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BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORDS 1968/63

THE USE OF HELICOPTERS IN GEOLOGICAL MAPPING IN PAPUA - NEW GUINEA

by

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SUMMARY

The Bureau of Mineral Resources has used small helicopters for geological mapping in the mountainous tropical rain-forest terrain of Papua - New Guinea since 1963, and increasingly since 1965. Where access is poor the helicopter is used to position small ground parties for three to eight day foot traverses; where access is better, day-traverse or leap-frog methods are used. The success of any survey depends on careful planning and skilful flying. Small turbine-powered helicopters will supersede the conventional Bell 47 G3B1 for some types of survey work in the next few years.

INTRODUCTION

Regional geological mapping in Papua - New Guinea by the Bureau of Mineral Resources (BMR) has accelerated rapidly over the past few years with the increasing use of small helicopters. This paper outlines the different field techniques which have been evolved for helicopter surveys.

Helicopters have been used in Papua since 1952 to transport drilling equipment for oil companies. Operating conditions were such that it was necessary to cut emergency landing pads at one mile intervals on their flight paths. This restriction, coupled with their limited performance above 5000 feet altitude, ensured that they were of little use for geological exploration in mountainous terrain.

Bell 47 G3B helicopter

The helicopter has since evolved into a more reliable and versatile machine. In 1961 Bell Helicopters introduced their model 47 G3B with a super-charged piston engine which maintains sea-level power to approximately 15,000 feet altitude. The Bell 47 G3B and its successor the 47 G3B1 were introduced to Papua - New Guinea in 1963 and were quickly recognized as an invaluable tool by surveyors, geologists, medical teams etc. Demand has increased rapidly and

there are now between 12 and 15 of these aircraft in the islands logging between them about 10,000 hours per year.

Turbine-powered helicopters

More recently Bell and Hiller have produced small turbine-powered helicopters (Bell Jetranger, Hiller FH 1100) and these may soon supercede the G3B1 in some types of work. At low altitude the turbine helicopters have higher speed and a larger payload but at high altitude the turbine engine loses power. Operating costs of the turbine aircraft are 50-60 percent higher than for the G3B1. The G3B1 will continue to be the more suitable machine for high altitude work, geological reconnaissance, small (two-man) field parties, and low-utilization surveys where the helicopter flies for less than three hours per day. Comparative figures for the three helicopters are given in Table 1.

SURVEY METHODS EVOLVED BY BMR

BMR has used Bell 47 G3B1 helicopters for regional geological mapping and mineral exploration intermittently since 1963. Since 1965 use has increased from about 100 hours per year to the present level of about 500 hours per year, and an additional 300 hours has been flown in regional gravity surveys. Increasing use of helicopter has been accompanied by a remarkable acceleration in geological mapping, and the discovery of several mineral prospects.

The first stage of investigation for a virgin area is a reconnaissance to familiarize the geologist with the area. This might be carried out by helicopter, in which case the geologist will be able to make spot-landings to check his photo-interpretation of the area.

The second stage of the investigation is the regional mapping and this may or may not be followed by a third stage of more detailed work in complex areas. BMR regional mapping is plotted at photo-scale (1:50,000) on field sheets, and these are subsequently reduced and compiled into 1:250,000 scale maps for publication.

TABLE 1: COMPARISON OF THREE TYPES OF HELICOPTER OPERATING IN PAPUA - NEW GUINEA*

	Bell 47 G3B1	Bell Jetranger	Hiller FH 1100
Engine	Lycoming piston, super-charged 270 hp	Allison gas turbine 317 shaft hp	Allison gas turbine 317 shaft hp
Fuel	Aviation gasoline 100/130 octane	Aviation kerosene	Aviation kerosene
Fuel consumption	14-16 imp. gals/hr	22 imp. gals/hr	19.5 imp. gals/hr
Tank capacity	47 imp. gals	61 imp. gals	56 imp gals
Fuel density	7.2 lbs/gal	7.83 lbs/gal	7.83 lbs/gal
Cruising speed			
on skids	60 knots	115 knots+	95-100 knots+
on floats	55 knots	95 knots	90 knots
Endurance on full tanks	180 minutes (can be increased by carrying extra fuel in jerrycans)	180 minutes approx.	170 minutes approx.
Range on full tanks with 30 minutes reserve (on skids)	150 miles	320 miles approx.	260 miles approx.
Operational ceiling	15,000 feet approx.	15,000 feet approx.	15,000 feet approx.

* The Bell 47 G3B1 has flown many thousands of hours in Papua-New Guinea, and figures can be taken as accurate. The turbine-powered helicopters are only now being introduced to Papua-New Guinea and figures are consequently based on only limited experience, compounded with makers' claims and operators' estimates.

+ Cruising speeds of Jetranger and FH 1100 will probably be lower in the tropics because higher temperatures restrict the power output of the turbine engine.

