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Systematic approach for FMEA to stringent implementation of Law of Land for Flammable Goods Warehouse

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ABSTRACT

The Research Work discuss about the systematic approach for FMEA to stringent implementation of Law of Land for storing the Flammable goods like Aerosol. The Fire Risk involved in Warehouse storing Flammable goods such as Goods containing Alcohol, LPG, Perfume, etc. All potential failures could be considered as risk. It becomes important for the company to identify the risks that potentially threat their products. Failure Mode and Effects Analysis (FMEA) is a robust methodology that can be used to identify, classify, and analyse potential risk. This research aims to utilize FMEA methodology to analyse the Fire risk in storing flammable products and recommends some solutions to overcome the predicted risk. During the complete study process at each stage efforts has been taken to maintain the safety standard above or at least equivalent to what the law of land is saying.

Keywords: FMEA, Fire Risk, Risk Priority Number, Aerosol, Flammable Goods.

I. INTRODUCTION

Warehousing or storage refers to the holding and preservation of goods until they are dispatched to the consumers. Generally, there is a time gap between the production and consumption of products. By bridging this gap, storage creates time utility. There is need for storing the goods to make them available to buyers as and when required. Some amount of goods is stored at every stage in the marketing process. Proper and adequate arrangements to retail the goods in perfect condition are essential for success in marketing. Storage enables a firm to carry on production in anticipation of demand in future.

The research aims to utilize FMEA methodology to analyse the Fire risk in storing flammable products and recommend some solutions to overcome the predicted risk. Need for warehouse arises also because some goods are produced only in a respected season but are demanded throughout the year.

The objectives of the work are given below:

- To carry out FMEA analysis and predicting all possible fire risks.
- To perform A-B-C Classifications of all Risks according to respective RPN.
- To give the recommendations to overcome the risks & re-evaluating to verify the reduction in RPN value.
- To 100% Compliance with Law of Land regarding Fire Safety.

This paper is organised as follows. Section I contains the introduction and the objectives of the research work, Section II describes the proposed methodology used for designing the warehouse for the storage of flammable goods, Section III contains the results, and

Section IV concludes the research work with the further directions and the future scope.

II. PROPOSED METHODOLOGY

There are several different types of risk analysis methods like Event Tree, Preliminary Hazard Analysis, What-if, Gretener, ROGA, NFPA 101. They can be performed on different levels in society, both nationally and locally on a specific system in a facility. According to ISO 23932:2009 Fire safety engineering-General principles, it is important to choose an engineering method that has acceptable accuracy and efficiency when it comes to prove if the performance criteria are fulfilled. This could be done by using deterministic or probabilistic calculation methods. Here, FMEA is used to analyse the fire risks in accordance with the statement of law of land.

FMEA can be apply to recognize probable failure modes, conclude their effect on the process of the product, and categorize actions to diminish the failures.The FMEA is a powerful design tool that provides a mean to compare, from a risk point of view, alternative machine system configurations. The FMEA is a formalized but subjective analysis for the systematic identification of possible Root Causes and Failure Modes and the estimation of their relative risks. The main goal is to identify and then limit or avoid risk within a design. Hence, the FMEA drives towards higher reliability, higher quality, and enhanced safety. It can also be used to assess and optimize maintenance plans. The analysis is successfully performed preferably early in the development cycle so that removal or mitigation of the failure mode is most cost effective. This analysis can be initiated as soon as the system is defined: FMEA timing is essential.

