

FREIGHTER TRENDS

September 2023

Rs. 75/-

AN UPDATED TRENDS IN THE FREIGHTER INDUSTRY, P2F CONVERSION, MRO & AEROSPACE

FEEDSTOCK REMAINS VERY DIFFICULT TO ACQUIRE AS THE PASSENGER AIRLINES CONTINUE TO THRIVE

The cargo sector is returning to a more typical market growth rate. 737 market seems presently a bit oversupplied and for A321 the industry feels a bit of limited feedstock availability at the moment. Freighter Trends learnt that the trends looks same for 2024 as well with freighter capacity of aircraft out of sync with reality. Whereas, the value of new widebody aircraft "reliability" is generally recognized with new build assets, but this must be carefully weighed against time sensitivity, market competition and yield potential of 'tomorrows" cargo. Here are the details

Where is the global freighter market moving forward? What are the early indications of the air cargo market in 2024?

Brian McCarthy - VP, Sales & Marketing Mammoth Freighters LLC - Everyone is suggesting that we are in some sort of downturn, but I honestly believe that we have simply returned to a pre-covid era of cargo volumes and yields. Certainly soft times for air cargo with all sorts of geopolitical unrest and a general lack of enthusiasm that has curbed consumer spending but the inflation and ongoing cost of day to day commodities such as food has

certainly put a dent in the demand for e-commerce driven "discretionary" spending among consumers. I think we can expect more of the same for 2024 with freighter capacity of aircraft out of sync with reality. Too many narrow body conversions were commissioned when it was thought that Covid induced spending habits were here to stay.

Further, if the collective industry is really committed to our attention to emissions and urgency to strip out the waste and inefficiency of some aircraft, then many aircraft should already be retired; aircraft which were activated

during the covid crisis that now must be retired 'again'. This retirement will likely take 2-3 years.

Robert T. Convey, Senior Vice President - Sales & Marketing, Aeronautical Engineers, Inc. - The global air freight market is has been retracting for the past six months and show no near term signs of a correction. From our perspective the slow down we are currently in will continue through mid 2024 with modest recovery coming in Q3 2024.

Zachary T. Young - Over the last 3 years we have seen freighter capacity flip between

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CFM56 ENGINES CONTINUE TO LEAD THE INDUSTRY

The CFM56 engine, developed by CFM International, a joint venture between General Electric (GE) and Safran Aircraft Engines, has indeed established itself as a leading engine in the aviation industry. With its exceptional performance, reliability, and efficiency, the CFM56 has become one of the most widely used engines in commercial aviation. Freightier Trends learnt from the professionals that they expect the market for the CFM56-7 to be above pre-Covid levels this year and to peak at just above 1,900 visits a year by 2026. They are of the opinion that engine shortage and pricing are a challenge. With some CFM56-7B engines becoming rare assets in the market, their purchase prices have risen, impacting overall maintenance costs. Here are the details

How do you see the recent trends or changes in the MRO market for CFM56 engines?

Jeremy Colin – Sales & Marketing

Manager, Aero Norway : Following the gradual resurgence of the aviation sector after the COVID-19 pandemic, there has been a noticeable increase in the need for maintenance, repair, and overhaul (MRO) services as airlines resume operations and bring their aircraft back into service. Aero Norway perceives that airlines will continue to explore independent MRO providers for CFM56 engines to optimize costs and access specialized services, challenging the traditional shop visits.

The pandemic exposed vulnerabilities in supply chains. Post-COVID, MRO providers seem to have reevaluated their supply chain strategies for CFM56 engines, seeking greater resilience to mitigate future disruptions. Like other MRO providers, Aero Norway is compelled to strategically plan for essential parts. By proactively managing materials

and implementing an exchange program, Aero Norway aims to minimize disruptions and maintain operational efficiency.

Michael Grootenboer - SVP AFI KLM E&M Group Engines Product -

The global aviation market is undergoing fundamental changes driven by new technologies, the influx of new generation aircraft, worldwide economic effects and of course decarbonization challenges. In recent times, the industry has seen an increased interest in more tailor made work scopes. Of course, CFM56 maintenance cycles remain above all driven by LLP replacement. But by using our depth of engineering knowledge, AFI KLM E&M is able to provide its customers with tailor made solutions that keep their fleet flying and optimize cost of ownership. Given the high utilization rates of CFM powered aircraft, this remains of utmost importance to our customers. Supply chain of course remains a challenge at times, which however we mitigate through the use of

our extensive repair capabilities and our ability to competitively source Used Serviceable Material.

