

Encyclopedia of U.S. Air Force Aircraft and Missile Systems

Post-World War II Fighters, 1945-1973

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LOCKHEED F-104 STARFIGHTER

Manufacturer's Model 183-93-02

Weapon System 303A

Basic Development

1949-1952

Lockheed developed the F-104 from its F-90, flight tested in 1949 but never produced. The F-104 also benefited from Douglas work on the X-3, an experiment flown in October 1952 that did not meet expectations because of the lack of an adequate engine. (1)

Unsolicited Proposal

November 1952

Lockheed knew (2) the Air Force (based on its Korean experience) needed a new air superiority fighter, capable of operating from forward air fields, accelerating rapidly from the ground, and fighting at high altitudes. Lockheed proposed a light-weight, straight-wing design, when the Air Force had in mind a relatively heavy delta-wing aircraft. Yet Lockheed's small, "Gee. Whizzer" day-fighter (later dubbed Starfighter) was tempting for it would be cheaper. (3)

General Operational Requirements

12 December 1952

Called for development of a light-weight air superiority day fighter to replace TAC's F-100s in 1956. The formal USAF requirement of December 1952 (finalized 1 month after Lockheed's unsolicited proposal) soon entered competitive bidding.

Contractor Selection

January 1953

After considering entries from Republic and North American Aviation, the Air Force endorsed Lockheed's official bid. Circumstances had favored Lockheed from the outset. The relative merits of each proposal were of primary importance. Nevertheless, the Air Force wanted to prevent Republic and North American from monopolizing the development and production of new fighters. (4)

Letter Contract

11 March 1953

Selection of the Lockheed proposal was not a blanket endorsement of the F-104 design. The Air Force moved cautiously. Lockheed was awarded a development LC (Letter Contract) for two XF-104s and 1 year of flight testing. An early 1954 first flight was scheduled.

(1) To recoup its losses on the X-3 program, the Air Force insisted that Douglas deliver the aircraft plans to Lockheed.

(2) In fact, Lockheed had rejected in May 1952 a letter contract covering the construction of flying prototypes because of a clause forfeiting all patent features to, and permitting, the government to assign the new airplane's production to others. Similar provisions, initially included in the North American F-100, Convair F-102, and McDonnell F-101 production contracts, were also turned down by the contractors. In all these cases, the government eventually gave in.

(3) Moreover, in late 1952 all criteria in the world of aviation were subordinated to flight performance. The weight controversy born of the Korean air battles was unsettled. Despite its kill superiority over the MiG, the heavier F-86 (with its sometimes superfluous gadgets) was criticized for complexity and extra weight. Notwithstanding, Clarence L. (Kelly) Johnson, Lockheed's chief engineer, said in 1954: "This [the XF-104] is still a highly complex airplane. You simply don't fly around at 40,000 feet at those kinds of speeds just by throwing a saddle over the thing and riding it. But what we have done is bring an end to the trend toward constantly bigger, constantly more complicated, constantly more expensive airplanes."

(4) Republic was already committed to the XF-105, the XF-103, and the F-84 program; North American to the F-86 and F-100.

Mockup Inspection**30 April 1953**

This initial inspection led to replacement of two 30-mm guns with one 20-mm GE Gatling gun-type M-61 Vulcan cannon (under development and then known as the T-171 gun) for a net weight decrease of 80 pounds. The F-104 cockpit's final inspection did not take place until 29 January 1955, almost 2 years later. Still, the F-104's early development stages were unusually rapid. (5)

First Flight (XF-104)**28 February 1954**

The aircraft featured a Buick built J-65 engine (6), far less powerful than the General Electric J-79 (7), intended for any F-104 productions. Lockheed flew its second XF-104 on 5 October, after fitting the J-65 engine with an afterburner. This raised the aircraft performance significantly. (A)

F-104A**Go-Ahead Decision****July 1954**

Still cautious, the Air Force programmed only 17 aircraft under "fly-before-you-buy." This meant more development tests before any large-scale production.

Initial Procurement**October 1954**

One month after the first XF-104 successfully completed Phase I testing. Yet as programmed, Lockheed's first production contract covered only 17 F-104s (8) (closely resembling their experimental predecessors). The Air Force planned to refurbish these aircraft for normal employment, after completion of scheduled suitability tests.

