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Analysis of structural discipline welding disables in Saudi Aramco project using statistical process control in PT. Mcdermott Indonesia

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ABSTRACT

It is known that some welding results were defect in the Saudi Aramco project, particularly at the TKY joint and splice joint, thus there is a reparation needed with the specific type of defect which is lack of fusion. The method used is the Pareto diagram, control diagram and fish bone diagram – to find out the graphs and the causes of the resulting structural welding results. The results shown by the pareto diagram state that for an event, about 80% of the effect is caused by 20% of the cause, the type of damage that often occurs in the welding results caused by a lack of fusion is 50%, consisting 23 joints of the 46 joints produced. Meanwhile, from the control chart, all data of the structural welding have been placed at the control limit. Based on the fish bone diagram, some of the causes the lack of fusion defect are because several factors such as human, machine and method, material and environmental factors.

Key words: Statistical process, Production, Structural

1. INTRODUCTION

Nowdays, construction companies engaged in oil and gas has begun to develop in Indonesia, many f it offer high-quality products to attract customer. Therefore companies are now required to be able to compete in ways that are more effective and efficient in improving quality to meet customer needs [1]. To meet customer desires, PT. McDermott Indonesia continues to make efforts to maintain the quality of fabrication carried out [2]. The work done is to routinely carry out inspections of project work carried out, namely specifically on the results of welding produced[3]. However, in the welding process itself, there are still many factors that cause improvements in the welding results[4].

In January, some defective welding results were required at the Saudi Aramco special project at TKY Joint and joint connections were needed to repair the types of deficiencies such as fusion. Definition of quality control is the process of controlling activities to determine the characteristics of product quality, comparing with specifications or requirements, and taking action according to the difference between the actual work results and the requirements contained in the standard [5]. The purpose of controlling quality is to control the quality of the product or service that can satisfy the customer [6][7].

Companies that will be discussed in this report are PT. McDermott Indonesia which is one of the companies engaged in the fabrication field to design offshore oil drilling facilities. This company, which was established in 1970, is indeed a company that has already dominated the market, however, not a few new companies have emerged to become competitors. Therefore PT. McDermott Indonesia has a quality target of the production process for the project designed [8].

From the guarantee given, the writer wants to know the quality of the production process, one of which is the results of the welding process carried out by the operator of PT. McDermott Indonesia whether there are still many defects in the welding carried out so that there are many improvements to the welding results. By using the control chart is expected to be able to find out whether the welding defects obtained are still in accordance with the control limits and with a pareto diagram to determine the highest type of defect in the welding results[9][10]. Then, using a causal diagram is expected to be able to provide an analysis of the types of structural disciplinary welding defects in the Saudi Aramco project at PT. McDermott Indonesia.

2. METHOD

This method is used in data collection, where the investigator directly jumps into the research project. Then the other method is library research, where used in obtaining data by way of studying literature in the library as well as by reading other data sources of information related to the discussion. So with this library research, the problems discussed can be solved with existing theories. While other methods used in this Research Field are: Interview, which is a method used in obtaining data by asking questions directly when the company conducts an activity. Observation, which is a method of obtaining data by making direct observations of the actual situation in the company. Documentation Method, which is a method of collecting data sourced from written objects (print and image media). Next is the processing of attribute defect data using several tools including pareto diagrams, control charts and fishbone diagrams to find out the graphs and the causes of defects produced in structural discipline welding results[11].

The steps in this study were divided into field observations, problem identification, research objectives, data management such as data defect, observation and interview, making control chart attribute (P-Chart), and analysis of cause and effect variations in the process (Fishbone diagram), analysis and discussion, conclusions and suggestions[12].

3. TYPE OF ATTRIBUTE DEFECT

To conduct an inspection of the welding results that have been carried out by the operator, PT. McDermott Indonesia checks visually according to the standard, namely AWS D1.1. One of the objects inspected was welding results for the SFNY jacket,as shown in the Figure1.

Figure 1: SFNY jacket with a lack of fusion type

With data processing, the attribute defect criteria are determined based on the compiled CTQ (Critical to Quality)[13]. Here are the types of visual defect welding categories that occur [14]:

3.1 Lack of fusion

Specifically the lack of fusion describes when the weld metal does not reach the root or does not completely fill the welded joint [15]. Thus, there is space between weld metal and parent material.

Figure 2: Lack of Fusion

This is due to the influence of welding preparation, lack of welding techniques, amperes that are too low or too high, welding speeds too high or too fast, roots are too large (gaps) that are too far away [16], as shown in the Figure 2.

