Learning Objectives

Advanced Product Quality Planning and Control Plan

- Identify the phases of APQP and SAPQP
- Understand the inputs and outputs from each phase
- Understand the GHSP Supplier APQP system (SAPQP)
- Applying the APQP concept in terms of timing of PDP
- Purpose of the major APQP deliverables
- Examples of applying concept
Advanced Product Quality Planning (APQP) was designed to help deliver benefits to the entire supply chain

- “Promote early identification of required changes”
- “Avoid late changes”
- “Provide quality product on time at lowest cost”
- “..Designed to be a ‘before-the-event’ action, not an ‘after-the-fact’ exercise……..AND

* PREVENT the risk of unintentionally designing in excessive cost stemming from design being incompatible with manufacturing technologies. (Feasibility)
1. Form a cross functional team
   - The first step in planning the program is to define who will make up the cross functional team. Cross functional team does not mean One (1) person doing everything!
   - Typical members of a cross functional team may include:
     - Sales, Engineering, Manufacturing, Quality, Purchasing, Program Manager
   - Identify the project team leader responsible to oversee the planning.

2. Define the Scope
   - Define internal roles and responsibilities. Rasics are helpful tools
   - Define who the customer is. (GHSP)
The 5 Phases of APQP

1. Plan and Define the Program
2. Product Design and Development
3. Process Design and Development
4. Product and Process Validation
5. Feedback, Assessment and Corrective Action
<table>
<thead>
<tr>
<th>APQP Phase</th>
<th>Design Responsible</th>
<th>Manufacturing Responsible</th>
<th>Service Organization (Heat Treat, plating)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Define the Scope</td>
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<td>S</td>
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<tr>
<td>Product Design</td>
<td>R</td>
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<td>Feasibility</td>
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<td>R</td>
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<td>Process Design</td>
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<td>R</td>
<td>R</td>
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<td>Product &amp; Process Validation</td>
<td>R (product)</td>
<td>R (process)</td>
<td>R (process)</td>
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<tr>
<td>Feedback, Assessment and</td>
<td>R (design)</td>
<td>R (process)</td>
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<td>Corrective Action</td>
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<tr>
<td>Control Plan</td>
<td>S</td>
<td>R</td>
<td>R</td>
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</tbody>
</table>
PDP = APQP + Financials

See how they align for GHSP?
Relationship between overall APQP and Supplier APQP

See how you start last but end first?
See how we are out of phase (behind then ahead)
5 SAPQP Phases
Fit in only 3 PDP Phase Exits
Inputs to Planning Product APQP:

• Voice of Customer
• Business Planning
• Product/Process Benchmark Data
• Product/Process Assumption
• Product Reliability Studies
• Customer input

Inputs in GHSP Language

• Design Requirements on Drawings (including references)
• Requests for Quote
• Annual Volume Estimates
• Customer PTR history and internal PPM assessment
• Supplier Manual
• Terms and Conditions

SDE’s in NA have no responsibilities in Phase 1 of GHSP APQP. There is no real part specific requirements. The only exception to this is for suppliers who have been pre-sourced in Phase 1 AND is design responsible.
APQP Element 1.1: Voice of Customer

Voice of Customer: Encompasses the following methods

• **Market research**
  • Customer interview and/or survey
  • Competitive product quality studies or teardowns
  • Warranty history from similar products

• **Historical Warranty and Quality**
  • Past problem history – PTR’s
  • Current process capability indicators
  • Internal PPM and/or scrap trends

• **Team Experience**
  • Applied Lessons Learned
  • Best Practices
  • Customer complaints that are not literal non-conformances to design records. (Opportunities for improvement)
Business Plan

The Business plan is a strategic document which may place some constraints on the development of the proposed product.

Examples of Constraints:
- Project timing
- Cost of investment in technology, machinery and human resources
- Quality requirements
- Manufacturing capabilities
- Government regulations

Suppliers will have Business Plans and/or targeted business plans. GHSP will have a commodity strategy that we use to identify potential suppliers. Ongoing Supplier Business Reviews help keep business aligned on both sides.

Do you have resources, capacity, money, skills to support?
At this stage of the process, benchmark data should be obtained. Be sure benchmark is appropriate.

Benchmark data may be used to establish the “GAP” between your current product or process and that of the “World Best”.

**Corrective action plans (developed and led by GHSP) should be developed to close the “GAP” with the focus on becoming “World Best”**.
Product and Process assumptions

List all of the current product and process assumptions. Examples may be:

- Material Characteristics and Performance
- Intellectual Property/ Innovations
- Reliability assessments
- Machine capabilities
- Management Structure
APQP Element 1.5: Product Reliability Studies

Product Reliability & Durability
This type of data provides a prediction of the frequency of repair (reliability) or replacement (durability) within designated periods of time.

Suppliers who have design responsibility fall into this category.
Customer Inputs

Most of this is previously covered under Voice of the Customer with the exception that sometimes the voice of the operator is not explicitly understood.

One approach is to ask *why* a requirement exists and to seek to understand the experience of the person who touch the part every day.
If Design Responsible, design goals are the output of translating Voice of the Customer into S.M.A.R.T. design goals.

