# Antarctic Aviation: Accidents and Safety Policy


*An Adelie penguin displays at Cape Hallett in November 1960. A disabled VX-6 R4D-5L (BuNo 17163) sits in the background. (D. Harrowfield Collection)*

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## Introduction

Safety in aviation concerns managing risk rather than its elimination. This is certainly true for aircraft operations to, from and within the Antarctic region. This report looks to a series of accidents and incidents that have occurred in the Antarctic region and the operation policy aimed at avoiding such occurrences.[1] This is not an exhaustive account of aviation accidents in the Antarctic. Rather, this report defines a pattern that has formed from the similarities in causative elements related to aircraft accidents. The trends provide an interesting insight to what factors are peculiar to the Antarctic region. The analysis then turns to the whether aviation safety policy is suitable in identifying the unique problems occurring in Antarctic aviation operations including recent developments in adventure tourism aviation.

## The Emerging Pattern

Since 1902, when Robert Falcon Scott became the first aviator on the continent in a balloon,[2] aviation in the Antarctic has become and essential service for surveying, logistics, and search and rescue operations. However, since the first aviation accident in the Antarctic, operators have needed to address the unique operating conditions and have had to adapt accordingly.

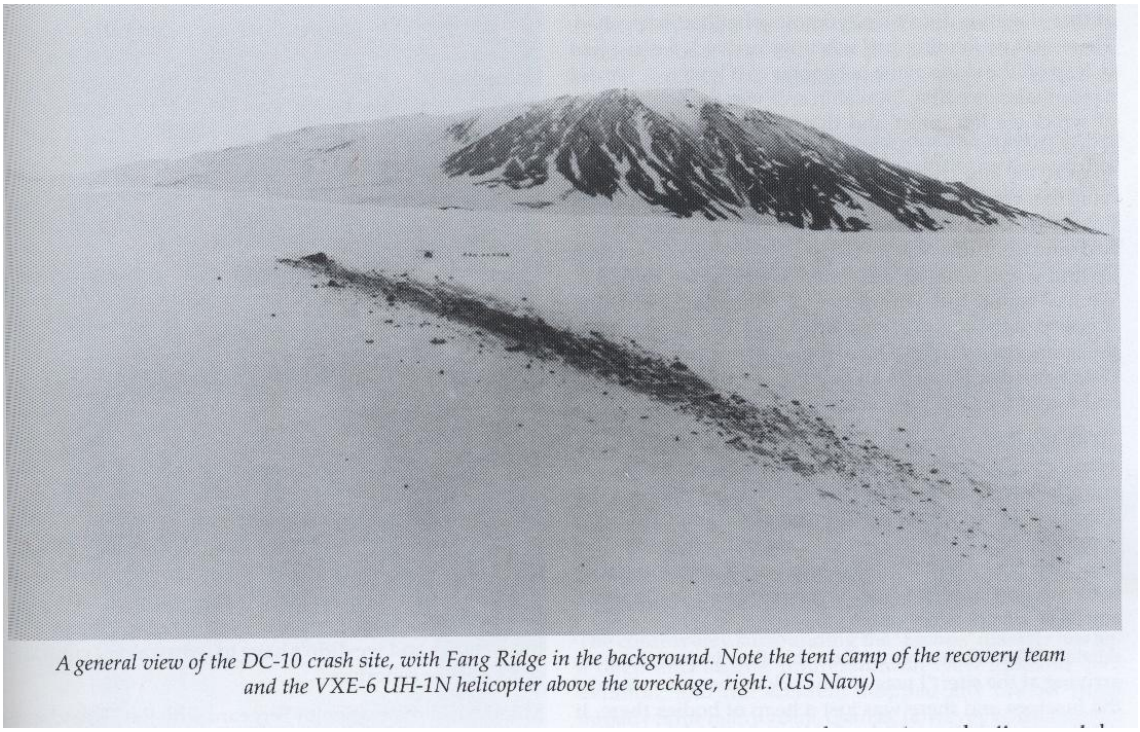
Three variables are present in any aviation incident; human, machine and the environment. Very rarely is one causative to the exclusion of the others. Below the categories are named along with an account of certain accidents that best illustrate the problems encountered.

