

PROTOTYPE AIRCRAFT DEVELOPMENT TRIALS WITH PARTICULAR REFERENCE TO TROPICAL TRIALS

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ABSTRACT

Flight development trials on prototype aircraft play a vital part in the design and development programme of a new aircraft and facilitate the introduction of the aircraft for operational use in Air Force Squadrons. The facilities required for such flight testing, the training of technical personnel and the organisation of a flight test centre are briefly described.

Introduction

Flight development trials on prototype aircraft play a vital part in the design and development programme of a new aircraft and facilitate the introduction of the aircraft for operational use in Air Force Squadrons. Of the 5 to 7 years taken for an aircraft design and development programme, i.e., from the day of the commencement of the design project to the day the aircraft enters squadron service with the Air Force, approximately two years or more are spent on prototype flight trials which form the concluding phase of the aircraft design and development programme. During these two to three years of flight trials, several prototype aircraft are flight tested and the programme involves several hundred flying hours. For example in the flight development of a typical interceptor/ground attack aircraft a total of about 750 flying hours carried out on six different prototype aircraft, are envisaged.

With the exception of the Hindusthan Trainer, the different types of aircraft in use in India have been either purchased directly from foreign countries or built under licence in this country and on this account there has been no necessity for any elaborate flight testing to be carried out in India. However, as we are now embarking on the indigenous design and development and manufacture of aircraft in India, it becomes a matter of urgent necessity to consider plans and undertake the execution of the plans for an early establishment of flight testing facilities.

Flight Testing Facilities in Foreign Countries

In the U. K. part of the flight testing of prototype aircraft is carried out by the Aircraft manufacturers and part of the tests are carried out at the Ministry of Supply, Aircraft and Armament Experimental Establishment at Boscombe Down. Similarly in France, part of the tests are carried out at the French Air Ministry CENTRE DE ESSAIS DE VOL (C.E.V.) at Bretigny. This distribution of work is significant in that even with well established aircraft manufacturers in foreign countries, it becomes necessary to carry out part

of the tests in a central establishment. The reason for this arrangement is partly on account of economy and partly to avoid duplication of flight testing by the Government Type Certifying Authority. The economy achieved is not only in terms of the expenditure on test instruments and facilities but also on account of conserving the number of highly qualified personnel required for flight testing.

A Typical Flight Testing Programme

The requirements for flight testing will depend on the roles for which the aircraft has been designed such as Interception, Ground Attack, Bombing, Transport etc. Certain tests are common to all types, such as handling, stability and control, buffet, vibration and flutter and engine development; certain other tests, such as gun firing, rocket firing, bombing, radius of action for operational sorties etc., will be peculiar to the role of the aircraft. The table given below summarises the flight development programme of a typical interceptor/ground attack aircraft.

Number of Prototype Aircraft	Period of flight test	Details of Flight test	No. of test flying hours programmed
First A/C ..	24 months ..	General handling, Low speed stability and control; Gun armament tests; Radio and Radar tests.	250 hrs.
Second A/C ..	4th to 24th month ..	High speed and high Mach No. stability and control tests; Buffet and flutter tests; External tank jettisoning.	150 hrs.
Third A/C ..	8th to 24th month ..	Engine development tests; Aircraft performance tests; Engineering tests.	100 hrs.
Fourth A/C ..	12th to 24th month ..	Stability and control tests with stores; Aircraft performance tests with stores; Buffet vibration and flutter tests with stores.	150 hrs.
Fifth A/C ..	16th to 24th month ..	Bombing and rocket firing tests	50 hrs.
Sixth A/C ..	20th to 24th month ..	Tropical trials including engineering tests, aircraft performance tests and power plant tests.	50 hrs.
Total ..			750 hrs.

It will be noted from the above table that the flight development programme gradually builds up, trials commencing with one aircraft (first prototype aircraft) and continues with more aircraft as additional aircraft roll out of the prototype production shops.

Execution of Flight tests

While the prototype aircraft are flown by experienced test pilots, the supervision as well as the detailed scheduling and analysis of the results of flight tests are carried out by highly qualified engineers. The flight testing programme involves the determination of complex quantitative data and requires a technical appreciation of the aircraft design in order to translate the data into a suitable form for the use of the aircraft designer, who uses the data to either substantiate his design or to modify, if required, the design. It is the practice in other countries to place the responsibility of conducting the flight testing programme in the hands of a Chief Flight Development Engineer who heads the team of test pilots and engineers.

Test Instrumentation

A period of two to three months out of the production schedule for a prototype aircraft is taken up merely for installing the test equipment in the aircraft. It will be appreciated that the test equipment along with the wiring and other fittings have to be installed in the aircraft at various stages in the manufacture of the prototype and cannot be done after the prototype has been built. Over fifty different types of instruments are required to be installed in the different phases of the flight testing in addition to the normal aircraft instrumentation. An idea of the magnitude of the instrumentation required can be gained from the fact that the cost of the test instruments for one aircraft including the labour taken to install them in the aircraft is of the order of Rs. 2 lakhs.

Scheduling of flight tests

Considerable experience and care is required in the programming of flight tests. It should be ensured that the critical performance of the aircraft is checked at a very early stage so that any major difficulties encountered can be studied and rectified at a very early stage and thereby avoid delay. At the same time the flight tests have to progress in a logical manner and should be undertaken with due caution to avoid a disastrous accident.