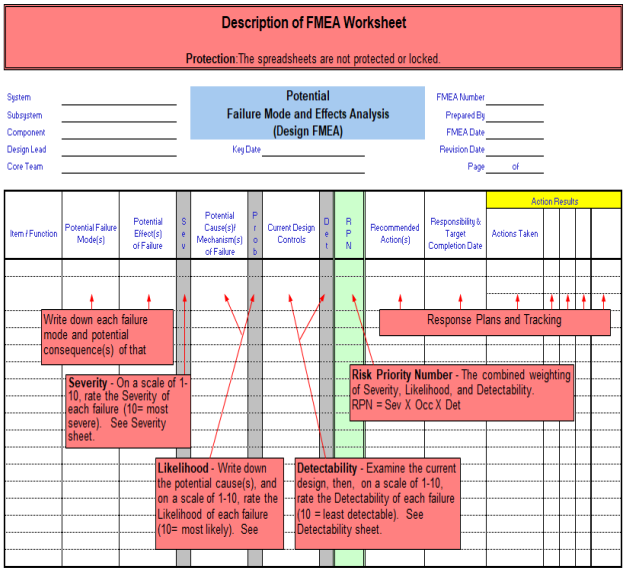
A vital step is anticipating what might go incorrect with a product. Whereas anticipating each failure mode is not possible, the improvement squad ought to invent as extensive a record of likely failure modes as probable.FMEA can be explained as a group of events projected to:

- Recognize and evaluate the potential failure of a product or process and its effects.
- Identify actions that could eliminate or reduce the chance of potential failures.
- Document the process.

❖ Description of FMEA Worksheet

The FMEA worksheet contains different sections like Item/Function, Potential Failure Mode, Potential Effect of Failure, Severity, Potential Causes/ Mechanism of Failure, Probability, Current Design Controls, Detectability, Recommended Actions, Responsibility and Target Completion Date, actions taken, Action Results. Table 1 show the FMEA Description Worksheet and can be described as follows:

Table 1: Description of FMEA Worksheet



To do the analysis of any item using FMEA, it is necessary for us first to know the function of all the sections present in this template. For this the detailed explanation of the FMEA Template is given below:

- **Item/Function:** The item is the one on which the FMEA analysis is done. It can be anything.
- **Potential Failure Mode:** Here, each failure mode is written down i.e. because of the failure is

occurring is written. Not only the failure mode but also the potential consequences of the failure mode are written

- **Severity:** Once the failure mode is written, thereafter it is necessary to consider the effects of this failure mode. Determine all failure modes, based on the functional requirements and their effects. Each effect is given a severity number (S) from 1 (no danger) to 10 (critical). A severity rating of 9 or 10 is generally reserved for those effects which would cause injury to a user or otherwise result in litigation.
- **Potential Causes/ Mechanisms of Failure and Probability:** In this step, it is necessary to look at the cause of a failure mode and the number of times it occurs. This can be done by looking at similar products or processes and the failure modes that have been documented for them in the past.
- **Current Design Controls and Detectability:** The proper inspection methods need to be chosen. One should identify testing, analysis, monitoring and other techniques that can be or have been used on similar systems to detect failures. From these controls an individual can learn how likely it is for a failure to be identified or detected. Each combination from the previous two steps receives a detection number (D). A high detection number indicates that the chances are high that the failure will escape detection, or in other words, that the chances of detection are low.
- **RPN (Risk Priority Number):** After ranking the severity, Probability/occurrence and detectability, the RPN can be easily calculated by multiplying these three numbers: RPN = S × P × D. This has to be done for the entire process and/or design. The failure modes that have the highest RPN should be given the highest priority for corrective action. These tests are often put in graphs, for easy visualization. Whenever a design or a process changes, an FMEA should be updated.
- **Recommended Actions, Responsibility and Target Completion Date:** This section recommends the actions that are to be taken after determining the failure modes, responsibilities and the date to complete the target.
- **Action Results and Action taken:** Once the failure mode is analysed, the results of the action should be given and accordingly the actions are taken to remove the failure.

❖ **Operation of Warehouse**

The Deodorant can will be received at warehouse. These cans will be unloaded and stored in warehouse. Packaging first operation will be can insertion in Mono Carton. These Mono cartons will be collated to form a bundle of 3 Mono cartons together and will be passed from Shrink wrapping machine to get those shrink wrapped.4 Shrink wrapped bundles (12 Cans) will be inserted in the CLD (cardboard box). CLD will tap from both side and final coding will done on CLD. These CLD's will be stacked and stored in warehouse and finally will be dispatched to main plant as per plan. Figure 1 diagrammatically elaborates the operation for new warehouse.

