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"A COMMERCIAL HELICOPTER OPERATOR'S RADIO NAVIGATIONAL REQUIREMENTS"

Some time ago, a noted electrical engineer for one of the helicopter manufacturing companies stood on this very spot and read the title of his paper. It was, as I remember, "The Differences Between the Electrical Systems of Fixed Wing and Rotary Wing Aircraft." After reading the title of his paper, this engineer stated simply: "There aren't any," and sat down. He did, however, return and point out some minor differences mostly in weight and size. I wish my answer could be that simple. I would like to say that there are no differences between the fixed wing navigational requirements and the rotary wing navigational requirements. But this would be impossible. True, both types of vehicle contain much of the same components, engines, generators, passenger seats and landing gear; and both types of vehicle are used for the same general mission: transportation of passengers, mail and freight. Here, however, even though they both use the same medium, the air, for movement, the similarity ends. The navigational systems and equipment that exist today were designed for aircraft that are equipped for long range, high altitude and high speed flights. Today's equipment has been designed over a period of the past 25 years by close cooperation of manufacturers, airlines, and interested companies. The advances in the state of the art are profound and noteworthy. For example, the four leg-Loop range system, developing into manual D.F. receiving equipment, further developing into automatic direction finding equipment. This is only one example, there are many others. But these examples all go to point up this one fact: While everyone is sure that the ultimate in radio-navigational equipment hasn't been reached, the fixed wing air carrier does have its own tailor-made equipment containing features that are designed around its own high speed,

high altitude, long flight type of operation. If we were to try to adapt this equipment for the needs of the helicopter we would be faced with a number of things. Equipments designed for the larger aircraft impose a small weight penalty, percentage wise, to the payload of the larger equipment. However, if the same equipment were loaded into a helicopter of today or even tomorrow, it could comprise nearly one-fourth of the payload of the machine. A dual ADF, dual Omni-Range receiver system, a glide slope, localizer, marker beacon receivers, radar transponders, etc. for the fixed aircarrier weigh in the neighborhood of 300 pounds. The average payload of the helicopter today (S-55) is 1200 pounds: a net result of 25 per cent of the payload. Yet the helicopter must take off at a terminal point in somewhat the same conditions as the fixed wing machine, navigate to a point, let down and land. But weight of the equipment is only one facet, and if it were the only consideration, I could say, as did the engineer I referred to earlier, "There aren't any differences--we have no problems" and sit down.

As a background for presenting our navigational requirements and needs for a navaid designed for and adapted to the helicopter, I would first like to point out some of the operational functions of the helicopter on the Los Angeles Airways system. These machines, today, are flying VFR--visually, under the weather. Keep in mind however, that the statistics quoted are today's flight patterns and routes. It is not unrealistic to assume that these statistics can be increased five or ten times in the foreseeable future. Further, these requirements and conditions could possibly be applied to any Helicopter Metropolitan Area operation with only slight modification of details.

Our routes are geographically tri-sected by two ranges of hills to result in three valleys of service: The Los Angeles Basin, the San Fernando Valley, and the Pomona - San Bernardino - Corona area. These hills are not high (1300 to 1500 MSL) but they do intensify the weather phenomena typical to this area and in our present "under-the-weather" VFR flying, present, at times, impassable obstacles. At the present time our navigational tools are: a slaved gyro

compass, artificial horizon, a magnetic compass and pilotage. A heliport, our landing site, is an area usually some 150 feet on a side, surrounded by a low fence, a wind "tee" in the corner, and to uninitiated personnel trying to locate it from the air, it can be clearly recognized by its immediate proximity to an automobile or a truck parked out in the middle of an open area. There are some 27 Regular (soon to be 35) and 22 Provisional heliports in the L.A.A. System. Some are located in vacant lots, some in city dumps (Alhambra is one of these, as you might remember from Secretary of Defense Wilson's comments) but very few are located at airports. Because of the integration problem of the helicopter with fixed-wing aircraft, whether air carrier or private, it has been L.A.A.'s considered decision to stay away from these established airports wherever possible. True, in some cases there would be terminal landing facilities for instrument operation available, but the entire advantages of the helicopter as a time-saving device would be lost if it were to be integrated with fixed-wing traffic and, for example, routed to the outer marker to orbit at 18,000 feet in the "stack" awaiting approach clearance.

Clearly stated, then, we have the following problems:

(1) 88 daily arrivals and departures from the Los Angeles International Airport bound for all or a portion of the 49 heliports. These trips are scheduled to operate throughout 20 of the 24 hours of the day. They include 24 round trip "shuttles" to the downtown Terminal Annex Post Office and the balance operate over the system.

