AVIATION WEEK Fleet&MRO FORECASTS

COMMERCIAL

2025 MARKET SUMMARY REPORT

AVIATION WEEK NETWORK

Table of Contents

Foreword: Shortages Continue – Passenger Demand Strong

Brian Kough, Senior Director, Forecasts & Aerospace Insights, Intelligence & Data Services

Regional Utilization Change – Sept 2024 Hour % of Jul 2019 Index	
China	131%
India	123%
Latin America	104%
Middle East	101%
Western Europe	97%
Asia Pacific	93%
North America	91%

Shortages are still the overall driving trend this year, as it was last year, against a backdrop of strong consumer demand for commercial aviation services. Despite high hopes at the end of 2023, the end of 2024 records in some cases even greater challenges albeit with light at the end of the proverbial tunnel.

Full operational recovery displayed in passenger demand from almost every area of the world is pointing us to even higher expectations of worldwide commercial air service requirements. Blunting the demand is the ability to supply the market needs. With supply chain challenges still impacting nearly every aspect of the ecosystem, and the labor market suffering from a lack of skilled technicians, costs of doing business are increasing. From original equipment manufacturers (OEMs) to aftermarket providers to flight crews and support staff, many aspects of the system are strained. On the OEM side, struggles with delivering products bares watching. Tier one suppliers like Spirit AeroSystems, CFM International and Pratt & Whitney all hold critical roles in keeping Airbus and Boeing production on pace to meet demands for up to 9-years of aircraft backlog.

Boeing, suffering from production quality issues resulting in enhanced FAA scrutiny and low output, has also delayed certification of both the MAX-7 and the MAX-10, the latter being the response to the growing popularity of the A321. Nipping at the heels of the Airbus-Boeing duopoly, COMAC recorded hundreds of firm orders last year to compete with the behemoths. Embraer is likely to compete heavily for a share of the narrowbody demand given the circumstances, but the design-test-certify-produce timeline is a long one making a clean sheet design a long-term, expensive bet.

The result seen over the past three years is operators extending the life of aircraft they normally would have retired. Itching for new generation aircraft (read more fuel efficient, less carbon footprint, cheaper to operate, and better dispatch reliability), operators are instead investing in the next C and D airframe checks, more legacy engine overhauls, and moving passengers with what they have on hand to fly.

MRO aftermarket services saw another substantial increase since last year. While not as

Airbus A321neo
Expected to be the most popular aircraft model delivered, >6,500

Credit: Mike Hopwood, Aviation Week Network

Foreword: Shortages Continue – Passenger Demand Strong

Brian Kough, Senior Director, Forecasts & Aerospace Insights, Intelligence & Data Services

aggressive as two years ago, prices showed low double-digit increases, especially for engine work. These one-time inflationary surges are driven by the same trends as other areas of the industry, raw material costs/shortages, labor costs/shortages, and supply chain costs/shortages. Unscheduled durability maintenance for the GTF and LEAP engines overwhelmed the shop capacity seen when 2024 started. Combined with deferred engine work, and with operators flying their engines longer given lack of new equipment from OEMs, this led to lack of engine shop availability for legacy engines too. Compounded over a short timeframe the impacts are felt in the pocketbook.

Add in flight crew wage increases and we see the effect in several market areas where airlines are struggling to remain profitable. In the leading market regions of the US, Europe, and Asia, few airline stocks have recovered to pre-pandemic levels. As the “bill-payer” for MRO aftermarket services, this is concerning, yet the price elasticity of passengers seems flexible and manageable.

Despite the cost and supply issues, expectations are that they will be overcome in the shorter-term should regional economies remain positive and global shocks are avoided. Non-scientific event surveys find supply chain recovery timeframes similar as previously noted, ‘…another two-years…’

Gross domestic product (GDP) estimates anticipate continued positive growth worldwide. Further, few risks to the all-important economic middle-class groups are in sight which are critical to overall growth. The continued domination of new deliveries by the narrowbody groups foretells a long-term shift. Fully 76% of commercial unit deliveries are in this class. Airbus has a decided lead versus Boeing with the A320 versus the 737 orderbook. Reliability teething issues with the GTF and LEAP engines along with production issues are extending the life of legacy platforms. Long-term, later aircraft retirements signal trouble for legacy engine parts suppliers as green time engines and USM materials enter the engine markets in the second half of the decade.

Like a flight crew on approach to landing through a broken layer of clouds, clear skies can be seen but with a chance of a few more clouds and turbulence ahead before making the runway.

Scheduled ASKs

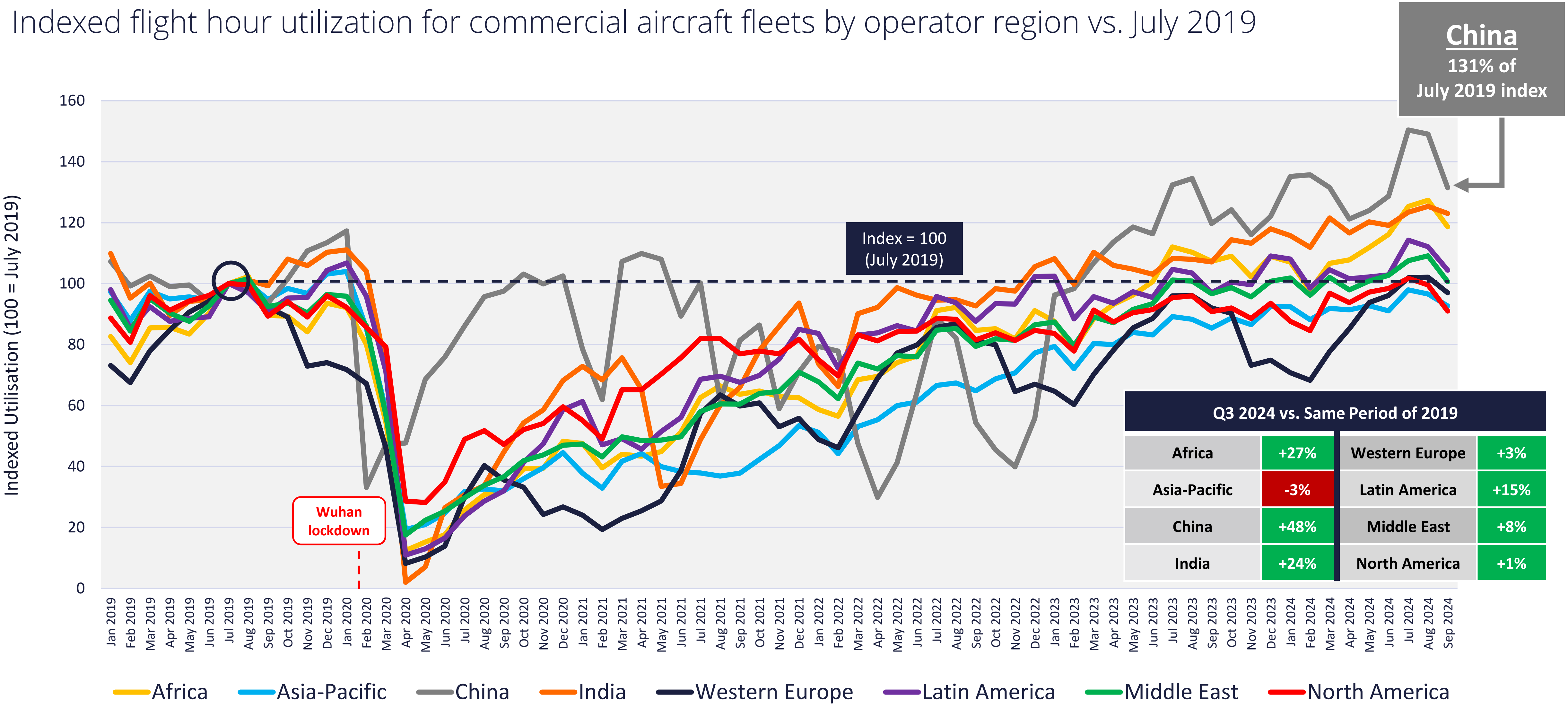
Region	Q4 2024 vs. 2023 % Change	2024 vs. 2023 % Change
U.S. & Canada	+4%	+6%
Europe	+9%	+11%
Asia-Pacific	+11%	+14%
China	+17%	+16%
Latin America	+8%	+8%
Middle East	+5%	+7%
Africa	+10%	+9%

Commercial Deliveries (Q1-Q3)

	Q1-Q3 2024	vs. 23	vs. 22	vs. 21	vs. 20	vs. 19
AIRBUS	498	+2%	+14%	+18%	+46%	-13%
BOEING	281	-23%	-10%	+29%	+251%	+5%
EMBRAER	41	+5%	+52%	+28%	+141%	-28%
ATR	22	0%	+69%	+38%	+340%	-29%
Others	36	+9%	+9%	-12%	+13%	-22%
TOTALS	878	-7%	7%	20%	85%	-10%

Utilization Change – Region

Indexed flight hour utilization for commercial aircraft fleets by operator region vs. July 2019



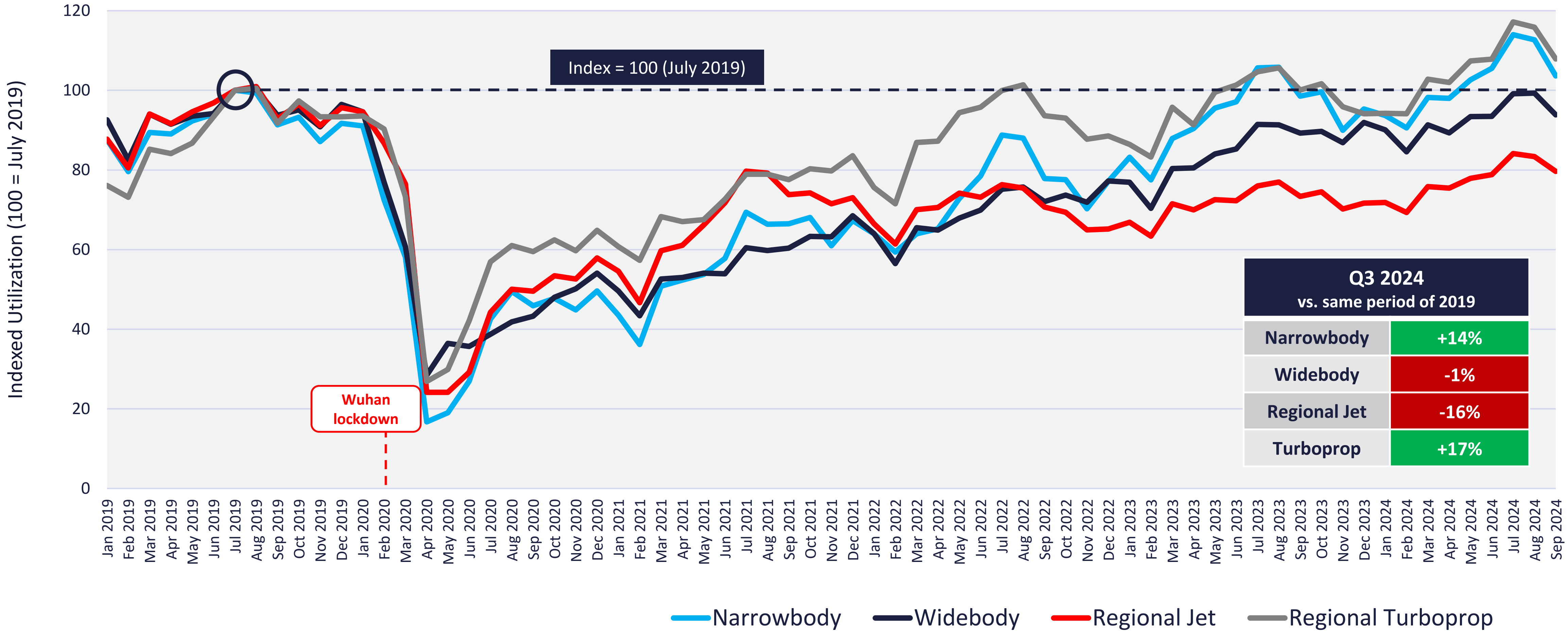
Q3 2024 vs. Same Period of 2019			
Africa	+27%	Western Europe	+3%
Asia-Pacific	-3%	Latin America	+15%
China	+48%	Middle East	+8%
India	+24%	North America	+1%

Source: Tracked Aircraft Utilization (TAU), Aviation Week Intelligence Network, Copyright 2024.

Source: Tracked Aircraft Utilization (TAU), Aviation Week Intelligence Network, Copyright 2024.

Utilization Change – Aircraft Category

Indexed flight hour utilization vs. July 2019

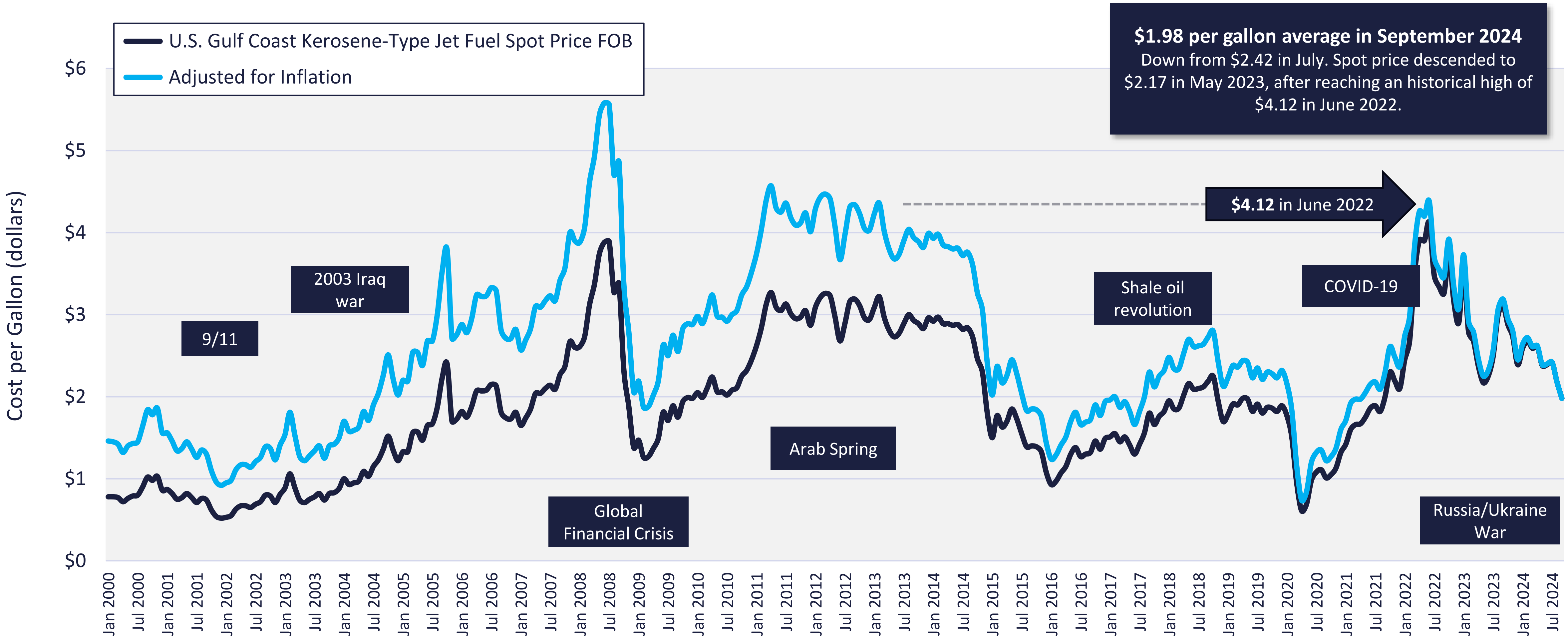


Q3 2024 vs. same period of 2019	
Narrowbody	**+14%**
Widebody	**-1%**
Regional Jet	**-16%**
Turboprop	**+17%**

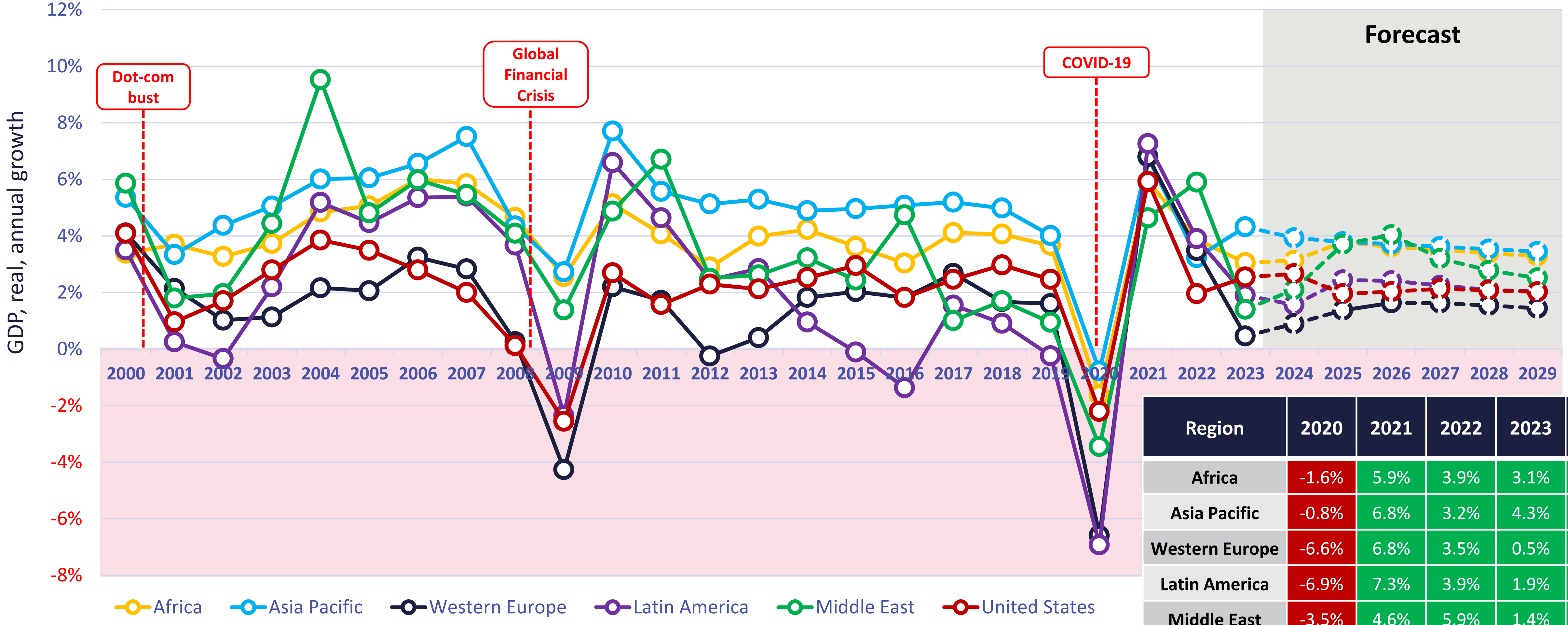
Source: Tracked Aircraft Utilization (TAU), Aviation Week Intelligence Network, Copyright 2024.

Jet Fuel Price and Inflation Adjusted

U.S. CPI-adjusted in latest month's price



GDP, Recent Economic Shocks & Forecast



Region	2020	2021	2022	2023	2024 (f)
Africa	-1.6%	5.9%	3.9%	3.1%	3.1%
Asia Pacific	-0.8%	6.8%	3.2%	4.3%	3.9%
Western Europe	-6.6%	6.8%	3.5%	0.5%	0.9%
Latin America	-6.9%	7.3%	3.9%	1.9%	1.6%
Middle East	-3.5%	4.6%	5.9%	1.4%	2.1%
United States	-2.2%	5.9%	2.0%	2.5%	2.7%
World	**-3.1%**	**6.5%**	**3.1%**	**2.7%**	**2.7%**

Source: Oxford Economics Ltd (18 September 2024 update)

What's New This Year?
Product Changes

Product Changes

Engine MRO - Engine LLP Modeling

New this year the algorithms to identify and account for expensive engine Life Limited Parts (LLPs) changed to more accurately capture the costs and maintenance exposure seen in our fleets. Significant costs are associated with mandatory maintenance updates to engine components as they age. Engines operating on commercial aircraft types will see the full spectrum of potential LLP events, their costs, and MRO demand impacts across the 10-years of the forecast. Please see the methodology section for further information.

Engine Expense Types

- [x] ATA 72 Engine LLP
- [ ] ATA 72 Engine OEM Tech Upgrade
- [ ] ATA 72 Engine Overhaul Event
- [x] ATA 72T Engine LLP
- [ ] ATA 72T Engine Overhaul Event


Credit: Brian Kough, Aviation Week Network

Product Changes

Changes to Engine Durability Issues or "Tech Upgrade" Modeling

Both Pratt & Whitney and CFM engine manufacturers are working their way through entry into service on-wing durability issues. Continuing and adding to the GTF and LEAP engine durability MRO coverage from last year, our modelling now makes assumptions about what's been fixed vs. what's remaining to see a fix through 2026. This is provided to give a more granular view, more specific results, and anticipated event counts and cost predictions on these two engine families.

For the P&W GTF engine (PW1000G) issues, airframes which have spent over 120 consecutive days on the ground during 2023/1H 2024 will be assumed to have had their engines inspected and repaired for the durability issues (powder metal contamination and combustion chamber). Further, engines whose cycle count reached 80% of TBO during the time of grounding will be assumed to have received an engine performance restoration or overhaul (OH) as well. In this latter case, the engines' OH timing will be re-set to account for this OH assumption and projected for the next shop visit via our utilization projection modelling.

Engine Expense Types

- [ ] ATA 72 Engine LLP
- [x] ATA 72 Engine OEM Tech Upgrade
- [ ] ATA 72 Engine Overhaul Event
- [ ] ATA 72T Engine LLP
- [ ] ATA 72T Engine Overhaul Event

Product Changes

Changes to Engine Durability Issues or "Tech Upgrade" Modeling (Cont.)

For the CFM LEAP engine issue, event modelling has been divided between the LEAP-1A and LEAP-1B (for the fuel nozzle issue and reverse bleed system retrofit) being modelled. In the case of the LEAP-1A, modelling assumptions anticipate that engines built in 2024 will have the necessary fixes included upon delivery or been completed in the field. In the case of 2023-built and earlier, the assumption is that those engine's retrofits will be finalized by the end of 2024 (pre forecast period).

In the case of the LEAP-1B engines, event modelling anticipates a 2025-2026 period to accomplish. Engines built in 2024 and earlier will require an update, but fielding and installations will not be fully completed until the end of 2026 since CFM has yet to field a retrofit kit. LEAP-1B modelling prioritized engines in this cohort by age and thrust ratings so that higher event randomization weighting was given to those that were the oldest and those that had the higher thrust ratings. This yields a fairly even 50/50% split of the anticipated 2025 engine fleet where half are assumed to be accomplished in 2025 forecast year and the remaining half anticipated for completion in year 2026. LEAP-1C engines are modelled separately and will be assumed to have all retrofits accomplished by the end of 2025.

Full result details are available via filters in the online dashboard tool. Please see the methodology section for further modelling information.

Market Outlook

Market Outlook

Jens Flottau, Executive Editor, Commercial Aviation, Aviation Week Network

Jens Flottau

Commercial aviation is often described as a never-ending growth story. General economic growth leads to a faster increase in demand for air travel and more aircraft deliveries. Recapturing that historic growth pattern in the aftermath of the Covid-19 pandemic is a task that the industry has been working on and Aviation Week’s latest ten-year commercial aircraft delivery forecast is again showing how hard the climb back up to previous heights and to continue onwards is. It also provides clues on market shares of the different manufacturers.

The industry as a whole is still not where it used to be. Combined 2024 deliveries will still be below 2019 (when Boeing 737 MAX deliveries were already suspended following the two accidents) and even further below 2018, which should be the real reference year to eliminate anomalies. 2025 will be the first year in which the industry will likely get above 2019 production, but it will take another year until it can claim to have resumed growth from where it had left off eight years earlier.

The reasons for the eight-year crisis are well known – the pandemic, the supply chain constraints affecting both manufacturers and of course the seemingly endless crisis at Boeing which has led to 737 MAX output much below original estimates. The forecast shows that while both Airbus and Boeing have ambitions to climb further, there are also defined limits: by 2028 or latest 2029 production will plateau at around 2,200 aircraft annually or somewhat higher. The figure includes all manufacturers and regional aircraft, but Boeing and Airbus will still capture 91% of the total market.

For one, that production number is defined by capacity of the current industrial set-up. Should either want to go further, heavy investment in new plants and tools would be required. That is unlikely to happen as the risks in a future downturn also escalate. More importantly, Boeing and Airbus customers have been very clear that they want the next generation of single-aisle aircraft to arrive sooner rather than later.

Airbus CEO Guillame Faury said at the recent U.S. Chamber of Commerce aviation summit in Washington that an A320neo replacement has to burn 25% less fuel. He also said production has to have been stabilized for some years before Airbus can make a firm launch decision. That milestone is already moving to the turn of the decade from around 2028 because of the current production mess.

While Airbus faces more political pressure to act for more sustainable flying, Boeing also has market share considerations to take into account. Its overall share of deliveries is 40% (Airbus' is 51%), but for the all-important narrowbody market it is likely lower given the relative weakness of the MAX versus the A320neo family. Aviation Week's forecast clearly shows the root causes: More than two thirds of the A320neo deliveries over the next ten years will be A321neos (6,500 of roughly 8,500 units). The A321neo alone will therefore account for almost one third of all commercial aircraft globally, including regional jets and turboprops. By contrast, the competing 737-10 will, if and when certified, be less than one third of the 6,600 MAX deliveries for the period.

The need for Boeing to act is blatantly obvious and all eyes are on its new CEO Kelly Ortberg and his future strategy that he has yet to articulate beyond fixing the current quality issues.

In the widebody market, the 777X will account for around 800 deliveries over ten years, well below the 787 and the A350, but well above the A330neo.

The forecast is not very good news for Embraer which Aviation Week analysts see at 712 deliveries over ten years, well below its previous peak production of up to 130 aircraft annually. Embraer is weighing whether it should enter the market for larger narrowbodies but even if it did, a new model would not have a large impact on market shares over the next ten years given how long development times have become.

Comac will deliver 291 C919s and 307 ARJ-21s until 2034. An annual production of between 20-30 aircraft is about one third of the output Airbus targets per month.

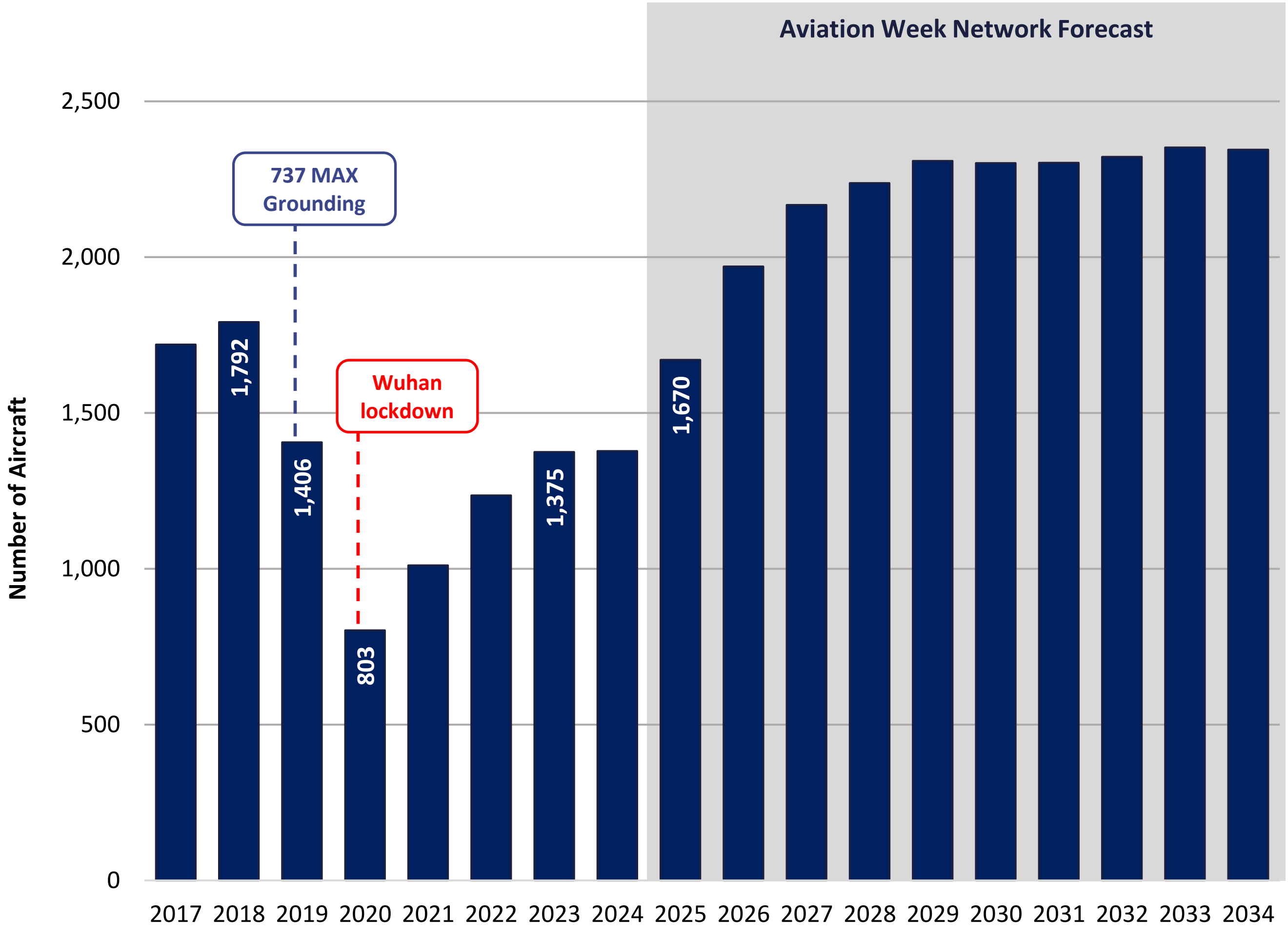
Boeing 737 Max 8

Credit: Mike Hopwood, Aviation Week Network

Fleet Forecast & Trends

Historical & Forecast Commercial Deliveries

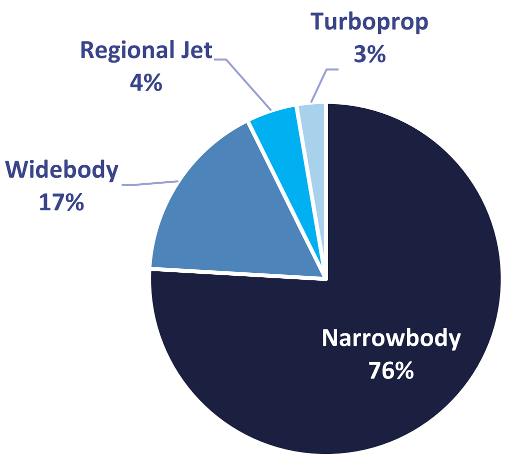
Annual new deliveries, historical trend & forecast



Highlights

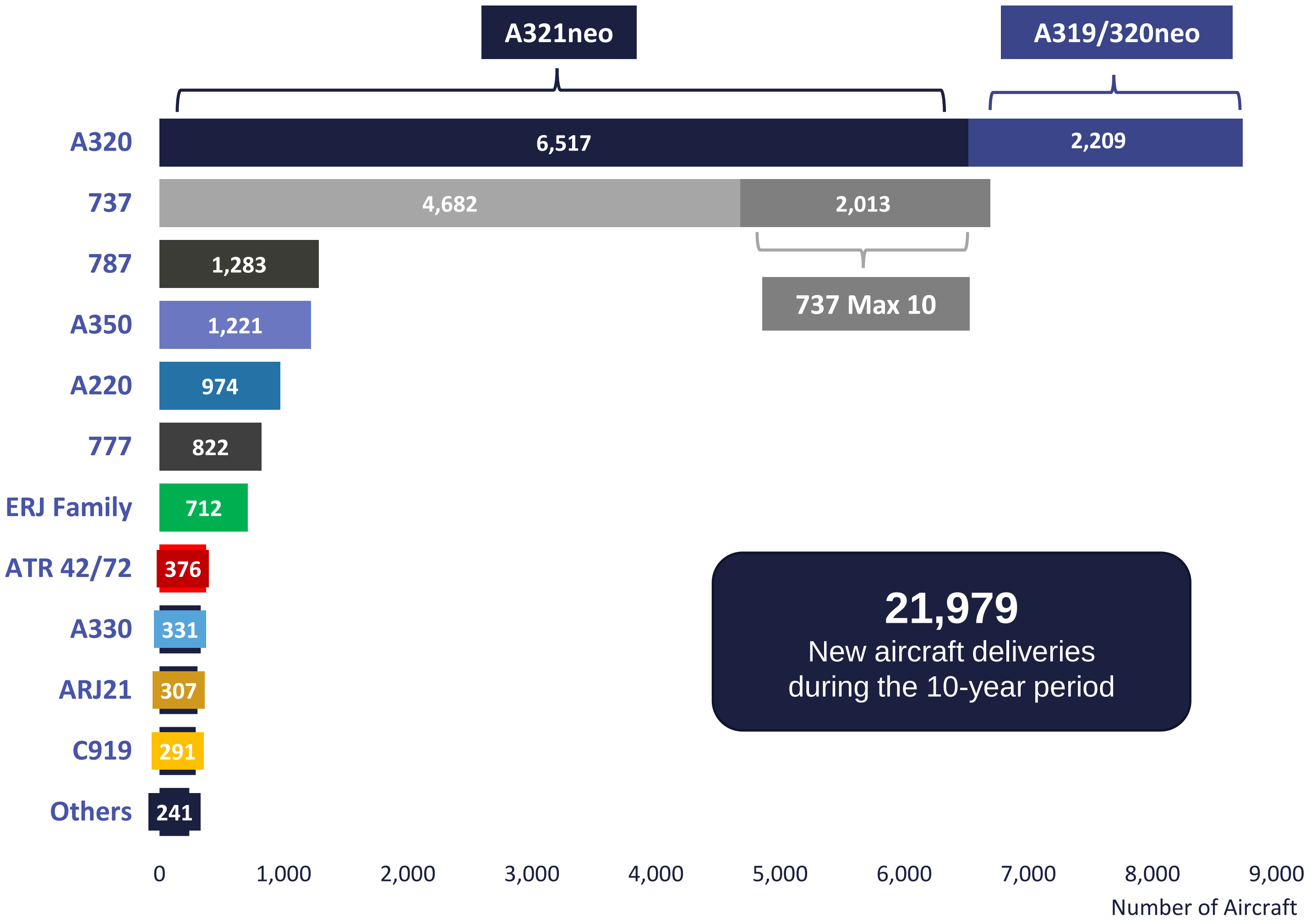
- 21,979 new deliveries over 10-year 2025-34 forecast period.
- Over 2,000 annual deliveries from 2027 onwards.
- Narrowbodies lead all size categories - Airbus A320 outpaces Boeing 737.
- Narrowbody share is 76% vs.17% share for widebodies.
- Russian origin types still removed from forecast – see scope.

2025-34 Share of Deliveries



Source: 2025 Commercial Aviation Fleet & MRO Forecast, Fleet Discovery, Aviation Week Network, Copyright 2024.

New Build Aircraft Deliveries 2025-34



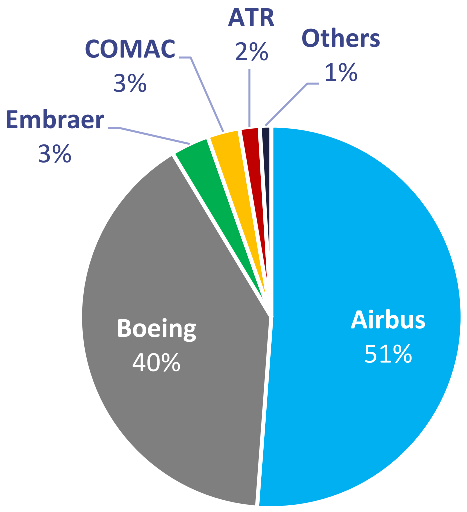
The A320 and 737 accelerate their domination of the delivery market. Of the 21,979 aircraft that are expected to be delivered between 2025 and 2034, 70% (15,421 units) will be these two aircraft families. Deliveries of the A320 will outpace those of the 737, with the A321 comprising 30% (+6,500) of all deliveries alone.

In the widebody market segment, the 787 and A350 are the most popular. These two account for 35% and 33% of new build widebody deliveries, respectively. Meanwhile, the 777 represents 22% of new build aircraft deliveries in that segment.

Deliveries of 11,252 new Airbus aircraft are expected over the forecast, accounting for just over half of the total. Boeing is expected to deliver 8,827 aircraft, representing a 40% share of total deliveries.

The two largest manufacturers therefore account for 91% of aircraft deliveries over the forecast period – one percentage point below last year's forecast.

By Manufacturer

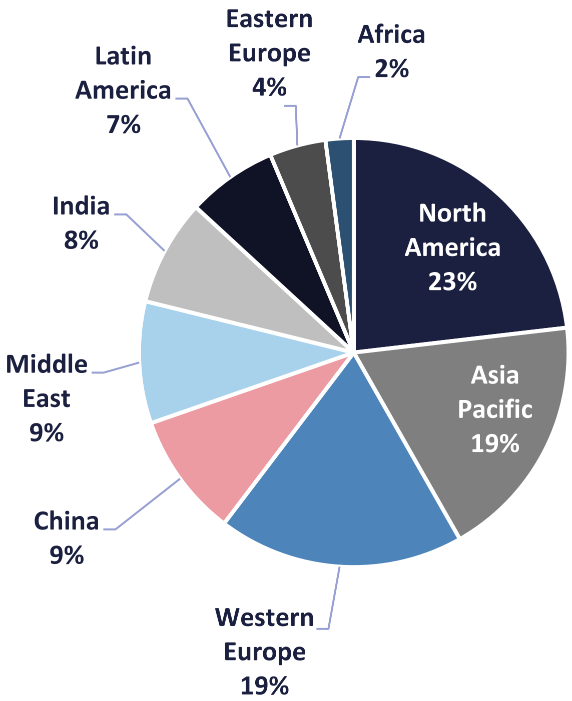


Source: 2025 Commercial Aviation Fleet & MRO Forecast, Fleet Discovery, Aviation Week Network, Copyright 2024.

