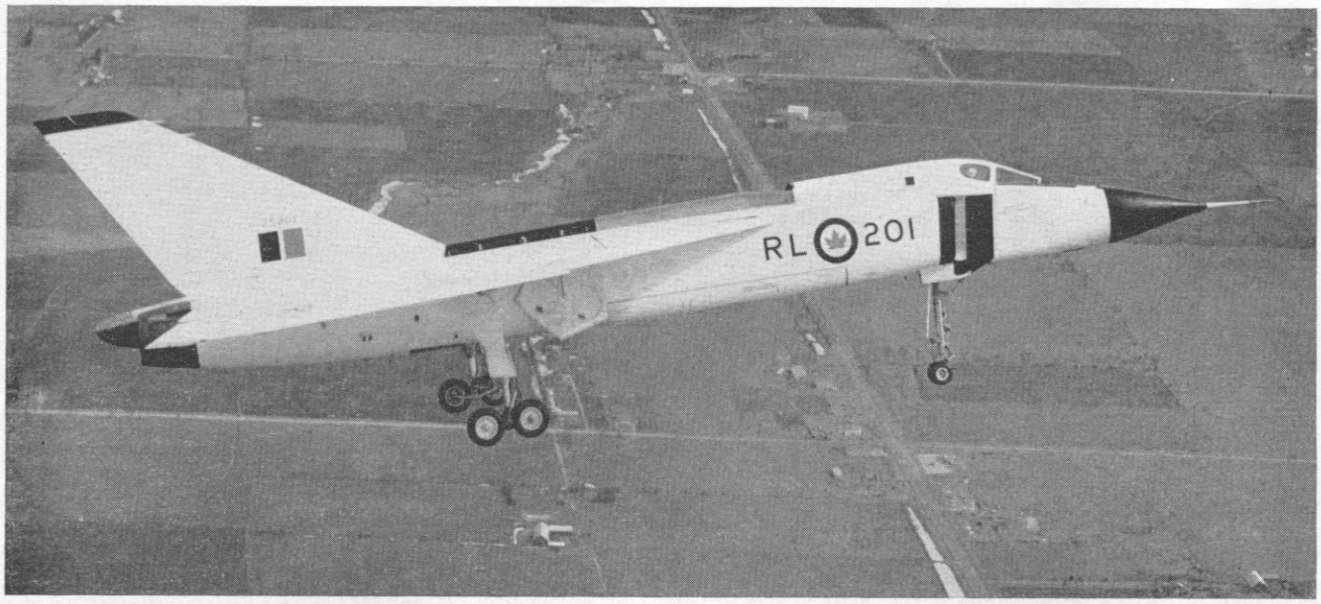


Avro Arrow

by Harry McDougall

First flown in 1958 this Mach 2 Canadian fighter would have ranked with the best today if it had not been scrapped in favour of surface-to-air missiles—which, ironically, had later to be supplemented by McDonnell CF-101 Voodoos

ON 25TH MARCH 1958 Polish-Canadian Jan Zurakowski, a Battle of Britain veteran, hauled back on the control column and lifted the prototype Avro Canada CF-105 Arrow twin-turbojet all-weather fighter off the 11,000-ft. runway at Malton Airport, Toronto, on the start of its maiden flight.

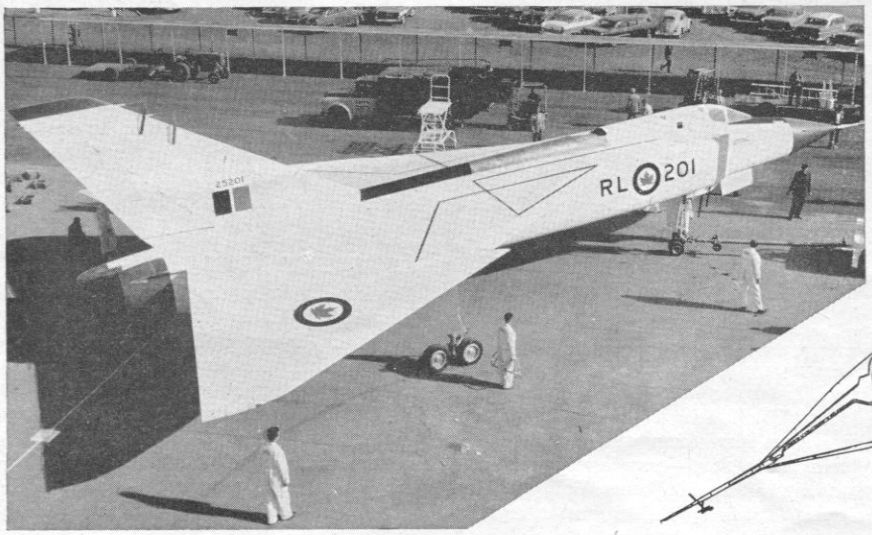
At that time the Arrow was acknowledged to be the most advanced long-range fighter in existence. Designed to fulfil substantially the same role as the Gloster Javelin, it was, however, of an entirely different breed—the first of what promised to be a new generation of supersonic long-range aircraft. The Arrow was intended as a replacement for the CF-100. Its primary role was to be the protection of the Northern Approaches to Canada and the U.S.A. from invasion by Russian bombers.

