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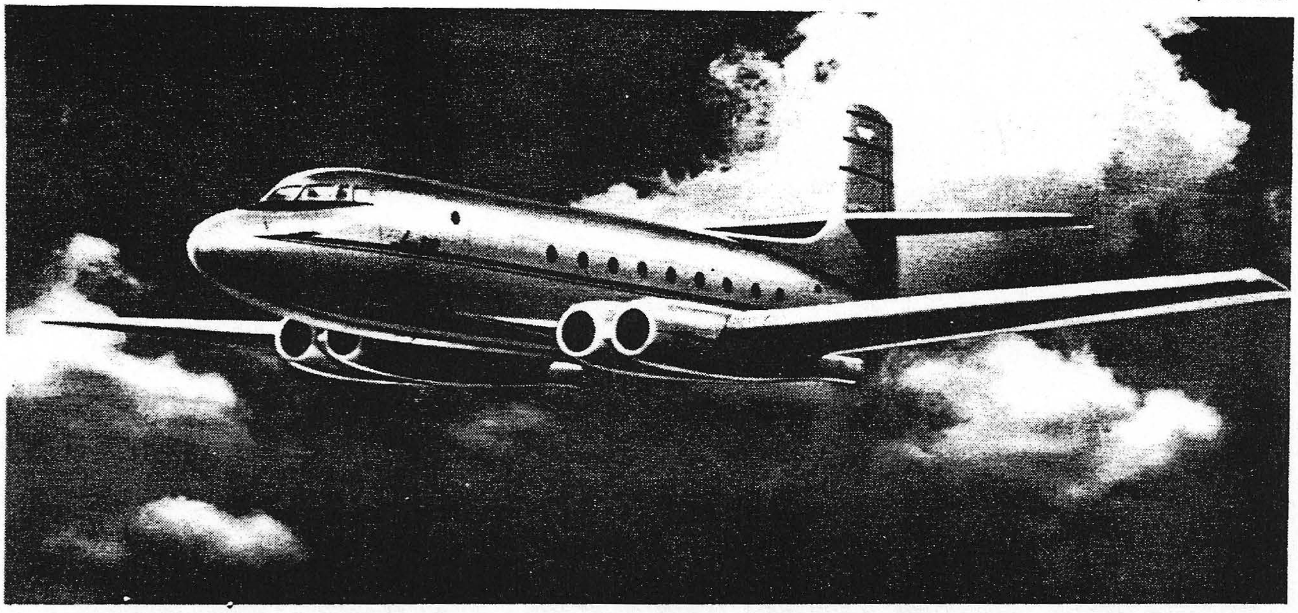


# First Jet Transport: Avro XC-102

## Canada's contribution to high-speed passenger service nearing completion. Designed to seat 40, cruise 430 mph. at 35,000 ft.

In the Avro XC-102 the Dominion . Canada has something brand new in the commercial transport field—a 100-percent-jet-powered design with an economical cruising speed 100 mph. faster than the newest American types. Flying tests of the prototype are scheduled to begin in the spring of 1949

The all-metal craft is an inter-city, short-medium range, low-wing configuration with nose wheel gear, and carries 40 passengers plus crew of three in a pressurized cabin.

Power is supplied by four 3,500-lb. static thrust (dry) Rolls-Royce Derwent V (civil) turbojets giving the 52,500-lb. liner a cruising speed of 430 mph. at 35,000 ft.

A noted American transport technician has said of the XC-102, "Everything that is wanted by an airline for maximum efficiency, combined with definite safety, is incorporated in this design."

Few chances have been taken in installing untried equipment or novel production methods.

▶ **Background**—The Avro Canada XC-102 was originally conceived, according to Chief Designer E. H. Atkin, as "the answer to the airline operators' needs, which, many admit, have not been met even by the most up-to-date of current types."

Drawing-board work was laid down in mid-1946, conforming to specific requirements of Trans-Canada Airlines, with appropriate ranges for domestic routes.

Costs of original layout engineering and planning and the two prototypes now under construction were not undertaken by TCA, but are borne by Canadian government and by Avro Canada.

