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PROCESSES FMEA ON SCREWING OF TERMINALS

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ABSTRACT
This paper provides the use of Failure Mode and Effects Analysis (FMEA) for improving the reliability of sub systems in order to improve the productivity which in turn improves the bottom line of a manufacturing industry. Thus the various possible causes of failure and their effects with the prevention are discussed in this work. Severity values, Occurrence number, Detection and Risk Priority Number (RPN) are some parameters, which need to be determined. These are the steps taken during the design phase of the equipment life cycle to ensure that reliability requirements have been properly allocated and that a process for continuous improvement exists. The FMEA technique is applied a testing bench for the controllers/ contactors to avoid the failures. The prevention suggested in this paper can considerably decrease the time for understanding, operation & failures.

INTRODUCTION
The failure mode and effect analysis is used to identify and analyzed: (a) all failure mode of different parts of the system, (b) effects of these failure mode on the system and (c) how to overcome the failure and/or moderate the effect of the failure system. FMEA is a very efficient method which is needed to be engaged with in companies and manufacturing industries for an engineering design, production process and new product in production and
planning in product life cycle. Purpose of FMEA is founding links between causes and effects of failures, as well as searching, solving and drawing the best decisions regarding solicitation of applicable action.

PFMEA
Objectives of FMEA
The main objectives of FMEA are to:
Identify the equipment or subsystem and mode of operation
1) Recognize potential failure modes and their causes
2) Evaluate the effects of each failure mode on the system and
3) Identify measures for eliminating or reducing the risks associated with each failure mode

Major types of FMEA
The following major types of FMEA are commonly used, based on the application:
1) Design FMEA (DFMEA) – focuses on potential failure modes of products caused by design deficiencies.
2) Process FMEA (PFMEA) - focuses on potential failure modes of products caused by manufacturing or assembly process deficiencies.
2) Machinery or Equipment FMEA (MFMEA) – focuses on designs that improve the reliability and maintainability of the machinery for long-term plant usage [4].

Key parameters of FMEA
Any type of FMEA involves the following key parameters for prioritizing the corrective action:
2.1.1 Severity: It is an assessment of seriousness of the effect of a failure mode on the customers.
2.1.2 Occurrence: Occurrence is an assessment of the likelihood that a particular cause will happen and result in a failure mode.
2.1.3 Detection: It is an assessment of the likelihood that the current controls will detect the cause of the failure mode thus preventing it from reaching the customer.
2.1.4 Risk Priority Number: (RPN) It is a mathematical product of Severity (S), Occurrence (O) and Detection (D). It serves in fixing the priority for the process / item to focus for corrective action.
It is computed as: RPN =S×O×D

The three indices (Severity, Occurrence and Detection) are individually assessed on a 1.0 to 10.0 scale basis for each failure mode, using the standard guidelines specifically tailored for Design, Process and Machinery FMEA's, to address the objectives and requirements of the selected type of FMEA. Then RPN is calculated for each process/system/sub-system to rank and prioritize the corrective action plan.

General benefits of FMEA
1) Prevention planning and brainstorming
2) Identifying change requirements
3) Cost reduction
4) Decreased waste

5) Decreased warranty costs
6) Reduced non-value added operations

BASIC TERMS USED

Failure: The loss of an intended function of a device under stated conditions.
Failure Mode: The manner by which a failure is observed; it describes the way the failure occurs.
Failure Effect: Immediate consequences of a failure on operation, function or functionality.
Local Effect: The failure effect as it applies to the item under analysis.
Next Higher Level Effect: The failure effect as it applies at the next higher level.
End Effect: The failure effect is at the highest indenture level or total system.
Failure Cause: Defects in design, process, quality, or part application, which are the underlying cause of the failure or which initiate a process which leads to failure.
Severity: The consequences of a failure mode are severity. Severity considers the worst potential consequence of a failure, determined by the degree of injury, property damage, or system damage that could ultimately occur.

Basic function of controller:

Controllers are very useful for converting high voltage in to discrete connection. They are assembled in between main 3 phase connection and motors, which gives large amount of current for a short period of time & producing large amount of torque to just start the motor & after that it gives regular supply to the motor.