Initial Testing (XF-104)**1954-1956**

Scheduled XF-104 flight tests ended in August 1956, marred by the April 1955 crash of one of the two aircraft.(9) In March 1955 an XF-104, still powered by the interim J-65 had attained Mach 1.7 and an altitude of 60,000 feet. Lockheed designers had predicted a speed around Mach 2 and a combat ceiling of 53,000 feet for the aircraft.

First Flight (Production Aircraft)**11 February 1956**

The flight was conducted at the Air Force Flight Test Center, Edwards AFB, Cal. A second aircraft, accepted in March, entered flight testing on 15 June. (10)

(5) Less than a year separated the development LC (Letter Contract) of March 1963 and the XF-104's first flight. Nevertheless, Lockheed had turned down 1 year before a contract calling for similar prototypes. In effect, the same 1951 design competition which resulted in the so-called 1964 Ultimate Interceptor (F-102 and F-106) also, in a sense, spawned the F-104. The Air Force removed Lockheed from consideration as regards the Ultimate Interceptor in September 1951, but soon went back for development of a very advanced day fighter. Nonetheless, the F-104 was unique-experiencing few serious problems during development, perhaps due to its derivation from earlier (F-90 and X3) developments.

(6) An adaptation of the British Sapphire, the J-65 was first built by Curtiss-Wright for the F-84F.

(7) The static thrust of the GE-J79 engine (developed for the B-58 bomber and first tested in June 1964), with afterburner, exceeded 14,000 pounds. The XF-104's J-65 had only an 11,500-lb thrust, counting the 3,500 pounds added by its afterburner.

(8) The Air Force ordered 209 additional F-104s the following year and 480 more (including 106 earmarked for training) in late 1956. By 1957, 722 F-104s of one kind or another were programmed for production. This number was drastically reduced in December 1958; the entire USAF F-104 program never went past 294.

(9) Testing of the armament and fire-control system in this aircraft was then switched to a Lockheed F-94C, because none of the 17 aircraft ordered in October 1954 were yet available.

(10) First of the F-104s ordered in October 1964. Primarily earmarked for testing, these aircraft were immediately accounted for as production models.

Other Flight Tests**1956-1958**

The F-104 evaluation and suitability test program uncovered all sorts of unexpected problems. This stretched testing to 52 F-104s, 35 more than the 17 test productions originally forecasted.

Engine Problems**1955-1958**

Fearing the General Electric J-79 turbojet might not be ready in time, the Air Force (until 1955) thought of using the J-65 for initial F-104s. J-65's new malfunctions took care of this temporary planning, however. Since no F-104 airframes were available in 1955 the Air Force then flight-tested the experimental J-79 in a borrowed Navy XF-4D. This worked. The December 1955 testing of the XJ-79-GE-3 and production of the J-79-GE-3A enabled the F-104 2 years later to approach Mach 2. Notwithstanding, flameouts, ignition failures, and oil depletions caused several crashes and in-flight emergencies during testing and after the aircraft had become operational. General Electric came up with a better engine (the J-79-GE-3B), but not before the F-104s were repeatedly grounded. Retrofit of the -3B in early F-104s began in April 1958.

Structural Deficiencies**1956-1957**

Lockheed reduced the F-104's pitchup to an acceptable USAF level in December 1956 and continued improvement. It corrected an aerodynamic weakness in 1957 by redesigning the tail section.

Other Problems**1956-1957**

The 20-mm M-61 Vulcan cannon was selected for the F-104 in 1953. However, repeated flight testing of the gun led the Air Force in November 1957 to consider it too unreliable for the early aircraft. (It was retrofitted in 1964.) The F-104's high speed rendered its downward ejection seat unsatisfactory despite safety improvements. Lockheed was perfecting a replacement upward ejection system, but progress was slow. Even so, retrofitting of all F-104s with the new seat got under way in the early 60's.

Enters Operational Service**26 January 1958**

The F-104A entered service 2 years late and not with TAC (as originally planned), but with ADC's 83rd Fighter Interceptor Squadron at Hamilton AFB. This April 1956 (11) shift rested on two factors: slippage of the F-104 operational due-date (causing TAC to make other arrangements) and ADC's urgent need of a fighter to fill the gap between the F-102 and F-106. The tiny F-104, (12) with its long nosed fuselage and razor-thin trapezoid wings, had never been intended as an interceptor. But ADC believed it could use it, due to its impressive performance.

