

# General Electric T408

**Turboshafts**  
**July 2020**

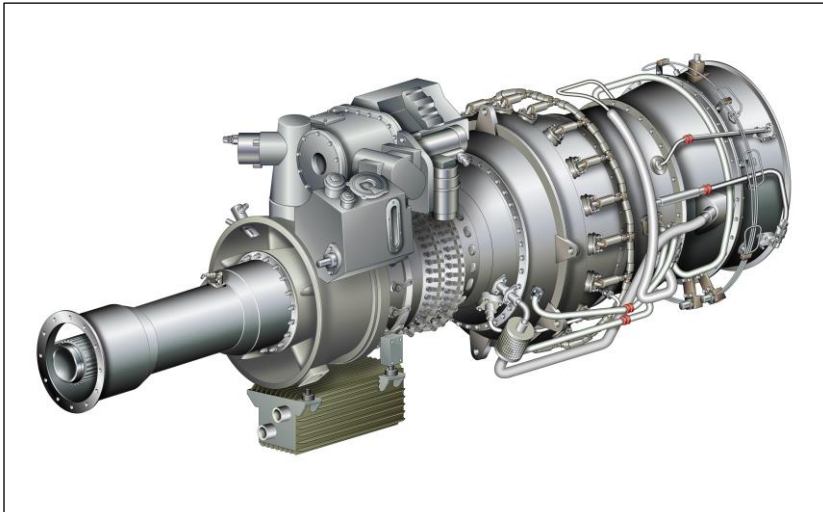
## Program Briefing

In January 2007, Sikorsky selected General Electric's 7,500-shp T408 (in-house designation is GE38-1B) turboshaft to power the CH-53K. The engine beat out the Pratt & Whitney Canada PW150 and Rolls-Royce AE1107 Liberty for the application.

The T408 is based on the GE27 technology demonstrator engine completed for the US military and the T407 turboprop developed for the US Navy. A turbofan derivative of the engine, the CFE738, powers the Dassault Falcon 2000 business jet.

Features of the engine include resistance to sand erosion and salt-water corrosion. Also, the powerplant is designed to be stall-free under all conditions. Maintenance and support costs will be reduced, in part, because the T408 will have 60% fewer parts than the T64 it will replace on the aircraft.

We forecast the production of 512 T408s during our forecast period, valued at \$1.4 billion.



### Quick Specs:

Power Class:	7,500 shp (5,593 kW)
Pressure Ratio:	n/a
Airflow:	n.a
SFC:	n/a
Configuration:	5A-1C HPC; Annular; 2A HPT; 3A PT

## Manufacturers

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

## Manufacturing Locations

- Lynn, MA: design, assembly, test.
- Hookset, NH: blisks tubes, compressor vanes.
- Dayton, OH: tubes, brackets, ducts.
- Rutland, VT: compressor vanes.
- Madisonville, KY: turbine blades, nozzles.
- Muskegon, MI: turbine shrouds, nozzles.

## Summary Forecast

	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	Total
Units Produced	10	20	23	37	51	65	72	77	77	80	512
Value (2020 \$ Millions)	28.0	56.0	64.4	103.6	142.8	182.0	201.6	215.6	215.6	224.0	1,433.6

- Strother, KA: assembly, overhaul.
- Jacksonville, FL: electrical components

## Technical Description

### Components

#### Compressor

Five-stage axial compressor coupled to a single centrifugal stage.

#### Combustor

Single low-emission annular combustor.

#### HP Turbine

Two-stage axial high-pressure (HP) turbine drives the compressor section.

#### LP Turbine

Three-stage axial low-pressure (LP) turbine (a.k.a. power turbine), drives the output shaft.

#### Other Features

Dual-channel full-authority digital electronic control (FADEC) system with advanced health monitoring functions.

