
JOB SAFETY ANALYSIS ON MANUFACTURING PROCESS OF HOUSE WIRES

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Abstract

The objective of this project is to analysis of hazards in the process of house wire manufacturing in V-Guard industries limited Coimbatore for the purpose of improving safety in the workplace and promoting safety culture among the workers. Manufacturing process involves cold wire drawing process, copper cable bunching process, Insulation process, testing and material handling process all of this process having its own significant hazards. By using the Job safety analysis technique, the analysis was carried out and the study is submitted as a report to V-Guard industries limited Coimbatore. Here the proposed practical solution in the sequence of Elimination, Substitution, Engineering control, Administrative control, and Personal Protective Equipment using the observation form Job Safety Analysis worksheet.

1.Introduction

V-Guard industries limited Coimbatore producing house wires, industrial power cables, UPS and inverters. House wire manufacturing plays major role in this Coimbatore plant. In the process of manufacturing involves the following sequence of process. To reduce the accident and promote the safety culture in the workplace is the ultimate aim of this project. Through the Job Safety Analysis, the analysis carries out and the recommendation given for the hazards associated with the work process. The deviation from the standard operating procedure also noted and recommendation was added with the standard operating procedure to ensure the safe operation.

2. Literature review

Job safety analysis (JSA) is systematic approaches for analysis the safe working condition at workplace which can be applied to all the jobs process and works. So JSA was applied to the house wire manufacturing process by the reference of the following papers and standards.

Cranes and the hazards associated with the cranes and its control measures were studied by using checklist. In this paper the author created a checklist for the crane and taken a survey for 48 numbers of lifting mechanism. Through his survey identification mark, hook condition, Hoist, Limit switch, Control lever / pendent, trolley, power transmission, Walkway floors, Electrical measures, Operator Cabin, Operational, first aid fire and emergency response and other general conditions were taken and deviation from safety measures was noted and recommendations given. From this paper checklist used for checking the safety deviation in wire manufacturing industry.

Crane safety device anti collection and Anti current device, safety latches and its use in the field was studied. The use of anti-current device prevent the transmission of electrical current from the

energized power line to the crane component it having the insulated boom cage, insulated line and links, insulated barrier, proximity or current warning device are included in that device. Safety latches used in the hooks for rigging failure. Anti-collection device used for the stop collection of cranes with other cranes or fixed structure.

Electric Overhead Travelling crane standards and the test procedures were studied in IS 3177: 1999 having the detailed study about the electric overhead travelling cranes selection, installation, and operation and testing procedure to operate the Electric overhead travelling crane.

3. Methodology

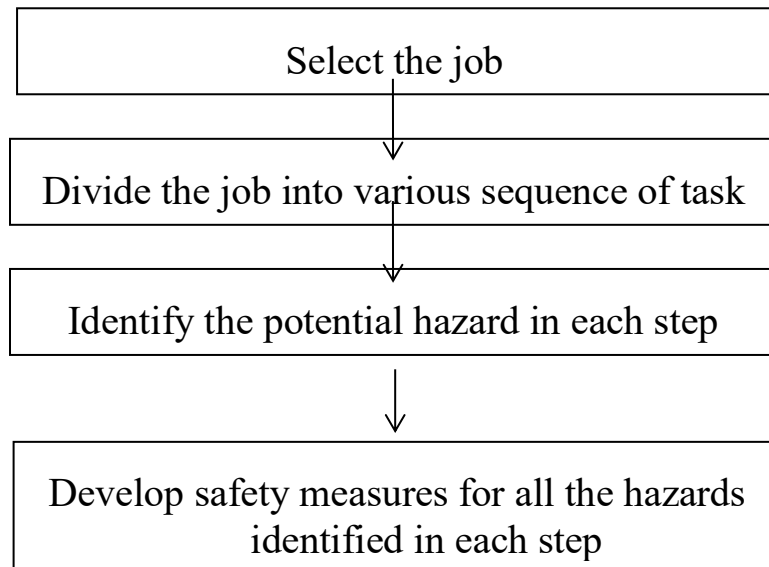


Figure 4.1 JSA Methodology

4. Results and discussion

Job Safety Analysis was done for the house wire manufacturing process and recommendation was given to the hazards identified. Through this project standard operating procedure was converted into safe operating procedure by using the JSA recommendation. In the house wire manufacturing process was subdivided into nine process sequence steps and for all the steps JSA performed and recommendation was given for hazards related to work process. By enforcing the workers towards the safe operating procedure instead of standard operating procedure will reduce the chance of accident and the safety of the workplace will be improve. The JSA shall be updated periodically and any process, product equipment, or tools changed for the operation means we have to update the JSA for the new change

