CFM56 VBV gear motor improvement status

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Agenda

- Issue
- Background
- Fleet management
- Wear improvement status
- Summary

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Issue

- Platform: CFM56-5B engines (A320 family)
- Aircraft problem/impact
  - Aborted Take-Offs (ATOs), Air Turn-Backs (ATBs), Delays and Cancellations
- Description of problem
  - Inability to control air into the engine core compressor due to heavy wear of the entire CFM56-5B Variable Bleed Valve (VBV) system driven by Eaton's VBV gear motor
- Assembly/part number
  - 396800-12 VBV Gear Motor (CFM 301-774-709-0)
- Additional maintenance is required to insure reliable operation

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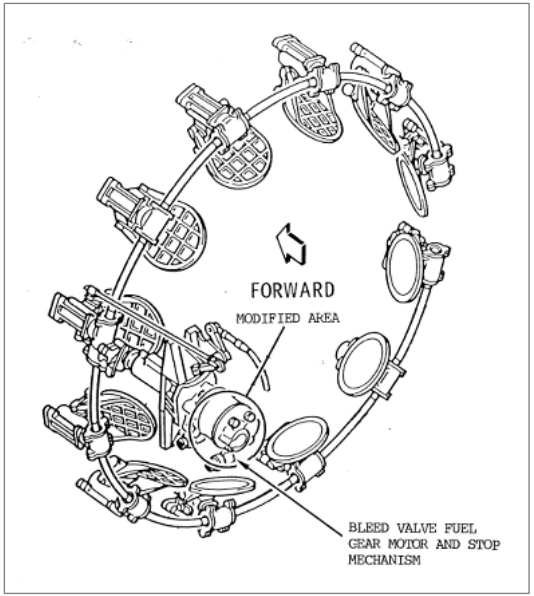
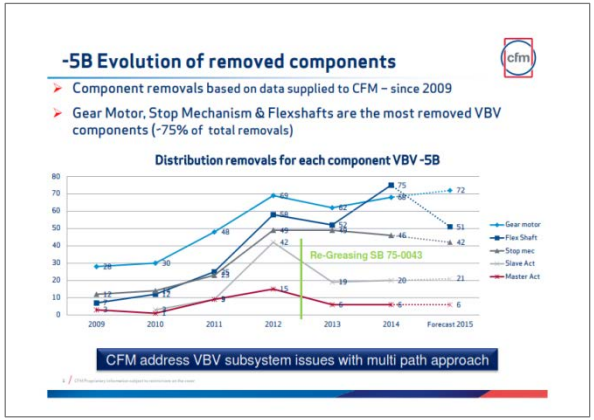
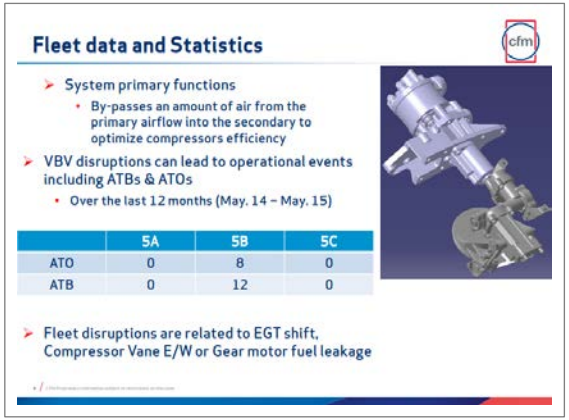
Background

Increased torque requirements of CFM56-5B VBV system drives maintenance







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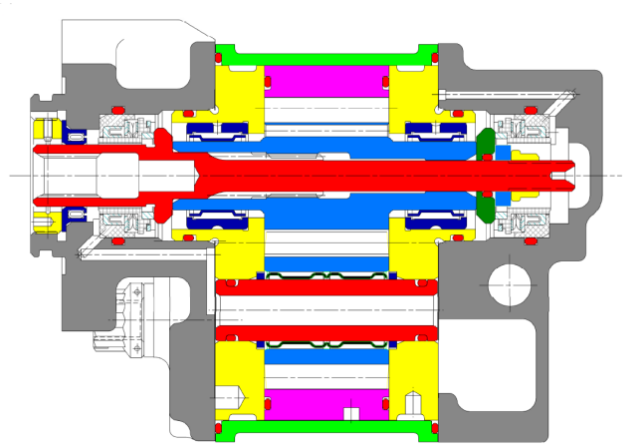
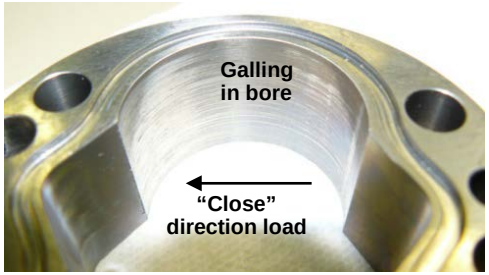
Background-root cause

Heavy wear of bearing races leads to contact between the gear tips and gear housing.



