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RISK ASSESSMENT AND BEST SAFETY PRACTICES ON CONVEYORS

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Abstract: This project deals with various types of hazards identification & finding a risk assessment (HIRA) and identifying best safety practices on conveyors including conveyor guarding, hazardous energy isolation and visual inspection procedures for industries that utilize conveyor systems. The safe working operation of conveyors needs to identify the hazards, assess the associated risks and bring the risks to tolerable level on a continuous basis. Each year, physical contact with machines and powered equipment accounts for a significant number of life-altering injuries and fatalities. A number of these incidents involve conveyor systems. The majority of these incidents occur during maintenance activities with conveyors still in operation and danger zones unprotected. A risk assessment is an important step in protecting the conveyors and humans from such conditions. It helps us to focus on the risks that really have the potential to cause harm. Risk classification by probability and severity can be performed by using a risk assessment class. Then risk level is assigned to each hazard for identifying required Preventive measures to minimize the risk or eliminate the Hazard. Preventive measures should be implemented in order for work on or near conveyors to be performed safely. Right from the design stage, worker exposure to hazards should be controlled by reducing the frequency of conveyor clean-ups, conveyor maintenance, removal of jams, etc. This project to best safety practices suggests possible preventive measures, but it is by no means exhaustive. In many situations, hazards must be analysed before any preventive measures are implemented.

Index Terms **- hazards, risk assessment, safety practices, conveyors, safe guards.**

I.INTRODUCTION

1.1 CONVEYORS

A conveyor system is a fast and efficient mechanical handling apparatus for automatically transporting loads and materials within an area. This system minimizes human error, lowers workplace risks and reduces labour costs among other benefits. They are useful in helping to move bulky or heavy items from one point to another. A conveyor system may use a belt, wheels, rollers, or a chain to transport objects.

1.1.1 Conveyor systems work

Typically, conveyor systems consist of a belt stretched across two or more pulleys. The belt forms a closed loop around the pulleys so it can continually rotate. One pulley, known as the drive pulley, drives or tows the belt, moving items from one location to another. The most common conveyor system designs use a rotor to power the drive pulley and belt. The belt remains attached to the rotor through the friction between the two surfaces. For the belt to move effectively, both the drive pulley and idler must run in the same direction, either clockwise or counter clockwise. While conventional conveyor systems such as moving walkways and grocery store conveyors are straight, sometimes, the unit needs to turn to deliver the items to the proper location. For the turns, there are unique cone-shaped wheels or rotors which allow the belt to follow a bend or twist without getting tangled.

1.1.2 Benefits of conveyor systems

The main purpose of a conveyor system is to move objects from one location to another. The design allows for movement of objects that are too heavy or too bulky for humans to carry by hand. Conveyor systems save time when transporting items from one location to another. As they can be inclined to span multiple levels, they make it simpler to move items up and down floors, a task that, when performed manually by humans, causes physical strain. Inclined belts can automatically unload material, eliminating the need for someone to be on the opposite end to receive pieces.

1.1.3 Types and examples of conveyor systems

You can probably imagine a large warehouse filled with conveyors using belts and rollers to move boxes and other heavy equipment, but this is just one of several types of conveyor systems. You'll also find conveyor systems in airports, where they're used to transport luggage. Other examples include escalators and ski lifts. These apparatuses still use a belt or chain and pulleys to move heavy items from one point to another.

There are many types of conveyor systems, including:

- Belt
- Roller
- Slat/apron
- Ball transfer
- Overhead
- Pneumatic
- Bucket
- Chute
- Magnetic
- Vertical
- Wheel
- Walking beam
- Vibrating
- Screw/auger
- Chain

1.2 COMPONENTS OF A CONVEYOR BELT

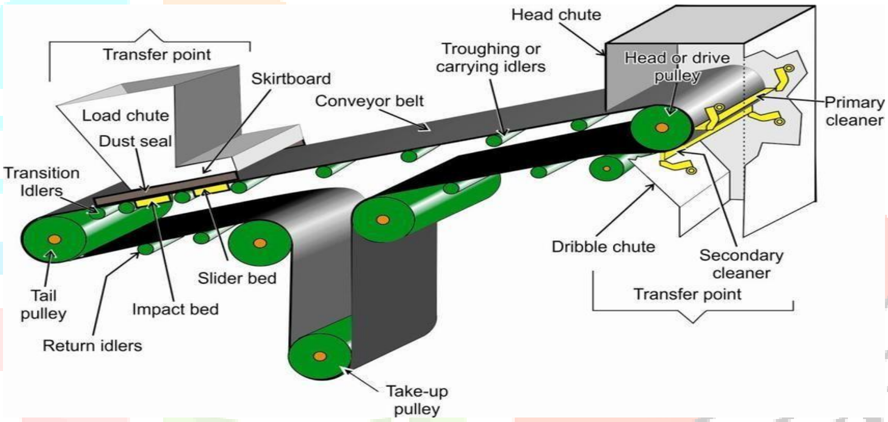

Fig.1; components of belt conveyor

1.3 PARTS OF BELT CONVEYORS:

Belts: Various types of textile belts are employed in belt conveyors: Camel hair, cotton (woven or sewed), duck cotton. Rubberized textile belts are widely used. Conveyors belts should meet the following requirements:

- Low hygroscopocity
- High strength
- Low own weight (Light in weight)
- Small specific elongation
- High flexibility
- High resistivity to ply (Layer of material)
- Long service life

Rubberized textile belts: Rubberized textile belts are made from several layers known as pliesof a rough woven cotton fabric known as belling. The plies are connected by vulcanization with natural or synthetic rubber. Sometimes the plies are made of extra – strong synthetic fabrics, Capron, perlon, nylon etc.

