

CANADA AVIATION MUSEUM AIRCRAFT
LOCKHEED / CANADAIR F-104A STARFIGHTER



Photo: DND

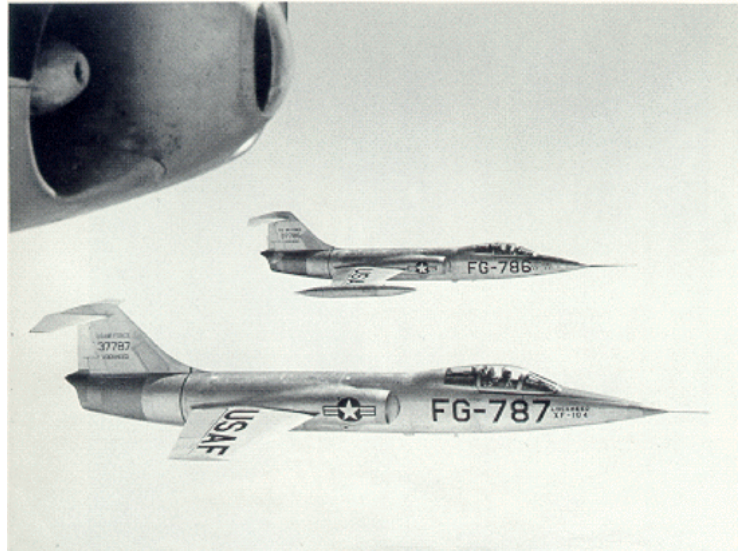
Compiled by: Kenneth D. Castle

Introduction

In the early 1950s, during the Korean War, the renowned “Skunk Works” of Lockheed Aircraft at Burbank, California, directed by Kelly Johnson, began the design and development of a high altitude interceptor which became known as “the missile with a man in it”. The prototype of the Lockheed F-104 STARFIGHTER first flew briefly, from Edwards AFB, in February 1954, and the first full flight occurred in early March. The F-104, over time, underwent design modification into a number of variations, (interceptor, recce, fighter-bomber), and eventually became one of the most widely operated fighters of the 1960s.

The STARFIGHTER was the first interceptor capable of sustained flight at speeds in excess of Mach 2 and was the first aircraft to simultaneously hold both the world speed and altitude records. A YF-104A set both on different flights in May 1958; altitude of 91,243 ft (27,811m) and a speed of 1404 mph (2260 km/h). The type in later months established seven climb-to-height records, and in December 1959, an F-104C “zoom-climbed” to another world altitude record, this time reaching 103,395 feet (31,515 m).

The STARFIGHTER, conceived as a lightweight fighter, ironically added considerable weight and additional equipment into its most successful version, the F-104G. More than 2,500 STARFIGHTER aircraft were manufactured over a thirteen-year period, starting in 1955, with about 1,600 being the CF-104/F-104G variety. In a strange twist, the US progenitor only used about 300 machines. STARFIGHTERS were:



The Lockheed XF-104 prototypes, FG-786 and FG-787, in formation circa 1955 near Edwards AFB, California. (Lockheed- AF 8137)

-manufactured and flown by:

Belgium	Italy	Netherlands	West Germany
Canada	Japan	United States	

-flown by:

Denmark	Jordan	Pakistan	Taiwan (Nationalist China)
Greece	Norway	Spain	Turkey

Acquiring the Lockheed CF-104 STARFIGHTERS

Toward the latter part of the 1950s, Canada was confronted with a number of decisions, which were both monetarily and politically expensive. The first concerned the replacement of eight squadrons of North American/Canadair F-86 SABRE, (day fighters), and four squadrons of Avro CF-100 CANUCK, (all-weather/night fighters), serving in Europe, in the Air Division. Secondly, NATO had adopted a doctrine of “limited nuclear warfare” and was pressuring Canada to undertake a nuclear strike role for its European based aircraft. Simultaneously the Avro CF-105 ARROW was undergoing flight trials, so a decision on its further development and production was required.

As the decade was coming to a close, all of these problems were resolved. In February 1959, the Avro ARROW program was canceled. In early July 1959, it was announced in the House of Commons that Canada had selected the Lockheed F-104 STARFIGHTER for use as a nuclear strike aircraft in Europe. A further announcement, about six weeks later, stated that Canadair would manufacture the CF-104s, under licence, at Cartierville, Quebec and that General Electric J-79 engines would be manufactured, under licence, by Orenda, at Malton Ontario.

