International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 10 Issue: 02 | Feb 2023 www.irjet.net p-ISSN: 2395-0072

HAZARD ASSESSMENT AND ITS CONTROL IN BULK MATERIAL HANDLING PROCESS OF AN INTEGRATED STEEL PLANT

Abhishek Sharma[1], Manish Kumar Mishra[2], Abhilash Trivedi[3]

[1]M.Tech. Scholar, Bhilai Institute of Technology, Raipur, Chhattisgarh, India
[2,3]Assistant Professor, Dept. of Mech. Engineering, Bhilai Institute of Technology, Raipur, Chhattisgarh, India

---

Abstract – *The proliferation of conveyor systems in various industrial sectors has fueled a growing demand for conveyors that surpass the capabilities of conventional systems. The need to transport bulk materials over longer distances at higher speeds and with greater efficiency has necessitated the development of a comprehensive and safe working methodology.*

However, the widespread use of conveyor systems has sometimes led to overlooking potential hazards and hazardous activities, putting workers at risk of fatal accidents. To address this, it is imperative to continuously monitor all activities and identify potential hazards through a Hazard Identification and Risk Assessment with Controls (HIRA) approach. This research aims to determine the hazards associated with various activities of conveyor systems using HIRA and ensure a safer working environment for all involved. The implementation of increasingly complex conveyor systems without a thorough understanding of the system can result in inefficiencies and decreased productivity. This study seeks to address this issue by identifying hazards through HIRA and creating standard operating procedures for different material handling activities. The conclusions drawn from this research will provide valuable insights and offer recommendations for future work to further enhance the safety and efficiency of conveyor systems.

Key Words: HIRA, Conveyor System, SOP, Integrated Steel Plant

1. INTRODUCTION

The steel industry is a highly sophisticated and technologically advanced sector, characterized by interdependent material flows and revenue streams. It is a crucial product in the modern world, with a wide range of applications, from infrastructure building and industrial machinery to consumer goods. The industry is also diverse in terms of the technologies used, which are dependent on the nature and quantity of raw materials utilized. In India, steel has a profound impact on the economy, with a 1.4X multiplier effect on GDP and a 6.8X employment multiplier factor.

At the time of India's independence in 1947, the country only had three steel plants - the Tata Iron & Steel Company, the Indian Iron and Steel Company, and Visveswaraya Iron & Steel Ltd - and a handful of electric arc furnace plants. Despite its small capacity of 1 million tonnes, the steel industry was robust and entirely in private hands. Today, India is the second largest crude steel producer in the world and the largest producer of sponge iron, with the Iron and Steel Industry contributing 2% to the Gross Domestic Product and employing around 25 lakh individuals directly or indirectly. The Indian steel industry, once with a negligible global presence, is now recognized for its product quality, having successfully navigated the challenges of the business cycle over its long history since independence.

In the year 2021, the global production of crude steel reached a staggering 1911.9 million tonnes, demonstrating a growth of 3.6% compared to the previous year. The World Steel Association's rankings revealed that China emerged as the leading producer of crude steel, with a production of 1032.8 million tonnes, followed by India, with 118.1 million tonnes, Japan with 96.3 million tonnes and the United States with 86.0 million tonnes. The per capita finished steel consumption in 2020 was 228 kg globally, with China leading the way with 691 kg, while India recorded a consumption of 70 kg.

Table -1: Major steel-producing countries 2021 and 2020 (million tonnes)

Country	2021		2020	
	Rank	Tonnage	Rank	Tonnage
China	1	1 032.8	1	1 064.7
India	2	118.2	2	100.3
Japan	3	96.3	3	83.2
United States	4	85.8	4	72.7
Russia	5	75.6	5	71.6
South Korea	6	70.4	6	67.1
Turkey	7	40.4	7	35.8
Germany	8	40.1	8	35.7
Brazil	9	36.2	9	31.4
lran	10	28.5	10	29.0

In the domestic scenario, the Indian steel sector has entered a new phase of growth, following de-regulation, as a result of the resurgence of the economy and increased demand for steel. This has led to a significant rise in production, and India is now the second largest producer of crude steel in the world, surpassing its previous third largest status. In addition, India was the largest producer of Sponge Iron and the second largest consumer of finished steel globally, as per rankings released by the World Steel Association.

In a de-regulated and liberalized market such as India, the role of the government is to act as a facilitator, providing policy guidelines and creating an institutional mechanism that promotes efficiency and performance in the steel sector. In this regard, the National Steel Policy 2017, released by the government, outlines the broad roadmap for the long-term growth of the Indian steel industry, both in demand and supply, by 2030-31. The government has also introduced a policy that provides preference to domestically manufactured iron and steel products in government procurement. Table 2 shows the production data of Indian steel industry as shared by joint plant committee. Table 3 shows the data on import and export of total finished steel in the past five years respectively.

