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9145:2016
Aerospace Standard
Advanced Product Quality Planning (APQP) and Production Part Approval Process (PPAP)
Guidance Material

November 2016

Rationale and Foreword

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- AS9145 standardizes the requirements for the Product Development Process (PDP) through the use of Advanced Product Quality Planning and Production Part Approval Process methodologies.

- Standardization results in establishing common, fully integrated requirements for the aviation, space, defense industries.

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5. Production Part Approval Process (PPAP) Requirements

Introduction

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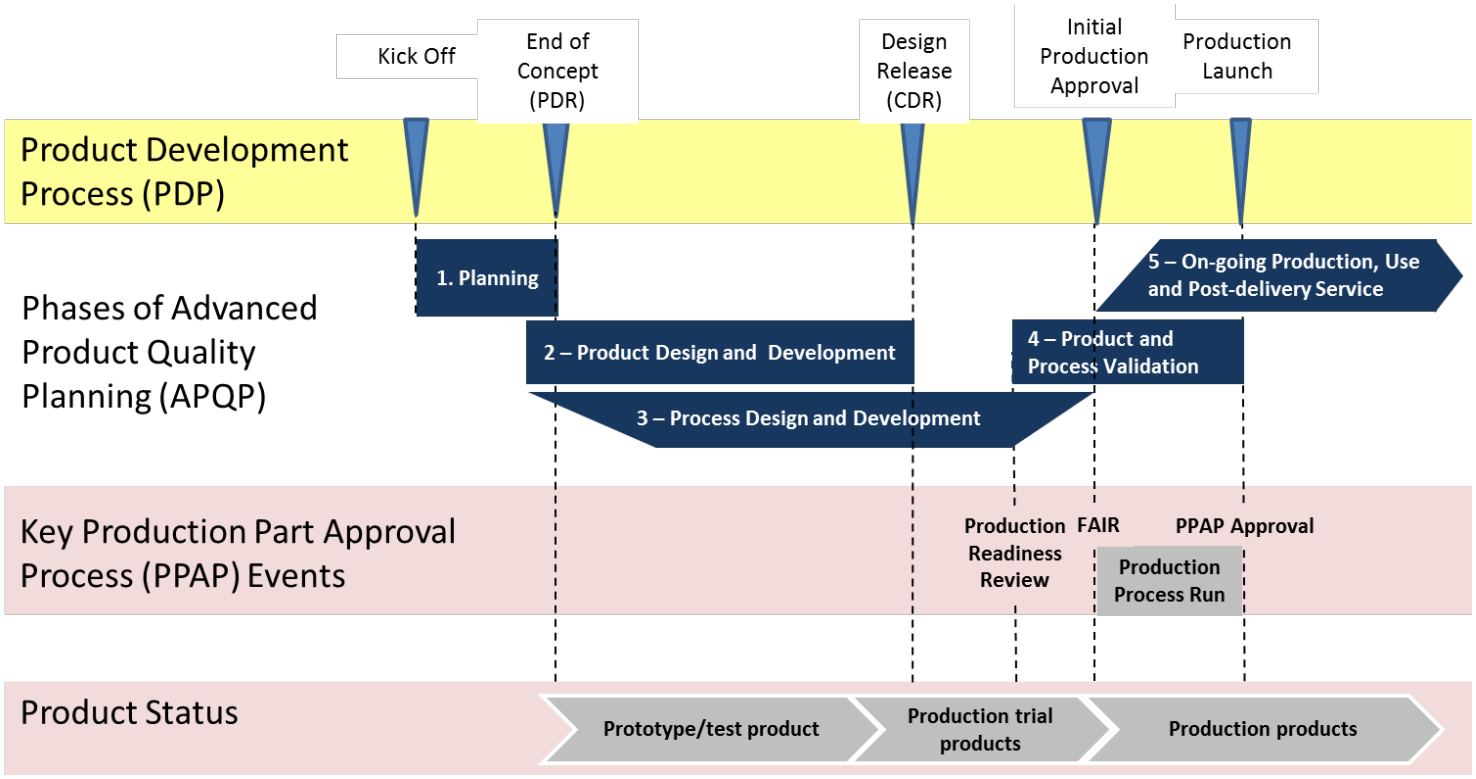
APQP has five phases starting with product concept and extending throughout the product life cycle.



