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Probability Analysis of Human Error in The Fiberglass Pipe Installation Process with Spar-H And FTA Methods at PT. GFRP

Sabrina Rahmadanty[1*], Mirna Apriani[1], I Putu Arta Wibawa[1]
[1] Study Program of the Surabaya State Shipping Polytechnic of Safety and Risk Engineering, Surabaya 60111

Abstract:- PT. GFRP is an engineering and manufacturing company of FRP (Fiber Reinforced Plastic) that produces various types of fiberglass production with resin mixtures. Most work accidents on FRP pipe installation work are caused by human error because the process mostly requires human labor. This study aims to analyze the probability of human error in the FRP pipe installation process using the Standardized Plant Analysis Risk Human Reliability Assessment and Fault Tree Analysis methods. Based on the results of the study using the SPAR-H method, the highest HEP values were found in 3 sub-tasks, namely sub-tasks 3.3.2, sub-tasks 4.2.1, and sub-tasks 5.6 with an HEP value of 0.5477 with a possible human error of 54.% and the value of the dependency factor with a high dependency failure probability value is found in the 3.3.3 sub-task of 0.51088 which means that this sub-task has an influence of approximately 51% and the results of the high risk assessment found 5 types of tasks that identify failure patterns with the FTA method and Then the appropriate recommendations are given.

Keywords:- *Fault Tree Analysis (FTA), Fiberglass, Human error, Pipe connection, Standardized Plant Analysis Risk Human Reliability Assessment (SPAR-H)*

I. INTRODUCTION

Of the various kinds of work activities carried out, of course there are various kinds of hazard risks, whether it is a hazard risk in light, medium, or heavy capacity. According to Gerry Silaban et. al (2009) that work accidents are the case with the most cases compared to other types of accidents, the effect is immediately felt, can be seen, and the incident is recorded and reported. PT. GFRP is an engineering and manufacturing company for FRP (Fiber Reinforced Plastic) that produces various types of fiberglass with a mixture of hazardous chemicals (B3) in the form of resin. FRP pipe connection work has 3 accident factors that can occur and from the data the highest accident factor is caused by human factors that cause work accidents. The purpose of this research is to find out work problems caused by human error, and to identify errors with the highest failure factor.

Work problems caused by Human Error can be minimized by using the HRA (Human Reliability Assessment) method, while the identification of failure patterns that can occur using the FTA (Fault Tree Analysis) method. Reliability measurement in this study uses one of the methods from the HRA (Human Reliability Assessment) namely SPAR-H (Standardized Plant Analysis Risk Human Reliability Assessment). Identification of failure patterns using the FTA (Fault Tree Analysis) method is carried out to determine work failure patterns due to human error and the possibility of accidents. The results of the research will be reported to the company to minimize work accidents caused by human error.

II. METHODOLOGY

The step that must be taken is to seek expert judgment to analyze the work stages of the FRP operator. (1) The stages of this work can be analyzed using HTA (Hierarchical Task Analysis). (2) After the HTA is created, determine the Human Reliability Assessment (HRA) to measure the human contribution to risk. In this case, the HRA used uses the SPAR-H method by calculating HEP (Human Error Probabilities) based on 8 PSF (Performance Shaping Factors). in a series of activities that occur before or after the activity. After that, identify errors to find out the highest risk in the risk assessment. After finding the highest risk rating, failure processing is carried out using the FTA (Fault Tree Analysis) method to determine the pattern of work failures due to human error and the possibility of accidents.

III. RESULTS AND DISCUSSION

This research requires expert judgment assistance, where 3 (three) experts have been obtained from the results of expert judgment criteria interviews, namely field HSE, GFRP Workshop Chair and GRFP SPV who are experienced in fiberglass work. After finding the expert judgment, the stages of work are arranged in the form of HTA (Hierarchical Task Analysis) obtained from the work instructions for installing FRP pipes. The HTA process for installing FRP pipes has 6 main tasks, namely preparation consists of 10 work elements, the use of PPE consists of 8 work elements, preparation for FRP pipe installation consists of 5 work elements, mixing of raw materials consists of 6 work elements. , FRP pipe connection which consists of 9 work elements, and the finishing process of FRP pipe connection which consists of 4 work elements.

