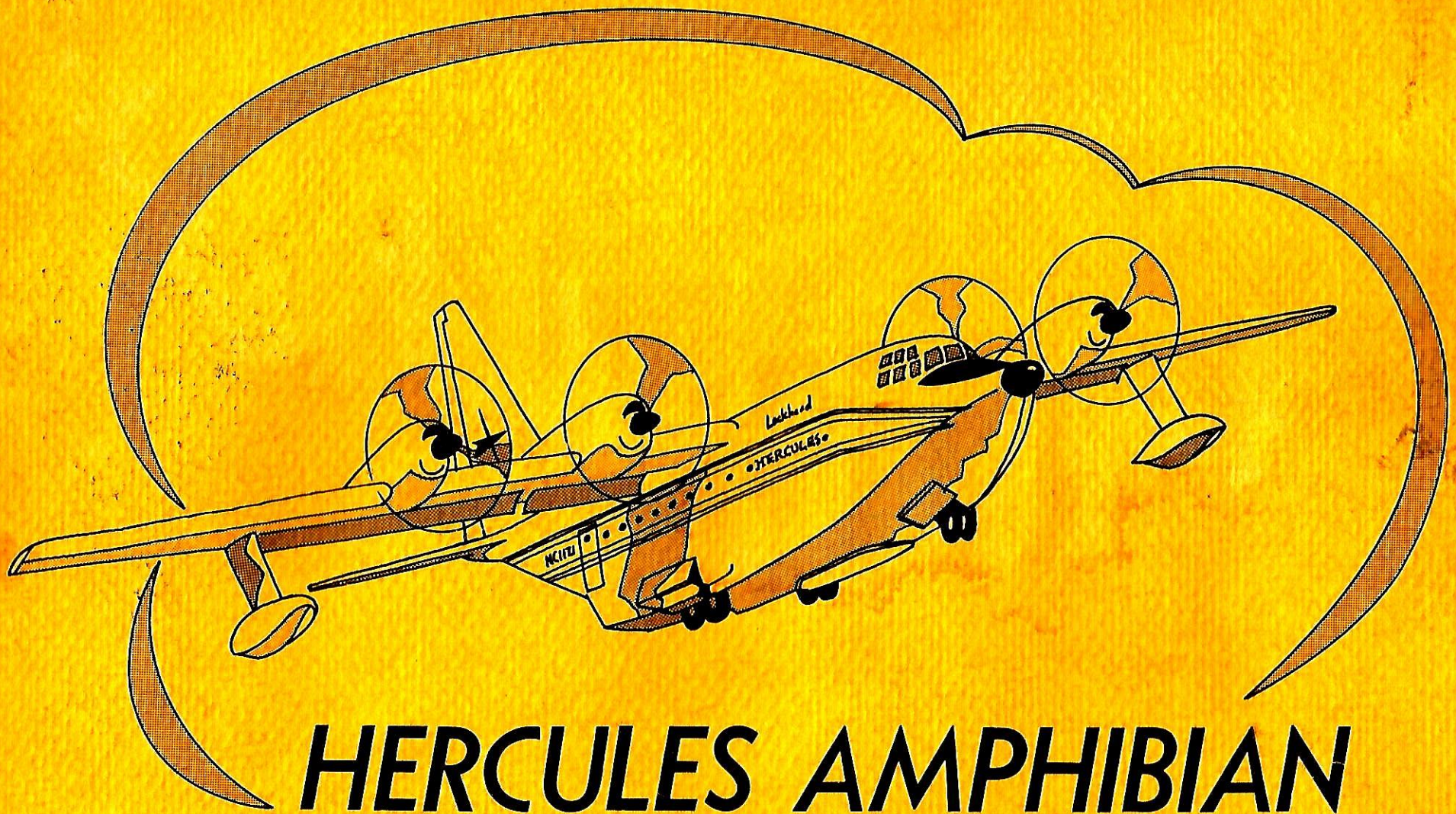


HERCULES AMPHIBIAN

ORD 72-1
January 1972

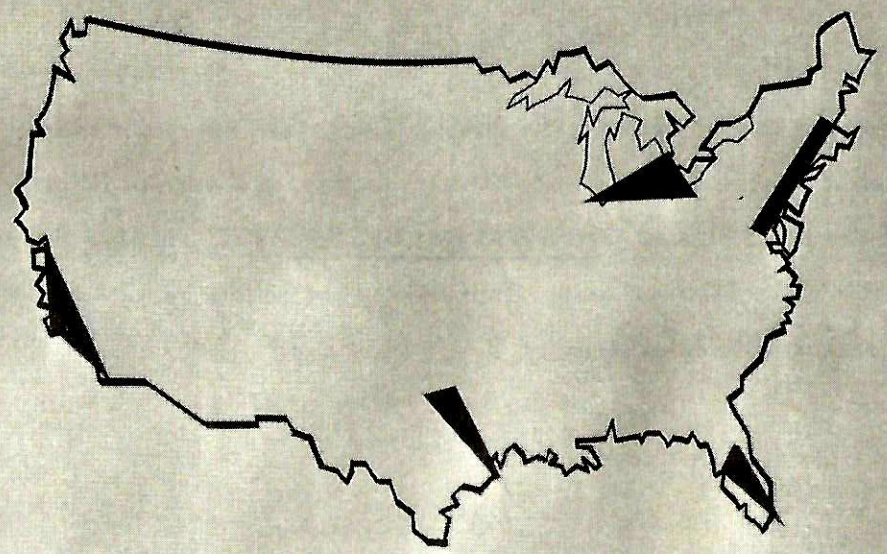
HERCULES STOL AMPHIBIAN

LOCKHEED-GEORGIA COMPANY • MARIETTA, GEORGIA

It has been said that there are five major population regions in the country which could benefit from a STOL aircraft transportation system. These are the Northeast Corridor; the Miami-Orlando (Disney World) -Pinellas County area of Florida; the Detroit-Cleveland-Chicago triangle; the Dallas-Fort Worth-Houston triangle; and the West Coast Corridor. All of these major centers are located on water.

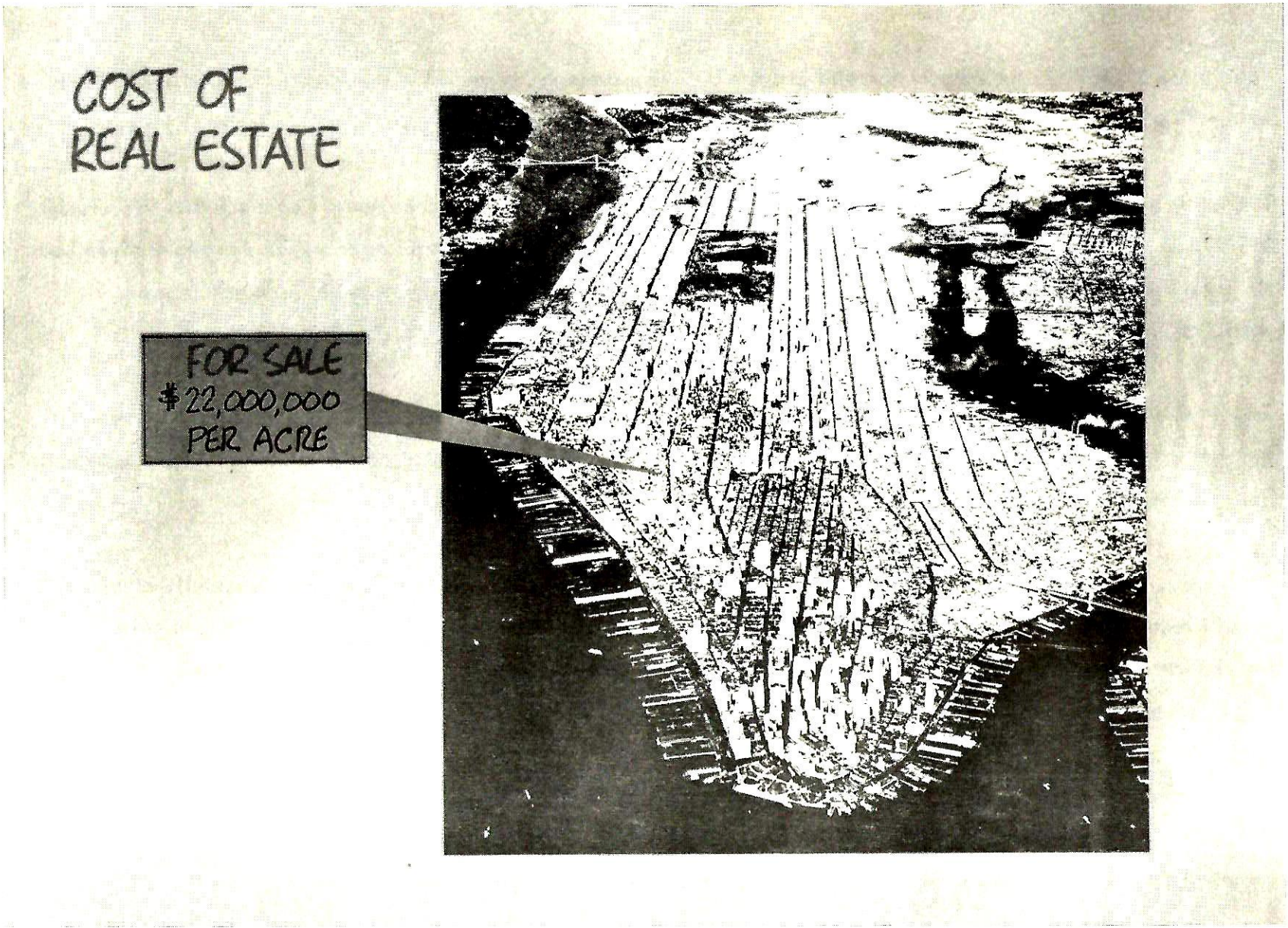
It is of significance, that among the reasons for the use of seaplanes on the early airlines was the lack of airports, plus the fact that all of the major population centers were on the water. The early Pan American Airways operations are evidence of the point. However, the rapid expansion and building of airports during the "unlimited cost" exigencies of World War II contributed to the fade of the seaplane. Nevertheless, the situation has once again arisen where there is very little precious land available for new airports (STOL or otherwise), but the world-wide population centers remain on the water. Phoenix-like, the seaplane/amphibian may yet rise again.

PRINCIPAL CANDIDATE STOL REGIONS



Some of the many factors inhibiting construction of downtown STOLports in the major cities of the country are expensive condemnation procedings, pressure from irate citizens groups, and various litigation actions. However, the most outstanding reason is the price of land. Forbes Magazine, June 1971, quoted the price of land in Manhattan as $500 per square foot or nearly $22 million an acre. Thus the cost of necessary land could run into hundreds of millions before any construction costs are considered.

COST OF REAL ESTATE



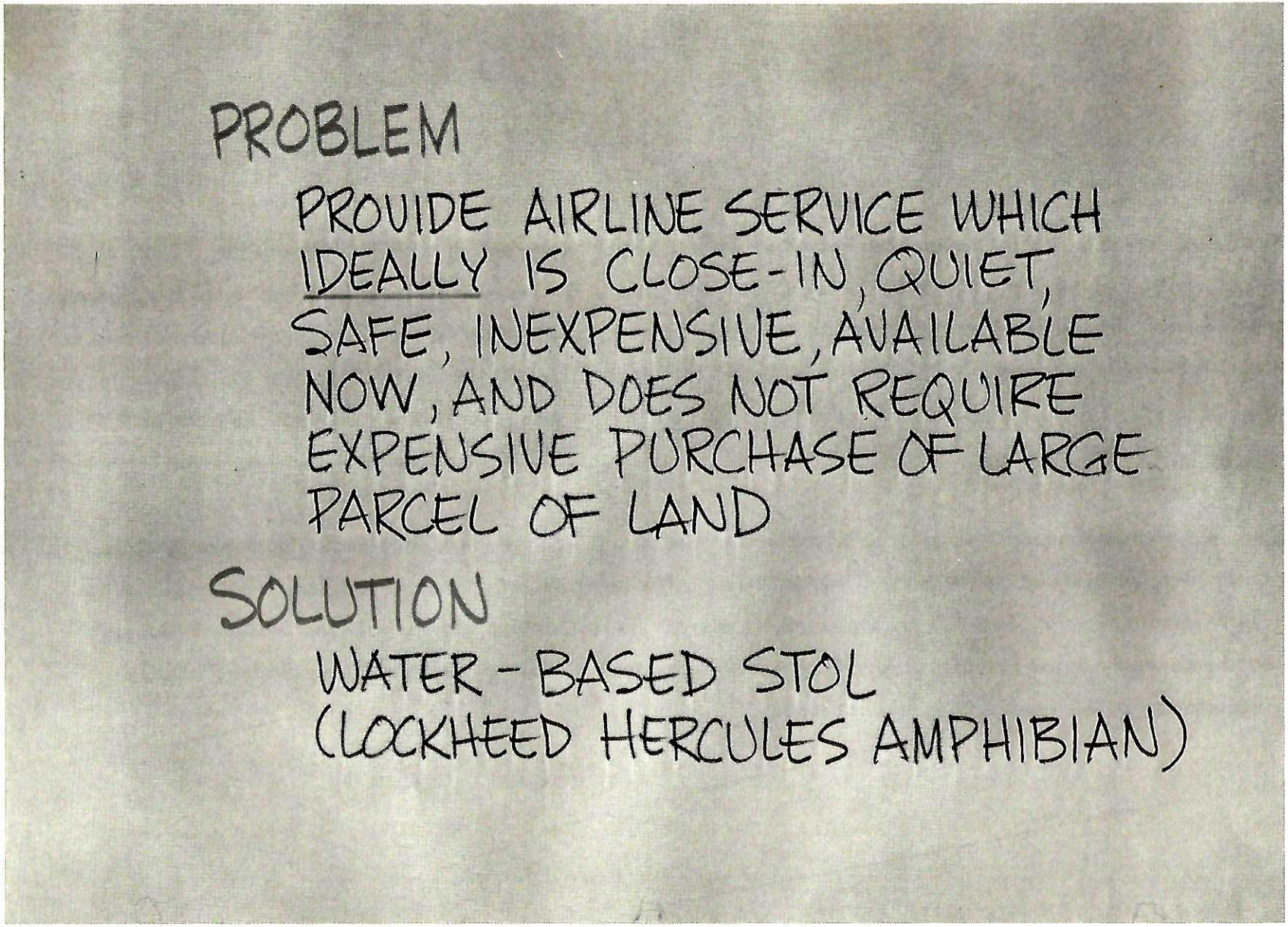
What price STOL? To the Airport operator and the city he represents, a new STOLport means acquisition of expensive land. This is particularly so if the land is downtown, as it should be to provide truly city-center-to-city-center service.

