I.A.T A Helicopter Symposium

Part of the Sixth I A T A Technical Conference held at PUERTO RICO, April 24—26th, 1953

The I A T A Helicopter Symposium, held on 24th—26th April, 1953, as part of the Sixth I A T A Technical Conference at Puerto Rico, has developed a unique record of international information and opinion on the operation of this new aerial vehicle, as well as a statement of those directions in which further development must be pressed before it can be put extensively into scheduled public service

We are therefore publishing two papers which summarise the results of this Symposium, viz

A statement of some of the requirements for further development which represents the opinion of the participants in the Symposium,

An informal and unofficial summary in question and answer form of the data and views put forward during the sessions

The Symposium was notable for a full and frank exchange of information between I A T A member airlines, metropolitan helicopter operators, manufacturers, government authorities and other interested groups, including representatives of the International Civil Aviation Oragnization In all, 150 persons, representing 65 companies and agencies of a score of countries, took part

A particularly valuable contribution was made by those companies and agencies which have already begun helicopter operations—Los Angeles Airways, Helicopter Air Services (Chicago), Okanagan Airways, New York Airways, Port of New York Authority, British European Airways and SABENA Belgian Airlines—and by representatives of the Helicopter Committee of the Air Transport Association of America

J T Dymant, Director of Engineering for Trans Canada Air Lines, was Chairman of the Symposium, while J A Collings, Executive Vice President of Trans World Airlines, was Chairman of the I A T A Technical Conference

The full and official record of the Symposium will be published by I A T A later this year, when it is hoped to have copies available in the Association Library

The following "Requirements for further Developments" have subsequently been endorsed by the I A T A Technical Committee They have also been officially submitted to the International Civil Aviation Organisation (I C A O) with a request to disseminate them to all contracting States of that Organisation, in order to initiate development action in those air navigation fields which will be affected by the introduction of the helicopter into civil air transport operation At the same time I A C O have been asked that their Air Navigation Commission should consider the inclusion in its work programme of such technical aspects and problems related to the helicopter which will require development

SOME REQUIREMENTS FOR FURTHER DEVELOPMENT

The following is a statement of some of the requirements for the further development of the helicopter for commercial transport service which represents the opinion of the persons participating in the Helicopter Symposium of the Sixth Annual I A T A Technical Conference at Puerto Rico

"The consensus of opinion of the Helicopter Symposium of the Sixth I A T A Technical Conference is that transport helicopters will be brought into effective commercial operation as rapidly as the development of equipment and technique will permit

"It appears that suitable transport helicopters may become available in quantity before adequate facilities, techniques and regulations for their operation have been fully developed

"These developments are dependent upon the broadening and acceleration of the present efforts of government agencies, operators and manufacturers

"In view of the importance of the transport helicopter to the transportation systems of the future, and of the mutual dependence of civil and military developments, it is hoped that military departments and appropriate civil regulatory agencies will foster, together with civil operators and manufacturers, a programmme of prototype testing of helicopters in commercial operating regimes The objectives of this programme should be the improvement of reliability, the development of operating

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procedures and techniques, and the accumulation of handling experience

" Since commercial transport helicopter operations will need to be carefully blended into the nature of the cities they will serve, civic agencies should be encouraged to participate in the development programme outlined above, with the object of providing adequate heliports and facilities , and protecting suitable approach paths in built-up areas, by keeping to a minimum the number and height of towers and other aerial obstructions and by marking adequately those obstructions which must be permitted

" Since certain of the problems associated with operations over city-centres have a fundamental bearing on the design of future trnasport helicopters and heliports, regulatory agencies should be encouraged to accelerate the determination by flight research of flight safety criteria and optimum approach, landing and take-off procedures for all-weather operations of transport helicopters This programme should include the development of instruments adequate for manual hovering in blind flight

" In view of the necessity for operating helicopters under adverse weather conditions in close proximity to obstacles in order to serve city-centres and otherwise to exploit their advantages, appropriate government agencies should be urged to accelerate the development of better weather forecasting, navigational facilities and procedures to meet the problems peculiar to the helicopter, and to institute smoke prevention laws in built-up areas

" In view of the lack of extensive transport helicopter operating experience, all regulatory and local governing agencies should be cautioned against restrictive requirements, primarily applicable to fixed-wing aircraft, which might deter the full exploitation of the unique characteristic of this new vehicle

" In order to reduce the cost and increase the availability of transport helicopters, both for military and commercial operators, government agencies, operators and manufacturers should attempt to assimilate as far as possible the design crtieria and specifications of civil and military helicopters

" Since the usefulness of the helicopter depends upon its convenience and freedom from delays associated with surface and fixed-wing operation, and since these delays have been most serious in international operations, governments should be urged to take the necessary steps to relax requirements for unnecessarily involved ticketing and other transport documents and to make proper arrangements for adequate and expeditious handling of customs and immigration facilities at helioprts "

A SUMMARY OF INFORMATION AND VIEWS

The Terms of Reference

In setting the terms of reference of the Symposium, Mr Dyment said that airlines are keenly interested in the helicopter because it promises to break the bottlenecks of ground transport between cities and airports which now detract from the value of scheduled operations of fixed-wing aircraft and because it may enable them to provide new and additional services to the public

The Symposium was not designed to produce policy decisions, but rather to provide an educational exchange of information between the people who make helicopters, those who hope to use them and those who will have to regulate them, he said He further hoped that the discussions might establish " where we stand today, what we would like to see developed, what we feel we will need—and when we will get it "

Prefatory Remarks

Igor Sikorsky, Chief Engineer of the Sikorsky Division of United Aircraft Corporation, and Frank Piasecki, President of the Piasecki Helicopter Corporation, outlined generally the views of helicopter manufacturers in order to set the technological scene for the discussions

Mr Sikorsky asserted that the helicopter is the " most universal vehicle yet created by man " and that the freedom of travel and of ground obstacles which it permits justifies a bright future for this vehicle—" one which has been barely estimated by its most enthusiastic admirers " He is certain, he said, that it will be an economically reasonable form of commercial transport as well as a vehicle of prime importance for rescue and other emergency work

It is still necessary, Mr Sikorsky continued, to accumulate information about many phases of helicopter operations through the widest possible exchange of data

between manufacturers and users He warned that unless a liberal attitude in this respect were maintained, " we will slow down progress "

Mr Piasecki estimated that about 1,800 helicopters have so far been produced and have accumulated about 2,000,000 hours of flying experience Eleven types are in production, 30 others have reached the experimental flight stage, and 14 new prototypes are in work, he said

