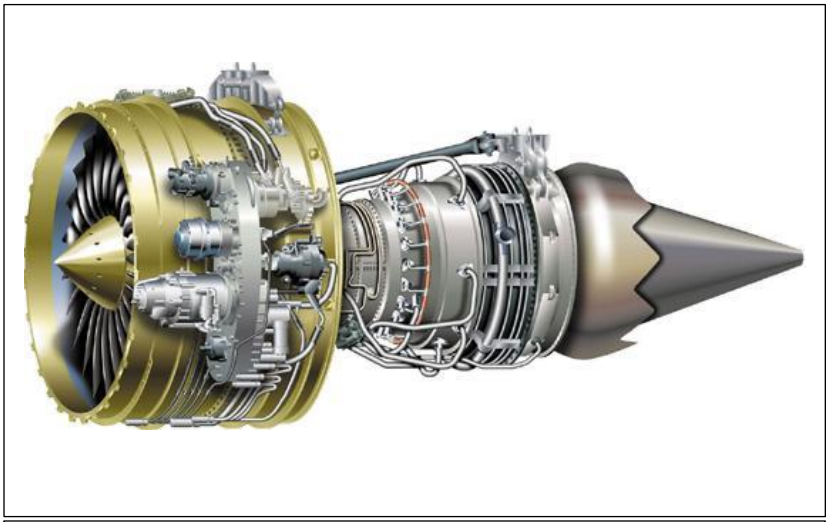
General Electric CF34/TF34

Turbofans
Small (<10k lbst)
Medium (10k–25k lbst)
May 2022



Quick Specs:

Power Class:	8,650 – 18,750 lbst (38.5 – 83.4 kN)
Bypass & Pressure Ratios:	4.9:1 – 6.2:1 & 21:1 – 29:1
Airflow:	320 – 446 lb/sec (145 – 202 kg/sec)
SFC:	0.345 – 0.390 lb/lbst-hr (10 – 11 mg/Ns)
Configuration:	1 F; 8A – 10A HPC; Annular; 2A HPT; 4A LPT

Program Briefing

The wildly successful General Electric CF34 turbine is a mid-range, high-bypass-ratio fan targeting the large business jet and regional jet markets. The CF34 has been scaled from 8,500- to 18,500-lbst, competing with the Rolls-Royce AE3007 and RB282, and P&WC PW300 at its lower end and the Rolls-Royce BR700 and PowerJet SaM146 at the upper end. A civil version of the TF34 found on the Fairchild A-10 attack aircraft, the engine's first commercial application was the Challenger 601 in 1980.

The proven reliability and low cost of ownership of the CF34 family has won over the regional jet manufacturers whose clients generally live on razor-thin profit margins and cannot afford any surprises. We see no immediate competition for the engine until GE's own Passport (see report) hits the market.

The latest variant in the family, the CF34-10E, is an 18,500-lbst fan, which received its FAA type certification in March 2005 and entered service aboard the Embraer 190 in early 2005.

The CF34 won the coveted competition to power the COMAC ARJ21 "People's RJ" (Safran, Rolls-Royce and P&WC were the losers), but we think the development schedule is exceedingly optimistic and the chance that the aircraft never goes beyond the low-rate series production phase is not insignificant.

We are not ready to include significant orders for the Chinese ARJ21, although we are a little more bullish compared to our last forecast update. The CF34 ultimately will be supplanted by the company's new Passport (see report herein) down the line, however. We project deliveries of 893 CF34s over the next 10 years, with an estimated retail value of $3.3 billion.

Manufacturers

General Electric Co.
GE Aviation
1 Neumann Way
Cincinnati, OH 45215-6301
tel: (513) 243-2000
website: www.geae.com

Summary Forecast

	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	Total
Units Produced	156	170	162	153	115	55	22	22	21	17	893
Value (2022 $ Millions)	579.0	631.8	609.1	580.2	445.4	214.2	74.8	74.8	71.4	57.8	3,338.4

Risk-Sharing Partners

- Ishikawajima-Harima Heavy Industries: 30% share in CF34-8C on the CRJ700.

Subcontractors

- Aero Decals, Palm Bay, FL, USA—placards, ID plated markings.
- Allen Aircraft Products, Inc., Ravenna, OH, USA—chip detectors.
- Allfast: rivets on engine nacelles
- Ametek Aerospace: engine sensor suite for CF34-10E on the Embraer 195
- Beldam Crossley Ltd., Bolton, England—seals and gaskets.
- CSE, Brea, CA, USA—clamping devices.
- Derlan Aerospace Canada: accessory gearboxes; power takeoff assemblies.
- DuPont Vespel Parts & Shapes, Valley View, OH, USA—VSV bushings.
- Engine Components, Turbine Fuel Technologies, West Des Moines, IA, USA—fuel nozzles.
- Goodrich Aerostructures: nacelle systems for CF34-10 on Embraer 190/195.
- Haskon Aerospace, Taunton, MA, USA—seals.
- Heroux-Devtek: various components.
- Hispano-Suiza: nacelles, transmissions.
- Honeywell: main engine start system, thrust reverser actuation system.
- Kawasaki Heavy Industries: engine pylon.
- Kirkhill Elastomers, Brea, CA, USA—clamping devices.
- Laserdyne Systems, Champlin, MN, USA—laser material processing systems.
- Lee Products Ltd., Gerrards Cross, England—valves.
- Middle River Aircraft Systems (GE): thrust reversers on Embraer 190.
- Neomet Ltd., Stockport, England—honeycomb seals.
- Omega Technologies Inc., Westlake Village, CA, USA—universal wrenches, sockets and adapters.
- PSI Bearings, Simi Valley, CA, USA—bearings.
- PTI Technologies Inc., Oxnard, CA, USA—filters.
- Precision Castparts Corp., Portland, OR, USA—castings.
- Reform Maschinenfabrik, Fulda, Germany—high-speed blade tip grinds.
- Schenck Trebel Corp., Deer Park, NY, USA—dynamic balancing machines.
- Sealtron Inc., Cincinnati, OH, USA—hermetic connectors.
- Short Brothers: engine nacelles (replacing Vought in early 1994).
- Simrit-Aerospace, Santa Ana, CA, USA—sealing products.
- Smiths Aerospace: thrust reverser actuators.
- Spincraft Inc., New Berlin, WI, USA—plugs, nozzles, anti-icing system.
- Sumitomo Precision: engine heat management system on Challenger.
- TA Aerospace, Valencia, CA, USA—clamping devices.
- Techspace Aero: combustor for CF34-10.
- Vibro-Meter: engine vibration monitoring system and engine interface unit.
- Vitta Corp., Bethel, CT, USA—brazing materials.
- Vought Aircraft: nacelle acoustic panels (for Aermacchi).
- Woodward: fuel nozzles.

Technical Description

Components

Layout

The CF34 is a two-shaft, medium sized, civil and military (TF34) turbofan.

Fan

Single-stage design of between 44 and 53 in. Bypass ratio is between 4.9:1 and 6.2:1. The -8C and -10 turbines have wide-chord blades.

Compressor

Fourteen stages for the TF34 and early models of the CF34 and 10 stages (including blisks) for the -8 models and newer.

Combustor

Single annular combustor with 18 burners.

HP Turbine

Two stage turbine driving the compressor assembly.

LP Turbine

Four stage turbine driving the fan.

Other Components

Models -8 and newer are equipped with a Lockheed Martin FADEC.

Engine Variants

CF34-3/3A/3A1/3B—The initial production version of the civil CF34, it is close in design to the TF34. The turbines generate 9,220 lbst and are used on the Canadair Challenger 600 and CRJ 100/200 aircraft.

CF34-8C/8E—Building on the success of the -3, GE extended the power range of the turbine by around 50% by introducing a new compressor, modified HP and LP turbines and a FADEC. The 12,500 to 14,500 lbst variant has been selected to power the Canadair CFJ700 and -900 and the Embraer ERJ-170. The CF34-8D was also selected to power the now defunct Fairchild Dornier 728 regional jet.

CF34-10A/10E—A further upgrade of the turbine to the 17,500-20,000 lbst range, the -10 touches on the power range of the larger CFMI CFM56 and IAE V2500 turbines. The variant has been selected to power the Embraer ERJ-190 and the COMAC ARJ21. As with the -8, the -10D was also selected by Fairchild Dornier for installation on the now cancelled 928 jet.

TF34-GE-100/100A/101—The -100 and -100A power the Fairchild A-10 Thunderbolt. The unaugmented, 9,065-lbst engine also was used on several experimental aircraft. The -100, based on the CF34-8, is rated at 11,000 lbst and has been proposed for A-10 re-engine program.

TF34-GE-400—The 9,300 lbst, unaugmented turbine is used aboard the Lockheed Martin S-3 Viking.

