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Error-Proofing in IATF 16949:2016 standard

Arash Asgharinejad

[1] Master's Degree in Mechanics, Energy Conversion, Islamic Azad University, South Tehran Branch

ABSTRACT

It is very important to eliminate mistakes, errors, and their factors in the industry, which leads to the implementation of the optimal process and continuous improvement in the organization. Hence, paragraph 4-2-10 of the IATF 16949 standard for the automotive industry has clearly stated that any organization that intends to implement this standard must design its process using the Error/Mistake-Proofing (EP/MP) method, authenticate the performance accuracy of EP devices at scheduled intervals according to their performance records, and include them in the Control Plan (CP).

Keywords: *POKA-YOKE, Error/Mistake-Proofing, IATF 16949.*

INTRODUCTION

1. Introduction

Definitions

1.1 POKA-YOKE: The Error/Mistake-Proofing (EP/MP) method or POKA-YOKE can avoid making human mistakes (errors). This means that by applying a series of permanent and appropriate changes in equipment, processes, and methods, the possibility of mistakes is eliminated and warnings are given when something goes wrong.

POKA-YOKE means avoiding unwanted mistakes. In the 1950s, Mr. Shigeo Shingo first introduced the Zero Quality Control (ZQC) system, which gained international fame. Although he was one of the main supporters of Statistical Process Control (SPC), since the mentioned approach was based on the principle of statistical sampling and did not prevent the complete transfer of product faults to the customer, he proposed the ZQC approach.

In a Zero Defects (ZD) approach, unlike Statistical Quality Control (SQC), all products are controlled by POKA-YOKE methods, and it reduces quality costs while maintaining or increasing customer satisfaction **[1]**.

1.2 ZQC (Zero Quality Control): To completely eliminate failures, we must either eliminate them permanently with a Problem Solving Process (PSP) or we need to identify and eliminate machine errors, system weaknesses (and most importantly) human errors with the EP procedure (industrial inspection) **[2]**.

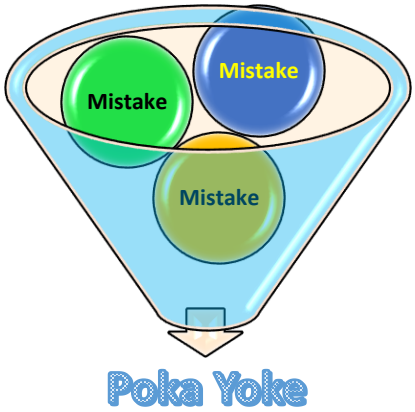

Fig. 1. Error/Mistake-Proofing

2. Implementation procedure

The first step

2.1 Identification and definition

During new Product Process Design (PPD) or monitoring of current processes, if one or more activities are identified as possible causes of the errors, the Product Development (PD) team investigates and identifies factors according to the EP team's goals and the problem-solving instructions. The EP procedure is used (i) to reduce the Risk Priority Number (RPN) during quality planning and after performing the Failure Mode and Effects Analysis (FMEA) and (ii) after receiving suggestions from the organization's employees. Generally, the Brainstorming Process (BP), Part per Million (PPM), defective (faulty) and nonconformity parts analysis, process reports, FMEA results, and Cost of Quality (COQ) should be used as inputs to the EP procedure. EP items are one of the inputs to Continuous Improvement Projects (CIP) or Corrective/Preventive Actions (C/P A). In this way, these cases must be first identified, defined, and approved so that during the process of continuous improvement, these cases will be checked with other improvement projects and implemented in case of final approval and prioritization. The EP technique can also be used to perform corrective and preventive actions. In addition to the above and due to the importance of this issue, the EP team is formed in specific time intervals of three months, and production lines, warehouse, processes, production/control procedures, production/control equipment, the production route layout, etc. are checked and validated in each visit. The results and cases having EP capability are identified. The identification and determination of the EP procedure of processes are recorded, and then, the prioritization of the EP projects is presented for weighting, prioritization, and subsequent related actions **[3].**

2.2 The second step

Forming the team and scheduling EP meetings

In addition to the team members who regularly attend the meetings, the team leader can invite other experts in the field under discussion to participate in the meetings.