Table -2: Production data of Indian steel industry

Category	2017-18	2018-19	2019-20	2020-21	2021-22
Pig Iron	5.73	6.41	5.42	4.88	5.76
Sponge Iron	30.51	34.71	37.10	34.38	39.03
Total Finished Steel	95.01	101.29	102.62	96.20	113.60

Table -3: Data on import and export of total finished steel in India

Category	2017-18	2018-19	2019-20	2020-21	2021-22
Import	7.48	7.83	6.77	4.75	4.67
Export	9.62	6.36	8.36	10.78	13.49

1.1 Equipment overview

An overview of the major equipment is provided below. These include:

1. Hot Blast Stoves. Air preheated to temperatures between 1000 and 1300 °C is produced in the hot blast stoves and is delivered to the furnace via a hot blast main, bustle pipe, tuyere stocks and finally through the tuyeres. The hot blast reacts with coke and injectants. The high speed gas forms the area known as the raceway in front of the tuyeres.

2. Stock house. The burden materials and coke are delivered to a stock house. The materials are stored, screened and then weighed before final delivery into the furnace. The stock house is operated automatically. Corrections for coke moisture are generally made automatically. The burden materials and coke are brought to the top of the furnace via skip cars or via a conveyor belt, where they are charged into the furnace in separate layers of ore and coke.

3. Gas cleaning. The top gas leaves the furnace via uptakes and a downcomer. The hot top gas contains a substantial quantity of fine particles, so it is required to remove these particles and cool the gas in a gas cleaning system consisting of a dust catcher or cyclone, a scrubber for wet cleaning of the gas and finally a demister for removing the water.

4. Casthouse. The liquid iron and slag collect in the hearth of the furnace, from which they are tapped via the taphole into the casthouse and to transport ladles. Depending on the size of the furnace, there may be one to five tapholes and one or two casthouses.

5. Slag granulation. The molten slag may be quenched with water to form granulated slag, which is used for cement manufacturing.

1.2 Conveyor System

The functioning of the Belt Conveyor is facilitated by electrical energy, a mechanism designed to enhance operational efficacy and serve as a solution to the drawbacks of the traditional Flat Belt Conveyor. Our team of experts has chosen to employ the Flat Belt Conveyor mechanism.

The Belt Conveyor consists of a minimum of two pulleys, around which a continuous loop of material - the conveyor belt - rotates. One or both pulleys are powered, driving the movement of the belt and its load. The powered pulley is known as the drive pulley, while the unpowered pulley is referred to as the idler. The Belt Conveyor system can be classified into two industrial categories, namely general material handling, which involves the transfer of boxes within a factory environment, and bulk material handling, which encompasses the transportation of industrial and agricultural materials such as coal, grain, and mustard sacks, generally in outdoor settings. It is important to note that companies specializing in general material handling Belt Conveyors typically do not provide conveyors for bulk material handling.

Furthermore, the Belt Conveyor has several commercial applications, including in grocery stores. The belt is

composed of one or more layers of material, which can be made of rubber. The majority of belts used in general material handling have two layers, including a carcass layer, which provides linear strength and shape, and a cover layer. Different types of Belt Conveyors exist, including the Flat Belt Conveyor, the Troughed Belt Conveyor, and the Blanket Conveyor, among others.

2. LITERATURE REVIEW

Conveyors, being durable and reliable components, are widely utilized in various industries such as automated distribution and warehousing, manufacturing, and production facilities. When paired with computer-controlled pallet handling equipment, these conveyors enable more efficient retail, wholesale, and manufacturing distribution, acting as a labor-saving system that allows for large volumes to be swiftly processed with reduced storage space and labor expenses (3).

Rubber conveyor belts, commonly used for conveying items with irregular bottom surfaces, small items that may fall between rollers, or saggy bags, consist of a metal frame with rollers at either end, looped around the belt. Upon powering one of the rollers with an electrical motor, the belting glides over the metal frame bed, moving the product. In heavy use cases, the metal beds are replaced by rollers that reduce friction from the heavier load on the belting (3).

Curved belt conveyors, with tapered rollers and curved belting, are widely used in postal sorting offices and airport baggage handling systems. Sandwich belt conveyors, with two face-to-face conveyor belts, allow for steep incline and vertical-lift runs by firmly containing the items being carried.

Belt conveyors, being the most versatile and cost-effective powered conveyors, are widely used for conveying a wide range of objects, both regular and irregular in shape, large or small, light or heavy, directly on the belt. To ensure smooth operation and reduce maintenance, these conveyors should utilize only premium belting products that reduce belt stretch. Belt conveyors can be utilized for straight line conveying, changes in elevation or direction, and even static accumulation or cartons (5).

