RESEARCHERID
THOMSON REUTERS
[IDSTM-18]
IC™ Value: 3.00
ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

IJESRT
INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

AN OVERVIEW OF PRODUCTION PART APPROVAL PROCESS IN AUTOMOTIVE MANUFACTURING INDUSTRY

Rajesh Kumar *[1], Hari Parshad [2], Pardeep [3]
[1&2] Department of Mechanical Engineering, School of Engineering & Technology, India
[3] Departments of Mechanical Engineering, Bhagwan Parshuram Institute of Technology, India

ABSTRACT
Product part approval process (PPAP) is a significant tool of Advance product quality planning (APQP) and developed by the North American Automotive Industry and is now widely used in many industrial sectors such as automotive, aerospace, renewable energy and mobile power generation. Production Part Approval Process (PPAP) defines generic requirements for production part approval, including production and bulk material. The objective of PPAP is to recognize all customer requirements and to prove that manufacturing process has the potential to produce meeting these requirements during actual production run. Hence it increases customer confidence in the organization and enhance customer satisfaction, but PPAP is much more than that. By implementing PPAP, organization gets more benefits like manufacturing process improvement and standardization, rejection reduction, high quality product, customer acceptance and many more which contributes towards continuous quality improvement. In this case study based research, the role of PPAP in the quality improvement and customer satisfaction is presented. The PPAP was implemented in four Small and Medium Enterprises (SMEs) and its effect on quality and customer satisfaction was monitored. In this research paper an overview of requirements, procedure, scope and benefits of part process approval process in automotive industry is discussed

Keywords: Production, Product Design, Product Quality.

I. INTRODUCTION
In automobile industry the original equipment manufacturing companies making their own product using many parts manufactured by small and medium companies. To maintain quality of the final automobile product the onus is not only on Original Equipment Manufacturers (OEMs) but on complete supply chain, means each suppliers. Same time, industry is going through the phase where competition and high customer demand makes life more difficult of manufacturers. To gain competitiveness in the manufacturing business, companies are required to continuously improve quality of product and service, reduce failures and their effects. There are many quality management tools available, so the selection of the most appropriate is not always an easy task. Tools are essential ingredients of a process and basic instruments for the success of a quality improvement program. Selection of the wrong tool for the problem may lead to failure of the project and emerged as barriers to continuous quality improvement. Consequently, it needs to be emphasized that while tools can be very effective in the right hands, they can be very dangerous in the wrong hands. It is, therefore, important to know how, when and which tools should be used in problem solving or improve processes. Production Part Approval Process (PPAP) is one of the most important tools for maintaining the quality of products from initial stage of product development. The PPAP process was not always used to develop automobiles, these quality processes were developed to gain back the manufacturing edge that America lost to Japan in the 1980s. Prior to the 1980s American manufacturing plants dominated the worldwide market for automobiles but they lost that dominance when the Japanese entered the market with a higher quality product. American manufacturers had to rethink how to compete with the Japanese and developed numerous processes that allowed them to regain their competitiveness in the automotive market.

The PPAP process was developed by a consortium of industry engineers within the Automotive Industry Action Group (AIAG). The AIAG was found in 1982 in Southfield, Michigan and was comprised of representative engineers from all the major manufacturers of automobiles in North America. The initial goal was to provide

recommendations to improve quality but the group expanded and grew to include key processes and automotive standards used within the industry. Numerous processes and initiatives were introduced to support that goal in the early years of the group's existence. In 1993 the Supplier Quality Task Force developed and launched the APQP manual and complementary processes to assist in the process validation. The goal of the PPAP process is to ensure that all designs and specifications are understood by the supplier and that the production process and produce products that consistently meet these requirements when running at rate. From its inception, the PPAP process has been widely used in the automotive industry worldwide.

The PPAP process impacts all engineers within the automotive industry from the design engineers who must complete the drawings and specifications for the vehicle to the production engineers who must design robust processes with the proper quality controls in place. Quality engineers are included in the PPAP process as well and are responsible for several elements of the process plus in many organizations the quality engineer complete the PPAP document and submits the entire package to the customer for approval and signoff.

PPAP defines the approval process for new or revised parts, or parts produced from new or significantly revised production methods. The PPAP process consists of 18 elements that may be required for approval of production level parts. Not all of the elements are required for every submission. There are five generally accepted PPAP submission levels. The PPAP manual contains detailed information, guidelines and sample documents useful for completing the process requirements. The resulting PPAP submission provides the evidence that the supplier has met or exceeded the customer's requirements and the process is capable of consistently reproducing quality parts. The PPAP process verifies that the supplier understands all customer engineering design specifications and requirements and that the process is capable of consistently producing product meeting those requirements during an actual production run at the quoted production rate. PPAP and other quality tools continue to be implemented into more industries; therefore it is important to gain an understanding of the PPAP requirements to remain competitive as a parts supplier. A PPAP is required for any new part submission as well as for approval of any change to an existing part or process. The customer may request a PPAP at any time during the product life. This demands that the supplier must maintain a quality system that develops and documents all of the requirements of a PPAP submission at any time.