Les Cronin - VP Marketing & Sales - MTU Aero Engines North America -

CFM56 engines were among the first to be reactivated after the pandemic and shop visit volumes have gradually recovered post-crisis. There were about 680 and 1,000 shop visits for the CFM56-5B and -7B, respectively, in 2022, although these volumes still represented 25-30 percent less than pre-Covid. We expect the market for the CFM56-7 to be above pre-Covid levels this year and to peak at just above 1,900 visits a year by 2026. On the CFM56-5B, which equips the A320ceo, demand will continue to slowly recover over the next three or four years to pre-Covid levels."

Network-wide, MTU has completed over 110 shop visits for this engine family in 2022, giving it a combined market share of seven percent. Since the start of the program back in 2000, we have performed over 2,700 shop visits in total.

Interestingly, given the delays in new deliveries for A320neo and 737 MAX aircraft, we now expect the current generation aircraft to continue to operate longer than originally anticipated, which will positively impact the long-term MRO market. For both engine types, we also expect that passenger-to-freighter conversions will contribute to a longer in-service life of the CFM56.

At the moment, there are just over 200 converted freighters using predominantly older generations of the CFM56-5B or -7B engines. Apart from a handful of aircraft conversion shops in Israel, Singapore, and South America, narrow-body conversion shops are mainly in the USA and Asia-Pacific regions, where MTU Maintenance, the largest independent MRO provider for these engine types,



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is well represented.

While MTU Maintenance Zhuhai has full overhaul capability for the CFM56-5B, MTU Maintenance Dallas has capabilities for both the -5B and -7B, although that location focuses on on-site, near-wing and smaller "hospital" shop visits. That latter type of MRO work has been a noticeably increasing trend throughout the pandemic, with the overall goal to keep the engines flying at minimal cost.

CFM56 engines lend themselves particularly well to this type of maintenance, as they were designed to enable more on-wing fixes than previous generations and are built in such a way that modules can easily be swapped as needed. As such, our material and asset management support team has been able to provide operators with cost-effective used material solutions as alternatives to MRO so-called "green-time" solutions, be it for single modules but also entire engines.

This trend is unabated and we continue to add on-site services capacity throughout our network. In conjunction with full MRO services for the -7B, our location in Ludwigsfelde also has a dedicated on-site shop to respond to the on-going demand for these services.

Jay Aiken, Vice President Turbofan Sales, Airlines & Fleets for StandardAero - The CFM56-5B/7B market rebounded strongly in the wake of the COVID-19 pandemic, due to the versatility of the A320 and B737 NG platforms. The CFM56-7B also benefitted from delays to the 737 MAX program, which led to 737NGs being retained in service for longer than originally planned, and the A320ceo and 737NG have also seen a resurgence of interest of late as 'back-up' solutions for operators experiencing teething issues with their GTF powerplants. The 737NG has also enjoyed popularity in the cargo market, as operators move to replace their 737 Classics. Driven by all of these market



Jeremy Colin

influences, plus the fact that 45% of CFM56-5B/7Bs have yet to undergo their first shot visit, the long-awaited bow wave in CFM56-7B shop visits is expected to



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Wasim Akthar

peak in 2025.

Wasim Akthar, Director of Engines, AJW Group - One of the major trends we've noticed is the demand for leasing or spare parts for CFM56-7B. The demand is through the roof and this trend extends to the CFM56-5Bs as well. These engines are currently the go-to engine in terms of investment. The recent spike in demand is due to delayed shop visits, the ongoing after-effects of Covid, parts and labour shortages. We've got to the point where the flying schedules have returned, and when flying comes back, that's when the repairs come back. You do the planned and unplanned repairs to keep flying.

Many people have the parts and engines in AR (As Removed) condition, but as TATs (turn around times) are higher, they don't have the capacity for the MROs to repair them on time for delivery to the customer. Shops are taking 6 months to repair the engines and parts they used to repair in 28 days.

