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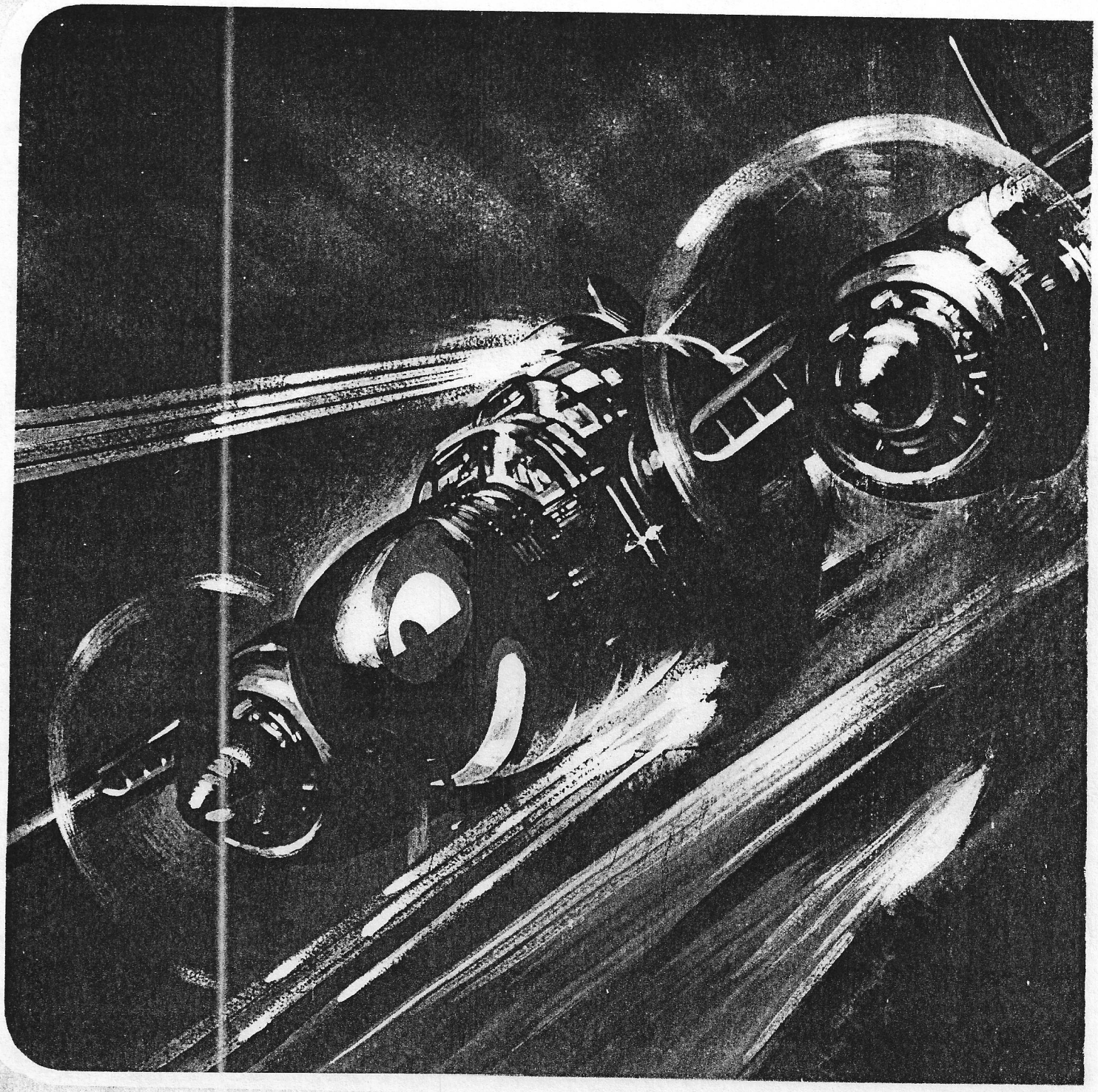

IN THIS ISSUE: FLYING TIGER SAGA ● THE WIDOW FROM HAWTHORNE

TUPOLEV'S TU-2 ● THE POST-WAR ME 262 ● PUP WITH A PEDIGREE

AIR Enthusiast Quarterly

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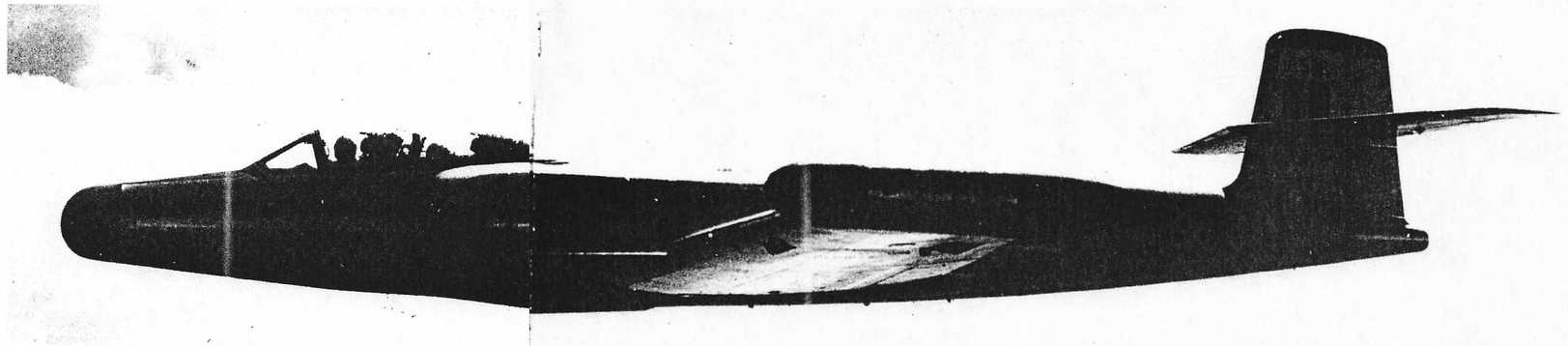
CANADIAN INNOVATION – CF-100 STORY

BY ROBERT BRADFORD



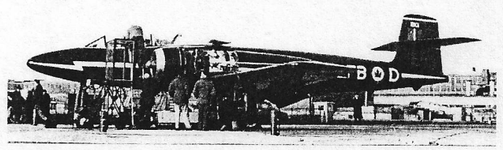
The Avro Canada CF-100 Mk 5 represented by this illustration of No 18532, an early aircraft in the final production batch, was the definitive version of Canada's only indigenous jet fighter. A few examples remain in service for ECM duties in Canada.

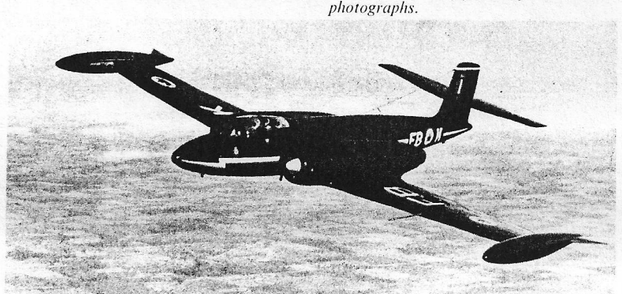
IT IS an August day at Ottawa International Airport, 1972. Air Canada Viscounts and DC-9s vie for position on the runway with smaller executive craft. Among the latter can be identified a Fan-Jet Falcon of a prominent North American corporation. Inside, a Canadian executive recognises the preceding aircraft as a Canadian Armed Forces CF-100, also known unofficially as the Canuck and colloquially as the "Clunk".

"Ever see anything like that?" he remarks to the Falcon pilot, an ex-USAF fighter jockey. "Sir", replies the latter, "I've never seen anything like *that*"! The CF-100, then entering its twentieth year of active service, had not lost its ability to prompt curiousity, provoke interest, and, to those familiar with her, command respect.

World War II had taught the world that the days were gone when a country could rely on a good dependable aircraft for an indefinite period of time. It taught instead that the superplane of today is the obsolete hulk of tomorrow. This inescapable fact has made victims of many an aircraft since the war, and those which have been able to continue a distinguished career for a long period of time make up only a small proportion of the total number of new types launched in the past three decades. Those aircraft that have achieved rare longevity of service almost automatically possess a string of credentials that, if aircraft were human, would turn the natural metal finish of some less successful types camouflage green with envy!

In this exclusive club, the Avro Canada CF-100 has consolidated its proud claim to membership as it continues a service career that is only now drawing slowly to a close. This account will trace the history of the CF-100 and will closely investigate the credentials of an aircraft born because of, and for, the cold Arctic.





(Above) The first of the two CF-100 Mk 1 prototypes, No 18101, at Malton in late-1949, a month or so before first flight. It served with the RCAF until 1965 but the second prototype (below) was less fortunate, crashing on an early flight, soon after posing for the first air-to-air photographs.

While World War II left much of Europe in ruins and with national ideals shattered, it uncovered in Canada a new surge of ambitious fervour that transformed the nation from a colonial state into a viable, pulsating country. This dynamic evolution of a nation is another story, but it was partially responsible for creating the ability to produce the CF-100, the history of which has to be seen against that background.

Both Canada and the United States had proved their industrial and military potential in World War II; in the early post-war years, the development of Soviet strategic weapons brought them both into the potential firing line, however. Canada foresaw the first time when her cities could be bombed, with close proximity to both the USA and the USSR making the Canadian homeland an automatic (and probably atomic) battleground in any future conflict involving the major powers.

Realising these conditions, Canada undertook a review of prospective systems under development. Major factors that would influence any decision were the newly established requirement for indigenous defence, and the unpleasant wartime experience which had revealed an over-dependency on foreign aircraft industries. The latter had been in part rectified during the war and by September 1945 a relatively large aircraft industrial establishment existed, but not enough to satisfy the new requirement.

At about this time, the late Sir Roy Dobson, then Chairman of A V Roe, a constituent of the Hawker Siddeley Group in the UK, was negotiating the establishment of a small subsidiary aircraft business in Canada. Seeking the purchase of a block of offices and some space in the Victory Aircraft plant at Malton, which had produced Lancasters during the war, he ended up by buying the entire facility! Thus was founded A V Roe Canada Ltd, a cornerstone of an indigenous aircraft industry. Avro Canada at first took in "bread-and-butter" conversion jobs to get production started in the Malton plant, but Dobson repeatedly voiced his intention that the company should design and produce a Canadian aircraft "from the drawing board into the air!"

Meanwhile, in Ottawa, Air Vice-Marshal W A Curtis was exerting as much pressure on the government as he could in the hope of obtaining support for a jet trainer and a fighter aircraft capable of operating in the Arctic. The trainer programme was begun (as the CF-101) but soon abandoned, leaving Avro Canada at work on a jet airliner (to emerge in due course as the C-102) and the fighter aircraft.

Having realised the need for effective air defence, the RCAF had drawn up a specification for a defensive fighter capable of operating by day or night, in all weather, with the range required to operate effectively in the Arctic and sub-arctic wilderness, and carrying a heavy firepower. Evaluations of available aircraft failed to show a fighter capable of meeting the RCAF requirements and the government decided, in the words of the Rt Hon C D Howe, that: "The only alternative was to produce one!" With the awarding of a government contract to the fledgling A V Roe Canada Ltd, the CF-100 was born.

The stormy beginning

If the conception of the CF-100 was relatively straightforward and its birth as a firm project uneventful, its infancy was far from placid. Almost seven years on from the events just recorded, a mounting barrage of criticism and querulous comment was being levelled at the Liberal government of Louis St Laurent. "What's holding up these CF-100s?" "Are they going to be obsolete before they are delivered in quantity?" "In view of the delays, is the project worthwhile?"