4.1 JSA for unloading of copper coil

Initially the copper coil was unloaded from the truck using Electric Operated Travelling crane. The JSA worksheet was given in the table 5.1

Table 4.1 Job Safety Analysis worksheet for unloading of copper coil

JOB SAFETY ANALYSIS		Date :
JOB/ACTIVITY NAME: Unloading of copper from truck to incoming area using EOT crane		Last revision date:
Prepared by :	Reviewed by :	JSA Number : 001
Approved by :	Department name :	Area / Location :
Other information :		
Personal Protective equipment's Required: Safety helmet, Cut resistant gloves, and Safety shoes.		
BASIC STEPS	POTENTIAL HAZARD	CONTROL MEASURES
Rigging	1.Loads not safely rigged before being hoisted	1. The Rigger must be trained to understand and anticipate the hazards related to the rigging process. 2. The rigger should be trained about the weight of the load and the rated capacities for the hoist.
	2.Fall of riggers from the truck during the rigging process	1. Riggers must be aware of their surroundings to prevent falls due to uneven walking or working surfaces while on the truck.
	3. Cuts and Severe Lacerations due to sharp edges in the wooden pallet.	1. Use proper PPEs (Safety shoes, cut resistant gloves) while providing belts for the copper coil.
Turn on the EOT crane &No load checkup	Machine failure due to improper maintenance.	Ensure the EOT crane in operating condition 1. Do not assumption ask if in doubt. 2. Do not operate the crane when it is locked out or tacked out. 3. Check for any Oil leakage 4. Check the necessary marking is there (up, down, right, left, front, back, start, emergency stop). 5. Check the valid test certificate Of the EOT crane and the lifting tackles by the competent person. (Crane should be tested and certified at least once in a year and Synthetic belts and other lifting tools should be inspected and certified every 6 month once).
	Synthetic web sling cut due to sharp edges in the wooden pallet.	1. Use proper padding techniques over the burrs, splinters, sharp edges, nails and sharp corners to prevent the damage to the synthetic web slings.

Check the intended route and point of placement	Slip and trip happen due to presence of moveable objects and spillage in the incoming area.	Inspect the area immediately around the load and the route for clearance and tripping hazards. Clear movable objects from the route. Check for uneven terrain. Clean up spills that could affect foot traction.
No load checkup	Machine failure due to improper maintenance.	<ol style="list-style-type: none"> 1. Any unusual sound or vibration. 2. Ensure all hoist limit switch and travel limit switches and indicating devices in good working condition. 3. Check the lifting hook for the good working condition. Check the safety latch is able to spring back and check there is no illegal modification. 4. Check the emergency limit switch is in operation. 5. Ensure the load indicator is available.
Placing load indicator	Failure of load indicator	<ol style="list-style-type: none"> 1. Check the load indicator having any creak or any damage in the surface and hook. 2. Check the valid test certificate issued by competent person.
Loading the belt in the hook.	Hand or foot caught in between load and belt.	<ol style="list-style-type: none"> 1. Communicate clearly between lifting team before lift the job. 2. Do not keep the hand on load while lifting. 3. Use guide rope, push/pull sticks to help control the loads.
	Fall of material due to presence of sharp edges in the wooden pallet	Rigger shall ensure there is no sharp edges contact with the belt during lifting operation.
Lifting of coil	1.fall of material due to improper lifting	<ol style="list-style-type: none"> 1. Use proper loading rigger technique for coil lifting and unloading of coil from the truck and ensure the lifted load was balanced. 2. Providing Necessary training for the EOT crane operator for the periodic time intervals. <ol style="list-style-type: none"> 2.1 Lifting technique 2.2 Good safety practice 2.3 Risk assessment, firefighting, and first aid procedures. 3. Ensure the load did not rise above the marked level of safe lifting height.
	2. Synthetic web sling cut due to sharp edges in the wooden pallet.	1. Use proper padding techniques over the burrs, splinters, sharp edges, nails and sharp corners to prevent the damage to the synthetic web slings.
	3. Structure collapse due to overloading.	<ol style="list-style-type: none"> 1. Ensure the load was not attached with the truck or other objects. 2. Ensure the load weight within the limit of crane SWL (safe work load).