Material handling encompasses the movement, packing, and storing of materials, and is considered a crucial activity in production, with 80% of the total time spent by materials inside a plant area dedicated to moving and waiting for processing. This function involves vertical, horizontal, or combination movements of fluid, semi-fluid, and discrete materials. With material handling accounting for 20% of total production cost, it is important to optimize this process. In this publication, several research papers are cited, including "Fabrication of a Conveyor Belt with Object Sorting and Counting Facility" by Mr. Nasif Hassan Khan, which discusses the use of factors and basic components in a conveyor system to avoid accidents and defective parts through control systems (1). Another study, "A Review of 'Improved Automated Conveyor with Auto Separated System for Oil Packaging Industry'" by Mr. Akshay K. Naphade and Prof. Manish J. Deshmukh, highlights the importance of sensors and monitoring systems to detect defective products using electronic systems for high reliability and fast operation (3). The paper "Design and Development of Automated Conveyor System and Material Handling" by Mr. Abhijit Gaikwad and Prof. Shreekant Pawar focuses on the design of a belt conveyor system for transporting materials and products from one manufacturing stage to another (4). Additionally, the paper "Implementing an Automated Sorting System" by Mr. Joshua Todd Fluke discusses the creation of a simulated and theoretical automated process for sorting products coming out of a distribution center (5). The various transport material handling systems, ranging from manual systems to conveyors, cranes, trucks, and automatic guided vehicles, are used to move materials over short or long distances, as discussed in "A Review on Material Handling Equipment and Their Selection for Potential Applications" by Vikas Gupta, Rajesh Bansal, and Vineet Kumar Goel.

3. PROBLEM IDENTIFICATION

To identify the hazards and to assess their corresponding risk, frequent site safety survey was carried out for a period of 30 days. The objective of conducting the site surveys were to note down the details of unsafe acts carried out by the workers/ operators/drivers and unsafe working conditions that may lead to an unwanted fatal accident at Blast Furnace and stock house.

Table 4 gives out the detail of the project undertaken for safety survey. The project mainly covers eight major part of the plant covering the blast furnace and stock house in particular.

Table -4: Parameters of blast furnace

S.No.	Parameter	Unit	Value
1	Useful Volume of BF	m3	4506
2	Working Volume of BF	M3	3815
3	Heart diameter	M	14.2
4	No. of Cast house	Nos	2
5	No. of tap hole in each cast house	Nos	2
6	Angle between tap holes in each cast house	Deg.	70
7	No. of tuyers	Nos	38
8	Production /day (avg.)	Tons/day	9500
9	Production / day (max.)	Tons/day	9500
10	Ash content in coke	%	12
11	Sinter in burden	%	80

12	Lump ore in burden	%	20
13	Pallets in burden	%	20
14	Availability of furnace	Days/yr	350
15	Consumption of input material (net & dry basis)		
	Iron ore lumps	Kg/thm	317
	Sinter	Kg/thm	1269
	Coke rate	Kg/thm	360
	PCI injection	Kg/thm	150

The Stock house will dispense batches of materials of the required composition and weight for charging to the furnace and will include two separate system, one for dispensing batches of coke and one for dispensing batches of ferrous materials. The stockhouse designed for Blast furnace is characterized by:

- A high operating flexibility in handling batch composition and charging sequence options,
- Sufficient spare charging capacity,
- A high screening efficiency and
- Minimum burden size degradation through a limited number of transfer points.

Stock house consist of:–

- Feeding Conveyor
- Shuttle Conveyor
- Charging Hutch
- Bunkers (Hopper)
- Rod Gate
- R/P Gate
- Vibro Feeder
- Vibro Screen
- Weigh Hopper
- Hyd. Gate
- Conveyors
- Magnetic Separator

In light of the extensive research conducted, it has become evident that numerous scholars have embraced the implementation of conjoint risk identification and assessment techniques. However, the sole identification of hazards during various conveyor operations, maintenance, and repair activities has yet to receive adequate attention. The literature survey conducted has shed light on the hazard identification and risk assessment practices, however, these assessments have been found to be superficial and not operation-specific. Therefore, it is imperative to conduct operation-specific hazard identification and risk assessment in conveyor systems to gain a deeper understanding of the risks associated with individual tasks.

4. METHODOLOGY

The methodology adopted in the research focuses on providing the task specific control measures to minimize or to mitigate the identified hazard during metro construction project. The methodology uses Hazard identification and risk assessment with controls (HIRA) method.

Hazard Identification, Risk Assessment and Control is a process that aids in management of occupational and health hazards in the workplace. HIRAC is implemented to maintain safe working environment with modern safety and health legislation.

