Presented by:
Dr. Robert Vaughan
Chief Technology Branch
Structures & Materials Division
Aviation Engineering Directorate
Aviation and Missile Research, Development and Engineering Center

Presented to:
DoD Maintenance Symposium
“Understanding and Combating Aging”
Phoenix Convention Center, Phoenix, AZ

US Army Aviation
Helicopter Dynamic Components

October 26, 2009
Approved for public release; distribution unlimited. Review completed by the AMRDEC Public Affairs Office (10/09/09 and FN4254).
In 2004 routine maintenance discovered a MH-47E Forward Rotating Ring with fatigue cracks during overhaul. This was a first time anomaly. Subsequent inspections have found that ~15% of the Swashplates inspected have these micro cracks near the bearing surface.

Testing, Analysis, and Inspections used to minimize the risk associated with fatigue cracking in the swashplate.
Three failures of the TR drive links were discovered this spring.

On 30 May 2009, failure of both drive link scissors on AH-64D Apache Aircraft xxx occurred during operational usage.

On 2 Jun 2009, a single knuckle lug of a single TR drive link scissors failed on AH-64D Apache Aircraft xxx during operational usage.

On 8 Jun 2009, a single lug of a single TR drive link scissors failed at the swashplate interface on AH-64D Apache Aircraft xxx during operational usage.
• **T700 Engine Stage 1 Blisk Erosion**
  - Erosion is caused by continuous ingestion of small hard particles such as sand into engine
  - Erosion degrades compressor efficiency and leads to reduced engine performance

RIMFIRE inspection at Corpus Christi Army Depot
Compressor Erosion Trending

Percentage of Engine/Module Removals Due to Compressor Erosion

T700 Series Engines

Trendline - 6 Month Moving Avg.
T700 Engine – 1\textsuperscript{ST} Stage Turbine Nozzle Vanes
- Oxidation, Burns and Cracks
- Increased Temperature/Performance Criteria
  Accelerates Condition Degradation

RIMFIRE inspections at Corpus Christi Army Depot
Percentage of Engine Removals Due to Burns, Oxidation and Cracks of Stage 1 Turbine Nozzles

Trendline - 6 Month Moving Avg.

T700 Series Engines

Removal Date
T700 Engine – 1\textsuperscript{st} Stage Turbine Blades
- Oxidation, Burns and Cracks
- Increased Temperature/Performance Criteria
  Accelerates Condition Degradation

RIMFIRE inspections at Corpus
Christi Army Depot
Percentage of Engine Removals Due to Burns, Oxidation and Cracks of Stage 1 Turbine Blades
Zone J – OD Outside of Limits

- 34.7% rejected due to this condition

DMWR Limit = 4.5090 inches min.
Average = .0102” under limit
• 294 Hinge Pins Inspected in RIMFIRE Project
• 121 Rejected by CCAD
• 41.2% Reject Rate

*Some parts had more than 1 reason for rejection.*

<table>
<thead>
<tr>
<th>Reasons for Rejection</th>
<th>Frequency *</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Zone J - OD Out of Limits</td>
<td>102</td>
</tr>
<tr>
<td>2 Zone H - OD Out of Limits</td>
<td>6</td>
</tr>
<tr>
<td>3 Zone B - Scoring</td>
<td>4</td>
</tr>
<tr>
<td>4 Zone D - Nicks/Wear</td>
<td>3</td>
</tr>
<tr>
<td>5 Zone D - Stained</td>
<td>2</td>
</tr>
<tr>
<td>6 Misc. Conditions</td>
<td>7</td>
</tr>
</tbody>
</table>
• Zones A & R Damage
  – 14% of Shafts rejected due to Chipping/Gouging/Denting in these Zones
• 150 Shaft Extensions Inspected in RIMFIRE Project
• 21 Rejected by CCAD
• 14% Reject Rate

Causal Rejections - UH-60 Main Shaft Extensions

<table>
<thead>
<tr>
<th>Reasons for Rejection</th>
<th>Frequency</th>
</tr>
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<tbody>
<tr>
<td>1 Zone R Damage</td>
<td>12</td>
</tr>
<tr>
<td>2 Zone T Damage</td>
<td>7</td>
</tr>
<tr>
<td>3 Zone A - Spline Damage &amp; Wear</td>
<td>4</td>
</tr>
<tr>
<td>4 Zone H - Chipped</td>
<td>1</td>
</tr>
<tr>
<td>5 Zone P - Chipped</td>
<td>1</td>
</tr>
</tbody>
</table>

* Some parts had more than 1 reason for rejection.
Zone L

- 37.4% of Pitch Housings did not pass initial DMWR inspection due to incorrect bonding prep.

Zone K

- 32.8% of washers in this zone were debonded and did not pass initial DMWR inspection.
- 24.6% of washers in this zone were missing and did not pass initial DMWR inspection.

This is a repairable condition per DMWR

Inspect for no paint or primer around threaded inserts (i.e., top mating surface for bearing retainer and shim, or on surface of 1.00 INCH counterbores (top hole outbd surfaces only) - if present: remove and static bond prep per instructions for upgrade of PN 7-311411215-7/-13 housing to -15 housing IAW WP 0061 00.
• 329 Pitch Housings Inspected in RIMFIRE Project
• 191 Failed Initial DMWR Inspection Criteria
• 58.1% Reject Rate†
• All -15 Pitch Housings with over 300 hours are being Retired at Depot due to 1204 Hour Life Limit.

† Prior to any repairs

Data collected between 2/5/2005 and 7/16/2007

Causal Rejections - AH-64 Pitch Housings

* Some parts had more than 1 reason for rejection.
Zone C - Wear

- 15.5% of Pitch Housings failed initial DMWR inspection due to inner diameter wear of bushing exceeding max. limit.

DMWR Limit = 2.507 in. max
Mean Wear = 0.0028 over limit

This is a repairable location.
Zone F - Wear

- 14% of Pitch Housings failed initial DMWR inspection due to inner diameter wear of bushing exceeding max. limit.

See Chart 4 for Location

DMWR Limit = 2.507 in. max
Mean Wear = 0.0014 over limit

This is a repairable location.
Zone B - Wear

- 37.5% of assemblies failed initial DMWR inspection due to inner diameter wear exceeding max. limit.

DMWR Limit = 1.628 in. max

Mean Wear = 0.077 over limit
• 48 Lower Shoe Assemblies Inspected in RIMFIRE Project
• 29 Failed Initial DMWR Inspection Criteria
• 60.4% Reject Rate†

† Prior to any repairs

* Some parts had more than 1 reason for rejection.
Zone C - Wear

- 25% of assemblies failed initial DMWR inspection due to inner diameter wear exceeding max. limit.

DMWR Limit = 0.691 in. max

Mean Wear = 0.067 over limit
- 106 Hub Subassemblies Inspected in RIMFIRE Project
- 45 Failed Initial DMWR Inspection Criteria
- 42.5% Reject Rate†

† Prior to any repairs

* Some parts had more than 1 reason for rejection.
Zone G - Wear

- 15.1% of Hubs failed initial DMWR inspection due to inner diameter wear exceeding max. limit.

DMWR Limit = 9.0475 in. max

Mean Wear = 0.005 over limit

Pitting / Corrosion

- 12.3% of Hubs failed initial DMWR inspection due to pitting or corrosion