1.3.1 Idlers

Generally the belt is supported by idler rollers, in rare cases by a solid wood, or sheetsteel, runway or a combination support comprising sections of a runway alternating with idle rollers. Idlers are used mainly in conveyors handling bulk loads, less frequently unit loads, while runways and combined supports are predomiantly used for piece goods. According to their location on the conveyors, idlers are classified as upper (supporting the loaded strand of the belt) and lower (supporting the idler return strand of the belt).

1.3.2 Centering device

A number of reasons, such as eccentric loading, soiling, sticking of the material to the pulleys and rollers etc., may cause the belt to run crooked. To prevent the belt from running off the rollers, special "Belt training idlers" of various designs are used. These idlers automatically maintain belt alignment with respect to a device (idlers) called centering device.

1.3.3 Take ups

A belt conveyor may have a mechanical (screw type) or counterweight (gravity type) take up. The latter may in turn be divided into carries – type (sometimes called horizontaland vertical. In the screw take up the tensioning pulley simultaneously serves as deflecting til or pulley androtates on a fixed shaft (best design) or in terminal bearings (worst design). In gravity take ups the tensioning pulley (serving simultaneously as tail and pulley) is placed on a movable carriage which is pulled backwards by means of a steel rope and deflecting pulleys. The vertical counterweight take up consists of three pulleys, (two deflecting and one tensioning) and are installed on the return strand of the conveyor. N.B. The carriage type take-up is superior to the vertical type because it is of much simpler design of considerably less height.

1.3.4 Drive units

In belt conveyors motive power is transmitted to the belt by friction as it wrapsaround the driving pulley rotted by an electric motor; the drive comprises the following parts:the pulley (Sometimes two pulleys), motor and the transmission gear between the motor and the pulley. Drives of inclined conveyors include a braking device which prevents slipping backof the loaded belt under the weight of the material conveyed if the current supplying the motoris interrupted.

1.3.5 Loading & discharging

Loading depends on the nature & characteristics of the load conveyed and the method of loading.

Example: Charging

For piece goods various types of chutes are directly loaded onto the belt.For loose materials feed hopper
Discharging: Generally employed by

- Scrapper ploughs
- A throw – off carriage known as tripper (only used for bulk materials.

1.3.6 Belt Cleaner:

In case of dry particles: The clinging dry particles are cleaned by scrapper/wiperIn case of wet and sticky materials: Revolving brushes are used
Scrappers are mounted on end pulley Brushes are mounted on lower num.
Belt cleaners are mounted near the discharge pulley.

1.3.7 Automated hold back brakes:

A sudden stoppage of a loaded inclined belt conveyor may cause slipping back of the loaded belt. This will happen if longitudinal component of load weight which is larger than the forces of frictional resistance to belt motion.

- ❖ To prevent this type of spontaneous movement of the belt, a special hold back brake is mounted on the main or auxiliary shaft which keep inclined in conveyor.
- ❖ It is a special protecting device which automatically disconnects the drive when thebelt slips on the pulley.

1.4 SCREW CONVEYOR

A screw conveyor or auger conveyor is a mechanism that uses a rotating helical screw blade, called a "flighting", usually within a tube, to move liquid or granular materials. They are used in many bulk handling industries. Screw conveyors in modern industry are often used horizontally or at a slight incline as an efficient way to move semi-solid materials, including food waste, wood chips, aggregates, cereal grains, animal feed, boiler ash, meat, and bone meal, municipal solid waste, and many others. The first type of screw conveyor was the Archimedes' screw, used since ancient times to pump irrigation water.

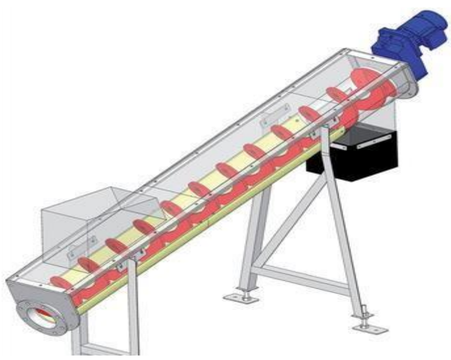

Fig.2; screw conveyor

1.5 BUCKET ELEVATOR

A bucket elevator, also called a grain leg, is a mechanism for hauling flowable bulk materials (most often grain or fertilizer) vertically.

It consists of:

1. Buckets to contain the material;
2. A belt to carry the buckets and transmit the pull;
3. Means to drive the belt;
4. Accessories for loading the buckets or picking up the material, for receiving the discharged material, for maintaining the belt tension and for enclosing and protecting the elevator.

A bucket elevator can elevate a variety of bulk materials from light to heavy and from fine to large lumps.

A centrifugal discharge elevator may be vertical or inclined. Vertical elevators depend entirely on centrifugal force to get the material into the discharge chute, and so must be run at a relatively high speed. Inclined elevators with buckets spaced apart or set close together may have the discharge chute set partly under the head pulley. Since they do not depend entirely on centrifugal force to put the material into the chute, their speed may be slower.

Fig.3; bucket elevator

1.5.1 Working principle

Charge/ Load: Here, no extra force is needed to collect the bulk material. Only gravitational force is acting on the material.

1.6 CHAIN CONVEYORS

A chain conveyor is a type of conveyor system for moving material through production lines.

1.6.1 Operation

Chain conveyors use an endless chain both to transmit power and to propel material through a trough, either pushed directly by the chain or by attachments to the chain. The chain runs over sprockets at either end of the trough. Chain conveyors are used to move material up to 90 metres (300 ft), and typically under 30 metres (98 ft). Chain conveyors utilize a powered continuous chain arrangement, carrying a series of single pendants. The chain arrangement is driven by a motor, and the material suspended on the pendants are conveyed. Chain conveyors are used for moving products down an assembly line and/or around a manufacturing or warehousing facility. Chain conveyors are primarily used to transport heavy unit loads, e.g. pallets, grid boxes, and industrial containers. These conveyors can be single or double chain strand in configuration. The load is positioned on the chains, the friction pulls the load forward.[2] Chain conveyors are generally easy to install and have very minimum maintenance for users.

