JULY/1953

THE AVRO UK Co TAKE
A LOOK HOW THEY WOULD
GO V.T.O.L.

AN APPRAISAL OF TWO VERTICAL TAKE-OFF INTERCEPTORS

INTRODUCTION

This report has been prepared to give an independent and unbiased assessment of the technical merits of the A.V.Roe Canada Ltd., Project 'Y' vertical take-off aircraft. The AVRO CANADA proposal is the design of an aircraft in which the engine and aircraft structure are integrated so as to give a low aircraft weight per lb. of thrust and a low drag per square foot of frontal area, making vertical take-off and supersonic flight possible. The design is based on a new type of engine which is wholly enclosed in the airframe envelope and is a radial flow gas turbine. This engine is a gas turbine of the type we now know of with its axis at right angles instead of in line with the plane of flight.

The engine therefore becomes a large diameter, relatively thin rotor carrying the compressor and turbine blades, and the annular combustion chamber, while the compressor and turbine stators are fixed to the aircraft structure. The engine is double sided, that is a complete compressor and combustion system on the top and bottom with the rotor structure in between. The hole formed in the centre of the aircraft is used for accommodating the pilot etc., and for feeding the air into the compressor.

The reports issued, by AVRO CANADA on Project 'Y', have been analysed and detail checks have been made of some of the more important aspects of the design such as stability, weight and drag. Amendments have been made to the design in the light of these checks and also to make the aircraft an operational fighter instead of the research aircraft originally proposed. Section 1 of this report contains details and an appraisal of this fighter.

The performance and requirements of the aircraft given in Section 1 together with engines of contemporary design and at the same stage of development as the AVRO CANADA Radial Flow engine, have been used to design a comparable fighter. This design and its technical details are given in Section 2.

Section 3 contains a comparison of the two designs, particularly the features claimed by AVRO CANADA as "selling points" of their aircraft.

Only one important comparison of the two designs has been omitted, that of the cost, simplicity and ease of production, as the writers are not competent to deal with these points fully.

PROJECT 'Y'

1. Introduction.

Project 'Y' is an aircraft proposed by A.V. ROE CANADA LIMITED powered by a radial flow gas turbine. The engine and airframe are closely integrated, the airframe being an envelope around the engine. This gives a plan form of the "wing" which is roughly circular. Due to the high thrust/weight ratio vertical take-off and landing are possible.

Since the inception of the idea in a paper "Proposal for a Gas Turbine Propelled Aircraft of Circular planform" by J.C.M. Frost and T.D. Earl in April, 1952, a brochure and numerous reports have been prepared giving details of the aircraft. The description that follows is therefore brief, serving only to familiarise one with the design.

2. Design Description.

Fig. 1 shows a general arrangement of the aircraft.

The aircraft is built around a radial flow double-sided gas turbine. Air intakes are positioned on the top and bottom surfaces of the wing and feed air into the centre of the disc, the air then flows radially outwards through the compressor, combustion and turbine stages. Over the forward portion of the wing the exhaust from the turbine emerging at the periphery of the engine is collected and expanded in nozzles to atmosphere, the nozzles facing aft at decreasing angles to the line of flight. The exhaust from the back (2/5 THS) of the rotor is exhausted between split controls placed at the trailing edge.

The pilot is seated in a cockpit placed in the centre of the aircraft and has a view forwards through a conventional canopy and downwards through an inverted canopy. Fairings which are continuations of the canopies house the four point landing gear.

The structure of the wing is built around the engine and is composed of radial ribs and the thickness of structure is used as integral tanks.

Twin fins and rudders are fitted to the wing tips in the jet stream. Two Blue Jay missiles are carried externally.

