PT6A Mission Analysis with Operational Loads Measurement Data

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Introduction

• What, Why, Who and How of MA
• Why PT6A-62 needs MA
• Aircrew Interviews and Mission Profiles
• OLM Data
• Pratt and Whitney Response and Future Actions
What?

• Engine critical part lives are based on an assumed usage spectrum.
• The assumed usage spectrum is compared with the usage spectrum of a specific operator.
• Operator specific changes to engine critical part lives may be recommended.
Why?

• ADF usage is often different from other operators/OEM assumptions.
• Ensure critical part lives are applicable to ADF usage.
• Constrain risk of critical part failure.
• Regulations mandate regular review (DASR.A.44.c).
Who and How?

• Operator: Compile an operator specific usage spectrum.
• OEM (usually): Analyse the operator specific usage spectrum and make recommendations for engine critical part lives.
Why does PT6A-62 need a MA?

- Turbine disk failure (Feb 2011).
- ADF unique role for PC-9/A.
- OEM states operators who frequently use MAX power require MA.
- OEM limits MAX power to 10% of total flying time.
PT6A-62 Usage Monitoring

- PT6A critical part lives are based on ENHRs and cycles.
- Cycles are based on manual recording:
  - Engine Start = Full Cycle
  - Landing = Abbreviated Cycle
PT6A-62 Usage Monitoring

- MAX
- MCP
- idle
- Shut down

Full Cycle:
- T/O
- climb
- barrel roll
- cruise
- stall turn
- TnG
- landing
- shut down

Abbreviated Cycle:
- rejoin

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Aircrew Interviews

• CFS Aircrew interviews to determine flight-manoeuvre cycles by mission type.
# Mission Profile Descriptions

<table>
<thead>
<tr>
<th>Cond</th>
<th>Description</th>
<th>Power setting</th>
<th>Time (min)</th>
<th>Altitude (ft)</th>
<th>Speed (kts)</th>
<th>$N_g$ (rpm)</th>
<th>SHP</th>
<th>Comments</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Taxi</td>
<td>idle</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>21000</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Takeoff</td>
<td>MAX</td>
<td>3</td>
<td>0</td>
<td>Accel to 140/180</td>
<td>39000</td>
<td>950</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Climb</td>
<td>MCP</td>
<td>6</td>
<td>To between 4000 and 10000</td>
<td>140-180</td>
<td>39000</td>
<td>900</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Stall</td>
<td>32psi-idle-MCP</td>
<td>3</td>
<td>Between 4000 and 10000</td>
<td>Decel to 70</td>
<td>21000 - 39000</td>
<td>0-900</td>
<td>2 stalls per flight</td>
</tr>
<tr>
<td>5</td>
<td>Spins</td>
<td>32psi-idle-MCP</td>
<td>3</td>
<td>“</td>
<td>80-130</td>
<td>21000 - 39000</td>
<td>0-900</td>
<td></td>
</tr>
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</table>
OLM Data

- OLM Data has been collected by the PC-9 Empennage and Aft-fuselage Recertification and Life Assessment (PEARLA)
- PEARLA was conducted for airframe fatigue issues
- Applicability to engines was coincidental
OLM Data - Screening

- Identify representative OLM data for each mission type
- Eliminate OLM data that is not representative
Touch and Go

PCLP vs Time

Elapsed Time (Seconds)

Parameter (%)
High-Low

PCLP vs Time

Parameter (%) vs Elapsed Time (Seconds)

- param = PCLP, freq = 60, max = 97.3382 % (874.56s), min = -3.7268 % (5546.46s), mean = 36.1723 %, range = 101.0650 %, std = 12.1972 %
General Flying

PCLP vs Time

param = PCLP, freq = 80, max = 99.5892 % (438.56s), min = -5.5652 % (4253.50s), mean = 35.5972 %, range = 105.1514 %, std = 16.7848%
Display Flying

PCLP vs Time

Parameter (%) vs Elapsed Time (Seconds)
OLM data vs Aircrew Interviews

• Compared applications of MCP and MAX
• Modified mission profile descriptions
Pratt and Whitney Canada Response and Future Actions

• General Flying and Display Flying are the mission profiles of interest.
• Raw parametric data will be provided for these two mission profiles.
• P&WC will provide revised critical part lives (if necessary).
Lessons Learnt

• PWD
• Other mission profile data may be useful for mission analysis
Questions

Thanks to Daniel Franke and Kate Niessen for assisting in OLM data extraction