel containment systems may be suitable for non-corrosive flammable liquids but should not be used for acids or other corrosive substances, as this can lead to material degradation.

• Conduct regular assessments of the compatibility between the containment systems and stored chemicals to ensure long-term effectiveness.

3) Containment System Features

• Ensure the containment systems are equipped with raised edges or grates to keep the drums elevated, preventing contact with leaked liquids and reducing the risk of further corrosion or damage to the drums.

• Install drainage plugs or ports on the containment units to allow for safe removal of spilled liquids for proper disposal, in compliance with hazardous waste regulations

Regulation / Guideline

1. OSHA 29 CFR 1910.106(e)(2)(iii) (U.S.) – Secondary Containment for Hazardous Substances

Separation and protection. Areas in which flammable liquids are transferred from one tank or container to another container shall be separated from other operations in the building by adequate distance or by construction having adequate fire resistance. Drainage or other means shall be provided to control spills. Adequate natural or mechanical ventilation shall be provided.

Key Requirement:

- Requires secondary containment systems for hazardous substances.
- The containment system must hold at least 110% of the volume of the largest stored drum.
- Applicable to facilities handling flammable and combustible liquids.

Recommended Implementation:

- Install secondary containment pallets or bunded storage for all hazardous substances.
- Conduct routine inspections to ensure containment integrity and capacity compliance.
- Ensure employees are trained on proper storage, handling, and spill response.

2. NFPA 30 (Flammable & Combustible Liquids Code) – Fire Safety for Liquid Storage

Chapter 9: Addresses the storage of liquids in containers, including design and construction of storage cabinets, storage arrangements, and maximum allowable quantities

Chapter 12: Focuses on the storage of liquids in containers and portable tanks within storage areas, detailing design and construction requirements for liquid storage rooms and warehouses.

Chapter 15: Covers the storage of liquids in tanks, specifying requirements for both

aboveground and underground storage tanks, including design, construction, and installation.

Key Requirement:

- Ensures flammable and combustible liquids are stored and handled safely to prevent fire hazards.
- Requires fire-rated storage cabinets and spill containment systems.
- Storage areas must maintain a minimum separation distance from ignition sources.

Recommended Implementation:

- Store flammable liquids in NFPA-approved fire-rated cabinets.
- Maintain minimum fire separation distances between storage areas and machinery.
- Install automatic fire suppression systems in high-risk zones.

3.5	CONTAINMENT / CATCH PIT / OUTLET DISCHARGE CONTAINMENT

Observation

The outlet discharge for the metal drums storing diesel has not been equipped with a containment system, posing a significant risk of spillage. Diesel is a flammable liquid, and spillage could lead to environmental contamination, fire hazards, and non-compliance with safety regulations.

Recommendation

To mitigate this risk, the following measures are strongly recommended:

Install Containment for Outlet Discharge:
A containment system, such as a drip tray, spill pallet, or bunded platform, should be installed beneath the outlet discharge to capture any accidental leaks or spills.
The containment system should be made of non-reactive, fire-resistant materials and sized to hold at least 110% of the maximum capacity of the largest drum in the area.

Spill Prevention Accessories:
Equip the outlet discharge with self-closing valves or nozzles to prevent uncontrolled flow of diesel during transfer operations.

Regular Inspection and Maintenance:
Implement a routine inspection program to ensure the containment system is in good condition and free of blockages or damage.

Compliance with Regulations:
Ensure the containment system meets the requirements of local environmental and fire safety regulations, such as NFPA 30 (Flammable and Combustible Liquids Code) or equivalent standards.

Regulation / Guideline

Regulations for Containment of Metal Drums Containing Diesel

1. National Fire Protection Association (NFPA) Standards

NFPA 30 (Flammable and Combustible Liquids Code):
Requires spill containment systems for flammable liquids, such as diesel.
Containment must have sufficient capacity to handle at least 110% of the volume of the largest container or as specified by local regulations.
Prohibits uncontrolled discharge of flammable liquids to reduce fire hazards.

2. Occupational Safety Standards OSHA 29 CFR 1910.106 (Flammable Liquids):

OSHA 29 CFR 1910.106(e)(2)(iii)
Separation and protection. Areas in which flammable liquids are transferred from one tank or container to another container shall be separated from other operations in the building by adequate distance or by construction having adequate fire resistance. Drainage or other means shall be provided to control spills. Adequate natural or mechanical ventilation shall be provided.

Requires proper storage and handling of flammable liquids, including diesel.
Secondary containment systems must be provided to contain leaks or spills during transfer or storage.

3.6	STORAGE OF COMBUSTIBLE MATERIAL

Observation

The storage area poses several fire safety risks due to improper arrangement. Mattresses and boxes are stacked in a disorganized and overcrowded manner, which can impede quick access to fire safety equipment and emergency exits. The lack of proper spacing between items limits ventilation, increasing the risk of heat buildup and potential fire ignition.

Recommendation

The correct storage of combustible materials is paramount. Understanding the risks combustible materials pose, and understanding how to control these risks, can help to prevent fires and explosions.

As such, it is recommended that,

1. Proper Organization of Stored Items
    - Proper Height and Stability: Items, especially large and bulky ones like mattresses, should be stacked at a safe height. Following manufacturer or industry guidelines for stacking heights ensures that the structure remains stable and reduces the risk of items toppling over. Over stacking increases the chance of items falling, which can obstruct exits, cause injuries, or potentially trigger a fire hazard if flammable items are involved.
    - Secure Stacking: Items must be stacked securely using shelving units or pallets to prevent any movement. Flammable materials should be arranged so that they do not lean or shift, which could cause instability and increase the likelihood of accidents.
    - Maximize Space Efficiency: he storage area should be organized to optimize the available space without overcrowding. Overcrowding creates the risk of blocked aisles, making it difficult for staff to access stored materials, emergency exits, or fire safety equipment during an emergency. Having clearly marked aisles or walkways ensures that there is adequate space for personnel to move safely in the event of a fire.

2. Designate Fire-Safe Storage Areas
    - Separate Combustible Materials: Materials that are highly combustible, such as mattresses or expanded foam should be stored in designated areas away from other less hazardous items. This prevents the spread of fire to non-flammable goods and helps ensure that fire risks are contained in one area. In some cases, it may be necessary to install fire-resistant partitions or barriers to further limit the risk of fire spreading from one storage area to another. These

barriers help contain a fire to a small zone, allowing staff more time to evacuate and control the situation.

- Clear Separation of Storage Zones: The storage area should be clearly marked to differentiate between safe and fire-hazard zones. For instance, use clearly visible signage to indicate fire hazard areas where flammable materials are stored, and ensure these areas are kept free from unnecessary items that could act as fuel in the event of a fire.

Regulation / Guideline

1. Occupational Safety and Health Act (OSHA) 1994

Section 15 - Duty to Ensure Safety and Health at Work

- Employers' Responsibility: Employers are required to ensure the safety, health, and welfare of employees at work. This includes:
    - Ensuring that proper storage and handling of combustible materials are implemented to avoid risk to employees.
    - Providing safe working conditions, which include safe storage for hazardous materials.

Section 24 - Reporting of Dangerous Occurrences

- Any dangerous occurrences involving combustible materials must be reported to the Department of Occupational Safety and Health (DOSH) immediately.

2. Fire Services Act 1988

The **Fire Services Act 1988** governs fire safety in Malaysia, including the storage of combustible materials.

Section 10 - Fire Prevention

- Fire Safety Measures: All premises where combustible materials are stored must have proper fire prevention measures. This includes:
    - Installation of fire alarms, sprinkler systems, and fire extinguishers.
    - Ensuring that the building's fire protection system is maintained and operational.

Section 11 - Fire Risk Assessment

- A Fire Risk Assessment must be conducted to evaluate the risks associated with storing combustible materials.
    - Identifying fire hazards, including ignition sources, and assessing whether combustible materials are stored in a way that could cause fires.

Section 12 - Fire Safety in Buildings

- For buildings storing combustible materials, specific fire safety measures must be followed:
    - The building must be designed to prevent the spread of fire.
    - Materials must be separated and stored in appropriate fire-rated rooms or areas.

Section 14 - Fire Protection Plans

- Fire protection plans must be prepared for premises that store combustible materials.
    - The plans should detail evacuation routes, emergency exits, and the location of fire-fighting equipment.

3. Uniform Building By-Law (UBBL) 1984

The **Uniform Building By-Law (UBBL) 1984** provides detailed regulations regarding the construction and maintenance of buildings, including provisions for fire safety and the storage of hazardous materials.

Part 7 – Fire Protection and Safety

This section details the design, construction, and fire safety measures for buildings, particularly those storing combustible materials.

Section 147 - Fire Compartments and Fire-Resistant Structures

- Fire-Rated Compartmentalization: Areas where combustible materials are stored should be compartmentalized to prevent the spread of fire. These compartments must be constructed using fire-resistant materials.
- Fireproof Doors and Partitions: Fireproof doors, windows, and partitions must be used to separate storage areas from other parts of the building.

Section 148 - Storage of Combustible Materials

- Storage Requirements: Combustible materials must be stored in a manner that minimizes the risk of fire. This includes:
    - Ensuring adequate ventilation to avoid the accumulation of flammable gases.
    - Storing materials at a safe distance from ignition sources.
    - Regular maintenance to prevent the buildup of combustible dust or other materials that may contribute to fire risks.

Section 149 - Emergency Exits and Evacuation Routes

- Evacuation Routes: Buildings storing combustible materials must have clearly marked and accessible evacuation routes to allow quick evacuation in the event of a fire.
- Exit Doors: Emergency exit doors should be fire-resistant and wide enough to accommodate quick evacuation.

3.7	INSTALLATION OF DIKE AROUND GENERATOR SET

Observation

The standby generator set is not provided with dike.

The absence of a containment dike around the generator set poses the following risks:

- Oil Spill & Environmental Contamination – Leakage of fuel or lubricating oil from the generator can seep into the ground or nearby drainage systems, causing soil and water contamination.
- Fire Hazard – Leaked fuel increases the risk of fire, especially if it comes into contact with hot surfaces or electrical components.
- Slips and Falls – Oil spills create a safety hazard for personnel working near the generator.

Recommendation

Here are some risk mitigation recommendations for improving this potential risk:

Installation of Containment Dike
-Construct a concrete dike around the generator to contain spills.
- The dike should have sufficient height and capacity to retain at least 110% of the largest single fuel or oil volume present in the generator system.
- Use a sloped or channelled floor to direct any spills to a collection sump.

Proper Drainage System
- Provide a sump with an oil-water separator to allow for proper disposal of leaked fluids.
- Regularly inspect and maintain the drainage system to prevent clogging.

Fire Safety Measures
- Ensure that Class B fire extinguishers (foam or dry chemical) are readily available near the generator.
- Install fire-rated containment material if necessary to prevent the spread of flammable liquid fires.

Example of the dike is as below.

Regulation / Guideline

1. **Environmental Protection & Pollution Control**
   Environmental Quality Act 1974 (EQA 1974) – Regulates industrial waste, including oil spills. Any leakage from generators must be contained to prevent soil and water contamination.

2. Fire & Safety Regulations Fire Services Act 1988 – Requires the implementation of fire prevention measures, especially in industrial settings with flammable substances.

3. **Factories and Machinery Act 1967 (FMA 1967)** – Part II, Section 10
   Stipulate the requirement to ensures workplace safety, including the safe handling of fuel and lubricants.

   - OSHA 29 CFR 1910.106 (d)(6)(iii) Flammable Liquids Regulations, US) – Governs storage and containment of flammable liquids.
   - The storage area shall be graded in a manner to divert possible spills away from buildings or other exposures or shall be surrounded by a curb at least 6 inches high. When curbs are used, provisions shall be made for draining of accumulations of ground or rainwater or spills of flammable liquids. Drains shall terminate at a safe location and shall be accessible to operation under fire conditions.

3.8	COMBUSTIBLE STORAGE NEAR CONTROL PANELS

Observation

The sub fire panel for the wastepaper warehouse is currently positioned in an area highly susceptible to impact damage from potential falling wastepaper bales. This is a critical issue as the storage of combustible materials near control panels presents significant fire hazards, as well as mechanical damage risks. Due to the occupancy of the warehouse and the nature of its operation, the removal of combustible storage from this area is deemed unachievable.

Sub panel at the storage area

The hazard identified from this are as follows:

- Accumulation of combustible materials (wastepaper bales) near control panels.
- Increased risk of fire initiation and propagation due to proximity of combustible storage.
- Potential mechanical damage to control panels caused by the impact of falling wastepaper bales.
- Difficulty in accessing control panels during emergencies due to obstructed working space.

The potential consequences may exist from this hazard:

- Electrical malfunction or short-circuit leading to ignition of combustible materials.
- Loss of power control systems, resulting in operational disruptions.
- Increased likelihood of fire-related incidents, potentially endangering personnel and assets.
- Damage to critical control equipment, resulting in costly repairs and downtime.

Recommendation

To mitigate the risks associated with smoking, the following measures are strongly recommended:

1. Relocation of Control Panels:
   - Relocate the sub fire panel and any other critical panels to a dedicated area free from possible impact damage caused by falling wastepaper bales.
   - Ensure the new location complies with the minimum working space clearance requirements specified in NEC 110.26(B).

- Install barriers or partitions to separate control panels from combustible materials if relocation is not immediately feasible

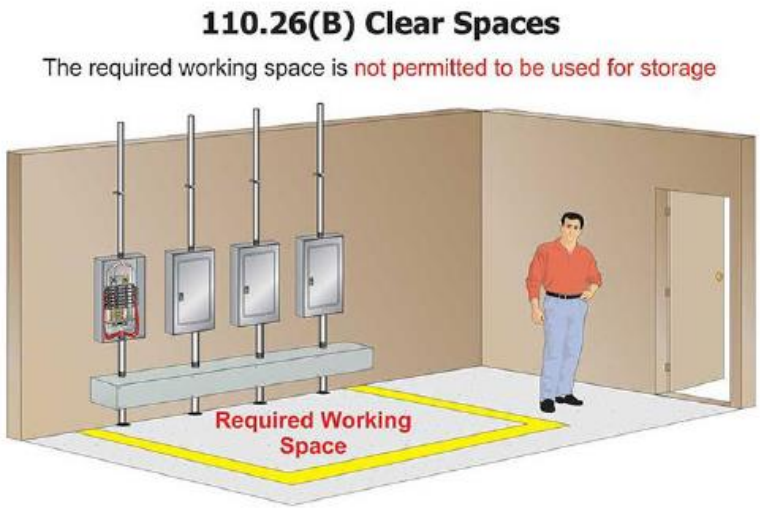
2. Installation of Protective Structures:
   - Where relocation is impractical, install impact-resistant enclosures or protective barriers to shield control panels from falling objects.
   - Ensure the barriers are constructed of non-combustible materials and are designed to withstand the potential force of falling bales.

3. Improved Housekeeping and Safety Protocols:
   - Implement stricter housekeeping procedures to minimize the buildup of combustible materials around control panels.
   - Clearly mark the designated working space around control panels and restrict its use for storage.
   - Regularly inspect and maintain clearance zones to ensure compliance with safety standards.

Regulation / Guideline

National Electrical Code (NEC) 110.26 - Spaces About Electrical Equipment (600 Volts or Less):

- Section 110.26(B) Clear Spaces:
  - States that the required working space around electrical equipment must not be used for storage.
  - Ensures that access to electrical control panels and other equipment is unimpeded for maintenance, inspection, and emergency shutdowns.
  - Requires sufficient clearance to prevent obstruction by any objects, especially combustible materials that may interfere with the safety and operational integrity of the equipment.
- Purpose:
  - To minimize the risk of fire and electrical hazards by ensuring adequate clearance and accessibility to electrical systems.
  - To enhance the safety of personnel performing maintenance or emergency response actions.



HUMAN ELEMENT

4.1	FIRE EVACUATION

Observation

Fire Evacuation is not adopted in the risk.