To the airline passenger, it means he is able to fly downtown-to-downtown, and he doesn't care whether the aircraft is STOL or not. However, he knows that the current airliner is taking longer and longer on the short-to-medium haul. He cares about safety and reliability; and, being a citizen, he wants a new airplane to be ecologically clean -- particularly in terms of noise. Then, too, he doesn't want the STOL airplane to cost him any higher fares.

To the airline, a STOL airplane must satisfy the aforementioned customer's needs. However, initial investment is a big factor; and to keep the fares down, so are operating costs. Then, too, the building of a new STOLport represents both serious involvement in site selection and a considerable capital investment.

Obviously, then, to provide airline service which is close-in, quiet, safe, economical, environmentally clean, and doesn't require use of expensive land, provides us with a set of requirements which are at odds with each other. It would seem that a solution to any one of the above problems produces unreasonable aspects to the others. What price STOL indeed?

At Lockheed-Georgia, we have under consideration a concept that we believe will uniquely solve STOL problems. It's a STOL airplane which would be able to take off and land from water, but would also have the flexibility to operate from land -- an amphibian STOL version of the versatile, proven, C-130 Hercules.


PROBLEM
PROVIDE AIRLINE SERVICE WHICH IDEALLY IS CLOSE-IN, QUIET, SAFE, INEXPENSIVE, AVAILABLE NOW, AND DOES NOT REQUIRE EXPENSIVE PURCHASE OF LARGE PARCEL OF LAND
SOLUTION
WATER-BASED STOL (LOCKHEED HERCULES AMPHIBIAN)

The amphibian offers unique advantages in solving the problem of implementing a STOL airline system. There would be no need to acquire expensive large parcels of downtown land. The water is already there and so are the "runways." Water runways are self-sealing, which would reduce maintenance costs and which need not be oriented precisely to prevailing winds, since water is literally paved in all directions. It would take less time to start the service, for the water is already there. However, of significance to the ecologist, noise effects tend to be reduced since takeoff is made further from housing.

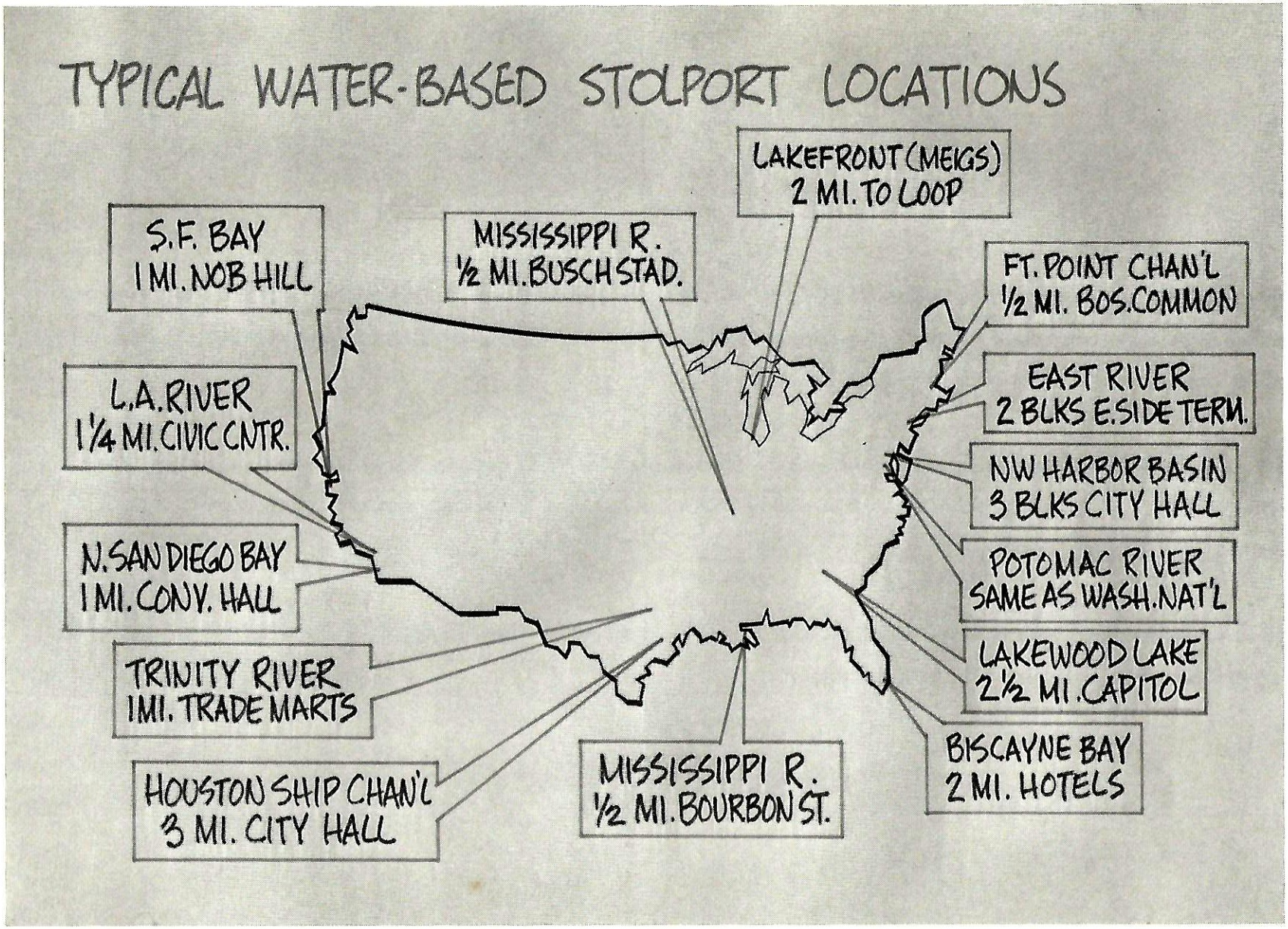
Use of an amphibian permits the pilot to drive the airplane up a ramp to dry land for boarding as a regular airliner would. But, importantly, in those cities where there are few airplanes arriving and departing, the Hercules doesn't have to land on water. Since it's an amphibian, it can use the regular land airport. For that matter, it wouldn't even be necessary to use STOL at cities with low density air traffic. Otherwise stated, it would be a flexible transportation system - wet or dry, short or long.

ADVANTAGES OF STOL AMPHIBIAN

1. FLEXIBILITY - OPERATES FROM LAND OR WATER
2. NO LARGE LAND AREA REQUIREMENTS
   - LOWER ACQUISITION COSTS
   - LOWER MAINTENANCE COSTS
3. REDUCED NOISE NUISANCE
4. REALLY "DOWNTOWN" IN MOST MAJOR CITIES
5. WATER "RUNWAYS" OMNIDIRECTIONAL
6. AMPHIBIAN PROVIDES "DRY" LOADING AND UNLOADING
7. LESS TIME TO START OF SERVICE
8. EASY EXPANSION OF STOL SERVICE

What does the ability to operate from water have to do with it? Consider that there is enough water located downtown in every major city of the country to accommodate a STOL amphibian. Some typical examples are shown including some in frigid climes. As will be discussed later, there has been developed a relatively simple, ecologically clean and safe, method of keeping a channel free of ice.

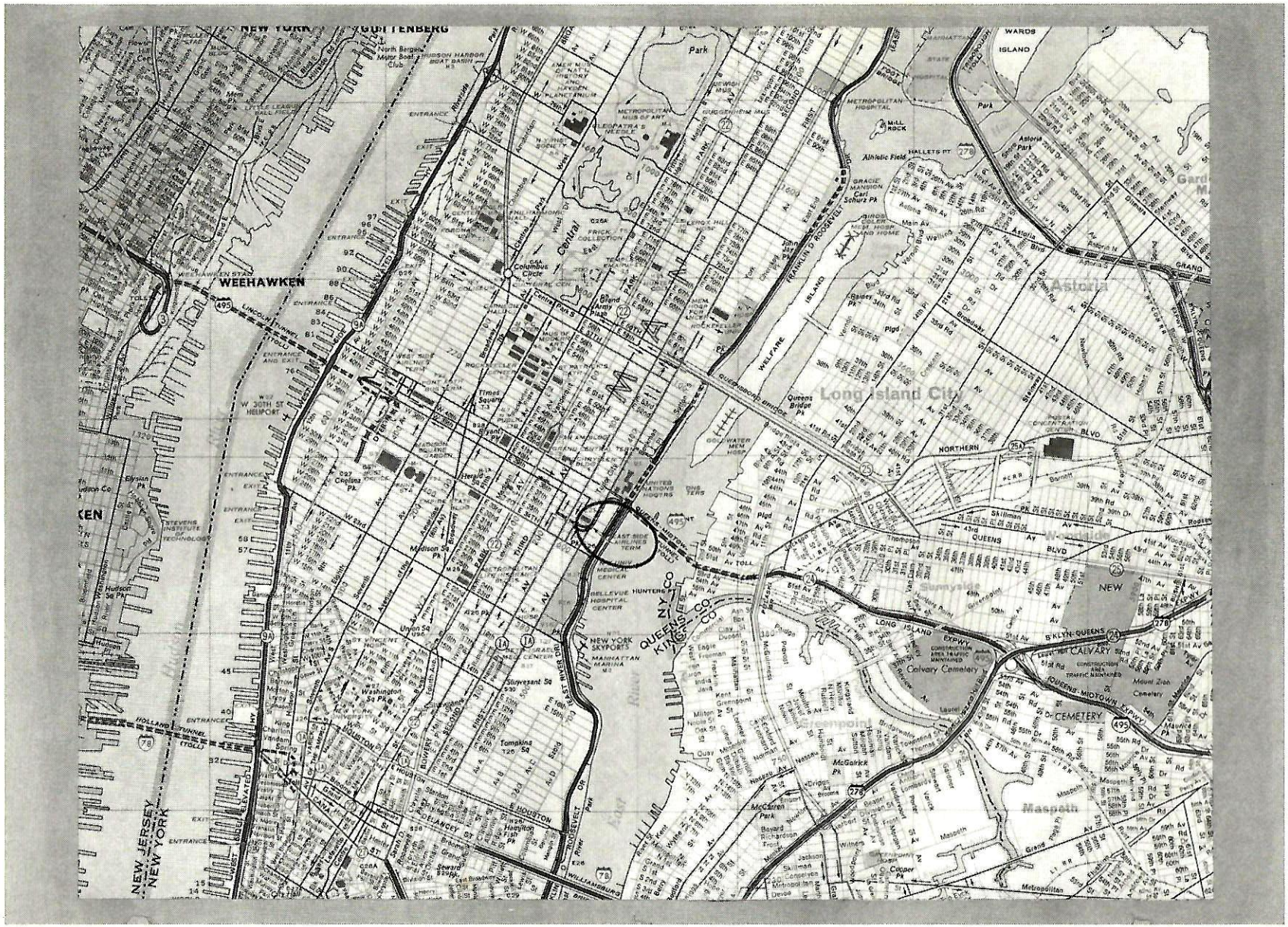
Since the major population centers of the country, including inland cities, were originally located on water, the opening statement is true, and can be realized by and large without dredging, dams, or other changes to the natural waterways.


TYPICAL WATER-BASED STOLPORT LOCATIONS
LAKEFRONT (MEIGS)
2 MI. TO LOOP
S.F. BAY
1 MI. NOB HILL
MISSISSIPPI R.
½ MI. BUSCH STAD.
FT. POINT CHAN'L
½ MI. BOS. COMMON
L.A. RIVER
1¼ MI. CIVIC CNTR.
EAST RIVER
2 BLKS E. SIDE TERM.
NW HARBOR BASIN
3 BLKS CITY HALL
N. SAN DIEGO BAY
1 MI. CONV. HALL
POTOMAC RIVER
SAME AS WASH. NAT'L
TRINITY RIVER
1 MI. TRADE MARTS
LAKEWOOD LAKE
2½ MI. CAPITOL
HOUSTON SHIP CHAN'L
3 MI. CITY HALL
MISSISSIPPI R.
½ MI. BOURBON ST.
BISCAYNE BAY
2 MI. HOTELS

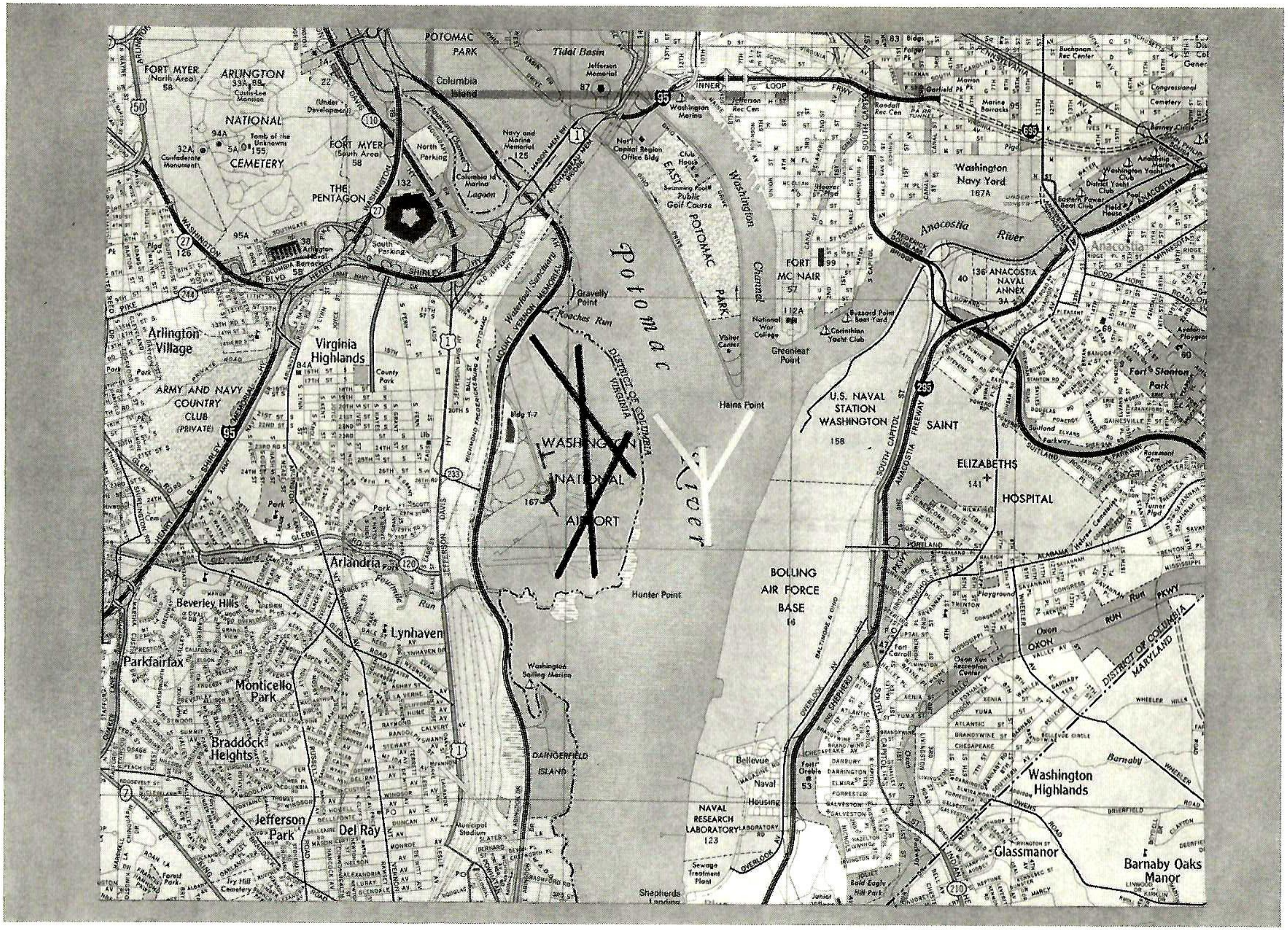
There are several possible sites in New York City. In fact, Charles Leedham, Commissioner of Marine and Aviation has secured approval from the Mayor, the Borough Presidents and the City Commissioners for five water-based STOL-ports located around Manhattan Island.