The swift progress of World War II had taught the Canadian that obsolescence could creep up on a weapon system all too rapidly, and more recently the lessons of the Korean war had been absorbed, rubbing home the nation's almost total impotence in defence. The Department of National Defence was being besieged from all quarters over suspected inefficiency which — many believed — was bottlenecking progress on important projects, the CF-100 among them. Unfortunately, some of the mud then being thrown attached to the CF-100 itself and not just to the way the programme was being handled.

The Toronto-based *Globe & Mail,* for example, took a vicious swipe at the project while commenting on the inefficiency controversy, chastising the government for its "foolish decision of April 1949 to stop buying jets from Britain". The fighters in question were Vampires and Meteors, both of which types had since been proven obsolete in the Korean conflict. The only other British aircraft available in the time-scale was the Hawker Hunter, not only judged to be unsuitable for Canadian conditions, but still too far in the future. What the public failed to realise in these "investigations" and queries was the complexity of the project. Canada, like the UK and the USA, was finding out that modern aircraft took time — a long time — to produce.

The CF-100 prototype was the culmination of over 450,000 man hours spent on design, compared with the 42,000 man hours required to design the P-51 Mustang day fighter of a few years before — more than a ten-fold increase of effort in a decade. Much of this time was devoted to scheming out and draughting over 10,000 original drawings from Avro shops, not to mention handling a constant stream of modifications and alterations which, by 1953, were pouring into the production organisation at a rate of 300 a week.

The two C-100 prototypes, serial 18101 and 18102, were designated Mk 1. Simultaneously with their construction, Orenda Ltd (the turbojet research, design, and production facility set up by Hawker Siddeley as an off-shoot of A V Roe Canada Ltd) had to continue work on an indigenous powerplant intended for the CF-100. Added to this flurry of activity, the A V Roe facilities were crowded with other work: Lancasters were being pulled out of storage and converted to maritime reconnaissance standards for the RCAF; Hawker Sea Fury fighters of the Royal Canadian Navy were being serviced and RCAF B-25 Mitchells required tending. Work was also continuing on the highly successful, but doomed, C-102 jetliner. With limited space and such heavy commitments, it became obvious that a new factory was needed, and in October 1950, the turf was cut for a new building to be erected opposite the main plant at Malton, Ontario.

Almost a year earlier, on 19 January 1950, the CF-100 Mk 1 had flown for the first time. Decked out in an overall black finish, the aircraft climbed into a crisp winter sky with company test pilot Bill Waterton (on loan from Gloster Aircraft in the UK) at the controls. The Orenda engines were not yet ready, so Rolls-Royce Avons provided the power, and achieving first flight some three years after launching the project did not compare unfavourably with British and US experience with projects of similar complexity. First impressions of the aircraft in the air lent optimism to the forecasts for the future success of the CF-100.

By the time the Korean situation reached flashpoint in June 1950, 12 CF-100s were in various stages of construction, with 10 pre-production Mk 2s following the two Mk 1s, but still only the first prototype had flown. By early September, the United Nations forces were clinging desperately to the Pusan perimeter and it was obvious that the conflict could no longer be considered a petty border conflict; Canada raised her defence sights and ordered a total of 124 CF-100 interceptors to be produced at a rate of 5 per month. In February 1951, Chinese forces came crashing over the Yalu to repulse the UN troops once again, and the Canadian government increased the number of CF-100s to be purchased, as well as the rate of production, by several hundred percent.

The immediate emergency that led to this escalation of CF-100 production was over by the time the new fighter began entering service in 1953, but the period of almost two years from contract to delivery was, again, comparable to the achievement of other nations. As one RCAF analyst put it, quoting William S Knudsen, "You can't hatch eggs in less than 21 days no matter how many hens you put on them!"

If production of the CF-100 *did* appear to be tardy, then it should be remembered that A V Roe not only had to design, test and produce the CF-100 and its Orenda engines, but also

to prepare the production facilities for both these products virtually from scratch. At the beginning, the standard CF-100 required 15,000 templates, 7,000 forming tools and dies, 3,000 machine tools, and 125 major assembly jigs. Assembly jigs gradually increased to several hundred as production mounted. This required space, and space was not always available. A new Orenda shop provided 708,000 sq ft (65,775 m²) of space for that division, but it took two years to stock the facility with the proper equipment in quantity and quality, and it was mid-1952 before there was adequate floor space for aircraft and engine production. Sub-contractors were also required. While many firms vied for the contracts, enthusiasm was not always enough. The labour force had to be qualified, which necessitated much training effort. By 1954, 40,000 Canadians were working on CF-100 production with 10,000 at Malton alone, and 450 plants from the Pacific coast, across the prairies and Ontario, to Quebec and the east were involved in the effort, which had no precedent in Canada.

By 1954 also, the Department of Defence Production was allocating 55 per cent of all defence procurement funds to the CF-100 project: $36 million was being funnelled to sub-contractors for work on the airframe alone, and only 35 per cent of the airframe was in fact being produced by companies other than A V Roe itself. The unprecedented scale of the CF-100 effort was also evident in the comparisons that were continually being made during the formative years. The CF-100 was about one-third the all-up weight of the Lancaster bomber of World War II, for example, yet even with the modern production equipment available, both aircraft took an equal amount of time to build. The Spitfire and Mustang could be rolled out of a factory for around $50,000 apiece: $140 million had been spent before the first CF-100 Mk 1 even flew.

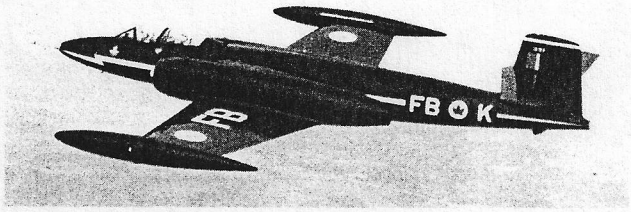
The product

By 1953, the light could be seen at the end of the tunnel of effort, frustration, pressure and criticism — often ill-founded, occasionally justified. As already recorded, the prototype CF-100 Mk 1 had performed successfully on its maiden flight of 19 January 1950 and this aircraft was subsequently stripped of its sombre black finish and decked out in standard RCAF markings to set to work in preliminary flight tests and then rocket firing bouts on RCAF ranges. It served for fifteen years until it was retired to a disposal depot (where it rests today), but the second Mk 1, 18102, was ill-fated, crashing on the day it was handed over to the RCAF, 23 June 1951.

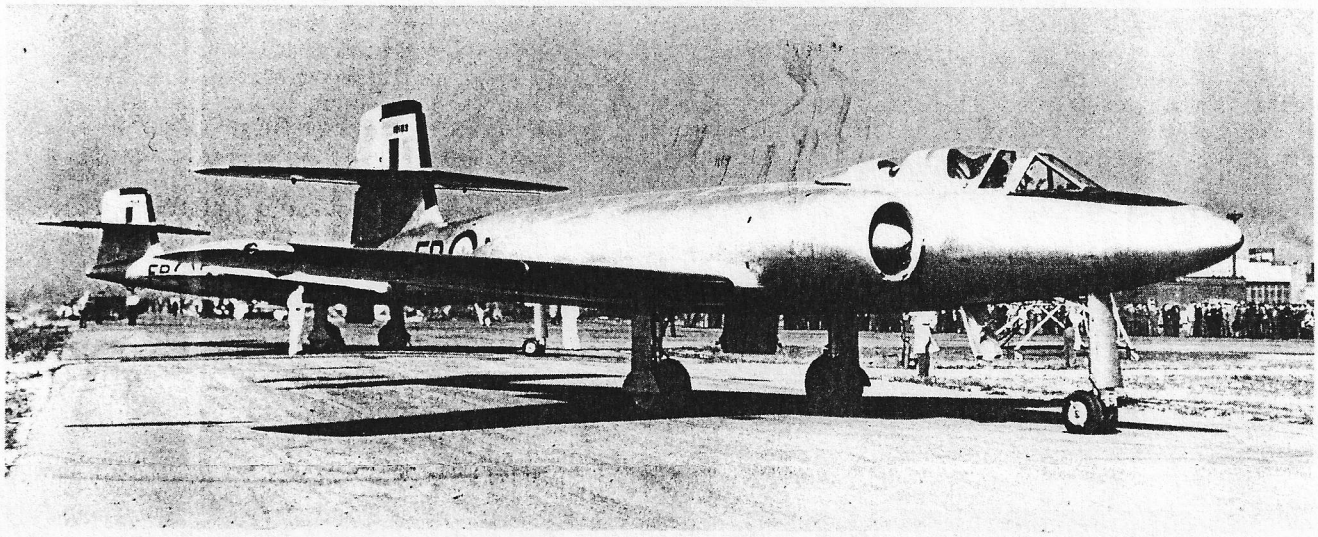
The first of the 10 pre-production Mk 2s made its maiden flight on 20 June 1952, the Avon turbojets of the Mk 1 being supplanted by two Avro Orenda 2 jet engines. This heralded the beginning of a long and successful relationship which, through the mating of a superior powerplant and superior airframe, blended to produce a competent and enduring design. Though unarmed, the Mk 2 served in accelerated flight tests; later, two became CF-100 Mk 2Ts to be used in the training rôle with dual flight controls and four were converted to Mk 3T standard, also as trainers, while the 10th and last served as the prototype Mk 4. The manufacture of these pre-production aircraft introduced Canadians to another facet of modern jet aircraft production. In the pre-war days, one or two prototypes had proved a sufficient number for an aircraft programme, and it often proved possible for even the single prototype to be modified up to operational status. The need to retain as many as a dozen aircraft off the assembly lines for a variety of flight tests and development work helped to create the impression, for those who did not understand the scale of effort required to prove a new weapon system, that untoward delays were occuring, the result perhaps of some dire technical problem.

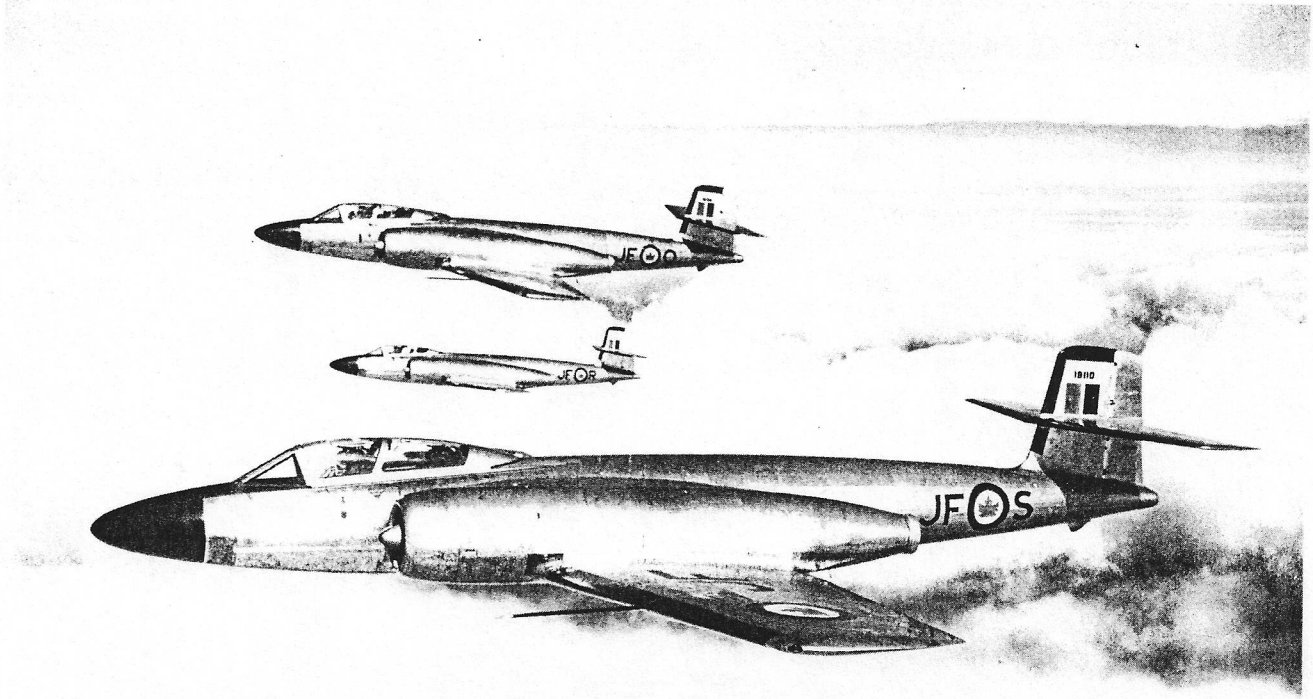
By 1958, all operational CF-100 Mk 2s had either been scrapped or had been assigned to the RCAF instructional register, the latter involving the deletion of the original serial and its replacement with an "A" prefix and number. These aircraft were then parcelled out to RCAF stations for static instructional displays. In this rôle, two Mk 2s have remained in use to this day, all other examples having now been scrapped or otherwise disposed of.

