Problems of Helicopter Operation peculiar to Shipboard Use*

By

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This paper deals solely with the operation of helicopters from ships in the Royal Navy

Since the great majority of helicopter flying at sea has been carried out from aircraft carriers, I propose first to deal with these operations, and secondly I shall describe a series of trials carried out in 1950 to determine the feasibility of operating from a specially constructed platform on a merchant type vessel

As an introduction I should like to give a brief history of the helicopter in the Royal Navy

In 1943 a small number of pilots were sent to the United States to learn the principles of Rotary Wing flying and on their return to this country a flight was formed equipped with Sikorsky R 4 machines Its task was to carry out communication, photographic and radar calibration duties In May 1947, this flight was formed into No 705 Squadron and based at the Royal Naval Air Station, Gosport, which is still the Squadron's home Its original task was retained but limited pilot training was added

In January 1950, the Squadron was re-equipped with Westland Sikorsky S 51's, known to the service as the Dragonfly This machine, with its more powerful engine and hydraulic winch, had a big advantage over the R 4 in that it could be used as an Air Sea Rescue machine The technique of sea rescue by helicopter was practised, new crews were trained, and at the present time each aircraft carrier in commission is equipped with two Dragonflies The major Naval Air Stations are similarly equipped

In November 1952, the first Royal Naval operational helicopter squadron was formed at Gosport, and by February 1953 it had commenced anti-bandit operations in Malaya This squadron is equipped with American built Sikorsky S 55's supplied under the Mutual Defence Aid Pact It is hoped that with the introduction of the Westland Sikorsky S 55 the Dragonfly will be replaced In view of the former's greater weight-carrying capabilities

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Before presenting his Paper Mr, Bristow showed a film which provided an interesting background to his Subject

and increased performance, it will be a more efficient and satisfactory rescue machine

Although the helicopter has been in service with the Royal Navy for some considerable time, the necessity of equipping the aircraft carriers with these machines has resulted in the majority of flying at sea being carried out from these ships

Prior to the introduction of the helicopter in the Rescue role, an aircraft carrier had to have a destroyer in attendance whenever aircraft were being launched or being landed on This destroyer followed some two or three hundred yards astern, with its sea boat ready for immediate lowering should an aircraft ditch on take off, or go over the side during landing on operations Not only was this a boring duty for the destroyer's crew, but it was depriving the escort screen of a ship During time of war this is of extreme importance since escort vessels are in great demand

The helicopter with its crew of two can replace this destroyer and allow it to do its proper duty as a screening vessel Owing to the lack of instrumentation, however, the helicopter cannot be used for night flying operations

Under normal conditions a pilot who is unfortunate enough to ditch while landing on, or taking off, will be rescued much more quickly by helicopter than by its predecessor the destroyer This is a very important advantage particularly when operating under conditions of extreme cold The helicopter makes an approach into wind aiming to arrive over the survivor in the hovering attitude, the winch cable with a sling attached is lowered during the approach The survivor then gets into the sling, is hoisted clear of the water, and winched into the cabin There are numerous instances of pilots being back on board the carrier within three minutes of ditching With its crew of two and approximately half fuel load the Dragonfly can rescue two people, except under conditions of no wind and very high air temperature Should the survivor be unconscious the pilot can lower the aircrewman on the winch cable , as soon as he has reached the survivor and secured him to the winch, the pilot can hoist them both up together

The attendant destroyer had to manoeuvre into position before lowering its seaboat, and except under perfect sea conditions the survivor often received fairly rough treatment from the seaboat's oars I'm quite sure a number of Fleet Air Arm pilots can speak with authority on this point

When employed in this role, or as we call it, Plane Guard duty, the helicopter is launched some few minutes before the range of conventional aircraft is due to take off The helicopter takes up a position on the starboard side of the carrier, level with the island This position is maintained at a height of approximately 100 feet until all the aircraft have left the vicinity of the carrier, when the helicopters land back aboard When aircraft return to the carrier, the helicopter is again launched a few minutes beforehand and takes up a position some fifty to a hundred yards on the starboard quarter of the carrier This position is roughly opposite the point where the conventional aircraft make their turn for the final approach to the flight deck By maintaining a height of not more than 100 feet the helicopter is clear of the conventional aircraft circuit, and can get to a survivor quickly without having to lose a considerable amount of height