Transferring the coil.	Hit by moving or swinging loads	<ol style="list-style-type: none"> 1. Communicate clearly between lifting team before lift the job. 2. Don't lift the load from the side ensures the crane in center over the load to avoid swinging and fall of material. 3. Keep away from the load before lifting is started. 4. Use guide rope, push/pull sticks to help control the loads. 5. Do not multitask when operating crane. 6. Do not operate when you are not feeling well. 7. Do not roughly handle the crane operate smoothly. 8. Do not operate when high wind times. 9. Do not lift loads over peoples.
	Caught in between load and the structure	Keep away from the load and be in the proper communication with the EOT crane operator.
Unloading the coil	Fall of material due to improper stacking	Ensure the loads are stacked in a stable location and not above the marked safe stacking height.
	Hand or foot caught in between load while stacking	Keep away your hand while stacking. Use tag lines or push/pull sticks to help control the loads.

Table 4.2 Job Safety Analysis worksheet for move the copper coil from incoming area to the RBD feeder using forklift

JOB SAFETY ANALYSIS		Date:
		Last revision date:
JOB/ACTIVITY NAME: Operator move the copper coil from incoming area to the RBD feeder using forklift		JSA Number : 002
Prepared by	Reviewed by	Approved by
Department name :	Area / Location :	Other information :
Personal Protective equipment's Required: Safety helmet, Cut resistant gloves, and Safety shoes.		
BASIC STEPS	POTENTIAL HAZARD	CONTROL MEASURES
Switch on the machine	Machine failure	<ol style="list-style-type: none"> 1. Operator should ensure the operating condition of the forklift. 2. Check the lifting mechanism before lifting the coil like any oil leak in the hydraulic system, Tire condition, and chain drive healthiness, any creak in the forks or load backrest unit. 3. Check the valid test certificate provided by the competent person (yearly once renewal).
Lifting the coil using forklift	Fall of coil due to improper lifting	1. Operator and lifting team shall be ensure the coil was stable and secure before lifting.

		<ol style="list-style-type: none"> 2. Providing training and license for the operator on safe lifting methods. 3. Ensure the operator having valid heavy duty license issued by the transport corporation.
	Fall of coil due to over loading or any attachment with that coil	<ol style="list-style-type: none"> 1. Operator and the lifting team should ensure the lifting weight is below the SWL. 2. Operator should ensure there is no attachment or stacking of other material or tools with that coil.
Transferring the load.	Hit the pedestrians during operation	<ol style="list-style-type: none"> 1. Before operate the forklift operator shall ensure the way is clear. 2. Keep away the non-essential workers from the forklift operation area. 3. Install boundary area with visual signs. 4. Operator should knock horn in corners and intersections. 5. Install guard rail in the walkway in the forklift area. 6. Ride the vehicle in safe speed (20 KMPH). 7. Check the sound and light indication during take reverse. <p>Do not raise the fork level above the human.</p>
Unloading the coil	Fall of material	<ol style="list-style-type: none"> 1. Operate at a safe speed (20KMPH). 2. Operator should ensure the unloading area is clear and there are no obstacles in the unloading area.

5.3 JSA for wire drawing process using RBD machine

Table 5.3 Job Safety Analysis worksheet for wire drawing process using RBD machine

JOB SAFETY ANALYSIS		Date:
		Last revision date:
JOB/ACTIVITY NAME: wire drawing process using RBD machine		JSA Number : 003
Prepared by	Reviewed by	Approved by
Department name :	Area / Location :	Other information :
Personal Protective equipment's Required: Cut resistant gloves with chemical protection, Safety shoes, Splash goggles, Apron.		
BASIC STEPS	POTENTIAL HAZARD	CONTROL MEASURES
Unpack the coil	Cut injury due to sharp edges of the metal strips used for packing	Use proper PPEs during unpacking the coil (Safety shoes, cut resistant gloves).
Switch on the panel supply	Short circuit may happen due to presents of water inside the cable trench.	Cable trenches shall be altered in such a way to stop the presence of water.
	Spillage of cooler drain water may cause electrical hazard (electric shock, short circuit etc) which is	<ol style="list-style-type: none"> 1. Cooler drain water shall be properly channeled and drained to ensure there is no contact with the panel and its accessories. 2. Cooler position can be replaced to backside of the panel to make the draining easy.

