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## SUPPLIER SAMPLING REQUIREMENTS (ASQR-20.1)

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## INTRODUCTION

This document defines supplier quality requirements as agreed upon by the following business entities herein referred to as "Member".

Member	Abbreviation	Applicability
Collins Aerospace	Collins	For Collins Aerospace Supplier Sampling requirements, please refer to your purchase order (PO).
Pratt & Whitney	PW	See below*
Pratt & Whitney Canada	PWC	See below*

\*When a supplier provides product or services to PW or PWC (together: "P&W").

## REVISION SUMMARY

This document has been revised for new formatting and removes non-P&W entities.

Required Member approval added for ANSI / ASQ Z1.4 and ANSI / ASQ Z1.9 sampling plans.

Add Ppk > 1.00 to qualification requirements for Periodic Inspection Plan when characteristic is not targeted.

Changed destructive sampling plan title to Lot-Based Destructive Sampling Plan.

Member approval is required for use of tightened and reduced switching rules for attribute sampling plan.

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## **SUPPLIER SAMPLING REQUIREMENTS FOR P&W**

### **1.0 SCOPE & APPLICABILITY**

- 1.1 This document defines requirements for supplier sampling and/or distributor inspection of selected characteristics permitted by this procedure for product, material or services supplied to P&W.
- 1.2 This document applies to build to print (Member Design) suppliers and design responsible suppliers.
- 1.3 Sampling requirements contained in this document shall only be used as a means of ensuring conformance to requirements, not for quality improvement.
- 1.4 Requirements contained in this document shall not be construed as permitting nonconforming parts to be sold to a Member. It is expected that all purchased parts be 100% conforming to all requirements of the Purchase Order, Engineering Drawing, and product definition requirements.

### **2.0 INFORMATIVE REFERENCES**

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

**Table 1: Documents Referenced in ASQR-20.1**

<b>Document</b>	<b>Title</b>
ANSI / ASQ Z1.4	Sampling Procedures and Tables for Inspection by Attributes
ANSI / ASQ Z1.9	Sampling Procedures and Tables for Inspection by Variables for Percent Nonconforming
AS13100	AESQ Quality Management System Requirements for Aero Engine Design and Production Organizations
ASQR-01	Aerospace Supplier Quality Requirements
ASQR-09.1	Flight Safety Parts Program
ASTM E140	Standard Hardness Conversion Tables for Metals
CPW121	Quality Assurance Requirements for Castings, Composite Products, Metal and Plastic Injection Moldings and Impression Die Forgings
CPW135	Engineering Source Approval
CPW138	ENSIP Critical Parts
CPW153	Management & Classification of Key Product Characteristics
DCS-178	Prime Reliable Parts
DCS-3	Main Bearing Carbon Split Rings Seals, Gap at Interface Between Carbon Seal and Housing, Accessory Shaft Carbon Seals and Mainshaft Carbon Face Seals (CARTRIDGE TYPE)
HIM-1	Hardness Inspection of Metallic Materials

ISBN 0-87389-305-0	Zero Acceptance Number Sampling Plans
PWA 370	Engineering Source Approval
PWA 79345	Management & Classification of Key Product Characteristics
PWQA-6078	Quality Control Requirements for Castings, Forgings, Extrusions, Rolled or Welded Rings, and Sonic Configuration Parts Produced by Suppliers
PWQA-6088	Control of Nonconforming Articles by Supplier
SQOP 01-02	Control of Non-Conforming Product

### 3.0 TERMS AND DEFINITIONS

#### **100% Inspected (100% Inspection or Inspect 100%)**

Every part is inspected for one or more characteristics.

#### **Acceptance Quality Limit (AQL)**

Used in the Z1.4 Attribute Sampling Plan and Z1.9 Variable Sampling Plan. It is the quality level that is the worst tolerable process average when a continuing series of lots is submitted for acceptance sampling.

#### **Acceptance Criteria**

Conditions for continued use of implemented sampling plan.

#### **Acceptance Number (Ac = 0 or C = 0)**

The max number of nonconformances in a sample to accept a lot. A lot is accepted when zero nonconformances are found in the sample.

#### **Airfoils**

A streamlined surface designed in such a way that air flowing around it produces useful motion and is found in applications such as integral bladed rotors, centrifugal impellers, blades, and vanes.

#### **Ball Bearings**

A spherical rolling element used as a component of a ball bearing assembly.

#### **Ball Bearing Critical Characteristics**

Internal radial clearance, axial play, contact angle (angular contact bearings only), inner bore diameter, outer ring outer diameter, diametral cage clearance on land riding surface, end flushness, cross corner, and step height of split inner rings (where required).

#### **Case Hardness**

The surface of a part after a treatment (e.g. carburizing, nitriding and induction brazing).

#### **Characteristic**

Dimensional, visual, functional, mechanical, and material features or properties that defines how to make a product (e.g. parts, details, assemblies). Characteristics can be measured, inspected, tested, or verified to determine conformance to the requirements.

## Continuous Process

A homogeneous process in which the product flows into the inspection station in essentially the order of manufacture and/or accumulation of identifiable lots may not be practical.

## Core Hardness

The core is the portion under the case, which is not affected by the treatment. This is the hardness of the material before the treatment, lower than the case hardness. Core hardness requirements are specified when case hardness is also a requirement.

## Critical Part For PWC

Refer to ASQR-09.1.

## Critical Characteristic

Refer to ASQR-09.1.

## Defects Per Million (DPM)

A measure of quality performance that equals the total parts nonconforming for a given characteristic divided by total parts produced and multiplied by a million.

## Distributor

Organization carrying the purchase, storage, splitting, and sale of products and not transforming, assembling, or otherwise modifying purchased product. Distributors are limited to raw material, industry standard, and Commercial-Off-The-Shelf (COTS) parts.

*Note: Suppliers that do perform per above but in addition purchase parts from third parties manufactured against P&W-proprietary drawings shall not be considered as Distributors.*

## Electro-Discharge Metal Removal (EDMR) for PW

A process by which metal is removed by discharging electrical energy between the tool (electrode) and the part. Both the part and the electrode are submerged in an electrically non-conducting dielectric fluid and connected to a DC power supply.

## Engine Structural Integrity Program (ENSIP) Critical Part for PWC

Refer to CPW138 and ASQR-09.1.

## ENSIP Critical Location (ECL) for PWC

Refer to CPW138 and ASQR-09.1.

## Hardening

Increasing hardness by suitable treatment, usually involving heating and cooling. When applicable, the following more specific terms should be used such as, annealing, precipitation heat treat or stress relief.

## Hardness

Resistance of material to plastic deformation or indentation, usually measured by an indentation test, such as, Rockwell, Brinell or Vickers.

**Homogeneous Lot**

A group of parts manufactured at approximately the same time under stable consistent conditions that are expected to share similar quality levels for the sampled characteristics. These parts should come from one production run.

**Homogeneous Process**

A process where all parts produced are made according to the same requirements under stable consistent conditions of production.

**Identical Characteristics (ICs)**

Characteristics which appear more than once on a single part and are produced by the identical manufacturing method to the same engineering drawing requirements for that operation (e.g., hole size, slot width). ICs do not apply to geometric characteristics such as parallelism, squareness, concentricity or true position.

**Index Value**

The value (i.e. 100%, .65%, 2.5%) used to determine the required sample size or sample frequency. Index value is determined by the requirements in 4.0, characteristic classification (reference Appendix A) and characteristic requirements for sampling determinations (reference Appendix B).

**KPC1**

Refer to PWA 79345 or CPW153

**KPC2**

Refer to PWA 79345 or CPW153

**Level Zero**

The initial Inspection Level required before sampling inspection may begin. Level zero specifies number of parts to be inspected for qualification.

**Lot**

A collection of parts treated as a unique entity from which a sample is to be drawn and inspected.

**Major Rotating Parts**

Any rotating part that rotates about its own centerline that has a safety related primary failure mode or high consequence of failure. Typical parts include disks, hubs, main shafts, free turbine coupling, turbine disk full hoop side plates. These parts are typically life limited, are made from forgings and require heat code and suffix controls of the forging.

**Minor Characteristic**

All characteristics not designated as critical or major.

**Mold**

The body containing the cavity(s) in which castings, composites and laminated parts are formed.

**Part**

Any item, detail, or assembly, etc., which is defined by an engineering drawing or specification.

**Prime Reliable Parts**

Refer to DCS-178.

**Process**

The combination of people, material, machines, tools, environment, measuring & test equipment, and work instructions necessary to produce a product or service.

**Ra**

The mean of the absolute values of the deviations from the average line in a surface profile.

**Rejection Criteria and Response**

Conditions for non-acceptance and actions required as a result such as requalification.

