Division PPAP Training Agenda

Place Your Divisions Agenda here!
## PPAP Training

### 3 Primary Training Sessions Available

<table>
<thead>
<tr>
<th>Sessions</th>
<th>Duration</th>
<th>Suggested Staff</th>
<th>Focus</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Overview</strong> PPAP Training</td>
<td>1 hour</td>
<td>Management, Manufacturing</td>
<td>Basic Overview of the Cooper PPAP Standard</td>
</tr>
<tr>
<td><strong>Internal Staff</strong> Training</td>
<td>2 Hours</td>
<td>Purchasing, Engineering</td>
<td>More in-depth training &amp; includes reviewer checklists &amp; tips.</td>
</tr>
<tr>
<td><strong>Supplier</strong> PPAP Training</td>
<td>3-4 Hours</td>
<td>Suppliers, Quality</td>
<td>Still more in-depth with focus on key topics and participation exercises</td>
</tr>
</tbody>
</table>
Benefits of PPAP Submissions

- PPAP provides for many benefits.
  - Forces formal part conformance and approval
  - Ensures formal quality planning
  - Helps to maintain design integrity
  - Identifies issues early for resolution
  - Keeps suppliers honest
  - Reduces warranty charges and prevents costs of poor quality
  - Assists with managing supplier changes
  - Prevents use of unapproved and nonconforming parts
  - Identifies suppliers that need more development
  - Improves the overall quality of the product & customer satisfaction

PPAP provides many benefits for all areas of the business.
PPAP Training Objectives

- What is the **Purpose** of PPAP?

- When is PPAP **Required**?

- What are the **Elements** of the submission?

- How are the **Levels** of PPAP applied?

- Details on successful PPAP submission to **Cooper Divisions**.
What is the PPAP standard?

- **Production Part Approval Process**
  - Standard for submitting to the customer for part approval.

- AIAG 4th edition is most recent in March 2006

- Developed by AIAG originally in 1993 for the Automotive Industry with input from the big three OEM’s.

- Outlines customer requirements that must be delivered and approved prior to production of product.

- Cooper’s PPAP requirements are targeted towards direct material suppliers (external)
What is the purpose of PPAP Submissions?

PPAP’s purpose is:

- To provide the evidence that all customer engineering design record and specification requirements are properly understood by the manufacturing organization.

- To demonstrate that the manufacturing process has the potential to produce product that consistently meets all requirements during an **actual production run** at the quoted production rate.

PPAP manages change and ensures product conformance!
PPAP data must be submitted from a “significant production run”, which is identified by AIAG as 300 consecutive pieces sampled randomly (unless otherwise agreed upon by the customer and supplier).

300 pieces from production not prototype
- Production equipment and tooling
- Production employees
- Production rate

All data reflects the actual production process to be used at start-up!
When is PPAP “typically” required?

- If the process or the part changes it requires PPAP submission
  - New part
  - Revised part
  - Supplier related changes
  - Changes in tooling, equipment or inspection
  - Change in the manufacturing process or method

- If you are unsure contact your Quality or Supplier Quality Representative.
  - **New Parts**: Typically will advise at time of business award (New Parts)
    - Reference the Cooper PPAP Quick Reference
  - **Changes**: Review at the time of a proposed change
    - Reference the Supplier Change Request Form

Any significant change to product or process!
What are the actual requirements?
The Basics of PPAP

Submission requirements are called **Elements**

Which element is required is determined by the submission **Level**

Don’t be intimidated by all of the acronyms
PPAP “Elements” (Requirements)

(AIAG) 4th Edition PPAP

- 1. Design Records
- 2. Engineering Change Documents
- 3. Customer Engineering Approval, if required
- 4. Design Failure Modes & Effects Analysis (DFMEA)
- 5. Process Flow Diagram
- 6. Process Failure Modes & Effects Analysis (PFMEA)
- 7. Control Plan
- 8. Measurement Systems Analysis (MSA)
- 9. Dimensional Results
- 10. Material, Performance Results
- 11. Initial Process Study
- 12. Qualified Laboratory Documentation
- 14. Sample Product
- 15. Master Sample
- 16. Checking Aids
- 17. Customer-Specific Requirements
- 18. Part Submission Warrant (PSW)

- 1. Part Submission Warrant (PSW)

Cooper Requirements

- 2. Design Records
- 3. Engineering Change Documents
- 4. Customer Engineering Approval
- 5. DFMEA
- 6. Process Flow Diagram
- 7. PFMEA
- 8. Control Plan
- 9. Measurement Systems Analysis (MSA)
- 10. Dimensional Results
- 11. Material, Performance Results
- 12. Initial Process Study
- 13. Qualified Laboratory Documentation
- 15. Sample Product
- 16. Master Sample
- 17. Checking Aids
- **18. Cooper-Specific Requirements**
  - Tooling information Form
  - Packaging Form
  - Inspection Plan (ASC Only)
  - Specification Deviation
  - Supplier PPAP Worksheet

Cooper will require most of these and Cooper specific documents.
## Cooper Requirements

1. Part Submission Warrant (PSW)
2. Design Records
3. Engineering Change Documents
4. Customer Engineering Approval
5. DFMEA
6. Process Flow Diagram
7. PFMEA
8. Control Plan
9. Measurement Systems Analysis (MSA)
10. Dimensional Results
11. Material, Performance Results
12. Initial Process Study
13. Qualified Laboratory Documentation
15. Sample Product
16. Master Sample
17. Checking Aids
18. Customer-Specific Requirements
   - Tooling information Form
   - Packaging Form
   - Inspection Plan (ASC Only)
   - Specification Deviation
   - Supplier PPAP Worksheet

### PPAP Submission Levels

<table>
<thead>
<tr>
<th></th>
<th>Level 1</th>
<th>Level 2</th>
<th>Level 3</th>
<th>Level 4</th>
<th>Level 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warrant Only</td>
<td>☑️</td>
<td></td>
<td></td>
<td></td>
<td>AR</td>
</tr>
<tr>
<td>Partial</td>
<td></td>
<td>☑️</td>
<td>☑️</td>
<td>AR</td>
<td>☑️</td>
</tr>
<tr>
<td>Full</td>
<td></td>
<td></td>
<td>☑️</td>
<td>AR</td>
<td>☑️</td>
</tr>
<tr>
<td>As Requested</td>
<td></td>
<td></td>
<td>AR</td>
<td>AR</td>
<td>☑️</td>
</tr>
<tr>
<td>Full On Site</td>
<td></td>
<td></td>
<td>AR</td>
<td>AR</td>
<td>☑️</td>
</tr>
</tbody>
</table>

**Shall Submit** ☑️  **Shall Retain** ☑️

**Level 3 will be the default submission level.**
Importance of Due Diligence through PPAP

Cooper Requirements

1. Part Submission Warrant (PSW)
2. Design Records
3. Engineering Change Documents
4. Customer Engineering Approval
5. DFMEA
6. Process Flow Diagram
7. PFMEA
8. Control Plan
9. Measurement Systems Analysis (MSA)
10. Dimensional Results
11. Material, Performance Results
12. Initial Process Study
13. Qualified Laboratory Documentation
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16. Master Sample
17. Checking Aids
18. Cooper-Specific Requirements
   - Tooling information Form
   - Packaging Form
   - Inspection Plan (ASC Only)
   - Specification Deviation
   - Supplier PPAP Worksheet

Element Links

2. Design Records
5. DFMEA
7. PFMEA
8. Control Plan
9. MSA
12. Initial Process Study
18. Cooper Specific

Critical Systems

Requirements CTQs
More Robust Design
Robust Process
Develop Process Control
Confirm Measurement
Verify and improve capability
Customer Requirements

Diligence is critical because elements relate and build on each other
## More on Level Application

| Level 1 | Warrant only and Appearance Approval Report as requested submitted to the customer.  
**Applied to:** "Non-critical" parts, "non critical" raw/bulk material or catalog/ commodity parts for electrical applications and re-certification of existing parts previously approved by Cooper at levels 3, 4 or 5. Also used for Self Certification  
**Levels are defined by AIAG and the Customer** |
| Level 2 | Warrant with product samples and limited supporting data submitted to the customer.  
**Applied to:** Critical Bulk products such as Plastic/Paint/Chemicals, critical fasteners, simple material changes, simple revision level only changes or simple print updates not affecting form-fit-function. This level can also be applied to low and medium risk parts within a product family. |
| Level 3 | Warrant with product samples and complete supporting data submitted to customer.  
**Default Cooper Industries Submission Level**  
**Applied to:** New parts on Cooper programs. Changes affecting form-fit-function, reliability, or performance. All product resourced to new suppliers, serial production parts, existing high risk parts undergoing a part number change. |
| Level 4 | Warrant and other requirements as defined by the customer.  
**This level is reserved for special applications only.**  
**Applied to:** This level can only be applied with prior approval from the designated divisional Cooper Quality PPAP representative. |
| Level 5 | Warrant with product samples and complete supporting data reviewed at the supplier’s manufacturing location.  
**Applied to:** On site review as requested by each Cooper Division. |
## Supplier Checklist for PPAP

