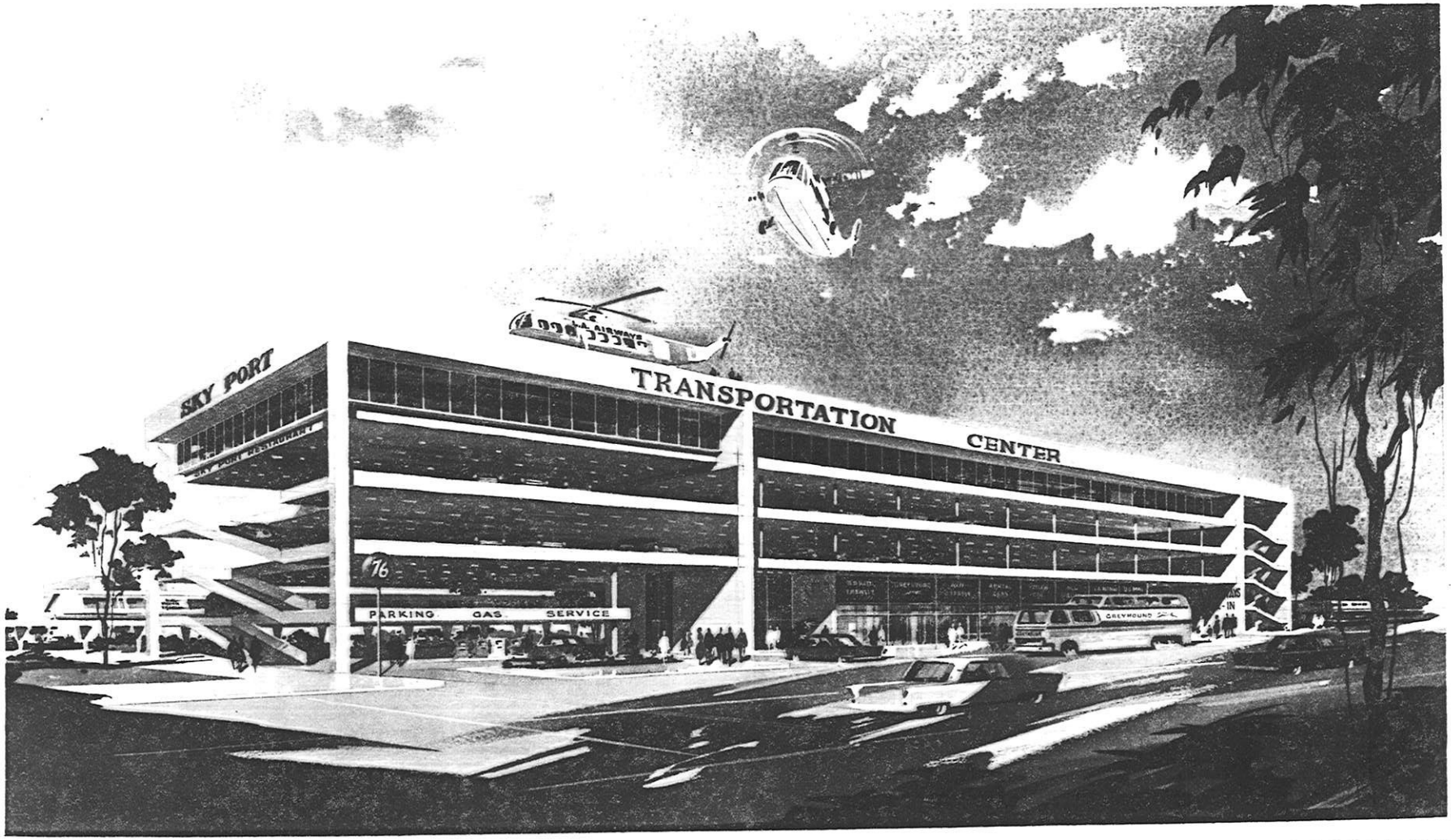


TRANSPORTATION CENTER
DEVELOPED BY L. A. AIRWAYS

KURT MEYER & ASSOCIATES
ARCHITECTS

NO RUNWAY NEEDED
Los Angeles #1 Opportunity Market

The 1990's offer some serious challenges for NORTHWEST and it's Los Angeles, gateway as it emergences into the world market. As airlines seek passengers for global traffic, competition for world travelers and freight will become more intense. Innovative marketing concepts will be required to capture these service conscious passengers.

Overcrowding is one of the major problems to overcome at LAX and is a wide spread Southern California phenomennon. The demand exceeds the capabilities of Terminal II and we are limited to futher expansion by the restrictions of our lobby, and baggage handling systems. The physycial layout of Terminal II inhibits our ability of giving superior service to our customers. Passengers are overwhelmed when they finally get to the airport after traveling gridlocked freeways, seeking space curbside to park, encountering harried skycaps, then to find a line inside of 100 or more in front of them. Our customers panic! Presently during our 10:00 to 13:00 push with 1400+ seats to fill, we are operating at full capacity. On 90% load factor days I re-book 15-20 passengers that miss their flights. Considering I am only one of 44 agents on the front line, at least 200 passengers are mis-judging the amount of time required to get to LAX, park, check in and board their flights.

To provide additional capacity as the Pacific Rim traffic increases along with expansion into Eurpoean markets feeding KLM route system, we must seek remote locations to process passengers. In meeting NW objectives to enhance customer service we have to begin operating more like a hub instead of a spoke.

I am sure we all agree that the best way to arrive at an airport is to fly in. This is one of the operating advantages our hubs enjoy. During their heavy pushes it's just a matter of transfering passengers from one plane to another while our problem is where to find space to process all our passengers seeking positions curb side, putting a severe strain on our front line people at the counter and resulting in congestion at security screening positions, our major bottle neck.

The ideal solution would be to tie in with an air-taxi operator but there are none presently operating from the areas our passengers travel from. Besides that, with over 2,500 daily fixed-wing operations, the traffic-jam in the approach pattern is almost as bad as the ground ingress.

S E R V I C E is going to be the key to keeping customers in the 90's. Most customers remember the days when gasoline stations gave service, pumped your gas, washed your windshield, checked your oil, ect, and yes it's true a few airlines still send limos to passenger's homes to ease their journey to the airport. NORTHWEST has a unprecedented opportunity to give their Southern California customers a better WORLDCLASS option; to arrive at LAX in Presidential Style. NORTHWEST passengers can be assured of a " seamless" travel experience by flying over the clogged Los Angeles freeway system in a reliable, on time, all weather, Sikorsky S-61 Helicopter.

ADVANTAGES OF REMOTE PROCESSING

** SET NEW STANDARD OF CONVENIENCE*
** IMPROVE LAX STATION PERFORMANCE.*
** INCREASE PASSENGER PROCESSING CAPACITY.*
** RELEIVE TERMINAL CONGESTION.*
** CAPTURE AND RETAIN NEW PASSENGER & FREIGHT MARKETS.*
** INCREASE U.S. MAIL REVENUES SYSTEM WIDE.*
** ADD PRESTIGE TO NORTHWEST IMAGE.*

In 1968 United and American airlines realized it was cheaper for them to have L.A. Airways fly their passengers into LAX already checked in than to process them theirselves. They paid LAA in excess of 1 million (1968) dollars for these services which will attest to the value of processing passengers off-site as well as the volume of business obtainable.

The market already exists and can be confirmed by surveying our Southern California frequent flyers. I am sure you will find 90% live at least 1hr away from L.A. International and that they would be delighted to drive to a local heliport, check their luggage and receive boarding passes to their final destination. Anaheim and Santa Ana will grow 80 % within the next 10 years. Mr. Gary Wilson former member of N.W. Board and now chief financial officer of Disney, might be quite influential in re-establishing service to Anaheim (LAA Anaheim Heliport on Disney property) which would make NORTHWEST the obvious carrier of preference on the routes we serve from LAX!

Anaheim would be an ideal site to build a transportation center. With local ground service facilities on the lower level, Airline City Ticket offices, gift shops and parking on the intermediate levels, and NW Helicopters operating on the upper levels it would not only give NORTHWEST a strong presence in Orange County but the facility would be self-supporting, generating non-airline operating revenues for NORTHWEST. The San Gabriel and San Fernando Valleys would be other ideal sites for Transportation Centers.

The Sikorsky S61 is the first helicopter specifically designed as a commercial short haul airliner, and the first multi-turbine helicopter certified for passenger service. This multi-purpose verticle lift vehicle requires no run way! (a 200 by 400 foot landing pad in suburban areas is sufficient). Tight, reliable, all weather schedules can be maintained without intefering, or being hindered by fixed-wing traffic.

The Sikorsky S-61 has a distinguished lineage with millions of flight hours logged in airline service; Presidential transport, Astronaut recovery, VIP transport, military service, and offshore oil rig supply. KLM, Royal Dutch Airlines, British European Airways, Greenlandair and Trump Air are just a few of the present operators.

Each NORTHWEST S-61 helicopter operating in the L.A. basin can generate 125,000 passengers a year. A three aircraft operation can feed 375,000 passengers to NORTHWEST Domestic, Asian, and European routes capturing a market that no other LAX competitor could touch. NORTHWEST helicopters can also generate several million pounds of mail and freight revenue capturing many new markets not available to any other LAX carriers. Imagine if you will, the competitive advantage we could offer our Pacific Rim and European markets by saving 1 day in time by flying their freight right to the door step of their customers by eliminating LA's renown surface congestion! This opportunity to offset helicopter operation expenses would make this feeder service to LAX self-supporting and at the same time further establish NORTHWEST World dominance in Southern California.

This innovative concept is not unproven. In 1944 Clarence Belinn was able to get the top experts in helicopter operations and pioneer the World's first Helicopter Airline. Mr. Belinn's idea was right on target; unfortunately he was 30 years ahead of his time. Now more than ever this type of service is needed and NORTHWEST can greatly benefit from the technological advances that have been made.

L A Airways bore the expense of placing a new aircraft (S-61) into service which has now become the best helicopter ever built for passenger operations. LA Airways fought a continuing battle of 14 years with FAA in obtaining FAA certification of IFR operations suffering from unfortunate loss of business of cancelled flights due to the Southern California coastal phenomennon of early morning low clouds and fog. NORTHWEST can benefit from greater dispatch reliablity due to increased IFR capability and MLS technology. Just as important, the helicopter's Special Visual Flight Rules capability often sets it apart, and above, other aircraft utilization capabilities.

NORTHWEST can profit from the six years (1965-1972) of scheduled helicopter IFR passenger-carrying operations in the Los Angeles Basin. Many hundreds of hours of actual IFR were flown carrying tens of thousands of fare-paying passengers while meeting airline standards of performance and safety.

NORTHWEST can enjoy many benefits of S-61 operations that LAA did not enjoy. LAA operated in the days before the sophistation of computers NW has, and certainly would have profited from a PARS tie-in with travel agents. LAA had to maintain a staff of 100 reservations agents they had to pay even when the phones were not ringing. NW would not have to increase reservations staff, with the present staff just inquiring where a Southern California passenger would like to begin their journey. There would be minimal additional staffing, if any, required to work rotary-wing flights because of efficiencies obtained by accepting 25 connecting passengers already checked in with boa passes and baggage already tagged, just a simple transfer involved.

LAA pioneered 3 minute turns and so amount of time involved for ramp operations would require minimal or no additional LAX staffing. Insurance liabilities on three additional aircraft would be minimial compared to an air-taxi operator not able to spread out the costs over a large fleet of planes. Market rates for the Rotary-Wing pilot group could be realized as they would all be hired at the lowest tier, and should cause no conflict with the fixed-wing pilot group.

