HINDUSTAN ZINC
Zinc & Silver of India

HZL Standard
"Machine Guarding & Conveyor Safety"

	Issued by	Approved by
Name	Chairman, SRP sub Committee	Corporate Council Chairman
Sign.		
Date		

Document Control Details:-

Revision	Date	Reason for Issue	Compiled By	Major Changes	Approved By
00	25.10.2017		Prasoon Godika		Rajesh Kundu
01	05.07.2019	Corporate Standard	Priya Singh	-Size of mesh of opening to and including 9 mm mesh, distance of guard from the hazardous point virtually same as sheet metal, working clearance only required. -The back end of tail pulley guards should extend to within 100 mm of the ground or walking surface. -Interlocking of conveyor carrying idlers must be through a second (can be identical pull cord wire) switch of IP66 rating. This wire should be of different colour than existing pull cord wire.	Rajesh Kundu
02	30.12.2022	Corporate Standard	Ashish Anchliya	All conveyors (except screw and Drag Chain conveyor which are completely enclosed by OEM during supply) guards must be fixed bolted with interlocks (To avoid interlocking on already enclosed machines) Emergency pull cords located in a manner as to be clearly visible and readily accessible. The height of pull cord should be such that it lies between your toe and shoulder when you stand straight on ground, as shown which helps to stop the conveyer in case somebody falls on the running system, or it should be between 900MM to 1500MM from ground level (As conveyor height is vary from ground so fixed figure can't be suitable) Pull Chord Switches should be Tension type (To avoid confusion b/w Stay put and tension type) Fire protection: Adequate fire protection facilities shall be provided as per IS 1641 depending on site condition or required by site (Code of Practice for Fire Safety of Buildings).(Not feasible at all location) Surveillance Camera should be installed in non-movement area/Gray area (Which should be specified by site or conveyor length more than 800 mtr)and taken in control room for tail end and head end of the drives.(Not feasible at all location)	
Next Revision Date					

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Acknowledgement: The management acknowledges the contributions of the following individuals for being a part of the Zone / location workgroup and for their assistance in preparing this standard on Machine Guarding & Conveyor Safety.

DOCUMENT ISSUE

The "Machine Guarding and Conveyor Safety" Standard is issued by the Corporate Safety Council on behalf of Hindustan Zinc Limited management and forms a part of the HZL Integrated Management System.

Name: Vinod Jangir

Signed: .....

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Abbreviations

- CSRP – Corporate Standards, Rules and Procedures Subcommittee
- HZL – Hindustan Zinc Limited
- LOTOTO – Lock Out Tag Out Try Out
- CSC – Corporate Safety Council
- UIC – Unit Implementation Committee
- PPE - Personal Protective Equipment
- HIRA- Hazard Identification & Risk Assessment
- JSA- Job Safety Analysis
- SMP--Safe Maintenance Procedure
- SOP – Standard Operating Procedure
- WI – Work Instruction
- PTW – Permit To Work (also known as Work Permit
- OSHA – Occupational Safety & Health Association.

Table of Content

1. Purpose:

The purpose of this standard is to provide framework and outline the company requirements with regards to Machine Guarding and Conveyor Safety in order to prevent access to dangerous parts of machinery or stop their movement before any part of a person enters a danger zone. The machines and conveyors to be designed procured, constructed, maintained and guarded to ensure zero harm. Line Management at HZL has the responsibility to implement this standard and related procedure.

2. Scope:

This standard is applicable to all HZL units & covers the leadership responsibilities at the business operations, functions and facility levels. It is aimed at all Hindustan Zinc Limited (HZL) operations and managed sites, including new acquisitions, corporate offices, project sites, residential colonies, research facilities and to all new and existing employees and contractor employees. This Standard is applicable to the entire operation lifecycle for all temporary and permanent installations.

Line management shall be responsible and accountable for defining and achieving acceptable risk for all human and machine interactions. They shall help ensure that risks are identified and assessed and that the risks are reduced to acceptable levels within the operating areas.

This standard focuses on the mechanical hazards associated with the use of machinery within HZL operations and how to control these hazards by using machine guarding. HZL operations shall also consider other hazards associated with machinery that are not covered under this standard such as: electrical; thermal; noise; vibration; radiation; hazardous materials and substances; slipping, tripping and falling; environmental hazards or a combination of these hazards. For all such hazards the corresponding Standards and Guidance Notes of HZL and Vedanta to be referred. HZL will comply with all local guarding rules as mandatory.

3. References:

In preparation of this standard, assistance has been derived from the following documents:

a) IS 9474:1980 Principles of Mechanical Guarding of Machinery
b) IS 7155: All Parts: Code of recommended practice for conveyor safety
c) GN 18: Vedanta Sustainability Framework
d) ISO 13857:2008 Safety of Machinery
e) GN 7: Risk Assessment

4. Management Responsibilities:

Line management has the responsibility to implement this standard. Site should identify a Machine Guarding Champion (Zone Champion) to assist management in implementing the mandatory requirements of this Standard. All line managers and their team including contractor workforce dealing in inspection, maintenance and operation, are responsible to comply with the requirements of the Standard on "Machine Guarding and Conveyor Safety".
Zone champion shall be responsible for assisting in implementation of the standard, conducting trainings, complying periodic checks and audits and maintaining documents related to the standard.

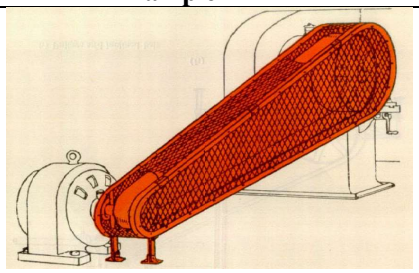
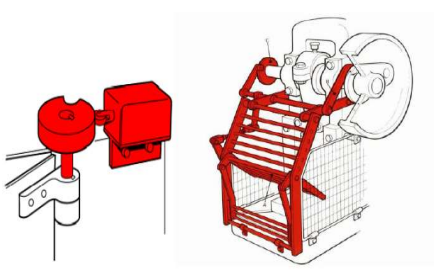
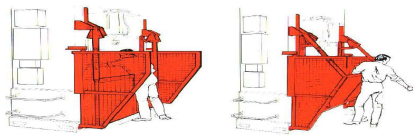
5. Definitions:

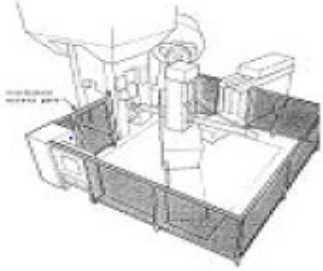
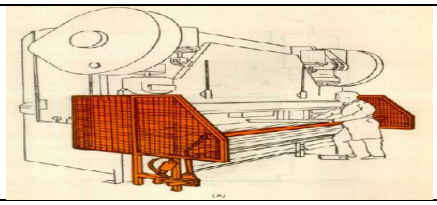
- **Administrative Controls: -** Methods of controlling employee exposure to hazards by procedures, employee work assignment, training in specific work practices designed to reduce exposure, inspecting, and auditing. Administrative controls generally rely on operational discipline and employee actions to be effective. Examples include Do Not Touch and Line of Fire programs.
- **Affected Personnel: -** Any person whose job involves operating, servicing or maintaining machinery or whose job involves working in an area exposed to machine hazards.
- **Authorized Person: -** Person(s) having permission from management to perform some action in a given location at specified times.
- **Behavioural-based Safety: -** A formal systematic program that seeks to reduce at-risk behaviours through personal engagement with workers and a focus on behaviour activators (antecedents), resultant behaviours, and their consequences.
- **Emergency Stop:-** The operation of a circuit, which can be initiated by a single human action that overrides all other machine controls, removes drive power, causes all moving parts to stop, and removes power from other hazardous functions present in the safeguarded space but does not cause additional hazards.
- **Engineering Controls: -** Any physical means and interlocks of controlling employee exposure to hazards, such as equipment design or redesign (e.g., machine guards, proximity sensors, limit switches, light curtains etc.). Engineering controls rely primarily on technology and not employee actions to be effective.
- **Guard: -** A barrier that prevents exposure to an identified hazard. It must be adequate enough to prevent access to all hazardous points and must meet the reach dimension criteria.
- **Fixed Guard: -** A guard that is affixed in such a manner (e.g., by screws, bolts, nuts, welding) that involves the use of hand tool(s) for opening or mounting and removal.
- **Hazard: -** An inherent property or characteristic of a material, machine, system or process, that has the potential for causing injury to people, property and/or environmental damage.
- **Safety Interlock: -** Consist of one or more switches that connect a sensor directly with either the control system or the power system of the machinery which can be operated in case of emergency or abnormality.
- **Interlocked Guard: -** A guard that can be opened or removed, with hand tools, and incorporates an interlock through proximity sensor, limit switch etc.
- **Line of fire: -**
    - The hazard path of the material, equipment, or energy flow (e.g., the path of the missile discharged from a firearm).

  - The practice of staying mentally focused and conscious of the hazards in the area, and helping to ensure that body parts are not potentially in the path of hazardous energy (mechanical, chemical, or thermal, potential, hydraulic, pneumatic , radiation etc.).
- LSR (Life Saving Rules):-
  - Any malpractice or interference with the conveyor safety system will be considered as LSR Violation and consequence management will be applied.
- **Machine:-** A single or multiple unit of powered, fixed, mechanical equipment used to form or transfer material and/or energy (e.g., rolls, conveyors, chain and sprocket, couplings, flywheels presses, bag formers, belt and pulley, table saw, drill press, lathe, grinder, feeders, etc.); it excludes all portable powered hand tools, self-propelled mobile equipment (e.g., hydra, forklifts and cranes), and hoists.
- **Machine Guarding:** Machine Guarding is the elimination of access by people to moving parts of a machine that may present a hazard to those people. This includes hazards of rotating equipment, nip points, conveyors, V-drives and chain drives, shaft ends, couplings, rotating and oscillating levers and other rotating parts.
- **Machine-related Injury: -** Any event related injury involving any human-machine interaction.
- **Machine Safety: -** Recognition of hazards associated with machine energy, with emphasis on the risks associated with human-machine interactions and the safeguards applied to mechanical processes and personal actions to prevent injury.
- **Troubleshooting: -** Typically abnormal, but necessary, work on or around machines that are running (e.g. cleaning, clearing jams, and aligning). These activities become very high risk especially when the work has not been pre-planned with an adequate safety system.
- **Mechanical Power Transmission:-** Any device involved with transferring power from a motor to the part of the machine performing the work, including belts and pulleys, chains and sprockets, shafts and couplings, connecting rods, gears, flywheels, cams, spindles, and cranks.
- **Nip Point:-** The point at which an element of a machine, which is moving in a line or rotating, meets another element, which is either rotating or moving in a line, in such a manner that it is possible to nip, pinch, squeeze, or entrap a person or object coming into contact with one of the two elements. (e.g., roll to roll, roll to web or strand).
- **Pinch Point: -** Any point at which it is possible for a part of the body to be caught between a moving part and stationary object e.g. Hydraulic presses, saws, pneumatic cylinders, etc.
- **Point of Operation: -** The location on the machine or tooling where the material or work piece is positioned and work is performed, such as cutting, shaping, boring, stretching, or forming of stock.
- **Risk: -** The product of the expected frequency (events/unit time) and the consequences (effects/event) of a single hazardous event or group of hazardous events; typically used as a measure of potential economic loss or human injury in terms of the probability of the loss or injury occurring and the magnitude of the loss or injury if it occurs.
- **Risk Assessment: -** A systematic and structured process whereby hazards present in a workplace or arising from workplace activity are identified; risks are evaluated; and protective and preventive measures, including procedures and practices, are put in place to reduce risks to acceptable levels.
- **Residual/Acceptable Risk: -** A risk that is adequately safeguarded as viewed by the risk assessment team and the standard.
- **Safeguard: -** A barrier guard, device, or safety procedure designed for the protection of personnel.
- **Self-adjusting Guard: -** Guard that prevents access to the danger, except when the guard is forced open by the passage of the work; usually incorporates a spring-loaded, pivoted element.

- **Trip Guard: -** A device that helps to stop or reverse the machine when there is approach to a dangerous part beyond a safe limit. Trip devices include trip bars and wires, photoelectric devices, and pressure-sensitive strips and mats.
- **Two-Hand Control Device: -** Devices applicable only to machines with a single operator with the control buttons positioned more than a hand-span apart. The control circuit is arranged so that both controls are activated simultaneously to start the cycle and both controls are released after each cycle before the next cycle can be initiated. Release of either button during the dangerous part of the cycle must stop or reverse the machine movement.
- **Normal Operations: -** predefined tasks with identified hazards occurring through the machine life cycle (i.e., start-up, shutdown, emergency shutdown, correcting deviations, cleaning, unjamming, and adjusting).
- **Abnormal Operations (troubleshooting):-** conditions outside standard operating conditions or beyond the predefined standard operating procedure (SOP) that may create unidentified, unrecognized hazards. Abnormal operations include any undefined task or condition where the hazards are potentially unknown (i.e., emergency shutdown, deviation response, cleaning, unjamming, and adjusting).

6. Types of Guards:

Machine Guards	Description	Example
Fixed Guards	This type of guards has no moving parts and prevents the contact between moving machinery and any moving parts. Fixed guards provides protection only when secured in position and fixed guards should be easy to remove and replace but be able to opened with the help of hand tool .	
Interlocking Guards	This type of guard is moveable with moving part interconnected with control system. Interconnection may be through electrical, mechanical, hydraulic, pneumatic. This interlock prevents the machinery from operating unless the guard is in closed position.	
Automatic Guards	This type of guard automatically moves into position as a machine or cycle is started. Automatic guards are also	

	known as push away guards. They are only suitable for slow running machines	
Distance Guards	This guard prevents access to hazardous area around the machine through barrier of fence. This guard is similar to fixed guard but also features a separation distance around the machine and must be fitted with interlock at the gate. As per reference table	
Trip Guard (Presence sensing devices)	These types of guards stop the machine when a person gets into position, where they are liable to be injured. A Photo electric curtain is the example of this type of guard.	

7. Machine Guarding and Safety :

7.1 Machine Hazards: - The line organization shall help ensure that all affected persons are trained to recognize machine motions and actions and conditional hazards. This requirement shall apply for each individual of the team in order to effectively evaluate and manage tasks to acceptable levels of risk. Hazardous moving parts that should be safeguarded fall into three categories namely

- Point of operation
- Mechanical power transmission, and
- Other moving parts.