II. METHODS

The process of completing a PPAP submission is fairly complex. This detailed process is a collection of key elements that must be completed to verify that the production process will produce a quality product. Not all of the elements are always required for a PPAP submission. The particular requirements of the PPAP are usually negotiated during the quoting process.

PPAP Levels of Submission

The PPAP submission requirements are normally divided into five classifications or levels, as follows:
Level 1 – Part Submission Warrant (PSW) only submitted to the customer
Level 2 – PSW with product samples and limited supporting data
Level 3 – PSW with product samples and complete supporting data
Level 4 – PSW and other requirements as defined by the customer
Level 5 – PSW with product samples and complete supporting data available for review at the supplier's manufacturing location

Elements of PPAP

Below is the list of all 18 elements accompanied by a brief description for each element:

1. Design Documentation

- Design documentation shall include both a copy of the customer and the supplier's drawings. The documentation should also include a copy of the purchase order. In some cases the supplier is required to supply documentation of material composition.
- The purchase order is used to confirm that the correct part is being ordered and that it is at the correct revision level.
- The design engineer is responsible for verifying that the two drawings match and all critical or key characteristics have been identified.
- Material composition information is required to supply evidence that the material used manufacture the parts meets the customer's specific requirements.

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

2. Engineering Change Documentation

If the PPAP is being required due to a request for a change to a part or product, the documentation requesting and approving the change must be included in the PPAP package. This documentation usually consists of a copy of the Engineering Change Notice (ECN), which must be approved by the customer engineering department.

3. Customer Engineering Approval

- When required as part of the PPAP, the supplier must provide evidence of approval by the customer engineering department.
- If required, pre-PPAP samples are ordered by the customer for onsite testing. The samples must be production intent and ship with a waiver so that testing can be done. When testing is complete, the test engineers will provide an approval form for inclusion in the PPAP submission.
- Note: A copy of a "Temporary Deviation" is normally required to submit parts to the customer prior to a PPAP approval.

4. Design Failure Mode and Effects Analysis

- Design Failure Mode and Effects Analysis (DFMEA) is a cross-functional activity that examines design risk by exploring the possible failure modes and their effects on the product or customer and their probability to occur. These failure modes can include:
- Product malfunctions
- Reduced performance or product life
- Safety and Regulatory issues
- The DFMEA is a living document that should be reviewed and updated throughout the product life cycle.

5. Process Flow Diagram

- The Process Flow Diagram outlines the entire process for assembling the component or final assembly in a graphical manner. The process flow includes incoming material, assembly, test, rework and shipping.

6. Process Failure Mode and Effects Analysis

- Process Failure Mode and Effects Analysis (PFMEA) reviews all of the steps in the production process to identify any potential process quality risk and then document the applied controls. The PFMEA is also a living document and should be updated even after the product is in normal production.

7. Control Plan

- The Control Plan is an output from the PFMEA. The Control Plan lists all product Special Characteristics and inspection methods required to deliver products that continually meet the customer quality requirements.

8. Measurement System Analysis Studies

- Measurement System Analysis (MSA) studies will include Gage Repeatability & Reproducibility (GR&R) studies on measurement equipment used during assembly or quality control checks. Calibration records for all gages and measurement equipment must be included.

9. Dimensional Results

- Dimensional layout of sample parts is required to validate the product meets the print specifications. The samples should be randomly selected from a significant production run usually at least 30 pieces. Each dimension on the drawing is measured on the final assembly to make sure that it falls within specification. The results are recorded in a spreadsheet and included within the PPAP submission.

10. Records of Material / Performance Tests

- This element should contain a copy of the Design Verification Plan and Report (DVP&R). The DVP&R is a summary of every validation test performed on the part. It should list each and every test performed, a description of how the test was performed, and the results of each test.

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

- This section may also include copies of all the certification documents for all materials (steel, plastics, etc.) listed on the prints. The material certification shall show compliance to the specific call on the print.

11. Initial Process Studies

- Initial process studies will be done on all the production processes and will include **Statistical Process Control (SPC)**charts on the critical characteristics of the product. These studies demonstrate that the critical processes are stable, demonstrate normal variation and are running near the intended nominal value.

12. Qualified Laboratory Documentation

- Qualified laboratory documentation consists of the industry certifications for any lab that was involved in completing validation testing. This could be for an in-house test lab or any offsite contracted test facilities that were used for validation or material certification testing.

13. Appearance Approval Report

- The Appearance Approval Inspection (AAI) is applicable for components affecting appearance only. This report verifies that the customer has inspected the final product and it meets all the required appearance specifications for the design. The appearance requirements could include information regarding the color, textures, etc.

14. Sample Production Parts

- Sample production parts are sent to the customer for approval and are typically stored at either the customer or supplier's site after the product development is complete. A picture of the production parts is usually included in the PPAP documentation along with documentation regarding the location that the parts are being stored.

15. Master Sample

- A master sample is a final sample of the product that is inspected and signed off by the customer. The master sample part is used to train operators and serves as a benchmark for comparison to standard production parts if any part quality questions arise.