Our new association with KLM, already a S-61 operator, would allow NORTHWEST to realize reduced rotary-wing maintance costs by having gear boxs and other major helicopter components serviced in KLM's European facilites and shipped comat on NW scheduled trips. (S-61's are manufactered in Italy) KLM would no doubt be willing to share their expertise in present day operations of S-61 Helicopters.

"Siempre Primero" spanish for "Always First" was L.A. Airways motto. NORTHWEST can be the first U.S. airline to help relieve airport congestion for it's passengers. I believe there will never be a better time to introduce this innovative concept for NORTHWEST passengers for the following reasons:

* SIKORSKY'S DESIRE TO REVITALIZE IT'S CIVIL BUSINESS.

* PRESENT AVAILABILITY OF S-61 HELICOPTERS.

* POSSIBLE AVAILABLITY OF TERMINAL II CONNECTOR BUILDING FOR HELICOPTER OPERATIONS.

* OPPORTUNITY TO ATTRACT COMPETITION'S SATELITE MARKETS AT BUR, ONT, & SNA

* NORTHWEST'S NEED TO EXPAND CAPACITY TO FEED KLM'S EUROPEAN MARKET.

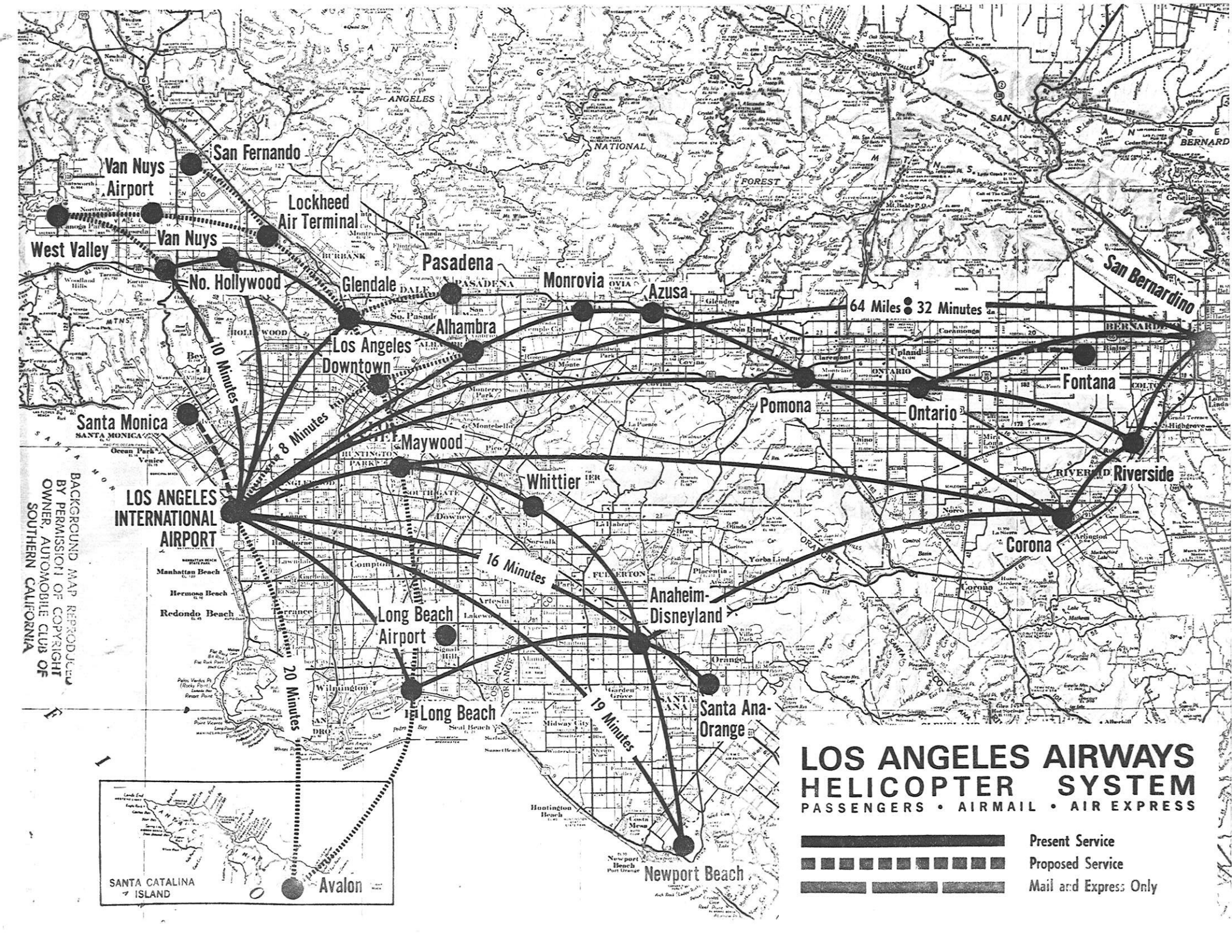
* KLM'S PRESENT OPERATING EXPERIENCE WITH S-61 HELICOPTERS.

* POSSIBLE ACCESS TO DISNEY'S ANAHEIM HELIPORT A PROVEN MARKET.

* AVAILABILITY OF FORMER L.A. AIRWAY'S RETIRED EXECUTIVES HELICOPTER OPERATIONS EXPERIENCE.

Mr. Fred Milam and Mr. Boyd Kesselring both retired executives of L.A. Airways, are willing to lend their support to NORTHWEST in starting a helicopter feeder system. Their vast experience and contacts with manufacturers, operators, and govermental officials in obtaining the best available aircraft, setting up maintenance procedures, and training rotary-wing pilot group is invaluable. Attached please find an old resume detailing my experience with LAA. I too would be willing to assist in any way necessary. In addition there are other former LAA employees in strategic positons such as Mr. John Hicks, Supt. of LAX operations, willing to lend support to airline helicopter operations of mixing rotary-wing and fixed-wing traffic at LAX.

Mike Minear
Customer Service Instructer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Van Nuys Airport
Lockheed Air Terminal
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No. Hollywood
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Herald Examiner 1-13-73

Readers' Forum
Letters to the Editor

Airport Congestion

Your editorial Jan. 5 relating to the SST program is a bench mark in clarity and purpose. Obviously you have done your homework well.

My primary interest in the matter relates to the other end of the spectrum, notably the short-haul segment. In my 45 years of experience in aviation, I have accumulated quite a bit of knowledge and information, usually based on practical application. Right now, one of the most miserable problems in scheduled air transportation is terminal congestion. Looking down the line, in 1946 the Post Office Department joined hands with the Civil Aeronautics Board and supported the creation of three test services by helicopter, the first of which was in Los Angeles. The contributions of these enterprises in both the Korean and Vietnam war effort have been astronomical. The service development resulting from high utilization levels and sophisticated operating techniques would have cost the taxpayer one hundred times more had the military been in the act. It is reasonably safe to say that spread over the three operators during a 25-year period, the developmental costs in terms of increased airmail and other postal revenues would have more than offset the developmental support dollars, normally referred to by the misleading and repugnant term "subsidy"

Events have now caught up with the vision of both the Post Office Department and the pioneer operators, except that the establishment appears, for some mysterious reason, to be turning its back upon the terminal market and dissipating its efforts and millions in two directions, neither of which are needed; one being the Supersonic, and the other being a critical version of the frozen-wing airplane, nicknamed STOL, which overlaps many of the existing medium-size airshipping science instead of their Creator and the results are evident in failing governments, the sky-rocketing crime rate, the frightening decay of the family unit, the rampant V.D. epidemic and the tragical losses in human lifes from drugs.

The hypothesis of evolution has had its share in destroying people's faith in their moral guide the Bible. Scientists are men like all the rest of us. They are just as ambitious, egotistical, dishonest and error prone as the rest of us. Because a hundred thousand scientists say it is so doesn't make it so. Evolution has become a religion for the scientists who dogmatically say it is a fact. For it has become for them a religion calling for faith: Faith in missing links, in processes which can not be demonstrated or observed such as beneficial mutation, faith in time periods which cannot be certified, recent moon findings putting earth's age and the carbon dating process into question.

Scientists argue that if you stick the Judeo-Christian creation story into the textbooks, you'll have to put every other religion's creation account into the books too. But evolutionists are divided into a chaotic number of different camps as regards how evolution is supposed to have occurred. They can't even agree among themselves, so they ask us to believe that evolution is a fact and have faith that one of them comes up with the evidence to prove evolution later.

Don't put the theory of evolution or the creation account in textbooks. Show the kids the facts. Explain that some believe in an accidental creation and evolution by nothing, and others believe in a special creation by an intelligent Creator with a purpose. Then let the kids decide what they want to believe.

ROSS YERKES
Los Angeles

UN Criticism

The letter of Palmer Van Gundy (Jan. 8,

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PARIS—It is 10 years since British membership in the

Sikorsky Revitalizes Its Civil Business: Past, Present, and Future

by Eugene Buckley

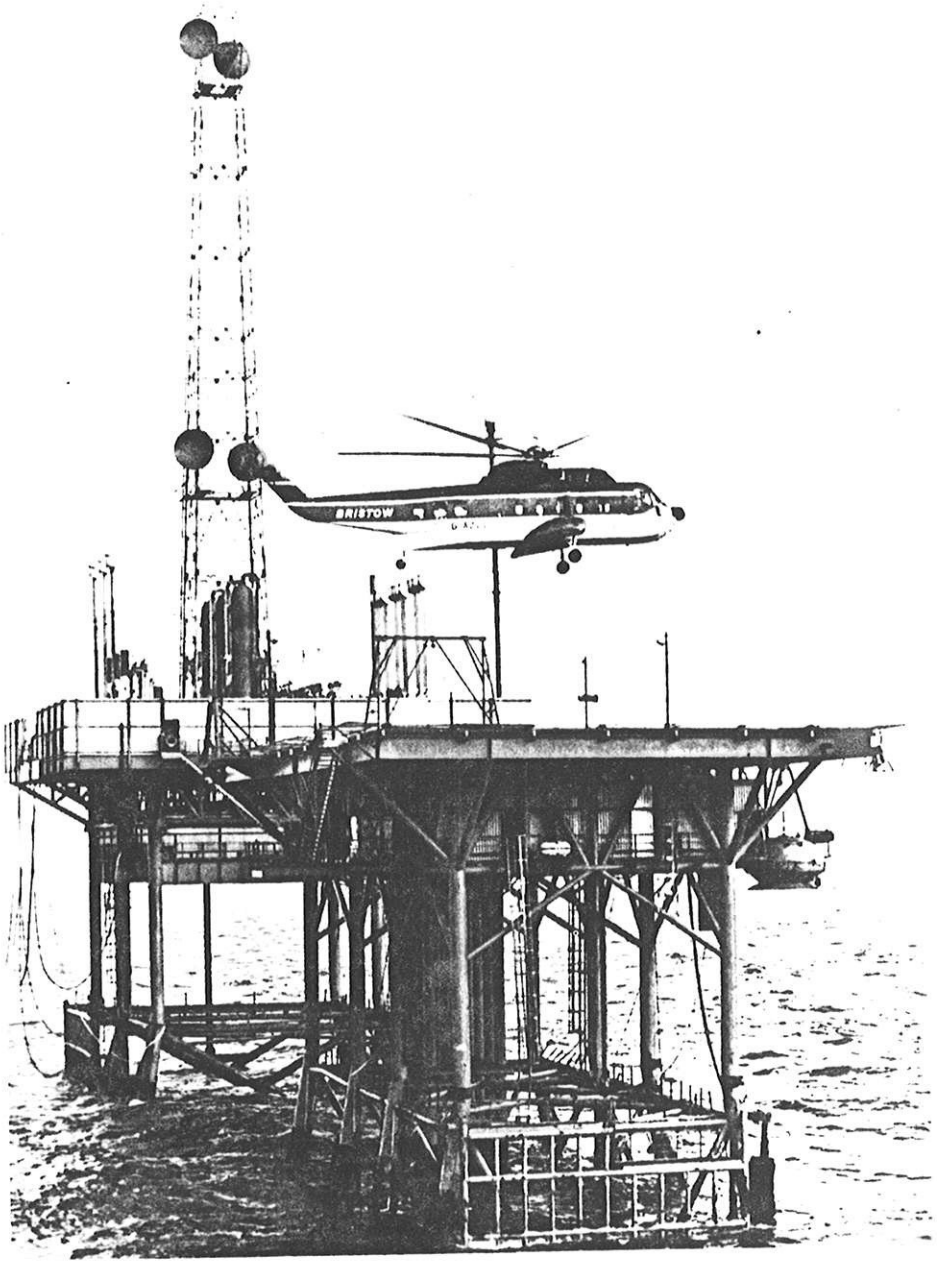
vertiflite (Feb 89)

For the past three years or so, the helicopter industry seems almost to have been on hold.