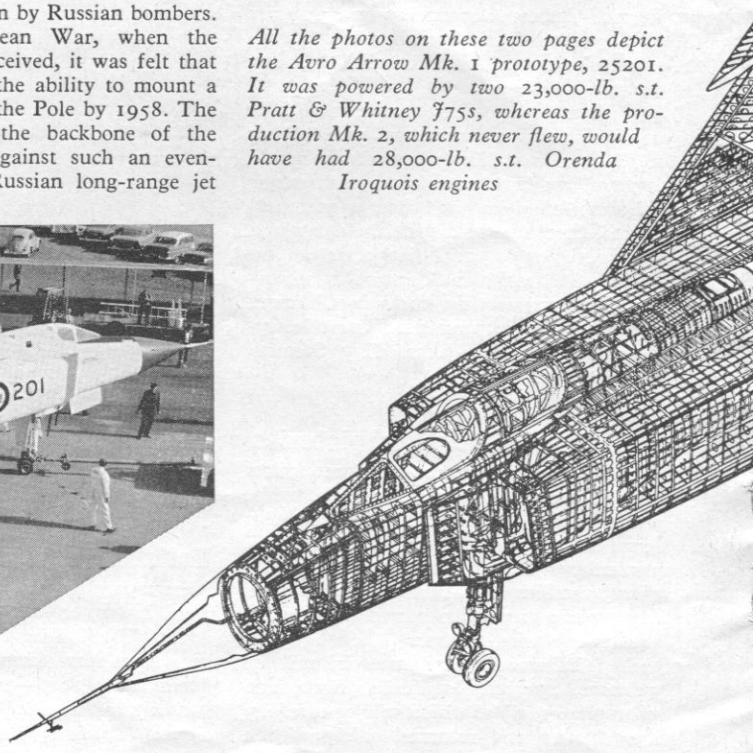
During the Korean War, when the Arrow was first conceived, it was felt that Russia would have the ability to mount a bomber attack over the Pole by 1958. The Arrow was to be the backbone of the Canadian defence against such an eventuality. By 1954, Russian long-range jet bombers and thermo-nuclear bombs had become a reality and work on the Distant Early Warning Line was speeded up. The requirement for an advanced type of fighter aircraft became urgent.

The then unnamed CF-105 was to have an operating radius of 300 miles, a combat ceiling of 60,000 ft. and a maximum speed, at altitude, of Mach 2. Work on the project started in May 1953.

Ground-to-air missiles were at that time in their infancy and the Canadian concept of air defence called for nine regular R.C.A.F. squadrons and ten auxiliary squadrons, with a total requirement of 500-600 aircraft. Subsequently, it was decided that the proposed new aircraft

All the photos on these two pages depict the Avro Arrow Mk. 1 prototype, 25201. It was powered by two 23,000-lb. s.t. Pratt & Whitney J75s, whereas the production Mk. 2, which never flew, would have had 28,000-lb. s.t. Orenda Iroquois engines

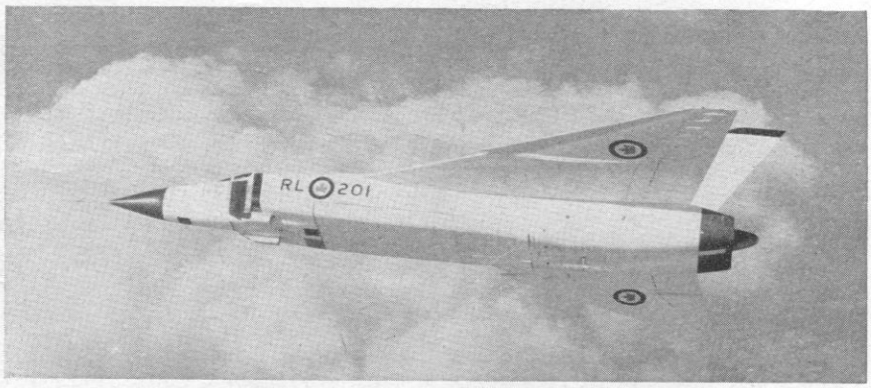




would be too advanced to be flown by the part-time pilots of the Canadian auxiliary squadrons and the requirement was reduced to 150 aircraft.