Specifications

(Imperial Units)

Model	Thrust (lbst)	Pressure Ratio	Bypass Ratio	Airflow (lb/sec)	SFC (lb/lbst-hr)	Fan Dia. (in)	Length (in)	Weight (lb)
CF34-1A	8,650	n/a	6.2:1	n/a	0.360	44	103	1,625
CF34-3A	9,220	21:1	6.2:1	319.7	0.357	44	103	1,625
CF34-3A1	9,220	21:1	6.2:1	319.7	0.357	44	103	1,625
CF34-3B	9,220	21:1	6.2:1	321.9	0.346	44	103	1,669
CF34-3B1	9,220	21:1	6.2:1	324.1	0.346	44	103	1,669
CF34-8C1	13,790	28:1	4.9:1	441.0	0.370	46	128	2,351
CF34-8C5	14,510	28:1	4.9:1	445.4	0.390	46	128	2,470
CF34-8C5A2	14,500	28:1	4.9:1	445.4	0.390	46	128	2,470
CF34-8C5B1	13,790	28:1	4.9:1	n/a	n/a	46	128	n/a
CF34-8D	14,500	28:1	4.9:1	445.4	0.390	46	128	2,470
CF34-8D1	12,500	28:1	4.9:1	445.4	0.390	46	128	2,470
CF34-8D3	12,875	27:1	4.9:1	445.4	0.390	46	128	2,470
CF34-8D6	13,050	28:1	4.9:1	445.4	0.390	46	128	2,470
CF34-8E	14,500	28:1	4.9:1	445.4	0.390	46	128	2,470
CF34-8E2	14,000	28:1	4.9:1	445.4	0.390	46	128	2,470
CF34-8E5	14,510	28:1	4.9:1	445.4	0.392	46	121.2	2,470
CF34-8E5A1	14,000	28:1	4.9:1	445.4	0.393	46	128	2,470
CF34-10A	18,285	29:1	5:1	n/a	n/a	53	90	n/a
CF34-10D	18,500	26.7:1	5:1	n/a	0.380	53	90	3,799

Embraer 190 powered by two CF34-10E5s

CF34-10D5	17,355	29:1	5:1	n/a	0.380	53	90	3,799
CF34-10D6	18,750	29:1	5:1	n/a	0.380	53	90	3,799
CF34-10E	20,000	29:1	5:1	n/a	0.380	53	145.5	3,799
CF34-10E5A1	16,500	26:1	5:1	n/a	0.380	53	90	3,799
TF34-GE-100	9,065	21:1	n/a	n/a	0.371	n/a	100	1,440
TF34-GE-400A	9,275	21:1	n/a	n/a	0.363	n/a	100	1,478

(Metric Units)

Model	Thrust (kN)	Pressure Ratio	Bypass Ratio	Airflow (kg/sec)	SFC (mg/Ns)	Fan Dia. (m)	Length (m)	Weight (kg)
CF34-1A	38.5	n/a	6.2:1	n/a	10	1.1	2.6	737
CF34-3A	41.0	21:1	6.2:1	145.0	10	1.1	2.6	737
CF34-3A1	41.0	21:1	6.2:1	145.0	10	1.1	2.6	737
CF34-3B	41.0	21:1	6.2:1	146.0	10	1.1	2.6	757
CF34-3B1	41.0	21:1	6.2:1	147.0	10	1.1	3.3	757
CF34-8C1	61.3	28:1	4.9:1	200.0	10	1.2	3.3	1,066
CF34-8C5	64.5	28:1	4.9:1	202.0	11	1.2	3.3	1,120
CF34-8C5A2	64.5	28:1	4.9:1	202.0	11	1.2	3.3	1,120
CF34-8C5B1	61.3	28:1	4.9:1	n/a	n/a	1.2	3.3	n/a
CF34-8D	64.5	28:1	4.9:1	202.0	11	1.2	3.3	1,120
CF34-8D1	55.6	28:1	4.9:1	202.0	11	1.2	3.3	1,120
CF34-8D3	57.3	27:1	4.9:1	202.0	11	1.2	3.3	1,120
CF34-8D6	58.0	28:1	4.9:1	202.0	11	1.2	3.3	1,120
CF34-8E	64.5	28:1	4.9:1	202.0	11	1.2	3.3	1,120
CF34-8E2	62.3	28:1	4.9:1	202.0	11	1.2	3.3	1,120
CF34-8E5	64.5	28:1	4.9:1	202.0	11	1.2	3.1	1,120
CF34-8E5A1	62.3	28:1	4.9:1	202.0	11	1.2	3.3	1,120
CF34-10A	81.3	29:1	5:1	n/a	n/a	1.4	2.3	n/a
CF34-10D	82.3	26.7:1	5:1	n/a	11	1.4	2.3	1,723
CF34-10D5	77.2	29:1	5:1	n/a	11	1.4	2.3	1,723
CF34-10D6	83.4	29:1	5:1	n/a	11	1.4	2.3	1,723
CF34-10E	89.0	29:1	5:1	n/a	n/a	1.4	3.7	n/a
CF34-10E5A1	82.3	26.7:1	5:1	n/a	11	1.4	2.3	1,723
TF34-GE-100	40.3	21:1	n/a	n/a	11	n/a	2.5	653
TF34-GE-400A	41.3	21:1	n/a	n/a	10	n/a	2.5	670

Applications

Engine	Aircraft	Engines per A/C
CF34-1A	American Aviation FanStar (prototype aircraft; JetStar conversion)	2
	Bombardier Challenger 601-1A	2
CF34-3A	Bombardier Challenger 601-3A	2
CF34-3A1	Bombardier Challenger 601-3R	2
	Bombardier Challenger 604	2
	Bombardier Challenger 800 (initial version)	2
	Bombardier CRJ100	2
CF34-3A2	Bombardier Challenger 601 (engine upgrade)	2
CF34-3B	Bombardier Challenger 604	2
CF34-3B1	Bombardier Challenger 604	2
	Bombardier Challenger 605	2
	Bombardier Challenger 800	2
	Bombardier Challenger 850	2
	Bombardier CRJ200	2
	Bombardier CRJ200B (optional hot-and-high -3B1 variant)	2
	Bombardier CRJ200B ER (optional hot-and-high -3B1 variant)	2
	Bombardier CRJ200B LR (optional hot-and-high -3B1 variant)	2
	Bombardier CRJ200ER	2
	Bombardier CRJ200LR	2

	Bombardier CRJ440	2
CF34-3B MTO	Bombardier Challenger 650	2
CF34-8C1	Bombardier Challenger 870	2
	Bombardier CRJ700	2
	Bombardier CRJ701	2
CF34-8C5A1	Bombardier CRJ1000	2
CF34-8C5A2	Bombardier CRJ1000	2
CF34-8C5B1	Bombardier Challenger 890	2
	Bombardier CRJ705	2
	Bombardier CRJ900	2
CF34-8E5A1	Embraer E-170	2
	Embraer E-170 LR	2
	Embraer E-170 STD	2
	Embraer E-175 AR	2
	Embraer E-175 LR	2
	Embraer E-175 STD	2
CF34-10	Boeing B-52H (proposed re-engining)	8
CF34-10A	COMAC ARJ21-700	2
CF34-10D	Fairchild Dornier 928 (canceled)	2
CF34-10E5	Embraer E-195 AR	2
	Embraer E-195 LR	2
	Embraer E-195 STD	2
CF34-10E5A1	Embraer E-190 AR	2
	Embraer E-190 LR	2
	Embraer E-190 STD	2
TF34-GE-100	Fairchild A-10A	2
TF34-GE-101	Fairchild A-10C (engine upgrade kits were scheduled for 2009)	2
TF34-GE-400A	Lockheed Martin S-3	2
TF34-GE-400B	Lockheed Martin S-3	2

Marketing Data

Costs

Estimated Unit List Prices (current dollars, except where noted)

TF34/CF34-1:	$1.65 million (1993)
CF34-3	$2.79 million
CF34-8	$4.10 million
CF34-10	$5.58 million

The Competition

The CF34 has competed with the Rolls-Royce AE3007 and P&WC PW300 family at its lower end and the Rolls BR700 series at the upper end of its power class. New entries into the field are the Pratt & Whitney Canada PurePower PW800, Power-Jet SaM146, Safran Silvercrest, and possibly the Honeywell HTF10000.

GE's new Passport (see report) and NG34 ultimately will replace the CF34.

