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HELICOPTERS

> This new vehicle costs too much for everyone. One estimate of initial and maintenance cost for six months is $5,500. It is unsafe, has no utility, is difficult to operate and expensive to run. There are no adequate service facilities, the insurance costs are extremely high, and there is a most undesirable noise factor. It is practically useless at night and cannot be used in bad weather. Moreover, it compares miserably with the relative cheapness of existing methods of transportation.
>
> (From a 1907 newspaper article about the automobile)[1]

In 1953, ASPO published Planning Advisory Service Information Report No. 52, Heliports in the City Plan, in a climate of general optimism concerning the role of rotary-wing aircraft in the nation's transportation system. The optimism turned out to be premature: the expectations linked to the helicopter and the anticipated need for landing sites have not been fulfilled in the intervening years. Rather, the helicopter has often been considered a special-purpose, somewhat esoteric, vehicle of limited use to the average traveler and a remote problem to regulatory agencies. While the main obstacle to its development was high cost, it is tempting to speculate that the generally negative attitude in itself stymied the growth potential of the helicopter. Public indifference, lack of familiarity with the operating characteristics of second-generation turbine-powered equipment, and resultant unreasonable constraints imposed on its use may have prevented the helicopter from reaching the scale of operations necessary for economic self-sufficiency. By far the most critical of these restrictions is its virtual exclusion from downtown areas:

> The helicopter cannot serve effectively if it is limited to edge-of-town heliports, for example, but must have landing areas located near the actual origins and destinations of traffic. This fact means that heliports, whether for private, commercial, or airline use, definitely will be needed in certain of the congested and highly developed areas of a community.[2]

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[1]This and subsequent references are listed at the end of the report.

Prepared by Leopold A. Goldschmidt.

The present report was prepared with the expectation that, in spite of birth pains and development problems, the helicopter will come of age as a significant element in future overall transportation systems. Regardless of how much the industry grows, however, helicopters warrant public consideration. This report therefore seeks to alert public officials to some of the problems associated with helicopter operations and to suggest guidelines for appropriate regulations and controls.

BACKGROUND: A STATUS REPORT

In overall use applications, the growth of the helicopter during the past ten years has been substantial. Even discounting the sometimes over-enthusiastic reports by the helicopter industry, the available evidence indicates solid improvements in rotary-wing aircraft utility and productivity. The industry itself reported an increase in the number of non-military helicopters from 936 in 1960 to 1,767 in 1964, and an increase in helicopter operators from 318 in 1960, to 710 in 1964.[3] The number of manufacturers increased from 9 to 17 in the ten-year span 1953-62, and in the last year of this period the industry delivered vertical lift aircraft and services in an amount totaling $340 million, the military services accounting for 88 per cent. The active inventory of the Armed Services was estimated at 5,000 helicopters at the end of 1963.[4] The number of landing facilities witnessed a similar increase: an industry publication enumerated 797 facilities (heliports and helistops) in 1963 compared to 327 in 1960, with an additional 69 sites proposed.[5] The use of these facilities is, of course, subject to considerable variation, and there is evidence to suggest that some of the listed landing sites are no longer in service; at other heliports, traffic volume is large and increasing, as indicated in a 1962 report by the planning director of Los Angeles:[6]

> . . .in July of this year the number of helicopter operations at Los Angeles International Airport amounted to 7,877, which is a 255.9 per cent increase compared to the same month in 1961. A recent unofficial count at five airports. . . showed helicopter operations reaching nearly 15,000 in one month. This does not include uncounted operations at the many heliports and helistops in this area.

The growth rate of scheduled passenger service, while limited to four metropolitan areas, has been equally impressive. The first of the carriers, New York Airways (NYA), was certificated in 1952, commenced service in 1953, and has expanded steadily since then to 255,000 passenger originations and over five million revenue passenger miles in 1963. Los Angeles Airways (LAA), certificated in 1947, inaugurated service in 1954 and grew slowly through 1961, but then doubled both passenger originations and revenue miles in each subsequent year, reaching 149,000 passengers and almost six million revenue passenger miles in 1963. The record of Chicago Helicopter Airways (CHA), which started passenger operations in 1956, is the most startling, being both spectacular and depressing and epitomizing in a sense the hazards confronting the industry. With the fastest growth rate of any scheduled carrier, CHA attained a level of 309,000 passenger originations in 1960, only to see its volume

dissipate under the impact of two events, both of which were beyond its control: the closing of Midway Airport and the opening of the Kennedy Expressway, the latter providing "door-to-door" ground access to the city's only remaining major airport from its downtown. The fourth scheduled carrier, San Francisco-Oakland Helicopter Airlines (SFO), began scheduled service in 1960 and a year later reached a level of 10,000 passengers per month.[7]

While the growth of scheduled passenger services has been substantial, it should be recognized that, except for SFO, it was achieved only with the benefit of government subsidies and that it in no way measured up to the exuberantly optimistic forecasts made in the early 1950's. In a 1952 study, for example, the Port of New York Authority predicted two million helicopter passengers in the New York-Newark Area in 1960[8]: the 1960 total was only 142,000. Nor is expansion of scheduled service to other cities likely within the immediate future, in spite of recent applications to the Civil Aeronautics Board from several metropolitan centers such as the Washington-Baltimore area. The high level of federal subsidy payments to three of the four scheduled-service carriers, amounting to $10.90 per passenger carried in 1963, undoubtedly limits federal enthusiasm for other ventures, unless economic feasibility can be proved to the government's satisfaction. In fact, even the survival of the present carriers in New York, Chicago and Los Angeles is jeopardized by the President's recently announced intention to discontinue all subsidies at the end of 1965. It seems unlikely that either of them can duplicate the San Francisco feat of non-subsidized operation. SFO, of course, faces less competition from ground transportation between airports because of the San Francisco Bay configuration and apparently receives aid from private sources.

To date, scheduled passenger service accounts for only a small percentage of total helicopter operations, although it has received most of the attention and may potentially be the most significant application. Only about 20 helicopters, little more than one per cent of the total, are flown in scheduled passenger service in the United States. Excluding military helicraft, over 98 per cent of the helicopters in use are operated on a private or hire basis, and more than 90 per cent are the small two-, three-, or four-seat machines. Some of these serve as air taxis -- rapid non-scheduled passenger service in densely populated areas, designed primarily for people for whom the time saved compensates for the high cost. The majority of helicopters are engaged in a multiplicity of other functions: they are used as ambulances and for rescue work; for agricultural tasks, such as dusting, spraying, seeding and fertilizing, for air-survey work and air photography; for ground traffic control and reporting; and for patrol and surveillance. In the performance of these tasks, the helicopter has demonstrated its versatility and maneuverability.

While the helicopter has varied uses, the scope of urban helicopter operations has not lived up to expectations. Recent ASPO inquiries to several major cities elicited responses which indicated limited activity and at times a declining need for helicopter facilities and services:

Minneapolis: A helistop was constructed on the roof of one of the major downtown stores but has never been put to use.

Seattle: The use of existing helistops within the Seattle area is diminishing. There are some eleven locations

within the city limits listed as, or known to be, helistops. Of these, only about three in the central area are, or have been, used with any frequency.

Denver: Except for the municipal airport, the city and county have very few heliports.

Portland, Ore.: Only one heliport has been established within the city limits.

Richmond, Va.: A location was approved ten years ago on the edge of the CBD, but service was never initiated.

Pittsburgh: The only application was made in 1962 for a heliport on a floating barge tied to a wharf in the downtown area. The facility was approved, but is no longer in operation.

Fort Worth: The city owns and operates a heliport located about one mile from the CBD. All airports have helicopter pads for occasional use.

Kansas City, Mo.: The Kansas City Power and Light Co. has a ground heliport alongside one of their power plants. Another firm is contemplating a rooftop heliport, but has been using a ground strip.

Miami: Three heliports exist within the city limits: Watson Island (city-owned park); the Medical Center; and a U.S. Coast Guard facility.

Peoria, Ill.: The Peoria Journal Star has installed a rooftop "heliplex" on its newspaper plant, with hangar, operating deck and landing platform.

Only on the West Coast have helicopters become part of the transportation system to an appreciable degree. San Francisco has the country's only nonsubsidized scheduled service, and the Los Angeles area accounts for 20 per cent of all commercial helicopters in use, with over 113 landing facilities either in operation or under construction -- 28 of these on rooftops.

According to some authoritative sources, the future role of the helicopter is not in urban transportation. Whether this will hold true will depend to a large extent on public policy, federal policy on subsidies, and local policies on regulatory measures. Public policy, in turn, will reflect the benefits expected to be derived from the helicopter as a mode of urban transportation. Some tentative answers will follow.

COSTS AND BENEFITS: A BALANCE SHEET

The helicopter is caught in a squeeze of high manufacturing cost, due in part to low production runs, high operating costs and consequently high fares and limited markets. In spite of its inherent advantages as a means of transportation, this puts the helicopter out of range of most people. But, as has been pointed out, "Chevrolets would cost twenty times as much if produced at the same rate as whirlybirds." Also, largely under the impact of military needs, important advances have been made, such as the use of turbine engines and of instruments giving an "all visibility" flight capability, which yield important improvements in performance characteristics and operational economy.

Present Services and Costs

At present, helicopter operations are concentrated in two areas -- airport transportation and air taxi service. The four scheduled passenger services are largely components of airport transportation systems. United Research estimates that 95 per cent of the passengers of these four helicopter airlines were making a connection to, from or between regular airline flights, and that 40 to 70 per cent of the passengers resided outside the metropolitan area in which they were making the trip.[9] Even this market is unlikely to reach substantial proportions within the near future. United Research concludes:[10]

> Airport transportation needs are almost insignificant in relation to the immensity of the present urban transportation problem. In fact, the contribution of airport transportation to the total urban traffic is almost imperceptible. On the other hand, the problems of urban transportation are of vital concern to airport transportation and to the airline system. If any substantial degree of relief is to be afforded airport transportation needs, it must come as a part of the nation's air transportation system and not as a part of any local urban transportation system.

The other present operation is the air taxi service, performed almost exclusively with small (three- and four-seat) craft on a for-hire basis, and designed for the businessman, and others, for whom the time-saving offsets the cost. Helicopter taxis operate in several metropolitan areas, serving a multitude of locations and justifying their existence by offering rapid connections between airports, downtown locations, and outlying industrial plants, as well as towns on the metropolitan periphery. Helicabs, Inc., operating in Los Angeles, for example, flies directly from a number of downtown hotels; Helicopter Air Lift, in Chicago, serves a large number of suburban communities and outlying industrial properties. A prerequisite, of course, is a suitable landing facility: in towns, it is usually the municipal airport; elsewhere it is a specially constructed heliport or helistop.

