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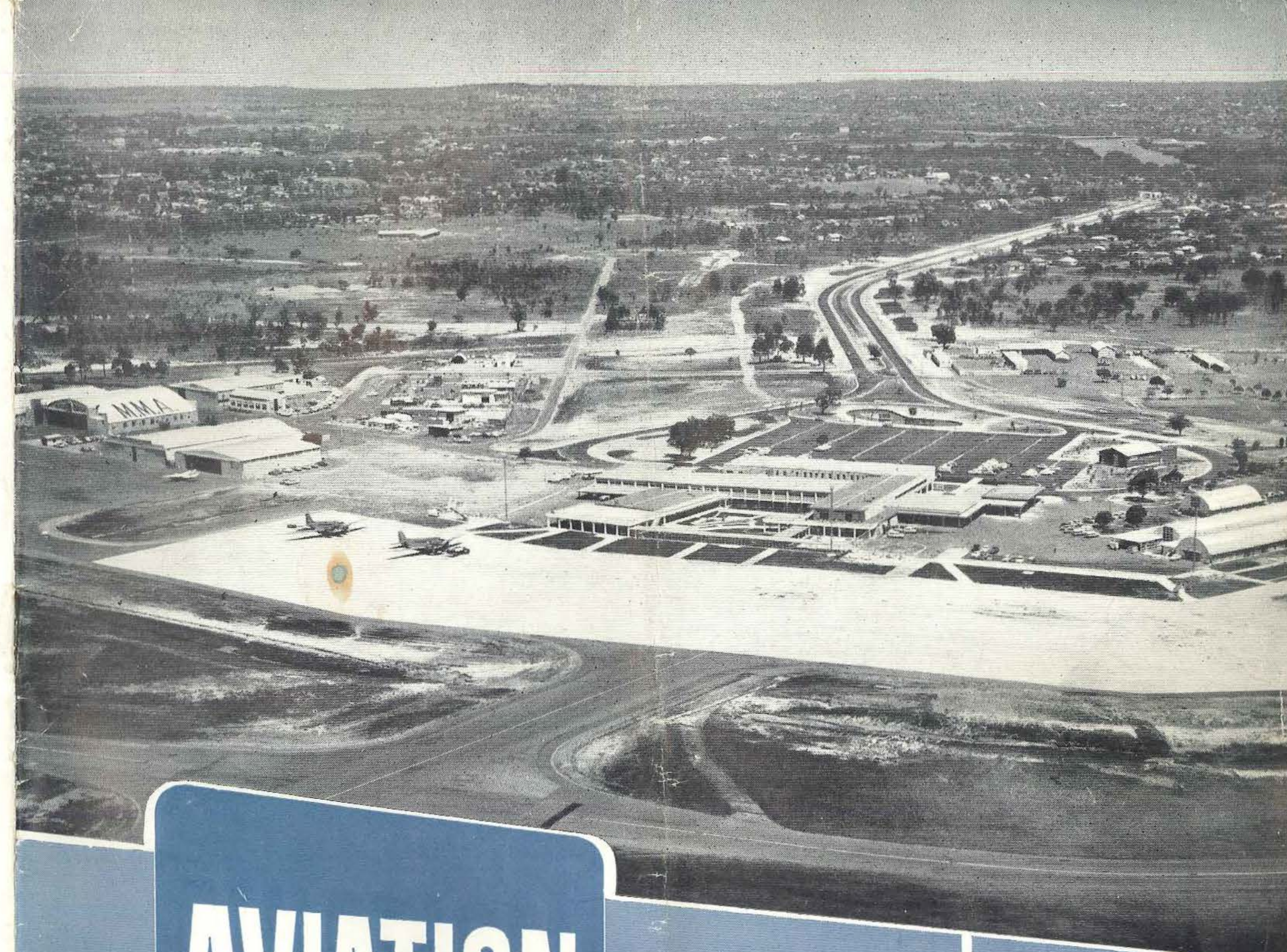

AVIATION SAFETY DIGEST

No. 32, DEC., 1962

DEPARTMENT OF CIVIL AVIATION

AVIATION SAFETY DIGEST

No. 32 **December, 1962**

Prepared in the Division of Air Safety Investigation
Department of Civil Aviation

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The New Passenger Terminal Loading Apron — Perth Airport.

Commonwealth of Australia

YOUR FLIGHT and RADIO COMMUNICATION

Without radio communication and radio navigation equipment airline transport services would not exist. Although light aircraft pilots are not and probably never will be equally dependent upon radio navigation aids, the proper use of efficient communication equipment is essential if the potential of the modern light aircraft is to be fully utilised for travel purposes. The right to use the aeronautical communication system imposes an obligation upon all pilots to become proficient in the art of voice communication.

The ever-growing network of airline transport routes, together with the wide range of performance obtained from the aircraft types used in transport operations, has brought more and more airspace under the jurisdiction of air traffic control during recent years. Control areas have been widened and, although some of the lower limits of these areas were raised in an endeavour to lessen the restrictions imposed on the light aircraft operators, it has been found necessary to extend the upper limits to embrace the higher altitudes used by the jet-engined transports.

Concurrent with this expansion of controlled airspace came the introduction of higher performance light aircraft, which in turn led to a rapid increase in private and business flying and also in flying training. This not only produced congestion at the capital city secondary airports but more and more operators sought permission to penetrate controlled airspace to obtain the full benefit from their aircraft.

It soon became essential for light aircraft to have air-ground communication equipment installed, to enable air traffic control to more readily integrate and control the flow of air traffic, distribute in-flight information and provide safe separation in the congested traffic areas. The widespread introduction of communication equipment provided worthwhile bonuses for pilots by way of simplification of flight notification and better in-flight information. Most important of all, however, was the benefit offered to pilots in the field of search and rescue. The light aircraft pilot is no longer "on his own" once airborne and he has available to him a nationwide network ready to provide advice or assistance on request, or on receipt of a distress transmission in an emergency.

Even though efficient radio communication equipment is available in most light aircraft, many pilots still experience difficulty in establishing contact due to gaps in their own knowledge of radio communication procedures and operating techniques, or because of the shortcomings of other pilots who are using the same frequency. The difficulties which one pilot experiences is only a fraction of the problem presented to the air traffic control and communication officers who have to cope with the shortcomings of a great number of pilots every day.

It was perhaps inevitable that the rapid increase in the number of radio equipped aircraft would present problems of this nature since most light aircraft pilots were trained in non-radio equipped aircraft. It is acknowledged that the standard of radio operating techniques by light aircraft pilots has shown considerable improvement during the past year and it is expected that this trend will continue as more and more pilots receive basic training in voice communication procedures. Nevertheless, many of the difficulties would be eliminated more readily if light aircraft pilots practised their radio-telephony techniques as diligently as they work at improving their flying skill.

To achieve proficiency in the art of radio communication pilots should have a basic understanding of the airways communication network and be aware of the services which can be obtained. They should be conversant with the frequencies appropriate to particular areas and services, and ensure that the appropriate reference documents are readily available. In addition, it is necessary to understand the propagation characteristics of VHF and HF and know the limitations of the equipment, both generally and in relation to the individual aircraft installation. A thorough knowledge of the operational requirements relative to flight in controlled airspace is also essential.

The ground stations of the Australian aeronautical communications system comprise an integrated network of air traffic control and communications units throughout the Australian mainland and New Guinea. In general, aircraft operating within controlled airspace are in direct contact with air traffic control (A.T.C.) units for the purpose of obtaining aerodrome surface movement control, aerodrome control, approach control, area control, radar control, operational control, search and rescue (S.A.R.) alerting and flight information services. Aircraft operating outside of control zones and controlled areas are normally in contact with the communication units (COM), which provide flight information and S.A.R. alerting services. The communication units, as part of the complete airways organisation, are directly linked with the air traffic control and flight information centres for exchange of information, for relay of requests, for traffic clearances and S.A.R. action. Whilst each unit is normally responsible for services to aircraft operating within its own defined area, the system is such that the ground stations offer each other mutual support in effecting communication with aircraft. This network concept is necessary because of the characteristics of the HF frequencies which are often subject to "skip" effects at certain times of the day.

To make the best use of radio equipment it is necessary to understand the behaviour of the frequencies used in the aeronautical network, and, where alternatives are available, to use the frequency which is best suited for the immediate purpose. In general, the VHF band provides the best frequencies for short ranges but in practical terms reception is restricted to "line of sight" transmission. For this reason, when aircraft are on the ground or at heights much below 1,000 feet, contact with other ground stations will be limited to a distance of approximately 15 nautical miles. A range of the order of 40 miles will be achieved at 2,000 feet, 65 miles at 4,000 and 120 miles at 10,000 feet. Transmitter power output has only a minor effect on the range achieved in the VHF band and an output of one watt is almost as effective as five watts, provided, of course, that the receivers used are of normal sensitivity.

Although the limited range of VHF equipment renders it ineffective for other than short range communication, this characteristic allows common frequencies to be used for similar services at different points in the network, provided adequate geographical separation exists. Unfortunately it is necessary to also utilise the HF bands, which are capable of long range communication but are subject to varying "skip" effects arising from the diurnal movement of the reflective layers in the upper atmosphere, to ensure complete communication coverage throughout the network.

The long range characteristic of the HF band frequently results in interference between stations situated great distances apart. To eliminate this as much as possible the HF network is divided into four basic areas, as illustrated. Each of these areas has been allotted certain frequencies in the 3 mc, 5 or 6 mc, and the 8 mc frequency bands. The behaviour of the frequencies within these bands, so far as they concern light aircraft communication at this time, are set out below. The distances quoted can vary appreciably throughout the 11 year sunspot cycle, during which the ranges change from a minimum to a maximum.

Daylight Conditions (0800-1600 hours local time)

3 mc.	: Ranges of 100 n.m. or a little more, with no "skip" effect.
5 and 6 mc.	: Ranges up to 500 n.m. with little or no "skip".
8 mc.	: Ranges up to 800 n.m. with a probability of "skip" resulting in loss of communication whilst the aircraft is between approximately 50 miles and 200 miles from the ground station.

