Supplier PPAP Manual

Policy

Intellectual Property Category:	1	2	3	4

4 - UNRESTRICTED - Free distribution to all parties

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1 Foreword

The Quality Department at Enerpac has prepared this handbook for new and existing suppliers of manufacturing based purchased goods to Enerpac. Its purpose is to define the Quality approval process of new or revised parts, or parts resulting from new or significantly revised production methods. As a supplier, it is your responsibility to ensure that you ship only parts that have been approved and meet specifications.

The procedures outlined in this handbook apply to all the Enerpac facilities. If you have questions regarding the contents or processes described in this handbook, please contact the Quality Assurance Representative of the Enerpac location to which your documentation is being submitted.

The requirements in this handbook were drafted in line with the Automotive Industry Action Group's, Production Part Approval Process (PPAP), Enerpac has specific customer specific requirements and additions to this standard that need to be fully understood before attempting to successfully submit a PPAP to Enerpac for review and approval.

It is expected that suppliers are capable to perform these activities without the support and training of Enerpac personnel. If specific assistance is required, please contact the Enerpac Quality Department for support.

2 When is a PPAP submission required?

A PPAP is required anytime a new part or a change to an existing part or process is being planned. It is at the discretion of each Enerpac facility to determine when and if a PPAP submission will be required. As a supplier you should have a quality system that develops all of the requirements of a PPAP submission regardless of whether you have been asked to deliver a submission. In the event a PPAP submission is not requested, Enerpac quality reserves the right to request any of these documents at any time during the life of the product. Enerpac quality also reserves the right to request a PPAP submission for a variety of reasons including but not limited to the following:

- New part or product.
- Changes to part, product, supply chain, or process.
- At Enerpac's discretion.
- If 2 years has passed since last production.

If there are any questions concerning the need for a PPAP Submission, please contact an Enerpac Quality Representative or Supplier Quality Representative.

3 Enerpac Part Qualification Process

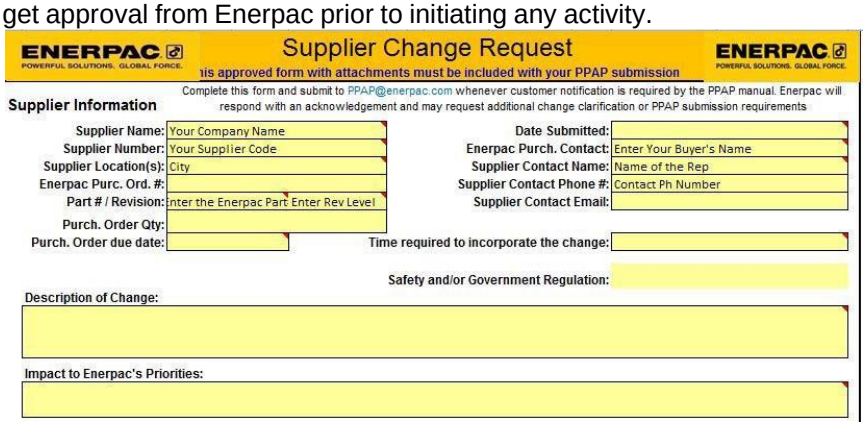
PPAPs are used as part of Enerpac Part Qualification Process. This is the process used to qualify parts and there are four Types:

- QV – Quality Validation: Follows normal incoming part quality procedures, including PPAP.
- PV – Production Validation: Follows normal incoming part quality procedures, including PPAP but also requires a build test before approval.
- SV – Sample Validation: This requires that an initial part run be created for qualification testing. This requires a PPAP at level 3. It is always followed by a PV that requires its own PPAP. As the PV parts are intended to be made from the planned production process.
- NV – No Validation: This does not require a PPAP.

These Types have been added to the PSW to identify the approval flow.

4 Supplier Change Request (SCR) Instructions

Whenever you are planning a change that affects the part, process making the part, design change request or cost you must get approval from Enerpac prior to initiating any activity.



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Supplier Change Request

his approved form with attachments must be included with your PPAP submission

Complete this form and submit to PPAP@enerpac.com whenever customer notification is required by the PPAP manual. Enerpac will respond with an acknowledgement and may request additional change clarification or PPAP submission requirements

Supplier Information

Supplier Name:	Your Company Name	Date Submitted:	
Supplier Number:	Your Supplier Code	Enerpac Purch. Contact:	Enter Your Buyer's Name
Supplier Location(s):	City	Supplier Contact Name:	Name of the Rep
Enerpac Purc. Ord. #:		Supplier Contact Phone #:	Contact Ph Number
Part # / Revision:	nter the Enerpac Part Enter Rev Level	Supplier Contact Email:	
Purch. Order Qty:			
Purch. Order due date:		Time required to incorporate the change:	

Safety and/or Government Regulation:

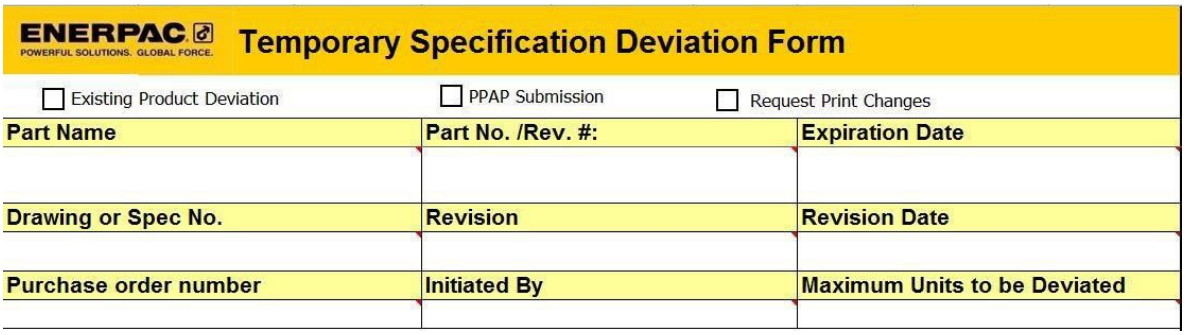
Description of Change:

Impact to Enerpac's Priorities:

This document is used for initiating all supplier changes through Enerpac facilities. The SCR must be approved by both Enerpac engineering, quality, and Purchasing. If a PPAP is required as a result of the change then the approved SCR must be included in the PPAP submission. Failure to have an approved SCR may affect future business opportunities.

Enerpac assumes a good faith agreement with you as a supplier with respect to change management. Therefore, we rely on the supplier to notify us in good faith of any planned change such as changing the location of manufacture or changing the process or material that manufactures the part supplied to Enerpac. The additional requirements section on the form can be used to document any additional testing, performance data or engineering changes that may be required to make the proposed change a success.

Any proposed change to an engineering requirement from a supplier should be done using the Supplier Change Request and follow the standard procedure for engineering changes. In addition, the SCR is only for changes that are permanent in nature. Temporary changes or deviations should always follow the Enerpac manufacturing site's process for Temporary Specification Deviation.



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Temporary Specification Deviation Form

☐ Existing Product Deviation ☐ PPAP Submission ☐ Request Print Changes

Part Name	Part No. /Rev. #:	Expiration Date
Drawing or Spec No.	**Revision**	**Revision Date**
Purchase order number	**Initiated By**	**Maximum Units to be Deviated**

The **SCR** identifies several "Types" of changes that require notification. All of these changes can have significant effect on overall part quality and are therefore identified for customer approval prior to making the change to avoid any unforeseen issues at Enerpac facilities or with end user customers. This methodology around change management is consistent with the Customer Notification section in the AIAG PPAP guidelines Fourth Edition. **As a supplier to Enerpac you are not under any of these circumstances allowed to make a change without prior notification and approval of the SCR form or other engineering design documentation (i.e. print, specification, etc.).**

Below is the list of Types of changes that require prior notification and approval by Enerpac.

Type of Change (Select One)	(Note:) You are required to notify and receive approval from Enerpac for any of these types. Designations in ( ) are the recommend PPAP Level submissions for this type of change	
	1. Change to construction, material or component (L3)	7. Product/process changes on product components (L4)
	2. New, additional or modified tools (L3)	8. Change in test or inspection method (L4)
	3. Upgrade or rearrangement of existing tools (L2)	9. Bulk Material: New source of raw material (L2)
	4. Tooling, production or equipment transferred to different site (L3)	10. Change in product appearance attributes (L2)
	5. Change of supplier or non-equivalent materials/services (L3)	11. Change in production process or method (L4)
	6. Product when tooling has been inactive for 24 months (L2)	

5 Elements of a PPAP Submission

The Enerpac PPAP submission requirements are compliant with the existing AIAG standard. One or more of the following elements may be required as part of your formal submission depending upon your assigned submission level:

1. Part Submission Warrant.
2. Design Records and Ballooned Drawings.
3. Approved 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. Test Results.
    a. Material Test Results.
    b. Performance Test Results.
12. Initial Process Study (Cpk) Capability Studies.
13. Qualified Laboratory Documentation.
14. Appearance Approval Report (AAR).
15. Sample Product Parts.
16. Master Sample(s).
17. Checking Aids.
18. *Enerpac-Specific Requirements*:
    a. Tooling information Form.
    b. Packaging Form.
    c. Measurement Equipment List.

Enerpac has these forms available to suppliers as part of our Supplier form pack which is available through the divisional Enerpac Quality Representative or on the supplier web link https://www.enerpac.com/en-us/support/e/supplier-documentation. You can use the Enerpac supplied forms or any AIAG compliant forms with the exception of Element 1 (PSW) and Element 10 (Dimensional Report). Both of these elements must be submitted on the Enerpac format.

6 Submission Levels.

Submission levels define which elements are required to be submitted. The levels are used for different reasons and applications. The level to be submitted is determined by Enerpac, and unless otherwise noted, always defaults to Level 3 which is a full PPAP submission. There are three submission levels listed below, and each is typically applied to the specific areas listed.

- **Level 1: Warrant only, Appearance Approval Report and limited supporting data as requested submitted to customer.**
  Applied to: Non-critical parts, "non-critical" raw / bulk materials, catalog commodity parts for electrical applications and recertification of existing parts previously approved by Enerpac and levels 3, 4 or 5.

- **Level 2: Warrant with product samples and limited supporting data submitted or as requested by 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 part within a product family.

- **Level 3: Warrant with product samples and complete supporting data submitted to customer.**
  Applied to: New parts for Enerpac high volume 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**. On site review at the supplier as requested by each Enerpac division.**

General Note

By filling out the fields on the Part Submission Warrant (PSW) the heading information will fill in on the other forms in the PPAP forms kit excel workbook. Do not force the fill on the other forms as it will break formulas and could create problems throughout.

7 Supplier PPAP Checklist

Enerpac has a customer specific requirement that can be used for referencing and organizing a PPAP submission. The Supplier PPAP Checklist lists all of the required elements for each level option 1 through 3.

The level for your PPAP submission is determined by Enerpac. If you are not sure what level you are submitting to you should check with your Enerpac Quality Representative. The Supplier Checklist provides an opportunity to assign responsibilities internally and documents concerns to Enerpac about specific areas within the submission. If you have issues or problems with any of the specific elements of a PPAP submission, then they should be documented here or on the PSW cover page. For example, if at the time of submission, you have not received approval of your packaging material, then this would be the place to document that concern. All concerns must be documented at the time of submission to avoid rejection of the issue at a later time.

Below is the top portion of Supplier PPAP Checklist and the full form is in the PPAP Tool Kit.

PPAP *Production Part Approval Process*	Submission Requirements *Supplier Checklist*	ENERPAC TOOLS. SERVICES. SOLUTIONS.	Submission Level *(Please Type 1-3)*	2

Enerpac Part Number	NUMBER								
Revision Level	ECL			Enerpac Buyer.			Submission Date		
Primary Manufacturing Site	ADDRESS			Enerpac Strategic Rep			PPAP Due Date		
Element Order	PPAP Requirements *AIAG PPAP Fourth Edition* Important: Submit your documents in this order.	Level 1	Level 2	Level 3	Required Documents	Assigned to	Internal Due Date	Comments/Concerns/Questions	Included
1	Part Submission Warrant (PSW)				Enerpac PSW Required				
2	Design Records & Bubbled part print(s).				**Enerpac** Divisional Parts Prints				
	Approved Engineering								

The numbering on the supplier checklist is used to identify the elements required on the PPAP in the notes of the PO.

