Proposal

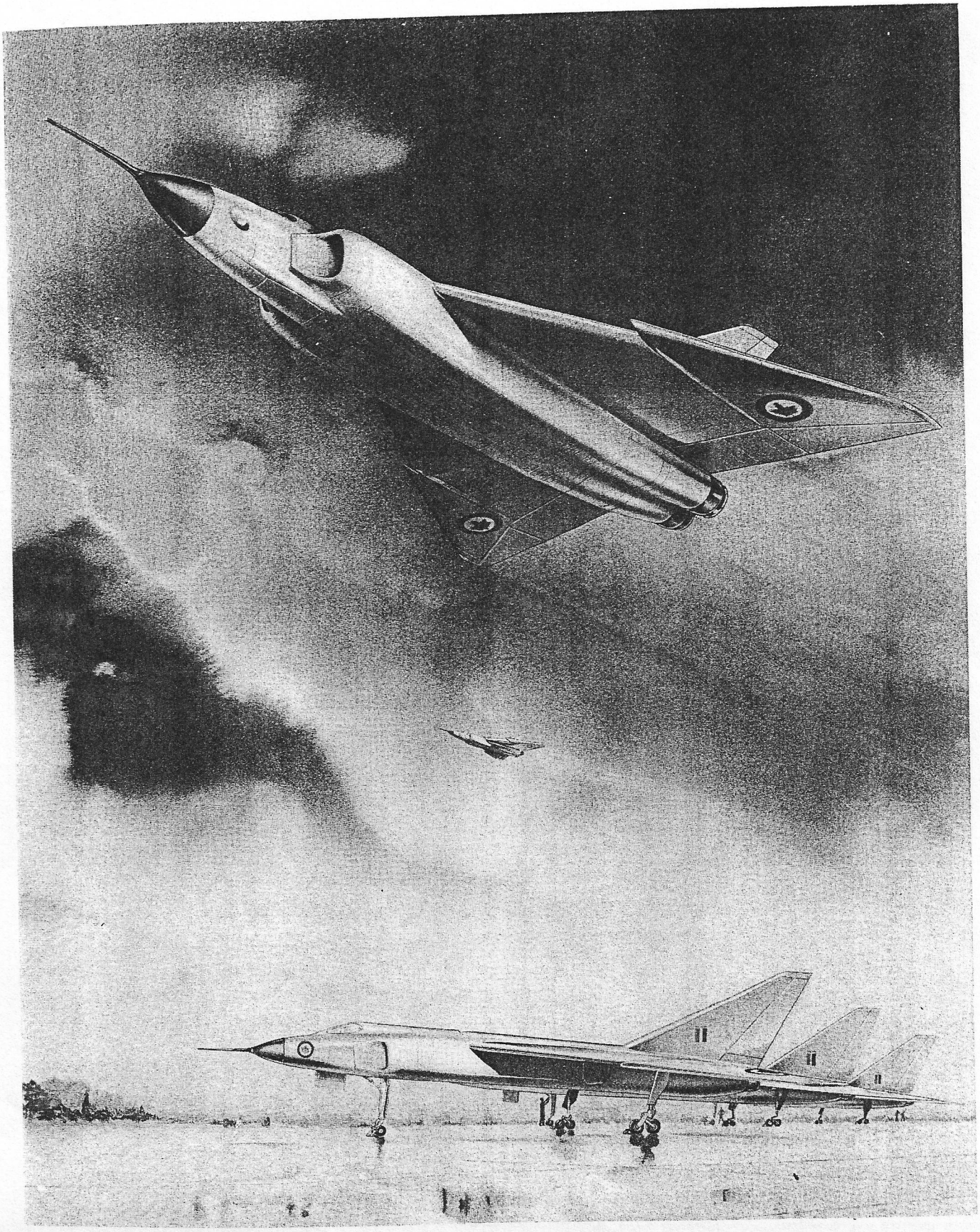
CF-105
DESIGN AND DEVELOPMENT PROGRAM

BROCHURE AD-15
(ISSUE 2)

