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THE COST OF NOISE REDUCTION IN COMMERCIAL TILT ROTOR AIRCRAFT

Henry B. Faulkner

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MIT

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Abstract

The relationship between direct operating cost and departure noise annoyance was developed for commercial tilt rotor aircraft. This was accomplished by generating a series of tilt rotor aircraft designs to meet various noise goals at minimum DOC. These vehicles were spaced across the spectrum of possible noise levels from completely unconstrained to the quietest vehicle that could be designed within the study ground rules. A group of optimization parameters were varied to find the minimum DOC while other inputs were held constant and some external constraints were met. This basic variation was then extended to different aircraft sizes and technology time frames. It was concluded that reducing noise annoyance by designing for lower rotor tip speeds is a very promising avenue for future research and development. It appears that the cost of halving the annoyance compared to an unconstrained design is insignificant and the cost of halving the annoyance again is small.

Acknowledgements

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1.0 Introduction

The tilt rotor VTOL aircraft configuration is a serious contender for a significant role in intercity public transportation in the future, particularly in densely populated regions. Like other rotary wing aircraft types, the tilt rotor is inherently relatively quiet due to its low disc loading and low flow velocities in and around the propulsion device. However, commercial rotary wing aircraft may have to be quieter in the future to achieve community acceptance. This is particularly true in the case of intercity service which would involve large vehicles and high frequency of operations at some terminals. Because of the small size of the vertiport, the aircraft operations are closer to the surrounding non-user population. Furthermore, it may be necessary for economic reasons to locate terminals in areas having a relatively low background noise level, such as residential areas.

In order to assess the potential of tilt rotor aircraft as a viable part of the intercity transportation system, it is necessary to know what degree of noise reduction can reasonably be expected in the future. In other words, the relationship between noise reduction and cost increases must be known. There are two methods of reducing the noise exposure due to aircraft operations, changes in flight profile and changes in design. The aircraft trajectory can be moved further from the listeners, the amount of noise generated can be reduced by

reducing thrust, or the speed can be increased in order to reduce noise exposure. This method of noise reduction is explored for VTOL aircraft in references 1 and 2. This method does not generally have a significant impact on direct operating cost (DOC). The second method is to change the design of the aircraft to reduce the noise generated at a given distance, thrust level, and speed. This is the method considered here.

Design changes for noise reduction in tilt rotor aircraft are discussed in Ref. 3 in considerable depth. Design changes in a 12,000 lb gross weight aircraft were considered there, both from the military point of view (to reduce aural detectability) and the commercial point of view (to reduce noise annoyance). It was found that reduction of the rotor tip speed used in the helicopter mode and conversion is the most effective means of reducing noise annoyance. Other design changes which were considered include variations in number of blades, blade tip shape, blade planform, blade airfoil section, blade twist, and blade spacing. It was found that dramatic noise reductions cannot be accomplished with these changes. It appears that they would also not generally result in a dramatic change in DOC. Therefore these types of changes were neglected in the work reported here.

The object of this study was to develop the relationship between direct operating cost and departure noise annoyance for tilt rotor aircraft. This was accomplished by generating a series of tilt rotor aircraft designs to meet various noise

goals at minimum DOC. These vehicles were spaced across the spectrum of possible noise levels from completely unconstrained to the quietest vehicle that could be designed within the study ground rules. A group of optimization parameters were varied to find the minimum DOC, while other inputs were held constant and some external constraints were met. This basic variation was then extended to different aircraft sizes and technology time frames. This study is analogous to the one conducted previously by the Flight Transportation Laboratory for helicopters (Ref. 4). However, unlike the helicopter work, this study used a single measure for evaluating total community annoyance due to a departure operation.

2.0 Design Procedure

In this study a large number of tilt rotor aircraft designs were created with the aid of a preliminary design computer program (Ref. 5). The purpose of this preliminary design program is to rapidly obtain parametric variations of the design for a set of particular requirements. The program does not internally optimize the design; this is done by the user. The program takes as input a set of design parameters sufficient to fix the design. It then performs the normal preliminary design calculations to obtain both the other design parameters of interest an various figures of merit. Figures of merit include performance parameters such as speed and payload-range, direct operating cost, and noise annoyance. The noise annoyance portion is the subject of section 3.

2.1 Program Description

A flow chart of the preliminary design computer program is shown in Fig. 1. The program begins by reading input data. Various parameters which are independent of gross weight are then calculated: atmospheric properties, fuselage profile drag and constant weights.

Then the program goes into a design procedure which is an iteration on gross weight. Initially a gross weight is estimated from the constant weights; on succeeding iterations a new gross weight is found from those of the preceding two iterations.

Fig. 1 Computer program flow chart

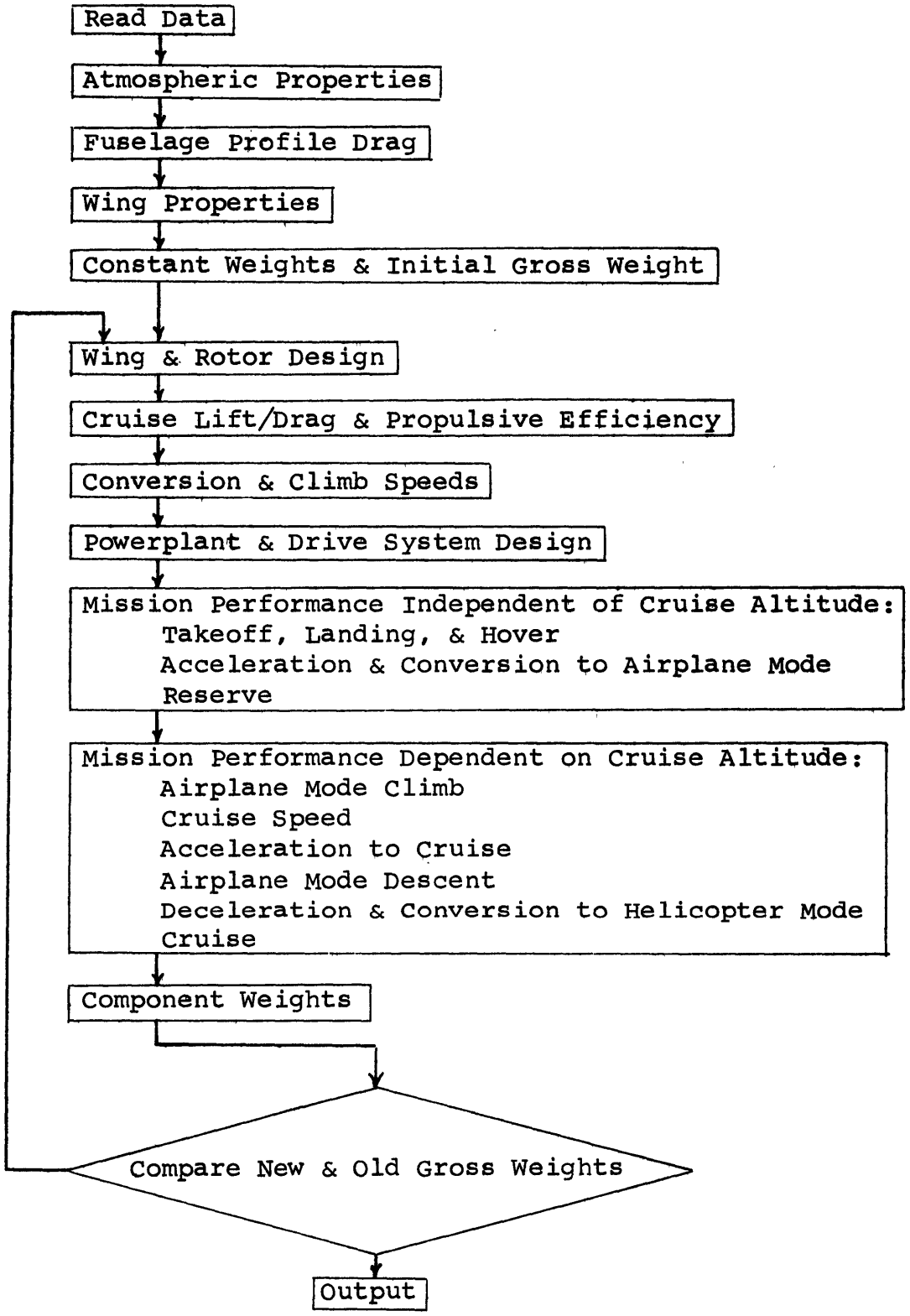
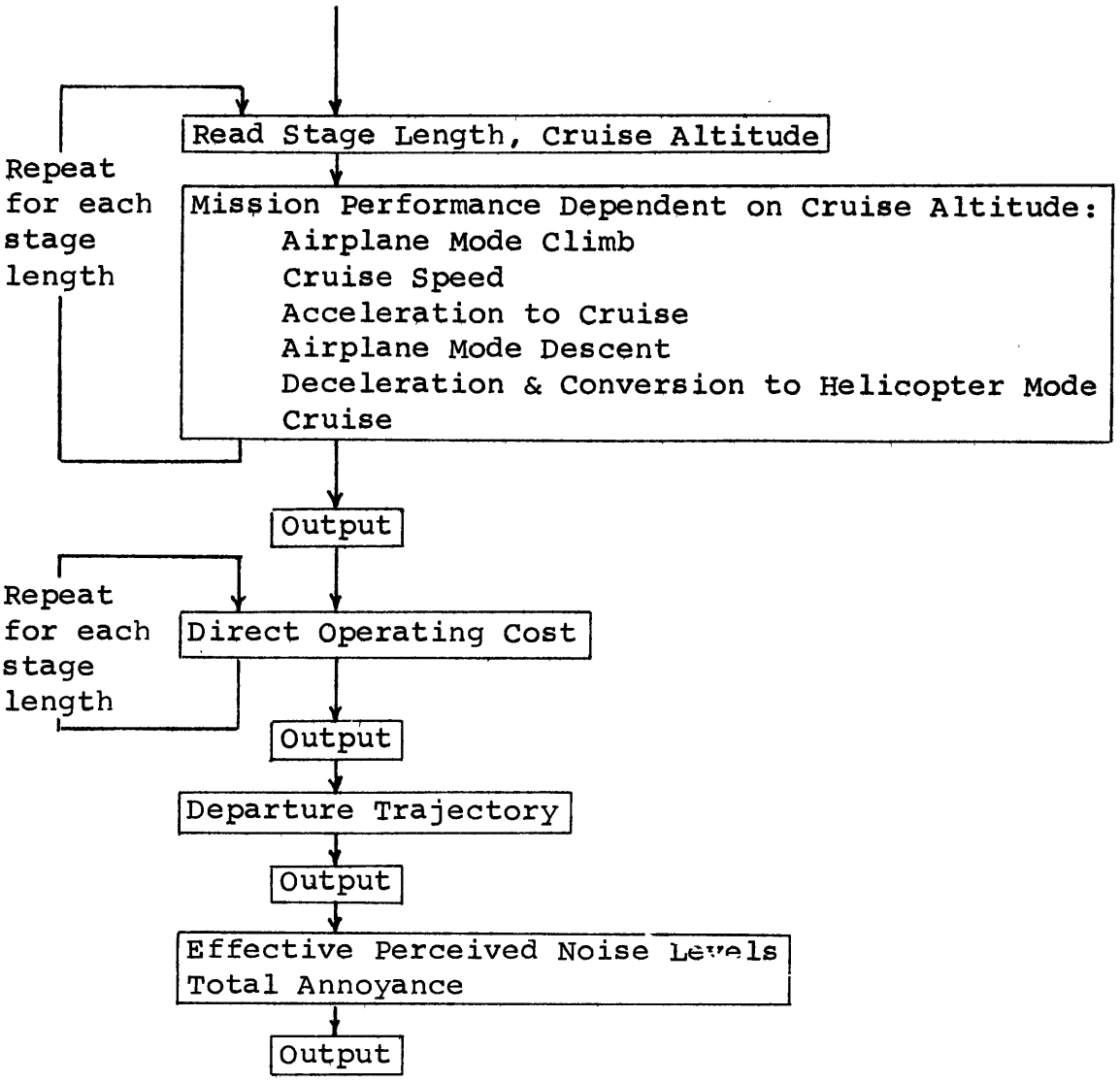


Fig. 1 Computer program flow chart (cont'd)



Next the rotors and wing are sized. The rotor radius is found from the input disc loading. The wing span is based on rotor-fuselage clearance. The wing loading is input and the area and aspect ratio are calculated. The hover thrust coefficient is found, using the input tip speed and corrected for wing download. Then the rotor solidity is found using the input thrust coefficient to solidity ratio (C_T/σ).

The cruise lift to drag ratio is found from the wing and fuselage geometry. Then the cruise propulsive efficiency of the rotors is calculated according to an empirical formula from the cruise forward Mach number, the cruise tip Mach number, and the rotor solidity.

Next the airplane mode best rate of climb speed is calculated. Then the conversion speed and airplane mode wing lift coefficient are calculated, corresponding to the input helicopter mode maximum advance ratio. This lift coefficient and the ratio of the airplane mode best rate of climb speed to the conversion speed are output to evaluate conversion performance.

Then the powerplant is sized to the maximum of the requirements for emergency hover, conversion and cruise. The emergency hover requirement is for one engine out hover on a hot day at an input altitude. The conversion requirement is established by an input conversion power factor (labelled "Excess Factor Hel Mode" in the output) which is the ratio of conversion power desired to normal hover power. Power

is corrected for temperature, altitude, forward speed and r.p.m. It is assumed that the engines operate at rated r.p.m. in hover and a penalty is accepted for any reduction in r.p.m. in the airplane mode. This completes the selection of design parameters.

The aircraft is then flown through the design mission to find the fuel consumed. The assumed mission profile consists of ten phases:takeoff, acceleration and conversion to the airplane mode, airplane mode climb, acceleration to cruise speed, cruise, airplane mode descent, deceleration and conversion to helicopter mode, hover, landing, and reserve. The portion which is independent of cruise altitude is done separately,so that it will not be repeated in the stage length variation later. The fuel burn rate is corrected in each phase for power setting, r.p.m., forward speed and altitude. Optional provision is made for the aircraft to obey the FAA speed limit of 250 kt. IAS below 10,000 feet. If the aircraft has more installed power than that required for cruise at design cruise speed, and if the drive system and rotor limits permit, then the aircraft is allowed to cruise faster, up to these limits. Cruise fuel is calculated according to the Breguet method.

Then the component weights are calculated. Both the rotor and drive system weights are taken to be the highest resulting from helicopter mode and airplane mode design requirements considered separately. If the rotor hover coning angle exceeds 8.5°, weight is added to approximate tip weight

and blade weight necessary to reduce coning to this amount. Here it is assumed that the rotor is of the gimballed type having a first flatwise bending mode frequency of 2 per rev. The wing weight is independent of flap area, but is adjusted for the lift coefficient required in conversion.

Now the component weights and fuel weights are summed, which results in a new gross weight. If the difference between the new and old gross weights is greater than ten pounds, the design procedure goes through another cycle. When the iteration is complete, the parameters describing the final design are printed.

The vehicle is then flown through various input stage lengths which are less than the design range, with appropriate input cruise altitudes. The time, distance and fuel for each stage is calculated and printed. Then the program calculates the direct operating cost (DOC) for each stage length, by category, and prints this out. The DOC is calculated according to the Lockheed/New York Airways formula. (Ref. 6)

2.2 Calibration

In order to calibrate the computer program, the program was used to produce approximations of two existing tilt rotor designs. These were the Bell D302 (Ref. 7) of 44,100 lb gross weight and the Vertol 215 (Ref. 8) of 67,000 lb gross weight. These designs were picked because they represent the experience of

two different firms and they are near the middle of the size range of interest. Both were configured as transport aircraft. However they were designed to meet military requirements which compromised their effectiveness as commercial aircraft. By making allowances for the military requirements in the inputs to the computer program, good agreement with the original designs was obtained. Both of these designs are intended to represent approximately 1975 technology, and therefore the values of the technology factors which gave the best agreement in the calibration were considered to be 1975 values.

3.0 Noise Evaluation Procedure

The arrival, or descent and landing, operation of a tilt rotor aircraft may generate slightly greater community annoyance than the departure, or takeoff and climbout, operation. There are two aspects of the descent and landing operation that account for the assymmetry between the two. First, there may be more blade/wake interaction in the helicopter mode descent than in climb, depending on the exact trajectory. Second, the descent must be constrained to avoid the vortex ring state and inability to control the descent. Thus the annoyance produced by the descent and landing is more dependent on operational considerations than on design parameters. The annoyance produced by the takeoff and climbout, on the other hand, is strongly dependent on operational considerations than on design parameters. Many of the design changes which reduce departure noise will also reduce arrival noise. For these reasons, departure annoyance was considered more appropriate for this study of noise reduction through design changes.

3.1 Departure Path

After the direct operating cost portion of the computer program, the departure trajectory to 10,000 feet altitude is calculated in detail. The result is a time history of the distance, altitude,

flight path angle, thrust and rotor tilt angle relative to the flight path. This history then is input to the noise annoyance calculation.

The departure path is shown schematically in Figure 2. Throughout this path acceleration is constrained by power available. There are three other constraints for passenger comfort. The acceleration builds up smoothly over a specified time to its allowable input maximum, which is used for all phases of flight. The rate of rotation of the acceleration vector after obstacle clearance is specified. Finally, the maximum fuselage pitch angle is specified.

To determine the departure path prior to the airplane mode climb, the program considers steps in velocity, of input size, and calculates the acceleration magnitude according to the routine shown in Figure 3. The rotor tilt angle is first found from the balance of forces perpendicular to the acceleration vector and the power limited acceleration magnitude is found from the force balance parallel to the acceleration vector. If the power limited acceleration is larger than the allowable acceleration, the force balances are set up again and solved for the thrust and a new tilt angle. The the time, distance, altitude, and flight path angle are found from the acceleration and velocity. The forces and angular relationships are shown in Figure 4. The nomenclature is given in Table 1.

A simple model is used to predict the performance of the

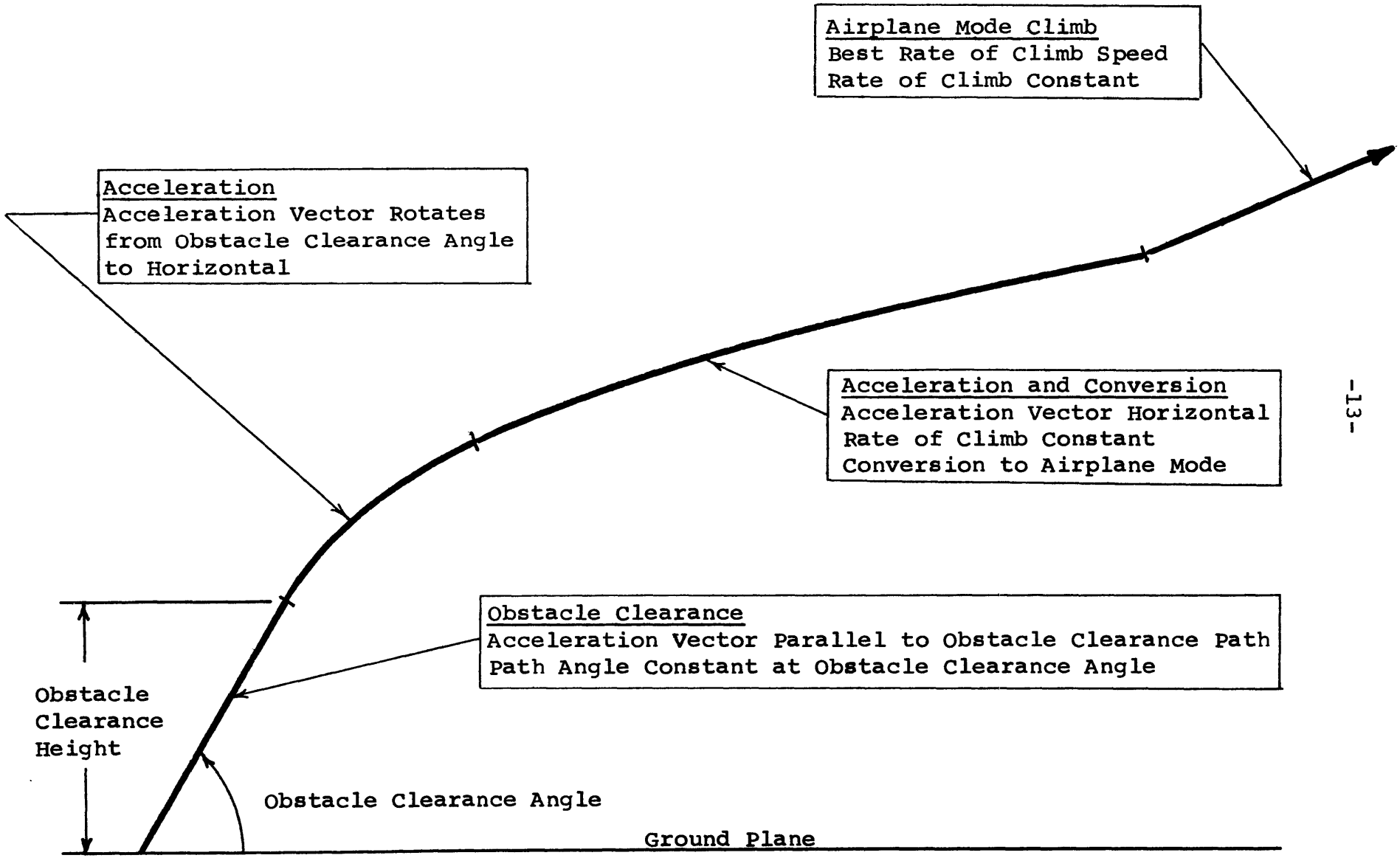


Fig. 2 Departure path schematic

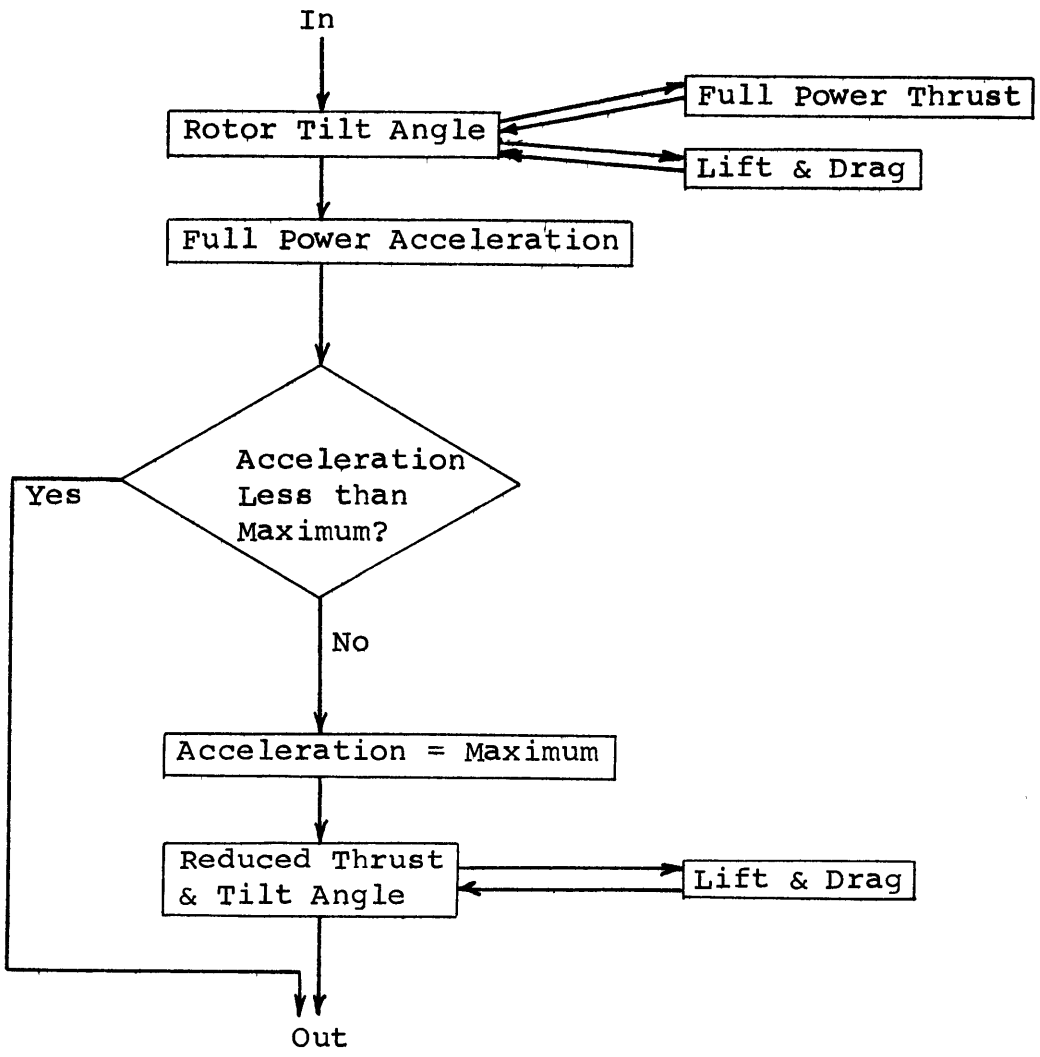


Fig. 3 Flow Chart for acceleration routine

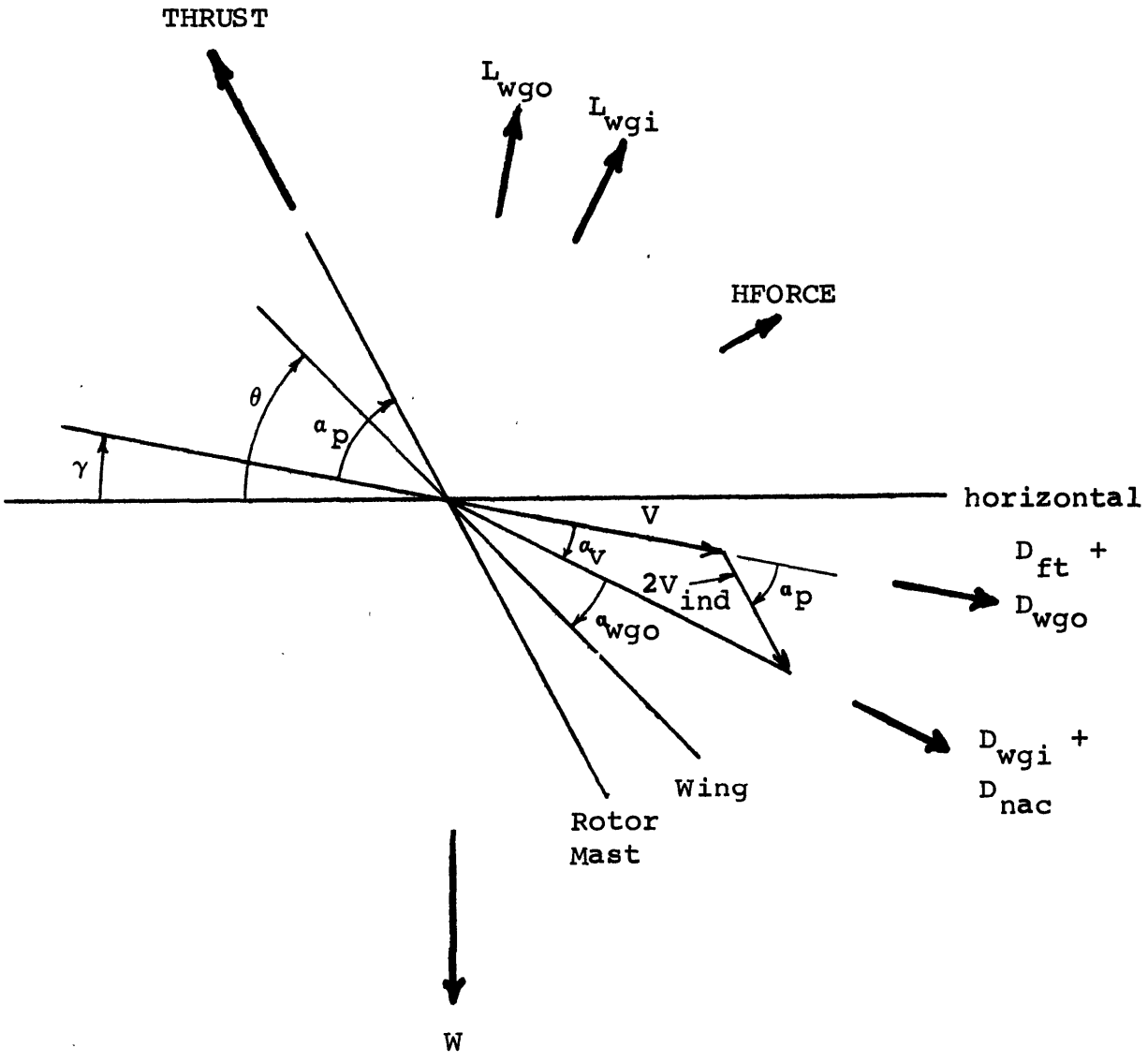


Fig. 4 Forces and angular relationships

Table 1 Conversion Nomenclature

Symbol	Computer Output Label	Description
V	VEL	Freestreem Velocity, ft/sec
V_{ind}	not shown	Induced Velocity of Rotors, ft/sec
THRUST	THRUST	Total Rotor Thrust, lb.
HFORCE	not shown	Total Rotor In-Plane Force, lb.
L_{wgo}	LWGO	Lift of Wing Portion not Influenced by Rotor Flow, lb.
L_{wgi}	LWGI	Lift of Wing Portion Influenced by Rotor Flow, lb.
D_{wgo}	DWGO	Drag of Wing Portion not Influenced by Rotor Flow, lb.
D_{wgi}	DWGI	Drag of Wing Portion Influenced by Rotor Flow, lb.
D_{ft}	DFUST	Drag of Fuselage and Tail, lb.
γ	GAM	Flight Path Angle, deg.
α_p	ALP	Angle between Rotor Mast and Freestream Velocity, deg.
θ	THE	Angle between Wing Zero Lift Line and Horizontal, deg.
α_{wgo}	AWO	Angle of Attack of Wing Portion not Influenced by Rotor Flow, deg.
α_v	ALV	Wing Angle of Attack Change Induced by Rotors, deg.

rotor and wing through the complete range of rotor tilt angles. Elementary helicopter blade element and momentum theory formulae are used to find the rotor thrust, since the advance and inflow ratios are not large. To predict the wing forces, it is assumed that the flow through the rotor is fully developed when it reaches the wing. Hence the portion of the wing that is influenced by the rotor is that portion which is overlapped by the inner half of the disc area. On this portion of the wing the total slipstream velocity is assumed to be the vector sum of the free-stream velocity and the fully developed induced velocity of the rotor. The optimum flap deflection cannot be conveniently found, so it is assumed to be equal to the flight path angle. The aircraft is assumed to be pitched up to the input maximum, or until the angle of attack of the rotor-influenced portion of the wing is 3° less than stall, whichever is less, until the aircraft reaches the speed where the wing lift is equal to the gross weight.

Conventional fixed wing methods are used to calculate performance at the beginning of the airplane mode climb and at 10,000 ft. altitude.

3.2 Noise Prediction

Noise nomenclature is given in Table 2. There are three significant sources of noise in the tilt rotor vehicle: the engines, the drive system and the rotors. The noise from the

Table 2 Noise Nomenclature

Symbol	Description
α	rotor blade angle of attack, deg.
ρ	air density, slugs/ft^3
ϕ	angle between rotor axis and a line joining the rotor hub and a ground noise measuring point
A_b	rotor blade area, ft^2
c	rotor blade chord, ft.
d	slant distance from aircraft to noise measuring point, ft.
DIR	vortex noise directivity correction, db.
DT	time increment in noise calculations, sec.
f_{peak}	vortex noise peak frequency, Hz
FENGI	engine installation weight factor
GAMOCD	obstacle clearance angle, deg.
HOC	obstacle clearance height, ft.
L_p	overall sound pressure level, db.
L_{PN}	perceived noise level, db.
L_{EPN}	effective perceived noise level, db.
RA	relative noise annoyance
SEL	effective perceived noise level at 500 ft. sideline, db.
t	rotor blade thickness, ft.
T	thrust
V_{tip}	rotor tip speed, ft/sec.

engines can generally be reduced to less than that from the rotors in a quite straightforward manner, as discussed in Ref. 3. The weight penalty for quieting the engine and drive system below the rotor noise level is accounted for by increasing the engine installation weight factor (FENGI) if the 500 ft. sideline noise livel (SEL) is below 95 EPNdb. In the absence of adequate empirical data, the author's engineering judgement was used to obtain the following relationship: The engine installation factor was kept at 1.50 at 95 EPNdb and was assumed to be 1.60 at 87 EPNdb and 2.00 at 80 EPNdb. A parabolic curve was fitted between these points.

Rotor noise is predicted using helicopter methods because only low disc loading and forward speeds are considered. Helicopter rotor noise is usually classified into three categories: blade slap or impulsive noise, rotational or discreet frequency noise, and vortex or broadband noise. The understanding of the mechanisms of rotor noise is rapidly evolving and this classification has been questioned. However, it remains the most useful one for the moment.

Blade slap is by far the most offensive of these types of noise when it occurs. (Ref. 12) It can occur in high speed helicopter flight due to compressibility phenomena in the vicinity of the advancing tip, (most frequently on two bladed rotors) or it can occur at low speed due to interaction

between a blade and the tip vortex of another blade. The former mode should not be a problem in commercial operation of tilt rotor aircraft because there should be no need to operate at high speed in the helicopter mode. Since there is no rotor overlap in the tilt rotor the latter mode should be limited to descent conditions where the wake does not leave the rotor disc rapidly. This noise generation mechanism is not strongly dependent on design parameters, but more on operational considerations. Because it is not likely to occur in the departure operation, it is neglected in this study.

Rotational noise will result because the pressure field around a rotor or propeller blade will change periodically relative to a stationary observer. The fundamental frequency is the blade passage frequency, which is very low (less than 20Hz.) for most rotary wing aircraft. The rotational noise spectrum consists of a series of discrete tones, starting at the fundamental and decreasing in amplitude as frequency increases. Since precise prediction of higher harmonic airloading is generally not possible, a partly empirical prediction method must be used. Unfortunately the body of experimental data is very small, and hence the process of deriving a prediction method is not unique. Nevertheless, there is a commonly accepted prediction method (Ref. 9). Using this method for typical rotary wing aircraft, it is found that rotational noise is significant compared to vortex noise only at high advancing tip Mach numbers in the helicopter mode or if the noise is calculated at large distances

from the vehicle. The former condition is not likely to apply to the tilt rotor aircraft in commercial operation. In the latter case the overall noise level has dropped below the background level assumed in this study. For these reasons rotational noise is neglected.

Vortex noise arises from two sources: random airloads on the blades and turbulent flow in the blade wakes. The vortex noise spectrum consists of a continuous broad hump with a peak generally in the range of 200-600 Hz. A reasonably reliable method for predicting vortex noise has been developed (Ref. 10 and 11). Overall sound pressure level (SPL) at 300 feet is given by the following formula:

$$L_p = 10 \log_{10} \frac{7.62 \times 10^{-10} T^2 (V_{tip})^2}{\rho^2 A_b}$$

The complete spectrum is predicted from the figure developed empirically by Schlegel for an unstalled rotor blade (Ref. 10).

It is then necessary to correct for the sensitivity of the human aural system; this is normally done by conversion to Perceived Noise Level (PNL). It is recognized that none of the currently accepted corrections take adequate account of the annoying nature of very low frequency sounds or amplitude modulation typical of helicopter noise spectra. Improvement in these corrections must await new subjective testing. Following unpublished work by Anthony Hays at the M.I.T. Flight Transportation Lab, the spectral distribution in SPL and the corresponding weighed and combined PNL measures were calculated for the range of base frequencies of 100-400 Hz. over distances from 100 to 20,000 ft.

It was found that the combined effect of the conversion from SPL to PNL and the losses and changes in emphasis due to atmospheric absorption could be approximated within a decibel by the formula

$$L_{PN} = L_P + 3.0 - 0.000375_*d$$

This held good for SPL ranges from 120 - 80 db, and was conservative in the 80-70db range. The formula was valid only for distances greater than 2000 ft. Within 2000 ft. a correction which depended upon the peak frequency was necessary.

$$L_{PN} = L_P + 3.0 - 0.000375*d + 0.0264\ f_{peak}\ (1- d/2000)$$

The peak frequency is the Strouhal frequency given by the following approximation for $\alpha = 6°$

$$f_{peak} = \frac{0.28\,(V_{tip}/\sqrt{2})}{t\cos\alpha + c\ \sin\alpha} \simeq V_{tip}/c$$

Distance attenuation is simply the dilution of sound energy by spreading over larger spherical surface areas as the distance from the source increases. Thus, if the standard distance is 300 ft., the energy levels at other distances are reduced by the ratio of the squares of the distances, or 6 decibels per doubling of distance.

There is in additon an adjustment to the local perceived noise level due to different viewing angles from the rotor shaft. Reference 9 gives the formula for the adjustment in decibels,

$$DIR = 10\log_{10}[\frac{\cos^2\phi + 0.1}{\cos^2 70° + 0.1}]$$

The conversion from perceived noise level (L_{PN}) to effective perceived noise level (L_{EPN}) involves converting the L_{PN} measure to energy units, multiplying by the duration, and dividing by the standard time, 10 seconds. Thus

$$10^{(L_{EPN})} = \sum_{\text{all DT}} (10^{(L_{PN}/10)} * DT/10)$$

3.3 Annoyance Prediction

The annoyance measure is based on the work of Ref. 13. The noise annoyance routine calculates Effective Perceived Noise Level at a large number of points on a grid representing the area on one side of the flight path. The noise pattern is symmetrical. The EPNL at each point is then converted to personal annoyance units,

$$\text{Annoyance} = 10^{(L_{EPN} - \text{cutoff})/33.2}$$

Because this measure is asymptotic to zero the cutoff noise level must be above the background noise level. Here this difference is assumed to be 10 EPNdB which is consistent with the normal fluctuation of the background level. The annoyance value is one at the cutoff and zero below. The land use pattern and cutoff levels used in this study are shown in Figure 5.

The personal annoyance is then integrated over the population surrounding the airport. Since the population density is assumed constant it does not appear explicitly. The annoyance value at each point is multiplied by the surrounding land area and the results are summed to obtain the total community annoyance from

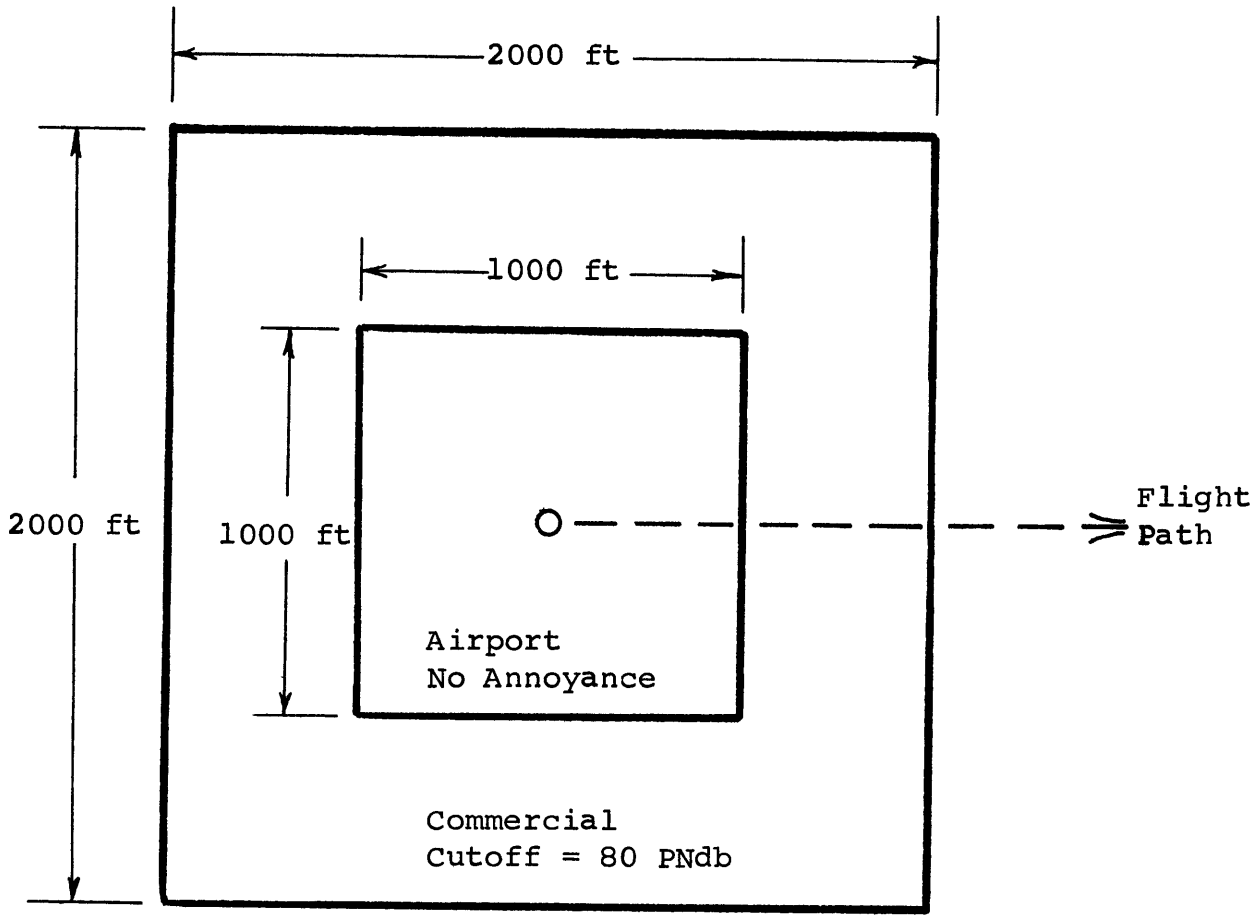


Fig. 5 Land use plan

a single departure.

Unlike other measures, this community annoyance measure obeys the following simple rules:

1) A sound 10 EPNdb louder is twice as annoying.
2) A noise quieter than the background noise level produces no annoyance.
3) The total annoyance resulting from two people listening to a noise is twice the annoyance of one person listening to the same noise.

4.0 Study Method and Ground Rules

4.1 Variations

The basic variation consisted of five aircraft designs of 1980 time frame having 50 seats. These vehicles were spaced across the spectrum of possible noise levels, from completely unconstrained to the quietest vehicle that could be designed within the study ground rules. The noise goals that were used for design optimization were in terms of Effective Perceived Noise Level at 500 feet side line, while the total noise annoyance was used for comparing optimum designs. The tilt rotor designs generated in this study are designated by codes consisting of a letter mnemonic indicating the noise class, a number indicating the time frame and a number indicating the size in terms of passenger seats. The basic variation aircraft and their noise goals are shown in Table 3. The parameters that were varied to find the minimum DOC aircraft for each noise goal are shown in Table 4, along with the approximate range over which they were varied. The final optimal values of these parameters are given in Table 10, section 5.

In the size variation the basic variation was repeated for sizes of 20, 80 and 110 seats. The gross weight did not converge for S-80-110, as discussed in Section 5, so it is not included here. In the timeframe variation the basic variation was repeated for time frames of 1975 and 1985. In this study, the time frame is intended to be the year of initial prototype flight

Table 3 Basic Variation Noise Goals

Designation	Mnemonic	Noise Goal EPNdb @ 500ft sideline
C-80-50	Cheap	Unconstrained
M-80-50	Medium	95
Q-80-50	Quiet	90
D-80-50	Double Quiet	87
S-80-50	Silent	84

Table 4 Design Optimization Parameters

Parameter	Units	Range
Cruise Speed	mph	250-425
Disc Loading	lbs/ft^2	6-16
Helicopter Mode Tip Speed	ft/sec	300-850
Airplane Mode Tip Speed	ft/sec	300-650
Wing Loading	lbs/ft^2	50-100
Conversion Power Factor*		1.10-2.20

* Ratio of power desired in conversion to that required in a normal hover.

testing, with airline service following two to five years later. The values of the parameters which were changed to produce the size and time frame variations are given in Tables 5 and 6 , respectively. The 1975 values of the parameters used in the time frame variation are based on the calibration of the computer program as discussed in Section 2. The 1980 and 1985 values were derived using the author's judgement and knowledge of projected technological developments to extrapolate historical trends. The optimality of the values of the optimization parameters found in the basic variation was checked by varying each of these parameters singly for extreme points of the size and time frame variations, namely C-75-20, C-80-110, S-80-80, C-75-50, and S-85-50, S-75-50, and S-85-50. No significant improvements could be found so these parameters were kept constant for each noise class throughout the size and time frame variations.