New Aircraft Deliveries by Region 2025-34

Region	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2025-34
North America	431	472	490	511	497	557	553	516	522	539	5,088
Asia Pacific	233	302	382	403	392	428	472	498	508	476	4,094
Western Europe	287	373	444	404	497	507	408	372	387	398	4,077
China	259	261	246	211	164	154	161	195	204	198	2,053
Middle East	133	189	195	182	203	218	231	228	223	216	2,018
India	77	82	129	180	157	196	223	242	236	237	1,759
Latin America	119	142	150	166	190	139	146	152	142	148	1,494
Eastern Europe	97	90	74	126	155	66	67	81	87	89	932
Africa	34	59	58	55	54	37	42	38	43	44	464
TOTAL	1,670	1,970	2,168	2,238	2,309	2,302	2,303	2,322	2,352	2,345	21,979

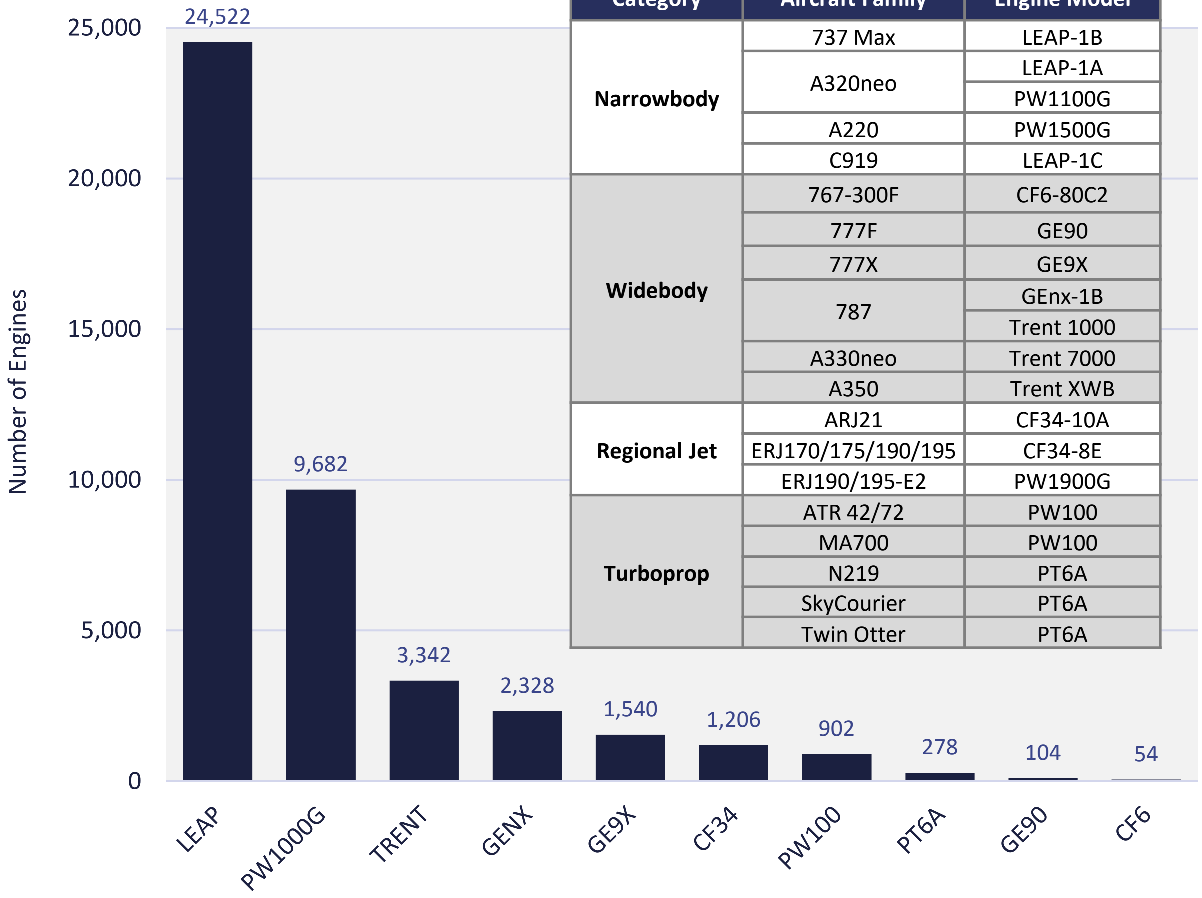
2025-34 Deliveries



Source: 2025 Commercial Aviation Fleet & MRO Forecast, Fleet Discovery, Aviation Week Network, Copyright 2024.

New Build Engine Deliveries Equipping the Fleet

By Engine Family



Category	Aircraft Family	Engine Model
Narrowbody	737 Max	LEAP-1B
	A320neo	LEAP-1A
		PW1100G
	A220	PW1500G
	C919	LEAP-1C
Widebody	767-300F	CF6-80C2
	777F	GE90
	777X	GE9X
	787	GEnx-1B
		Trent 1000
	A330neo	Trent 7000
	A350	Trent XWB
Regional Jet	ARJ21	CF34-10A
	ERJ170/175/190/195	CF34-8E
	ERJ190/195-E2	PW1900G
Turboprop	ATR 42/72	PW100
	MA700	PW100
	N219	PT6A
	SkyCourier	PT6A
	Twin Otter	PT6A

Driven by the expected growth in the global single aisle fleet, the CFM LEAP and Pratt & Whitney PW1000G will see the highest volume of deliveries. The LEAP alone is projected to account for 24,522 engines between 2025 and 2034, equating to more than half of the 43,958 engines expected to be produced over the decade. Although production of the ubiquitous CFM56 concluded in 2022, its aftermarket impacts will be felt well beyond the scope of this forecast.

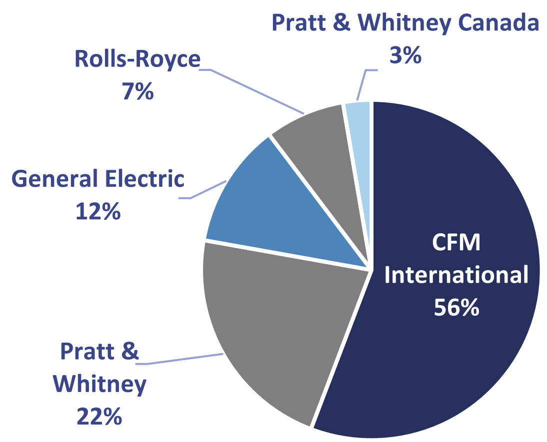
The expansion of the 787 and A350 fleets will drive deliveries of 3,342 TRENT engines and 2,328 GENX engines in the forecast. 73% of all TRENT deliveries will be of the XWB model which powers the A350.

As a result of the success of the LEAP series, CFM international engines will account for 56% of all delivered.

Pratt & Whitney account for a further 22%, General Electric 12%, and Rolls- Royce 7%.

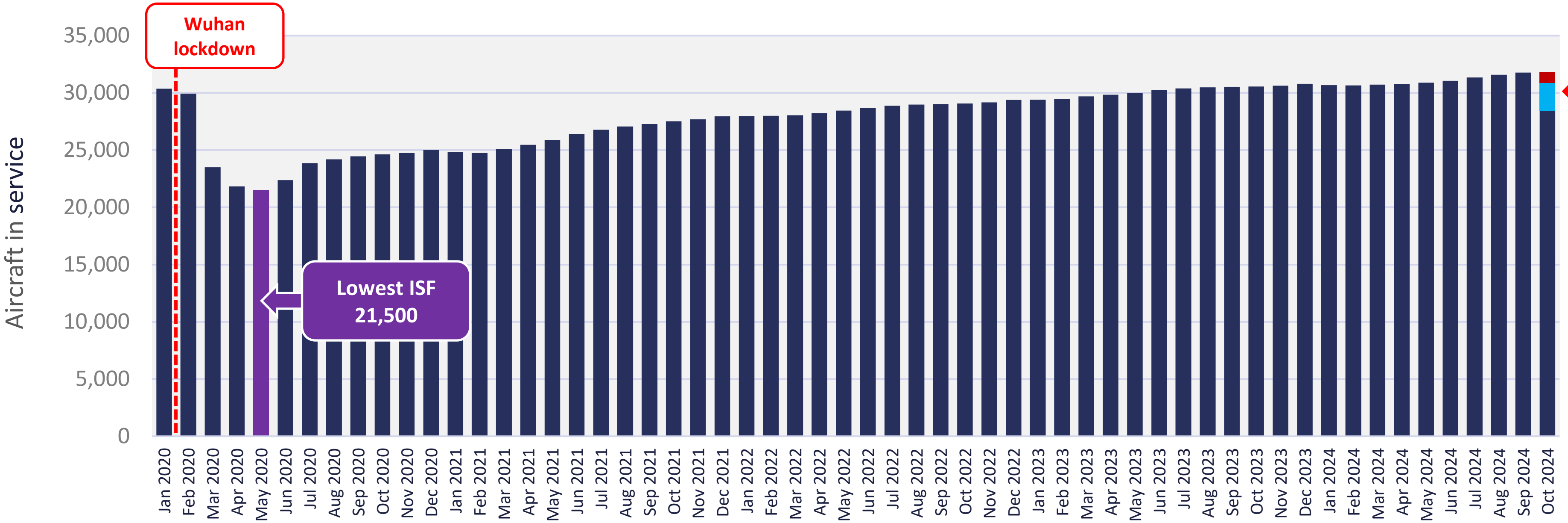
Deliveries of the PW100 and PT6A turboprop engines account for Pratt & Whitney Canada's remaining share.

By Manufacturer



Source: 2025 Commercial Aviation Fleet & MRO Forecast, Fleet Discovery, Aviation Week Network, Copyright 2024.

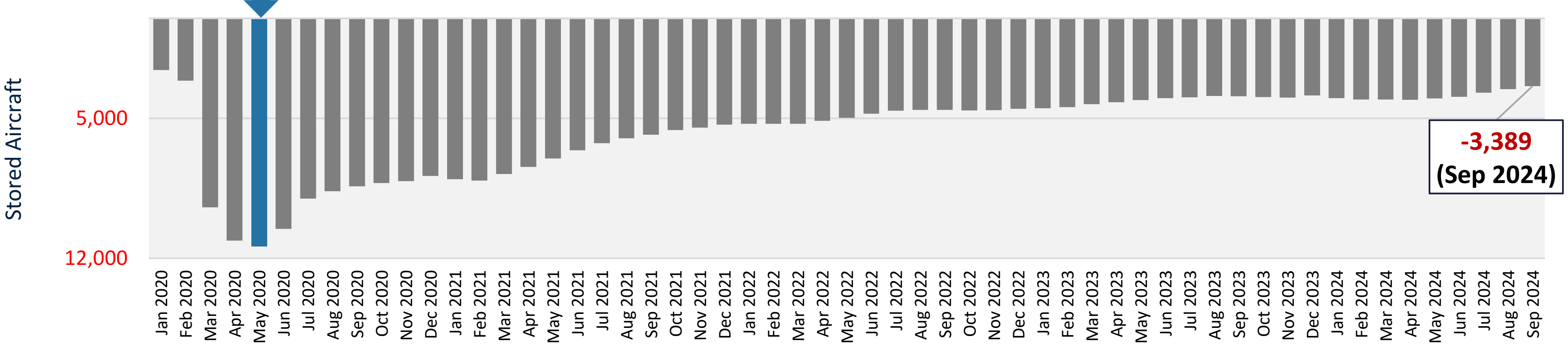
Historic Trends in Storage & Global In-Service Fleet



10% of the global fleet temporarily parked or under-utilized, Oct 2024

Parked Aircraft During Pandemic

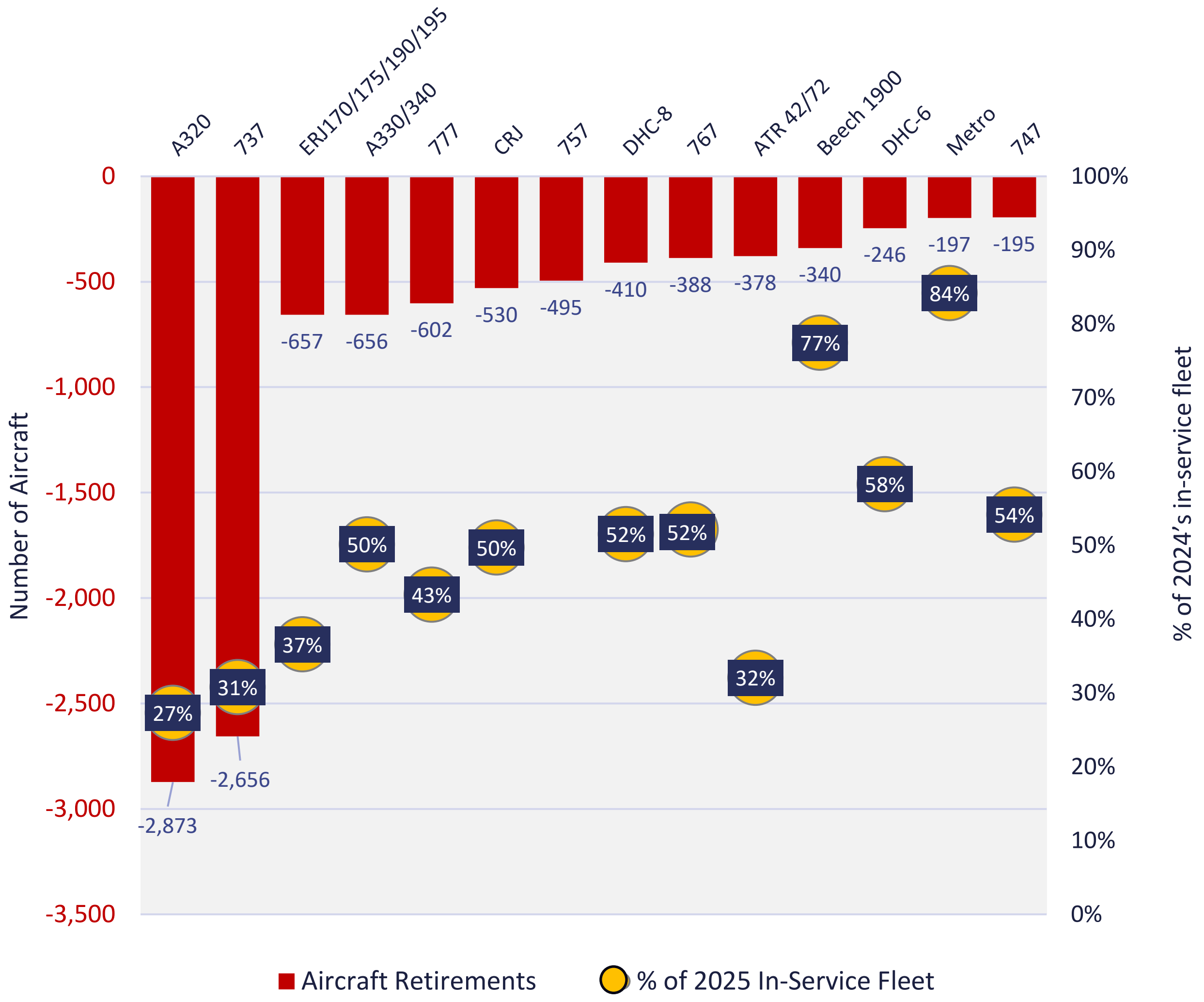
~11.4k aircraft stored in May 2020



~3.4k stored September 2024

Source: Fleet Discovery, Aviation Week Intelligence Network, Copyright 2024.

Aircraft Retirements 10-Year & Share of Fleet

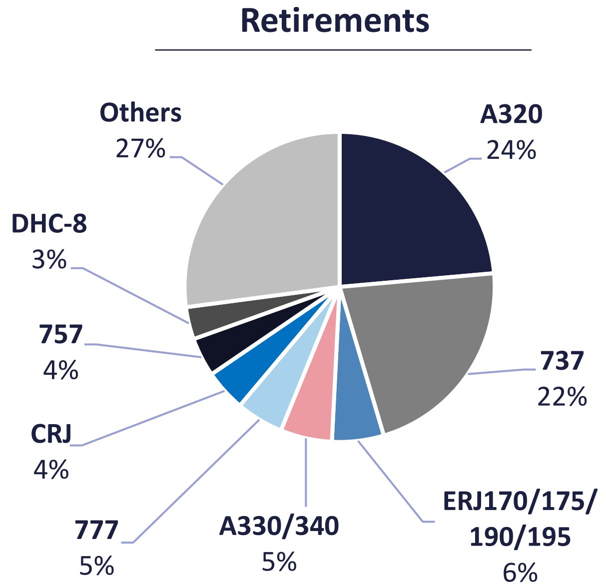


The scale of the in-service fleets of both the A320 and 737 will drive the highest number of retirements over the decade. A useful measure is comparing to the active, remaining fleet. Despite the large number of both of these aircraft families leaving passenger service, the number of retirements in relation to the share of the active fleet as of 2024 is relatively low at 31% for the 737 and 27% for the A320.

By comparison, the number of retirements in relation to the 2025 in-service fleet for the 757 stand at 100%. The Beech 1900 and 767 are at 77% and 52% respectively, as these aircraft are gradually withdrawn over the course of the forecast.

Meanwhile, 195 Boeing 747s will leave service to be retired out of a fleet of 360 aircraft in 2025.

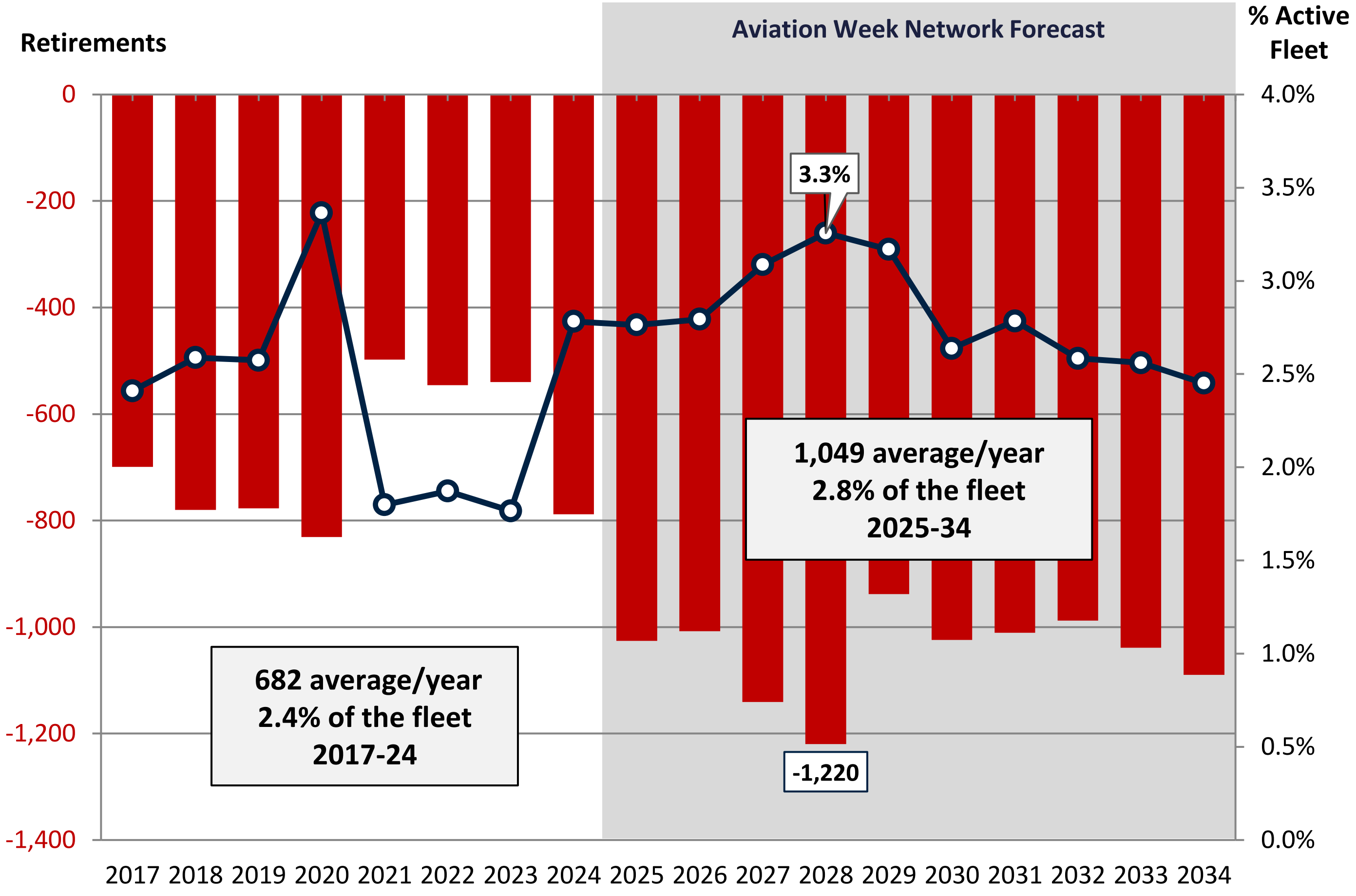
Within the retirement total, over 1,100 commercial aircraft are expected to be converted to freighter configurations over the 10-year forecast period. Conversions are primarily for 737s, A320s, 767s and A330s. These are delineated as "fleet exits" and "fleet entries" in the online dashboard tool.



Source: 2025 Commercial Aviation Fleet & MRO Forecast, Fleet Discovery, Aviation Week Network, Copyright 2024.

Forecast Trends in Aircraft Retirements

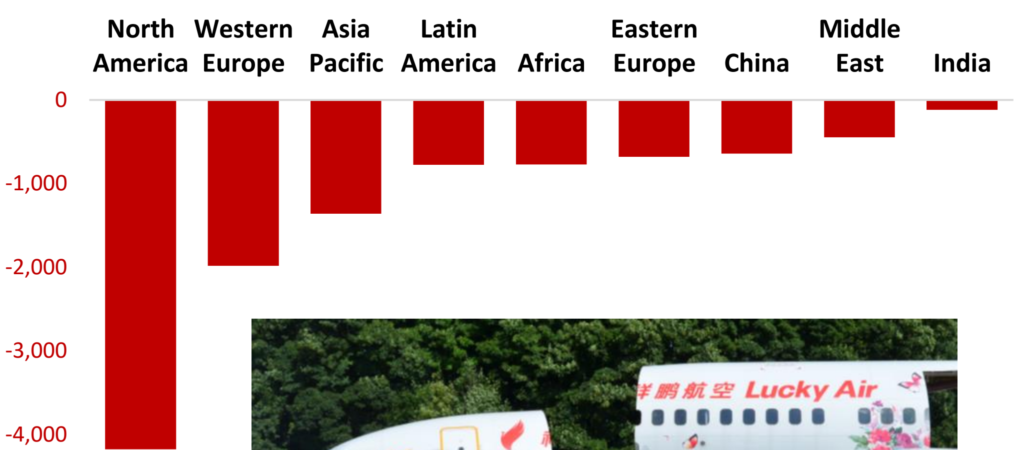
Annual retirements historical & forecasted, % of in-service fleet



Highlights

- ~10,900 retirements over 10-year forecast period.
- ~1,250 PTF conversions extra (not included in adjacent figures).
- Retirement projections peak at 1,220 in year 2028.
- Used spare parts/green time engines may flood markets for popular legacy types depressing pricing.

Regional Retirements 2025-34

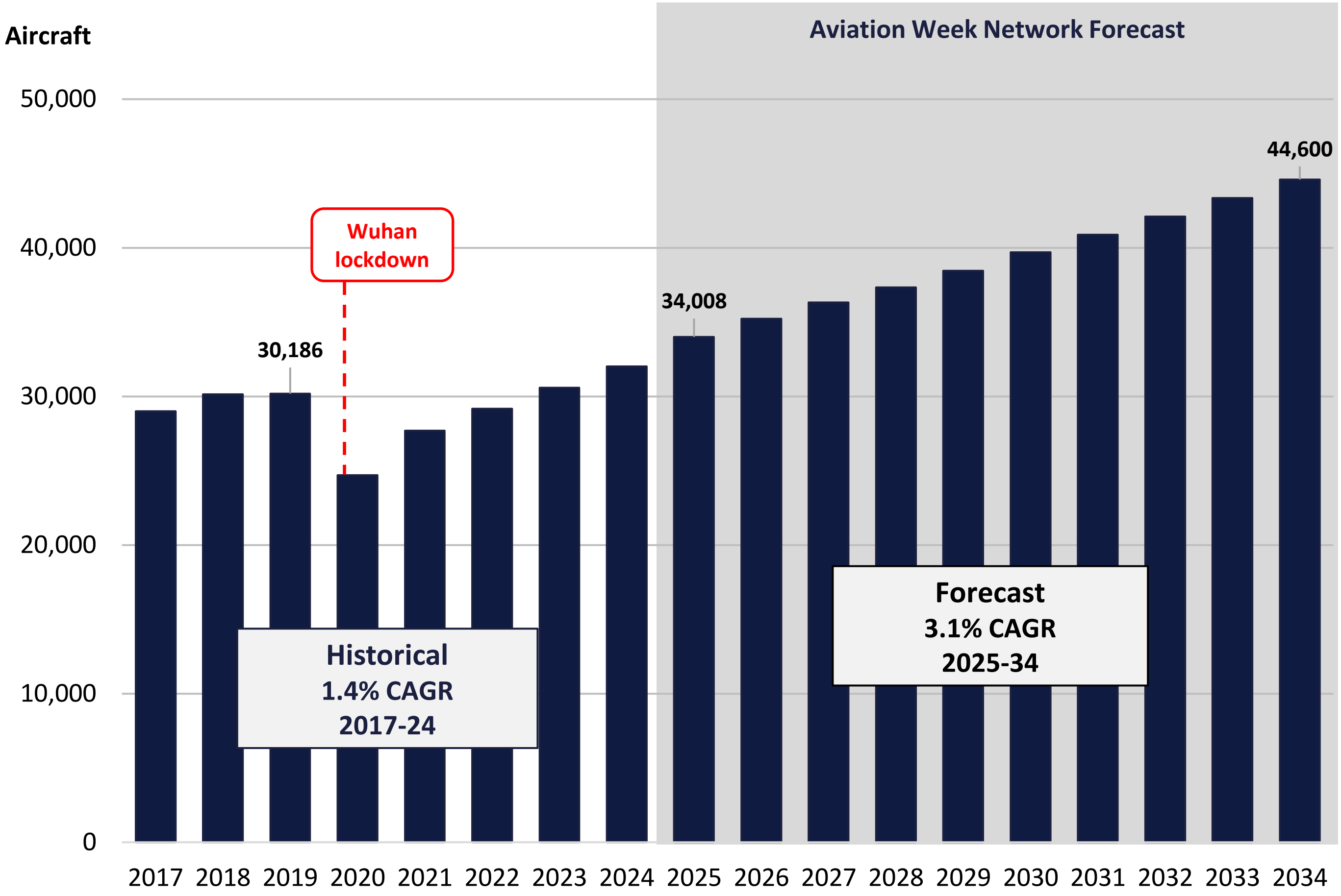


Credit: Nigel Howarth, Aviation Week Network

Source: 2025 Commercial Aviation Fleet & MRO Forecast, Fleet Discovery, Aviation Week Network, Copyright 2024.

Forecast In-Service Commercial Aircraft Fleet

Annual count of active commercial aircraft, historical & forecasted



Highlights

- 3.1% future CAGR expected for the 2025-34 period.
- Since 2023, in-service fleet exceeded 2019 levels.
- Narrowbodies are key growth driver over decade.

Airbus A350

Credit: Nigel Howarth, Aviation Week Network

Active fleet increases from 34,008 in 2025 to 44,600 in 2034

31% increase in active fleet strength

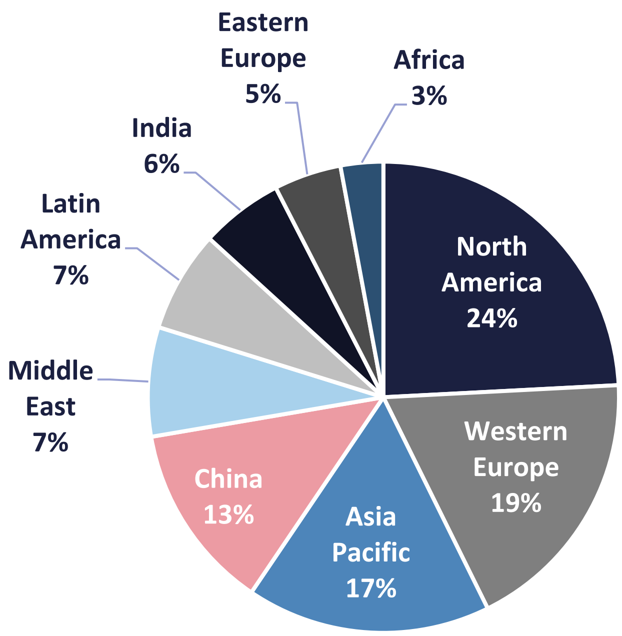
~At end of 2034, 36% of the fleet will be from the A320 family

Source: 2025 Commercial Aviation Fleet & MRO Forecast, Fleet Discovery, Aviation Week Network, Copyright 2024.

Forecast Aircraft In-Service Fleet by Region

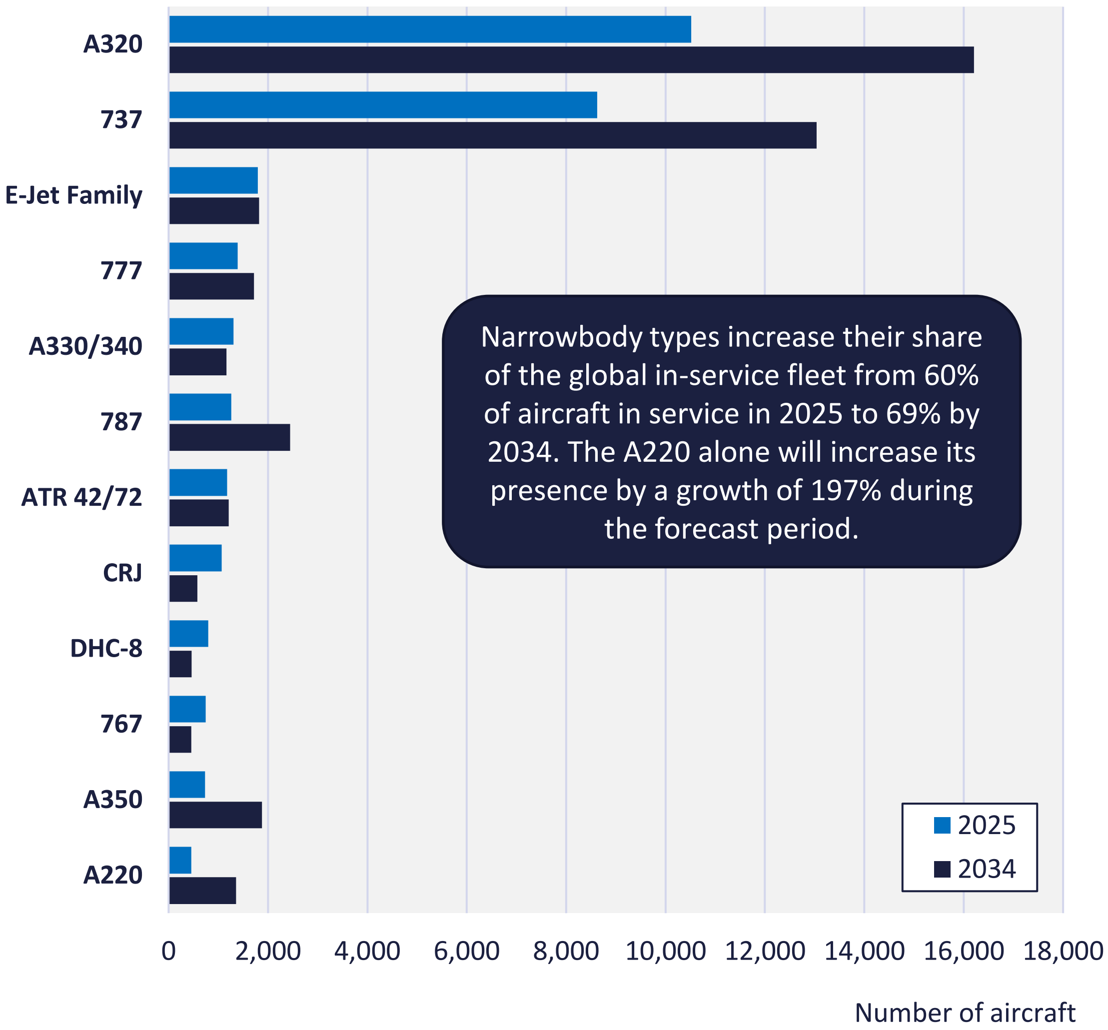
Region	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2025 % Share	2034 % Share	% Change	CAGR
North America	9,632	9,648	9,633	9,517	9,515	9,733	9,936	10,207	10,484	10,784	28%	24%	12%	1.3%
Western Europe	6,287	6,526	6,785	7,012	7,306	7,648	7,823	7,954	8,060	8,259	18%	19%	31%	3.1%
Asia Pacific	4,959	5,208	5,485	5,755	5,988	6,252	6,533	6,850	7,195	7,479	15%	17%	51%	4.7%
China	4,684	4,927	5,111	5,278	5,362	5,436	5,528	5,628	5,703	5,730	14%	13%	22%	2.3%
Middle East	1,822	1,990	2,144	2,291	2,454	2,635	2,827	3,007	3,183	3,344	5%	7%	84%	7.0%
Latin America	2,402	2,510	2,604	2,722	2,842	2,882	2,927	2,973	3,040	3,103	7%	7%	29%	2.9%
India	935	1,023	1,155	1,332	1,487	1,669	1,883	2,107	2,316	2,533	3%	6%	171%	11.7%
Eastern Europe	1,743	1,819	1,837	1,885	1,961	1,961	1,961	1,986	2,016	2,063	5%	5%	18%	1.9%
Africa	1,544	1,568	1,559	1,552	1,528	1,485	1,451	1,392	1,351	1,305	5%	3%	-15%	-1.9%
TOTAL	34,008	35,219	36,313	37,344	38,443	39,701	40,869	42,104	43,348	44,600			31%	3.1%

2034 In-Service Fleet Share



Note: Four aircraft are unassigned.
Source: 2025 Commercial Aviation Fleet & MRO Forecast, Fleet Discovery, Aviation Week Network, Copyright 2024.

Forecast In-Service Fleet – Aircraft Family



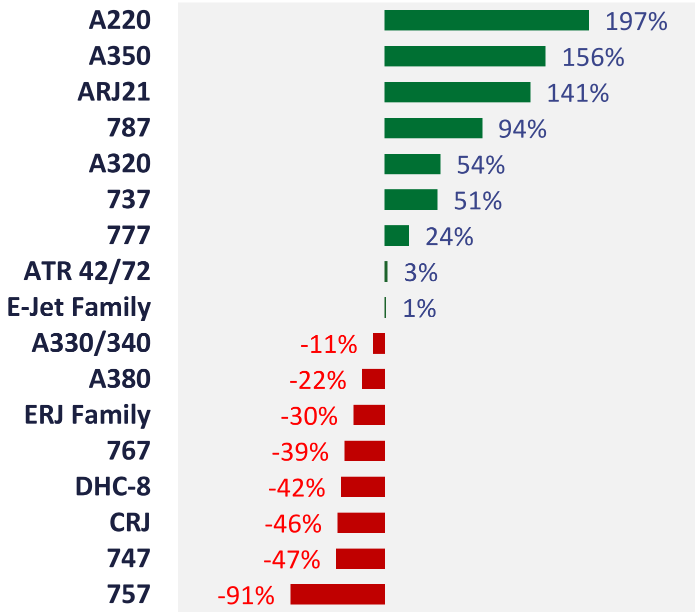
The narrowbody segment is expected to experience the highest growth over the forecast period, expanding by 52%, from 20,376 aircraft in 2025 to 30,957 by 2034. Despite being hit hardest by the recent pandemic years, the widebody fleet is also expected to see growth rising by 29%, growing from 6,207 aircraft at the beginning of the forecast to 8,037 by the end of the decade. The number of regional turbofan and turboprop aircraft in service is however anticipated to fall by 13% and 36%, respectively.

Narrowbodies increase their share of the global in-service fleet from 60% of aircraft in service in 2025 to 69% by 2034. Widebody aircraft see its share of 18% unchanged during the same period, while regional turbofans decline from 11% to 7% and turboprops from 11% to 5%.

The 2025-34 decade sees in-service numbers of the Airbus A220 and A350, Comac ARJ21 and Boeing 787 expand rapidly. The A220 fleet grows by 197% for the period – from 457 to 1,359 aircraft. The A350 by 156%, from 735 to 1,859; the RJ21 by 141%, from 191 to 460; and the 787 by 94%, from 1,258 to 2,446 aircraft. Despite their already dominant position within the commercial market, in-service numbers of the A320 and 737 will also increase significantly, by 54% and 51%, respectively.

New aircraft replace legacy types during the forecast. The 757 declines by 91%, down to only 42 aircraft in service by 2034. The 747 reduces by 47% to 191 aircraft, while the CRJ by 46% to 579 aircraft.