16. Checking Aids

- This is a detailed list of checking aids used by production. It should include all tools used to inspect, test or measure parts during the assembly process. The list should describe the tool and have the calibration schedule for the tool. Checking aids may include check fixtures, contour, variable and attribute gages, models or templates.
- MSA may be required for all checking aids based on customer requirements.

17. Customer Specific Requirements

- This element of the submission package is where any special customer requirements are contained. For bulk materials, the customer specific requirements shall be recorded on the "Bulk Material Requirements Checklist".

18. Part Submission Warrant

The Part Submission Warrant (PSW) form is a summary of the entire PPAP submission. A PSW is required for each of part number unless otherwise stated by the customer. The PSW includes:

- The reason for submission (design change, annual re-validation, etc.)
- The level of documents submitted to the customer
- Declaration of part conformity to customer requirements
- A section provided for any required explanation or comments
- Supplier authorized person signature along with contact information
- An area for the customer to indicate disposition of the PPAP

The PPAP process is a detailed and lengthy process. The PPAP package includes documentation of various multiple cross-functional tools and documents the ability of the supplier to meet all customer requirements. PPAP

provides customers adequate information to validate that all areas of the design and production processes have been reviewed thoroughly to ensure that only high quality products will be allowed to ship to the end customer.

III. BENEFITS

Production Part Approval Process is often mandated by automotive, aerospace and other engineering primary manufacturers as a specific requirement on their suppliers to give them assurance that the supplier understands the customers product specifications and that the suppliers manufacturing process has the potential to produce good quality product at agreed quality levels and production rates. Companies that apply Production Part Approval Process as the culmination of Advanced Product Quality Planning, gain greater customer confidence in their ability to introduce new products and processes or make changes to existing products & processes. Implementation of PPAP helps both suppliers (manufacturers of parts) and customers (OEMs). Process functions that are clearly planned, validated, documented and communicated or in short that have been subjected to PPAP result in:

Improved Quality ensures:

- Reduced variation in manufacturing process
- Statistically controlled processes
- Consistent approach in assuring quality and providing Evidence
- Process changes are better controlled
- Quality Process Monitoring & Controlling

Paced Delivery:

- Improves on time delivery with complete avoidance / minimization of rework, repair or rejection
- Controls quality before delivery to customer
- Helps tracking of part and product status

Saved Cost:

- PPAP along with APQP contributes to lowering the COPQ, which will be substantial

Confident Customer:

- Enhanced customer confidence in supplier's capabilities
- Early identification & resolving bottlenecks

IV. CONCLUSION

The process of successful new product development (NPD) requires much skill and disciplines. There are lots of different reasons why NPD is so challenging for an NPD team. New product development and innovations are one of the most profitable ways for a company to get a stronger place at the market, create better possibilities for further product development, growth, compete in markets and find new market areas and make an impact to the customers. There are many factors that make product development challenging and more complicated. The deployment of the PPAP in case company requires the checking of new product development processes. The most important things are to follow decided process steps and include suppliers in the process if possible. Also documentations and drawing needs to be on better level and include critical metrics and parameters. New product development would be more effective and PPAP possible to get through. This supports the elimination of defects in the beginning of the new product development process. Product development departments work often separately from others and there are many peoples in other departments who don't know what the new product designers are doing.

V. REFERENCES

[1]. AIAG Automotive Industry Action Group, 2006. Production Part Approval Process. Chrysler Corporation, Ford Motor Company, General Motor Corporation, Southfield.

[2]. Crosby, Philip B., 1988. Kvalitet är gratis: Hur man säkerställer kvalitet. Utbildningshuset Studentlitteratur. 277 p., ISBN 91-44-99301-3. Hannukainen, Timo, 1993. Laatuyritykset – Laatujohtaminen maailman valioyrityksissä. Tammerpaino Oy. 316 p., ISBN 951-817-570-5.

[3]. Hirsijärvi, Sirkka, Remes, Pirkko and Sajavaara, Paula, 2010. Tutki ja kirjoita. Tammi. 464 p., ISBN 978-951-314-8362.

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

[4]. Krajewski, Lee, Larry Ritzman & Manoj Malthora 2010. Operations Management. Processes and Value Chain. Prentice Hall, New Jersey. 672 p., ISBN 978-0-13-245891-7.
[5]. Kuan, Meng-Jong, Tzeng, Gwo-Hshiung & Hsiang Chia-Chun, 2010. Exploring the Innovative Quality System Structure Model for NPD Process by combining DANP with MCDM Model. International Journal of Innovative Computing, Information and Control.
[6]. Lecklin, Olli ,2002. Laatu yrityksen menestystekijänä. Gummerus Kirjapaino Oy, Jyväskylä. 464 p., ISBN 952-14-0519-8.
[7]. Salomäki, Rauno, 1999. Hyödynnä SPC – Suorituskykyiset prosessit. Metalliteollisuuden Kustannus Oy. 398 p. ISBN 951-817-707-4.
[8]. Ulrich, Karl., Eppinger, Steven, 2000. Product design and development. 2. Ed. Boston: Irwin McGraw-Hill. ISBN 0–07–229647–X