In all the previous variations the obstacle clearance path was kept fixed at 60° to 100 ft. In order to assess how this choice of path might affect the results, the obstacle clearance path was varied. Eight other departure paths were considered with obstacle heights of 50, 100 and 200 feet and obstacle clearance angles of 30°, 60° and 90°. It was found that the basic variation aircraft did not have sufficient power in the conversion phase to execute the departure paths having greater obstacle heights or steeper obstacle clearance angles. The reason for this is the assumption in the departure path calculation that that the vertical speed built up in the obstacle clearance phase is maintained through the acceleration and conversion phase.

Table 5 Design Parameters Varied with Size

Parameter	20	50	80	110
Cabin Crew	0	1	2	3
Fuselage Length, ft.	55	80	95	110
Fuselage Diameter, ft.	8.5	10	11.5	13

Table 6 Design Parameters Varied with Time Frame

Parameter	1975	1980	1985
Rotor Hover Efficiency	0.83	0.85	0.87
Rotor Conversion Efficiency	0.81	0.83	0.85
Specific Fuel Consumption, lb/hp. hr.	0.42	0.40	0.38
Airframe Weight Technology Factor	0.80	0.78	0.76
Rotor Weight Technology Factor	1.05	1.00	.95
Drive System Weight Technology Factor	0.85	0.83	0.81
Engine Power/Weight, hp/lb	7.0	8.5	10.0

The higher paths require that conversion be executed while maintaining a greater vertical speed requiring extra power which the basic variation aircraft do not have. Therefore the path variation was accomplished using a more powerful aircraft, QP-80-50. This design is similar to Q-80-50 but the conversion power factor has been increased from 1.40 to 2.00.

Finally a hovering case was run to develop a standard level of total annoyance. A vehicle was found which generated 95.0 PNdB at 500 ft. distance while hovering at 100 ft. altitude. This is approximately the noise level of the Vertol 347 helicopter. Then this vehicle was hovered over the center of the vertiport for one minute at 100 ft. altitude to obtain a standard level of total annoyance. All gross levels of annoyance produced by other vehicles were divided by this value to obtain relative annoyance, which is used for all plots.

4.2 Constraints

Several constraints, which are external to the computer program, were obeyed during the variations described above. A rotor solidity of 0.25 was considered the arbitrary maximum. The wing aspect ratio was kept below 8.0 to avoid aeroelastic problems. The wing loading was kept above 50 to permit reasonable ride quality. Finally the conversion speed was not permitted to be less than two thirds of the airplane mode best rate-of-climb speed, in order to have an adequate conversion corridor.

4.3 Constants

The values of significant constants which were used throughout the study are shown in Tables 7, 8 and 9. Complete data on all the aircraft designs discussed in this report is presented in Appendix 1. Direct operating cost was calculated at a variety of stage lengths. The cost over two 200 mile segments, with the engines not shut down at the intermediate stop, was selected as representative of typical high-density short haul operations. DOC is in 1973 dollars.

Table 7 Design Constants

Parameter	Value
Design Range, stat. mi.	500
Cruise Altitude, ft.	15,000
Max. Helicopter Mode Advance Ratio	0.40
Wing Thickness/Chord Ratio	0.21
Wing Taper Ratio	0.70
Flap Area/Wing Area	0.25
Wing Max. Clean Lift Coefficient	1.40
Number of Engines	2
Emergency/Normal Power	1.40
Climb/Normal Power	1.20
Cruise/Normal Power	0.90
Field Elevation, ft.	0
Emergency Hover Altitude, ft.	2000
Maximum Acceleration, g.	0.25
Maximum Deceleration, g.	0.20
Hot Day Temperature, ^{o}F.	95
Standard Day Temperature, ^{o}F	59

Table 8 Operating Cost Constants

Parameter	Value
Utilization, hr./yr.	2000
Depreciation Period, yr.	10
Residual Value, %	0
Airframe Cost, $/lb.	80
Engine Cost, $/hp.	60
Fuel Cost ¢/gal.	18
Hull Insurance Rate, % per yr.	4.0
Maintenance Labor Rate, $/hr.	7.00

Table 9 Departure Path Constants

Parameter	Value
Max. Fuselage Pitch Angle, deg.	20
Max. Accel. Vector Rotation Rate, deg./sec.	20
Acceleration Buildup Time, sec.	5
Obstacle Clearance Angle, deg.	60*
Obstacle Clearance Height, ft.	100*

*Except in Path Variation

5.0 Results and Discussion

The basic variation resulted in five aircraft covering the spectrum of noise levels, but designed to common ground rules as discussed in Section 4. The basic variation includes only 1980 50 seat aircraft. The principal characteristics of these aircraft are shown in Table 10. For comparison the principal characteristics of QP-80-50, and of the hover example aircraft are given in Table 11. The rotor and wing planforms are shown in Figure 6. DOC is plotted vs. relative annoyance for the basic variation in Figure 7. This curve is the central result of this study. DOC for other stage lengths can be found from Figure 8. Complete information on all the aircraft designs discussed in this report is given in Appendix 1. Effective Perceived Noise Level Maps for basic variation aircraft are given in Appendix 2.

Starting with C-80-50 and moving downward in noise level, we see that each step cuts the relative annoyance roughly in half. M-80-50 differs from C-80-50 mainly in helicopter mode tip speed and solidity, and the resulting change in DOC is very small. Going on to Q-80-50, we see that now airplane mode tip speed and wing loading are also reduced, resulting in a slightly greater change in DOC. With D-80-50 cruise speed is added to the list of changing fundamental parameters and DOC begins to rise more sharply. Finally, in S-80-50 the effects of further changes in all these parameters combine to give a sharp increase

Table 10 Characteristics of Basic Variation Aircraft

	C	M	Q	D	S
Disc Loading lbs/ft^2	12.0	12.0	9.0	7.0	6.5
Solidity	0.081	0.143	0.179	0.200	0.245
Tip Speed Hel. Mode ft/sec	825	620	480	400	350
Tip Speed, Airplane Mode ft/sec	560	550	480	400	350
Installed Power, hp	9388	9447	8784	8328	9190
Conversion Power Factor	1.30	1.30	1.40	1.50	1.65
Wing Loading, lb/ft^2	95	95	75	63	50
Wing Aspect Ratio	7.91	7.85	7.72	7.91	6.56
Cruise Speed, mph	429	431	411	351	284
Cruise Lift/Drag	9.98	10.11	10.55	12.52	14.57
Fuel Weight, lb	4248	4126	3973	3978	4803
Payload, lb	10,150	10,150	10,150	10,150	10,150
Empty Weight, lb	28,114	29,924	33,861	37,778	44,719
Gross Weight, lb	42,511	44,200	47,984	51,906	59,672
DOC, $/seat trip for two 200 mile trips	13.56	13.84	14.93	17.18	21.89
EPNdB @ 500 ft Sideline, Departure	103.1	95.0	90.0	86.8	84.0
Relative Annoyance, Departure	1.482	.657	.279	.133	.074

Table 11 Characteristics of Two Example Aircraft

	QP-80-50	Hover Example
Disc Loading lbs/ft^2	9.0	12.0
Solidity	0.179	0.122
Tip Speed Hel Mode, ft/sec	480	673
Tip Speed Cruise ft/sec	480	550
Installed Power, hp	10,500	9393
Wing Loading lb/ft^2	75	95
Wing Aspect Ratio	7.57	7.87
Cruise Speed, mph	427	432
Cruise Lift/Drag	10.36	10.01
Fuel Weight, lb	4561	4127
Payload, lb	10,150	10,150
Empty Weight, lb	38,938	29,295
Gross Weight, lb	53,649	43,572
DOC, $/seat trip for two 200 mi. trips	16.04	13.75
EPNdB @ 500 ft Sideline Departure	90.1	97.5
Relative Annoyance Departure	.324	.839

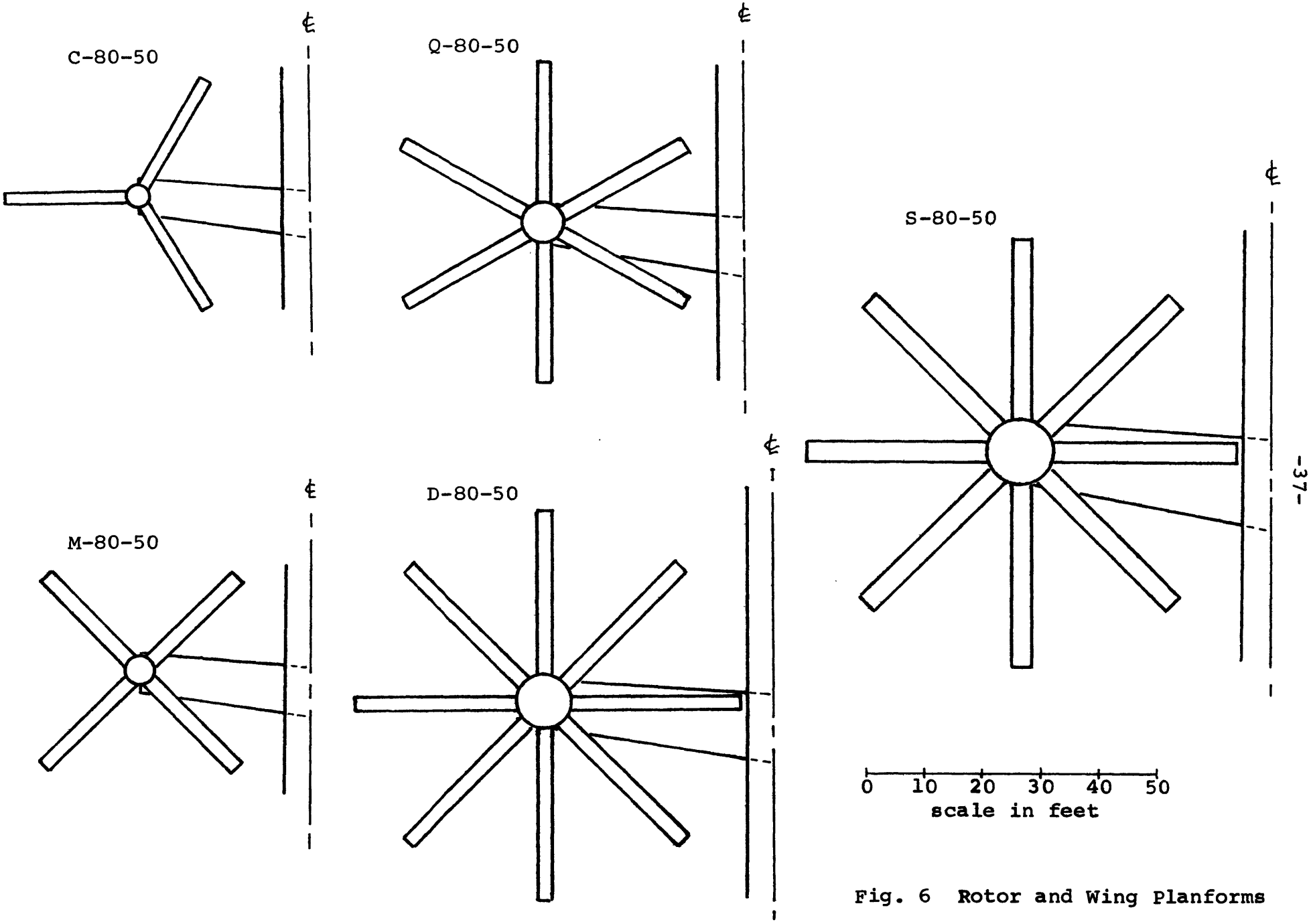


Fig. 6 Rotor and Wing Planforms

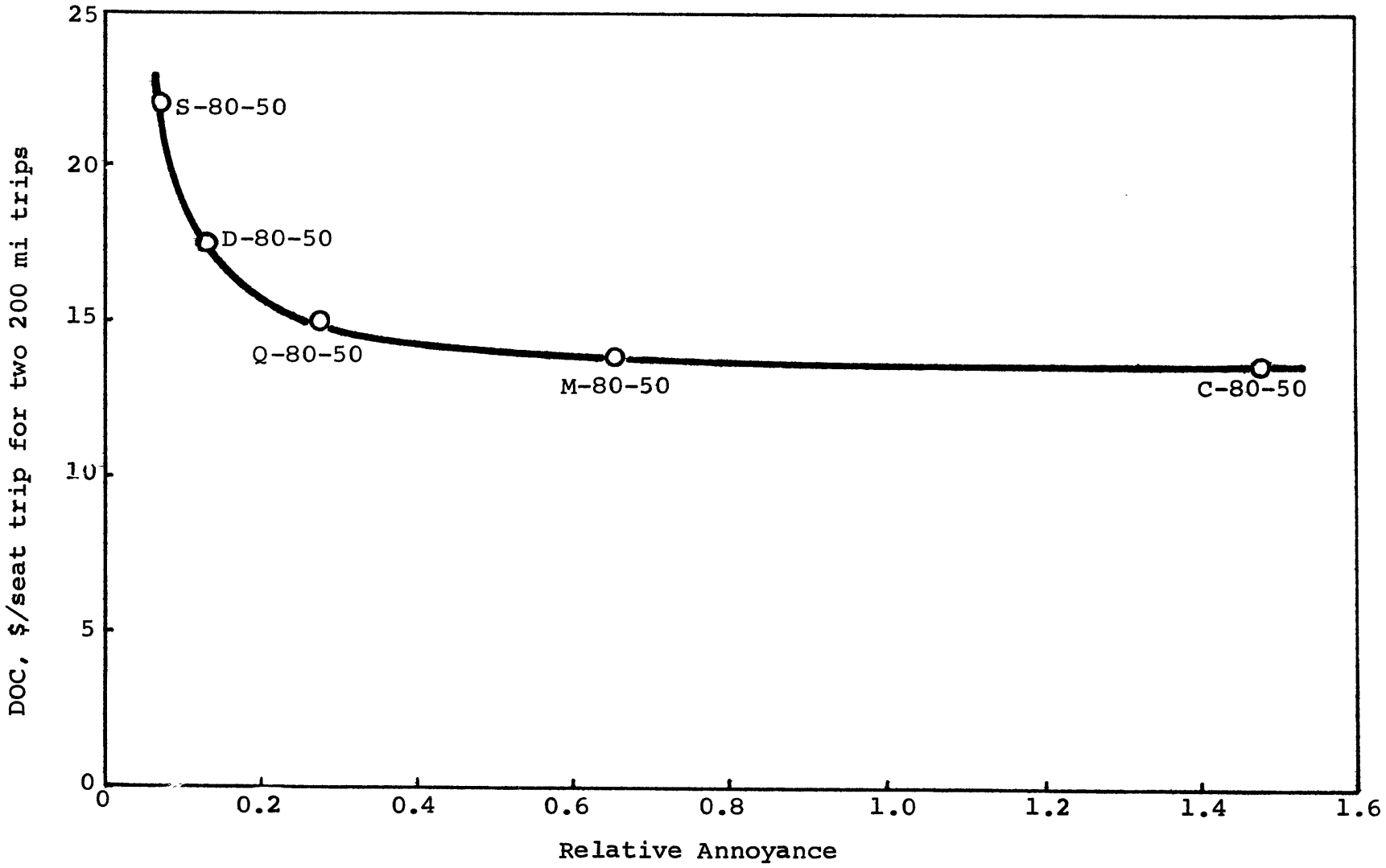


Fig. 7 Basic variation - DOC vs relative annoyance

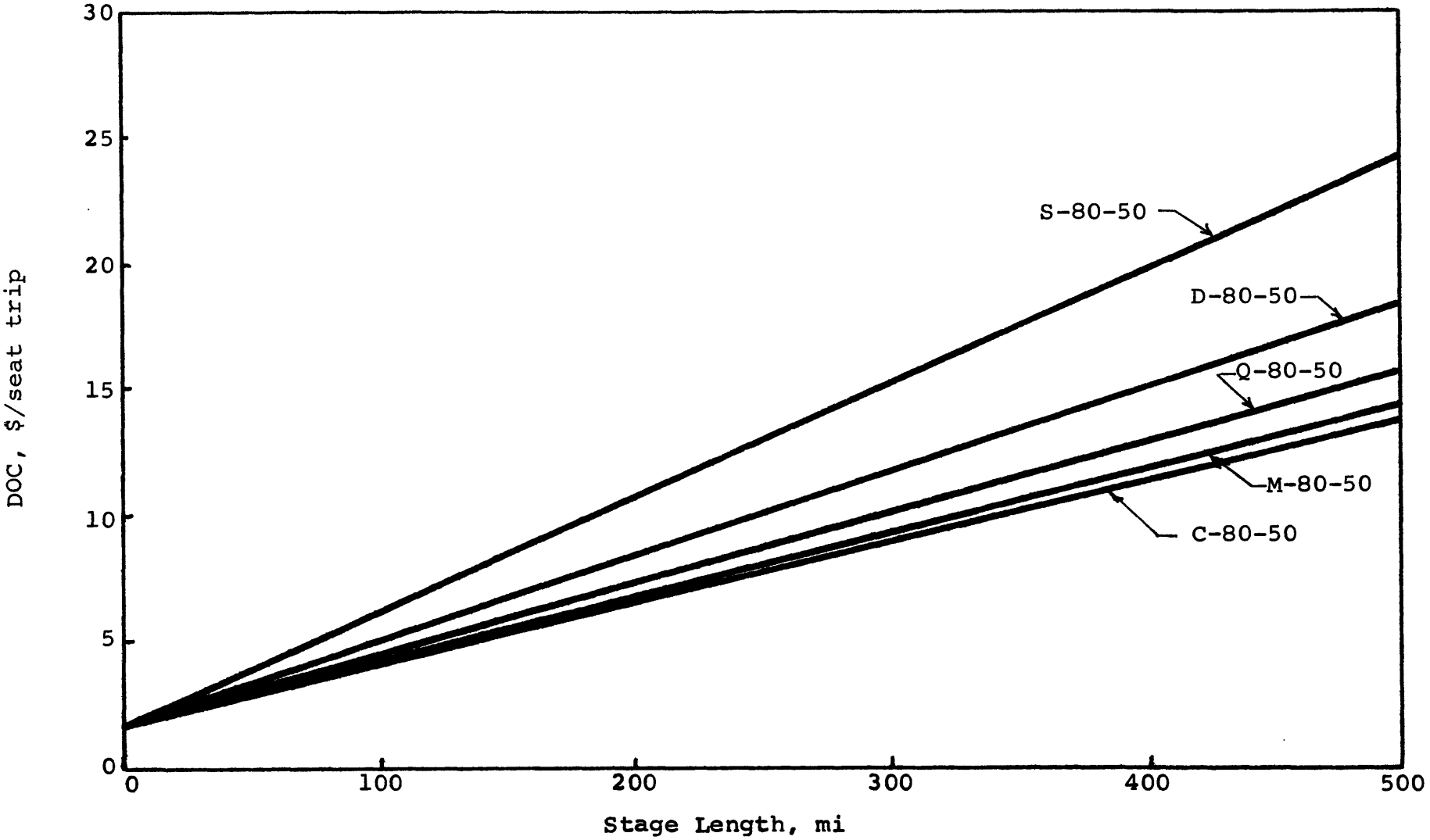


Fig. 8 Basic variation - DOC vs stage length

in gross weight and a large increase in DOC. This vehicle is up against all the constraints discussed in Section 4. Thus it is appropriate that the slope of the DOC vs. relative annoyance curve in Figure7 is nearly infinite at this point.

In the size variation, the basic variation was extended to include 20, 80 and 110 seat sizes. The gross weight did not converge for S-80-110, because the rotor weight penalty to prevent excessive coning at low tip speeds increases rapidly with aircraft size. DOC is plotted against relative annoyance for each size in Figure 9. However, it is appropriate when comparing the noise annoyance of aircraft of varying size to consider the annoyance per seat, since fewer departures would be required to transport a given number of passengers on larger aircraft. Thus DOC is plotted vs relative annoyance per seat in Figure 10. It can be seen that the minimum DOC aircraft decreases in size as the permissable annoyance is reduced. The 110 seat aircraft has the lowest DOC over most of the annoyance range but it is interesting to see how close the 50 seat and 80 seat aircraft are in DOC. The effect of frequency on demand would favor smaller aircraft, and hence the best aircraft from the airline system point of view is probably smaller than 80 seats. Also the curves indicate that DOC would not decrease significantly for aircraft larger than 110 seats.

In the time frame variation, the basic variation was extended forwards and backwards in time, from 1980 to 1985 and 1975. DOC is plotted against relative annoyance for each time frame in

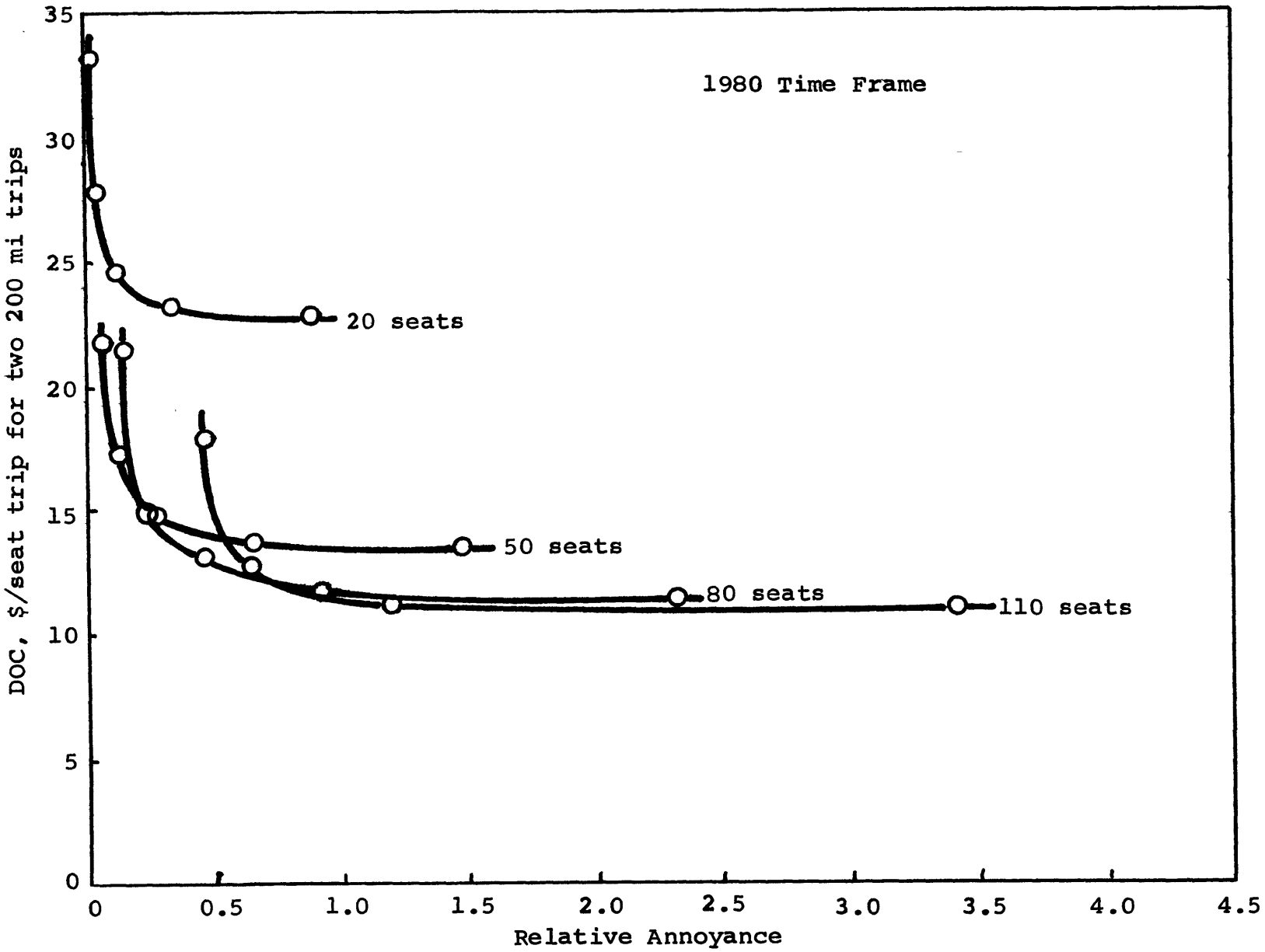


Fig. 9 Size variation - DOC vs relative annoyance

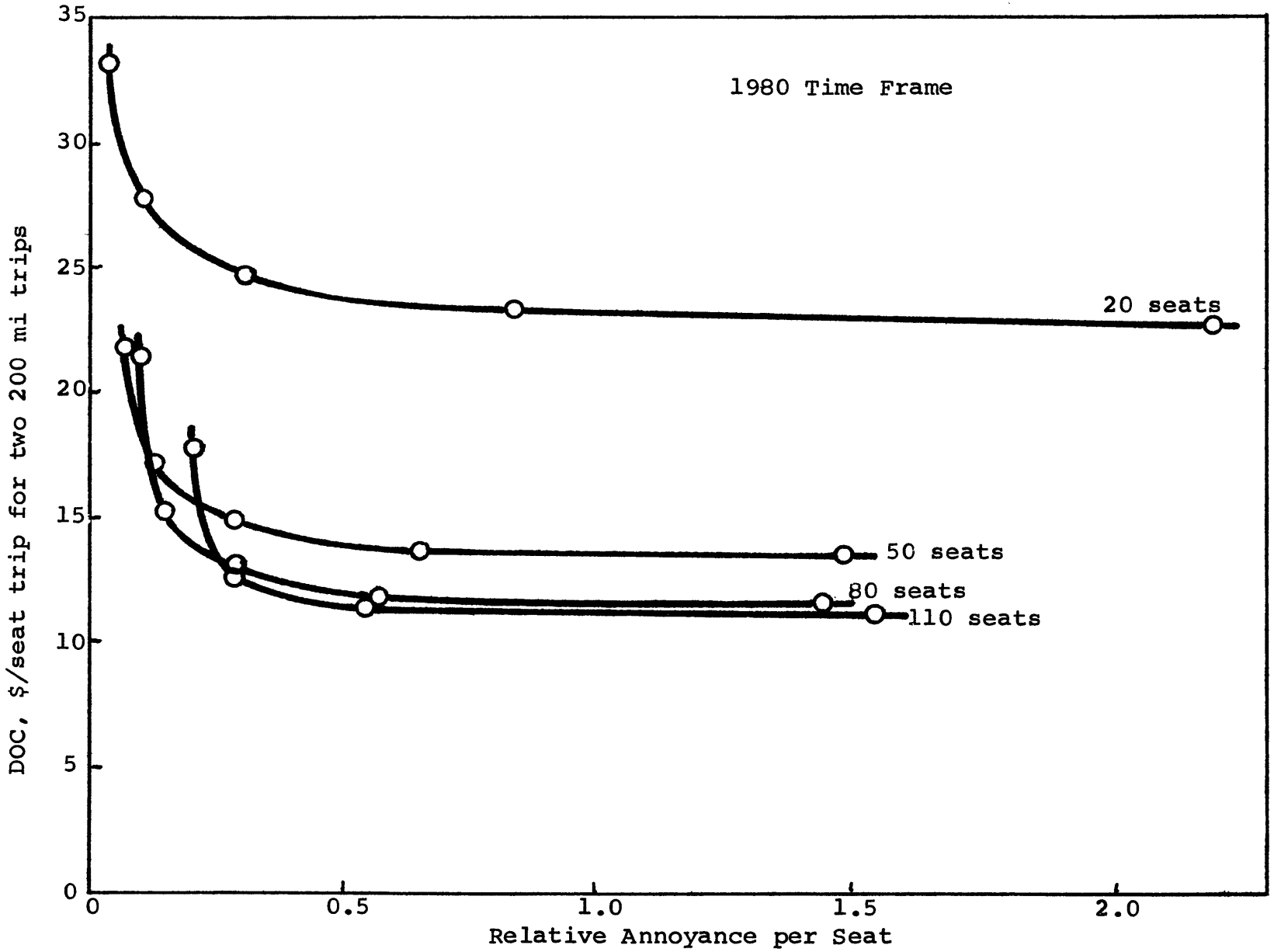


Fig. 10 Size variation - DOC vs relative annoyance per seat

Figure 11. The curves fall rather close together, reflecting a fairly small advancement in aircraft technology over this time period. However, over most of the annoyance range, moving ahead in time can produce a substantial reduction in annoyance at constant DOC.

The path variation was accomplished with an aircraft, QP-80-50, which is similar to Q-80-50 but the conversion power factor was increased from 1.40 to 2.00, as discussed in Section 4. Nine different departure paths were used with obstacle heights of 50, 100 and 200 feet and obstacle clearance angles of 30°, 60°, and 90°. The results are plotted in Figure 12. From these curves it can be seen that higher departure paths produce greater annoyance, but annoyance is not very sensitive to the height of the path. To explore this further, the highest, middle and lowest paths are shown in Figure 13. Although the middle path in this figure is approximately twice as high as the lowest one, it takes longer to execute resulting in the annoyance being increased about 15%. The same thing can be said with respect to the highest and middle paths. This is in agreement with Ref. 14. There it was shown that higher flight paths result in substantial reduction of the areas within contours of Perceived Noise Level. However, when these values were adjusted for the duration of the noise, the area within most contours of Effective Perceived Noise Level was slightly increased.

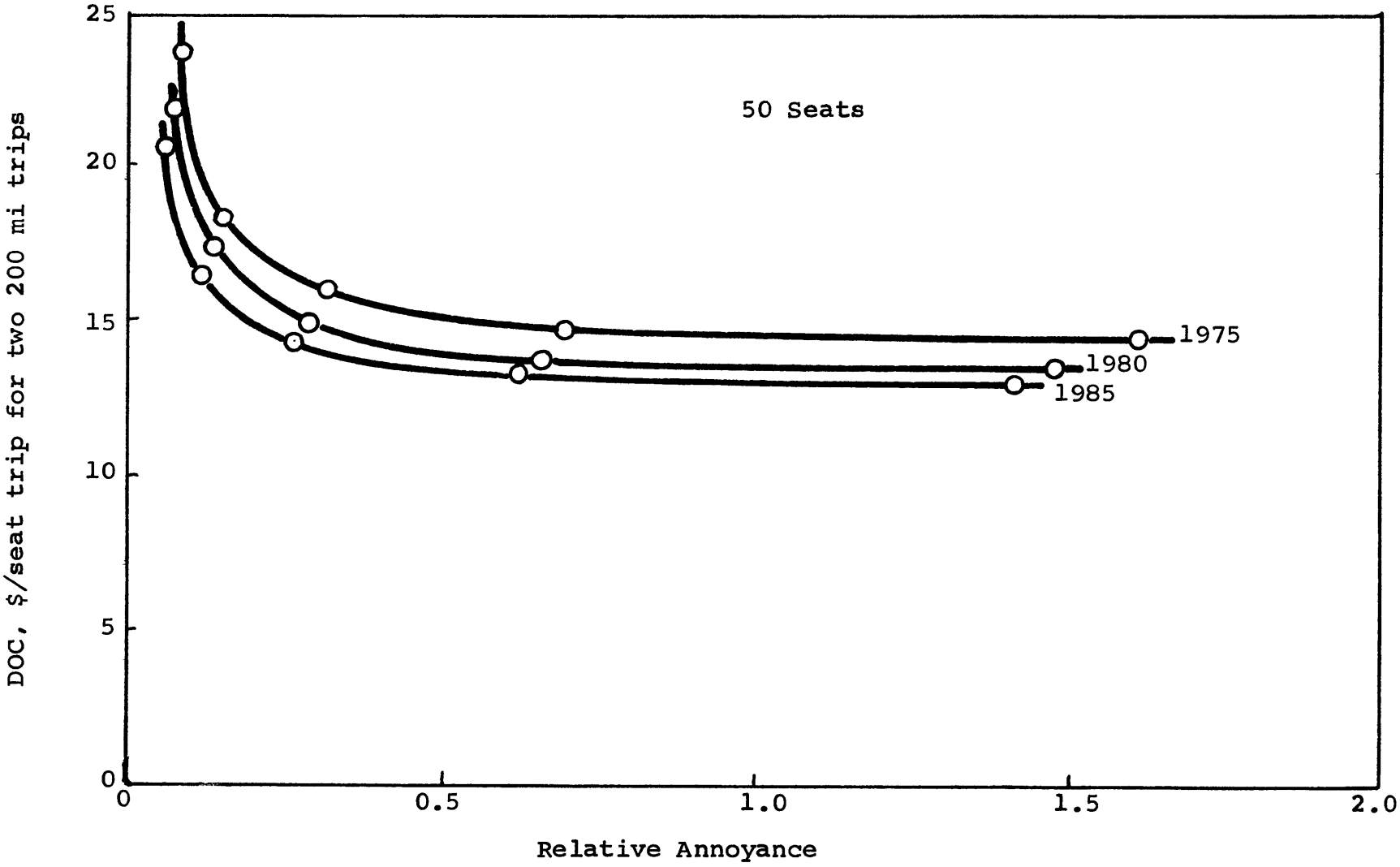


Fig. 11 Time frame variation - relative annoyance

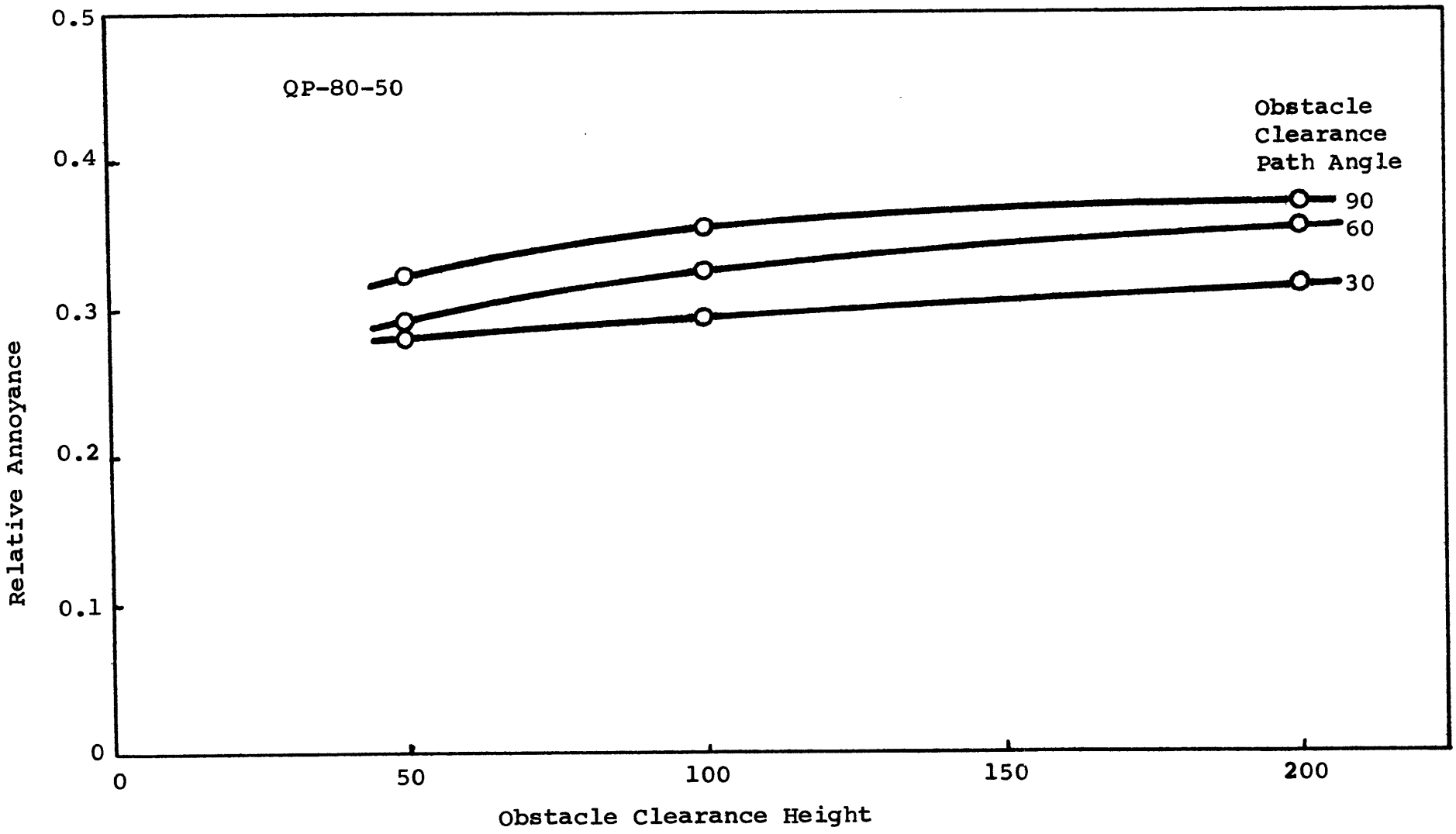


Fig. 12 Path variation - relative annoyance vs obstacle clearance height

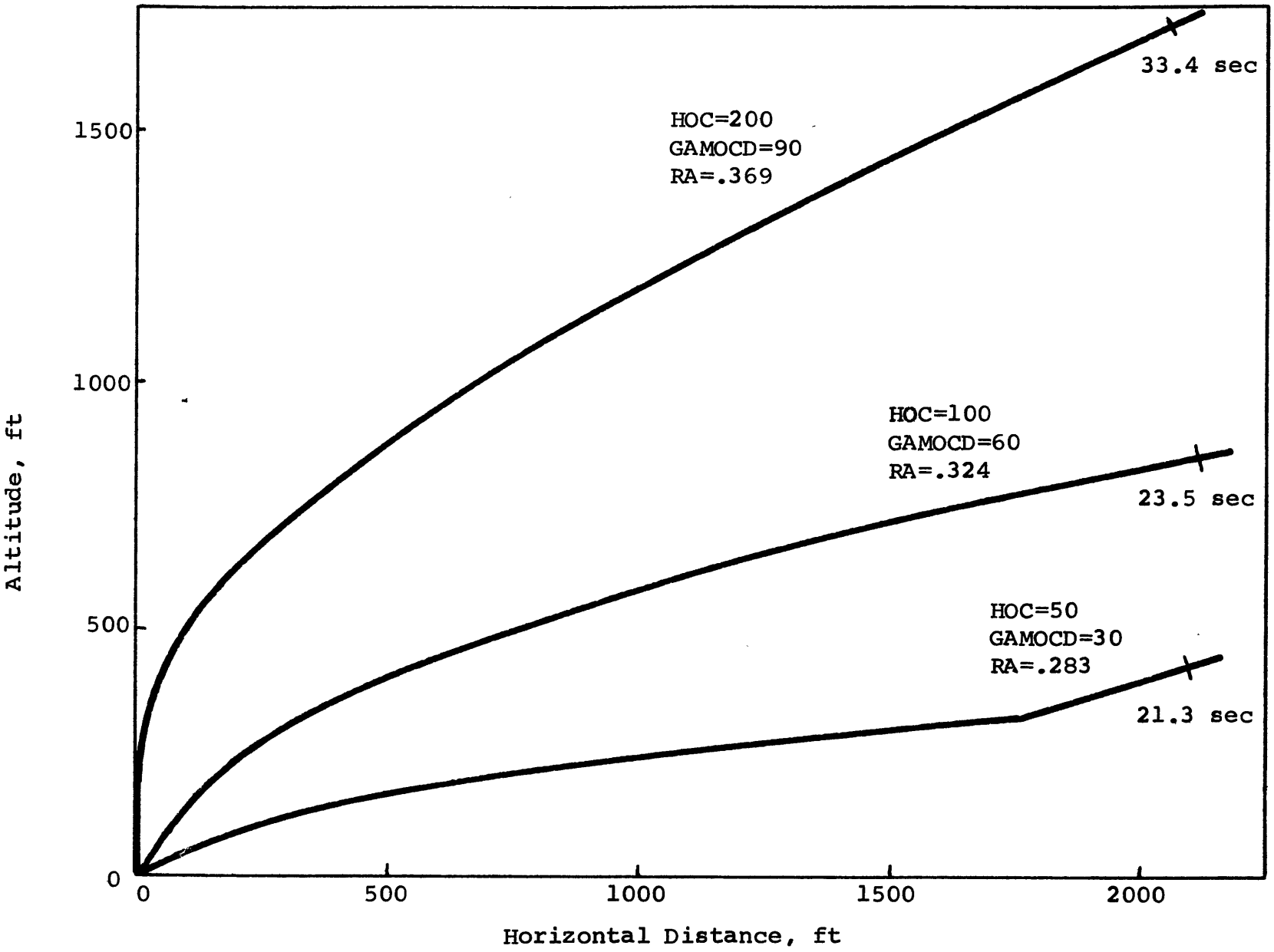


Fig. 13 Path variation - sample departure paths

6.0 Conclusions

The central conclusion of this work is that reducing the noise annoyance of commercial tilt rotor aircraft by designing for lower rotor tip speeds is a very promising avenue for future research and development. It appears that the cost of halving the annoyance compared to an unconstrained design is insignificant and the cost of halving the annoyance again is small.

Designing for noise reduction biases size selection in favor of smaller designs and the decrease in DOC for sizes over 80 seats is small. Improvements in aircraft technology in the next ten years will offset the cost of considerable noise reduction. The noise annoyance is not very sensitive to choice of departure path but higher departure paths produce slightly greater annoyance.

The principal limitation of this study is the state of the art regarding low tip speed, high solidity rotors. The prediction of performance, weight, and noise generation are all based on substantial extrapolations of data on existing rotors. There is a critical needfor research in this area if commercial tilt rotor aircraft are going to have a small noise impact. If the noise impact is not small these aircraft will probably not be viable.

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Appendix 1

Computer Output for All Designs

TILT ROTOR DESIGN PROGRAM 1974

C-80-50

DESIGN ITERATIONS: 5

OVERALL		POWERPLANT		FUSELAGE		STRUCT TECHNOLOGY FACTORS	
GROSS WEIGHT (LB)	42511.	INST NORMAL PWR (HP)	9388.	*LENGTH (FT)	80.0	*ROTOR	1.00
EMPTY WEIGHT (LB)	28114.	*NUMBER OF ENGINES	2.	*DIAMETER (FT)	10.0	*TRANSMISSION	0.83
FUEL WEIGHT (LB)	4248.	*EXCESS FACTOR HEL MODE	1.30	*DRAG FACTOR	1.00	*AIRFRAME	0.78
PAYLOAD (LB)	10150.	*% RATED EMRG HVR	140.			*ENGINE (HP/LB)	8.50
CRUISE SPEED (MPH)	429.	* CONV + CLIMB	120.	FLAT PLATE AREAS (SF)		*ENGINE INSTALLATION	1.50
L/D CRUISE	9.98	* CRUISE	90.	WING PROFILE	3.04		
*RANGE (STAT MI)	500.	INST PWR EMRG HVR (HP)	9388.	FUSELAGE	5.31	DESIGN MISSION	
*PASSENGER SEATS	50.	CONVER (HP)	6563.	EMPENNAGE	1.82	*FIELD ELEVATION (FT)	0.
*CARGO (LB)	0.	CRUISE (HP)	7865.	TOTAL PROFILE	12.31	SOUND SPEED HVR (FPS)	1117.
		*SFC (LB/HP HR)	0.400	WING INDUCED	2.06	*STD DAY TEMP (DEG F)	59.
ROTORS						*EMERG HOVER ALT (FT)	2000.
*DISC LOADING (PSF)	12.00	DRIVE SYSTEM		COMPONENT WEIGHTS (LB)		*HOT DAY TEMP (DEG F)	95.
RADIUS (FT)	23.7	*EFFICIENCY	0.97	ROTORS	3269.	*CT/SIG MAX	0.150
SOLIDITY	0.081	HEL MODE WEIGHT (LB)	3146.	DRIVE SYSTEM	4256.	*MAX ACCELERATION (G)	0.25
BLADE CHORD (FT)	2.01	AIRPLANE WEIGHT (LB)	4256.	POWERPLANT	1657.	*DESIGN CRUISE (MPH)	400.
TOTAL BLADES	6			NACELLES	241.	*CRUISE ALTITUDE (FT)	15000.
*CT/SIG HOVER	0.120	WING		FUEL SYSTEM	362.	SOUND SPEED CRSE (FPS)	1058.
*PROFILE DRAG COEFF	0.010	AREA (SF)	448.	WING	3223.	*MAX DECELERATION (G)	0.20
% DOWNLOAD	4.9	*LOADING (PSF)	95.0	FUSELAGE	5536.	*STRUCT LOAD FACTOR	4.5
*EFFICIENCY HOVER	0.85	ASPECT RATIO	7.91	EMPENNAGE	829.	*FLIGHT CREW	2.
* CONVER	0.83	SPAN (FT)	59.5	LANDING GEAR	1275.	*CABIN CREW	1.
CRUISE	0.79	MEAN CHORD (FT)	7.52	FLIGHT CONTROLS	1787.	*ATC SPEED LIMIT	YES
HEL MODE WEIGHT (LB)	3268.	*THICKNESS/CHORD RATIO	0.210	HYDRAULICS	267.		
AIRPLANE WEIGHT (LB)	2512.	*TAPER RATIO	0.70	ELECTRICAL	659.		
*TIP SPEED HOVER	825.	SWEEP (DEG)	-5.3	INSTR+AVIONICS	703.		
* CRUISE	560.	CRUISE LIFT COEFF	0.32	AIR CONDITIONING	1150.		
*FUSELAGE CLEARNCE (FT)	2.0	MAX LIFT COEFF CONVER	0.75	FURNISHINGS	2500.		
*MAX HEL MODE ADV RATIO	0.40	*MAX LIFT COEFF CLEAN	1.40	FLUIDS	213.		
		*FLAP AREA/WING AREA	0.25	FLIGHT CREW	400.		
* INDICATES INPUT VARIABLE		CLIMB SPD/CONVER SPD	0.75	CABIN CREW	150.		