PROJECT 'Y'

3. Performance Data.

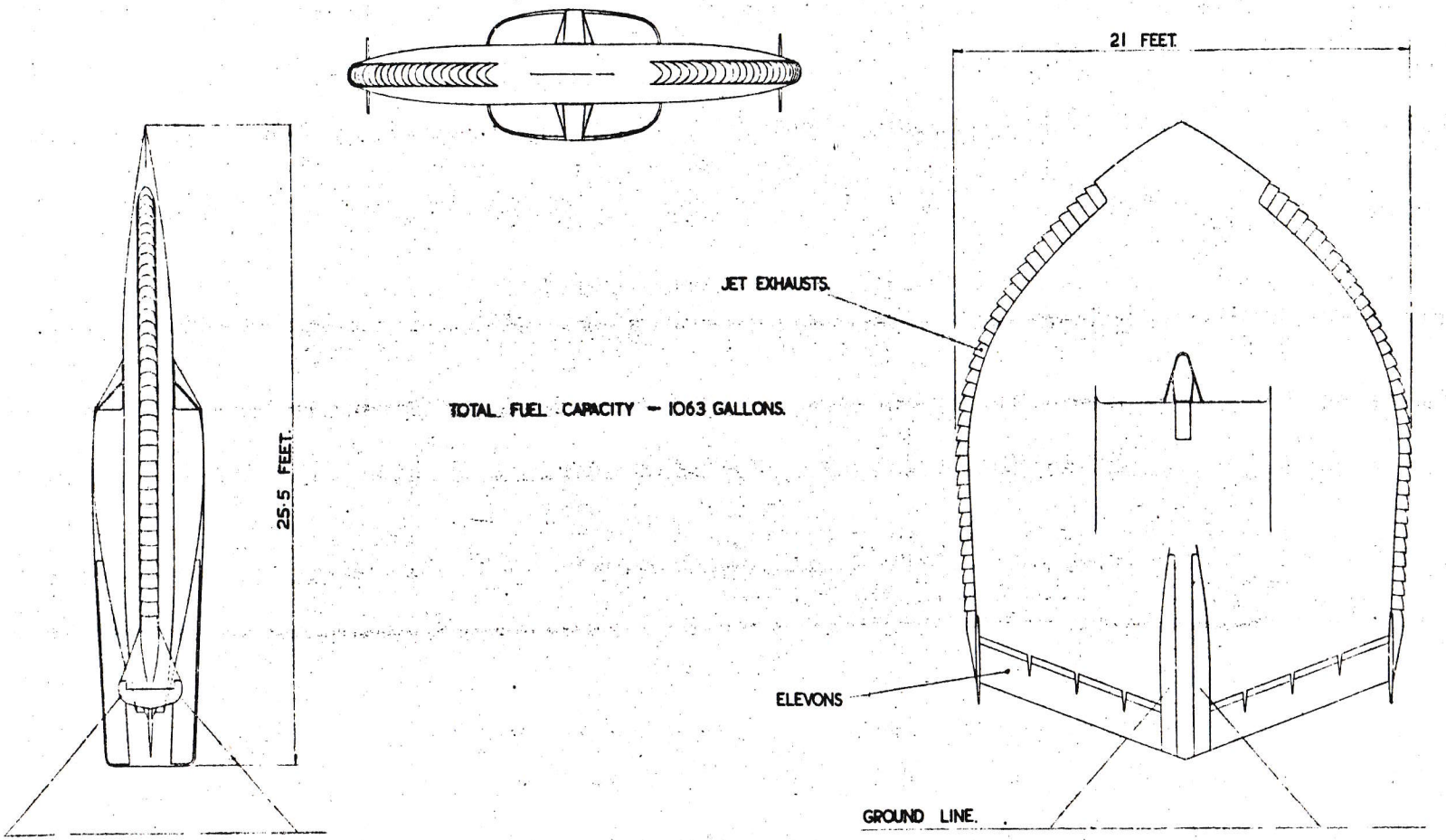
3.1. LEADING PARTICULARS

OVERALL DIMENSIONS

LENGTH	FT.	25.6
SPAN	FT.	21.0
HEIGHT	FT.	5.08

MAINPLANE

GROSS AREA	FT^2	380.0
SPAN	FT.	21.0
ASPECT RATIO		1.16
MEAN GEOMETRIC	t/c	11.8%
- EFFECTIVE	t/c	10%
ROOT CHORD	FT.	23.85
TIP CHORD	FT.	12.2
TAPER RATIO		0.51
MEAN LEADING EDGE SWEEP	DEG.	35
DIHEDRAL	DEG.	0



SECTION I.
FIG. I.

PROJECT 'Y.'

GENERAL ARRANGEMENT

AVRO 724.

1. Introduction

The type designation AVRO 724 has been used to cover the design of an aircraft having a comparable performance to Project 'Y' and the same operational requirements and military load.