It is primarily the newer configuration engines, the ones with TI (tech insertion), that are in demand. If you have a CFM56-7B engine available for lease, it could go on lease without any questions, for example, AJW recently bought one, which was placed on lease immediately after the acquisition. Historically, operators needed a good CFM56-5B engine regardless of the configuration PI (Performance Indicator), but people want the latest and greatest modified engine because it is more fuel

efficient and has reduced CO2 emissions with better compatibility. It has a lot to do with people deciding to do the right thing for the environment.

AJW committed to the United Nations Global Compact (UNGC) earlier this year and has implemented a strategy to drive business awareness and action in support of achieving the Sustainable Development Goals by 2030, so it is promising to see others in the industry trying to do the same to reach net zero.

David Alejandro Fernández de Pedro – Business Manager Engine Shop, Iberia Maintenance - During the pandemic, operators have tried to protect cash and minimize the number of shop visits (sometimes purchasing green time engines) or reduce the scope and spent of the shop visit. Iberia Maintenance has offered flexibility, customised workscopes and module

exchange solutions

How does your maintenance process for CFM56-5B and CFM56-7B engines differ from other engine types, and what unique challenges does this engine series present?

Jeremy Colin – Aero Norway specializes exclusively in CFM56 engines and does not handle any other engine types. While we continue to carry out CFM56-3 maintenance, we face challenges with CFM56-5B and CFM56-7B engines, particularly concerning the yield time of our single source repair vendor. Components like fan blades have extended lead times, potentially impacting our planned shop visits. To mitigate disruptions, we proactively work ahead to ensure the availability of such parts for our production and engine deliveries.

Furthermore, the CFM56-7B engine is becoming a scarce asset in the market. Both purchase prices and lease availability are rising, leading to an impact on the prices and availability of used serviceable material (USM) parts. This scenario presents additional complexities for Aero Norway to manage in the context of our specialized focus on CFM56 engines.

Michael Grootenboer - CFM56 is the workhorse of the medium haul fleet and is driven mainly by LLP cycle consumption. The maintenance policy is set to support that. CFM56 has, as we all know, exceeded expectations in terms of time on wing as the type has matured. However, given the vast size of the worldwide fleet, the extension of the service life of CFM-powered aircraft to cover delays in new generation aircraft deliveries, and the drawing down of green time in recent years, there is a large demand for maintenance in the market. This may drive bottlenecks in terms of worldwide shop capacity, as well as, the supply of spare parts. We work closely with our customers and suppliers to anticipate needs and make sure any potential impact on our customers' engines is avoided where possible.

Les Cronin - Our approach to these engines varies according to operator needs. For operators with younger fleets, the focus tends to be on generating more flight hours with customized solutions such as CFMI's Special Procedure 10. We achieve this by intelligent fleet management that optimizes removals and shop visits across a defined period. Such services are complemented by predictive maintenance, based on engine trend monitoring, on-site services and spare engine support. Once an engine comes into the shop, our customized workscoping and our engineering expertise help lower overall costs. We call this program PERFORMPlus. This is particularly relevant for customers



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preparing for increased flight schedules later in the year and we are seeing an increased number of customers now seeking full shop visits and carrying out long-term planning.

As engines age, MRO costs increase. Which is why we also provide smart strategies for mature engines. Our fully independent solutions include alternative MRO, with a broad repair catalogue and tailored worksopes to suit operators' remaining flight periods, as well as material salvation and intelligent teardowns. As mentioned in the answer to the first question, there is also the increasing trend of on-site MRO and services with smaller worksopes which do not necessarily require full shop visits, but a relatively quick "hospital" visit.

Because there are no production narrow-body freighters, all aircraft are converted from passenger feedstock usually between 12-18 years of age. The converted freighter will see further service for about 15 years. If the freighter is leased, this will usually involve two leases, each of about eight years. Sourcing the perfect feedstock airframe with the desired engine life and build standard is difficult, so new owners and operators may want to overhaul or swap the engines while the airframe is being converted. At the least, a thrust upgrade is generally required. As mentioned, the CFM56 design is quite flexible, so our asset traders at MTU Maintenance Lease Services are able to mix and match parts and modules from a large stock of USM to give the operator the optimal combination of flight cycles and thrust that will yield the maximum value. Beyond that, we also offer engine exchanges and consignment sale of parts, as well as aircraft end-of-life solutions and other cost saving services to eke out the most value out of the assets of



Jay Aiken

an operator.

