ESCOM
ELECTRICAL SAFETY COMMITTEE

GUIDELINES AND BEST PRACTICES FOR ELECTRICAL SAFETY FOR CONVEYORS

DOCUMENT NO: ESCOM/2026/09, REVISION 1.0

What is ESCOM?

The Safety, Health and Environment National Authority (SHENA) and Autoriti Elektrik Negara Brunei Darussalam (AENBD) established the Electrical Safety Committee or "ESCOM" in January 2023; with the objectives of promoting regulatory compliance and raising electrical safety standards within Brunei Darussalam.

Who are the ESCOM members?

The Electrical Safety Committee (ESCOM) comprises representatives and industry experts drawn from relevant government institutions and private organisations, collectively bringing extensive technical experience in electrical engineering, safety management, and industry practice.

ESCOM is **chaired by a representative from the Safety, Health and Environment National Authority (SHENA)**, with a **Deputy Chairperson appointed in accordance with the Committee's Terms of Reference**. Subject matter experts from regulatory bodies, utilities, and industry may be invited to participate in specific working groups or provide technical input where required.

ELECTRICAL SAFETY BEST PRACTICES			
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Disclaimer:

This document was developed to provide guidance and recommendations, as well as to serve as an industry reference for best practices with the aim of improving electrical safety practices. This Guideline and Best Practices is not a statutory document and does not create or replace any legal obligations under the Workplace Safety and Health Act (Chapter 277) or its subsidiary regulations. In the event of any inconsistency, the provisions of the WSHA and its subsidiary regulations shall prevail. Accordingly, this document should not be construed as implying any liability nor should it be taken to encapsulate all the responsibilities and obligations of the law.

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1 INTRODUCTION

1.1 Background

Electrical safety constitutes a fundamental element in the design, operation, and maintenance of belt conveyors. Such systems, widely used in commercial and industrial operations, rely on a range of electrical components such as motors, control panels, sensors, and drive systems to facilitate the safe and efficient horizontal or inclined conveyance of materials. If these components are not improperly maintained, improperly operated or utilised outside established safety parameters, belt conveyors can pose serious electrical hazards to operators and maintenance personnel.

This document outlines the guidelines and best practices for ensuring electrical safety of conveyors. As essential components in modern buildings, conveyors involve complex electrical systems that pose potential safety hazards if not properly installed, maintained, or operated.

1.2 Purpose

The purpose of this document is to serve as guidance and reference on the basic requirements for the design, construction, installation, inspection and safe use of work practices for conveyors. **This is only recommended as the final option if there is no safer, practical or conventional means of access to.**

1.3 Scope

This document applies to the standard that specifies the safe use of conveyors. This guideline only covers the following: belt conveyors.

2 DEFINITIONS

Key definitions for this guideline are listed below:

TERM	DEFINITION
Competent Person	A person with the sufficient knowledge, experience, training, skill and ability to perform the specific work required and who has passed any courses that is required for that work. This includes having such practical and theoretical knowledge and experience of the equipment which is to be thoroughly examined that will enable him / her to detect defects or weaknesses. The purpose of their examination is to discover and assess the safety of the equipment. The person must be able to certify with confidence whether it is free from patent defects and suitable in every way for the duty for which the equipment is required. An example of this person could be a Conveyor Systems Engineer.
Employer	A person who, in the course of the person's trade, business, profession or undertaking, employs any person to do any work under a contract of service.
Factors of Safety	The Factor of Safety (FoS) is the design margin applied to the rated load capacity of conveyor system components to establish their maximum allowable operating load. The FoS for all conveyor structural and mechanical elements shall be sufficient to ensure safe operation under all foreseeable loading conditions, including static, dynamic, and impact loads, in accordance with applicable engineering standards, manufacturer specifications, and site operating conditions.
Capacity/Load rating	The maximum load or material throughput that a conveyor is designed and rated to safely transport under specified operating conditions. The capacity/load rating is established by the manufacturer and shall not be exceeded to ensure the safe and reliable operation of the conveyor.
Professional Engineer	A person registered as a professional engineer and who has in force a practicing certificate issued under the Board of Architects, Professional Engineers and Quantity Surveyors (BAPEQs).
Maximum load capacity	The maximum amount of material a conveyor is designed to safely carry under normal operating conditions.

3 ACRONYMS AND ABBREVIATIONS

ABBREVIATIONS	TERM	DEFINITION
LOTO	Lockout/Tagout	A safety procedure used to ensure that machinery or equipment is completely shut off, isolated from its energy sources, and cannot be started again before maintenance or servicing work is completed.
WSHA, Cap 277	Workplace Safety and Health Act, Chapter 277	Primary Law on Workplace Safety and Health in Brunei Darussalam, introduced in 2009 which sets the general legal framework related to the safety, health and welfare of persons at all workplaces.

