Aerojet Rocketdyne Quality Note **Rev. 0** **Date: 02/02/2016**
M04

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1. PURPOSE

This document defines the requirements for validating a manufacturing or assembly process which produces parts for Aerojet Rocketdyne (AR) using the Production Part Approval Process (PPAP).

A PPAP is a collection of supplier documentation or other objective evidence that not only validates that the supplied product meets requirements to the latest design and process configuration, but also demonstrates the supplier's capability to produce it consistently at AR's demand rate.

When invoked the Supplier must receive AR approval of the PPAP file prior to delivery of product.

2. APPLICATION

This specification is flowed via a Purchase Order (PO) when AR determines it is applicable. Because of variations in product criticality and supplier manufacturing complexity, AR may add special instructions in the PO pertaining to PPAP that are not included in the body of this specification. In other words, the PPAP requirement is the totality of this specification AND any PO special instructions.

The supplier shall include records pertaining to any PPAP special instructions in the PPAP file referenced in paragraph 5.1.

NOTE: Physical retention of PPAP elements following review or approval will be per existing contracts or agreements.

When applicable and agreed upon with AR, the supplier shall flow down this requirement to their supply chain to obtain records required and ensure all detail part characteristics are properly included in the PPAP file.

This specification is generally applicable to an item from the supplier's first production run and therefore not intended for prototype products or product meant for experimentation or Research and Development (R&D).

The PPAP requirement is not applicable to standard parts (e.g., MS, AN, AS, etc.), Commercial Off-the-Shelf (COTS) parts or parts procured directly from a distributor.

As soon as practical after the PO and in agreement with the timeline in Section 5.4, the supplier and AR shall identify required PPAP elements, applicable component(s), its feature(s), and the process that produces the feature(s).

2.1. Resubmissions

A PPAP resubmission is required when a previously approved product or process undergoes a change (reference AS9102) or when specified in purchase order. When a resubmission is required due to a product or process change, the supplier shall re-perform and submit for approval those PPAP elements affected by the change.

Examples of changes that require a PPAP resubmission:

- Design that affects form, fit or function
- Material spec that alters properties or characteristics
- Supplier owned items that affect the control plan, such as:
  - Process
  - Facility or work cell
  - Equipment
- Tooling that defines or accepts product

The supplier shall notify AR of changes to their process that trigger a PPAP resubmittal and the need for re-approval.

2.2. Applicable Documents

The following publications form a part of this document to the extent specified herein. The latest edition of the referenced document, including any amendments, applies.

AS9102	Aerospace First Article Inspection Requirement
AS9103	Aerospace Series - Quality Management Systems – Variation Management of Key Characteristics
SAE J 1739	Potential Failure Mode and Effects Analysis in Design (Design FMEA), Potential Failure Mode and Effects Analysis in Manufacturing and Assembly Processes (Process FMEA)

3. CONVENTIONS

The following conventions are used in this specification:

- The words “shall,” “will,” or “must” indicate mandatory requirements.
- The word “should” indicates a requirement with some flexibility allowed in compliance methodology.
  - A supplier must be able to show that their approach meets the intent of the “should.”
- Words “typical,” ”example,” “reference,” or “e.g.” indicate suggestions given as guidance.
- “NOTES” are clarification of a stated requirement and not an additional requirement.

4. DEFINITIONS

The items defined below are not necessarily requirements of PPAP but are referenced in this document.

4.1. Commercial Off-the-Shelf (COTS) Items

Product offered commercially or via catalogues and often through distributors. COTS items are not necessarily standard items.

4.2. Component

The physical object that is the subject of the control plan. The component may or may not be the item that is on the PO, for example if AR is ordering an assembly.

NOTE: The component definition may originate from either AR or the supplier.

4.3. Critical Item (CI)
An item (e.g., 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 requires specific actions to ensure they are adequately managed. Examples include safety CIs, fracture CIs, and mission Cis.

4.4. Item
The subject of the PO; what the supplier is providing to AR; also known as deliverable or End Item.

4.5. 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 AS9103).

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 requirements.

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

NOTE: CIs and KCs should be traceable through the process flow diagram, PFMEA, and control plan.

4.6. Product Characteristic
An objectively measurable property of a product specified in the product definition (e.g., length, diameter, flatness, hardness, voltage, resistance). A characteristic usually has a target value and a tolerance.

