

**T-021 Inspection Limits and Repair**

Revision: N

Issued: 2/02/16

<b>Subject:</b>	Inspection and Repair of Compressor Wheels
<b>Applicable EXTEX Engineered Products Part Numbers:</b>	E23057111 (Stage 1), E23057112 (Stage 2-3), E23057114 (Stage 4), E23057115 (Stage 5), E23057116 (Stage 6)
<b>Installations:</b>	Rolls-Royce (250-B17, B17B, B17C, B17D, B17E, C20, C20B, C20F, C20J, C20S, C20W)
<b>Revision History:</b>	M – Dated 10/02/13 Updated to new format. Revised Tables 1 and 2. N – Dated 2/02/16 Updated Timken to EXTEX Engineered Products.
<b>Reason:</b>	To provide Supplemental Instruction for Continued Airworthiness (ICA)
<b>Description:</b>	This document provides the owner/operator with inspection and repair procedures for Stage 1 through Stage 6 Compressor Wheels. Any time the compressor is disassembled for overhaul, it can be inspected to Extex Engineered Products, Inc. or OEM criteria. The inspection results determine if the component is serviceable in its current condition, if the component is repairable per this instruction or if the component should be replaced.
<b>Accomplishment Instructions:</b>	<ol style="list-style-type: none"> <li>1. Clean part in an alkaline bath per standard practices using AMS 1536, AMS 1537, or equivalent.</li> <li>2. Perform Non-Destructive Testing (NDT) via Fluorescent Penetrant Inspection (FPI) per AMS 2647, Method D, Sensitivity Level 3 or equivalent.</li> <li>3. Inspect part using the criteria below.</li> </ol>
<b>Approval:</b>	This document is FAA approved.
<b>Inspection:</b>	When operating in an erosive or corrosive environment – inspect the wheels for corrosion and erosion at an interval based on the operating environment that does not exceed 300 engine operation hours or 12 months. This can be performed concurrently with compressor case half inspection (Ref OEM Maintenance Manual 72-00-00, Table 602). Special attention should be given to the trailing edge of the 2/3 stage compressor wheel. Verify that there is no corrosion product along the trailing edge or pressure side of the blades.
<b>Notes:</b>	<p><b>Compliance:</b> Anytime compressor is disassembled for overhaul.</p> <p><b>Wheels Made From Forgings:</b> EXTEX Engineered Products Compressor Wheels (CAGE Code 1L9D9) are fabricated from forgings while some wheels with the same PN, but with a different CAGE code, were fabricated from castings. Some of the instructions in this document are noted as applicable only to wheels manufactured from castings and do not apply to wheels manufactured from forgings.</p> <p>EXTEX Engineered Products wheels fabricated from forgings can be identified by the EXTEX CAGE Code (1L9D9) as well as the smooth (machined) surfaces between the airfoils. Please contact Extex Customer Service with your wheel serial number(s) if you have any question as to the manufacturing method.</p> <ul style="list-style-type: none"> <li>• For other in-service/maintenance level inspection and repair reference the OEM</li> </ul>

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Maintenance Manual compressor wheel inspection and repair limits.

- EXTEX Compressor Wheels are made from Custom 450, a purer, specialty stainless steel which is more corrosion resistant than the generic 17-4 used by the O.E.M. EXTEX Engineered Products does not approve coating these compressor wheels.
- Glass bead peen the compressor wheels, using an approved method, after all blending, rework, and subsequent FPI. Glass bead intensity is .002-.005N with 200% coverage.
- Refer to OEM's published data for installation, engine operation, and disassembly.
- All dimensions are in inches. Dimensions in ( ) are in mm.
- Should P/N or S/N marking become obscured, part maybe remarked using controlled vibropeen per AS478-2E1 or Electrochemical etch per AS478-7A2.

Please contact your EXTEX Engineered Products representative with any questions.