That several years later the Arrow programme would be cancelled suddenly and that the products of their workmanship were destined only for the scrap heap certainly never occurred to most of the nearly 10,000 designers, technicians and craftsmen who laboured to bring the aircraft to reality. The plane had become more than just an advanced example of modern technology; it symbolised the skill of the post-war Canadian aviation industry and eventually became, in many respects, a prestige symbol for the Canadian people as a whole.

It was significant that the technical excellence of the Arrow was never questioned. Designed specifically as a long-range intercepter, it was to be mated with the Iroquois engine which was being designed at the same time by Orenda Engines Ltd., a company which had started its corporate life as a division of Avro Canada but had then been reorganised as a separate but closely associated organisation. The 28,000-lb. s.t. Iroquois was not available at the time the first Arrows were scheduled for completion. Instead, they used less powerful 23,000-lb. s.t. Pratt & Whitney J75s.



Just discernible is the outline of the large belly pack for Sparrow II missiles, which was designed to drop for firing and then retract immediately

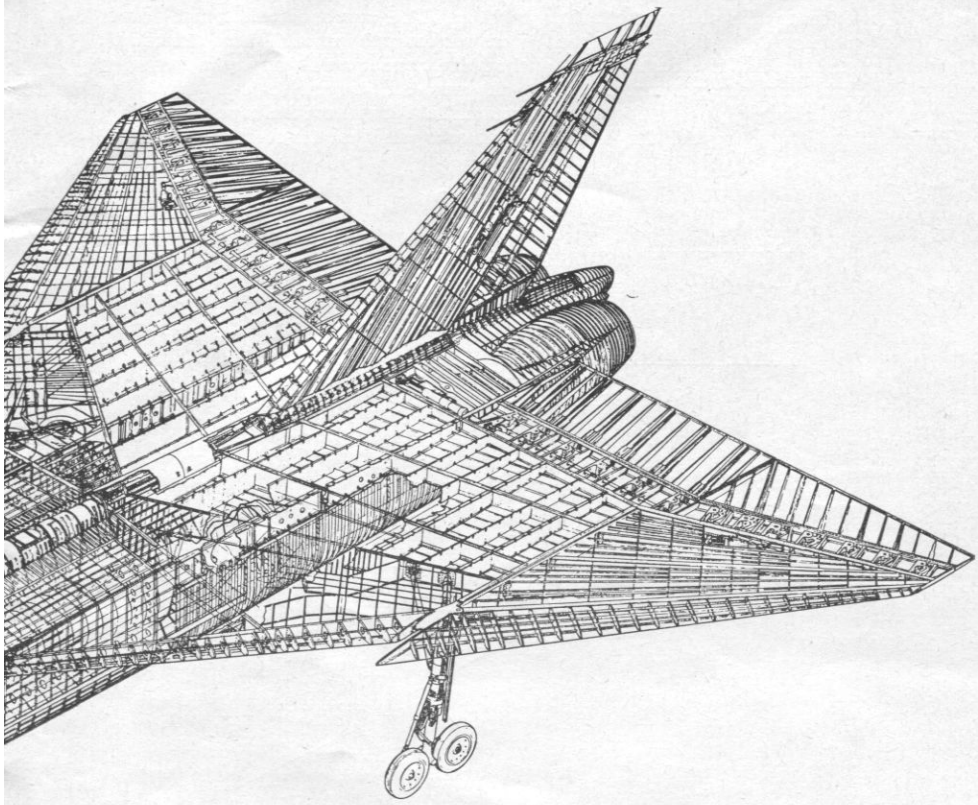
The delta shape of the wing, which probably owed something in inspiration if not in actual technical background to the Avro Vulcan and its test-vehicle predecessors, was heavily swept back. The entire trailing edge of the wing was taken up by flaps and ailerons. Pilot and navigator sat in tandem in a cockpit enclosed by a clam-shell canopy made largely from magnesium alloys.