### Engine Variants

**CFE738**—Turbofan version employing core of GE38. Powers the Dassault Falcon 2000.

**CPX38**—Turboprop variant based on the core of the GE38.

**GE38-1B**—In-house designation for engine developed for the CH-53K.

**T408-GE-400**—Military for designation for the GE38-1B powering the Sikorsky CH-53K.

### Specifications

#### (Imperial Units)

Model	T-O Rating (shp)	Max. Cont. Rating (shp)	Air Mass Flow (lb/s)	Shaft rpm	SFC at T-O (lb/shp-hr)	Max. Dia. (in)	Length (in)	Weight Dry (lb)
T408-GE-400	7,500	n/a	n/a	n/a	n/a	27.0	57.5	n/a

#### (Metric Units)

Model	T-O Rating (kW)	Max. Cont. Rating (kW)	Air Mass Flow (kg/s)	Shaft rpm	SFC at T-O (µg/J)	Max. Dia. (m)	Length (m)	Weight Dry (kg)
T408-GE-400	5,593	n/a	n/a	n/a	n/a	0.686	1.461	n/a

### Applications

Engine	Aircraft	Engines per A/C
T408-GE-400	Sikorsky CH-53K King Stallion	3

## Marketing Data

### Costs

Initial T408s appear to be priced around \$4 million per the contract awarded to GE for flight test engines. We estimate the unit cost for series production T408-GE-400s will be near \$2.8 million.

### The Competition

The T408 will compete for further applications with the Rolls-Royce AE1107 Liberty.

**Delivery History (estimates)**

	<u>2011</u>	<u>2012</u>	<u>2013</u>	<u>2014</u>	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>	<u>Total</u>
GE38	—	10	10	—	—	—	—	—	—	20
T408-GE-400	—	—	4	4	4	5	1	3	4	25
<b>Total</b>	<b>—</b>	<b>10</b>	<b>14</b>	<b>4</b>	<b>4</b>	<b>5</b>	<b>1</b>	<b>3</b>	<b>4</b>	<b>45</b>

**Contract Briefs**

Below is a listing of prime contracting actions involving the T408 program that have been announced by the Pentagon since the beginning of FY13 (10/1/12) and through the date at the end 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.

<u>Date</u>	<u>Contract Number</u>	<u>Obligation</u>	<u>Details</u>
<i>General Electric, GE Aviation</i>			
05/16/2013	N00019-10-G-0007	\$7,580,113	FFP delivery order against a previously issued basic ordering agreement contract action issued by the Naval Air Systems Command for the procurement of critical hard tooling required to support the manufacturer of the GE38-1B engines. Work will be performed in Lynn, MA (20%); Morristown, TN (20%); Groton, CT (20%); and 4 other locations (40%). The contract is scheduled to be completed by 11/30/2014. Program involvement: CH-53, GE38, T408. RDT&E involvement: 0205633N.
07/17/2013	N00019-13-C-0132	\$15,691,247	CPFF contract action issued by the Naval Air Systems Command for the procurement of time critical parts for incorporation into the T408-GE-400 gas turbine engine in support of the CH-53K helicopter program. The contract is scheduled to be completed by 12/31/2016. Program involvement: CH-53, GE38, T408. RDT&E involvement: 0604212N.
07/31/2014	N00019-13-C-0132	\$22,499,879	increment as part of a \$68,550,240 modification to a previously awarded FFP contract action issued by the Naval Air Systems Command for the procurement of 16 GE38-1B engines, closure kits, tooling, and associated systems engineering and program management in support of the CH-53K helicopter. The contract is scheduled to be completed by 1/31/2017. Program involvement: CH-53, GE38, T408. RDT&E involvement: 0605212N.
01/15/2015	N00019-13-C-0132	\$28,997,331	modification to a previously awarded FFP contract action issued by the Naval Air Systems Command for the procurement of six T408-GE-400 (GE38-1B) System Demonstration Test Article engines in support of the CH-53K helicopter program. Work will be performed in South Windsor, CT (17%); Lynn, MA (15%); Evendale, OH (12%); and various locations