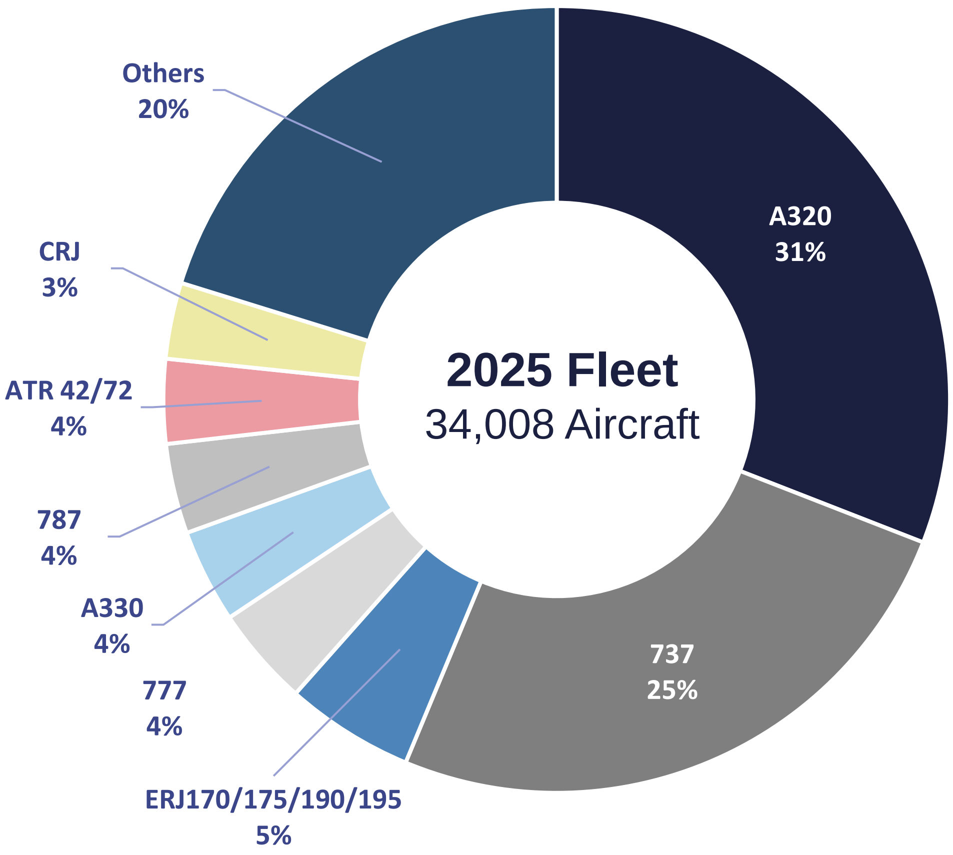
ISF % Change for Select Aircraft
(2034 vs. 2025)

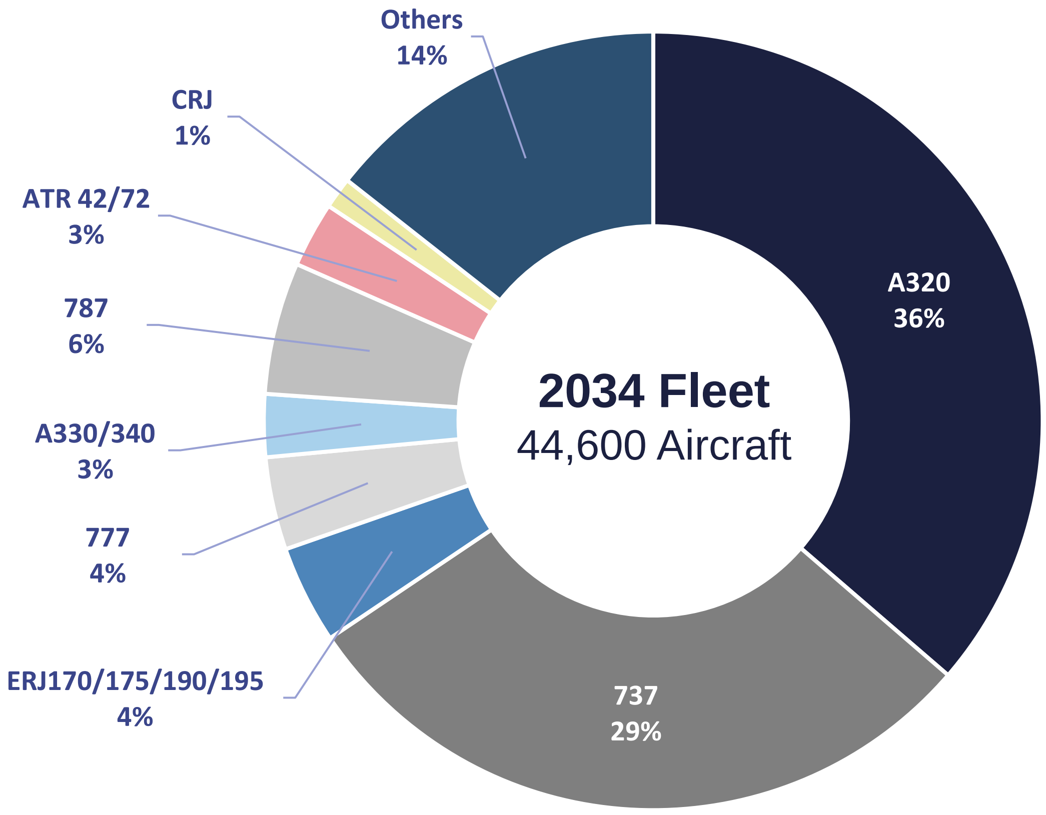


Source: 2025 Commercial Aviation Fleet & MRO Forecast, Fleet Discovery, Aviation Week Network, Copyright 2024.

In-Service Fleet Comparison - Aircraft Family

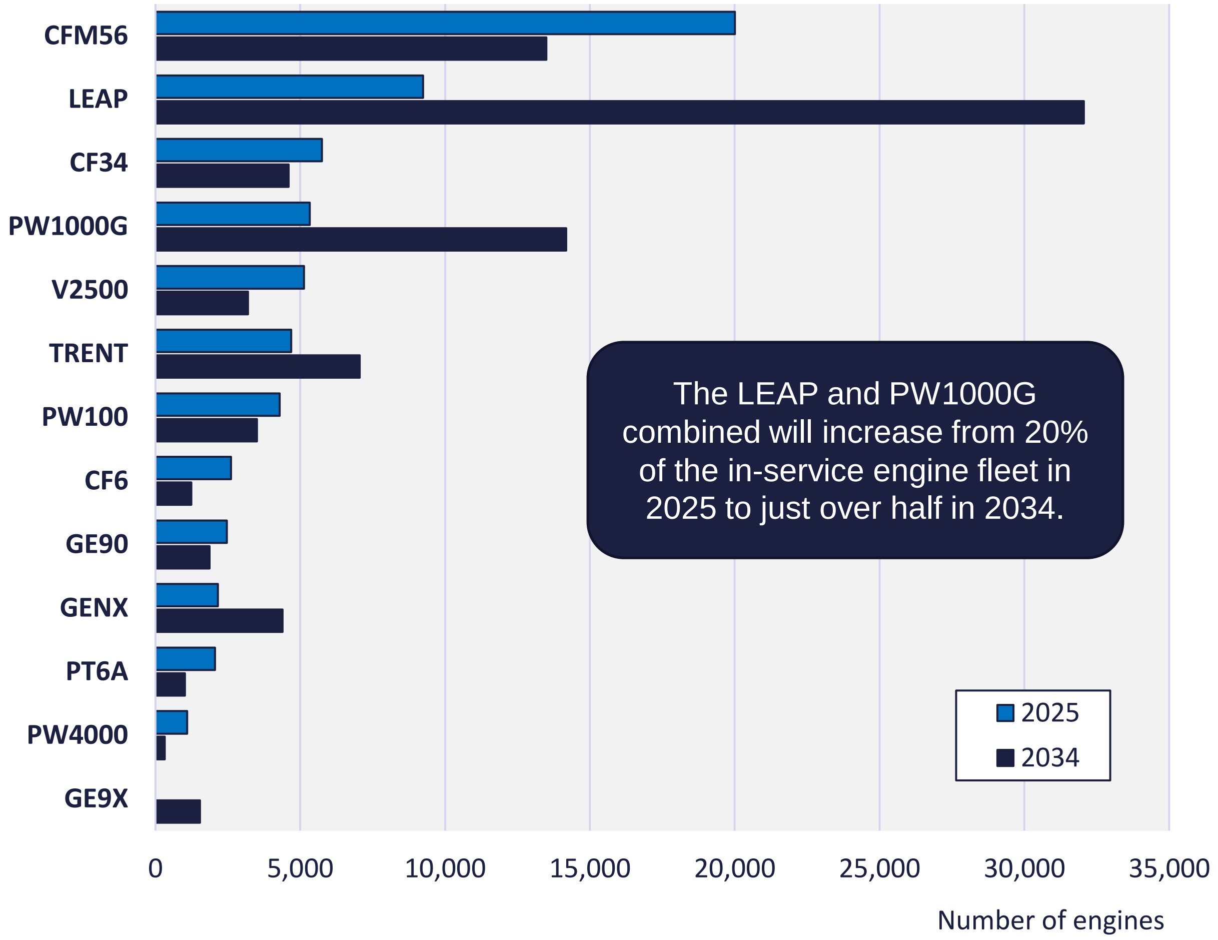
3.1%
Fleet CAGR





Source: 2025 Commercial Aviation Fleet & MRO Forecast, Fleet Discovery, Aviation Week Network, Copyright 2024.

In-Service Engines - Trends for Engines



Note: Selected engine families.
Source: 2025 Commercial Aviation Fleet & MRO Forecast, Aviation Week Network, Copyright 2024.

The number of commercial turbofan and turboprop engines in service globally is forecast to increase by 29%, from 69,465 in 2025 to 89,875 by 2034.

At present, the in-service fleet of engines is still dominated by the CFM56 family. As of 2025 a total of just over 20,000 of these engines are in service worldwide, representing almost a third of engines in service on commercial aircraft. While the number of these engines in service will gradually decline through the forecast period as narrowbody fleets transition to aircraft with new generation engines, less than 14,000 of CFM56s will remain in service in 2034, accounting for 15% of the in-service fleet at that time.

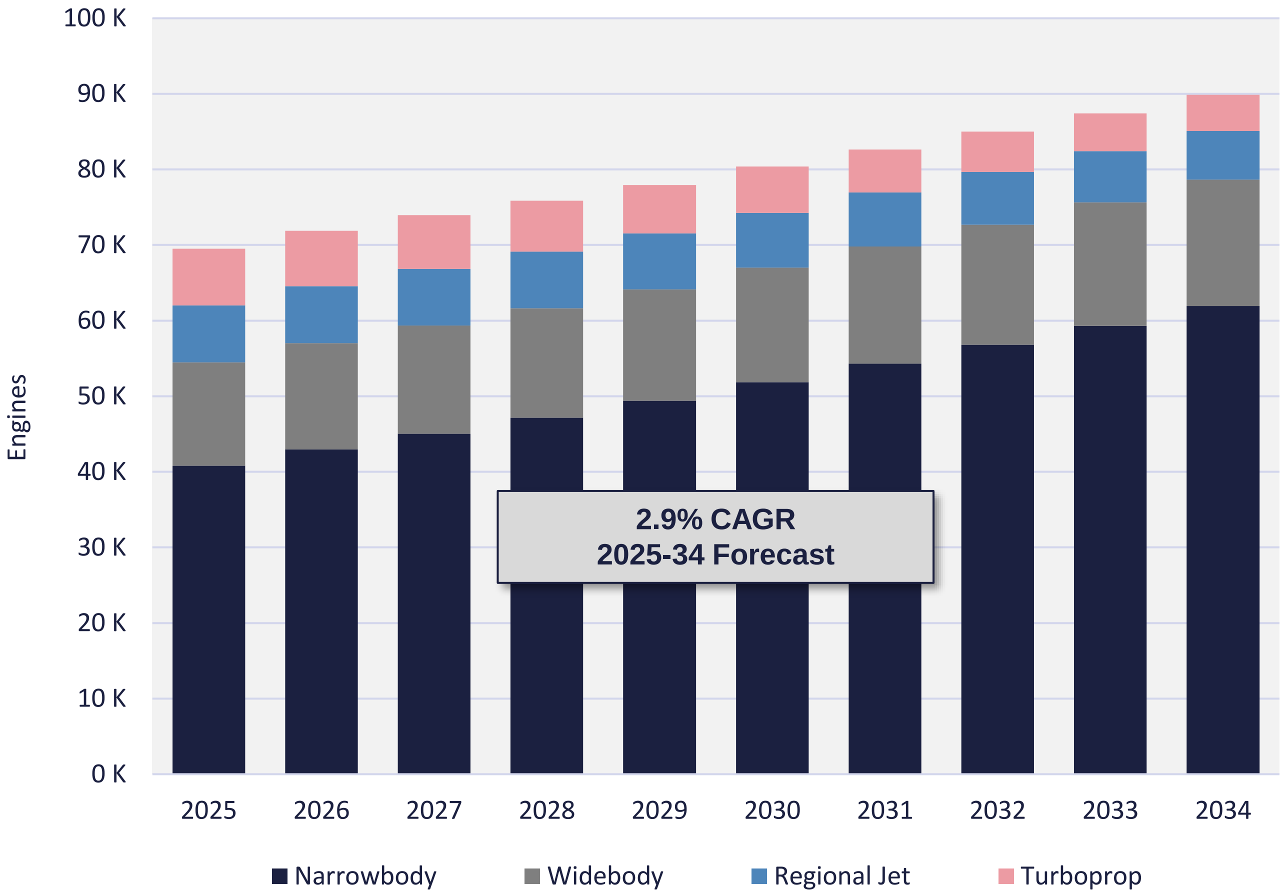
The main beneficiary of the gradual withdrawal of the CFM56 is the LEAP family of engines. The in-service number of the LEAP is projected to increase by nearly 250% over the forecast period, from 9,242 engines in 2025 to 32,060 in 2034. The PW1000G will similarly see numbers of in-service engines increase by 166%, the GENX by 104% and the TRENT family by 50%.

While mature engines such as the CFM56, CF34 and V2500 will continue to account for the majority of the in-service fleet of engines throughout the 2020s, new generation engines will progressively increase their market share over the period. Between 2025 and 2034, new generation engines such as the LEAP and PW1000G combined will increase from 20% of the in-service engine fleet to just over half, as commercial aircraft fleets are gradually recapitalised.

Simultaneously in-service numbers of RB211 engines are expected to fall by 88%, CF6-80s by 52%, V2500s by 38%, CFM56s by 33% and CF34s by 20% over the forecast period.

In-Service Engines - Trends for Engines

In-service fleet growth & trends by engine category



Highlights

- The engine fleet rises by 2.9% CAGR over 10 years.
- The predominant driver of growth, narrowbody engines, grow at 4.7% CAGR.
- Narrowbody engines comprise a 69% fleet share by 2034.
- LEAP surpasses CFM56 by 2029.

Engine Fleet increases from 69,495 in 2025 to 89,875 in 2034

LEAP-1B

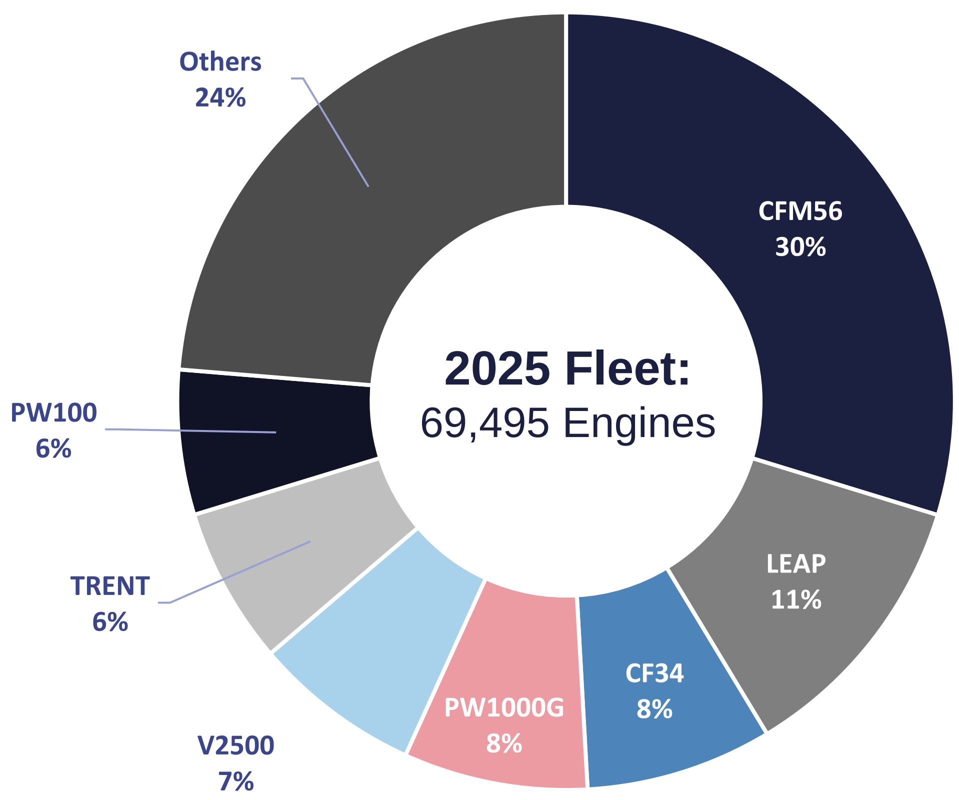
PW1100G

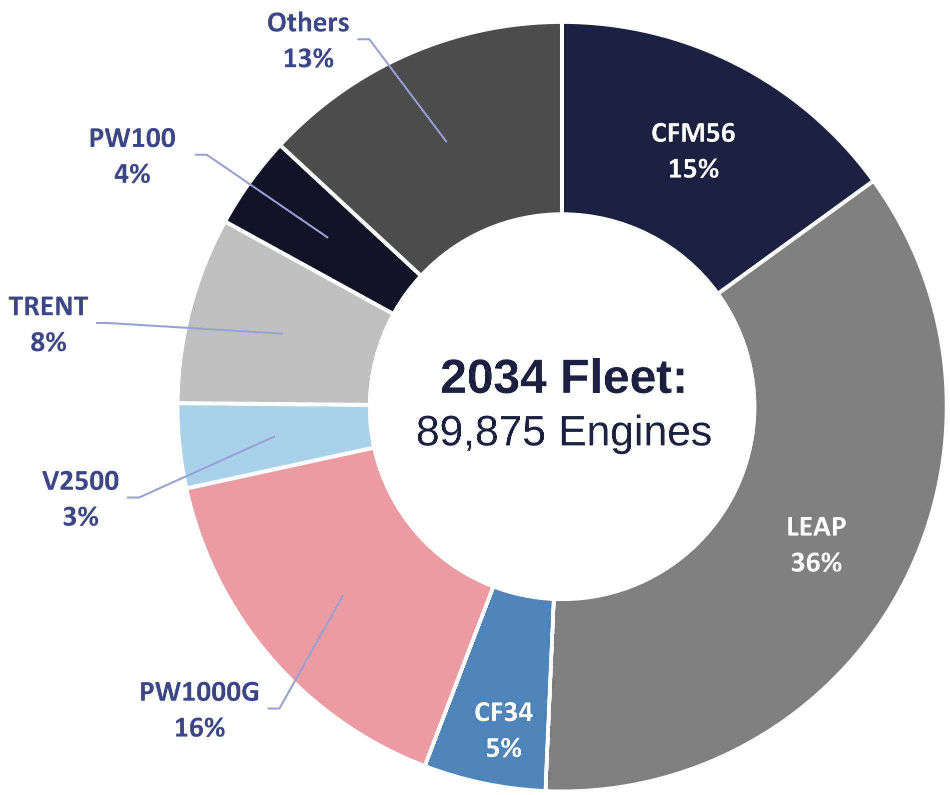
Source: 2025 Commercial Aviation Fleet & MRO Forecast, Aviation Week Network, Copyright 2024.

In-Service Engine Comparison by Engine Family

In-service fleet changes over time

2.9%
CAGR

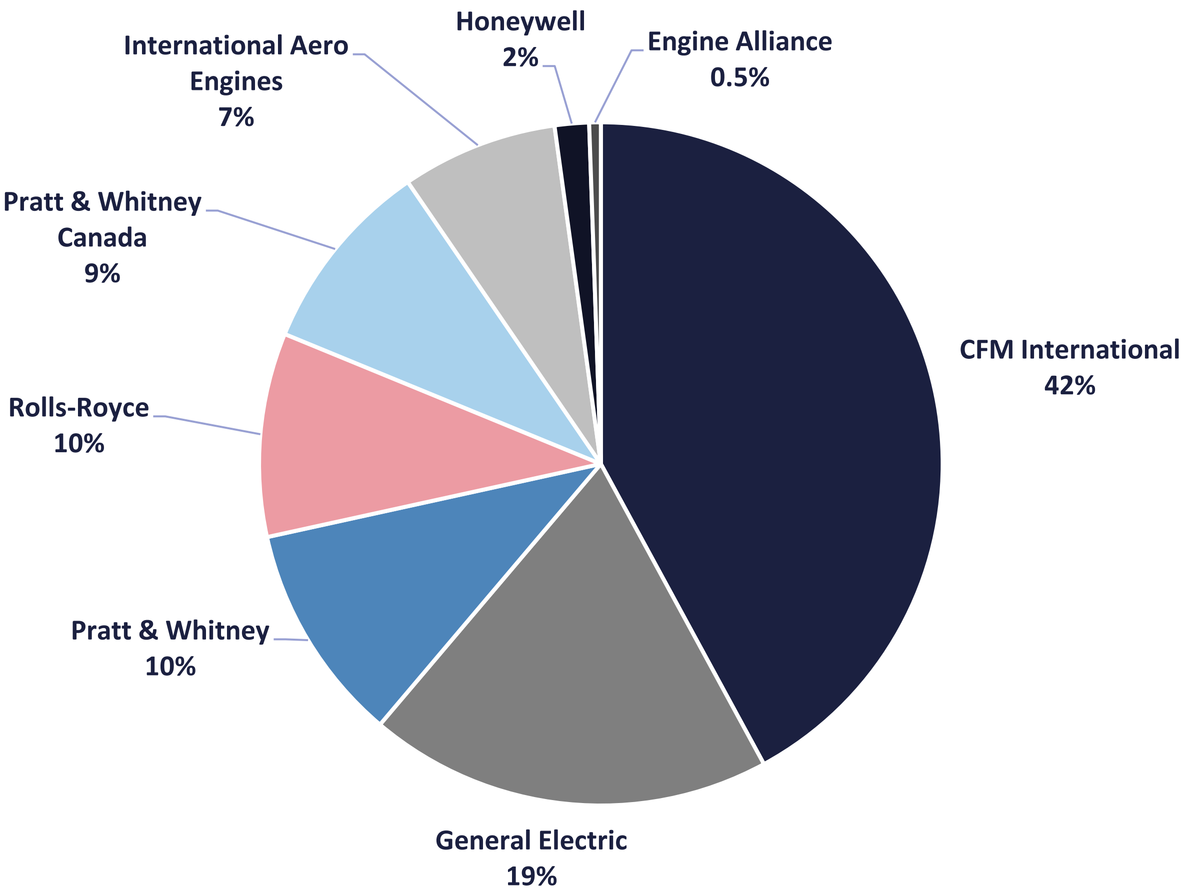




Source: 2025 Commercial Aviation Fleet & MRO Forecast, Fleet Discovery, Aviation Week Network, Copyright 2024.

Engine Share by Type Certificate Holder

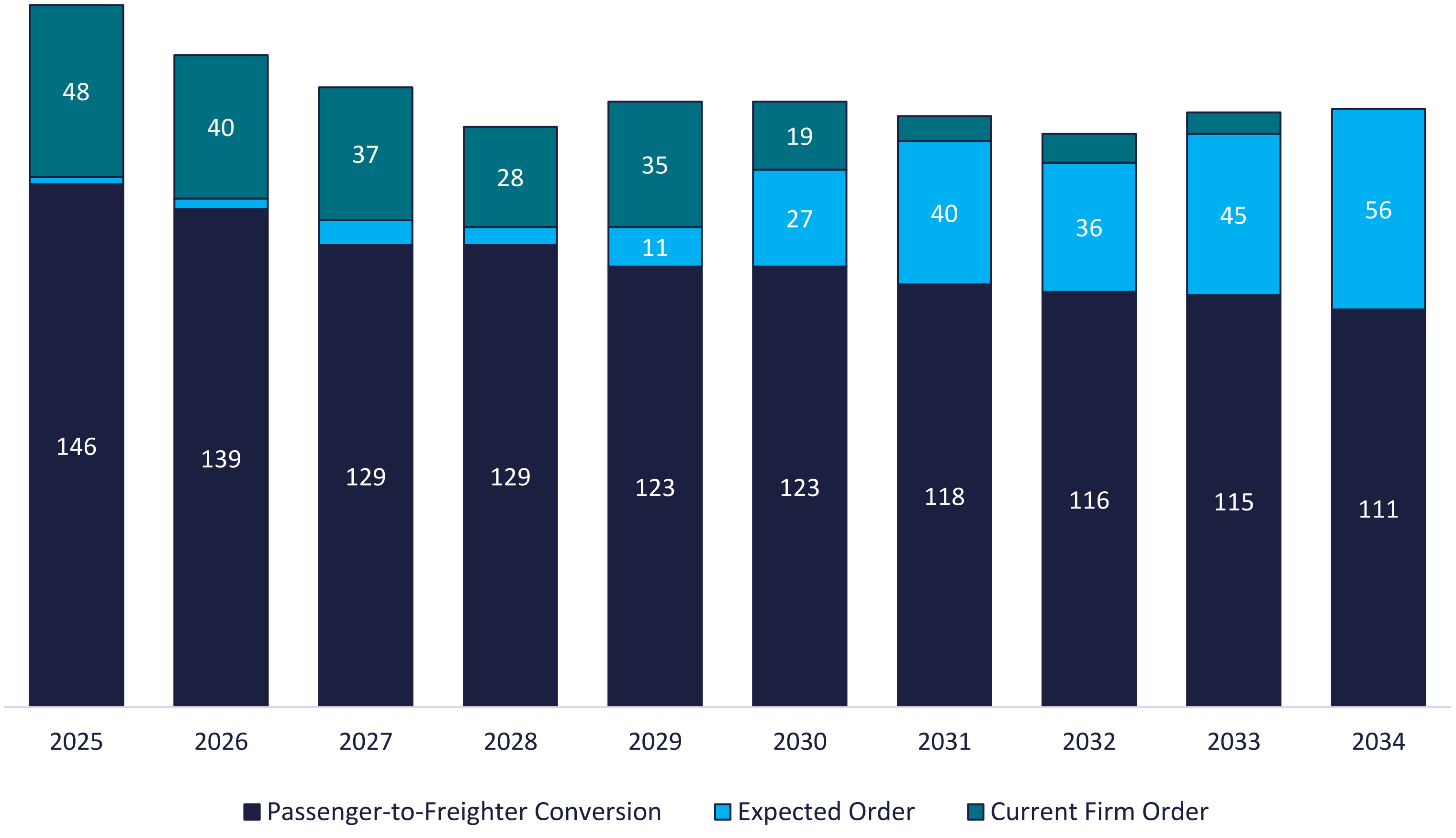
2034 Engines in service by manufacturer

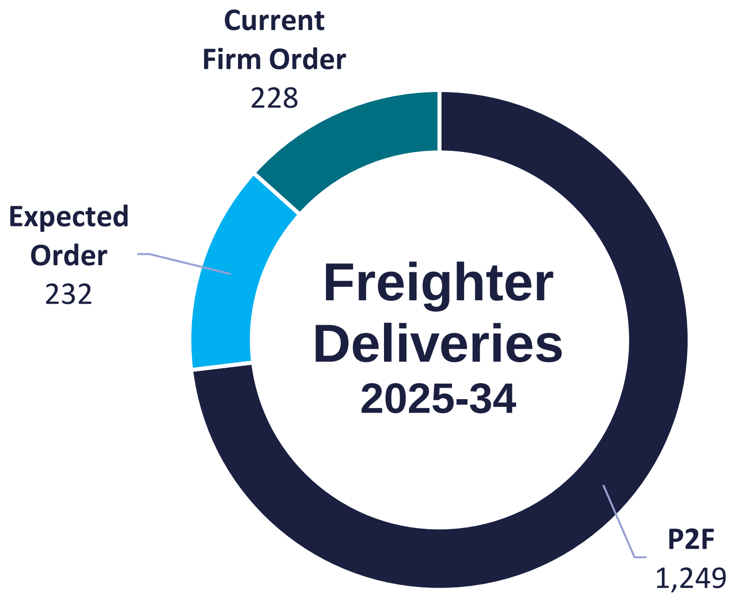


Source: 2025 Commercial Aviation Fleet & MRO Forecast, Fleet Discovery, Aviation Week Network, Copyright 2024.

Freighter Aircraft Delivery Forecast 2025-34

P2F conversions, expected orders and current firm orders



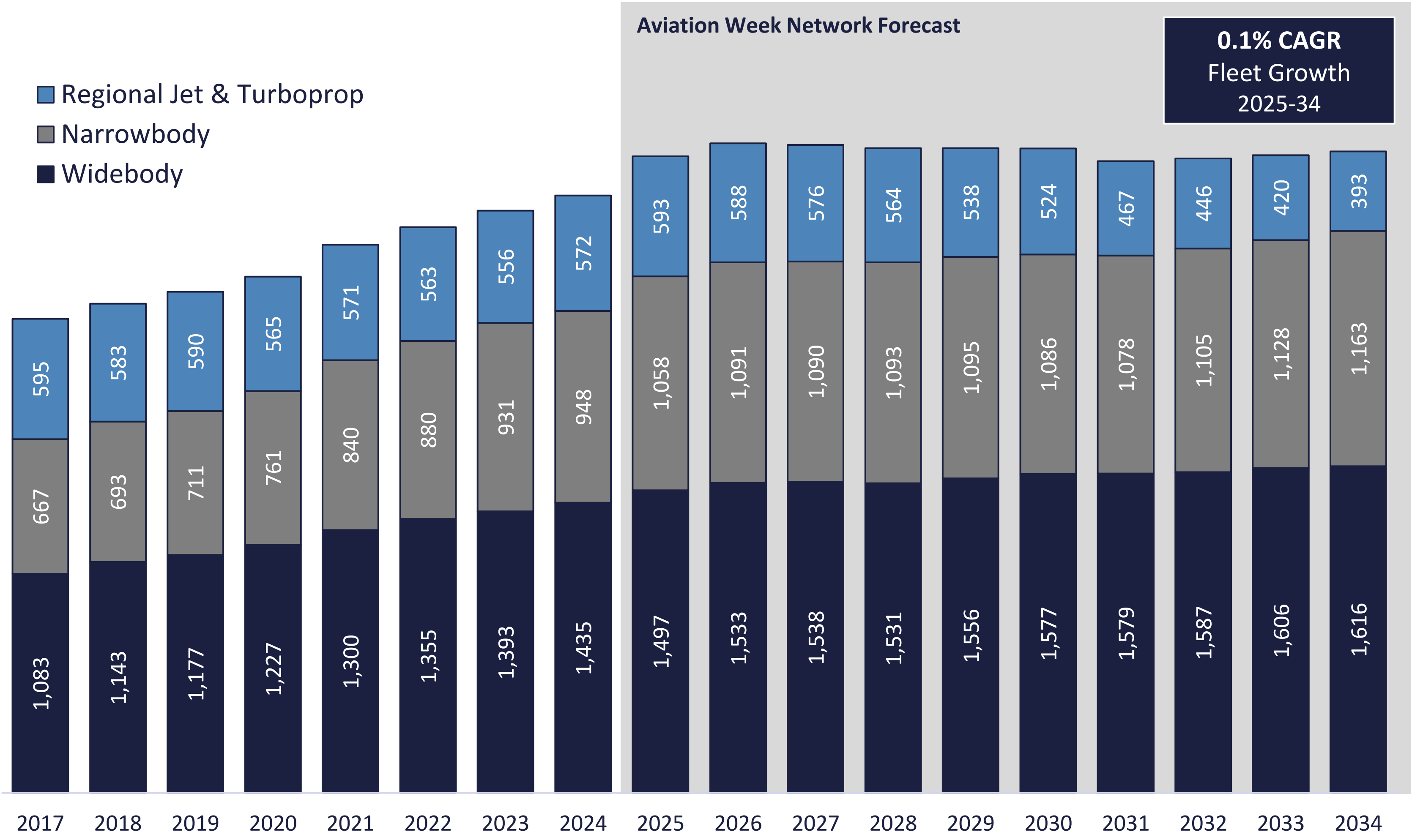


1,709
Dedicated freighter aircraft will be delivered during the 10-year period

45%
of conversions are for the **Boeing 737-800** over the 2025-34 period

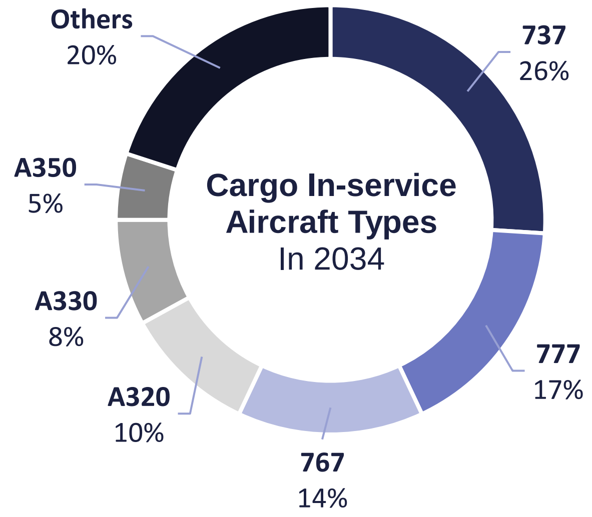
Source: 2025 Commercial Aviation Fleet & MRO Forecast, Fleet Discovery, Aviation Week Network, Copyright 2024.

Historical & Forecast Air Cargo In-Service Fleet



Cargo Fleet Change
(highest increase & decreases)
2034 vs. 2025

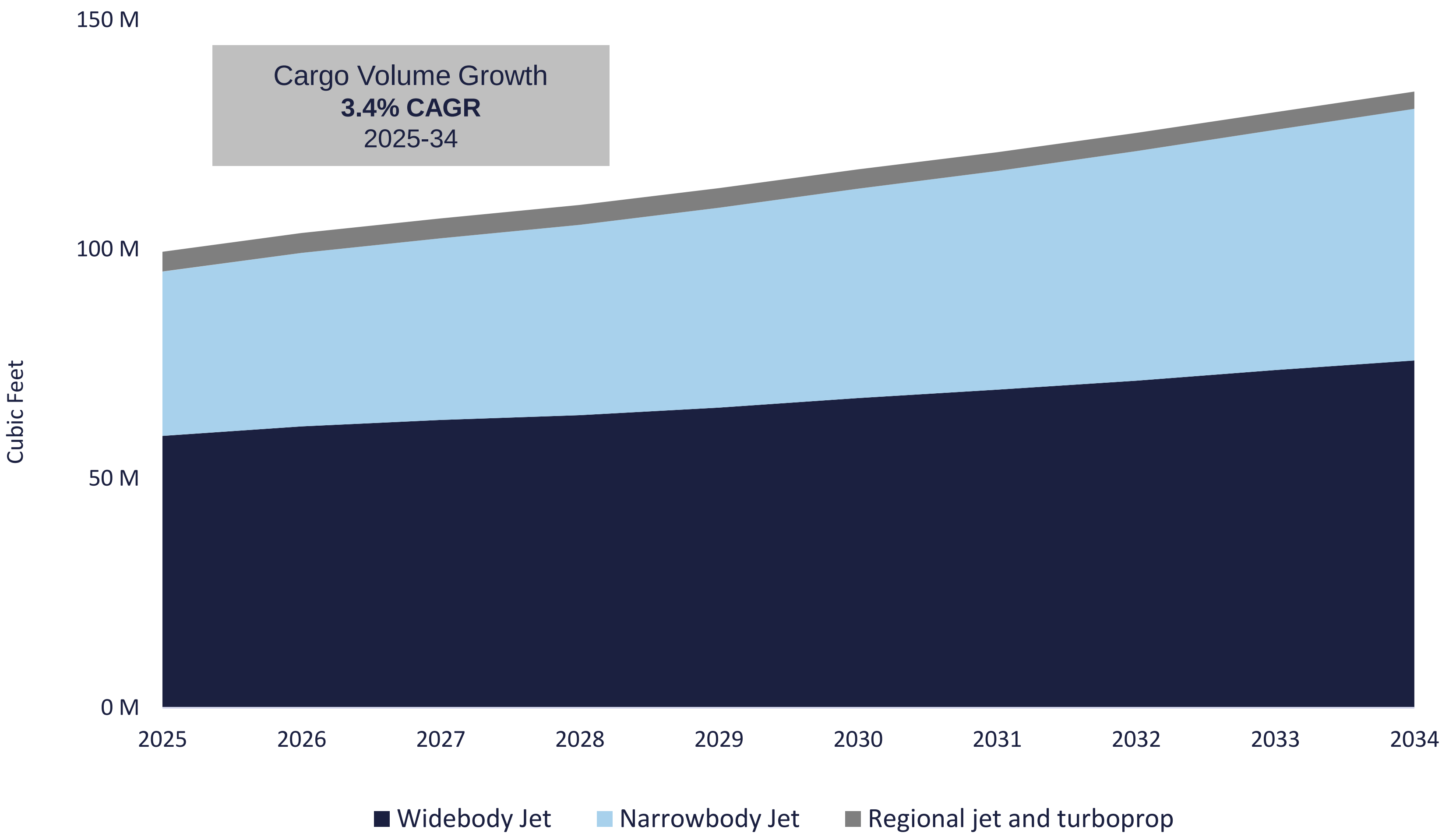
777	+225
737	+220
A320	+205
A350	+169
A330	+132
A300	-96
747	-148
757	-244

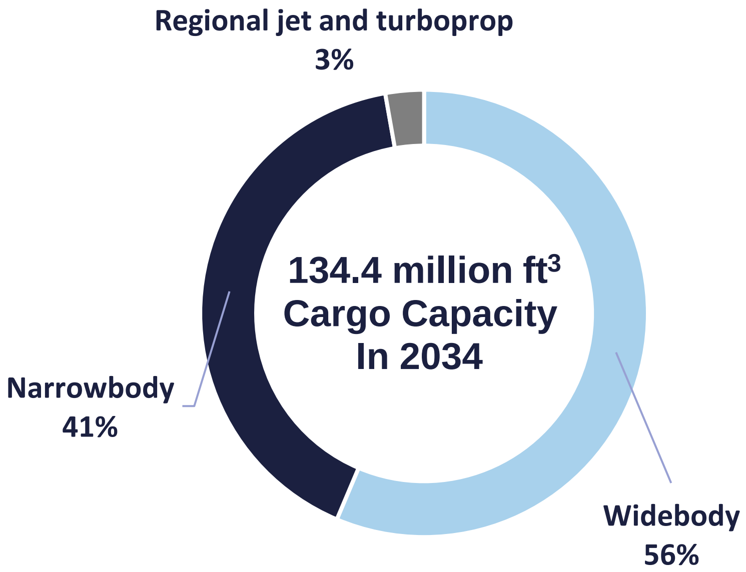


Source: 2025 Commercial Aviation Fleet & MRO Forecast, Fleet Discovery, Aviation Week Network, Copyright 2024.
Note: +19-seat certified capacity size aircraft (when in passenger configuration) and greater.