3.2 Slag

Specifically, this type of defect is an oxide and other non-metal objects trapped in weld metal. Then it can be caused by outside air contamination [17]. This is due to less clean when done welding, as shown in the Figure 3.

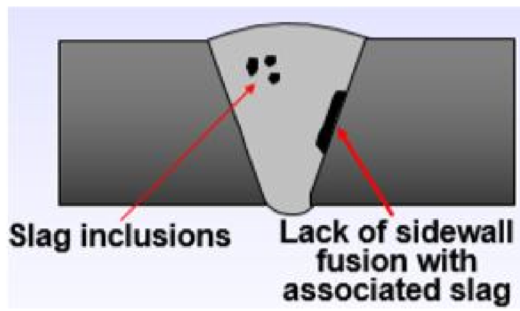

Figure 3: Slag

3.3 Incomplete of fusion

This defect is due to the occurrence of discontinuity that is there are parts that are not fused between the parent metal with weld metal [18], as shown in the Figure 4. This defect is caused by an error in the use of current, welding speed and welding error.

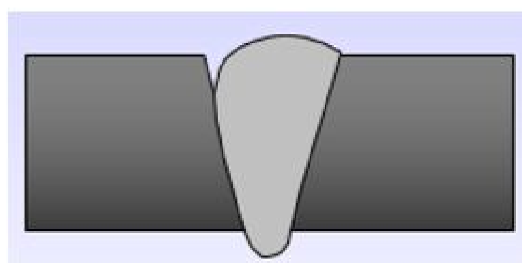

Figure 4: Incomplete of fusion

Figure 5: Porosity

3.4 Porosity

For porosity defects, they form holes in the weld surface as shown in the Figure 5. The cause of this type of defect is due to the dampness of the flux, which turns into a small steam explosion, or even the reaction of gases left in the steel formed during the welding process.

3.5 Incomplete penetration

For this type of defect occurs when weld metal does not completely fill the joint welding as shown in the Figure 6.Usually the condition will consist of concave welding on the surface. The reason is that during the welding process, the welding wire is not perfectly penetrated [19].

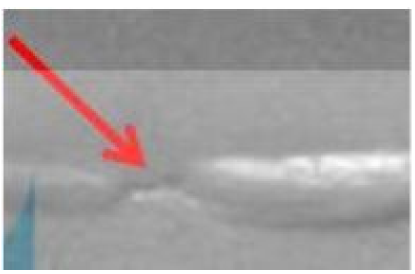

Figure 6: Incomplete penetration

3.6 Lack of root fusion

This type of defect is found in the root area because the welding results are lacking / do not meet the welding area as shown in the Figure 7. The cause of this type of defect is the lack of penetration during the welding process

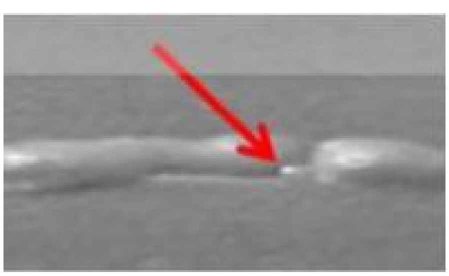

Figure 7: Lack of root fusion

3.7 Lack of side fusion

This type of defect is due to the welding results do not blend perfectly / less fusion between the welding material and the previous welding results, but occurs on the sides of the welding as shown in the Figure 8. The cause of this type of defect is that during the welding process, the angle of the welding wire is incorrectly positioned .

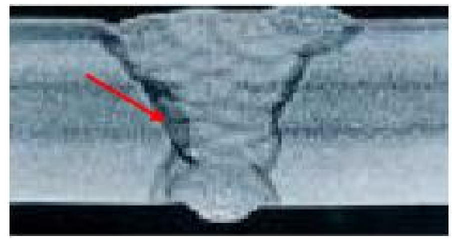

Figure 8: Lack of side fusion

3.8 Cluster Porosity

For this type of cluster porosity defects is similar to porosity which forms holes on the surface of the welding result only the holes are gathered somewhere as shown in the Figure 9. The cause of this type of defect is due to the dampness of the flux, which turns into a small steam explosion, or even the reaction of gases left in the steel formed during the welding process [20].