One area Lockheed has considered is on the East River between the Williamsburg and Queensboro Bridges. Ample room exists for a STOL amphibian since it is nearly five miles between the bridges and only slightly more than 3000 feet is required for operations.

Such a site would put the traveler just two blocks from the East Side Airlines Terminal, thus saving him a lengthy and expensive cab or limousine ride from the airport.


WEEHAWKEN
Long Island City
Astoria
Maspeth
Calvary Cemetery
NEW JERSEY
NEW YORK
QUEENS CO.
KINGS CO.
N.Y. CO.

Washington National Airport is considered by many to be ideal because it is essentially "downtown." Yet it is crowded and there is apparently no room to build additional runways to increase capacity. However, three runways parallel to those currently in use are now available in the Potomac and they don't have to be built. Such "building" of parallel runways could typically be duplicated at Tampa, San Diego, or Los Angeles International, again, illustrating an advantage of using a water-based STOL.

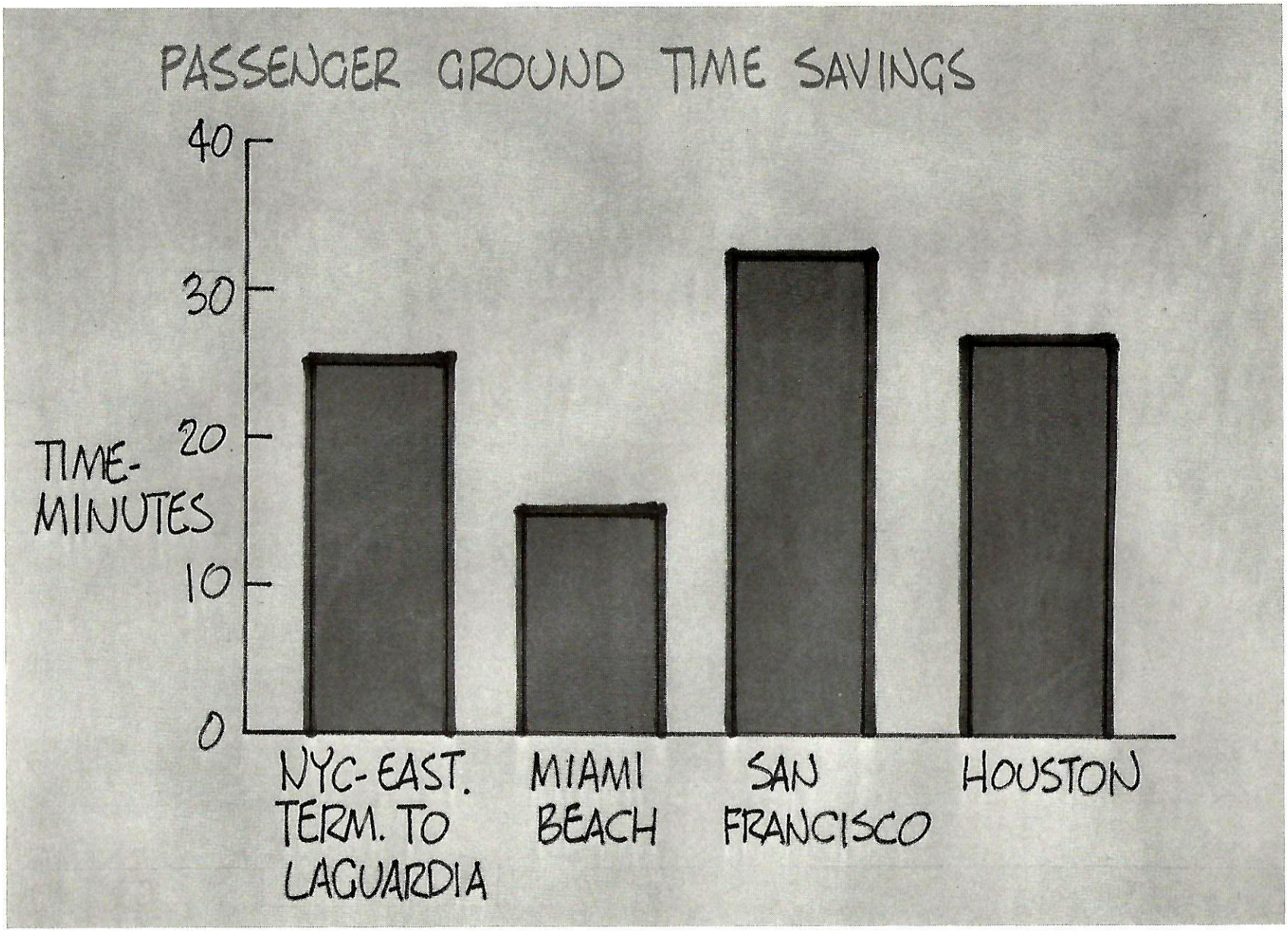

FORT MYER (North Area)
ARLINGTON
NATIONAL CEMETERY
Tomb of the Unknowns
Confederate Monument
FORT MYER (South Area)
THE PENTAGON
North Parking
South Parking
POTOMAC PARK
Columbia Island
Columbia Is Marina Lagoon
Navy and Marine Memorial
Tidal Basin
Jefferson Memorial
Washington Marina
EAST POTOMAC PARK
Public Golf Course
Washington Channel
Potomac River
Gravelly Point
Roaches Run
DISTRICT OF COLUMBIA
VIRGINIA
WASHINGTON NATIONAL AIRPORT
Hains Point
Hunter Point
FORT MC NAIR
National War College
Greenleaf Point
Washington Navy Yard
Anacostia River
Anacostia
ANACOSTIA NAVAL ANNEX
U.S. NAVAL STATION WASHINGTON
SAINT ELIZABETHS HOSPITAL
Fort Stanton Park
BOLLING AIR FORCE BASE
Arlington Village
Virginia Highlands
ARMY AND NAVY COUNTRY CLUB (PRIVATE)
Arlandria
Beverley Hills
Lynhaven
Parkfairfax
Monticello Park
Braddock Heights
Jefferson Park
Del Ray
Washington Sailing Marina
DAINGERFIELD ISLAND
Municipal Stadium
Bellevue Naval Housing
NAVAL RESEARCH LABORATORY
Sewage Treatment Plant
Shepherds Landing
Washington Highlands
Glassmanor
Barnaby Oaks Manor
DISTRICT OF COLUMBIA
MARYLAND
ANACOSTIA FREEWAY
SOUTH CAPITOL ST
Oxon Run

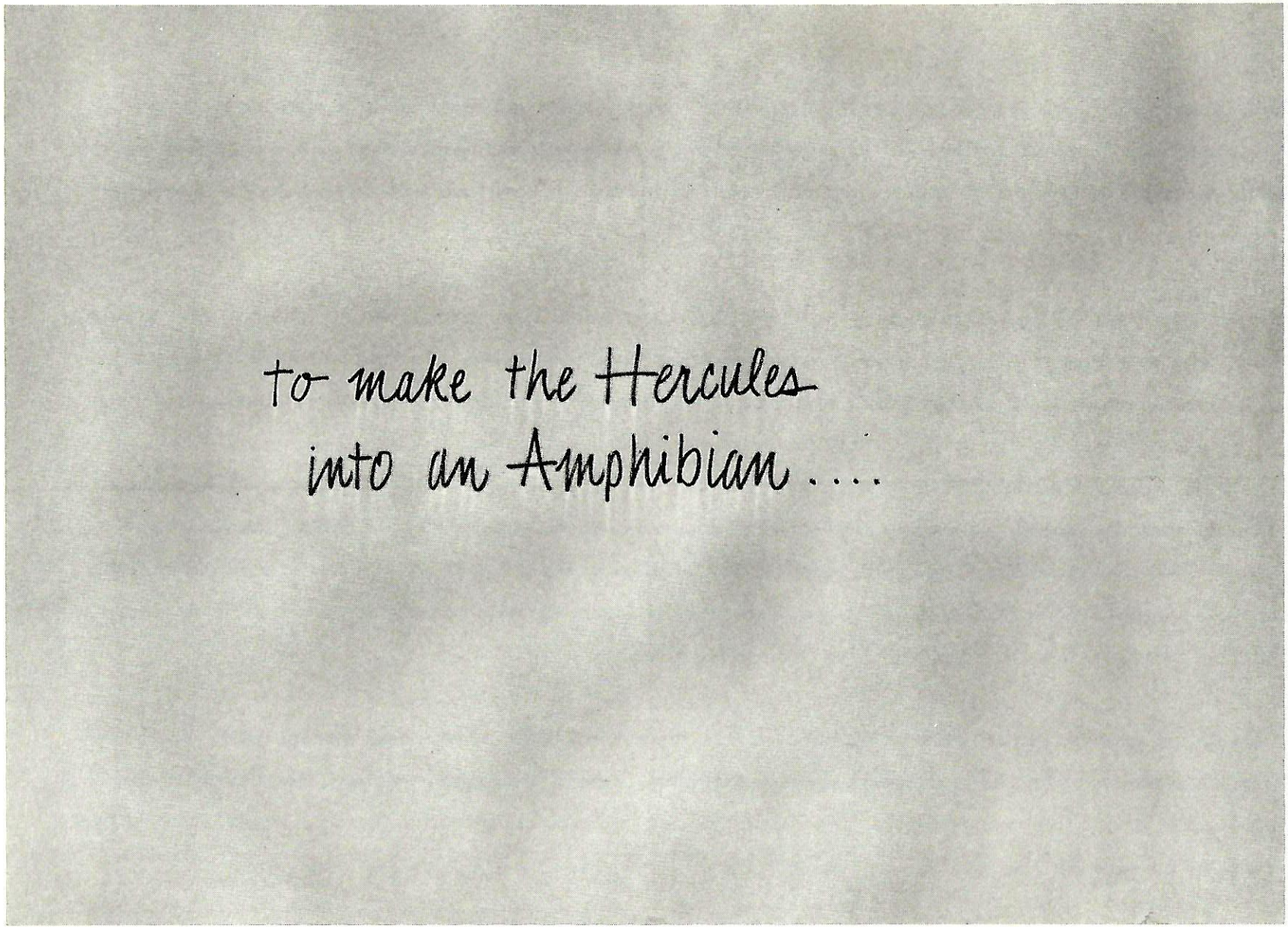
Typical savings in ground transportation are:

NYC - LaGuardia to East Side Terminal	26 minutes
Miami International Airport to Miami Beach hotels	14 minutes
San Francisco International Airport to Nob Hill	32 minutes
Houston Intercontinental Airport to city center	25 minutes

These estimates have been made based upon average speed of ground transportation at other than peak times of day, say 10 a.m. Obviously the time would increase during "rush hour" traffic. Typical rush-hour times in NYC would be 45 to 50 minutes depending upon the weather.

Of significance too, to the traveler, are the savings in fares.


PASSENGER GROUND TIME SAVINGS
40
30
20
10
0
TIME-
MINUTES
NYC-EAST.
TERM. TO
LAGUARDIA
MIAMI
BEACH
SAN
FRANCISCO
HOUSTON

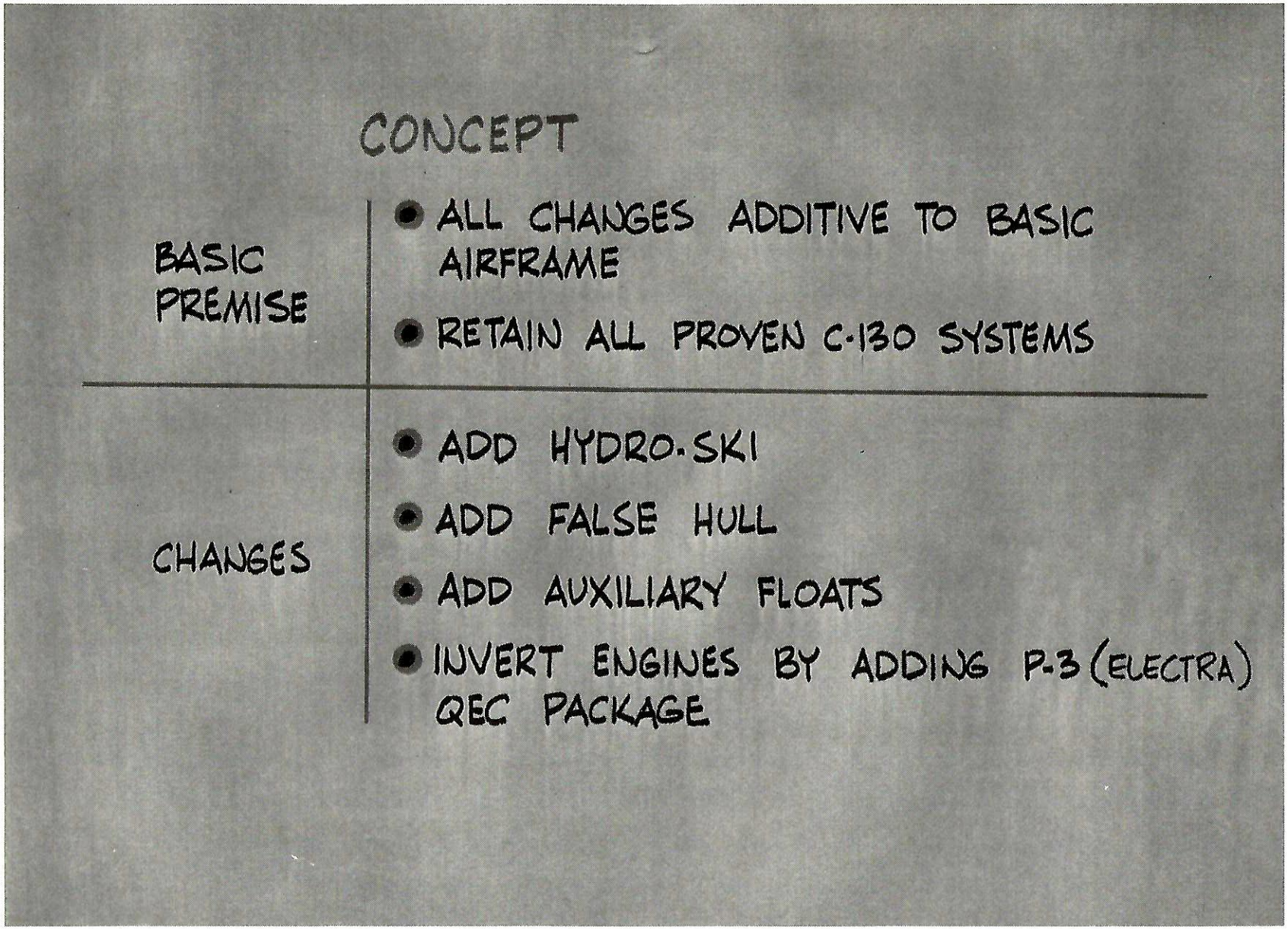

to make the Hercules
into an Amphibian....