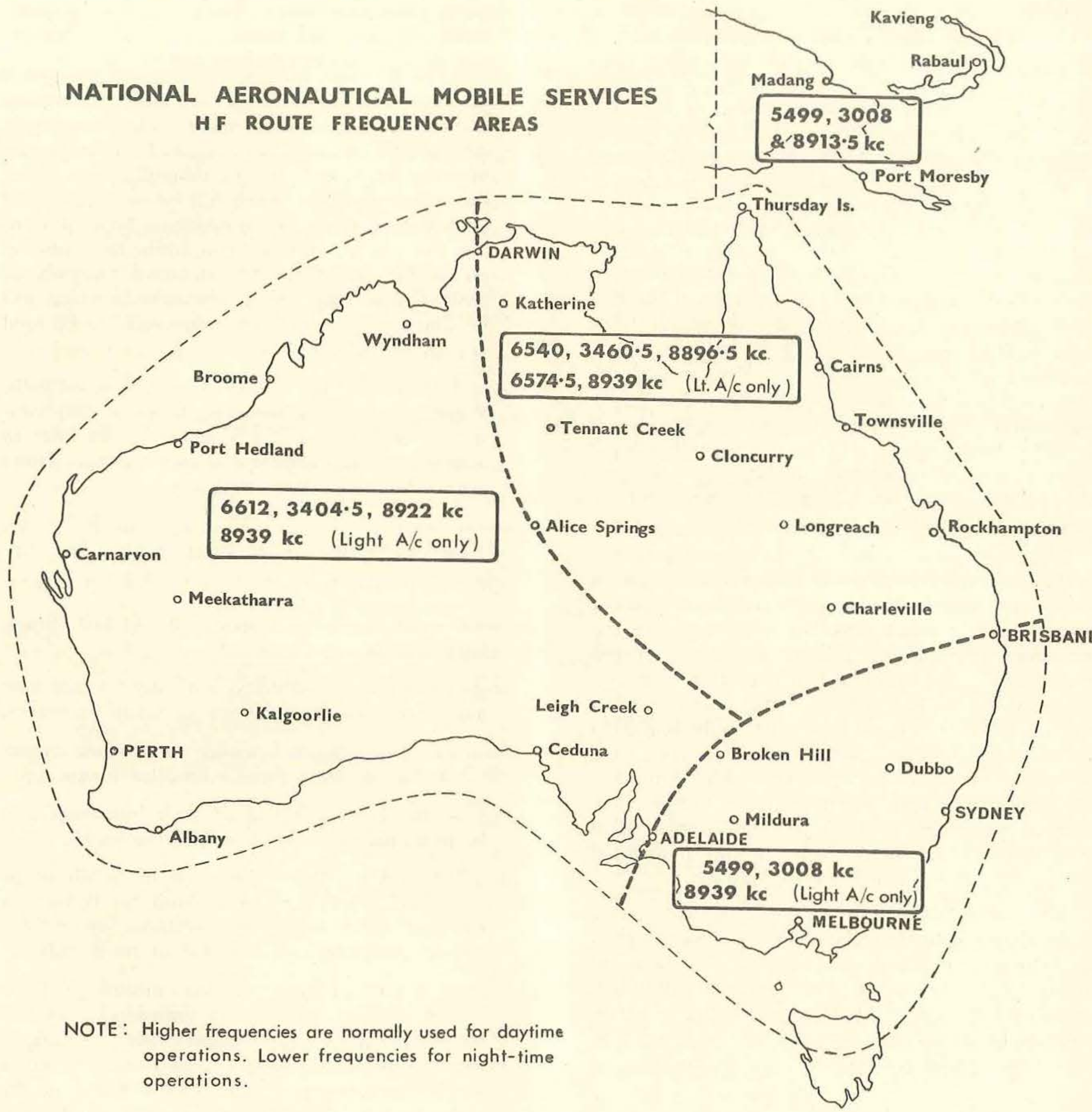
Night Conditions (1600-0800 hours local time)

3 mc.	: Range may extend to 800 500 n.m. without any appreciable "skip".
5 and 6 mc.	: Range may extend to 800 n.m. "Skip" will probably occur between about 50 and 200 nautical miles.
8 mc.	: Range may extend to 1,500 n.m. "Skip" will probably be experienced between 50 and 400 n.m. from the ground station.

It is obvious that as most light aircraft are confined to daylight operations the 3 mc. frequency is of little value for "en route" communications except when less than 100 miles from the ground station. Because it is effective over the shorter ranges, however, it is used as an alternative to VHF frequencies for aerodrome control purposes, thus eliminating the need for owners to install both HF and VHF equipment in their aircraft. The characteristics of the frequencies on the 5 and 6 mc. band are substantially similar to those of the 8 mc. band and between them these frequencies provide ranges sufficient to ensure communication with a ground station somewhere in the network.

For obvious reasons, it is essential that the weight of radio equipment in light aircraft be kept to the minimum commensurate with the performance required. To achieve satisfactory results from these units the pilot must ensure that the set is operated and maintained correctly and that its performance is not affected by outside influences. In spite of its simplicity particular care is required in the adjustment of the volume control in the modern HF Transceiver. In general, when flying away from a ground station, it is necessary to continually advance the gain, especially when operating in the 3 mc. band where the signal strength may decrease very rapidly. If the volume control is not advanced the ground signal may be lost in travelling only a short distance. The reverse applies, of course, when approaching a station, as excessive volume will produce severe distortion and reduce readability.

NATIONAL AERONAUTICAL MOBILE SERVICES
HF ROUTE FREQUENCY AREAS



NOTE: Higher frequencies are normally used for daytime operations. Lower frequencies for night-time operations.

Ignition and generator noises are a source of trouble which is frequently overlooked by pilots. These effects cause a reduction in performance and sometimes result in radio equipment being unnecessarily removed from service. This type of difficulty can be recognised and eliminated if adequate radio checks are carried out prior to flight and the manufacturers recommended inspection and maintenance tests faithfully followed.

The use of a trailing aerial is a definite advantage, particularly where difficulty is being experienced in communication on the lower frequencies in the HF band. Below 8 mc., the fixed aerials installed on many light aircraft radiate less than half the power developed by the transmitter. Modern methods of fitting a manual drogue-operated trailing antenna are comparatively simple and inexpensive. Where the performance of an HF transmitter with a fixed aerial is not meeting operational needs, it is suggested that owners seek advice from an appropriate organisation regarding the installation of a trailing aerial.

The frequencies appropriate to the communication services throughout the network are clearly set out in the Light Aircraft Handbook; so, too, are the procedural requirements relative to the search and rescue service, for entry to and operation in contol zones and contol areas, and for the communication function itself. The Light Aircraft Handbook merely sets out the basic knowledge which a pilot must have to achieve a successful operation. Unfortunately, this seems to be regarded by many as the practical optimum, whereas, in fact, there is a great deal more that can and should be learnt and practised if one is to become a skilled radio operator.

In the course of preparing this article field officers of the Department throughout Australia were invited to comment on errors in procedure that are encountered in day-by-day communication with light aircraft pilots. There was a large measure of agreement as to the most common types of errors and the following advice is based on this experience.

To reduce the communication time consumed by each aircraft all pilots should observe the following points:—

Answer calls as soon as possible, and make all transmissions of a short, concise and impersonal nature.

Use the standard phrases specified in COM-2 of the Light Aircraft Handbook (L.A.H.). When there is a need to depart from the standard phrases, the improvised message should be consise and clear. If possible, think out and write down the message before calling.

Know the phonetic alphabet and the proper pronunciation for the transmission of numerals set out in COM-2 of the L.A.H.

Understand the phrases used by ground stations. If you have the opportunity spend an hour or two at one of our ground stations and listen to the operator at work. Before take-off think about the communications which will be required during the course of the flight. If necessary seek information from A.T.C. or COM concerning the reporting points for the flight, the standard methods of position reporting, the ground stations which will be contacted and the best frequencies to be used during the flight.

Avoid "jamming" the frequency with repeated calls. Where a call is not answered, transmit your message, then listen out. Try again a little later to obtain an acknowledgment of your message. Don't acknowledge an acknowledgment.

When operating in or near controlled airspace, the following points are important:—

Never enter controlled airspace without first obtaining a clearance.

Remember that the submission of flight details does not amount to obtaining an air traffic clearance.

Maintain a continuous listening watch when operating in or about to enter controlled airspace.

Advise the ground station of your intentions if it becomes necessary to close listening watch.

Read back flight levels contained in an air traffic control clearance and understand the distinction between flight levels and altitudes, as defined under "Altimetry", R.A.C. 1-3 of the L.A.H.

Advise A.T.C. of your position, altitude and expected track if, through an emergency, you are forced to enter or even suspect that you may be entering controlled airspace. If unable to make direct contact with A.T.C. advise COM of the facts and inform them of the frequencies that are available in your aircraft.

In regard to the general aspects of radio communication, owners and pilots should note:—

Before purchasing or installing new radio equipment in an aircraft, it is advisable to discuss the suitability of the proposed equipment with Regional Officers of the Department.

A radio check should be carried out before departure or at the first opportunity en route.

Trailing aerials should be used for HF, when fitted.

Headphones should be used in preference to loud speakers if communication conditions are at all difficult.

When unable to establish contact —

- **assume that the transmitter is working and broadcast your intentions. Do not assume too readily that because you have not received an acknowledgment, your transmission is not being received.**
- **endeavour to use other aircraft for relay purposes, if necessary utilising different frequencies.**
- **Call "all stations" if the message is important, such as in an emergency. This alerts the entire network and ensures immediate relay action by any station receiving the transmission.**

Remember to adjust the volume control as you advance toward or depart from a station.

Use correct microphone technique. The microphone should be held so that it is almost touching the lips, to exclude extraneous aircraft noises as much as possible. Speak all words plainly and end each word clearly, to prevent the consecutive words being run together. Preserve the rhythm of ordinary conversation. Avoid any tendency to shout or to accentuate syllables artificially. Avoid variations in the intensity of speech and the introduction of hesitant sounds as "ah" and "er". Maintain a business-like manner, do not use colloquialisms and christian names. Don't indulge in irrevelant personal conversations.

Do not forget to listen out before transmitting, or to press the transmit switch before speaking.

Request air traffic clearances at least 15 minutes before the estimated time of reaching controlled airspace.

Never acknowledge receipt of a message without question, unless you are sure of the intention of the message. Don't be too proud to use the phrase "say again" to confirm your understanding. If necessary for comprehension, ask the ground station to speak more slowly.

Always use three letter call signs and avoid the repetition of call signs at the end of a message.

Do not fail to cancel the S.A.R. watch where a SARTIME has been nominated. Radio contact with the destination aerodrome does not necessarily constitute an arrival report, as specific reference must be made to the cancellation of S.A.R. services.

To avoid misunderstanding between the pilot and the attendant A.T.C. or COM services pilots must clearly indicate the extent of position reporting that will be carried out during a particular flight, at the time of submitting the flight notification. This information provides the basis of the subsequent S.A.R. action. Where a flight is complying with the full in-flight position reporting procedure, S.A.R. action will be initiated immediately an aircraft fails to report at a designated position. Where a SARTIME is nominated, it will be assumed that the flight may or may not report position and S.A.R. action does not take place until after the nominated SARTIME unless there is other advice which indicates that the aircraft is in need of assistance. Where radio is carried but "NOSAR" is nominated, A.T.C. or COM. will assume that the aircraft may or may not report during the flight and S.A.R. action will be initiated only when a degree of apprehension is felt for the safety of the aircraft.

Notification of a proposed flight simplifies communications in the event of an emergency. When faced with a distress call under circumstances where no prior advice of a flight has been given it may be necessary for the ground station to attempt to obtain additional information from the pilot in order to establish his whereabouts during the short time that may be available. To avoid this, ensure that flight notification is passed to A.T.C. or COM at all times and that en route reports are transmitted.

Most of these points are common sense, which amounts to knowing precisely what to say, saying it without hesitation and in the clearest possible terms. Above all else, don't overlook the importance of using your radio to obtain a clearance before entering controlled airspace. The speed at which modern airliners operate is such that there is little time for collision avoidance; consequently, the responsibility for safe separation rests largely with A.T.C. Unless they are fully informed of the height, heading and position of all aircraft in the controlled airspace, air traffic controllers cannot effect separation. In this field the proper use of your radio can be a life-saver.

Loss of Hydraulic Fluid Proves Costly

DENVER, COLORADO

(Summary based on the report of the Civil Aeronautics Board, U.S.A.)

At 1136 hours on 11th July, 1961, a Douglas DC-8 crashed during its landing roll at Stapleton Airfield, Denver, Colorado. None of the 122 occupants was severely injured as an immediate result of the impact. There were, however, 17 passenger fatalities, 16 of which resulted from carbon monoxide poisoning when the aircraft burned. In addition, the driver of a panel truck, which the aircraft struck after leaving the runway, suffered fatal injuries.

