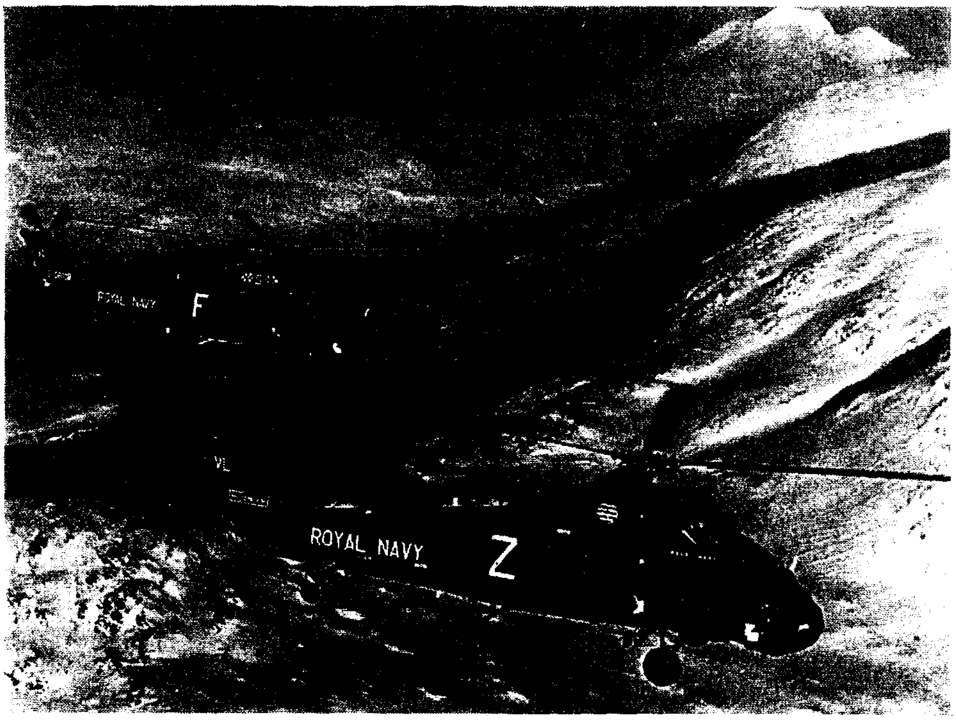

FIG. 1—WESSEX HU MK 5 OF 845 NAVAL AIR SQUADRON FLYING OVER TYPICAL NORTHERN NORWAY TERRAIN

ARCTIC HELICOPTER OPERATIONS

BY

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Introduction

Naval Air Commando Squadrons have traditionally since their inception in the mid 1950s had a world-wide role in support of the Royal Marines. The early years saw these squadrons in service in the Middle and Far East (Suez in 1956 and Borneo from 1963 to 1966), and more recently they have been involved in support of U.K. forces in Northern Ireland.

The aircraft, aircrew, and maintenance personnel concerned have been found to adapt quickly and readily to most climates and theatres of operation with little or no prior training or specialized equipment, with one significant exception —operation in the Arctic. Early attempts in the late 1960s to operate helicopters in this demanding environment in support of the Royal Marines commitment to NATO's Northern Flank highlighted a number of problems both with equipment and personnel. As a result, a specialized cell was set up in the early 1970s to study these problems and to carry out regular training in the Arctic. The Mountain and Arctic Warfare Cell, as it became known, based at R.N.A.S. Yeovilton and parented by 707 Naval Air Squadron, now conducts an annual winter-training exercise in northern Norway known as Exercise Clockwork.

This article outlines the training programme which has been developed and discusses some of the problems which have been met and the methods devised to overcome them. The opinions expressed in the article are those of the author.