Twenty-seater helicopters should shortly be available, and seating capacities should be increased to about 50 passengers in the near future " There appears to be no limit to their size," he asserted " It really depends on economics "

Mr Piasecki said that the speed of the " pure " helicopter—now about 150 m p h maximum and 90 to 110 m p h cruising—can be raised to about 170 m p h The addition of wings and propellers should make possible speeds in the order of 250 m p h , while convertiplanes assuming fixed-wing characteristics for forward flight, may attain 600 m p h or better, he added

The extreme range of the helicopter, now about 1,000 miles, can be increased to around 2,500 miles with the proper power plants, he said

The mechanical parts of the helicopter are not more complex than engines currently in use Mr Piasecki continued, while the vehicle's unique characteristic of auto-rotation without engine power represents " a tremendous safety factor "

Initial cost of helicopters, he estimated, will be about the same as those of fixed-wing aircraft Direct operating costs are and may likely remain higher than those of conventional aircraft, but indirect costs will be lower, he added

Lord Douglas of Kirtleside, Chairman of British European Airways, reported that his own company's experimental experience with helicopters had resulted in specifications for a large multi-engine helicopter bus for which a number of manufacturers had already submitted plans

Under the conditions of the area which it serves, he said, B E A believed that the first principal role of helicopters would be passenger transport on an inter-urban basis and that the ability of this vehicle to operate from city-centre to city-centre would enable it to improve on fixed-wing airline service between cities up to 250 miles apart, as well as to provide service for cities not now on airline routes

Looking into the immediate future, Lord Douglas said that losses could be expected in the early years of operation, but that the costs of service could soon be brought to the point where helicopter operation would be a profitable addition to the airline services

1 The Transport Role

What are the roles in which helicopter transport operations are most likely to prove economically feasible with respect to the carriage of passengers, freight and mail ?

B E A felt that economic aspects would make the first important role of the helicopter transport from city-centre to city-centre on existing airline routes However, it was felt that it would serve other purposes as well in the preliminary period A second step might be transport between cities not presently served by air, as for example, London-Birmingham SABENA shared this view, adding as another early use transport between airports and outlying towns

Eastern foresaw three uses taxi service, " star " routes and, most important, inter-city operation They felt the latter to be their proper sphere of operations

Metropolitan operators, such as New York Airways and Los Angeles Airways, felt that the helicopter would tap the entire transport field and pointed out that their services have already been integrated with buses, trucks, trains and other forms of transport As operators of helicopters only, they felt that their first step is airport-to-city-centre and airport-to-suburb service

A feeder line foresaw helicopters as replacements for DC-3's on existing services

What civil transport helicopters will be available and in production within two or three years ?

Manufacturers reported a wide variety of models to be in various stages of design and production They ranged in size from 14 to 60 seats Power plants included piston, gas generator, turboprop and tip- jet units Cruising speeds were cited at from 75 to 170 m p h , with dates of production ranging from 8 months to more than 8 years

Cost estimates by manufacturers were approximate and in a number of cases necessarily hypothetical It was hazarded that the price of production models might

range from $200,000 for a 14-seat helicopter to $500,000 for a 36-seater

Estimates of direct operating cost were based on varying assumptions, but figures were mentioned in the range of 25 to 35 cents per ton mile for large capacities

How do helicopter requirements for these civil roles compare with possible requirements for military roles ?

There was felt to be no fundamental difference in the basic transport role of the helicopter in either civil or armed service

However, it was believed that the military were more willing to accept the simpler single-engine helicopters, while the airlines' insistence upon the ability to land safely with one engine out would make them insistent on multi-engined models by 1960 It was also felt that economic considerations would not influence design appreciably for military use Airline spokesmen asserted that they could profitably use only the sort of equipment which would operate around the clock, in all weather and with maximum flight safety, a combination of characteristics which they felt was not possible in a single-engine machine

At the same time, however, U S military spokesmen pointed out that their wide use of the single-engine machines stemmed to a large extent from the fact that these were the only ones presently available Manufacturers pointed out equally that interim use of single-engine models would give the airlines the chance to build up the operational experience which they would require

It was suggested that civil operators be given a chance to participate with the military in the planning of new machines in order to facilitate their use of military models and thus to absorb some part of the heavy basic development costs Some manufacturers held that there were divergencies between military and civilian requirements which might make such assimilation of needs difficult However, it was also asserted that standardisation of the most expensive parts of the machine—the rotor and engine system—was quite possible as between civil and military types, and that there was only a relatively superficial difference in the larger helicopters designed for personnel transport Both manufacturers and military spokesmen reiterated the savings which civil operators might make if they could accept some military specifications which might perhaps not be ideally suited to civil operations The military also pointed out that, while they must accept certain risks in order to do the jobs assigned to military helicopters, airlines could adapt such machines to their own purposes by derating the load they could carry , thus obtaining an over-all economic gain by being able to use the military production run machines

2 Characteristics of the Routes

What will be the stage lengths in the immediate future ?

Inter-city operations over existing routes imply a maximum stage length of about 200 to 250 miles This will probably require a cruising speed of at least 115—120 m p h

Metropolitan operators already serve stops from 3 to 62 5 miles apart, and could probably meet their requirements with a maximum block length of 75 miles

What are the characteristics of the services with which the helicopter will be competitive in its various roles ?

As a rule-of-thumb guide, it was suggested that the helicopter would compete with automobiles and buses over distances less than 30 miles, with trains on routes of 30 to 175 miles, and with fixed-wing aircraft over greater distances

In inter-city operations the helicopter will compete with both fixed-wing aircraft and surface transport Its chief advantage over normal airline service would lie in its elimination of long city-centre-to-airport trips, an advantage summed up by the example that a helicopter service between Brussels and Cologne would take 90 minutes, city-centre to city-centre, as against 150 minutes by present service

The helicopter was held to have an advantage over train service on inter-city routes, to which it would add substantially where combinations of train and boat were involved, as on the surface route from London to Paris

In metropolitan transport, helicopters already compete with taxis, buses, trucks, and trains Some doubt, however, was expressed as to how it might fare in the commuter market, carrying passetgers between major cities and outlying dormitory towns The Commuter traffic was characterised as perhaps the richest and the

most full of headaches for the carrier , and it was felt that while helicopters would compete strongly for such traffic when it was carried on through trains, it might be hard put to compete with the special-rate peak hour commuter trains

In other short-distance transport, as from suburbs to airports, it was pointed out that price competition might not be important, since a passenger might be quite willing to pay $5 to make a trip in 15 minutes which would otherwise take an hour or two by far cheaper surface transport

Over what terrain and under what conditions will be helicopter required to operate ?