Oversea Deployments**October 1958**

Twelve F-104As from the 83d FIS were disassembled and flown by C-124s to beef up Taiwan's air defense during the Quemoy crisis of 1958. This took place less than a year after the F-104 became operational.

Total F-104As Accepted

170 (excluding the two XF-104 s ordered in March 1953), against the 610 programmed in 1957. Fund shortages accounted for most of the cut; TAC revised requirements, the remainder.

Acceptance Rates

The Air Force accepted 7 F 104As in FY 56, 28 in FY 57, 94 in FY 58, and 41 in FY 59. (13)

(11) The Air Force also decided at this time to give the aircraft Philco air-to-air, heat-seeking Sidewinder missiles-developed by the US Navy in 1947 and first carried by TAC's F-100Ds. The timing of the two decisions was coincidental. All F-104s were equipped with Sidewinders and a final decision on each model's allocation (F-104As and Bs to ADC, and F-104Cs and Ds to TAC) was not reached until January 1958.

(12) One of the Air Force's smallest, with a 21.9 ft wing span; lightest too, with maximum takeoff weight below 28,000 pounds for most models.

(13) Extensive F-104 testing and the problems uncovered resulted in only one or two F-104As being accepted each month until May 1957. Thereafter, monthly acceptance rates increased several fold.

End of Production

December 1958

In that month, the last eight F-104As were received and the entire F-104 program was slashed.

Flyaway Cost per Production Aircraft

\$1.7 million:

airframe \$1,026,859

engine (installed) \$624,727

electronics \$3,419

ordnance \$29,517

armament \$19,706

Average Cost Per Flying Hour

\$655.00

Average Maintenance Cost Per Flying Hour

\$395.00

Subsequent Model Series

F-104B

Other Configurations

None. In 1956 the Air Force approved a November 1954 TAC proposal of a preliminary design for a reconnaissance version of the F-104. The Air Force, however, cancelled all RF-104 work in January 1957, believing that forthcoming RF-101s (RF-101Cs in particular) would satisfy TAC requirements. (14)

Initial Phase-out

1960

Longer-range all-weather F-101 and F-106 interceptors (15), operational malfunctions and shortages of spare parts prompted ADC to quickly get rid of its four F-104 squadrons (B trainers included). Too small to carry the data link equipment called for by ADC's new SAGE control-system, the F-104 would be a windfall for the Air National Guard and the Military Assistance Program.

Reactivation

1961-1963

The Berlin Crisis of 1961 embarked the F-104 on a new tour of active service. In October three federalized ANG squadrons of F-104s went to Europe and stayed until the summer of 1962. Then, one squadron converted to C-97 transports to support active military airlift requirements. The other two wound up their federalized duty with ADC. The Cuban Missile Crisis of October 1962 rekindled USAF interest in the F-104. This quick reacting aircraft could challenge most hostile aircraft that might attack the United States from Cuba. So, upon return to state control, the two ANG F-104 squadrons surrendered their aircraft (16) to ADC's 331st FIS at Webb AFB, Texas, and to the 319th FIS at Homestead AFB, Florida. (17) Reactivated F-104s were retrofitted with M-61 Vulcans.

Final Phase-out

1967-1969

A general reduction in active ADC fighter-interceptor squadrons brought the F-104A's final phase-out. The 331st was inactivated in February 1967; the Homestead-based 319th in December 1969.

Other Countries

A number of F-104As relinquished by the Air Force in 1960 were transferred to the Chinese Nationalist Air Force and to the Pakistan Air Force.

(14) TAC considered the earlier RF-101A (operational in May 1957) as a sort of consolation prize for the RF-104 and RF-105, both deleted from future reconnaissance forces for lack of money. TAC at one point had envisioned four RF-104 squadrons.

(15) Both the F-101B and F-106 entered operational service in 1959, the F-101B in January, the F-106 in May.

(16) Receiving F-102A interceptors in return.

(17) The 319th was purposefully relocated to Homestead during the Cuban Crisis.