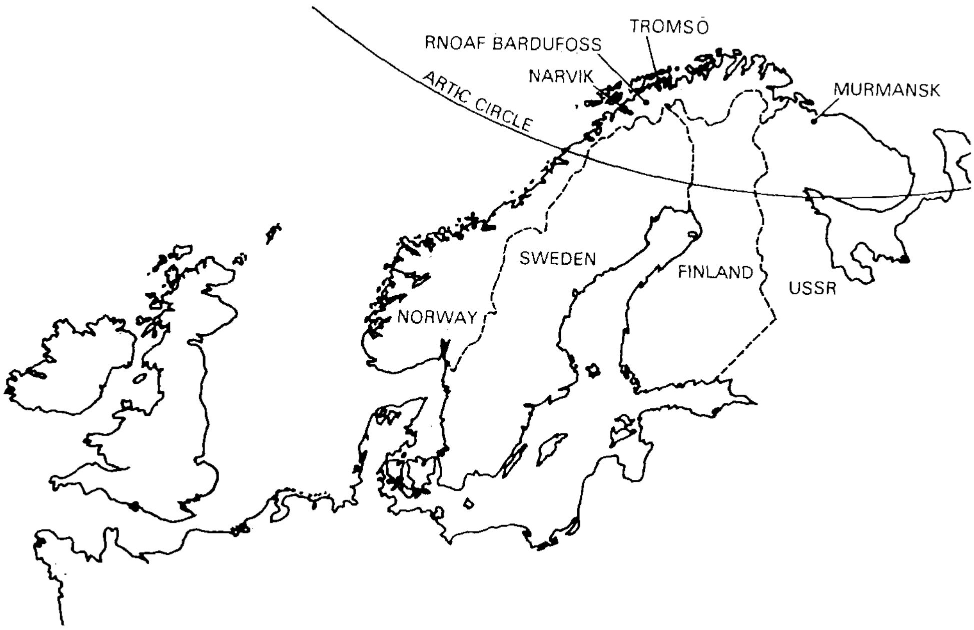

FIG. 2—MAP SHOWING POSITION OF TRAINING AREA

Geography and Climate

The training area selected in northern Norway has some of the most varied terrain and extremes of arctic weather to be found in that country. It is centred on the Royal Norwegian Air Force Base at Bardufoss, some 175 miles inside the Arctic Circle and approximately mid-way between the cities of Narvik and Tromso (see FIG. 2). Bardufoss is fairly close to the Swedish border to the south-east and to the Finnish border to the east, and so a helicopter flying area has been designated to prevent aircraft from inadvertently straying over these borders. The area surrounding Bardufoss is extremely mountainous with several mountains exceeding 5000 ft, and the local coastline is deeply indented with fjords. The climate is influenced by two principal features, the warm Gulf Stream to the west and anticyclonic weather originating in Siberia. The former produces relatively mild weather with temperatures around 0°C, heavy snowfall, and quite often strong winds on the coast, while the latter results in classic cold, clear

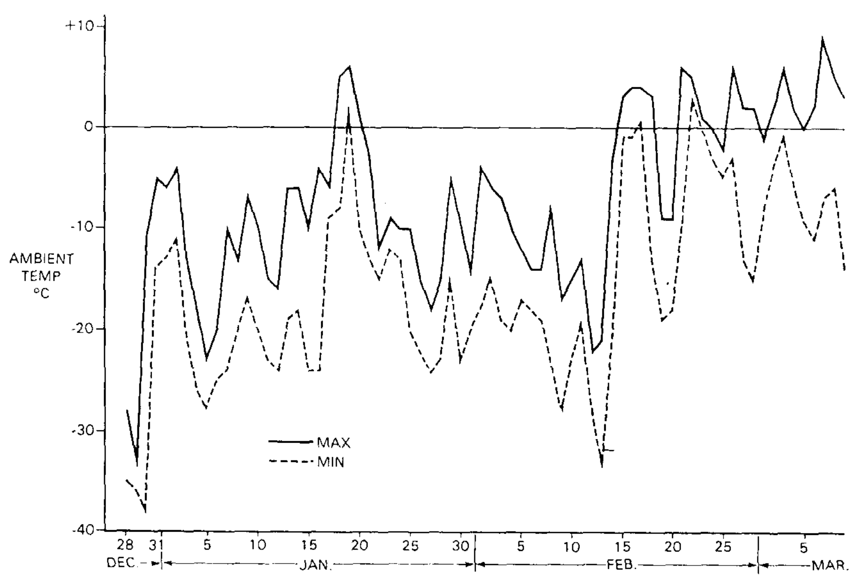

FIG. 3—TEMPERATURE CHART FOR TYPICAL WINTER IN NORTHERN NORWAY

arctic weather with little or no wind and temperatures down to −40°C (or even less) in the valleys. FIG. 3 shows the variation in temperature at Bardufoss for a typical winter and illustrates well the rapid and frequent alternations between these two influences. Particularly significant are the periods of thaw conditions in February and March which in many ways produce the most difficult conditions in which to operate.

