UTC Production Part Approval Process (PPAP)

INTRODUCTION

This document defines Production Part Approval Process (PPAP) requirements as agreed upon by the following business entities herein referred to as "Member".

Collins Aerospace	Collins
Pratt & Whitney	PW
Pratt & Whitney Canada	P&WC

This document has been developed based upon the requirements of the International Aerospace Quality Group (IAQG) AS/EN/JISQ 9145 Aerospace Series - Requirements for Advanced Product Quality Planning and Production Part Approval Process.

The purpose of the phased APQP approach is to assure that new products satisfy customer requirements, as well as project timing and delivery. To accomplish this, necessary steps need to take place at the appropriate times within the product realization process. A successful APQP project will always start with a detailed plan based on key customer dates. A project management approach that continually reinforces identification and mitigation of risks, monitors status of tasks and deliverables, and escalates issues to management as necessary, is used to implement the plan. This approach provides effective early warning signals to drive on-time and on-quality delivery of products.

APQP has five phases (see Figure 1) starting with conceptual product needs and extending throughout the product life cycle.

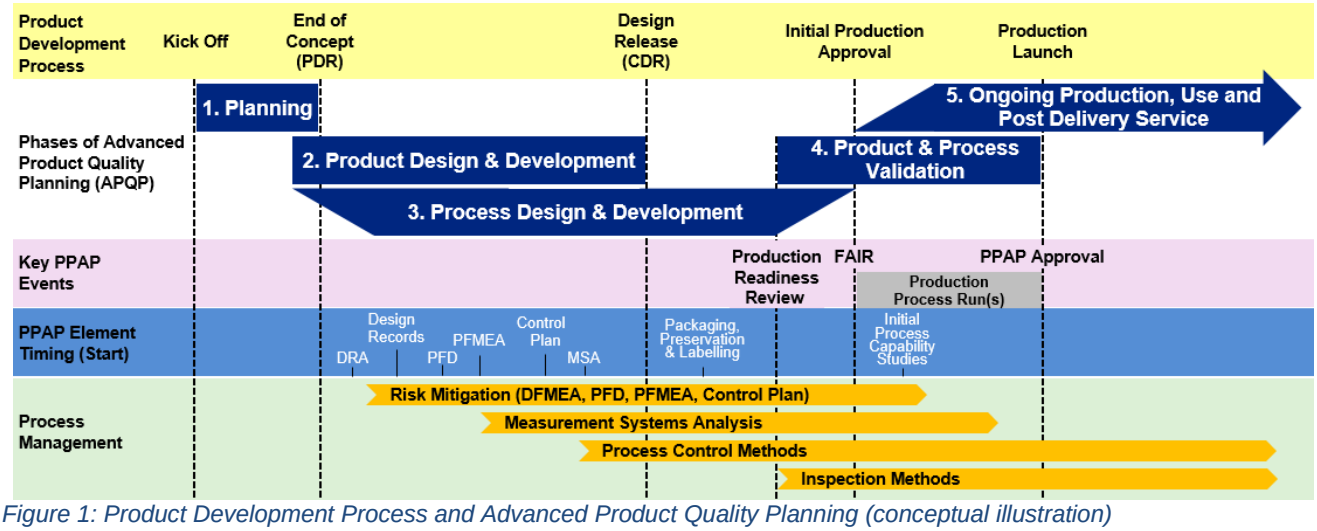

Figure 1: Product Development Process and Advanced Product Quality Planning (conceptual illustration)

PPAP Approval is Gate 4 of APQP and used to validate that the production process has demonstrated the potential to produce products that consistently fulfill all Member requirements while operating at the customer demand rate.

Reference AS9145 & IAQG Supply Chain Management Handbook (SCMH) - Section 7.2 APQP)

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REVISION SUMMARY

This requirement document has been entirely revised. Among the more significant changes are:

- Introduction of APQP – AS9145 methodologies
- Aligned to AS9145 PPAP (19 Elements reduced to 11 Elements)
- Elimination of Appendix for Member-specific requirements

A detailed change overview of this revision can be found in the PPAP Toolbox.

1 SCOPE

1.1 PPAP is required when invoked pursuant to a Purchase Order (PO) or any other contractual document issued by the Member. PPAP may also be required as part of a Member quality initiative (e.g., Collins Aerospace Zero Defect Plan (ZDP), Pratt & Whitney Triage, Pratt & Whitney Canada Ring Fence).

Note 1: Generally PPAP is not required on industry standard parts or Commercial-Off-The-Shelf (COTS) parts.

