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ATTACHMENT 2

PRATT & WHITNEY QUALITY STANDARD
VISUAL INSPECTION STANDARD 454
(WITH DELETIONS)

(7 PAGES)

QUALITY STANDARD

UNITED TECHNOLOGIES PRATT&WHITNEY

Visual Inspection Standard

VIS - 454 I
Page 1 of 1
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PEW QRE-C

SURFACE IMPERFECTIONS ON MAJOR ROTATING PARTS

1 **Scope:** This standard provides **acceptance** limits for surface imperfections on major rotating parts e.g. disks, hubs, shafts, seals, spacers & couplings for all engines. Visual inspection instructions per Visual Inspection Standard - Master (VIS-M) forms a part of this standard.

2 **Application:** Applies only when specified by the Quality Assurance Data (QAD) sheet.

3 **Sequence of Inspection:**

3.1 Applies at final inspection after peening and may be applied at any in-process inspection.

3.2 Surfaces requiring plating, coating, or any other treatment that could conceal imperfections shall be inspected prior to those operations.

4 **Special Instructions:** This standard contains General Limits, Code A Limits, Code B Limits and Code C Limits. The QAD sheet will invoke the applicable code and the General Limits will always apply.

INDEX OF LIMITS

5 **Definitions:** Definitions listed below apply to the terms specifically used in this standard.

Blending: An operation which locally removes an irregularity from a surface, resulting in a shallow, smooth depression.

Burnish Mark: A shiny area resulting from rubbing against a hard smooth surface; may contain scratches of no apparent depth.

Chatter Mark: Closely spaced tool marks caused by the vibration of the cutting tool.

Dent: A surface depression normally having rounded edges, corners, and bottom, caused by the impact of some object.

• **Depressed Imperfection:** Imperfection below the general surface of the part. Scratches, tool lines, nicks, toolmarks, dents, etc. are examples.

Imperfection: An interruption (non-uniformity) in the normal surface condition of a part configuration which must be evaluated for acceptance.

• **Mismatch:** A step or misalignment on a machined surface which interrupts the smooth continuation of that surface or smooth transition of an adjacent radius.

Nick: A small surface imperfection having sharp edges, corners, or bottom caused by impact of a sharp object.

Pick Up: Transfer of material from tool to part or part to tool in machining resulting in surface roughening.

Pit: Small irregular cavity in a surface, usually dark bottomed.

@ **Raised Imperfection:** Imperfection above the general surface of the part. May be erupted material from depressed imperfection.

Scratch: A linear depression with a sharp bottom caused by movement of a sharp object or particle across the surface.

Superficial Imperfection: An imperfection which disrupts the surface and appears smooth-edged but does not penetrate the surface roughness texture. This condition is so slight, that there is no perceptible depth.

Tool Line: An inherent mark left by any metal cutting tool, i.e., Feed Lines.

Tool Mark: A deviation from the normal surface plane, usually appearing as an undercut. Also defined as a deviated tool line.

6 **Acceptance Limits:**

• Parts shall be cosmetically representative of quality workmanship based on such factors as inspection experience with parts previously returned from customers and/or unusual variation from normal appearance.

NOTE: Parts considered not to be cosmetically acceptable, which may be acceptable to the limits of this standard, shall be brought to the attention of the inspection supervision.

6.1 General Limits: Applicable to all parts

6.1.1 Table 1 provides **acceptance limits** for **holes, scallops, slots, .250 nom. radii, knife edges,** and **sealing surfaces**

Part Feature	Location	Acceptable Imperfection
Holes See Figure 1 & 2	.125 all around including ID	• Burnish Marks • Water discoloration light grey or light brown in color • Superficial gage removal marks • Spiral tool marks provided a .007R stylus (TAM 142928 or equiv) does not hesitate or depth does not exceed .0005. Spiral tool marks must be separated by at least .030.
Scallops See Figure 3	.125 zone all around including ID	
Slots See Figure 4	.125 zone all around fillet radii	
Radii .250 nom or less See Figure 5	radius including .100 each side of tangency	
K 6		
Sealing Surfaces	complete sealing surface	**NOTE:** Air cooling holes in turbine disks must be evaluated with 3x to 4x magnification with illumination and optical aids. See Figure 2 for typical cooling hole.

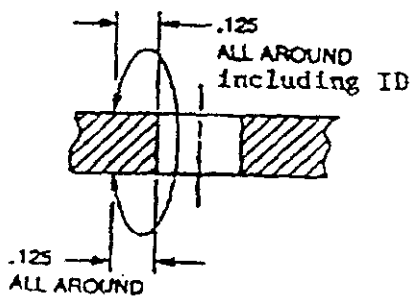
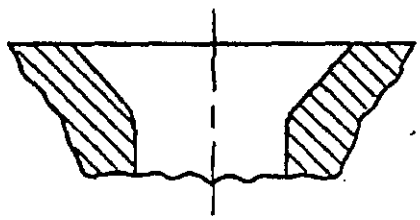


FIGURE 1
TYPICAL HOLE

Table 1.