Wasim Akthar - Narrowbody engines have always been AJW's bread and butter, these are the CFM56-5B and the CFM56-7B engines. Their maintenance processes don't differ massively from their counterpart in the same family, the V2500 engine.

In the recent past, you would only have done light scope repairs, not full PR (Performance Restoration) shop visits. If you were to do a full PR on either of these engines, it would cost you roughly \$3 to \$3.5 million, excluding the materials such as the LLPs. On the other hand, a light repair will be anything between 500,000 to one million dollars. The delayed PRs are now underway, hence the demand for shop access.

We're speaking with the MROs who can do these repairs and asking them for quotes to do full restoration repairs, as well as quoting on light repairs, so we can make educated and financially wise decisions.

What we've been doing alongside many of our industry peers, is delaying PR work scopes by doing the light repairs and extending the life of the engine to keep it going until getting to the point where it is necessary to open the engine front to back and restore the condition of the parts of the engine, to as good as new i.e., do the performance restoration. It's a matter of asking ourselves whether the investment we're making will be worthwhile. Will a light repair be sufficient to continue going for X number of hours and cycles, or are we at the point where light repairs are not the best thing to do economically? We always strive to do the engine repair in the best way possible, while keeping the



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economics of the repair foremost in our minds.

We're at the point where we're saying, we need a quote for both repairs to make an informed and logical decision to see whether it is financially, commercially, and technically viable.

Jay Aiken - StandardAero supports the CFM56-7B from our Winnipeg, MB MRO facility, and from our DFW, TX service center. In Winnipeg, the CFM56 is processed through common workstations alongside the GE CF34-3/8, though the CFM56 undergoes de-stack and stack horizontally, while the CF34 is de-stacked and stacked vertically. The CFM56-7B poses few intrinsic challenges for our facilities, both of which offer engine test for the engine: the sheer volume of CFM56s produced means that the MRO processes for the engine have been well-refined, while any SBs or ADs are promptly addressed by CFM International and its partner companies.

David Alejandro Fernández de Pedro - Our engine disassembly and assembly lines can process V2500 and CFM56 engines indistinctively. Segregated modular assembly areas are reserved for each engine model. We intend to keep the Gate 1 process as standardized as possible, assuring the same turn-around time independently from the engine fleet in order to maximize production lines capacity maximization. The only difference is the possibility to offer exchange options for CFM modules that makes more sense on the CFM due to the different life of the LLPs.

How does your organization ensure that its CFM56 engine overhauls are cost-effective for customers, while still maintaining high quality standards?

Jeremy Colin - Our focus is on advanced planning and resource optimization. By proactively planning engine overhauls and optimizing the allocation of resources, Aero Norway ensures that the maintenance process is streamlined, reducing downtime and overall operational costs for customers.

Thanks to our in-house expertise and split production between overhaul and repair work (we have seven repair bays available) we customize and tailor workscopes for each individual customer.

Michael Grootenboer - As an airline-MRO, AFI KLM E&M understands as no other the balance between maintenance cost and asset availability to generate airline revenues. Combining our deep knowledge of the engine and our close relationship with our customers, we make sure we optimize that balance for each customer's particular needs. Our main priority is to keep the customer's fleet flying. The



Michael Grootenboer

support of the customer is focused on cost effective maintenance by tailormade work scoping, our repair network and availability of USM. Also, preventive measures are applied such as water-wash programs and On wing services.

Based on our motto "repair rather than replace whenever possible", AFI KLM E&M developed Prognos®: the most advanced engine predictive maintenance solution on the market, to anticipate engine deterioration and avoid unscheduled grounding of aircraft. Developed in-house on the basis of in-depth operational knowledge and with the help of highly qualified data scientists, our algorithms produce impressive predictions and lower cost of ownership.

Les Cronin - We always search for the most cost-effective solution for customers and, to this end, have a wide array of tools in

our toolbox see answer to question two. The aviation industry adheres to the highest safety standards, and we at MTU, are no exception. As such, we always strive to maintain the highest quality standards across all facilities and our entire portfolio.

