1953-54 REVIEW

In this issue we present the first review of the helicopter activities of those firms from whom The Helicopter Association of Great Britain has received support during the past year

The Editors wish to point out that not all the firms approached have been able to submit material in this first instance

It is hoped, however, that these annual reviews will expand in future years to become a useful reference section of the Journal

It is intended to include such a section yearly in each October issue of the Association Journal as a report on the previous twelve months' activities within those companies associated with helicopter design, manufacture and operation

BRISTOL AEROPLANE COMPANY LTD

The increasing scope of the Bristol Aeroplane Company's helicopter programme was underlined by the recent Government order for about 100 twin-engined twin-rotor helicopters—the largest single order for helicopters ever placed in this country

These aircraft are to serve the Royal Navy and the Royal Air Force One of the chief roles on which the aircraft will be engaged in the naval sphere is anti-submarine duty operations—a duty which was perhaps foreshadowed by the successful series of trials at sea carried out by one of the Type 173 prototypes aboard the aircraft carrier H M S *Eagle*.

The Type 173 is, of course, already well known, and the two prototypes now flying—the second experimentally fitted with auxiliary wings which improve forward flight performance—have attracted considerable interest when appearing at S B A C Farnborough displays

Since the first of these machines made its maiden flight in January, 1952, a considerable number of flying hours has been completed and the type is justifiably regarded as the most advanced of the large helicopters now flying Three more proto-

Bristol Type 173 Tandem Rotor Twin Engine Helicopter

https://doi.org/10.1017/S2753447200002262 Published online by Cambridge University Press

types are being built and will be used to extend investigation into application of multi-engined helicopters to naval and military requirements

The successful development of the Type 173 owes much to experience gained with the single-engined Sycamore (Type 171), which first flew in 1947 and was the first British helicopter to gain a Certificate of Airworthiness

In its current production form, the Mark 4, the Sycamore is one of the most versatile transport vehicles in the world, capable of undertaking communications and general transport, search and rescue, and air ambulance duties It is already in service with R A F Fighter and Coastal Commands, the British Army, the Royal Australian Navy, the Belgian Air Force, and British European Airways, and is in series production to meet substantial Service requirements

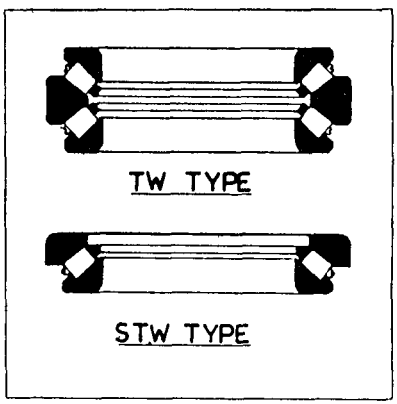
This demand, together with the heavy Type 173 commitment, necessitates a considerable increase in productive capacity Plans have accordingly been made to establish helicopter production at the Company's Weston-super-Mare factory, which during the last war was a " shadow " production centre for Beaufighter aircraft

Research and design activity is no less intense, and there can be little doubt that the Company will maintain its established position as one of the leading firms engaged in helicopter development

BRITISH TIMKEN LTD

Among the many Timken tapered roller bearings used in helicopters are the TW and STW types shown

TW type bearings are extensively used to sustain the loads due to centrifugal force and bending moments on the blade roots of variable pitch propellers, for which application they were first of all designed They are now also in successful use on the blade torsion hinges of rotary wing aircraft



STW type bearings, which are single row versions of the TW type, are used in pairs Thus the distance between the centres of these bearings may be increased in order to sustain bending moments which would not be within the compass of a TW type of the same size

Both types of bearings have low torque characteristics and, due to the tapered construction of the rollers and raceways, lend themselves readily to preloading in order to inhibit fretting corrosion which is a problem associated with oscillatory motion Furthermore, both types are equally suitable for application where there is continuous rotation

THE DECCA NAVIGATOR COMPANY LTD

The Decca Navigator radio position-fixing system, at present used by about 2,200 ships and a wide variety of fixed-wing aircraft, has for some time been the subject of a long-term flight evaluation programme by the British Eoropean Airways Helicopter Unit The use of long radio wave-lengths combined with the " phase comparison " hyperbolic position-line technique gives Decca three important characteristics in relation to helicopter navigation operation down to ground level without loss of range, high accuracy and direct pictorial display of position to the pilot The first of these characteristics—the ability to pass behind rising ground or to make a let-down in any urban area without loss of the signals—is obviously paramount A single four-station Decca chain covers an area of at least 50,000 square miles at the

high accuracy likely to be required by helicopters, and everywhere in that area, down to ground level, the continuous position-fixing service is available without interruption or screening