Sikorsky CH-53K powered by three General Electric T408-GE-400s

			(56%). The contract is scheduled to be completed by 1/31/2017. Program involvement: CH-53, GE38, T408. RDT&E involvement: 0605212N.
11/16/2017	N00019-18-C-1007	\$143,481,258	firm-fixed-price, cost-plus-fixed-fee contract action issued by the Naval Air Systems Command for the procurement of 22 low-rate initial production Lot 1 and 2 T408-GE-400 turboshaft engines for the CH-53K helicopter, including associated engine and programmatic support, logistics support, peculiar support equipment, and spares. The contract is scheduled to be completed by 7/31/2021. Program involvement: T408, CH-53.
12/20/2017	N00019-13-C-0132	\$7,342,618	increment as part a \$21,435,687 modification to a previously awarded cost-plus-fixed-fee contract action issued by the Naval Air Systems Command for programmatic and logistical support to develop damage limits and tolerances of engine components as well as the completion of maintenance task analysis and maintenance planning to establish organic depot level repair for the T408-GE-400 engine installed on the CH-53K helicopter. The contract is scheduled to be completed by 12/31/2021. Program involvement: T408, CH-53. RDT&E involvement: 0205633N.
08/29/2019	N00019-18-C-1007	\$143,680,709	modification to a previously awarded firm-fixed-price, cost-plus-fixed-fee contract action issued by the Naval Air Systems Command for 24 low rate initial production Lot 3 T408-GE-400 turboshaft engines and three Lot 2 T408-GE-400 engines for the CH-53K helicopter. In addition, this modification provides for associated engine and programmatic support, logistics support, peculiar support equipment and spares. The contract is scheduled to be completed by 12/31/2022. Program involvement: T408, CH-53.

## Milestones

<u>Date</u>	<u>Milestone</u>
March 1990	first run of T407 turboprop
December 2006	USMC selects GE38 for CH-53K
Jan. 24, 2007	GE launches development of GE38
July 2008	MTU takes 18% stake in GE38
Jan. 13, 2009	GE38 passes CDR
June 24, 2009	First full engine test
May 6, 2010	FETT phase completed
Aug. 4, 2011	First GE38 delivered for CH-53K Ground Test Vehicle
July 31, 2013	Contract awarded for 16 flight test engines
Dec. 18, 2013	300-hour endurance test completed
Oct. 27, 2015	First flight of CH-53K/T408
Apr. 4, 2017	Milestone C awarded by DAB
Nov. 16, 2017	LRIP 1 and 2 contracts awarded for 22 T408s
Aug. 29, 2019	LRIP 3 contract awarded
Sep. 30, 2019	First production T408 delivered to NAVAIR

## Program Overview

### Background

#### T407 Shelved

General Electric developed the T407/GLC38 turboprop in the late 1980s and it was selected to power the P-7A follow-on to the P-3C Orion ASW aircraft. The engine was a two-shaft axial-centrifugal, free turbine engine rated at 5,660 shp (4,220 kW). It was based on work GE performed

on the GE27 demonstrator which was sponsored by the US Army and Navy. The first T407 ran in March 1990. The P-7A subsequently was cancelled, along with further development of the engine. The engine's core, however, served as the basis of the CFE738 turbofan for the Dassault

Falcon 2000, which has just completed series production.

#### Sikorsky Wins the CH-53K

In April 2006, DoD awarded Sikorsky a \$3 billion System Development and Demonstration (SDD) contract to oversee development, sys-

tems integration, testing and evaluation of the CH-53K, the helicopter that will replace the currently fielded Marine Corps CH-53E Super Stallion. Initial operational capability is planned for 2015. The "E" version of the helicopter is powered by three General Electric T64 turboshafts.

### GE Wins Engine Contest

In December 2006, Sikorsky and the Marine Corps selected General Electric's GE38-1B turboshaft candidate to power the CH-53K. The engine beat out the Pratt & Whitney Canada PW150 and Rolls-Royce AE1107 Liberty for the application.

Features of the engine include resistance to sand erosion and salt-water corrosion. Also, the powerplant is designed to be stall-free under all

conditions. Maintenance and support costs will be reduced, in part, because the GE38 will have 60% fewer parts than the T64 it will replace on the aircraft.

### MTU Takes on Risk Share

In July 2008, it was reported that MTU had taken an 18% risk share in the GE38. Responsibilities for the German company include the development and production of the power turbine module, and will also assemble, test and support GE38s for European customers.

The deal also covers the supply of engines for the proposed Eurocopter/Sikorsky European Heavy Transport Helicopter, which could replace Germany's old CH-53s.

### CDR Completed

GE Aviation reported in January 2009, that the GE38 had successfully passed its critical design review (CDR). This milestone cleared the way for full-engine testing in 2009.

### FETT

A milestone was reached on 24 June 2009 when the first engine to test (FETT) was accomplished at GE's Lynn, MA, facility. Later, in October 2009, GE announced that the first GE38 had reached 7,300 shp, thereby setting a horsepower record for the test facility.

In May 2010, GE reported that the GE38 had completed its First Engine to Test (FETT) phase. Included in the accomplishment was a 30-hour endurance test.

