Processes of Quality Planning and Quality Assurance in Automotive

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Abstract: *A part of the systematic approach in project management in automotive industry is a phase described as launch of a product into the serial production. This process is in his development further structured into several sub-processes. One of them are processes of quality planning and quality assurance, which define the frame for fulfill of all requirements on quality of a new product set by the customer according the norm ISO/TS 16949 and VDA2. The main goal of these processes is the approval of a product into the serial production described based on the norm as the PPAP process.*

Keywords: *quality planning, automotive industry, PPAP process*

INTRODUCTION

Part of the systematic approach in the project management by introducing a new product in the automotive industry is the launch of the product in to the serial production. This process is further subdivided into individual subprocesses. One of them is the planning and quality assurance process, that defines the exact framework to meet all of the quality requirements of the new product set by customers in accordance with ISO / TS 16949 and VDA2 standards. The main purpose of these processes is to release parts from the quality perspective in to the serial production according to the standardized steps set out in the PPAP process.

MATRIAL AND METHODS

PROCESSES OF PLANNING AND QUALITY ASSURANCE

The planning and quality assurance processes are one of the main processes of quality management within the project which is in the phase of the launch of product in to the serial production. According to the literature, quality planning defines which quality standards apply to the project and determines how to meet these standards [7]. On the other hand, quality assurance is a regular evaluation of the overall performance of the project in order to provide the confidence, that the project will meet the relevant standards [7].

From customer requirements, an effective quality concept tailored to product and process risk is defined through the quality planning process. This is to evaluate, define and implement a series of optimization and corrective actions affecting product quality that have emerged from the product's production process and mass production. Consequently, in the quality assurance process, security measures are implemented and their effectiveness checked. In automotive industry the planning and quality assurance processes are in the responsibility of the planning department or quality assurance department [2]. For the quality management area in automotive industry, four steps can be identified for the launch of a product in to the serial production:

- - Determining quality requirements from customer requirements
- - Embedding quality requirements into dimensioning and demonstration of feasibility
- - Product and process management in a serial production
- - Optimization and adjustment

Determining quality requirements from customer requirements

The goal of the process of determining quality requirements is to check customer requirements against existing product standards and supplement or update them in case of any differences. This process is running in the product definition phase. The customer requirements defined in the request list need to be checked from a quality point of view and

then compared with existing product standards. After re-checking it is required to give project management a feedback about the result. He checks and then creates a list of product quality specifications.

Embedding quality requirements into dimensioning and prove of feasibility

The goal of the process of incorporating requirements is to ensure the development of a stable product and process up to the phase of design freeze [1]. This process runs through three phases: prototype phase, optimization phase and launch phase.

In the prototype phase, the functionality of the product is developed according to the specification list, focusing on product performance testing [6, 11, 12]. The main task of the process is the detailed risk analysis of the FMEA of the product, referred to as DFMEA. Based on a drawing or request sheet, DFMEA analyses and evaluates potential product risks to determine the specific features of the product. Subsequently, DFMEA will develop measures to reduce the potential risks of the product and these will be recorded in verification plan. Based on DFMEA and planning of the mass production process, a FMEA of the process called PFMEA is created. Specific features are transferred from DFMEA to PFMEA. In order to reduce the potential risks of the process, measures will be created which are summarized in a plan for process and monitored and implemented as part of the process development. At the customer's request, it is possible to create a quality control checklist for prototypes. This contains all the risk signs that are relevant to the product under FMEA.

During the optimization phase quality measures to ensure product and process stability are established and verified. The main task is to optimize the production process for its smooth – rump up. After incorporating a portion of the identified risk measures, DFMEA is upgraded and the product achieves the degree of maturity required for the design freeze (design freeze). Production processes are defined in the manufacturing or process flow diagram. Based on defined serial processes, PFMEA sets out measures to improve and secure processes. To further reduce potential risks in the process, process plan will be created for the optimization phase. Based on the PFMEA, a control plan for a serial process is created, from which the concept of the series of instruments and test equipment is derived. Subsequently, the development and procurement of test facilities can begin.

During the launch phase the measures taken to ensure the quality of the product in the mass production are being implemented. DFMEA and PMFEA should be checked based on the results from the optimization phase tests. After verification, it is possible to close the FMEA process. On the basis of updated FMEA data, the control plan for the mass production is reworked. For the mass production test equipment the capability study needs to be done, of which the result is relevant to the release of the process. It is also necessary to demonstrate machine and process capability study before producing the first serial samples. Subsequently, serial sample documentation according to the PPAP process needs to be prepared.