4.1 Hazard Identification

The identification of hazards is a critical component of ensuring a safe working environment. This process involves recognizing potential dangers in the workplace and comprehending their nature. Hazards can be categorized into physical, biological, chemical, and psychosocial types, which are commonly present in work settings.

Undertaking a comprehensive hazard identification process can be labor-intensive and time-consuming, therefore, it is crucial to carry out the process regularly to maintain its effectiveness. A best practice for hazard identification is to divide the workplace into distinct areas and prioritize high-risk zones based on hazardous substances, processes, plant, or environment.

The individuals best equipped to identify hazards are domain experts who possess in-depth knowledge of the work procedures and processes. This includes workers and supervisors who can provide their valuable insights and experiences.

4.2 Risk Assessment

Risk assessment is the process of evaluating the level of risk and determining its acceptability for a given task. It involves estimating the “likelihood” and “consequence” of a potential hazardous event. For high-risk tasks, appropriate measures must be taken to reduce the risk level and ensure a safe workplace.

The next step involves listing and ranking the identified hazards based on the severity of their consequences and likelihood of occurrence. Consequence refers to the harm caused by the risk, while likelihood is the probability that a risk will occur. The risk level is calculated by multiplying the likelihood (L) and severity (S).

$$\text{Risk Level} = L \times S$$

The scores of likelihood and severity rating can be used to form the risk matrix where it is positioned in cells equivalent to the appropriate likelihood and severity. Respectively of the

risks positioned in the table will tumble under one of the categories, for which unlike colours can be used to signify the priority level

Table -5: Rating scale Likelihood of occurrence

Likelihood (L)	**Example**	**Rating**
Most Likely	The most likely result of the hazard/ event being realized	5
Possible	Has a good chance of occurring and it is not unusual	4
Conceivable	Might be occur at sometimes in future	3
Remote	Has not been known to occur after many after	2
Inconceivable	Is practically impossible and has never occurred	1

Table -6: Rating scale severity of the occurrence

Severity (S)	**Example**	**Rating**
Catastrophic	Numerous fatalities, irrecoverable property damage and productivity	5
Fatal	Approximately one single fatality major property damage if hazard is realized	4
Serious	Non-fatal injury, permanent disability	3
Minor	Disabling but not permanent disability	2
Negligible	Minor abrasions, bruises, cuts, first aid type injury	1

Table -7: Risk Matrix

Risk matrix		Severity (S)				
		1	2	3	4	5
Probability (P)	1	1	2	3	4	5
	2	2	4	6	8	10
	3	3	6	9	12	15
	4	4	8	12	16	20
	5	5	10	15	20	25

The outcome from comparative risk will be rank rendering to the risk matrix score in Table 7. The higher the risk relative score, the further substantial action is needed. High score calls for instant action, intermediate score required preparation of controlling the hazard and low risk is deliberated acceptable and tolerable.

Table 8: Action description for risk levels

Index	Description	Action
1-4	Low	Acceptable and further reduction may not be necessary.
5-12	Medium	Planned approach to controlling the hazard and applies temporary measure if required.
15-25	High	Immediate action to control the hazard as detailed in the hierarchy of control.

4.3 Risk control

The risk control actions were determined based on the hazard and the application of engineering controls, administrative controls, and PPEs. Proper hierarchy of risk control measure should be followed as shown.

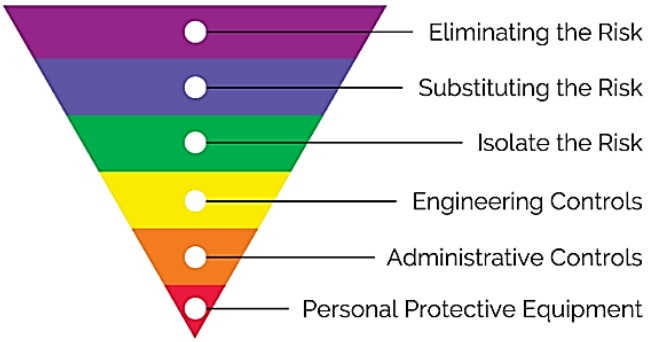

Figure 1 Hierarchy of controls

5. RESULT

Hazard Identification, Risk Assessment and Control method of assessing hazards in a worksite is a comprehensive and extensive approach aiming to make the workplace safe and healthy. However, due to the comprehensive, cumbersome and laborious nature of the approach, it is not possible to assess each activity or task during the different stages of conveyor system Therefore, in this research the Hazard Identification, Risk Assessment and Control method is applied to three major operations that involves extensive man-machine interaction. The operations under assessment are:

- Conveyor replacement work
- Belt press belt replacement work
- Idler replacement work
- Pulley replacement work
- Patching/Repairing work

Hazards have been identified in each task involved in the above work and their risk has been assessed in terms of severity (S) and probability (P) before and after the

application of control measure to minimize the risk level. Refer to Annexure 1 for complete HIRA for all the above conveyor operations.