All design and construction is now centered at 1,000,000-sq.ft. Malton plant, a modern factory area situated on the border of Toronto Airport.

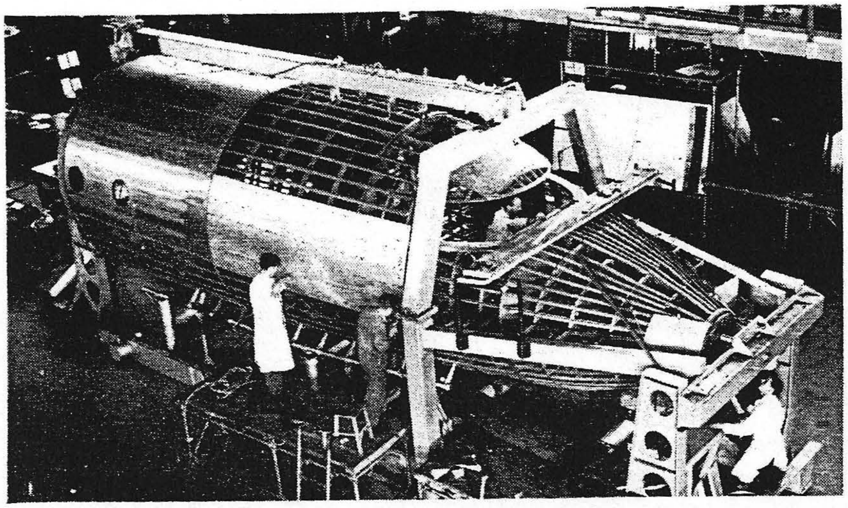
When the XC-102 design was first drawn, the engineers applied much of the British Avro Tudor technique. But as more British technicians were incorporated into the Avro Canada setup, the design progressed quickly and now owes very little to the original British concept.

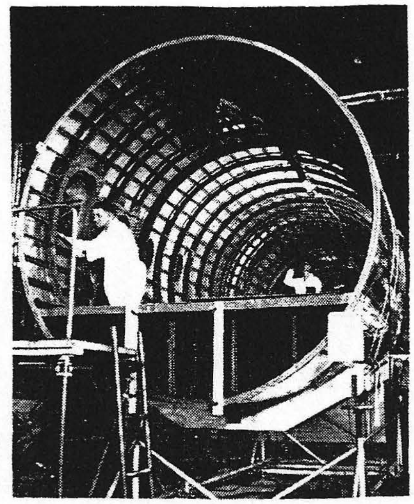
First thoughts were to use two, as then untried, Rolls-Royce Avon axial-flow turbojets, each with 6500-7000 lb. static thrust. To speed up prototype trials the Avon has been dropped temporarily, and the four Rolls-Royce Derwent Vs utilized.

Naturally, the jet nacelle areas are now larger because of twin grouping on each wing, but Avro Canada engineers are not seriously concerned about additional drag.

▶ **Key Personnel**—When the first prototype flies next February, Chief Test Pilot D. H. Rogers, a Canadian, will be at the controls. He is scheduled to go to the Avro plant of the Hawker-Sid-

> **Editor's Note:** The accompanying article is the first detailed report on the world's first airplane designed from the start as a turbojet transport and actually under construction.





Avro XC-102 nose section (left) and rear center fuselage section reveal strength of structure required for high cabin pressurization.

deley Group, at Woodford, Lancashire, to gain multi-jet transport experience by flying the Avro Tudor 8, powered by four Rolls-Royce Nene turbojets. This craft is for research only.

Since design was started just over two years ago, fewer than 80 designers, engineers and technicians have worked on the XC-102. Key man is the Airplane Division's British-born chief designer Atkin, who was assistant to the late Roy Chadwick. Together they worked on the Manchester and Lancaster bombers, the York and Tudor transports.

Number two man is another Britisher, J. C. Floyd, assistant chief designer, who is highly confident of the success of the XC-102 but is non-committal regarding expected performance.