Hazardous Mechanical Motions and Actions: - A variety of different types of hazardous mechanical motions and actions can be present in nearly all machines. These hazards need to be recognized in order to be controlled. Motions and related hazards are as follows:

Rotating Motion: - The hazard exists even with smooth, slowly rotating shafts, which can grip clothing; skin contact alone can cause injury, which can be severe. The hazard increases when bolts, nicks, abrasions, and projecting keys or set screws are exposed on rotating parts.

Reciprocating Motion: - A person can be struck by or caught between one moving and one stationary part during the back-forth or up-down motion.

Transverse: - Movement in a straight, continuous line, which creates a hazard because a worker may be struck or caught in a pinch or shear point by the moving equipment or material.

Actions and related hazards are as follows:

Cutting Action: - The hazard exists at the point of operation where finger, head, and arm injuries can occur and where flying chips or scrap material can strike someone close by.

Punching Action: - results when power is applied to a slide (e.g., ram) for the purpose of blanking, drawing, or stamping metal or other materials. The hazard is located at the point of operation where materials are inserted, held, and withdrawn by hand.

Shearing Action: - involves applying power to a slide or knife in order to trim or shear. A hazard exists at the point of operation where material is inserted, held, and withdrawn.

Bending Action: - Hazard present at the point of operation from uncontrolled release of energy (including stored energy) and uncontrolled application of energy

Stretching Action: - involves the application of force to pull material to expand or extend the orientation. A hazard exists at the point of operation where the material is inserted, pulled, drawn, and released.

Conditional Hazards: - A variety of conditional hazards can be present through the machine task life cycle. These hazards need to be recognized in order to control them

7.2 Machine Safety Management (MSM): When the operation or inadvertent contact with a machine could cause injury to the person, the hazards shall be eliminated or the risks controlled to an acceptable level. All HZL sites shall implement and maintain a risk management and reduction process based on the following hierarchy (preferred order) of controls (See Annexure 3):

1. Elimination
2. Substitution of less hazardous processes, operations, or equipment
3. Engineering controls
4. Warnings
5. Administrative controls
6. Personal protective equipment (PPE)

Often a combination of controls is the most effective way to achieve acceptable risk.

The processes outlined in this standard are interrelated to provide comprehensive hazard recognition and safeguarding for the varied task conditions of the industrial machine and workplace. Unless the task activity is eliminated or automated, the risk control provisions often count on multiple controls from engineering, warning, and administrative control options.

The management system in this standard is designed to challenge and improve machine safety performance and is aligned with a continuing improvement cycle (i.e., Plan, Do, Check, Act) to achieve an injury-free workplace. Refer Annexure 1: “Annual Improvement Plan”

7.3 Equipment Design Safeguards: - Engineering Controls

Following machine hazard elimination and task automation, the single greatest opportunity to achieve acceptable risk is through effective design safeguards of machine hazards. The line management is responsible for the design safeguarding of machine hazards in collaboration with engineering, sourcing, and the equipment suppliers. The line management shall help ensure that systems are in place to identify and safeguard the machine hazards created by new, existing and modified equipment. Further, they must help ensure that design safeguards are installed, used, and maintained as specified, and that provisions are in place to help ensure that the guard itself does not create a hazard when in operation or when removed for repair. Engineering design safeguards are in the form of mechanical controls or electrical and instrumented controls. The proper installation and function of these controls shall be verified during the commissioning phase and periodically thereafter, especially following maintenance, troubleshooting and repairs.

7.3.1 Mechanical Design Controls: - (equipment guard) General guidance for point-of-operation and perimeter guards are as follows. It must:

a) Prevent contact between or with moving equipment or materials.
b) Be robust and securely fixed.
c) Avoid creating ergonomics problems.
d) Avoid creating new hazards.
e) Avoid creating interference for correct performance of tasks.
f) Allow safe predictive and preventative maintenance if possible.
g) Are of sufficiently robust construction to prevent ejected machine parts or material penetrating the guard;
h) Do not give rise to additional hazards;
i) Are not easily bypassed or made non-operational;
j) Are located at an adequate distance from the danger zone;
k) Cause minimum obstruction of view for machine operators; and
l) Enable essential work to be done without guard removal.
m) Fixed guards must be installed such that guard removal/ opening is impossible without using tools, either by permanent means (e.g. welding) or by means of fasteners (bolts etc.).
n) Ensure systems and equipment are in place for the safe startup of conveyors, which may include engineering controls such as interlocks and conveyor logic systems
o) Ensure systems and equipment are in place that provide positive feedback for the safe startup of conveyors, such as audio warning, radio communication, CCTV and visual display for the operator
p) Ensure adequate illumination during machinery inspection, maintenance, cleaning and operation
q) The user shall not make alternations which affect the design, construction, installation or handling requirements of the appliances without the consent of the manufacturer constructor and/or the contractor, as some alterations may give rise to detrimental consequences.

7.3.2 Electrical and Instrumented Design Controls: - An electrical and instrumented control safety device must perform one or more of the following functions:-

a) Stop the machine if a hand or any part of the body is inadvertently placed in the danger area (e.g., presence sensing).
b) Call for the operator to use both hands on machine controls (i.e., two-hand control).
c) Provide a barrier that is synchronized with the operating cycle of the machine in order to prevent entry to the danger area during the hazardous part of the cycle (i.e., interlocked guards).
d) Provide a means to stop the machine in the event of an emergency or any malpractice (i.e., emergency stops or safety trip controls, interlocked fixed guard etc.).

7.4 Risk Assessment of Machines:-

This section is focused on purposeful work activities on or around machine entrapment hazards. Each site shall ensure that systems are in place to prevent inadvertent entry into the danger zones of machine hazards through physical barriers (i.e., point of operation guards, perimeter guards, barricades, or enclosures) or controlled access for authorized persons only.

Site Risk Analysis: - Each site shall evaluate their overall machine safety risk using the checklist in Annexure 2 and determine whether the site falls into the low or high machinery safety risk category (HMSR). The evaluation shall be repeated after any significant machine change or machine-related injury incident or at a minimum of every two years.

Risk Assessments (HIRA):- HIRA is to systematically review specific work activities by identifying hazards, assessing risk, and reducing risk to acceptable levels through defined safeguards (See Annexure 3). Often a combination of controls is the most effective option to achieve acceptable levels of risk. These HIRA must be conducted using a cross-functional team, including members from:

a) Those directly exposed to the hazards (e.g., production and maintenance team).
b) Line organization leadership.
c) Technical or engineering representation, with subject matter expertise.

In addition to the routine tasks and subtasks associated with the machine, subtasks known to have high risk, such as adjusting and aligning, belt replacement, shall be included in the HIRA as applicable. The machine hazards, and safeguards identified for each task or subtask must be included in the appropriate documented safe work practice (e.g. SOP/SMP). The risk assessment shall be reassessed at least every two years as long as the hazard or risk remains at moderate or high levels. The outcomes of the HIRA shall help establish the priorities for the HMSR (high machine safety risk). All Sites must plan to annual continuous improvement plans to reduce or eliminate machine risks. Refer Annexure 1 for Annual Improvement Plan.

Human-Machine Interactions: - Each site with the status of HMSR must annually review or update an inventory list of specific human-machine interactive tasks. The inventory list should include all routine, normal operation, and maintenance tasks and all credible, non-routine, abnormal human-machine interactive tasks where people are exposed to hazards from machinery that is energized or stopped. This inventory is the foundation for the annual improvement plan.