DESIGN MISSION	SPEED MPH	HEIGHT FT	DIST MI	TIME MIN	FUEL LB
TAKEOFF & LANDING				2.00	86.
ACCEL. & CONV.		900.	0.9	0.64	33.
AIRPLANE CLIMB	168.,208.	14100.	13.1	4.19	226.
ACCEL. TO CRUISE			12.1	2.08	118.
CRUISE	429.		439.5	61.44	2869.
AIRPLANE DESCENT	429.,292.	14100.	33.4	5.88	44.
DECEL. & CONV.		900.	0.9	1.11	9.
TOTAL			500.0	77.35	3385.
RESERVE				20.00	862.

Information Processing Center
Information Processing Center

C-80-50

STAGE LENGTH (MI.)	25.	50.	75.	100.	150.	200.	300.	400.	500.
CRUISE ALTITUDE (FT.)	2000.	4000.	10001.	12500.	15000.	15000.	15000.	15000.	15000.
CRUISE SPEED (MPH)	296.	305.	438.	451.	461.	461.	461.	461.	461.
CRUISE L/D	12.27	12.27	8.46	8.75	9.02	9.02	9.02	9.02	9.02
CRUISE DISTANCE (MI.)	17.1	35.1	22.3	38.2	79.6	129.6	229.6	329.6	429.6
BLOCK TIME (MIN.)	8.7	13.8	17.1	20.7	27.5	34.1	47.1	60.1	73.1
BLOCK FUEL (LB.)	293.	431.	631.	804.	1184.	1552.	2276.	2988.	3687.
BLOCK SPEED (MPH)	172.	218.	263.	289.	327.	352.	382.	399.	410.

DIRECT OPERATING COST - ANN UTILIZATION(HR)=2000. DEPRECIATION PERIOD(YR)=10. LABOR RATE($/HR)= 7.00
AIRFRAME COST ($/LB)= 80.0 ENGINE COST ($/HP)= 60.0 INSURANCE RATE=0.040 FUEL COST (CENTS/GAL)= 18.0
DOC=1.70+0.0244*SL $/SEAT-TRIP (SL= 25.,500.)
HOP LENGTHS 50+150+ 0+ 0+ 0=200 100+200+ 0+ 0+ 0=300 200+200+ 0+ 0+ 0=400

STAGE LENGTH	25.	50.	75.	100.	150.	200.	300.	400.	500.	200.	300.	400.
NO. CYCLES/STARTS	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	2/1	2/1	2/1
FLIGHT CREW	0.563	0.446	0.369	0.336	0.297	0.276	0.254	0.243	0.237	0.351	0.306	0.284
FUEL & OIL	0.326	0.240	0.234	0.224	0.219	0.216	0.211	0.207	0.205	0.225	0.218	0.216
HULL INSURANCE	0.311	0.246	0.204	0.185	0.164	0.152	0.140	0.134	0.131	0.185	0.163	0.152
TOTAL FLIGHT OPS	1.200	0.931	0.807	0.745	0.681	0.643	0.605	0.585	0.572	0.760	0.688	0.651
LABOR AIRFRAME	0.474	0.311	0.240	0.206	0.171	0.152	0.133	0.123	0.118	0.204	0.169	0.151
MATERIAL AIRFRAME	0.184	0.113	0.085	0.071	0.057	0.049	0.042	0.038	0.036	0.068	0.055	0.048
LABOR ENGINES	0.317	0.174	0.123	0.098	0.072	0.059	0.046	0.040	0.036	0.083	0.066	0.055
MATERIAL ENGINES	0.519	0.280	0.195	0.154	0.111	0.090	0.068	0.058	0.051	0.136	0.099	0.081
MAT. BURDEN	1.029	0.631	0.472	0.396	0.316	0.274	0.233	0.212	0.200	0.380	0.305	0.267
TOTAL MAINTENANCE	2.524	1.509	1.115	0.925	0.727	0.625	0.523	0.471	0.441	0.876	0.694	0.602
DEPPECIATION	0.904	0.715	0.592	0.539	0.477	0.442	0.408	0.390	0.380	0.537	0.474	0.442
TOTAL DIRECT OPERATING COST												
$/AIRCRAFT MILE	4.628	3.156	2.514	2.208	1.885	1.710	1.535	1.447	1.393	2.173	1.856	1.695
$/FLIGHT HOUR	798.0	687.7	661.4	638.7	615.9	602.7	586.9	577.6	571.4	631.1	609.8	597.4
$/SEAT MILE	0.0926	0.0631	0.0503	0.0442	0.0377	0.0342	0.0307	0.0289	0.0279	0.0435	0.0371	0.0339
$/SEAT-TRIP	2.31	3.16	3.77	4.42	5.65	6.84	9.21	11.57	13.93	8.69	11.14	13.56

C-80-50

DEPARTURE PATH TO 10,000 FT MSL

MAX FUSE ANGLE=20. OBSTACLE CLEAR ANGLE=60. OBSTACLE HEIGHT=100. MAX ACCEL ROTATION RATE=20. ACCEL BUILDUP TIME= 5.

TIME SEC	DIST FT	ALT FT	VEL FPS	ACC G	GAM DEG	THRUST LB	LWGO LB	LWGI LB	DWGO LB	DWGI LB	DFUST LB	ALP DEG	THE DEG	AWO DEG	ALV DEG	LAMDA	MU	CT	POWER HP
OBSTACLE CLEARANCE																			
3.1	4.	7.	3.	0.050	60.0	45113.	-0.	-560.	0.	733.	1.	29.3	24.6	-35.4	28.8	0.0641	0.0015	0.0079	6463.
4.0	7.	13.	8.	0.171	60.0	49670.	-3.	-684.	2.	670.	10.	26.5	24.6	-35.4	24.8	0.0698	0.0041	0.0097	7539.
5.0	13.	23.	13.	0.163	60.0	49361.	-10.	-694.	5.	626.	28.	26.7	24.6	-35.4	23.6	0.0728	0.0068	0.0086	7772.
6.2	24.	41.	18.	0.129	60.0	48050.	-19.	-697.	9.	584.	54.	27.4	24.6	-35.4	22.5	0.0748	0.0095	0.0084	7772.
7.8	42.	73.	23.	0.095	60.0	46808.	-31.	-696.	15.	561.	90.	28.2	24.6	-35.4	21.9	0.0768	0.0126	0.0082	7772.
8.5	58.	100.	24.	0.060	60.0	45531.	-46.	-695.	23.	537.	134.	29.1	24.6	-35.4	21.2	0.0789	0.0159	0.0080	7772.
ACCELERATION AND CONVERSION																			
9.5	78.	127.	33.	0.152	52.4	44541.	-83.	-940.	26.	326.	137.	30.3	24.6	-27.8	21.5	0.0807	0.0203	0.0078	7772.
10.4	106.	151.	40.	0.171	41.7	43891.	-166.	-1265.	28.	211.	105.	40.1	24.6	-17.1	25.4	0.0818	0.0309	0.0077	7772.
11.3	142.	175.	48.	0.174	33.8	44118.	-202.	-1571.	28.	168.	74.	48.1	24.6	-9.2	28.2	0.0814	0.0431	0.0077	7772.
12.2	186.	199.	57.	0.176	28.2	44176.	59.	-1836.	26.	148.	54.	53.6	24.6	-3.6	28.3	0.0812	0.0549	0.0078	7772.
13.0	238.	222.	66.	0.179	24.1	44202.	407.	-2091.	34.	141.	45.	57.4	24.6	0.5	27.1	0.0811	0.0666	0.0078	7772.
13.8	295.	244.	75.	0.191	21.0	44238.	851.	-2361.	52.	142.	48.	59.6	24.6	3.6	25.2	0.0809	0.0783	0.0078	7772.
14.7	360.	266.	85.	0.191	18.5	44142.	1393.	-2656.	79.	148.	62.	61.7	24.6	6.1	22.9	0.0810	0.0900	0.0078	7772.
15.5	435.	288.	94.	0.188	16.6	43971.	2036.	-2988.	117.	159.	87.	63.4	24.6	8.0	20.6	0.0812	0.1017	0.0077	7772.
16.3	521.	311.	104.	0.180	15.0	42927.	2781.	-2336.	165.	116.	123.	64.0	24.6	9.6	17.9	0.0830	0.1125	0.0076	7772.
17.2	614.	334.	113.	0.183	13.7	41224.	3628.	-907.	223.	71.	170.	63.1	24.6	10.9	15.2	0.0863	0.1227	0.0073	7772.
18.0	716.	357.	123.	0.184	12.6	39305.	4578.	598.	291.	68.	229.	61.8	24.6	12.0	12.8	0.0904	0.1325	0.0069	7772.
19.0	837.	382.	133.	0.167	11.7	36927.	5631.	2246.	369.	104.	298.	61.2	24.6	12.9	10.6	0.0960	0.1416	0.0065	7772.
19.9	969.	407.	143.	0.165	10.9	34576.	6787.	3953.	457.	174.	379.	59.3	24.6	13.7	8.7	0.1024	0.1504	0.0061	7772.
21.0	1126.	435.	153.	0.149	10.1	31788.	8045.	5834.	555.	277.	470.	57.7	24.6	14.4	7.1	0.1112	0.1577	0.0056	7772.
22.2	1318.	467.	162.	0.130	9.5	28723.	9406.	7866.	663.	413.	572.	55.6	24.6	15.1	5.6	0.1229	0.1630	0.0051	7772.
23.5	1541.	502.	172.	0.118	9.0	25665.	10868.	10006.	781.	574.	686.	52.1	24.6	15.6	4.3	0.1375	0.1658	0.0045	7772.
24.9	1803.	542.	182.	0.107	8.5	22474.	12430.	12299.	909.	765.	810.	47.3	24.6	16.1	3.2	0.1571	0.1636	0.0040	7772.
26.6	2123.	587.	192.	0.092	8.0	19955.	13596.	13978.	979.	892.	880.	43.7	24.0	15.9	2.4	0.1772	0.1594	0.0035	7772.
28.4	2483.	635.	202.	0.086	7.6	18184.	14498.	15186.	1012.	964.	915.	40.3	23.0	15.4	1.9	0.1946	0.1567	0.0032	7772.
30.3	2882.	686.	212.	0.082	7.3	16448.	15425.	16459.	1047.	1039.	952.	35.8	22.2	14.9	1.4	0.2156	0.1479	0.0029	7772.
32.2	3308.	738.	222.	0.080	7.0	14831.	16383.	17796.	1084.	1118.	991.	29.8	21.4	14.5	1.0	0.2400	0.1393	0.0026	7772.
34.1	3742.	789.	232.	0.082	6.7	13507.	17410.	19195.	1127.	1201.	1038.	21.8	20.8	14.2	0.6	0.2648	0.1349	0.0024	7772.
36.0	4191.	839.	241.	0.083	6.4	12429.	18428.	20623.	1169.	1286.	1084.	12.4	20.2	13.8	0.3	0.2893	0.1342	0.0022	7772.
AIRPLANE MODE CLIMB TO 10,000 FT																			
36.0	4191.	839.	246.	0.0	14.2	13859.													
196.7	46673.	10000.	283.	0.0	11.7	12058.													

NOISE AT 500 FT SIDELINE=103.1 EPNDB

TIME	1.5	4.5	7.5	10.5	13.5	16.5	19.5	22.5	25.5	28.5	31.5	34.5	39.0	45.0
PNL	101.5	102.3	101.7	100.3	98.7	95.4	89.9	83.2	75.9	70.6	66.6	61.9	54.5	52.1

NOISE 500 FT FORWARD OF TAKEOFF POINT=104.5 EPNDB

NOISE AT 20,000 FT SIDELINE= 65.5 EPNDB

NOISE 25,000 FT FORWARD OF TAKEOFF POINT= 63.3 EPNDB

THE TOTAL NOISE IMPACT IS 0.11476D+07

TILT ROTOR DESIGN PROGRAM 1974

M-80-50

DESIGN ITERATIONS: 5

OVERALL		POWERPLANT		FUSELAGE		STRUCT TECHNOLOGY FACTORS	
GROSS WEIGHT (LB)	44200.	INST NORMAL PWR (HP)	9447.	*LENGTH (FT)	80.0	*ROTOR	1.00
EMPTY WEIGHT (LB)	29924.	*NUMBER OF ENGINES	2.	*DIAMETER (FT)	10.0	*TRANSMISSION	0.83
FUEL WEIGHT (LB)	4126.	*EXCESS FACTOR HEL MODE	1.30	*DRAG FACTOR	1.00	*AIRFRAME	0.78
PAYLOAD (LB)	10150.	*% RATED EMRG HVR	140.			*ENGINE (HP/LB)	8.50
CRUISE SPEED (MPH)	431.	* CONV + CLIMB	120.	FLAT PLATE AREAS (SF)		*ENGINE INSTALLATION	1.50
L/D CRUISE	10.11	* CRUISE	90.	WING PROFILE	3.15		
*RANGE (STAT MI)	500.	INST PWR EMRG HVR (HP)	9447.	FUSELAGE	5.31	DESIGN MISSION	
*PASSENGER SEATS	50.	CONVER (HP)	6566.	EMPENNAGE	1.89	*FIELD ELEVATION (FT)	0.
*CARGO (LB)	0.	CRUISE (HP)	7845.	TOTAL PROFILE	12.52	SOUND SPEED HVR (FPS)	1117.
		*SFC (LB/HP HR)	0.400	WING INDUCED	2.14	*STD DAY TEMP (DEG F)	59.
ROTORS						*EMERG HOVER ALT (FT)	2000.
*DISC LOADING (PSF)	12.00	DRIVE SYSTEM		COMPONENT WEIGHTS (LB)		*HOT DAY TEMP (DEG F)	95.
RADIUS (FT)	24.2	*EFFICIENCY	0.97	ROTORS	4076.	*CT/SIG MAX	0.150
SOLIDITY	0.143	HEL MODE WEIGHT (LB)	4018.	DRIVE SYSTEM	4901.	*MAX ACCELERATION (G)	0.25
BLADE CHORD (FT)	2.72	AIRPLANE WEIGHT (LB)	4901.	POWERPLANT	1667.	*DESIGN CRUISE (MPH)	400.
TOTAL BLADES	8			NACELLES	244.	*CRUISE ALTITUDE (FT)	15000.
*CT/SIG HOVER	0.120	WING		FUEL SYSTEM	345.	SOUND SPEED CRSE (FPS)	1058.
*PROFILE DRAG COEFF	0.010	AREA (SF)	465.	WING	3323.	*MAX DECELERATION (G)	0.20
% DOWNLOAD	5.0	*LOADING (PSF)	95.0	FUSELAGE	5569.	*STRUCT LOAD FACTOR	4.5
*EFFICIENCY HOVER	0.85	ASPECT RATIO	7.85	EMPENNAGE	862.	*FLIGHT CREW	2.
* CONVER	0.83	SPAN (FT)	60.4	LANDING GEAR	1326.	*CABIN CREW	1.
CRUISE	0.71	MEAN CHORD (FT)	7.70	FLIGHT CONTROLS	1888.	*ATC SPEED LIMIT	YES
HEL MODE WEIGHT (LB)	4076.	*THICKNESS/CHORD RATIO	0.210	HYDRAULICS	272.		
AIRPLANE WEIGHT (LB)	3928.	*TAPER RATIO	0.70	ELECTRICAL	696.		
*TIP SPEED HOVER	620.	SWEEP (DEG)	-5.3	INSTR+AVIONICS	703.		
* CRUISE	550.	CRUISE LIFT COEFF	0.32	AIR CONDITIONING	1150.		
*FUSELAGE CLEARNCE (FT)	2.0	MAX LIFT COEFF CONVER	1.34	FURNISHINGS	2500.		
*MAX HEL MODE ADV RATIO	0.40	*MAX LIFT COEFF CLEAN	1.40	FLUIDS	221.		
		*FLAP AREA/WING AREA	0.25	FLIGHT CREW	400.		
* INDICATES INPUT VARIABLE		CLIMB SPD/CONVER SPD	1.00	CABIN CREW	150.		

DESIGN MISSION	SPEED MPH	HEIGHT FT	DIST MI	TIME MIN	FUEL LB
TAKEOFF & LANDING				2.00	86.
ACCEL. & CONV.		900.	0.9	0.64	33.
AIRPLANE CLIMB	169.,210.	14100.	11.5	3.66	192.
ACCEL. TO CRUISE			9.7	1.67	93.
CRUISE	431.		443.0	61.69	2811.
AIRPLANE DESCENT	431.,292.	14100.	34.0	5.98	39.
DECEL. & CONV.		900.	0.9	1.10	9.
TOTAL			500.0	76.75	3263.
RESERVE				20.00	864.

M-80-50

STAGE LENGTH (MI.)	25.	50.	75.	100.	150.	200.	300.	400.	500.
CRUISE ALTITUDE (FT.)	2000.	4000.	10001.	12500.	15000.	15000.	15000.	15000.	15000.
CRUISE SPEED (MPH)	296.	305.	437.	438.	442.	442.	442.	442.	442.
CRUISE L/D	12.45	12.45	8.68	9.20	9.79	9.79	9.79	9.79	9.79
CRUISE DISTANCE (MI.)	17.5	35.7	29.9	48.8	90.9	140.9	240.9	340.9	440.9
BLOCK TIME (MIN.)	8.7	13.7	16.8	20.6	27.7	34.5	48.0	61.6	75.2
BLOCK FUEL (LB.)	281.	409.	592.	746.	1076.	1409.	2066.	2713.	3351.
BLOCK SPEED (MPH)	173.	219.	268.	292.	325.	348.	375.	390.	399.

DIRECT OPERATING COST - ANN UTILIZATION(HR)=2000. DEPRECIATION PERIOD(YR)=10. LABOR RATE($/HR)= 7.00
AIRFRAME COST ($/LB)= 80.0 ENGINE COST ($/HP)= 60.0 INSURANCE RATE=0.040 FUEL COST (CENTS/GAL)= 18.0
DOC=1.71+0.0253*SL $/SEAT-TRIP (SL= 25.,500.)
HOP LENGTHS 50+150+ 0+ 0+ 0=200 100+200+ 0+ 0+ 0=300 200+200+ 0+ 0+ 0=400

STAGE LENGTH	25.	50.	75.	100.	150.	200.	300.	400.	500.	200.	300.	400.
NO. CYCLES/STARTS	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	2/1	2/1	2/1
FLIGHT CREW	0.557	0.440	0.361	0.331	0.297	0.277	0.258	0.248	0.242	0.349	0.306	0.285
FUEL & OIL	0.313	0.228	0.220	0.208	0.199	0.196	0.191	0.188	0.186	0.206	0.200	0.196
HULL INSURANCE	0.326	0.258	0.211	0.194	0.174	0.162	0.151	0.145	0.142	0.195	0.173	0.162
TOTAL FLIGHT OPS	1.196	0.926	0.792	0.733	0.670	0.635	0.600	0.581	0.570	0.750	0.679	0.643
LABOR AIRFRAME	0.482	0.316	0.242	0.209	0.174	0.156	0.138	0.128	0.123	0.208	0.172	0.155
MATERIAL AIRFRAME	0.193	0.118	0.088	0.074	0.060	0.052	0.045	0.041	0.039	0.072	0.058	0.051
LABOR ENGINES	0.317	0.174	0.123	0.098	0.073	0.060	0.047	0.040	0.037	0.089	0.066	0.055
MATERIAL ENGINES	0.522	0.281	0.196	0.154	0.112	0.091	0.070	0.059	0.053	0.137	0.100	0.082
MAT. BURDEN	1.039	0.637	0.474	0.399	0.321	0.281	0.240	0.220	0.207	0.385	0.310	0.273
TOTAL MAINTENANCE	2.553	1.526	1.121	0.934	0.740	0.639	0.538	0.488	0.458	0.890	0.706	0.616
DEPRECIATION	0.946	0.748	0.613	0.563	0.504	0.471	0.438	0.421	0.411	0.565	0.501	0.471
TOTAL DIRECT OPERATING COST												
$/AIRCRAFT MILE	4.695	3.200	2.526	2.229	1.915	1.746	1.576	1.490	1.439	2.206	1.886	1.730
$/FLIGHT HOUR	813.9	701.6	675.8	650.0	622.7	607.9	590.6	580.7	574.1	639.9	616.9	602.6
$/SEAT MILE	0.0939	0.0640	0.0505	0.0446	0.0383	0.0349	0.0315	0.0298	0.0288	0.0441	0.0377	0.0346
$/SEAT-TRIP	2.35	3.20	3.79	4.46	5.74	6.98	9.46	11.92	14.39	8.82	11.32	13.84

Information Processing Center
Information Processing Center

M-80-50

DEPARTURE PATH TO 10,000 FT MSL

MAX FUSE ANGLE=20. OBSTACLE CLEAR ANGLE=60. OBSTACLE HEIGHT=100. MAX ACCEL ROTATION RATE=20. ACCEL BUILDUP TIME= 5.

TIME SEC	DIST FT	ALT FT	VEL FPS	ACC G	GAM DEG	THRUST LB	LWGO LB	LWGI LB	DWGO LB	DWGI LB	DFUST LB	ALP DEG	THE DEG	AWD DEG	ALV DEG	LAMDA	MU	CT	POWER HP
OBSTACLE CLEARANCE																			
3.1	4.	7.	3.	0.050	60.0	46909.	-0.	-585.	0.	765.	1.	29.3	24.6	-35.4	28.8	0.0853	0.0020	0.0139	6442.
4.0	7.	13.	8.	0.171	60.0	51647.	-4.	-714.	2.	700.	10.	26.5	24.6	-35.4	24.8	0.0929	0.0054	0.0154	7560.
5.0	13.	23.	13.	0.162	60.0	51265.	-10.	-727.	5.	656.	28.	26.7	24.6	-35.4	23.6	0.0966	0.0090	0.0152	7776.
6.2	24.	42.	18.	0.123	60.0	49719.	-19.	-720.	10.	604.	54.	27.5	24.6	-35.4	22.5	0.0996	0.0127	0.0148	7776.
7.9	43.	75.	23.	0.092	60.0	48536.	-32.	-723.	16.	587.	90.	28.3	24.6	-35.4	22.0	0.1020	0.0168	0.0144	7776.
8.5	58.	100.	24.	0.057	60.0	47245.	-48.	-725.	24.	561.	134.	29.1	24.6	-35.4	21.3	0.1048	0.0210	0.0141	7776.
ACCELERATION AND CONVERSION																			
9.5	76.	124.	33.	0.167	52.0	46214.	-86.	-992.	26.	330.	133.	29.8	24.6	-27.4	21.3	0.1071	0.0267	0.0138	7776.
10.4	104.	148.	40.	0.173	41.1	45648.	-172.	-1337.	28.	216.	99.	40.5	24.6	-16.6	25.8	0.1084	0.0413	0.0136	7776.
11.2	139.	171.	48.	0.175	33.3	45866.	-184.	-1656.	27.	173.	69.	48.5	24.6	-8.7	28.5	0.1078	0.0575	0.0137	7776.
12.1	183.	194.	57.	0.176	27.7	45925.	88.	-1930.	26.	153.	51.	54.0	24.6	-3.1	28.6	0.1076	0.0731	0.0137	7776.
13.0	235.	217.	66.	0.181	23.7	45962.	452.	-2193.	35.	146.	44.	57.6	24.6	0.9	27.3	0.1073	0.0888	0.0137	7776.
13.8	292.	239.	75.	0.190	20.6	45965.	915.	-2475.	55.	148.	48.	59.9	24.6	4.0	25.3	0.1071	0.1043	0.0138	7776.
14.6	358.	260.	84.	0.189	18.2	45881.	1480.	-2781.	85.	155.	63.	62.0	24.6	6.4	23.1	0.1071	0.1199	0.0137	7776.
15.5	433.	282.	94.	0.186	16.3	45700.	2149.	-3127.	125.	166.	90.	63.7	24.6	8.3	20.7	0.1073	0.1356	0.0137	7776.
16.4	525.	306.	104.	0.169	14.8	44452.	2924.	-2333.	176.	116.	127.	64.7	24.6	9.8	17.9	0.1101	0.1498	0.0133	7776.
17.2	619.	329.	113.	0.182	13.5	42773.	3804.	-866.	237.	72.	176.	63.1	24.6	11.1	15.2	0.1142	0.1635	0.0128	7776.
18.1	726.	352.	123.	0.174	12.4	40653.	4791.	729.	308.	71.	236.	62.3	24.6	12.2	12.8	0.1198	0.1764	0.0122	7776.
19.0	846.	377.	133.	0.169	11.5	38351.	5894.	2414.	390.	110.	307.	61.0	24.6	13.1	10.6	0.1267	0.1889	0.0115	7776.
20.0	985.	403.	143.	0.156	10.7	35701.	7083.	4239.	483.	187.	389.	59.7	24.6	13.9	8.7	0.1358	0.2001	0.0107	7776.
21.1	1145.	431.	152.	0.146	10.0	32902.	8389.	6177.	585.	296.	482.	57.7	24.6	14.6	7.1	0.1473	0.2103	0.0099	7776.
22.3	1345.	464.	162.	0.124	9.4	29642.	9800.	8316.	699.	442.	586.	55.8	24.6	15.2	5.6	0.1629	0.2171	0.0089	7776.
23.7	1577.	500.	172.	0.114	8.8	26447.	11316.	10553.	822.	614.	700.	52.2	24.6	15.8	4.3	0.1825	0.2208	0.0080	7776.
25.2	1851.	540.	182.	0.102	8.3	23114.	12936.	12953.	956.	816.	826.	47.2	24.6	16.3	3.2	0.2090	0.2175	0.0070	7776.
27.0	2183.	586.	192.	0.089	7.9	20660.	14058.	14562.	1019.	934.	886.	44.0	23.8	15.9	2.4	0.2341	0.2137	0.0062	7776.
28.8	2559.	635.	202.	0.083	7.5	18803.	14987.	15824.	1052.	1009.	921.	40.6	22.9	15.4	1.9	0.2575	0.2101	0.0057	7776.
30.8	2972.	687.	212.	0.079	7.2	16997.	15945.	17153.	1088.	1088.	958.	36.0	22.1	14.9	1.4	0.2857	0.1983	0.0051	7776.
32.8	3409.	740.	222.	0.078	6.8	15321.	16935.	18550.	1126.	1172.	998.	30.0	21.4	14.5	1.0	0.3186	0.1747	0.0046	7776.
34.7	3848.	790.	232.	0.082	6.5	13953.	17995.	20014.	1171.	1259.	1045.	21.9	20.7	14.2	0.6	0.3520	0.1493	0.0042	7776.
36.6	4295.	839.	242.	0.083	6.3	12834.	19079.	21543.	1216.	1350.	1093.	12.3	20.1	13.9	0.3	0.3854	0.0848	0.0039	7776.
38.5	4758.	889.	247.	0.083	6.1	12369.	19704.	22428.	1242.	1403.	1121.	6.2	19.8	13.7	0.1	0.4010	0.0446	0.0038	7776.
AIRPLANE MODE CLIMB TO 10,000 FT																			
38.5	4758.	889.	248.	0.0	16.1	15796.													
178.4	42023.	10000.	285.	0.0	13.4	13754.													

NOISE AT 500 FT SIDELINE= 95.0 EPNDB

TIME	1.5	4.5	7.5	10.5	13.5	16.5	19.5	22.5	25.5	28.5	31.5	34.5	37.5	42.0
PNL	93.2	94.0	93.4	92.2	90.7	87.8	82.9	77.0	70.8	66.1	62.2	57.8	52.9	51.9

NOISE 500 FT FORWARD OF TAKEOFF PCINT= 96.2 EPNDB

NOISE AT 20,000 FT SIDELINE= 60.7 EPNDB

NOISE 25,000 FT FORWARD OF TAKEOFF PCINT= 58.6 EPNDB

THE TOTAL NOISE IMPACT IS 0.50865D+06

TILT ROTOR DESIGN PROGRAM 1974

Q-80-50

DESIGN ITERATIONS: 5

OVERALL		POWERPLANT		FUSELAGE		STRUCT TECHNOLOGY FACTORS	
GROSS WEIGHT (LB)	47984.	INST NORMAL PWR (HP)	8784.	*LENGTH (FT)	80.0	*ROTOR	1.00
EMPTY WEIGHT (LB)	33861.	*NUMBER OF ENGINES	2.	*DIAMETER (FT)	10.0	*TRANSMISSION	0.83
FUEL WEIGHT (LB)	3973.	*EXCESS FACTOR HEL MODE	1.40	*DRAG FACTOR	1.00	*AIRFRAME	0.78
PAYLOAD (LB)	10150.	*% RATED EMRG HVR	140.			*ENGINE (HP/LB)	8.50
CRUISE SPEED (MPH)	411.	* CONV + CLIMB	120.	FLAT PLATE AREAS (SF)		*ENGINE INSTALLATION	1.54
L/D CRUISE	10.55	* CRUISE	90.	WING PROFILE	4.23		
*RANGE (STAT MI)	500.	INST PWR EMRG HVR (HP)	8784.	FUSELAGE	5.31	DESIGN MISSION	
*PASSENGER SEATS	50.	CONVER (HP)	6572.	EMPENNAGE	2.54	*FIELD ELEVATION (FT)	0.
*CARGO (LB)	0.	CRUISE (HP)	8287.	TOTAL PROFILE	14.61	SOUND SPEED HVR (FPS)	1117.
		*SFC (LB/HP HR)	0.400	WING INDUCED	2.29	*STD DAY TEMP (DEG F)	59.
ROTORS						*EMERG HOVER ALT (FT)	2000.
*DISC LOADING (PSF)	9.00	DRIVE SYSTEM		COMPONENT WEIGHTS (LB)		*HOT DAY TEMP (DEG F)	95.
RADIUS (FT)	29.1	*EFFICIENCY	0.97	ROTORS	5471.	*CT/SIG MAX	0.150
SOLIDITY	0.179	HEL MODE WEIGHT (LB)	5714.	DRIVE SYSTEM	6248.	*MAX ACCELERATION (G)	0.25
BLADE CHORD (FT)	2.73	AIRPLANE WEIGHT (LB)	6248.	POWERPLANT	1550.	*DESIGN CRUISE (MPH)	400.
TOTAL BLADES	12			NACELLES	206.	*CRUISE ALTITUDE (FT)	15000.
*CT/SIG HOVER	0.120	WING		FUEL SYSTEM	323.	SOUND SPEED CRSE (FPS)	1058.
*PROFILE DRAG COEFF	0.010	AREA (SF)	640.	WING	4111.	*MAX DECELERATION (G)	0.20
% DOWNLOAD	4.9	*LOADING (PSF)	75.0	FUSELAGE	5638.	*STRUCT LOAD FACTOR	4.5
*EFFICIENCY HOVER	0.85	ASPECT RATIO	7.72	EMPENNAGE	936.	*FLIGHT CREW	2.
* CONVER	0.83	SPAN (FT)	70.3	LANDING GEAR	1440.	*CABIN CREW	1.
CRUISE	0.71	MEAN CHORD (FT)	9.11	FLIGHT CONTROLS	2120.	*ATC SPEED LIMIT	YES
HEL MODE WEIGHT (LB)	5270.	*THICKNESS/CHORD RATIO	0.210	HYDRAULICS	283.		
AIRPLANE WEIGHT (LB)	5471.	*TAPER RATIO	0.70	ELECTRICAL	782.		
*TIP SPEED HOVER	480.	SWEEP (DEG)	-5.3	INSTR+AVIONICS	703.		
* CRUISE	480.	CRUISE LIFT COEFF	0.28	AIR CONDITIONING	1150.		
*FUSELAGE CLEARNCE (FT)	2.0	MAX LIFT COEFF CONVER	1.76	FURNISHINGS	2500.		
*MAX HEL MODE ADV RATIO	0.40	*MAX LIFT COEFF CLEAN	1.40	FLUIDS	240.		
		*FLAP AREA/WING AREA	0.25	FLIGHT CREW	400.		
* INDICATES INPUT VARIABLE		CLIMB SPD/CONVER SPD	1.20	CABIN CREW	150.		

DESIGN MISSION	SPEED MPH	HEIGHT FT	DIST MI	TIME MIN	FUEL LB
TAKEOFF & LANDING				2.00	80.
ACCEL. & CONV.		1000.	0.8	0.61	31.
AIRPLANE CLIMB	157.,195.	14000.	11.6	3.94	189.
ACCEL. TO CRUISE			9.5	1.73	88.
CRUISE	411.		443.4	64.74	2739.
AIRPLANE DESCENT	411.,292.	14000.	33.9	6.03	34.
DECEL. & CONV.		1000.	0.8	1.12	8.
TOTAL			500.0	80.16	3171.
RESERVE				20.00	802.

Q-80-50

STAGE LENGTH (MI.)	25.	50.	75.	100.	150.	200.	300.	400.	500.
CRUISE ALTITUDE (FT.)	2000.	4000.	10001.	12500.	15000.	15000.	15000.	15000.	15000.
CRUISE SPEED (MPH)	296.	305.	406.	410.	411.	411.	411.	411.	411.
CRUISE L/D	12.37	12.37	9.36	9.98	10.55	10.55	10.55	10.55	10.55
CRUISE DISTANCE (MI.)	17.6	35.8	32.7	50.3	92.7	142.7	242.7	342.7	442.7
BLOCK TIME (MIN.)	8.7	13.8	17.4	21.4	29.1	36.4	51.0	65.6	80.2
BLOCK FUEL (LB.)	274.	401.	564.	707.	1019.	1332.	1952.	2564.	3167.
BLOCK SPEED (MPH)	172.	218.	259.	280.	309.	330.	353.	366.	374.

DIRECT OPERATING COST - ANN UTILIZATION(HR)=2000. DEPRECIATION PERIOD(YR)=10. LABOR RATE($/HR)= 7.00
AIRFRAME COST ($/LB)= 80.0 ENGINE COST ($/HP)= 60.0 INSURANCE RATE=0.040 FUEL COST (CENTS/GAL)= 18.0
DOC=1.72+0.0280*SL $/SEAT-TRIP (SL= 25.,500.)
HOP LENGTHS 50+150+ 0+ 0+ 0=200 100+200+ 0+ 0+ 0=300 200+200+ 0+ 0+ 0=400

STAGE LENGTH	25.	50.	75.	100.	150.	200.	300.	400.	500.	200.	300.	400.
NO. CYCLES/STARTS	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	2/1	2/1	2/1
FLIGHT CREW	0.556	0.440	0.370	0.341	0.309	0.290	0.271	0.261	0.256	0.358	0.318	0.298
FUEL & OIL	0.305	0.223	0.209	0.197	0.189	0.185	0.181	0.178	0.176	0.197	0.189	0.185
HULL INSURANCE	0.362	0.286	0.241	0.222	0.201	0.189	0.176	0.170	0.166	0.222	0.200	0.189
TOTAL FLIGHT OPS	1.222	0.949	0.820	0.759	0.699	0.664	0.628	0.610	0.598	0.778	0.706	0.672
LABOR AIRFRAME	0.503	0.330	0.257	0.223	0.188	0.169	0.150	0.141	0.135	0.222	0.186	0.168
MATERIAL AIRFRAME	0.212	0.130	0.098	0.083	0.068	0.060	0.051	0.047	0.045	0.081	0.066	0.058
LABOR ENGINES	0.310	0.171	0.121	0.097	0.073	0.060	0.048	0.041	0.038	0.088	0.066	0.056
MATERIAL ENGINES	0.486	0.262	0.183	0.145	0.106	0.086	0.066	0.057	0.051	0.128	0.095	0.078
MAT. BURDEN	1.057	0.651	0.491	0.417	0.339	0.298	0.257	0.237	0.224	0.402	0.328	0.291
TOTAL MAINTENANCE	2.569	1.543	1.151	0.965	0.774	0.674	0.573	0.523	0.493	0.921	0.741	0.651
DEPRECIATION	1.040	0.823	0.692	0.638	0.579	0.543	0.507	0.489	0.479	0.640	0.575	0.543
TOTAL DIRECT OPERATING COST												
$/AIRCRAFT MILE	4.832	3.315	2.663	2.363	2.052	1.881	1.708	1.622	1.569	2.338	2.022	1.866
$/FLIGHT HOUR	831.6	721.3	688.8	662.8	634.9	620.1	603.1	593.4	587.1	654.4	629.9	615.3
$/SEAT MILE	0.0966	0.0663	0.0533	0.0473	0.0410	0.0376	0.0342	0.0324	0.0314	0.0468	0.0404	0.0373
$/SEAT-TRIP	2.42	3.32	3.99	4.73	6.16	7.52	10.25	12.97	15.69	9.35	12.13	14.93

Q-80-50

DEPARTURE PATH TO 10,000 FT MSL

MAX FUSE ANGLE=20. OBSTACLE CLEAR ANGLE=60. OBSTACLE HEIGHT=100. MAX ACCEL ROTATION RATE=20. ACCEL BUILDUP TIME= 5.

TIME SEC	DIST FT	ALT FT	VEL FPS	ACC G	GAM DEG	THRUST LB	LWGO LB	LWGI LB	DWGO LB	DWGI LB	DFUST LB	ALP DEG	THE DEG	AWO DEG	ALV DEG	LAMDA	MU	CT	POWER HP
OBSTACLE CLEARANCE																			
3.1	4.	7.	3.	0.050	60.0	50914.	-1.	-632.	0.	823.	1.	29.3	24.6	-35.4	28.7	0.0954	0.0026	0.0174	5971.
4.0	7.	13.	8.	0.171	60.0	56048.	-5.	-768.	2.	740.	10.	26.5	24.6	-35.4	24.5	0.1050	0.0070	0.0192	7085.
4.7	12.	20.	13.	0.221	60.0	58204.	-13.	-822.	6.	721.	28.	25.5	24.6	-35.4	23.2	0.1119	0.0116	0.0199	7771.
5.6	19.	33.	18.	0.178	60.0	56344.	-26.	-836.	13.	634.	55.	26.3	24.6	-35.4	20.9	0.1156	0.0157	0.0193	7771.
6.7	32.	56.	23.	0.136	60.0	54589.	-42.	-832.	21.	606.	90.	27.2	24.6	-35.4	20.3	0.1194	0.0208	0.0187	7771.
8.4	55.	95.	28.	0.093	60.0	52800.	-63.	-828.	31.	577.	135.	28.2	24.6	-35.4	19.6	0.1234	0.0262	0.0181	7771.
8.5	58.	100.	28.	0.055	60.0	51270.	-88.	-837.	43.	560.	188.	29.2	24.6	-35.4	18.9	0.1271	0.0320	0.0176	7771.
ACCELERATION AND CONVERSION																			
9.5	80.	129.	37.	0.156	52.7	49906.	-139.	-1092.	45.	353.	173.	29.6	24.6	-28.1	18.2	0.1305	0.0374	0.0171	7771.
10.4	109.	156.	44.	0.172	42.5	49719.	-261.	-1482.	46.	259.	132.	39.3	24.6	-17.9	22.0	0.1309	0.0570	0.0171	7771.
11.4	151.	185.	52.	0.158	35.0	49982.	-391.	-1849.	48.	211.	97.	47.8	24.6	-10.4	24.0	0.1301	0.0784	0.0172	7771.
12.3	201.	214.	60.	0.160	29.5	50053.	-30.	-2203.	41.	190.	73.	53.1	24.6	-4.9	23.7	0.1297	0.0988	0.0172	7771.
13.3	259.	241.	69.	0.169	25.4	50128.	449.	-2574.	49.	185.	61.	56.5	24.6	-0.8	22.3	0.1292	0.1192	0.0173	7771.
14.2	326.	268.	78.	0.167	22.3	50071.	1054.	-2979.	70.	189.	60.	59.4	24.6	2.3	20.4	0.1291	0.1395	0.0173	7771.
15.1	404.	296.	87.	0.163	19.8	49933.	1790.	-3435.	105.	201.	71.	61.7	24.6	4.8	18.3	0.1291	0.1600	0.0172	7771.
16.1	497.	326.	97.	0.154	17.8	48389.	2661.	-3044.	153.	168.	93.	63.1	24.6	6.8	15.9	0.1312	0.1792	0.0169	7771.
17.1	590.	353.	107.	0.171	16.1	47009.	3668.	-1261.	216.	104.	126.	61.5	24.6	8.5	13.4	0.1363	0.1970	0.0163	7771.
18.1	712.	385.	116.	0.143	14.8	44169.	4813.	771.	292.	98.	170.	61.9	24.6	9.8	10.9	0.1446	0.2129	0.0153	7771.
19.3	849.	418.	126.	0.138	13.6	41336.	6095.	2871.	381.	145.	225.	60.6	24.6	11.0	9.0	0.1540	0.2289	0.0143	7771.
20.5	1011.	455.	136.	0.127	12.6	38093.	7515.	5171.	485.	240.	292.	59.1	24.6	12.0	7.2	0.1667	0.2430	0.0132	7771.
21.8	1203.	495.	145.	0.115	11.7	34558.	9073.	7661.	602.	379.	370.	56.9	24.6	12.8	5.7	0.1832	0.2547	0.0120	7771.
23.3	1431.	539.	155.	0.104	11.0	30782.	10767.	10351.	733.	560.	459.	53.7	24.6	13.6	4.4	0.2054	0.2621	0.0107	7771.
25.0	1703.	588.	165.	0.093	10.3	26800.	12597.	13257.	878.	782.	558.	49.1	24.6	14.3	3.2	0.2359	0.2619	0.0093	7771.
26.8	2019.	643.	175.	0.085	9.7	22807.	14562.	16380.	1036.	1042.	669.	42.1	24.6	14.8	2.2	0.2783	0.2472	0.0080	7771.
28.8	2377.	701.	185.	0.079	9.2	19516.	16301.	19133.	1160.	1269.	759.	34.0	24.2	15.0	1.4	0.3275	0.2156	0.0068	7771.
30.8	2768.	761.	195.	0.076	8.7	17456.	17459.	20886.	1206.	1375.	798.	27.8	23.3	14.5	0.9	0.3693	0.1848	0.0061	7771.
32.8	3167.	819.	204.	0.079	8.3	15935.	18712.	22733.	1260.	1487.	843.	19.1	22.5	14.2	0.6	0.4088	0.1400	0.0055	7771.
34.8	3588.	878.	214.	0.078	7.9	14592.	20008.	24672.	1317.	1605.	890.	8.5	21.8	13.8	0.2	0.4470	0.0687	0.0051	7771.
37.0	4075.	943.	224.	0.071	7.6	13857.	21385.	26598.	1380.	1717.	943.	-3.2	21.1	13.5	0.0	0.4712	-0.0347	0.0049	7771.
39.2	4582.	1009.	230.	0.070	7.4	13510.	21421.	26562.	1331.	1650.	919.	-3.2	20.3	12.9	0.0	0.4835	-0.0270	0.0048	7771.
AIRPLANE MODE CLIMB TO 10,000 FT																			
39.2	4582.	1009.	231.	0.0		15.8	16666.												
189.0	41702.	10000.	265.	0.0		13.2	14537.												