The evaluation of replacement aircraft for the European Air Division encompassed more than 10 different types, including:

- Avro CF-105 ARROW
- Dassault MIRAGE IIIC
- Douglas A-4 SKYHAWK
- Fiat G-91
- Grumman F11F-1F SUPER TIGER
- Hawker Siddeley B-103 BUCCANEER
- Lockheed F-104 STARFIGHTER
- MacDonnell F-4 PHANTOM
- Northrop F-5 FREEDOM FIGHTER
- Republic F-105 THUNDERCHIEF
- Vought F-8 CRUSADER

Initial requirements had been for a twin-engined, two crew aircraft, but these were dropped as the list got smaller. Material from that period suggests that the MacDonnell PHANTOM was a very popular contender, but was too expensive, and could not be supplied in time. By early 1959, the field had narrowed to two choices, the Grumman SUPER TIGER and the Lockheed STARFIGHTER. Then, the US Navy canceled the SUPER TIGER (only two were ever built).

The RCAF eventually took delivery of 239 high performance, all-weather STARFIGHTER fighter-bombers, as follows:

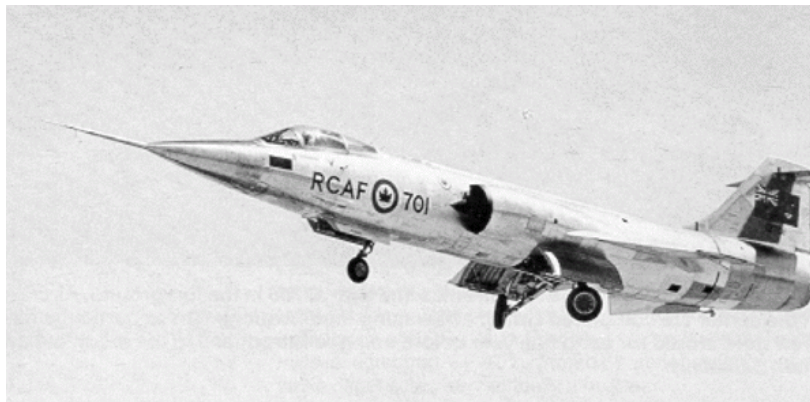
Single Seat: One F-104A, (12700), manufactured by Lockheed Aircraft Corporation, of Burbank California, accepted in March of 1961, (refer to The Museum Aircraft); and

Two hundred (200) CF-104s, (12701-12900), manufactured under licence by Canadair Limited, at Cartierville Quebec with a Canadair designator of CL-90, and delivered from March 1961 until December 1963.

Dual Seat: Twenty-two (22) CF-104Ds Mk I, (12631-12652), accepted between January 1962 and September 1963; and

Sixteen (16) CF-104Ds Mk II, (12653-12668), all accepted in November 1964, (with both batches being manufactured by Lockheed, at Palmdale, California).

The initial flight of a CF-104 STARFIGHTER took place on 26 May 1961, at Palmdale California. The aircraft, 12701, had been built in Cartierville, airlifted to California and was flown by a Lockheed pilot, Ed Brown. The first flights in Canada occurred from Canadair on 14 August 1961 with 12703, flown by R.M. 'Bill' Kidd (Canadair pilot) and later the same day, 12704, flown by Glen "Snake" Reaves (Lockheed pilot).



First take-off of a CF-104 at Palmdale CA, 26 May 1961, flown by Lockheed pilot Ed Brown

As Canadairs' production increased, eventually reaching 14 aircraft per month, CF-104s were delivered to both the OTU (Operational Training Unit), in Cold Lake, Alberta and to the squadrons which were reactivating in Europe. One hundred and thirty-nine of the machines for service in Europe were partially disassembled and airlifted across the Atlantic, in the back of Lockheed C-130 HERCULES (RCAF transport aircraft) during operation RHO DELTA. When the squadrons were again 'on line', the six in Germany were nuclear strike, and the two in France were photo-reconnaissance, all still part of the Air Division, and moving up through the NATO command structure of the 4th Allied Tactical Air Force, which covered Southern Europe, to ultimately reach SACEUR (Supreme Allied Commander Europe).

