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Fault Tree Analysis for over pressurization in high pressure section of Fertilizer plant

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ABSTRACT :- Hazard Identification is one of the very important tools which need to be carried out in every industry where hazardous process has been carried out. Fertilizer industry is one of the most hazardous industries and there are very critical sections, which possess hazards such as fire, toxic gas release, over pressurization, which may leads to explosion. In order to carry out hazard identification in process industry, fault tree analysis is one of the best tool sto identify the hazards. Fault tree analysis is a technique used to find all the reasons for any undesired top event. In this paper, over pressurization in HP section is taken as a top event in order to find out all the basic and root causes which may lead to such hazardous event. In order to find all out the possible root causes for over pressurization in HP section, there is a need to consider several intermediate events and with the help of different logic gates it is very easy to understand the structural tree including top event, intermediate event and basic events. It is a technique that can have outcomes in both the forms as qualitative and quantitative as well, if probabilities of basic events are known. Even FTA is a very effective technique to take necessary actions in order to prevent it to leads to undesired events; it includes various engineering controls, administrative controls & several other controls. Operator error is one of the main findings of the fault tree analysis which needs to be considered for immediate actions in the form of administrative controls. Intermediate event can be considered as a top event in case separate fault tree is design or fault is carry forwarded. There are different types of logic gates is used & very essential to have a proper knowledge of gates in order to draft fault tree and even to understand the meaning of all logic gates in order to get proper understanding of fault tree.

Keywords: *Fault Tree, Top event, Intermediate event, Basic event, logic gates.*

I. INTRODUCTION

Urea is a combination of ammonia and carbon di-oxide basically a high-concentration nitrogenous fertilizer (46 % nitrogen content). Production of urea requires carbon di oxide in gaseous form at about 170- 190º C and 135- 145 bar. Urea Plant consists of two pressure section as high-pressure section and low-pressure section. High-pressure section is composed of urea rectifying operation and urea synthesis (High stripper and condenser). Low-pressure section is composed of Prilling, evaporation and recovery.

Liquid ammonia is heated to 10^0C before it sent to synthesis section in a molar ration of $2NH_3$ / CO_2. Compressed carbon di oxide is sent to HP stripper from its bottom,

$$CO_2 + 2NH_3 \rightarrow NH_2COONH_4 \quad (1)$$

$$NH_2COONH_4 \leftrightarrow NH_2CONH_2 + H_2O \quad (2)$$

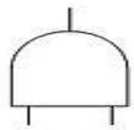
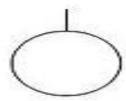
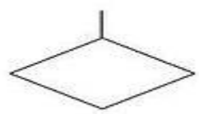
Initially urea is formed in liquid form with concentration of 70-80 %, and then further this solution is concentrated to a melt to reach up to 98% with the help of evaporation in two stages.

Finally, it goes through prilling tower so that prills can be formed and bagged to supply.

II. MATERIALSAND METHODS

FTA is a systematic technique used to find out all the root cause of any undesired event by using various logic gates, which helps to understand the fault tree in very easy way. FTA is done in such a way that ample amount of information can be conveyed about all the activities from top to down event. Generally, FTA uses the following types of logic gates:-

Table 1 – Logic gates

Logic gates		The OR-gate indicates that the output event occurs if any of the input events occur
		The AND-gate indicates that the output event occurs only if all the input events occur at the same time
Input events (states)		The basic event represents a basic equipment failure that requires no further development of failure causes.
		The undeveloped event represents an event that is not examined further because information is unavailable or because its consequences are insignificant.

II. PROCESS TO PERFORM FAULT TREE ANALYSIS

The first and foremost thing required for fault tree analysis is the basic knowledge about the process in which FTA has to be performed and then to arrange systematic diagrams, procedures and drawings accordingly. After that, it is necessary to find out the problem and decide undesired event (top event).Then to define scope/boundary of the work and draw the fault tree by using various logic gates. Once fault tree is developed, it is necessary to define intermediate events which need to be considered according to the findings. Finally the evaluation of the fault tree thoroughly and the accuracy and correctness check must be performed. The modification of the fault tree if required before finalizing the fault tree and sent for approval.