The Lockheed Hercules is already a certified commercial cargo carrier and could easily be converted to carry passengers in pressurized comfort. All changes required are additive to the basic airframe, thus providing the least expensive and shortest time to the development of a working STOL airliner with city-center-to-city-center capability.

To make the Hercules into an amphibian would require only four additions: a hydro-ski, a false hull over existing pressurized fuselage, auxiliary wing floats, and inversion of the T-56 engines a la the Electra (which basically uses the same engine). All proven and certificated systems (including the landing gear) are retained.

The basic principles of the conversion were proven during the course of a 1968 Navy contract which featured a 1/16 dynamically scaled, radio-controlled model used as a development tool. Costing $9000, the model was used to determine water-handling characteristics, best location of the ski, and spray effects (absolutely no water in engine inlets). Over 60 flights were made, and data were obtained which otherwise could only have been realized if a full-scale Hercules amphibian had been available.

It should be emphasized that the modifications required are not indicative of high development costs. Beginning with the advantage of an in-production certificated airplane, retaining all proven systems, and designing around the concept of additive changes would keep the unit price of a Hercules Amphibian to only a modest increase over the basic airframe.

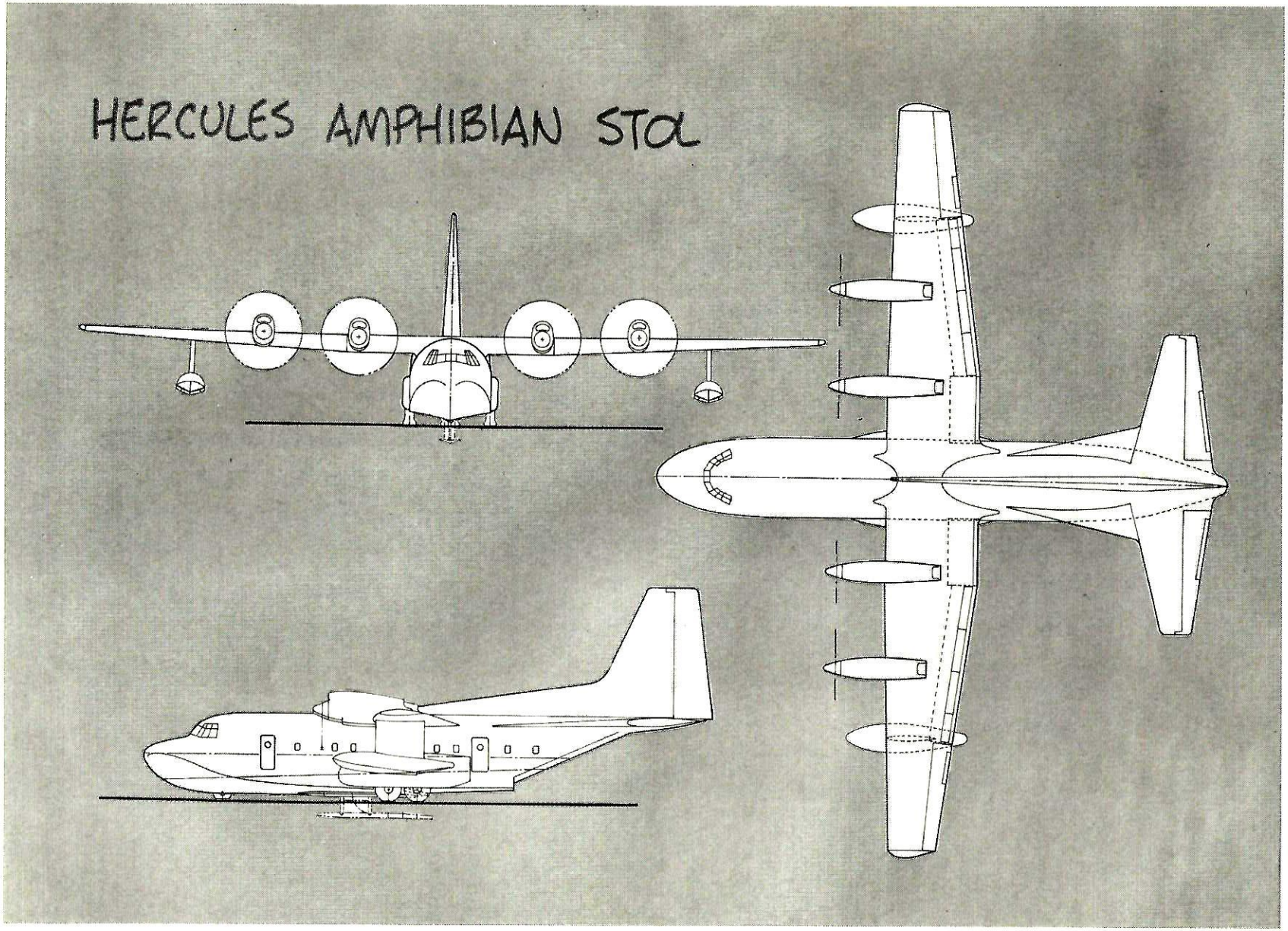

CONCEPT
BASIC PREMISE
ALL CHANGES ADDITIVE TO BASIC AIRFRAME
RETAIN ALL PROVEN C-130 SYSTEMS
CHANGES
ADD HYDRO-SKI
ADD FALSE HULL
ADD AUXILIARY FLOATS
INVERT ENGINES BY ADDING P-3 (ELECTRA) QEC PACKAGE

The hydro-ski is the key to modern seaplane design in that it is essentially a load-alleviating device. While the lower STOL landing speeds work wonders in reducing fore-and-aft loads, water-based aircraft still need to be designed for 10-feet-per-second sinking speed. It is this vertical impact, the slapping of the water like a kid diving off the diving board and hitting the water at a flat angle, which has caused thick hull plates and heavy weights in oldtime seaplanes. However, the ski reduces such impact loads to values frequently less than those realized in a hard runway landing. In addition, the ski shortens takeoff time to something less than half of the usual, removes the old bugaboo of porpoising, and provides increased safety since more time is spent on the surface rather than in the water.

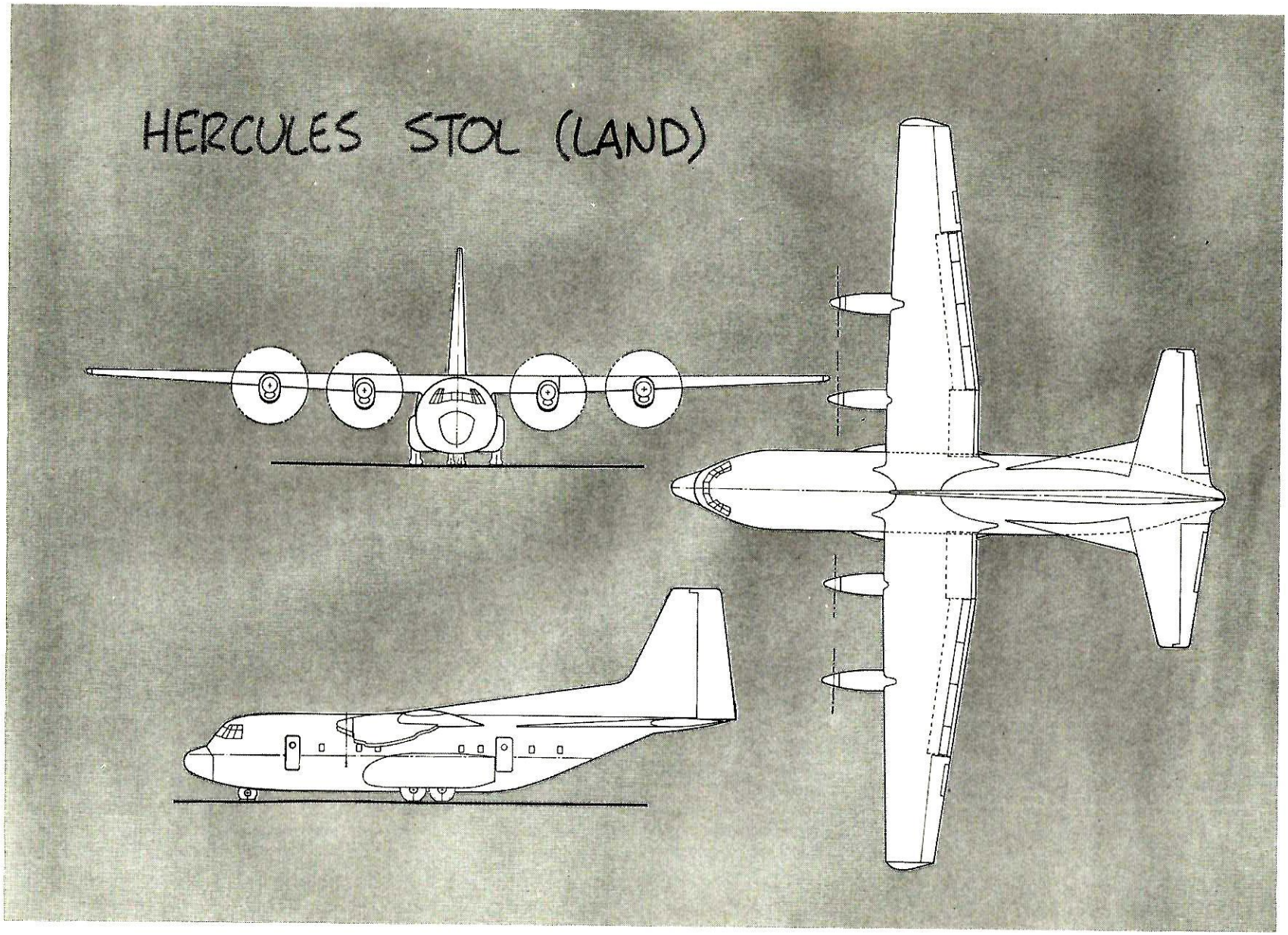
A stable, low drag, hull shape was developed under Lockheed contract by The Stevens Institute of Technology in Hoboken. Meeting the requirement to fit over the outside of the existing fuselage, fabrication will be one-piece molded fiberglas. All 'tween spaces and the underfloor area will be filled with foam to provide infinite compartment action.

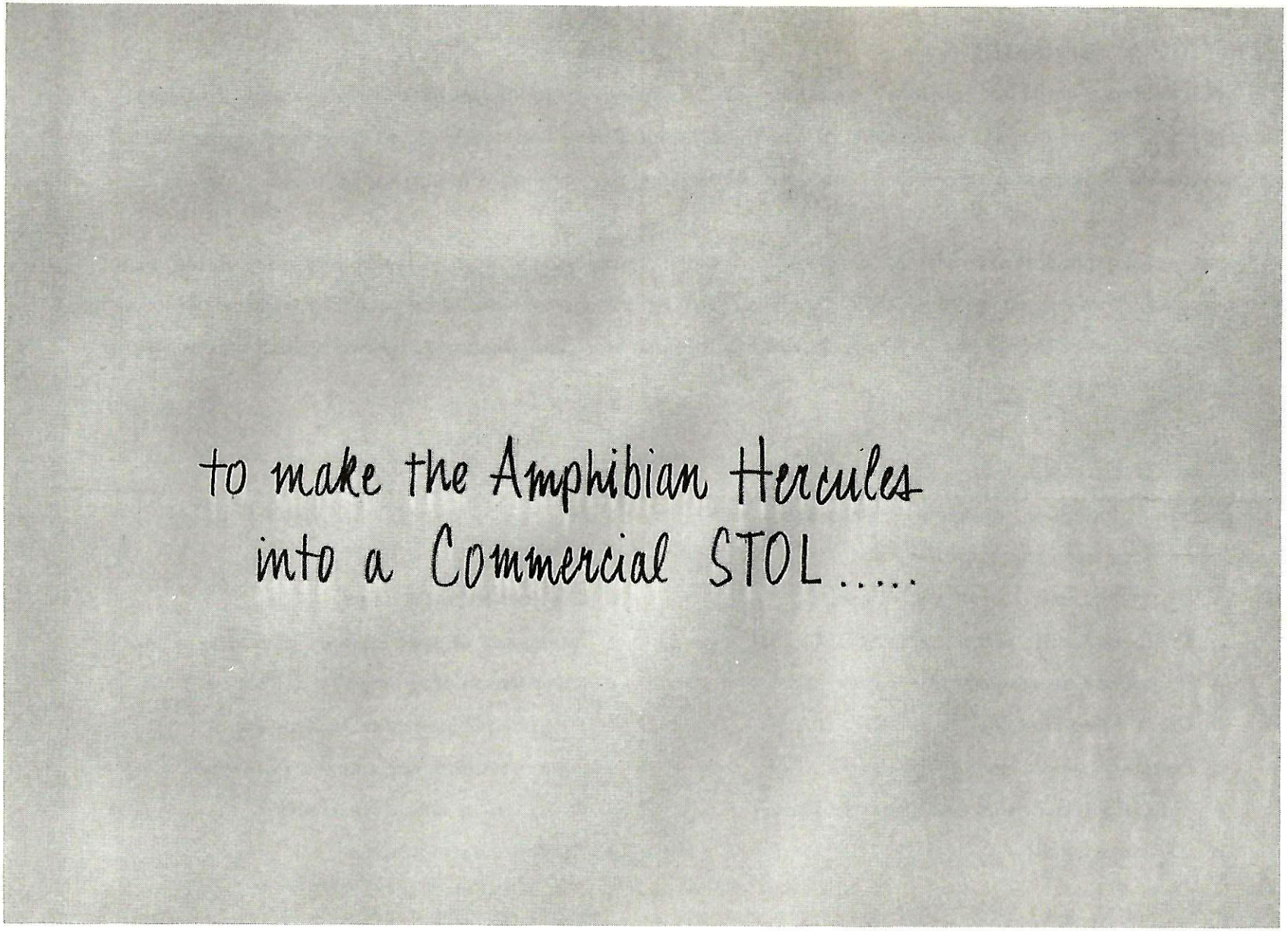
The engines are inverted to achieve better propeller tip clearance with the water. Fortunately, the basic Electra (Navy P-3) engine is the same as that for the L-100 -- only the gear box is inverted to provide over-the-wing installation.