**Roller Bearing Critical Characteristics**

Internal radial clearance, roller end clearance, roller corner radius runout (mainshaft bearings only), roller end runout (mainshaft bearings only), diametral cage clearance on land riding surface, ring out of roundness for preload (where required), inner bore diameter, and outer ring outer diameter.

**Sample**

One or more parts drawn from a lot or batch. The units of the sample shall be selected at random, without regard to their quality.

**Sampled Characteristic**

Specific characteristic which is assigned a sampling plan.

**Sample Frequency**

Rate of inspection for continuous sampling plans (e.g., 1/50, 1/25, 1/10, 1/3, etc.).

**Sampling Plan**

A statement of the sample size to be used or the sample frequency and the associated acceptance and rejection criteria.

**Set-Up**

To put in proper machining or measuring position. The term “set-up” is defined as the installation of the fixture, die, or jig and details thereof in proper position on the same machine in preparation for producing part characteristics.

**Shearography**

An NDT Inspection technique that analyzes laser based interferometric images taken under both loaded and unloaded conditions to detect defects in composites and other materials.

**Special Process**

Certain processes that may affect the structural or functional integrity of parts and where the results of these processes may not be fully verified by subsequent inspection.

**Total Tolerance**

The full tolerance indicated on the engineering drawing for both unilateral and bilateral tolerances.

**4.0 GENERAL REQUIREMENTS**

- 4.1 Sampling inspection for product acceptance as defined herein shall be for in-process inspection or final inspection.
- 4.2 For product acceptance, all characteristics shall be 100% inspected unless the characteristic is eligible for sampling and the qualification requirements for use of sampling plans per paragraph 5.0 are met or an alternate sampling plan is approved per paragraph 6.0.
- 4.3 Sampling inspection shall not be allowed for characteristics affected by repair or rework.
- 4.4 The designation of the characteristic classification shall be identified per Appendix A.
- 4.5 If a characteristic is eligible for sampling, Index Value and/or Inspection Level shall be determined by characteristic classification (reference Appendix A) in conjunction with Characteristic Requirements for Sampling Determinations in Appendix B.
- 4.6 Critical characteristics per Appendix A shall be 100% inspected unless otherwise specified in 4.0.
- 4.7 Major characteristics per Appendix A shall have a .65% Index Value unless otherwise specified in 4.0 or Appendix B.
- 4.8 Minor characteristics per Appendix A shall have a 2.5% Index Value unless otherwise specified in 4.0 or Appendix B.
- 4.9 100% inspection shall be performed for all characteristics on PWC Critical Parts, PWC ENSIP Critical Parts, PW Major Rotating Parts, and PW Prime Reliable Parts.

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- 4.9.1 For PWC, sampling of PWC Critical Parts and PWC ENSIP Critical Parts are allowed for dimensions with a total tolerance over .001" (.025mm), provided qualification requirements are met (reference 5.0), except for KPC1 and characteristics identified as ECL.
- 4.10 100% inspection shall be performed for KPC1, PWC ENSIP Critical Locations (ECL), and other critical characteristics, except as noted in 4.13, 4.14, 5.5 and Table B1.
- 4.11 For PWC ENSIP Critical Parts, 100% NDT inspections shall be performed.
- 4.12 Selected Ball Bearing Critical Characteristics and Roller Bearing Critical Characteristics shall be 100% inspected (reference the Terms and Definitions Section herein).
- 4.13 PW Major Rotating Parts and PW Prime Reliable Parts Element Inspection of broached slots, threads, splines, and edges of broached slots (radii) may be sample inspected by qualified inspection personnel when approved by applicable Members' Quality Group per paragraph 6.0.
- 4.14 Where KPC1 and other critical characteristics that are produced by product of the die per PWQA-6078 for PW or CPW121 for PWC (e.g., investment castings, etc.), cannot be practically measured (e.g., a radius with small arc length, etc.) or when destructive testing is required, an alternate inspection plan may be applied when approved by applicable Member's Quality Group per paragraph 6.0.
- 4.15 For PW Flight Safety characteristics identified with a FSC racetrack on the engineering drawing, reference ASQR-09.1 for characteristic classification.
- 4.16 Identical characteristics (IC) application may be used with the attribute sampling plan in paragraph 5.1.
  - 4.16.1 When IC application is used, IC shall be combined for purposes of determining lot size and sample size.
  - 4.16.2 Combining of IC shall not apply to operator dependent characteristics (e.g., welded joints, hand drilled holes).
  - 4.16.3 Combined lot size shall be the number of identical characteristics that are on one part, multiplied by the number of parts in the original manufacturing lot (Example: a part has 12 identical characteristics and there are 50 parts per lot. The combined lot size is  $12 \times 50 = 600$ ).
  - 4.16.4 The IC sample size shall be determined by the combined lot size and Index Value in Table 2. (Example: the combined lot size is 600 and the Index Value is .65%. Then the IC sample size is 47)

4.16.5 Selection of IC to inspect shall be as follows:

If...	Then...	Example
IC sample size is less than the original manufacturing lot size	Inspect one random identical characteristic per part until IC sample size is reached.	Criteria: <ul style="list-style-type: none"> <li>• Manufacturing lot size is 20.</li> <li>• Number of IC per part is 10.</li> <li>• Combined lot size is 200.</li> <li>• Index Value is 2.5%</li> <li>• IC Sample Size is 13</li> </ul> Inspection: Inspect 1 IC on each of 13 randomly inspected parts.
IC sample size is greater than the original manufacturing lot size	Inspect one random identical characteristic on each part in the original manufacturing lot and the remainder of the samples randomly spread across the parts.	Criteria: <ul style="list-style-type: none"> <li>• Manufacturing lot size is 1.</li> <li>• Number of IC per part is 30.</li> <li>• Combined lot size is 30.</li> <li>• Index Value is .65%</li> <li>• IC Sample Size is 7</li> </ul> Inspection: Inspect 7 IC on 1 part
		Criteria: <ul style="list-style-type: none"> <li>• Manufacturing lot size is 10.</li> <li>• Number of IC per part is 15.</li> <li>• Combined lot size is 150.</li> <li>• Index Value is 2.5%</li> <li>• IC Sample Size is 11</li> </ul> Inspection: Inspect 1 IC on 9 parts and 2 IC on 1 part for a total of 11 IC on 10 parts.

- 4.17 A specified sampled characteristic shall only have one sample plan applied to it at a time.
- 4.18 Inspection personnel shall be trained in the application of sampling methods for product acceptance.
- 4.19 Sampling inspection by an operator is not allowed for the OpCert program (reference ASQR-01) unless approved by applicable Member per paragraph 6.0.
- 4.20 The First Article Inspection (FAI) per ASQR-01 shall be complete and accepted before implementation of sampling plans outlined in this document and before approval of alternate sampling plans.

- 4.21 The supplier shall maintain records of sampling usage per ASQR-01. Documentation is subject to review by Member.
- 4.22 Objective evidence of parts used for qualification, and requalification if applicable, shall be documented as a quality record and available upon request.
- 4.23 The supplier shall meet applicable qualification requirements prior to implementing sampling for product acceptance.
- 4.23.1 Where specified in this procedure, supplier shall obtain Member approval per paragraph 6.0 prior to implementation of a sampling plan or alternate sampling plan.
- 4.24 Visual inspection shall be performed after all manufacturing operations have been completed and shall be performed on all parts. (See examples in Appendix B Table B3)
- Note:** *Reference applicable Purchase Order for specific visual inspection instructions (e.g. visual standards, prior packaging requirements, etc.)*
- 4.25 Sampling for nondestructive testing (NDT) inspection shall not be used when the intent of the NDT is to look for isolated type nonconformances.
- 4.26 Sampling for NDT inspection may be applied within each separate exposure for radiographic inspection, when not looking for isolated type nonconformances and full inspection is not practical.
- 4.27 For any change that may affect quality and/or product fit, form, or function (e.g., a change in: design characteristic, manufacturing or assembly process, inspection method, tooling, materials, numerical control program, etc.), supplier shall stop sampling and requalify when the change is complete.
- 4.28 Characteristics known to be nonconforming and related suspect characteristics shall be inspected 100% (i.e., every part until sampling requalification).
- Note:** *The remaining characteristics may continue to be inspected per the appropriate sampling plan for that sampled characteristic*
- 4.29 When a Member detects a nonconformance not reported by the supplier (reference PWQA-6088 for PW or SQOP 01-02 for PWC) or a Member's audit determines incorrect application of sampling, previous and/or subsequent lots and/or parts shall be inspected as specified by the applicable Member.

## 5.0 SAMPLING PLAN REQUIREMENTS

### 5.1 Attribute Sampling Plan

#### 5.1.1 Description

- 5.1.1.1 A lot-based sampling plan where measurements can be taken with an attribute gage (e.g. go / no-go gage, Likert or ordinal scale) or variable gage and the outcome of inspection is pass or fail relative to acceptance criteria.