The absence of a fire evacuation plan at the facility poses significant safety risks to employees, visitors, and assets. A fire evacuation plan is a critical component of workplace safety, designed to ensure that all occupants can exit the premises quickly and safely during an emergency. Failure to implement such a plan not only increases the likelihood of injuries or fatalities during a fire but also exposes the facility to legal, operational, and reputational risks.

Risks Associated with the Absence of a Fire Evacuation Plan:

Increased Risk of Injuries or Fatalities:
- Without a structured evacuation plan, occupants may panic or take unsafe actions during a fire, leading to injuries or loss of life.

Operational and Asset Damage:
- Delays in evacuation can result in increased exposure to fire, potentially causing more extensive damage to property and critical infrastructure.

Non-Compliance with Safety Regulations:
- The lack of a fire evacuation plan may violate local safety regulations and standards, leading to penalties, fines, or operational shutdowns.

Reputational Damage:
- Inadequate safety measures can harm the organization’s reputation, impacting employee morale and public trust.

Recommendation

It is recommended that a fire evacuation plan be adopted. To address these risks, the following recommendations are proposed:

Develop a Comprehensive Fire Evacuation Plan:
Engage a certified fire safety consultant to design a customized evacuation plan tailored to the facility's layout, occupancy, and operational hazards.
Include detailed evacuation routes, designated assembly points, and procedures for aiding individuals with mobility challenges.

Install Appropriate Emergency Signage and Equipment:
Clearly mark all exit routes with illuminated signs.
Install emergency lighting in critical areas to guide occupants during power outages or low visibility conditions.

Conduct Regular Training and Drills:
Train all employees on evacuation protocols, including the location of exits, assembly points, and fire-fighting equipment.
Conduct evacuation drills at least bi-annually to reinforce awareness and evaluate plan effectiveness.

Appoint and Train Fire Wardens:
Designate responsible individuals as fire wardens to lead evacuation efforts and assist in ensuring all occupants are safely evacuated.

Install and Maintain Fire Safety Systems:

Equip the facility with functional fire alarms, sprinklers, and extinguishers. Ensure regular maintenance checks.

Develop Emergency Communication Protocols:
Implement a system to communicate evacuation orders effectively, such as alarms, PA announcements, or mobile notifications.

Regulation / Guideline

In Malaysia, the implementation of fire evacuation plans is governed by several key regulations and guidelines designed to ensure the safety of building occupants during emergencies.

1. Fire Services Act 1988 (Act 341):

Section 27: Empowers the Director General to designate certain premises as requiring specific fire safety measures, which may include the development and implementation of fire evacuation plans.

Section 28: Mandates that owners or occupiers of designated premises obtain a fire certificate, which necessitates compliance with prescribed fire safety measures, potentially encompassing evacuation procedures.

2. Uniform Building By-Laws 1984 (UBBL 1984):

By-Law 225: Requires the formulation of a fire emergency plan for buildings, detailing evacuation procedures, escape routes, and the appointment of fire safety managers to oversee emergency preparedness.

By-Law 139: Stipulates that exit routes must be clearly marked and maintained to facilitate safe evacuation during emergencies.

3. Occupational Safety and Health Act 1994 (OSHA 1994):

Section 15: Obligates employers to ensure, as far as practicable, the safety, health, and welfare of all employees, which includes establishing effective emergency response plans like fire evacuation procedures.

Section 16: Mandates the formulation of a safety and health policy, encompassing measures for dealing with emergencies, including fires.

4.2	DESIGNATED SMOKING AREA

Observation

There is a designated smoking shed area outside of the building. However, there is sometimes combustible paper-based stocks are stored at this area.

Area designated as smoking area, but also utilized to store goods

Recommendation

Combustible paper-based stocks are sometimes stored at the shed area near to the designated smoking area, posing a fire hazard if smoking is allowed in or near these areas. Sparks, cigarette butts, or improperly discarded smoking materials could easily ignite these materials, causing fires that could spread to nearby structures or equipment.

Recommendation:

To mitigate this risk, it is strongly recommended that:

1. **Smoking Ban:** Strictly prohibit smoking in and around areas where combustible paper-based materials are stored.
2. **Designated Smoking Area:** Establish a controlled and clearly marked designated smoking area at a safe distance from storage areas and buildings.
3. **Signage and Communication:** Install visible signage to inform employees and visitors about the smoking restrictions and the location of the designated smoking area.
4. **Monitoring and Enforcement:** Implement regular checks to ensure compliance with the smoking policy and enforce disciplinary actions for violations if necessary.
5. **Fire-Safe Disposal Facilities:** Provide fire-safe receptacles for the proper disposal of cigarette butts and smoking-related materials in the designated smoking area.

By implementing these measures, the risk of fire caused by smoking in or near combustible material storage areas can be significantly reduced, protecting both the facility and its occupants.

Regulation / Guideline

1. Fire Services Act 1988 (Act 341):

Section 27: Empowers the Fire and Rescue Department to enforce measures preventing fire hazards, including controlling ignition sources near combustible materials.

2. Occupational Safety and Health Act 1994 (OSHA 1994):
Section 15: Mandates employers to ensure the safety, health, and welfare of employees, necessitating policies that mitigate fire risks, such as prohibiting smoking near combustible materials.

3. Smoking Products Control for Public Health Act 2024 (Act 852):
Designates specific areas as non-smoking zones to protect public health, including workplaces and areas where combustible materials are present.

4. Department of Occupational Safety and Health (DOSH) Guidelines:
Recommend the allocation of designated smoking areas to develop effective no-smoking policies, ensuring such areas are safely located away from combustible materials.

4.3	HOT WORK

Observation

Hot work permit scheme is not adopted in the risk.

The absence of a Hot Work Permit Scheme in the facility introduces significant fire and explosion risks during hot work operations, such as welding, cutting, or the use of equipment that generates heat or naked flames. Among hazards from hot work activities are fire hazards, explosion and safety hazards.

Fire Hazard
- Hot work generates sparks, heat, or open flames, which can easily ignite flammable materials, oils, gases, or dust present in the work area.
Fires originating from hot work activities have been known to spread rapidly, causing extensive property damage and potential loss of life.

Explosion Risks:
- The presence of flammable vapours or gases in poorly ventilated areas increases the likelihood of explosions during hot work.

Safety Hazards:
- Lack of controls can lead to unsafe working conditions, putting employees and contractors at significant risk of injury or fatalities.

Recommendation

To mitigate these risks and align with best practices, it is strongly recommended that the insured adopt a formal Hot Work Permit System. This system is designed to establish control measures for hot work activities, ensuring that potential hazards are identified and mitigated before, during, and after operations.

A formal Hot Work Permit System shall consider the followings key elements:

1. **Permit Issuance Process**
    - A hot work permit is a documented authorization that allows specific hot work to be carried out in designated or temporary areas.
    - The permit is issued by a responsible authority, such as a safety officer or supervisor, after assessing the risks and ensuring all safety precautions are in place.
2. **Pre-Work Risk Assessment**
    - Evaluate the work area for fire hazards, such as combustible materials, flammable liquids, and potential ignition sources.
    - Assess whether hot work can be avoided by using alternative methods (e.g., mechanical fasteners instead of welding).
3. **Control Measures and Precautions**
    - **Fire Watch:** Assign a trained fire watch person to monitor the area during and after the work.
    - **Isolation of Hazards:** Remove flammable materials or shield them with fire-resistant barriers.
    - **Ventilation:** Ensure adequate ventilation to prevent the accumulation of flammable gases or vapours.
    - **Fire-Extinguishing Equipment:** Provide readily accessible fire extinguishers and other fire-suppression tools.
    - **Personal Protective Equipment (PPE):** Workers should wear appropriate PPE, such as fire-resistant clothing, gloves, goggles, and helmets.
4. **Documentation and Record-Keeping**
    - Maintain a written record of all hot work permits issued, including the work

location, time, nature of the work, and safety measures implemented.
    - The permit should also include details of the fire watch duration and post-work inspection results.
5. **Post-Work Inspection**
    - Conduct a thorough inspection of the work area after the hot work is completed to ensure no residual heat, sparks, or smoldering materials remain.
    - Typically, a fire watch should continue for a specified duration (e.g., 30-60 minutes) after the work ends.
6. **Employee Training and Competence**
    - Train all personnel involved in hot work activities and those responsible for overseeing the permit system.
    - Training should cover fire risks, control measures, the proper use of equipment, and emergency response protocols.

Regulation / Guideline

Occupational Safety and Health Act 1994 (OSHA 1994):

Section 15 - General Duties of Employers and Self-Employed Persons to Their Employees:
Employers are required to ensure, so far as is practicable, the safety, health, and welfare at work of all their employees.
This includes providing and maintaining a safe working environment without risks to health, which encompasses controlling hazards associated with hot work activities.

Section 15: General Duties of Employers
This section mandates employers to ensure the safety, health, and welfare of employees at work as far as is practicable. Implementing a Hot Work Permit System satisfies this duty by:

4. Hazard Identification and Control:
The permit system requires a comprehensive risk assessment to identify hazards associated with hot work (e.g., sparks, open flames, and heat generation).
Control measures, such as removing flammable materials, providing fire extinguishers, and ensuring proper ventilation, mitigate risks before the work begins.

5. Safe Work Systems:
A Hot Work Permit System establishes a structured and documented process for managing hot work operations, ensuring safety protocols are consistently followed.

Section 16: Duty to Formulate a Safe Work System
Employers are required to establish and maintain systems of work that are safe and without risks to health. A Hot Work Permit System fulfils this requirement through:

a) Pre-Work Authorization:
No hot work activity can proceed without prior authorization from the designated safety officer or Factory Manager, ensuring that all safety measures are in place.

b) Standard Operating Procedures (SOPs):
The system enforces SOPs for hot work activities, such as inspection of the work area, fire watch assignments, and post-work monitoring.

Section 17: General Duties of Employers and Self-Employed Persons
This section applies to ensuring the safety of non-employees (e.g., contractors, visitors) affected by workplace activities. A Hot Work Permit System ensures:

a) Control of Third-Party Activities:
Contractors performing hot work must obtain permits and adhere to the same safety requirements, ensuring a uniform standard across the workplace.

b) Minimization of Risks to Surrounding Areas:
The permit system extends safety precautions to areas adjacent to hot work operations, reducing risks to non-participants.

c) Training and Awareness:
Employers are obligated to provide training and resources to employees. The Hot Work Permit System includes educating workers and contractors on safe hot work practices and the importance of obtaining permits.

4.4	GAS TEST BEFORE HOT WORK OPERATION

Observation

There is no gas test being conducted before conducting hot work operation. This practice increases the risk of fire or explosion, especially if combustible gases are present in the work area. The absence of gas testing also contravenes established safety standards and regulations designed to minimize such risks.

Recommendation

To ensure the safety of workers, equipment, and the facility, it is strongly recommended to conduct a gas test before starting any hot work operations. The following measures should be implemented:

1) Pre-Hot Work Gas Testing:
Conduct gas tests in all areas where hot work, such as welding, cutting, or grinding, is planned.
Use calibrated gas detectors or multi-gas analyzers to measure concentrations of flammable gases or vapours, ensuring they are below the Lower Explosive Limit (LEL).

2) Establish a Hot Work Permit System:
Incorporate gas testing into a formal Hot Work Permit process.
Ensure that the gas test results, including date, time, and measured levels, are documented on the permit before hot work begins.

3) Continuous Monitoring:
Where there is a potential for flammable gas buildup during the work, conduct continuous gas monitoring to detect hazardous conditions in real-time.

4) Safety Measures Based on Results:
If combustible gas is detected, ensure adequate ventilation or purging of the area before proceeding.
Postpone the hot work operation until the area is confirmed safe by gas testing and other control measures.

5) Regular Calibration of Gas Testing Equipment:
Ensure gas detectors are regularly calibrated and maintained to ensure accurate readings.

Regulation / Guideline

1. Occupational Safety and Health Administration (OSHA)

29 CFR 1910.252 (Welding, Cutting, and Brazing):
Requires a thorough evaluation of the hot work area for potential fire hazards, including the presence of flammable gases.

29 CFR 1915.14 (Hot Work on Shipyard Employment):
Mandates that testing for flammable atmospheres be performed before hot work begins in confined spaces or other hazardous areas.

2. National Fire Protection Association (NFPA)

NFPA 51B (Standard for Fire Prevention During Welding, Cutting, and Other Hot Work):
Specifies that gas testing must be performed to detect the presence of combustible gases or vapours before starting hot work.

Emphasizes implementing a Hot Work Permit system and maintaining a fire watch during operations.

4.5	COOKING FACILITIES

Observation

Noted that there is a cooking activity utilising LPG cylinder gas located at the rear side of the building. The room where the cooking activity is conducted is not separated by a proper fire break wall from the adjacent furniture showroom. This poses significant risks in the event of a fire, as the fire could easily spread from the cooking area to the showroom, causing substantial property damage, potential injury, or loss of life.

Recommendation

The risks associated with the cooking activity utilizing LPG cylinders in the absence of proper fire separation are significant, particularly with regards to fire spread, explosion hazards, and the potential for severe property and life damage.

As such, it is recommended that,

1. Install Fire Break Wall:
    - Construct a fire-rated wall (minimum 1-hour fire resistance) between the cooking area and the furniture showroom to prevent the spread of fire. Fire-rated doors should also be installed in this partition.
2. Improve LPG Cylinder Storage:
    - Store LPG cylinders in a well-ventilated area, away from any sources of heat, and ensure they are properly secured to prevent accidental tipping.
    - Install gas leak detection systems and automatic shutoff valves for early detection of leaks and to minimize the impact of any leaks.
3. Install Fire Suppression Systems:
    - Implement a wet chemical fire suppression system (especially if deep fryers or open flame cooking are used).
    - Ensure portable fire extinguishers (Class B) are readily available and easily accessible.

Alternatively, the cooking activity is moved from current location into the staff quarters (dedicated for JBR Bundle, one the building tenant) at the left side of Building A.

Staff quarter

Regulation / Guideline

Not applicable

4.6	MANAGING RISKS IN CONSTRUCTION AREAS

Observation

Construction activities pose unique safety and security challenges, particularly in occupied buildings where ongoing operations may expose workers, visitors, and assets to hazards. To minimize these risks and ensure compliance with safety standards, the following measures are recommended for construction areas, specifically for the new third and fourth floors.

- Designate a Responsible Safety Officer
- Secure Construction Zones
- Implement Regular Monitoring and Patrols

Recommendation

1. Designate a Responsible Safety Officer

Recommendation:

In alignment with Section 3.1.1 of FM Global' s Safeguards During Construction, Alteration, and Demolition, designate one individual responsible for overseeing safety and security measures in the construction areas. This person should:

- Have full authority to enforce fire, safety, and security protocols.
- Conduct at least one round of inspection each working day.
- Ensure adherence to safety standards, including the control of fire hazards, and supervise access control to construction zones.

Purpose and Benefits:

Ensures accountability for hazard mitigation and the enforcement of safety protocols.
Promotes a centralized approach to managing risks such as fire, wind damage, vandalism, theft, and unauthorized access.

2. Secure Construction Zones

Recommendation:

Ensure that construction zones on the third and fourth floors are properly barricaded and clearly marked as restricted areas to prevent unauthorized access by the insured's workers and other personnel. Use signage to indicate hazards such as falling debris, electrical work, or restricted access.

Purpose and Benefits:

Reduces the risk of accidents, such as falls or injuries, caused by untrained individuals entering construction zones.
Limits liability for injuries resulting from unauthorized access.

3. Implement Regular Monitoring and Patrols

Recommendation:

Assign dedicated personnel to monitor and patrol the construction zones at regular intervals. This ensures that:

- Unauthorized personnel do not enter restricted areas.
- Safety protocols, such as fire hazard control, are being followed.
- Any hazards or anomalies are identified and addressed promptly.

Purpose and Benefits:

Ensures ongoing compliance with safety measures.
Quickly identifies and mitigates risks before they escalate into incidents.