2.3 The third step

The derivation process

To evaluate and analyze a problem, a relevant Flow Process Chart (FPC) must be prepared and, if one does not exist, it must be created. The location of the error must be indicated in the FPC. Identifying the error source and analyzing the causes of its occurrence should be discussed in EP meetings and, if necessary, authenticated with control tools and procedures.
The error source in EP must be placed in one of the following categories:

- Mistake
- Changes
- Complexity

Techniques like Fishbone Diagram (FD), 5Why, 5W2H, and Is/Is not should be used. Also, to identify human errors, the form "Check of the source of defects, unconformity, and their relationship with human errors" must be used **[5].**

2.4 The 4th step

Finding a solution

In the first step, for any possible error, we must look for a solution by checking the starting point to prevent errors. In this situation, we should try to eliminate the cause of the error by changing the product design or changing the process design. For this purpose, the principles of a redesign can be used and by relying on four methods (elimination, combination, replacement, and simplification) the cause of the error can be eliminated. If it is not possible to prevent the error, let's check the ways of detection, informing, and non-transmission of the error. One of the following methods should be used to diagnose the error.

- **Contact methods:** This method requires physical contact between two or more things, and the irregular shape of the parts can be used to the maximum in this method. (Such as electrical outputs).

- **Motion-Step/Sequencing methods:** This method uses sensors to monitor (record) a movement or a step. If the desired step is not completed, the sensor stops the device by sending a message and informs the operator.

- **Fixed-Value/Constant Number methods:** This method is used when a process must be performed a certain number of times or when a product consists of a certain number of parts.

One of the following strategies should be defined at the time of error detection:

- **Control Approach:** This approach is an error correction mechanism so that the process factor goes within an acceptable range.

- **Warning Approach:** A mechanism that warns humans about the occurrence of an error through sound or light.

- **Shout Out/Intervention Approach:** When an error occurs, this approach automatically stops the possibility of continuing the operation.

Finding at least three solutions should be on the agenda of problem-solving sessions.
Finally, the best device or EP procedure must be chosen as the main plan and two plans as substitutes **[5].**

2.5 The 5th step

A preliminary check of the plan before implementation (COQ feasibility)

A review of the proposed design is done by the sub-team in the EP process test form.
Approval by the process owner: The Action Plan (AP) and the feasibility report is submitted by the sub-team leader of the target workshop to the management of the engineering organization or the relevant process owner for approval.
If it is approved, a step forward will be taken, but if it is not approved, it will go back to the previous stage to evaluate the feasibility of alternative plans. Among the features of the plan, we can mention things like cost-effectiveness, effectiveness, simplicity, and practicality. If a system incurs a significant cost, a recoverable COQ analysis helps to determine whether this system will be profitable. To estimate recoverable COQ, the monthly cost of mistakes in the organization must first be determined. Then, the costs related to correcting the same mistakes must be determined. By dividing the EP costs by the monthly cost of mistakes, it is possible to determine when the company's COQ will return. Spending $1 on prevention costs saves $10 in corrections costs and $100 in failure costs **[2].**

2.6 The 6th step

Definition and approval of the project: With the approval of the management of the engineering system organization or the relevant process owner, the project definition and approval process is implemented.

2.7 The 7th step

Plan implementation: The target project must be presented according to the schedule and implemented according to the project management procedure.

2.8 The 8th step

Authentication of the plan after implementation

The output of the device or EP procedure using statistical quality control tools in monitoring and authentication
After the implementation of the plan and with the knowledge of following the previous steps and completing the form of "Recording EP systems after authentication", it should be completed and archived as the main solution.

2.9 The 9th step

Updating documents

All documents related to product production should be reported to the product engineering supervisor of the engineering organization for updating. Among the technical documents of product production, the following can be mentioned:

- FMEA
- Control Plan (CP)
- Analysis of FPC **[1]**

2.10 The 10th step

Knowledge management

The instrument of the plan Implementation should be appropriately documented for knowledge enhancement and shared for use by other EP team members and general staff of SAPCO suppliers **[4].**

2.11 The 11th step

Documents and archives

The report related to all the implemented steps of the plan must be archived by the sub-team leader in the 8D (Eight Disciplines) method. The list of available stations for each workshop should be prepared and archived by the sub-team leader in the form of "Identification and determination of EP procedure of the processes".