Delivery History (production engines; estimated)

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
TF34	1	9	17	28	130	254	258	258	235	173
	1980	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**
TF34	173	173	173	171	124	—	—	—	—	—
CF34-1	—	—	8	34	34	26	45	43	54	50
Total	**173**	**173**	**181**	**205**	**158**	**26**	**45**	**43**	**54**	**50**
	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
TF34	—	15	15	—	—	—	—	—	—	—
CF34-1	60	48	43	15	—	—	—	—	—	—
CF34-3	—	2	24	87	121	155	191	222	259	286
Total	**60**	**65**	**82**	**102**	**121**	**155**	**191**	**222**	**259**	**286**
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
TF34	—	—	—	—	—	—	—	—	—	—
CF34-1	—	—	—	—	—	—	—	—	—	—
CF34-3	313	344	379	377	279	176	111	100	93	81
CF34-8	13	65	111	174	267	302	260	229	265	197
CF34-10	—	—	—	—	7	45	119	186	206	196
Total	**326**	**409**	**490**	**551**	**553**	**523**	**490**	**515**	**564**	**474**
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
TF34	—	—	—	—	—	—	—	—	—	—
CF34-1	—	—	—	—	—	—	—	—	—	—
CF34-3	87	90	74	73	74	57	57	52	50	40
CF34-8	144	115	88	160	278	292	285	221	203	184
CF34-10	194	202	180	129	66	46	46	55	50	47
Total	**425**	**407**	**342**	**362**	**418**	**395**	**388**	**328**	**303**	**271**

	2020	2021	Total
TF34	—	—	2,207
CF34-1	—	—	460
CF34-3	27	38	4,281
CF34-8	99	71	4,023
CF34-10	50	46	1,870
Total	**176**	**155**	**12,841**

Order Book

CF34-3A Family

Customer	A/C Model	Ord./Del.	Engine Model/Notes
Air Canada	CRJ100	24/24	CF34-3A1
Air Littoral	CRJ100	19/19	CF34-3A1
Brit Air	CRJ100	20/20	CF34-3A1
Comair	CRJ100	110/110	CF34-3A1
Lauda Air	CRJ100	8/8	CF34-3A1
Lufthansa CityLine	CRJ100	35/35	CF34-3A1
SkyWest Airlines	CRJ100	10/10	CF34-3A1
The Fair	CRJ100	1/1	CF34-3A1
Total		**227/227**	

CF34-3B Family

Customer	A/C Model	Ord./Del.	Engine Model/Notes
Adria Airways	CRJ200	5/5	CF34-3B1
Air Canada	CRJ200	17/17	CF34-3B1

Air Dolomiti	CRJ200	5/5	CF34-3B1
Air Nostrum	CRJ200	35/35	CF34-3B1
Air Wisconsin	CRJ200	64/64	CF34-3B1
Ansett/Kendell	CRJ200	12/12	CF34-3B1
Atlantic Southeast Airlines	CRJ200	45/45	CF34-3B1
Austrian Arrows	CRJ200	13/13	CF34-3B1; engine launch
British European	CRJ200	4/4	CF34-3B1
China Eastern Yunnan	CRJ200	6/6	CF34-3B1
China Ocean Aviation	Challenger 800	1/1	CF34-3B1
Cimber Air	CRJ200	2/2	CF34-3B1
Compaq Computer	Challenger 800	1/1	CF34-3B1
DAC Air	CRJ200	2/2	CF34-3B1
Delta Connection	CRJ200	94/94	CF34-3B1
Eurowings	CRJ200	12/12	CF34-3B1
Execujet Air Charter	Challenger 800	1/1	CF34-3B1
Fruit of the Loom	Challenger 800	1/1	CF34-3B1
GECAS	CRJ200	5/5	CF34-3B1
Government of China	Challenger 800	5/5	CF34-3B1
Independence Air	CRJ200	87/87	CF34-3B1
J-Air	CRJ200	9/9	CF34-3B1
Lufthansa CityLine	CRJ200	10/10	CF34-3B1
Maersk Air	CRJ200	11/11	CF34-3B1
Malev	CRJ200	4/4	CF34-3B1
Mesa	CRJ200	32/32	CF34-3B1
Midway Airlines	CRJ200	24/24	CF34-3B1
Northwest Airlines	CRJ200	56/56	CF34-3B1
Northwest Airlines	CRJ440	86/86	CF34-3B1
Saeaga	CRJ200	1/1	CF34-3B1
Shandong Airlines	CRJ200	5/5	CF34-3B1
Shanghai Airlines	CRJ200	3/3	CF34-3B1
SkyWest Airlines	CRJ200	100/100	CF34-3B1
South African Express	CRJ200	6/6	CF34-3B1
Southern Winds	CRJ200	2/2	CF34-3B1
Styrian Spirit	CRJ200	1/1	CF34-3B1
The Fair	CRJ200	1/1	CF34-3B1
Unidentified Customer(s)	Challenger 800	23/23	CF34-3B1
US Airways	CRJ200	35/35	CF34-3B1
Xerox Corp.	Challenger 800	1/1	CF34-3B1; launch for Corporate RJ
Total		**827/827**	

CF34-8C Family

Customer	**A/C Model**	**Ord./Del.**	**Engine Model/Notes**
Adria Airways	CRJ900	6/6	CF34-8C5B1
Air Canada	CRJ705	15/15	CF34-8C5
Air Nostrum	CRJ1000	35/35	CF34-8C5A1
Air Nostrum	CRJ900	11/11	CF34-8C5B1
Air One	CRJ900	10/10	CF34-8C5B1
American Airlines	CRJ900	69/54	CF34-8C5B1
American Eagle	CRJ701	47/47	CF34-8C1
Arik Air	CRJ900	7/7	CF34-8C5B1
Atlantic Southeast Airlines	CRJ701	12/12	CF34-8C1
Atlasjet	CRJ900	3/3	CF34-8C5B1
Brit Air	CRJ1000	14/14	CF34-8C5A1
Brit Air	CRJ700	15/15	CF34-8C1
China Express	CRJ900	38/38	CF34-8C5B1

Chorus Aviation	CRJ900	5/5	CF34-8C5B1
CIB Leasing	CRJ900	5/5	CF34-8C
CityJet	CRJ900	10/10	CF34-8C5B1
Comair	CRJ700	20/20	CF34-8C1; Delta connector
Delta Air Lines	CRJ900	60/60	CF34-8C5B1
Delta Connection	CRJ701	30/30	CF34-8C1
Delta Connection	CRJ900	44/44	CF34-8C5B1
Eurowings	CRJ900	15/15	CF34-8C5B1
Felix Airways	CRJ701	2/2	CF34-8C1
Garuda Indonesia	CRJ1000	6/6	CF34-8C5A1
Government of Iraq	CRJ900	6/6	CF34-8C5B1
Horizon Air	CRJ700	20/20	CF34-8C1
Libyan Airlines	CRJ900	5/5	CF34-8C5B1
Lufthansa CityLine	CRJ700	20/20	CF34-8C1
Lufthansa CityLine	CRJ900	12/12	CF34-8C5B1
Macedonian	CRJ900	1/1	CF34-8C5B1
Maersk Air	CRJ701	5/5	CF34-8C1
Mesa	CRJ701	20/20	CF34-8C1
Mesa	CRJ900	38/38	CF34-8C5B1
My Way	CRJ900	4/4	CF34-8C5B1
Nordic Aviation Capital	CRJ1000	12/12	CF34-8C5A1
Northwest Airlines	CRJ900	36/36	CF34-8C5B1
Pluna	CRJ900	13/13	CF34-8C5B1
RwandAir	CRJ900	2/2	CF34-8C5B1
SAS Scandinavian	CRJ900	12/12	CF34-8C5B1
Shandong Airlines	CRJ701	2/2	CF34-8C1
SkyWest Airlines	CRJ700	79/79	CF34-8C1
SkyWest Airlines	CRJ900	21/21	CF34-8C5B1
Styrian Spirit	CRJ701	1/1	CF34-8C5B1; first customer for engine variant
Tartarstan	CRJ900	2/2	CF34-8C5B1
Tuninter	CRJ900	1/1	CF34-8C5B1
Uganda Airlines	CRJ900	4/4	CF34-8C5B1
US Airways	CRJ705	8/8	CF34-8C1
Unidentified Customer(s)	CRJ701	18/18	CF34-8C1
Unidentified Customer(s)	CRJ900	6/6	CF34-8C5B1
Subtotal CRJ700		**346/346**	
Subtotal CRJ900		**478/478**	
Subtotal CRJ1000		**63/63**	
Total		**887/887**	

CF34-8E Family (as of 2Q2022)

Customer	**A/C Model**	**Ord./Del.**	**Engine Model/Notes**
Air Canada	E175	15/15	CF34-8E5
Air Lease	E175	8/8	CF34-8E5
Air North	E170	1/1	CF34-8E5
Alitalia	E170	6/6	CF34-8E5
Alitalia	E175	2/2	CF34-8E5
American Airlines	E175	101/98	CF34-8E5
BA City Flyer	E170	6/6	CF34-8E5
Belavia	E175	1/1	CF34-8E5
Cirrus	E170	1/1	CF34-8E5
CIT	E175	4/4	CF34-8E5
ECC	E170	6/6	CF34-8E5
ECC	E175	1/1	CF34-8E5

