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PROBLEM IN PRECISION -

TEST FLYING JET PLANES

SPECIAL PROBLEMS IN TEST FLYING TURBINES AS SEEN BY D.O.T. TEST PILOT

CONCLUDING INSTALLMENT — By D. D. "Des" MURPHY

THERE is intensive research and development of jet engines currently proceeding in the U. K. Several engines were seen which will develop as yet unheard-of thrust and many known engines are now standing up to long periods of endurance.

At Hatfield, advice was given that the Ghost engine had passed the 1,000-hour mark.

The following are some of the points which require care on the part of pilots flying jets:

1. Jet pipe temperatures must be watched carefully. Too-high temperatures cause the turbine blades to creep when combined with high rpm with subsequent failure. Jet-pipe deterioration also occurs.

2. RPM creep up with altitude, must be watched to prevent over-revving.

3. Throttle must be used carefully at high altitudes to prevent over-revving—very small movements produce correspondingly large changes in rpm.

4. Some care is required in lighting the engines to prevent resonance. This requires careful use of the high-pressure cock.

5. Throttles should not be fully closed below 7,000 ft. to 10,000 ft. or flame likely to go out.

6. Re-lighting is difficult above 10,000 ft. and impossible above 15,000 ft. (Note: New burners under development will eliminate last two mentioned.)

The most common cause of failure is broken compressor or turbine blades. Strangely enough, these do not always cause complete disintegration of either the compressor or turbine. Blades have been known to come off axial compressors and go right through the engine without damaging anything else. The slightest vibration in a turbine indicates trouble, and the engine should be immediately shut off by closing the high-pressure cock. Vibration sometimes is so slight and subsequent disintegration so rapid, however, that the pilot does not have time to shut off.

Icing can be a problem and although every effort has been made to find icing conditions which would permit observation of ice accretion, no one has yet found the necessary conditions in or around the U. K. The opinion was given that, particularly in axial-flow jets, should a piece of ice go back through the engine, it would completely ruin the compressor, which in turn would ruin the turbine.

ABOVE—Author D. D. "Des" Murphy, 49, has 30 years of flying experience, joined the Dept. of Transport in 1937, and has been official test pilot since 1940. He recently spent nine months in Britain studying jet testing techniques. Some of his findings are reported in this series.

I have been told that at Mount Washington some icing tests on a turbine engine were carried out and that a 60% loss of power occurred in three minutes. It is generally believed, however, that icing is less of a problem with turbine than reciprocating engines and since the rate of climb of turbine-powered aircraft is great it is easier to get out of icing. This is a point which can only be proven by extensive tests. In any case such aircraft normally operate well above any severe icing.

There has been little or no experience to date in the operation of turbine-powered aircraft in a civil air transport along modern airways systems. Assuming that a turbine-powered aircraft has met modern airworthiness requirements, there yet remain many problems associated with its operation in transport work.

Jet-powered aircraft are only efficient when operated at optimum altitude and speed, because of excessive fuel consumption which occurs at lower altitudes. The reserves of fuel required by modern operational standards is, in the case of jet-powered aircraft, excessive, when sufficient reserve is carried to provide for a missed approach at the destination and diversion to a planned alternate at lower altitude than the optimum for fuel economy.

It was found that in the U. K. that

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Aircraft Industry

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second prototype ready for demonstration flights.

Fred T. Smye, assistant general manager of Avro Canada, summarizes his company's 1950 plans in the following words:

"With limited preproduction contracts for the Orenda and the CF-100 fighters, we are now busily engaged in tooling and in all other respects preparing for their production. We have reasonable assurances that there will be further production contracts soon if the CF-100 proves successful and if its performance comes up to its design specification.

"In 1950 more of our energy will be devoted to production of Orendas and CF-100 fighters or more specifically to the plans and preparations for their production and delivery.

"There will be substantial plant rearrangement, including the establishment of a production layout for the CF-100 and a production shop for the Orenda. Most of the tool design and tooling for both engine and fighter should be completed during the year.

"Materials, bought-out parts and equipment will be purchased and a substantial amount of work should be in progress so that our products can come off the line in early 1951. In fact, the first of the production fighters are scheduled for completion during the latter half of 1950.

"As far as the Jetliner is concerned, this year will be devoted to extensive test flights, construction of the second aircraft and a concentrated sales effort."

During a recent visit to Canada, Sir Roy Dobson, who is a director of the parent Hawker-Siddeley Aircraft group in England and president of Avro Canada, indicated that the know-how of the English group deserved a lot of credit for the achievements at Malton. However, he said, "the operation here is 95% or 98% Canadian right now. Maybe it's higher."

