210 STOL

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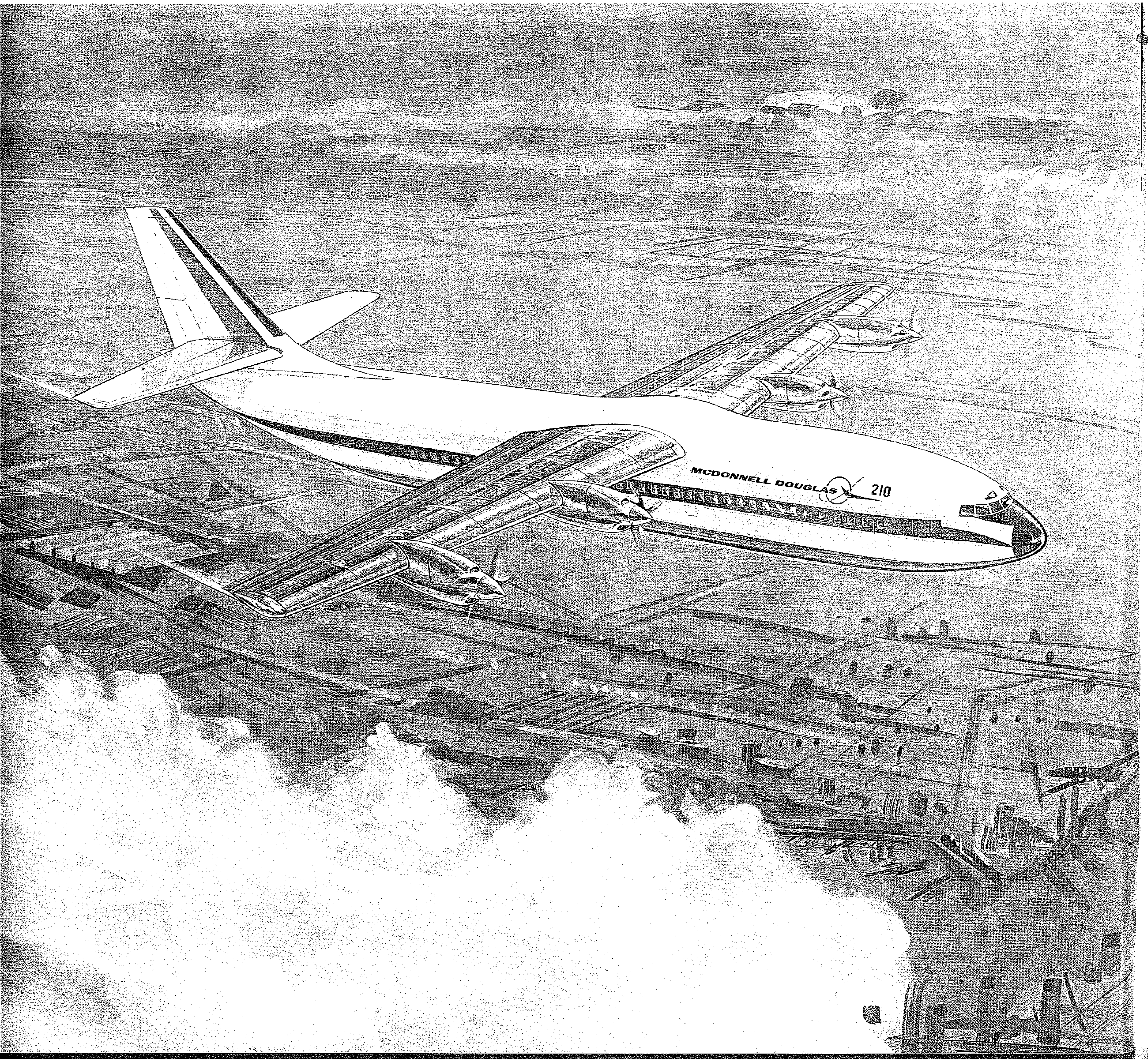
MCDONNELL DOUGLAS

DECEMBER 1968
REPORT NO. G521


MCDONNELL DOUGLAS
210

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CITY-CENTER TRAVEL POTENTIAL

Large cities and their urban satellite communities need a new transportation concept to meet the mobility demands of the 1970s. Direct city-center air transportation has been proposed as the next dimension to increase short haul travel mobility, while providing convenience, comfort and economy for the traveling public.

The most practical way to improve the use of available air and ground space and revolutionize the metropolitan transportation environment is to implement the short takeoff and landing (STOL) concept.

McDonnell Douglas, through many years of hardware development and research effort on present and future air travel needs, presents a systems developed aircraft to bring the STOL concept into near term reality—the 210 STOL Transport.

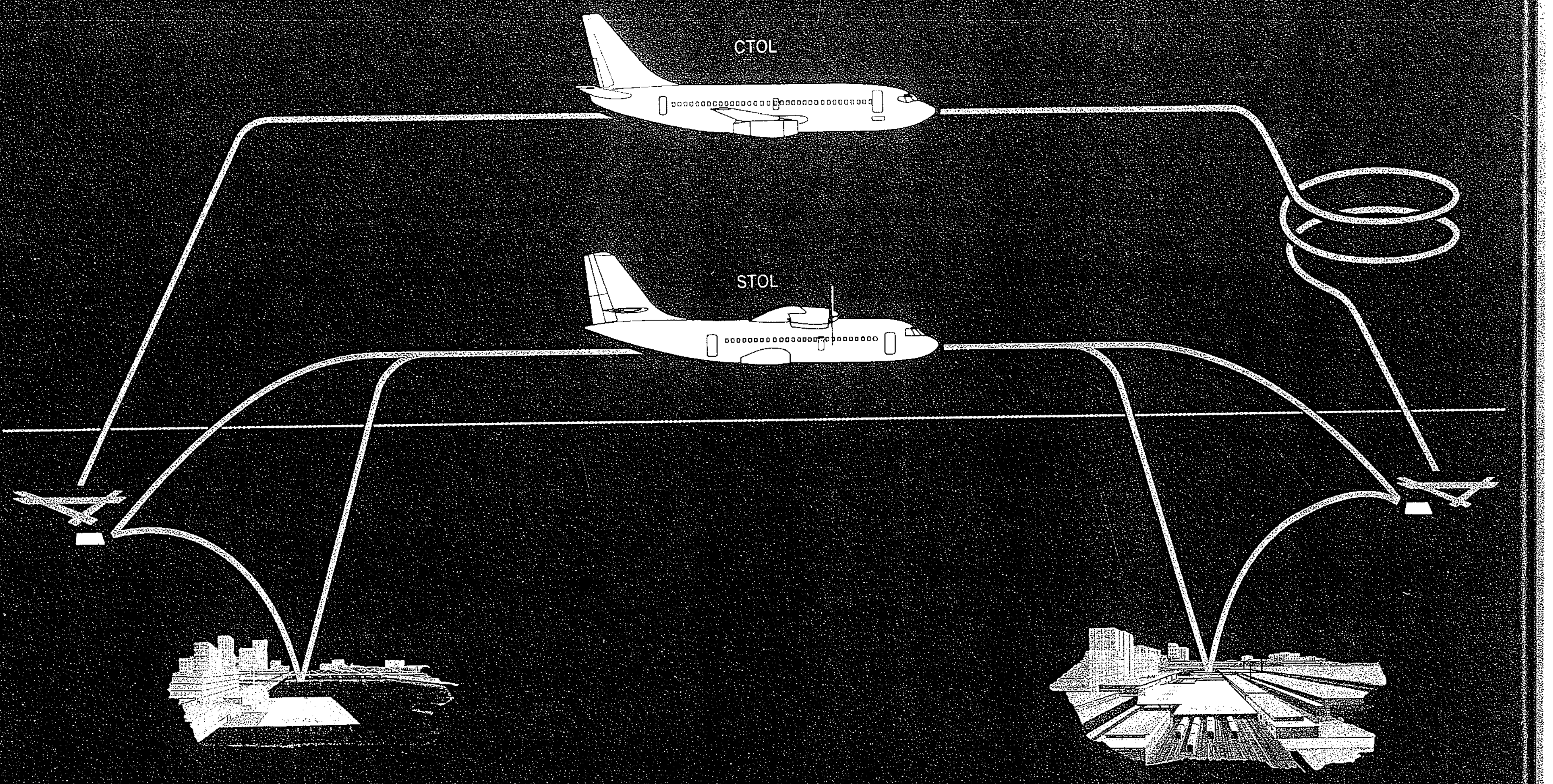
OPERATIONAL ENVIRONMENT OF THE '70s

The operational environment at major traffic hubs needs little introduction—congested ground access to airports, crowded terminal and gate areas, limited runways and taxiways and crowded airspace access to airports are all compounding to increase travel delays and operating costs. These problems are escalating toward the '70s. The FAA forecasts that by the end of 1979, air carrier and general aviation operations will increase at least three and a half times the level of 1967. The rate of increase in seats per aircraft lags the projected passenger growth rate by at least one third—which means that the introduction of larger aircraft in the '70s will provide only a partial offset for the activity growth equation.

The burden of air traffic demands on existing aviation services and facilities is receiving widespread publicity. One obvious solution has been to propose new and larger airports which will open up new operating space. Real estate constraints, however, force new airport construction to more remote locations—increasing ground travel time and cost for the traveler. These time and cost increases become quite significant for the average short haul traveler who currently tolerates over 50% of his travel time in surface vehicles, while paying a surface mileage rate up to ten times the air mileage rate.

It is vital for the future of air transportation to improve the use of existing facilities, expand the use of available airspace and open new air travel networks which will serve short haul travelers at locations closer to origins and destinations. The STOL concept offers such solutions—with the kind of flexibility required to fit in with present transportation systems and improve the operational environment of the '70s.

THE STOL CONCEPT



STOL MODES OF OPERATION

Mode 1. STOLport to STOLport. Planned city-center to city-center service with operations from urban STOL facilities on both ends of the travel route.

Mode 2. Major airport to STOLport. An independent STOL site at a major airport with an urban STOL facility at one end of the travel route.

Mode 3. Major airport to major airport. Independent STOL sites at major airports on both ends of the travel route. STOL advantage in this mode is attributable to air/ground maneuverability and the minimum space requirements of STOL aircraft.

The STOL concept offers a bold new time and cost saving formula for modern air travel. It defines a highly flexible transportation system wherein new operational dimensions open up through the channeling of short haul air traffic into airspace and ground operating sites that cannot be used by conventional aircraft.

The STOL concept is made effective through three modes of operation. Mode I envisages the development of direct city-center travel with STOLports located near metropolitan centers (small "close-in" airports now in existence may also serve as STOLports). Mode II requires one STOLport for a given travel route, which allows much of the ground travel time advantage of Mode I. Mode III requires only the allocation of independent STOL operating sites at major airports—allowing STOL time savings over conventional air travel by avoiding congestion.

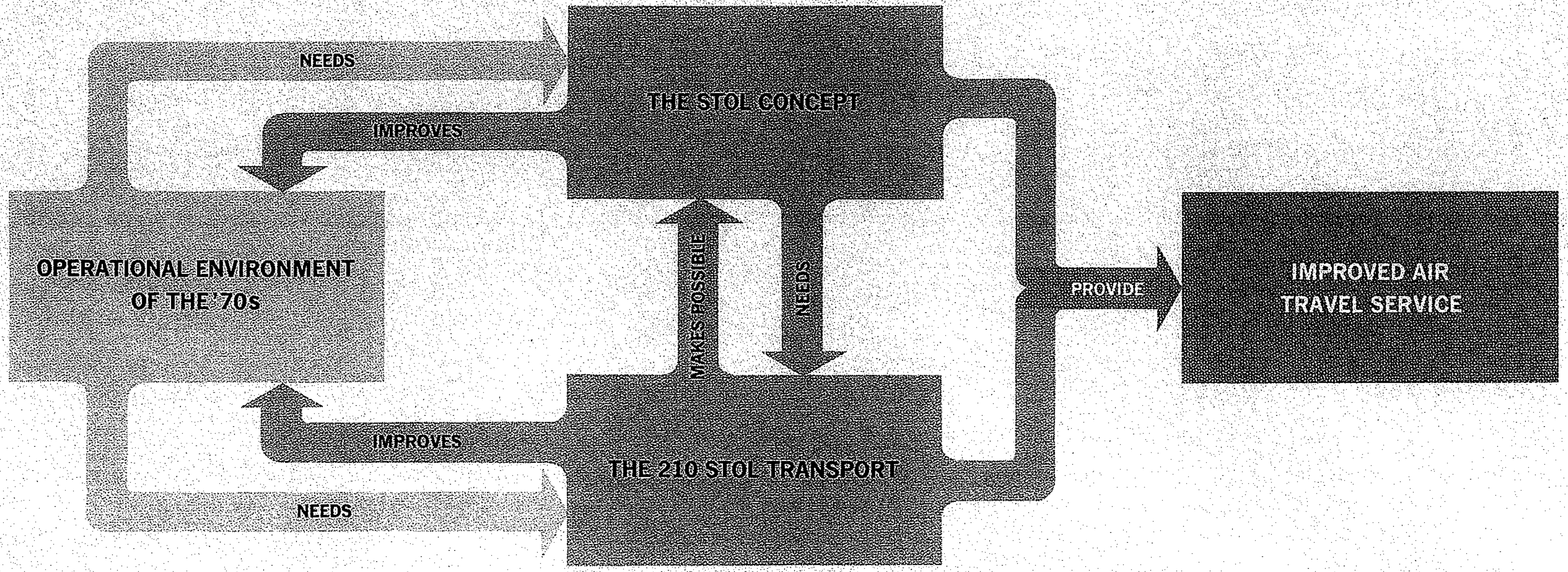
A mixture of all three modes of operation are expected in STOL system networks. As more STOL aircraft are introduced into service, additional Mode I and Mode II routes will develop as more city-center facilities open up —extending the full benefits of the STOL concept to the traveling public.

A SYSTEMS APPROACH

The job of implementing a successful STOL transportation system can be achieved through the total systems planning process. This involves an orderly method of analyzing the operational environment and the interactions of the many variables affecting this environment. The systems approach must then identify solutions to operational problems through systems engineering and, finally, carry out solutions using the systems management process.

Aircraft designs for the future must consider the total integration of: facilities design, baggage handling systems, passenger processing, operational planning and scheduling, systems maintenance and rapid turnaround cycles.

Through continuing systems analysis of these requirements, the 210 STOL is projected as a positive response to the need for improved travel service in the '70s.



THE 210 STOL

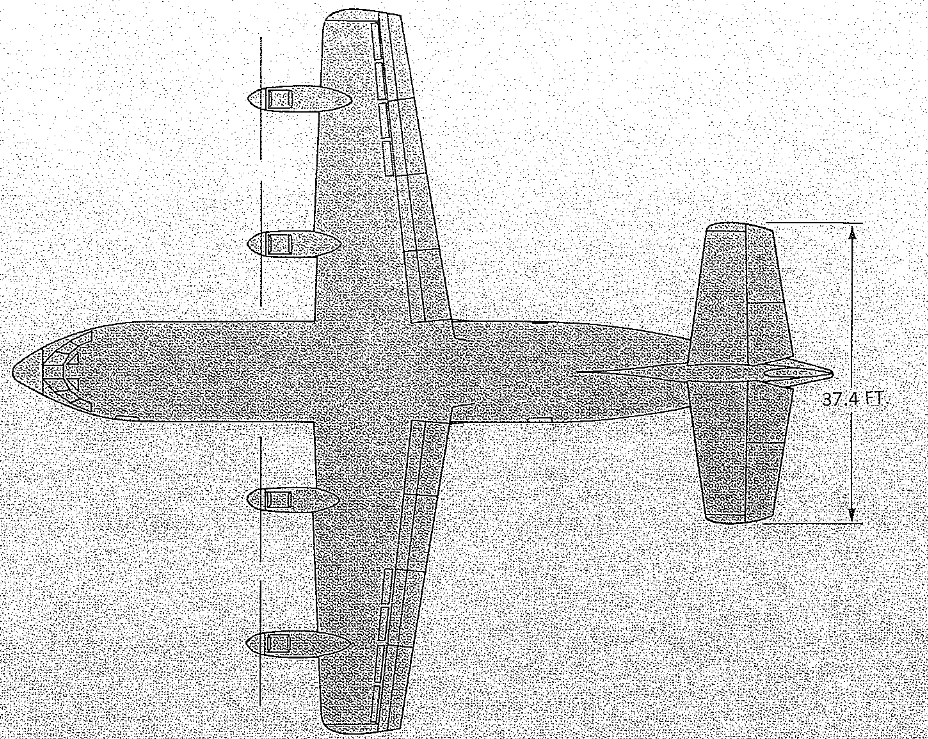
The McDonnell Douglas 210 STOL Transport is an advanced technology turboprop aircraft. The 210 has been designed for commercial carrier service from 1500 foot air strips located at independent sites on conventional airports or on STOLports in the heart of the metropolitan environment. The 210 is based on flight-proven technology which ensures an unusually high level of flight and ground operating safety, low noise levels near operating sites, new dimensions in air and ground maneuverability and enhanced all weather capabilities with low speed, steep gradient approaches.

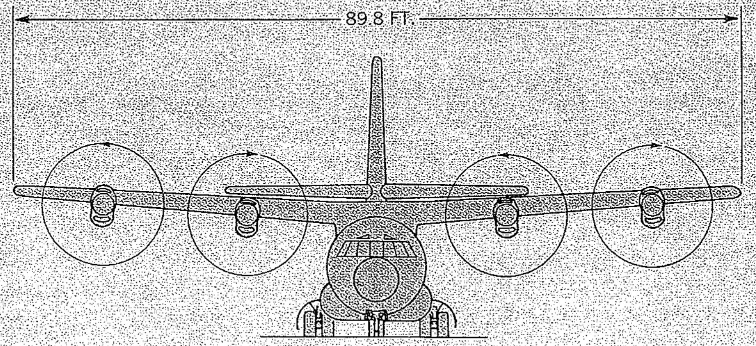
The 210 features highly developed air conditioning and pressurization systems plus the passenger service facilities required of modern transport aircraft.

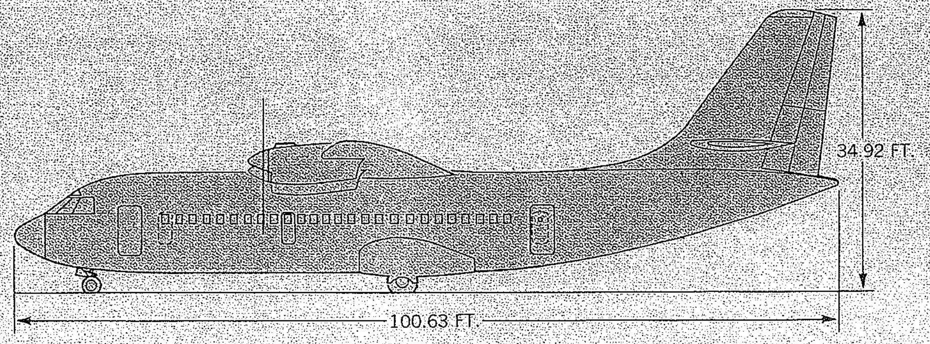
Two design configurations are introduced: (1) The 210E is a 90 passenger, single aisle version defined by a 150 inch outside diameter fuselage. (2) The 210G is a larger, twin aisle, 112 passenger version defined by a 165 inch outside diameter fuselage. Basic characteristics, general arrangements, interiors, performance and operating economics are presented for both configurations.

210E GENERAL ARRANGEMENT

Propeller Diameter	15.625 ft.
Fuselage Outside Diameter	150 in.
Cabin Floor to Ground Distance	6.0 ft.
Engines	Free Turbine Turboshaft
Aspect Ratio	6.5
Under Floor Cargo Volume	530 cu. ft.
Wing Area	1240 sq. ft.
Tail Area:	
Vertical	283 sq. ft.
Horizontal	400 sq. ft.



