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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 convey or guarding, hazardous energy isolation and visual inspection procedures for industries that utilize convey or 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.

Key Word:hazards; risk assessment; safety practices; conveyors; safe guards.

1. 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 AConveyorBelt

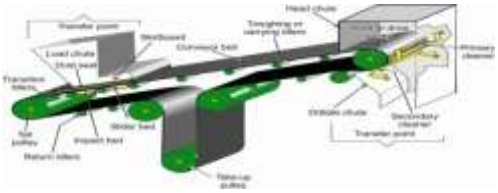

Fig.1; components of belt conveyor

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 beltsshouldmeet thefollowingrequirements:

- Lowhygroscopocity
- Highstrength
- Lowownweight(Lightinweight)
- Smallspecificelongation
- Highflexibility
- High resistivityto ply(Layer ofmaterial)
- Longservicelife

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 vulcanizationwith natural or synthetic rubber. Sometimes the plies are made of extra – strong syntheticfabrics, Capron, perlon, nylon etc.

1.3.1 Idlers

Generallythebeltissupportedbyidlerrollers,inrarecasesbyasolidwood,orsheetsteel, runway or a combination support comprising sections of a runway alternating with idlerollers. Idlers are used mainly in conveyors handling bulk loads, less frequently unit loads,whilerunwaysandcombinedsupportsarepredomiantlyusedforpiecegoods. According to their location on the conveyors, idlers are classified as upper (supporting theloadedstrand ofthe belt) and lower (supportingtheidlerreturn strand ofthebelt).

1.3.2 Centering device

A number of reasons, such as eccentric loading, soiling, sticking of thematerial 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. Theseidlers 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)takeup. The latter may in turn be divided in to carries–type (some times called horizontal and vertical. In the screw take up the tensioningpulley simultaneously servesas deflecting tilorpulleyandrotatesonafixed shaft(bestdesign) orinterminalbearings(worstdesign). In gravity take ups the tensioning pulley (serving simultaneously as tail and pulley) is placedon a movable carriage which is pulled backwards by means of a steel rope and deflectingpulleys. The vertical counter weight takeup consist softhreepulleys,(two deflecting and one tensioning)and are installed on their turn strand of the conveyor. N.B. The carriage type take-up is superior to the vertical type because it is of much simplerdesignofconsiderablyless height.

1.3.4 Driveunits

Inbeltconveyorsmotivepoweristransmittedtothebeltbyfrictionasitwrapsaround 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 convey orsincludea braking device which prevents slipping back of the loaded beltun dertheweightofthematerialconveyedifthecurrentsupplyingthemotorisinterrupted.

1.3.5 Loading & discharging

Loading depends on the nature & characteristics of the loadconveyedand 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: Generallyemployed by

- Scrapperploughs
- Athrow – offcarriage known astripper(only used for bulk materials.

1.3.6 Belt Cleaner:

Incaseofdryparticles:Theclingingdryparticlesarecleanedbyscrapper/wiperIncaseof 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 maycause slipping back of the loaded belt. This will happen if longitudinal component of load weight which is larger than the forces offrictionalresistance to belt motion.

- To prevent this type of spontaneous movement of the belt, a special hold back brake ismounted on the main or auxiliaryshaft which keep inclined in conveyor.
- Itisaspecialprotectingdevicewhichautomaticallydisconnectsthedrivewhenthebelt 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 flow able 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.

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

1.6 chain conveyors

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.

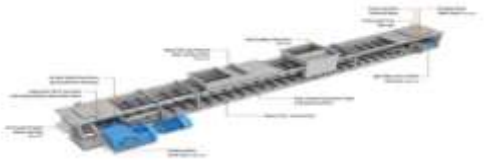

Fig.4; drag chain conveyor

2. 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.

3. 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.

4. Hazard Identification And Risk Assessment

Hazard Identification and Risk Assessment (HIRA) is a process that consists of a number of sequentiall steps such as hazard identification, consequence & frequency assessment, risk estimation based on the existing controls and recommendations to reducethoserisks which arenotunderacceptablelimits.Hazard.Identification and risk assessment vary greatly across industries, ranging from simple assessment to complexquantitative analyses withextensivedocumentation.

Risk assessment is a process or application of a methodology for evaluating risk asdefined 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. Thetool facilitates to assess each manufacturing step with respect to critical operations and identify the hazardous process.