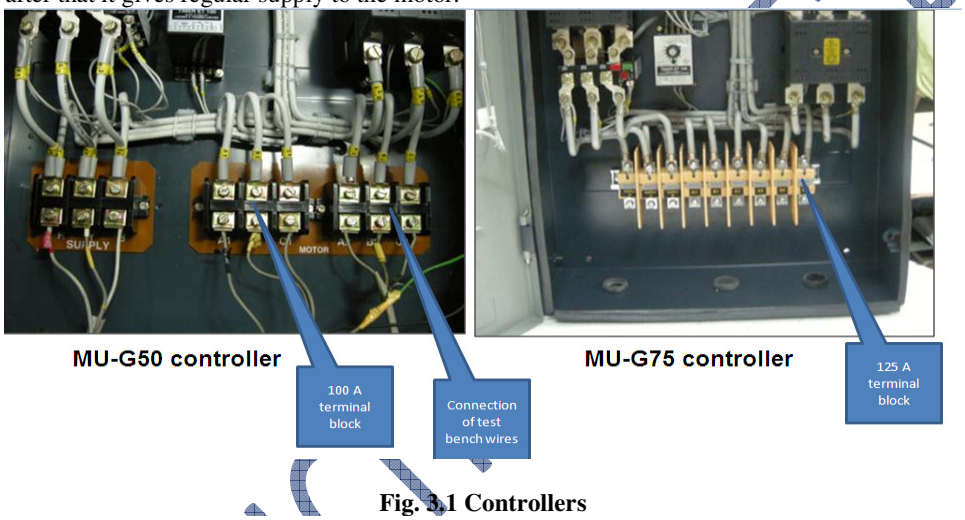

Fig. 3.1 Controllers

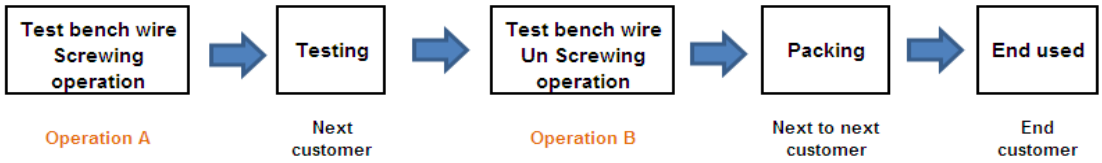

Fig. 3.2 Process Flow Diagram

SCREWING & UNSCREWING OF TEST BENCH WIRES TO TERMINAL BLOCK

In regular quality inspector of the MU-G conductors operators manually attached all the wires with the help of pneumatic screwing gun, in that case there is one accident is held & the operator is getting shock. This is very hazardous for the human being. Hence we have to find some perfect solution to this problem also the time span of the testing is up to the 45minutes. Hence if is very risky to check the quality of that product hence we are moving towards the PFMEA project.

In PFMEA there are two main aspects

i) Incoming material should be ok.
ii) Design of the component should not change during & after your project completion.

Screwing of test bench wires to terminal block –

Screwing is the method to make connections of wire to components. In many industries it is done by manually. So that there is manual errors occurs, these manual errors are as follows.

Under tightening:
At the time of screwing, screw leaved in a partial tightened position called as under tightening due to repetitive work of tightening the screw works get bored. This results in under tightening of screw. When screw are not well tightened there is a sparking at terminal because of loose wire, some times wire get disconnected & will touch to other wire which hazardous to component & operator also represents black marks on the plates due to sparking it will happens if the torque is less than the specified.

Over tightening:
As we use screwing gun , if some operator continues on screwing & screwing then there are chances of bending of washer & hence customer get dissatisfied also there are chances of breaking the plastic mould in which washers & screw get fitted . This many occurs due to the excess torque applies by the operator then the average torque. Also it is difficult to remove the wire from terminals.

Interchanging the connections:
While testing, if the connections get interchanged from the operator & you pass the current from the testing is not possible to the change in phase sequence conductor get rejected.

Distorted screwing:
If there is distorted screwing done by the operator; then there will be chances of breaking, the side wall between the two terminals & hence at the time of high voltage test, starter gets fail.

Screwing operation missing:
While screwing the connections, if one terminal is remains as it is i.e. unscrewed then there is major possibility of that lugs get engage with the terminal or not & the wires may touch to each other. It is very danger it will burn all the system due to sparking. Also it is very hazardous to the operator also.

All these factors are applicable to the unscrewing operation, which is done after the testing, get completed. After the studying all these process & their different functions we deliver the potential effect of failure for the testing, packing & end customer i.e. failure at next customer & end customer. Then security of that problem is decided with the help of the given table no 2. Also we decide potential causes of that failure & the current controls of each potential failure modes. Then we decided to make a wooden fixture which will overcome all the possible potential failure modes and decided the recommended action for each failure modes. After studying all these potential failure modes, we decide the target date completion of that specific failure mode & the result are displayed in the given table 1.

PROCESS- Failure Mode and Effect Analysis

System : Screwing & unscrewing of test bench wires to terminal block. | Responsibility :RAT | FMEA No. - STR/06

Team: RAT,KDJ,NJD,NJR(Trainee) | Key date: 30.11.2015 | FMEA date (Org.): 10.07.2015