Regulation / Guideline
1. Occupational Safety and Health Act 1994 (OSHA 1994): Section 15 mandates that employers provide a safe working environment by identifying and mitigating risks, including those related to construction activities. Section 24 obligates employees to cooperate in safety measures implemented by the employer. **2. Factories and Machinery Act 1967 (FMA 1967):** Outlines the requirements for safe access and egress from work areas, including the use of ladders, scaffolds, and other equipment. **3. Occupational Safety and Health (Use and Standards of Exposure to Hazardous Chemicals) Regulations 2000:** Requires the identification and communication of hazards in work areas, including construction zones. **4. Factories and Machinery (Safety, Health, and Welfare) Regulations 1970:** Regulation 32 Outlines the working clothes and personal protective clothing in worksites to ensure safety conditions.

4.7	SMOKING POLICY NOT ENFORCED

Observation

Smoking has been identified as one of the top ten sources of ignition, making it a leading cause of fires globally. This risk becomes significantly heightened in high-hazard areas where flammable liquids, gases, or large quantities of combustible materials are stored or processed. Carelessly discarded cigarettes, matches, or smoking materials can smolder undetected, often leading to fully developed fires that can cause extensive damage before being discovered.

To address this risk effectively and align with regulatory and industry standards, it is essential to implement and enforce a robust smoking policy.

Recommendation

To mitigate the risks associated with smoking, the following measures are strongly recommended:

1. Smoking Prohibition in High-Risk Areas

Smoking should be strictly prohibited in all areas of the facility where flammable or combustible materials are present, including:

- Storage areas for flammable liquids and gases.
- Processing zones handling combustible materials.
- Warehouses, laboratories, and confined spaces where fire hazards exist.

2. Development of a Comprehensive Smoking Policy

Establish a formal smoking policy that clearly defines:

- Areas where smoking is prohibited.
- The location and management of designated smoking areas (if applicable).
- Enforcement measures for non-compliance.
- Ensure the policy includes basic smoking safeguards such as proper disposal methods for smoking materials (e.g., fire-safe receptacles).

3. Effective Communication of the Smoking Policy

The smoking policy should be communicated effectively to all levels of employees, contractors, visitors, and other stakeholders. This can be achieved through:

- Safety briefings and orientations.
- Signage and written materials.
- Digital communication platforms (e.g., emails, intranet postings).
- Special attention should be given to ensuring language and literacy considerations are addressed so the policy is clearly understood by all.

4. Provision of Clear and Visible Signage

Install prominent and visible signage at strategic locations within the facility, including:

- Entrances, exits, and common areas.
- High-hazard zones.
- Designated smoking areas (if applicable).
- Examples of signage include:
  - “Strictly No Smoking" signs for prohibited areas.
  - "Designated Smoking Area" signs for controlled smoking zones.

5. Designation of Safe Smoking Areas (If Smoking is Permitted)

Designate specific areas for smoking that are:

- Located a safe distance from high-risk zones.
- Equipped with fire-safe ashtrays or receptacles for proper disposal of cigarette butts and matches.
- Clearly marked and easily accessible.

6. Regular Monitoring and Enforcement
- Conduct regular inspections to ensure compliance with the smoking policy.
- Assign personnel (e.g., safety officers or supervisors) to monitor adherence and address violations promptly.
- Establish and communicate penalties for non-compliance to deter breaches of the policy.

Regulation / Guideline

1. NFPA Standards (National Fire Protection Association)

NFPA 101: Life Safety Code mandates fire safety measures, including smoking restrictions, in various facilities.
NFPA 10: Standard for Portable Fire Extinguishers emphasizes the importance of reducing ignition sources such as smoking in fire-prone zones.

2. OSHA 1994

1. General Duties of Employers
Under Section 15 of OSHA 1994, employers are required to:
- Ensure, so far as is practicable, the safety, health, and welfare of employees at work.
- Provide a safe working environment, which includes controlling fire hazards like smoking in high-risk areas.

Application to Smoking Policy:
- Smoking poses fire risks, especially in workplaces with flammable substances or materials.
- Employers must establish and enforce a smoking policy to eliminate or minimize this risk.
- They are also responsible for ensuring that all employees are informed about the smoking restrictions.

2. Control of Workplace Hazards
Under Section 16 of OSHA 1994, employers must formulate and implement a safety and health policy. This includes addressing workplace hazards like smoking.

Application to Smoking Policy:
- The smoking policy should be part of the overall safety and health policy.
- It should identify areas where smoking is prohibited, such as:
  - Storage areas for flammable materials.
  - Areas with high concentrations of combustible materials.
- Employers must also implement measures like signage, designated smoking areas (if allowed), and fire-safe disposal receptacles.

4.8	SAFETY COMMITTEE

Observation

A well-structured Safety and Health Committee (SHC) is critical to ensuring workplace safety, legal compliance, and a proactive approach to occupational hazards. Given that insured employs more than 40 personnel, it is a mandatory requirement under Regulation 30 of the Occupational Safety and Health Act (OSHA) 1994 that a Safety Committee be established.

Recommendation

A properly functioning safety committee helps to:

- Ensure compliance with occupational health and safety laws.
- Prevent workplace accidents through hazard identification and mitigation.
- Improve workplace safety culture by fostering communication between employees and management.
- Reduce financial and reputational risks arising from workplace accidents, injuries, and legal penalties.
- Provide a structured response in the event of an emergency or accident.

To mitigate safety risks and ensure compliance, it is strongly recommended that insured:

1. Establish a Safety Committee Immediately
- Form a dedicated Safety and Health Committee (SHC) comprising employer representatives, management, and employee representatives.
- Assign a Chairperson, Secretary, and Committee Members with clear roles and responsibilities.
- Conduct an inaugural safety meeting to set objectives, review past incidents, and discuss safety policies.

2. Conduct Regular Safety Meetings & Inspections
- Hold quarterly safety meetings (at least once every three months) to review workplace hazards, near misses, and safety improvements.
- Carry out comprehensive safety inspections every three months to assess compliance with OSHA regulations and identify potential risks.
- Maintain a Safety Inspection Logbook to record observations, recommendations, and corrective actions.

3. Maintain Safety Records and Compliance Documents
- Ensure that all meeting minutes, inspection reports, and incident records are properly documented and retained for at least seven years as per Regulation 18.
- Keep an Accident and Incident Report Log to track workplace injuries and submit reports to DOSH when required.

4. Strengthen Workplace Safety Culture
- Conduct safety awareness training for employees to reinforce best practices and legal responsibilities under OSHA 1994.
- Establish clear reporting mechanisms for employees to report hazards, unsafe practices, or near-miss incidents.
- Encourage management support to drive a strong safety culture and proactive risk management.

Regulation / Guideline

The establishment and operation of a Safety Committee must comply with the following legal provisions:

1. **Occupational Safety and Health Act (OSHA) 1994 (Act 514)**

Section 30: Requires employers with more than 40 employees to form a Safety and Health Committee.
Section 15: Employers have a duty to ensure the safety, health, and welfare of employees.
Section 24: Employees must take reasonable care for their own safety and cooperate with safety measures implemented by their employer.

2. **Occupational Safety and Health (Safety and Health Committee) Regulations 1996**

Regulation 6(1): A Safety and Health Committee must be established if the workplace has more than 40 employees.
Regulation 21: The Safety Committee must meet at least once every three months.
Regulation 12: A comprehensive workplace safety inspection must be conducted every three months to identify hazards.
Regulation 18: Minutes of safety committee meetings must be kept for at least seven years.
Regulation 22: Employers must report any workplace accidents, near misses, or dangerous occurrences to the Department of Occupational Safety and Health (DOSH).

4.9	PROPOSAL OF PATROL CLOCKING

Observation

There is no patrol clocking system be adopted in the premises.

Recommendation

To enhance the security and safety standards of the premises, it is strongly recommended that a patrol clocking system be adopted. This system involves the installation of patrol clocking points at strategic locations along the premises' perimeter and other high-risk areas. These points should be carefully selected to ensure comprehensive coverage of the property, facilitating regular and systematic patrols by security personnel.

Purpose and Benefits:

- Enhanced Monitoring: The patrol clocking system ensures that security guards patrol designated areas at scheduled intervals, particularly during vulnerable periods such as nighttime, minimizing security lapses.
- Deterrence of Unauthorized Activities: Visible and consistent patrols serve as a deterrent against unauthorized access, theft, vandalism, and other illicit activities.
- Early Detection of Risks: By conducting systematic patrols, security personnel are more likely to identify and respond promptly to signs of unauthorized entry, fire hazards, equipment malfunctions, or other irregularities.
- Accountability and Compliance: The system provides documented proof of patrols, ensuring accountability and adherence to security protocols.

Risk Mitigation:
This proactive measure helps mitigate risks related to:
- Security breaches: Unauthorized access to sensitive or restricted areas.
- Fire safety lapses: Early identification of fire risks, such as unsecured electrical appliances or combustible materials.
- Operational disruptions: Prevention of sabotage or tampering with critical systems or infrastructure.

Regulation / Guideline

The implementation of a patrol clocking system aligns with Occupational Safety and Health Act 1994 (OSHA 1994), particularly under Section 15, which mandates employers to ensure a safe working environment for all employees.

Details of Section 15 of the Occupational Safety and Health Act 1994 (OSHA 1994):

Section 15 of OSHA 1994 outlines the general duties of employers and self-employed persons to their employees. This section mandates employers to ensure, so far as is practicable, the safety, health, and welfare of all employees while at work. The specific provisions under Section 15 include:

Provision of a Safe Work Environment (Section 15(2)(a)):
Employers are required to ensure that the working environment is free from risks to health and safety.
Note: The implementation of a patrol clocking system contributes to this by minimizing risks such as unauthorized entry, fire hazards, and other security threats that could jeopardize employee safety.

Safe Systems of Work (Section 15(2)(b)):
Employers must ensure that safe work systems are implemented.
Note: A patrol clocking system formalizes the security patrol process, creating a systematic approach to monitoring and addressing risks.

Provision of Necessary Information, Instruction, Training, and Supervision (Section 15(2)(c)):
Employers must provide employees, including security personnel, with the necessary training and supervision to carry out their duties safely. Training security staff to use the patrol clocking system ensures they understand the risks, procedures, and actions required to maintain workplace safety.

Maintenance of Facilities (Section 15(2)(d)):
Employers are responsible for maintaining the premises and any equipment used to ensure safety and health. Installing and maintaining a patrol clocking system aligns with this obligation, as it requires regular checks and upkeep to ensure its effectiveness.

Health and Safety Policy (Section 15(2)(e)):
Employers must establish and update policies that address safety and health risks. The introduction of a patrol clocking system can be integrated into the organization's security and safety policy, demonstrating compliance with this requirement.

Application of Section 15 in Relation to Patrol Clocking Systems:
By adopting a patrol clocking system, employers actively fulfil their responsibilities under Section 15 by:

- Creating a safer environment that proactively addresses risks to health and safety.
- Ensuring systematic supervision and monitoring to prevent incidents.
- Providing a structured process for the identification and mitigation of hazards, particularly during high-risk periods such as nighttime.
- The patrol clocking system thus supports the overarching goal of Section 15 to ensure the safety, health, and welfare of employees and aligns with the legislative framework designed to uphold workplace safety in Malaysia

PROCESS

5.1	SPRAY COATING

Observation

The spray coating booth in Coating Factory is not provided with explosion proof type electrical installation.

Spray coating booth

Recommendation

The absence of explosion-proof electrical installations in the spray coating booth at the Coating Factory poses a significant safety risk. Spray coating operations often involve the use of flammable materials, which generate vapours, fumes, or mist that can form explosive atmospheres. Any spark or ignition source from non-explosion-proof electrical equipment in these areas can lead to devastating fires or explosions.

To mitigate this risk and ensure compliance with safety standards, it is strongly recommended that all electrical installations within the spray coating booth be upgraded to explosion-proof specifications.

Regulation / Guideline

Ensuring that the spray coating booth in your Coating Factory is equipped with explosion-proof electrical installations is crucial for safety and compliance with Malaysian regulations. The following legislative frameworks and standards govern this requirement:

1. Electricity Regulations 1994:

Regulation 15(1): Any apparatus, conductor or accessory for the purpose of connection to an installation shall be sufficient in size,
power and number to serve the purpose for which it is intended and shall be constructed, installed, ar ranged, protected, worked and maintained in such a manner as to prevent danger.

This includes the requires that all electrical equipment and wiring comply with standards ensuring safety and suitability for their operating environment. In areas with flammable vapours, such as spray coating booths, this implies the use of explosion-proof equipment.

2. Non-Domestic Electrical Installation Safety Code (ND-EISC):
Issued by the Energy Commission, this code provides guidelines for the design, construction, inspection, testing, operation, and maintenance of electrical installations in non-domestic settings. It emphasizes the need for appropriate equipment in hazardous areas to prevent ignition sources.

3. Malaysian Standards (MS) and International Electrotechnical Commission (IEC) Standards:
- MS IEC 60364-4-42: Addresses protection against thermal effects, including measures to prevent ignition in hazardous areas.

- IEC 60079 Series: Provides comprehensive requirements for electrical installations in explosive atmospheres, detailing the selection, installation, and maintenance of explosion-proof equipment.

5.2	BATTERY CHARGING SOCKET

Observation

The battery charging socket was observed to be located approximately 1 foot away from a racking system used for storing paper cores, which are combustible materials. This proximity poses a significant fire risk, as any sparks, overheating, or electrical faults during the charging process could potentially ignite the paper cores, leading to a fire outbreak.

Recommendation

To mitigate this risk effectively, it is highly recommended to take the following actions:

1) Relocation of the Charging Socket: The battery charging socket should be relocated to a designated area that is well-separated from combustible goods, such as paper cores. Ideally, this new location should be in a non-combustible area or a dedicated battery charging station with adequate fire protection measures.

2) Installation of Fire-Resistant Barriers: If immediate relocation is not feasible, install fire-resistant barriers or shielding between the charging socket and the racking system to minimize the risk of fire spread.

3) Adequate Ventilation and Monitoring: Ensure that the new charging area is well-ventilated to prevent heat buildup and is equipped with monitoring systems to detect any overheating or electrical issues promptly.

4) Signage and Safety Measures: Clearly mark the battery charging area with appropriate warning signs and enforce strict no-storage policies for combustible materials within a safe radius.

5) Regular Inspections and Maintenance: Implement a schedule for regular inspection and maintenance of the battery charging equipment to ensure it remains in safe working condition.

By adopting these measures, the risk of fire from the proximity of the battery charging socket to combustible materials can be significantly reduced, ensuring a safer working

environment.

Regulation / Guideline

1. National Fire Protection Association (NFPA) Standards

NFPA 70 (National Electrical Code):
Requires electrical equipment, including charging sockets, to be installed in locations that minimize fire risks.
Combustible materials must be kept at a safe distance from heat-producing or electrical equipment.

NFPA 30 (Flammable and Combustible Liquids Code):
Specifies the need for physical separation of combustible materials from potential ignition sources.

2. Occupational Safety and Health Standards

OSHA (Occupational Safety and Health Administration) – 29 CFR 1910.178(g)(1) (Battery Charging Requirements):
Requires adequate ventilation and safe clearance around battery charging areas to prevent ignition of nearby flammable materials.
States that battery charging installations should avoid proximity to combustible storage.

3. Local Fire Safety Codes

Fire and Building Codes (e.g., IFC, IBC):
International Fire Code (IFC) and local fire codes typically require fire safety measures to prevent ignition hazards.
Mandates separation of electrical equipment from combustible storage areas, often specifying minimum clearance distances.

5.3	OVERHEAD CRANE

Observation

The production area is equipped with an overhead crane designed to lift heavy materials and work-in-progress components, facilitating efficient handling and movement of loads. However, the operation of such equipment introduces significant safety risks, including the potential for heavy objects or metal components to fall from the crane. This poses serious hazards to personnel, equipment, and operations in the vicinity.