Housing scoring that leads to seizure due to journal and shaft wear



Idler shaft wear
(One heavily loaded quadrant)

Typical drive gear journal wear

Idler shaft
(Opposite side not worn)

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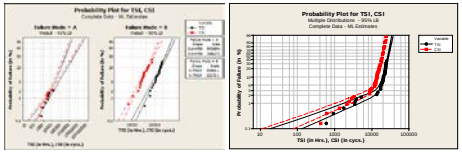
Fleet management

- Follow CFM service recommendations provided by CFM56-5B SB 75-0045 rev 1
- VBV system overhaul at 12,000 hours (includes 396800-12 gear motor)
- Eaton reliability data confirms the need for this mid-life overhaul

Weibull plot for Failure modes

- Assuming A and B are the Failure Modes



ailure modes.
ing an infant mortality.
indicating a Wear out failure mode.
es together on one plot.

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Results

TSI (in Hrs)	10000	15000	20000	25000	30000	35000	40000
Reliability with Failure mode A	98%	98%	97%	97%	97%	96%	96%
Reliability with Failure mode B	100%	99%	95%	77%	37%	5%	0%
Reliability with Failure mode A & B (System)	98%	97%	93%	75%	36%	4%	0%

CSI (in Cycles)	10000	15000	20000	25000	30000
Reliability with Failure mode A	98%	97%	96%	96%	95%
Reliability with Failure mode B	99%	88%	47%	5%	0%
Reliability with Failure mode A & B (System)	97%	86%	45%	4%	0%

- This quantifies the reliability of Gear Motor
- (based on the data from one operator).

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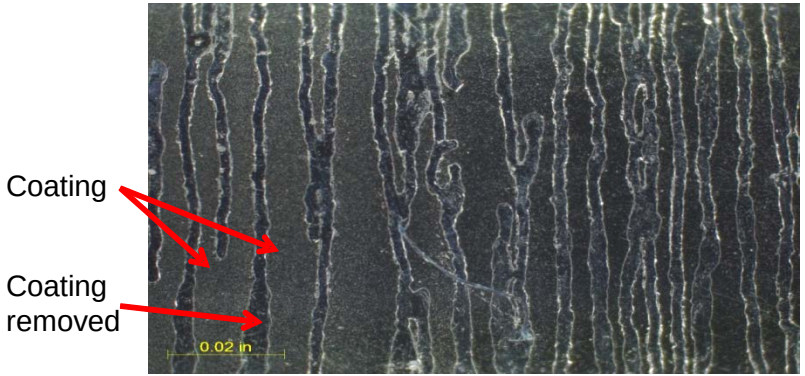
Wear improvement status

Eaton engineering developing wear improvement for gear motor

- Initial development testing of Titanium Zirconium Di-Boride (TZB) coating looked very promising
- Inconsistent coating adhesion was experienced
- Process to eliminate the base metal re-crystalized layer from super finish to improve TZB adhesion
- Continuing adhesion issue drove evaluation of alternative coatings

PVD coating missing following production acceptance test



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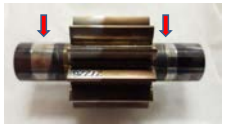
Wear improvement status

Evaluation of wear alternatives

- Following certification failure of TZB coating alternative solutions were evaluated
- No Plasma Vapor Deposited (PVD) coatings demonstrated reliable adhesion during gear motor testing

Condition Following Production Acceptance Test (ATP)

Hyperlox AlTiN



The Hyperlox coating was removed from the gear journals during test.

The Hyperlox coating remained on the idler shaft after test. (Note that the ends of shaft are masked and not coated).

Condition Following Production Acceptance Test (ATP)

Hi-Pulse AlTiCrN

The Hi-Pulse coating was removed from the gear journals during test.

The Hi-Pulse coating was removed from the idler shaft during test.

Results of 26- hour high speed, High torque test on Hyperlox coated H-11

The Hyperlox coated (AlTiN) Idler shaft was tested for 26 hours at 3000 RPM in one direction, at 70±5 inch-lbs Torque at room temperature in Gearmotor EX-1352A.
The part had no substrate wear but some of the coating did chip off.

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Summary

Evaluation of base material alternatives for improved wear continues

- Long lead times will drive late 2017 introduction at best

Adherence to CFM56-5B SB 73-045 R1 recommended

- Midlife overhaul of VBV gear motor at 12,000 hours highly recommended by CFM and Eaton

Contact your local Eaton account team for support

- Special pricing for VBV gear motor overhauled prior to 12,000 hours
- Spares support available

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Questions/Comments

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