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**TABLE 1: Event Inspection  
Applicable to All Wheel Part Numbers**

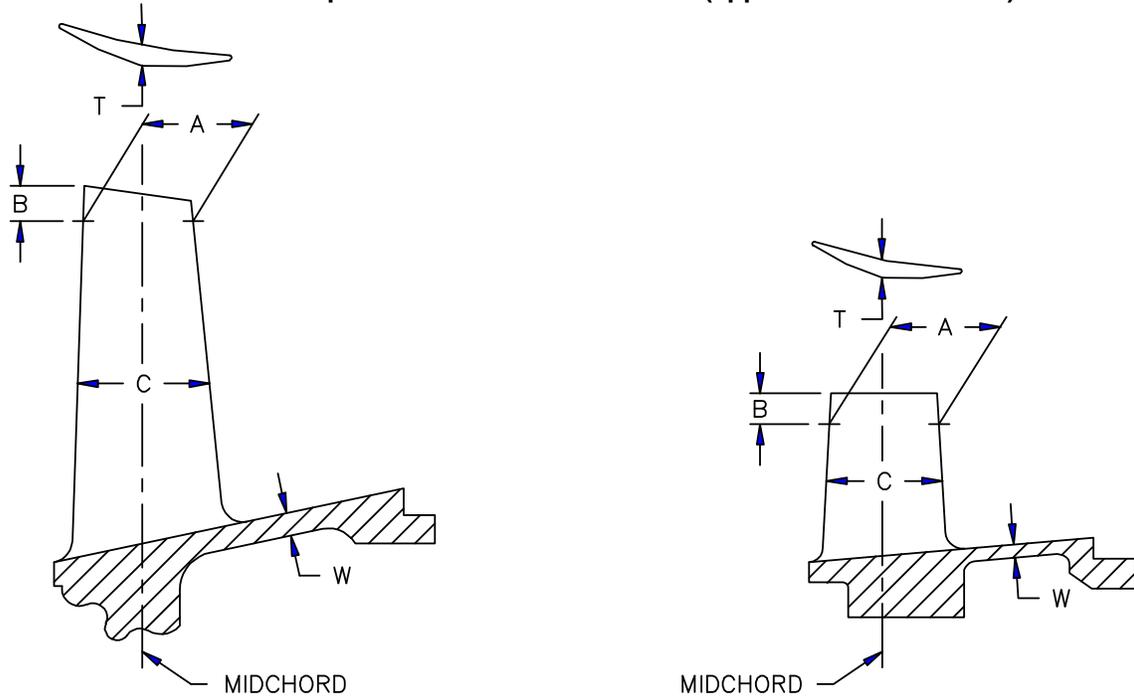
Condition	Service Limit	Repair Limit	Corrective Action
<b>Operational time or cycle limit</b>	None. This component is on-condition. There is no mandatory replacement interval.	n/a	n/a
<b>Air Blockage</b>	None	None	Replace compressor wheel
<b>Oil Temp &gt; 248° F (120°C) or Oil Temp &gt; 225° F (107°C) for over 10 minutes</b>	None	None	Inspect for carbon contamination and/or bearing damage.
<b>Overspeed &gt; 105% N<sub>1</sub> and &lt; 110% N<sub>1</sub></b>	None	None	FPI per Figure 4.
<b>Overspeed &gt; 110% N<sub>1</sub> Blade O.D.</b>	Stage 1 O.D. <4.378 inch at .8885 inch gage dimension (center of blade). All other stages (2 through 6) O.D. < 4.314 inch.	None	Replace compressor wheel.
<b>Pilot Diameter</b>	Any wheel's pilot diameters having grown or closed down beyond print limits must be scrapped.  Leading edge pilot diameter limits: Stage 2/3: 1.8845 - 1.8837 inch. Stage 4: 2.5980 - 2.5972 inch. Stage 5: 2.8228 - 2.8220 inch. Stage 6: 2.9978 - 2.9970 inch.  Trailing edge pilot diameter limits: Stage 1: 1.8878 - 1.8870 inch. Stage 2/3: 2.6008 - 2.6000 inch. Stage 4: 2.8253 - 2.8245 inch. Stage 5: 3.0003 - 2.9995 inch. Stage 6: 2.9528 - 2.9520 inch.	None	Replace compressor wheel.
<b>Rubbing on stator path</b>	See Figure 1 for min. allowable wall thickness.	None	Replace compressor wheel
<b>Erosion of Blade Tip</b>	Stage 1 O.D. > 4.372 inch at 0.8885 inch gage dimension (center of blade). All other stages (2 through 6) O.D. > 4.304 inch	None	Replace compressor wheel
<b>Blade Tip Burn From Rubbing</b>	None	None	Replace compressor wheel
<b>Compressor Blade Erosion</b>	Replace wheel if 50% or more of the blades in that stage are less than either A min. or T min. (See Figure 1).  Replace wheel if any blade has C min. equal to or less than A, or blade thickness is less than T min. at mid chord point inward of B, or W varies more than 0.005 inch. (0.13 mm) (See Figure 1).	None  None	Replace compressor wheel  Replace compressor wheel

