Pilot's Operating Instructions

MOST IMPORTANT TECHNICAL PUBLICATION OF ALL

By HARRY McDOUGALL

IN A RECENT article (*Aircraft*, August and September, 1955) the writer outlined some of the problems involved in the preparation of technical publications in the aircraft industry. One publication, however, was dealt with only superficially—the Pilot's Operating Instructions. This particular volume is probably the most difficult of all publications to prepare since usually only a small proportion of the required information can be readily crystallized. Information covering the actual handling of the aircraft is frequently the subject of considerable controversy, particularly in the case of a new type, or an extensively modified aircraft.

Memory Work: Neville Shute, in his book, "Slide Rule" tells how a test pilot spent "several hours" learning the details of a new type aircraft before flying it. It would be interesting to speculate how much study a post-war test pilot gives to an aircraft before that first take off, and how much instruction must be given to a pupil pilot before the function of each of the array of perhaps 200 knobs, buttons, switches and dials is fully understood. The problem of complexity shows little sign of diminishing. As manually operated systems are changed to automatic, new systems are added, and the cockpit of a jet aircraft continues to constitute a test of sheer memory as well as skill.

Having gone through the curriculum of piston and jet trainer types, the pilot graduating to an operational type must study the Pilot's Operating Instructions to familiarize himself with the aircraft and learn something of its performance and of its particular quirks and foibles.

Just how much and what information should be put into the Pilot's Operating Instructions is the thorny problem that the technical writer must try, with the assistance of everybody who has an opinion to express, to solve. The first issue of the Pilot's Operating Instructions is usually prepared in a very preliminary form but it always contains illustrations showing the layout of the cockpit and defines the purpose of each control. The first part, under the title of Description, gives a brief outline of the fuel system, hydraulics and other systems, stressing the operating techniques but dealing only lightly, if at all, with their mechanical features.

The second part covers Handling. This gives the procedure for all normal operations from climbing into the cockpit until the engines are finally switched off on completion of the flight. Emergency Handling, appropriately marked in red, covers the procedure to be taken in all foreseeable emergencies. The final section gives Operating Data; statistics covering performance, fuel consumption etc.

absorption factor

IT IS IN defining the extent of the coverage required in each section that difficulties begin to arise. The problem is not how much information to give in the book but how much a pilot can reasonably be expected to absorb. If every possible contingency were to be covered, the book would be so big that no pilot would be able to memorize more than a fraction of it. Since the pilot can hardly be expected to fly with the control column in one hand and the Pilot's Operating Instructions in the other (!) the book must obviously be kept as concise as possible.

How concise can you get—with safety?

If an accident occurs the technical writer knows that a search will be made through the book to see whether the particular emergency which caused the accident was catered for. If not, then he is conceivably at fault. Yet if every possible emergency were to be covered the book would became so large that nobody could hope to absorb all the information it would contain. Therefore he must exercise his own judgment in selecting what to put in the book and what to leave out. Experience has proved that if the book is kept small it will be of the utmost use to the pilot since he will read it and make a genuine effort to commit the information contained in it to memory; but the writer will run the risk of failing to cover some particular emergency. Conversely if the book is very comprehensive the writer will probably be "fire-proofed" against criticism, but the book will be so bulky it is improbable that the pilot will read it. To the technical writer, this almost amounts to a problem in ethics.

Matter of Judgment: Only by discussing the operating techniques with company test pilots, RCAF pilots from operational squadrons and all others qualified to express an opinion can he effect a reasonable compromise between the two extremes and even then he must, in the final analysis, rely largely upon his own judgment. It is usually possible to get opinions on the correctness of a statement once it is written down but it is almost impossible to get any person to vouch for the completeness of the coverage. Since the omission of an important item of information can be just as disastrous as an erroneous statement, the technical writer must give as much attention to the scope of the publication as to its accuracy.