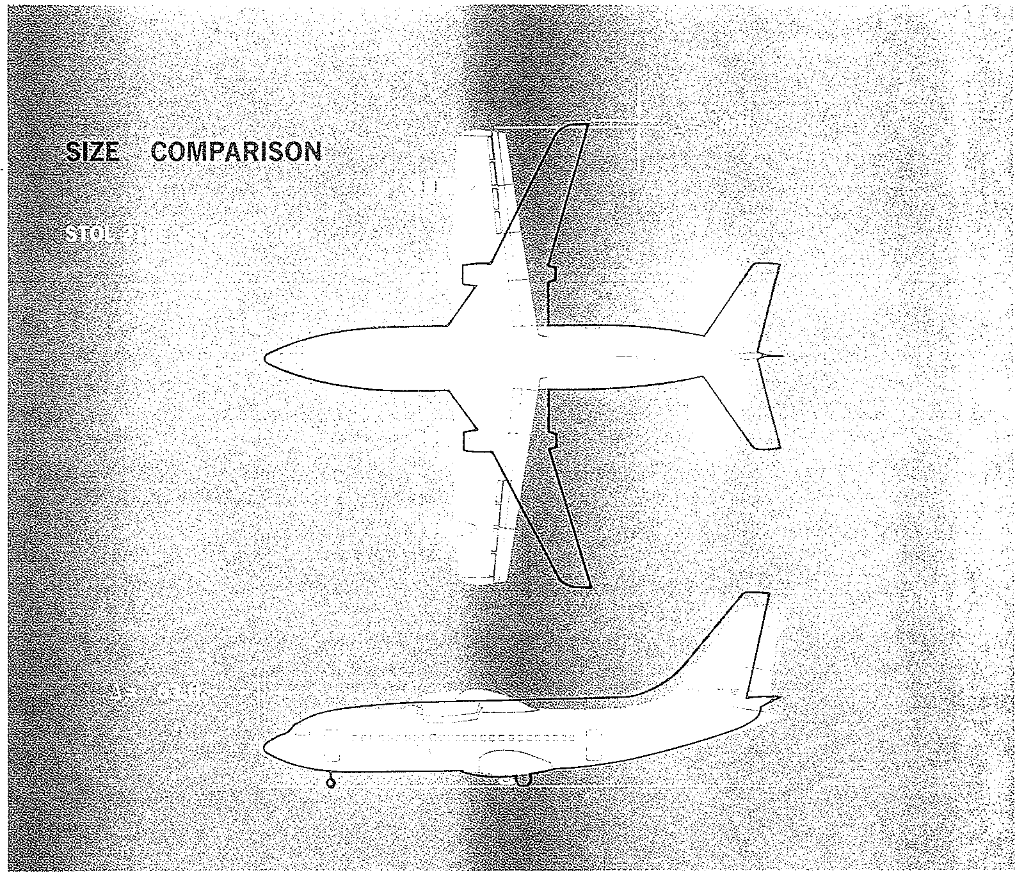


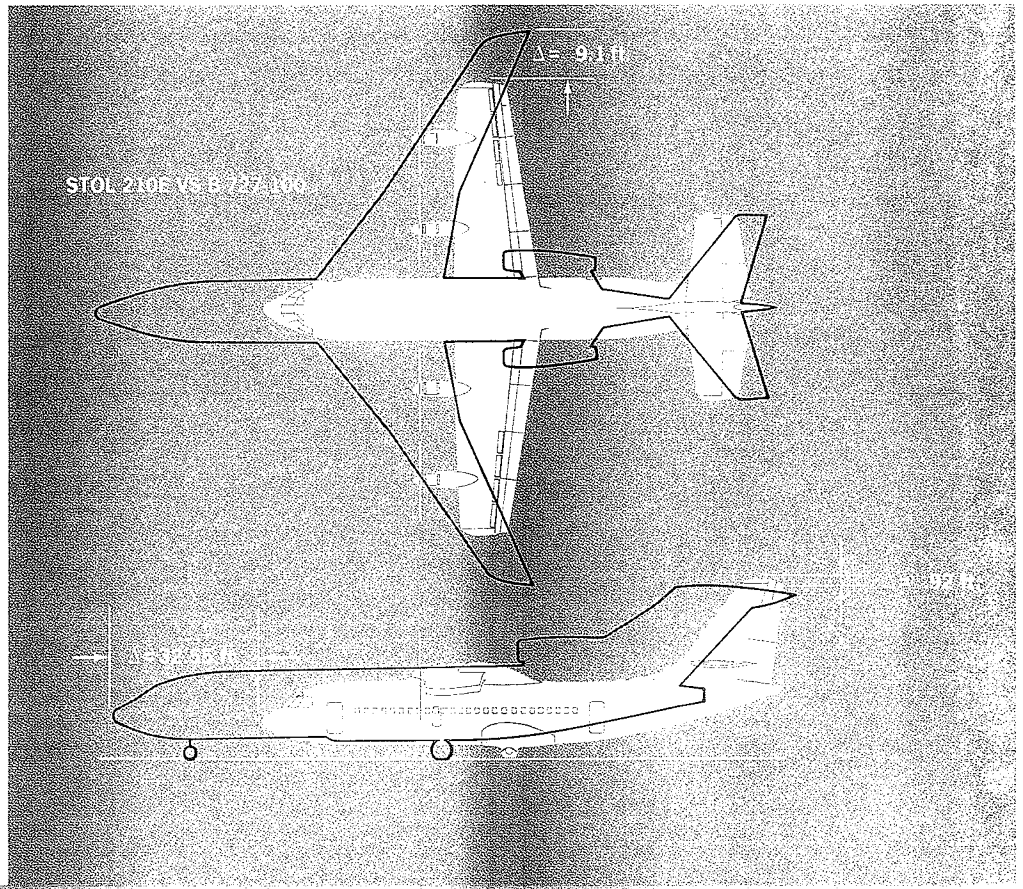


210E CHARACTERISTICS SUMMARY

90 Passengers

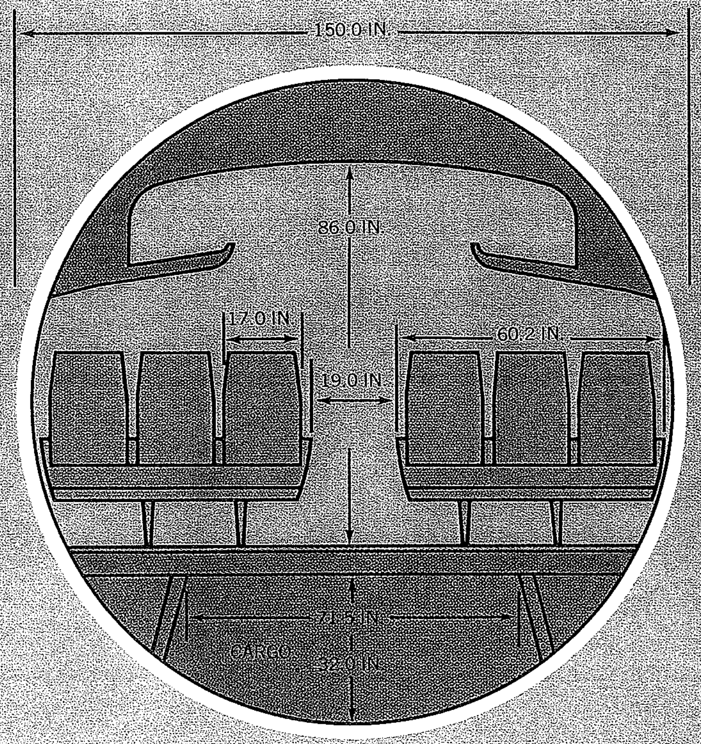
Weights	
Manufacturer's Weight Empty	43,750 lbs.
Operator's Weight Empty	44,794 lbs.
Maximum Payload	18,860 lbs.
Maximum Zero Fuel Weight	63,654 lbs.
Fuel Capacity (1,664 U.S. gals.)	11,149 lbs.
Maximum Gross Weight (takeoff/landing)	72,854 lbs.
Dimensions	
Overall Length	100.63 ft.
Wing Span	89.8 ft.
Tail Height	34.9 ft.
Fuselage Outside Diameter	150 in.
Wing Area	1240 sq. ft.
Propeller Diameter	15.625 ft.
Cabin Length	56.92 ft.
Under Floor Cargo Volume	530 cu. ft.
Economics	
Direct Operating Cost (cents/seat mile)	
200 mile stage length	2.25 to 2.46
Performance	
Takeoff Field Length (to 35 ft.)	1160 ft.
Cruise Speed (normal cruise power)	348 knots
Range (@ 20,000 ft.)	600 n.m.
Approach Speed	62-72 knots
Landing Field Length (from 50 ft.)	1440 ft.
Engine Power Rating (takeoff)	3300 ESHP each

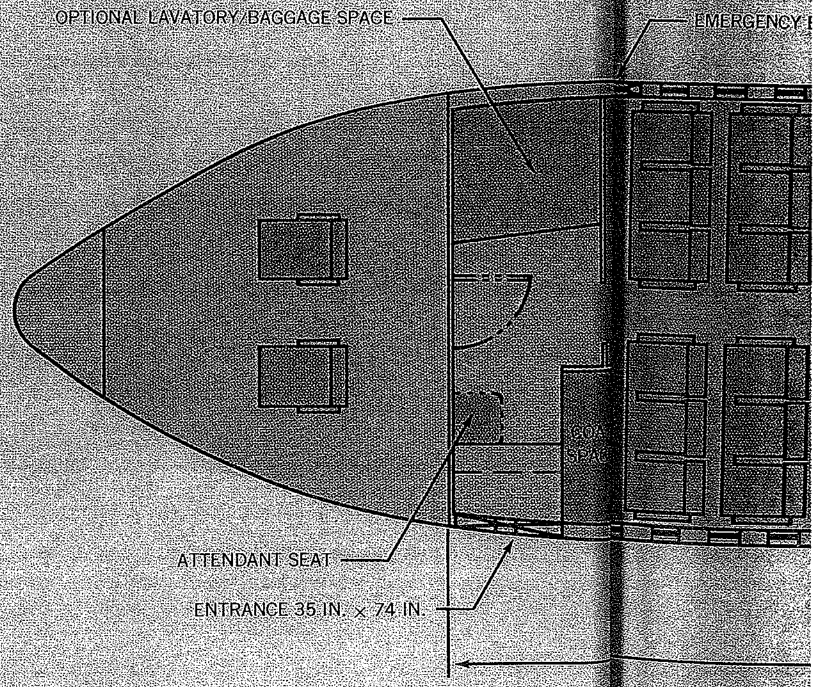


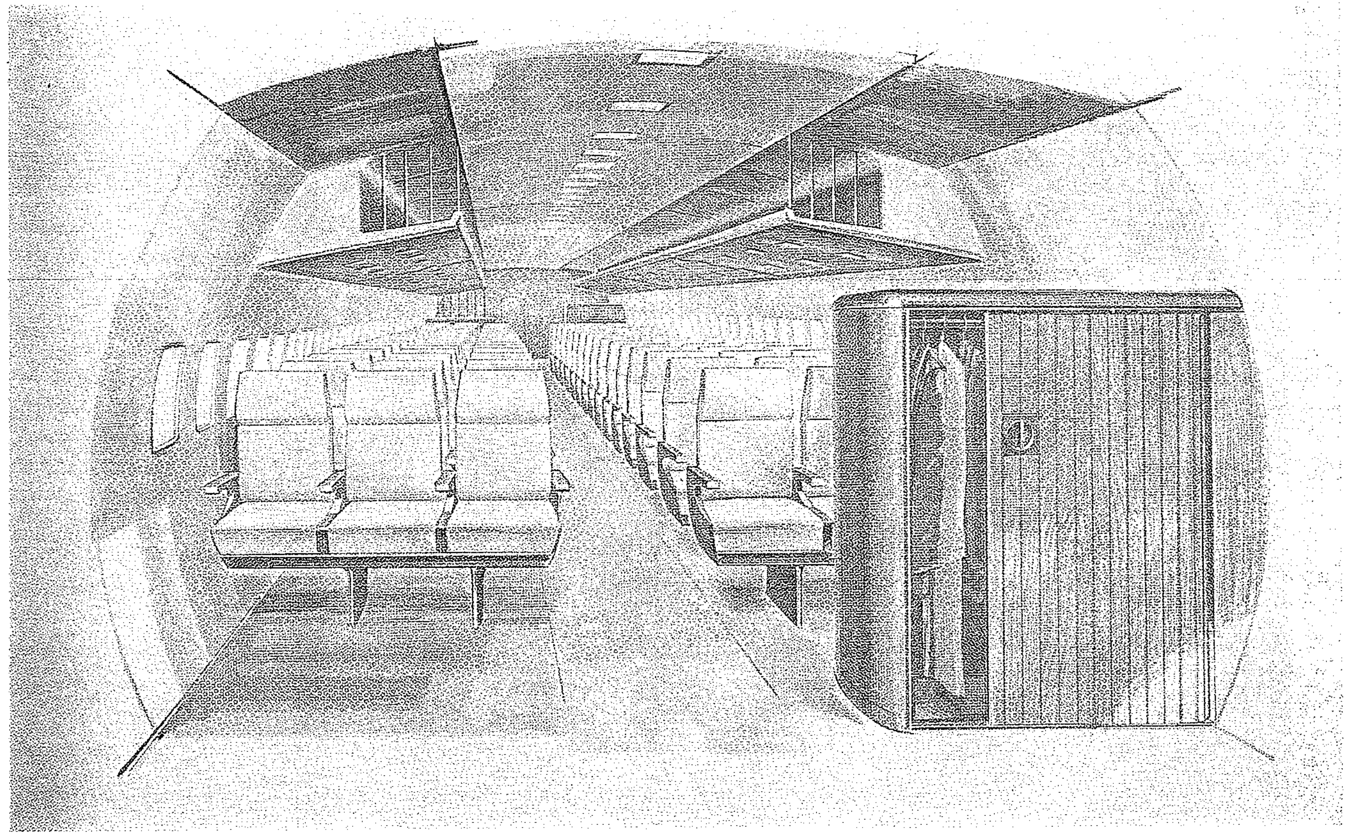


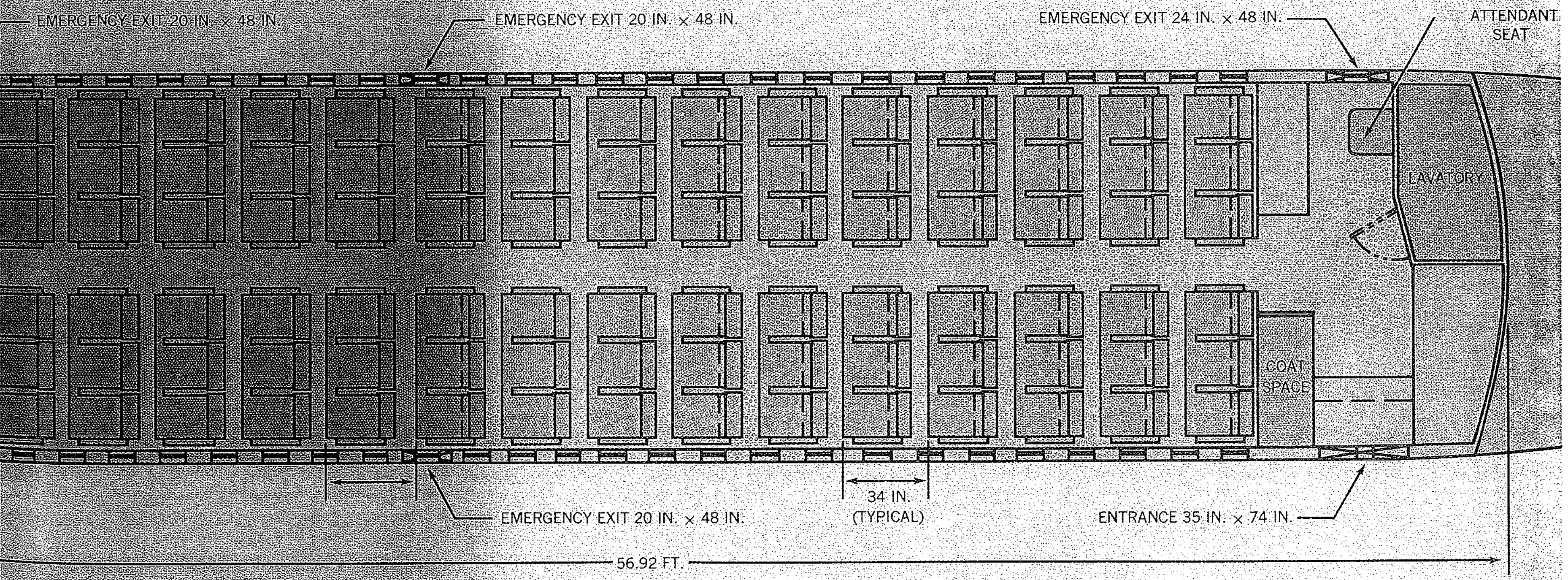
210E CABIN CONFIGURATION

The 210E cabin arrangement has been tailored to requirements for short haul service between major metropolitan centers. Lavatories, coat racks, beverage service and overhead stowage are featured. Cabin access is provided through large-sized fore and aft doors.



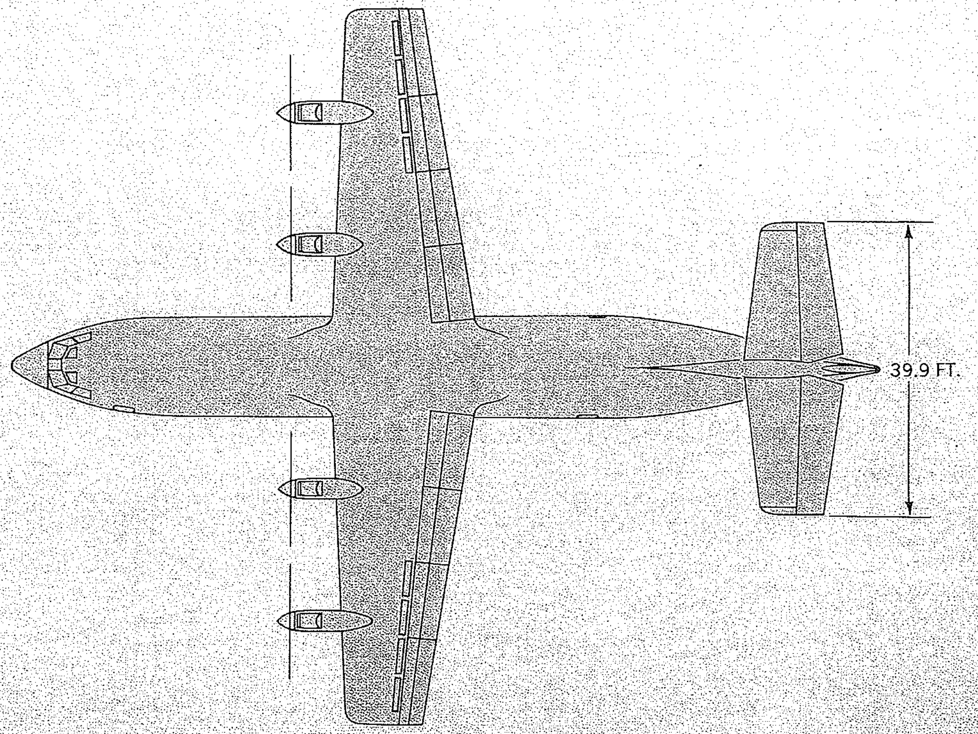


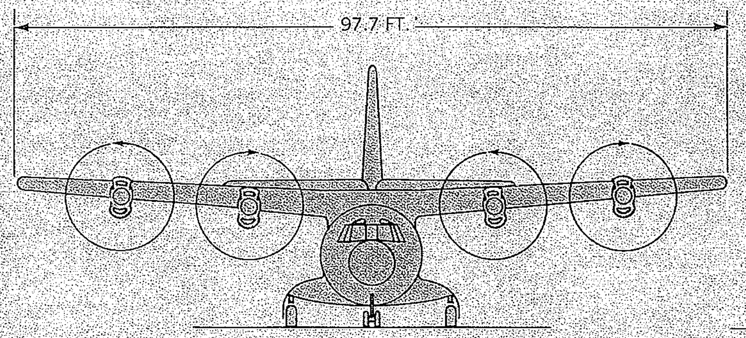


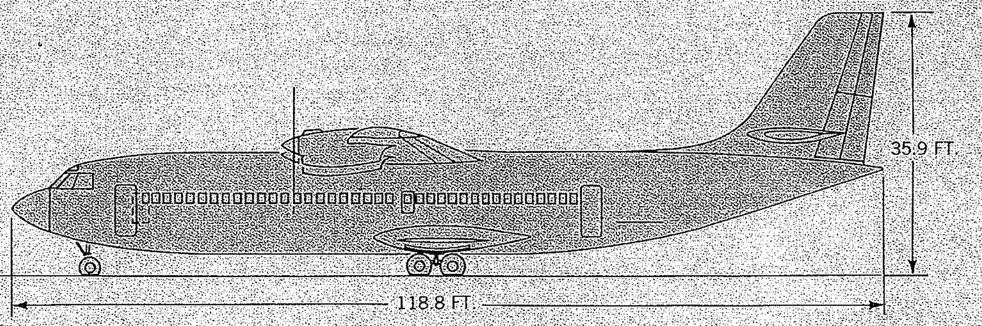

EMERGENCY EXIT 20 IN. × 48 IN.
EMERGENCY EXIT 20 IN. × 48 IN.
EMERGENCY EXIT 24 IN. × 48 IN.
ATTENDANT SEAT
LAVATORY
COAT SPACE
EMERGENCY EXIT 20 IN. × 48 IN.
34 IN. (TYPICAL)
ENTRANCE 35 IN. × 74 IN.
56.92 FT.

210G GENERAL ARRANGEMENT

Propeller Diameter	15.625 ft.
Fuselage Outside Diameter	165 in.
Cabin Floor to Ground Distance	7.29 ft.
Engines	Free Turbine Turboshaft
Aspect Ratio	6.27 ft.
Under Floor Cargo Volume	830 cu. ft.
Wing Area	1520 sq. ft.
Tail Area:	
Vertical	323.5 sq. ft.
Horizontal	456.3 sq. ft.







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Weights

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Approach
Landing Fi
Engine Po

210G
CHARACTERISTICS
SUMMARY

112 Passengers

Weights

Manufacturer's Weight Empty	51,081 lbs.
Operator's Weight Empty	52,260 lbs.
Maximum Payload	23,040 lbs.
Maximum Zero Fuel Weight	75,300 lbs.
Fuel Capacity (1,567 U. S. gals.)	10,500 lbs.
Maximum Gross Weight (takeoff/landing)	84,500 lbs.

Dimensions

Overall Length	118.8 ft.
Wing Span	97.7 ft.
Tail Height	35.9 ft.
Fuselage Outside Diameter	165 in.
Wing Area	1520 sq. ft.
Propeller Diameter	15.625 ft.
Cabin Length	71.5 ft.

Under Floor Cargo Volume	830 cu. ft.

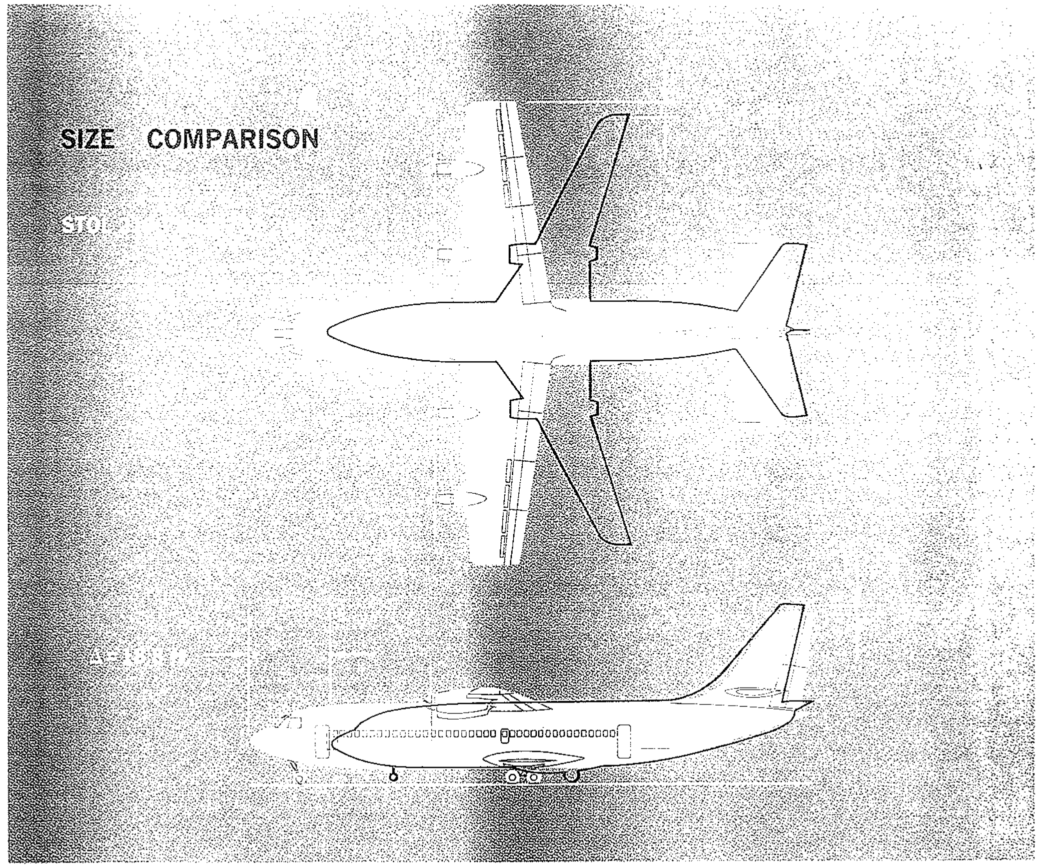
Economics

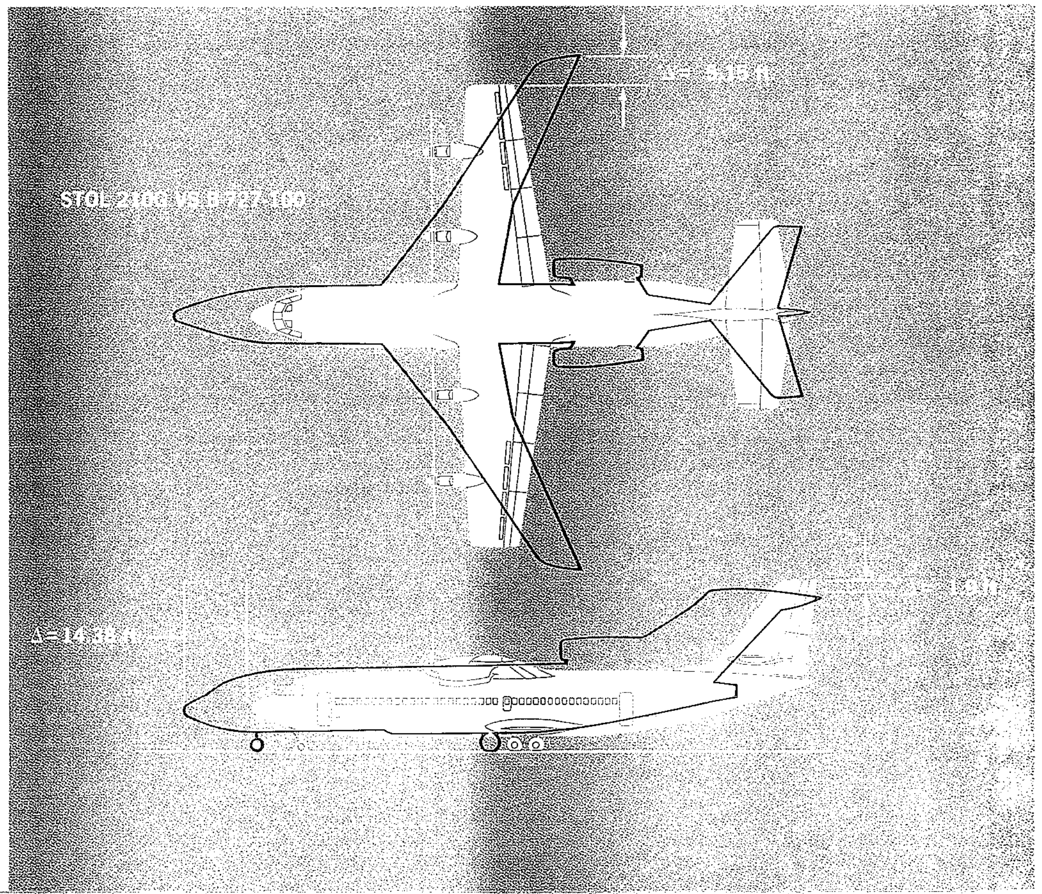
Direct Operating Cost (cents/seat mile) 200 mile stage length	2.05 to 2.21