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**FIGURE 1: Compressor Blade Erosion Limits (applicable to all wheels)**



**DEFINITIONS**

- W = WALL THICKNESS (CHECK WHEN THERE'S EVIDENCE OF TIP RUB)
- A = CHORD WIDTH MEASURED 'B' FROM TIP
- B = GAGE DISTANCE
- C = CHORD WIDTH MEASURED INSIDE 'B' FROM TIP
- T = BLADE THICKNESS AT MIDCHORD MEASURED 'B' FROM TIP

Stage #	Dimension W, Minimum	Dimension B, Minimum	Dimension A, Minimum	Dimension T, Minimum
1	0.078 inch	0.110 inch	0.559 inch	0.032 inch
2	0.078 inch	0.135 inch	0.517 inch	0.032 inch
3	0.078 inch	0.095 inch	0.504 inch	0.032 inch
4	0.040 inch	0.085 inch	0.482 inch	0.030 inch
5	0.040 inch	0.115 inch	0.455 inch	0.030 inch
6	0.040 inch	0.100 inch	0.455 inch	0.028 inch

Determine acceptance limits for blade erosion using locally fabricated "Compressor Blade Thickness and Blade Chord Gages". (See Figures 5 and 6 for gage dimensions.)

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**TABLE 2: Negative Imperfection Inspection**  
**Applicable to All Wheel Part Numbers**

