Safety Risk Assessment in Valve Industry Using Fault Tree Analysis Method

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***Abstract*: For any industry to be successful it is to identify the Hazards to assess the associated risks and to bring the risks to tolerable level. In the manufacturing and assembling of Valves, as part of the project work, hazard identification and risk analysis, aspect and impact study was carried out for various departments and through fault tree analysis the recommendations were arrived.**

***Keywords*: Hazard, Risk, Aspect, Impact, Fault Tree, Valve Manufacturing**

I. INTRODUCTION

The mechanical device valves come into use for helping in controlling and reducing the flow of various liquids, gases, oil, vapors. Valves are used in several types of pipe systems to handle the pressure. For all valve manufacturing companies, valves are the essential component for doing manufacturing. The fundamental demand for valve manufactures is very high and plays a fundamental role for industrial and technological companies. Several companies are having an interest in investing in valve manufacturing companies [1]

This project is based on the Valve Manufacturing and Assembly industry and Safety Risk Assessment done on the activities during the production of valves. The products made by valve manufacturing industry normally includes,

Table 1 List of Products

Sl.No.	Products
1	Control valves & Accessories
2	Desuperheaters
3	Pressure Reducing Stations
4	Steam Conditioning Valves
5	Turbine, HP&LP Bypass Valves
6	Quick Closing Non-Return Valves
7	Pressure Reducing Valves
8	Safety Valves for Steam service
9	Refinery Valves

II. METHODOLOGY

Hazard Identification: This is the process of examining each work area and work task for the purpose of identifying all the hazards which are "inherent in the job". Work areas include but are not limited to machine workshops, laboratories, office areas, stores, maintenance and teaching spaces. Tasks can include (but may not be limited to) using industrial equipment, hazardous substances and/or teaching/dealing with people, driving a vehicle, dealing with emergency situations. This process is about finding what could cause harm in work task or area.

Risk Assessment: Is defined as the process of assessing the risks associated with each of the hazards identified so the nature of the risk can be understood. This includes the nature of the harm that may result from the hazard, the severity of that harm and the likelihood of this occurring.

Risk Control: Taking actions to eliminate health and safety risks so far as is reasonably practicable. Where risks cannot be eliminated, then implementation of control measures is required, to minimize risks as far as is reasonably practicable. A hierarchy of controls has been developed and is described below to assist in selection of the most appropriate risk control measure/s.

Figure 1. Risk Assessment Procedure Illustrated

Evaluation of significant environmental aspects: The purpose of the evaluation of environmental aspects is focusing on what matters the most. You do not need to manage all environmental aspects – only the ones that are, according to your own criteria, declared significant. Significant environmental aspects are the main focus of your organization's environmental management system.

Fault Tree Analysis: There is a need to analyze all the possible failure mechanisms in complex Systems also perform probabilistic analyses for the expected rate of failures estimate probabilities of events that are modelled as logical combinations or logical outcomes of other random events

III. Safety Risk Assessment

The HIRA, Aspect & Impact study and Fault tree analysis was carried out on the Valve Manufacturing Industry which involves hazardous activities in some specific areas which has intolerable risks. The Risks are identified through Hazard Identification and Risk Assessment and Aspect and Impact Study, the high level priority risks are analyzed using Fault tree analysis to find out the root cause of the event. The control measure was be derived to maintain the risk in very low level [2].