4.1 Steps InvolvedInHira:

Step1-IdentificationofHazard
Step2-RiskAssessment
Step3-MonitorandReview

Step4- Control

4.1.1 Step1-Identification of Hazard:

Accurately identifying potential hazards in the work place 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, orchanges 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 workareas. Other common hazards include,motorizedequipment,energizedequipment,extreme temperatures, noise, vibration, violence work design (poor ergonomics), workingalone, materialhandling, fuel storages, raw material moving workandtheft.

4.1.2 Step2-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 withthe severity of harm the event would cause to the University community, the public and the environment if it occurred. Each identified risk is given a rating using the Risk Rating Matrix which is recorded on the

HIRAC plan.

PROBABILITYFACTORS 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 Probabilitymatrix

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

4.1.1.1 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.

4.1.1.1 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

4.1.1.1 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 Step3MonitorAndReview:

Assess effectiveness of selected controls the worker and the worker's super visorare responsible for the evaluation of the effectiveness of the hazard control selected and to make improvements where deficiencies are identified. This canbe 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:Repeatednon-compliance, which could be oflackof training, supervision, or other problems in the control that cause persons to be reluctantto 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 themeasured risk after the control has been implemented. In other cases students/staff or others mayhave a continued complaint.

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

Best practice includes

- Regularinspections.
- Testing(e.g.airquality,ifapplicable)
- ReviewingInjury/illnessstatistics.
- Identifying new hazards.
- Addressing safety concerns as soon as possible.

4.1.4 Step4 Control:

All hazards must be controlled either by removing the hazard or reducing its risk of harmtoanacceptablelevel,bothproactively(topreventitsoccurrence)andreactively(tominimize harmful effects in the event it does occur). Often, more than one hazard controlmethod must be implemented. For example, certain chemicals require a combination ofproper storage, labeling, safe work practices, the use of Personal Protection Equipment(PPE) and emergency response equipment, procedures, and training in order to effectivelycontrol the hazards. When considering how to reduce the risk, best practice is to follow thehierarchyofhazardcontrols.

4.1.4.1 Eliminationorsubstitution

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, iffallingisahazard, eliminate the risk by storing stockat lower heights so workers don't havetoreachthegoods.oCanIusesomethinglessharmful?Forexample,ifstockisstored high, consider substituting a step stool for a rolling staircase with a railing. Makesurethe substitutiondoesn'tcreate new hazards suchas tripping.

4.1.4.2 Engineeringcontrols

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 includemachine guards, noise enclosures, ventilation to dilute the concentration of a hazardoussubstance). For example, while working at heights cannot be avoided in construction,guardrails canbeinstalledto preventfallsfromhappening.

4.1.4.3 Administrativecontrols

Administrative controls involve identifying and implementing afeworkprocedures. 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.

4.1.4.4 Personal protective equipment and clothing(PPE)

Personal protective equipment is a common control, and is a last resort to protect workers from hazards that are difficulttoeliminate or engineer out. For example, the useof protective eyewear will help to reduce the exposure risk to foreign bodies for workinvolving cuttingandgrinding.

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.

5. Best Safety Pratices On Conveyors

5.1 Safeguards Against Hazards

5.1.1 Hazard assessment and reduction

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

- Hazardassessmentmustbedonetoidentifyexistingandpotentialhazards.
- Identifiedhazardsmustbeeliminatedorreduced.
- Thehazardassessmentprocessmustbedocumentedand,shouldanychangesinprocessoccur, repeated.
- Workersmustbeinformedofallhazards,andallaffectedworkersmustbeinvolvedinassessment,eliminationandcontrolofhazard sidentified.
- Foreachhazardthatcannotbeeliminatedorreducedbyengineeringoradministrativecontrols,safeguardsorprotectivedevicesmu stbeinstalled.

5.2 Safe guards Against Mechanical Hazards

5.2.1 General principles

Many danger zones exist in and around convey or belts. Hazards are located inthese dangerzones. Section 310 of the Code describes provisions relating to the installation of guards and protective devices on machines.

A conveyor must be constructed in such a way as to not allow access to danger zonesor,bydefault,mustbeequippedwithguards and protective devices. Deterrent devices may also be used.