Purpose

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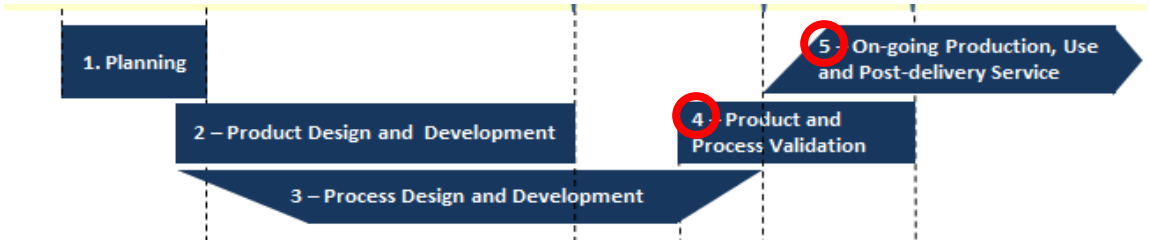
Phase 1 – Planning - capture customer inputs, benchmark data, lessons learned, regulatory requirements, technical specifications, company know-how, and strategy into a product concept and a realization plan. This includes identification of the high-level technical, quality, and cost targets.

Phase 2 – Product Design and Development - translate the technical, quality, and cost requirements into a controlled, verified, and validated product design. Design validation is achieved using prototype, development, or production parts in test environments that can represent the customer's installation and subject the product to extreme conditions required by contract or regulation.

Phase 3 – Process Design and Development - design and develop the production processes needed to produce product that consistently fulfill technical, quality, and cost requirements while operating at the customer demand rate.

Purpose



Phase 4 – Product and Process Validation - validate that product fulfills the design requirements and the process has demonstrated the capability to constantly produce conforming products at the customer demand rate. Product validation is achieved using product produced from the final production process.

Phase 5 – On-going Production, Use, and Post-delivery Service - ensure customer requirements are continuously met through the use of process control, lessons learned, and continuous improvement.

General Terms

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The complexity of APQP requires a universal understanding of the terms used throughout the standard. For effective implementation the reader should become familiar with the 31 terms defined in this standard.

Bill of Materials (BOM)

Commercial off-the-Shelf (COTS)

Control Plan tem

Critical Item (CI)

Customer

Deliverables

Demand Rate

Design Characteristics

Design Records

Design Risk Analysis

Failure Mode & Effects Analysis FMEA)

Inspection/Test Plan

Key Characteristic (KC)

Measurement Systems Analysis (MSA)

Phase

Post Delivery Service

Pre-Design

Preliminary BOM

Preliminary Capacity Assessment

Preliminary Capacity Study

Product Breakdown Structure (High-level BOM)

Product Development Process (PDP)

Production Part Approval Process (PPAP) File

Production Preparation Plan

Production Readiness Review (PRR)

Special Requirements

Stakeholder

Standard Part

Supplier

Validation (Design, Process, Product)

Verification

4.1 General Requirements

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- Standard requirements to be applied for products within the design and/or manufacturing responsibility
- Establish a scope of products - when standard is flowed down as a general contractual requirement or invoked by the organization
- Define Roles & responsibilities for managing & accomplishing APQP, PPAP elements
- Appropriate allocation of resources
- Ensure effective execution of product & process changes
- Include Supply Chain Management to support project, identify supplier related risks, define mitigation actions; including flow down of standard requirements

4.2 Project Management

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The Organization shall define application of APQP in PDP structure by :

- Identifying a project owner responsible for :
  - accomplishing project objectives
  - ensuring availability of resources
- Requiring a multidiscipline for effective communication
- Developing a project plan to meet customer expectations
- Monitoring and reporting on status of deliverables and escalating risks to project objectives.
- Holding periodic reviews at the appropriate levels within the organization.

4.3 Phase 1 - Planning

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Activities	Deliverables	Phase Output Key Milestones
• Collect the technical and non-technical requirements applicable to the product and associated project • Develop a Statement of Work (SOW) for the project • Define the product and associated project targets • Develop the product breakdown structure [i.e., high-level Bill of Material(BOM)] to support source selection • Coordinate and communicate timing with all applicable stakeholders • Schedule all key dates and deliverables in the project plan	• Product design requirements • **Project targets – safety, quality/manufacturability, service life, reliability**, durability, maintainability, schedule, and cost • Preliminary listing of Critical Items (CIs) and Key Characteristics (KCs) • **Preliminary BOM** • Preliminary process flow diagram • SOW review • **Preliminary sourcing plan** • **Project plan**	• The product concept is finalized and a pre-design is available

"Bold" *text indicates requirements defined in this standard*

Phase 1 Outputs

- **Finalization Product Concept**
- **Availability of Preliminary Bill of Material (BOM)**