4 APPLICABLE STANDARDS AND INDUSTRY GUIDANCE

4.1 Regulatory & Standards overview

Table 4-4-1 Regulatory & Standards overview

STANDARD/GUIDELINE	SCOPE
EN 81-20 & 81-50	Safety rule for design, inspection, maintenance and testing of passenger and goods (covers many electrical safety aspects, interlocks, emergency systems and control equipment
ISO 13849-1 / IEC 62061	Safety of control systems (machinery) - Control-system architecture, safety requirements specification and validation ISO 13849-1: performance levels (PL) method for safety-related parts of control system (protective controls) IEC 62061: functional safety for safety-related electrical/electronic/programmable control systems in machinery
ISO 14118	Safety of machinery — Prevention of unexpected start-up
ISO 14119 / IEC 60204-1	Interlocks and machinery electrical safety Part 1: general requirements. Primary reference for electrical control panels, wiring, earthing, isolation, protective devices, control circuits etc
IEC 60079	Equipment in Explosive Atmospheres
OSHA 29 CFR 1910.68 / .212	Conveyors – Guarding and inspection
NFPA 70 / NEC	Electrical system safety and grounding
Manufacturer Recommendations	Always follow OEM guidelines for intervals and methods
IEC 60364	Design, installation, and verification of electrical installations to ensure safety from electric shock, fire, and other electrical hazards.
BS7671	Design, installation, inspection, and testing of electrical systems up to 1000 V AC or 1500 V DC

5 TECHINICAL REQUIREMENT

Engineering controls reduce risk by eliminating hazards at the design stage.

5.1 Design and installation requirements

When specifying technical requirements for a conveyor system, we must consider their intended applications, capacities, safety standards, and integration within the facility.

These systems are often used in industrial, warehouse, or commercial applications for vertical and horizontal movement of goods or people.

5.1.1 Type of Conveyor

- Belt conveyor: General material handling
- Roller conveyor: For boxes and flat-bottom items
- Screw conveyor: For powders and granular materials
- Chain/slat conveyor: For heavy or irregular items
- Overhead conveyor: For hanging loads

5.1.2 Capacity & Speed

- Load capacity: kg/m or total kg/load
- Speed: m/min or m/s depending on process requirements
- Duty cycle: Continuous, intermittent, or batch

5.1.3 Dimensions

- Belt/roller width
- Length and height: Based on layout
- Incline/decline angles if applicable

5.1.4 Motor & Drive System

- Motor type: AC, DC, or servo (depends on control and speed needs)
- Power rating: Based on load and speed
- Variable speed drives (VFDs): For adjustable speed

5.1.5 Control & Automation

- Start/stop buttons, sensors (photoelectric, proximity)
- Integration with PLC/SCADA systems
- Sorting, diverging, merging, or accumulating logic

5.1.6 Safety & Compliance

- Emergency stops, guardrails, side skirts
- Interlocks and safety switches
- Noise and dust control
- Standards compliance:
- ISO 5048, DIN 22101 (design and safety)
- OSHA/CE directives depending on region

5.1.7 Material & Environmental Considerations

- Belt material: PVC, rubber, stainless steel, etc.
- Temperature and corrosion resistance
- Clean room or food-grade compatibility if required

Basic Design Schematic:

[Motor]-->[Drive Pulley]======= Belt =======[Idler Pulley]

|| ||

Material Flow Direction ---> ||

[Load] [Load] [Load]

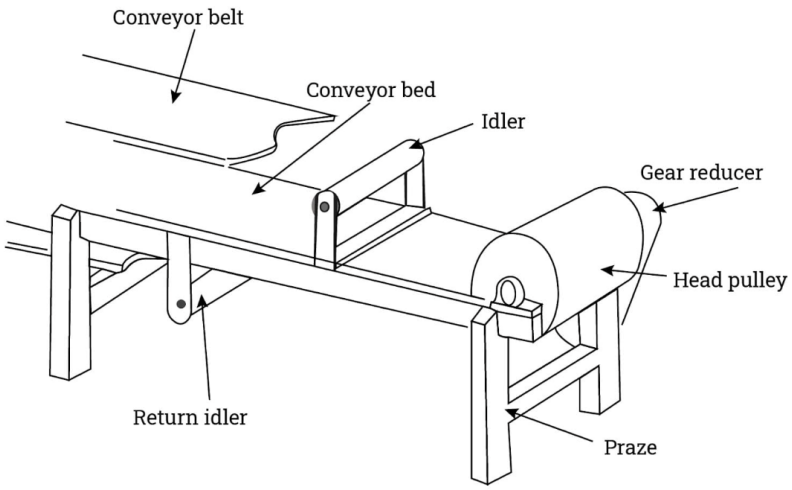

Figure 5-1 Conveyor Basic Design Schematic

Source: IQS Directory, "Components of Belt Conveyor"

5.2 Electrical Safety

Electrical safety is critical in conveyor systems to ensure safe operation, protect equipment, and prevent injury or fire.