In further regard to engines, seaplanes and amphibians traditionally seem to have been underpowered. The wartime PBM carried 14 pounds per horsepower, the HU-16 Albatross has a weight-to-power ratio of about 11, and the still-born Sauders Roe Princess's ratio was 9.9. However, the Hercules will have ample power at a ratio of 7.3. In fact, during takeoff it has nearly 100% more power available than the maximum drag encountered. Thus, based on model tests, takeoff is estimated to require only 23 seconds ... not bad for a big heavyweight.


HERCULES AMPHIBIAN STOL

The Hercules is, of course, also available in a basic land-based STOL configuration. Removal of the amphibian features, utilizing the existing engine/nacelle configuration, and adding STOL mods (discussed later) results in the configuration shown.


HERCULES STOL (LAND)


to make the Amphibian Hercules
into a Commercial STOL.....

COMFORT CONSIDERATIONS

To make a commercial STOL airliner from a basic L-100 amphibian would require addition of seats, windows, emergency exits, and lavatory cubicles. All of these features have been designed with appropriate soundproofing to provide the passenger with comfort equal to or better than that available in current jetliners.

The basic unstretched version of the Hercules would seat 70 passengers with the stretched versions seating more; for example, the Dash 20 would seat 82. The basic seating arrangement would be six abreast with a center aisle. An alternative arrangement would be six abreast, in three pairs of seats separated by two aisles, thus achieving a continuity with wide-body jets.

SAFETY CONSIDERATIONS

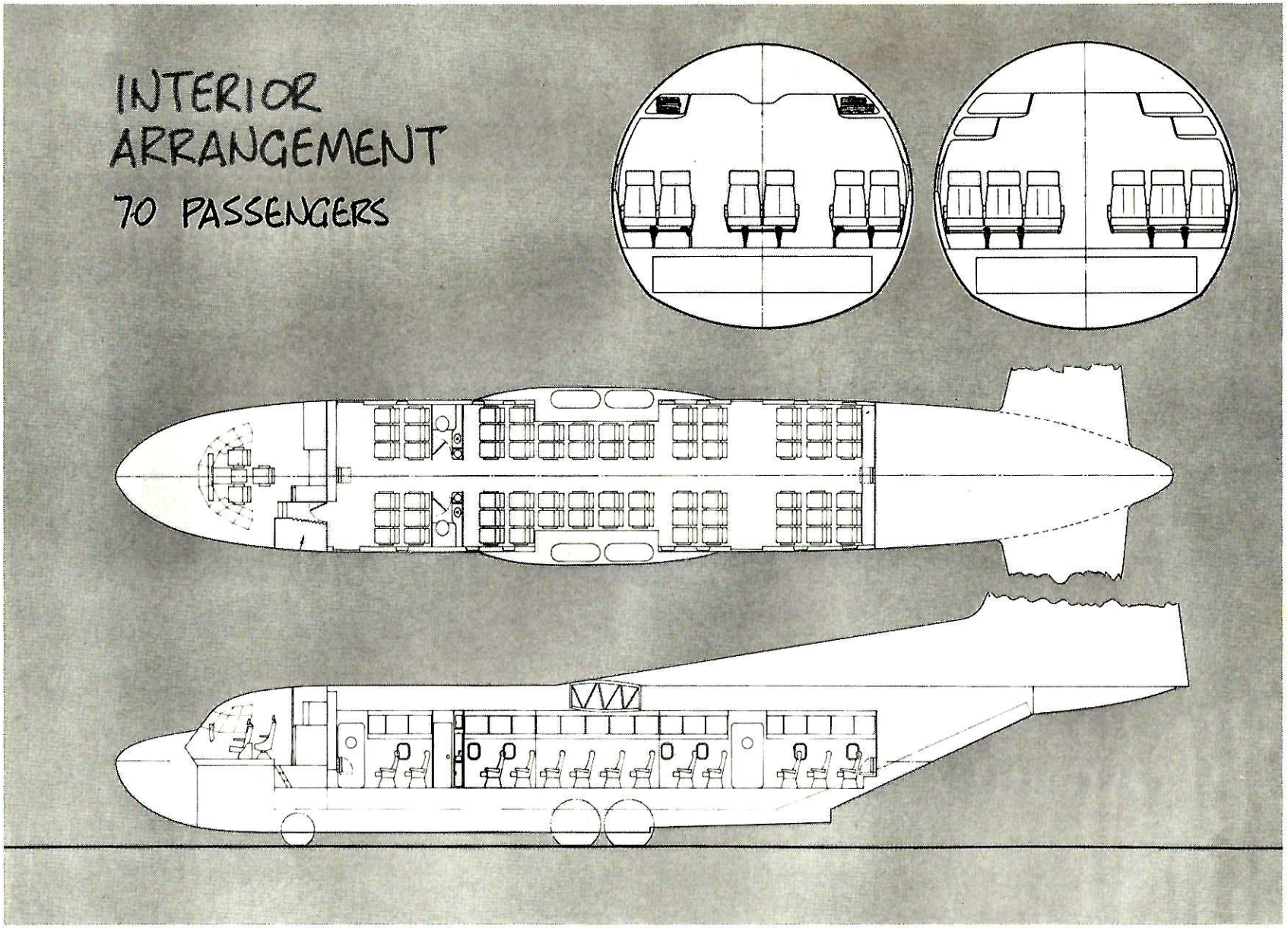
In addition to the usual navigational equipment, seat belts, lighting, etc., the following items of safety equipment have been incorporated:

- Emergency exits, passenger compt. (4) *
- Emergency exits, crew compt. (3) *
- Emergency depressurization hatch
- Ditching hatches (4)
- Portable ladders and life lines
- Watertight floor and underfloor bulkheads
- Life rafts for all
- Life jackets under seats
- Emergency oxygen supply and masks
- Illumination of emergency exits
- Long range signal device (stowed)
- Flame resistant material - all compt.
- Propeller ice shield (fuselage)
- Hand fire extinguishers

* Above water line

INTERIOR ARRANGEMENT

70 PASSENGERS



STOL capability would be achieved through changes to the flaps, enlargement of the rudder, addition of dorsals to both the fin and stabilizer, spoilers, stability augmentation, and a fully-powered control system. These changes have already been designed in detail and, significantly, are also essentially additive to the basic airframe.

"Horsals" are Lockheed-Georgia's appelation for increased area to the stabilizer, ergo a "horizontal dorsal."

STOL ADD-ON MODS
(ALREADY DESIGNED)

- DOUBLE SLOTTED, COMPOUND FOWLER FLAPS
- ENLARGED RUDDER
- INCREASED SIZE DORSAL FIN
- HORSAL FINS
- SPOILERS
- FULLY POWERED FLIGHT CONTROL SYSTEM
- STABILITY AUGMENTATION SYSTEM

The basis for performance calculations is an adaptation of the rules proposed in the so-called FAR XX. Grooved, wet runways and clearways have been assumed for all calculations.

The critical balanced field length is based on clearing a 35-foot obstacle with 3-engine operation. For engine failure situations, delay times of 1.0 second for pilot recognition, 2.0 seconds for pilot reaction, and 4.0 seconds for engine response have been used, based upon flight test data.

The so-called Channel Length for water operation corresponds to Field Length for land operation. The critical condition on the water is the accelerate-stop distance following an engine failure while riding on the ski.

Although the Hercules Amphibian has internal fuel capacity of 45,240 pounds, only 15,900 pounds has been utilized. This weight is sufficient for 600 n. mi. range plus reserve for an additional 100 n. mi. and 45 minutes of loiter at 500 feet. A range of 600 n. mi. is considered ample for operation in any of the major STOL regions, the longest of which is the 392 n. mi. from San Francisco to San Diego.

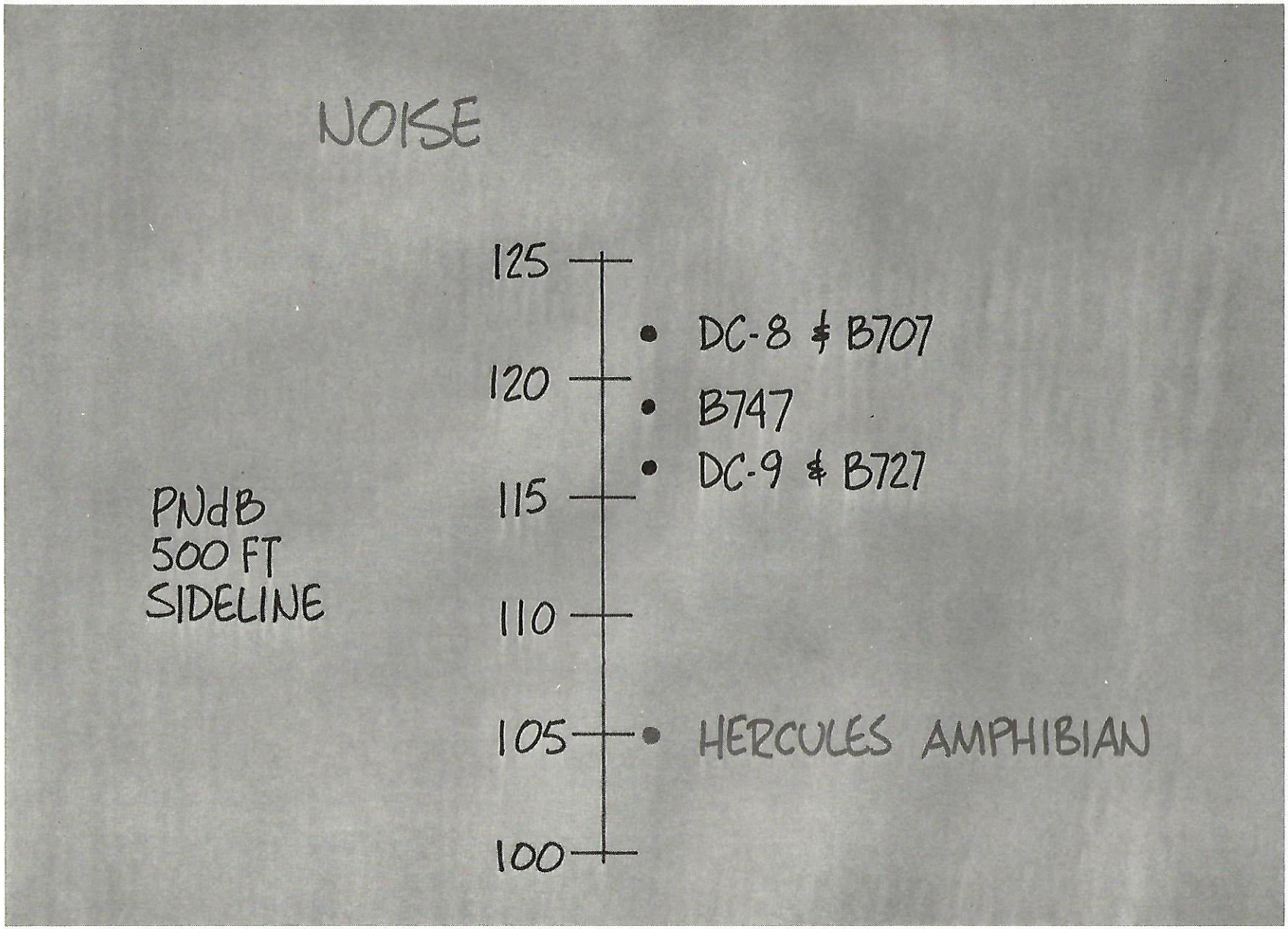
ESTIMATED PERFORMANCE

◦ CRUISE SPEED	300 KT
◦ T.O.G.W.	126,000 LB
◦ RANGE	600 N.M. (PLUS RESERVES)
◦ LAND OPERATIONS	
T.O. GROUND ROLL	1750 FT. (HOT DAY)
T.O. FIELD LENGTH	2450 FT. "
LDG. DISTANCE AT 126,000 LB.	1580 FT. "
LDG. FIELD LENGTH	2270 FT. "
APPROACH SPEED	91 KT
MIN FLYING SPEED	76 KT
◦ WATER OPERATIONS	
T.O. DISTANCE	2570 FT. (HOT DAY)
CHANNEL LENGTH	3300 FT. "

The Hercules Amphibian would be a relatively quiet airliner as far as local citizenry is concerned. Its 500-foot sideline noise level would be 105 PNdB which compares to the 117 to 123 PNdB range for today's jets or the approximate 113 to 115 PNdB for the newer wide-body airliners.

However, it should be noted that the noise level would be, in a relative sense, even better due to operations from the water. This is of significance, for example, in New York City, where a takeoff from the middle of the East River would result in only 93 PNdB along the short at FDR Drive. A comparable value in a takeoff from the Hudson would occur dockside at 12th Avenue. Operations from Washington's Potomac would cause noise levels only in the 80s by the time the sound waves reached inhabited areas. Thus, the Hercules Amphibian would apparently produce noise comparable to normal urban levels in the "people" areas -- an obvious improvement over the current situation.