## 5.1.2 Qualification Requirements

5.1.2.1 Parts shall be manufactured in homogeneous lots. No additions or exchanges shall be made to the original lot.

5.1.2.2 A minimum of 25 consecutive parts shall be inspected for the sampled characteristic being produced with zero nonconformances detected.

5.1.2.3 Parts for qualification shall be representative of the process including multiple set-ups, shifts, operators, etc. Variable data should be collected if possible. Historical data (i.e., in-process or final inspection record of the conforming parts) may be used to meet this requirement.

5.1.2.4 Documented member approval per paragraph 6.0 shall be required to implement tightened and reduced switching rules.

## 5.1.3 Sample Size Determination

5.1.3.1 Product acceptance sample size shall be determined by characteristic classification per Appendix A, characteristic requirements in Appendix B and lot size in Table 2.

5.1.3.2 The sample shall be randomly selected from the lot and representative of the population. No exchanges shall be made to the original sample.

**Table 2: Attribute Sampling Plan**

Lot Size	Index Values															
	.010	.015	.025	.040	.065	.10	.15	.25	.40	.65	1.0	1.5	2.5	4.0	6.5	10.0
2-8	ALL	ALL	ALL	ALL	ALL	ALL	ALL	ALL	ALL	ALL	ALL	ALL	5	3	3	3
9-15	ALL	ALL	ALL	ALL	ALL	ALL	ALL	ALL	ALL	ALL	13	8	5	3	3	3
16-25	ALL	ALL	ALL	ALL	ALL	ALL	ALL	ALL	ALL	20	13	8	5	3	3	3
26-50	ALL	ALL	ALL	ALL	ALL	ALL	ALL	ALL	32	20	13	8	7	7	5	3
51-90	ALL	ALL	ALL	ALL	ALL	ALL	80	50	32	20	13	11	11	8	5	4
91-150	ALL	ALL	ALL	ALL	ALL	125	80	50	32	20	13	13	11	9	6	5
151-280	ALL	ALL	ALL	ALL	200	125	80	50	32	29	29	19	13	10	7	6
281-500	ALL	ALL	ALL	315	200	125	80	50	48	47	29	21	16	11	9	7
501-1200	ALL	800	500	315	200	125	80	75	73	47	34	27	19	15	11	8
1201-3200	1250	800	500	315	200	125	120	116	73	53	42	35	23	18	13	9
3201-10000	1250	800	500	315	200	192	189	116	86	68	50	38	29	22	15	9
10001-35000	1250	800	500	315	300	294	189	135	108	77	60	46	35	29	15	9
35001-150000	1250	800	500	490	476	294	218	170	123	96	74	56	40	29	15	9
150001-500000	1250	800	750	715	476	345	270	200	156	119	90	64	40	29	15	9
500001-Over	1250	1200	1112	715	556	435	303	244	189	143	102	64	40	29	15	9

**NOTES:**

- a. ALL indicates that the entire lot shall be inspected.
- b. Extracted from "Zero Acceptance Number Sampling Plans" (ISBN 0-87389-305-0). Reprinted with permission of the American Society for Quality.
- c. Contact Member for information about sampling risks (e.g., Operating Characteristic Curves etc.).

#### 5.1.4 Acceptance Criteria

- 5.1.4.1 The current lot shall be accepted for the sampled characteristic if zero nonconformances are found (i.e.,  $C = 0$ ).

**Note:** *Lot acceptance is only applicable for the sampled characteristic being inspected. The remaining characteristics require 100% inspection or shall meet the sampling requirements in this document.*

#### 5.1.5 Rejection Criteria and Response

- 5.1.5.1 Supplier shall stop sampling and reject the current lot if one or more nonconformances are found in the sample.
- 5.1.5.2 Supplier shall inspect current lot 100% (100% inspected) for the nonconforming sampled characteristic.
- 5.1.5.3 The subsequent lots shall be 100% inspected for the sampled characteristic until qualification requirements per 5.1.2 are met again.

### 5.2 Single Continuous Sampling Plan

#### 5.2.1 Description

- 5.2.1.1 A sampling plan used when the sampled characteristic is manufactured by a continuous process and sampling is based on order of parts manufactured. The sample frequency remains constant.

#### 5.2.2 Qualification Requirements

- 5.2.2.1 Sampled characteristic shall be manufactured by a continuous process.
- 5.2.2.2 The number of consecutive conforming parts to be inspected for qualification shall be per Level Zero in Table 3. No additions or exchanges shall be made.

#### 5.2.3 Sample Frequency Determination

- 5.2.3.1 Sample frequency shall be determined by characteristic classification per Appendix A, characteristic requirements in Appendix B and sampling frequency per Level 1 in Single 1 plan or Single 2 plan in Table 3.

**Table 3: Single Continuous Sampling Plan**

Index Value	Inspection Level	Single 1		OR	Single 2	
		f	i		f	i
100%	100%	N/A	N/A		N/A	N/A
.65%	Level Zero	100%	114		100%	161
	Level 1	1/3	-		1/10	-
2.5%	Level Zero	100%	32	100%	75	
	Level 1	1/3	-	1/10	-	

f = sample frequency  
i = consecutive items required to proceed to next sample level.  
If a nonconformance is found, return to Level Zero (reference definitions section)

**Example:**

- For sampled characteristics identified with Index Value of .65% and Single 1, upon completion of 114 parts at Level Zero, proceed to Level 1 with a 1/3 frequency.
- For sampled characteristics identified with Index Value of 2.5% and Single 2, upon completion of 75 parts at Level Zero, proceed to Level 1 with a 1/10 frequency.

#### 5.2.4 Acceptance Criteria

5.2.4.1 Parts manufactured since the last conforming sample shall be accepted for the identified sampled characteristic when the current sample is conforming.

**Note:** Acceptance is only applicable for the sampled characteristic being inspected. The remaining characteristics require 100% inspection or shall meet the sampling requirements in this document.

#### 5.2.5 Rejection Criteria and Response

5.2.5.1 Supplier shall stop sampling if a nonconformance is found.

5.2.5.2 Parts processed prior to the nonconforming parts shall be inspected for the nonconforming characteristic until all skipped parts are inspected since the last conforming sampled part.

5.2.5.3 Supplier shall inspect 100% of subsequent parts for the identified sampled characteristic until qualification requirements per 5.2.2 are met again.

### 5.3 Multiple Continuous Sampling Plan

#### 5.3.1 Description

5.3.1.1 A sampling plan used when the sampled characteristic is manufactured by a continuous process and sampling is based on order of parts manufactured. The sample frequency may progress to the next level of inspection when Inspection Level qualification requirements are met.

#### 5.3.2 Qualification Requirements

5.3.2.1 Sampled characteristic shall be manufactured by a continuous process.

- 5.3.2.2 The number of consecutive conforming parts to be inspected for qualification shall be per Level Zero in Table 4. No additions or exchanges shall be made.
- 5.3.3 Sample Frequency Determination
- 5.3.3.1 Sampling frequency shall be determined by characteristic classification per Appendix A, characteristic requirements per Appendix B and sampling frequency per Level 1 in Table 4.
- 5.3.3.2 Supplier may progress to the next sampling inspection level after the completion of consecutive inspections of sampled parts per Table 4 with zero nonconformances. See examples in Table 4.
- 5.3.3.3 Progression levels shall be completed sequentially. No levels shall be skipped.

**Table 4: Multiple Continuous Sampling Plan**

Inspection Level	.65% Index Value		2.5% Index Value	
	F	i	f	i
<b>Zero</b>	100 %	269	100 %	43
<b>1</b>	1/3	269	1/3	43
<b>2</b>	1/9	269	1/9	43
<b>3</b>	1/27	269	1/27	43
<b>4</b>	1/81	--	1/81	--

f = sample frequency, i = consecutively inspected parts required to proceed to next sample level.  
If a nonconformance is found, return to Level Zero (reference Rejection Criteria and Response)

**Examples:**

- For characteristics identified with a .65% Index Value and after completion of 269 parts at Level Zero, proceed to Level 1 with a 1/3 (1 in 3) sampling frequency. Upon completion of the next 269 conforming parts sampled out of a total of 807 parts produced, proceed to the 1/9 (1 in 9) level.
- For characteristics identified with a 2.5% Index Value and after completion of 43 parts at Level Zero, proceed to Level 1 with a 1/3 (1 in 3) sampling frequency. Upon completion of the next 43 conforming parts sampled out of a total of 129 parts produced, proceed to the 1/9 (1 in 9) level.

- 5.3.4 Acceptance Criteria
- 5.3.4.1 Parts manufactured since the last conforming sample shall be accepted for the identified sampled characteristic when the current sample is conforming.
- Note:** Acceptance is only applicable for the sampled characteristic being inspected. The remaining characteristics require 100% inspection or shall meet the sampling requirements in this document.
- 5.3.5 Rejection Criteria and Response
- 5.3.5.1 Supplier shall stop sampling if a nonconformance is found.
- 5.3.5.2 Parts processed prior to the nonconforming part shall be inspected for the nonconforming characteristic until all skipped parts are inspected since the last conforming sampled part.