INVESTIGATION

The flight originated at Philadelphia and was scheduled to proceed to Chicago, Omaha and Denver. The first two stages were completed without incident. The operation of the aircraft and its systems were normal during taxi, take-off and climb out of Omaha. At about 20,000 feet the crew noticed that the manual reversion lights in the flight control system were indicating that the hydraulic boost controls had reverted to manual system and the hydraulic fluid quantity gauge indication was decreasing rapidly. They immediately isolated all hydraulic systems by placing the system selector lever in the No. 1 position and the engine-driven hydraulic pump by-pass switches in the "off" position. The reading of the hydraulic quantity gauge stabilized at the midpoint of the low range of the instrument.

The captain, who had been flying the aircraft manually, passed control over to the first officer whilst he and the second officer evaluated the situation, consulting the aircraft manuals and an operator's training bulletin. They decided that they had an abnormal rather than an emergency situation, and therefore elected to continue to Denver rather than return and take advantage of the longer runway at Chicago.

(All times stated are local time)

As the flight progressed the crew passed appropriate advice of their situation to air traffic control and company officers, calculated the critical speeds and other data required during the landing and further reviewed the situation. As a precaution, after commencing descent into Denver, permission was requested and received for the flight to hold at 14,000 feet in order to check out the hydraulic system for landing.

The crew then tried to extend the ejectors (engine thrust reversing assemblies) by letting the airstream blow them back. This was unsuccessful even when they increased speed from about 180 knots to 260 knots. This action undertaken by the crew was of no value because the system is designed to prevent, by mechanical means, blowback of the ejectors under aerodynamic loads. After reducing speed again, they turned on the auxiliary hydraulic pump. Pressure built up to 3,000 p.s.i., steady blue lights indicated that the ejectors had extended properly, and the hydraulic fluid quantity indication remained constant.

The captain then called for and obtained 15 degrees of flap. At the same time the slot extend indicator light came on and then went out, indicating that the wing slots were open and locked. The hydraulic pressure gauge indicated 3,000 p.s.i., and the quantity remained constant. After completing the approach descent checklist and receiving a clearance to the airport, 25 degrees of flap was selected. At this time, the hydraulic pressure fluctuated rapidly and then fell to zero. The hydraulic fluid quantity gauge indication fell to a point about ⅛ inch from the bottom of the scale, whereupon the flap selector lever was returned to the 15 degree detent and the auxiliary pump was turned OFF.

It was then decided to allow the gear to free-fall. The three green landing gear indicator lights came on, indicating that the gear had locked down. Throughout this operation the hydraulic quantity indication remained constant. The hydraulic system selector control was then placed in position No. 3, the auxiliary pump was turned on, the flaps were selected to 25 degrees and extended normally.

The captain decided to use runway 26L so as to avoid flying over the city and because this runway offered a flatter approach. After the final checklist was completed 40 degrees of flap was obtained. The approach speed was kept at approximately 155 knots in case the flaps returned toward their retracted position. Approximately one-half mile from the threshold airspeed was reduced and the flaps were lowered to 50 degrees. The aircraft crossed the runway threshold at a speed of 125-128 knots and a normal touchdown was made at about 120 knots. It was later determined from the flight recorder data that the touchdown occurred at about 1,650 feet from the threshold.

The crew stated that their normal procedure after touchdown was to place all four power levers into the idle reverse position, without command, prior to touchdown of the nose gear. When the first officer felt the nose gear on the runway, and on the captain's command, he would apply reverse power to Nos. 2 and 3 engines and then to Nos. 1 and 4 which could be used differentially for directional control. This, according to testimony, was the procedure followed.

The crew subsequently stated that the touchdown was normal, the power levers were brought to the idle reverse position and all four amber reverse indicator lights came on. As the nose gear touched the captain called for reverse and felt the aircraft swerve to the right. He immediately applied full left brake and left rudder. When this action failed to prevent the aircraft leaving the runway he used the emergency airbrakes to slow the aircraft as much as possible. Soon after the aircraft left the runway a loud snap was heard and the right wing dropped sharply. The aircraft continued to skid off the runway, turning onto a north-easterly heading before hitting a newly constructed raised concrete taxiway.

Initially, the first officer stated that as the nosewheel touched down he applied reverse power to Nos. 2 and 3 engines and was reaching for the levers on Nos. 1 and 4 as he felt the aircraft lurch to the right off the runway. He then advanced the power levers for Nos. 3 and 4 to the forward thrust range. He subsequently stated, however, that he had not noticed the amber reverse indicator lights and did not apply reverse thrust on any engine.

The second officer had been instructed to monitor the flap indicator during the approach and warn the captain immediately if the flaps started to move toward UP. He was further instructed to swivel his seat immediately on landing and call brake accumulator pressures. He confirmed that the approach and landing were normal but was unable to place in sequence, with any degree of certainty, his observations regarding the series of events which occurred immediately after touchdown. As the aircraft skidded across the grass he vacated his seat and started back to the passenger cabin, anticipating an emergency evacuation. By the time the aircraft came to rest on its belly he had opened the forward passenger loading door and installed the emergency slide. He noticed that fire had broken out on the left side of the aircraft and that the cabin was beginning to fill with smoke as he began to assist passengers to the exit.

The first officer and two male passengers held the uninflated evacuation slide at the forward door and assisted passengers from the aircraft. Meanwhile, the captain and second officer were making repeated trips into the smoke filled cabin to assist passengers. Finally, no more passengers could be found in the first class section, by which time flames completely covered the forward door.

The senior stewardess in the first-class section opened the forward galley door, but as flames were already present on the right hand side of the fuselage she did not attempt to use this exit. After ensuring that the divider door between the first-class and tourist sections was open she proceeded to assist passengers through the emergency exits until she too was instructed to leave the aircraft. The other stewardesses opened the rear galley exit and installed and inflated the emergency slide. They then assisted passengers out and away from the burning wreckage.

Several ground witnesses, some of them pilots, confirmed that the approach and touchdown were normal and that the aircraft rolled straight down the runway for a distance of 700 to 800 feet. Their evidence indicates that the left wing lifted quite high as the aircraft swerved off the runway.

One passenger seated in the forward lounge was positive that the thrust reverser buckets on both Nos. 1 and 2 engines did not close. He said he heard the power cut and felt the aircraft touch down with what he described as a hard landing. He also felt the nose wheel touch down and immediately thereafter heard power re-applied. His impression was that the aircraft accelerated before swerving off the runway.

Several fire fighting crews attended the aircraft. Although there was substantial variation in the estimates of the time taken by fire fighting equipment to reach the scene, it has been estimated that the fire was brought under control in approximately 30 minutes.

The impact with the raised taxiway occurred 4,950 feet from the threshold of the runway, 400 feet from its centre line. All four tyres on the right main gear were blown out. The skid marks left by these tyres were visible continuously, curving off the runway and across the grass to the point where the gear failed and separated from the aircraft. The marks left by the left main gear tyres were intermittent and were not discernible as the aircraft curved off the runway and across the grass. Three of the tyres blew out during the skid, whilst the fourth ruptured on impact with the raised taxiway. The nose gear failed during the skid and separated from the aircraft.

Three of the four engines were torn out of the aircraft and suffered varying degrees of damage. No evidence of any pre-impact malfunctioning was detected in the subsequent examination.

The extensive fire after impact destroyed a major portion of the left wing and left side of the fuselage, from the flight deck area aft to the rear passenger loading door. In addition, the entire inside of the cabin was gutted. The fuselage area aft of the rear passenger door was crushed inward by contact with a surveyors panel truck which was parked 300 feet from the runway centreline. The force of this impact distorted the rear door lower frame, thus preventing the door from being opened from the inside.

Fire damage on the right hand side of the aircraft was confined to the wing trailing edge and flap. The empennage was intact and the control surfaces were undamaged.

Apart from establishing the position of the significant controls and confirming that the various systems were capable of normal operation, the technical investigation was centred on the hydraulic system. An extensive investigation was also conducted into the crash injury and emergency evacuation aspects. It was learned from the survivors and from the pathological study of bodies that the deceleration of the aeroplane was not excessively high and that no apparent traumatic injuries were sustained by the crew or passengers as a result thereof. Sixteen of the deceased were found in the fuselage after the fire was brought under control. These fatalities resulted from carbon monoxide poisoning. One passenger, an 87-year-old woman, broke both of her ankles during the evacuation of the aeroplane and subsequently died in hospital as a result of shock. The driver of the panel truck struck by the aircraft also suffered fatal injuries.

The crew members opened the forward left maintenance door and the aft right galley door, while passengers opened both of the overwing exits on the right side of the cabin. Through these exits 106 of the occupants evacuated the aeroplane. All of the 39 first-class passengers, three flight crew members, and two stewardesses evacuated through the forward left hand door or through the overwing exits. Sixty-two of the 78 occupants of the tourist section evacuated the aeroplane, utilizing the two door exits and the aft overwing exit on the right side. The entire evacuation was hampered by the dense smoke throughout the cabin.

ANALYSIS

The damage sustained by the aircraft was such that it was not possible to determine the source of the initial loss of hydraulic fluid, although some sections of the system could be eliminated from consideration either because they were not utilized during the flight or were isolated by crew actions.

Following the initial loss of fluid the crew reported that the hydraulic quantity indicator was about ⅛ inch from the bottom of the gauge. The hydraulic reservoir holds 10 gallons of fluid but the minimum fluid level which the float transmitter in the tank will sense is 3.5 gallons. The quantity gauge dial presentation consists of an arc of 120 degrees with a "low" and "normal" segment, the low end representing the 3.5 gallon level and the high end representing the 10 gallon level. A change of one gallon of fluid within these limits would be reflected by 18.5 degrees of movement of the quantity indicating needle.

When the crew extended the ejectors no change occurred in the indicated fluid quantity level, although about ¾ gallon of fluid would be removed from the reservoir. Also, when the landing gear was allowed to free fall, about 1.6 gallons of fluid would have been returned to the reservoir, yet no increase was registered on the quantity gauge. From these indications it appears that the hydraulic fluid level must have been below the lowest level measurable by the float transmitter at the time the ejectors were extended.

It also appears that the initial inability to get 25 degrees of flap was because the fluid level at that time was below the taller standpipe supplying fluid to the auxiliary hydraulic pump inlet.

The procedures followed by the crew to prepare the aircraft for landing were the approved procedures based on the information available to them during the flight. The shift to the No. 3 position of the hydraulic system selector was proper and necessary to ensure positive flap actuation during the approach. In this position there was no pressure available to the general hydraulic system, which powered, among others, the ground spoilers, nosewheel steering and the rudder. Hydraulic braking was available from the brake accumulator.

The evidence indicates that after touchdown the thrust reverser buckets on the left side of the aircraft did not rotate to the closed position. These buckets must be closed to deflect thrust in a forward direction. They are actuated by an engine air bleed which is connected to the bucket only when the ejectors are fully extended. If an ejector does not extend or moves forward as much as ⅜ inch, the coupling will not engage and the bucket will not close.

The ejectors are hydraulically operated. There is also provision for emergency extension by means of an air bottle, which was not used in this case. Each ejector unit is controlled by an electrically activated valve which ports hydraulic pressure to either the extend or retract side of the piston. It is a characteristic of the control valves that the possibility of internal system leakage increases when the hydraulic pressure is low. Any internal leakage through a control valve or a system check valve will relieve the hydraulic lock feature which is designed to hold the ejectors in the extended position and, because the supply pressure is common, will permit both ejectors on the same side of the aircraft to move forward under applied forces. These forces include pressure in the system return lines, aerodynamic loads and the forward shifting tendency upon touchdown and roll out.