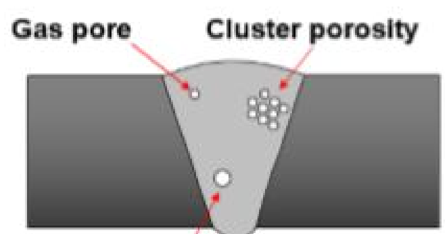

Figure 9: Cluster Porosity

4. RESULTS AND DISCUSSION

There is processing attribute defect data using several tools including pareto diagrams, control charts and fishbone diagrams to find out the graphs as well as the causes of defects that result in structural discipline welding results.

From each of the defects in the attributes of the structural discipline welding results can be categorized by each type of defect and the number of welding carried out, so that the defects obtained from the cumulative amount and are presented in Table 1.

Table 1: Cumulative type of defect

Defective Type	**Number of Defects**	**Total Cumulative**	**Percent Relatively**	**Cumulative Percent**
Lack of fusion	23	23	50%	50%
Slag	10	33	22%	72%
Incomplete penetration	4	37	9%	81%
Porosity	2	39	4%	85%
Lack of Root Fusion	2	41	4%	89%
Lack of Side Fusion	3	44	7%	96%
Cluster Porosity	1	45	2%	98%
TOTAL	1 **46**	46	2%	100%

From the cumulative table, the Pareto diagram can be seen in Figure 10.

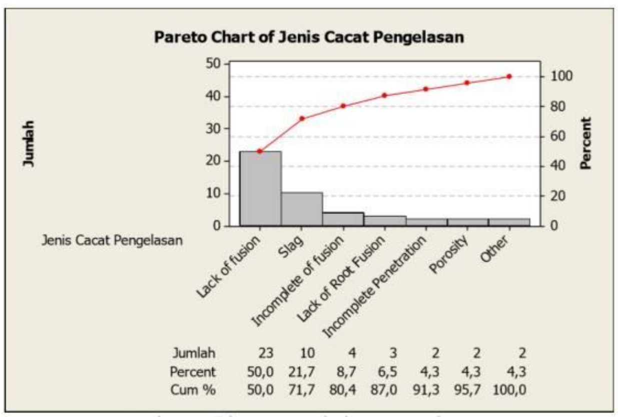

Figure 10: Type of welding defect pareto diagram.

The Pareto principle states as shown in the figure 10 that for about 80% the effect is caused by 20% of the causes [18]. From the Pareto diagram above it can be seen that the type of defects that often occur in welding results is dominated by the lack of fusion by 50%, as many as 23 joints out of the 46 joints produced. Other product defects that occur include slag by 22%, incomplete of fusion by 9%, porosity by 4%, incomplete of penetration by 4%, lack of root fusion by 7%, lack of side fusion by 2%, and cluster porosity by 2%.

From the defect data attributes that have been shown in Table 1_we get a proportion of each defect. The following is an example of calculating proportions, central limit, UCL, and LCL used in making p-charts.

$$Proporsi\ (p) = \frac{x}{p} = \frac{0}{125} = 0$$

$$CL = \sum_{i=g}^{k} \frac{xi}{n} = \frac{40}{12718} = 0.00315$$

$$UCL = \bar{p} + 3\sqrt{\frac{\bar{p}(1-\bar{p})}{n}} = 0{,}00315 + 3\sqrt{\frac{0{,}00315\,(1-0{,}00315)}{125}} = 0{,}0181$$

$$LCL = \bar{p} - 3\sqrt{\frac{\bar{p}(1-\bar{p})}{n}} = 0{,}00315 - 3\sqrt{\frac{0{,}00315(1-0{,}00315)}{125}} = -0{,}0118$$

From the calculation of proportions, central limit, UCL, and LCL we get the results as in table 1. From the data obtained above so we get a control chart like in Figure 11.