There are numerous problems attached to the operation of helicopters

from aircraft carriers These will be seen from the following description of operating procedures

The helicopter when not in use is secured in the aircraft hangar but due to the limited size of the elevators in British aircraft carriers, helicopters of the S55 and S51 type cannot be taken up and down without having their main rotors folded However, an experienced maintenance party can normally spread or fold the main rotors in four minutes

The helicopter is placed on the elevator which is then lowered or raised to approximately 6 feet from the flight deck level This enables the blades to be handled without the necessity of bringing large and unwieldy work stands up from the hangar Experience has shown that with wind speeds over 12 knots it is preferable to have the helicopter as near as possible pointing into the relative wind Since the blades have to be turned through ninety degrees before folding, the number of men required to handle the blades varies with the wind speed Experience has shown that although this operation has been performed in wind speeds of 30 knots, it becomes difficult and hazardous in excess of 25 knots

It can be seen that this limitation on the wind speed may prove to be an embarrassment to a carrier, particularly in time of war, when it may have to turn off its course in order to reduce the wind speed over the deck

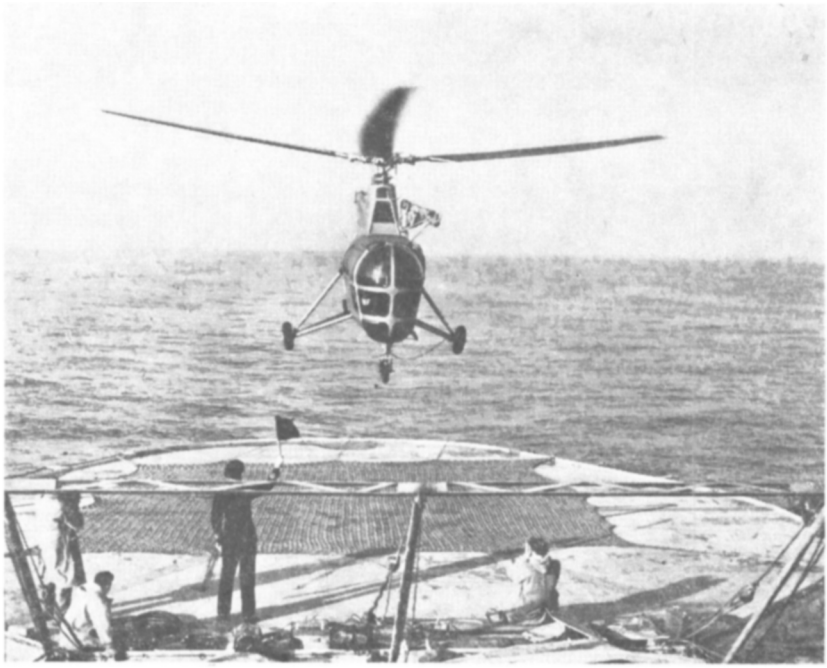
Once the main rotors have been spread, canvas boots are secured to the blade tips and lines from these boots are secured to the fuselage This is done to prevent unnecessary flexing of the blades, particularly in conditions of high or gusty wind The machine is then positioned facing into the relative wind or intended direction of take off Handling the helicopter on deck is quite straightforward since the nose-wheel is fully castoring Once in the selected spot chocks are placed in position and if there is an appreciable amount of movement of the ship then the helicopter should be secured to the deck

This applies particularly to the Dragonfly since with its high centre of gravity and tricycle undercarriage it has a distinct tendency to topple or slide on a wet deck

Various factors must be taken into consideration when selecting the take off position It should be as near as possible to the centre line of the deck and clear of all obstructions such as the island, and other aircraft which may cause turbulent airflow round the helicopter The rotor blades should not be allowed to overhang the deck edge, as an up draught from the ship's side may cause undue oscillation of the blades This turbulance caused by airflow from the ship's side varies with different classes of carrier