Referring to the degree of achievement by the Canadian industry he said:

"I am delighted. I think it has surprised everybody at home. And I think it has surprised a lot of people in Canada too."

Test Flying Jets

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there were two schools of thought for optimum fuel economy—one was that it was more economical to climb to optimum altitude and provide for a long slowly-descending approach, and the second was for cruising at the optimum altitude until close to destination, then descending rapidly by employing air brakes. It would appear that before this argument can be resolved, operational data will have to be compiled for comparison.

The use of air brakes or an air brake flap system is almost mandatory in high-speed high-altitude turbine-powered aircraft, for the reason that since maximum efficiency is attained only at optimum altitude and speed it follows that the stalling speed increases to the point where there is considerably less margin between the stall and the critical Mach number.

At high altitudes, the slightest depression of the nose results in rapid increases of speed where a dangerous condition might result by too close an approach to the critical Mach number. The careful manipulation of the throttles also is required at high altitudes to avoid losing engines. It is here that the air brake becomes necessary to slow down sufficiently to maintain safe control and also to lose altitude rapidly without dangerous increases in air speed.

For both operational and stability reasons it is generally considered essential that the application of dive brakes should result in a zero change of trim no matter what the speed or airplane configuration may be. The reasons for this requirement are many; for instance it may be necessary to slow down quickly if the critical Mach number is being exceeded or uncontrollability appears; in the event of explosive decompression with its dangerous impairment of human faculties, the pilot needs to have as few things requiring care and judgment to do as possible; during an approach or descent it becomes necessary sometimes to apply and release dive brakes frequently when it would be intolerable to have trim changes; dive brakes might also be used to shorten landing distances which may well be critical in turbo-jet airplanes and no change of trim would be acceptable when retraction became necessary as in the case of a baulked approach or landing.

Better Traffic Control

It was very definitely stated everywhere in the U. K. that before jet-powered aircraft can be used operationally in air transport work, the provision of more efficient traffic control and radio aids under instrument conditions, is mandatory. This is the thorniest problem of all, since it is generally held that even with the civil air transports currently in use, present landing aids for use in bad weather are even now inadequate. Even when turbine-powered aircraft cut out half their engines and cruise on the remaining while stacked, fuel consumption is still so high that large amounts of reserve fuel must still be carried to provide for holding missed approaches and diversion to alternate airdromes.

It was the opinion of one chief engineer of an aircraft manufacturer, that the use of jet-powered aircraft in scheduled air transport is still 20 years away for both high-altitude airworthiness performance and operational reasons. It was the opinion of this gentleman and others, that interim aircraft will be the prop-jet-powered airplanes.

Jet aircraft have many advantages over reciprocating engine propeller aircraft in that the jets can be grouped together, close inboard on the wings, and due to the absence of propeller disc, loss of power on one side scarcely affects controllability. Minimum controllability speed almost invariably will be below the stalling speed of the airplane, and loss of an engine on take-off should have far less disastrous consequences.

It is not anticipated that **take-off distance** will be critical in jet powered aircraft because, although initial acceleration is slower than with propellered airplanes, thrust actually builds up with acceleration due to ram, with jet aircraft, and falls off with acceleration in propellered aircraft. It is anticipated that take-off distances will remain virtually the same for aircraft of the same weight, equipped with different type power units.

Several test pilots express the opinion, however, that wing loading appears to be more critical in respect to turbo-jet-powered aircraft at take-off in so far as take-off distance is concerned, than with propellered aircraft.

It is expected that the landing distance will be critical with jet-powered aircraft, due to the absence of the propeller disc, and the braking effect of windmilling engines. One difficulty at present is that due to the care which must be exercised to avoid resonance during the first few thousand rpm of jet engines, it is customary to approach to land with the throttles set at that point where they may be opened rapidly without resonance or excessive jet-pipe temperature rises.

Fortunately, through the initial range of throttle opening, the thrust curve is very flat; nevertheless there is an appreciable increase of thrust. It is common practice to close the throttles only when a landing is obviously possible, and due to the absence of propeller discs, the aircraft floats a considerable distance without much decrease in speed.

It is the intention of the Air Registration Board when measuring landing distances of jet-powered aircraft, to require the manufacturer to make a declared throttle setting for the approach to land and to require the throttles to be in this position until the touchdown is made, after which the throttles may be closed. On very large, clean, tricycle undercarriage aircraft, the landing distance obviously would be great.