(2) Weather. Stratus, haze, smoke, "smog" frontal activity and the results thereof,

(3) and the most serious problem, the completion of these scheduled flights.

Whenever we get into a discussion of a helicopter navaid or helicopter instrument flying, we always seem to preface our remarks with "when we get multi-engine equipment..." Referring to a Stanford Research Institute Report on "Helicopter Navigation Requirements", I found the statement: "Multi-engined helicopters will not be available for extensive aircarrier operations prior to 1960";

and while this statement might be more than a little optimistic, if we accept it, it means that we could conceivably have the multi-engined machine before we have the means and methods to navigate it under IFR conditions. Yet, the lethargy prevails: 'We don't have the machine--we don't have the aid. When we get one--we'll have the other." I don't subscribe to this, and fortunately, neither do some of the rest of the industry. No one wants the aid to be a "Topsy" who was never born but "jus' growed", and the commercial helicopter operators as well as the utility helicopteroperators have taken increased heart in the activities of the industry manufacturer's interest in our problem.

Now, if we had the aid today, what could we accomplish? Assuming that existing CAR's that limit instrument flight to multi-engined aircraft are in force, what could we do with it? First, in marginal weather, the pilot could back up his pilotage. Present minimums call for 300 and ½ (300 foot ceiling and ½ mile visibility). I have been on flights under those conditions and looking over the side, I could see roads and houses; but I was certainly glad that the pilot had been over the route many times before, because all those roads and houses looked pretty much alike to me. Secondly, the pilot could not be expected to take his brand new multi-engined helicopter and brand new navaid and take off and go flying in instrument weather. He certainly would require considerable training on the aid and the system. If we had the aid now, this would be accomplished as well as to perfect the aid and develop the overall helicopter instrument plan into a package that fits the requirements.

Let me outline a few of the evaluation tests we have made on existing systems, pointing out their advantages yet incompatibility with the helicopter system.

(1) The low frequency group. The Loop, Adcock, or four-leg range system, through use of a low frequency receiver with associated antennae and filters would provide the same aural signal to the pilot of the helicopter as it would to the fixed-wing pilot. He could orient himself, bracket the legs of the range, and navigate. Unfortunately, these ranges were established as guide posts for the fixed-wing airway

system and there just aren't enough of them to provide navigational information for the helicopter who is traveling from suburban city to suburban city within a 65 mile radius of the center of a metropolitan area. The D.F. system or Automatic D.F. system has a little more advantage in enroute flying as it can be tuned to existing facilities (homing beacons, L.F. ranges, broadcast radio stations, marker beacons, etc.) and through the use of tangent course computing, enroute information could be obtained. Further, it isn't inconceivable that landing information could be obtained if a pair of airborne receivers were used in conjunction with a pair of in-line homing beacons or similar facilities lined up with the approach area to the heliport or terminal. The obvious disadvantages of this are multiple: two ADF equipments in the helicopter; the non-existence of homing facilities in the immediate proximity to the 49 heliports; and the unavailability of frequencies in the spectrum to establish these facilities. In short, the L.F. or ADF system could be used to navigate enroute, but could not be used for landing.

(2) I.L.S. The Instrument Landing System composed of two airborne receivers on paired channels with a crossed needle presentation to the pilot, works very well in the helicopter. The approach speed is slow enough that the helicopter can make a very accurate approach, in fact, he could follow every minor deviation and "dog-leg" that is known to exist in many of the I.L.S. installations throughout the country. These installations, however, exist only at the major airports throughout the country at considerable capital and maintenance cost. Imagine the cost to a commercial operator to install and maintain 49 of these systems! And even if the operator could stand the cost, the frequency availability problem would again defeat the system. Here too, frequencies in this number are not available. It would have the undesirable effect of forcing the helicopter to be integrated with the fixed-wing traffic at terminal points.

area vehicle. Look at the complexity of "airways" we would have to have if we were to set up such a system for even our present day VFR traffic. The Los Angeles Metropolitan area is approximately 35 miles in a north-south direction and 65 miles in an east-west direction. And as previously pointed out, we now serve 27 separate stops on a regularly scheduled basis (which will be soon increased to 35) plus an additional 22 stops on a provisional basis for alternate operations under the terms of our certificate. This is a total of 57 stops in an area of 35 by 65 miles. The actual establishment of all possible routes between these 57 stops and the various terminals would create a maze of cris-crossing "airways" and the constant revision of these routes due to moving of the heliports (which happens more than occasionally) revision of flight patterns and changes of ground tracks due to constant construction on the ground would impose a heavy burden on not only our company but any helicopter operator in the area. The complexity of the "airway" system would be none less complicated in an IFR system. Therefore, our navaid would have to supply us, in lieu of the navigational information to stay within a fixed track or airway, the pinpoint navigational information to allow the helicopter to pass through any area in safety with adequate vertical and adequate lateral separation with other helicopters.

