PRODUCTION PART APPROVAL PROCESS IN THE METALLURGICAL SECTOR FOR AUTOMOTIVE INDUSTRY

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Abstract

Achieving high standards of a product quality at minimum cost is only possible using modern methods and approaches of the quality management. For most companies, their application is vital regarding their competitiveness in the business area. This is valid also for the automotive industry, where modern approaches to quality management becoming the standard. One of these approaches mainly used in the automotive industry is PPAP (Production Part Approval Process). The advantage of companies using PPAP consisted mainly in strengthening of supplier awareness of special customer requirements for the particular product. The paper deals with the possibilities of application PPAP for suppliers of metallurgical products. Based on the analysis of selected organizations producing metallurgical products for the automotive industry main advantages of PPAP implementation will be specified.

Keywords: APQP, PPAP, Process Flow Chart, PSW

1. INTRODUCTION

Quality of the final product no longer depends solely on its manufacturer. The very important part of final product quality covers quality of each single component supplied by subcontractors selected and then approved by customer.

In automotive industry, a considerable complexity of the product structure combined with a high pace of implementation of manufacturing processes (usually accompanied by requirements to assure on-time deliveries) created a narrow specialization of suppliers. The suppliers of Original Equipment Manufacturers (OEMs) along with their suppliers create a supply chain that is complicated and difficult to manage [1,3].

Transferring of production from manufacturers premises to suppliers caused huge limitations with respect to controlling of all processes and their sub-processes. Moreover, one can notice a considerable shortening of the product life cycle, not only in automotive sector. Products used to be manufactured without any changes in past. This is no longer possible contemporary market. Currently, the life cycle of any car model amounts up to several years [2]. Such a situation is the one of the main reasons of frequent implementation of new manufacturing processes at OEMs plants and their suppliers. This has raised an important issue of processes control in supply base to assure quality of the supplied products and timely deliveries. As the remedy formal quality management systems were developed (ISO 9001 [3,4] and its extension for automotive industry ISO/TS 16949 [5]). However, the requirements contained in these standards do not sufficiently protect interest of car manufacturers in terms of quality and timely deliveries, therefore the great American OEMs (Ford, Chrysler and General Motors) have developed additional so called customer specific requirements (CSRs) for all suppliers known under the name of AIAG Manuals including among others APQP, FMEA, SPC, MSA and PPAP procedure (Production Part Approval Process) [6,7].

2. PPAP CHARACTERISTIC AND REQUIREMENTS

The PPAP procedure is an essential part of preparation phase of production process. It contains a number of guidelines for suppliers who are obliged to present a set of qualitative evidences proving readiness for start of serial production (SOP). This means that supplier, before starting deliveries of purchased components, is required to develop and submit a particular documentation for the customer for his approval. The required documents correspond to 18 requirements imposed by PPAP manual (see Table 1).

Table 1 PPAP requirements for suppliers [6]

REQUIREMENTS – PPAP ELEMENTS	LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4	LEVEL 5
1. Design Record	R	S	S	*	R
- for proprietary components/details	R	R	R	*	R
- for all other components/details	R	S	S	*	R
2. Engineering Change Documents, if any	R	S	S	*	R
3. Customer Engineering Approval **	R	S	S	*	R
4. Design FMEA	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. Material, Performance Test 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)	S	S	S	*	R
Bulk Material Checklist	S	S	S	*	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

All PPAP requirements have been specified together with customer-supplier agreed level of submission. It determines which of evidences (documents) shall be submitted to customer as default and which of evidences should be submitted on customer demand. The most frequently used level of submission is level number 3 (so called full PPAP). After completing the required documents, a Part Submission Warrant (PSW) is filled and all are sent to a customer together with reference samples. A customer makes a decision based on documents submitted by a supplier notifying supplier of PPAP approval, temporary approval or PPAP rejection. To get PPAP approval on time a process of acquisition and development of PPAP required evidences should be planned, monitored, measured, evaluated and systematically improved on the basis of obtained results [1,6].