(SUPERCEDES BROCHURE AD-15 DATED SEP. 1954 FIRST ISSUE)

JUNE 1955

AVRO AIRCRAFT LIMITED
MALTON — ONTARIO



604-105-2

CF-105 SUPERSONIC ALL-WEATHER FIGHTER

LIST OF CONTENTS

INTRODUCTION

This brochure outlines the Company's latest proposal for the design, development, and testing of the CF-105 aircraft. It describes the program which will be carried out from the initial design stages, through the various testing programs, and up to the first flight of the fifth airplane.

Included in the brochure are financial forecasts of the costs of the development programs for 5 aircraft and for 40 aircraft by fiscal years.

The basic philosophy behind the Avro Engineering Program to design, develop, and produce an aircraft to the CF-105 configuration, is to get the most advanced aircraft into Squadron service as early as possible but without taking unnecessary and unusual risks.

The requirement of getting an aircraft into Squadron use by 1960 dictates a much more accelerated program than the previous philosophy of building two prototypes and then holding up the decision to produce additional aircraft for a year to 18 months after the first prototype has flown. If the program was carried out in this conventional manner, the aircraft would not be in Squadron service until 1962 or 1963, which date is considered by the R. C. A. F. to be far too late for their replacement requirement.

As a result of the above, it was decided after much discussion within the R. C. A. F., the D. D. P., and the Company, that this program would be carried out in a manner similar to the USAF Cook-Craigie method. In this plan the manufacture of aircraft on an experimental tooling basis is discontinued. The

first aircraft are built with production tooling from production drawings. Wind tunnel tests and free flight model are completed as early as possible in an attempt to prevent major changes in tooling (it is estimated that abandoning the experimental tooling philosophy saves about 18 months in the overall-build time cycle). It is most important to note that the plan also provides for getting a considerable number of aircraft into the air for flight testing as early in the program as possible.

DESCRIPTION

The CF-105 is a supersonic, long range, high altitude, all-weather, day and night fighter, designed specifically for Canadian conditions. It has as its primary object the destruction of any bomber aircraft likely to be available to a potential enemy during the next four to ten years. When fully loaded with fuel and armament for the primary mission, the aircraft weighs approximately 60,000 lbs.

The external features of the aircraft are a high wing of delta plan-form, a swept fin, and a fuselage with engine air intakes at each side, ahead of the wing. To keep the supersonic drag to a minimum, the thickness to chord ratio of the wing and fin has been kept as low as structural considerations will permit. The high wing allows straight through spars which increase the strength/weight ratio of the design.

A tricycle landing gear is fitted, the main legs retracting inwards and forwards into the wing, and the nose leg retracting forwards into the fuselage. Tandem-bogey wheels are fitted to each main leg, and twin wheels are fitted to the nose leg. The control surfaces are fully power operated. Fuel is contained in integral tanks in the wing, and in tanks between the air intake ducts in the fuselage. Provision is made for carrying an auxiliary fuel tank beneath the fuselage.

The crew members are seated in tandem. Ejection seats enable the crew to escape from the aircraft under most conditions of flight. The cockpits are pressurized and air conditioned.

All armament is stored internally in a very large bay in the forward part of the underside of the fuselage. The aircraft is equipped with a completely integrated electronic system capable of automatic interception and weapon firing. The CF-105 is considered by both the Royal Canadian Air Force and the United States Air Force as being the most advanced manned project of its kind in terms of firepower and performance on contract with any manufacturer at the present time.

TEST PROGRAM

The Company recognizes that it is imperative that extensive testing be carried out as early in the program as possible to cut down the risks to the minimum, consistent with the policy of producing an operational aircraft as quickly as possible. To this end, every effort is being made to ensure that the Company's experience and knowledge is as high as possible by the time the first aircraft is flown, and therefore that the risk is as low as possible. Structural tests will be performed on a complete aircraft assembly prior to first flight. Mechanical and electrical systems will be duplicated in detail on ground rigs which can be subjected to ambient temperatures covering the full range of expected conditions. In addition to the above, the number of static and dynamic measurements taken on all the tests will be far in excess of those taken on the program carried out on, for example, the CF-100.