Egyptair	E170	12/12	CF34-8E5
Finnair	E170	10/10	CF34-8E5
Flybe	E175	11/11	CF34-8E5
Fuji Dream	E175	2/2	CF34-8E5
GECAS	E170	9/9	CF34-8E5
GECAS	E175	5/5	CF34-8E5
Horizon Air/Alaska	E175	50/30	CF34-8E5
Japan Air Lines	E170	18/18	CF34-8E5
KLM Cityhopper	E175	17/17	CF34-8E5
LOT Polish Airlines	E170	6/6	CF34-8E5
LOT Polish Airlines	E175	12/12	CF34-8E5
Mauretania	E175	2/2	CF34-8E5
Mesa	E175	7/7	CF34-8E5
Nordic Aviation Capital/Aldus	E175	2/2	CF34-8E5
Nordic Aviation Capital/Jetscape	E170	1/1	CF34-8E5
Nordic Aviation Capital/Jetscape	E175	4/4	CF34-8E5
Northwest Airlines	E175	36/36	CF34-8E5
Oman Air	E175	5/5	CF34-8E5
Overland Airways	E175	3/—	CF34-8E5
Petro Air	E170	2/2	CF34-8E5
Regional	E170	10/10	CF34-8E5
Republic Airways	E170	48/48	CF34-8E5
Republic Airways	E175	223/123	CF34-8E5
Royal Jordanian	E175	2/2	CF34-8E5
Satena	E170	1/1	CF34-8E5
Saudi Arabian Airlines	E170	15/15	CF34-8E5
Sirte Oil	E170	1/1	CF34-8E5
SkyWest	E175	209/192	CF34-8E5
Suzuyo	E170	2/2	CF34-8E5
Suzuyo	E175	11/11	CF34-8E5
TAME	E170	2/2	CF34-8E5
TRIP	E175	5/5	CF34-8E5
United Airlines	E175	110/110	CF34-8E5
US Airways	E170	28/28	CF34-8E5
Virgin Australia	E170	6/6	CF34-8E5
Subtotal E170		**191/191**	
Subtotal E175		**848/705**	
Total		**1,039/896**	

CF34-10A Family

The ARJ21 order book is not publicly available. COMAC has claimed up to 616 orders for the ARJ21, but this seems to include options and LoIs. Only identifiable (but not necessarily firm) orders have been listed below. Orders total approximately 305 aircraft.

Customer	A/C Model	Ord./Del.	Engine Model/Notes
Air China	ARJ21-700	35/4	CF34-10A
Institute of Electronics/China Academy of Sciences	ARJ21-700	2/—	CF34-10A
Chengdu Airlines	ARJ21-700	30/21	CF34-10A
China Aircraft Leasing (for TransNusa)	ARJ21-700	30/—	CF34-10A
China Southern	ARJ21-700	35/3	CF34-10A
China Flight General Aviation	ARJ21-700	2/1	CF34-10A
Congo Government	ARJ21-700	4/—	CF34-10A
GECAS	ARJ21-700	5/—	CF34-10A; 20 options

Genghis Khan Airlines	ARJ21-700	25/4	CF34-10A; first delivery 2-2019
Hebei Airlines	ARJ21-700	10/—	CF34-10A
Joy Air	ARJ21-700	50/—	CF34-10A
Jiangxi Airlines	ARJ21-700	5/4	CF34-10A
OTT Airlines (China Eastern)	ARJ21-700	30/6	CF34-10A
Shandong Airlines	ARJ21-700	10/—	CF34-10A
Shenzhen Financial Leasing	ARJ21-700	20/—	CF34-10A
United Eagle Airlines	ARJ21-700	30/—	CF34-10A
Urumqi Airlines	ARJ21-700	20/1	CF34-10A

CF34-10E Family (as of 2Q2022)

Customer	A/C Model	Ord./Del.	Engine Model/Notes
Aero República	E190	5/5	CF34-10E
Aeromexico	E190	12/12	CF34-10E
Air Astana	E190	2/2	CF34-10E
Air Canada	E190	45/45	CF34-10E
Air Caraibes	E190	1/1	CF34-10E
Air Lease	E190	23/23	CF34-10E
Air Moldova	E190	1/1	CF34-10E
Arkia	E195	1/1	CF34-10E
Augsburg	E190	2/2	CF34-10E
Aurigny	E195	1/1	CF34-10E
Austral Líneas Aéreas	E190	22/22	CF34-10E
AZAL	E190	4/4	CF34-10E
Azul	E190	5/5	CF34-10E
Azul	E195	59/59	CF34-10E
BA City Flyer	E190	9/9	CF34-10E
Belavia	E195	4/4	CF34-10E
BOC Aviation	E190	14/14	CF34-10E
BOC Aviation	E195	1/1	CF34-10E
China Southern Airlines	E190	20/20	CF34-10E
CIAF	E190	3/—	CF34-10E
CIT Leasing	E190	7/7	CF34-10E
Conviasa	E190	16/16	CF34-10E
COPA Airlines	E190	15/15	CF34-10E
Dnoproavia	E`90	5/5	CF34-10E
ECC Leasing	E190	1/1	CF34-10E
Finnair	E190	12/12	CF34-10E
Flybe	E195	14/14	CF34-10E
GECAS	E190	27/27	CF34-10E
GECAS	E195	12/12	CF34-10E
Globalia	E195	12/12	CF34-10E
Guizhou Airlines	E190	9/9	CF34-10E
Hainan Airlines	E190	50/50	CF34-10E
Hainan Airlines	E195	20/20	CF34-10E
Hebei Airlines	E190	6/6	CF34-10E
Japan Air Lines	E190	14/14	CF34-10E
JetBlue Airways	E190	64/64	CF34-10E
Kenya Airways	E190	10/10	CF34-10E
KLM Cityhopper	E190	26/26	CF34-10E
KunPeng Airlines	E190	5/5	CF34-10E
LAM	E190	2/2	CF34-10E
LOT Polish Airlines	E195	4/4	CF34-10E
Lufthansa	E190	9/9	CF34-10E
Lufthansa	E195	34/34	CF34-10E

M1 Travel	E190	8/8	CF34-10E
Montenegro	E195	1/1	CF34-10E
NAS Air	E190	3/3	CF34-10E
NIKI	E190	7/7	CF34-10E
Nordic Aviation Capital/Aldus	E190	21/21	CF34-8E5
Nordic Aviation Capital/Aldus	E195	4/4	CF34-8E5
Nordic Aviation Capital/Jetscape	E190	9/9	CF34-8E5
Nordic Aviation Capital/Jetscape	E195	2/2	CF34-10E
Regional	E190	10/10	CF34-10E
Republic Airways	E190	2/2	CF34-10E
Royal Jordanian	E195	2/2	CF34-10E
TACA	E190	11/11	CF34-10E
TAME	E190	3/3	CF34-10E
TRIP	E190	3/3	CF34-10E
TRIP	E195	1/1	CF34-10E
US Airways	E190	25/25	CF34-10E
Virgin Australia	E190	18/18	CF34-10E
Virgin Nigeria	E190	2/2	CF34-10E
Subtotal E190		**568/565**	
Subtotal E195		**172/172**	
Total		**740/737**	

TF34 Family

Customer	A/C Model	Ord./Del.	Engine Model/Notes
US Air Force	S-3A	196/196	TF34-GE-400A/B
US Air Force	A-10A/C	724/724	TF34-GE-100/101

Contract Briefs

Below is a listing of US military prime contracting actions involving the TF34 program that have been announced by the Pentagon during the last 10 completed fiscal years and through the date at the top of this report. These actions include the award of, or modification to, all unclassified DoD prime contracts with a base value of $7 million or more.

Date	Contract Number	Obligation	Details
General Electric, GE Aviation			
04/13/2020	SPE4AX-20-D-9002	$138,237,708	firm-fixed-price, requirements type contract action issued by the Defense Logistics Agency - Aviation, Philadelphia, PA [Defensewide] for supplies related to the TF34 engine. Work will be performed in Ohio. The contract is scheduled to be completed by 9/30/2025. Program involvement: TF34, A-10.