The first operational version soon followed the Mk 2, being designated CF-100 Mk 3. Similar in appearance to its immediate predecessors, its operational capability was visually defined by the slight bulge located just aft of the nosewheel door, indicating the presence of eight 0·50-in (12.7-mm) Colt-Browning machine guns. These weapons were completely self-contained in an innovative and for its time unique retractable



(Above right) Another view of the second CF-100, No 18102, without stabilising fins on the tip tanks. (Below) The two prototypes were followed by a small batch of Mk 2s, the first of which, Nos 18103 and (background) 18104 are shown here. Note the experimental masking of the cockpit transparencies.





Part of the original batch of 10 CF-100 Mk 2s, this trio of aircraft was converted to Mk 3T standard to be used as trainers by No 3 (AW) OTU which was set up at North Bay to prepare air and ground crews for the operational introduction of the CF-100.

gun pack, or tray. The trays were interchangeable between all CF-100s and in an operational situation, the expended gun pack was merely exchanged for a new one to reduce ground time to a minimum. The dividends in increased flying time and operational readiness are obvious.

The CF-100 Mk 3 made its first flight on 11 October 1952, powered by two Orenda 8 turbojets. Destined to be the first version to achieve operational status with the RCAF, the Mk 3 was in fact only an interim variant, production of which had proceeded with all possible speed under the impetus of the Korean conflict while Avro engineers in conjunction with the RCAF had been busy evolving a more potent all-weather version of the Canuck designed to take advantage of the latest state-of-the-art advances in weaponry and fire control. As the Mk 4, this version would achieve large-scale production and the prototype actually flew on the very same day that the Mk 3 first took to the air. Before the changes planned for the Mk 4 could be introduced on a production basis, however, they had to be proved in flight test, and production drawings had then to be produced and issued to the shops. While this process went ahead, Avro turned out 70 Mk 3s and the RCAF set about the process of introducing the Canuck into service.

The RCAF accepted its first Mk 3 on 15 August 1952. Records of the day show its assignment as "ADC North Bay." This was fitting, as perhaps no other Canadian military station was destined to have as many connections with the CF-100. North Bay was a World War II base updated in the early 'fifties to accommodate modern jet fighters such as the Sabre and, particularly, the Canuck. It was here that the serenity of the northern Ontario wilderness was first pierced by the loud roar of the Orendas bouncing off the rocks of the Canadian Shield as the first two RCAF units to receive the CF-100 were formed and began to work up on the new fighter.

These units comprised the RCAF's first all-weather, round-the-clock operational squadron and the first all-weather operational training unit. The squadron selected for the former rôle was a brand new unit beginning its career with new aircraft and a new assignment — No 445 Squadron, which chose to commemorate its originality in its heraldic insignia, "a wolverine rampant holding in its dexter paw a lightning flash." The explanation of this insignia noted that "the wolverine, like the squadron, ventures forth to travel both day and night in all weather. It is indigenous to Canada and ingenious, fearless, and of great strength. The flash of lightning is suggestive of the speed with which modern aircraft strike."

The training unit at North Bay was No 3 (AW) OTU and as already noted, many of the Mk 3s were assigned, either initially or subsequent to their period of operational service, to the training rôle. One special training conversion was designated the CF-100 Mk 3D and others were known as Mk 3T or Mk 3CT. The designation Mk 3B was used for a number of the production aircraft, apparently reflecting a change of equipment, and aircraft so designated were used to equip No 423 Squadron at St Hubert, PQ, in June 1953 and No 440 Squadron at Bagotville, PQ, from November 1953. On 18 December 1952, a CF-100 broke the sound barrier for the first time, in a dive from 30,000 ft (9 150 m), and is believed to be the first straight-wing combat aircraft to go supersonic.

An impression of the early days of CF-100 operation has been provided for this account by Lt Col J H Pocklington, a veteran Canuck pilot and latterly commanding officer of No 414 (EW) Squadron. He recalls his love-hate relationship with the aircraft as follows:

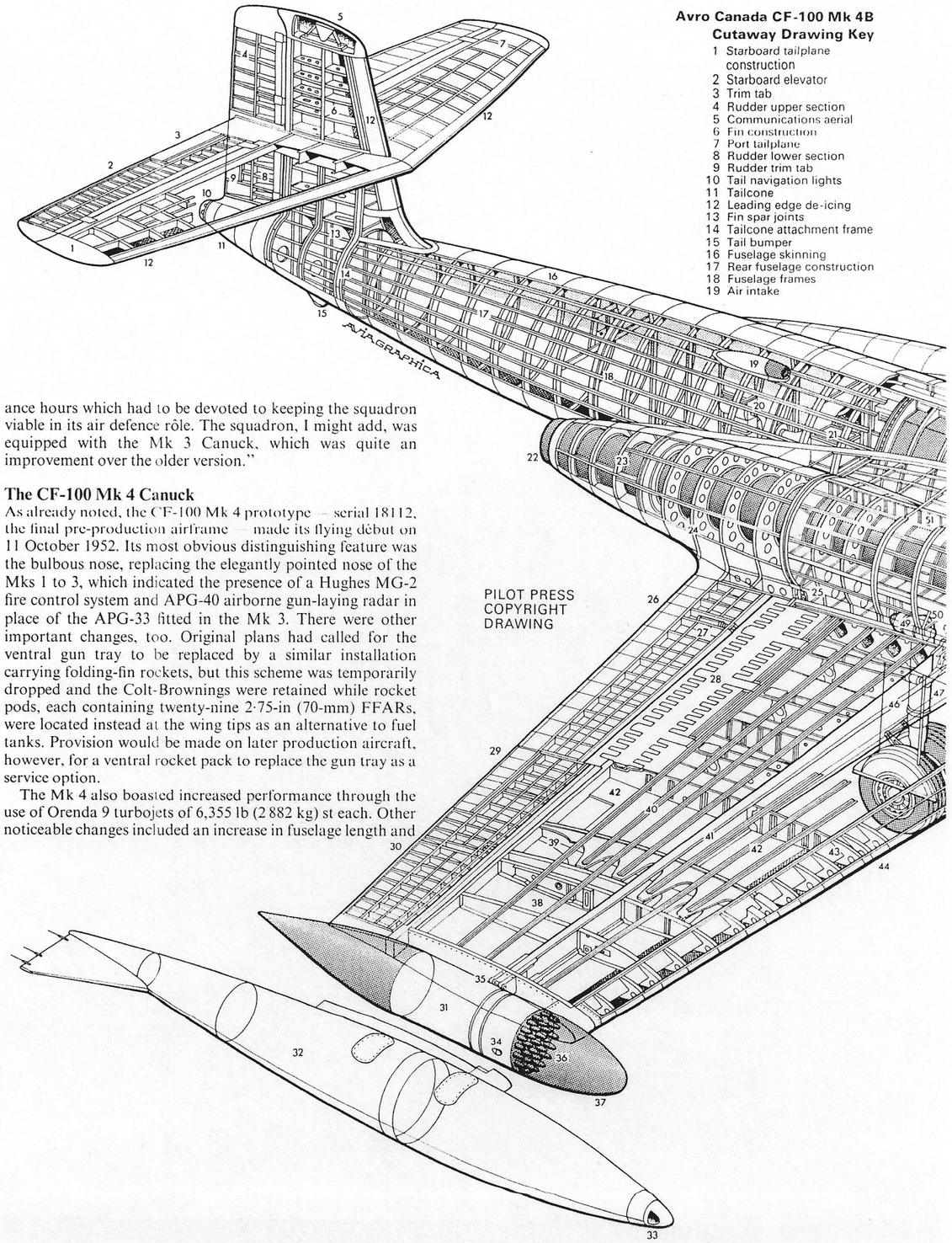
"I was fortunate, at the age of 19 years, to be selected as one of the first pilots to go on the OTU and join the first operational squadron equipped with the CF-100, 445 (AW) F Squadron. The CF-100 I initially flew was a Mk 2 version and had many things to be desired from both an engineering and pilot's point of view. I think I can sum up my feelings at that time by saying that although it had lots of 'get up and go' and was considered a top line interceptor, it soon became apparent that a flight simulator for emergency training was not a necessity. About every second flight, one was faced with an in-flight emergency, so simulation on the ground was hardly necessary. Of course, it followed that our flying time initially was somewhat restricted because of the numerous mainten-

ance hours which had to be devoted to keeping the squadron viable in its air defence rôle. The squadron, I might add, was equipped with the Mk 3 Canuck, which was quite an improvement over the older version."

The CF-100 Mk 4 Canuck

As already noted, the CF-100 Mk 4 prototype — serial 18112, the final pre-production airframe — made its flying début on 11 October 1952. Its most obvious distinguishing feature was the bulbous nose, replacing the elegantly pointed nose of the Mks 1 to 3, which indicated the presence of a Hughes MG-2 fire control system and APG-40 airborne gun-laying radar in place of the APG-33 fitted in the Mk 3. There were other important changes, too. Original plans had called for the ventral gun tray to be replaced by a similar installation carrying folding-fin rockets, but this scheme was temporarily dropped and the Colt-Brownings were retained while rocket pods, each containing twenty-nine 2·75-in (70-mm) FFARs, were located instead at the wing tips as an alternative to fuel tanks. Provision would be made on later production aircraft, however, for a ventral rocket pack to replace the gun tray as a service option.