- 5.3.5.3 Supplier shall inspect 100% of subsequent parts for the identified sampled characteristic until qualification requirements per 5.3.2 are met again.

**Note:** After requalifying to Level Zero, progress sequentially to next level and no levels can be skipped.

#### 5.4 Lot-Based Destructive Sampling Plan

##### 5.4.1 Description

- 5.4.1.1 A lot-based sampling plan in which a destructive method is used to measure the sampled characteristic. The lot-based destructive sampling plan should be used only when there is no other practicable method of verifying the conformance of the sampled characteristic.
- 5.4.1.2 The lot-based destructive sampling plan shall not be used on characteristics or drawing requirements that have a known nonconformance rate.
- 5.4.1.3 The lot-based destructive sampling plan shall not be used on Critical Rotating Parts, Major Rotating Parts, Prime Reliable Parts, KPC1, other critical characteristics or characteristics identified with Index Value of 100% per Appendix B unless approved by Pratt & Whitney per paragraph 6.0.

##### 5.4.2 Qualification Requirements

- 5.4.2.1 Parts shall be manufactured in homogeneous lots. No additions or exchanges shall be made to the original lot.
- 5.4.2.2 Qualification substantiation for sampled characteristic conformance (e.g. quantity of conforming consecutive cutups, ESA approval, objective evidence of mistake proofing, etc.) shall be available upon request.

**Note:** For PWC ESA approval, reference CPW135 and SQOP 01-07

- 5.4.2.3 Adequate process controls shall be in place (reference AS13100).
- 5.4.2.4 Control plan shall be utilized (reference AS13100).

##### 5.4.3 Sample Size Determination

- 5.4.3.1 Product acceptance sample size shall be determined by lot size and Table 5.

**Table 5: Lot-Based Destructive Sampling Plan (Formerly Table W)**

Lot Size	Sample Size
1-100	1
101-500	2
501-2500	3
2501 and up	Divide into 3 subgroups and select 3 from each subgroup (lot accept/reject based on results from all 3 groups)

**Note:** In special cases (i.e., small lots or expensive parts) use a test part(s) representative of the actual parts.



#### 5.4.4 Acceptance Criteria

5.4.4.1 The current lot shall be accepted for the sampled characteristic if zero nonconformances are found.

#### 5.4.5 Rejection Criteria and Response

5.4.5.1 Supplier shall stop sampling if a nonconformance is found and notify Member.

### **5.5 Sampling Plan for Major and Minor Characteristics for Airfoil Sections on Integral Bladed Rotors and Centrifugal Impellers**

#### 5.5.1 Description

5.5.1.1 Sampling plan for non-dimensional major and minor characteristics for airfoil sections on Integral Bladed Rotors and Centrifugal Impellers. Sampling is applied within a part and each part is inspected.

#### 5.5.2 Qualification Requirements

5.5.2.1 A minimum of two (2) integral bladed rotors or two (2) centrifugal impellers, as applicable, shall be inspected for all blade airfoil sections with zero nonconformances detected.

#### 5.5.3 Sample Size Determination

5.5.3.1 Supplier shall inspect a minimum of 2 blades for each part at approximately 0 and 180 degrees.

5.5.3.2 Supplier shall inspect 50% of the sections on the first blade and the balance of the remaining sections on the other blade.

#### 5.5.4 Acceptance Criteria

5.5.4.1 The current integral bladed rotor or centrifugal impeller shall be accepted for those sampled characteristics if zero nonconformances are found.

#### 5.5.5 Rejection Criteria and Response

5.5.5.1 If a nonconformance is detected, supplier shall inspect part 100% for that sampled characteristic.

5.5.5.2 If the same nonconformance is detected on two (2) consecutive parts, supplier shall stop sampling and requalify as described in 5.5.2

### **5.6 Sampling Plan for PW Ball Bearings - Finished Batch Lot - Metal Balls (Steel Only)**

#### 5.6.1 Description

5.6.1.1 Lot-based sampling plans for steel ball bearings. This sampling plan is not applicable to critical ball bearing characteristics.

## 5.6.2 Qualification Requirements

- 5.6.2.1 A minimum of 25 consecutive ball bearings shall be inspected for the sampled characteristic being produced with zero nonconformances detected.

**Note:** *An entire lot needs to be inspected to determine lot diameter variation.*

- 5.6.2.2 Parts for qualification shall be representative of the process including multiple set-ups, shifts, operators, etc. Variable data shall be collected if applicable. Historical data (i.e., in-process or final inspection record of the minimum 25 consecutive conforming parts) may be used to meet this requirement.

## 5.6.3 Sample Size Determination

- 5.6.3.1 When the single ball diameter variation (i.e., The difference between the largest and the smallest single diameters of one ball) less than .25 inches (diameter ball) then the minimum sample size shall be 32 balls per lot.
- 5.6.3.2 When the single ball diameter variation greater than or equal to .25 inches (diameter ball) then the minimum sample size shall be 25 balls per lot.
- 5.6.3.3 When the lot diameter variation (i.e., the difference between the average diameters of the largest and smallest balls in a finished lot) less than .25 inches (diameter ball) then the minimum sample size shall be 32 balls per lot.
- 5.6.3.4 When the lot diameter variation greater than or equal to .25 inches (diameter ball) then the minimum sample size shall be 25 balls per lot.
- 5.6.3.5 When surface finish lot size is less than or equal to 2500 then the minimum sample size shall be 5 balls per lot.
- 5.6.3.6 When surface finish lot size is greater than 2500 and up to and including 10,000 the minimum sample size shall be 10 balls per lot.
- 5.6.3.7 When surface finish lot size is greater than 10,000, the lot shall be split, with sample sizes per 5.6.3.5 and 5.6.3.6

## 5.6.4 Acceptance Criteria

- 5.6.4.1 The current lot shall be accepted for the sampled characteristic if zero nonconformances are found.

**Note:** *Lot acceptance is only applicable for the sampled characteristic being inspected. The remaining characteristics require 100% inspection or shall meet the sampling requirements in this document.*

## 5.6.5 Rejection Criteria and Response

- 5.6.5.1 Supplier shall stop sampling and reject the current lot if one or more nonconformance(s) are found on the sampled characteristic.
- 5.6.5.2 Supplier shall inspect current lot 100% for the nonconforming sampled characteristic.

5.6.5.3 Subsequent lots shall be 100% inspected for the sampled characteristic until qualification requirements per 5.6.2 are met again.

## **5.7 P&W Radiographic Inspection Sampling Plan for PW Raw Material (Casting) Turbine Blades and Vanes – Neutron Radiographic Standard (NRS-1/CNRS-E.1)**

### 5.7.1 Description

5.7.1.1 An attribute sampling plan for raw material turbine airfoils using NRS-1 for PW or CNRS-E.1 for PWC.

### 5.7.2 Qualification Requirements

5.7.2.1 A minimum of 500 consecutive parts shall be inspected with zero nonconformances.

5.7.2.2 Part, material or process shall be authorized for Engineering Source Approval per PWA 370 and PW Form 4692, or per CPW135 and approved on the Supplementary Material Data (SMD) sheet for PWC.

### 5.7.3 Sample Size Determination

5.7.3.1 Product acceptance sample size shall be determined by lot size and .65% Index Value in Table 2.

### 5.7.4 Acceptance Criteria

5.7.4.1 The current lot shall be accepted if zero nonconformances are found in the sample (i.e., C=0).

### 5.7.5 Rejection Criteria and Response

5.7.5.1 Supplier shall stop sampling if a nonconformance is found and implement 100% inspection for that sampled characteristic found nonconforming until qualification requirements in 5.7.2 are met again.

5.7.5.2 If a significant process change is documented per PWA 370 and PW Form 4692 for PW or CPW135 for PWC, supplier shall requalify per paragraph 5.7.2.

## **5.8 ANSI / ASQ Z1.4 Attribute Sampling Plan**

### 5.8.1 Description

5.8.1.1 Sampling Procedures and Tables for Inspection by Attributes is an acceptance sampling plan that can be used on a continuous stream of lots for Acceptance Quality Limit (AQL) specified. Implementing ANSI/ASQ Z1.4 sampling plans does not allow nonconforming parts to be sold to P&W (Reference paragraph 1.3)

### 5.8.2 Qualification Requirements

5.8.2.1 Documented Member approval per paragraph 6.0 shall be required for initial qualification.

- 5.8.2.2 Parts shall be manufactured in homogeneous lots. No additions or exchanges shall be made to the original lot.
- 5.8.2.3 A minimum of 25 parts shall be inspected for the sampled characteristic being produced with zero nonconformances detected.