The procedure to be taken to cope with foreseeable emergencies, e.g., running out of fuel, is covered as a matter of course but complications arise when minor mishaps occur, insignificant in themselves, but which combine with each other to form unusual conditions which could not conceivably have been catered for. It is in trying to foresee how these combinations of small faults can add up to a major failure that the technical writer must exercise more than average skill. He must, in assec-

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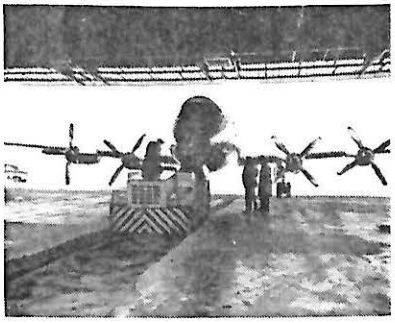
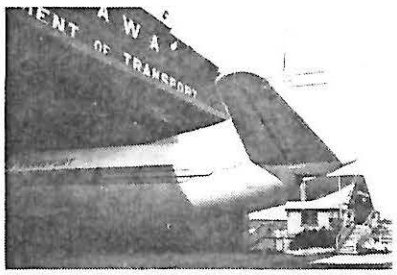




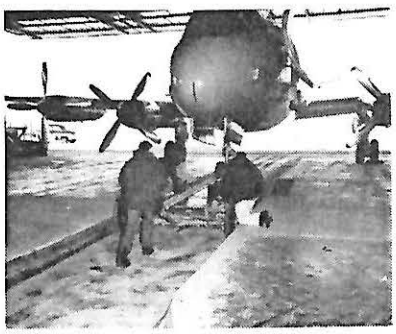
Tale of a Tail

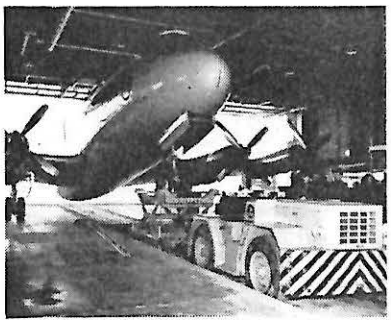
When the DoT acquired a Vickers Viscount last year, it also acquired a king-sized hangaring problem. This problem, reduced to its simplest terms, was a matter of getting an airplane with a 27-ft. high vertical fin through a 21½-ft. door.

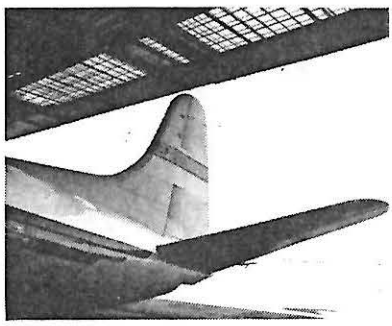
To have enlarged the hangar door at the DoT Viscount's Ottawa Airport base of operations would have meant a major alteration costing $75,000 or more. A clever solution to the problem costing a fraction of this amount, was devised by DoT Supt. of Flight Operations J. D. Hunter and Base Supervisor Harry Cashell. The solution involves a hydraulic lift trailer, a shallow trench in the hangar floor and a door in the hangar's rear wall, large enough to permit passage of a small tractor.

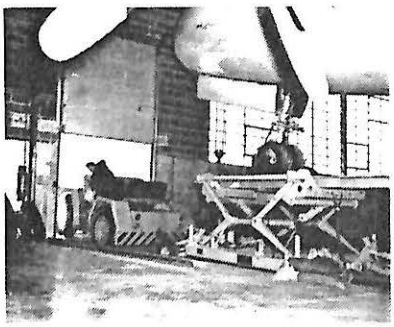
The lift raises the aircraft's nose four feet, thereby depressing the tail 6½ feet, thus allowing the Viscount to be pulled into the hangar with a foot to spare. Once the transport is completely inside, the nose is lowered and the fin nestles comfortably between the hangar's roof trusses. The procedure is reversed when moving the Viscount out of the hangar. The hangaring operation requires 20-25 mins. and the services of three men.