6.1.5 Parts Finished Per PWA 99-1, PWA 99-2, or PWA 99-3

6.1.5.1 The contour of the holes at the intersection of the part face may range from a radius through a smoothly faired curve to a blended chamfer-like condition as shown in the following sketch.



ACCEPTABLE BLENDED CHAMFER-LIKE CONDITION

Figure 1.

6.1.5.2 **PWA 99-1 (Reciprocating Spindle Finishing):** After finishing, titanium parts may exhibit irregular blemished areas having a dull matte appearance in contrast to the highly reflective surface typical of PWA 99-1 finish. This condition is acceptable. For a typical example see photograph H-84233 in appendix.

6.1.5.2.1 Parts inspected to this standard following anodize etch and fluorescent penetrant inspections will exhibit a blue to grey color that may vary from a semi-reflective to a light matte finish.

6.1.5.3 **PWA 99-2 & PWA 99-3 (Butterfly Finish):**

6.1.5.3.1 Circular tool marks on the bolting surface, resulting from the finishing operation, are acceptable provided surface texture requirements are met.

6.1.5.3.2 Photograph H-30924 in appendix illustrates an acceptable and not-acceptable condition of butterfly finished holes. Note the chatter marks on the not-acceptable illustration.

6.1.6 **BLENDS:** Fifteen blended areas are acceptable provided the following conditions are maintained.

6.1.6.1 Blends shall not be on peened surfaces.

6.1.6.2 Blending, however accomplished, shall produce smooth rounded edges and bottom and shall have a surface finish no rougher than the surface finish specification permits.

6.1.6.3 The depth of blends shall not exceed .003.

6.1.6.4 Blend diameters shall be at least 15 times the depth, except that when parts are subjected to PWA 99-1, the blending produced by that process shall be considered acceptable provided the blends meet the limits of paragraphs 6.1.6.2 and 6.1.6.5

6.1.6.5 Blending shall not reduce wall thickness below drawing minimum.

6.1.6.6 Parts need not be resubjected to reciprocating spindle finish following blending of imperfections.

6.1.7 **Blend Mismatch Areas:** Where the engineering drawing allows mismatch areas but requires that they be blended, the blending shall result in a smooth transition between the mismatched surfaces. The transition surface shall be continuously even and free of irregularities, with no resistance to the sliding of a finger or .007 radius stylus. Any remaining visual evidence of surface mismatch is acceptable.

6.1.8 **Smooth Transition Areas:** Where the engineering drawing allows smooth transition between two planes, the transition surface shall be continuously even and free of irregularities, with no resistance to the sliding of a finger or .007R stylus. Any remaining visual evidence of surface mismatch is acceptable.

6.2 **CODE A LIMITS:** See table 7 for all **Remaining Surfaces** not addressed by the general limits.

Acceptance Limits For Remaining Surfaces	
Imperfections	**Acceptance Limits**
Burnish Marks	Unlimited
Water discoloration	Light gray or light brown in color
Superficial imperfections	Unlimited
Nicks, Dents, Scratches & Toolmarks	Acceptable provided a .007 R stylus (TAM 142928 or equiv) does not hesitate.
Pits on AMS 6415 Hubs	Acceptable provided they are separated by at least .125 and a .007 R stylus (TAM 142928 or equiv) does not hesitate.

Table 7.

NOTE: Raised metal on mating surfaces is not permitted.

not for bolt holes

6.3 **CODE B LIMITS** See table 8 for all **remaining surfaces** not addressed by the general limits.

Acceptance Limits For Remaining Surfaces	
Imperfections	**Acceptance Limits**
Burnish Marks	Unlimited
Water discoloration	Light grey or light brown in color
Superficial imperfections	Unlimited
Scratches, nicks & dents	Acceptable provided a .007R stylus (TAM 142928 or equiv.) does not hesitate.
Tool lines	Acceptable within drawing surface texture requirements.
Circumferential Toolmarks	.001 max depth, separated by at least .250.
Circumferential Mismatches	.002 or less, separated by at least .250.
Circumferential Chatter	• .001 max depth x .100 max width • Chatter wider than .100 but less than .250 is acceptable provided a .007 R stylus (TAM 142928 or equiv.) does not hesitate. • Chatter areas shall be separated by at least .500. • Surface texture requirements per drawing must be maintained.
Pits on AMS 6415 Hubs	Acceptable provided they are separated by at least .125 and a .007 R stylus (TAM 142928 or equiv) does not hesitate.

Table 8.

NOTE: Raised material on mating surfaces is not permitted.

APPENDIX OF PHOTOGRAPHS

NEGATIVE NO.	CONDITION
H-30924	Butterfly Finished Holes
H-84233	Titanium Blemished Areas
91A1111-002	JT8D Spacer With Pick Up

P & W department requests for photographs should be directed to Quality Assurance Publications. Supplier requests should be directed to P & W Purchasing Department.