**Note:** *Parts used for qualification should be produced consecutively*

- 5.8.2.4 Parts for qualification shall be representative of the process including multiple set-ups, shifts, operators, etc. Variable data should be collected if possible. Historical data (i.e., in-process or final inspection record of the conforming parts) may be used to meet this requirement.

### 5.8.3 Sample Size Determination

- 5.8.3.1 Sample size for product acceptance shall be determined by characteristic classification per Appendix A, characteristic requirements in Appendix B, Table 6 and Z1.4 Table II-A.
- 5.8.3.2 The sample shall be randomly selected from the lot and representative of the population. No exchanges shall be made to the sample.

**Table 6: ANSI/ASQ Z1.4 Attribute Sampling Plan**

Index Value	AQL	General Inspection Level
100%	100% Inspection	Not Applicable (N/A)
.65%	.65%	II
2.5%	2.5%	II

### 5.8.4 Acceptance Criteria

- 5.8.4.1 The current lot shall be accepted for the sampled characteristic if zero nonconformances are found in the sample (i.e.,  $A_c = 0$ ).

**Note:** *Lot acceptance is only applicable for the sampled characteristic being inspected. The remaining characteristics require 100% inspection or shall meet the sampling requirements in this document.*

### 5.8.5 Rejection Criteria and Response

- 5.8.5.1 Supplier shall stop sampling and reject the current lot if one or more nonconformances are found in the sample.
- 5.8.5.2 Supplier shall inspect current lot 100% (100% inspected) for the nonconforming sampled characteristic.
- 5.8.5.3 Subsequent lots shall be 100% inspected for the sampled characteristic until qualification requirements per 5.8.2.2 through 5.8.2.4 are met again.

## 5.9 ANSI / ASQ Z1.9 Variable Sampling Plan

### 5.9.1 Description

5.9.1.1 Sampling Procedures and Tables for Inspection by Variables for Percent Nonconforming is an acceptance sampling system to be used on a continuing stream of lots for Acceptance Quality Limit (AQL) specified. It provides tightened, normal, and reduced plans to be used on measurements which are normally distributed. Variation may be measured by sample standard deviation, sample range, or known standard deviation. It is applicable only when the normality of the measurements is assured (Reference ANSI / ASQ Z1.9). Implementing ANSI/ASQ Z1.9 sampling plans does not allow defective parts to be sold to Pratt & Whitney (reference paragraph 1.3)

### 5.9.2 Qualification Requirements

5.9.2.1 Documented Member approval per paragraph 6.0 shall be required for initial qualification.

5.9.2.2 A minimum of 50 parts shall be inspected for the sampled characteristic being produced with zero nonconformances detected.

**Note:** *Parts used for qualification should be produced consecutively*

5.9.2.3 Parts for qualification shall be representative of the process including multiple set-ups, shifts, operators, etc. Variable data should be collected if possible. Historical data (i.e., in-process or final inspection record of the conforming parts) may be used to meet this requirement.

5.9.2.4 The inspection parts for qualification per 5.9.2.2 and subsequent parts shall be normally distributed (i.e., the distribution of individual measurements shall be normal in shape).

**Note:** *Periodic distribution fitting may be necessary to ensure the data remains normally distributed.*

### 5.9.3 Sample Size Determination

5.9.3.1 Sample size shall be determined by characteristic classification per Appendix A, characteristic requirements in Appendix B, Table 7 and applicable Z1.9 tables.

**Table 7: ANSI / ASQ Z1.9**

Index Value	AQL	General Inspection Level
100%	100% Inspection	Not Applicable (N/A)
.65%	.65%	II
2.5%	2.5%	II

### 5.9.4 Acceptance Criteria

5.9.4.1 The lot shall be accepted if the (total) estimate of lot percent nonconforming is less than the max allowable percent nonconforming. (reference ANSI / ASQ Z1.9)

## 5.9.5 Rejection Criteria and Response

5.9.5.1 Supplier shall stop sampling and reject the current lot if one or more of the following occur:

- a. The maximum allowable percent nonconforming is greater than the (total) estimate of lot percent nonconforming.
- b. One or more nonconformance(s) are found on the sampled characteristic while sampling.

5.9.5.2 Supplier shall inspect current lot 100% for the nonconforming sampled characteristic.

5.9.5.3 Subsequent lots shall be 100% inspected for the sampled characteristic until qualification requirements per 5.9.2.2 through 5.9.2.4 are met again.

## 5.10 Sampling under Process Control

### 5.10.1 Description

5.10.1.1 A lot-based sampling plan for normally distributed data in which the acceptance or rejection of the lot is based on process control and the descriptive statistics and capability of the variable measurements of the sampled characteristic.

### 5.10.2 Qualification Requirements

5.10.2.1 Documented Member approval per paragraph 6.0 shall be required for initial qualification.

5.10.2.2 Parts shall be manufactured in homogeneous lots. No additions or exchanges shall be made to the original lot.

5.10.2.3 Lot size shall not exceed 2500 parts.

5.10.2.4 A minimum of 25 parts shall be inspected for the sampled characteristic being produced with zero nonconformances detected.

**Note:** *Parts used for qualification should be produced consecutively.*

5.10.2.5 Parts for qualification shall be representative of the process including multiple set-ups, shifts, operators, etc. Variable data should be collected if possible. Historical data (i.e., in-process or final inspection record of the conforming parts) may be used to meet this requirement.

5.10.2.6 Adequate process control shall be in place (reference AS13100).

5.10.2.7 Control plan shall be utilized (reference AS13100).

5.10.2.8 The inspection parts for qualification per 5.10.2.4 and subsequent parts shall be normally distributed (i.e. the distribution of individual measurements shall be normal in shape).

5.10.2.9 Applicable process shall meet a minimum Ppk of 1.33 or equivalent measure of process capability (e.g. PpU or PpL for one-sided tolerances).

### 5.10.3 Sample Size Determination

5.10.3.1 Product acceptance sample size shall be a minimum of five (5) randomly selected parts from the lot for the sampled characteristic. No exchanges shall be made to the original sample.

### 5.10.4 Acceptance Criteria

5.10.4.1 All sampled parts (minimum of 5 parts) shall be within the engineering drawing tolerance for the sampled characteristic.

5.10.4.2 For each sample (minimum of 5 parts), the average or median shall be within the middle 50% of engineering drawing tolerance for the sampled characteristic.

5.10.4.3 After each sample (minimum of 5 parts), process capability shall be calculated based on the last 25 inspected parts for the sampled characteristic and accept current lot if  $Ppk \geq 1.00$ .

**Note:** *The last 25 inspected parts may include the qualification parts*

### 5.10.5 Rejection Criteria and Response

5.10.5.1 Supplier shall stop sampling and reject the current lot if one or more of the following occur:

- a. One or more nonconformance(s) are found on the sampled characteristic.
- b. The process goes out-of-control based on the on-going process monitoring results.
- c. The average or median of the 5 parts is outside the middle 50% of engineering drawing total tolerance for the sampled characteristic.
- d.  $Ppk < 1.00$  for the last 25 inspected parts.
- e. Three consecutive capability calculations have a  $Ppk < 1.33$

5.10.5.2 Supplier shall inspect current lot 100% for sampled characteristic.

5.10.5.3 Subsequent lots shall be 100% inspected for the sampled characteristic until qualification requirements per 5.10.2.2 through 5.10.2.9 are met again.

## 5.11 Periodic Inspection Plan

### 5.11.1 Description

5.11.1.1 Plans that permit true position requirements of holes, lugs, and slots (not dimensional features) to be accepted when these characteristics are produced on controlled tooling that have demonstrated high levels of accuracy, repeatability, and minimal chance of operator error, and first piece and subsequent periodic inspections are acceptable.

### 5.11.2 Qualification Requirements

5.11.2.1 Documented Member approval per paragraph 6.0 shall be required for initial qualification.

5.11.2.2 Documented evidence that part-to-part variation for a drawing requirement shall be consistently controlled by the manufacturing method utilizing dies, fixtures, jigs or numerically controlled machines.

5.11.2.3 Adequate process control shall be in place (reference AS13100).

5.11.2.4 Characteristics for periodic inspection shall demonstrate a Ppk of 1.33 or greater for variable data based on a statistical study of the first 25 consecutively produced parts, or an equivalent DPM level (63 DPM) for attribute data.

**Note:** *An equivalent capability index of PpU or PpL may be used for a one-sided tolerance.*

5.11.2.5 When the characteristic is not targeted at nominal as a result of the process set-up and  $Ppk > 1.00$ , a Pp of 1.33 or greater may be allowed with Member approval.