Performance

Takeoff Field Length (to 35 ft.)	1380 ft.
Cruise Speed (normal cruise power)	323 knots
Range (@ 20,000 ft.)	565 n.m.
Approach Speed	58-72 knots
Landing Field Length (from 50 ft.)	1410 ft.
Engine Power Rating (takeoff)	3300 ESHP each

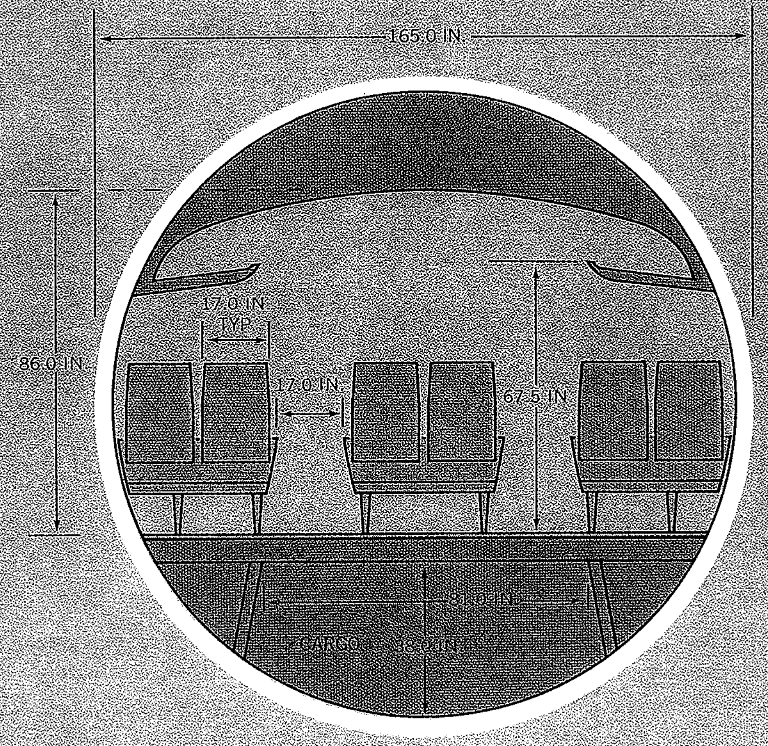
SIZE COMPARISON

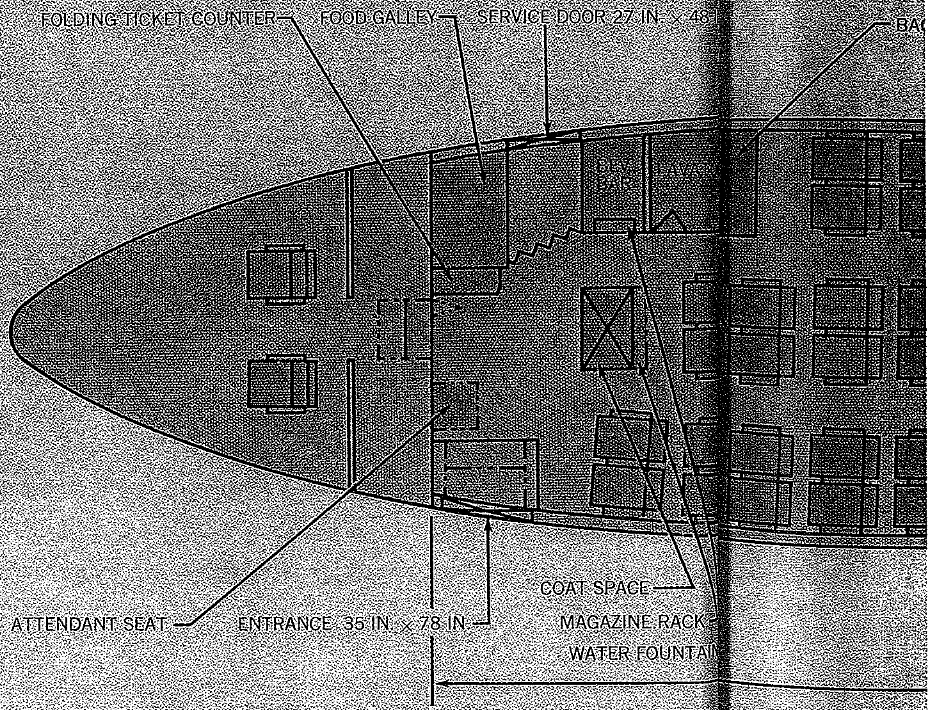


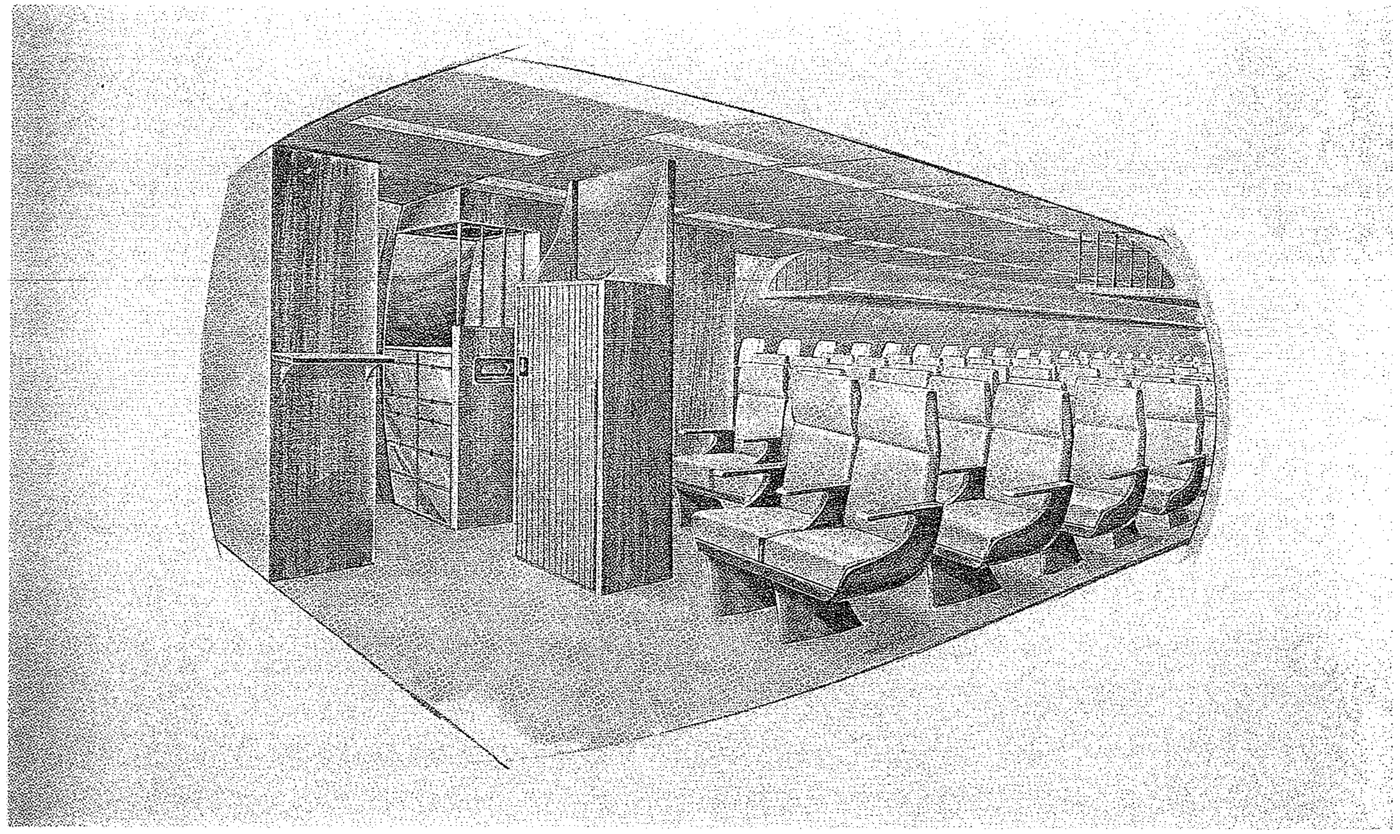


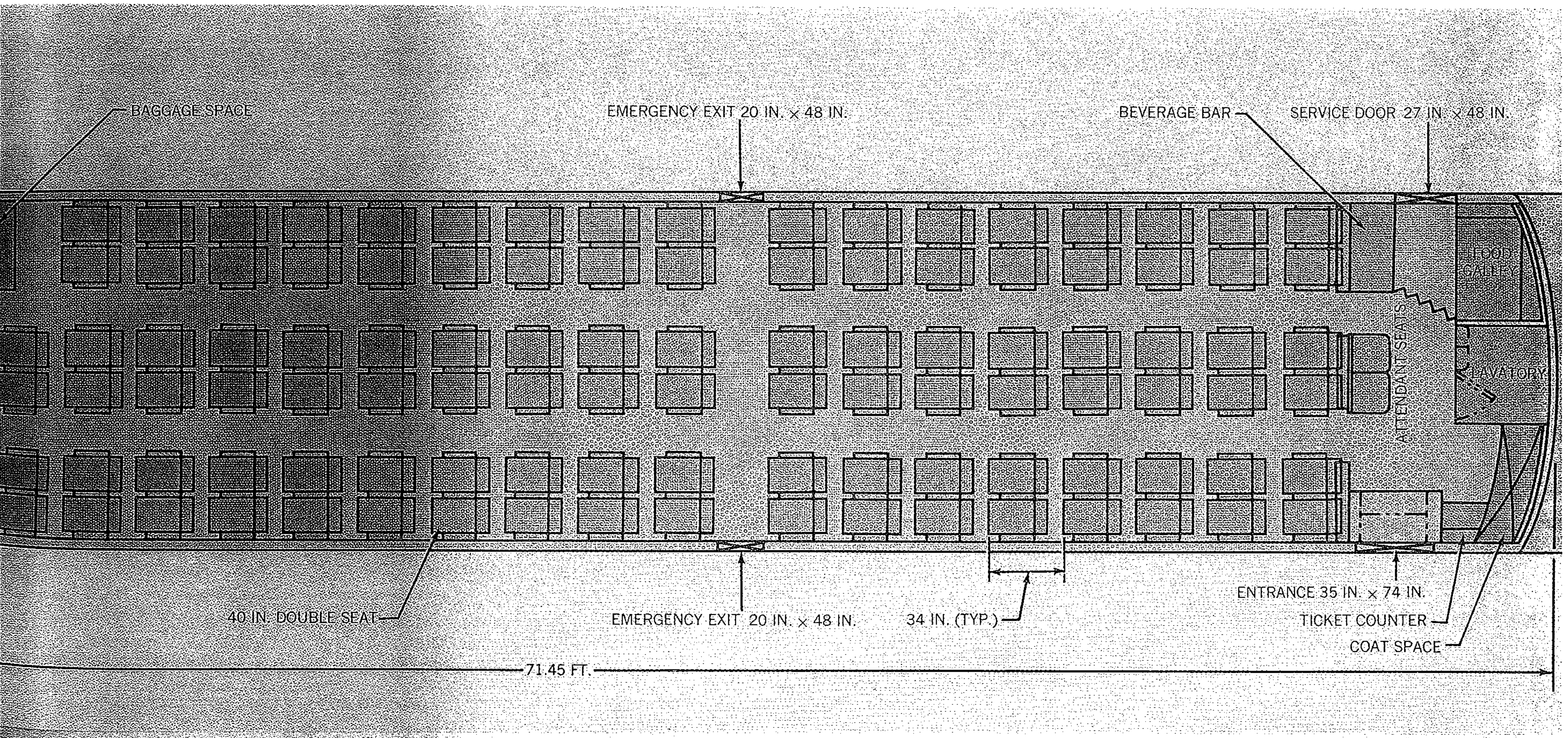
210G CABIN CONFIGURATION

The 210G cabin arrangement affords added passenger comfort with twin aisle, two abreast seating. Lavatories, coat racks, beverage service, full hot food service and overhead stowage are featured. The twin aisle arrangement allows rapid passenger loading and unloading and counters are provided for ticketing aboard the aircraft.





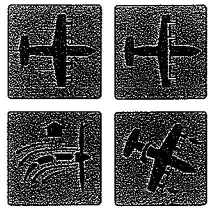



BAGGAGE SPACE
EMERGENCY EXIT 20 IN. × 48 IN.
BEVERAGE BAR
SERVICE DOOR 27 IN. × 48 IN.
FOOD GALLEY
ATTENDANT SEATS
LAVATORY
40 IN. DOUBLE SEAT
EMERGENCY EXIT 20 IN. × 48 IN.
34 IN. (TYP.)
ENTRANCE 35 IN. × 74 IN.
TICKET COUNTER
COAT SPACE
71.45 FT.

CARGO APPLICATIONS

The 210 STOL has been designed primarily for passenger operations. With minor alterations to the interior overheads, however, it is possible to fit within the spacious cabins of "E" and "G", large volumes of cargo. The 210E cabin can accommodate up to seven standard 88 × 125 inch igloo containers (up to 86 inches high). The 210G cabin can accommodate nine of these standard containers. Rapid change versions which would provide loading access for cargo containers are under study for both the "E" and "G" designs.

McDonnell Douglas also has under study an "all cargo" 210 derivative which features a rear loading cargo fuselage with a wing/propulsion system and other flight control surfaces common with the 210G. This cargo version will have soft field operating capabilities and a high payload capacity, while retaining the short field performance and safety features of the 210.



ADVANCED TECHNOLOGY

The advanced STOL technology incorporated in the 210 features a unique integration of proven aerodynamic and kinematic principles. A wing fully immersed in the propeller slipstream, full span triple slotted flaps, and four propellers interconnected with a common cross shaft—provide unmatched short field performance, slow speed flight maneuvering in the STOL mode and the high level of operating safety required of modern transport aircraft.

This advanced design provides simplicity in flight controls and, at the same time, gives control redundancy for all axes of flight. For cruise flight, the 210 is designed to fly conventionally with conventional control surfaces. For slow speed flight, coordinated high lift and drag configurations augment these normal controls to make possible short takeoffs and landings and provide flight path control for steep gradient approaches and departures. Powered lift, in conjunction with positive thrust interconnection, assures safety in this STOL mode of flight. Powered lift is supplemented by powered control (differential thrust and lift) to provide excellent flight characteristics and accurate maneuverability in the slow speed flight regime.

THE WING / PROPULSION SYSTEM

The wing/propulsion system is the heart of the 210. The mechanical interconnection of the four propeller units, by means of a small diameter flexible cross shaft, provides a capability for power transfer across the wing. This enables the aircraft to retain symmetrical thrust and controllability in the event of an engine loss, and it allows differential thrust and lift distribution on the wing for enhanced slow speed flight control. In the event of an engine loss at the critical point in takeoff, the remaining three engines continue to drive all four propellers. With this 25% reduction in available power, total thrust is reduced only 15-17%, and actual takeoff distance to a 35 foot height is increased by only 11-13%. On landing, the interconnect feature allows immediate and symmetrical reverse thrust, greatly enhancing the short field landing capability of the aircraft. Through interconnection, synchrophased propellers provide low internal noise levels and propeller thrust or engine power transients are subdued due to the stabilizing influence of the cross shaft.

In normal operation, the cross shaft bears essentially no load, transmitting power only in the following cases:

(1) When unequal propeller pitch settings are commanded by the flight control system (through a central pitch control) to augment yaw and roll control in the STOL mode. In this case, power is transmitted from one outboard propeller to the other through the shaft.

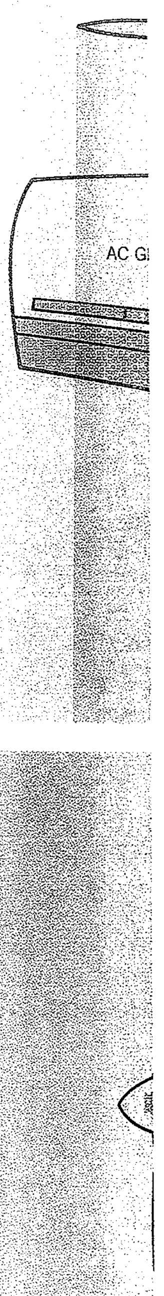
(2) When it is desired to increase drag for flight path control during an approach, the outboard propeller thrust is reduced to near zero (through propeller pitch control) which impoves wing lift distribution. In this case, the power of all four engines is transmitted to the two inboard propellers through the cross shaft system.

(3) For maintaining constant speed of all four propellers, which insures smooth flight control. In this case very small power transfers are required.

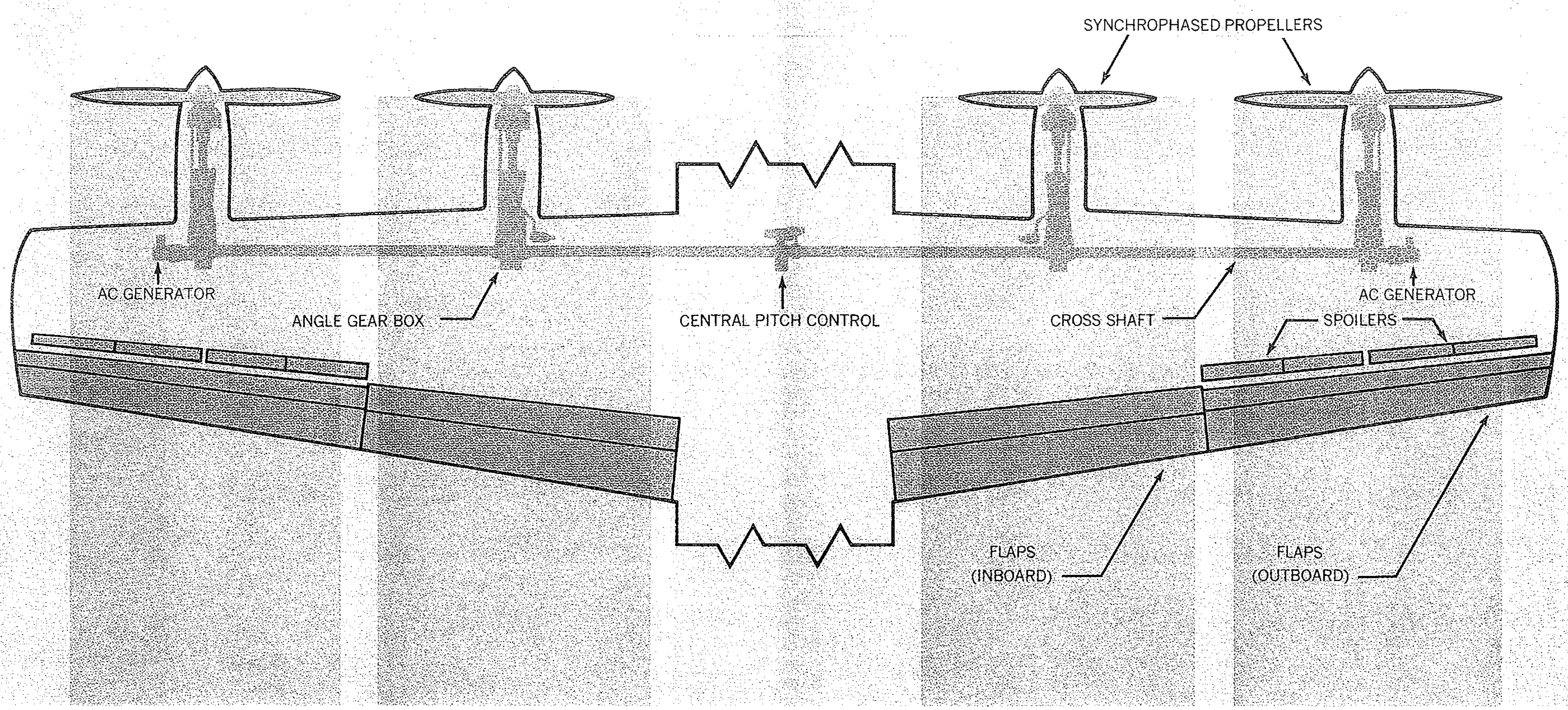
(4) For driving the electrical and hydraulic accessories in the system. In this case, less than 50 horsepower is transferred through the shafting system.

This cross shaft system (the shaft and angle gear boxes) has been proven through many hours of prototype flying and rigorous bench testing—providing a long operating life and low maintenance costs.

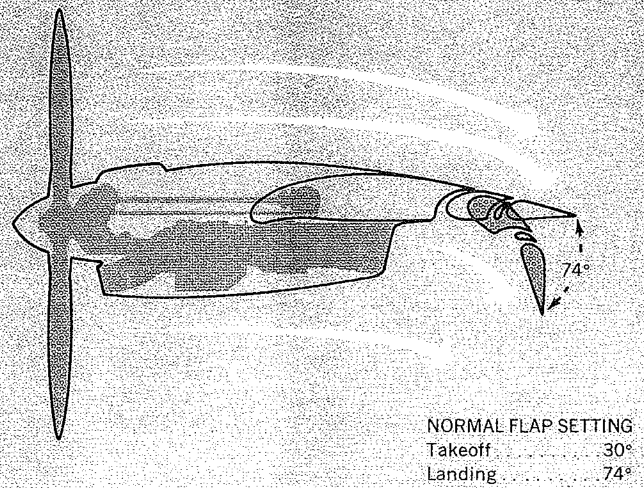
On the opposite page cross sections of the wing/propulsion system, at the centers of the inboard and outboard free turbine engines, indicate the air flow across the wing, the range of flap deflections and the normal flap settings for takeoff and landing. The inboard and outboard flaps are automatically coordinated with the use of one flap control for the full range of deflections.



WING / PROPULSION SCHEMATICS



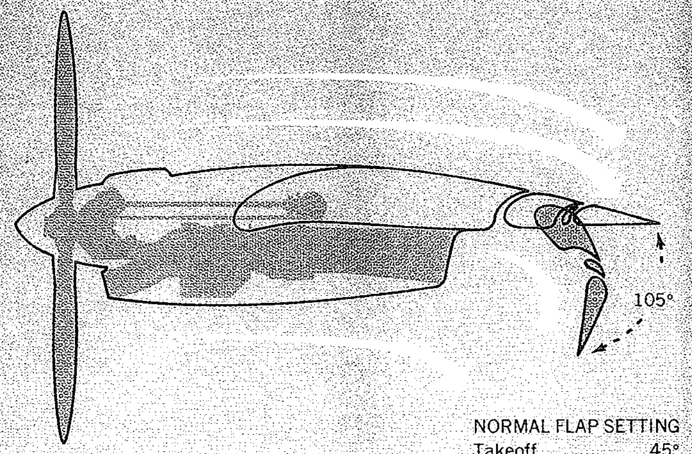
OUTBOARD SECTION



NORMAL FLAP SETTING

Takeoff	30°
Landing	74°

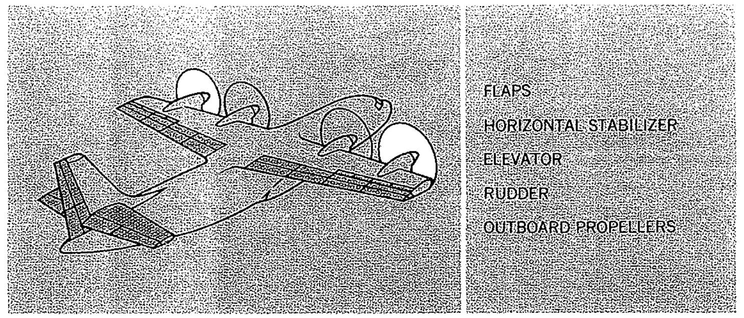
INBOARD SECTION



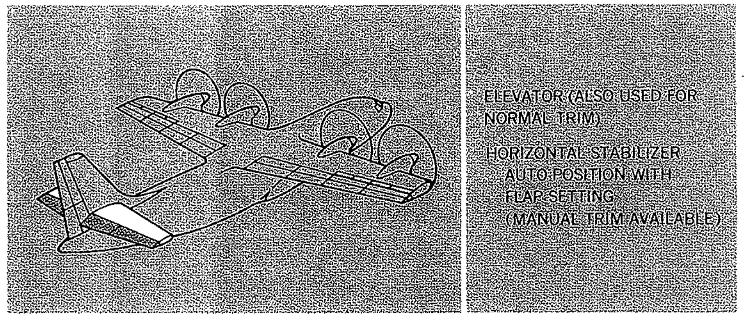
NORMAL FLAP SETTING

Takeoff	45°
Landing	105°

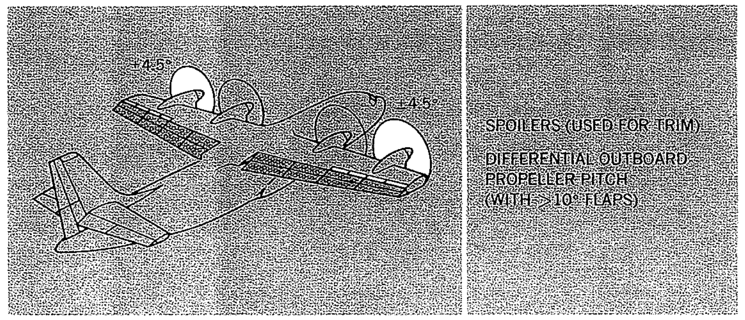
FLIGHT CONTROLS



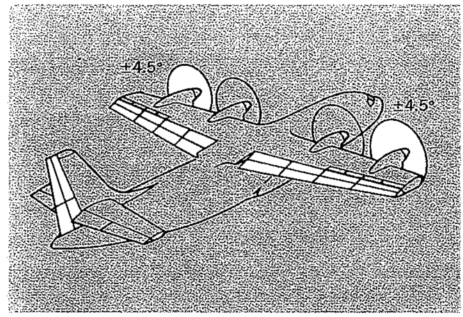
CONTROL SURFACES Conventional cruise flight control is effected by an elevator, spoilers and a rudder for pitch, roll, and yaw, respectively. For slow speed flight in the STOL mode, conventional controls are augmented by the horizontal stabilizer, flaps and differential propeller pitch. The additional controls provide flight control redundancy as well as control power for maneuvering of the aircraft in slow speed flight.