## The Human Element

The human element is affected by the other two elements of machine and the environment. Aircraft are complex thus increasing the heavy workload of the pilot. The polar environment can play tricks on the pilots ability to perceive correctly the world outside the flight deck. The flight crew on Air New Zealand flight TE901, 28 November 1979, were deceived by their observations in Lewis Bay in thinking they were cruising safely down the McMurdo Sound. The combination of the rising white terrain and low 2000ft cloud gave them the impression that an expansive

[1] New Zealand Civil Aviation Regulations Part 1 define accident and incident per Annex 1 of this report as promulgated through the New Zealand Civil Aviation Act 1990.
[2] The balloon was affectionately called *Eva* after Scott's wife. The assent took place on 4 February, 1902.

horizon lay before them. What in fact existed beyond the illusion was the lower slope of Mount Erebus, Fang Ridge.



*A general view of the DC-10 crash site, with Fang Ridge in the background. Note the tent camp of the recovery team and the VXE-6 UH-1N helicopter above the wreckage, right. (US Navy)*

The aircraft was destroyed upon impact. Flight data and cockpit voice recorder tapes indicated that the crew up until that moment had no idea of the approaching terrain before them. Air New Zealand submitted that such phenomena was rare, however the head of the Royal Commission of Inquiry, Justice Mahon, visited the area and experienced the same conditions. He was told by local operators that in fact such conditions were not unlikely and those experienced by Justice Mahon that day were nearly identical to that which deceived the flight crew of TE901. The false horizon illusion coupled with the compelling effect of what they expected to see was considered a major contribution to the 1979 accident.[3]

Other instances of perception difficulties occur upon the approach and touchdown phases of flight. In certain overcast conditions the contours of the runway disappear giving the effect of

[3] *Flight 901: The Erebus Disaster,* Kier Productions 1980. At the time considered the worlds fourth worst air disaster, Compare the findings of the Accident Report with the Commission of Inquiry headed by Justice Mahon. The former placing the blame with the pilots where Mahon determined that the blame lay squarely with the "administrative blunders" of Air New Zealand management.

landing in an eternal white abyss.[4] The loss of contour perception and the characteristic surface of landing strips formed by snow drifts combine to create a dangerous situation during take-off or landing. Wind sculptured snow ridges known as sastrugi are hazardous to the landing gear due to high speed impact loads. In 1971 a US LC-130 BU No 148321 aborted a take-off but struck a sastrugi damaging the nose gear.[5] In 1962, November 9, a Lockheed P2V-7P Neptune Bu No 140439, modified with two jet engines, crashed at Wilkes Station. It had just arrived from Mirny Station and was taking off from the skiway, when it caught fire and crashed. Five of the nine men aboard were killed. The subsequent investigation reported that the Neptune was subject to stress and exceeding the design limits of the aircraft during take-off from a very 'rough' runway.[6]

## The Environment

### *Landing Surfaces*

Landing surfaces in the Polar regions are unique from those ordinarily encountered in ice regions in higher latitudes. This is because great effort is made to accommodate heavy transport aircraft such as C-141 Starlifters, C17 Globmaster III, and C-5 Galaxies. These airfields require constant maintenance and to compact the surface of up to 10 000 ft in length. The purpose of which is to remove sastrugis and check for crevasses. The importance of which can be supported by a accident ridden past.


In the Deep Freeze operations of 1965 the Squadron lost seven aircraft. A LC-47J Bu No 50778 was on its rollout on the skiway, when one of its skis struck a large sastrugi, and in turn striking its propeller, tearing off the port engine and twisting its fuselage. On October 6 a LC-47H Bu No 17239 crashed on the Ross Sea Ice Shelf, while practicing open field landings. Two months later another LC-47's Bu No 17107 main gear mount collapsed while

[4] Aviation Week and Space Technology, May 25 1998, p65.
[5] A. A. Phillips, *Gateway to the Ice* (2001), p81.
[6] D. Burke, *Moments of Terror: The Story of Antarctic Aviation* (1994), p102.

landing in the Horlick Mountains. The investigation board reported the cause as material failure, the mount not being strong enough to withstand the pressure of the sastrugi in the landing area.