One major handicap to passenger operations is the high operating cost and concomitant high fares. Costs start with the purchase of equipment: $80-90,000 for a four-place helicopter to $600-700,000 for a 25 to 28-place craft. Operating costs are estimated at $153-190 per hour for the ten-seat Sikorsky S-62 employed by SFO; total operating expenses, computed by United Research on the basis of passenger miles in 1963 ranged from a high of 128 cents per

passenger mile for CHA, to 90 cents for NYA; 60 cents for SFO, and 50 cents for LAA. (Comparable figures for communter trains are 2-3 cents.) Construction costs of landing sites are more moderate; SFO estimates that the cost of its fully developed heliport facilities averaged $25,000,[11] and Helicabs, Inc., set the cost of a ground-level helistop at about $3,000. Rooftop installations are usually more expensive: the cost to build one on an existing building can range from $10-35,000, depending on modifications necessary in the structural support; if incorporated in the design of a new building, costs will average $4,500.[12] Theoretically, at least, the helicopter can land just about anywhere. The relatively high operating cost is reflected in the fare structure. For the four scheduled service carriers, fares range from $5.00 to $10.00 per passenger for trips almost exclusively to, from and between airports, and thus exceed ground limousine or taxi fares by a considerable margin, especially if the taxi is occupied by more than one person. SFO charters its ten-passenger crafts for $300 per flight hour, or $550 per day and $110 per flight hour. Chicago's Helicopter Air Lift has a group-lease plan with rates, based on annual subscriptions, ranging from $83 to $70 per hour for a three-seat helicopter. Los Angeles' Helicabs charge $11 per passenger from downtown to the airport, compared to an average taxi fare of $6.50 for one or more passengers. The four scheduled service carriers, however, have made arrangements with the regular airlines which include, in addition to reciprocal inter-line ticket and baggage agreements and interline reservation teletype circuits, also joint fare agreements. In some instances these latter permit reduced rates for passengers making airline flight connections.

Even with high rates, three of the four scheduled service carriers have been unable to operate without federal subsidies. In the period 1947-1963, these have totaled $48 million, according to United Research. During 1963, subsidies constituted 47.8 per cent of all revenues received by NYA, 59.3 per cent by LAA, and 77.4 per cent by CHA. The high percentage for Chicago Helicopter Airways is due, of course, to its unfavorable operating environment. Subsidies per passenger carried in 1963 were $19.12 for CHA, compared to $12.57 for LAA, and $8.09 for NYA; but while subsidies to the latter two carriers have steadily declined, subsidies to CHA have risen sharply from $5.07 per passenger carried in 1960. The 1960 subsidy per passenger carried to CHA was the lowest subsidy to any carrier in any year. The fourth scheduled carrier, SFO, has throughout its existence operated without federal support, as have all other helicopter operators.

The reward for the high cost of helicopter service is fast transportation, but even here rotary-wing aircraft is subject to limitations to its usefulness. The most critical impediment -- regulatory restrictions on location, flight patterns, safety and nuisances -- will be discussed later. Another limitation to successful operation of scheduled service is headway or the time between trips. The headway of scheduled helicopters is a major contributor to a passenger's total trip time because waiting time is estimated as one-half of headway. With the helicopter service presently available, the waiting time often exceeds the actual travel time. The experience of SFO indicates that passengers will wait a maximum of 25-30 minutes, and helicopter networks, therefore, must have numerous high-density, short-haul route segments. Helicopters, of course, have the potential of reducing headway considerably when their load factors increase sufficiently to justify more frequent trips.

New Equipment and Future Services

To a large extent, the future scope of helicopter operations is tied to the availability of new, more productive equipment. Operating expenses of scheduled carriers have been reduced, due mainly to the change-over from first-generation piston-engine helicraft to turbine-powered craft. For LAA, the introduction of the 28-passenger, twin-engine, turbine-powered Sikorsky S-61 helicopter reduced operating expenses by almost 60 per cent, to 22.8 cents per available seat-mile in 1963. Similarly, the 25-passenger, twin-engine, turbine-powered Boeing Vertol 107 enabled NYA to reduce expenses from 75 cents in 1961, to 41 cents per available seat-mile in 1963. The most efficient of the present crop of helicopters is operated by SFO: the ten-passenger, single-engine, turbine-powered Sikorsky S-62 which, according to FAA regulations, requires only one pilot. Of the scheduled service carriers, only CHA still operates piston-engine equipment. It has been estimated that the second generation of turbine helicopters, with a capacity of 35-40 passengers, adapted from military helicopters, will further reduce costs, and that 60-passenger craft, to be available by the end of the decade, should bring operating costs per available seat-mile down to 8-10 cents. This compares with 6-7 cents for fixed-wing, short-haul aircraft.[13] FAA's "Project Hummingbird" foresees not only the small twin-engine turbine helicopter, which might revolutionize the aerocab market, but also the "flying crane," a helicopter without a fuselage, which would serve the commuter market by picking up passenger capsules and transporting them from origin to destination during rush hours, while being available for other tasks during off-rush hours.[14]

With the introduction of twin-turbine helicopters, economic self-sufficiency is now a definite possibility, according to United Research. Furthermore, the simplicity of helicopter operations implies the capacity to reduce drastically the relationship between ground handling expenses and direct aircraft operating expense. Only the limited scale of operations has so far prevented the carriers from demonstrating the possibilities of reduced overhead expenses. According to United Research, self-sufficiency can be attained if overhead expenses can be held to 75 per cent of direct aircraft operating expense; if aircraft utilization is increased to approximately five hours per day; and if the passenger load factor is increased from the present 42 per cent to at least 50 per cent.

In spite of improved equipment and operating characteristics, it seems likely that helicopter services will remain marginal in the foreseeable future even under the most favorable circumstances. Under less than favorable conditions, these services will depend heavily on outside support, either private or public, for survival. In addition to financial assistance, this support must take the form of public regulations which minimize nuisance problems and hazards but still allow the helicopter latitude to profit from its unique operating characteristics.

Scheduled helicopter service to date has been largely a component of an airport transportation system. Other markets, however, seem within reach. According to the Buckley study done for Philadelphia, the outlook is for a significant aerocab market; for scheduled operations, the outlook is for a substantial potential inter-city market up to 250 miles and a limited commuter market, 30-50 miles from the downtown area. In general, helicopters, are more likely to

supplement than to compete with the existing types of surface transportation.

United Research considers the use of helicopters in commuting unlikely within the foreseeable future. The next stage of development in the application of vertical-lift aircraft to the nation's transportation needs will come in the area of short-haul inter-city travel, primarily urgent business trips between city centers. Expansion of metropolitan areas and concomitant traffic congestion will increase the need for other forms of intra-metropolitan transportation. While helicopters may not provide daily commuting service, they may well provide shuttle, feeder and pick-up services within these large areas. For the time being, however, the market for helicopters in inter-city travel will be limited to the business component which has in the past supported the development of regular domestic air transportation. The basic reason is, of course, that businessmen place the highest economic value upon the time saved in travel.

A comparison made by United Research between fixed-wing aircraft fares and time (including ground transportation from downtown) with those of assumed helicopter operations for a number of major routes of less than 250 miles between major cities shows a considerable saving in time (exceeding 50 per cent in several instances) but at a considerable increase in cost.

As the use of fixed-wing aircraft has increased, the airspace in which they operate has become more congested. The approach zones to jet airports are becoming saturated because, in take-off and landing, planes are restricted to a "tube," or corridor, of air leading up from the ends of the runways. Since helicopters are not confined to the approach zones, but can go more or less anywhere between, at a certain point of saturation, they become more advantageous. The present cost of aircraft and passenger delay at major air terminals is huge and growing, as are also the costs of reducing such delay through more efficient utilization of ground and air space.

The Public Interest

The public interest aspect of scheduled helicopter services has been the subject of periodic intensive hearings before the Civil Aeronautics Board since all certifications are temporary. In each case it was found that the ultimate objective of expedited air transportation in congested areas warranted the continued certification of the carriers and that such operations were considered to be in the public interest. Thus, the hearing examiner determined "that the public convenience and necessity requires the renewal of Chicago Helicopter Airways' temporary certificate,"[15] and "that the public convenience and necessity requires air transportation by rotary-wing aircraft without subsidy eligibility in the San Francisco Bay area."[16] In the CHA hearings at the end of 1963, indications of public benefit came from a different and somewhat unexpected source: Sikorsky's Chief of Technical Support estimated that the use by the civilian commercial operators of S-58 aircraft, because of more intensive utilization and the experience gathered, had resulted in operating savings for the 1,229 S-58 military helicopters -- totaling $77 million or nearly twice the total subsidy paid to three carriers from 1947 through 1962. The estimate is interesting, in view of the negative position taken in recent years by the Congress in regard to subsidies for air transportation in general, and for the helicopter carriers in particular.

A recent estimate shows that direct benefits of helicopter services accrue to approximately one-half million passengers annually. While some may argue that these services are too limited in scope to justify continued public subsidies, and that these subsidies in fact underwrite the traveling costs of only a small segment of the traveling public, others may maintain that a new means of transportation is being tested and developed and, while its ultimate benefits are still beyond exact calculation, the development cost in terms of the critical urban transportation needs seems negligible. Furthermore, subsidies to the aircraft industry in its early days provide a precedent for subsidizing the helicopter industry today.

REGULATORY MEASURES

Previously, it was stated that if the helicopter industry is to survive, public regulations to minimize its nuisance problems must still allow room for it to benefit from its unique operating characteristics.

The regulatory impact on the feasibility of helicopter operations is demonstrated by an emphatic statement by the Vertical Lift Aircraft Council:[17]

> Many corporations and business interests have reversed their earlier intention and declined to acquire helicopter services for their own uses because of the difficultues in obtaining from the local authorities the necessary clearances to establish their own private heliports or to land the helicopter in off-heliport spots where they desire to go even though the owners of such spots are willing, or even anxious, to have the landings made.

A comment was recently received from the planning agency of a major city to the effect that it would be an untimely exercise to write regulations for helicopters or propose them in the absence of any recognized need. The same thinking must have been prevalent in Los Angeles in 1959, for when Helicabs, Inc., was organized at that time, the operator found that there were no city ordinances governing helicopter operations; that the Federal Aviation Agency did not have set rules or patterns for the establishment of an air taxi service; that the California Aeronautics Commission did not have any set rules or regulations for the establishment of a heliport or helistop; that the Public Utilities Commission had no rules governing the fares for an air taxi service; and that the Los Angeles Building Department did not have any design criteria upon which to base its approval of helistop plans. Also, the Los Angeles Fire Department did not have any applicable fire safety standards.[18]

In Pittsburgh, an application for a landing site in 1962 required the approval of the City Traffic Engineer, the Director of Public Safety, the State Highway Department, the U.S. Army Corps of Engineers, the Pittsburgh Area Transportation Study, the City Planning Commission and the City Council. In spite of this cumbersome procedure, an ordinance approving this use was enacted by the City Council only six weeks after the filing of the application.

