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THE OPERATION OF AIRCRAFT IN ANTARCTICA

By W. J. B. Chapman

The continent of Antarctica is not only a difficult region to approach, but it is also a difficult region in which to travel, whether on foot or by dog sledge, tracked vehicle or aircraft. To the average person an aircraft, especially a helicopter, is apt to suggest itself as the best means of transport there. Generalisations, however, are dangerous. Such factors as the purpose and length of the journey, nature of the terrain, surface conditions, food and fuel requirements, etc., will dictate which mode, or combination of modes, is the most suitable. Although helicopters and aeroplanes are playing an important role today in the unlocking of the secrets of Antarctica, so too are the forms of surface travel.

Although aircraft and their equipment are designed to operate in widely varying climatic conditions, the operation of helicopters and aeroplanes in high latitudes presents many problems which require special preparations and precautions to overcome them.

Because of the very low ambient air temperatures which are experienced, a standard aircraft needs special preparation for operation in Antarctica, or for that matter, in the Arctic. Normal greases are unsuitable; thus all parts which require greasing must be treated with special low-temperature grease. Aircraft will also be grounded when men are still capable of performing tasks because, due to condensation in pneumatic systems, droplets are formed which freeze and clog the airlines; consequently special air drying devices must be incorporated in such systems. The aircraft cabin, moreover, requires a greater degree of draught-proofing, and a cabin heating system, which is effective at low temperatures, is essential. Furthermore, because of the incredible penetrating quality of snow, the entire airframe should be made as "snow proof" as possible, and tight fitting covers must be provided for engine cowlings, pilot heads, static vents, etc., in order to obviate hours spent later on clearing the interior of cabins, engine bays, mainplanes (wings), etc., of snow.

Antarctica is largely an unmapped, featureless white desert, having the worst flying weather in the world. There are virtually no alternate airfields for emergency landings. Moreover, due to the immense logistic problems, the continent is poorly served with long-range radio navigation aids. Such aids, however, if available, are subject to heavy interference from auroral activity which reduces their effectiveness. The navigational techniques employed are thus basically those used in other featureless, ill-mapped areas of the world, having inadequate navigational aids. Owing to the proximity of the South Magnetic Pole and the imperfect knowledge of magnetic variation in those latitudes, however, a magnetic compass is an unsuitable instrument to steer by. An astro-compass, whereby the aircraft's true heading can be obtained from the sun, is thus essential. Owing to the convergence of the meridians in very high latitudes, rhumb line (constant aircraft heading) tracks are impracticable, because of the excessively curved route followed over the earth's surface; nor are great circle tracks (giving the shortest distance between two points on the earth's surface) convenient, because of the need to change the aircraft's heading constantly. Except over short distances, the grid navigation technique is thus employed. This demands a very high quality directional gyro being fitted in the aircraft to serve as the master directional indicator. Furthermore, because the greater part of the continent is featureless and the map contours inaccurate, a good drift sight and radio altimeter are essential to give drift and ground speed. In large aircraft this information should be provided by a doppler navigation system. Whilst long-range navigation aids may be lacking, the aircraft's base is bound to have a radio transmitter, if not a radio beacon; a radio compass is thus also a must. And, finally, every aircraft should be fitted with some form of locater beacon and search receiver, and should have a bright red or orange colour scheme.

Provided a runway of compacted snow, or hard ice covered with a thin layer of snow, is available, aeroplanes with wheeled undercarriages may be used, but ski undercarriages on aeroplanes and float undercarriages on helicopters are generally to be preferred. In fact, except where the nature of the sastrugi renders it impossible, the shelf ice and polar plateau of Antarctica present one vast airfield to aircraft fitted with skis, while helicopters on floats can land on any level surface of undisturbed water, ice, firn, snow or rock which is free of obstructions to the rotor blades.