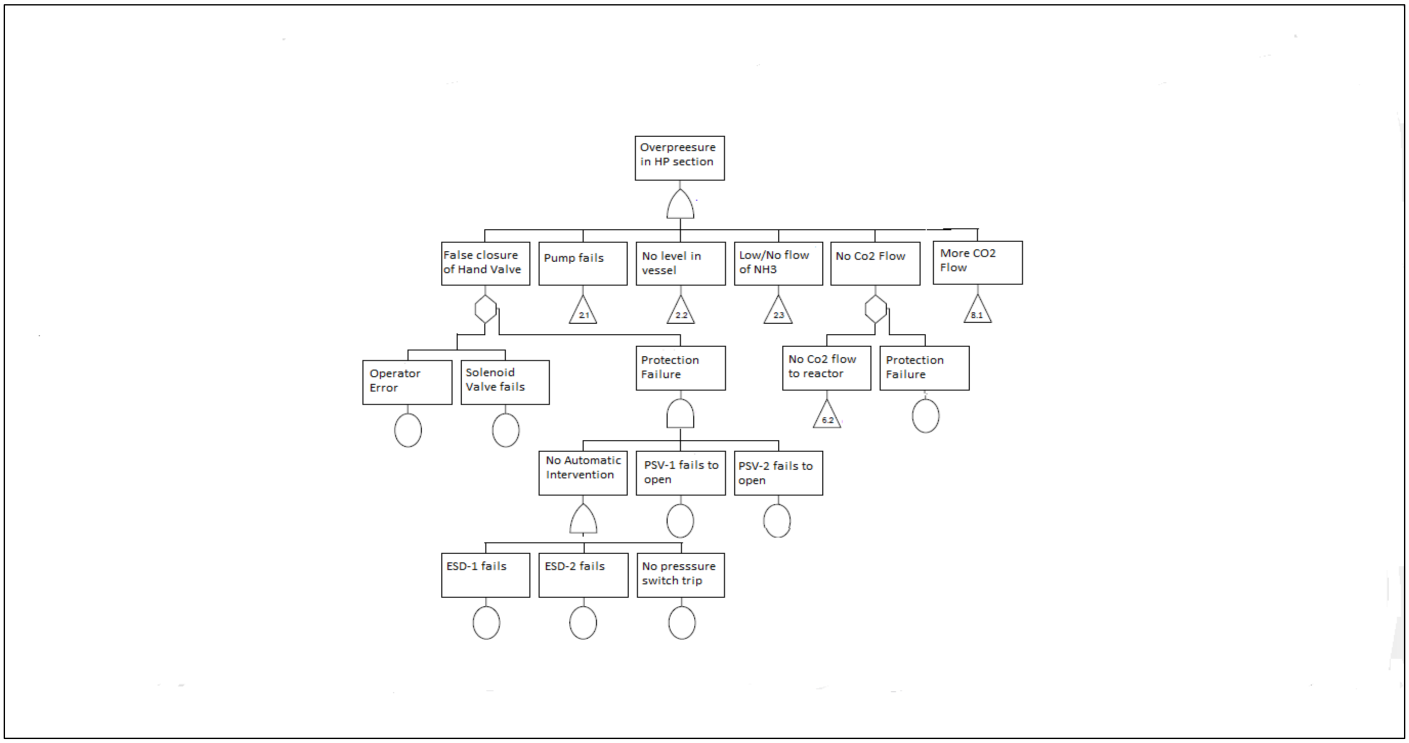
Following are the 4 types of events mostly used in FTA:-