	Bell 47 G3B1	Bell Jetranger	Hiller FH 1100
Empty weight* (skids)	1950	1480	1540
Gross weight+ (legal)	2900	2900	2750
Gross weight (actual TPNG)	2900	2750 (estimate)	2750
Oil	18	10	10
Floats	50	138	94
Fuel weight full tanks	340	490	450
Pilot weight	170	170	170
Payload on skids, tanks full	420	600	580
Payload on skids, tanks half full	590	845	805
Payload on floats, tanks full	370	462	486
Passengers	2	4	4
Cargo space	Litters on each side of aircraft	In cabin, or on litters	Litters each side of aircraft

* All weights in pounds.

\+ Gross weight must be reduced for high altitude operations into and out of tight clearings. For instance geological reconnaissance of areas above 10,000 feet is best carried out with only one passenger, no cargo, and minimum safe quantity of fuel.

	Bell 47 G3B1	Bell Jetranger	Hiller FH 1100
Charter rates in TPNG (excluding fuel and oil costs; higher rates apply for short term hire)			
High utilization (more than 25 hours per week) $A1.00 = $US1.12	$A80 - $A100 per hour	$A150 per hour	$A150 per hour
Low utilization	$A180 per day plus $A26 - $A30 per flying hour	$A250 - $A260 per day plus $A50 - $A60 per flying hour	same
Cost of fuel in TPNG, per gal.			
Coast	$A0.30 - $A0.50	same	same
Inland	Up to $A1.00	same	same
Cost of fuel per hour	$A4.50 - $A15.00	$A6.60 - $A22.00	$A6.00 - $A20.00
Warm up	Average 2 minutes	1 minute	1 minute
Run down (landing to switch-off)	3 minutes	1 minute	1 minute

NOTES:

1. Although the Bell 47 G3B1 has an operational ceiling of 15,000 feet the supercharger which makes this possible is driven by the exhaust and the engine cannot therefore be restarted after switching off at altitudes above 7500 feet.

2. For turbine aircraft great care must be exercised to ensure that aviation kerosene contains no water in suspension. This precaution is not necessary with aviation gasoline which will not take water into suspension. Precautionary measures with aviation kerosene might entail some delays and some fuel wastage in New Guinea conditions.

The second stage is carried out by a party of between three and six geologists. Ideally, base camps are located near airstrips at about 60 mile intervals so that the radius to be flown from any one base camp is 30 miles.

The first days at the base camp include some detailed reconnaissance by the party leader to locate natural helicopter landing sites and to check different walking traverses from the air to ensure that there are no unforeseen difficulties such as impassable streams, cliffs etc. As soon as possible he starts his men on walking traverses. These may be day trips (set-down 0630 hrs, pick-up 1200-1400 hrs) or may extend over a number of days. For day trips the geologist is accompanied by a native assistant; in isolated areas an emergency overnight pack is carried or is dropped at the proposed pick-up point.

Traverses lasting from three to eight days may be more effective where landing sites are sparse. The geologist is accompanied by three or five native assistants carrying food and lightweight camping gear. This method is discussed fully under "Sepik region".

In areas where the geology is relatively simple and natural landing sites are spaced only a few miles apart (e.g. grass country, or areas drained by wide gravelly rivers) foot traverses may be abandoned in favour of leap-frog helicopter traverses. The helicopter moves systematically across country with two geologists. The geologists are dropped at exposures preferably one to two miles apart. After dropping the second geologist the helicopter returns to pick up the first and carry him a few miles further on and so on. The geologists are dropped as close as possible to rock faces and normally have about five minutes on the ground in which to make and record their observations. The mapping proceeds at about 200 square miles per day in favourable areas.

An advantage of the leap-frog and day-traverse systems is that the geologists are in contact every afternoon to exchange information and to plan the following day's work. The party leader takes an active part in each days mapping and is able to spend some time in the field with each geologist and to visit critical localities.

OPERATING NOTES

Landing sites

The helicopter landing site should provide at least ten feet of clearance around the aircraft, have a ground slope not greater than 7°, and

have straight line approaches in two directions at least 150° apart; the gradient of the approaches should not exceed 40° up to a height of 200 feet above the pad.

In mountainous rain-forest country these specifications often cannot be met. The most common landing sites are gravel banks in rivers, natural clearings in the forest, and native gardens and villages. The most common obstacles are tall and overhanging trees on the approaches, and tree stumps, boulders, and uneven ground at the landing pad. If load is light and weather conditions are favourable it is possible to "winch" vertically in and out of clearings which are barely larger than the overall dimensions of the helicopter. Where ground is uneven the pilot may hover with one skid on the ground or on a boulder or stump while the passenger moves on or off. If he has a good understanding with his passenger he may allow him to climb down a knotted rope from the hovering aircraft.