Air Cargo Capacity 2025-34

Global capacity growth for dedicated freighter aircraft and belly cargo combined





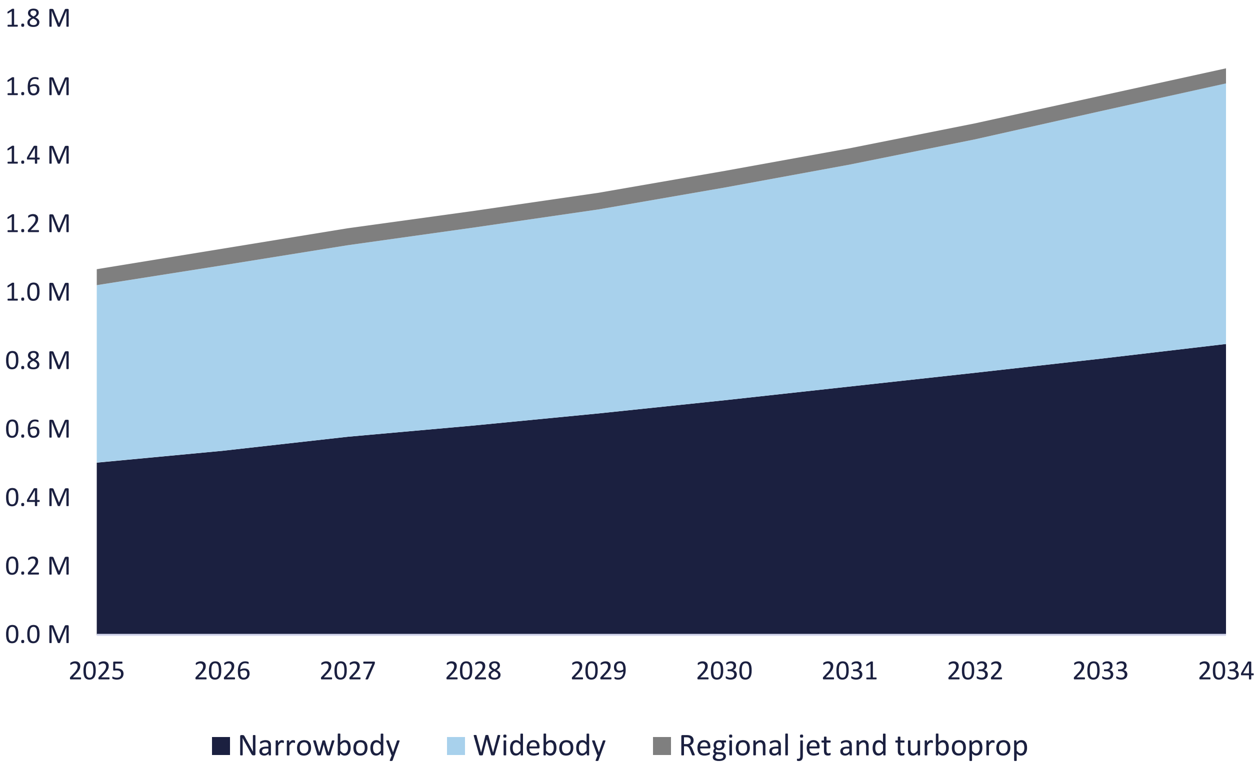
Source: 2025 Commercial Aviation Fleet & MRO Forecast, Aviation Week Network, Copyright 2024.

Emissions & Fuel Consumption

Total Market Results

Average Annual Flight Hours	Average Annual Flight Cycles	CO2 per Seat Growth Rate (CAGR)	Fuel Burn per Seat Hour Growth Rate (CAGR)	Fuel Burn/CO2 Growth Rate (CAGR)
3,100	1,301	-6.9%	-0.7%	5.0%

Total Emissions CO_2 (KG)



Source: EUROCONTROL; 2024 Commercial Fleet & MRO Forecast,, Aviation Week Network, Copyright 2023.

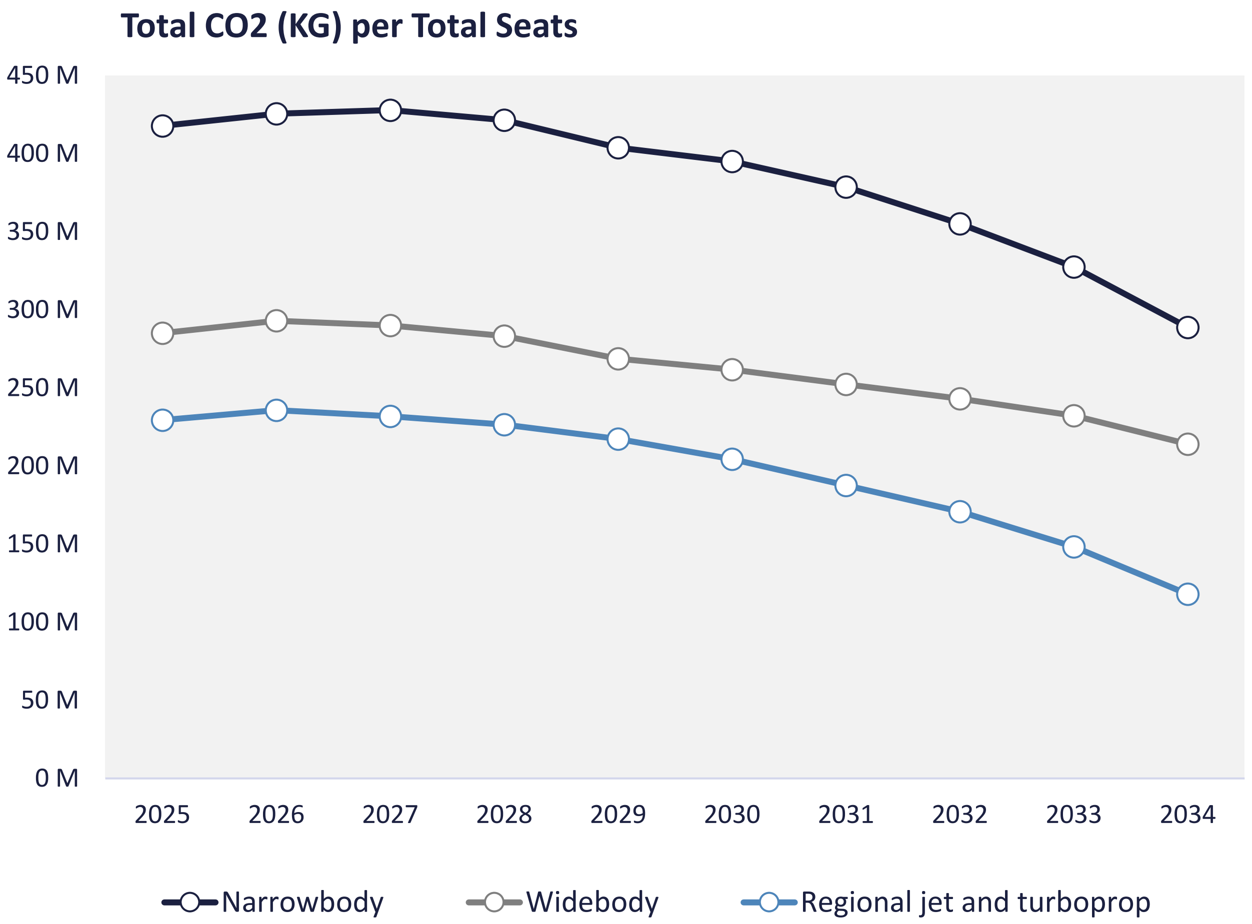
Based on current policy frameworks and technological evolution, total emissions from commercial aviation will continue to grow through the early 2030s. While there are efficiency improvements mainly through the use of new engines and more efficient widebody aircraft, these are superseded by the fast growth of the sector, exposing the industry to increased criticism and potentially more political action around its environmental performance.

The forecast predicts a 5.0% annual increase in total CO2 emissions, higher than the predicted fleet growth. While that may seem counterintuitive given that older aircraft are being replaced by new ones, there are concrete reasons for it: airlines continue to up-gauge their average aircraft size, and these larger aircraft burn more fuel per trip. Also, utilization is expected to increase. Despite the issues affecting mainly the Pratt & Whitney powered part of the narrowbody fleet, over time the aircraft delivered now are going to be used more than those they are replacing, partly as narrowbodies such as the A321XLR will be flying new long-haul routes with more passengers but too thin for widebodies.

The densification does have a positive effect on *per seat* CO2 emissions, which will decline by 6.9% annually. It is also shown in the predictions for seat availability: airlines will grow capacity as measured in seats by 4.9% annually, against a passenger fleet growth of 3.1%. The numbers also reflect Airbus' success in the narrowbody market, which Aviation Week Network expects to continue in the next 10 years. The Airbus A320 fleet will outnumber the Boeing 737 by more than 1,800 aircraft by 2025. And there are still substantial risks on the Boeing side, particularly for the certification timeline of the 737-7 and -10.

Emissions & Fuel Consumption

10-year trend analysis for forecast period



Highlights

- Annual fuel consumption and CO_2 grows 5.0% CAGR over 10-years.
- Seats grow 4.9% CAGR, 6.6 million commercial seats in 2034.
- Upgauging/seat densification drives per seat exposure lower.
- -0.7% CAGR fuel consumption per seat hour.
- -6.9% CAGR fuel & CO_2 decline per seat.
- Dedicated cargo aircraft, while seeing a 2.5% CO_2 CAGR rate, only experience a 1.5% CAGR increase in cubic volume.

Boeing 787-8

Credit: Brian Kough, Aviation Week Network

Source: EUROCONTROL; 2025 Commercial Aviation Fleet & MRO Forecast, Aviation Week Network, Copyright 2024.

MRO Market Outlook

State of MRO

Sean Broderick, Senior Air Transport Editor, Commercial Aviation, Aviation Week Network

Sean Broderick

Given the demand for lift, a bustling commercial aftermarket is hardly a surprise. Year-to-date passenger traffic was up 12% on a 10% increase in all-important available seat kilometers through August, International Air Transport Association show.

But the combination of solid macro trends that drive passenger and air freight demand and myriad struggles with current-generation aircraft has turned a bustling MRO environment into a venerable gold rush.

Boeing's narrowbody and widebody deliveries are well below levels forecasted coming out of the pandemic, due to a spate of quality control and supply chain issues. Airbus in mid-2024 acknowledged that supply-chain constraints, largely affecting engines, will lead to fewer than expected deliveries and a slower than planned A320-family production-rate ramp-up over the next few years.

Mix in groundings of 350 Pratt & Whitney PW1000G-powered A320neos, A220s, and Embraer E2s on any given day through the end of 2026 due to required life-limited parts inspections, and the current generation of aircraft is leaving a lot of capacity unfilled.

For MRO providers, this translates into full shops and high demand for spare parts.

But such opportunities do not come without challenges.

In many cases, material suppliers are scrambling to keep up with parts demand. As manufacturers work to increase production to eat into massive backlogs, parts manufacturers face pressure to feed both production lines and overhaul shops. Pratt & Whitney acknowledged a brief slowdown in V2500 parts production in early 2024 as it prioritized meeting unexpected demand for PW1000G geared turbofan spares for hundreds of engines undergoing earlier than expected shop visits.

Delaying airframe and engine retirements helps MRO providers stay busy, but it also robs them of much-needed used serviceable material (USM) harvested from out-of-service aircraft. Retirements are projected to pick up in 2025, but getting material from part-out to market can take 12-18 months, so USM stocks will not be replenished anytime soon.

Credit: Brian Kough, Aviation Week Network

With USM scarce and manufacturers not shy about raising spare parts prices, market conditions are as favorable as ever for parts manufacturer approval (PMA) producers. While lessors still chafe at having non-OEM parts on their equipment, more operators are negotiating favorable deals that open the door for PMA parts.

More hot-section PMA parts for the most popular engine types such as the CFM56 are in development. With more older aircraft staying in service longer, the market for cost-effective alternatives, from simple aircraft interior pieces to parts that go deep inside engines, is only expanding.

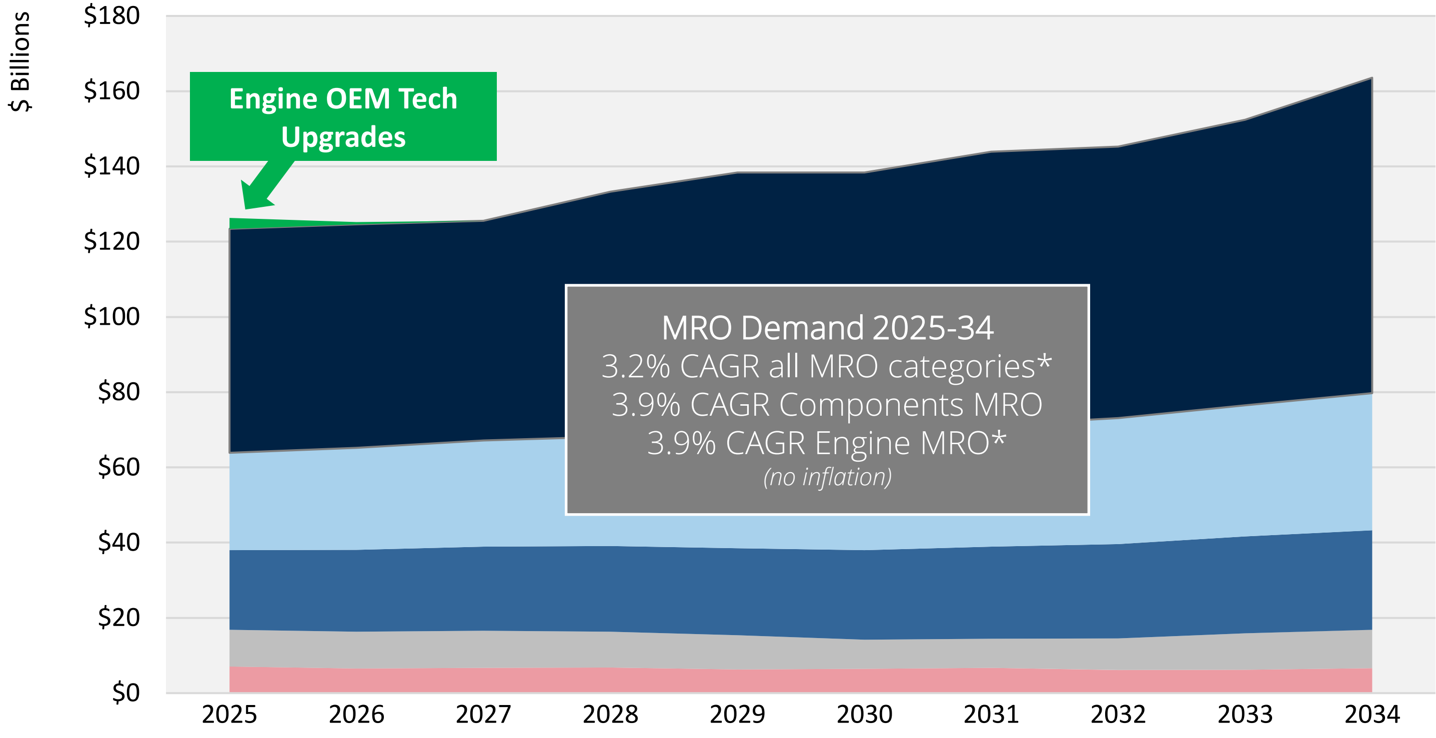
Like the rest of the industry, the aftermarket's largest constraint is labor. Certified mechanics remain in short supply, but the constraints go far beyond shop floors. A shortage of skilled labor in the supply chain is part of the reason key parts are harder to find; the special processes involved in manufacturing many parts require specialized training and skills that take time to master. The same issues have slowed repair work.

Many companies have replaced workers lost or shed during the downturn – at least on paper. But the newcomers aren't always as skilled or productive as their predecessors. Only time will ease such constraints.

Engine Components, US MRO

MRO Demand Forecast & Trends

Forecast MRO Demand Trends

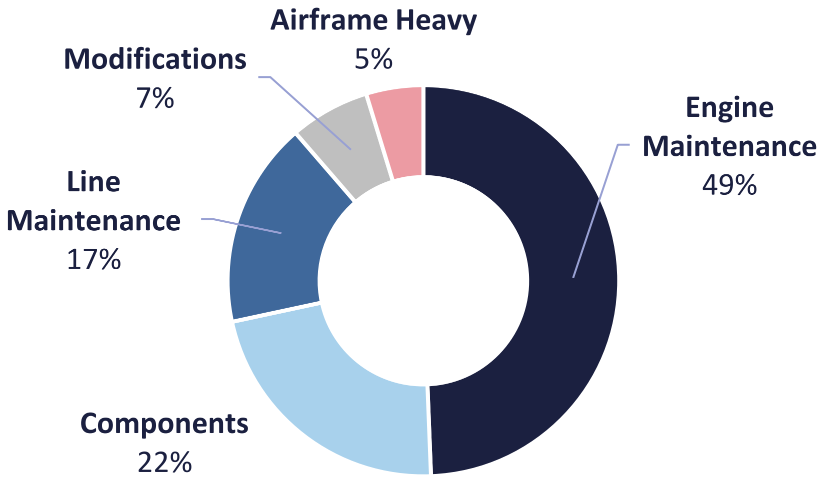


	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
OEM Tech Upgrade	$2.9	$0.6								
Engine Maintenance	$59.5	$59.4	$58.4	$65.1	$69.7	$69.2	$72.7	$72.2	$75.9	$83.9
Components	$25.9	$27.1	$28.3	$29.1	$30.2	$31.2	$32.4	$33.5	$34.9	$36.4
Line Maintenance	$21.1	$21.8	$22.3	$22.7	$23.2	$23.8	$24.4	$25.0	$25.7	$26.4
Modifications	$9.8	$9.8	$9.9	$9.6	$9.0	$7.7	$7.7	$8.4	$9.7	$10.3
Airframe Heavy	$7.1	$6.5	$6.7	$6.8	$6.3	$6.5	$6.8	$6.2	$6.2	$6.6

Highlights

- $1,388 billion* over the 10-year forecast period.
- Over 150,000 engine shop visits worth $685.8 billion.
- $309.0 billion in components demand.
- $236.5 billion in line maintenance.
- $91.8 billion in modifications demand.
- Over 118,000 heavy airframe checks (C and D checks).

MRO Demand 2025-34
$1.4 Trillion



Source: 2025 Commercial Aviation Fleet & MRO Forecast, Fleet Discovery, Aviation Week Network, Copyright 2024.
Note: *2025/2026 engine technical upgrades/warranty repairs shown on chart only, not included in analysis nor CAGR figures.

Unscheduled Engine Repairs

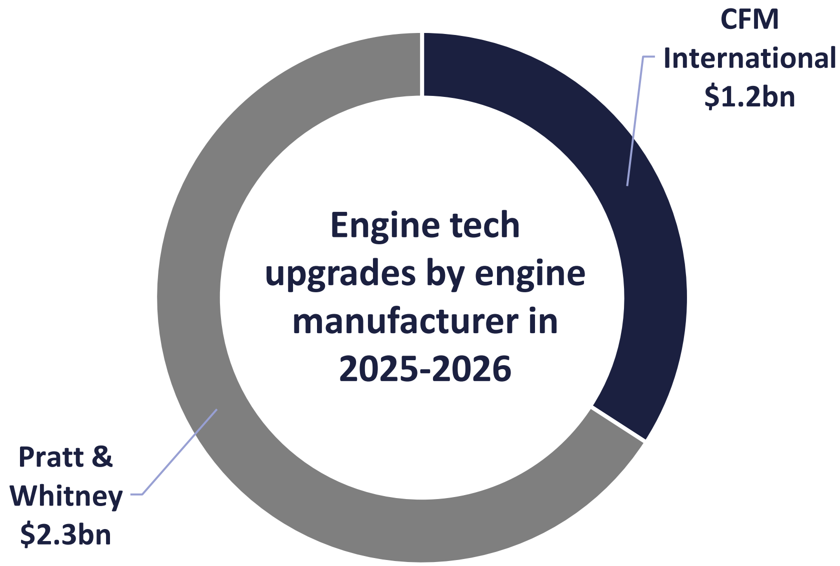
Engine OEM Tech Upgrades
See slide #64 Methodology For details

$3.5 billion MRO aftermarket impacts for Pratt & Whitney GTF & CFM LEAP

Issues

- GTF – Combustion/heat exchanger
- GTF – HPT #1 and #2, HPC (2015-21 year of manufacture)
- LEAP – Fuel nozzles, Reverse Bleed System

$3.5 billion
Aftermarket impacts
for Pratt & Whitney and CFM



Aircraft/Engine for Retrofits/Fixes 2025-2026

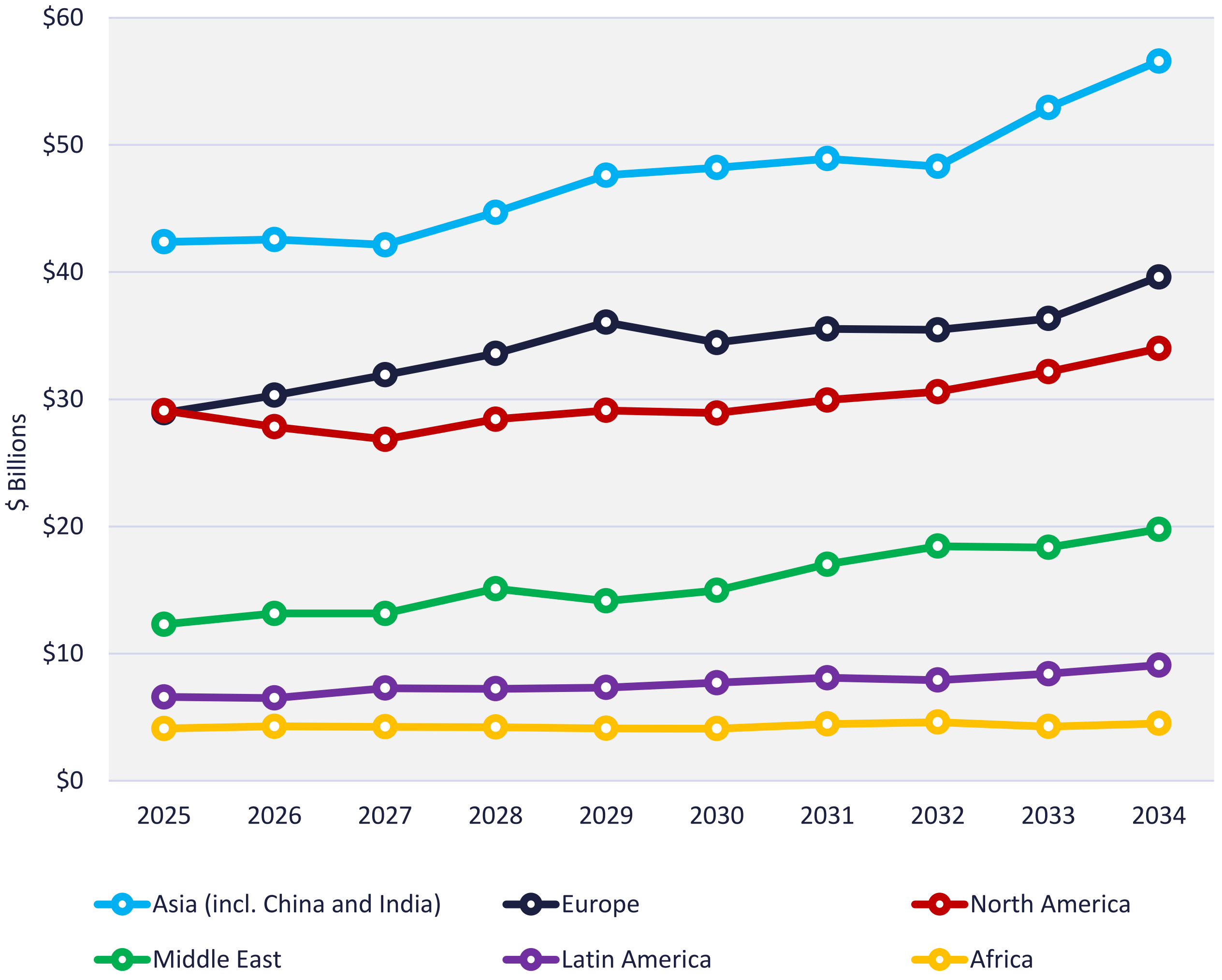
Commercial Aircraft	Engine Family	Engine Model
737 Max 8/9	LEAP	LEAP-1B
A220-100/300	PW1000G	PW1500G
A319/320/321neo	LEAP	LEAP-1A
	PW1000G	PW1100G-JM
C919	LEAP	LEAP-1C
E190/E195-E2	PW1000G	PW1900G

Credit: Nigel Howarth, Aviation Week Network

Credit: Brian Kough, Aviation Week Network

Source: 2025 Commercial Aviation Fleet & MRO Forecast, Fleet Discovery, Aviation Week Network, Copyright 2024.

MRO Demand – Region



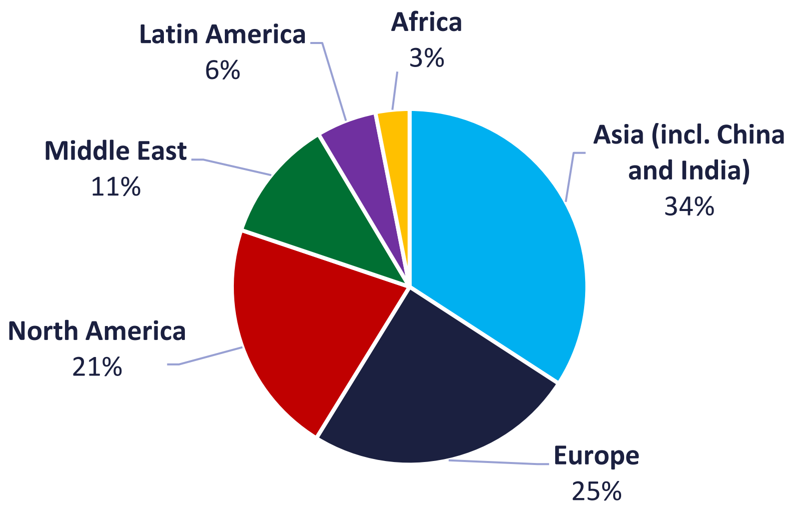
Source: 2025 Commercial Aviation Fleet & MRO Forecast, Fleet Discovery, Aviation Week Network, Copyright 2024.
Note: 2025/2026 new generation engine technical upgrade events not included.

All of the world's regions see MRO demand growth throughout the decade. The growth is driven primarily by increasing fleet strengths, higher utilization projections, and fleet compositions.

In some geographies, this trend is driven by aircraft composition and routes. As aircraft utilization picks up due to more international flying and use of widebodies, it's a double impact - more usage with more expensive aircraft – particularly in Asia and the Middle East.

The expansion of commercial aircraft fleets in each of the regions forms the foundation of the growth trend. The fastest rate of growth in MRO demand is expected in the Middle East, with a 5.4% CAGR over the decade, much of which is driven by new aircraft entering the market.

The overall Asian region is expected to generate the most MRO demand over the forecast period, at a total of $475 billion. Demand in Asia is expected to increase from $42.4 billion in 2025 to $56.6 billion by 2034, an increase of 34% over the forecast period. Europe alone is expected to generate $342 billion between 2025 and 2034 – its growth is influenced by fleet growth and also the composition of a bit older aircraft. The North America market, still in the midst of a massive fleet recapitalization, will see demand shrink slightly in the early years with newer aircraft lessening demand, but will then increase to near tracking European levels closely.



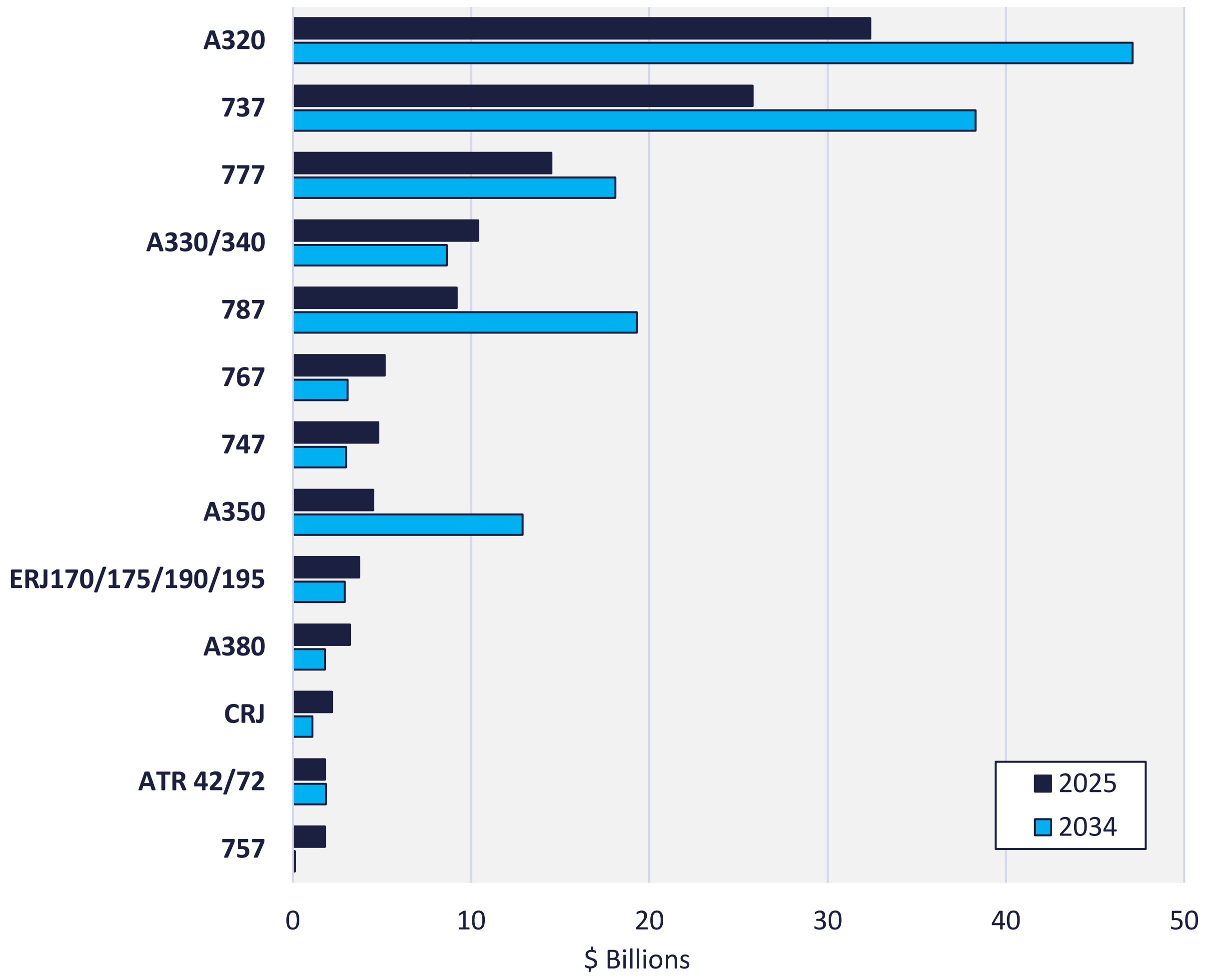
Forecast Regional MRO Demand, +$1.3 Trillion

Region	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2025 % Share	2034 % Share	% Change	CAGR
North America	$29.1	$27.8	$26.8	$28.4	$29.1	$28.9	$29.9	$30.6	$32.2	$34.0	24%	21%	17%	1.7%
Western Europe	$24.3	$25.0	$26.7	$28.0	$30.3	$29.1	$30.0	$29.4	$30.8	$33.8	20%	21%	39%	3.7%
Asia Pacific	$22.9	$22.3	$22.0	$22.9	$23.5	$23.7	$23.9	$24.1	$26.8	$28.2	19%	17%	23%	2.4%
China	$16.0	$16.7	$16.8	$17.9	$18.1	$18.1	$18.1	$17.6	$18.1	$19.6	13%	12%	22%	2.3%
Middle East	$12.3	$13.2	$13.2	$15.1	$14.1	$15.0	$17.0	$18.4	$18.3	$19.8	10%	12%	61%	5.4%
Latin America	$6.6	$6.5	$7.3	$7.2	$7.3	$7.7	$8.1	$7.9	$8.4	$9.1	5%	6%	38%	3.7%
India	$3.5	$3.5	$3.3	$3.9	$6.0	$6.4	$7.0	$6.6	$8.0	$8.8	3%	5%	152%	10.8%
Eastern Europe	$4.6	$5.3	$5.2	$5.6	$5.7	$5.4	$5.6	$6.0	$5.6	$5.9	4%	4%	26%	2.6%
Africa	$4.1	$4.3	$4.2	$4.2	$4.1	$4.1	$4.5	$4.6	$4.3	$4.5	3%	3%	10%	1.0%
TOTAL	$123.4	$124.6	$125.6	$133.3	$138.4	$138.4	$144.0	$145.3	$152.4	$163.6			33%	3.2%

Credit: Nigel Howarth, Aviation Week Network

Source: 2025 Commercial Aviation Fleet & MRO Forecast, Fleet Discovery, Aviation Week Network, Copyright 2024.
Note: 2025/2026 new generation engine technical upgrade events not included.

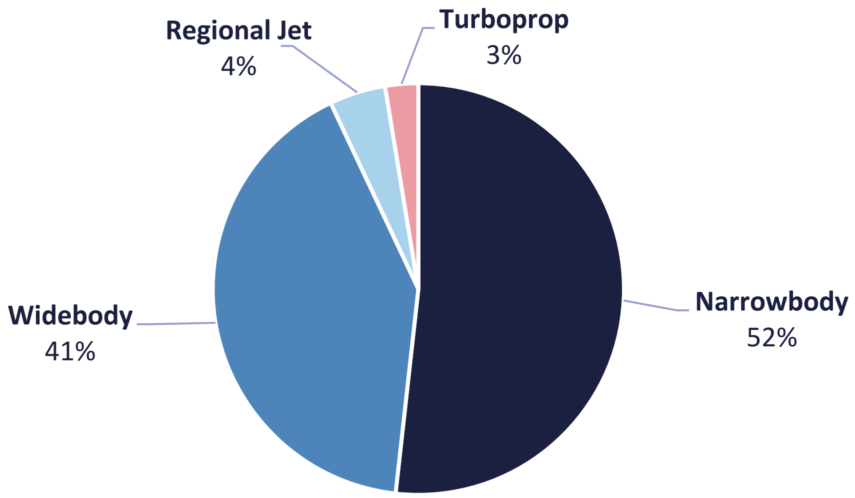
MRO Demand Change – Aircraft Family



While narrowbody aircraft dominate the global fleet in the future, the higher costs associated with larger widebody aircraft will ensure that MRO demand is split almost equally between the two. Between 2025 and 2034, narrowbodies account for 52% of demand, widebodies 41%, regional jets 4% and turboprops 3%.

