

Investigating Marking Mistake on Piping Installation to Avoid Accidents, Injuries, and Damage of Equipment Using Root Cause Analysis Techniques

Ayu Puspa Wirani, Ganjar Sidik Gandara, Riko Muri, Erry Rimawan
Magister of Industrial Engineering
MercuBuana University, Jakarta, Indonesia

Abstract:- Pipe marking has a major role in the safety of facility workers. Pipe marking quickly communicates essential information to everyone in a facility, improving overall workplace safety and productivity. Unmarked pipes are a danger to both people and property. In fact, marking mistake are found in pipe identification during the installation. The aim of this research is to investigate the root cause of this problem happen due to avoid accidents, injuries and damage to equipment can be caused by not knowing what is flowing through the pipes. Root Cause Analysis (RCA) was used to identify the problem. In this research, the 5-whys tools was used to investigations marking mistake during piping installation. Based on results, there is a relationship between three main section, i.e. owner, QC of contactor, and Painting section of contractor which caused marking mistake. The root cause of the problem are Painting section assumed that RFI for marking number not required again based on previous piping project and Checking marking of installation number is not mention in the final checklist. To avoid this problem occurred in the future, recommendations of problem solving should be apply by all of section.

Keywords:- Marking Mistake, Piping, RCA, 5-Whys.

I. INTRODUCTION

Pipelines usually transport flammable, explosive, toxic, or corrosive media under extremely harsh environments (Li, 2017). Pipe marking has a major role in the safety of facility workers, as well as emergency responders who need to quickly understand the purpose and contents of piping systems. Just like hazardous materials in other containers, piping systems should be appropriately labeled. Most safety regulations have specific guidelines on pipe markings and identification. Having a successful pipe identification program helps both employees and external contractors quickly and effortlessly distinguish between pipes during maintenance. Pipe markers also enhance and facilitate traceability for repairs, saving you time and money. In emergency situations, pipe markers aid emergency responders in the quick identification of pipes.

The American Society of Mechanical Engineers

(ASME) A13.1 Scheme for the Identification of Piping Systems standard addresses pipe marking by offering a common labeling method for use in all industrial, commercial and institutional facilities as well as in buildings used for public assembly. Pipe marking labels must effectively communicate the contents of the pipes and give additional detail if special hazards (such as extreme temperatures or pressures) exist (Benmark). The legend should be short in length and easy to understand.

Unmarked pipes are a danger to both people and property. Errors and accidents can be prevented by marking and identifying pipes. It also makes maintenance work easier and helps prevent time-consuming searches. In fact, there are still found a mistake in pipe marking during the installation. The aim of this research is to investigate the root cause of this problem happen due to avoid accidents, injuries and damage to equipment can be caused by not knowing what is flowing through the pipes. Root cause analysis (RCA) was used to identify the problem. RCA is a structural step by step technique that focuses on finding the real cause of a problem and deals with it. RCA also known as procedure for ascertaining and analyzing the cause of problems, to determine how these problems can be solved or be prevented from occurring (Akgun, 2014).

II. LITERATURE REVIEW

A. Piping Identification

There are several guidelines to proper pipe identification and marking, some specific to industries and countries, but in general there are 7 international industry standards as reference. Compliance to the relevant guidelines will ensure proper deployment of the markings for your specific facility. The purpose of the standard is to assist in identification of hazardous materials conveyed in piping systems and their hazards when released into the environment. Pipes are defined as conduits for the transport of gases, liquids, semi-liquids or fine particulate dust.

Some guidelines such as the ASME A13.1 and Health & Safety Signs Regulation (1.4.96) provide a general coverage of the specification of pipe contents and their hazards, while others such as the ISO 14726 provide very

specific principle colors for Marine pipe identification in ship & offshore sites. According to ASME A13.1, the colors of pipe identification are based on the contents of the pipe and in general, the most hazardous feature of the contents is used to determine the colors used.

ANSI / ASME A13.1-2015	
Fluid Service	Colors
Flammable & Oxidizing Fluids	Yellow / Black
Potable, Cooling, Boiler Feed & Other Waters	Green / White
Compressed Air	Blue / White
Fire Quenching Fluids	Red / White
Toxic & Corrosive Fluids	Orange / Black
Combustible Fluids	Brown / White
Defined by User	Purple / White
Defined by User	White / Black
Defined by User	Gray / White
Defined by User	Black / White

Fig 1:- ANSI/ASME Code for Pipe Identification

In general, there are five elements that make an effective pipe label (ASME A13). These elements are used by most pipe marking standards:

- Color coding provides important information about the hazard presented by the pipe’s contents.
- Text identifies the pipe’s contents by name and may also indicate temperature or pressure (if either presents a hazard).
- Direction of flow to indicate the direction in which the content flows, or if the contents can flow in either direction.
- Label and text size guidelines ensure labels can be read and understood from a distance.
- Label placement ensures that workers can locate the information they need.