7.5 Procedure and Guidelines on Machine Guarding:

Each site operation or process unit that operates or maintains machines shall implement this standard or may prepare its site specific procedure putting more stringent requirement in line with released Machine Guarding Standard, for safe human machine interactions that:

- Identifies the affected personnel (exposed to machine hazards).
- Identifies the machine hazards with the help of HIRA/JSA
- Promotes employee engagement of the affected personnel.
- Meets the requirements of the standard.

Effective Machine Guarding Safety Program is a fundamental component of most workplace safety and health program. Machine guarding helps to prevent body parts, accessories, and clothing from coming into contact with moving or dangerous parts of machinery. Without such guarding, the result can be severe or even fatal. To develop such a program it is important to understand the ways that our machinery moves and the non-moving hazards of the equipment. These movements and hazards can cause severe damage should a body part come in contact. While designing guards, consideration must be given to identify the "Points of Operation" and power transmission sources for each machine or piece of equipment. Knowing both the moving / non-moving hazards of the machinery following solutions is offered as guidance to resolve the problems.

Design and Construction of Guards

- Guards should be made of solid material, mesh, or equivalent construction, and should be designed to prevent persons reaching into the hazardous area. Sheet metal guards shall be not less than 1.5 mm thick.
- For mesh guards, 9 mm mesh shall be not less than 1.5 mm wire thick; 50 mm mesh shall not be less than 3mm wire thickness.
- Guards shall not deflect more than 12 mm under a force of 450 N applied at any point on the guard over a square area of 50 mm side. Guard shall be capable of sustaining a mass of 75 kg placed in any position upon it, together with a simultaneous force of 220 N applied horizontally in the same or any other position.
- The guard shall maintain the required safe clearances. For standardization across all units ISO 13857:2008 specifications and Vedanta guidance Note GN18 on Machine Guarding along with IS 7155 (various chapters) and IS 9474 to be followed.

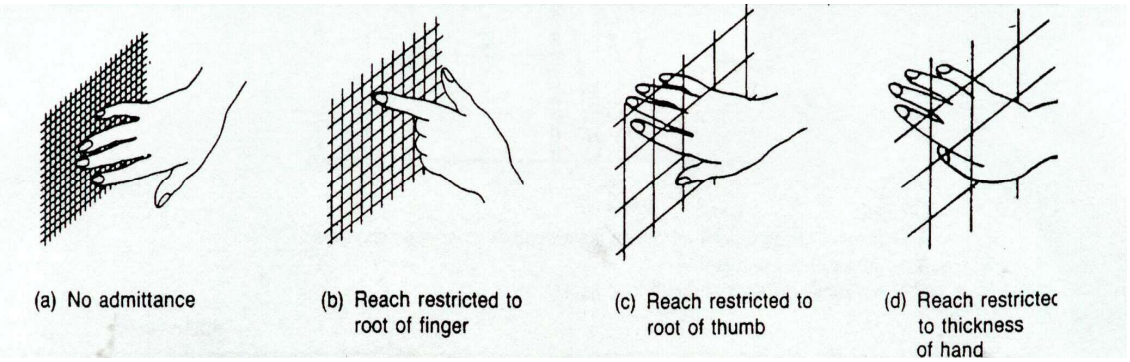
Reach Dimensions

The design and construction of guards and their subsequent location shall be such that the distance of any nip point or shear hazard and the nearest point of access is restricted as follows.

- Arm Reach . . . . . 1000 mm from under arm to fingertips

- Elbow Reach . . . .500 mm from the inside elbow to fingertips
- Wrist Reach . . . . 280 mm from wrist to tip of middle finger
- Finger reaches . . ..150 mm
- Vertical reach . . . 2500 mm maximum when standing on toes.

The above dimensions include an allowance made to obtain clearance from the hazardous area.



Guard Placement

The size of mesh or other openings in the guard and the distance of the guard from the hazardous point shall be as follows:

(a) Size of mesh of opening up to and including 9 mm mesh, distance of guard from the hazardous point virtually same as sheet metal, working clearance only required.

(b) Above 9 mm up to 50 mm mesh, guard at least 150 mm from hazardous point.

(c) All types of guards distance between the underside of the guard and the floor not to exceed 100 mm subjected nip point is beyond reach as per reach dimension criteria mentioned in page No. 13.

Where complete enclosure with a guard is not provided, distance/fence type guards need to be used and the height of the guard and the distance of the guard from the hazardous point shall be in accordance with the below table:-

The table below provides an example of the various height and distance requirements.

Height of nip point from floor or working surface	Millimetres
	Distance from nip point to Guard (c)

(a)	Height of Guard from floor or working surface (b)								
	2290	**2130**	**1980**	**1830**	**1680**	**1520**	**1380**	**1220**	**1000**
2500	-	-	-	-	-	-	-	-	-
2360	75	150	230	230	230	230	230	230	230
2290	75	150	230	300	380	380	380	380	-
2210	-	200	300	300	450	530	530	530	600
2130	-	200	300	450	530	600	600	600	-
2050	-	150	300	450	600	600	600	680	1100
1980	-	150	300	450	600	680	680	750	-
1900	-	-	230	450	600	680	680	840	-
1830	-	-	-	450	600	680	750	840	1200
1750	-	-	-	450	600	750	840	900	-
1680	-	-	-	300	600	750	840	900	-
1600	-	-	-	300	530	750	840	900	1300
1520	-	-	-	230	530	750	840	900	-
1450	-	-	-	-	530	750	840	900	-
1380	-	-	-	-	450	750	840	900	-
1300	-	-	-	-	380	750	840	900	1350
1220	-	-	-	-	-	750	840	900	-
1150	-	-	-	-	-	680	840	900	-
1050	-	-	-	-	-	680	750	840	-
1000	-	-	-	-	-	680	680	840	1400
920	-	-	-	-	-	300	680	940	-
840	-	-	-	-	-	-	600	840	-
750	-	-	-	-	-	-	380	750	-
680	-	-	-	-	-	-	300	600	1200
600	-	-	-	-	-	-	-	530	-
530	-	-	-	-	-	-	-	380	-

Table 1 : Reaching over protective structures – High Risk (from ISO 13857:2008)

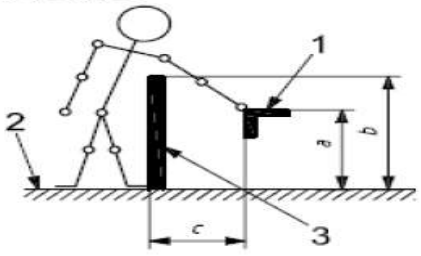
Dimension in millimetres

Height of hazard zone *a*	Height of protective structure [a, b] *b*									
	1 000	1 200	1 400	1 600	1 800	2 000	2 200	2 400	2 500	2 700
	Horizontal safety distance to hazard zone, *c*									
2 700	0	0	0	0	0	0	0	0	0	0
2 600	900	800	700	600	600	500	400	300	100	0
2 400	1 100	1 000	900	800	700	600	400	300	100	0
2 200	1 300	1 200	1 000	900	800	600	400	300	0	0
2 000	1 400	1 300	1 100	900	800	600	400	0	0	0
1 800	1 500	1 400	1 100	900	800	600	0	0	0	0
1 600	1 500	1 400	1 100	900	800	500	0	0	0	0
1 400	1 500	1 400	1 100	900	800	0	0	0	0	0
1 200	1 500	1 400	1 100	900	700	0	0	0	0	0
1 000	1 500	1 400	1 000	800	0	0	0	0	0	0
800	1 500	1 300	900	600	0	0	0	0	0	0
600	1 400	1 300	800	0	0	0	0	0	0	0
400	1 400	1 200	400	0	0	0	0	0	0	0
200	1 200	900	0	0	0	0	0	0	0	0
0	1 100	500	0	0	0	0	0	0	0	0

[a] Protective structures less than 1 000 mm in height are not included because they do not sufficiently restrict movement of the body.