Line no	Item Number Rev Vendor Item Number	Item Description Note To Vendor
1. 1	DA3879190 Rev: -A	VENT PLUG BODY HTS: 7616995190
	-	**PPAP Level 3; PPAP Elements: [01, 02, 06, 07, 08, 09, 10, 11a, 12, 15, 18b]** **EES110-1 Rev: -A**

8 Electronic Submission / Submission Method.

Enerpac requires that all PPAPs be submitted electronically. It is preferred that the PPAP be 1 PDF file of the entire submission package. If this is not possible then we would request that each element would be in PDF format and not native format such as MS Excel or Word.

The PDF submission is to be submitted labeled with the naming convention of:
"Type".PPAP_"Part.Number"_Rev."XX"_"Supplier.Name"_Submitted_Year.Month.Day

Electronic submission subject line should include: Supplier Name, Part Number, Rev Level, PO Number, Type and Quantity, the PPAP submission should be sent to PPAP@enerpac.com.

9 Significant Production Run

PPAP data must be submitted from a "Significant Production Run". It is important that adequate quantities of parts be manufactured during the run to confirm that quality and capability of the production process at rate prior to full production. Enerpac recognizes that in low volume applications, sample sizes as small as 30 pieces may be utilized for preliminary process capability studies.

Sample sizes must be discussed and agreed to early in the NPD/APQP process. If projected volumes are so low that 30 samples are not attainable then interim approval may be granted until an adequate quantity can be produced, and a quality index calculated.

In higher volume applications a Significant Production Run shall be from one to eight hours of production to total a minimum of 125 consecutive parts, unless otherwise agreed upon by Enerpac Purchasing, Enerpac Quality with the supplier. Sampling should be randomly taken from the production run, utilizing production equipment, tooling and production employees operating at production rate.

The intent is that all data reflects the actual production process to be used during production. You are required to document the date, time and the actual rate of the production run on the Part Submission Warrant.

10 Submission Status.

The review and approval process will be managed by Enerpac. Subsequently the PPAP submission will be reviewed and dispositioned with one of the following submission statuses:

- **Approval:** Formal acceptance of the submission within the guidelines of any and all criteria set forth by the Enerpac facility managing the PPAP.
- **Rejected**: The provision is not acceptable and needs to be resubmitted for approval. *(Note: Submission to the wrong revision level or part number will constitute an automatic rejection.)*
- **Interim Approval:** An interim approval can occur through an agreement with Enerpac quality management. The product must be deemed "sellable" by Enerpac and the interim may only be issued for quantity on the open purchase order(s). This is used in cases where further verification is being done. This primarily occurs during the PQ process.

This is provided with an expiration date until a Production Validation (PV) production run fully evaluating the part in a production environment at the Enerpac facility.

Interim approvals may also allow shipments of parts pending follow up documents that will be submitted at a later date. For example, Packaging documents may not be completed in time for the PPAP to be submitted before the delivery date.

11 Ongoing Requirements

Enerpac reserves the right to request any information you have provided in any data or documented in any element of approval, at any time, including after the approval has been granted. Enerpac reserves the right to require recertification at any time.

As a supplier to Enerpac, the expectation is that you will build your product and processes to be robust not only for the launch of the product, but for the life of the product. The expectation is that your system will include verification of the parts and the part requirements on an "on-going basis". This includes building periodic conformance testing into your overall process such as routine dimensional analysis, functional analysis and process verification.

SC/CC's Our recommendation is that you have designated intervals for verifying Critical To Quality (CTQ) characteristics and key process related methods. All of these must be identified on the control plan as part of your ongoing process to verify that your product meets Enerpac's requirements. Enerpac reserves the right at any time throughout the life of the product to request evidence of this ongoing conformance.

Critical to Quality (CTQ) Features CTQ Characteristic Definition:

- A critical PART requirement specified on a controlling document (typically an engineering drawing, a specification or performance requirements).
- 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.

Critical to Quality (CTQ) characteristics are those features that most affect the outcome of a product or process and are designated with a geometric shape adjacent to the feature. CTQ controls must be designed and implemented as part of your company's advanced quality planning. Special attention is required during this phase to identify and control variables that affect the conformance of the product.

Enerpac's expectation is that you will address all CTQs in the control plan and ensure that you have a robust process for consistently achieving all CTQ requirements as they are defined in the Enerpac part print.

CTQ are typically mandatory for Element 12, the "initial process study" which is sometimes referred to as the capability element. Enerpac requires capability studies for all CTQ and any process related characteristics that either you or Enerpac identify as critical. This section is mandatory even if there are no CTQs on your part print because there are always critical elements and characteristics of the process that manufactures the part.

Enerpac Quality has developed CTQ reference prints to aid suppliers in understanding the CTQ features as well as past failures. Contact your Enerpac Quality Representative for information on how to obtain these prints for parts under your scope of supply. CTQ reference prints should not be used as a balloon print. Only use Production prints for FSIR documentation.

As a supplier developing product for Enerpac, your team may discover process and sometimes additional product characteristics that are critical to part performance. Even if the print does not clearly define any CTQs, Enerpac expects that suppliers will identify CTQs for their processes and methods.

12 Instructions for completing a PPAP Submission

All submissions must be received at least 48 hours prior to the Purchase Order delivery date. The PPAP review and approval process will be managed by Enerpac.

13 Part Submission Warrant (PSW)

The purpose of the Part Submission Warrant (PSW) is to document the submission and the approval or rejection of purchased parts prior to production. Enerpac has developed its own Part Submission Warrant document and this form is a required element of the PPAP. It must be submitted as part of the PPAP at every submission level. Enerpac will not accept the AIAG form or any supplier internal PSW format.

13.1 Completing the Part Submission Warrant

The Part Submission Warrant is included in the forms file in the Enerpac' PPAP tool Kit. It must be filled out and signed by the supplier. The part number and revision must match the Purchase Order or material agreement that is provided by Enerpac Purchasing.

The form must be submitted in this format with the correct part number, revision, and submission level. This is 1 of 2 forms that are mandatory for all Enerpac submissions. Any fields that do not apply to your submission should be filled in with "N/A" (Not Applicable). It is critical to make sure the PSW is filled out correctly, and contains accurate and legible information. The PSW is to be filled out first. As it will auto populate much of the other forms. A sample of the Part Submission Warrant described above can be found below. **Each field in the Enerpac PSW in the forms kit has comments that provide additional clarity on each field.**

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Part Submission Warrant

Part Name: **Part Description** | Enerpac Part Number: **Enter Your Part Number**

Safety and/or Government Regulation: ☐ Yes ☐ No | Engineering Drawing: Drwg Number | Revision Level: Enter Rev Level | Dated: Enter Rev Date

Additional Engineering Changes | Dated

Shown on Drawing Number | Purchase Order No. | Weight (kg)

PO Due date.

SUPPLIER MANUFACTURING INFORMATION

Your Company Name (Supplier Company Name) | Your Supplier Code (Supplier Vendor Number)

Additional Manufacturing Sites

SUBMISSION INFORMATION

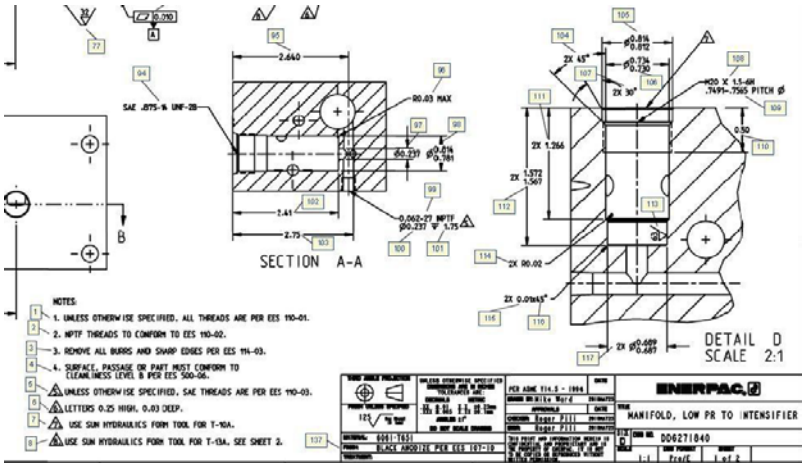
Customer Name:

Enerpac Manufacturing Locations using the part (list all)

14 Design Records and Ballooned Drawings

The purpose of designed records and ballooned drawings is to document and provide a copy of the formal part print and to provide any additional engineering records for reference.

A ballooned drawing shows the parts or assemblies in a part print with numbered “balloons” that point to individual dimensions and requirements of the part. The numbers on the ballooned drawing correlate with the numbers found on the First Sample Inspection. Report. A ballooned drawing must be submitted as part of PPAP for every submission level when there are dimensional results.



14.1 Completing the balloon drawing:

All part requirements on the Enerpac print must be ballooned and numbered for reference and measurement. These may include:

- Dimensions and tolerances of parts.
- Electrical requirements (performance data, functional tests, etc.)
- Visual features (color, texture, etc.)
- Chemical characteristics (cure time, etc.)
- Physical and mechanical properties (tensile strength, plating thickness, heat-treat hardness, etc.)
- Any other specified requirement that you have the capability to measure or that is described in print notes or referenced specifications.

When dimensions are specified at multiple locations on the drawing, the data for each location should be numbered separately. In other words, if a dimension is 4X on the print then it must be recorded once for each dimension.

14.2 Dimensional data

For Element 10 such as dimensions and tolerances must be addressed on the Enerpac *First Sample inspection Report (FSIR).*

14.3 Material or Performance data

Should be included in Element 11 on a format that allows for clear interpretation of the results. For example, material results can be addressed using a material composition report or a Certificate of Analysis. Either an in-house format or the AIAG formats for material and performance are acceptable.

Test reports and certifications are to include verification of all specifications identified on the drawing.

15 Approved Engineering Change Documentation

This section is used to cover anything that is not addressed in a part print such as emails, Supplier Change Requests (SCR), Temporary Specification Deviations (TSD), etc. (e.g. feasibility studies).

Enerpac print change submissions must include a redlined print with the ECN number, expiration date (90 days from change date), and have the Engineer's initials.

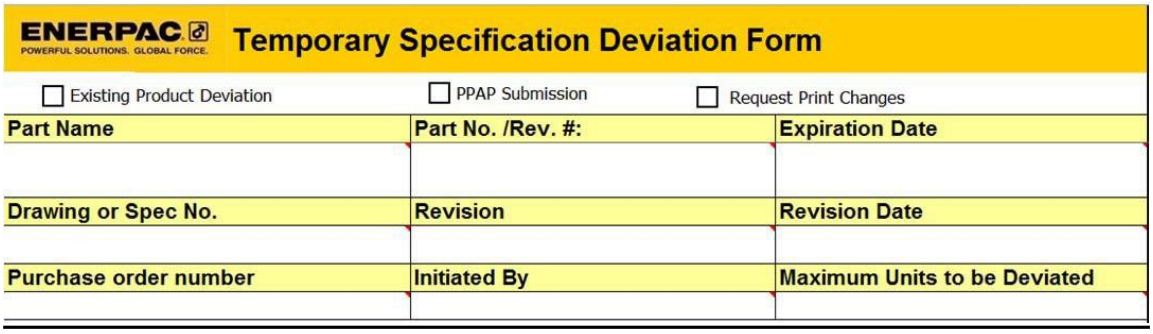
Emails can only clarify requirements, not define them. Emails cannot re-define a requirement in lieu of a print change. All supplier initiated changes must have a copy of an approved redlined print submitted with the PPAP and/or the approved SCR or TSD. Suppliers should not proceed with any changes until an approved redlined print/specification and or an approved Temporary Specification Deviation from Enerpac is received.

Submissions that have drawings from New Product Development labeled as ECO must be signed and dated by the design engineer with an expiration date noted on the print. Drawings labeled as CONCEPT shall be signed and dated by the Engineer and noted with the Purchase Order and quantity. PPAPs submitted with drawing that do not comply with the required notation will be rejected.