NOISE AT 500 FT SIDELINE= 90.0 EPNDB

TIME	1.5	4.5	7.5	10.5	13.5	16.5	19.5	22.5	25.5	28.5	31.5
PNL	88.2	89.2	88.5	87.1	85.5	82.7	78.3	73.2	67.7	62.1	57.7

NOISE 500 FT FORWARD OF TAKEOFF POINT= 91.0 EPNDB

NOISE AT 20,000 FT SIDELINE= 56.6 EPNDB

NOISE 25,000 FT FORWARD OF TAKEOFF POINT= 54.5 EPNDB

THE TOTAL NOISE IMPACT IS 0.21649D+06

TILT ROTOR DESIGN PROGRAM 1974

D-80-50 DESIGN ITERATIONS: 5

OVERALL		POWERPLANT		FUSELAGE		STRUCT TECHNOLOGY FACTORS	
GROSS WEIGHT (LB)	51906.	INST NORMAL PWR (HP)	8328.	*LENGTH (FT)	80.0	*ROTOR	1.00
EMPTY WEIGHT (LB)	37778.	*NUMBER OF ENGINES	2.	*DIAMETER (FT)	10.0	*TRANSMISSION	0.83
FUEL WEIGHT (LB)	3978.	*EXCESS FACTOR HEL MODE	1.50	*DRAG FACTOR	1.00	*AIRFRAME	0.78
PAYLOAD (LB)	10150.	*% RATED EMRG HVR	140.			*ENGINE (HP/LB)	8.50
CRUISE SPEED (MPH)	351.	* CONV + CLIMB	120.	FLAT PLATE AREAS (SF)		*ENGINE INSTALLATION	1.60
L/D CRUISE	12.52	* CRUISE	90.	WING PROFILE	5.49		
*RANGE (STAT MI)	500.	INST PWR EMRG HVR (HP)	8328.	FUSELAGE	5.43	DESIGN MISSION	
*PASSENGER SEATS	50.	CONVER (HP)	6710.	EMPENNAGE	3.29	*FIELD ELEVATION (FT)	0.
*CARGO (LB)	0.	CRUISE (HP)	7761.	TOTAL PROFILE	17.19	SOUND SPEED HVR (FPS)	1117.
		*SFC (LB/HP HR)	0.400	WING INDUCED	3.75	*STD DAY TEMP (DEG F)	59.
ROTORS						*EMERG HOVER ALT (FT)	2000.
*DISC LOADING (PSF)	7.00	DRIVE SYSTEM		COMPONENT WEIGHTS (LB)		*HOT DAY TEMP (DEG F)	95.
RADIUS (FT)	34.4	*EFFICIENCY	0.97	ROTORS	6541.	*CT/SIG MAX	0.150
SOLIDITY	0.200	HEL MODE WEIGHT (LB)	7634.	DRIVE SYSTEM	7825.	*MAX ACCELERATION (G)	0.25
BLADE CHORD (FT)	2.70	AIRPLANE WEIGHT (LB)	7825.	POWERPLANT	1470.	*DESIGN CRUISE (MPH)	340.
TOTAL BLADES	16			NACELLES	181.	*CRUISE ALTITUDE (FT)	15000.
*CT/SIG HOVER	0.120	WING		FUEL SYSTEM	324.	SOUND SPEED CRSE (FPS)	1058.
*PROFILE DRAG COEFF	0.010	AREA (SF)	824.	WING	4872.	*MAX DECELERATION (G)	0.20
% DOWNLOAD	4.7	*LOADING (PSF)	63.0	FUSELAGE	5705.	*STRUCT LOAD FACTOR	4.5
*EFFICIENCY HOVER	0.85	ASPECT RATIO	7.91	EMPENNAGE	1012.	*FLIGHT CREW	2.
* CONVER	0.83	SPAN (FT)	80.7	LANDING GEAR	1557.	*CABIN CREW	1.
CRUISE	0.64	MEAN CHORD (FT)	10.21	FLIGHT CONTROLS	2368.	*ATC SPEED LIMIT	YES
HEL MODE WEIGHT (LB)	6474.	*THICKNESS/CHORD RATIO	0.210	HYDRAULICS	295.		
AIRPLANE WEIGHT (LB)	6541.	*TAPER RATIO	0.70	ELECTRICAL	874.		
*TIP SPEED HOVER	400.	SWEEP (DEG)	-5.3	INSTR+AVIONICS	703.		
* CRUISE	400.	CRUISE LIFT COEFF	0.32	AIR CONDITIONING	1150.		
*FUSELAGE CLEARNCE (FT)	2.0	MAX LIFT COEFF CONVER	2.16	FURNISHINGS	2500.		
*MAX HEL MODE ADV RATIO	0.40	*MAX LIFT COEFF CLEAN	1.40	FLUIDS	260.		
		*FLAP AREA/WING AREA	0.25	FLIGHT CREW	400.		
* INDICATES INPUT VARIABLE		CLIMB SPD/CONVER SPD	1.35	CABIN CREW	150.		

DESIGN MISSION	SPEED MPH	HEIGHT FT	DIST MI	TIME MIN	FUEL LB
TAKEOFF & LANDING				2.00	76.
ACCEL. & CONV.		1400.	1.0	0.81	42.
AIRPLANE CLIMB	148.,192.	13600.	12.1	4.43	199.
ACCEL. TO CRUISE			5.7	1.21	58.
CRUISE	351.		444.5	75.94	2798.
AIRPLANE DESCENT	351.,284.	13600.	35.6	6.76	36.
DECEL. & CONV.		1400.	1.0	1.33	10.
TOTAL			500.0	92.50	3218.
RESERVE				20.00	760.

D-80-50

STAGE LENGTH (MI.)	25.	50.	75.	100.	150.	200.	300.	400.	500.
CRUISE ALTITUDE (FT.)	2000.	4000.	10001.	12500.	15000.	15000.	15000.	15000.	15000.
CRUISE SPEED (MPH)	296.	305.	354.	353.	351.	351.	351.	351.	351.
CRUISE L/D	11.97	11.97	11.19	11.84	12.52	12.52	12.52	12.52	12.52
CRUISE DISTANCE (MI.)	17.9	36.0	37.8	54.5	94.5	144.5	244.5	344.5	444.5
BLOCK TIME (MIN.)	9.1	14.2	18.8	23.5	32.7	41.2	58.3	75.4	92.5
BLOCK FUEL (LB.)	303.	451.	579.	722.	1028.	1347.	1978.	2602.	3218.
BLOCK SPEED (MPH)	165.	211.	239.	255.	275.	291.	309.	318.	324.

DIRECT OPERATING COST - ANN UTILIZATION(HR)=2000. DEPRECIATION PERIOD(YR)=10. LABOR RATE($/HR)= 7.00
AIRFRAME COST ($/LB)= 80.0 ENGINE COST ($/HP)= 60.0 INSURANCE RATE=0.040 FUEL COST (CENTS/GAL)= 18.0
DOC=1.73+0.0335*SL $/SEAT-TRIP (SL= 25.,500.)
HOP LENGTHS 50+150+ 0+ 0+ 0=200 100+200+ 0+ 0+ 0=300 200+200+ 0+ 0+ 0=400

STAGE LENGTH	25.	50.	75.	100.	150.	200.	300.	400.	500.	200.	300.	400.
NO. CYCLES/STARTS	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	2/1	2/1	2/1
FLIGHT CREW	0.568	0.445	0.392	0.368	0.341	0.322	0.304	0.295	0.289	0.382	0.348	0.330
FUEL & OIL	0.338	0.251	0.215	0.201	0.191	0.187	0.183	0.181	0.179	0.206	0.192	0.187
HULL INSURANCE	0.413	0.323	0.285	0.267	0.247	0.234	0.221	0.214	0.210	0.266	0.245	0.234
TOTAL FLIGHT OPS	1.319	1.019	0.892	0.835	0.779	0.744	0.708	0.689	0.678	0.854	0.785	0.751
LABOR AIRFRAME	0.533	0.348	0.281	0.249	0.214	0.194	0.175	0.165	0.159	0.245	0.211	0.193
MATERIAL AIRFRAME	0.235	0.144	0.112	0.096	0.080	0.071	0.062	0.058	0.055	0.093	0.077	0.070
LABOR ENGINES	0.307	0.169	0.122	0.099	0.075	0.063	0.051	0.045	0.041	0.090	0.069	0.058
MATERIAL ENGINES	0.463	0.250	0.177	0.141	0.105	0.086	0.067	0.058	0.052	0.125	0.094	0.078
MAT. BURDEN	1.093	0.673	0.524	0.451	0.376	0.335	0.293	0.272	0.260	0.436	0.364	0.327
TOTAL MAINTENANCE	2.632	1.584	1.216	1.035	0.850	0.749	0.648	0.598	0.568	0.989	0.815	0.727
DEPRECIATION	1.180	0.923	0.814	0.763	0.708	0.669	0.631	0.612	0.600	0.762	0.701	0.669
TOTAL DIRECT OPERATING COST												
$/AIRCRAFT MILE	5.131	3.526	2.922	2.633	2.336	2.162	1.987	1.899	1.846	2.605	2.300	2.148
$/FLIGHT HOUR	846.4	743.6	698.9	671.9	643.0	629.1	613.2	604.4	598.7	666.1	639.2	624.8
$/SEAT MILE	0.1026	0.0705	0.0584	0.0527	0.0467	0.0432	0.0397	0.0380	0.0369	0.0521	0.0460	0.0430
$/SEAT-TRIP	2.57	3.53	4.38	5.27	7.01	8.65	11.92	15.19	18.46	10.42	13.80	17.18

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DEPARTURE PATH TO 10,000 FT MSL

MAX FUSE ANGLE=20. OBSTACLE CLEAR ANGLE=60. OBSTACLE HEIGHT=100. MAX ACCEL ROTATION RATE=20. ACCEL BUILDUP TIME= 5.

TIME SEC	DIST FT	ALT FT	VEL FPS	ACC G	GAM DEG	THRUST LB	LWGO LB	LWGI LB	DWGO LB	DWGI LB	DFUST LB	ALP DEG	THE DEG	AWO DEG	ALV DEG	LAMDA	MU	CT	POWER HP
OBSTACLE CLEARANCE																			
3.1	4.	7.	3.	0.050	60.0	55026.	-1.	-651.	0.	842.	1.	29.3	24.6	-35.4	28.6	0.1013	0.0031	0.0195	5674.
4.0	7.	13.	8.	0.171	60.0	60581.	-6.	-797.	3.	752.	10.	26.4	24.6	-35.4	24.2	0.1121	0.0083	0.0215	6773.
4.7	12.	20.	13.	0.227	60.0	63177.	-16.	-880.	8.	704.	28.	25.3	24.6	-35.4	21.8	0.1202	0.0134	0.0224	7495.
5.4	17.	30.	18.	0.229	60.0	63336.	-32.	-913.	16.	667.	55.	25.3	24.6	-35.4	20.3	0.1267	0.0187	0.0225	7887.
6.3	27.	48.	23.	0.175	60.0	60786.	-52.	-907.	26.	604.	91.	26.4	24.6	-35.4	18.8	0.1320	0.0240	0.0216	7887.
7.5	44.	76.	28.	0.129	60.0	58713.	-78.	-911.	39.	584.	135.	27.4	24.6	-35.4	18.1	0.1367	0.0305	0.0209	7887.
7.9	58.	100.	29.	0.084	60.0	56753.	-109.	-924.	54.	567.	189.	28.4	24.6	-35.4	17.3	0.1414	0.0374	0.0202	7887.
ACCELERATION AND CONVERSION																			
9.7	96.	155.	38.	0.090	55.3	54952.	-175.	-1111.	65.	435.	216.	31.1	24.6	-30.7	17.5	0.1460	0.0488	0.0196	7887.
11.0	138.	200.	46.	0.115	46.7	53512.	-321.	-1470.	72.	328.	196.	38.0	24.6	-22.1	18.5	0.1498	0.0695	0.0191	7887.
12.4	197.	247.	54.	0.110	38.8	53916.	-529.	-1887.	75.	267.	151.	46.5	24.6	-14.3	20.3	0.1484	0.0956	0.0192	7887.
13.9	272.	296.	62.	0.107	33.0	54262.	-460.	-2324.	71.	238.	117.	52.6	24.6	-8.4	20.1	0.1472	0.1205	0.0194	7887.
15.2	352.	339.	70.	0.121	28.6	54373.	92.	-2803.	66.	230.	95.	56.0	24.6	-4.0	18.8	0.1465	0.1446	0.0195	7887.
16.5	444.	382.	79.	0.121	25.1	54357.	791.	-3334.	80.	234.	84.	59.2	24.6	-0.5	17.0	0.1461	0.1691	0.0195	7887.
17.8	552.	427.	88.	0.118	22.3	54255.	1648.	-3937.	109.	248.	85.	61.7	24.6	2.2	15.2	0.1459	0.1937	0.0195	7887.
19.2	682.	474.	98.	0.110	20.1	52899.	2667.	-3186.	156.	198.	98.	63.0	24.6	4.5	13.0	0.1491	0.2163	0.0190	7887.
20.6	820.	520.	107.	0.114	18.3	50241.	3851.	-1002.	219.	139.	121.	62.1	24.6	6.3	10.7	0.1564	0.2370	0.0181	7887.
22.0	977.	567.	117.	0.110	16.7	47126.	5203.	1377.	298.	145.	157.	61.2	24.6	7.9	8.7	0.1661	0.2568	0.0170	7887.
23.4	1156.	616.	126.	0.106	15.4	43639.	6722.	3970.	395.	210.	203.	59.7	24.6	9.2	7.0	0.1787	0.2751	0.0157	7887.
25.1	1372.	671.	136.	0.094	14.3	39675.	8410.	6818.	507.	330.	261.	57.9	24.6	10.3	5.5	0.1958	0.2910	0.0143	7887.
27.1	1666.	741.	146.	0.075	13.3	35170.	10265.	9959.	637.	505.	330.	55.7	24.6	11.3	4.2	0.2204	0.3020	0.0127	7887.
29.5	2017.	819.	155.	0.067	12.5	30618.	12283.	13318.	782.	725.	410.	51.4	24.6	12.1	3.1	0.2529	0.3062	0.0111	7887.
32.1	2438.	906.	165.	0.060	11.7	25902.	14464.	16960.	944.	992.	501.	44.9	24.6	12.9	2.1	0.2999	0.2952	0.0094	7887.
34.7	2892.	995.	175.	0.059	11.1	21452.	16804.	20877.	1121.	1305.	603.	34.5	24.6	13.5	1.3	0.3656	0.2529	0.0078	7887.
37.2	3342.	1078.	185.	0.063	10.5	17979.	19254.	24994.	1309.	1653.	712.	18.9	24.5	14.1	0.6	0.4436	0.1509	0.0066	7887.
39.7	3819.	1162.	195.	0.062	9.9	16484.	20727.	27301.	1374.	1790.	759.	8.2	23.7	13.7	0.2	0.4873	0.0719	0.0060	7887.
42.5	4394.	1257.	204.	0.055	9.4	15625.	22308.	29597.	1448.	1921.	812.	-3.8	22.9	13.5	0.0	0.5148	-0.0441	0.0057	7887.
45.4	5003.	1354.	213.	0.054	9.1	15010.	22367.	29538.	1367.	1805.	786.	-3.8	21.5	12.4	0.0	0.5362	-0.0357	0.0055	7887.
AIRPLANE MODE CLIMB TO 10,000 FT																			
45.4	5003.	1354.	216.	0.0		14.5	16661.												
212.2	43602.	10000.	247.	0.0		12.2	14606.												

NOISE AT 500 FT SIDELINE= 86.8 EPNDB

TIME	1.5	4.5	7.5	10.5	13.5	16.5	19.5	22.5	25.5	28.5	31.5
PNL	84.8	85.9	85.2	83.5	81.9	79.8	77.1	73.6	69.7	65.6	61.8

NOISE 500 FT FORWARD OF TAKEOFF POINT= 87.5 EPNDB

NOISE AT 20,000 FT SIDELINE= 54.4 EPNDB

NOISE 25,000 FT FORWARD OF TAKEOFF POINT= 52.5 EPNDB

THE TOTAL NOISE IMPACT IS 0.10338D+06

TILT ROTOR DESIGN PROGRAM 1974

S-80-50

DESIGN ITERATIONS: 5

OVERALL		POWERPLANT		FUSELAGE		STRUCT TECHNOLOGY FACTORS	
GROSS WEIGHT (LB)	59672.	INST NORMAL PWR (HP)	9190.	*LENGTH (FT)	80.0	*ROTOR	1.00
EMPTY WEIGHT (LB)	44719.	*NUMBER OF ENGINES	2.	*DIAMETER (FT)	10.0	*TRANSMISSION	0.83
FUEL WEIGHT (LB)	4803.	*EXCESS FACTOR HEL MODE	1.65	*DRAG FACTOR	1.00	*AIRFRAME	0.78
PAYLOAD (LB)	10150.	*% RATED EMRG HVR	140.			*ENGINE (HP/LB)	8.50
CRUISE SPEED (MPH)	284.	* CONV + CLIMB	120.	FLAT PLATE AREAS (SF)		*ENGINE INSTALLATION	1.70
L/D CRUISE	14.57	* CRUISE	90.	WING PROFILE	7.85		
*RANGE (STAT MI)	500.	INST PWR EMRG HVR (HP)	9190.	FUSELAGE	5.58	DESIGN MISSION	
*PASSENGER SEATS	50.	CONVER (HP)	8144.	EMPENNAGE	4.71	*FIELD ELEVATION (FT)	0.
*CARGO (LB)	0.	CRUISE (HP)	9000.	TOTAL PROFILE	21.95	SOUND SPEED HVR (FPS)	1117.
		*SFC (LB/HP HR)	0.400	WING INDUCED	9.58	*STD DAY TEMP (DEG F)	59.
ROTORS						*EMERG HOVER ALT (FT)	2000.
*DISC LOADING (PSF)	6.50	DRIVE SYSTEM		COMPONENT WEIGHTS (LB)		*HOT DAY TEMP (DEG F)	95.
RADIUS (FT)	38.2	*EFFICIENCY	0.97	ROTORS	8491.	*CT/SIG MAX	0.150
SOLIDITY	0.245	HEL MODE WEIGHT (LB)	10790.	DRIVE SYSTEM	10790.	*MAX ACCELERATION (G)	0.25
BLADE CHORD (FT)	3.68	AIRPLANE WEIGHT (LB)	10222.	POWERPLANT	1622.	*DESIGN CRUISE (MPH)	280.
TOTAL BLADES	16			NACELLES	229.	*CRUISE ALTITUDE (FT)	15000.
*CT/SIG HOVER	0.120	WING		FUEL SYSTEM	447.	SOUND SPEED CRSE (FPS)	1058.
*PROFILE DRAG COEFF	0.010	AREA (SF)	1193.	WING	5345.	*MAX DECELERATION (G)	0.20
% DOWNLOAD	5.5	*LOADING (PSF)	50.0	FUSELAGE	5825.	*STRUCT LOAD FACTOR	4.5
*EFFICIENCY HOVER	0.85	ASPECT RATIO	6.56	EMPENNAGE	1163.	*FLIGHT CREW	2.
* CONVER	0.83	SPAN (FT)	88.4	LANDING GEAR	1790.	*CABIN CREW	1.
CRUISE	0.51	MEAN CHORD (FT)	13.49	FLIGHT CONTROLS	2882.	*ATC SPEED LIMIT	YES
HEL MODE WEIGHT (LB)	8491.	*THICKNESS/CHORD RATIO	0.210	HYDRAULICS	316.		
AIRPLANE WEIGHT (LB)	8301.	*TAPER RATIO	0.70	ELECTRICAL	1065.		
*TIP SPEED HOVER	350.	SWEEP (DEG)	-5.6	INSTR+AVIONICS	703.		
* CRUISE	350.	CRUISE LIFT COEFF	0.38	AIR CONDITIONING	1150.		
*FUSELAGE CLEARNCE (FT)	2.0	MAX LIFT COEFF CONVER	2.24	FURNISHINGS	2500.		
*MAX HEL MODE ADV RATIO	0.40	*MAX LIFT COEFF CLEAN	1.40	FLUIDS	298.		
		*FLAP AREA/WING AREA	0.25	FLIGHT CREW	400.		
* INDICATES INPUT VARIABLE		CLIMB SPD/CONVER SPD	1.49	CABIN CREW	150.		

DESIGN MISSION	SPEED MPH	HEIGHT FT	DIST MI	TIME MIN	FUEL LB
TAKEOFF & LANDING				2.00	84.
ACCEL. & CONV.		1500.	0.9	0.76	46.
AIRPLANE CLIMB	142.,175.	13500.	12.3	4.66	230.
ACCEL. TO CRUISE			2.5	0.63	33.
CRUISE	284.		443.6	93.79	3509.
AIRPLANE DESCENT	284.,230.	13500.	39.8	9.34	55.
DECEL. & CONV.		1500.	0.9	1.09	9.
TOTAL			500.0	112.28	3966.
RESERVE				20.00	837.

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STAGE LENGTH (MI.)	25.	50.	75.	100.	150.	200.	300.	400.	500.
CRUISE ALTITUDE (FT.)	2000.	4000.	10001.	12500.	15000.	15000.	15000.	15000.	15000.
CRUISE SPEED (MPH)	296.	299.	290.	289.	284.	284.	284.	284.	284.
CRUISE L/D	11.02	11.51	13.06	13.84	14.57	14.57	14.57	14.57	14.57
CRUISE DISTANCE (MI.)	18.1	36.6	40.3	54.8	93.6	143.6	243.6	343.6	443.6
BLOCK TIME (MIN.)	9.1	14.4	20.9	26.8	38.3	48.9	70.0	91.1	112.3
BLOCK FUEL (LB.)	395.	594.	679.	840.	1216.	1617.	2411.	3194.	3966.
BLOCK SPEED (MPH)	166.	209.	215.	224.	235.	246.	257.	263.	267.

DIRECT OPERATING COST - ANN UTILIZATION(HR)=2000. DEPRECIATION PERIOD(YR)=10. LABOR RATE($/HR)= 7.00
AIRFRAME COST ($/LB)= 80.0 ENGINE COST ($/HP)= 60.0 INSURANCE RATE=0.040 FUEL COST (CENTS/GAL)= 18.0
DOC=1.70+0.0452*SL $/SEAT-TRIP (SL= 25.,500.)
HOP LENGTHS 50+150+ 0+ 0+ 0=200 100+200+ 0+ 0+ 0=300 200+200+ 0+ 0+ 0=400

STAGE LENGTH	25.	50.	75.	100.	150.	200.	300.	400.	500.	200.	300.	400.
NO. CYCLES/STARTS	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	2/1	2/1	2/1
FLIGHT CREW	0.555	0.440	0.426	0.410	0.391	0.374	0.357	0.349	0.344	0.418	0.396	0.381
FUEL & OIL	0.438	0.330	0.252	0.234	0.225	0.225	0.223	0.222	0.221	0.252	0.228	0.225
HULL INSURANCE	0.483	0.383	0.371	0.357	0.340	0.326	0.311	0.304	0.299	0.351	0.336	0.326
TOTAL FLIGHT OPS	1.476	1.154	1.050	1.001	0.956	0.924	0.892	0.874	0.864	1.021	0.960	0.932
LABOR AIRFRAME	0.561	0.369	0.319	0.288	0.256	0.236	0.216	0.206	0.200	0.282	0.252	0.235
MATERIAL AIRFRAME	0.268	0.165	0.136	0.119	0.102	0.092	0.083	0.078	0.075	0.114	0.099	0.091
LABOR ENGINES	0.317	0.175	0.130	0.107	0.083	0.070	0.058	0.052	0.048	0.097	0.076	0.066
MATERIAL ENGINES	0.511	0.276	0.201	0.162	0.123	0.102	0.082	0.072	0.065	0.144	0.111	0.094
MAT. BURDEN	1.141	0.707	0.583	0.513	0.441	0.399	0.356	0.335	0.323	0.492	0.427	0.391
TOTAL MAINTENANCE	2.797	1.693	1.369	1.189	1.005	0.900	0.795	0.742	0.711	1.129	0.964	0.876
DEPRECIATION	1.378	1.094	1.060	1.019	0.971	0.929	0.887	0.867	0.854	1.002	0.959	0.929
TOTAL DIRECT OPERATING COST												
$/AIRCRAFT MILE	5.652	3.940	3.479	3.209	2.932	2.753	2.574	2.483	2.429	3.151	2.883	2.737
$/FLIGHT HOUR	935.7	822.1	749.0	718.8	689.3	676.3	661.9	654.0	648.9	718.1	686.2	672.3
$/SEAT MILE	0.1130	0.0788	0.0696	0.0642	0.0586	0.0551	0.0515	0.0497	0.0486	0.0630	0.0577	0.0547
$/SEAT-TRIP	2.83	3.94	5.22	6.42	8.80	11.01	15.44	19.87	24.29	12.60	17.30	21.89

Information Processing Center
Information Processing Center

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DEPARTURE PATH TO 10,000 FT MSL

MAX FUSE ANGLE=20. OBSTACLE CLEAR ANGLE=60. OBSTACLE HEIGHT=100. MAX ACCEL ROTATION RATE=20. ACCEL BUILDUP TIME= 5.

TIME SEC	DIST FT	ALT FT	VEL FPS	ACC G	GAM DEG	THRUST LB	LWGO LB	LWGI LB	DWGO LB	DWGI LB	DFUST LB	ALP DEG	THE DEG	AWO DEG	ALV DEG	LAMDA	MU	CT	POWER HP
OBSTACLE CLEARANCE																			
3.1	4.	7.	3.	0.050	60.0	63443.	-1.	-895.	0.	1148.	1.	29.4	24.6	-35.4	28.5	0.1119	0.0035	0.0237	6258.
4.0	7.	13.	8.	0.171	60.0	69826.	-8.	-1091.	4.	1041.	10.	26.6	24.6	-35.4	24.4	0.1240	0.0096	0.0261	7491.
4.7	12.	20.	13.	0.227	60.0	72803.	-23.	-1207.	11.	971.	28.	25.5	24.6	-35.4	21.8	0.1331	0.0154	0.0273	8309.
5.3	17.	30.	18.	0.248	60.0	73974.	-45.	-1275.	22.	916.	55.	25.1	24.6	-35.4	20.0	0.1417	0.0212	0.0277	8930.
5.9	24.	42.	23.	0.250	60.0	74160.	-74.	-1334.	37.	882.	92.	25.0	24.6	-35.4	18.6	0.1491	0.0272	0.0278	9389.
6.7	34.	59.	28.	0.211	60.0	72126.	-111.	-1349.	55.	825.	137.	25.8	24.6	-35.4	17.2	0.1563	0.0332	0.0270	9560.
7.6	50.	86.	33.	0.162	60.0	69574.	-155.	-1366.	77.	799.	191.	26.8	24.6	-35.4	16.2	0.1620	0.0404	0.0261	9560.
7.9	58.	100.	33.	0.113	60.0	67103.	-206.	-1388.	102.	784.	254.	28.0	24.6	-35.4	15.4	0.1680	0.0484	0.0252	9560.
ACCELERATION AND CONVERSION																			
9.3	92.	153.	43.	0.106	56.8	64880.	-299.	-1586.	123.	672.	295.	29.4	24.6	-32.3	15.2	0.1736	0.0602	0.0244	9560.
10.4	129.	196.	51.	0.141	49.5	62154.	-517.	-2046.	138.	548.	291.	34.0	24.6	-25.0	14.9	0.1811	0.0806	0.0234	9560.
11.7	184.	245.	58.	0.123	42.0	62633.	-817.	-2650.	142.	459.	234.	43.0	24.6	-17.4	16.7	0.1794	0.1109	0.0236	9560.
13.2	260.	301.	66.	0.108	36.2	63447.	-1214.	-3288.	153.	414.	190.	50.0	24.6	-11.6	17.2	0.1766	0.1421	0.0239	9560.
14.5	345.	353.	74.	0.116	31.6	63659.	-531.	-4005.	128.	400.	157.	53.9	24.6	-7.0	16.2	0.1756	0.1701	0.0240	9560.
15.9	446.	407.	83.	0.113	28.0	63713.	394.	-4803.	129.	408.	137.	57.4	24.6	-3.4	14.9	0.1749	0.1983	0.0241	9560.
17.3	566.	463.	92.	0.108	25.1	63679.	1522.	-5707.	156.	431.	129.	60.1	24.6	-0.5	13.4	0.1742	0.2267	0.0241	9560.
19.0	724.	529.	101.	0.092	22.7	62337.	2862.	-5291.	209.	380.	132.	62.1	24.6	1.9	11.7	0.1773	0.2528	0.0237	9560.
20.4	872.	585.	110.	0.108	20.7	58747.	4420.	-2193.	288.	259.	147.	60.4	24.6	3.9	9.6	0.1874	0.2752	0.0223	9560.
21.9	1034.	641.	120.	0.108	19.0	54557.	6200.	1196.	393.	245.	174.	58.7	24.6	5.6	7.7	0.2010	0.2957	0.0208	9560.
23.5	1233.	704.	129.	0.096	17.5	49674.	8205.	4935.	524.	331.	213.	57.0	24.6	7.1	6.1	0.2200	0.3134	0.0189	9560.
25.5	1500.	782.	139.	0.077	16.3	44129.	10434.	9059.	681.	511.	263.	54.8	24.6	8.3	4.6	0.2471	0.3257	0.0169	9560.
27.7	1814.	867.	148.	0.071	15.2	38450.	12882.	13492.	863.	775.	325.	50.3	24.6	9.4	3.4	0.2834	0.3299	0.0147	9560.
30.1	2188.	962.	158.	0.064	14.3	32519.	15550.	18329.	1071.	1124.	398.	43.6	24.6	10.3	2.3	0.3361	0.3162	0.0125	9560.
32.6	2592.	1058.	168.	0.063	13.4	26940.	18434.	23559.	1304.	1553.	482.	32.7	24.6	11.2	1.4	0.4099	0.2654	0.0104	9560.
35.0	2999.	1150.	178.	0.066	12.7	22694.	21536.	29172.	1562.	2058.	577.	15.9	24.6	11.9	0.5	0.4946	0.1449	0.0088	9560.
37.8	3519.	1260.	187.	0.055	12.0	20902.	24907.	34765.	1851.	2583.	685.	-5.0	24.6	12.6	0.0	0.5404	-0.0485	0.0081	9560.
40.7	4077.	1373.	197.	0.054	11.4	19899.	25013.	34659.	1725.	2390.	673.	-4.8	22.8	11.4	0.0	0.5678	-0.0493	0.0077	9560.
43.6	4673.	1488.	205.	0.053	10.9	19116.	25089.	34583.	1632.	2249.	671.	-4.6	21.4	10.5	0.0	0.5912	-0.0488	0.0075	9560.
AIRPLANE MODE CLIMB TO 10,000 FT																			
43.6	4673.	1488.	209.	0.0	14.2	18950.													
217.5	43475.	10000.	238.	0.0	11.9	16647.													

NOISE AT 500 FT SIDELINE= 84.0 EPNDB

TIME	1.5	4.5	7.5	10.5	13.5	16.5	19.5	22.5	25.5	28.5
PNL	82.1	83.2	82.7	80.6	78.8	76.6	73.9	70.6	66.9	63.0

NOISE 500 FT FORWARD OF TAKEOFF POINT= 84.6 EPNDB

NOISE AT 20,000 FT SIDELINE= 52.6 EPNDB

NOISE 25,000 FT FORWARD OF TAKEOFF POINT= 50.7 EPNDB

THE TOTAL NOISE IMPACT IS 0.57228D+05

TILT ROTOR DESIGN PROGRAM 1974

C-80-20

DESIGN ITERATIONS: 4

OVERALL		POWERPLANT		FUSELAGE		STRUCT TECHNOLOGY FACTORS	
GROSS WEIGHT (LB)	18489.	INST NORMAL PWR (HP)	4119.	*LENGTH (FT)	55.0	*ROTOR	1.00
EMPTY WEIGHT (LB)	12530.	*NUMBER OF ENGINES	2.	*DIAMETER (FT)	8.5	*TRANSMISSION	0.83
FUEL WEIGHT (LB)	1959.	*EXCESS FACTOR HEL MODE	1.30	*DRAG FACTOR	1.00	*AIRFRAME	0.78
PAYLOAD (LB)	4000.	*% RATED EMRG HVR	140.			*ENGINE (HP/LB)	8.50
CRUISE SPEED (MPH)	401.	* CONV + CLIMB	120.	FLAT PLATE AREAS (SF)		*ENGINE INSTALLATION	1.50
L/D CRUISE	9.07	* CRUISE	90.	WING PROFILE	1.42		
*RANGE (STAT MI)	500.	INST PWR EMRG HVR (HP)	4076.	FUSELAGE	3.38	DESIGN MISSION	
*PASSENGER SEATS	20.	CONVER (HP)	2850.	EMPENNAGE	0.85	*FIELD ELEVATION (FT)	0.
*CARGO (LB)	0.	CRUISE (HP)	4119.	TOTAL PROFILE	6.83	SOUND SPEED HVR (FPS)	1117.
		*SFC (LB/HP HR)	0.400	WING INDUCED	1.03	*STD DAY TEMP (DEG F)	59.
ROTORS						*EMERG HOVER ALT (FT)	2000.
*DISC LOADING (PSF)	12.00	DRIVE SYSTEM		COMPONENT WEIGHTS (LB)		*HOT DAY TEMP (DEG F)	95.
RADIUS (FT)	15.7	*EFFICIENCY	0.97	ROTORS	1316.	*CT/SIG MAX	0.150
SOLIDITY	0.081	HEL MODE WEIGHT (LB)	1157.	DRIVE SYSTEM	1565.	*MAX ACCELERATION (G)	0.25
BLADE CHORD (FT)	1.32	AIRPLANE WEIGHT (LB)	1565.	POWERPLANT	727.	*DESIGN CRUISE (MPH)	400.
TOTAL BLADES	6			NACELLES	34.	*CRUISE ALTITUDE (FT)	15000.
*CT/SIG HOVER	0.120	WING		FUEL SYSTEM	96.	SOUND SPEED CRSE (FPS)	1058.
*PROFILE DRAG COEFF	0.010	AREA (SF)	195.	WING	1232.	*MAX DECELERATION (G)	0.20
% DOWNLOAD	4.6	*LOADING (PSF)	95.0	FUSELAGE	2675.	*STRUCT LOAD FACTOR	4.5
*EFFICIENCY HOVER	0.85	ASPECT RATIO	8.99	EMPENNAGE	361.	*FLIGHT CREW	2.
* CONVER	0.83	SPAN (FT)	41.8	LANDING GEAR	555.	*CABIN CREW	0.
CRUISE	0.80	MEAN CHORD (FT)	4.65	FLIGHT CONTROLS	552.	*ATC SPEED LIMIT	YES
HEL MODE WEIGHT (LB)	1316.	*THICKNESS/CHORD RATIO	0.210	HYDRAULICS	176.		
AIRPLANE WEIGHT (LB)	1012.	*TAPER RATIO	0.70	ELECTRICAL	203.		
*TIP SPEED HOVER	825.	SWEEP (DEG)	-5.1	INSTR+AVIONICS	580.		
* CRUISE	560.	CRUISE LIFT COEFF	0.37	AIR CONDITIONING	760.		
*FUSELAGE CLEARNCE (FT)	2.0	MAX LIFT COEFF CONVER	0.75	FURNISHINGS	1300.		
*MAX HEL MODE ADV RATIO	0.40	*MAX LIFT COEFF CLEAN	1.40	FLUIDS	92.		
		*FLAP AREA/WING AREA	0.25	FLIGHT CREW	400.		
* INDICATES INPUT VARIABLE		CLIMB SPD/CONVER SPD	0.68	CABIN CREW	0.		

DESIGN MISSION	SPEED MPH	HEIGHT FT	DIST MI	TIME MIN	FUEL LB
TAKEOFF & LANDING				2.00	38.
ACCEL. & CONV.		900.	0.9	0.71	16.
AIRPLANE CLIMB	153.,190.	14100.	11.7	4.12	96.
ACCEL. TO CRUISE			10.6	1.93	48.
CRUISE	401.		447.3	66.97	1365.
AIRPLANE DESCENT	401.,292.	14100.	28.5	5.11	17.
DECEL. & CONV.		900.	0.9	1.23	4.
TOTAL			500.0	82.08	1583.
RESERVE				20.00	375.

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STAGE LENGTH (MI.)	25.	50.	75.	100.	150.	200.	300.	400.	500.
CRUISE ALTITUDE (FT.)	2000.	4000.	10001.	12500.	15000.	15000.	15000.	15000.	15000.
CRUISE SPEED (MPH)	296.	305.	408.	420.	430.	430.	430.	430.	430.
CRUISE L/D	10.41	10.40	7.71	7.98	8.21	8.21	8.21	8.21	8.21
CRUISE DISTANCE (MI.)	17.3	36.2	29.8	46.9	82.9	132.9	232.9	332.9	432.9
BLOCK TIME (MIN.)	8.9	14.0	17.6	21.4	28.7	35.6	49.6	63.5	77.5
BLOCK FUEL (LB.)	138.	205.	296.	377.	555.	726.	1061.	1391.	1714.
BLOCK SPEED (MPH)	168.	214.	256.	280.	314.	337.	363.	378.	387.

DIRECT OPERATING COST - ANN UTILIZATION(HR)=2000. DEPRECIATION PERIOD(YR)=10. LABOR RATE($/HR)= 7.00
AIRFRAME COST ($/LB)= 80.0 ENGINE COST ($/HP)= 60.0 INSURANCE RATE=0.040 FUEL COST (CENTS/GAL)= 18.0
DOC=2.86+0.0411*SL $/SEAT-TRIP (SL= 25.,500.)
HOP LENGTHS 50+150+ 0+ 0+ 0=200 100+200+ 0+ 0+ 0=300 200+200+ 0+ 0+ 0=400

STAGE LENGTH	25.	50.	75.	100.	150.	200.	300.	400.	500.	200.	300.	400.
NO. CYCLES/STARTS	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	2/1	2/1	2/1
FLIGHT CREW	0.564	0.443	0.370	0.339	0.302	0.281	0.261	0.251	0.245	0.353	0.311	0.289
FUEL & OIL	0.154	0.115	0.110	0.105	0.103	0.101	0.099	0.097	0.096	0.106	0.103	0.101
HULL INSURANCE	0.142	0.111	0.093	0.085	0.076	0.071	0.066	0.063	0.062	0.085	0.076	0.071
TOTAL FLIGHT OPS	0.859	0.669	0.574	0.529	0.481	0.453	0.425	0.411	0.402	0.544	0.489	0.461
LABOR AIRFRAME	0.391	0.257	0.200	0.173	0.145	0.129	0.114	0.107	0.102	0.171	0.143	0.129
MATERIAL AIRFRAME	0.116	0.071	0.054	0.045	0.036	0.032	0.027	0.025	0.024	0.044	0.035	0.031
LABOR ENGINES	0.260	0.144	0.103	0.082	0.062	0.051	0.041	0.035	0.032	0.075	0.057	0.048
MATERIAL ENGINES	0.229	0.123	0.086	0.068	0.049	0.040	0.031	0.026	0.023	0.060	0.044	0.036
MAT. BURDEN	0.845	0.521	0.394	0.332	0.268	0.235	0.202	0.185	0.175	0.320	0.260	0.229
TOTAL MAINTENANCE	1.840	1.116	0.836	0.701	0.560	0.487	0.415	0.378	0.356	0.670	0.539	0.473
DEPRECIATION	0.412	0.323	0.271	0.247	0.220	0.206	0.191	0.183	0.179	0.246	0.220	0.206
TOTAL DIRECT OPERATING COST												
$/AIRCRAFT MILE	3.111	2.108	1.681	1.477	1.262	1.147	1.031	0.972	0.937	1.460	1.248	1.140
$/FLIGHT HOUR	523.2	451.4	430.0	413.6	396.2	386.0	374.1	367.3	362.8	410.6	393.6	383.8
$/SEAT MILE	0.1556	0.1054	0.0840	0.0739	0.0631	0.0573	0.0515	0.0486	0.0469	0.0730	0.0624	0.0570
$/SEAT-TRIP	3.89	5.27	6.30	7.39	9.46	11.47	15.46	19.45	23.43	14.60	18.72	22.80

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DEPARTURE PATH TO 10,000 FT MSL

MAX FUSE ANGLE=20. OBSTACLE CLEAR ANGLE=60. OBSTACLE HEIGHT=100. MAX ACCEL ROTATION RATE=20. ACCEL BUILDUP TIME= 5.

TIME SEC	DIST FT	ALT FT	VEL FPS	ACC G	GAM DEG	THRUST LB	LWGO LB	LWGI LB	DWGO LB	DWGI LB	DFUST LB	ALP DEG	THE DEG	AWO DEG	ALV DEG	LAMDA	MU	CT	POWER HP
OBSTACLE CLEARANCE																			
3.1	4.	7.	3.	0.050	60.0	19600.	-0.	-227.	0.	296.	1.	29.3	24.6	-35.4	28.7	0.0640	0.0015	0.0079	2806.
4.0	7.	13.	8.	0.171	60.0	21585.	-2.	-277.	1.	271.	6.	26.4	24.6	-35.4	24.7	0.0698	0.0040	0.0087	3274.
5.0	13.	23.	13.	0.163	60.0	21446.	-4.	-281.	2.	253.	16.	26.6	24.6	-35.4	23.5	0.0728	0.0067	0.0086	3375.
6.2	24.	41.	18.	0.128	60.0	20877.	-9.	-282.	4.	236.	32.	27.4	24.6	-35.4	22.4	0.0747	0.0095	0.0084	3375.
7.8	42.	74.	23.	0.094	60.0	20337.	-14.	-282.	7.	227.	52.	28.2	24.6	-35.4	21.8	0.0767	0.0125	0.0082	3375.
8.5	58.	100.	24.	0.058	60.0	19782.	-22.	-282.	11.	217.	78.	29.0	24.6	-35.4	21.2	0.0789	0.0157	0.0080	3375.
ACCELERATION AND CONVERSION																			
9.4	77.	125.	33.	0.161	52.2	19359.	-39.	-384.	12.	130.	79.	29.9	24.6	-27.6	21.4	0.0806	0.0201	0.0078	3375.
10.3	105.	149.	40.	0.171	41.4	19098.	-78.	-517.	13.	84.	59.	40.3	24.6	-16.8	25.5	0.0817	0.0309	0.0077	3375.
11.2	140.	173.	48.	0.174	33.5	19191.	-93.	-641.	13.	66.	42.	48.3	24.6	-8.9	28.3	0.0813	0.0431	0.0077	3375.
12.1	185.	196.	57.	0.176	27.9	19205.	31.	-747.	12.	58.	31.	53.6	24.6	-3.3	28.3	0.0811	0.0548	0.0077	3375.
13.0	236.	219.	66.	0.182	23.8	19206.	199.	-850.	16.	55.	26.	57.2	24.6	0.7	27.1	0.0811	0.0665	0.0078	3375.
13.8	293.	241.	75.	0.191	20.8	19197.	412.	-960.	24.	55.	28.	59.5	24.6	3.8	25.1	0.0810	0.0781	0.0078	3375.
14.6	358.	262.	84.	0.191	18.4	19129.	672.	-1079.	36.	57.	37.	61.5	24.6	6.2	22.8	0.0812	0.0898	0.0077	3375.
15.4	433.	284.	94.	0.188	16.4	19024.	980.	-1213.	53.	61.	52.	63.1	24.6	8.1	20.5	0.0815	0.1014	0.0077	3375.
16.3	519.	307.	104.	0.180	14.9	18547.	1337.	-931.	73.	45.	74.	63.6	24.6	9.7	17.7	0.0835	0.1122	0.0075	3375.
17.1	607.	329.	113.	0.194	13.6	17867.	1743.	-353.	99.	29.	102.	62.0	24.6	11.0	15.1	0.0865	0.1225	0.0072	3375.
18.0	720.	354.	123.	0.166	12.5	16855.	2198.	310.	128.	29.	137.	62.3	24.6	12.1	12.5	0.0915	0.1317	0.0068	3375.
19.0	845.	379.	133.	0.161	11.5	15891.	2702.	978.	162.	44.	178.	60.8	24.6	13.0	10.4	0.0969	0.1410	0.0064	3375.
20.0	982.	405.	143.	0.159	10.7	14861.	3255.	1687.	201.	70.	226.	58.8	24.6	13.8	8.6	0.1035	0.1496	0.0060	3375.
21.1	1147.	434.	153.	0.142	10.0	13628.	3858.	2472.	243.	110.	280.	57.0	24.6	14.5	6.9	0.1127	0.1566	0.0055	3375.
22.3	1351.	468.	162.	0.122	9.4	12276.	4509.	3320.	290.	163.	340.	54.8	24.6	15.2	5.4	0.1250	0.1614	0.0050	3375.
23.7	1591.	506.	172.	0.110	8.9	10931.	5209.	4212.	342.	224.	407.	51.1	24.6	15.7	4.2	0.1403	0.1635	0.0044	3375.
25.3	1876.	548.	182.	0.098	8.4	9536.	5957.	5169.	397.	297.	480.	45.9	24.6	16.2	3.1	0.1610	0.1598	0.0039	3375.
27.1	2222.	596.	192.	0.085	8.0	8709.	6351.	5633.	409.	322.	497.	43.9	23.5	15.6	2.4	0.1763	0.1603	0.0036	3375.
29.1	2621.	649.	202.	0.078	7.6	7933.	6764.	6119.	422.	347.	516.	40.7	22.6	15.0	1.9	0.1937	0.1578	0.0032	3375.
31.2	3063.	705.	212.	0.074	7.2	7181.	7192.	6631.	437.	375.	537.	36.3	21.8	14.6	1.4	0.2144	0.1495	0.0029	3375.
33.4	3527.	762.	221.	0.073	6.9	6568.	7578.	7099.	450.	399.	556.	31.3	21.1	14.2	1.0	0.2352	0.1359	0.0027	3375.
AIRPLANE MODE CLIMB TO 10,000 FT																			
33.4	3527.	762.	224.	0.0	15.8	6613.													
192.9	41918.	10000.	258.	0.0	13.0	5747.													