4.7. Production Process Run
The series of steps or sequences needed to produce a set of products using the same equipment, materials, operators, method, process settings, tooling and gaging that will be used to meet the rate / volume needs of AR. Reference Figure 1.

4.8. Standard Parts
Parts that are defined by industry recognized specifications or standards and often offered through distributors. Standard parts are also considered COTS parts.

4.9. Special Instructions
Quality requirements in and/or attached to the PO that are not specified in SupplierNet (on rocket.com).

4.10. Validation
4.10.1 Design Validation
Confirmation through testing a prototype or development article to ensure the product conforms to defined user needs and/or requirements. Design validation follows successful design verification.

4.10.2 Process Validation
Confirmation through physical demonstration that a process consistently produces acceptable results or product meeting its predetermined specifications (i.e., key product or key process characteristics are stable and capable at the desired level).

4.10.3 Product Validation
The assurance that a product meets the needs of AR and other identified stakeholders. It often involves acceptance and suitability with external customers (i.e., qualification testing).

4.11. Verification

4.11.1 Design Verification
Confirmation through objective evidence that all design outputs meet requirements. It may include activities such as: design review, performing alternate calculations, understanding tests and demonstrations, and review of design stage documents before release.

4.11.2 Product Verification
The evaluation of a product's compliance to requirements, specifications, or physical conditions as related to the intended design. This is typically accomplished by testing and/or inspecting a product against its design requirements [i.e., First Article Inspection (FAI)].

5. REQUIREMENTS

5.1. PPAP File

The supplier shall assemble a PPAP file and submit to AR for approval. The file shall be subject to any record retention requirements that may be flowed in the PO. Records may be applicable to the supplier's sub-tier and if so, shall be obtained from the sub-tier for inclusion in the PPAP. The PPAP shall contain the following elements, unless modified per PO special instructions as noted in Section 2:

5.1.1. PPAP Approval Form
The supplier shall include a cover sheet that shall be used as a check list and a record of AR approval. The form is shown as Appendix B.

5.1.2. Design Records
The supplier shall include records that define the product and demonstrate the configuration of the design, which includes: A copy of the released production drawings or models (where supplier has design cognizance), Bills of Materials (BoMs), and a Controlled Document Notice (CDN) list if applicable.

Design records shall also include authorized changes (i.e. engineering orders, change notices, etc.), even if they are not yet incorporated into the released product definition.

5.1.3. Design Failure Modes and Effects Analysis (DFMEA)
The supplier shall include a design risk analysis related to product performance, fit, form, function, and durability. It shall, to the extent possible, assure that potential functional failure modes and their associated causes / mechanisms have been considered, prioritized, and addressed.

Any Key Characteristics (KCs) or Critical Items (CIs) identified as such in the DFMEA shall also be identified as such in the design records.

5.1.4. Process Flow Diagram
The supplier shall include a process flow diagram that clearly defines the production process steps and sequences from receipt of raw material to shipment of the item. Alternate process steps and/or planned rework steps should be included in the flow diagram.

5.1.5. Process Failure Modes and Effect Analysis (PFMEA)
The supplier shall include an analysis intended to recognize and evaluate the potential failure of a process and the effects of the failure. It shall identify mitigation plans that could eliminate or reduce the chance of the potential failure occurring.

The PFMEA shall be in accordance with SAE J1739 for the product and any subassemblies that are applicable.

The PFMEA shall identify any process KCs as a basis for selection of a process for which to create a control plan.

5.1.6. Control Plan
In order to manage process variation, the supplier shall include a control plan that lists the component and/or process characteristics agreed to jointly with AR that will be monitored during the manufacturing process along with any required control methods.

The control plan shall also conform to the requirements of Appendix A.

5.1.7. Measurement System Analysis (MSA)
The supplier shall include an analysis of the measurement process and equipment in order to quantify its variation and compare it to the engineering tolerance in the component definition.

The MSA shall be performed on the measurement methods identified in the control plan.

NOTE: Applicable MSA studies can be established using various methods [e.g., Gage Repeatability and Reproducibility (Gage R&R), repeatability study, measurement uncertainty analysis, attribute agreement analysis]. A study of measurement system bias is also required to confirm the measurement results are valid and should be included in the analysis.