The Mk 4 also boasted increased performance through the use of Orenda 9 turbojets of 6,355 lb (2 882 kg) st each. Other noticeable changes included an increase in fuselage length and



Avro Canada CF-100 Mk 4B Cutaway Drawing Key

1 Starboard tailplane construction
2 Starboard elevator
3 Trim tab
4 Rudder upper section
5 Communications aerial
6 Fin construction
7 Port tailplane
8 Rudder lower section
9 Rudder trim tab
10 Tail navigation lights
11 Tailcone
12 Leading edge de-icing
13 Fin spar joints
14 Tailcone attachment frame
15 Tail bumper
16 Fuselage skinning
17 Rear fuselage construction
18 Fuselage frames
19 Air intake
20 Air conditioning plant
21 Radio equipment bay
22 Jet efflux
23 Nacelle tailpipe
24 Nacelle construction
25 Wing rear spar fixing
26 Starboard wing flap
27 Flap hydraulic jack
28 Herringbone airbrake
29 Aileron trim tab
30 Starboard aileron
31 Wing-tip rocket pod
32 292 US gal (1 105 l) wing-tip fuel tank
33 Tip tank navigation light
34 Rocket pod navigation light
35 Wing-tip attachment
36 29 folding fin 2·75-in (70-mm) rockets
37 Rocket pod frangable nose cone
38 Wing construction
39 Wing inner skin
40 Wing stringers
41 Main spar
42 Wing fuel tanks
43 Leading edge construction
44 Leading edge de-icing
45 Twin mainwheels
46 Undercarriage leg door
47 Main undercarriage leg
48 Main spar fixing
49 Undercarriage leg pivot
50 Retraction jack
51 Nacelle centre section construction
52 Jet pipe shroud
53 Engine mounting struts
54 Orenda 11 turbojet engine
55 Fuselage fuel tanks
56 Control duct along top of fuselage
57 Port engine nacelle
58 Airbrake hydraulic jack
59 Port airbrake
60 Port wing flap
61 Aileron trim tab
62 Port aileron
63 Aileron hydraulic jack
64 Wing-tip rocket pod
65 Landing lamp
66 Wing inner skin
67 Leading edge de-icing boots
68 Pitot head
69 Port wing fuel tanks
70 Port engine cowlings
71 Sliding canopy cover
72 Canopy rails
73 Air intake
74 Engine mounting frame
75 Firewall
76 Engine driven gearbox
77 Engine bay construction
78 Nacelle lower fairing
79 Ventral gun pack
80 Ammunition boxes
81 Spent cartridge deflector plates
82 Eight 0·5-in (12,7-mm) Browning machine guns
83 Gun muzzle fairings
84 Gun port
85 Starboard engine intake guard
86 Engine air intake
87 Intake anti-ice spray
88 Ammunition bay
89 Navigator's ejector seat
90 Radar display
91 ADF loop aerial
92 Port engine intake
93 Pilot's ejector seat
94 Nosewheel bay
95 Nosewheel door
96 Pressurised cockpit structure
97 Control column
98 Engine throttles
99 Windscreen frame
100 Gun sight
101 Nose electronics compartment
102 Rudder pedals
103 Nose undercarriage pivot
104 Nosewheel leg
105 Twin nosewheels
106 Nosewheel leg door
107 Nose radar bay construction
108 Hughes APG-40 radar
109 Fire control and interrogation radar
110 Radar scanner
111 Radome

the replacing of the original obstructed canopy by a long, unobstructed blister canopy.

The initial production Mk 4, serial 18183, flew for the first time on 24 October 1953, and this and subsequent production aircraft had to embark on a long array of test programmes at the RCAF weapons test range, newly constructed at Cold Lake, Alberta, before deliveries to operational squadrons of RCAF's Air Defence Command could begin. The large number of sunshine hours, low relative humidity, and moderate winds all year round made Cold Lake a desirable location for the weapons test range, and 3 (AW) OTU, the CF-100 training unit, was also transferred to that base from North Bay in the course of 1953.

Avro Canada CF-100 Mk 5 Specification

Power Plant: Two Avro Orenda Mk 11 or 14 turbojets each rated at 7,275 lb st (3 700 kgp) for take-off.
Performance: Max speed, 650 mph (1 046 km/h) at 40,000 ft (12 200 m); typical cruise, 480 mph (772 k /h); initial rate of climb, 8,500 ft (43,2 m/sec); time to 50,000 ft (15 250 m), 8 min; service ceiling, 54,000 ft (16 460 m); combat radius, 700 mls (1 126 km); max range, 2,300 mls (3 700 km).
Weights: Empty, 23,100 lb (10 478 kg); normal loaded, 33,600 lb (18 254 kg); max overload, 36,465 lb (16 555 kg).
Dimensions: Span (over rocket pods) 60 ft 10 in (18,54 m); length, 54 ft 2 in (16,50 m); height, 15 ft 6½ in (4,71 m); wing area, 591 sq ft (54,90 m²); aspect ratio, 5·9:1; dihedral, 3 deg constant; undercarriage track, 10 ft 2 in (3,10 m); wheelbase, 18 ft 1½ in (5,52 m).
Armament: Fifty-two 2·75-in (70-mm) folding-fin rockets in each of two wing-tip pods.
Accommodation: Pilot and radar operator/navigator in tandem cockpits with Martin-Baker Mk 2E ejection seats, under one-piece rearwards-sliding canopy.

On 24 April 1954, a team of RCAF personnel accompanied by Avro engineers arrived at Cold Lake to establish facilities for evaluating the CF-100 Mk 4. At this time, the RCAF's lead collision course attack technique, using air-to-air rockets, was being developed, and required test facilities of great complexity, for which purpose the Primrose Lake Evaluation Range was established on the southern boundary of the Cold Lake weapons range.

The lead collision course tactic, once described by *Weekend Magazine* editor Frank Lowe as a "aerial version of Russian Roulette", involved the close co-operation of ground installations, aircraft and crew. When a CF-100 approached an unknown target guided by the radar installations of either the DEW line, the Mid-Canada Line, or the Pinetree Line, it was required to follow a specific pattern. The lead aircraft (interceptions were always made by aircraft flying in pairs) utilised its radar and made a curved climb to put itself above and behind the intruder while the second Canuck dropped back. The lead aircraft would then close from behind to make positive identification; should the intruder be a harmless airliner or private aircraft, then radio contact or signals with navigation lights would instruct it to follow the defenders.

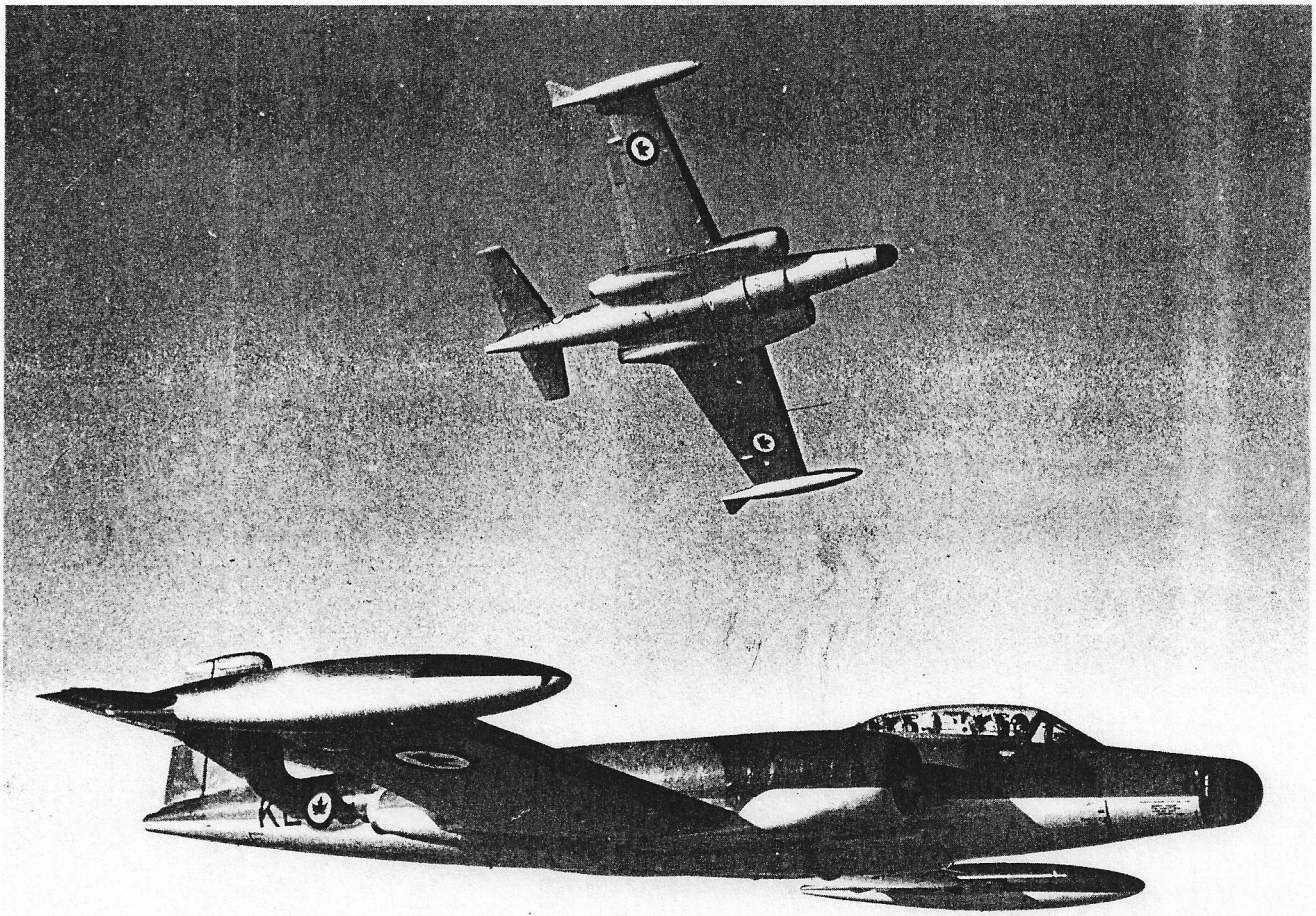
Should the intruder prove to be hostile, however, the same initial procedure would be followed by a revised outcome. It was generally held during the 'fifties that the first casualty in World War III over North America would be the CF-100 crew who made the first identification run on an intruder proving to be a "hostile"! In such a case, the second Canuck would route itself to intersect with the bomber's path, aided by ground radar/airborne guidance system, and make a head-on attack to destroy the intruder with combined rocket and machine-gun fire.

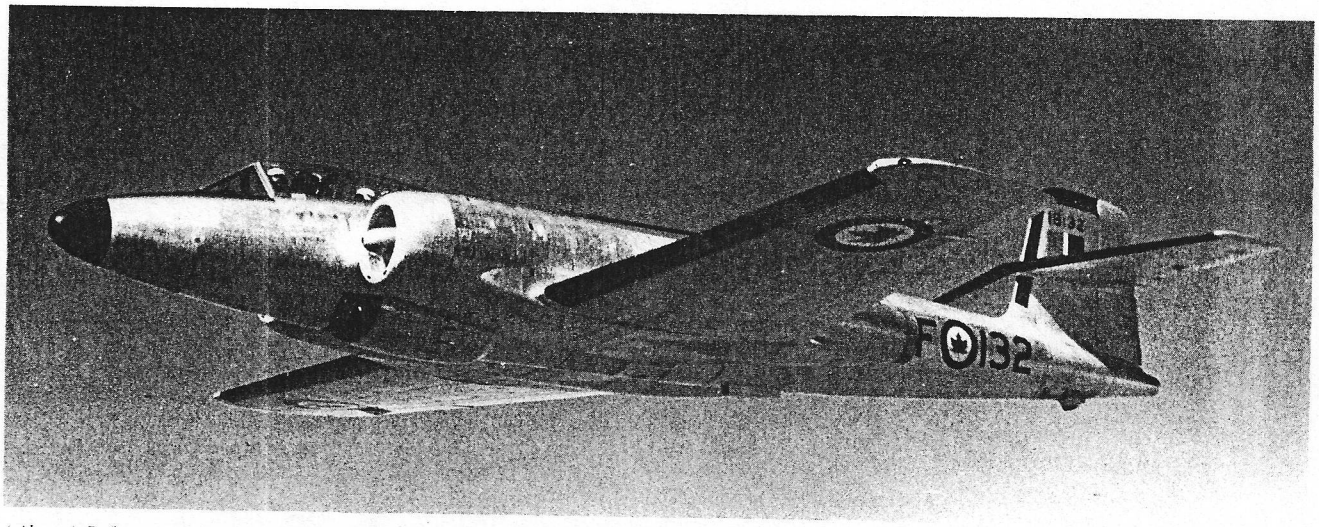
While very effective, the CF-100's lead collision course was also a risky undertaking, and during combined exercises with the USAF Strategic Air Command in the mid 'fifties, several close calls were reported. The RCAF soon realised that firing head-on at ranges down to as little as 200 ft (61 m) with rockets would not long continue to be a suitable means of conducting aerial combat and to rectify this situation, it was decided to mate the CF-100 with a guided missile.