- **Specific** (think requirements)
- **Measureable** (think acceptance criteria)
- **Attainable** (think laws of physics)
- **Realistic** (think theory of constraints)
- **Time bound** (think planned date to complete)

They also include regulatory requirements such as polymeric part marking and IMDS.

Suppliers may ask to co-develop design requirements based on capabilities.
APQP Element 1.8: Reliability & Quality Goals

Quality Goals are established based on customer expectations. Some GHSP specific requirements are:

- 100% First time, On time, PPAP approval
- 0 PPM
- 0 R/1,000 warranty rate claim
- 0 Past thru characteristic failures at customers
- Containment at every GHSP location
- Year over year scrap reduction (result of effective CI program and problem solving)

Most of this are captured in Supplier Manual or GHSP Terms and Conditions?
The Preliminary BOM is for the manufacturer (GHSP) to know we properly accounted for all elements in the product design which feeds the Tier 2 sourcing and sub-supplier APQP. The BOM may detail out manufacturing process and may be used to identify special characteristics.

<table>
<thead>
<tr>
<th>Part name</th>
<th>Provider</th>
<th>Part #</th>
<th>Unit Cost</th>
<th>Quantity</th>
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<tbody>
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<td>30mw 532nm Green Laser</td>
<td>Amazon (see link in desc.)</td>
<td>See link</td>
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<td>1/2&quot; diam. cast acrylic</td>
<td>McMaster-Carr</td>
<td>8528K32</td>
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<td>1x1' rod</td>
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<td>&quot;</td>
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<td>31050S</td>
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<td>Total:</td>
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<td>219 (249)</td>
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</table>
The anticipated manufacturing process should be described using a flow chart developed from the preliminary BOM and product/process assumptions.

Hint: The PFD flows into the PFMEA
The Special Characteristics are defined by the OEM customer in addition to those selected by GHSP Engineering.

The Special Characteristics should be developed from:

- Product Assumptions based on analysis of customer needs
- Identification of reliability goals (X times life, R/C confidence levels)
- Identification of special process characteristic from the GHSP system manufacturing process
The Product Assurance Plan:

In the traditional sense, this is directed as System Engineering with specific emphasis of Concept Development. This planning is very engineering design focused thus would only apply in specific situations in which GHSP is expecting supplier to design the product to a set of reliability and/or durability requirements.

Any successful product quality planning initiative is the result of an organization that who’s management makes sure the program team has:

- The Right Resources
- The Right Tools
- At the Right Time
- In the Right Amount

And the management is:

- Engaged through measuring progress
- Supportive through leading, managing and motivating
- Engaged to help
- Serving the customer and employees concurrently
Phase 1 APQP focuses on the business planning, targeting business and getting sourced by OEM the targeted business.

Supplier Development Engineers have no Supplier APQP deliverables on the SAQP report.

SDE (China) on small occasion may be asked to obtain quotes for key or high risk parts.
APQP Phase 1: Outputs of Planning

Outputs to Planning Product APQP:

- Design Goals
- Quality Objectives
- Preliminary BOM
- Preliminary Process Flow Diagram
- Characteristics Matrix
- Customer Requirements

Outputs for GHSP SCM*:

- Supplier Quote (Critical High Risk)
- Costed BOM (in Quote)
- Tool and gage costs (in Quote)

* SDE’s in China may have some responsibilities to get a supplier quote(s) with cost breakdown, tooling and gage costs for high risk components that the program team decides we need firm pricing.

**Example 1** – A Shock Pin Solenoid which is a new product need to GHSP and we want supplier to design sub-system to meet performance specifications.

**Example 2** – A Piazzo Capacitive Flex Circuit bonded to stainless steel that enables user to control operation of appliances (Microwave, Dishwasher or Oven) thru metal
End of APQP & PDP Phase 1

Time Check : Prompt for Cindy to see how long it took
Phase 2 starts with GHSP doing Product Design and Development of the System (Shifter/Smart Actuator/Controls)

Phase 2 Ends with DV Release (Prototype Release)

Supplier Development Engineers have 3 Supplier APQP deliverables on the SAQP report in Phase 2 of PDP
## APQP Phase 2: Design & Development Inputs

<table>
<thead>
<tr>
<th>Inputs to Design Development</th>
<th>Outputs for GHSP Design Development</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Design Goals</td>
<td>- DFMEA</td>
</tr>
<tr>
<td>- Quality Objectives</td>
<td>- DFM/DFA</td>
</tr>
<tr>
<td>- Preliminary BOM</td>
<td>- DV Verification Plan</td>
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<tr>
<td>- Preliminary PFD</td>
<td>- Design Reviews</td>
</tr>
<tr>
<td>- Characteristics Matrix</td>
<td>- Engineering Drawings &amp; Data</td>
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<tr>
<td>- Customer Requirements</td>
<td>- Team Feasibility</td>
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<td>- Prototype Control Plan</td>
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<td>- SC/CC/PTC</td>
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<td></td>
<td>- Equipment, Tooling, Gage, Test and Facility Requirements</td>
</tr>
</tbody>
</table>

### Outputs for GHSP Supply Chain for Design Dev
- Complete Quotes (piece cost, tooling and gage)
- Supplier Technical Feasibility Commitment
- Supplier APQP Kick off meeting
- Team Roster
Personnel within the design activity should be qualified in the following/or other skills, as appropriate*