Note 2: For further clarification of UTC PPAP requirements, the Supplier should contact its Member procurement representative who can refer it to the appropriate Member Focal Point (MFP).

Note 3: If a conflict arises between ASQR-09.2 and Member-defined specifications or procedures, the latter takes precedence.

1.2 This requirement is applicable to all members of the supply chain (Reference 4.1.4).

2 NORMATIVE REFERENCES

2.1 It is the responsibility of the Supplier to obtain the latest revisions of all applicable documents specified by this ASQR. These documents include, but may not be limited to the following:

Document	Title
AS9102*	Aerospace First Article Inspection Requirement
AS9145*	Aerospace Series - Requirements for Advanced Product Quality Planning and Production Part Approval Process
AS13000	Problem Solving Requirements for Suppliers
AS13003	Measurement Systems Analysis Requirements for the Aero Engine Supply Chain
AS13004	Process Failure Mode & Effects Analysis (PFMEA) & Control Plans
AS13006	Process Control Methods
ASTM E2782	Standard Guide for Measurement Systems Analysis (MSA)
ASQR-01	Supplier Quality System Requirements
ASQR-20.1	Supplier Sampling Requirements
AIAG Manuals	Advanced Product Quality Planning (APQP) & Control Plan, Production Part Approval Process (PPAP), Failure Mode Effects & Analysis (FMEA), Measurement System Analysis (MSA), and Statistical Process Control (SPC)
IAQG SCMH	IAQG Supply Chain Management Handbook
J1739	Potential Failure Mode and Effects Analysis in Design (Design FMEA), Potential Failure Mode and Effects Analysis in Manufacturing and Assembly Processes (Process FMEA)

Table 1: Referenced Documents

* *Developed under the auspices of the IAQG and listed here as SAE International "AS" publications. Equivalent versions may be published by other standards bodies (e.g., European Committee for Standardization (CEN), Japanese Standards Association/ Society of Japanese Aerospace companies (JSA/SJAC).*

2.2 Additional PPAP reference documents, such as Forms and the PPAP Assessment Checklist, can be found online at www.utc.com/suppliers in the PPAP Toolbox. Contact your Member Focal Point (MFP) for more information.

3 TERMS & DEFINITIONS

3.1 **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.

3.2 **Design Records:** Design Records are comprised 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.

3.3 **Design Responsible Supplier:** Supplier of products defined by a design/drawing proprietary to that Supplier and linked to a Member part number through the use of a Member-referenced drawing and/or other PO requirements (e.g., Category 1, Source Control, Source Design, Engineered Item).

3.4 **Feature:** Any characteristic, dimension, note, specification, or embedded requirement found on the drawing or drawing related documents.

3.5 **Input Data Sheet (IDS):** A summary completed by the UTC Member or Design Responsible Supplier to communicate Key Characteristics as defined by the output of the Design Risk Assessment.

3.6 **Industry Standard Parts:** Parts for which the design, manufacturing, inspection data, and marking requirements necessary to demonstrate conformity of the part are in the public domain and published or established as part of officially recognized standards (e.g., AN (Air Force-Navy Aeronautical Standard), AS (Aerospace Standard), MS (Military Standard), NAS (National Aerospace Standard)).

3.7 **Kappa:** Kappa Statistic that is a measure for assessing the reliability of agreement between a fixed number of assessors.

3.8 **Key Characteristic (KC):** An attribute or feature whose variation has a significant influence on product safety, fit, performance, service life, or producibility; that requires specific action for the purpose of controlling variation. KCs may be identified by the Member and/or the Supplier. 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, whose variation control is necessary in meeting Member requirements and enhancing Member satisfaction.
- Process KCs are those selected measurable or attribute characteristics of a process whose control is essential to manage variation of part or system KCs.
- Substitute KCs may be identified when a Member-defined KC is not readily measurable within the production/maintenance setting and other characteristics may need to be controlled to ensure conformance.

Note: Member-defined KCs may be identified differently (KPC1, KPC2, etc.).

3.9 **Member Focal Point (MFP):** Member designated PPAP interface between the Supplier and Member that is responsible for supporting deployment and approving the PPAP Package.

3.10 **Part Family:** A group of similar parts used for similar applications that have similar features, material, and manufacturing process steps.

3.11 **Process Capability:** The ability of a process or product to consistently meet a specification or Member requirement (often expressed as a capability index such as Cpk or Ppk).

3.12 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.