Very likely, the need for helicopter services in many cities has been limited. Nevertheless, regulations where they exist seem inadequate in view of the experience gained and the new equipment now in operation. The helicopter has been usually classified and treated as an aircraft, although its operating characteristics are radically different from those of fixed-wing aircraft and it has peculiarly different service requirements. Furthermore, public relations tend to reflect the small size of the helicopter, while it seems likely that the helicopter will reach financial maturity only with increased size -- beyond the 15,000 pounds gross weight accepted as maximum in the Chicago ordinance. Regulations should therefore be broadened to recognize more fully these large, multi-engine craft.

Public Considerations

The location of landing sites and the regulation of helicopter operations in urban areas should reflect the following standards: (1) good locations to best serve present and potential helicopter traffic; (2) minimum obstructions in the approach and departure path; (3) minimum disturbances to the public from noise and dust; (4) easy access to surface transportation; and (5) reasonable costs for acquiring and developing heliport sites. The operating characteristics of helicopters and design standards of heliports have been discussed in PAS Report No. 52, mentioned above, and were covered extensively in the Heliport Design Guide, published by the Federal Aviation Agency in November 1964 (first edition published in December 1959). These federal design guides (which are not requirements) cover heliport layout, approach and departure paths, obstruction clearances as well as the construction of heliport surfaces, and, for elevated heliports, landing and take-off areas, structural design, impact load, landing surface, and turbulence and visibility. Three specific problems will be discussed in detail below: noise, rotor airflow, and elevated landing sites.

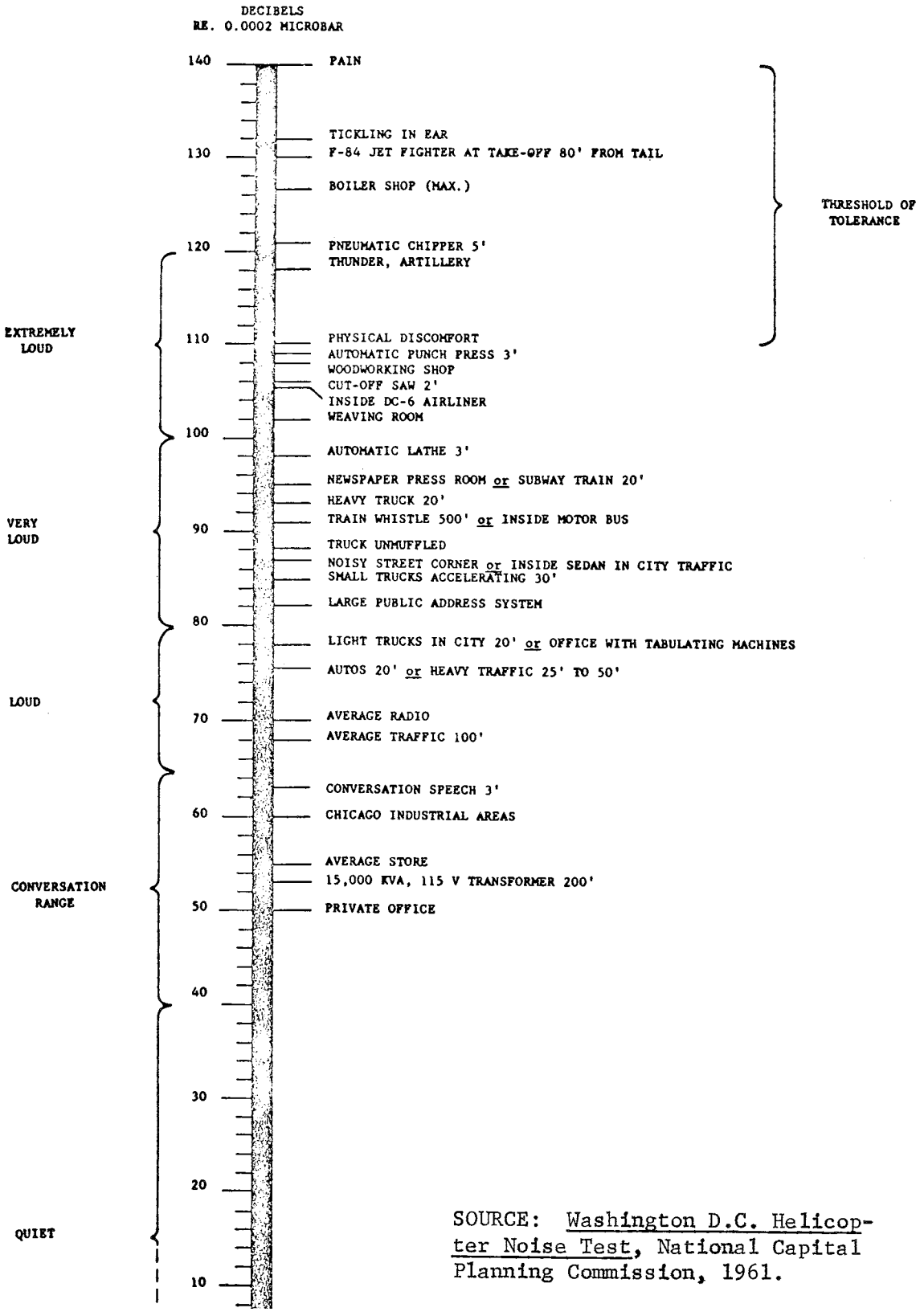
It should be mentioned that while the Federal Aviation Agency does not license heliports, it does prescribe through its regulations various requirements which must be observed by the user and which indirectly affect the heliport design and location. Under certain conditions, through the Federal-Aid Airport Program, the FAA may be able to assist in the development of specific heliports designed for public use. In addition, the FAA Civil Air Regulations prescribe air traffic rules, including detailed safety rules for helicopter operations, such as: minimum safe altitudes, ceiling and visibility limitations, the prohibition of careless and reckless operation, the licensing of pilots and aircraft, and the establishment of safe traffic patterns for airports and heliports.

Noise

> People will be attracted to helicopter noise because it is not a familiar sound. The "blade-slap" and the "swish" of the rotor blade as it cuts through the air produces a novel sound to the listener. As an example, a person standing 100 feet away from an accelerating truck would be exposed to a noise level of 90 to 95 decibels. . . . A helicopter flying overhead at approximately 200-300 feet altitude may produce 85 db. The listener accepts the truck noise but would be attracted to the helicopter even though it is not as 'noisy" as the truck.[19]

Figure 1

TYPICAL OVER ALL SOUND LEVELS



SOURCE: Washington D.C. Helicopter Noise Test, National Capital Planning Commission, 1961.

Noise generated by typical sources are shown in Figure 1. In the subsequent discussion, the reader may compare noise generated by helicopters with other more familiar generators.

The helicraft is noisiest in a position of hover, which requires maximum power use. In the Washington test, from 106 to 116 db. were registered at a 100-feet distance by the three larger machines, while hovering. The smaller Hiller 12-4E four-place machine used in the test, more typical of the majority of helicopters in use at present, registered a maximum of 98 db. at a distance of 100 feet.

Sound frequency must also be taken into consideration. A sound spectrum analysis of helicopter noise shows that most of the energies are confined to the low frequencies which, although more acceptable than high frequency sounds, are more apt to produce speech interference. People judge high frequencies to be more annoying, or less acceptable, than low frequencies so that although the intensity is the same, a noise at higher frequency will be far less tolerable than one lower. A notable example would be the comparison of a Viscount and a DC-6 in idling condition. The intensity levels could very well be the same, but the whine of the turbo-prop Viscount engine would be much less tolerable than the flat, piston-engine sound of the DC-6.

The Washington test, utilizing noise data gathered from the large ten-seater helicraft, concluded that:

> The collected noise data, in conjunction with this exercise, indicates that in most instances the background level was exceeded to no serious degree with the exception of the on-site location. It is here that heliport planners should give serious consideration with regard to the immediate environs. As an example, during the hovering operation, the overall sound pressure level was measured at 108 db at a distance of 100 feet. We can assume this level will not change appreciably on a radius of 100 feet for the purpose of considering an envelope around the noise source. Noise attenuates with respect to the inverse square law under free field conditions. Without the benefit of a mathematical exercise, this means, as you double the distance from the source, you decrease the sound pressure level 6 db.

Similarly, the overall sound pressure level of the smaller four-seater helicraft was measured at 98 db at a distance of 100 feet. The decrease in sound pressure level at the same distance for the two types of helicraft would be:

Distance from Source (ft.)	Ten-Seater db Level	Four-Seater db Level
100	108	98
200	102	92
400	96	86
800	90	80
1,600	84	84
3,200	78	78

Finally, the Washington report cautioned that:

> A number criterion in decibels is not suggested here in terms of predicting annoyance, zoning restrictions, etc., in view of the many factors. Some of the more important considerations are: (1) frequency of operations; (2) prevailing building construction; (3) speech interference; (4) background noise levels; (5) socio-economic status of the community involved; and (6) attitude of the residents toward the heliport. However, it is believed that the noise data presented in this report should be of great value in assessing some of the issues involved in the selection of a heliport. . . .

Many zoning ordinances stipulate that a landing facility be at least 200-300 feet from the nearest residential zone or residence. A comparison to the table on page 12 from the Washington report shows that the 200 to 300 foot distance requirement in other ordinances amounts more or less to the same measurements taken under actual test conditions.

Another useful publication, entitled Land-Use Planning Relating to Aircraft Noise, prepared for the Federal Aviation Agency in 1964, will be helpful in calculating noise contours of helicopter landings at given locations since the study concerns procedure. The only helicopters referred to are multi-seater models, but the system of calculating composite noise ratings should be workable for any type and the guidelines helpful for all kinds of aircraft.

The contours of equal composite noise ratings, as illustrated in the report, will be biased by the flight path to and from the landing area. Helicopter sound is greatest directly underneath the flight path, but is brief due to the fact that an individual take-off or landing involves only a few seconds of time. Thus, where the frequency of landings is three a day or less, and where the weight of the machine is less than 3,500 pounds, the noise factor should not be objectionable. More careful attention, however, should be given to site review where helicraft above 5,000 pounds will be used, or where it is anticipated that more than three flights daily will be made.

In summary, the following factors should be taken into account in planning heliports and helistops in relation to noise:

Frequency of Use. - As most helicopter landing areas are used only two or three times a week, exaggeration of the noise problem should be avoided. The purpose of the landing facility should be made clear.

