LEAP

LEAP overview

THE LEAP ENGINE REPRESENTS THE OPTIMUM COMBINATION OF CFM INTERNATIONAL'S UNRIVALED EXPERIENCE AS THE PREFERRED ENGINE SUPPLIER FOR SINGLE-AISLE AIRCRAFT AND ITS 40+ YEAR INVESTMENT IN RESEARCH AND DEVELOPMENT.

The LEAP engine is a worthy successor to the CFM56 family, the best-selling engine in aviation history. Leveraging the strengths of its parent companies, GE and Safran Aircraft Engines, the LEAP engine incorporates leading-edge technologies to meet customers' increasingly demanding economic and environmental requirements.

These technology innovations include optimized thermodynamic design, higher bypass and compression ratios, advanced 3-D aerodynamic design, and greater use of lightweight materials.

CFM COMMITMENTS:

- Best engine performance
- Best execution
- Technology firsts

AIRCRAFT COMPLIANCE WITH FUTURE CHAPTER 14 **NOISE REGULATION**

MAINTENANCE COSTS COMPARABLE TO TODAY'S INDUSTRY-LEADING CFM56 ENGINES

15%

REDUCTION
IN FUEL CONSUMPTION
AND CO_2 EMISSIONS VERSUS
PREVIOUS GENERATION ENGINES

UP TO 50%

MARGIN
ON NO_X EMISSIONS
VERSUS
CAEP/6 STANDARD

Commercial success

TO DATE, CFM HAS RECEIVED MORE THAN 12,200 LEAP ENGINES ORDERS AND COMMITMENTS ACROSS ALL THREE MODELS.

A320neo

Dual-source (LEAP-1A)

737 MAX

Single-source (LEAP-1B)

C919

Sole western powerplant (LEAP-1C)

THE **LEAP** IS THE FASTEST-SELLING ENGINE IN AVIATION HISTORY

OPERATING WORLDWIDE

~100,000

LEAP ENGINE FLIGHT-HOURS IN LESS THAN A YEAR

Low risk best execution

GE AND SAFRAN AIRCRAFT ENGINES TOGETHER SINCE 1974, **PARTNERS THROUGH**

2040+

CFM has leveraged all of this unrivaled experience for the LEAP engine program, and the basic principle hasn't changed: give customers the best possible engine, today and for years to come.

CFM has a long history of constantly investing in its product lines to deliver greater value. This is the approach the company used to develop the LEAP engine and will continue to develop new technologies that will be incorporated into the engine throughout its service life, as well as in a new generation of engines.

CFM EXPERIENCE:

31,000+

CFM ENGINES DELIVERED
22 SUCCESSFULL ENTRIES INTO SERVICE

EVERY

2 SECONDS

A CFM POWERED AIRCRAFT TAKES OFF
SOMEWHERE IN THE WORLD

Technology firsts

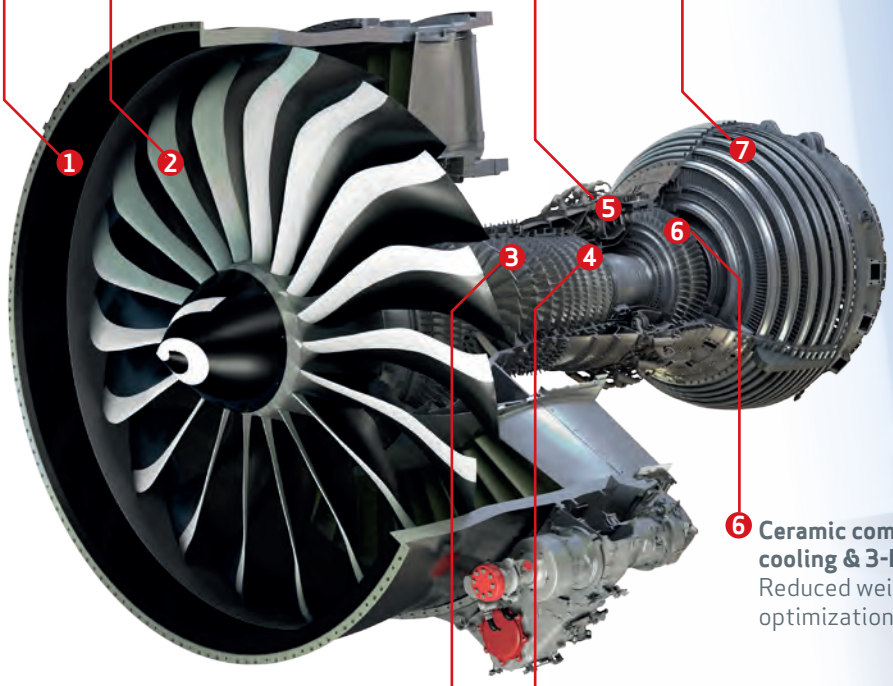
MULTIPLE PROVEN CUTTING-EDGE TECHNOLOGIES