In 1967, the two recce squadrons shared in NATO's eviction from France and moved into what had been a French Air Force Base in Lahr, Germany. That same year, two of the strike squadrons were disbanded, and then, two years later, one German base, Zweibrücken, was closed (and promptly taken over by the USAF). Three more strike squadrons were disbanded in 1970, and the early part of that decade also saw the end of the nuclear strike role. The surviving squadrons transitioned into a conventional ground support mode using "iron" and cluster bombs, air-to-ground rockets and a Vulcan cannon.

The STARFIGHTER, with continuous modifications and updates, remained an active player in Canada's air force for nearly a quarter of a century. Regrettably, over 100 of the machines were lost in flying accidents, and there were 37 aircrew fatalities. The STARFIGHTERS were replaced by McDonnell Douglas CF-18s.

The Canadian Lockheed F-104 STARFIGHTER

Powerplant

CF-104s and CF-104Ds were equipped with a General Electric J-79-OEL-7 axial flow turbojet engine, manufactured under licence by Orenda Engines Ltd. of Malton. This engine produced 10,000 lbs (4,540 kg) thrust at "full military" power, and with afterburner, this increased to 15,800 lbs (7,175 kg).



AETE STARFIGHTER 104704 near Cold Lake, Alberta 1982 (Photo: DND/AETE)

External Dimensions

Wing span:	21 ft. 11 in	(6.6 m)
Length:	54 ft. 9 in	(16.7 m)
	58 ft 3 in	(17.7 m) with pitot static boom)
Height:	13 ft. 6 in	(4.1 m)

Weights

Empty:	13,900 lbs (6,305 kg)
Clean Aircraft plus fuel:	21,000 lbs (9,526 kg)
Maximum Take-Off Weight:	28,900 lbs (13,109 kg)

Approximate Fuel Capacities (CF-104 Single Seat)

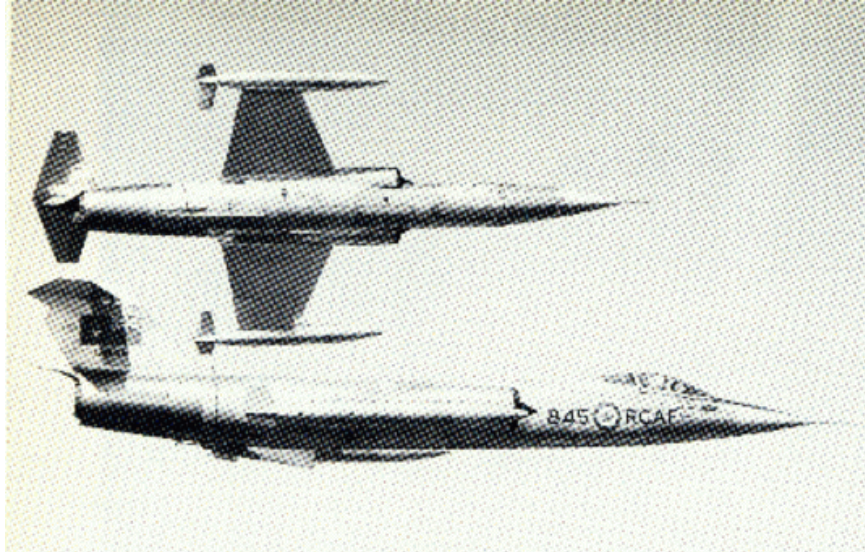
Internal:	5,750 lbs (2,608 kg)
With tip tanks:	7,955 lbs (3,608 kg)
With pylon tanks:	8,280 lbs (3,756 kg)
With tip and pylon tanks:	10,495 lbs (4,760 kg)

Altitude

Normal Operation:	48,500 ft (14,780 m)
Service Ceiling:	58,000 ft (17,680 m)
Zoom Climb:	over 90,000 ft (27,430 m)

Systems and Features

- S capable of high subsonic cruise and high supersonic combat speeds;
- S extremely thin, short, straight wings, with negative dihedral, and fitted with both leading and trailing edge flaps. The trailing edge flaps, in the landing setting, also featured a "blown" boundary layer control system (to reduce landing speeds);
- S irreversible, hydraulically powered flight controls;
- S controllable horizontal stabilizer (no elevators), mounted at the top of the vertical stabilizer;
- S automatic pitch control system (shaker and kicker);
- S maneuvering autopilot;
- S anti-skid wheel brakes, coupled with a drag chute, and an arrester hook;
- S liquid oxygen system (pilot breathing);
- S LN-3 Inertial Navigation System, capable of guiding the aircraft to pre-programmed targets without external references. This was replaced by an LW-33 Inertial Navigation and Attack System, which continuously computed the effects of wind, aircraft attitude, speed and G forces, thus allowing for very accurate navigation and weapons delivery ;
- S Computing Devices of Canada 'Position and Homing Indicator' system;
- S North American Search and Ranging Radar (NASARR R-24A);
- S central air data computer; and
- S C-2 rocket propelled upward ejection seat, with an operating envelope, which started at 90 kts (164 km/h), in level flight.