Other Users

1960-1963

The Air Force converted 24 F-104As into target drones (18) soon after ADC first declared the aircraft surplus. In October 1963 one F-104A was delivered to Edwards AFB's Flight Test Center to test a liquid-fueled rocket that would add 6,640 pounds to the engine thrust. This test aircraft (NF-104A) set on 6 December 1963 an unofficial world altitude record by reaching 120,000 feet.

Milestones

1958

The F-104 was the first USAF combat aircraft to sustain a speed faster than Mach 2. In May 1958 an F-104A at Edwards AFB set a world speed record of 1,404.19 miles per hour and a 91,249 feet altitude record for ground-launched planes. The following December, F-104A aircraft at Pt. Mugu, California, set three time-to-climb records: 3,000 meters in 41.36 seconds; 15,000 meters in 131.1 seconds; and 25,000 meters in 266.03 seconds.

F-104B

Manufacturer's Model Series 283-93-03

Previous Model Series

F-104A

New Features

Second cockpit aft of the F-104A's single seat-in the space otherwise designed for the M-61 Vulcan (19)

Basic Development

Lockheed developed the F-104B purely as a two-seat training version (TF-104) of the F-104A. The Air Force's December 1955 decision to equip operational F-104A squadrons with the two-seater brought about its redesignation (all possible F-104A armament was retained-usual in such cases). The Air Force earlier in the year also thought of using the F-104 trainer for suitability, high altitude, and physiological research tests.

Initial Procurement

April 1956

Procurement started slowly, as it had for the F-104A. The Air Force first ordered six F-104Bs; 106 more in 1957.

First Flight (Production Aircraft)

16 January 1957

The flight took place less than a year after the two-seater's first mockup inspection-an uneventful flight over California, from the Lockheed Palmdale plant to the nearby USAF Flight Test Center. The Air Force took official delivery of the aircraft in the same month.

Flight Testing

1957

The first 30 days of flight tests showed F-104A and F-104B performance to be similar. This was expected. The Air Force did not plan to accept any more F-104Bs until the fall of 1957, when extensive F-104A flight tests would be completed. Meanwhile, it needed the first F-104B to test the downward ejection seat that first equipped most F-104s. The Air Force took official delivery of a second F-104B in September, 1 month ahead of schedule.

(18) Flyaway cost per drone (QF-104) reached \$1.7 million

airframe \$1,010,830

engine (installed) \$628,551

electronics, \$3,419

ordnance \$29,617

armament \$19,706

(19) In contrast to the F-104A (retrofitted with the M-61 in 1964), the F-104B's armament never exceeded two AIM-9B (originally designated GAR 8) Sidewinders.

Enters Operational Service**1958**

With the 83d FIS (the first F-104A recipient) at Hamilton AFB. ADC's three other F-104A squadrons shared later F-104Bs.

Total F-104Bs Accepted

26, against 112 ordered in 1957.

Acceptance Rates

The Air Force accepted one F-104B in FY 57, 14 in FY 58, and 11 in FY 59.

End of Production**November 1958**

With delivery of the last 4 F-104Bs.

Subsequent Model Series

F-104C

Other Configurations

None

Flyaway Cost Per Production Aircraft

\$2.4 million

airframe \$1,756,388

engine (installed) \$336,015

electronics \$13,258

ordnance \$59,473

armament \$231,996

Average Maintenance Cost Per Flying Hour

\$544.00

Phase-out**1960-1969**

Transferred to the ANG in 1960, the F-104B returned to ADC's active inventory in 1962-1963. It phased out again in 1967-1969, along with and in the same manner as the F-104A.

F-104C**Manufacturer's Model 583-04-05****Previous Model Series**

F-104B

New Features

J-79-GE-7A engine (15,000 lb static thrust with afterburner) having 1,000 pounds more thrust than the J-GE-3B (with afterburner) in F-104Bs, late F-104As, and retrofitted in early F-104As. The F-104C also featured an improved fire-control system (AN/ASG-14T-2, replacing the F-104A's T-1) for day and clear-night operations; a probe-drogue air refueling system; and external nuclear stores. (20)

First Flight Production Aircraft**July 1958****First Acceptance****September 1958**

The Air Force accepted four F-104Cs, then seven or more each month, beginning in October.