Charts 1, 2 and 3 show in some detail the various wind tunnel model, free flight model, structural tests, and systems tests which are to be carried out and the timing of each of these tests. Chart No. 4 illustrates graphically the phasing of the test program in relation to aircraft deliveries. The main wind tunnel, systems, and structural tests, are shown in relation to the flight of the first aircraft and it is apparent from this chart that a large portion of the test program is in fact completed before production of aircraft at a moderate rate is committed.

Chart No. 5 illustrates the flight test program and the allocation to various development phases of the first 15 aircraft. Aircraft 16 to 36 inclusive are allocated to RCAF for evaluation programs and the 37th and subsequent aircraft

are scheduled for Squadron delivery. This is for planning purposes only, since the development work and the results of tests prior to the first flight will obviously have some effect on flight test allocations.

While there is no doubt that changes will in fact have to be made throughout the whole of the development program, it is hoped that by having the various test stages sequenced properly, such changes can be kept to a minimum.

AVRO AIRCRAFT LIMITED

CF-105 WIND TUNNEL AND FREE FLIGHT TEST SCHEDULE

WIND TUNNEL MODELS

1.	LONGITUDINAL STABILITY. NO CAMBER, T/C 3%	3/100 COMPLETE MODEL CORNELL DESIGN & MFR.	COMPLETE SEPT/53
2.	LONGITUDINAL & LATERAL STABILITY. CAMBER, T/C 3½% INCL. AILERON.		COMPLETE APR/54
3.	DIRECTIONAL STABILITY INCL. RUDDER LONG. STAB. CHECK. NEW CANOPY, NEW NOSE.		COMPLETE JUNE/54
4.	NOTCH INVESTIGATION. COMPLETE TEST WITH BEST NOTCH. LOW SPEED ONLY & HIGH ANGLES OF ATTACK.		COMPLETE JULY/54
5.	NOTCH INVESTIGATION, ALL SPEEDS. HIGH R. N., L. E. EXTENSION, LONGITUDINAL & DIRECTIONAL STABILITY.		COMPLETE OCT/54
	LONGITUDINAL & DIRECTIONAL STABILITY COMPARISON .03 & .04 SCALE MODELS.	4/100 COMPLETE MODEL CORNELL DESIGN & MFR.	COMPLETE MAR/55
	TRANSONIC FORCE TESTS ON MISSILES.		COMPLETE MAR/55
	TRANSONIC TESTS FOR MISSILE EFFECT ON AIRCRAFT.		COMPLETE MAR/55
	TRANSONIC FORCE TESTS ON MISSILE FOR TRAJECTORY ANALYSIS.		COMPLETE APR/55
	LONGITUDINAL STABILITY. INVESTIGATE L. E. DROOP.		COMPLETE MAY/55
	COMPLETE LONGITUDINAL & DIRECTIONAL STABILITY & CONTROL WITH OPTIMUM DROOP.		COMPLETE MAY/55
	INVESTIGATION AT HIGH R. N. AND HIGH ANGLE OF ATTACK.		COMPLETE MAY/55

CORNELL WIND TUNNELS
3' x 4' TRANSONIC
10' x 12' SUBSONIC

CORNELL WIND TUNNEL
3' x 4' TRANSONIC

FIRST AIRCRAFT

(REF. ONLY)

AVRO AIRCRAFT LIMITED

CF-105 WIND TUNNEL AND FREE FLIGHT TEST SCHEDULE

DESIGN AND MANUFACTURE
TESTING
SCHEDULED, NOT FINALIZED

WIND TUNNEL MODELS (CONT'D)