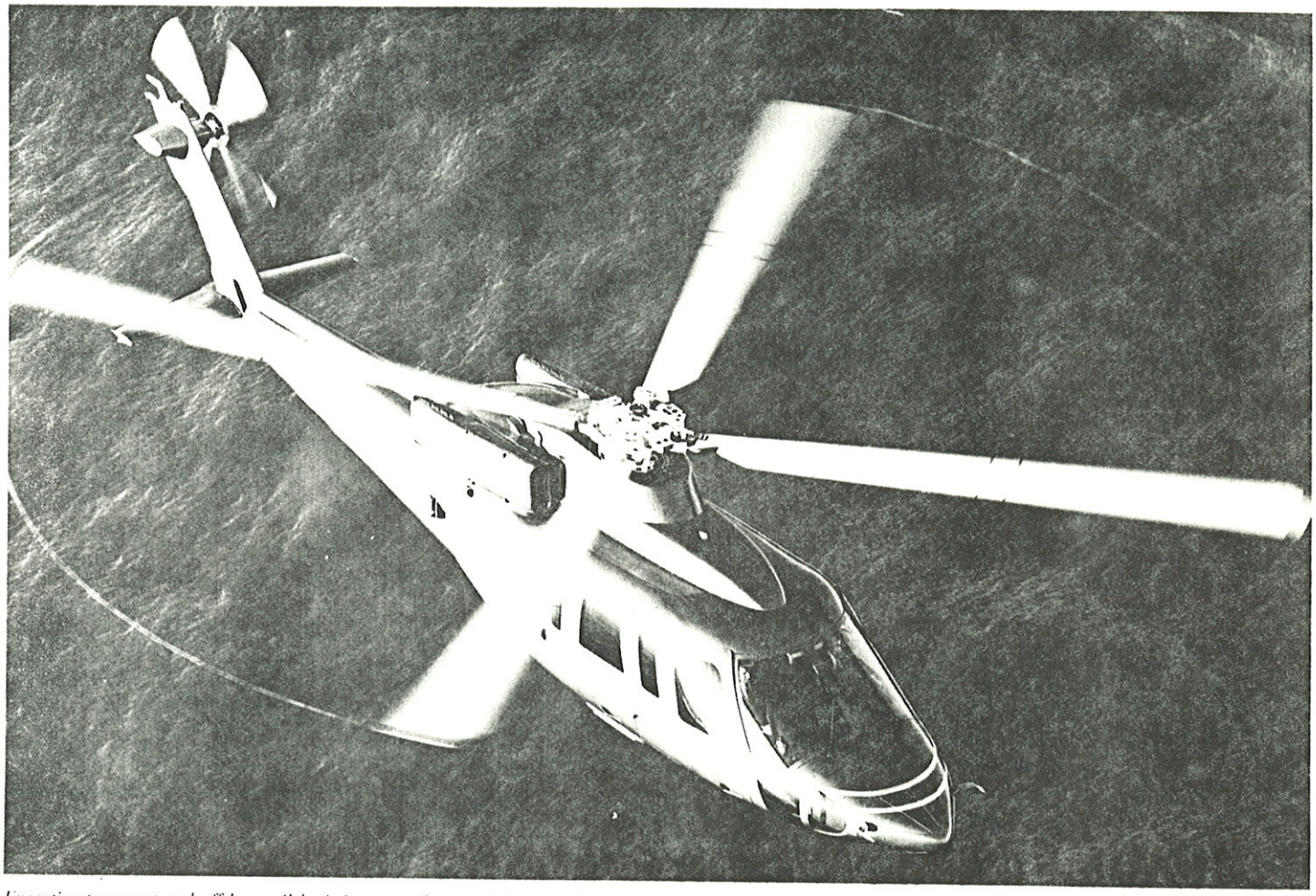
The constant threat of cutbacks in U.S. military expenditures and the difficulties in financing international sales have created an atmosphere of "wait and see," which has been reinforced by the on-again/off-again character of specific important program starts such as LHX, V-22, X-wing, and until recently, PAH-2. But this uncertainty is not unusual in the military markets; in fact, it is a normal pattern, and one in which the manufacturers and their customers have learned to survive.

What is more curious is the recent malaise in the civil markets. Less than a decade ago, all the indicators were climbing. The people and businesses who use helicopter services were thriving, the civil products were rapidly incorporating the advances of Vietnam helicopter technology, and a pessimistic outlook for military sales rekindled the interest of manufacturers and their suppliers in the commercial helicopter market. In fact, two major manufacturers developed dedicated intermediate twins for the civil marketplace—something that had never been done before, and perhaps will never be done again—and the sales backlog for those aircraft numbered well into the hundreds before either of them flew over the fence.

And then the industry was battered by fate. First, the offshore oil business, which had become the largest user of helicopters in dollar terms, collapsed in a succession of crude-oil price crises. Worse than that, the rapid acquisition of helicopters and charter commitments just prior to the collapse resulted in a substantial surplus of helicopters of all sizes, which badly destabilized the markets for new civil helicopters, used helicopters, and especially charter services.



A British-based S-61N working in the North Sea on an oil platform.



Executive transport and offshore oil logistics are only two of the varied roles for which the S76B is designed.

At the same time, the business environment in the United States was changing. A growth recession and the inability of many companies to improve their profits made it difficult to budget for new corporate helicopters, and changes in federal income tax laws had the effect of increasing their prices. And then, skyrocketing insurance costs inflated the cost of hiring helicopters to the point where less effective alternatives began to look attractive. During this time, the widespread availability of surplus equipment—primarily from the weak oil sector—attracted new operators and intensified price competition among existing helicopter operators, who were already on the financial ropes.

Things were cetainly grim, and they stayed that way for a long time. Many operators left the industry, and the manufacturers seemed disinterested in the civil market, or at least so distracted by their other business that they couldn't give it much time or effort. There were rumors that some manufacturers were going to abandon their commercial business, and it may be that some did, in fact, reduce their efforts down to a caretaker level.

But I believe that we will soon see, albeit through the benefit of hindsight, that the civil helicopter business is far from dead; that the market for civil products, even now regaining its vigor, will again be an important part of a healthy manufacturer's portfolio.

At Sikorsky, our renewed civil business activity takes three parallel paths: (1) strengthening the position of our S-61 through improved and enlarged product support; (2) expanding the role of our S-76 by extending the product line and further improving its usefulness and reliability; and (3) continuing to invest in the research and development necessary for us to field new technology civil rotorcraft in the next decades. I'll address each of these three paths in turn.

Strengthening the S-61

The S-61 helicopter, developed for the U.S. Navy and subsequently modified for the civil transport mission, gained its initial success as a commuter airliner, serving the downtown-to-airport markets of New York, Los Angeles, and San Francisco, and then a number of specialized commuter markets around the world. But its greatest success, and one in which it still excels, was as a personnel and material transport on routes from distant offshore oil installations to their shore bases. It was, in fact, the S-61 that made possible the large-scale development of oil fields in the North Sea, the Atlantic, and the South Pacific, up to 200 miles or more from shore.

The S-61, as such, is no longer in production at Sikorsky. But as long as the S-61 remains a viable and active offshore transport, we will remain committed to its continuing improvement and reliable support. Two current Sikorsky activities serve as appropriate examples.

Anticipating a stabilization of oil prices and a return to the normal balancing of crude oil supply and demand, it is inevitable that oil exploration will again move farther offshore toward the continental slopes. We would thus expect that within a few years we will see a very small but very urgent market for a longer-range offshore aircraft—too small a market to justify developing a brand new civil helicopter, but

a market that could effectively and economically use an extended-range S-61. We are actively researching a number of options that can give us this extended range. For example, Westland Helicopters has developed a composite main rotor blade for the Sikorsky-designed SeaKing, which they manufacture under license. One route to extended range might be an adaptation of the Westland blade for the civil S-61. And there are other options, as well, which we are presently discussing with the operating community.

Another ongoing investment in the S-61 has to do with the support of that aircraft in the field. We are working closely with the European Helicopter Operators Conference on the potential for increasing component overhaul capability in Europe, and we are exploring other ways to reinforcing support of the S-61.

Expanding the S-76

The S-76, one of the two helicopters I mentioned above that were designed specifically for the civil market, was launched in 1974 as a 12-passenger offshore-service transport with an alternative executive configuration for five or six passengers. After delivering a generation of Allison C30-powered S-76A's, in 1983 we offered the more powerful S-76B version with P&W PT-6 engines, and this past year we supported Turbomeca in certification of a third powerplant alternative, the Arriel 1-S. During this period, the payload and other characteristics of the S-76 have improved. And now, with three powerplant choices and a number of in-production configuration options, we are in the process of defining specific model alternatives best suited to short and long-range missions in offshore oil, EMS, and corporate transportation.

With particular references to offshore-oil service, we recognize the high cost of flight cancellations in that sector and the associated urgency of parts availability, and thus, for some time, we have maintained a large consignment of material in Europe for our operators there. This consignment of about 400 line items is managed for us by KLM, who are S-76 operators themselves. The value of the inventory averages more than a million dollars, and we continually consider prospective increases in that level that might improve the reliability of service, and, particularly, to prepare for what we feel will be a gradual but significant increase in flight operations.