Size of Helicopter. - Since the majority of helicopters using the site will be two-, three-and four-seater machines, in most cases the noise will be within tolerable limits of background noise levels. The only exception will be on-site noise levels. Introduction of helicraft containing more than four seats, however, warrants a fairly careful noise study.

Site Location. - It is recommended that each landing site be considered in its own right with appropriate field inspection and noise tests made, if necessary. For example, in Los Angeles, an application was submitted for a roof-top helistop on a two-story building located in a commercial zone.[20] Opposition

was unusually heavy, particularly with reference to noise. Objectors contended that the proposed facility would be detrimental to the surrounding area and that use of a nearby sound studio and a hospital would be adversely affected. At the request of the planning commission, an investigation was conducted by city representatives and an independent acoustical consultant, using approved sound-detection equipment. With the helicopter simulating landings and take-offs using the proposed flight pattern, it was found that sounds registered for adjacent street traffic exceeded the sound level of the helicopter at both the hospital and the sound studio. In approving the application the planning commission specified that sound-pressure levels created by the operation must be within the limits of the official test. Sound-pressure levels exceeding said limits would void the conditional use granted. The conditions of approval also subjected the operation to tests at six-month intervals for a period of two years.

In conclusion, reference must be made to the introduction of turbine engines in the helicopter market. These reduce the noise level ten decibels, or so, for capacities equivalent to the normal motor. At present, turbines are used mainly in the larger models, so that the overall sound level is still high. The silent helicopter, due partly to the nature of the rotor blades, is still off in the distant future. It is also important to realize that most of the literature on noise levels concerns the larger craft, the six-, ten- and twenty-four seat helicopters. There is a dearth of information on the smaller vehicles which form the bulk of the helicopter service industry and which should be of primary interest in present helicopter planning.

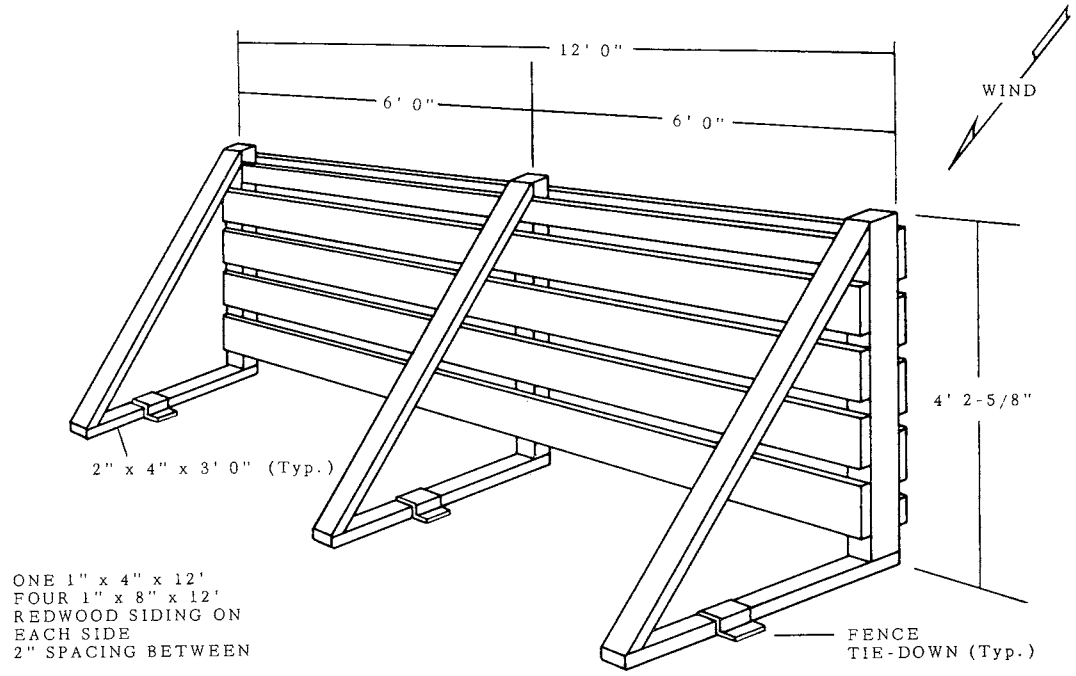
Rotor Airflow

The nature of the helicopter rotor slip-stream is such that, although downward through the rotor, the primary result is a horizontal velocity outward over the ground just beyond the tips of the main rotor blades. A continuous surface is necessary to obtain this deflecting "cushion effect." It is interesting to note, that where a steel-mesh was used as a landing platform in Chicago, the helistop could not be used since the holes in the mesh dissipated the "cushion."

In all cases these horizontal velocities exist only close to the ground or at a distance of less than four to six feet, and are at their highest level at approximately two feet from the ground. Thus, any objectionable features that they produce in relation to passengers or visitors surrounding the touchdown area can be avoided by use of fences, three or four feet high. A generally acceptable height is three feet, and this figure is reflected in many ordinances and model site plans.

Research has shown the fence in Figure 2 to be the most useful. This type has been installed by Los Angeles Airways at many of its heliports requiring such protection. The average cost of fences at each of these heliports is approximately $2,000.

Figure 2

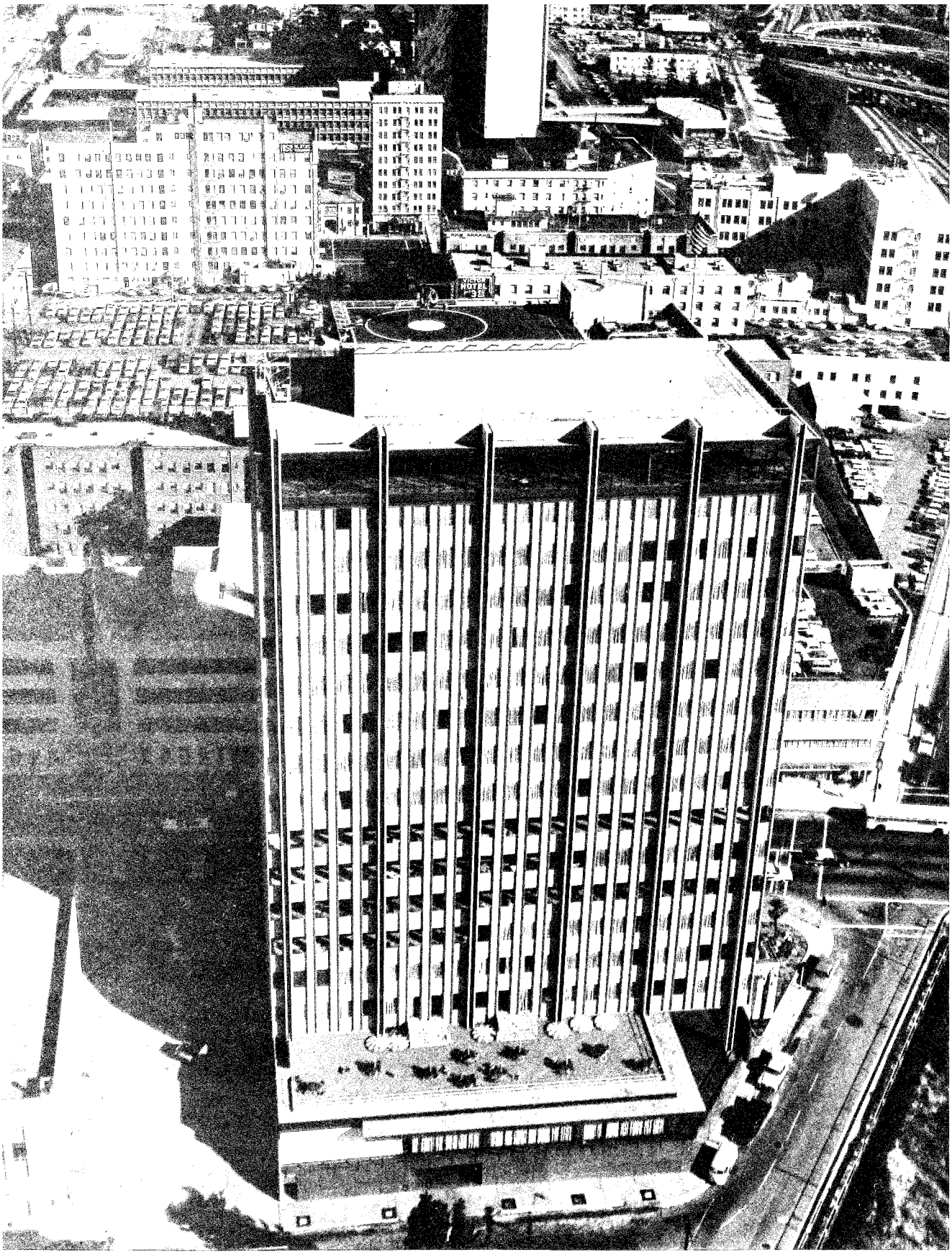


WIND DEFLECTION FENCE
Typical 12 ft. Section

SOURCE: "Consideration of Helicopter Noise and Rotor Airflow in Heliport Planning," by Edward J. Nesbitt. Delivered at Second National Conference on Planning and Designing Urban Helicopter Facilities, Los Angeles, 1962.

Generally there is a relationship between weight of the craft and velocity of the horizontal airflow. For a machine weighing 7,500 pounds (the lowest weight for which airflow figures are available) the horizontal velocity produced is about 30 miles per hour along the ground, immediately outboard of its main rotor blade when hovering. A machine weighing 19,000 pounds results in a velocity of only 40 miles per hour. For the average machine, weighing about 3,500 pounds the velocity would probably be around the 20 miles per hour mark. As low as 50 feet above the ground the effects of vertical airflow are insignificant to a person standing on the ground.

The greatest, or perhaps the only real, objection results from the use of larger multi-engine designs, whose downwash area is increased two-fold and whose operational scope does not extend to the smaller helistops. A rooftop landing could lead to downwash "overflow" and side effects on neighboring property if the touchdown area was of limited size. In Seattle, part of the reason for cancelling a temporary helistop permit was the airflow effect on surrounding buildings. So far as we know, this is the only instance where an



Rooftop Heliport, Los Angeles, California.

Rooftop landing area, Santa Monica Hospital, Santa Monica, California.

airflow problem played a part in the denial of a landing facility application. Most helicraft are light in weight and it seems reasonable to discount the downwash effect in most locational considerations. Only where frequent public use, congested conditions or rooftop dangers prevail is there a necessity for fence precautions to counteract rotor-flow.

It is a universal requirement that the landing surface should be free from dust, dirt and other loose material which could be blown into adjoining properties by the airwash. It is usual to insist on the installation of suitable surfacing.

Rooftop Landing Areas

Apart from location, one of the major problems in permitting rooftop helistops is adequate regulation of post-crash fire hazards. The requirements of the Los Angeles Department of Fire are reproduced in Appendix A, page 31.