Provide lockable local isolators, proper grounding, clear labeling and overload protection.

5.2.1 Power and Isolation

• Clearly labeled isolator switch: Positioned near the conveyor and accessible.

• Emergency stop switches (pull cords or buttons) should immediately cut power to all motors.

5.2.2 Motor Protection

• Overload relays and thermal protection to prevent motor burnout.

• Motors should have IP-rated enclosures (e.g., IP55 or better for dusty/wet environments).

5.2.3 Control Panel & Cabling

• Lockable, dust-tight or waterproof control panels (IP54 to IP66 based on environment).

• Color-coded and numbered wiring for identification.

• Avoid loose wires, use cable trays or conduits.

• Low-voltage controls (24 V or 48 V DC) for safety-critical systems like sensors or actuators.

5.2.4 Earthing and Surge Protection

• All metallic parts must be properly earthed.

• Use surge protection where VFDs (Variable Frequency Drives) or sensitive electronics are used.

5.2.5 Emergency LOTO

Install emergency stop pull-cords along the full conveyor length. Ensure they are visible, accessible and tested regularly.

• E-stop systems must cover the entire conveyor line and be fail-safe.

• LOTO procedures should be in place for maintenance:

• Tagging switches

• Releasing residual stored energy in motors

5.2.6 Common Safety Tips:

• Routine inspections of electrical systems, cables, and enclosures.

• Regular IR thermographic scans to detect overheating or loose connections.

• Train operators and maintenance personnel on electrical hazards and emergency shutdowns.

• Use only qualified electricians for installation, modification, or repairs.

5.3 Inspection and maintenance requirements

Focusing on compliance, preventive maintenance, and fail-safe operation.

Table 5-1 Conveyor Inspection requirement

INTERVAL	INSPECTION TASKS
Daily/Pre-shift	Belt alignment, tension, motor temperature, unusual noise or vibration
Weekly	Emergency stop pull cord check, guard integrity, motor load readings
Monthly	Electrical connections, drive alignment, lubrication check
Quarterly	Limit switches, photoelectric or proximity sensors, zero-speed switches
Annually	Gearbox oil, frame corrosion, safety device testing under load conditions

Key Safety Inspection Points:

• Condition of belt and rollers

• Condition of guards and covers

• Tension/misalignment switches

• Grounding and bonding of frames and motors

• Function of e-stop circuits and interlocks

• Control panel cleanliness and labeling

5.3.1 Maintenance requirements

Table 5-2 Conveyor Maintenance requirements

TASK	FREQUENCY	NOTES
Motor bearing lubrication	Monthly	Non-overlubricated; avoid grease contamination
Belt tension/track adjustment	Monthly	Follow manufacturer specs for sag and alignment
E-stop switch reset test	Weekly	Test full pull range
Gearbox oil change	12–24 months	Depending on usage and temperature
Electrical insulation resistance test	Annually	Especially in dusty or damp areas
Dust removal from panels/motors	Monthly	Compressed air or vacuum (non-sparking in hazardous areas)

5.3.2 General safety measures during inspection & maintenance

• LOTO: Mandatory before accessing motors, electrical panels, or control circuits.

• Use of PPE: Gloves, safety shoes, arc-rated clothing, helmets for shaft or conveyor access.

• Proper Access: Use of certified ladders, platforms, or catwalks with guardrails.

• Two-Person Rule: Requires that at least two qualified personnel be present during conveyor maintenance to ensure safety, provide immediate assistance in emergencies, and prevent accidents.

• Calibration: Test devices and safety sensors must be calibrated according to OEM instructions.

5.3.3 Recordkeeping & Documentation

Table 5-3 Recordkeeping & Documentation

DOCUMENT	PURPOSE
Maintenance Logbook	Record all maintenance, repairs, replacements
Inspection Checklists	Daily/weekly/monthly forms signed by technician
Fault/Breakdown Log	Fault codes, causes, and corrective actions
Certification Logs	Calibration, load testing, brake test certification
Training Records	Ensure technicians are qualified for inspections

5.3.4 Inspection outcome

- Pass: No faults; system safe for continued use.
- Conditional Pass: Minor issues noted; scheduled repair without shutdown.
- Fail: Major fault; system must be locked out until repaired.

5.4 Correct sizing of electrical equipment

It is essential to ensure that electrical equipment is properly sized, rated, and classified, particularly if installed in hazardous environments.

The following outlines the technical requirements in these areas:

5.4.1 Motor Sizing

- Consider conveyor length, load weight, friction, incline, and duty cycle.
- Start-up load: Heavier than running load, requiring higher starting torque.

5.4.2 Electrical Panel and Controls

- Rated for operational voltage + 10–20 %.
- Overload protection for motors and drives.
- Control panels should comply with IEC 60204-1, NFPA 70, or local electrical codes

5.4.3 Drive Systems

- VFDs are standard for variable-speed conveyors.
- Must match motor rating (voltage and current).