<table>
<thead>
<tr>
<th>Element Order</th>
<th>PPAP Requirements</th>
<th>Level 1</th>
<th>Level 2</th>
<th>Level 3</th>
<th>Level 4</th>
<th>Level 5</th>
<th>Required Documents</th>
<th>Additional Comments and Clarity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Part Submission Warrant (PSW)</td>
<td>AR</td>
<td></td>
<td></td>
<td></td>
<td>AR</td>
<td>Cooper PSW or AIAF PSW acceptable</td>
<td>Cooper PSW is preferred for all submissions and required on all Cooper designed parts. AIAF form CFG-1001 is acceptable.</td>
</tr>
<tr>
<td>2</td>
<td>Design Records &amp; Bubbled part print(s)</td>
<td>AR</td>
<td></td>
<td></td>
<td></td>
<td>AR</td>
<td>Two Cooper Divisional Parts Prints</td>
<td>Include one clean copy of the current approved revision print. Provide a second copy with all dimensions, applicable specifications, and notes, bubbled (circle with corresponding number) on the print for reference to dimensional report.</td>
</tr>
<tr>
<td>3</td>
<td>Approved Engineering Change Documentation</td>
<td>AR</td>
<td>AR</td>
<td></td>
<td></td>
<td></td>
<td>Various engineering documentation</td>
<td>Any formal documentation that is not reflected in the current releasable print such as un-released masked up prints, formal engineering changes and any pertinent engineering correspondence.</td>
</tr>
<tr>
<td>4</td>
<td>Customer Engineering Approvals</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>AR</td>
<td>Not required</td>
<td>Not used with Cooper Industries submissions.</td>
</tr>
<tr>
<td>5</td>
<td>Design FMEA</td>
<td>AR</td>
<td>AR</td>
<td>AR</td>
<td></td>
<td></td>
<td>Can be Cooper FMEA Format or an AIAF compliant DFMEA.</td>
<td>Required only if supplier is responsible for part design.</td>
</tr>
<tr>
<td>6</td>
<td>Process Flow Diagrams</td>
<td>AR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Any standard flowchart format.</td>
<td>Identifies all process steps from receiving to shipping/warehouse operations. Must include all offline and in-process inspections and testing including ongoing routine conformance checks such as annual dimensional layouts. Process steps must match FFMEA and Control Plan steps.</td>
</tr>
<tr>
<td>7</td>
<td>Process FMEA</td>
<td>AR</td>
<td></td>
<td></td>
<td></td>
<td>AR</td>
<td>Can be Cooper PFMEA Format or an AIAF compliant PFMEA</td>
<td>FFMEA must be AIAF or comparable format that contains the same information as the AIAF form. Process steps must match Process Flow Chart, Control Plan and address all characteristics associated with each operation. RPN numbers must be in accordance with AIAF guidelines with critical processes and inspections identified. Recommended Actions for high RPN totals are required.</td>
</tr>
<tr>
<td>8</td>
<td>Control Plan</td>
<td>AR</td>
<td></td>
<td></td>
<td></td>
<td>AR</td>
<td>Can be Cooper supplied format or AIAF compliant format.</td>
<td>Control Plan must be AIAF or comparable format that contains the same information. Must match the Flow Chart/FMEA process steps and describe the actions of each phase of the manufacturing process from receiving to shipping/warehouse. All CTQs and SPCs must be addressed within the corresponding process step. Any dedicated check/testing fixtures that are used will be identified along with the numbered characteristics it measures/verifies on the print. All CTQ's must be identified in the control plan.</td>
</tr>
<tr>
<td>9</td>
<td>Measurement System Analysis Studies</td>
<td>AR</td>
<td>AR</td>
<td>AR</td>
<td></td>
<td>AR</td>
<td>Cooper GRR format or any statistical package format for gage R&amp;R.</td>
<td>Require an analysis of the capability of all measuring tools identified in the Control Plan (in process or offline) used in the decision making process of normal production. As a minimum gauge R&amp;Rs, using percent of total tolerance must be included for all process tools used in determining acceptability of equipment measurement capability.</td>
</tr>
</tbody>
</table>

Cooper has both a Supplier Checklist and an Internal Quick Reference.
When is notification of change required?

- Suppliers are required to receive formal approval for changes.
- Cooper has a formal document called the **Supplier Change Request** to be used by suppliers for **ALL** potential changes.
- The SCR form allows for proper disposition of PPAP.
  - Must be approved by both Cooper purchasing and quality.
  - Can also be used for supplier changes that are driven internally!
  - Includes recommendations for the PPAP Level

Suppliers are required to notify Cooper of ANY intent to change!
When is notification of change required?

### Type of Change

(Select One)

1. Change to construction, material or component (L3)
2. New, additional or modified tools (L3)
3. Upgrade or rearrangement of existing tools (L2)
4. Tooling, production or equipment transferred to different site (L3)
5. Change of supplier or non-equivalent materials/services (L3)
6. Product when tooling has been inactive for 12 months (L2)
7. Product/process changes on components of the product (L4)
8. Change in test or inspection method (L4)
9. Bulk Material: New source of raw material (L2)
10. Change in product appearance attributes (L2)
11. Change in production process or method (L4)
12. Change of Sub Supplier or material source (L3)

Designations in () are the recommended PPAP Level submissions for this type of change.

Reference: Section 3 Table 3.1 on Page 13 of AIAG PPAP 4th edition (May 2006)

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### Cooper Requirements

**Purchasing**

- Timing: Plan Received
  - Yes [ ]
  - No [ ]
  - Date SCR Received

**Quality or Supplier Quality**

- PPAP Required?
  - Yes [ ]
  - No [ ]

- Level

- Due Date

**Process Audit**

- Engineering Consulted

- Engineer

- Date

**Additional Requirements**

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### Approval Signatures

**Purchasing Representative**

- Signature

- Date

**Quality Representative**

- Signature

- Date

Mandatory Distribution: Plant Operations, Plant Quality, Purchasing, Supplier Quality and Engineering

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Reference: Section 3 Table 3.1 on Page 13 of AIAG PPAP 4th edition (May 2006)
Completing the PPAP Submission
Cooper Industries requires that all PPAPs be submitted electronically.

- **Preferred Method**: Use a designated FTTP site for downloading.
- **Alternate Method**: Send file(s) via email in PDF or Native Format.

Use of a paper or email submission must have prior approval by the authorized SQ or Quality representative.

Submission must be received prior to the PPAP due date.

**Recommendation:**
- Review and Approval process will be managed by each Cooper division.
- Each Cooper Division will determine how to apply “status” of a submission.

**Cooper requires all submissions to be electronic**
Cooper Industries has created a free “PPAP Kit” for suppliers
- Contains all of the forms required for submission
  - Cooper can control the content of the requirement
  - The forms can be given out without copyright concerns
  - Some needs are not addressed on the AIAG forms.
- Includes instruction on the use of the forms through field comments.
- Fully compliant with the AIAG 4th edition PPAP standard.
- Includes this training presentation, PPAP manual and the forms kit

- Two forms are mandatory for submission to Cooper
  - Cooper PSW page
  - Cooper Dimensional Data Page

- All other requirements can be met by using either:
  - The additional forms in the kit (Preferred Method)
  - Forms consistent with AIAG guidelines

The Cooper PPAP Kit contains everything required for submission
Individual PPAP Elements

The Requirements of a PPAP Submission
Element 1 Part Submission Warrant

Purpose:
- To document part approval
- To provide key information
- To declare (warrant) that the parts meet specification

All submissions must have a Cooper PSW Warrant
- Must be completely and accurately filled out
- Part numbers must be consistent with the Cooper PO
- Suppliers are not authorized to send parts until warrant is signed by Cooper
  - Suppliers must not ship to a production PO without an approved warrant
  - Can have email approval by a designated quality member

The approved PSW officially warrants the parts ready for production
Part Submission Warrant

REQUESTED SUBMISSION LEVEL (Check one)

☐ Level 1 - Warrant only submitted to the customer (Applied to non-critical parts and raw bulk material)
☐ Level 2 - Warrant with product samples and limiting support data. (Applied to critical bulk product and simple changes)
☐ Level 3 - Warrant with product samples and complete supporting data. (Applied to new parts on Cooper programs) DEFAULT COOPER SUBMISSION LEVEL
☐ Level 4 - Warrant and other requirements as defined by Cooper (Applied only with prior approval from Cooper... special situations only)
☐ Level 5 - Warrant with product samples and complete supporting data reviewed at supplier's manufacturing location. (Applied only with onsite review)

SUBMISSION RESULTS
The results for:
☐ dimensional measurements
☐ material and functional tests
☐ appearance criteria
☐ statistical process package

These results meet all drawing and specification requirements: %YES %NO (If "NO" - Explanations Required in Explanation/Comments section below)

Is this a multicavity tool? %YES %NO How many Cavities/Spindles (for molds or dies)? ______ Number of parts submitted by cavity/spindle _______________

DECLARATION
I affirm that the samples represented by this warrant are representative of our parts, have been made to the applicable Production Part Approval Process Manual 4th Edition requirements. I further warrant these samples were produced with the specified materials on regular production tooling with no operations other than the regular production process. The data and samples were produced at the production rate of ______ parts in ______ hours on ______. Any deviations to the warrant submission are noted below in the explanation/comments section.

EXPLANATION/COMMENTS: ____________________________

Print Name: ____________________________ Job Title: ____________________________ Phone No: ______________ Fax: No ______________

Supplier Authorized Signature: ____________________________ Date ______________ Email: ____________________________

FOR COOPER INDUSTRIES USE ONLY

Initial Part Warrant Disposition: %Quality / Supplier Quality ________ Date ______________
☐ Interim ________ Expires: ______________
☐ Quality / Supplier Quality Management ________ Date ______________

Final Part Warrant Disposition: ________ Approved ________ Rejected ________ Quality or Supplier Quality ________ Date ______________

Print Approver Name: ____________________________ Cooper PPAP Tracking Number: ____________________________
Reviewer’s Checklist

- Must be completely filled out
- Must be signed by the supplier
- Part# must match the PO and SAP
- Submitted at the correct revision level
- Submitted at the correct submission level
- Specify the number of parts, rate and date of run

The reviewer’s checklist is available for each element
E2 Design Records and & Bubbled Part Prints

Purpose:
- To document & provide a copy of the formal part print.
  - All part prints must have clearly defined CTQ's
  - To provide any additional engineering records for reference.

All submissions should have one copy of the formal print
- Bubble print that supports the dimensional report.
  - Must have all notes and specifications circled and numbered.
  - Must be clear and legible.

Any additional supporting information including
- Reference prints
- Sub-assembly prints
- Component prints with a different part number
- Applicable specifications
Print bubble number must correspond to the “Item” number on the Dimensional
## Reviewer’s Checklist

- Must be a clean and legible “Bubble” print
- Must be correct Cooper Part # and Revision
- Every requirement must have a separate bubble
  - Dimensions
  - Notes
  - CTQ’s are identified
  - Referenced specifications
- Verify that no other prints need to be submitted
  - Sub-assemblies
  - Component level detail
E3 Approved Engineering Change Documentation

Purpose:
- To provide any pertinent change information for reference

This is a placeholder for all relevant information not covered in the part print.
- ECN’s
- Specifications
- Feasibility studies
- Supplier Change Requests
- Emails
- Sub assembly drawings
- Life or reliability testing requirements

This element is used when changes occur to the design documentation.
Reviewer’s Checklist

- Cooper ECNs must be approved, not pending.
- Print change submissions must have current prints.
- Mark up prints are not acceptable for PPAP.
- Supplier initiated changes must have approved Supplier Change Request (SCR) form in this section.
- Emails can only clarify requirements, not define them.
- Emails cannot re-define a requirement in lieu of an upcoming print change.

**Example:** I am submitting REV A even though a REV B print is coming because this email requested me to make the change.  
**Answer:** Then submit PPAP to REV B, Not REV A
Purpose:
- To demonstrate pre-approval by Cooper’s customers of a design
- *Not currently required for Cooper PPAP Submissions.*
DFMEA
DESIGN Failure Mode and Effects Analysis

PFMEA
PROCESS Failure Mode and Effects Analysis

AIAG FMEA

Click for AIAG Training

Click for AIAG Manual
E5 Design FMEA (DFMEA)

- **Purpose:** To show evidence that potential failure modes and risk have been addressed at the design level.
- Required only when the part is designed by the supplier.
- DFMEA must follow AIAG FMEA guidelines
  - Must use an AIAG compliant format (Cooper format preferred)
- Must incorporate all design CTQ characteristics.
- A single design FMEA can be applied to a family of parts.
- DFMEA can be proprietary and if there is a concern notify Quality.