The standard ISO 9000 [8] defines the process as a set of interrelated activities which interact and transform inputs into required outputs. Tasks required by PPAP (no mentioned its name) implies that it is a process, therefore it is necessary to:

- define it as a sequence of activities,
- assign each activity its input and output with specific requirements (targets),
- identify and assure necessary resources and assign responsibility for each single activity.

PPAP treated as a process can be presented as flowchart (see Fig. 1) defining the order of activities aiming at obtaining evidences for PPAP submission. At the PPAP input a supplier has to gather and review all engineering data and records defining requirements for a product, a supplier is supposed to deliver (design, manufacturing), including technical changes (if any) and evidence of customer technical approval. Engineering data at PPAP input is usually delivered in electronic format (CAD/CAM data). At the output of PPAP process a customer approval status of the submitted PPAP documents is obtained.

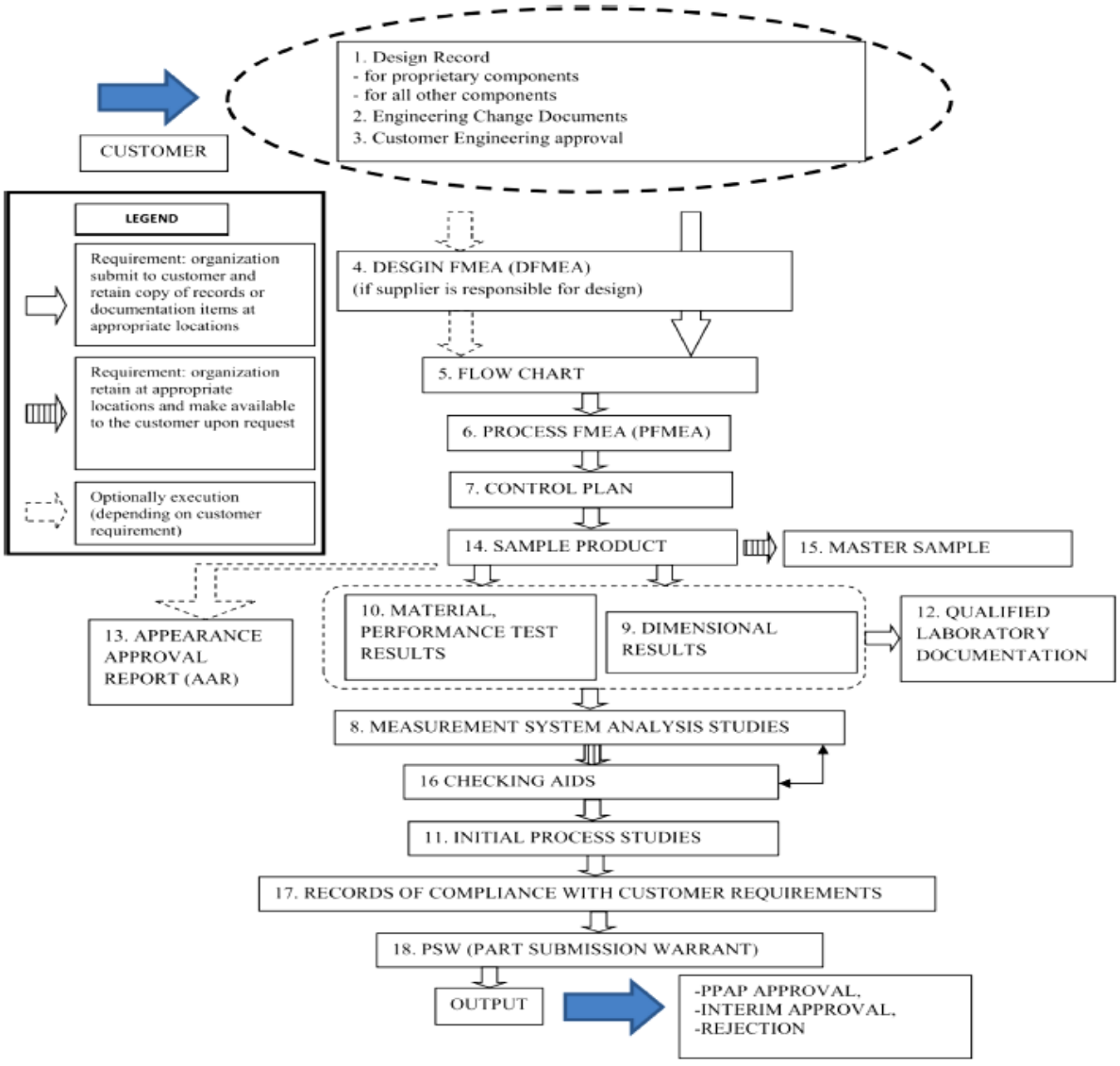

Fig. 1 The flow chart of preparing PPAP documentation at level 3 [1]

3. ANALYSIS OF PPAP IMPLEMENTATION FOR SUPPLIERS OF METALLURGICAL PRODUCTS

For the analysis were selected companies supplying metallurgical products in various industry sectors. Ten companies were selected as a representative sample. Specifically, there were companies from both the Czech Republic and Slovakia, which are suppliers of metallurgical products. Given sample of companies is used in the following section for the analysis and identification of the main benefits of implementation of PPAP process.

Selected companies can be classified into the middle category with a staff of 100-300 employees, which supply more than ten types of products and whose main production technology is casting or forging. Most of companies, namely eight companies from the survey, supply their products to different sectors of the engineering industry. Only two of them supply their products to the automotive industry. In Table 2 are summarized the basic information about individual companies, which are due to preservation of confidentiality identified only by numbers 1 to 10.

Table 2 Basic information about individual companies