STARFIGHTER 12845 and "friend" showing profile and underside (Photo: DND)

RCAF/CF CF-104 Bases and Squadrons

1 Wing: Marville, France and Lahr, Germany

2 Wing: Grostenquin, France

3 Wing: Zweibrücken, Germany

4 Wing: Baden-Soellingen, Germany

RCAF Station/CFB Cold Lake, Alberta

6 Strike/Reconnaissance Operational Training Unit

Formed in October 1961 at RCAF Station Cold Lake, and temporarily relocated to Namao, Alberta graduated the first course in November 1962. In March 1968, it became:

417 Strike/Reconnaissance Operational Training Squadron

In 1972, all training was converted towards the conventional ground attack role, and continued until the unit was disbanded in July 1983, after graduating the 75th course, and more than 750 students.

421 Squadron (Red Indian)

Reactivated December 1963 at 2 Wing, Grostenquin. In February 1964, the Squadron moved to 4 Wing, Baden-Soellingen, Germany in the nuclear strike role, and in January 1972, to the conventional attack role. The squadron was disbanded in October 1985.

422 Squadron (Tomahawk)

Reactivated in July 1963 at 4 Wing, Baden-Soellingen, in the nuclear strike role, and disbanded in July 1970.

427 Squadron (Lion)

Reactivated in December 1962 at 3 Wing, Zweibrücken, and became the first operational nuclear strike CF-104 squadron. In June 1969, moved to 4 Wing, Baden-Soellingen. Disbanded in July 1970.

430 Squadron (Silver Falcon)

Reactivated 30 September 1963 at 2 Wing, Grostenquin. On 23 February 1964, moved to 3 Wing, Zweibrücken, in nuclear strike role. In February 1969, moved to 1 Wing, Lahr, and continued in the strike role. Disbanded in May 1971, having achieved nearly seven years of fatality free CF-104 flying.

434 Squadron (Bluenose)

Reactivated in April 1963 at 3 Wing Zweibrücken, as nuclear strike squadron, and disbanded in February 1967.

439 Squadron (Sabre-Toothed Tiger)

Reactivated March 1964 at 1 Wing, Marville in the photo-reconnaissance role, and moved to Lahr in March 1967. Moved to Baden-Soellingen in July 1970 and switched to conventional ground attack role. Disbanded in November 1984.

441 Squadron (Silver Fox)

Reactivated January 1964 at 1 Wing, Marville in the photo reconnaissance role, and moved to Lahr in March 1967. In July 1970, moved to 4 Wing, Baden-Soellingen, and converted to nuclear strike. January 1972 saw another role change into conventional attack, with a secondary function of air defence augmentation. Became Canada's last CF-104 squadron, until disbandment in March 1986.

444 Squadron (Cobra)

Reactivated in May 1963 at 4 Wing, Baden-Soellingen in the nuclear strike role, and disbanded in March 1967.



Top to bottom, 441, 439 and 421 Squadron aircraft painted to mark the 30th anniversary of Baden Soellingen in 1983 (DND-BSC 85-565)

STARFIGHTER Operational Support Establishments

Decimomannu, (DECCI) Sardinia (Italy)

This aerodrome exemplified NATO, being shared and funded by three member countries. Germany paid 50%, while Canada and Italy each paid 25%. The base, and the associated Capo Frasca air-to-ground range were operated by the Italian Air Force. The Canadian "Air Weapons Unit", although it had no aircraft of its own, was actively involved with STARFIGHTER flying operations for the first decade (nuclear strike role) and about the last five years (air combat role) of that aircraft's service life.

Air Division pilots attended regular weapons training and qualification 'camps', and a nucleus of Canadians, based in "Decci" were supplemented by servicing personnel from the Wings of the Air Division. The last Sardinian deployment occurred in October, 1983. Hundreds of Canadian military pilots also fondly remember being dragged around the Bay of Cagliari, by motor launch, while taking part in the "Sea Survival School".