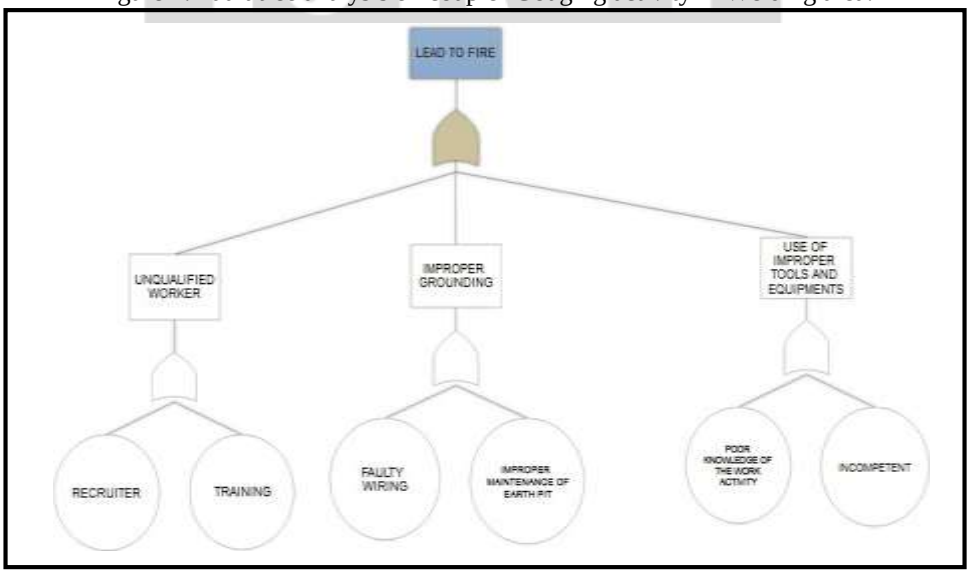
IV. Fault Tree Analysis

The Fault tree analysis were conducted on the highest risk which was identified through HIRA and Aspect & Impact study. The hazards which have highest level of risks were analyzed to identify their root cause based on the activities and other aspects that might get involved. There are some hazards in the facility that have highest risk and Fault Tree Analysis for them are listed below,

ACTIVITY: COUPLER GOUGING OPERATION

The operations like coupler gouging operation has a high risk of fire hazard. It may cause serious explosion, Injury and damage to the property and the worker. The Fault tree construction for the highest risk activity is illustrated below

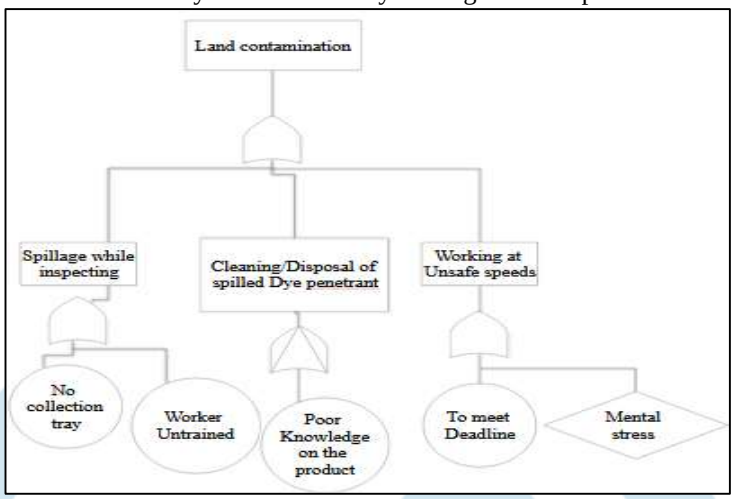
Figure 2. Fault tree analysis on coupler Gouging activity in Welding area:



AREA: WELD SHOP

In the weld shop area there is a inspecting of products using dry penetrant. Dye penetrant is used to find the defects of the products. It is one of the most cost effective method for detecting defects. These risk was identified through HIRA and Aspect & Impact Study.

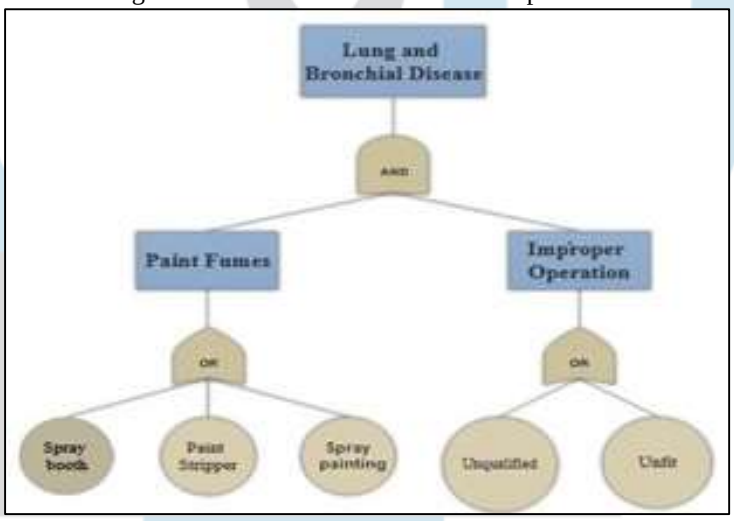
Figure-3. Fault tree analysis on the activity - Using of developer for DP checking



