Application of Control Plan – PPAP Tool in Automotive Industry Production

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Abstract

"Production Part Approval Process", known as "PPAP", is a requirement of ISO/TS 16949 standard in the automotive industry. It is a methodology through which providers are required to demonstrate a proper understanding of all customer requirements and the ability to produce products that meet all the requirements imposed in the stipulated time and in a constant manner. This paper presents the importance of the Control Plan in the product development and staging, this being one of the tools on which PPAP methodology is based. Companies use Control Plans realized using the results from Failure Mode and Effects Analysis (FMEA) to evaluate a process or product for strengths and weaknesses and to prevent problems before they occur.

Keywords: *PPAP, quality assurance, failure mode and effects analysis, control plan.*

1. Introduction

The automotive industry is one of the most important industries in the world that concerns not only the economy, but also the world culture. This is vital for the growth of the labor market, providing, along with related fields, jobs for millions of people, creating the basis for a multitude of services. Each company in the field must maintain product quality, deliver on time and at a competitive price in order to achieve customer satisfaction. For this, companies always appeal to various quality assurance programs at the same time ensuring that their suppliers do this. One of the most important tools to ensure that the supplier understands all customer requirements and can translate them into processes that meet these requirements is "The Production Part Approval Process" known as "PPAP" [1].

At the same time, through the PPAP approach, the supplier ensures that the manufacturing process has the potential to produce permanent product in compliance with the requirements of production and the cadence imposed. Depending on customer request a PPAP file consists in the following documents that are presented in *Table* 1.

Among the requirements imposed to the suppliers through PPAP, this paper presents the characteristics of the control plan: definition, implementation steps and components.

2. What are Control Plans?

The Control Plans represent: [2]:

- ❑ written descriptions of the systems used to control and minimize product and process variation;
- ❑ in addition control plans specify the process monitoring and control methods (for example, special controls) used to control special characteristics;
- ❑ are living documents – must be reviewed annually, as issues arise, and as process improvements are made and process knowledge increases;
- ❑ requirement of ISO/TS 16949 [3]:

"The organization must:

- *develop control plans at the system, subsystem, component, and/or material level for the product supplied, including processes producing bulk materials, as well as, parts;*
- *have a control plan for pre-launch and production that takes into account the design FMEA and manufacturing process FMEA outputs.*

The control plan must:

- *list the controls used for manufacturing process control;*
- *include methods for monitoring of control exercised over special characteristics defined by both the customer and the organization;*
- *include the customer required information, if any;,*
- *initiate the specified reaction plan when the process becomes unstable or not statistically capable.*

Control plans must be reviewed and updated when any change occur affecting product, manufacturing process, measurement, logistics, supply sources, or FMEA."

It is important to note that there is a direct relationship from the Process FMEA to a Process Control Plan.

FMEA is considered a rigorous preventive method for identifying, and assessing potential failures of a system [4]. It is a prevention tool, it defines, identifies, prioritizes, eliminates potential failures or the failures known in the earliest stage possible. Its results are inputs in the control plan:

- ❑ a list of potential failure modes;
- ❑ a confirmed list of critical characteristics confirmed and/or significant;
- ❑ a list of the operator's safety characteristics and characteristics of high impact;
- ❑ a list of recommended special controls for the special characteristics of the product, which have to be included in the control plan;
- ❑ a list of processes or actions to reduce the severity, the elimination of causes of product failure mode, or reducing their frequency, and improving the defect detection capability of the product in the case the process cannot be improved;
- ❑ changes in process documents and in the assembly drawings.

Typical outputs from a Process FMEA are shown in the *figure* 1.

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Table 1. PPAP – Requirements for supplier [1]

REQUIREMENTS – PPAP ELEMENTS	Level 1	Level 2	Level 3	Level 5	Level 5
1. Design Record ❑ for proprietary components/details ❑ for all other components/details	R R R	S R S	S R S	* * *	R R R
2. Engineering Change Documents, if any	R	S	S	*	R
3. Customer Engineering Approval**	R	S	S	*	R
4. Design FMEA (DFMEA)	R	R	S	*	R
5. Process Flow Diagrams	R	R	S	*	R
6. Process FMEA	R	R	S	*	R
7. Control Plan	R	R	S	*	R
8. Measurement System Analysis	R	R	S	*	R
9. Dimensional Results	R	S	S	*	R
10. Dimensional Results	R	S	S	*	R
11. Initial Process Studies	R	R	S	*	R
12. Qualified Laboratory Documentation	R	S	S	*	R
13. Appearance Approval Report (AAR)**	S	S	S	*	R
14. Sample Product	R	S	S	*	R
15. Master Sample	R	R	R	*	R
16. Checking Aids	R	R	R	*	R
17. Records of Compliance with Customer- Specific Requirements	R	R	S	*	R
18. Part Submission Warrant (PSW) Bulk Material Checklist	S S	S S	S S	* *	R R
Required way of presenting the evidence to customer:					
S	The organization shall submit to the customer and retain a copy of records or documentation items at appropriate locations				
R	The organization shall retain at appropriate locations and make available to the customer upon request				
*	The organization shall retain at appropriate locations and submit to the customer				
**	If required / applicable				