Stopping and starting the rotors proves to be the most hazardous of all operations on deck, particularly under conditions of high wind Under these conditions, or even, with gusty or turbulent air flow, the probability of blade flexing at low r p m is very real Such flexing may be severe enough to cause one of the blades to strike the tail cone Experience has shown that in order to minimise the attendant hazards without seriously restricting the operational use of the helicopter, the rotors should not be started or stopped when the wind velocity is in excess of thirty knots Should gusty conditions prevail then this figure should be reduced to twenty five knots In any wind condition above twenty knots the helicopter should be pointing into the wind However, it cannot be categorically stated that any wind conditions below these speeds are necessarily safe Conditions of turbulence, gustiness,

https://doi.org/10.1017/S2753447200001955 Published online by Cambridge University Press



(By Courtesy of Aeroplane)

A helicopter hovers above the landing platform on which the stretched net can be clearly seen

roll of ship and various other factors make it extremely dangerous to engage or disengage the rotors even with low wind speeds Each situation has to be evaluated on its merits and every effort must be made by the pilot and ship's personnel to minimise these hazardous conditions whenever they exist Once the helicopter engine has been started the rotors are engaged as quickly and as smoothly as possible When operating a helicopter from a position forward of the carrier's island it is advisable to avoid relative winds from broad on the starboard beam to dead astern Similarly, from a position astern of the island, winds from dead ahead to broad on the starboard beam are avoided It is the recommended practice to launch the helicopter before the carrier turns into wind or builds up speed for launching or recovering her conventional aircraft This avoids subjecting the helicopter to unnecessary high wind speeds It can be seen that, if the carrier is steaming across wind, the helicopter can be launched into a relative wind before the carrier makes her turn into the wind , if on the other hand the helicopter is not launched until the carrier has completed her turn into wind, it will be subjected to a rapid increase in wind speed If it is not intended to fly the helicopter off until the carrier has turned into the wind then the helicopter will be positioned on the fore and aft line of the flight deck Should the carrier's course be across wind the helicopter will be subject to a wind on its side and with a Dragonfly or S 55 type whose rotor disc is parallel to the flight deck the

wind is striking the edge of the rotor disc However, when the ship turns into wind it heels over, thus the wind which is increasing rapidly will strike the rotor disc from below This has a distinct tendency to lift the windward side of the helicopter, and with the Dragonfly there is a danger of the helicopter rolling over, or sliding on a wet deck A pilot can minimise this risk by displacing the cyclic control towards the direction of the wind, thus keeping the wind on the edge of the rotor disc However, with a rapid increasing change of strength and direction this is not too easy Similar conditions apply when moving a helicopter on deck with the main rotors engaged This is considered a highly dangerous procedure under all conditions except possible perfect calm

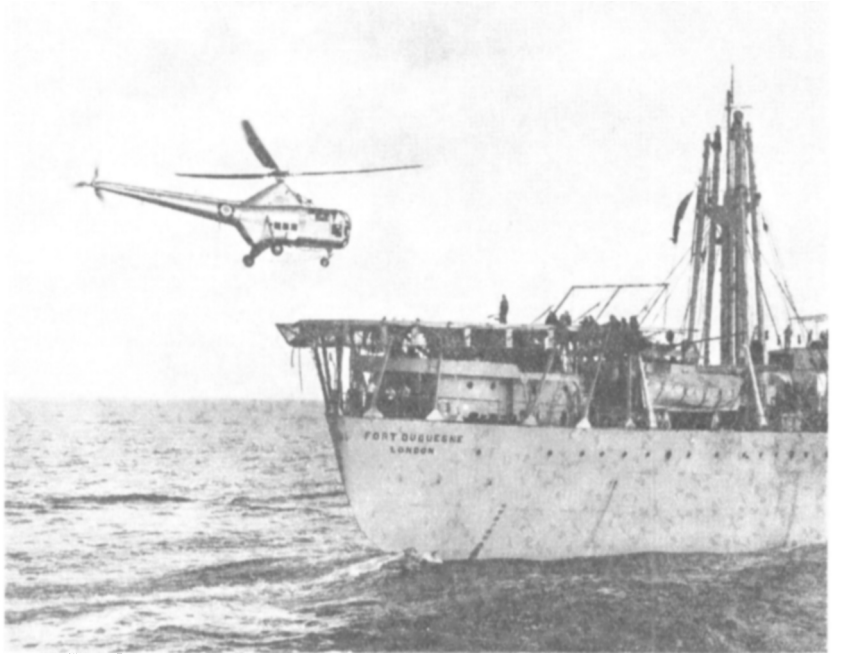
The take-off is made quickly and smoothly to gain an initial height of 8—10 feet above the deck This height is sufficient to ensure being well clear of the deck when the ship is moving considerably By remaining for a brief period at this height the pilot can check that full power is available before attempting forward flight