[b] Protective structures lower than 1 400 mm should not be used without additional safety measures.

Reaching over protective structures

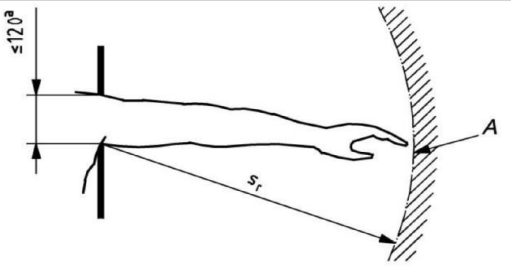
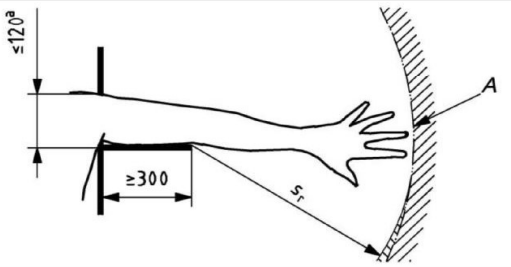
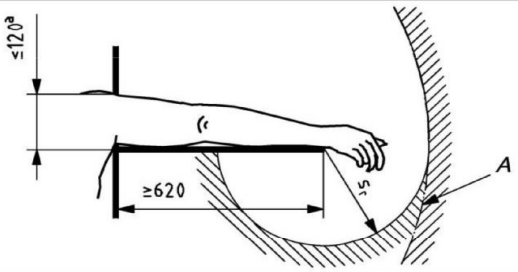
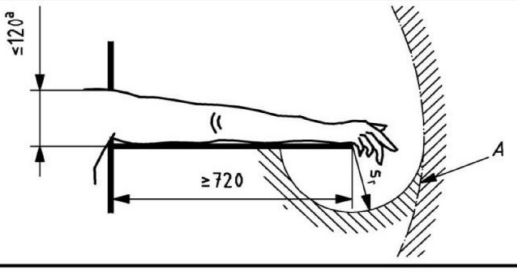


Key

a height of hazard zone
b height of protective structure
c horizontal safety distance to hazard zone
1 hazard zone (nearest point)
2 reference plane
3 protective structure

Table 2: Reaching around with limitation of movement (from ISO 13857:2008)

Dimensions in millimetres

Limitation of movement	Safety distance, s_r	Illustration
Limitation of movement only at shoulder and armpit	⩾ 850	
Arm supported up to elbow	⩾ 550	
Arm supported up to wrist	⩾ 230	
Arm and hand supported up to knuckle joint	⩾ 130	

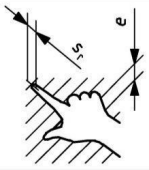
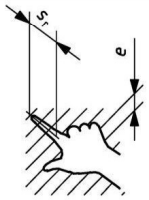
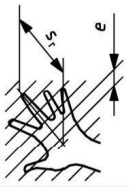
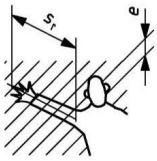
A range of movement of arm

s_r radial safety distance

[a] This is either the diameter of a round opening, or the side of a square opening, or the width of a slot opening.

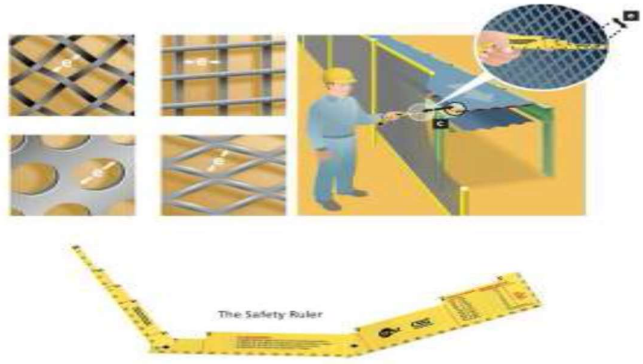
Table 3: Reaching through regular openings – Persons of 14 years of age and above (from ISO 13857:2008)

Dimensions in millimetres

Part of body	Illustration	Opening	Safety distance, s_r		
			Slot	Square	Round
Fingertip		$e \leqslant 4$	$\geqslant 2$	$\geqslant 2$	$\geqslant 2$
		$4 < e \leqslant 6$	$\geqslant 10$	$\geqslant 5$	$\geqslant 5$
Finger up to knuckle joint		$6 < e \leqslant 8$	$\geqslant 20$	$\geqslant 15$	$\geqslant 5$
		$8 < e \leqslant 10$	$\geqslant 80$	$\geqslant 25$	$\geqslant 20$
Hand		$10 < e \leqslant 12$	$\geqslant 100$	$\geqslant 80$	$\geqslant 80$
		$12 < e \leqslant 20$	$\geqslant 120$	$\geqslant 120$	$\geqslant 120$
		$20 < e \leqslant 30$	$\geqslant 850$ [a]	$\geqslant 120$	$\geqslant 120$
Arm up to junction with shoulder		$30 < e \leqslant 40$	$\geqslant 850$	$\geqslant 200$	$\geqslant 120$
		$40 < e \leqslant 120$	$\geqslant 850$	$\geqslant 850$	$\geqslant 850$

The bold lines within the table delineate that part of the body restricted by the opening size.

[a] If the length of the slot opening is $\leqslant$ 65 mm, the thumb will act as a stop and the safety distance can be reduced to 200 mm.



Guarding Access Points:-

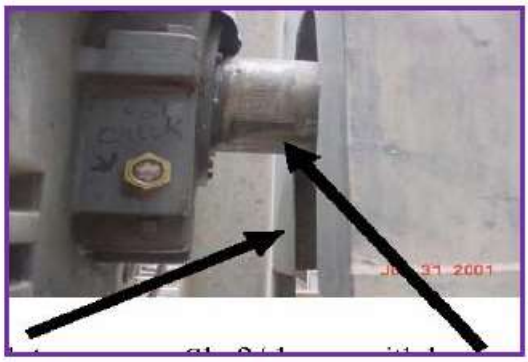
The response to the issue of adequately covering access points addresses general categories of equipment: tail pulleys; drive shafts; drive belts/sheaves; and chains/sprockets.

Tail Pulleys: - The back end of the tail pulley guards do not extend close enough to the ground or walking surface to prevent someone from intentionally reaching under the guard and contacting a moving part. To address this concern, the back end of tail pulley guards should extend to within 100 mm of the ground or walking surface.

Drive Shafts:- Guards covering drive shafts, whether they are smooth shafts or have keyways, setscrews or couplings, should extend far enough in both directions so that no more than ¼ inch of the shaft is exposed at either end. The guard should cover the shaft completely, without a gap at either end.