A great deal of attention was paid to pilot visibility and for several months experiments were carried out with a mock-up of the nose of the aircraft, carrying a pilot and navigator, which sped along the runway on top of a motor lorry. One slight modification which was found necessary to cut out cross-reflections was the addition of a vertical panel between the two halves of the windshield.

The undercarriage, designed and built by Dowty, constituted a major engineering project because of its length and the weight of the aircraft, which was expected to exceed 60,000 lb.

The Arrow was designed from the outset as a missile-carrying aircraft. No other type of armament was ever contemplated.

The fire control system, named the



STRUCTURAL CUTAWAY

Like most aircraft of its type the Arrow was densely packed with equipment, engines, fuel, etc. and its wing loading was therefore high. This, together with the forces imposed on the aircraft during high-speed manoeuvres, necessitated a correspondingly rigid structure, hence the close spacing of the frames and other structural components

Jan Zurakowski, Avro Canada's Chief Experimental Pilot at the time, about to take the prototype Arrow off on its first flight on 25th March 1958

Avro Arrow . . .

Astra I, was under development in the U.S.A. by RCA, acting as prime contractor. Full information on the system was never released, but it was known to embrace search, automatic flight, fire control, navigation and communication functions.

The Sparrow II missiles with which the aircraft was to be armed were to be carried in a belly pack which was approximately the same size as the bomb bay of a Boeing B-29. At the point of firing the belly pack would drop, the missiles would fire, and the pack would retract—all in a rapid, virtually continuous motion. Although the belly packs, armament and fire control systems were never installed in any aircraft they were in an advanced stage of ground testing at the time the programme was cancelled.

From the outset, all tooling was made for production runs and there was never any suggestion of the first aircraft being a "one-off" prototype. One of the techniques used extensively in testing the Arrow configuration was the firing of Nike missiles propelling large-scale models of the aircraft to high altitudes. After separating in much the same manner as a two-stage rocket, the models continued on their way, telemetering information back to the ground. Although this was considered an expensive test programme, it produced very useful results early in the design stages. That the Arrow configuration was the correct one was never in doubt.

Since Avro Canada had no wind-tunnel, extensive use was made of the one at the National Aeronautical Establishment at Ottawa and the NACA tunnels at Langley Field, at Cleveland, and at the Cornell Aeronautical Laboratory.

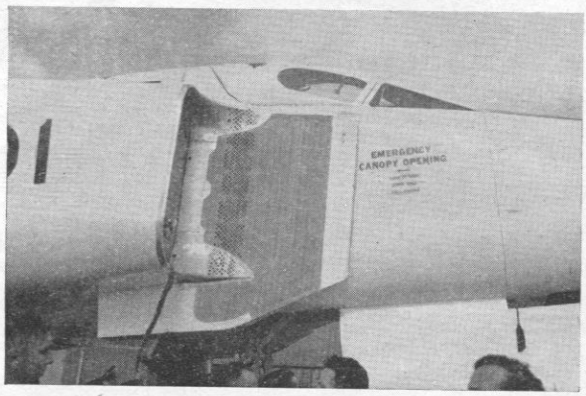
The first take-off of the Arrow had something of the aura of a gladiatorial contest. Unlike its predecessor, the CF-100, which had made its first flight before a comparatively small audience, the Arrow became airborne before the eyes of several thousand people. When the rumour spread through the factory that the plane was ready for flight, the thousands of employees who had spent years designing and building the craft abandoned drawing boards and workbenches and went outside to watch.

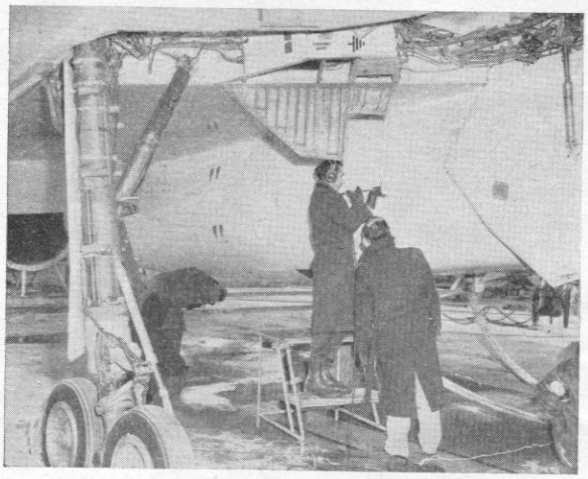
The two chase planes—an R.C.A.F. Sabre and a CF-100 carrying a photographer in the rear seat—circled around to be in position to film the take-off. At 9.55 that morning "Zura" opened the throttle and thirty tons of steel and aluminum headed down the runway. As it lifted, the crowd cheered.