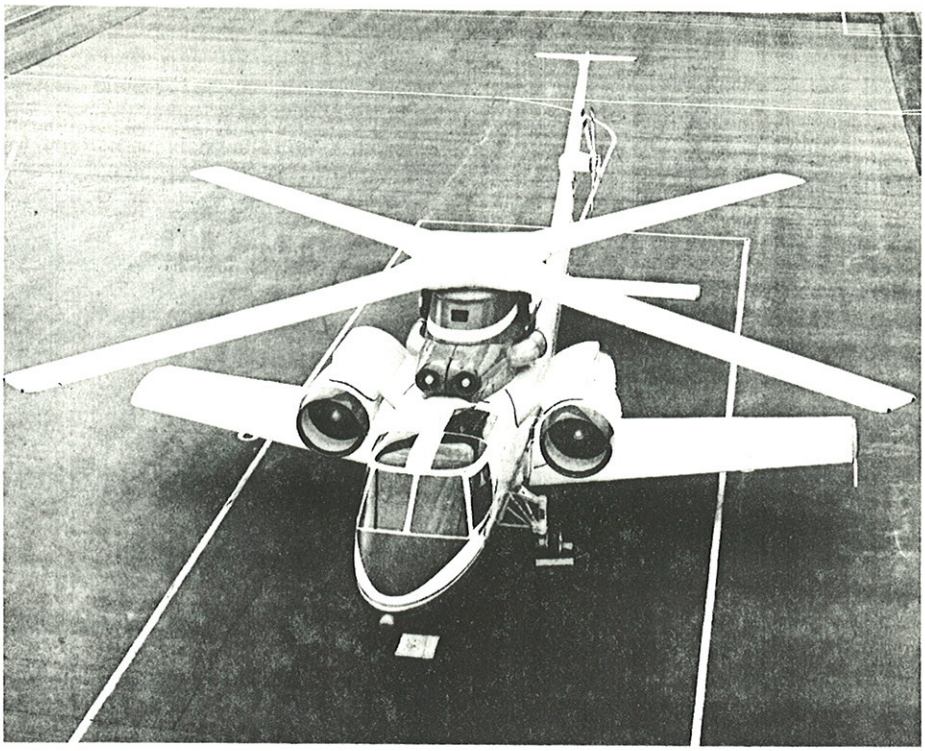
To support this expected market improvement, we have extended our production commitment by increasing our orders for S-76 manufacturing material to the highest level in several years, and we have undertaken a series of new investments in S-76 product improvement. Representative of this thrust is a series of dramatic extensions in component service lives approved during the past two years and our recent commitment to obtain FAA and CAA approval for Category A and Group A Phase 2 performance, which we feel will be prerequisite to commercial operations in urban centers in the United Kingdom, Japan, and eventually in the United States and elsewhere.

We will continue our ongoing survey of operational needs, and as the worldwide market for helicopter services continues its recovery, we will continue to provide S-76 operators with the technology they need to successfully and fruitfully ride that wave.

Developing New Technology

In any frank assessment, one would have to say that, with a few quite notable exceptions, there has been a drought in new civil helicopter technology during the last few years. One reason, of course, has been the stagnancy in many parts of the civil market, which was bound to dampen enthusiasm for bold new investments. But another, broader, issue has emerged. That is that investment in new technology can almost never be justified by the financial returns to that investment from commercial sales

The application of dynamic components that power Sikorsky-built CH-53E heavy lift helicopters are being studied for the civil market.



The X-wing, Sikorsky's experimental aircraft, employs futuristic design.

alone.

Thus, after some interesting experiments in that direction when the commercial markets were peaking in the mid-1970's, we on the manufacturing side now tend to return to the conventional wisdom that technical advances in civil helicopters must always transfer from military technology. I think that's a valid conclusion, and it doesn't necessarily mean that the civil technology drought will continue. In fact, the opposite is probably more likely, because if the industry can upgrade civil products with off-the-shelf technology at only incremental costs, the payback is likely to be favorable enough to bring it about.

This kind of thinking suggests that each of the manufacturers would be inclined to transfer to the civil market those technologies he has already developed for other purposes. In other words, we might look forward to more specialization in civil helicopter production, rather than the scenario of the '70's, when many manufacturers tried to challenge all their competitors in all weight classes and all missions. That often works in the military side of the business, but the civil market isn't large enough to support such a proliferation of models. Now, however, we seem to be entering a more rational business environment, where each developer tries to apply his particular product strengths to market development. That is an old adage of strategic planning, and it makes sense. It is eminently logical, for example, that Bell/Boeing should be interested in developing a civil tilt rotor, and that McDonnell Douglas should find civil applications for its NOTAR.

One of our strengths at Sikorsky has always been the design and development of relatively heavy helicopters, and we have continually sought niches in the civil fleet for that heavy-lift technology. We have observed with interest what appears to be a resurgence of demand for service between city centers and remote airports, and the significant business generated by a number of helicopter commuter carriers during the last few years. Clearly, this responds to the parallel escalation of airport access congestion, which was the single factor that powered the commuter helicopter business in the 1950's and 1960's. And, just as clearly , the newer technology helicopters of today will go a long way toward relieving that problem.

Just in the last half-decade, we have seen airraft from the Sikorsky 58T to the Bell 222 to the Westland W-30 serve that market, albeit with varying degrees of sucess. And we will certainly see Westland-Agusta EH-101's and Aerospatiale Pumas in that market before long. As the congestion problem worsens, the success of the helicopter, as a unique solution to the problem, will improve.

In the strategic process I mentioned above, of reviewing our strong technical suits against market requirements, it was inevitable that we would look to heavy-lift dynamic components, such as those that power our CH-53E, as a means of developing large, high-density, short-haul helicopters for the civil market. And we are doing that.

Along with the sheer size that we are used to dealing with at Sikorsky, there are other significant technologies, developed for existing military products, that can be further developed for application to the civil side. Some of these, like advanced composites, will be essential to the economics of the very large civil transports; others, which lead to cockpit management, improved fuel consumption, and lower vibration, will find their ways into all new civil helicopters.

As this article goes to press, the Transportation Research Board is holding its Annual Meeting in Washington. During the meeting, helicopter planners from government and industry are deliberating on this very idea of technology transfer to the civil sector. With our know-how in heavy-lift and our long-range commitment to the civil part of our business portfolio, we intend to remain in the forefront of this movement.

Conclusion

Thus, Sikorsky is aggressively addressing the civil business sector on three fronts: past, present, and future. The S-61, which was the mainstay of our commercial business from 1962 to the early 1970's, still holds for us an obligation to support it and to improve it, and we honor that obligation.

The S-76, current center of our civil business, is rebounding with the market recovery; not only will we keep it in production, but we will improve it and refine it in all the missions in which it has achieved its notable success.

And finally, as we look to the future, it is time now to plan transportation systems for the turn of the century. We are confident that today's Sikorsky technology has cost-effective, low-risk answers to the problems of short-haul inefficiencies and airport congestion, and we are addressing those problems with creative thought, with the necessary resources, and with enthusiasm.

Mr. Buckley is President, Sikorsky Aircraft Division, UTC.

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their nascent stages back in the 1980s. Tiltrotor tech was an obvious way to move people up to 600 miles. And the enormous VLCT—Sikorsky's magic carpet—linked exurban areas and nearby cities to fuel economic growth at the start of this new and exciting century.

Back to Earth

Of course, the interesting part about the foregoing fantasy is that it veers only slightly from the realm of the possible. Japan is constructing an extensive infrastructure for helicopters throughout her archipelago. The on-again, off-again tiltrotor, recently canceled by the Defense Department for budgetary reasons, has significant potential as a commercial transport. And Sikorsky's VLCT already exists—in slightly altered form.

When Sikorsky Aircraft presented a drawing of its future VLCT at the Helicopter Industry Assn. meeting last January, only the drawing was futuristic. Technologically, the machine was doable with even less than state-of-the-art tooling and materials. The idea was to present a concept helicopter with passenger-hauling capabilities rivaling that of fixed-wing commercial aircraft. The ability to lift and transport 100 passengers in a helicopter over short and medium distances at speeds more than 150 mph is simple using presently available technology. And it would only be stretching it a little to envision a helicopter capable of hauling as many as 200 passengers.

Military choppers have been hauling larger loads around for years. In fact, Sikorsky's own CH-53E helicopter now used by the Marines (*Super Stallion*) and the Navy (*Sea Dragon*) is capable of hefting loads up to 32,000 pounds. The load requirement for the VLCT, with an average passenger weighing 170 pounds, would be somewhat less than 20,000 pounds, including baggage.

The CH-53E, in fact, is the aircraft Sikorsky would use as the starting point for developing the VLCT. Like its military antecedents, the VLCT would be powered by three turbines, putting out more than 13,000 horsepower. It would also probably use a 7-blade rotor similar to that found on the present military chopper. Items like the landing gear and drivetrain would also swap over.

So if it can be done today, why doesn't Sikorsky just go and do it? Because a lot of things have to be in place before the VLCT would be commercially feasible. First, you need the heliports for the VLCTs to fly into and out of (tiltrotor proponents prefer the term vertiports). Then, you would need a whole separate air traffic system—complete with ground navigation aids and control personnel—to get the most benefit out of vertical takeoff aircraft like the VLCT.

The present system, especially around large metropolitan areas like New York, Chicago and Los Angeles, is quickly reaching saturation. Airports are even closer to capacity. New slots are just not available, and the existing ones get gobbled up by current carriers. A lot of those slots are being used for short-haul flights, flights that would be ideal for aircraft like the VLCT.

Conventional fixed-wing aircraft have reached their size limit—about 500 passengers is tops. And whether the airplane is a 747 bound for Tokyo, or a small commuter coming in from 100 miles away, only one aircraft can fit on one runway at a time. Japan has even worse problems. The country's current intercity travel system is overloaded. That is why the Japanese are looking most seriously at a proposal to build a system of 600 heliports, with the possibility of eventually having 3300 of them.

Add to this the fact that more and more people who have never flown before are climbing into commercial airplanes every day, and you have the potential for massive problems popping up around the turn of the century. A separate vertical takeoff system would be a neat solution to the air travel mess the experts forecast. In fact, that's the reason behind Sikorsky's proposal for the VLCT—to promote the idea that planning must begin now for the next century.

Part of the plan envisions a separate air traffic system just for vertical takeoff machines. Roy Lobosco, who is working on an FAA-funded study on the issue of heliports for the Port Authority of New York and New Jersey, points out that with the new system, helicopters would also be able to fly into and out of airports without conflicting with fixed-wing traffic, adding enormous versatility.

A new VTOL system, as some vertiport visionaries see it, would have aircraft like the VLCT handling trips from 100 to 200 miles. Tiltrotor aircraft, with twice the speed, would handle longer distances, say from 300 to 600 miles.

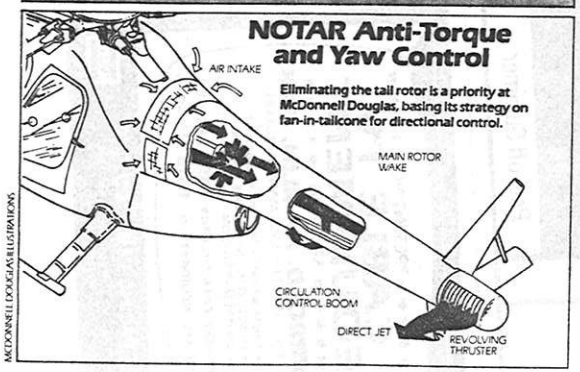
Key issues

While some may argue that future large-scale VTOL flight remains a distant dream, the basic systems we'll find aboard tomorrow's helicopters are taking shape right now. Military VTOL programs are closely linked to the advancement of civilian VTOL technology in general—technology directly transferable to the VLCT of the future.

For instance, the current program for the development of a new Army helicopter, dubbed LHX, is the main engine driving vertical flight technology at the present time. Two teams—McDonnell Douglas/Bell and Boeing/Sikorsky—are currently competing to see who will build the $38 billion worth of new Army helicopters LHX planners envision. This prize, which is supposed to be awarded in December 1990, represents 50 percent of the world's new helicopter business over the next 20 years.