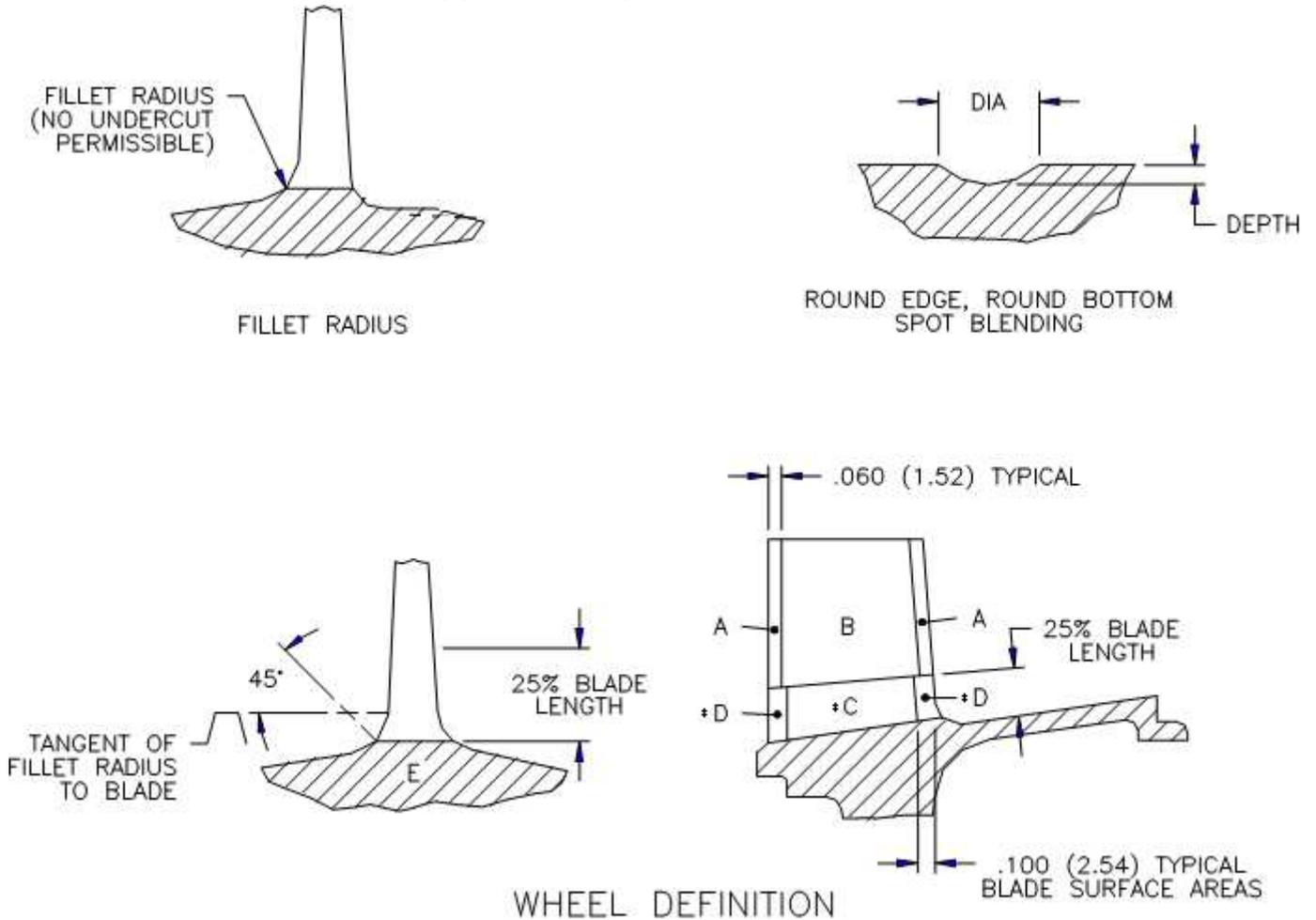
Condition	Service Limit	Repair Limit	Corrective Action
<b>Visual Inspection for Corrosion Pitting performed as part of the compressor case half inspection: Area C and Area D.</b>	None. Visual indications of corrosion pitting in these areas is cause for rejection.	None	Replace compressor wheel.
<i>Note: During case half inspection, extra emphasis should be given to inspecting the Stage 2 (E23057112) blade root fillet radius and leading/trailing edges (ref. Bulletin T-099).</i>			
<b>Corrosion Pits, Nicks, Dents, and other Negative Imperfections (See Fig. 2 for definition of wheel areas A through E). After blending rework, FPI per approved method and accept per Fig. 4. Use 10X magnification for corrosion pit inspection.</b>	Round edge, round bottom indents can occur in the original as cast surface; these aren't corrosion pits. Corrosion pits can't be wiped clean, a dark spot remains in the indent.	Spacing of imperfections shall not be less than 2x the dia. of the smaller <b>imperfection</b> . Imperfections less than the allowable depth may be increased in dia. Proportionally, i.e., blending to 1/2 max. depth may have twice max. dia.	See corresponding areas.
<i>Note: The serviceable limits and corrective actions vary by wheel area as noted below:</i>			
<b>Area A: Leading and Trailing Edges</b> <i>(Note: See also Figure 3)</i>	0.015 inch dia., 0.005 inch deep	0.015 inch dia., 0.005 inch deep	Blend with a fine file or stone and final polish radially with 320 grit (or finer) abrasive paper. LE and TE radii must be maintained.
<b>Area B</b>	0.040 inch dia., 0.010 inch deep, not to exceed 1/3 wall thickness.	0.040 inch dia., 0.010 inch deep, not to exceed 1/3 thickness.	Blend with a fine file or stone and final polish radially with 320 grit (or finer) abrasive paper.
<b>Area C: Concave and Convex sides.</b>	0.015 inch dia., 0.005 inch deep	None	None, Polish only, no measurable metal removal allowed.
<b>Area D Leading and Trailing Edges</b> <i>(Note: See also Figure 3)</i>	0.005 inch dia., 0.001 inch deep	None	None, Polish only, no measurable metal removal allowed. LE and TE radii must be maintained.
<b>Area E</b>	0.060 inch dia., 0.030 inch deep, not to exceed 1/3 wall thickness.	0.060 inch dia., 0.030 inch deep, not to exceed 1/3 wall thickness.	Blend with a fine file or stone and final polish radially with 320 grit (or finer) abrasive paper. Do not blend bearing journal and threads on 1st stage wheel.

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**FIGURE 2: Blade Surface Area Blend Limits**



\*No blending in areas D or C permitted.