Another important characteristic of Decca is that it is an area-coverage system, using no " beams " or specific tracks, and as such it enables any desired path to be followed at will within the service area Hence it follows that any point in the coverage can be approached from any direction , to take full advantage of this property in relation to the control of helicopter traffic in the approach to landing sites, the Company has under development an " approach meter " which combines height-information with the continuous Decca fix This instrument gives a simple glide-path indication which it will be possible to align on any required destination point, at any angle of descent In addition to the approach meter, other refinements of the system have been under development with the helicopter application in mind , these include an extremely light and compact airborne receiver with a complementary light-weight Flight Log

DOWTY EQUIPMENT LTD

Dowty Equipment Limited, well known all over the world as designers of under-carriages and hydraulic equipment for the aircraft industry also produce a wide range of electro-hydraulic components, many of which are eminently suitable for use in helicopters These include patented switch-valve combinations such as the " Hydel " 4-way selector valve fitted to the Westland Sikorsky S51, and push button, lever, drum and commutator type switches In addition, the Company's pressure and priming switches and magnetically operated indicators are of particular interest to helicopter designers

A new component introduced for use in any type of aircraft is a multi-operation indicator which, measuring only 2½″ in length and weighing less than 2¼ ounces, gives three separate indications on a tiny but perfectly clear inch-square observation screen

At Arle Court, near Cheltenham, headquarters of the Dowty Group, is installed what is probably the most effective and comprehensive undercarriage test equipment in the country, and designers and manufacturers take advantage of these facilities by sending their undercarriages to Dowty's for testing

FAIREY AVIATION CO , LTD

The Fairey Aviation Company has for some years devoted a considerable part of its design effort to helicopters The fruits of this effort are now becoming apparent and while the stage of series production has not yet been reached a number of proto-types are under construction and an experimental aircraft has been flying for some months

The experimental jet-powered Gyrodyne, illustrated in the photograph, first flew on January 8th, 1954, and has since been engaged on a programme of steady develop-ment So far work has been mainly directed towards establishing the mechanical reliability of the aircraft The air ducting system functions satisfactorily and the problem of metering fuel to the tip jets to give smooth running over a wide range of operating conditions has been overcome The performance of the tip jets in fact is extremely satisfactory in terms of the mass flow and pressure ratio available The blades have no drag hinges but a calculated flexibility in azimuth has been provided to reduce Coriolis stresses at the roots Throughout a comprehensive trial programme no trace of ground resonance has been experienced A further notable feature is that even at moderately high forward speeds the vibrations normally associated with a two bladed rotor are completely absent Alternative schemes for controlling the transition from helicopter to autogyro flight regime are now being evaluated

The jet-powered Gyrodyne is not intended for production, it is in fact a test vehicle for the Rotodyne This is a 33,000 lb aircraft powered by two Eland engines It has a 90 ft diameter rotor driven by pressure jets, forward facing propellers and a lifting wing It will take 40 passengers over a 200 mile stage at a cruising speed in excess of 130 knots The design is in an advanced stage and in fact construction

of the prototype is under way This major undertaking does, of course, involve breaking new ground in a number of directions, raising for example unfamiliar stability and control problems An extensive wind tunnel programme has been scheduled and a survey of a $\frac{1}{8}$th scale model without rotor or propellers has already been carried out, a $\frac{1}{4}$ scale model for testing with these items is under construction

The pressure jets are developed on a rotor test tower and a considerable back-

ground of experience has already been built up Future aims are to increase thrust while retaining reasonable fuel economy and at the same time without permitting the noise level to increase to a level at which it is no longer acceptable

The Company looks forward with confidence to a period of accelerating activity in the rotating wing field

THE HUNTING PERCIVAL HELICOPTER PROJECT

The Hunting Percival Helicopter Division was formed by pioneers of the helicopter in this country Their long association with the helicopter had given some disappointment to these early workers, in that the machine was still expensive, complicated, inefficient as a load carrier, slow, and costly to maintain—in fact, very far from the early hopes of Mr Everyman's flying machine

The conventional configuration that had established the success of the helicopter was the natural one to be taken up and developed That is, the shaft-driven conception with torque balance provided by another non-lifting or lifting rotor As powers increased and multi-engines were considered, to be followed by higher revving turbine drives, it was soon seen that nothing was being done to lessen the complications of this form of aircraft