The Canuck wore gloves

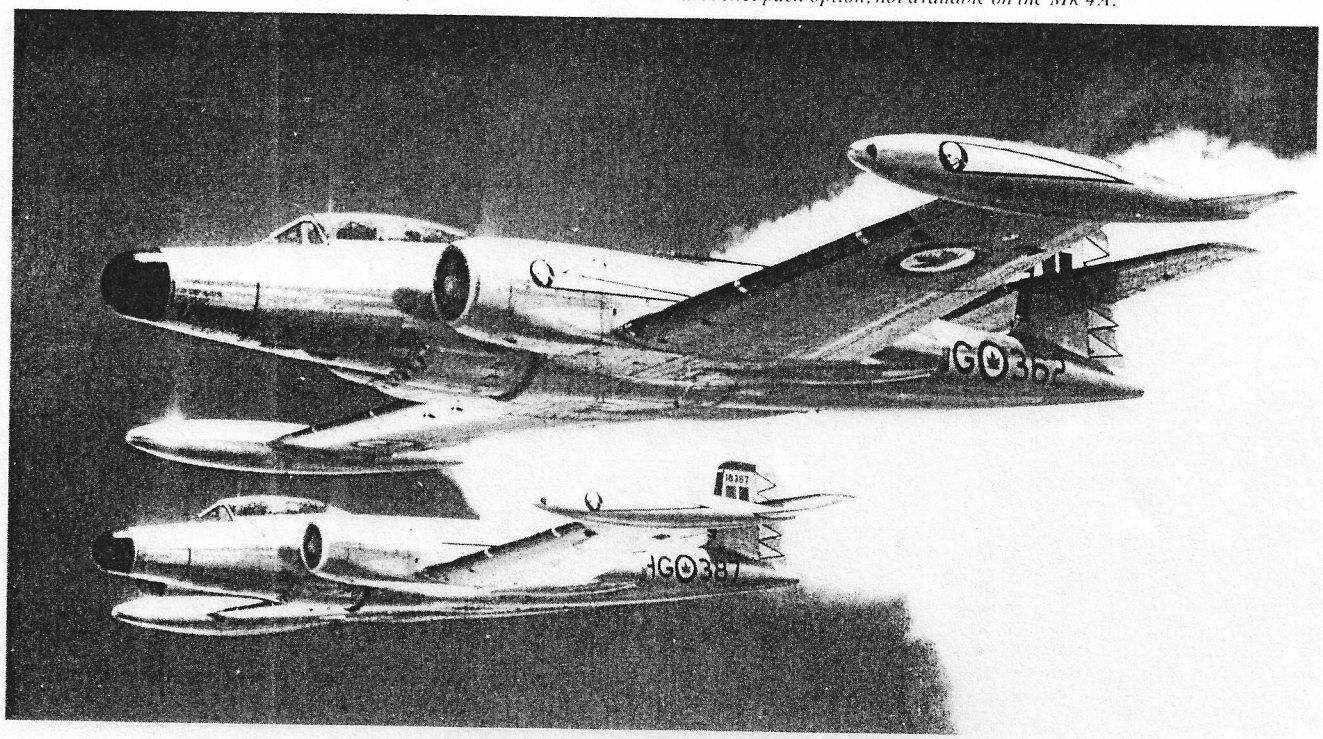
In 1947, one year after the initial designs for the CF-100 were underway, the Canadian government had confirmed its view that modern weapons such as guided missiles were here to stay. In order to ensure a working knowledge of these systems, the newly formed Defence Research Board (DRB) was assigned to conduct studies in the field. That same year, a small group of DRB scientists embarked on the effort. Looking to the future needs of Canadian defence, they decided to concentrate on air-to-air weapons in conjunction with the United States and the United Kingdom. Finally, the decision was made to undertake a programme which would lead to the practical, but experimental, design and production of an air-to-air guided missile. It was fully understood from the outset that should the US or British aerospace industries in the meantime produce a missile that exceeded by any considerable margin the product of this indigenous programme, then Canada would not

For service in Europe, where the RCAF at one time had four CF-100 Squadrons assigned to NATO Fighter Wings in France and Germany, the Canadian aircraft were finished in standard NATO camouflage colours.





(Above) Before receiving the Mk 4 series of CF-100s, the RCAF took delivery of 70 Mk 3s of assorted sub-type. No 18132, illustrated, was a Mk 3A.
(Below) The CF-100 Mk 4 differed from previous versions in having APG-40 radar in a more bulbous nose radome. The Mk 4B, illustrated here in the markings of No 428 Squadron, re-introduced the ventral rocket pack option, not available on the Mk 4A.



hestitate to adopt such a weapon in favour of the home-produced version.

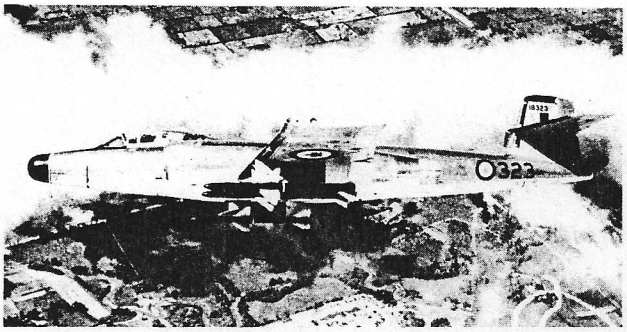
The project was approved in 1950 and dubbed "Velvet Glove". Eight months later, the first test vehicle was fired. From this point, the programme expanded to embrace over 300 progressive test vehicles and from a handful of DRB scientists to more than 400 specialists from the DRB, the RCAF and the Canadian aerospace industry, including Avro. The primary objective of the programme was to conduct successful research into the field of guided missiles to familiarise the Canadian aerospace companies with the disciplines involved; the second objective was to equip the RCAF with this missile.

This history of the programme itself is beyond the scope of this account, but in 1950 the RCAF had submitted specifications for the weapon to be carried by a version of the CF-100. The missile was a first generation system using semi-active homing in a pursuit course. Initially, the design called for a four-missile installation on the CF-100 Mk 4; later, a two-missile specification was added for the RCAF's CL-13 Sabre fighters (nicknamed "Swords") then serving predominantly in Europe. The Canuck, however, possessed one great advantage: self-sufficiency; the Sabre would require ground control to vector it onto its target.

The missile was developed at the Canadian Armament Research and Development Establishment (CARDE) at Valcartier, near Quebec City, and several CF-100s (as well as CL-13 Sabres) were assigned to the test programme, launching more than 300 Velvet Gloves before the project came to an end when it was realised that the Sparrow II system had outstripped Canadian progress and that Velvet Glove performance was, by 1956, no longer adequate to counter the Soviet threat. The first CF-100 used in connection with the project was Serial 18117, a Mk 3A operated from the Central Experimental & Proving Establishment (CEPE). It carried two missiles beneath each wing and a long nose cone containing test instruments.

Progressive developments led to the introduction of the CF-100 Mk 4B after production of 137 Mk 4As to the initial standard, two of the latter being converted to Mk 4B

The CF-100 was a primary tool in Canada's guided missile research programme. Among several aircraft used to flight test the Velvet Glove missile were the Mk 3A No 18117 (above) and the Mk 4B No 18323, each with four of the weapons on pylon mounts.



prototypes. The later version, of which 194 examples were built, differed in having uprated Orenda 11 engines offering 7,275 lb st (3 300 kgp), and the ventral rocket pack option. Mk 4B acceptances began in November 1954 and were completed by June 1955; the final 50 were, it appears, witheld from squadron delivery until modified to Mk 5 configuration as described later, but the total of 281 Mk 4As and 4Bs on hand by the middle of 1955 was sufficient for the RCAF to bring its Air Defence Command squadrons up to the planned strength and in addition to replacing Mk 3s in Nos 423, 440 and 445 Squadrons, the new CF-100s were used to equip 409 (the Nighthawks), 419 (Moose), 425 (Alouette), 428 (Ghost), 432 (Panther) and 433 (Porcupine) squadrons.

Three CF-100s flew from Canada to the UK on 24 March 1955, becoming the first Canadian-designed jets to cross the Atlantic and spending some time at the RCAF base at North Luffenham. The latter had been established some four years previously, in January 1951, with the arrival of No 421 Squadron to fly Vampires and subsequently CL-13 Sabres as the RCAF's initial contribution to NATO air power in Europe. With the introduction of CF-100 Mk 4s, however, it became possible for Canada to make a much more significant contribution to European air defence which was, in the mid 'fifties, badly lacking in all-weather capability. Early in 1956, the decision was taken to assign four Canuck squadrons to Europe, one to serve in each Fighter Wing, as replacements for Sabre units that would return to Canada and, eventually, reform on later CF-100s within ADC.

Giving effect to this decision, No 445 Squadron, the original CF-100 unit, was chosen to pioneer the transfer, flying its aircraft from RCAF Station Uplands to Marville, France, between 1 and 4 November 1956 to join 1 Fighter Wing. It was followed by 423 Squadron in 2 FW at Gros Tenquin, France, 440 Squadron in 3 FW at Zweibrucken, and 419 Squadron in 4 FW at Baden-Soellingen, the two last-mentioned being in Federal Germany. All the aircraft moved to Europe were Mk 4Bs, painted, for the occasion, in NATO colours of dark sea grey and dark green upper surfaces and pale blue undersides.

European mission

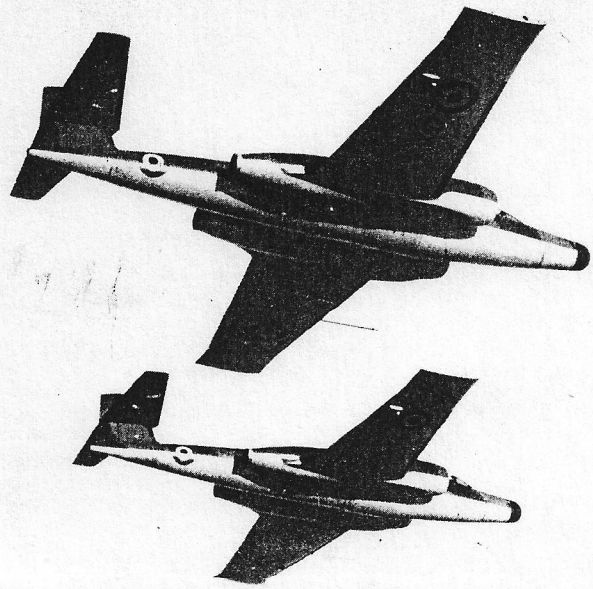
The CF-100s, which soon acquired the nickname of the "Klunk", provided NATO with much-needed all-weather capability. As the recently-published *Pictorial History Album* of 4 Fighter Wing records: "Unlike Canada, Germany seldom, if ever, has what can be called a clear day. The normal European weather (if there is such a thing) has a visibility of about three miles in haze and some clouds. In winter, thick fog and/or an overcast cloud layer are the norm. Under these conditions, the all-weather capabilities of the CF-100 team soon became apparent . . . 'Moose's' prowess in Baden's environment was to put it in a class all its own when it came to 'dirty' weather, and night flying duties."