1 High bypass ratio
Optimum propulsive efficiency

2 3-D woven carbon fiber composites
Lightweight, increased durability

5 New-generation combustor
Lean burn, low temperature

7 Lightweight materials & 3-D aerodynamics
Reduced weight, increased efficiency



6 Ceramic composites, new cooling & 3-D aerodynamics
Reduced weight, cooling optimization

4 High technology compressor
Optimum thermal efficiency

3 Debris rejection system
Airfoils protection against erosion

CFM 'S LEAP ENGINE IS AN IMPRESSIVE PACKAGE OF INNOVATIVE TECHNOLOGIES. IT SETS A NEW STANDARD IN ENGINES FOR SINGLE-AISLE COMMERCIAL JETS, PROVIDING A 15% REDUCTION IN FUEL CONSUMPTION AND CO_2 EMISSIONS VERSUS PREVIOUS GENERATION ENGINES.

3-D WOVEN CARBON FIBER COMPOSITES

The 3-D woven RTM (Resin Transfer Molding) carbon fiber composites used for the fan blades and fan case on the LEAP engine are revolutionizing the single-aisle market.

This material helps reduce engine weight by 500 lbs per engine. The 3-D RTM technology is highly impact resistant and, thus, reduces maintenance requirements.

ADDITIVE MANUFACTURING

Additive manufacturing is transforming the way engines are built. This technology "grows" engine parts directly from a CAD* file using layers of fine metal powder and a laser. This results in complex, fully dense, lighter parts, manufactured in a fraction of the time it would take using traditional subtractive methods. Each LEAP engine contains metal 3-D-printed fuel nozzles, which are up to 25% lighter than traditional nozzles.

* Computer Assisted Design.

All certified

LEAP-1A

NOVEMBER 20, 2015
CFM LEAP-1A
Achieves Joint
EASA / FAA
Certification

Entered into service
in August 2016

LEAP-1B

MAY 4, 2016
CFM LEAP-1B
Achieves Joint
EASA / FAA
Certification

Entered into service
in 2nd quarter 2017

LEAP-1C

DECEMBER 21, 2016
CFM LEAP-1C
Achieves Joint
EASA / FAA
Certification

Entry into service
scheduled in 2019

" 2016 has been an incredible year for the LEAP program. It has been marked by the entry into service of the first model of the family and ended with the certification of the third version of this family. "

" Everyone, from the project and engineering teams to manufacturing and our suppliers, has done an incredible job. They kept this program on schedule and built an engine that is delivering everything that we have promised. "

LEAP in operation

THE LEAP ENGINE STARTED REVENUE SERVICE IN AUGUST 2016. ITS FOOTPRINT IS NOW GLOBAL, IT HAS DELIVERED PERFORMANCE IN LINE WITH THE COMMITMENT MADE BY SAFRAN AND GE.

As of June 2017, more than 100 LEAP engines were in service on four continents, flying in various environments, logging a total of 100,000 flight-hours. Within the first five years, CFM will have support 50 entries into service, which has never been done in aviation history.

Closer to our customers

CFM HAS IMPLEMENTED THE MOST COMPREHENSIVE READINESS PLAN EVER TO ENSURE A SMOOTH, SUCCESSFUL ENTRY INTO SERVICE FOR ALL LEAP OPERATORS.

INITIATIVES:

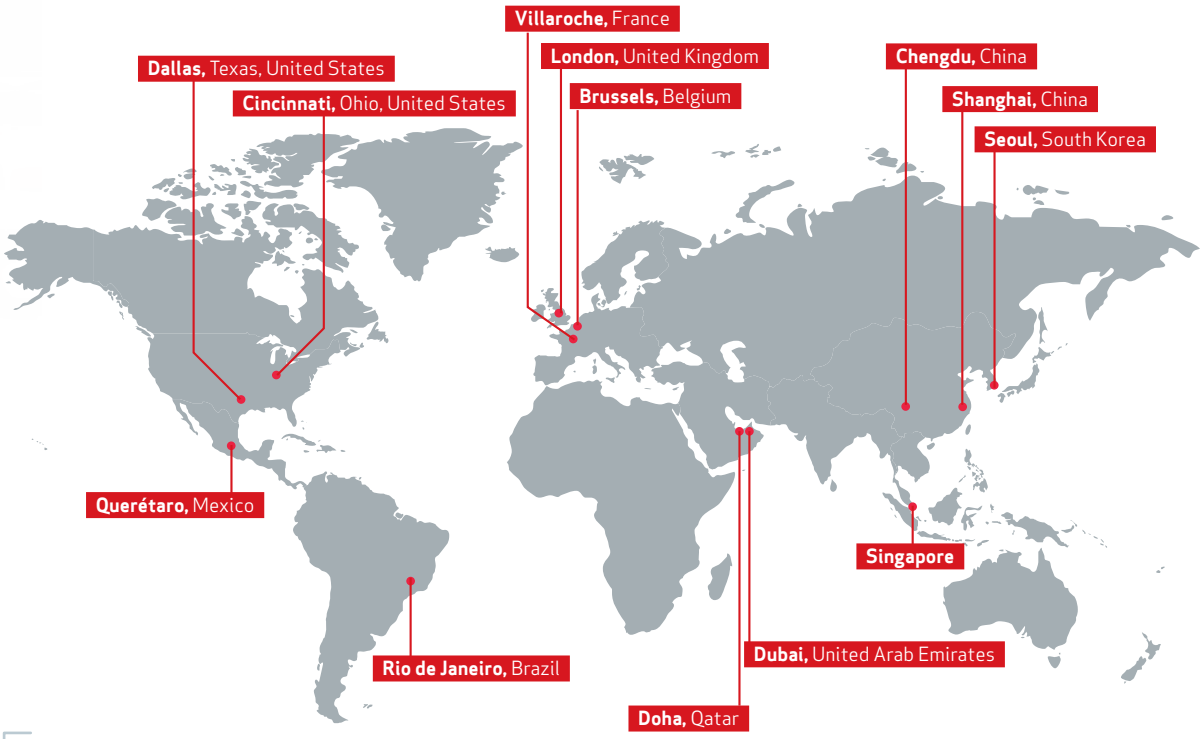
- Dedicated LEAP experts network supporting new LEAP operators
- Entry into Service Road Map customized for each airline
- New LEAP Customer Support Center (CSC) (Available 24/7)
- LEAP Maintenance Training Centers
- Customer web portal (myCFMportal.com)
- Flight Ops dedicated to airline pilots LEAP training

A PROVEN GLOBAL SUPPORT NETWORK IS ALREADY IN PLACE:

12
DEDICATED LEAP EXPERTS SUPPORTING NEW LEAP OPERATORS

On-Site Support

WORLDWIDE COVERAGE FOR A NEW STANDARD OF EXCELLENCE



- **WORLDWIDE NETWORK**
- **MAXIMIZED RESPONSIVENESS** AND MINIMIZED COSTS FOR CUSTOMERS
- **STANDARDIZED PRACTICES** AND DELIVERABLES BASED ON CFM56

13
ON-SITE SUPPORT CENTERS

4
TRAINING CENTERS ON 3 CONTINENTS

3
CUSTOMER SUPPORT AND **DIAGNOSTICS CENTERS**

Strong execution assures unparalleled success

INDUSTRIAL FACILITIES SMOOTH RUNNING, CONSTANTLY IMPROVING.

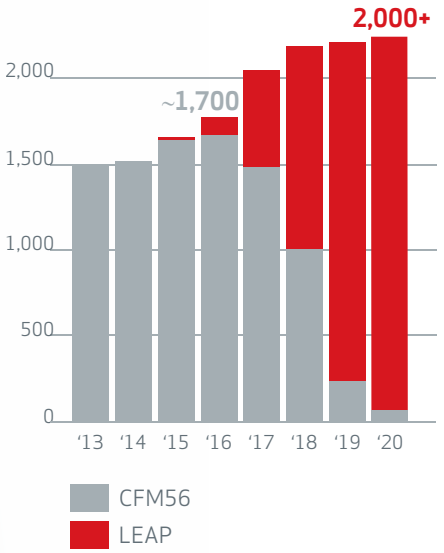
CFM has produced and delivered the world's largest fleet of jet engines in the single-aisle market. This achievement is anchored in the development and continuous improvement of world-class facilities on both sides of the Atlantic, with each partner responsible for half the workshare.