THE TOTAL NOISE IMPACT IS 0.688170+06

NOISE AT 500 FT SIDELINE=103.4 EPNDB

NOISE AT 20,000 FT SIDELINE= 61.8 EPNDB

NOISE 25,000 FT FORWARD OF TAKEOFF POINT= 59.7 EPNDB

NOISE 500 FT FORWARD OF TAKEOFF POINT=105.1 EPNDB

TILT ROTOR DESIGN PROGRAM 1974

C-80-80

DESIGN ITERATIONS: 6

OVERALL		POWERPLANT		FUSELAGE		STRUCT TECHNOLOGY FACTORS	
GROSS WEIGHT (LB)	69044.	INST NORMAL PWR (HP)	15257.	*LENGTH (FT)	95.0	*ROTOR	1.00
EMPTY WEIGHT (LB)	46027.	*NUMBER OF ENGINES	2.	*DIAMETER (FT)	11.5	*TRANSMISSION	0.83
FUEL WEIGHT (LB)	6716.	*EXCESS FACTOR HEL MODE	1.30	*DRAG FACTOR	1.00	*AIRFRAME	0.78
PAYLOAD (LB)	16300.	*% RATED EMRG HVR	140.			*ENGINE (HP/LB)	8.50
CRUISE SPEED (MPH)	445.	* CONV + CLIMB	120.	FLAT PLATE AREAS (SF)		*ENGINE INSTALLATION	1.50
L/D CRUISE	10.47	* CRUISE	90.	WING PROFILE	4.75		
*RANGE (STAT MI)	500.	INST PWR EMRG HVR (HP)	15257.	FUSELAGE	7.04	DESIGN MISSION	
*PASSENGER SEATS	80.	CONVER (HP)	10665.	EMPENNAGE	2.85	*FIELD ELEVATION (FT)	0.
*CARGO (LB)	0.	CRUISE (HP)	11708.	TOTAL PROFILE	17.72	SOUND SPEED HVR (FPS)	1117.
		*SFC (LB/HP HR)	0.400	WING INDUCED	3.07	*STD DAY TEMP (DEG F)	59.
ROTORS						*EMERG HOVER ALT (FT)	2000.
*DISC LOADING (PSF)	12.00	DRIVE SYSTEM		COMPONENT WEIGHTS (LB)		*HOT DAY TEMP (DEG F)	95.
RADIUS (FT)	30.3	*EFFICIENCY	0.97	ROTORS	5546.	*CT/SIG MAX	0.150
SOLIDITY	0.081	HEL MODE WEIGHT (LB)	5633.	DRIVE SYSTEM	7652.	*MAX ACCELERATION (G)	0.25
BLADE CHORD (FT)	2.57	AIRPLANE WEIGHT (LB)	7652.	POWERPLANT	2692.	*DESIGN CRUISE (MPH)	400.
TOTAL BLADES	6			NACELLES	760.	*CRUISE ALTITUDE (FT)	15000.
*CT/SIG HOVER	0.120	WING		FUEL SYSTEM	795.	SOUND SPEED CRSE (FPS)	1058.
*PROFILE DRAG COEFF	0.010	AREA (SF)	727.	WING	5530.	*MAX DECELERATION (G)	0.20
% DOWNLOAD	5.1	*LOADING (PSF)	95.0	FUSELAGE	7979.	*STRUCT LOAD FACTOR	4.5
*EFFICIENCY HOVER	0.85	ASPECT RATIO	7.54	EMPENNAGE	1346.	*FLIGHT CREW	2.
* CONVER	0.83	SPAN (FT)	74.0	LANDING GEAR	2071.	*CABIN CREW	2.
CRUISE	0.78	MEAN CHORD (FT)	9.82	FLIGHT CONTROLS	3541.	*ATC SPEED LIMIT	YES
HEL MODE WEIGHT (LB)	5546.	*THICKNESS/CHORD RATIO	0.210	HYDRAULICS	340.		
AIRPLANE WEIGHT (LB)	4272.	*TAPER RATIO	0.70	ELECTRICAL	1309.		
*TIP SPEED HOVER	825.	SWEEP (DEG)	-5.4	INSTR+AVIONICS	826.		
* CRUISE	560.	CRUISE LIFT COEFF	0.30	AIR CONDITIONING	1540.		
*FUSELAGE CLEARNCE (FT)	2.0	MAX LIFT COEFF CONVER	0.75	FURNISHINGS	3700.		
*MAX HEL MODE ADV RATIO	0.40	*MAX LIFT COEFF CLEAN	1.40	FLUIDS	345.		
		*FLAP AREA/WING AREA	0.25	FLIGHT CREW	400.		
* INDICATES INPUT VARIABLE		CLIMB SPD/CONVER SPD	0.78	CABIN CREW	300.		

DESIGN MISSION	SPEED MPH	HEIGHT FT	DIST MI	TIME MIN	FUEL LB
TAKEOFF & LANDING				2.00	140.
ACCEL. & CONV.		900.	0.9	0.62	52.
AIRPLANE CLIMB	175.,217.	14100.	13.6	4.18	367.
ACCEL. TO CRUISE			13.6	2.24	208.
CRUISE	445.		435.0	58.60	4458.
AIRPLANE DESCENT	445.,292.	14100.	36.0	6.28	76.
DECEL. & CONV.		900.	0.9	1.06	14.
TOTAL			500.0	74.98	5315.
RESERVE				20.00	1401.

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STAGE LENGTH (MI.)	25.	50.	75.	100.	150.	200.	300.	400.	500.
CRUISE ALTITUDE (FT.)	2000.	4000.	10001.	12500.	15000.	15000.	15000.	15000.	15000.
CRUISE SPEED (MPH)	296.	305.	458.	464.	476.	476.	476.	476.	476.
CRUISE L/D	13.24	13.23	8.91	9.11	9.46	9.46	9.46	9.46	9.46
CRUISE DISTANCE (MI.)	17.0	34.5	-9.3	36.9	74.5	124.5	224.5	324.5	424.5
BLOCK TIME (MIN.)	8.6	13.7	0.0	20.5	27.1	33.4	46.0	58.6	71.2
BLOCK FUEL (LB.)	460.	673.	0.	1265.	1857.	2436.	3579.	4702.	5807.
BLOCK SPEED (MPH)	174.	220.	0.	293.	333.	360.	392.	410.	421.

DIRECT OPERATING COST - ANN UTILIZATION(HR)=2000. DEPRECIATION PERIOD(YR)=10. LABOR RATE($/HR)= 7.00
AIRFRAME COST ($/LB)= 80.0 ENGINE COST ($/HP)= 60.0 INSURANCE RATE=0.040 FUEL COST (CENTS/GAL)= 18.0
DOC=1.44+0.0209*SL $/SEAT-TRIP (SL= 25.,500.)
HOP LENGTHS 50+150+ 0+ 0+ 0=200 100+200+ 0+ 0+ 0=300 200+200+ 0+ 0+ 0=400

STAGE LENGTH	25.	50.	75.	100.	150.	200.	300.	400.	500.	200.	300.	400.
NO. CYCLES/STARTS	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	2/1	2/1	2/1
FLIGHT CREW	0.569	0.451	0.0	0.338	0.298	0.275	0.253	0.242	0.235	0.353	0.307	0.284
FUEL & OIL	0.511	0.374	0.0	0.351	0.344	0.338	0.331	0.326	0.322	0.351	0.342	0.338
HULL INSURANCE	0.502	0.399	0.0	0.299	0.264	0.244	0.224	0.214	0.208	0.297	0.262	0.244
TOTAL FLIGHT OPS	1.581	1.224	0.0	0.988	0.905	0.857	0.808	0.782	0.765	1.001	0.912	0.865
LABOR AIRFRAME	0.546	0.358	0.0	0.236	0.194	0.172	0.150	0.139	0.132	0.232	0.191	0.171
MATERIAL AIRFRAME	0.263	0.162	0.0	0.101	0.081	0.070	0.059	0.054	0.050	0.097	0.078	0.068
LABOR ENGINES	0.381	0.208	0.0	0.116	0.085	0.069	0.053	0.045	0.041	0.104	0.077	0.063
MATERIAL ENGINES	0.843	0.454	0.0	0.249	0.180	0.145	0.110	0.093	0.082	0.219	0.160	0.131
MAT. BURDEN	1.206	0.735	0.0	0.457	0.362	0.313	0.264	0.239	0.224	0.437	0.349	0.304
TOTAL MAINTENANCE	3.239	1.917	0.0	1.159	0.901	0.769	0.636	0.570	0.530	1.090	0.855	0.736
DEPRECIATION	1.460	1.160	0.0	0.869	0.766	0.708	0.651	0.622	0.604	0.864	0.762	0.708
TOTAL DIRECT OPERATING COST												
$/AIRCRAFT MILE	6.281	4.300	0.0	3.016	2.572	2.334	2.094	1.973	1.899	2.956	2.529	2.310
$/FLIGHT HOUR	1095.6	944.7	0.0	883.9	855.5	839.5	820.0	808.4	800.4	871.1	845.5	830.7
$/SEAT MILE	0.0785	0.0537	0.0	0.0377	0.0322	0.0292	0.0262	0.0247	0.0237	0.0369	0.0316	0.0289
$/SEAT-TRIP	1.96	2.69	0.0	3.77	4.82	5.83	7.85	9.87	11.87	7.39	9.48	11.55

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DEPARTURE PATH TO 10,000 FT MSL

MAX FUSE ANGLE=20. OBSTACLE CLEAR ANGLE=60. OBSTACLE HEIGHT=100. MAX ACCEL ROTATION RATE=20. ACCEL BUILDUP TIME= 5.

TIME SEC	DIST FT	ALT FT	VEL FPS	ACC G	GAM DEG	THRUST LB	LWGO LB	LWGI LB	DWGO LB	DWGI LB	DFUST LB	ALP DEG	THE DEG	AWO DEG	ALV DEG	LAMDA	MU	CT	POWER HP
OBSTACLE CLEARANCE																			
3.1	4.	7.	3.	0.050	60.0	73299.	-1.	-934.	0.	1224.	2.	29.4	24.6	-35.4	28.8	0.0641	0.0015	0.0079	10505.
4.0	7.	13.	8.	0.171	60.0	80696.	-5.	-1141.	3.	1119.	14.	26.5	24.6	-35.4	24.8	0.0698	0.0041	0.0087	12251.
5.0	13.	23.	13.	0.164	60.0	80190.	-15.	-1157.	7.	1045.	38.	26.7	24.6	-35.4	23.6	0.0728	0.0068	0.0086	12630.
6.2	24.	41.	18.	0.129	60.0	78062.	-30.	-1162.	15.	975.	74.	27.4	24.6	-35.4	22.5	0.0748	0.0095	0.0084	12630.
7.8	42.	73.	23.	0.095	60.0	76045.	-49.	-1161.	24.	936.	123.	28.2	24.6	-35.4	21.9	0.0768	0.0126	0.0082	12630.
8.5	58.	100.	24.	0.060	60.0	73972.	-73.	-1160.	36.	895.	183.	29.1	24.6	-35.4	21.2	0.0789	0.0158	0.0080	12630.
ACCELERATION AND CONVERSION																			
9.5	79.	127.	33.	0.149	52.4	72363.	-131.	-1563.	41.	547.	188.	30.4	24.6	-27.9	21.5	0.0807	0.0204	0.0078	12630.
10.4	106.	152.	40.	0.170	41.8	71268.	-261.	-2104.	44.	354.	145.	40.1	24.6	-17.2	25.3	0.0819	0.0309	0.0077	12630.
11.3	142.	176.	48.	0.174	33.9	71644.	-319.	-2615.	44.	283.	102.	48.1	24.6	-9.3	28.2	0.0814	0.0431	0.0077	12630.
12.2	186.	200.	57.	0.176	28.3	71755.	87.	-3057.	40.	250.	75.	53.6	24.6	-3.7	28.3	0.0812	0.0549	0.0078	12630.
13.0	238.	223.	66.	0.179	24.1	71818.	631.	-3483.	53.	239.	63.	57.4	24.6	0.4	27.1	0.0811	0.0666	0.0078	12630.
13.9	295.	245.	75.	0.191	21.0	71904.	1324.	-3933.	82.	242.	67.	59.7	24.6	3.6	25.2	0.0809	0.0783	0.0078	12630.
14.7	361.	267.	85.	0.191	18.6	71783.	2171.	-4425.	127.	253.	86.	61.8	24.6	6.0	23.0	0.0809	0.0901	0.0078	12630.
15.5	435.	289.	94.	0.189	16.6	71549.	3174.	-4978.	188.	271.	120.	63.5	24.6	7.9	20.7	0.0811	0.1018	0.0078	12630.
16.4	520.	312.	104.	0.181	15.1	69882.	4337.	-3913.	265.	197.	169.	64.2	24.6	9.5	18.0	0.0829	0.1126	0.0076	12630.
17.2	613.	335.	113.	0.185	13.8	67134.	5659.	-1553.	358.	118.	234.	63.2	24.6	10.8	15.2	0.0861	0.1228	0.0073	12630.
18.0	713.	357.	123.	0.186	12.6	64037.	7141.	929.	468.	111.	314.	62.0	24.6	11.9	12.8	0.0901	0.1326	0.0070	12630.
18.9	833.	382.	133.	0.169	11.7	60193.	8795.	3649.	594.	171.	409.	61.4	24.6	12.9	10.6	0.0957	0.1418	0.0065	12630.
19.9	963.	407.	143.	0.168	10.9	56403.	10589.	6463.	736.	288.	518.	59.5	24.6	13.7	8.8	0.1020	0.1507	0.0061	12630.
20.9	1116.	434.	153.	0.152	10.2	51895.	12553.	9566.	894.	464.	643.	57.9	24.6	14.4	7.1	0.1106	0.1581	0.0056	12630.
22.1	1302.	466.	162.	0.134	9.6	46953.	14678.	12915.	1069.	694.	783.	55.9	24.6	15.0	5.6	0.1221	0.1636	0.0051	12630.
23.3	1517.	500.	172.	0.123	9.0	42009.	16960.	16442.	1260.	970.	938.	52.5	24.6	15.6	4.4	0.1364	0.1667	0.0046	12630.
24.7	1769.	538.	182.	0.111	8.5	36841.	19401.	20222.	1466.	1293.	1108.	47.8	24.6	16.1	3.3	0.1557	0.1649	0.0040	12630.
26.3	2076.	581.	192.	0.096	8.1	32359.	21435.	23363.	1610.	1555.	1228.	43.7	24.1	16.1	2.4	0.1775	0.1590	0.0035	12630.
28.0	2420.	627.	202.	0.090	7.7	29491.	22866.	25383.	1665.	1679.	1278.	40.1	23.2	15.5	1.9	0.1949	0.1562	0.0032	12630.
29.9	2800.	676.	212.	0.086	7.3	26668.	24335.	27512.	1722.	1811.	1330.	35.6	22.4	15.1	1.4	0.2161	0.1472	0.0029	12630.
31.7	3209.	726.	222.	0.084	7.0	24043.	25854.	29748.	1783.	1949.	1387.	29.6	21.6	14.6	1.0	0.2406	0.1292	0.0026	12630.
33.5	3629.	775.	232.	0.085	6.7	21897.	27479.	32090.	1853.	2094.	1452.	21.4	21.0	14.3	0.6	0.2654	0.1032	0.0024	12630.
35.4	4069.	825.	242.	0.085	6.4	20129.	29134.	34536.	1924.	2245.	1519.	11.7	20.4	14.0	0.3	0.2903	0.0607	0.0022	12630.
37.3	4553.	877.	252.	0.080	6.2	19004.	30861.	37080.	2001.	2402.	1590.	0.3	19.8	13.7	0.0	0.3083	0.0039	0.0021	12630.
39.3	5069.	931.	257.	0.077	6.0	18665.	31384.	37659.	1999.	2398.	1596.	-2.7	19.4	13.4	0.0	0.3140	-0.0158	0.0021	12630.
AIRPLANE MODE CLIMB TO 10,000 FT																			
39.3	5069.	931.	257.	0.0	13.7	21676.													
198.0	48843.	10000.	295.	0.0	11.3	18886.													

THE TOTAL NOISE IMPACT IS 0.179160+07

NOISE AT 500 FT SIDELINE=103.6 EPNDB

NOISE AT 20,000 FT SIDELINE= 67.6 EPNDB

NOISE 25,000 FT FORWARD OF TAKEOFF POINT= 65.4 EPNDB

NOISE 500 FT FORWARD OF TAKEOFF POINT=104.9 EPNDB

TILT ROTOR DESIGN PROGRAM 1974

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DESIGN ITERATIONS: 6

OVERALL		POWERPLANT		FUSELAGE		STRUCT TECHNOLOGY FACTORS	
GROSS WEIGHT (LB)	101100.	INST NORMAL PWR (HP)	22349.	*LENGTH (FT)	110.0	*ROTOR	1.00
EMPTY WEIGHT (LB)	68939.	*NUMBER OF ENGINES	2.	*DIAMETER (FT)	13.0	*TRANSMISSION	0.83
FUEL WEIGHT (LB)	9710.	*EXCESS FACTOR HEL MODE	1.30	*DRAG FACTOR	1.00	*AIRFRAME	0.78
PAYLOAD (LB)	22450.	*% RATED EMRG HVR	140.			*ENGINE (HP/LB)	8.50
CRUISE SPEED (MPH)	453.	* CONV + CLIMB	120.	FLAT PLATE AREAS (SF)		*ENGINE INSTALLATION	1.50
L/D CRUISE	10.74	* CRUISE	90.	WING PROFILE	6.76		
*RANGE (STAT MI)	500.	INST PWR EMRG HVR (HP)	22349.	FUSELAGE	9.00	DESIGN MISSION	
*PASSENGER SEATS	110.	CONVER (HP)	15623.	EMPENNAGE	4.06	*FIELD ELEVATION (FT)	0.
*CARGO (LB)	0.	CRUISE (HP)	16222.	TOTAL PROFILE	23.97	SOUND SPEED HVR (FPS)	1117.
		*SFC (LB/HP HR)	0.400	WING INDUCED	4.17	*STD DAY TEMP (DEG F)	59.
ROTORS						*EMERG HOVER ALT (FT)	2000.
*DISC LOADING (PSF)	12.00	DRIVE SYSTEM		COMPONENT WEIGHTS (LB)		*HOT DAY TEMP (DEG F)	95.
RADIUS (FT)	36.6	*EFFICIENCY	0.97	ROTORS	8408.	*CT/SIG MAX	0.150
SOLIDITY	0.081	HEL MODE WEIGHT (LB)	8905.	DRIVE SYSTEM	12131.	*MAX ACCELERATION (G)	0.25
BLADE CHORD (FT)	3.11	AIRPLANE WEIGHT (LB)	12131.	POWERPLANT	3944.	*DESIGN CRUISE (MPH)	400.
TOTAL BLADES	6			NACELLES	1874.	*CRUISE ALTITUDE (FT)	15000.
*CT/SIG HOVER	0.120	WING		FUEL SYSTEM	1495.	SOUND SPEED CRSE (FPS)	1058.
*PROFILE DRAG COEFF	0.010	AREA (SF)	1064.	WING	8329.	*MAX DECELERATION (G)	0.20
% DOWNLOAD	5.2	*LOADING (PSF)	95.0	FUSELAGE	10855.	*STRUCT LOAD FACTOR	4.5
*EFFICIENCY HOVER	0.85	ASPECT RATIO	7.32	EMPENNAGE	1972.	*FLIGHT CREW	2.
* CONVER	0.83	SPAN (FT)	88.2	LANDING GEAR	3033.	*CABIN CREW	3.
CRUISE	0.77	MEAN CHORD (FT)	12.06	FLIGHT CONTROLS	6062.	*ATC SPEED LIMIT	YES
HEL MODE WEIGHT (LB)	8408.	*THICKNESS/CHORD RATIO	0.210	HYDRAULICS	412.		
AIRPLANE WEIGHT (LB)	6483.	*TAPER RATIO	0.70	ELECTRICAL	2247.		
*TIP SPEED HOVER	825.	SWEEP (DEG)	-5.4	INSTR+AVIONICS	949.		
* CRUISE	560.	CRUISE LIFT COEFF	0.28	AIR CONDITIONING	1930.		
*FUSELAGE CLEARNCE (FT)	2.0	MAX LIFT COEFF CONVER	0.75	FURNISHINGS	4900.		
*MAX HEL MODE ADV RATIO	0.40	*MAX LIFT COEFF CLEAN	1.40	FLUIDS	506.		
		*FLAP AREA/WING AREA	0.25	FLIGHT CREW	400.		
* INDICATES INPUT VARIABLE		CLIMB SPD/CONVER SPD	0.80	CABIN CREW	450.		

DESIGN MISSION	SPEED MPH	HEIGHT FT	DIST MI	TIME MIN	FUEL LB
TAKEOFF & LANDING				2.00	205.
ACCEL. & CONV.		900.	0.9	0.60	74.
AIRPLANE CLIMB	180.,223.	14100.	14.0	4.17	538.
ACCEL. TO CRUISE			13.6	2.22	302.
CRUISE	453.		432.9	57.38	6401.
AIRPLANE DESCENT	453.,292.	14100.	37.6	6.55	117.
DECEL. & CONV.		900.	0.9	1.02	20.
TOTAL			500.0	73.94	7658.
RESERVE				20.00	2053.

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STAGE LENGTH (MI.)	25.	50.	75.	100.	150.	200.	300.	400.	500.			
CRUISE ALTITUDE (FT.)	2000.	4000.	10001.	12500.	15000.	15000.	15000.	15000.	15000.			
CRUISE SPEED (MPH)	296.	305.	468.	478.	483.	483.	483.	483.	483.			
CRUISE L/D	13.88	13.88	9.17	9.46	9.74	9.74	9.74	9.74	9.74			
CRUISE DISTANCE (MI.)	16.9	34.2	14.9	31.2	74.3	124.3	224.3	324.3	424.3			
BLOCK TIME (MIN.)	8.5	13.6	16.8	20.3	26.8	33.0	45.5	57.9	70.3			
BLOCK FUEL (LB.)	660.	962.	1417.	1806.	2667.	3503.	5156.	6780.	8377.			
BLOCK SPEED (MPH)	176.	221.	268.	296.	335.	363.	396.	415.	427.			

DIRECT OPERATING COST - ANN UTILIZATION(HR)=2000. DEPRECIATION PERIOD(YR)=10. LABOR RATE($/HR)= 7.00
AIRFRAME COST ($/LB)= 80.0 ENGINE COST ($/HP)= 60.0 INSURANCE RATE=0.040 FUEL COST (CENTS/GAL)= 18.0
DOC=1.38+0.0203*SL $/SEAT-TRIP (SL= 25.,500.)
HOP LENGTHS 50+150+ 0+ 0+ 0=200 100+200+ 0+ 0+ 0=300 200+200+ 0+ 0+ 0=400

STAGE LENGTH	25.	50.	75.	100.	150.	200.	300.	400.	500.	200.	300.	400.
NO. CYCLES/STARTS	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	2/1	2/1	2/1
FLIGHT CREW	0.574	0.457	0.376	0.341	0.301	0.278	0.255	0.244	0.237	0.357	0.310	0.286
FUEL & OIL	0.732	0.534	0.524	0.501	0.493	0.486	0.477	0.470	0.465	0.503	0.491	0.486
HULL INSURANCE	0.744	0.592	0.488	0.442	0.390	0.360	0.330	0.316	0.307	0.441	0.387	0.360
TOTAL FLIGHT OPS	2.051	1.583	1.388	1.283	1.184	1.124	1.062	1.029	1.008	1.301	1.188	1.132
LABOR AIRFRAME	0.621	0.406	0.311	0.266	0.219	0.193	0.168	0.155	0.148	0.262	0.216	0.192
MATERIAL AIRFRAME	0.364	0.224	0.167	0.139	0.111	0.096	0.081	0.074	0.069	0.134	0.107	0.094
LABOR ENGINES	0.459	0.249	0.174	0.138	0.100	0.081	0.062	0.053	0.047	0.123	0.090	0.074
MATERIAL ENGINES	1.233	0.664	0.463	0.363	0.263	0.212	0.161	0.135	0.120	0.321	0.234	0.191
MAT. BURDEN	1.404	0.851	0.631	0.524	0.415	0.357	0.299	0.270	0.253	0.501	0.398	0.346
TOTAL MAINTENANCE	4.081	2.394	1.745	1.431	1.107	0.939	0.771	0.687	0.637	1.341	1.045	0.895
DEPRECIATION	2.161	1.720	1.416	1.282	1.132	1.046	0.959	0.916	0.890	1.279	1.125	1.046
TOTAL DIRECT OPERATING COST												
$/AIRCRAFT MILE	8.294	5.697	4.549	3.996	3.424	3.109	2.793	2.632	2.535	3.921	3.358	3.074
$/FLIGHT HOUR	1457.6	1258.4	1220.4	1183.8	1148.4	1129.1	1105.5	1091.3	1081.4	1164.4	1134.0	1116.3
$/SEAT MILE	0.0754	0.0518	0.0414	0.0363	0.0311	0.0283	0.0254	0.0239	0.0230	0.0356	0.0305	0.0279
$/SEAT-TRIP	1.88	2.59	3.10	3.63	4.67	5.65	7.62	9.57	11.52	7.13	9.16	11.18

C-80-110

DEPARTURE PATH TO 10,000 FT MSL

MAX FUSE ANGLE=20. OBSTACLE CLEAR ANGLE=60. OBSTACLE HEIGHT=100. MAX ACCEL ROTATION RATE=20. ACCEL BUILDUP TIME= 5.

TIME SEC	DIST FT	ALT FT	VEL FPS	ACC G	GAM DEG	THRUST LB	LWGO LB	LWGI LB	DWGO LB	DWGI LB	DFUST LB	ALP DEG	THE DEG	AWO DEG	ALV DEG	LAMDA	MU	CT	POWER HP
OBSTACLE CLEARANCE																			
3.1	4.	7.	3.	0.050	60.0	107359.	-1.	-1391.	0.	1823.	2.	29.4	24.6	-35.4	28.8	0.0641	0.0015	0.0079	15390.
4.0	7.	13.	8.	0.171	60.0	118186.	-8.	-1698.	4.	1667.	18.	26.5	24.6	-35.4	24.8	0.0698	0.0041	0.0087	17945.
5.0	13.	23.	13.	0.164	60.0	117452.	-22.	-1724.	11.	1556.	50.	26.7	24.6	-35.4	23.6	0.0728	0.0068	0.0086	18501.
6.2	24.	41.	18.	0.129	60.0	114334.	-42.	-1730.	21.	1452.	97.	27.5	24.6	-35.4	22.5	0.0748	0.0095	0.0084	18501.
7.8	42.	73.	23.	0.096	60.0	111381.	-70.	-1728.	35.	1394.	160.	28.2	24.6	-35.4	21.9	0.0768	0.0126	0.0082	18501.
8.4	58.	100.	24.	0.061	60.0	108345.	-105.	-1727.	52.	1333.	239.	29.1	24.6	-35.4	21.2	0.0789	0.0158	0.0080	18501.
ACCELERATION AND CONVERSION																			
9.5	79.	128.	33.	0.148	52.5	105986.	-188.	-2323.	60.	818.	247.	30.5	24.6	-27.9	21.6	0.0807	0.0204	0.0078	18501.
10.4	106.	152.	40.	0.170	41.9	104343.	-375.	-3126.	63.	529.	191.	40.0	24.6	-17.3	25.3	0.0819	0.0309	0.0077	18501.
11.3	142.	176.	48.	0.174	34.0	104900.	-459.	-3888.	63.	423.	135.	48.0	24.6	-9.4	28.1	0.0815	0.0431	0.0077	18501.
12.2	186.	200.	57.	0.176	28.3	105076.	120.	-4546.	58.	375.	99.	53.6	24.6	-3.7	28.3	0.0813	0.0549	0.0078	18501.
13.1	239.	224.	66.	0.179	24.2	105188.	897.	-5181.	76.	359.	84.	57.4	24.6	0.4	27.1	0.0811	0.0666	0.0078	18501.
13.9	296.	246.	75.	0.191	21.1	105339.	1885.	-5852.	118.	364.	88.	59.7	24.6	3.5	25.2	0.0809	0.0784	0.0078	18501.
14.7	361.	267.	85.	0.191	18.6	105195.	3092.	-6585.	183.	381.	113.	61.8	24.6	5.9	23.0	0.0809	0.0901	0.0078	18501.
15.5	434.	290.	94.	0.189	16.7	104891.	4524.	-7409.	271.	409.	158.	63.5	24.6	7.9	20.7	0.0810	0.1019	0.0078	18501.
16.4	520.	313.	104.	0.181	15.1	102477.	6182.	-5842.	384.	297.	222.	64.2	24.6	9.5	18.0	0.0828	0.1127	0.0076	18501.
17.2	612.	335.	113.	0.186	13.8	98473.	8068.	-2353.	520.	175.	307.	63.3	24.6	10.8	15.3	0.0960	0.1229	0.0073	18501.
18.0	712.	358.	123.	0.187	12.7	93949.	10183.	1320.	679.	163.	411.	62.0	24.6	11.9	12.9	0.0900	0.1327	0.0070	18501.
18.9	830.	382.	133.	0.171	11.7	88344.	12527.	5341.	863.	252.	535.	61.5	24.6	12.9	10.7	0.0955	0.1419	0.0066	18501.
19.8	958.	407.	143.	0.170	10.9	82819.	15101.	9500.	1070.	427.	679.	59.6	24.6	13.7	8.8	0.1017	0.1508	0.0061	18501.
20.8	1109.	434.	153.	0.154	10.2	76242.	17904.	14087.	1301.	691.	843.	58.1	24.6	14.4	7.2	0.1103	0.1583	0.0057	18501.
22.0	1292.	465.	162.	0.136	9.6	69037.	20935.	19034.	1556.	1038.	1026.	56.1	24.6	15.0	5.7	0.1217	0.1639	0.0051	18501.
23.2	1502.	498.	172.	0.126	9.0	61822.	24193.	24246.	1834.	1453.	1229.	52.7	24.6	15.6	4.4	0.1358	0.1672	0.0046	18501.
24.6	1748.	535.	182.	0.114	8.5	54271.	27675.	29833.	2135.	1941.	1451.	48.2	24.6	16.1	3.3	0.1547	0.1658	0.0040	18501.
26.1	2036.	576.	192.	0.102	8.1	47577.	30830.	34837.	2381.	2380.	1635.	43.2	24.3	16.2	2.4	0.1768	0.1597	0.0035	18501.
27.8	2370.	621.	202.	0.093	7.7	43155.	32847.	37852.	2456.	2571.	1696.	40.0	23.3	15.6	1.8	0.1951	0.1559	0.0032	18501.
29.5	2740.	669.	212.	0.088	7.3	39004.	34961.	41027.	2540.	2772.	1766.	35.4	22.5	15.2	1.4	0.2164	0.1466	0.0029	18501.
31.3	3139.	718.	222.	0.086	7.0	35161.	37148.	44363.	2629.	2984.	1841.	29.4	21.7	14.7	1.0	0.2410	0.1284	0.0026	18501.
33.1	3551.	766.	232.	0.087	6.7	32026.	39490.	47857.	2733.	3205.	1929.	21.2	21.1	14.4	0.6	0.2658	0.1021	0.0024	18501.
35.0	3987.	815.	242.	0.086	6.4	29455.	41875.	51506.	2838.	3436.	2017.	11.4	20.5	14.1	0.3	0.2906	0.0592	0.0022	18501.
36.9	4469.	867.	252.	0.081	6.2	27835.	44362.	55301.	2951.	3677.	2113.	-0.1	20.0	13.8	0.0	0.3083	0.0019	0.0021	18501.
38.9	4990.	922.	260.	0.077	6.0	26976.	45089.	56011.	2878.	3575.	2082.	-2.7	19.1	13.1	0.0	0.3182	-0.0159	0.0020	18501.
AIRPLANE MODE CLIMB TO 10,000 FT																			
38.9	4990.	922.	264.	0.0	13.4	31015.													
197.4	49906.	10000.	303.	0.0	11.0	27018.													

THE TOTAL NOISE IMPACT IS 0.26426D+07

NOISE AT 500 FT SIDELINE=104.2 EPNDB

NOISE AT 20,000 FT SIDELINE= 69.3 EPNDB

NOISE 25,000 FT FORWARD OF TAKEOFF POINT= 67.1 EPNDB

NOISE 500 FT FORWARD OF TAKEOFF POINT=105.4 EPNDB

TILT ROTOR DESIGN PROGRAM 1974

M-80-20

DESIGN ITERATIONS: 4

OVERALL		POWERPLANT		FUSELAGE		STRUCT TECHNOLOGY FACTORS	
GROSS WEIGHT (LB)	19001.	INST NORMAL PWR (HP)	4068.	*LENGTH (FT)	55.0	*ROTOR	1.00
EMPTY WEIGHT (LB)	13124.	*NUMBER OF ENGINES	2.	*DIAMETER (FT)	8.5	*TRANSMISSION	0.83
FUEL WEIGHT (LB)	1877.	*EXCESS FACTOR HEL MODE	1.30	*DRAG FACTOR	1.00	*AIRFRAME	0.78
PAYLOAD (LB)	4000.	*% RATED EMRG HVR	140.			*ENGINE (HP/LB)	8.50
CRUISE SPEED (MPH)	401.	* CONV + CLIMB	120.	FLAT PLATE AREAS (SF)		*ENGINE INSTALLATION	1.50
L/D CRUISE	9.20	* CRUISE	90.	WING PROFILE	1.45		
*RANGE (STAT MI)	500.	INST PWR EMRG HVR (HP)	4054.	FUSELAGE	3.38	DESIGN MISSION	
*PASSENGER SEATS	20.	CONVER (HP)	2818.	EMPENNAGE	0.87	*FIELD ELEVATION (FT)	0.
*CARGO (LB)	0.	CRUISE (HP)	4068.	TOTAL PROFILE	6.90	SOUND SPEED HVR (FPS)	1117.
		*SFC (LB/HP HR)	0.400	WING INDUCED	1.07	*STD DAY TEMP (DEG F)	59.
ROTORS						*EMERG HOVER ALT (FT)	2000.
*DISC LOADING (PSF)	12.00	DRIVE SYSTEM		COMPONENT WEIGHTS (LB)		*HOT DAY TEMP (DEG F)	95.
RADIUS (FT)	15.9	*EFFICIENCY	0.97	ROTORS	1621.	*CT/SIG MAX	0.150
SOLIDITY	0.143	HEL MODE WEIGHT (LB)	1457.	DRIVE SYSTEM	1767.	*MAX ACCELERATION (G)	0.25
BLADE CHORD (FT)	1.78	AIRPLANE WEIGHT (LB)	1767.	POWERPLANT	718.	*DESIGN CRUISE (MPH)	400.
TOTAL BLADES	8			NACELLES	33.	*CRUISE ALTITUDE (FT)	15000.
*CT/SIG HOVER	0.120	WING		FUEL SYSTEM	89.	SOUND SPEED CRSE (FPS)	1058.
*PROFILE DRAG COEFF	0.010	AREA (SF)	200.	WING	1267.	*MAX DECELERATION (G)	0.20
% DOWNLOAD	4.6	*LOADING (PSF)	95.0	FUSELAGE	2686.	*STRUCT LOAD FACTOR	4.5
*EFFICIENCY HOVER	0.85	ASPECT RATIO	8.92	EMPENNAGE	370.	*FLIGHT CREW	2.
* CONVER	0.83	SPAN (FT)	42.2	LANDING GEAR	570.	*CABIN CREW	0.
CRUISE	0.72	MEAN CHORD (FT)	4.73	FLIGHT CONTROLS	574.	*ATC SPEED LIMIT	YES
HEL MODE WEIGHT (LB)	1621.	*THICKNESS/CHORD RATIO	0.210	HYDRAULICS	178.		
AIRPLANE WEIGHT (LB)	1558.	*TAPER RATIO	0.70	ELECTRICAL	211.		
*TIP SPEED HOVER	620.	SWEEP (DEG)	-5.1	INSTR+AVIONICS	580.		
* CRUISE	550.	CRUISE LIFT COEFF	0.37	AIR CONDITIONING	760.		
*FUSELAGE CLEARNCE (FT)	2.0	MAX LIFT COEFF CONVER	1.34	FURNISHINGS	1300.		
*MAX HEL MODE ADV RATIO	0.40	*MAX LIFT COEFF CLEAN	1.40	FLUIDS	95.		
		*FLAP AREA/WING AREA	0.25	FLIGHT CREW	400.		
* INDICATES INPUT VARIABLE		CLIMB SPD/CONVER SPD	0.91	CABIN CREW	0.		

DESIGN MISSION	SPEED MPH	HEIGHT FT	DIST MI	TIME MIN	FUEL LB
TAKEOFF & LANDING				2.00	37.
ACCEL. & CONV.		900.	0.9	0.70	16.
AIRPLANE CLIMB	154.,191.	14100.	10.4	3.64	81.
ACCEL. TO CRUISE			8.3	1.53	36.
CRUISE	401.		450.5	67.46	1317.
AIRPLANE DESCENT	401.,292.	14100.	29.0	5.20	14.
DECEL. & CONV.		900.	0.9	1.22	4.
TOTAL			500.0	81.75	1506.
RESERVE				20.00	371.

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STAGE LENGTH (MI.)	25.	50.	75.	100.	150.	200.	300.	400.	500.
CRUISE ALTITUDE (FT.)	2000.	4000.	10001.	12500.	15000.	15000.	15000.	15000.	15000.
CRUISE SPEED (MPH)	296.	305.	406.	408.	409.	409.	409.	409.	409.
CRUISE L/D	10.54	10.54	7.89	8.36	8.86	8.86	8.86	8.86	8.86
CRUISE DISTANCE (MI.)	17.7	36.8	36.0	55.3	99.1	149.1	249.1	349.1	449.1
BLOCK TIME (MIN.)	8.9	13.9	17.3	21.3	29.0	36.4	51.0	65.7	80.4
BLOCK FUEL (LB.)	131.	193.	275.	347.	502.	656.	960.	1259.	1554.
BLOCK SPEED (MPH)	169.	215.	260.	281.	310.	330.	353.	365.	373.

DIRECT OPERATING COST - ANN UTILIZATION(HR)=2000. DEPRECIATION PERIOD(YR)=10. LABOR RATE($/HR)= 7.00
AIRFRAME COST ($/LB)= 80.0 ENGINE COST ($/HP)= 60.0 INSURANCE RATE=0.040 FUEL COST (CENTS/GAL)= 18.0
DOC=2.83+0.0427*SL $/SEAT-TRIP (SL= 25.,500.)
HOP LENGTHS 50+150+ 0+ 0+ 0=200 100+200+ 0+ 0+ 0=300 200+200+ 0+ 0+ 0=400

STAGE LENGTH	25.	50.	75.	100.	150.	200.	300.	400.	500.	200.	300.	400.
NO. CYCLES/STARTS	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	2/1	2/1	2/1
FLIGHT CREW	0.557	0.437	0.362	0.335	0.303	0.285	0.267	0.258	0.252	0.352	0.312	0.293
FUEL & OIL	0.146	0.108	0.103	0.097	0.093	0.092	0.089	0.088	0.087	0.097	0.093	0.092
HULL INSURANCE	0.146	0.115	0.095	0.088	0.080	0.075	0.070	0.068	0.066	0.089	0.079	0.075
TOTAL FLIGHT OPS	0.849	0.659	0.560	0.520	0.477	0.452	0.426	0.413	0.405	0.538	0.485	0.459
LABOR AIRFRAME	0.394	0.259	0.200	0.175	0.148	0.133	0.119	0.111	0.107	0.174	0.146	0.132
MATERIAL AIRFRAME	0.119	0.073	0.055	0.046	0.038	0.033	0.029	0.026	0.025	0.045	0.036	0.032
LABOR ENGINES	0.259	0.144	0.102	0.082	0.062	0.052	0.041	0.036	0.033	0.075	0.057	0.048
MATERIAL ENGINES	0.226	0.121	0.085	0.067	0.049	0.040	0.031	0.026	0.023	0.059	0.044	0.036
MAT. BURDEN	0.949	0.523	0.393	0.334	0.273	0.240	0.208	0.192	0.182	0.324	0.264	0.235
TOTAL MAINTENANCE	1.846	1.119	0.834	0.704	0.569	0.498	0.427	0.392	0.370	0.677	0.547	0.483
DEPRECIATION	0.424	0.333	0.276	0.255	0.231	0.217	0.203	0.196	0.192	0.257	0.230	0.217
TOTAL DIRECT OPERATING COST												
$/AIRCRAFT MILE	3.119	2.112	1.671	1.479	1.277	1.167	1.057	1.001	0.967	1.472	1.262	1.160
$/FLIGHT HOUR	527.2	454.8	433.8	415.6	395.7	384.9	372.5	365.5	361.0	411.1	393.5	382.7
$/SEAT MILE	0.1559	0.1056	0.0835	0.0739	0.0638	0.0583	0.0528	0.0500	0.0484	0.0736	0.0631	0.0580
$/SEAT-TRIP	3.90	5.28	6.27	7.39	9.58	11.67	15.85	20.02	24.19	14.72	18.93	23.20

M-80-20

DEPARTURE PATH TO 10,000 FT MSL

MAX FUSE ANGLE=20. OBSTACLE CLEAR ANGLE=60. OBSTACLE HEIGHT=100. MAX ACCEL ROTATION RATE=20. ACCEL BUILDUP TIME= 5.