DFMEA highlights and reduces design risks
### E5 Design FMEA (DFMEA) EXAMPLE

#### Potential Failure Mode and Effects Analysis (Design FMEA)

<table>
<thead>
<tr>
<th>Item</th>
<th>Potential Failure Mode</th>
<th>Potential Cause(s) of Failure</th>
<th>Severity</th>
<th>Occur</th>
<th>Current Design Controls Prevention</th>
<th>Current Design Controls Detection</th>
<th>Detect</th>
<th>Recommened Action(s)</th>
<th>Responsibility &amp; Target Completion Date</th>
<th>Action Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Front Door L.H. HBX-0050-A</td>
<td>Corroded interior lower door panels</td>
<td>Deteriorated life of door leading to: Unsatisfactory appearance due to rust through paint over time Impaired function of interior door hardware</td>
<td>7</td>
<td>6</td>
<td>Vehicle general durability test veh.</td>
<td>T-118</td>
<td></td>
<td>Add laboratory accelerated corrosion testing</td>
<td>8X-09-30</td>
<td>2 2 28</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ingress to and egress from vehicle</td>
<td></td>
<td></td>
<td></td>
<td>T-109</td>
<td>294</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Occupant protection from weather, noise, and side impact</td>
<td></td>
<td></td>
<td></td>
<td>T-331</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Support anchorage for door hardware including mirror, hinges, latch and window regulator</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Provide proper surface for appearance items</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Paint and soft trim</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Inappropriate wax formulation specified</td>
<td>2</td>
<td></td>
<td>Physical and Chem Lab Test - Report No. 1205</td>
<td></td>
<td>2</td>
<td>None</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Entrapped air prevents wax from entering comolide access</td>
<td>5</td>
<td></td>
<td>Design aid investigation with non-functioning spray head</td>
<td>260</td>
<td></td>
<td>Add team evaluation using production spray equipment and specified wax</td>
<td>Body Engng &amp; Assy Ops 8X-11-15</td>
<td>3 1 21</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Insufficient room between panels for spray head access</td>
<td>4</td>
<td></td>
<td>Drawing evaluation of spray head access</td>
<td>112</td>
<td></td>
<td>Add team evaluation using design aid booth and spray head</td>
<td>Body Engng &amp; Assy Ops 8X-60-14</td>
<td>1 1 7</td>
</tr>
</tbody>
</table>
## E5 Design FMEA (DFMEA) Template

### Potential Failure Modes and Effects Analysis

**Design FMEA**

**Print #:**

<table>
<thead>
<tr>
<th>Item/Function</th>
<th>Potential Failure Mode</th>
<th>Potential Effects of Failure</th>
<th>Severity</th>
<th>Potential Cause(s)/Failure Mechanisms</th>
<th>CCC</th>
<th>Current Product Controls</th>
<th>DET</th>
<th>RPN</th>
<th>Recommended Action(s)</th>
<th>Responsibility and Completion Date</th>
<th>Action Results</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</table>
Reviewer’s Checklist

- DFMEA is only required if designed by the supplier.
- Address all Critical to Quality (CTQ) characteristics.
- Show evidence of an objective design evaluation.
- Document review by a team, not a single engineer.
- Date should show release prior to print release.
- Severity, Occurrence and Detection must be compliant with AIAG guidelines.
- Must take the technical/physical limits of the manufacturing/assembly process into consideration.
E6 Process Flow Diagrams

Purpose:
- To document the entire manufacturing process for a part
- To clarify the steps in manufacturing the part.

Process flows must include:
- The entire manufacturing process (receiving through shipping)
- All key steps in the process
- All offline activities (such as measurement, inspection and handling)
- Should identify areas containing nonconforming material
  - Scrap, defective and rework parts

Process Flow can be provided in any format used within an organization
- Primary process steps must match both the Control plan and the PFMEA

The process flow should clearly identify each step in the process
E6 Process Flow Diagrams Examples
Reviewer’s Checklist

✓ Process Flow must identify each step in the process
   ▪ Each Line item step in the flow numbered
   ▪ Match both PFMEA and Control Plan

✓ Should include abnormal handling processes
   ▪ Scrap
   ▪ Rework

✓ Process Flow must include all phases of the process
   ▪ Receiving of Raw Material
   ▪ Part Manufacturing
   ▪ Offline inspections and checks
   ▪ Shipping
   ▪ Assembly
E7 Process FMEA (PFMEA)

- **Purpose:** To show evidence that failure mode and risk have been assessed at the Manufacturing Process level.

- Can be on the AIAG format or internal format as long as it complies with the AIAG standard.
  - Cooper has provided an excel format in the PPAP kit.

- Should be performed for every part, piece of equipment or process involved in manufacturing.

- Evidence that high RPNs are addressed with action!

Should be performed internally, updated routinely & reviewed periodically.
Cooper PFMEA has “comments” that include important ranking information.
### E7 Process FMEA (PFMEA)

#### Examples of PFMEA Mistakes

<table>
<thead>
<tr>
<th>Potential Failure Mode</th>
<th>Potential Effect(s) of Failure</th>
<th>Potential Cause(s) of Failure</th>
<th>Current Controls</th>
<th>Severity</th>
<th>Occurrence</th>
<th>Detection</th>
<th>RPN</th>
<th>Repair or</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change speed/stop</td>
<td>Cure/scrap</td>
<td>Drive failure</td>
<td>Setup,Pre-control (D)</td>
<td>6</td>
<td>2</td>
<td>3</td>
<td>36</td>
<td>Repair or</td>
</tr>
<tr>
<td>Wire slips</td>
<td>Run togetherers</td>
<td>Air pressure too low</td>
<td>Visual,Oven Wreck (D)</td>
<td>5</td>
<td>2</td>
<td>3</td>
<td>30</td>
<td>Install run alarms</td>
</tr>
<tr>
<td>Wrong amount</td>
<td>Out of spec.</td>
<td>Setting/failure/wrong medium/worn</td>
<td>Lube test (D)</td>
<td>5</td>
<td>2</td>
<td>6</td>
<td>60</td>
<td>Repair or</td>
</tr>
<tr>
<td>Wrong lube</td>
<td>Out of Specification</td>
<td>Setting up Wrong</td>
<td>Visual,MWP training (D)</td>
<td>7</td>
<td>1</td>
<td>5</td>
<td>35</td>
<td>Use corre</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rating</th>
<th>Criteria</th>
<th>Suggested Detection Methods</th>
<th>Detection Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Absolute Certainty of non-detection</td>
<td>Cannot detect or is not checked</td>
<td>ALMOST IMPOSSIBLE Manual</td>
</tr>
<tr>
<td>9</td>
<td>Controls will probably not detect</td>
<td>Control is achieved with indirect or random checks</td>
<td>VERY REMOTE Manual</td>
</tr>
<tr>
<td>8</td>
<td>Controls have poor chance of detection</td>
<td>Control is visual inspection only</td>
<td>REMOTE Manual</td>
</tr>
<tr>
<td>7</td>
<td>Controls have poor chance of detection</td>
<td>Control is 2X visual inspection</td>
<td>VERY LOW Manual</td>
</tr>
<tr>
<td>6</td>
<td>Controls may detect</td>
<td>Control is achieved with charting (SPC)</td>
<td>LOW Gauging Manual</td>
</tr>
<tr>
<td>5</td>
<td>Controls may detect</td>
<td>Control is based on 100% gauging</td>
<td>MODERATE Gauging</td>
</tr>
<tr>
<td>4</td>
<td>Controls have a good chance to detect</td>
<td>Error detection in subsequent steps or gauging performed on setup &amp; first piece</td>
<td>MODERATELY HIGH Error Proof, Gauging</td>
</tr>
<tr>
<td>3</td>
<td>Controls have a good chance to detect</td>
<td>Error detection in station or in subsequent steps, cannot accept bad part</td>
<td>HIGH Error Proof, Gauging</td>
</tr>
<tr>
<td>2</td>
<td>Controls almost certain to detect</td>
<td>Error detection in station (auto gauging with stop) cannot pass bad part</td>
<td>VERY HIGH Error Proof, Gauging</td>
</tr>
<tr>
<td>1</td>
<td>Controls certain to detect</td>
<td>Bad parts cannot be made because of error product or process design</td>
<td>VERY HIGH Error Proof</td>
</tr>
</tbody>
</table>
### Examples of PFMEA Mistakes

<table>
<thead>
<tr>
<th>Process or Product Function</th>
<th>Potential Failure Mode</th>
<th>Potential Effects of Failure</th>
<th>SEV</th>
<th>Potential Cause(s)/Mechanism(s) of Failure</th>
<th>OCC</th>
<th>REACT</th>
<th>CURRENT Process Controls</th>
<th>DP</th>
<th>ED</th>
<th>RP</th>
<th>PN</th>
<th>Recommended Action(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>May endanger machine or operator. Hazardous WITHOUT warning.</td>
<td>May endanger machine or operator. Hazardous WITHOUT warning.</td>
<td>EXTREME</td>
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<tr>
<td>9</td>
<td>Item inoperable/major process disruption. Loss of primary function. 100% scrap or long repair.</td>
<td>Item inoperable/major process disruption. Loss of primary function. 100% scrap or long repair.</td>
<td>VERY HIGH</td>
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<tr>
<td>8</td>
<td>Item operable but at a reduced level of performance. Product requires sorting with some scrap.</td>
<td>Item operable but at a reduced level of performance. Product requires sorting with some scrap.</td>
<td>HIGH</td>
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<tr>
<td>7</td>
<td>Item operable but comfort/convenience inoperable. No sorting, some portion scrapped or repaired.</td>
<td>Item operable but comfort/convenience inoperable. No sorting, some portion scrapped or repaired.</td>
<td>MEDIUM</td>
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<tr>
<td>6</td>
<td>Minor defect noticed by most customers (75% or more). No scrap. May require sorting or rework.</td>
<td>Minor defect noticed by most customers (75% or more). No scrap. May require sorting or rework.</td>
<td>MEDIUM</td>
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<tr>
<td>5</td>
<td>Minor defect noticed by some customers (Up to 50%) Some off-line rework but with no scrap.</td>
<td>Minor defect noticed by some customers (Up to 50%) Some off-line rework but with no scrap.</td>
<td>LOW</td>
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<tr>
<td>4</td>
<td>Minor defect noticed by discriminating customers (25% or less) In-Line rework with no scrap.</td>
<td>Minor defect noticed by discriminating customers (25% or less) In-Line rework with no scrap.</td>
<td>NONE</td>
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</table>

**How Severe is the effect to the customer?**

- **10**: May endanger machine or operator. Hazardous WITHOUT warning.
- **9**: May endanger machine or operator. Hazardous WITHOUT warning.
- **8**: Item inoperable/major process disruption. Loss of primary function. 100% scrap or long repair.
- **7**: Item operable but at a reduced level of performance. Product requires sorting with some scrap.
- **6**: Item operable but comfort/convenience inoperable. No sorting, some portion scrapped or repaired.
- **5**: Minor defect noticed by most customers (75% or more). No scrap. May require sorting or rework.
- **4**: Minor defect noticed by some customers (Up to 50%) Some off-line rework but with no scrap.
- **3**: Minor defect noticed by discriminating customers (25% or less) In-Line rework with no scrap.
- **2**: No Effect

---

Note: The table and text are translated into English. The table details potential failure modes, effects, causes, and recommended actions for various scenarios.