Milestones

Date	***Milestone***
1965	development of TF34 commences
April 1968	TF34 chosen for S-3A
January 1973	TF34 chosen for A-10A
April 1976	CF34 program announced by GE
January 1980	CF34-1A chosen for Challenger 601
August 1982	CF34-1A certificated by FAA
March 1983	Challenger 601/CF34-1A certificated by FAA

September 1986	CF34-3A certificated by FAA
April 1987	Challenger 601-3A certificated bf FAA/CAA
September 1986	first flight of Challenger 601-3A/CF34-3A
July 1991	CF34-3A1 certificated by FAA
1992	Bombardier CRJ100/CF34-3 enters regional service
May 1995	CF34-3B/-3B1 certificated by FAA
Summer 1995	CF34-3B certificated by FAA
April 1996	CF34-8C program launched
February 1998	first run of CF34-8C
June 1999	CF34-8E and CF34-10E programs officially launched
November 1999	CF34-8C1 certificated by FAA
2001	CRJ700/CF34-8 enters service
November 2000	First CF34-8E to test
February 2002	First flight of CF34-8E
April 2002	CF34-8E certificated by FAA
3Q 2002	First CF34-10E to test
November 2002	ACAC selects CF34-10A for ARJ21
February 2004	ERJ 170/CF34-8E certificated by FAA
March 2004	ERJ 170/CF34-8E enters service
2Q 2004	CF34-10E awarded FAA type certification
July 19, 2004	CF34-8C1 reaches one-million-flight-hour milestone
Mar 3, 2006	CF34-1A/3A/3A2 upgrade program announced
Oct. 17, 2007	CF34-10A First Engine to Test (FETT)
Dec. 21, 2007	ARJ21-700 rolled out
Sept. 3, 2008	First flight of CRJ1000 powered by CF34-8C5
Nov. 24, 2008	CF34 fleet reaches 50 million hours
Nov. 28, 2008	First flight of ARJ21
Aug. 12, 2010	CF34-3A2 upgrade offered
Dec. 30, 2014	ARJ21-700 receives Chinese type certification
Nov. 16, 2015	Aviall gets exclusive support of CF34-3
Dec. 22, 2020	SkyWest Airlines CF34 fleet reaches 25 million flight hours

Program Overview

Background

Early History/TF34

The TF34 program began in the mid-1960s and flew for the first time in 1971. The turbine was selected to power the Fairchild A-10 and the Lockheed Martin S-3. Production for the military versions of the aircraft ended in 1984.

CF34 for Challenger/CRJ

Just before the termination of the military production run, GE's long-time effort to launch a civilian version of the turbine met success aboard the Canadair Challenger 601 (and later 604). Reliability problems of the ALF502 led Canadair to seek other alternatives.

The success of the 601 led Canadair to design a stretch version, eventually named the CRJ. The CF34 was the natural selection for the aircraft, albeit a slightly underpowered one.

New Engine Variants & Applications

As with the original CRJ, the success of the initial RJ models led the Canadian company to develop further stretch versions, the 700 and 900. To provide power for the larger aircraft GE went about the business of upgrading the 25-year-old design and came up with the -8 model.

Somewhat fortuitously, the company hit the jackpot with the -8 and later -10 series which happened into the market just when the 70 to 100 seat regional jet market was finally taking off.

The company was also able to win the competitions for the Embraer

170/190, the Fairchild Dornier 728/928 (later cancelled).

At 9,220 lbst at the lower end of its range, the CF34 turbine is currently the smallest active civil turbofan program offered by General Electric. GE unsuccessfully offered a derated version of the CF34 for installation on the Gulfstream V.

ACAC Selects CF34-10A

In 2002, AVIC 1 Commercial Aircraft Co. (ACAC) chose the CF34-10A to power its new 90-seat commuter liner, the ARJ21-700. The Chinese company sees the potential for at least 850 ARJ21s over the next 20 years.

CF34-3 Problems

In late 2002, the company urged operators of the CF34-3 to inspect the gearbox and stage-two HP turbine blades for early wear. The -3 was installed on the Canadair Challenger 600 and CRJ aircraft.

CF34-10E

The latest member of the CF34 family is the -10E variant. The engine program was launched in 1999 for the Embraer 190/195 aircraft series. First flight of the engine aboard the new Brazilian aircraft took place in March 2004. In March 2005, GE reported that the -10E had received its FAA type certificate.

A-10 Re-engining

In January 2005, it was reported that the Air Force had finally decided to pursue a $160 million program to upgrade the A-10s TF35-GE-100 engines (presumably to -101 standard) as the final part of the general A-10C upgrade. The service plans to buy upgrade kits for 356 aircraft, as well as 65 additional spare kits. The upgrades will be performed as field installations and will commence in 2009. The modified aircraft are designated A-10C.

Upgrade Programs for Early CF34s

In May 2006, GE announced a modernization program for CF34-1A/3A/3A2 engines powering Challenger 601 aircraft. The modification primarily involves retrofitting the hot section of these engines with that of the airline-proven -3A1 engine version. This results in an "on-condition" engine maintenance plan rather than a "hard-time" schedule.

The upgrade includes adding high-pressure turbine (HPT) boroscope capability, utilizing advanced steel shrouds and more a robust stator in the HPT, and incorporating advanced combustion and transition liners.

In October 2006, GE reported that the operator Herzog was the first customer for the mod effort.

In August 2010, GE announced the availability of an another on-wing engine upgrade program for certain configurations of the CF34-3A2 engine that will allow the engines to go from a hard-time maintenance schedule to an on-condition maintenance schedule. These upgraded engines will have longer time on wing and greatly reduced maintenance costs with no scheduled hot section inspections or overhauls.

ARJ21

On Dec. 21, 2007, GE announced that COMAC had rolled out the first ARJ21. At the same ceremony, COMAC announced that it had received orders for 50 firm and 50 options for the aircraft from Kunpeng Airlines. Previously, in October, the first CF34-10A for the aircraft was tested (First Engine to Test/FETT). The aircraft made its first flight in November 2008.

As of July 2010, there were four aircraft in the test program. In September 2010, however, it was reported that first delivery of the ARJ21 would be delayed at least until the third quarter of 2011 because of "design issues."

In December 2014, the ARJ21-700 aircraft received the Type Certificate from the Civil Aviation Administration of China (CAAC), paving the way for the aircraft's entry into service.

GE Aviation Unveils New Upgrade to CF34-3A2 Engines

As of August 2010, GE Aviation began offering an on-wing engine upgrade program for certain configurations of the CF34-3A2 engine that allow the engines to go from a hard-time maintenance schedule to an on-condition maintenance schedule. The upgraded engines have longer time on wing and greatly reduced maintenance costs with no scheduled hot section inspections or overhauls.

The new on-wing upgrade was available for 36 CF34-3A2 engines that were in service on Challenger 601 aircraft.

The original CF34 modernization program was available for all CF34-1A and -3A and all remaining CF34-3A2 engines. This upgrade must be performed during an overhaul at GE's Strother facility, a GE Branded Service facility, or other GE-authorized shop. For these CF34 engines, the upgrade involved the replacement of the engine's existing honeycomb shrouds in the high-pressure turbine with new advanced steel shrouds and the addition of a borescope port. The combustor liner also was replaced with a new more durable, robust liner.

With the upgrade, the engines are fully on-condition with next unscheduled shop visit typically driven by the cycle limited parts lives.

CF34 for the B-52?

In October 2014, yet another re-engining proposal emerged for the USAF B-52 fleet. In this one, per the Global Strike Command, Boeing had presented a "concept brief" in which GE had examined fitting the bombers with eight CF34-10 engines. The scheme would increase the overall thrust rating of the plane and greatly increase fuel efficiency and maintainability.

But, at the time, due to budgetary constraints and other issues, this was not likely to happen. Two previous proposals were offered, one with four Pratt & Whitney PW2000s (in 1982) and another involving four Rolls-

Royce RB211-535s (in 1996). Both engines, however, are now out of production and these eventualities became moot.

Bombardier Opts for Upgraded CF34-3 for G650

In October 2014, Bombardier selected an optimized version of the CF34-3 to power its new Challenger 650 aircraft.

The new engine, called CF34-3B MTO, incorporated improved take-off thrust allowing the Challenger 650 aircraft to take flight from shorter runways while maintaining current CF34-3 durability and dispatch reliability. In addition, the CF34-3B MTO's offered a reduced take-off thrust mode for smoother departure and to further reduce maintenance operations.

MRO

100th OnPoint Agreement

GE Aviation reported in January 2008 that it had signed its 100th agreement for its OnPoint solution for maintaining CF34-3-powered business aircraft. More than 200 aircraft are covered by the agreements worldwide. The total value of the 100 five- to 10-year contracts is given as $180 million. OnPoint services include overhaul, on-wing support, new and used serviceable parts, component repair, technology upgrades, engine leasing and diagnostics.

GE/Aviall Distribution Agreement

In January 2009, GE signed an exclusive distributor agreement with Aviall Services that expanded its spare parts distribution for CF34-3 engines. Under the agreement, Aviall became responsible for forecasting, ordering, and delivering OEM replacement parts unique to CF34-3s, as well as documentation management, worldwide inventory deployment, warehousing, and product distribution.

Azul Linhas Aéreas OnPoint Agreement

In October 2009, Azul Linhas Aéreas Brasileiras signed a 15-year OnPoint solution agreement covering the maintenance, repair, and overhaul of CF34-10Es powering its Embraer 190/195 aircraft. The agreement was valued at nearly $1 billion. The work was specified to be performed at the GE Celma facility in Petropolis, Brazil.

MTU CF34 Repair Station

In September 2010, it was reported that MTU Aero Engines had received FAA approval for its Appleton, WS, division to operate as a certified repair station to offer on-wing services for CF34 engines. Previously, the unit had to fly spares and technicians from its Berlin-Brandenburg maintenance arm.