Training

Two separate courses are run during a winter-training period, each of four and a half weeks' duration with a changeover of trainees at the half-way point. Each course comprises some fourteen or so aircrew and approximately forty-five maintenance personnel. The course is designed to build up the confidence of the trainees progressively, starting with fairly modest flying operations from the base at Bardufoss and ending with full-scale five-day deployment into the field to set up a forward operating base (FOB). The course includes personal survival training of two to three days' duration for all trainees under the supervision of a survival officer, and instruction in the use of several items of specialized arctic domestic and ground support equipment.

Concept of Operations

This article would be incomplete without a brief outline of the concept of commando helicopter operations in Norway as currently practised. In this concept, deep support and major spares for the aircraft are kept back in a forward air base (FAB) which would normally be collocated with the Royal Marines' base maintenance area (BMA). From the FAB, small groups of four to six aircraft would then be deployed into FOBs. These will contain sufficient technical resources for first-line and limited second-line servicing but, for obvious tactical reasons, there is increasing emphasis on making these as lightweight and mobile as possible. For this reason there has been a move away from the centralized FOB with all its aircraft and resources concentrated into a small area to the idea of a dispersed and more independent FOB. In this, the aircraft are dispersed half a kilometre or more from the headquarters and each other with independent, self-supporting tent groups located at each aircraft site and linked to

FIG. 4—A TYPICAL FORWARD OPERATING BASE

the H.Q. for tasking by means of mobile VHF radios or field telephones. This concept reduces significantly the total amount of tentage and domestic support required and greatly improves the reaction time for moving the FOB to another site. FIG. 4 shows a recent training FOB with Wessex and Sea King aircraft. The H.Q. is located in the edge of the tree line at the base of the hill beyond the aircraft. Spacing between aircraft would normally be greater than that shown here.

Aircraft Policy

In the early days there was little experience of cold soaking and operating aircraft in extreme cold, and so a policy of caution was adopted. Aircraft were stored overnight in heated hangars and a number of additional cold weather inspections were called up before aircraft could fly each day. For instance, it was considered likely that embrittlement of seals and flexible pipes together with the effects of ice and snow would cause unusual leaks from aircraft hydraulic and fuel systems. A special inspection of the whole aircraft for leaks was therefore called up before each flight, which proved to be time consuming and costly in manpower. However, no leaks were ever found as a result of this special inspection and after some years the requirement was cancelled. Current policy is to leave aircraft outside, subjected to all the extremes of the arctic weather, for the whole deployment in Norway and this is now a proven practice. It occasionally causes some surprise to the resident RNoAF helicopter squadron at Bardufoss, all of whose aircraft are stored and maintained almost exclusively in a heated hangar. When major maintenance is required and particularly where