Example:

- **Process**: Soldering wire connecting
- **Failure Mode**: 1. Soldering wire disconnected
- **Effects**: 1. Damage to control gear
- **Cause**: 1. Poor soldering technique
- **Recommended Action**: Solder wire properly.
E7 PFMEA Exercise

In class exercise For PFMEA

---

### Potential Failure Modes and Effects Analysis (PFMEA)

<table>
<thead>
<tr>
<th>Process/Function</th>
<th>Potential Failure Mode</th>
<th>Potential Effects of Failure</th>
<th>Current Process Controls</th>
<th>Recommended Actions</th>
<th>Responsibility and Completion Date</th>
<th>Action Results</th>
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</table>

**How Severe is the effect to the customer?**

| 1 | Key endanger machine or operator. Hazardous WITHOUT warning. | EXTREME |
| 2 | Key endanger machine or operator. Hazardous WITH warning.  | EXTREME |
| 3 | Item inoperable/major process disruption. Loss of primary function. 100% scrap or long repair. | VENT HIGH |
| 4 | Item defective at a lower level of performance. Product requires sorting with some scrap. | MIRROR |
| 5 | Item defective at comfort/convenience at reduced level of performance. 100% rework or repair. | MODERATE |
| 6 | Minor defect notified by all customers (75% or more). No scrap, may require sorting or rework. | MODERATE |
| 7 | Minor defect notified by some customers (50 to 75%). Some off-line rework but with no scrap. | MODERATE |
| 8 | Minor defect notified by discriminating customers (25% or less). In-Line rework with no scrap. | LOW |
| 9 | No Effect                                                   | NONE |
Reviewer’s Checklist

- Address all Critical to Quality characteristics CTQ.
- Verify there is a system for prioritizing risk of failure such as top 25 or 33% of RPN numbers.
- Show evidence of an objective process evaluation.
- Discourage suppliers from setting RPN thresholds arbitrarily.
- Evidence of cross functional participation.
- Severity, Occurrence and Detection must be compliant with AIA guidelines and scored within reason.
- Discourage suppliers from setting RPN thresholds as arbitrary scoring becomes biased.
- Make sure that all critical failure modes are addressed and the action will actually have impact.
- Make sure that high RPN process concerns are carried over into the control plan.

Safety
Form, Fit, Function
Material concerns
### E& PFMEA Exercise

**In class exercise For PFMEA**

| Design Failure Mode(s) | Occurrence | Detection | Severity | Likelihood | Action
|------------------------|------------|-----------|----------|------------|-------
| 10 Key endanger machine or operator. Hazardous WITHOUT warning. | EXTREME | |=|=|=|
| 9 Key endanger machine or operator. Hazardous WITH warning. | ESCAPE | |=|=|=|
| 8 Item inoperable/major process disruption. Loss of primary function. 100% scrap or long repair. | HIGH | |=|=|=|
| 7 Item operable but at a reduced level of performance. 100% rework or repair. | HIGH | |=|=|=|
| 6 Item operable but comfort/convenience is inoperable. No sorting, some portion scrapped or repaired. | HIGH | |=|=|=|
| 5 Item operable but comfort/convenience at reduced level of performance. 100% rework or repair. | MODERATE | |=|=|=|
| 4 Minor defect noticed by most customers (75% or more). No scrap, may require sorting or rework. | MODERATE | |=|=|=|
| 3 Minor defect noticed by some customers (8% to 50%). Some off-line rework but with no scrap. | MODERATE | |=|=|=|
| 2 Minor defect noticed by discriminating customers (25% or less) In-Line rework with no scrap. | MODERATE | |=|=|=|
| 1 No Effect | NONE | |=|=|=|

**Potential Failure Modes and Effects Analysis (PFMEA)**

<table>
<thead>
<tr>
<th>Potential Failure Mode (P)</th>
<th>Potential Effects of Failure</th>
<th>Potential Causes/Failure Mechanisms</th>
<th>Current Process Controls</th>
<th>Recommended Actions</th>
<th>Responsibility and Completion Date</th>
<th>Action Results</th>
</tr>
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</table>

**COOPER**

*Please include PHMEC:
- A designated PMF考核 for this process
- A target percentage of steps to be addressed
- Check boxes*
Examples of typical PFMEA Mistakes

- Misapplication of Severity, Occurrence and Detection
- Redefining Severity, Occurrence and Detection
- Over estimating the effectiveness of a “Recommended Action”
- Applying thresholds.
- Not recognizing all potential failures.
- Failure to properly identify the customer.
- Misapplication of ranking scales.
- Confusing Failure Modes with Effects or Failure Modes with Causes.
- Allowing the PFMEA to turn into a design review.
Purpose: A structured approach for the design, selection and implementation of control methods used in producing a part.

- All process must have a control plan that defines all methods used for process control and complies with customer-specified requirements.
- Can be on the Cooper supplied format or AIAG compliant.
- Control Plan should list all operations used in the process.
- Control Plans must address and include all print CTQ’s.
- Suppliers should also include other details they know to be vital to the process.

Control Plans are critical for planning a robust process.
A **Control Plan** defines the operations, processes, materials, equipment, methodologies, and CTQs (as determined by Cooper and suppliers) integral to the manufacturing process. Its purpose is to communicate the supplier’s decisions during the entire manufacturing process from materials purchase through final packaging.

Specifically, the control plan should address the following:
- Methods of production
- **Identification of CTQ characteristics’ controls**
- Secondary or outsourced operations
- Materials and their physical and chemical characteristics
- Types of process equipment at each operation
- Types of test equipment used to measure each characteristic
- **Specifications, sampling strategy, control and reaction methods used**
- **Periodic conformance testing and product verification**

Control Plans address all key process steps
## Control Plan

<table>
<thead>
<tr>
<th>Control Plan Number</th>
<th>Key Contact / Phone</th>
<th>Date (Org)</th>
<th>Current Release Level</th>
<th>Current Release Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part Number/ Latest Change (Rev) Level</td>
<td>Part Description</td>
<td>Supplier Code</td>
<td>Plant Location</td>
<td></td>
</tr>
<tr>
<td>Core Team</td>
<td>Supplier Name</td>
<td>Quality Department Approval</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Customer Engineering Approval / Date (If Req'd)</td>
<td>Supplier Plant Approval</td>
<td>Other Approval / Date (If Req'd)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>PROCESS NAME / OPERATION DESCRIPTION</th>
<th>MACHINE DEVICES / JIG / TOOLS FOR MANUFACTURING</th>
<th>CHARACTERISTICS</th>
<th>SPECIAL CHAR.</th>
<th>PRODUCT / PROCESS / SPECIFICATION / TOLERANCE</th>
<th>EVALUATION / MEASUREMENT TECHNIQUE</th>
<th>SAMPLE</th>
<th>CONTROL METHOD</th>
<th>REACTION PLAN</th>
</tr>
</thead>
<tbody>
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</tbody>
</table>
What is your opinion of these Control Plans

<table>
<thead>
<tr>
<th>Operation No.</th>
<th>Description</th>
<th>Machine</th>
<th>Characteristics</th>
<th>Specification</th>
<th>Class</th>
<th>Measurement system (evaluation method)</th>
<th>Sample</th>
<th>Present control method</th>
<th>Reaction plan &amp; Corrective action</th>
<th>Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>Boss ID min.</td>
<td>24.21 ± 0.12</td>
<td>CTQ</td>
<td>Vernier 6 nos. Each die approval</td>
<td>FPI</td>
<td></td>
<td>Discuss in MDI, correct &amp; take another trial</td>
<td>Head UL lab</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Boss ID max</td>
<td>24.46 ± 0.12</td>
<td>CAQ</td>
<td>Vernier 5 nos. Each die approval</td>
<td>FPI</td>
<td></td>
<td>Discuss in MDI, correct &amp; take another trial</td>
<td>Head UL lab</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Cover mounting hole dia.</td>
<td>4.47 ± 0.12</td>
<td>Vernier 5 nos. Each setting Setup approval</td>
<td>FPI</td>
<td></td>
<td>Change pin, reset</td>
<td>Supervisor</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Cover mounting hole PCD across length</td>
<td>79.31 ± 0.12</td>
<td>CTQ</td>
<td>Vernier 5 nos. Each die approval</td>
<td>FPI</td>
<td></td>
<td>Discuss in MDI, correct &amp; take another trial</td>
<td>Head UL lab</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Cover mounting hole PCD across width</td>
<td>27.99 ± 12</td>
<td>CTQ</td>
<td>Vernier 5 nos. Each die approval</td>
<td>FPI</td>
<td></td>
<td>Discuss in MDI, correct &amp; take another trial</td>
<td>Head UL lab</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Cover mounting hole distance from base side</td>
<td>0.20 ± 0.12</td>
<td>CTQ</td>
<td>Vernier 5 nos. Each die approval</td>
<td>FPI</td>
<td></td>
<td>Discuss in MDI, correct &amp; take another trial</td>
<td>Head UL lab</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Boss ID angle</td>
<td>1.50 ± 0.50°</td>
<td>CTQ</td>
<td>Vernier 5 nos. Each die approval</td>
<td>FPI</td>
<td></td>
<td>Discuss in MDI, correct &amp; take another trial</td>
<td>Head UL lab</td>
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<tr>
<td>9 ± 10</td>
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<td></td>
<td>Flash</td>
<td>No flash</td>
<td>vis</td>
<td>visual 100% per lot Operator self inspection</td>
<td>Check the parameter correct as per process parameter sheet</td>
<td>operator / supervisor</td>
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<td>Non-filling</td>
<td>No non-filling</td>
<td>vis</td>
<td>visual 100% per lot Operator self inspection</td>
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<td>operator / supervisor</td>
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<td>Metal temp.</td>
<td>560 ± 20°</td>
<td>CTQ</td>
<td>Temp. indicator Once every hr Supervisor inspection</td>
<td>Check the parameter correct as per process parameter sheet</td>
<td>operator / supervisor</td>
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<td></td>
<td>Start of first shot</td>
<td>200 ± 5</td>
<td>SC</td>
<td>Display on control panel Once Start of each shift Operator self inspection</td>
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<td>operator / supervisor</td>
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<td>Injection age</td>
<td>90 ± 100</td>
<td>sc</td>
<td></td>
<td>Check the parameter correct as per process parameter sheet</td>
<td>operator / supervisor</td>
<td></td>
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</tbody>
</table>
CTQ Characteristic:

- A critical **PART** requirement specified on a controlling document (typically an engineering drawing or specification)
- A critical **PROCESS** requirement identified by Customer or Supplier.
- Directly represents the safety, regulatory, or primary functional performance requirements by the end customer or business
- Requires verification of part conformance during first production.
- Requires documented evidence of *process control* to maintain part conformance through the life of the product

CTQ’s identify critical Cooper requirements
AIAG APQP
(contains the Control Plan Methodology and concepts)
Reviewer’s Checklist

- Control Plan requires highest degree of scrutiny!
  - Must define a robust level of process control!
  - Dimensional
  - Material
  - Performance
- Address every Critical To Quality characteristic
- Address all product and process characteristics at every step throughout the process.
- Effective reaction plans that control the process
  - The "Control Method" should be based on an effective analysis of the process such as:
    - Periodic Dimensional confirmation
    - Error proofing
    - Performance testing
  - Must address periodic performance testing
- Can and should reference other documentation
  - Specifications
  - Tooling
- Good Control Plans address all testing requirements
E9 Measurement System Analysis (MSA)

- **Purpose:** Measurement system analysis (MSA) is a mathematical method of determining how much the variation within the measurement process contributes to overall process variability.