Central Experimental and Proving Establishment (CEPE),

This later became the "Aerospace and Engineering Test Establishment" (AETE) which, in the middle of 1967, spawned 448 (Test) Squadron. This latter squadron was involved with STARFIGHTER operations

throughout the aircraft's entire lifetime. It started initially in Cold Lake, with five single seat aircraft, serials 12701 to 12705, and one dual, 12652, and continually undertook evaluations and flight trials of all the aircraft modifications, systems and armaments. Testing operations also took place in Uplands (Ottawa #10 hangar), from a flight test detachment at the Canadair factory in Cartierville, and another detachment at Scottish Aviation, in Prestwick Scotland. The latter company carried out periodic overhauls and modifications of the Air Division aircraft.

Operational Roles

Nuclear Strike

In this role, the STARFIGHTER was tasked as a low-level tactical bomber against pre-selected military installations, command and control centres, storage depots and key transportation facilities behind the "Iron Curtain". The pilots had to be very knowledgeable about their particular assigned route and target.



Armed guards, one RCAF (dark uniform) and one USAF (khaki uniform) oversaw each strike aircraft loaded with a nuclear weapon. (Photo DND)

Loaded aircraft (Canadian airplane-American bomb) were quartered inside a heavily fenced and guarded Quick Reaction Alert (QRA) area on each of the 'strike' bases. Each aircraft also had its own armed guards, of the two concerned nationalities, and was parked inside a well defined "no-lone zone". Any physical contact with a loaded aircraft required at least two people, all of whom were fully qualified for the task which had to be carried out.

The target routes were all low-level, hopefully to avoid detection by enemy radar, and were flown in two ways. Under visual flight conditions, the transit was at 250 ft (75 m) above ground, at 450 kts (835 km/h). For the final few miles running up to the target, the aircraft dropped to 50 ft (15m) and accelerated to 540 kts (1,000 km/h). In bad weather, the route was flown at approximately 1,000 ft (300 m) above ground, with the pilot navigating by using the aircraft's ground mapping radar. No Canadian STARFIGHTER, loaded with an actual nuclear weapon, was ever flown.

Conventional Attack & Air Combat

Attacks and air combat were usually undertaken by sections of either two or four aircraft. The air combat



A CF-104 poses with the assorted conventional weapons which it could deliver. (DND - Baden Photo Section)

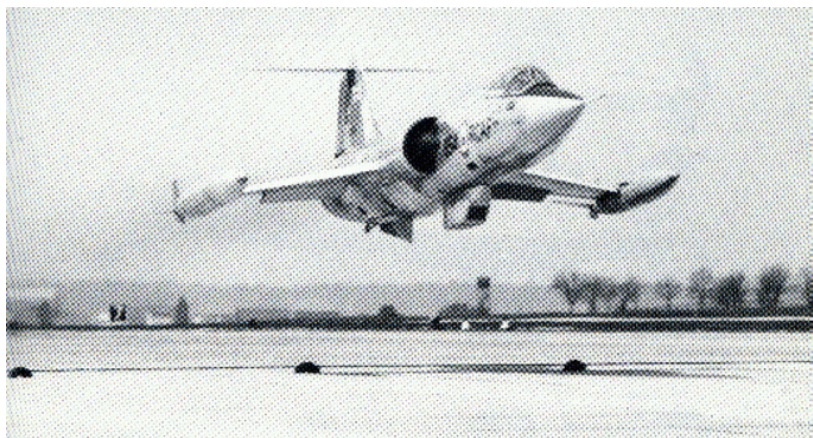
mode used only the Vulcan cannon, while the ground attack function made use of a wide variety of weapons which were capable of being loaded in a number of combinations, as determined by pre-flight mission planning.

The arsenal of weapons included:

- a) Gun: M-61A1 Vulcan (a six-barrelled 20mm cannon, with a firing rate of 66 rounds per second. Six seconds of ammunition were carried).
- b) Rockets (Unguided, Air to Ground):
 - Mk 4 2.75" FFAR (folding fin aircraft rocket). Up to 76 could be carried in four 19-tube launch pods.
 - CRV-7 (Canadian Rocket Vehicle, as developed by the Defence Research Establishment, in Valcartier, Quebec, with number, and launcher as above).
- c) Bombs:
 - Mk 82 GP "Snakeye" (a general purpose, retarded fall, "iron" bomb).
 - CBU-2/B (cluster bomb).
 - Mk 20 "Rockeye" (cluster bomb).
 - BL 755 (high explosive cluster bomb).
 - BLU-1/B, later BLU-27/B (Up to four napalm firebombs could be carried).