With a plum this huge ripe for the plucking, you can bet that the two teams are working at full steam to do their best to develop the world's best helicopter. And a lot of what's being

(Please turn to page 102)



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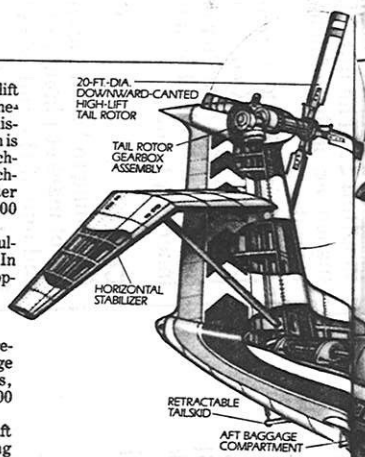

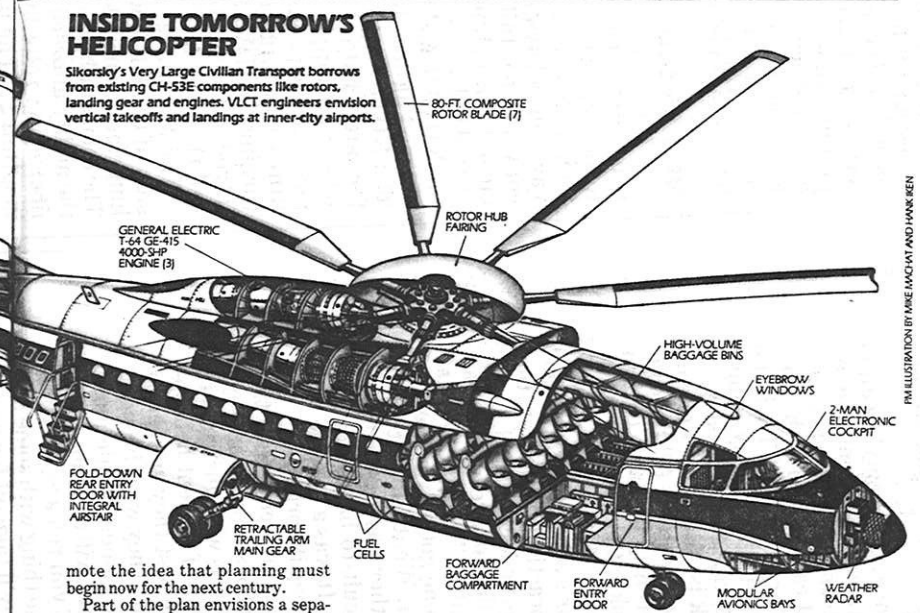

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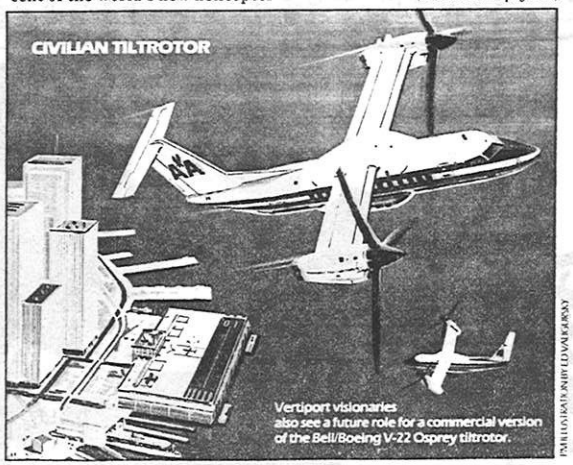

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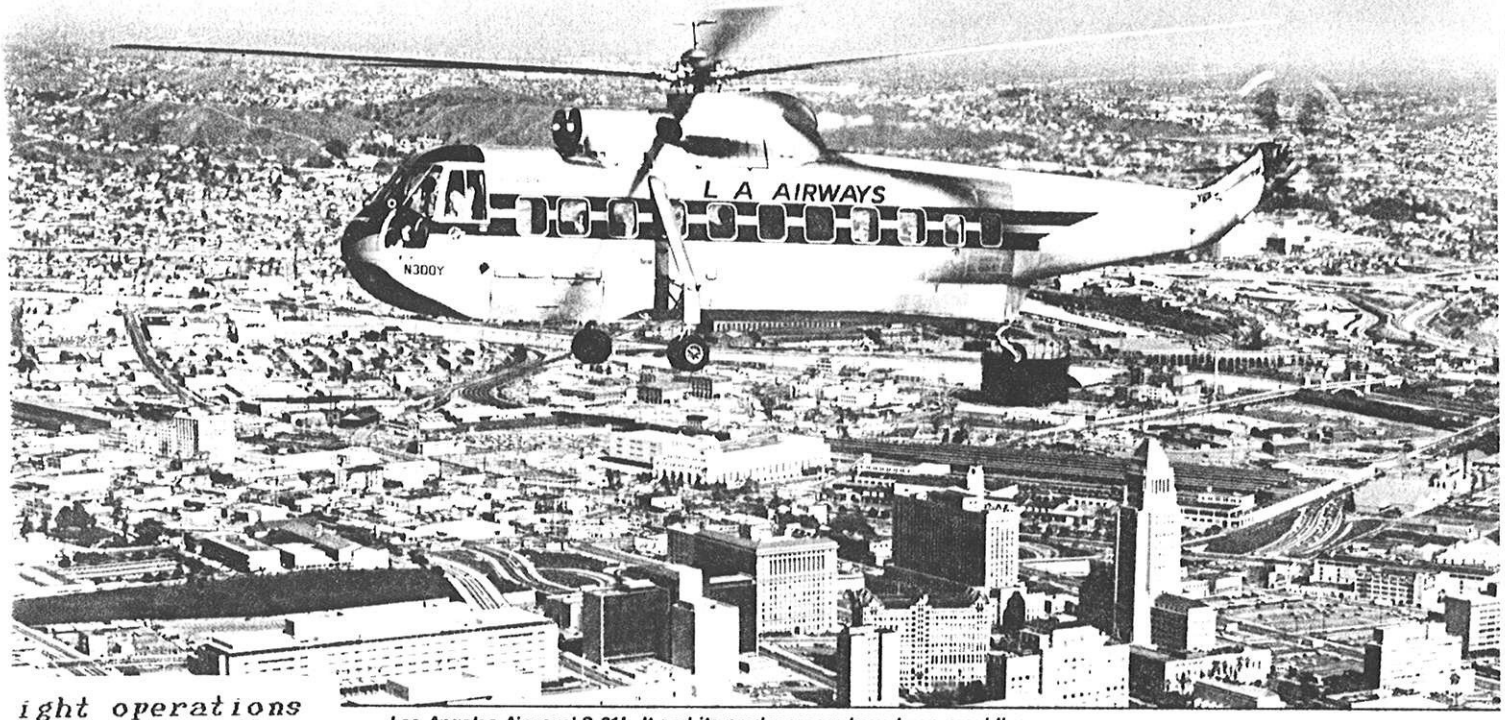

ight operations
anuary 1978)

Los Angeles Airways' S-61L. It and its predecessors have been providing unrestricted IFR service since 1964.

Another look at helicopter IFR

By Ronald G. Crawford

"Those who fail to learn from history are forced to repeat it." This famous quotation is especially meaningful when considering implementation of commercial helicopter IFR regulations. Operating civil helicopters IFR is neither novel nor unproven, except to those who ignore history—those who are unaware of the past are condemned to repeat the same laborious process that the earlier efforts required. In other words, instead of building on previous successes in the manner of most developments, helicopter IFR is proceeding today with limited knowledge of its actual accomplishments. To show how true this is, I would like to relate the highlights of one of the industry's successful attempts that has been largely ignored in the present efforts to establish current operations. I will leave it to the reader to decide whether there has been progress or regression since then:

ED. NOTE: Ronald G. Crawford was chief pilot and operations manager for Los Angeles Airways. He joined Sikorsky Aircraft in 1974 and is now commercial marketing manager for the Eastern third of the U.S.

Between 1965 and 1972 there were over six years of scheduled helicopter IFR passenger-carrying operations in a major terminal area, the Los Angeles Basin. Many hundreds of hours of actual IFR were flown carrying tens of thousands of fare-paying passengers while meeting airline standards of performance and safety. The operator was Los Angeles Airways, which had initiated scheduled day VFR operations in October 1947 and expanded this to night VFR operations in October 1948.

First IFR certification in 1950: Los Angeles Airways' initial helicopter IFR efforts started in June 1949 with the Sikorsky S-51. In June 1950 LAA received approval to operate its four S-51s in s ed service under IFR for periods not exceeding 15 minutes. This permitted departures and approaches in localized IFR conditions. The aircraft were so certified and the pilots were instrument rated by the Civil Aeronautics Administration, the predecessor of the FAA. The aircraft were unstabilized with only a force trim system on the cyclic stick, utilizing bungee cords. An interesting sidelight is that the first two presidential pilots were sent from Washington, D.C. to LAA in 1952 for an instrument training course in these aircraft.

Unrestricted IFR in 1964: In 1961, LAA began working on an instrument program for the Sikorsky S-61. Primary responsibility for this program rested with Boyd Kesselring, the man who had developed the S-51 instrument operation 12 years earlier. Only now, it was to be unrestricted and provide scheduled passenger service to and from heliports in a network stretching from Los Angeles International Airport (LAX) on the west to Newport Beach on the south, San Bernadino on the east and Van Nuys on the north.

There were many delays and problems too numerous to cover in this article, but they were overcome. The IFR certification of the S-61 was completed by LAA in November 1964, and in April 1965 LAA flew their first IFR scheduled

Five IFR S-61's were serving Los Angeles Airways by 1967.

passenger flight. Pilots, dispatchers and heliport weather observers had been trained and licensed to airline standards.

A helicopter enroute IFR evaluation was flown, which substantiated helicopter-only IFR airways providing 500 feet of obstruction clearance two miles each side of centerline, reducing to 0 obstruction clearance at three miles each side. This utilized only VOR/DME without any RNAV system. Of course, fixed-wing routes in the same area are 10 miles wide with 1,000 to 2,000 feet of obstruction clearance required. The flight-test work is covered in FAA Project Report No. 65-920-6. This permitted the development of a segregated route structure between the LAA heliports.

Approaches: Helicopter-only instrument approaches and departures were developed for LAX and the heliports providing a complete IFR system. Helicopter SIDs at LAX permitted IFR departures from the passenger terminal area with minimal interference between rotary and fixed-wing traffic. Jeppesen published our approach plates and provided a subscription service tailored to Southern California.

It was determined that as long as we were headed towards the heliport on final approach, it could be considered a straight-in approach regardless of the maneuvering necessary for landing. On the other hand, the San Bernadino approach required a turn of 160 degrees at the missed approach point to proceed to the heliport 1.1 nautical miles away and still had minimums of 300 feet and one-half mile. This had to be the forerunner of the "point-in-space" approach now in use.

When utilizing the ILS at LAX, we would often be paralleled with the localizer at low altitude until inside the outer marker for a turn-on at approximately three miles out. An opening would have been created by speeding up one fixed-wing and slowing down the succeeding one slightly so we would have access to the ILS for a minimal time. That was all that was needed to complete the approach, make a quick break-off and proceed to the terminal.

We were also permitted simultaneous, nonprecision radar approaches with only one-mile lateral separation from fixed-wing aircraft on the ILS at LAX. It is covered in a Letter of Agreement, dated Sept. 20, 1965.

Reserves: Fuel reserves were 20 minutes for flight plans of one hour or less and 30 minutes if they were over an hour. Alternate minimums were 400/1 for flight plans of an hour or less, and 600/1 or 500/2 for flight plans over an hour. No alternate was required if destination weather was forecast to be 1,000/2 for one hour prior to and one hour after ETA. All of our trips had IFR flight plans stored in the ATC computer so the pilot only had to call clearance delivery with trip number and destination to turn on the system.

