Reducing the cost of ownership of the CFM56 engines family

Serguei Vizenkov
Technical Sales in Russia, General Manager
AFI KLM E&M

MRO Russia 2015 – Moscow
Table of contents

- AFI KLM E&M Overview
- Our Engine Services
- AFI KLM E&M a major CFM56 engine MRO
- Reducing the cost of ownership of CFM56 engines
  - Engine Condition Monitoring
  - On-wing and On-site services
  - Part repairs
  - Engine shop process improvements
- Conclusion
Table of contents

- AFI KLM E&M Overview
- Our Engine Services
- AFI KLM E&M a major CFM56 engine MRO
- Reducing the cost of ownership of CFM56 engines:
  - Engine Condition Monitoring
  - On-wing and On-site services
  - Part repairs
  - Engine shop process improvements
- Conclusion
The Air France – KLM group

1 group

Group Air- France KLM

3 businesses

Air France Airline

KLM Airline

2 airlines

Passenger

Cargo

Maintenance
AFI KLM E&M, a multi-product MRO with nose-to-tail adaptive solutions

GLOBAL No.2 IN ITS MARKET
€ 3,134 TOTAL REVENUES
35% CUSTOMER TURNOVER

AFI KLM E&M MRO Solutions

Engine
Aerostructure
Components
Airframe
Cabin Modifications
Additional Services
Total Care

14,000 EMPLOYEES
1,300+ AIRCRAFT IN COMPONENT SUPPORT
>400 ENGINE SHOP VISITS PER YEAR

2014 & 2015 MRO OF THE YEAR
Airline Economics
Best Component MRO
Aircraft Technology E&M

AFI KLM E&M
MRO
Solutions

GLOBAL No.2
IN ITS MARKET

€ 3,134
TOTAL REVENUES

35%
CUSTOMER
TURNOVER

2014 & 2015
MRO OF THE YEAR
Airline Economics
Best Component MRO
Aircraft Technology E&M
Table of contents

- AFI KLM E&M Overview
- Our Engine Services
- AFI KLM E&M a major CFM56 engine MRO
- Reducing the cost of ownership of CFM56 engines:
  - Engine Condition Monitoring
  - On-wing and On-site services
  - Part repairs
  - Engine shop process improvements
- Conclusion
Keep a strong & competitive engine MRO activity

Introduction & Growth
- GEnx
- Trent1000
- PW1000G
- Leap-X
- Trent XWB

Maturity
- CFM56-5B
- CFM56-7B
- GE90-94
- CF6-80E
- GE90-110/115
- GP7200

Decline & End of Life
- PW4000
- CF6-80C2
- CFM56-5C
- CFM56-5A
- CF6-50
- JT8D

Current capability
- Potential development
A Customer Driven Organization

- Revenue: 1.116 billion euros
- 100+ customers worldwide
- 2300 trained employees
- 5 maintenance sites in France, Netherlands and USA
- 220 customer overhauls out of 400 overhauls per year

AFI KLM E&M
Engine MRO Turnover (m€)

2012 2013

480 521

533 595

+24%

Sales Manager

Engineering Support

Customer Support Manager

A dedicated Support Team proactive and flexible at Customer service
Engine Shop in Amsterdam

- APU Repair & Overhaul Shop
- On-Site Support 24/7
- Engine Pool
- Engine Test Cell

- Engine parts repair
- Repair development
- Fleet & Shop Engineering
- Full Overhaul Shop
  - Low Pressure and Core modules
  - Piece part level
- Hospital Shop
- Engine Pool
- Accessories shop
Engine Shop in Paris

- Fan Thrust Reversers Shop
- On-Site Support 24/7
- Engine Pool
- Hospital Shop
- Engine Test Cell

- Engine parts repair
  - Combustor
  - TCF
- Repair development
- Fleet & Shop Engineering
- Full Overhaul Shop
  - Low Pressure and Core modules
  - Piece part level
- Accessories shop
Table of contents