Photo-Reconnaissance

Photo-reconnaissance was normally undertaken by a single aircraft which was assigned ground targets within a particular area. The pilot, after mission planning, transited to the affected area and then undertook photographic runs which were supplemented by visual assessments, the latter having to be committed onto forms on his kneepad. The recce aircraft were all fitted with a Vinton Vicom camera pod, mounted on the aircraft's centreline on the underside of the fuselage. The pod contained four 70mm cameras, three of which were oriented obliquely (forward, left and right side), and the fourth was aimed vertically downward. The cameras, selected and operated from a cockpit control panel, were loaded with black and white film.



STARFIGHTER 12854, with centreline camera pod, on a very low photo run at Marville, April 1964 (DND-PL152070)

The Museum Aircraft

STARFIGHTER 104700 was manufactured as an F-104A-LO for the United States Air Force in 1957, as part of the block F-104A-15-LO, with a company designation of Model 183-92-02, and a construction number of 183-1058. It received USAF acceptance on 13 November 1957, and bore the registration 56-770. It was powered by a J79-GE-3B engine of 9,600 lbs. dry thrust (4,360 kg) or 14,800 lbs. (6,720 kg) with afterburner. About two weeks after acceptance, it went to the USAF's 3241st F&I Test Group, at Elgin AFB in Florida. Six months later, it moved to Hamilton AFB, in California, first to serve with the 78th Consolidated Aircraft Maintenance Squadron (CAMRON), and then with the 78th Fighter Group. Two years after going into service (November 1959) the machine went into storage at Sacramento Air Material Area where it appears to have remained until becoming "Canadian".



The Canadian Airforces sole Lockheed F-104A (Single Seat) STARFIGHTER on display at the Canada Aviation Museum

STARFIGHTER 104700 was 'taken on charge' by the RCAF in March of 1961, and was on loan to Lockheed Aircraft until the middle of 1963. It apparently resided at Canadair, serving as a pattern for the Canadian production run. By June 1963, it made its way to CFB Cold Lake, where it went on strength of the Cental Experimental and Proving Establishment (CEPE)- Air Armament and Evaluation Detachment (AAED). Two years later, it moved to CEPE in Ottawa, Ontario. On the 14th December 1967, Wing Commander Robert A. "Bud" White piloted 12700 to establish a Canadian absolute altitude record of 100,110 ft (30,513 m). This achievement earned W/C White the Trans-Canada Trophy. (In accelerating up to about Mach 2.4 for the zoom climb on that flight, he also set a Canadian speed record of 1,800 mph (2,897 km/h). W/C White was Senior Test Pilot of the Aerospace Engineering Test Establishment at RCAF Station Uplands and led a Centennial Project team which attempted to set a new world altitude record in honor of Canada's Centenary. The team received assistance from several companies and agencies on both sides of the Canada-US border, (such as full pressure suits from the Surgeon-General of the USAF).



Wing Commander R.A. "Bud" White, in partial pressure suit and helmet (Lockheed LA-6290)

Their assault on the record was premised upon three main points:

- S utilization of STARFIGHTER 12700, which was lighter than the standard Canadian single seat aircraft;
- S initiation of the zoom climbs from within the core of the high altitude jet stream winds (thus

increasing the aircraft's total kinetic energy); and

S very carefully calculated and executed climb profiles.

STARFIGHTER 12700 underwent extensive modification, including:

S removal of all exterior paint, except the registration;

S an improved engine;

S extended engine air inlet cones;

S completely redesigned electrical and cockpit pressurization systems; and

S very sophisticated angle-of-attack measuring devices and cockpit instrumentation.

During the program the aircraft made at least 25 'zoom' flights, with 12 of them attaining altitudes in excess of 95,000 ft (28,956 m). The aircraft made its last flight the day after setting the record, and had then accumulated slightly over 780 hours of total flight time. About six months later, in June 1968, it was transferred to the Canada Aviation Museum. Because of its 'one-of-a-kind' status, it had never served outside of AETE.