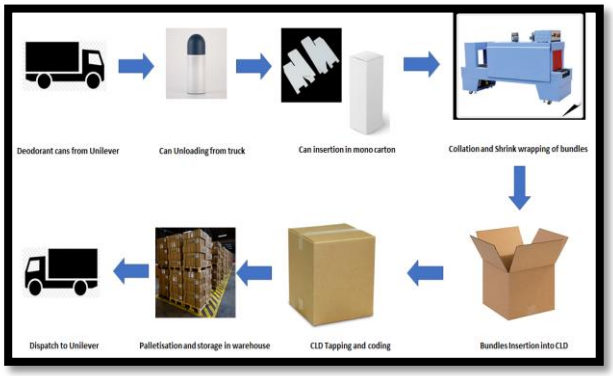


Figure 1: Operation for New Warehouse

III. RESULTS

After detailed study and analysis of all factors contributing to fires in warehouse in coordination with Law of Land FMEA has been carried for the warehouse operation. All the possible Items/Function which are supposed to carry out in day to day operation of warehouse and according to the scope for

need of warehouse are considered. Further these items/function are challenged on basis of their potential failure and consequences which they may cause due their failure which is followed by FMEA process of S*P*D = RPN.

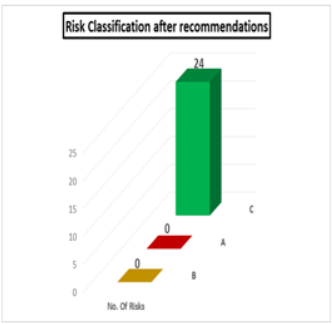


Figure 2(a): Risk Classification after Recommendations

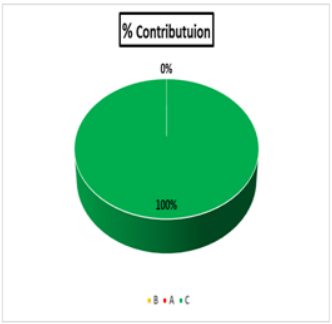


Figure 2(b): Percentage Contribution

As per the FMEA total 24 Risks were identified out of which 7 was C type risk, 10 was B typer risk and 76 are C type risk. All A & B type of risk are treated as serious type of risks and need some additional barriers/system to overcome the same. Hence, recommendations are suggested according to previous analysis and same risk are reevaluated again after implementations of the recommendations in the same FMEA and revised RPN has been founded. According to revised FMEA there are no more A & B type of risks and all 24 risks are classified as C type of risks.

IV. CONCLUSION

In this way, we will conclude that by using FMEA technique we can predict all possible fire risk & evaluate RPN (Risk priority number), accordingly recommend solution & re-evaluate the FMEA to verify reduction in RPN value to build a fire safe warehouse and accomplish that FMEA gives very systematic approach to do the analysis and reduce the risk, it doesn't mean that the work is completed. There are some systems which require stringent system and set frequency to review for their functionality and also verifying that the system is working fine, this may include timely maintenance of system, Testing schedule and checklist of the system (Safety check Calendar), Area Audits by management team, refresher training for the operators and fire fighters. Also, a mock drill for an Emergency scenario shall be conducted time to time to review the working of all the emergency devices and cross checking functionality of the fire protection system.

Figure 3: Images of the Designed Warehouse

Today there are different types of fire risk analysis methods having their own advantages and disadvantages. Hence, there will be a need to develop a single methodology which can be combination of advantages of all the methods and all the gaps from different methods will be taken care off in the upcoming method. In our research work we had recommended a solution which is as best suitable to the scenario. As we are taking credit of different kind of safety devices which will prevent, warn, safeguard us in case of emergency. Hence, it becomes more critical to conduct a study in detail for each of equipment mounted as a safety device and evaluating their reliability, functionality and failure mode in different emergency scenario and can be rated on their integrity levels.

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