If a PPAP has been has submitted and approved under an ECO or Concept drawing then the supplier must resubmit the PPAP to the production revision before the supplier can ship production parts, components, or products. Exceptions may be taken when there is an approved Temporary Specification Deviation to this requirement. If you have questions regarding the required submission level and supporting documentation contact the Quality Assurance Representative of the Enerpac location to which your documentation is being submitted.

16 Temporary Specification Deviation Form

The Temporary Specification Deviation (TSD) Form documents variations in products from the initial specification, and the actions of the supplier regarding those variations. This also includes deviations to this Supplier Quality Manual.
There are three instances in which a Temporary Specification Deviation Form can be submitted:



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Temporary Specification Deviation Form

☐ Existing Product Deviation ☐ PPAP Submission ☐ Request Print Changes

Part Name	Part No. /Rev. #:	Expiration Date
Drawing or Spec No.	**Revision**	**Revision Date**
Purchase order number	**Initiated By**	**Maximum Units to be Deviated**

1. Existing Production Deviation: When temporary out-of-tolerance parts or out-of- control processes are encountered during manufacturing. The Deviation Form will document the actions of the supplier in correcting the non- conformances.

Important: Enerpac requires a *temporary deviation* approval to utilize product with temporary issues or nonconformance's. The deviation form is used only to notify Enerpac of the issue and your plan to resolve the issue. You will still be required to receive approval via a temporary deviation from Enerpac. Contact the Supplier Quality Representative for additional clarification on the requirement for temporary deviation.
Submitting a TSD form to Enerpac does not allow for shipment of nonconforming product.

2. PPAP Submission: When documenting issues with the PPAP requirements that are either viewed as not attainable or may require a print change in order to approve the submission.

Important: It is the responsibility of the supplier to notify Enerpac as early as possible in the development process of issues with part conformance to requirements. Issues that are documented only on a TSD form and that have not been communicated to Enerpac prior to PPAP submission will be treated as a non-conformance. Do not wait until PPAP submission to document and notify Enerpac of product issues.

3. Print Changes: Requested when seeking a change to a part specification to accommodate manufacturing variances, design review feedback or any long term manufacturability issues via capability or test results. The TSD will cover the actual parts that are out of tolerance. The SCR form should be submitted to accommodate the long term changes requested.

A Deviation form should be included any time a PPAP submittal is made seeking approval of engineering changes to a part or product. Alternatively, a Deviation form should be included in a PPAP submittal as requested by Enerpac in response to production of nonconforming parts, or identification of out-of-control processes by a supplier. A deviation must be included to get interim approval on a PPAP submission.

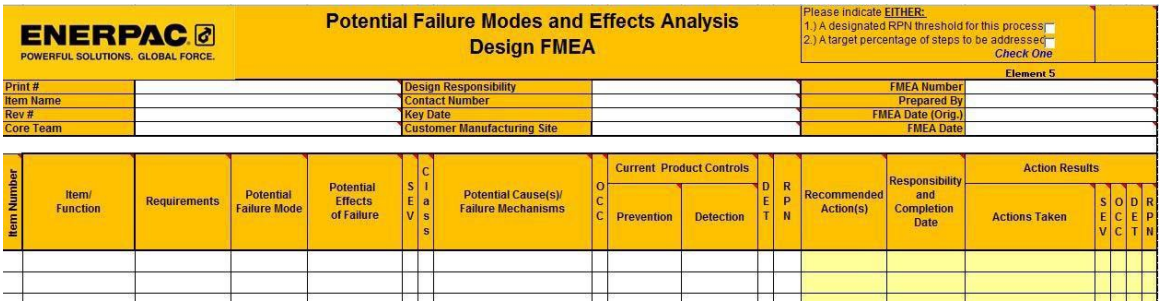
17 Customer Engineering Approvals

Customer Engineering Approvals are used to demonstrate pre-approval by Enerpac's customers of a design. Customer Engineering Approvals are not required for supplier submissions. In the event that this would be required in the future we have maintained a placeholder within the Enerpac requirements.

18 Design FMEA (DFMEA).

Design FMEA stands for Design Failure Mode and Effects Analysis (DFMEA) and shows evidence that potential failure modes and their associated risks have been addressed in order to eliminate or minimize their effects through product design changes and improvements. DFMEA is only required when the part is designed by the supplier and must address all Critical to Quality characteristics (CTQs) and any potential voice of the customer inputs identified in the Enerpac New Product Development Team.

The date on the DFMEA should show release prior to print release. Severity, Occurrence and Detection ratings are used when performing FMEA activities. These rating scales must be compliant with the AIAG guidelines for FMEA and definitions are included in the DFMEA worksheet as well as this handbook.



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Potential Failure Modes and Effects Analysis
Design FMEA

Please indicate EITHER:
1.) A designated RPN threshold for this process ☐
2.) A target percentage of steps to be addressed ☐
Check One

Element 5

Print #		Design Responsibility		FMEA Number	
Item Name		Contact Number		Prepared By	
Rev #		Key Date		FMEA Date (Orig.)	
Core Team		Customer Manufacturing Site		FMEA Date	

Item Number	Item/ Function	Requirements	Potential Failure Mode	Potential Effects of Failure	SEV	Class	Potential Cause(s)/ Failure Mechanisms	OCC	Current Product Controls		DET	RPN	Recommended Action(s)	Responsibility and Completion Date	Action Results				
									Prevention	Detection					Actions Taken	SEV	OCC	DET	RPN

Enerpac has included a worksheet format in the "PPAP tools kit". The ratings scale for Severity is available in the Appendix A. Any potential failure mode not mitigated in the DFMEA should be included in the PFMEA also included on the PPAP worksheet. Any potential failure mode with a severity ranking of 9 or 10 should be addressed with a corrective action plan. Furthermore, potential failure items in the top 25 percent high RPN ranking should have corrective action items addressing the potential failure mode.

Organizations that have already developed a DFMEA or PFMEA can submit that as part of their PPAP submission. For organizations without a DFMEA or PFMEA, sample forms have been included in the PPAP Tools kit.

18.1 Completing the DFMEA.

The DFMEA supports the design process by reducing the risk of failures. The DFMEA should be initiated before the design concept is finalized. Each item/function needs to be addressed. Any potential failure mode of the item/function should be defined as completely as possible. Recommended actions should be recorded. All severities of 9 or 10 should have an associated action plan. Prevention is the preferred method to address the design failure mode. If prevention is not possible, then highlight detection controls. The DFMEA is not meant to be a standalone document and the results of the DFMEA can be used in the PFMEA.

The FMEA tables for Severity, Occurrence and Detection are embedded in the cell comments on Enerpac's FMEA template. The three of these ratings multiplied together produce the initial Risk Priority Number or RPN.

Severity x Occurrence x Detection = RPN

The use of an RPN threshold is not recommended practice for determining the need for actions. Applying thresholds assumes that RPNs are a measure of relative risk (which they often are not) and that continual improvement is not required (which it is). Enerpac recommends that you treat all FMEA activity on a separate case by case basis and that you address the top 25% of your highest RPN values within the FMEA activity you are doing.

19 Process Flow Diagrams.

The purpose of Process Flow Diagrams is to document and clarify all the steps required in the manufacturing of a part. The Primary process steps must match both the Control plan and the PFMEA. Process flows must include the entire manufacturing process (receiving through shipping).

The Process Flow Diagram must also include all key steps in the process and all offline activities (such as outside services, measurement, inspection and handling). The flow of nonconforming material such as scrap parts, non-conforming parts and rework parts should also be included. The Process Flow can be provided in any format used within an organization.

20 Process FMEA (PFMEA)

The Process FMEA (PFMEA- Process Failure Mode and Effects Analysis) is used to show evidence that any potential failure modes and risks have been assessed at the manufacturing process level. Process FMEA's can be submitted in the Enerpac format or any AIAG compliant format. Enerpac has provided a PFMEA Worksheet in excel format in the PPAP Tool kit.

A PFMEA should be performed for every part, piece of equipment or process involved in manufacturing. PFMEA is a cross-functional activity that is performed internally, updated routinely and reviewed periodically. Severity, occurrence and detection ranking values are included in this handbook, as well as in the PPAP tool kit.

Enerpac requires that any severity ranking of 9 or 10 be addressed with a corrective action plan. Furthermore, potential failure items in the top 25 percent of the high RPN ranking items should have action items addressing the potential failure mode. This in turn will lower the re-calculated RPN value for that failure mode. Any high RPN process concerns should be carried over and addressed in the control plan. All critical failure modes must be addressed.

20.1 Completing the PFMEA

The PFMEA worksheet is a tool used to identify and show potential process risks associated with the manufacture of each part. It also highlights the controls associated with each process. Each process step/function should be identified with an action plan to address the process failure mode. All high RPN process concerns should be carried over to the control plan.

The recommended actions in any FMEA should address the initial high RPN numbers to minimize risk in the manufacturing process. The goal is to drive the final RPN number as low as possible.

FMEA is a cross-functional activity that can lead to inconsistency particularly when specific team members are not trained. A number of organizations provide good training on both DFMEA and PFMEA. In addition, the AIAG manual is the industry reference for comprehensive details on FMEA and can be purchased through their website. In addition, AIAG also offers additional training that you or your team can attend. Your Enerpac Supplier Quality Representative can also

assist with any questions concerning FMEA. Below is a list of some of the more common mistakes made when performing FMEAs and should be avoided when performing the activity. It is recommended that you review this list with your team prior to performing FMEA.

Examples of common mistakes made on PFMEA:

- Misapplication of Severity.
- Occurrence and Detection Redefining Severity.
- Occurrence and Detection over estimating the effectiveness of a Recommended Action.
- Applying RPN thresholds arbitrarily.
- 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.

21 Control Plan

A **Control Plan** defines the operations, processes, materials, equipment, methodologies, and CTQs (as determined by Enerpac and suppliers) for controlling variations in key product or process characteristics integral to the manufacturing process. Its purpose is to communicate the supplier's decisions during the entire manufacturing process from materials purchase through final shipping. 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.

All processes must have a control plan that defines all methods used for process control and complies with the customer-specified requirements. The control plan must clearly state each step in the process. The specification, and all Critical to Quality (CTQs) characteristics must be addressed for product and process.

21.1 Completing the Control Plan

Completing the Control Plan is a fairly straightforward process whereby the supplier simply documents all materials and processes involved in the manufacturing process from start to finish. The process flow diagram and ballooned drawing provide inputs to the Control Plan. All CTQ features identified as Process, First-Piece, or Safety Related by the supplier must be listed on the control plan form. Additionally, the supplier will list decisions that are foreseen to affect the outcome of production.

A control plan should address all testing requirements, inspection and measurements that are required to make a quality product. Suppliers should also include other details they know to be vital in the process. The control plan cannot be excessively dependent on visual inspection and should target prevention techniques wherever possible. The control plan can be submitted on the Enerpac supplied format or any AIAG compliant format.

The control plan should be developed in stages from proto-type through production. *Early planning* on the control plan will usually result in a more robust process. Suppliers should develop a *pre-launch control plan* early in the development of a new product and submit it to their Enerpac New Product Design Engineer team for feedback. This will allow both the supplier and Enerpac to troubleshoot and finalize the production level control plan early and avoid unexpected costs or delays. Enerpac may also request that you provide specific documents required at PPAP early in the development phase and the most common ones are the PFMEA and a pre-launch Control Plan.

It is vital the control plan describes the actions required within the manufacturing process flow to ensure that all process outputs are in a state of control and that every step in the process requiring disposition has a defined "Control Method" and "Reaction Plan" outlined on the control plan. This includes all forms of testing, inspection, measurement, and process setup. The "Reaction Plan" should clearly define any contingency planning that may need to be addressed during the manufacturing of the product.

Finally, the Control Plan should be a living active part of your overall quality system. Enerpac prefers that all suppliers develop the Control Plan methodology as part of their everyday practice and Quality system. Control plans should not be developed just for a PPAP submission and in the event of an issue will typically be requested by Enerpac.

Therefore, it is in the best interest of all suppliers to embrace the overall concepts that develop from implementing a robust Control Plan. Enerpac may also request that a specific ***pre-launch Control Plan*** be developed that minimizes the overall risk of specific product concerns during the launch phase. Unless otherwise requested the control plan for all PPAP submissions is the *"production"* control plan.

