

“INVESTIGATION OF PRODUCTION PART APPROVAL PROCESS AND INNOVATION OF DIFFERENT COMPOSITION IN CAST IRON MOUNTING FLANGE AND COMPARE”

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Abstract

Effective June 1, 2006, PPAP Fourth Edition replaces PPAP Third Edition, unless otherwise specified by your customer.

Production Part Approval Process (PPAP) is updated to the 4th edition to incorporate the customer focused process approach associated with ISO/TS 16949:2002 and other changes listed below to update requirements.

PPAP purpose continues to be to provide the evidence that all customer engineering design record and specification requirements are properly understood by the organization and that the manufacturing process has the potential to produce product consistently meeting these requirements during an actual production run at the quoted production rate.

PPAP 4th Edition includes the following changes:

- . *Aligning the order of the PPAP requirements with the automotive product development*
- . *Relocation of Customer Specific Instructions to appropriate websites, (e.g. OEM and IAOb, www.iaob.org) to provide current requirements*
- . *Update of Truck OEM requirements and moved to Appendix H*
- . *Revised PSW (part Submission Warrant) to:*
 - . *Provide a more logical flow for the part / design description fields*
 - . *Make the suppliers address field applicable to international location*
 - . *Include imds material reporting to indicate reporting status*
 - . *Update specific ppap requirement*
 - . *Materials reporting and polymeric identification requirement in the design record.*
 - . *Process capability index (cp, cpk)*

PPAP refers to the following reference manuals: Advanced Product Quality Planning & Control Plan, Potential Failure Modes and Effects Analysis, Measurement System Analysis, and Statistical Process Control. These manuals are authored by DaimlerChrysler Corporation, Ford Motor Company, and General Motors Corporation and are available through the Automotive Industry Action Group (AIAG) at www.aiag.org.

The Supplier Quality Requirements Task Force gratefully acknowledges the contributions of the many individuals and their respective companies that participated in the revision process

Introduction:

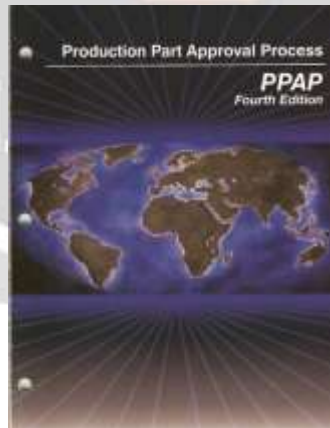
Modern companies have been focused on producing own final products and have been decided to buy all components from suppliers. There are often many different supplier firms, from big, well-known listed companies to small family firms with a couple of employees. To ensure the high quality of the final product the buyer companies have to be sure that all components are following the quality requirements and expectations. The purpose of this paper is to test and analyze Production Part Approval Process (PPAP) as a tool to build quality into the new product and processes and ensure that the product meets the customer expectations. The purpose is to test the usability of PPAP to ensure that the supplier has understood what is expected from component, reduce quality defects in production lines by preventing them and doing things right at the first time.

This article includes four parts. The first part is introducing part including the description of the study, targets and backgrounds and research question. The second part includes a theoretical framework of PPAP, quality management and new product development processes in the form of literature review. The third part includes an empirical part of this study in which a case study related to PPAP and its effects to new product development (NPD) is described. In the case study we have tested PPAP with three suppliers from three different kinds of component fields, and the results are summarized and discussed.

The Quality Assurance staff at Cooper Industries has prepared this handbook for new and existing suppliers of manufacturing based purchased goods to Cooper Industries. Its purpose is to define the approval process of new or revised parts, or parts resulting from new or significantly revised production methods. As a supplier, it is your responsibility to ensure that you ship only parts that have been approved and meet specifications.

The procedures outlined in this handbook apply to all Cooper Industries facilities. If you have questions regarding the contents or processes described in this handbook, please contact the Quality Assurance representative of the Cooper Industries location to which your documentation is being submitted. Please note that Green Text in this manual will link to the Definitions Appendix.