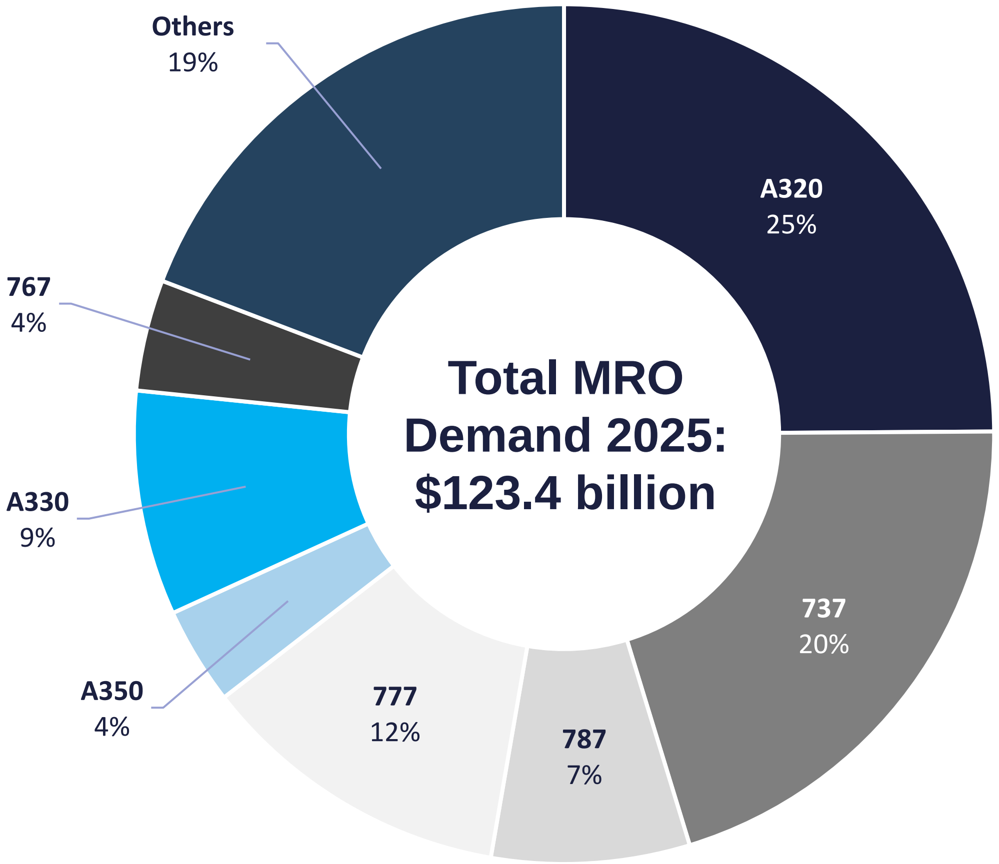
The two biggest programs by some distance will be the Airbus A320 and the Boeing 737. The A320 family alone is expected to generate $390 billion in demand, equivalent to 28% of all MRO activity over the decade. Boeing's 737 family is expected to generate $304 billion, representing a further 22% of the total.

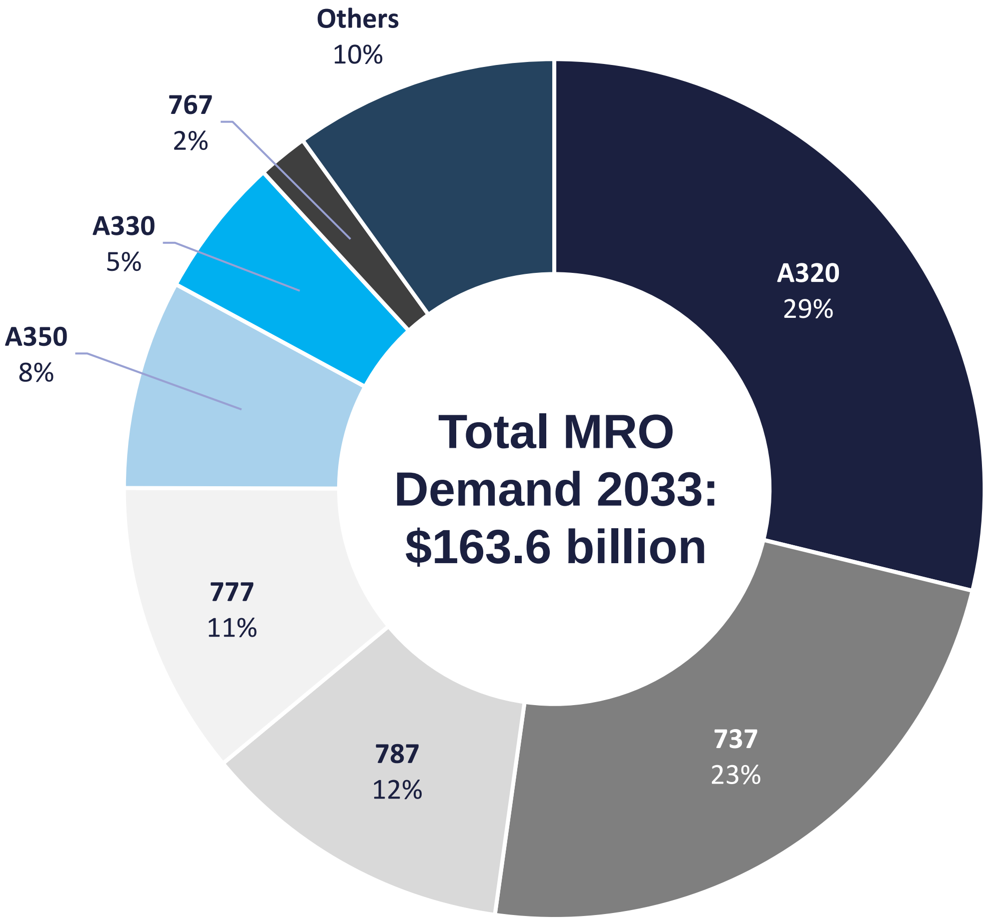
The fastest growing widebody aircraft families are the Airbus A350 and the Boeing 787, which are expected to see combined demand growth from $13.7 billion in 2025 to $32.1 billion by 2034. Increased demand from these families will offset the decline of other widebody types, such as the Boeing 747 and 767.



Source: 2025 Commercial Aviation Fleet & MRO Forecast, Fleet Discovery, Aviation Week Network, Copyright 2024.
Note: 2025/2026 new generation engine technical upgrade events not included.

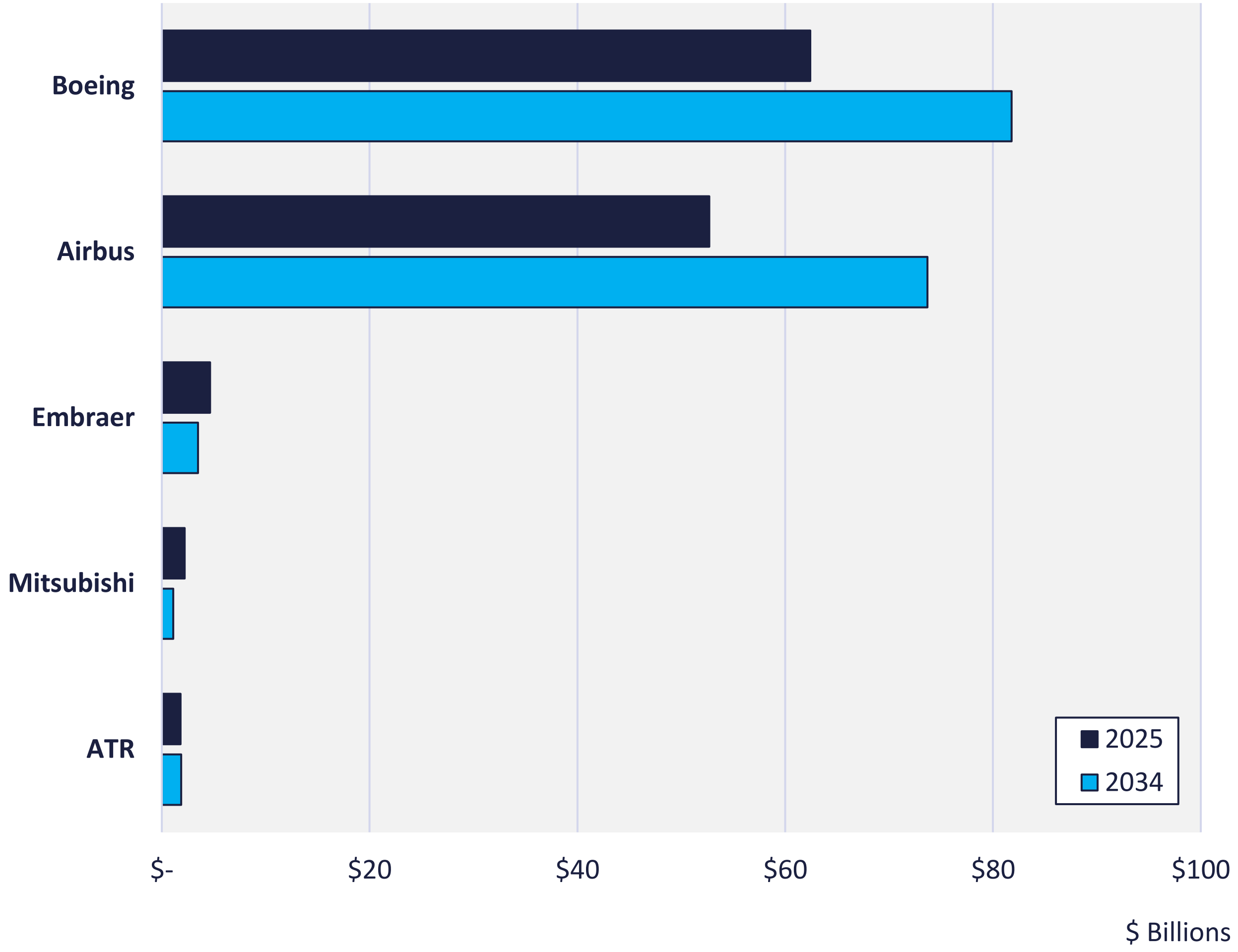
MRO Demand Change – Aircraft Family Share Trends





Source: 2025 Commercial Aviation Fleet & MRO Forecast, Fleet Discovery, Aviation Week Network, Copyright 2024.
Note: 2025/2026 new generation engine technical upgrade events not included.

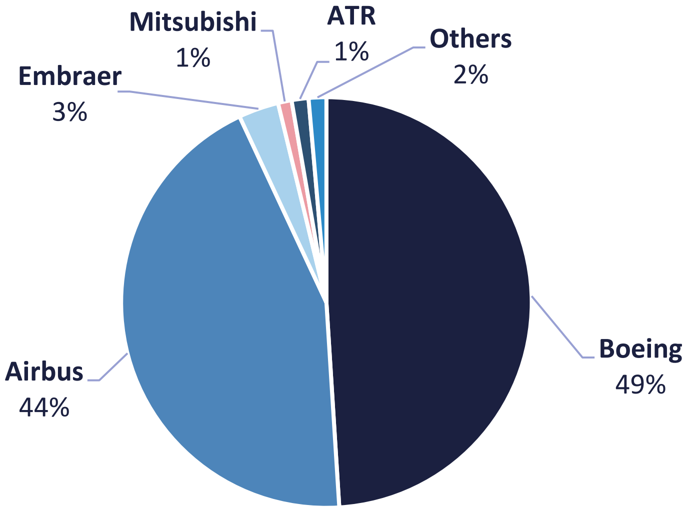
MRO Demand Change – Aircraft Type Certificate Holder



Boeing aircraft overall account for the largest share of MRO demand during the forecast period at 49% or a value exceeding $680 billion. Airbus follows with a share of 44% and a value of $612 billion. In 2034 alone, MRO demand for Boeing aircraft will surpass $81.8 billion, with Airbus accounting for $73.7 billion that year in 2024 US dollars.

The Airbus A320 family accounts for the largest percentage of MRO capture by unique airframe family, accounting for over 28% of the total MRO demand. The popular A321 amongst that family in particular will experience 10.2% MRO demand CAGR.

Boeing's 737 (21.9%) and 777 (11.1%) families rank 2nd and 3rd overall. The 737 will drive $304 billion growing at 4.5% CAGR.

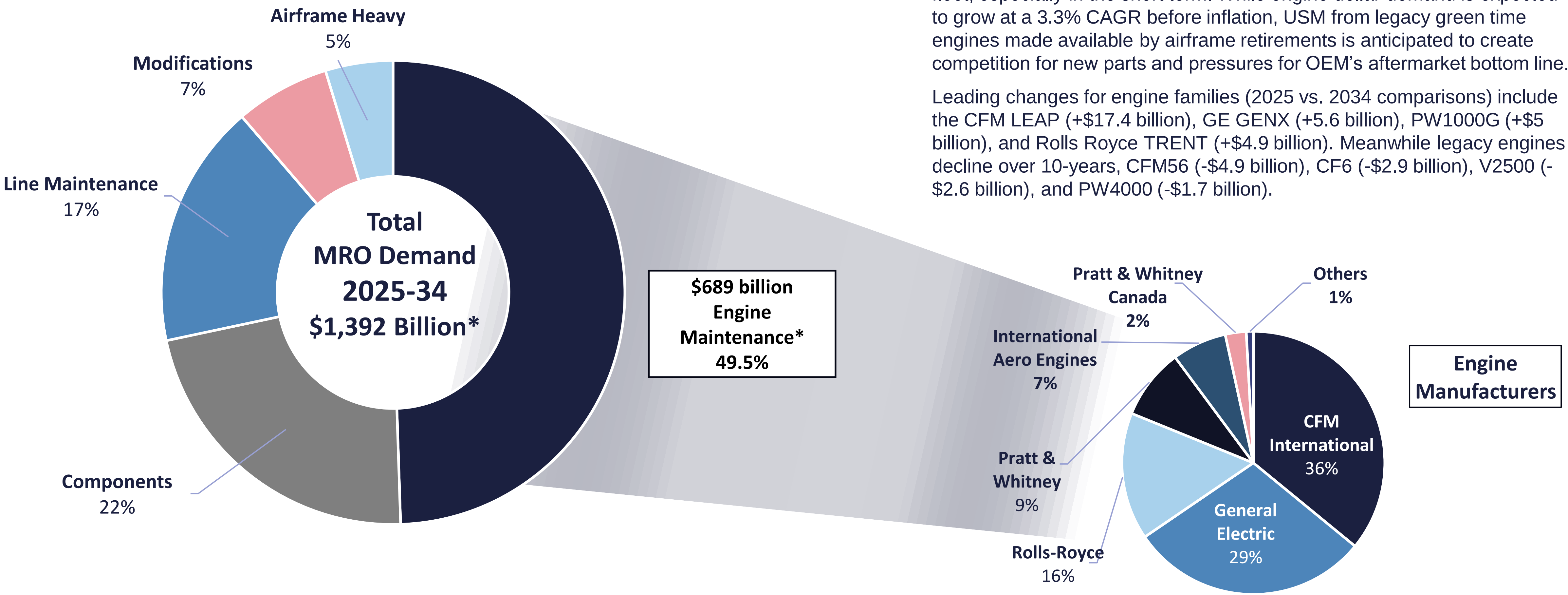


Source: 2025 Commercial Aviation Fleet & MRO Forecast, Fleet Discovery, Aviation Week Network, Copyright 2024.
Note: 2025/2026 new generation engine technical upgrade events not included.

MRO $ Demand Share – Engines

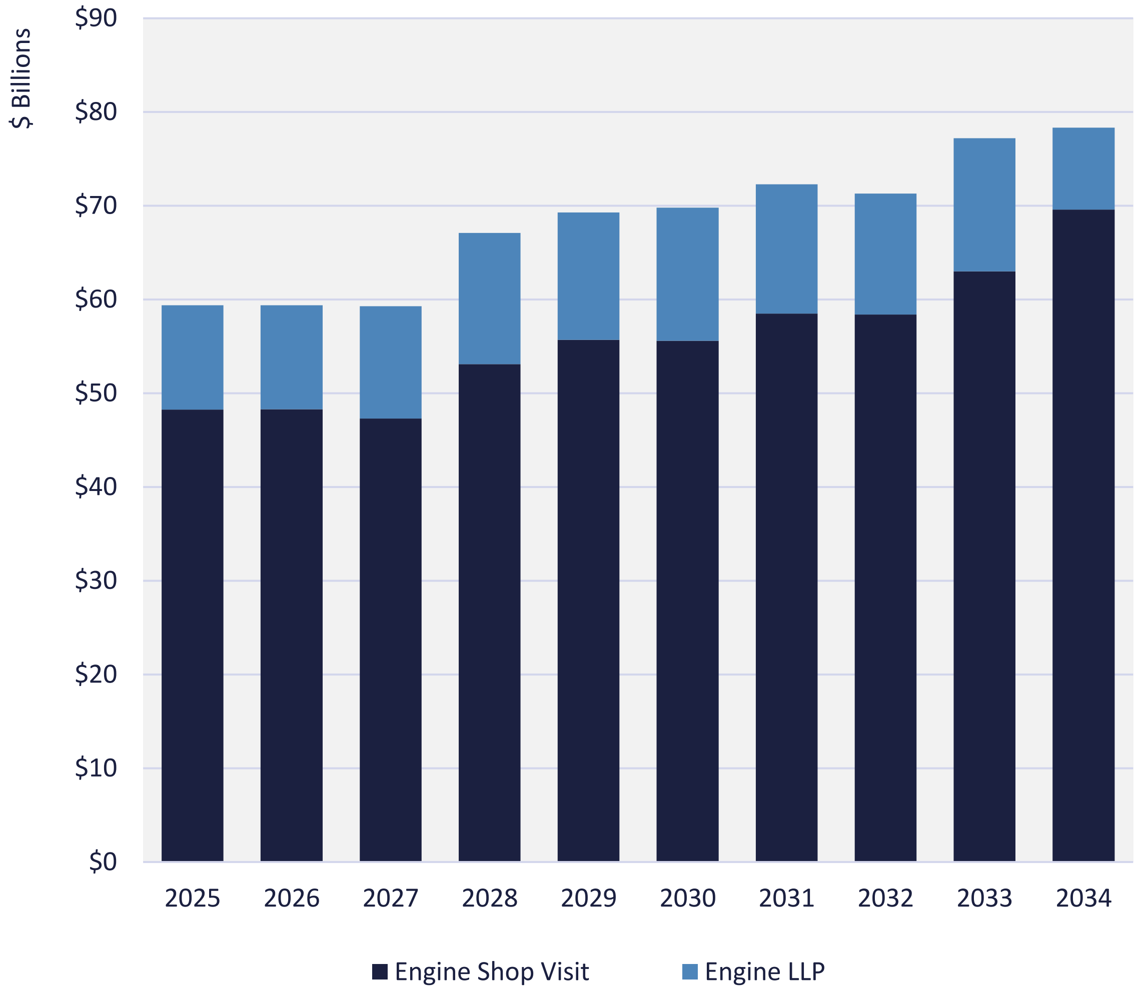
Top shares of the projected 10-year aftermarket revenue go to CFM, GE Aviation, and Rolls Royce. With increasing supply chain and shop visit pressures, OEM replacement parts are under increasing pressure from PMA parts and local DER approvals to facilitate engine availability for the fleet, especially in the short term. While engine dollar demand is expected to grow at a 3.3% CAGR before inflation, USM from legacy green time engines made available by airframe retirements is anticipated to create competition for new parts and pressures for OEM's aftermarket bottom line.

Leading changes for engine families (2025 vs. 2034 comparisons) include the CFM LEAP (+$17.4 billion), GE GENX (+5.6 billion), PW1000G (+$5 billion), and Rolls Royce TRENT (+$4.9 billion). Meanwhile legacy engines decline over 10-years, CFM56 (-$4.9 billion), CF6 (-$2.9 billion), V2500 (-$2.6 billion), and PW4000 (-$1.7 billion).



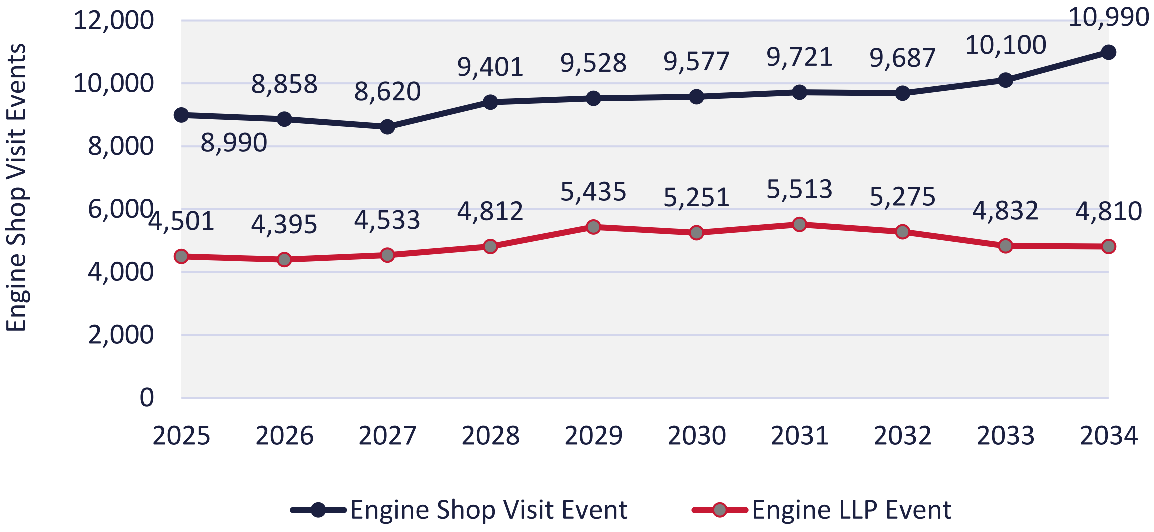
Source: 2025 Commercial Aviation Fleet & MRO Forecast, Fleet Discovery, Aviation Week Network, Copyright 2024.
Note: *2025/2026 engine technical upgrade events not included.

MRO Demand Change – Engine Maintenance Events



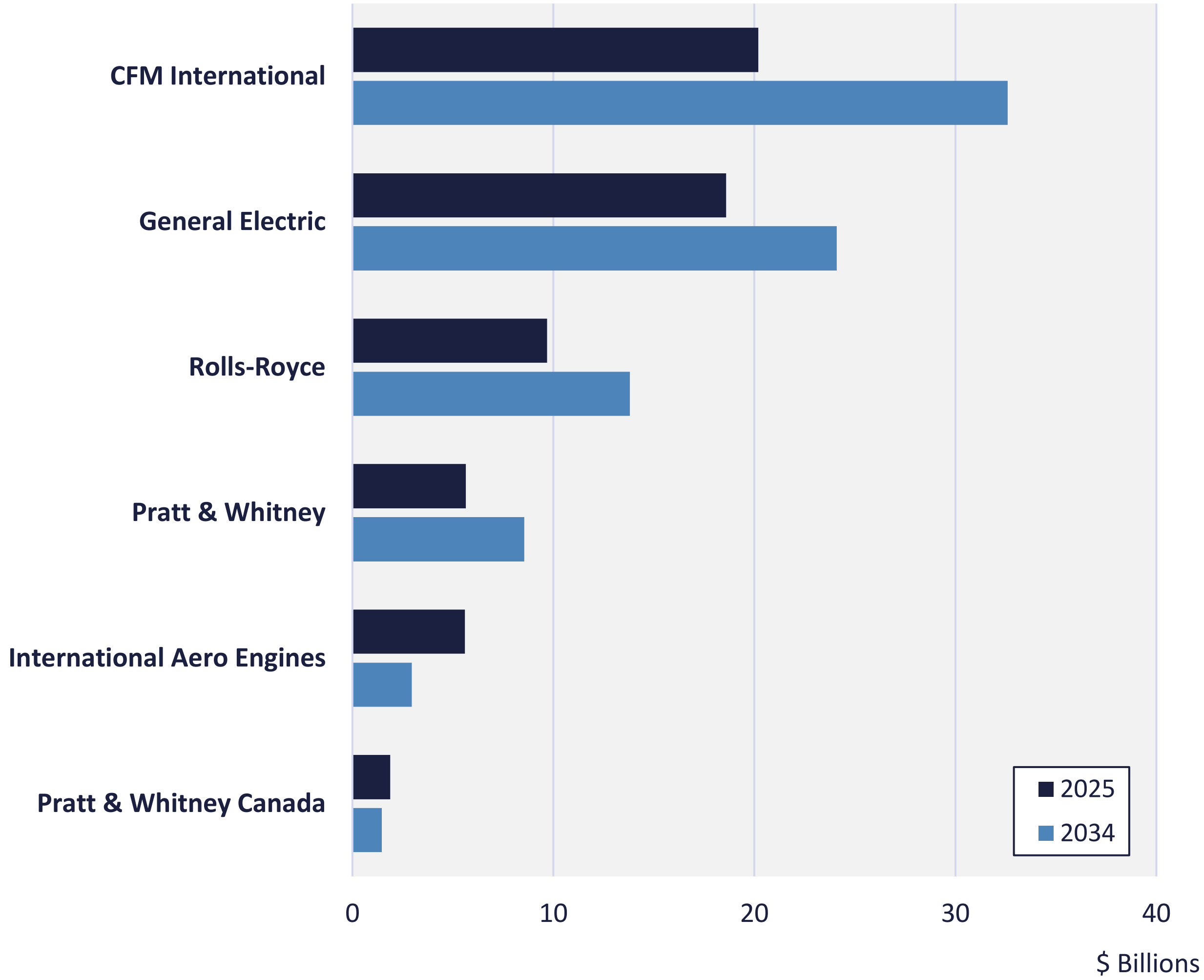
Engine maintenance makes up the largest share of MRO demand over the decade at nearly 50% and is projected to total $685B over the forecast period. It grows at a 3.3% CAGR, the second highest rate by expense category after Components (3.9%). A share of 97% of the $1,392B of MRO demand is generated by aircraft powered by turbofan engines, with turboprop MRO valued at $36B.

A share of 81%, or $557B of requirements, relate to engine performance restoration shop visits (SVs) events with the remaining 19% associated with the cost of replacing life limited parts (LLPs). SV events are accounted for distinctly from LLP replacements, both by events and by dollar demand. Over 95,400 engine restorations are expected over the period, while more than 49,300 LLP replacement events are projected to be needed.



Source: 2025 Commercial Aviation Fleet & MRO Forecast, Fleet Discovery, Aviation Week Network, Copyright 2024.
Note: 2025/2026 new generation engine technical upgrade events not included.

MRO Demand Change – Engine Type Certificate Holder



CFM engines account for the largest share of MRO demand, at 35% during the 2025-34 period. GE Aviation and Rolls-Royce follow with shares of 29% and 15% respectively.

By 2034, the leading three type certificate holders generating the most demand annually will remain CFM International ($32.6bn, up 61%), GE Aviation ($24.1bn, up 30%), and Rolls-Royce ($13.7bn, up 42%) on a 2024 constant dollar basis. Increasing pressures from material costs, labor, supply chain and PMs will act to reduce profitability, however.

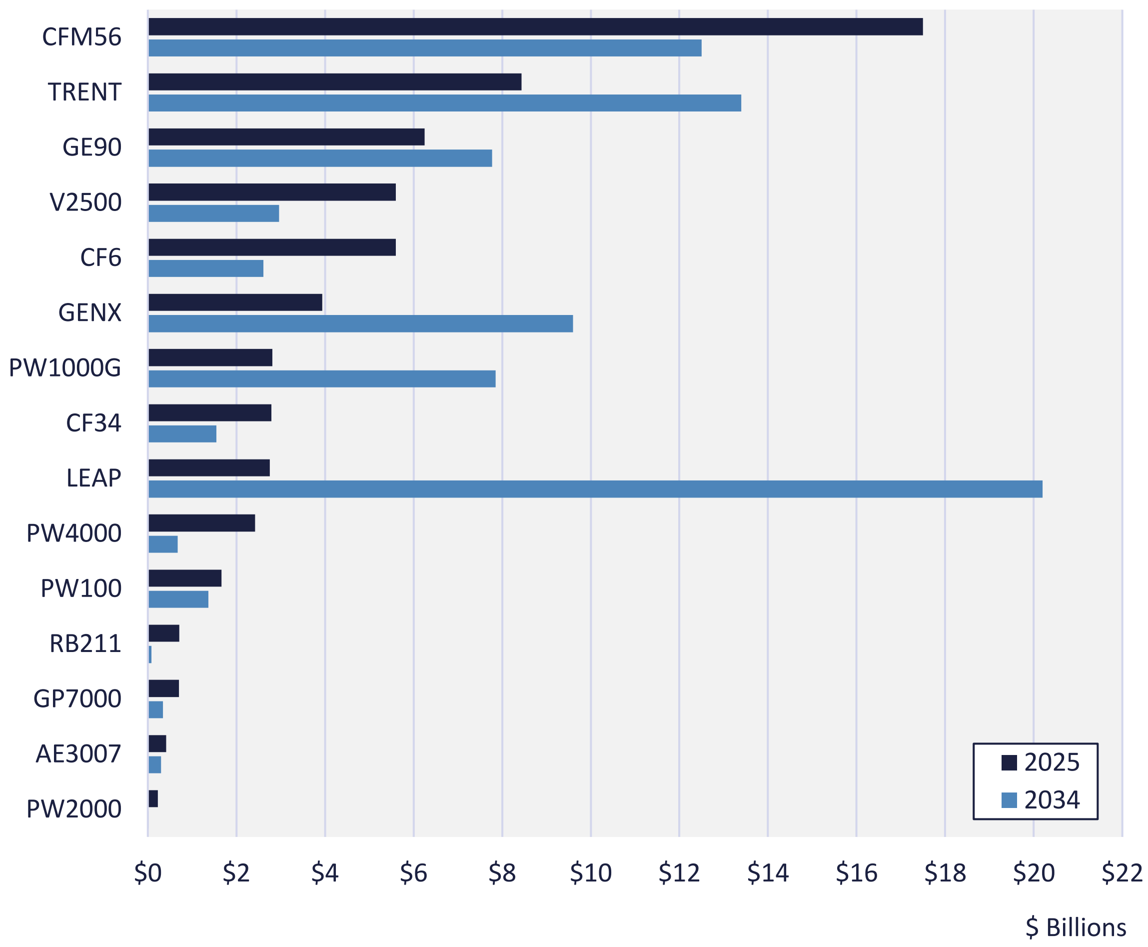
Engine TCH	Engine OEM
CFM International	CFM International
Engine Alliance	Engine Alliance
General Electric	General Electric
Honeywell	Garrett-AiResearch
	Honeywell
	Textron-Lycoming (AVCO)
International Aero Engines	International Aero Engines
Pratt & Whitney	Pratt & Whitney
Pratt & Whitney Canada	Pratt & Whitney Canada
Rolls-Royce	BMW + Rolls-Royce
	Rolls-Royce

Delta TechOps - Engine Test Stand
Credit: Brian Kough, Aviation Week Network

Source: 2024 Commercial Aviation Fleet & MRO Forecast, Aviation Week Network, Copyright 2023.
Note: 2025/2026 engine technical upgrade warranty events not included in demand figures here.

MRO Demand Change – Engine Family

Effects of new generation engines on MRO demand will be felt by the end of the decade



Source: 2025 Commercial Aviation Fleet & MRO Forecast, Fleet Discovery, Aviation Week Network, Copyright 2024.
Note: 2025/2026 new generation engine technical upgrade events not included.

While declining, the CFM56 family alone still accounts for almost a quarter of all demand at $154B. Maintenance spending is expected to peak toward the end of the 2020s just before legacy 737 and A320ceo models are replaced. Demand for V2500 MRO requirements will similarly decline before the end of the decade.

PW1000G and LEAP overhauls ramp up in the latter half of the forecast period generating $7.8B and $20B in annual demand respectively by 2034. GENX demand more than doubles over the decade rising from $3.9B in 2025 to just over $9.5B by 2034. Shop visit events relating to these three families of engines are expected to total over 39,000 over the course of the decade.

Linked closely to the shifts in the composition of widebody fleets around the world the TRENT family will see rapid growth over the decade. Driven by increased demand from Boeing's 787's, the TRENT1000 and the Airbus A350's TRENTXWB, spending on maintenance for the Rolls Royce family of engines is expected to rise from $8.4B to $13.3B over the decade.

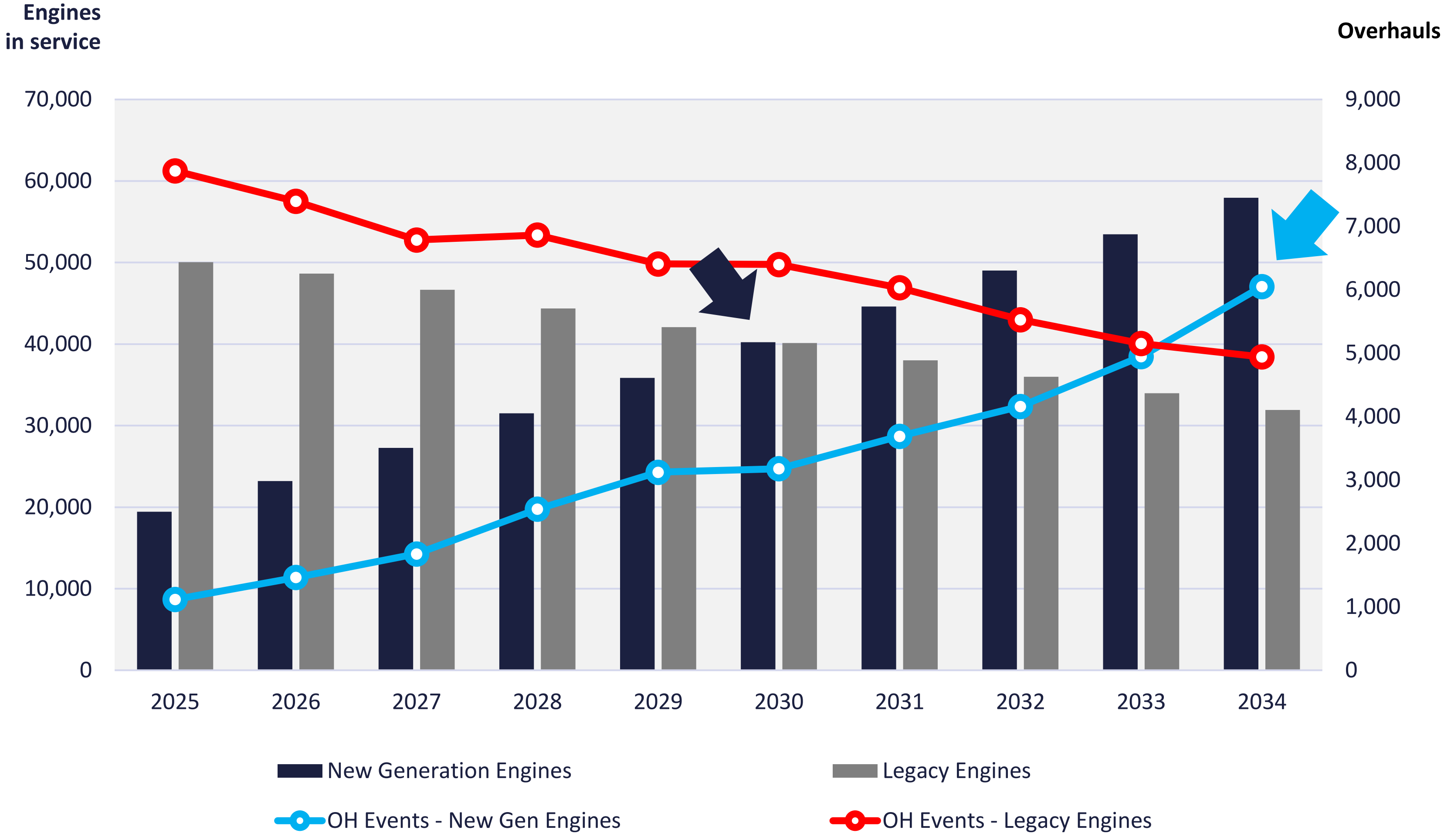
Decline in demand for CF6-80 and RB211 maintenance over the forecast is closely linked to the weakening around the large widebody market segment. The PW4000 and AE3007 will also see demand fall over the decade.