(20) Previous F-104s carried only conventional ordnance and extended their range with external fuel tanks (suspended from a centerline fuselage rack, in place of additional Sidewinders).

Enters Operational Service**September 1958 (21)**

The 476th Tactical Fighter Squadron at George AFB, along with three other squadrons of the 479th Tactical Fighter Wing, became TAC's only F-104 combat units. All four squadrons at George converted from F-100s, the last in 1959.

Total F-104Cs Accepted

77

Acceptance Rates

All F-104Cs were accepted in FY 59-seven to nine each month from October 1958 through June 1959.

End of Production**June 1959**

It ended with delivery of the last seven F-104Cs.

Subsequent Model Series

F-104D

Other Configurations

None

Flyaway Cost Per Production Aircraft (22)

\$1.5 million

airframe \$863,235

engine (installed) \$473,729

electronics \$5,219

ordnance \$44,684

armament \$91,535

Average Maintenance Cost Per Flying Hour

\$395.00

Operational Problems**1959-1964**

Shortages of engines, components, and supplies plagued TAC's F-104Cs and their few accompanying trainers (F-104Ds). Even worse was the unreliability of components-the new J-79-GE-7A engine a major culprit. In less than 5 years, 40 major accidents occurred claiming nine lives and destroying 24 aircraft. This paved the way for Project Seven Up, a General Electric modification that started in May 1963 and ended in June 1964.

Modernization**1961-1963**

In October 1961, (23) the Air Force had launched Project Grindstone by which Lockheed modernized the F-104 air superiority fighter. Completed by early 1963, Grindstone gave the F-104C four Sidewinders (all other F-104s carried only two), plus a variety of air ground weapons-2.75 inch rockets, napalm and gravity bombs. **(B)**

Special Deployments**1962-1964**

The Cuban Missile Crisis of 1962 saw the unexpected deployment of F-104Cs to Key West, Florida. As a result of the same crisis, F-104Cs in 1964 were also called upon to fulfill some F-104As air defense commitments. They moved to Homestead AFB, while F-104A interceptors were retrofitted with M-61 Vulcans.

(21) TAC officially accepted the F-104C in mid-October during the USAF annual fighter weapons meet at Nellis AFB.

(22) Plus cumulative R&D (Research and Development) and Class V modification costs of \$189,473 and \$198,348 per aircraft.

(23) Almost 2 years before implementing the upcoming Seven Up modification.

Oversea Deployments

1965-1967

F-104Cs went first to Southeast Asia on a temporary basis. In 1965 one squadron stood alert at Kung Kuan, Taiwan, and DaNang, South Vietnam. From DaNang, the aircraft soon struck targets in both South and North Vietnam-enemy ground fire taking its toll. A new contingent of F-104Cs returned to SEA in mid 1966, this time permanently. F-104Cs of TAC's 479th Tactical Fighter Wing were then assigned to the 435th TFS at Udorn, resuming their attacks until they were replaced by more efficient F-4Ds in July 1967.

Phase-out

1966-1967

The F-4D program slippage and the war's impact on USAF resources postponed the aircraft phase-out. In 1962 one of TAC's four squadrons of F-104 tactical fighters equipped a combat crew training squadron; the other three did not begin converting to F-4Ds until 1966. For all practical purposes, phase-out wound up in 1967-almost 5 years later than planned with redeployment of the last F-104s left in Thailand. The aircraft joined the ANG in time for the 198th Tactical Fighter Squadron in Puerto Rico to convert in August from the elderly F-86H. (24)

Milestones

14 December 1959

An F-104C reached 103,389 feet, breaking the world altitude records set by the Soviets and the US Navy (who had broken records set by an F-104A in May 1958).

F-104D

Manufacturer's Model 583-04-06

Previous Model Series

F-104C

New Features

A rear cockpit, basic to most trainers. (To make room, the M-61 Vulcan had to be removed.)

First Flight

October 1958

Enters Operational Service

November 1958

First, the 476th Tactical Fighter Squadron at George AFB, and later TAC's three other F-104C squadrons were equipped with the F-104D.

Total F-104Ds Accepted

21

Acceptance Rates

The Air Force accepted 16 in FY 59 and 5 in FY 60 (2 monthly from November 1958 through August 1959).

End of Production

September 1959

With the delivery of the last F-104D.