The ejectors were fully extended and remained in this position during the approach, as evidenced by the four steady blue lights of the position indicating system. At the moment of touchdown, however, the second officer recalled seeing ejector lights blinking, indicating that one or more were in transit.

It is believed that the ejectors for Nos. 1 and 2 engines did shift forward at touchdown and prior to the positioning of the power levers to the reverse idle detent. As a result, when reverse thrust was applied, the thrust reversers for Nos. 1 and 2 engines were not closed. This allowed Nos. 1 and 2 engines to develop forward thrust whilst Nos. 3 and 4 were producing reverse thrust during power application.

Evidence of an asymmetric thrust condition was found in the flight recorder trace, which contained an unusual fluctuation in indicated altitude, beginning about six seconds after touchdown. Detailed studies of two other recorder traces of DC-8 landings in which asymmetric thrust was known to exist revealed almost identical trace patterns, whilst study of the traces of normal landings disclosed no evidence of similar aberrations. The rapid fluctuation in indicated altitude that was recorded whilst the aircraft was at a constant altitude obviously resulted from the asymmetrically disturbed airflow over the static ports during asymmetric reversing.

In order to clearly understand the sequence of events which took place during this accident the data obtained from the flight recorder, tyre skid marks, ground survey and crew statements was comprehensively analysed. From the results of the analysis it was concluded that:—

1. All four engines were at or near idle forward thrust at touchdown.
2. All four power levers were placed in their reverse idle detents 2.5 to 3 seconds after touchdown.
3. The thrust reverses for engines Nos. 1 and 2 were inoperative.
4. Maximum continuous thrust was initiated on the inboard engines 5 seconds after touchdown.
5. Full manual rudder control and differential braking were initiated 5 to 6.5 seconds after touchdown.
6. The application of maximum continuous power to all engines resulted in high asymmetric thrust forces causing an uncontrollable lateral deviation from the runway.

The crew's original diagnosis of the trouble was correct, in that an abnormal hydraulic situation existed. Very shortly after commencing the descent, however, the abnormal situation abruptly developed into an emergency, when 25 degrees of flap were selected. It was considered that when complete loss of hydraulic pressure occurred the crew should have been aware that a normal landing could not be expected.

As a result of this accident the manufacturer introduced several modifications to the hydraulic system. These included the installation of a power lever thrust-brake interlock system to prevent the application of reverse thrust until the thrust reverser buckets are in the reverse position. The interlock is also designed to return a power lever to the idle detent position should the corresponding bucket move from the reverse thrust position.

CAUSE

It was concluded that the probable cause of the accident was the asymmetric thrust, which, during hydraulic emergency, resulted from the failure of the first officer to monitor the thrust reverse indicator lights when applying the reverse thrust.

COMMENT

The safety lessons apparent in this accident report could well apply to any of the complex modern transport aircraft. The report also highlights the need to ensure that ample clearance exists between the runway used and any ground equipment, or unserviceable areas, where the ground controllability of the aircraft may be affected in an abnormal or emergency situation.

It is obvious that the crew made every effort to evacuate the passengers from the aircraft, yet despite their endeavours 17 lives were lost because the passengers could not be evacuated before the interior of the aircraft became untenable. The circumstances described are a tragic illustration of the thoughts which prompted us to publish the article "90 Seconds for Action in Emergency Evacuation" in "Aviation Safety Digest" No. 26 of June, 1961. We suggest that flight crews and ground engineers take another look at this article and also re-check on their individual responsibilities regarding emergency evacuation equipment.

DISTRACTION leads to LOSS OF CONTROL

ELMHURST, NEW YORK

(Summary based on the report of the Civil Aeronautics Board, U.S.A.)

A Beechcraft Bonanza engaged on an air taxi operation crashed at Elmhurst, New York, at 1414 hours on 18th July, 1961.

The aircraft departed from LaGuardia Airport at 1412 hours and almost immediately thereafter the pilot requested clearance from the tower to return in order to close the cabin door. Clearance to land was given, the pilot acknowledged this and the tower then asked if emergency equipment was wanted. The pilot replied in the negative. Shortly afterwards the aircraft was seen to roll to an inverted position, dive steeply to the ground and burn in a vacant lot some 1,750 feet short of the approach end of the runway. The pilot and three passengers were fatally injured.

Radio communications were established between LaGuardia tower and the Bonanza and the aircraft was cleared for take-off. Shortly thereafter the pilot requested a right turnout. The right turn was approved and the pilot was advised to watch for traffic inbound from the north-east. Seconds after take-off the pilot radioed the tower that he had to land and stated that he could make a 360 degree turn from his present position. The control tower issued a landing clearance and asked the nature of the emergency, whereupon the pilot advised that he had an open door and stated that he could land on runway 4, if cleared. The aircraft was immediately cleared to land on runway 4.

A number of persons saw the final descent and crash. The general observations indicate that the aircraft initially followed what was substantially a standard pattern for landing on runway 4. Its altitude on the downwind leg, which was towards the south-west, was variously estimated as from 200 to 400 feet. At the end of the downwind leg a left turn was started. At or about the start of this turn the left wing dropped sharply, came up again, and the aircraft then seemed to wobble. Again the left wing dropped and this time it did not come up. Instead the aircraft started what appeared to be a left spin, rolled over to an inverted position, and then dived nearly vertically to the ground and caught fire.

(All times stated are local time)

Ground impact markings and wreckage examination indicate that the aircraft struck the ground in a nearly vertical inverted position. The main landing gear and nose gear were found in the "down" position. The flaps were found in the "up" position.

The main cabin door, located on the right side of the aircraft, was torn from the fuselage structure at the two forward hinges. The inside door latch was found to be in a vertical (unlocked) position relative to the horizontal portion of the door frame. Examination of the upper door latch showed it to be in the unlocked position, compatible with the inside door handle position.

The small ventilating window on the pilot's side of the cockpit was found separated from any adjoining structure in the wreckage. Its latching handle was found in the unlocked (window open) position with the actuator portion of the handle in the 10 o'clock position. The latching mechanism functioned properly and the window was relatively undamaged although the window frame was badly deformed.

There have been other instances of the cabin door of this model coming ajar during flight. Some have been the result of taking off with the door not secured while in other cases the door has been unlatched, either purposely or accidentally, during flight. The result is that the door stays ajar by about three or four inches and is kept ajar by rather strong aerodynamic forces. Although possible, it is difficult to close the door during flight even if the accepted technique of reducing airspeed and opening the ventilating window is followed. Consequently, it has become an established procedure to land, as soon as feasible, in order to latch and secure the open door. An extremely noisy and disconcerting — even alarming — rush of air around the door edges is attendant upon this door being open, but the aircraft's flight characteristics are not noticeably changed.

The ventilating window at the pilot's left is routinely opened while on the ground, particularly during hot weather. The window is seldom opened in flight because it also causes a noisy and disconcerting rush of air.

In order to experience the flight conditions that existed during this flight (with cabin door open), a Board Air Safety Investigator participated in special flights with similar type aircraft to determine handling characteristics and the psychological effect of the door coming open in flight. These flights were conducted at the Beech Aircraft Corporation, Wichita, Kansas. In the course of these tests the Board's Investigator flew with a Beech Aircraft pilot and acted alternately as pilot and as passenger. In neither capacity was he able to close the door once it was open, nor was the Beech pilot any more successful. On the first flight the door was closed by hard slamming, but was not placed in the fully locked position. This was purposely done with the hope that the door would come open at the time of liftoff or shortly after becoming airborne. However, in this condition, the door came open upon reaching 50 m.p.h. during take-off roll, and the take-off was aborted.

On the second attempt, the door was closed but not completely locked. After becoming airborne, it was noted that the side latch remained fastened although the top latch was in the unlocked position which permitted an opening at the top of the door with an attendant noise of rushing air.

On subsequent flights the door was placed in the fully locked position prior to takeoff and after becoming airborne the door was intentionally opened. It was noted that the initial opening of the door was alarming and there was a level of noise from rushing air to make conversation most difficult. The trailing edge of the door remained open approximately three to four inches.

During level flight at speeds ranging from 80 m.p.h. to 120 m.p.h., several attempts were made to close the door. These attempts were unsuccessful. Additional experiments with the side window opened while skidding the aircraft at an indicated airspeed of 80 m.p.h. also proved unsuccessful. During the experiment there was no significant effect on the control of the aircraft or its handling characteristics. During test flights elsewhere in a similar aircraft, the pilot was also unable to close the door although a male passenger in the front right seat did do so after several attempts.

These tests confirm the difficulty of closing an opened door of this model aircraft during flight. At the time of being hired the pilot involved in this accident was briefed by the operator on the proper method of coping with an open door — which was to land and close it rather than attempt to close it during flight.

ANALYSIS

Throughout the investigation of the accident, nothing was found to indicate or even suggest any operational defect or malfunction of the aircraft or of its powerplant or any of its accessory equipment. Further, the weather was virtually ideal for the flight and the pilot was properly certificated and had been acceptably flight checked by his employer.

This tragedy appears to have been induced by the open cabin door. It is clear that the pilot intended to land in order to close the door. His request for landing clearance, and his acknowledgment, in addition to the aircraft's landing gear being down, establish that intent. However, the open ventilator window suggests that he may have attempted to close the door in flight, after having been cleared to land, because with the window open the change in airflow and pressure makes the closing of the main door somewhat less difficult.

The aircraft stalled and started to spin but the reason for the loss of control and critically lessened airspeed, which must have preceded loss of control, remain obscure. Possibly there was interference with the controls or with the pilot by one or more of the passengers. This interference could have been induced by fright caused by the noise of the open door. Possibly the pilot, without this interference, had his attention diverted in some other manner. He may have been trying to close the door which, as has been explained, is not a simple process and while so engaged allowed his speed to become dangerously low.

PROBABLE CAUSE

The Board determines that the probable cause of this accident was a serious diversion of the pilot's attention during crucial seconds of the final approach, resulting in loss of control at an altitude too low to effect recovery.

COMMENT

In September, 1961, a Beech A35 aircraft crashed in almost identical circumstances at Montreal International Airport, Canada. All four occupants lost their lives and the aircraft was destroyed. In their report relative to the accident the Canadian authorities concluded that "the door came open in flight and control of the aircraft was lost during a turn at low altitude".

Cabin doors have come open in flight on several types of light aircraft on the Australian Register, generally because they were not securely locked prior to take-off. Although the flight characteristics of the aircraft were not materially affected in these cases, most of the pilots' reports carry a strong suggestion that they did not enjoy the experience.

In Digest No. 31, of September, 1962, attention was drawn to incidents in which seat belts have been caught in doors, again causing the pilot's attention to be diverted from controlling the aircraft. Any alarming condition such as this can cause experienced pilots to lose concentration at a vital moment where an accident is inevitable. The potential hazard for inexperienced pilots is obvious.

Explosive Turbine Failure

Boeing 720B near Albany N.Y.

(Summary based on the report of the Civil Aeronautics Board, U.S.A.)

A Boeing 720B departed Los Angeles, California, on a regularly scheduled, non-stop passenger flight to Boston.

The aircraft was cruising normally at 25,000 feet in the vicinity of Albany, New York, when the No. 1 engine failed because of the disintegration of the low pressure turbine. Fragments from the turbine penetrated the left wing, No. 2 engine pylon and the fuselage, resulting in a ruptured wing fuel cell and loss of cabin pressurisation.

An emergency was declared and a let-down to a lower altitude was effected. The flight continued to Boston and landed without further incident.