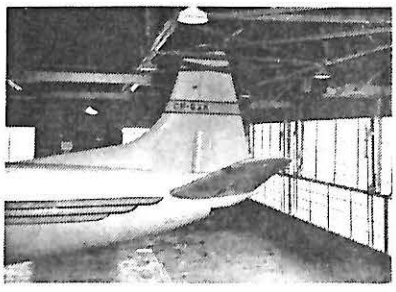
Pictures show, left, top to bottom: tractor entering trench in hangar floor; hangaring crew pushing hydraulic lift trailer into position to receive nose wheel; the nosewheel has been fastened to the trailer which has been elevated; the tail fin just as it enters the door; having completed its job, the tractor is leaving by the special rear door. Picture at top shows Viscount tail before entering hangar door, and bottom, after the aircraft is inside.











iation with the test pilot, devise procedures to be adopted in emergencies which might never arise.

Varied Opinions: Opinions on such procedures can vary widely. The action which would be taken in a particular emergency by a skilled test pilot is not necessarily that which should be taken by a relatively inexperienced pupil pilot. If an aircraft goes into a spin below a certain altitude it becomes prudent to abandon it. But at what altitude? An experienced test pilot thoroughly familiar with the aircraft will give one figure; an Air Force pilot, new to the aircraft will give another; an instructor teaching the aircraft to pupils experienced only on trainers will give a third. Which is the correct one?

The use of modern canopy and seat ejection apparatus arouses considerable controversy. Due to the nature of the apparatus, extensive tests obviously cannot be undertaken. Yet the writer must not only insert into the Pilot's Operating Instructions the actual ejection techniques but must obtain all other available information on the altitudes, speeds, etc., at which ejection is safest.

Where and when to insert the familiar NOTES, CAUTIONS and WARNINGS, probably causes more differences of opinion than any other single problem. A NOTE is defined as a statement to which it is desired to draw particular attention; a CAUTION is a statement which, if ignored, can result in damage to an aircraft and a WARNING is an instruction which, if not complied with, can result in loss of life. These definitions however, although good as a general guide, cannot always be applied literally and the proper classification of the information is largely a matter of opinion.

No Extremes: Thus, the pilot is told to pull back the control column at takeoff. Carried to an absurd extreme this could be followed by a WARNING covering the disastrous results of failure to do so. The technical writer must take the best opinions he can get and then use his own judgment, his usual endeavour being to keep insertions of this nature to a minimum. It is annoying to a reader to peruse a publication which consists largely of NOTES, CAUTIONS and WARNINGS strung together with occasional sentences of narrative. Nor is such a publication likely

Soaring Meet

"The gliding enthusiast has an exceedingly important and special role, for here real and genuine enthusiasm must be the basic test," Deputy Transport Minister J. R. Baldwin told the Soaring Association of Canada, in convention at Ottawa early last month.

"Pure knowledge and pure skill are the final support for the individual, without any reliance on help from the explosive qualities of gasoline," Mr. Baldwin continued. "This is a challenge for the man whose interest is not just sky-riding but knowledge of the basic features that go into aviation, the straight-forward concepts of lift and drag and the effect of varying wind currents upon them."

He pointed out that the Department of Transport had issued some 201 glider pilot licenses, of which 42 had been issued in 1955. All of them were actively in force.

During the course of the meeting the association elected Richard Noonan as its new president. Mr. Noonan, who is from Winnipeg, succeeds John D. Agnew of Montreal, president for the two preceding years. Frank Brame of Toronto was re-elected to a second term as vice president.

The annual meeting was once again the scene of a number of presentations. To the Southern Ontario Soaring Association, formerly the Toronto Gliding Club, went the Roden Trophy, awarded each year to the Canadian gliding club showing the most activity and efficiency during the year.

Barrie Jeffery of Ottawa received the "Ball & Chain" Trophy, which is presented annually to the male Canadian glider pilot who most successfully combines gliding and marriage. To Mr. Jeffery also went the British Aviation Insurance Co. trophy for the year's best distance flight.

Jack Ames of Toronto was declared National Meet Champion, repeating his victory of the year previous.