For the first flight, Zura took the Arrow to 10,000 ft. He cruised around, mostly within sight of the airport, for about 35 minutes, without retracting the undercarriage. The approach and touch-down were perfect and with tail-chute streaming the plane came to a halt very quickly.

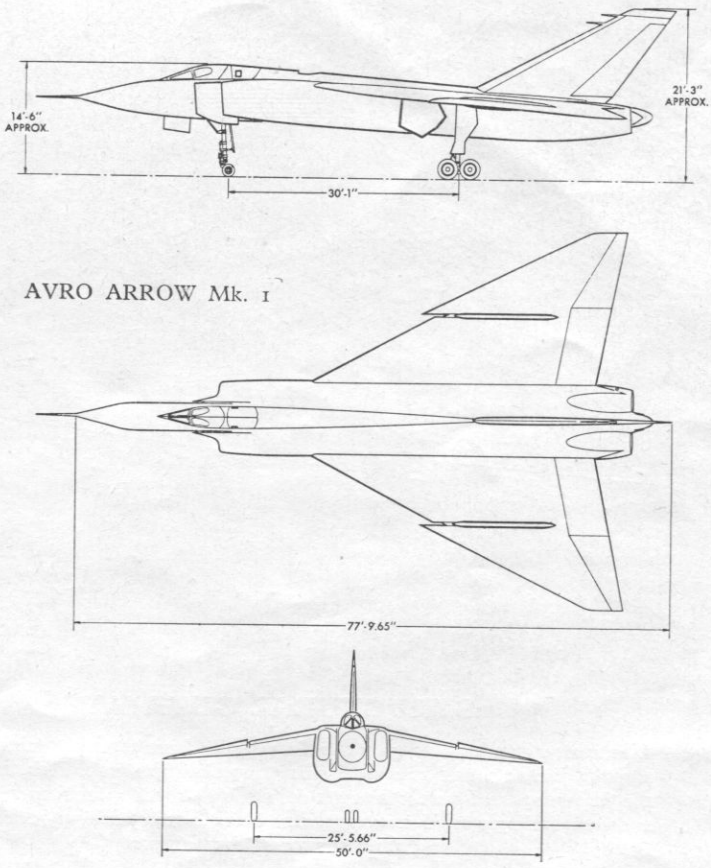
It was an impressive but relatively uneventful début and the tape-recordings of Zurakowski's matter-of-fact comments

To test the Arrow's aerodynamic configuration, scale models of the aircraft were fired to high altitudes by Nike missiles and telemetered information back to the ground