- Basic Event
- Gate Event
- Conditional Event
- Transfer event

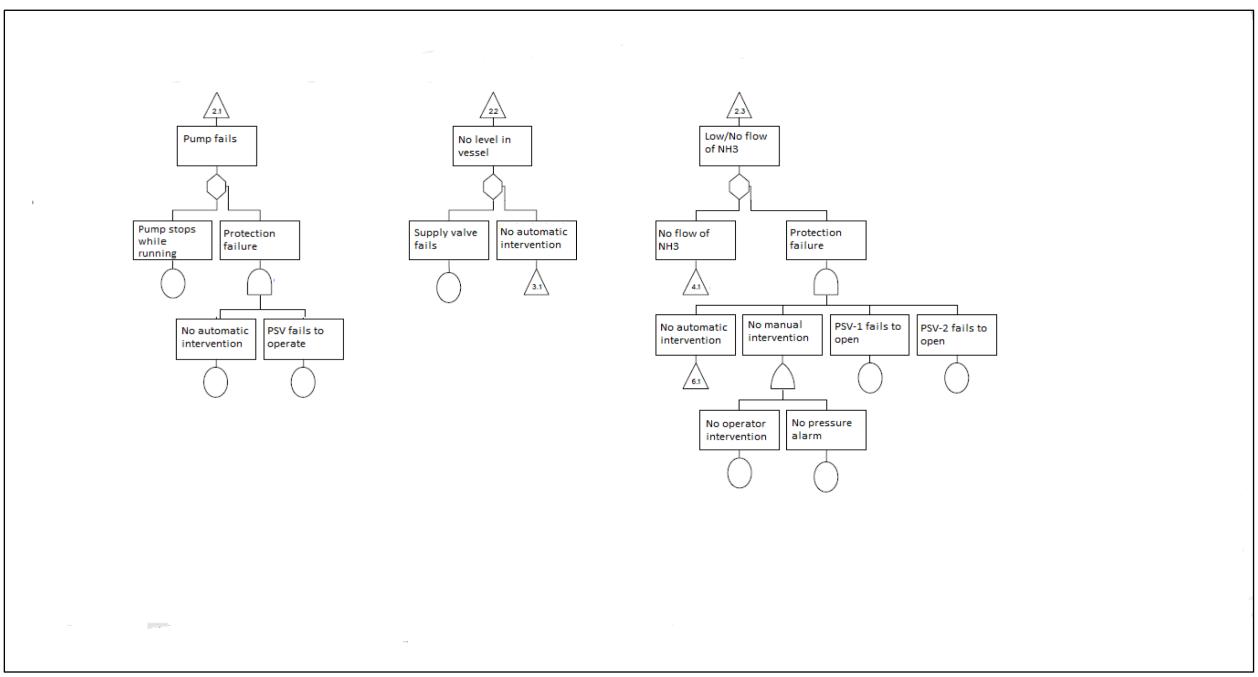
III. RESULTS AND DISCUSSION

HP section of fertilizer plant is one of the most critical section in which over pressurization is the most typical activity carried out of mixing ammonia and carbon-di-oxide in order to form urea. Here many intermediate events need to be considered in finding out the root cause of the undesired event. Here the findings of the study directly in the form of fault tree for undesired top event are shown. By using transfer gate various other undesired event is consider in order to find out final root cause which can help to prevent the accident which may takes in future. In order to find out all the possible root causes through which top event may takes place, various parameters need to be considered and many mechanical devices failure comes out from finding which may get fail by one or the other reasons, may be due to operator failure. All automatic electronic devices failure may also leads to diverted system from the design intent and some time may transmit the spurious signal to the control panel, finally resulting in wrong operation on the same basis. Various actions can be taken in order to minimize the possibility of false closure of valves, wrong indication by transmitter devices, PSV and ESD failure etc.