Drive Belts/Sheaves and Chains/Sprockets:- Guards should extend all the way around drive belts and sheaves as well as around drive chains and sprockets. This means totally enclosing guards must be present on the front, sides, top, bottom, and back areas of the belt or chain drive.

The sprocket and chain in this picture are not effectively guarded.



Slot opening is too large.

Shaft/sheave with key way is not sufficiently guarded.

Maintenance Access Points:- When access is needed to allow machine parts to be greased or lubricated, the guard should include an extension fitting (hose or rigid pipe) that protrudes through the guard sufficiently so there is no chance of contacting moving parts. In some cases, adjusting bolts are associated with moving machine parts (such as with tail pulleys). In such cases, the guards should be constructed so that a person adjusting the bolt is protected from moving parts.

Before Pic **After Pic**

Holes should not be cut in guards to allow for predictive or preventive maintenance testing (e.g., rotational, vibration, temperature, bearing condition analysis). Below are pictures depicting equipment that might be used and the types of applications:-

Equipment for testing bearings, Vibration and temperature.

Where a motion indicator "target" extends beyond a shaft guard, an additional guard should be placed around the target. See the examples below.

Before Pic

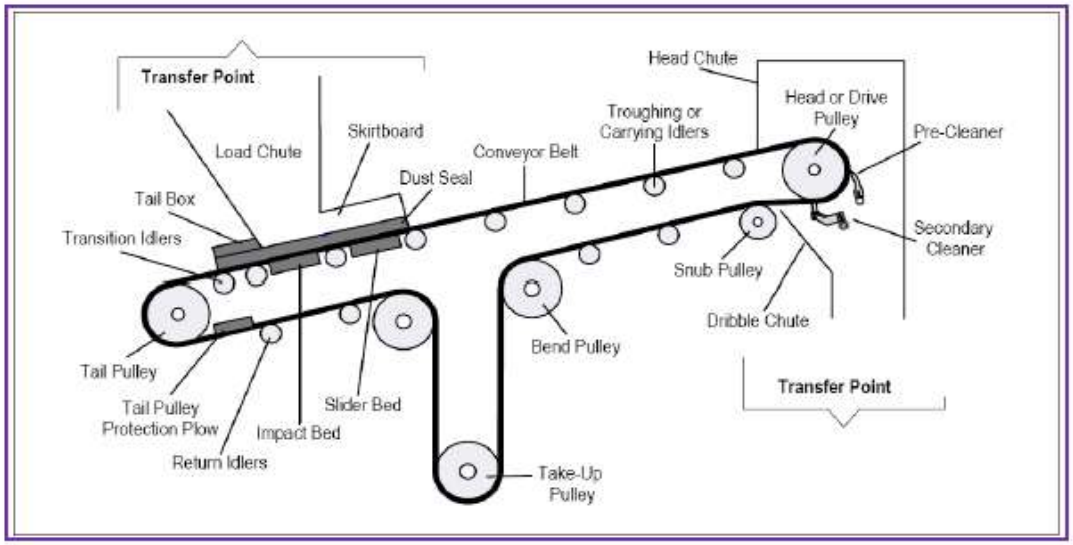
After Pic

8. Conveyor Safety:-

8.1 Introduction:

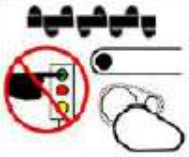
Conveyors have been used within our industry for decades to move large quantities of material over long distances. Of all material handling systems, conveyors typically operate with the lowest transport, maintenance, power and labour costs per tonne of material handled and therefore are an integral part of our operations. Past and recent history within HZL clearly demonstrates that when individuals intentionally or inadvertently contact moving conveyor components they are subject to serious injury or death.

Conveying terminology



8.2 Rules to Live By: - Conveyors have many moving parts and any worker (i.e. employee, contractor, vendor, visitor, and others) who works on or near them must be knowledgeable about conveyor safety. Each rule is important and necessary to prevent serious or fatal injury.

Conveyor Safety Rules to Live By

	***Conveyors SHALL*** only be operated with approved guarding in place		***Workers SHALL NOT*** climb, sit, ride, stand, touch, or walk on or walk under exposed conveyors
	***Workers SHALL*** LOTOTO all energy sources before doing maintenance		***Workers SHALL*** be trained and competent to operate & maintain conveyors
	***Workers SHALL NOT*** modify, misuse or remove controls, interlocks or warning devices		***Workers SHALL*** ensure everyone is away from conveyors before starting
	***Workers SHALL*** keep clothing, tools, body parts and loose hair away from conveyors		***Workers SHALL*** report all unsafe conditions and behaviors

8.3 Conveyor Maintenance: - Maintenance management begins when planning the conveyor system. Conveyors should be designed in ways that will minimize maintenance (e.g. frequently cleaning spillage, etc.) and to facilitate maintenance when it is required. If not, short-cuts will likely be taken if the maintenance task is difficult and time consuming and this will lead to an injury or worse.

8.4 Conveyor Guarding: - Conveyors shall be fitted with guards which prevent access to the nip points. These include the head and tail drums (or pulleys), the feed (or load) chute and feed chute rollers, snub pulleys, v-belts and shaft drives, gravity tension devices, and changes in belt direction. All guards shall be designed to fit for purpose. Principle features include:-

- Robust construction with proper mesh size to prevent finger or hand contact with moving components.
- Suitable for the conditions in which they are used.
- Designed, located and installed to prevent worker access.
- Designed to reduce the need for removal, and when removal is necessary, the guard requires a hand tool to be detached.

Illustrated below are a few examples of guarding methods for conveyors

	Guards should be provided to prevent access to head drums and all associated parts. Note the good walkway extending around both sides of the head drum.
	Guards should be provided to prevent access to tail drums and all associated nip point Guards should be designed such that clean-up, lubrication and tracking can be performed without removing the guard.
	Conveyor snub drums are generally located on the underside of the conveyor directly behind the head drum and should be guarded to prevent access. Return idlers and troughing rollers should be guarded based on risk assessment and local regulations.

	Guards should be designed such that lubrication and adjustment can be carried out without removing the guard for all bearings.
	Guards should be provided to prevent access to the gravity take-up to prevent being crushed by the weights.
	A majority of conveyor take-up pulley assemblies are located along a conveyor walkway. Guards should be provided to prevent access to the take-up pulley assembly.

Conveyor Safety Requirements: - Belt Conveyor Safety Devices must incorporate important safety features including:

- All conveyors (except screw and Drag Chain conveyor which are completely enclosed by OEM during supply) guards must be fixed bolted with interlocks.
- Audible start-up warning system supported by a visible warning system for a minimum of 30 seconds signal time when the entire length of the conveyor is not visible from the starting controls. Wherever applicable the Audible siren should be placed at multiple locations so that siren is Audible for the entire group of conveyors.
- Conveyor should not automatically restart upon resetting of any of the emergency control.
- Emergency pull cords located in a manner as to be clearly visible and readily accessible. The height of pull cord should be such that it lies between your toe and shoulder when you stand straight on ground, as shown which helps to stop the conveyer in case somebody falls on the running system, or it should be between 900MM to 1500MM from ground level.
- Emergency cord wire (pull cord) must terminate at Pull Cord Switches at both ends.
- The pull cord switches should not be more than 30 m apart. Pull cord support shall not be less than 2.5 metres apart and not more than 3 meters apart. Emergency pull cord should cover entire belt lengths from centre of head pulley to the centre of tail pulley and should be placed on both sides of the conveyors. Pull Chord Switches should be Tension type.