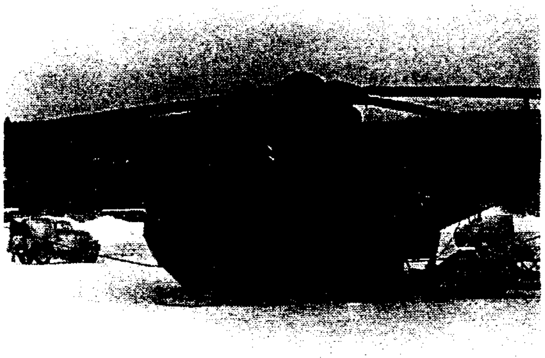

FIG. 5

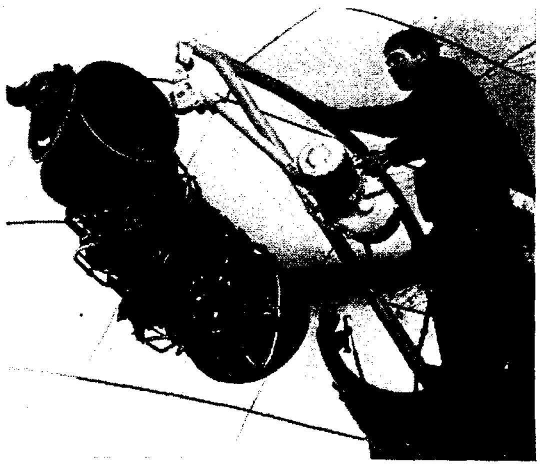

FIG. 6

ENGINE CHANGE IN PROGRESS ON A SEA KING

bare hands are necessary for awkward and fiddly jobs, a simple cover (e.g. a parachute) thrown over the work area into which warm air can be ducted provides a comfortable working environment. FIGS. 5 and 6 show an engine change in progress on a Sea King at Bardufoss. Heat is here being supplied from a mobile, petrol-fired heater of American origin which provides heated, non-toxic air through flexible trunking. The ambient temperature when the photographs were taken was −20°C.

Aircraft Cold Soak Release

Specifications for Wessex and Sea King were written before operation in the Arctic was first considered. This has resulted in limitations to the low temperature clearances of both types of aircraft which are somewhat restrictive and are proving difficult to extend. The original Design Requirements of AvP970 specified a lower operating temperature of −15°F (−26·1°C) for helicopters. Thus for many years aircraft could not be operated below −26°C because the manufacturer had not been required to prove the integrity of the aircraft below that limit. However, as can be seen from FIG. 3, the ambient temperature in northern Norway often goes below −26°C, and on a statistical average can be expected to lie between −26°C and −30°C for approximately 10 per cent. of winter days.

There is therefore a need to extend the low temperature release for all R.N. helicopters expected to operate in the Arctic to a lower limit of −30°C for operation and to allow cold soaking of the aircraft without damage to −35°C.

Technical Problem Areas

Improvement of the snow and ice clearance for the Wessex HU Mk 5 has proved to be one of the most troublesome problems in the past ten years. The original upward-facing intake nose door (1051 standard) was anti-iced by means of hot air tapped from the two Rolls-Royce Gnome engines, but it was found that flying in heavy snowfall could cause a build-up of snow and ice inside the intake on the front pressure face; if this detached, it would go through the intake and damage the engines. The initial approach taken to overcome this problem was to tap ever-increasing quantities of anti-icing bleed air from the engines, but this proved to be counter-productive: the ice build-up still occurred and was likely to detach even more easily due to the increased surface heating in the intake. The Aeroplane and Armament Experimental Establishment, Boscombe Down, then came up with a radical solution—a new nose door with a downwards-facing intake which operated cold, i.e. no anti-icing heat was applied to any of the intake surfaces. This nose door, the Cold-Running Nose Door (CRND), was first introduced to Norway during the winter of 1972/3. Without doubt the CRND offered a better in-flight ice and snow clearance, as the intake itself was at right angles to the direction of flight and this effectively prevented a high proportion of ice and snow particles from entering the intake by simple momentum separation. However, the Achilles heel of the CRND was that, on landing, the intake became perilously close to the snow surface (the aircraft always bellies on landing in deep snow). At worst, this could cause air starvation of the engines, and more than one such incident is on record; at least, there was a risk of hard compacted pieces of snow and ice being picked up when high power was demanded (e.g. on take off) causing foreign object damage (ice FOD) to the engines.

Ice FOD occurred with monotonous regularity whenever the CRND was flown in Norway, reaching a peak in 1977 when no less than seventeen engines had to be replaced. An attempt was made to overcome these weaknesses in 1979 by fitting conical wire-mesh grilles inside the CRND over both engine intakes, and this certainly prevented any further incidents of ice FOD. However, this nose door remained very unpopular with aircrew because of the inherent risk of air starvation to the engines, particularly on land or taking off from rough unprepared sites in 'whiteout' conditions when the immediate topography of the ground beneath the aircraft is uncertain. The CRND has therefore been formally discarded by the R.N. and a return made to the 1051 nose door with its upwards-facing intake. Trials continue to confirm realistic operating limits for this nose door in icing conditions, and it would appear that the limit in heavy snowfall coincides with the practical safe limit for flying from aircrew, visibility, and navigational considerations.