Although the servicing of aircraft in Antarctica follows the same principles as in more temperate climates, certain additional precautions must be observed. Great care must be taken not to overtighten nuts, bolts, and control cables or rods, as they may sheer due to contraction. All filters must be checked for the presense of ice which may clog fuel and pneumatic lines. Oil and hydraulic fluid leaks, which due to freezing may hamper the functioning of moving parts, must be eliminated. And rubber pipes must constantly be checked for cracks brought about by the cold. Whilst Antarctica is the coldest continent, it is also the windiest region on earth, which introduces another factor, namely "wind chill" — that is, the speeding up, because of the wind, of the natural loss of heat by the human body by greater evaporation and a more rapid conduction of heat from the body. Most work on aircraft in the open is thus not possible unless adequate protective clothing is worn and shelters or windbreaks and heaters are provided. Heated hangers are a boon, but the movement of aircraft in and out of heated hangars introduces snags because of the rapid changes in temperature which take place. Differential expansion and contraction may cause windscreens, windows and canopies to crack, or fuel, oil and hydraulic leaks to occur. Pressures in hydraulic accumulators, oleo legs and tyres will be affected. To prevent the formation of ice, any moisture due to the sweating of an aircraft in a heated hangar will have to be removed before the aircraft is moved into the open again.

Prior to flight, great care must be taken that all aircraft surfaces, control hinges, oleo legs, hydraulic jacks, undercarriage locks and micro-switches, pilot heads and static vents are free of snow, ice and frost. As low temperature causes a loss of capacity and a decrease in the ability to accept re-charging, batteries need special care. Aircraft starting loads are very high; thus an external power supply must be used to avoid overloading the aircraft's batteries. In fact, if the aircraft is large enough, it should be equipped with an auxiliary power unit. Few precautions, except for fuel filter icing, need be taken before starting gas-turbine engines at low temperatures. Special care, however, must be taken during the starting of piston engines. Oil dilution and high volatility priming, or engine pre-heating, are essential, and the warm-up procedures must be adhered to.

During flight, navigation is the most difficult problem. To obtain the aircraft's true heading, the sun must be visible; and, unless the aircraft is equipped with a doppler navigation system, surface features must be visible in order to obtain the track and ground-speed made good. The weather in Antarctica, however, can deteriorate unexpectedly rapidly. If the sky, moreover, should become overcast, the daylight might become so diffused by multiple reflection between the snow and the cloud layer overhead, a condition known as "white out", that the pilot will be unable to distinguish the horizon or any snow surface feature. This can be extremely hazardous. There are also few bases to serve as alternate landing fields. Very thorough flight planning is thus essential. Furthermore, adequate provision must be made on board the aircraft for adequate clothing, food and equipment for survival at low temperature in case of a forced landing.

Although the helicopter is an extremely versatile aircraft, it has to pay a price for its versatility. In order to enable it to ascend vertically, its engine(s) must develop sufficient power to enable its main rotor to impart lift exceeding its fully laden weight. This does not apply to an aeroplane which relies upon the effect of its forward speed to produce the requisite lift. Weight for weight the helicopter thus requires a more powerful engine, which in turn implies a greater fuel consumption. A helicopter, consequently, is able to carry a smaller load over a shorter distance than an aeroplane having the same fully laden weight. Because each rotor blade is acting as a "wing", while the whole rotor assembly is rotating like a great flywheel, each rotor blade must be perfectly balanced aerodynamically (to ensure the production of the same lift by each) as well as dynamically (to obviate excessive vibration) in relation to the others. The rotor head, moreover, must incorporate devices which will permit the helicopter not only to ascend, but also to move forwards, sideways and backwards. This raises production costs considerably. The purchase price and operating costs of a helicopter thus far exceed those of an aeroplane of the same all up weight. For this reason helicopters should not be employed indiscriminately on tasks which aeroplanes can perform more efficiently and cheaply, but should be used solely for those tasks which the other modes of transport cannot perform

The operation of aircraft in Antarctica, or any polar region, thus presents a difficult task; but, provided the problems involved are thoroughly appreciated, and the requisite preparations made and the necessary precautions taken, air operations can be conducted safely.