13.	SUBSONIC, PRELIMINARY STUDY ICING CONDITIONS ON LONGITUDINAL & LATERAL CONTROL.	1/10 REFLECTION PLANE WING NAE DESIGN & MFR.	COMPLETE JAN./55 — NAE WIND TUNNEL 10'x5.7' LOW SPEED
14.	SUBSONIC, ADVANCED STUDY ICING CONDITIONS. NOTCHES & L. E. EXTENSION INCLUDED.	1/8 REFLECTION PLANE WING NAE DESIGN & MFR.	COMPLETE MAR/55 — NAE WIND TUNNEL 10'x5.7' LOW SPEED
15.	SUBSONIC, CANOPY AND MISSILE JETTISON, GROUND EFFECTS.	7/100 COMPLETE MODEL AVRO & NAE DESIGN & MFR.	NAE WIND TUNNEL 10'x5.7' LOW SPEED
16.	SUPERSONIC, LATERAL & DIRECTIONAL STABILITY & CONTROL.	1/80 COMPLETE MODEL AVRO	NAE WIND TUNNEL 16"x30" SUPERSONIC
17.	SUPERSONIC, STUDY OF AIRFLOW THROUGH INTAKES.	1/40 FUSELAGE INTAKE AVRO DESIGN & MFR.	NAE WIND TUNNEL 10"x10" SUPERSONIC
18.	SUPERSONIC, LONGITUDINAL STABILITY & CONTROL, LATERAL CONTROL.	1/50 REFLECTION PLANE NAE DESIGN & MFR.	NAE WIND TUNNEL 16"x30" SUPERSONIC
19.	SUBSONIC, SPIN CHARACTERISTICS & RECOVERY.	1/24 COMPLETE MODEL NAE DESIGN & MFR.	NAE SPINNING TUNNEL
20.	SUPERSONIC, STUDY OF AIRFLOW THROUGH INTAKES.	1/6 FUSELAGE INTAKE AVRO DESIGN & MFR.	NACA CLEVELAND 8'x6' LEWIS LAB. SUPERSONIC
21.	SUPERSONIC, DIRECTIONAL STABILITY AT HIGH ANGLES OF ATTACK.	3/100 COMPLETE MODEL CORNELL DESIGN & MFR.	BEDFORD, ENGLAND 3'x3' SUPERSONIC

FIRST AIRCRAFT

(REF. ONLY)

J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J

1954 1955 1956 1957 1958

AVRO AIRCRAFT LIMITED

CF-105 WIND TUNNEL AND FREE FLIGHT TEST SCHEDULE

DESIGN AND MANUFACTURE

TESTING

FREE FLIGHT MODELS

ALL MODELS 1/8 SCALE; FIRED AT C. A. R. D. E. MISSILE RANGE

CRUDE MODEL	CHECK FIRING TECHNIQUE, TELEMETERING AND TRACKING.	COMPLETE DEC./54
CRUDE MODEL	CHECK FIRING TECHNIQUE, TELEMETERING AND TRACKING.	COMPLETE DEC./54
CRUDE MODEL	CHECK FUNCTIONING OF YAW IMPULSE AND α-β VANES.	COMPLETE MAY/55
DRAG MODEL - STRAIGHT L. E. PLUS NOTCHES	DRAG CHECK AND TELEMETERING SYSTEM CHECK FLOW THROUGH INTAKES AND DUCTS.	COMPLETE MAY/55
RUDE MODEL	RE-CHECK FUNCTIONING OF YAW IMPULSE AND α-β VANES.	COMPLETE JUNE/55
RAG MODEL	DRAG CHECK WITH TWO DIFFERENT AIR INTAKES AND DUCTS.	
RAG MODEL	DRAG CHECK WITH TWO DIFFERENT AIR INTAKES AND DUCTS.	
YAW STABILITY MODELS. EXTENDED E. & DROOP & NOTCH	DIRECTIONAL STABILITY CHECK.	C. A. R. D. E. MISSILE RANGE
MODELS WITH MOVABLE ELEVATORS	LONGITUDINAL STABILITY CHECK.	
SPARE MODEL	TO BE DECIDED	