European operators indicated that they plan to operate for the most part up to a 2,000-foot altitude and with a 7,000-foot maximum North American operators, however, pointed out that it would require a minimum altitude of 10,000 feet to surmount some mountain passes on instruments with an additional requirement of 5,000 to 10,000 feet for manoeuvring This would bring the required altitude for helicopters within the range of that needed by fixed-wing aircraft

A 5,000-foot maximum hovering altitude was felt satisfactory by European operators, while metropolitan operators felt that they would seldom go above 3,000 feet The latter pointed out that they expect to fly lower, rather than higher and, in some cities, to fly along water ways and under the weather It was estimated that 80% of helicopter services throughout the world would be operated below 5,000 feet, but that there was a requirement for landing and take-off ability at altitudes above this figure

Operators generally agreed that helicopter engines must meet the same general range of temperature conditions required for fixed-wing aircraft, although operating conditions might not be exactly the same They would wish their power plants to provide standard rated performance up to a ground temperature of 90°F without any sacrifice of payload to ensure proper performance There was some question as to whether engines satisfactory for fixed-wing aircraft under these conditions would serve equally well for helicopters, since helicopters require fairly high R P M settings for longer periods Manufacturers suggested that it would be difficult to set any universal standard specification in this regard and that it might be necessary to vary performance specifications to fit various installations

3 Operations

What are the desirable cruising powers for reciprocating engines and turbine engines ?

Power settings were held to be important because of their direct effect on the cost of maintenance and engine overhaul Operators indicated that they would use 50% to 55% of maximum take-off power for cruising with reciprocating engines, and between 65% and 70% of maximum take-off power with turbines

It was pointed out that since helicopters would operate nearer the ground and in less clean air, it might be necessary to use special filters in order to preserve performance

Manufacturers were asked to be cautious and conservative in putting forth performance figures for engines to be used in helicopters, having regard to the overhaul periods desired by the operators

Is the ability to fly under instrument conditions regarded as essential for all helicopter operations ?

It was felt that helicopters used in commercial transport will need reasonably full instrumentation in all cases in order to provide the necessary operating regularity

What problems are foreseen in connection with air traffic control ?

It was pointed out that the present requirements for enroute air traffic control were the VFR/IFR criteria established by international regulation for fixed-wing aircraft and that these prescribed definite procedures to be followed under certain weather conditions At the same time, manufacturers and operators stressed the fact that the helicopter is a different and unique vehicle with characteristics of its own and without many of the limitations of the airplane The helicopter can manoeuvre at speeds ranging from absolute zero to 150 m p h or more, and is capable of accurate control in all circumstances It is basically a low-flying vehicle and will in many cases be operating on very short stages

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There was strong feeling that it would be unwise to subject the helicopter to exactly the same regulatory limitations as fixed-wing aircraft, and that it would be most desirable to consider its air traffic control problems from a completely fresh viewpoint

Strong support was given by operators and manufacturers to the suggestion that the helicopter be given the very greatest leeway during the years of development when traffic would not be particularly heavy It was felt that a single helicopter in a given area could operate down to very low minima and that limitations of speed or traffic control could be progressively applied as the amount of helicopter flying increased, assuming that special areas for this type of traffic were provided

In areas where helicopter traffic control does become necessary, it was felt desirable to the fullest extent possible to assign helicopters their own exclusive areas and corridors of manoeuvre It was suggested that they might be given the lowest parts of the air space for their exclusive use and that under instrument conditions they could use the lower instrument flight ranges in which smaller aircraft operate at very much the same speed and which the faster, higher-flying aircraft did not normally use The critical point was felt to be that at which fixed-wing aircraft would cross these lower ranges on their way to landing, and in this case separate approach paths for helicopters and fixed-wing airplanes were advocated

It was felt that when special air traffic control for helicopters becomes necessary, requirements should be kept as simple and flexible as possible Nevertheless, operators felt that they would need sufficient instrumentation and control to allow them to achieve as close to 100% regularity as possible in all services While they were presently achieving 97% regularity in daytime, there was little experience of night flying except in Britain, where night regularity had fallen to 77% during an experimental period

Metropolitan operators expressed a need for greater instrument flight assistance because their regularity must be equal to that of both airplane and surface carriers with whom they make connections Los Angeles Airways asserted that they want "micro-accuracy," which would give them navigation from street to street rather than from area to area

What will be the "alternate" procedures ?

Under present conditions, little need for the use of alternate landing places has as yet been felt, but it was considered possible that when helicopters grow larger and commence passenger operation into city centres, it would become more pronounced In serious enroute emergencies, it was held possible for the pilot to put down in any available space If weather prevented a landing at a rotor station in the centre of the city, it was suggested that the normal major airport near by would be an acceptable alternate, particularly since it possessed communications and landing aids It was pointed out that in international operations the choice of alternates may be influenced by the availability of customs and immigration personnel

What fuel reserves will be required in respect to weather, holding, and alternates ?

It was generally agreed that the I C A O requirement for a 45-minute fuel reserve does not apply to helicopter operations and that this was already reflected in the attitude of the American, British and Belgian governments

As a basic principle, it was felt that it would be best to stipulate the factors which must be taken into account in calculating fuel reserves and to let the operators judge their actual quantities to best fit the requirements under local conditions

What type of air/ground communications are required ?

It was forecast that the basic need for helicopter communications will be a static-free, two-way voice-operated connection between the pilot and the air traffic service on the ground It is likely that VHF radiotelephone can serve this need

Metropolitan operators stated further that their type of operation required "total saturation" or continuous communications, so that they could maintain constant contact with all of the people with whom they connect One American operator asserted that the cost of telephone communication to keep post offices advised of mail pick-up times was already fantastic, and that it had been necessary to install a special transmitter and receiver in a New York skyscraper in order to keep in touch with helicopters

It was pointed out that helicopters will probably have separate communications requirements for air traffic control and for operational messages, and that it might be cheaper and easier to fill these two needs with two different systems

What special means of identification, such as navigation lights, are required for the helicopter ?

There was general agreement that the normal type now used by fixed-wing aircraft are not entirely satisfactory In conditions of snow or sleet, they have created a troublesome reflection in the atmosphere around the pilot's bubble and affected his vision In addition, navigation lights now used are based on the traditional code for ships which, on observation, can be relied upon to be moving in the direction in which they are heading Since helicopters can move in several planes, it was felt that new ways of indicating the possible direction of movement might be required It was also felt desirable that the lighting indicate clearly to another pilot that the aircraft is a helicopter rather than a fixed-wing aircraft

No present solution to this problem was reported, although a number of proposals —high intensity lights, quick-flashing lights, and rotor tip lights—were all reported under further study

What will be the take-off and landing procedures ?