SOUTH AFRICA AND BIOLOGICAL RESEARCH IN THE ANTARCTIC

By J. A. J. Nel

The history of scientific endeavour in the Antarctic is a long one, extending back for at least a century or two. As perhaps befitting a continent with so little to offer in the way of material and financial gains, the interest shown in Antarctica in the past has proved to be rather desultory, although at times (notably at the turn of the century and after the last world war) there was a sudden upsurge in interest which led to discoveries of a major nature. Unhappily the attention was very little accorded to biological research up to very recently, with one notable exception—the voyages of the research vessels "Discovery I" and "Discovery II" in the Southern Ocean.

I would like to give you in this short article some idea of the biological, and especially the zoological, research undertaken in the immediate past and at present in the Antarctic region, with special reference to the possible future role of South Africa in this respect.

It is only during the last ten to fifteen years (apart from the work done on the voyages of the Discovery I and II) that biological research in the Antarctic has become one of the major fields of study being undertaken, primarily, by scientists of Great Britain, the United States and Australia, with scientists of other nations contributing to a lesser degree. A number of valuable studies on seals were undertaken by members of the Falkland Islands Dependencies Survey (now the British Antarctic Survey) and by them and others on the ornithology and botany of South Georgia and the islands off the coast of the Antarctic Peninsula (Graham Land). Similar work has been undertaken by the Australians on Heard and Macquarie Islands. During the past few years the Americans have initiated a comprehensive programme, mostly in the vicinity of McMurdo Sound, including a number of diverse projects such as entomological research; systematics, distribution and origin of the deep-sea Isopoda; growth and metabolic rate of fishes; a study of the bacteria, fungi and other biota in air, soil and melt pools, and a study of the parasites of Antarctic vertebrates, to name but a few.

South Africa's contribution in the field of biological research should be seen against the background of the organisation of all research in the Antarctic region. South Africa's interest in the Antarctic region used to be (and I suspect still is) mainly in the field of meteorological observations. With this in mind, various weather stations were established, starting with the one on Marion Island in 1948, Gough Island in 1956, and on Queen Maud Land, Antarctica, in 1960, when the old Norwegian station (used during the I.G.Y.) was taken over. Control of the weather stations, *and Antarctic research*, was vested in the Department of Transport. This is still the case although later on, especially at the Antarctic base SANAE, a start was made with research on physical projects. At no time, however, was any sustained biological research programme initiated. There is at the moment of writing, a Committee for Scientific Research in the Antarctic, with a Biological Panel, but this body acts in a purely advisory capacity. In this respect South Africa is rather out of step with most of the other nations participating in Antarctic research in that there is no statutory body or council which directs the overall scientific programme. What is more serious is that little effort seems to be made to publish the results obtained.

Up to the present the only research undertaken by South Africa in the biological sphere has been by Rand on the Marion Island Fur seal, La Grange on the Elephant seal on Marion Island, Rand on some of the birds of the Southern Ocean and La Grange on the breeding cycles of some of the birds of Marion, as well as their behaviour. In addition, La Grange also made observations on the bird and mammal life encountered on the way to SANAE. Van Zinderen Bakker has done some work on the flora of Marion, and Plumstead a great deal on the *Glossopteris* flora of the Antarctic continent. This year, under the leadership of Prof. van Zinderen Bakker, a team of scientists, including biologists, left for Marion Island to study, *inter alia*, aspects of the botany as well as the zoology. It is the intention to publish the results as a monograph on the biology of this island.

A thorough and comprehensive study of the biology of the Antarctic region should prove to be of inestimable value in the understanding of the distribution patterns of plants and animals of this region at present and in the past; of the biological history of this region — the origin of its plants and animals; its ecology, and, perhaps the most important of all, the effect of human occupation on the balance of nature in this remote part of the globe.

Let us now take a brief look at the scope for biological research open to South Africa. For purposes of delimitation of research projects, it is logical to subdivide the Antarctic region into four zones, not necessarily biotic zones, although this may eventually prove to be the case.

(*a*) The subantarctic Islands (Marion, Gough and Bouvet);

(*b*) The Southern Ocean (South of the Antarctic Convergence);

(*c*) The pack ice, and

(*d*) The Antarctic continent with, in summer, a variable amount of open water between the continental iceshelf and the inner edge of the pack ice.

Of these four zones, only the subantarctic islands offer any worthwhile scope for botanical research. All four zones, however,