FIRST AIRCRAFT

(REF. ONLY)

J A S O N D | J F M A M J J A S O N D | J F M A M J J A S O N D | J F M A M J J A S O N D | J F M A M J J A S O N D | J F M A M J

1954 | 1955 | 1956 | 1957 | 1958

SECRET

AVRO AIRCRAFT LIMITED

CF-105 STRUCTURAL TEST SCHEDULE

STRUCTURAL TESTS

SPECIMEN TESTS

1. PANELS
2. BOXES
3. JOINTS
4. CASTINGS AND FORGINGS
5. PLASTIC MODELS

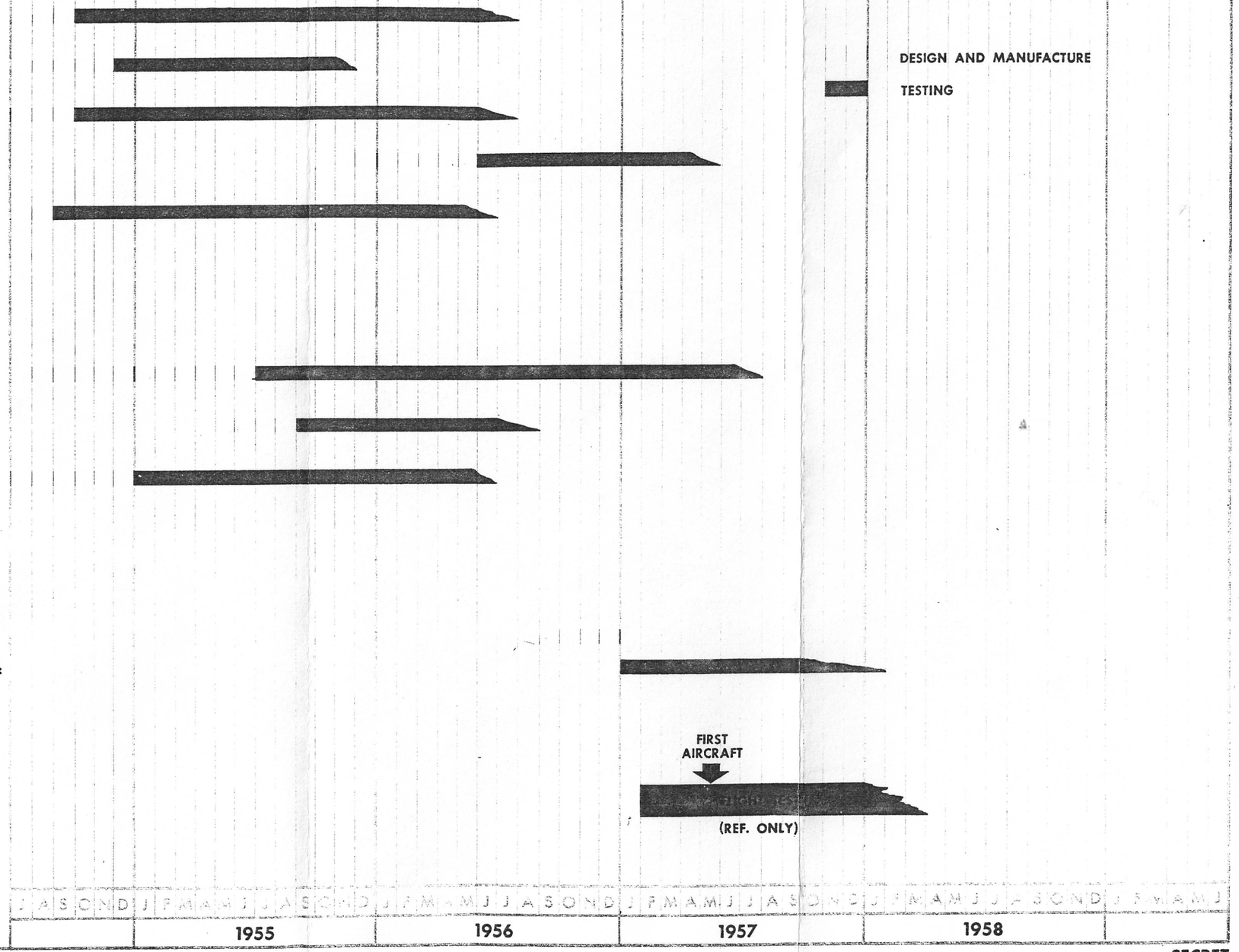
COMPONENT TESTS

1. CONTROL SURFACES
2. COCKPIT AND CANOPY
3. DUCT TESTS

COMPLETE AIRCRAFT STATIC TESTS

FINAL ASSEMBLY

TESTING WING, FUSELAGE, FIN, UNDERCARRIAGE ETC:



AVRO AIRCRAFT LIMITED

CF-105 SYSTEMS TEST SCHEDULE

DESIGN AND MANUFACTURE

TESTING

SYSTEMS TESTS

1. FLYING CONTROL SYSTEM
2. UTILITY HYDRAULIC SYSTEM
3. FUEL SYSTEM
4. AIR CONDITIONING AND PRESSURIZATION
5. ELECTRICAL SYSTEM
6. ARMAMENT SYSTEM (FALCON)
7. DE-ICING SYSTEM
8. ELECTRONICS SYSTEM

QUALIFICATION TESTING OF

AIRCRAFT ACCESSORIES AND EQUIPMENT (TEMPERATURE, FUNCTION, PRESSURE, LOAD, ETC.)

FIRST AIRCRAFT

FLIGHT TEST

(REF. ONLY)

J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J

1955 1956 1957 1958

CHART NUMBER 4

AVRO AIRCRAFT LIMITED