Recommendation

It is recommended that the workers be wearing the appropriate personal protective equipment (PPE) i.e., safety helmet, safety shoes when working under lifting machine/equipment area. As such, it is recommended to gazette the lifting crane area as a mandatory area for PPE especially safety helmet and safety shoes. A clearly demarcate the crane's operating zones and restrict access to unauthorized personnel during lifting operations. In addition, a display visible warning signs and signals shall be made to alert workers of ongoing crane operations.

Other routine maintenance and safety inspections shall also be observed to minimize the hazards such as:

- Conduct routine maintenance and safety inspections of the overhead crane to ensure it operates reliably and meets safety standards.
- Inspect all components, including hoists, slings, hooks, and load-lifting attachments, for wear and tear or damage.
- Verify the integrity of the crane's limit switches and safety mechanisms.
- Ensure all loads lifted by the crane are within the rated capacity of the equipment.
- Overloading significantly increases the risk of accidents.
- Use appropriate rigging and lifting techniques to secure loads properly and minimize the

risk of detachment.
- Ensure all crane operators are adequately trained, certified, and familiar with the crane's operating procedures and emergency protocols.
- Provide regular refresher training to reinforce safe operating practices and update operators on any changes in regulations or equipment.

Regulation / Guideline

1. Factories and Machinery Act 1967 (Act 139)

The Factories and Machinery Act 1967 is one of the primary regulations in Malaysia concerning the operation, safety, and maintenance of machinery, including overhead cranes.

2. Occupational Safety and Health Act 1994 (OSHA 1994)

The Occupational Safety and Health Act 1994 (OSHA) emphasizes the duty of employers to ensure workplace safety, which extends to the use of overhead cranes. Key provisions include:

General Duties of Employers (Section 15):
Employers are obligated to provide and maintain machinery, in a safe condition to prevent workplace accidents.
Adequate training, supervision, and instructions must be provided to workers to ensure safe operations.

3. Guidelines by the Department of Occupational Safety and Health (DOSH)

DOSH has developed comprehensive guidelines to ensure the safe use, maintenance, and inspection of overhead cranes. The guidelines serve as a reference for employers, operators, and safety officers. Key highlights include:

Safe Use of Cranes:
Cranes must only be operated by personnel certified as competent under DOSH guidelines.
Operating manuals and safe work procedures must be readily available at the crane site.

Inspection Requirements:
Cranes must undergo a thorough inspection by DOSH-certified personnel during installation, after any modifications, and at regular intervals **(typically 15 months).**
Inspections include checking structural integrity, electrical systems, hoist mechanisms, and load-bearing components.

Load Testing:
Before commissioning, cranes must undergo load testing to ensure they can handle the specified maximum load safely. Load tests must also be performed periodically to verify continued compliance.

Emergency Systems and Controls:
Overhead cranes must be equipped with emergency stop systems and load-limiting devices to prevent overloading.
Clear signage must indicate load capacities, operating zones, and safety warnings.

Training and Certification:
Operators must complete DOSH-recognized training programs and hold valid certifications. Refresher courses are recommended to ensure operators are updated on safety practices and regulations.

5.4	LABELLING OF PIPES AND TUBES

Observation

Hazardous materials flow through various piping in many industrial, commercial and institutional facilities. Just like hazardous materials in other situations, piping systems should be appropriately labelled to make people aware of the materials they carry.

Recommendation

In industrial, commercial, and institutional facilities, it is essential to clearly label pipes and tubes that carry hazardous materials to ensure the safety of employees, contractors, and visitors. Proper labelling reduces the risk of accidents, injuries, and operational disruptions by providing critical information about the contents, flow direction, and potential hazards associated with the piping systems.

Purpose and Benefits:

- Enhanced Safety: Proper labelling prevents accidental exposure to hazardous materials, including toxic, flammable, or corrosive substances. It also reduces the likelihood of injury during routine operations or emergencies.
- Informed Decision-Making: Clear labelling allows maintenance personnel and emergency responders to identify and handle hazardous materials appropriately, mitigating confusion during time-sensitive situations.
- Compliance: Labelling ensures adherence to applicable safety standards and regulations, minimizing legal and reputational risks.

Key Risk Considerations:

- Chemical Exposure: Improper or missing labelling could result in accidental exposure to hazardous chemicals, leading to severe health impacts.
- Fire and Explosion Risks: Misidentification of flammable materials within pipes could lead to inappropriate handling, increasing the likelihood of fire or explosion.
- Operational Interruptions: Maintenance activities could be delayed or mishandled due to the inability to identify the materials in unlabelled pipes, potentially causing costly downtime.

As per ANSI/ASME A13.1: Scheme for the Identification of Piping Systems, there is a standard for the color-coding of pipes to identify their contents and associated hazards.

Yellow/Black: Flammable or combustible fluids (e.g., gasoline, oil, natural gas).
Green/White: Water (e.g., potable water, cooling water).
Blue/White: Compressed air.
Red/White: Fire suppression materials (e.g., fire water, sprinkler systems).
Orange/Black: Toxic and corrosive substances.
Brown/White: Combustible fluids.
Gray/White: Steam.

Regulation / Guideline

1. <u>Control of Industrial Major Accident Hazards Regulations (CIMAH 1996)</u>

Purpose of CIMAH 1996
The Control of Industrial Major Accident Hazards Regulations focuses on preventing and mitigating the effects of major accidents involving hazardous materials. Facilities handling significant quantities of hazardous substances are required to take preventive measures to avoid accidents.

Key Provisions Relevant to Pipe Labelling:
Demonstration of safe operation (Regulation 10):
Employers must identify all hazards associated with the materials stored, transported, or

processed, including those within piping systems. Proper labelling helps in identifying these hazards clearly.

Color-coding piping systems based on the materials they transport is essential for ensuring workplace safety and regulatory compliance. Several standards and guidelines provide rules for identifying pipe contents through colours, labels, and markings. Here's an overview of the relevant regulations and standards:

2. ANSI/ASME A13.1: Scheme for the Identification of Piping Systems

Color-coding piping systems based on the materials they transport is essential for ensuring workplace safety and regulatory compliance. Several standards and guidelines provide rules for identifying pipe contents through colours, labels, and markings.

This widely recognized standard provides a comprehensive system for the color-coding of pipes to identify their contents and associated hazards. This ANSI/ASME A13.1 ensures that piping systems are consistently identified across industries, promoting safety and efficient communication.

Key Provisions:
Colour Coding: Specific colours are assigned to different categories of materials:

Yellow/Black: Flammable or combustible fluids (e.g., gasoline, oil, natural gas).
Green/White: Water (e.g., potable water, cooling water).
Blue/White: Compressed air.
Red/White: Fire suppression materials (e.g., fire water, sprinkler systems).
Orange/Black: Toxic and corrosive substances.
Brown/White: Combustible fluids.
Gray/White: Steam.

Labelling: Text legends accompany the colour coding to provide additional information about the pipe contents.
Flow Direction Arrows: Indicate the direction of material flow.

5.5	BATTERY CHARGING IN NON-VENTILATED ROOM

Observation

The battery charging area is located in a non-ventilated room, which poses serious safety hazards. During the charging process, lead-acid batteries generate hydrogen gas, which can form an explosive atmosphere if not adequately dispersed.

Hazards & Risks:

1) Fire & Explosion Risk
Hydrogen gas is highly flammable and can ignite at concentrations as low as 4% in air.
A single spark (from electrical equipment or static discharge) could result in an explosion.

2)Health Hazards (Asphyxiation & Toxic Exposure)
Accumulated hydrogen gas can displace oxygen, causing suffocation in confined spaces.
Lead-acid batteries may also release sulfuric acid vapours, which cause respiratory irritation and corrosion of equipment.

Recommendation

To eliminate the risks associated with hydrogen gas accumulation, the following controls should be implemented:

1. Install a Forced Ventilation System
As per NFPA 70E (Standard for Electrical Safety in the Workplace), Section 240.1, battery charging areas must be provided with ventilation to remove flammable gases.
A mechanical ventilation system with an exhaust fan should be installed at the highest point of the room (since hydrogen is lighter than air).

2. Use Natural Ventilation (If Relocation is Feasible)
If mechanical ventilation is not feasible, relocate the battery charging area to an open or semi-open space with natural air circulation.
Position batteries near windows, louvered walls, or roof vents to allow passive hydrogen dissipation.

Regulation / Guideline

1. Electrical & Fire Safety Standards
NFPA 70E (Standard for Electrical Safety in the Workplace), Section 240.1
- Requires proper ventilation for battery charging areas to prevent hydrogen accumulation.
- Mandates explosion-proof electrical equipment in battery rooms.

2. IEEE/ASHRAE Std 1635 2018
- Outline the battery operating modes and the hazards associated with it.

3. Occupational Safety & Health Regulations
OSHA 29 CFR 1910.178(g) (US Regulations on Battery Charging Areas)
-Mandates adequate ventilation and prohibits smoking or open flames near battery charging stations.

4. Occupational Safety and Health Act 1994 (Malaysia – OSHA 1994)
- Employers must assess and control workplace hazards, including chemical exposure and fire risks.

5.6	SPRAY PAINTING WITHIN SHOWROOM SPACE

Observation

During the inspection, it was observed that a small spray painting area is located within the showroom space, without proper segregation from public areas or other activities. Additionally, the area lacks adequate ventilation to disperse flammable fumes, posing a potential fire hazard. Spray paints and related materials are not stored in appropriate fire-resistant cabinets, which increases the risk of fire.

Recommendation

Flammable liquid would release and liberate flammable vapours in the air. Being heavier than air, they could settle and accumulate at ground level. Flammable vapours could be ignited from the electrical fault/flash over in the event of electrical malfunction or short circuiting.

In general, we recommend that if any of the liquids fall under the flammable category, the following points should be adopted for their storage arrangement where necessary.

- For the flammable liquids we recommend to be stored in separate location or detached room away from other combustible materials. In every storage room, there shall be maintained an aisle at least 1 m wide. If flammable liquid maintains to be stored in the existing location, provision must be made to relocate it to the far corner of the building with one hour fire rated partition to cut-off the flammable liquid occupancy from surrounding occupancies.
- Ventilation is provided for the room in the form of gravity or a mechanical exhaust ventilation system designed to provide a complete change of air in the room and the vapor or concentration in the room should be maintained below 25% of the lower flammability level. The ventilation for flammable liquids is recommended to be installed at low-level because flammable vapor is heavier than air and therefore, it settles to the ground level.
- To contain the flammable liquids from approaching other properties, a containment system should be constructed to permit safe collection of spillage or leakage. The size of containment should be able to accommodate the largest container stored.
- The quantity of flammable liquids kept in the production area must strictly limit merely for daily consumption. Any balance must be returned back to the designated storeroom or kept in the approved flammable cabinet (as per photo below).

Alternatively, the spray painting activity could be carried out outside the building away from any combustible materials.

Regulation / Guideline

1. <u>Fire Services Act 1988 (Act 341)</u>

The **Fire Services Act 1988** is the primary legislative framework governing fire safety in Malaysia. Key provisions include:

- Section 8: Abatement of Fire Hazards
  - Authorities, such as the Director General of Fire Services, have the power to issue notices requiring premises to rectify fire hazards.
  - Improper storage or handling of flammable substances (e.g., spray paints) that pose a fire risk can lead to such notices.
  - Failure to comply with these notices can result in fines or prosecution.
- Section 23: Installation of Fire Safety Systems
  - Owners of premises where flammable substances are used or stored must ensure appropriate fire safety systems, such as fire extinguishers and suppression systems, are installed.

2. <u>Uniform Building By-Laws (UBBL) 1984</u>

The **UBBL** is Malaysia's building regulation framework and includes fire safety provisions that apply to all buildings, including those handling hazardous materials. Relevant sections include:

- Regulation 225: Storage of Dangerous Goods
  - Flammable and combustible materials must be stored in designated areas away from public spaces.
  - Proper ventilation must be installed to prevent the accumulation of hazardous vapours.
- Regulation 247: Fire Extinguishing Appliances
  - Fire extinguishers must be provided at accessible locations.
  - Equipment must comply with standards set by the Malaysian Fire and Rescue Department.

3. <u>Department of Occupational Safety and Health (DOSH) Guidelines</u>

The **Occupational Safety and Health Act 1994** and associated guidelines from DOSH emphasize safe handling, storage, and use of hazardous chemicals:

- Chemical Safety Guidelines:
  - Employers are required to identify hazards and ensure that flammable materials like spray paints are stored in fire-resistant cabinets.
  - Material Safety Data Sheets (MSDS) must be provided for all hazardous substances and accessible to employees.
- Control of Industrial Major Accident Hazards (CIMAH) Regulations 1996:
  - Requires facilities that store flammable chemicals to conduct risk assessments and implement measures to mitigate potential fire hazards.

4. Malaysian Standards (MS)

The **Malaysian Standards** provide technical requirements for fire safety equipment and installations. Notable standards include:

- MS 1539:2002 – Portable Fire Extinguishers:
    - Specifies the types of fire extinguishers suitable for different classes of fire, including Class B (flammable liquids).
- MS 830:1983 – Ventilation Systems for Hazardous Areas:

Provides guidelines for proper ventilation systems to reduce the risk of flammable vapor accumulation.

5.7	THICKNESS TESTING OF BULK TANKS

Observation

The bulking facilities have been operating since 2008, but the thickness test for the tanks has not been conducted since the start of operations.

Recommendation

The thickness testing of bulk storage tanks is conducted to assess the condition and integrity of the tank's structure. This test ensures that the tank's walls, particularly the bottom and shell, are still thick enough to withstand the operational pressures and are safe for continued use. The testing is typically performed on above-ground storage tanks used for petroleum, chemicals, and other bulk liquids.

It is recommended that a thickness test for the tanks be conducted promptly to assess their structural integrity and ensure continued safe operation. Moving forward, thickness testing should be scheduled based on industry standards as follows:

- Initial Test: To be conducted immediately to establish the current condition of the tanks.
- Subsequent Tests: Thickness tests should be carried out every 5 years in accordance with standard industry practices (e.g., API 653 for storage tanks).
- Additional Testing: If any significant corrosion or structural issues are identified, additional tests should be scheduled based on the severity of the findings and the recommendations from the inspection report.

This approach will help prevent potential failures and maintain compliance with safety standards.

Regulation / Guideline

Ensuring the structural integrity and safety of storage tanks is paramount in industrial operations. Several standards and guidelines govern the inspection, maintenance, and repair of these tanks. Below is an overview of key international and Malaysian standards.

1. API 650 (American Petroleum Institute) - Welded Tanks for Oil Storage

- Scope: API 650 provides the standards for the design, fabrication, and inspection of welded steel tanks for the storage of petroleum and other liquids, which includes palm oil.
- Relevance: This standard is widely used for bulk storage tanks, including palm oil tanks, as it specifies the minimum requirements for the tank's material, design, construction, and safety. For palm oil tanks, particularly those storing crude palm oil or refined palm oil, API 650 ensures that the tank is designed to withstand the internal pressures, temperatures, and other mechanical stresses while maintaining structural integrity over time.
- Design Criteria:
    - Material Selection: The material must be compatible with the chemical properties of the stored liquid (e.g., palm oil).
    - Thickness of Tank Shell and Bottom: The standard specifies calculations for determining the minimum thickness based on the size, pressure, and type

of liquid being stored.
    - Corrosion Allowance: A corrosion allowance is typically added to ensure the tank maintains integrity over its service life, particularly at the bottom where water accumulation and contamination might accelerate corrosion.

- Inspection & Maintenance:
    - API 650 requires regular inspections of tanks, including ultrasonic thickness measurements and visual inspections, to identify areas of corrosion or thinning.
    - It also recommends periodic hydrostatic testing (filling the tank with water to check for leaks), especially after repairs or modifications.
- Acceptance Criteria:
    - If the thickness of the tank wall falls below the allowable thickness defined by the design, repairs or replacement of the affected section are required.