Each of these elements work together to form a pipe marking system that provides the information workers need most.

B. Root Cause Analysis

Root Cause Analysis is a procedure for ascertaining and analyzing the cause of problems, to determine how these problems can be solved or be prevented from occurring (Akgan, 2014). Root Cause Analysis is a tool for identifying

prevention strategies. In Root Cause Analysis, basic and contributing causes are discovered in a process similar to diagnosis of disease - with the goal always in mind of preventing recurrence. Since the situation (condition) is usually affected by many factors (physical conditions, human behavior, behavior of systems or processes), several root causes will usually be found. The main points of RCA process mentioned in below picture.

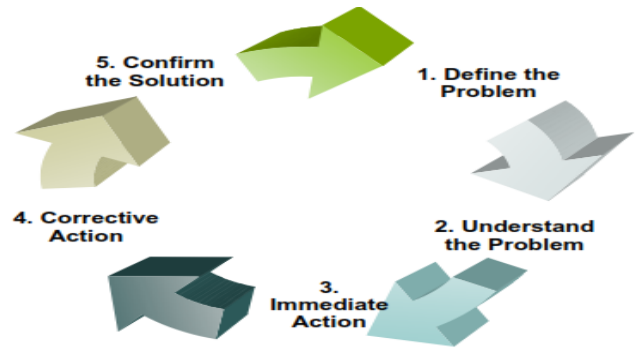


Fig 2:- Root Cause Analysis Process

Andersen and Fagerhaug (2006) consider RCA as a practice that looks deeply into the chain of events prior to an undesired event to identify its primary causes.

There are several tools to found the real cause of problem using RCA (Vorley, 2008):

➤ *5-Whys*

5-Whys analysis refers to the practice of asking, five times, why the failure has occurred in order to get the root cause of the problem.

➤ *Pareto Analysis*

Pareto analysis is a formal technique for finding the changes that will the biggest benefits. It is useful where many possible courses of action are competing for your attention.

➤ *Cause & Effect Diagrams*

This useful technique is used for more complex process and factors that could contribute to a problem.

➤ *Fault Tree*

This is a graphical technique that provides a systematic description of the combinations of possible occurrences in a system. This method can combine system and human failures.

III. METHODOLOGY

This paper using Root cause analysis (RCA) method to find out the real cause of problem. Root Cause Analysis process are absolutely essential for the improvement of the quality management system and increasing the quality of the final product or service. RCA is simply the application of a series of well known, common sense techniques which can

produce a systematic, quantified, and documented approach to the identification, understanding and resolution of underlying causes.

As mentioned in literature review, there are several tools to find the real cause of problem using RCA. In this research, the 5-whys approach was used to investigations marking mistake during piping installation. During the installation, construction company as main contractor of the project will following specification, drawing, and procedure of owner requirement. The project involved collaborations between five main divisions, such as Project Leader, Quality Control (QC), Quality Assurance (QA), Field Installation, and Scheduler. The major role of quality inspections process include measuring, examining, and testing of product or service and the comparison of these with specified requirements to determine conformity will be responsibility of Quality Control (QC). Case in this project was found in field installation of piping project. The data about the project studied was obtained from construction company includes written records, such as problem report and event logs, and an interview with the project manager & Quality Control (QC).

IV. RESULT

A. Chronological of Case Study

Pipe identification should pay attention to four key areas, namely the format of the standard used, color schemes of the pipe application, text height based on the required pipe size and visibility based on the infrastructure. In this research, there found a mistake in pipe identification during the installation. Marking stencil on piping drawing A217-021 installation drawing supposed to be E242001. But in actual condition, marking stencil for this piping is E210001. Marking of piping installation conduct by Painting Section of contractor and inspection by QC. The purpose of pipe identification based on drawing is to know the location of pipe installation and actually avoid failure during installation. Every part of pipe has specific criteria due to some of flowing fluids/material through the pipes also difference.

Having a successful pipe identification program helps both employees and external contractors quickly and effortlessly distinguish between pipes during maintenance and avoid Accidents, Injuries, and Damage of Equipment. In this case, marking mistake of piping systems is danger to both people and equipment. Chronological of this research are :

- Kick of meeting between QC of contractor with owner company
- Owner didn't explained requirement marking on this meeting, only explained Painting specification and Procedure.
- Kick of meeting between QC & Project Leader of contractor

- In this meeting, Project Leader was explained requirement for Marking on Pipe installation.
- QC had Kick off meeting internal, but QC engineer not describe requirement of pipe marking, and only describe stamping and tagging for pipe and valve.
- QC Engineer prepared check list items from master schedule of piping installation, but some reference were not mention as per marking requirement, such as: Container No. , Installation Drawing No., and weight of product
- Field Installation Engineer request to QC for made marking stamping for only for pipe equipment (such as valve)
- QC engineer prepared marking stamping for pipe equipment without prepared marking and stamping for main piping
- QC Inspector checked marking used List from QC engineer with uncompleted reference
- QC inspector carried out inspection without RFI (Request of Inspection) from painting section

Various methods have been developed to identify the causes of undesired problem in piping installation and prevent them from reoccurring. In this research, Root cause analysis (RCA) was used to identify the problem with 5-why tools.