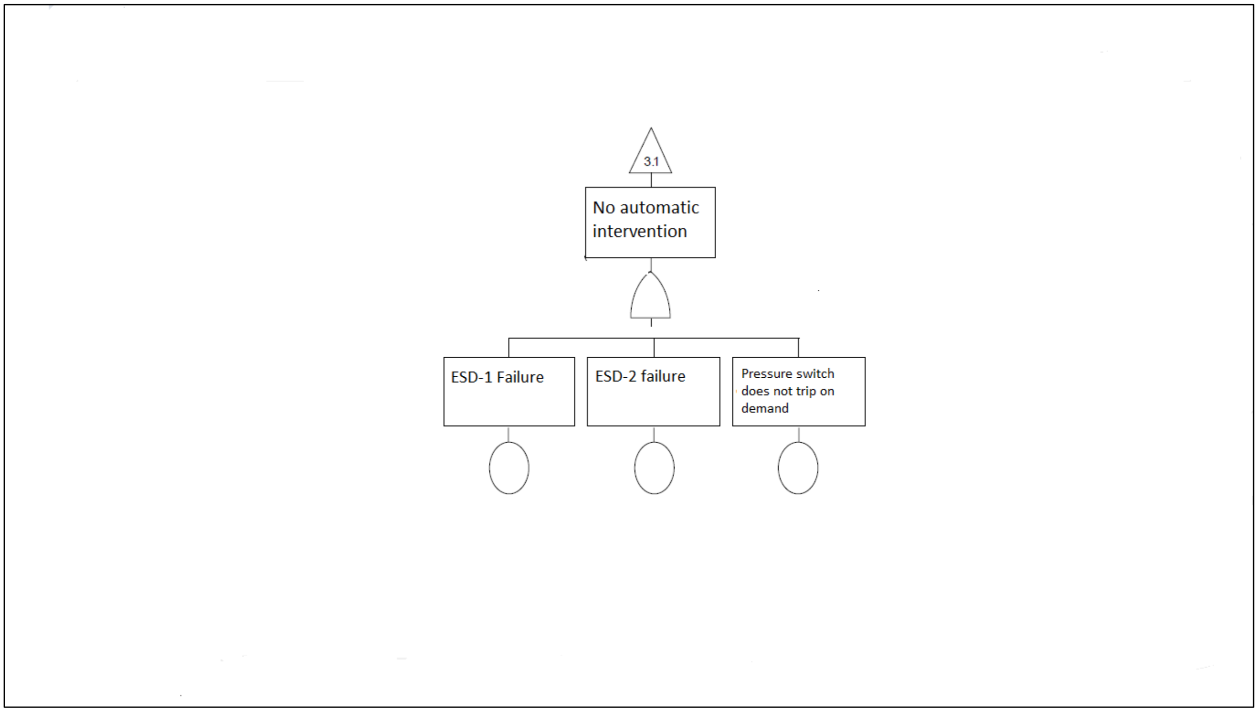
It can be easily analyzed that root cause of many undesired events are same but it results into several different undesired events. Few actions are required to prevent those several root causes because fault tree shows how lowest event resulted in the top most event through a series of events and finally undesired event occurred.