The Canadair Trophy went to Frank Brame of Toronto, in recognition of his status as Canadian Soaring Champion. The Trophy, offered for annual competition by Canadair Ltd., was awarded on the basis of the aggregate of Mr. Brame's five best sailplane flights during the year: 209 miles from Regina, Sask., to Minto, North Dakota; 165 miles from Regina to Gainsborough, Sask.; 57 miles from Brantford to Orangeville, Ont.; 47 miles from Brantford to Brampton, Ont.; 42 miles from Brantford to Dunnville, Ont.

Picture at top shows Mr. Brame (left) receiving the Canadair Trophy from John Agnew of Canadair (right), while John Baldwin, Deputy Minister of Transport, looks on (centre).

During the meeting, the SAC also chose the team which will represent Canada at the World Gliding Championships, to be held this year at St. Yan, France, from June 29 to July 13. The actual competitions are to be preceded by a practice week, starting June 22. The team will be headed by Frank Woodward, team captain and manager, and will include Jack Ames, Frank Brame, Elvi Smith, and Al Pow. It is expected that some 20 countries operating approximately 60 machines will compete at St. Yan.

to increase his confidence in the aircraft.

Queries are sometimes raised due to the Pilot's Operating Instructions conflicting with the aircraft Model Specification. The Model Spec. might call for the aircraft to be able to fly inverted for a given length of time. The Pilot's Operating Instructions may quote a time considerably less. This does not imply that the aircraft cannot meet the specification, merely that the writer has inserted a reasonable limit for normal operation. This safety factor is also built into the Operating Data covering fuel consumption. The figures are invariably conservative. The Operating Data in the first issue consists of calculated figures inserted in the charts in red. These figures are later test-proved, changed as dictated by experience and re-inserted in black.

Of particular importance with a modern jet aircraft is the section covering handling of the fuel system. The correct handling of fuel systems has become increasingly important with the advent of the jet engines. It is no longer possible to drain one tank and then switch over to another when the engine falters, since with a jet engine such a procedure would result in a flame-out. The pilot must be quite positive in his fuel system selections, and the Pilot's Operating Instructions must contain very full information on this particular system. With some modern aircraft amply endowed with cross-feeds and shut-off valves, a total of over fifty different selections may be possible. Of these, the pilot might reasonably be expected to memorize five or six—but which five or six? This apparently simple problem can cause a considerable amount of debate.

Pictures: The illustrations for the Pilot's Operating Instructions are mainly cockpit layouts, supplemented by additional detail drawings of particular controls and instruments, schematics of the fuel system with diagrams of the various selections and other miscellaneous sketches intended to draw attention to specific points. A recent innovation is the provision of cartoons. These are not intended merely to entertain the reader but to increase interest. If the pilot chuckles over the cartoonist's interpretation of the consequences of committing an error, he will probably

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FUEL CONTROL

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around the tapered end of the valve, permitting more fuel to flow. This opening and closing of the servo valve and movement of the piston is taking place automatically while the pilot is flying the aircraft, thus the fuel flow is trimmed to suit the changing conditions of flight.

Acceleration Control: Still another adjustment has to be made, this is to control the fuel flow during acceleration, when there is a danger of overfueling at the early stages of throttle opening. This could cause a situation where the sudden increase in fuel burning results in the setting up of a back pressure at the rear end of the compressor, sufficient to damage the compressor blades. This condition is called "compressor stall" and is avoided by making use of the pressure differential across the compressor in conjunction with a pressure modulator. The modulator is a sub-assembly of the acceleration control unit (A.C.U.) containing a capsule stack, one section of which is open to compressor inlet pressure. A series of restrictors and a half-ball valve, modulate the compressor inlet and outlet pressures which are passed on to a second chamber containing a closed bellows assembly. When the modulated pressure is sufficiently high, the closed bellows contract to open the metering valve servo valve and bleed fuel from the back of the metering valve piston. This permits the metering valve to move to allow an increased flow of fuel, sufficient to accelerate the engine within the specified time limit and yet avoid overfueling at the critical engine speed.

The A.C.U. also contains a pressure drop piston and servo valve mechanism which bleeds the pump servo line to reduce pump delivery should the A.C.U. fuel inlet pressure get too high in relation to the outlet pressure.

