MAINTENANCE TEST FLYING IN THE ROYAL NAVY

BY

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At one time when the words " test pilot " were mentioned many were apt to picture a fearless and heroic aviator executing terminal velocity dives in an effort to prove that the aircraft would not disintegrate and be safe for other pilots to fly.

Today we are more realistic and most of us are aware that a host of technicalities have caused the flight-testing of both experimental and production aircraft to become a science each of their own.

The purpose of maintenance test flying in the Royal Navy is not only to check functionally the work of the maintenance staff, but to ensure that the performance of the power plant and airframe remain at the highest possible level during the life of the aircraft.

The main routine of functional testing and performance checking connected with maintenance test flying requires thorough and accurate flying.

On leaving the production line at the makers the aircraft is tested by the firm's test pilots to a schedule laid down by the firm and the Aeronautical Inspection Directorate. This schedule is also used by maintenance test pilots in conjunction with a naval test flight procedure which is promulgated in official publications. Such a procedure ensures that the airframe and power plant are operated throughout their ranges in power and speed. In fact, from the pilot's viewpoint it asks for forty-five minutes to an hour of accurate " limit flying " including a functional test of every possible component in flight.

Maintenance test flights are called for on all aircraft after receipt from the makers, on production out of storage, after repairs and changes of major components, after important modifications have been incorporated, and at periods during the aircraft life after minor inspections have been carried out.

The number of individual test flights undertaken on each particular aircraft varies with the type and the nature of the snags encountered in flight, and in some instances many test flights have to be carried out before the aircraft can be released for despatch to a squadron.

The maintenance test pilots at naval air establishments are part of the Air Engineering complement. They are held at the Royal Naval Aircraft Repair Yards at Fleetlands and Donibristle, at the R.N. Aircraft Maintenance Yard, Belfast, and at all Aircraft Holding Stations and Sections under the administration of the Rear-Admiral Reserve Aircraft.

Apart from being a competent pilot there are two factors which enable the maintenance test pilot to assist in the prompt delivery of serviceable aircraft to the Squadrons.

First, a thorough working knowledge of the aircraft which will enable him to recommend correct adjustments and to give an accurate diagnosis of faults, and thus save the time of the maintenance staff.

Secondly, an intimate knowledge of the progress of maintenance and paper work connected with the aircraft before and after it has been through his hands. This will direct his attention to the possible sources of faults.

A sound appreciation of the role to be played by each aircraft is also

important in order that special attention can be given to details. For instance, throttle damping nuts and engine response, trim at low speed for aircraft that are to be used for deck landing and assisted dummy deck landings, trim at high speed and accuracy of gunsights and radar equipment for Front Line Squadrons.

The time factor in the shape of target dates which fits into a plan for embarking, or working up of squadrons, is a matter which must closely concern the maintenance test pilot. Here, close liaison with the progress staff is essential, for if each understands the other's problems much time can be saved. On many occasions in deciding the balance between quality and quantity both sides require the patience of Job—and the judgment of Solomon!

The weather is another factor which at least gives variety to the test pilot's job. Like his opposite number in a squadron he is often working against time. He cannot afford always to wait for good flying weather, and may have to modify his programme accordingly.

A full maintenance test flight generally occupies forty-five minutes and consists of the following procedure.

(1) A thorough external pre-flight examination on the ground and engine power check is carried out. Hydraulic and pneumatic systems are checked together with flying instruments and engine controls.

(2) Take-off is effected at full power to at least 1,000 feet, and recordings are made of boost and engine r.p.m., temperatures, pressures and any undue trim required, vibration and the correct functioning of the retractable undercarriage.

(3) In the initial climb, having reduced from take-off power to maximum permissible climbing power, any obvious defects in engine or flying instruments are revealed, and by the time Rated Altitude in M gear (low speed supercharger drive) is reached, the flying trim (*i.e.*, stability of the aircraft without manual control) will have been assessed and recorded, and any incipient cooling troubles brought to light. Having changed to " S " gear (high speed supercharger drive), the climb is continued at the best climbing speed to " S " gear Rated Altitude (where climbing boost starts to fall), and all engine instrument readings are then recorded.