- When pull cord is operated than indication must come in the control room and before reset/restart, must be investigated.
- Interlocking of conveyor side guards with an additional distinguished coloured pull cord wire (zig zag pattern) which 'll parallel to existing pull cord wire without defeating its original purpose, guard interlocking installation design should as per Site condition
- Pull cord device should be such that any breaking, slacking or removal of pull cord wire shall activate the device.
- Lighting - Suitable lighting of conveyor systems, equipment and machinery shall be provided. For guidance recommendations of IS: 3646 (Code of Practice for Interior Illumination) to be implemented.
- Fire protection: Adequate fire protection facilities shall be provided as per IS 1641 depending on site condition or required by site(Code of Practice for Fire Safety of Buildings).
- To prevent over-running or running backwards of the conveying device, all inclined or vertical conveyors appliances shall include a safety device which operates whenever the motive power is cut off or fails and where the load conveyed possesses kinetic or potential energy.
- A clear access platform or floor space of at least 600 mm width on both sides shall be provided for the maintenance of every driving mechanism. For all new installations from March 2018 onwards, it should be 1000 mm platform on both the sides.
- Where walkways are provided on both sides of a conveyor and where convenient access to either side of the conveyor may be required by employees, as per risk assessment who regularly works in the area, crossovers shall be provided at appropriate intervals and at the head and tail ends of the conveyors where no other crossing is available. Safe means of access shall be provided at crossovers.
- All chutes should have a chute jamming sensor.
- Sequence interlocks shall be provided at start of every conveyor.
- In case of sequential interlock system, zero speed switch and belt sway switch shall also be provided.
- Surveillance Camera should be installed in non-movement area/Gray area (Which should be specified by site or conveyor length more than 800 mtr)and taken in control room for tail end and head end of the drives.
- Belt rib detector should be provided for all the belt conveyors.
- All starting and stopping devices shall be clearly indicated and easily accessible. It is recommended that they be painted to a specified pattern.
- It is recommended that all lubrication points be painted to a specified pattern. If, for lubrication purposes, it is necessary to remove or to open guards, lubrication shall only be carried out with the equipment rendered inoperative :
- A log-book shall be kept for each appliance and/or for each installation.
- Counterweight tension devices shall be guarded up to a height of 2.5 m at points accessible to personnel.
- Guards shall prevent access to the space directly below the counter-weight.
- 360 Degree Guarding extending to 2.5 metres should be done on both side of the conveyor where there is a cross over or a possibility of material falling over conveyor from upper platform.
- The conveyor feeding shall be regular, avoiding over-loading. The feeding points shall not be changed, particularly not their position, or increase the flow, without previously consulting the manufacturer/constructor.

- All shuttle conveyors must be protected by distance guards/fixed guards with interlocks for complete track length.
- Clear operating instructions concerning the loading of the appliances shall be prominently displayed adjacent to the loading positions.
- No inspection hole shall be opened while the appliance is in operation.
- Normal and emergency stopping devices shall be made known to all personnel and be easily accessible; all areas giving access to them shall be kept clear of obstacles. Their proper working shall be periodically checked.
- It shall be strictly forbidden to cross over or under an appliance except at the points specially provided for the purpose.
- Overhead gentry, portion of road and rail crossings, walkways, galleries, work places under the overhead conveyors used by the personnel, shall be protected by means of suitable covering such as plates/steel sheet covers to prevent falling of the material/objects over such areas/personnel.
- In the case of gangways inclined more than 5 degrees, a suitable non-slip surface to avoid slippage/skidding shall be provided with uninterrupted vertical sheeting on the side remote from the moving appliance.
- Properly designed ladders, walkways and platforms including handrails and toe boards must be ensured.
- Lighting signals and safety signage shall be provided wherever necessary.
- Conveyor Cleaning and Housekeeping: - Many accidents occur during cleaning activities when individuals are working on moving, unguarded conveyors or when the conveyor starts-up unexpectedly. The risk of entanglement is very high and once caught – the victim will suffer a violent injury or death. Workers shall:
  - Never use a shovel or other tool to remove build-up on a running conveyor;
  - Never clean running conveyor drums or pulleys;
  - Never try to dislodge rocks from pulleys while the conveyor is running.
  - Never cross under or over a conveyor unless at a designated and properly guarded crossing
  - Cleaning on or around conveyors shall not be performed unless the power to the conveyor is off, locked-out / tagged-out / tried-out (LOTOTO), and machinery components are blocked against motion.

9. Management Systems:-

Support Resources: - Safety resources in the site, at the corporate and Zone Champions are available to assist with the implementation of this standard.

Management Records: - All records associated with the standard shall be retained for a minimum period of 3 years.

Audits: - Each site shall conduct first party and second party audit with reference to audit standard of HZL. Refer annexure 4 for Belt conveyor scorecard.

Standard Renewal Process: - This standard shall be reviewed and revised as necessary and, at a minimum, not later than two years from the date of the last revision.

Deviation Process: - Deviations from this standard must be authorized by the CSC after consultation with the APEX. Deviations must be written documented, and documentation must include cause of deviations with safety plan.

Training and Communications: - Each Zone or location must be familiar with this standard to carry out its responsibilities. Training on this standard is the responsibility of each Zone and Location. Refresher trainings shall be conducted after every one year.

ANNEXURE 1: Annual Improvement Plan

Item	Responsibility	Start date	Activity or action item description	Completion date
1			Identify/confirm Machine Safety (MS) Champion and Team.	
2			Establish or confirm access to subject matter experts for task assessment.	
3			Evaluate MS event related (ER) injuries for last 1 to 5 years.	
4			Conduct MS Program Self Assessment	
5			Review and update MS task assessments Inventory List and establish Metrics for year	
7			Based on items 1 to 5, establish or update annual improvement plan	
			Implement (Do)	
7			Communicate plan and objectives.	
8			Conduct targeted task based risk assessments.	
9			Conduct MS training with focus on the interrelatedness of safeguards (e.g., lockout, Do Not Touch (DNT), Instrumented Controls, troubleshooting).	
10			Conduct first-party MS audit with focus on administrative controls (see audit checklist).	
11			Inspect and verify MS design safeguards.	
12			Progress and complete tool, design and administrate control upgrades.	
			Track Progress (Check and Correct)	
13			Track progress and corrective action on items 7 to 12.	
14			Review and identify all MS ER's Year To Date (YTD).	
15			Solicit new tasks needing review.	
17			Report progress to Core team.	
			Adjust plans if needed and Recognize Success (Act)	
17			Review and adjust plans.	
18			Communicate progress, and next steps include feedback on new issues identified.	
19			Establish draft Critical Operating Tasks (COTs) for next year.	

ANNEXURE 2 — Site, facility, or process Unit Level Risk Analysis Checklist

	True	False
Site, facility, or process unit has experienced zero machine-related injuries in the last five years, including current year.		
At no time (routine or non-routine) are personnel allowed or authorized to work on or in close proximity to moving product/material or equipment without a documented verifiable safety system (e.g., standard operating procedure [SOP] or work permit [WP]).		
The site, facility, or process unit does have documented safety system(s) (e.g., SOP or WP) for safeguarding tasks related to abnormal or non-routine human-machine interactions, including, but not limited to troubleshooting, process upset, equipment malfunction, power interruption, un-jamming, and adjusting.		
The site, facility, or process unit has need for ―Do Not Touch Exception‖ procedures or SOPs that authorize personnel on specific tasks to work directly on moving product/material or equipment Note : Each site needs to prepare a Do not touch exception & get it approved by director IBU .		
The site, facility, or process unit has an effective process to promote inherently safer machine design on new and or modified equipment.		
The site, facility, or process unit has an inspection process to periodically verify design machine safeguards are in place and working properly.		
The site, facility, or process unit has an effective process to help ensure that only fully qualified persons perform machine-related work.		