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Then determine whether the work process is classified as an action/diagnosis activity or includes both. After that, the HEP reliability data was processed using 8 PSF in the SPAR-H method with the highest data in table 1.

No	*Sub Task*	PSF Composite	HEP_{Action}	$HEP_{Diagnosis}$	HEP_{Total}
1.	3.3.2	100	0,09099	0,50251	0.54777
2.	4.2.1	100	0,09099	0,50251	0.54777
3.	5.6	100	0,09099	0,50251	0.54777
4.	2.3	40	0,03849	0,28776	0,31517
5.	2.4	40	0,03849	0,28776	0,31517

Table 1:- SPAR-H . reliability data processing

The results of data processing in table 1 can be seen that the highest HEP value is found in 3 sub-tasks, namely sub-task 3.3.2 ensuring that the grinding handle is attached when cutting, sub-task 4.2.1 ensuring that the resin ratio is in accordance with the prometer and catalyst which often causes errors, and sub task 4.2.1 task 5.6 process of leveling the pipe surface layer using a grinder with a HEP value of 0.5477 with the possibility of human error or human error of 54%. Subtasks 3.3.2, 4.2.1, and 5.6 had the highest HEP scores due to time availability, stress, ergonomics, and fitness. This work stage is a coordination stage and requires more operator attention and focus so that it takes a little longer to complete the work.

From the HEP calculation that has been done, it can be seen that the causative factor is influenced by the dependency factor. The dependency factor is the fault relationship on the job. Determination of the value of dependence is determined by discussing with expert judgment about 4 (four) criteria, namely workers, time, location, and procedures when the pipe installation production work takes place with the results as shown in table 2 below.

Sub task	Worker	Time	Location	Procedure	Dependency	Result Dependency
3.3.1	s	c	d	a	High	0,51088
4.3	d	c	d	a	Moderate	0,24834
4.1.1	d	c	d	a	Moderate	0,21323
4.1.2	d	c	d	a	Moderate	0,21323
4.1.3	d	c	d	a	Moderate	0,21323

Table 2:- Factor Dependency SPAR-H

Based on the table above, subtask 3.3.3 has a high dependency value of 0.51088, meaning that this subtask has an effect of approximately 51% on the success/failure of the next subtask. After getting the results of the HEP and the dependency factor from the SPAR-H router, error identification was carried out using a risk rating, after getting the results of a high risk rating, a failure analysis was carried out using the FTA (Fault Tree Analysis) method. The FRP pipe connection work has identified errors using a risk rating and obtained 5 cases of high risk rating, namely cases of chemical splash, hearing loss, respiratory problems, pipe installation slope and electric shock. Then a failure analysis was carried out using the FTA (Fault Tree Analysis) method as shown in Figure 1 and Figure 2.