TIME SEC	DIST FT	ALT FT	VEL FPS	ACC G	GAM DEG	THRUST LB	LWGO LB	LWGI LB	DWGO LB	DWGI LB	DFUST LB	ALP DEG	THE DEG	AWO DEG	ALV DEG	LAMDA	MU	CT	POWER HP
OBSTACLE CLEARANCE																			
3.1	4.	7.	3.	0.050	60.0	20144.	-0.	-234.	0.	305.	1.	29.3	24.6	-35.4	28.7	0.0852	0.0020	0.0139	2765.
4.0	7.	13.	8.	0.171	60.0	22184.	-2.	-286.	1.	279.	6.	26.4	24.6	-35.4	24.7	0.0929	0.0054	0.0153	3246.
5.0	13.	23.	13.	0.161	60.0	22014.	-5.	-291.	2.	262.	16.	26.6	24.6	-35.4	23.5	0.0965	0.0090	0.0152	3337.
6.2	24.	42.	18.	0.127	60.0	21349.	-9.	-288.	4.	241.	32.	27.5	24.6	-35.4	22.4	0.0996	0.0127	0.0148	3337.
8.0	44.	76.	23.	0.090	60.0	20840.	-15.	-290.	7.	234.	52.	28.2	24.6	-35.4	21.9	0.1020	0.0168	0.0144	3337.
8.6	58.	100.	24.	0.055	60.0	20271.	-22.	-290.	11.	224.	78.	29.1	24.6	-35.4	21.2	0.1048	0.0210	0.0141	3337.
ACCELERATION AND CONVERSION																			
9.4	76.	123.	33.	0.175	51.6	19769.	-40.	-399.	12.	126.	75.	29.6	24.6	-27.1	20.9	0.1075	0.0260	0.0137	3337.
10.3	102.	145.	40.	0.178	40.6	19644.	-80.	-543.	12.	84.	55.	40.7	24.6	-16.0	26.0	0.1081	0.0412	0.0136	3337.
11.2	137.	168.	48.	0.179	32.8	19728.	-78.	-670.	12.	67.	38.	48.7	24.6	-8.2	28.7	0.1076	0.0574	0.0137	3337.
12.0	180.	190.	57.	0.180	27.3	19740.	51.	-779.	12.	59.	28.	54.0	24.6	-2.7	28.7	0.1074	0.0730	0.0137	3337.
12.9	231.	212.	66.	0.184	23.3	19738.	225.	-884.	16.	56.	25.	57.6	24.6	1.3	27.3	0.1073	0.0886	0.0137	3337.
13.7	288.	233.	75.	0.193	20.2	19726.	445.	-996.	25.	56.	28.	59.8	24.6	4.3	25.3	0.1072	0.1041	0.0137	3337.
14.5	353.	254.	84.	0.192	17.9	19653.	714.	-1119.	38.	58.	38.	61.8	24.6	6.7	23.0	0.1074	0.1196	0.0137	3337.
15.3	428.	275.	94.	0.188	16.0	19542.	1033.	-1257.	56.	62.	54.	63.4	24.6	8.6	20.6	0.1078	0.1352	0.0136	3337.
16.2	515.	298.	104.	0.178	14.5	18995.	1402.	-904.	78.	43.	77.	63.8	24.6	10.1	17.8	0.1106	0.1494	0.0132	3337.
17.1	611.	320.	113.	0.179	13.2	18214.	1820.	-290.	105.	28.	107.	62.8	24.6	11.4	15.0	0.1151	0.1628	0.0127	3337.
17.9	716.	343.	123.	0.178	12.2	17335.	2289.	357.	136.	30.	142.	61.5	24.6	12.4	12.6	0.1207	0.1758	0.0121	3337.
18.9	843.	368.	133.	0.159	11.3	16245.	2809.	1067.	171.	46.	185.	60.9	24.6	13.3	10.4	0.1284	0.1877	0.0113	3337.
19.9	983.	394.	143.	0.155	10.5	15163.	3379.	1804.	211.	76.	234.	58.8	24.6	14.1	8.6	0.1373	0.1992	0.0106	3337.
21.0	1152.	423.	153.	0.138	9.8	13891.	3999.	2615.	256.	118.	289.	57.0	24.6	14.8	6.9	0.1495	0.2085	0.0097	3337.
22.4	1364.	458.	162.	0.118	9.2	12486.	4669.	3494.	305.	174.	350.	54.8	24.6	15.4	5.4	0.1662	0.2147	0.0087	3337.
23.8	1613.	496.	172.	0.106	8.7	11094.	5388.	4418.	358.	239.	418.	50.9	24.6	15.9	4.1	0.1869	0.2172	0.0078	3337.
25.5	1920.	540.	182.	0.091	8.2	9717.	6086.	5319.	407.	307.	482.	46.6	24.4	16.2	3.0	0.2136	0.2131	0.0068	3337.
27.4	2282.	589.	192.	0.081	7.8	8907.	6495.	5794.	420.	332.	499.	44.3	23.3	15.6	2.4	0.2330	0.2149	0.0063	3337.
29.5	2698.	643.	202.	0.075	7.4	8110.	6918.	6296.	434.	359.	518.	41.0	22.4	15.0	1.9	0.2562	0.2117	0.0057	3337.
31.7	3157.	700.	212.	0.071	7.0	7336.	7356.	6824.	448.	387.	539.	36.6	21.6	14.6	1.4	0.2840	0.2008	0.0052	3337.
33.9	3634.	756.	221.	0.071	6.7	6657.	7781.	7346.	463.	414.	561.	31.1	20.9	14.2	1.0	0.3144	0.1804	0.0047	3337.
AIRPLANE MODE CLIMB TO 10,000 FT																			
33.9	3634.	756.	225.	0.0		17.8	7412.												
175.1	37828.	10000.	259.	0.0		14.7	6441.												

THE TOTAL NOISE IMPACT IS 0.26190D+06

NOISE AT 500 FT SIDELINE= 93.5 EPNDB

NOISE AT 20,000 FT SIDELINE= 57.0 EPNDB

NOISE 25,000 FT FORWARD OF TAKEOFF POINT= 54.8 EPNDB

NOISE 500 FT FORWARD OF TAKEOFF POINT= 94.9 EPNDB

TILT ROTOR DESIGN PROGRAM 1974

M-80-80 DESIGN ITERATIONS: 6

OVERALL		POWERPLANT		FUSELAGE		STRUCT TECHNOLOGY FACTORS	
GROSS WEIGHT (LB)	72322.	INST NORMAL PWR (HP)	15466.	*LENGTH (FT)	95.0	*ROTOR	1.00
EMPTY WEIGHT (LB)	49453.	*NUMBER OF ENGINES	2.	*DIAMETER (FT)	11.5	*TRANSMISSION	0.83
FUEL WEIGHT (LB)	6568.	*EXCESS FACTOR HEL MODE	1.30	*DRAG FACTOR	1.00	*AIRFRAME	0.78
PAYLOAD (LB)	16300.	*% RATED EMRG HVR	140.			*ENGINE (HP/LB)	8.50
CRUISE SPEED (MPH)	447.	* CONV + CLIMB	120.	FLAT PLATE AREAS (SF)		*ENGINE INSTALLATION	1.50
L/D CRUISE	10.61	* CRUISE	90.	WING PROFILE	4.96		
*RANGE (STAT MI)	500.	INST PWR EMRG HVR (HP)	15466.	FUSELAGE	7.04	DESIGN MISSION	
*PASSENGER SEATS	80.	CONVER (HP)	10750.	EMPENNAGE	2.98	*FIELD ELEVATION (FT)	0.
*CARGO (LB)	0.	CRUISE (HP)	11756.	TOTAL PROFILE	18.12	SOUND SPEED HVR (FPS)	1117.
		*SFC (LB/HP HR)	0.400	WING INDUCED	3.19	*STD DAY TEMP (DEG F)	59.
ROTORS						*EMERG HOVER ALT (FT)	2000.
*DISC LOADING (PSF)	12.00	DRIVE SYSTEM		COMPONENT WEIGHTS (LB)		*HOT DAY TEMP (DEG F)	95.
RADIUS (FT)	31.0	*EFFICIENCY	0.97	ROTORS	6975.	*CT/SIG MAX	0.150
SOLIDITY	0.143	HEL MODE WEIGHT (LB)	7257.	DRIVE SYSTEM	8892.	*MAX ACCELERATION (G)	0.25
BLADE CHORD (FT)	3.49	AIRPLANE WEIGHT (LB)	8892.	POWERPLANT	2729.	*DESIGN CRUISE (MPH)	400.
TOTAL BLADES	8			NACELLES	784.	*CRUISE ALTITUDE (FT)	15000.
*CT/SIG HOVER	0.120	WING		FUEL SYSTEM	765.	SOUND SPEED CRSE (FPS)	1058.
*PROFILE DRAG COEFF	0.010	AREA (SF)	761.	WING	5701.	*MAX DECELERATION (G)	0.20
% DOWNLOAD	5.1	*LOADING (PSF)	95.0	FUSELAGE	8035.	*STRUCT LOAD FACTOR	4.5
*EFFICIENCY HOVER	0.85	ASPECT RATIO	7.48	EMPENNAGE	1410.	*FLIGHT CREW	2.
* CONVER	0.83	SPAN (FT)	75.4	LANDING GEAR	2170.	*CABIN CREW	2.
CRUISE	0.70	MEAN CHORD (FT)	10.09	FLIGHT CONTROLS	3780.	*ATC SPEED LIMIT	YES
HEL MODE WEIGHT (LB)	6975.	*THICKNESS/CHORD RATIO	0.210	HYDRAULICS	348.		
AIRPLANE WEIGHT (LB)	6733.	*TAPER RATIO	0.70	ELECTRICAL	1398.		
*TIP SPEED HOVER	620.	SWEEP (DEG)	-5.4	INSTR+AVIONICS	826.		
* CRUISE	550.	CRUISE LIFT COEFF	0.30	AIR CONDITIONING	1540.		
*FUSELAGE CLEARNCE (FT)	2.0	MAX LIFT COEFF CONVER	1.34	FURNISHINGS	3700.		
*MAX HEL MODE ADV RATIO	0.40	*MAX LIFT COEFF CLEAN	1.40	FLUIDS	362.		
		*FLAP AREA/WING AREA	0.25	FLIGHT CREW	400.		
* INDICATES INPUT VARIABLE		CLIMB SPD/CONVER SPD	1.04	CABIN CREW	300.		

DESIGN MISSION	SPEED MPH	HEIGHT FT	DIST MI	TIME MIN	FUEL LB
TAKEOFF & LANDING				2.00	141.
ACCEL. & CONV.		900.	0.9	0.61	52.
AIRPLANE CLIMB	176.,219.	14100.	12.0	3.65	315.
ACCEL. TO CRUISE			10.8	1.79	164.
CRUISE	447.		438.7	58.86	4400.
AIRPLANE DESCENT	447.,292.	14100.	36.6	6.39	68.
DECEL. & CONV.		900.	0.9	1.05	14.
TOTAL			500.0	74.36	5154.
RESERVE				20.00	1414.

M-80-80

STAGE LENGTH (MI.)	25.	50.	75.	100.	150.	200.	300.	400.	500.
CRUISE ALTITUDE (FT.)	2000.	4000.	10001.	12500.	15000.	15000.	15000.	15000.	15000.
CRUISE SPEED (MPH)	296.	305.	456.	456.	454.	454.	454.	454.	454.
CRUISE L/D	13.44	13.44	9.16	9.69	10.21	10.21	10.21	10.21	10.21
CRUISE DISTANCE (MI.)	17.4	35.1	1.7	44.6	87.6	137.6	237.6	337.6	437.6
BLOCK TIME (MIN.)	8.6	13.6	18.6	20.2	27.2	33.8	47.0	60.2	73.4
BLOCK FUEL (LB.)	444.	642.	728.	1174.	1704.	2235.	3284.	4317.	5335.
BLOCK SPEED (MPH)	175.	221.	241.	297.	331.	355.	383.	398.	408.

DIRECT OPERATING COST - ANN UTILIZATION(HR)=2000. DEPRECIATION PERIOD(YR)=10. LABOR RATE($/HR)= 7.00
AIRFRAME COST ($/LB)= 80.0 ENGINE COST ($/HP)= 60.0 INSURANCE RATE=0.040 FUEL COST (CENTS/GAL)= 18.0
DOC=1.46+0.0219*SL $/SEAT-TRIP (SL= 25.,500.)
HOP LENGTHS 50+150+ 0+ 0+ 0=200 100+200+ 0+ 0+ 0=300 200+200+ 0+ 0+ 0=400

STAGE LENGTH	25.	50.	75.	100.	150.	200.	300.	400.	500.	200.	300.	400.
NO. CYCLES/STARTS	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	2/1	2/1	2/1
FLIGHT CREW	0.561	0.446	0.408	0.332	0.298	0.278	0.257	0.247	0.241	0.351	0.307	0.286
FUEL & OIL	0.493	0.357	0.270	0.326	0.315	0.310	0.304	0.300	0.296	0.326	0.315	0.310
HULL INSURANCE	0.532	0.422	0.387	0.315	0.282	0.263	0.244	0.234	0.228	0.317	0.280	0.263
TOTAL FLIGHT OPS	1.586	1.225	1.064	0.972	0.895	0.851	0.805	0.781	0.766	0.994	0.902	0.859
LABOR AIRFRAME	0.558	0.365	0.301	0.239	0.199	0.178	0.156	0.145	0.139	0.238	0.197	0.176
MATERIAL AIRFRAME	0.279	0.171	0.135	0.107	0.086	0.075	0.064	0.058	0.055	0.103	0.083	0.073
LABOR ENGINES	0.383	0.209	0.151	0.116	0.085	0.070	0.054	0.046	0.042	0.105	0.077	0.064
MATERIAL ENGINES	0.853	0.459	0.328	0.251	0.183	0.148	0.113	0.095	0.085	0.223	0.163	0.133
MAT. BURDEN	1.223	0.746	0.588	0.462	0.370	0.322	0.273	0.249	0.235	0.446	0.356	0.312
TOTAL MAINTENANCE	3.297	1.950	1.503	1.175	0.923	0.792	0.660	0.594	0.555	1.114	0.875	0.759
DEPRECIATION	1.543	1.224	1.121	0.912	0.818	0.763	0.707	0.679	0.662	0.920	0.812	0.763
TOTAL DIRECT OPERATING COST												
$/AIRCRAFT MILE	6.426	4.399	3.688	3.059	2.637	2.405	2.172	2.054	1.983	3.028	2.590	2.380
$/FLIGHT HOUR	1126.9	972.2	890.2	907.6	871.9	853.2	831.2	818.4	809.9	890.6	862.5	844.4
$/SEAT MILE	0.0803	0.0550	0.0461	0.0382	0.0330	0.0301	0.0271	0.0257	0.0248	0.0379	0.0324	0.0298
$/SEAT-TRIP	2.01	2.75	3.46	3.82	4.94	6.01	8.14	10.27	12.39	7.57	9.71	11.90

M-80-80

DEPARTURE PATH TO 10,000 FT MSL

MAX FUSE ANGLE=20. OBSTACLE CLEAR ANGLE=60. OBSTACLE HEIGHT=100. MAX ACCEL ROTATION RATE=20. ACCEL BUILDUP TIME= 5.

TIME SEC	DIST FT	ALT FT	VEL FPS	ACC G	GAM DEG	THRUST LB	LWGO LB	LWGI LB	DWGO LB	DWGI LB	DFUST LB	ALP DEG	THE DEG	AWO DEG	ALV DEG	LAMDA	MU	CT	POWER HP
OBSTACLE CLEARANCE																			
3.1	4.	7.	3.	0.050	60.0	76786.	-1.	-983.	0.	1288.	2.	29.4	24.6	-35.4	28.8	0.0853	0.0020	0.0140	10549.
4.0	7.	13.	8.	0.171	60.0	84533.	-6.	-1201.	3.	1178.	14.	26.5	24.6	-35.4	24.8	0.0929	0.0054	0.0154	12378.
5.0	13.	23.	13.	0.162	60.0	83909.	-16.	-1222.	8.	1103.	38.	26.7	24.6	-35.4	23.6	0.0966	0.0090	0.0153	12731.
6.2	24.	42.	18.	0.123	60.0	81379.	-31.	-1210.	15.	1016.	74.	27.6	24.6	-35.4	22.5	0.0996	0.0127	0.0148	12731.
7.9	43.	75.	23.	0.092	60.0	79443.	-51.	-1216.	25.	987.	123.	28.3	24.6	-35.4	22.0	0.1020	0.0168	0.0145	12731.
8.5	58.	100.	24.	0.058	60.0	77331.	-76.	-1219.	38.	944.	183.	29.1	24.6	-35.4	21.3	0.1048	0.0210	0.0141	12731.
ACCELERATION AND CONVERSION																			
9.5	77.	125.	33.	0.163	52.1	75633.	-136.	-1666.	42.	556.	183.	30.0	24.6	-27.5	21.2	0.1072	0.0265	0.0138	12731.
10.4	104.	149.	40.	0.173	41.3	74672.	-272.	-2240.	44.	366.	137.	40.5	24.6	-16.7	25.7	0.1085	0.0413	0.0136	12731.
11.3	140.	172.	48.	0.175	33.4	75039.	-293.	-2776.	43.	293.	97.	48.5	24.6	-8.8	28.5	0.1079	0.0575	0.0137	12731.
12.2	184.	195.	57.	0.176	27.8	75152.	133.	-3238.	41.	260.	71.	54.0	24.6	-3.2	28.6	0.1076	0.0731	0.0137	12731.
13.0	236.	218.	66.	0.181	23.8	75235.	704.	-3681.	56.	250.	61.	57.6	24.6	0.8	27.3	0.1073	0.0888	0.0137	12731.
13.8	293.	240.	75.	0.190	20.7	75302.	1431.	-4154.	87.	253.	67.	60.0	24.6	3.9	25.4	0.1071	0.1044	0.0138	12731.
14.6	359.	262.	84.	0.190	18.3	75171.	2319.	-4669.	136.	266.	88.	62.1	24.6	6.3	23.1	0.1071	0.1200	0.0138	12731.
15.5	434.	284.	94.	0.187	16.4	74921.	3370.	-5250.	201.	285.	124.	63.8	24.6	8.2	20.8	0.1072	0.1357	0.0137	12731.
16.4	526.	308.	104.	0.169	14.8	72891.	4586.	-3941.	283.	198.	175.	64.9	24.6	9.8	18.0	0.1099	0.1499	0.0134	12731.
17.2	619.	330.	113.	0.184	13.5	70196.	5969.	-1510.	382.	120.	242.	63.2	24.6	11.1	15.3	0.1139	0.1637	0.0129	12731.
18.1	725.	354.	123.	0.176	12.4	66729.	7519.	1147.	499.	117.	324.	62.5	24.6	12.2	12.8	0.1195	0.1766	0.0122	12731.
19.0	842.	378.	133.	0.172	11.5	62999.	9237.	3944.	632.	183.	421.	61.1	24.6	13.1	10.7	0.1263	0.1891	0.0116	12731.
20.0	979.	403.	143.	0.159	10.7	58678.	11121.	6979.	782.	313.	533.	59.9	24.6	13.9	8.8	0.1352	0.2005	0.0108	12731.
21.0	1135.	431.	152.	0.150	10.0	54137.	13173.	10197.	950.	499.	660.	57.9	24.6	14.6	7.1	0.1463	0.2108	0.0100	12731.
22.3	1329.	463.	162.	0.128	9.4	48833.	15390.	13748.	1134.	749.	802.	56.1	24.6	15.2	5.6	0.1619	0.2179	0.0090	12731.
23.6	1553.	498.	172.	0.118	8.8	43632.	17773.	17463.	1335.	1043.	959.	52.6	24.6	15.7	4.4	0.1810	0.2220	0.0080	12731.
25.0	1815.	536.	182.	0.107	8.4	38193.	20319.	21450.	1554.	1390.	1131.	47.8	24.6	16.2	3.2	0.2070	0.2195	0.0070	12731.
26.7	2132.	581.	192.	0.093	7.9	33752.	22314.	24531.	1687.	1641.	1239.	43.9	24.0	16.1	2.4	0.2346	0.2131	0.0062	12731.
28.5	2489.	628.	202.	0.087	7.5	30721.	23799.	26657.	1744.	1774.	1288.	40.4	23.1	15.6	1.9	0.2580	0.2094	0.0057	12731.
30.3	2882.	677.	212.	0.083	7.2	27762.	25327.	28898.	1803.	1913.	1341.	35.8	22.3	15.1	1.4	0.2864	0.1973	0.0051	12731.
32.2	3300.	728.	222.	0.082	6.9	25021.	26906.	31254.	1867.	2060.	1398.	29.7	21.5	14.7	1.0	0.3194	0.1732	0.0046	12731.
34.1	3724.	776.	232.	0.084	6.6	22791.	28597.	33721.	1940.	2213.	1464.	21.5	20.9	14.3	0.6	0.3528	0.1381	0.0042	12731.
35.9	4162.	825.	242.	0.085	6.3	20979.	30327.	36299.	2015.	2374.	1532.	11.8	20.3	14.0	0.3	0.3860	0.0817	0.0039	12731.
37.8	4641.	875.	252.	0.081	6.0	19816.	32137.	38980.	2097.	2540.	1606.	0.5	19.8	13.7	0.0	0.4102	0.0071	0.0037	12731.
39.8	5153.	928.	258.	0.078	5.9	19382.	32707.	39615.	2083.	2523.	1605.	-2.6	19.2	13.3	0.0	0.4194	-0.0209	0.0036	12731.
AIRPLANE MODE CLIMB TO 10,000 FT																			
39.8	5153.	928.	259.	0.0	15.5	24898.													
178.7	43774.	10000.	297.	0.0	12.9	21691.													

THE TOTAL NOISE IMPACT IS 0.71439D+06

NOISE AT 500 FT SIDELINE= 96.2 EPNDB

NOISE AT 20,000 FT SIDELINE= 62.9 EPNDB

NOISE 25,000 FT FORWARD OF TAKEOFF POINT= 60.7 EPNDB

NOISE 500 FT FORWARD OF TAKEOFF POINT= 97.4 EPNDB

TILT ROTOR DESIGN PROGRAM 1974

M-80-110

DESIGN ITERATIONS: 6

OVERALL	
GROSS WEIGHT (LB)	106775.
EMPTY WEIGHT (LB)	74757.
FUEL WEIGHT (LB)	9569.
PAYLOAD (LB)	22450.
CRUISE SPEED (MPH)	455.
L/D CRUISE	10.91
*RANGE (STAT MI)	500.
*PASSENGER SEATS	110.
*CARGO (LB)	0.

ROTORS	
*DISC LOADING (PSF)	12.00
RADIUS (FT)	37.6
SOLIDITY	0.144
BLADE CHORD (FT)	4.24
TOTAL BLADES	8
*CT/SIG HOVER	0.120
*PROFILE DRAG COEFF	0.010
% DOWNLOAD	5.2
*EFFICIENCY HOVER	0.85
* CONVER	0.83
CRUISE	0.69
HEL MODE WEIGHT (LB)	10668.
AIRPLANE WEIGHT (LB)	10311.
*TIP SPEED HOVER	620.
* CRUISE	550.
*FUSELAGE CLEARNCE (FT)	2.0
*MAX HEL MODE ADV RATIO	0.40

* INDICATES INPUT VARIABLE

POWERPLANT	
INST NORMAL PWR (HP)	22844.
*NUMBER OF ENGINES	2.
*EXCESS FACTOR HEL MODE	1.30
*% RATED EMRG HVR	140.
* CONV + CLIMB	120.
* CRUISE	90.
INST PWR EMRG HVR (HP)	22844.
CONVER (HP)	15878.
CRUISE (HP)	16403.
*SFC (LB/HP HR)	0.400

DRIVE SYSTEM	
*EFFICIENCY	0.97
HEL MODE WEIGHT (LB)	11587.
AIRPLANE WEIGHT (LB)	14240.

WING	
AREA (SF)	1124.
*LOADING (PSF)	95.0
ASPECT RATIO	7.25
SPAN (FT)	90.3
MEAN CHORD (FT)	12.45
*THICKNESS/CHORD RATIO	0.210
*TAPER RATIO	0.70
SWEEP (DEG)	-5.4
CRUISE LIFT COEFF	0.28
MAX LIFT COEFF CONVER	1.34
*MAX LIFT COEFF CLEAN	1.40
*FLAP AREA/WING AREA	0.25
CLIMB SPD/CONVER SPD	1.07

FUSELAGE	
*LENGTH (FT)	110.0
*DIAMETER (FT)	13.0
*DRAG FACTOR	1.00

FLAT PLATE AREAS (SF)	
WING PROFILE	7.11
FUSELAGE	9.00
EMPENNAGE	4.26
TOTAL PROFILE	24.65
WING INDUCED	4.37

COMPONENT WEIGHTS (LB)	
ROTORS	10668.
DRIVE SYSTEM	14240.
POWERPLANT	4031.
NACELLES	1973.
FUEL SYSTEM	1457.
WING	8580.
FUSELAGE	10944.
EMPENNAGE	2082.
LANDING GEAR	3203.
FLIGHT CONTROLS	6548.
HYDRAULICS	423.
ELECTRICAL	2427.
INSTR+AVIONICS	949.
AIR CONDITIONING	1930.
FURNISHINGS	4900.
FLUIDS	534.
FLIGHT CREW	400.
CABIN CREW	450.

STRUCT TECHNOLOGY FACTORS	
*ROTOR	1.00
*TRANSMISSION	0.83
*AIRFRAME	0.78
*ENGINE (HP/LB)	8.50
*ENGINE INSTALLATION	1.50

DESIGN MISSION	
*FIELD ELEVATION (FT)	0.
SOUND SPEED HVR (FPS)	1117.
*STD DAY TEMP (DEG F)	59.
*EMERG HOVER ALT (FT)	2000.
*HOT DAY TEMP (DEG F)	95.
*CT/SIG MAX	0.150
*MAX ACCELERATION (G)	0.25
*DESIGN CRUISE (MPH)	400.
*CRUISE ALTITUDE (FT)	15000.
SOUND SPEED CRSE (FPS)	1058.
*MAX DECELERATION (G)	0.20
*STRUCT LOAD FACTOR	4.5
*FLIGHT CREW	2.
*CABIN CREW	3.
*ATC SPEED LIMIT	YES

DESIGN MISSION	SPEED MPH	HEIGHT FT	DIST MI	TIME MIN	FUEL LB
TAKEOFF & LANDING				2.00	209.
ACCEL. & CONV.		900.	0.9	0.59	75.
AIRPLANE CLIMB	182.,225.	14100.	12.3	3.64	465.
ACCEL. TO CRUISE			11.0	1.79	243.
CRUISE	455.		436.5	57.56	6363.
AIRPLANE DESCENT	455.,292.	14100.	38.4	6.67	105.
DECEL. & CONV.		900.	0.9	1.01	20.
TOTAL			500.0	73.28	7479.
RESERVE				20.00	2089.

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STAGE LENGTH (MI.)	25.	50.	75.	100.	150.	200.	300.	400.	500.
CRUISE ALTITUDE (FT.)	2000.	4000.	10001.	12500.	15000.	15000.	15000.	15000.	15000.
CRUISE SPEED (MPH)	296.	305.	463.	468.	468.	468.	468.	468.	468.
CRUISE L/D	14.11	14.10	9.42	10.03	10.60	10.60	10.60	10.60	10.60
CRUISE DISTANCE (MI.)	17.3	34.7	25.2	42.2	84.2	134.2	234.2	334.2	434.2
BLOCK TIME (MIN.)	8.5	13.5	16.5	20.0	26.8	33.2	46.0	58.9	71.7
BLOCK FUEL (LB.)	641.	924.	1345.	1690.	2448.	3210.	4717.	6203.	7667.
BLOCK SPEED (MPH)	177.	222.	273.	300.	336.	361.	391.	408.	418.

DIRECT OPERATING COST - ANN UTILIZATION(HR)=2000. DEPRECIATION PERIOD(YR)=10. LABOR RATE($/HR)= 7.00
AIRFRAME COST ($/LB)= 80.0 ENGINE COST ($/HP)= 60.0 INSURANCE RATE=0.040 FUEL COST (CENTS/GAL)= 18.0
DOC=1.42+0.0212*SL $/SEAT-TRIP (SL= 25.,500.)
HOP LENGTHS 50+150+ 0+ 0+ 0=200 100+200+ 0+ 0+ 0=300 200+200+ 0+ 0+ 0=400

STAGE LENGTH	25.	50.	75.	100.	150.	200.	300.	400.	500.	200.	300.	400.
NO. CYCLES/STARTS	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	2/1	2/1	2/1
FLIGHT CREW	0.570	0.453	0.369	0.336	0.300	0.279	0.258	0.247	0.241	0.355	0.309	0.287
FUEL & OIL	0.711	0.513	0.497	0.469	0.453	0.445	0.436	0.430	0.425	0.468	0.453	0.445
HULL INSURANCE	0.795	0.633	0.515	0.469	0.419	0.389	0.360	0.345	0.336	0.472	0.416	0.389
TOTAL FLIGHT OPS	2.077	1.599	1.382	1.274	1.171	1.113	1.053	1.022	1.002	1.295	1.178	1.121
LABOR AIRFRAME	0.637	0.416	0.316	0.271	0.225	0.200	0.175	0.162	0.155	0.269	0.221	0.198
MATERIAL AIRFRAME	0.390	0.240	0.178	0.149	0.119	0.104	0.088	0.080	0.076	0.144	0.115	0.101
LABOR ENGINES	0.464	0.252	0.176	0.139	0.101	0.082	0.063	0.054	0.048	0.124	0.091	0.075
MATERIAL ENGINES	1.259	0.678	0.471	0.370	0.268	0.217	0.165	0.139	0.124	0.328	0.239	0.195
MAT. BURDEN	1.432	0.868	0.639	0.533	0.424	0.366	0.309	0.280	0.263	0.512	0.406	0.355
TOTAL MAINTENANCE	4.193	2.453	1.779	1.461	1.137	0.968	0.800	0.715	0.665	1.377	1.073	0.924
DEPRECIATION	2.304	1.832	1.493	1.358	1.212	1.127	1.041	0.999	0.973	1.367	1.204	1.127
TOTAL DIRECT OPERATING COST												
$/AIRCRAFT MILE	8.564	5.884	4.655	4.094	3.521	3.208	2.894	2.736	2.639	4.039	3.455	3.172
$/FLIGHT HOUR	1513.4	1307.4	1269.3	1226.9	1182.3	1159.1	1131.6	1115.4	1104.6	1202.5	1168.2	1146.0
$/SEAT MILE	0.0779	0.0535	0.0423	0.0372	0.0320	0.0292	0.0263	0.0249	0.0240	0.0367	0.0314	0.0288
$/SEAT-TRIP	1.95	2.67	3.17	3.72	4.80	5.83	7.89	9.95	12.00	7.34	9.42	11.53

M-80-110

DEPARTURE PATH TO 10,000 FT MSL

MAX FUSE ANGLE=20. OBSTACLE CLEAR ANGLE=60. OBSTACLE HEIGHT=100. MAX ACCEL ROTATION RATE=20. ACCEL BUILDUP TIME= 5.

TIME SEC	DIST FT	ALT FT	VEL FPS	ACC G	GAM DEG	THRUST LB	LWGO LB	LWGI LB	DWGO LB	DWGI LB	DFUST LB	ALP DEG	THE DEG	AWO DEG	ALV DEG	LAMDA	MU	CT	POWER HP
OBSTACLE CLEARANCE																			
3.1	4.	7.	3.	0.050	60.0	113396.	-1.	-1476.	0.	1935.	2.	29.4	24.6	-35.4	28.8	0.0853	0.0020	0.0140	15582.
4.0	7.	13.	8.	0.171	60.0	124829.	-8.	-1803.	4.	1770.	18.	26.5	24.6	-35.4	24.8	0.0929	0.0054	0.0154	18281.
5.0	13.	23.	13.	0.159	60.0	123577.	-23.	-1818.	11.	1640.	50.	26.8	24.6	-35.4	23.6	0.0969	0.0090	0.0152	18803.
6.2	24.	42.	18.	0.124	60.0	120435.	-45.	-1828.	22.	1543.	97.	27.5	24.6	-35.4	22.6	0.0994	0.0127	0.0148	18803.
7.9	43.	75.	23.	0.092	60.0	117328.	-74.	-1829.	36.	1480.	161.	28.3	24.6	-35.4	22.0	0.1020	0.0168	0.0145	18803.
8.5	58.	100.	24.	0.057	60.0	114123.	-110.	-1827.	54.	1415.	240.	29.2	24.6	-35.4	21.3	0.1049	0.0210	0.0141	18803.
ACCELERATION AND CONVERSION																			
9.4	76.	124.	33.	0.168	52.1	111674.	-197.	-2501.	61.	834.	239.	29.8	24.6	-27.5	21.3	0.1072	0.0267	0.0138	18803.
10.3	103.	147.	40.	0.175	41.2	110280.	-395.	-3373.	64.	549.	179.	40.4	24.6	-16.6	25.7	0.1085	0.0412	0.0136	18803.
11.2	138.	170.	48.	0.178	33.3	110813.	-411.	-4177.	62.	441.	126.	48.5	24.6	-8.7	28.5	0.1079	0.0574	0.0137	18803.
12.1	182.	193.	57.	0.178	27.8	110990.	204.	-4871.	59.	393.	93.	53.9	24.6	-3.2	28.6	0.1076	0.0731	0.0137	18803.
12.9	234.	216.	66.	0.180	23.7	111099.	1028.	-5538.	81.	378.	81.	57.8	24.6	0.9	27.3	0.1074	0.0888	0.0137	18803.
13.7	291.	238.	75.	0.192	20.6	111250.	2075.	-6246.	128.	384.	89.	60.0	24.6	3.9	25.4	0.1070	0.1044	0.0138	18803.
14.6	356.	259.	84.	0.191	18.2	111088.	3353.	-7020.	199.	404.	116.	62.1	24.6	6.3	23.1	0.1070	0.1201	0.0138	18803.
15.4	430.	281.	94.	0.188	16.3	110757.	4867.	-7893.	295.	435.	164.	63.8	24.6	9.2	20.8	0.1071	0.1358	0.0137	18803.
16.3	520.	305.	104.	0.172	14.8	107766.	6618.	-5873.	417.	297.	232.	64.8	24.6	9.8	18.0	0.1098	0.1500	0.0134	18803.
17.1	613.	327.	113.	0.186	13.5	103735.	8609.	-2228.	563.	177.	320.	63.3	24.6	11.1	15.3	0.1138	0.1637	0.0129	18803.
18.0	717.	350.	123.	0.179	12.4	98646.	10840.	1732.	734.	172.	428.	62.5	24.6	12.2	12.8	0.1194	0.1767	0.0123	18803.
18.9	833.	373.	133.	0.175	11.5	93138.	13312.	5910.	931.	274.	556.	61.2	24.6	13.1	10.7	0.1261	0.1892	0.0116	18803.
19.8	967.	399.	143.	0.162	10.7	86788.	16024.	10436.	1152.	473.	703.	60.0	24.6	13.9	8.8	0.1350	0.2007	0.0108	18803.
20.9	1120.	425.	153.	0.153	10.0	80096.	18976.	15239.	1399.	758.	870.	58.0	24.6	14.6	7.1	0.1460	0.2110	0.0100	18803.
22.0	1308.	457.	162.	0.132	9.4	72293.	22168.	20536.	1671.	1138.	1057.	56.2	24.6	15.2	5.6	0.1615	0.2183	0.0090	18803.
23.3	1526.	490.	172.	0.121	8.8	64636.	25597.	26077.	1967.	1588.	1264.	52.7	24.6	15.8	4.4	0.1804	0.2225	0.0081	18803.
24.7	1780.	528.	182.	0.110	8.3	56621.	29262.	32024.	2288.	2117.	1490.	48.0	24.6	16.2	3.3	0.2061	0.2203	0.0071	18803.
26.3	2087.	570.	192.	0.096	7.9	49787.	32284.	36896.	2506.	2535.	1647.	43.9	24.1	16.2	2.4	0.2349	0.2128	0.0062	18803.
28.0	2430.	616.	202.	0.090	7.5	45312.	34441.	40096.	2591.	2739.	1713.	40.3	23.2	15.7	1.9	0.2584	0.2090	0.0057	18803.
29.8	2809.	663.	212.	0.086	7.2	40938.	36659.	43470.	2680.	2955.	1784.	35.7	22.4	15.2	1.4	0.2868	0.1967	0.0051	18803.
31.7	3213.	712.	222.	0.085	6.8	36893.	38953.	47017.	2774.	3182.	1861.	29.5	21.6	14.8	1.0	0.3200	0.1722	0.0046	18803.
33.5	3627.	759.	232.	0.086	6.6	33608.	41409.	50732.	2884.	3419.	1949.	21.3	21.0	14.4	0.6	0.3535	0.1366	0.0042	18803.
35.3	4057.	807.	242.	0.087	6.3	30951.	43921.	54612.	2996.	3667.	2040.	11.5	20.4	14.1	0.3	0.3865	0.0796	0.0039	18803.
37.2	4531.	857.	252.	0.082	6.0	29260.	46548.	58647.	3117.	3925.	2138.	0.1	19.9	13.8	0.0	0.4103	0.0044	0.0037	18803.
39.2	5047.	909.	261.	0.078	5.8	28226.	47343.	59431.	3021.	3793.	2099.	-2.6	18.8	13.0	0.0	0.4253	-0.0209	0.0036	18803.
AIRPLANE MODE CLIMB TO 10,000 FT																			
39.2	5047.	909.	266.	0.0	15.1	35896.													
178.0	44745.	10000.	306.	0.0	12.6	31265.													

THE TOTAL NOISE IMPACT IS 0.931820+06

NOISE AT 500 FT SIDELINE= 97.3 EPNDB

NOISE AT 20,000 FT SIDELINE= 64.6 EPNDB

NOISE 25,000 FT FORWARD OF TAKEOFF POINT= 62.4 EPNDB

NOISE 500 FT FORWARD OF TAKEOFF POINT= 98.5 EPNDB

TILT ROTOR DESIGN PROGRAM 1974

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DESIGN ITERATIONS: 3

OVERALL		POWERPLANT		FUSELAGE		STRUCT TECHNOLOGY FACTORS	
GROSS WEIGHT (LB)	21254.	INST NORMAL PWR (HP)	4336.	*LENGTH (FT)	55.0	*ROTOR	1.00
EMPTY WEIGHT (LB)	15295.	*NUMBER OF ENGINES	2.	*DIAMETER (FT)	8.5	*TRANSMISSION	0.83
FUEL WEIGHT (LB)	1960.	*EXCESS FACTOR HEL MODE	1.40	*DRAG FACTOR	1.00	*AIRFRAME	0.78
PAYLOAD (LB)	4000.	*% RATED EMRG HVR	140.			*ENGINE (HP/LB)	8.50
CRUISE SPEED (MPH)	401.	* CONV + CLIMB	120.	FLAT PLATE AREAS (SF)		*ENGINE INSTALLATION	1.54.
L/D CRUISE	9.18	* CRUISE	90.	WING PROFILE	2.00		
*RANGE (STAT MI)	500.	INST PWR EMRG HVR (HP)	3885.	FUSELAGE	3.38	DESIGN MISSION	
*PASSENGER SEATS	20.	CONVER (HP)	2907.	EMPENNAGE	1.20	*FIELD ELEVATION (FT)	0.
*CARGO (LB)	0.	CRUISE (HP)	4336.	TOTAL PROFILE	7.97	SOUND SPEED HVR (FPS)	1117.
		*SFC (LB/HP HR)	0.400	WING INDUCED	0.99	*STD DAY TEMP (DEG F)	59.
ROTORS						*EMERG HOVER ALT (FT)	2000.
*DISC LOADING (PSF)	9.00	DRIVE SYSTEM		COMPONENT WEIGHTS (LB)		*HOT DAY TEMP (DEG F)	95.
RADIUS (FT)	19.4	*EFFICIENCY	0.97	ROTORS	2327.	*CT/SIG MAX	0.150
SOLIDITY	0.179	HEL MODE WEIGHT (LB)	2148.	DRIVE SYSTEM	2549.	*MAX ACCELERATION (G)	0.25
BLADE CHORD (FT)	1.81	AIRPLANE WEIGHT (LB)	2549.	POWERPLANT	765.	*DESIGN CRUISE (MPH)	400.
TOTAL BLADES	12			NACELLES	39.	*CRUISE ALTITUDE (FT)	15000.
*CT/SIG HOVER	0.120	WING		FUEL SYSTEM	96.	SOUND SPEED CRSE (FPS)	1058.
*PROFILE DRAG COEFF	0.010	AREA (SF)	283.	WING	1587.	*MAX DECELERATION (G)	0.20
% DOWNLOAD	4.6	*LOADING (PSF)	75.0	FUSELAGE	2731.	*STRUCT LOAD FACTOR	4.5
*EFFICIENCY HOVER	0.85	ASPECT RATIO	8.57	EMPENNAGE	414.	*FLIGHT CREW	2.
* CONVER	0.83	SPAN (FT)	49.3	LANDING GEAR	638.	*CABIN CREW	0.
CRUISE	0.71	MEAN CHORD (FT)	5.75	FLIGHT CONTROLS	672.	*ATC SPEED LIMIT	YES
HEL MODE WEIGHT (LB)	2166.	*THICKNESS/CHORD RATIO	0.210	HYDRAULICS	188.		
AIRPLANE WEIGHT (LB)	2327.	*TAPER RATIO	0.70	ELECTRICAL	247.		
*TIP SPEED HOVER	480.	SWEEP (DEG)	-5.2	INSTR+AVIONICS	580.		
* CRUISE	480.	CRUISE LIFT COEFF	0.29	AIR CONDITIONING	760.		
*FUSELAGE CLEARANCE (FT)	2.0	MAX LIFT COEFF CONVER	1.76	FURNISHINGS	1300.		
*MAX HEL MODE ADV RATIO	0.40	*MAX LIFT COEFF CLEAN	1.40	FLUIDS	106.		
		*FLAP AREA/WING AREA	0.25	FLIGHT CREW	400.		
* INDICATES INPUT VARIABLE		CLIMB SPD/CONVER SPD	1.11	CABIN CREW	0.		

DESIGN MISSION	SPEED MPH	HEIGHT FT	DIST MI	TIME MIN	FUEL LB
TAKEOFF & LANDING				2.00	36.
ACCEL. & CONV.		1000.	0.8	0.66	15.
AIRPLANE CLIMB	146.,180.	14000.	9.3	3.42	81.
ACCEL. TO CRUISE			7.9	1.48	37.
CRUISE	401.		452.3	67.77	1408.
AIRPLANE DESCENT	400.,292.	14000.	28.9	5.18	14.
DECEL. & CONV.		1000.	0.8	1.22	5.
TOTAL			500.0	81.71	1596.
RESERVE				20.00	363.

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STAGE LENGTH (MI.)	25.	50.	75.	100.	150.	200.	300.	400.	500.			
CRUISE ALTITUDE (FT.)	2000.	4000.	10001.	12500.	15000.	15000.	15000.	15000.	15000.			
CRUISE SPEED (MPH)	296.	305.	400.	397.	400.	400.	400.	400.	400.			
CRUISE L/D	10.63	10.62	8.20	8.61	9.17	9.17	9.17	9.17	9.17			
CRUISE DISTANCE (MI.)	18.2	37.4	38.6	58.3	101.6	151.6	251.6	351.6	451.6			
BLOCK TIME (MIN.)	8.9	13.9	17.4	21.5	29.3	36.8	51.8	66.8	81.7			
BLOCK FUEL (LB.)	134.	199.	281.	356.	513.	671.	984.	1291.	1594.			
BLOCK SPEED (MPH)	169.	216.	259.	279.	307.	326.	348.	359.	367.			

DIRECT OPERATING COST - ANN UTILIZATION(HR)=2000. DEPRECIATION PERIOD(YR)=10. LABOR RATE($/HR)= 7.00
AIRFRAME COST ($/LB)= 80.0 ENGINE COST ($/HP)= 60.0 INSURANCE RATE=0.040 FUEL COST (CENTS/GAL)= 18.0
DOC=2.94+0.0459*SL $/SEAT-TRIP (SL= 25.,500.)
HOP LENGTHS 50+150+ 0+ 0+ 0=200 100+200+ 0+ 0+ 0=300 200+200+ 0+ 0+ 0=400

STAGE LENGTH	25.	50.	75.	100.	150.	200.	300.	400.	500.	200.	300.	400.
NO. CYCLES/STARTS	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	2/1	2/1	2/1
FLIGHT CREW	0.555	0.435	0.362	0.337	0.306	0.288	0.270	0.261	0.256	0.354	0.315	0.296
FUEL & OIL	0.150	0.111	0.105	0.099	0.096	0.094	0.091	0.090	0.089	0.099	0.096	0.094
HULL INSURANCE	0.168	0.132	0.110	0.102	0.093	0.087	0.082	0.079	0.078	0.102	0.092	0.087
TOTAL FLIGHT OPS	0.872	0.678	0.577	0.539	0.494	0.469	0.443	0.430	0.422	0.556	0.503	0.477
LABOR AIRFRAME	0.409	0.268	0.208	0.182	0.154	0.139	0.124	0.117	0.112	0.181	0.153	0.139
MATERIAL AIRFRAME	0.129	0.079	0.059	0.051	0.041	0.036	0.031	0.029	0.027	0.049	0.040	0.035
LABOR ENGINES	0.262	0.145	0.103	0.083	0.063	0.052	0.042	0.037	0.034	0.076	0.058	0.049
MATERIAL ENGINES	0.240	0.129	0.090	0.072	0.052	0.043	0.033	0.028	0.025	0.064	0.047	0.039
MAT. BURDEN	0.872	0.537	0.404	0.345	0.282	0.249	0.216	0.200	0.190	0.335	0.274	0.243
TOTAL MAINTENANCE	1.912	1.159	0.865	0.733	0.593	0.520	0.447	0.411	0.389	0.704	0.571	0.505
DEPRECIATION	0.485	0.381	0.317	0.295	0.267	0.252	0.236	0.229	0.224	0.296	0.266	0.252
TOTAL DIRECT OPERATING COST												
$/AIRCRAFT MILE	3.270	2.219	1.759	1.566	1.354	1.241	1.127	1.070	1.035	1.556	1.339	1.233
$/FLIGHT HOUR	553.5	478.4	455.9	436.4	415.9	404.6	391.7	384.5	379.8	431.9	413.3	402.2
$/SEAT MILE	0.1635	0.1109	0.0880	0.0783	0.0677	0.0620	0.0563	0.0535	0.0517	0.0778	0.0670	0.0617
$/SEAT-TRIP	4.09	5.55	6.60	7.83	10.16	12.41	16.90	21.39	25.87	15.56	20.09	24.67

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DEPARTURE PATH TO 10,000 FT MSL

MAX FUSE ANGLE=20. OBSTACLE CLEAR ANGLE=60. OBSTACLE HEIGHT=100. MAX ACCEL ROTATION RATE=20. ACCEL BUILDUP TIME= 5.