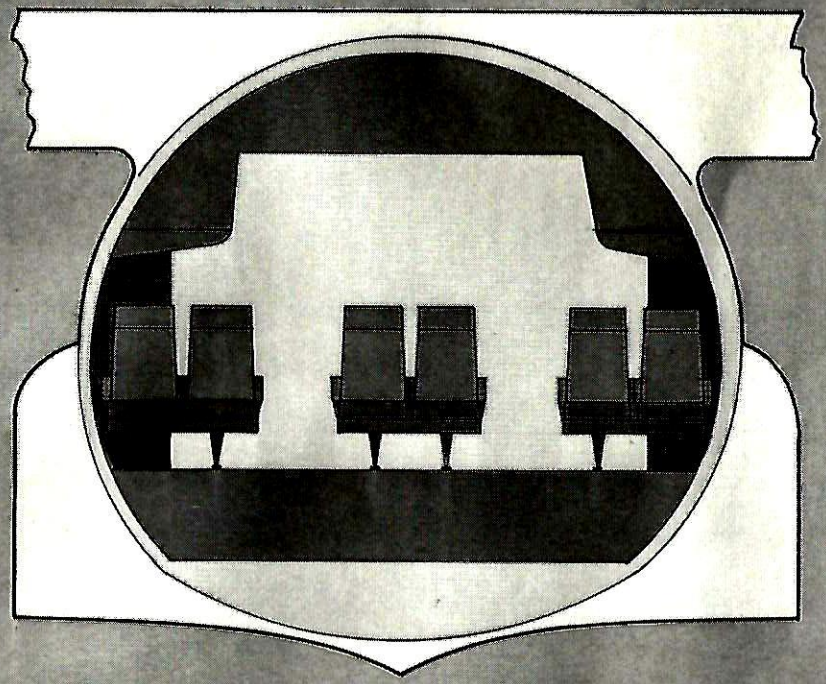
It should be noted that design changes can be made to the Hercules to achieve 95 PNdB at 500-foot sideline distances. These include development and installation of a 16.5 foot highly-cambered propeller, a new gear box to reduce the tip speed of the new propeller, and acoustical lining of the inlet and exhaust ducts. However, costs increase considerably.


NOISE
125
120
115
110
105
100
DC-8 & B707
B747
DC-9 & B727
HERCULES AMPHIBIAN
PNdB
500 FT
SIDELINE

INTERIOR NOISE

OVERALL LEVEL:
89 dB

SPEECH INTERFERENCE:
62 dB

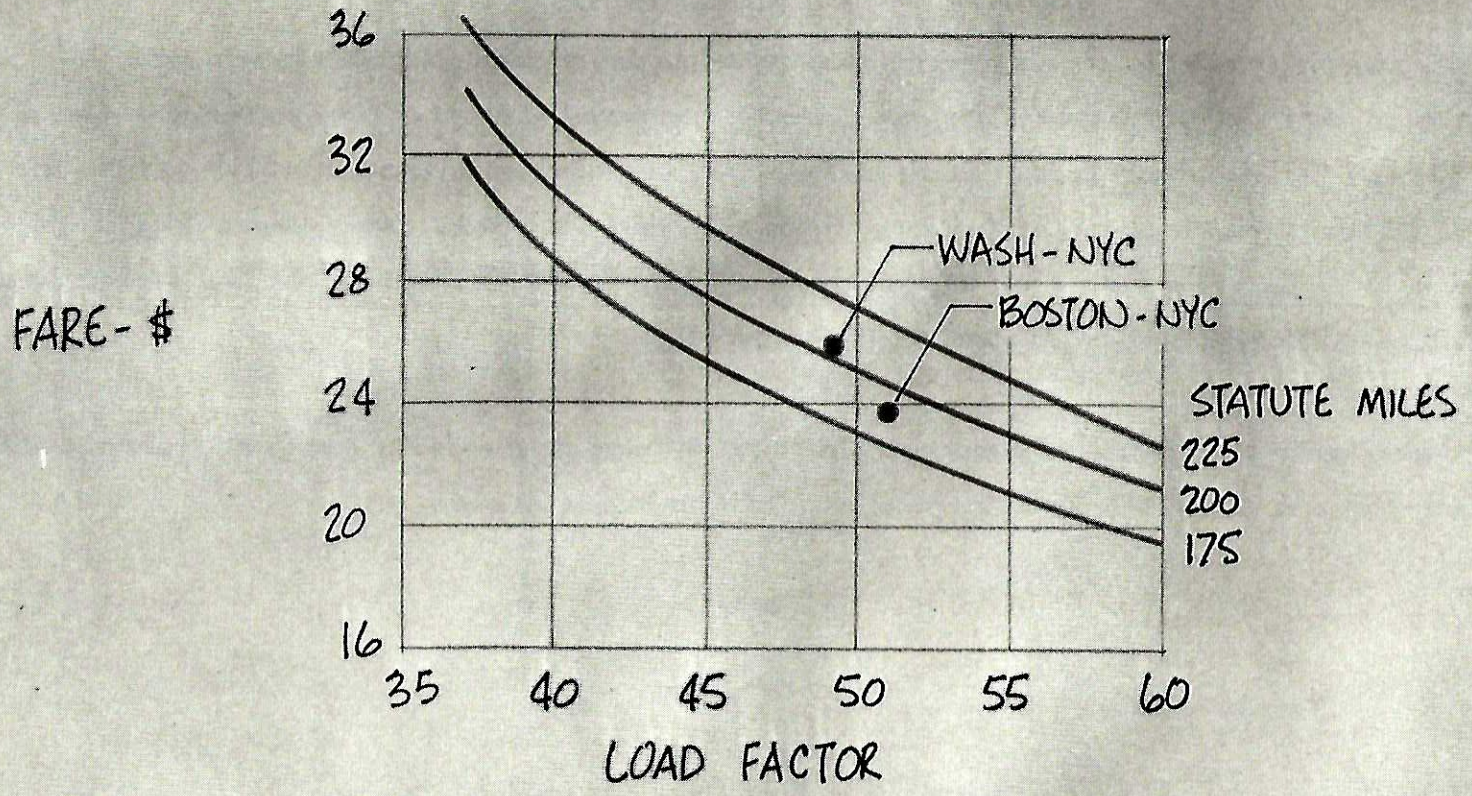


		OASPL	SIL
NOTE:	B727	93	70
	DC-9	95	68

This chart shows fare requirement vs. load factor for various stage lengths. At the current New York-Washington fare of $26 one-way, a 15 percent profit operation can be maintained to as low as 49 percent load factor. The New York-Boston fare of $24 requires 51 percent load factor. Looking at it the other way, fares as low as $22 New York to Washington can provide the same 15 percent profit if load factors of 60 percent are realized. The whole point of this chart is that the service is highly competitive.

OPERATING ECONOMICS

FARE = TOTAL OF COST + 15% PROFIT



Aircraft costs are projected at $5.6 million each with straight-line depreciation of 12 years to zero residual. This yields an annual depreciation of $466,667 for each airplane. Insurance is assumed at three percent hull value per annum. Crew cost of ONA Electra operation was assumed for this analysis, which amounts to $117 per flight hour. We used Delta's maintenance expense on their cargo Hercules operation from 1966 to the present of $106 per hour and added $5 extra for the Northeast local labor situations and $6 extra for water peculiars for $117 per hour. Fuel costs of 20¢ per gallon appear to be typical of the northeastern U. S.

Indirect operating cost of 39 percent of direct operating costs are being experienced by a large trunk operator of the L-100, and is assumed for this analysis on top of which is added a 15 percent profit.

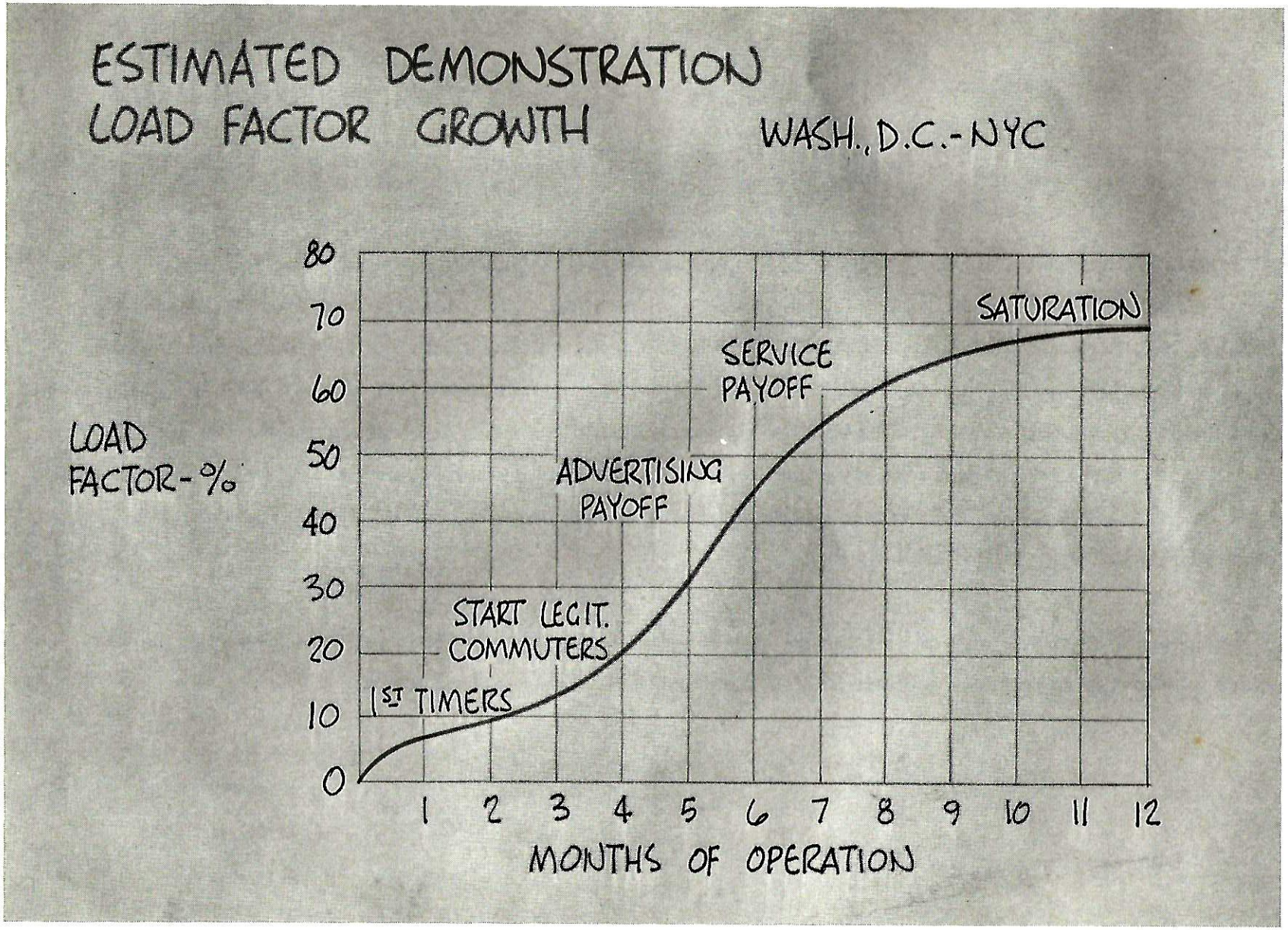
BASIS FOR ECONOMIC ESTIMATES

- DEPRECIATION - OVER 12 YRS TO ZERO RESIDUAL
- CREW COSTS BASED ON ELECTRA EXPERIENCE
- MAINT. COST BASED UPON DELTA EXPERIENCE
- MAINT. COST INCREASE $6/HR. FOR WATER
- FUEL COST 20¢/GAL.
- 6 DAY WEEK
- TYPICAL UTILIZATION - NYC TO D.C. AT 11.8 HRS/DAY
- INDIRECT COSTS BASED UPON ACTUAL AIRLINE DATA

For purposes of determining operating economics, a load factor growth as depicted on this chart was assumed for the first 12 months of operation. This curve is based on two airplanes flying from New York to Washington six days per week from 7:00 a.m. to midnight. Eleven one-way trips per airplane are accomplished daily.

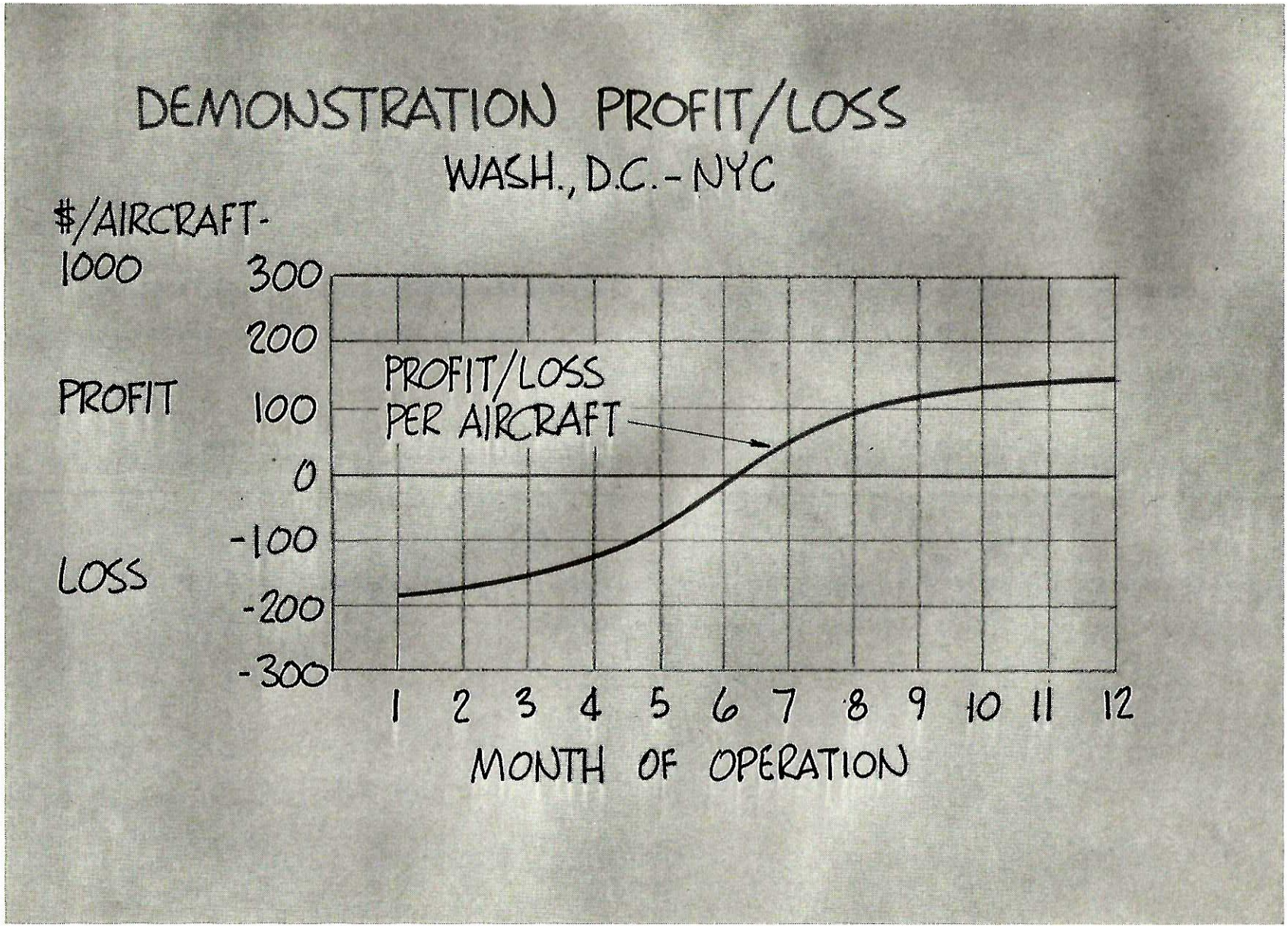
This curve assumes the curious will fill the airplanes to only 10 percent capacity for the first few months, but, with a good advertising campaign, legitimate commuter traffic should see a growth to 50 percent in the first six months. We've assumed a full realization of 70 percent at the end of the first year of operation. This is consistent with other commuter-type service, including EAL's shuttle which frequently requires an on-time extra section with few people aboard, which is not contemplated herein.