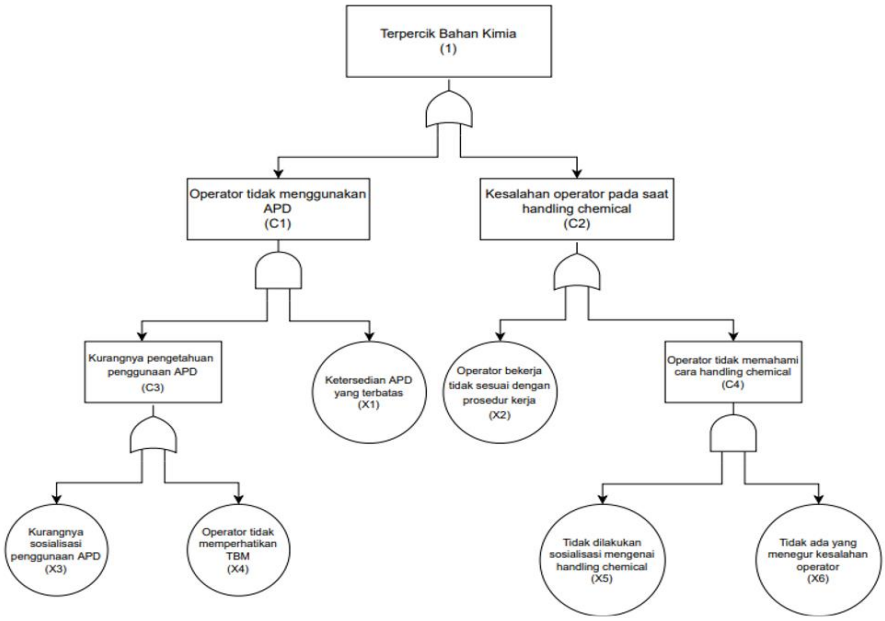

Fig 1:- FTA cases of chemical splash

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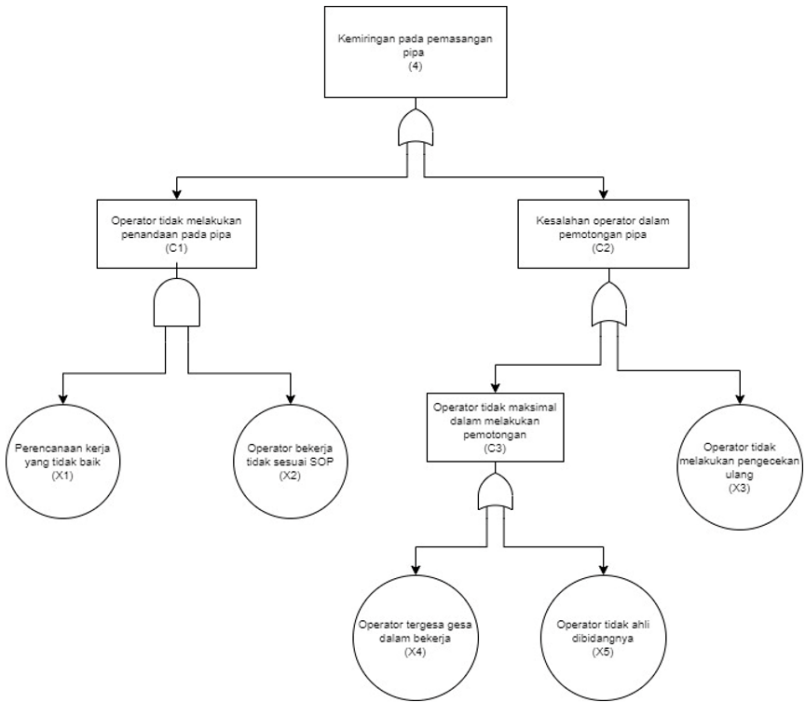

Fig 2:- FTA Pipe installation slope

From the picture above, it can be seen the basic causes of accidents that may occur in the work of connecting the FRP pipes. So that recommendations can be given in accordance with the basic causes that affect the top event.

IV. CONCLUSION AND SUGGESTIONS

Based on research conducted on the analysis of the probability of human error in the work of connecting the FRP pipe, the highest HEP results were found in 3 sub-tasks, namely sub-tasks 3.3.2, sub-tasks 4.2.1, and sub-tasks 5.6 with a HEP value of 0.5477 with the possibility of occurrence human error or human error by 54%. The value of the dependency factor with a high dependency failure probability value is found in the 3.3.3 sub-task of 0.51088, meaning that this sub-task has an effect of approximately 51% on the success/failure of the next sub-task. And there are 5 cases with a high risk rating and have been analyzed with FTA failure patterns.

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