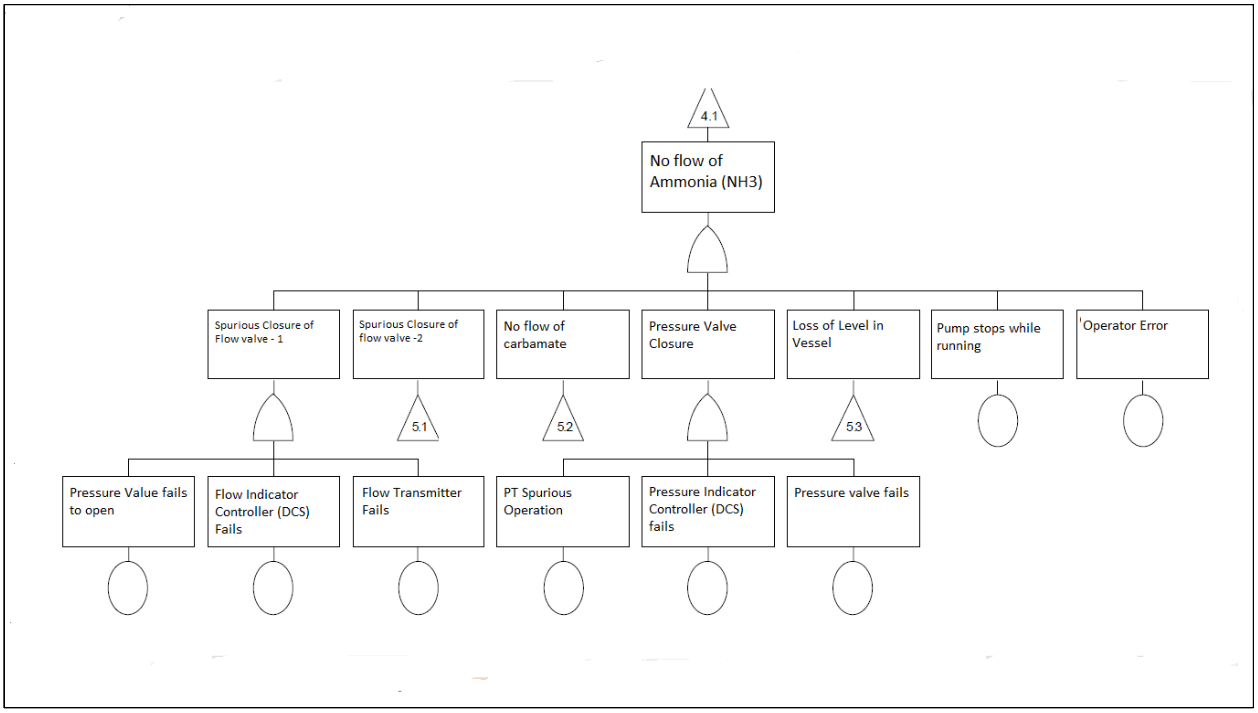
Fault Tree 1 – Overpressure in HP section