PITCH AXIS At cruise, the elevator operates conventionally with a deflection range of +25 degrees (airplane nose down) to −35 degrees (airplane nose up). During slow speed flight, the elevator control is coordinated with the engine power control, in accordance with flap deflection, and the horizontal stabilizer (deflection range 0 to 8°) is slaved to the flap setting to keep the airplane in trim automatically. Manual trim is also available for the horizontal stabilizer.



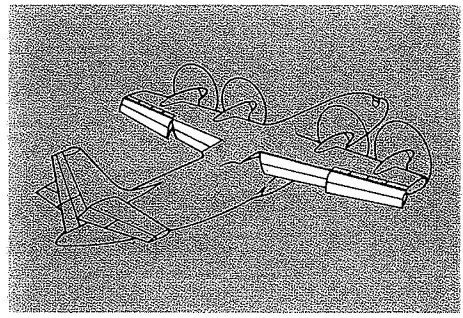
ROLL AXIS Spoilers provide roll axis control and normal lateral trim. With flap deflections greater than 10°, the control system authorizes differential pitch (±4.5°) between the outboard propellers. With this 10° or greater flap deflection, lateral displacement of the control stick results in a decrease in pitch of the outboard propeller on the inside of the turn and an increase in pitch of the outboard propeller on the outside of the turn. The resulting change in relative slipstream velocities over the outer wing panels creates differential lift, providing powerful roll moments at slow speed (a favorable yawing moment also results from the differential thrust).



DOUBLE HINGED SPLIT RUDDER (UPPER SECTION <110 KIAS ONLY)

DIFFERENTIAL OUTBOARD PROPELLER PITCH (WITH >10° FLAPS)

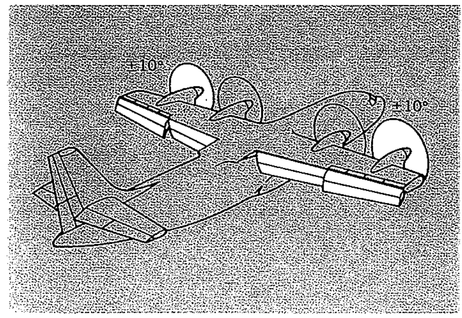
YAW AXIS The rudder is double hinged with upper and lower sections. For cruise flight (speeds above 110 KIAS) only the lower section is operative, leaving the upper section secured in the neutral position. During low speed flight (< 110 KIAS) the full rudder is used for yaw control along with ±4.5° differential pitch (after the flaps are deflected more than 10°). This differential pitch is automatically available with application of the rudder pedals.



INBOARD FLAP SETTING >75° (DRAG RANGE)

7.0°-7.5° APPROACH ANGLE

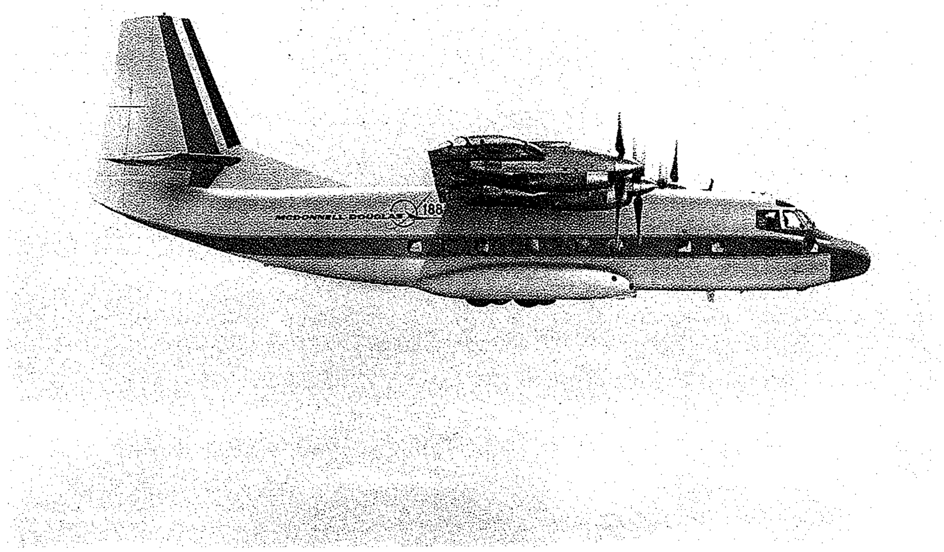
STEEP GRADIENT APPROACH During steep gradient approaches (7.0°-7.5° approach angle) the inboard flaps are deflected up to 105° with a corresponding outboard flap deflection of 74°. In the 75° to 105° deflection range of the inboard flaps, no additional lift is provided, but the additional drag incurred assists flight path control and touchdown accuracy.



OUTBOARD PROPELLERS ESSENTIALLY ZERO THRUST

DIFFERENTIAL PITCH RANGE INCREASED TO ±10° @ 105° FLAP SETTING

Additional drag for flight path control can be selected which sets the outboard propeller pitch at near zero (eliminating outboard thrust) and increases the inboard propeller pitch (increasing inboard thrust). This feature alters the wing lift distribution, providing the capability for steeper approach angles. Additionally, with inboard flap deflections of 105°, the differential pitch authority of the outboard propellers is increased to ±10°, which provides powerful roll and yaw control at very low approach speeds.



PROVEN TECHNOLOGY

The 210 has been preceded by many years of development experience. The McDonnell Douglas 188 (Breguet 941S) has been flying since April 1967 with over 500 flight hours on four production aircraft. The 188 resulted from many years of development—its own prototype (the Breguet 941.01) has flown over 1140 hours. 210 STOL technology has evolved from this strong base.

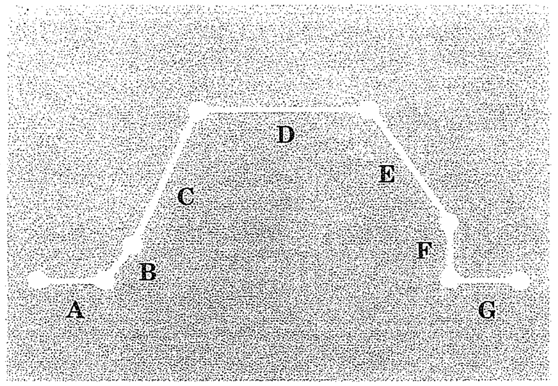
The McDonnell Douglas 188 has been used in demonstration programs involving airline-manufacturer-government agency participation to prove the practicality of the STOL concept and to establish operating criteria for STOL transport aircraft.

210 PERFORMANCE PARAMETERS

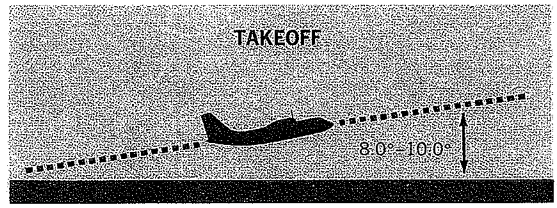
BASIC MISSION PROFILE

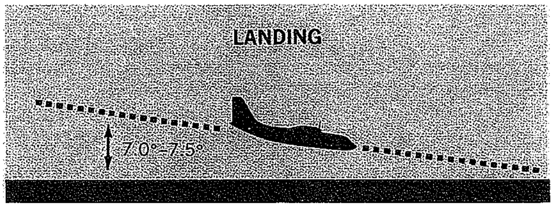
	Fixed Time (Mins.)
A. Start—taxi	3.0
B. Takeoff	.5
C. Climb to cruise altitude	*
D. Cruise	*
E. Descend	*
F. Approach and Land	2
G. Taxi	2
Total Fixed Time in profile	7.5 Mins.

*Time variable with mission range



TAKEOFF AND LANDING PROFILES





ENGINE CHARACTERISTICS

Engines under consideration for the 210 are advanced free turbine types and are direct derivatives of proven production models.

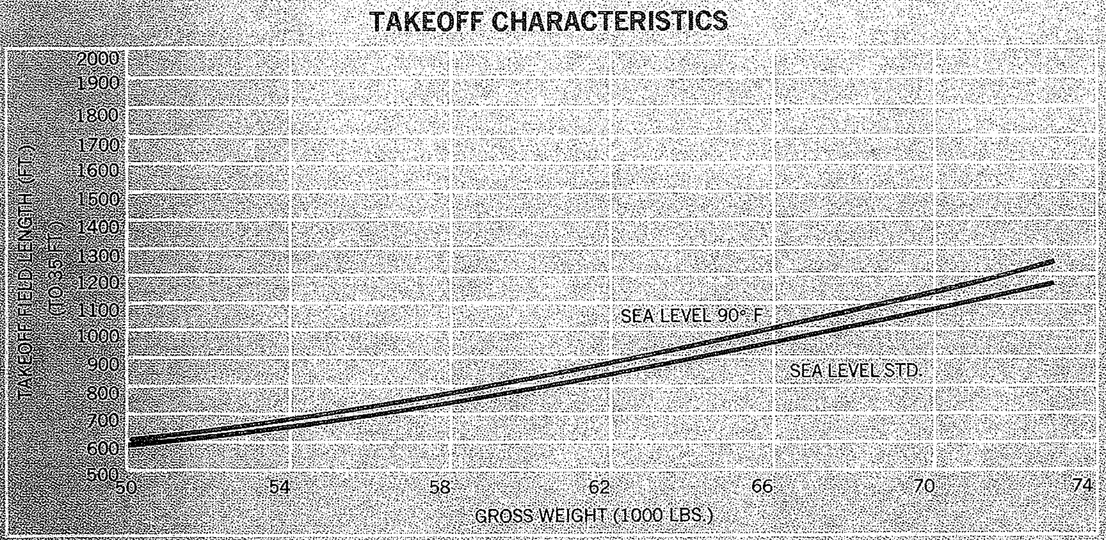
PERFORMANCE RATINGS (S.L. STATIC)

	ESHP* (59°-86°F)	ESFC (59°F)	ESFC (86°F)
Take-off	3300	.487	.491
Max. Continuous	3130	.492	.497
Max. Cruise	2820	.506	.511

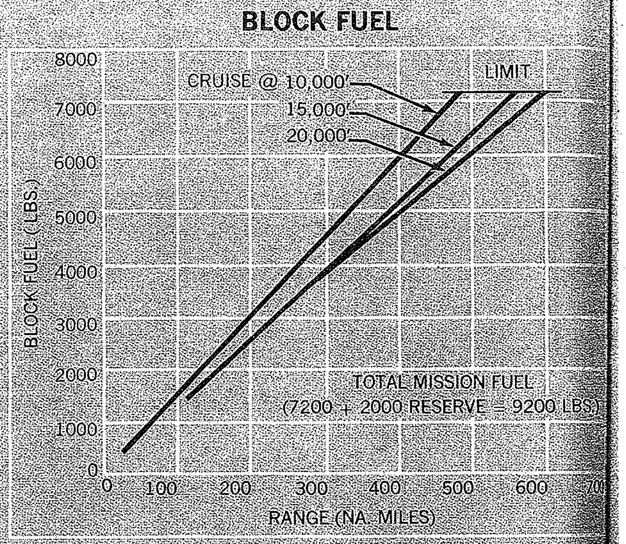
*Includes jet nozzle thrust

210E PERFORMANCE

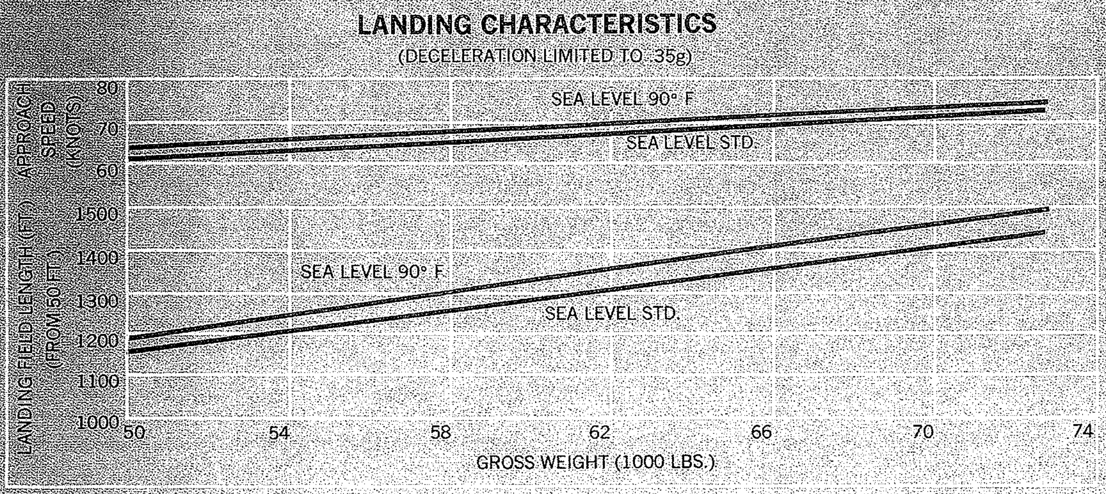
The takeoff and landing performance that is presented illustrates the outstanding STOL capability of the 210E. The block fuel, block speed, and holding fuel charts provide information for basic flight planning.



TAKEOFF CHARACTERISTICS

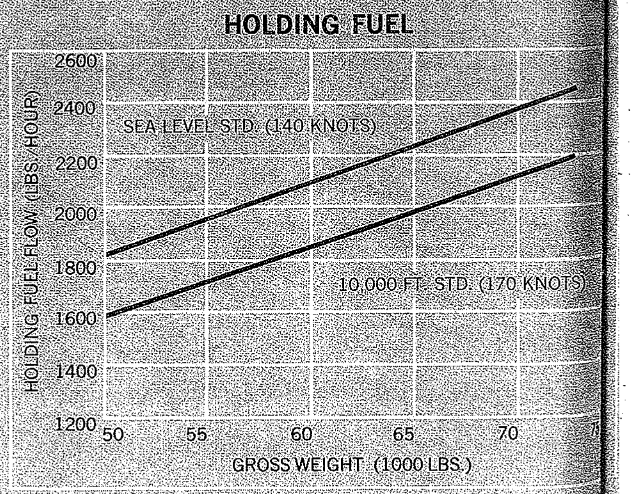


BLOCK FUEL



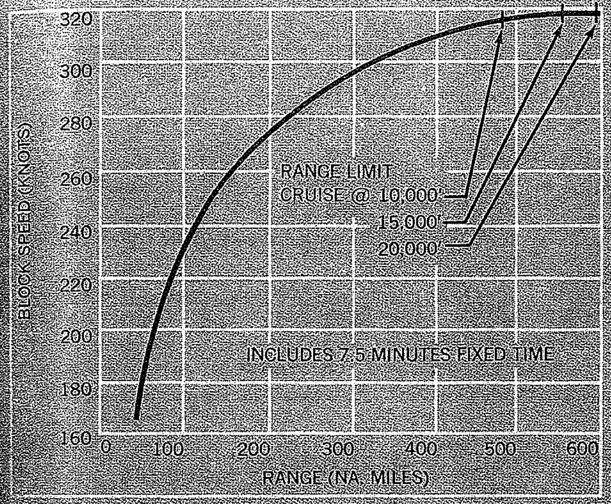
LANDING CHARACTERISTICS

(DECELERATION LIMITED TO .35g)

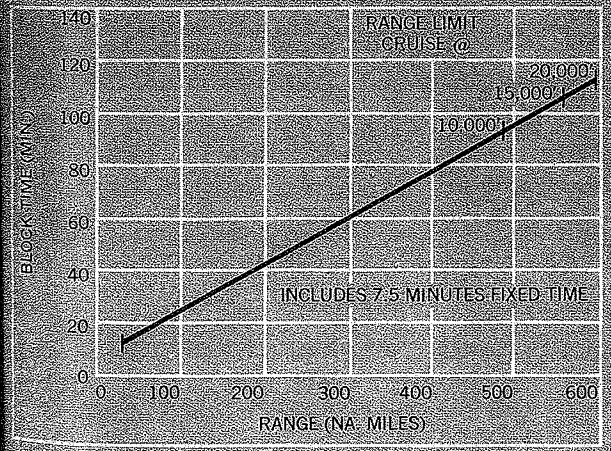


HOLDING FUEL

BLOCK SPEED



BLOCK TIME



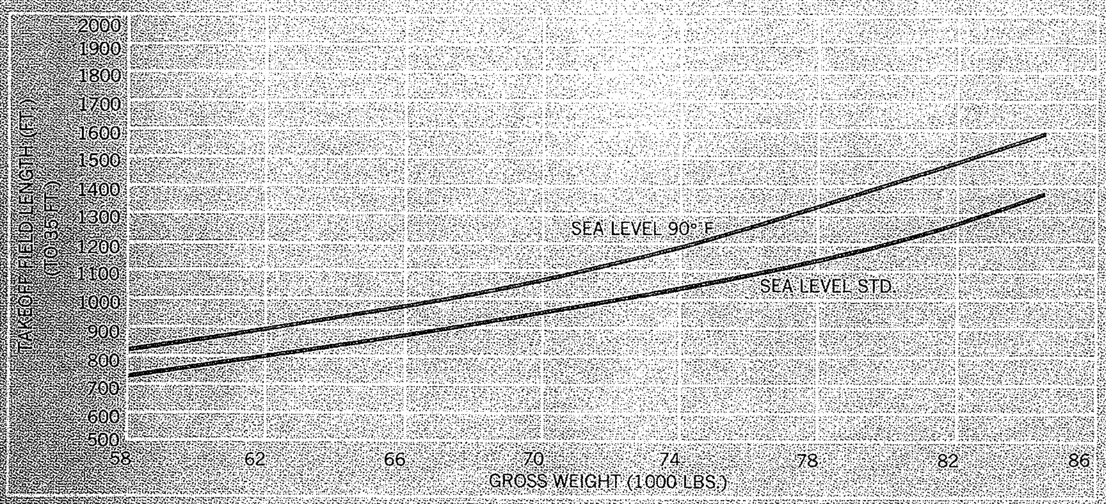
210E MISSION PERFORMANCE SUMMARY

Maximum Weight (takeoff/landing)	72,854 lbs.
Range (max. weight)	
10,000 ft. Cruise Altitude	490 n.m.
15,000 ft. Cruise Altitude	555 n.m.
20,000 ft. Cruise Altitude	600 n.m.
Seating Capacity	90
Payload	18,860 lbs.
Mission Fuel (including 2,000 lbs. reserve)	9,200 lbs.
Average Cruise Speed	348 knots
Field Length (S.L. standard day—max. weight)	
Takeoff (to 35 ft.)	1160 ft.
Landing (from 50 ft.)	1440 ft.

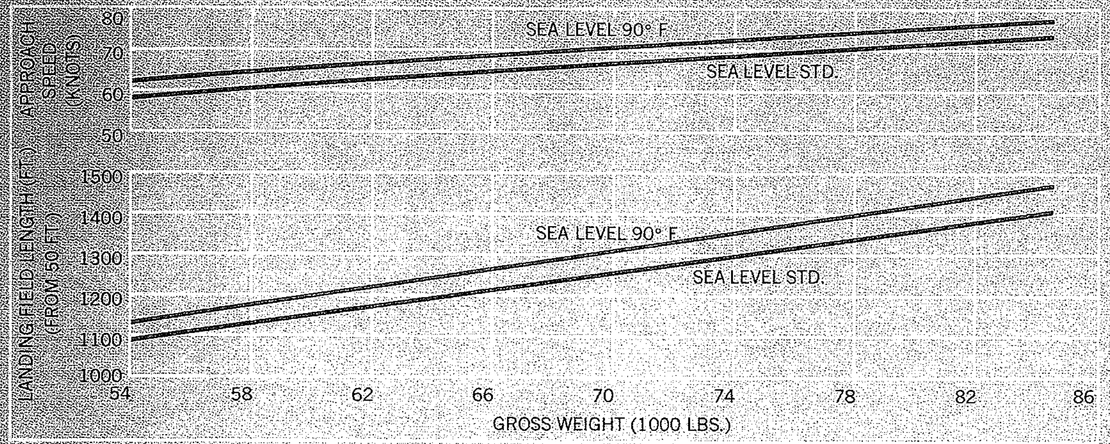
DESIGN FEATURES
ECONOMICS
THE STOL ENVIRONMENT
AIRLINE APPLICATIONS
AVAILABILITY

210G PERFORMANCE

210G performance has been computed with the same commercial ratings used for 210E performance calculations. 210G field length performance is more closely matched between takeoff and landing than the 210E. Fuel consumption is only slightly higher for the 210G, resulting in approximately the same range capability for the same quantity of mission fuel.