Product and process management in the mass production

The goal of the production control process is to provide and demonstrate stable repeatability of products produced under serial conditions to match the drawing specifications in the required quantity and time, to meet the quality and cost requirements. This process takes place during the product's launch phase and the type and scope of the control is determined in the test plan for the product for the mass production. When determining the deviation from the required specification, it is necessary to implement the following process control measures, that are defined in the control plan:

− - The process must be stopped and can only be started after the new settings and releases.

− - The non-conformity product management process will start.

− - Product complaint can be initiated

Optimization and modification

The aim of the optimization process is to improve the quality measures in the mass production. Quality planning needs to be optimized towards testing efficiency and production with zero error by feedback from manufacturing tests and input control. All optimization changes need to be reviewed and compared to the drawing specifications and FMEA of the product. If changes are not blocked, it is possible to modify the control plan, process flow chart, and inform the customer (if necessary). Reasons for optimization can be as follows: test plan corrections, failure to achieve capability values, customization of test frequency and real-time measurement techniques, product and process changes.

Production parts approval process (PPAP)

In the automotive industry the process of approving parts into the mass production is referred to the Production Part Approval Process (PPAP). This process ensures that products meet customer quality requirements, with emphasis on product and process control [4, 10]. The release process itself involves product release through sample and process control through product or process audit checkings to ensure that products meet all the requirements. In the automotive industry, the PPAP process monitors the execution of all activities within the launch of a new or changed product and process under the ISO / TS 16949 standard as well as other VDA 6, QS9000, EAQF 94 and AVSQ 94 by submitting documents such as e.g. DFMEA, PFMEA, process flow chart, control plan, process capability test results, and Part Submission Warrant PSW. Submission of the necessary documents is divided according to the submission stages in ISO / TS 16949 [Annex 1]. In connection with the release of samples, process audits are also carried out according to the standards mentioned [3, 8, 9].

Product release

Product release samples are product samples, for which compliance with specified requirements can be verified, as specified in the drawing. The first serial samples are parts produced with serial equipment and under serial conditions. Serial equipment means serial tools, machines and production lines. Serial conditions represent serial production and control processes. Deliveries to the customer can only be started after successful release of the first samples. The first serial samples must be submitted in the following cases:

− - the start of a new part or product that has not yet been delivered to the customer

− - design changes with effects on drawing specifications or product material

− - removing the part error that has already been delivered to the customer with a conditional release or previous release of the first samples has been rejected

− - use of new or modified means (tools, machines)

− - the use of new or modified conditions (processes)

− - changing supplier or multiple suppliers for funds or conditions

− - changes or introduction of new control or test methods released in the production of the sample

Before the first serial samples are delivered, the product manufacturer must satisfy himself that the product meets all customer requirements. The control is performed by sampling in the laboratory and the results are compared with the drawing specifications. Subsequently, a report or measurement protocol shall be made of the measurement to be attached to the samples. If it is necessary to check the specifications that the manufacturer can not measure, it is necessary to provide written confirmation of performance of the test with specific results or to provide a test report from the certified testing center. For the first serial samples, it is checked whether the material used and the contents of the elements comply with the legal requirements and the customer's requirements with respect to the environment, safety and recycling. These data will be summarized in a document that is then stored in a material bank to give the so- IMDS (International Material Data System) and attaches to sample documentation.

The size of the sample documentation required for the release is divided according the category of submission into 5 categories:

Level 1: Customer will only be presented with proof of submission, PSW form

Level 2: The PSW is submitted to the customer along with the sample parts and limited sample documentation

Level 3: The PSW will be submitted to the customer together with sample parts and detailed sample documentation

Level 4: Present PSW and other fixed customer requirements

Level 5: The PSW is submitted together with the sample parts, and the complete supporting documentation is made available to the customer for on-site evaluation at the supplier.

Unless otherwise specified by the customer, according to the VDA6.5 standard for releasing the first serial samples it is necessary to remove and check, according to the drawing specification, 5 randomly selected parts from the serial process. If multiple or compound tools are used in the production process, 5 randomly selected pieces must be removed from each mould nest. In order to verify the suitability of the process of functionally important or specially labelled parameters, it is necessary to check at least 25 random sets of parts with 5 pieces. Before sending the first serial samples, the customer must be informed about the shipment. It is necessary that the shipment is properly identified to avoid confusion with the serial parts [5].

Upon submission of the samples and necessary documents to the customer, the appropriate quality assurance department at the customer performs the necessary inspection by own measurements in the laboratory. Verification of the first samples can be done directly by the manufacturer according to the stage of submission. On the basis of the measurements made and the checking of the accuracy of the documents submitted, the samples may be released, refused or released subject to the condition. The PSW Release Certificate [Annex 2] is signed by the customer and sent to the supplier who is qualitatively eligible to deliver the first series of parts to the customer immediately after receipt.