The landing is straightforward, consideration being given to the movement of the flight deck The approach towards the deck is made fairly steeply, and there is a greater tendency to overshoot the approach Forward speed is maintained throughout the approach, commencing at the normal approach speed and gradually reducing to approximately 5 knots when the deck is underneath This final part of the approach is adjusted to bring the aircraft to a stationary position at between 10 and 15 feet above the deck Height is reduced to approximately 5 feet above the deck and the hover held The ground cushion will tend to move the helicopter up and down in sympathy with any rise and fall of the deck From this position a steady rate of descent is maintained until the wheels make contact with the deck, when the collective stick must be lowered and held in the fully down position The greater the relative wind, the greater the necessity to unload the main rotor as quickly as possible, maintaining high enough r p m to prevent blade flexing An emergency take off must never be attempted unless the pilot can be absolutely certain of clearing all personnel and obstacles without jeopardy

Under conditions of extreme wind speeds it can be seen that the carrier may have to turn off its course in order to allow the helicopter to stop and start its rotors During war time operations this necessity to alter course may present a number of problems to the Task Force Commander

Although the carrier's helicopter is carried primarily for rescue duties it is an extremely useful general purpose machine The tasks it may be called upon to perform are varied , they include photography, radar calibration, gunnery and torpedo spotting However, its most common use is in the communications role

Mail, materials and personnel, can be swiftly and easily transferred The Dragonfly is limited to lifting 200 lb in any one hoist, and the size of the material should not exceed 3 feet by 2 feet by 2 feet Mail and material weighing less than 30 lb are picked up and delivered by means of a weighted hand line Personnel and material over 30 lb in weight are raised and lowered by using the hydraulic winch, a sling being used for personnel and a bag or net for stores When a single hoist of stores weighs more than 50 lb the pilot is informed of its approximate weight by a blackboard



(By Courtesy of "Aeroplane")

A helicopter approaches the landing platform on the stern of the "Fort Duquesne"

Transfers with most ships of the British Navy are conducted by the helicopter hovering over the quarterdeck. The ship with which the helicopter is carrying out the transfer steams on a steady course keeping a relative wind of not less than 10 knots, from not less than 20 degrees on either bow. Should it be impossible to maintain a steady course without exceeding a relative wind of approximately 35 knots then the vessel should steam down wind keeping the relative wind not less than 20 degrees on either quarter. The transfer will then be carried out on the forecastle.

Before any transfer takes place all obstructions must be removed from the hovering area, and funnel smoke reduced to a minimum. The helicopter hovers over the transfer area at a comfortable height and the ship's personnel should make every effort to expedite the transfer, and so reduce hovering time.

The advantage of a helicopter for communications duties in a naval force is tremendous. By collecting and delivering mail and despatches the signal traffic can be considerably reduced. Transfer of personnel can be carried out quickly and does not involve ships changing station. Previous to the introduction of the helicopters, ships wishing to transfer personnel and stores had to steam close alongside each other and rig the necessary lines from ship to ship.