- AFI KLM E&M Overview
- Our Engine Services
- AFI KLM E&M a major CFM56 engine MRO
- Reducing the cost of ownership of CFM56 engines:
  - Engine Condition Monitoring
  - On-wing and On-site services
  - Part repairs
  - Engine shop process improvements
- Conclusion
CFM56 experience, expertise & know-how

- Extensive Shop Experience, worldwide leader in CFM56-5 & -7 engine maintenance, repair & overhaul
- Over 900 CFM56 engines supported
- Optimized on-wing & off-wig policy for all kind of operations
- ~200 Shop Visits per year
- Hospital Chain, On-Wing services with dedicated tooling
- Smart solutions to maximize TOW up to performance restoration
- Very good spare availability to support customers

Airline experience:
- Air France launch customer
  - 1988, A320 with CFM56-5A
  - 1993, A340 with CFM56-5C
  - 1994, A320 equipped with CFM56-5B
- KLM operates CFM56-7B engines since 1999
- The group operates 230+ CFM56-5B (second world largest fleet) and 100+ CFM56-7B including latest standards
- Unrivaled experience & a broad engineering expertise from legacy airlines as well as from low cost carriers
- A key role toward the OEM, in optimizing procedures and repairs to reduce total cost of ownership

MRO experience:
Table of contents

- AFI KLM E&M Overview
- Our Engine Services
- AFI KLM E&M a major CFM56 engine MRO
- Reducing the cost of ownership of CFM56 engines:
  - Engine Condition Monitoring
  - On-wing and On-site services
  - Part repairs
  - Engine shop process improvements
- Conclusion
Engine Condition Monitoring
Smart monitoring prevents UER and limits spare utilization

- Operational experience from the airlines used within MRO support

- From Diagnostics to Prognostics
  - Diagnostics: basic alerting system on specific parameters
  - Prognostics: large data availability combined with advanced algorithms leads to early warning / avoid unexpected failure / reduce damage to critical equipment

➔ AFI KLM E&M able to detect defects at earlier stage, predict future deterioration and avoid major damages
Engine Condition Monitoring
Smart monitoring prevents UER and limits spare utilization

- AFI Specific designed tools
  - CFM56: IGV ring failure / HPT shroud burns / HPC condition / HPTCC & PS3 leakage / VBV flex shaft failure
  - GE90 tip curl issue: AF designed specific tool which generates automatic alert to MCC before the end of incriminated flight

» Engine Trend Monitoring is more and more crucial
Table of contents

- AFI KLM E&M Overview
- Our Engine Services
- AFI KLM E&M a major CFM56 engine MRO
- Reducing the cost of ownership of CFM56 engines:
  - Engine Condition Monitoring
  - On-wing and On-site services
  - Part repairs
  - Engine shop process improvements
- Conclusion
Engine Repairs On-Wing Services

- Most of new generation engines require on-wing and/or off-wing repairs before going to shop for performance restoration
- Cost savings are gained by combination of Line and Shop maintenance operations

⇒ That’s why AFI KLM E&M developed Adaptive On-Wing Services

Adaptive On-Wing Services

Reach expected Time On Wing
- Engine monitoring
- Technical recommendations
- Water wash
- AMM limits optimization

Minimize flight operation disruptions
- On-Wing repairs/inspections
- Outstation engine or booster change
- Quick Turns
- Assistance in Transit
- Spare engine
- Logistics

Overhaul & Repair
- Engine shop overhaul
- Hospital chains with dedicated workscopes
- Customized workscopes
- In-house capability
- Co-development of repairs with OEM & independents
- Used parts sourcing
On-Site & On-Wing Engine Support
Unrivaled know-how, some examples

Oct09 to Jun10, Montreal - Air Canada
GE90, 6 LPT6 Quick Changes carried out during maintenance checks

Apr 2012, Trois Rivieres – Sunwing
CFM56-7B J-hook repair

Aug 2014, Moscow – Transaero
CFM56-7B J-hook repair (joint project with Transaero)