1.6.2 Types

Types of chain conveyor include apron, drag, plain chain, scraper, flight, and en-masse conveyors.

1.6.3 Drag conveyor

Drag conveyors, variously called drag chain conveyors, scraper chain conveyors and en-masse conveyors, are used in bulk material handling to move solid material along a trough. They are used for moving materials such as cement clinker, ash, and sawdust in the mining and chemical industries, municipal solid waste in cinerators, and the production of pellet fuel.

The difference between drag conveyors, scraper conveyors, and flight conveyors largely depends on whether the chain links have obvious flights or paddles attached. In a drag conveyor, the chain moves the material directly, while a flight conveyor uses a series of wood, metal, or plastic flights attached to the chain at regular intervals, which push the material along the trough.

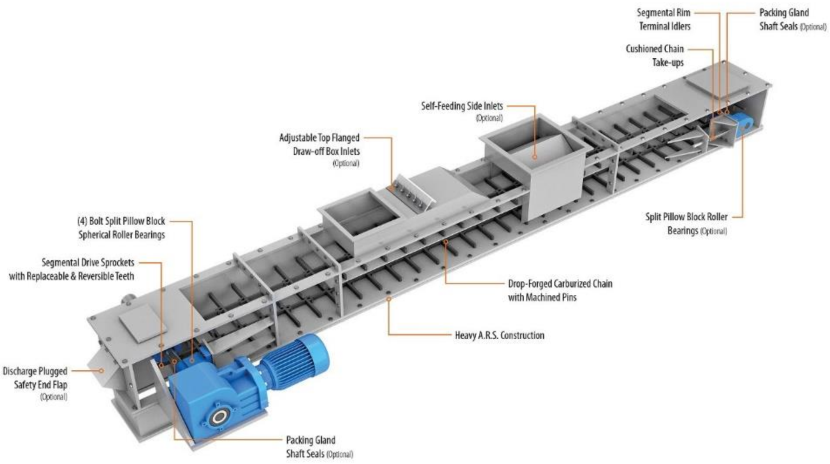

Fig.4; drag chain conveyor

II. METHODOLOGY

Hazard identification and risk assessment is a combinations deterministic, probabilistic and quantitative method. The deterministic methods take into consideration the products, the equipment and the quantification of the various targets such as people, environment and equipment. The probabilistic methods are based on the probability or frequency of hazardous situation apparitions or on the occurrence of potential accident. The quantitative methods analyses various data numerically.

The five steps of hazard identification and risk assessment are:

Step1: System Description
Step2: Hazard Identification
Step3: Risk Assessment
Step4: Risk Rating
Step5: Resolve the Risk

The above steps for hazard identification and risk assessment (HIRA)

Step1: System Description:

Define the system and there subsystem and operations or activities.

Step2: Hazard Identification

Defining and describing a hazard, including its physical characteristics, magnitude and severity, causative factors, and locations or areas affected.

Step3: Risk Assessment

Analyse the Probability, frequency or likelihood the potential losses associated with a hazard.

Step4: Risk Rating

Risk Classification Screening Table is formed and value of hazard or calculated risk class gives the require action to be taken.

Step5: Resolve the Risk

Corrective action recommended preventing, reducing or transferring the risks, by short and long term planning.

III. MAJOR HAZARDS DESCRIPTION IN CONVEYORS

The given table as follows to the major hazards in the conveyors. Table.1

S.NO	SPECIFICATION	HAZARDS
1.	**Power transmission moving parts**	Drive shaft; shaft end; sprocket; pulley; chain; drive belt; gear coupling
2.	**Belts**	Belt in good condition Deteriorated belt or belt splice
3.	**Conveyor belts in a straight run**	In-running nips between the rollers/load beds under the hopper Load side under the skirt board or skirt In-running nips between load side and support rollers in a straight run In-running nips between lower strand and return rollers in a straight run Return strand scrapers Return rollers
4.	**Curved zone**	In-running nip between the belt and rollers in the curved zone
5.	**Transition zone**	In-running nips between the load side and the load carrying rollers in the transition zone
6.	**Drums**	In-running nips between belt and drums Take-up system Junction between two conveyors. In-running nips between belt and drums.
7.	**Moving loads**	Load and load carrying rollers exceeding belt width Loads falling from the belt
8.	**Moving sub assembly**	Pushers; bumpers; ejectors; sorters
9.	**Moveable conveyors**	Vertical and/or horizontal movement
10.	**Screw conveyors**	Screw conveyors are troughs with a revolving shaft with a spiral or twisted plate. In-going nip points for the entire length of the screw conveyor exist between the revolving shaft and trough. Because the trough may not be covered and the conveyor may be located at or near floor level, screw conveyors can be particularly dangerous.
11.	**Chain conveyors**	Nip points occur when a chain contacts a sprocket. Nip points also occurat drives, terminals, take-ups (automatic take-ups may also have shear points), and idlers. Clothing, jewelry, and long hair may also get entangled and caught in the moving chain conveyor.
12.	**Roller conveyors**	Roller conveyors are used to move material on a series of parallel rollers that are either powered or gravityfed. Powered roller conveyors can snag and pull hands, hair, and clothing into the area between the rollers and the stationary components of the conveyor. In-going nip points may exist between the drive chain and sprockets; between belt and carrier rollers; and at terminals, drives, take-ups, idlers, and snub rollers.

IV. HAZARD IDENTIFICATION AND RISK ASSESSMENT

Hazard Identification and Risk Assessment (HIRA) is a process that consists of a number of sequential steps such as hazard identification, consequence & frequency assessment, risk estimation based on the existing controls and recommendations to reduce those risks which are not under acceptable limits. Hazard Identification and risk assessment vary greatly across industries, ranging from simple assessment to complex quantitative analyses with extensive documentation.