GE and Bombardier Announce Engine Service Agreements for Challenger and Global Aircraft

GE Aviation and Bombardier Aerospace in October 2011 announced two new engine service agreements that boosted services support for Bombardier business aircraft customers. GE's OnPoint solutions engine maintenance coverage is being offered on Challenger aircraft equipped with CF34 engines and Global 7000 and Global 8000 aircraft. What is more, Bombardier's five wholly owned business aircraft service centers in the US were named GE Authorized Service Centers for CF34 engines for business aircraft.

Under the new service center agreement, Bombardier's five wholly owned business aircraft service centers, located in Dallas, Texas; Fort Lauderdale, Florida; Hartford, Connecticut; Tucson, Arizona and Wichita, Kansas, expanded their offering to provide factory-quality line maintenance and mobile repair services on CF34 engines. GE Aviation would provide Bombardier facilities with comprehensive material and technical support.

Jet Aviation St. Louis to Service CF34-3s

Jet Aviation St. Louis was named in March 2012 an authorized service center for the CF34-3 engine. Jet Aviation St. Louis is FAA- and OEM-authorized to support Bombardier Challenger aircraft.

With the GE authorization, Jet Aviation St. Louis was approved to perform line maintenance inspections; routine installed engine maintenance including removal and replacement of engine components; removal and replacement of engines; and removal and reinstallation of external engine components. This designation also allowed Jet Aviation St. Louis to provide warranty support and facilitates access to both GE parts and technical support.

Duncan Aviation to Service CF34-3s

Duncan Aviation was named an authorized service center for CF34-3 engines in August 2012. Under this agreement, Duncan Aviation could now perform line maintenance and on-wing engine maintenance, as well as provide OnPoint solution agreement and warranty support and facilitate access to both GE parts and technical support.

MNG Jet Tagged for CF34-3 Service

December 2012 saw GE Aviation name MNG Jet as an authorized service center for CF34-3. With the agreement, MNG Jet could now perform line maintenance inspections and routine installed engine maintenance, including removal and replacement of engines and engine

components. This authorization also allows MNG Jet to provide OnPoint solution and GE new engine warranty support.

MNG Jet specializes in business jet operations and maintenance. Base maintenance is performed at MNG Jet's Istanbul, Turkey location with line maintenance support available in Sabiha Gokcen Airport in Istanbul and other stations requested by customers.

RUAG Named an Authorized Service Center for CF34-3s

In February 2013, GE Aviation named RUAG Aviation as an authorized service center for CF34-3 engines. Under this agreement, RUAG Aviation could perform engine line maintenance, as well as provide On-Point solution agreement and warranty support and facilitate access to both GE parts and technical support.

Air Canada Commits to OnPoint Agreement

In June 2013, it was announced that Air Canada had committed to a five-year OnPoint solution agreement for a firm-fixed-price on time-and-material to repair and overhaul its CF34-8E engines that powered its Embraer 175 aircraft. The value of the OnPoint solution agreement was not disclosed.

TAG Farnborough Engineering Agreement

In July 2013, GE Aviation named TAG Farnborough Engineering in the UK as an authorized service center for CF34-3. Under this agreement, TAG Farnborough Engineering could perform engine line maintenance, as well as provide On-Point solution agreement and warranty support and facilitate access to both GE parts and technical support.

Aviall Signs Deal for CF34 Services

Aviall, Inc., a wholly owned subsidiary of Boeing, in October 2014, signed an agreement with GE Aviation to become a provider of GE CF34-3A and CF34-3A2 used material and lease engines powering the Bombardier Challenger 601.

The ownership transfer built on an exclusive distributor agreement launched in 2009, where Aviall was responsible for forecasting, ordering, and delivering all Original Equipment Manufacturer (OEM) replacement parts that are unique to CF34-3 engines. This agreement leveraged Aviall's worldwide part distribution capabilities.

GE Expands CF34-3 Services in Asia

GE Aviation named Metrojet and STAECO in October 2015 as authorized service centers for CF34-3.

With this agreement, STAECO in Jinan and Metrojet in Hong Kong could perform line maintenance inspections and routine installed engine maintenance, including removal and replacement of engines and engine components. The two centers could also be allowed to provide On-Point solution and GE's new engine warranty support.

Bombardier Singapore Service Centre is Authorized

In April 2015, GE Aviation named Bombardier Singapore Service Centre as an authorized service facility for CF34-3 engines. With this agreement, Bombardier's Singapore Service Centre could perform line maintenance inspections and routine installed engine maintenance, including removal and replacement of engines and engine components. With this agreement, Bombardier's Singapore facility was authorized like its six other wholly owned service centers in Amsterdam, Hartford, Fort Lauderdale, Dallas, Wichita, and Tucson.

Aviall Buys Leased CF34-3s

Aviall signed an agreement with GE Aviation in November 2015 to become the sole provider of all CF34-3 parts for business jets. The agreement included used and new parts, used line-replaceable units (LRUs) and lease engines powering the Bombardier Challenger 601, 604, 605, 650 and 850 aircraft.

The announcement built on previous CF34-3 agreements between the two companies. In October 2014, Aviall became the sole provider of GE CF34-3A and CF34-3A2 used material and lease engines powering the Bombardier Challenger 601. The ownership transfer built on an exclusive distributor agreement launched in 2009, where Aviall became responsible for forecasting, ordering, and delivering all genuine Original Equipment Manufacturer (OEM) replacement parts that are unique to CF34-3 engines.

Lufthansa Technik Deal

GE Aviation signed Lufthansa Technik AERO Alzey GmbH (LTAA) in November 2015 to a maintenance support agreement where LTAA will be responsible for dispatching its mobile repair teams to Russia, Europe, the Middle East, and Africa to service CF34-series engines powering the Bombardier Challenger series and Embraer Lineage aircraft.

In October 2014, GE Aviation named LTAA an authorized service center for GE's CF34-series engines. With the expanded agreement announced today, LTAA's service center and mobile repair teams will perform line maintenance inspections, routine installed engine maintenance, including removal and replacement of engines and engine components as well as repair and overhaul services. The authorizations also allow LTAA to provide OnPoint solution and GE's new engine warranty support.

ExecuJet Named for Service

GE Aviation, in November 2015, announced that it had designated each of ExecuJet's global repair facilities as authorized service centers for CF34-3 engines powering the Bombardier Challenger series.

ExecuJet managed 160 business jets in six regions worldwide: Africa, Asia, Australasia, Europe, Latin

America, and the Middle East. In December 2012, GE Aviation had named ExecuJet Middle East as an authorized service center for CF34-series engines.

With the expanded agreement, ExecuJet's global service centers would perform line maintenance inspections, routine installed engine maintenance, including removal and replacement of engines and engine components as well as repair and overhaul services. The authorizations also allowed ExecuJet to provide On-Point solution and GE's new engine warranty support.

RUAG Named ASC for CF34-10E

In May 2016, GE named RUAG Aviation as an authorized service center (ASC) for CF34-10E engines. Expedited approval process had begun in February 2016, when GE approached RUAG Aviation with its requirements.

Prognostic Health Management Plus for CF34-3

In October 2016, GE Aviation introduced its Prognostic Health Management Plus for CF34-3 engines powering the Bombardier Challenger 600 series aircraft. Prognostic Health Management Plus would provide real-time enhanced engine prognostics plus C-FOQA Centerline.

The new service would collect data wirelessly after each flight using Avionica's miniature Quick Access Recorder (miniQAR) with 4G Cellular Module (avCM 4G) and utilizing Avionica's avSYNC global data transfer service. avSYNC service speeds data delivery directly to GE's Prognostic Health Management data centers. Once the engine data is transmitted to GE's expert analysts, customers would, in turn, receive operational insights, predictive maintenance reports, and safety event awareness for FOQA.

Aviall Named Sole Part Provider for CF34-8 and -10

In October 2016, Aviall, a wholly owned subsidiary of Boeing, signed an agreement with GE Aviation to become the sole provider of CF34-8 and CF34-10 new and used parts and line-replaceable units (LRUs) for corporate business jets.

ExecuJet Service Expands

In December 2016, GE Aviation named ExecuJet Middle East as an authorized service center (ASC) for GE's CF34-10E engines. With this further expanded agreement, ExecuJet Middle East was authorized to perform line maintenance inspections, routine installed engine maintenance, including removal and replacement of engines and engine components as well as repair and overhaul services for CF34-10E and CF34-3 engines. The authorizations also allow ExecuJet to provide On-Point solutions and GE's new engine warranty support.

LTAA MRO

In April 2017, GE Aviation signed Lufthansa Technik AERO Alzey GmbH (LTAA) to a maintenance support agreement. LTAA would be responsible for dispatching its mobile repair teams to Asia Pacific, Australia and China to service CF34-series engines powering the Bombardier Challenger series and Embraer Lineage aircraft.