Flyaway Cost Per Production Aircraft (25)

\$1.5 million

airframe \$873,962

engine (installed) \$271,148

electronics \$16,210

ordnance \$70,067

armament \$269,014

(24) By mid 1972, the Air Force had only 18 F-104s (6 F-104Cs and 12 F-104Ds) in active service; the Guard, 6 (2 F-104Cs and 4 F-104Ds).

(25) Excluding cumulative R&D (Research and Development) and Class V modification costs of \$189,473 and \$196,396 for each F-104D.

Average Maintenance Cost Per Flying Hour

\$395.00

Modernization

1961

Under Project Grindstone's F-104C modernization, Lockheed fitted the F-104D with 2.75 inch rockets for air-ground support.

Subsequent Model Series

F 104G-mostly foreign-made

Other Configurations

F-104F. Built in the United States for MAP, the F-104F was accepted by the Air Force (20 in FY 60 and 10 in FY 61) for West German pilot training in Europe. The F -104F closely resembled the F-104D but featured upward ejection seats. Until retrofitted, most USAF F-104s (D models included) had the troublesome downward ejection seat.

Phase-out

1966-1967

F-104Ds phased out of TAC's active inventory along with and in the same manner as the F-104Cs. In 1967, the D model, as well as the C, equipped the ANG 198th Tactical Fighter Squadron in Puerto Rico.

F-104G

Manufacturer's Model 863-10-19

New Features

Stronger structure (through extensive internal redesign) for performing many roles in any weather. (26) Had four Sidewinders for interceptor duty. Carried air-to-surface missiles, (27) rockets, and gravity bombs for attack. Featured the J-79-GE-11A engine-with the -7 thrust, but more reliable-and F-15AM-11 fire-control system.

Production Decision

December 1960

The Office of the Secretary of Defense, based the decision on West Germany interest in 1958 and the growing obsolescence of allied forces F-84s and F-86s. (28)

Production Policy

December 1960

US agreements with West Germany, Belgium, the Netherlands, and Italy authorized these countries to produce F-104s. The United States subsequently signed similar agreements with Canada and Japan. In keeping with political restraints on offensive operations, Japanese production was limited to an interceptor version of the F-104.

First Production Order

February 1961

The order was placed by the United States with the Lockheed California plant (with MAP funds) for TAC training of allied pilots.

(26) The F-104G retained the 20-mm M-61 Vulcan of other F-104s and, in addition, the nuclear-conventional ordnance of the F-104C.

(27) Two nuclear warhead AGM-12Bs, an improved version of the Martin air-to surface Bullpup missile developed in 1954 by the US Navy. Then known as the GAM-83B, the AGM-12B first equipped TAC's F-100s in November 1960.

(28) F-84/F-86 shortcomings had long been known. USAF as early as 1953 needed a lightweight, high-performance fighter to satisfy the requirements of the North Atlantic Treaty Organization standing group Lockheed F-104 was then the leading American contender; the British pushed their Folland Gnat (FO-141) small jet fighter. As a ground-support fighter, the French SNCASE (Societe Nationale de Constructions Aeronautiques du Sud-Est) SE-5000 Baroudeur transonic jet was highly favored by the Western European powers.

Other US Procurement

F-104G components, paid for by MAP, would also be manufactured in the United States to support allied F-104 production. Moreover, MAP funded F-104Gs would be fabricated by Canadair (a Lockheed subsidiary in Ontario, Canada) and handed out to Denmark, Norway, Greece, and Turkey.

First Acceptance

July 1962

The Air Force accepted the first American-made MAP F-104G earmarked for TAC. The Air Force then accepted the first Canadair-built F-104G in September 1963.

Enters Operational Service

10 October 1962

With a TAC combat crew training unit at George AFB. MAP F-104 training began at George and Luke AFB, Arizona. It was later consolidated at Luke, where West German pilots had been the first students.

Total MAP F-104G Accepted

Of 192 accepted, 52 came from California (for TAC allied training) and 140 from Canadair (for designated allies).

Acceptance Rates

From California, 23 in FY 63 and 29 in FY 64

From Canadair, 40 in FY 64, 74 in FY 65, 25 in FY 66, and 1 in FY 67.

End of Production

June 1964

Production first ended in California. Canadair F-104G production extended to September 1966.