6. CONCLUSIONS

The ever-increasing demand for bulk material handling systems has seen belt conveyors change more in the past 20 years, than they have since their inception. In order to maximise efficiencies and productivity, more complex conveyor systems are being installed without adequate knowledge of the system. In order to rectify this, this Thesis is aimed at identifying the underlying hazards in the conveyor system using HIRA and on the basis of identified hazards, standard operating procedure to be prepared for different material handling activity. Following this, conclusions are drawn about the work contained herein, and recommendations for future work presented.

In idler replacement, pulley replacement and repair and patching work the hazards identified were less compared to the earlier activities like conveyor replacement work and press belt replacement work where maximum underlying hazards were identified. During the initial investigation, the risk rating of identified hazards in few tasks were above the accepted level. With proper implementation of control measures according to the hazard mitigation hierarchy, the risk level was bought down to an acceptable level of work.

Based on the identified hazards, standard operating procedure for different work activity was prepared. Upon implementation of work as per the standard operating procedure the risk involved in job was completely taken down to an acceptable level and in few cases mitigating the risk completely.

Further work can be performed in the conveyor system with FMEA approach, where effect of failure of different parts of a conveyor system can be assessed and on the basis of which proper action plan can be prepared to make the system safer.

REFERENCES

[1] K. P. Shah: "Construction and Maintenance of Belt Conveyors for Coal and Bulk Material Handling Plants, visit www.practicalmaintenance.net

[2] G. Velmurugan, Dr. E. Palaniswamy, M. Sambathkumar, R. Vijayakumar, T. M. Sakthimuruga (2014). Conveyor Belt Troubles International Journal of Emerging Engineering Research and Technology Volume 2, Issue 3, June 2014, pp. 21-30

[3] S. Rajeshkumar (2017) 'Design and Analysis of Belt Conveyor for Finishing House Pulper', pp. 4540–4546. doi: 10.15680/IJIRSET.2017.0603212.

[4] Gaikwad, A. et al. (2017) 'Design and Development of Automated Conveyor System for Material Handling', IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), pp. 31–34.

[5] Salave, V. IV., I. S., Dalvi, A. B. B. B. H. and Arulkar, A. C. P. (2017) 'To Design and Analysis of 360 Degree Rotating Conveyor Belt with Up- Down Mechanism : A Review ', 5(08), pp. 263 – 265.

[6] S, Memane Vijay, P. N. S. B. and PG (2015) 'Design and Analysis of Belt Conveyor System of Sugar Industry for Weight Reduction', Journal of Emerging Technologies and Innovative Research (JETIR), 2(5), pp. 1473–1477.

[7] Gupta, D. (2015) 'Study and Performance of Belt Conveyor System with Different Type Parameter', 2(06), pp. 29–31.

[8] B. Kharag, A. (2015) '[Kharage , 4(4): April, 2015]', 4(4), pp. 296–301.

[9] Sangolkar, R. N. and Kshirsagar, V. P. (2015) 'Modeling and Analysis of Industrial Belt Conveyor System Using Creo Parametric and Ansys Software', 3(4), pp. 178–181.

[10] S.Ojha B.K. Pal B.B. Biswal (2015) "Minimising the breakdown in belt conveyor system of Coal Handling Plant" SSRG International Journal of Mechanical Engineering (SSRG-IJME) – volume 2 Issue 9

[11] Vaidya, S. D., Jagtap, A. A. and Samrutwar, A. R. (2015) 'Design of Material Handling Conveying System for Lucent Energy Pvt .', 3(1), pp. 19–24.

[12] Taher, G. A. et al. (2014) 'Automation of Material Handling with Bucket Elevator and Belt Conveyor', International Journal of Scientific and Research Publications, 4(3), pp. 1–13.

[13] Harrison, A., 1983. Criteria for minimising transient stress in conveyor belts. Mechanical Engineering Transactions 8 (3), pp. 129–134.

[14] He, D., Pang, Y., Lodewijks, G., 2016a. Belt conveyor dynamics in transient operation for speed control. International Journal of Civil, Environmental, Structural, Construction and Architectural Engineering 10 (7), pp. 828–833.

[15] He, D., Pang, Y., Lodewijks, G., 2016b. Determination of acceleration for belt conveyor speed control in transient operation. International Journal of Engineering and Technology 8 (3), pp. 206–211.