B. RCA with 5-Whys Analysis

The 5-Why method helps to determine the cause-effect relationships in a problem or a failure event. It can be used whenever the real cause of a problem or situation is not clear. Using the 5-Whys is a simple way to try solving a stated problem without a large detailed investigation requiring many resources. When problems involve human factors this method is the least stressful on participants. It is one of the simplest investigation tools easily completed without statistical analysis.

For investigate the real cause of problem occurred during marking of piping installation, 5-Whys analysis in this case divided to three main section mistake, i.e. owner, QC of contractor, and Painting section of contractor as shown in this figure.

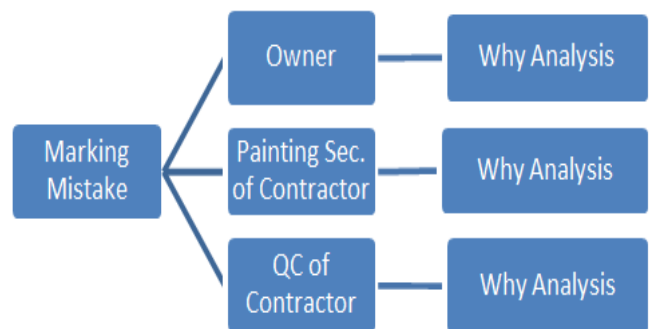


Fig 3:- Related Section Caused Marking Mistake

➤ Problem

Painting section mistake on marking of piping identification number

- Why Painting section mistake on marking of piping identification number?
- ✓ Because painting operator conduct mistake marking based on painting leader instruction

- Why painting leader instructed wrong marking?
- ✓ Because painting leader miss-read pipe installation drawing.

- Why painting leader miss-read pipe installation drawing?
- ✓ Because checklist of pipe identification number by Painting engineer not mention installation drawing.
- Why painting engineer not mention installation drawing on pipe identification number?
- ✓ Because painting engineer prepare checklist based on mark mass document which only mentioned project number, block number, container number, and weight. This documents not mentioned installation drawing number. In the other hand, QC inspector not inspection marking number of piping installation drawing.

- Why QC inspector not checking marking number of piping installation drawing?
- ✓ Because QC not received RFI (Request of Inspection) for marking number from painting section and QC inspector inspect by checklist from QC engineer. Painting section assumed that RFI for marking number not required again based on previous piping project. Meanwhile, QC engineer prepare checklist not for checking a marking number. This checklist documents used for prepare report of painting. QC inspector not received all of drawing for piping installation. They only used checklist from QC engineer.

Beside 5-Why analysis, in this case piping identification procedure not explained by owner because owner assumed that format of marking are same with previous project. In the previous project, owner not found mistake marking on product by contractor. Owner assumed contractor was understood marking procedure on piping installation.

C. Recommendations to Avoid Marking Mistake

Based on 5-Whys analysis, we found more than one recommendations based on root cause of the problems. Recommendations of this case shown in Table 1.

No	The Countermeasure & Preventive action	Action By
1	Owner should explained requirement of marking during kick of meeting	Owner and Project Leader
2	Owner Should Notice in marking specification if hade additional requirement for marking in drawing such as "additional information shall be refer to Drawing" due to some department such as painting not received drawing	Owner and Project Leader
3	Project Leader should remainder owner if there are some matter not yet include in discuss. Project Leader should be making any query or make a topic which will be discuss before kick-off Meeting.	Owner and Project Leader
4	QC Engineer should explain requirement on procedure of marking during kick Off meeting	QC Engineer and QC inspector
5	QC Engineer should be prepare check list for marking based on drawing and other	QC Engineer and QC inspector
6	QC inspector should check the identification marking stencil based on marking procedure	QC inspector
7	Education should be done to all QC inspector regarding marking procedure of each project	QC inspector
8	QC inspector shall be check before RFI submitted by Painting section	QC Engineer and QC inspector
9	Painting sect. shall be attached for FRB and kick off meeting if PIC person can't attend shall change with other person. This required by internal procedure to avoid some miss information. If some section doesn't attend Project Leader shall be made sure all related section attend.	Painting Section and QC Inspector
10	All procedure application shall be inform to owner (if required). Before apply, Painting sec. Shall be inform to related department if has changed from procedure and QC inspector shall not check without RFI from painting sec.	Painting Section

Table 1:- Recommendations

V. CONCLUSION AND IMPLICATION

The purpose of this research is to enable companies that can improve the process and to avoid any mistake in future. Based on 5 why's tool analysis the root caused of the problem are:

- Painting section assumed that RFI for marking number not required again based on previous piping project
- Checking marking of installation number is not mention in the final checklist

To avoid the same mistake occur again in the future Companies should follow recommendations from this research.

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