The requirements in this handbook were drafted to be fully compliant with the Automotive Industry Action Groups (AIAG) Production Part Approval Process (PPAP) standard revision 4 March, 2006. Cooper Industries has specific customer specific requirements and additions to this.



standard that need to be fully understood before attempting to successfully submit a PPAP to Cooper Industries for review and approval.

Purpose:

The purpose of the **Production Part Approval Process (PPAP)** is:

- ✓ To provide the evidence that all customer engineering design record and specification requirements are

- properly understood and fulfilled by the manufacturing organization.
- ✓ To demonstrate that the now established manufacturing process has the potential to produce product that consistently meets all requirements during an actual production run at the quoted production rate.

When PPAP Required:

In general a PPAP is required anytime a new part or a change to an existing part or process is being planned. It is at the discretion of each Cooper Industries Division to determine when and if a PPAP submission will be required. As a supplier you should have the type of quality system that develops all of the requirements of a PPAP submission regardless of whether you have been asked to deliver a submission. In the event a PPAP submission is not requested, Cooper quality reserves the right to request any of these documents at any time during the life of the product. Cooper Quality reserves the right to request a PPAP submission for a variety of reasons including all of the following.

New parts, process or suppliers:

1. Change to construction, material, or component
2. New, additional or modified tools
3. Upgrade or re-arrangement of existing tools
4. Tooling, production, or equipment transferred to a different site
5. Change of supplier or non-equivalent materials/services
6. Product when tooling has been inactive for 12 months
7. Product or process changes on the components of the product
8. Change in test or inspection method
9. Bulk material: New source of raw material
10. Change in product appearance attributes
11. Change in production process or method
12. Change of sub-supplier or material source

If there are any questions concerning the need for a PPAP Submission, please contact a Cooper Industries Quality or Supplier Quality representative.

2. LITERATURE REVIEW

2.1 Quality management

Earlier, quality has been understood as a defect free product. Since then, quality has become an organization's comprehensive business concept and a critical success factor. It is linked to all operations in the company. Defining quality has become more and more difficult because of the development of quality thinking and growing importance of quality. Quality concept largely depends on the situation which varies case by case (Lecklin, 2009, pp. 17-325).

What is quality exactly? There must be as many definitions as it is people who have written about it. We favor the following IBM's definition of quality (Van Weele, 2013, p. 192):

"Quality is the degree in which customer requirements are met. We speak of a quality product or quality service when both supplier and customer agree on requirements and these requirements are met".

Crosby (2008, p. 7) says that "Quality is free". According to Crosby, quality is the fulfillment of the specified requirements which can be measured. Crosby advises to study tasks as processes, find the areas that need improving and build quality in processes. Crosby highlights actively prevent problems to get quality right at the first time instead of wasting time to inspect final product and repair defects (Hannukainen, 2005, pp. 21-23).

According to Deming, quality is all those aspects and characteristics that product or service meets the needs and

expectations. He highlights that when decreasing the variance of the process, the consequence is the better quality and productivity (Hannukainen 2005:19-21).

- Juran highlights three points in his trilogy, an approach to cross-functional management: quality planning, quality control and quality improvement (Hannukainen, 2005 p. 24). Hannukainen (2005, p. 11) divides quality in four parts: Product oriented
- Function oriented
- Customer oriented
- Value oriented

Product oriented quality is the sum of the properties of the product. Product oriented quality can be defined by metrics. According to this definition, better quality requires higher costs, because some new property increases costs.

Function oriented quality is defined as a uniformity or equivalence to product specification. It is effective and faultless of the function. Function oriented quality is strongly linked to preventive problem solving and cost reduction.

Customer oriented quality fulfills customers' needs and expectations and highlights suitability for use. Products with high quality fulfill customers' expectations, but high quality can be defined many different ways and different kinds of peoples recognize it many different ways. According to Ulrich and Eppinger (2015), success of manufacturing companies depends mostly on their ability to identify the customer needs and create products that meet their needs and are produced at low cost.