Equipment: By 1967, LAA had five IFR S-61s and they were equipped as follows: dual transceivers, dual VORs with glideslope receivers, dual remote gyro compass systems, single ADF, DME and marker beacon receivers. It was top-of-the-line airline equipment. Both panels were identical and had a reverse T layout in order to place the airspeed, triple tachometer and torquemeter in the captain's peripheral vision when contact. There was an HSI and flight director, but the flight director was not required equipment. We did *not* have a standby VGI, radar altimeter, weather radar or coupler.

We were working in one of the busiest air traffic areas in the world, and a crew could make as many as three departures and three approaches within an hour's time. Minimums were ultimately brought to 100 feet DH and one-fourth mile or 1,200 RVR visibility with no additional equipment. In order to establish these minimums, an evaluation program with the FAA was conducted in weather down to and including 0/0 conditions. All of this was done utilizing Category I ILS equipment.

Training standards were high, with heavy emphasis on flight without stabilization and gyros since the AFCS was nonredundant. Most of the initial training flights and check rides were conducted between midnight and 6:00 A.M. in order not to interfere with scheduled operations. At the peak, there were 45 instrument-rated pilots, 27 of whom had ATRs. A check ride would take two hours and covered basic airwork, navigation, emergencies, departures, approaches and VFR maneuvers.

Recency of experience was met during extended periods of VFR weather by enroute training on scheduled passenger flights. The captain occupied the right seat, a hooded pilot flew from the left seat and a copilot was on the jump seat as a safety observer. To our knowledge, this is the only instance where this has been permitted on an aircraft certified for two pilot operations.

The pilots' attitude toward instrument flying was excellent. They recognized that it was safer, more productive and increased their professional value. Our special VFR minimums were one-half mile visibility during daylight hours and one mile in darkness. Enroute minimum altitudes were from 300 feet to 500 feet, depending on location and time of day. The LAX control zone was 300 feet day and night. We also had a special VFR route structure with excellent control, but this still did not permit reliable, safe completion of all scheduled flights. Many trips had been stymied by only a short segment of below minimums weather. Instrument operations definitely increased completion factors while *decreasing* the pilot's work load. Enroute times did not increase significantly and, in fact, they declined in many instances. It often took longer to fly a trip Special VFR than it did IFR. The ATC people were excellent and imaginative. I can't relate in this short space the many examples of their assistance.

In May 1970, when the first helicopter TERPS conference was held, the Los Angeles Airways experience was practically the total civil IFR background available. It had a major impact on Chapter 11 as it is now written. Perhaps this experience should be reexamined to see if it can contribute to the industry's present efforts.

Possibly more could have been done, and I'm certain more will be accomplished in the future, with the equipment improvements being made. The important thing is: We should be moving forward, insisting we will not accept less than was proven more than 10 years ago. □

Some Aspects of Instrument F[illegible]nt

By R. J. van der Harten*
KLM Noordzee Helikopters N.V.

KLM Noordzee Helikopters N.V. has been operating a successful, 24-hour service supplying oil rigs in the North Sea and transporting harbor pilots to ships since '68—a success based largely on flight in conditions of poor visibility

When my company became operational on March 15, 1968, the Dutch Civil Airworthiness Authority (RLD) already had decided that helicopter operations at night must be conducted under IFR as defined for fixed-wing aircraft. This was contrary to the practice in England where night operations with helicopters are still permitted under VFR in Visual Meteorological Conditions (VMC). However, in the opinion of RLD, the practice does not meet the safety level required for Airline Transport Category Operations, under which Dutch helicopter companies are certified. The RLD thus followed the example of the Norwegian Civil Airworthiness Authority that was the first in Europe to insist on flights under IFR with helicopters, at night over the North Sea for the oil rig operations of Helikopter Services A.s., a Norwegian firm.

Despite the fact that only 4 months were available between ordering the aircraft and commencing actual operations, Noordzee was able to provide from the start a 24-hr. full IFR service to the oil rigs for the Nederlandse Aardolie Maatschappij (NAM) with its first S-61N.

The company started operations with one S-61N and one S-62A. In 1969 this fleet was expanded with the acquisition of a second S-61N equipped with radar and a hoist (Fig. 1). A third S-61N equipped with radar and Decca Doppler 71 was delivered later.

The concept

The main purpose of this paper is to review the typical difficulties which were encountered, but also the possibilities that became clear when the RLD made its decision regarding IFR flight with helicopters.

As a fully owned subsidiary of KLM Royal Dutch Airlines, our company could use the immense background and the technical facilities of the mother company for the training of pilots, to equip the helicopters with the most reliable instruments and electronics, and to use airline methods and knowhow. Regarding the general directives for the calculation of weather minima, as required by the RLD, for obtaining approval of limits and procedures, we were on our own.

The main difficulty proved to be the lack of ICAO recommendations for instrumentation, approach aids and limits for helicopters. However, because the RLD compelled our company to instrument flight, they also took the consequences that, because of this lack of knowledge and recommendations of the ICAO, they should have an open mind for all proposals we made and could prove to be safe, without unnecessary reference to accepted fixed-wing standards.

They accepted in fact a different attitude toward instrument flying with helicopters because of the different characteristics of this aircraft, the main consideration being that a helicopter, using the right procedures, does not have to accelerate to best climbing speed after an aborted approach and thus has no appreciable sink rate.

Realizing that a helicopter thus, contrary to fixed wing aircraft, is *never committed to land*, it was possible to define a concept providing a 24-hr service, 7 days a week, to oil rigs and ships at a competitive flight-hour price. This concept can be defined as follows:

1. Use existing approach and navigation ground aids.
2. Prevent undue duplication of aircraft instrument and aoproach systems, saving unnecessary weight and cost, accepting higher weather limits for approaches when one system fails and has to be backed up by a different system. This includes nonduplicated multi-purpose navigation systems such as Decca navigation, radar, ADF, VOR/ILS and Doppler to provide airborne approach aids where practicable.
3. Define and certify procedures aiming for maximum reliability, passenger comfort and safety of the operation; proving that the helicopter can indeed safely achieve lower weather limits than possible with fixed-wing aircraft using the basic Cat I instrumentation, and exploiting the specific flight characteristics of the helicopter to its maximum safe potential.
4. As the crew always consists of 2 pilots, use their full potential to share tasks and divide the increased workload inherent with the simplified system concept.

Realization of the concept

Certification of the aircraft

Because of the KLM background of our company, choice of the Sikorsky S-61N helicopter was natural, because this aircraft was the only civil helicopter at that time which had been certified for instrument flight in the U.S. and also was at that moment operationally the best aircraft available. It had been in use with several operators in the North Sea area for a number of years and had shown itself to be very reliable.

The RLD requirements to certify helicopters for IFR flight state that:

a. A reliable automatic stabilization system with separate channels for roll, pitch and yaw must be provided.

*The author is deputy managing director. He will be remembered by *Vertiflite* readers as having been designated by his company to receive in its behalf the 1970 Capt. William J. Kossler Award of the Society at the 27th AHS Annual National Forum. The award was "for development of IFR and approach capabilities to serve North Sea oil rigs and provide harbor pilot service to ships on a 24-hour basis." He has been a member of AHS since 1960 and is an Associate Fellow, RAeS. This article was delivered as a lecture before the Nederlandse Vereniging voor Luchtvaarttechniek May 13, 1971.

b. The aircraft must be equipped with at least two engines.

c. The aircraft must be flown by 2 pilots and instrumentation must be duplicated.

d. The aircraft must be certified for IFR flight in its country of origin.

e. Navigation, instrumentation and communication systems as required by law for airline transport flights must be provided for.

The S-61N offered no problems as to the requirements under a, b, c and d. The requirements under e were discussed with the RLD, taking into account the concept as defined for instrument flight with helicopters.

Navigation systems

The first S-61N was equipped with dual ADF (Automatic Direction Finder), single VOR/ILS (Very High Frequency Omnidirectional Range/Instrument Landing System) and single Decca Mk 19 navigation system, providing 4 navigation systems, which is in excess of the requirement for duplicated systems for airline transport operations. All systems use different DC buses.

The second S-61N was equipped with the Bendix-Air Equipment RDR-1DM weather and approach radar, two ADFs, single Decca Mk 19 and single VOR/ILS. The third S-61N has been equipped with the same basic systems but the Decca Mk 19 has been replaced by a single Decca Doppler 71, providing hover and slow speed capability as well as a navigation aid. Only the hover indicator has presently been duplicated. All systems double as approach aids and are certified for different weather limits, thus backing up each other to a certain degree. Dual instrumentation is provided for navigation and approach information, except for Decca Mk 19 and radar where single presentation is provided at the center panel. In the case of the radar approach the captain directs the co-pilot in basically the same way as for groundbased GCA and PAR.

Instrumentation

Sikorsky provided dual instrumentation in the basic aircraft, with dual pitot and static sources as well as gyro horizon systems, except for the single, 3-channel Hamilton Standard Automatic Flight Control Stabilization System *(AFCS)* and the Sperry C-14 flux gate compass which has a master indicator on the pilot, and a slave indication on the co-pilot side, backed up by a magnetic standby compass.

The single C-14 compass was acceptable for the RLD after the standby compass was made to read accurate enough by reducing heater blower electric interference. For AFCS failures it was proven that an approach to modified Cat I limits (600 m visibility and 200 feet Break Off Altitude (BOA)) without AFCS, could safely be conducted. This modified Cat I limit will probably remain the limit for failure of any or all of the AFCS channels.

For accurate altitude information as required for radar approaches, a single Collins radio altimeter is installed with dual indicators.

The VOR/ILS signal is presented by a Radio Magnetic Indicator on the pilot's side with a slave on the co-pilot's side. Information from the ADF is presented on the course (Sperry/C6F) indicators which have a possibility to switch each needle also to VOR.

When developing instrument approach procedures with the original panel as installed by Sikorsky it was found that in unstabilized flight vertigo could easily occur. This phenomenon, caused by the inherent dynamic instability

Fig. 1. The Sikorsky S-61N.

of the unstabilized helicopter, has mainly been responsible, for the long delay in the development of instrument flying.

Our solution to enable the pilot to cope with an AFCS failure before or during the approach was relatively simple. The instruments were regrouped as shown in Fig. 2 to provide for the possibility of a close scan for different flight conditions. With this panel a safe ILS procedure is possible to the existing limits without AFCS and, en route, the aircraft can safely be flown home on instruments with the pilots flying alternately.

On an ILS approach the pilot scans in one glance attitude, altitude, ILS, and course and uses a constant power setting to follow the ILS glide path. The glide path is followed by small attitude changes.

For ADF approaches basically the same scan is used. Radar approaches require basically only a scan of the upper row of instruments to fly as directed by the captain, who corrects course with the yaw trim of the AFCS.

This "close-scan panel" also deleted the need for a flight director system for the present weather limits, and has been found even to allow approaches below Cat II limits (400 meters visibility and 100 ft decision height). In particular when introducing Doppler Groundspeed and Hover indicators this panel may provide practically all-weather capability. Presently, all ILS approaches under training include complete blind landings.

Communication

The communication system consists of a dual VHF radio as required by law, a single HF system for communication at low altitudes and in areas without VHF coverage such as Flight Information Regions (FIR's), and a VHF/FM radio as required for communication with ships.

Using quite a number of single systems with only partial backup possibilities of a different nature required reliable equipment to prevent diversions or cancellations of

Fig. 2. Close-scan instrument panel.

flights, which would be against the policy of providing a reliable service at all times.