The Navy lost their first C-130F Hercules named ‘City of Christchurch’ in a taxing accident. The Hercules had just taken 7000 gallons of fuel for the return trip to Christchurch, but burst into flames, as it was taxiing around a building. Its left ski went over a five and half foot snow bank; its right wing hit the ground and broke between the two starboard engines. The fire fed by fuel and high winds soon engulfed the aircraft.

*The burnt out remains of the VXE-6 LC-130F (BuNo 148318) “City of Christchurch” at McMurdo in February 1971. (US Navy)*

Providing permanent and reliable airfields in Antarctica has always been a major problem for the military command, before the construction of the Blue Ice Runway, the only other runways regularly maintained for both ski-equipped and wheeled aircraft were located at Williams Field on the Ross Sea Ice Shelf.

The USAF landed the C-5 Galaxy aircraft on the blue ice runway in 1989, this was the first aircraft of its class ever to have landed in Antarctica, and the largest to ever land on the sea-ice runway. Weighing some 870.000 pounds, the C-5A became a regular transport to McMurdo, together with the C-141, having taken over from the early the US Coast Guards, Naval shipping and the Douglas C-124 Globemasters.

However, C-5A operation at McMurdo had not been without risk. Due to the aircraft's weight leaving heavy ‘footprints’ on the ice, necessitated the sea ice ramps to be constantly monitored for cracks. Another limitation of the Lockheed aircraft in Antarctica is the cold. The C-5A utilizes extensive hydraulic systems to raise and lower the fore and aft cargo doors and ramps as

well as the aircraft's kneeling landing gear. Whilst there are no reported incidents regarding the C-5 Galaxy, the size and complexity off the aircraft requires a great deal of monitoring for safe operation.

The Air National Guard had their first C-130 # 10295 incident late in 1998, when the aircraft's portside ski-equipped undercarriage lodged down a 38 metre deep crevasse, whilst preparing to take off from a remote West Antarctic science field camp 130 km south-west of Siple Dome and 1000km from McMurdo. After partly filling the crevasse with snow, engineers used airbags and a special harness developed by Air New Zealand's Engineers to pull the C-130 free. Once free engineers working in sub zero conditions replaced an engine and two propellers, before being flown back to Air New Zealand Engineering Services in Christchurch.


***Wind***

Antarctica is renowned for its katabatic winds that flow down from the plateau reaching 300km/h. Such winds create havoc on picketed aircraft. Several aircraft have been lost during storms where the tie-downs snap resulting in the wind flipping the aircraft, or worse, blowing it away. In preparation for his South Pole aerial visit 130 knots blizzard Richard E. Byrd's Fokker Triplane broke from its moorings wrecking his aircraft.[7]

These extreme winds create severe mechanical turbulence making flying extremely difficult. During his assent to the polar plateau on the 28th November 1929, Byrd encountered downwinds of such force that he was forced to ditch some of his precious cargo.[8] On August 31 1957, the Squadron lost a UC-I Otter Bu No 142426. The aircraft had been tied down with double lines at Little America V, however, an 80 mph wind opened the tie-down rings blowing the Otter away.

[7] D Burke, *Moments of Terror,* (1994) p235
[8] R. Byrd, *Little America : Aerial Exploration in the Antarctic, the Flight to the South Pole*, (1930), p 335.

During the Australia National Antarctic Research Expedition (ANARE) in 1959, the Australians lost three aircraft, two de Havilland Beavers (DHC 2)and a Douglas Dakota (C47) in a hurricane that produced winds of up to 116 mph. Despite the courageous efforts by the crews in attempting to 'ground fly' the aircraft, the decision was made to desert the aircraft. The Dakota sheared its 15 ton fuselage cables and each of its 7 ton wing cables. It then disappeared and still has not been found to this day.[9] The Beavers were not heavy enough to break their ties, but instead they disintegrated before helpless crew.[10]

As recently as this November 2003 a British Antarctic Survey Twin Otter overturned when strong, gusting winds lifted the tail on landing. The aircraft was returning from a routine re-supply flight to Fossil Bluff, a remote field station situated on Alexander Island on the Antarctic Peninsula.