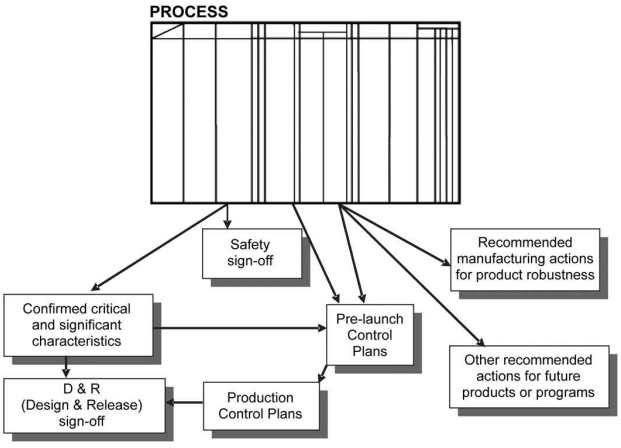

Figure 1. Outputs from Process FMEA [4]

By using a control plan together with a dynamic FMEA one can identify potential process failures before they occur, so the process engineer will be allowed to take proactive action to a much lower cost and ensure continuous improvement of the process, *Figure* 2.

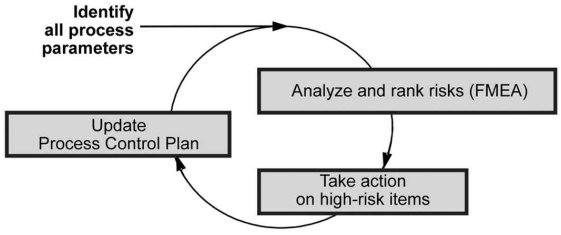

Figure 2. Continuous Improvement Cycle

3. Control Plan methodology

3.1. The stages of the Control Plan

Based on the results of the FMEA analysis, the working team responsible with the elaboration of the control plan will go through the following steps [5], shown in *Figure* 3.

3.2. The components of the Control Plan

Table 2 shows an example of a control plan developed during the production processes in the automotive industry. Components included in the control plan are the following [1], [3]:

Table 2. Example of Control Plan

Control Plan

	Prototype	(1)	Pre-launch	X	Production	Key Contact/Phone (7) Stanciu Ion/2558			Date (Original.) (10)\ 10.11.2012			Date (Review) (11)
Control Plan Number – (2) EUR_12303												
Part Number/Latest Change Level (3) **8640017685R**						Core Team (8) Stancu Marian, Alexe Ion			Customer Engineering Approval/Date (If Required) (12)			
Part Name/Description (4) Auto Sun Visor						Supplier/Plant Approval/Date (9)			Customer Quality Approval / Date (If Required) (13)			
Supplier/Plant (5) EAPIR				Supplier Code (6) KF0UCV		Other Approval/Date (If Required) (14)			Other Approval/Date (If Required)			
Process Number (15)	Process Name/ Operation Description (16)	Machine, Device, Jig, Tools for Manufac-turing (17)	Characteristics			Special Charac-teristic Classifi-cations (21)	Methods					Reaction Plan d (27)
			No. (18)	Product (19)	Process (20)		Product/ Process Specifications/ Tolerance (22)	Evaluation/ Measu-rement Technique (23)	Esantion		Control Method (26)	
									Size (24)	Frequency (25)		
Op. 200	Cutting PVC sheet	Cutting Machine Balacchi Cutting PVC 1	1		Air pressure		7+/-3 barr, cf.CT.T007	Gauge	1 inspection/ shift	1 inspection to Start-up	Reading	Setting the parameters
			2	1. Length 2. Width			1.182,5± 2,5mm 2.430± 5 mm	1, 2-visual-reading on the display machine	1,2 1/shift	1,2 1/shift-to Start-up	1,2-reading on the display machine IL. T009	According to the instruction "The Rule of the Reactivity Failure Occurrence" PIT-I-PSS
Op. 300	Welding sun visor	Balacchi Machine Welding 1	1		1. closing time 2.cooling time 3.welding time 4 welding pressure; 5. welding power 6. air pressure 7. heating plate a. left b. right c. table …	3. CCC 2 5. CCC1 …	1. 2+/-0.5 s 2. 2+/-0.5 s 3. 2 +/-1 sec. 4. 2000+/-500 kg 5. 45+/-5% 6. 7barr+/- 3barr 7. a. 0 b. 65+/-10°C c. 75+/-10°C CT.T007 …	1.electronic display; 2.electronic display; 3. electronic display; 4.gauge; 5. electronic display; 6.gauge; 7. electronic display; …	1, 2,3,4,5,6,7 -3 Tests	1,2,3,4,5, 6,7-1 inspection to Start-up + 2 inspections in flux (after 2 hours of Start-up , with 2 hours before stopping production	1,2,3,4,5, 6,7-measuring	Setting the parameters
			2	Shape: 1. 2.109 burr on the contour 2.2.110 semi-mould distorted in the area of spring 3.2.100 air bubbles on the body and whole surface A and B 4.2.116 missing material on the contour 5.2.105 spots on the whole surface A and B of the part 6.2.127 foreign body on the whole surface A and B of the part 7.2.104 scratches on the whole surface A and B of the part 8.2.109 burr on the contour 9.4.106 separate welding on the contour and area of ax – crochet 21. 3.108 presence of grease 23.2.105 grease on the sun visor body 25. 2.113 presence of pocket on the surface A 26. 2.102 conforming positioning of pocket on the surface A		9. CPC6 5. CPC8	Shape: Without: 1. 2.109 burr on the contour 2.2.110 semi-mould distorted in the area of spring 3.2.100 air bubbles on the body and whole surface A and B 4.2.116 missing material on the contour 5.2.105 spots on the whole surface A and B of the part 6.2.127 foreign body on the whole surface A and B of the part 7.2.104 scratches on the whole surface A and B of the part 8.2.109 burr on the contour 9.4.106 separate welding on the contour and area of ax – crochet 21. 3.108 presence of grease 23.2.105 grease on the sun visor body 25. 2.113 presence of pocket on the surface A 26. 2.102 conforming positioning of pocket on the surface A		1 part	1,2,3,4,5, 6,7,8,9,21 ,23,25,26-1 inspection to Start-up, 100% during the process	1,2,3,4,5, 6,7,8,9,21 ,23 25,26-visual inspection according to work instruction IL T009	According with the instruction"" Reactivity Rule" Occurrence Failure" OIT-I-PSS-K007/R

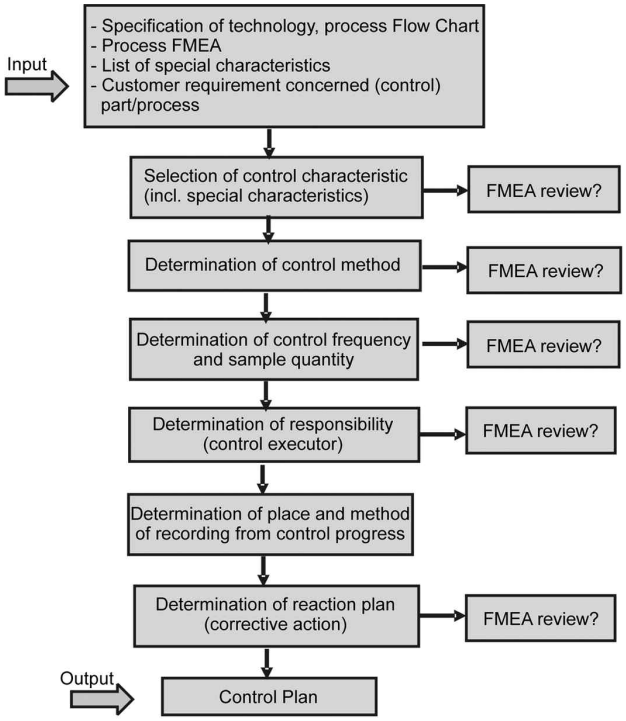

Figure 3. The process of creating of the Control Plan

1. Applicable phase: Prototype, Pre-Launch, Production

Prototype – A description of the dimensional measurements material and performance tests occurring during Prototype build.