(4) A level speed run in " S " gear at maximum continuous power will next be done at the laid down altitude for the type, and again trim will be assessed and a record taken of all engine instruments and the Air Speed Indicator. Mixture or ignition faults are accentuated at altitude and are usually revealed by engine vibration or rough running which may vary with the throttle setting.

(5) In aircraft that are fully aerobatic and equipped for inverted flying, an inverted flight is carried out at high altitude. Faults such as aeration of the lubricating oil, or non-operation of the negative-G valves, will be readily apparent in the loss of oil pressure or cutting of the engine.

(6) A dive to maximum permissible speed is now undertaken to check changes of flying trim and weight and response of controls. Any flexing of panels or skin panting is checked visually.

A pull out at 4 G is desirable to ensure security of walkways and panels. Any undue tendency to tighten up or heaviness of the elevator controls is recorded.

(7) Aerobatics are an important feature in a maintenance test flight. In addition to the data recorded in the preceding and subsequent tests, they give the pilot the opportunity to assess the feel of the controls and any faulty tensioning of control wires. Also the airframe is thoroughly worked, and any

loose electrical connections and free objects are exposed. To those who are not pilots this may sound far-fetched, but the author has gained quite a collection of articles ranging from a comb and pay-book, to a " bridge megger " and smuggled lead, besides the inevitable nuts and washers.

(8) Stalling speeds and characteristics in level flight, clean (*i.e.*, with undercarriage and flaps up), and again with undercarriage and flaps down and cockpit hood open are carefully investigated. In nearly all cases of high stalling speed in modern aircraft it is the Air Speed Indicator that is at fault. Wing root fillets distorted or loose, twisted centre sections, or missing panels in the wing root may, however, be causes of high stalling speeds.

(9) After a second level speed run in M gear, the remaining components that have not already been tested are dealt with. These will include among others the Gyro Gun Sight, contacting and radio altimeters, YG beacon, filter and carburettor warm air shutter, supercharger and gear change automatic switch and fuel transference. On landing, any faults or adjustments required are immediately transcribed to the Form A.700 (the record of unserviceability and work undertaken). Instrument readings obtained in flight are corrected to what they would read in the standard ICAN atmosphere. This standardization provides a very ready comparison amongst aircraft of the same type and unusual readings are at once noticed. With practice and knowing the ambient air temperature at a given height, or even the nature of an air mass, the maintenance test pilot can allow for this correction and judge whether his readings indicate a poor performance or not, and thus save time which would otherwise be wasted before the meteorological office would provide him with the temperatures for the relevant time and place.

Jet aircraft require the same principles of testing, although the actual technique is a little different. One of De Haviland Aircraft Company's test pilots is reputed to have said that the testing of a jet aircraft was a matter of the " consumption of Guinness at specific lunch-time temperatures ! "

From the engine side, the Maintenance Test Pilot is concerned chiefly with jet pipe temperatures at high engine r.p.m. forward speeds, and fuel consumption.

Time to height at maximum climbing r.p.m., that is, the time taken to climb from " wheels roll " to 30,000 feet at an accurate indicated air speed which will vary as height is increased, is a good yardstick by which to measure the power produced against fuel consumption. This will vary with ambient air temperature as will the relation between indicated Mach Number and indicated air speed.

The behaviour of the aircraft at the critical Mach Number is assessed and pressurization of the cockpit and functioning of de-misting equipment add further items to be checked. High altitude navigation requires accurate dead-reckoning.

The analysis of faults back in the test flight office produces considerable food for thought, and it very often gives the information required by the design staff for the remedy of small defects in the original design and manufacture of the aircraft components.

Small adjustments can turn an awkward aircraft with rough engine into one which will give pleasure and efficiency to the squadron pilot. When this has been done the maintenance test pilot can feel, together with the maintenance staff, that a satisfactory job has been completed.

Editor's Note. The opinions expressed and procedures employed are those of an experienced Maintenance Test Pilot. They are not necessarily identical with orthodox maintenance test flying practice.