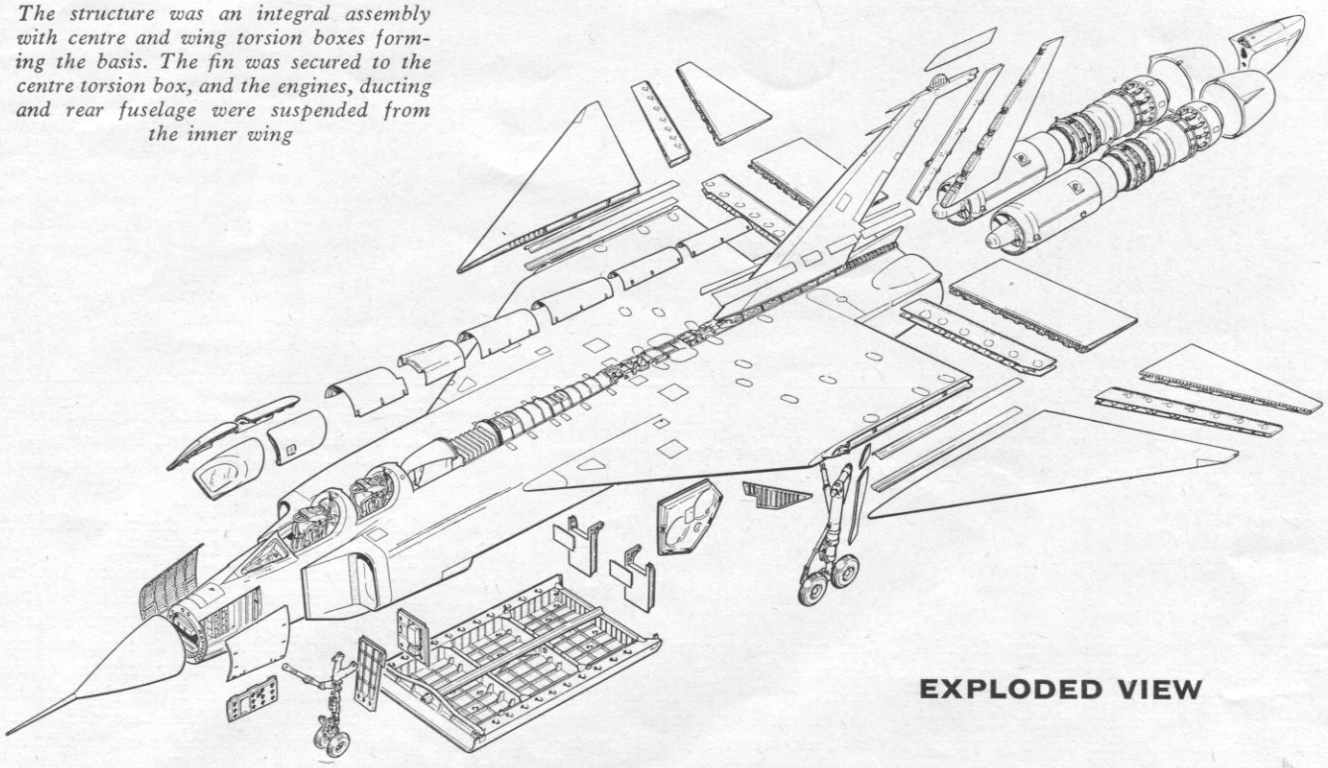


TOP: *Merged into the Arrow's engine air intakes were large slab-like boundary layer divertors which also helped to position the shock wave appropriately at various speeds.* BOTTOM: *Details of the Dowty main undercarriage unit*



AVRO ARROW Mk. 1

The structure was an integral assembly with centre and wing torsion boxes forming the basis. The fin was secured to the centre torsion box, and the engines, ducting and rear fuselage were suspended from the inner wing



EXPLODED VIEW

on the performance of the aircraft made during the flight became a historical document—one of the few tangible mementoes of the event.

After the first flight, the test programme proceeded rapidly. On the seventh flight, less than a month later, during a test run at 50,000 ft., Mach 1.5 was exceeded—equivalent to 1,000 m.p.h.—with the aircraft still in a climb.

The first five Arrows, all powered by J75s, were completed and flown and about sixty hours of flying time accumulated. The sixth aircraft, which was the first to be fitted with Iroquois engines, was completed and moved from the production line to the experimental flight test hangar. Even with the J75s, the performance of the Arrow was excellent, but its true potential could only have been realised with Iroquois engines which would have boosted the aircraft's speed to at least Mach 2.5.

With five aircraft already airborne, the first Iroquois version being readied for flight and several more in various stages of completion, the entire project was suddenly cancelled.

The prime reason advanced by the Government for making the decision was the inability of the Canadian economy to meet the costs involved. However, there is no doubt that there were many other contributing factors.

The Russian leaders had announced that they were discontinuing the production of bombers, and U.S. military planners had expressed doubts whether a requirement for a fighter still existed. They were later to allow the North American F-108 to suffer the same fate as the Arrow and their opinions undoubtedly exerted a strong influence on the Canadian decision.

Ironically, after the Arrow cancellation, a whole new family of Russian long-range bombers made its appearance and when the fighter requirement was revived once more, F-101 Voodoos were imported from the U.S.A. to equip Canadian squadrons.

Was the decision to cancel the Arrow sound? Probably not. So many factors were involved that the true answer will never be known, but it is significant that the U.S., five years later, initiated the design of a new fighter aircraft.

Arrow 1 specification

2 × 23,000-lb. s.t. Pratt & Whitney J75s	
Span	50 ft.
Length (excluding probe)	74 ft. 5 in.
Overall length	83 ft.
Height	21 ft. 3 in.
Wing area (including 390 sq. ft. of fuselage)	1,225 sq. ft.
Operational weight empty	49,040 lb.
Maximum a.u.w.	68,602 lb.
Maximum landing weight	55,000 lb.

The fourth Arrow Mk. 1, 25204, alongside an Avro Canada CF-100, the type it was intended to replace