Take-off and landing procedures were felt still to depend very largely on the kind of landing space which will be used At least a number of variations in procedures will be probable The case for the backward take-off during the next few years was strongly urged by European operators They pointed out that if a helicopter were to be able to land again in the case of any engine failure during take-off a very large amount of power would be necessary in the remaining engine to enable the machine to fly around and into the wind and come down However, a take-off facing into the wind, but with a flight path backwards at a very steep angle, would put the aircraft into position to slide easily back into the landing space should there be any power trouble Actual vertical ascent and descent, it was suggested, would require running the engine at very high power and would limit the pilot's ability to see the landing space

In discussing the angles of approach and take-off for helicopter operations, manufacturers suggested that angles up to 45° provided a proper safety margin and were not so steep as to cause any discomfort to passengers The amount of tilt in the cabin of the helicopter under these circumstances would be about the same as that of a fixed-wing aircraft coming in for a landing

Cabin pressurization was not considered necessary for helicopters, at least during the next six or seven years It was pointed out that the rate of descent on landing would average about 200 feet per minute and that elevators in New York skyscrapers drop as much as 1,000 feet per minute without any need for pressurization The point being that a high rate of descent can be accepted if the total change in height is only a thousand feet or so

Manufacturers suggested that it was possible to render the cabin almost air-tight in normal construction and that this feature would minimize the effects of descent

Helicopter approach speeds will probably vary to some extent according to type, and while it was held impossible to generalize, it was felt that 40 to 60 m p h would be normal, this being flared off at the final stage for an almost stationary landing

The helicopter was seen to have excellent characteristics for landing in strong cross winds and no particular problem could be foreseen in this direction as the aircraft could trim into wind, if necessary, for the final touchdown Scandinavian operators were particularly interested in helicopter reactions to down-draughts and heavy gusts which might be encountered in the mountainous fjords area of Norway, and were assured by Canadian helicopter operators already flying under similar conditions that their equipment had never experienced a down-draught which brought its pilot anywhere within range of being in trouble These down-draughts had been encountered as high as 8,000 feet pressure altitude with a 9,000 to 10,000 feet density altitude It was felt that the ability of the helicopter to withstand gusts and down-draughts was largely a question of power and rotor solidity plus an appreciation on the part of the pilot of where to expect a down-draught

A definite need was seen by metropolitan operators for better weather forecasting for their kind of operation They consider present arrangements extremely inadequate and are attempting to develop new criteria Their requirements will probably

include a need for forecasting smoke conditions in urban areas European operators have not encountered any forecasting difficulties, but felt that in future they may want more detailed forecasts on local conditions for certain elements

Some helicopter operators have already experienced icing conditions, but it was reported that good progress has been made in both electrical and thermal de-icing

What navigational aids will be required for helicopters ?

These were considered to be relatively simple under contact flying conditions In instrument flying weather, however, European operators asked for an over-all coverage at low altitude and simple presentation of data which could be easily read by the pilot alone, since they foresee operation by a one-man crew They would prefer light-weight equipment, whose accuracy would increase as the helicopter approaches its landing point The general opinion was that most existing aids may not be adequate but B E A reported DECCA shows promise and is capable of further development

For metropolitan operations, carriers wished a high degree of versatility which would, in effect, simulate visual conditions at all times Like the Europeans, they felt that point-to-point navigation on inter-city routes would present only a very small problem, but that navigation between many points over a grid route in an area of 100 to 150 miles might require something in the way of radar pictorial display

What kind of electronic approach aids are required and how simple can they be kept ?

The electronic approach aids necessary were felt to depend to a large extent on whether it will be possible to make straight-line approaches to landing or to fly a prescribed approach pattern, the requirements being much simpler in the former case A substantial limiting factor would be the expense of installing, maintaining, and staffing electronic aids at the large number of landing places which are implied, particularly in metropolitan operation It was reported that certain navigational aids had been tested for this purpose and had not been entirely satisfactory, and the cheaper form of talk-down radar had been found highly dependent on the kind of landing site and its surroundings VHF talking beacons, while simple and omni-directional in nature, were felt to be insufficiently accurate for landing purposes A British electronics manufacturer reported that it is working on an approach meter which would give the pilot necessary information on height and approach by integrating his altimeter and a decometer, this system having the advantage of not requiring ground equipment at the heliport Generally speaking, it was felt that existing radar systems were not applicable to helicopter approach problems in the present state of the art It was considered that the ideal approach aid for helicopters would be one which offered a high degree of reliability , which was self-monitoring with, perhaps, an additional check by means of a fan marker or other cheap aid , which was easy for the pilot to fly , low in cost , and which required no ground staff to operate it

What visual aids are required and how simple can they be kept ?

Prospective inter-city operators considered that it might be advisable to give a helicopter something like normal approach lighting when operating under conditions as low as 200 yards and one-quarter mile visibility They pointed out that a distinctive form of lighting would be desirable in order to eliminate possible confusion with normal background illumination in built-up areas

Metropolitan operators said that they were using no special helicopter lighting for their operations at the present time, and that their current needs were being met by the use of a rotating light beacon on the heliport itself or by the use of " scotch light " or reflecting paint on the landing areas These measures were not felt to be entirely satisfactory for all weather operations and investigation is being carried on into heliport and obstruction lighting

In the U K , some success has been achieved by the use of a circular system of approach lighting which assisted the pilot to determine his horizon and gave an indication of his angle of approach The landing surface had been painted in a checkerboard pattern, both for identification and to add " texture " to the surface during landing

It was pointed out that visual aids were desirable both for identification purposes and to provide the pilot with references for approach and landing

What will be the turn-around procedures ?