Weather

High winds, cloud and rain should be avoided if possible. High winds decrease maneouvrability of the aircraft and produce dangerous down drafts in mountainous terrain. Cloud and rain mean decreased visibility; the pilot must maintain visual contact with the ground as the aircraft is not equipped to fly on instruments alone.

Flying conditions are best in the early morning and usually deteriorate as the day progresses. For this reason it is most important to start flying as soon as possible after dawn. Base camp should be located away from areas of morning ground fog.

Communication between ground party and helicopter

BMR has not used radio communication between ground parties and helicopter but this would be useful in some circumstances. To draw the attention of the helicopter, ground parties have experimented with different lightweight flares with varying success. The flares must have sufficient range to penetrate the tree canopy (200 - 300 feet) and the longer they burn above the canopy the better. Flares which give a thick smoke trail are probably best. A Very pistol will do the job but is heavy; a smoky fire

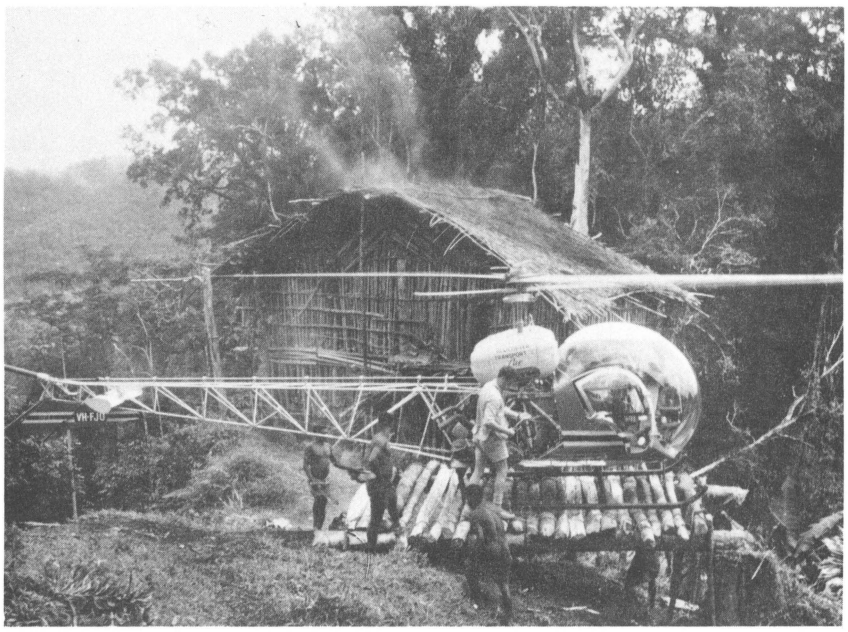


Figure 1: Helicopter pad constructed near a native hamlet in Sepik region (photo R.P. Macnab)

Figure 2: Creekbed landing on Goodenough Island, eastern Papua (photo J.S. Milsom)

is most effective but there is not always time to build one. In sunny weather a small heliograph is ideal.

As an added precaution ground parties are issued with light-weight bright red nylon jackets, which can be spotted readily from the air.

Emergencies

Survival equipment should be carried on the helicopter at all times, and field parties operating in isolated areas should ensure that they have access to survival equipment in an emergency. In Papua - New Guinea if the survey helicopter were to fail it should always be possible to bring another helicopter in to pick up ground parties within 48 hours. Ground parties should stay near their pick-up point and prepare clearings, fires, etc. to ensure that they will be spotted.

Ground party traverse routes should be plotted and prominently displayed in base camp so that in an energency the ground parties can be located.

SELECTING A HELICOPTER CONTRACTOR

When selecting a helicopter contractor the first consideration must be safety; he must provide the most reliable pilots and his aircraft must have the most thorough maintenance. Pilot error or engine failure over mountainous rain-forest country is more likely to end in disaster than would be the case over, say, savannah plains country.

The second consideration is to be sure that the contractor has pilots who can do the job. Many pilots are simply not capable of making landings in tight clearings for instance, and others may not have enough bush sense to re-locate their ground party, or will waste valuable time searching for base, or flying a familiar route instead of cutting across country. Others will not fly in rain or over partial cloud cover. It is difficult to write these requirements into a contract agreement. The only course is to find the right men, by trial and error if necessary, and to stick with them. It may be a false economy to select the cheapest contractor, because a poor pilot can fritter away hundreds of dollars a day and can reduce an otherwise well-planned survey to an ineffective shambles.

HISTORY OF BMR HELICOPTER OPERATIONS

BMR first made use of the G3B1 for geological mapping in the Western Highlands of New Guinea in 1963. Much of this operation was at above 7500 feet and this meant that the helicopter engine could not be switched off during reconnaissance traverses. Because of this, and because of the sparsity of landing sites and variable weather, the party leader concluded that the helicopter has serious limitations for geological mapping and should primarily be used to position and supply ground parties (Dekker, 1964).