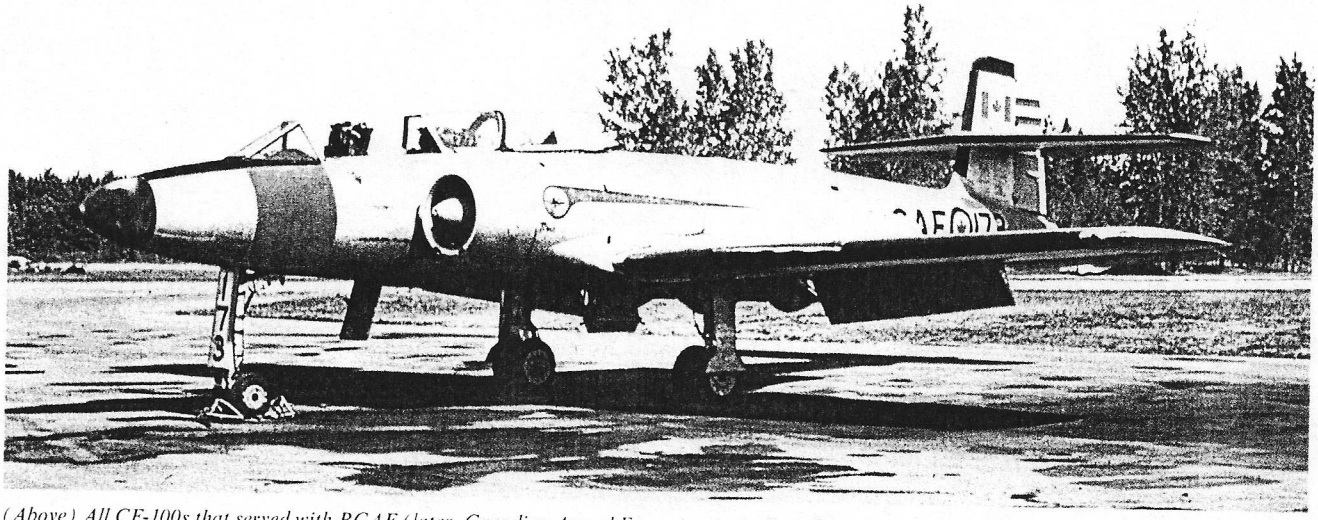
The operations of the CF-100 in Europe are also described in this same *Album*, from which the following description is extracted with permission:

"The sun is shining, and hardly a cloud in the sky. What a great day to launch off into the blue. Too bad it's Wednesday because that means the morning is going to be devoted to groundschool instead of punching holes in the sky: groundschool the necessary scourge of generations of aircrew. Without pencil and paper work, the value of the jobs in the air would be undermined. So . . . thoughts of getting airborne are tucked away until the afternoon and into the school they trudge. Out come the books on air combat tactics, aircraft operating instructions, base flying orders, squadron operating procedures, intelligence briefs, and many more to be poured over for the n'th time. All this is part of the continuing process of ensuring that these men are able to perform their duties competently in a time of war.

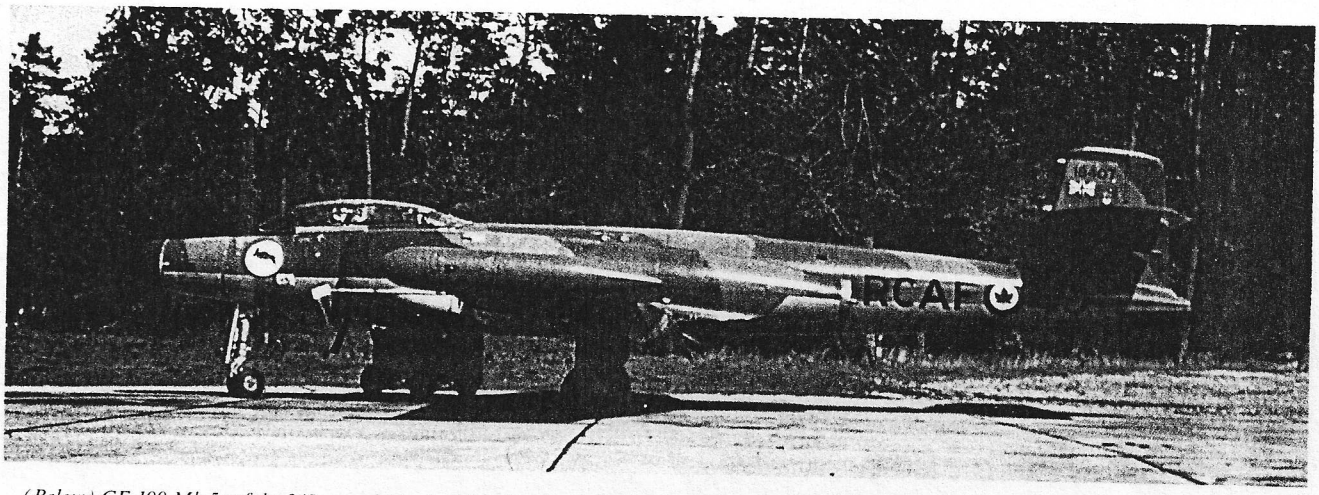
"Noon, and the pall is lifted, but the ceiling has fallen and Rhine Valley is fogged in. The sorry 'Sword' jockeys looked forward to a long afternoon biting their nails at squadron, but not so the followers of 'Bruce the Moose', who hop into their all-weather Canucks and wave bye-bye to the ground-bound Sabre-drivers.

Only user of the CF-100 other than the RCAF was the Force Aérienne Belge, *which acquired 53 Mk 5s through a US government aid programme. They served with the* escadrilles *of the 1st All-Weather Fighter Wing until 1964.*

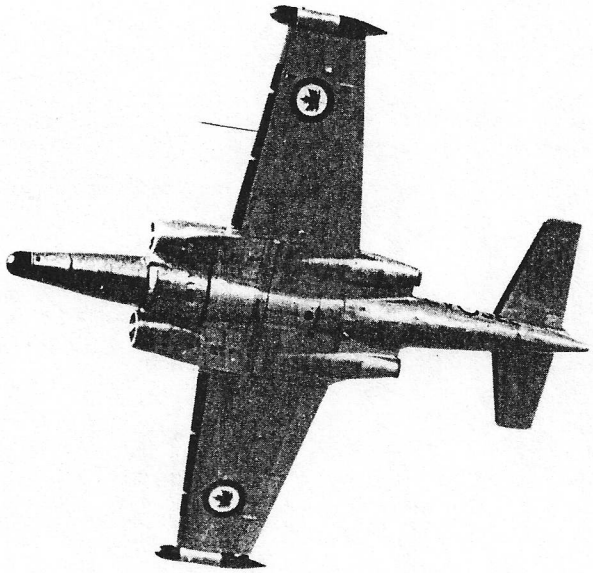


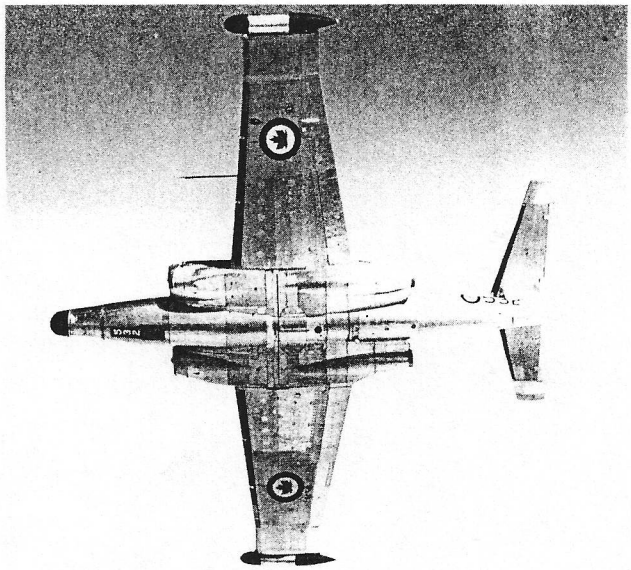


(Above) All CF-100s that served with RCAF (later, Canadian Armed Forces) units in Canada were flown in natural metal finish, as on this Mk 3, No 18173, sometimes with squadron insignia on the nacelles or tail units. (Below) A camouflaged Mk 4B of No 419 Squadron, RCAF, during its assignment to Europe.



*(Below) CF-100 Mk 5s of the 349*e escadrille, *1*e Wing de chasse tout temps, *of the* Force Aérienne Belge, *photographed at Beauvechain in 1960.*





The major external difference between the CF-100 Mk 4 and Mk 5 was the extended wing-tips of the latter, well shown in the comparative views of the two types above left and right respectively.

"Charlie section is to be the first airborne 'Klunk' team today. Their [training] mission, in hot from Metz, is handed to the section lead, and briefed to the rest of the section: to intercept and destroy a bogey westbound from the Iron Curtain. Ordnance: rockets. After the briefing the pilots check out their airplanes and prepare for their sortie. A final check before departing: Mae Wests, parachutes, helmets, gloves, pubs and clipboards. All set, then let's go! Check in on channel 17 and call ready.

"'Charlie two ready!'

"'Charlie lead checks. Charlies, let's to button eight.'

"'Soellingen tower. Charlie section taxi two.'

"On the way out to the button the pre-flight checks are completed, and take-off clearance is received. They line up echelon left and do an engine check. A nod of the head and brakes release. Full power, and you know those birds are going flying.

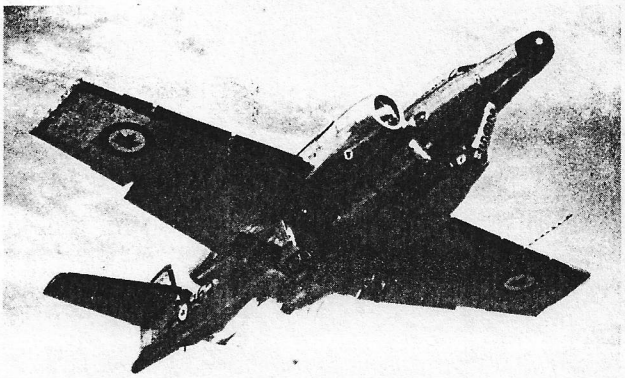
"After Charlies are safely airborne and their aircraft cleaned up, it's time for a check with the GCI controller who will give them radar vectors to their target.

"'Soellingen tower. Charlie section airborne. QSY your frequency.'

"'Charlie section button four, go.'

"'Yellow Jack. This is Charlie section. Your frequency, requesting vectors to target.'

The short take-off and landing ability of the CF-100 was adequate for most of its operational applications, but a JATO installation was developed for the Canadian fighter and is demonstrated here in use on the Mk 4A No 18265.



"'Charlie section. Steer heading 070 climb to angels 18 and maintain.'

"Throughout the climb, number two has maintained about a thousand feet separation from number one and is covering his tail, but will close in for the kill. Up here, above the fog, there is not a cloud in the sky and you can see for miles. You can even see that contrail about forty miles off to the east. The contrail is going to sweep right in front of the two CF-100s, but is will go no farther.

"'Charlie section. Turn left ten degrees and climb to angels two three.' There on the right edge of the nav's screen appears a steadily brightening blip. 'Lock on.' 'Go buster through the gate' and number two selects full power to come up line abreast of lead for the shot. It's his ball game, and the mission's success rides on his ability to read his scope. 'Right two degrees. Steady, steady. Rockets gone!' The cameras start to roll and assess the kill. Had the target been a real enemy, rockets rather than film would have fired automatically when the cross hairs on the scope lined up with their target. Shortly after, when the target and rockets intercepted flight paths, there would have appeared a momentary bloom on the radar, and then nothing.