5.4.4 Other Considerations

- Emergency Power Supply: Backup battery or generator
- Thermal Management: Heat dissipation for drives and motors.
- Cable Selection: Flame-retardant, low smoke halogen-free (LSHF), especially in buildings.
- Earthing and Bonding: Essential in both safe and hazardous environments.

5.5 Correct installation of electrical equipment

5.5.1 General Safety Principles

• Compliance with Standards:
Electrical installations must comply with:
- IEC 60204-1 – Safety of machinery electrical equipment
- NFPA 70 / NEC – U.S. National Electrical Code
- ISO 13849-1 / IEC 62061 – Functional safety of control systems
- Qualified Personnel:

Installation must be performed by licensed electricians or trained technicians under proper supervision.

5.5.2 Motor and Drive Units

• Secure mounting with vibration dampers.
• IP-rated enclosures (typically IP55 or higher).
• Overload protection via thermal relays or VFD parameters.

5.5.3 Cable Routing

• Use industrial-grade cable trays or conduits.
• Prevent entanglement with moving parts by maintaining clearance.
• Flexible cables must be strain-relieved.

5.5.4 Control Panels

• Should be located in accessible, protected, and ventilated locations.
• Enclosures must meet IP65 or NEMA 4X rating for dusty or wet environments.
• Clearly labeled terminals and circuit identifiers.

5.5.5 Safety Devices

• Emergency stop pull cords along conveyor length.
• Interlock switches on guards and covers.
• Photo-electric sensors, light curtains, or proximity sensors to detect jams or obstructions.

5.5.6 LOTO Provisions

• Install isolation switches with lockout capability at motor and control points.
• Include energy isolation procedures in maintenance plans.

5.5.7 Earthing & Bonding & Surge Protection

• Earth all metal supports, motor frames, and enclosures.
• Use surge protection devices (SPDs) for power and control circuits in outdoor or lightning-prone areas.
• Bonding: Essential to eliminate static charges on conveyors and associated equipment, reducing the risk of sparks, fire, or explosions in hazardous or flammable environments.

Summary Installation Checklist

Table 5-4 Summary installation checklist

ITEM	REQUIREMENT
Power Disconnects	Lockable, accessible, emergency-rated
Cable Type	Flame-retardant, LSHF, shielded, flexible where needed
Overcurrent Protection	Breakers or fuses rated per motor/controller specs
Earthing & Bonding	All metal components must be earthed and bonded with continuity checks to prevent electric shock and safely dissipate fault currents or static charges.
IP/NEMA Rating	Based on environmental exposure (dust, water)
Safety Interlocks & E-Stops	Mandatory on guards, platforms, and access points
Control Panels	Labeled, IP65 or higher, separate low-voltage control
Backup Power	Required for conveyor emergency systems
Compliance	IEC, ISO or local electrical codes

5.6 Lock out and tag out (LOTO) for electrical equipment

LOTO procedures are essential to prevent accidental energization during installation, maintenance, inspection, or repair activities. Mandatory isolation of all energy sources during maintenance or cleaning.

5.6.1 Energy Isolation:

- Disconnect all sources of hazardous energy, including:
- Electrical (main power, control circuits)
- Mechanical (motors, tension, gravity)
- Stored energy (capacitors, springs, hydraulic)

5.6.2 Lockout Devices:

- Use mechanical locks on disconnect switches, breakers, or isolators.
- Devices must be durable, standardized, and resistant to environmental factors.

5.6.3 Tagout Devices:

- Attach clearly visible warning tags stating:
- “Do Not Operate”
- Name of person who applied it
- Date and time of application

5.6.4 Zero Energy Verification:

- Test the equipment to ensure no voltage or residual energy remains.
- Use a voltage tester or meter after lockout is applied.

5.6.5 LOTO

5.6.5.1 Isolation Points

- Main power disconnect
- Motor control center (MCC) isolators
- Local motor starters / VFDs
- Control power transformers (if separate)

5.6.5.2 Specific Safety Steps

- Shut down conveyor using normal stop procedures.
- Switch off and lock main disconnect.
- Tag the device and alert personnel.
- Attempt to start conveyor to ensure inoperative condition.
- Discharge any stored energy (e.g., motor braking systems, tension springs).

5.6.5.3 Emergency Stop Circuit Isolation

- Never rely on E-stop for LOTO.
- Always isolate upstream power sources.

5.7 Roles & Responsibilities

Table 5-5 Roles & Responsibility

ROLE	RESPONSIBILITY
Authorized Person	Applies lock/tag, performs work
Affected Person	Notified of LOTO, does not operate equipment
Supervisor	Verifies proper LOTO procedure, ensures compliance
Safety Officer	Audits procedures, trains personnel

5.8 Documentation & Signage

- Have in place and ensure comprehensive LOTO procedures for each machine, equipment or system.
- Such procedures shall, at a minimum, include:
- Clear Equipment or system concerned identification
- Energy sources and isolation points
- Lock/tag placement instructions
- Verification method
- Provide LOTO station with the necessary locks, tags, keys, and supporting documentation near the work area.