– Geometric Dimension and Tolerance (GD&T)
– Design for Manufacture/Assembly (DFM/DFA)
– Failure Mode and Effects Analysis - Design and Process
– Finite Element Methods (FEM)
– Solid Modeling
– Simulation techniques
– Computer Aided Design/Engineering (CAD/CAE)
– Reliability Engineering plans

* Design responsibility for purchased parts must be identified at Phase 2 of GHSP PDP and captured in the Supplier Statement of Work (if applicable)
The Product Design and Development phase begins with the generation of a Design FMEA:

The System DFMEA feeds into:

- GHSP System Process FMEA and all sub-tier sub-system and components.
- GHSP Internally made components/subsystems
- Supplier DFMEA (if design responsible) and PFMEA

The DFMEA will communicate:

- The interaction of the purchased part to system and related severity. Explains why we have PTC or Special Characteristics.

It is strongly recommended to use the A-1 DFMEA checklist on page 73 in the APQP Manual to cue the team’s performance.
Design output shall be the result of a process that includes the following:
– Efforts to simplify, optimize, innovate and reduce waste with methods such as:
  • Critical To Quality (CTQs)
  • Design for Manufacture/Assembly (DFM/DFA)
  • Design of Experiment
  • Tolerance studies (GD&T)
  • Analysis of costs/performance/risks trade offs
  • Use of feedback from testing, production and the field
  • Use of Design FMEA’s

It is very important that we design to tolerances that can be met for the price and technology we drive by design.
Plan and Conduct Design verification at appropriate stages of design

The purpose of the design verification is to ensure that the design output is meeting the planned design input as defined in phase 1, Plan and Define the program.

Example:
Phase 1: Design Input - Hole locations +/- 1.0 mm
Phase 2: Design Output - Engineering Drawings stipulating the Hole locations at the tolerance of +/- 1.0 mm AND verification that this tolerance is manufacturable to industry standards.
Plan and Conduct Design reviews *(formal documented review)*

Design reviews are conducted to monitor the progress of the project relative to customer requirements. The reviews are conducted by a cross functional team and the results of each review must be documented.

Typically, the Design reviews might cover; Design FMEA, Design verification progress, reliability tests and studies, computer simulation results, benchmark data and overall progress relative to time constraints.

Suppliers need to lead these for those parts they are design responsible for; Example: Solenoids.
Prototype Build- Control Plan

Prototype Control Plans generally list the dimensional, material and functional tests that will occur during the prototype build(s).

This applies only to the System level at this phase. We get to this for suppliers in next phase.
Finalization of:

– Engineering drawings including CAD data
– Engineering specifications
– Material specifications

At this stage the cross functional team should have reviewed and approved all drawings, engineering specifications and material specifications.
The New Equipment, Tooling & Facilities:

- Any new inspection, assembly and assembly test equipment is required.
- If new equipment is required, this should be recorded into the overall program timeline and progress towards the completion be monitored.
- If new facilities (Factory expansion, Clean room, New test laboratory) are required, this should be recorded in the overall program timeline and monitored to ensure completion.
Special Product and Process Characteristics
Critical and Significant Characteristics are confirmed again at the end of this phase. Remember we had a preliminary list in prior phase for system that is now getting reflected into the component level drawing we need to source.

FOCUS area in the technical feasibility commitment for suppliers
Gage and Test Equipment design should be reviewed

- Confirm design records have appropriate GD&T that can be affordably represented in a gage or validation tester design.
- Confirm cost and timing for gages or testing equipment
- If specific tests cannot be performed by GHSP, we must confirm cost/timing and have this properly accounted for in the program timeline.
Team Feasibility statement

At this time the cross functional team must be satisfied that the proposed design can be manufactured to the customer’s requirements.

Once satisfied, the cross functional team members must sign off the Team Feasibility Statement

Make sure we are working with the production intent suppliers, not quick turn around prototype suppliers
## Supplier Technical Feasibility Commitment

**Team Feasibility Commitment**

<table>
<thead>
<tr>
<th>Date (日期)</th>
<th>Customer (客戶)</th>
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<tbody>
<tr>
<td></td>
<td>GHSP</td>
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</table>

<table>
<thead>
<tr>
<th>Part number (產品編號)</th>
<th>Part Rev Level ( )</th>
<th>Part Name (產品名稱)</th>
</tr>
</thead>
</table>

### Feasibility Considerations (可行性考慮的構想)

- Is product adequately defined (application requirements, etc.) to enable feasibility evaluation? (製品是否清楚地定義了應用要求等項目以進行可行性評價？)
- Can engineering Performance Specifications be met as written? (工程性能規格能否滿足所寫規定？)
- Can product be manufactured to tolerances specified on drawing? (產品能否按照圖紙上的公差進行製造？)
- Can product be manufactured with Cpk's/Ppk's that meet requirements? (產品能否按照Cpk或Ppk的標準進行製造？)
- Is there adequate capacity to produce product? (是否有足夠的產能？)
- Does the design allow the use of efficient material handling techniques? (設計是否允許使用高效的物料處理技術？)
- Can the product be manufactured without incurring any unusual (產品是否能在不發生任何異常情況下生產？)
- Costs for capital equipment? (資本設備的成本？)
- Costs for tooling? (工具費用？)
- Alternative manufacturing methods? (替代製造方法？)
- Is statistical process control required on product? (產品是否需要統計過程控制？)
- Is statistical process control presently used on similar products? (統計過程控制是否已經在相似產品中使用？)
- Are the process in control, stable and normal? (過程控制，穩定和正常？)
- Are LONG TERM Cpk's/Ppk's greater than 1.67? (Cpk或Ppk長期大於1.67？)