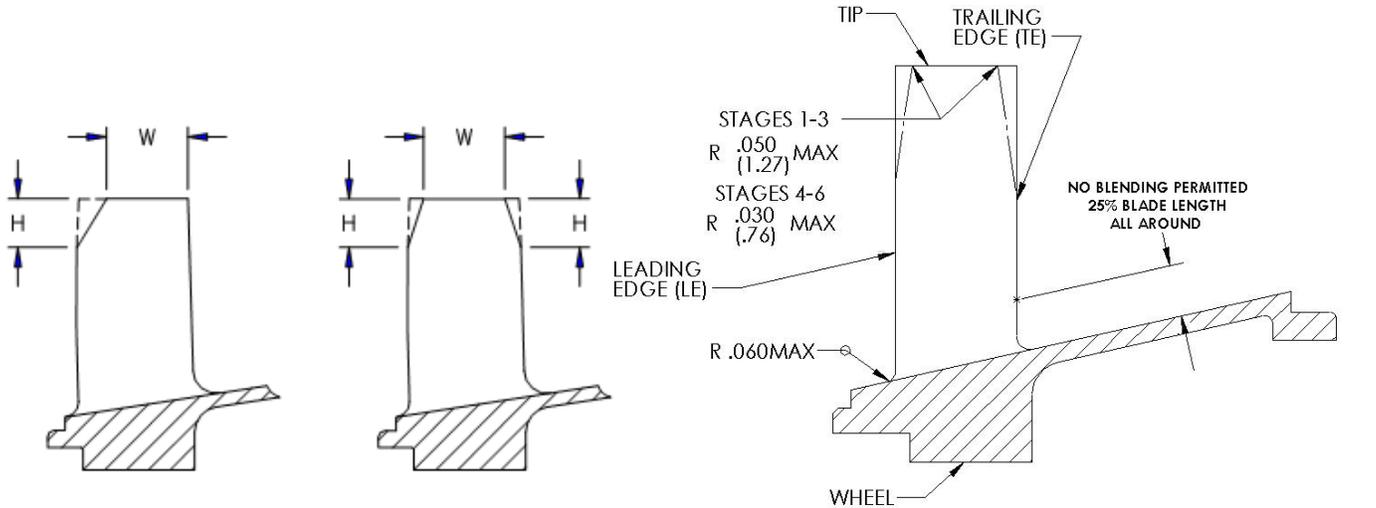
**FIGURE 2**

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**FIGURE 3: Leading and Trailing Edge Blend Limits**



Example of Blade Tip Chamfer Blend

Example of Blade Edges after straight on LE, TE, or both (Convex Curve allowed) line blending typical of either edge.

W = Blade Chord Width measured at tip.

H = Chamfer Length inward from blade tip.

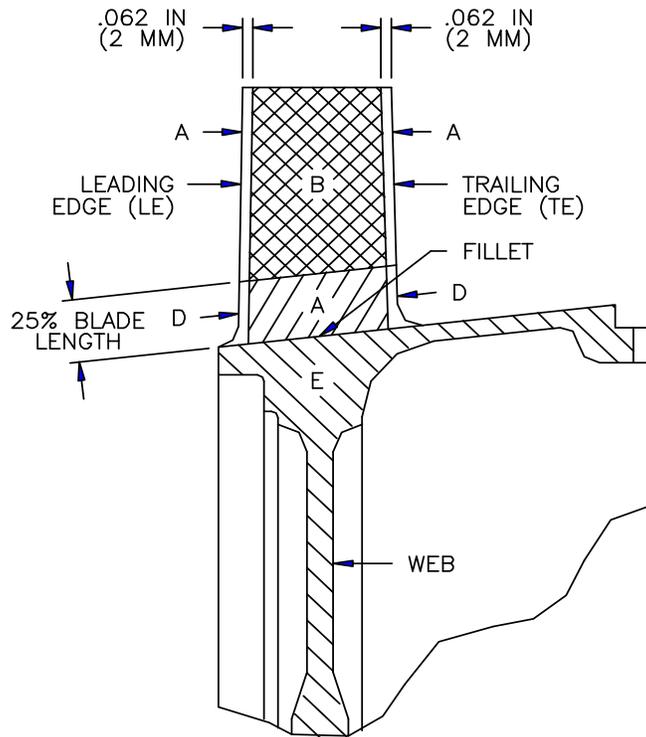
Dimensions are in inches (millimeters)

See Figure 5, Compressor Blade Chord Gage, for inspection of Blade Chord Width.