The control plan methodology is formally defined in the AIAG APQP guidelines. You must utilize an AIAG compliant format and Enerpac has provided one in the PPAP Forms Kit.

Below is the control plan template provided in the Enerpac PPAP Kit.

Control Plan

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☐ Prototype ☐ Pre-Launch ☑ Production

Control Plan Number	Key Contact / Phone	Date (Orig.)	Current Release Level	Current Release Date

Part Number/ Latest Change (Rev) Level	Part Description	Supplier Code	Plant Location	
Enter Your Part Number Enter	Part Description	Your Supplier Code	City	State

Core Team	Supplier Name	Quality Department Approval
	Your Company Name	

Customer Engineering Approval / Date (If Req'd)	Supplier Plant Approval	Other Approval / Date (If Req'd)

PART / PROCESS NUMBER	PROCESS NAME / OPERATION DESCRIPTION	MACHINE DEVICES / JIG / TOOLS FOR MANUFACTURING	CHARACTERISTICS			SPECIAL CHAR. CLASS	METHODS		SAMPLE		CONTROL METHOD	REACTION PLAN
			NO.	PRODUCT	PROCESS		PRODUCT / PROCESS / SPECIFICATION / TOLERANCE	EVALUATION/ MEASUREMENT TECHNIQUE	SIZE	FREQ.		

22 Measurement System Analysis Studies (MSA).

Measurement system analysis (MSA) is a mathematical method of determining how much the variation within the measurement process contributes to overall process variability. MSA is used to ensure the use of the right measurement system for running production. Detail on MSA is found in the AIAG manual which defines guidelines for stability, bias, linearity, repeatability and reproducibility.

Enerpac requires an analysis of the capability of all measurement tools identified in the Control Plan (in process and offline gages). The requirement for suppliers is to perform a Gage R&R study using Total Tolerance on each measurement tool. The percentage R&R should be at 10% or less.

22.1 A Gage Repeatability and Reproducibility (GR&R) study

Is used to ensure that measurements used in the manufacturing process are reasonably consistent regardless of how many times they are performed, or by who they are performed. GR&R studies can be useful to suppliers in that they can identify equipment that is in need of service, or operators who may need additional training on the equipment. Below is the Enerpac ANOVA format provided in the PPAP Tool Kit.

A GR&R must be submitted for devices measuring data on CTQs and for each measurement device on all Level 3 submissions. Guidelines for Enerpac Suppliers performing GR&R are:

- Enerpac requires an analysis of the capability of ALL measurement tools identified in the Control Plan. *(In process and offline gages). The m*inimum requirement for Enerpac Suppliers are:

  A Gage R&R study using Total Tolerance on each measurement tool:
  - % R&R should be at 10% or less for CTQs.
  - Marginal gages (between 10% and 30%).
  - Gages with R&R at 30% or more cannot be used.

Important: Marginal Gages with 10 - 30% error need an action plan to address and improve the method of measurement.

Below is a table showing the percentage breakdown for acceptance from the study.

$GR\&R_{TOL}\% < 10$	Pass - Gage System is Useable
$10 \leq GR\&R_{TOL}\% \leq 30$	Gage System is useable but marginal
$GR\&R_{TOL}\% > 30$	Fail - Gage System is Unstable

22.2 Completing the GR&R Worksheet

The individual completing the GR&R worksheet should fill out the data at the top of the sheet as appropriate. The Gage Type, Gage ID, Calibration Date, and Unit of Measure should be entered. “USL” and “LSL” values should be entered based on the specifications and tolerances for the feature as listed on the ballooned drawing.

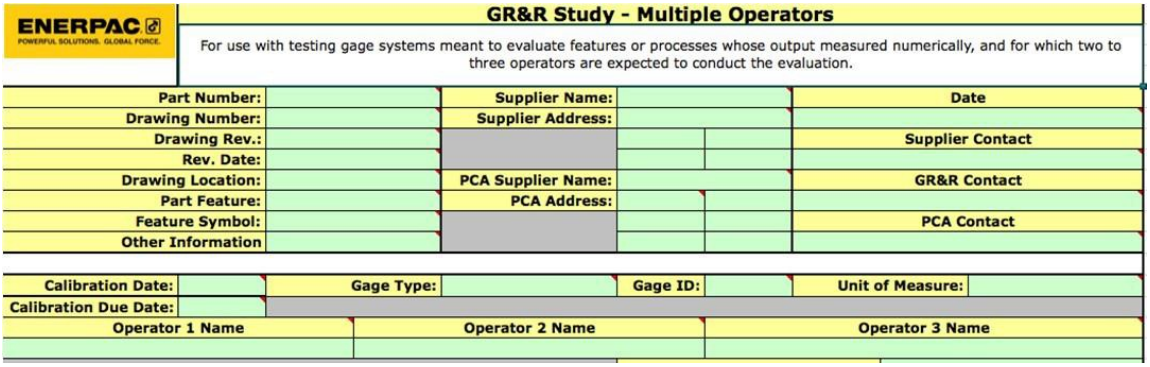
This worksheet is appropriate for 2-3 operators. You must enter an operator name or id for the results to be counted. The worksheet is also designed for two to three trials. (Two is the minimum to establish repeatability. Three is preferred.) Ten sample parts should be selected and tested to act as a reference standard.

All operators will use these same ten parts. Also, all operators will use the same gage, and the gage will be reset before each measurement is taken. If the reference standard parts have unique identifiers you can enter them into the “Part #” column. Once all the data is entered, the Disposition will reflect either “Pass”, “Marginal”, or “Fail”.

Two graphs are provided showing the performance of operator measurements. Even when a GR&R shows that your gage system is passing or useable, an examination of the graphs can aid in refining your gage system.

For instance, if one operator’s results aren’t consistent with the other two, then one or more of the operators may need retraining on the use of the gage. If all three operators show consistent deviations from mean, the

reference standard part itself may be the problem.



GR&R Study - Multiple Operators

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

Part Number:		Supplier Name:		Date
Drawing Number:		Supplier Address:		
Drawing Rev.:				Supplier Contact
Rev. Date:				
Drawing Location:		PCA Supplier Name:		GR&R Contact
Part Feature:		PCA Address:		
Feature Symbol:				PCA Contact
Other Information				

Calibration Date:		Gage Type:		Gage ID:	Unit of Measure:
Calibration Due Date:					

Operator 1 Name	Operator 2 Name	Operator 3 Name

23 Dimensional Results.

The **Dimensional Results** are documented in the "First Sample Inspection Report" provided in the PPAP Tool Kit. The measurements on this form must correlate with your balloon drawing from Element 2.

The purpose is to show conformance to the Enerpac part print on dimensions and all other print requirements.

The parts used for dimensional data must be from production tooling and randomly sampled from a run at production rate. The dimensional report must address all of the following:

- All dimensions.
- All applicable notes that have variable dimensions (example: tensile test)
- Any dimensions contained on reference prints.

- Tolerances that include bonus points for Geometric Dimensioning & Tolerancing (GD&T) callouts.

Sample Requirements Important: The parts measured for Element 10 should be the same parts submitted as formal samples in Element 15. Single Cavity Mold The minimum number of parts to measure for the dimensional elements is dictated by the Enerpac FSIR sampling plan shown under Element 15 and communicated as a PPAP requirement. These must be the same parts that are submitted as Sample Parts in Element 15. All sample parts should be identified with the corresponding number on the part or the tag. Multiple Cavity Molds The minimum number of parts to measure for the dimensional element is 1 part from each cavity. A minimum of 1 part from each cavity should be submitted as Sample Parts.

23.1 Completing the First Sample Inspection Reports

All dimensional requirements and notes on the ballooned drawing must be listed on the First Sample inspection Report. The dimensional element must be submitted on the Enerpac First Sample inspection Report. When requirements are referenced at multiple locations on the print the data must be recorded for each individual location. All callouts and notes must be included.

Two separate conversion worksheets are provided in the PPAP tool kit to facilitate conversions from Metric to Imperial and vice versa. Dimensions entered on either of those spreadsheets can transferred automatically to the FSIR by entering a date in the upper left date field.

Or you can fill out the FSIR directly. Be aware that if you do this it will overwrite the formulas in the FSIR and the Conversion spreadsheets will not continue to function.

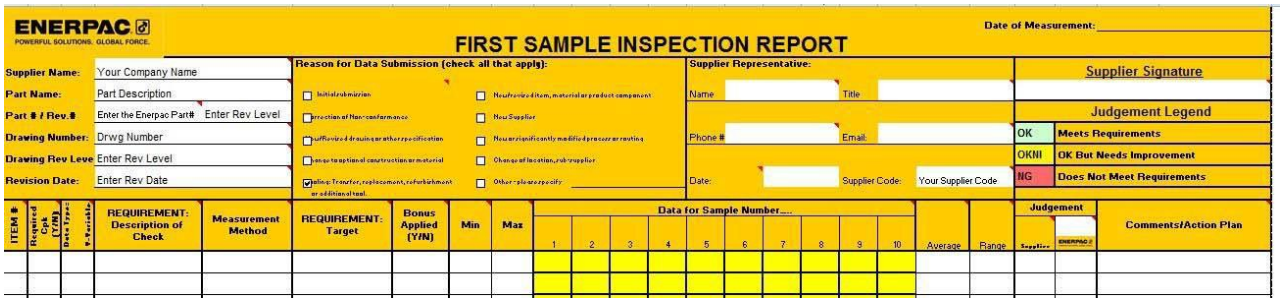
All sections of the Dimensional Data Sheet must be filled out completely. The Method of Measurement must be documented for every line item set of data. In addition, on GD&T tolerances the specification and any bonus tolerance must be added to the minimum and maximum tolerances.

The following conditions will result in this requirement being deemed unacceptable:

- Any requirement that is non-conforming.
- Any requirement with excessive range or variation.
- Any requirement that is too close to the proposed tolerance limits.

Any of these conditions will require corrective action to be addressed and identified on the First Sample Inspection Report. The proposed corrective action should address the cause and what will be done in response. This same issue should be addressed on the “Temporary Specification Deviation” sheet provided in the forms kit.

Any concerns identified in the First Sample Inspection Report should be brought to the attention of Enerpac Engineering or Quality before submitting your PPAP submission. **We expect all suppliers to place the formal dispositions on each line item.**



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FIRST SAMPLE INSPECTION REPORT

Date of Measurement:

Supplier Name:	Your Company Name	Reason for Data Submission (check all that apply):	Supplier Representative:
Part Name:	Part Description	☐ Initial submission ☐ New/revised item, material or product component	Name / Title
Part # / Rev.#	Enter the Enerpac Part# Enter Rev Level	☐ Correction of Non-conformance ☐ New Supplier	Phone # / Email:
Drawing Number:	Drwg Number	☐ Tool/Revised drawing or other specification ☐ New or significantly modified processor or routing	
Drawing Rev Level	Enter Rev Level	☐ Change to optional construction or material ☐ Change of location, sub-supplier	
Revision Date:	Enter Rev Date	☑ Tooling: Transfer, replacement, refurbishment or additional tool. ☐ Other - please specify:	Date: / Supplier Code: Your Supplier Code

Supplier Signature

Judgement Legend

OK	Meets Requirements
OKNI	OK But Needs Improvement
NG	Does Not Meet Requirements

ITEM #	Required Cpk (Y/N)	Data Type: V=Variable A=Attribute	REQUIREMENT: Description of Check	Measurement Method	REQUIREMENT: Target	Bonus Applied (Y/N)	Min	Max	Data for Sample Number.... 1	2	3	4	5	6	7	8	9	10	Average	Range	Judgement Supplier	Judgement ENERPAC	Comments/Action Plan

24 Material and Performance Test Results.

Material/Performance Test Results is a broad category for the majority of all other test results other than the dimensional results reported in the previous element. Either your own in house documents or AIAG forms may be used for test results. Enerpac is primarily concerned that the material is confirmed, and the acceptable performance is demonstrated. If there is a performance requirement, make sure the results of the testing are acceptable, credible, and performed to the specification. Together with the First Sample Inspection Report, this section of the submission should address a complete review of all product specifications and/or part print requirements.