Process	Function	Potential Failure mode	Potential effect of Failure: Next customer (Testing)	Potential effect of Failure: Next to next customer (Packing)	Potential effect of Failure: End customer Farmer	SEV	Potential Cause(s) of failure	OCC	Current Controls (Detection): Prevention	Current Controls (Detection): Detection	DET	RPN	Recommended action(s)	Responsibility and Target Completion date	Action Taken	Action Results: SEV	Action Results: OCC	Action Results: DET	Action Results: RPN
Screwing of test bench wires to terminal block	Join components. (make connection)	Under tightening	Sparking at terminal (loose wire) or wire may touch to other wire/enclosure. (10)	_____	Customer dissatisfaction as black marks on terminal. (6)	10	Man intervention/ operator mistake / Torque less than specified	1	Not available	manual means to detect the fault.	8	80	Alternate method of wire connection.	RAT / 19/11/15	Fixture made	10	1	1	10
		Over tightening	_____	_____	Customer dissatisfaction (Washer may get bend) (8)	8	Excess torque than specified	1	Not available	manual means to detect the fault. Unable to remove wire.	8	64	Alternate method of wire connection.	RAT / 19/11/15	Fixture made	8	1	1	8
		Interchanging the connection	Testing not possible as change in phase sequence. Starter get rejected. (8)	_____	_____	8	Man intervention/ operator mistake	2	Color codes for wires	manual means to detect the fault.	8	128	Provide POKAYOKE for phase sequence	RAT / 19/11/15	POKAYOKE for phase sequence implemented	8	1	1	8
		Distorted screwing	Starter fail in HV test as wall between two terminal get break due to distorted screwing. (10)	_____	Hazardous without warning. HV failure between two terminals. Danger to live. (10)	10	No vertical screwing. Slippage of screw driver hits the wall of relay / Man intervention/ operator mistake	2	Not available	manual means to detect the fault.	8	160	Provide guide for screwing/Alternate method of wire connection.	RAT / 19/11/15	Fixture made	10	1	1	10
		Screwing operation missing	wire may touch to other wire/enclosure. Danger to live. (10)	_____	_____	10	Man intervention/ operator mistake	1	Not available	Manual detection	8	80	Provide POKAYOKE /Alternate method of wire connection.	RAT / 19/11/15	POKAYOKE for each terminal connection implemented	10	1	1	10
Un-Screwing of test bench wires from terminal block	Remove Joint (Remove connection)	Under tightening	NA	_____	Washer & Screw may fall. Customer dissatisfaction.(May damage few components in starter) (10)	10	Man intervention/ operator mistake / Torque less than specified	1	Not available	manual means to detect the fault.	6	60	Alternate method of wire connection.	RAT / 19/11/15	Fixture made	10	1	1	10
		Over tightening	NA	_____	Customer dissatisfaction (Washer may get bend / Screw washout) (8)	8	Excess torque than specified	1	Not available	manual means to detect the fault. Unable to remove wire.	8	64	_____	RAT / 19/11/15	Fixture made	8	1	1	8
		Distorted screwing	NA	_____	Hazardous without warning. HV failure between two terminals. Danger to live. (10)	10	No vertical screwing. Slippage of screw driver hits the wall of relay / Man intervention/ operator mistake	2	Not available	manual means to detect the fault.	7	140	Provide guide for screwing/Alternate method of wire connection.	RAT / 19/11/15	Fixture made	10	1	1	10
		Screwing operation missing	NA	_____	Washer & Screw may fall. Customer dissatisfaction.(May damage few components in starter) (10)	10	Man intervention/ operator mistake	1	Not available	Manual detection	6	60	Provide POKAYOKE /Alternate method of wire connection.	RAT / 19/11/15	POKAYOKE for each terminal connection implemented	10	1	1	10

Table No. 1 PFMEA Chart for screwing of terminals

Ranking	Severity	Occurrence	Detection
10	Hazardous without warning. Danger to live & / or illegal.	Failure rate > 50%	No check method to detect OR check method won't detect the fault at all.
9	Hazardous with warning. Danger to live & / or illegal.	Failure rate between 33-49%	Very remote chance that check method will detect the fault.
8	Very high. 100% Loss of primary function	Failure rate between 13-32%	Remote chance that check method will detect the fault.
7	High. Deterioration of primary function resulting into customer dis-satisfaction.	Failure rate between 5-12%	20-40% chance that check method will detect the fault. manual means to detect the fault.
6	moderate. No loss of primary function, loss of secondary function causing discomfort.	Failure rate between 1.2-4%	40-60% chance that check method will detect the fault. manual means to detect the fault.
5	Low. No loss of primary function, secondary function deteriorated causing discomfort.	Failure rate between 0.25-1.1%	60-85% chance that check method will detect the fault. manual means to detect the fault.
4	Very low. No loss of Primary or secondary function. But visible defects (mainly aesthetics) majority of customer could detect the same.	Failure rate between 0.05-0.24%	85% chance that check method will detect the fault. manual means to detect the fault.
3	Minor. No loss of Primary or secondary function. But visible defects (mainly aesthetics) few customers could detect the same.	Failure rate between 0.00006-0.05%	90% chance that check method will detect the fault. manual means to detect the fault.
2	Very minor. Only conscious / discriminative customer can detect the defect.	Failure rate between 0.000006-0.00006%	95% chance that check method will detect the fault. Automatic means to detect the fault.
1	None. No effect / no problem.	Failure rate between 0.0000006-0.000006%	Design control will 100% detect the detect / cause. Automatic means to detect the fault.

Table No. 2 Table of Severity, occurrences and detection

For MU-G75 Controller For MU-G50 Controller

Fig. 4.1 Fixture made during with the help of PFMEA

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