Thus the Instruments and Electronics Department of KLM (IERA) recommended to use KLM or related equipment where possible. The weight and cost penalty involved in this recommendation was largely offset by lower investments for spares and the improvements in reliability, as well as the possibility to exchange and repair this equipment rapidly, using KLM facilities. The RDR-1DM radar for example is basically the same as the RDR-1D used by KLM.

Certification and training of pilots

As to the certification of the pilots, the main problem was that never before in the Netherlands had an instrument or airline transport license for helicopters been issued by the RLD. Certification was accomplished as follows:

1. One of our first pilots was in the possession of a fixed-wing commercial and instrument license, and had obtained considerable instrument and instructors experience on U.S. Army helicopters when employed as a production acceptance pilot by this organization. He received the first Netherlands helicopter airline transport pilot's license and was appointed as an instructor and general advisor as well as an RLD examiner for the instrument training and certification program.
2. The RLD consented to issue a restricted helicopter airline transport pilot license excluding the normal instrument rating on the basis of a commercial helicopter pilot's license and a type rating on the S-61N.

After passing the instrument theory and flight examinations, the complete helicopter airline transport pilot's license was issued.

When the first pilots were under training, the few night flights at that time were carried out by the instructor and a hired Norwegian pilot from Helicopter Services A.s. Norway had issued the first instrument license for helicopters in 1966 and this license was validated by the RLD for the time that our company had a shortage of instrument-rated pilots.

The second pilot received his instrument license June 18, 1968, [illegible] after commencing operations. This pilot was also appointed as an instructor and examiner. These pilots trained all other pilots and are doing this as of today.

In the meantime training programs including instruction handbooks, proficiency and captain decks were produced and, where applicable, certified by the RLD, before the middle of 1968. All pilots are trained from the start to obtain their captaincy within 2 years. They rotate regularly as captain and co-pilot without seniority restrictions.

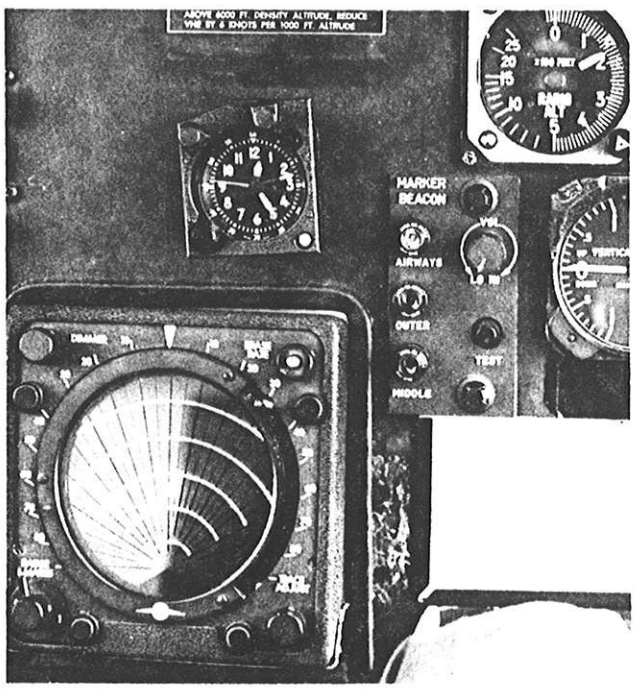

Fig. 3. RDR-1DM radar scope in instrument panel.

RLD approval of the directives

To obtain certified take off and approach weather limits for airfields, oil rigs and ships, directives to calculate these limits have to be approved by the RLD. These general directives were developed in close cooperation with the KLM Navigation Department and approved Oct. 7, 1969. Thereafter it was possible to have lower limits certified than the provisional Cat I limits (800 m visibility and 200 feet cloudbase) for ILS approaches and the 800 m visibility and 400 feet cloudbase for ADF approaches to oil rigs allowed in the preliminary period. In a later stage radar approaches to rigs and ships were included.

Certification of weather limits

The certification of the weather limits required calculation of limits for the different airfields in use, as well as for heliports, oil rigs and ships, according to the approved directives, that in a later stage also included radar aporoaches. Procedures were standardized and approved for each approach system and separately flight tested with the RLD for concurrence with the predictions of the concept and the method.

Approaches are presently being carried out at near cruise speeds. This means that an approach can be aborted without a sink rate at any altitude, up to the landing stage. Furthermore, as the helicopter also has the possibility to abort a landing at any point, accepting a small sink rate at lower airspeeds, when full power is available, it is possible to decrease the present weather limits further, by decreasing the airspeed in the approach. Attitude changes according to the attitude indicator readings are tolerable to around 60k IAS, which presently is used after passing the middle marker beacon.

With the introduction of the Doppler hover and groundspeed indicators much lower airspeeds up to an actual hover can be envisaged. The reason for this is that the attitude indicator does not show rotor disc but airframe attitude and thus does not present the true situation. It may even lag out of phase due to the delay of the airframe in following the rotor, which is the case at lower airspeeds in particular. The Doppler groundspeed and hover indicator, however, can present the pilot the true picture of his actual movements in space.

The present weather limits for take-off and approaches, as certified by the RLD, are basically for Schiphol Airport:

Take-off	—visibility—300 meters
	—cloudbase—non required
Approach	—visibility—600 meters
ILS and PAR	—cloudbase—200 ft (BOA)
ILS backbeam	—visibility—800 meters
and PPI	—cloudbase—250 ft (BOA)

Furthermore, approaches may be initiated under a "look see" policy, where a reduced visibility and cloudbase may be accepted of respectively two (200 meters) and

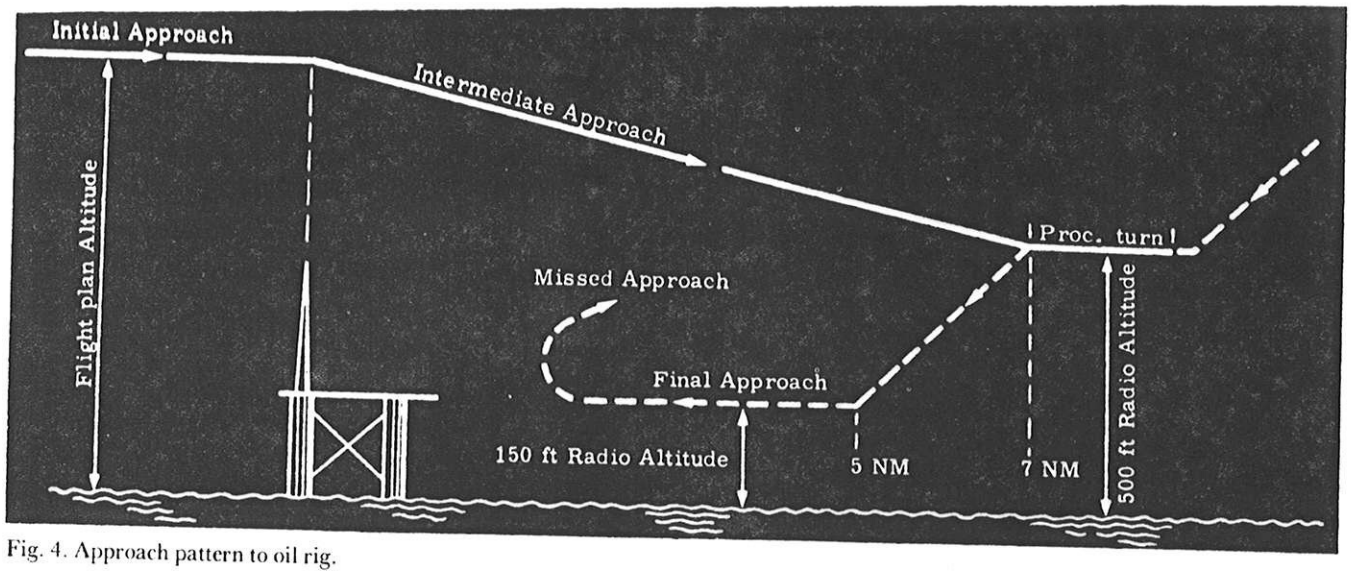

Fig. 4. Approach pattern to oil rig.

one (100 ft) increment allowing e.g. an approach on the ILS or PAR to be initiated when a visibility of 400 meters and a cloudbase of 100 feet are reported by ATC (CAT II conditions).

When RVR (Runway Visual Range) is reported, this always prevails regardless of a reported cloudbase, and an approach must be aborted if visibility is below minimum when arriving at the designated Break Off Altitude.

The weather minima for ADF approaches to oil rigs and ships were defined at 800 meters visibility and 400 ft cloudbase. Because the Decca Mk 1g navigation system and the ADF were found to be unreliable at night and in static, and the ADF limits (particularly with regard to the cloudbase) were insufficient to warrant regularity, the use of radar as an airborne approach aid was developed and certified Oct. 14, 1969 for oil rigs and Aug. 14, 1970 for ships—this last one providing the required regularity in the pilot service. The weather limits for approaches to oil rigs and ships, using the RDR-1DM radar, are presently 800 meters visibility and 150 ft cloudbase. The visibility limit will probably be reduced to 600 meters.

This is, we believe, the first time that an airborne approach system has been certified by a civil aviation authority.

The radar system has furthermore been approved for instrument approaches to heliports and small airports without ATC or approach aids, situated near the coast where this coast is used as a reference for the let-down within defined sectors. The present weather limitations are a cloudbase of 500 ft at a visibility of 1500 meters.

For these heliports and airfields an inexpensive lighting system has also now been developed and certified, in close co-operation with Philips N.V. and the RLD.

IFR flights furthermore, when conducted to and from oil rigs and ships, may be carried out to a minimum altitude of 250 ft en route when the visibility at that altitude is 1500 meters.

The RLD has recently granted a waiver of the alternate airports, for which fuel has to be carried, when filing IFR flight plans at night, if the airport weather reports indicate a visibility of at least 1500 meters lasting for at least 2 hr after the ETA.

The radar system

When starting operations, weather radar was found to be essential to avoid flying into icing conditions. The S-61N is not certified for flights in weather conditions where icing can be expected. This still holds true for all helicopters manufactured in the Western hemisphere.

The Russians are using an electrical blade deicing system with a fair amount of success, and Sikorsky has been trying to certify such a system. But the FAA requirements in the USA are apparently much more severe than in Russia, and based on the icing conditions expected at the low altitude at which the helicopter is expected to fly. Airframe icing is in that case also probably more important than blade icing and comparable with the fixed-wing aircraft. However, icing can mostly be avoided since radar can detect icing conditions in clouds at a sufficient distance to avoid them.

The engines of the S-61 are, of course, equipped with the normal anti-icing devices and an ice-deflector. The blades are coated in the winter with an anti-icing fluid, which prevents ice accretions very successfully. BEAH is presently on the verge of obtaining permission from the ARB to accept light to moderate icing conditions using this system combined with an ice detection system.

The black dots on the sponsons shown in Fig. 1 are used to detect icing and will show icing growth fairly well if not as accurately as the electrical ice detectors used by BEAH.

During the study of available radar equipment, it became clear that radar could be used to detect obstacles in the approach path to oil rigs and ships, thus providing a safe means to descend on instruments to lower altitudes than were possible with ADF and Decca.