[16] He, D., Pang, Y., Lodewijks, G., 2016c. Speed control of belt conveyors during transient operation. Powder Technology 301, pp. 622–631

[17] Limberg, H., 1988. Untersuchung der raumbezogenen bewegungswiderstände von gurtförderern. Thesis, Hannover University. Lodewijks, G., 1995.

[18] The rolling resistance of conveyor belts. Bulk Solids Handling 15 (1), pp. 15–24.

[19] Nave, M., 1996. A comparison of soft start mechanisms for mining belt conveyors. Tech. rep., Intertec Presentations, Inc., Englewood, CO (United States).

[20] Nel, P., Shortt, G., 1999. Controlling belt slip. Bulk Solids Handling 19 (4), pp. 481–486.

Annexure 01

HIRA for Conveyor replacement work

S. No.	Activity	Hazard	Risk	R/N	Legal requirement(L)	Existing Controls	Risk Before Control			Risk After Controls			Frequency of Monitoring	Risk (A/ UA)
							(S)	(P)	(SxP)	(S)	(P)	(SxP)		
1	Shifting of conveyor belt drum to work site	Fall of material, struck by / with other objects, Crush / cut injury, Failure of lifting device / mechanism.	Damaged to the properties, hit by object, crush, cut, caught in between,	R	L	* Designated worker need to be engaged in lifting and shifting activity. * Proper training on material handling need to be ensure to engaged workman. *Tested and right tools and tackles to be used for lifting work. . * While shifting of material ensure that it should not be overload beyond the safe working load of shifting device or mechanism. * Guide rope with red flag to be used by the workmen to handle the belt drum during shifting. * Required PPEs (Safety helmet, Safety shoe, Safety goggles, hand gloves, Nose Mask etc.)to be worn during work activity. * Strict supervision to be ensured all time. * If person get injured they must be taken to the OHC centre.	3	3	9	2	2	4	When needed	A
2	Positioning of belt for performing joint process	* Fall of material * Struck by / with other objects * Crush/cut injury * Run over/Roll over of conveyor belt due to applied tension on belt. * Accidentally / Suddenly starting of energised equipment. * Dust exposure.	Damaged to the properties, hit by object, crush, cut, caught in between, Health hazards	R	L	* Work permit must be ensure before execution of job. * LOTO must be checked physically by the PTW requester/holder after isolation. * Trained and skilled workmen to be deployed for the job. * Lifting and pulling path of material and equipment must be free from obstruction to avoid excessive load on devices. * Required PPEs (Safety helmet, Safety shoe, hand gloves, nose mask etc.)to be worn during work activity. * Be aware of crush/hit injury while lifting/ shifting/pulling a conveyor belt. * Strict supervision to be ensured all time. * Proper communication need to be ensured at both end while positioning of conveyor belt.	2	2	4	2	2	4	When needed	A

S. No.	Activity	Hazard	Risk	R/N	Legal requirement(L)	Existing Controls	Risk Before Control			Risk After Controls			Frequency of Monitoring	Risk (A/ UA)
							(S)	(P)	(SxP)	(S)	(P)	(SxP)		
3	* Take up lifting/holding (Lifting of take-up pulley by chain block, Locking of lifted take-up) * Clamping of belt for joint * De-coupling (Decoupling of geared coupling (in order to avoid holdback bearing opening) * Scrapper Release	* Fall of material * Struck by/with other objects * Crush/cut injury * Run over/Roll over of conveyor belt due to applied tension on belt. * Slip/trip hazard. * Dust exposure.	Damaged to the proprties, hit by object, crush, cut, cought in between,	R	L	* While lifting of material ensure that it should not be overload beyond the safe working load of lifting device or mechanism. * Lifting device must be inspected for healthiness before to each use and ensure availability of competent person inspection report of all lifting devices/mechanism. * Lifting and pulling path of material and equipment must be free from obstruction to avoid excessive load on device. * Belt locking arrangement must be ensured by providing multiple locking at both carrying & return side of the belt. * Operate portable tools with care. * Unauthorise person should not allow to operate electrical power tools. * Guarded portable / electrical tools must be ensured.	2	2	4	2	2	4	When needed	A
4	* Positioning and laying of new belt conveyor. * Positioning of winch machine and rope for laying of conveyor belt. * Pulling new conveyor by winch machine operation. * Positioning of belt.	* Fall of material * Struck by/with other objects * Crush/cut injury * Run over/Roll over of conveyor belt due to applied tension on belt. * Slip/trip hazard.	Damaged to the proprties, hit by object, crush, cut, cought in between,	R	L	* Evacuate the area and barricade to restrict the entry below suspended load(Take up) and affected area.Remove loose material from height. * All openings and edges should be hard barricaded. Use and anchoring of safety harness is mandatory at height. * While lifting of material ensure that it should not be overload beyond the safe working load of lifting device or mechanism. * Lifting device must be inspected for healthiness before to each use and ensure availability of competent person inspection report of all lifting devices/mechanism. * Lifting and pulling path of material and equipment must be free from obstruction to avoid excessive load on device. * Release/ apply belt tension slowly.	2	3	6	2	2	4	When needed	A