Risk assessment is a process or application of a methodology for evaluating risk as defined by probability and frequency of occurrence of a hazard event, exposure of people and property to the hazard, and consequences of that exposure. Different methodologies exist for assessing the risk of natural hazard events, ranging from qualitative to quantitative. A tool for helping to identify, evaluate and control the risk. The tool facilitates to assess each manufacturing step with respect to critical operations and identify the hazardous process.

4.1 STEPS INVOLVED IN HIRA:

Step 1 -Identification of Hazard

Step 2 -Risk Assessment

Step 3 -Monitor and Review

Step 4 - Control

4.1.1 Step 1-Identification of Hazard:

Accurately identifying potential hazards in the workplace is the first step in developing a HIRAC. Conduct a work site inspection and observe how work tasks are performed, assess equipment workers are using, and analyze the design and layout of the work area. Consider non routine operations, such as maintenance, cleaning operations, or changes in work cycles. All the processes and situations that could possibly harm workers, students, or visitors that may be on campus must be considered. Hazards can be identified by reviewing manufacturers' manuals, safety reports, and work site inspections, as wellas conducting worker interviews and reviewing incidents in the workplace or similar work areas. Other common hazards include, motorized equipment, energized equipment, extreme temperatures, noise, vibration, violence work design (poor ergonomics), working alone, material handling, fuel storages, raw material moving work and theft.

4.1.2 Step 2 Risk Assessments:

Once hazards are identified, the next step is to decide what to do about them risk assessment. Risk assessment uses a rating system to quantify risk and prioritize mitigation. Risk is assessed by considering the probability of an event occurring in combination with the severity of harm the event would cause to the University community, the public and theenvironment if it occurred. Each identified risk is given a rating using the Risk Rating Matrix which is recorded on the HIRAC plan.

PROBABILITY FACTORS are scored based on the likelihood of risk occurrence:

Rare - Possible but unlikely – Likely – Often – Frequent

SEVERITY FACTORS are scored based on the impact of the risk:

Insignificant –Minor – Significant – Major – Catastrophic

4.1.2.1 Probability matrix

Rating	Category	Indicative Frequency (expected to occur)
5	Frequent	Daily or twice in a week
4	Often	Occurs several times per year ie., Once in a month or up to three months
3	Likely	Once in a year
2	Possible but unlikely	Once in every ten years.
1	Rare	Once every 30 years.

Table.2; Probability matrix

4.1.2.2 Severity table:

Rating	Category	Consequence
5	Catastrophic	Multiple fatalities, or significant irreversible effects to more than one persons.
4	Major	Single fatality and/or severe irreversible disability (>30%) to one or more persons
3	Moderate	Serious injuries requiring off-site treatment by medical practitioner or immediate hospitalization. Potential long-term or permanently disabling effects.
2	Minor	Injuries requiring on-site treatment by medical practitioner. Personnel unable to continue to perform duties.
1	Insignificant	Minor injuries, which may require first aid. Injured personnel can continue to perform normal duties.

Table.3; Severity table

4.1.2.3 Risk matrix

Consequence Probability	Insignificant (1)	Minor (2)	Moderate (3)	Major (4)	Catastrophic (5)
Rare (1)	1	2	3	4	5
Possible (2)	2	4	6	8	10
Likely (3)	3	6	9	12	15
Often (4)	4	8	12	16	20
Frequent or Almost certain (5)	5	10	15	20	25

Table.4; Risk matrix

4.1.2.4 Risk level screening table

Score	Risk category	Action to be taken
15 to 25	Extreme Risk	Activity should not proceed in the current form
8 to12	High Risk	Activity should be modified to include remedial planning
4 to 6	Moderate Risk	Activity can operate subject to management control and modification
1 to 3	Low Risk	No action required

Table.5; Risk level

4.1.3 Step 3 Monitor And Review:

Assess effectiveness of selected controls the worker and the worker's supervisor are responsible for the evaluation of the effectiveness of the hazard control selected and to make improvements where deficiencies are identified. This can be done through regular inspections, testing and monitoring, evaluations of complaints or concerns received and investigations into near misses or other incidents. Other situations that may prompt evaluation include: Repeated non-compliance, which could be of lack of training, supervision, or other problems in the control that cause persons to be reluctant to implement them. For example, implementing control that creates another hazard. Failure toreduce risk. For example, testing may demonstrate that there has been no change in the measured risk after the control has been implemented. In other cases students/staff or others may have a continued complaint.

Controlling hazards requires ongoing effort. Monitor the effectiveness of the hazardcontrols in place and improve those that don't measure up.

Best practice includes

- Regular inspections.
- Testing (e.g. air quality, if applicable)
- Reviewing Injury/illness statistics.
- Identifying new hazards.
- Addressing safety concerns as soon as possible.

4.1.4 Step 4 Control:

All hazards must be controlled either by removing the hazard or reducing its risk of harmto an acceptable level, both proactively (to prevent its occurrence) and reactively (tominimize harmful effects in the event it does occur). Often, more than one hazard control method must be implemented. For example, certain chemicals require a combination of proper storage, labeling, safe work practices, the use of Personal Protection Equipment (PPE) and emergency response equipment, procedures, and training in order to effectively control the hazards. When considering how to reduce the risk, best practice is to follow the hierarchy of hazard controls.

4.1.4.1 Elimination or substitution

Eliminating the hazard completely is always the first choice (e.g. redesign the work process). Substitution involves replacing the material or process with a less hazardous one. Consider these questions: o Can I find safer ways to perform the task? For example, if falling is a hazard, eliminate the risk by storing stock at lower heights so workers don't have to reach the goods. o Can I use something less harmful? For example, if stock isstored high, consider substituting a step stool for a rolling staircase with a railing. Make sure the substitution doesn't create new hazards such as tripping.