In 1965 a Bell 47 J4 was used with limited success during the regional geological mapping of Bougainville Island. The J4 is a personnel aircraft and is not designed for survey operations.

EASTERN PAPUA

In eastern Papua BMR geologists had been working sporadically since 1957 on the regional mapping of a 250 mile-long strip of mafic and ultramafic rocks, the Papuan Ultramafic Belt. Progress was slow, even by New Guinea standards, as the ultramafic rocks support a poor forest with much undergrowth and much of the area is trackless and unpopulated. In September 1965 a helicopter was utilized for the first time and, although it was an unsupercharged Bell 47 G2 with a very cautious pilot, its potential was obvious. In that first survey the limits of the Belt were roughly defined by reconnaissance and a ground party was emplaced in otherwise inaccessible country.

In the following year six separate surveys of the Ultramafic Belt were mounted in succession. In each the helicopter was used primarily to position and supply ground parties but as the year progressed the helicopter was increasingly employed as a reconnaissance vehicle.

By the end of 1966 the initial regional mapping of the Ultramafic Belt was virtually completed. Map compilation in early 1967 pointed up a number of critical areas and these were checked with the helicopter using a mixture of spot landings, day traverses, and three to four day traverses.

The final stage of the Ultramafic Belt survey was to map an area of 200 square miles around Mount Suckling (9°40'S, 149°E), a 12,000 foot peak which falls away to sea level to the north and merges into other unpopulated mountain ranges to east and south. Helicopter-supported day traverses were selected as the best technique for this area because there are many landing sites. Base camp was established in the centre of the area to be mapped, at 5,500 feet elevation on the eastern flank of the mountain, and personnel, supplies, and fuel were flown in from the nearest airstrip 30 miles away. In seven days four geologists had completed the project.

In March-April 1968 a similar method was used to make a reconnaissance of 4,700 square miles of eastern Papua between 149° and 151°E. Three base camps were used in turn, each camp being occupied for 10 to 14 days. Base camps were established close to airstrips to simplify camp shifts.

The base camps were selected so that no part of the survey area was more than 30 miles distant from a base. Between two and five geologists were employed in day traverses or in leap-frogging as the terrain and geology dictated. Traverses lasting more than one day were avoided because of the reconnaissance nature of the survey but two and three day traverses will be used subsequently in areas where more detailed work is required.

Regional gravity survey

BMR geophysicists carried out a helicopter-borne regional gravity survey of eastern Papua between 147° and 155°E in 1966-7; stations were read on a four to seven mile spacing. A geologist accompanied the meter reader for some of the survey to make the most of the opportunity for cheap geological reconnaissance.

SEPIK REGION

BMR geologists began mapping the area south of the Sepik River in 1966 and continued the survey with helicopter support in 1967. This area is one of the most remote and inaccessible regions in New Guinea and poses difficult logistics problems, as the only access from the supply centre of Ambunti is by over 100 miles of river travel up the major tributaries of the Sepik River. The work could have been done entirely by

helicopter using Ambunti as base, but it would have been prohibitively expensive because the flying time would have been about doubled.

The only alternative was to set up base camps close to the mountains from which the helicopter could position traverse parties in the mountains.

Though the use of jet-boats made setting up and supplying these advanced camps a relatively simple and inexpensive operation, the nature of the terrain nevertheless posed formidable difficulties for the traverse parties. The region forms the northern fall of the Central Range, and in places is rugged in the extreme, ranging in altitude from about 150 feet at the Sepik River, to 13,000 feet along the Central Range.

Probably the most serious handicap to the mapping was the lack of population, and the consequent lack of tracks over almost the whole of the region. Even where there were people, most had never before seen white men, and though most were friendly, they were reluctant to show us their tracks.

Access into the mountains beyond the limit of jet-boat travel was therefore well-nigh impossible on foot, except at prohibitive cost, and the helicopter provided the only practicable answer. Even so there were difficulties, for most of the area is poorly endowed with landing sites, and new methods of working had to be evolved.

Field method

It was thought early in the season that much of the mapping could be done by day trips from the helicopter or by making spot observations wherever the helicopter could land, but we soon found that only a small part of the area could be mapped in this way because the geology is so complex and photo-interpretation almost worthless.

However, spot observations made during the initial reconnaissance of an area were an essential prelude to the later mapping and were used to delineate critical areas for traversing. Availability of landing sites and some idea of the terrain could be gained during these reconnaissances.

Only by traversing streams and examining all the available outcrops can the critical rock relationships be deciphered, but even where this can be done by day trips from the helicopter, a minimum of several hours walk is generally required. In some cases the helicopter can wait for the geologist to do this walk, but usually it is required elsewhere and must return later for the pick-up.