Jun 2012, Novosibirsk – Vladivostok Air
CFM56-5B HPT blade replacement

Feb 2012, Novosibirsk – Vladivostok Air
CFM56-5B HPC bushing & VBV chain

Aug 2009, Istambul – Pegasus
CFM56-7B HPT blades replacement

Aug 2009, Bahrain – Gulf Air
CFM56-5C HPC blades replacement

Jul 2010, Miami – LAN
CFM56-5C Engine preservation

April 2011, Miami – LAN
GE90 Engine preservation

Sep 2010, Mauritius – Air Mauritius
CFM56-5B HPC bushing & VBV chain replacement during maintenance check

Nov 2011, Sardaigna – AKFED
CFM56-5B Fan disk replacement

Feb 2010 Amman – Gulf Air
CFM56-5A HPC blades replacement

Mar 2014 Nairobi – Kenya Airways
CFM56-7B AGB replacement

Feb 2012, Abu Dhabi – Air Mauritius
CFM56-5B HPC bushing & VBV chain replacement during maintenance check

Dec 2005, Hanoi - Vietnam Airlines
GE 90-94B Booster changes

Jul 2011, Rome - Alitalia
GE 90-94B Booster change

Jul 2011, Rome - Alitalia
GE 90-94B Booster change

Aug 2009, Istambul – Pegasus
CFM56-7B HPT blades replacement

Aug 2009, Bahrain – Gulf Air
CFM56-5C HPC blades replacement
On-Site Services
Example of CFM56-5B HPT blade replacement

- Vladivostok Air experienced HPT blades out of limit following boroscopic inspection
- AFI developed dedicated tooling including lifting device to be able to perform On-Site Support anywhere in the world and proposed an On-Site solution to avoid the engine shop
- HPT blade replacement performed in Novosibirsk for Vladivostok Air

➲ Able to perform on-wing & on-site services anywhere
- In full autonomy
- At locations lacking hoisting facilities
- With highly experienced mechanics
On-Site Services
Example of CFM56-7B, J-Hook Repair

- On-Site repair performed in Vnukovo in cooperation with Transaero
- AFI KLM E&M developed CFM56-7B On-wing support to fix specific technical issues for AFKL Fleet, and is proposing it to MRO Customers
- Earlier performed in Trois Rivières (Canada) during aircraft maintenance check

❖ Share scale effect, specific On-Site processes & solutions
- Smooth flight operations
- Avoid engine shop visit, transportation and spare lease
On-Site Services
Some other solutions in place for CFM56-7B issues

- Fan Disk replacement
- Accessory gearbox replacement

- And others:
  - Fan OGV refurbishment
  - Fan case elongated boltholes
  - VBV Guide pad wear
  - HPC IGV Ring wear
  - HPT Blade replacement
  - HPT & LPT Nozzle Guide Vane replacements
  - Oil tube coking
  - TRF Cracking…
Table of contents

- AFI KLM E&M Overview
- Our Engine Services
- AFI KLM E&M a major CFM56 engine MRO
- Reducing the cost of ownership of CFM56 engines:
  - Engine Condition Monitoring
  - On-wing and On-site services
  - Part repairs
- Engine shop process improvements
- Conclusion
Overhaul and Repair Services

- Most of new generation engines require on-wing and/or off-wing repairs before going to shop for performance restoration
- Cost savings are gained by combination of Line and Shop maintenance operations

➤ That’s why AFI KLM E&M developed Adaptive Shop Services

Overhaul & Repair
- Engine shop overhaul
- Hospital chains with dedicated workscopes
- Customized workscopes
- In-house capability
- Co-development of repairs with OEM & independents
- Used parts sourcing

Reach expected Time On Wing
- Engine monitoring
- Technical recommendations
- Water wash
- AMM limits optimization

Minimize flight operation disruptions
- On-Wing repairs/inspections
- Outstation engine or booster change
- Quick Turns
- Assistance in Transit
- Spare engine
- Logistics
Part repair
Example: Development of repair for multi-holes combustors

- Full overhaul capability for 5B & 7B combustors
- Taking advantage of GE90 expertise and know-how
- Developed full capability for multi-hole combustors (including Tech Insert standards)