MTU also employs a number of digital tools to monitor engine performance and to forecast the most cost-effective workscopes for single engines or entire fleets. Please refer to question 5 for further details.

It is also highly beneficial to be in close proximity to the customers and, in the case of P2F conversion shops, being able to send MTU's engine experts to a hangar for on- and near-wing work. MTU Maintenance is very well positioned in that regard because it has locations in Europe, North and South America and China.

Jay Aiken - As a CFM-authorized MRO facility for the CFM56-7B (via a General Support License Agreement or GSLA), StandardAero is able to assure operators of the highest levels of quality service, while our status as an independent provider provides us with operational flexibility, ensuring that our customers are our sole priority. StandardAero has almost 15 years' experience supporting the CFM56, having originally been appointed as a GE Designated Fulfillment Center (DFC) in 2009. This means that our CFM56 line operates at peak efficiency, supported by experienced technicians. We are also able to utilize used serviceable material (USM) to minimize operators' costs, as desired, with our PTS Aviation subsidiary ensuring a reliable supply of quality material. Furthermore, our in-house StandardAero Component Services (SACS) team has

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extensive experience with CFM56 CR6-O, with our 'repair not replace' philosophy further minimizing operators' costs.

Wasim Akthar - You can't reinvent the wheel, the only way you could ensure overhauls are cost-effective is by supplying USM (Used Serviceable Material) with sufficient life left in them. The USM must have the correct configuration, it must have been repaired by an OEM approved shop, must be priced accordingly, and meet the necessary regulatory requirements. On the downside, however, due to the demand for USM, the price has gone up quite significantly.

Airlines generally lease their engines, and a lease contract will stipulate what is acceptable life-remaining when the engine or aircraft is returned to them. Whether it's your customer's engine or your engine that you're repairing it needs to be built in a way that meets your needs at the time, while still watching your costs.

You build the engine in line with the customer's requirements and according to the length of time it will be in operation. If they're only going to operate it for another 2 to 3 years, there is no point in building that engine for 5 or 6 years.

There are different sections of the engine, some sections require a certain amount of work every time you get access to them, and others where you could postpone repair in favour of doing light maintenance. The core of the engine needs restoration work every time you gain access, but with the LPC (low-pressure compressor) and the LPT (low-pressure turbine), you could get away with light servicing.

At AJW we find the right material and plan the repair carefully. Scoping engines in the correct way initially, sourcing the right material, and knowing

the customer's needs are the most important factors to consider. It is understanding the need, while keeping your financial hat on the whole time, be it your engine or the customers.

David Alejandro Fernández de Pedro - Scrap rates reduction and used serviceable material sourcing are paramount towards a cost-effective shop visit. Our inspection area is directly supported by both our powerplant and part-repair engineering teams in order to ensure that the necessary parts are scrapped and our program management and parts sourcing teams remain in constant and direct contact with our extensive supply chain in order to find the right parts for each customer and shop visit. On top of that, our extended repair capability allow us to reduce the total maintenance cost and control the TAT

What are the notable projects or collaborations that your organization has undertaken in relation to the CFM56 engine series?

Jeremy Colin - Aero Norway has implemented its own engine 'BUY and SELL' program, designed to meet the demands of our customers whenever suitable assets become available. This program allows us to effectively address the needs of our customers by providing them with the required assets in a timely manner. This program is designed to meet the demands of our customers by efficiently handling asset transactions when they become available.

Engaging in upfront planning to prepare an asset within our 'BUY and SELL' program can offer significant benefits to customers. This includes the option to either directly sell the required engine or,



Les Cronin

alternatively, to offer the engine to a lessor partner with the specific intention of leasing it back to customers.

Michael Grootenboer - Industrialization of repairs is a major contributor to support the CFM56. Our extensive repair network ensures more control on cost levels. For example, we have set up Airfoils Advanced Solutions, a joint venture with Safran for Airfoils repairs. More information can be found on our website: AFI KLM E&M - Airfoils Advanced Solutions (afiklmem.com)

Les Cronin - As the largest independent MRO provider worldwide, MTU Maintenance carries out full overhaul services for: CFM56-7B engines at MTU Maintenance Berlin-Brandenburg, and CFM56-5B and -7B engines at MTU Maintenance Zhuhai, our joint venture with China Southern Airlines, the largest CFM56 operator not based in the United States. Our partnership with China Southern helps us to have a good insight into an airline's operational matters for this engine type.