Another factor militating against day traverses is that each geologist must be accompanied by one native carrier on these trips both to cut tracks and carry survival equipment, and also as a safety precaution in case of accident. Under these circumstances, to position and return each geologist for a day traverse required at least two hours flying, and the geological returns were generally not commensurate with the cost.

Organization of traverse parties

One of the most economical, and geologically most productive, methods used was to position a geologist and his carrier line for traverses of 3 to 8 days' duration.

Previous geological parties in New Guinea used a minimum of 14 carriers per geologist, but as the helicopter can carry only 2 passengers and some gear, the cost of positioning such a party by helicopter is obviously prohibitive. With the lightweight equipment evolved by Bureau parties over the last few years, it has proved possible to cut the number of carriers down to five per geologist for traverses of more than four days and to three per geologist for less than four days.

Thus a party can be positioned in the field by three return trips in the case of the larger party, and two return trips for the smaller. The same number of trips is required to return the party to base at the end of the traverse.

This method allowed some obvious economies not possible using day traverses:

(1) In some cases the carriers were kept in the field and were taken over by a new geologist who continued the traverse; only one return trip of the helicopter was therefore needed to position the geologist. Such an arrangement is rather hard on the carriers and was done only where the

distances away from base warranted it.

(2) The most economical method, which was used wherever possible, was to position one party on the outward flights, and repatriate another party on the return flights. To utilize the helicopter fully by this method requires a large number of traverse parties operating, and is one of the main reasons for requiring at least four traverse geologists in the party.

In suitable areas a temporary camp accommodating the traverse geologists and the helicopter pilot can be established in a central location and the mapping done by means of day traverses. Only one area in the South Sepik region proved to have sufficient day trips available within a short distance to enable this method to be used.

Base camp organization

The cost of the helicopter overshadows the other costs of the expedition, so it is imperative that the amount of flying be kept to the absolute minimum. It has been found that this is best done by the Party Leader confining his work to that of co-ordinator, whose main function is to gather the results of the traverses and use them to programme the later helicopter work. The time spent in this way during the Sepik Survey, though totalling many hours per day, resulted in the saving of many hours flying time.

The Party Leader is then able to take advantage of any periods suitable for reconnaissance flights.

On these occasions there was nobody left at base camp conversant with the operation, and a record of the parties' movements had to be kept in camp. The lines of traverse of all the party members and any possible alternatives were plotted on a photo-mosaic kept permanently in the office, alongside a timetable on which all the parties schedules were plotted.

Early in the season the helicopter pilot was also given a copy of the photo-mosaic with all the traverse lines plotted, but as he became familiar with the area, he found perusal each morning of the copy kept in

the office was sufficient. It must be emphasized however that the Sepik Party had an exceptional pilot and navigator, and most pilots would need explicit instructions every day.

REFERENCE

DEKKER, F.E., 1964 - Helicopter Operations, Western Highlands, New Guinea. Bur. Miner. Resour. Aust. Rec. 1964/30 (unpubl.).

APPENDIX I

SCHEDULE OF CONTRACT RATES AND CONDITIONS FOR THE HIRE OF HELICOPTER USED BY THE SEPIK PARTY, 1967

CONTRACT PERIOD: 1st June, 1967 to 31st January, 1969

ESTIMATED REQUIREMENTS: The quantities shown are estimated requirements only. Although every endeavour has been made to form accurate estimates the Commonwealth does not bind itself to take these quantities but reserves the right to order greater or lesser quantities than those stated according to the requirements of the Ordering Officer during the period of the Contract.

2. Type of Helicopters - Bell 47G3B-1.

3. Price Schedule

(a) Positioning Charge The rate per hour for positioning of helicopter, which shall include fuel and other charges, and to commence from Lae to area of operation and returning to Lae at the completion of the charter.

$40.00 per hour

NOTE: No positioning charge shall be applied where area of operation is Lae.

(b) STANDING CHARGE: per day or part thereof to charters where twenty-five (25) flying hours or less are required in any seven (7) day period.

$180.00 per day

(c) Flying Rate: per hour to charters where twenty-five (25) flying hours or less are required in any seven (7) day period and shall be exclusive of fuel and oil costs.

$25.00 per hour

(d) Overall Flying Rate per flying hour to be applied to all charters where more than twenty-five (25) hours flying are required in any seven (7) day period and shall be exclusive of fuel and oil costs.

$80.00 per hour

(e) Idling Time Rate per hour (if applicable) exclusive of oil and fuel costs.
Prices are firm for the duration of the contract.

$80.00 per hour

NOTE: The Bureau of Mineral Resources, Department of National Development and Department of the Army will be responsible for the arrangements for positioning of fuel and oil in the areas of operation, as required for any charter under this contract.

4. PERIOD OF CONTRACT: The Period of the contract shall be from 1st June, 1967 to 31st January, 1969.

5. SERVICE: The service shall be executed to the entire satisfaction of the Officer Commanding the exercise or his representative, in accordance with the attached General Conditions of Contract.