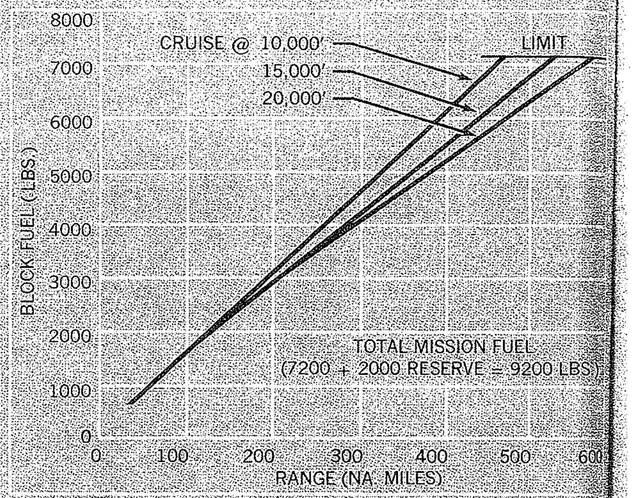


TAKEOFF CHARACTERISTICS

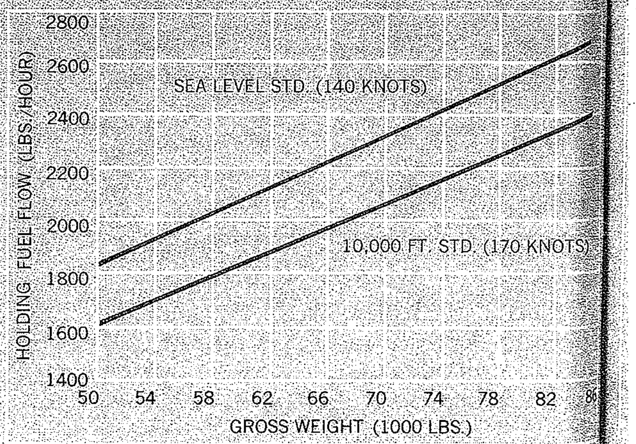


LANDING CHARACTERISTICS

(DECELERATION LIMITED TO .35g)

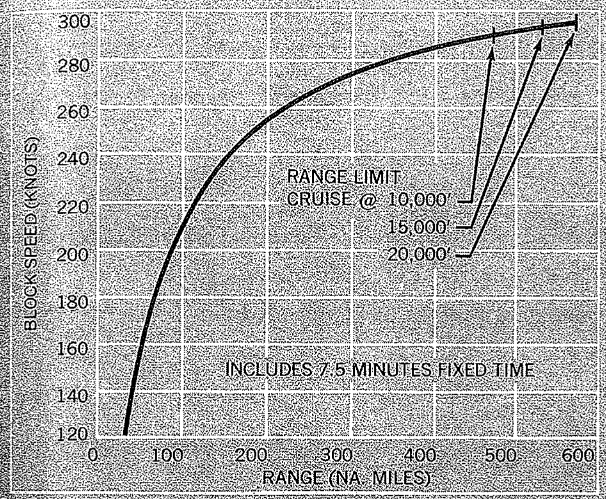


BLOCK FUEL

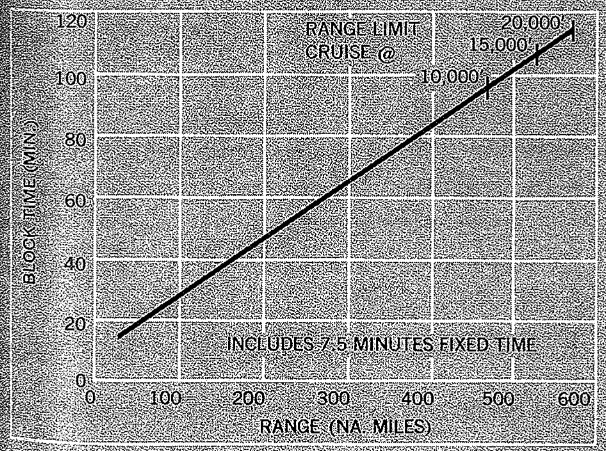


HOLDING FUEL

BLOCK SPEED



BLOCK TIME



210G MISSION PERFORMANCE SUMMARY

Maximum Weight (takeoff/landing)	84,500 lbs.
Range (max. weight)	
10,000 ft. Cruise Altitude	465 n.m.
15,000 ft. Cruise Altitude	525 n.m.
20,000 ft. Cruise Altitude	565 n.m.
Seating Capacity	112
Payload	23,040 lbs.
Mission Fuel (including 2,000 lbs. reserve)	9,200 lbs.
Average Cruise Speed	323 knots
Field Length (S.L. standard day—max. weight)	
Takeoff (to 35 ft.)	1380 ft.
Landing (from 50 ft.)	1410 ft.

AN INTEGRATED DESIGN

The 210 is designed to operate efficiently in the mass air transportation environment of the '70s. This means new modes of operation, with passenger and baggage handling, ticketing and aircraft servicing at STOLports of limited size and service facilities, small airports and separate STOL sites at major airports. Self-sufficiency and rapid turnaround times are required. 210 design features meeting these requirements are described in this section.

DESIGN FEATURES

Integral Stair The fore and aft doors will have self contained folding stairs which speeds passenger loading and unloading.

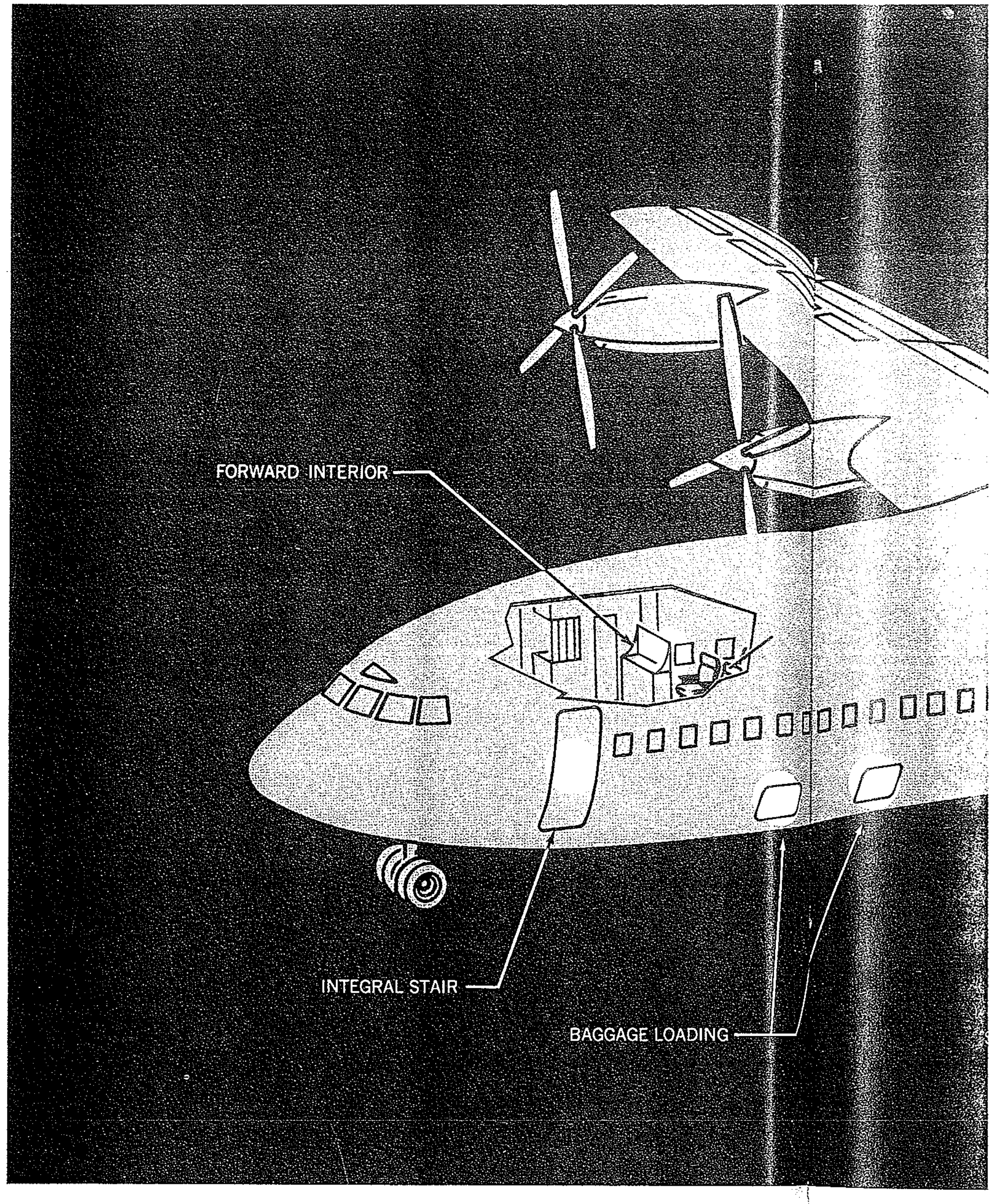
Interior Design The 210 interiors have been designed for rapid passenger processing and efficient servicing on the ground. Ticket counters are provided for on-board ticketing, which reduces passenger check in times and lowers indirect operating costs. The location of service doors allows quick access to the beverage and food service areas. The twin aisle configuration speeds passenger loading and unloading operations by providing separate routes for ingress and egress.

Baggage Loading Containers A self contained baggage loading system is being developed featuring wheeled loading carts that can load and unload from two lower cargo doors on self contained tracks. These cars move longitudinally inside the cargo compartment on internal tracks. Baggage containers can be loaded with baggage by the passengers at the side of the aircraft—to reduce check-in times in rapid turnaround situations.

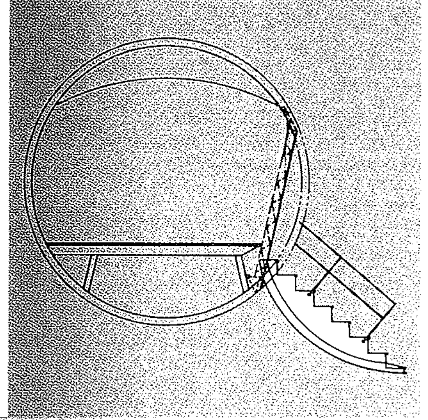
Single Point Refueling A single point access for refueling is located in the forward section of the left landing gear fairing, permitting rapid refueling from fuel trucks or ground hoses.

Wing Propulsion System The wing/propulsion system, perfected during prototype development, will require little maintenance and is expected to have a long time-between-overhauls. A brake will be incorporated in the system to stop the propellers during quick turnaround, while the four engines remain at idle power—obviating the requirement to shut down the engines for passenger loading and unloading.

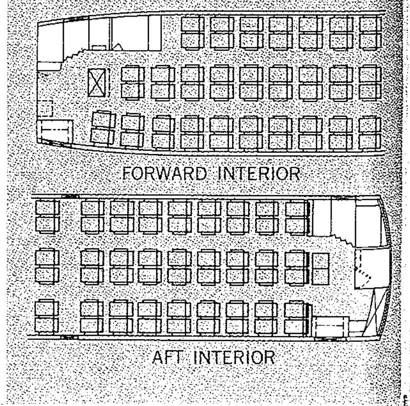
Auxiliary Power Unit An APU is located in the extreme aft section of the fuselage to provide air conditioning and electrical power on the ground. The APU location reduces passenger ground noise exposure during loading and unloading operations.



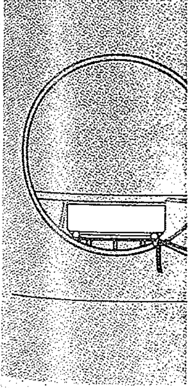
INTEGRAL STAIR

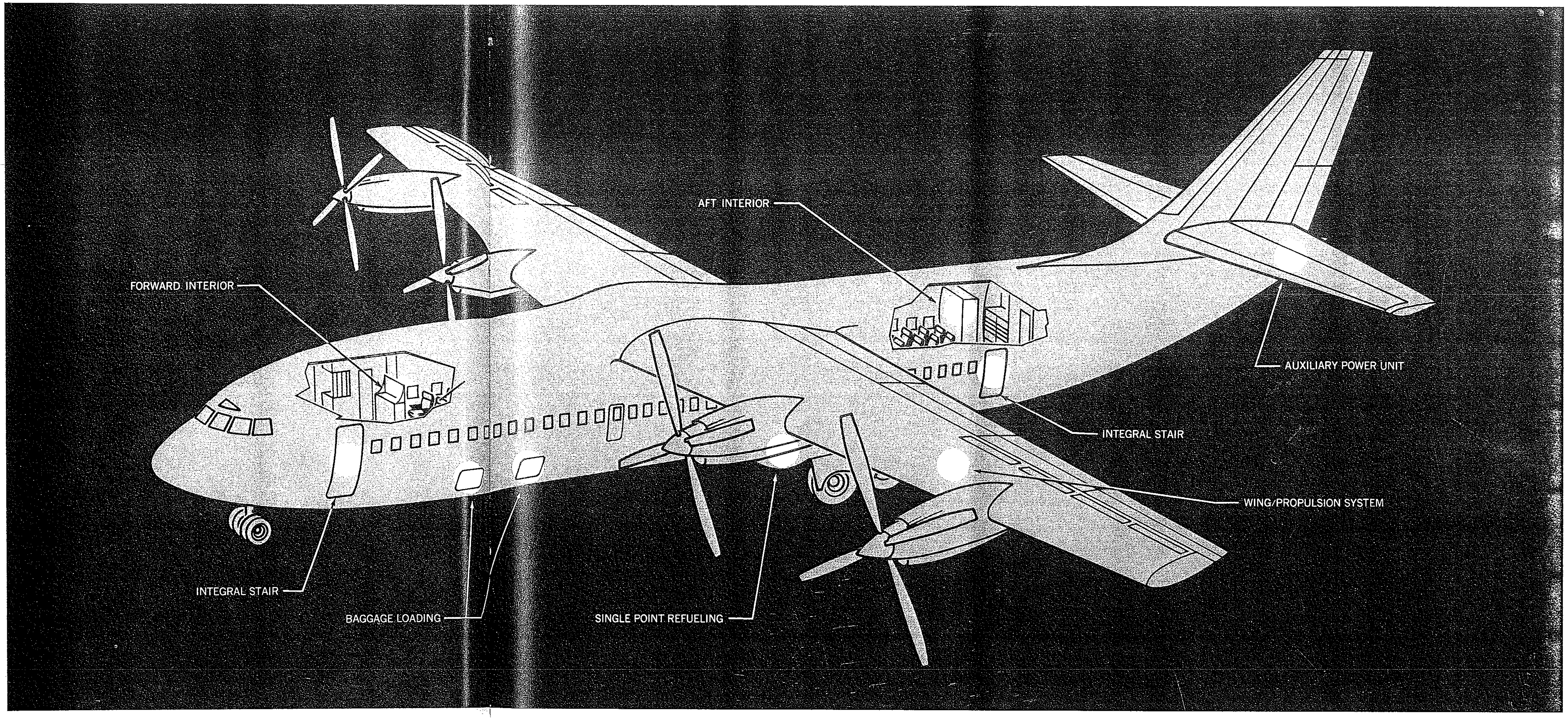


INTERIOR DESIGN

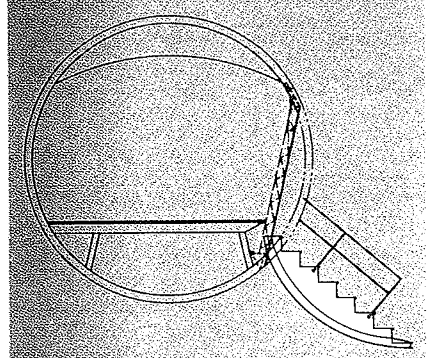


BAGGAG
CONT

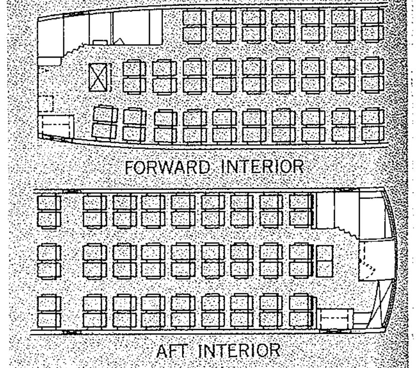




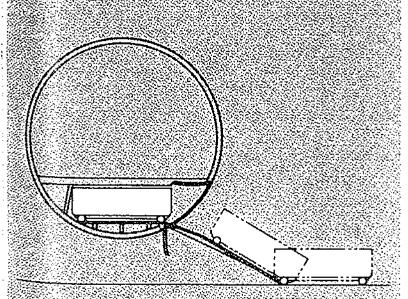
INTEGRAL STAIR



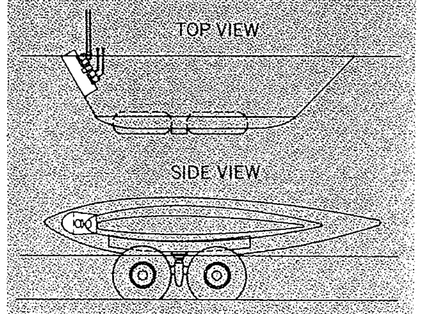
INTERIOR DESIGN



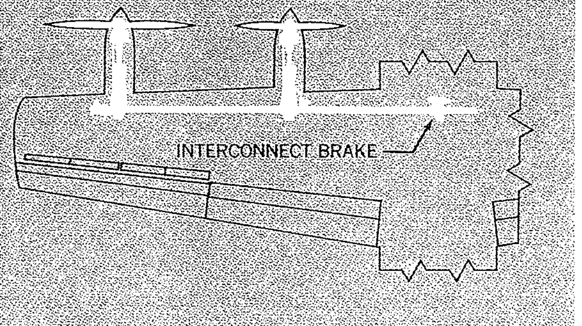
BAGGAGE LOADING CONTAINERS



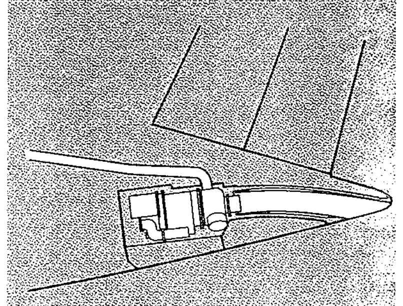
SINGLE POINT REFUELING

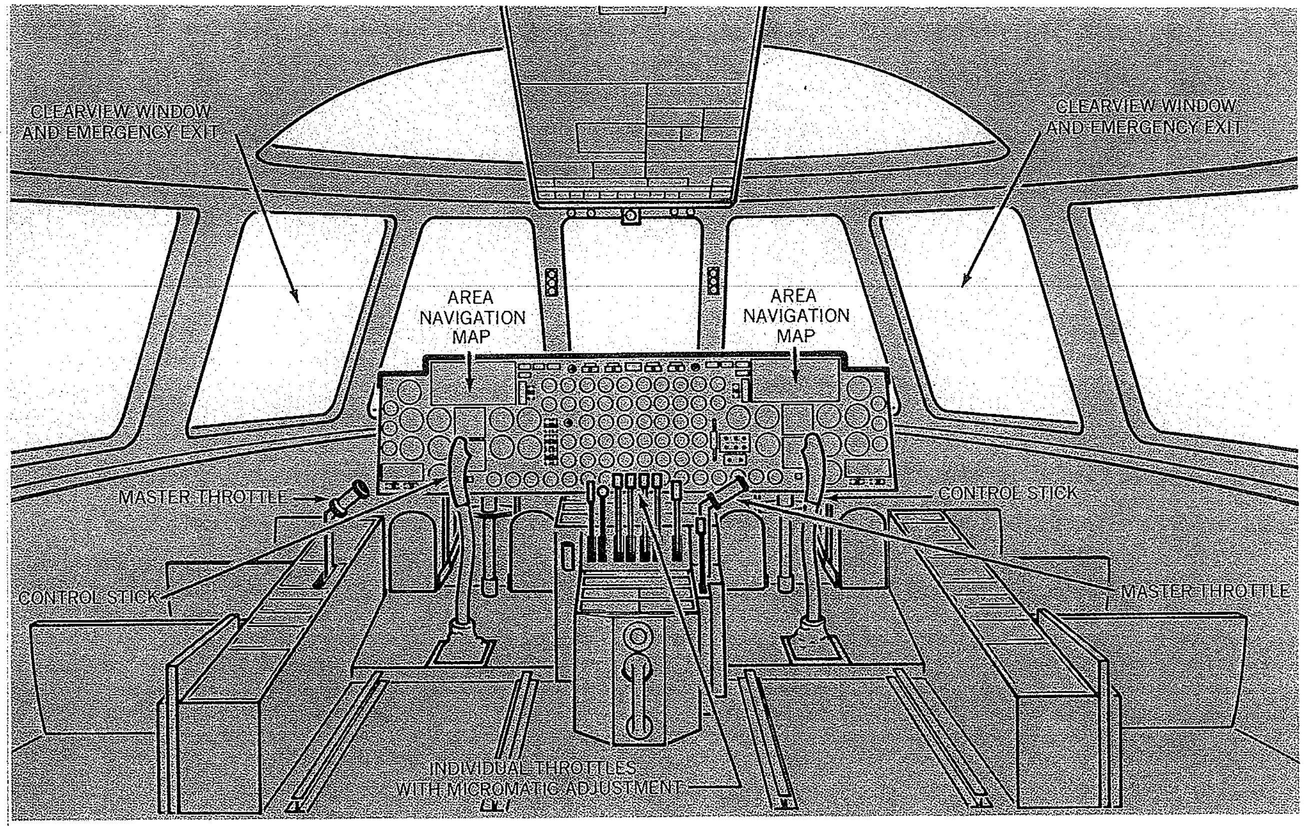


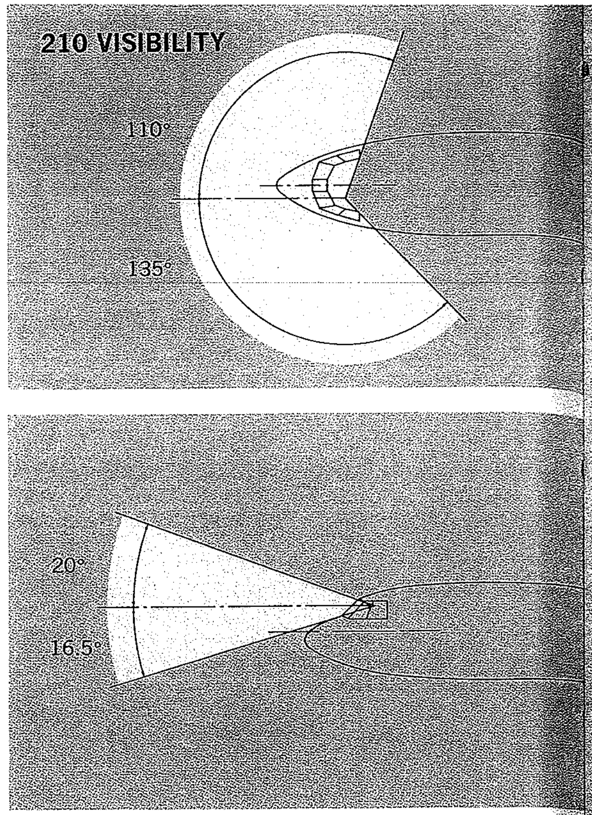
WING/PROPULSION SYSTEM



AUXILIARY POWER UNIT







FLIGHT COMPARTMENT DESIGN

The 210 flight compartment is spacious and comfortable with all instruments and controls centrally located for easy operation by a two man crew. A control stick is used instead of the conventional yoke–a single power lever performs the task of the usual multiple throttles (after engine trim)–and provisions have been made for map displays of advanced area navigation equipment. Space is provided in the flight compartment for crew baggage.

Windshields and windows of the 210 are designed to exceed the cockpit visibility ranges afforded by most conventional aircraft.

ECONOMIC ADVANTAGES OF THE 210 STOL

The 210 STOL is a profit making commercial aircraft. 210 airline systems will enjoy significant economic advantages—due to operating efficiencies of the aircraft and economic benefits inherent in the STOL concept. The major economic advantages offered by the 210 are:

1. Reduced passenger travel time—translating to reduced passenger travel costs
2. Reduced airline operating costs
3. More efficient utilization of available air and ground operating space
4. Lower facilities investment costs

Direct operating costs are presented for both the 210E and 210G. In addition, comparative seat mile operating costs are presented (210 STOL vs. CTOL twin jet). Using standard costing assumptions, twin jet direct operating costs are slightly lower than 210 direct operating costs. When the cost of CTOL air and ground delays is introduced, however, the difference between CTOL and STOL DOCs rapidly diminishes. Carpet plots illustrating the cost of delays show that 210 DOCs can be significantly less than CTOL twin jet DOCs when air and ground delays reach a level that airline operators now frequently experience. Profitability of the 210 is presented on the basis of the current fare structure and on the basis of current fares plus a modest STOL surcharge.

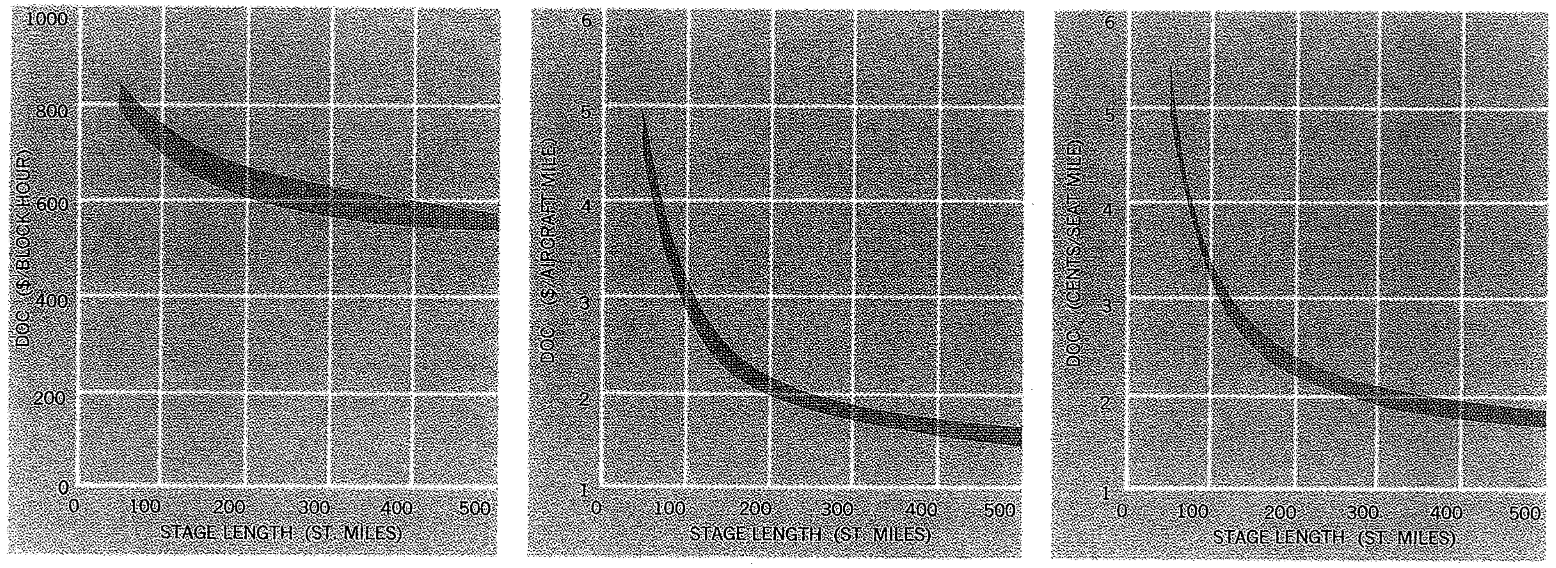
The study prices used in formula costing have been derived from a preliminary market estimate, and will be completely determined by further analysis of total 210 market demand.