We also have a network of seven on-site facilities around the world, with the ability to send our engine experts to customers, wherever they are, and perform on-site and near wing services. Five of those have CFM56 capabilities, including in North America at our locations in Dallas and Vancouver, as well as in Sao Paulo, Brazil, and as mentioned, in Zhuhai, China.

We utilize this network to perform services for our customers. As such, there are no notable collaborations to share in this field. Regarding projects, please see below.

Jay Aiken - StandardAero has had the privilege of supporting a large number of





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leading CFM56-7B passenger and cargo airlines over the years, including the world's largest operator of the type, Southwest Airlines. We also have the honor of supporting the U.S. Navy's fleet of P-8A Poseidon multi-mission maritime aircraft. As already noted, we do also have close relationships with CFM International and its partner companies, which included authorization as a GE TruEngine provider in 2013.

Wasim Akthar - AJW collaborates with the OEMs (Original Equipment Manufacturers), the shops which are approved by the OEMs, and some of the partners. We may have an engine needing repair and we don't have the kit ready to go but our partner does, so it means doing exchanges with them. However, collaboration is only really going to happen with partners who can do something for you in return. Communication and relationships are of primary importance in this sector. It is about managing slow TATs and the shortage of spare parts in a way that you can get the job done and still work with suppliers in looking for mutually beneficial ways to improve TATs together.

David Alejandro Fernández de Pedro - We signed an agreement with RwandAir recently to repair their CFM56-7B engines.

What are the new technologies or innovations related to CFM56-5B and CFM56-7B engines that you are currently exploring, and how may these developments impact your maintenance services in the future?

Jeremy Colin - In response to recent developments, Aero Norway has made substantial investments to enhance its capabilities. These include acquiring new equipment like a plasma spray machine and

high-speed grinder, as well as a modern engine storage machine for the warehouse. These continuous upgrades ensure that we, as a maintenance provider, retains our competitive edge and offer greater flexibility in production.

Furthermore, Aero Norway is actively evaluating and investing in updated tooling to expedite repair and overhaul processes. This commitment to constant improvement aims to reduce turnaround times, providing customers with faster and more efficient services.

Michael Grootenboer - We focus on developing innovative repairs to further decrease maintenance cost, and on implementing AI and ML technology to streamline engine MRO. This will be extended of course to our full portfolio including the LEAP-1A/1B engines that we recently added. We are also exploring opportunities to expand our worldwide presence, to be closer to our customers.

Les Cronin - There is an increasing focus to move more towards data driven decision making as opposed to a hardware driven process, which has traditionally been the dominating paradigm. MTU has over 40 years of MRO experience with a wide range of engine types and has respectively large sets of data which it can feed into digital tools.

MTU Maintenance uses a number of digital tools in its MRO processes and offers digital maintenance services, most prominently CORTEX and Engine Trend Monitoring (ETM), our proprietary software programs which are used for data processing and analysis, and maintenance planning either for single engines or entire fleets.

CORTEX analyses technical, commercial and market data to generate



David Alejandro Fernández de Pedro

tailor-made maintenance strategies for the customers. Using AI optimization algorithms and taking into account a multitude of variable parameters, such as utilization, operational conditions, parts availability, cost structures and engine health, the software produces cost-optimized MRO scenarios. These results are then discussed by our experts with each customer to find the best solution.

For a given contract period and type, the tool is able to forecast material needs down to a life-limited part (LLP) level, comply with configuration requirements and can calculate spare engine requirements to cover the respective MRO intervals. Thanks to the tool, the customer then knows how much on-wing time is left and what the residual value of their assets will be at the end of the lifecycle. We leave nothing to chance and seek out all possible factors that could save the engine operator maintenance costs.

ETM collects engine performance and other operational parameters recorded during the flight, processes them with our proprietary physics-based models and continually updates the customer on the latest condition of their assets. ETM is offered in conjunction with our MRO services as well as a stand-alone service as a means to increase efficiency and lower the operating cost of an engine through advanced diagnosis, analysis and prognosis.