	placed in-front of the panel.	
Check the panel setting as per log sheet	Lubrication and coolant system pressure setting deviation can cause system failure and create hazard to the operator.	Check the pressure, Die size and speed values before turn on the machine.
Put initial setting using pointing machine	Hand may crush between wheel and copper rod.	Fixed guard can provided for the rotating parts and keep away from the rotating parts.
Switch on the coolant system	Spillage of coolant may cause slip hazard	<ol style="list-style-type: none"> 1. Good housekeeping practice and regular checkup and maintenance of coolant lines. 2. Take immediate action to clear the spillage.
Switch on the lubrication oil motor	Motor failure can cause electric shock due to presence of lubrication oil and dusts on the motor	<ol style="list-style-type: none"> 1. Lube oil system oil leakage should be arrested. 2. Motor should be provided with external cover. 3. Motor cleaning schedule timings can be reduced.
	Spillage of lubrication oil and grease	<ol style="list-style-type: none"> 1. Good housekeeping practice and regular checkup and maintenance of oil lines and grease points. 2. Take immediate action to clear the spillage.
Coolant operation room	Operator visit the coolant room to check the coolant tank level and change the filter paper in case of alone worker cant contact others in case of emergency situations.	Entry of alone worker shall be prohibited in the coolant room to ensure the safety of the operator.
	Exposure to slippery floor while changing the filter paper and tank cleaning	<ol style="list-style-type: none"> 1. One operator should be available on the top of the tank. 2. Safety shoes should be used to avoid slip.
	Chemical stored inside the coolant room not having secondary containment so in case of leak in the container spillage and trip hazard happen.	Secondary containment shall be provided for the chemicals storage area at-least 110 percentage of its total stored capacity of the chemical.
	Eye injury and skin irritation may happen due to Splash of coolant with copper dust while handling filter paper change.	Proper PPEs shall be used during filter paper change.(Cut resistant gloves with chemical protection, Splash goggles, Safety shoes)
Providing die in	Fall of die metal on foot can	Use firm grip to the lift the tool.

the die holder	cause injury.	
Feeding 8 mm copper rod from coil to upper guide roller	Fall of person from height	Providing proper platform arrangement for access the upper guide roller instead of ladder.
Feeding 8 mm copper rod from upper guide roller to bottom guide roller	Caught between rollers	Providing fixed guard for the bottom guide roller.
Tie the copper rod in the die.	Coolant splash during start-up setting and process disturbance works it may contact with eye skin and cause eye and skin irritation	1. Provide auto pressure setting of coolant can be done by valve control or coolant motor speed control during initial start-up. 2. Use proper PPEs for the maintenance and process activities. (Safety shoes, splash goggles, cut resistant gloves with chemical protection and apron).
Operating RBD machine in manual mode for the initial setup.	Caught between roller and copper rod due to accidental pressing of foot pedal	Foot pedal switch shall be protected with guarding arrangement to avoid accidental one of the machine during start-up setting or break down work.
	Wire drawing motor earthing line was buried inside the concrete floor so earth line breakage inside the concrete floor cannot find easily. So this may lead to electrical shock.	Earth line shall be laid such a way continuity can be checked visually.
	Wire drawing motor painting was not in good condition so in case of insulation failure electric shock may occur.	Motor painting condition shall be checked every year in case of necessary it shall be repainted.
Speeding up the machine	Exposure to Noise	1. Regularly check the lubrication oil and grease point for any abnormal sound or vibration. Keep regular practice for lubrication and grease top-up as per manufacturer specification. 2. Use ear muffs or ear plugs to reduce the noise exposure.
	Exposure to copper dust	1. Good housekeeping practice and regular cleaning of machine in every shifts. 2. Use dust mask during cleaning of machine.
RBD coiling	Fall of coil due to Improper lifting.	Experienced persons only handle the forklift there should be refreshment course should be conducted as per necessary.
	Cut injury may occur due to sharp edges of the coil.	Cut resistant gloves can be used when finishing edge handling of the RBD outlet coil.
Machine cleaning and waste disposal	Exposure to compressed air can cause injury and it may spread copper dust into	1. Do not use compressed air for cleaning the machine or cloths. 2. Use wet & dry clothes for cleaning the motor.

	your eye, nose and ears.	
	Dust emission during cleaning the filter of the blower	<ol style="list-style-type: none"> 1. Use water for cleaning the filter. 2. Use dust mask while cleaning the blower filter.
	Disposal of hazardous waste	<ol style="list-style-type: none"> 1. All hazardous wastes should be collected by separate waste bins. 2. It should be stored in a separate weather proof room with good ventilation. 3. Coolant and other liquid hazardous wastes should be stored in cans in designated place with secondary containment. 4. Empty hazardous waste cans also properly segregated and stored in distinct location.