***Weather***

For most aircraft the hazards of Antarctic aviation begin a long way before the southern continent is ever sighted. Fuel capacity is limited in the C-130 Hercules whereby a decision slightly over half-way must be made to either turn back or commit to a landing at McMurdo.

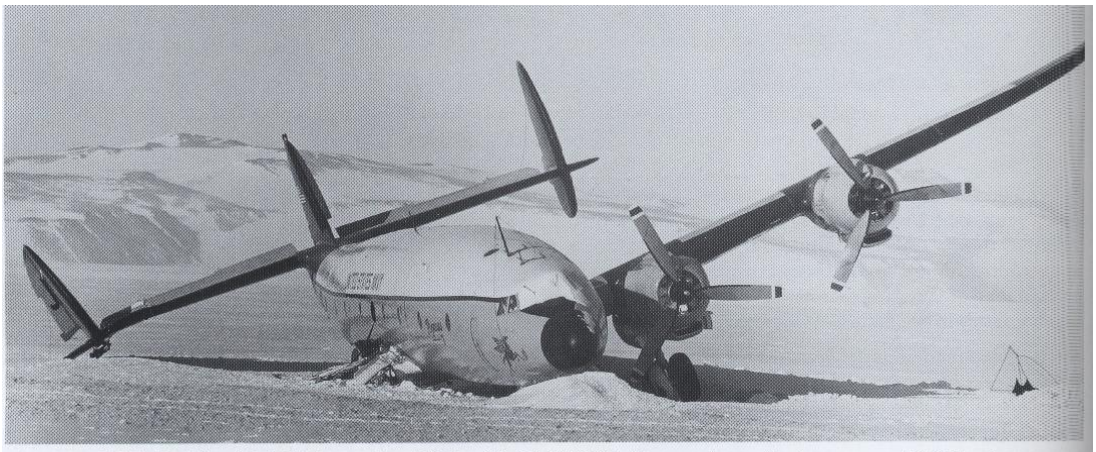
Even after taking the precaution of assessing landing suitability, the changeable weather of Antarctica can thwart the best laid plans. If zero-zero conditions existed at Williams Field, for example, the aircraft is vectored to a pre-surveyed whiteout landing zone where there were no obstacles to flight within twenty miles of the selected flight path. After following pre-established whiteout procedures, the Antarctic aviators would commence a 100 to 200 fpm rate of descent with landing skies and flaps down.

Despite these precautions, VX-6 Squadron's C-121 Bu No 131644 crashed during "Deep-Freeze 70" while landing at Williams Field on the first day of the summer season. With 68 aboard including a crew of 12, it was the seventh aircraft to depart Christchurch for the Antarctic that

[9] Burke et al *Moments of Terror: The Story of Antarctic Aviation*, (1994), p207.
[10] Ibid.

season. Some half-hour before arriving, the weather suddenly deteriorated to zero visibility in a blinding snowstorm.

With no other alternative airfield, and the aircraft low on fuel, the pilot made several low-level radar controlled approaches, all unsuccessful. On the last attempt, and with almost no fuel left, he landed, veered off to the right of the runway. The C-121 was seriously damaged, without any injuries.



*VXE-6 Lockheed C-121J Super Constellation (BuNo 131644) "Pegasus" near the ice runway at McMurdo, after the mishap in October 1970. (US Navy)*