In forming a new team of helicopter enthusiasts Hunting Percivals therefore determined to try and avoid this trend, and to design a helicopter of basically simpler conception, as simplicity promised to bring in its wake improvements in all the other desirable features

After a prolonged study a method of torqueless drive by tip gas jets was chosen A special gas producer was designed, burning at high efficiency for good fuel consumption and discharging through the rotor blades to the tips a gas of qualities designed to give a low noise level and an acceptable temperature

The last year has been devoted to solving the problems connected with gas ducting, rotating and articulated seals, blade construction, etc These components replace the many moving parts in the shaft-driven helicopter, parts that require lubrication, that wear, suffer fatigue limitations, and demand frequent inspection and maintenance

Besides the decisive benefits to be derived from greater simplicity, the use of gas through the blades as a driving force can be taken advantage of in several ways Sufficient heat can be allowed to reach the skin of the blades to provide de-icing at no added cost, weight or complication The tip jets can be reversed to provide rapid braking, again with negligible complexity compared with a normal rotor brake installation Also the same system can quickly spill lift, as for deck landing A development of great promise is that of boundary layer control by means of the jet stream, which may lead to greatly improved performance

The price paid for this simpler design is all in the form of added fuel consumption An approximate comparison with the shaft-driven helicopter shows a first cost of about 60%, a maintenance cost of 50%, and a fuel consumption of 130 to 140%

The question of material for helicopter construction has been closely studied and many tests carried out As a result it was decided not to use light alloys for any of the main structural parts that could be subject to alternating stresses The higher strength weight ratios of the stronger light alloys cannot be benefitted from under the loading conditions in helicopters, and it is found that stainless steel, whose strength can be much more fully employed, gives a more reliable structure with no increase in weight

An interesting work which has been completed during the last year is the provision of a rotor test site This does not take the form of the usual rotor tower with protective steel screens as the cost was considered prohibitive For future testing of rotors to destruction an excessively elaborate station would have been required Instead a pit was dug in the ground and the rotors are tested well below the top edge of the circular wall of earth, providing a safe barrier upon failure during rotation

ROTOL AND BRITISH MESSIER, LTD

The British Messier Company of the above Organisation have fitted several helicopters with landing gear equipment, also with wheel and rotor brakes

A typical set of the landing gear equipment has been installed on the Bristol 171 Sycamore The main undercarriage essentially consists of a small shock-absorber operating on a hinged wheel-carrying frame The nose undercarriage is of the orthodox telescopic type and is fitted with an automatic centring mechanism

Apart from providing adequate travel to deal with the normal vertical velocity of 7 feet per second, and an emergency velocity of 12 feet per second, the principal problem of the helicopter undercarriage is to make provision for damping the out-of-balance forces that are set up by the spinning rotor or rotors

In the case of the Sycamore aircraft, the conditions permit the use of independent shock absorber units In the case of some twin-rotor units, as on the Bristol B 173, the resonance problem is considerably more serious The British Messier landing gear for this helicopter application incorporates traverse interconnection of the under-carriage so that the rolling stiffness of the aircraft is reduced , a central damping device being employed to deal with energy absorption

The Bristol B 173 helicopter is also fitted with British Messier single-disc brakes on the two front wheels Each brake has an annular piston for obtaining a high torque The rotor brake is different in design as compared with the wheel brakes and has a simplified construction specially suited for fitting on to a rotor drive having its own integral brake disc

D NAPIER & SON, LTD

Power Plant Design for Helicopter Propulsion

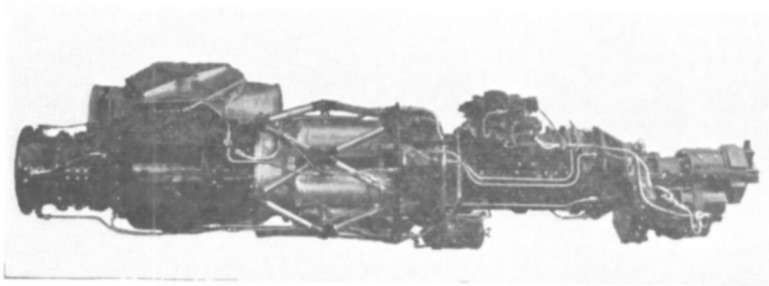
D Napier & Son Ltd have recently displayed a marked interest in engines for helicopter propulsion It has been known for some time that a variant of the 3135 e h p Napier Eland propeller turbine engine had been chosen as the power unit for the Fairey " Rotodyne," which will have two of these engines Flight trials of a Vickers Varsity aircraft equipped with Elands are well under way, and these standard versions of the engine are giving a good account of themselves The Rotodyne version of the Eland will, of course, do its flight trials in the prototype Fairey Rotodyne