Material Test Results should be provided in the form of a material composition report typically called a Certificate of Analysis (COA) from an accredited lab that confirms the material content meets a known standard. It is your responsibility as a supplier to Enerpac to confirm the composition of your material for both the PPAP submission and ongoing conformance. It is also your responsibility to plan for ongoing material conformance testing and identify this as a separate requirement (line item) in your control plan. This ensures that you have a plan for continuing conformance to the material standard.

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Production Part Approval

Material Test Results

Organization:	Your Company Name	Part Number:	Enter Your Part Number
Supplier/Vendor Code:	Your Supplier Code	Part Name:	Part Description
Material Supplier:		Drawing Number:	Drwg Number
*Customer Specified Supplier/Vendor Code:	Your Supplier Code	Revision Level:	Enter Rev Level
* If source approval is req'd, include the Supplier (Source) & Customer assigned code.		Name of Laboratory:	

Material Specification	Specification Limits	Test Date	Qty. Tested	Test Results	Ok	Not Ok

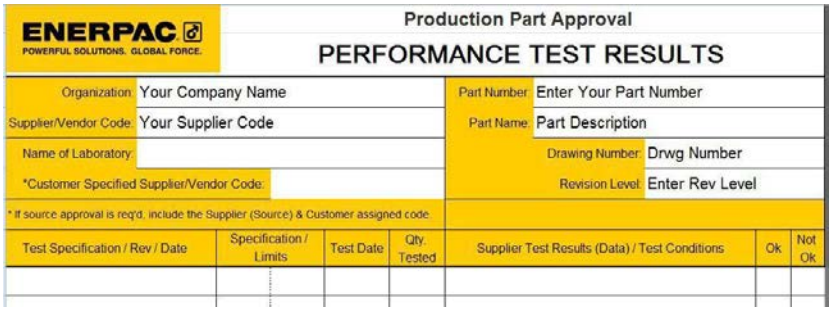
Enerpac's expectation is that you have a designated lab (internally or externally) that is capable of confirming your raw material on a periodic basis. The interval of inspection is recommended by the supplier however Enerpac reserves the right to request a change in the frequency of inspection at any time throughout the life of the part to ensure quality. In addition, Enerpac may require submission of composition test results or other forms of material certification as part of the supplier's standard process.

For raw material (i.e. bar or plate stock, castings and forging) a report from the mill or foundry may be submitted as long as it reports all the required chemical and physical data required by the engineering design documents. For example, if the Drawing requires yield properties of 90k KSI then the material test report must include this information in the mechanical properties section of the MTR.
Certificate of Compliance (COC) is acceptable but not preferred. Enerpac prefers to have results in the format of Certificate of Analysis (COA). COA will show actual test results to a known standard rather than simply certifying that a material meets the standard. When an Enerpac Specification is noted on the print (e.g. EES 107-6) then it is expected that the COA will also have that noted in the body to ensure the supplier used the correct specification to process the parts.

Performance Test Results should be acceptable, credible and meet the agreed upon specifications to be measured. Performance results may include data confirming any referenced specifications in the part print or specific testing required by Enerpac.

Safety and/or Government regulated components may be documented on the Performance Test Results form. A copy of a catalog page(s) denoting the part provided and the safety certification should be included in the PPAP. Review and acceptance must be listed on the form.

Enerpac engineering or quality will communicate specific material, performance, and testing requirements either the in part print, reference specifications or by specific request prior to PPAP approval. It is the responsibility of the supplier to confirm the data and format for this requirement with the Enerpac Quality or Supplier Quality Representative.



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Production Part Approval

PERFORMANCE TEST RESULTS

Organization:	Your Company Name	Part Number:	Enter Your Part Number
Supplier/Vendor Code:	Your Supplier Code	Part Name:	Part Description
Name of Laboratory:		Drawing Number:	Drwg Number
*Customer Specified Supplier/Vendor Code:		Revision Level:	Enter Rev Level

* If source approval is req'd, include the Supplier (Source) & Customer assigned code

Test Specification / Rev / Date	Specification / Limits	Test Date	Qty. Tested	Supplier Test Results (Data) / Test Conditions	Ok	Not Ok

25 Initial Process Study (Cpk, Ppk)

The purpose of initial process studies (Cp, CpK, Pp, Ppk) is to determine if the production process is likely to manufacture product that will meet our requirements. Initial process studies (capability) are mandatory for all CTQs.

Subgroups are the preferred method of determining Cpk in most cases. There are two primary indexes used in determining process capability.

- **Cpk** predicts future capability and should be used when developing new parts or revising specifications on a part. Cpk should also be used when materials, processes, manufacturing location, or equipment have significantly changed or material suppliers have changed (including Certificates of Analysis).

- **Ppk** indicates past performance. Use Ppk when you are a new supplier to Enerpac, but have already been manufacturing a part.
  Minimum requirement for capability studies is 25 subgroups containing at least 100 readings and sampled consecutively from a "significant production run." If testing involves destructive tests of expensive parts, Cpk by Moving Range can also be allowed. **Minimum acceptable capability for all CTQs is 1.33 and 1.67 for all safety related CTQs**.

- **Reporting Ppk vs. Cpk**
  When asked to report a CTQ for initial process study, what must be reported is the Ppk or Cpk number derived from a study of actual production parts from a production run that are sampled randomly.

Whether Ppk or Cpk is used will depend on the reason for the PPAP submission.

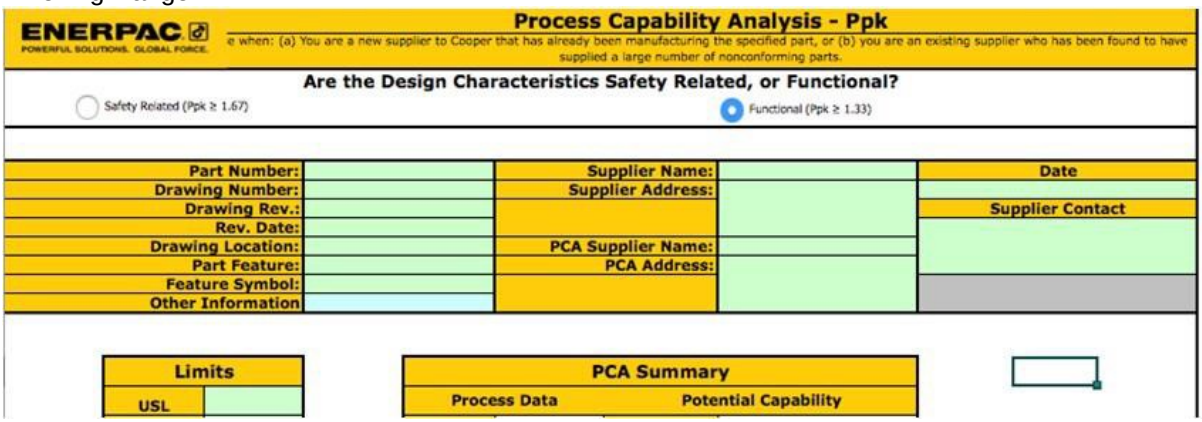
(Cpk) If a supplier is submitting a PPAP for a (a) new part, (b) a part with revised specifications, (c) a part in which the materials, processes, manufacturing location, or production equipment have significantly changed, or (d) a part in which the material suppliers have changed, then the supplier will be asked to report the Cpk.

(Ppk) If the supplier (a) has already been manufacturing the specified part, but is a new supplier to Enerpac, or (b) is an existing supplier to Enerpac that has been found to have supplied a large number of nonconforming parts, then the supplier will report Ppk numbers.

Whether using Cpk or Ppk, it must be noted that where processes exist involving multi- cavity/multi-spindle tooling, the Cpk or Ppk numbers reported must reflect a survey of parts from **each individual cavity or spindle**, not the total output of parts from a given machine. This will help isolate non-conformances resulting from problems with individual cavities or spindles.

25.1 Enerpac Capability Forms

Enerpac has provided 3 separate forms to use for capability studies. Below are the forms for Ppk, Cpk, and Cpk moving range.



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Process Capability Analysis - Ppk

e when: (a) You are a new supplier to Cooper that has already been manufacturing the specified part, or (b) you are an existing supplier who has been found to have supplied a large number of nonconforming parts.

Are the Design Characteristics Safety Related, or Functional?

○ Safety Related (Ppk ≥ 1.67) ◉ Functional (Ppk ≥ 1.33)

Part Number:		Supplier Name:		Date
Drawing Number:		Supplier Address:		
Drawing Rev.:				Supplier Contact
Rev. Date:				
Drawing Location:		PCA Supplier Name:		
Part Feature:		PCA Address:		
Feature Symbol:				
Other Information				

Limits	
USL	

PCA Summary	
Process Data	Potential Capability

25.2 Completing the Ppk Worksheet

Fill out the relevant information at the top of the Ppk worksheet. Remember that for safety-related features, a Cpk/Ppk greater than 1.67 is required. For functional features a Cpk/Ppk greater than 1.33 is required.

Enter the Upper Specification Limit (USL) and Lower Specification Limit (LSL) from the ballooned drawing. If you need to calculate the USL/LSL, then use the following formulas:

USL = Specification + Tolerance LSL = Specification – Tolerance

For each item, enter the value recorded during your testing procedure. If the part being tested has a unique identifier associated with it, you can enter that identifier in the left column under “Item Number” and overwrite the default value. Once the data has been entered, the disposition will reflect whether the Ppk is “Acceptable”, or is “Rejected”. If it becomes necessary to clear the values, the user can single left-click the “Clear Test Values” button. This will clear the “USL” and “LSL” fields, the data in the “Test Data” column, and will return the “Test No.” column to its default enumeration.

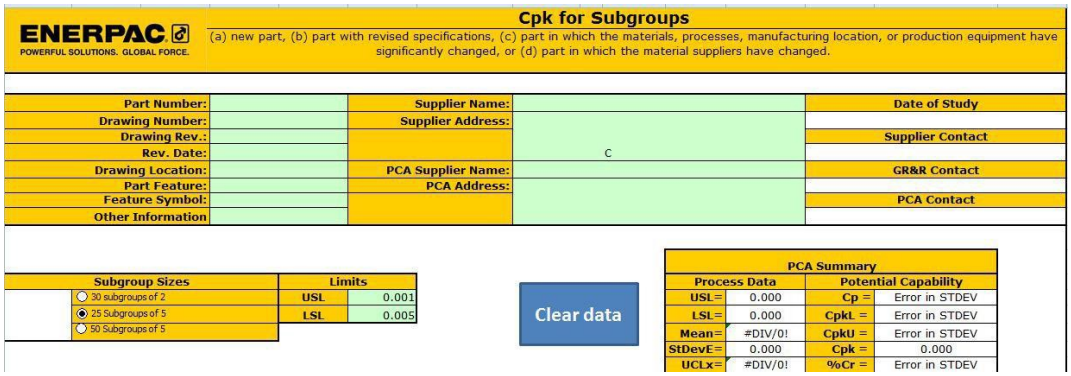
After completing the Ppk worksheet, the supplier should examine the results. Even if the worksheet “Accepts” a process as in- control, the distribution of data on the histogram may indicate a process that could be improved. Ideally, the histogram should resemble a bell shaped curve, be somewhat symmetrical, and all the data points should be within the limits of the graph.

If the worksheet “Fails” the process, or the histogram shows a process that is barely in control, the supplier should investigate factors that might be causing this to happen and run the analysis again after the issues have been resolved.

Remember that this worksheet should only be used when you are interested in “estimating” past performance.

25.3 Completing the Cpk Worksheet

The individual completing the Cpk Subgroup worksheet should fill out the data at the top of the sheet as appropriate. Then they should determine which Subgroup configuration is most appropriate for data collected and click the button next to that subgroup. Upon doing so, the table will change such that only columns and rows where data is expected to be entered will be active.



Data entered outside these columns will not be included in overall Cpk calculations. Finally, the "USL" and "LSL" should be entered. After all data is entered, be sure to save the workbook. If the subgroup being tested has a unique identifier associated with it, you can enter that identifier in the left column under "Subgroup" and overwrite the default value.

If at any time the user wishes to clear the values, they can single left-click the "Clear Data" button. This will clear the "USL" and "LSL" fields, the data in the "Test Data" column, and will return the "Subgroup" column to its default enumeration.