Carriers planning inter-city services estimated that they might be able to hold to a turn-around time of 5 to 7 minutes for 20-seat helicopters and 8 to 10 minutes for 40—50 seaters, including all necessary fuelling and services This was on the assumption that rotors would continue to turn, that there would be entrances and exits at both ends of the vehicle and that passengers would carry their own bags

Metropolitan operators felt that time was a particularly precious advantage in their services and that they intended to load and unload their vehicles in the same manner as urban buses, with no reservations and with the simplest type of bus ticket arrangements

Both types felt that they would need helicopters capable of indiscriminate loading —*i e*, vehicles in which no possible passenger or cargo arrangement would put the centre of gravity outside acceptable limits

Operators of international services desire to hold the usual traffic handling and frontier documentation procedures to an absolute minimum They hope to be able to satisfy all government requirements with a single flight document

A British manufacturer suggested that if weight considerations were particularly critical, it might be possible to install integrated weighing scales at the front and back entrances of the helicopter in order to provide instant weight computation An American operator said that it had already considered a turn-stile which provided automatic weight registration A free baggage allowance of 10 kilograms is under consideration for inter-city European services, but it was felt that the requirement the passengers handle their own baggage would in itself probably act as a limitation For the time being, it was felt that normal gravity refuelling would be satisfactory for helicopter operations and that pressure fuelling would not be necessary until helicopters attained larger size or used turbine power extensively Suggestions for cartridge refuelling by changing empty tanks for full ones were made, but it was felt by some operators that the trouble inherent in breaking fuel line connections outweighed the possible advantages The economic problem in refuelling, it was felt, was the relationship between the weight of fuel carried on board as against the necessity for maintaining ground fuelling installations

While some operators felt that it would be desirable to be able to fold rotor blades in order to park their helicopters in small landing spaces and thus minimize the parking problems that appear possible, manufacturers warned that the weight of power folding machinery installed in the rotors, or the wages of staff which would have to be maintained for manual folding, might be quite high

4 Helicopter Requirements (Design Characteristics)

To what extent can single-engine helicopters be operated on passenger service ?

All present and prospective operators were agreed that it is possible to operate single-engine helicopters in passenger service during daylight hours under certain weather minima, provided that the pilot has emergency landing available to him at all times Metropolitan operators felt that with higher minima, they can also operate safely at night, at least in the well-lighted metropolitan areas Inter-city carriers, however, pointed out that they would be required to fly over broken and unlighted terrain where pilots could not see emergency landing spaces It was felt that the terrain of most U S cities provided adequate available landing space for single-engine operations around the clock, but the same conditions were not geld to exist in many parts of Europe

What are the preformance requirements for multi-engine helicopters with all engines operating ?

Operators were generally agreed that they would like to have speeds of not less than 100 m p h at 50% to 55% engine take-off power for reciprocating engines and 65% to 70% of maximum power for turbines They also wished a hovering ceiling of at least 5,000 feet with a vertical climb rate of 500 to 600 feet per minute on a standard 59°F day These requirements would apply to a helicopter with a seating capacity of 30—40 passengers in the first stage

What are the performance requirements with one engine inoperative ?

There was considerable difference of opinion among operators and regulatory authorities as to specific requirements under this heading, and manufacturers emphasized their own need for a strong indication of what is desired, as they considered that

the requirements under this heading would be fundamental in determining the economics of helicopter operations

European operators felt that they wished a minimum rate of climb of 200 feet per minute at all altitudes up to 5,000 feet, at the best forward speed and with the remaining engine(s) at maximum continuous power

American operators stated a wish for hovering ability up to and during the critical part of the ascent together with a rate of descent which would ensure an undamaged machine They also wished to retain a cruising speed of about 160 m p h to 170 m p h under these conditions They added that with the kind of engines presently available, these requirements would indicate two possible sizes of helicopters, one seating 35 to 40 passengers, and the other 45 to 55

Other determining factors in this phase were the size of landing space at present and whether or not pilots would follow forward or backward take-off patterns Manufactorers asserted that it would be possible to build a machine embodying any characteristics which were desired, but warned that the costs might be inordinately high in some cases

What are the performance requirements for safe landing with total loss of power ?

It was felt that this constituted an emergency procedure and that it should be possible for the helicopter to make a fixed-wing aircraft type landing in any suitable open space at an approach speed of about 50 m p h and a landing speed at a figure less than 25 m p h

What are the performance requirements for stability and control ?

It was reiterated that helicopter control is good at all speeds Manufacturers pointed out that the stability characteristics of the helicopter have become equal to those of the fixed-wing aircraft at speeds higher than 35 m p h , but not as good below

There was considerable discussion as to whether or not carriers would wish to have a high degree of stability during hovering, and whether they would wish to employ an automatic pilot While a specific reply to this demand could not be formulated, it was felt that carriers would not be too concerned about the mathematical degree of stability so long as it was reasonably easy to hover without an automatic pilot and without putting too much strain on the pilot under instrument conditions

Instrument manufacturers pointed out that necessary improvements in instrumentation of helicopters and the probable requirement for power boosters on controls would automatically give the helicopter two of the three elements of the autopilot in any case Operators felt, however, that they could not accept autopiloting under instrument conditions unless it was possible for the pilot to take over at any time

What are the relative advantages and disadvantages of reciprocating engines, turbine engines and jet tip propulsion ?

A discussion of this question indicated that few conclusions could be drawn until a considerable operating experience of all three types of propulsion could be had

What consideration must be given to noise ?

Noise considerations were among the factors which were considered to have a substantial determining effect on the operations of the helicopter, since excessive noise might restrict their city-centre operation, and the measures necessary to reduce noise might constitute a weight penalty Government representatives warned that unless noise levels could be held down, many locations which would otherwise be ideal for heliports would be denied to operators

The control of internal noise in helicopters was considered reasonably easy to achieve by normal sound-proofing Desirable internal noise maxima suggested were 87 decibels in the 75—150 octave band, and 55 to 65 decibels in the 1200—2400 c p s band

European operators reported that they had had few complaints about external noise with the helicopters now in use and recommended 90 decibels at a distance of 200 feet as a desirable maximum criterion

Government spokesmen pointed out that complaints about noise seemed to begin when the noise level of the helicopter reached a point 15 decibels above background

noise and expressed a preference for a maximum criterion of 75 decibels at 150 feet for daytime operation and 55 decibels at the same range at night

Manufacturers said they were well aware of the noise problem and were working hard to find some means of reducing it It was pointed out that it might not be necessary to reduce noise, but to change its frequency by the use of silencer devices A metropolitan operator suggested that a compromise might be necessary whereby less weight would be devoted to internal soundproofing and the weight used for the installation of external mufflers, which would kill two birds with one stone

Is a single main rotor preferable to a multi-rotor system ?

It was felt that there was no categorical answer to this question, that there will be a role for both types and that this will vary with the circumstances of equipment and operation

Is a conventional wheel type of undercarriage necessary ?

While manufacturers suggested that there would be some economy in weight and in stress on rooftop heliport surfaces if operators could replace wheels with floats or skids, the carriers felt that wheels were necessary for easy ground handling of equipment

What should be the specifications of helicopter cabins and what should be the standards of comfort ?