Quite naturally this changing of positions by ships often meant the complete reorganisation of the screening force by the force commander. This was of importance during wartime.

https://doi.org/10.1017/S2753447200001955 Published online by Cambridge University Press

Although landings have been made on board H M S *Vanguard* it is considered that by removing a certain number of the permanent fixtures from the quarterdecks of our cruisers, landings could comfortably be made on this class of ship Possibly at some later date we shall see all our major war vessels equipped with a helicopter, particularly in view of its versatility

Early in 1951 a Royal Fleet Auxiliary vessel was fitted with a steel landing platform This platform conformed roughly to the shape of the stern of the vessel and measured 59 feet fore and aft by 50 feet beam With these dimensions it overhung the ship's side, so safety nets were fitted all round the edge of the platform The platform was roughly hexagonal in shape and three screens 12 feet in height were fitted to the forward end These screens could be lowered and raised as required, and it was hoped that they would provide protection for the helicopter both when stopping and starting the rotors, and also when secured on deck A number of sunken eye bolts were fitted to enable the helicopter to be satisfactorily secured even under rough conditions A large number of cleats were arranged round the perimeter of the platform for the same purpose The surface of the platform was painted with a non-skid paint and yellow lines superimposed to act as a guide for the pilot when landing A special grass rope net was stretched across the deck to act as a decelerator

Fuel was carried in 50 gallon drums stowed in such a position as to be easily jettisoned in an emergency The ship's fire fighting hoses were lengthened to reach the platform and the normal portable fire-fighting equipment provided

The helicopter used in this particular trial was a Dragonfly Mark 1 with an all up weight of 5,970 lb

The main difficulties envisaged in operating from a platform on this type of vessel were threefold

First, starting and stopping rotors Second, securing the aircraft on deck immediately after touchdown Third, overcoming the tendency of the helicopter to skid or overturn when landing with the ship pitching or rolling

The windscreens already mentioned were provided to make the evolution of stopping and starting less hazardous However, it was found that although they were adequate for this purpose with wind speeds up to 25 knots, above this speed the airflow round the edge of the screens caused the blades to flex dangerously

As a result of these findings it was decided that if the screens were to be fitted they should be arranged all round the platform to give cover from any direction Since a hangar was not provided it was generally felt that screens would be an essential requirement for protection from weather

In order to secure the helicopter to the deck immediately after landing various ideas were put forward and the following were adopted for the purpose of the trial The deck handling party, consisting of 8 men, was split up into two teams , each team positioned itself in the safety nets at the deck edge at right angles to the helicopter approach path Each team had a hook rope fitted with a quick release device When the helicopter reached a steady position over the deck one member of each team, under the direction of the Control Officer, hooked on to a special net fitting underneath the helicopter If the landing was satisfactory the ropes were secured to one of the cleats on the deck edge In the event of a wave off being given the ropes were unhitched by operating the quick release This practice was dis-

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continued after the first few landings as it was considered that although it would undoubtedly prevent the helicopter from going over the side, it would not have stopped it overturning under rough weather conditions It was also considered dangerous to the handlers who had the task of hooking on

As a result of these trials it was considered that a device should be provided which could secure the helicopter immediately the landing was completed It would not, of course, be possible to have it in a fixed position, since except under the most perfect conditions the helicopter cannot always land on the same spot

The Dragonfly with its high centre of gravity and tricycle undercarriage presented a more difficult problem than a helicopter with a lower C of G

It was found possible to take off with a cross wind of 20 degrees without any difficulty With any pronounced movement of the ship the aircraft tended to be thrown off the deck at an angle, but once clear of the deck this was fairly easy to control

Circuits were made at about 200 feet, but it is felt that 400 feet would have been a safer height to allow an autorotative turn in the event of an engine failure The initial approach speed was 40—45 knots, height and speed being reduced until about 10 yards from the deck edge From this position a slow steady approach was made to the centre of the deck The height of this approach varied according to the amount of movement of the deck