3.13 Process Family: A group of manufacturing processes used to produce similar features using similar machines, tools, fixtures, set-ups, and programs.

3.14 Process Stability: A condition or state of behavior of a process where, through the use of past experience, near-term future behavior can be predicted reliably within limits. A condition where there is no indication of a special cause of variation, but where only random common cause variation is present.

3.15 PPAP Element: The supporting evidence that a defined development requirement has been met.

3.16 PPAP File: A file containing objective evidence in support of PPAP requirements.

3.17 PPAP Package: A collection of all applicable PPAP Elements submitted to the Member. The package represents the PPAP File at submission.

3.18 Submission Level: Defines the required documentation to be submitted to the MFP for review.

3.19 Acronyms

CI	Critical Item
DFMEA	Design Failure Mode and Effects Analysis
DRA	Design Risk Analysis
FAIR	First Article Inspection Report
IDS	Input Data Sheet
KC	Key Characteristic
MFP	Member Focal Point
MSA	Measurement Systems Analysis
P/T	Precision-to-Tolerance
PFD	Process Flow Diagram
PFMEA	Process Failure Mode and Effects Analysis
PO	Purchase Order or Production Order
PRR	Production Readiness Review
SPC	Statistical Process Control
QN	Quality Notification

4 PPAP REQUIREMENTS

4.1 General Requirements

4.1.1 The Supplier shall submit all PPAP planning & objective evidence utilizing the Member online PPAP software application. In the event the software is not available, the Supplier shall contact the MFP for submission requirements.

4.1.2 Upon notification of a PPAP requirement, the Supplier shall submit a plan with the commitment dates to complete each PPAP Element (the "PPAP Plan") within 15 business days.

Note: The PPAP Plan should show development of the Elements as early as possible in the part design and manufacturing process development phases as illustrated in the Introduction (e.g., DRA, PFD, PFMEA, Control Plan).

4.1.3 There are eleven (11) PPAP Elements described in Section 5 hereof (individually, an "Element" and collectively, the "Elements"). The Supplier shall meet the requirements of all Elements unless an Element is not applicable to the part or to the activities performed by the Supplier (e.g., Element 2 (Design Risk Analysis) would only be applicable to a Design Responsible Supplier). Elements that the Supplier proposes as not applicable require approval by the MFP.

4.1.4 The Supplier shall flow down the requirements of PPAP to all levels of its supply chain (internal & external) and maintain records of their compliance. A risk based decision process may be used to assess PPAP applicability of supply chain components & operations when approved by the Member (Reference 5.11).

4.1.5 The Supplier shall collect supporting data to demonstrate that it has met the requirements of each Element and include it in the PPAP File as the data is produced. Supporting data shall be representative of the production process (e.g., tools, machines, instructions, methods, and operators). Data from non-production tooling or processes must be identified and documented within the Element(s) and may only be used in the PPAP Package when approved by the MFP.

4.1.5.1 The Supplier shall submit the required evidence for each applicable Element as it is completed.

Note: MFP will review and disposition individual Elements. The PPAP Package disposition is initiated upon Element 11 (PPAP Approval) submission.

4.1.6 When PPAP requirements have not been completely fulfilled, the Supplier may submit the PPAP Package (including partially completed Elements as per 4.2.2.2) for review. Elements identified as incomplete shall contain an action plan to achieve closure of any open item(s) including the commitment of actions, target dates and owners to achieve Full Approval.

4.1.7 The Supplier shall obtain authorization via the Member online PPAP software application or PPAP Approval Form (ASQR-09.2 Form 1) for Full or Interim Approval from the MFP before production parts are shipped.

4.1.8 The Supplier shall submit all required evidence for Elements previously identified as incomplete in order to obtain a formal Full Approval disposition from the MFP (Reference 4.2.2.1).

4.1.9 The Supplier shall review applicable Elements as part of any corrective action (e.g., QNs, escapes, Member/Certification Body/Regulatory audit findings, negative trending of Cost of Poor Quality) to determine the impact and update affected Elements where appropriate as per 4.2.4. (Reference AS13000)

4.2 PPAP Submission and Disposition

4.2.1 Submission Levels

4.2.1.1 The default submission is Level 3 unless otherwise specified by the MFP.

4.2.1.2 Regardless of the submission level, the Supplier shall complete and maintain documentation for all applicable Elements in its PPAP File.