COSTING ASSUMPTIONS

(1967 ATA METHOD MODIFIED-1973 ECONOMICS)

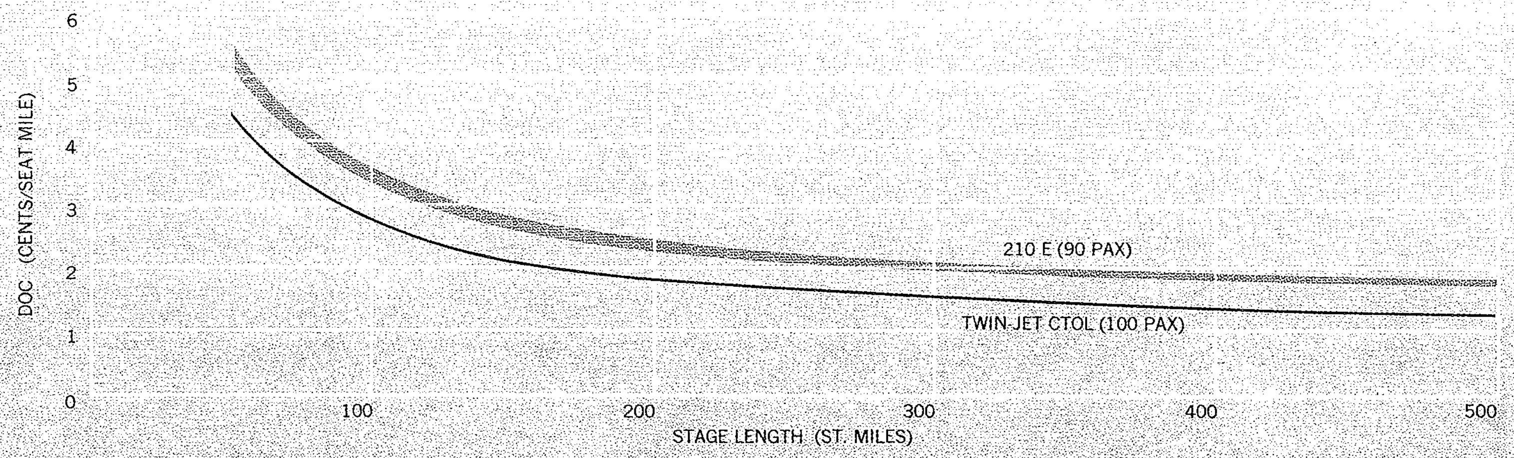
	210E	CTOL
Study Price Range (Million $)	5.5–6.6	5.0
Utilization (Blk. Hrs/Yr)	2,500	2,500
Takeoff Gross Weight (Lbs.)	72,854	108,000
Number in Flight Crew	2	2
Number of Engines	4	2
Depreciation Period (Yrs)	12	12
Residual Value (%)	5	5
Initial Spares and GSE (% of Study Price)	15	13
Insurance Rate (%)	1	1
Maintenance Labor Rate ($/Hr)	5.69	5.69
Maintenance Burden (% of Direct Labor Cost)	83	90
Seats	90	100
Fixed Time in Profile (Min.)	7.5	7.5

210E DIRECT OPERATING COSTS



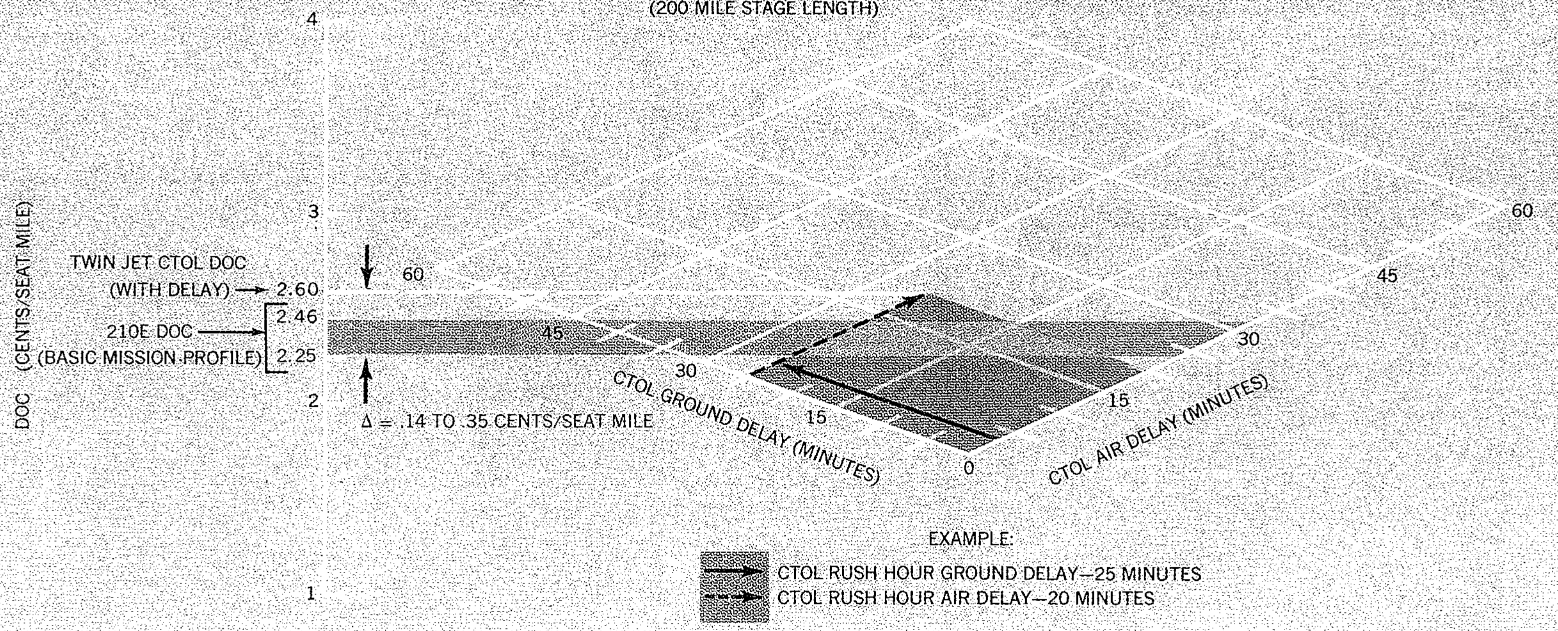
210E / TWIN JET COST COMPARISONS

DOC COMPARISON



COST OF DELAYS

(200 MILE STAGE LENGTH)

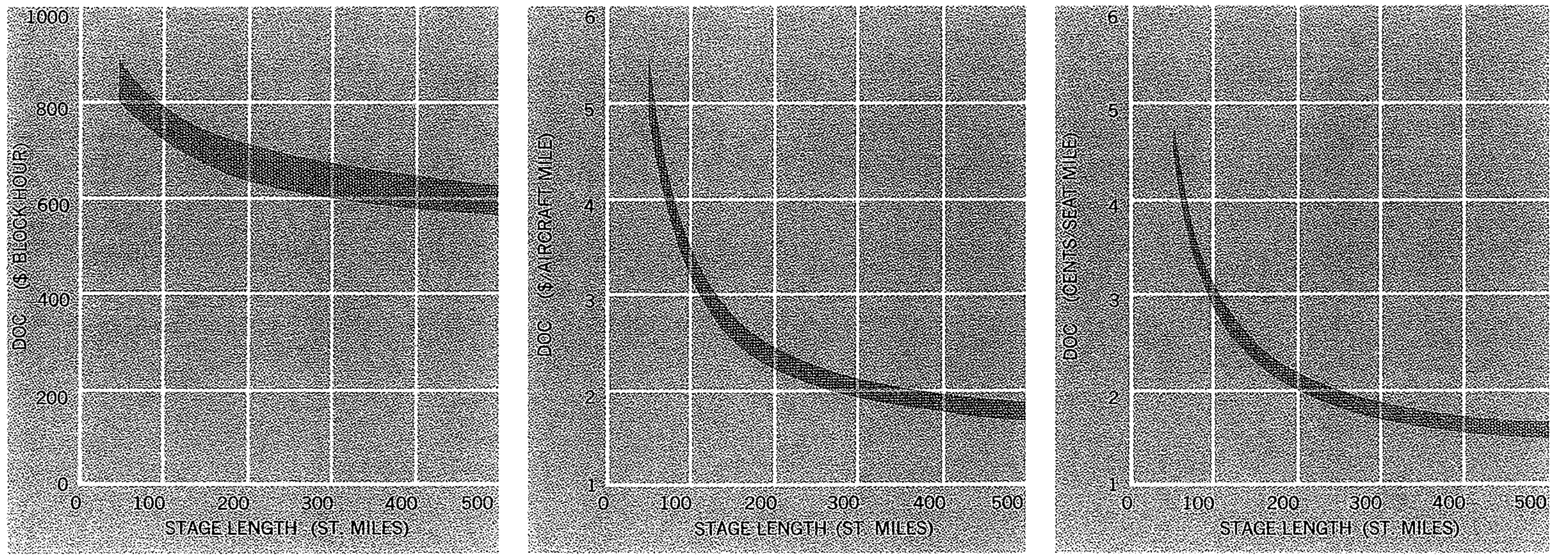


COSTING ASSUMPTIONS

(1967 ATA METHOD MODIFIED-1973 ECONOMICS)

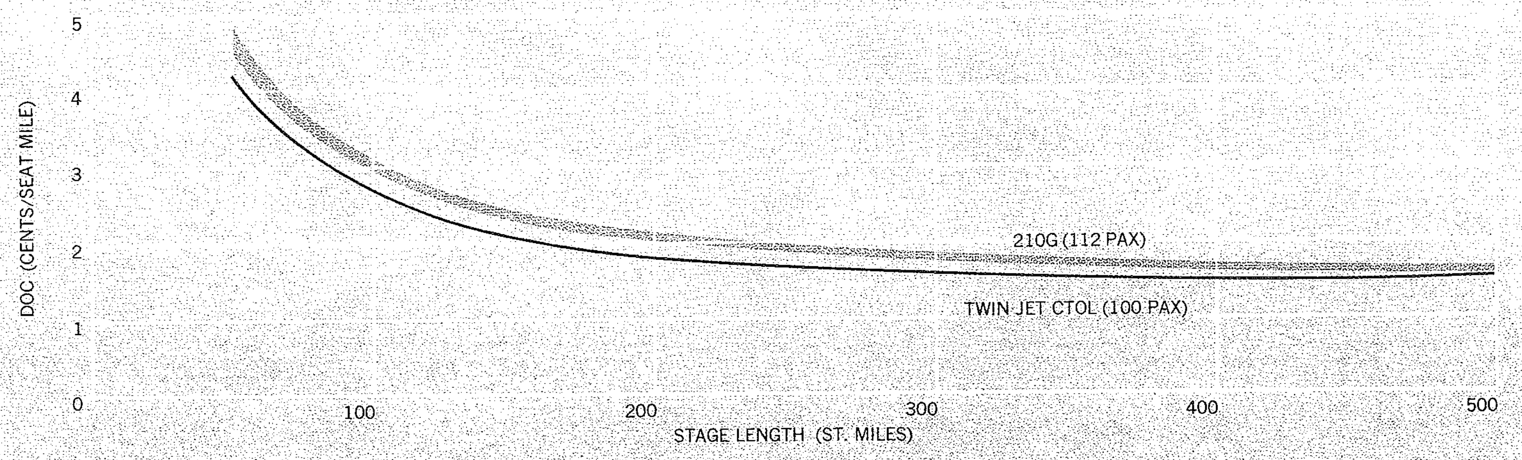
	210G	CTOL
Study Price Range (Million $)	6.0–7.2	5.0
Utilization (Blk. Hrs/Yr/A/C)	2,500	2,500
Takeoff Gross Weight (Lbs.)	84,500	108,000
Number in Flight Crew	2	2
Number of Engines	4	2
Depreciation Period (Yrs)	12	12
Residual Value (%)	5	5
Initial Spares and GSE (% of Study Price)	15	13
Insurance Rate (%)	1	1
Labor Rate ($ Man-hour)	5.69	5.69
Maintenance Burden (% of Direct Labor Cost)	87	90
Seats	112	100
Fixed Time in Profile (Min.)	7.5	7.5

210G DIRECT OPERATING COSTS



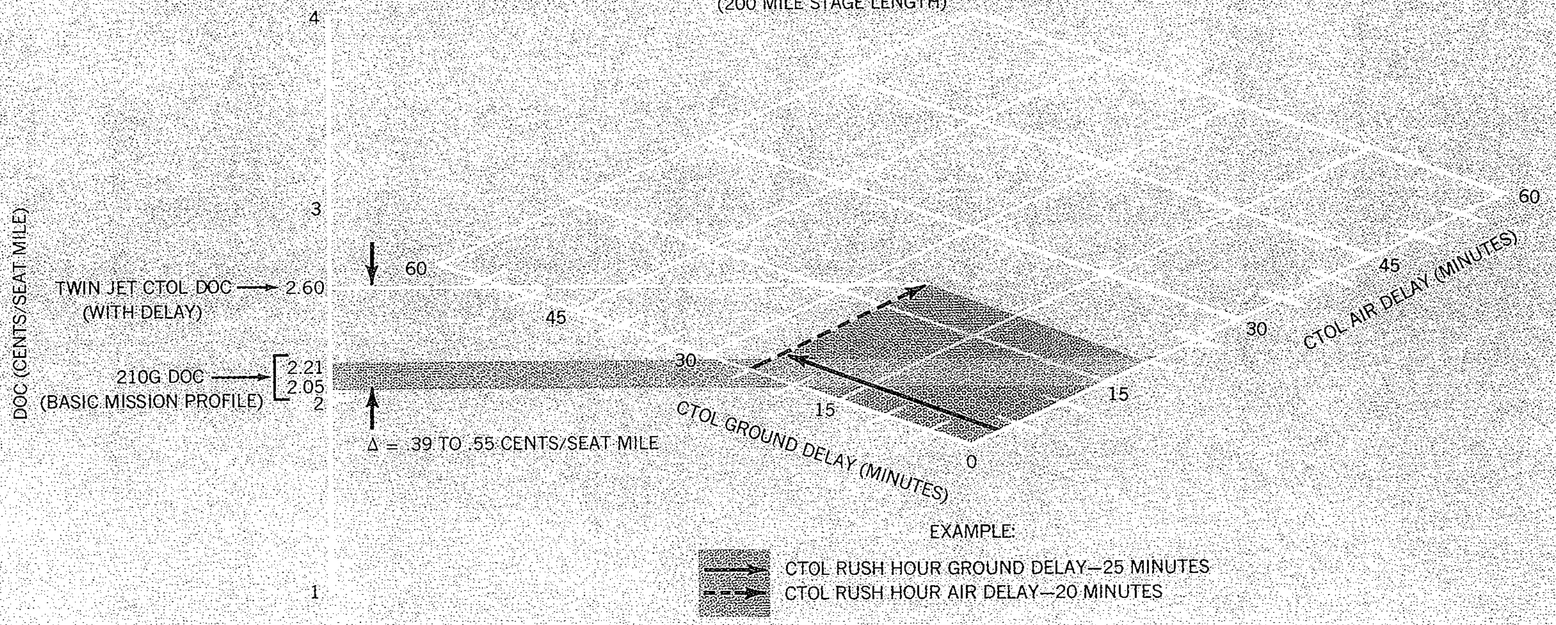
210G / TWIN JET COST COMPARISONS

DOC COMPARISON



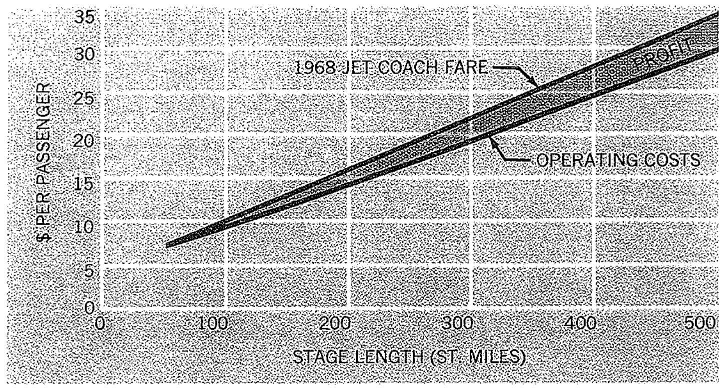
COST OF DELAYS

(200 MILE STAGE LENGTH)

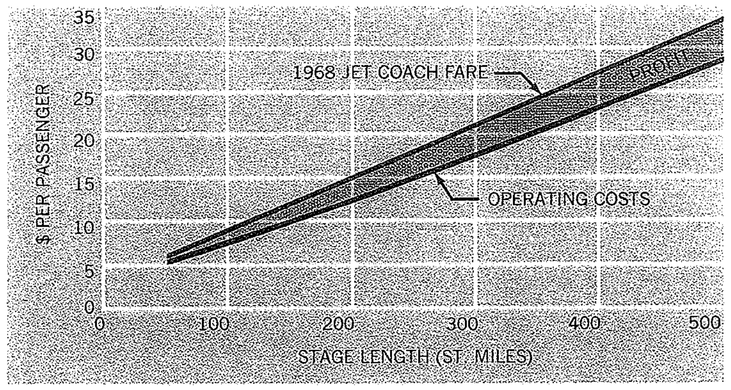


210 PROFITABILITY

210E OPERATING COST AND FARE
(60% LOAD FACTOR)

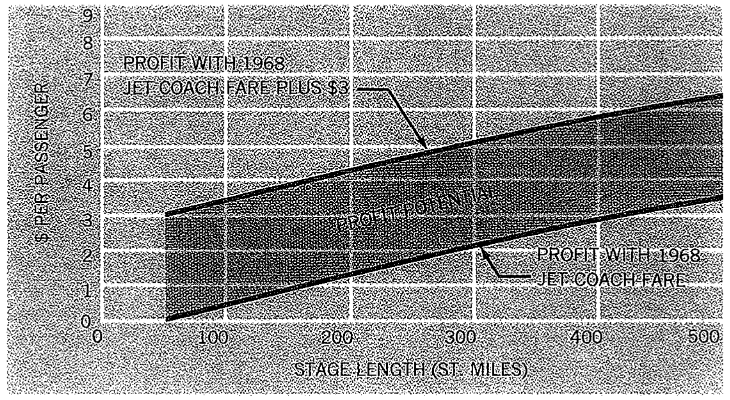


210G OPERATING COST AND FARE
(60% LOAD FACTOR)

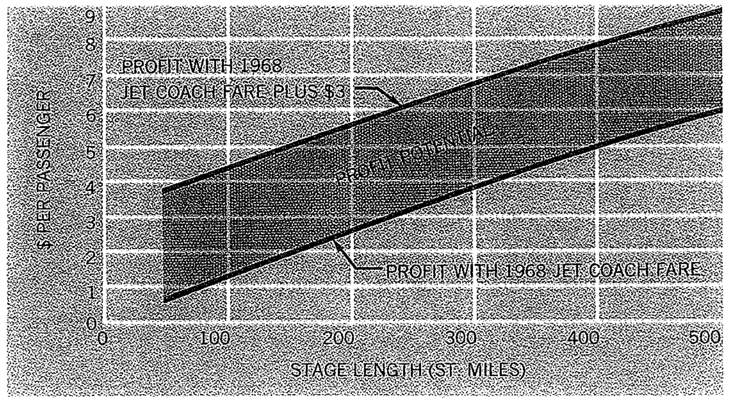


Operating costs (DOC and IOC) have been computed for the indicated stage lengths on a per passenger basis - assuming an average 60% load factor. Midpoint study prices were selected for DOC computations. Indirect operating costs (IOC) were computed on the basis of 1966 CAB statistics assuming that STOL indirect costs will, at given load factors, be equal to the indirect costs currently experienced by the airlines. These charts show that the 210 can be profitable in *1973* with the *1968* jet coach fare structure.

210E PROFIT POTENTIAL
(60% LOAD FACTOR)



210G PROFIT POTENTIAL
(60% LOAD FACTOR)



McDonnell Douglas studies show that a moderate fare surcharge can be used for routes on which STOL service reduces ground transportation time and costs - and the surcharge could be no more than the ground transportation cost savings (up to three dollars per passenger). Profit per passenger for the STOL operator will then fall in the profit regions indicated - with total trip costs for the passenger which are less than or equal to the total costs presently incurred using conventional travel modes. It may also be appropriate to charge a STOL fare premium on the basis of the convenience and travel time saving offered on each STOL route.

A NEW ENVIRONMENT

The introduction of STOL transportation networks will result in a new operational environment - both in the air and on the ground. New airspace will be opened up with direct routing by advanced precision navigation and terminal guidance equipment - permitting the use of exclusive airways to connect STOL sites, while providing independent STOL terminal operations which do not interfere with conventional traffic. New operating sites on the ground will expand the use of limited real estate at existing airports - and for the first time in aviation history, make direct, high volume air service from metropolitan locations both *technically* and *economically* feasible.

Contemporary avionics technology has produced integrated navigation, guidance and control equipment which can free the 210 STOL from a long straight-in approach and permit an order of magnitude increase in airspace utilization. Enroute, these advanced systems eliminate circuitous airways routing and reduce communications and navigation workload for cockpit crews and air traffic controllers. In the terminal area, on-board equipment can be programmed to provide precision straight-in or curved path approach and landing to any point on an airport—without depending upon highly sophisticated ground based instrument landing systems. The 210 STOL is particularly suited for these kinds of operations due to:
(1) A slow speed steep gradient approach
(2) A slow speed steep gradient climb-out
(3) A high degree of maneuverability at slow speeds with precision control
(4) The ability to operate from very small airstrips
(5) The safety inherent in slow speed takeoff and landing energy levels
These characteristics will also allow the 210 to readily receive Category II and Category III instrument landing capabilities - as advanced systems are introduced into service.

The McDonnell Douglas 210 is compatible with this new STOL environment - and with its special operating capabilities, it can adapt to the changing environmental requirements of future air transportation systems.