Operators agreed that they will want cabins which can be easily convertible for use for either passengers or cargo, or for varying combinations of the two There was also general agreement that helicopter passenger accommodations in inter-city machines would approximate those of present tourist class aircraft—with a 36 inch seat pitch and 17 inch seat width—while those of metropolitan services could be of the bench type resembling street cars

In both cases, it was felt that seats should be made of light weight alloys and reinforced plastics and that arm rests and cushions be dispensed with wherever possible in order to conserve weight Canadian and American government agencies indicated this was acceptable It was generally agreed that seat belts would continue to be necessary, although there was no agreement on the required strength of these belts British authorities required that they bear 4G forward stress and 5G lateral stress, but the matter is still under investigation in the U S

It was generally agreed that for quick turn-around, passenger helicopters should be equipped with exits at front and rear, while it was further suggested that one or more doors be provided in each side of the passenger cabin, together with hatches at the bottom Built-in steps were accepted generally

While there were no definite figures put forward as to an acceptable vibration criterion for passenger comfort in the cabin, it was suggested that a good target would be an amplitude of not more than 035 inches at a two-cycle per second frequency and 003 inches at a 20-cycle per second frequency

Helicopters will require the same heating and ventilating arrangements as fixed-wing aircraft, but no pressurization, it was felt

Provision of the largest possible windows was considered desirable These would serve the important requirements of sight-seeing service and would have a better psychological effect on passengers

Toilets were held to be necessary for inter-city services but not for shorter metropolitan routes

Inter-city operators expressed a wish for removable type of galley

No desire for individual seat lighting was registered, although a requirement for adequate over-all cabin illumination was voiced

It was stated that airsickness is less likely to occur in helicopters than in fixed-wing aircraft Large windows would contribute to reducing airsickness, it was said, because the psychological aspects of the malaise are less if the passenger can see the horizon or another fixed point

It was pointed out that operating and economic characteristics would be decided in some part by the angles of take-off which operators felt would be sufficiently comfortable for their passengers The discomfort of take-off would probably be little, it was suggested, even at steep angles and with quick acceleration, since this part of the take-off process would last only a few seconds at most

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What should be the cockpit layout ?

Although operators wish to have a single pilot whenever this will be consistent with safety because of the short flights generally involved, it was acknowledged that co-pilots will be necessary on some occasions with the smaller machines and very often in larger ones It was therefore considered that dual instruments should be provided, each group fully readable by a single pilot

The basic group of flight instruments in the cockpit, it was suggested, would consist of a vertical speed indicator, an artificial horizon, a rotor and engine speed indicator, an altimeter, a directional aid and an airspeed indicator Recommendations were made for other instruments which might be helpful to the pilot, including backward and lateral speed indicators and additional R P M indicators for rotors and engines in multiple-engined machines

What should be the maintenance characteristics ?

Operators asserted strong desires for the utmost simplicity and ease of maintenance, including easy interchange of engines and other components and the greatest possible accessibility to any parts which might require repairs They pointed out that stream-lining was not as necessary in helicopters as in fixed-wing aircraft—if, indeed, it was necessary at all—and urged that the interior be arranged for the convenience of the passenger and the exterior for the convenience of servicing and maintenance A metropolitan operator urged that manufacturers break entirely with fixed-wing practice and consider the helicopter as an entirely new machine on its own merits Among the few specific requirements mentioned was a stipulation that it be possible to accomplish an engine change in no more than two hours as the total time of a machine being out of service

Are external power sources acceptable for starting purposes ?

Operators felt they would be, but that it would always be necessary to provide enough battery power in the helicopter to permit self-starting, particularly at heliports which will not have a great deal of ground equipment It was pointed out that this would be more difficult when turbine power is used

5 Heliport Requirements

Is it possible to standardize on one word that will signify an area used by helicopters for take, off and landing e g , heliport, rotorstation, airstop, helidrome, etc ?

Such agreement was considered convenient, rather than necessary The preference of the symposium was narrowed down to " heliport " and " rotorstation," with the considerable majority favouring the former because it remains the same in English and French (It was pointed out that the first syllable in " heliport " is pronounced " hell " and not " heal ")

When operations into city-centres are contemplated, should the city be served by a central heliport capable of handling a number of small heliports located around the metropolitan area ?

This was held to depend upon local circumstances

How close will it be possible to site heliports to one another in view of traffic control limitations and collision hazard ?

This question was felt to be impossible to answer with certainty because of lack of sufficient operating experience If straight approaches from different directions are involved, it may be possible to site heliports very close together Special minima for such close-by landing spaces might not be needed in contact weather, but might be necessary under instrument conditions

What requirement is there for emergency landing locations where helicopters are operated over built-up areas ?

Single-engine helicopters presently skirt these areas and do not fly over them to any extent With multi-engined types, possessing one-engine-out performance, the helicopter will not need emergency landing areas, but will be able to sustain flight to the regular landing place

Bearing in mind the previous discussion of performance requirements and take-off and landing techniques, what is the requirement likely to be with respect to take-off and landing area dimensions ?

Statements of actual and prospective needs for helicopter take-off and landing space varied within up to a limit of 300 × 300 feet, which was cited by European inter-city operators as their preference It was admitted that prtt of this space is to permit parking a helicopter previously landed U S civil studies have resulted in a criteria for minimum space of 50 per cent more than the diameter of the rotor, while in military operations, the standard for open field spaces is twice the rotor diameter, or in current practice, a circle of 250 feet diameter

Metropolitan operators in the U S felt that their requirements are limited by the fact that they must land in the middle of cities in order to exploit the characteristics of the helicopter, and by the dimensions of the average city block They are therefore planning to use landing areas about 200 feet square In New York, plans are being made for a heliport which would incorporate two such areas, one for take-off and the other for landing, together with an intervening area for administration and passenger handling within a single block

It was stressed that these dimensions, together with the characteristics of the approaches to these heliports, would constitute limitations in which manufacturers would have to build their machines and would determine economic characteristics to a large extent

Manufacturers had no particular comment on heliport sizes, since they felt that machines could be designed to fit any requirement If operators wished to have hovering power with one engine out, they would need no more landing space than that required for their wheels , while with any decrease in this critical power, the area requirement would grow

What ramp space and parking facilities are likely to be needed for important traffic centres and for secondary traffic centres ?

While it was felt that every location will present a different set of conditions, metropolitan operators were of the opinion that their heliports should be expected to provide only minimum space for parking For inter-city operators, who might be holding numbers of helicopters for flight departures, more praking space might be necessary

In this connection, rotor-blade folding was again advanced as a possible means of saving space The down-wash from turning rotors was mentioned as a possible source of harm to parked helicopters, but it was reported that low baffle walls were an adequate safeguard

What is likely to be the movement rate for any one heliport ?