2.2 New product development process

New product development can be used to solve all above mentioned kinds of problems. According to Ulrich and Eppinger (2015), to succeed as a company and get as high customer satisfaction as possible it is very important to be familiar with the characteristics of successful product development. They also say that the performance of a new product development can be evaluated by looking at product quality, product cost, time, cost and capability of development

The new product development is a process which is designed to develop, test and ensure the profitability of the new products. Therefore, the managers reduce and control the uncertainty activities before the next phase is implemented according to the integrity of information. It can ensure the improvement of the performance and quality of NPD (Kuan, et al., 2010).



Figure 1 – Product development process (Viitaniemi et al. 2010)

The planning phase is a link for research and technology development activities. The planning phase begins with corporate strategy including the assessment of technology development and market objectives. The output of this phase is a project mission statement, which specifies the market for the product, business goals, constraints and key assumptions.

In the concept development phase it is time to identify the target market, generate and evaluate alternative product concepts, select one or more concepts for further development and testing. The system-level design phase requires the definition of the product architecture and major sub-systems and interfaces. Refining industrial design, identifying suppliers for key components and developing a plan for product options and an extended product family helps the development team to create a

clear picture of a future product. These activities allow the process to move further into the phase of detail design which includes the complete specification of the geometry, tolerances and materials to all parts in the product (Viitaniemi, et al., 2010).

The end of the product development process is the product ramp-up making the product available for purchase. Before ramping up a new product, it has to be tested and refined. When ramping up a new product or new manufacturing location it is needed to ensure that the product and process is well-planned and organized before starting production. The ramp up phase includes a preparation stage, a verification stage and a production start phase.

3. Experimental procedure and PPAP methodology

The Cooper Industries PPAP submission requirements are compliant with the existing AIAG standard. One or more of the following elements may be required as part of your formal submission depending upon your assigned submission level:

1. Part Submission Warrant
2. Design Records &Ballooned Drawings
3. Approved Engineering Change Documents
4. Customer Engineering Approval
5. DFMEA
6. Process Flow Diagram
7. PFMEA
8. Control Plan
9. Measurement Systems Analysis(MSA)
10. Dimensional Results
11. Material, Performance Test Results
12. Initial Process Study (Cpk) Capability Studies
13. Qualified Laboratory Documentation
14. Appearance Approval Report(AAR)
15. Sample Product Parts
16. Master Sample(s)
17. Checking Aids

Method Status

The review and approval process will be managed by each Cooper division. Subsequently the PPAP submission will be reviewed and dispositioned with one of the following submission statuses:

Approved: A formal acceptance of the submission within the guidelines of any and all criteria set forth by the Cooper division managing the submission.

Rejected: The provision is not acceptable and needs to be resubmitted for approval. (Note: Submission to the wrong revision level or part number will constitute an automatic rejection.)

Interim: An interim approval can occur through an agreement with quality management. The product must be deemed “sellable” by Cooper and the interim

Flange edge break due to increase hardness & silicon



Above flange break due to increase of hardness & silicon .when it gets check of hardness properties its found 307 BHN against 201-269 BHN & silicon found 3.86% against 1.80-2.30%

Testing image of BHN







After hardness test



Material test report:

HI-CAST INDUSTRIES HATKANANGALE METALLURGICAL TEST REPORT	
CUSTOMER:- CLIMAX ENGG ENTERPRISES	DATE:- 16.01.19
PART NAME:- BOLT PUMP FLANGE (I D)	Invoice no:- 1595
PART NO:- 931548	Quantity:- 557 nos.
Material Specification:- VS 2-1-3-2	HEAT CODE:- 81 / KAS
SPECIFICATION	ACTUAL OBSERVATION
CHEMISTRY	
C %:- 3.10-3.40%	C %:- 3.11%
Si %:- 1.80-2.30 %	Si %:- 3.86%
Mn %:- 0.60-0.90%	Mn %:- 0.90%
S %:- 0.15%Max	S %:- 0.09%
P %:- 0.20% Max.	P %:- 0.09%
Cu %:- 0.10% MIN	Cu %:- 0.18%
Cr %:- 0.40% MAX	Cr %:- 0.29%
CE %:- 4.30 MAX	CE %:- 3.73%
MICRO-STRUCTURE ANALYSIS	
	