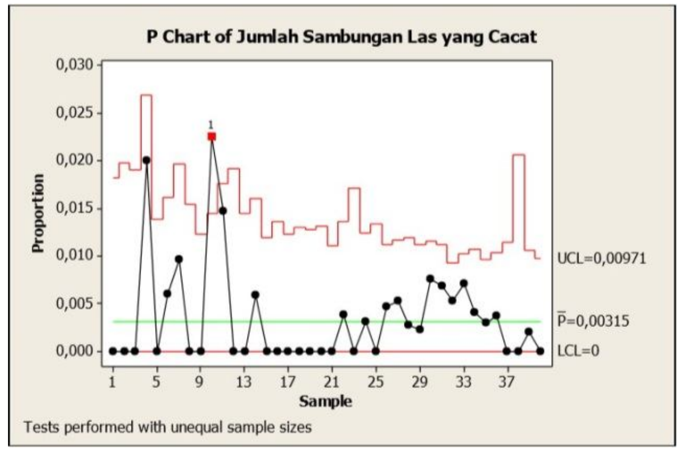

Figure 11: Control chart of structural disciplinary weld joint defects

From the control chart in Figure 11, it can be seen that the welding connection defect data shows that data is out of the control limit, namely the 10th data with a proportion of 0.022523 that exceeds the upper control limit of 0.0144, so it needs to be revised. The revision was done by eliminating the 10th data. The following is a revision of the proportion calculation. After the revision, the control chart is obtained as shown in Figure 12.

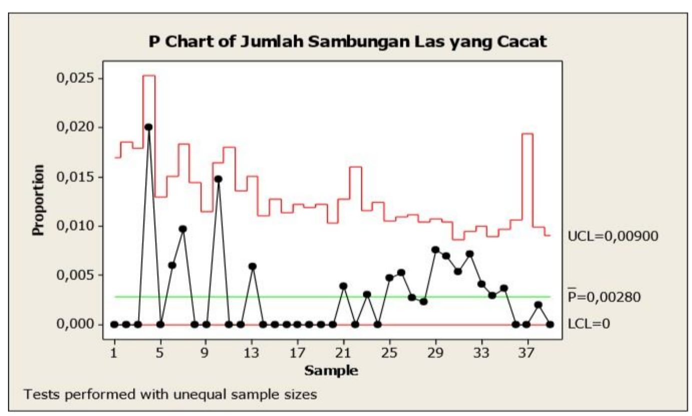

Figure 12: Revised control chart of structural disciplinary weld joint defects

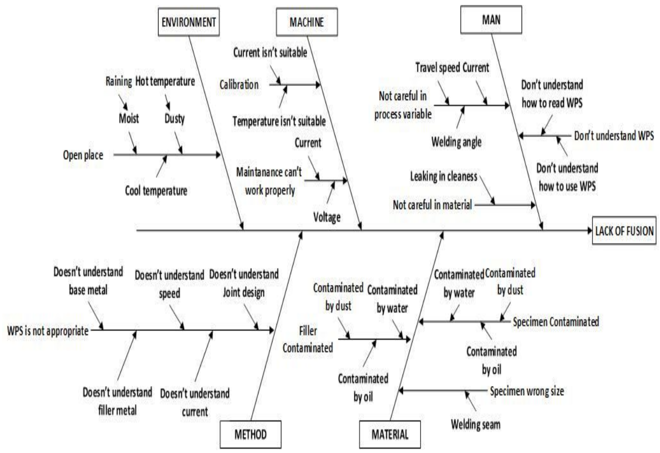

Figure 13: Fishbone welding defect diagram for lack of fusion

Based on the control chart in Figure 12, it can be seen that all data defects in the structural disciplinary weld joints are at the control limit. The control chart is to produce a quality welding connection and to minimize the time taken to repair the welded joint. So that further analysis is needed to produce a control chart like Figure 12.

From the attribute defect data obtained, an analysis of the causes of the attribute defects was performed. This analysis was obtained from the results of discussions with the company about the causes of these attribute defects. Based on the Pareto diagram in the Figure 13 it can be concluded that the types of welding joint defects that dominate are lack of fusion. So that it will be analyzed further about the causes of the defect. The following is an analysis of the causes of lack of fusion defects using fishbone diagrams.

Based on the fishbone diagram in Figure 13 some causes of the lack of fusion defects of several factors namely human, machine and method, material and environmental factors.

1. Humans

In the process of welding human factors also play a role as a cause of defects. The lack of fusion defects caused by travel speed that is too fast and the presence of dirt on the surface of the seam. Lack of understanding the amperage value that must be used in welding can also be one of the causes of defects [21].

2. Machine

In the welding process, the machine is the main tool supporting the welding process. In the process of welding a working machine must be routinely carried out maintenance, this is related to the accuracy of the parameter settings that will be used in welding .

3. Method

The method applied to welding depends on the WPS (Weldling Procedure Specification) where there are parameters from the welding results that have been tested and determined in accordance with the specified specifications. In the lack of fusion defects that occur here because the position of the angle of the welding wire is wrong and the seam angle is too small .

4. Material

Material namely filler that is contaminated with water, oil or paint during the preparation can cause the surface to be oxidized and contaminated. Welding consumables must be ensured not to be contaminated by water, oil or paint by the operator before welding .