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**Signed by Supplier, GHSP Buyer and SDE**

**Standardized Form:**
GHSP Form Number SC-WI-Form X30

**References in Procedure Supplier APQP**

- **Number the questions on the form and put in this material**
- This is the chance for supplier to say “I cannot make this”. We NEED them to say no if they cannot commit regardless of cost.
At the completion of this stage the following items should be defined for the System:

- Design goals
- Reliability goals
- Quality targets
- Preliminary Bill of Material (BOM)
- Preliminary process flow chart
- Preliminary listing of special characteristics

At the completion of this stage the following items are completed by Supply Chain (Buyer & SDE):

- Valid Quotes (no exceptions)
- Completed Technical Feasibility Commitments
- Supplier Kick off Meetings with Supplier Management Support
- Team Roster
In order to Exit Phase 2 – The Buyer is responsible for deciding sources (SDE can be a delegate) and the SDE is responsible to have 3 key elements complete:

- List of cross functional program contacts from supplier(s)
- Have a kick of meeting with supplier(s)
- Have a completed Technical Feasibility Commitment Form for each part with NO exceptions. Any feasibility issues must have an agreed upon plan to exit phase 2

### Supplier Advanced Product Quality Planning Report

<table>
<thead>
<tr>
<th>Program Manager:</th>
<th>SDE:</th>
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<tbody>
<tr>
<td>Model Year:</td>
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<tr>
<td>Customer:</td>
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<td>Program:</td>
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<td>Product:</td>
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<tr>
<td>GHSP Mfg Location(s):</td>
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</table>

<table>
<thead>
<tr>
<th>Prototype Build Date(s):</th>
<th>Customer System Fill Date:</th>
<th>Customer SOP Date:</th>
<th>Last Revision Date:</th>
</tr>
</thead>
</table>

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Managing the Issues – Exiting Phase 2 with Red/Yellow

If there are gaps (yellow or red) use the action item report section to document the gap and the countermeasure, owner and date. GHSP may have actions needed to resolve gaps. For example, a supplier communicates a “no” on technical feasibility indicating they need more manufacturing tolerance, the action may be for engineering to conduct a tolerance analysis to find a method to give more tolerance. If we cannot resolve the gap, we cannot exit phase 2.

Supplier Advanced Product Quality Planning Report

<table>
<thead>
<tr>
<th>#</th>
<th>Describable</th>
<th>Who</th>
<th>Due Date</th>
<th>% Complete</th>
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</table>
What are the Key activities going on INSIDE GHSP during phase 2 of PDP?

What are the Key activities going on OUTSIDE GHSP with suppliers in phase 2 of PDP?

What elements are done by GHSP in APQP Phase 2 that are NOT done until we are in PDP Phase 3?

Time Check: Prompt for Cindy to see how long it took
Phase 3 Starts GHSP testing the design and verifying that our design is likely to meet our Quality Objectives, Customer Requirements and Internal Requirements. *We may also have suppliers DV testing and Prod. Design*

Phase 3 Ends with Production Design Release

Supplier Development Engineers have **9-11** Supplier APQP deliverables on the SAQP report in Phase 3 of PDP
Phase 3 – Design The Process

• The objective in Phase 3 of PDP is to start designing the Production Manufacturing Process simultaneously with the product design verification. **For this reason we are actually in 2 APQP phases at the same time with our suppliers.**

• In parallel with this, GHSP is buying prototype parts, building prototype shifter systems and doing Design Verification Testing. The output of Phase 3 of PDP is to release for production.

• So, at this point suppliers are building prototype tools, developing the PFD, PFMEA and prototype control plan documents.

• Suppliers are using FMEA to drive improvements in the manufacturing process, before high costs of detection controls are designed in.

• Suppliers are also laying out parts for each prototype run to verify parts match prototype design.
APQP Phase 3: Inputs & Outputs of Design Verification

Inputs to Design Verification:
• DFMEA
• DFM/DFA
• DV&R Plan
• Design Reviews (TRB)
• Prototype Control Plan (system)
• Engineering Drawings & Specs
• Special Characteristics
• Team Feasibility Commitments (supplier)
• Customer Requirements

Additional Outputs for GHSP *
• Process Flow Diagram (PE)
• Pre-launch control plan (AQE)
• MSA (AQE)
• Preliminary Capability studies (AQE)
• Packaging Standard Design/Plan (Customer)
• Floor Plan Layout & Process Instructions
• DV Test Results

Key Outputs from GHSP Suppliers
• Process Flow Diagram
• PFMEA (DFMEA if Design Resp)
• Floor Plan Layout
• Quality System Review
• Prototype Control Plan

* This is for the shifter system, not for the component.
The Process Design and Development phase requires the following aspects to be defined and/or documented:

- **Customer packaging and labeling standards**

  Generally, the customer will provide documented packaging and labeling guidelines. These documents should be followed. When no guidelines are available, the cross functional team is responsible for developing guidelines to ensure integrity of the packaged product.
Review of the current Quality Management System to ensure its suitability for the prospective product and associated processes

• The cross functional team should review the manufacturing sites Quality Manual to ensure the current Quality Management System addresses all of the requirements to design and manufacture the product under consideration.