Submission	Required Documentation
Level 1	Element 11 only
Level 2	Element 11 and any additional MFP requested evidence
Level 3	Element 11 with complete supporting data for all Elements per 4.2.3
Level 4	Element 11 with complete supporting data for all Elements per 4.2.3, reviewed by the Member at the Supplier's manufacturing location

Table 2: Submission Levels

4.2.2 Disposition

4.2.2.1 The Supplier shall receive a copy of the PPAP Approval Form (ASQR-09.2 Form 1) from the Member online PPAP software application or the MFP with the following possible PPAP dispositions:

- Full Approval
- Interim A Approval
- Interim B Approval
- Rejected (not authorized to ship)

4.2.2.2 Interim Approval indicates a gap between the PPAP requirements and the Supplier's current status on the following Elements:

2 Design Risk Analysis
4 Process Failure Modes and Effects Analysis (PFMEA)
6 Measurement Systems Analysis (MSA)
7 Initial Process Capability Studies
9 First Article Inspection Report (FAIR)
10.2 Production Process Run(s)

Refer to these Elements for further detail on Interim Approval requirements.

4.2.2.3 Interim Approval expires with the plan date for Element 11 (PPAP Approval). A new submission dispositioned by the MFP is required to continue shipment of production parts.

4.2.2.4 In very limited circumstances, an authorization for deferral may be requested via the Member online PPAP software application or using the PPAP Deferral Form (ASQR-09.2 Form 2) and Element 9 (FAIR) to authorize the shipment of production parts prior to achieving Full or Interim Approval.

Note: The Supplier should initiate a deferral request at the time that it is identified the planned timing cannot be met.

4.2.3 PPAP Documentation

4.2.3.1 The PPAP File shall:

a) Be part number specific. The following Elements may be satisfied using a part or process family methodology with all unique characteristics accounted for with approval from the Member:

2 Design Risk Analysis
3 Process Flow Diagram (PFD)
4 Process Failure Modes and Effects Analysis (PFMEA)
5 Control Plan
6 Measurement Systems Analysis (MSA)
8 Packaging, Preservation and Labeling Approvals

b) Be maintained by the Supplier at the manufacturing location

c) Be maintained with all applicable items up-to-date and represent the current production process regardless of whether a Member requests a formal submission

d) Contain copies of all PPAP approvals including objective evidence

e) Be retained for the period required by ASQR-01

4.2.4 PPAP Change (Delta)

4.2.4.1 A PPAP resubmission is required when a previously approved (Interim or Full) product or process undergoes a change or for a correction of a discrepancy on a previous submission. A change is defined as:

a) A change in design characteristics affecting fit, form, or function of the part

b) A change in manufacturing source(s), process(es), inspection method(s), locations of manufacture, tooling, or materials that can potentially affect fit, form, or function

c) A change in numerical control program or translation to another media that can potentially affect fit, form, or function

d) A natural or man-made event, which may adversely affect a manufacturing process

e) A lapse in production for two years

4.2.4.2 When a resubmission is required due to a product or process change, the Supplier shall review all affected Elements.

4.2.4.3 MFP disposition of Element 11 (PPAP Approval) shall be obtained prior to shipping production parts after the implementation of any such changes.

5 ELEMENT REQUIREMENTS

5.1 Element 1 – Design Records

5.1.1 The Supplier shall document all Design Records (e.g., Member / Supplier drawings, models, specifications, IDS, Bill of Materials) including the PO with quoted demand rate in the PPAP File.

5.1.2 The Supplier shall document that the product has been manufactured to a production released design record aligned with the PO.

5.2 Element 2 – Design Risk Analysis (DRA)

5.2.1 The Design Responsible Supplier shall perform and document a design risk analysis related to performance (i.e., fit, form, and function), durability, service life, reliability, manufacturability, maintainability, and cost. Appropriate design risk mitigation activities are identified, prioritized, and completed.

5.2.2 A Design Failure Mode and Effects Analysis (DFMEA) per J1739 shall be used. Alternate methods that achieve the same objectives as a DFMEA may be used with prior approval by the Member.

Note: A safety or criticality analysis that may fulfill regulatory requirements does not address the full scope of a design risk analysis and cannot be considered as an equivalent method.

5.2.3 All KCs and CIs identified through the risk analysis shall be documented in Element 1 (Design Records) using the Input Data Sheet (ASQR-09.2 Form 3) or equivalent.

Note: The MFP may grant Interim Approval if open actions and mitigation plans exist at the time of submittal (Reference 4.2.2).