Company	Country	Production technology	Supplier	PPAP implementation
1	Czech Republic	Casting	Engineering industry	NO
2	Czech Republic	Casting	Engineering industry	NO
3	Czech Republic	Forging	Engineering industry	NO
4	Slovakia	Casting	Automotive industry	YES
5	Slovakia	Casting	Engineering industry	NO
6	Czech Republic	Forging	Engineering industry	NO
7	Slovakia	Forging	Engineering industry	NO
8	Czech Republic	Casting	Engineering industry	NO
9	Czech Republic	Casting	Automotive industry	YES
10	Slovakia	Casting	Engineering industry	NO

From the table is evident that the PPAP is implemented only in two cases involving companies that are suppliers to the automotive industry. The reason is that all suppliers to the automotive industry must have implemented this process to become a supplier in this industry sector. Other companies supplying to other industry sectors haven't implemented this process, when one of the reason is the lack of customer demand for the implementation of the PPAP process.

All selected companies were then evaluated on the basis of audit reports of executed audits with a view to show the main benefits of the implementation of PPAP. For the analysis the several parameters were selected. These are parameters which are always monitored during the audit and determine the organization's approach to the quality management. They also represent an important indicator of product quality and quality of production process.
With respect to the identification of the main benefits of PPAP the following parameters were monitored: completeness and transparency of process documentation, results of dimensional monitoring, approved reference samples and application of special customer requirements.

Given parameters were determined by the rating scale expressing the implementation level in the particular company. Because of the clear identification of results only three-stage evaluation scale was chosen, and thus "Yes", "Yes, with deviation" and "No". Yes means the fulfillment of the parameter without further action. Yes, with a deviation means partial fulfillment when there are weaknesses and 'no' means fail of the

parameter. The selected range reflects the real results of audits in the particular companies. Results for individual companies in terms of implementation level of monitored parameters are shown in Table 3.