- **Importance:**
  - Ensures we are using the right measurement system for running production. There are two fundamental questions:
    - Are we using the right gage?
    - Are we using it correctly?
  - Measurement variation can make our processes look worse than they really are with respect to capability.

Reduces the opportunity for passing a bad part & rejecting a good part
**E9 Measurement System Analysis (MSA)**

- Detail on **MSA** is found in the AIAG manual (3rd Edition) which defines guidelines for:
  - Stability
  - Bias
  - Linearity
  - Repeatability and Reproducibility.

- Cooper requires an analysis of the capability of **ALL** measurement tools identified in the Control Plan. *(in process and offline gages)*

- Minimum requirement for Cooper Suppliers are:
  - Gage R&R study using Total Tolerance on **each** measurement tool.
    - % R&R should be at 10% or less **for CTQ’s**
    - Marginal gages (between 10% and 30%)*
    - Gages with R&R at 30% or more cannot be used.

*Note: must have an action plan!*
Repeatability (Gage precision)
- The variation in measurements obtained with one gage when used several times by an operator while measuring the identical characteristic on the same part.
- Referred to as Equipment Variation in a Gage R&R study.

Reproducibility (Operator precision)
- The variation in the average of the measurements made by different operators using the same gage when measuring a characteristic on one part.
- Referred to as Operator Variation in a Gage R&R Study.
GRR is the combined estimate of measurement system **Repeatability** and **Reproducibility**.

- Typically we perform a 2 or 3 person study
  - Each person randomly measures 10 marked parts per trial
  - Each person can perform up to 3 trials

- Typically we look at three key indicators in the study
  - **EV** or Equipment Variation
  - **AV** or Appraiser Variation
  - Overall % **GRR** *(TV or Total Tolerance)*
E9 (MSA) Cooper Gage R&R Form

**GR&R Study - Multiple Operators**

For use with testing gage systems meant to evaluate features or processes whose output is measured numerically, and for which two to three operators are expected to conduct the evaluation.

---

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Supplier Name</th>
<th>Date</th>
<th>Supplier Address</th>
<th>Supplier Contact</th>
</tr>
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<tbody>
<tr>
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<table>
<thead>
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<th>Supplier Contact</th>
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<table>
<thead>
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<th>Gage ID:</th>
<th>Unit of Measure:</th>
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**Other Information**

**Calibration Date:**

**Gage Type:**

**Gage ID:**

**Unit of Measure:**

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<tr>
<th>Operator 1 Name</th>
<th>Operator 2 Name</th>
<th>Operator 3 Name</th>
<th>Goh!</th>
</tr>
</thead>
<tbody>
<tr>
<td>John Doe</td>
<td>Jane Doe</td>
<td>Doh!</td>
<td></td>
</tr>
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**USL**

**LSL**

**Number of Trials:**

<table>
<thead>
<tr>
<th>Operator 1 Name</th>
<th>Operator 2 Name</th>
<th>Operator 3 Name</th>
<th>Goh!</th>
</tr>
</thead>
<tbody>
<tr>
<td>John Doe</td>
<td>Jane Doe</td>
<td>Doh!</td>
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**Number of Operators:**

3

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<th>Range</th>
<th>1st Trial</th>
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</tr>
</tbody>
</table>

**Gage R&R Summary**

**Measurement Unit Analysis**

Repeatability: %EV = #DIV/0!
Reproducibility: %AV = #DIV/0!
R&R: %DIV/0!
Part Variation: %PV = #DIV/0!
Total Variation: %TV = #DIV/0!

<table>
<thead>
<tr>
<th>% Process Variation (TV)</th>
<th>% Tolerance Variation (TOL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Equipment Variation (EV)</td>
<td>#DIV/0!</td>
</tr>
<tr>
<td>% Appraiser Variation (AV)</td>
<td>#DIV/0!</td>
</tr>
<tr>
<td>%GR&amp;R (GR&amp;R)</td>
<td>#DIV/0!</td>
</tr>
<tr>
<td>%Part Variation (PV)</td>
<td>#DIV/0!</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>GR&amp;R &amp; R %</th>
<th>Disposition</th>
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<tbody>
<tr>
<td>&lt; 10</td>
<td>Pass - Gage System is Useable</td>
</tr>
<tr>
<td>10 ≤ GR&amp;R % ≤ 30</td>
<td>Gage System is useable but marginal</td>
</tr>
<tr>
<td>&gt; 30</td>
<td>Fail - Gage System is Unstable</td>
</tr>
</tbody>
</table>

**Gage R&R Disposition**

#DIV/0!
### E9 (MSA) Cooper Gage R&R Example

**Table: Gage R&R Data**

<table>
<thead>
<tr>
<th>Part #</th>
<th>1st Trial</th>
<th>2nd Trial</th>
<th>3rd Trial</th>
<th>Range</th>
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<td>0.088</td>
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<td></td>
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</tbody>
</table>

**Gage R&R Disposition**

- **Disposition**
  - GR&R<sub>TOL</sub>% < 10
  - 10 \leq GR&R<sub>TOL</sub>% \leq 30
  - GR&R<sub>TOL</sub>% > 30

- **Disposition**
  - Pass - Gage System is Useable
  - Gage System is useable but marginal
  - Fail - Gage System is Unstable

**Variance Components**

<table>
<thead>
<tr>
<th>Variance Component</th>
<th>% Variation</th>
<th>% Variation</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Equipment Variation (EV&lt;sub&gt;TOL&lt;/sub&gt;)</td>
<td>43.56%</td>
<td>12.71%</td>
</tr>
<tr>
<td>% Appraiser Variation (AV&lt;sub&gt;TOL&lt;/sub&gt;)</td>
<td>40.00%</td>
<td>11.93%</td>
</tr>
<tr>
<td>% GR&amp;R (GR&amp;R&lt;sub&gt;TOL&lt;/sub&gt;)</td>
<td>59.73%</td>
<td>17.43%</td>
</tr>
<tr>
<td>% Part Variation (PV&lt;sub&gt;TOL&lt;/sub&gt;)</td>
<td>80.20%</td>
<td>12.71%</td>
</tr>
</tbody>
</table>

**Number of Trials:** 3

**Number of Operators:** 3

---

**Notes:**

- The table above shows the Gage R&R data for three operators and three trials per part.
- The Gage R&R Disposition evaluates the gage system based on the GR&R<sub>TOL</sub>% criteria.
- The variance components indicate the contribution of each source of variation to the total variation.
Reviewer’s Checklist

✓ If the gage/inspection affects quality then GRR must have a Gage R&R.
✓ Make sure the study is recent, less than 1 year.
✓ Key gages & inspection processes that are part of the manufacturing process against also a GRR.
✓ Make sure the study is recent, less than 1 year.
✓ Key gages & inspection processes that are part of the manufacturing process against also a GRR.
✓ Gage R&R results must follow the approval % > 30% must have corrective action.
✓ Should encourage suppliers to use total tolerance.
✓ Make sure discrimination vs tolerance makes sense.
 Rule: 1 level MORE than tolerance
Tolerance = .01, The gage should be .001
✓ Questions on the need for a GRR. Generally the answer to rate the gage: Measures a CTQ, Tolerance, .01. The gage should be .001.
✓ Must look at all of the following GRR study results %GR, %EV and %AV.
E9 (MSA) Gage R&R Study Example

- In class exercise with Gage R&R

### GR&R Study - Multiple Operators

For use with testing gage systems meant to evaluate features of processes whose output measured numerically, and for which two to three operators are expected to conduct the evaluation.

**Rev:** 1/17/01 Dave Olson

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Supplier Name</th>
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<td>Operator 1 Name</td>
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**USL:** **LSL:** Number of Totals: **Number of Operators:**

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<tr>
<td>8</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>9</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>10</td>
<td>0.000</td>
<td>0.000</td>
</tr>
</tbody>
</table>

### Gage R&R Summary

#### Measurement Unit Analysis

- Reproducibility: $\text{DIV/0!}$
- Repeatability: $\text{DIV/0!}$
- Part Variation: $\text{DIV/0!}$
- Total Variation: $\text{DIV/0!}$

#### % Process Variation (TV) / % Tolerance Variation (TV)

<table>
<thead>
<tr>
<th>% Equipment Variation (EV)</th>
<th>% Appraiser Variation (AV)</th>
<th>% Part Variation (PV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\text{DIV/0!}$</td>
<td>$\text{DIV/0!}$</td>
<td>$\text{DIV/0!}$</td>
</tr>
</tbody>
</table>

#### Gage R&R Disposition

<table>
<thead>
<tr>
<th>Disposition</th>
<th>#DIV/0!</th>
</tr>
</thead>
<tbody>
<tr>
<td>GR&amp;R% &lt; 10</td>
<td>Fail - Gage System is Unusable</td>
</tr>
<tr>
<td>10 ≤ GR&amp;R% ≤ 20</td>
<td>Gage System is usable but marginal</td>
</tr>
<tr>
<td>GR&amp;R% &gt; 30</td>
<td>Fail - Gage System is Unusable</td>
</tr>
</tbody>
</table>

### COOPER

[Image of a person throwing an arrow at a target]
**Purpose:** To show conformance to the customer part print on dimensions and all other noted requirements.

- Cooper requires a full dimensional layout of the part on all PPAP submissions except level 1.
- Dimensional report must be submitted on Cooper’s report format.
- The dimensional report must address all of the following:
  - All dimensions
  - All applicable notes that have variable dimensions (ex: tensile test)
  - Any dimensions contained on reference prints.
  - Tolerances that include bonus for Geometric Dimensioning & Tolerancing (GDT)

The dimensional report is evidence of conformance to print.
<table>
<thead>
<tr>
<th>ITEM#</th>
<th>Required</th>
<th>C/N</th>
<th>Description of Check</th>
<th>Measurement Method</th>
<th>REQUIREMENT: Target</th>
<th>Min</th>
<th>Max</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Y</td>
<td>Y</td>
<td>Width</td>
<td>CMM</td>
<td>22.36</td>
<td>N</td>
<td>21.60 22.60 22.360 22.410 22.320 22.190 22.000 22.380 22.450 22.420</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>N</td>
<td>Y</td>
<td>Hole Diameter</td>
<td>CMM</td>
<td>0.75</td>
<td>N</td>
<td>0.625 0.675 0.656 0.715 0.723 0.645 0.658 0.642 0.643 0.678</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>N</td>
<td>Y</td>
<td>True Position</td>
<td>CMM</td>
<td>0.5</td>
<td>Y</td>
<td>0.450 0.442 0.459 0.450 0.439 0.450 0.459 0.465</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Reviewer’s Checklist

- Ensure “Method” is on every measurement
- Identify all “methods” make sense for the dimension
- Make sure the dimensional report addresses all print requirements.
- With GDT callouts, make sure each requirement is listed as a line item with tolerances:
  - Example: 1. Hole diameter
  - 2. True Position (MMC) Bonus!
  - 3. Cylindricity
- Make sure you agree and question the dispositions.
- Make sure you understand what the CTQs are!
E11 Material, Performance Test Results

- Broad category for the majority of all test results.
  - Material Testing (ex: Material Composition Reports)
  - Performance testing (ex: EOL and offline final test results)
  - Life Test Results (ex: Summary of all life cycle testing performed on the part)

- Cooper requires results for all print requirements that require testing
  - 1. “Notes” that specify a requirement (tensile strength)
  - 2. “Specifications” detailed on a print. (ex: NEMA, CSA or UL specifications)

- Cooper requires the following for all submissions:
  - Material Confirmation in the form of lab data.
    - Preferred is COA Certificate of Analysis
  - Performance Testing (evidence of how the product performs).