Table 5.9 Job Safety Analysis worksheet for Dispatch the finished goods to godown using forklift

JOB SAFETY ANALYSIS		Date:
		Last revision date:
JOB/ACTIVITY NAME: Dispatch the finished goods to godown using forklift		JSA Number : 009
Prepared by	Reviewed by	Approved by
Department name :	Area / Location :	Other information :
Personal Protective equipment's Required: Safety helmet, Cut resistant gloves, and Safety shoes.		
BASIC STEPS	POTENTIAL HAZARD	CONTROL MEASURES
Switch on the machine	Machine failure	<ol style="list-style-type: none"> 1. Operator should ensure the operating condition of the forklift. 2. Check the lifting mechanism before lifting the coil like any oil leak in the hydraulic system, Tire condition, and chain drive healthiness, any creak in the forks or load backrest unit. 3. Check the valid test certificate provided by the competent person (yearly once renewal).
Lifting the goods using forklift	Fall of coil due to improper lifting	<ol style="list-style-type: none"> 1. Operator and lifting team shall be ensuring the goods was stable and secure before lifting. 2. Providing training and license for the operator on safe lifting methods. 3. Ensure the operator having valid heavy duty license issued by the transport corporation.
Lifting the goods using forklift	Fall of coil due to over loading or any attachment with that goods	<ol style="list-style-type: none"> 1. Operator and the lifting tram should ensure the lifting weight is below the SWL. 2. Operator should ensure there is no attachment or stacking of other material or tools with those goods.
Transferring the goods.	Hit the pedestrians during operation	<ol style="list-style-type: none"> 1. Before operate the forklift operator shall ensure the way is clear. 2. Keep away the non essential workers from the forklift operation area. 3. Install boundary area with visual signs. 4. Operator should knock horn in corners and intersections.

		<ol style="list-style-type: none"> 5. Install guard rail in the walkway in the forklift area. 6. Ride the vehicle in safe speed (20 KMPH). 7. Check the sound and light indication during take reverse. 8. Do not raise the fork level above the human.
Unloading the goods.	Fall of material	<ol style="list-style-type: none"> 1. Operate at a safe speed (20KMPH). 2. Operator should ensure the unloading area is clear and there are no obstacles in the unloading area.

6. Conclusion

Through this project each and every manufacturing process of house wire was divided into various steps in the process sequence and the Job Safety Analysis conducted for the all sequential process. From the observations from the analysis was suggested with suitable safety measures and recommendation. For the potential hazards involved in the process of house wire manufacturing was analysed and precaution given in the hierarchy of 1. Elimination, 2. Substitution, 3. Engineering control, 4. Administrative control, 5. Personal protective Equipment. Ultimately the management will take responsibility to enforce the workers to follow the safe operating procedure and regular monitoring of worker and the implemented safety precaution to know the effectiveness of the implementation.

References

- 1) Vinay dubay and rajivpermi (2016), “Hazard identification of cranes and their control measures”, International Journal of Engineering Development and Research volume 4, pp 2-6
- 2) Richard L. Neitzel, Noah S. Seixas, and Kyle K. Ren (2001), “A review of crane safety in construction industry” volume 16, pp 5-8.
- 3) Is 3177: 1999 code of practice for electric overhead travelling crane and gantry crane other than steel work cranes “Bureau of Indian standards” , pp44-45.
- 4) OSHA 3072:1996 revised Sling safety pp 5-8
- 5) Praveen Kumar, Dr. Geeta Agnihotri, “Cold wire drawing process – A review” International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622, Vol. 3, Issue 3, May-Jun 2013, pp.988-994
- 6) OSHA 1910.178 powered industrial trucks
- 7) Eirik Albrechtsen, Ingvild Solberg, Eva Svensli (2019), “The application and benefits of job safety analysis”, Safety Science Elsevier pp 4-11
- 8) Jung-Keun Park, (2016), “Job Hazard Analyses for Musculoskeletal Disorder Risk Factors in pressing Operations of Dry-cleaning Establishments”, Journal of Safety and Health at Work, Vol. 7, pp. 389-393.
- 9) Wei Zheng, Jain Shuai and Ke Shan, (2017), “The energy source based job safety analysis and application in the project”, Journal of Safety Science, Vol. 93, pp. 9-15.
- 10) Morrish Colin, (2017), “Incident prevention tools-incident prevention and pre-job safety analyses”, International Journal of Mining Science and Technology, Vo. 27, pp.635-640.
- 11) Varun Gopinath and Kerstin Johansen, (2016), “Risk Assessment Process for Collaborative Assembly- A Job Safety Analysis Approach, CIRP Conference on Assembly Technologies and Systems, Vol. 44, pp. 199-203.
- 12) Reza Khoshk Daman, (2018), “Evaluating the effect of using warning signs on risk reduction using job safety assessment (JSA) in one of the automobile cable manufacturing companies”, Journal of Research in Medical and Dental Science, Vol. 6, pp. 293-297.