An endeavour has been made to make the design conventional and available in the same time scale as Project 'Y'. The engines used are the Rolls Royce RB.106 axial flow gas turbines which are in the same state of development as the AVRO CANADA radial flow engine.

This section contains the designs of a twin engined and a single engine aircraft. The twin engine aircraft has been examined in detail as it was appreciated that the weight per lb. of thrust of the single engine aircraft could never be as low as the twin engined aircraft, due to a fixed weight of pilot, equipment and armament. A drawing of the single engine aircraft has been included to show the form it would take.

The cost of the single engine aircraft would obviously be less than the twin engined aircraft but as previously stated we are not concerned with the relative costs of the aircraft.

2. Design Description

2.1. Twin Engined Aircraft.

The AVRO 724 is a tailless delta powered by two Rolls-Royce axial flow R.B.106 engines of 15,000 lb. S.L. static thrust without reheat and 21,800 lb. S.L. S.T. with reheat to 2,000°K. A general arrangement drawing is shown on Fig.1. The engines are in a paired underslung nacelle beneath the wing at the aircraft centre line. The engines are angled outward at the front and a small body is fitted between the engines, this body divides the intakes. The intakes are fitted with flaps just inside the lips to enable the intake size to be varied according to the forward speed of the aircraft.

The small body is fitted with a prone pilot position and optically flat surfaces are blended into the contour. The aircraft radio, radar and equipment is carried in this pressurised body and a small forward viewing search radar is fitted in the nose. The pressurisation will be obtained by tapping off air from the engines and the services will be electrical or stored air.

The wing is of cropped delta planform with 60° sweep on the leading edge and 4% thick. A moderately low aspect ratio of 1.54 has been chosen to give a fairly low induced drag subsonically yet keeping the wave drag reasonable. The delta planform provides a stiff structure at a thickness/ chord ratio of 4% without undue weight penalty.

Control is by means of elevons at the trailing edge and for low speed, control deflectors in the jet pipe are used. In order to give a rolling moment at low speeds air is tapped off the engine and exhausted through outlets at the wing tips. A single fin and rudder is fitted of conventional form and carries a fairing at the tip which houses one of the shock absorber units which the aircraft stands on. Small fillets on the undersurface of the wing either side of the engines accommodate the other two legs of the tripod standing gear.

The aircraft structure has been assumed to be light alloy since at M = 2 (approximate top speed) the effects of aerodynamic heating on the strength should be slight. The wing structure comprises of a front spar at 12% of the chord and a rear spar at 80% of the chord, the leading edge is a 'D' shaped box fitted to the front spar as a unit and the rear spar carries the elevon hinges. Continuous tip to tip shear webs are placed at right angles to the line of flight and pitched at approx. 2 ft. intervals. Four canted ribs are fitted one at the inboard and outboard of each engine, these ribs are broken at the junctions of the shear webs. The skin covering is a sandwich of corrugated plate running spanwise with a top and bottom skin. The whole of the wing from the leading edge to the rear shear web is built as an integral tank.

External ribs matching up with those in the wing are used for mounting the engines. The fairing between the inboard ribs of each engine forms another fuel tank.

The inboard ribs and the external ribs end at the front of the engine compressor casing and mounted onto these ribs is the rear bulkhead of the forward body.

Provision is made to carry one Blue Jay missile externally at each wing tip.