PW1500G | Trent XWB | CFM LEAP-1B

Credit: Nigel Howarth, Aviation Week Network

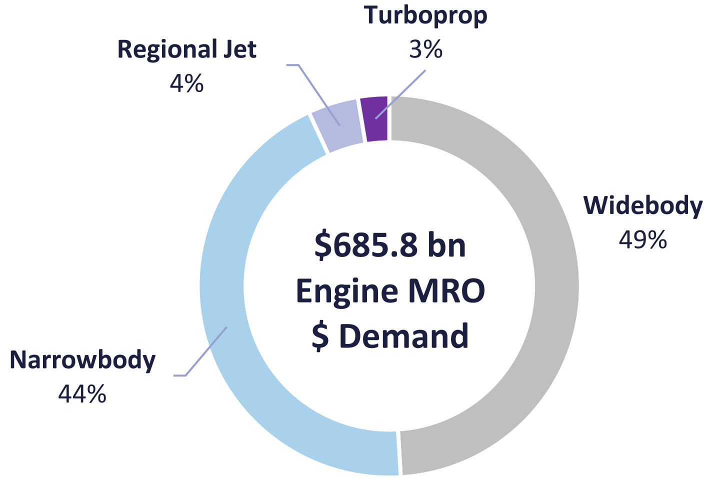
Global Engine Fleet & Overhaul Events

New generation vs. legacy fleet share & overhaul event forecast



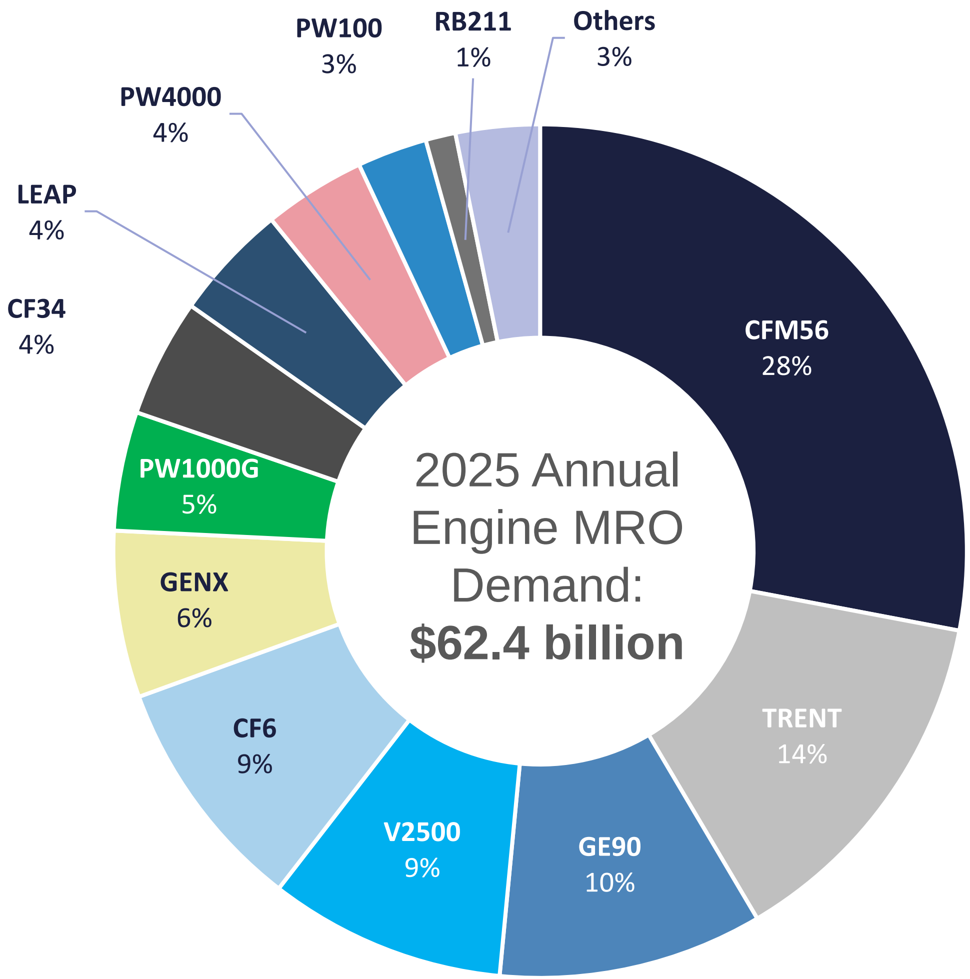
2030
Inflection Year for
New Generation Engine Fleet Strength

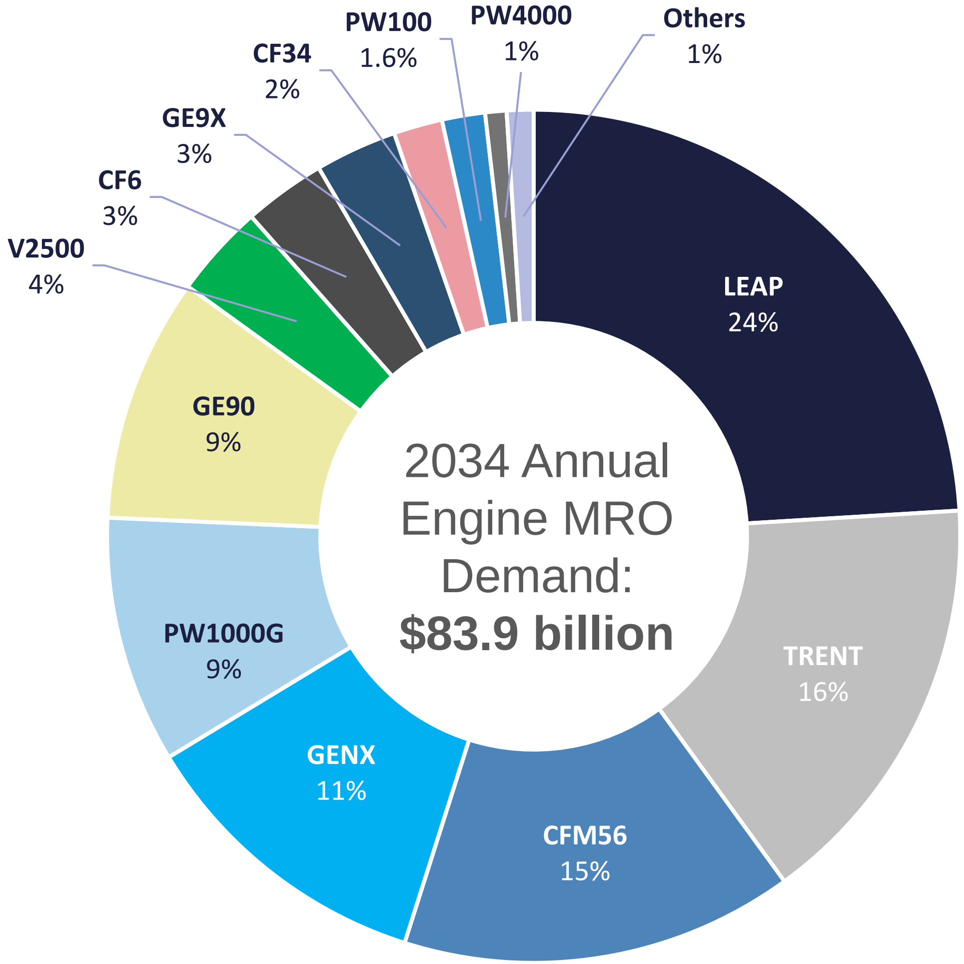
95,400+
Overhaul Events during period.
Inflection in 2034



Source: 2025 Commercial Aviation Fleet & MRO Forecast, Aviation Week Network, Copyright 2024.
Notes: LLPs and 2025/2026 engine technical upgrade *events* not included. New generation engines include LEAP, PW1000G, GENX, GE9X and Trent 1000/7000/XWB.

MRO Demand – Engine Family

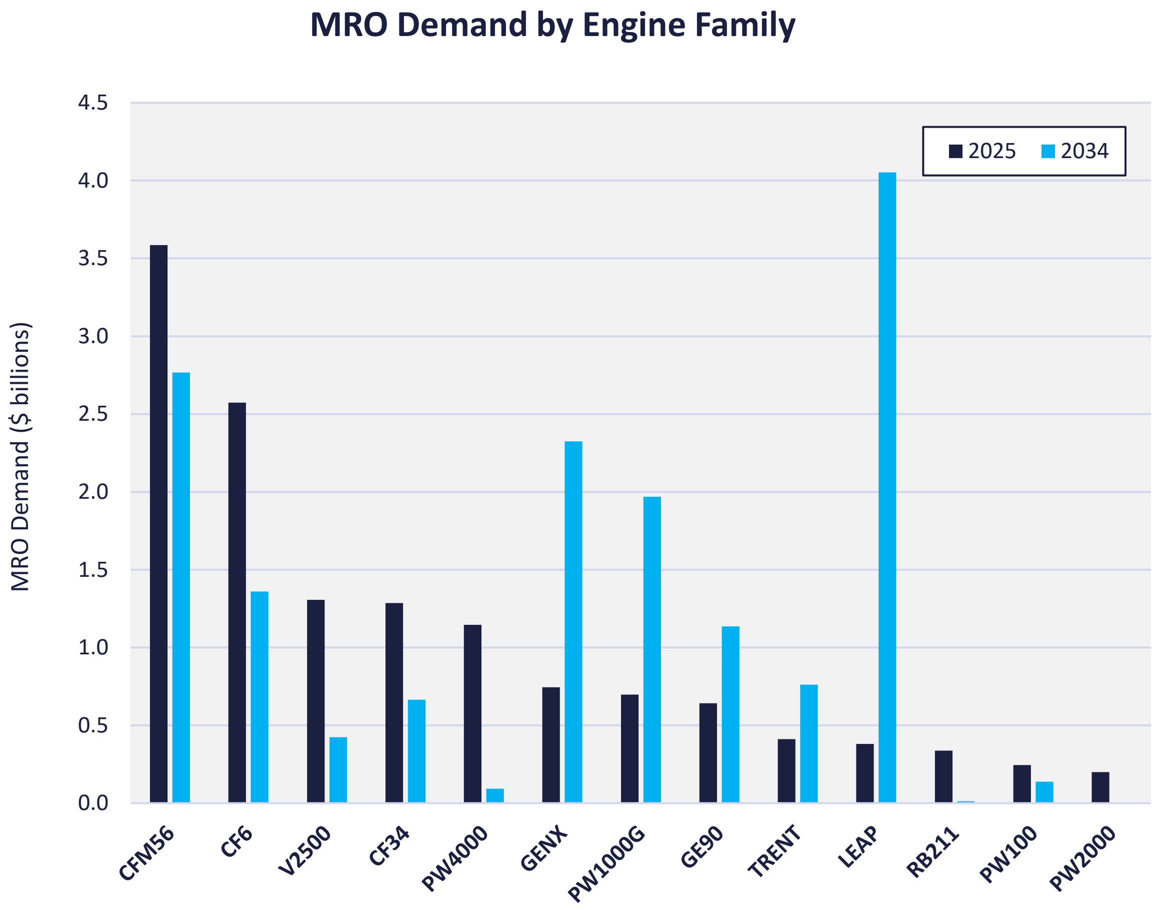


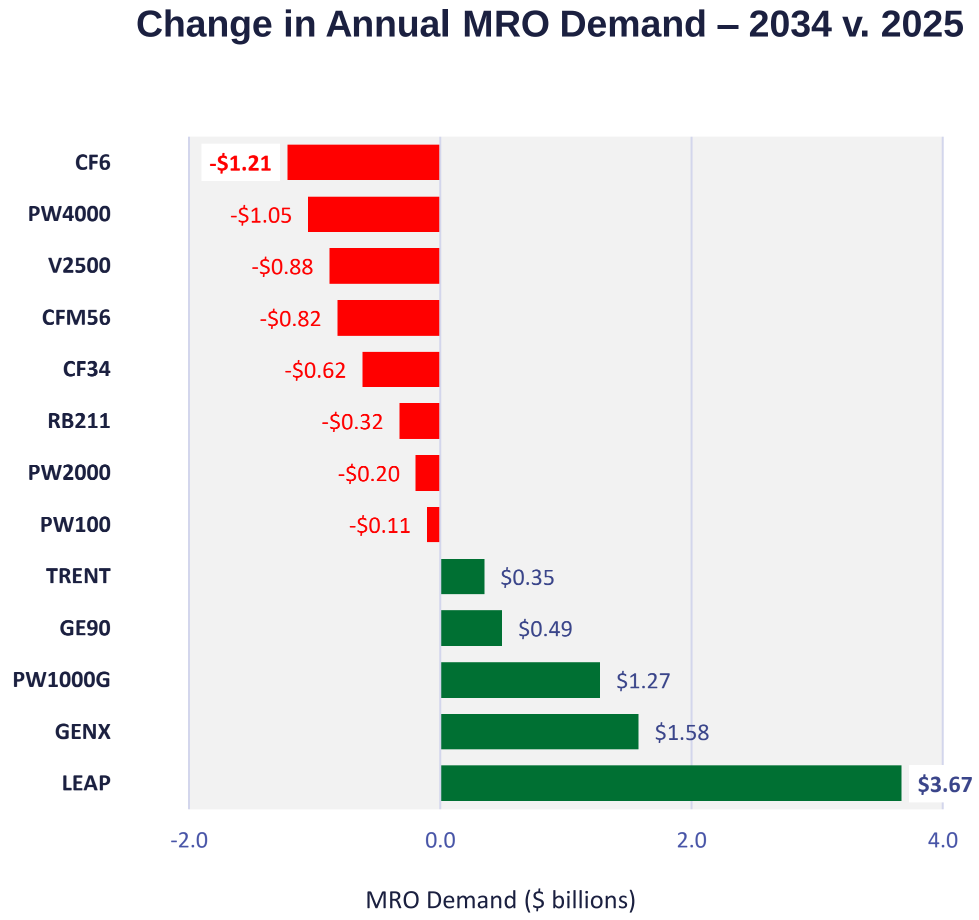


Source: 2025 Commercial Aviation Fleet & MRO Forecast, Fleet Discovery, Aviation Week Network, Copyright 2024.
Note: 2025/2026 new generation engine technical upgrade events not included.

Engine MRO Demand – North America

Dollar Demand change over time by engine family

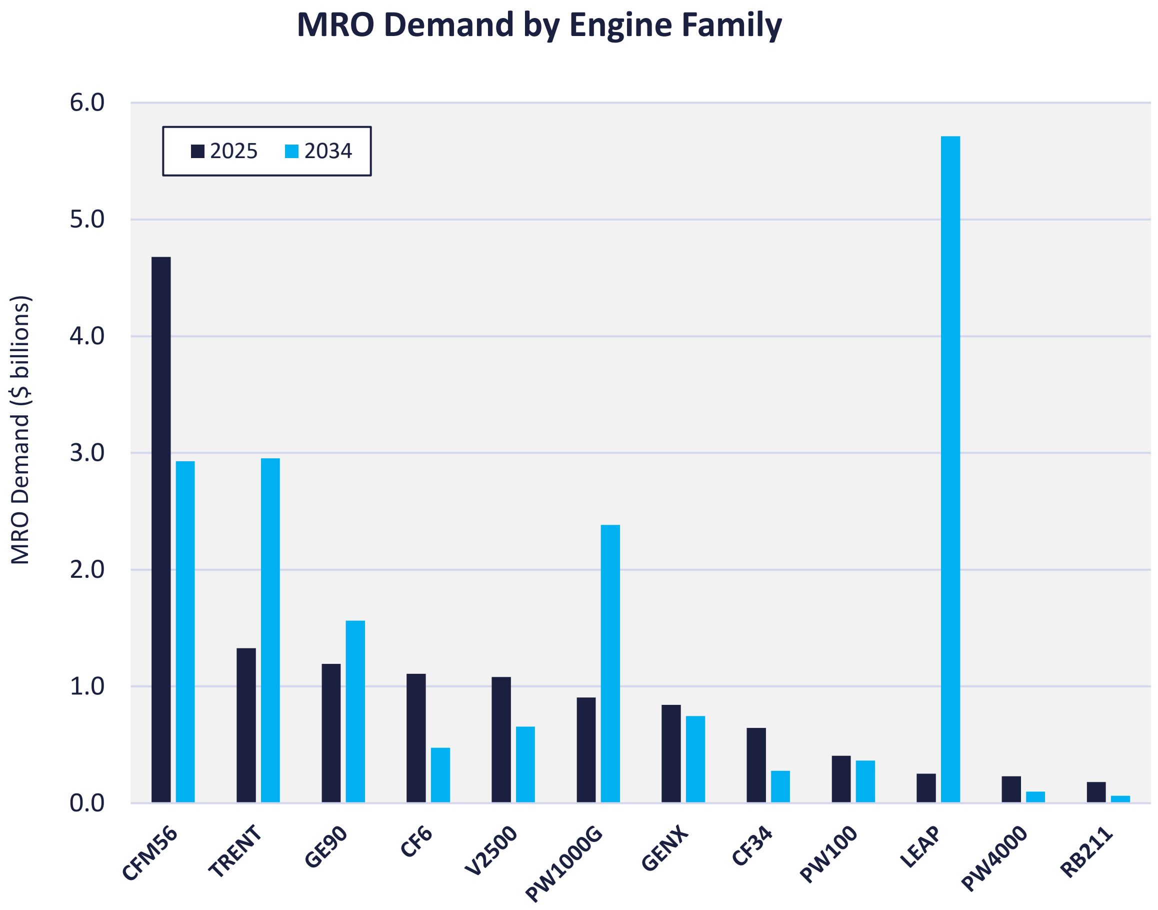


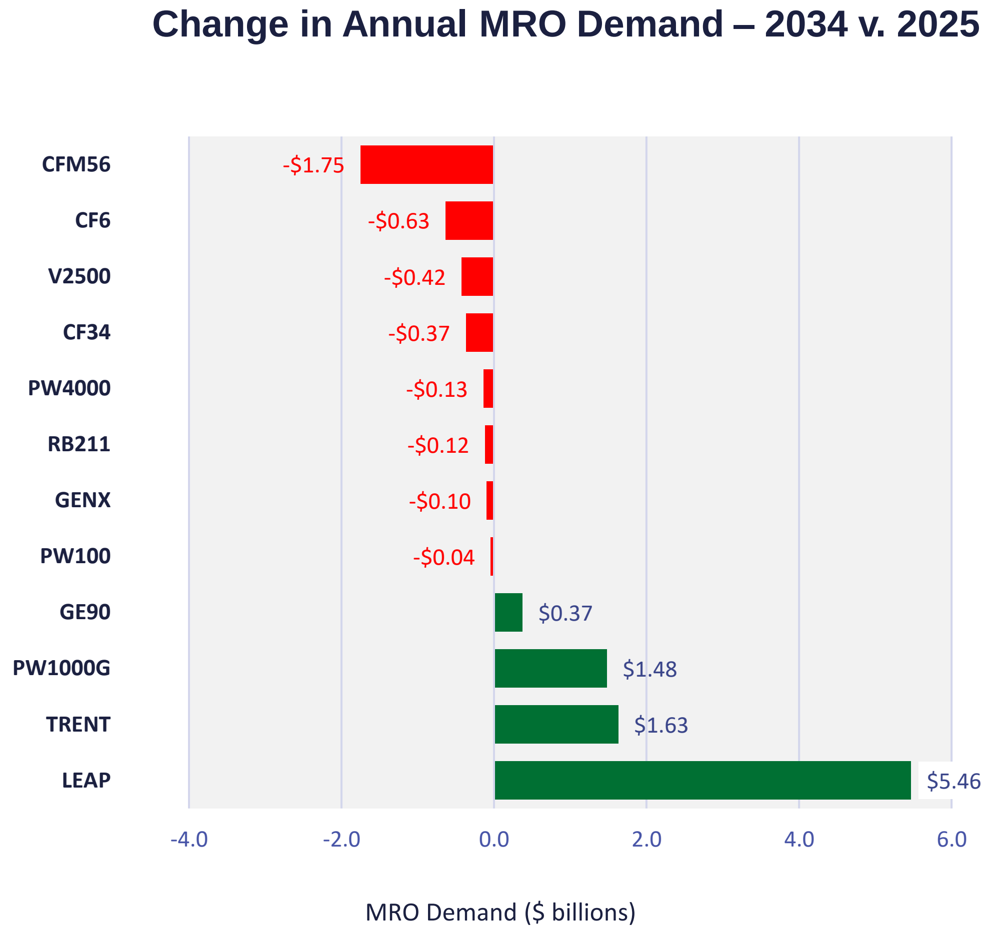


Source: 2025 Commercial Aviation Fleet & MRO Forecast, Aviation Week Network, Copyright 2024.
Note: 2025/2026 new generation engine technical upgrade events not included.

Engine MRO Demand – Europe

Dollar Demand change over time by engine family

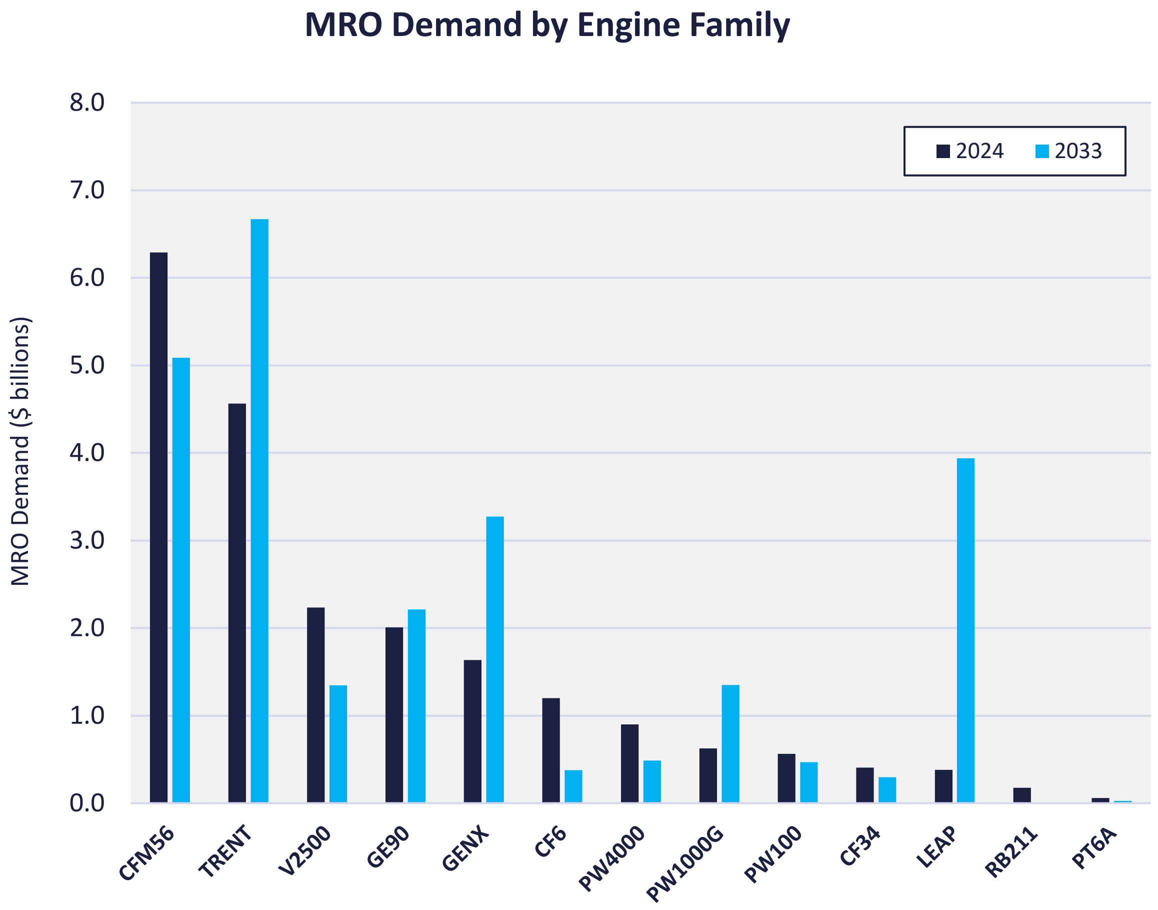


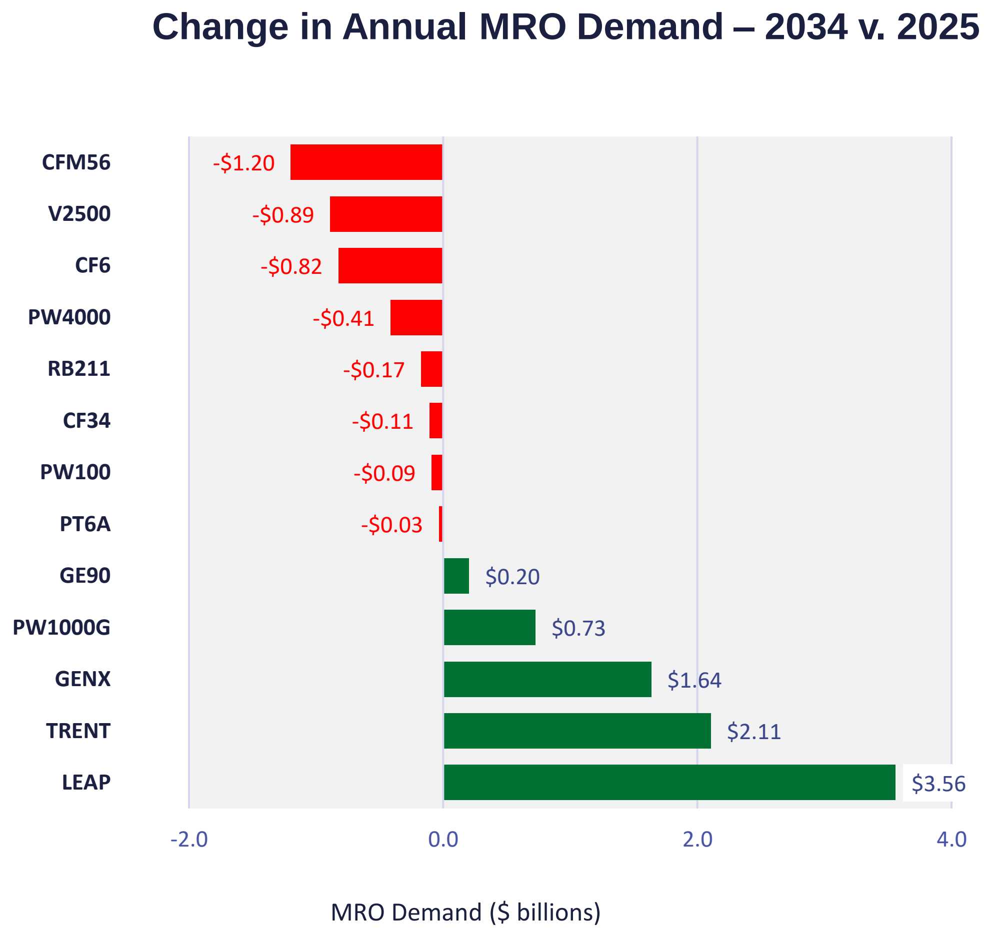


Source: 2025 Commercial Aviation Fleet & MRO Forecast, Aviation Week Network, Copyright 2024.
Note: 2025/2026 new generation engine technical upgrade events not included.

Engine MRO Demand – Asia Pacific and China

Dollar Demand change over time by engine family

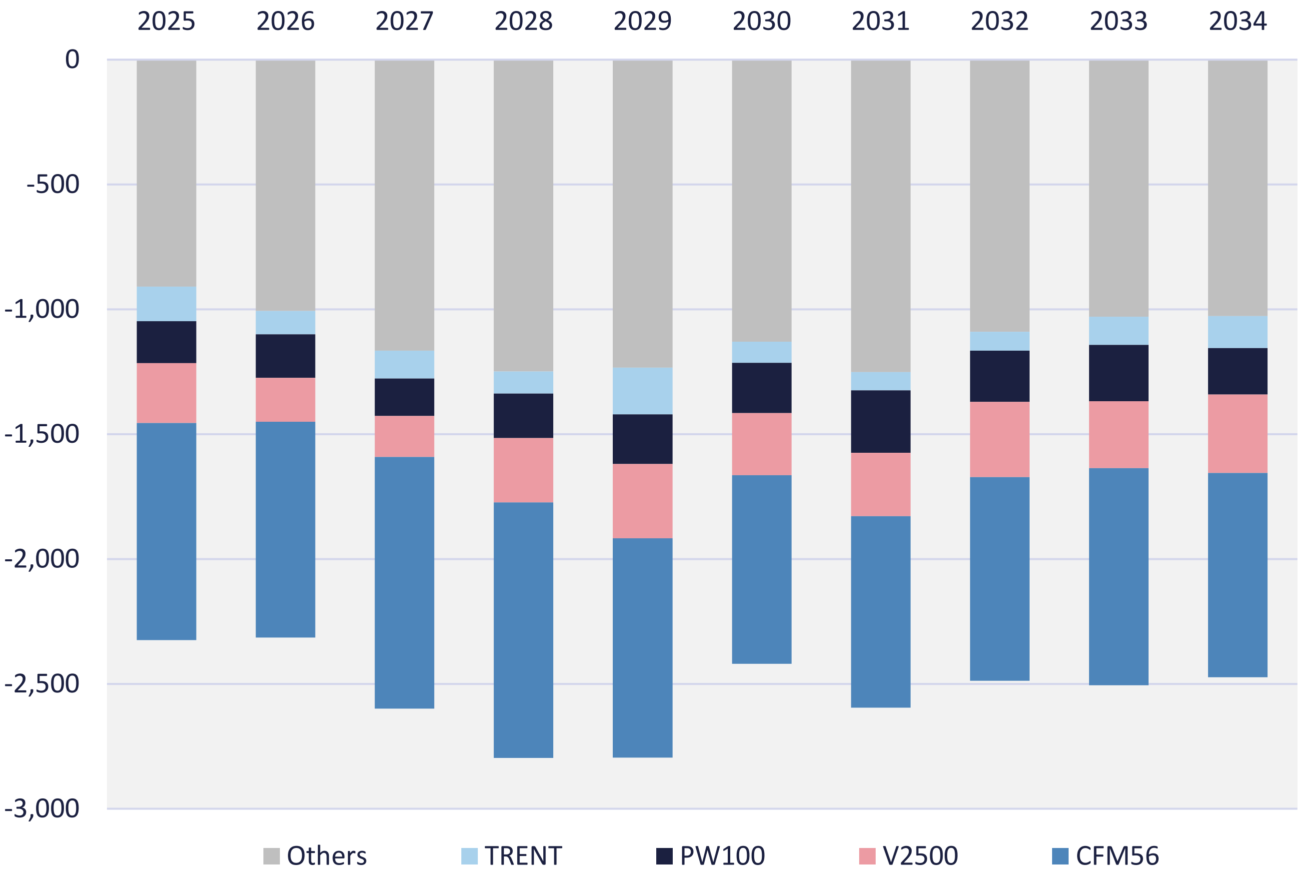




Source: 2025 Commercial Aviation Fleet & MRO Forecast, Aviation Week Network, Copyright 2024.
Note: 2025/2026 new generation engine technical upgrade events not included.

Commercial Engines – USM and Green Time

Engines associated with retiring aircraft, potentially available as used serviceable material (USM) or green time spares



The retirement of large numbers of legacy *aircraft* is expected to have a significant impact on spare *engines* and USM parts, likely impacting engine MRO market demand.

Topping the list, 8,600 CFM56s, 2,500 V2500s and 1,900 PW100s powerplants are associated with retiring airframes, providing many engines – potentially with green time – to become available for the remaining legacy aircraft in service. These engines will be available either as complete powerplants (spares) or as components after part out (USM).

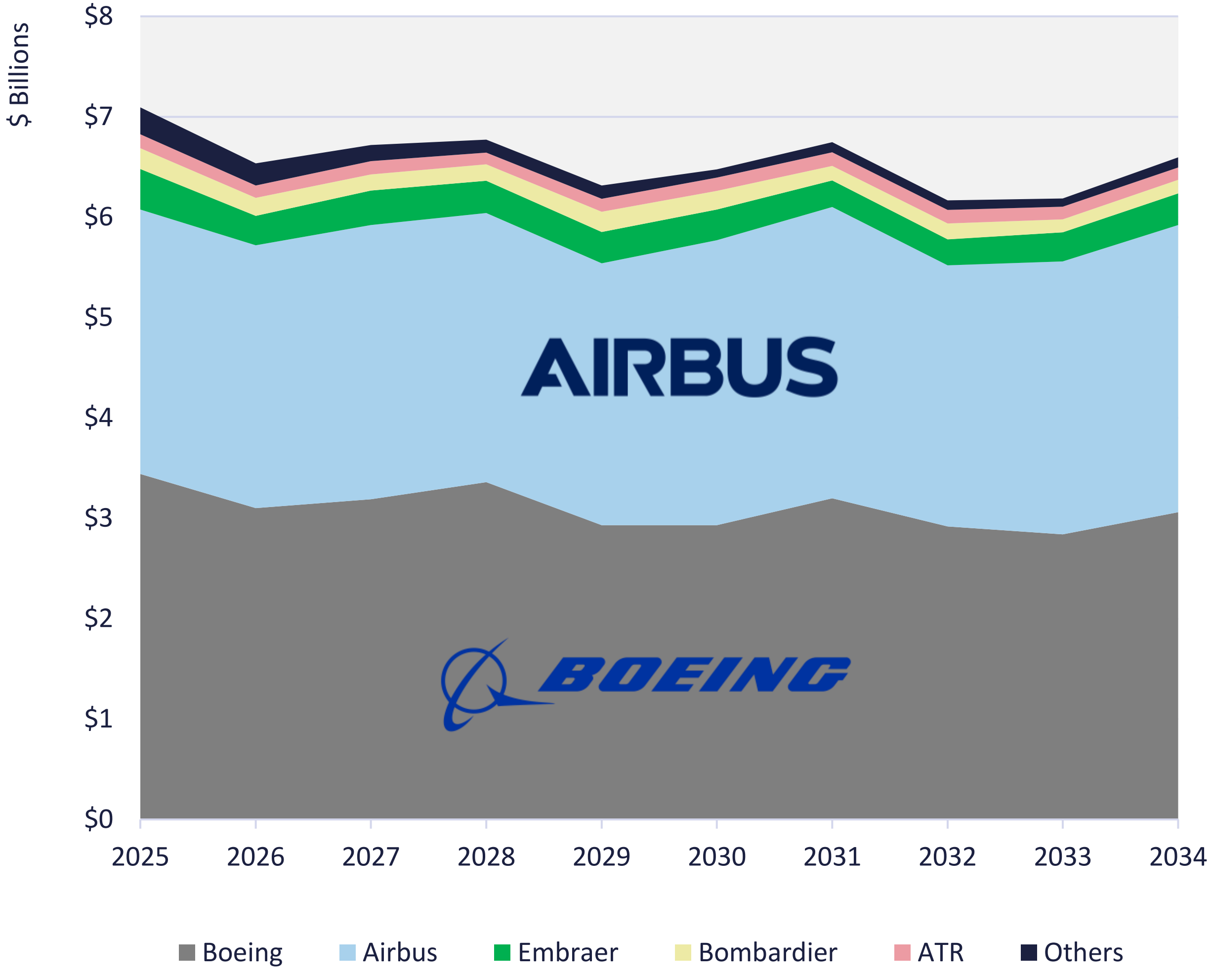
While retirements of aircraft have not been meeting expectations in the last few years, teardowns are expected to gather pace as the decade progresses. This has the potential to apply downward pressure on the material cost of shop visits as engines reaching limits are exchanged for ones with green time. Similarly, the use of USM from legacy engines has the potential to reduce costs through the abundance of USM relating to these popular engine families.

Trends prior to 2024 suggest that both airframe and engine maintenance events were avoided by switching aircraft and engines between parked and active fleets to delay maintenance costs. However, the wave of shop visits/overhauls is now evident, but are being constrained by lack of materials, supply chain issues, and shop availability. This along with new generation engine durability issues is creating additional demand to keep legacy aircraft engines flying. Engine lease rates for legacy engines have increased substantially.

Once new aircraft and engine supply constraints are resolved, look forward to increasing airframe retirements and legacy engine availability.

Source: 2025 Commercial Aviation Fleet & MRO Forecast, Aviation Week Network, Copyright 2024.

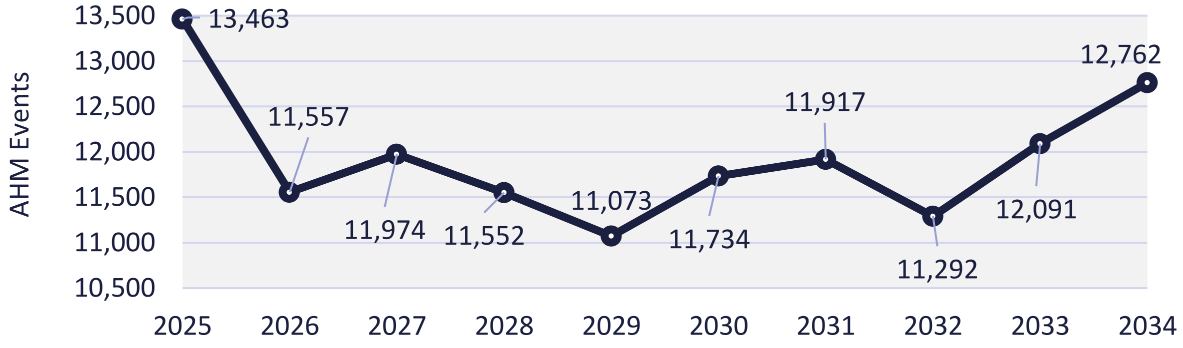
MRO Demand – Airframe Heavy Maintenance



Over the next decade, $65.6 billion is anticipated to be spent on airframe heavy maintenance (C & D checks); however, CAGR slightly declines (-0.8%) – the lowest rate of any MRO category. Annual demand is expected to start at a peak of $7.1 billion in 2025, decline over the following years, and rise to $6.6 billion in 2034.

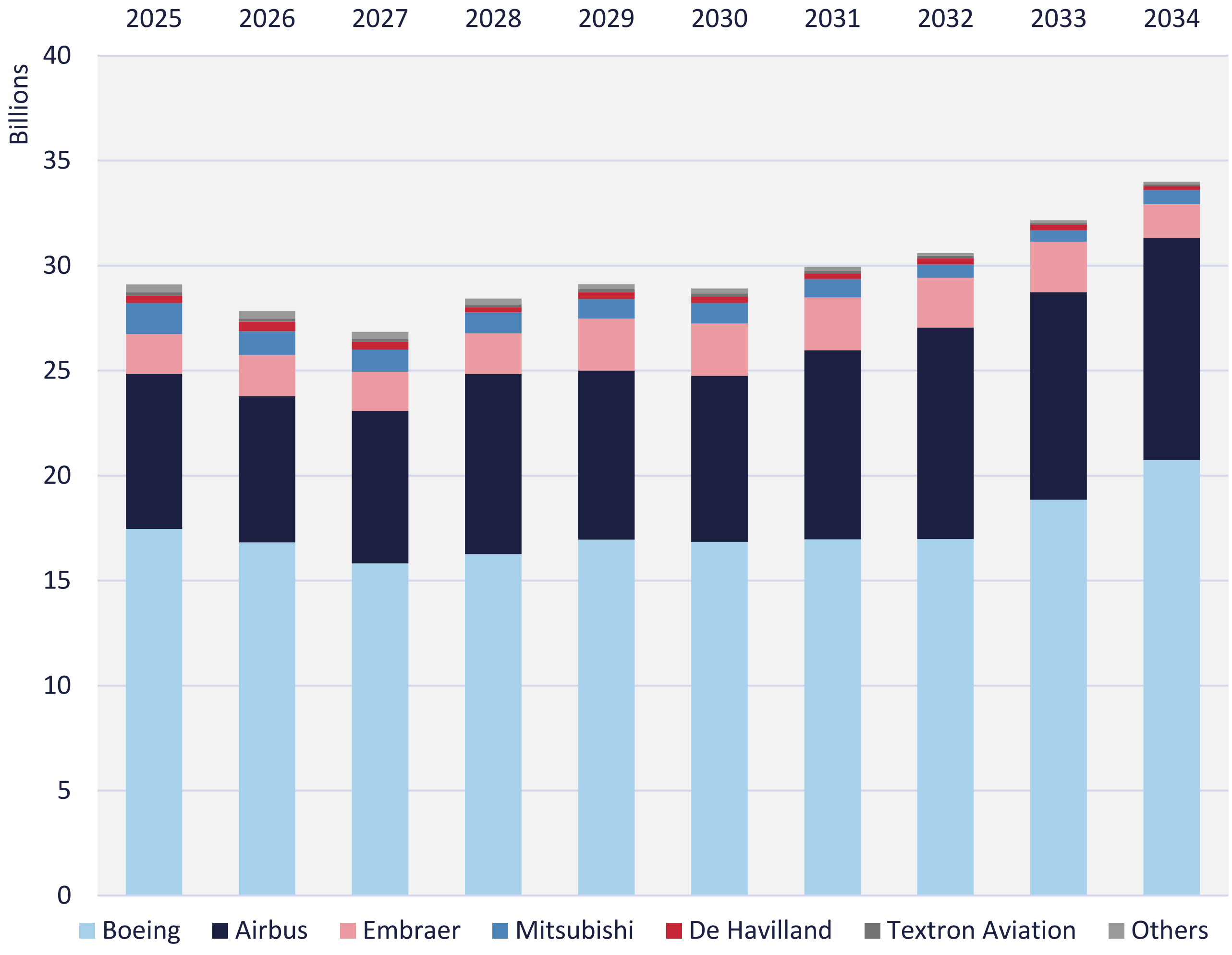
The biggest driver is Boeing who's AHM demand shrinks because of intervals between check events is increasing for newer generation aircraft. Legacy aircraft such as the 737 Classic, 767 and 747 which have 18–24-month C Check and 72-96-month D Check intervals are being replaced by new generation aircraft with 36-month C Check and 108-month D Check intervals. In contrast, Airbus, who generally has had longer intervals, will see demand increase 8% over 10-years.