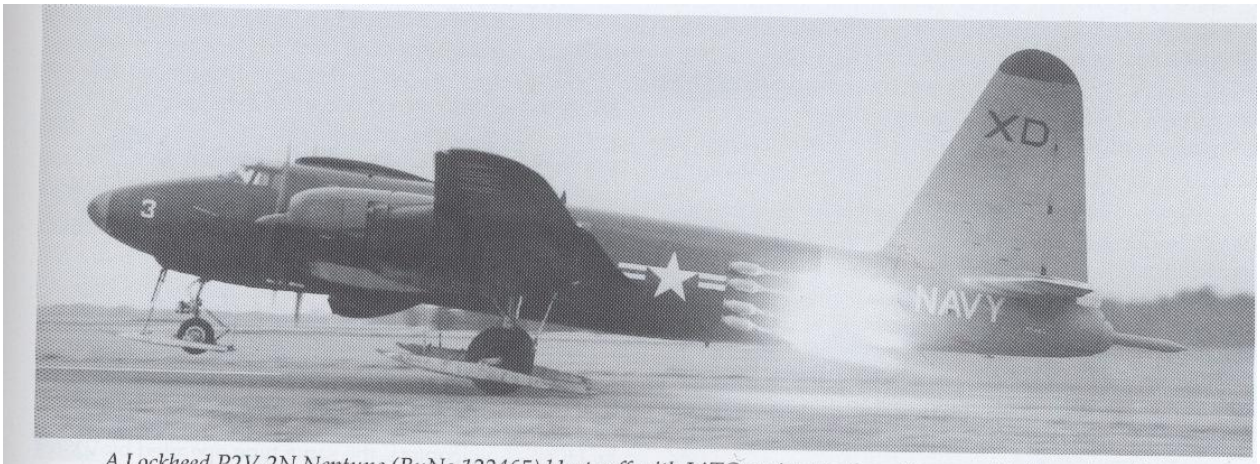
Visibility is not solely impaired by the blizzard type conditions. The low temperatures of the aircraft windscreen cause any moister to super-cool and freeze on contact thus impairing the pilots view. A Sikorsky helicopter was lost on July 12 1957 when a VX-6 HO4-3 Bu No 138580 returning to McMurdo crashed short of base. The windscreen frosted and the visibility suddenly worsened from ice crystals in the Antarctic air. The lack of vision cause spatial disorientation that resulted in the pilot over-flaring and settling the machine on its tail. The helicopter burst into flames causing severe burns to three of the passengers seated in the cabin suffered severe burns. Another passenger died as a result of his burns.

**Machine**

***JATO Rockets***

The extreme environment and high surface altitudes on which the aircraft operate necessitates unusual measures to assure adequate performance. The use of JATO (jet assisted take-off) rockets have a dramatic effect on take-off performance. The rockets are attached to the fuselage and fired in banks near take-off speed to provide thrust augmentation. The use of such devices in

the Antarctica began during “Operation High Jump 1” (1946-47).[11] The operation was a large US Navy deployment led by the now *Admiral* Byrd consisting of 4700 men. The JATO rockets were initially used for carrier aircraft RD4[12](C-47) deployment, of the naval ship the *Philippine Sea*.




*A Lockheed P2V-2N Neptune (BuNo 122465) blasts off with JATO assistance from Harewood in December 1955. This aircraft was the first VX-6 aircraft to reach Antarctica and was later involved in a fatal accident at McMurdo at the beginning of Operation Deep Freeze II. (The Press)*

JATO rockets were instrumental in the successful completion of the first aircraft to land at the geographical South Pole On October 31, 1956 an the R4D named "Que Sera Sera" (what will be, will be).[13] The aircraft was sitting on the ground subject to –50ºC temperatures compounded by a 10-15 knot wind. After approximately 50 minutes the decision was made to leave. However, the R4D's skis during the landing heated a few degrees from the friction causing the snow to melt, subsequently freezing to the skis. At 9,200 feet, the engines had insufficient power to ‘unstick’ the skis. Consequently, fired all the JATO bottles were fired in order to avoid an unscheduled and potentially fatal stay at the pole.

This historic expedition was a valuable lesson in the unique problems encountered by aircraft and crew in the plateau regions of Antarctica. The combination of increased surface altitudes and the effects of the Southern Ocean swirl were to produce ground temperatures never experienced before.

[11] Named Task Force 68 comprising of 13 ships and 23 aircraft.
[12] Naval classification for Dakota DC-3 also has another military classification C-47.
[13] Piloted by Captain William Hawkes and co-pilot Lieutenant Conrad Shinn.