The system observes fuel flow, exhaust gas temperature, shaft speeds and other metrics. If there are abnormalities in the values, it sends an alert to a platform that is fully accessible via any smart device. Our experts in engineering then analyze the deviations and make recommendations about a course of action, helping our customers to avoid operational disruptions.

Jay Aiken - While StandardAero does



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have a number of interesting technologies related to the CFM56-5B and -7B, not least our Engine Health Monitoring (EHM) data analysis capabilities, our most exciting development is probably the recent introduction of our CFM56-7B service center at our DFW International Airport facility, which includes test cell support. Beyond this, our recent award of a LEAP-1A/1B CBSA license from CFM ensures that we will be able to offer 'future-proof' support to CFM operators, combining our existing CFM56-7B capabilities with go-forward LEAP-1A/1B support from our facility in San Antonio, TX.

Wasim Akthar - As a spare parts supplier and engine trading firm, there is not much we can do around this topic. We don't do R&D (Research and Development), we only deal with parts from our engines and the suppliers out there which lie in the mid-life to end-of-life assets. Choosing the latest and greatest parts when you're repairing engines or when supplying to customers is the only part of new technology that we touch upon. We listen to the MROs and OEMs and ask what they can do to help us because we need the parts to put on the shelves to supply to operators. The R&D and new technology work is mainly the role of the OEMs or the major MROs who open and close these engines every day. They're the ones who could find ways of changing TATs.

There is talk in the industry about using PMA (Parts Manufacturer Approval) parts and DER (Designated Engineering Representative) repairs. It is a digression from the usual way of doing business, but although many people are talking about it we're yet to see it. Maybe we'll get to a point of accepting these to help with TATs, but it's not happening just yet.

AJW's position remains that we do not deal with DER repairs and do not trade in PMA parts. In short, AJW Group can find ways to manage things differently, but we cannot create new technologies as such.

David Alejandro Fernández de Pedro - We have entered across the years several improvements in our CFM production process, mainly focused in quality assurance and productivity increase. In such regard, we have gradually introduced faster and more accurate and reliable inspection methods and machines (such as augmented reality in BSI inspections and robotic arms and photogrammetry inspection machines) as well as automatic cleaning and NDT preparation lines, among several other improvements. We continue growing our repair capability as well.



What measures does your organization have in place to manage the inventory of parts and components needed for CFM56 engine overhauls.

Jeremy Colin - Aero Norway collaborates with external partners and possesses in-house expertise for repairing specific components, thereby minimizing the requirement for new inventory. Emphasizing the refurbishment of parts,



the company prioritizes component exchange over placing orders for new ones. Moreover, Aero Norway actively focuses on cost reduction within its inventory. The Company is currently advancing the use of consignment stock provided by reliable sources, which significantly contributes to maintaining a lower inventory value.

Michael Grootenboer - Given the current global constraint on both shop capacity and the supply chain for new parts, the used serviceable materials (USM) market provides a key way to reduce our reliance on the supply of new parts. To support our access to USM, we have a joint venture in

the US, Bonustech Inc., which specializes in the teardown of end-of-life engines and the extraction of serviceable parts. More information:

<https://www.afiklmem.com/en/network/joint-venture-bonustech>

Our predictive analysis program Prognos® for Engine, accurate work scoping through highly competent engineering, extensive repair capabilities and access to used serviceable material ensures a proper anticipation of new part needs and therefore timely part availability, leading to TAT optimization and material cost minimization.

Les Cronin - MTU is unique in the sense that it has a team specifically dedicated to procuring used engine parts, the asset traders at MTU Maintenance Lease Services, who use MTU's extensive network of repair vendors and the company's own capabilities to get parts back into working order. So if a location happens to be missing a part during a shop visit of a customer is in need of a CFM56

part or module, we can supply it from our own well-stocked shelves and do not have to rely on the tightening USM market.

Jay Aiken - We are able to ensure a reliable flow of CFM56 parts and materials via three means: firstly, through our position as a CFM-authorized CFM56 overhaul facility; secondly, through our dedicated asset management subsidiary, PTS Aviation; and, thirdly, through our in-house StandardAero Component Services (SACS) team, whose capabilities include component manufacturing.