Charles W. Bahme, Deputy Fire Chief, Los Angeles Department of Fire, notes, though, that "the safety record is so good in Los Angeles that the operator

of our largest helicopter airline can boast that a fire extinguisher has never been used but once, at any of his heliports -- on roof or on the ground -- in the past 17 years in over one million operations."[21] Even so, Mr. Bahme says that:

> No amount of conventional fire fighting equipment will be adequate to give any real assurance that there will be no loss of life in a serious post-crash fire, for it often happens so fast that it is impossible for fire equipment to be brought into action quickly enough to save the lives of the victims.
>
> Our Los Angeles fire equipment requirements, calling for wet standpipes, 1½ inch hose, fog nozzles, and dry chemical extinguishers, while possibly inadequate to prevent a loss of life in a serious post-crash fire, are sufficient to control an incipient fire, protect the building, and handle spills, leaks, or other minor type of emergency which might arise on the roof. Of course, we have no assurance that this equipment will be promptly used by anyone.[22]

Another safety aspect relates to helicopter pilots using rooftop facilities. One of the main dangers a municipality has to face when setting up a public heliport is the learner pilot, or private aviator, who has the right to use the facility. Of Los Angeles Mr. Bahme says: "We have no helistops in our city where amateur pilots can land without permission, and if some 'flight deviate' should 'buzz' a building, we are confident that the FAA's procedure for handling such violation is adequate without intervention by the fire department."[23]

A final consideration in evaluating rooftop land areas is proper structural design to carry the additional load. Disc-loading is the figure in pounds per square foot that results from dividing the gross weight of the helicopter by the area swept by the main rotor blades. The Bell four-seater (including pilot) 47J-2 with a gross weight of 2,950 pounds and a disc-loading of about 2.7 pounds per square foot, is typical of the majority of helicopters in use. The Sikorsky S-55, which can carry up to twelve persons, has a gross weight of 7,500 pounds and a disc-loading of approximately 3.4 pounds per square foot. For small craft, live loads other than the helicopter, such as snow, crowds of people, or freight, may govern structural requirements. A strengthening of the landing surface and the installation of a load-distributing pad may be necessary, but most buildings will need only small modification.

It should be noted that the load requirements in Los Angeles, which are 1.5 times the helicopter's weight, are designed for a region susceptible to earthquakes and ground tremors. The FAA recommendation of a surface designed to support a concentrated load equal to .75 times the helicopter's weight has been found, by experience and experiment, to be adequate for rooftop sites.

ZONING CONTROLS

"Heliports are like freeways; they're a needed type of urban facility, but don't put one in my block." This comment is symptomatic of a general attitude toward the helicopter and one reflected in many zoning ordinances, in spite of the finding that its operating characteristics are relatively inoffensive, that it has an excellent safety record, and that its effect on property values is neutral at worst. Where a need for zoning regulation is recognized, the fear of undesirable side effects has at times resulted in overly severe restrictions which have lessened the chance of profitable helicraft ventures. Also, in many zoning ordinances where allowable uses are affirmatively stated, heliports are not listed among such uses and, as a result, are barred entirely from the community simply by inadvertence. In other ordinances, "airports" are included as uses, but are broadly defined to cover heliports without mentioning them by name. Consequently, heliports are often subject to entirely inappropriate classifications, restrictions and conditions designed for the long runways and relatively low angle approach paths required for fixed-wing aircraft.

Two prerequisites are crucial. As was mentioned, the full benefits from helicopter operations cannot be realized unless the helicopter has direct access to highly congested, downtown areas, with landing facilities in proximity to passenger origins and destinations. Few potential passengers are likely to pay the premium fare of helicopter flight without convenient access to its take-off point. But the necessity of downtown facilities conflicts with a major safety consideration: the availability of suitable approach-departure paths leading to and from the heliport.

Despite technological advancements which permit helicopters to make safe landings at certain minimum altitudes, speeds and power, the fact remains that helicopters pass through positions in their ascent and descent patterns where safe continuance of operation is jeopardized in the event of power loss. This situation, plus the fact that most helicopters in use are single-engine machines, has affected municipal regulations governing the location of heliports. The development of twin-engine equipment with the capacity to take off and land and to operate safely at all altitudes on one engine may greatly reduce these requirements.

According to the Heliport Design Guide:[24]

> . . . The routes to heliports should be over terrain which affords suitable emergency landing areas no farther away than a glide angle of one foot vertically to two feet horizontally from the proposed altitude (unless the manufacturer's authoritative performance data indicate other than such a glide angle). This provision is necessary for all but multi-engine helicopters capable of continued flight on one engine. Heliport approach-departure routes usually are sought over waterways, beaches, parks, golf courses, industrial yards, and vacant land. Usually avoided, are routes over residential developments, playgrounds, shopping districts, and other highly populated areas.

The second prerequisite affects primarily small craft, whether owned by an air taxi operator and made available on a rental or lease basis, or whether owned by a business enterprise for its own use only. It concerns the permission to land intermittently or infrequently at outlying locations, such as industrial plants, without the necessity of obtaining numerous permits from a multitude of public authorities, including prolonged public hearings to obtain the consent of adjacent property owners. This, of course, does not mean the abdication of municipal power to take reasonable precautions, and to prevent nuisance effects. It does, however, give the operator the flexibility necessary to operate profitably in what is still a precarious market.

The spectrum of provisions stipulated in local zoning ordinances is an interesting reflection of the yardsticks chosen and the factors influencing site location in communities throughout the nation. A 1962 survey of zoning regulations revealed a considerable variety in provisions regulating helicopter landing areas.[25] Undoubtedly, many provisions were drafted without a thorough understanding of helicopter operational characteristics. Safety, for instance, is still a subject of speculation since the nearly accident-free record of commercial flights has produced only fragmentary evidence of what dangers to guard against. Unfortunately, some communities, in their concern for the safety of the public, have drafted regulatory measures based more on fiction than on fact. It is likely that some of the earlier zoning ordinances did not foresee the flexibility of helicopter operations, and thus contained provisions which regulated these aircraft facilities too stringently.

Definitions

Distinctions among helicopter landing facilities in zoning ordinances are made in several ways: according to use by public or private groups; according to supporting facilities; according to helicopter weight; and according to function. The most general treatment of landing facilities is found in the Fort Worth and Phoenix zoning ordinances which have a single definition to include all types of facilities. For example:

> /Fort Worth, Texas/ The term "heliport" shall mean any area of land or water or a structural surface which is used or intended to be used for the landing and take-off of helicopters and any appurtenant areas which are used or intended to be used for heliport buildings and other heliport facilities.

This definition is an oversimplification in view of the present pattern of the helicopter business.

In the Seattle zoning ordinance, landing facilities are classified as follows:

> Heliport: An area used by helicopters or by other steep-gradient aircraft which area includes passenger and cargo facilities, maintenance and overhaul, fueling service, storage space, tie-down space, hangers and other accessory buildings, and open spaces.
>
> Helistop: An area on a roof or on the ground used by helicopters or steep gradient aircraft for the purpose of picking up or discharging passengers or cargo, but not including fuel service, maintenance or overhaul.

The Portland, Oregon, zoning ordinance has a similar definition for heliports but divides helistops into two categories -- public and private. The private stop has its operations limited to those helicraft "which are owned or controlled by the owner or occupant of the premises or by guests or patrons of such owner or occupant." Facilities are limited to "tie-down or hangar facilities. . . for the accommodation of a single aircraft." Public helistops may be used by any helicopter, but may have only one tie-down facility. In Minneapolis, helicraft landing facilities are divided into two categories -- heliports and helipads (similar to heliports), but the latter is allowed "terminal facilities for handling passengers and goods."

In the FAA Heliport Design Guide, a threefold classification of heliport landing facilities is suggested. All facilities are listed under the heading of heliports, but landing areas are subdivided into Class I, Private; Class II, Public Small; and Class III, Public Large. Each of these may or may not have "supporting facilities," which in effect creates a sixfold classification. The categories are distinguished by the size of the area and the type of helicopter using the site.

A similar classification was suggested by the City of El Segundo, California, in A Resolution Adopted by the Planning Commission, March, 1960, Regulating Helicopters and Their Landing Areas:

> WHEREAS, Article 13, Section 1300 (1) "Airports or Landing Fields," is a very broad generalization that is of no assistance or guide to any person or business organization desiring to establish such airport or landing field within the limits of the City of El Segundo.
>
> WHEREAS, the Planning Commission of the City of El Segundo, while maintaining that (1) of Section 1300 shall continue to require a "use permit," it is the Commission's belief that a statement of policy would be of assistance to a person or organization desiring to receive such a permit.
>
> THEREFORE, BE IT RESOLVED that the Planning Commission of the City of El Segundo, California, finds, defines, declares and determines as follows:
>
> A. Definitions.
>
> 1. Heliport -- Unlimited Use. Any land area used by helicopters which, in addition, includes all necessary passenger and cargo facilities, maintenance and overhaul, fueling, service, storage, tie-down areas, hangars, and other necessary buildings and open spaces.
>
> 2. Heliport -- Limited Use. Any landing area used for the landing and taking off of helicopters, including all necessary passenger and cargo facilities, fueling, and emergency service facilities.
>
> 3. Helistop -- Unlimited Use. Any landing area used for the landing and taking off of helicopters for the purpose of picking up or

discharging of passengers or cargo. No fueling, refueling, or service facilities.

4. Helistop -- Limited Use. Any landing area for the purpose of taking off or landing of private helicopters for the purpose of picking up and discharging of passengers or cargo. This facility is not open to use by any helicopter without prior permission having been obtained. Numbers 3 and 4 may be established on the tops of buildings.

B. Area Requirements.

1. Heliport -- Unlimited Use.

2. Heliport -- Limited Use. Minimum landing area for each of the above shall be 200' x 400'. This does not include tie-down facilities, taxi-ways, terminal buildings, parking areas, service areas, and other necessary facilities.

3. Helistop -- Unlimited Use; Helistop -- Limited Use. Minimum landing area for each of the above shall be 100' x 100'. If erected on a building, the minimum landing area shall be 40' x 40'. Landing areas in all cases shall be surrounded by a fence at least 4' in height.

Denver and Chicago are examples of cities with detailed definitions of landing areas, including weights of helicopters, site dimensions, obstruction, and lateral clearance specifications. The distinctions are dependent principally on the weight of helicraft. Denver has three categories: Class I - 0 to 6,000 pounds; Class II - 6,000 to 12,500 pounds; Class III - 12,500 to 20,000 pounds. Chicago has two: Class I - 0 to 6,000 pounds; Class II - 6,000 to 15,000 pounds. Some authorities contend that these kinds of definitions are so little related to reality that it is to be discouraged.[26]

A fourfold set of definitions, qualified by the proposed function of the facility has been proposed by Pogue and Neal:[27]

Class I Any heliport used only by helicopters having a gross weight not exceeding 6,000 pounds, while engaged in the personal or business operations of the person or company maintaining such heliport, if facilities or operations hereinafter described with respect to other classes of heliports are not present thereon.