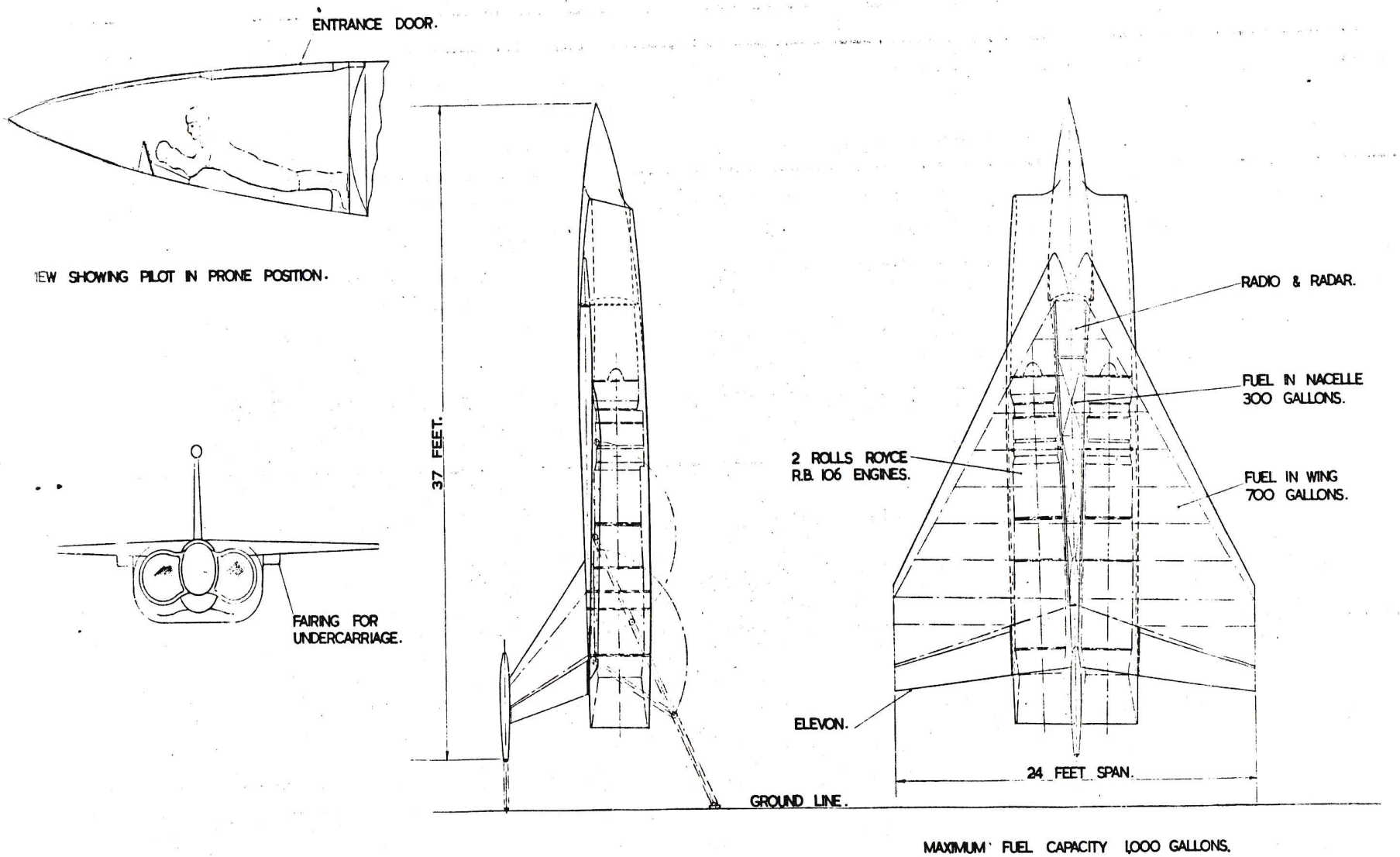
2.2. Single Engine Aircraft

The layout of this aircraft is shown on Fig.2 and utilises one Rolls Royce RB.106 engine. The engine is placed above the wing with the crew compartment forming the bottom of the intake. The wing area has been reduced to give a comparable wing loading to the twin engined aircraft. The structure and arrangement of the pilots position, equipment and controls is on similar lines to the twin engined aircraft.