Various types of conveyor belt protectors and deterrent devices, as well as safety requirementsforconveyorsub-assemblies,aredescribed below.

Preventive measures for hazards related to conveyor operation must be implemented when ahazardis2700 mmorless fromthefloor orworking platform.

5.2.2 Guards

A guard is a machine element that makes the danger zone inaccessible by isolating it. Guardsonconveyorbeltsarerequiredtobedesigned with operating conditions in mind. They shouldbe capable of resisting the loads to which they will be subjected. These devices must not createadditional hazards or tempt workers to bypass their use. The dimensions and weight of movableguardcomponentsshouldtobedesignedtoallowforeasyhandling.Tothisend,itispreferableto have articulated or hinged guards. Guard removal and reinstallation should be quick andeasy. Ideally, guards should be self-locking when closed. For more information on user-relatedcharacteristics (color, ease of manipulation, etc.) And guard construction, see Appendix A ofthisguide.

There are three types of guards:

1. Fixedguards
   - Surrounding fixed guards
   - Barrierguards(fixeddistance)
   - In-running nipfixedguards
2. Interlockingguards
3. Interlockedguardswithguardlocking

5.2.3 Fixedguards

Afixed guard is apermanent part of them achine. It is not dependent upon moving parts to perform its intended function. It may be constructed of sheet metal, screen, wire cloth, bars, plastic, or any other material substantial enough to with stand what ever impact it may receive, and toendureprolongeduse. Afixed guard is usually preferable to all other types because of its permanence and relative simplicity.

Guards may be easily opened with tools or keys, for instan cewhenequippedwithquarter-turnlatches. When keyedlatchesare

used, responsibility for controlling and distributingsocketkeysor tools must be assigned.

5.2.4 Surroundingfixedguards

Thisisafixedguardthateithercompletelyorpartiallysurroundsthedangerzone.(Becauseofopenings 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 principleshapes:

- Partialcages,asillustratedandusedmainlyforheadandreturndrumsside screens, as illustrated

Guards must extend beyondthe in-running nipsbetween the beltsand rollers so asto make theminaccessiblefrom above,below andfrom the ends.

5.2.5 Barrierguards

Barrier guards do not completely surrounddanger zones but rather restrict or preventaccessbytheirsizeandseparationfromthedanger zone.

5.2.6 In-runningnipfixedguards

A fixed guard can be placed at a height of an in-running nip that will not allow access tothis zone. In-running nip fixed guards may beform-fitting or made fromangled deflectors with side plates. They are well suitedtoanindividualloadconveyance,aswellastorollersanddrumswith a smooth, unbroken surface. They may be used in troughed conveyor belts as long astheyhave followed the belt profile. However, these guards are ill-suited to cleated type, ribbedorraised-edgebelts.

5.2.7 Interlockingguards

Aguardequippedwithaninterlockingdeviceshouldhavethefollowingcharacteristics.It should:

- Causethemachineortheoperationofitshazardouscomponentstostopasitisslightly opened
- Makeitimpossibletostartthemachineortooperateitshazardouscomponentsforaslong as itis notin place
- Notcausethemachineoritshazardouscomponentstorestartonceitisfullyrestoredto itsplace

5.2.8 Interlockedguardwithguardlocking

Aninterlockedguardequippedwithalockingdeviceshouldhavethefollowingcharacteristics.It should:

- Remainlockedinplaceforaslongasthemachineoritshazardouscomponentsaremoving
- Makeitimpossibletostartthemachineortooperateitshazardouscomponentsforaslong as it is not in place and reactivated
- Notcausethemachineoritshazardouscomponentstoberestartedonceitisrestoredto its place and reactivated.

5.3 SafeguardsAgainstOtherHazards

5.3.1 Hazardsgeneratedbypoorergonomicdesign

Equipment must be designed so that operators and other users need not assume constrainingworkpostures,overexertthemselvesorcarryoutrepetitivemovements.

Control devices must be grouped near workstations to allow easy access for operators and otherusers. 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 bepositionedtopreventunexpectedstart-ups,andprotected.