Stage #	Dimension W, Minimum	Dimension H, Minimum	Chord Print Minimum
1	0.450 inch	0.270 inch	0.599 inch
2	0.410 inch	0.215 inch	0.547 inch
3	0.396 inch	0.175 inch	0.528 inch
4	0.378 inch	0.150 inch	0.504 inch
5	0.358 inch	0.130 inch	0.477 inch
6	0.339 inch	0.115 inch	0.452 inch at 2.154 inch R Tip and 0.579 inch at 1.649 inch R Hub

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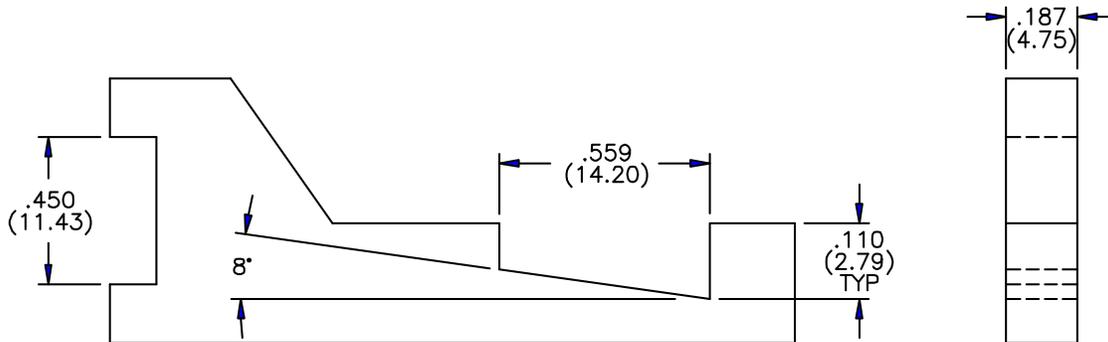
**Figure 4: Compressor FPI Limits (applicable to all wheels)**



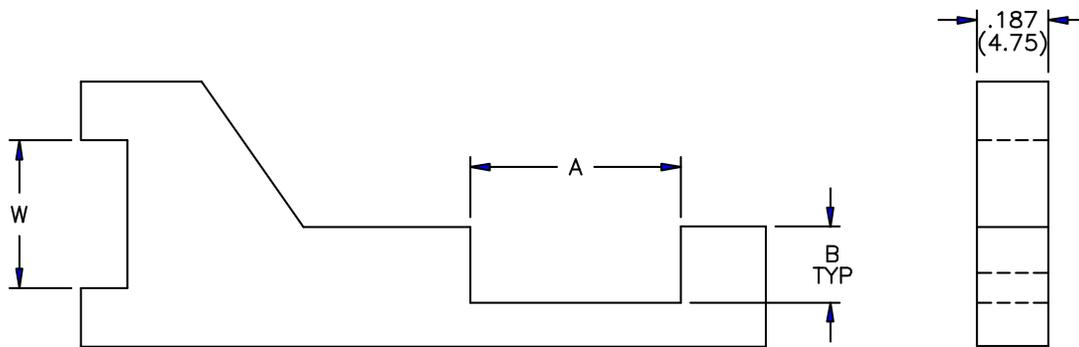
<b>SURFACE</b>	<b>FLUORESCENT PENETRANT ACCEPTANCE LIMITS</b>
<b>ALL</b>	Cracks or line indications are not acceptable. Multiple indications within the maximum size specified for individual indications shall be considered as an individual indication. Individual indications are evaluated regardless of shape. Excessive bleedback indications, which are in excess of the size specified after being erased and redeveloped for a minimum of five minutes, are not acceptable.
<b>A</b>	Isolated individual indications to 0.010" are acceptable.
<b>B</b>	Individual indications to 0.020" are acceptable when separated by at least 2 times the size of the larger defect. Clustered indications (33% maximum density) to 0.060" dia are acceptable when separated from adjacent clusters and/or individual indications by at least 0.060". Indications through the airfoil are acceptable if located in the outer 2/3 of the blade and separated from adjacent indications by at least 1/8 inch with a max. of one through indication per blade.
<b>D</b>	None
<b>E</b> <b>Cast Surfaces</b>	APPLICABLE ONLY TO WHEELS MANUFACTURED FROM CASTINGS. Individual indications to 0.060" dia are acceptable when separated by at least 2 times the size of the larger defect. Cluster indications (33% maximum density) to 0.25" dia are acceptable when the separation between cluster and/or individual indications is at least 2 times the size of the larger defect.
<b>E</b> <b>Machined Surfaces &amp; Balance Ring</b>	Individual indications to 0.030" dia are acceptable when separated by at least 2 times the size of the larger defect. Cluster indications (33% maximum density) to 0.25" dia are acceptable when the separation between cluster and/or individual indications is at least 2 times the size of the larger defect.