• Any additional controls and/or procedural changes should be used to improve the Quality Management System in operation.

• For suppliers, we may want to consider a manufacturing focused supplier assessment if they have a history of problems.

• If we do a supplier assessment audit and discover weaknesses, we should consider a supplier development plan to be done in parallel to product/process development.
Finalization of the process flow chart

- The finalized process flow chart is a schematic representation of the process flow. This chart is used to detect any potential bottlenecks, such as, material flow problems and manpower.

- This chart also serves as a starting point when conducting the Process Failure Mode and Effects Analysis (PFMEA).

- For Suppliers, we want to make sure that the Process Flow is complete and has all the key processes from receiving raw materials to outgoing product quality control steps.
Floor plan layout with an emphasis on minimizing material travel

• The floor plan should be developed to determine the acceptability of inspection points, control chart locations, visual aid locations, rework area(s) and storage areas.

• When developing the process and subsequent floor plan an emphasis must be placed on utilizing floor space for value added activities.

• For suppliers, we would like to see a floor layout that describes number of assembly stations, people, location of raw material, location of WIP and location of finished goods.
• The Process FMEA should be conducted prior to purchasing production equipment and tooling.
• The PFMEA is a structured & detailed study performed by a cross functional team on a process to determine how potential external & internal factors could impact a process.
• Once potential problems and causes are predicted, additional PREVENTION countermeasures should be designed into the manufacturing process (including tooling poke-yokes) based on RPN.
• For Suppliers, look for evidence of past problem history with GHSP PTR # on PFMEA and check recommended actions prevent root cause(best) or minimum detect 100% the failure mode.
## PFMEA Example

<table>
<thead>
<tr>
<th>050</th>
<th>Electrical Test (Prior to Electrical)</th>
<th>Electrical Test does not detect failures</th>
<th>Failure to meet customer requirements</th>
<th>5</th>
<th>N/A</th>
<th>Failure or lesser</th>
<th>2</th>
<th>Work Instructions, Visual Inspection, Preventive Maintenance</th>
<th>1500 Test Result, First Piece Approval Records</th>
<th>4</th>
<th>40</th>
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<tbody>
<tr>
<td>050a</td>
<td>Inoperative Part (PTR #117927)</td>
<td>Electrical test acceptable</td>
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<td>4</td>
<td>N/A</td>
<td>Lack of training</td>
<td>2</td>
<td>One piece flow, Work Instructions, Training Matrix</td>
<td>Records of electrical Test, Visual Inspection, First Piece Approval</td>
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<td>56</td>
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<tr>
<td>030c</td>
<td>Twist green and brown wires</td>
<td>Incorrect twisting</td>
<td>Product does not meet the specs</td>
<td>4</td>
<td>N/A</td>
<td>Lack of training, Failure to follow work instruction</td>
<td>2</td>
<td>One piece flow, Work Instructions, Training Matrix</td>
<td>Visual Inspection, First Piece Approval</td>
<td>7</td>
<td>56</td>
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<tr>
<td>030d</td>
<td>Wires assembled incorrectly</td>
<td>Missing Wires/Connectors</td>
<td>Interconnexion, no continuity, can't be assembled, Failure to meet customer requirements</td>
<td>5</td>
<td>N/A</td>
<td>Poor material handling, lack of training</td>
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<td>One piece flow, Work Instructions, Training Matrix</td>
<td>Electrical Test, First Piece Approval</td>
<td>3</td>
<td>30</td>
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<tr>
<td></td>
<td></td>
<td>Damageal components</td>
<td>Interconnexion, no continuity, can't be assembled</td>
<td>5</td>
<td>N/A</td>
<td>Poor material handling, lack of training</td>
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<td>Work Instructions, Training Matrix</td>
<td>Visual Inspection, First Piece Approval</td>
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<td>70</td>
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<tr>
<td>030e</td>
<td>Add cover to the connector A</td>
<td>Missing Cover</td>
<td>Product does not meet the specs, risk of external damages</td>
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<td>Poor material handling, lack of training</td>
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<td>Work Instructions, Training Matrix</td>
<td>Electrical Test, First Piece Approval</td>
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<td>24</td>
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<td></td>
<td>Component assembled incorrectly (PTR #117717)</td>
<td>Product does not meet the specs, risk of external damages</td>
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<td>Work Instructions, Training Matrix</td>
<td>Visual Inspection, First Piece Approval</td>
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<td>56</td>
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</table>

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Push Suppliers to link past problem history to the PFMEA and show evidence by recording the PTR #
Completion of the Pre-launch Control Plan
The Pre-Launch control plan provides a description of the dimensional measurements and functional test that occur after prototype and prior to full production. The pre-launch control plan typically includes additional product/process controls until the production process is validated.
This is only for GHSP System in phase 3 of PDP.