Note: "Directly" refers to direct hand contact to moving material or equipment including a gloved hand or cloth in hand. "Direct" is different than "indirect": An indirect touch would be a controlled touch of moving product or equipment by use of an approved hand held tool.

If all the above statements were responded to with ― "true", at the time of analysis, the facility or process unit is deemed to have a **Low Machine Safety Risk (LMSR).**

If any of the above statements were responded to with ―"false" ,at the time of analysis, the facility or process unit is deemed to have a **High Machine Safety Risk (HMSR).**

Note: The ideal state is to have all facilities reach and maintain the LMSR position.

Annexure 3 – Machine Safety Hierarchy of Controls

Control Approach	Activities and/or Systems	Examples	
Remove Hazards			
Elimination or Substitution	Removal of Nip or Pinch Points Automation to replace Human interactions	Eliminate need for task, increase clearance, remove drive energy, and provide local lockout points. Replace manual task with automatic cleaning device or robotics	**More Effective** ↑
Reduce Risks			
Engineering Controls	Guarding and/or Barriers Drive Controls – Disengage or reduce Trips, interlocks, Designed tools Emergency Stops	Distance Guards, ip guards, limited clearance, temporary barricades Reduce drive energy, speed, tension, force Pressure sensors, light curtains, optical beams, gate limit switches, two hand devices, dead persons handles, key locks Mushroom buttons, pull cord	
Warnings	Activated Warnings Passive Warnings	Real time Measurement activated sounds and/or lights Signs	
Administrative controls (operational discipline relies on procedures, training, inspections, auditing)	Body positioning Standard operating Procedures (SOP), Permit to Work (PTW), trouble shooting	Eliminate line of Fire or Elevated position Lockout procedure – Do not Touch Exception, lessen risk with hand held tools, checklist, verification by second person attendant at emergency stop, lower speed, increased distance from danger reduced tackiness	
Protect People			
Personal Protective Equipment (PPE)	Specialist PPE Defined cases when not to use PPE Standard PPE Clothing Design	Impervious Materials, shock resistance gloves No gloves if alongside rotating shafts Light eye protection, gloves, safety shoes, hard hats Tight fitting clothing without external pockets/flaps	**Less Effective**

Note : An exception to no loose clothing w.r.t usage of balaclava which is mandatorily to be worn on conveyors handling hot metal ingots and material.

Annexure 4 – Belt Conveyor Score card

Belt Conveyor Scorecard

S.No.	Requirement	Description	Scoring Criteria	Belt No.
1	Guard Safety	1. Are guards of all drive systems are in place and with fixed bolts 2. Availability of 360 degree Fixed bolt guards at head pulley 3. Availability of 360 degree Fixed bolt guards at tail pulley 4. Availability of 360 degree Fixed bolt guards at all snub and bend pulley 5. Availability of 360 degree Fixed bolt guards at take up pulley at every accessable point 6. Availability of Guards on carrying side 7. Availability of Guards on return side	If all 7 points comply than score 10, else 0	10
2	Guard Effectiveness	1. All Guards should be effective and maintain minimum clearance from the line of fire as per IS Standard 9474 2. Guards are not more than 20 mm deflected	Score 10 if both points are comply, else 0	10
3	Safety Interlock	1. Are conveyor belts provided with emergency stop cables that extend the entire length of the conveyor belt to allow access to the cable from any point along the belt. 2. Emergency Safety cord (pull cord) should terminate at Pull Cord switches. 3. Are all pulleys (head, tail, snub, bend and take up) provided with guard sensors and its interlock is healthy 4. Are side guards provided with guard sensors and its interlock is healthy 5 Audible/visual belt start up warning indicator available and in line	If all 5 points comply than score 10, If any 4 points comply than score 5, else 0	10
4	Conveyor Interlocks	1. Are conveyors equipped with interlocking devices that shut them down during electrical or mechanical overload such as product jam or other stoppage. 2. BSS and its interlocks is healthy 3. ZSS and its interlock is healthy 4. Are Rib detectors installed on belt conveyor and are in line 5. Are chute jamming detectors installed and are in line	if all 5 point comply then scroe 10, If point 1,2 and 3 comply then score 5. else 0	10
5	Illumination Level	Illumination is as per IS 6665 Standard along conveyor length	Score 10 if if Illumination compliance is throughout the lenght of conveyor, else 0	10
6	General house keeping	Based on frequency of maintaining 5s condition	1. When cleaning not required, score 5, 2. When cleaning required to maintained after every 1 months, score 4, 3. When cleaning required to maintained after every 3 weeks, score 3, 4. When cleaning required to maintained after every 2 weeks, score 2, 5. when cleaning required to maintained in less than 2 weeks score 0.	5
7	Cleaner/scraper condition	Based on carryback	1. No carryback, score 5, 2. Carryback found on 10% of return roller score 4, 3. Carryback found on 11-30% of return roller score 3, 4. Carryback found on 31-60% of return roller score 2, 5. else 0	5
8	Belt Tracking/Sway	Based on frequency of adjustment	1.Not required, score 5 2. Required in 3-4 months, score 4 3. Required in 1-2 months, score 3, 4. Required within 10-25 days, score 2 5. Else 0	5
9	Impact Pad	Based on changing frequency/adjustment	1. Changing time is more than 3years,score 5 2. Changing time is between 2-3 years,score 4 3. Changing time is b/w 1-2 years,score 3 4. Changing time is b/w 6-12 months,score 2 5. Else 0	5
10	Transfer Point Spillage	Based on quantity of spillage	1. No spillage, score 5 2. spillage less than 1 tonne, score 4 3. Spillage b/w 1-2 tonne, score 3, 4. Spillage b/w 2-2.5 tonne score 2, 5. Else 0	5
11	Skirting System	Based on changing frequency/adjustment	1. Changing time is more than 3years,score 5 2. Changing time is between 2-3 years,score 4 3. Changing time is b/w 1-2 years,score 3 4. Changing time is b/w 6-12 months,score 2 5. Else 0	5
12	V-plough	Based on carryback to tailpulley	1. No carryback to tail pulley, score 5, 2. 10% Carryback found on tail pulley score 4, 3. 11-30% Carryback found on tail pulley score 3, 4. 31-60% Carryback found on tailpulley score 2, 5. else 0	5
13	Condition of Rollers/Idlers	Based on condition of rollers	1. All rollers working, score 5 2. Less than 10% rollers are not working , score 4 3. 11-30% rollers are not working, score 3 4. 31-70 % rollers are not working, score 2 5. else score 0	5
14	Belt Tension	Based on frequency of adjustment	1.Not required, score 5 2. Required in 3-4 months, score 4 3. Required in 1-2 months, score 3, 4. Required within 10-25 days, score 2 5. else score 0.	5
15	Checklist Compliance	Based on Checklist fill up	If checklist is filled fortnightly score 5, else 0	5
	Total Marks			**100**