INVESTIGATION

At 1141 hours on 5th November, 1961, the aircraft departed from Los Angeles and was cleared to proceed under Instrument Flight Rules at 27,000 feet. On levelling off after the climb, and for approximately 15 minutes thereafter, a slight vibration was noted in the N1 and N2 tachometer needles relative to No. 1 engine. This vibration, or "nervous needle", referred to by the aircraft captain then ceased and did not recur for the remainder of the flight. The flight progressed normally until reaching Cleveland, Ohio, where turbulence was encountered and descent was made to 25,000 feet.

In the vicinity of Albany, New York, a muffled explosion was felt and heard by the crew and the aircraft commenced a yaw to the left. The autopilot was immediately disengaged and the aircraft was brought back to a normal flight attitude. The flight engineer then advised that cabin pressure was dropping. Thereupon the crew went on emergency oxygen and activated the seat belt sign. Air Traffic Control was contacted and the flight was cleared to descend to and maintain 9,000 feet.

It was noted at this time that the utility hydraulic system and the No. 1 generator had failed. The No. 1 engine was then shut down and an off-airways gear-up descent was initiated using only the inboard spoilers. The second officer then advised that the turbine section of the No. 1 engine had disintegrated and that the exhaust section was oscillating quite severely. The firewall shutoff valve to the engine was actuated. The aircraft's speed and rate of descent were reduced. As the aircraft passed through 19,000 feet, the cabin pressurisation warning horn sounded and the oxygen flow light came on. At that time the airspeed was approximately 200 knots and the descent was continued at this slower speed.

Westover and Pease Air Force Bases were alterted in the event that the condition of the aircraft would not permit continuation of the flight to Boston. An inspection made from the cabin revealed that the left wing and No. 1 pylon were badly damaged. One turbine fragment had penetrated the fuselage from the left, approximately head high, directly above seat 16-A. The fragment struck the right side above seat 16-F and dropped to the floor. There was sufficient residual heat remaining in the fragment to burn a hole one inch in diameter in the floor carpeting.

The captain elected to continue to Boston because of favourable weather conditions, runway length, and available emergency equipment at that location. The cabin attendants were thoroughly briefed by the captain on emergency procedures and the passengers were advised of the emergency. All emergency gear and flap extensions were made over water and a normal approach to a landing on runway 22L was effected with ground emergency equipment standing by. Trim was adequate to compensate for the yaw effect of the inoperative No. 1 engine and the total loss of fuel from the damaged outer left wing tank. On roll-out, steady braking was applied, reverse thrust was applied slowly to the Nos. 2 and 3 engines, and the aircraft cleared the active runway by turning left on runway 15. At this time normal braking pressure had been depleted and airbrakes were used to bring the aircraft to a full stop on runway 15. The passengers deplaned in a normal manner through the forward compartment door.

Ground inspection of the aircraft revealed that several oxygen masks and containers had failed to function properly when a cabin pressure altitude of 10,000 feet was reached. During the depressurisation the oxygen mask container latch failed to function for seats 6-C and D, 10-A and B, and 25-A and B. However, no passengers occupied these seats. All passengers aboard donned their oxygen masks successfully. The oxygen mask container doors in lavatories B forward, and C and D in the aft cabin opened, but the masks failed to drop out. It appeared that these masks had been stored improperly and were too tight in their containers.

An investigation at Boston revealed that the No. 1 engine pod was ruptured in the vicinity of the turbine. The turbine exhaust case and reverser mechanism were completely separated from the engine but had remained attached to the pylon mount. Approximately 80 per cent of the turbine nozzle case was torn away and missing. The only portion of the low-pressure turbine section remaining was the forward mount flange of the second stage turbine disc which was still attached to its mating flange of the low turbine shaft. A section (approximately ⅙) of the second stage turbine disc was recovered from the left wing just inboard of the No. 1 engine pylon where it had imbedded itself. The remainder of the disc was not recovered. Approximately one-half of the third stage turbine disc was recovered on the ground near Albany. The remainder of the disc has not been recovered. No portions of the fourth stage turbine disc and/or blades have been recovered.

There were numerous holes of various sizes in the left wing and fuselage which accounts for the relatively rapid depressurisation of the cabin. The outer left wing tank was punctured in several places. The left spar was torn through approximately one-fourth of its width. Fuel lines, hydraulic lines, and electrical leads to the No. 1 engine were severed. Skin punctures were found in the No. 2 engine pod, the lower left wing surface, and the left side of the fuselage. Several of the nozzle guide vanes along with second and third stage turbine blades were found in the wing, the No. 2 pylon, and the baggage compartment. One root section of a third stage turbine blade was found in the cabin section adjacent to row 16. The rear hub had separated from the fourth stage turbine and was found lying in the No. 6 bearing support.

Examination of the engine revealed extensive damage consistent with oil starvation. The main oil filter was clogged with foreign material. The "last chance" strainer serving the intermediate case was also completely clogged, whilst the other three were partially blocked.

The engine had undergone partial overhaul and repair prior to being installed in the aircraft, due to excessive oil breather pressure. Several manufacturer's recommended modifications were incorporated. Heat shields were installed around the No. 4 and 5 bearing compartments to reduce the transfer of heat to the engine oil and improve oil scavenging. The high compressor centre tube was nickel plated at each end to reduce galling and possible bleed leakage into the bearing compartments. In addition, the No. 1 bearing support was reworked to improve stress distribution and design configuration.

After a satisfactory test run the engine was installed into the aircraft two weeks prior to the accident.

ANALYSIS

The sequence of events culminating in the failure of the engine began at the main strainer assembly in the pressure oil line within the intermediate case. The main oil filter became clogged with carbon deposits and began to bypass contaminated oil. A downstream "last chance" strainer filtered the oil just before delivery to the low compressor thrust bearing and seal (No. 2), intermediate housing bearing (No. 2½) and high compressor front support bearing and seal (No. 3). Carbon accumulations collected in this "last chance" strainer choked off the oil supply and starved the bearings. The No. 2 thrust bearing overheated, material strength faded, and plastic yielding commenced under the forward load of the low-pressure spool, allowing the low-pressure compressor and turbine assemblies to move forward. The blades of the compressor began to rub against the trailing edge of the stator vanes. Inner race wear pattern and roller interference with the No. 1 seal plate indicated that the front support bearing (No. 1) then failed from thrust loading induced by excessive forward axial movement of the front hub. Loss of rigid front radial location allowed wobbling in the front compressor as shown by uneven blade tip rub. Vibrations induced in the inlet case precipitated fatigue failure of the No. 1 oil jet. The No. 2½ bearing, mounted on the rear hub of the front compressor, was pounded by the wobbling as shown by the damaged balls; however, the intermediate bearing housing continued to rotate. The No. 3 seal plate integral with the intermediate bearing housing then wore down the No. 3 seal. A photomicrograph of the No. 3 seal plate indicated the presence of a temperature above 1,400°F. The No. 3 bearing, also mounted on the rear hub of the front compressor, failed and allowed the high compressor to wobble slightly. This was evidenced by blade tip rubbing and knife-edge seal wear. The No. 4½ bearing moved forward with the low shaft and continued to turn freely, leaving traces of the new roller path. Metallic deposits began

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(All times stated are Eastern Standard)

to form on the convex faces of the first nozzle guide vanes from compressor blade vane shavings. Large axial clearances obviated any rubbing of the rear of the high turbine disc by the low turbine assembly.

Thus, the engine was in the process of sustained self-destruction. The time element involved for this deterioration was approximately 10 seconds. Prior to the explosion, the stewardess who was seated in the last row was looking out the window toward the No. 1 engine. Noting red bursts coming from the engine tailpipe, she turned, remarked on this condition to another stewardess seated next to her, turned back again and witnessed the No. 1 pod bursts. The red bursts were the initiation of the failure, evidenced by the compressor blades rubbing the vanes.

The immediate cause of the final explosion was the deterioration of the No. 2 bearing, where the steel balls were now fused to the inner race. As the front compressor rear hub rotated in the bearing, the frozen inner race was both grooving and heating the journal of the hub. The strength rapidly diminished until the torque load from the driving turbine, transmitted by the low shaft, began to exceed the hub yield point. The ultimate strength of the hub was reached. The hub sheared through the thinned, overheated bearing plane under torsional loading and uncoupled the low turbine from the low compressor. Since the low compressor was no longer absorbing the energy the low turbine was extracting from the gaspath, the low turbine assembly began to accelerate. The turbine disc centrifugal loading increased with the square of the angular velocity, until the ultimate strength of the discs was reached and they burst through the engine casing and nacelle panels. Meanwhile, the low compressor was slowing down and was pushed rearward by the inlet airstream. The blade trailing edges then began to rub the vane leading edges. Oil filters continued to fill up with metallic particles from the break-up of the damaged bearings. The high rotor assembly was still rotating freely. Only the rear of the high turbine blades was damaged and shifted forward by the exploding low turbine assembly. A hardness check of the turbine blade leading edges indicated no excessive engine overtemperature.

Examination of the carbon deposits on the low turbine drive shaft, which passes through the centre tube, indicated that very slight bleed air leakage occurred in the front and moderate leakage in the rear of the centre tube. This leakage, coupled with earlier carbon accumulation and the high temperature environment of the No. 4-No. 5 bearing areas and towershaft strut, produced enough carbon to contaminate the oil system, causing the main oil filter assembly to clog and bypass. It should be noted that on October 11, 1961, the engine manufacturer wired all airlines concerned: "If installation of heat-shielding being accomplished without complete overhaul, recommend thorough cleaning of diffuser case and No. 5 support. Suggest daily check as required in subsequent operation". However, testimony of Company personnel indicated that the subject engine had probably been rebuilt beyond this stage when the above information was received. It is therefore relatively certain that the subject areas were not cleaned of carbon deposits prior to reassembly at overhaul. In addition, although the main oil filter was removed prior to the critical flight, it was not disassembled and was given only a cursory examination; therefore, any internal accumulations could have gone unnoticed. Examination of the diffuser case showed a heavy carbon deposit around the breather tube and the tower shaft packed with carbon. Examination of the No. 5 support also revealed carbon on the inner walls. An analysis of oil samples indicated no significant discrepancies.

The theory was raised that the two seals between the rear compressor front hub and the No. $2\frac{1}{2}$ housing were omitted during the previous Company repair and modification. This was based on the condition of the hub seal grooves, one clean and the other with some white deposits. If this were the case, twelfth-stage bleed air would have leaked through this opening and started breaking down the oil within the No. 2 area. It is believed that a much greater accumulation of carbon sludge would have been present in the intermediate area, had the seals been omitted. The deposits which were found can be attributed to the heat transfer through the No. 3 diaphragm which is subjected to twelfth-stage bleed air. A hardness check of the grooves indicated that the hub had been subjected to temperature high enough to destroy the aforementioned seals during the failure sequence. Bleed air could then have blown the grooves clean before or after any residue was able to have been deposited. Although not conclusive from the evidence, it appears unlikely that the two seals in question were omitted.

The catastrophic potential of turbo disc rupture has been a matter of concern to the industry for a number of years. Recognising this problem the Federal Aviation Agency has required certain design features and proof testing of turbine engines in order to protect against this type of failure. In addition, the manufacturers have devoted much time and effort toward assuring turbine disc integrity. Despite these precautions, this failure and other turbine disc ruptures have occurred on engines in commercial service.

In view of the time element involved in the destruction of this engine, it is believed that warning could have been given to the crew by vibration equipment and would have allowed for engine shutdown prior to the turbine failure. Excessive vibration would have been immediately noted by pick-ups as soon as the No. 2 bearing failed. Although the state of the art does not allow absolute vibratory limits to be established at this time, a relative control can be maintained by which an abnormal shift from an accepted engine vibration base line can be utilised for trouble-shooting and shutdown before extensive engine damage occurs.