The foregoing is only a very brief description of how the Lucas-Bendix flow control unit operates. However it should be sufficient to provide an insight into the subject without getting too involved.

PILOT'S NOTES

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remember not to commit that particular error himself. Cartoons, however, fail if they do not get the point over to the reader. Used with discretion, they are a useful attention-getter. Used freely they can reduce the book to an inferior type of comic strip.

When the manual has been drafted and the illustrations are in a sufficiently advanced stage of preparation, the contents of the book are agreed, paragraph by paragraph, with the company test pilots. This may be a lengthy procedure since opinions on operating techniques may vary widely, and test pilots, particularly when the weather is good, are busy people. Eventually agreement is reached with them and with other interested parties within the company and then a conference is called at which RCAF representatives go over the draft and make their comments and suggestions. A technique advocated by the aircraft manufacturer may not be agree-

able to the operational squadrons. If not, suitable changes are made. At these conferences, various departments may delegate representatives to cover particular phases of the operation of the aircraft. The importance of accuracy in this particular publication is widely recognized and the full co-operation of all parties is readily given.

A problem arises when a series of aircraft has been considerably modified but when all models must be covered by a single issue of the Pilot's Operating Instructions. A change in the operation of a single switch can require changes in several parts of the text covering Description & Operation, one or more changes in the Handling section and several further changes in the Emergency Handling sections.

Possible Confusion: Similarly, when the text reads, "If this switch is fitted . . . and if the switch is not fitted . . . " and the situation is multiplied by dozens of such instances, the result can be confusion, and only the skill of the writer can prevent confusion degenerating into chaos. He must decide where to cover the situation with an extra paragraph, where by a complete new procedure, and where—in the extreme case—by finalizing the book, identifying it as "Applicable to aircraft up to Serial No. . . . . " and requesting permission to start afresh with a completely new publication.

Although the Pilot's Operating Instructions is one of the smallest publications prepared by a Technical Publications Department it is printed in greater quantities and is probably more widely read than any other.

Even before the first issue of the publication has left the press, work has usually commenced on amendments. These rarely involve radical changes since the first issue must be essentially correct. However, as experience with an aircraft is gained, so the operating techniques to be used can be improved. The writer relies largely on personal contact with the test pilots and others in close contact with the aircraft and in particular on discussions with Service pilots to improve the publications and continue the process of addition and deletion. As new or improved techniques are added, so the "dead-wood" is progressively removed. As the RCAF gradually becomes an almost all-jet service, the generalizations about keeping a certain distance away from the intake or the jet pipe when the engines are running and similar information can be deleted. It is sometimes found that by adding a carefully thought-out illustration, it is possible to delete a considerable amount of text while still giving essentially the same information.

Readership: Can the type of Pilot's Operating Instructions produced at present be improved? Many pilots believe that a simple change, reduction of the format to a size where the publication can be slipped into the pocket, would increase the "readerage factor" immeasurably. The use of more pictures and less words will also assist the reader in assimilating the information he requires, and this latter is now a distinct trend in all Pilot's Operating Instructions.

Perhaps the biggest problem is that of presenting operating data in an intelligible form. Although the charts presently supplied give a reasonable amount of data, it is necessary for the user to "live with" them to comprehend properly all the factors involved and plan his flights to make full use of his available fuel. Even then it is virtually impossible to cover every contingency. It frequently happens that a jet pilot running short of fuel can travel farther on his remaining fuel by climbing higher and the problem thus becomes one involving an infinite number of variables. There are even instances where, with multi-engined aircraft, range can be extended by switching off one engine; although this is an emergency procedure not normally catered for.

Generally, all Cruise Control data is conceived with one end in view—to travel the farthest distance on the fuel available. The basic problem is to get the pilot home with a reasonable margin of fuel. And even this basic thinking has been questioned. One pilot read very carefully through all the data provided and then said "But suppose I have plenty of fuel to get me home, but my wife is waiting at home for me to take her to an early movie. How fast can I go and still not burn too much?" ! ! To answer that one question would have meant just about doubling the number of charts in the book. So far, nobody has solved his problem.