2. API 653 (American Petroleum Institute) - Tank Inspection, Repair, Alteration, and Reconstruction

- Scope: API 653 deals specifically with the inspection, repair, and maintenance of above-ground storage tanks (ASTs). It is directly applicable to bulk storage tanks used for palm oil.
- Relevance: This standard is used once a storage tank is in service and needs ongoing inspection and maintenance. It complements API 650 by providing specific guidance for post-construction activities.
- Inspection & Maintenance:
    - Ultrasonic Thickness Testing: API 653 provides guidelines on when and how to perform thickness testing to assess the level of corrosion, especially at critical points like the tank bottom and welds.
    - Tank Cleaning: Palm oil tanks need to be cleaned regularly to remove sediment and microbial growth, especially at the tank bottom where water and oil residue can accumulate.
    - Repair and Alteration: If corrosion or thinning exceeds allowable limits, the tank may require repair or alteration, such as replacing corroded plates or adding reinforcement.
- Structural Integrity: API 653 requires the tank to undergo a comprehensive inspection, including checking for leakages, deformation, and any signs of overstress. Tanks with significant corrosion or defects should be derated (used under lower operating conditions) until repairs are made.

3. MS 1984: Part 2 - Storage Tanks for Petroleum Products and Other Liquids (Malaysian Standard)

- Scope: This standard, aligned with API 650, is the Malaysian Standard for designing, constructing, and maintaining storage tanks for various liquids, including palm oil.
- Relevance: MS 1984 Part 2 applies to storage tanks for liquids like palm oil and sets the local benchmarks for tank construction, safety, and inspections. It ensures that tanks meet both local regulations and international standards.
- Design Requirements:
    - Corrosion Allowance: The standard requires a corrosion allowance for the tank shell and bottom to accommodate the effects of palm oil's chemical composition, especially free fatty acids (FFAs) and moisture that may accelerate corrosion.
    - Seismic and Wind Load Considerations: As Malaysia is prone to tropical

storms, MS 1984 includes guidelines for tanks to withstand high winds, especially if the tanks are located in areas susceptible to such conditions.

- Inspection and Maintenance:
  - Similar to API 650, this standard recommends periodic thickness measurements and visual inspections.
  - Leak testing and structural checks are mandatory as part of tank inspections to ensure there are no cracks or potential leaks, especially when the tank is storing edible products like palm oil.

4. ASME (American Society of Mechanical Engineers) - Boiler and Pressure Vessel Code

- Scope: ASME standards are used for pressure vessels and other tanks that operate under pressure. While this is not always directly applicable to storage tanks, certain types of palm oil storage tanks that are pressurized or have heating systems (e.g., for crude palm oil storage) may follow these standards.
- Relevance: If the storage tank is designed to withstand internal pressures (such as high-temperature crude palm oil storage), ASME standards will apply to ensure the tank can withstand operational stresses without failure.
- Design Criteria:
  - The ASME code will specify material strength, corrosion allowances, and pressure relief requirements for tanks operating at elevated temperatures or pressures.
- Inspection and Testing:
  - For pressurized tanks, ASME standards require pressure testing to ensure structural integrity.
  - Ultrasonic testing and radiographic testing may be used to check welds and areas subject to fatigue or corrosion.

5. DOSH (Department of Occupational Safety and Health, Malaysia) Regulations

- Scope: DOSH regulations govern safety in the workplace and apply to the operation and maintenance of storage tanks used in Malaysia. These regulations ensure that workers are not exposed to unsafe working conditions while inspecting, maintaining, or repairing storage tanks.
- Relevance: These regulations ensure that palm oil storage tank operations are carried out in a safe manner, especially in terms of confined space entry, spill containment, and fire safety.
- Inspection & Maintenance:
  - Tanks must comply with DOSH safety guidelines when it comes to entering confined spaces (tank interiors), and appropriate gas testing is required before entry.
  - Tanks must be properly maintained to prevent leaks, which could result in environmental hazards or accidents.

6. **ISO 9001: Quality Management Systems**

- Scope: ISO 9001 is a globally recognized standard for quality management systems (QMS). Though it is not directly related to tank design, it plays an important role in ensuring that the maintenance and inspection processes for storage tanks follow a standardized procedure.
- Relevance: Compliance with ISO 9001 ensures that tank maintenance procedures are consistent and well-documented, which is vital for ensuring the reliability and safety of palm oil storage tanks.
- Inspection & Documentation:

- Maintenance, inspections, and repairs must be documented and follow a quality control process to ensure consistent performance and traceability of all tank-related activities.

5.8	TEMPERATURE MONITORING FOR PALM KERNEL STORAGE

Observation

The risk is provided with two units of palm kernel silos, and sometimes the palm kernel is stored in the warehouse during peak production periods. It was noted that both the kernel silo and pile storage are not equipped with temperature monitoring.

Recommendation

Palm kernels, though not as volatile as crude palm oil, can still pose a fire risk under certain conditions. Some of the factors contributing to fire risks in palm kernel storage are:

- Oily nature of palm kernels: The kernels contain natural oils, which are flammable under the right conditions, especially when exposed to high temperatures or improper storage conditions.
- Dust accumulation: The dust generated from processing palm kernels can be highly flammable and pose an explosion risk when mixed with air.
- Spontaneous combustion: Spontaneous combustion can occur if palm kernels or other organic materials like fibre are stored in poorly ventilated conditions. The internal heat generated from biological decomposition or oxidation of the oil may lead to a fire.

To mitigate the risk of fire hazards and spontaneous combustion, it is recommended to install a comprehensive temperature monitoring system for both palm kernel silos and pile storage. Palm kernels are prone to spontaneous combustion due to their oily nature and the buildup of heat from biological activity and oxidation. Installing continuous temperature monitoring with sensors placed at multiple levels within the silo and across different areas of the pile storage will help detect abnormal temperature increases early. High-temperature alarms should be integrated with the plant's control system to trigger an automatic response if temperatures exceed safe limits (typically 45°C to 50°C). The monitoring system should provide real-time data logging and remote access to allow for quick intervention. Regular calibration and maintenance of the sensors should be included in the maintenance program to ensure accuracy and reliability. Implementing this system will improve safety, prevent product loss, and enhance overall operational efficiency

Regulation / Guideline

1. <u>MSPO (Malaysian Sustainable Palm Oil) Standard</u>

The MSPO certification is the national standard for sustainable palm oil production in Malaysia. It ensures that palm oil production complies with environmental, social, and economic criteria. While MSPO does not explicitly require temperature monitoring for **palm kernel storage**, it emphasizes the importance of **good agricultural practices** (GAP) and overall sustainability, which includes proper handling and storage of palm products.

Relevant MSPO Principles and Criteria Related to Temperature Monitoring

- Principle 3: Social Responsibility, Health, Safety, and Employment
    - MSPO emphasizes the health and safety of workers, which can include ensuring that palm oil storage conditions are safe and that the environment around the storage is non-hazardous. Proper temperature control in storage areas is one way to ensure the safety and quality of stored palm kernels, as poorly controlled temperature can lead to spoilage or contamination that may compromise worker safety.
- Principle 4: Environmental Responsibility and Conservation of Natural Resources

and Biodiversity
    - This principle stresses the need for responsible environmental practices that prevent harm to natural resources. In the context of palm kernel storage, environmental responsibility would include maintaining proper temperature control to prevent spoilage or decomposition, which could lead to waste, environmental contamination, or unnecessary disposal of products.
- Principle 5: Best Practices
    - MSPO stresses the importance of following best practices throughout the production and processing phases, including the storage of palm products. Temperature control would be considered part of these best practices in the handling and storage of palm kernels to ensure that the product remains of high quality.
- Traceability and Record-Keeping:
    - MSPO requires producers to maintain records that demonstrate traceability of the palm oil products from farm to mill and ultimately to the consumer. This includes ensuring that palm kernels are stored in a controlled environment. Monitoring temperature in the storage process could form part of the documentation and record-keeping practices, which ensures that palm kernels are stored at appropriate conditions throughout the entire supply chain.

MSPO Guidelines on Storage Conditions

- While MSPO does not have a dedicated temperature monitoring requirement for palm kernel storage, it does require proper storage conditions to avoid degradation. Storing palm kernels at proper temperatures (around 25-30°C) is essential to preserve their quality and prevent rancidity, mold growth, or insect infestations.
- For sustainability, palm oil processors must ensure that storage practices do not negatively impact the environment. Ventilated storage areas and appropriate temperature monitoring systems help mitigate negative impacts such as spoilage or unnecessary waste.

2. <u>RSPO (Roundtable on Sustainable Palm Oil) Standard</u>

The **RSPO** is an international certification system that promotes the production and use of sustainable palm oil. It sets criteria for environmental, social, and economic sustainability, including the handling, storage, and transportation of palm oil products. Like MSPO, RSPO does not explicitly mandate temperature monitoring for palm kernel storage, but it emphasizes good manufacturing practices (GMP) and the maintenance of quality throughout the supply chain.

Relevant RSPO Principles and Criteria Related to Temperature Monitoring

- Principle 4: Use of Appropriate Best Practices by Growers and Millers
    - RSPO requires that palm oil mills and storage facilities implement best practices for palm oil production and processing. This includes the handling and storage of palm oil products such as palm kernels. Temperature control is considered part of good practice because it ensures that palm kernels do not spoil or degrade, preserving the quality and sustainability of the product.
- Principle 5: Environmental Responsibility and Conservation of Natural Resources and Biodiversity
    - RSPO requires that palm oil producers minimize waste and optimize

resource use. Proper storage conditions—such as maintaining the right temperature for palm kernels—help reduce spoilage, waste, and loss of product. This aligns with the RSPO's commitment to reducing environmental impact and optimizing the use of natural resources in palm oil production.

- Principle 7: Responsible Development of New Plantings
    - RSPO certification ensures traceability throughout the palm oil supply chain, which includes monitoring the quality and storage conditions of products. Proper temperature control is one aspect of ensuring traceability, as maintaining product quality during storage is essential for ensuring that it meets the sustainability and quality criteria required for RSPO certification.

RSPO Guidelines on Storage Conditions and Temperature Control

- Temperature control is part of the good manufacturing practices (GMP) that RSPO promotes. The guidelines emphasize the importance of ventilation, cooling, and proper handling of palm oil products, including palm kernels, to ensure they remain in good condition.
- Best practices for palm kernel storage include:
    - Ensuring cool and dry storage conditions to prevent oxidation, fungal growth, or insect infestations.
    - Monitoring the temperature and humidity of storage areas to ensure the product is maintained within the ideal range (typically 25-30°C for palm kernels) to avoid spoilage.
- Traceability is another key element in the RSPO certification process. The standard encourages the monitoring and documentation of storage conditions, including temperature logging, to ensure that products are stored correctly, and their quality is maintained from the point of production to distribution.

3. <u>Industry Best Practices for Temperature Control in Palm Kernel Storage</u>

While MSPO and RSPO do not mandate temperature monitoring in detail for palm kernel storage, industry best practices are often followed in compliance with the broader sustainability and quality guidelines provided by these certifications. Some of these best practices include:

- Temperature Range:
    - Palm kernels should ideally be stored at ambient temperatures between 25-30°C. If stored at higher temperatures, kernels may undergo oxidation, leading to rancidity and quality loss.
- Ventilated Storage:
    - Proper ventilation is critical in controlling both temperature and humidity. Poor ventilation can lead to moisture buildup, which increases the risk of mold growth and spoilage.
- Temperature Monitoring Systems:
    - Automated temperature control systems and monitoring devices are increasingly used in storage facilities. These systems include sensors to track temperature fluctuations and alarms to signal when temperatures fall outside acceptable ranges.
- Regular Monitoring and Record Keeping:
    - Temperature logs are often maintained as part of traceability efforts. These logs record the temperature conditions of storage areas at regular intervals and help ensure compliance with sustainability standards and industry norms.
- Monitoring of Humidity:

- In addition to temperature, humidity is another critical factor in palm kernel storage. High humidity can lead to mold growth and fungal contamination. Proper moisture control can prevent the kernels from degrading and ensure they remain in good condition.

5.9	TANK MANAGEMENT PROGRAM

Observation

There is no proper tank management program adopted by the insured.

Recommendation

A Tank Management Program (TMP) is a structured approach to managing storage tanks, ensuring their integrity, safety, and operational efficiency through proper design, construction, inspection, maintenance, and repair. Various international and Malaysian standards provide detailed guidelines to regulate the management of storage tanks, including material selection, thickness testing, fire safety, and environmental protection.

A comprehensive Tank Management Program (TMP) is essential to ensure the integrity, safety, and operational efficiency of storage tanks. The program should cover tank design and construction following API 650 and BS 2654 standards, ensuring minimum shell thickness of 6 mm and proper foundation design to handle structural loads. Regular inspections are crucial, with external and ultrasonic thickness testing (UTT) conducted every 5 years and internal inspections every 10 years, as per API 653 and MS 2523. Corrosion control measures, including protective coatings and cathodic protection, should be implemented to prevent metal thinning. Repairs and alterations must comply with API 653 guidelines, with weld repairs subjected to non-destructive testing (NDT). Operational measures, such as continuous pressure and temperature monitoring, emergency venting, and overpressure protection, should align with API 620 and BS 2654 requirements. Proper documentation of inspections, repairs, and thickness measurements should be maintained, while trained and certified personnel should oversee TMP implementation to ensure compliance and enhance safety and efficiency.

Regulation / Guideline

The most relevant standards related to Tank Management Programs (TMP) primarily focus on the design, construction, inspection, maintenance, and repair of storage tanks. Below are the key standards, including their timeline requirements and technical aspects such as allowable thickness, inspection intervals, and other operational parameters:

1. <u>API 650 – Welded Tanks for Oil Storage</u>

Scope and Purpose

API 650 is the key standard for the design and construction of new welded storage tanks for oil and petroleum products. It covers tanks with internal pressures up to 2.5 psi and operating temperatures between −40°F and 500°F.

Key Technical Aspects

- Tank Material and Thickness:
  - Minimum thickness for carbon steel: 1/4 inch (6.35 mm).
  - Tanks with diameters greater than 15 m should have a minimum shell thickness of 6 mm.
  - Corrosion allowance should be added based on service conditions.

- Design Requirements:
  - Allowable stress limits for different materials based on operating pressure and temperature.
  - Wind and seismic load considerations.
  - Annular plates required for tanks greater than 30 m in diameter.

- **Inspection Requirements:**
  - Shell and bottom thickness must be measured during construction.
  - Non-Destructive Testing (NDT) of welds (ultrasonic, radiographic) is mandatory.

Timeline for Inspection and Testing

Activity	Frequency	Details
Visual Inspection	Monthly	External check for leaks, corrosion, and structural integrity.
Ultrasonic Thickness Test (UTT)	Every 5 years (or more often based on corrosion rate)	Evaluate corrosion rate and remaining thickness.
Internal Inspection	Every 10 years	Comprehensive inspection of shell, bottom, and roof.
Hydrostatic Test	After construction or major repair	Hold for 24 hours, test pressure at 1.25x design pressure.

2. <u>API 653 – Tank Inspection, Repair, Alteration, and Reconstruction</u>

Scope and Purpose

API 653 governs the inspection, repair, alteration, and reconstruction of existing tanks built to API 650 or similar standards. It ensures that tanks remain fit for service over their lifetime.

Key Technical Aspects

- Minimum Shell Thickness:
  - For tanks over 30 m in diameter: Minimum shell thickness = 6 mm.
  - Minimum bottom plate thickness = 6 mm.

- Corrosion Rate Calculation:
  - Corrosion rate = (Original thickness - Current thickness) ÷ Years of service.
  - Minimum acceptable shell thickness should not fall below calculated minimum based on stress limits.

- Repair Guidelines:
  - If thickness is below minimum, plate replacement or weld overlay is required.
  - Bottom patching allowed if patch overlaps extend at least 50 mm beyond the thinned area.

- Weld Quality and Inspection:
  - NDT (radiography and ultrasonic) required for weld joints.
  - Weld repairs must follow pre-approved welding procedures.