In October 2014, GE Aviation named LTAA an authorized service center for GE's CF34-series engines. With this current agreement, LTAA's service center and mobile repair teams would support Asia with line maintenance inspections and routine installed engine maintenance, including removal and replacement of engines and engine components. LTAA would also provide repair and overhaul services. The authorizations would allow LTAA to provide GE's OnPoint solution and GE's new engine warranty support.

HNA GBSA

In June 2017, HNA's subsidiaries Hainan Airlines and HNA Technic reached a 30-year GE Branded Service Agreement (GBSA) for GEnx and CF34 engines with GE Aviation.

TrueChoice™ for Royal Air Maroc

In June 2017, Royal Air Maroc selected a five-year, TrueChoice™ overhaul agreement for the maintenance, repair, and overhaul of the CF34-10E engines powering its four Embraer E190 aircraft.

SA Airlink MRO

In September 2017, SA Airlink signed a 10-year, TrueChoice™ Flight Hour agreement with GE Aviation for the maintenance, repair, and overhaul of the CF34-8E and CF34-10E engines powering its three Embraer E170 and 10 Embraer E190 aircraft.

Biggin Hill ASC

In October 2017, GE added the Bombardier Service Centre at London Biggin Hill Airport in the United Kingdom to its business jet Authorized Service Centre (ASC) network to support CF34 engines.

ACI Jet Deal

In October 2017, GE added ACI Jet in San Luis Obispo, California, as a business jet Authorized Service Center to support CF34-3 engines powering the Bombardier Challenger series.

West Star Aviation

In October 2017, GE announced the renewal of its Authorized Service Center agreement for CF34 engine service with West Star Aviation for its East Alton, Illinois and Grand Junction, Colorado locations.

AerFin Deal

In April 2018, Wales-based aftermarket supply specialist AerFin signed a three-year TrueChoice™ Material agreement with GE Aviation for serviceable OEM parts, ad-

vanced repairs, and technology upgrades for the CFM56, CF34 and CF6-80C2 engines.

Lufthansa Bombardier Aviation Services

In May 2018, GE signed an agreement with Lufthansa Bombardier Aviation Services (LBAS) to become an authorized service center for CF34-3 engines powering the Bombardier Challenger series.

This agreement gave LBAS authorization to perform line maintenance inspections, routine installed engine maintenance—including removal and replacement of engines and engine components—as well as repair and overhaul services for the CF34-3.

Luxaviation Opts for OnPoint Business Jet Maintenance Solution

In May 2018, GE and Luxaviation signed a collaborative agreement, making GE's OnPoint Business Jet Maintenance Solution program available to Luxaviation's owners and operators worldwide.

The agreement made GE Aviation the preferred engine service provider for Luxaviation's owners and operators with CF34-powered aircraft. This included Bombardier's Challenger series, powered by CF34-3s, and the Embraer Lineage 1000 series, powered by the CF34-10E.

RUAG Aviation Agreement

In May 2018, GE and RUAG Aviation extended its authorized service center agreement for CF34-3 and CF-34-10E engines.

Azorra Aviation Signs Agreement for CF34-10Es

Azorra Aviation and GE Aviation signed a Set Maintenance Offer (SMO) agreement for its CF34-10E engine fleet aimed at helping reduce the engine's cost of ownership. GE notes that the SMO agreement is available to all CF34-10E customers, regardless of their maintenance, repair, and overhaul provider.

Customers can purchase the SMO agreement for parts only or incorporate it into an overhaul agreement with GE. Under the SMO, customers receive the following parts: high pressure compressor blades, combustor dome, inner and outer combustor liners, high pressure turbine blades and nozzles, Stage 1 low pressure turbine nozzles and a brand-new stack of rotating LLPs.

GA Telesis Opens New Engine Hospital Shop

In July 2020, the engine division of GA Telesis reported it had opened a new aircraft engine hospital shop in Helsinki to service demand in Europe from airlines and lessors for minor repairs, test cell runs, and end of lease inspections. Initially, the shop would offer these services on three engine types: CF6-80C2B, which powered the Boeing 747-400 and was one of two options for the 767-300, and the CFM56-5B and CFM56-7B, powering the Airbus A320 family and the 737, respectively.

The company confirmed that over the course of the next 18 months, it planned to expand the number of engines serviced and was specifically targeting the V2500-A5, Pratt & Whitney PW4000-94/100, GE CF6-80E1 and CF34-8/10 engine types.

MTU Maintenance Signs GBSA

In May 2021, MTU Maintenance signed an agreement for an eight-year GE Branded Service Agreement (GBSA) extension for CF34 engines with GE Aviation. The GBSA enabled MTU to continue serving as an authorized service provider through 2030 for CF34-3, CF34-8C, CF34-8E, and CF34-10E engines and perform OEM maintenance, overhaul work-scoping, and component repairs as well as provide comprehensive materials support.

Large Chinese Spare Engine Order

In July 2021, according to Yicai Global, Chinese regional carrier China Express Airlines agreed to a deal with GE for 58 CF34 engines, with 28 on firm order and the rest as options.

All but one was the -8C5 variant for the Bombardier CRJ900, plus a single -10A to support China Express' ARJ21 fleet. The airline currently operates 38 CRJ900s.

GE Licenses Cleaning System to Japan Airlines

In January 2022, GE Aviation awarded Japan Airlines a technical license to use GE's 360 Foam Wash system on its CF34-8E engines. This made Japan Airlines the first global CF34 engine operator—and first regional jet operator—to be licensed for the patented engine cleaning system.

GE's 360 Foam Wash is an alternative to the water wash method. It can help restore engine performance leading to reduced fuel consumption and improved time on wing. The process involves injecting a specially formulated, proprietary solution that reduces build-up of deposits in the engine, which can lower engine exhaust temperatures and improve engine compressor efficiency.

Estimates were that 360 Foam Wash had the potential to save Japan Airlines up to 82,000 liters of fuel and save up to 285 metric tons of carbon emissions a year by replacing some water washes with foam wash for CF34 engine cleaning.

StandardAero Provides Lufthansa CityLine with CF34-8C Services

In August 2021, Lufthansa CityLine selected StandardAero to provide support for the CF34-8C engines powering its fleet of MHI RJ Aviation (formerly Bombardier) CRJ900 regional jets.

Under the exclusive seven-year agreement, StandardAero would support Lufthansa CityLine with a range of CF34-8C services from its overhaul facility in Winnipeg, Canada. StandardAero also planned to qualify its European field service team based

in Rijen, Netherlands, to support the CF34

MTU Maintenance Expands CF34 Services

MTU Maintenance built up its engine MRO capability in Berlin by launching new on-site services for several engine types from the facility in November 2021.

The new facility at Berlin-Brandenburg focuses on quick-turn engine bays while also providing a base for on-site and AOG teams for CF34-8/-10 and CFM56-7B engine models.

Current Developments

COVID-19 Fallout

In June 2020, as the COVID-19 pandemic continued to keep global fleets grounded, StandardAero reported a significant increase in its engine preservation business.

"We are seeing a higher than normal—possibly a record—number of customer requests for engine storage and preservation, particularly for the CFM56-7B and CF34-3 and -8 lines," said David Green, vice president & general manager for StandardAero CF34 and CFM56 MRO programs.

Preservation work and storage of those engines was being carried out by StandardAero at its Winnipeg, Canada, facility, a GE Designated Fulfillment Center for the CFM56-7B, and a GE Aviation Authorized Service Provider for the CF34-3 and -8.

Green said that his company saw sustained demand for its engine preservation services for the next couple of years—the timeline for a reasonable industry recovery estimated by analysts.

FAA Mandates -8 Inspections

In September 2021, The FAA finalized a mandatory inspection program for CF34-8 engines to detect cracks in combustion liner outer shells that, if left to propagate, could cause the structure to buckle and, in extreme cases, trigger inflight shutdowns.

Under an airworthiness directive set for publication Sept. 17, 2021, operators of engines with at least 17,500 flight hours (FH) since new or repair would have to perform a borescope or visual inspection within 500 FH. Depending on findings, follow-up inspections would be required as frequently as every 300 FH. Shells with excessive cracking must be removed and replaced.

The FAA's inspection protocol is based on CF34-8C and CF34-8E service bulletins issued by GE in 2019. The directive affected about 1,500 engines on US-registered aircraft—all larger Bombardier CRJs and Embraer E170-series models—though adoption by other regulators was likely.

At least eight engines had been removed "due to significant distress in the combustion outer liner shell," GE explained in the bulletins. In two of the cases, the damage caused inflight shutdowns "due to severe thermal distress of the high-pressure turbine/low pressure turbine hardware including burn through of the LPT case," GE said.

GE determined the root cause was a crack initiating at the trailing edge of one shell panel, propagating across an adjacent panel and into a third panel before meeting up with another crack. Possible ramifications include "buckling of the combustion outer liner shell as well as oxidation of large sections of it," the service bulletins said.

The inspections would target the area where the cracks begin.