For Suppliers, they do Prototype Build- Control Plan
• Prototype Control Plans generally list the dimensional, material and functional tests that will occur during the prototype build(s). They cannot do a pre-launch control plan because we have not released production design yet.
APQP Element 3.8 - Process Instructions

Process Monitoring and Operator Instructions - these shall typically include or reference as follows:

- Operation Name and number keyed to process flow chart
- Part Name and Number
- Current Engineering level/date
- Required tools, gages and other equipment
- Material identification and disposition instructions
- Customer and supplier designated special characteristics
- SPC requirements
- Relevant Engineering and manufacturing standards
- Inspection and test instructions
- Corrective action instructions
- Revision date and approvals
- Visual aids
- Tool change intervals and set up instructions

For suppliers, they may be in early development stage of this as production design release is not yet complete.
Measurement systems analysis plan to encompass all of the inspection measuring and test equipment designated on the control plan

All inspection, measuring and test equipment utilized to measure product or process characteristics as defined in the Control plan must undergo a Measurement Systems Analysis. The analysis should not be just restricted to Gauge Repeatability and Reproducibility but should also include studies on, linearity, and accuracy, as appropriate.

We are reviewing preliminary production release design reviews of the GD&T to confirm they can design a gage to measure the part/sub-system. This would be a good time to double check that the plan to measure is expected to be accurate using past history.
The Purpose of the Preliminary Capability Study:
To gain an understanding of the early process capability to detect issues EARLIER than the significant production run (PSO) which can be too late to recover from and still maintain timing commitments to customers

This is only for GHSP System in phase 3 of PDP.
Customer Packaging Specification have been transformed into a Packaging design including interior partitions.

Cost and timing for the packaging has been completed.

Some preliminary or prototype packaging trials may be required prior to kicking off final production packaging tooling.
Sub-Contractor APQP

There is not a specific Subcontractor APQP requirement in the APQP Manual.

However, the GHSP supplier APQP process does have an element called Sub-Contractor APQP Assessment.

The objective of the element is to gather some evidence from the supplier that indicates they are managing their sub-suppliers.

Example of evidence of Sub-Contractor List
Supplier APQP Deliverables
PDP Phase 3 Exit

Outputs from GHSP Suppliers

- Drawing and Specifications Review
- DFMEA (if Design Responsible)
- Verification of Quality Objectives (0 PPM)
- Process Flow Chart and Floor Layout
- PFMEA
- Subcontractor APQP Assessment
- DVP&R (if Design Responsible or if Supplier Agrees to testing)
- Tool Design and Approval
- Prototype Tool Builds
- Prototype Control Plan

Objective Evidence

- APQP report & meeting
- DFMEA with PTR history
- APQP report and meeting
- Process Flow Diagram
- PFMEA with PTR History
- List of Sub-Suppliers
- DVP Report
- Tool Design File and email approval from engineering.
- Prototype Control Plan and dimensional layouts for each run
In order to Exit Phase 3 – The SDE is responsible to have PhaseXX elements complete:
Managing the Issues – Exiting Phase 3 with Red/Yellow

If there are gaps (yellow or red) use the action item report section to document the gap and the countermeasure, owner and date. GHSP may have actions needed to resolve gaps. For example if tool. If **we cannot** resolve the gap, we cannot exit phase 3.

---

**Supplier Advanced Product Quality Planning Report**

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<tr>
<th>#</th>
<th>Description</th>
<th>Who</th>
<th>Due Date</th>
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<th>Actions</th>
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</tbody>
</table>
What are the Key activities going on INSIDE GHSP during phase 3 of PDP?

What are the Key activities going on OUTSIDE GHSP with suppliers in phase 3 of PDP?

What elements are done by GHSP in APQP Phase 3 that are NOT done until we are in PDP Phase 4?

Time Check: Prompt for Cindy to see how long it took
Phase 4 Starts GHSP releasing Production Design

Phase 4 Ends with Customer PPAP Approval

Supplier Development Engineers have Supplier APQP deliverables on the SAQP report in Phase 3 of PDP. Supplier PPAP is a key milestone in the middle of Phase 4.
APQP Phase 4: Outputs of Product Validation

**Outputs to Process Design APQP:**
- Production Trial Run
- MSA (Gage R&R, linearity, bias)
- Preliminary Process Capability
- Supplier PPAPs
- Product Validation Testing
- Packaging Evaluation
- Production Control Plan
- Customer PPAP

**Key Outputs in GHSP Language:**
- Process Sign Off/Run at Rate (PE/SDE)
- MSA (AQE/SDE)
- Initial Process studies (AQE/SDE)
- Pre-Launch Control Plan (AQE/SDE)
- Process Instructions (PE)
- Packaging Specifications (PE/SDE)
- Dimensional Layout (AQE/SDE)
- Material & Performance Testing (VE/SDE)
- PV testing (VE/SDE; if supplier responsible)
- All remaining elements of PPAP including customer specific
Supplier Technical Feasibility Commitment - Production Design Release

Signed by Supplier, GHSP Buyer and SDE

Standardized Form: GHSP Form Number see other slide

References in Procedure Supplier APQP

If the production design has additional, performance, material, dimensional or CC/SC requirements do another Technical Feasibility

---

### TEAM FEASIBILITY COMMITMENT

<table>
<thead>
<tr>
<th>Date (日期)</th>
<th>Customer (客户)</th>
<th>GHSP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part number (产品编号)</td>
<td>Part Rev Level (版本号)</td>
<td>REL</td>
</tr>
<tr>
<td>Feasibility Considerations (可行性考虑的事项)</td>
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</tr>
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</table>

Our product quality planning team has considered the following questions, not intended to be all-inclusive in performing a feasibility evaluation. The drawings and/or specifications provided have been used as a basis for analyzing the ability to meet all requirements. All "no" answers must be supported with problem description, data and proposed changes to overcome gaps and meet the specified requirements.