5. Environment

The environment is a factor that can affect the welding results. Because welding is generally carried out in an open place, so that due to strong winds can affect the dirty spot due to dust welding. Then the weather conditions, namely erratic rain can affect the welding results due to rain water that interferes with the work process [22].

From the results of the analysis of the causes of welding defects in structural discipline, it can be given an improvement proposal that aims to reduce the level of welding improvement that occurs. The following is a proposed improvement to the structural discipline welding process.

To improve the results of welding, generally is from the operator error. So as to improve the performance of the welding operator itself, retraining is needed, especially for the problem of adjusting the travel speed and amperage that is appropriate for the welding to be carried out, as well as the importance of cleanliness of the welding camp. The operator is given training at the CTC (Craft Training Center) until the operator has the expertise which is good for welding. Then a test is performed to test whether the operator has good ability.

Routine checking and calibration of the machine is carried out once a year. In addition, routine maintenance schedules are also made so that if there are parts or parts of the machine that need to be replaced or repaired, it can further handling is done immediately. In addition, routine cleaning and lubrication are also carried out on the engine so that the engine performance remains stable.

In the welding process to check the right method, it is necessary to periodically check the operator to see the WPS used whether it matches the parameters, both for the selected amperes, the position of the welding wire angle and the precision of the seam angle used [23]. Foreman, Supervisor / Lead to always distribute the latest revised WPS to its subordinates. incorrect position of weld wire angle and seam angle is too small.

For material used alone due to work done in the open, operators must be diligent in ensuring that welding consumables are maintained using the portable oven provided, closing the portable oven while working so that welding consumables are not contaminated with water, air, oil or paint. This is very important, because the results of welding are very dependent on the special treatment of this process [24], [25].

To improve welding results, because welding is carried out in an open place so that it is easily contaminated by the environment, adequate weather shielding (wind shielding) is needed to avoid rainwater or wind .

Close monitoring of structural discipline performance results for continuous improvement [26].

4. CONCLUSION

Based on the analysis and discussion that has been done, the conclusions that can be drawn are as follows:

Based on processing data obtained from direct observations, the type of defect that often occurs in welding results is dominated by the lack of fusion by 50%, as many as 23 joints out of the 46 joints produced. Other product defects that occur include slag by 22%, incomplete of fusion by 9%, porosity by 4%, incomplete of penetration by 4%, lack of root fusion by 7%, lack of side fusion by 2%, and cluster porosity by 2%. Based on the results of the calculation of the control chart (p chart) on the structural discipline welding attribute defects, there is data that is outside the control limits so that the data is not included and the revision calculations are carried out in order to obtain a control map that matches the company's target.

To find out the cause of the defects in the welding process, analysis is needed using a causal diagram (fishbone diagram). With using fishbone diagrams can be known the cause of the type of welding defects that is the lack of fusion in terms of human factors, machines, methods, materials and the environment. From the human factor including the operator being in a hurry, lack of experience and lack of training and fatigue of the operator that causes the operator to be less thorough. From the engine factors including obsolete machines so that calibration and routine engine maintenance are needed. From the method factors including not carrying out work procedures that are not in accordance with the specified WPS, then the work position is not ergonomic. The material factor is welding consumables which are oxidized due to filler content contaminated with water, oil or paint. As well as environmental factors, namely open fields cause dirty welding spots and weather factors where there is strong wind and erratic rain.

After the known causes of defects are found, proposed improvements that aim to reduce the defects and improvements that occur in the results of welding. The solutions offered are based on each of the contributing factors including human factors including providing clear rules and rewards and punishments in the form of retraining for negligent workers. From the engine factor by doing routine scheduling for maintenance and calibrate the machine regularly. From the method factor by ensuring operators use the appropriate WPS. From material factors, operators must ensure that welding consumables are not contaminated with water, oil or paint. From environmental factors, weather protectors are needed to avoid rain and dust.

After a known cause of the defect is found, it is proposed an improvement aimed at reducing the defects and repairs that occur in the welding results. The solutions offered are based on each contributing factor including human factors including providing clear rules and rewards and penalties in the form of retraining for negligent workers. From the engine factor do regular scheduling for regular machine maintenance and calibration. From the method factor by ensuring the operator uses the appropriate WPS. From material factors, the operator must ensure that the consumables for welding are not contaminated with water, oil or paint. From environmental factors, weather protection is needed to avoid rain and dust.

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