The Avro CF-100 Interceptor

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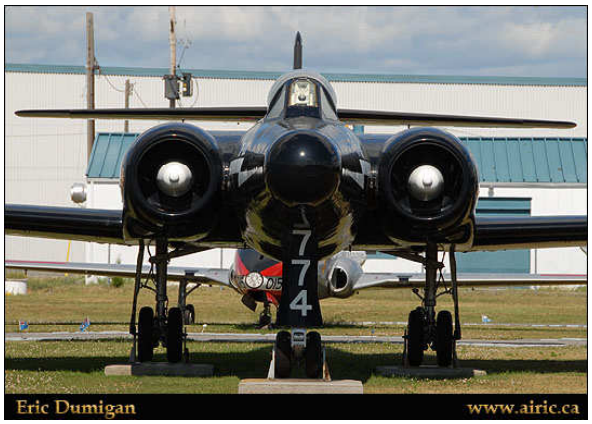
Introduction: The Avro Canada CF-100 takes its place in Canadian aviation history as the only home-grown interceptor design to attain operational status. Between 1950 and 1958, 692 CF-100s were built and flown by nine Canada-based RCAF all-weather fighter squadrons, and four European-based squadrons. Of the total built, 53 American-financed aircraft were sold to Belgium under the Mutual Aid Plan. Belgium was the only other country to use the CF-100 operationally.

Although conventional in appearance, the CF-100 was superior to other contemporary Allied all-weather aircraft. Its good short field performance, low-speed handling qualities, long range, fast rate of climb, two-man crew, and excellent fire control system provided the CF-100 with overall capabilities unmatched by any other all-weather interceptor of the period.

Known affectionately as the "Clunk" by its aircrews, or disparagingly as the heavy metal "Lead Sled" by F-86 pilots, the CF-100 was the most effective all-weather fighter in the West's inventory during the 1950s. (The "Clunk" nickname arose from the noise the front landing gear made as it retracted into its well after takeoff.)



Design & Development: After the Second World War, it became apparent that the RCAF's tight integration with the RAF would cease. Also, the Cold War was becoming a reality and North Americans had to consider the possibility of Soviet bomber attacks from the north, "over the pole".

Immediately after the war Canada had equipped itself with stopgap aircraft such as North American Mustangs and De Havilland Vampires, but both types were essentially obsolete by the early 1950s.

The postwar air force had agreed to take on three major commitments: home defence; participation in the newly formed NATO; and United Nations operations when required. To help meet these commitments, Canadair was tasked with producing the Lockheed T-33A jet trainer, to be known in Canada as the "Silver Star", and what was then the west's finest fighter, the F-86 Sabre.

But for northern defence, no licence-built aircraft was suitable. What was needed was a long-range, twin-jet, all-weather interceptor, with a two man crew, capable of operating under extreme climactic conditions. The task to design such a machine fell to Avro Canada, a company evolved from Victory Aircraft, British Avro's Canadian subsidiary during the war.

Design of the "XC-100" to meet the RCAF specifications for an all-weather fighter was initiated at Avro Canada in October, 1946. Chief Engineer Edgar Atkin's work on the CF-100 was subsequently passed to John Frost, formerly of De Havilland, who, along with Avro's Chief Aerodynamicist Jim Chamberlin, reworked the original fuselage design. There were early problems typical of a major new

aircraft type, mainly involving hydraulics and skin buckling, and both were eventually solved by Avro. By 1950, a new engine was available and the first RCAF test pilots got to fly the new design.

The CF-100 Mark 1 prototype, "18101", emerged from the factory painted gloss black overall with white lightning bolts running down the fuselage and engines, and flew its maiden flight on January 19, 1950, with Gloster Aircraft Company chief test pilot S/L Bill Waterton at the controls. The Mark 1 was powered by two Avon RA 3 turbojets.

The second prototype, "18102", was also powered by Rolls-Royce Avons, although subsequent pre-production and production series aircraft used the Avro Orenda turbojet.

Five pre-production Mk 2 test aircraft were produced (18103-18107), all fitted with the Orenda 2 jet engines; one was fitted with dual controls and designated a Mk 2T trainer.

The first production version, designated Mk 3, incorporated the APG-33 radar and was armed with eight 50-cal. machine guns. The Mk 3CT and Mk 3DT were again dual control versions supplied to operational training units.

CF-100 Mk. 3B 423 (Eagle) Squadron

Production: In September 1950, the RCAF ordered 124 of the Mk 3 version, planned for entering service in 1953.