- Is product adequately defined (application requirements, etc.) to enable feasibility evaluation?
- Can engineering Performance Specifications be met as written?
- Can product be manufactured to tolerances specified on drawing?
- Can product be manufactured with Cpk’s/Ppk’s that meet requirements?
- Is there adequate capacity to produce product?
- Does the design allow the use of efficient material handling techniques?
- Can the product be manufactured without incurring any unusual costs?
- Cost for capital equipment?
- Cost for tooling?
- Alternative manufacturing methods?
- Is statistical process control required on product?
- Is statistical process control presently used on similar products?
- Where statistical process control is used on similar products?
- Are the process in control, stable and normal?
- Are LONG TERM Cpk’s/Ppk’s greater than 1.67?

Standardized Form: GHSP Form Number see other slide

References in Procedure Supplier APQP

If the production design has additional, performance, material, dimensional or CC/SC requirements do another Technical Feasibility
Production trial run is the PSO Run at Rate Event- typically the results from this trial production run are used for;

- Initial process capability studies
- Measurement systems analysis (Gauge R&R)
- Process review
- **Supplier PPAP completed and approved**
- Product validation testing (Functional fit)
- Packaging evaluation
- Finalization of Production Control Plan
- **Production Part Approval**
Example of PSO

Station 3: Assemble Omron Switch to case
Start 11:00 am  End 11:15 am
Cycle Time Range: 25 seconds
Content in Scrap bin: empty

PFMEA Linkage:
Process controls overstated as they indicated Electrical testing and/or camera was a control that actually exists much further downstream. Severity of failures are both understated (intermittent) and overstated (missing zip tie not meeting req’s). Failure effects are missing the next operation as customer (for example scrap).

Control Plan:
The controls do NOT match what they are doing on the shop floor and the work instructions. The control plan does not match the PFMEA (refer to above issues). The cause and failure controls are all visual at this station (which is acceptable) and then failure detection is downstream at rivet station and/or tester.

Opportunities to Improve:
A. Evaluate line balancing with next station by moving the insertion of the grey connector to next station.
B. Look at material replenishment rate. This station needed replenishment more than the others so maybe we need to increase the size of the bins that hold the connectors

Station 4: Wire harness Sub Assembly
Start 11:15 am  End 11:20 am
Cycle Time Range: 15 - 20 seconds

C. Gap Analysis - Required OEE vs. Demonstrated OEE; Predicted Good Parts / Week

<table>
<thead>
<tr>
<th>Process Description</th>
<th>Barrel Splice / Soldering</th>
<th>Arm Orman Switch</th>
<th>Wire harness arm 1</th>
<th>Wire harness arm 2</th>
<th>Wire harness arm 3</th>
<th>Tape 4</th>
<th>Station 5 Rivet</th>
<th>Station 6 EOLT</th>
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</thead>
<tbody>
<tr>
<td>Predicted Good Parts / Week</td>
<td>APW</td>
<td>MPW</td>
<td>APW</td>
<td>MPW</td>
<td>APW</td>
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<td>12738</td>
<td></td>
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</table>

Notes:
- Onsite verification indicates that supplier is not yet able to meet cycle time needed to meet APW on APW with originally planned production schedule of 5 four-link APW and 4 four-link MPW. Supplier is able to meet APW and MPW through additional shift and have committed to this until the cycle times at the assembly and rivet stations can be improved. Improvement plans are in place and adequate to resolve the 15% efficiency gap. (C. Price)
APQP Element 4.2 MSA/4.3 Initial Process Capability

• The production validation of the Measurement System Shall be done with the parts produced from the Significant Production Run (Run at Rate)
• The MSA shall be done at a minimum using the ANOVA GRR method. Why?
• The Initial Process Capability shall be done with parts produced from the Significant Production Run (Run at Rate)
• The initial process capability study will be done with 125 parts, subgroup sizes of 5 and shown on a Xbar/R control chart.
• The process MUST be stable and in statistical control in order to accept a Ppk or Cpk index.* See SPC training
• **Customer Production Part Approval** is required to validate that the product manufactured meets all customer requirements. This element is for Customer PPAP (phased) where we submit CPPAP for dimensional, SPC and Appearance.

• **Supplier PPAP Approval Required** (not phased) for all submission results prior to GHSP conducting PV System Testing.

• **Production Validation Testing**
  Production Validation testing refers to Engineering tests that validate the production process as meeting all of the customer requirements, particularly, Engineering requirements.
Packaging Evaluation

Validating the packaging to ensure product is protected to the point of delivery is an integral phase of Product and Process Validation. In addition the cross functional team representatives should ensure that the type of packaging will allow the end user to handle the product in a safe and efficient manner.