PROBABLE CAUSE

The Board has determined that the probable cause of this accident was oil starvation of the No. 2 bearing which caused its failure. This precipitated the fracture of the low-pressure compressor rear hub and the overspeeding and subsequent disintegration of the low-pressure turbine section.

COMMENT

This accident shows, very clearly, the importance of proper examination of the main oil screen, particularly after the engine has been dismantled between overhauls, to the extent of exposing any of the bearing compartments.

It also serves to illustrate the need for care in the stowage of emergency equipment, to ensure that in an emergency each and every item functions as designed.

THOUGHTFUL REPORTING

We acknowledge the safety lesson demonstrated in a recent incident in which the pilot of a transport aircraft reported conditions hazardous to flying safety by means of a "special AIREP". In providing air traffic control with a special air report this pilot was instrumental in preventing other aircraft from being exposed to unexpected hazards which he had encountered.

Prior to the departure of the flight, which was planned to proceed from Sydney to Dubbo, the pilot was advised of a strong unstable westerly stream over the Sydney-Blue Mountains area. There was heavy cloud on and west of the mountain ranges and current meteorological conditions indicated that freezing level would be at approximately 5,000 feet. Moderate to severe icing and some turbulence could be expected.

The DC-3 involved in the flight encountered light icing and moderate turbulence at 8,500 feet on entering cloud prior to reaching Katoomba, at which time carburettor heat was being used and was maintaining the carburettor temperature at +20°C. Severe icing was experienced soon after passing over Katoomba and, despite the fact that the application of carburettor heat had previously progressed to the stage where full heating was in use, the port engine lost power due to ice accretion. Fortunately the port engine regained normal power at about the time that the starboard engine was affected and sufficient power was available to carry the aircraft past 9,000 feet to a height where the carburettor icing was less severe. Despite a heavy accretion of airframe icing the flight was able to continue to its planned destination with both engines operating normally.

Knowing that icing had also been reported at 6,000 feet and having in mind the lowest safe altitude of 5,250 feet for that section of the route, the **pilot immediately reported the conditions he had experienced to the Sydney operations centre and informed them that he considered the route unsafe for DC-3 aircraft.** A.T.C. immediately issued a SIGMET report relative to the severe icing and very shortly afterwards closed the air route between Katoomba and Bathurst to DC-3 aircraft. Subsequently, as conditions deteriorated further, the route was closed to all aircraft operating below 12,000 feet.

It is of interest to note that additional ice accumulated on the aircraft during the descent, until the aircraft passed through the freezing level of 5,000 feet. From approximately 4,000 feet downward large pieces of ice were steadily shed from the wings and surfaces but it was necessary for the pilot to extend the circuit and delay the landing for some time to enable all of the ice to be shed from the leading edges. During the time when the icing was most severe the radio compass was virtually useless and the captain's airspeed indicator fluctuated continuously, over a range of approximately 15 knots.

The majority of the incident reports that we are able to use to convey a lesson in flying safety stem from errors of commission or omission. It is therefore a pleasing change to use a report in which the pilot has done all that could be expected of him. Not only did he promptly furnish significant meteorological information to the operational control centre, but provided the controllers with the benefit of his assessment of the conditions as they affected the type of aircraft that he was operating.

From CRUISE FLIGHT LEVEL To TOUCH-DOWN

By Captain Thad May

(Extract from Flight Safety Foundation Bulletin)

"If the air traffic controller was not providing radar vectoring, then who was responsible for the plane's navigation?"

Replied Hendershot, "The pilot!" These were the last words from the government, spoken by FAA official Wayne Hendershot at the close of the UAL/TWA accident* hearing in Brooklyn, New York, recently.

And how right he is!

The official investigation resulting in issuance of the "Probable Cause" is for the officials. Nevertheless, small groups of pilots in hotel lobbies around the country are busy doing a little constructive analysis of their own. We don't mean to second guess the deceased pilots, but we see a new threat to our security, so we instinctively try to imagine all possible factors which might contribute, and then devise our own safeguards.

One obvious fact emerging from this accident is that one of the victims was not where he thought he was! We are the first to defend the pilot against those who imply "pilot error". Not because he's from our group, but because we have travelled this road, too, and we know how easily one can be led astray by a combination of erroneous indications from our radio navigation equipment. Cross-checking is our trade mark, but there are rare occurrences in which two erroneous signals can add up to a "copecetic" situation.

The mere fact that such an accident can happen under IFR control and IFR conditions has challenged us as never before. So, as always, we turn not so much to better control procedures and more advanced navigation equipment, but to our own ingenuity for security.

Safety is our creed. Safety is our whole existence! The engineers and manufacturers deserve a lot of credit for providing us with high performing equipment having advanced and refined instrumentation. Modern technology has certainly enhanced the safety and efficiency of air travel. But it's the professional pilot, with his never-ending search for better techniques and safer methods, who turns a potentially hazardous profession into a statistically safe way to travel.

We explore each new "improved" gadget which advancing technology gives us. We tinker with it, test it, evaluate it, and then accept it in its proper perspective.

One such gadget is the FPDI** selector switch which permits alternate selection of No. 1 and 2 VOR signals. There was a period several years ago when we toyed with that one, too, as evidenced by frequently finding a selector switched to the opposite VOR. It's no coincidence that you never find switches in "alternate selection position" any more. We learned very quickly that, under high work load conditions when our responses to stimuli are governed more by habit pattern, we were vulnerable to misinterpretation! Result? We spontaneously, individually and collectively, dropped this "toy" like a hot potato.

Progress is an inevitable product of our society, and I'm sure we pilots would not trade the FPDI for a static-y "dit-da". However, we can never gain something without giving up something, and so it is with our modern VHF radio navigation equipment. The integrity of the low frequency range and an air driven gyro, crude as they were, did not hinge on circuit breakers, transformers, and "dimestore" fuses.

The weird behaviour of the sometimes fickle RMI's*** and FPDI's is too well known to us all to warrant further mention here.

Nor is the future outlook encouraging with "Steer this heading, follow that radial, slow it down, keep your speed up, turn right 45 degrees for one minute, now YOU take over — - — ? ? ! !

With more control from the ground and more "advanced" navigation equipment in the picture, the chance for human error and technical failure is compounded. We may long for the DC-3 and a gyro "compass", but we can't turn back the clock. We must, instead, rise to the challenge.

Perfecting complex electronic gear to 100 per cent reliability is only a dream, and we pilots demand perfection.

Wherein then lies the answer, the "weapon", that will deliver us from this seemingly inescapable "jungle"?

It's ironic in this modern age of atom bombs and digital computers that our most useful tool may be found by reaching back 200 years for a science used by Captain Cook—Dead Reckoning. It's also ironic that this science requires only your simplest and most reliable instruments — ****compass, airspeed and clock.

Does this mean we must clutter the cockpit with mercator charts, dividers and plotters? No. But there is a way by employing a sort of Impromptu D.R. (permit me to coin a phrase).

When used over long distances with infrequent fixes, one must be meticulous for success with D.R. However, over short distances, a "Bobtailed" approach is amazingly accurate.

Simply stated, "Impromptu D.R." is the art of following the progress of your plane by latching onto a heading, monitoring the clock as you proceed from fix to fix, and protecting yourself with a shrewd "guesstimate" for your next fix. This technique is intended to replace the tendency to "chase the needle" and assume you are there when it swings.

If you are familiar with the local area (distances) and have a general knowledge of current winds, this can be done without bothering with charts and computers. If not, it is certainly good insurance to delegate this responsibility to your first or second officer.

A pre-flight study of weather and winds will have prepared you to make an intelligent guess at ground speed even though you may be descending and varying your true airspeed. Using this ground speed and working in increments and multiples of increments shown below, ETA's sufficiently accurate to double check your radio navigation instruments can be obtained. By adding your personal touch of intuitive interpolation and establishing the habit of practicing when VFR, you can convert this science of navigation into a highly precise ART. And then, if those radio signals don't jibe with your D.R.—suspect the radio!

I recall an instance a number of years ago, of being cleared from New Brunswick to Flatbush with a restriction to cross Flatbush at 3,000 feet, then descend to 1,500. It was wintertime, and we were on the gauges. A neat reversal of the ADF needle signalled Flatbush! We were "tooling" along at a fast clip because of a high descent rate, but a quick check with the clock indicated a ground speed of around 500 m.p.h. and therefore alerted us to the erroneous needle swing. It later developed that high speed and ice had stripped us of a sense antenna.

Since this incident, I have found comforting security in keeping track of my position by this art of Impromptu D.R. In spite of all this electronic gear, it's still the best tool we have to safeguard us from erroneous radio signals and human error from the ground controller. In fact, Dead Reckoning is the only pure method of navigation. All other "methods", such as radio, pilotage, pressure pattern, celestial, inertial, etc., are merely aids to D.R.

ETA BY D.R.

	Ground Speed (m.p.h.)	Distance (Miles)	Time (Minutes)
	180	6	2
	210	7	2
	240	8	2
or:	180	9	3
	200	10	3
	220	11	3
	240	12	3
	300	15	3
Jet	500	25	3
or:	500	approx. 8	1
	600	10	1

* United Airlines DC-8 and Trans World Airlines Constellation collision near Staten Island, New York, on 16th December, 1960.

** FPDI = Flight Path Deviation Indicator.

*** RMI = Radio Magnetic Indicator.

**** Lack of a compass comparator is the only weak link.

"Modifications require Verification"

A reader has drawn our attention to the need for clarification in the article under the above title printed in the Aviation Safety Digest No. 31, September, 1962.

The contention is that the opening paragraph of that article conveys the impression that modifications may be approved only by the Director-General whereas there are also persons authorised by the Director-General to perform this function. The true situation would be more clearly expressed if the first paragraph of the article were to read as follows:—

"Air Navigation Regulations require that all modifications to an aircraft must be approved either by the Director-General or by an appropriately qualified person who has been authorised as a Design Signatory by the Director-General for the purpose. The Regulations further require that all modifications be undertaken by persons approved for the purpose."

PERSONAL DANGER IN ELECTRICAL SYSTEMS

The introduction of alternating current primary electrical systems into modern transport aircraft has greatly increased the possibility of receiving a fatal shock from the aircraft electrical services. The danger that lurks within the wiring of the domestic electrical power supply is well known to all except the very young, but relatively few are aware that the electrical potential in a modern aircraft is similar to that in the home and is equally as deadly.

For this reason we believe that there is a need for all who are concerned with aircraft operations to fully appreciate the comparatively small electrical potentials that can affect the human body.

Current is the killing factor in electrical shock. Voltage is important only in that it determines how much current will flow through a body of given resistance. The overall resistance of the human body is primarily dependent upon the resistance of the skin and this, in turn, is dependent upon the amount of moisture that is present at the point that comes in contact with the source of electrical power. Dry skin has an electrical resistance of between 100,000 and 600,000 ohms, but these figures fall to approximately 1,000 ohms when the skin is wet or moist. If the skin is broken, due to a cut or an open blister, the resistance falls still further, as the internal resistance of the body is of the order of 100 to 600 ohms only.

The danger to life depends mainly upon the amount of current that passes through the body muscles, particularly those of the heart, and whether or not the electrical current is "direct" or "alternating". For a given voltage, the shock hazard present in a direct current system is far below that of an alternating current system, although the former will usually inflict more severe burning, due to the greater persistency of the arcs produced by direct current. It is unlikely that a direct current potential below 140 volts will prove fatal, even when skin resistance is low. Under similar conditions, however, alternating currents can be fatal if the potential exceeds 35 volts.

