



# AEROSPACE STANDARD

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Aerospace Series – Requirements for Advanced Product Quality  
Planning and Production Part Approval Process

## RATIONALE

This standard was created to define the aviation, space, and defense process requirements for Advanced Product Quality Planning (APQP) and Production Part Approval Process (PPAP). The APQP aspects of this standard define a methodology for ensuring that the product development processes deployed throughout the aviation, space, and defense industries are fully integrated phased processes that extend from concept and design through manufacturing process planning and execution, and on into product use, service, and customer feedback. The PPAP is an output of APQP confirming that the production process has demonstrated the potential to produce products that consistently fulfill all requirements at the customer demand rate.

## FOREWORD

To assure customer satisfaction, the aviation, space, and defense industry organizations must produce and continually improve safe, reliable products that equal or exceed customer and regulatory authority requirements. The globalization of the industry and the resulting diversity of regional/national requirements and expectations have complicated this objective. End-product organizations face the challenge of assuring the quality of and integration of product purchased from suppliers throughout the world and at all levels within the supply chain. Industry suppliers face the challenge of delivering product to multiple customers having varying quality expectations and requirements.

The aviation, space, and defense industry established the International Aerospace Quality Group (IAQG) for the purpose of achieving significant improvements in quality, delivery, safety, and reductions in cost, throughout the value stream. This organization includes representation from companies in the Americas, Asia/Pacific, and Europe.

This document standardizes the requirements for the Product Development Process (PDP) through the use of APQP and PPAP methodologies. The establishment of common requirements, for use at all levels of the supply chain, should result in the elimination or reduction of organization unique requirements, and the resulting variation inherent in the multiple expectations.

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## INTRODUCTION

### 0.1 General

This standard specifies requirements in a structured framework to plan and complete actions of the product realization cycle which are necessary to ensure quality product(s) are delivered on time, while satisfying cost performance targets. APQP drives a quality focused approach to product development through the use of a phased planning process within which specific deliverables are established, monitored, and tracked to closure, while highlighting and mitigating risks as they are identified. PPAP is an output of APQP confirming that the production process has demonstrated the potential to produce products that consistently fulfill all requirements while operating at the customer demand rate.

Successful implementation of APQP requires: management commitment and support from the beginning of the product development cycle, and multidisciplinary project teams integrating all stakeholders and delivering a committed timeline for executing planned activities.

APQP has five phases (conceptually illustrated in Figure 1) starting with conceptual product needs and extending throughout the product life cycle. The actual duration of each phase will differ depending upon the scope and timing of the specific product and/or production development project. These phases are described as follows:

- Phase 1 – Planning

The goal of this phase is to capture customer inputs, benchmark data, lessons learned, regulatory requirements, technical specifications, company know-how, and strategy into a product concept and realization plan. This includes identification of the high-level technical, quality, and cost targets.

- Phase 2 – Product Design and Development

The goal of this phase is to 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

The goal of this phase is to 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.

- Phase 4 – Product and Process Validation

The goal of this phase is to validate that product fulfills the design requirements and the production processes have demonstrated the capability to consistently produce conforming product at the customer demand rate. Product validation is achieved using product produced from the defined production processes.

- Phase 5 – On-Going Production, Use, and Post-Delivery Service

The goal of this phase is to ensure customer requirements are continually fulfilled through the use of process control, lessons learned, and continuous improvement.