Looking after turbojet problems is P. B. Dilworth, chief engineer and manager of the Gas Turbine Design Division, a Canadian who previously worked with the National Research Council in Canada (1939-42) and Great Britain (1943-44). Before joining Avro Canada, he was officer-in-charge of the Cold Test Section (1944-46) taken over from the NRC by Turbo Research Ltd.

Three men primarily responsible for the green light are British Sir Roy H. Dobson, president of Avro Canada; Canadian Walter N. Deisher, vice-president and general manager (recently general manager of Fleets); and Canadian Fred T. Smye, assistant general manager.

Avro Canada is not working under parent name Avro Manchester (England) but is a self-supporting unit of the Hawker-Siddeley Group. As a small compact team, it is very conscious of its role in the future world market for jet transports.

If expectations are realized, the C-102 will be widely sought after. Quiet flying is the desire of air travelers weary of excessive cabin noise and enervating vibration of the contemporary piston engine passenger transport.

### Descriptive Data

Although declining to give extensive data on the XC-102 until it has flown, nevertheless Avro Canada did permit release of basic details on the full-scale mock-up and the two prototypes under construction. This allows sufficient scope for close approximation of various factors, including some dimensions, weights, and performance data.

▶ **Fuselage**—Length of this structure is 82½ ft. It utilizes a conventional circular cross-section similar to the British Tudor series, and is air-conditioned and fully pressurized.

Special attention has been given to air conditioning in view of the extreme temperature range existing in Canada. Because of the limited size of the XC-102, the single-cylinder cross-section has been found practical, simplifying many problems associated with pressurization.

Fuselage skin is 24ST aluminum alloy, with flush riveting throughout. Extrusions are supplied by Aluminum Company of Canada. Frames and bulkheads are fabricated of 75ST sheet. First two sets of frames came from England to speed up production but later models will be built with all Canadian processed parts.

▶ **Main Components**—The four major fuselage sections are: (1) Nose, embodying the step-down cockpit and nosewheel gear installation, (2) pressurization-gear, baggage and mail compartments, and forward entry hatch (port), (3) 40-seat passenger compartment and rear entry hatch (port), and (4) tail section, housing the rear baggage compartment and entry hatch (starboard). Combined areas of front and rear baggage compartments total just under 300 sq. ft.

▶ **Cockpit Details**—Crew will consist of pilot; copilot, handling radio and radar equipment; and stewardess. A spare seat is situated behind copilot's for use of a trainee.

Instrument grouping is simple and follows standard practice. All instrumentation is being obtained from the States.

Wire-sandwich glass is being tried for anti-icing on the windshield, usin an a.c. system with a power range 4-8kw.

Some electrical equipment is duplicated to minimize localized transmission failures.

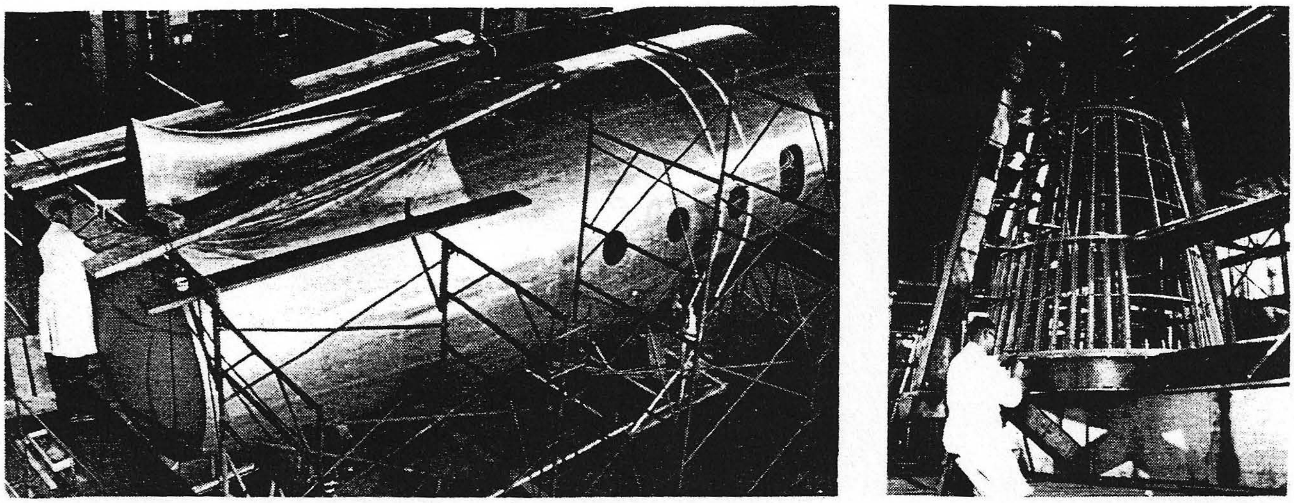
▶ **Passenger Accommodations**—A central aisle divides the compartment into twin lines of 20 seats. All except the first four seats face forward, although this is not necessarily standard. As a 36-seat transport, these forward seats would be removed.