4.4 Phase 2
Product Design & Development

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Activities	Deliverables	Phase Output Key Milestones
• Turning product specifications into robust product definition - Design risk analysis - Design for Manufacture and Assembly (DFMA) - Design for Maintenance, Repair, and Overhaul (DFMRO) - Identification of product KCs - Product error proofing • Create BOM • Conduct design reviews • Validate and verify product design • Conduct design record review at production sources to evaluate manufacturing feasibility	• **Design risk analysis*** • **Design records and BOM*** addressing the findings of the design risk analysis • DFMA, tolerance, stack-up analysis, etc. • **Special requirements, including product KCs and CIs listings** • **Preliminary risk analysis of sourcing plan** • Packaging specification • Design review report • Development product build plan • **Design verification and validation plans, and associated results** • **Feasibility assessment**	• Design record and BOM • Design verification and validation plans, and associated results

"Bold" *text indicates requirements defined in this standard*

** Indicates PPAP requirement*

Phase 2 Outputs

- **Release of Design Records**
- **Completion of Design Verification, Validation Plan**
- **Initiation of Sourcing Plan risk analysis**

4.5 Phase 3
Process Design & Development

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Activities	Deliverables	Phase Output Key Milestones
• Complete source selection and establish a supply chain risk management plan • Create a process flow diagram • Conduct Process Failure Mode and Effects Analysis (PFMEA) on the proposed process(es) and identify process KCs • Update the process based on the PFMEA risk mitigation plans, focusing on process KCs • Create the control plan including results of the PFMEA and KCs identification • Create process manufacturing instructions and documentation • Evaluate production readiness	• **Process flow diagram*** • Floor plan layout • **Production preparation plan** • Operator staffing and training plan (Human Resources) • **PFMEA*** • **Process KCs** • **Control plan*** • **Preliminary capacity assessment** • **Work station documentation** • **Measurement Systems Analysis (MSA) Plan** • Supply Chain Risk Management Plan • **Material handling, packaging, labelling, and part marking approvals*** • **Production Readiness Review (PRR) results**	• Production process defined and deployed • Successful completion of the PRR

"Bold" *text indicates requirements defined in this standard*

** Indicates PPAP requirement*

Phase 3 Outputs

- **Production Readiness Review (PRR)**
- **Completion of Applicable Activities/Deliverables**

4.6 Phase 4
Product and Process Validation

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Activities	Deliverables	Phase Output Key Milestones
• Conduct a First Article Inspection (FAI) and assemble Production Part Approval Process (PPAP) file • Completion of a production product run(s) • Conduct a capacity analysis • Collect data to demonstrate the manufacturing and assembly processes can produce conforming product at the customer demand rate • Conduct the MSA per the MSA Plan • Review the results of production process runs and determine corrective actions, as needed • Subsequent to corrective actions being implemented, determine process readiness for entry into serial production	• **Product from production process run(s)** • **MSA*** • **Initial process capability studies*** • **Control plan*** • **Capacity verification** • Product validation results • **First Article Inspection Report (FAIR)*** • **PPAP file and approval form*** • **Customer specific requirements***	• Validation that intended manufacturing process and the associated product conforms to specified requirements • Approved FAI • Approved PPAP

"Bold" *text indicates requirements defined in this standard*

** Indicates PPAP requirement*

Phase 4 Outputs

- **Product conforms to Specified Requirements**
- **Completion & Approval of PPAP**
- **Completion of FAI, Applicable Activities/Deliverables**

4.6 Phase 5 On-Going Production, Use & Post Delivery Service

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Activities	Deliverables	Phase Output Key Milestones
• Monitor product and process performance and compare to the defined • Phase 1 targets, including: - Reliability, quality, and customer satisfaction - Product post-delivery performance (including warranty) - Maintenance, Repair, and Overhaul (MRO) operations • Implement actions to reduce product and process variation in associated production and MRO activities • Document sources of variation in support of continual improvement efforts • Capture lessons learned and integrate into other design activities, as appropriate • Update FMEAs based on lessons learned	• Quality indices [e.g., CpK, Parts Per Million (PPM), rejection rates] • Key Performance Indicators (KPIs) reflecting product quality and reliability • **Evidence that project targets have been met** • On-time Delivery (OTD) and capacity KPIs • OTD and capacity improvement plan • MRO KPIs and plan(s) to reach the established targets • Project closure recommendations • **Continuous improvement actions** • **Lessons learned** • Updated design risk analysis, PFMEA, and control plans	• Project closure

"Bold" *text indicates requirements defined in this standard*

Phase 5 Output

- **Project closure**

5.1 PPAP Requirements

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Organizations are to :

- Identify PPAP elements & customer specific requirements
- Develop a PPAP file
- Comply with PPAP submission requirements
- Provide required PPAP documentation
- Maintain the PPAP file including accessibility
- Notify customer of product/process changes
- Determine requirements for changes
- Provide a revision plan to address unfulfilled submission requirements