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Wasim Akthar - AJW has been around for over 90 years, so it boils down to our knowledge and experience of the parts. As a spare parts company, when we induct an engine into a shop for teardown we know from our own experience and data gathered from historical repairs and sales, that the demand follows that, which gives us an idea of what should be repaired. We're constantly wearing a financial hat and finding ways to deal with maintenance schedule issues. We've been very smart with the placement of parts by growing our global strategic locations, such as the hub we opened in Turkey in 2022.

We stand by our commitment to having the right part, in the right place, at the right time; this is why AJW is the aviation partner of choice and why we recently secured a position among the top three suppliers at ALTA CCMA Awards in the Maintenance, Repair, and Overhaul (MRO) category, and were acknowledged as a leading supplier in the Distributor category. With nine decades of experience in the aviation industry, it is our people and our legacy experience and knowledge that are our most valued assets.

David Alejandro Fernández de Pedro - We are continuously monitoring the inventory to ensure the availability of material based on historical data of consumptions but, on top of that, we have material consignments with different providers and this helps us having material available without increasing our inventory

What challenges or issues you have faced in overhauling CFM56 engines, and how has the company addressed these?

Jeremy Colin - Engine shortage and pricing are a challenge. With some CFM56-7B engines becoming rare assets in the market, their purchase prices have risen,

impacting overall maintenance costs. To mitigate this issue, Aero Norway actively explores cost-effective options, such as the Engine BUY and SELL program, to secure required assets at competitive prices and offer flexible solutions to customers.

In the last two years the increase of the catalogue list prices from the manufacturer has been a major challenge. All material but especially high value parts such as life limited parts (LLPs) has increased by double digits every year.

Lead time and TAT are other factors.

Customers often demand faster turnaround times for engine overhauls to minimize aircraft downtime. Efforts are made to reduce turnaround time (TAT) by preparing materials in advance before the engine arrives for repair. However, the reality of long lead items can still impact the engine overhaul process.

Some specific engine components, such as fan blades, have had longer lead times from single-source repair vendors, impacting planned shop visits. Aero Norway has worked ahead by anticipating these delays and making advanced arrangements to ensure timely availability of required parts, reducing the impact on production schedules.

Each customer has unique requirements and worksopes for their CFM56 engines. Aero Norway addresses this challenge by utilizing our split production capabilities and in-house expertise to customize and tailor worksopes for individual customers, ensuring their specific needs are met efficiently.

Michael Grootenboer - AFI KLM EGM is very actively working with OEMs to develop and certify new repairs for engines and components. This helps constrain new

material cost as well provide more flexibility to manage the supply chain.

Les Cronin - As is the case throughout aviation at the moment, consistent inventory of engine parts and a shortage of personnel are the on-going headaches. However, MTU retained all their personnel and continued to purchase USM through active engine teardowns and module harvesting during the pandemic for the purpose explained in question 6, and in tandem to expand our network in both capacity and capabilities, so that we have not felt that pinch as badly as some.

Jay Aiken - None to speak of: our biggest challenge over the years has been in keeping up with demand, with the CFM56-7B continuing to be hugely popular in service. As such, the establishment of our new service center at DFW International Airport helps us to expand our support of global 737NG operators from a highly convenient and accessible location.

Wasim Akthar - Costs and TAT are probably the biggest challenges now. This is primarily driven by the rising cost of the material CLP (catalogue list price), which has recently gone up by 12%, which means the market value of the parts has gone up. The major challenge is knowing how to get comfortable with the high cost of materials. There is a bottleneck situation at the repair shops, it is well known that they don't have the capacity they did before. You can't just arrive and ask them to repair a part, there is now a very long waiting list. Things aren't happening at the speed they used to, and this is a major challenge for us.

In terms of timing, I believe it is going to be well beyond 2026 before we see an alleviation in this situation. By then, the shop visits would have peaked and the engines we deal with will still be worthwhile repairing and using for component supply. We will catch up, this is cyclical. There are retirements planned, which will improve the parts supply and this will soften the current demand to some extent, but this won't happen anytime soon.

David Alejandro Fernández de Pedro - We have been overhauling CFM56 since 1992 including -5A and -5C versions. Our powerplant engineering counts with 25+ years of experience in this engine model, accompanying our customers in the definition of the right worksopes depending on their needs per Engine Serial Number. CFM56 is fortunately a very robust platform that has provided reliable service to many airlines in the world, being one of its success factors its maintainability.