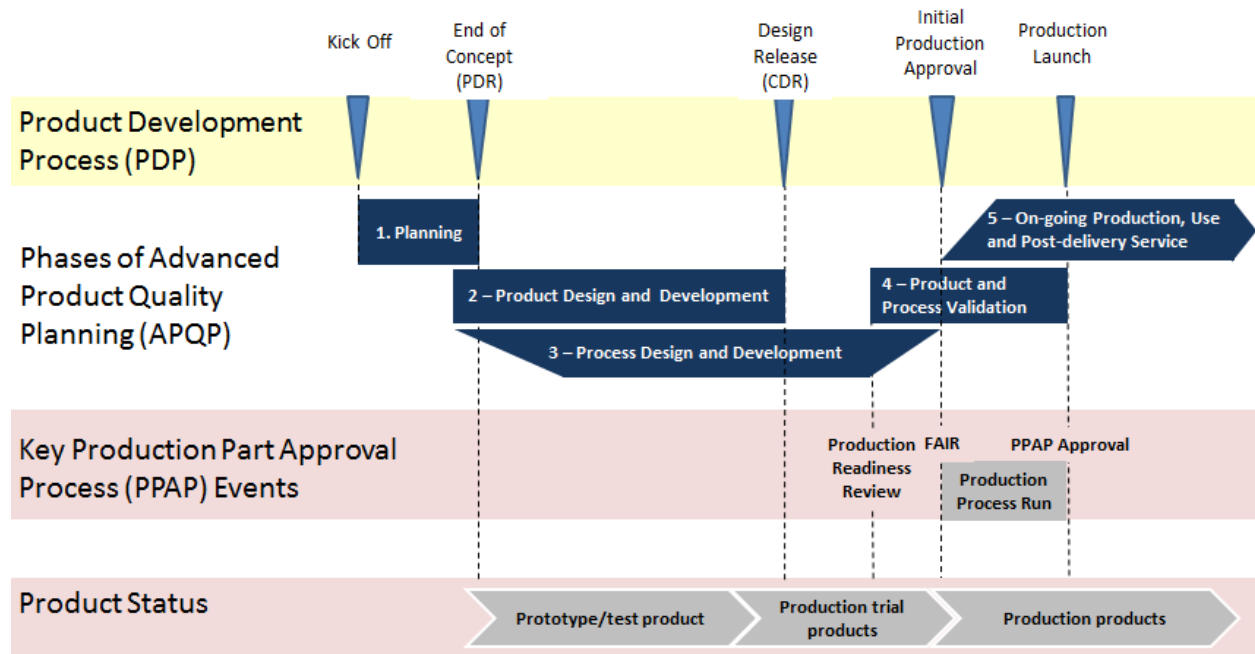


**Figure 1 – Product development process and advanced product quality planning (conceptual illustration)**

## 0.2 Application

This standard applies to new product development efforts, but can also be applied to products currently in production where changes are planned. It can be applied to the final product or selected levels of parts (i.e., parts within an assembly as defined by the organization or customer). When this standard is flowed down as a general contractual requirement (i.e., not for a specific program or project), the scope of applicability is established between the organization and the customer.

This standard is generally not applied to standard parts or Commercial-off-the-Shelf (COTS) items. Producers and their suppliers are responsible for flow down of the requirements of this standard, as appropriate, to suppliers who design and/or produce product.

When this standard is invoked, APQP and PPAP shall continue to apply when previously approved products and processes undergo change (e.g., introduction of a new production process, change to existing production process, change of production source, addition to the existing production sources).

## 1. SCOPE

This standard establishes requirements for performing and documenting APQP and PPAP. APQP begins with conceptual product needs and extends through product definition, production planning, product and process validation (i.e., PPAP), product use, and post-delivery service. This standard integrates and collaborates with the requirements of the 9100, 9102, 9103, and 9110 standards.

The requirements specified in this standard are complementary (not alternative) to contractual and applicable statutory and regulatory requirements. Should there be a conflict between the requirements of this standard and applicable statutory or regulatory requirements, the latter shall take precedence.

### 1.1 Purpose

The purpose of this standard is to establish a uniform approach to product realization across the aviation, space, and defense industry ensuring that quality products are delivered on time, while satisfying cost performance targets.

### 1.2 Convention

The following conventions are used in this standard:

- The word “shall” indicates a requirement.
- The word “should” indicates a recommended action (content or path), but not mandatory application.
- Words “typical”, “example”, “for reference”, or “e.g.” indicate suggestions given for guidance only.
- “NOTES” are used for additional clarification.
- Words or phrases with specific meaning pertaining to this document are defined in Section 3.

## 2. REFERENCES

The following publications form a part of this document to the extent specified herein; referenced documents are supportive for the application of this standard. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document, including any amendments, applies.

9100            Quality Management Systems – Requirements for Aviation, Space, and Defense Organizations

9102            Aerospace First Article Inspection Requirement

9103            Aerospace Series – Quality Management Systems - Variation Management of Key Characteristics

9110            Quality Management Systems – Requirements for Aviation Maintenance Organizations

NOTE: Equivalent versions (e.g., AS, EN, JISQ, SJAC, NBR) of the IAQG standards listed above are published internationally in each sector.

IAQG Supply Chain Management Handbook (SCMH) – <http://www.sae.org/iaqg/>.