Combustor Assembly modifications: Multi-Holes liners

First worldwide MRO to offer Combustor Multi-holes repairs
Part repair
Example: Bevel Gear Shaft Fwd Thread

- No existing repair for Fwd thread damage
- Repair developed using e-beam welding technology
- Real innovation is in the use of e-beam welding in a critical area
- AFI KLM E&M sole engine MRO with full range of repairs on this part

ﺀ Repair than replace
ﺀ Lower repair cost: less than 50% of new part catalog price
ﺀ OEM-approved repair
ﺀ Meets customer and Lessor expectations
Table of contents

- AFI KLM E&M Overview
- Our Engine Services
- AFI KLM E&M a major CFM56 engine MRO
- Reducing the cost of ownership of CFM56 engines:
  - Engine Condition Monitoring
  - On-wing and On-site services
  - Part repairs
  - Engine shop process improvements
- Conclusion
From Wing to reDelivery
A global approach to meet customer expectation

« ForWarD »

- Improve the quality perceived by the customer
- Reduce the engine TAT
- Reduce the number of standard exchanges

A global project, **not restricted to production activities**, but also involving support staff

An extensive participation of the employees in a **bottom up approach**, covering all areas of progress

**Do the job right the first time**
Quality is the first pillar of TAT. The efficient shift is the one which performs the job without rework

**Decide locally**
The best level to make a decision is the one closer to the field

**Remove the barriers**
The smoothest process is the one which contains the fewest interruptions and changes of responsibilities

**Make it simple**
Look for simple solutions to guarantee an effective work and eliminate waste
AF’s Team: We improved our dedication to the CFM56-5B program
- Reinforced support teams CSM/CSE

Customer program management implementation
- TRM/CRM twice a year
- Management Meeting & Shared KPI’s
- Customer Procedure Manual customisation

Communication & Shop visit management: Better anticipation
- Before SV: anticipation of constraints as Lessors requirements, LLP needs etc
- During SV: Real time updates, weekly status
- After SV: Wash-up meeting 10 days after re-delivery

Supply Chain (USM & Purchasing contract)
- Used serviceable material: more aggressive chasing on CFM56-5B 2nd market
- Structured contract with major sources

Engine Flow Process: increasing of repair window
- “Premium” shop flow process by reinforced resources utilization

Improved Shop Process in line with market expectations
+ wing to wing vision

Anticipation of specific customers/lessors needs

Enlarged repair window allowing up to 100% closed-loop repairs

Reduced discrepancies and quality issues
Amsterdam Shop Process improvements achieved
Simples Solutions Eliminating Waste

- Return Own Engine or Fleet principle
- Repair carefully rather than replace rapidly

- Separate full performance shopvisit production lines
  - with separate disassembly and assembly lines
- Separate Quick Turn or Hospital Visit production lines

- Process control using SAP ERP
- Flow lines within the stages concept

![Diagram of process stages](image)
Gaspath Analysis Tool and Core Trim balance
Smart tools for limiting of the workscopes/module exposure

- Continuous improvement by sharing of process-, product-, lean- knowhow, between engine services, OEM’s and Universities such as:
  - Core Trim balance with OEM
  - Gaspath Analysis with Universities

- No gaspath analysis tools available by the OEM

- KLM E&M developed this tool in cooperation with the Technical University and National Aerospace Laboratory

- Analyze the performance of the gas turbine after overhaul or after an inbound test run
Table of contents

- AFI KLM E&M Overview
- Our Engine Services
- AFI KLM E&M a major CFM56 engine MRO
- Reducing the cost of ownership of CFM56 engines:
  - Engine Condition Monitoring
  - On-wing and On-site services
  - Part repairs
  - Engine shop process improvements
- Conclusion
Conclusion

Reducing total cost of ownership of the CFM56

- Cost savings are gained by combination of On-Wing/On-Site and Shop maintenance operations
- Engine condition monitoring is key
- On-wing & on-site services smooth flight operations and avoid engine shop visit
- Development of high tech part repair with the objective of cutting cost
- Continuous development of innovative solutions in every areas
Thank You

Visit us at www.afiklmem.com