Subsequent Model Series

None

Other Configurations

RF 104G. A MAP, California-produced, F -104G was equipped with three KS-67A cameras to demonstrate its reconnaissance potential.

The Air Force accepted 24 RF-104Gs between March and September 1963 (14 in FY 63 and 10 in FY 64), but quickly returned 5 to their basic F-104G configuration.

TF-104G. A two-cockpit F-104G built in California for MAP and Military Assistance Sales (MAS). The Air Force accepted 29 MAP TF-104Gs, 28 for TAC allied training (the first in September 1962, the last in December 1964) and 1 for Spain in October 1965. The Air Force also accepted 87 MAS TF-104Gs between October 1962 and February 1965 (40 in FY 63, 35 in FY 64, and 12 in FY 65). West Germany bought 72; Italy 12; and Belgium 3.

F -104J. Produced by Mitsubishi Heavy Industries, under license from Lockheed. Japan also manufactured a two-cockpit F-104J interceptor, the TF-104J trainer. **(C)**

CF-104. Produced by Canadair for air support of Canadian ground troops. For better ground-attack performance it sacrificed versatility-an F-104G strong point. A two-crew CF-104D accompanied the Canadian CF-104.

Flyaway Cost Per Production Aircraft (29)

F-104G. \$1.42 million

airframe (including electronics, ordnance, and armament) \$1,251,000

engine (installed) \$169,000

TF-104G. \$1.26 million

Items of Special Interest

More than 1,400 F-104Gs of one configuration or another were produced during the 1960's by Europe, Japan, Canada, or the United States. This bore out Lockheed's financial foresight in retaining all F-104 patent rights.

Program recap

The Air Force accepted a grand total of 663 F-104, 296 for its own use, the rest for MAP and MAS. The USAF lot counted for 2 XF-104s, 170 F-104A, 26 F-104B, 77 F-104C, and 21 F-104D. The 280 MAP F-104 consisted of 30 F-104F, 197 F-104G (some of them accepted as RF-104G but quickly stripped of recon equipment and returned to F-104G configuration), 24 RF-104G, and 29 TF-104G. All 87 MAS F-104 were TF-104G.

Total	663		
USAF:	296	2 XF-104	
		17 YF-104A	
		153 F-104A	
		26 F-104B	
		77 F-104C	
		21 F-104D	
MAP	367	87 TF-104G (GAF) MAS	
		30 F-104F (GAF) MAP	
		250 F/RF/TF-104G	
			57 F-104G Lockheed
			24 RF-104G Lockheed (MAP, Norway)
			29 TF-104G Lockheed (MAP)
			140 F-104G (Canadair) MAP

Summery:

- F-104A: One of the Air Force's smallest and lightest planes. The tiny F-104A, with its long-nosed fuselage and razor-thin trapezoid wings, had never been intended as an interceptor, but the Air Defense Command liked its performance.
- F-104B: Second cockpit aft of the F-104A's single seat-in the space otherwise designed for the M-61 Vulcan gun. The F-104B trainer retained the Sidewinder air-to-air missiles of the F-104A.
- F-104C: The slightly heavier F-104C served as a tactical fighter with the Tactical Air Command. It featured a more powerful engine, a probe-drogue air refueling system, and could carry nuclear stores. Several F-104C were used in Southeast Asia
- F-104D: The two-seat trainer version of the F-104C was eventually fitted with 2.75 inch rockets for air-ground support.
- F-104G The all-weather fighter-bomber had a stronger structure. It was produced under patent by Europe and Canada in various configurations. Japanese-made F-104 were interceptors, designated F-104J.

Comments:

(A) February 28.1954 XF-104 s/n 53-7786 code FG-786 with test pilot A.W. "Tony" LeVier made some lift-off tests during a high speed taxiing run (unofficial first flight)
First flight: March 4.1954 (official first flight)

(B) Among the changes made was the addition of a Catamaran-shaped device which enabled another pair of Sidewinder air-to-air missiles to be mounted underneath the fuselage.

(C) F-104DJ: serial number: 26-5001 until 46-5020, not TF-104J
Twenty examples were built by Lockheed and reassembled in Japan between July of 1962 and January 1964. No F-104DJ two-seaters were manufactured by Mitsubishi.