CF-105 OVERALL PHASING OF TESTING PROGRAM

WIND TUNNEL AND FREE FLIGHT TESTS

- LEWIS INTAKE
- BEDFORD SUPERSONIC
- FREE FLIGHT DRAG & STABILITY
- TRANSONIC DROOPED L.E.
- N.A.E. SUPERSONIC
- FREE FLIGHT DRAG & YAW
- ARMAMENT & MISSILE SEPARATION

PORTIONS OF WIND TUNNEL PROGRAM COMPLETED

(a) TRANSONIC LONGITUDINAL DERIVATIVES
(b) TRANSONIC LATERAL DERIVATIVES
(c) 3-5% WING, EXTENDED L.E. & NOTCH
(d) FREE FLIGHT PROGRAM START

SYSTEMS TESTS

- HYDRAULIC FLYING CONTROLS AND COMPLETE FLYING CONTROL SYSTEM TEST
- RUDDER SYSTEM TESTS
- AILERON SYSTEM TESTS
- FUEL SYSTEM TESTS
- ELECTRICAL SYSTEM TESTS
- CONTROL SURFACE STRENGTH & STIFFNESS TESTS
- WINDSCREEN & CANOPY TESTS
- DETAIL SPECIAL TESTS
- OXYGEN SYSTEM TESTS
- ELEVATOR SYSTEM TESTS
- BOX BEAM TESTS
- STIFFNESS TESTS
- MISC. SYSTEM TESTS
- AILERON SIMULATION
- RUDDER SIMULATION
- ELEVATOR SIMULATION
- DAMPING SYSTEM SIMULATION
- HYDRAULIC UTILITY SYSTEM TESTS

SIMULATION

- AUTOMATIC FLIGHT CONTROL SYSTEM SIMULATION

STRUCTURAL TEST

- SELECTED FAILURE CASES
- UNDERCARRIAGE CASES
- SYMMETRICAL FLIGHT (FWD. C.P.)
- SYMMETRICAL FLIGHT (AFT C.P.)
- ROLLING PULL-OUT CASE

AVRO F/TEST (AIRWORTHINESS ETC.)