Timeline for Inspection and Testing

Activity	Frequency	Details
External Inspection	Every 5 years	Visual inspection of shell, roof, nozzles, and foundation.
Ultrasonic Thickness Test (UTT)	Every 5 years (or based on corrosion rate)	Shell, roof, and bottom thickness measurements.
Internal Inspection	Every 10 years	Detailed check of bottom and internal surfaces.

Leak Testing	Every 10 years or after major repair	Use vacuum box, tracer gas, or hydrostatic testing.

3. <u>API 620 – Design and Construction of Large, Low-Pressure Storage Tanks</u>

Scope and Purpose

API 620 covers tanks that store products at low pressures (up to 15 psig) and low temperatures (down to −325°F). It focuses on larger tanks used for cryogenic or refrigerated liquids.

Key Technical Aspects

- Minimum Thickness:
  - Minimum bottom plate thickness = 6 mm.
  - Minimum shell thickness = 6 mm for carbon steel tanks.
  - Additional thickness required for vacuum service or thermal stress.

- Design Pressure and Temperature:
  - Maximum allowable stress based on tank material and temperature.
  - Pressure relief valves and vacuum breakers must be installed.

- Seismic and Wind Load:
  - Calculation based on regional seismic data and wind speed limits.
  - Foundation design to accommodate settlement and thermal movement.

Timeline for Inspection and Testing

Activity	**Frequency**	**Details**
External Inspection	Annually	Assess shell, roof, and insulation condition.
Internal Inspection	Every 10 years	Bottom and shell ultrasonic testing, weld quality check.
Leak Testing	After construction or major repair	Pneumatic or hydrostatic testing.

4. <u>BS 2654 – Manufacture of Vertical, Cylindrical, Welded Steel Tanks</u>

Scope and Purpose

BS 2654 is a British standard covering the construction and installation of vertical cylindrical tanks used for petroleum and other liquids.

Key Technical Aspects

- Minimum Thickness:
  - Minimum bottom plate thickness = 6 mm.
  - Minimum shell thickness depends on tank height and diameter.

- Design Pressure and Temperature:
  - Max operating pressure = 2.5 psi.
  - Design for thermal expansion and contraction.

- Inspection and Repair:
  - Shell distortion = maximum ±1% of the shell height.
  - Foundation settlement should not exceed 12 mm.

Timeline for Inspection and Testing

Activity	**Frequency**	**Details**
External Inspection	Every 5 years	Assess shell, roof, and foundation.

Internal Inspection	Every 10 years	Detailed thickness check and weld assessment.
Pressure Test	After major repairs	Hydrostatic testing at 1.25x design pressure.

5. MS 2523:2013 – Code of Practice for Storage Tanks for Petroleum Products

Scope and Purpose

MS 2523 is a Malaysian standard based on API 650 and 653 but adapted to local regulations and conditions. It applies to both new and existing tanks for petroleum products.

Key Technical Aspects

- Minimum Thickness:
  - Shell and bottom plate = 6 mm minimum.
  - Roof plate = 5 mm minimum.

- Inspection and Maintenance:
  - Corrosion allowance = 1 mm minimum.
  - Emergency venting required for pressure relief.

Timeline for Inspection and Testing

Activity	**Frequency**	**Details**
External Inspection	Every 5 years	Shell, roof, and foundation inspection.
Internal Inspection	Every 10 years	Thickness measurement and NDT.
Pressure Test	After major repair or relocation	Hydrostatic testing at 1.25x design pressure.

5.10	WEIR INTEGRITY TESTING

Observation

Currently, weir inspection and integrity testing are not conducted as part of preventive maintenance for mini hydroelectric.

Recommendation

Weirs require regular integrity testing as part of maintenance and safety protocols to ensure structural stability and hydraulic efficiency. A weir, constructed across a river or stream to regulate water flow or raise water levels, is a critical component of flood control, flow measurement, and water management infrastructure.

As such, an integrity testing should be incorporated into the preventive maintenance program for the mini hydroelectric. Integrity testing should include detailed structural inspections to identify cracks, deformation, and material degradation using visual methods and non-destructive testing (NDT) techniques such as ultrasonic testing (UT) and acoustic emission testing (AET) to detect internal defects and voids. Seepage monitoring should be conducted using piezometers to measure pore water pressure and identify seepage paths through the structure or foundation. Dye tracing can be employed to map leakage patterns and identify failure points. Hydraulic performance evaluation should involve stage-discharge analysis and flow rating measurements to confirm the weir's discharge capacity under varying hydraulic loads. Sedimentation surveys using sonar or echo sounders should be performed to monitor sediment accumulation that could reduce flow efficiency. Erosion monitoring should include scour depth measurements and geotechnical assessments at the crest, spillway, and downstream apron to detect undercutting and soil instability. For mechanically operated weirs, functional testing of gates, valves, and actuators should be performed, including load testing, torque measurements, and alignment verification. Structural health monitoring (SHM) systems incorporating piezometers, tiltmeters, and strain gauges should be installed for real-time monitoring of displacement, settlement, and structural response under hydraulic loading. These comprehensive testing measures ensure that the weir maintains operational integrity and structural resilience under dynamic flow conditions.

Regulation / Guideline

Weirs are considered important hydraulic structures, and although there are no specific standards exclusively dedicated to weir integrity testing, several general standards and guidelines related to water control structures can be applied. These standards mainly focus on aspects like structural integrity, hydraulic performance, and safety for all types of water-related infrastructure, including dams, weirs, and spillways. Below are key standards and guidelines that can be relevant for weir integrity testing in Malaysia:

1. Malaysian Standard (MS) 1195:2011 - Code of Practice for Earthworks in the Urban Environment

While this standard is mainly for earthworks, it also applies to structures like weirs, which often involve embankment and earth-fill construction. The standard outlines requirements for construction quality, material testing, and monitoring of earthworks, which can be useful when considering the foundations of a weir.

Relevant Sections:

- Soil Compaction and Material Integrity: MS 1195 specifies methods for soil compaction and the required quality of materials used in the embankment, which is crucial for the stability of weirs that rely on earth materials.

- Settlement Monitoring: The standard recommends practices for settlement monitoring that can be applied to monitor shifts or deformations in the earth structures around weirs.

2. MS ISO 9001:2015 - Quality Management Systems

Although this is a general standard for quality management systems, its principles can be applied to the maintenance and integrity testing of weirs. MS ISO 9001 emphasizes continual improvement and risk management, both of which are critical when assessing the safety and performance of hydraulic structures.

Relevant Sections:

- Inspection and Monitoring: Under MS ISO 9001, weir operators are required to inspect and monitor the performance of the structure, including aspects such as seepage, structural deformations, and hydraulic efficiency.
- Documenting Maintenance Activities: The standard mandates that inspections and integrity tests be well-documented and traceable, ensuring accountability for the testing and maintenance processes.

3. Malaysian Code of Practice for Structural Use of Concrete (MS 523:2005)

This code of practice covers the design and construction of concrete structures, including weirs, particularly concrete weirs and spillways. It provides guidelines for structural integrity testing of concrete components, which is a crucial aspect of weir safety.

Relevant Sections:

- Concrete Quality and Testing: The standard outlines the requirements for testing the quality of concrete, such as compressive strength, crack resistance, and watertightness. This applies to the weir structure itself, especially if it's made of reinforced concrete.
- Inspection and Monitoring: MS 523 specifies methods for the visual inspection and NDT (non-destructive testing) of concrete surfaces to detect cracks or defects in the structure.

4. Jabatan Pengairan dan Saliran (JPS) Guidelines

JPS (Department of Irrigation and Drainage) under the Ministry of Water, Land, and Natural Resources provides guidelines for water resources management, including the design, construction, and maintenance of weirs and similar structures.

Key Aspects:

- Maintenance and Inspection Protocols: JPS guidelines provide general protocols for regular maintenance and safety inspections of hydraulic structures, including weirs. This involves both visual inspections and more advanced instrumental monitoring.
- Seepage and Erosion Control: JPS guidelines specifically focus on the prevention of seepage and erosion, which are critical to the safety of weirs.
- Hydraulic Performance Monitoring: JPS also emphasizes the need to regularly check hydraulic performance, including flow measurement and ensuring that the weir is functioning within the expected range.

5. International Commission on Large Dams (ICOLD) Guidelines

The ICOLD provides best practices and guidelines for dam safety that can be applied to similar hydraulic structures, such as weirs. ICOLD guidelines emphasize the need for safety assessments, regular testing, and monitoring of water-retaining structures.

Key Areas in ICOLD Guidelines:

- Safety Assessments: ICOLD emphasizes that a safety assessment of a weir should include structural testing, hydraulic evaluations, and seepage monitoring.

- Monitoring and Maintenance: ICOLD guidelines suggest implementing a monitoring system that tracks the performance of the weir, particularly during high-flow events or significant weather changes.

6. Malaysian Standard (MS 2446:2012) - Design and Installation of Embedded Ground Instrumentation

This standard focuses on the design and installation of instrumentation to monitor the integrity of structures, including weirs. It covers the use of various geotechnical instruments to monitor stress, strain, and displacement in the soil and structure.

Relevant Sections:

- Piezometers: This standard provides guidelines for the installation of piezometers to measure pore water pressure, which is crucial for monitoring seepage in weir foundations and surrounding areas.
- Inclinometers and Displacement Monitoring: It also outlines how inclinometers and other instruments can be used to measure displacement and detect deformations in the structure over time.

7. The Manual for Safety of Dams (JPS Guidelines)

The JPS Manual for Safety of Dams is a comprehensive document that provides safety guidelines for all types of dams and water management structures, including weirs. While more focused on larger dams, many of the safety principles apply to weirs as well.

Key Guidelines:

- Regular Inspections and Testing: The manual mandates that safety and integrity inspections of weirs should be conducted on a regular basis and whenever significant changes occur (e.g., after floods).
- Hydrological Monitoring: It also suggests ongoing hydrological assessments to ensure that water levels are controlled and that the structure can handle high-water events.
- Failure Modes and Risk Assessments: The manual emphasizes the importance of performing failure mode analyses and risk assessments to predict potential problems and take pre-emptive action.

8. Department of Irrigation and Drainage (DID) - Guidelines for Hydrological and Hydraulic Design of Weirs

This set of guidelines from the Department of Irrigation and Drainage (DID) provides best practices for the design and hydraulic performance of weirs, ensuring that they meet safety requirements.

Key Areas:

- Flow Capacity and Performance Tests: The guidelines emphasize regular flow capacity tests to ensure that the weir is functioning correctly and not obstructing water flow.
- Seepage and Erosion: Specific guidelines are given for monitoring seepage around the weir structure and taking corrective measures for any signs of erosion or degradation.

5.11	DUST EXTRACTION SYSTEM

Observation

It was noted that the environment inside the furniture production area is dusty, which indicates that the dust extraction system may not be functioning properly or is poorly maintained.

Recommendation

A dust extraction system is an engineered solution designed to capture, transport, filter, and remove dust and airborne particulates generated during industrial processes. It is essential in industries such as woodworking, metalworking, food processing, and manufacturing to maintain a clean and safe working environment, prevent health hazards, and protect equipment from dust accumulation.

It is recommended to conduct a thorough inspection and testing of the dust extraction system to identify potential malfunctions or maintenance deficiencies. This should include checking the integrity of ductwork, ensuring that the extraction fan is operating at the correct capacity, and confirming that dust filters are not clogged or damaged. Regular maintenance should be scheduled according to manufacturer recommendations and relevant guidelines such as the MS and DOSH standards. Additionally, monitoring dust levels within the production area using appropriate measuring instruments is advised to ensure that the dust extraction system maintains air quality within permissible limits. Proper training for workers on the use and maintenance of the system, as well as periodic performance audits, should also be implemented to sustain the effectiveness of the dust extraction system.

Regulation / Guideline

Dust extraction systems in industrial settings, including furniture manufacturing, are governed by various regulations and standards to minimize fire and explosion risks, improve air quality, and ensure worker safety. Furniture manufacturing generates substantial amounts of fine dust from cutting, sanding, and processing wood, which can create hazardous conditions if not properly controlled. Key guidelines and standards addressing dust extraction systems include:

1. Occupational Safety and Health Act (OSHA) 1994 (Act 514)

The **OSHA Act 1994** establishes the general duty of employers to ensure a safe working environment, which includes the control of airborne contaminants such as wood dust.

Relevant Sections:

- Section 15: General duties of employers to provide and maintain a safe working environment, including safe air quality.
- Section 16: Requirement for a written safety policy where dust extraction systems are necessary due to exposure to hazardous materials.
- Section 24: General duties of employees to comply with safety measures, including proper use of dust extraction systems.

Application to Dust Extraction:

- Employers are required to implement suitable engineering controls, such as local exhaust ventilation (LEV), to capture dust at the source.
- Employers must regularly inspect and maintain dust extraction systems to ensure they operate effectively.

2. Factories and Machinery Act (FMA) 1967 (Act 139)

The **FM Act 1967** regulates the design, installation, and maintenance of machinery and equipment used in manufacturing facilities, including dust extraction systems.

Relevant Regulations:

- Section 18: Requires that machinery and systems generating airborne contaminants (such as wood dust) must be equipped with proper ventilation and extraction systems.
- Safety, Health and Welfare Regulations 1970: Stipulates that dust extraction systems must be installed and maintained to minimize worker exposure to hazardous dust.

Application to Dust Extraction:

- Dust extraction systems must meet minimum air quality and capture efficiency requirements.
- Systems must be capable of controlling the spread of dust to prevent inhalation risks and potential dust explosions.

3. Malaysian Standard MS 1436: 2017 – Code of Practice for Local Exhaust Ventilation (LEV)

MS 1436 outlines the best practices for the design, installation, operation, and maintenance of local exhaust ventilation (LEV) systems, including dust extraction systems.

Key Requirements:

- Design Requirements:
  - LEV systems must be designed to capture dust at the source before it disperses into the work environment.
  - Hood design, ductwork, and fan capacity must be properly specified based on the type and volume of dust generated.
- Airflow and Capture Efficiency:
  - Minimum airflow rates and static pressure requirements must be calculated based on the dust particle size and material type.
  - Typical airflow for wood dust extraction is around 20–30 m/s (metres per second) at the capture point.
- Filtration and Exhaust:
  - Systems should use high-efficiency filters (e.g., HEPA filters) to trap fine dust particles.
  - Clean, filtered air should be vented outside the building or recirculated with proper filtration.
- Inspection and Maintenance:
  - Regular testing (e.g., every 6 months) of airflow, pressure drop, and capture efficiency.
  - Documentation of system performance and any repairs or adjustments made.

5.12	SURGE PROTECTION DEVICE AT PV SOLAR FARM

Observation

Based on the single line diagram, it was noted that no surge protection devices (SPDs) are installed on either the DC or AC side of the system. This presents a significant risk to the photovoltaic (PV) solar farm, as it increases the vulnerability of critical components—such as PV strings, inverters, combiner boxes, transformers, and monitoring systems—to transient overvoltage caused by lightning strikes, switching surges, and grid disturbances. The absence of SPDs can lead to insulation breakdown, damage to electronic components, reduced operational efficiency, and potential downtime.

Recommendation

A Surge Protection Device (SPD) is a critical component in electrical systems, engineered to safeguard electrical and electronic equipment from transient overvoltage resulting from lightning strikes, switching operations, and grid disturbances. SPDs operate by rapidly diverting or clamping excess voltage to a predefined safe threshold, thereby protecting sensitive components and maintaining the stability and integrity of the electrical network.

It is technically recommended to install Type 1+2 SPDs on the DC side at the PV strings and combiner boxes to mitigate both direct lightning strikes and switching surges. On the AC side, Type 2 SPDs should be deployed at the inverter output and the main AC distribution panel to counter grid-induced transients. For protection of sensitive monitoring and communication systems, installing Type 2 or Type 3 SPDs is advised to prevent data corruption and operational failure. Proper coordination between different SPD types must be established to ensure layered protection across the PV solar farm, minimizing let-through energy and optimizing response times. Furthermore, periodic testing and maintenance of SPDs are essential to validate performance and sustain long-term system reliability.

