QUALITY MANAGEMENT ENGINEERING

Comprehensive Guide to Production Part Approval Process (PPAP) 4th Edition: Technical Standards and Implementation

Published: August 23, 2025 | Index ID: #665

The **Production Part Approval Process (PPAP)** represents the industry standard for ensuring that a supplier can consistently produce a part that meets the customer's design and specification requirements. Originally developed by the **Automotive Industry Action Group (AIAG)**, the PPAP 4th Edition is a critical component of the **Advanced Product Quality Planning (APQP)**framework. Its primary purpose is to provide 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.

The Evolution and Significance of PPAP 4th Edition

The transition from the third to the **fourth edition of PPAP** brought about significant alignment with the **ISO/TS 16949**(now IATF 16949) quality management systems. The 4th Edition focused on making the process more adaptable to various supplier tiers and clarified the requirements for 'Service PPAP' and 'Bulk Materials.' In the modern manufacturing landscape, PPAP is no longer confined to the automotive sector; it has been adopted by aerospace, medical device, and heavy machinery industries as a gold standard for supply chain quality assurance.

Core Objectives of the PPAP Process

- Requirement Verification: Ensuring the supplier understands the design intent.
- Process Stability: Proving that the manufacturing process is stable and capable.
- Consistency: Demonstrating that the production rate meets the customer's volume requirements without compromising quality.
- Documentation: Creating a standardized communication interface between the customer and the supplier.

The 18 Elements of a PPAP Submission

A complete PPAP package consists of up to 18 elements, though the specific requirements depend on the **Submission Level** requested by the customer. Below is an exhaustive breakdown of these technical components.

1. Design Records

This includes a copy of the drawing or the CAD model. If the customer is responsible for the design, this is the document that provides the specifications. It must include every feature, dimension, and tolerance. All 'ballooned' drawings—where every dimension is numbered—originate here.

2. Authorized Engineering Change Documents

Any document that shows changes to the design record that have not yet been incorporated into the master drawing but are authorized by the customer's engineering department must be included.

3. Customer Engineering Approval

Usually required when there are deviations from the standard specs, this element provides formal evidence that the

customer has accepted the proposed design or process changes.

4. Design Failure Mode and Effects Analysis (DFMEA)

If the supplier is design-responsible, they must perform a **DFMEA**to identify potential risks in the design and implement mitigations. This focuses on preventing failures at the drawing and material specification stage.

5. Process Flow Diagram (PFD)

The PFD outlines the entire manufacturing process from receiving raw materials to shipping finished goods. It must include inspection points, rework loops, and scrap handling. A clear PFD ensures that no step in the manufacturing sequence is overlooked.

6. Process Failure Mode and Effects Analysis (PFMEA)

The **PFMEA** is perhaps the most critical document. It evaluates every step of the manufacturing process for potential failure modes. Each failure is ranked by **Severity (S)**, **Occurrence (O)**, and **Detection (D)** to calculate a **Risk Priority Number (RPN)**or to determine Action Priorities (AP) under the newer AIAG & VDA FMEA standards.

7. Control Plan

The Control Plan is a direct output of the PFMEA. It defines the methods used to control the process and ensure product quality. It specifies the characteristics to be measured, the equipment used, the sample size, and the frequency of checks.

8. Measurement System Analysis (MSA)

To trust the data, the measurement tools must be verified. **MSA** typically involves **Gauge Repeatability and Reproducibility (GR&R)**studies. A common standard is that the GR&R should be less than 10% of the total tolerance for the measurement system to be considered acceptable.

9. Dimensional Results

This is the evidence that the manufactured parts meet the design record. Suppliers must provide a list of every dimension ballooned in the design record, showing the actual measurement versus the specification. Typically, a sample of 3 to 5 parts is measured for this element.

10. Records of Material / Performance Test Results

This involves laboratory reports confirming that the material used (e.g., steel grade, plastic resin) meets the chemical and physical requirements. Performance tests might include salt spray testing for corrosion or cycle testing for durability.

11. Initial Process Studies

Suppliers must demonstrate process capability using statistical indices. For critical characteristics, the **Ppk (Initial Process Performance)**index is calculated. Generally, a Ppk > 1.67 is required for new processes to account for initial variability.

12. Qualified Laboratory Documentation

Any laboratory used for testing must have a defined scope and documentation showing it is qualified (e.g., ISO/IEC 17025 certification).

13. Appearance Approval Report (AAR)

Applied to parts where aesthetic qualities (color, texture, grain) are critical. The **AAR**is a specific form (often

referred to in the 4th Edition instructions) that compares the production part to a master standard.

14. Sample Production Parts

Physical samples from the production run are sent to the customer for hands-on evaluation.

15. Master Sample

A sample signed off by the customer and supplier, kept at the supplier's facility to serve as a visual and physical reference for future production runs.

16. Checking Aids

If the supplier uses specialized fixtures, gauges, or templates for inspection, they must provide evidence that these aids are calibrated and aligned with the part's design record.

17. Customer-Specific Requirements

Each OEM (Original Equipment Manufacturer) like Ford, GM, or Stellantis may have unique requirements that go beyond the standard 18 elements. These are documented here.