NOTE: The supplier should demonstrate that all measurement methods and checking aids included in the control plan are suitable and capable.

Action plans are required when MSA results do not meet internal and/or AR acceptance criteria, minimum 20% precision to tolerance unless otherwise specified or agreed to.

5.1.8. Process Capability Charts
The supplier shall include a capability chart(s) (aka control charts) displaying the variation and statistical study of the output of the process in order to show that the process stability and capability is within the acceptance criteria below. Reference AS9103.

NOTE: Process capability indices can only be calculated after the process is determined as stable.

The quantity of samples required to establish process stability or capability shall be statistically valid. As necessary, this is determined in conjunction with AR, prior to the starting of the study.

Results (Ppk/Cpk)	Acceptance Criteria
Index >1.33	The process is acceptable.
1.00 ≤ Index < 1.33	The process may be acceptable. The supplier shall determine acceptability based on internal and/or AR requirements. Implement appropriate control methods to ensure product conformance and initiate corrective action, as required.
Index <1	The process is not acceptable. Implement appropriate control methods to ensure product conformance and initiate corrective action. Contact authorized AR representative, as required.

In cases where it may be impossible or prohibitively expensive to meet the stability and capability acceptance criteria above, the exceptions shall be documented by the supplier and AR approval obtained as required.

5.1.9. First Article Inspection Report
The supplier shall include an inspection report of a representative item from the first production run in accordance with AS9102.

5.1.10. Packaging and Preservation Approvals
The supplier shall provide objective evidence that the production intended packaging, preservation, and if applicable labeling meet AR requirements and obtain approval as required.

5.2. Supplier Manufacturing Readiness Review (SMRR)
The supplier shall conduct an SMRR with AR to demonstrate that the process in the control plan is appropriately defined, documented, and ready for continuous production.

At a minimum, the review shall include applicable PPAP elements (Reference Figure 1). It shall include any other relevant manufacturing processes, equipment, operator training, and associated measurement tools.

5.3. Timeline
Though the supplier may have their own product realization phases or milestones outside the scope of this specification, it is important that the elements of the PPAP be developed in the proper order.

Figure 1 shows the PPAP elements in order relation to other PPAP elements and to supplier typical milestones. Because of their interdependencies, certain PPAP elements completed before other ones may be rejected by AR.

NOTE: The typical product development status timeline shown is an example and may differ than what the supplier chooses. The timeline intention is to show that the first six PPAP elements are based on design and analysis and not collected data.

If the supplier has design cognizance over the product, the design records and DFMEA cannot be completed until after the design is released, typically at their Critical Design Review (CDR) or equivalent milestone.

Only after the design is locked down, as evidenced by the design records and DFMEA, can the process flow be determined, from which the PFMEA can be developed.

After the process risks are prioritized from the PFMEA, a control plan can be written and the MSA particular to that process can be performed.

When the six aforementioned PPAP elements are complete, the production trials can be considered complete and the supplier will conduct an SMRR with AR.

Successful completion of an SMRR marks the approval to begin initial production, from which the first article can be inspected.