As with Ppk, the supplier will want to examine the results of the Cpk histogram. The Cpk histogram should resemble a bell shaped curve that is centered on the graph. Further, the Control Chart should show data randomly distributed on or about the mean or "R- Bar" line. If data shows extreme fluctuations, or cyclical patterns, it can indicate either a process that is out-of-control, or merely an incorrect sub grouping. Below is the Cpk worksheet. This worksheet should be used for the majority of capability studies unless you are estimating past performance.

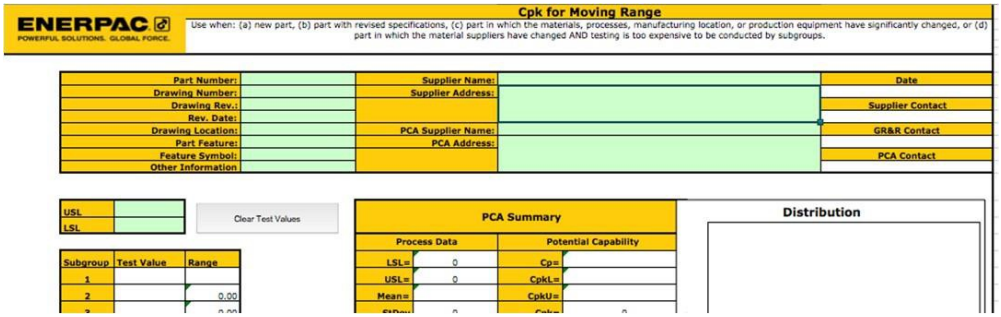
25.4 Completing the Cpk Moving Range Worksheet

When using the *Cpk Moving Range* worksheet fill out the data at the top of the sheet as appropriate. Fill in the USL and LSL fields as appropriate. Lastly, data collected during testing is entered under the "Test Value" column. If the Subgroup being tested has a unique identifier associated with it, you can enter that identifier in the left column under "Subgroup" and overwrite the default value.

If at any time the user wishes to clear the values, they can single left-click the "Clear Data" button. This will clear the "USL" and "LSL" fields, the data in the "Test Data" column, and will return the "Subgroup" column to its default enumeration. Interpretation of results for the Cpk Moving Range worksheet is similar to that for the Subgroups worksheet. Remember that even if the Cpk meets or exceed Enerpac standards, repeating patterns or extreme peaks and valleys in the Control Chart may indicate a process that is only barely in control, and may need further examination

Below is the Cpk moving range worksheet. Remember to utilize this worksheet when you need Cpk data but the parts you are studying have high expense or involve destructive testing in order to perform the study.

Cpk for Moving Range



25.5 Reporting Cpk Subgroup vs. Cpk Moving Range

In most cases, Cpk numbers will be reported based on the results of the Cpk Subgroup worksheet. This worksheet gives a choice between subgroups measuring 30 x 2 (30 subgroups of size 2), 25 x 5 (25 subgroups of size 5), or 50 x 5 (fifty subgroups of size 5). Unless the supplier receives instructions otherwise, they should choose the subgroup configuration most appropriate to analyzing the data. That decision will be a balance between maximizing data points, and minimizing overall cost of testing.

For instance, if reporting Cpk involves nondestructive testing of safety related features, then the 50 x 5 subgroup will yield 250 data points and is therefore preferred. On the other hand, destructive testing of slightly more expensive items with only functional characteristics can be satisfactorily completed with a 30 x 2 subgroup (60 data points). If expense is really a concern, then the Cpk Moving Range worksheet will be more appropriate for calculating Cpk numbers.

26 Qualified Laboratory Documentation

The purpose of Qualified Laboratory Documentation is to ensure that the testing for PPAP has been done by a qualified lab. If your organization performs testing or measurement internally or externally at an outside facility then proof of Scope and accreditation is required.

26.1 Internal Labs located at the Supplier

All suppliers that have testing or measurement performed on site must provide the following in this section of the PPAP submission.

a) Record/Scope that identifies the testing to be done and it must include:
   i) List of your personnel's competency and training to perform the testing
   ii) List of all test equipment used in process and offline.
   iii) List of methods and standards used to calibrate the equipment.

26.2 External Labs located offsite from the Supplier

If you are sending out for measurement and testing you must ensure that you have an accredited lab and can provide proof of the accreditation. Enerpac prefers that external labs be accredited to known lab accreditation standards such as A2LA and ISO 17025.

- 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 have to be identified.

- **Note: See below for more info on Lab accreditation standards**

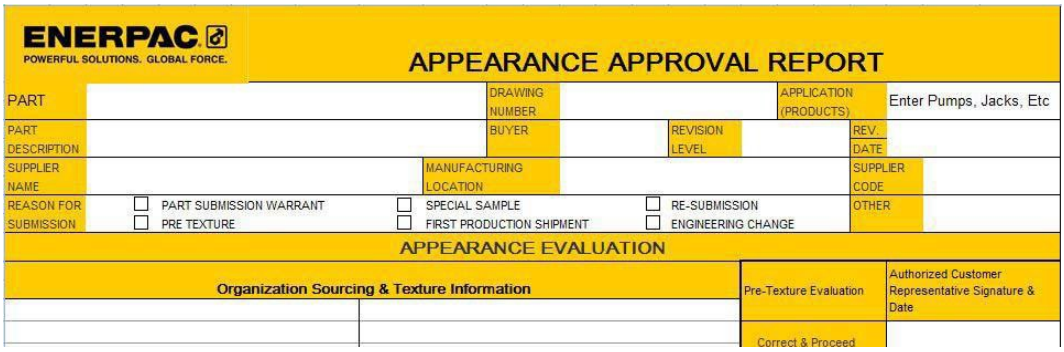
More Information on A2LA: A2LA The American Association for Laboratory Accreditation.

More information on ISO 17025: ISO/IEC 17025:2005 - General requirements for the competence of testing and calibration laboratories

27 Appearance Approval Report.

Appearance approvals can be used when a specific testing to a known standard or in defining limit samples. This requirement should always be in reference to a specific specification such as color, texture, contrast or paint.

It is not uncommon for projects that have no defined appearance requirements to develop them throughout the course of development. This could be as simple as a paint or color application that has developed into an appearance issue based on Enerpac feedback or Enerpac's customer feedback. Whenever appearance related issues arise that have no defined specification it is in the best interest of both the supplier and Enerpac to utilize this element and clearly define what is acceptable and what is not acceptable. When non-conformances arise appearance issues can be readily resolved when there is clear definition of acceptance.



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APPEARANCE APPROVAL REPORT

PART		DRAWING NUMBER		APPLICATION (PRODUCTS)	Enter Pumps, Jacks, Etc		
PART DESCRIPTION		BUYER		REVISION LEVEL		REV. DATE	
SUPPLIER NAME		MANUFACTURING LOCATION				SUPPLIER CODE	
REASON FOR SUBMISSION	☐ PART SUBMISSION WARRANT ☐ PRE TEXTURE	☐ SPECIAL SAMPLE ☐ FIRST PRODUCTION SHIPMENT		☐ RE-SUBMISSION ☐ ENGINEERING CHANGE		OTHER	

APPEARANCE EVALUATION

Organization Sourcing & Texture Information		Pre-Texture Evaluation	Authorized Customer Representative Signature & Date
		Correct & Proceed	

28 Sample Parts.

Sample Parts are to be included and are to be the actual samples measured in the dimensional element (Element 10). Sample parts should be delivered with or before the submission.

Contact your Supplier Quality Representative for clarification on who should receive the sample parts. The default quantity for all submissions is no less than 3 parts unless requested otherwise. The quantity of sample parts to submit are determined by the sampling plan below and communicated as a PPAP requirement. Sample parts must reflect the current print revision, the submission data, and be sampled from an actual production run.

Significant Production Run Qty	Required Quantity for production volume FSIR	Required Quantity for Prototype/low volume FSIR
2 to 8	2	2
9 to 15	2	2
16 to 25	2	2
26 to 50	3	3
51 to 90	4	4
91 to 150	5	5
151 to 250	6	6
250 to 500	7	N/A
501 to 1200	8	N/A
1201 to 3200	9	N/A
3201 to 10,000	9	N/A
10,001 to 35,000	9	N/A
35,001 to 150,000	9	N/A
150,001 to 500,000	9	N/A
500,001 and over	9	N/A

28.1 Differentiate between FSIR/PPAP samples at SV/PV/PPAP

Multicavity/Spindle Parts: If the product you are providing comes from a multi-cavity or multi spindle tool then Enerpac's requirement is that you provide 1 part from each cavity/spindle.

28.2 Instructions for Sample Parts Identification.

Each sample part MUST be properly tagged and identified as a PPAP sample part with information listed below. The box that ships the parts should also be clearly labeled as containing Unapproved PPAP Sample Parts in order to avoid being misplaced or inadvertently mixed with approved production parts.

Your sample parts must contain the following information listed below at a minimum or could possibly be rejected back for re-submission:

- Identifying the part as a PPAP Sample Part.
- Enerpac Part Number.
- Revision Level.
- Supplier Name.
- Quantity of Sample (Indicate Partial Shipments).

29 Master Samples.

Master Part Samples are required only when Level 3 PPAP is requested on a case by case basis. Enerpac requires Master Part maintenance as 1 Master part for every part number at the most recent revision level or part number. The Master Part must be must be maintained for the life of the product.

30 Checking Aids.

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. Examples of checking aids include but are not limited to certified check fixtures, un-certified check fixtures, templates and custom gauges. Hard gaging such as Thread plug or ring gages are not considered checking aids in the sense noted here. However, calibration of Thread and ring gages must be a part of your overall Calibration System.

Enerpac 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, there should be a calibration record on file for it.
- Evidence that the checking aid has been verified as repeatable.

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 formal print and all additional verification data submitted with PPAP. You should review the design of your checking aid with Enerpac prior to building the check fixture to avoid additional costs.

Checking aids must have evidence of the following submitted with the PPAP:

- Conformance to the design print.
- Evidence of Repeatability in measuring the part.
- GRR studies for all CTQ related features.

31 Customer Specific Requirements.

Purpose: To address Enerpac specific requirements during PPAP submission.

Element 18 of the PPAP process is reserved for Customer Specific requirements and Enerpac has three designated Customer Specific requirements. Each PPAP level requires a different combination of these specific requirements. The customer specific requirements for Enerpac are:

- Tooling Information Form.
- Packaging Form.
- Measurement Equipment List.

Enerpac reserves the right to request any of these at the time of PPAP submission or to request updates to these documents anytime during the life of the part. It is important for suppliers to understand each of these requirements and why they are important. We strongly recommend that you actively communicate with your Enerpac Quality Representative to facilitate the completion of these specific requirements prior to submitting your PPAP for approval.

32 Tooling Form.

Purpose: Document important information on all Enerpac owned tools at the time of production start-up.

This requirement is mandatory for all Enerpac owned tools and must be completed by the supplier prior to PPAP approval.

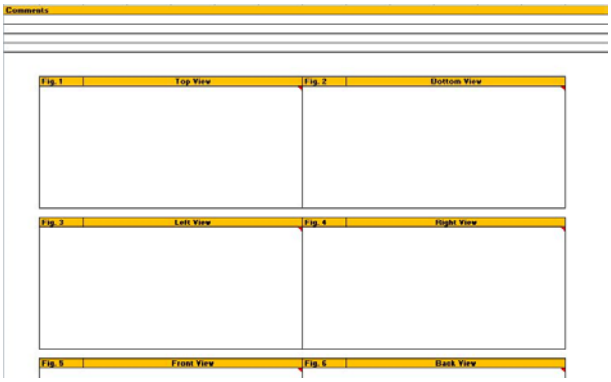
The **Tooling** Information form documents critical information including:

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

It is critical that all information on the tooling form be filled out completely and for the supplier to take the time to photograph the requested pictures and place them into the tooling form. The tool used for production is owned by Enerpac and documentation of the tool is critical for future reference and comparison. The form consists of 2 sections. The first seen below is for documenting technical information related to the tool. It is set up in a worksheet format to assist with acquiring all of the information Enerpac requires to complete this document.