5.9 Re-energization Procedure

- Confirm all personnel, tools and people are safely cleared from the system.
- Remove lockout devices only by the person who applied them.
- Notify affected personnel.
- Restore power and test normal operation.

Summary Table:

Table 5-6 LOTO Summary table

REQUIREMENT	CONVEYOR SYSTEMS
Lockable Disconnect	At MCC or local control
Tag with Info	Same
Verify Zero Energy	Attempt start-up
Additional Isolation	VFDs, tensioners
Re-energize	Controlled and authorized

5.10 Fail safe mechanism

Fail-safe mechanisms are designed so that in the event of a failure (power loss, component fault, signal loss, etc.), the system defaults to a safe condition, preventing injury or equipment damage.

5.10.1 Emergency Stop (E-Stop) System

- Pull cords or buttons installed along the conveyor.
- Normally closed contacts — if a wire breaks or button is pressed, power is cut (fail-safe).
- Complies with ISO 13850 for safety stop functions.

5.10.2 Overload & Overcurrent Protection

- Motor overload relays trip power if current exceeds preset threshold.
- Ensures motor failure doesn't result in fire or mechanical damage.
- Thermistors in motor windings provide early failure detection.

5.10.3 Belt Misalignment and Tension Detection

- Misalignment switches trip conveyor if belt drifts from center.
- Tension detection sensors stop conveyor if belt becomes too loose or tight.
- Fail-safe: trip on loss of signal or sensor failure.

5.10.4 Speed Monitoring Devices

- Ensure the conveyor moves at correct speed.
- If belt breaks or motor shaft shears, device detects under-speed and stops system.

5.10.5 Safety Interlock on Guards

- Mechanical covers or guards have interlock switches.
- If guard is opened or removed, conveyor cannot operate (fail-safe contact opens).

5.10.6 Zero-Speed Switches

- Prevent start-up until system is confirmed to be at rest.
- Useful after emergency stops or during maintenance.

5.10.7 General fail-safe design principles

Table 5-7 General fail-safe design principles

PRINCIPLE	DESCRIPTION
De-energize to trip	Systems trip to safe mode when power is lost (e.g. brakes, E-stop)
Redundancy	Critical sensors (e.g. overspeed, door locks) may be duplicated
Open-Circuit Safety	Control circuits are designed so that open/broken wire = trip
Mechanical Backup	Buffers, brakes, clamps engage without need for power
Battery/UPS	Ensures safety systems function during power outages
Self-Diagnosis	Modern systems monitor for faults and revert to safe state

Summary Table:

Table 5-8 Fail-safe design summary table

SYSTEM COMPONENT	FAIL-SAFE MECHANISM
Overspeed	Mechanical trip + rail clamp
Conveyor E-Stop	Pull-cord / button (NC circuit)
Belt Safety	Misalignment, speed sensors trigger stop
Control Power	Battery/UPS for control & rescue
Guard Interlocks	Power cut when guard removed

Fail-Safe Verification Checklist that you can use during the commissioning or routine inspection of conveyor systems. It's structured for practical, on-site use and ensures all critical safety features are functioning in a fail-safe manner.

6 TRAINING AND COMPETENCY REQUIREMENTS

Well-trained personnel are critical for conveyor safety.

The proper maintenance and inspection of conveyors are critical to ensuring their safe operation and safeguarding members of the public. Accordingly, conveyors must be maintained in a safe, reliable and serviceable condition at all times.

It is the responsibility of the company to ensure their service technicians are competent to perform maintenance and inspection on conveyors.

Provide initial and refresher training on hazards, emergency response and LOTO. Enforce safety rules and address unsafe behavior immediately for supervision.

Below is the minimum competency expected by the service technician:

Safety:
• Good understanding of electrical safety and hazard
• Adequate awareness of health, safety and environment at workplace
• Hazard and risk awareness
• Safety during work at height
• Understanding safety features
• Completed relevant training programs

Maintenance, inspection, troubleshooting and repair:
• Mechanical wear & tear
• Corrosion inspection
• Wire rope inspection
• Electrical inspection
• Motor inspection
• Electrical system
• Risk awareness
• Control system
• Operation
• Basic mechanical and rotating equipment

Title:
ELECTRICAL SAFETY: CONVEYOR SYSTEMS

1. ALWAYS ISOLATE BEFORE WORKING
- Use LOTO before maintenance, clearing jams, or adjustments
- Confirm **zero energy** (no electrical, mechanical, pneumatic power)

2. KNOW YOUR EMERGENCY STOPS
- Locate **E-stop** buttons and pull-cords before starting work
- Test during routine inspections

3. KEEP ELECTRICAL PANELS SAFE
- Keep panels **closed, locked, and dry**
- Report **damaged cables**, exposed wires, or burning smell immediately

4. OPERATE SAFELY
- Never bypass interlocks or guards
- Follow proper startup and shutdown procedures

5. TRAINING AND AWARENESS
- Only trained personnel access electrical equipment
- Stay alert for abnormal noises, heat, or trips

Footer:
Safety First – Report all hazards, Protect yourself and your team

7 CERTIFICATIONS

7.1 Employers are required to **ensure that conveyors are properly maintained, regularly inspected by competent persons, and kept in a safe condition at all times**. Guards, emergency stop devices, and other safety features must be maintained and verified through routine inspections based on risk and manufacturer requirements.