AREA: PAINT SHOP

In the Paint shop area the top event is taken as the Respiratory problems. The risk associated with these operations is quite high. The painting operations is one of the hazardous area in the whole facility various hazardous chemicals are being used for the painting and removal operations which also makes the worker to get exposed so a fault tree analysis is carried out to find the root cause of the operations.

Figure 4. FTA and Results of Paint Shop



V. RECOMMENDATIONS

AREA: MACHINE SHOP

The machining operations like honing and de-burring the components are done here for fabrication works and have conducted hazard analysis and aspect impact study on this area. Flying of burr in the machining operations is one of the hazard that was found in this project. So, the workers are encouraged towards the safety culture by wearing proper PPE's Safety Goggles and Ear muffs to safeguard themselves from the dangerous risks that will turn in to accidents. Downdraft tables are work bench with built-in ventilation to capture dust, smoke, and fumes and draw them away from the material being worked on. They typically consist of a perforated surface whose underside is connected to a ventilation or dust collection system, to draw material through the holes and away from the work. It has a ceiling filters for filtering suspended particles and fine dust, booth ceiling filters shall have suitable arrangement to hold down the filters.

Figure 5. Down Draft Booth Table

AREA: PAINT SHOP

The sludge is generated from paint shop. Here Sludge is removed by centrifugal separation. High speed rotating parts needs maintenance. Secondary concentration tank required in between sludge pit and sludge separator. So one more stage of additional pumping will be required. Sludge water mixture is sucked from pit. Fixed suction point, which takes care of only floating sludge. Water level maintenance is critical. Also the sludge settles at bottom will not be removed. Water content in extracted sludge will be 30%. They will take responsibility of sludge separation - only if the paint coagulation part is taken. Most of their installations are manual systems in which every hour the centrifuge system needs to be opened and sludge to be removed

Figure 6. Sludge separator

AREA: ASSEMBLY SHOP

The High pressure testing in done without precautions and it has high potential for the exposure of high pressure explosion to the worker working nearby. High pressure link breakage is recorded in the Incident report card.

The study found that the high pressure testing can carried out in enclosed separate cabin which can avoid the exposure of the worker to the danger zone. Also the necessary safety measures to be followed inside the HP testing cabin.

Figure 7. High Pressure Testing Cabin

INSTALLATION OF EFFLUENT TREATMENT PLANT

The Effluent Treatment Plant works at various levels and involves various physical, chemical, biological and membrane processes to treat waste water from paint shop. The expansion activity of providing the additional Paint booth and process effluent leads to increase the Trade Effluent, hence it is required to revamp the existing ETP with advanced technology. The adequacy is checked and suggested modifications. The Trade effluent generated from the DM regeneration, Water curtain effluent, anodizing effluent will be treated through the existing ETP and with Zero discharge management with advanced technology.

Figure 8. Trade effluent treatment flow sheet

VI. Conclusion

Welding operations and Painting operations are the key operations which had highest hazard and health consequences than other risks in the Plant. In order to minimize the risks of accidents safety risk assessment was conducted using Hazard Identification and Risk Assessment (HIRA), Aspect & Impact study method and Fault Tree Analysis (FTA) method. HIRA and Aspect & Impact study was used to identify the hazards and Impact on environment that have highest risk level, and FTA was used to search for the root causes of those hazards.

There were three hazards that have very high level of risk (Coupler Gouging operation, Dye penetrant inspection, Painting). Most common root causes are unclear SOP, improper personnel, recruitment and training, and unclear regulation. By pointing out and finding the root causes and risks of the operations these hazards were minimized by following the Safety recommendations that was given through these Safety Risk Assessment.

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