ENERPAC	Tooling Information Form			Enerpac Tooling reference number. (if applicable)	XXXX
Supplier Name	PPAP Submission Level	Affected Feature Number(s)		Tool Description	
Date / PPAP Due Date	Part Number	Tool Location			
		Facility			
Date of Tooling Change	Part Name	Machine			
		Station			
New Tooling:	Modified Tooling:	Required for PPAP:	Note: This document must be completed for all Enerpac owned tooling.		
Complete Supplier Tooling Action Item List to ensure all items are completed.					
TOOLING ACTION ITEMS	Who	What	When	Status	
Tooling Images					
Diagram or Strip Layout					
Tool Drawings					
Tool Cost Breakdown					

The second portion of the tooling form requests specific pictures of the front, back and tool label required by each division.



33 Packaging Form.

Purpose: Approve the packaging method and material for supplied product. Suppliers are required to provide packaging to Enerpac that:

- Ensures the prevention of shipping and handling defects.
- Addresses any Hazmat related concern – Refer to Enerpac Packaging Guidelines.

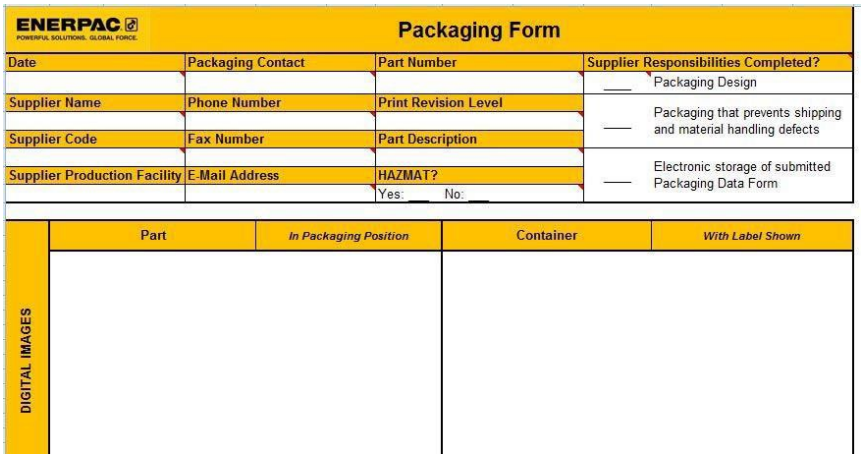
Below is the first page of the Packaging form. The top portion is basic technical information. It is important that Enerpac have a designated supplier contact identified in this section for any packaging questions. The most important part of the form is the pictures.

This portion of the form is very important and addresses the following issues:

- Approval of the intended packaging material.
- Documentation of the intended packaging material.
- 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 Enerpac.
- Package labeling.

The packaging form must be filled out in detail and all questions answered. It is important that there be clear pictures of the packaging in all four areas specified:

- A picture of the part in the packaging position.
- A picture of the outside container with label.
- A picture of any dunnage for the container.
- A picture of the final unit load in the shipping configuration.



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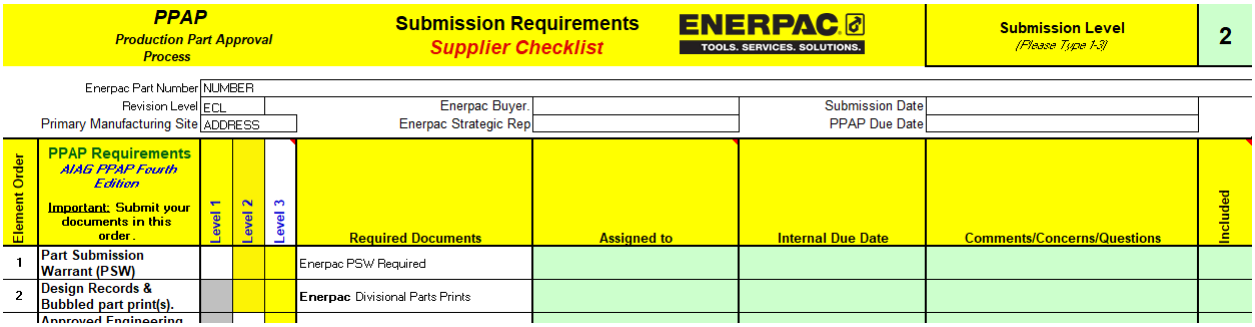
Packaging Form

Date	Packaging Contact	Part Number	Supplier Responsibilities Completed?
			___ Packaging Design
Supplier Name	Phone Number	Print Revision Level	___ Packaging that prevents shipping and material handling defects
Supplier Code	Fax Number	Part Description	
Supplier Production Facility	E-Mail Address	HAZMAT? Yes: ___ No: ___	___ Electronic storage of submitted Packaging Data Form

DIGITAL IMAGES	Part	*In Packaging Position*	Container	*With Label Shown*

34 Supplier Checklist.

The Supplier PPAP Checklist is a useful tool. It provides a reference for what elements are required by each level. It allows for assigning and delegating responsibilities for each of the elements that often originate from different areas within a supplier's organization. And it allows for communication of issues.



PPAP *Production Part Approval Process* — **Submission Requirements** *Supplier Checklist* — ENERPAC TOOLS. SERVICES. SOLUTIONS. — **Submission Level** *(Please Type 1-3)* **2**

Enerpac Part Number: NUMBER
Revision Level: ECL
Primary Manufacturing Site: ADDRESS
Enerpac Buyer:
Enerpac Strategic Rep:
Submission Date:
PPAP Due Date:

Element Order	PPAP Requirements *AIAG PPAP Fourth Edition* Important: Submit your documents in this order.	Level 1	Level 2	Level 3	Required Documents	Assigned to	Internal Due Date	Comments/Concerns/Questions	Included
1	Part Submission Warrant (PSW)				Enerpac PSW Required				
2	Design Records & Bubbled part print(s).				**Enerpac** Divisional Parts Prints				
	Approved Engineering								

Enerpac recommends that you utilize these documents to assist you and to show that you have done the due diligence required by the PPAP process. We recommend that as soon as your company is requested to supply a new part to Enerpac, that you hold a cross functional meeting to discuss, assign and target goals for completion of all the elements required. In this way you can track and delegate the requirements across your company during the development of the part. At the time of submission, the Supplier PPAP checklist allows for two additional things.

1. Confirmation that the element is included (Check the "included" box)

2. Additional comments or concerns that **would not be** identified on a deviation form as a nonconformance but still need to be brought to the attention of Enerpac. This includes areas such as packaging concerns, needed feedback from Enerpac on specific issues and additional information related to areas such as testing, measurement and appearance etc.

Enerpac strongly encourages all suppliers to utilize this document in preparing and submitting your PPAP.

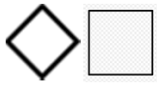
35 Definitions

Acronyms	Definition
Actual Production Run.	The production run that PPAP data is sampled from must be conducted using production tooling, equipment, environment (including production operators), facility, cycle time, etc. It should be performed once the supplier's process is considered ready for production.
Advanced Product Quality Planning (APQP).	APQP is a framework of procedures and techniques used to develop products in various industries. It was developed by AIAG for the automotive industry.
Automotive Industry Action Group (AIAG) AIAG	(The Automotive Industry Action Group **www.aiag.org**) is a group based in Southfield Michigan originally created to develop recommendations and a framework for the improvement of quality in the American Automotive Industry.
Approved Status.	Approved indicates that the part or material PPAP submission has been deemed acceptable and will meet customer requirements.
Ballooned Drawings.	A ballooned drawing shows the parts or assemblies in a part print with numbered "balloons" that identifies individual dimensions and requirements of the part.
Certificate of Analysis (COA).	Certificate of Analysis (COA) normally is from an accredited lab that confirms the material content meets a known standard. Material Test Results should be provided in the form of a material composition report.
Certificate of Conformance (COC).	A certification of material/part that states the material/part meets the agreed upon specification per customer requirements.

Acronyms	Definition
Checking Aids.	Any tool, gage or assembly equipment that verifies the physical or performance requirements of a part for the customer. Thread plug and ring gages notwithstanding.
Control Plan.	The Control Plan follows the PFMEA and Process Flow steps, and provides step-by-step details on how the process is controlled to product specification and how to respond to potential issues in the event of non-conformances.
Cp.	This is the capability index which is defined as the tolerance width divided by the process capability, irrespective of process centering.
Cpk.	Cpk is an index that measures “process capability” and also accounts for process centering. It “estimates” the capability that could be achieved over time assuming a stable process. It looks at how close a process is running to its specification limits, relative to the natural variability of the process. The larger the index, the less likely it is that any item will be outside the specs. It uses a population estimator to calculate the standard deviation and therefore “estimates” what the process is capable of producing in the future. Cp measures straightforward process capability and Cpk measures process capability as well as how close you are to your target and how consistent you are around your average performance. Cpk should at a minimum be 1.33 or higher, 1.67 on CTQ requirements. It should be used in the short term for estimating whether a process is capable of meeting customer requirements in the future.
Critical To Quality (CTQ).	CTQ is the key measurable characteristic(s) of a product or process whose performance standards or specification limits must be met in order to satisfy the customer. These are typically the most important characteristics of the part design. Enerpac defines CTQ in Appendix B.
Design Failure Mode Effects Analysis (DFMEA).	DFMEA is the application of the Failure Mode and Effects Analysis method specifically to product design. It is an analytical method performed cross-functionally and used in engineering to document and explore the ways that a product design might fail in real- world use.
Design Record.	A copy of the drawing or related specifications. If the customer is design responsible this is a copy of customer drawing that is sent together with the Purchase Order (PO). If supplier is design responsible this is a released drawing in supplier's release system. Electronic parts often have several components of the “design record” including part prints and other related specifications.
Detection Rating.	The rating scale utilized in FMEA to evaluate the ability of the current design or process control to actually “detect” a failure mode based on the assessed testing method and the quality of evidence.
Dimensional Results.	A list of all dimensions or requirements identified on the ballooned drawing and control plan. This list shows the product characteristics, specifications, measurement results, measurement method or final disposition.
Electronic Submission.	Electronic submission is the sending of files and the final PPAP submission electronically to Enerpac.
Elements.	The 18 sections listed in the PPAP submission requirements. The elements of PPAP submission package depends on the required submission level.

Acronyms	Definition
Engineering Change Notice (ECN).	A customer approved document that shows the detailed description of the change.
Existing Part.	A part currently made from a supplier used at Enerpac.
Gage R&R.	Gage R&R measures the amount of variability induced in measurements that comes from the measurement system itself and compares it to the total variability observed to determine the viability of the measurement system. A Gage R&R study is used to determine the repeatability and reproducibility of a specific gage or measurement device.
Geometric Dimensioning and Tolerancing (GD&T).	Geometric dimensioning and tolerancing is used to define the nominal geometry of parts and assemblies, to define the allowable variation in form and possibly size of individual features, and to define the allowable variation between features.
Initial Process Studies.	The purpose of initial process studies (CpK, Ppk) is to determine if the production process is likely to manufacture product that will meet Enerpac requirements.
Interim Status.	Interim approval permits shipment of material for production requirements on a limited time or piece quantity basis.
Levels	Determine which of the 18 elements are required at the time of submission. Level 3 is the default submission unless you have prior agreement with Enerpac.
Master Samples.	A sample signed off by customer and supplier that are used to train operators on subjective inspections such as visual or for noise. It documents the current revision level of the product being manufactured.
Material Test Results.	Specific requirements defined by Enerpac that validates the Design Verification Plan & Report and summarizes appropriate performance and functional test results.
Measurement System Analysis (MSA).	MSA usually contains the Gage R&R for the critical or high impact characteristics, and a confirmation that gages used to measure these characteristics are calibrated.
New Part.	A part made from an approved, new or changed drawing that the current part number or revision level has not been used in mass production.
Occurrence Rating.	The rating scale utilized in the Design and Process FMEA (that estimates how many times a potential failure may occur.
Ongoing Requirements.	Enerpac's supplier requirement to continually monitor product quality and the right to request any information or data that confirms conformance of product. It is the responsibility of the supplier to ensure that adequate proof of ongoing conformance is performed and is available.
Part Submission Warrant (PSW).	This is the form that summarizes the whole PPAP package. This form shows the reason for submission (design change, biennual revalidation, etc.) and the level of documents submitted to the customer. If there are any deviations the supplier must note them on the warrant.
Performance Test Results.	Performance Test Results covers all tests for a product, part or product materials when performance or functional requirements are specified by the design record, control plan or customer request.