- Advanced Product Quality Planning (APQP)
- Aerospace Advanced Product Quality Planning (APQP) Manual

Advanced Product Quality Planning and Control Plan; APQP Second Edition; Automotive Industry Action Group (AIAG); [www.aiag.org](http://www.aiag.org).

|                |                                                                                                                                                                                                             |
|----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ASTM E 2782    | Standard Guide for Measurement Systems Analysis (MSA)                                                                                                                                                       |
| IEEE 1490:2011 | Guide – Adoption of the Project Management Institute (PMI) Standard; “A Guide to the Project Management Body of Knowledge (PMBOK Guide)” – Fourth Edition; <a href="http://www.ieee.org">www.ieee.org</a> . |
| ISO 9000       | Quality management systems – Fundamentals and vocabulary                                                                                                                                                    |
| SAE J1739      | Potential Failure Mode and Effects Analysis in Design (Design FMEA), Potential Failure Mode and Effects Analysis in Manufacturing and Assembly Processes (Process FMEA)                                     |

### 3. TERMS AND DEFINITIONS

Definitions for general terms can be found in ISO 9000 and the IAQG International Dictionary (located on the IAQG website). An acronym log for this document is presented in Appendix A. For the purpose of this standard, the following definitions apply:

#### 3.1 Bill of Material (BOM)

List of components and materials contained in the design record(s) of a product.

#### 3.2 Commercial off-the-Shelf (COTS)

Commercially available applications, defined by industry recognized specifications and standards, sold through public catalog listings.

#### 3.3 Control Plan

A documented description linking manufacturing process steps to key inspection and control activities. The intent of a control plan is to control the design characteristics and the process variables to ensure product quality.

#### 3.4 Critical Item (CI)

Those items (e.g., functions, parts, software, characteristics, processes) having significant effect on the product realization and use of the product; including safety, performance, form, fit, function, producibility, service life, etc.; that require specific actions to ensure they are adequately managed. Examples include: safety CIs, fracture CIs, mission CIs, Key Characteristics (KCs), and maintenance tasks critical for safety (reference 9103 standard).

#### 3.5 Customer

Organization, legal entity, or person that receives a product or service (e.g., consumer, client, end-user, retailer, beneficiary, purchaser).

#### 3.6 Deliverables

Items (outputs) completed as part of the APQP process.

#### 3.7 Demand Rate

The quantity of products required to be produced by the production organization over a specified period of time to fulfill the delivery schedule.

### 3.8 Design Characteristic

Those dimensional, visual, functional, mechanical, and material features or properties, which describe and constitute the design of the article, as specified by drawing or Digital Product Definition (DPD) requirements. These characteristics can be measured, inspected, tested, or verified to determine conformance to the design requirements. Dimensional features include in-process locating features (e.g., target-machined or forged/cast dimensions on forgings and castings, weld/braze joint preparation necessary for acceptance of finished joint). Material features or properties may include processing variables and sequences, which are specified by the drawing or DPD (e.g., heat treat temperature, fluorescent penetrant class, ultrasonic scans, sequence of welding and heat treat). These provide assurance of intended characteristics that could not be otherwise defined (reference 9102 standard).

### 3.9 Design Records

The records of the engineering definition/specification, which fully define the product (system, part, component, or assembly), including physical or electronic/digital drawings, electronic/digital models, software, or other associated information. This includes records of authorized engineering changes not yet incorporated into the released engineering definition/specification.

### 3.10 Design Risk Analysis

Analytical techniques used by the design responsible organization to identify, to the extent possible, potential failure modes related to product performance (i.e., fit, form, and function), durability, manufacturability, and cost.

### 3.11 Failure Mode and Effects Analysis (FMEA)

A structured method for analyzing risk by ranking and documenting potential failure mode in a system, design, or process. The analysis includes:

- identification of potential failures and their effects;
- ranking of factors (e.g., severity, frequency of occurrence, detectability of the potential failures); and
- identification and results of actions taken to reduce or eliminate risk.

The FMEA assists in the identification of CIs as well as key design and process characteristics, helps prioritize action plans for mitigating risk, and serves as a repository for lessons learned. Examples include: system FMEA, interface FMEA, design FMEA, and process FMEA.

### 3.12 Inspection/Test Plan

A detailed description of inspection and test activities (e.g., tolerances, methods, gages) for features or attributes to be performed during specific manufacturing operations.

### 3.13 Key Characteristic (KC)

An attribute or feature whose variation has a significant influence on product fit, performance, service life, or producibility; that requires specific action for the purpose of controlling variation (reference 9103 standard).

This definition is further explained as follows:

- KCs for a part, subassembly, or system are those selected geometrical, material properties, functional, and/or cosmetic features; which are measurable, and whose variation control is necessary for fulfilling customer requirements and enhancing customer satisfaction.

- Process KCs are those selected measurable characteristics of a process whose control is essential to manage variation of part or system KCs.

Substitute KCs may be identified when a customer-defined KC is not readily measurable, within the production/maintenance setting, and other characteristics may need to be controlled to ensure conformance.