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**FIGURE 5: Compressor Blade Chord Gage**



TYPICAL FOR #1 WHEEL ONLY



TYPICAL FOR STAGES 2-6

Dimensions are in inches (millimeters).

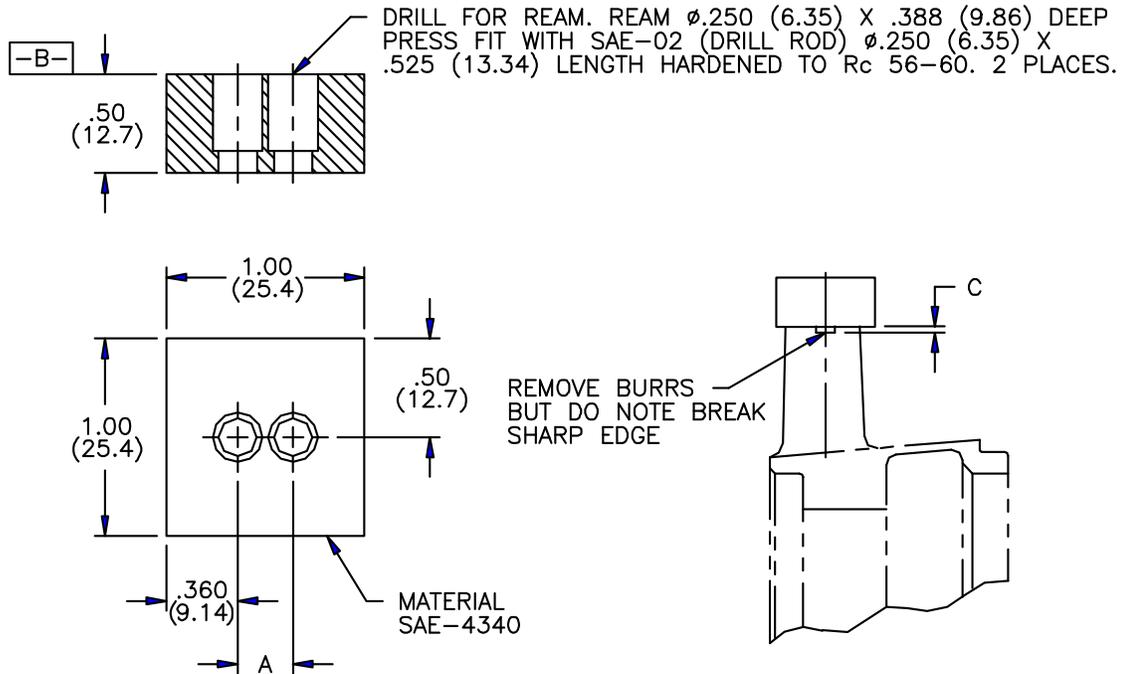
Stage #	A	W	B
2	0.517 inch	0.410 inch	0.135 inch
3	0.504 inch	0.396 inch	0.095 inch
4	0.482 inch	0.378 inch	0.085 inch
5	0.455 inch	0.358 inch	0.115 inch
6	0.455 inch	0.339 inch	0.100 inch

Machined dimensions  $\pm 0.0002$  inch.

Locally fabricate a gage for each stage to check acceptance limits for erosion and tip chamfer rework.

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**FIGURE 6: Compressor Blade Thickness Gage**



Dimensions are in inches

Stage #	Dist. A +/- .0002 inch	Dist. C +/- .0005 inch
1	0.2820 inch	0.110 inch
2	0.2820 inch	0.135 inch
3	0.2820 inch	0.095 inch
4	0.2800 inch	0.085 inch
5	0.2800 inch	0.115 inch
6	0.2780 inch	0.100 inch

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**#1 Bearing Journal Repair**

Item	Shaft OD Limits	Corrective Action
#1 Compressor Wheel, #1 Bearing Journal:	0.3936 - 0.3940"	Plate

Plate as follows:

1. Before plating, FPI any reworked surface per ASTM E 1417.
2. Chrome plate per AMS 2406. As an optional repair, Electroless Nickel plate per AMS 2405. If optional plating method is used, heat treat part at 275 ± 10°F (135 ± 6°C) for not less than five hours before and after plating.
3. After finishing, FPI any reworked surface per ASTM E 1417.
4. Break sharp edges, .010 max UOS.

Compliance with OEM published procedures for this repair is permitted as an alternate means of compliance.