Process release

Unless otherwise agreed with the customer, the manufacturer of the product evaluates his serial production process according to the ISO / TS16949 or VDA6.3 standard separately, but in some cases, it is necessary that the process release check is carried out in the presence of the customer. The goal of the process is to determine if the serial production process is capable of producing products in accordance with the quality requirements of the required tool and production capacities within a set time. At the same time, it is checked whether the serial production process is in line with the production plan and quality plan. Verification of required performance must be carried out by complete production facilities in full capacity operation with the use of trained personnel and all support systems. The exact date of the inspection is the agreement between the manufacturer and the customer, but always before the first serial samples are delivered.

CONCLUSION

To ensure the quality of products produced in the automotive industry the principles set out in ISO / TS16949, VDA2 are applied. These provide an accurate framework of processes that determine the qualitative maturity of mass production products. These processes include the PPAP process and his sub-processes, product audit and manufacturing process audit. The main outcome of these steps is the successful release of the new product into the mass production by issuing a release certificate, a PSW document that guarantees that the product meets all the quality requirements set by customers as well as subsequent deliveries from series production.

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APPENDIX 1 – the list of submission levels according the PPAP process

Cis	Požiadavka	Objasnenie, komentár	Stupeň predloženia				
			1	2	3	4	5
1	Konštrukcné podklady	Zákaznícky výkres (výkres so slzickami - pozíciami).	R	S	S	R	R
		Požiadavkový list, smernica dodávok produktu, technické podmienky dodávania	R	R	R	R	R
2	Dokumenty k zmenám	Dokumenty o zákazníkom odsúhlasených zmenách, ktoré ešte nie sú zdokumentované vo výkrese, ak tieto existujú.	R	S	S	R	R
3	Uvolnenie konštrukcie zákazníkom	Schválenie konštrukcie zákazníkom, ak je to na výkrese zákazníka požadované.	R	R	S	R	R
4	Systém- FMEA produkt/ Design- FMEA	Týka sa len dodávatelov so zodpovednostou za konštrukciu. Dokumentovat stav zmeny a dátum system- FMEA produkt/design- FMEA alebo priložit titulnú stranu.	R	R	S	R	R
5	Postupový diagram procesu	Postupový diagram procesu pre produkt alebo pre rodinu výrobkov	R	R	S	R	R
6	Systém- FMEA proces/ Proces- FMEA	Dokumentovat stav zmeny a dátum system- FMEA proces/proces- FMEA alebo priložit titulnú stranu.	R	R	S	R	R
7	Dimenzionálne výsledky merania	Kontrolná správa o rozmeroch všetkých parametrov na zákaznickom výkrese („Production Part Approval Dimensional Report – Prevzatie sériových dielov – výsledky merania").	R	S	S	R	R
8	Kontrolná správa o materiále a výsledky kontroly funkcie	Musia sa priložit údaje o materiále (analýza a tvrdost) ako 3.1 Osvedcenie skúšobného odberu. Vo formulári „Production Part Approval Material Test Results – Prevzatie sériových dielov – výsledky skúšok materiálu" je prípustný odkaz na 3.1 Osvedcenie skúšobného odberu. Nebezpecné látky sú uložené v systéme IMDS, vo výnimocných prípadoch je prípustný aj formulár „Production Part Approval Material Constituents – Prevzatie sériových dielov – obsah látok". Pri odlievaných dieloch sa musia vykonávat analýza materiálu na hotovom výrobku taktiež aj sa musia dodržat s odsúhlasením zákazníka vnútorné a vonkajšie chyby. Funkcné testy len v prípade ak sú požadované vo výkrese prípadne v požiadavkovom liste. („Production Part Approval Performance Test Report – Prevzatie sériových dielov – Správa z výkonnostných testov")	R	S	S	R	R
9	Zistovanie spôsobilosti procesu	Ako doklad treba uviest alternatívne Cm/Cmk-, Pp/Ppk-, alebo Cp/Cpk-hodnoty pre všetky dôležité a kritické parametre (spravidla je to oznacené na zákaznickom výkrese príp. definované dodávatelom).	R	S	S	R	R
10	Zistovanie spôsobilosti meradiel	Zistovanie spôsobilosti meradiel (napr.: R&R-Test alebo opakovatelnost pre kontrolné automaty) pre všetky meradlá uvedené v kontrolnom pláne; Potvrdenie pre všetky dôležité a kritické parametre v dokumentácii Sériový diel – postup uvolnenia.	R	R	S	R	R
11	Dokumentácia skúšobných laboratórií	V prípade využitia externých laboratórií je nutné dokladovat certifikát s udaním platnosti. Príručka laboratória (alebo dokumentácia titulu a vydania) pre merové stredisko a laboratórium pre materiály, ak to zákazník požaduje.	R	R	S	R	R
12	Skúšobný plán	Kontrolný plán/Skušobný plán minimálne pre všetky dôležité a kritické parametre	R	R	S	R	R
13	Potvrdenie o predložení dielov	Použit „Part Submission Warrant PSW (Potvrdenie o predložení dielov)"	S	S	S	S	R
14	Správa o dieloch, pri ktorých sa kladie dôraz na vzhlad	Napr.:. Odsúhlasené katalógy chýb vzhladu, prevedenie lakovania ak to zákazník požaduje.	S	S	S	R	R
15	Kontrolný zoznam požiadaviek na surový materiál	Nerobí sa	R	R	R	R	R
16	Vzorkové diely	Skontrolovat 5 vzoriek pokial nie je zadané inak. Diely v sériovom balení podla listu údajov o balení.	R	S	S	R	R
17	Referencné vzorky	Dodávatel musí uchovávat minimálne jednu referencnú vzorku z každého hniezda po dobu výroby produktu plus jeden rok. Prostredníctvom jednoznacného oznacenia týchto referencných dielov treba zabezpecit priradenie ku kontrolnej správe o prvých vzorkách.	R	R	R	R	R
18	Meradlá/skúšobné pomôcky	Nerobí sa (len ak je to zvlášt požadované)	R	R	R	R	R
19	Dalšie záznamy špecifikované zákazníkom	Ak je to v špecifikácii stanovenej zákazníkom požadované.	R	R	S	R	R