3. Performance Data

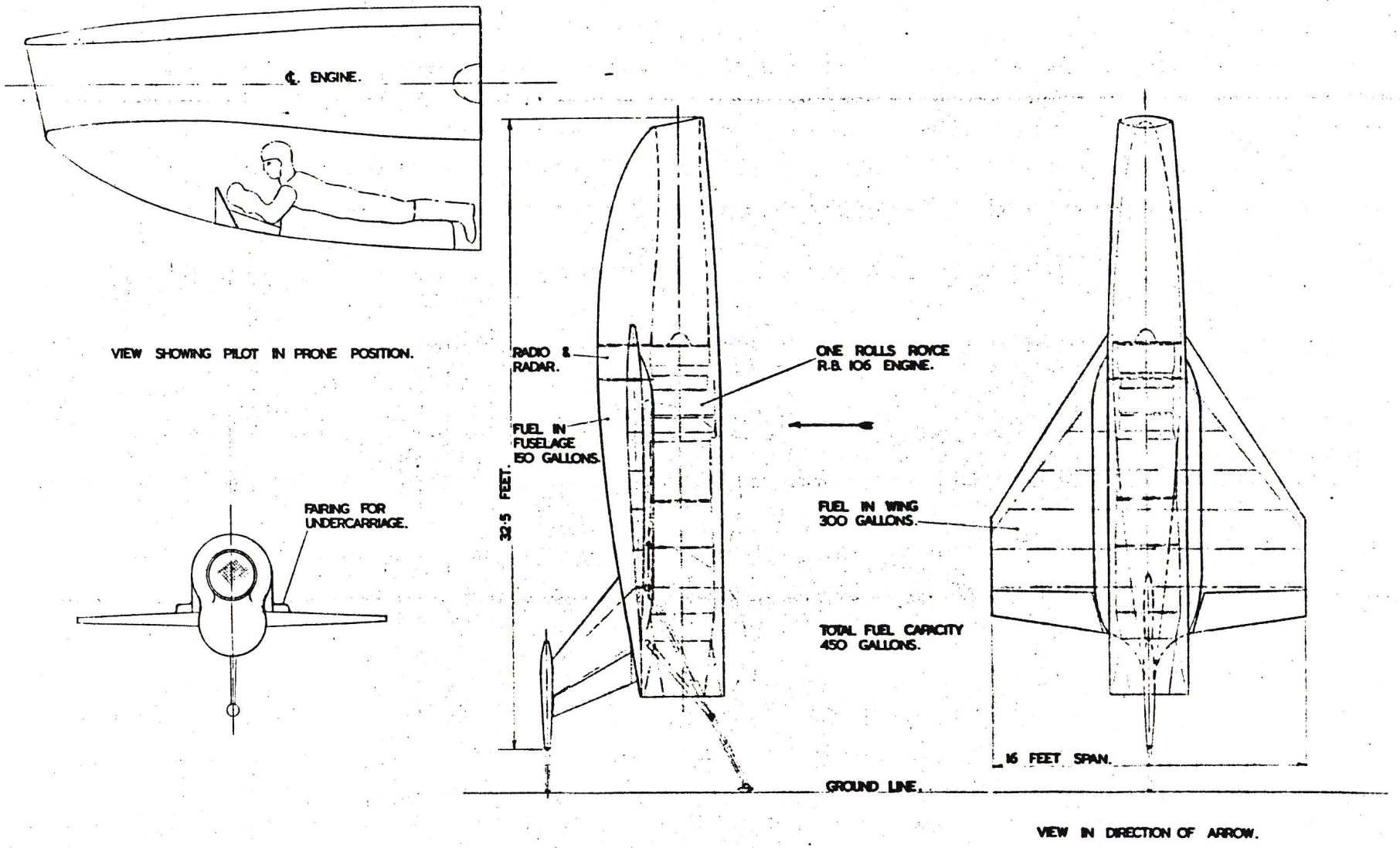
3.1. Leading Particulars

		Twin Engined Aircraft	Single Engined Aircraft
Overall Dimensions			
Length	ft.	37	32.5
Span	ft.	24	16
Fuselage & Nacelle			
Length	ft.	35.5	30
Maximum width	ft.	8.75	4.1
Maximum depth	ft.	4.5	6.25
Main plane			
Gross area	$ft.^2$	375	192
Span	ft.	24	16
Aspect ratio		1.53	1.33
T/C at centre line		4%	5%
T/C at tip		4%	5%
Root chord	ft.	25.25	19
Tip chord	ft.	6	5
Length of S.M.C.	ft.	15.65	12
Dihedral	deg.	0	0
Sweepback of ¼ chord	deg.	53	49
Fin & Rudder			
Net area	$ft.^2$	26	13.5
Span	ft.	5.2	4
Aspect ratio		1.04	1.18
T/C		8%	8%



RO 724.

GENERAL ARRANGEMENT - TWIN ENGINED AIRCRAFT.



AVRO 724.

GENERAL ARRANGEMENT - SINGLE ENGINED AIRCRAFT.