B-52 Re-engining; CF34 Loses Out to Rolls

As of early 2018, the Air Force had reinvigorated its enthusiasm for re-engining the B-52H fleet. Current plans are for retiring all the B-1 and B-2 bombers and replacing them with the new B-21 Raider stealth bomber and upgraded B-52s (i.e., re-engining and other enhancements).

The CF34-10 was one of the main candidates for the re-engining program, but in September 2021, the Air Force awarded Rolls Royce with a contract for 608 F130 engines to begin the re-engining program.

CemAir Orders Six CF34-3Bs

Announced in July 2022 at the Farnborough Air Show, CemAir ordered six new CF34-3B spare engines to power its fleet of Bombardier CRJ 100/200 LR aircraft. The Johannesburg-based company currently owns and operates a fleet of 12 CRJ 100/200 LR airliners.

Program Status

In July 2022, GE reported that there were more than 7,500 CF34 engines powering regional aircraft, and that the engine family had logged more than 200 million flight hours and 157 million flight cycles.

Teal Group Evaluation

Bread and Butter

The CF34 has been one of the largest contributors to the GE Aviation top line revenue besides the 50% stake in CFM International, the GE90 and the GEnx—all large turbofans. That is a huge accomplishment for a program that used to power something nicknamed the Warthog in the early 1970s.

Challenger Saves the Line

The reason for the engine's success following its modest military production run starts with its fortune in garnering the Challenger 601 bizjet application. The CF34 then rode the wave of expansion in this market segment which continues to this day with the Challenger 650.

Regionals Continue the Run

When Canadair came up with the Regional Jet (CRJ) variant of its successful bizjet, the CF34's fortunes blossomed even more. And then Embraer jumped in with its 170/190 series which has proven even more successful than the CRJ series. Between these two RJs, the CF34 has turned into a real money maker and the trend is likely to continue virtually unabated throughout our 10-year forecast period.

We're Bearish on the ARJ21

A wildcard in our projections is the Chinese ARJ21 program. This is a Chinese government-supported project that should at least show a modest level of yearly production in the near term.

The Future

Besides the latest variant of the CRJ, the CRJ1000, the business of winning new platforms is probably over for the CF34, a job that will be taken over by the successor to the CF34, the Passport (see report). Also, new engines from Pratt & Whitney Canada (PW800) and Rolls-Royce (Pearl) are waiting in the wings, so to speak, and will be tough competition for any new platform.

Now the GE team must get down to continuing delivery and upgrades of a good product, which we are confident they will. The successful testing and launch of the -10 series have been a continuing example of this.

The Bottom Line

We are not ready to include significant orders for the Chinese ARJ21, although we are a little more bullish compared to our last forecast update. The CF34 ultimately will be supplanted by the company's new Passport (see report herein) down the line, however. We project deliveries of 893 CF34s over the next 10 years, with an estimated retail value of $3.3 billion.

Production Forecast

Units	Thru 2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	Total
TF34 series												
A-10A	1,738	—	—	—	—	—	—	—	—	—	—	1,738
S-3	469	—	—	—	—	—	—	—	—	—	—	469
Subtotal TF34 Series	***2,207***	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	***2,207***
CF34-1A												
Challenger 601-1A	152	—	—	—	—	—	—	—	—	—	—	152
Challenger 601-3A	305	—	—	—	—	—	—	—	—	—	—	305
FanStar (prototype aircraft)	3	—	—	—	—	—	—	—	—	—	—	3
Subtotal CF34-1 Series	***460***	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	***460***
CF34-3A1												
Challenger 601-3R	132	—	—	—	—	—	—	—	—	—	—	132
CRJ100	503	—	—	—	—	—	—	—	—	—	—	503
CF34-3A1/3B/3B1												
Challenger 604	809	—	—	—	—	—	—	—	—	—	—	809
CF34-3B1												
Challenger 605	739	—	—	—	—	—	—	—	—	—	—	739
CRJ200/440	1,857	—	—	—	—	—	—	—	—	—	—	1,857
CF34-3B MTO												
Challenger 650	264	32	33	25	22	16	—	—	—	—	—	392
Subtotal CF34-3 Series	***4,304***	***32***	***33***	***25***	***22***	***16***	**—**	**—**	**—**	**—**	**—**	***4,432***
CF34-8C1												
CRJ700/701	777	—	—	—	—	—	—	—	—	—	—	777
CF34-8C5A2												
CRJ1000	142	—	—	—	—	—	—	—	—	—	—	142
CF34-8C5B1												
CRJ900	1,072	—	—	—	—	—	—	—	—	—	—	1,072
CF34-8E5A1												
Embraer 170/175	2,032	81	88	88	88	77	33	—	—	—	—	2,487
Subtotal CF34-8 Series	***4,023***	***81***	***88***	***88***	***88***	***77***	***33***	**—**	**—**	**—**	**—**	***4,478***

CF34-10A												
COMAC ARJ21	165	43	49	49	43	22	22	22	22	21	17	475
CF34-10E5/E5A1												
Embraer 190/195/Lineage 1000	1,702	—	—	—	—	—	—	—	—	—	—	1,702
Subtotal CF34-10 Series	***1,867***	***43***	***49***	***49***	***43***	***22***	***22***	***22***	***22***	***21***	***17***	***2,177***
Total	**12,861**	**156**	**170**	**162**	**153**	**115**	**55**	**22**	**22**	**21**	**17**	**13,754**

Value ($ Millions)	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	Total
CF34-3B MTO											
Challenger 650	90.6	93.5	70.8	62.3	45.3	—	—	—	—	—	362.6
CF34-8E5A1											
Embraer 170/175	342.1	371.7	371.7	371.7	325.2	139.4	—	—	—	—	1,921.9
CF34-10A											
COMAC ARJ21	146.2	166.6	166.6	146.2	74.8	74.8	74.8	74.8	71.4	57.8	1,053.9
Total	**579.0**	**631.8**	**609.1**	**580.2**	**445.4**	**214.2**	**74.8**	**74.8**	**71.4**	**57.8**	**3,338.4**

Then-year $Millions	Thru 2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	Total
TF34 series												
A-10A	1,273.4	—	—	—	—	—	—	—	—	—	—	1,273.4
S-3	272.8	—	—	—	—	—	—	—	—	—	—	272.8
Subtotal TF34 Srs	***1,546.1***	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	***1,546.1***
CF34-1A												
Challenger 601-1A	172.5	—	—	—	—	—	—	—	—	—	—	172.5
Challenger 601-3A	421.5	—	—	—	—	—	—	—	—	—	—	421.5
FanStar (prototype aircraft)	3.6	—	—	—	—	—	—	—	—	—	—	3.6
Subtotal CF34-1 Srs	***597.6***	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	***597.6***
CF34-3A1												
Challenger 601-3R	216.4	—	—	—	—	—	—	—	—	—	—	216.4
CRJ100	857.6	—	—	—	—	—	—	—	—	—	—	857.6
CF34-3A1/3B/3B1												
Challenger 604	1,522.8	—	—	—	—	—	—	—	—	—	—	1,522.8
CF34-3B1												
Challenger 605	1,740.5	—	—	—	—	—	—	—	—	—	—	1,740.5
CRJ200/440	3,572.0	—	—	—	—	—	—	—	—	—	—	3,572.0
CF34-3B MTO												
Challenger 650	703.2	90.6	92.1	69.8	61.4	44.7	—	—	—	—	—	1,061.8
Subtotal CF34-3 Srs	***8,612.4***	***90.6***	***92.1***	***69.8***	***61.4***	***44.7***	**—**	**—**	**—**	**—**	**—**	***8,971.0***
CF34-8C1												
CRJ700/701	2,419.5	—	—	—	—	—	—	—	—	—	—	2,419.5
CF34-8C5A2												
CRJ1000	522.5	—	—	—	—	—	—	—	—	—	—	522.5
CF34-8C5B1												
CRJ900	3,792.5	—	—	—	—	—	—	—	—	—	—	3,792.5
CF34-8E5A1												
Embraer 170/175	7,392.0	342.1	377.3	382.9	388.7	345.2	150.2	—	—	—	—	9,378.4
Subtotal CF34-8 Srs	***14,126.5***	***342.1***	***377.3***	***382.9***	***388.7***	***345.2***	***150.2***	**—**	**—**	**—**	**—**	***16,112.9***
CF34-10A												
COMAC ARJ21	387.8	146.2	169.1	171.6	152.9	79.4	80.6	81.8	83.0	80.4	66.1	1,498.8
CF34-10E5A1												
Embraer 190/195	5,952.9	—	—	—	—	—	—	—	—	—	—	5,952.9
Subtotal CF34-10 Srs	***6,340.7***	***146.2***	***169.1***	***171.6***	***152.9***	***79.4***	***80.6***	***81.8***	***83.0***	***80.4***	***66.1***	***7,451.7***
Total	**31,223.4**	**579.0**	**638.5**	**624.3**	**603.0**	**469.2**	**230.7**	**81.8**	**83.0**	**80.4**	**66.1**	**34,679.4**