APPENDIX 2 – Part submission warrant

Part Submission Warrant

Part Name _____ Cust. Part Number _____

Shown on Drawing Number _____ Org. Part Number _____

Engineering Change Level _____ Dated _____

Additional Engineering Changes _____ Dated _____

Safety and/or Government Regulation ☐ Yes ☐ No Purchase Order No. _____ Weight (kg) _____

Checking Aid Number _____ Checking Aid Engineering Change Level _____ Dated _____

SUPPLIER MANUFACTURING INFORMATION

Organization Name & Supplier/Vendor Code

Street Address

City Region Postal Code Country

CUSTOMER SUBMITTAL INFORMATION

Customer Name/Division

Buyer/Buyer Code

Application

MATERIALS REPORTING

Has customer-required Substances of Concern information been reported ? ☐ Yes ☐ No ☐ n/a

Submitted by IMDS or other customer format: _____

If submitted by IMDS, enter Modul ID number, version and date transmitted _____

Are polymeric parts identified with appropriate ISO marking codes ? ☐ Yes ☐ No ☐ n/a

REASON FOR SUBMISSION (Check at least one)

- ☐ Initial submission
- ☐ Engineering Change(s)
- ☐ Tooling: Transfer, Replacement, Refurbishment, or additional
- ☐ Correction of Discrepancy
- ☐ Tooling Inactive > than 1 year
- ☐ Change to Optional Construction or Material
- ☐ Sub-Supplier or Material Source Change
- ☐ Change in Part Processing
- ☐ Parts produced at Additional Location
- ☐ Other - please specify below

_____

REQUESTED SUBMISSION LEVEL (Check one)

- ☐ Level 1 - Warrant only (and for designated appearance items, an Appearance Approval Report) submitted to customer.
- ☐ Level 2 - Warrant with product samples and limited supporting data submitted to customer.
- ☐ Level 3 - Warrant with product samples and complete supporting data submitted to customer.
- ☐ Level 4 - Warrant and other requirements as defined by customer.
- ☐ Level 5 - Warrant with product samples and complete supporting data reviewed at supplier's manufacturing location.

SUBMISSION RESULTS

The results for ☐ dimensional measurements ☐ material and functional tests ☐ appearance criteria ☐ statistical process package

These results meet all design record requirements: ☐ YES ☐ NO (If "NO" - Explanation Required)

Mold / Cavity / Production Process _____

DECLARATION

I affirm that the samples represented by this warrant are representative of our parts which were made by a process that meets all Production Part Approval Process Manual 4th Edition Requirements. I further affirm that these samples were produced at the production rate of _____ /___ hours using _____ production streams. I also certify that documented evidence of such compliance is on file and available for review. I have noted any deviations from declaration below.

EXPLANATION/COMMENTS: _____

_____

Is each Customer Tool properly tagged and numbered ? ☐ Yes ☐ No ☐ n/a

Organization Authorized Signature _____ Date _____

Print Name _____ Phone No. _____ Fax No. _____

Title _____ E-mail _____

FOR CUSTOMER USE ONLY (IF APPLICABLE)

Part Warrant Disposition: ☐ Approved ☐ Rejected ☐ Other _____

Customer Signature _____ Date _____

Print Name _____ Customer Tracking Number (optional) _____