EXISTING STOL SITES

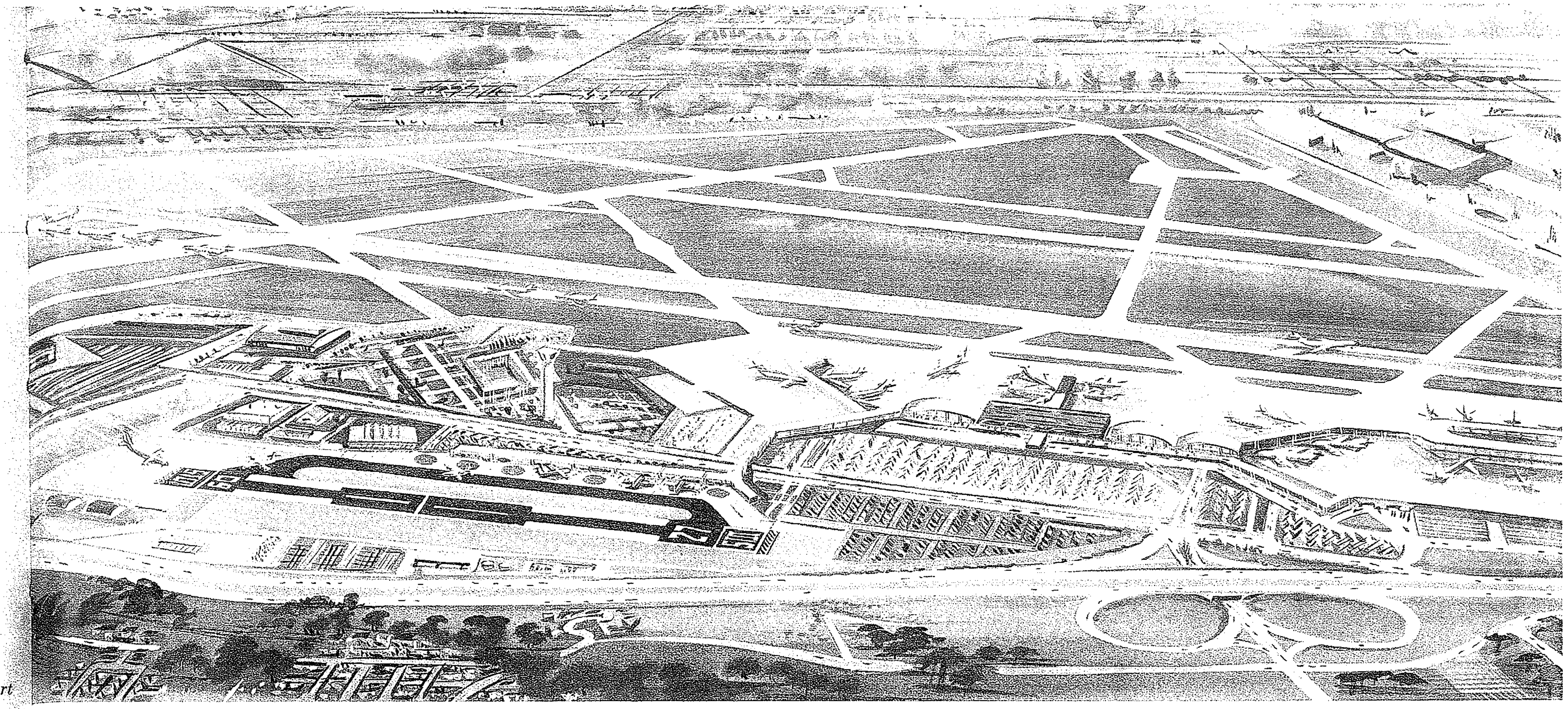
There are many aviation facilities in operation which can easily accommodate STOL traffic.

Most major airports have unused taxiways, runways or vacant spots of land, which could be used for STOL operations—independent of conventional operations. Los Angeles International, LaGuardia and Washington National have separate STOL strips which are now handling STOL traffic—increasing the aircraft movements at these hub airports. The addition of STOL terminal facilities near STOL strips will add passenger convenience, relieve crowded terminal conditions and improve the passenger handling capacity of major airports—at modest facilities improvement costs.

STOL site at major airport

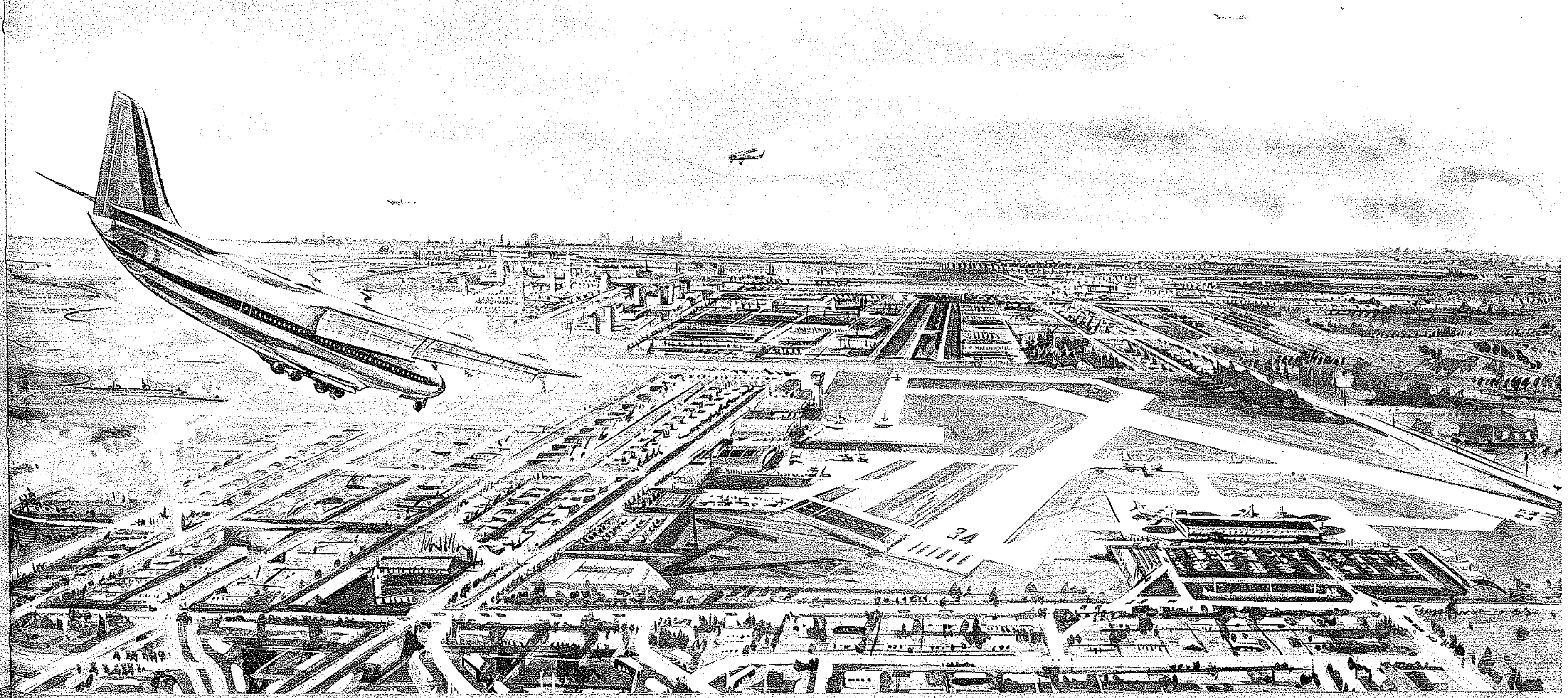
Small "close-in" airport

There are also many small "close-in" airports at large cities which have become outdated for jet operations. With the short takeoff and landing capabilities and low operating noise levels of the 210, these facilities could be opened to high volume short haul service. Due to their close proximity to city-center, substantial ground travel savings could be enjoyed. Chicago, Detroit, Hartford, San Francisco and Miami are several examples of major U. S. cities which could be served with STOL service from existing small "close-in" airports. Again, separate STOL terminal facilities could improve substantially the passenger handling capacity of these airports.



STOL site at major airport

Small "close-in" airport



STOLPORT DESIGNS

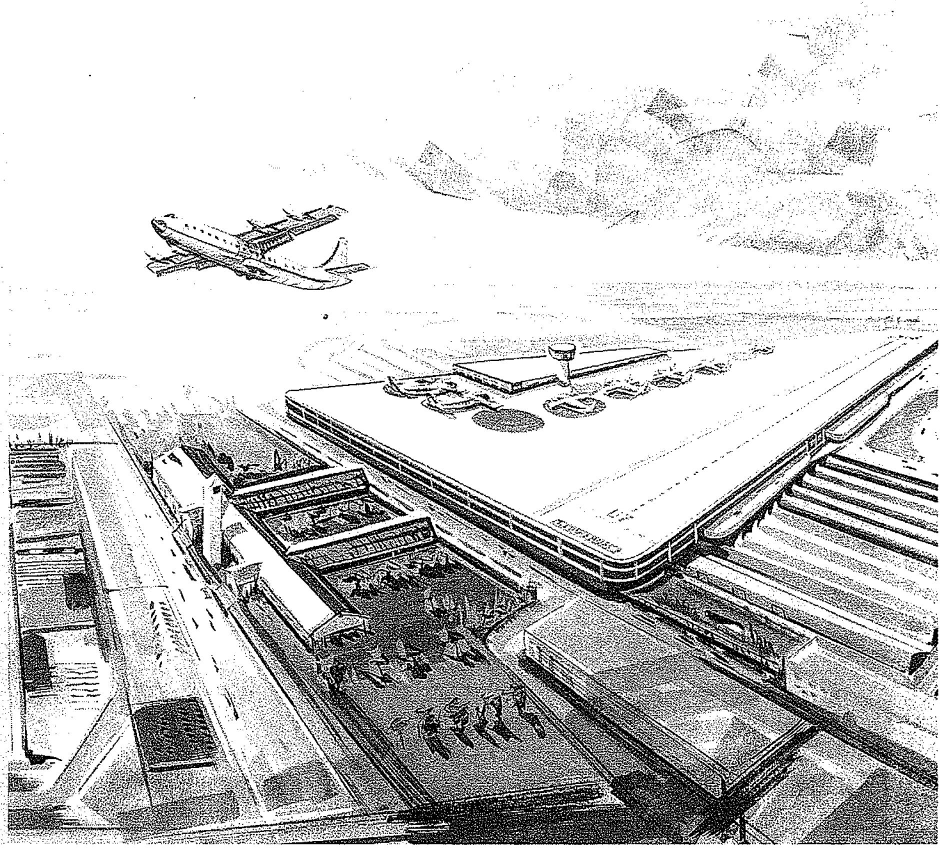
The STOL concept envisages the construction of metropolitan STOLports—facilities especially designed to handle high volume air traffic.

A 1500 foot field length dictates very modest real estate requirements for STOLport facilities. At the same time, however, studies of terminal requirements for major cities point out that the size of the terminals and site areas are not determined by the 1500 foot field length, but rather are derived as a function of (1) the number of gates, (2) the number of passengers to be processed, (3) the automobile parking spaces to be provided, and (4) other service spaces required of all modern passenger terminals.

McDonnell Douglas studies indicate that STOLport investment and operating costs are a minor part of the costs of operating a total STOL system. A large portion of terminal investment and operating costs can be provided by automobile parking and other concession revenues—which means that indirect operating cost increments for use of STOL facilities should be minimal.

METROPORT DESIGN

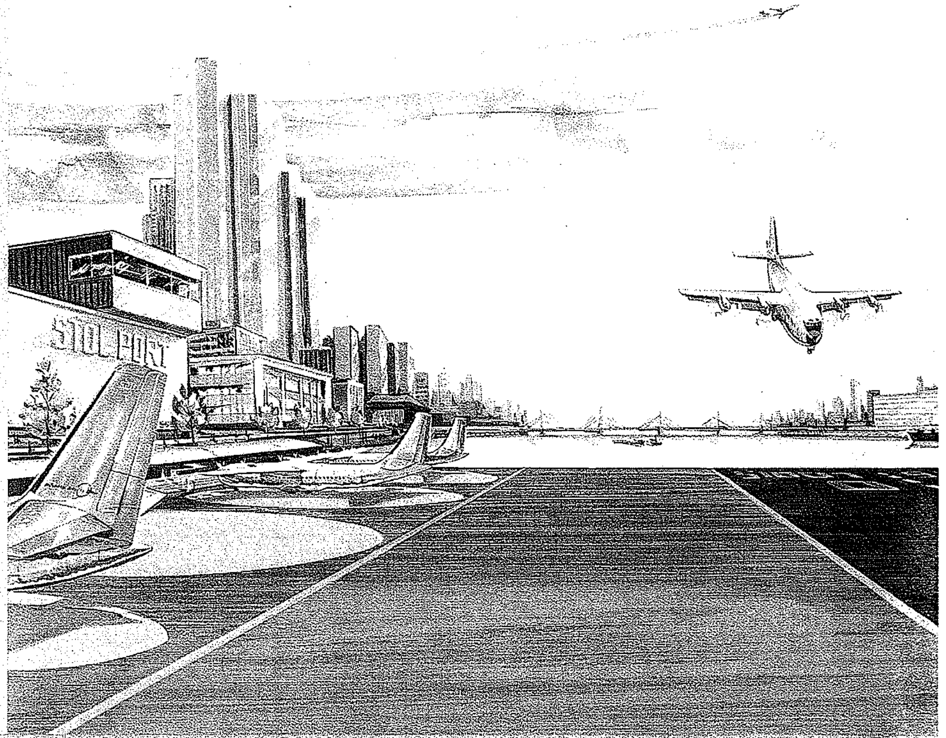
Downtown metroports which integrate various transportation modes (air, bus, rail, and automobile) are under consideration in several communities. One advanced design is a facility recently proposed for the downtown Union Station location in Los Angeles. This design provides approach and departure routes over industrial areas, rail yards, and freeways—to reduce community sound levels and avoid flight path obstacles.



Courtesy of City of Los Angeles—Department of Airports

WATERFRONT DESIGN

Many large U. S. cities have waterfront areas near the city-center. STOLports could be built at these locations which would allow clear approach and departure routes over the water, eliminating the noise problem and enhancing the safety of flight operations.



SOUND LEVELS

Aircraft sound levels are of utmost concern in planning for city center operations.

Several *technical* and *operational* features of the 210 STOL Transport make possible low ground level noise in areas surrounding STOL terminals:

Technical

(1) Use of propellers—lowering thrust energy levels for lift, climb, and slow speed flight.
(2) Low propeller tip speeds.
(3) Low compressor and turbine noise levels.

Operational

(1) Steep gradient climb and approach capability.
(2) Short radius turns provided by slow speed maneuverability.

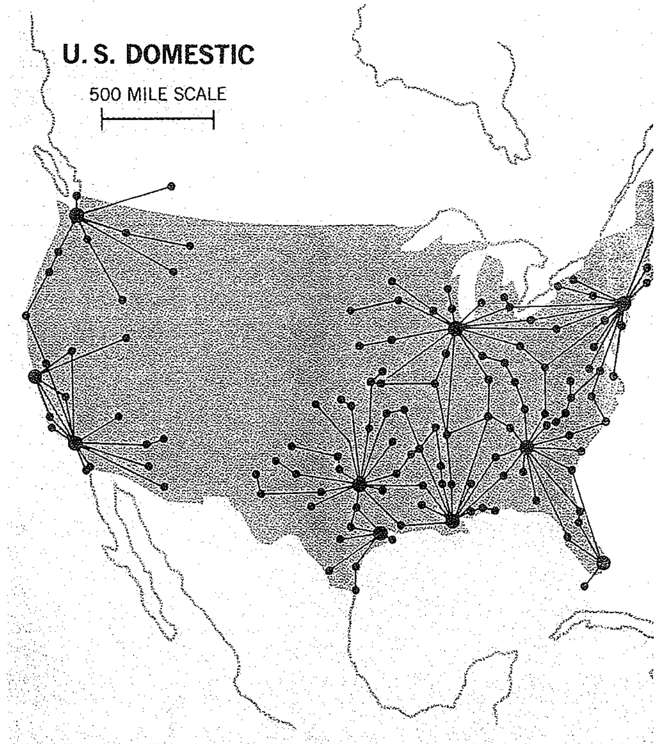
The flexibility of approach path and rapid climb descent enable the 210 to avoid noise sensitive areas and reduce the ground level time exposure to aircraft operating noise. In comparison, the climb and approach of conventional jets expose a much larger ground area to their higher operating noise levels—for a longer period of time.

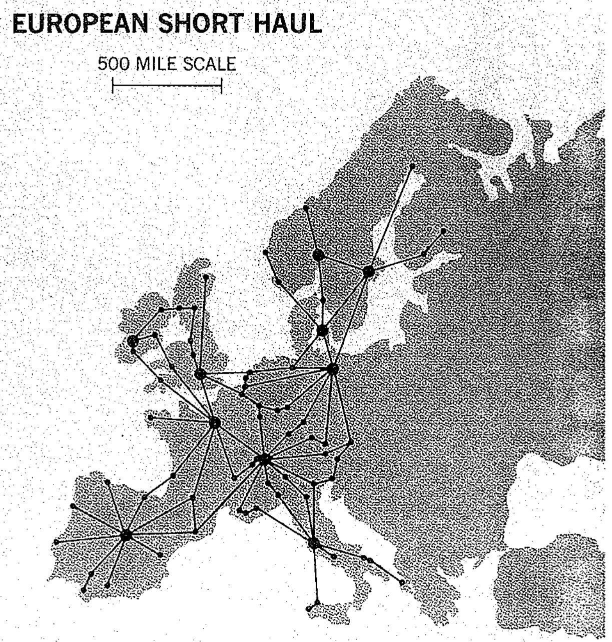
INTERURBAN TRAVEL

The need for improved air service is increasingly apparent in high density short haul operations—particularly in the concentrated air "corridors" which connect our large urban areas. The "hub" nature of U. S. air traffic is revealed by recent CAB statistics which report that the top U. S. cities generate over one half of the total domestic traffic —and approximately one half of this "hub" traffic is short haul (less than 500 miles).

In Europe and certain Asian areas the need for improved short haul air service is also detected—since there are substantial numbers of large cities separated by short distances. In Europe alone, there are nearly three times as many city pairs with a population of over 250,000, and less than 500 miles apart, as there are in the U. S.

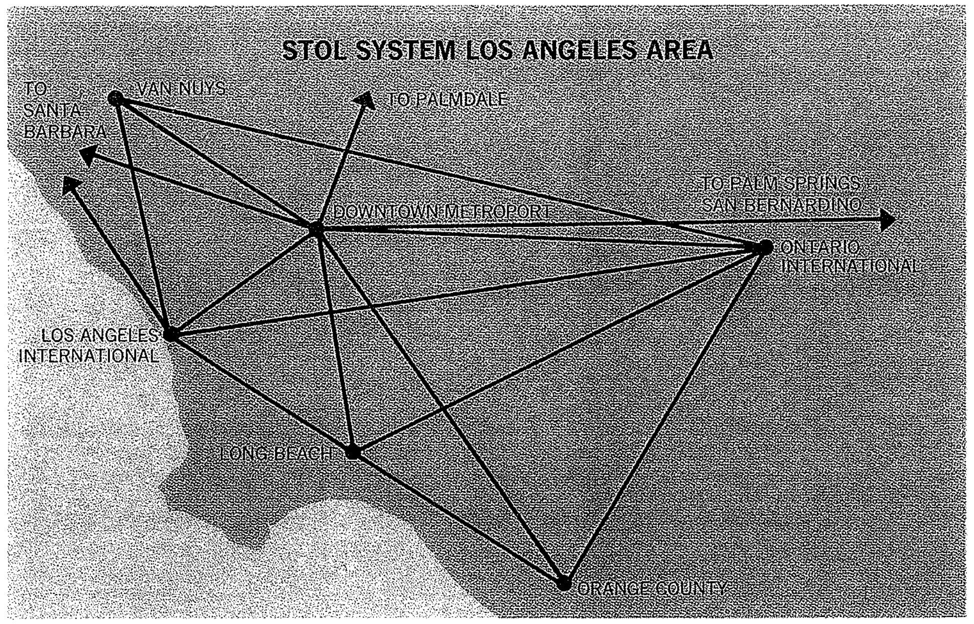
These short haul travel markets represent a large potential for airline operators. Studies show that STOL systems employing the McDonnell Douglas 210 STOL can enjoy very high penetration of high density markets with the construction of STOLports in a few selected hub cities. STOL service will provide improved travel convenience and time savings for short haul interurban passengers and will relieve air traffic at major airports by funneling the bulk of short haul traffic into STOL operating sites.





INTRAURBAN AND FEEDER SERVICE

As large urban areas continue to grow, there is a need to decentralize air terminal locations in order to reduce costly surface transportation time and improve passenger convenience. The 210 STOL Transport makes it possible to offer connections between small outlying airports, downtown metroports, other STOLports and major airports—all located in the same general metropolitan area. Intraurban and feeder connections can be employed economically as a continuous operation using 210 STOL aircraft—or they could be provided as an additional leg at one end of a longer STOL route. A typical intraurban/feeder STOL network is illustrated for the Los Angeles area.

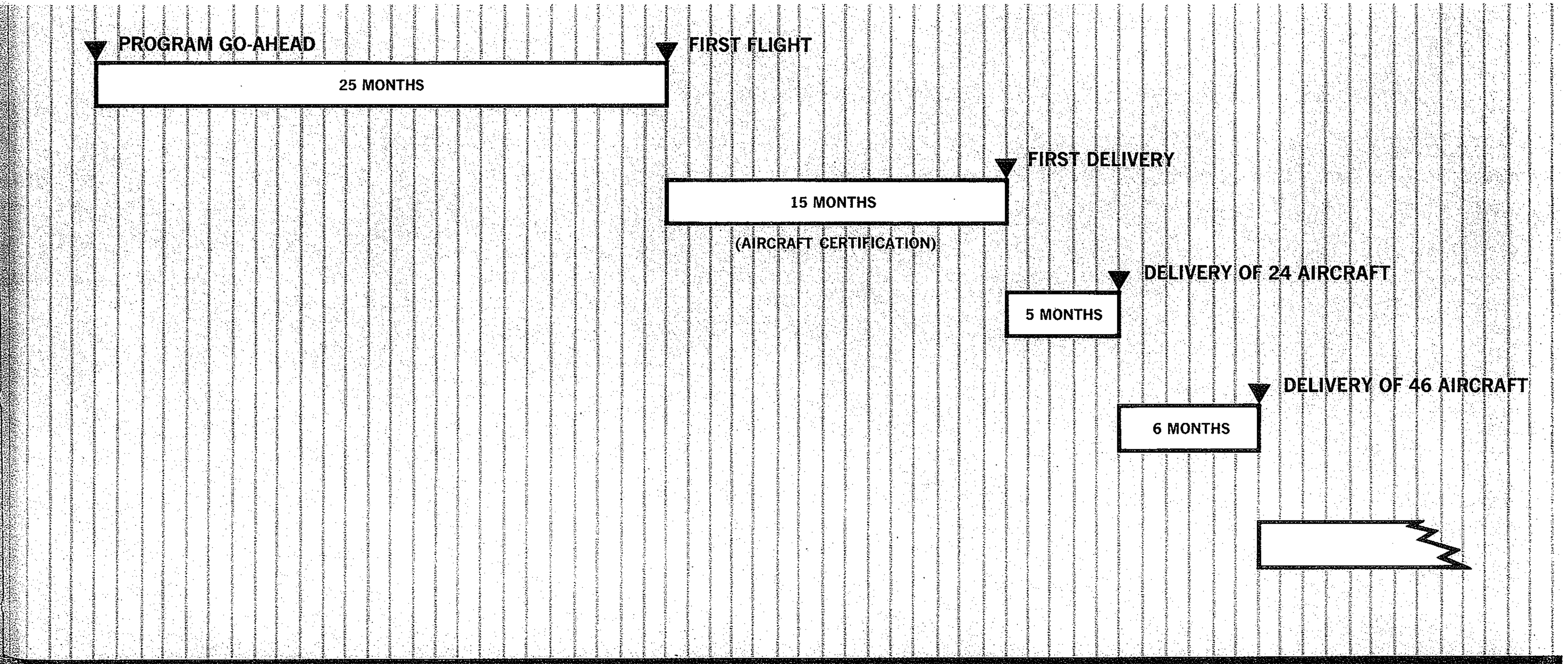


CONVENTIONAL OPERATIONS

The 210 STOL can also operate as a conventional aircraft where airfield or other terminal conditions are not established to take advantage of STOL characteristics. Smaller airports where traffic is not yet congested can accept the 210 with no special preparations.

210 PROGRAM MILESTONES

Final configuration definition for the 210 STOL Transport is progressing rapidly at McDonnell Douglas. Airline deliveries could begin in the early '70s. Airport saturation and other operating problems are calling for immediate solutions—the time frame for action is *now.*




McDONNELL DOUGLAS
210

210E CHARACTERISTICS SUMMARY

90 Passengers

Weights

Manufacturer's Weight Empty	43,750 lbs.
Operator's Weight Empty	44,794 lbs.
Maximum Payload	18,860 lbs.
Maximum Zero Fuel Weight	63,654 lbs.
Fuel Capacity (1,664 U.S. gals.)	11,149 lbs.
Maximum Gross Weight (takeoff/landing)	72,854 lbs.