MICRO-STRUCTURE	
ASTM Form VII, Type A ISO Form 1, Distribution A 85% Graphite Flake Size 4 to 6, 3-6 80% Free Pearlite 90% Min. Free Ferrite 10% Max. Free Cementite 5%Max.	97.5% Type A Graphite Form VII. Graphite Flake Size 4 to 6 with 86.5% Mainly Pearlite 97% & Ferrite 2% Cementite .1.00%
MECHANICAL PROPERTIES IN SPECIMEN SEPARATELY CAST	
BRINELL HARDNESS:- 201 - 269 BHN	HARDNESS:- 307 BHN
TENSILE STRENGTH:- 241 MPA Verified by:-	TENSILE STRENGTH:- 278.04 MPA

DISCUSSION AND CONCLUSIONS

The process of successful 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. A changing environment, changing customers' preferences, multiple choices, time winning product the company has to create something new which differs from the competitive products and brings special and unique benefits to the users. Finding new ideas and solutions has its effects to the quality level and that extends also to the suppliers' processes. New product development and quality management go hand in hand representing a commitment to better order. Product development is born from innovation creating new products and services. New product or service generates instability of the process and variation of the quality during ramp up- and learningphase.

Quality activities in production ensure the faultlessness of the products or services and the expected functions of the processes. Quality management has changed from the characteristic of the product or service to one of the biggest success factors of the organization. It is important to build the quality into the processes and product and create meters metrics to measure it. In addition to its theoretical contribution to new product development and quality management literature, this paper offers several implications for those responsible for managing quality in new product development method.

PFMEA, Control plan and MSA are the most important steps in the PPAP. A Process Failure Mode and Effects Analysis (PFMEA) follow the process flow steps and indicate possible implications during the manufacture and assembly of each component. The control plan provides more details on how the “potential issues” are checked during the whole manufacturing process. The measurement system analysis study (MSA) is a specially designed experiment and its purpose is to identify the variation of the components in the measurement. The common tools and techniques of MSA are usually selected and determined by the characteristics of the measurement system itself. Production can be started and ramped up to the required production level after an approved verification. When starting production, it must be ensured, that all documents (such as working instructions) are up-to-date, all

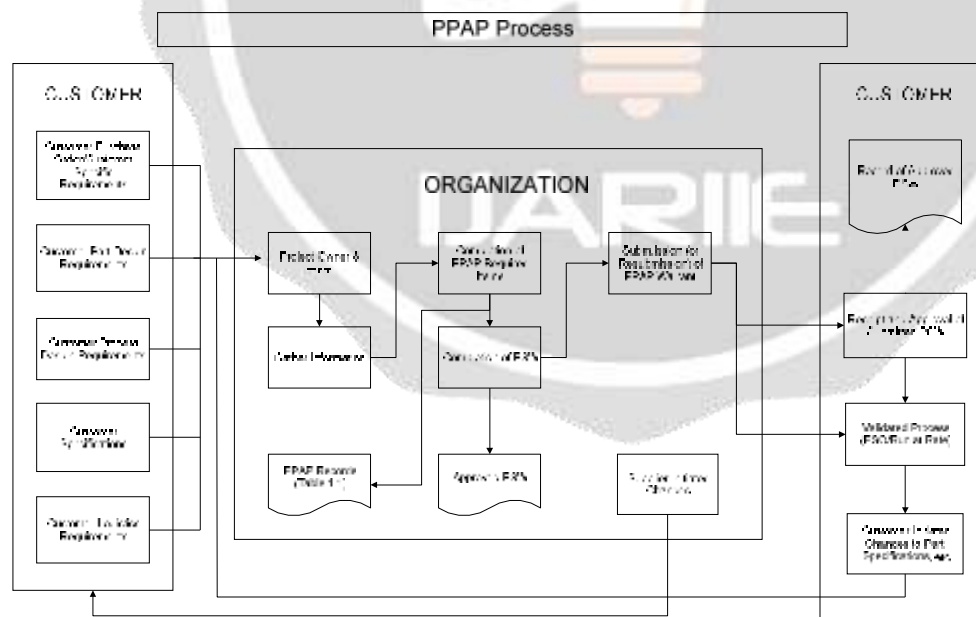
personnel have the required training and all the needed capacity is available (human and machine capacity).