5.3.2 Heat-related hazards

Whereconveyedproductsoranypartoftheequipmentmaycauseburns,takethefollowingprecautions:

- Preventcontactwithconveyedloadsandhot(orcold)surfacesbyusingscreensorfixedsurrounding or barrier guards.
- Reducethetemperatureofhotsurfaces

5.3.3 Electrical hazards

Conveyor electrical equipment must conform to the Canadian Electrical Code. Such equipmentincludes materials, accessories, devices, appliances, fasteners and other equipment used in theelectricalpowersupplyofaconveyororinconnectionwithaconveyor,includingpowerdisconnectdevices.

5.3.4 Fireandexplosionhazards

The use of a conveyor can present a fire and explosion hazard. This hazard can be caused by theuse 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 measuresthat may be implemented.

5.3.5 Inappropriatepersonalprotectiveequipmentandunsafeacts

Based on the hazard assessment of the work site, adequate personal protective equipment,includingclothing,footwearandrespirators,mustbeselectedandwornbyworkers.

Unsafeactssuchasclimbingoverorunderaconveyor,orsteppingover,walkingonorridingonaconveyor, must not be tolerated.

5.4 SafeguardsAgainstControlSystemFailuresOrMalfunctions

5.4.1 Start-Up

Start-upofequipmentmustrequireavoluntaryaction.Equipmentstart-upmustbepreventedin the following situations:

- Duringtheclosingofaguard
- Duringtheactuationofanoperationmodeselector
- Duringtheresettingofanemergencystopdevice
- Duringtheresettingofathermalprotectiondevice

Inconveyorsdesignedtosupplyloadstootherconveyors,start-upofthesupplyconveyorsmustbe linked with the receiving conveyors, using appropriate interlock devices. These devices mustcontrol and ensure sequential start-up, and must prevent conveyor overloading (whether theconveyorisfullyloaded,or notinuse)

To prevent unexpected start-up, replace two-stable position (toggle) switches (start-stop) withself-poweredorsingle-stablepositioncontroldevices.Theseswitcheswillbringthecontrolstoanoff-circuit mode(opencontacts)shouldtherebeapoweroutageorconveyorfailure.

5.4.2 Regularstop

There must be adevice or method accessible to the worker(s) where equipment operations can be interruptedsafely, 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 theroleofanemergencystopdevice.Astopcommandhasprioryoverastartcomman

5.4.3 Emergencystopdevice

The emergency stop device of a conveyor to which workers have access comprises several controldevices located at the loading and unloading areas, as well as along the length of the conveyor.Thesedevicesmustbeeasilyvisibleandclearlyidentified,andmustactivateonasingleaction.

Emergencystopdevicesmustbeinstalledataheightofbetween0.6and1.7metersfromthefloor.Inaddition,thedevicemusthavet hefollowingfeatures:

- Oneormorepushbuttonswitches
- Oneormoreemergencystoppull-cordsifrequired,
- Aconveyorpower-disconnectdevice,ifthedistancetothedisconnectdeviceislessthan10 metres from any conveyor access point

Anemergencystopdevicemustallowequipmenttoshutdowninthesafestpossibleway.Thiscanbeachievedbyslowingdownmoving partsatanoptimalrate,asfollows:

- By animmediateinterruptionofpowertothemotors
- Byacontrolledstop(motorsremainenergizedtobringtheequipmentdowntoaprogressivestopandpowerisinterruptedoncethe equipmenthascometohalt)

Theresettingofanemergencystopdevicemustnotbyitselfcausethestart-upofthemachineunless the conveyor is a slow-moving type which workers can access safely. Start-up must beconfirmedby 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.
Theemergencystopdevicemustnotbeusedtobringtheconveyortoanall-stopstate.Theemergencystop must not be used as a regular stop.

Remember that an emergency stop device does not replace appropriate protection devices.
Aswell,emergencystopdevicesmustnotreplaceequipmentlockoutproceduresduringmaintenancerequiring access to danger zones.

5.4.4 Emergencystoppull-cords

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

A sheathed metal strand cable shut-down device (pull-cord) must function as an emergency stopswitch,whateverdirectionthecableispulledin,orwhentheemergencystopswitchisbroken.Aspring failuremust also triggeran emergency stop.

A horizontal force of less than 125 N, when applied midway between two support rings and perpendicularlytothecable, must be sufficient to activate an emergency cable. Lateral movement of the cable (between the positionwhil eatrestandtheactivationpoint) must not exceed 300mm. The cable must be able to resistatensionforce 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 suffertheriskofbeingtwistedduringuse.Ifabeltwidthis800mmorless,asinglecentralcable may be used above the belt.