The amount of alternating current required to operate a 100 watt light bulb is eight to ten times as great as the amount that is capable of terminating a human life. Currents from one to eight milliamperes flowing through the body are perceptible but are not painful. From nine to 15 milliamperes causes pain and an involuntary contraction of the muscles, whilst above 20 milliamperes muscular control is lost. Currents of 20 to 50 milliamperes, passing through the body on a path that affects the chest muscles, causes breathing to become difficult, whilst from 100 to 200 milliamperes passing in the region of the heart can cause a fatal heart condition known as ventricular fibrillation, for which there is no known practical remedy.

Higher alternating currents, up to three amperes, may not necessarily prove fatal unless prolonged for over a minute. Such currents for shorter periods will cause burns and stop heart action for the duration of the passage of the current, but heart action usually returns when the current ceases to flow. These higher currents also cause unconsciousness, severe burning and, because of their effect on the nervous system that controls the lungs, prevent the victim breathing. For this reason it is essential that persons engaged in working on modern aircraft electrical systems are not alone. Immediate application of artificial respiration may be essential to avoid death to the victims of severe electrical shock.

Prior to the introduction of the Boeing 707 and the Electra most heavy aircraft in operation in Australia incorporated a number of circuits that carried relatively high voltage alternating currents but the primary electrical system was low voltage direct current. The nature of these direct current systems was such that personal safety could if necessary be ignored where the circumstances were such that some immediate action was required to affect rectification of a fault or the restoration of an essential circuit. The same disregard to personal safety, applied to a modern alternating current system, could well have fatal consequences.

Rigid requirements are laid down by the responsible authorities to ensure that the people engaged on the installation and maintenance of the domestic power supplies are properly protected whilst engaged in this work, and that the user is protected against inadvertant contact through inadequate or faulty insulation. In the design of the modern aircraft electrical system the manufacturer has given due regard to the power potentials involved and has produced a system that, treated with respect and properly maintained, does not present a hazard. The operators of these aircraft have, in turn, prescribed procedures to protect their engineers from injury due to inadvertent connection of the power whilst engaged on maintenance of the electrical equipment. Provided they are faithfully followed by supervisory staff and the engineers themselves, these procedures afford adequate protection. The final responsibility for protecting all others who may have reason to service or operate the aircraft rests with the engineer. A high standard of workmanship and intelligent anticipation of service faults during routine inspections is not only essential to ensure aircraft serviceability but also to protect the user of the equipment from personal danger.

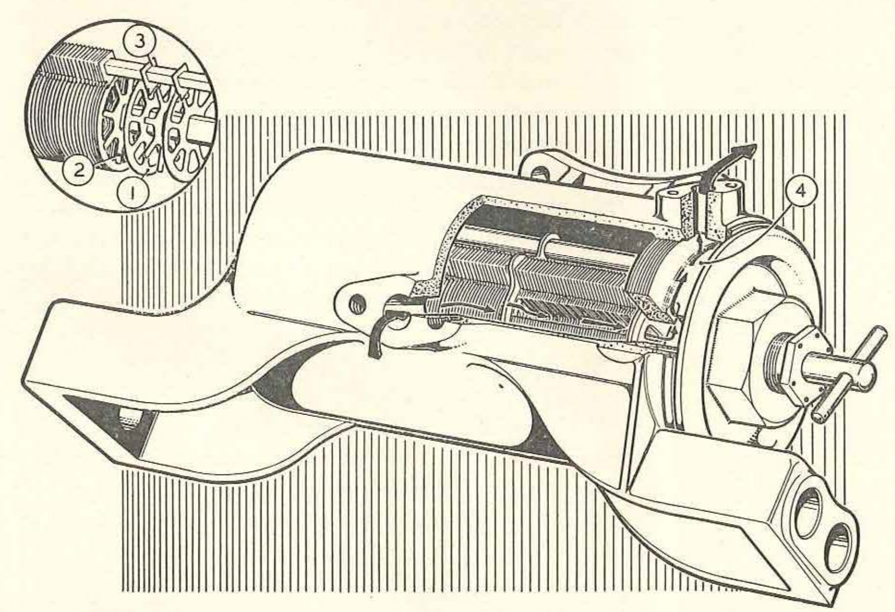
EXPENSIVE OMISSION

In the course of an agricultural spraying run the engine of a DH.82 seized completely, without warning. Fortunately the operation was being carried out over an open cropped field and the aircraft was landed without further damage.

The engine seizure was due to oil starvation, which in turn was caused by a choked main pressure filter. It was subsequently learned that because the pilot found the handle of the Auto-klean filter stiff to turn some 30 flying hours earlier, the filter elements had not been rotated during the subsequent operations.

The Auto-klean filter has proved one of the most effective and trouble-free units ever fitted to an aircraft and it is surprising to find that any pilot endorsed to fly an aircraft with this type of filter installed was not fully aware of the essential need to rotate the filter element during daily maintenance services. Perhaps there are others who are similarly unaware of the reason for such action.

On this type of filter the oil percolates between thin laminated plates spaced approximately .003 inches apart. The filter plates are flat wheel-like discs with eight spokes which radiate out to a circumferential ring and are packed on a central rod. The spacer plates are similar, except for the circumferential ring. Scraper blades .002 inches in thickness are supported on a square rod and project one into each of the annular spaces between the filter plates as illustrated. The complete assembly is clamped to the filter end-cover, through which the end of the central rod protrudes. This end of the rod is fitted with a handle so that the filter plates can be rotated against the fixed scraper plates, thus clearing the filter of sludge and other deposits extracted from the oil. These deposits collect in the filter casing and are removed during major maintenance services.



On all engines where this or similar types of filters are installed it is essential that the handle be rotated two or three times prior to the first flight on each day. This is a simple task and one that requires no special knowledge or mechanical training. If it is found that the handle is abnormally stiff to turn the cause must be investigated immediately as a clogged or ineffective oil filter will inevitably lead to engine failure.

HOW SAFE IS A GLUED STRUCTURE?

In September, 1962, the Director-General wrote personally to owners of several types of light wooden aircraft informing them of severe operational restrictions that had been imposed on each type and suggesting that the aircraft should be withdrawn from service. The wisdom of this advice is clearly illustrated by a recent incident in which, by chance alone, a serious accident was averted.

In advising the Department of the occurrence, the owner wrote:

"On 14th November, I took off in my aircraft, a Miles Messenger, to make a routine inspection of the watering facilities on my property and also to try to "spot" some sheep that were missing in a certain paddock.

"The time of take-off was 5 p.m. and I encountered only slight turbulence. However, after flying for 10 to 15 minutes I noticed that the port wing had a decided tendency to drop, but I did not take too much notice of this and put it down to the slight turbulence I was encountering at the time.

"At approximately 5.25 p.m. I arrived at a dam, which I flew around twice to check the water level and also to see if any sheep were bogged. At this point I was flying at 300 feet, and in about a rate two turn. After a thorough inspection of the dam I decided to fly home and land, but then found that the aileron control was semi-locked. I was in a left turn and could not move the 'stick' to the right, but found I could move it to the left. I was over open country and was seriously considering an attempt to land in a side slip attitude, but after another five or six circles (more or less), I tried thumping the stick with the flat of my left hand. After several thumps the stick finally moved far enough to the right to bring the plane to a more or less straight and level attitude. I then flew a direct course to the areodrome using rudder and elevator control only and landed without further incident. Towards the end of the landing run the plane veered rather sharply to the left and ran right off the strip. I then noticed that the port aileron was hanging down and was apparently disconnected from the control system. It was just after sundown at this time and too late to make any inspection of the aileron section.

"The following day, 15th November, I was too busy to inspect the aircraft, but on the next day I opened the under-wing inspection holes on the port side and saw that the block of timber carrying the aileron control arm had come away from its position due to a glue failure.

"I then notified the Department of Civil Aviation, Brisbane, of the incident and an aircraft surveyor came out to my property to inspect the aircraft.

"Whilst awaiting his arrival and thinking over what the Director-General's letter had said, I decided that the best thing to do with my aircraft was to withdraw it from the register and make it so unserviceable that I would not be tempted to fly it again.

"When the surveyor arrived I told him of my decision and mentioned that I would be cutting it up. It was decided then was as good a time as any, so the surveyor, a station hand and myself cut off the wings. The condition of the structure convinced me that the aircraft was no longer airworthy.

"I forgot to mention previously that while I was in the turn and could not straighten out, I had elevator control throughout."

This aircraft was 15 years old and had spent its operational life of 2,100 hours in Queensland, the majority of which was in an area where there is considerable variation between the summer and winter temperature conditions, with low relative humidity throughout the year. The owner was well aware of its past history at the time of purchasing the aircraft and knew that it had been hangared almost every night throughout its life. Before taking delivery he erected a hangar on his own property and continued the policy of keeping it under cover and ensuring that all regular maintenance inspections were faithfully performed. The owner, as well as others who knew the history of the aircraft, believed that no aircraft could have been better cared for, or more carefully maintained.

Records show that in 1958 shear tests were performed on samples from the spar structure and inspection holes were cut in the wing skin along the spar to provide a means of inspecting the adhesion. These tests, together with the most searching examination, indicated that the structure was sound.

In 1959, and again in 1961, the structure was carefully examined through the holes previously cut. The glue adhesion appeared to be satisfactory throughout. Consequently, further shear tests were deferred as there is a limit to the number of tests that can be conducted without causing structural weaknesses. A most comprehensive examination of the aircraft at this time did not reveal any physical reason to doubt the integrity of the aircraft structure.

Cutting off the wings permitted a thorough examination of the basic structure and revealed strong evidence to support the contention that only by complete dismantling can the true condition of the glued structure be properly assessed. Separation had commenced in the glued joints between the spar booms and webs in numerous places, some of which were well advanced but still could not be detected through the inspection holes which had been cut in the skin. Despite the fact that the plywood skin appeared to be soundly stuck to the ribs, sectioning showed that, due to there being little or no adhesion at the skin to rib joining surfaces, it was little more than a separate shell which was virtually disconnected from the ribs.

There are no known non-destructive testing methods which can be applied to glued joints to determine their strength. Experience has also shown that there is no other criterion, such as service history and the manner in which the aircraft has been protected from the weather, which can be used as a guide to the extent of deterioration that may have taken place. For these reasons even the most ex-experienced engineers can do no more than guess at the airworthiness condition of an old glued wooden aircraft.

It may well be that amongst the original 28 Australian registered aircraft of built up wooden construction using synthetic glues there are one or two which are airworthy in the true sense of the word. This is purely a guess. Doubtless, too, it would be a reasonably accurate guess to say that quite a number of these aircraft will continue to fly safely whilst all circumstances remain favourable and the loads carried by the structure remain well below the maximum for which they were designed. Guesswork such as this has no place in aviation, particularly where the integrity of basic structure is concerned, for it is inevitable that if these aircraft continue to fly, sooner or later they will encounter a flight condition which imposes a load beyond the capabilities of the deteriorated glue. When a major structural failure occurs in flight it is abrupt and catastrophic. In all cases on record in this country the resulting accident has been fatal.

Pilot Responsibility for Separation

Air traffic control provides for the separation of aircraft operating within controlled airspace. The pilot alone is responsible for maintaining separation when operating outside controlled airspace. He will, of course, be given infomation concerning the movements of other aircraft **known** to the air traffic control or communications officers.