There has also been recent speculation in the Press regarding the application of the Eland to the S 56

Last year reference was made to a new type of Helicopter power plant, but security prevented a statement by the manufacturers until the Ministry of Supply

released a brief announcement that Napier were producing an engine called the "Oryx," described as a Turbo-Gas-Generator and suitable for helicopter propulsion A further relaxation of security permitted an example of the "Oryx" to be shown on Napier's stand at the S B A C Display, Farnborough, with the information that this engine gave an output of 750 gas horsepower at sea level, for a consumption of 0 68 lb /g h p -hr The "Oryx" has a length of 76 ins , a maximum diameter of 19¼ ins and weighs 495 lbs

The layout of the axial type compressor, five combustion chambers and turbine, is orthodox The remainder of the engine is interesting but has to be guessed All



the air from the turbine seems to pass into the ducting, seen in the illustration, and there appears to be an auxiliary compressor, also designed to supply air into the ducting As a means of supplying air under pressure to rotor tips, the "Oryx" has interesting possibilities Further news of Napier's progress on both these engines and their variants may be looked for as the time for the flight trials of various prototypes approaches

SABENA

The helicopter is due to stay SABENA experience of one year of international scheduled operations seems sufficient to prove it

The Belgian airline uses 4 Sikorsky S 55 equipped with 7 seats and operates the following services

— Brussels/Antwerp/Rotterdam (Netherlands)
— Brussels/Lille (Northern France)
— Brussels/Liege/Maastricht/Cologne/Bonn (Germany)

The airline also contemplates opening this year a

— Brussels/Eindhoven/Duisbourg/Essen link

All these services are operated three-times-a-day on weekdays in Summer, with the exception of Lille which has two daily services Since helicopter flying is limited to VFR conditions, the helicopters are used extensively by day and maintenance is done at night This scheme has allowed an average yearly utilization of 1750 to 1800 flying hours per aircraft

It must be noted that VFR conditions are not the same for the helicopters as for fixed-wing aircraft The following minima have been approved by the Belgian, Dutch, French and German Civil Aviation Administrations in co-operation with Sabena

— visibility 800 yards
— ceiling 300 feet above open country
400 feet above built up areas

Sabena management felt that the success of their network would depend mainly on the possibility of taking full advantage of the unique characteristics of the helicopter , consequently they planned to operate many stops at very low indirect cost, without reducing the average speed noticeably

Therefore downtown heliports had to be found and very simple operating rules to be set up

Heliports were built with the enthusiastic support of the cities and with the co-operation of Sabena They do not have standard measurements since standard

pattern would not always fit the ground offered by the cities The best approach to this problem was to look at various places and see if they were suitable for the setting up of a heliport

Simplicity was achieved by asking the passenger to carry his own luggage Administration's co-operation and good-will will be emphasized by saying that the single remaining flight document is the very simple loadsheet reducing the en-route stop duration to 3 minutes and the turn around time with refuelling to 10 minutes

These basic requirements well-located heliports, simplicity, shorts stops and quick turn-around may be considered as the golden rules of any scheduled helicopter service and may to a very great extent, explain the success of this first year of passenger helicopter operations

Up to September 1st, about 15,000 passengers have been carried on the scheduled network and about 25,000 have flown on a Sabena helicopter

Experience shows definitely that Sabena is on the right way As soon as bigger helicopters are on the market, new lines will be opened and more services put into operation

SAUNDERS-ROE LIMITED

Saunders-Roe took over responsibility for the development of the Air Horse and Skeeter helicopters when the Cierva organisation was acquired in 1951

The Air Horse, which will be remembered for its three rotor configuration, is still the largest helicopter to have been built in this country (gross weight 17,500 lb)

The original version of the Skeeter was of welded tubular construction, and was powered by a 104 h p Jameson F F I engine This type was first flown by Cierva's

in 1948 Subsequently, the Skeeter was redesigned with conventional sheet metal construction and the Mark 2 version, forerunner of the present series, was flown in 1949 Powered by a 145 h p de Havilland Gipsy Major 10, the Mark 2 had an A U W of 1,800 lb A military version, the Mark 3, followed in 1950 with a 2,000 lb A U W