7.2 Conveyor owners/employers/occupiers/persons in control must ensure:

- Risk assessments are conducted, and necessary safety controls are in place before operations begin.

8 RISK MANAGEMENT

These legal responsibilities include:

- Periodic maintenance of conveyor as per the manufacturer's recommendation by engaging a conveyor service contractor to ensure the conveyor are in safe condition and precautions are undertaken.
- Clearly display the certificate of test and examination, as well as the maximum load capacity which the conveyor system can safely carry.
- Establish and implement an emergency response plan, such as conveyor entrapment and loss of power.
- To act promptly to remedy any defects that were found.
- Ensure that every mechanical component, part of the structure and every article supporting the conveyor is of good construction and sound material and is of adequate strength suitable for the nature of its use.

8.1 Regular maintenance

- Regular maintenance prevents equipment failure and unsafe conditions.
- Routine Inspections: Conduct daily operation checks and scheduled technical inspections.
- Preventive Maintenance: Replace worn components early and keep conveyors clean.
- Record Keeping: Maintain inspection records, maintenance logs and corrective action reports.

8.1.1 Regular maintenance of conveyor is essential to ensure their safe, reliable, and efficient operation. It involves the routine inspection and servicing of electrical systems, control panels, wiring, safety devices, and mechanical components. Preventive maintenance plays a vital role in identifying potential issues early, reducing the risk of unexpected breakdowns, and extending the service life of the equipment. The primary objectives of conveyor maintenance are to prolong the equipment’s lifespan, improve its safety and reliability, minimize the inconvenience caused by equipment downtime, avoid costly repairs, and prevent violations of safety regulations that could lead to penalties.

8.1.2 Maintenance activities should strictly follow the manufacturer's recommendations and comply with all relevant local safety standards and regulations.

8.1.2.1 Records

Maintenance and Servicing work processes ensure that we have properly documented formal inspection procedures and records. Capturing all data output takes the form of a review. These are reviewed for accuracy and completeness and the review is signed off prior to them being issued to the customer.

After all the maintenance had been done / carried out successfully then the equipment/s will be put back to normal operation.

8.2 Risk assessment

Conduct conveyor-specific risk assessments and in accordance with applicable safety standards and regulatory requirements.

A comprehensive risk assessment is essential to systematically identify potential hazards associated with conveyor operations, evaluate the likelihood and severity of associated risks, and implement proportionate control measures to safeguard all users and maintenance personnel. Common hazards associated with conveyor systems include entanglement or entrapment in moving parts such as belts, rollers, pulleys, and drive mechanisms, as well as injuries caused by unexpected start-up, sudden stoppage, or belt misalignment. Additional risks include electrical hazards during maintenance of motors and control systems, unauthorized access to conveyor guarding or restricted zones, and slips, trips, and falls around conveyor walkways, transfer points, and loading or discharge areas. There are also risks related to overloading the conveyor beyond its rated capacity, which may lead to belt damage, spillage, or mechanical failure, as well as potential fire hazards arising from overheating of rollers, friction at belt interfaces, or electrical faults in control equipment due to inadequate maintenance.

To mitigate these risks, all conveyor must be routinely inspected and maintained according to manufacturer guidelines and local safety regulations. Emergency alarms, communication systems, and safety interlocks should be tested regularly to ensure functionality. Appropriate signage must be displayed to warn of load limits, and conveyor should not be used during fire emergencies unless certified for such use. Maintenance personnel must follow LOTO procedures and wear appropriate personal protective equipment (PPE) as determined by the risk assessment. Safety barriers and warning notices must be installed during any repair or servicing work to prevent unauthorized access.

Additionally, all conveyor users should be educated on shall be appropriately instructed and periodically reminded of safe operating practices, such as waiting for the conveyor to fully arrive, not blocking, and avoiding unnecessary movement. A clear emergency response plan must be in place in case of equipment failure.

Users shall, in particular, observe the following requirements:

- Exercise due caution when stepping in and out of the conveyor to avoid tripping hazards and to be cautious of any loose clothing or personal items from getting entangled with moving compartments.
- Promptly report any defects, irregularities or malfunctions related to the conveyor to the building management for immediate attention.
- Refrain from using the conveyor during emergencies such as fire or natural disaster, and instead utilise designated evacuation routes such as the stairs.
- Strictly adhere to the stated maximum load capacity of the conveyor and avoid overloading at all times.