6. ACCOUNTS: The contractor will forward his accounts for payment direct to the Ordering Officer together with any relevant documents.

GENERAL CONDITIONS OF CONTRACT FOR HIRE OF HELICOPTERS

1. SCOPE: This contract provides for the charter of Bell 47G3B1 helicopters on a period contract basis for the Departments of the Army and National Development for use in the Territory of Papua and New Guinea. Orders for such charters will be placed for work as required, and at the rates set out on page 1 hereof.

2. ESTIMATED REQUIREMENT: The estimated requirements set out below are furnished as a guide only. Although every endeavour has been made to form accurate estimates, the Commonwealth does not bind itself to adhere to these times, but reserves the right to order greater or lesser periods than those stated, according to the requirements of both the Departments of the Army and National Development, during the period of the contract.

Department of the Army -500 hours.

Department of National Development -900 hours.

The above flying hours may be taken under several Charters during the period hire from 1st June, 1967, to 31st January, 1969.

A tentative schedule of anticipated requirements for the first six months is given for the guidance of the contractor, and shall be subject to confirmation by the Department of the Army and Department of National Development before proceeding with the charter.

(a) Department of National Development

(i) 26th June, 1967 - 7th July, 1967 - Kui - Popondetta.

(ii) 14th August, 1967 - 16th October, 1967 - Sepik (Ambunti-Mt Hagen)

(iii) 1st October, 1967 - 31st October, 1967 - Safia (S.E. of Popondetta)

(b) Department of the Army

8th July, 1967 - 22nd July, 1967 - Lae Area.

3. LANDING PERIODS: Landing periods will vary in time. The charterer will co-operate with the contractor and advise him at the time of ordering the approximate amount of time he will require on the ground. As a normal day's operation may involve only three (3) to four (4) hours' flying, the contractor shall make provision for the shutting off of engines during stops for any longer than five (5) minutes. (Flying time shall be based on individual engine start to engine off).

3. NAVIGATION AND SEATING ARRANGEMENTS:

(a) The pilot will be required to co-operate with the charterer's representative in navigating by means of air photos and air photo mosaic maps. The photos will have marked on them the exact position at which the charterer wishes to be set down and picked up. Landing and identification problems will determine the actual site of the landing. At times the pilot will be required to fly and navigate alone.

(b) Seating arrangements must be such as to permit the charterer's representative to sit alongside the pilot to enable them to navigate from the same air photo, and must be such as to accommodate two (2) persons in addition to the pilot.

5. RADIO COMMUNICATION: The helicopters must be equipped with a radio transceiver fitted for communication with the Department of Civil Aviation station for the area. The contractor will be required to maintain the transeiver in first class order at all times. Radio communication may be required between the helicopter and the field party, therefore provision of this facility should be made. The relevant radio frequency will be notified to the contractor at the time of ordering.

6. CONCENTRATED USE OF HELICOPTER: It may be necessary in exceptional circumstances (and by mutual agreement between the Ordering Officer and the contractor to utilise one (1) helicopter for periods in excess of the hours laid down by Department of Civil Aviation in respect of aircraft crews (viz. 8 hours per day, 30 hours per week and 100 hours per month) which would thereby require the use of two (2) crews to carry out the charter.

In such instance, the price shall be on the all inclusive rate, per flying hour.

7. FLIGHT PLANS: A plan, either on photo-mosaics or on air photos, showing the projected route of each flight will be held at the appropriate base camp, until such time as it is known that the flight has been successfully completed.

8. ACCOMMODATION AND CAMPING EQUIPMENT: During the helicopter survey Commonwealth personnel may camp at the successive operating bases, and accommodation will be available in the camps for the helicopter crew. All messing and camping equipment will be provided by the Commonwealth. Crew members will be required to live under the same conditions as the Commonwealth personnel.

9. MESSING ARRANGEMENTS: Commonwealth personnel receive fixed camping allowances, and each contributes a set amount per week to a party mess account. Bulk purchases of food for the party are made from this account.

The helicopter crew will be required to contribute to this mess account at the relevant rate per week per person.

10. PREPARATION OF PERSONAL EFFECTS AND MOVEMENT PROCEDURE: Subject to operation commitments, members of the helicopter crew will be expected to prepare all personal effects, bed-rolls, stretchers and tents ready to load on to trucks when camp is to be moved, and set up their own bed, etc. at the new camp site.

To permit full utilisation of the helicopter during the operation, all helicopter personnel other than the pilot will be required to travel by Commonwealth or other vehicles between operating bases, if so requested by the party leader.