Maximumcablelengthandothercharacteristicsmustconformtomanufacturers'recommendations(for support rings and pulley protection, freeze-up prevention, variation in length due to temperaturechanges, etc.)

Otherappropriatecabledevices,asdeterminedbythehazardassessment,maybeusedwhereactivation of the switch is done by pressure, compression, torsion or tension applied to the cable.Thismethodisbestsuitedtocomplexcablerunsandtodustyorheavy-vibrationenvironments.

5.5 SafeguardsWhilePerforming Maintenance

5.5.1 Generalprinciples

Equipment must to be designed insuch away that maintenance adjustments, greasing, lubricating, temperature and/or vibration monitoring, cleaning, un-jamming, unclogging, etc.) Can be done away from dangerzones 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 in to contact with

a) Movingpartsofmachineryorequipment,
b) Pointsofmachineryorequipmentatwhichmaterialiscut,shapedorbored,
c) Surfaceswithtemperaturesthatmaycauseskintofreeze,burnorblister,
d) Energizedelectricalcables,
e) Debris,materialorobjectsthrownfrommachineryorequipment,
f) Materialbeingfedintoorremovedfromprocessmachineryorequipment,
g) Machineryorequipmentthatmaybehazardousduetoitsoperation,or
h) Anyotherhazard.

5.5.2 Lockout(controllinghazardousenergy)procedures

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

Procedures for controlling hazardousenergy should include(but arenot limited to)the following:

- The equipment must be brought to a complete stop

- Allsourcesofenergy(electric,pneumatic,hydraulic,mechanical,thermal,chemical,radiationand gravity) must be disconnected
- All accumulated energy must be removed (by purging reservoirs, removing counter weights,unloading springs, etc.)
- Personallock(s)mustbeappliedtoeachenergy-isolatingdevice
- The equipment must be tested to verify that it will not operate or move

5.5.3 Safeguardsformaintenancewithinoperatingdangerzones

At the core of injury and loss prevention is an understanding of workplace hazards and theassociated risks. Hazard assessment is a systematic process of reviewing job methods andworkplaces to identify, evaluate and prioritize hazards. Assessing hazards and understanding theirnature and potential are critical to developing acceptable controls for avoiding incidents, injuryandlosses. Goodsolutionsorcontrolsarearesultofadequatehazardassessments.

Ifemergencyactionisrequiredtocontroloreliminateahazardthatisdangeroustothesafetyorhealthofworkers:

- Onlythoseworkerscompetentincorrectingthecondition,andtheminimumnumbernecessarytocorrectthecondition ,maybeexposedtothehazard,and
- Everyreasonableeffortmustbemadetocontrolthehazardwhiletheconditionisbeing 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 inestablished preventive measures and work procedures. All safety-related procedures and instructions must be documented.

5.6.1 Workertraining

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:

- Conveyorstart-up
- Normalshutdownandtheuseofemergencystopdevices
- Requiredchecksforrestartingaconveyorafteranemergencyshutdownoraccidentalstoppage
- Properloadingprocedurestopreventoverload

5.6.2 Maintenancecrewtraining

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

Whentheremovalofaguardordeterrent device is scheduled, workers must receive detailed instructions relative to their tasks, including procedures for installing and repositioningguardsor deterrent devices. Supervisors and workers must check that guards and deterrent devices are back inplace after maintenance activities are completed.

6. 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		Risk Score	Protective Measures
			(P)	(S)		
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	2	3	6	Load Strand: Workstation:

		Impact with belt, drawing-in (Depending upon belt characteristics and speed)				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	Trapping Crushing	2	2	4	Workstation Install fixed barrier guard (separation type or plates

	width					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 conveyor may be located at or near floor level, screw conveyors can be particularly dangerous.	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 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. 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.	Drawing-in Severe Injury/fatality	3	3	9	Enclose roller conveyors if Possible. Install permanent barrier guards to protect workers 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.

7. 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 literaturestudy, the results obtained from this risk assessment are the 12 potential hazards present inthe conveyors, According to the existing categories of extreme risk, high risk, medium risk and low risk thenthe findings are groupedintoeachrisk 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.

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