Evidence of verification of Cooper’s test requirements
E11 AIAG Forms for Material and Performance

- Cooper does not require any specific format for test results.
  - Utilize in-house documents
  - Utilize the AIAG forms

- Primary concern is that we get results that:
  - Confirm the Material & Material Properties
  - Demonstrate Performance

- Some Cooper part prints do not define testing requirements
  - Consult with Engineering or Supplier Quality
  - Verify that no known standard testing is required

Make sure the need for a test plan has been evaluated
**E11 Examples of Material Test Results**

**Metallurgical Test Report**

**F.O. NUMBER 4725-04**

**SOLD TO:** 0242143 002
WEXCOIL INC.
SUITE 810
555 E. OCEAN BLVD
LONG BEACH, CA 90802

**MILL ORDER NUMBER NS51024**

**SHIP TO:**
WEXCOIL INC.
1495 COLUMBIA AVE. BLDG 2
RIVERSIDE, CA 92507

**PREPARED BY THE OFFICE OF:**
TOM LOYES
MANAGER QA SHEETS

**ON:**
DATE 03-26-2007
TIME 12:38:09

**SPEC:** GALVANIZED SHEETS ASTM A653-05A PS TYPE A, M IN.
SPANGEL, G40. CHEM TREAT: NO OIL 1/2 STD MIN GAUGE
TOLERANCE, 1/2 STANDARD FLATNESS TOLERANCE
.0345 MIN BASE METAL THICKNESS

**CERT:** THIS IS TO CERTIFY THAT THE MATERIAL DESCRIBED HEREBIN
WAS MANUFACTURED, SAMPLED, TESTED AND/OR INSPECTED
IN ACCORDANCE WITH THE STATED SPECIFICATION AND
FULFILLS SPECIFICATION REQUIREMENTS IN SUCH RESPECTS.

<table>
<thead>
<tr>
<th>MATERIAL DESCR.</th>
<th>HEAT TEST</th>
</tr>
</thead>
<tbody>
<tr>
<td>ITEM</td>
<td>THICKNESS</td>
</tr>
<tr>
<td>IDENT</td>
<td>NUMBER</td>
</tr>
</tbody>
</table>

| 04   | .0345 | MIN X 47.1250 | 036048 | GBT520 | 54  |
|      |       |               | 036048 | GBT524 | 54  |
|      |       |               | 036048 | GBT524 | 56  |
|      |       |               | 036048 | GBT524 | 60  |

**HEAT C**
- 036048: .01 .01 .002 .031 .002 .000 .000 .000 .002
- 036048: .015 .14 .009 .004 .000 .01 .01 .002 .003 .000 .000 .000 .001

**END-OF-REPORT**
C11 Examples of Performance Test Results

Frequency Response for 2.0 V Stepped Sine Input at .316 m
40 Pts/decade

<table>
<thead>
<tr>
<th>Freq (Hz)</th>
<th>Resp (dB)</th>
<th>Diff (dB)</th>
<th>Freq (Hz)</th>
<th>Resp (dB)</th>
<th>Diff (dB)</th>
<th>Freq (Hz)</th>
<th>Resp (dB)</th>
<th>Diff (dB)</th>
<th>Freq (Hz)</th>
<th>Resp (dB)</th>
<th>Diff (dB)</th>
<th>Freq (Hz)</th>
<th>Resp (dB)</th>
<th>Diff (dB)</th>
<th>Freq (Hz)</th>
<th>Resp (dB)</th>
<th>Diff (dB)</th>
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<tbody>
<tr>
<td>20</td>
<td>68.2</td>
<td>0.2</td>
<td>22.4</td>
<td>74.7</td>
<td>0.3</td>
<td>23.6</td>
<td>77.2</td>
<td>0.4</td>
<td>25</td>
<td>79.3</td>
<td>0.4</td>
<td>26.5</td>
<td>80.9</td>
<td>0.4</td>
<td>28</td>
<td>82.2</td>
<td>0.4</td>
</tr>
<tr>
<td>30.5</td>
<td>84.3</td>
<td>0.4</td>
<td>32.1</td>
<td>87.7</td>
<td>0.5</td>
<td>33.5</td>
<td>85.4</td>
<td>0.5</td>
<td>35.5</td>
<td>86.5</td>
<td>0.5</td>
<td>37.5</td>
<td>87.7</td>
<td>0.5</td>
<td>39.5</td>
<td>89.4</td>
<td>0.5</td>
</tr>
<tr>
<td>40</td>
<td>90.1</td>
<td>0.6</td>
<td>42.5</td>
<td>90.1</td>
<td>0.6</td>
<td>45</td>
<td>91.3</td>
<td>0.6</td>
<td>47.5</td>
<td>92.5</td>
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<td>93.5</td>
<td>0.7</td>
<td>53</td>
<td>94.5</td>
<td>0.7</td>
</tr>
<tr>
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<td>98.1</td>
<td>0.4</td>
<td>53</td>
<td>94.5</td>
<td>0.7</td>
<td>57</td>
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<td>59</td>
<td>97.6</td>
<td>0.5</td>
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<td>66</td>
<td>100</td>
<td>0.5</td>
</tr>
<tr>
<td>60</td>
<td>99.0</td>
<td>0.6</td>
<td>63</td>
<td>100</td>
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<td>71</td>
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<td>0.4</td>
<td>75</td>
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<td>0.4</td>
<td>80</td>
<td>99.0</td>
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<td>85</td>
<td>100</td>
<td>0.6</td>
</tr>
<tr>
<td>70</td>
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<td>0.2</td>
<td>106</td>
<td>99.8</td>
<td>0.2</td>
<td>112</td>
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<td>0.2</td>
<td>118</td>
<td>99.8</td>
<td>0.3</td>
<td>125</td>
<td>99.7</td>
<td>0.3</td>
<td>132</td>
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<td>0.3</td>
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<tr>
<td>80</td>
<td>100</td>
<td>0.1</td>
<td>100</td>
<td>99.8</td>
<td>0.1</td>
<td>100</td>
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<td>100</td>
<td>99.8</td>
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<td>0.0</td>
<td>95</td>
<td>99.7</td>
<td>0.0</td>
<td>95</td>
<td>99.7</td>
<td>0.0</td>
<td>95</td>
<td>99.7</td>
<td>0.0</td>
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<td>99.7</td>
<td>0.0</td>
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<td>99.7</td>
<td>0.0</td>
</tr>
<tr>
<td>100</td>
<td>99.6</td>
<td>0.3</td>
<td>95.4</td>
<td>99.6</td>
<td>0.3</td>
<td>95.4</td>
<td>99.6</td>
<td>0.3</td>
<td>95.4</td>
<td>99.6</td>
<td>0.3</td>
<td>95.4</td>
<td>99.6</td>
<td>0.3</td>
<td>95.4</td>
<td>99.6</td>
<td>0.3</td>
</tr>
</tbody>
</table>

Spec Sens = 100.2 dB [-0.7] Sens Freq (Hz): 250 315 400 500
Reviewer’s Checklist

- Utilize this section to get more information that could become a significant quality issue at a later date.

- Most parts have some type of material requirement so make suppliers prove they have a system for checking.

- Sometimes performance is not directly addressed via the part print and therefore.

- Material results should be compared against a known standard. Do not assume the test result spec is correct. Verify the correct specification (ex: ASTM xxxx) Verify the composition breakdown

- The resource for performance and functionality is

- Verifying design is not JUST for PPAP, it should be a periodic check that is identified in the CP.

- Always probe for the need to demonstrate performance if it is not on the print.
**E12 Initial Process Study (Cpk/Ppk)**

- **Purpose:** To determine if the production process is likely to produce product that will meet customer requirements.

- Required for all CTQ’s (Critical to Quality characteristics)

- If CTQ’s are not expressed, capability is still required!
  - Require the supplier to recommend what is critical in their process
  - Cooper Quality can review the print for key part characteristics
  - Finalize through your Cooper Quality Representative.

- Process studies are typically measured with capability or performance
  - Cp and Cpk are indices used to *estimate* potential process capability
  - Pp and Ppk are indices used to *measure* actual process performance

**Capability studies are critical for verifying that processes are in control!**
Subgroups is the preferred method of determining Cpk in most cases.
- Minimum is 25 subgroups
- Containing at least 100 readings
- Sampled consecutively from a “significant production run”

If testing involves destructive tests of expensive parts, Cpk by Moving Range can also be allowed.

Capability is preferred as follows unless otherwise defined:
- 1.67 or higher on all print CTQs
- 1.67 or higher on critical process characteristics
- 1.33 or higher as a default for all unspecified characteristics.