Small-diameter, double-thickness, porthole-type windows are used because larger, square windows would complicate pressurization and design factors.

Cabin accessories will be of Canadian manufacture, and seats will be produced in the Malton plant.

Behind the rear twin seats on the portside, and forward of the rear entry door, is a lighting, pressure, and temperature panel for use by the stewardess. To the rear of this door is the galley, powder room, and usual effects.

▶ **Pressurization**—Immediate inspection is possible by concentrating all cabin



Exterior view of rear center fuselage (left) shows pressure dome at end. Right: Rear section, with spars for lower portion of fin.

refrigeration, smoke clearance and pressurization gear in the forward compartment (behind cockpit), in contrast to other designs where passenger compartment ancillary units have been placed under the cabin floor resulting in additional maintenance problems and complexities.

British Normalair pressurization equipment, in conjunction with the standard Godfrey Brothers blower, exerts a maximum pressure of 8.3 psi., but the cabin can be safely subjected to 10 psi.

Pressurization tests were based extensively on the Hawker-Siddeley Group trials with such types as the Tudor series. The XC-102 high pressure differential range is as follows (at 8.3 psi.): Sea-level conditions at 21,500 ft. operating altitude; 2000 ft. conditions at 25,000 ft.; 4000/ft. at 30,000 ft.; and 6000 ft. at 35,000 ft.

A special distribution technique will be employed which will give "warm wall" heating to the cabin.

▶ **Wing**—With total span of 98 ft., the flush-riveted wing is produced on the orthodox two-spar principle but with the difference that the closely spaced stringers in conjunction with the tapered-thickness skin (0.125 in. at root tapering to 0.040 in. at tip) are designed to take care of torsional rigidity.

This is especially important because of the high gust factor associated with low wing loadings and high speeds.

Airfoil is an NACA symmetrical section (maximum thickness about 30 percent from leading edge) and no attempt has been made to reduce the thickness to gain additional speed. (Example is the British Armstrong-Whitworth A.W.52.) Dihedral starts 6 in. outboard of the jet nacelles.

Wing root fillets are unusual. The fuselage-to-wing leading edge is shaped to cope with wing root upwash and consequent "juddering." The trailing edge root is equally prominent.

Ordinary split flaps are incorporated.

Integral fuel tanks totalling 3000 U. S. gal. are built into the wing inboard and outboard of the jet engines. If integral tanks prove unsatisfactory there is provision to accommodate collapsible bag tanks.

The empennage is a flush-riveted cantilever structure of simple design and conventional construction. Tailplane span is 37 ft.

▶ **Wing Anti-icing**—Rubber boot thermal anti-icing is incorporated in the wing leading edge. Developed by Goodrich in conjunction with NACA's Cleveland Lab, it has been reported that this thin wire heating has not, in the past, proved completely successful, but Avro Canada thinks it to be the answer to their bad weather problems.

▶ **Power Plants** — The four 3500-lb.-static-thrust, British-built, civil Derwent Vs, used because the Rolls-Royce Avon axial turbojets would not be in production by the time Avro Canada projected any scale production program, has refinements for safety operation. These include bleed valve and automatic shutoff cocks to prevent possibility of internal vaporization explosion, which has been responsible for a number of mishaps recently.

Power units are mounted side-by-side in a housing and attached under the main spars. The entire nacelle is fireproof, and the firewall is equipped with extinguisher fluid entrances.