The Mark 3 was fitted with a US-built Hughes E-1 fire control system, organized around an AN/APG-33 radar mounted in the nose, the same radar fitted to the CF-100's American counterpart, the Northrop F-89A Scorpion. Armament consisted of eight 12.7 mm (50-cal.) Browning machine guns in a belly tray that could be dropped out for fast servicing. Trials were conducted with a tray containing four 20 mm cannon, but technical problems led to the abandonment of this weapons fit.

Two stores pylons could be fitted under each wing for carriage of munitions, such as four 450 kilogram (1,000 pound) bombs. However, though the test program had included bombing trials, the CF-100 would never be used in the attack role operationally.

Trials also included tests of "rocket assisted take-off gear" (RATOG), but though the scheme worked well, it too was not used operationally.

Another test-fit evaluated by the Mark 3 was the "Velvet Glove" radar-guided air-to-air missile (AAM), with four missiles carried on the underwing pylons, or in some trials on pylons under the fuselage and engine intakes. Velvet Glove was a collaborative effort conducted by Canada, the US and the UK. Most of the missile was designed in Canada, with a solid-rocket motor provided by the US. The program was cancelled in 1956 and Velvet Glove never entered service.

Only 70 Mark 3s were actually built, not counting four preproduction machines that had actually started life as part of the batch of ten Mark 2 preproduction aircraft. These four aircraft were built as "Mark 3T" dual-control trainers. Of the 70 production Mark 3s, nine were built as "Mark 3As" with Orenda 2 engines; 11 were built as "Mark 3CT" dual-control trainers, also with Orenda 2 engines; and 50 were built as "Mark 3Bs", with Orenda 8 engines, providing greater reliability than the Orenda 2 but the same level of thrust.

In service, the Mark 3 was promising, but it suffered from a number of teething problems, leading the Mark 3s to be, in effect, training and evaluation machines. One problem was that the control stick obscured the compass, a problem that was fixed in the field by modifying the stick. A second problem was a manual fuel control system that was too workload-intensive; the fuel system was also overly complicated and unreliable. Other annoyances were the lack of nose-wheel steering and unreliable landing gear.

CF-100 Mk.4B 423 (Eagle) Squadron

The first production Mark 4 was rolled out in September 1953. The Mark 4 featured:

- A windscreen between the forward and rear halves of the cockpit to make it easier for the back-seater to punch out after the front-seater had ejected. A one-piece canopy was also introduced.
- Twin Orenda 9 engines, the new engines requiring modified engine nacelles.
- A new Hughes MG-2 collision-course fire-control system, with AN/APG-40 radar accommodated in a bigger nose. This was the same system as used on the Northrop F-89D Scorpion. It not only permitted attacks on targets from a forward or right-angle ("collision course") flight path, but also provided a beacon mode for tracking, and a ground-mapping mode for navigation.
- Wingtip pods with 29 Mighty Mouse rockets each, which could be swapped with wingtip tanks for ferry flights.
- Three-round and seven-round wingtip rocket pods were fitted for training.

The Mark 4 was the first really satisfactory CF-100 variant, and so the last Mark 3 order was cut short, ending Mark 3 production at 70 aircraft. A total of 137 Mark 4s were built, and then the up-rated Orenda 11 engine, with 12% more thrust, was introduced as a production change. Subsequently, 193 of these souped-up Mark 4s were built and designated "Mark 4B", while the 70 Orenda 9 powered machines were retroactively re-designated "Mark 4A". Two of the Mark 4As were converted to Mark 4B configuration.

In all, five versions, or "marks", were produced, ending in 1955 and onwards with the high-altitude Mk 5 that featured a 1.06 m (3 ft. 6 in.) extended wingtip and enlarged tailplane, along with removal of the machine guns.

CF-100 Mk.5 432 (Black Cougar) Squadron

A proposed "Mk 6" was to have mounted Sparrow II missiles and been powered by afterburning Orenda 11IR engines in an effort to provide an "interim" fighter prior to the introduction of the anticipated, Canadian-designed Avro CF-105 Arrow.

A projected transonic swept-wing CF-103 was built in mock-up form in 1951, but was considered obsolescent even before the CF-100 demonstrated its ability to exceed the speed of sound in a dive; on December 18, 1952, S/L Janusz Żurakowski, Avro's chief development test pilot, took the CF-100 Mk 4 prototype to Mach 1.0 in a dive from 30,000 ft., the first straight-winged jet aircraft to achieve controlled supersonic flight.