PPAP File

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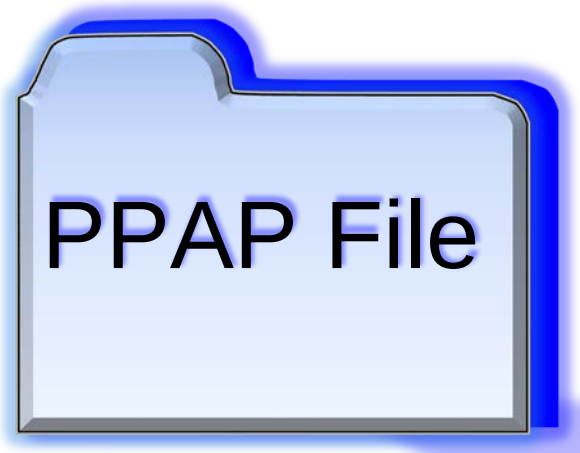

PPAP ELEMENT	APQP PHASE
1. Design Records	2
2. Design Risk Analysis	2
3. Process Flow Diagram	3
4. PFMEA	3
5. Control Plan	3
6. MSA	4
7. Initial Process Capability Studies	4
8. Packaging, Preservation, and Labeling Approvals	3
9. FAIR	4
10. Customer PPAP Requirements	4
11. PPAP Approval Form (or equivalent)	4

5.2 PPAP File & Submission

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Submission contents:

- ✓ Applicable elements of PPAP file
- ✓ Reference to alternate locations of elements (when applicable)
- ✓ PPAP Approval Form or equivalent form containing required fields
- ✓ Customer defined submission levels

Incomplete Submission contents:

- ✓ Requirements not completely fulfilled
- ✓ Customer directed/allowed
- ✓ PPAP Approval Form required to indicate incomplete submission
- ✓ Plan provided for resubmission for full approval

- ❖ **PPAP authorized approvers/customer delegates/internal submission recipients are to be identified**

PPAP APPROVAL FORM

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PPAP APPROVAL

1. Part Number:		*6. Additional Changes:*	
2. Part Name:			
3. Part Revision Level:			
4. Drawing Number:		*7. Customer Purchasing Representative:*	
5. Drawing Revision Level:		*8.Purchase Order Number:*	

SUPPLIER INFORMATION

1. Organization Name: *10. Supplier/Vendor Code:*

11. Address (Street, City, State, Country, Postal Code): Country:

1. Submission

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Submission mission Reason:

13a. PPAP ELEMENTS PROVIDED				13b. CUSTOMER PPAP ELEMENT ACCEPTANCE (Customer use only)		
Yes	No	N/A	ELEMENT DESCRIPTION	Yes	No	CUSTOMER COMMENTS
			1. Design Records			
			2. Design Risk Analysis (e.g., DFMEA)			
			3. Process Flow Diagram			
			4. Process FMEA			
			5. Control Plan			
			6. Measurement System Analysis			
			7. Initial Process Studies			
			8. Packaging, Preservation, and Labelling Approvals			
			9. First Article Inspection Report			
			10. Customer Specific PPAP Requirements			

Note: "No" selections in Section 13a require an Action Plan item documented in Section 14 below

14. Action Plan	Element #	Target Date

15. Declaration

I, the supplier, submit this PPAP Approval form as declaration of having met all applicable requirements of the 9145 standard, except as noted above, including having implemented the requirements at the sub-tier level where applicable. I further certify that our production process meets all defined product delivery, engineering and quality requirements. I understand that the approval of this form by the customer does not release me from responsibility or liability for any non-conformances.

Clearly Print Name and Sign Title Email Address Date

16. Customer Use Only

oved m Approval Rejected

Comments	

Customer Authorization: Clearly Print Name and Sign Title Email Address Date

5.3 PPAP Disposition

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- **PPAP Submission Disposition**
  - ***Approved*** – PPAP requirements fulfilled & product can ship
  - ***Interim Approval*** – PPAP requirements not fulfilled. Product may ship under customer specified conditions/restrictions
  - ***Rejected*** – PPAP requirements not fulfilled & product is not authorized to ship.

- **PPAP Approval Process Disposition** is recorded on the PPAP Approval Form

5.4 PPAP Resubmission

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PPAP Resubmission is required:

- ✓ A previously approved product/process undergoes a change
- ✓ Correction of a discrepancy on a previous submission

PPAP Resubmission requirements:

- ✓ Applicable APQP activities applied
- ✓ Compliance with internal & customer requirements