Among the other problems associated with the operation of jet-powered aircraft is that of **explosive decompression.** Above 40,000 ft. and certainly at 45,000 ft. life is possible only for a few seconds without pressurizing, and even 100% oxygen is not sufficient to sustain life for very long. Flying medical authorities at RAF Farnborough, told me that 100% oxygen would have to be available within three seconds after explosive decompression at 45,000 ft. and a rapid descent possible to at least 35,000 ft. for even that to sustain life. This would appear to be another reason why the provision of air brakes will be essential. They should be capable of being applied at optimum speed and quick acting.

In a jet aircraft with high pressure differential, the complete loss of a whole window, which might be considered explosive decompression, nevertheless takes quite an appreciable time for pressure equalizing between the interior and exterior. This is a slight safety factor. However, it would appear that passengers will have to remain strapped in throughout the flight to avoid the danger of being ejected out of the window.

Considerable experimenting is taking place with transparent materials which will withstand the great pressure differentials and the extreme differences in temperature between the interior and exterior without fracturing. It is understood that to date no really satisfactory material has been evolved.

One of the worst problems associated with high altitude flight is the **frosting of windows** and windshields when rapid descents essential with jet-powered aircraft are made. The frosting occurs on both surfaces and is extremely hard to remove. No entirely-satisfactory frost removal system has yet been evolved. Frosting is aggravated by the heating and humidification made necessary by the high altitudes and their low temperatures and humidity. I have heard of cases where a rainshower of thawing condensed moisture has occurred when descents have been made from very high altitudes.

Another problem visualized in the operation of jet aircraft is that of fuel losses through boiling. Let us take the case of a jet aircraft which has been refueled in high ground temperatures and has been sitting in a hot sun. Due to the high performance in climb provided by turbine power the aircraft will reach its operational height in a relatively short time, since this is necessarily a great altitude the fuel will boil and boiling will be more rapid with increasing altitude. Fuel losses experienced from this cause have been as high as 30% with gasoline. In large, long-distance turbine-powered transport airplanes this would be a serious problem since it is conceivable that it would take an appreciable time for the large mass of fuel to cool down enough to stop boiling.

During all the talks I had with manufacturers, test pilots, Ministry of Civil Aviation and Air Registration Board officials in the U. K. I found that thinking had not jelled in any way with respect to turbine-powered aircraft. Everyone appears to be keeping a very open mind and to be certain of very little at the present moment.

No one would venture, for instance, to prophesy as to when turbo-jet-power transports could be used efficiently in civil air transport. All felt that there were still too many problems to be overcome.

Reader's Voice

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ing my flight test I learned that the hours put in on my own plane would not count on the subsidy plan. My training had to be taken in a school plane.

Well, O.K., I'd lease the Luscombe to the Club and the D.O.T. said this would be fine. After another month or so the lawyer came out of his shell with a fine looking lease presumably covering everything. It was signed by club directors (after another few weeks waiting for a meeting) and copies were sent to the D.O.T. Ah! at last I was on my way! My hours started piling up again — almost 30, when the D.O.T. wrote saying that the lease was "not properly drawn up" as no stipulated amount for rental was in the agreement. I guess they figured I should lease the plane to the club for $10 an hour and the club should in turn rent it to me for $10 an hour (perhaps this would ease the unemployment, another bookkeeper would have a job).

By this time I was fuming, so made a visit to Mr. Saunders in Toronto and suggested that I had better either quit flying or go through on the 40-hour plan and forget the subsidy. Mr. Saunders, by the way, was very nice to me but explained that rules were rules and he could not change them. And that's how I finally got my license — on the 40-hour plan—no $100.

However my complaint is that I DID go to ground school and paid for it, I DID take instruction from a qualified instructor, I DID pass all the written exams and the flight test, I DID sign the agreement, I DID put in the required number of hours. In fact I did everything but get that elusive $100 simply because I trained in my own plane.

Isn't a privately owned plane constructed exactly the same as a school plane? It seems to have wings, ailerons, fuselage, elevators, rudder, etc., the same as the other planes in the hangar and yet the training I received in it does not count.

Has anyone else got stuck in this manner? I certainly would like to hear the experiences of some other plane owners who tried for their license in their own planes.

By the way, though, I still haven't given up! After reading Mr. Cox's letter I got steamed up again and wrote directly to Ottawa to see if I could get any action there. No reply yet of course as I presume the D.O.T. puts letters of this sort in what I term their "fortnight file" (to be answered in a couple of weeks).

In the meantime if Mr. Cox doesn't want his check tell him to send it on to an eager receiver.

Very truly yours,

Dorothy Rungeling
Niagara St. N.,
Welland, Ontario.