There are numerous airports throughout the Australian mainland and Papua/New Guinea around which no control zones are provided. Unless a control zone is in existence, pilots are expected to maintain adequate separation from all other aircraft operating in their vicinity on the "see and be seen" principle or, if operating in IMC, by direct communication between the aircraft concerned. Flight information on all known significant traffic and suggested courses of action will be provided by the nearest ATC or COM unit to assist the pilot, where possible.

The decision to establish a control zone at a particular airport is based upon air traffic density, that is, the number and type of aircraft movements involved. Whilst the majority of airports which have no associated control zone are also remote from controlled routes, there are some of these non-controlled airports beneath controlled routes.

In view of a recent air safety incident involving the separation of aircraft descending into Wynyard, it would seem that some pilots may not be aware of the extent of the ATC/COM service which can be expected at this and similar locations. Apparently the pilot who submitted the report regarded advisory messages, received from Launceston, as clearances. The pilot was fully informed of the other traffic in the area, but failed to realise that the responsibility to maintain separation was his.

The communication unit at Wynyard provides an aerodrome information service only. This means that aerodrome weather conditions and known traffic information will be provided but that an approach control service is not available.

The pilot alone is finally responsible for avoiding other traffic when operating outside controlled airspace. Air Traffic Control terminology such as "leave control area on descent to lowest safe altitude" is used to indicate that positive traffic separation by A.T.C. ceases at that point. Provided communication facilities permit, the pilot is not precluded from seeking additional information from A.T.C. or COM, should he so desire. Direct communications between aircraft operating in the vicinity should be established and other aircraft kept informed of your intentions.

Trim Jamming — P.A.22

Although a modification was introduced by A.N.O. DCA/PA22/18 to rectify stabiliser trim jamming on Piper PA22 aircraft, a number of incidents have since occurred in which jamming or stiffness has been experienced on modified aircraft.

In the first cases of trim jamming investigated by the Department, the cause was found to be locking of the actuator spindle thread and the yoke assembly thread when forceful application of full nose down trim brought the yoke assembly Pt./No. 42692-00 hard against the actuator drive pulley Pt./No. 12982-00. As explained, this occurred only at the full nose down trim position and the A.N.O. referred to above was designed to prevent this jamming.

The later reports of stiffness or jamming have been investigated and it is to be noted that these are not limited merely to the full nose down position but could occur at any position. In the two cases brought to our notice the jamming was experienced approximately midway between neutral and full nose down trim positions.

The causes attributed to these incidents are:

(a) Stiffness in the screw-jack assembly caused by wear in the acme thread on the spindle and yoke.

(b) Grease and oil on the endless cable and in the pulley grooves which causes a lowering of friction between the cable and the pulley wheels, making it impossible for the pilot to force the screw-jack from the jammed position.

Examination of the grease from the screw jack showed that it contained a considerable amount of finely ground grit as well as a few grains of sand, and other particles of foreign matter. The open position of the screw jack in the aircraft allows this contamination of the grease and it is considered that the main cause of the wear on the spindle and yoke nut is this abrasive grit in the grease. On one aircraft examined, abrasive grit was observed in the grease after only 10 hours' operation following complete washing and re-greasing of the screw-jack unit. Prolonged operation without cleaning and re-greasing will certainly cause excessive wear which will not only call for premature replacement of parts, but can lead to a potentially hazardous situation.

Thorough inspections will reveal any abnormal wear in the unit but the relatively easy task of regular cleaning and re-greasing will prevent it.

MODIFICATION VERSUS DESIGN

In arranging the layout of controls in the flight compartment of an aircraft, the manufacturer is well aware of the possibility of one control being operated by mistake when it is intended to select another that is close by. To guard against the hazards that arise from inadvertent operation, vital controls are designed so that they are distinguishable by feel, are positioned remote from others that may be similar or are provided with a retaining device that must be unlocked before operation.

Occasionally standard controls are changed by local modifications. Although functionally satisfactory, such modifications frequently result in a non-standard layout which ultimately leads to an accident. The wisdom of maintaining the safeguards incorporated in the original design is well illustrated by a recent accident involving a Miles Gemini.

The pilot taxied the aircraft to the control tower and shut down both engines. After vacating the pilot's seat he reached into the cockpit, from where he was standing on the wingwalk, intending to select the master electrical switch to the OFF position. The undercarriage control switch had been modified, making it identical with the electrical master switch, and it so happened that the pilot accidentally selected the landing gear to the UP position. The wheels retracted and the aircraft suffered substantial damage.

The main landing wheels of a Gemini are retracted by electrical actuating motors, the control for which is situated at the lower centre of the instrument panel, immediately alongside the electrical system master switch. The standard Gemini undercarriage selector consists of two separate switches, one for each retraction motor, which are interconnected by a gang-bar. They are retained in the position to which they are selected by a spring loaded plunger, which must be depressed before the switches can be moved to the opposite selection, thus preventing both accidental and inadvertent operation.

In this particular aircraft the two standard single-pole double-throw switches had been replaced by one switch which incorporated a double-pole double-throw mechanism. The locking mechanism had also been removed and a lift-up guard substituted. The switch was electrically satisfactory for the purpose and was correctly placarded. The guard, too, was effective in so far as it prevented the switch being accidentally knocked to the reverse position. Because it was adjacent to and identical with the guard installed on the electrical master switch, however, it was not effective in preventing inadvertent operation. Had the shape of the switch, or even the guard, been significantly different or had some form of spring loaded locking device been incorporated, the damage that resulted from the unintentional operation of the undercarriage switch would have been avoided.

An installation such as this not only introduces the possibility of the aircraft being damaged whilst on the ground, but also leaves the way open for an incorrect selection, with far greater potential danger, under the stress of an abnormal flight condition. It could happen that in attempting to retract the wheels after take-off the pilot could operate the wrong switch, thus selecting the electrical power off. Although such a situation would, of course, become self-evident after a short space of time, at a critical stage of the climb this delay could result in the aircraft failing to clear obstacles in the flight path.

With exception of the instances where operational experience has shown that there is a need for some particular modification, it is best to preserve the original cockpit layout by using only standard replacement parts, as designed by the manufacturer. Unfortunately, aircraft do become obsolete and there are occasions when standard replacement parts are no longer available. In these circumstances it is necessary for changes to be engineered and incorporated by appropriately approved organisations. It is a responsibility of the design change organisation, and the aircraft owner, to ensure that adequate safeguards are incorporated into even the simplest of modifications.

We all like Cookies, but . . .

By Major Robert L. Hill, U.S.A.F.

(Aerospace Safety)

The degree of self-discipline an individual has attained is perhaps the only valid yard-stick of his maturity.

Each of us once knew a child who would furtively raid the cookie jar when alone in the kitchen, but resist the impluse when his mother was watching. This example shows that a child's behaviour is greatly determined by external pressures. As this child grew older, he absorbed many rules of social behaviour and learned to resist temptation. By high school age he had earned the right to handle money, and to use the family car, by demonstrating the level of maturity and self control his father required. He found that success in school depended directly on the amount of will power he could muster toward sticking with his homework when he would rather watch television or harass the local populace by hot-rodding around town with the gang.

Developing a man-sized, bedrock foundation of self-discipline is a slow and painful process, and a lonely one — for each man must build his own out of the materials provided him by his mother, father, church, school and friends.

A man may exhibit a certain degree of self control in the company of his commander, another when surrounded by his friends, and yet a different level when among strangers. I know a man who is afraid to speed past a highway patrol car and ashamed to be a litterbug in his own neighbourhood, but when driving without these lawful or social pressures acts like he owns the world. This immature type is still raiding the cookie jar because no one is looking.

As officers and pilots you are frequently placed in a situation where you must probe for your own personal level of self-discipline. You may fly with the Standboard, or with your buddies, or perhaps all alone in the airplane. Do you regress in age, allow your self control to erode away in direct proportion to the removal of external pressures, or is your compulsion to act as you know you should, deeply imbedded in a solid layer of honesty, maturity and pride of achievement?

Do not indulge in the luxury of allowing rationalisation to excuse your minor defections — the man who parks his car improperly or skips a haircut is the same man who will skip a pre-flight check or chase jack rabbits on a local transition flight.

Only you can fix the level of your maturity. Only you can make yourself into the man your mother and father wanted you to be. Only you can create within yourself the self-discipline it takes to keep your hand out of the cookie jar when no one is looking.

THE RIGHT SPIRIT

It is well known to all the aviation industry that there are some who, either from lack of knowledge, or just plain foolhardiness, persist in departing from commonsense rules and regulations designed to promote safety in aviation. The manner in which one recent case came to our notice is in itself interesting.

The evening edition of a capital city newspaper carried a small news item illustrating "1962 travel, country style". The proprietors of a country service station spotted a light aircraft circling overhead. Soon after, the plane landed in a nearby paddock and the pilot walked in to buy several gallons of super-grade petrol.

In case others might be misled by this news item and believe such a practice to be acceptable, the newspaper was asked to point out that for very good reasons it is an offence under the Air Navigation Regulations to use other than aviation gasoline in piston-engined aircraft.

A little over three years ago, in Aviation Safety Digest No. 18, we published an article on this subject, under the heading "Stick to Avgas". No doubt there are many light aircraft pilots who have never read this warning. Doubtless, too, there are some who have read it but have forgotten its content, whilst there are still others who prefer to believe that their experience is sufficient to enable them to ignore the advice of engineering experts. For these reasons, the orginal article is reproduced below:—

"In the highly competitive automobile fuel business it is essential for the various distributors to keep the name of their product before the public by intensive advertising.

"This advertising material is prepared by some of the best exponents of the art and the persuasive powers of such advertising may tend to influence even aviation people to whom it is not directed.

"Now don't let all this advertising tempt you into trying automobile fuel in your aircraft. It certainly won't give you any improvement over the correct grade of aviation fuel — on the contrary, its use can be positively dangerous in some conditions.

"In brief, here are some points where automobile fuel and aviation fuel differ significantly:

Knock Rating

"Aviation fuels are graded in terms of their knock rating and every precaution is taken to ensure that the fuel supplied is true to grade.

"On the other hand the knock ratings of motor fuels are not normally disclosed and all claims are purely qualitative.

"The use of a fuel with a knock rating lower than the minimum specified for your aircraft engine will quickly lead to engine failure as the result of detonation.

Vapour Pressure

"The vapour pressure of automobile fuel is considerably higher than that of aviation fuel. In consequence, there is a very real danger that the use of automobile fuel in aircraft will lead to vapour locking of the fuel system under high ambient temperature conditions and at altitude.

Tetra Ethyl Lead

"The lead content of automobile fuel (both standard and premium grades) is relatively high and may exceed 2 mls. per gallon in some cases. As many light aircraft engines are designed to use a low lead fuel, the use of automobile fuel may result in spark plug fouling and could also lead to a rapid deterioration of the condition of the combustion chamber.

"Remember, aviation fuel is produced against exacting specifications and handled under a strict quality control system. The end result is a uniform, high quality product which will produce the optimum performance from your engine."

Legally the use of other than the correct grade of fuel in an engine invalidates the aircraft's Certificate of Airworthiness. From the practical viewpoint, it can lead to engine failure either immediately or by delayed action. If flights are properly planned and competently executed pilots should never be placed in a situation where they are tempted to use automobile fuel. It is perhaps inevitable, however, that there will be the odd occasion when an aircraft runs short of petrol due to circumstances beyond the control of the pilot. Where this occurs, any temptation to use an incorrect grade of fuel should be firmly resisted.

Having expressed the very necessary aversion to the use of motor spirit in aircraft engines it is perhaps only fair to point out that there is nothing wrong with automobile fuel for automobiles because their engines are designed for it and they like it. Aircraft engines are in a different category.