9 SIGNAGES

Clear and appropriate signage plays a vital role in ensuring electrical safety in and around conveyors. Such signs serve as clear visual reminders to alert personnel of potential electrical hazards, delineating restricted or controlled areas, identifying emergency procedures, and reinforcing necessary safety precautions. By prominently displaying safety signages, workplaces can help prevent accidents, support compliance with safety regulations, and fosters a culture off heightened awareness and responsibility.

Warning signs shall be prominently installed at nips points and other moving parts to highlight entrapment and electrical risks. Clear emergency stop signage, floor marking for safety zones are also among crucial signages important for application.

Table 9-1 Signage

TYPES OF SIGNAGES	SIGNAGES
Warning	
Emergency Communication Instruction	“Jika berlaku kerosakan sila hubungi” In case of conveyor breakdown please call During office hours: After office hours:

TYPES OF SIGNAGES	SIGNAGES
Prohibition Signs	

10 SAFETY CULTURE

Encourage hazard reporting, investigate near misses and demonstrate management commitment to safety.

11 EXAMPLES OF SCENARIOS THAT MAY LEAD TO ACCIDENTS OR INJURIES

This presents real-world inspired conveyor system accident scenarios commonly reported across Brunei Darussalam and ASEAN industries such as oil & gas, logistics, manufacturing, food processing, and ports.

This section aims to strengthen safety awareness, highlight recurring risk factors and reinforce crucial preventive measures to mitigate similar incidents.

Case Study 1: Hand Entrapment in Moving Conveyor Roller

- **Scenario:** An operator attempted to clear a jammed carton without stopping the conveyor system. His glove was pulled and became entangled into the roller.
- **Main Cause:** Lack of awareness of nip point hazards and failure to isolate equipment prior to intervention.
- **Outcome:** Crushed fingers leading to partial amputation.
- **Key Lesson:** Conveyor systems must be fully stopped and isolated before any attempt is made to clear blockages or jams.

Case Study 2: Entanglement Due to Loose Clothing

- **Scenario:** A worker leaned over a running conveyor while wearing loose clothing.
- **Main Cause:** Poor awareness and understanding of entanglement hazards and inadequate PPE control.
- **Outcome:** Serious upper-body injuries.
- **Key Lesson:** Properly secure clothing, hair, and PPE when working in proximity to conveyor systems.

Case Study 3: Fall While Crossing Over Conveyor

- **Scenario:** A worker climbed over a conveyor instead of using a designated access walkway.
- **Main Cause:** Unsafe shortcut behavior compounded by weak enforcement of safety rules.
- **Outcome:** Fractures and multiple bruises.
- **Key Lesson:** Conveyors must never be used as walkways and designated crossings must always be utilised.

Case Study 4: Electrical Shock During Maintenance Activities

- **Scenario:** Maintenance was carried out without isolating electrical power supply.
- **Main Cause:** Lack of lock-out/tag-out (LOTO) awareness.
- **Outcome:** Electrical burns and lost-time injury.
- **Key Lesson:** Always apply LOTO before maintenance or troubleshooting.

Case Study 5: Failure to Activate Emergency Stop

- **Scenario:** A worker became trapped in a conveyor system, however, nearby co workers failed to activate the emergency stop.
- **Main Cause:** Insufficient awareness of emergency stop locations and function.
- **Outcome:** Injury severity increased.
- **Key Lesson:** All workers must be trained and made well known as to where emergency stops are and how to use them in the event of an incident.

Case Study 6: Cleaning Accident involving an on Operating Conveyor

- **Scenario:** Cleaning was performed while the conveyor remained running.
- **Main Cause:** Inadequate training and awareness among cleaning personnel regarding conveyor hazards.
- **Outcome:** The incident resulted in arm injuries and a lost-time accident.
- **Key Lesson:** All Cleaning and maintenance activities must only be undertaken after the conveyor system has been fully shutdown and effectively isolated in accordance with any established LOTO procedures.

- **Common Safety Awareness Gaps Identified**: Failure to recognise nip points and pinch points, ignoring lock-out/tag-out (LOTO) procedures, poor understanding of emergency stop systems, unsafe shortcuts becoming normalised, and inadequate induction and refresher training.
- **Safety Reminder:** Conveyor systems move with significant force and speed. Awareness, training, and discipline save lives

12 REFERENCES

- Components of belt conveyor (IQS directory)
- Conveyor system safety guide- RS

13 APPENDIX

ELECTRICAL SAFETY CHECKLIST

A. Electrical Controls and Hardware
   - [ ] Emergency stop devices functional)buttons, pull-cords)
   - [ ] All interlocks and limit switches operational
   - [ ] Control panels closed, labeled, and secured
   - [ ] No exposed conductors or open junction boxes
   - [ ] Grounding/earthing connections intact