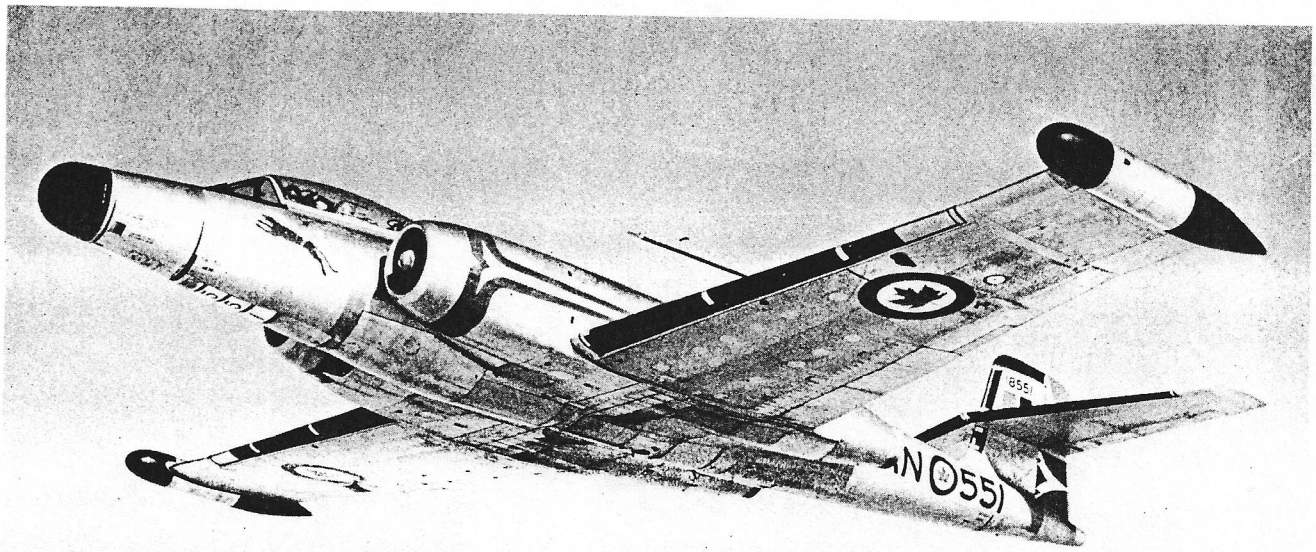
"'Charlie. This is yellow Jack. A kill. Good shooting.'

"The mission was successful, and two triumphant 'chop-sticks' turn for home. The mission completed, a little bit of fun seems to be well deserved. 'Number two. Three seconds spacing' and up they sweep into the sun. Soaring on silver wings, oblivious to the demands of gravity, they loop and roll, dive and climb. This is their element. That is 'what it's all about.' Miles down below, the rest of the world is surrounded by the fog and just on the limits of their perception they can hear the faint buzz of the CF's flying high above.

"Ten minutes of fun and it's time to return to base. 'Charlie two. Charlie section is ten miles north at eight thousand feet requesting a random radar stop.' Fifteen minutes later, they're on the ground taxying to the south Marguerite, right past the Sabres sitting idle for lack of good weather.

"A good mission; blue skies above the fog, and a good aircraft. What more could be asked?"

Every second week, the "Moosemen" took over the "graveyard shift" on the continual watch on the eastern frontiers. On a typical night, two CF-100 crews with ground crew would go out to the button of the runway to prepare their aircraft for flight within two minutes of the sounding of the alert siren. Two additional aircraft were readied in the



(Above) A CF-100 Mk 5 of the final production batch, in the markings of No 410 "Cougar" squadron. (Below right) Late service modification of Mk 5s produced the target tug with targets at each wing tip and wind-driven winches under the wings, and the Mk 5D with ECM equipment.

dispersal for flight within five minutes, and a final two were held ready for flight within thirty minutes.

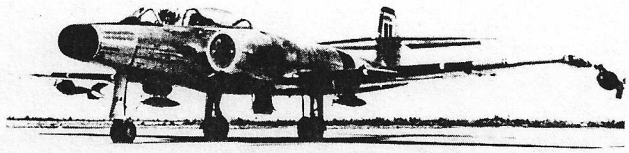
At sunset, the Sabre crews would retire the watch to the CF-100 team, the crews fully dressed and ready to go at any time and in any weather. Should an alert be sounded, these crews would be climbing up the ladder and throwing the switches to start the engines before the horn even stopped. At daybreak, the Sabres took over again.

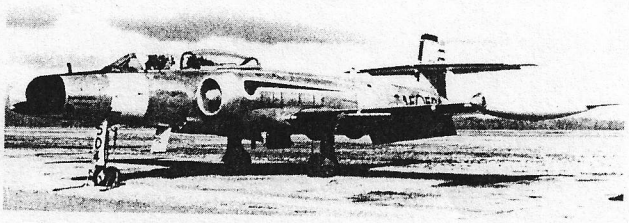
Aircraft do not make a squadron; squadrons adopt them. However, the pride in aircraft cannot be ignored as a factor in healthy, inter-squadron rivalry. It is worthy to note that the CF-100 squadrons were among the more healthy units around in Europe at the time.

Carry on Canuck

In Canada, meanwhile, the RCAF had begun to receive the CF-100 Mk 5s, destined to be the final production version, although work continued for some time also on a projected Mk 6. The Mk 5, powered initially by the Orenda 11 and eventually by the Orenda 14 of similar power but with improved operational characteristics, differed primarily in having a 6-ft (1,83-m) increase of wing span (by the addition of constant chord sections at the tips), enlarged tailplane and some structural economies. The ventral gun pack was abandoned and the capacity of the wing-tip pods was increased to 52 rockets each. The prototype Mk 5, one of two converted Mk 4Bs, flew in September 1954, and the first production example on 12 October 1955. As previously noted, the final 50 CF-100 Mk 4Bs, accepted *en bloc* by the RCAF on 28 June 1955, had been retained at the factory and were brought up to Mk 5 standard before delivery; these were followed by 279 more Mk 5s built as such, deliveries of which continued into the last quarter of 1958.

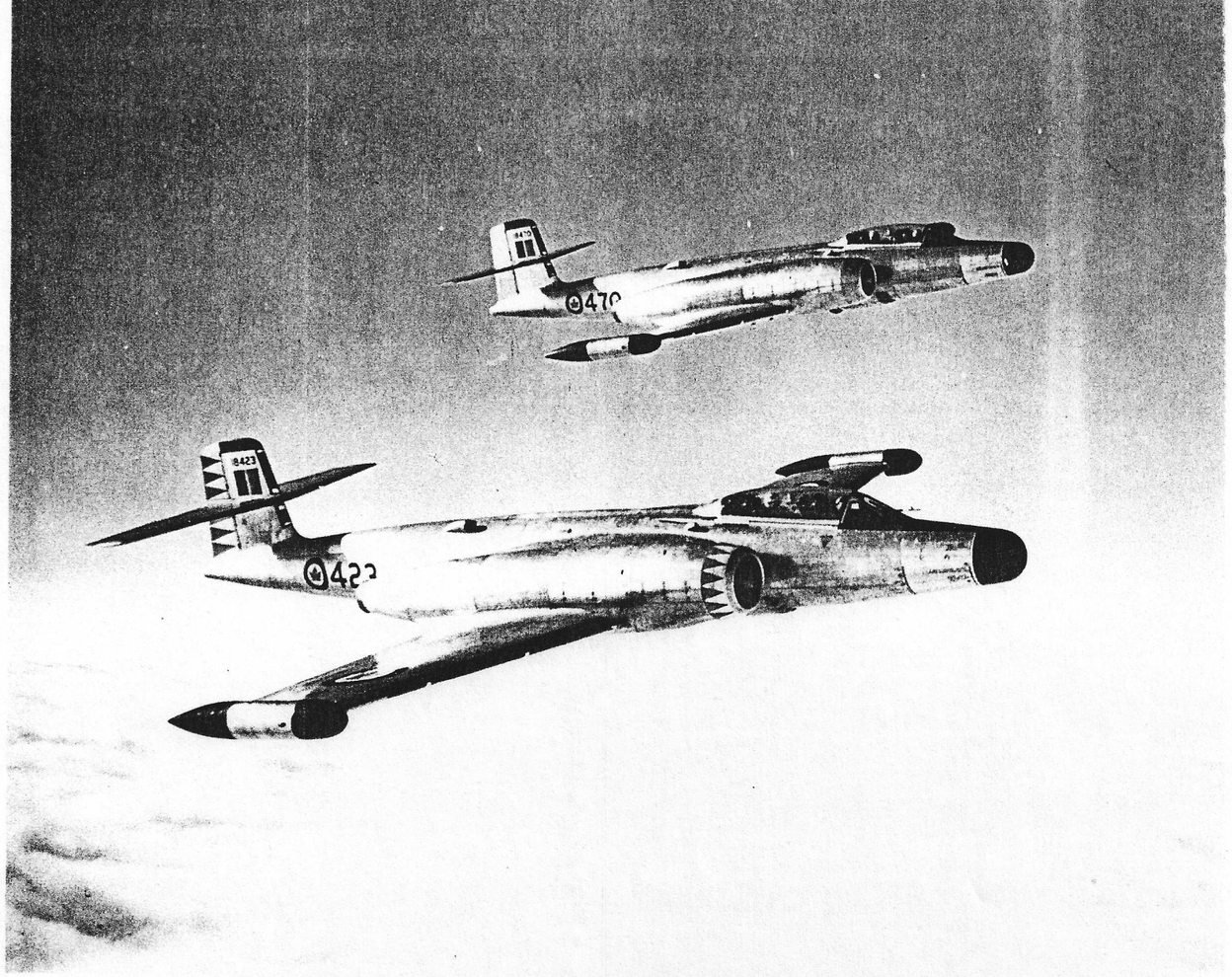
Gradually used to replace Mk 4 CF-100s in the squadrons already flying the type, Mk 5s were also used to equip 410 (Cougar), 413 (Tusker), 414 (Black Knight) and 416 (Lynx) squadrons, the four Sabre units that had been withdrawn from Europe when the CF-100s entered service there. In due course, it was planned, the Mk 5 would be followed by the Mk 6, designed to carry an armament of four Sparrow IIs, with the appropriate fire control system, and to be powered by 8,250 lb st Orenda 11R turbojets with afterburners. This plan was eventually abandoned, but not before a total of seven Mk 5s had been assigned for use as test-beds in the development of the Sparrow II installation as Mk 5Ms.