With 15 minutes allowed for taxi in and taxi out, 30 minutes for passenger unloading and reloading, and 49 minutes flying time, New York to Washington (zero wind), an annual utilization of 3672 block hours is realized.


ESTIMATED DEMONSTRATION
LOAD FACTOR GROWTH
WASH., D.C.-NYC
LOAD FACTOR-%
80
70
60
50
40
30
20
10
0
1 2 3 4 5 6 7 8 9 10 11 12
MONTHS OF OPERATION
SATURATION
SERVICE PAYOFF
ADVERTISING PAYOFF
START LEGIT. COMMUTERS
1ST TIMERS

With these costing factors as a basis, an assumption of $26 revenue per passenger between New York and Washington was used to determine the cost flow of requirements for the operation. $26 is the current cost of the EAL shuttle between New York and Washington and should be attractive because of the substantial taxi-fare savings between downtown and LaGuardia. The first flight is all cost and no revenue, of course, for a loss of $755. If five percent load factor is realized at the end of the first month, then each trip produces $104 revenue and the loss per trip is cut to $651. The first month of operation losses per aircraft is $186,000, with subsequent losses of $171,000, $156,000, $134,000, $82,000 and $15,000. The seventh month shows an operating profit of $52,000 and grows to $148,000 per month at a constant 70 percent load factor.

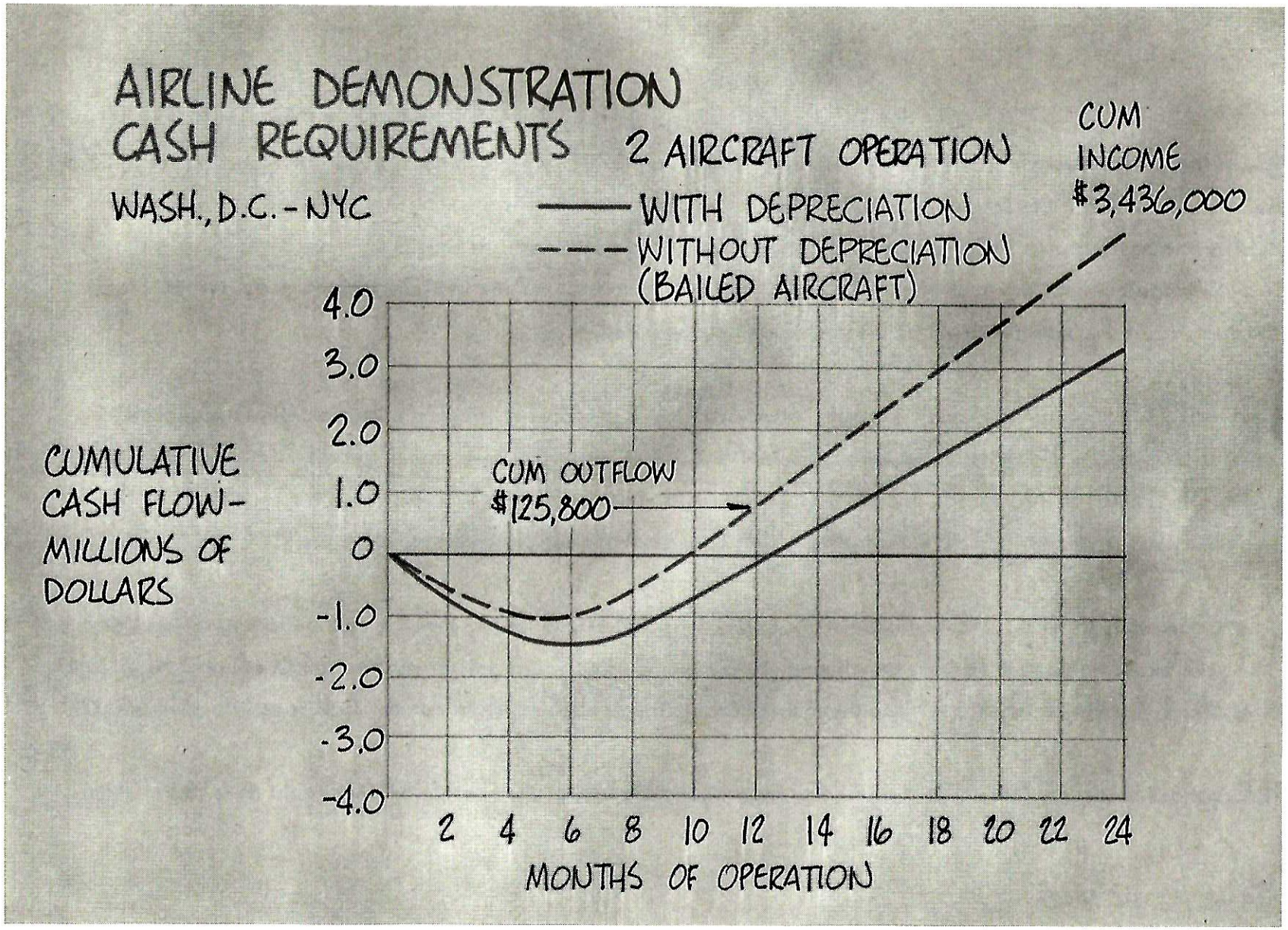
Because the initial cost as well as maintenance of the land plane is less, breakeven occurs at the end of the fifth month with sustaining operating profit of $171,000 per month at 70 percent load factor.


DEMONSTRATION PROFIT/LOSS
WASH., D.C. - NYC
$/AIRCRAFT-
1000
300
200
PROFIT
100
0
-100
LOSS
-200
-300
PROFIT/LOSS
PER AIRCRAFT
1 2 3 4 5 6 7 8 9 10 11 12
MONTH OF OPERATION

Cash required for a two-airplane operation is as shown here. The solid line includes the annual depreciation based on 12 years to write-off. The dotted line assumes that bailed aircraft were used for a test operation and no aircraft depreciation is considered.

The solid line shows that a maximum exposure of $1,490,000 is required for the owned airplanes, which is completely paid back by the 13th month of operation. A two-year operation should yield a cumulative new income of $3,436,000.

The land plane again, because of lower acquisition and maintenance cost, creates a maximum expose of only $1,234,000, which is paid back in 11 months. Two-year net income is $4,520,000.

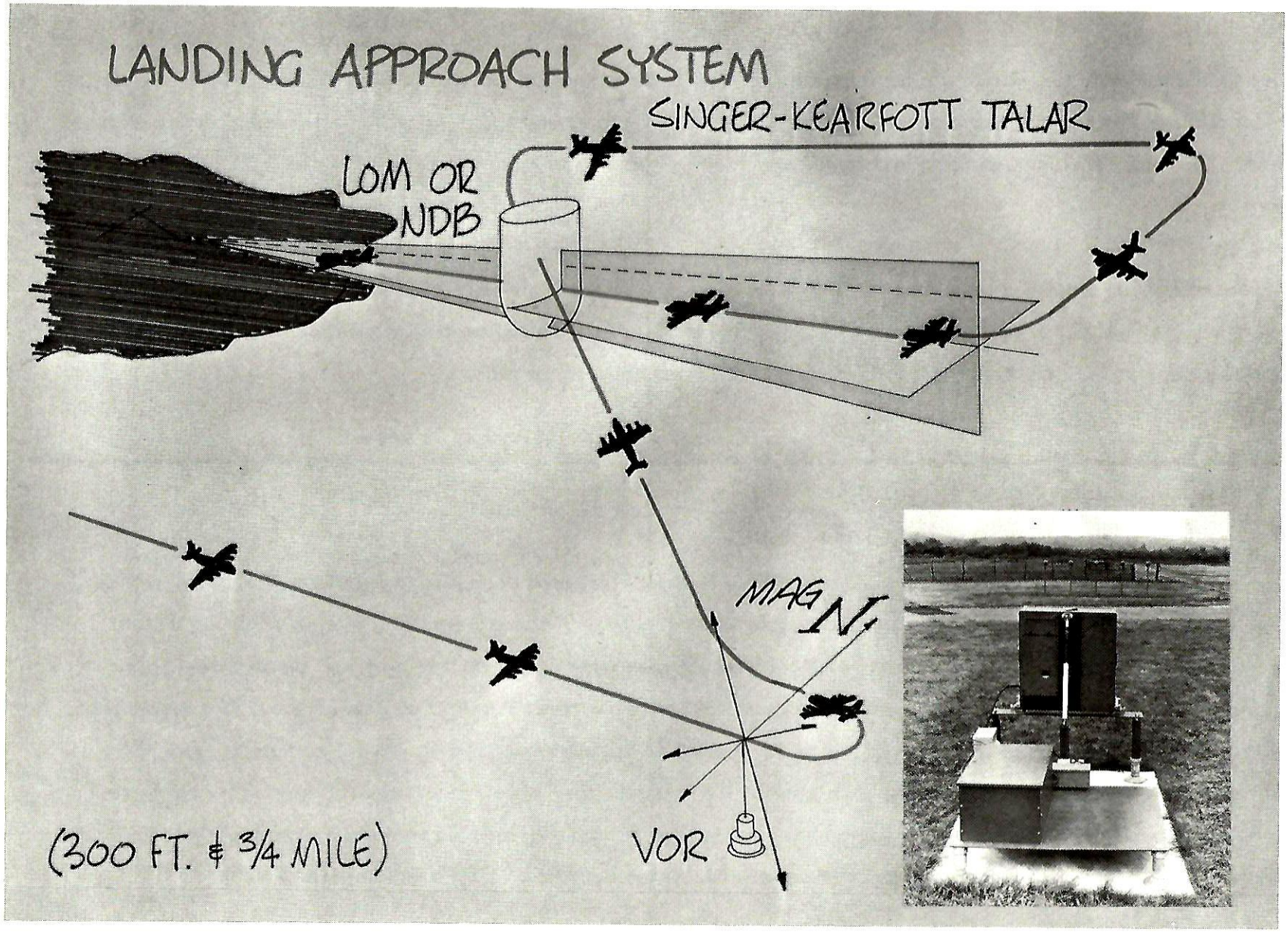

AIRLINE DEMONSTRATION
CASH REQUIREMENTS
2 AIRCRAFT OPERATION
WASH., D.C. - NYC
WITH DEPRECIATION
WITHOUT DEPRECIATION
(BAILED AIRCRAFT)
CUM INCOME
$3,436,000
CUM OUTFLOW
$125,800
CUMULATIVE CASH FLOW - MILLIONS OF DOLLARS
4.0
3.0
2.0
1.0
0
-1.0
-2.0
-3.0
-4.0
2
4
6
8
10
12
14
16
18
20
22
24
MONTHS OF OPERATION

While the Hercules Amphibian is considered an excellent solution to the problems of STOL service, it is recognized that there are certain operational considerations generated by the use of water. Among these are installation of appropriate navigational aids, removal of floating debris, and boat traffic -- particularly small pleasure craft. It is also recognized that any such system must be as reliable as today's airline service, and so, apparent techniques to cope with these operational considerations have been evolved.

Kearfott's TALAR microwave landing system, or equivalent, is proposed to provide instrument-landing capability down to ceiling and visibility minimums of 300 feet and 3/4 mile. This equipment is currently in use with FAA approval at Fullerton, California and has also been used by Houston Metro Airlines. Recent demonstration of amphibian operations in the East River at New York City also successfully employed the system.

Kearfott indicates that the TALAR transmitter can be offset 200 to 300 feet to the side of the landing channel or out along the extended centerline from the channel threshold. Since this transmitter must be firmly mounted on pilings or on shore, its actual location will be determined for each operational site selected. Cost is estimated at $60,000.

If operations below the 300 and 3/4 minimums are desired, high-intensity approach lights would have to be added.