TIME SEC	DIST FT	ALT FT	VEL FPS	ACC G	GAM DEG	THRUST LB	LWGO LB	LWGI LB	DWGO LB	DWGI LB	DFUST LB	ALP DEG	THE DEG	AWO DEG	ALV DEG	LAMDA	MU	CT	POWER HP
OBSTACLE CLEARANCE																			
3.1	4.	7.	3.	0.050	60.0	22533.	-0.	-264.	0.	343.	1.	29.3	24.6	-35.4	28.7	0.0953	0.0025	0.0174	2641.
4.0	7.	13.	8.	0.171	60.0	24810.	-2.	-321.	1.	309.	6.	26.4	24.6	-35.4	24.5	0.1049	0.0070	0.0192	3135.
4.7	12.	20.	13.	0.220	60.0	25759.	-6.	-343.	3.	301.	16.	25.4	24.6	-35.4	23.1	0.1119	0.0116	0.0199	3438.
5.6	19.	34.	18.	0.177	60.0	24936.	-12.	-349.	6.	265.	32.	26.3	24.6	-35.4	20.9	0.1156	0.0157	0.0193	3438.
6.7	32.	56.	23.	0.135	60.0	24158.	-20.	-347.	10.	253.	53.	27.2	24.6	-35.4	20.3	0.1193	0.0208	0.0187	3438.
8.4	55.	96.	28.	0.092	60.0	23366.	-30.	-346.	15.	241.	79.	28.2	24.6	-35.4	19.5	0.1234	0.0262	0.0181	3438.
8.5	58.	100.	28.	0.053	60.0	22688.	-42.	-350.	21.	234.	110.	29.1	24.6	-35.4	18.8	0.1270	0.0320	0.0176	3438.
ACCELERATION AND CONVERSION																			
9.4	77.	125.	37.	0.180	52.4	22100.	-66.	-460.	21.	146.	99.	28.5	24.6	-27.8	18.2	0.1304	0.0372	0.0171	3438.
10.3	106.	151.	44.	0.175	42.1	22046.	-124.	-625.	21.	106.	74.	39.4	24.6	-17.5	22.2	0.1306	0.0569	0.0171	3438.
11.2	147.	179.	52.	0.160	34.6	22154.	-180.	-779.	22.	86.	54.	47.9	24.6	-10.0	24.1	0.1298	0.0783	0.0172	3438.
12.2	197.	208.	60.	0.162	29.2	22172.	-5.	-926.	19.	77.	41.	53.1	24.6	-4.6	23.8	0.1295	0.0987	0.0172	3438.
13.1	254.	234.	69.	0.170	25.1	22186.	227.	-1081.	23.	74.	35.	56.4	24.6	-0.5	22.3	0.1292	0.1190	0.0173	3438.
14.0	321.	261.	78.	0.168	22.0	22135.	520.	-1250.	33.	76.	35.	59.3	24.6	2.6	20.3	0.1292	0.1393	0.0172	3438.
15.0	399.	289.	87.	0.164	19.5	22041.	877.	-1441.	49.	80.	41.	61.5	24.6	5.0	18.2	0.1294	0.1596	0.0172	3438.
16.0	492.	318.	97.	0.154	17.6	21580.	1298.	-1247.	71.	66.	55.	62.7	24.6	7.0	15.8	0.1318	0.1787	0.0168	3438.
16.9	587.	346.	106.	0.167	15.9	20681.	1786.	-482.	99.	43.	75.	61.3	24.6	8.6	13.3	0.1371	0.1964	0.0161	3438.
18.1	716.	379.	116.	0.135	14.6	19387.	2339.	390.	133.	42.	101.	61.9	24.6	10.0	10.8	0.1458	0.2122	0.0151	3438.
19.2	857.	413.	126.	0.135	13.4	18147.	2959.	1283.	174.	62.	134.	60.2	24.6	11.1	8.8	0.1553	0.2281	0.0142	3438.
20.5	1027.	450.	136.	0.121	12.5	16681.	3646.	2271.	220.	101.	174.	58.6	24.6	12.1	7.1	0.1684	0.2418	0.0131	3438.
21.9	1230.	492.	145.	0.109	11.6	15094.	4399.	3338.	273.	158.	220.	56.3	24.6	13.0	5.6	0.1857	0.2529	0.0118	3438.
23.5	1474.	539.	155.	0.097	10.9	13401.	5218.	4491.	331.	230.	272.	52.8	24.6	13.7	4.2	0.2089	0.2594	0.0105	3438.
25.3	1768.	592.	165.	0.086	10.2	11623.	6101.	5738.	396.	319.	331.	47.9	24.6	14.4	3.1	0.2410	0.2573	0.0091	3438.
27.3	2104.	649.	175.	0.080	9.6	9857.	7050.	7077.	467.	423.	396.	40.3	24.6	15.0	2.1	0.2854	0.2390	0.0078	3438.
29.4	2495.	711.	185.	0.072	9.1	8644.	7685.	7956.	499.	481.	428.	34.7	23.8	14.7	1.4	0.3271	0.2162	0.0068	3438.
31.6	2907.	774.	195.	0.072	8.6	7757.	8234.	8684.	519.	522.	450.	28.4	22.9	14.2	0.9	0.3665	0.1884	0.0061	3438.
33.6	3319.	834.	204.	0.076	8.2	7033.	8821.	9452.	542.	564.	476.	19.8	22.1	13.9	0.6	0.4069	0.1454	0.0056	3438.
35.6	3735.	892.	211.	0.078	7.9	6611.	9241.	10012.	559.	595.	494.	12.8	21.6	13.6	0.3	0.4352	0.0990	0.0052	3438.
AIRPLANE MODE CLIMB TO 10,000 FT																			
35.6	3735.	892.	213.	0.0	19.8	8844.													
167.4	33927.	10000.	245.	0.0	16.5	7701.													

THE TOTAL NOISE IMPACT IS 0.990200+05

NOISE AT 500 FT SIDELINE= 88.1 EPNDB

NOISE AT 20,000 FT SIDELINE= 53.0 EPNDB

NOISE 25,000 FT FORWARD OF TAKEOFF POINT= 50.9 EPNDB

NOISE 500 FT FORWARD OF TAKEOFF POINT= 89.3 EPNDB

TILT ROTOR DESIGN PROGRAM 1974

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DESIGN ITERATIONS: 5

OVERALL	
GROSS WEIGHT (LB)	79928.
EMPTY WEIGHT (LB)	57147.
FUEL WEIGHT (LB)	6481.
PAYLOAD (LB)	16300.
CRUISE SPEED (MPH)	422.
L/D CRUISE	10.94
*RANGE (STAT MI)	500.
*PASSENGER SEATS	80.
*CARGO (LB)	0.

ROTORS	
*DISC LOADING (PSF)	9.00
RADIUS (FT)	37.6
SOLIDITY	0.179
BLADE CHORD (FT)	3.53
TOTAL BLADES	12
*CT/SIG HOVER	0.120
*PROFILE DRAG COEFF	0.010
% DOWNLOAD	5.0
*EFFICIENCY HOVER	0.85
* CONVER	0.83
CRUISE	0.70
HEL MODE WEIGHT (LB)	9194.
AIRPLANE WEIGHT (LB)	9559.
*TIP SPEED HOVER	480.
* CRUISE	480.
*FUSELAGE CLEARNCE (FT)	2.0
*MAX HEL MODE ADV RATIO	0.40

POWERPLANT	
INST NORMAL PWR (HP)	14640.
*NUMBER OF ENGINES	2.
*EXCESS FACTOR HEL MODE	1.40
*% RATED EMRG HVR	140.
* CONV + CLIMB	120.
* CRUISE	90.
INST PWR EMRG HVR (HP)	14640.
CONVER (HP)	10953.
CRUISE (HP)	12593.
*SFC (LB/HP HR)	0.400

DRIVE SYSTEM	
*EFFICIENCY	0.97
HEL MODE WEIGHT (LB)	10545.
AIRPLANE WEIGHT (LB)	11573.

WING	
AREA (SF)	1066.
*LOADING (PSF)	75.0
ASPECT RATIO	7.38
SPAN (FT)	88.7
MEAN CHORD (FT)	12.02
*THICKNESS/CHORD RATIO	0.210
*TAPER RATIO	0.70
SWEEP (DEG)	-5.4
CRUISE LIFT COEFF	0.26
MAX LIFT COEFF CONVER	1.76
*MAX LIFT COEFF CLEAN	1.40
*FLAP AREA/WING AREA	0.25
CLIMB SPD/CONVER SPD	1.25

FUSELAGE	
*LENGTH (FT)	95.0
*DIAMETER (FT)	11.5
*DRAG FACTOR	1.00

FLAT PLATE AREAS (SF)	
WING PROFILE	6.77
FUSELAGE	7.04
EMPENNAGE	4.06
TOTAL PROFILE	21.63
WING INDUCED	3.38

COMPONENT WEIGHTS (LB)	
ROTORS	9559.
DRIVE SYSTEM	11573.
POWERPLANT	2583.
NACELLES	689.
FUEL SYSTEM	747.
WING	7087.
FUSELAGE	8156.
EMPENNAGE	1559.
LANDING GEAR	2398.
FLIGHT CONTROLS	4353.
HYDRAULICS	366.
ELECTRICAL	1611.
INSTR+AVIONICS	826.
AIR CONDITIONING	1540.
FURNISHINGS	3700.
FLUIDS	400.
FLIGHT CREW	400.
CABIN CREW	300.

STRUCT TECHNOLOGY FACTORS	
*ROTOR	1.00
*TRANSMISSION	0.83
*AIRFRAME	0.78
*ENGINE (HP/LB)	8.50
*ENGINE INSTALLATION	1.54

DESIGN MISSION	
*FIELD ELEVATION (FT)	0.
SOUND SPEED HVR (FPS)	1117.
*STD DAY TEMP (DEG F)	59.
*EMERG HOVER ALT (FT)	2000.
*HOT DAY TEMP (DEG F)	95.
*CT/SIG MAX	0.150
*MAX ACCELERATION (G)	0.25
*DESIGN CRUISE (MPH)	400.
*CRUISE ALTITUDE (FT)	15000.
SOUND SPEED CRSE (FPS)	1058.
*MAX DECELERATION (G)	0.20
*STRUCT LOAD FACTOR	4.5
*FLIGHT CREW	2.
*CABIN CREW	2.
*ATC SPEED LIMIT	YES

* INDICATES INPUT VARIABLE

DESIGN MISSION	SPEED MPH	HEIGHT FT	DIST MI	TIME MIN	FUEL LB
TAKEOFF & LANDING				2.00	134.
ACCEL. & CONV.		1000.	0.8	0.59	50.
AIRPLANE CLIMB	164.,203.	14000.	12.0	3.93	316.
ACCEL. TO CRUISE			9.8	1.74	148.
CRUISE	422.		440.1	62.60	4422.
AIRPLANE DESCENT	422.,292.	14000.	36.4	6.45	61.
DECEL. & CONV.		1000.	0.8	1.07	14.
TOTAL			500.0	78.38	5145.
RESERVE				20.00	1336.

Q-80-80

STAGE LENGTH (MI.)	25.	50.	75.	100.	150.	200.	300.	400.	500.
CRUISE ALTITUDE (FT.)	2000.	4000.	10001.	12500.	15000.	15000.	15000.	15000.	15000.
CRUISE SPEED (MPH)	296.	305.	423.	424.	422.	422.	422.	422.	422.
CRUISE L/D	13.44	13.44	9.83	10.40	10.94	10.94	10.94	10.94	10.94
CRUISE DISTANCE (MI.)	17.5	35.2	4.9	47.0	89.5	139.5	239.5	339.5	439.5
BLOCK TIME (MIN.)	8.6	13.7	18.9	21.1	28.6	35.7	50.0	64.2	78.4
BLOCK FUEL (LB.)	439.	639.	705.	1135.	1643.	2152.	3161.	4156.	5139.
BLOCK SPEED (MPH)	174.	219.	238.	285.	314.	336.	360.	374.	383.

DIRECT OPERATING COST - ANN UTILIZATION(HR)=2000. DEPRECIATION PERIOD(YR)=10. LABOR RATE($/HR)= 7.00
AIRFRAME COST ($/LB)= 80.0 ENGINE COST ($/HP)= 60.0 INSURANCE RATE=0.040 FUEL COST (CENTS/GAL)= 18.0
DOC=1.49+0.0246*SL $/SEAT-TRIP (SL= 25.,500.)
HOP LENGTHS 50+150+ 0+ 0+ 0=200 100+200+ 0+ 0+ 0=300 200+200+ 0+ 0+ 0=400

STAGE LENGTH	25.	50.	75.	100.	150.	200.	300.	400.	500.	200.	300.	400.
NO. CYCLES/STARTS	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	2/1	2/1	2/1
FLIGHT CREW	0.562	0.446	0.411	0.343	0.311	0.291	0.271	0.261	0.255	0.361	0.319	0.299
FUEL & OIL	0.498	0.355	0.261	0.315	0.304	0.299	0.292	0.288	0.285	0.317	0.304	0.299
HULL INSURANCE	0.603	0.478	0.441	0.368	0.334	0.312	0.291	0.280	0.274	0.370	0.331	0.312
TOTAL FLIGHT OPS	1.653	1.279	1.113	1.026	0.948	0.902	0.855	0.830	0.815	1.047	0.954	0.910
LABOR AIRFRAME	0.589	0.385	0.319	0.259	0.217	0.195	0.172	0.161	0.154	0.257	0.214	0.194
MATERIAL AIRFRAME	0.317	0.194	0.155	0.124	0.100	0.088	0.076	0.069	0.066	0.119	0.097	0.086
LABOR ENGINES	0.375	0.205	0.148	0.115	0.085	0.070	0.055	0.047	0.043	0.104	0.077	0.064
MATERIAL ENGINES	0.809	0.436	0.312	0.240	0.176	0.143	0.110	0.093	0.083	0.213	0.157	0.129
MAT. BURDEN	1.253	0.767	0.608	0.486	0.394	0.344	0.295	0.271	0.256	0.468	0.379	0.335
TOTAL MAINTENANCE	3.342	1.986	1.542	1.223	0.972	0.840	0.708	0.642	0.602	1.161	0.925	0.808
DEPRECIATION	1.734	1.376	1.268	1.059	0.959	0.898	0.837	0.806	0.788	1.063	0.952	0.898
TOTAL DIRECT OPERATING COST												
$/AIRCRAFT MILE	6.729	4.641	3.922	3.308	2.880	2.640	2.400	2.278	2.205	3.272	2.831	2.616
$/FLIGHT HOUR	1170.2	1017.3	933.0	942.3	905.5	886.6	864.6	852.0	843.7	928.0	897.0	878.5
$/SEAT MILE	0.0841	0.0580	0.0490	0.0414	0.0360	0.0330	0.0300	0.0285	0.0276	0.0409	0.0354	0.0327
$/SEAT-TRIP	2.10	2.90	3.68	4.14	5.40	6.60	9.00	11.39	13.78	8.18	10.61	13.08

Q-80-80

DEPARTURE PATH TO 10,000 FT MSL

MAX FUSE ANGLE=20. OBSTACLE CLEAR ANGLE=60. OBSTACLE HEIGHT=100. MAX ACCEL ROTATION RATE=20. ACCEL BUILDUP TIME= 5.

TIME SEC	DIST FT	ALT FT	VEL FPS	ACC G	GAM DEG	THRUST LB	LWGO LB	LWGI LB	DWGO LB	DWGI LB	DFUST LB	ALP DEG	THE DEG	AWO DEG	ALV DEG	LAMDA	MU	CT	POWER HP
OBSTACLE CLEARANCE																			
3.1	4.	7.	3.	0.050	60.0	84841.	-1.	-1078.	0.	1406.	2.	29.3	24.6	-35.4	28.7	0.0954	0.0026	0.0175	9952.
4.0	7.	13.	8.	0.171	60.0	93387.	-8.	-1312.	4.	1264.	14.	26.5	24.6	-35.4	24.5	0.1050	0.0070	0.0192	11807.
4.7	12.	20.	13.	0.221	60.0	96985.	-21.	-1403.	10.	1232.	38.	25.5	24.6	-35.4	23.2	0.1120	0.0116	0.0200	12952.
5.6	19.	33.	18.	0.178	60.0	93888.	-41.	-1428.	20.	1083.	75.	26.4	24.6	-35.4	21.0	0.1157	0.0157	0.0193	12952.
6.7	32.	55.	23.	0.137	60.0	90964.	-68.	-1420.	34.	1034.	123.	27.3	24.6	-35.4	20.3	0.1194	0.0208	0.0187	12952.
8.4	55.	95.	28.	0.094	60.0	87984.	-102.	-1414.	50.	985.	184.	28.2	24.6	-35.4	19.6	0.1234	0.0262	0.0181	12952.
8.5	58.	100.	28.	0.056	60.0	85435.	-142.	-1430.	70.	956.	257.	29.2	24.6	-35.4	18.9	0.1271	0.0320	0.0176	12952.
ACCELERATION AND CONVERSION																			
9.5	81.	131.	37.	0.147	52.8	83136.	-225.	-1859.	72.	605.	239.	30.1	24.6	-28.2	18.2	0.1306	0.0374	0.0172	12952.
10.4	111.	158.	44.	0.170	42.7	82773.	-421.	-2518.	74.	445.	185.	39.2	24.6	-18.1	22.0	0.1310	0.0571	0.0171	12952.
11.4	152.	187.	52.	0.157	35.1	83226.	-640.	-3146.	79.	364.	136.	47.8	24.6	-10.6	24.0	0.1302	0.0784	0.0172	12952.
12.4	204.	217.	60.	0.159	29.6	83368.	-63.	-3749.	67.	328.	104.	53.1	24.6	-5.1	23.7	0.1297	0.0989	0.0172	12952.
13.3	261.	244.	69.	0.168	25.5	83526.	702.	-4384.	79.	320.	87.	56.5	24.6	-1.0	22.3	0.1292	0.1193	0.0173	12952.
14.3	329.	272.	78.	0.167	22.4	83476.	1668.	-5076.	113.	328.	86.	59.4	24.6	2.2	20.4	0.1290	0.1397	0.0173	12952.
15.2	407.	300.	87.	0.163	19.9	83299.	2845.	-5855.	170.	349.	100.	61.8	24.6	4.7	18.4	0.1289	0.1601	0.0173	12952.
16.2	500.	330.	97.	0.154	17.9	81802.	4238.	-5245.	249.	293.	130.	63.2	24.6	6.7	16.0	0.1309	0.1794	0.0170	12952.
17.1	592.	357.	107.	0.173	16.2	78546.	5848.	-2235.	352.	179.	175.	61.6	24.6	8.4	13.4	0.1359	0.1972	0.0163	12952.
18.2	714.	389.	116.	0.143	14.8	73809.	7679.	1206.	477.	165.	236.	62.1	24.6	9.7	11.0	0.1442	0.2132	0.0153	12952.
19.3	849.	422.	126.	0.140	13.7	69147.	9730.	4746.	625.	244.	313.	60.8	24.6	10.9	9.0	0.1535	0.2293	0.0144	12952.
20.5	1008.	458.	136.	0.129	12.7	63772.	12002.	8630.	795.	407.	404.	59.3	24.6	11.9	7.3	0.1659	0.2435	0.0133	12952.
21.8	1195.	497.	145.	0.118	11.8	57928.	14494.	12830.	989.	647.	511.	57.2	24.6	12.8	5.7	0.1821	0.2554	0.0121	12952.
23.3	1416.	540.	155.	0.107	11.1	51673.	17205.	17371.	1205.	960.	633.	54.0	24.6	13.5	4.4	0.2038	0.2633	0.0108	12952.
24.9	1679.	588.	165.	0.096	10.4	45065.	20134.	22275.	1444.	1344.	770.	49.6	24.6	14.2	3.3	0.2337	0.2639	0.0094	12952.
26.7	1985.	641.	175.	0.087	9.8	38414.	23279.	27545.	1705.	1796.	922.	42.8	24.6	14.8	2.2	0.2751	0.2507	0.0080	12952.
28.6	2334.	698.	185.	0.081	9.3	32424.	26355.	32739.	1949.	2257.	1068.	33.9	24.4	15.1	1.4	0.3286	0.2139	0.0068	12952.
30.6	2715.	757.	195.	0.078	8.8	29033.	28243.	35738.	2027.	2446.	1123.	27.5	23.5	14.7	0.9	0.3691	0.1831	0.0061	12952.
32.5	3109.	815.	204.	0.080	8.4	26346.	30277.	38898.	2119.	2646.	1188.	18.7	22.7	14.3	0.5	0.4096	0.1376	0.0055	12952.
34.5	3527.	874.	214.	0.079	8.0	24280.	32379.	42215.	2215.	2855.	1256.	8.1	21.9	14.0	0.2	0.4474	0.0654	0.0051	12952.
36.7	4012.	939.	224.	0.071	7.6	23094.	34543.	45385.	2313.	3038.	1326.	-3.3	21.3	13.7	0.0	0.4711	-0.0348	0.0049	12952.
38.9	4529.	1005.	234.	0.070	7.3	22130.	34642.	45286.	2169.	2836.	1274.	-3.2	19.8	12.5	0.0	0.4919	-0.0278	0.0047	12952.
41.2	5066.	1072.	240.	0.069	7.1	21629.	34691.	45237.	2098.	2735.	1252.	-3.1	19.1	12.0	0.0	0.5033	-0.0280	0.0046	12952.
AIRPLANE MODE CLIMB TO 10,000 FT																			
41.2	5066.	1072.	241.	0.0		15.3	26767.												
189.5	43359.	10000.	276.	0.0		12.7	23369.												

THE TOTAL NOISE IMPACT IS 0.35602D+06

NOISE AT 500 FT SIDELINE= 91.5 EPNDB

NOISE AT 20,000 FT SIDELINE= 58.9 EPNDB

NOISE 25,000 FT FORWARD OF TAKEOFF POINT= 56.9 EPNDB

NOISE 500 FT FORWARD OF TAKEOFF POINT= 92.5 EPNDB

TILT ROTOR DESIGN PROGRAM 1974

Q-80-110

DESIGN ITERATIONS: 6

OVERALL		POWERPLANT		FUSELAGE		STRUCT TECHNOLOGY FACTORS	
GROSS WEIGHT (LB)	119457.	INST NORMAL PWR (HP)	21885.	*LENGTH (FT)	110.0	*ROTOR	1.00
EMPTY WEIGHT (LB)	87537.	*NUMBER OF ENGINES	2.	*DIAMETER (FT)	13.0	*TRANSMISSION	0.83
FUEL WEIGHT (LB)	9470.	*EXCESS FACTOR HEL MODE	1.40	*DRAG FACTOR	1.00	*AIRFRAME	0.78
PAYLOAD (LB)	22450.	*% RATED EMRG HVR	140.			*ENGINE (HP/LB)	8.50
CRUISE SPEED (MPH)	435.	* CONV + CLIMB	120.	FLAT PLATE AREAS (SF)		*ENGINE INSTALLATION	1.54
L/D CRUISE	11.34	* CRUISE	90.	WING PROFILE	9.82		
*RANGE (STAT MI)	500.	INST PWR EMRG HVR (HP)	21885.	FUSELAGE	9.00	DESIGN MISSION	
*PASSENGER SEATS	110.	CONVER (HP)	16374.	EMPENNAGE	5.89	*FIELD ELEVATION (FT)	0.
*CARGO (LB)	0.	CRUISE (HP)	17735.	TOTAL PROFILE	29.89	SOUND SPEED HVR (FPS)	1117.
		*SFC (LB/HP HR)	0.400	WING INDUCED	4.82	*STD DAY TEMP (DEG F)	59.
ROTORS						*EMERG HOVER ALT (FT)	2000.
*DISC LOADING (PSF)	9.00	DRIVE SYSTEM		COMPONENT WEIGHTS (LB)		*HOT DAY TEMP (DEG F)	95.
RADIUS (FT)	46.0	*EFFICIENCY	0.97	ROTORS	14829.	*CT/SIG MAX	0.150
SOLIDITY	0.179	HEL MODE WEIGHT (LB)	17082.	DRIVE SYSTEM	18793.	*MAX ACCELERATION (G)	0.25
BLADE CHORD (FT)	4.32	AIRPLANE WEIGHT (LB)	18793.	POWERPLANT	3862.	*DESIGN CRUISE (MPH)	400.
TOTAL BLADES	12			NACELLES	1783.	*CRUISE ALTITUDE (FT)	15000.
*CT/SIG HOVER	0.120	WING		FUEL SYSTEM	1432.	SOUND SPEED CRSE (FPS)	1058.
*PROFILE DRAG COEFF	0.010	AREA (SF)	1593.	WING	10655.	*MAX DECELERATION (G)	0.20
% DOWNLOAD	5.1	*LOADING (PSF)	75.0	FUSELAGE	11129.	*STRUCT LOAD FACTOR	4.5
*EFFICIENCY HOVER	0.85	ASPECT RATIO	7.18	EMPENNAGE	2329.	*FLIGHT CREW	2.
* CONVER	0.83	SPAN (FT)	106.9	LANDING GEAR	3584.	*CABIN CREW	3.
CRUISE	0.70	MEAN CHORD (FT)	14.90	FLIGHT CONTROLS	7669.	*ATC SPEED LIMIT	YES
HEL MODE WEIGHT (LB)	14248.	*THICKNESS/CHORD RATIO	0.210	HYDRAULICS	448.		
AIRPLANE WEIGHT (LB)	14829.	*TAPER RATIO	0.70	ELECTRICAL	2845.		
*TIP SPEED HOVER	480.	SWEEP (DEG)	-5.4	INSTR+AVIONICS	949.		
* CRUISE	480.	CRUISE LIFT COEFF	0.25	AIR CONDITIONING	1930.		
*FUSELAGE CLEARNCE (FT)	2.0	MAX LIFT COEFF CONVER	1.76	FURNISHINGS	4900.		
*MAX HEL MODE ADV RATIO	0.40	*MAX LIFT COEFF CLEAN	1.40	FLUIDS	597.		
		*FLAP AREA/WING AREA	0.25	FLIGHT CREW	400.		
* INDICATES INPUT VARIABLE		CLIMB SPD/CONVER SPD	1.29	CABIN CREW	450.		

DESIGN MISSION	SPEED MPH	HEIGHT FT	DIST MI	TIME MIN	FUEL LB
TAKEOFF & LANDING				2.00	200.
ACCEL. & CONV.		1000.	0.8	0.57	73.
AIRPLANE CLIMB	168.,209.	14000.	12.3	3.92	473.
ACCEL. TO CRUISE			11.0	1.88	240.
CRUISE	435.		436.7	60.24	6372.
AIRPLANE DESCENT	435.,292.	14000.	38.4	6.74	95.
DECEL. & CONV.		1000.	0.8	1.04	20.
TOTAL			500.0	76.39	7472.
RESERVE				20.00	1998.

Q-80-110

STAGE LENGTH (MI.)	25.	50.	75.	100.	150.	200.	300.	400.	500.
CRUISE ALTITUDE (FT.)	2000.	4000.	10001.	12500.	15000.	15000.	15000.	15000.	15000.
CRUISE SPEED (MPH)	296.	305.	434.	435.	435.	435.	435.	435.	435.
CRUISE L/D	14.18	14.17	10.15	10.73	11.34	11.34	11.34	11.34	11.34
CRUISE DISTANCE (MI.)	17.4	34.8	26.8	44.6	86.1	136.1	236.1	336.1	436.1
BLOCK TIME (MIN.)	8.6	13.6	17.0	20.8	28.1	35.0	48.8	62.6	76.4
BLOCK FUEL (LB.)	641.	928.	1316.	1653.	2386.	3125.	4590.	6037.	7465.
BLOCK SPEED (MPH)	175.	220.	264.	288.	320.	342.	369.	383.	393.

DIRECT OPERATING COST - ANN UTILIZATION(HR)=2000. DEPRECIATION PERIOD(YR)=10. LABOR RATE($/HR)= 7.00
AIRFRAME COST ($/LB)= 80.0 ENGINE COST ($/HP)= 60.0 INSURANCE RATE=0.040 FUEL COST (CENTS/GAL)= 18.0
DOC=1.46+0.0241*SL $/SEAT-TRIP (SL= 25.,500.)
HOP LENGTHS 50+150+ 0+ 0+ 0=200 100+200+ 0+ 0+ 0=300 200+200+ 0+ 0+ 0=400

STAGE LENGTH	25.	50.	75.	100.	150.	200.	300.	400.	500.	200.	300.	400.
NO. CYCLES/STARTS	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	2/1	2/1	2/1
FLIGHT CREW	0.573	0.455	0.379	0.348	0.313	0.293	0.272	0.262	0.255	0.366	0.322	0.301
FUEL & OIL	0.712	0.515	0.487	0.459	0.441	0.433	0.424	0.419	0.414	0.460	0.442	0.433
HULL INSURANCE	0.915	0.727	0.606	0.556	0.501	0.468	0.434	0.418	0.408	0.557	0.497	0.468
TOTAL FLIGHT OPS	2.199	1.697	1.472	1.363	1.255	1.194	1.131	1.098	1.077	1.383	1.261	1.202
LABOR AIRFRAME	0.678	0.443	0.342	0.295	0.247	0.220	0.194	0.181	0.173	0.292	0.243	0.219
MATERIAL AIRFRAME	0.453	0.278	0.209	0.176	0.142	0.124	0.107	0.098	0.092	0.170	0.137	0.121
LABOR ENGINES	0.454	0.247	0.173	0.137	0.101	0.082	0.064	0.054	0.049	0.123	0.091	0.075
MATERIAL ENGINES	1.208	0.650	0.454	0.358	0.261	0.212	0.162	0.138	0.123	0.317	0.233	0.191
MAT. BURDEN	1.472	0.896	0.669	0.562	0.452	0.394	0.335	0.306	0.288	0.540	0.435	0.382
TOTAL MAINTENANCE	4.266	2.514	1.847	1.530	1.203	1.033	0.862	0.776	0.725	1.443	1.139	0.988
DEPRECIATION	2.628	2.089	1.740	1.599	1.439	1.344	1.248	1.201	1.172	1.601	1.428	1.344
TOTAL DIRECT OPERATING COST												
$/AIRCRAFT MILE	9.092	6.301	5.058	4.491	3.898	3.570	3.241	3.075	2.975	4.427	3.829	3.534
$/FLIGHT HOUR	1592.1	1387.6	1337.6	1292.8	1246.3	1222.5	1194.5	1178.4	1167.7	1271.8	1233.3	1210.2
$/SEAT MILE	0.0827	0.0573	0.0460	0.0408	0.0354	0.0325	0.0295	0.0280	0.0270	0.0402	0.0348	0.0321
$/SEAT-TRIP	2.07	2.86	3.45	4.08	5.31	6.49	8.84	11.18	13.52	8.05	10.44	12.85

Q-80-110

DEPARTURE PATH TO 10,000 FT MSL

MAX FUSE ANGLE=20. OBSTACLE CLEAR ANGLE=60. OBSTACLE HEIGHT=100. MAX ACCEL ROTATION RATE=20. ACCEL BUILDUP TIME= 5.

TIME SEC	DIST FT	ALT FT	VEL FPS	ACC G	GAM DEG	THRUST LB	LWGO LB	LWGI LB	DWGO LB	DWGI LB	DFUST LB	ALP DEG	THE DEG	AWO DEG	ALV DEG	LAMDA	MU	CT	POWER HP
OBSTACLE CLEARANCE																			
3.1	4.	7.	3.	0.050	60.0	126831.	-1.	-1637.	1.	2135.	2.	29.4	24.6	-35.4	28.8	0.0954	0.0026	0.0175	14881.
4.0	7.	13.	8.	0.171	60.0	139597.	-11.	-1991.	5.	1920.	18.	26.5	24.6	-35.4	24.5	0.1050	0.0070	0.0192	17653.
4.7	12.	20.	13.	0.221	60.0	144965.	-31.	-2129.	15.	1871.	50.	25.5	24.6	-35.4	23.2	0.1120	0.0116	0.0200	19363.
5.6	19.	33.	18.	0.179	60.0	140339.	-60.	-2167.	30.	1645.	98.	26.4	24.6	-35.4	21.0	0.1157	0.0157	0.0193	19363.
6.7	32.	55.	23.	0.137	60.0	135968.	-100.	-2156.	49.	1570.	162.	27.3	24.6	-35.4	20.3	0.1194	0.0208	0.0187	19363.
8.4	55.	95.	28.	0.094	60.0	131516.	-149.	-2147.	74.	1495.	241.	28.3	24.6	-35.4	19.6	0.1234	0.0262	0.0181	19363.
8.5	58.	100.	28.	0.057	60.0	127706.	-208.	-2171.	103.	1451.	337.	29.2	24.6	-35.4	18.9	0.1271	0.0321	0.0176	19363.
ACCELERATION AND CONVERSION																			
9.6	82.	132.	37.	0.143	52.8	124254.	-329.	-2817.	106.	920.	315.	30.3	24.6	-28.2	18.2	0.1306	0.0375	0.0172	19363.
10.5	111.	159.	44.	0.170	42.8	123675.	-617.	-3814.	110.	678.	244.	39.2	24.6	-18.2	21.9	0.1311	0.0571	0.0171	19363.
11.5	153.	188.	52.	0.158	35.2	124381.	-940.	-4769.	116.	555.	181.	47.7	24.6	-10.6	24.0	0.1302	0.0784	0.0172	19363.
12.4	204.	218.	60.	0.158	29.7	124595.	-99.	-5684.	98.	501.	139.	53.1	24.6	-5.1	23.7	0.1298	0.0989	0.0172	19363.
13.4	262.	245.	69.	0.168	25.6	124860.	1014.	-6647.	115.	489.	117.	56.5	24.6	-1.0	22.3	0.1292	0.1193	0.0173	19363.
14.3	329.	273.	78.	0.167	22.4	124823.	2420.	-7697.	165.	503.	115.	59.5	24.6	2.2	20.4	0.1290	0.1397	0.0173	19363.
15.2	407.	301.	88.	0.163	19.9	124609.	4133.	-8880.	249.	536.	134.	61.8	24.6	4.7	18.4	0.1288	0.1602	0.0173	19363.
16.2	500.	331.	97.	0.154	17.9	122423.	6160.	-7982.	367.	449.	174.	63.3	24.6	6.7	16.0	0.1308	0.1796	0.0170	19363.
17.2	600.	361.	107.	0.159	16.3	117129.	8504.	-3339.	519.	269.	234.	62.5	24.6	8.3	13.4	0.1363	0.1971	0.0163	19363.
18.2	713.	391.	116.	0.154	14.9	110872.	11168.	1651.	704.	246.	314.	61.7	24.6	9.7	11.1	0.1435	0.2139	0.0154	19363.
19.3	840.	422.	126.	0.150	13.7	103891.	14154.	7018.	924.	364.	414.	60.4	24.6	10.9	9.1	0.1527	0.2297	0.0145	19363.
20.4	989.	455.	136.	0.138	12.7	95900.	17462.	12970.	1177.	611.	535.	59.0	24.6	11.9	7.3	0.1649	0.2441	0.0134	19363.
21.7	1175.	494.	145.	0.119	11.8	86836.	21097.	19280.	1464.	984.	675.	57.4	24.6	12.7	5.8	0.1816	0.2558	0.0121	19363.
23.1	1391.	536.	155.	0.109	11.1	77573.	25040.	26109.	1785.	1463.	836.	54.2	24.6	13.5	4.4	0.2029	0.2640	0.0108	19363.
24.7	1648.	584.	165.	0.098	10.4	67717.	29306.	33502.	2140.	2052.	1016.	49.9	24.6	14.2	3.3	0.2324	0.2650	0.0095	19363.
26.4	1947.	635.	175.	0.089	9.8	57782.	33886.	41443.	2527.	2745.	1216.	43.3	24.6	14.8	2.3	0.2733	0.2527	0.0081	19363.
28.3	2285.	691.	185.	0.084	9.3	48500.	38648.	49763.	2930.	3515.	1427.	33.6	24.5	15.2	1.4	0.3284	0.2143	0.0068	19363.
30.2	2661.	749.	195.	0.080	8.8	43350.	41403.	54324.	3044.	3810.	1501.	27.3	23.6	14.8	0.9	0.3696	0.1821	0.0061	19363.
32.2	3050.	807.	204.	0.081	8.4	39343.	44390.	59128.	3183.	4121.	1588.	18.5	22.8	14.4	0.5	0.4100	0.1361	0.0055	19363.
34.1	3468.	865.	214.	0.079	8.0	36277.	47479.	64171.	3326.	4447.	1680.	7.8	22.0	14.0	0.2	0.4477	0.0634	0.0051	19363.
36.3	3951.	930.	224.	0.071	7.6	34523.	50588.	68869.	3465.	4717.	1771.	-3.3	21.4	13.7	0.0	0.4711	-0.0348	0.0049	19363.
38.5	4467.	996.	234.	0.070	7.3	33082.	50736.	68721.	3248.	4400.	1702.	-3.2	19.9	12.6	0.0	0.4918	-0.0279	0.0047	19363.
40.8	5013.	1064.	243.	0.069	7.1	31912.	50849.	68608.	3078.	4153.	1659.	-3.1	18.8	11.7	0.0	0.5100	-0.0285	0.0045	19363.
AIRPLANE MODE CLIMB TO 10,000 FT																			
40.8	5013.	1064.	247.	0.0	14.9	39090.													
188.9	44285.	10000.	283.	0.0	12.5	34124.													

THE TOTAL NOISE IMPACT IS 0.49409D+06

NOISE AT 500 FT SIDELINE= 92.8 EPNDB

NOISE AT 20,000 FT SIDELINE= 60.7 EPNDB

NOISE 25,000 FT FORWARD OF TAKEOFF POINT= 58.5 EPNDB

NOISE 500 FT FORWARD OF TAKEOFF POINT= 93.7 EPNDB

TILT ROTOR DESIGN PROGRAM 1974

D-80-20

DESIGN ITERATIONS: 3

OVERALL		POWERPLANT		FUSELAGE		STRUCT TECHNOLOGY FACTORS	
GROSS WEIGHT (LB)	22259.	INST NORMAL PWR (HP)	3873.	*LENGTH (FT)	55.0	*ROTOR	1.00
EMPTY WEIGHT (LB)	16391.	*NUMBER OF ENGINES	2.	*DIAMETER (FT)	8.5	*TRANSMISSION	0.83
FUEL WEIGHT (LB)	1867.	*EXCESS FACTOR HEL MODE	1.50	*DRAG FACTOR	1.00	*AIRFRAME	0.78
PAYLOAD (LB)	4000.	*% RATED EMRG HVR	140.			*ENGINE (HP/LB)	8.50
CRUISE SPEED (MPH)	341.	* CONV + CLIMB	120.	FLAT PLATE AREAS (SF)		*ENGINE INSTALLATION	1.60
L/D CRUISE	11.13	* CRUISE	90.	WING PROFILE	2.52		
*RANGE (STAT MI)	500.	INST PWR EMRG HVR (HP)	3567.	FUSELAGE	3.46	DESIGN MISSION	
*PASSENGER SEATS	20.	CONVER (HP)	2874.	EMPENNAGE	1.51	*FIELD ELEVATION (FT)	0.
*CARGO (LB)	0.	CRUISE (HP)	3873.	TOTAL PROFILE	9.06	SOUND SPEED HVR (FPS)	1117.
		*SFC (LB/HP HR)	0.400	WING INDUCED	1.64	*STD DAY TEMP (DEG F)	59.
ROTORS						*EMERG HOVER ALT (FT)	2000.
*DISC LOADING (PSF)	7.00	DRIVE SYSTEM		COMPONENT WEIGHTS (LB)		*HOT DAY TEMP (DEG F)	95.
RADIUS (FT)	22.5	*EFFICIENCY	0.97	ROTORS	2663.	*CT/SIG MAX	0.150
SOLIDITY	0.200	HEL MODE WEIGHT (LB)	2761.	DRIVE SYSTEM	3007.	*MAX ACCELERATION (G)	0.25
BLADE CHORD (FT)	2.35	AIRPLANE WEIGHT (LB)	3007.	POWERPLANT	683.	*DESIGN CRUISE (MPH)	340.
TOTAL BLADES	12			NACELLES	30.	*CRUISE ALTITUDE (FT)	15000.
*CT/SIG HOVER	0.120	WING		FUEL SYSTEM	89.	SOUND SPEED CRSE (FPS)	1058.
*PROFILE DRAG COEFF	0.010	AREA (SF)	353.	WING	1854.	*MAX DECELERATION (G)	0.20
% DOWNLOAD	4.4	*LOADING (PSF)	63.0	FUSELAGE	2750.	*STRUCT LOAD FACTOR	4.5
*EFFICIENCY HOVER	0.85	ASPECT RATIO	8.72	EMPENNAGE	434.	*FLIGHT CREW	2.
* CONVER	0.83	SPAN (FT)	55.5	LANDING GEAR	668.	*CABIN CREW	0.
CRUISE	0.64	MEAN CHORD (FT)	6.37	FLIGHT CONTROLS	718.	*ATC SPEED LIMIT	YES
HEL MODE WEIGHT (LB)	2569.	*THICKNESS/CHORD RATIO	0.210	HYDRAULICS	193.		
AIRPLANE WEIGHT (LB)	2663.	*TAPER RATIO	0.70	ELECTRICAL	264.		
*TIP SPEED HOVER	400.	SWEEP (DEG)	-5.2	INSTR+AVIONICS	580.		
* CRUISE	400.	CRUISE LIFT COEFF	0.34	AIR CONDITIONING	760.		
*FUSELAGE CLEARNCE (FT)	2.0	MAX LIFT COEFF CONVER	2.16	FURNISHINGS	1300.		
*MAX HEL MODE ADV RATIO	0.40	*MAX LIFT COEFF CLEAN	1.40	FLUIDS	111.		
		*FLAP AREA/WING AREA	0.25	FLIGHT CREW	400.		
* INDICATES INPUT VARIABLE		CLIMB SPD/CONVER SPD	1.25	CABIN CREW	0.		

DESIGN MISSION	SPEED MPH	HEIGHT FT	DIST MI	TIME MIN	FUEL LB
TAKEOFF & LANDING				2.00	33.
ACCEL. & CONV.		1400.	1.0	0.88	19.
AIRPLANE CLIMB	137.,169.	13600.	10.1	3.98	83.
ACCEL. TO CRUISE			5.0	1.09	24.
CRUISE	341.		451.4	79.53	1357.
AIRPLANE DESCENT	341.,276.	13600.	31.5	6.17	15.
DECEL. & CONV.		1400.	1.0	1.41	5.
TOTAL			500.0	95.05	1536.
RESERVE				20.00	331.

STAGE LENGTH (MI.)	25.	50.	75.	100.	150.	200.	300.	400.	500.			
CRUISE ALTITUDE (FT.)	2000.	4000.	10001.	12500.	15000.	15000.	15000.	15000.	15000.			
CRUISE SPEED (MPH)	296.	305.	343.	342.	341.	341.	341.	341.	341.			
CRUISE L/D	10.16	10.16	9.91	10.51	11.13	11.13	11.13	11.13	11.13			
CRUISE DISTANCE (MI.)	18.2	37.3	43.3	60.3	101.4	151.4	251.4	351.4	451.4			
BLOCK TIME (MIN.)	9.3	14.4	19.1	24.0	33.4	42.2	59.8	77.4	95.1			
BLOCK FUEL (LB.)	144.	218.	277.	344.	492.	644.	946.	1243.	1536.			
BLOCK SPEED (MPH)	162.	209.	236.	250.	270.	284.	301.	310.	316.			