11. COMMENCEMENT OF HIRE: The hiring period shall be deemed to have commenced on the helicopter being declared "available for flying" by the Commonwealth's field party leader even though the helicopter is not required for flying on the day declared available or on subsequent days. Payment for the hire of the helicopter will be from the day it is declared "available for flying". If, on this day, a helicopter is not available before 10 a.m.* the Commonwealth reserves the right to refuse to declare the helicopter "available for flying" provided that, in the opinion of the party leader, the late start does not allow efficient utilisation of the aircraft on that day.

All claims for payment will be based on the full period of the charter. The helicopters must be available for hire within fourteen (14) days from date of ordering. The availability of the aircraft on the nominated day is important because the Commonwealth has to arrange for field officers to be in the area on the date nominated.

12. CERTIFICATION: The contractor shall be required to provide the aircraft at the commencement of hire airworthy and properly so certified, and properly manned and equipped in accordance with the standard configuration for the type of aircraft as required by the Department of Civil Aviation, and shall so maintain the aircraft for the period of the hire subject to the conditions hereinafter provided. Provision is to be made for the aircraft to operate over the open sea when required.

13. ORDERS AND DIRECTIONS: The pilot and engineer operating and maintaining the aircraft shall be and remain at all times the servants of the contractor, but shall carry out the orders and directions of the hirer for the purpose of the hire provided that such orders do not require the contravention of any law or any order or regulation made under the law of the Commonwealth of Australia, and provided that the pilot shall have the right, having regard to the safety of the aircraft and of the passengers, to decide the composition, weight, or stowage of any cargo to be carried in the aircraft, the suitability of weight for flying, the altitude and speeds of flight, and the locality of any landing place.

* In future contracts 10 a.m. will read 0630 hrs.

14. TIME OUT: In each seven (7) day period there will be a total allowance of two (2) days unserviceability without penalty, calculated in periods of half days. The total allowance of two (2) days for unserviceability is to include time required for normal service maintenance and routine component changes.

Except in unusual circumstances there will be no flying on Sundays, and the contractor is required to undertake as much maintenance as possible on that day. The contractor must agree that when an "unusual circumstance" is declared by the party leader one other day each week will be taken in lieu of Sunday for maintenance purposes, and that the start of such day should coincide (as far as is deemed practicable by the helicopter personnel) with the cessation of flying from any one base.

The remaining one (1) day per weekly period shall be credited against any other servicing requirements.

15. LIQUIDATED DAMAGES: Where the aircraft is unavailable for flying in excess of a total of two (2) days per seven (7) day period owing to repairable mechanical failure or repairable damage due to accident, the contractor shall use his best endeavour to expedite the necessary repairs in order to proceed with the hirer's requirements. However, in respect of each day's delay so occasioned, the contractor shall make allowance to the hirer of 7/5 of the daily hire charge for each day on which the helicopter is unserviceable in excess of the total of two (2) days per seven (7) day period, provided that no such allowance shall be made in respect of any seven (7) day period where the total utilisation of the helicopter by the hirer equals or exceeds twenty (20) flying hours.

Where the contract cannot be completed within two (2) weeks owing to unserviceability of the helicopter any period of unserviceability in excess of the allowable four (4) days may be credited to the hirer, and added on to the original two (2) days.

(a) Unserviceability will be based on half-day periods.

(b) The first seven (7) day period shall commence from the day the helicopter is declared "available for flying" by the field party leader.

(c) "Available for Flying" means that the aircraft (including pilot) is ready in all respects to carry out the type of flying required by the hirer. The daily rate of hire shall commence from the date the aircraft is certified by the field party leader as "available for flying", whether the machine is required or not.

A period of unserviceability shall cease upon certification by the party leader that the machine is "available for flying".

16. DAILY INSPECTION: In planning the operation time will be allowed for daily inspection to be carried out before the first and after the last flight.

17. AIRCRAFT LOGS: The Contractor must maintain a log, a copy of which shall be made available to the hirer.

18. IDEMNITY AND INSURANCE: The Commonwealth shall not be responsible for loss or damage to the aircraft and the owner shall indemnify and deep indemnified the Commonwealth and all of its officers, employees and agents against all actions, proceedings, suits and claims or demands which may be made by any such person arising out of or in any way connected with the operation of the aircraft under this contract and the Contractor shall insure and keep himself insured against such risks.

19. ASSIGNMENT: During the period of the contract the helicopter shall be used only by the Commonwealth. The benefit of the hire shall not be assigned to any other person by either the Commonwealth or the contractor, nor any sub-contract entered into by the contractor during the period of the contract.

20. RIGHT TO REFUSE PASSENGERS OR CARGO: The contractor shall have the right to refuse to carry any passengers or cargo which might endanger the safety of the aircraft.

21. CURTAILMENT OF SORTIE: If during the course of a sortie it becomes apparent that insufficient daylight remains to complete it, the pilot shall discuss with the Commonwealth Officer in the aircraft an alternative method of completing as much work as is practicable. If the pilot should insist on reducing the time by other than the method preferred by the geologist, he shall submit a written explanation on his return to base.