Regulation / Guideline

1. IEC 61643-31:2018 – Low-voltage Surge Protective Devices – Part 31: Requirements and Test Methods for SPDs for Photovoltaic Installations

- Scope (Clause 1): This section defines the applicability of the standard to SPDs intended for surge protection against indirect and direct effects of lightning or other transient overvoltage on the DC side of PV installations rated up to 1,500 V DC.
- Normative References (Clause 2): Lists the standards referenced within IEC 61643-31, providing a foundation for the requirements and test methods specified.
- Terms and Definitions (Clause 3): Establishes the terminology used throughout the standard, ensuring clarity and consistency in the application of its provisions.
- Requirements (Clause 4): Outlines the performance characteristics and safety requirements for SPDs, including parameters such as:
    - Maximum continuous operating voltage (Uc)
    - Nominal discharge current (In)
    - Voltage protection level (Up)
    - Operating duty tests
    - Environmental conditions
- Tests (Clause 5): Details the standard methods for testing SPDs to verify compliance with the performance and safety requirements specified in Clause 4.

2. IEC 60364-7-712:2017 – Electrical Installations of Buildings – Part 7-712: Requirements for Special Installations or Locations – Solar Photovoltaic (PV) Power Supply Systems

- Scope (Clause 1): Specifies the requirements for the electrical installation of PV

systems intended to supply all or part of an installation, focusing on safety and proper integration into the electrical system.

- Protection for Safety (Clause 712.410): Addresses measures for protection against electric shock, emphasizing the need for appropriate insulation and protective devices in PV installations.
- Selection and Erection of Equipment (Clause 712.512): Provides guidelines on selecting and installing equipment, including SPDs, to ensure compatibility with the PV system's characteristics and environmental conditions.
- Wiring Systems (Clause 712.521): Covers the requirements for wiring systems within PV installations, considering factors such as current-carrying capacity, voltage drop, and protection against mechanical damage.
- Protective Devices (Clause 712.533): Focuses on the selection and installation of protective devices, including SPDs, to safeguard the PV system against overcurrent and overvoltage.

5.13	PIPELINE FOR GAS SUPPLY FOR COMMERCIAL BUILDING / APARTMENT

Observation

The apartment has been using the natural gas for cooking via gas pipeline. the pipeline has been operating for 5 years with no proper maintenance.

Recommendation

Over time, gas pipelines are susceptible to corrosion, leaks, pressure irregularities, and mechanical wear, which can compromise the integrity of the system and pose serious safety hazards such as gas leaks, fires, and explosions. To address this, a structured maintenance program should be implemented in accordance with industry standards and regulations.

It is recommended that the maintenance program begins with a comprehensive inspection and pressure testing to assess the current condition of the pipeline and identify potential issues such as corrosion, leaks, and joint failures. All accessible piping, valves, regulators, and fittings should be visually inspected for signs of damage or deterioration. Pressure testing should be conducted at 1.5 times the operating pressure for at least 15 minutes to confirm system integrity. Any leaks detected should be repaired immediately, followed by a retest to ensure no further pressure loss.

A corrosion protection program should also be established, involving the application of protective coatings on exposed pipes and the installation or maintenance of cathodic protection for underground pipes. Regulators and pressure relief valves should be tested and calibrated at least once a year to maintain consistent gas pressure and prevent over-pressurization. Emergency shut-off valves should be tested regularly to ensure they are operational and accessible in case of an emergency.

Routine leak detection should be carried out using both soap solution tests and electronic gas detectors to identify and address small leaks before they escalate. Gas meters should be calibrated annually to ensure accurate readings, and flexible connections to appliances should be checked for wear, cracks, and secure fitting. A detailed maintenance logbook should be maintained to record inspection dates, pressure test results, repairs, and component replacements.

In addition to regular maintenance, a structured emergency response plan should be established and communicated to residents and maintenance staff. This plan should include procedures for gas shut-off, evacuation, and contacting emergency services (e.g., BOMBA). Staff should undergo regular training to handle gas-related emergencies effectively.

To ensure compliance with Malaysian regulations, a certified gas contractor should perform a full system inspection and certification under the Suruhanjaya Tenaga guidelines annually. This will confirm that the system meets safety and operational standards. Following this, a five-year maintenance plan should be implemented, including full internal pipe inspection using smart pigging or ultrasonic testing, replacement of worn-out valves and regulators, and a comprehensive pressure drop test to detect any hidden issues.

Implementing this structured maintenance program will enhance the safety, efficiency, and

longevity of the natural gas pipeline system. It will also reduce the risk of gas leaks, fires, and operational disruptions while ensuring compliance with national and international gas safety standards.

Regulation / Guideline

1. NFPA 54 – National Fuel Gas Code

Key Requirements for Maintenance:

1. Leak Detection and Repair

- All piping, valves, and fittings must be inspected periodically for leaks.
- Use the following methods for leak detection:
  - Soap solution test – Apply soapy water to joints and look for bubbles.
  - Electronic gas detector – Use an approved gas detector to detect leaks.
  - Pressure drop test – Pressurize the system and monitor pressure drop over time.
- If a leak is found:
  - Shut off the gas supply immediately.
  - Repair or replace the affected component.
  - Conduct a new pressure test before returning to service.

2. Pressure Testing and Regulation

- After installation, modification, or repair, pipelines must undergo a pressure test.
- Test pressure should be 1.5 times the maximum operating pressure but not less than 3 psi (20.7 kPa).
- Test duration should be at least 10 minutes for small systems and longer for large systems.
- Pressure regulators must be inspected and calibrated regularly to maintain proper operating pressure.

3. Corrosion Protection

- Protect piping systems from corrosion using:
  - Coatings (e.g., epoxy, paint) for above-ground pipes.
  - Cathodic protection for underground pipes.
- Inspect coatings annually for signs of wear or damage.
- Replace or repair damaged protective coatings.

4. Ventilation and Combustion Air

- Ensure adequate ventilation in rooms with gas appliances.
- Ventilation openings must remain unobstructed.
- Inspect ventilation systems annually to prevent gas accumulation.

5. Emergency Shut-off Valves

- Install manual shut-off valves at key points in the system (e.g., near the gas meter and at the appliance).
- Test the operation of shut-off valves at least once a year.
- Ensure valves are accessible and clearly labelled.

6. Maintenance Documentation

- Maintain detailed maintenance and inspection records, including:
  - Date and results of inspections.
  - Repairs and modifications.
  - Pressure test results.

- Records must be kept for at least 5 years.

2. ASME B31.8 – Gas Transmission and Distribution Piping Systems
Key Requirements for Maintenance:

1. Pipeline Integrity and Corrosion Control

- Perform internal and external inspections regularly.
- Inspect protective coatings and repair damaged areas.
- Implement cathodic protection for underground pipes.

2. Leak Detection and Monitoring

- Install leak detection systems (e.g., sensors, gas detectors).
- Continuously monitor pipeline pressure and flow rates.
- Respond to alarms immediately and repair leaks promptly.

3. Pressure Regulation and Relief

- Test pressure regulators and relief valves periodically.
- Adjust regulators to maintain consistent operating pressure.
- Replace malfunctioning valves and regulators.

4. Pigging and Cleaning

- Clean pipelines using mechanical pigs to remove debris and deposits.
- Conduct smart pigging (using ultrasonic or magnetic sensors) to assess internal pipeline conditions.

5. Record Keeping

- Maintain inspection, testing, and repair records for at least 5 years.
- Include pressure test results, corrosion reports, and leak detection logs.

3. MS 930 – Code of Practice for the Installation of Fuel Gas Piping Systems
Key Requirements for Maintenance:

1. Leak Testing

- Conduct leak tests at least once a year.
- Use pressure drop tests and gas detectors to identify leaks.

2. Corrosion Control

- Protect pipes using approved coatings.
- Repair corroded sections immediately.

3. Emergency Response

- Provide emergency shut-off valves.
- Train building personnel on emergency shutdown and evacuation.

4. Suruhanjaya Tenaga (Energy Commission of Malaysia) Guidelines
Key Requirements for Maintenance:

1. Annual Inspection and Certification

- Engage a licensed gas contractor to conduct an annual inspection.
- Issue a certificate of compliance upon successful inspection.

2. Pressure Testing

- Test pipelines at 1.5 times the operating pressure.
- Maintain pressure for at least 15 minutes without pressure drop.

3. Leak Detection

- Monitor gas flow using meters and pressure sensors.
- Repair any identified leaks promptly.

5.14	PARTIAL DISCHARGE (PD) FOR UNINTERRUPTIBLE POWER SUPPLY (UPS)

Observation

The maintenance team detected increased noise and harmonic distortion in the UPS output, along with elevated temperatures at cable joints and terminations. These signs indicated possible insulation degradation, which could lead to serious electrical failure. The problem arose in a UPS data centre that had been operating for more than two years with no record of a partial discharge test being conducted.

Recommendation

Partial discharge (PD) is a localized electrical discharge that occurs due to imperfections or damage in the insulation of high-voltage components in Uninterruptible Power Supply (UPS) systems. PD can take various forms, including internal discharge within solid insulation, surface discharge along insulation surfaces, corona discharge in gaseous insulation, and treeing caused by progressive electrical stress. PD testing is essential for UPS systems to detect early-stage insulation defects, assess insulation aging, and prevent catastrophic failures that could lead to system downtime or damage.

There are several methods for detecting PD activity in UPS systems. Electrical PD detection measures high-frequency current pulses using capacitive or inductive sensors, such as high-frequency current transformers (HFCT) and coupling capacitors. Ultrasonic detection identifies high-frequency acoustic signals produced by PD using microphones or acoustic sensors, while UHF detection captures electromagnetic waves emitted by PD at ultra-high frequencies. Optical detection uses light sensors to detect emissions from corona and surface discharges. These methods allow for accurate identification of PD sources and the extent of insulation damage.

The PD testing process for UPS systems involves five key steps. It starts with a pre-test inspection of components and installation of sensors at key points. During testing, voltage is applied incrementally to measure PD activity. Recorded data is analysed to determine PD inception voltage (PDIV), extinction voltage (PDEV), pulse magnitude, and repetition rate. Test results are compared to baseline data and industry standards, followed by recommendations for corrective actions such as insulation repair, joint tightening, and component replacement to prevent future failures.

Regulation / Guideline

1. IEC 60270 – High-Voltage Test Techniques – Partial Discharge Measurements

IEC 60270 is the primary international standard that defines the methods and requirements for PD measurement in high-voltage equipment, including UPS systems.

Key Technical Aspects:

- Scope:
  - Applies to PD measurements in high-voltage components like cables, switchgear, transformers, and UPS systems.
  - Provides guidelines for measuring PD in gas-insulated, liquid-insulated, and solid-insulated systems.
- PD Measurement Method:
  - Specifies the use of electrical measurement methods such as:
    - High-Frequency Current Transformer (HFCT) – For monitoring PD in power cables.
    - Coupling Capacitors – For direct measurement of PD pulses.
    - Wideband and Narrowband Detection – For analyzing PD signal patterns.

- Testing Conditions:
  - Test voltage should be applied gradually up to 1.5 times the operating voltage.
  - The test should last long enough to ensure stability in PD activity readings.
  - Background noise should be controlled to avoid interference.
- PD Limits:
  - PD magnitude should not exceed 10 pC for low-voltage UPS systems and 100 pC for high-voltage UPS systems.
  - If PD magnitude exceeds acceptable limits, corrective actions such as insulation repair or replacement must be taken.
- Data Analysis:
  - PD patterns should be classified by type (internal, surface, corona).
  - PD inception voltage (PDIV) and extinction voltage (PDEV) should be recorded and analysed.
- Reporting:
  - Test reports should include:
    - PD magnitude (in pC)
    - Location of discharge
    - PDIV and PDEV values
    - Any corrective actions taken

2. IEEE 1434 – Guide for Partial Discharge Testing of Shielded Power Cable Systems in a Field Environment

IEEE 1434 provides comprehensive guidance for detecting and measuring PD activity in shielded power cable systems, which is directly applicable to UPS power connections and cabling.

Key Technical Aspects:

- Scope:
  - Covers both factory-based and field-based PD testing of shielded power cable systems.
  - Applicable to medium- and high-voltage UPS systems using shielded cables.
- Testing Techniques:
  - Electrical PD detection using:
    - HFCT Sensors – Installed around the power cable for real-time PD pulse detection.
    - Capacitive Sensors – Used for sensitive PD signal measurements.
    - Directional Couplers – Installed at cable joints and terminations to identify PD location.
- PD Classification:
  - Internal PD – Within the insulation or conductor.
  - Surface PD – Across the insulation surface.
  - Corona PD – In air-filled gaps or voids.
- Measurement Criteria:
  - PD activity should be measured at various applied voltages to determine PDIV and PDEV.
  - Allowable PD levels for shielded cables in UPS systems:
    - PD magnitude should remain below 100 pC for healthy systems.
    - If PD magnitude exceeds 500 pC, immediate corrective action is required.
- Acceptance Criteria:
  - PD magnitude should not increase with increasing voltage.
  - No sustained PD activity should be present once the voltage is reduced below PDEV.
- Corrective Actions:

- Insulation repair or replacement.
- Re-termination of joints or cables.
- Shielding enhancement to reduce PD levels.

3. IEEE 400.2 – Guide for Field Testing of Shielded Power Cable Systems Using Partial Discharge Detection

IEEE 400.2 is an extension of IEEE 1434, specifically targeting PD testing in the field for shielded power cable systems used in UPS installations.

Key Technical Aspects:

- Scope:
  - Focuses on field testing conditions for shielded power cables.
  - Applicable to medium- and high-voltage UPS cables and terminations.
- Testing Techniques:
  - PD testing can be performed using:
    - On-line Testing – While the UPS is operational.
    - Off-line Testing – When the UPS is disconnected from the load.
  - Use of sensors:
    - HFCT
    - Capacitive Couplers
    - Directional Couplers
- Voltage Application:
  - Applied voltage should range from the rated operating voltage to 1.5 times the rated value.
  - Voltage should be increased gradually to allow for accurate PD inception measurement.
- PD Thresholds:
  - PD levels below 50 pC – System considered in good condition.
  - PD levels between 50 pC and 300 pC – Monitor closely, consider maintenance.
  - PD levels above 300 pC – Immediate action required.
- Data Interpretation:
  - PD activity should decrease with time as voltage stabilizes.
  - PD signal pattern should be compared with baseline test data.
  - Persistent or increasing PD activity indicates insulation weakness.
- Corrective Actions:
  - Repair or replace degraded cable insulation.
  - Improve cable shielding or joint termination.
  - Remove contaminants causing surface discharge.

4. IEC 62478 – Measurement of Partial Discharges by Electromagnetic and Acoustic Methods

IEC 62478 outlines advanced methods for detecting PD using electromagnetic and acoustic signals, which are particularly useful for complex UPS installations with high shielding or difficult-to-access components.

Key Technical Aspects:

- Scope:
  - Applicable to PD testing in gas-insulated, liquid-insulated, and solid-insulated equipment.
  - Useful for PD detection in transformer windings and high-voltage cable terminations.
- Measurement Techniques:
  - UHF Detection – Captures electromagnetic waves from PD sources.
  - Acoustic Detection – Uses ultrasonic sensors to pinpoint discharge location.
- Signal Filtering and Noise Reduction:

    - High-frequency signals are filtered to remove background noise.
    - Pattern recognition software used to distinguish PD from environmental noise.
- **Thresholds and Criteria:**
    - PD magnitude should be below 50 pC in low-voltage UPS systems.
    - PD magnitude above 100 pC indicates insulation weakness or contamination.

5.15	CORROSION OF UNDERWATER BRIDGE PILINGS

Observation

A bridge located in a coastal area has been in operation for over 10 years. During a routine underwater inspection, divers discovered signs of corrosion on the steel pilings, particularly around the splash zone and at the welded joints. Ultrasonic thickness testing revealed a 20% reduction in wall thickness, indicating progressive corrosion due to constant exposure to saltwater and marine organisms. Some areas showed visible rust and pitting, raising concerns about the structural integrity of the bridge.