4.1.4.2Engineering controls

If it's not practical to eliminate the hazards or substitute safer alternatives, engineering controls are the next best options. Engineering controls are physical changes tothe workplace that prevent workers from being exposed to a hazard and may include machine guards, noise enclosures, ventilation to dilute the concentration of a hazardous substance). For example, while working at heights cannot be avoided in construction, guardrails can be installed to prevent falls from happening.

4.1.4.3Administrative controls

Administrative controls involve identifying and implementing safe work procedures. A risk assessment will usually form the basis of these safe work procedures. Examples of administrative controls include implementing working alone procedures, training, and supervision.

4.1.4.4Personal protective equipment and clothing (PPE)

Personal protective equipment is a common control, and is a last resort to protect workers from hazards that are difficult to eliminate or engineer out. For example, the use of protective eyewear will help to reduce the exposure risk to foreign bodies for work involving cutting and grinding.

The worker and the worker's supervisor are responsible for the evaluation of the effectiveness of the hazard control selected and to make improvements where deficiencies are identified. This can be done through regular inspections, testing and monitoring, evaluations of complaints or concerns received and investigations into near misses or other incidents.

V. BEST SAFETY PRATICES ON CONVEYORS

5.1 SAFEGUARDS AGAINST HAZARDS

5.1.1Hazard assessment and reduction

The process for hazard assessment and reduction.The following guidelines will be helpful in hazard assessment, elimination and control:

- ❖ Hazard assessment must be done to identify existing and potential hazards.
- ❖ Identified hazards must be eliminated or reduced.
- ❖ The hazard assessment process must be documented and, should any changes in processoccur, repeated.
- ❖ Workers must be informed of all hazards, and all affected workers must be involved in assessment, elimination and control of hazards identified.
- ❖ For each hazard that cannot be eliminated or reduced by engineering or administrative controls, safeguards or protective devices must be installed.

5.2 SAFEGUARDS AGAINST MECHANICAL HAZARDS

5.2.1 General principles

Many danger zones exist in and aroundconveyor belts. Hazards are located in these danger zones. Section 310 of the Code describesprovisions relating to the installation of guards and protective devices on machines.

A conveyor must be constructed in such a way as to notallow access to danger zones or, by default, must be equipped with guards and protective devices. Deterrent devices may also be used.

Various types of conveyor belt protectors and deterrent devices, as well as safety requirements for conveyor sub-assemblies, are described below.

Preventive measures for hazards related to conveyor operation must be implemented when ahazard is 2700 mm or less from the floor or working platform.

5.2.2 Guards

A guard is a machine element that makes the danger zone inaccessible by isolating it. Guardson conveyor belts are required to be designed with operating conditions in mind. They should be capable of resisting the loads to which they will be subjected. These devices must not create additional hazards or tempt workers to bypass their use. The dimensions and weight of movable guard components should to be designed to allow for easy handling. To this end, it is preferable to have articulated or hinged guards. Guard removal and reinstallation should be quick and easy. Ideally, guards should be self-locking when closed. For more information on user-related characteristics (color, ease of manipulation, etc.) and guard construction, see Appendix A of this guide.

There are three types of guards:

1. fixed guards
   - ❖ surrounding fixed guards
   - ❖ barrier guards (fixed distance)
   - ❖ in-running nip fixed guards
2. interlocking guards
3. interlocked guards with guard locking

5.2.3 Fixed guards

A fixed guard is a permanent part of the machine. It is not dependent upon moving parts to performits intended function. It may be constructed of sheet metal, screen, wire cloth, bars, plastic, or any other material substantial enough to withstand whatever impact it may receive, and to endure prolonged use. A fixed guard is usually preferable to all other types because of its permanenceand relative simplicity.

Guards may be easily opened with tools or keys, for instance when equipped with quarter-turnlatches. When keyed latches are used, responsibility for controlling and distributing socket keys or tools must be assigned.

5.2.4 Surrounding fixed guards

This is a fixed guard that either completely or partially surrounds the danger zone. (Because ofopenings required for belt and load passage, surrounding fixed guards may only partially surroundthe danger zone.)

In conveyor belts, fixed guards that only partially surround the danger zone take on two principle shapes:

- ❖ partial cages, as illustrated and used mainly for head and return drumsside screens, as illustrated

Guards must extend beyond the in-running nips between the belts and rollers so as to make them inaccessible from above, below and from the ends.

5.2.5 Barrier guards

Barrier guards do not completely surround danger zones but rather restrict or prevent access by their size and separation from the danger zone.

5.2.6 In-running nip fixed guards

A fixed guard can be placed at a height of an in-running nip that will not allow access to this zone. In-running nip fixed guards may beform-fitting or made from angled deflectors with side plates. They are well suited to an individual loadconveyance, as well as to rollers and drumswith a smooth, unbroken surface. They maybe used in troughed conveyor belts as long asthey have followed the belt profile. However,these guards are ill-suited to cleated type,ribbed or raised-edge belts.

5.2.7 Interlocking guards

A guard equipped with an interlocking device should have the following characteristics. It should:

- cause the machine or the operation of its hazardous components to stop as it isslightly opened
- make it impossible to start the machine or to operate its hazardous components for as long as it is not in place
- not cause the machine or its hazardous components to restart once it is fully restored to its place

5.2.8 Interlocked guard with guard locking

An interlocked guard equipped with a locking device should have the following characteristics. It should:

- remain locked in place for as long as the machine or its hazardous components aremoving
- make it impossible to start the machine or to operate its hazardous components for as long as it is not in place and reactivated
- not cause the machine or its hazardous components to be restarted once it is restored to its place and reactivated.

5.3 SAFEGUARDS AGAINST OTHER HAZARDS

5.3.1 HAZARDS GENERATED BY POOR ERGONOMIC DESIGN

Equipment must be designed so that operators and other users need not assume constrainingwork postures, overexert themselves or carry out repetitive movements.

Control devices must be grouped near workstations to allow easy access for operators and other users. Such devices must be located outside danger zones so that activating them does not createhazards and so that workers do not have to enter the danger zones to access them. They must be positioned to prevent unexpected start-ups, and protected.