In 1951 the 180 h p Blackburn Cirrus Bombardier 702 engine was adopted and the Marks 3B and 4 military versions were flown, the A U W being increased to 2,100 lb From these two versions a civil aircraft, the Mark 5, has been developed This incorporates many improvements over the previous types, and made its first flight in 1953

The latest in the Skeeter series, the Mark 6, is at present undergoing tests at the Company's Southampton works Powered by a de Havilland Gipsy Major 30 giving

200 h p , this version has a greatly improved performance The maximum A U W has been increased to 2,200 lb with a corresponding increase in disposable load

In 1952, after an investigation into the various forms of rotor propulsion, the Company embarked on the development of pulse jet engines

The first Saunders-Roe pulse jet, the PJ-1, ran in August, 1952, and has been developed to its designed maximum thrust rating of 45 lb A second engine with a designed maximum thrust of 120 lb has also been constructed, and spun on an arm representative of a helicopter blade The results obtained to date have proved most encouraging, particularly with regard to increased valve life and low specific fuel consumption, but these improvements have by no means reached their limit, and as the work continues even better results are expected

For rotor blade research and development, Saunders-Roe has designed and built a rotor test tower Powered by a de Havilland Gipsy Queen aircraft engine, this tower is suitable for testing rotors up to approximately 40 feet in diameter Primarily designed for blade fatigue testing, the tower is provided with a full set of conventional " flying " controls It is also equipped for strain gauge recording, thus making possible the measurement of blade motion and blade pitching moment, in addition to the measurement of rotor thrust and torque The tower may also be adapted for aerodynamic purposes such as the determination of the blade mean profile drag coefficient

SHELL-MEX AND B P LTD

The Royal Dutch Shell Group have proved the worth of helicopters for oil prospecting in New Guinea, Nigeria and Venezuela and other projects are under consideration Easily manoeuvrable and able to operate from small quickly made clearings in the jungle, they have proved invaluable for lifting men and materials under difficult conditions

In western New Guinea annual production of 250,000 tons of crude oil is now being shipped from the new port of Sorong and exploration to find new oilfields is on a large scale The prospecting involves the movement and maintenance from base camp to site (sometimes as far as eight miles) of technical parties numbering up to 300 men and 50 tons of equipment and food in thick, swampy jungle

Three single-engined two-seater Bell 47Ds, able to land in a clearing 100 yards by 30 yards on a flat space no more than three or four yards square, are used Should circumstances require it, floats are fitted to enable use to be made of the many rivers in the area With one helicopter held in reserve, the average monthly load carried over a half-year period was more than 78 tons, despite the fact that each machine carries a maximum payload of only 3 cwts During 50 machine days they made a total of 974 separate flights aggregating 183 flying hours and covering 5,600 miles

The great speed at which work can progress by the use of helicopters offsets in large measure its higher cost Urgent spares were, on a number of occasions, flown in within minutes

In Venezuela, Bell 47D helicopters under contract from an American company, are being used in the oil-fields for many purposes An interesting feature is their use as a means of communication with offshore drilling rings in Lake Maracaibo

In Nigeria helicopters are being used to transport men and light equipment between the company's base camp at Owerri and the exploration areas, and are giving invaluable service in speeding up communications

The machines employed are two Hiller 360 aircraft under contract to the Shell-D'Arcy Petroleum Company of Nigeria Ltd (jointly owned by Shell and the D'Arcy Exploration Co Ltd , the prospecting company of Anglo-Iranian Oil Co Ltd) from Pest Control Ltd Each is two-bladed and powered by a Franklin 178 h p engine They can be equipped either with wheels for ordinary land flying or with floats for amphibious operations

Shell technicians are also engaged in research into the problems of pest, disease and weed control in three countries—in Britain, Holland and the United States—and the importance of aircraft as a means of applying spray materials is fully appreciated In the Netherlands, Shell engineers have designed spraying equipment for a Sikorsky S 51 helicopter which has been used with great success

https://doi.org/10.1017/S2753447200002262 Published online by Cambridge University Press

THE SPERRY GYROSCOPE COMPANY LTD

The introduction of the helicopter into the pattern of air transportation has brought with it new problems to be solved by the aircraft instrument designer If these versatile machines are to be used to the full extent of their unique capabilities, they must become " all weather " aircraft