Development of Specialized Arctic Ground Support Equipment

Mention has already been made of the mobile petrol-fired space heater which is the mainstay of arctic aircraft maintenance. This heater (the Herman Nelson) has an output of 400 000 Btu/h (approximately 120 kW) and has proved to be highly reliable; it had been further improved in R.N. service by re-engining with a Honda general-purpose engine. Other specialized items of arctic ground support equipment (GSE) include an R.N.-developed plant spray rig for spraying complete aircraft with anti-icing fluid (AL 34) to prevent ice and snow adhering to the aircraft surface. One particular point of interest is the change to low-viscosity (SAE5/10) OMD 30 oil in all ground equipment engine sumps (as well as MT engine sumps) from the more normal (temperate use) OMD 75. OMD 30 has been found to give much easier and more reliable starting of engines at low temperatures (particularly below −10°C) without giving any evidence as yet of increased wear rates or poor lubrication.

Introduction of the Sea King HC. Mk 4

For some years there had been criticism of the Wessex's inability to lift some of the Royal Marine's heavier equipment deployed to Norway, in particular the new light gun and the Volvo BV 202 tracked oversnow personnel carrier. Funds became available in the summer of 1978 for a purchase of the commando version of the Sea King helicopter, and a rapid development programme enabled first deliveries to be made from Westland Helicopters to the R.N. late in 1979. The first three Sea King HC Mk4 to be delivered to 846 Naval Air Squadron at R.N.A.S. Yeovilton flew up to northern Norway in February 1980 to join in Exercise Clockwork 80 (FIG. 7). This aircraft represents a quantum jump in capability for the Royal Marines, being able to move as many as twenty-two arctic-equipped troops (compared to eight in the Wessex) and having an ultimate lift capability of 8000 lb on the external sling. The Sea King HC Mk4 is also

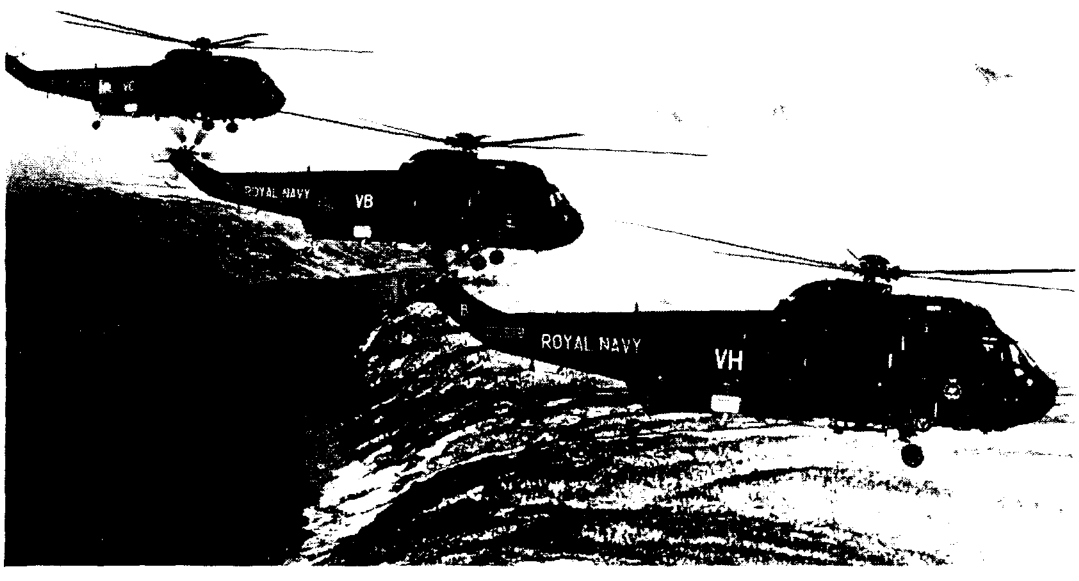

FIG. 7—SEA KINGS HC MK 4 OF 846 NAVAL AIR SQUADRON EN ROUTE TO NORTHERN NORWAY

extremely well equipped with radio and navigational aids, possessing a tactical air navigational system (TANS) with inputs from Decca hyperbolic radio chains as well as independent doppler and air data inputs, VOR, DME, ADF, and ILS. The TANS proved particularly impressive during the flight out to Norway and during the deployment, when accuracies of fifty metres in position were regularly achieved after several hours flying.