SPECIFICATIONS – CF-100 Mk. 5

General characteristics

- **Crew:** 2, pilot and navigator
- **Length:** 16.5 m (54 ft 2 in)
- **Wingspan:** 17.4 m (57 ft 2 in)
- **Height:** 4.4 m (14 ft 6 in)
- **Wing area:** 54.9 m² (591 ft²)
- **Empty weight:** 10,500 kg (23,100 lb)
- **Loaded weight:** 15,170 kg (33,450 lb)
- **Powerplant:** 2× Avro Canada Orenda 11 turbojets, 32.5 kN (7,300 lbf) each

Performance

- **Maximum speed:** 888 km/h (552 mph)
- **Range:** 3,200km (2,000mi)
- **Service ceiling:** 13,700 m (45,000 ft)
- **Rate of climb:** 44.5 m/s (8,750 ft/min)
- **Thrust/weight:** 0.44

Armament

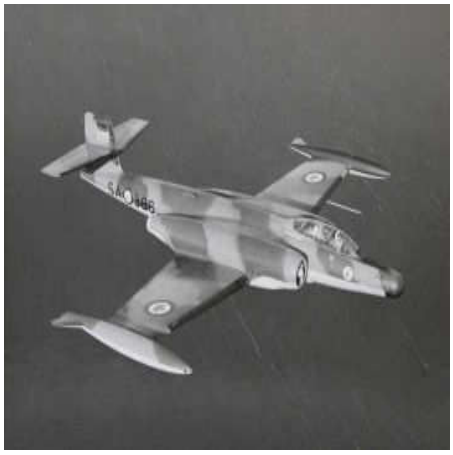
- 2 wingtip pods of 29 x 70-mm (2.75 in) "Mighty Mouse" fin-folding aerial rockets

Operational History: The air force began CF-100 operations in 1952 at RCAF Station North Bay, after which the interceptor saw further modifications including a better radar and fire-control system, and upgraded engines. The CF-100 was officially retired in October, 1981.

During its service, the aircraft operated under the US/Canadian North American Air Defence Command (NORAD) to protect North American airspace from Soviet intruders such as nuclear-armed bombers. Additionally, as part of NATO, four CF-100 squadrons were based in Europe with 1 Air Division from 1956–1962, and were for some time the only NATO fighters capable of operating in zero visibility and poor weather conditions.

When the Korean War started, the US Air Force was in urgent need of a jet-propelled, all-weather, interdiction / surveillance aircraft. The urgency was so great that the USAF was willing to consider two non-American designs: the CF-100 and the English Electric Canberra. The CF-100 was rejected because of insufficient range and payload. The English Electric design was selected and developed into the USAF's B-57 Canberra.

The CF-100 served with nine RCAF squadrons at its deployment peak in the mid-1950s. Four of these squadrons were based in Europe from late 1956–1962, under the NIMBLE BAT ferry program, replacing some NATO RCAF squadrons equipped with Canadair Sabre day fighters, in order to provide all-weather defence against Soviet intruders. CF-100s flying at home retained a natural metal finish, but those flying overseas were given a British-style disruptive camouflage scheme – a mix of dark sea grey and green on top, and light sea grey on the underside.



CF-100 Mk.5 in European Camouflage

In the CF-100's lifetime, 692 models of different variants were produced, including the 53 aircraft delivered to the Belgian Air Force. Although the airframe was originally designed for only 2,000 hours, experience proved that it could serve for a remarkable 20,000 hours-plus before retirement. Consequently, though it was ultimately replaced in its front-line interceptor role by the US-designed CF-101 Voodoo, the CF-100 served in reconnaissance, training and electronic warfare roles with 414 Squadron at CFB North Bay until 1981, some three decades after the aircraft's introduction.

Many of the innovations in radar and quick-change weaponry that were developed on the CF-100, and some of its design features, were incorporated into the ill-fated Avro CF-105 Arrow that was planned to be the CF-100's Canadian-designed and built successor. However, the Arrow along with the sophisticated Orenda Iroquois engine, both Canadian-designed, and both world-class at the time, were cancelled in 1959 in a controversial decision by the Canadian government.

In the years since the CF-100 was retired from service, a number of this classic aircraft still remain as static displays across Canada and elsewhere.