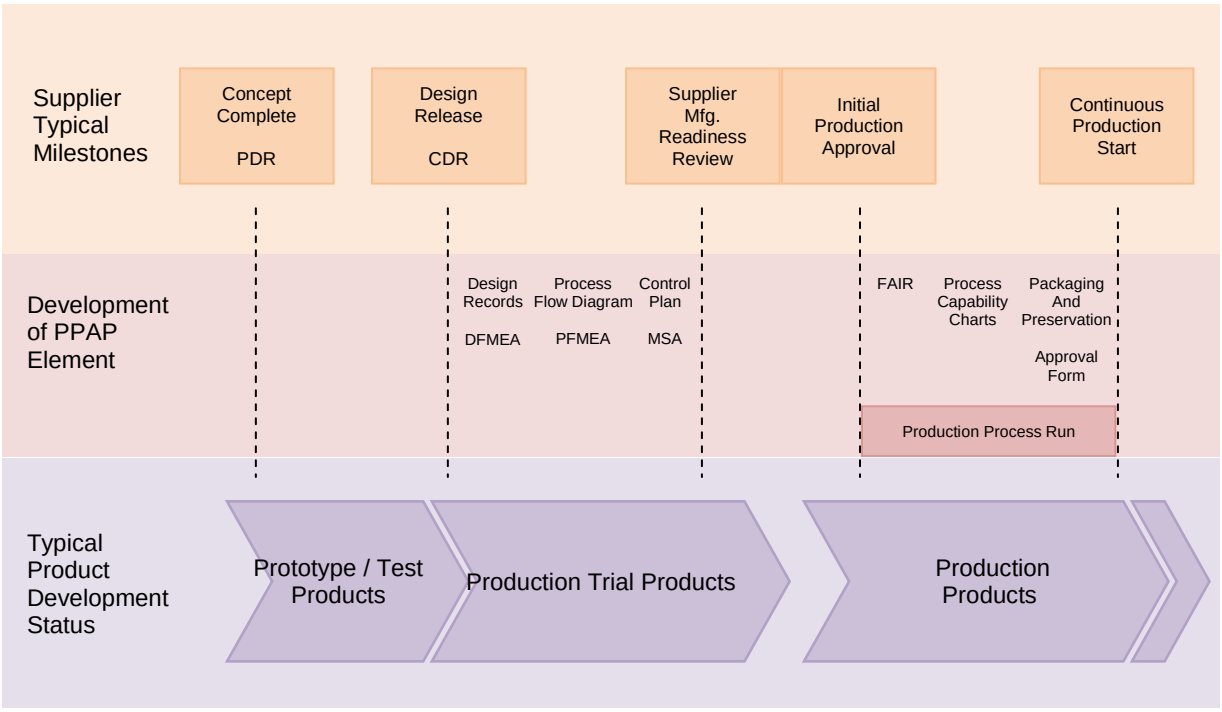

Figure 1 – PPAP Element Timeline

While the first, second and subsequent articles are being produced in the Production Process Run, their data can be collected and entered into the respective Process Capability Chart.

NOTE: This may require one or more production process runs.

After a statistically significant number of articles have been entered into the Process Capability Chart, the last approval forms can be entered and the PPAP compiled.

5.4. Supplier Review and Sign-Off

The supplier shall:

- Verify that all measurement and test results show conformance with AR requirements.
- Ensure all required documentation is available within the PPAP file.
- Review all applicable data for content, accuracy and process repeatability before submitting for approval.
- Upon a satisfactory internal review, complete a PPAP Approval Form (refer to Appendix B) and submit to AR for approval.

NOTE: Multiple PPAP approval forms may be required for one complete end item approval.

6. DISPOSITIONS

Upon review of the PPAP submittal, one of the following dispositions will be made by AR.

6.1. Approved

All PPAP requirements have been met. The supplier is authorized to ship product and may commence with continuous production

6.2. Interim Approved

All PPAP requirements have not been met; however, the supplier is authorized to ship product under the conditions/restrictions determined by AR. The supplier may proceed with continuous production and shipment of the product.

When known gaps in the PPAP submission requirements exist at the time of submission, the supplier shall provide a written plan for completion of all requirements.

6.3. Rejected

All PPAP requirements have not been met and the supplier is not authorized to continue production or ship product.

APPENDIX A – CONTROL PLAN

Description
The control plan details how product quality is controlled and confirmed during the manufacturing process. The control plan should be sufficiently detailed to clearly define who is responsible for completing the specified quality control tasks / activities at each stage of the process.

The supplier and AR shall agree on which process requires a control plan prior to execution.

The control plan should take into account the design records, process flow diagram, as well as the outputs from the DFMEA and PFMEA.

The control plan shall include and identify all product and process KCs and CIs defined by AR and the supplier.

Whereas a control plan typically applies to one component, in some cases control plans for component families may cover a number of similar components produced using a common process.

The control plan is a living document that is revised and updated throughout the life of the component in response to quality issues or component or process changes. The supplier shall review and update the control plan when these changes occur, in accordance with Section 2.1.