5.11.2.6 Control plan shall be utilized (reference AS13100).

5.11.2.7 Supplier shall have a documented procedure which includes at a minimum:

- a. Periodic inspection plans shall not be applied to characteristics identified with a 100% Index Value.
- b. A qualification check for initial control of new, altered, or repaired tooling.
- c. A set-up check of first part and any subsequent parts manufactured until an accept is received on each new numeric control program, or new set-up of a fixture, die, or jig on the machine.
- d. Frequency of periodic inspection per 5.11.3.
- e. Document and monitor periodic inspections results.
- f. A provision to ensure timely adjustment, repair or replacement of the die, fixture, jig or numerical control program before a nonconformance occurs (e.g., process control charts or an acceptance criteria that the measured characteristic shall be within 75% of tolerance).
- g. A requirement concerning the rejection criteria and response that meets the requirements in 5.11.5.

5.11.3 Sample Size Determination

5.11.3.1 Periodic inspection shall not be less than 1 in 100 parts.

5.11.3.2 The maximum calendar interval between periodic inspections shall not exceed three months.



#### 5.11.4 Acceptance Criteria

##### 5.11.4.1 Supplier shall continue use of Periodic Inspection Plan while:

- a. 100% conformance for sampled characteristic,
- b. Process stability is maintained using statistical process control methods,
- c. Process capability ( $Ppk \geq 1.33$  or DPM level  $\leq 63$  or equivalent) is maintained.

#### 5.11.5 Rejection Criteria and Response

##### 5.11.5.1 Supplier shall stop the Periodic Inspection Plan if either of the following occur:

- a. A nonconformance is found.
- b. A significant process change occurred affecting the sampled characteristic. (e.g., new numerical control program, or new set-up of a fixture, die or jig on the machine)

5.11.5.2 In the event of a nonconformance or significant process change, supplier shall reinspect previously produced parts (until last inspected part) and inspect subsequently produced parts 100% until the qualification requirements in 5.11.2.2 through 5.11.2.7 are met again.

### **5.12 Mold Control Inspection Plan**

#### 5.12.1 Description

5.12.1.1 A type of inspection plan that involves inspecting features of the mold to verify acceptance of the part. Mold control ensures characteristic conformance through the control of the geometry and wear factors for the mold used to generate the characteristic. Inspection frequency is substantiated by a repeatable process during a mold operation and part-to-part variation is minimal.

#### 5.12.2 Qualification Requirements

5.12.2.1 Documented Member approval per paragraph 6.0 shall be required for initial qualification.

5.12.2.2 Mold control shall not be applied to characteristics identified as critical per the engineering drawing nor characteristics identified with a 100% Index Value per this document.

5.12.2.3 Supplier shall confirm that process is repeatable with minimal chance of operator error.

5.12.2.4 Where a mold operation is dependent on an operator function (such as properly closing a mold prior to a cure operation), supplier shall inspect one or more part characteristics by gaging methods to ensure that dimensions affected by operator functions are maintained.

5.12.2.5 Procedure and/or control plan shall include:

- a. Type of material being molded,
- b. Tolerances,

- c. Tools used in the process,
- d. Key process inputs are well defined,
- e. Identify as “Mold Control”,
- f. Identify as “First piece check is required”,
- g. Operation number where mold is used,
- h. Frequency of periodic check,
- i. Characteristics that are mold controlled,
- j. List of the mold(s) to be controlled by tool number,
- k. A sequence to verify an acceptable check for first piece, set-up or periodic inspection.

**Note:** Manufacturing operation sheets may be used in lieu of a control plan

- 5.12.2.6 Supplier shall inspect engineering drawing characteristics and/or lay-up mold control features (as applicable) for new and modified molds for five consecutive pieces (minimum for each mold).
- 5.12.2.7 The mold shall be inspected until all engineering drawing characteristics and/or lay-up mold control features (as applicable) are found acceptable, at which time production may begin. This check is repeated only when the mold is altered, repaired, or replaced by a new mold.
- 5.12.3 Sample Frequency Determination
  - 5.12.3.1 Periodic inspection levels shall be per Table 8.

**Table 8: Mold Control Inspection Frequency**

Percent of Engineering Drawing Total Tolerance	Inspection Frequency
Within 75%	1/50 or 1 part per 3 months, whichever occurs first
Within 85%	1/25 or 1 part per 3 months, whichever occurs first
Within 95%	1/10 or 1 part per 3 months, whichever occurs first

- 5.12.3.2 If data shows that mold wear is no greater than 5% for a total of 500 pieces produced, the limits specified in Table 9 may be applied on a part number basis when approved by Member per paragraph 6.0.

**Table 9: Mold Control Inspection Frequency for Mold Wear < 5%:**

Percent of Engineering Drawing Total Tolerance	Inspection Frequency
Within 75%	1/500 or 1 part per 3 months, whichever occurs first
Within 85%	1/300 or 1 part per 3 months, whichever occurs first
Within 95%	1/150 or 1 part per 3 months, whichever occurs first

5.12.3.3 If production is required from a mold that has consumed more than 95% of the part tolerance, all characteristics for every part produced shall be 100% inspected.

#### 5.12.4 Acceptance Criteria

5.12.4.1 Parts shall be accepted for the identified sampled characteristic when zero nonconformances are found in the sample.

**Note:** *Acceptance is only applicable for the sampled characteristic being inspected. The remaining characteristics require 100% inspection or shall meet the sampling requirements in this document.*

#### 5.12.5 Rejection Criteria and Response

5.12.5.1 Supplier shall stop mold control inspection if a nonconformance is found and inspect parts 100%.

5.12.5.2 Supplier may reinstate mold control inspection after qualification requirements in 5.12.2.2 through 5.12.2.7 are met again.

### 5.13 Electro-Discharge Metal Removal (EDMR) Turbine Blade Hole Location Feature Inspection Plan

#### 5.13.1 Description

5.13.1.1 A continuous sampling plan specific to EDMR turbine blade hole location characteristics.

#### 5.13.2 Qualification Requirements

5.13.2.1 Documented Member approval per paragraph 6.0 shall be required for initial qualification.

5.13.2.2 Procedure shall include:

- a. A capable homogenous process that can consistently produce features within tolerance, with total hole pattern true position not exceeding 75% of tolerance,
- b. A mistake proof process with tooling and/or fixtures that prevent relying on operator adjustment (no tinkering allowed),
- c. Process is adequately monitored to provide feedback using reliable gaging and/or inspection methodology that is accurate enough to ensure the process stays targeted,
- d. Electrodes are inspected prior to producing parts to ensure tolerance is maintained,

- e. Evaluation of x and y true position errors during initial set-up and adjustment of EDM process as necessary to nominal.

5.13.2.3 Supplier shall meet the following First Piece Check Requirements:

- a. Inspect the first piece of each part number produced or after a change in the EDM operation or other correction to the EDM machine,
- b. Inspect the part in the machine at the time a power and/or equipment failure occurs and the first part produced after that failure,
- c. Inspect the first part produced after changing machine settings due to corrections made after a nonconforming part is discovered.

5.13.2.4 The following inspection requirements shall apply after an acceptable first piece check and results have been certified by qualified inspection personnel:

- a. Maintain a logbook for each machine/brass tag number, part number/operation number combination and record part quantities produced to indicate when submittals for inspection are required.
- b. Qualify process by inspecting 100% of the quantity of consecutive parts specified by Level Zero for each part number hole location feature using variable measurement equipment (i.e., optical comparator, coordinate measuring machine [CMM])
- c. For all parts dimensionally inspected, including the periodic checks, record and monitor x-error and y-error using an applicable control chart (i.e., x bar and range chart) and record total hole pattern true position using a process control chart record (e.g., rainbow chart).
- d. Attribute or variable (template) gaging, as applicable, shall also be used 100% by the Operator to detect gross error assignable causes or shifts in the process.

5.13.2.5 To qualify to use EDMR Single Level or Multiple Level Continuous Type Sampling plan, the number of consecutive inspection parts for qualification with zero nonconformances shall be per Level Zero in Table 10 for single continuous sampling and in Table 11 for multiple continuous sampling.

5.13.3 Sample Frequency Determination

5.13.3.1 Sampling frequency shall be determined by Single Level or Multiple Level sampling plan type (i.e., 1, 2 or 3) and Inspection Level in Table 10 for EDMR Single Level or Table 11 for EDMR Multiple Level.

5.13.3.2 When applying multiple level continuous type sampling plans, approval of the Member's supplier quality representative in writing shall be required prior to proceeding to the next level.

**Table 10: EDMR Single Level Continuous Type Sampling Plan**

<u>Single Type 1</u>			<u>Single Type 2</u>			<u>Single Type 3</u>		
Inspection Level	f	i	Inspection Level	f	i	Inspection Level	f	i
Zero	100%	36	Zero	100%	29	Zero	100%	23
1	1/100	---	1	1/50	---	1	1/25	---

**f** = sample frequency  
**i** = number of consecutive items inspected and found acceptable required to proceed to next sample level. If a nonconformance is found return to Level 0 and re-qualify to paragraph 5.13.2 requirements.