There was very little experience of cold soaking the Sea King to extremely low temperatures prior to this exercise, and there was some concern initially as to the vulnerability of the main rotor gearbox at low temperatures. Manufacturer's calculations had shown that thermal contraction of the magnesium alloy gearbox casing could cause the accessory drive gear train to go into hard mesh (i.e. zero backlash) at very low temperatures and, assuming a 'worst tolerance' gearbox, it was thought that such a situation could arise at −26°C. Some preliminary trials at Boscombe Down in a cold chamber gave no evidence to substantiate this concern, but nevertheless caution dictated that the initial low-temperature release be limited to −26°C. Although this was increased to −30°C later during the deployment, a further requirement to ensure the main gearbox core temperature never dropped below −30°C remained. Naturally the gearbox oil temperature takes some considerable time to cool to ambient temperature after aircraft shut-down, but nevertheless some external heat had to be applied during a prolonged period at low temperature (down to −34°C by night) shortly after the Sea Kings arrived in Norway. For the future, work is in hand to achieve a 'no-damage' cold-soak low-temperature clearance to −35°C for the Sea King HC Mk4.

Another interesting problem with this aircraft on arrival in Norway was the collapse of oleos; an occurrence that had also been experienced in Canada and at Boscombe Down during cold-soak trials. This had been attributed to fluid leakage past defective seals, but a few calculations showed that the phenomenon was simply a demonstration of Boyle's Law: recharging the oleos to take account of thermal contraction of the air and hydraulic fluid restored the oleo extensions to normal, and no further problems with oleos occurred!

The three Sea King HC Mk4 aircraft performed extremely well in their first deployment to Norway, and very few defects were attributable to arctic operation: some broken main wheel brake pipe unions and a few distorted aerials mounted under the fuselage were the only casualties.

FIG. 8—TWO TYPES OF OVERSNOW VEHICLE USED FOR FORWARD OPERATING BASES

Oversnow Vehicles

The dispersed FOB concept described earlier leads to a requirement for a small oversnow vehicle to transport personnel and equipment around the dispersed aircraft sites. This needs to be highly manoeuvrable, heliportable, and very reliable. FIG. 8 shows the two types of oversnow vehicles so far used in Norway—the Rolba Prinoth P4 on the right which has been in service for some years, and the Bombardier Bombi on the left which was taken on trial for the first time last winter. The Rolba Prinoth is based on a Fiat 600 cc engine and transmission but has an unhappy reputation for poor reliability; the Bombi, of Canadian origin, is based on a standard Ford 1600 cc engine and transmission and looks set to be a far more reliable solution to the requirement.

Trials

A large number of trials is a regular feature of each winter exercise, and is of course the means by which techniques and equipment are constantly improved. The Mountain and Arctic Warfare Cell participates in many joint service evaluations of specialized arctic clothing and associated equipment and, as a result, the standard issue of arctic clothing given to all U.K. personnel deployed to Norway is second to none in NATO. One particular requirement which is proving surprisingly difficult to meet, however, is a glove which provides good thermal protection for the hands (particularly against 'cold burns' from bare metal at low temperatures) while still allowing the wearer some tactility and dexterity for more delicate tasks. Various attempts have been made over the years to meet this requirement but none has been wholly successful yet.

Other recent trials have included a portable NBC respirator for aircrew, that allows aircrew to continue flying in an NBC environment without detriment to vision.

Conclusions

Early R.N. helicopter operations in the Arctic proved beyond doubt that there is no substitute for experience in this hostile and demanding environment. The regular series of winter-training exercises (known as Exercise Clockwork) in northern Norway conducted by the Mountain and Arctic Warfare Cell have established over the last ten years a nucleus of air and ground crews experienced in arctic conditions and produced a wealth of expertise.

The recent arrival of the Sea King HC Mk4 has provided a most welcome extension to the capabilities of commando helicopter squadrons in Norway. Based on its first showing, this aircraft promises to be very successful in complementing the Wessex HU Mk5 in this theatre.