It is obvious then, that a privately owned, installed, and operated navaid for the movement of helicopters is not the answer. A controlling agency must be established for the purposes outlined. This agency must have sufficient tracking facilities to monitor the helicopter movements and to back up the helicopter position reporting. Perhaps a branch of ATC (Air Traffic Control) could be established for this purpose. We also strongly maintain that all helicopter approaches to terminal points be maintained, as they are now, at right angles to the fixed-wing patterns and approaches. Along these same lines, further thinking by our operational people have developed approach plans that would cause the helicopter to "break out" into visual conditions at a minimum altitude of no less then 100 feet at a point no closer then 1 mile from the airport and thence be controlled by the tower facility in much the same manner as they do now to approach and cross the active runways to

land under visual rules. This one-mile point was designed to allow for missed approaches by the helicopter to make a climbing turn back to altitude without becoming intermingled with the fixed-wing traffic.

The controlling agency, which we might call HATC, possibly using a surveillance radar, could guide the helicopter through the area or into an approach corridor with standard (helicopter) approach procedures. These approach corridors could fan out from a point a mile either side of the active runways to accommodate traffic arriving from all points of the system. The spacing of the traffic inbound or outbound can be controlled by the agency who can assign altitudes as well as maintain monitor on the lateral spacing. It is not recommended that the primary movement aid be the surveillance radar but that it act as a backup to the helicopter's airborne navaid system. It is further envisioned that the HATC, as a part of ATC will have much the same control area as they have now. In the Los Angeles area, the four controls, Burbank, Los Angeles, Long Beach, and Ontario, would appear more than adequate for safe instrument flying in the system.

So much for the plan, without which, however, we feel no navigational system can be made to work adequately, and back to the "aid". We have some general recommendations to the designer-manufacturer. These are:

(1) Equipment to be light weight (airborne portion) in keeping with the limited payload of the helicopter.

(2) Comprehensive yet simple cockpit presentation.

(3) "Ground up" coverage.

(4) Accuracy commensurate with function.

(a) Terminal approach: 50 feet of actual course.

(b) Climb to enroute altitudes: 50 feet of actual course.

(c) Enroute flying: somewhat less accuracy required.

(d) Let-down to heliport approach: 50 feet of actual course.

(e) Heliport landing and departures: 50 feet of actual course.

Further, we'd like to look over the shoulder of the design engineer and add a few notes for his consideration:

(1) The helicopter is now, and will continue to be, a slow speed machine.

(2) While it is capable of hovering enflight, it does not normally do so.

(3) While it is capable of vertical ascent and descent, it does not normally do so. A standard approach angle should be considered in the neighborhood of 10^{o}. A standard departure angle should be considered in the neighborhood of 10^{o}:

(4) It has limited skin surface for antenna; therefore, increase your receiver sensitivity rather then depend upon large antenna capture area. The present S-55 has 9-10 inches of usable antenna space directly below the cabin, slightly more fore and aft.

(5) It has a very limited payload. Keep the equipment light. Design for the maximum weight to be placed in a single, readily removable "black box" that can be removed for "fair weather" flying.

(6) No "P-Static" conditions have been observed on S-55 or S-51 aircraft (such as static departure pitting of the skin, etc.), however, this phase should be investigated as it could determine the part of the frequency spectrum or type of emission of the aid. (Static wicks on the blade tips would appear highly impractical from an aerodynamic standpoint.)

(7) Adequate "fail-safe" systems to advise the pilot whether or not his equipment is functioning properly.

(8) Keep in mind the "dual installation" requirements that are now in force with most fixed-wing equipment. Design major components for dual function if required, thus reducing weight.

(9) From a power standpoint, most helicopters are equipped with both 27.5 VDC and 110 VAC 400 CPS systems; however, the latter is usually just adequate for its required functions. A complete system operating from the primary power, developing its own high voltage or functional AC requirements would seem desirable.

Generally, then, that is the picture. These are our requirements and we

don't feel that they differ too greatly from the requirements of the rest of the helicopter industry. I certainly hope that these specifications and requirements may help in some way in producing a navaid for helicopters. At the same time, however, I want to emphasize that these requirements and recommendations are not iron-clad and can and will be revised if necessary to fit an aid that will provide the navigational information we need and can use.

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