S. No.	Activity	Hazard	Risk	R/N	Legal requirement(L)	Existing Controls	Risk Before Control			Risk After Controls			Frequency of Monitoring	Risk (A/ UA)
							(S)	(P)	(SxP)	(S)	(P)	(SxP)		
5	Joint cold process.	* came in contact with belt jointing chemicals. * Fire hazard due belt joint chemical.	Health hazards, Fire Hazards	R	L	* Skilled belt jointer must be deployed for splicing process. * Use chemical gloves for belt joint chemical. * Uses of face shield / safety goggle, nose mask,hand gloves must be ensure to belt jointer while buffing of belt will be carried out. * Do not kept open to avoid contact with source of ignition/ naked flame. Belt joint chemical solution must be Store in cool, dry and safe places. Keep away from combustible material. * Fire extinguisher must be kept while performing the belt joint.	2	4	8	2	2	4	When needed	A
6	* Removal of clamps * Releasing of Take-up (Support removal by lifting of take-up, Take-up release) * Scrapper positioning 4. Coupling (Coupling teeth to be cleaned by proper cleaner & lubricated, Tightening of coupling Bolts)	* Fall of material * Struck by/with other objects * Run over/Roll over of conveyor belt due to applied tension on belt. * Slip/trip hazard.	Crush/cut injury, Damaged to the proprties, hit by object, crush, cut, cought in between,	R	L	* Trained and skilled workmen to be deployed for the job. * While lifting and removal of support ensure that it should be done safely . * It is to be ensure that during releasing of takeup and belt tension no workman will work near by conveyor vicinity. * Lifting and pulling path of material and equipment must be free from obstruction to avoid excessive load on device. * Ensure scrapper is properly tightened at suitable point. * Required PPEs (Safety helmet, Safety shoe, Safety goggles, Cotton hand gloves, nose mask etc.) to be worn during work activity. * Be aware of crush/hit injury while lifting/ shifting / pulling a conveyor belt. * It is to be ensure that during losening of belt clamp belt clamp must be hold with ppe rope.	2	2	4	2	2	4	When needed	A

S. No.	Activity	Hazard	Risk	R/N	Legal requirement(L)	Existing Controls	Risk Before Control			Risk After Controls			Frequency of Monitoring	Risk (A/ UA)
							(S)	(P)	(SxP)	(S)	(P)	(SxP)		
7	Shifting of damaged conveyor and belt drum to store	* Fall of material * Struck by/with other objects * Failure of lifting device/mechanism.	* Crush/cut injury * Damaged to the proprties, hit by object,	R	L	* Trained and skilled workmen to be deployed for the job. * Tested and right tools and tackles to be used for lifting work. * Tested lifting equipments to be used at site. * While shifting of material ensure that it should not be overload beyond the safe working load of shifting device or mechanism. * Guide rope to be used by the workmen to handle the belt drum. * Required PPEs (Safety helmet, Safety shoe, Safety goggles, Cotton hand gloves, nose mask etc.)to be worn during work activity. * Stict supervision to be ensured all time.	2	2	4	2	2	4	When needed	A
8	Waste management	* Slip, trip and fall * Dust exposure	Hit, cut and health hazards	R	L	* All unused materials should be properly cleaned from the work area. * Required PPEs (Safety helmet, Safety shoe, Safety goggles, Cotton hand gloves, nose mask etc.)to be worn during work activity	2	2	4	2	2	4	When needed	A
9	Trial Run	* Sudden start of conveyor belt. * Improper communication * Struck by/with moving objects * Came in contact with rotating part.	Crush/cut injury	R	L	* Field Engineer is to take the initiative to go for the trial run in co-ordination with Control room and Operation Shift-In Charge. * Trained workman must be engaged in all point of conveyor belt for close look. * Prior to start the conveyor close monitoring throughout the conveyor must be carried out to find the problem. * Hooter must be blow before start of conveyor to alert the near by workman.	2	2	4	2	2	4	When needed	A