Metropolitan operators felt that they should be able to handle three helicopters at a time at their heliport—one landing, one loading and one taking off—and saw nothing to prevent take-offs at one-minute intervals Under instrument conditions this rate would be slower To a large extent, it was felt that the interval might be determined by the time necessary to load and unload the aircraft in the small landing area, rather than by any air traffic considerations

What limitations must be placed on obstructions in respect of angle of clearance, turbulence and visibility limitations ?

These limits were also regarded as important in determining the economics of helicopter construction and operation It was felt that limitations on helicopters would be less stringent than those affecting fixed-wing aircraft European experience has indicated a general requirement for one foot of clearance for every two feet away from the edge of the heliport , U S regulatory opinion favours more severe limitation of one in ten

It was stated that turbulence, particularly in city centres, would affect the helicopter in much the same way as normal aircraft, but that it was not a serious problem for the pilot Experience in Europe had made it necessary to discontinue operations out of a ground-level heliport in cities when winds reached a velocity of 35 m p h or more, a fact which was cited as arguing for rooftop heliports

Should refuelling, maintenance, minor or major repairs, overnight stops, be done at heliports, or should these be done at other sites outside the built-up area ?

The necessity for occasional refuelling and minor servicing on rooftops was generally conceded, although the fire hazard involved in handling of fuel might make some present buildings unsuitable for use However, it was pointed out that heliports located on the roof of parking garages for automobiles should not create a problem as the building would already have a fuel supply in it

Suggestions were made that tanker helicopters be used for delivering fuel to rooftops, and that retriever, or crane-type helicopters could be put into service to take away damaged machines

What type of refuelling facilities are preferred ?

It was felt that until more operating experience had been had, mobile tankers would be preferable to fixed-point fuelling facilities

Should the heliport be at ground or at rooftop level ?

Turbulence troubles at ground heliports in built-up areas were acknowledged, but it was suggested that these would disappear when multi-engined helicopters are introduced Advantages of rooftop operations, it was said, were their elimination of high ground costs, their comparative freedom from nuisances, and the fact that they provide the pilot with ready-made altitude

At the same time, the opinion was also voiced that buildings of only three or four stories would be preferable for heliports, since they were low enough to enable the pilot to come in under the weather If owned or operated by the carrier, the building might also produce revenue from its office floors

In advising constructors of the main design features needed for heliport, what features should be emphasized ? For example, how strong should the roof be, what type of surface is required, etc ?

No particular difficulty in using rooftops for existing operations was reported, although it was said that mails were not now being carried directly to the main post office in New York because its roof requires strengthening at a substantial cost

Planning of future operations have shown it to be quite practicable to strengthen roofs of many existing buildings One specification calls for reinforcing the roof to withstand 4G vertical stress and 3G lateral stress, a provision which some operators considered extremely generous It was pointed out that the main stress comes at the touchdown point, rather than on the whole roof area Some suggestions were made that if helicopters could use skids instead of wheels the weight would be more widely distributed, but operators indicated that the losses in ease of handling would more than counter-balance the gain Cost estimates for strengthening roofs of three existing buildings for heliports were cited in two cases, only 2 per cent was added to the over-all cost, and in the third, 10 per cent

By whom should heliports be owned and operated ?

In European practice, it was felt that ownership and operation might vary in different cases, and that there would be many variations of private, airline and government participation In U S experience, some operators have been forced to provide their own facilities, but were anxious to make them self-supporting Elsewhere it had been found that communities recognized the value of their service and were willing to furnish the minimum necessary facilities American operators felt generally that heliports should be locally owned and financed by local authorities, but it was acknowledged that the operator might have to take a hand in certain cases

How are ground communications and navigational facilities to be provided ?

Some carriers now provide these services themselves, but it was felt that these should be provided by government authorities as in the case of fixed-wing aircraft In some countries, carriers having their own ground communications facilities could use them for their helicopter services as well

6 Personnel

Should crews be retained solely for helicopter operations or should they be transferable to fixed-wing aircraft ?

There was universal agreement by operators that helicopter crews should be

kept solely on helicopter operations European carriers stated that they wanted helicopter pilots to have between 500 to 1,000 hours of fixed-wing experience, of which at least 300 hours should have been spent in mail operations American operators said they would like between 750 to 1,000 hours experience on fixed-wing aircraft and that, moreover, they would require pilots to keep up their instrument ratings In general, transport pilots were preferred on the argument that " there is no substitute for experience "

What classes of helicopters are needed to train pilots from the ab initio stage to the transport class of aircraft ?

Operators were generally agreed that pilot training should begin with the more elementary types of helicopters before they were transferred to the future transport types Training on present small types of helicopters in service was regarded as the ab initio stage

In a two-pilot helicopter, should the captain sit on the right-hand side of the cockpit, as has been recently adopted for U S and U K military helicopters, or should the conventional left-hand captain's seat be retained ?

This appeared at present to be one of the most contentious questions in the symposium and was largely unresolved American operators, especially military, explained that because of rotor movements an unstable helicopter generally tends to tip over on its left side Hence, the pilot and the door were placed on the right so that the pilot could extricate himself in case of an emergency One manufacturer contended that the pitch controls of a helicopter are placed so as to make it mandatory for a pilot to sit on the right side Moreover, dual control also favours the continuing arrangements of the pitch controls in the positions they now occupy A European manufacturer, however, argued strongly for placing of the first pilot on the left side of a helicopter cockpit, especially in the case of the design of coming multi-engine transports Considerable history was related on the reasons for the seating of pilots on the left side in fixed-wing aircraft The most important reason for left-side seating appeared to be that from pioneer days of multi-engined aircraft pilots held the flying control in their left hands which left their right hands free for the throttle and other supplementary controls of an aircraft

7 Passenger Handling

Can ticketing be made as simple, say, as railway standards ?

This was considered feasible for domestic operations, but it was pointed out that the requirements of the Warsaw Convention affecting liability made it necessary to enter on international tickets the cities of origin and destination, the dates of flight, the passenger's name and the conditions of carriage of the airline The hope was expressed that these stipulations might be simplified

Can reservations be relaxed to railway standards ?

While all operators felt that they would at least begin their passenger services on a reservation basis, they hoped that it would not always remain necessary One European carrier asserted the principle that seats should only be reserved by the payment of an extra charge Metropolitan operators expressed the hope that they could dispense with reservations entirely once they achieved sufficient frequency and capacity It was stated, however, that railway experience had shown that service without reservations had a tendency to reduce loads

Can loading documentation be simple and largely undertaken 'on board' ?