Fault Tree - 2



Fault Tree - 3



Fault Tree – 4

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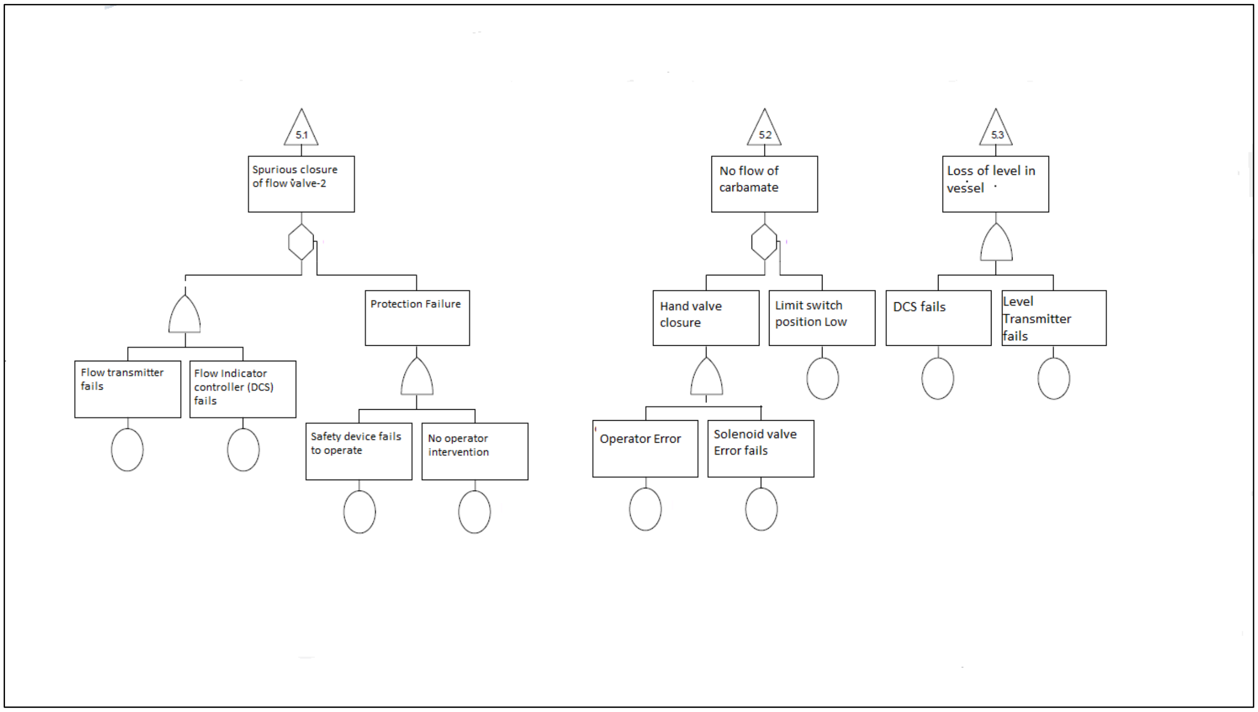
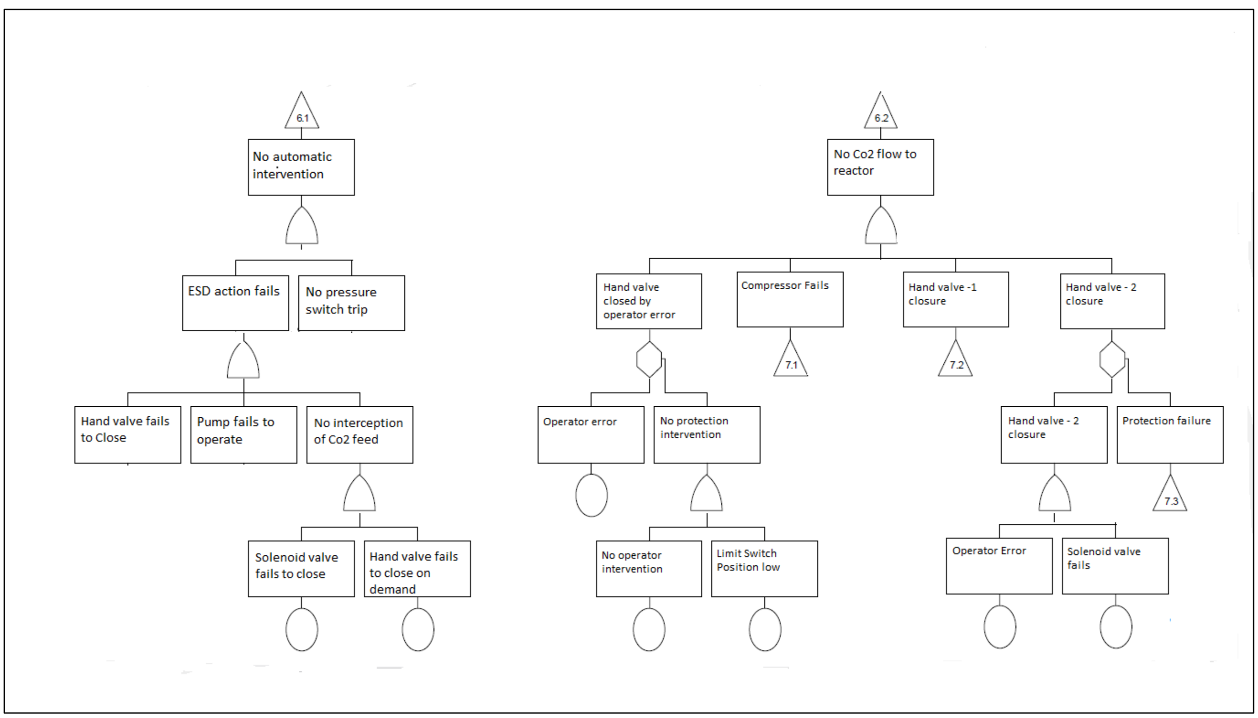
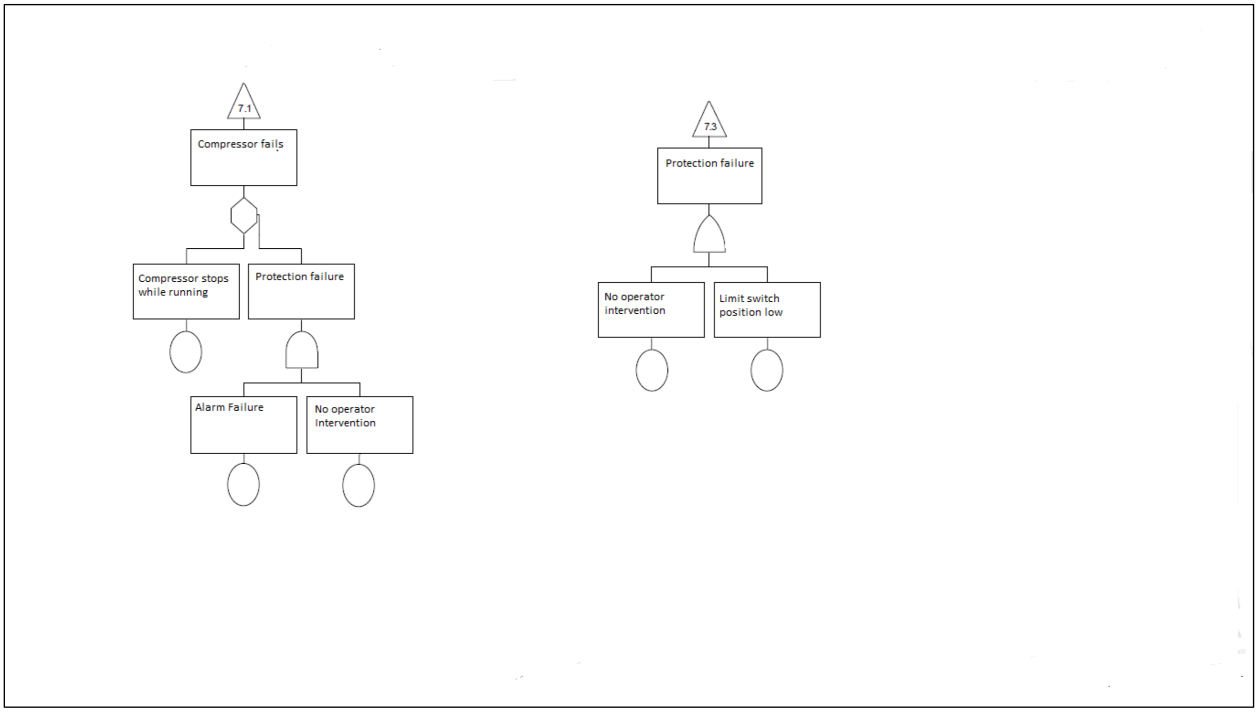