Recommendation

Proper maintenance of underwater pilings is crucial to ensure the long-term structural integrity and safety of the bridge, especially in a coastal environment where exposure to saltwater accelerates corrosion. The discovery of corrosion around the splash zone and welded joints indicates that protective measures are either insufficient or have deteriorated over time.

It is recommended to apply an epoxy-based anti-corrosion coating to the affected areas to provide a protective barrier against saltwater exposure. Installing sacrificial anodes and an impressed current cathodic protection (ICCP) system can further prevent corrosion by redirecting corrosive currents away from the steel surface. Additionally, regular underwater inspections using remote-operated vehicles (ROVs) and ultrasonic testing should be scheduled every 2 to 3 years to monitor the condition of the pilings and assess the effectiveness of the protection systems. Proper maintenance not only extends the service life of the bridge but also reduces the risk of structural failure, ensuring the safety of users and minimizing costly repairs.

Regulation / Guideline

1. Standard Specification for Road Works - Section 10: Piling Works (JKR)

- This standard specifies the requirements for the supply, installation, and testing of piling works for road and bridge construction in Malaysia.
- While it mainly focuses on the design and installation of piles, it includes important guidelines for material selection and protection against environmental degradation, including corrosion.

Key Provisions:

- Material Requirements:
  - Piling materials must comply with specified strength, durability, and corrosion resistance.
  - Common materials include reinforced concrete, steel, and composite materials.
- Protection Measures:
  - Protective coatings and cathodic protection systems (especially for steel piles) are recommended to reduce corrosion risks.
  - Anti-corrosion coatings must comply with recognized international coating standards (e.g., ISO or ASTM).
- Testing and Inspection:
  - Piles must be tested using Non-Destructive Testing (NDT) methods such as:
    - Ultrasonic Testing (UT)
    - Magnetic Particle Testing (MT)
    - Radiographic Testing (RT)
  - Regular underwater inspections are advised to identify early signs of

corrosion and structural degradation.

- Remedial Measures:
  - If corrosion is detected, protective measures such as epoxy coating, sacrificial anodes, or impressed current cathodic protection (ICCP) should be applied.

2. API RP 2SIM – Structural Integrity Management of Fixed Offshore Structures

- This recommended practice provides a comprehensive framework for the structural integrity management of fixed offshore structures, including submerged and underwater piling systems.
- It focuses on the use of a Risk-Based Inspection (RBI) strategy to prioritize inspections and maintenance efforts based on structural risk levels.

Key Provisions:

- Design Life Consideration:
  - The inspection program should align with the original design life of the piling structure.
  - Corrosion risk is assessed based on material properties, environmental exposure, and loading conditions.
- Inspection Planning:
  - Defines different levels of inspection based on risk:
    - General Visual Inspection (GVI): Routine inspection to check for surface-level corrosion.
    - Close Visual Inspection (CVI): Detailed assessment using divers or remotely operated vehicles (ROVs).
    - Non-Destructive Testing (NDT): Use of ultrasonic or acoustic methods to measure wall thickness and detect internal corrosion.
- Data Analysis and Integrity Assessment:
  - Data from inspections should be analysed to determine the remaining service life of the structure.
  - Corrosion rates should be calculated to predict the time frame for potential failure.
- Remedial Actions:
  - Application of corrosion protection methods:
    - Sacrificial anodes
    - Coatings
    - ICCP systems

3. API RP 2A – Recommended Practice for Planning, Designing, and Constructing Fixed Offshore Platforms

- API RP 2A is widely used for offshore platforms and is applicable to bridge pilings in marine environments.
- It emphasizes the impact of marine exposure, including corrosion from saltwater and environmental loading.

Key Provisions:

- Design and Material Selection:
  - Steel and concrete materials should be selected based on resistance to marine corrosion.
  - Coatings and sealants must meet offshore durability standards.
- Inspection Procedures:
  - Underwater visual and NDT inspections should be conducted at regular intervals.
  - Specific focus on welded joints, splash zones, and high-stress areas.
- Corrosion Allowance:

- Minimum thickness requirements should account for anticipated corrosion loss over the design life.
- Cathodic protection systems should be designed to last for the intended service life of the structure.

- Repair and Protection:
  - Epoxy coatings and anode replacement should be planned as part of long-term maintenance.

4. ISO 19902 – Fixed Steel Offshore Structures

- This standard provides technical guidelines for the design, construction, maintenance, and inspection of fixed steel offshore structures, including bridge pilings.

Key Provisions:

- Corrosion Assessment:
  - Structural analysis should incorporate corrosion loss rates based on environmental exposure.
  - Protective coatings should be applied to surfaces exposed to seawater.
- Inspection Methods:
  - Use of Remote Operated Vehicles (ROVs) for underwater inspection.
  - Acoustic and ultrasonic inspection to assess wall thickness and internal corrosion.
- Maintenance Strategy:
  - Corrosion protection using sacrificial anodes and ICCP systems.
  - Regular replacement of protective elements based on inspection results.
- Structural Monitoring:
  - Installation of monitoring systems to measure corrosion rates and stress levels over time.

5. Risk-Based Underwater Inspection (RBUI) – PETRONAS Carigali Sdn Bhd (PCSB)

- PETRONAS developed RBUI as part of its Structural Integrity Management System (SIMS) for managing offshore structures.
- The RBUI approach applies to underwater bridge piling inspections in similar environmental conditions.

Key Provisions:

- Risk-Based Strategy:
  - Prioritize inspection based on the probability of failure and consequences.
  - High-risk areas (e.g., splash zones, joints) require more frequent inspections.
- Corrosion Monitoring:
  - Corrosion rates should be monitored continuously using acoustic and ultrasonic sensors.
  - Historical data should be analyzed to predict long-term corrosion impact.
- Maintenance Recommendations:
  - Proactive anode replacement and coating repairs based on inspection findings.
  - Real-time monitoring to assess ongoing structural health.

6. JKR and Malaysian Institute of Road Safety Research (MIROS) – Guidelines for Bridge Inspection and Maintenance

- Provides general guidelines for the maintenance and inspection of bridges in Malaysia, including underwater pilings.

Key Provisions:

- Inspection Intervals:
  - Routine inspection – every 1 to 2 years

    - Detailed underwater inspection – every 5 years
- Assessment Methods:
    - Visual inspection (using divers or ROVs)
    - Ultrasonic thickness measurement
    - Acoustic emission testing
- Documentation:
    - All findings should be recorded in a central database.
    - Digital models should be used to track long-term degradation.
- Maintenance Strategies:
    - Apply protective coatings based on environmental exposure.
    - Install sacrificial anodes and ICCP systems in high-risk areas.

5.16	STATIC ELECTRICITY DURING THE UNWINDING AND WINDING OF PLASTIC SHEETS

Observation

A rotogravure printing machine in a plastic packaging factory has been operating for several years without an electrostatic eliminator. The machine prints high-speed plastic film rolls used for food packaging. During the printing process, the plastic film unwinds and passes over multiple rollers at high speeds, creating friction between the rollers and the plastic surface. This friction generates a significant buildup of static electricity on the plastic film surface

Recommendation

Managing static electricity during the unwinding and winding of plastic sheets is essential to ensure product quality, operational efficiency, and safety. Static charges accumulate due to friction, separation, and contact with machine components, leading to issues such as dust attraction, material misalignment, operator shocks, and potential fire hazards in flammable environments.

As such, it is recommended that:

1. Installation of Static Elimination Devices:
    - Ionizing Bars: Position ionizing bars at critical points, such as near unwind and rewind stations, to neutralize static charges on the plastic film. This prevents dust attraction, reduces contamination, and minimizes operator shocks.
    - Ionizing Nozzles and Blowers: Utilize these devices to deliver ionized air onto specific areas of the film, effectively neutralizing static charges during processes like sheeting or bagging.

2. Proper Grounding and Conductive Pathways:
    - Ensure that all machinery components, including rollers and frames, are properly grounded to provide a path for static dissipation. Ungrounded conductive parts can accumulate charge, exacerbating static issues.

3. Environmental Controls:
    - Humidity Control: Maintain optimal humidity levels within the production environment. Low humidity reduces air conductivity, increasing static buildup. Using humidifiers can help mitigate this effect.

4. Material Handling Practices:
    - Antistatic Additives: Incorporate antistatic agents into plastic materials during manufacturing to reduce their tendency to hold static charges.
    - Controlled Unwinding/Winding Speeds: Operate machinery at speeds that minimize friction and separation-induced static generation.

5. Regular Maintenance and Monitoring:
    - Equipment Inspection: Periodically inspect and clean rollers, ionizing devices, and other components to ensure they function effectively
    - Static Charge Monitoring: Use static meters to monitor charge levels on materials and equipment, allowing for timely intervention when high static levels are detected.

By implementing these measures, manufacturers can effectively control static electricity during the unwinding and winding of plastic sheets, leading to improved product quality,

enhanced safety, and increased operational efficiency.

Regulation / Guideline

Managing static electricity during the unwinding and winding of plastic sheets is essential to ensure safety and maintain product quality. While there are no regulations exclusively dedicated to this specific process, several broader standards and guidelines address the control of static electricity in industrial settings:

1. National Fire Protection Association (NFPA) Guidelines

NFPA 77 – Recommended Practice on Static Electricity

- NFPA 77 is the key document addressing static electricity hazards across industries.
- It provides detailed recommendations on identifying, evaluating, and mitigating static discharge risks.
- The guideline covers three key static control strategies:

(i) Grounding and Bonding:

- All metallic machine components, rollers, and frames involved in the plastic handling process should be properly grounded to prevent charge buildup.
- Bonding ensures that all connected parts are at the same electrical potential, preventing spark discharge between surfaces.

(ii) Humidity Control:

- Static electricity generation increases in low humidity environments because dry air reduces the conductivity of the surrounding atmosphere.
- NFPA recommends maintaining a relative humidity of 50% to 65% to reduce static charge accumulation on plastic surfaces.

(iii) Use of Antistatic Devices:

- Installation of ionization bars or ionizing blowers at winding and unwinding stations helps to neutralize surface charges by introducing balanced positive and negative ions into the air.
- Antistatic tinsel or grounded brushes can also be used to dissipate static charges.

Application to Plastic Sheet Handling:

- Install ionization bars or blowers near the winding/unwinding points.
- Maintain controlled humidity within the processing area.
- Ensure that all components involved in the processing are grounded and bonded.

2. MS 1979:2007 - Electrical Installations of Buildings - Code of Practice

This Malaysian Standard offers guidelines for low voltage electrical installations in buildings, emphasizing safety measures to protect against electrical hazards. While its primary focus is on building electrical systems, several provisions are relevant to controlling static electricity during industrial processes, including the handling of plastic sheets

Key Provisions:

- Earthing (Grounding) of Equipment: Ensures all electrical installations are properly grounded to prevent the accumulation of static charges, thereby reducing the risk of electrical shocks and fires.
- Insulation of Live Conductors: Requires that all live conductors be insulated with materials like polyvinyl chloride (PVC) or cross-linked polyethylene (XLPE) to prevent direct contact and potential static discharge.

- Use of Barriers or Enclosures: Recommends implementing physical barriers or enclosures to prevent unintended contact with live parts, which can be a source of static electricity.

Application to Plastic Sheet Handling:
While MS 1979:2007 is tailored for building electrical installations, its emphasis on proper grounding and insulation can be applied to machinery used in the unwinding and winding of plastic sheets. Ensuring that all equipment is adequately grounded and insulated can significantly reduce the buildup of static electricity during these processes.

List of References

List of references

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https://www.osha.gov/laws-regs/regulations/standardnumber/1910

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https://www.safetyinfo.com/safe-chemical-storage-osha-requirements-free-index/

3) Control of Industrial Major Accident Hazard Regulation in Malaysia:

https://www.researchgate.net/publication/368692141_Control_of_industrial_major_accident_hazard_regulation_in_Malaysia_second_decade_in_examination#:~:text=The%20Control%20of%20Industrial%20Major,major%20hazard%20risks%20are%20taken.

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https://oshe.uthm.edu.my/images/document/Biosafety/GUIDELINES_FOR_INDUSTRIAL_GAS_CYLINDER%202021_JKKP.pdf

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https://webstore.ansi.org/preview-pages/ASHRAE/preview_IEEE+Std+1635TM-2018+ASHRAE+Guideline+21-2018.pdf?srsltid=AfmBOooCphih3rOZJsyyIg6R-ZzQtEnedgDmIggNPlhmxkDNErPs84-j

6) Guideline on Gas Piping System:

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7) Occupation Safety and health Standard 1910.178 Material Handling and Storage:

https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.178#:~:text=Battery%20charging%20installations%20shall%20be%20located%20in%20areas%20designated%20for%20that%20purpose.&text=Facilities%20shall%20be%20provided%20for,of%20fumes%20from%20gassing%20batteries.

8) Non-Domestic Electrical Installation Safety Code:

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9) Occupation Safety and health Standard 1910.252 Welding, Cutting and Brazing:

https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.252

10) The Geotechnical Design Guidelines by JKR (Jabatan Kerja Raya) http://epsmg.jkr.gov.my/images/c/c3/GEOTECHNICAL_DESIGN_GUIDELINES.pdf

11) National Landscape Policy:

https://www.jln.gov.my/jln/resources/user_1/Text%20Documents/Dokumen%20Penerbitan/Dasar%20Landskap%20Negara/dln_bi.pdf

12) Specification for Load Bearing Block Work System (JKR 20601-0252-18):

http://epsmg.jkr.gov.my/images/d/db/Specification_For_Load_Bearing_Blockwork_System_JKR_20601-0252-18.pdf

13) Wind Load Consideration in Structural Design:

https://ipm.my/wind-load-consideration-in-structural-design/

14) National Electrical Code (NEC) 110.26 - Spaces About Electrical Equipment (600 Volts or Less):

https://up.codes/s/spaces-about-electrical-equipment

List of Acts / Regulations / Note / Guidelines

List of Acts and Regulations

No	Items
7.1	Act 127: Environmental Quality Act 1974
7.2	Act 133: Street, Drainage and Building Act 1974
7.3	Act 139: Factories and Machinery Act 1967 Revised 1974
7.4	Act 172: Town and Country Planning Act 1976
7.5	Act 341: Fire Services Act 1988
7.6	Act 447: Electricity Supply Act 1990
7.7	Act 501: Gas Supply Act 1993
7.8	Act 514: Occupational Safety and Health Act 1994
7.9	Act 514: Occupational Safety and Health Act 1994 / Occupational Safety and health (Safety and health Committee) Regulation 1996
7.10	Act 514: Occupational Safety and Health Act 1994 / Occupational Safety and health (Control of Industrial Major Accident hazards) Regulation 1996
7.11	Act 655: Water Services Industry Act 2006
7.12	Act 757: Strata Management Act 2013
7.13	Perundangan Subsidiary Persekuturan – Uniform Building By Laws 1984
7.14	MS830:2013: Storage, Handling and Transportation of Liquefied Petroleum Gases (LPG)
7.15	Selangor Unform Building By-Laws 1986 / Act 133: Street, Drainage and Building Act 1974 Sel.P.U. 26/1985
7.16	ANSI/ASME A13.1
7.17	Electricity Regulation 1994
7.18	Geotechnical Design Guideline
7.19	Non-Domestic Electrical Installation Safety Mode (Suruhanjaya Tenaaga, KOD/ST/No.4/2016)
7.20	NFPA 850 Recommended Practice for Fire Protection for Electric Generating Plants and High Voltage Direct Current Converter Stations, 2015 Edition
7.21	Guideline for Electrical Wiring In Residential Buildings, 2008 Edition
7.22	Guideline for The Approval of Electrical Equipment, 2024 Edition
7.23	Risk Control Practice: Occupancy, Renewable Energy Handbook Engineering & Property
7.24	Imia 16-71(98)E, Hydro-Electric Power, Technical and Insurance Development
7.25	MS1979:2007, Electric Installation of Buildings