It was hoped that in international operations only one sheet, which would include the loading data, would be required, and that this could be completed in flight by an attendant

Can baggage be largely carried by passengers ? And what will be the requirements for passenger handling personnel at heliports ?

It was generally thought that passengers would carry their own baggage, although personnel would have to be maintained at some points to make certain of the proper transfer of baggage from connecting services In this discussion, it was pointed out that stowage space for passenger's baggage when they carry their own is usually greater than the amount required for checked baggage in an aircraft hold

Is a flight attendant necessary ?

This discussion was broadened to include the question of co-pilots, whom all carriers felt would not be needed until larger helicopter types are introduced At that time, inter-city operators felt that co-pilots will be needed, but metropolitan carriers felt that the short stages of their service would eliminate their necessity

While metropolitan carriers are already carrying attendants, for mail handling, European operators felt that they would not be necessary until bus size machines come in At that point, however, the attendant will be more like a railway conductor than the usual flight steward

In the U S , it was said that the flight attendant will also act as " an extra pair of eyes " in the co-pilot's seat Government regulation does not require a co-pilot for the helicopters presently in use, but regional officers have the authority to demand such an extra aid by a flight attendant if they feel that air traffic conditions warrant In such cases, the attendants are checked out on some of the simpler functions of the co-pilot, such as radio operation

How are customs and immigration formalities to be handled ?

It was agreed that international helicopter operations would create a greater need for facilitation activity by the airlines aimed at the reduction of red tape European operators suggested that it would be particularly important to insist that helicopters be given the simple kind of treatment accorded buses and trains, rather than be subjected to the more stringent requirements imposed on fixed-wing operations

8 Economics

What are likely to be the economic characteristics of helicopter operations ?

European operators felt that circumstances dictate that they concentrate on passenger operations primarily They estimated that the economics of the inter-city helicopter bus service which they hoped to run would be about the same as those of DC-3 fixed-wing services They felt that they might lose money for several years, but that the services would eventually become profitable

Metropolitan operators reported that their costs were in the range of local feeder service operators in the fixed-wing class, but that they were limited for the time being by the lack of adequate navigation facilities and weather information One operator stated that his utilization rate is now about 8 hours per day and he hoped to extend this to 10 or 12, depending on whether new machines can be made more easily accessible for repairs and component changes

All operators, present and prospective, were agreed that they had a particularly valuable service to render to the public for which premium prices could be charged In Europe, it was estimated that the cost of helicopter transport will be as high, or possible somewhat higher than the combination of present first-class air fares and city-to-airport limousines on a given route In the U S , metropolitan operators indicated that they might use a tapered fare structure Where their services covered routes competitive with taxis, they might charge the same fares of 25 to 35 cents per mile, while on longer routes the charge might go down to 10 cents per mile At the same time, however, it was felt that convenience, rather than cost per mile, may well be the determining factor in setting fare levels

It was pointed out in addition that passenger helicopters would have other sources of revenue, such as sight-seeing, which were not available to fixed-wing services

In discussing future costs, manufacturers pointed out that as helicopters grow larger, the comparative weight of rotor blades and transmission gear increases considerably at the cost of payload It was suggested that the optimum economic weight of a helicopter using gear transmission is between 20,000 and 60,000 lbs gross weight and that operators might be well advised to keep their equipment within this limit

Is the existing formula for deriving aircraft operating costs broadly applicable to helicopters ? What are the main differences, if any ?

It was felt that there was not yet sufficient experience with helicopters to develop a separate formula for their costing, although it has already been necessary to overhaul the Air Transport Association formula as regards maintenance and overhaul

Operators in the U S have found that their ratio of man-hours of maintenance and overhaul to hours of flight is now running at about five to one, and hope that

this will be reduced to four to one when larger helicopters are introduced

Higher costs, however, have been found in the maintenance of transmission, rotor heads and rotor blades, due in part to design changes It was suggested that a fundamental characteristic of rotor aircraft would lie in the fact that the helicopter will likely wear out several sets of gears and transmissions during its operating lifetime, although it was not yet possible to say how long its operating life might be Some concern was expressed about the fatigue life of helicopter components, especially rotor blades U K regulations on this point are presently severe, it was said, and are not likely to change until a large body of further operating statistics indicates that an extension is possible

Both users and manufacturers suggested that fineness of design and lightness of parts, while they might make for greater initial payload, do increase maintenance costs

There was a general feeling that much more requires to be known about the economic, operating and maintenance characteristics of the transport helicopter and that this could only be gained through actual experience It was therefore suggested that governments might sponsor a programme of accelerated service testing of prototypes in simulated airline operation The suggestion was given broad support by all participants

How is the approximate initial cost of the transport helicopter likely to compare with that of a fixed-wing aircraft of similar capacity ?

It was pointed out that there is more machinery in a helicopter than in a fixed-wing aircraft Initial cost of rotor aircraft will likely be higher in early stages than their fixed-wing contemporaries, especially when few units are produced, but the cost differential may come down as production gains in volume In computing these costs, it was stated, airframe and engine and installation costs are about the same as for fixed-wing, while gearbox and transmission have the same cost per pound as engines and rotor blades cost about the same per pound as propellers

How should helicopter insurance rates compare with existing rates for fixed-wing aircraft——airframe, contractual and third-party liability ?

It was generally agreed that helicopter insurance rates are higher, largely because there are so few operators as yet in the business to provide good actuarial data At the same time, rates are subject to strong fluctuations as the result of a single accident

It was hoped that rates will eventually be lower than those for fixed-wing aircraft, especially when multi-engined helicopters are introduced, because the risks attendant upon take-off and landing will be further diminished

Operators agreed on the desirability of exchanging insurance data

9 Regulatory Aspects

What governmental regulatory steps should be taken in order to ensure the maximum development consistent with safety of the helicopter itself and of its operational procedures ?

Government agencies reported that they are now in the course of studying and producing requirements for helicopter operations, but that considerably more work must be done before they will be in a position to circulate these requirements

Both manufacturers and operators reiterated their hope that these regulations would be based on the characteristics of the helicopter itself and would not be arbitrarily carried over from existing regulations for fixed-wing aircraft

10 General

What is the over-all picture with respect to safety ?

The helicopter has had a higher accident rate, but a lower fatality rate per accident, than conventional aircraft With twin-engine operation, it was felt, the accident rate will be considerably reduced

What minimum amount of mail or cargo accommodation should be required in passenger-carrying helicopters ?

There was general agreement on a minimum provision of 1,000 lbs , or alternatively, 150 cubic feet, of space reserved for mail and cargo compartments on passenger helicopters