5.3 Element 3 – Process Flow Diagram (PFD)

5.3.1 The Supplier shall create and document a PFD as per AS13004 that includes all operations in sequential order from receipt of materials through storage and shipment of finished product. Alternative formats for a PFD require approval by the Member and at a minimum shall include:

- Alternate processes, standard rework loops, and movement of product to and from external operations
- Key inputs and outputs of each process step including identification of all KCs that impact product or process
- Flow direction and a legend to define symbols

Note: The Supplier should consider the maximum expected volume as communicated by the Member in defining the PFD

5.4 Element 4 – Process Failure Mode and Effects Analysis (PFMEA)

5.4.1 The Supplier shall perform and document a risk analysis of the manufacturing process and identify mitigation plans for high risks using the PFMEA methodology per AS13004. Appropriate process risk mitigation activities are identified, prioritized, and completed. Alternate methods that achieve the same objectives as a PFMEA may be used with prior approval by the Member and at a minimum shall include:

- Process Flow Diagram alignment (including all process steps)
- All product KCs (including customer defined KCs)
- Consideration of product family quality history including but not limited to, non-conformances, escapes, and lessons learned
- Identification of process KCs (as defined by risk) to be included in the Control Plan

5.4.2 The Supplier may define alternate Severity, Occurrence, and Detection ranking criteria when AS13004 tables do not suit the process being analyzed. Use of supplier-defined criteria requires prior approval by the Member.

Note: The MFP may grant Interim Approval if open actions and mitigation plans exist at the time of submittal (Reference 4.2.2).

5.5 Element 5 – Control Plan

5.5.1 The Supplier shall document any manufacturing risks are adequately controlled by developing a Control Plan as per AS13004. Alternate methods and/or formats for a Control Plan require approval by the Member and at a minimum shall include:

- Alignment to the PFMEA
- All product KCs and CIs defined by the Member and/or the Supplier as well as where they are controlled
- Process KCs and CIs defined by the Supplier and/or Member as well as where they are controlled
- Any other design and process characteristics to be monitored during the manufacturing process, along with any required control methods (Reference AS13006)
- The Reaction Plan to be invoked when the process becomes unstable as indicated by the control method, or a failure occurs
- Specifications/tolerances for all product and process KCs
- The measurement system used
- The sample size and frequency

5.6 Element 6 – Measurement System Analysis (MSA)

5.6.1 MSA shall, at a minimum, be performed and documented on the measurement methods for KCs (product and process) identified in the Control Plan as per AS13003 Table 2. For additional guidance, reference ASTM E2782.

5.6.2 Gage Repeatability & Reproducibility (Gage R&R) studies shall have a Precision-to-Tolerance (P/T) ratio of ≤ 20% unless a lower maximum ratio is required by the Member.

5.6.3 Where attribute data is used to assess feature acceptability (e.g., pass/fail criteria), the following criteria shall be used to determine acceptance of the measurement system:

Pass/Fail: Attribute agreement ≥ 90% or Kappa ≥ 0.8

5.6.4 When deficiencies are identified with meeting the requirements of AS13003 - Table 2 (e.g., P/T ratio, bias, stability, linearity, repeatability, discrimination), the Supplier shall document a mitigation plan that ensures conformity of product.

Note: The MFP may grant Interim Approval if open actions and mitigation plans exist at the time of submittal (Reference 4.2.2).

5.7 Element 7 – Initial Process Capability Studies

5.7.1 Initial process capability studies using industry recognized statistical methods shall be performed and documented for product and process KCs identified within the design records and supporting Control Plan.

Note: Capability studies should take into consideration the effects of people, machines, tooling, methods, materials, measurements, and environmental conditions.

5.7.2 The Supplier shall collect a minimum quantity of 25 consecutive samples utilizing variable data where feasible.

Note 1: Data collected from development or pre-production parts can be considered, provided the same tooling, equipment, and processes intended for production are used.

Note 2: Use of short run SPC techniques (e.g., target, group, part family charts) may be permitted, with MFP agreement of the approach and source of data.

5.7.3 Process capability indices (e.g., Cpk, Ppk based on distribution) shall only be calculated after the process is determined to be stable, using statistically valid methods (e.g., Control Charts) for determining process capability, and stability, and the requirements of Element 6 (MSA) have been met. Measures of process capability other than Cpk may be used only if such measures have received documented approval by the MFP (Reference AS13006).