**Table 11: EDMR Multiple Level Continuous Type Sampling Plan**

<u>Multiple Type 1</u>				<u>Multiple Type 2</u>				<u>Multiple Type 3</u>			
Insp. Level	f	Accumulated Parts	i	Insp. Level	f	Accumulated Parts	i	Insp. Level	f	Accumulated Parts	i
Zero	100%	37	37	Zero	100%	30	30	Zero	100%	24	24
1	1/100	3700	37	1	1/50	1500	30	1	1/25	600	24
2	1/200	7400	37	2	1/100	3000	30	2	1/50	1200	24
3	1/400	14800	37	3	1/200	6000	30	3	1/100	2400	24
4	1/800		---	4	1/400		---	4	1/200		---

**f** = sample frequency  
**i** = number of consecutive items inspected and found acceptable required to proceed to next sample level.  
**Accumulated Parts** = the number parts required to be manufactured before proceeding to next sample level.  
If a nonconformance is found return to Level 0 and requalify to paragraph 5.13.2 requirements.

#### 5.13.4 Acceptance Criteria

5.13.4.1 Parts shall be accepted for the identified sampled characteristic when zero nonconformances are found in the sample.

#### 5.13.5 Rejection Criteria and Response

5.13.5.1 Supplier shall stop EDMR inspection plan when a nonconformance is found and implement 100% inspection for that sampled characteristic found to be nonconforming.

5.13.5.2 Supplier shall notify Manufacturing and Quality Engineers when x-error or y-error exceed control limits or when total hole pattern true position exceeds more than 75% of tolerance.

5.13.5.3 If a nonconformance is detected, supplier shall inspect all previous parts for that hole location feature until the last acceptable inspection check. The Quality Engineer and Manufacturing Engineer shall re-evaluate the process and initiate appropriate corrective action, as applicable.

- 5.13.5.4 To re-qualify the nonconforming sampled characteristic, supplier shall inspect the given quantity of parts per Level Zero in Table 10 for EDMR Single Level Continuous sampling or Table 11 for EDMR Multiple Level Continuous sampling.
- 5.13.5.5 For parts failing the template gage, supplier shall visually compare to a known dimensionally acceptable part (or Tam tool template blade) using the template gage to determine part acceptance.
- 5.13.5.6 When gross errors (i.e., missing holes, hole out of position within a pattern) are detected, supplier shall notify supervisor or delegate to determine the extent of the problem and submit part for CMM hole location check equipment.
- 5.13.5.7 If CMM hole location check equipment verifies suspect nonconformance detected during 100% attribute or variable template check, then the nonconforming sampled characteristic shall be requalified to Level Zero in Table 10 for EDMR Single Level Continuous sampling or Table 11 for EDMR Multiple Level Continuous sampling.

#### **5.14 Ultrasonic Inspection Turbine Blade Airfoil Thickness Sampling Plan**

##### 5.14.1 Description

- 5.14.1.1 An attribute sampling plan for airfoil thickness when the inspection method is ultrasonic inspection.

##### 5.14.2 Qualification Requirements

- 5.14.2.1 Documented Member approval per paragraph 6.0 shall be required for initial qualification.
- 5.14.2.2 An approved Engineering Source Approval (ESA) process for the part number shall be on file. This applies to each wax die and/or core die combination as a unique process population.
- 5.14.2.3 A minimum of 4600 consecutive parts shall be processed (part number specific) with zero nonconformances detected.
- 5.14.2.4 Adequate process controls shall be in place (reference AS13100).
- 5.14.2.5 A minimum of three, 25-part process capability studies from three consecutive conforming lots shall be completed.
- 5.14.2.6 Ppk shall be greater than or equal to 1.33 for each wall point, or equivalent capability index.

##### 5.14.3 Sample Size Determination

- 5.14.3.1 An attribute sampling plan with a .65% Index Value shall be applied for all qualified wall points and sample size is determined by lot size and Table 2.

#### 5.14.4 Acceptance Criteria

5.14.4.1 The current lot shall be accepted for the sampled characteristic when:

- a. Zero nonconformances are found in the sample.

**Note:** Lot acceptance is only applicable for the sampled characteristic being inspected. The remaining characteristics require 100% inspection or shall meet the sampling requirements in this document.

- b.  $Ppk \geq 1.33$  is maintained.

#### 5.14.5 Rejection Criteria and Response

5.14.5.1 Supplier shall reject the current lot if one or more nonconformance(s) are found.

5.14.5.2 Supplier shall inspect current lot 100% for the nonconforming sampled characteristic.

5.14.5.3 Subsequent lots shall be 100% inspected for the sampled characteristic.

5.14.5.4 Wall points that fall below a Ppk of 1.33 shall be 100% inspected until corrective action is taken and assignable cause is identified.

5.14.5.5 Wall points shall be requalified to paragraph 5.11.2.2 through 5.11.2.6.

### **5.15 Radiographic Inspection Sampling Plan for Raw Material (Casting) Turbine Blade Root Areas**

#### 5.15.1 Description

5.15.1.1 An attribute sampling plan for raw material (casting) turbine blade root areas.

#### 5.15.2 Qualification Requirements

5.15.2.1 Documented Member approval per paragraph 6.0 shall be required for initial qualification.

5.15.2.2 Adequate process controls shall be in place (reference AS13100).

5.15.2.3 Quality history shall show 4600 consecutive parts were processed (part number specific) with zero nonconformances.

#### 5.15.3 Sample Size Determination

5.15.3.1 Product acceptance sample size shall be determined by lot size and .65% Index Value in Table 2.

#### 5.15.4 Acceptance Criteria

5.15.4.1 The current lot shall be accepted if zero nonconformances are found in the sample (i.e.,  $C = 0$ ).

#### 5.15.5 Rejection Criteria and Response

- 5.15.5.1 Supplier shall stop sampling if a nonconformance is found and implement 100% inspection for that sampled characteristic found nonconforming until qualification requirements in 5.15.2 are met again.

### 6.0 Sampling Plan Approval Process

- 6.1 To apply for Member approval of a sampling plan or alternate sampling plan, supplier shall submit a written request in accordance with ASQR-01 to applicable Member's Quality Group.

*Note: Members strongly recommend the use of approved sampling plans described herein.*

- 6.2 Requests shall include, but not be limited to the following information, when applicable:
- a. Description of sampling plan,
  - b. Sampling procedure,
  - c. Part number / name / commodity / engine model
  - d. Average inspection lot size for each subject part
  - e. Characteristic type (e.g., dimension, diameter, minimum wall, nondestructive test, etc.)
  - f. Classification of characteristic as defined by applicable engineering drawing or specification (i.e., critical, major or minor)
  - g. Characteristic quality history (i.e., escapes, nonconformances)
  - h. Sequence of in-process and final inspections
  - i. Description of manufacturing or process control at the operation to ensure that good quality will be maintained (e.g., process capability, control charts, control plan, etc.)
  - j. Additional supplier data or information as requested by applicable Member.
- 6.3 The applicable Member's Quality Group will authorize the use of an acceptable sampling plan via issuance of a documented approval in accordance with ASQR - 01.
- 6.4 Approval forms shall be retained for a minimum of four years after use of the alternate sampling plan is discontinued.



## Appendix A –Characteristic Classification

1.0 For Member designed product, characteristic classification is defined in Table A1.

Table A1 - Member Designed Product Characteristic Classification			
Member	Critical	Major	Minor
PW	<p style="text-align: center;">(KPC1)</p> <p>Or ⊕ adjacent to blueprint feature, or "CLC" per QAD or Fracture Critical Part Characteristics</p>	<p style="text-align: center;">(KPC2)</p> <p>Or ⊖ adjacent to blueprint feature</p>	All other characteristics not Critical or Major. No KPC designation.
PWC	<p style="text-align: center;">(KPC1)</p> <p style="text-align: center;">(ECL)</p>	<p style="text-align: center;">(KPC2)</p>	All other characteristics not Critical or Major. No KPC or ECL designation.
<p><b>Notes:</b></p> <p>a. Symbols in this Table are shown on Member's engineering drawings and/or specifications.</p> <p>b. For PW Flight Safety Characteristics, reference ASQR-09.1.</p>			

2.0 For supplier designed product, characteristics are classified as Critical, Major, and Minor.

2.1 When requested by Member, suppliers shall submit characteristic classification to Member for approval.

## Appendix B –Requirements for Sampling Determinations

- 1.0 The following tables contain requirements identified on the engineering drawing or related product definition documents and the corresponding index values for product acceptance.