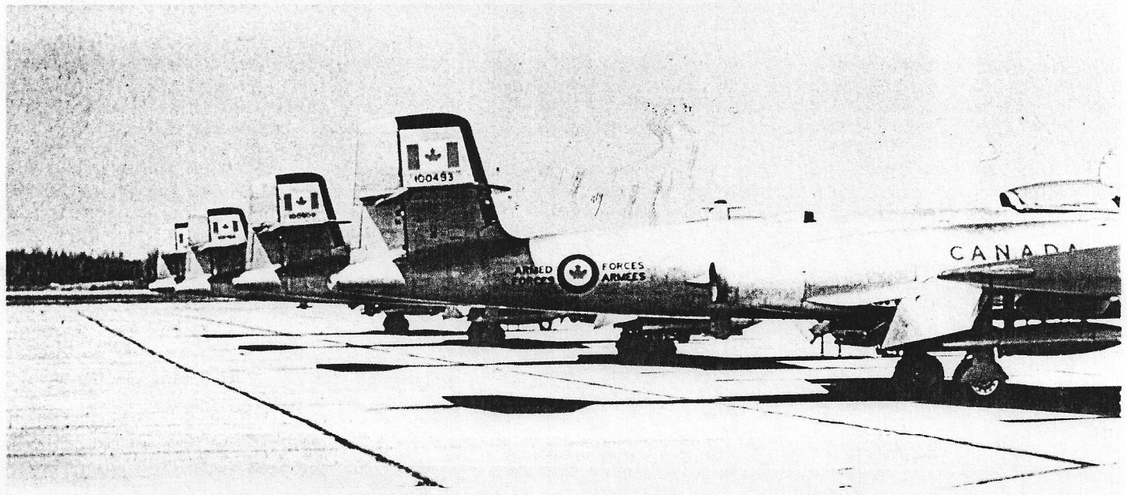


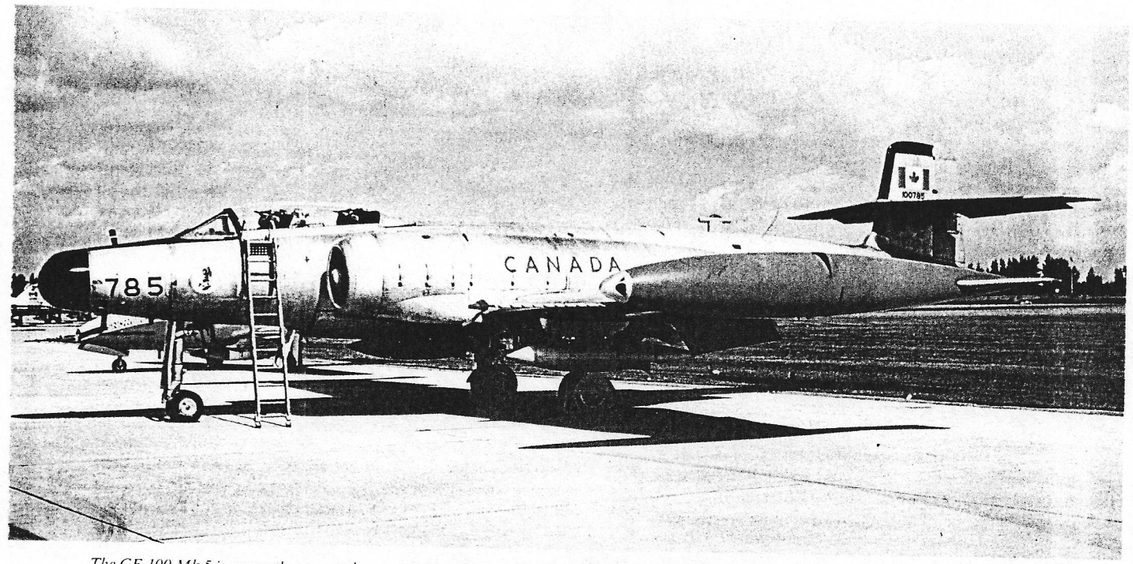
The nine home-based CF-100 squadrons, all with Mk 5 aircraft, became a major part of Canada's contribution to North American Air Defence Command (NORAD), following signature of the US-Canadian air defence agreement on 12 May 1958. In the same year, the Distant Early-Warning (DEW) line was completed with its series of radar detection sites right across the continent from Alaska to Greenland. Two CF-100s from the CEPE at Valcartier participated with the USAF in another venture, far to the south of the DEW-line, in 1960 as part of "Operation Lookout". This was concerned with research into ICBM detection and required the use of aircraft capable of carrying infra-red sensors and operating from restricted airfields — specifically, a strip on Ascension Island in the south Atlantic. During an 11-month period operating from this barren and lonely outpost, the CF-100s, with special equipment in wing-tip pods, flew missions to intercept and track re-entering nose cones from ICBMs launched 5,000 mls (8 000 km) up-range at Cape Canaveral. In a second phase of this work in the spring of 1962, three CF-100s were based at Patrick AFB, Florida, to investigate infra-red emissions from ICBM boosters and sustainer motors during the launch and separation phases.

Included in the production total of Mk 5s already quoted were 53 CF-100s purchased by the US government and supplied to Belgium under the terms of Mutual Aid. This deal followed upon an operational suitability test conducted at Cold Lake and, subsequently, Elgin AFB, Florida, in 1955/56. The entire batch of aircraft was technically taken on strength by the RCAF on 7 October 1957, but written off the books on



(Above) A 1956 illustration of two CF-100 Mk 4Bs in flight. (Below) Almost 20 years later, in May 1975, these Mk 5s were still in service with No 414 Squadron, the CAF's specialised electronic warfare unit. Farthest from the camera in this line-up is a Mk 5C, the other three aircraft being Mk 5Ds.

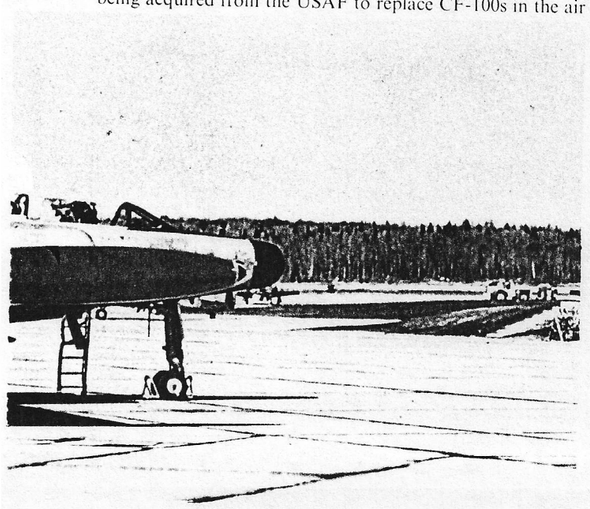




The CF-100 Mk 5 is currently expected to remain in service with No 414 Squadron for ECM duties for several more years. This illustration of No 100785 was taken at Trenton in September 1976.

the same day upon transfer to Belgium. These CF-100s began to reach Belgium in December, entering service with the 350*éme Escadrille* of the 1st All-Weather Fighter Wing, and subsequently equipping the 11*éme* and 349*éme Escadrilles*, also at Beauvechain. These were the only examples of the Avro fighter used outside the RCAF, serving the FAéB until 1963/64, when they were progressively replaced by F-104Gs; a few continued to serve thereafter as target tugs with the *Flight de Remorquage* at Coxyde and at Solenzara in Corsica.

In this same year, 1964, the CF-100 also ceased to rank as a front-line type in the RCAF, having been steadily declining in importance for three years prior to that date. Obsolescence had finally begun to catch up with the Canuck in 1961, the year in which Air Defence Command celebrated its 10th anniversary; four CF-100 squadrons were disbanded in that year, starting in April, and in June the government officially confirmed that McDonnell F-101B Voodoo fighters were being acquired from the USAF to replace CF-100s in the air defence rôle. With the CF-105 Arrow programme having been cancelled in 1953 and 56 Boeing Bomarc -B SAMs (with non-nuclear warheads) purchased in their place, the decision to withdraw the CF-100s was the final blow for both the Avro Canada and Orenda companies, which neither was able to survive. By the beginning of 1962, five ex-CF-100 squadrons — Nos 409, 410, 414, 416 and 425 — were flying Voodoos and by the end of that year CF-104s were rolling off the Canadair production line, ready to replace the "Klunk" in Europe. By March 1963, the four European squadrons were all flying CF-104s and their earlier aircraft had been returned to Canada.



The RCAF now found itself with an abundance of CF-100s that were far from time-expired but for which there seemed to be little operational application. The Canuck had, by this time, become the predominant tool in the RCAF's Electronic Warfare Unit, warranting continuation of the work of 3 (AW) OTU for a little longer: transferred to Bagotville in 1961, it remained active until May 1964, having trained more than 1,000 CF-100 crews by the time it stood down. Almost at the same moment that this event appeared to write *finis* once and for all to the career of the CF-100, the RCAF requested the National Aeronautical Establishment of the NRC to conduct a fatigue study to ascertain how much life remained in the fighter's airframe.

A seven-month fatigue test was undertaken on an ex-squadron aircraft and was continued to destruction. Its result was to show that the previously estimated life of 2,000 flying hours could safely be doubled; and armed with this knowledge the RCAF set about modifying selected CF-100s to serve in reconnaissance, training, EW and other rôles. Of these, electronic warfare proved to be the most important, and in this rôle the CF-100 has soldiered on for another 10 years and has not yet reached the end, current plans calling for its retention until 1978.

The unit operating the aircraft in this mode is 414 (Black Knight) Squadron (this designation replaced EWU — Electronic Warfare Unit — about the mid 'sixties), at CFB North Bay. With a complement of fourteen CF-100 Mk 5C and Mk 5D aircraft and fifteen T-33 A/N Silver Stars, the main rôle of the squadron is to provide electronic counter-measures in the training and exercising of air defence forces. The operations of the squadron extend from Goose Bay, New-

foundland to Comox, British Columbia, and its Canucks can be found anywhere from the Arctic circle and beyond down to the Mexican border.

The work of the squadron allows NORAD crews and commanders to experience potential actions in combat situations so that they will be better prepared to deal with them under actual circumstances. To achieve this end, its CF-100s are crammed full of the latest electronic equipment, such as jammers used to distort and degrade the detection capability of SAGE (semi-automatic ground environment), thus leading Voodoos to false vectors onto false targets. They can also jam the Voodoo's radar so that the image on the radar-scope is obliterated to such an extent that the navigator cannot lock onto his target. The CF-100s also employ such old but reliable ruses as changing routes and altitudes to confuse the defenders and releasing "chaff" from wingtip dispensers.

Writing as Commanding Officer of 414(EW) Squadron in September 1972, Lt Col J H Pocklington had this to say:

"The CF-100, in its present rôle of electronic warfare, is considered throughout NORAD as being one of the finest. We are called upon to conduct operations across the length and breadth of North America. Of course, Canadian aircrew and ground crews have always been known throughout the world as the finest. The crews' ability, a tried and true airframe, dependable serviceability rate and good equipment, have been melded together to provide an ECM squadron with the rôle of training both the ground environment and interceptor aircrews, which is second to none . . . all Canadian squadrons are top notch and are manned by professional officers and men, but one will look far to find a squadron which is more pleased with its capability and expertise than 414."

CF-100s were also used by the RCAF for target-towing, starting in the late 'fifties, when several were equipped for "collision course" target-towing. The towing hook is contained in an extended tail cone with an all over coat of luminous red for safety. The original target-tow paint scheme, a 360 deg band around the forward section and partial rear fuselage coverage, has become the standard CF-100 scheme. By the end of 1973, the inventory of CF-100s in service with the Canadian Armed Forces was down to 42; today, considerably fewer remain, but a surprising number of surviving examples can be found in museums and preserved by various organisations around the country. The Canadian National Aeronautical Collection at Rockliffe houses Mk 4B serial 18434, and the Alberta Museum has a Mk 3A. A Mk 5 is included in Belgium's Royal Museum in Brussels and a Mk 5M serial 18626, mounted on a pylon, is owned by the City of North Bay and is featured in Battle of Britain memorial ceremonies each September. Others are to be found preserved formally or informally at various CAF bases, and a number have become instructional airframes. A substantial number of CF-100s has also been retained in the reserve category, protected by a coat of olive drab preservative and with foil covering their canopies and landing gear.

Privileged visitors to the AMDU Mountainview, a satelite of the base at Trenton, Ontario, can glimpse line upon line of these cocooned Canucks in the dimly-lit hangars and in their imagination may hear ghostly voices: "Charlie section . . . turn left 10 degrees and climb to angels two three . . . lock on! . . . Charlie two, go buster through the gate . . . Charlie, this is Yellow Jack. A kill . . . good shooting". And sometimes during moonlit summer nights and at others when the cold winds bring the arctic snow swirling round the bucketed Martin-Bakers and down the empty nacelles, other voices may be heard . . .

"Gigolo two . . . gigolo two . . . Angel at 35 . . . angel at 35 . . ." "Angel at 35 . . . OK, Cupid".

"Lock on! . . . rockets gone . . . returning to base . . ."

Living with the ghosts of past glories, the Avro CF-100 has achieved its place in history. □

In this illustration, the CF-100 Mk 4B is depicted in three views, with additional side views of the prototype Mk 1 and of the Mk 3.