5.3.2 Heat-related hazards

Where conveyed products or any part of the equipment may cause burns, take the following precautions:

- Prevent contact with conveyed loads and hot (or cold) surfaces by using screens or fixedsurrounding or barrier guards.
- Reduce the temperature of hot surfaces

5.3.3 ELECTRICAL HAZARDS

Conveyor electrical equipment must conform to the Canadian Electrical Code. Such equipment includes materials, accessories, devices, appliances, fasteners and other equipment used in the electrical power supply of a conveyor or in connection with a conveyor, including power disconnect devices.

5.3.4 FIRE AND EXPLOSION HAZARDS

The use of a conveyor can present a fire and explosion hazard. This hazard can be caused by the use of the conveyor itself or by the load (for example, combustible particles) the conveyor iscarrying. Such hazards may be amplified by tunnels or by the stack effect. Preventive measures that may be implemented.

5.3.5 INAPPROPRIATE PERSONAL PROTECTIVE EQUIPMENT AND UNSAFE ACTS

Based on the hazard assessment of the work site, adequate personal protective equipment, including clothing, footwear and respirators, must be selected and worn by workers.

Unsafe acts such as climbing over or under a conveyor, or stepping over, walking on or riding on a conveyor, must not be tolerated.

5.4 SAFEGUARDS AGAINST CONTROL SYSTEMFAILURES OR MALFUNCTIONS

5.4.1 Start-Up

Start-up of equipment must require a voluntary action. Equipment start-up must be prevented in the following situations:

- during the closing of a guard
- during the actuation of an operation mode selector
- during the resetting of an emergency stop device
- during the resetting of a thermal protection device

In conveyors designed to supply loads to other conveyors, start-up of the supply conveyors must be linked with the receiving conveyors, using appropriate interlock devices. These devices must control and ensure sequential start-up, and must prevent conveyor overloading (whether theconveyor is fully loaded, or not in use)

To prevent unexpected start-up, replace two-stable position (toggle) switches (start-stop) with self-powered or single-stable position control devices. These switches will bring the controls to an off-circuit mode (open contacts) should there be a power outage or conveyor failure.

5.4.2 Regular stop

There must be a device or method accessible to the worker(s) where equipment operations can be interrupted safely, while also ensuring that equipment cannot be unexpectedly restarted.

An all-stop switch is not designed to put an end to a recurring dangerous situation; this is therole of an emergency stop device. A stop command has priority over a start comman

5.4.3 Emergency stop device

The emergency stop device of a conveyor to which workers have access comprises several control devices located at the loading and unloading areas, as well as along the length of the conveyor. These devices must be easily visible and clearly identified, and must activate on a single action.

Emergency stop devices must be installed at a height of between 0.6 and 1.7 meters from thefloor. In addition, the device must have the following features:

- one or more push button switches
- one or more emergency stop pull-cords if required,
- a conveyor power-disconnect device, if the distance to the disconnect device is less than 10 metres from any conveyor access point

An emergency stop device must allow equipment to shut down in the safest possible way. Thiscan be achieved by slowing down moving parts at an optimal rate, as follows:

- by an immediate interruption of power to the motors
- by a controlled stop (motors remain energized to bring the equipment down to a progressive stop and power is interrupted once the equipment has come to halt)

The resetting of an emergency stop device must not by itself cause the start-up of the machineunless the conveyor is a slow-moving type which workers can access safely. Start-up must beconfirmed by a manual action (manual resetting).

The emergency stop command has priority over all other commands. Emergency stop devicesmust stop any upstream or downstream conveyors which may pose a safety risk to workers. The emergency stop device must not be used to bring the conveyor to an all-stop state. The emergency stop must not be used as a regular stop.

Remember that an emergency stop device does not replace appropriate protection devices. As well, emergency stop devices must not replace equipment lockout procedures during maintenancerequiring access to danger zones.

5.4.4 Emergency stop pull-cords

If workers can access a conveyor in operation, it must be equipped with an emergency shutdown device along the full length of conveyor.

A sheathed metal strand cable shut-down device (pull-cord) must function as an emergency stop switch, whatever direction the cable is pulled in, or when the emergency stop switch is broken. A spring failure must also trigger an emergency stop.

A horizontal force of less than 125 N, when applied midway between two support rings and perpendicularly to the cable, must be sufficient to activate an emergency cable. Lateral movement of the cable (between the position while at rest and the activation point) must not exceed 300mm. The cable must be able to resist a tension force 10 times greater than the tension required to activate the emergency shut-down switch, when such force is applied perpendicularly to the cable.

The cable must move freely within its supports, particularly at bends. Cables must not be twistednor suffer the risk of being twisted during use. If a belt width is 800 mm or less, a single centralcable may be used above the belt.

Maximum cable length and other characteristics must conform to manufacturers' recommendations (for support rings and pulley protection, freeze-up prevention, variation in length due to temperature changes, etc.)

Other appropriate cable devices, as determined by the hazard assessment, may be used whereactivation of the switch is done by pressure, compression, torsion or tension applied to the cable.This method is best suited to complex cable runs and to dusty or heavy-vibration environments.

5.5 SAFEGUARDS WHILE PERFORMING MAINTENANCE

5.5.1 GENERAL PRINCIPLES

Equipment must to be designed in such a way that maintenance adjustments, greasing, lubricating, temperature and/or vibration monitoring, cleaning, un-jamming, unclogging, etc.) can be done awayfrom danger zones and without having to remove guards or other protective devices.

An employer must provide safeguards if a worker may accidentally, or through the work process, come into contact with

a) moving parts of machinery or equipment,
b) points of machinery or equipment at which material is cut, shaped or bored,
c) surfaces with temperatures that may cause skin to freeze, burn or blister,
d) energized electrical cables,
e) debris, material or objects thrown from machinery or equipment,
f) material being fed into or removed from process machinery or equipment,
g) machinery or equipment that may be hazardous due to its operation, or
h) any other hazard.