Cooper has provided Forms for Capability Studies
- Cpk Form
- Ppk Form
- Cpk for moving ranges
### E12 Initial Process Study (Cpk/Ppk) – Forms in PPAP Kit

#### Process Capability Analysis – Ppk

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Supplier Name</th>
<th>Supplier Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>01894915</td>
<td></td>
<td></td>
</tr>
<tr>
<td>02523460</td>
<td></td>
<td></td>
</tr>
<tr>
<td>00789425</td>
<td></td>
<td></td>
</tr>
<tr>
<td>01098234</td>
<td></td>
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</tr>
</tbody>
</table>

Are the Design Characteristics Safety Related, or Functional?
- Safety Related (Y/N): Y
- Functional (Y/N): N

#### PCA Summary

<table>
<thead>
<tr>
<th>Test Data</th>
<th>Test No</th>
<th>Frequency</th>
<th>Spec Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1.0</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>2</td>
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</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

#### CPK

- LSL = Lower Specification Limit
- USL = Upper Specification Limit
- MSL = Middle Specification Limit

#### PPK

- LSL = Lower Specification Limit
- USL = Upper Specification Limit
- MSL = Middle Specification Limit

#### Cpk moving range

- Cpk = Process Capability Index
- Ppk = Process Performance Index
E12 Initial Process Study – Cpk/Ppk indices

- **Cpk** predicts capability. Use Cpk when:
  - Developing new parts;
  - Revising specifications on a part;
  - Materials, processes, manufacturing location, or equipment have significantly changed;
  - Material suppliers have changed - (include Cert’s of Analysis)

- **Ppk** indicates past performance. Use Ppk when:
  - You are a new supplier to Cooper, but have already been manufacturing a part.
  - You are an existing supplier, and have been found to have produced a number of nonconforming parts.
E12 Initial Process Study (Cp/Cpk) – Difference between indices

- **Cp** – are we capable of producing to specification.
- **Cpk** – same as Cp but also measures how centered the process is!
- It is Important to look at both!! (Note same applies for Pp/Ppk)

<table>
<thead>
<tr>
<th>Cp</th>
<th>Cpk</th>
<th>LS</th>
<th>USL</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥ 1.67</td>
<td>≥ 1.67</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 1.00</td>
<td>&lt; 1.00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Capable, Centered
- Capable, Not Centered
- Not Capable, Centered
- Not Capable, Not Centered

Cp ≥ 1.67
Cpk ≥ 1.67

Cp ≥ 1.67
Cpk < 1.00

Cp < 1.00
Cpk < 1.00

Cp < 1.00
Cpk < 0
E12 Initial Process Study (Cpk/Ppk) – Good Process

- Process is capable! (Cp > 1.67)
- Process is “centered” close to the target (Cpk > 1.67)
- Distribution is normal, resembles “bell shaped curve”
- Disposition reflects “Accept”
E12 Initial Process Study (Cpk/Ppk) – Bad Process

- Results are not centered
- Distribution is skewed or excessive with “tails” extending beyond specification limits
- Disposition reflects “Reject”. Supplier will need to correct the process.

<table>
<thead>
<tr>
<th>Disposition</th>
<th>Invalid PPK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ppk &lt; 1.67</td>
<td>Reject, Corrective Action Needed</td>
</tr>
<tr>
<td>Ppk ≥ 1.67</td>
<td>Accept</td>
</tr>
</tbody>
</table>
### Reviewer’s Checklist

- Make sure the results are acceptable, process is stable and capable of producing a quality part.

- Capability is required for all CTQ’s
  - Minimum Cpk, Ppk, is division specific

- Capability is often required on the process! Make sure there are no key “process” capabilities!

- PPAPs should not be approved (even Interim) if the capability on CTQ’s is less than 1.33.

- Submissions with no capability are not acceptable! Every process has characteristics that are critical.

- Challenge ourselves and suppliers to identify what is important and to approve they are capable.
E12 Initial Process Study - References

Applied SPC and MSA for Practitioners

Description:

Enhance your quality management system by learning the basics of SPC, how SPC and MSA are interrelated, and the fundamental tools/techniques for both SPC and MSA. Discover how to select and apply the appropriate tools for an identified purpose, interpret the results of the application and make logical business recommendations or decisions based on the interpretation. This hands-on course is recommended for anyone involved in the implementation of APQP/PPAP; quality managers, team leaders and planners; quality technicians and specialists; third-party ISO/TS 16949:2002 auditors or anyone involved in the implementation of ISO/TS 16949:2002 or ISO 9001:2000.

You will cover basic statistical calculations for each topic, and participate in team activities (discovery) designed to reinforce lessons learned. A fundamental knowledge of mathematics at the level of first-year algebra, basic calculator skills, and an understanding of the need for SPC and MSA studies in the management of successful organizations is recommended.

Coursework covers:
- Prevention vs. detection
- Common and special causes of variation
- X-bar and R charts: construction, setting limits, analysis, and process control
- Individual and moving range charts: construction, setting limits, analysis, and process control
- Process capability: Pp, Ppk, Cp, and Cpk analysis
- Attribute charts: proportion non-conforming (p) charts and non-conformities (c) charts; construction, setting limits, analysis, and process control
- Process stability
- Measurement systems, process and studies
- Measurement uncertainty
**Purpose:** To demonstrate that the inspection and testing for PPAP has been performed by a qualified lab.

**Element’s original intent:**
- All data for the submission was produced by an accredited lab.
- Labs needed to have “Scope” & “Documentation” with qualifications for:
  - Measurements
  - Specific testing
- If the Lab was “external” then they had to be identified!
  - The name of the Lab
  - Reports had to be on company letterhead
  - Date of the testing had to be identified
  - Standards used for testing had to be identified.
  - Proof of accreditation (A2L, ISO 9001 etc…)

Verify that all testing is performed by accredited labs
E13 Qualified Lab Documentation

- **Recommendation** for performing testing or measurement *(INTERNAL).*
  - Record/Scope that identifies the testing to be done and it must include:
    - List of your personnel’s competency and training to perform the testing
    - List of all test equipment used in process and offline.
    - List of methods and standards used to calibrate the equipment.

- If you are sending out for measurement and testing *(EXTERNAL).*
  - Provide a copy of the lab company’s *THIRD PARTY* accreditation.
  - Results must be on company letterhead and includes:
    - The name of the Lab
    - Date of testing
    - Standards used for testing had to be identified.
A2LA has accredited

QTR, INC.
Evansville, IN

for technical competence in the field of

Mechanical Testing

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005 General Requirements for the Competence of Testing and Calibration Laboratories. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated 18 June 2005).

Presented this 3rd day of June 2008.

[Signature]
President
For the Accreditation Council
Certificate Number 2664.01
Valid to June 30, 2010

For the tests or types of tests to which this accreditation applies, please refer to the laboratory’s Mechanical Scope of Accreditation.
E13 Qualified Lab Documentation-Accreditation

American Association for Laboratory Accreditation

The American Association for Laboratory Accreditation (A2LA) is a nonprofit, non-governmental, public service, membership society. The mission of A2LA is to provide comprehensive services in laboratory accreditation and laboratory-related training. Services are available to any type of organization, be it private or government. Laboratory accreditation is based on internationally accepted criteria for competence (ISO/IEC 17025:2005). A2LA also offers programs for accreditation of inspection bodies, proficiency testing providers, reference material producers and product certification bodies.

Goals: The fundamental goals of A2LA are to:

- Achieve customer satisfaction through meeting the needs of both laboratories and their users for competent testing and calibration;
- Improve the quality of laboratories and the data they produce; and
- Increase acceptance of accredited laboratory data to facilitate trade.

Recognition: A2LA is a signatory to several bilateral and multilateral recognition agreements. These agreements facilitate the acceptance of test and calibration data between A2LA-accredited laboratories and 48 economies around the globe. In addition, A2LA has recognition from over 30 federal, state and local government agencies, companies and associations. These partners recognize the competence, quality of service, and cost effectiveness of A2LA.

Laboratory Accreditation Programs: Laboratories are accredited in the following fields: Acoustics & Vibration, Biological, Calibration, Chemical, Construction Materials, Electrical, Environmental, Geotechnical, Information Technology, Mechanical, Nondestructive, and Thermal. In addition to these broad fields, specifically-tailored programs are available for animal drugs, automotive electromagnetic compatibility (EMC), environmental lead (Pb), fertilizers, food testing, and putting green materials testing. Users of laboratory services are advised to seek the specific scope of accreditation from any accredited laboratory or to visit our searchable directory of accredited laboratories on the A2LA website. The scope identifies the specific testing or calibration capabilities for which the laboratory is accredited.
### Reviewer’s Checklist

- **Third party labs that measure parts for performance, material or dimensional should be accredited.**

- **If any testing is performed to measure or monitor part quality they should have:**
  - Lab Scope – internal labs
  - Evidence of Calibration - in process

- **Accreditation:** Minimum third party accreditation by:
  - Either ISO 17025 or A2LA
  - Note: Some Cooper Parts require UL

- **Lab Scope:** Make sure internal labs have a “System” defining what can be measured, method, training etc.
Purpose: To verify appearance requirements as defined on the part print.

Typically applies to:
- Class A surfaces
- Color definition
- Grain and texture requirements
- Surface appearance requirements

All Appearance requirements should be defined on the part print.

Appearance requirements should require limit samples to help distinguish acceptable versus unacceptable parts.

Cooper requires AARs on a case by case basis
# APPEARANCE APPROVAL REPORT

## Ford General Motors

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Drawing Number</th>
<th>Application (Vehicles)</th>
<th>Application Date</th>
</tr>
</thead>
<tbody>
<tr>
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</table>

<table>
<thead>
<tr>
<th>Part Name</th>
<th>Supplier Name</th>
<th>Manufacturing Location</th>
<th>Address</th>
<th>City</th>
<th>State</th>
<th>Zip</th>
<th>Supplier Code</th>
<th>Code</th>
<th>Reason for Submission</th>
<th>Texture</th>
<th>Special Sample</th>
<th>Re-Submission</th>
<th>Engineering Change</th>
<th>Other</th>
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<tbody>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PART SUBMISSION/WARRANT</td>
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<td></td>
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<td>SPECIAL SAMPLE</td>
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<td>FIRST PRODUCTION SHIPMENT</td>
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<td>ENGINEERING CHANGE</td>
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</table>

### APPEARANCE EVALUATION

#### SUPPLIER SOURCING AND TEXTURE INFORMATION

<table>
<thead>
<tr>
<th>Supplier</th>
<th>Textures</th>
<th>Evaluation</th>
<th>Correct</th>
<th>Proceed</th>
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<tbody>
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</table>

<table>
<thead>
<tr>
<th>Correct and Proceed</th>
<th>Correct and Resubmit</th>
<th>Approved to Texture</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
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</tbody>
</table>

### COLOR EVALUATION

<table>
<thead>
<tr>
<th>Color Suffix</th>
<th>Tristimulus Data</th>
<th>Master Number</th>
<th>Master Date</th>
<th>Material Type</th>
<th>Material Source</th>
<th>Hue</th>
<th>Value</th>
<th>Chroma</th>
<th>Gloss</th>
<th>Metallic Brilliance</th>
<th>Color Shipping Suffix</th>
<th>Part Disposition</th>
</tr>
</thead>
<tbody>
<tr>
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</tbody>
</table>

### Comments

<table>
<thead>
<tr>
<th>Supplier Signature</th>
<th>Phone No.</th>
<th>Date</th>
<th>Customer Representative Signature</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
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</tbody>
</table>
### Reviewer’s Checklist

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>If no specification or print reference exists, the reviewer should use requirement for more ‘print” definition.</td>
<td>Appearance Approval Report</td>
</tr>
<tr>
<td>Specific testing to a known standard</td>
<td></td>
</tr>
<tr>
<td>Defining limit samples</td>
<td></td>
</tr>
<tr>
<td>Force actual sign off of the appearance approval.</td>
<td></td>
</tr>
<tr>
<td>When receiving a submission, only accept this requirement if it is clearly defined on the print or in Cooper’s engineering documentation.</td>
<td></td>
</tr>
<tr>
<td>This requirement should always be in reference to a designated specification.</td>
<td></td>
</tr>
<tr>
<td>▪ Color</td>
<td></td>
</tr>
<tr>
<td>▪ Texture</td>
<td></td>
</tr>
<tr>
<td>▪ Contrast</td>
<td></td>
</tr>
<tr>
<td>▪ Paint</td>
<td></td>
</tr>
</tbody>
</table>
E15 Sample Parts

- **Purpose:** To provide actual samples that reflect the parts documented in the PPAP.