HUGHES F/TEST - I.E.S.

- CLEARED FOR SUPERSONIC FLIGHT WITHIN FLIGHT ENVELOPE
- CLEARED FOR LIMITED SUPERSONIC FLIGHT (M = 0 TO 2, n = -1 TO 3)

AVRO F/TEST (WEAPON PACK)

AIRCRAFT DELIVERED TO F/TEST

AIRCRAFT DELIVERY TO R.C.A.F.

LEAD TIME FLIGHT TO DELIVERY

AIRCRAFT FOR R.C.A.F. FLIGHT TEST PROGRAM

AIRCRAFT FOR AVRO FLIGHT TEST PROGRAM

AIRCRAFT TO SQUADRONS

FIRST FLIGHT

FIRST FLIGHT

AIRCRAFT NUMBER

50 45 40 35 30 25 20 15 10 5

TESTING
DELIVERY
SIMULATION

MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.
1955

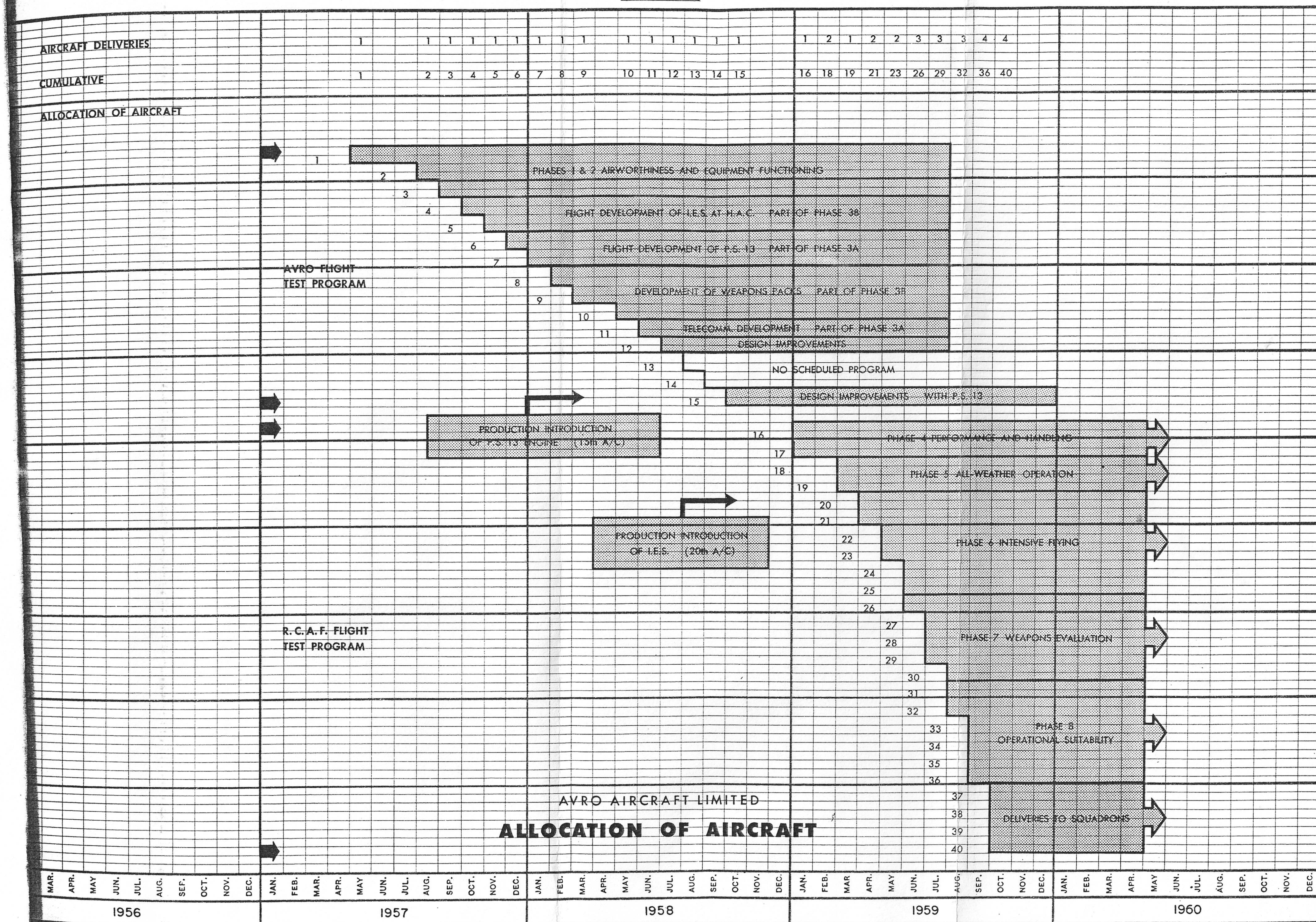
JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.
1956

JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.
1957

JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.
1958

JAN. FEB. MAR APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.
1959

SECRET



AVRO AIRCRAFT LIMITED

ALLOCATION OF AIRCRAFT

SECRET

FINANCIAL FORECAST

The two statements following this analysis indicate the forecast expenditures covering two phases of this CF-105 Program. Statement "A" shows the expenditures for a program behind five aircraft up to and including the first flight of the fifth aircraft. Statement "B" shows forecast expenditures for the program behind 40 aircraft up to March 31, 1960. Both of these cost forecasts have been developed in accordance with the requirements called for in specification AIR 7-4 Issue 2, but provide for the installation of the P. S. 13 Engine and also the Sparrow Missile as an alternative to the Falcon Missile Installation.

Further requirements which may be called up by later issues of the specification are not contained in these cost forecasts nor are such items as service publications included in the statements.

Inasmuch as these costs are based on Issue 2 of the specification, the following work content is set out in order to clarify what is generally covered in these forecasts.

(1) Design & Development of the P. S. 13 Engine installation in the CF-105 Airframe.

(2) Design & Development of the Sparrow installation in the CF-105 Airframe.

(3) Design Engineering as follows:

Scheme and detail design of the airframe as required by Issue 2 of the specification, together with design of the required Wind Tunnel and Free Flight Models, Test Rigs, etc.

(4) Experimental Manufacturing of Wind Tunnel and Free Flight Models, Test Rigs and System testing Equipment and Mock-Ups.

(5) Maintenance, Operation and Flight Testing of Flight Test Vehicles (in accordance with Chart No 5 - Program B) including CF-100 Aircraft associated with this program.

(6) Testing Program as detailed in this brochure.

(7) Development of Damping system.

(8) Installation of integrated electronic system using modified MX 1179 equipment.

(9) Installation of interim electronic system until item (8) above is available.

The following items have not been provided for in the forecasts.

(1) Repair and Overhaul of Flight Test Aircraft.

(2) Design and Development of Flight Simulator or Aircraft Systems Training units.

(3) Design, Liaison engineering, manufacture or procurement of Readiness Equipment.

(4) Manufacture or Procurement of Damping System hardware.

(5) Weapons evaluation program including sled-testing program.

(6) Maintenance and Operation of aircraft on loan to other companies such as Hughes Aircraft.

(7) Maintenance and Operation and Testing of 7th Aircraft on Chart No 5 (PS13).

(8) Instrumentation required by R.C.A.F. for R.C.A.F. test program.

(9) Flight Testing of Aircraft other than from Malton.

Included in the forecast is provision for some increases in the prime costs of

labour and overhead over present day rates. Also included is a fee figure of 5% of costs.

Because the forecasts of costs extend for five years, it must be recognized that there are many factors which may affect the cost elements, such as changes to the specification or in the state of the art. The forecast of expenditures are prepared from a known scope of work as generally defined above and the Company does not attempt to provide for major changes in requirements which it may be directed to carry out in the future.