Dimensions

Overall Length	100.63 ft.
Wing Span	89.8 ft.
Tail Height	34.9 ft.
Fuselage Outside Diameter	150 in.
Wing Area	1240 sq. ft.
Propeller Diameter	15.625 ft.
Cabin Length	56.92 ft.

Under Floor Cargo Volume	530 cu. ft.

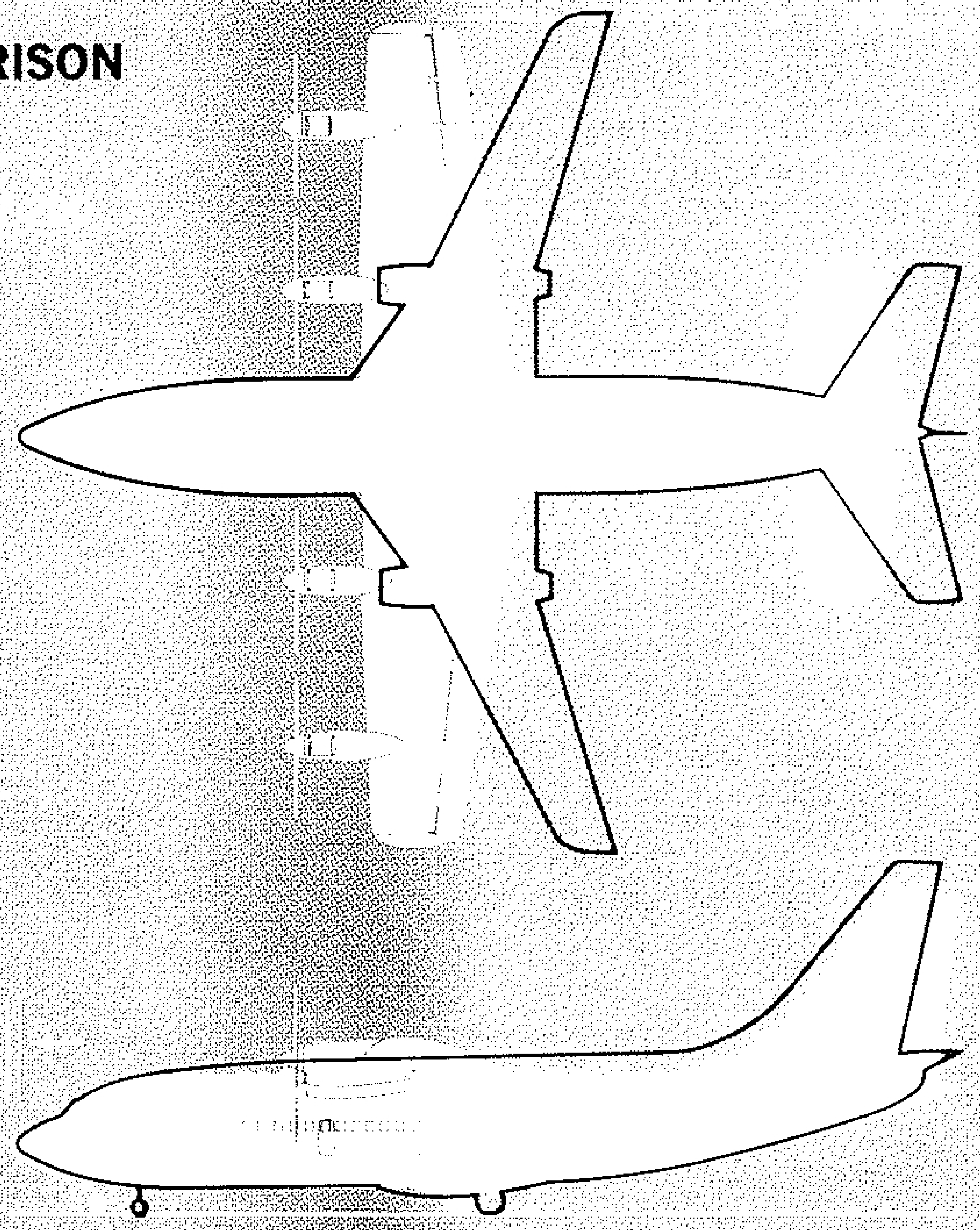
Economics

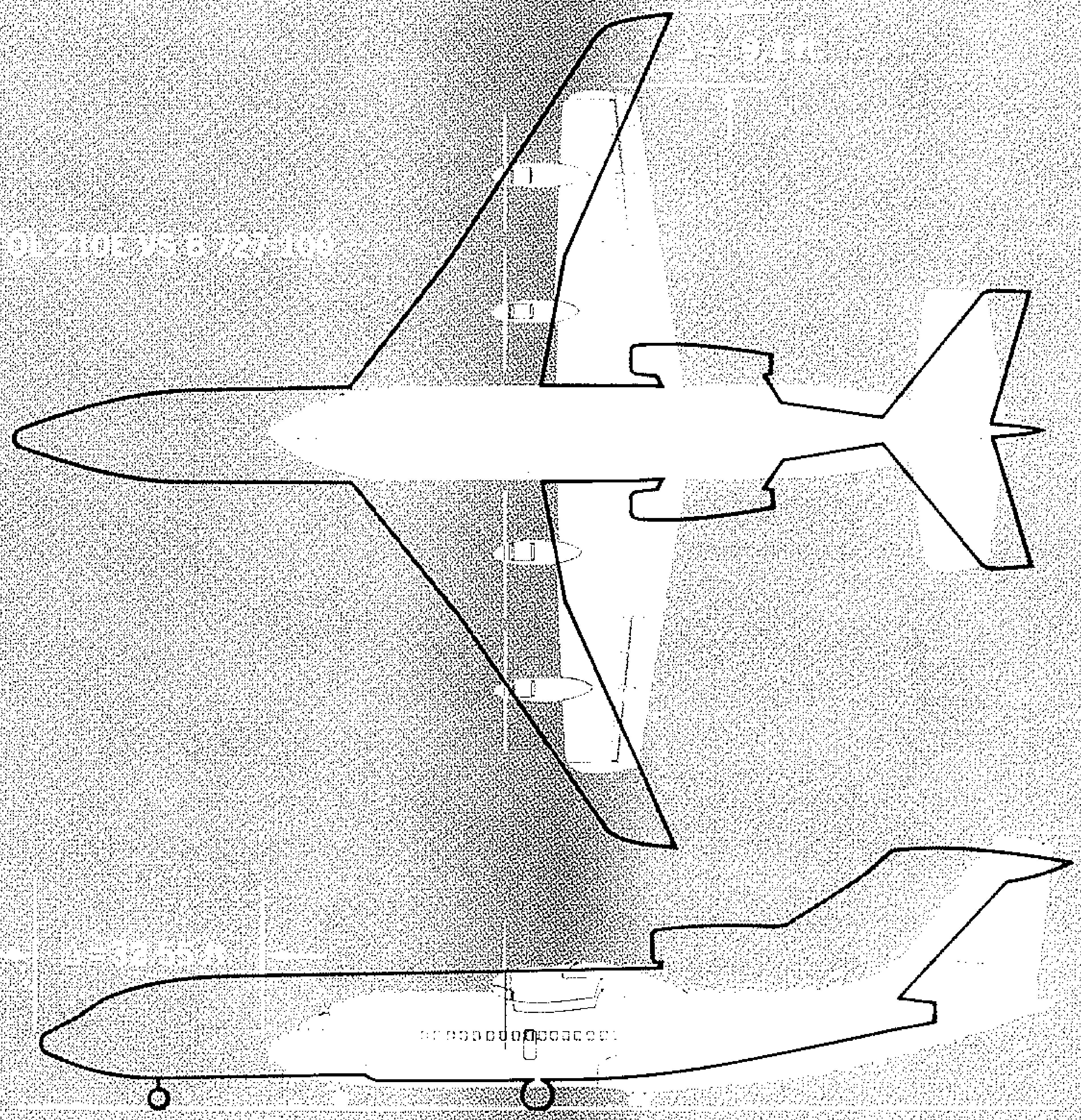
Direct Operating Cost (cents/seat mile) 200 mile stage length	2.25 to 2.46

Performance

Takeoff Field Length (to 35 ft.)	1160 ft.
Cruise Speed (normal cruise power)	348 knots
Range (@ 20,000 ft.)	600 n.m.
Approach Speed	62-72 knots
Landing Field Length (from 50 ft.)	1440 ft.
Engine Power Rating (takeoff)	3300 ESHP each

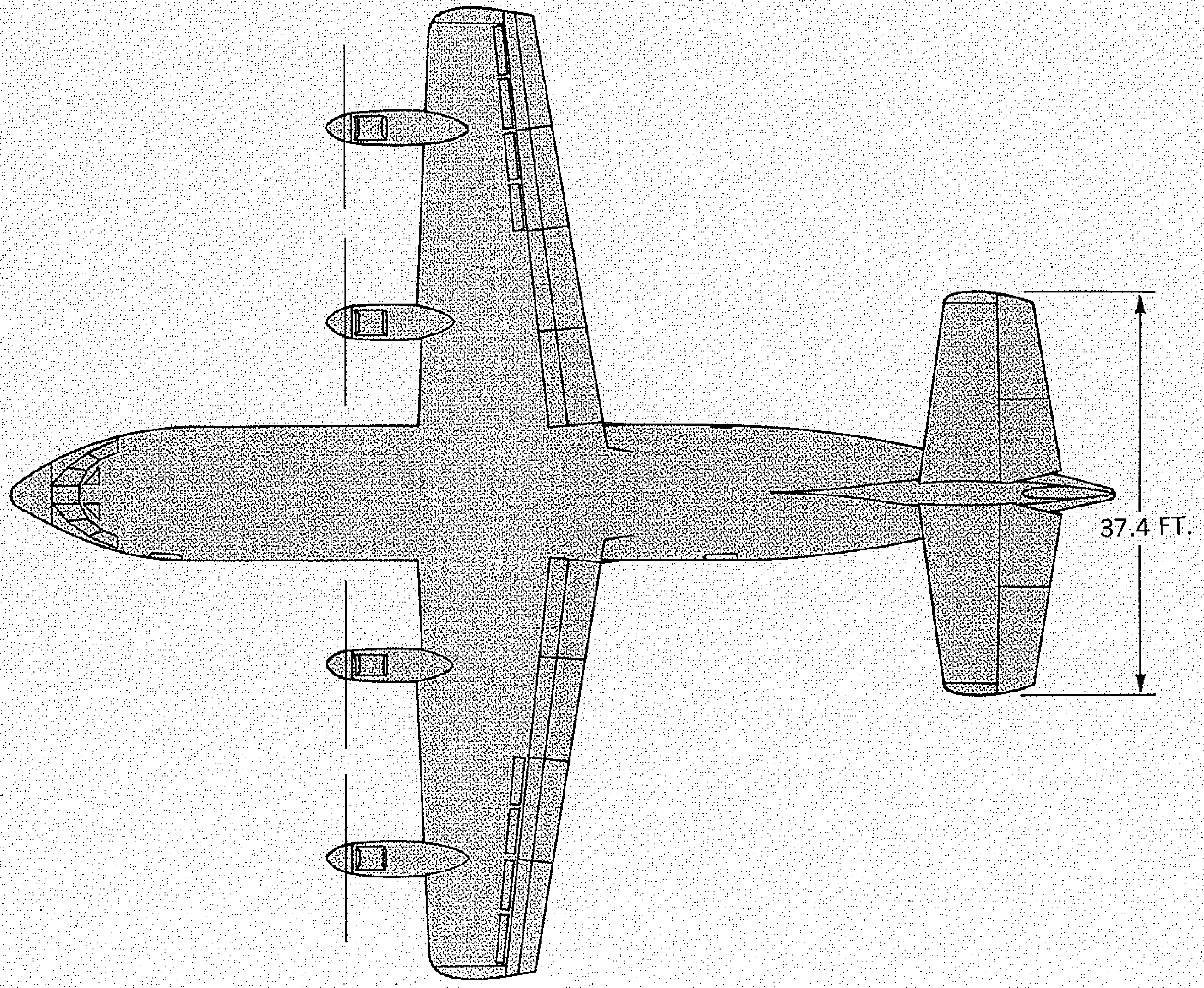
SIZE COMPARISON

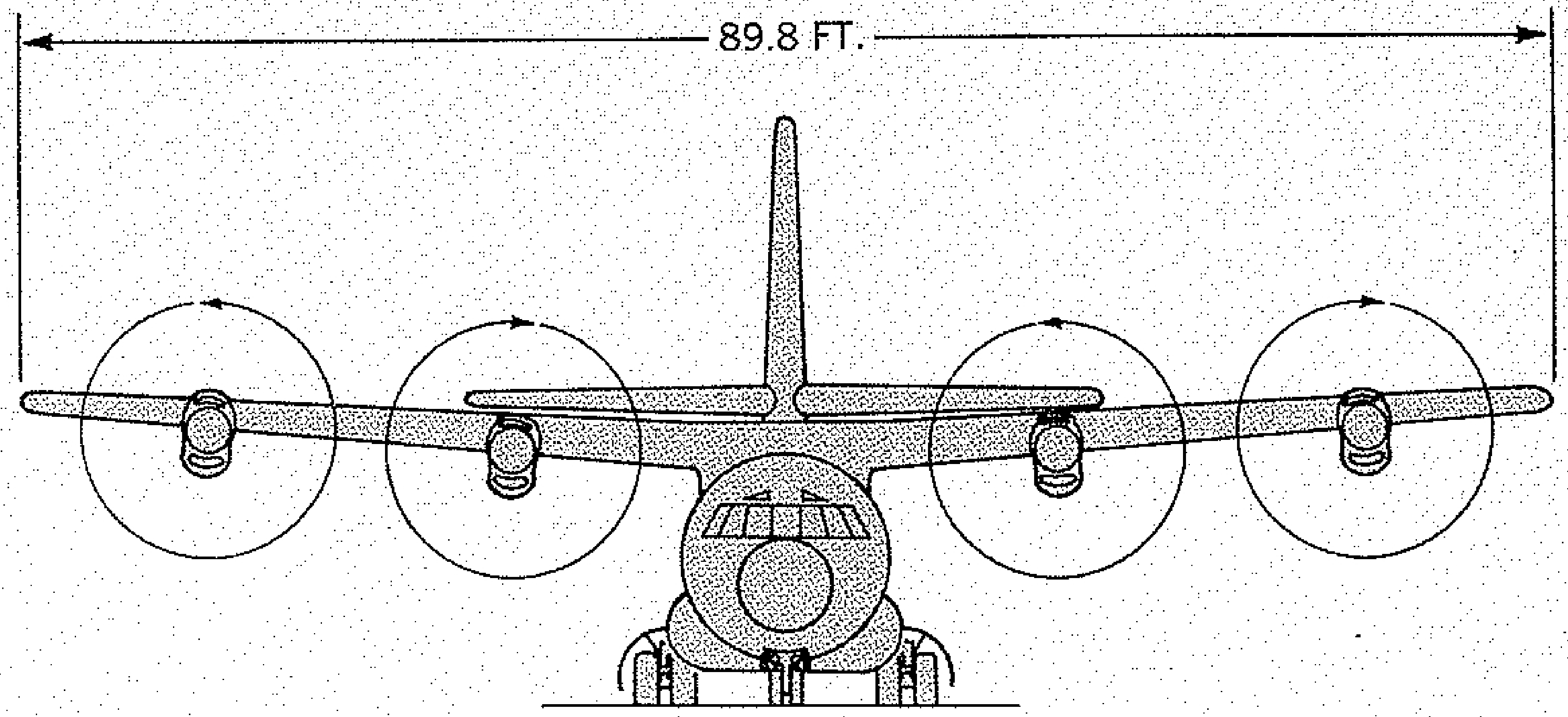


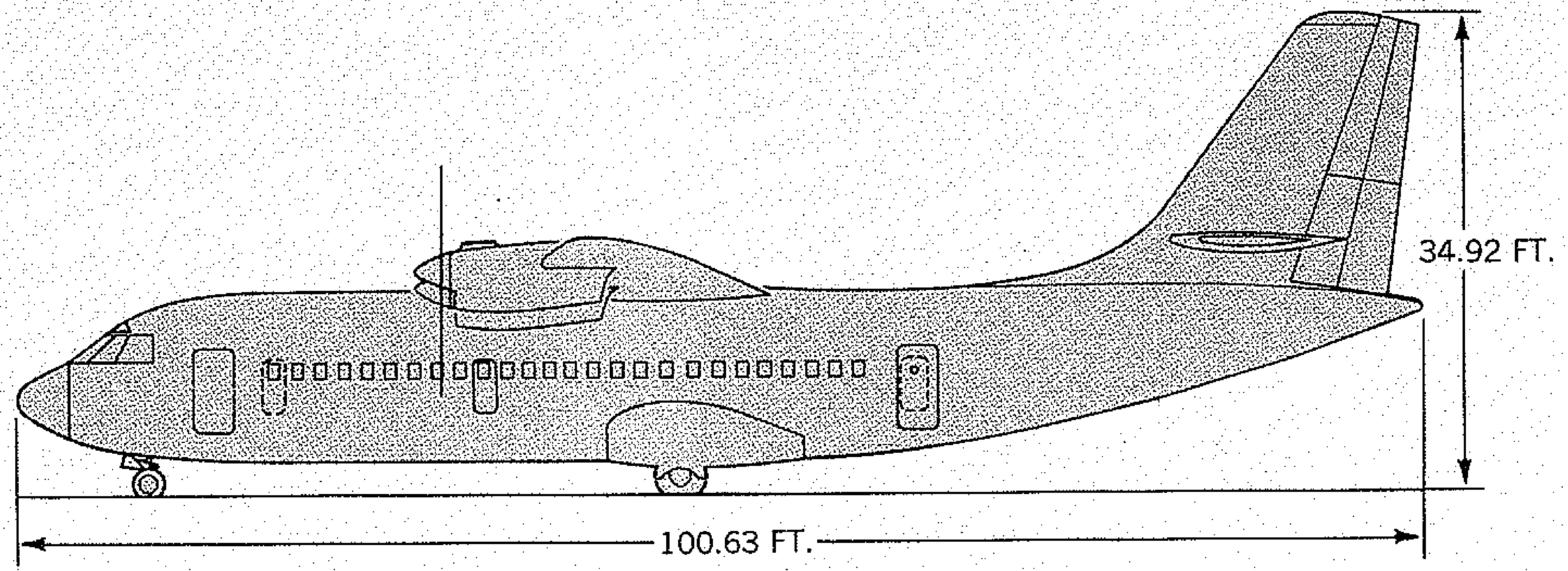


210E GENERAL ARRANGEMENT

Propeller Diameter	15.625 ft.
Fuselage Outside Diameter	150 in.
Cabin Floor to Ground Distance	6.0 ft.
Engines	Free Turbine Turboshaft
Aspect Ratio	6.5
Under Floor Cargo Volume	530 cu. ft.
Wing Area	1240 sq. ft.
Tail Area:	
Vertical	283 sq. ft.
Horizontal	400 sq. ft.







210G CHARACTERISTICS SUMMARY

112 Passengers

Weights

Manufacturer's Weight Empty	51,081 lbs.
Operator's Weight Empty	52,260 lbs.
Maximum Payload	23,040 lbs.
Maximum Zero Fuel Weight	75,300 lbs.
Fuel Capacity (1,567 U.S. gals.)	10,500 lbs.
Maximum Gross Weight (takeoff/landing)	84,500 lbs.

Dimensions

Overall Length	118.8 ft.
Wing Span	97.7 ft.
Tail Height	35.9 ft.
Fuselage Outside Diameter	165 in.
Wing Area	1520 sq. ft.
Propeller Diameter	15.625 ft.
Cabin Length	71.5 ft.
Under Floor Cargo Volume	830 cu. ft.

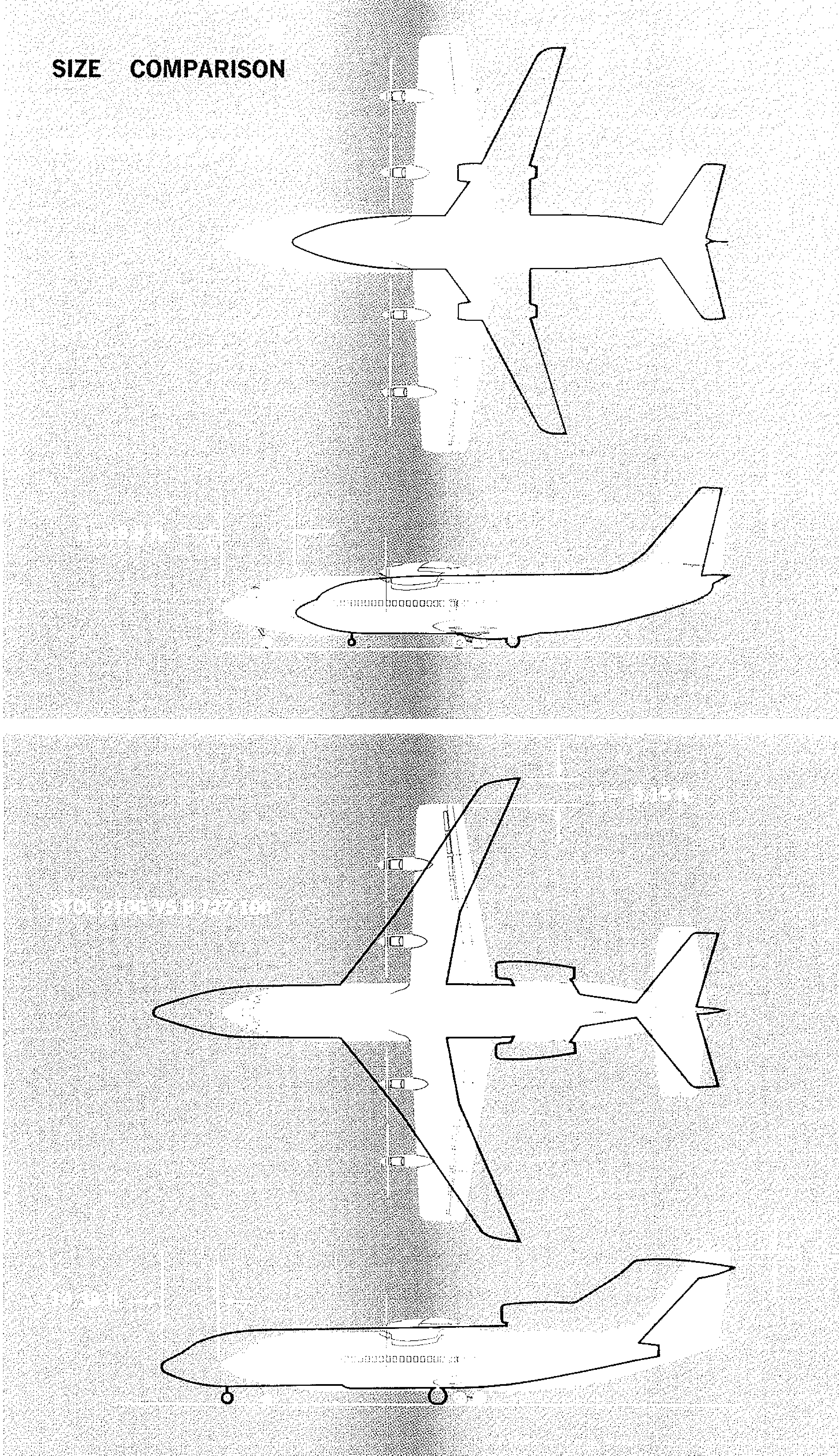
Economics

Direct Operating Cost (cents/seat mile)	
200 mile stage length	2.05 to 2.21

Performance

Takeoff Field Length (to 35 ft.)	1380 ft.
Cruise Speed (normal cruise power)	323 knots
Range (@ 20,000 ft.)	565 n.m.
Approach Speed	58-72 knots
Landing Field Length (from 50 ft.)	1410 ft.
Engine Power Rating (takeoff)	3300 ESHP each

SIZE COMPARISON



210G GENERAL ARRANGEMENT

Propeller Diameter	15.625 ft.
Fuselage Outside Diameter	165 in.
Cabin Floor to Ground Distance	7.29 ft.
Engines	Free Turbine Turboshaft
Aspect Ratio	6.27 ft.
Under Floor Cargo Volume	830 cu. ft.
Wing Area	1520 sq. ft.
Tail Area:	
Vertical	323.5 sq. ft.
Horizontal	456.3 sq. ft.