2.12 The 12th step

Visual management

The purpose of visual management is culturalization, training, strengthening the suggestions system, and strengthening the spirit of group work and teamwork. For visual management, one or more boards (signs) should be installed in each flagship workshop. Leaders of sub-teams in flagship workshops are responsible for installing information on visual management boards. The location of errors or their source should be identified using a card, label, or flag called Red Flag. The purpose of using red flag is to express the problem as an open problem to get feedback from the production line staff. Sub-team leaders are responsible for identifying red flag locations. The list of red flags and final steps of problem-solving should be placed on the visual management board and archived by the sub-team leader.

Identification flag of EP stations

The location of EP stations must be determined visually. Operators and line workers should be aware of how EP stations work and the benefits of using them. The sub-team in the target workshop is responsible for installing the identification flag of the EP stations.

2.13 The 13th step

Authentication of EP samples

Routine authentication of EP stations

All EP equipment must be recorded in the form of "The POKA-YOKE master list" (appendix-form No.6) to prevent the occurrence of errors and the detection of errors with the potential of failure, and the possibility of rotting and failure. To ensure proper operation, it must be authenticated once per shift at start-up by production units. Authentication of EP stations must be done as part of the start-up process at the beginning of the start-up shift. EP stations can include:

- Error prevention equipment
- Fault detection equipment

To ensure the performance of the mentioned stations, the product engineering unit must determine the authentication procedure of the relevant stations. Also, the questions mentioned

for the EP equipment of the production line should be documented as a start-up authentication form at the beginning of the shift or as a form of start-up authentication and validation of the inspection and test equipment at the beginning of any shift. As the nature of EP stations changes, these questions should be updated. The production unit must authenticate the EP stations once per shift with relevant blank samples and based on the questions mentioned in the form of "Report on the accuracy of the operation of EP devices (appendix-form No. 7)". If the answer to the question is authenticated, the mentioned observations must be recorded in the observation section.

Note 2: To validate EP system performance, an entrapment (trapping) technique (using a nonconformity part or nonconformity master) can be used in the EP process and the result is recorded.

Control of blank (control) samples

The masters of EP stations should include the approved and rejected masters prepared by the engineering units, and be provided to the production and quality control units for control.

Staining of blank samples

The OK blank samples should be marked white and NOK blank samples should be marked as a combination of white and red colors. All masters must be controlled by the QC unit and, if calibration is required, certified, and periodically authenticated in terms of correct operation. When using GR&R, EP must be calculated to ensure the correct operation of equipment.

Explanation: Validation of suppliers' EP stations is done by the Quality Assurance (QA) team of SAPCO using the instruction "Using quality techniques and tools in the supply chain" and the "Audit checklist of EP of the production process (POKA YOKE)".

2.14 The 14th step

To check the failure of EP stations

In case of failure at EP stations, a Quick Response (QR) program including containment must be implemented. To implement limitation, all the produced parts must be controlled and determined as backward until the last OK/authentication of the EP station according to the implementation procedure of nonconformity product control.

After observing the failure in the EP stations, notification should be made immediately according to the implementation procedure of nonconformity product control and the notification form, and also be informed verbally shift chief or the supervisor of each part. Also, after limiting the produced parts according to the implementation procedure of nonconformity product control, the failure of EP stations must be sent as input to the QR meetings, and an 8D form issued to check failures of EP stations **[5].**

Conclusions

To use the EP technique correctly, it is necessary to use the method defined in the IATF 16949 standard and the requirements of car manufacturers such as General Motors (GM), Peugeot Citroen, Renault, and other car manufacturers. Periodic control of the EP system to check the performance of this system is one of the priorities of organizations. Also, the performance results of the EP system can be seen in the PFMEA. If G R&R is used, it should be updated as necessary to improve the EP system.

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