Since then the use of JATO bottles became commonplace but not without their associated accidents. A LC-47H Bu No 50777, while making a jet assisted take-off at Davis Glacier, was written off after a JATO bottle was released prior to it being extinguished hitting the aircraft's propeller. On October 22 19%% a LC-47H Bu No 12407 crashed when one of its JATO canisters was inadvertently fired while being jettisoned. Striking the left prop, the aircraft was a total loss


In “Deep Freeze 72”, VXE-6 lost their second C -130F Bu No 148321 landing in an open ice field to supply a French traverse team participating in the International Glaciological Project. After unloading, the C-130F made the usual JATO take off before returning to McMurdo 750 nautical miles away, however when the pilot had reached 50 feet, two of the bottles separated from the left hand side, striking the left inward engine and prop. The aircraft sustained serious damage on impact with the ice.[14]

JATO bottles, even without the accidental detachment, pose hazards. Just before the 73-74 season finish on January 15, a C-130R Bu No 148319 made a forced landing after a JATO bottle exploded. The crew was 600 miles from McMurdo and eagerly awaited rescue. To their dismay, the rescue C-130 Bu No 159129 nose ski collapsed while taking off with the aircrew and passengers on board. Both aircraft were not recovered until 1979.

[14] The abandoned aircraft was retrieved from its frozen resting-place in December 1986 after 16 years, repaired and returned to Antarctic service.

**Aviation Safety Policy**

As discussed above, aviation operations in the Antarctic and the associated risk are inseparable. Whilst minimising the risk is paramount, managers must accept the realities of working in the Antarctic. Indeed, the words "Safety enhancement" rather than "accident prevention" are considered more appropriate.[15] To take a conservative approach would undermine the utility of the vital services that aircraft operations provide.[16] Policy has taken a common sense approach in the context of accepting the additional risk the Antarctic affords but adapting safety policy to promote best practices.

Safety policy in the US programme took the form of the VX6 Air Operations Manual (AOM).[17] The manual contained comprehensive detail on procedures to be followed whilst around and operating the UH-1N helicopters and C-130 Hercules aircraft. Specific attention is given to operating in the polar region defined as regions greater than 60º latitude. Minimum crews are provided for and the survival equipment to be taken.[18] Minimum training standards are required for ground handling and "hot refueling".[19] Of note is the attention given to flying in whiteout conditions or poor surface definition.[20]

Section 6 of the AOM covers search and rescue and lost communications. Strict requirements govern the authorisation of any aircraft movement. Except for local helicopter flights, no aircraft may operate without another craft being available capable of carrying out search and rescue. This includes Christchurch to McMurdo flights.[21] The annexes to the AOM contain a list of polar phenomena and ways to minimize its effects on aircrew. Annex B lists Specially Protected Areas (SPA) and Sites of Special Scientific Interest (SSSI) for aircraft to avoid the environmental risks in cases of emergency landing.

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[15] G. Hughes 'Accident Prevention –A Regulators View' p29 cited in *33rd Annual International Air Safety Seminar, Sep 1980 Christchurch NZ.* Flight Safety Foundation, 1980.
[16] See for example the Winfly operations conducted by both the US and RNZAF for the medical evacuation of critically ill persons. Antarctic Vol. 17 No 1 August 1999, Antarctic, Vol. 18, No 3 & 4, 2001.
[17] Ref Antarctic Deveron Six INST 3710.7H Air Operations Manual.
[18] Ibid 22, 23.
[19] Refueling whilst engines are still operating.
[20] Above note 17, p31.
[21] The exception being that an aircraft may proceed beyond the point of safe return if the follow up flight is aborted, p48.

The current operator, the Air National Guard, began taking over the roll of U.S. air logistics from the VX-6 in the 1998-99 season. The high degree of Antarctic focused safety policy has continued with strict maintenance regimes continuing to include regular inspection of the landing gear particularly of the nose ski that is critical to safe operation.[22]

***Antarctic Treaty***

At the Treaty level[23] the Council of Managers of National Antarctic Programs (COMNAP) was established to review operational matters and to exchange information and cooperation with SCAR. Under COMNAP the Standing Committee on Antarctic Logistics and Operations (SCALOP) was established.[24] The question of aviation safety was discussed in depth at the XVIth Antarctic Treaty Consultative Meeting (ACTM). Having recalled the recommendation XV-20 from the last meeting held in Paris that was implemented by COMNAP and SCALOP, certain policies were established. All measures implemented were to be on the basis of the International Civil Aviation Organisation (ICAO) criteria. Emphasis is placed on standardization of practices and procedures and the creation of an Antarctic Flight Information Manual that promulgates such information including information on aircraft, airfields, and areas of national operations. Russia considered special measures should be taken on air traffic control procedures and the use of airspace. Recommendation XV-20 recognised the increasing problems that are associated with increased air traffic. Measures recommended were the sharing of proposed aircraft movements from each national program. Members have welcomed the advance in emergency locater transmitter technology as a necessary incorporation to aircraft inventories during Antarctic operations.[25]

The treaty system relies heavily on national driven implementation of domestic aviation regulations. The recommendations however are without a specific date for incorporation and thus it appears uncertain when the measures will actually be effective.