Since the helicopter first emerged as a practical vehicle, Sperry engineers have applied themselves to the task of providing instrument aids suited to the characteristics of rotating wing flight The H L 4 Helicopter Gyro Horizon, developed from its fixed wing counterpart by a modification to the presentation and to the erection and tilt mechanism, and the standard Directional Gyro were the first means used to provide the helicopter pilot with attitude and azimuth information in conditions of zero visibility Recent developments include the improvement of the horizon presentation and the utilisation of the " Gyrosyn "* compass as the primary heading indicator The latest design of " Gyrosyn " compass and electric Gyro Horizon provide the azimuth and attitude indications on repeater instruments so that they can be incorporated readily on the sloping instrument panel common to many helicopters

A close liaison is maintained with the associate company in America, the Sperry Gyroscope Company—Division of the Sperry Corporation, who have recently purchased a Sikorsky S 55 helicopter to add to the fleet of aircraft they operate for research purposes Among the future instrumentation systems which are at present being explored with this machine, an adaptation of the " Zero Reader "† flight director shows signs of great promise The rotating wing version will be known as the Helicopter Flight Director Automatic stabilisation has, also, received close attention in the U S A Following the adoption, in 1951, of a slightly modified version of the Sperry A-12 Gyropilot as standard equipment in the Piasecki HUP helicopters, a new automatic pilot is in the design stage When complete, it will provide a fully integrated automatic control stabilisation system designed specifically for helicopter use

* *Registered Trade Mark*
† *Trade Mark*

WESTLAND AIRCRAFT LTD

Production During the past 12 months the first production assemblies of the Westland S 55 have been running concurrently with the Westland S 51's built for the Ministry of Supply and a number of Foreign Governments A large number of both types have been completed Westlands retains a substantial lead in the production of British helicopters and they claim that the present availability of these machines has well proved the necessity, which their Company envisaged as far back as 1946, of utilising American experience in order to ensure the most rapid development of rotory wing machines

Parallel with initial production of the Westland S 55, following its re-design to meet British airworthiness requirements, has been the accumulation of extensive test-rig running and flight development time, with a view to securing C (S) A, release followed by the A R B approval for Certificate of Airworthiness In this development work Westland Aircraft Limited have had extensive co-operation from the Air Registration Board

The first production S 55 completed its contractors trials in March, 1954, and after the usual extensive tests by A and A, E E received C (S) A approval in June This was followed by the initial limited category C of A in July Concurrently a number of helicopters were delivered to the Admiralty, French Admiralty and French Army

In the civil field considerable interest has been displayed in the Westland S 55, and among other important operators both B E A and S A B E N A have placed orders for this type The initial B E A helicopter service from London Airport to the South Bank will utilise Westland S-55's fitted with amphibious gear

Development Work Considerable experimental work has been carried out with both the Westland S-55 and S-51 Among developments has been the design and flight investigation of a four-blade rotor system on the S-51 in order to obtain experimental data for other projects This machine was first demonstrated at the 1953 S B A C Show at Farnborough

Flight trials and ground development tests have also been devoted to extension of working life of major components, such as rotor blades, and have shown that so large is the reserve margin on the safety limitation of a number of these units that the replacement period could be deferred, with consequent benefit to operational costs

Other experimental work has included modification of the Westland Whirlwind S-55 to take as alternatives to the Pratt & Whitney 1340/40 the Wright 1300 engine or the Alvis Leonides Major—both giving an even greater reserve of performance, particularly where take-offs or hovering is required at high altitude The S-51 has been following a similar course of performance development, and tests have included

Westland Sikorsky S 55 as granted limited category A R B certification in July, 1954

operations at higher boost rating than standard Further development work is in hand which will extend the useful operational capacity of this machine

Following earlier design investigations of tip mounted power units as described in Mr O L L Fitzwilliams paper before the Association on November 23rd, 1951, attention has been devoted towards practical experimental work of this nature

Flying School For a number of years the Company has operated the only Helicopter Flying School, open to civilian and Service personnel of all nationalities Several Westland S-51's are currently employed for this purpose and a very considerable number of pupils have converted from aeroplanes to helicopters, and in some cases from other helicopters to Westland types

A Helicopter Maintenance School has also been established, and several hundred service personnel and ground engineers have attended the extensive series of lectures and practical work on both the S-55 and S-51

As a result of the foregoing experience both the Flying and Maintenance School are being extended with a view to dealing with a greater input and covering a still wider field of work

Policy Westland Aircraft Limited is vigorously establishing its own line of design and development work, with a view to meeting any particular helicopter requirement which may eventuate Nevertheless, the Company is maintaining the closest association with the United Aircraft Corporation of the U S A , and by thus acquiring the benefit of immediate availability of design and development experience is prepared to put into production further Sikorsky types as required