Acronyms	Definition
Production Part Approval Process (PPAP).	PPAP is used to establish confidence in component suppliers and their production processes, by demonstrating that all customer engineering design records and specification requirements are properly understood by the supplier. It validates that the process has the potential to produce product consistently meeting these requirements during an actual production run at the quoted production rate.
Pp	This is the performance index which is defined as the process width divided by the process performance, irrespective of process centering.
Ppk.	Ppk is an index (a simple number) that measures actual "process performance" or whether the sample that you have generated from the process is capable of meeting customer requirements. Ppk estimates total standard deviation by using individual values and it tells you how the process has performed in the past. Pp measures straightforward process performance and Ppk measures both process performance and how close you are to the target value. It differs from process capability (Cp Cpk) in that process performance only applies to a specific batch of material. It should be used only for measuring the capability of past performance over the long term when identifying issues and determining future improvement.
Process Failure Mode Effects Analysis (PFMEA).	The PFMEA follows the Process Flow steps and identifies potential modes of failure during the fabrication and assembly of each component. The PFMEA is a living document that serves to continuously address and reduce the potential of failure and non-conforming product.
Process Flow Diagram.	Process Flow Diagram is a process map in the form of a flow chart that outlines all steps in the production process, including incoming components and outside services. In PPAP, it should focus on the manufacturing process, including rework and repair.
Rejected Status.	Used when a PPAP is determined to be unacceptable at the current part number or revision level and typically requires re-submission for approval.
Risk Priority Number (RPN).	During an FMEA activity and after ranking the severity (S), occurrence (O) and detection (D) an RPN number can be easily calculated by multiplying these 3 numbers together: RPN = Severity (S) x Occurrence (O) x Detection (D)
RPN Threshold.	An RPN threshold is a specific number chosen as the point when action on a failure mode is required. For example, if you have an RPN threshold of 50, then any failure mode with an RPN value higher than 50 would require action on the right hand side of the FMEA form. Enerpac discourages against using arbitrary RPN thresholds and encourages suppliers to improve the top 20%-30% of the highest RPN values generated during the FMEA exercise.
Sample Parts.	Sample parts are the parts delivered with the PPAP submission and should be the same parts measured in the dimensional report. The default quantity is a minimum of three (3) parts for all submissions or as agreed to with Enerpac. For multi-cavity molded parts suppliers need to at least provide one (1) part per cavity.
Serial production parts.	Components produced by a series of machines placed adjacent to each other with determined buffers between each machine.
Severity Rating.	The rating scale utilized in FMEA to determine and estimate the "severity" of the failure modes based on the functional requirements and their effects.

Acronyms	Definition
Supplier Change Request (SCR).	This document is used for initiating all supplier changes through all Enerpac divisions. The SCR should not be used to suggest or directly initiate print related or temporary changes.
Temporary Specification Deviation.	Document used to advise Enerpac of nonconformance(s) on a PPAP submission, and supplier requested corrective actions or suggestions.
Tooling.	It is defined as the portion of process machinery which is specific to component or sub- assembly. Tooling is used in process machinery to transform raw material into a finished part or assembly. All Enerpac owned tooling must have a tooling form submitted with the PPAP submission.
Total Tolerance.	In GR&R, the total tolerance calculation for overall Gage R&R % is the preferred method instead of Total Variation.
Critical Dimensions and Gage Checkpoints.	Identifies features as CTQ on specifications or ballooned drawing. Supplier then determines if CTQ belongs to one of the three following categories:
Process.	Features that may vary during production are marked as Process CTQs. A GR&R Study and Process Capability Analysis will likely be required on all Process CTQs. Process related CTQ characteristics must have cpk/Ppk indices 1.33 or greater.
First-Piece.	Features that if verified at job start and job end will assure production to specification F are considered First Piece CTQs.
Safety Related.	Features that affect the safe handling or operation of the part are considered Safety CTQs. All safety CTQs will require a Process Capability Analysis. Safety related CTQ characteristics must have Cpk/Ppk indices 1.67 or greater. 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 Each CTQ shall be indicated by a geometric symbol  Enerpac Quality has developed CTQ reference prints to aid suppliers in understanding the CTQ features as well as past failures. Contact your Enerpac Quality Representative for information on how to obtain these prints for parts under your scope of supply.

36 DFMEA Detection Table

Estimate how well you can detect cause or failure mode. Do not automatically presume that the detection is low because the occurrence is low. Assess the capability of the design controls to detect low frequency failure modes.

SUGGESTED DETECTION EVALUATION CRITERIA		
DETECTION	**CRITERIA**	**RNK.**
Absolute Uncertainty	Design Control will not and/or cannot detect a potential cause/ mechanism and subsequent failure mode; or there is no Design Control.	10
Very Remote	Very Remote chance the Design Control will detect a potential cause/mechanism and subsequent failure mode.	9
Remote	Remote chance the Design Control will detect a potential cause/ mechanism and subsequent failure mode.	8
Very Low	Very Low chance the Design Control will detect a potential cause/mechanism and subsequent failure mode.	7
Low	Low chance the Design Control will detect a potential cause/mechanism and subsequent failure mode.	6
Moderate	Moderate chance the Design Control will detect a potential cause/ mechanism and subsequent failure mode.	5
Moderately High	Moderately High chance the Design Control will detect a potential cause/mechanism and subsequent failure mode.	4
High	High chance the Design Control will detect a potential cause/ mechanism and subsequent failure mode.	3
Very High	Very High chance the Design Control will detect a potential cause/ mechanism and subsequent failure mode.	2
Almost Certain	Design Controls will almost certainly detect a potential cause/ mechanism and subsequent failure mode.	1

37 PFMEA Detection Table

How well can you detect cause or failure mode?

Suggested PFMEA Prevention / Detection Evaluation Criteria						
Rank	**Likelihood of Detection**	**Opportunity for Detection**	**Inspection Types**			**Criteria: Likelihood of Detection by Design Control**
			A - Error Proofed	**B - Gauged**	**C - Manual**	
10	Almost Impossible	No Detection Opportunity			X	No Current Process Control; Cannot Detect or is not Analyzed
9	Very Remote	Not Likely to Detect at any Stage			X	Failure Mode and/or Error (Cause) is not easily detected (eg random audits)
8	Remote	Controls will probably not detect. Problem detection post processing.			X	Failure Mode detection post processing by operator through visual tactile audible means
7	Very Low	Controls have poor chance of detection Problem detection at source.		X	X	Failure Mode detection in-station by operator through visual tactile audible means or post processing through use of attribute gauging (go/no go, manual torque check / clicker wrench etc.)
6	Low	Controls might detect. Problem detection post processing.		X	X	Failure Mode detection post processing by operator through variable gauging or in-station by operator through the use of attribute gauging (go/no go, manual torque check / clicker wrench etc.)
5	Moderate	Controls might detect. Problem detection at source.	X	X		Failure Mode or Error (Cause) detection in-station by operator through the use of variable gauging or by automated controls in-station that will detect discrepant part and notify operator (light buzzer etc.). Gauging performed on set-up and first piece check (for set-up causes only)
4	Moderately High	Controls may detect. Problem detection post processing.	X	X		Failure Mode detection post processing by automated controls that will detect discrepant part and lock part to prevent further processing.
3	High	Controls have a good chance to detect. Problem detection at source.	X			Failure Mode detection in-station by automated controls that will detect discrepant part and automatically lock part in station to prevent further processing.
2	Very High	Controls almost certain to detect. Error detection and or problem prevention.	X			Error (Cause) detection in-station by automated controls that will detect error and prevent discrepant part from being made.
1	Almost Certain	Detection not applicable, error prevention.	X			Error (Cause) prevention as a result of fixture design, machine design or part design. discrepant parts cannot be made because item has been error proofed by process/product design.

38 Occurrence rating table

How often does the cause or failure mode occur?

Suggested PFMEA Occurrence Evaluation Criteria		
Rank	**Likelihood of Failure**	**Criteria: Occurrence of Cause - DFMEA (Incidents per Item / Products)**
10	Very High	=> 100 per Thousand
		=> 1 in 10
9	High	50 per Thousand
		1 in 20
8		20 per Thousand
		1 in 50
7		10 per Thousand
		1 in 100
6	Moderate	2 per Thousand
		1 in 500
5		0.5 per Thousand
		1 in 2,000
4		0.1 per Thousand
		1 in 10,000
3	Low	0.01 per Thousand
		1 in 100,000
2		=< 0.001 per Thousand
		1 in 1,000,000
1	Very Low	Failure is eliminated through preventive control

39 DFMEA Severity table

Estimate how well you can detect cause or failure mode. Do not automatically presume that the detection is low because the occurrence is low. Assess the capability of the design controls to detect low frequency failure modes.

SEVERITY EVALUATION CRITERIA		
EFFECT	**CRITERIA: Severity of Effect**	**RNK.**
Hazardous - without warning	Very high severity ranking when a potential failure mode affects safe vehicle operation and/or involves noncompliance with government regulation without warning	10
Hazardous - with warning	Very high severity ranking when a potential failure mode affects safe vehicle operation and/or involves noncompliance with government regulation with warning	9
Very High	Vehicle/item inoperable (loss of primary function).	8
High	Vehicle/item operable but at a reduced level of performance. Customer very dissatisfied.	7
Moderate	Vehicle/item operable but Comfort/Convenience item(s) inoperable. Customer dissatisfied.	6
Low	Vehicle/item operable but Comfort/Convenience item(s) operable at a reduced level of performance. Customer somewhat dissatisfied.	5
Very Low	Fit & Finish/Squeak & Rattle item does not conform. Defect noticed by most customers (greater than 75%).	4
Minor	Fit & Finish/Squeak & Rattle item does not conform. Defect noticed by 50% of customers.	3
Very Minor	Fit & Finish/Squeak & Rattle item does not conform. Defect noticed by discriminating customers (less than 25%).	2
None	No discernable effect.	1

40 PFMEA Severity Table

How Severe is the Effect on the Product

Suggested PFMEA Severity Evaluation Criteria				
Rank	**Effect**	**Criteria: Severity of Effect on Product (Customer Effect)**	**Effect**	**Criteria: Severity of Effect on Process (Manufacturing / Assembly Effect)**
10	Failure to Meet Safety and/or Regulatory Requirements	Potential failure mode affects safe Product operation and/or involves noncompliance with government regulation without warning	Failure to Meet Safety and/or Regulatory Requirements	May Endanger Operator (machine or assembly) without warning
9		Potential failure mode affects safe Product operation and/or involves noncompliance with government regulation with warning		May Endanger Operator (machine or assembly) with warning
8	Loss or Degradation of Primary Function	Loss of primary function (Product inoperable, does not affect safe Product operation)	Major Disruption	100% of product may have to be scrapped. Line shutdown or stop ship.
7		Degradation of primary function (Product operable, but at reduced level of performance)	Significant Disruption	A portion of the production run may have to be scrapped. Deviation from primary process including decrease line speed or added manpower.
6	Loss or Degradation of Secondary Function	Loss of secondary function (Product operable, but comfort / convenience functions inoperable)	High Disruption	100% of production run may have to be reworked off line and accepted
5		Degradation of secondary function (Product operable, but comfort / convenience functions at reduced level of performance)		A portion of production run may have to be reworked off line and accepted
4	Annoyance	Appearance or audible Noise, Product operable, item does not conform and noticed by most customers (>75%)	Moderate Disruption	100% of production run may have to be reworked in station before it is processed.
3		Appearance or audible Noise, Product operable, item does not conform and noticed by most customers (50%)		A portion of production run may have to be reworked in station before it is processed.
2		Appearance or audible Noise, Product operable, item does not conform and noticed by most customers (<25%)	Minor Disruption	Slight inconvenience to process operation or operator.
1	No Effect	No discernible effect	No Effect	No discernible effect

41 Revision History

Rev No	Reason for change
1.0	Created and released
2.0	Brand Image Changed

NOTE: This document is released across a number of sites ISO 9001 document systems.
The document is also known under the following numbering:

Site	Form Number
CPC	F-232A
EDE	ETG-QAP-003
Morpeth	ETG-QAP-003
Mirage	MML 478
ACI	ASTWI32
AST	ASTWI32
Hengelo	**TBD**