[22] Aviation Week and Space Technology, May 1998, p73-74. Damage to the nose ski can result in serious and potentially fatal consequences if not regularly examined.
[23] Antarctic Treaty 1959.
[24] The terms of reference of each group are reproduced in the Antarctic Treaty Handbook (2002) pp238-239.
[25] Such devises operate on 406mhz and transmit both the emergency signal and the location of the aircraft.

**Antarctic Tourism**

The above recommendations of XV-20, whilst recognising the increase of aviation traffic, make no mention of non-governmental operations. Recognised tourist operators must comply with International Association of Antarctic Tourist Operators (IAATO) guidelines. However, recent years have seen an increase in private aviation expeditions involving single engine aircraft and some with disastrous results.[26] Government organisations are reluctant to assist adventure tourists other than in emergencies. For example, in 2002 14 people were stranded at the South Pole after the Antonov 3 aircraft was grounded. The government officials were airlifted immediately whilst the remaining non-governmental officials had to negotiate their way out tot the tune of US20,000.[27]

The reluctance to assist is complicated by the fact that there seems little or no attention given to the required state of preparedness prior to these private expeditions being undertaken. The degree of preparation is up to the discretion of the individual concerned. Recently in December 2003, a private adventurer Jon Johanson, flew down to the continent from Invercargill landing at McMurdo. He then requested both Scott Base and the United States to assist in the uplift of 400 litres of fuel. Press reports communicated Johanson's surprise at the US and NZ bases refusal to help. An international incident loomed with State officials exchanging words over the stance taken by the US and NZ programs. However, before the incident further escalated, Johanson was offered fuel from another private venture that was cancelled.[28]

Johanson's actions clearly demonstrate an emerging concern in Antarctic aviation safety. There are no regulations providing for minimum preparations and contingency plans. Although Johanson filed flight plan, it was of little use because he did not alert any officials in the region that he was in fact transiting. Clearly, there should be provision for authorised transit and declarations of contingency plans. These requirements could be promulgated through national Civil Aviation Regulations consistent with ICAO and thus commensurate with the current provisions of the Antarctic Treaty System.

[26] Antarctic, Vol. 20 No 3 & 4, 2003, p29, Frenchman Henri Choroz in a single engine homebuilt Glasair; Antarctic Vol. 21 No. 1 & 2 , 2003, p33 British woman Polly Vacher in a Piper Dakota.
[27] Antarctic Vol. 19, No 3 & 4 2002 p153.
[28] Polly Vacher cancelled her planned trip and made available her fuel that was stored at Scott Base.

**Conclusion**

As discussed, the short aviation history of Antarctica has had an array of accidents of which the causes are closely related to the continent's unique environment. The occurrences of whiteout and loss of perception have an adverse affect on the pilot performance. The conditions to which the aircraft are subjected are equally difficult. Low temperatures, rough landing surfaces, sticking skis and high altitude operations have placed extreme demands on the aircraft performance. JATO modifications incorporated to overcome operational obstacles have introduced dangers of their own.

However, such risks are an inevitable consequence of operating in the Antarctic. Whilst fatalities are not acceptable, the reality for safety policy makers is the management of risk rather than its illumination. COMNAP, set up by the Antarctic Treaty System, has provided clear safety policy guidelines for governmental organisations. Unfortunately, the same cannot be said for non-governmental organisations. The increase in aviation adventure traffic requires that a review is urgently needed for NGO operator standards. Procedures on preparation and contingency plans should be mandatory and enforced at a national level by the country of departure. Only once specific NGO aviation policy is developed will all parties involved understand exactly where their responsibilities lay.

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