5.5.2 Lockout (controlling hazardous energy) procedures

Lockout/isolation procedures or controls should be an integral part of overall maintenance and operating procedures. Through the hazard/risk assessment process, the requirement for lockout(s)/isolation should be identified, evaluated and controlled.

Procedures for controlling hazardous energy should include (but are not limited to) the following:

- the equipment must be brought to a complete stop
- all sources of energy (electric, pneumatic, hydraulic, mechanical, thermal, chemical, radiation and gravity) must be disconnected
- all accumulated energy must be removed (by purging reservoirs, removing counter weights, unloading springs, etc.)
- personal lock(s) must be applied to each energy-isolating device
- the equipment must be tested to verify that it will not operate or move

5.5.3 Safeguards for maintenance within operating danger zones

At the core of injury and loss prevention is an understanding of workplace hazards and the associated risks. Hazard assessment is a systematic process of reviewing job methods and workplaces to identify, evaluate and prioritize hazards. Assessing hazards and understanding theirnature and potential are critical to developing acceptable controls for avoiding incidents, injury and losses. Good solutions or controls are a result of adequate hazard assessments.

if emergency action isrequired to control or eliminate a hazard that is dangerous to the safety or health of workers:

- only those workers competent in correcting the condition, and the minimum number necessary to correct the condition, may be exposed to the hazard, and
- every reasonable effort must be made to control the hazard while the condition is being corrected.

5.6 WORKER TRAINING

All workers who work on or in the vicinity of conveyors must be informed of the hazards they mayencounter, and must receive training in established preventive measures and work procedures. All safety-related procedures and instructions must be documented.

5.6.1 WORKER TRAINING

Only competent and authorized workers must be allowed to start up, operate and interrupt the normal operation of a conveyor. Workers must be trained in:

- conveyor start-up
- normal shutdown and the use of emergency stop devices
- required checks for restarting a conveyor after an emergency shutdown or accidental stoppage
- proper loading procedures to prevent overload

5.6.2 Maintenance crew training

Assign only competent workers who have the technical skills to maintain conveyors. Assignedworkers must be informed of the conditions under which various maintenance tasks are to becompleted. Workers must be trained in lockout procedures.

When the removal of a guard or deterrent device is scheduled, workers must receive detailedinstructions relative to their tasks, including procedures for installing and repositioning guardsor deterrent devices. Supervisors and workers must check that guards and deterrent devices are back in place after maintenance activities are completed.

VI. RESULT AND DISCUSSION

Hazards in various operational area of the conveyors is as follows, Table.6

6.1 RISK CLASSIFICATION SCREENING TABLE

S.NO	HAZARDS	POTENTIAL CONSEQUENCES	RISK (P)	RISK (S)	RISK SCORE	PROTECTIVE MEASURES
1	**POWER TRANSMISSION MOVING PARTS**					
	Drive shaft; shaft end; sprocket; pulley; chain; drive belt; gear coupling	Drawing-in and crushing Entanglement of loose clothing in protruding or moving parts	**3**	**3**	**9**	Guard all rotating devices including the rotating shaft. (If hazard is less than 2700 mm From floor or working platform)
2	**BELTS**					
	Belt in good condition	Friction burns or abrasion Impact with belt, drawing-in (Depending upon belt characteristics and speed)	**2**	**3**	**6**	**Load Strand:** Workstation: Install guard, as per hazard assessment. **Return Strand:** Workstation Install guard, as per hazard assessment. **Throughway parallel to conveyor** Install guardrail, as per hazard assessment. **Throughway passing under conveyor** Install protection plate as per hazard assessment. **Service way passing under conveyor** Install protection plate, as per hazard assessment.
	Deteriorated belt or belt splice	Drawing-in, burns, pokes, cuts	**1**	**2**	**2**	Change the belt splice design or manufacture.

						Maintain belt and/or splice.
3	**CONVEYOR BELTS IN A STRAIGHT RUN**					
	In-running nips between the rollers/load beds under the hopper Load side under the skirt board or skirt	Drawing-in, Shearing Belt burns	**3**	**4**	**12**	Install surrounding or barrier guard.
	In-running nips between load side and support rollers in a straight run	Drawing-in	**2**	**2**	**4**	**Workstation:** Install surrounding fixed guard (plates between rollers). **Throughway and service way:** As determined by hazard assessment.
	In-running nips between lower strand and return rollers in a straight run	Dragging Impact with rollers (may lead to severe injury or fatality)	**3**	**3**	**9**	**Workstation (beside or under conveyor)** Install surrounding or in-running nip guards and additional protection plates, if the control station is located below return rollers. **Throughway parallel to conveyor** Install deterrent devices (guardrail side plate). Install surrounding in-running nip guard or barrier guard, or other deterrent devices. **Throughway under a conveyor** Install surrounding in-running nip or barrier guards or deterrent devices (guardrail) and add protection plates.
	Return rollers	Impact with rollers Crushing by falling rollers	**2**	**3**	**6**	Install retaining device for return rollers, as per hazard assessment. It is possible to reduce risk with a preventive maintenance program, which should be taken into account when doing the