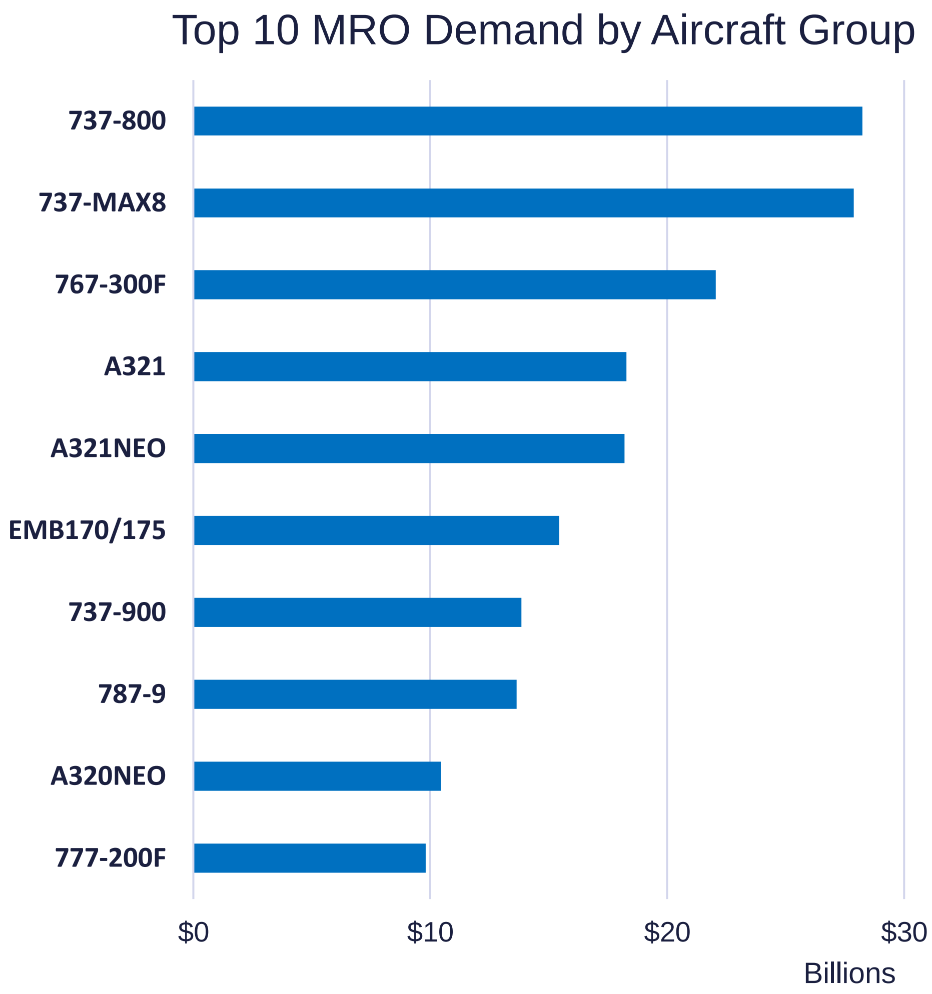
Another factor is stored aircraft. Over 1,500 aircraft stored long-term are expected to return to service between 2025/27 which creates an expectation that most will require a C Check before returning to revenue service. This creates an initial bow wave of C Checks in 2025. Other timing and fleet factors take over in the intervening years, while eventually ending up near the same level due to organic growth.



Source: 2025 Commercial Aviation Fleet & MRO Forecast, Fleet Discovery, Aviation Week Network, Copyright 2024.

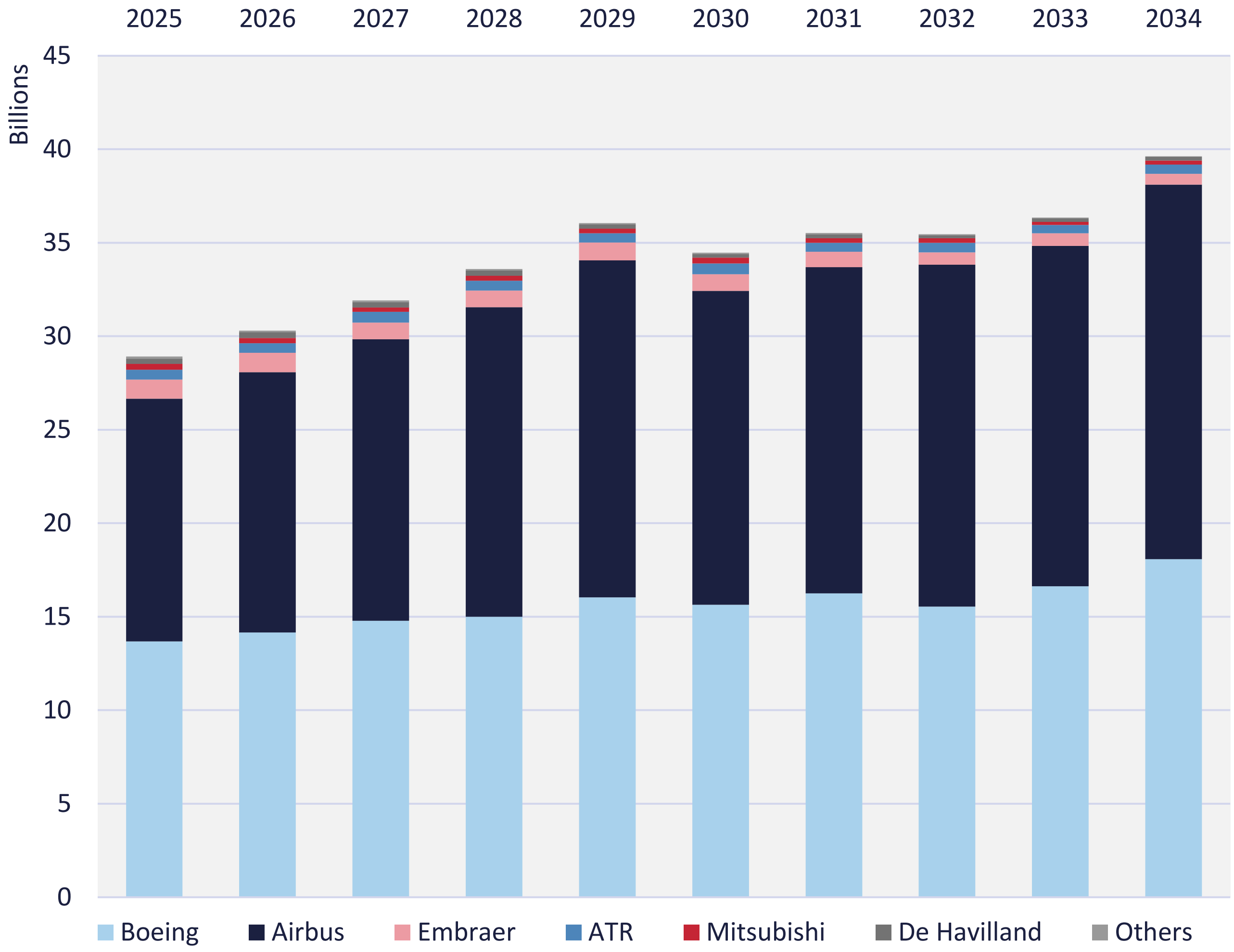
MRO Demand by Type Certificate Holder – North America





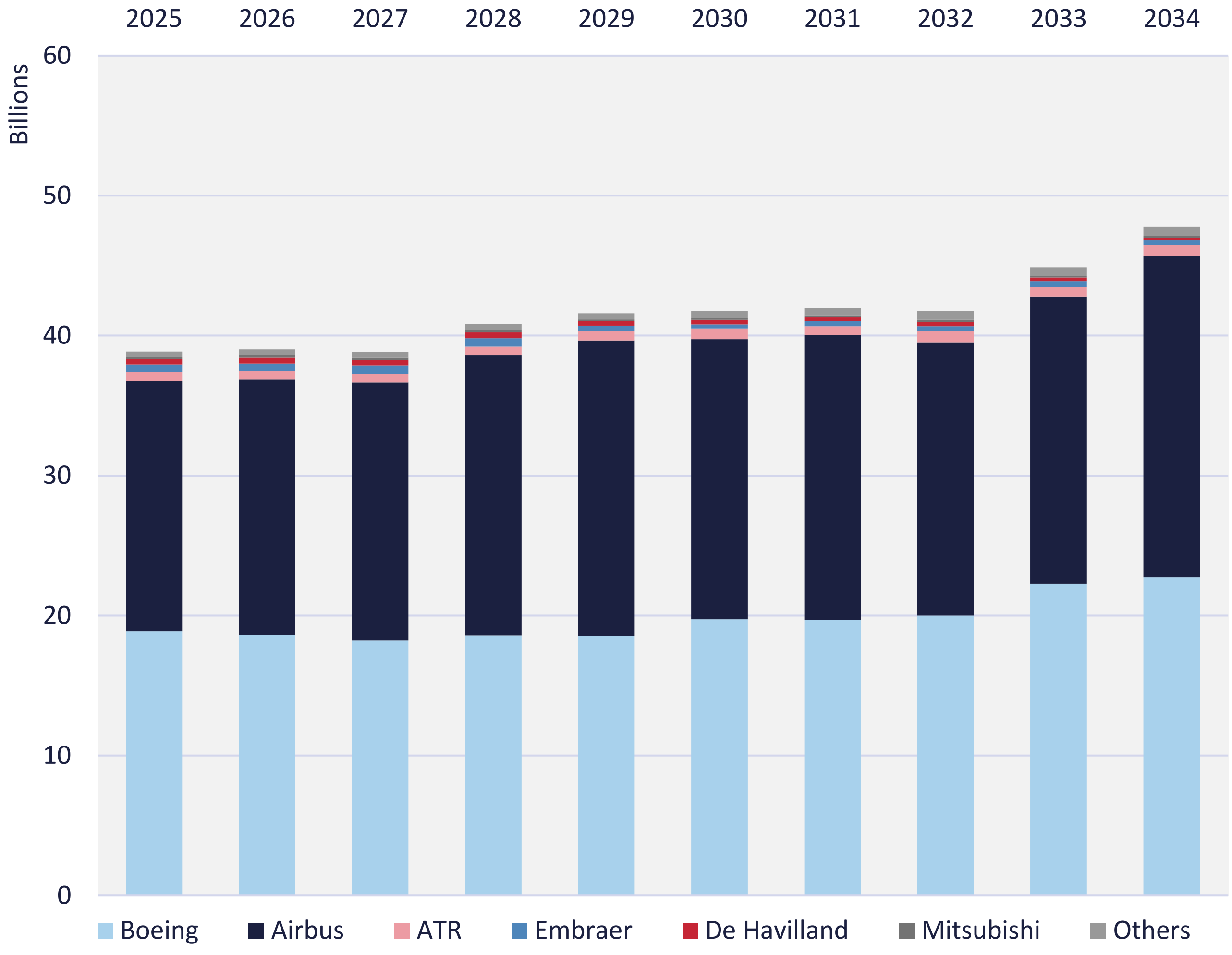
Source: 2025 Commercial Aviation Fleet & MRO Forecast, Aviation Week Network, Copyright 2024.
Note: 2025/2026 new generation engine technical upgrade events not included.

MRO Demand by Type Certificate Holder– Europe



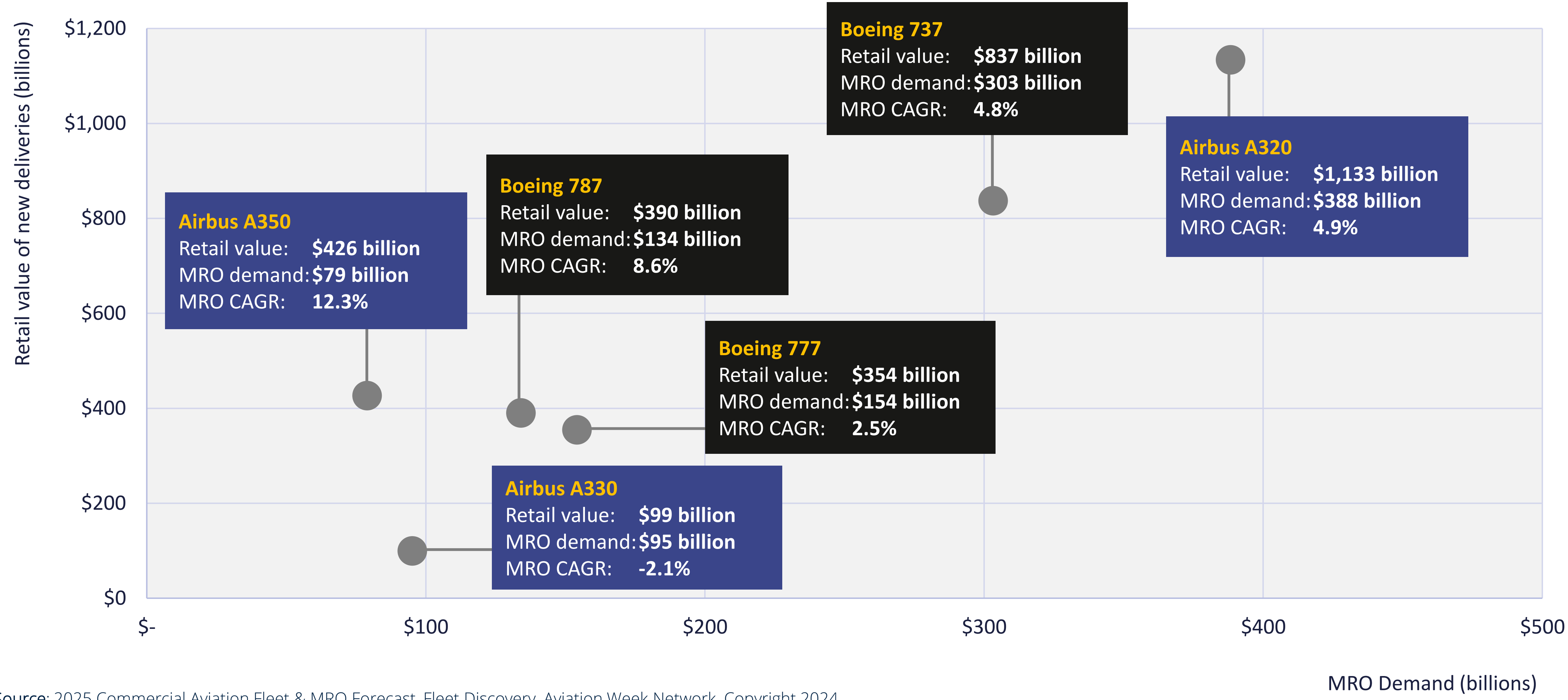
Source: 2025 Commercial Aviation Fleet & MRO Forecast, Aviation Week Network, Copyright 2024.
Note: 2025/2026 new generation engine technical upgrade events not included.

MRO Demand by Type Certificate Holder – Asia Pacific and China



Source: 2025 Commercial Aviation Fleet & MRO Forecast, Aviation Week Network, Copyright 2024.
Note: 2025/2026 new generation engine technical upgrade events not included.

Most Valuable Aircraft Programs – Aircraft Family (2025-34)



Source: 2025 Commercial Aviation Fleet & MRO Forecast, Fleet Discovery, Aviation Week Network, Copyright 2024.
Note: 2025/2026 engine technical upgrade events not included in MRO demand.

Methodology

Methodology

Overview

Market Summary Reports are a synopsis of the forecast and represents a highlight of the extensive dataset of fleet and MRO information complied in-house by the Aviation Week Network Intelligence & Data Services' research. The comprehensive forecast dataset is available via an online business-information (BI) tool. Users may customize analysis by filtering through various categories—such as: aircraft family/group/type/categories, geographic regions, OEMs, engines and operators as well as MRO categories or expense types—to yield customized data, graphs and table displays for any segment of the fleet and MRO projections. Dedicated summary, regional, fleet, engine, MRO and MRO event tabs provide users with access to the most sought-after information for strategic planning. Projections by the Aviation Week Fleet & MRO Forecast commercial aviation segment are predicated on data for estimated aircraft production, deliveries, retirements and resultant in-service fleets, as well as projections for maintenance requirements based on historical and future trends, aircraft operating economics, regional variations, variable labor rates and ownership types. This independent industry resource combines Aviation Week's aircraft fleet database information, Fleet Discovery, with past/projected utilization, OEM hour/cycle/calendar MRO service intervals along with service cost assumptions to develop an MRO forecast for strategic decision-makers and analysts. Its dedicated research team, with more than 160 years of industry experience, acquires first-hand information and developments from industry surveys, OEM data feeds, and guidance from external advisory board contributors representing top-tier OEMs, MRO providers, consultants and independent analysts.

Scope

The forecast examines the 10-year (**2025-34**) market for commercial turbine-powered aircraft with seating capacities greater than 19 seats and most freighters in commercial service. It projects fleet and MRO demand across nine world regions (see map and appendices). The aircraft scope encompasses the entirety of the world's Western-built commercial fleets as defined by type and/or operator.

Forecast World Regions – See also Appendices

Included

The forecast includes commercial aircraft operated in scheduled airline service, nonscheduled airline service, cargo/freight operations, and commercial types in *civil* government service. Additionally, these popular aircraft are included by virtue of being *powered* by Western engines: Comac C919, and Comac ARJ21.

Excluded

The Sukhoi Superjet 100 and Irkut MC-21 are excluded due to engine manufacturer change.

Types operated by or operated for a military service are excluded. Military *operators* of commercial or crossover types such as the Dornier Do228, Boeing 737 (P-8), Boeing 707 (E-3), Boeing 767 (KC- 46), de Havilland DHC-6, Embraer 110 and McDonnell Douglas DC-10 are also excluded.

Likewise, business types: Airbus ACJs, Boeing BBJs, Embraer Lineage (ERJ190)/Legacy (EMB135), and Challenger 800/850/870/890 (CRJ-200/700/900) are excluded.

The number of in-service (not stored) aircraft and utilization projections are combined in each of ten forecast years to create a model of fleet strength and potential utilization and MRO demand at multiple levels such as aircraft family/group, ATA chapter code, engine, OEM, operator, region and country.

Methodology

Fleet Modeling, Fleet Forecast, Models & Assumptions

The summation of an extensive dataset of fleet and MRO information is complied in-house by the Aviation Week Network, Intelligence & Data Services. Assumptions within the model reflect estimates for dollar demand, hourly costs and/or shop-visit events at the airframe, engine and/or the Air Transport Association (ATA) Chapter Code levels, which are derived from primary research, manufacturers, survey data, and/or industry standards.

Aviation Week does not model characteristics of individual operators; data or outputs in the model do not reflect any single operator's specific airframe or engine maintenance programs, specific operating environment or aircraft retirement policies. MRO yields represent *average* costs for a given utilization, which is customized by aircraft type and operating region dynamics. For a complete listing of aircraft in scope or country/region assignments, please see the appendices.

The forecast modeling begins with the present active fleet tracked at the tail/serial number and operator levels and extracted from Fleet Discovery. The total in-service fleet for each subsequent year is calculated by factoring in projected annual deliveries and decrementing retirements. The effects on fleet totals of parked/stored or destroyed aircraft also are calculated to determine annual in-service fleet values. Stored aircraft are not counted as active and do not add any MRO requirements but are not retired either.

Deliveries

New aircraft forecast deliveries are based on an analysis combining general macro-economic factors, known *firm* orders and production capacity - especially in the case of narrowbodies. Order and delivery estimates are created for the period beginning with confirmed firm orders announced by OEMs for specific operators by year and type. *Firm orders* are assigned to operators and individual countries. Expected delivery estimates fill any gaps between firm orders and what the market is anticipated to receive based on production capacity and economic conditions. The balances of expected orders are then allocated by region based on projected economics-driven demand, but not assigned to individual operators or countries.

"Fleet entries" is the term used for aircraft that are returning to active service from storage/parked status or after undergoing passenger-to-freighter conversions.

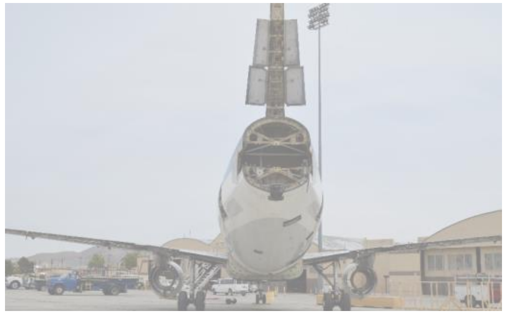
New-production deliveries are expected to be significantly dependent on the certification and the delivery velocity capability of manufacturers, especially for the Boeing 737 MAX and Airbus A320 aircraft. The final certification outcome of the Max 7 and 10 as well as the production velocity capabilities for the Airbus A321 XLR remain speculative.

Retirements & Parked/Stored Aircraft

Projections for turbofan aircraft are assigned among candidates with specified age/airframe criteria and then evaluated by group/type, both regionally and overall, by industry experts for consensus and final adjustments. Turbofan retirement assumptions follow a specific age unique formula. After a minimum *trigger* retirement age is reached—which varies by aircraft model and role—aircraft are retired with their next heavy-maintenance event, D Check, in mind.

Turboprop projections are based solely on airframe age and initially are randomly distributed among candidates with specified age/airframe criteria and then evaluated by group/type, both regionally and overall, by industry experts for consensus and final adjustments. Retirement curves are recalibrated with fleet data during the analysis, leading up to the forecast release to incorporate the latest data by type for both utilization and actual retirements. In the online interface, care should be taken to select appropriate filtering between traditional retirements as mentioned above and fleet departures for passenger-to-freighter conversions.

Stored (sometimes called parked) aircraft analysis is based on several factors, including assessment of future demand, age and relative attractiveness of a particular type. Parked aircraft returned to active service are specifically noted in the forecast model and allocated to roles, regions and the year of their projected return. Should an aircraft be stored for a prolonged period, it is evaluated and retired from the active fleet if assessed as unlikely to return - these retirements are not counted in the modeling, only retirements from active service are enumerated.



Drivers/Considerations

- **Aircraft economics**
- **Engine economics**
- **Stored fleet types, storage history**
- **Lease rates**
- **Future viability as a passenger-to-Freighter (PTF) conversions**
- **Value as scrapped, USM**
- **Heavy Maintenance Visit (HMV) costs/economics**

Passenger-to-Freighter (PTF) conversions, add to in-service fleet

Credit: Brian Kough, Aviation Week Network

Retirement Processing/Algorithm – MRO Informed Retirement Projections

INPUTS - AIRCRAFT FLEET DATA

- Assign or calculate age of each aircraft using the starting, baseline in-service fleet.
- Assign or calculate current utilization hours and cycles per aircraft of the in-service fleet.

ASSUMPTIONS – UTILIZATION, MRO & HMV TRIGGERS

- Project hour & cycle utilization
  - For each of 10 forecast years
  - For each aircraft category (NB, WB, freighter, etc.) and world region.
- Determine months, hours, and or cycles between maintenance events for AHM D Check (MRO assumptions).

RETIREMENT TRIGGER AGES

- Evaluate historical fleet retirements by type to estimate average future retirement ages, determine: Initial retirement trigger, years past trigger, old age trigger, maximum retirement age.
- Evaluate current aircraft economics/popularity by type (subjective SME).
  - Fleet counts
  - Historical retirement ages
  - Storage activity
  - Intelligence on subject aircraft

RETIREMENT SELECTION – ALGORITHM & SME INTERVENTION

SME QUALITY ASSURANCE REVIEW

- Assign age trigger to each aircraft.
- Determine retirement ages - calculate by adding trigger + year to retire (for those not already too old).
- Any aircraft past trigger age is assigned the maximum retirement age as the age to retire, then further D Check logic is used.
- Identify the projected HMV D Check event timing for aircraft within the window.
- D-check logic. When an aircraft is in-service and has not been retired by one of the above algorithms, then it is evaluated for the next D-check past the old age trigger and retired at estimated D Check timing.
- If intelligence exists to support retiring aircraft earlier, an additional step to remove aircraft manually from the fleet is included; likewise, to retain aircraft, manual intervention is required.

SME QUALITY ASSURANCE REVIEW

Methodology – In-Service Fleet Calculation

2024 Year-End Projected In-Service Fleet + **2025 Fleet Entry Projections** − **2025 Fleet Removal Projections** = **2025 In-Service Fleet**

Aircraft in-scope fleet data extract at the end of 2024 becomes the starting point for year one (2025) of the 2025-2034 forecast

+ New-build deliveries in 2025 are added to the in-service fleet.
+ Returns from long-term storage.
+ Converted passenger-to-freighter (PTF) aircraft.

- Retirements in 2025 are subtracted.
- Aircraft selected for conversions to freighters are removed.

In-service fleet net result is the active fleet for one year. Each individual aircraft in-service drives future MRO demand.

This algorithm provides year one (2025) of the active, in-service fleet for the 2025-2034 forecast.
The process repeats for the subsequent years in the forecast.

Credit: Nigel Howarth, Aviation Week Network

Credit: Nigel Howarth, Aviation Week Network

Methodology

Retirements & Parked/Stored Aircraft (cont.)

The return from storage estimation is critical again this year. In May 2020 over 12,000 aircraft entered long term storage! Nearly 1,500 are expected to come out of storage by 2024. More details are found in the online tool.

Retail Price-Based Valuations

Aviation Week examines the value of new deliveries and MRO over the 10-year period in *constant 2024 U.S. dollars*. The study uses advertised retail prices and does not adjust for discounts. To draw conclusions about the future market, the examination looks at regional distribution by year of aircraft-size classes, aircraft families, manufacturers and roles.

Assumptions

Fleet

Aviation Week's fleet database, Fleet Discovery, tracks individual aircraft by tail number/owner/ operator and other attributes and combines operator-provided or derived utilization data to offer initial assumptions about the fleet's aircraft. These preliminary assumptions become the baseline for projections of utilization, MRO service events, and ultimately, MRO demand.

On the delivery side, accounting for depressed production rates is filled with uncertainty as supply chain issues play out and global economic forces provide headwinds. Our assessment has grown out of gaming likely scenarios and choosing the most likely outcome.

Used, stored aircraft returning to service are anticipated to display above average fleet returns, but not as strong as the previous two years.

Delivery counts are projected to be heavily influenced by the continued sluggish production values anticipated for Boeing in the short-term due to production quality and certification issues. Our expectations are that Boeing will eventually recover its market position but the Airbus A320 will likely lead 737 deliveries into the foreseeable future. Some "inventory deliveries", built and waiting for delivery pre-pandemic remain which should soften cash flow pinches. In the widebody arena, the 787 and A350 will be near equal in deliveries, while the 777 will outperform the A330.

A detailed utilization projection schema models expectations by aircraft class, region and operator type. For example, a widebody in Western Europe operated by a passenger carrier in year 2025 vs. a freighter in North America in year 2025, using the same aircraft will have completely different expectations and utilization projections. These projections are built form OEM supply historical data and augmented by our in-house flight tracking data, Tracked Aircraft Utilization (TAU).

MRO

MRO dollar-demand—based on unique per-aircraft-group utilization projection assumptions and fleet turnover—shows demand for services and material increasing at a 3.2% CAGR..

Hierarchy - Typology

Aircraft Hierarchy (Arranged from highest to lowest level)	MRO Major Categories & Expense Types
Family	Airframe Heavy Maintenance
Group	Components
Type	Engine
Model (unused)	Line Maintenance
	Modifications

Methodology

MRO (cont.)

The total demand for MRO will surpass $1.388 billion and is up from $1.027 billion total in the 2024 forecast. Driving much of the gains are operators unwillingly operating older aircraft given their appetite for newer aircraft. Unfortunately, OEMs are not able to meet demands of their customers. Comparing last year's 10-year forecast with this forecast period shows engine MRO demand increasing $140 billion – two trends are driving this, costs of shop visits increasing at double digit rates of inflation and a more complete accounting for LLP events and costs. Comparatively, heavy airframe, modifications, line maintenance and components all increased on an absolute basis by $60.4 billion over 10-years.

MRO Modeling

A life-cycle algorithm loop models each aircraft type, from service-entry date through retirement. The utilization database is fed by historical OEM utilization data and augmented significantly with in-house flight tracking data. Utilization is projected by region, aircraft size category, and type and is used to drive most MRO demand projections. Calendar-based event triggers are also used which is important due to the large number of aircraft with deferred maintenance in long-term storage.

Data output includes maintenance demand such as engine service and airframe events based on projected utilization, component costs per flight hour and modification demand. In all, 42 distinct expense types are projected. Utilization changes based on actuals to date, the aircraft's age, and its role and operating region also are considered with unique factors. Key parameters of the life-cycle loop are then fed back into the main algorithm.

Engine Methodology

Engine Service Event Scope

Major maintenance service events are usually performed off the aircraft at an engine repair facility. Turbofan engines are assumed to be overhauled to manufacturer's type-certificate specifications. On-condition and life limited component parts are inspected and/or replaced as necessary. The model assumes turbofans have each of at least four different events with unique costs and cycle intervals. Tech inserts, unscheduled engine removals, airworthiness-directive/service-bulletin compliance and dilution rates for spare engines are not assumed as unique events, but compliance costs during overhauls are built into the event. Cycle event-trigger algorithms are used to note when an event should occur, and the corresponding expense/demand is recorded.

In general, events are based on historical engine fleet-wide averages applied to unique predicted events. No factors are applied for a specific operators for proprietary engine maintenance practices/schedules assumed under their certification authority; however, harsh environmental condition factors are applied by country location. Turboprop engines follow the same modeling as turbofan engines.

Credit: Brian Kough, Aviation Week Network

Methodology

Engine MRO Service Event Modeling

Engine events are forecast based upon the following parameters:

- Aircraft projected flight cycles per year
- Engine projected flight cycles per year
- Average fleet engine service intervals (average engine cycles between shop visits derived from OEMs and surveys of MROs) triggered uniquely by projected utilization.

The model links the engines continuously to the aircraft. Roughly speaking, the algorithms make the following calculations: engine utilization history + projected utilization in Year 1 + projected utilization in Year 2, and so on. Once the aircraft/engine combination arrives at a cycle trigger limit, a service event is counted, and its corresponding costs are recorded against that airframe/engine combination.

See also the new unscheduled engine event modeling, aka hospital visits.

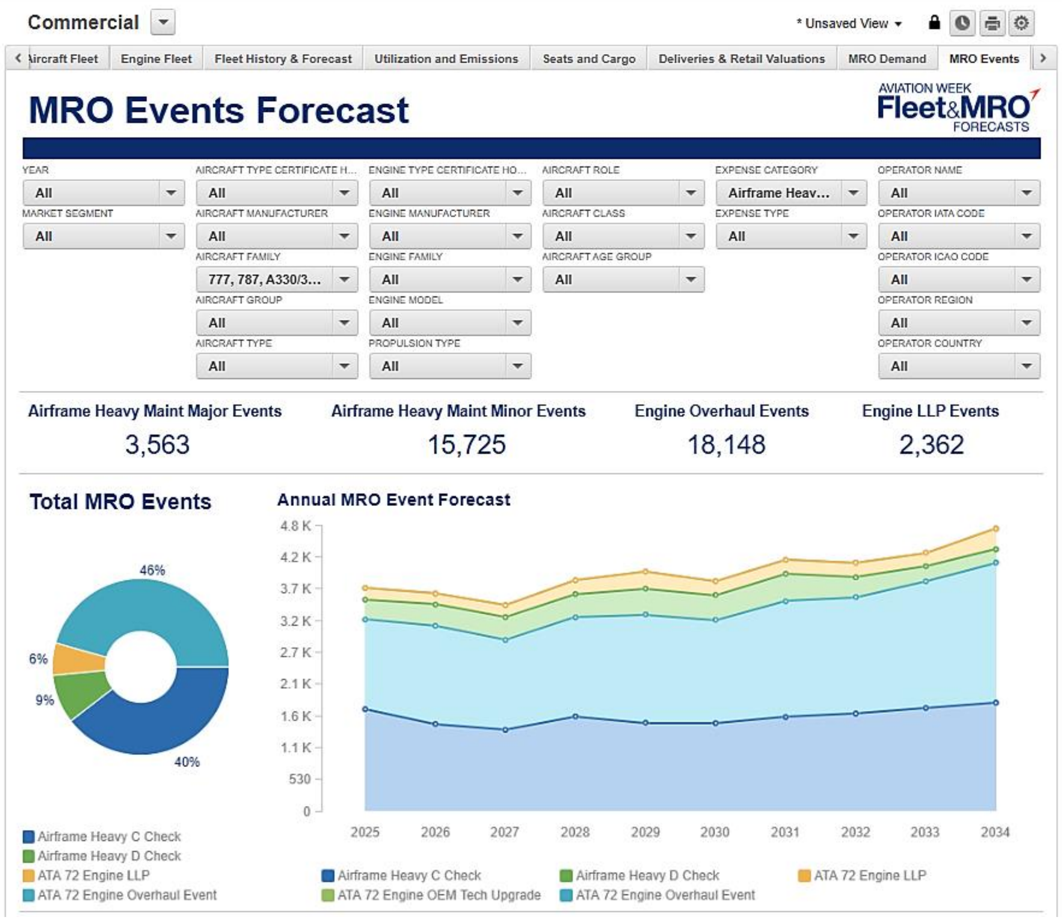
LLPs

Engine Life Limited Parts (LLPs) represent significant costs for mandatory maintenance updates to engine components as they age. Engines see the full spectrum of potential LLP events, their costs, and MRO demand impacts across the 10-years of the forecast via the events section.

Engine Count Modeling

Aircraft deliveries, retirements and in-service fleet counts are proxies for engine counts in the forecasts. For example, when the forecast shows a Boeing 737 MAX delivered, the model adds two LEAP-1Bs to the engine in-service fleet. At that point, utilization starts accruing for the aircraft/engine combinations and MRO demand accrues for event triggers. As an aircraft is retired, the corresponding engines are retired in the model. The forecast does not account for spare engines at operators or MROs.

Engine Event Reporting



Methodology

Changes to Engine Durability Issues or “Tech Upgrade” Modeling – GTF and LEAP

Continuing and adding to the GTF and LEAP engine durability MRO coverage from last year, our modeling now makes assumptions about what tech upgrades have been accomplished by engine family and what upgrades are remaining to be accomplished by the end of 2026. This is provided to give a more granular view, more specific results, and anticipated event counts and cost predictions on these two engine families.

Both engine manufacturers are working their way through entry into service on-wing durability issues. Aircraft engine “hospital visits” (ATA 72 Engine OEM Tech Upgrade - in the online tool) are calculated based on two known durability issues for the Pratt & Whitney GTF family and one for the CFM LEAP engine family.

Pratt & Whitney GTF engine issues

For airframes which have spent over 120 days on the ground during 2023 / 1H 2024 will be assumed to have had their engines, removed, inspected, and repaired for the durability issues (powder metal contamination and combustion chamber). Further, engines whose cycle count reached 80% of TBO during the time of grounding will be assumed to have received an engine performance restoration or overhaul (OH) as well.

Hospital Visits Forecasted

1. GTF - HPT #1 and #2 (4Q 2015 to 3Q 2021, date of MFG)
2. GTF - combustion/heat exchanger
3. LEAP - fuel nozzle/module upgrade, reverse bleed system

In this latter case, the engines’ OH timing will be re-set to account for this OH assumption and projected for the next shop visit via our utilization projection modeling.

Projected Engine Fleet Strengths & Tech Upgrade Event					
Commercial Aircraft	Engine Family / Models	2025		2026	
		Forecast Engine In-Service Fleet	Engine OEM Tech Upgrade Events	Forecast Engine In-Service Fleet	Engine OEM Tech Upgrade Events
A220-100/300 A319/320/321neo E190/E195-E2	**PW1000G (GTF)** (PW1500G, PW1100G-JM, PW1900G)	5,332	4,352	6,354	0
737 Max 8/9 A319/320/321neo C919	**LEAP** (LEAP-1A, LEAP-1B, LEAP-1C)	9,242	1,628	11,380	1,538

Per engine accounting for these maintenance issues is based on industry reporting for the scope, projected fleet strengths, assumed/projected fleet accomplishment rates in the future, and fielding of necessary ship-sets of repair kits to repair stations or engine shops.

Methodology

Changes to Engine Durability Issues or "Tech Upgrade" Modeling – GTF and LEAP (Cont.)

CFM LEAP engine issue

Event modeling has been divided between the LEAP-1A and LEAP-1B (for the fuel nozzle issue and reverse bleed system retrofit). In the case of the LEAP-1A, modeling assumptions anticipate that engines built in 2024 will have the necessary fixes included upon delivery. In the case of 2023 built and earlier, the assumption is that those engine's retrofits will be finalized by the end of 2024 (pre forecast period).