Pre-Launch – A description of the dimensional measurements, material and performance tests that will occur after Prototype and before normal.

Production – A comprehensive documentation of product/process characteristics, process controls, tests, and measurement systems occurring during normal production.

2. Control Plan – Number

Presents the Control Plan document number used for tracking.

3. Part number/latest change level

It is presented the number of the system, subsystem, or component being controlled. When applicable, enter the latest engineering change level and/or issue date from the drawing specification.

4. Part Name/Description

It is presented the name and description of the product/process being controlled.

5. Supplier/Plant

It is presented the name of the company and the appropriate division/plant/department preparing the control plan.

6. Supplier Code

Enter the identification number as requested by the procuring organization.

7. Key Contact/Phone Responsible

8. Core Team

9. Supplier/Plant Approval/Date

10. Original Date

It is notated the date that the original control plan was compiled.

11. Review Date

It is notated the date of the latest Control Plan updates.

12. Customer Engineering Approval/Date (if required)

Obtain the responsible engineering approval (if required).

13. Customer Quality Approval/Date

Obtain the responsible supplier quality representative approval (if required).

14. Other Approval/Date (if required).

15. Process Number

This item number is usually referenced from the Process Flow Chart

16. Process Name/Operation Description

It is presented the process/operation name from the flow diagram that best describes the activity being addressed All steps in the manufacturing of a system, subsystem, or component are described in a process flow diagram..

17. Machine, Device, Jig, Tools for Manufacturing

For each operation that is described, identify the processing equipment, e.g., machine, device, jig, or other tools for manufacturing, as appropriate.

18. Characteristics Number

19. Characteristics of Product

Product characteristics are the features or properties of a part, component or assembly that are described on drawings or other primary engineering information. The core team should identify the special product characteristics that are a compilation of important Product characteristics from all sources. All special characteristics must be listed on the control plan. In addition, the manufacturer may list other Product characteristics for which process controls are routinely tracked during normal operations.

20. Characteristics of Process

Process characteristics are the process variables (input variables) that have a cause and effect relationship with the identified product characteristic. The core team should identify process characteristics for which variation must be controlled to minimize product variation. There could be one or more process characteristics listed for each product characteristic.

21. Special Characteristic – Classifications

All products/processes have features described by characteristics that are important and need to be controlled. However, some characteristics require extra attention/ efforts to minimize the risk of adverse consequences. These are Special Characteristics Special Characteristics – are those which affect: vehicle/process safety, compliance with government regulations, customer satisfaction.

In the automotive industry, ISO TS 16949 [3] standard specifies that "the organization must identify special characteristics". This standard defines the special characteristic as "product characteristic or manufacturing process parameter which may affect safety or compliance with regulations, fit, function, performance or subsequent processing of product."

In order to designate special characteristic type using the appropriate classification, this box can be left free for other characteristics that are not special. Customers can use unique symbols to identify a major characteristic such as those affecting the customer's security, regulatory compliance, operation, installation or design.

22. Product/Process Specification/Tolerance

Specifications/tolerance may be obtained from various engineering documents, such as, drawings, design reviews, material standard, computer-aided design data, manufacturing, and/or assembly requirements.

23. Evaluation/Measurement Technique

This column identifies the measurement system being used. This could include gages, fixtures, tools, and/or test equipment required to measure the part/process/manufacturing equipment.

24. Sample Size

25. Sample Frequency

26. Control Method

This column contains a brief description of how the operation will be controlled, including procedure numbers where applicable.

The control method utilized should be based on effective analysis of the process and may include:

- ❑ Statistical process control SPC;
- ❑ Inspection;
- ❑ Mistake-proofing;

- ❑ Error-proofing;
- ❑ Sample plans.

27. Reaction Plan

The reaction plan specifies the corrective actions necessary to avoid producing nonconforming products or operating out of control. Many reaction plans only instruct the operator on what to do if the process is out of design specification. Reaction plan should contain instructions on how the operator should react when the process is moving out of control. Reaction plans should be based on the output from control charts. The plans are necessary to be at the operator station.

4. Conclusions

The approval of the products before normal production has become common practice (often mandatory) not only in the automotive sector, but also in other industries.

The results of FMEA analysis and control plans along with the quality proofs submitted to the customer to obtain "PPAP approved", if prepared correctly and with full involvement of engineers who thoroughly analyze the implemented process, are able to effectively prevent against majority of non-conformances prior to serial production. Such preventive approach is indispensable for suppliers whose customers have begun to require failure rate 0 ppm. **Q-as**

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