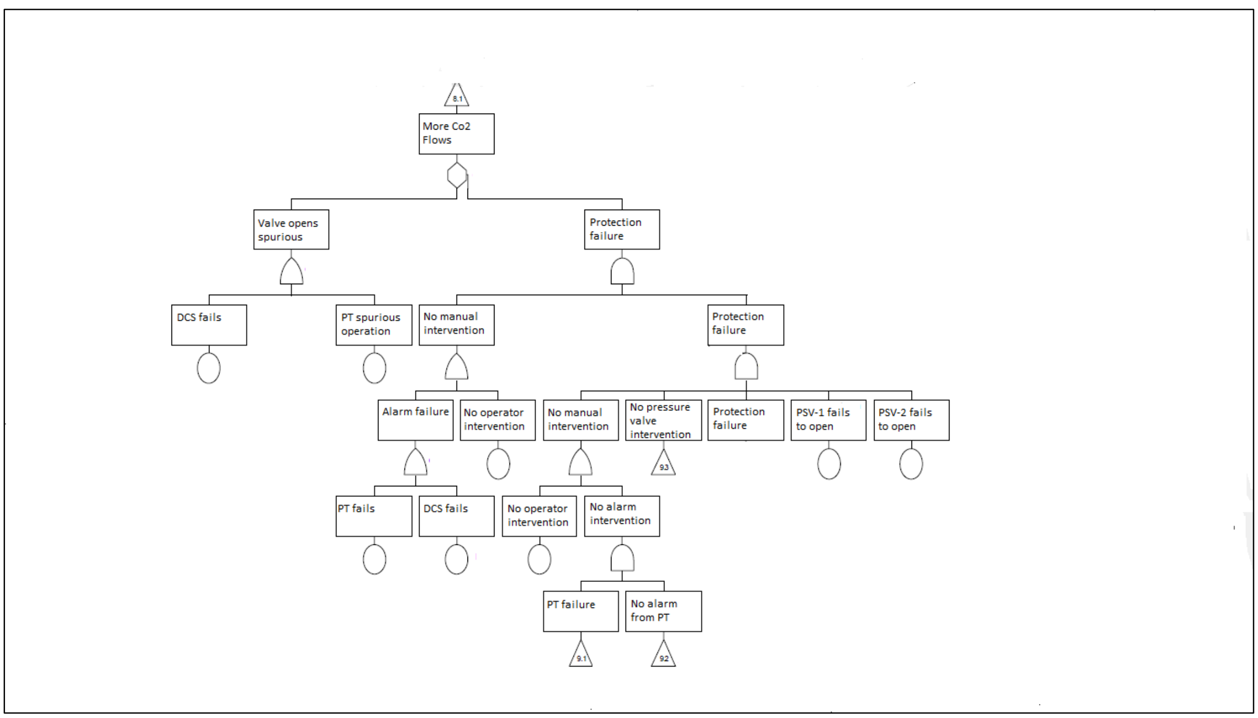
Fault Tree – 5



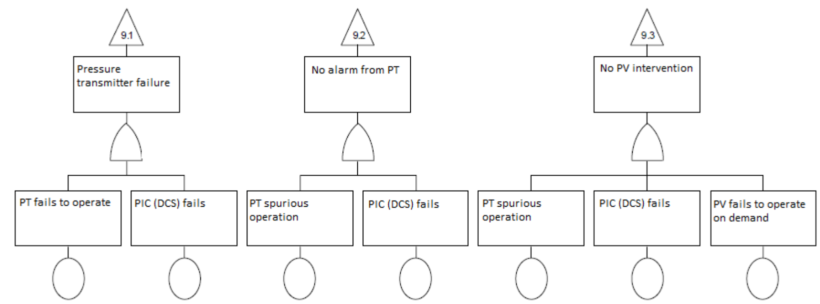
Fault Tree – 6



Fault Tree – 7



Fault Tree – 8



Fault Tree – 9

IV. CONCLUSION

FTA is very effective technique, which helps to prevent the accident by taken prior action to all the critical points which may leads to undesired event (top event) to all hazardous industry. This study will helps to all the similar kind of industry in order to look forward to the basic events and to take proper action in order to enhance safety of the workplace the person exposed. Here only qualitative study has been done of the over pressurization in HP section, further it can be done in quantitative way if probability of the basic event is known. Many assumptions are to be considered while determining the quantitative result of the fault tree. The only drawback of FTA is very lengthy and requires a lot of time, moreover it can only be performed by expert who knows how to apply technique in proper manner along with the process in detail.

Maintenance of mechanical devices and equipment is very important parameter, many times it is observed that various basic events results in operator error this can only be overcome by proper administrative control. Operator shall be competent enough to engage in such critical activities and all the safety measures are to be taken in advance. Management can review the fault tree analysis in order to enhance the safety and can used to implement the necessary actions.

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