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 production rate. The PPAP ensures also that the process produces sufficient quality. The content of the PPAP is defined during the component's proto state. The target is that the product

requirements are understood and the process is effective enough.

PPAP will be started when there exists a prototype of the product. Product development responsible and quality engineer will define the level of the PPAP and what kinds of documents are required. It is depending on supplier what kind of elements are required. There may be a big listed company which processes and quality assurance is on a good level and only a few stages of PPAP are necessary. There can also be a small family company and in that case a heavy and broad PPAP is impossible to carry through because of lack of resources. When PPAP is carried through the product is ready for mass production. The purpose of PPAP is to continuously develop quality level, actions and processes and to ensure the capability of new products and processes.

Figure 2 – PPAP (AIAG, 2006)



RESULTS:

The purpose of this paper was to test and analyze Production Part Approval Process as a tool to build quality into the new product and processes and ensure that it meets the customer expectations. The purpose was to find out if PPAP

is capable tool to ensure that the New product development engineers and managers found that PPAP enabled them to better understand the customers. In turn, PPAP enabled the new product development department to demonstrate commitment and support to their 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 he new product design doing.

What was valued about this study was the manner in which the stakeholders could use to facilitate a sense of partnerships or co-workers aiming the same goals rather than have a traditional customer-seller relationship. While this study offers new insights into the quality management of new product development processes there are a number of limitations. The study only covers three medium sized companies making generalization a little bit difficult.

Future scope: further study may wish to consider other tools for developing quality in new product development processes and compare those to PPAP as a tool.

REFERENCES:

- AIAG Automotive Industry Action Group, 2006. Production Part Approval Process. Chrysler Corporation, Ford Motor Company, General Motor Corporation, Southfield.
1. Crosby, Philip B., 1988. *Kvalitet är gratis: Hur man säkerställer kvalitet* Utbildningshuset Studentlitteratur. 277 p., ISBN 91-44-99301-3.
2. Hannukainen, Timo, 1993. *Laatuyritykset – Laatujohtaminen maailmanvalioyrityksissä*. Tammerpaino Oy. 316 p., ISBN 951-817-570-5.
3. Hirsijärvi, Sirkka, Remes, Pirkko and Sajavaara, Paula, 2010. *Tutkijakirjoita*. Tammi. 464 p., ISBN 978-951-314-8362.
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. *Laatuyrityksen menestyksen tekijä*. 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.
9. Van Weele, Arjan J., 2005. *Purchasing & Supply Chain Management: Analysis, Strategy, Planning and Practice*. Thomson Learning 2005. 364 p., ISBN 1-84480-024-7 Viitaniemi, Juhani., Aromaa, Susanna., Leino, Simo-Pekka., Kiviranta, Sauli., Helin, Kaj., 2010. *Integration of User-Centered Design and Product Development Process within a Virtual Environment. Practical case KVALIVE*. Finland: VTT. Available from Internet: <URL: <http://www.vtt.fi/publications/index.jsp>> ISSN 1459-7683.