18. Part Submission Warrant (PSW)

The **PSW**is the summary of the entire PPAP package. It is the formal contract where the supplier declares that the samples and testing were performed according to requirements and that the results are compliant. It requires a signature from a responsible official at the supplier.

PPAP Submission Levels: Comparison and Analysis

Not every PPAP requires all 18 elements to be submitted to the customer. The 4th Edition defines five levels of submission, which determine which documents are sent and which are merely retained at the supplier's site.

Submission Level	Requirements / Description	Retention Location
Level 1	Warrant only (and for designated appearance items, an AAR) submitted to customer.	Elements 2-17 retained at supplier.
Level 2	Warrant with product samples and limited supporting data submitted to customer.	Remaining data retained at supplier.
Level 3	Warrant with product samples and complete supporting data submitted to customer.	The default level for most submissions.
Level 4	Warrant and other requirements as defined by the customer.	Customizable based on risk.
Level 5	Warrant with product samples and complete supporting data reviewed at the supplier's facility.	Supplier facility for customer review.

Technical Implementation: The Significant Production Run

A common point of failure in PPAP implementation is the misunderstanding of the **Significant Production Run**. Per the AIAG 4th Edition, the PPAP data must be gathered from a production run consisting of one hour to eight hours of production, with a total quantity of at least **300 consecutive parts**, unless otherwise specified by the customer.

Calculations for Process Capability (Ppk vs. Cpk)

In a PPAP context, we often look at **Ppk**. Unlike Cpk, which represents long-term capability by using an estimate of sigma based on within-subgroup variation, Ppk uses the actual standard deviation of all individual data points. This is more rigorous for a startup process.

The formula for Ppk is:

Where:

- USL: Upper Specification Limit
- LSL: Lower Specification Limit
- ;Ã Process Mean
- <3 Calculated Standard Deviation

Service PPAP: A Specialized Approach

The **Service Production Part Approval Process (Service PPAP)**is a supplement to the 4th edition. It is designed specifically for service parts, which often have lower volume requirements than production parts. Service PPAP recognizes that the high-volume '300-piece run' may not be feasible for replacement parts for older vehicle models. It allows for adjusted sample sizes and different evidence of capability while maintaining the core quality requirements of the standard PPAP.

Common Failure Modes in PPAP Submissions

Even seasoned quality engineers encounter hurdles during the PPAP process. Understanding these failure modes is essential for successful first-time approval.

1. Inadequate MSA (Measurement System Analysis)

Suppliers often submit GR&R studies that use 'lab' conditions rather than 'production' conditions. If the operator who will actually be doing the inspection isn't involved in the MSA, the data is technically invalid.

2. Disconnect between PFMEA and Control Plan

The Control Plan must be an evolution of the PFMEA. If a high-RPN risk is identified in the PFMEA but there is no corresponding control mechanism in the Control Plan, the PPAP will be rejected for lack of logical flow.

3. Non-compliant Material Certifications

Material certs must be current and traceable. Using a certification from a previous batch or a different supplier is a frequent cause of rejection. In the 4th Edition, the focus on the **Design Record**means the cert must match the specific revision levels mentioned in the drawing.

4. Statistical Misinterpretation

Calculating Ppk on non-normal data without performing a transformation is a technical error. If the data distribution is skewed, the standard Ppk formula will provide a misleading result of process capability.

Integration with IATF 16949

The PPAP process is not an isolated event but a requirement of **IATF 16949 Clause 8.3.4.4**(Product Approval Process). Organizations must conform to a product and manufacturing process approval procedure recognized by the customer. Successful PPAP completion is the gatekeeper for 'SOP' (Start of Production). Without an approved PSW, the supplier cannot legally ship parts for production use, and any parts shipped may be subject to quarantine or rejection.

Strategic Advantages of a Robust PPAP

While often viewed as a bureaucratic hurdle, a meticulously executed PPAP offers several strategic advantages to a manufacturing organization:

- Reduced Warranty Costs: By identifying failure modes early through PFMEA, suppliers prevent costly field failures.
- Improved Yield: Initial process studies force an optimization of the manufacturing parameters, leading to less scrap.
- Supply Chain Transparency: PPAP creates a clear 'baseline' of what a good part looks like, making it easier to identify when a process has drifted over time.
- Risk Mitigation: Level 5 PPAPs allow for deep-dive audits that can uncover systemic issues before they impact the OEM's assembly line.

The **Production Part Approval Process (PPAP) 4th Edition**remains a cornerstone of industrial quality management. Its structured approach to risk assessment, statistical verification, and documented evidence ensures that the complexities of modern manufacturing are managed with precision. As the industry moves toward Industry 4.0, the digitization of PPAP forms—moving from Excel templates to integrated PLM (Product Lifecycle Management) systems—is the next logical step, but the underlying principles of the 4th Edition will continue to govern quality for years to come.

Baca Juga (Artikel Terkait)

- **Mastering Six Sigma and Process Improvement: A Technical Framework for Practitioners and Students**
  URL: http://123caramba.com/six-sigma-process-improvement-technical-guide.pdf
- **The Comprehensive Guide to AIAG & VDA FMEA Handbook: Master the 7-Step Methodology for Risk Management**
  URL: http://123caramba.com/comprehensive-guide-aiag-vda-fmea-handbook-7-step-methodology.pdf
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