No appreciable sound is expected in the cabin from the jet units because the tailcone is away from the fuselage by a good margin.

Even if the overall weight of the craft is increased, it may be offset by greater thrust from the Derwents because civil development of the engine is still continuing and the manufacturers hope to increase its power.

A new axial-flow turbojet, the Avro Canada T.R. 5 Orenda, may be used in the future, but at least a year is needed in development.

At present Avro Canada does not favor the turboprop as a power unit, one of the chief reasons, apart from operation, being the factors of propeller noise and engine vibration.

▶ **Landing Gear**—One important feature of the XC-102 design is the very light undercarriage, consisting of twin-tire main and nose gear designed by Dowty in England. Lightness is obtained by short-length oleo units. Main wheel attachments are to the rear spar, the wheels retracting forward to fit in between the twin nacelles. Hydraulic actuation is used.

Popular query of airplane pilots is length of takeoff run. Because the XC-102 is lightly loaded (overall weight of 52,500 lb. for a payload of more than 12,500 lb.), its takeoff run of under 4000 ft. compares favorably with contemporary transports.

With 1,000,000 sq. ft. of production space available, the Malton plant employs under 2000 persons (9000 employed building Avro Lancaster bombers during last war). With these facilities, combined with the projected first flight early in 1949 , it looks as if Canada will beat both Britain and the U. S. in the pure jet transport field.

# SYSTEMS

### FUEL SYSTEM

Fuel is carried in four integral wing tanks located in the outer mainplanes between the spars.

Each group of two engines has its independent fuel system. Fuel from any tank, however, can be delivered to any engine.

Engines are fed normally from inboard tanks with a total capacity of 1,375 imperial gallons. Fuel from outboard tanks of 1,025 Imperial gallons total capacity is transferred into inboard tanks continuously at a controlled rate, thus relieving the pilot from the necessity of manual selection of tanks. If required, engines can also be fed directly from the outboard tanks by means of by-pass valves.

Booster pumps located in each tank deliver fuel free of vapour and air to the engines at a steady pressure of 6 to 8 lb/sq. in. at any operational altitude. The engines can, however, function with the booster pumps inoperative. A signal light system permits the pilot to check instantaneously the operational conditions of the fuel system on a diagram located at the top of the central instrument panel.

Capacitor type fuel gauges indicate the quantity of fuel in the tanks to within 2%. Any appreciable difference in weight of fuel carried on either side of the aircraft is indicated by a warning light, which enables pilot to correct the trim of the aircraft by manual selection of tanks.

The tanks can be refueled through underwing connectors (one on each side of the aircraft), at the rate of 200 Imp. g p m through each connector. Selector valves integral with the underwing connectors permit fueling or defueling of each tank individually.

### HYDRAULIC SYSTEM

This is a high pressure system operating at a normal pressure of 1,800 lb/sq. in. Cut-out pressure is 2,200 lb. ± 200 lb, and the relief valve pressure is 2,700 lb ± 100 lb. Power is provided by two constant pressure variable displacement engine-driven pumps providing duplication against failure. In addition, an electrically driven hydraulic power pack is provided for emergency, in the event of failure of the main system.

The following components are operated hydraulically by the main system:

(a) Undercarriage
(b) Brakes
(c) Nosewheel Steering Gear
(d) Landing Flaps
(e) Dive Flaps
(f) Aileron Power Booster

In addition, the more important of the above services may be operated by the emergency system as follows:

Undercarriage:

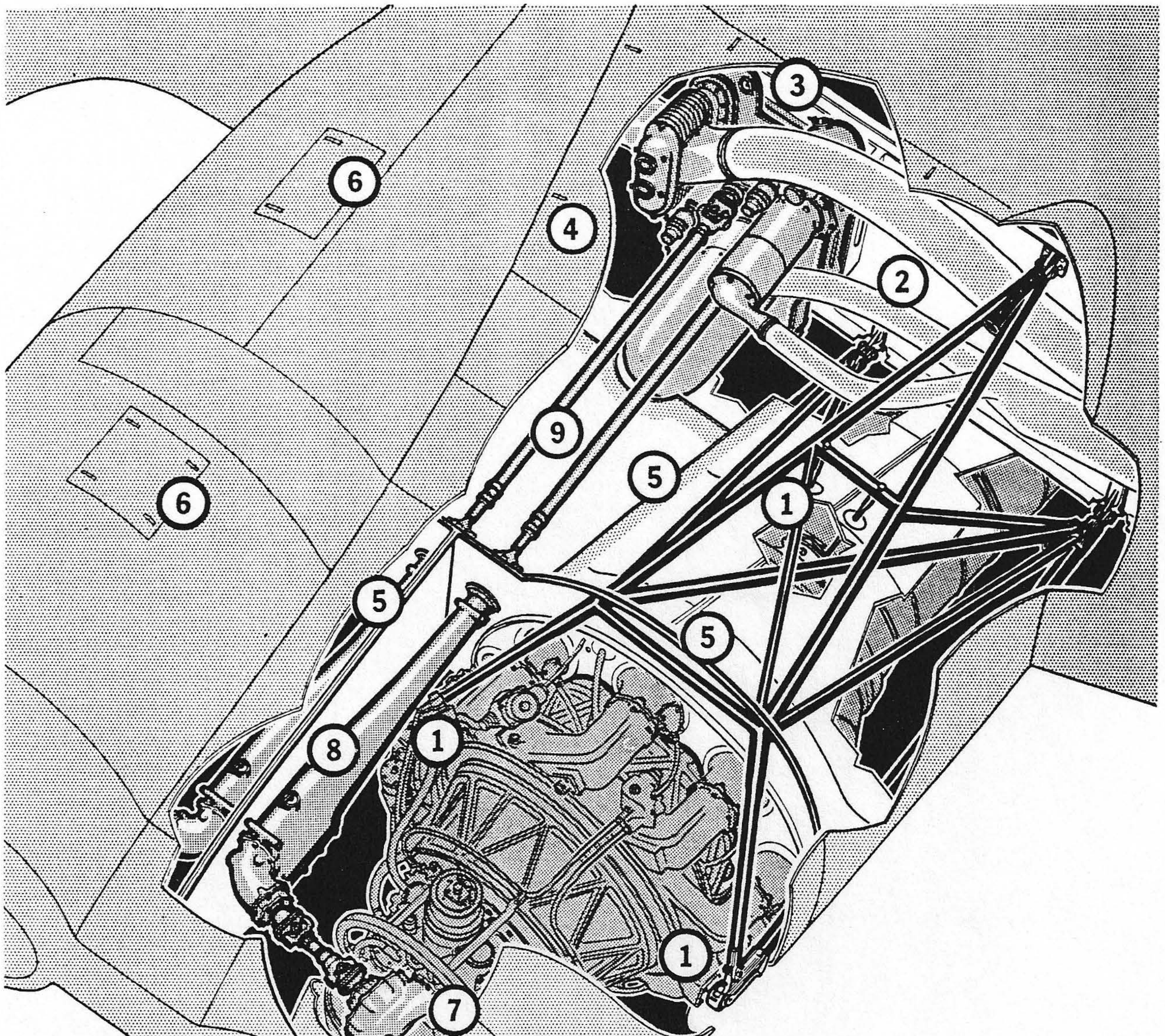
The undercarriage can be extended for landing by operation of a switch located adjacent to the main undercarriage control on the pedestal.

Brakes:

No action is required by the pilot other than operating the brakes in the normal manner to provide full emergency braking. Complete hydraulic duplication is provided.

Fig. X
Engine Installation






1 ENGINE MOUNTING ASSEMBLY POINTS
2 CENTRE SECTION FRONT SPAR
3 ACCESSORIES GEAR BOX
4 ACCESS PANEL
5 FIREPROOF BULKHEADS
6 ACCESS PANELS FOR LOWERING ENGINE
7 BEVEL GEAR DRIVE HOUSING
8 INTERMEDIATE DRIVE HOUSING
9 INPUT DRIVE SHAFT

**FIG. 6 POWER PLANTS**