Class II Any heliport used by helicopters having a gross weight exceeding 6,000 pounds or regularly used by helicopters engaged in the personal or business operations of persons or companies other than the person or company maintaining the heliport, if facilities or operations hereinafter described in the definitions of Class III or Class IV are not present thereon.

Class III Any heliport, not falling within Class IV, regularly used by helicopters carrying persons or property for hire, or used for the conduct of flight instruction for hire, or used as a base for the charter or rental of helicopters.

Class IV Any heliport having thereon facilities for the regular maintenance or overhaul of helicopters, or for the sale of fuel.

The authors argue that these definitions provide a "general differentiation between heliports based upon factors which should ordinarily mean differences in the volume of traffic, the frequency and the time of use, the relative noise of operations, and the extent of public access, with its related volumes of pedestrian and surface vehicle traffic."[28] Provision can be made within the first three classes for the helistop, which has no supporting facilities. While the classification might prove difficult to put into effect, the scheme does suggest a more carefully thought out basis for local policy decisions.

Zoning Districts

Zoning regulations for landing facilities often permit heliports by right in industrial zones, as conditional uses in commercial zones, and as conditional uses for public purposes in residential zones. The larger helicopter landing areas are permitted by right chiefly in manufacturing and waterfront zones. For example, New Haven, Connecticut, allows heliports in its light and heavy industrial districts and in its marine business districts. Cincinnati and Miami both allow heliports by right in their waterfront districts: the latter restricts them to the Waterfront-Recreational Zone. New Haven is one of the few cities which permits helicopter landing facilities by right in its central business district and in wholesale and distribution districts. Although some zoning ordinances distinguish between heliports and helistops, it would appear that in most cases the word "heliport" covers both types of landing facilities. However, Anaheim, California, makes the distinction, specifying heliports as a conditional use in all zones, while helistops are a permitted use in the M-1 Manufacturing District.

In other ordinances there is no reference to the actual districts in which landing areas are allowed or prohibited. Appendix B, page 33, offers zoning districts of selected cities in which helicopter facilities are permitted. Dallas considers each case individually and attaches whatever conditions are needed to the use permit. San Diego, California, has no special regulations for heliports, and applications are processed under the conditional use permit procedure of the zoning ordinance. This reliance on special permit provisions for location in any zoning district is typical of a number of ordinances, including that of Los Angeles. In spite of the large number of landing facilities approved in Los Angeles, it is significant that no helisite has been established thus far in a residential zone.

Ordinances including research, agricultural, or waterfront zones sometimes allow helicopter landing facilities conditionally in these areas. Los Angeles County, for instance, has a provision under its SR-D Scientific Research and Development Zone for a heliport as a conditional use. Huntsville, Alabama, allows heliports in its Research Park District.

The majority of ordinances appears to prohibit landing facilities in residential areas. In some cities there is even a stipulation specifying the relation of the approach path to nearby residential zones. Where landing areas are permitted in residential districts, they are qualified, as in the Portland

ordinance: a private helistop may be permitted in connection with a principal or conditional use occupying a lot of ten acres or more. Another example is the Seattle ordinance:

> Helistops in RS 9600 - Single Family Residence Low Density Zone (26.12.060(d)) Helistops accessory to Principal Uses permitted subject to the provisions for heliports in Section 26.38.050, provided that the authorization of such Accessory Conditional use shall be subject to annual review by the Board and, for cause, may be withdrawn by the Board following any such annual review.

The "appropriateness" of a heliport must be judged in the light of the conditional use criteria specified within the ordinance. In most cases these criteria are general, such as those in the Los Angeles County ordinance: "The Commission may grant a special use permit, under such conditions as it deems necessary for the protection of public health, safety and general welfare."

The City of Anaheim Municipal Code is fairly typical of the majority of ordinances. The framework in which the heliport, as other conditional uses, must be fitted, is as follows:

> (1) The proposed use will not adversely affect the adjoining land uses and the growth and development of the area in which it is proposed to be located.
>
> (2) The size and shape of the site proposed for use is adequate to allow the full development of the proposed use in a manner not detrimental to the particular area nor to the peace, health, safety and general welfare.
>
> (3) The traffic generated by the proposed use will not impose an undue burden upon the streets and highways designed and improved to carry the traffic in the area.
>
> (4) The granting of the conditional use permit under the conditions imposed, if any, will not be detrimental to the peace, health, safety, and general welfare of the citizens of the City of Anaheim.

The relationship of the helicopter landing area to these conditions can be complex. In every case, the local FAA office should be called in and an FAA site study and recommendations obtained. These studies focus primarily on safety factors relating to the site, especially approach paths and emergency landing areas. In Los Angeles, the application will be approved by the hearing body if:

1. It is found desirable to the public convenience and welfare.
2. Compatibility with surrounding development is assured.
3. The use is in harmony with Master Plan objectives.
4. The application has approval of all concerned agencies.
5. Adequate alternate landing facilities are provided.[29]

These site review criteria are administrative and have not been incorporated into the zoning ordinance. New York, in a June 27, 1963, zoning ordinance

amendment established similar criteria provided that the following findings are made:

> (a) That the heliport is an appropriate use of the land and will not unduly interfere with surrounding land uses.
>
> (b) That due consideration has been given to the selection of a site situated near or adjacent to large parks or other open areas, or bodies of water . . .
>
> The City Planning Commission may prescribe appropriate additional conditions and safeguards to minimize adverse effects on the character of the surrounding area.

The only other stipulations in the New York ordinance concern traffic generation ("accessory off-street parking spaces") and inclusion within the "general plan for airports" for the city and its region. The FAA is requested to evaluate the effect of the proposed facility on the air transportation system of the metropolitan area.

It should be noted that no zoning ordinance which has come to the attention of Planning Advisory Service is as permissive with regard to heliports as the recommendations of the FAA Heliport Design Guide:[30]

> In general, zoning regulations should treat heliports as a permitted use in industrial, manufacturing, agricultural, or unzoned areas. In addition, some heliports (especially those without support facilities or with limited facilities) should be a permitted use in certain commercial, retail, and business districts. . . . Heliports also should be eligible for consideration in other zones (including residential) under conditional use procedures. Provisions for the occasional or infrequent use of off-heliport landing sites on short notice also should be covered in a reasonable manner by appropriate ordinances.

PLANNING CONSIDERATIONS

In the past, planning for helicopter landing facilities has been concerned primarily with heliports handling scheduled operations. While heavy-duty facilities envisaged for scheduled operations still have a place in the overall plan, the part they play in many cities will be small in the immediate future.

It now appears that, on the basis of the number of movements, pattern of location, and function, five distinct types of helicopter landing facilities are discernible. They range from a few heavy-duty heliports to a large number of emergency landing areas scattered throughout the city. While it may not be desirable to establish these categories precisely within regulatory provisions, they should be helpful for study and analysis to guide planning policy.

Heavy-Duty Heliports

These landing areas are the base-points for flight operations. They are few in number, probably less than ten for any metropolitan area, and are intensively used, with four or more movements per day. The supporting facilities include refueling, maintenance, storage for the aircraft, and passenger handling facilities such as parking space and terminal facilities. Presently, these facilities are located at the major airports.

Helistops

These landing points are characterized by greater dispersion in the urban area than are heavy-duty ports. No services, refueling, passenger facilities, maintenance, or storage are provided but they may have one tie-down and limited parking space. Nearly all helistops are privately owned but many, particularly in the Los Angeles region, are public pick-up stations.

Public Service Helistops

Increasingly, public agencies are finding the helicopter a useful vehicle in discharging their responsibilities. Helistops should be considered at the following locations: (a) Fire stations: Both Chicago and Los Angeles have fire department helistops for auxiliary assistance such as base laying, flame dampening, transporting firemen, above ground inspection and direction, and aerial evacuation from buildings beyond reach of conventional equipment. (b) Hospitals: More than 30 U.S. hospitals have helistops. Probably all large hospitals should be equipped with a stop for helicopter ambulance service. (c) Police stations: Traffic control is the most frequent use for police helicraft in several cities. Chicago, for instance, has two policemen who fly over major expressways five hours every day assisting in traffic control. (d) Patrol points: the Coast Guard, waterfront police division, and other agencies which regularly patrol over coastal and harbor areas should be provided with stops. New York's harbor authority has several for these purposes. The Coast Guard in Miami has a stop specifically for its waterfront patrols. (e) Temporary landing areas: These are unmarked landing areas and are widely dispersed throughout the urban area. Their infrequent use would permit, for example, a helicopter taxi-cab to land wherever needed. The landing area requirements are minimal and may be on vacant lots, playing fields, or backyards. Permission to land on these sites, however, must be granted by an appropriate public agency with an allowance of an hour or so each side of the proposed landing time. The Los Angeles regulations for infrequent landings are as follows:

> INFREQUENT HELICOPTER LANDINGS. Notwithstanding any provisions of this Article to the contrary, helicopters may land and take-off in any zone except RA, R, C1 and CR Zones provided that a permit therefor has first been obtained from the Fire Department under the provisions of Division 5, Article 7 of Chapter 5 of this Code. Such helicopter landings and takeoffs shall not exceed three per day in or upon any single location or premises except that the Fire Department may permit as many such landings and take-offs in

> or upon any single location or premises in a day as it determines are required by the individual nature of each such helicopter use, including occasions of civic interest, and are consistent with the public health, safety, general welfare and intent of this Article. The provisions of this subdivision shall not be construed or interpreted as permitting the establishment of a regularly operating airport, aircraft landing field, heliport or helistop.

The importance of adopting careful procedures in reviewing temporary landing applications cannot be overemphasized. In Los Angeles, the procedure begins with a request for a cab. The helicopter operator inspects a nearby landing site, obtains the owner's permission, and contacts the city fire department. The department reviews the application, inspects the site, and issues the permit. This procedure takes a short time to complete and has apparently proved workable. In Dallas, a similar provision requires the permission of the director of aviation. Ultimately, it should be possible to map every landing site usable for infrequent touch-down, rather than deal with each application as it arrives.

Emergency Helistops

A network of helicopter landing areas to be used only in emergencies could be developed, principally for fire, hospital, and police services. These sites, of course, should be as close as possible to potential trouble areas and should be selected by local public safety agencies. It is interesting to note that after a disastrous fire in a hotel in Jacksonville, Florida, where many people were removed from the roof of a burning building by helicopter, it was proposed in Los Angeles that all new buildings exceeding the height of fire department aerial ladders be required to provide emergency helistops to carry out rescue operations. The mayor directed the city fire commission to make a feasibility study of emergency helistops not only on future high-rise buildings but also on existing multi-storied buildings. These stops would not need approval for zoning changes from the city planning commission.