In the case of the LEAP-1B engine, event modelling anticipates a 2025-2026 period to fully accomplish. Engines built in 2024 and earlier *will* require an update, but CFM creation and fielding of kits has not yet begun. For assumption purposes, maintenance actions in the field will not be fully completed until the end of 2026. LEAP-1B modelling prioritized engines in this cohort by age and thrust ratings so that higher event randomization weighting is given to those that were the oldest and those that had the higher thrust ratings. This yields a fairly even 50/50% split of the anticipated 2025 engine fleet where half are assumed to be accomplished in 2025 forecast year and the remaining half anticipated for completion in year 2026.

The dollar demand annual totals are given high confidence as each issue is likely to occur, i.e., we have high confidence in their costs per engine and therefore annually. However, predicting the exact timing of the completion of events/issues is left to the judgement of the user. We felt compelled to separate out these issues into events so that users may make their own assessments as to timing and combinations as many have detailed, on the ground experience in these markets.

Events vs. Shop Visits

Actual, physical off-wing *shop visits* will be far fewer than the *events* depicted, i.e., they will have combined work scopes when inducted into a engine shop.

For instance, as a GTF engine is inducted into maintenance, it could *potentially* undergo as many as four procedures in one physical service visit: issue 1, issue 2, an LLP replacement, and a performance restoration (overhaul). It will depend on the age, cycles/hours, physical condition, warranty status, and decisions of each individual engine's owner/operator as to the work scope involved. LEAP engine durability issue physical shop visits are doubtful since the maintenance can be accomplished locally.

Users of the online forecast tool may "toggle" between seeing the event visit's dollar demand and events and not seeing them by using the MRO filters. Also, extensive use of the other available forecast filters provides more granular insights into our projections, for example, years, regions, aircraft types, engine types, other projected engine events, etc.

Credit: Brian Kough, Aviation Week Network

Methodology

Airframe MRO Methodology

Airframe Service Event Scope

Airframe events include multiple different maintenance events per aircraft based on manufacturers' designated service intervals, calendar, hours or cycles.

Events are categorized and forecast under both line maintenance and airframe heavy maintenance. (See the appendices for a breakout of these categories into expense types and definitions).

Generally, these categories include:

- Line maintenance: aircraft A checks, daily and weekly checks, transit check/turnaround checks/preflight checks and other scheduled line maintenance, if appropriate.
- Airframe Heavy C check: aircraft C checks (extensive system/component checks) excluding line/light maintenance and major modification programs.
- Airframe Heavy D check: aircraft D checks or four C checks (extensive structural and system component checks) excluding line/light maintenance and major modification programs.

Airframe Service Event Modeling

Airframe demand is modeled by applying triggering assumptions for average time (hours or cycles), or date (calendar) intervals for each active aircraft in-service during each forecast year. Once an aircraft reaches an event trigger, costs for that service are recorded in the model for that aircraft.

Costs are applied for both labor and material for A, C and D checks. Labor costs vary by operator region based on prevailing rates. Material costs are established on prevailing fleetwide averages and applied uniquely to each active aircraft per event sequence, i.e. C1, C2, C3, or D2, etc. Each event sequence has both unique material costs and unique labor hours at the group level. Demand is calculated for each forecast year when the events trigger, on a constant dollar basis.

Example: **AHM event C3 cost = C3 material costs + (C3 labor hours x regional labor rate)**

Components Methodology

Most component costs are based on cost-per-flight-hour factors, e.g., $10.35 per each flight hour of utilization. As an individual airframe accrues hourly utilization in the model, these factors are applied per the projected utilization for each airframe/operator region combination for each forecast year. Demand accrues and is aggregated on an annual basis at multiple levels: airframe, operator, region, OEM, TCH and other categories. Several components are tracked/forecasted on an event basis, such as landing gear and thrust reversers, where either hours, cycles, or calendar intervals are used to trigger unique maintenance spending events.

Credit: Brian Kough, Aviation Week Network

Credit: Mike Hopwood, Aviation Week Network

Methodology

Fuel Consumption & Emissions Projections

Fuel Consumption

Consumption or fuel burn is calculated based on nominal values as recognized by Eurocontrol standards. These baselines are combined with Aviation Week Network proprietary assumptions, calculations, and forecasts to provide an estimate of future values for each forecast year. In all cases, nominal values are used for number of seats per aircraft (Aviation Week) and fuel burn (Eurocontrol) while hourly utilization is an Aviation Week forecast projection.

Engine Emissions

Engine CO_2 emissions are calculated based on nominal values as recognized by Eurocontrol standards. These baselines are combined with Aviation Week Network proprietary assumptions, calculations, and forecasts to provide an estimate of future values for each forecast year. In all cases, nominal values are used for number of seats per aircraft (Aviation Week) and emissions (Eurocontrol) while hourly utilization is an Aviation Week forecast projection.

Analysis

Projected emissions and fuel consumption are highlighted in the online forecast dashboard along with various utilization metrics. Fuel consumption (fuel burn) and emissions are filterable by all the accompanying filter fields at the top of the tab. Supporting analysis, various headline reports and charts are provided to assist the user in visualizing the information for any given filterable scenario over the next 10-years.

Market Situation

Wild swings can occur rapidly in this market as we've seen, but pent-up passenger demand is strong if not a bit uneven, regionally. The major concerns now are global economic conditions and manufacturing capability/capacity.

The pandemic is the overarching marker on which we are gauging our market. Creating a new normal for regulations, travel importance, and passenger behaviors. International traffic behavior is still a bit impacted, but optimism in the commercial market is high.

Economic, manufacturing and financial factors influenced this forecast. Government debt levels are high in the Americas and Europe with inflation seemingly under control. Fuel costs are relatively low but seems to have little effect on margins given labor and material costs increasing. Capital costs are still high but projected to decrease. Manufacturing issues include supply chain issues and labor shortages while operation staff have seen big wage increases. The potential for economic softening in many regions are the items to watch; inflation and or recessions, could all potentially conspire to impact the commercial market before airlines are able to become profitable despite the ongoing recovery.

General Assumptions

Delivery predictions are derived from OEM production estimates, corporate announcements, one-on-one discussions, internal staff research, and are evaluated against external and internal sources before forecast release. GDP predictions from major sources are used to estimate overall economic conditions over the forecast period and shape the end results.

Model assumptions reflect estimates for aircraft utilization that influence service intervals as well as average costs at the airframe, engine, modification, component and line-maintenance levels. The forecast does not model characteristics of individual operators nor their unique maintenance programs; however, it does provide valuable market trend information for strategic investment and decisions.

Constant 2024 U.S. dollars, without adjustment for inflation or escalation, are used in all cost figures. Additionally, material costs and regional labor rates are not escalated in MRO assumptions, but costs are adjusted for inflation in each annual release of the forecast.

Future global and regional recessions and/or major geopolitical shocks cannot be predicted and are not accounted for in the forecast; however, current global risks and trends are accounted for to shape the forecast results.

Appendices

Appendix – Aircraft In-Scope

Type Certificate Holder	Original Aircraft Manufacturer	Aircraft Group	Aircraft Category
328 Support Services	Avcraft Aviation	328JET	Regional Jet
328 Support Services	Dornier	328JET	Regional Jet
328 Support Services	Fairchild-Dornier	328JET	Regional Jet
328 Support Services	RUAG	328JET	Regional Jet
Airbus	Airbus	A220-100	Narrowbody Jet
Airbus	Airbus	A220-300	Narrowbody Jet
Airbus	Airbus	A300	Widebody Jet
Airbus	Airbus	A300-600	Widebody Jet
Airbus	Airbus	A310	Widebody Jet
Airbus	Airbus	A318	Narrowbody Jet
Airbus	Airbus	A319	Narrowbody Jet
Airbus	Airbus	A319NEO	Narrowbody Jet
Airbus	Airbus	A320	Narrowbody Jet
Airbus	Airbus	A320NEO	Narrowbody Jet
Airbus	Airbus	A321	Narrowbody Jet
Airbus	Airbus	A321NEO	Narrowbody Jet
Airbus	Airbus	A330-200	Widebody Jet
Airbus	Airbus	A330-200F	Widebody Jet
Airbus	Airbus	A330-300	Widebody Jet
Airbus	Airbus	A330-300F	Widebody Jet
Airbus	Airbus	A330-700L	Widebody Jet

Type Certificate Holder	Original Aircraft Manufacturer	Aircraft Group	Aircraft Category
Airbus	Airbus	A330-800	Widebody Jet
Airbus	Airbus	A330-900	Widebody Jet
Airbus	Airbus	A340-200/300	Widebody Jet
Airbus	Airbus	A340-500/600	Widebody Jet
Airbus	Airbus	A350-1000	Widebody Jet
Airbus	Airbus	A350-900	Widebody Jet
Airbus	Airbus	A350-950F	Widebody Jet
Airbus	Airbus	A380	Widebody Jet
Airbus	Airbus	BELUGA	Widebody Jet
Airbus	Bombardier	A220-100	Narrowbody Jet
Airbus	Bombardier	A220-300	Narrowbody Jet
ATR	ATR	ATR42	Turboprop
ATR	ATR	ATR72	Turboprop
ATR	ATR	ATR72F	Turboprop
BAE Systems	British Aerospace	ATP	Turboprop
BAE Systems	British Aerospace	BAE 146	Regional Jet
BAE Systems	British Aerospace	HS748	Turboprop
BAE Systems	British Aerospace	JETSTREAM31	Turboprop
BAE Systems	British Aerospace	JETSTREAM41	Turboprop
BAE Systems	Hawker-Siddeley Aviation	HS748	Turboprop

Appendix – Aircraft In-Scope

Type Certificate Holder	Original Aircraft Manufacturer	Aircraft Group	Aircraft Category
Boeing	Boeing	707	Narrowbody Jet
Boeing	Boeing	717	Narrowbody Jet
Boeing	Boeing	727	Narrowbody Jet
Boeing	Boeing	737-200	Narrowbody Jet
Boeing	Boeing	737-300	Narrowbody Jet
Boeing	Boeing	737-400	Narrowbody Jet
Boeing	Boeing	737-500	Narrowbody Jet
Boeing	Boeing	737-600	Narrowbody Jet
Boeing	Boeing	737-700	Narrowbody Jet
Boeing	Boeing	737-800	Narrowbody Jet
Boeing	Boeing	737-900	Narrowbody Jet
Boeing	Boeing	737-MAX10	Narrowbody Jet
Boeing	Boeing	737-MAX7	Narrowbody Jet
Boeing	Boeing	737-MAX8	Narrowbody Jet
Boeing	Boeing	737-MAX9	Narrowbody Jet
Boeing	Boeing	747-200/300	Widebody Jet
Boeing	Boeing	747-400	Widebody Jet
Boeing	Boeing	747-8	Widebody Jet
Boeing	Boeing	747-8F	Widebody Jet
Boeing	Boeing	747SP	Widebody Jet
Boeing	Boeing	757	Narrowbody Jet

Type Certificate Holder	Original Aircraft Manufacturer	Aircraft Group	Aircraft Category
Boeing	Boeing	767	Widebody Jet
Boeing	Boeing	767-200F	Widebody Jet
Boeing	Boeing	767-300F	Widebody Jet
Boeing	Boeing	777-200/300	Widebody Jet
Boeing	Boeing	777-200ER/LR	Widebody Jet
Boeing	Boeing	777-200F	Widebody Jet
Boeing	Boeing	777-300ER	Widebody Jet
Boeing	Boeing	777-300F	Widebody Jet
Boeing	Boeing	777-8F	Widebody Jet
Boeing	Boeing	777-9	Widebody Jet
Boeing	Boeing	787-10	Widebody Jet
Boeing	Boeing	787-8	Widebody Jet
Boeing	Boeing	787-9	Widebody Jet
Boeing	Douglas Aircraft	DC-9	Narrowbody Jet
Boeing	McDonnell Douglas	DC-10	Widebody Jet
Boeing	McDonnell Douglas	DC-8-60/70	Narrowbody Jet
Boeing	McDonnell Douglas	DC-9	Narrowbody Jet
Boeing	McDonnell Douglas	MD-10	Widebody Jet
Boeing	McDonnell Douglas	MD-11	Widebody Jet
Boeing	McDonnell Douglas	MD-80	Narrowbody Jet

Appendix – Aircraft In-Scope

Type Certificate Holder	Original Aircraft Manufacturer	Aircraft Group	Aircraft Category
COMAC	COMAC	ARJ21	Regional Jet
COMAC	COMAC	C919	Narrowbody Jet
De Havilland Aircraft of Canada	Bombardier	DHC-8-100/200	Turboprop
De Havilland Aircraft of Canada	Bombardier	DHC-8-300	Turboprop
De Havilland Aircraft of Canada	Bombardier	DHC-8-400	Turboprop
De Havilland Aircraft of Canada	De Havilland Aircraft of Canada	DHC-8-400	Turboprop
De Havilland Aircraft of Canada	de Havilland Canada	DHC-8-100/200	Turboprop
De Havilland Aircraft of Canada	de Havilland Canada	DHC-8-300	Turboprop
Deutsche Aircraft	Dornier	DO328	Turboprop
Embraer	Embraer	E190-E2	Regional Jet
Embraer	Embraer	E195-E2	Regional Jet
Embraer	Embraer	EMB110	Turboprop
Embraer	Embraer	EMB120	Turboprop
Embraer	Embraer	EMB135/140/145	Regional Jet
Embraer	Embraer	EMB170/175	Regional Jet
Embraer	Embraer	EMB190/195	Regional Jet
Embraer	Yabora Industria Aeronautica	E190-E2	Regional Jet
Embraer	Yabora Industria Aeronautica	E195-E2	Regional Jet
Embraer	Yabora Industria Aeronautica	EMB170/175	Regional Jet
Embraer	Yabora Industria Aeronautica	EMB190/195	Regional Jet

Type Certificate Holder	Original Aircraft Manufacturer	Aircraft Group	Aircraft Category
Fokker	Fokker	F-27	Turboprop
Fokker	Fokker	F-28	Regional Jet
Fokker	Fokker	Fk100	Narrowbody Jet
Fokker	Fokker	Fk50	Turboprop
Fokker	Fokker	Fk70	Regional Jet
General Atomics AeroTech Systems	Dornier	DO228	Turboprop
General Atomics AeroTech Systems	Dornier	DO228NG	Turboprop
General Atomics AeroTech Systems	Hindustan Aeronautics Ltd.	DO228	Turboprop
General Atomics AeroTech Systems	Hindustan Aeronautics Ltd.	DO228NG	Turboprop
General Atomics AeroTech Systems	RUAG	DO228NG	Turboprop
Hawker Beechcraft	Beech Aircraft Corporation	BEECH1900	Turboprop
Hawker Beechcraft	Raytheon Aircraft	BEECH1900	Turboprop
Indonesian Aerospace (PTDI)	Indonesian Aerospace (PTDI)	N219	Turboprop
Lockheed Martin	Lockheed	L-1011	Widebody Jet
M7 Aerospace	Fairchild Aircraft	METRO	Turboprop
M7 Aerospace	Swearingen	METRO	Turboprop
Mitsubishi	Bombardier	CRJ-100/200	Regional Jet
Mitsubishi	Bombardier	CRJ-700/900/1000	Regional Jet
Mitsubishi	Canadair	CRJ-100/200	Regional Jet

Appendix – Aircraft In-Scope

Type Certificate Holder	Original Aircraft Manufacturer	Aircraft Group	Aircraft Category
SAAB	SAAB	SAAB2000	Turboprop
SAAB	SAAB	SAAB340	Turboprop
Textron Aviation	Beech Aircraft Corporation	BEECH1900	Turboprop Aircraft (Non-Business)
Textron Aviation	Raytheon Aircraft	BEECH1900	Turboprop Aircraft (Non-Business)
Textron Aviation	Textron Aviation	CE408	Turboprop Aircraft (Non-Business)
Textron Aviation	Textron Aviation	CE408F	Turboprop Aircraft (Non-Business)
Viking Air	de Havilland Canada	DHC-6	Turboprop
Viking Air	de Havilland Canada	DHC-7	Turboprop
Viking Air	Short Brothers	SHORT330	Turboprop
Viking Air	Short Brothers	SHORT360	Turboprop
Viking Air	Viking Air	DHC-6-300G	Turboprop
Viking Air	Viking Air	DHC-6-400	Turboprop
Xi'an Aircraft Industrial Corporation	Xi'an Aircraft Industrial Corporation	MA700	Turboprop

Appendix – Engines In-Scope

Engine Manufacturer	Engine Family	Engine Model
BMW + Rolls-Royce	BR700	BR700
CFM International	CFM56	CFM56-2
CFM International	CFM56	CFM56-3
CFM International	CFM56	CFM56-5A
CFM International	CFM56	CFM56-5B
CFM International	CFM56	CFM56-5C
CFM International	CFM56	CFM56-7B
CFM International	LEAP	LEAP-1A
CFM International	LEAP	LEAP-1B
CFM International	LEAP	LEAP-1C
Engine Alliance	GP7000	GP7000
Garrett-AiResearch	TPE331	TPE331-1 to 8
Garrett-AiResearch	TPE331	TPE331-10/11
Garrett-AiResearch	TPE331	TPE331-12
Garrett-AiResearch	TPE331	TPE331-14
General Electric	CF34	CF34-10A
General Electric	CF34	CF34-10E
General Electric	CF34	CF34-3A
General Electric	CF34	CF34-3B
General Electric	CF34	CF34-8C
General Electric	CF34	CF34-8E

Engine Manufacturer	Engine Family	Engine Model
General Electric	CF6	CF6-50
General Electric	CF6	CF6-80A
General Electric	CF6	CF6-80C2
General Electric	CF6	CF6-80E
General Electric	CT7	CT7
General Electric	GE90	GE90
General Electric	GE90	GE90-110B
General Electric	GE90	GE90-115B
General Electric	GE90	GE90-94B
General Electric	GE9X	GE9X
General Electric	GENX	GENX-1
General Electric	GENX	GENX-2
Honeywell	TPE331	TPE331-1 to 8
Honeywell	TPE331	TPE331-10/11
International Aero Engines	V2500	V2500-A1
International Aero Engines	V2500	V2500-A5
Pratt & Whitney	JT3	JT3D
Pratt & Whitney	JT8D	JT8D
Pratt & Whitney	JT8D	JT8D-200
Pratt & Whitney	JT9D	JT9D-7A
Pratt & Whitney	JT9D	JT9D-7R4

Appendix – Engines In-Scope

Engine Manufacturer	Engine Family	Engine Model
Pratt & Whitney	PW1000G	PW1100G-JM
Pratt & Whitney	PW1000G	PW1500G
Pratt & Whitney	PW1000G	PW1900G
Pratt & Whitney	PW2000	PW2000
Pratt & Whitney	PW4000	PW4000-100
Pratt & Whitney	PW4000	PW4000-112
Pratt & Whitney	PW4000	PW4000-94
Pratt & Whitney Canada	PT6A	PT6A LARGE
Pratt & Whitney Canada	PT6A	PT6A MEDIUM
Pratt & Whitney Canada	PT6A	PT6A SMALL
Pratt & Whitney Canada	PW100	PW100 LARGE
Pratt & Whitney Canada	PW100	PW100 MEDIUM
Pratt & Whitney Canada	PW100	PW100 SMALL
Pratt & Whitney Canada	PW300	PW300

Engine Manufacturer	Engine Family	Engine Model
Rolls-Royce	AE2100	AE2100
Rolls-Royce	AE3007	AE3007
Rolls-Royce	BR700	BR700
Rolls-Royce	DART	DART
Rolls-Royce	RB211	RB211-524BC
Rolls-Royce	RB211	RB211-524GH
Rolls-Royce	RB211	RB211-535
Rolls-Royce	SPEY	SPEY
Rolls-Royce	TAY	TAY600
Rolls-Royce	TRENT	TRENT1000
Rolls-Royce	TRENT	TRENT500
Rolls-Royce	TRENT	TRENT700
Rolls-Royce	TRENT	TRENT7000
Rolls-Royce	TRENT	TRENT800
Rolls-Royce	TRENT	TRENT900
Rolls-Royce	TRENT	TRENTXWB
Textron-Lycoming (AVCO)	LF507	LF507

Appendix – Region-Country Alignments

Africa			
Algeria	Equatorial Guinea	Malawi	Senegal
Angola	Eritrea	Mali	Seychelles
Benin	Eswatini (Swaziland)	Mauritania	Somalia
Botswana	Ethiopia	Mauritius	South Africa
Burkina Faso	Gabon	Mayotte	South Sudan
Cameroon	Gambia	Morocco	Sudan
Cape Verde	Ghana	Mozambique	Tanzania
Central African Republic	Guinea	Namibia	Togo
Chad	Ivory Coast	Niger	Tunisia
Congo (Brazzaville)	Kenya	Nigeria	Uganda
Congo (Democratic Republic)	Lesotho	Reunion	Zambia
Djibouti	Libya	Rwanda	Zimbabwe
Egypt	Madagascar	Sao Tome & Principe	

Asia-Pacific			
Afghanistan	Hong Kong	Myanmar	South Korea
Australia	Indonesia	Nauru	Sri Lanka
Bangladesh	Japan	Nepal	Taiwan
Bhutan	Kiribati	New Caledonia	Thailand
Brunei	Laos	New Zealand	Tonga
Cambodia	Macau	Pakistan	Vanuatu
Cook Islands	Malaysia	Papua New Guinea	Vietnam
East Timor	Maldives	Philippines	
Fiji	Marshall Islands	Singapore	
French Polynesia	Mongolia	Solomon Islands	

China
China

Appendix – Region-Country Alignments

Eastern Europe			
Albania	Czech Republic	Lithuania	Slovakia
Armenia	Estonia	Montenegro	Slovenia
Azerbaijan	Georgia	North Macedonia	Tajikistan
Belarus	Hungary	Poland	Turkmenistan
Bosnia & Herzegovina	Kazakhstan	Romania	Ukraine
Bulgaria	Kyrgyzstan	Russia	Uzbekistan
Croatia	Latvia	Serbia	

India
India

Latin America			
Antarctica	Cayman Islands	Guatemala	St. Vincent & The Grenadines
Antigua & Barbuda	Chile	Guyana	Suriname
Argentina	Colombia	Haiti	Trinidad & Tobago
Aruba	Costa Rica	Honduras	Turks & Caicos
Bahamas	Cuba	Jamaica	Uruguay
Belize	Curacao	Mexico	Venezuela
Bermuda	Dominican Republic	Panama	
Bolivia	Ecuador	Paraguay	
Brazil	El Salvador	Peru	
British Virgin Islands	Guadeloupe	St. Maarten	

Appendix – Region-Country Alignments

Middle East		
Bahrain	Kuwait	Syria
Iran	Lebanon	United Arab Emirates
Iraq	Oman	Yemen
Israel	Qatar	
Jordan	Saudi Arabia	

North America	
Canada	United States

Western Europe			
Austria	Greece	Luxembourg	Switzerland
Belgium	Greenland	Malta	Turkey
Cyprus	Guernsey	Netherlands	United Kingdom
Denmark	Iceland	Norway	
Faroe Islands	Ireland	Portugal	
Finland	Isle Of Man	San Marino	
France	Italy	Spain	
Germany	Jersey	Sweden	

Appendix – MRO Categories & Expense Types

Expense Category	Expense Type/ATA Chapter	Overview	Description	Major Components
Airframe Heavy	**Heavy Maintenance D Check**	Major Airframe Heavy Maintenance/Base Maintenance	Aircraft "D" Checks (IL, 4C, 8C, etc.) - Extensive structural check. Excludes line / light maintenance and major modification programs.	Service inspections include visual/non-destructive structure tests, corrosion, structural, deformation, cracking, other deterioration.
	Heavy Maintenance C Check	Minor Airframe Heavy Maintenance/Base Maintenance	Aircraft "C" Checks (PI, 1C, 2C, 3C, etc.) - Extensive system/component check. Excludes line / light maintenance and major modification programs.	Service inspections include extensive system and component checks, visual, functional, emergency systems, DC bus tie control unit, door seals, flight controls, APU, engine inlet, RAT deployment.
	Turboprop Airframe Heavy Maintenance	Major & Minor Airframe Heavy Maintenance Turboprop	Structural and extensive systems check. Excludes line / light maintenance and major modification programs.	Inspections include visual/non-destructive systems and or structure tests, corrosion, structural, deformation, cracking, and deterioration.

Appendix – MRO Categories & Expense Types

Expense Category	Expense Type/ATA Chapter	Overview	Description	Major Components
Components (1/7)	**ATA 21 Air Conditioning & Pressurization**	Air Conditioning & Pressurization	Units and components which furnish a means of pressurizing, heating, cooling, moisture controlling, filtering and treating the air used to ventilate the areas of the fuselage within the pressure seals. Includes cabin supercharger, equipment cooling, heater, heater fuel system, expansion turbine, valves, scoops, ducts, etc.	Cabin air distribution system, pressure indicating system, cooling system, pressure sensors, pressure regulators, heating system, temperature control.
	ATA 22 Autoflight	Autoflight	Those units and components which furnish a means of automatically controlling the flight of the aircraft. Includes those units and components which control direction, heading, attitude, altitude and speed.	Autopilot, auto throttle.
	ATA 23 Communications	Communications	Those units and components which furnish a means of communicating from one part of the aircraft to another and between the aircraft or ground stations, includes voice, data, continuous wave communicating components, PA system, intercom and tape reproducers-record player.	Radios, data links, PA system, intercom, ACARS, voice recorders.
	ATA 24 Electrical Power	Electrical Power	Electrical units and components which generate, control and supply AC and/or DC electrical power for systems, including generators and relays, inverters, batteries, etc., through the secondary busses. Also includes common electrical items such as wiring, switches, connectors, etc.	Inverters, regulators, phase adapter IDGs/generators, electrical load distribution, engine starters.

Appendix – MRO Categories & Expense Types

Expense Category	Expense Type/ATA Chapter	Overview	Description	Major Components
Components (2/7)	**ATA 25 Interior Equip & Furnishings**	Interior Equip & Furnishings	Those removable items of equipment and furnishings mounted in the aircraft or contained in the flight, passenger, cargo, and accessory compartments. Includes emergency, buffet, and lavatory equipment. Does not include structures of equipment assigned specifically to other chapters.	Seats, carts, galleys, lavatories, storage compartments, emergency equipment: ELTs, life rafts, escape slides.
	ATA 26 Fire Protection	Fire Protection	Fixed and portable units and components which detect and indicate fire or smoke and store and distribute fire extinguishing agent to all protected areas of the aircraft; including bottles, valves, tubing, etc.	Fire/smoke detectors, fire extinguishing equipment, explosion suppression
	ATA 27 Flight Controls	Flight Controls	Components which furnish a means of manually controlling the flight attitude characteristics of the aircraft, including items such as hydraulic boost system, rudder pedals, controls, mounting brackets, etc. Also includes the functioning and maintenance aspects of the flaps, spoilers, and other control surfaces, but does not include the structure which is covered in the Structures Chapters.	Control column, aileron, rudder, elevator actuators, hydraulic boost system, flap drive transmissions, electric motors, servo valves, leading edge slats, trailing edge flaps.

Appendix – MRO Categories & Expense Types

Expense Category	Expense Type/ATA Chapter	Overview	Description	Major Components
Components (3/7)	**ATA 28 Fuel**	Fuel Storage & Delivery	Components which store and deliver fuel to the engine. Includes tanks (bladder), valves, boost pumps, etc., and those components which furnish a means of dumping fuel overboard. Includes integral and tip fuel tank leak detection and sealing. Does not include the structure of integral or tip fuel tanks and the fuel cell backing boards which are covered in the Structures Chapters, and does not include fuel flow rate sensing, transmitting and / or indicating, which are covered in Chapter 73.	Engine tanks, distribution systems, valves, boost pumps, sensors, quantity indicating systems, connectors.
	ATA 29 Hydraulic Power	Hydraulics	Components which furnish hydraulic fluid under pressure (includes pumps, regulators, lines, valves, etc.) to a common point (manifold) for redistribution to other defined systems.	Pumps, valves, accumulators, regulators, lines, manifolds, heat exchangers, indicating systems.
	ATA 31 Instruments/Avionics	Instruments/Avionics	Pictorial coverage of all instruments, instrument panels and controls. Procedural coverage of those systems which give visual or aural warning of conditions in unrelated systems. Units which record, store or compute data from unrelated systems. Includes systems/units which integrate indicating instruments into a central display system and instruments not related to any specific system.	Primary and secondary displays, instrument & control panels, flight recorders, enunciators, automatic data reporting systems.

Appendix – MRO Categories & Expense Types

Expense Category	Expense Type/ATA Chapter	Overview	Description	Major Components
Components (4/7)	**ATA 32 Wheels & Brakes**	Wheels & Brakes (only)	That portion of the system which provides for rolling and stopping the aircraft while on the ground and stopping wheel rotation after retraction.	Wheels, tires, brakes, brake cylinders.
	ATA 34 Navigation/Avionics	ATA 34 Navigation/Avionics	Components which provide aircraft navigational information. Includes airspeed indicator, air data computer, stall warning, attitude indicator, VOR, pitot, static, ILS, flight director, compasses, GPS, etc.	Flight management systems (FMS), GPS navigation systems, navigation sensors, air data computer/pitot systems, inertial navigation systems, weather radar, ground proximity warning system, TCAS, and ground collision avoidance systems
	ATA 35 Oxygen	Oxygen	Components which store, regulate, and deliver oxygen to the passengers and crew, including bottles, relief valves, shut-off valves, outlets, regulators, masks, walk -around bottles, etc.	Oxygen tanks, bottles, relief valves, shut off valves, regulators, and masks.
	ATA 36 Pneumatics	Pneumatics	Components (ducts and valves) which deliver large volumes of compressed air from a power source to connecting points for such other systems as air conditioning, pressurization, deicing, etc.	Bleed valves, ducts, regulators, heat exchangers.
	ATA 44 IFE(C) Components	IFE(C) Components	Units and components required to deliver video, audio and connectivity services.	Wifi, seat-based video screens and control units, overhead video units, satellite antennas and central control units.

Appendix – MRO Categories & Expense Types

Expense Category	Expense Type/ATA Chapter	Overview	Description	Major Components
Components (5/7)	**ATA 49 APU**	APU	Airborne power plants installed on aircraft generating and supplying a single type or combination of auxiliary electric, hydraulic, pneumatic or other power. Includes power and drive section, fuel, ignition and control systems; also wiring, indicators, plumbing, valves, and ducts up to the power unit. Does not include generators, alternators, hydraulic pumps, etc. or their connecting systems which supply and deliver power to their respective aircraft systems.	Auxiliary Power Unit.
	ATA 61 Turboprop Propeller	Turboprop Propeller	Propeller & accessories specifically found in turboprop powered aircraft.	Propeller, propeller systems. Includes propeller spinner synchronizers, pumps, motors, governor, alternators, propulsor duct assemblies, aerodynamic fairing of mechanical components, stators, vectoring systems.
	ATA 73 Engine Fuel & Control	Engine Fuel & Control	Units and components associated with mechanical systems or electrical circuits which furnish or control fuel to the engine beyond the main fuel quick disconnect; and trust augmenter, fuel flow rate sensing, transmitting and/or indicating units whether the units are before or beyond the quick disconnect. Includes coordinator of equivalent, engine driven fuel pump and filter assembly, main and thrust augmenter fuel controls, electronic temperature datum control, temperature datum valve, fuel manifold, fuel nozzles, fuel enrichment system, speed sensitivity switch, relay box assembly, solenoid drip valve, etc.	Fuel controls, main engine pump, and filter assembly valves, fuel flow indicating, fuel nozzles.

Appendix – MRO Categories & Expense Types

Expense Category	Expense Type/ATA Chapter	Overview	Description	Major Components
Components (6/7)	**ATA 75 Bleed Air**	Bleed Air	External units and components and integral basic engine parts which go together to conduct air to the extension shaft and torque meter, assembly, if any. Includes compressor bleed systems used to control flow of air through the engine, cooling air systems and heated air systems for engine anti-icing. Does not include aircraft anti-icing, engine starting systems, nor exhaust supplementary air systems.	Compressor bleed systems used to control air through the engine, cooling air systems and heated air systems for engine anti-icing.
	ATA 76 Engine Controls	Engine Controls	Controls which govern operation of the engine. Includes units and components which are interconnected for emergency shutdown. For turboprop engines, includes linkages and controls to the coordinator or equivalent to the propeller governor, fuel control unit or other units being controlled.	Emergency shutdown systems, linkages, and wiring.
	ATA 77 Engine Indicating	Engine Indicating	Units, components and associated systems which indicate engine operation. Includes indicators, transmitters, analyzers, etc. For turbo-prop engines includes phase detectors. Does not include systems or items which are included in other chapters except when indication is accomplished as part of an integrated engine instrument system	Thrust, speed, pressure and temperature indicators, integrated engine instrument systems
	ATA 78 Exhaust Non-Thrust Reverser	Exhaust	Units and components which direct the engine exhaust gases overboard. Excludes exhaust-driven turbines.	Exhaust nozzles, noise suppressors, ducts.

Appendix – MRO Categories & Expense Types

Expense Category	Expense Type/ATA Chapter	Overview	Description	Major Components
Components (7/7)	**ATA 78-30 Thrust Reverser (only)**	Thrust Reverser (only)	That portion of the system which is used to change the direction of the exhaust gases for reverse thrust. Includes items such as clamshells, linkages, levers, actuator, plumbing, wiring, indicators, warning systems, etc.	Clamshells, actuators, linkages, indicators, wiring.
	ATA 79 Engine Oil	Engine Oil Storage & Delivery	Units and components external to the engine (airframe furnished) for storing and delivering lubricating oil to and from the engine. Covers all units and components from the lubricating oil engine outlet to the inlet, including the inlet and outlet fittings, tank, radiator, by-pass valve, etc., and auxiliary oil systems.	Oil pumps, tanks, valves, radiators, indicating systems.
	ATA 80 Starting	Engine Starting	Those units, components and associated systems used for starting the engine. Includes electrical, inertial air or other starter systems.	Starters, valves, relays

Appendix – MRO Categories & Expense Types

Expense Category	Expense Type/ATA Chapter	Overview	Description	Major Components
Engine Maintenance	**ATA 72 Engine Overhaul**	Engine – Turbofan Overhaul	Shop visits/major overhauls returning engine to manufacturer's specifications. Aviation Week models this activity as a trigger event based on hours of utilization.	Engine & engine systems.
	ATA 72T Engine Overhaul	Engine – Turboprop Overhaul	Shop visits/major overhauls returning engine to manufacturer's specifications. Aviation Week models this activity as a trigger event based on hours of utilization.	Engine & engine systems.
	ATA 72 Engine LLP	Engine – Turbofan Life Limited Parts (LLPs)	Includes costs of LLPs materials and labor. Aviation Week models this activity based on trigger events based on cycle utilization.	Life limited parts as specified in individual type certificate approvals associated to the engine.
	ATA 72T Engine LLP	Engine – Turboprop Life Limited Parts (LLPs)	Includes costs of LLPs materials and labor. Aviation Week models this activity based on trigger events based on cycle utilization.	Life limited parts as specified in individual type certificate approvals associated to the engine.
	ATA 72 Engine OEM Tech Upgrade	Engine – Durability Issues	Also referred to as "Hospital Visits", the new feature projects both events and MRO demand for retroactive corrective actions forecasted to take place in future years 2025/26 for the LEAP and PW1000G (GTF) engines.	Hospital visits forecasted: GTF HPT #1 and #2, GTF combustion/heat exchanger, LEAP fuel nozzle upgrade and reverse bleed system.

Appendix – MRO Categories & Expense Types

Expense Category	Expense Type/ATA Chapter	Overview	Description	Major Components
Line Maintenance	**A Check**	A Check	Light aircraft check. Includes: Hangar checks at intervals of typically 500 to 1,000 flight hours for narrowbodies and widebodies, respectively. Includes labor costs, materials and overhead. Excludes: Off-wing or off-aircraft activity/materials. Aviation Week models this activity as a flight hour or calendar cost.	Inspections includes oxygen system, emergency lighting, landing gear, brakes, flight controls. Visual inspection for obvious damage, deterioration, or general issues with condition or security.
	Daily & Weekly Checks	Daily & Weekly Checks	Light overall aircraft check. Includes: Daily checks at intervals of 24-36 hours, sometimes described as overnight checks. Weekly checks include 7/8 day checks and 3/4 day checks. Includes labor factors, materials and overhead. Excludes: Off-wing or off-aircraft activity/materials. Aviation Week models this activity as a daily cost.	Inspections include obvious visual damage, deterioration, or general issues with condition or security.
	Transit Check	Transit Check/Turn Around Checks/Pre Flight Checks	Light overall aircraft check. Includes: Turn-around checks sometimes also described as transit check and/or ETOPS checks for long-haul operations. Includes labor factors and overhead Excludes: pilots 'walkaround' on an estimated 10% of short-haul operations and technicians doing pushback. Off-wing or off-aircraft activity/materials. Aviation Week models this activity as a cycle based cost.	Inspection includes a walk around inspection looking for obvious visual damage, deterioration, or general issues with condition or security.

Appendix – MRO Categories & Expense Types

Expense Category	Expense Type/ATA Chapter	Overview	Description	Major Components
Modifications	**Avionics & Systems Modifications**	Avionics & Systems Modifications	Upgrade/modification of the avionics or mission systems	Avionics, FMS, cockpit systems, GPS
	ATA 44 IFE(C) - Modifications	IFE (C) Modifications	Upgrade/modification to the components required to deliver video, audio, and connectivity.	Seat based video screens and control units, overhead video units, satellite antennas and central control units
	ATA 25 Interior Equip & Furnishings - Modifications	Interior Modifications	Upgrade/modification to the interior fixtures/fittings of the aircraft.	Furniture, seats, carpet
	Painting	Painting	Exterior paint	Exterior Paint

AVIATION WEEK Fleet&MRO FORECASTS

Thank You

COMMERCIAL

2025 MARKET SUMMARY REPORT

For more information, visit aviationweek.com/Forecasts

Contact:
Melissa Crum
+1 913 284 2951

Intelligence & Data Services | Aviation Week Intelligence Network
Washington, D.C.

AVIATION WEEK NETWORK