						hazard assessment.
	Return strand scrapers	Trapping and crushing Belt abrasions Severe injury fatality	**2**	**3**	**6**	In accordance with hazard assessment results, the scraper protection device may be combined with a drum protection device.
4	**CURVED ZONE**					
	In-running nip between the belt and rollers in the curved zone	Drawing-in	**3**	**4**	**12**	Install surrounding in-running nip or separation barrier guard.
5	**TRANSITION ZONE**					
	In-running nips between the load side and the load carrying rollers in the transition zone	Drawing-in	**3**	**4**	**12**	Install surrounding or in-running nip guard.
6	**DRUMS**					
	In-running nips between belt and drums.	Drawing-in Severe injury/fatality	**3**	**4**	**12**	Install surrounding in-running nip or barrier guards.
	In-running nips between belt and drums Take-up system	Crushed by falling weights Drawn-in at pinch points Severe injury/fatality	**3**	**3**	**9**	Install surrounding or barrier guards. Install deterrent device (guardrail) to prevent access under the weight.
	Junction between two conveyors	Drawing-in and trapping	**2**	**2**	**4**	Install fixed guard (plate) or free-wheeling pop-up roller.
7	**MOVING LOADS**					
	Skirtboards Individual moving loads	Trapping between belt and skirtboard or between load and skirtboard	**2**	**2**	**4**	**Workstation** Limit gap between skirt board and belt to a maximum of 5 mm. Remove skirt board. Design a surrounding fixed guard, if need determined by hazard assessment. **Other Areas** Hazard assessment.
	Individual loads and fixed obstacles not part of the conveyor, e.g., post, wall, tunnel entrance, enclave, associated fixed equipment (such as detectors), etc. Large or bulky loads (such as boulders)	Crushing between loads and fixed objects Shearing Impact with loads or other objects	**2**	**2**	**4**	Fixed guard or deterrent device in accordance with hazard assessment results, in respecting the safe distances between loads and obstacles. The following are the minimum distances for

						different situations: If entire body can be drawn in: 500 mm If arms can be drawn in: 120 mm If legs can be drawn in: 180 mm
	Load and load carrying rollers exceeding belt width	Trapping Crushing	**2**	**2**	**4**	**Workstation** Install fixed barrier guard (separation type or plates between rollers). **Other areas** Install fixed barrier guard (separation type or plates between rollers) or deterrent device.
	Loads falling from the belt	Impact with moving loads Crushed by falling loads	**2**	**3**	**6**	Install protection plate, mesh netting or guiding rail to maintain individual loads on the conveyor and prevent them from falling off, in accordance with hazard assessment results.
8	**MOVING SUB ASSEMBLY**					
	Pushers; bumpers; ejectors; sorters	Crushing and shearing	**1**	**2**	**2**	Install surrounding fixed or barrier guards.
9	**MOVEABLE CONVEYORS**					
	Vertical and/or horizontal movement	Crushing; entanglement; trapping	**1**	**2**	**2**	In accordance with hazard assessment results: barrier guard, deterrent device or ground markings or signs to indicate the conveyor's operating area. It is also possible to use electronic safety devices (surface detectors, etc.).
10	**Screw Conveyors**					
	Screw conveyors are troughs with a revolving shaft with a spiral or twisted plate. In-going nip points for the entire length of the screw conveyor exist between the revolving shaft and trough. Because the trough may not be covered and the	Drawing-in Severe injury/fatality	**3**	**3**	**9**	A screw conveyor housing must completely enclose moving elements (screw mechanism,power transmission apparatus), except for loading and discharge points. Permanently affixed grids or polycarbonate can be installed for visibility purposes to allow the

	conveyor may be located at or near floor level, screw conveyors can be particularly dangerous.					operator to see the operation. Alternatively, trough side walls should be high enough to prevent workers from reaching into or falling into the trough. If open troughs are used, workers must be protected by secondary safeguarding methods, such as a railing or fence. Feed loading and discharge points can be guarded by enclosures, screening, grating, or some other interruption across the openings which allow the passage of materials but do not allow entry of a part of the body.
11	**Chain Conveyors**					
	Nip points occur when a chain Contacts a sprocket. Nip points also occur At drives, terminals, take-ups (automatic take-ups may also have shear points), and idlers. Clothing, jewelry, and long hair may also get entangled and caught in the moving chain conveyor.	Drawing-in Severe injury/fatality	**3**	**3**	**9**	Enclose moving chains if possible. If moving chains cannot be enclosed without impairing the functioning of the conveyor, barrier guards can be installed around moving parts, or nip and shear points can be eliminated by a guard at the nip point or shear point. Other secondary safe guarding options include safeguarding by distance (location) and the use of awareness devices.
12	**Roller Conveyors**					
	Roller conveyors are used to move material on a series of parallel rollers that are either powered or gravityfed.	Drawing-in Severe injury/fatality	**3**	**3**	**9**	Enclose roller conveyors if possible. Install permanent barrier guards to protect workers

	Powered roller conveyors can snag and pull hands, hair, and clothing into the area between the rollers and the stationary components of the conveyor. In-going nip points may exist between the drive chain and sprockets; between belt and carrier rollers; and at terminals, drives, take-ups, idlers, and snub rollers.					from nip and shear points. For example, the unused section of rollers closest to the worker should be guarded when transporting small items on a roller conveyor that do not require the use of the entire roller width. Eliminate or minimize projections from the roller through the use of pop-up rollers. Other secondary safeguarding options include safeguarding by distance (location) and the use of awareness devices.

VII. CONCLUSION

In this project we observe and involve that risk assessment and best safety practices on conveyors, it's very helpful for finding hazards identification and conditions of conveyors. Risk Assessment can be used to establish priorities so that the most dangerous situations are addressed first and those least likely to occur and least likely to cause major problems can be considered later. Risk Assessment is performed using the Risk Matrix as described in the literature study, the results obtained from this risk assessment are the 12 potential hazards present in the conveyors, According to the existing categories of extreme risk, high risk, medium risk and low risk thenthe findings are grouped into each risk category. The risk rating of the present and possible hazard is evaluated which divide them into basic, acceptable and significance risk level. Which risks are in significance level there possible protective control measures also recommended to improve safety measure and analysis. The results of this analysis will be of valuable to find out the consequence on emergency situation that may occur. And involved on this project to best safety practices and safe guard against from the hazards with this knowledge, the level of preparedness can be assessed and measures taken to enhance capabilities through training and preparation of a more effective response to such occurrences.

VIII. REFERENCES

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