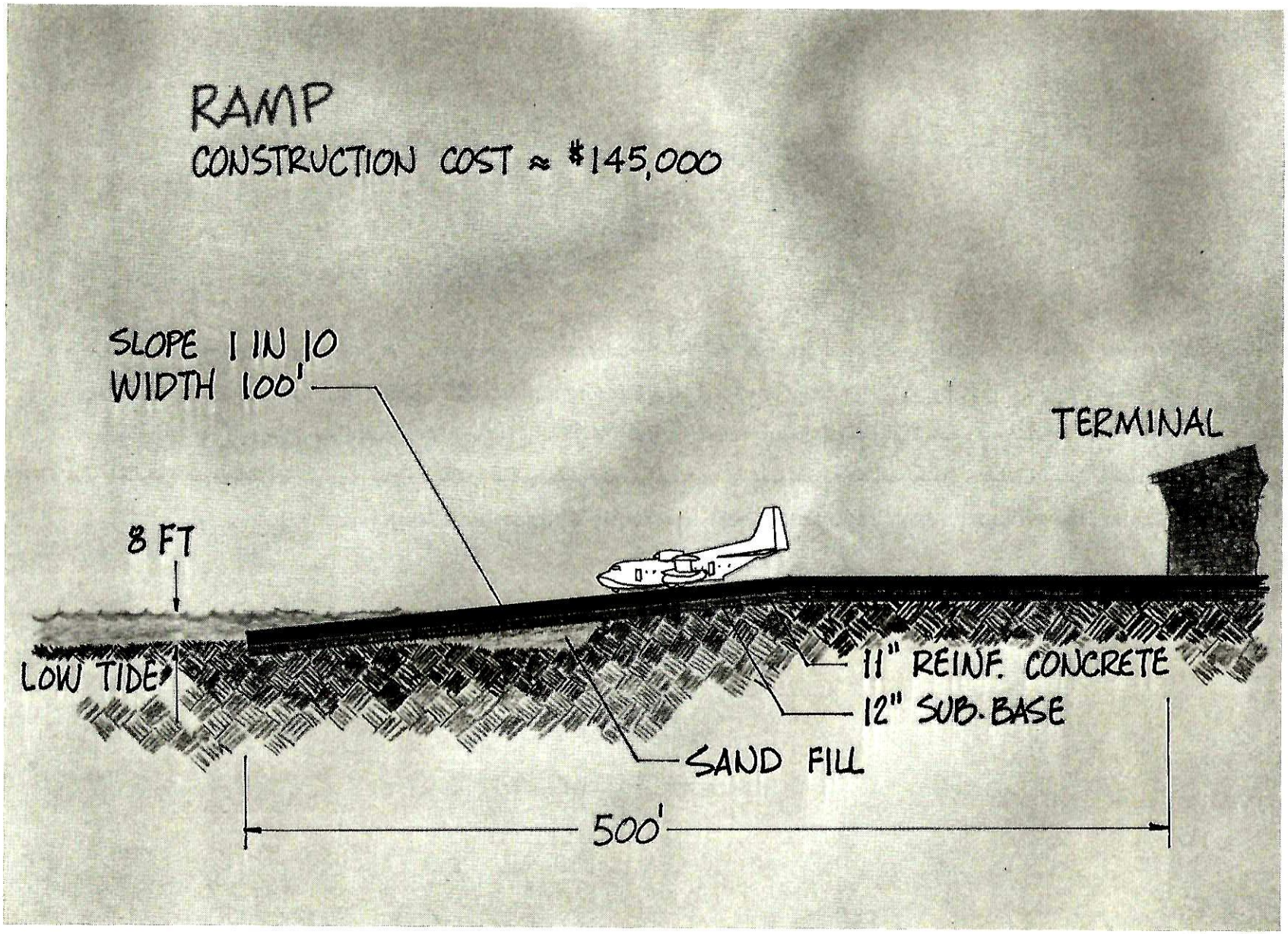

LANDING APPROACH SYSTEM
SINGER-KEARFOTT TALAR
LOM OR
NDB
MAG N.
(300 FT. & 3/4 MILE)
VOR

In accordance with the Navy's standard seaplane-planning documents, it is suggested that a ramp, 100 feet wide, extend into the water at a slope of one foot in ten feet to a depth of eight feet below the low-water, or low-tide line. The ramp, including parking and turnaround area in front of the terminal building, is assumed to be 500 feet long.

Construction will require a cofferdam to allow excavation below the high-water line to a depth sufficient to ensure the removal of all silt or other unstable material. This material will be replaced with suitable backfill and the ramp constructed of a 12-inch sub-base and an 11-inch reinforced concrete surface.

Cost of construction is estimated to be $145,000 based upon Navy estimates and those of Lockheed-Georgia's Facilities Engineering personnel.

The width and location of the landing and takeoff channel will be based upon airplane performance, all-weather operational requirements, and the amount of usable water available. Using Aerodrome Manual, Part 7, Water Aerodromes, as a guide, it is expected that a channel 300 feet wide and 3600 feet long will be sufficient. The channels will be marked by yellow and black striped marker buoys, which present an area of about four square feet when viewed from any angle in azimuth and up to at least 30 degrees above the horizontal. These buoys will be set not more than 500 feet apart along each edge of the channel. For night operations, suitable battery-powered green lights will be mounted on the channel markers; yellow threshold lights will be added at each end of the channel. The lights will each have an intensity of at least ten candelas. Cost is estimated at $5000.


RAMP
CONSTRUCTION COST ≈ $145,000
SLOPE 1 IN 10
WIDTH 100'
TERMINAL
8 FT
LOW TIDE
11" REINF. CONCRETE
12" SUB-BASE
SAND FILL
500'

Semi-permanent passenger facilities are suggested for the demonstration program. A pre-fabricated metal building is planned having approximately 2000 square feet for a waiting room plus 1000 square feet for offices, ticketing, and baggage. The estimated building size compares favorably with a similar steel building erected by Houston Metro at their Clear Lake facility. The building is actually comprised of 5600 square feet; however, this includes the airline's general offices. About 2500 square feet is actually utilized for operations.

Estimates from dealers indicate a cost of $45,000.

TERMINAL FACILITIES

- PRE-FAB METAL BUILDING
- 3000 SQ. FT.
- PASSENGER FACILITIES
- CHECK-IN & BAGGAGE AREA
- OFFICE SPACE

To permit operation in northern climes subject to freezing conditions, it is planned to use a "bubbler" system long used by sailing marinas to protect pleasure craft. Adaptations of such systems are now under test to keep large seaways open with successful results.

The bubbler system involves placing a tube, or network of tubes, near the floor of the waterway from which air bubbles are emitted. The escaping bubbles stir the water and cause the warmer water near the bottom to rise to the top, thawing any ice at the surface or keeping ice from forming.

Discussions with the Corps of Engineers personnel in Chicago and in their Cold Regions Research and Engineering Laboratory in Hanover, New Hampshire, reveal that many tests of the bubbler system have been conducted. During the winter of 1970-71, a test was run at Duluth Harbor, Minnesota (at the extreme western end of Lake Superior) to thaw the 24-inch ice in the harbor and keep it clear. The bubbler operated for two weeks, at which time a channel 1600 feet long and 40 feet wide was ice-free. Obviously, if such a system were employed at the start of winter, it could maintain a clear, ice-free channel.

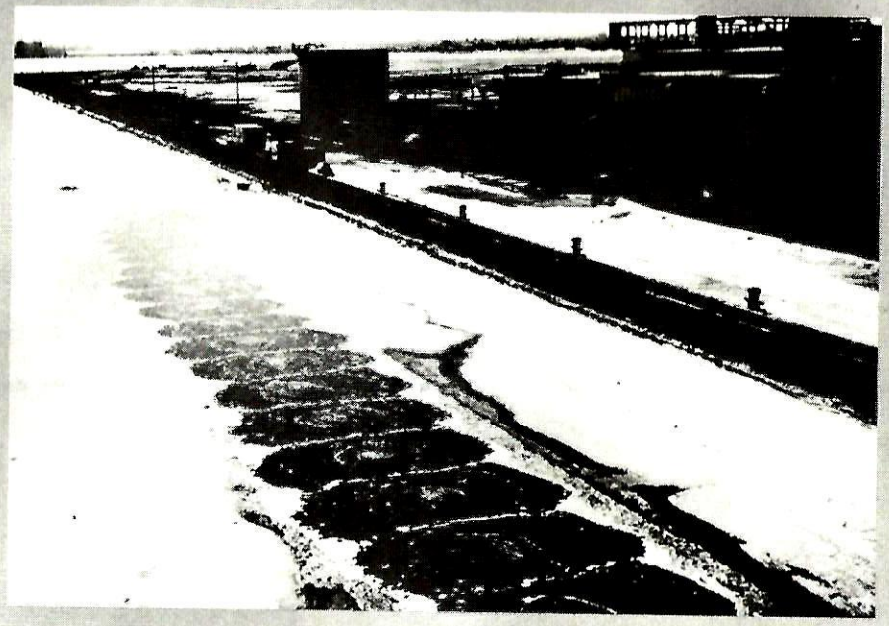
In late December 1971, bubbling was begun on a 3000-foot test section in the Saint Mary's River which connects Lakes Superior and Huron. This test is to keep a channel from freezing and thus extend the shipping season.

Based on experience from these and other tests, it is expected that a 300- by 3500-foot landing channel could be kept ice-free by the bubbler system for $75,000 to $100,000.

ICE-FREE BUBBLER SYSTEM

ARMY CORPS OF ENGINEERS
DULUTH HARBOR TEST *

1.5 INCH PIPE DIAMETER
15 FT. ORIFICE SPACING
50 HP COMPRESSOR
284 CFM FLOW
27 FT. SUBMERGED DEPTH



* IT MELTED ICE 24 INCHES THICK IN 2 WEEKS, OPENING A CHANNEL 40 FT. WIDE & 1600 FT. LONG

The amount of floating debris in waterways which might be used for amphibian operations varies widely. However, past amphibian operations have not been hampered by debris. In fact, Colonel Blain (USAF ret.), owner and operator of Antilles Airboats, states that he flew amphibians for Pan American from New York's East River for five years and had no debris problem. For this reason, it is proposed that no special precautions be taken other than to provide a small power boat for periodic inspection of the landing channel. The cost of a 19-foot, inboard-outboard, power boat, including required support, is estimated at $6000.

A report by the Army Corps of Engineers, dated November 1970, indicates that nearly $2.5 million is spent every year by the Corps to conduct debris removal operations in various river and port areas. One half million is spent in New York City harbor area alone. In addition, the Corps has recommended aggressive enforcement of the Refuse Act (USC 407) to remove from river and harbor areas the sources of debris. Such activity has assumed particular importance from an ecological point of view as well.

Most of the major cities of the U. S. have little or no ice problem in their waterways. However, in such cities as St. Louis or New York, it is proposed to use booms and nets located upstream of the landing channel to deflect floating ice.

FLOATING DEBRIS

I. SMALL BOAT PATROL

II. PAN AM FLYING BOAT EXP. - NO. PROBLEM

III. UPSTREAM BOOM & NET (DIVERT NOT TRAP)

IV. CORPS OF ENGINEERS REMOVAL EFFORT
≈ $2.5 M / YEAR
- NYC $522,000
- SFO $520,000

V. ENFORCEMENT OF REFUSE ACT (USC 407) TO REMOVE SOURCES OF DEBRIS / DRIFT

It is believed that the Hercules STOL Amphibian offers the optimum solution to the problem of implementing a STOL airline transportation system from the viewpoint of the cities, airlines, and traveling public, in terms of cost, ecology, and time.

It is further believed that the traveling public will accept water-based STOL. The time and money saving will provide the impetus, the improvement in service will produce approval, and the uniqueness will, in and of itself, help advertise the system.

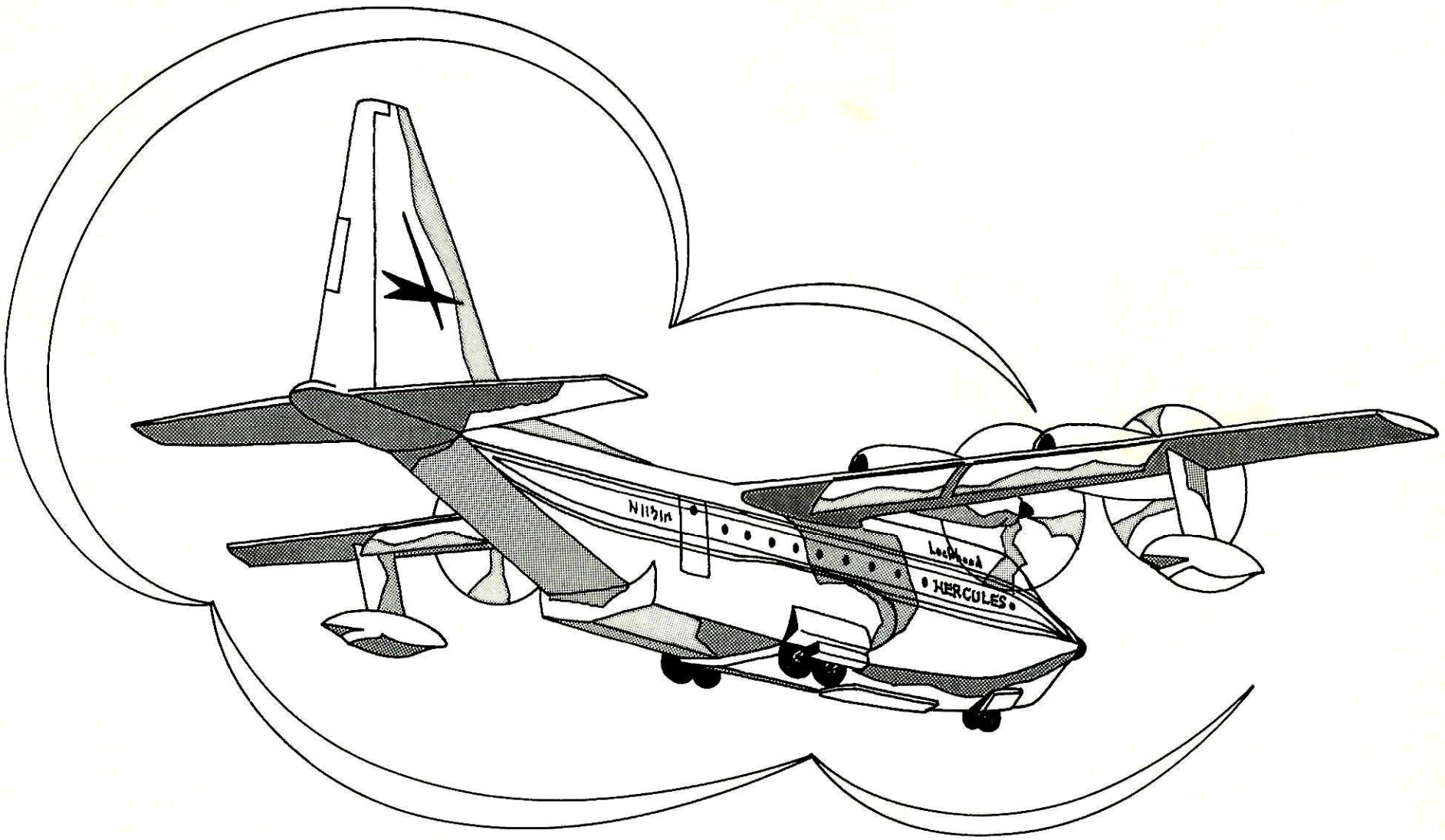
SUMMARY

AMPHIBIAN STOL OFFERS:

- QUICKEST IMPLEMENTATION OF STOL SERVICE
- MINIMUM COST STOLPORT
- MAXIMUM ADVANTAGE OF NATURAL FACILITIES
- WATER-LAND FLEXIBILITY
- MAXIMUM BENEFIT TO TRAVELER

LOCKHEED'S HERCULES AMPHIBIAN STOL OFFERS:

- MOST READILY AVAILABLE VEHICLE
- LOWEST COST VEHICLE
- PROVEN AIRCRAFT SYSTEMS


N1191N
Lockheed
HERCULES