Table B1 – Raw Material Characteristics	Index Value
Raw material characteristics including those on Critical Rotating Parts, Major Rotating Parts and Prime Reliable Parts that will be further processed or formed	2.5%

Table B2 - Mechanical Requirements	Index Value
Dim. Total Tolerance Range less than or equal to .004 inches	.65%
Radii less than .010 inches Total Tolerance Range	.65%
Angle Total Tolerance Range less than or equal to 1 degree	.65%
Surface Finish Waviness	.65%
Surface Finish Roughness (Ra) less than or equal to 20 micro inches	.65%
Flatness Carbon Face Seals using optical flats	100%
Threaded parts: <ul style="list-style-type: none"> <li>• Internal Profile Pre-load Locking</li> <li>• Straight screw threads - total tolerance on pitch diameter</li> <li>• AN &amp; MS parts or MH electrical connectors</li> <li>• All other thread applications/characteristics</li> </ul>	.65% .65% 2.5% .65%
Splines (all characteristics)	.65%
Gears (all characteristics)	.65%
Dimensions with only maximum or minimum values which directly control material thickness of weldments, castings or forgings and at least one surface is machined.	100%
Absence of magnetism	.65%
Spring Rate	.65%
Balancing	100%
Cored passages requiring mass airflow testing	100%
Turbine blade minimum wall thickness	100%
Ball Check For brazed & welded tube assemblies	100%
Dimensional characteristics for Integral bladed rotors and Centrifugal Impellers require 100% inspection except for major and minor characteristics for airfoil sections. For major and minor characteristics, see paragraph 6.12	100%
PW Bearing Balls - Finished Batch Lot - Metal Balls (Steel Only)	See paragraph 6.13

<b>Table B3 – Visual Inspection Requirements</b>	<b>Index Value</b>
Part marking (including serialization) and acceptance symbols	100%
Completeness of assembly	100%
Damage	100%
Existence of similar physical features	100%
Orientation and alignment	100%
Number of bearing rollers/balls	100%
Inspection of locking installations	100%
Welds or Brazes	100%
Presence of sealants and lubricants	100%
Presence of protective end caps (tubes, hoses, electrical connectors)	100%
Plating, Coating, Surface Treatment and Protective Finishes	100%
Fuel holes and oil holes/passages	100%
Cleanliness	100%
Corrosion	100%
Adhesive bond	100%
Evidence of staking	100%
Contamination and freedom of debris in internal passages	100%
Coolant passages for blades, vanes and disks	100%
Radii	100%
Surface Finish Cosmetic Appearance (e.g. scratches, fingerprints, uniform color, etc.)	100%

<b>Table B4 - Functional Test Inspection</b>	<b>Index Value</b>
Flow	100%
Pressure/leak	100%
Vacuum	100%
Electrical	100%
Seal Face Load check (Specification DCS-3 for PW)	100%

<b>Table B5 - Special Processes (Other than NDT)</b>	<b>Index Value</b>
All special process characteristics	.65%
<b>Note:</b> For hardness requirement, see Table B16	

<b>Table B6 - Radiographic Inspection</b>	<b>Index Value</b>
Turbine Blades and Vanes	100%
Raw Material (Casting) Turbine Blade Root Areas	see paragraph 5.15
PW Raw Material (Casting) Turbine Blades and Vanes – Neutron Radiographic Standard (NRS-1/CNRS-E.1)	see paragraph 5.7
Brazed Joints: <ul style="list-style-type: none"> <li>On transfer pipes and other tubes which carry fuel, oil, or hydraulic fluid</li> <li>All other brazed joints</li> </ul>	100% 2.5%
Resistance Welding	2.5%
Fusion Welded Joints: (100% unless otherwise specified below) <ul style="list-style-type: none"> <li>Classes A &amp; B</li> <li>Classes C &amp; D 100% visual inspection required only</li> <li>That are accessible on both sides and also require MPI or FPI of the weld joint</li> </ul>	100% 100% 100% 2.5%
Casting Grades: <ul style="list-style-type: none"> <li>A, B, C and D that are specified Class 1 per AMS - STD 2175, otherwise;</li> <li>Grade A areas</li> <li>Grades B, C and D areas</li> </ul>	100% .65% 2.5%
Wall Thickness: <ul style="list-style-type: none"> <li>Turbine blades</li> <li>Compressor blades</li> <li>Turbine and Compressor Vane Rings and Segments</li> </ul>	100% .65% 2.5%
Electron Beam (E.B.) Welds: <ul style="list-style-type: none"> <li>Class 1</li> <li>Classes 2 &amp; 3</li> </ul>	100% 2.5%
Core cleanliness for castings	100%
All other Radiographic Inspection	100%

<b>Table B7 - Magnetic Particle Inspection (MPI) or Fluorescent Penetrant Inspection (FPI)</b>	<b>Index Value</b>
Turbine Blades and Vanes	100%
Fusion Welded Joints	100%
Steel Compressor Vanes	.65%
Brazed Valve Seats and Silver Brazed Joints	100%
Turbine Vane baffles	.65%
Threaded fasteners not requiring alloy type test	.65%
All other MPI or FPI Inspection	100%

<b>Table B8 - Etch Inspection</b>	<b>Index Value</b>
Surface Temper, Gears/Splines	100%
Surface Temper on Mainshaft Balls	100%
Surface Temper on accessory components including bearings anti-friction and electron beam (E.B.) welds class 3	2.5%
Blue Etch Anodize	100%
All other Etch Inspection	100%

<b>Table B9 - Ultrasonic Inspection</b>	<b>Index Value</b>
Minimum Wall Thickness of turbine blades <i>Note: For PW a .65% AQL Sampling Plan may be applied when the requirements of paragraph 6.11 are met.</i>	100%
Minimum Wall Thickness of compressor blades	.65%
Minimum Wall Thickness of turbine and compressor vanes	2.5%
When ultrasonic inspection is used to replace mechanical inspection for PW part numbers other than specified above the following shall apply: <ul style="list-style-type: none"> <li>• Minimum or maximum requirement</li> <li>• Dimensional Total Tolerances less than or equal to .004</li> <li>• Dimensional Total Tolerances .0041 and up</li> </ul>	2.5% .65% 2.5%
All other Ultrasonic Inspection	100%

<b>Table B10 - Eddy Current Inspection</b>	<b>Index Value</b>
ECM Code 4 Method PC	100%
All other Eddy Current Inspection	100%
<b>Table B11 - Salt Residue Inspection</b>	<b>Index Value</b>
Salt brazed joints	100%

<b>Table B12 - Holography Inspection</b>	<b>Index Value</b>
Holography Inspection	100%

<b>Table B13 - Shearography Inspection</b>	<b>Index Value</b>
Shearography Inspection	.65%

<b>Table B14 - Alloy Type Test</b>	<b>Index Value</b>
Alloy Type Test	100%

<b>Table B15 – PW Thickness Determination Method TDM-10</b>	<b>Index Value</b>
Verify the presence of coating	100%

Table B16 - Hardness Requirements	Index Value
Case hardness requirements of Ra 79 -85 or Ra 81 - 85	.65%
All other case hardness requirements	100%
Core hardness requirements when case hardness is also a requirement	See Table B17
Parts where hardness is a requirement (i.e., annealing, precipitation heat treat or stress relief) and all parts have been thermally treated in unit batches	See Table B17
<p><b>Note:</b> For hardness requirements of high volume hardware (i.e., nuts, bolts, shims, washers, small miscellaneous parts) when size/configuration of parts does not permit nondestructive hardness testing, or when hardness indentation (mark) is not allowed per engineering drawing resulting in a scrap part, use the destructive test sampling requirements per paragraph 6.6</p> <p><b>Note:</b> For PWC, a hardness test to a part is considered a destructive test except when an indentation mark on the part is permitted per its drawing or removed by subsequent processing. See paragraph 6.6 for additional information.</p>	

Table B17 - Tolerance (HARDNESS UNITS)				
Minimum Requirements	2.9 or Less	3.0 to 4.0	4.1 to 9.9	10 or more
	Index Value			
100Rb or less	.65%	.65%	2.5%	2.5%
Rc15 - 27.9	2.5%	2.5%	2.5%	2.5%
Rc28 - 43.9	.65%	.65%	2.5%	2.5%
Rc44 - 47.9	.65%	.65%	.65%	2.5%
Rc48 - 62.9	100%	.65%	.65%	.65%
Rc63 & Up	100%	100%	.65%	.65%
<p><b>Note:</b> When hardness sampling is applicable, convert hardness requirement into equivalent Rb or Rc reading (reference PW Specification HIM-1 or ASTM E140 for PWC for Rockwell Conversion Chart Numbers). Assign 100% inspection or one of the sampling plans based on the minimum hardness requirement and the tolerance as specified in Table B17.</p>				

Table B18 - Tolerance (HARDNESS UNITS) For Maximum or Minimum Requirements Only		
Requirement	Minimum Only	Maximum Only
	Index Value	
Up to Rc43.9	2.5%	2.5%
Rc44 & Greater	.65%	2.5%
All other parts thermally treated (including stress relief) without evidence of processing in unit batches	100%	100%