### 3.14 Measurement Systems Analysis (MSA)

A study of the effects of selected elements of a measurement process (i.e., people, machines, tools, methods, materials, environment) on accuracy, precision, and uncertainty of measurement.

### 3.15 Phase

Period of time (during the PDP) in which specific processes, tasks, deliverables, and outcomes of APQP occur; phases may overlap as illustrated in Figure 1. The end of a phase is indicated by fulfillment of phase deliverables (see Appendix B).

### 3.16 Post-delivery Service

Service rendered to the customer or to end users in support of the product's successful continuing use. This includes, but is not limited to, providing documents (e.g., maintenance manuals, service bulletins), product use training, repair or overhaul activity, service hot lines, and spare parts provisioning.

### 3.17 Pre-design

A set of design related activities that establishes a preliminary concept design based upon the product specifications and requirements. This may include sketches, drawings, and physical or mathematical models that provide an understanding of the principle of operation and a high-level product structure.

### 3.18 Preliminary Bill of Material (BOM)

An initial BOM completed, prior to design validation and release of design record, for production use.

### 3.19 Preliminary Capacity Assessment

An assessment performed early in the process planning and development phase to determine resources (e.g., people, equipment, facilities) necessary to produce product at the customer demand rate.

### 3.20 Process Capability Study

A study that compares the output of an in-control process to the specification limits, expressed in terms of process capability index (e.g., Cpk) or as a process performance index [e.g., Ppk, Parts Per Million (PPM)].

### 3.21 Product Breakdown Structure [also known as a High-level Bill of Material (BOM)]

A breakdown of a product into its subsystems and major components; it is used to support early planning activities, including sourcing decisions.

### 3.22 Product Development Process (PDP)

A generically applied term referring to an organization's process(es) for product realization. The process begins with conceptual product needs and expands throughout the life of the product. Common milestones include: kick-off, end of concept [i.e., Preliminary Design Review (PDR)], design release [i.e., Critical Design Review (CDR)], initial production approval, and production launch (see Figure 1).

### 3.23 Production Part Approval Process (PPAP) File

A file containing objective evidence in support of PPAP requirements.

### 3.24 Production Preparation Plan

A plan that identifies all resources (e.g., production and test/inspection equipment, tooling, jigs, fixtures, computing processes, materials, supply chain, trained work force, facilities) required to produce a product in sufficient quantity to satisfy the customer demand rate; additionally, it defines the timing of the release of work instructions, operator training, and commissioning of the machines.

### 3.25 Production Readiness Review (PRR)

A review of the manufacturing process (e.g., equipment, operator training, manufacturing documentation, control plan, associated measurement tools) by a multi-disciplinary team to verify that the production processes are appropriately defined, documented, and ready for production.

### 3.26 Special Requirements

Those requirements identified by the customer or determined by the organization, which have high risks of not being achieved, thus requiring their inclusion in the risk management process. Factors used in the determination of special requirements include product or process complexity, past experience, and product or process maturity. Examples of special requirements include performance requirements imposed by the customer that are at the limit of the industry's capability, or requirements determined by the organization to be at the limit of its technical or process capabilities (reference 9100 and 9110 standards).

### 3.27 Stakeholder

Individual or organization having a right, share, claim, or interest in a system or in its possession of characteristics that meet their needs and expectations. Stakeholders include, but are not limited to: customers, suppliers, regulatory bodies, and functional organizations or groups involved in product realization.

### 3.28 Standard Part

Parts for which the design, manufacturing, inspection data, and marking requirements necessary to demonstrate conformity to the part are in the public domain and published/established as part of the officially recognized standards.

### 3.29 Supplier

The entity or party that supplies product or services to a customer in accordance with contract requirements.

NOTE 1: Product and services may include: designs, production materials, production/service parts, assemblies, special processes (e.g., heat treatment, welding), or services to a customer per a contractual agreement.

NOTE 2: The term supplier is synonymous with the term contractor, producer, seller, or vendor.

### 3.30 Validation

The assurance that a product, service, or system fulfills the needs of the customer and other identified stakeholders. It often involves acceptance with external customers (defined in IEEE 1490:2011). Relevant types of validation include:

- Design Validation – Confirmation through the provision of objective evidence, that the requirements for a specific intended use or application have been fulfilled. Testing and/or analysis to ensure the product design conforms to defined user needs and/or requirements. Design validation follows successful design verification and may involve pre-production product (e.g., development, prototype) [reference AIAG Advanced Product Quality Planning and Control Plan].