The RDR-1DM radar, a basic Bendix RDR-1D modified by Air Equipement in France, provided, next to

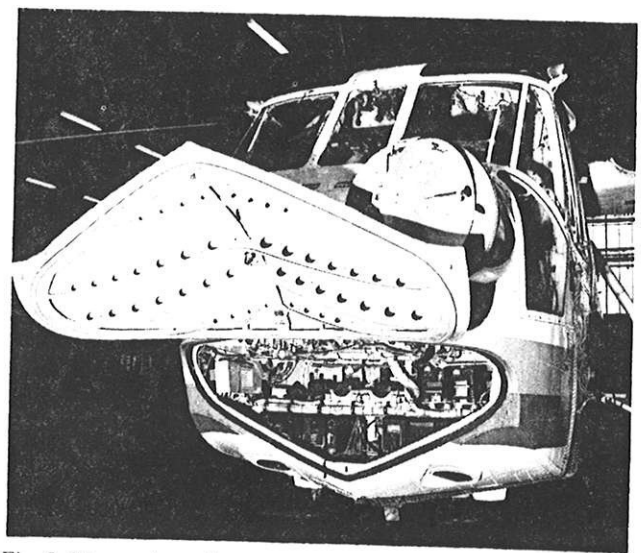

Fig. 5. Electronic equipment bay and radar antenna.

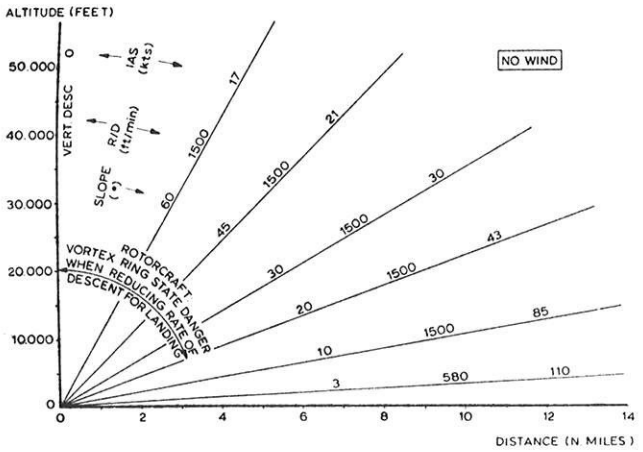

Fig. 6. Airspeed and glideslope angle vs altitude and distance.

weather detection, also the short ranges necessary for approaches. The range settings are 5, 10, 20, 50, and 150 n.mi. The minimal power is 17 KW. The pulserate for long range is 2.5 μsec and for short range 1 μsec.

The radar operates in the X band (3 cm) which combines excellent weather information with sufficient resolution, to clearly pick up oil rigs and ships at sea, without too much clutter because of waves. The resolution is even sufficient to pick up separately the oil rig and its rescue vessel, which is normally closer than 400 meters to the rig. This is clearly visible in Fig. 3. The approach procedure is shown in Fig. 4. The radar installation is shown in Fig. 5.

Thus also with the radar, the concept of combining several possibilities in one system was realized, as the radar can be used for navigation, weather detection and approaches.

Future developments

The RLD has been very responsive to our developments and has always shown a good understanding of our concept. The inspector in charge of helicopter operations should be particularly mentioned for his vision and critical

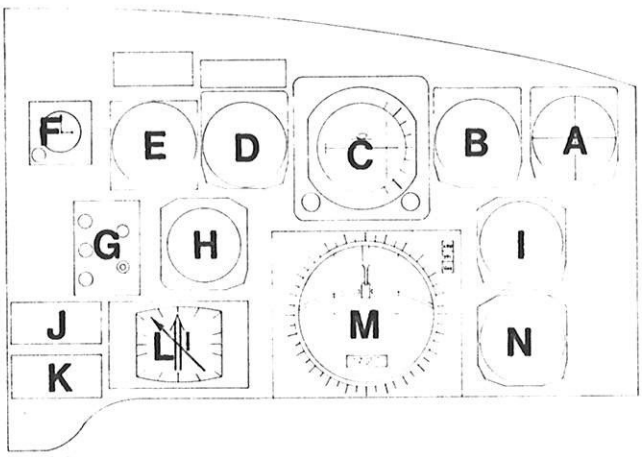

Fig. 7. Possible instrument panel arrangement for future VTOL aircraft. A. Doppler hover indicator. B. Airspeed indicator. C. Artificial horizon with flight director and radio altitude signal. D. Radio altimeter. E. Barometric altimeter. F. Clock. G. Marker beacon. H. Rate-of-climb indicator. I. Engine torque. J. Flight director monitor panel. K. Selector panel automatic approach to hover. L. ADF/VOR/ILS/compass indicator. M. Radar for weather and approach, and master compass indicator. N. Rotor/engine rpm.

thinking in ...ing this, for the RLD, completely new concept ar ...operational development. This also ensures their future cooperation to certify still lower limits and e.g. Doppler approaches.

Our company has presently defined the criterion for the minimum approach speed at 60k, which is the best climb speed on one engine. With Doppler information this could theoretically become a very low speed, up to the critical decision point altitude for the hover at 50 ft, from which point a single engine climb away is still possible.

In practice however, approach speeds lower than 43k might introduce vortex ringstate conditions and might furthermore be uncomfortable for the passengers. Also the rate of descent should not increase above 1500 ft/min, when using steeper glide paths. In Fig. 6 it is shown that for future vertical take off and landing (VTOL) aircraft the limit for the glidepath slope, without using automatic approach couplers is probably in the region of 20°.

This is more than twice as steep as for short take off and landing (STOL) aircraft (8°) and results in a shorter noise footprint. By increasing the slope of the approach path from 3° to 8° the length of the footprint decreases to 37% of the original figure. Further increase to 20° decreases the footprint length to just over 14% of its original length. It should be borne in mind that for all-weather operations CTOL and STOL aircraft have to be equipped with the same expensive multiplicated automatic approach systems, while VTOL aircraft up to a 20° glide slope can keep the pilot in the control loop. At any time the pilot can take over control under much less critical conditions than faced by a fixed-wing pilot on a 3° approach for CTOL, or 8° approach for STOL aircraft at low altitude. At glide slopes over 20° VTOL aircraft will have to rely also on automatic approach systems. Our feeling is that steeper glide slopes than 20° are not worth the complication and extensive equipment.

In principle the all-weather characteristics of the helicopter, and thus of VTOL aircraft in general, will be defined in the next decade. Some aspects of the superior safety and reliability of VTOL aircraft will be proven by our company as a result of the certification of more sophisticated procedures and lower limits.

Our first aim will be to decrease the present radar approach visibility limit of 800 meters to 600 meters by reducing airspeed in the final approach to 60k instead of the present 70k. When using Doppler information this limit may be lowered further. ILS approaches have already experimentally been carried out at a visibility less than 250 meters and a cloudbase below 100 ft without the use of flight directors. This confirmed the NLR study, which reported a sufficient number of useful approach lights at the measured cockpit slant angles, for different visibility-altitude combinations, allowing visual continuation of the approach.

Probably the visibility limits for ILS and PAR will be certified to 400 meters at a cloudbase or decision height of 150 ft. The next step will be to reduce the cloudbase or BOA to 100 ft. The 2-pilot concept is then a necessity, one pilot going visual at the outer marker and carrying out the landing when he considers that sufficient guidance is available from the approach lights.

The "look see" policy should then allow initiation of an approach at very low limits. With Doppler information available it is expected to satisfy the RLD that an accurate azimuth and glide path can be maintained on the ILS at the lower airspeeds required for this accuracy, without flight directors.

When more experience has been gained this could ultimately lead to a waiver of all limits for certain airfields, which have approach systems certified for Cat II ap-

Gustafson Reprint is Still Available

The *Vertiflite* series by F. B. Gustafson, the magazine's technical editor, on "*History of NACA/NASA Rotating-Wing Aircraft Research, 1915–1970*" is still available as a reprint to individual and corporate members of the Society at $1/copy. The non-member price is $2.50. Designated VF 70, it may be obtained from the Membership Services Dept.

proaches. Flight directors may be useful to reduce the workload and therefore could be added when the cost of these systems, in the case of large VTOL aircraft, is a less dominant factor.

Concluding remarks

In our type of unscheduled operations it is not feasible to proceed to limits lower than Cat II. From what we already have obtained using a basically Cat I panel, we can be quite certain that future large VTOL aircraft will be truly safe, all-weather aircraft, and at the same time considerably decrease noise pollution in the built-up areas around VTOLports and particularly airports.

With the advance in radar approach systems, already in military use or development as airborne fire control systems, it may be possible to use cheap VTOLports in adverse weather conditions without ground aids.

VTOL aircraft, as we have proven in our IFR operations from Schiphol, rarely have to cope with delays due to traffic and runway congestion. Furthermore helicopters can accept any ILS approach up to 90° out of the prevailing wind. They do not have to cope with drift in the landing, as they can land from the hover in any wind direction.

The delays due to weather, in seconds per flight hour as recorded at Schiphol Airport were: 1969, 77; 1970, 71; 1971, 58.

The number of cancellations due to weather, mainly icing, as recorded per 1000 flights averaged in 1969 - nil; 1970, 14; 1971, 11.

Of course, these figures are debatable for scheduled services with VTOL aircraft, but it should also be borne in mind that this result was obtained with the minimum of equipment. Thus the same or better results may be expected for the large VTOL aircraft of the future, equipped as envisaged in Fig. 7. Preventing delays will then mainly be an area navigation problem and this is already being studied by several airlines in the U.S. for the Northeast Corridor, as well as by other companies in Europe. It will be certain, however, when economic VTOL aircraft become available, and this is envisaged by the manufacturers between 1975 and 1980, that these aircraft with their inherent all-weather capability can provide a service as reliable and safe as present ground transportation. They thus can become a definite competitor of fixed-wing aircraft on medium haul operations, in particular when VTOL ports can be more conveniently situated, because of relatively low cost, than present airfields.

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I certify that the statements made by me above are correct and complete.

Signed
Allan Bernhardt
Editor

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I began my airline career working as a TRAFFIC REPRESENTATIVE in the G.O. I assisted the V.P. Sales in developing and maintaining direct mailing lists, tariffs, company manuals, and A.T.C. bulletins of authorized Travel Agents. I then worked for three years in San Bernardino, as a PASSENGER AGENT. I was then promoted to SALES REPRESENTATIVE in the San Fernando Valley. I called on established accounts, travel agents, commercial accounts, JAMTOS, REA, post offices, and other airlines. Developed new group travel through speaking engagements at service clubs and civic groups. My efforts helped increase boardings by 400% in one year.

I then accepted position of DISTRICT MANAGER of Anaheim, Newport Beach, and Whittier. I directed station operations through three supervisors at Anaheim, and one station supervisor each at Newport, and Whittier. I was responsible for the development and maintenance of superior and constant standards of passenger and c service with emphasis on the simplification of procedures, sy, and interested treatment of customers, and on-time mance.

MIKE MINEAR

Through these efforts, Anaheim developed into the world's busiest heliport, boarding 78,857 passengers in 1968, which was more than 293 other airports served by a single carrier.

EDUCATION: Weaver Airline school, Kansas City, Kansas City, Mo. Present plans include obtaining B.A. in Business Adminstration, and learning to program computers in Fortran.

LICENSES: Certified Weather Observer (Inactive)
Restricted Radiotelephone Operator Permit.

INTERESTS: Computers, and their applications, electronic kits, music, backpacking, photography, and travel.

OTHER EXPERIENCE: During my 24 years of airline work, during times of strikes, bankruptcys, and furloughs and before I started my airline career I have held the following positions:

Newspaper Route
Bicycle Shop (Sales/Mechanic)
Bee Keeper
Gas Station Attendant
Grocery Clerk
Shoe Salesman
Sporting Goods Salesman
Electronic Manufacturing

In 1979 I published a book titled "AIR TRAVEL ANSWERS", which provided valuable information to air travelers with 32 maps of the major air terminals. I learned type setting, layout, and graphics skills of the book printing trade.

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