5.7.4 The following acceptance criteria for the evaluation of initial process study results shall be applied:

Approval Level	Results	Interpretation
Full	IDS KC: Cpk ≥ 1.33 Process KC: Cpk ≥ 1.00 Attribute: 45 in a row with no QNs	The process satisfies the acceptance criteria. The Supplier shall determine acceptability of Supplier defined process KCs based on internal requirements
Interim A	IDS KC: Cpk ≥ 1.00 Process KC: Cpk ≥ 1.00 Attribute: Yield ≥ 90% Minimum 25 samples	The process does not meet the acceptance criteria. The Supplier shall investigate root cause, implement corrective actions and process control methods to ensure conformance. Mitigation plans shall be approved by the Member.
Interim B	Cpk < 1.00 Attribute: Yield < 90% Out-of-control conditions Insufficient sample size	

Table 3: Process Capability Acceptance

Note 1: Ppk may be used in place of Cpk when capability is being calculated for non-normal distributions.

Note 2: Execution of this PPAP Element does not automatically grant any sampling authorization. For UTC Supplier sampling requirements, refer to ASQR-20.1.

5.7.5 Where there are current technology limitations or it is prohibitively expensive to satisfy the stability, capability, and/or production yield requirements of this section, the Supplier shall submit a request for exception via the online PPAP system. Member-specific form may be used in the event the online system is not available.

5.8 Element 8 – Packaging, Preservation, and Labeling Approvals

5.8.1 The Supplier shall obtain Member approval that the methods of packaging, preservation, and labelling of production materials and product conform to Member-defined specifications.

Note 1: The Supplier should verify that the planned packaging ensures that the product or material will not be damaged, nor will the packaging degrade in performance through the normal course of transportation, delivery, and storage.

Note 2: The packaging materials should satisfy standards for environmental safety and pose no hazards to operators who are in contact with them. Consideration should be given to both primary and secondary packaging, as well as use and recycling of packaging materials.

5.9 Element 9 – First Article Inspection Report (FAIR)

5.9.1 The Supplier shall perform and document a FAIR in accordance with ASQR-01.

Note: The MFP may grant Interim Approval when the signed FAIR Form 1 has been marked as "Not Complete" and the Supplier has an action plan in place (Reference 4.2.2).

5.10 Element 10 – UTC PPAP Requirements

5.10.1 Element 10.1 – Part Marking Approval

5.10.1.1 The Supplier shall document all part marking requirements are met by obtaining approval from the Member.

5.10.2 Element 10.2 – Production Process Run(s)

5.10.2.1 A Production Readiness Review (PRR) should be completed prior to the Production Process Run to verify that the manufacturing process is documented and ready for production while operating at the customer demand rate. Upon Member request, the Supplier shall record and submit the results of the review, including corrective action to resolve any identified risks or issues.

5.10.2.2 The Production Process Run(s) shall be performed at the intended production site(s) under production conditions (i.e., tooling, gauges, processes, sequence, operations, instructions, materials, personnel, environment) to demonstrate the ability to satisfy Member requirements.

5.10.2.3 The Supplier shall track and document the defect rate of all parts produced during the Production Process Run.

5.10.2.4 Subsequent to the complete FAIR the Supplier shall perform and document one additional dimensional report (AS9102 Form 3 or equivalent form may be used) at the end of the Production Process Run yielding 25 consecutive pieces with no QNs.

5.10.2.5 The following acceptance criteria for the evaluation of the Production Process Run results shall be applied.

Approval Level	Results	Interpretation
Full	Minimum 25 consecutive parts with no QNs and second dimensional report	The process satisfies the acceptance criteria.
Interim A	90% part yield. Minimum 25 samples	The process does not meet the acceptance criteria. The Supplier shall implement Corrective Action as necessary and continue data collection
Interim B	FAIR with data from any additional parts available at time of submission	

Table 4: Production Readiness Acceptance

5.10.2.6 Where there are current technology limitations or it is prohibitively expensive to satisfy the requirements of this section, the Supplier shall submit a request for exception via the online PPAP system. Member-specific form may be used in the event the online system is not available.

5.11 Element 11 – PPAP Approval

5.11.1 Upon a satisfactory internal review, the Supplier shall submit Element 11 to the MFP for approval including submission of all approved PPAP Approval Forms (ASQR-09.2 Form 1) from all levels of its supply chain.

5.11.2 Any risk-based process used to determine applicability of PPAP to any level of the supply chain shall be documented and approved by the MFP.

6 FORMS

The following records are referenced within this document:

Record	Title
ASQR-09.2 Form 1	PPAP Approval
ASQR-09.2 Form 2	PPAP Deferral
ASQR-09.2 Form 3	Input Data Sheet (IDS)

Table 5: PPAP Forms