Contents
At a minimum, the control plan shall contain the following information:

1. Supplier name / site
2. Component number(s)
3. Component description
4. Component revision
5. Process name/operation description
6. Process control method
7. Control plan revision
8. Operation / process step number
9. Product or process characteristic description
10. Product or process spec limit / tolerance
11. Process control limits
12. Evaluation measurement technique
13. Sample size and frequency

APPENDIX B – PPAP APPROVAL FORM

1. Purchase Order #:		**2. AR Buyer:**	
3. Item Number on PO:		**4. Item Descript on PO:**	
5. Component Number:		**6. Component Dscriptn:**	
7. Component Revision:		**8. Additional Changes:**	

SUPPLIER INFORMATION

9. Supplier Name & Address

SUBMISSION

10A. ☐ INITIAL SUBMISSION
10B. ☐ RESUBMISSION Reason:

PPAP ELEMENT STATUS

Yes	No	N/A	Para	11. Elements	Description
☐	☐	☐	**5.1.2**	Design Records	BoMs, CDNs, change records, & drawings
☐	☐	☐	**5.1.3**	Design FMEA	Analysis of design failure modes and effects
☐	☐	☐	**5.1.4**	Process Flow Diagram	Diagram showing relationship between processes
☐	☐	☐	**5.1.5**	Process FMEA	Analysis of process failure modes and effects
☐	☐	☐	**5.1.6**	Control Plan	Steps to control variation in a manufacturing process
☐	☐	☐	**5.1.7**	Measurement System Analysis	Quantification of gage repeatability & reproducibility
☐	☐	☐	**5.1.8**	Process Capability Charts	Control charts with means & capability indices
☐	☐	☐	**5.1.9**	First Article Inspection Report	Verification record of item from first production run
☐	☐	☐	**5.1.10**	Packaging, and Preservation Approvals	Evidence that items are packaged appropriately

Note: "No" selections require an Action Plan be documented below.

No.	12. Action Item	Element #	Target Date
1			
2			
3			
4			
5			

CERTIFICATION

I, the supplier's representative, submit this PPAP approval form as declaration of having met all applicable requirements of QN-M04 and any relevant special instructions, except as noted above. I further certify that our production process meets all product delivery, engineering, and quality requirements. I understand that the approval of this form by AR does not release me from responsibility or liability for any non-conformances.

Supplier Print Name and Sign | **Title** | **Email Address** | **Date**

AR USE ONLY

☐ Approved ☐ Interim Approved ☐ Rejected Maestro Supplier Code:

Comments

AR Approval: Print Name and Sign | **Title** | **Email Address** | **Date**

Instructions to Complete PPAP Approval Form

1. Purchase Order Number: Enter AR purchase order number.
2. AR Buyer: Enter the AR Buyer name who issued the PO.
3. Item Number on PO: Enter the number of the item as it appears on the P.O.
4. Item Description on PO: Name or short description of the item.
5. Component Number: Enter the number of the component that is the object of the control plan. This may be an AR or supplier generated number.
6. Component Description: Name or short description of the component.
7. Component Revision: Revision level of the component at the time it went through the process.
8. Additional Changes: Provide reference number(s) of any changes that are incorporated in the component, but not reflected in referenced drawing / component revision level.
    - (e.g., engineering changes, manufacturing changes, or deviation)
9. Supplier's Name & Address: Address should be of the site that manufactured the item, not a remit-to or sales office.

10A. Initial Submission: Select for first-time submittal or a complete new package.

10B. Resubmission: Select when updating a previously approved PPAP.

11. PPAP Elements: For all the elements check the appropriate box:
    - Yes – Element has been completed.
    - No – Element has not been completed.
    - N/A – Element has been waived by AR.
12. Action Item: For any "No" items in the "PPAP Element Status", identify the element, any associated action items, and target completion dates.

APPENDIX C - ACRONYMS

AR	Aerojet Rocketdyne
BOM	Bill of Material
CI	Critical Item
CDN	Controlled Document Notice
CDR	Critical Design Review
COTS	Commercial Off-the-Shelf
Cpk	Process Capability Index
DFMEA	Design Failure Modes and Effects Analysis
FAI	First Article Inspection
FAIR	First Article Inspection Report
FMEA	Failure Modes and Effects Analysis
Gage R&R	Gage Repeatability and Reproducibility
KC	Key Characteristic
MSA	Measurement Systems Analysis
PDR	Preliminary Design Review
PFMEA	Process Failure Modes and Effects Analysis
PPAP	Production Part Approval Process
Ppk	Process Performance Index
PO	Purchase Order
R&D	Research and Development
SMRR	Supplier Manufacturing Readiness Review