## Current Developments

### GE38 Offered For SSC

To expand its market base, GE announced that it would offer the GE38 as power for the Navy's new Ship-to-Shore Connector (SSC) vessels. The SSCs are planned to replace the service's LCAC (Landing Craft Air-Cushion) vehicles. However, this application subsequently was won by Rolls-Royce (with an AE1107 variant called MT7).

### GE 38 Progress

In August 2012, GE reported that four ground test engines were undergoing testing, with a fifth and final one soon to join the program. The four engines had accumulated 2,300 hr of the planned 5,000 hr (by late 2013) of run-time.

Further reported was that seven of the 20 flight test engines had been fabricated with the final 13 to be completed by early 2013.

### Turboprop Variant Announced

In September 2012, GE announced that it was working on a new turboprop engine suitable for 70- to 90-seat regional airliners. The new engine, dubbed the CPX38, is based on the GE38 core. The company says

that the turboprop could be ready within three or four years of an identified application.

### Ground Tests Completed

In December 2013, GE reported that the GE38-1B had successfully completed its 300-hr endurance test. This cleared the way for the flight test program which is scheduled to begin in late 2014.

In July 2014, GE was awarded a \$68.5 million System Demonstration Test Article (SDTA) contract to manufacture 16 T408s (the military designation for the GE38) for the flight test effort (Operational Evaluation phase).

### First Flight of CH-53K

In October 2015, GE reported that the CH-53K had successfully made its first flight. Earlier, in January 2015, the Navy awarded GE a contract for six additional T408s. The exiting test engines have reached 4,500 hr.

### Production Contracts

In November 2017, NAVAIR awarded GE Aviation a \$143.5 million Low-Rate Initial Production

(LRIP) contract to build 22 T408-GE-400 engines. The contract followed the Apr. 4, 2017, Milestone C decision by the Defense Acquisition Board (DAB) approving LRIP production.

### T408 Program Status

In August 2019, GE was awarded a \$143 million contract for the third lot of LRIP T408s.

In September 2019, GE delivered the first production T408 to NAVAIR.

### CH-53K Program Status

Milestone C (LRIP) was approved in April 2017. The Marines received their first production K in May 2018. In May 2019, the Navy signed the \$1.1 billion LRIP 2/3 contract, covering 12 Ks for \$1.3 billion.

The total acquisition objective is 194 K models (up from the original 156), but the Navy may buy into the program too, to replace its MH-53E fleet. Of the 194, 26 will be procured under LRIP and 168 under full-rate production. The final batch funded will be Lot 12, in 2031.

## Teal Group Evaluation

As an engine capable of powering one of the world's largest helicopters, future new production applications for the T408 are liable to be few a far between. There are, however, a couple possibilities for re-engineing that are floating about.

The Marine Corps has examined the T408 as a replacement for the T406s on its MV-22 Osprey tiltrotor aircraft. The Rolls-Royce engines ex-

perienced durability problems because of sand ingestion in Iraq. A T408 in this regime would employ protective coatings to protect the compressor component, which the T406 apparently does not have.

Another possibility lies with re-engineing the C-130J.

A recent effort to expand the T408 sales base was the announcement that GE would offer the engine for Navy SSC propulsion duties. However,

this application subsequently was won by Rolls-Royce (with an AE1107 variant called MT7).

We do not see these possibilities as very likely, though. Thus, we have only the CH-53K generating production requirements during the next decade. Still, we see 512 of the big 'shafts being built during the forecast period. The value of the engines will be an estimated \$1.4 billion.

## Production Forecast

Units	Thru 2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	Total
<b>GE38-1B</b>												
ground test engines	20	—	—	—	—	—	—	—	—	—	—	20
<b>T408-GE-400</b>												
YCH-53K (prototypes)	17	—	—	—	—	—	—	—	—	—	—	17
CH-53K	8	10	20	23	37	51	65	72	77	77	80	520
<b>Total</b>	<b>26</b>	<b>10</b>	<b>20</b>	<b>23</b>	<b>37</b>	<b>51</b>	<b>65</b>	<b>72</b>	<b>77</b>	<b>77</b>	<b>80</b>	<b>538</b>
Value (2020 \$Millions)		2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	Total
<b>T408-GE-400</b>												
CH-53K		28.0	56.0	64.4	103.6	142.8	182.0	201.6	215.6	215.6	224.0	1,433.6