Recording of observations

In the case of general handling trials, observations are recorded either through a taperecorder or on his test pad by the test pilot. In respect of all other tests, a great variety of observations are required to be made continuously and it is not possible for the pilot to record all these observations and at the same time devote attention to the flying of the aircraft. Therefore, with the exception of general handling trials, observations are recorded by the use of automatic observers. The automatic observers may consist of cameras which photograph the test instrument panel or may consist of the HUSSENOT type of continuous trace recorder.

Processing of the data: The observations of the automatic observer are recorded on photographic films. These films are developed and placed in projectors from which a group of film tracers and plotters read the films and write down the data gathered in the form of tables and graphs for the ready use of the staff employed on the analysis of the flight test data.

Reduction and analysis of data : While the actual flight tests may have been carried out under ambient conditions which differ from the international standard atmosphere and while the all up weight of the aircraft may be less or

more than the normal all up weight, it is necessary to reduce all flight test data to a set of standard conditions so that the performance of the aircraft can be readily compared with the estimated performance, which is always expressed in terms of a standard set of conditions. After reducing the results to a standard set of conditions, the data is analysed to determine in what respects the aircraft conforms to the estimated performance and in what respects the aircraft is deficient.

Test Equipment: The test equipment used for test flying is of a very delicate nature and requires careful maintenance and frequent calibration in a laboratory which is equipped with suitable calibration equipment. The laboratory has to be specially built with adequate air-conditioning for satisfactory calibration. The flight test laboratory will also include a photographic section and a small instruments workshop.

Service Trials

Apart from the test flying in the hands of the test pilot, it will be necessary to conduct additional flying in the hands of squadron pilots of the Air Force, the aircraft being operated under service field conditions. This is an essential element of a test flying programme before the aircraft can be considered as satisfactory for squadron service. Any snags in flying or maintenance discovered during the service trials will have to be rectified before the aircraft is produced in quantity. However, for these tests the procedure given above does not apply, observations being principally qualitative in nature.

Tropical Trials

In addition to the normal flight development programme, operational aircraft for use under Indian climatic conditions require certain tests to be repeated under actual tropical conditions which prevail for a considerable part of the year. It is not always possible to extrapolate the performance of aircraft, evaluated under temperate conditions, to determine with any degree of reliability the actual performance under tropical conditions. Thus, an important phase of the Gnat Mk. I flight development programme, the major part of which is being carried out in the U.K., is the tropical trials which are being conducted in India by the I.A.F. at the Aircraft and Armament Testing Unit. The importance of the tropical trials lies in the fact that not only will the trials determine the performance of the aircraft under tropical conditions but represents the very first serious attempt at flight testing of prototype aircraft in India. Experience gained during the tropical trials will be of great benefit in the setting up of a proper flight testing establishment in India. The tropical trials programme is rather limited in scope as the trials are scheduled for only one aircraft involving about 60 hours of flying. The following aspects will be considered during the tropical trials :—

(a) Engineering Tests.

(i) Cabin Conditioning.

(ii) Functioning of the fuel system, oil system, electrical system, radio and radar equipment and hydraulic system.

(iii) Ammunition Temperatures.

(iv) Structures Temperatures.

(b) Aircraft performance tests including take off and landing performance, climb performance, level speed performance, range performance and thrust boundaries.

(c) Power plant tests including starting behaviour, handling on the ground, performance during take off, climb, level flight, approach and landing, acceleration performance and relighting tests.

A team of Air Force officers and technicians have been trained at the Flight Test Department of the Folland Aircraft Company in the U.K. for the conduct of these trials. A Gnat Mk. I aircraft has been instrumented for this purpose at Follands and service officers have been associated with the installation of the test equipment. A small flight test laboratory has been constructed at the Aircraft and Armament Testing Unit.

The organisation of the Aircraft and Armament Testing unit of the Air Force can be considered under three principal sections all of which come directly under the Commanding Officer:—

- (a) The Flight Test Section consisting of test pilots and technical staff for the processing and analysis of the flight test data.
- (b) Aircraft Maintenance Section consisting of personnel for servicing and maintenance of the aircraft and test equipment.
- (c) Administrative Section.

Proposed Flight Test Establishment

Apart from the limited flight test facilities which are being set up in the Aircraft and Armament Testing Unit of the Air Force, we do not have at the present moment a suitable flight test establishment. The following features will require to be carefully considered for the setting up of a Flight Test Establishment:—

- (a) Definition of the organisation, functions and responsibilities of the establishment;
- (b) The selection of a suitable site with airfield facilities;
- (c) Training of technical personnel;
- (d) Acquisition of flight test equipment both for installation in the aircraft and for use on the ground and in the flight test laboratory;
- (e) Phased programme for the immediate setting up of a nucleus establishment and the ultimate expansion of the nucleus establishment.

With regard to the organisation and functions of the test establishment it is envisaged that, unlike the practice in U.K. and in France, there will be only one establishment to cater for the needs of both the aircraft industry and the Government Type Certifying authority for flight testing of prototype aircraft. This arrangement will effect an important economy and conserve the number of technical personnel required and is considered to be more suitable for our present limited resources in money and technical man power. It is envisaged that the instrumentation of the aircraft will be carried out by the

Aircraft firm who can draw upon the flight testing establishment for advice and guidance. The actual flight testing will be carried out by Air Force test pilots. The officers and technicians required for the conduct of the flight testing programme will be drawn from a team of service officers and civilians who have received specialised training on the subject. The technical team will also include representatives of the aircraft firm. The flight testing establishment should be made responsible to the Type Certifying Authority of the Government.

To set up even a nucleus establishment for our immediate needs will take a period of approximately two years and as we already have certain new aircraft design projects in progress, the setting up of a flight test establishment is a matter of great urgency.