Due to the general characteristics of the Dragonfly it was found necessary to fly the aircraft right on to the deck It could not be positioned right over the centre line of the deck and given a fixed rate of descent relative to the horizon, as movement of the ship could easily have broken the undercarriage or alternatively upset the aircraft Naturally the higher the wind the higher the reserve of power and control, and landings were made easier with a relative wind of 30 knots Under gusty conditions the number of control movements required during approach and landing increased considerably Once the helicopter was over the deck, ground cushion effect appeared to assist the pilot, since the ship's vertical movement was transferred to the aircraft

The most satisfactory touchdown point was to the lee side of the platform with the main wheels about 3 feet clear of the deck edge This kept the rotors clear of any updraught from the upwind side of the platform Although collective pitch was reduced to minimum immediately after touchdown, it was necessary in high winds, or if any degree of movement was on the ship, to be constantly on the alert for an emergency take off if it was found impossible to stop the rotor blades, or if, before the aircraft could be secured, it started to roll

In all a total of 183 deck landings were made of which 27 were made when the ship was in harbour, the total flying time being 24 hours, 45 minutes The maximum ship movements observed during the landings were 10—14 feet vertical movement and 10 feet lateral movement through roll The maximum wind speed recorded was 38 knots

As a result of this trial it was considered that in order to be able to operate in all but the very worst of sea states the following points should be embodied

The C of G of the helicopter should be as low as practicable

The skid undercarriage of wide track would be more preferable than the wheeled undercarriage If, however, a wheeled undercarriage must be used,

it should be of wide wheel base and have four wheels with all four wheels capable of being locked in the fore and aft position for landing

The deck itself should be fitted with a turntable This would allow the helicopter to be manoeuvred into the relative wind without any alteration of course by the ship This turntable would prove to be of great value during the stopping and starting of rotors since the helicopter could under some conditions be turned down wind With a Dragonfly it is considered that the risk of damage to the fuselage by the blades flexing at low r p m would be decreased with a stern wind

As far as helicopter operations from a specially constructed platform on small ships are concerned, undoubtedly the survey vessel of the Royal Navy has the greater possibilities

The helicopter would be of enormous value to such a vessel It could be used to transport equipment from ship to shore, and in shallow waters a reconnaissance would assist in finding a passage, as would be the case in waters where ice floes were heavy Photography from a helicopter would also assist the surveyors in their task

No doubt it will also be the policy to equip hospital ships with landing platforms for helicopters Operations in Korea have proved this to be a necessity, for casualties have been flown direct from the mainland to the American hospital ships lying off the coast Although these ships have not had a specially constructed landing platform, the helicopters have landed on pontoons alongside

The uses to which helicopters can be put, both in peace and war, in naval operations are many and varied Development will considerably increase their usefulness and ability of the helicopter in the many roles it may be caled upon to undertake Experience and design improvements should overcome many of our present problems, which are by no means unsurmountable

With improved weight lifting capabilities, range and endurance and improved instrumentation the helicopter will play a most important part in Naval operations

THE CHAIRMAN

We have had a very interesting Paper, which has indicated to us the role of the helicopter in the Royal Navy and the problems which have so far been encountered I hope that in the discussion which is to take place later some solutions to them will be forthcoming

We are now going to hear a Paper by Mr ALAN BRISTOW whom most of you know which deals with a very unusual and specialised form of helicopter activity from shipboard, namely the use of the helicopter for whaling At the outbreak of war Mr BRISTOW joined the Merchant Navy, with which he served for three and a half years He then transferred to the Fleet Air Arm where he was trained as a fighter pilot Towards the end of the war he converted to helicopters, and in 1945-46 was Flight Commander of the Royal Navy helicopter unit at Portland Soon after that he was demobilised and joined Westland Aircraft as Chief Helicopter test pilot, a position which he held for approximately three years Then he became technical manager and chief pilot to Helicopair, Paris In 1948 he was awarded the Royal Aero Club Silver Medal for the relief of the Wolf Rock lighthouse, and in 1949 the Croix de Guerre for jungle rescue work in Indo-China Since 1950 he has been pioneering the use of helicopters for whaling in the Antarctic His total flying hours to date are about 3,000, of which 2,000 have been on ten different types of helicopter

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