References and Sources

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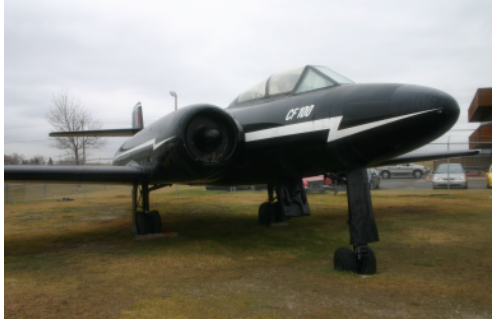
Eric Dumigan, http://www.airic.ca/html/nafmcairpark.html

RCAF CF-100 Squadrons and Other Units

Squadron	Name	Base	CF-100 Intro	CF-100 Phase-out
409	Nighthawk	Comox	1 Nov 54	Mar 62
410	Cougar	Uplands	1 Nov 56	Nov 61
413	Tusker	Bagotville	1 May 57	30 Dec 61
414	Black Knight	North Bay	5 Aug 57	Feb 62
416	Black Lynx	St. Hubert	1 Feb 57	1 Sep 61
419	Moose	North Bay, Baden-Soellingen	15 Mar 54	31 Dec 62
423	Eagle	St. Hubert, Grostenquin	1 Jun 53	31 Dec 62
425	Alouette	St. Hubert	1 Oct 54	1 May 61
428	Ghost	Ottawa	21 Jun 54	1 Jun 61
432	Black Cougar	Bagotville	1 Oct 54	15 Oct 61
433	Porcupine	Cold Lake, North Bay	15 Nov 54	1 Aug 61
440	Bat	Bagotville, Zweibrucken	1 Oct 53	31 Dec 62
445	Wolverine	Uplands, Marville	1 Apr 53	31 Dec 62
No. 3	AW(F)OTU	North Bay, Cold Lake, Bagotville	Jul 52	Dec 64
WPU	Weapons Practice Unit	Cold Lake	Apr 56	1 Apr 61

CF-100 Variants

Mark 1	Prototype with Avon engines. 2 Aircraft. 1st flight 19 Jan 50. 2nd Aircraft crashed 5 Apr 51.
Mark 2	First CF-100 with Orenda engines. 1st flight 20 June 51, Aircraft #18103
Mark 2T	Mk. 2 with dual controls and Orenda 1 engines. Aircraft 18104-18107
Mark 3T	Dual controls and Orenda 2 engines. Aircraft 18108-18111
Mark 3CT	Dual controls and Orenda 8 engines. Aircraft 18114-18125 less 18117
Mark 3A	Production fighter. Aircraft 18113 with Orenda 2 engines. Aircraft 18117 and 18126-18132 with Orenda 8 engines.
Mark 3B	Production fighter with Orenda 8 engines. Aircraft 18133-18182
Mark 3DE	56 dual control trainers converted from Mk. 3As, Mk. 3Bs, and Mk. 3CTs.
Mark 4	Prototype aircraft 18112. First flight 11 Oct 52. Crashed 23 Aug 54.
Mark 4A	Production fighter with Orenda 9 engines. First flight of Mk 4A 4 Oct 53. Aircraft 18183-18319.
Mark 4B	Production fighter with Orenda 11 engines. Aircraft 18320-18512.
Mark 5	Production fighter with Orenda 11 engines. First flight Sep 54. Aircraft 18513-18792.

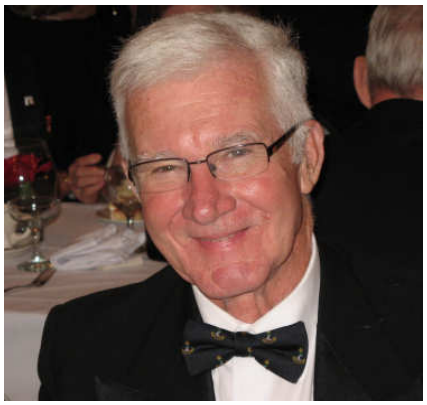


Mk. 3 CF-100 on display at Calgary Aerospace Museum in colours of original prototype aircraft.

CF-100s On Display

The following are Museums or sites that have an Avro Canada CF-100 on display:

- 4 Wing Cold Lake, Alberta
- Alberta Aviation Museum, Edmonton, Alberta
- Atlantic Canada Aviation Museum, Halifax, NS
    - CFB Borden Military Museum
    - Calgary Aerospace Museum
    - Canada Aviation Museum, Ottawa, ON
- Canadian Museum of Flight, Langley, BC
- Canadian Warplane Heritage Museum
- Centennial Park, Moncton, NB
- CFB Winnipeg
- Canadian Forces Garrison St. Hubert, Quebec
- Comox Air Force Museum, Comox, BC
- Head Lake Park, Haliburton, Ontario
- Imperial War Museum Duxford, England
- John C. Munro Hamilton International Airport, Hamilton, ON
- Memorial Military Museum, Campbellford, ON
- Nanton Lancaster Society Air Museum, Nanton, AB



Mike Braham is a graduate of the Royal Military College (1965) and a former naval officer and senior official with DND. He has an abiding interest in military history. His father flew CF-100s while commanding No. 3 AW(F) OTU at North Bay from 1954-