22. SEARCH AND RESCUE: The contractor shall be responsible for initiating action for search and rescue should such be necessary. Costs involved are to be shared as follows:-

Search and Rescue of Personnel: pro rata according to the number of personnel of each party, and their equipment.

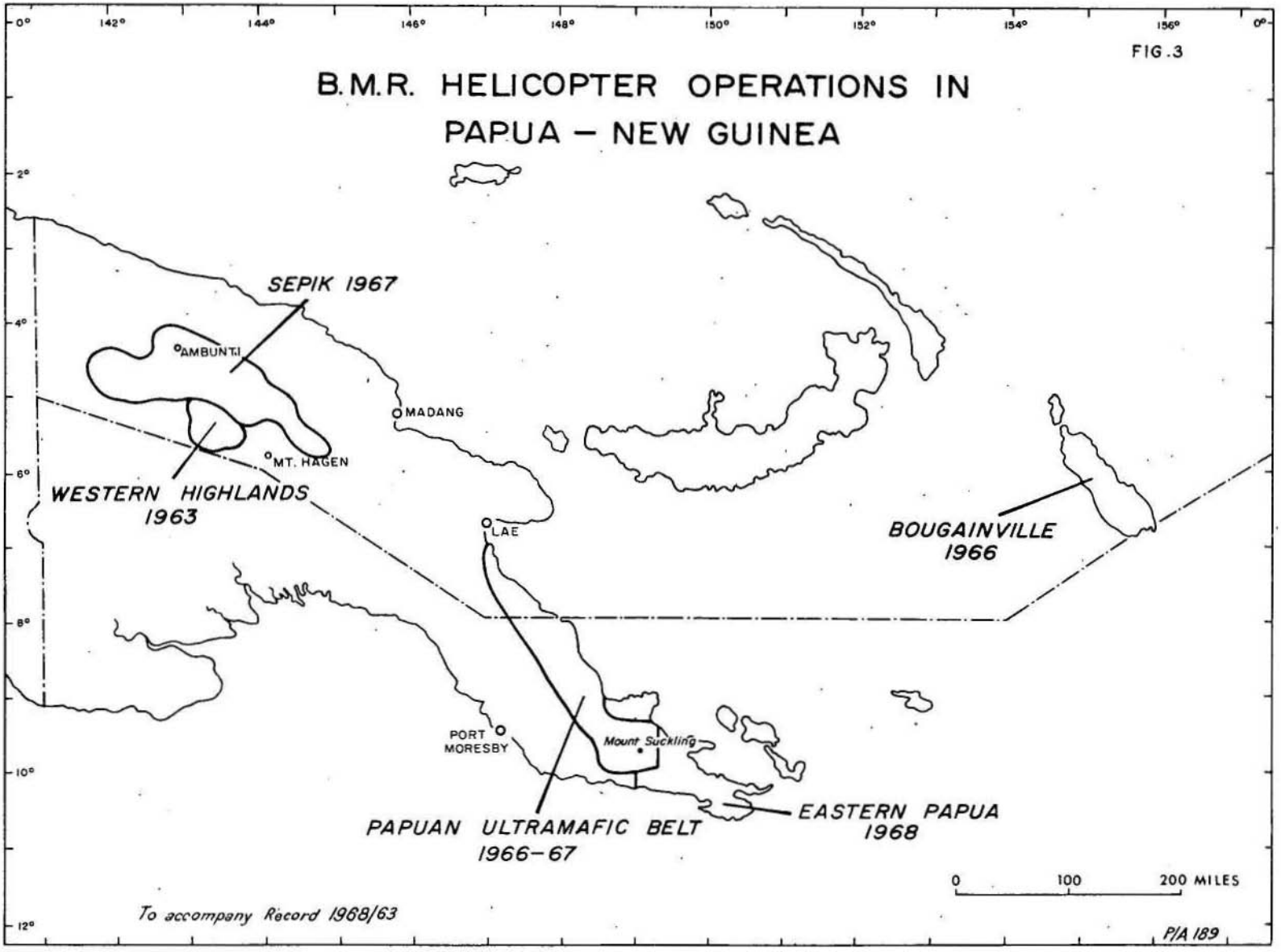
Salvage and Recovery of Helicopter: responsibility to be the contractor's.

All persons on board must be equipped with suitable footwear, head gear, and water bottle in case of stranding. For flights over the sea the contractor will be required to provide and carry life-belts, an inflatable dinghy and paddles, and survival rations.

23. CONCLUSION: When the survey is nearing completion, the party leader shall keep the pilot informed and shall notify the pilot, as an agent of the contractor, two (2) days in advance, the date on which the contract will conclude.

FIG. 3

B.M.R. HELICOPTER OPERATIONS IN PAPUA – NEW GUINEA



To accompany Record 1968/63

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