Production Control Plan

The production control plan describes the systems for controlling the entire process. The production control plan is a living document that must reflect the current flow of production. Any addition or deletions of process, inspection activities etc. must be reflected in the control plan.
Quality Planning Sign-off

The Quality planning sign off is typically conducted by the cross functional team once the control plan accurately reflects the entire process, process instructions are satisfactory, FMEAs are complete and Measurement System Studies have been completed.

The form which is typically used for sign off is referred to as the Product Quality Planning Summary and Sign Off Report. *GHSP Uses our APQP Report Summary to meet this requirement.*
In order to Exit Phase 4 – The SDE is responsible to have Phase 4 elements complete: 24 Deliverables in total

### Supplier Advanced Product Quality Planning Report

<table>
<thead>
<tr>
<th>Program Manager:</th>
<th>SDE:</th>
<th>SDE:</th>
<th>BOLD indicate PPAP Deliverables</th>
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<tr>
<td>GHSP Mfg Location(s):</td>
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</table>

**Prototype Build Date(s):**
**PV Build Date(s):**
**Supplier Part Submission Date:**
**Customer System Fill Date:**
**Customer SOP Date:**
**Last Revision Date:**

**Phase 2**
- Supplier Program Contacts
- APQP Kick-Off Meeting
- Feasibility Commitment
- Design FMEA
- Design Review (Quality Objective)
- Process Flow Chart & Manufacturing Floor Plan
- Subcontractor APQP Assessment
- Design Verification Plan and Report (DVPR)
- Tool Design and Approval
- Prototype Tool Build
- Prototype Build

**Phase 3**
- Packaging Sketch Form
- Tool Qualification
- Material Certification / Material Testing
- Order & Appearance Mastes
- Preventative Maintenance Plan
- Pre-Launch Control Plan / Containment Plan
- Production Control Plan
- Production Trial
- Production Trial
- Pre-Launch
- Master Samples

**Phase 4**
- Ergonomic Design and Approval
- Production Tool Build
- Equipment Design and Approval
- Tool Qualification
- Material Certification & Material Testing
- Order & Appearance Mastes
- Preventative Maintenance Plan
- Pre-Launch Control Plan / Containment Plan
- Production Control Plan
- Production Trial
- Production Trial
- Pre-Launch
- Master Samples

### GHSP Supplier APQP Report

Phase 4 PDP Exit Criteria

*GHSP Solutions In Motion*
## Outputs from GHSP Suppliers

- Production Tool Build
- Equipment and Fixture Build
- Equipment Design and Approval
- Packaging Sketch Form
- Tool Qualification
- Material Certification/Testing
- Color & Appearance Masters (if applicable)
- Preventative Maintenance Plan
- Pre-launch Control Plan (safe launch)
- Gage Certification and R&R
- Production Control Plan (exit criteria for safe launch containment)
- Operator Instructions
- Production Trial Run
- Error and Mistake Proofing
- Capability Studies
- Dimensional Studies
- SPSO (documentation and run at rate)
- AAR Approval form
- PV testing (if applicable)
- Supplier PPAP Submission (PSW)
- Supplier PPAP Submission samples

## Objective Evidence*

- Tool and Gage data form with picture of asset tag
- APQP report showing complete
- APQP report showing complete
- Completed Packaging Sketch form (approved by GHSP PE)
- APQP report showing complete (option for tool dimensional)
- Material Test results and Certifications < 1 yr old
- Samples with filled out AAR, boundary samples if needed
- PFMEA (controls), Control Plan, PM Schedule
- Pre Launch Control Plan with Containment section
- Tool & Gage form, ANOVA GRR, Linearity and Bias studies
- Production Control Plan with exit criteria
- APQP report showing complete (check at PSO)
- PSO run at rate report
- PFMEA/Control Plan & Operator poke yoke verification
- Xbar/R, Normality plot, Cpk/Ppk; Best fit or Transformations
- 6 piece layout per cavity
- PSO run at rate report and approval of documents
- AAR approval form
- DVP&R report
- PSW with rate verified against contract requirements
- Sample Qty as defined by SDE
Phase 5
Feedback, Assessment and Corrective Action
Based on the output of phase 4, more specifically the

– Production trial run
– Measurement Systems Analysis
– Preliminary process capability study
– Production part approval
– Production validation testing
– Packaging Evaluation
– Customer concerns
Feedback, Assessment and Corrective Action

the results (feedback) are assessed and corrective action is instigated with a focus on;

CONTINUOUS IMPROVEMENT
Feedback, Assessment and Corrective Action

Additionally, the following three aspects need to be continually assessed;

• **Variation**

  Control charts or other statistical techniques should be utilized to identify process variation. This should be assessed and corrective action taken if required
Feedback, Assessment and Corrective Action

Customer Satisfaction

The supplier in conjunction with the customer must continually assess the performance of the end product in its operating environment. This may be done by product audits, warranty analysis, customer complaints, benchmark details etc…

This information should be assessed and if required corrective action taken.
Feedback, Assessment and Corrective Action

Delivery and Service

Delivery and service is an integral part of quality. The delivery performance of suppliers must be focused on achieving 100% delivery on time. The supplier must assess its delivery performance and service and if appropriate take the required corrective action.