B. Cables & wiring
   - [ ] No frayed, damaged, or unprotected cables
   - [ ] Cables routes away from moving parts
   - [ ] No water ingress or moisture near wiring

C. Motors, Drives & Electrical Equipment
   - [ ] Motors run without abnormal heat, noise or vibration
   - [ ] VFDs and starters ventilated and dust-free
   - [ ] Overload protection correctly rated and functional
   - [ ] No signs of overheating, arcing, or burning smell

D. Isolation & LOTO
   - [ ] Local isolators installed and accessible
   - [ ] LOTO devices available and used correctly
   - [ ] Verification of zero energy performed before maintenance
   - [ ] Isolation points clearly labeled

E. Housekeeping & Environment
   - [ ] No liquids stored near electrical panels
   - [ ] Area around panels clear (1m clearance recommended)
   - [ ] Dust built-up removed (esp. in MCC rooms)

F. Documentation & Training
   - [ ] Up-to-date single-line diagrams available
   - [ ] Maintenance logs updated
   - [ ] Staff trained on electrical and conveyor safety
   - [ ] Risk assessments reviewed and current

FAIL-SAFE VERIFICATION CHECKLIST– CONVEYOR SYSTEM

ITEM	DESCRIPTION	PASS / FAIL	NOTES
1. E-stop Pull Cord	Pull at multiple points – conveyor must stop immediately	☐ / ☐	
2. Guard Interlocks	Remove or open guards – conveyor must not operate	☐ / ☐	
3. Belt Misalignment	Simulate belt drift – verify misalignment switch stops conveyor	☐ / ☐	
4. Belt Tension Loss	Disconnect tension switch – verify conveyor does not run	☐ / ☐	
5. Speed Monitoring	Simulate speed loss – verify zero-speed switch trips conveyor	☐ / ☐	
6. Motor Overload	Simulate overload – test relay cutout response	☐ / ☐	
7. Local Disconnect Switches	Test lockable isolators at motor/control panels	☐ / ☐	
8. Control Power Loss	Disconnect control power – system must remain stopped	☐ / ☐	
9. Restart Prevention	After power restoration, verify manual restart is required	☐ / ☐	
10. Grounding Check	Confirm PE continuity to motors, panels, and frame	☐ / ☐	

VERIFICATION DETAILS

- Project/Area Name: _____
- Location: _____
- System Type: ☐ Conveyor
- Performed By: _____
- Date: _____
- Supervisor Sign-off: _____

RISK ASSESSMENT TEMPLATE				
Item	**Work Activity**	**Hazard / Effect**	**Risk Control Actions**	**Emergency Preparedness Plan**
Manual Handling	Lifting/moving items onto or around conveyor	Musculoskeletal injuries	Manual handling training; use mechanical lifting for heavy items	Maintenance Team: 1234567; BOMBA 995; Ambulance 991
Mechanical/Machinery Failure	Working on damaged or defective conveyor systems	Cuts, abrasions, strains, sprains, entanglement, entrapment, electrocution, fractures; unexpected start-up; unguarded moving parts	Authorised trained operators only; preventive maintenance; daily inspections; emergency stop buttons; safety bars; anti-pinch rollers; interlocks; warning sirens; repairs by qualified personnel; no climbing/handling belts during operation	
Electricity	Working on faulty equipment	Electric shock, injury from faulty systems	Preventive maintenance; contractor servicing; PAT testing; statutory electrical inspections; daily checks	
Falling Objects	Parcels falling from conveyor	Impact injuries, cuts, sprains, fractures	Correct loading; avoid overloading; centre placement of parcels; emergency stop for congestion; stack light over heavy items; remove items top-down	
Chemical Contamination	Damaged/leaking parcels containing chemicals or dangerous goods	Eye/skin contamination, minor injury, chemical reaction/fire	Dangerous goods segregation area; spill kits; PPE; Dangerous goods awareness & spill training; isolation of leaks; audits; correct packaging/marking	

RISK ASSESSMENT TEMPLATE				
Item	**Work Activity**	**Hazard / Effect**	**Risk Control Actions**	**Emergency Preparedness Plan**
Slips, Trips & Falls	Floor hazards, spills, debris, unsafe access	Cuts, sprains, fractures, major injuries	Walkways marked; housekeeping; spill kits; slip-resistant footwear; lighting; handrails; safe access routes; defect reporting; awareness training	
Entrapment (Moving Parts)	Hands/fingers trapped between conveyor parts or parcels	Cuts, bruises, fractures, entrapment	Guarding at pinch points; trained operators; emergency stops at key points; maintenance procedures; immediate defect reporting	
Fixed Objects	Contact with beams, structures, conveyors; incorrect lifting; clearing jams	Bruising, lacerations, musculoskeletal injuries	Awareness training; protective padding on beams; safe clearance procedures; correct lifting practices	