Other Memorabilia

25 November 1961 First CF-104 crash (12702) during a test flight from Canadair. Pilot ejected safely.

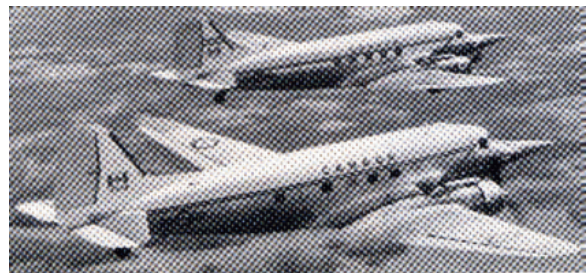
22 May 1962 First crash of CF-104 in service (12707), near Namao, Alberta.

During take-off in a CF-104, once the afterburner had been lit, the aircraft started to accelerate down the runway, whether or not the wheel brakes had been released. Pilot ejected safely.

7 March 1969 Major G.R. "Bob" Ayres became first Canadian Forces STARFIGHTER pilot to attain 2,000 hours.

Each CF-104 cost just under two million Canadian dollars.

6ST/R OTU initially had three douglas DAKOTA aircraft which were fitted with a CF-104 nose cone holding a NASAAR radar system used for ground mapping radar navigation. The CC-129's were nicknamed PINOCHIO, WOODY WOODPECKER and DOLLY'S FOLLY. PINOCCHIO, (12959) was used until 1989.



Two C-47 NASARR trainers "Pinocchio" and "Dolly's Folly" flying near Cold Lake (DND - 417 Squadron).

- 2 June 1970 All remaining CF-104 STARFIGHTERS were renumbered into the "104" block (e.g. 12700 became 104700).
- Upon completion of the CF-104 production, Canadair went on to manufacture another 140 F-104G aircraft as part of the US Military Assistance Program (MAP) for other NATO member countries.
- 20 June 1981 Major John David, 441 Squadron, achieved a total of 3,000 hours CF-104 flight time.
- On a standard day (+15°C) a CF-104 with no external stores would go from the start of take-off, to Mach 2 at 35,000 ft (10,668 m), in approximately six minutes.
- 2 November 1982 75th and final CF-104 course (8203), with 8 trainees started at 417 OTS, Cold Lake.
- The STARFIGHTER tailpipe housed a nozzle of vanes which opened and closed according to the power being produced. While accelerating up or down through approximately 80% of military thrust, the vanes produced a howling noise which caused all legendary banshees to turn green with envy and which could be heard for several miles. Anyone living close to a STARFIGHTER base became quite familiar with this phenomena.
- 17 October 1983 Last CF-104 flight in Canada, 104646 (dual) ferried from AETE Cold Lake to Trenton crewed by Major Croll and Captain Youngson.
- One CF-104, armed with a thermonuclear weapon, carried more explosive power than an entire one thousand bomber raid of the Second World War.

BIBLIOGRAPHY

CF-104 Starfighter, 1961-1986, CFB Baden-Soellingen, 1986.

Clearwater, John, *Canadian Nuclear Weapons*, Dundurn Press, Toronto, 1998.

Francillon, Rene J., *Lockheed Aircraft since 1913*, Putnam Aeronautical Books, 1982.

Griffin, John A., *Canadian Military Aircraft, Serials and Photographs, 1920-1968*, Canadian War Museum, Ottawa, 1969.

Kostenuk, S. and Griffin, John A., *RCAF Squadrons and Aircraft*, National Museums of Canada, Ottawa, 1977.

McIntyre, R., *CF-104 Starfighter Canadian Profile*, SMS Publishing, Ottawa, 1984.

Milberry, L., *Sixty Years - The RCAF and CF Air Command 1924-1984*, CANAV Books, Toronto, 1984.

Molson, K.M. and Taylor, H.A., *Canadian Aircraft Since 1909*, Canada's Wings Inc., Stittsville, 1982.

Pickler, R., and Milberry, L., *Canadair - The First 50 Years*, CANAV Books, Toronto, 1995.

Sutherland, Alice Gibson, *Canada's Aviation Pioneers*, McGraw-Hill Ryerson Ltd., Canada, 1978.

Swanborough, Gordon and Bowers, Peter M., *United States Military Aircraft since 1909*, Putnam Aeronautical Books, 1989.

Taylor, John W.R., *Combat Aircraft of the World*, George Rainbird Ltd., London, Eng., 1969.



CF-104 at daybreak in Baden - Soellingen, September 1974 (DND-BS73-0073)