- Sample parts can be used to confirm cosmetic or **functional part** approval.

- Each Cooper Division should have a defined procedure for delivering & approving parts.
  - **Minimum:** Parts should be reviewed by both Quality and Engineering
  - **Ideally:** Sample parts are used in a functional part qualification procedure

- Sample parts should be delivered WITH the PPAP submission.

- Default quantity for all submissions is 3 parts unless requested otherwise.

- Verify the **MOLDED/STAMPED PART** quantities required with each submission.
  - 3 parts for every single cavity mold
  - 1 part from each cavity on multi-cavity molds.

Sample parts must reflect both the submission and actual production.
E15 Sample Parts

Sample parts **MUST** be properly identified by:

- Tagging each part in accordance with PPAP reference manual
- Identifying the part as a **PPAP Sample Part**
- Include key information on the part label
  - Date of Manufacture
  - Cooper Part Number
  - Revision Level
  - Supplier Name
  - Name of Product (Optional)
  - Product Serial and Batch Number (Required if applicable)
  - Supplier Part and Type (Optional)
  - Approval markings (CL, UL, etc) where applicable
  - Quantity of Sample (Indicate Partial Shipments)
  - Procurement Contact, Purchasing Representative, etc

---

Sample parts must be clearly tagged and identified
E15 Division Process for Submitting Sample Parts

Sample parts
Purpose: The original intent was that a “Master” part must be maintained throughout a product’s production life for all revision levels.

Concept is good but difficult to maintain and store parts.

The automotive industry relaxed this requirement in various ways.

Cooper does not require Master Part maintenance except when:
- A Level 5 PPAP is requested.
  - Typically a high risk part
  - The criticality of the product warranted on site review
  - Therefore Master Part maintenance is a useful tool

Cooper requires Master Part maintenance as follows:
- 1 Master part for every part number at the most recent revision level.
- Must be maintained for the life of the product.

Master samples aid in referencing revision differences.
**Reviewer’s Checklist**

- **Sample Parts** should be received with every PPAP submission and examined thoroughly,

- Reviewer needs to determine if any value added analysis can be gained using the **Sample Parts**: Get additional dimensional data, Feedback and questions from engineering, Perform additional testing, Functional analysis, Fit Analysis

- **Sample Parts** must be properly tagged, if not reject!

- If **Master samples** are requested make sure the supplier has a system for maintaining the parts.
Purpose: To provide evidence that the checking aids used to verify product exist and have been properly validated.

There are many different types of checking aids.
- Certified Check Fixtures
- Un-certified check fixtures
- Templates
- Custom Gauges
- In-house developed test stands (ex: leak test)

Cooper requires the following for all checking aids.
- Copy of a controlled print that documents the design of the checking aid
- If the aid confirms form or fit, then there should be a third party certification
- Evidence that the checking aid has been verified successful.
  - Example: Gage R&R

Checking aids must be verifiable to be successful!
**Reviewer’s Checklist**

- If a fixture is used to check physical print dimensions either in process or off line then it is a checking aid.

- Checking aids must be documented through a print and submitted with PPAP:
  - Check Fixtures
  - Templates
  - Assembly fixtures that confirm fit

- Checking aids must have evidence of:
  - Conformance to the provided print
  - Repeatability
  - GRR for CTQ features

- Encourage suppliers that utilize critical checking aids to get third party certification.
Purpose: Provide a placeholder for all customer specific requirements that are not covered in the first 17 elements of PPAP.

Used differently by every customer for all types of requirements!

Cooper Industries has 5 specific requirements defined for PPAP submissions.
- Tooling Information Form
- Packaging Form
- Inspection Plan
- Specification Deviation Form
- Supplier PPAP Checklist

Each Division may request additional documents on a case by case basis.
Purpose: Document important information on all Cooper owned tools.

Applies only to Cooper owned tools and is mandatory.

Each division tracks their tooling differently and has different requirements for:
- Identification and labeling
- Recording reference numbers.

Tooling Information form documents critical information including:
- New or Modified Tooling
- Cost Information
- Dimensional Information
- Capacity Information
- Life Expectancy
- Location of the Tool

Cooper requires tooling documentation on most submissions.
E18A Tooling Information Form

**Purpose:** Document important information on all Cooper owned tools.

- Applies only to Cooper owned tools and is mandatory.
- Each division tracks their tooling differently and has different requirements for:
  - Identification and labeling
  - Recording reference numbers.

Tooling Information form documents critical information including:

- New or Modified Tooling
- Cost Information
- Dimensions
- Capacity Information
- Life Expectancy
- Location of the Tool
- Location of the Tool

---

<table>
<thead>
<tr>
<th>Supplier Name</th>
<th>PPAP Submission Level</th>
<th>Affected Feature Number(s)</th>
<th>Part Description</th>
</tr>
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<tbody>
<tr>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Date</th>
<th>PPAP Due Date</th>
<th>Part Number</th>
<th>Tool Location</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Facility</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Machine</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Station</td>
</tr>
</tbody>
</table>

- New Tooling
- Modified Tooling
- Required for PPAP

Note: This document must be completed for all Cooper owned tooling.

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![Diagram of tooling information form]

**Fig. 5** Front View

**Fig. 6** Back View

**Fig. 7** Tool Tag View

**Fig. 8** Example
Purpose: Approve the packaging method and material for supplied product.

Applies to all parts for all divisions.

Suppliers are required to provide packaging to Cooper facilities that:
- Meet all facility related requirements
- Ensures the prevention of shipping and handling defects
- Addresses any Hazmat related concern

Packaging Information Form must be completely filled out and documents:
- Weight and Dimensions of the finished part packaging
- Pictures of the part, part container, dunnage and packing material
- The final packaged product load delivered to Cooper with correct labeling.

Cooper requires verification of internal and external packaging
## Packaging Form

<table>
<thead>
<tr>
<th>Date</th>
<th>Packaging Contact</th>
<th>Part Number</th>
<th>Supplier Responsibilities Completed?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>( ) Packaging Design</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>( ) Packaging that prevents shipping and material handling defects</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>( ) Electronic storage of submitted Packaging Data Form</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Supplier Name</th>
<th>Phone Number</th>
<th>Print Revision Level</th>
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<tbody>
<tr>
<td>Supplier Code</td>
<td>Fax Number</td>
<td>Part Description</td>
<td></td>
</tr>
<tr>
<td>Supplier Production Facility</td>
<td>E-Mail Address</td>
<td>HAZMAT?</td>
<td>Yes</td>
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</table>

<table>
<thead>
<tr>
<th>Part</th>
<th>In Packaging Position</th>
<th>Container</th>
<th>With Label Shown</th>
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</table>

### DIGITAL IMAGES

### PACKAGE DATA

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<thead>
<tr>
<th>Component</th>
<th>L (mm)</th>
<th>W (mm)</th>
<th>H (mm)</th>
<th>Component</th>
<th>Wt (kg)</th>
<th>Quantities</th>
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<tbody>
<tr>
<td>Part Size</td>
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<td>Part</td>
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<tr>
<td>Container Only</td>
<td></td>
<td></td>
<td></td>
<td>Urunage (lale)</td>
<td>Container(s) per Layer on Pallet</td>
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<tr>
<td>Pallet Only</td>
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<td></td>
<td></td>
<td>Container (Tare)</td>
<td>Later per Pallet</td>
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<tr>
<td>Unit Load As Shipped</td>
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<td></td>
<td></td>
<td>Pallet (Tare)</td>
<td>Container(s) per Pallet</td>
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</tr>
<tr>
<td>In to MM</td>
<td></td>
<td>Lbs to Kg</td>
<td></td>
<td>Container Gross (Inc Parts)</td>
<td>Stacking Rule</td>
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<td></td>
<td></td>
<td>Unit Load Gross (Inc Parts)</td>
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</tbody>
</table>
IQC Inspection plans are required only for ASC/CES submissions.
C18d Specification Deviation Form

**Purpose:**
To request deviation on any requirement that is non-conforming and requires review by Cooper to provide for approval of the PPAP submission.

- Used to document specific non-conformances that could require exception!
- Defines difference between actual and observed results.
- Must recommend a specific deviation and requires an interim action plan.
- Specification Deviation will by default only allow for Interim Approval.
- Specification Deviations are not to be used for any purpose other than PPAP non-conformances and does not replace “temporary deviation requests” used for documenting permission to use non-conforming product.
C18e Supplier PPAP Checklist

Supplier Checklist documents what has been submitted and all concerns.
## Reviewer’s Checklist

- Must be present if required by Level
- Must be completely filled out and include pictures!
- Must be signed if required.
- Should be confirmed during on-site reviews!
Cooper Requirements

1. Part Submission Warrant (PSW)
2. Design Records
3. Engineering Change Documents
4. Customer Engineering Approval
5. DFMEA
6. Process Flow Diagram
7. PFMEA
8. Control Plan
9. Measurement Systems Analysis (MSA)
10. Dimensional Results
11. Material, Performance Results
12. Initial Process Study
13. Qualified Laboratory Documentation
15. Sample Product
16. Master Sample
17. Checking Aids
18. Cooper-Specific Requirements
   - Tooling information Form
   - Packaging Form
   - Inspection Plan (ASC Only)
   - Specification Deviation
   - Supplier PPAP Worksheet

Element Links

2. Design Records
3. DFMEA
4. PFMEA
5. Control Plan
6. MSA
7. Initial Process Study
8. Cooper Specific

Critical Systems

Requirements CTQs
More Robust Design
Robust Process
Develop Process Control
Confirm Measurement
Verify and improve capability
Customer Requirements

PPAP is the process for ensuring total part conformance.
Rolling Out PPAP

Discussion for Successful Implementation!
When do the new requirements take effect!
**Formal PPAP Dispositions**

- **Approved**: When a submission is completely through review and approved for use in mass production. (Should be mass production release!)

- **Rejected**: When a submission has been reviewed and determined to be either nonconforming or does not reflect the latest revision.

- **Interim Approval**: Interim PPAP can be allowed on a limited basis as long as the following criteria is met.
  - The part is saleable to the customer in its current state
  - The part has a plan of action detailed on a specification deviation form

Interim PPAPs must be controlled with the following conditions.
- Interim can only be granted 3 times
- Each Interim Approval cannot exceed 60 days.

**PPAPs can have unique division dispositions but these are universal!**
Division PPAP Review and Approval Process
Recommendations – Application Priority

- **New Product Design Submissions** – Full level 3 PPAP Submission
  - New Technology, New product design for the business
  - New Suppliers, Significant changes in design

- **Change Management Submissions** – Application based on “Type of Change”
  - Develop a Process for reviewing and assessing all changes
    - Supplier Related Changes
    - ECN related Changes
  - Tier PPAP requirements based on overall risk and value to the business

- In order to manage the risk we need to effectively manage resources
  - Maximize the value PPAP can bring to Cooper
  - Minimize the impact of poorly developed and unapproved product

Each division should develop a process and a plan to ensure value.