HIRA for belt press belt replacement work

S. No.	Activity	Hazard	Risk	R/N	Legal requirement(L)	Existing Controls	Risk Before Control			Risk After Controls			Frequency of Monitoring	Risk (A/ UA)
							S	P	SxP	S	P	SxP		
1	Shifting of belt drum to work site	Fall of material, struck by / with other objects, Crush / cut injury, Failure of lifting device / mechanism.	Damaged to the proprties, hit by object, crush, cut, cought in between,	R	L	* Designated worker need to be engaged in lifting and shifting activity. * Proper training on material handling need to be ensure to engaged workman. *Tested and right tools and tackles to be used for lifting work. . * Required PPEs (Safety helmet, Safety shoe, Safety goggles, hand gloves, Nose Mask etc.)to be worn during work activity. * Strict supervision to be ensured all time. * If person get injured they must be taken to the OHC centre.	3	3	9	2	2	4	When needed	A
2	Positioning & belt laying	* Fall of material * Struck by / with other objects * Crush/cut injury * Run over/Roll over of belt due to applied tension on belt. * Accidentally / Suddenly starting of energised equipment. * Slurrey exposure.	Damaged to the proprties, hit by object, crush, cut, cought in between, Helath hazards	R	L	* Work permit must be ensure before execution of job. * LOTO must be checked physically by the PTW requester/holder afterisolation. * Trained and skilled workmen to be deployed for the job. * Lifting and pulling path of material and equipment must be free from obstruction to avoid excessive load on devices. * Required PPEs (Safety helmet,Safety shoe,hand gloves,nose mask etc.)to be worn during work activity. * Be aware of crush/hit injury while lifting/ shifting/pulling a belt. * Strict supervision to be ensured all time.	2	2	4	2	2	4	When needed	A
3	Joint process.	* came in contact with belt jointing pin	Cut/Minor injury, hit by object	R	L	* Skilled belt jointer must be deployed for stitching process. * Use gloves for belt joint process.	2	2	4	2	2	4	When needed	A
4	Provide tension to belt	* Struck by/with other objects * Run over/Roll over of belt due to applied tension on belt. * Slip/trip hazard.	Crush/cut injury, Damaged to the proprties, hit by object, cought in between,	N	L	* Trained and skilled workmen to be deployed for the job. * While lifting and removal of support ensure that it should be done safely . * It is to be ensure that during providing tension to belt no workman will work near by belt vicinity. * Ensure scrapper is properly tightened at suitable point. * Required PPEs (Safety helmet, Safety shoe, Safety goggles, Cotton hand gloves, nose mask etc.) to be worn during work activity. * Be aware of crush/hit injury while	2	2	4	2	2	4	When needed	A

						lifting/ shifting / pulling a belt.									
5	Shifting of damaged belt to store	* Fall of material * Struck by/with other objects	* Crush/cut injury * Damaged to the proprties, hit by object,	R	L	* Trained and skilled workmen to be deployed for the job. * Tested and right tools and tackles to be used for lifting work. * Tested lifting equipments to be used at site. * Required PPEs (Safety helmet, Safety shoe, Safety goggles, Cotton hand gloves, nose mask etc.)to be worn during work activity. * Stict supervision to be ensured all time.	2	2	4	2	2	4	When needed	A
6	Waste management	* Slip, trip and fall * Slurry exposure	Hit, cut and health hazards	R	L	* All unused materials should be properly cleaned from the work area. * Required PPEs (Safety helmet, Safety shoe, Safety goggles, Cotton hand gloves, nose mask etc.)to be worn during work activity	2	2	4	2	2	4	When needed	A

HIRA for Idler replacement work

S. No.	Activity	Hazard	Risk	R/N	Legal requirement(L)	Existing Controls	Risk Before Control			Risk After Controls			Frequency of Monitoring	Risk (A/ UA)
							S	P	SxP	S	P	SxP		
1	Shifting of idler on job location	Fall of idler from hand	Crush and cut injury,	R	L	* Tractor / camper must provide to carry the idler * Trained and physically fit worker need to be engaged in lifting and shifting activity. * Proper training need to be ensure to engaged workman.. * Required PPEs (Safety helmet, Safety shoe, hand gloves etc.) to be worn during work activity. * Stict supervision to be ensured while lifting shifting of idler. * If person get injured they must be taken to the OHC centre.	2	2	4	2	2	4	Fortnight	A
2	Fixing of idler	Came in contact with rotating part, fall of material, fall of person/idler from height	Crush, cut, cought in between, disability , fatality.	R	L	* Valid PTW from shift incharge / control room must be ensure before execution of job. * Proper Lock Out & Tag Out of permit with isolation verification is required before commencement of job. * Full body harness must be ensure while working at height. * It is to be ensure that tools & tackle using at height must secure with tag line. * Idler must be tied and locked properly with lifting belt before lifting at height. * Barrication below the area must be ensure before changing/lifting the idler. * Close supervision need to be done.	2	3	6	2	2	4	Fortnight	A