GE develops and builds the core, comprising the high-pressure compressor, high-pressure turbine, and the combustor, while Safran Aircraft Engines designs and builds the fan, the accessory gearbox, and the low-pressure compressor and turbine. Final assembly of CFM engines is performed at both GE and Safran Aircraft Engines facilities.

CFM maintains the highest production rate in the industry and the company is modernizing and expanding its facilities to ensure the successful ramp-up in production for the new LEAP engine. Both GE and Safran Aircraft Engines have added new manufacturing capability worldwide, making a combined capital investment of more than $1 billion U.S.

WHILE ACHIEVING A PRODUCTION RECORD IN 2016 **CFM HAS BEEN PREPARING ITS SUPPLY CHAIN FOR AN UNPRECEDENTED LEAP RAMP-UP.**

The transition is expected to be completed by 2020 with an anticipated production rate of more than 2,000 engines per year. CFM will continue to build CFM56 spare engines for several years to support the in-service fleet.



CFM commitments

- **BEST ENGINE PERFORMANCE**
  FUEL CONSUMPTION, MAINTENANCE COST, RELIABILITY, MINIMAL ENVIRONMENTAL FOOTPRINT.
- **BEST EXECUTION**
  22+ SUCCESSFULL SERVICE ENTRIES
- **TECHNOLOGY FIRSTS**
  PROVEN ARCHITECTURE
  MULTIPLE PROVEN AND NEW TECHNOLOGIES.

www.cfmaeroengines.com

cfm LEAP

LEAP-1A

Airbus A320neo

LEAP

The LEAP® family of engines

is designed to power commercial aircraft requiring 20,000 to 35,000 pounds of thrust. These new-generation engines will set the standard in terms of fuel efficiency and total cost of ownership.

CHARACTERISTICS

A/C application	A320neo family
Takeoff thrust	Up to 35,000 lbf *
Bypass ratio (CR)	11:1 class
Overall pressure ratio (T/O)	40:1 class
Fan diameter	78"
Compressor Stages (fan / booster / HPC)	1+3+10
Turbine Stages (HP / LP)	2+7
Combustor	TAPS II
Control	FADEC IV

** 32,900 lbf at Sea Level – Increased thrust at altitude*

TIMETABLE

2017
LEAP POWERED A321neo ENTRY INTO SERVICE

2016
LEAP POWERED A320neo ENTRY INTO SERVICE

2015
LEAP-1A CERTIFICATION

2014
FLIGHT TESTS

2013
FIRST ENGINE TO TEST

2010
A320neo LAUNCH

LEAP INCORPORATES IMPROVEMENTS DEVELOPED THROUGH ADVANCED RESEARCH & TECHNOLOGY TO OFFER:

15%
REDUCTION IN FUEL CONSUMPTION
AND CO_2 EMISSIONS VERSUS PREVIOUS GENERATION ENGINES

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MAINTENANCE COSTS
COMPARABLE TO TODAY'S INDUSTRY-LEADING CFM56 ENGINES

cfm LEAP

LEAP-1B

Boeing 737 MAX

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CHARACTERISTICS

A/C application	737 MAX family
Takeoff thrust	Up to 28 K
Bypass ratio (CR)	9:1 class
Overall pressure ratio (T/O)	40:1 class
Fan diameter	69”
Compressor Stages (fan / booster / HPC)	1+3+10
Turbine Stages (HP / LP)	2+5
Combustor	TAPS II
Control	FADEC IV

TIMETABLE

2017
737 MAX 9
FIRST FLIGHT

2017
737 MAX 8
ENTRY INTO SERVICE

2016
LEAP-1B
CERTIFICATION

2015
FLIGHT TESTS

2014
FIRST ENGINE
TO TEST

2011
737 MAX
LAUNCH

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MAINTENANCE COSTS
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TO TODAY’S
INDUSTRY-LEADING
CFM56 ENGINES

cfm LEAP

LEAP-1C

Comac C919

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CHARACTERISTICS

A/C application	C919 family
Takeoff thrust	Up to 30 K
Bypass ratio (CR)	11:1 class
Overall pressure ratio (T/O)	40:1 class
Fan diameter	78"
Compressor Stages (fan / booster / HPC)	1+3+10
Turbine Stages (HP / LP)	2+7
Combustor	TAPS II
Control	FADEC IV

TIMETABLE

2019
C919
ENTRY INTO SERVICE

2017
FIRST FLIGHT

2016
LEAP-1C
CERTIFICATION

2014
FLIGHT TESTS

2013
FIRST ENGINE
TO TEST

2009
C919
LAUNCH

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