Ownership and Management

In addition to types and functions of heliports, their ownership and management are subjects for planning considerations. Seattle provides an example of a city which has completed a study concerning public involvement in the ownership, management, and construction of helicopter terminals, concluding with recommendations for policies and plans:[31]

> 1. For the foreseeable future, a policy of non-involvement in helicopter terminal facility ownership or operation should be followed.
>
> 2. The Port of Seattle should be encouraged to concern itself increasingly with helicopter activities, including the development of a county-wide plan for the location of heliports. This plan would be consistent with local zoning regulations to complement local airports and to serve major population centers in King County.

3. Private interests should be encouraged to develop helistops at suitable transfer points such as centrally located parking garages, the Central Bus Depot and train depots, to permit an interchange of travel facilities at convenient locations.

In Los Angeles, landing facilities are presently under private management, and there are no helistops publicly owned which are avilable for commercial use. Los Angeles Airways and Helicabs, Inc., as well as the larger aircraft companies which use helicopters in their business, manage their terminals for their own use. The city, however, operates helistops for the use of the police and fire departments. The operator of Helicabs, Inc., takes the position that each individual helistop has certain characteristics and restrictions that make it impossible for other operators to use the helistop safely and in conformity with the rules and regulations under which the permits for the helistop were granted.

The restriction of private commercial helistops to a single lessee by contract or operating practices, however, may deny competitors access to air and surface space nearby. At some point in the expansion of commercial helicopter service, landing facilities very likely could be regulated as private utilities -- as with railroad and bus depots and some civilian airports. In addition, there are specific advantages to public ownership: (1) municipal rights of condemnation and zoning to locate properly and protect the facility for maximum safety and convenience; (2) inclusion of the heliport into the over-all plan for municipal air facilities with proper planning and construction which can qualify the facility for federal financial assistance through the National Airport Plan; and (3) centralized municipal facilities to enable the FAA to establish criteria more efficiently for and regulate air traffic in downtown congested areas.

The operator of SFO Helicopter Airlines in San Francisco goes one step further:[32]

> In the operation of our company, we are not interested in serving a community unless it is willing to provide the quality of heliport facilities we feel must be made available to the public to gain their approval. Unless the community is willing to provide such facilities, it is not really interested in scheduled helicopter service.

Compared with other transportation fields, research in helicopter transportation has been sparse. Los Angeles is conducting an origin-and-destination survey and a study of public attitudes. The study also includes suggested methods for centralizing and formalizing heliport and helistop applications in the city. The Santa Monica Chamber of Commerce has conducted a public opinion survey and a study of possible heliport sites. Studies of heliports and helicopter transportation were prepared in New York, Baltimore, and San Francisco during the 1950's. One of the most comprehensive studies was conducted for the Philadelphia City Planning Commission in 1959 by James C. Buckley, Inc., to evaluate the present and future need for public heliports and helistops in Philadelphia; to recommend locations for such needed facilities; and to suggest means for reserving and obtaining suitable sites. The study included the metropolitan area of approximately 3,500 square miles as well as points within a 200 to 250 mile radius. The scope of the investigation included the following major points:[33]

Downtown Manhattan Heliport.

1. A forecast of the commercial helicopter traffic in Philadelphia and the region in 1970 and 1980.

2. A determination as to the approximate locations of heliports required to service the anticipated traffic.

3. The peak-hour flight activity anticipated at each such locations as a basis for establishing the size of heliport likely to be required.

4. The type of helicopter operation anticipated at each such location as a basis for determining the type of heliport to be required in each case and its impact on adjacent areas.

5. The space and design requirements for each location in order properly to handle anticipated passenger and property movements.

6. The landing, take-off, and flight characteristics of present

and prospective helicopters as a basis for recommending standards to be followed with respect to physical development.

7. The types of heliports which appear to be required.

8. The extent, if any, to which heliport development can or should be integrated with other forms of transportation, particularly with the region's developing highway and transit programs.

9. The relationship between the Plan for Heliports and the Comprehensive Plan, including the possibility of combining heliport development with other activities such as off-street parking, bus terminals, park and recreational areas, school building programs, highway development, pier development, and the like.

10. The means which might be employed to reserve needed sites, including possible reservation for automobile parking, public recreation, and the like.

CONCLUSION

A report prepared by the Philadelphia Department of Commerce, Division of Aviation, in 1960, contained among other conclusions the following:[34]

> /The/ variety of potential uses, public and private, coupled with the differences in sizes and capabilities of existing and future helicopters gives further weight to our opinion that the controlling factor in the ultimate location of heliports and helistops will not be the character of existing land use. To be sure, such existing land use may well dictate certain ancillary characteristics of the facility. We have in mind such things as beautification and other refinements of installation and operation. The basic control in location, however, we must emphasize, will be traffic demand.

The traffic demand for helicopter service is closely related to its penetration into highly congested and densely populated areas, especially downtown, and to the ease with which permits for landing facilities may be obtained. The cost factor, present and foreseeable, makes helicopter operations a precarious proposition, even under the most favorable conditions, and places extraordinary reliance on the content and form of public regulatory measures. The development of helicopter services -- and the potential benefits to be derived from them -- depend therefore to a large extent on the restrictions imposed upon its use.

Planning for helicopters has been a difficult problem for local officials. Helicopters were rushed into use before their functions were properly understood. Their potential suffered from the overenthusiasm of the industry and from the skepticism of public officials. To a considerable degree, the helicopter can play a useful role in the urban transportation system. To survive, though, its operating requirements must be understood, assessed fairly, and regulated intelligently.

APPENDIX A

ROOF-TOP HELICOPTER LANDING FACILITIES

The Los Angeles Fire Department's minimum fire safety requirements for roof-top helicopter landing facilities follow. Use of such facilities is limited to the loading or unloading of passengers or freight. The refueling or repairing of helicopters is prohibited except in an emergency.

General:

1. The helicopter landing facility shall be located in an area that will permit a glide slope angle of eight feet horizontal distance for every one foot vertical clearance required. Two such approaches shall be available, at least 90 degrees removed from each other.

2. On all touch-down or landing areas, whether elevated or flush with the roof, provision shall be made for collecting fuel which may be spilled in event of any emergency. Separator or clarifier tanks for collecting spilled fuel shall be installed under approval and supervision of the Industrial Waste Control Section of the Bureau of Sanitation.

3. The touch-down area shall be surrounded on all sides by a clear roof area averaging 15' in width, but with no side less than 5' wide. For helicopters of less than 3,500 lbs. gross weight, the touch-down area shall be a minimum of 20' x 20' in size. The minimum size of the touch-down area for helicopters over 3,500 lbs. gross weight shall be at least one and one-half (1½) times the rotor diameter.

4. If the roof has no parapet wall, a substantial fence shall be provided around the perimeter of the roof.

5. A wind indicating device shall be installed. A flag, banner, or any other device is acceptable.

6. The roof-top shall be marked as prescribed by the Federal Aviation Agency.

Fire Protection:

1. Two or more wet standpipes shall be provided and equipped with 1½" rubber lined fire hose not over 75' in length. Hose shall be equipped with combination fog nozzles. Sufficient pressure shall be available to afford a good fog pattern. Hose cabinets or racks shall be located near the separate exists. Standpipes shall be so located that all portions of the roof area shall be accessible to within 20 ft. of the nozzle when attached to not more than 75' of hose.

SOURCE: Fire Department Requirements issued by City of Los Angeles as F.P.B. Requirement No. 50, March 26, 1964.

2. Two dry powder type fire extinguishers of at least 16 BC rating shall be provided. If desired, a CO_2 extinguisher of equal rating may be substituted for one of the dry powder extinguishers.

Exits:

1. The roof-top shall have two conforming exits and they shall be remote from each other.

Obstructions:

1. No light standards, roof vents, guy lines, TV antennas, or other similar roof-top obstructions which may be difficult to see from the air, shall be permitted within the required guide slope on three sides, or with a 270 deg. arc.

2. Such lights as are installed shall illuminate and be directed onto the touch-down pad only, and in such a manner that the light rays cannot interfere with the helicopter pilot's vision.

3. No persons shall be permitted in the general landing area in any location where any portion of their bodies will be higher than the touch-down area surface while landing or take-off operations are under way.

Communications:

1. Approved means of communication such as telephone, radio, fire alarm box or signalling device shall be provided adjacent to the landing area.

APPENDIX B

ZONING DISTRICTS OF SELECTED CITIES IN WHICH HELICOPTER LANDING FACILITIES ARE PERMITTED*

Anaheim, California

Permitted Use: Helistops in manufacturing district M-1

Conditional Use: Heliports in residential-agricultural district RA; commercial districts C-1, C-2 and C-3; manufacturing districts M-1 and M-2

Boston, Massachusetts

Conditional Use: General business districts B-1, B-2, B-4, B-8 and B-10; restricted manufacturing districts M-1, M-2, M-4, and M-8; waterfront industrial district W-2; general industrial district I-2

Chicago, Illinois

Conditional Use: Heliports in local retail districts B1-1 to B1-5; restricted retail districts B2-1 to B2-5; general retail districts B3-1 to B3-5; restricted service districts B4-1 to B4-5; general service districts B5-1 to B5-5; restricted CBD B6-6 and B6-7; general CBD B7-5 to B7-7; restricted commercial districts C1 to C5; general commercial districts C2-1 to C2-5; commercial manufacturing districts C3-1 to C3-7; motor freight terminal district C4; restricted manufacturing districts M1-1 to M1-5; general manufacturing districts M2-1 to M2-5; heavy manufacturing districts M3-1 to M3-5

Cincinnati, Ohio

Permitted Use: Riverfront commercial-industrial district RF-2

Conditional Use: Riverfront recreational-residential district RF-1

Dallas, Texas

Conditional Use: All districts

Denver, Colorado

Permitted Use: Heavy business district B-5; industrial districts I-0, I-1, I-2

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*All information obtained from cities' zoning ordinances.