Table 3 Implementation level of monitored parameters

	Monitored parameter			
Company	**Completeness and transparency of process documentation**	**Results of dimensional monitoring**	**Approved reference samples**	**Application of special customer requirements**
1	YES with deviation	YES with deviation	NO	NO
2	NO	NO	NO	NO
3	YES	YES with deviation	YES with deviation	YES with deviation
4	YES	YES	YES	YES
5	NO	NO	NO	NO
6	YES	YES with deviation	YES with deviation	YES with deviation
7	NO	NO	NO	NO
8	YES with deviation	YES with deviation	NO	NO
9	YES	YES	YES	YES
10	YES with deviation	NO	NO	NO

From the table is evident that companies with PPAP implementation, namely companies 4 and 9 supplying into automotive industry, achieve better results and fulfilled all these monitored parameters. It is also evident that some companies are close to the application of PPAP, namely companies 3 and 6, because they are close to the fulfilment in all monitored parameters. For other companies, namely for companies 2, 5 and 7 would be the implementation of PPAP very complicated, since they didn't fill any parameter. It is clear that these companies are not able to react flexibly to special customer requirements.

To specify additional benefits of PPAP implementation for suppliers of metallurgical products selected companies were evaluated in terms of factors that significantly related to the quality of manufactured products and affect the production efficiency. Monitored factors were: scrap after introduction of serial production, reaction to required customer changes and the total number of complaints. These factors were evaluated under a range that reflects real results of realized audits. Since the specific values could not be published the rating scale showing the fulfillment rate of monitored factors was elected. Three levels of evaluation were: over target, close to target, below target. Level of fulfillment of monitored factors for all selected companies is shown in Table 4.

Even in this case, the best performing companies supplying metallurgical products in automotive industry. In case of these companies, the scrap rate is lower than the set limit. Speed of response to changes required by the customer is above the set target and shows very good flexibility by the application of additional customer requirements for the product change. The total number of complaints is contrary below the target which clearly shows one of the main benefits of the implementation of PPAP. Reducing the number of complaints means reduction of production costs and improvement of supplier position in face of the customer. At the same time it is real feedback of the supplier quality.

Table 4 Fulfilment rate of monitored factors

	Monitored factor		
Company	**Scrap after introduction of serial production**	**Reaction to required customer changes**	**Total number of complaints**
1	close to target	below target	close to target
2	over target	below target	over target
3	close to target	close to target	close to target
4	below target	over target	below target
5	over target	below target	over target
6	close to target	close to target	close to target
7	over target	below target	over target
8	close to target	below target	close to target
9	below target	over target	below target
10	close to target	below target	over target

As for the previous analysis, with regard to the fulfilment of individual factors, there are companies where the implementation of PPAP is after optimization achievable, e.g. companies 3 and 6. In contrast, companies 2, 5 and 7 show deficiencies confirming results of previous analysis. Implementation of PPAP will be, without application of principal changes, very difficult.

CONCLUSION

Production part approval process defines generic requirements for production part approval. The purpose of PPAP is to determine if all customer engineering design records and specifications requirements are properly understood by the supplier and that the process has the potential to produce product consistently meeting these requirements during an actual production run at the quoted production tare. Any results that are outside specification are cause for the supplier not to submit the parts, documentation and records. Every effort shall be made to correct the process so that all design record requirements are met. If the supplier is unable to meet any of these requirements, the customer shall be contacted for determination of appropriate corrective action.

From the above analysis it is clear that the PPAP is practically used mainly in organizations producing metallurgical products, that they are the suppliers in automotive industry. This fact is based on clearly defined and strictly following the requirements of the automotive industry.

The implementation of PPAP means for suppliers at early stage increasing of costs, which explains why most suppliers of metallurgical products resist the implementation of this process. The customers, except automotive industry, don't require the implementation of this process and suppliers usually see in it only the additional costs and problems associated with its implementation. Introduced analysis clearly demonstrates that the implementation of PPAP is beneficial. It enables suppliers to improve their competitiveness in the market and at the same time to increase the awareness about quality in relation to their employees. For the customer means the implementation of PPAP process confirmation of the quality and responsiveness of the supplier and reflects the reaction capability on its requirements.

Authors of this paper believe that the production part approval process may become a practical and very useful part of quality management system in metallurgical companies that are not suppliers in automotive

industry because this will establish a process of understanding, analysing and handling all technical issues before the serial production of the relevant metallurgical component is started.

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