Fort Worth, Texas

Conditional Use: All districts

Kansas City, Missouri

Conditional Use: Residential districts R-A, R-1, R-2, R-3, R-4, R-5, R-6; commercial districts C-1, C-2, C-3, C-4; manufacturing districts M-1, M-2, M-3

Los Angeles, California

Permitted Use: Light industrial district M2; heavy industrial district M3

Conditional Use: All districts except RA, R, C1 and CR

Miami, Florida

Permitted Use: Waterfront recreational district W-R

Conditional Use: Central business district C-3; commercial districts C-4 and C-5; industrial districts I-1 and I-2

Minneapolis, Minnesota

Conditional Use: Helipads in community retail district B3. Heliports and helipads in community service district B3S; light manufacturing district M1; limited manufacturing district M2; general manufacturing district M3

New Haven, Connecticut

Permitted Use: Heliports in marine business district C; central business district D; wholesale and distribution business district E; light industrial district L; heavy industrial district H

New York, New York

Conditional Use: Heliports in general central commercial district C6; general service district C8; light manufacturing district M1; medium manufacturing district M2; heavy manufacturing district M3

Phoenix, Arizona

Permitted Use: Private heliports in industrial districts

Pittsburgh, Pennsylvania

Conditional Use: Commercial districts C4 and C5; manufacturing districts M2, M3 and M4

Portland, Oregon

Conditional Use: Heliports in manufacturing districts M1 and M2. Helistops in commercial districts C1 and C2; manufacturing district M3. Private helistops accessory to a hospital in R5, R7, A0, A1, A2.5 and C4. Private helistop with a minimum lot area of 10 acres in R20

San Francisco, California

Permitted Use: Industrial districts

Conditional Use: Commercial districts; residential districts for public purposes

Seattle, Washington

Permitted Use: Industrial districts; manufacturing districts

Conditional Use: Helistops in business districts and residence districts

REFERENCES

1. Dale H. Dooley, "Preparing Your Community to Accept Helicopter Facilities as a Land Mark of Progress." Presented at the Second National Conference, Planning and Designing Urban Helicopter Facilities, Los Angeles, October 18-19, 1962, p. 3.

2. Heliport Design Guide, Federal Aviation Agency Advisory Circular, November 1964, p. 3.

3. 1964 Directory of the Helicopter Operators Commercial - Executive - Government and the Helicopter Flight Schools in the United States and Canada. The Vertical Lift Aircraft Council, Aerospace Industries Association, 1725 De Sales Street, N.W., Washington, D.C. 20036, 1964.

4. Government-Industry Relations in the Field of Vertical Lift Aircraft. Presentation to FAA by the Vertical Lift Aircraft Council, September 20, 1963, p. 4.

5. Heliports-Helistops in the United States, Canada and Puerto Rico. The Vertical Lift Aircraft Council, Aerospace Industries Association, 1963.

6. John E. Roberts, "Analysis of Twenty Case Histories in the City of Los Angeles." Presented at the Second National Conference, Planning and Designing Urban Helicopter Facilities, Los Angeles, October 18-19, 1962, p. 6.

7. "Air Carrier Traffic Statistics, Civil Aeronautics Board." From Outlook for Vertical-Lift Aircraft in Scheduled Commercial Transportation, United Research, Inc., 1730 Cambridge Street, Cambridge 38, Mass., 1963.

8. James C. Buckley, Heliport Survey for the Philadelphia City Planning Commission, James C. Buckley, Inc., 30 East 40th Street, New York, N.Y., 1959, p. 28.

9. Outlook for Vertical-Lift Aircraft. . . . Op cit. III-29.

10. Ibid., p. III-49.

11. M. F. Bagan, "Financing and Managing Successful Helicopter Facilities." Presented at the Second National Conference, Planning and Designing Urban Helicopter Facilities, Los Angeles, October 18-19, 1962, p. 7.

12. Bruce W. McNeil, "Planning, Designing, and Operating Helicopter Facilities, from the Viewpoint of a Helicopter Air Taxi Operator." Presented at the Second National Conference, Planning and Designing Urban Helicopter Facilities, Los Angeles, October 18-19, 1962, p. 3.

13. Richard K. Waldo, "The 10-Year Outlook for Helicopters." Presented at the Second National Conference, Planning and Designing Urban Helicopter Facilities, Los Angeles, October 18-19, 1962, p. 4.

14. Text of a slide presentation on FAA Project Hummingbird by the Federal Aviation Agency at the National Conference of the American Society of Planning Officials, Denver, 1961, p. 11.

15. Chicago Helicopter Airways, Inc. Civil Aeronautics Board Docket 14008 et al.

16. San Francisco and Oakland Helicopter Airlines. Civil Aeronautics Board Docket 14029 et al.

17. Heliports-Helistops in the United States, Canada and Puerto Rico. Op. cit., p. 36.

18. Bruce W. McNeil, op. cit., p. 1.

19. Washington, D.C., Helicopter Noise Test. Staff Summary, National Capitol Planning Commission, Washington 25, D.C., October 1961.

20. John E. Roberts, op. cit., p. 5.

21. Charles W. Bahme, "Fire Protection for Elevated Heliports," Quarterly of the National Fire Protection Association, Vol. 58, No. 1, July 1964, p. 8.

22. Loc. cit.

23. Loc. cit.

24. Heliport Design Guide, op. cit., p. 15.

25. L. Welch Pogue and Philip A. Fleming, "Status of Urban Helicopter Facilities." Presented at the Second National Conference, Planning and Designing Urban Helicopter Facilities, Los Angeles, October 18-19, 1962, p. 25.

26. Ibid., p. 20.

27. L. Welch Pogue and George C. Neal, "Legal Aspects of Planning for Urban Heliports," Virginia Law Review, Vol. 46, No. 1, 1960, p. 89.

28. Loc. cit.

29. John E. Roberts, op. cit., p. 4.

30. Heliport Design Guide, op. cit., p. 16.

31. Letter from the Seattle Planning Commission, October 30, 1964.

32. M. F. Bagan, op. cit., p. 6.

33. James C. Buckley, op. cit., p. 15.

34. Recommendations with Regard to Heliports and Helistops Prepared for the Philadelphia City Planning Commission, City of Philadelphia Department of Commerce, Division of Aviation, 1960, p. 8.

BIBLIOGRAPHY

American Society of Planning Officials. Heliports in the City Plan. Planning Advisory Service Information Report No. 52, Chicago, Illinois, July 1953.

Angstadt, R. S. "Operations of Chicago Helicopter Airways, Inc." Journal of The Royal Aeronautical Society, 4 Hamilton Place, London W.1, Vol. 66, No. 620, August 1962.

Ashlock, James R. "Expansion Seen Saving Helicopter Service," Aviation Week, August 24, 1964.

Baltimore Planning Commission. A Study of Heliports for Baltimore City, Baltimore, Md., 1954.

Bolt, Beranek & Newman, Inc. Land Use Planning Relating to Aircraft Noise. Technical Report prepared for the Federal Aviation Agency, October 1964.

Borgeson, Melvin B. "Planning for Helicopter Service in the New York Metropolitan Area," Landscape Architecture, October 1953.

Branch, Melville C. "Urban Planning and the New Mobility," Journal of the American Institute of Planners, Vol. XXX, No. 1, February 1964.

Buckley, James C., Inc. Heliport Survey for the Philadelphia City Planning Commission, Philadelphia 7, Pa., December 1959.

Clegg, Peter. "Unsubsidized Helicopter Operation May be Round the Corner," Aeroplane and Commercial Aviation News, London, June 25, 1964.

Federal Aviation Agency. Aircraft Noise Abatement. Planning Series Item No. 3, Washington, D.C., September 1960.

Federal Aviation Agency. Airport Maintenance. Advisory Circular AC No: 150/5380-1. Washington, D.C., April 1963.

Federal Aviation Agency. Certification and Operations of Scheduled Air Carriers with Helicopters. Federal Aviation Regulations Part 127. Distribution Section, HQ-438, Washington, D.C. 20553, 1964.

Federal Aviation Agency. Heliport Design Guide. Advisory Circular AC No.: AC 150/5390-1. Washington, D.C. 20553, November 1964.

Federal Aviation Agency. Project Hummingbird. A Technical Summary and Compilation of Characteristics and Specifications on Steep-Gradient Aircraft, Washington 25, D.C., April 1961.

Henderson, Danna K. "Helicopters - Should They Be Subsidized?" American Aviation, August 1963.

Kawa, Myron M., Jr. "Helicopters Are Not Noise Makers," The American City, May 1960.

Los Angeles Chamber of Commerce. Second National Conference on Planning and Designing Urban Helicopter Facilities. Institute of Aerospace Sciences, 404 South Bixel Street, Los Angeles, California 90054, October 18-19, 1962.

McDonnel Aircraft Corporation. STOL-V/STOL City Center Transport Aircraft Study. Technical report prepared for Federal Aviation Agency, Aircraft Development Service, Washington, D.C. October 1964.

Miller, Laymon N., Beranek, Leo L., and Sternfeld, Harry Jr. "Acoustical Design for Transport Helicopters," Noise Control, March 1959.

Nesbitt, Edward J. Consideration of Helicopter Noise and Rotor Airflow in Heliport Planning. Sikorsky Aircraft, Stratford, Conn., 1962.

"New York Heliport Sets Pattern for the Future," American Aviation, November 1963.

Pogue, L. Welch. "Business Trends in Rotary Wing Operation." An address presented before the 13th Annual Convention of the Helicopter Association of America, Haddonfield, N.J., January 1961.

Pogue, L. Welch, and Neal, George C. "Legal Aspects of Planning for Urban Heliports," Virginia Law Review, Vol. 46, No. 1, 1960.

Recommendations with Regard to Heliports and Helistops for the Philadelphia City Planning Commission. Philadelphia Department of Commerce, Division of Aviation, May 1960.

San Francisco Bay Area Council. Helicopter Service for the San Francisco Bay Area. Bay Area Aviation Committee, San Francisco, Calif., 1957.

Stanford Research Institute. An Economic Analysis of Commercial VTOL and STOL Transport Aircraft. Final report. Prepared for Federal Aviation Agency, Aircraft Development Service, Washington, D.C., February 1965.

United Research, Inc. Outlook for Vertical-Lift Aircraft in Scheduled Commercial Transportation. Prepared for the United Aircraft Corporation, The Boeing Company, and the General Electric Company, 1730 Cambridge Street, Cambridge, Mass., 1963.

Vertical Lift Aircraft Council. 1964 Directory of the Helicopter Operators, Commercial - Executive - Government, and the Helicopter Flight Schools in the United States and Canada. Aerospace Industries Association, 1725 De Sales Street, N.W., Washington, D.C. 20036, 1964.

Vertical Lift Aircraft Council. Government-Industry Relations in the Field of Vertical Lift Aircraft. Presentation to the Administrator of the Federal Aviation Agency, Aerospace Industries Association of America, Inc., 1725 De Sales Street, N.W., Washington, D.C. 20036, September 20, 1963.

Vertical Lift Aircraft Council. Heliports - Helistops in the United States, Canada and Puerto Rico. Directory published by the Aerospace Industries Association of America, Inc., 1725 De Sales Street, Washington, D.C., November 1963.

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CONTENTS