DIRECT OPERATING COST - ANN UTILIZATION(HR)=2000. DEPRECIATION PERIOD(YR)=10. LABOR RATE($/HR)= 7.00
AIRFRAME COST ($/LB)= 80.0 ENGINE COST ($/HP)= 60.0 INSURANCE RATE=0.040 FUEL COST (CENTS/GAL)= 18.0
DOC=2.87+0.0536*SL $/SEAT-TRIP (SL= 25.,500.)
HOP LENGTHS 50+150+ 0+ 0+ 0=200 100+200+ 0+ 0+ 0=300 200+200+ 0+ 0+ 0=400

STAGE LENGTH	25.	50.	75.	100.	150.	200.	300.	400.	500.	200.	300.	400.
NO. CYCLES/STARTS	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	2/1	2/1	2/1
FLIGHT CREW	0.567	0.440	0.390	0.367	0.341	0.323	0.305	0.296	0.291	0.381	0.348	0.331
FUEL & OIL	0.161	0.122	0.103	0.096	0.092	0.090	0.088	0.087	0.086	0.099	0.092	0.090
HULL INSURANCE	0.184	0.143	0.126	0.119	0.110	0.105	0.099	0.096	0.094	0.119	0.109	0.105
TOTAL FLIGHT OPS	0.912	0.705	0.619	0.582	0.543	0.518	0.492	0.479	0.471	0.599	0.549	0.525
LABOR AIRFRAME	0.427	0.279	0.227	0.201	0.175	0.159	0.144	0.136	0.132	0.199	0.172	0.158
MATERIAL AIRFRAME	0.137	0.084	0.065	0.056	0.047	0.042	0.037	0.034	0.033	0.054	0.045	0.041
LABOR ENGINES	0.259	0.144	0.105	0.085	0.066	0.055	0.045	0.040	0.037	0.078	0.060	0.052
MATERIAL ENGINES	0.216	0.116	0.083	0.066	0.049	0.040	0.032	0.027	0.025	0.059	0.044	0.037
MAT. BURDEN	0.892	0.550	0.431	0.372	0.312	0.279	0.246	0.229	0.219	0.360	0.303	0.273
TOTAL MAINTENANCE	1.931	1.174	0.910	0.781	0.648	0.576	0.503	0.467	0.445	0.751	0.625	0.561
DEPRECIATION	0.527	0.409	0.362	0.341	0.317	0.300	0.284	0.275	0.271	0.340	0.314	0.300
TOTAL DIRECT OPERATING COST												
$/AIRCRAFT MILE	3.371	2.288	1.891	1.704	1.508	1.394	1.279	1.221	1.187	1.689	1.488	1.387
$/FLIGHT HOUR	545.7	477.1	445.8	426.7	406.5	396.3	384.9	378.6	374.5	424.3	404.8	394.4
$/SEAT MILE	0.1686	0.1144	0.0946	0.0852	0.0754	0.0697	0.0640	0.0611	0.0593	0.0845	0.0744	0.0693
$/SEAT-TRIP	4.21	5.72	7.09	8.52	11.31	13.94	19.19	24.43	29.67	16.89	22.32	27.74

D-80-80

STAGE LENGTH (MI.)	25.	50.	75.	100.	150.	200.	300.	400.	500.
CRUISE ALTITUDE (FT.)	2000.	4000.	10001.	12500.	15000.	15000.	15000.	15000.	15000.
CRUISE SPEED (MPH)	296.	305.	363.	363.	365.	365.	365.	365.	365.
CRUISE L/D	13.05	13.05	11.55	12.27	13.07	13.07	13.07	13.07	13.07
CRUISE DISTANCE (MI.)	17.9	35.5	12.4	51.6	91.8	141.8	241.8	341.8	441.8
BLOCK TIME (MIN.)	9.0	14.1	19.6	23.1	31.8	40.0	56.5	72.9	89.4
BLOCK FUEL (LB.)	492.	725.	748.	1177.	1679.	2199.	3230.	4248.	5253.
BLOCK SPEED (MPH)	167.	213.	230.	260.	283.	300.	319.	329.	336.

DIRECT OPERATING COST - ANN UTILIZATION(HR)=2000. DEPRECIATION PERIOD(YR)=10. LABOR RATE($/HR)= 7.00
AIRFRAME COST ($/LB)= 80.0 ENGINE COST ($/HP)= 60.0 INSURANCE RATE=0.040 FUEL COST (CENTS/GAL)= 18.0
DOC=1.53+0.0296*SL $/SEAT-TRIP (SL= 25.,500.)
HOP LENGTHS 50+150+ 0+ 0+ 0=200 100+200+ 0+ 0+ 0=300 200+200+ 0+ 0+ 0=400

STAGE LENGTH	25.	50.	75.	100.	150.	200.	300.	400.	500.	200.	300.	400.
NO. CYCLES/STARTS	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	2/1	2/1	2/1
FLIGHT CREW	0.576	0.452	0.419	0.370	0.339	0.320	0.301	0.292	0.286	0.383	0.348	0.328
FUEL & OIL	0.547	0.403	0.277	0.327	0.311	0.305	0.299	0.295	0.292	0.334	0.312	0.305
HULL INSURANCE	0.700	0.549	0.508	0.449	0.412	0.389	0.366	0.354	0.348	0.446	0.409	0.389
TOTAL FLIGHT OPS	1.822	1.404	1.205	1.146	1.062	1.014	0.966	0.941	0.926	1.163	1.069	1.022
LABOR AIRFRAME	0.629	0.410	0.342	0.289	0.246	0.223	0.200	0.188	0.181	0.284	0.243	0.222
MATERIAL AIRFRAME	0.359	0.221	0.176	0.146	0.120	0.107	0.093	0.086	0.082	0.141	0.117	0.104
LABOR ENGINES	0.371	0.203	0.148	0.117	0.088	0.073	0.058	0.050	0.046	0.105	0.080	0.067
MATERIAL ENGINES	0.782	0.421	0.303	0.237	0.175	0.144	0.112	0.096	0.087	0.210	0.157	0.130
MAT. BURDEN	1.300	0.797	0.636	0.527	0.434	0.385	0.335	0.310	0.295	0.506	0.420	0.375
TOTAL MAINTENANCE	3.442	2.052	1.604	1.316	1.064	0.931	0.798	0.731	0.691	1.247	1.017	0.899
DEPRECIATION	2.000	1.569	1.453	1.285	1.177	1.112	1.046	1.013	0.994	1.275	1.169	1.112
TOTAL DIRECT OPERATING COST												
$/AIRCRAFT MILE	7.264	5.025	4.262	3.747	3.303	3.057	2.810	2.686	2.611	3.685	3.255	3.033
$/FLIGHT HOUR	1211.6	1068.0	978.2	973.0	935.9	917.3	896.0	884.1	876.3	964.0	928.5	910.1
$/SEAT MILE	0.0908	0.0628	0.0533	0.0468	0.0413	0.0382	0.0351	0.0336	0.0326	0.0461	0.0407	0.0379
$/SEAT-TRIP	2.27	3.14	4.00	4.68	6.19	7.64	10.54	13.43	16.32	9.21	12.21	15.16

D-80-80

DEPARTURE PATH TO 10,000 FT MSL

MAX FUSE ANGLE=20. OBSTACLE CLEAR ANGLE=60. OBSTACLE HEIGHT=100. MAX ACCEL ROTATION RATE=20. ACCEL BUILDUP TIME= 5.

TIME SEC	DIST FT	ALT FT	VEL FPS	ACC G	GAM DEG	THRUST LB	LWGO LB	LWGI LB	DWGO LB	DWGI LB	DFUST LB	ALP DEG	THE DEG	AWO DEG	ALV DEG	LAMDA	MU	CT	POWER HP
OBSTACLE CLEARANCE																			
3.1	4.	7.	3.	0.050	60.0	93003.	-1.	-1125.	1.	1457.	2.	29.3	24.6	-35.4	28.7	0.1014	0.0031	0.0195	9593.
4.0	7.	13.	8.	0.171	60.0	102382.	-10.	-1377.	5.	1301.	14.	26.5	24.6	-35.4	24.3	0.1121	0.0084	0.0215	11449.
4.7	12.	20.	13.	0.227	60.0	106760.	-27.	-1521.	13.	1217.	38.	25.3	24.6	-35.4	21.8	0.1202	0.0134	0.0224	12668.
5.4	17.	30.	18.	0.230	60.0	107041.	-52.	-1578.	26.	1153.	75.	25.3	24.6	-35.4	20.4	0.1267	0.0187	0.0225	13332.
6.3	27.	48.	23.	0.175	60.0	102729.	-86.	-1568.	42.	1044.	124.	26.4	24.6	-35.4	18.8	0.1320	0.0240	0.0216	13332.
7.5	44.	76.	28.	0.129	60.0	99226.	-128.	-1574.	63.	1009.	185.	27.4	24.6	-35.4	18.1	0.1367	0.0306	0.0209	13332.
7.9	58.	100.	29.	0.085	60.0	95915.	-179.	-1596.	88.	980.	259.	28.5	24.6	-35.4	17.3	0.1414	0.0374	0.0202	13332.
ACCELERATION AND CONVERSION																			
9.7	95.	154.	38.	0.090	55.3	92850.	-287.	-1917.	107.	753.	297.	31.0	24.6	-30.7	17.5	0.1460	0.0489	0.0196	13332.
11.0	138.	199.	46.	0.116	46.7	90372.	-527.	-2536.	118.	569.	271.	37.9	24.6	-22.1	18.5	0.1499	0.0694	0.0191	13332.
12.4	196.	247.	54.	0.111	38.9	91059.	-868.	-3257.	123.	463.	210.	46.4	24.6	-14.3	20.3	0.1485	0.0955	0.0192	13332.
13.8	271.	295.	62.	0.108	33.1	91653.	-753.	-4011.	116.	414.	164.	52.5	24.6	-8.5	20.1	0.1472	0.1205	0.0194	13332.
15.1	350.	338.	70.	0.121	28.6	91877.	145.	-4939.	109.	400.	134.	56.0	24.6	-4.0	18.8	0.1465	0.1447	0.0195	13332.
16.4	441.	381.	79.	0.121	25.1	91897.	1284.	-5756.	130.	409.	120.	59.2	24.6	-0.6	17.0	0.1461	0.1692	0.0195	13332.
17.7	548.	425.	88.	0.119	22.4	91786.	2678.	-6798.	180.	434.	122.	61.8	24.6	2.2	15.2	0.1457	0.1938	0.0195	13332.
19.1	677.	472.	98.	0.111	20.1	89522.	4336.	-5502.	257.	344.	140.	63.1	24.6	4.4	13.0	0.1489	0.2165	0.0190	13332.
20.4	812.	517.	107.	0.116	18.3	85054.	6263.	-1762.	362.	238.	174.	62.2	24.6	6.3	10.8	0.1561	0.2372	0.0181	13332.
21.8	967.	564.	117.	0.112	16.8	79809.	8462.	2314.	495.	247.	223.	61.4	24.6	7.8	8.8	0.1657	0.2570	0.0170	13332.
23.3	1141.	612.	126.	0.109	15.5	73952.	10935.	6753.	656.	360.	289.	59.8	24.6	9.1	7.1	0.1782	0.2754	0.0158	13332.
24.9	1351.	665.	136.	0.097	14.3	67281.	13682.	11630.	845.	571.	369.	58.1	24.6	10.3	5.6	0.1951	0.2915	0.0144	13332.
26.8	1631.	732.	146.	0.078	13.4	59712.	16701.	17004.	1062.	877.	465.	56.0	24.6	11.2	4.2	0.2193	0.3028	0.0128	13332.
29.0	1965.	806.	155.	0.071	12.5	52050.	19987.	22756.	1306.	1264.	576.	51.7	24.6	12.1	3.1	0.2514	0.3075	0.0112	13332.
31.5	2364.	889.	165.	0.063	11.8	44094.	23539.	28992.	1577.	1735.	703.	45.4	24.6	12.8	2.2	0.2975	0.2975	0.0095	13332.
34.1	2802.	975.	175.	0.061	11.1	36545.	27351.	35700.	1874.	2286.	844.	35.3	24.6	13.5	1.3	0.3624	0.2575	0.0079	13332.
36.5	3244.	1057.	185.	0.064	10.5	30561.	31425.	42871.	2199.	2912.	1000.	19.6	24.6	14.1	0.6	0.4406	0.1594	0.0066	13332.
39.0	3718.	1140.	195.	0.063	10.0	27838.	34056.	47282.	2335.	3209.	1079.	7.8	23.8	13.9	0.2	0.4877	0.0687	0.0060	13332.
41.8	4288.	1235.	204.	0.055	9.5	26409.	36581.	51119.	2452.	3426.	1151.	-3.9	23.0	13.6	0.0	0.5148	-0.0442	0.0057	13332.
44.7	4998.	1332.	214.	0.054	9.0	25204.	36696.	51004.	2290.	3183.	1111.	-3.8	21.4	12.3	0.0	0.5397	-0.0362	0.0055	13332.
47.6	5542.	1430.	222.	0.053	8.7	24352.	36772.	50928.	2179.	3018.	1092.	-3.6	20.2	11.5	0.0	0.5587	-0.0366	0.0053	13332.
AIRPLANE MODE CLIMB TO 10,000 FT																			
47.6	5542.	1430.	225.	0.0	14.0	27174.													
212.5	45216.	10000.	256.	0.0	11.8	23850.													

THE TOTAL NOISE IMPACT IS 0.188670+06

NOISE AT 500 FT SIDELINE= 88.4 EPNDB

NOISE AT 20,000 FT SIDELINE= 56.7 EPNDB

NOISE 25,000 FT FORWARD OF TAKEOFF POINT= 54.8 EPNDB

NOISE 500 FT FORWARD OF TAKEOFF POINT= 89.2 EPNDB

TILT ROTOR DESIGN PROGRAM 1974

D-80-110

DESIGN ITERATIONS: 15

OVERALL		POWERPLANT		FUSELAGE		STRUCT TECHNOLOGY FACTORS	
GROSS WEIGHT (LB)	160657.	INST NORMAL PWR (HP)	25803.	*LENGTH (FT)	110.0	*ROTOR	1.00
EMPTY WEIGHT (LB)	126566.	*NUMBER OF ENGINES	2.	*DIAMETER (FT)	13.0	*TRANSMISSION	0.83
FUEL WEIGHT (LB)	11641.	*EXCESS FACTOR HEL MODE	1.50	*DRAG FACTOR	1.00	*AIRFRAME	0.78
PAYLOAD (LB)	22450.	*% RATED EMRG HVR	140.			*ENGINE (HP/LB)	8.50
CRUISE SPEED (MPH)	378.	* CONV + CLIMB	120.	FLAT PLATE AREAS (SF)		*ENGINE INSTALLATION	1.60
L/D CRUISE	13.69	* CRUISE	90.	WING PROFILE	15.56		
*RANGE (STAT MI)	500.	INST PWR EMRG HVR (HP)	25803.	FUSELAGE	9.21	DESIGN MISSION	
*PASSENGER SEATS	110.	CONVER (HP)	20789.	EMPENNAGE	9.34	*FIELD ELEVATION (FT)	0.
*CARGO (LB)	0.	CRUISE (HP)	20165.	TOTAL PROFILE	41.27	SOUND SPEED HVR (FPS)	1117.
		*SFC (LB/HP HR)	0.400	WING INDUCED	9.17	*STD DAY TEMP (DEG F)	59.
ROTORS						*EMERG HOVER ALT (FT)	2000.
*DISC LOADING (PSF)	7.00	DRIVE SYSTEM		COMPONENT WEIGHTS (LB)		*HOT DAY TEMP (DEG F)	95.
RADIUS (FT)	60.4	*EFFICIENCY	0.97	ROTORS	32505.	*CT/SIG MAX	0.150
SOLIDITY	0.201	HEL MODE WEIGHT (LB)	29641.	DRIVE SYSTEM	30600.	*MAX ACCELERATION (G)	0.25
BLADE CHORD (FT)	4.76	AIRPLANE WEIGHT (LB)	30600.	POWERPLANT	4553.	*DESIGN CRUISE (MPH)	340.
TOTAL BLADES	16			NACELLES	2632.	*CRUISE ALTITUDE (FT)	15000.
*CT/SIG HOVER	0.120	WING		FUEL SYSTEM	2040.	SOUND SPEED CRSE (FPS)	1058.
*PROFILE DRAG COEFF	0.010	AREA (SF)	2550.	WING	9976.	*MAX DECELERATION (G)	0.20
% DOWNLOAD	4.9	*LOADING (PSF)	63.0	FUSELAGE	11635.	*STRUCT LOAD FACTOR	4.5
*EFFICIENCY HOVER	0.85	ASPECT RATIO	7.24	EMPENNAGE	3133.	*FLIGHT CREW	2.
* CONVER	0.83	SPAN (FT)	135.9	LANDING GEAR	4820.	*CABIN CREW	3.
* CRUISE	0.63	MEAN CHORD (FT)	18.77	FLIGHT CONTROLS	11647.	*ATC SPEED LIMIT	YES
HEL MODE WEIGHT (LB)	22193.	*THICKNESS/CHORD RATIO	0.210	HYDRAULICS	519.		
AIRPLANE WEIGHT (LB)	22490.	*TAPER RATIO	0.70	ELECTRICAL	4329.		
*TIP SPEED HOVER	400.	SWEEP (DEG)	-5.4	INSTR+AVIONICS	949.		
* CRUISE	400.	CRUISE LIFT COEFF	0.27	AIR CONDITIONING	1930.		
*FUSELAGE CLEARNCE (FT)	2.0	MAX LIFT COEFF CONVER	2.16	FURNISHINGS	4900.		
*MAX HEL MODE ADV RATIO	0.40	*MAX LIFT COEFF CLEAN	1.40	FLUIDS	803.		
		*FLAP AREA/WING AREA	0.25	FLIGHT CREW	400.		
* INDICATES INPUT VARIABLE		CLIMB SPD/CONVER SPD	1.47	CABIN CREW	450.		

DESIGN MISSION	SPEED MPH	HEIGHT FT	DIST MI	TIME MIN	FUEL LB
TAKEOFF & LANDING				2.00	235.
ACCEL. & CONV.		1400.	1.0	0.75	118.
AIRPLANE CLIMB	161.,198.	13600.	13.1	4.40	618.
ACCEL. TO CRUISE			6.9	1.36	204.
CRUISE	378.		438.1	69.52	7966.
AIRPLANE DESCENT	378.,294.	13600.	39.8	7.22	118.
DECEL. & CONV.		1400.	1.0	1.25	28.
TOTAL			500.0	86.51	9287.
RESERVE				20.00	2354.

STAGE LENGTH (MI.)	25.	50.	75.	100.	150.	200.	300.	400.	500.
CRUISE ALTITUDE (FT.)	2000.	4000.	10001.	12500.	15000.	15000.	15000.	15000.	15000.
CRUISE SPEED (MPH)	296.	305.	382.	379.	378.	378.	378.	378.	378.
CRUISE L/D	14.49	14.48	12.24	12.90	13.69	13.69	13.69	13.69	13.69
CRUISE DISTANCE (MI.)	17.9	34.9	31.3	47.4	87.4	137.4	237.4	337.4	437.4
BLOCK TIME (MIN.)	8.9	14.0	18.2	22.6	31.0	38.9	54.8	70.7	86.5
BLOCK FUEL (LB.)	858.	1251.	1646.	2056.	2946.	3866.	5691.	7495.	9278.
BLOCK SPEED (MPH)	169.	215.	248.	266.	290.	308.	329.	340.	347.

DIRECT OPERATING COST - ANN UTILIZATION(HR)=2000. DEPRECIATION PERIOD(YR)=10. LABOR RATE($/HR)= 7.00
AIRFRAME COST ($/LB)= 80.0 ENGINE COST ($/HP)= 60.0 INSURANCE RATE=0.040 FUEL COST (CENTS/GAL)= 18.0
DOC=1.79+0.0351*SL $/SEAT-TRIP (SL= 25.,500.)
HOP LENGTHS 50+150+ 0+ 0+ 0=200 100+200+ 0+ 0+ 0=300 200+200+ 0+ 0+ 0=400

STAGE LENGTH	25.	50.	75.	100.	150.	200.	300.	400.	500.	200.	300.	400.
NO. CYCLES/STARTS	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	2/1	2/1	2/1
FLIGHT CREW	0.594	0.468	0.405	0.378	0.346	0.326	0.306	0.296	0.290	0.393	0.354	0.334
FUEL & OIL	0.952	0.694	0.609	0.570	0.545	0.536	0.526	0.520	0.515	0.582	0.547	0.536
HULL INSURANCE	1.338	1.054	0.913	0.851	0.779	0.734	0.688	0.666	0.652	0.848	0.773	0.734
TOTAL FLIGHT OPS	2.884	2.216	1.927	1.799	1.669	1.595	1.520	1.481	1.457	1.822	1.675	1.604
LABOR AIRFRAME	0.791	0.514	0.408	0.357	0.304	0.274	0.244	0.229	0.220	0.352	0.299	0.272
MATERIAL AIRFRAME	0.642	0.394	0.303	0.259	0.213	0.188	0.163	0.151	0.144	0.249	0.206	0.184
LABOR ENGINES	0.500	0.271	0.192	0.153	0.113	0.093	0.073	0.063	0.057	0.137	0.103	0.085
MATERIAL ENGINES	1.431	0.771	0.544	0.432	0.318	0.260	0.202	0.173	0.156	0.383	0.285	0.236
MAT. BURDEN	1.679	1.021	0.780	0.664	0.542	0.477	0.412	0.380	0.360	0.636	0.522	0.464
TOTAL MAINTENANCE	5.043	2.971	2.227	1.865	1.490	1.292	1.095	0.996	0.937	1.757	1.414	1.241
DEPRECIATION	3.817	3.007	2.604	2.429	2.221	2.093	1.964	1.900	1.861	2.418	2.205	2.093
TOTAL DIRECT OPERATING COST												
$/AIRCRAFT MILE	11.743	8.194	6.757	6.093	5.381	4.981	4.579	4.377	4.254	5.997	5.294	4.937
$/FLIGHT HOUR	1985.3	1758.4	1674.4	1618.8	1562.9	1535.6	1504.3	1486.6	1475.0	1600.5	1549.2	1522.3
$/SEAT MILE	0.1068	0.0745	0.0614	0.0554	0.0489	0.0453	0.0416	0.0398	0.0387	0.0545	0.0481	0.0449
$/SEAT-TRIP	2.67	3.72	4.61	5.54	7.34	9.06	12.49	15.92	19.34	10.90	14.44	17.95

D-80-110

DEPARTURE PATH TO 10,000 FT MSL

MAX FUSE ANGLE=20. OBSTACLE CLEAR ANGLE=60. OBSTACLE HEIGHT=100. MAX ACCEL ROTATION RATE=20. ACCEL BUILDUP TIME= 5.

TIME SEC	DIST FT	ALT FT	VEL FPS	ACC G	GAM DEG	THRUST LB	LWGO LB	LWGI LB	DWGO LB	DWGI LB	DFUST LB	ALP DEG	THE DEG	AWO DEG	ALV DEG	LAMDA	MU	CT	POWER HP
OBSTACLE CLEARANCE																			
3.1	4.	7.	3.	0.050	60.0	170441.	-2.	-2116.	1.	2743.	2.	29.3	24.6	-35.4	28.7	0.1014	0.0031	0.0195	17585.
4.0	7.	13.	8.	0.171	60.0	187609.	-17.	-2589.	8.	2449.	18.	26.5	24.6	-35.4	24.3	0.1122	0.0084	0.0215	20983.
4.7	12.	20.	13.	0.227	60.0	195613.	-47.	-2860.	23.	2290.	51.	25.4	24.6	-35.4	21.8	0.1202	0.0134	0.0224	23214.
5.4	17.	30.	18.	0.230	60.0	196191.	-92.	-2971.	45.	2171.	99.	25.3	24.6	-35.4	20.4	0.1267	0.0187	0.0225	24438.
6.3	27.	47.	23.	0.176	60.0	188269.	-152.	-2950.	75.	1963.	164.	26.4	24.6	-35.4	18.8	0.1321	0.0240	0.0216	24438.
7.4	44.	76.	28.	0.130	60.0	181856.	-227.	-2962.	112.	1898.	245.	27.4	24.6	-35.4	18.1	0.1367	0.0306	0.0209	24438.
7.9	58.	100.	29.	0.086	60.0	175788.	-316.	-3003.	156.	1842.	341.	28.5	24.6	-35.4	17.3	0.1414	0.0374	0.0202	24438.
ACCELERATION AND CONVERSION																			
9.7	95.	154.	38.	0.090	55.4	170114.	-507.	-3601.	190.	1421.	394.	31.0	24.6	-30.8	17.4	0.1461	0.0489	0.0196	24438.
11.0	137.	199.	46.	0.117	46.8	165469.	-930.	-4760.	210.	1074.	364.	37.8	24.6	-22.2	18.4	0.1500	0.0694	0.0191	24438.
12.4	195.	246.	54.	0.111	39.0	166737.	-1532.	-6115.	219.	875.	284.	46.4	24.6	-14.4	20.2	0.1487	0.0955	0.0192	24438.
13.8	269.	294.	62.	0.108	33.2	167857.	-1328.	-7534.	205.	785.	226.	52.5	24.6	-8.6	20.1	0.1474	0.1205	0.0194	24438.
15.1	348.	337.	70.	0.122	28.7	168353.	241.	-9093.	191.	761.	189.	56.0	24.6	-4.1	18.8	0.1466	0.1447	0.0195	24438.
16.3	439.	380.	79.	0.122	25.2	168499.	2232.	-10817.	229.	779.	174.	59.3	24.6	-0.6	17.1	0.1460	0.1693	0.0195	24438.
17.7	545.	424.	88.	0.119	22.4	168432.	4669.	-12778.	318.	830.	180.	61.8	24.6	2.1	15.3	0.1456	0.1940	0.0195	24438.
19.0	673.	471.	98.	0.111	20.2	164364.	7567.	-10361.	457.	654.	208.	63.2	24.6	4.4	13.1	0.1486	0.2167	0.0191	24438.
20.4	807.	516.	107.	0.118	18.4	156234.	10935.	-3401.	647.	443.	256.	62.3	24.6	6.2	10.8	0.1558	0.2375	0.0182	24438.
21.7	959.	562.	117.	0.114	16.8	146666.	14779.	4186.	887.	457.	325.	61.5	24.6	7.8	8.8	0.1653	0.2573	0.0171	24438.
23.1	1129.	609.	126.	0.111	15.5	136021.	19102.	12439.	1178.	671.	416.	60.0	24.6	9.1	7.1	0.1775	0.2759	0.0159	24438.
24.7	1333.	661.	136.	0.100	14.4	123854.	23905.	21515.	1519.	1073.	527.	58.3	24.6	10.2	5.6	0.1943	0.2921	0.0145	24438.
26.6	1603.	725.	146.	0.082	13.4	110089.	29185.	31505.	1911.	1659.	659.	56.2	24.6	11.2	4.3	0.2180	0.3037	0.0129	24438.
28.7	1922.	796.	155.	0.074	12.5	96116.	34932.	42203.	2352.	2401.	811.	52.1	24.6	12.0	3.2	0.2494	0.3091	0.0113	24438.
31.0	2302.	876.	165.	0.066	11.8	81568.	41146.	53803.	2842.	3305.	984.	46.0	24.6	12.8	2.2	0.2946	0.3004	0.0096	24438.
33.5	2727.	959.	175.	0.063	11.1	67669.	47817.	66281.	3381.	4364.	1176.	36.2	24.6	13.5	1.4	0.3582	0.2632	0.0080	24438.
35.9	3165.	1040.	185.	0.064	10.5	56447.	54947.	79623.	3969.	5568.	1389.	21.0	24.6	14.1	0.6	0.4366	0.1700	0.0067	24438.
38.4	3637.	1124.	195.	0.063	10.0	50981.	60241.	89181.	4303.	6309.	1528.	7.4	24.0	14.0	0.2	0.4882	0.0650	0.0060	24438.
41.2	4204.	1218.	204.	0.055	9.5	49404.	64553.	96105.	4497.	6695.	1626.	-3.9	23.2	13.7	0.0	0.5148	-0.0441	0.0057	24438.
44.1	4809.	1315.	214.	0.054	9.1	46198.	64760.	95897.	4196.	6213.	1582.	-3.8	21.5	12.4	0.0	0.5396	-0.0364	0.0055	24438.
47.0	5457.	1413.	224.	0.053	8.7	44218.	64935.	95722.	3934.	5799.	1560.	-3.6	20.0	11.4	0.0	0.5639	-0.0372	0.0053	24438.
50.0	6144.	1514.	232.	0.052	8.3	42689.	65059.	95598.	3743.	5499.	1557.	-3.5	18.9	10.6	0.0	0.5843	-0.0368	0.0051	24438.
AIRPLANE MODE CLIMB TO 10,000 FT																			
50.0	6144.	1514.	236.	0.0	13.4	47692.													
212.5	47176.	10000.	269.	0.0	11.3	41911.													

THE TOTAL NOISE IMPACT IS 0.35560D+06

NOISE AT 500 FT SIDELINE= 90.5 EPNDB

NOISE AT 20,000 FT SIDELINE= 59.4 EPNDB

NOISE 25,000 FT FORWARD OF TAKEOFF POINT= 57.4 EPNDB

NOISE 500 FT FORWARD OF TAKEOFF POINT= 91.2 EPNDB

TILT ROTOR DESIGN PROGRAM 1974

S-80-20

DESIGN ITERATIONS: 3

OVERALL		POWERPLANT		FUSELAGE		STRUCT TECHNOLOGY FACTORS	
GROSS WEIGHT (LB)	24419.	INST NORMAL PWR (HP)	4126.	*LENGTH (FT)	55.0	*ROTOR	1.00
EMPTY WEIGHT (LB)	18273.	*NUMBER OF ENGINES	2.	*DIAMETER (FT)	8.5	*TRANSMISSION	0.83
FUEL WEIGHT (LB)	2146.	*EXCESS FACTOR HEL MODE	1.65	*DRAG FACTOR	1.00	*AIRFRAME	0.78
PAYLOAD (LB)	4000.	*% RATED EMRG HVR	140.			*ENGINE (HP/LB)	8.50
CRUISE SPEED (MPH)	281.	* CONV + CLIMB	120.	FLAT PLATE AREAS (SF)		*ENGINE INSTALLATION	1.70
L/D CRUISE	13.09	* CRUISE	90.	WING PROFILE	3.45		
*RANGE (STAT MI)	500.	INST PWR EMRG HVR (HP)	3756.	FUSELAGE	3.56	DESIGN MISSION	
*PASSENGER SEATS	20.	CONVER (HP)	3329.	EMPENNAGE	2.07	*FIELD ELEVATION (FT)	0.
*CARGO (LB)	0.	CRUISE (HP)	4126.	TOTAL PROFILE	10.98	SOUND SPEED HVR (FPS)	1117.
		*SFC (LB/HP HR)	0.400	WING INDUCED	3.74	*STD DAY TEMP (DEG F)	59.
ROTORS						*EMERG HOVER ALT (FT)	2000.
*DISC LOADING (PSF)	6.50	DRIVE SYSTEM		COMPONENT WEIGHTS (LB)		*HOT DAY TEMP (DEG F)	95.
RADIUS (FT)	24.5	*EFFICIENCY	0.97	ROTORS	3224.	*CT/SIG MAX	0.150
SOLIDITY	0.244	HEL MODE WEIGHT (LB)	3689.	DRIVE SYSTEM	3749.	*MAX ACCELERATION (G)	0.25
BLADE CHORD (FT)	2.34	AIRPLANE WEIGHT (LB)	3749.	POWERPLANT	728.	*DESIGN CRUISE (MPH)	280.
TOTAL BLADES	16			NACELLES	34.	*CRUISE ALTITUDE (FT)	15000.
*CT/SIG HOVER	0.120	WING		FUEL SYSTEM	112.	SOUND SPEED CRSE (FPS)	1058.
*PROFILE DRAG COEFF	0.010	AREA (SF)	488.	WING	2067.	*MAX DECELERATION (G)	0.20
% DOWNLOAD	5.3	*LOADING (PSF)	50.0	FUSELAGE	2789.	*STRUCT LOAD FACTOR	4.5
*EFFICIENCY HOVER	0.85	ASPECT RATIO	7.23	EMPENNAGE	476.	*FLIGHT CREW	2.
* CONVER	0.83	SPAN (FT)	59.4	LANDING GEAR	733.	*CABIN CREW	0.
CRUISE	0.51	MEAN CHORD (FT)	8.22	FLIGHT CONTROLS	818.	*ATC SPEED LIMIT	YES
HEL MODE WEIGHT (LB)	3202.	*THICKNESS/CHORD RATIO	0.210	HYDRAULICS	202.		
AIRPLANE WEIGHT (LB)	3224.	*TAPER RATIO	0.70	ELECTRICAL	301.		
*TIP SPEED HOVER	350.	SWEEP (DEG)	-5.4	INSTR+AVIONICS	580.		
* CRUISE	350.	CRUISE LIFT COEFF	0.39	AIR CONDITIONING	760.		
*FUSELAGE CLEARNCE (FT)	2.0	MAX LIFT COEFF CONVER	2.24	FURNISHINGS	1300.		
*MAX HEL MODE ADV RATIO	0.40	*MAX LIFT COEFF CLEAN	1.40	FLUIDS	122.		
		*FLAP AREA/WING AREA	0.25	FLIGHT CREW	400.		
* INDICATES INPUT VARIABLE		CLIMB SPD/CONVER SPD	1.38	CABIN CREW	0.		

DESIGN MISSION	SPEED MPH	HEIGHT FT	DIST MI	TIME MIN	FUEL LB
TAKEOFF & LANDING				2.00	35.
ACCEL. & CONV.		1500.	0.9	0.82	21.
AIRPLANE CLIMB	132.,163.	13500.	10.1	4.11	91.
ACCEL. TO CRUISE			2.3	0.59	14.
CRUISE	281.		450.2	96.20	1609.
AIRPLANE DESCENT	281.,228.	13500.	35.7	8.48	22.
DECEL. & CONV.		1500.	0.9	1.18	4.
TOTAL			500.0	113.38	1796.
RESERVE				20.00	349.

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STAGE LENGTH (MI.)	25.	50.	75.	100.	150.	200.	300.	400.	500.
CRUISE ALTITUDE (FT.)	2000.	4000.	10001.	12500.	15000.	15000.	15000.	15000.	15000.
CRUISE SPEED (MPH)	292.	291.	284.	283.	281.	281.	281.	281.	281.
CRUISE L/D	9.71	10.17	11.62	12.35	13.09	13.09	13.09	13.09	13.09
CRUISE DISTANCE (MI.)	18.5	38.1	44.5	60.2	100.2	150.2	250.2	350.2	450.2
BLOCK TIME (MIN.)	9.3	14.7	21.2	27.1	38.6	49.3	70.6	92.0	113.4
BLOCK FUEL (LB.)	177.	270.	310.	385.	555.	736.	1095.	1448.	1796.
BLOCK SPEED (MPH)	162.	204.	212.	221.	233.	244.	255.	261.	265.

DIRECT OPERATING COST - ANN UTILIZATION(HR)=2000. DEPRECIATION PERIOD(YR)=10. LABOR RATE($/HR)= 7.00
AIRFRAME COST ($/LB)= 80.0 ENGINE COST ($/HP)= 60.0 INSURANCE RATE=0.040 FUEL COST (CENTS/GAL)= 18.0
DOC=2.73+0.0673*SL $/SEAT-TRIP (SL= 25.,500.)
HOP LENGTHS 50+150+ 0+ 0+ 0=200 100+200+ 0+ 0+ 0=300 200+200+ 0+ 0+ 0=400

STAGE LENGTH	25.	50.	75.	100.	150.	200.	300.	400.	500.	200.	300.	400.
NO. CYCLES/STARTS	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	2/1	2/1	2/1
FLIGHT CREW	0.554	0.441	0.424	0.406	0.385	0.369	0.353	0.344	0.340	0.414	0.391	0.376
FUEL & OIL	0.198	0.151	0.116	0.108	0.103	0.103	0.102	0.101	0.100	0.115	0.104	0.103
HULL INSURANCE	0.204	0.162	0.156	0.149	0.142	0.136	0.130	0.127	0.125	0.147	0.140	0.136
TOTAL FLIGHT OPS	0.956	0.753	0.695	0.663	0.630	0.607	0.584	0.572	0.565	0.676	0.636	0.615
LABOR AIRFRAME	0.439	0.292	0.251	0.228	0.202	0.187	0.171	0.164	0.159	0.223	0.199	0.186
MATERIAL AIRFRAME	0.146	0.090	0.074	0.065	0.056	0.050	0.045	0.042	0.041	0.062	0.054	0.049
LABOR ENGINES	0.262	0.146	0.110	0.090	0.071	0.061	0.051	0.045	0.042	0.082	0.066	0.057
MATERIAL ENGINES	0.230	0.125	0.091	0.073	0.055	0.046	0.037	0.032	0.030	0.065	0.050	0.042
MAT. BURDEN	0.911	0.569	0.469	0.413	0.355	0.322	0.289	0.272	0.262	0.397	0.345	0.316
TOTAL MAINTENANCE	1.998	1.221	0.995	0.870	0.739	0.666	0.592	0.556	0.534	0.829	0.714	0.651
DEPRECIATION	0.593	0.464	0.446	0.427	0.405	0.388	0.371	0.362	0.357	0.420	0.401	0.388
TOTAL DIRECT OPERATING COST												
$/AIRCRAFT MILE	3.527	2.438	2.136	1.960	1.774	1.661	1.548	1.490	1.456	1.925	1.751	1.654
$/FLIGHT HOUR	571.7	497.3	453.1	433.6	413.9	404.6	394.4	388.8	385.2	433.5	412.5	402.8
$/SEAT MILE	0.1763	0.1219	0.1068	0.0980	0.0887	0.0831	0.0774	0.0745	0.0728	0.0963	0.0875	0.0827
$/SEAT-TRIP	4.41	6.10	8.01	9.80	13.31	16.61	23.21	29.81	36.39	19.25	26.26	33.07

S-80-20

DEPARTURE PATH TO 10,000 FT MSL

MAX FUSE ANGLE=20. OBSTACLE CLEAR ANGLE=60. OBSTACLE HEIGHT=100. MAX ACCEL ROTATION RATE=20. ACCEL BUILDUP TIME= 5.

TIME SEC	DIST FT	ALT FT	VFL FPS	ACC G	GAM DEG	THRUST LB	LWGO LB	LWGI LB	DWGO LB	DWGI LB	DFUST LB	ALP DEG	THE DEG	AWD DEG	ALV DEG	LAMDA	MU	CT	POWER HP
OBSTACLE CLEARANCE																			
3.1	4.	7.	3.	0.050	60.0	25938.	-0.	-347.	0.	444.	1.	29.4	24.6	-35.4	28.5	0.1119	0.0035	0.0237	2557.
4.0	7.	13.	8.	0.171	60.0	28554.	-4.	-423.	2.	402.	6.	26.5	24.6	-35.4	24.3	0.1240	0.0096	0.0261	3062.
4.7	12.	20.	13.	0.227	60.0	29776.	-10.	-468.	5.	376.	16.	25.4	24.6	-35.4	21.8	0.1331	0.0153	0.0272	3397.
5.3	17.	30.	18.	0.248	60.0	30261.	-20.	-495.	10.	355.	32.	25.0	24.6	-35.4	20.0	0.1416	0.0211	0.0277	3652.
5.9	24.	42.	23.	0.250	60.0	30345.	-33.	-517.	16.	341.	53.	25.0	24.6	-35.4	18.6	0.1491	0.0271	0.0278	3841.
6.7	34.	59.	28.	0.210	60.0	29486.	-49.	-523.	24.	319.	80.	25.8	24.6	-35.4	17.1	0.1563	0.0332	0.0270	3907.
7.7	50.	87.	33.	0.160	60.0	28445.	-68.	-529.	34.	310.	111.	26.8	24.6	-35.4	16.2	0.1620	0.0404	0.0261	3907.
7.9	58.	100.	33.	0.110	60.0	27434.	-90.	-538.	45.	304.	148.	27.9	24.6	-35.4	15.4	0.1679	0.0483	0.0252	3907.
ACCELERATION AND CONVERSION																			
9.4	93.	154.	43.	0.104	56.8	26540.	-131.	-616.	54.	260.	171.	29.4	24.6	-32.2	15.2	0.1735	0.0601	0.0243	3907.
10.5	131.	198.	51.	0.136	49.4	25460.	-226.	-795.	60.	211.	167.	34.3	24.6	-24.8	15.0	0.1807	0.0809	0.0234	3907.
11.8	187.	249.	58.	0.119	41.9	25655.	-358.	-1026.	61.	176.	134.	43.1	24.6	-17.3	16.8	0.1790	0.1117	0.0236	3907.
13.3	267.	307.	66.	0.103	36.1	25990.	-532.	-1277.	66.	158.	108.	50.2	24.6	-11.5	17.3	0.1763	0.1423	0.0239	3907.
14.7	355.	361.	74.	0.112	31.5	26058.	-240.	-1555.	56.	152.	89.	54.0	24.6	-6.9	16.3	0.1753	0.1702	0.0240	3907.
16.1	459.	416.	83.	0.109	27.9	26042.	173.	-1864.	57.	154.	76.	57.3	24.6	-3.3	14.9	0.1748	0.1982	0.0241	3907.
17.6	584.	474.	92.	0.104	25.0	25980.	677.	-2214.	68.	162.	71.	60.0	24.6	-0.4	13.4	0.1746	0.2263	0.0241	3907.
19.4	748.	542.	101.	0.088	22.6	25420.	1275.	-2081.	91.	145.	72.	61.9	24.6	2.0	11.6	0.1777	0.2525	0.0236	3907.
20.9	905.	601.	110.	0.102	20.6	23931.	1971.	-851.	124.	101.	80.	60.2	24.6	4.0	9.5	0.1881	0.2747	0.0222	3907.
22.6	1101.	668.	120.	0.090	18.9	22116.	2766.	511.	168.	97.	95.	59.3	24.6	5.7	7.6	0.2028	0.2945	0.0206	3907.
24.5	1334.	742.	129.	0.082	17.5	20116.	3661.	1990.	222.	130.	117.	57.2	24.6	7.1	6.0	0.2222	0.3119	0.0188	3907.
26.7	1616.	824.	139.	0.073	16.2	17908.	4655.	3607.	287.	197.	145.	54.2	24.6	8.3	4.6	0.2490	0.3241	0.0167	3907.
29.1	1965.	918.	148.	0.064	15.2	15530.	5747.	5374.	363.	295.	180.	49.7	24.6	9.4	3.3	0.2870	0.3267	0.0146	3907.
31.7	2371.	1021.	158.	0.059	14.2	13099.	6936.	7293.	450.	425.	222.	42.5	24.6	10.4	2.2	0.3416	0.3102	0.0123	3907.
34.3	2789.	1121.	168.	0.061	13.4	10834.	8222.	9370.	546.	584.	270.	30.9	24.6	11.2	1.3	0.4176	0.2532	0.0102	3907.
36.6	3191.	1211.	178.	0.067	12.6	9183.	9605.	11597.	654.	772.	324.	13.4	24.6	12.0	0.4	0.5007	0.1224	0.0087	3907.
39.4	3699.	1318.	187.	0.056	12.0	8541.	10921.	13498.	751.	928.	376.	-5.1	24.4	12.4	0.0	0.5407	-0.0461	0.0081	3907.
42.2	4230.	1427.	193.	0.055	11.6	8302.	10947.	13472.	722.	888.	371.	-4.9	23.3	11.7	0.0	0.5564	-0.0487	0.0079	3907.
AIRPLANE MODE CLIMB TO 10,000 FT																			
42.2	4230.	1427.	194.	0.0	17.3	9120.													
197.0	36279.	10000.	221.	0.0	14.6	8004.													

THE TOTAL NOISE IMPACT IS 0.13833D+05

NOISE AT 500 FT SIDELINE= 81.1 EPNDB

NOISE AT 20,000 FT SIDELINE= 48.6 EPNDB

NOISE 25,000 FT FORWARD OF TAKEOFF POINT= 46.8 EPNDB

NOISE 500 FT FORWARD OF TAKEOFF POINT= 81.7 EPNDB

TILT ROTOR DESIGN PROGRAM 1974

S-80-80 DESIGN ITERATIONS: 13

OVERALL		POWERPLANT		FUSELAGE		STRUCT TECHNOLOGY FACTORS	
GROSS WEIGHT (LB)	113921.	INST NORMAL PWR (HP)	17559.	*LENGTH (FT)	95.0	*ROTOR	1.00
EMPTY WEIGHT (LB)	88762.	*NUMBER OF ENGINES	2.	*DIAMETER (FT)	11.5	*TRANSMISSION	0.83
FUEL WEIGHT (LB)	8858.	*EXCESS FACTOR HEL MODE	1.65	*DRAG FACTOR	1.00	*AIRFRAME	0.78
PAYLOAD (LB)	16300.	*% RATED EMRG HVR	140.			*ENGINE (HP/LB)	8.50
CRUISE SPEED (MPH)	297.	* CONV + CLIMB	120.	FLAT PLATE AREAS (SF)		*ENGINE INSTALLATION	1.70
L/D CRUISE	15.31	* CRUISE	90.	WING PROFILE	14.26		
*RANGE (STAT MI)	500.	INST PWR EMRG HVR (HP)	17559.	FUSELAGE	7.41	DESIGN MISSION	
*PASSENGER SEATS	80.	CONVER (HP)	15561.	EMPENNAGE	8.55	*FIELD ELEVATION (FT)	0.
*CARGO (LB)	0.	CRUISE (HP)	15990.	TOTAL PROFILE	36.56	SOUND SPEED HVR (FPS)	1117.
		*SFC (LB/HP HR)	0.400	WING INDUCED	16.56	*STD DAY TEMP (DEG F)	59.
ROTORS						*EMERG HOVER ALT (FT)	2000.
*DISC LOADING (PSF)	6.50	DRIVE SYSTEM		COMPONENT WEIGHTS (LB)		*HOT DAY TEMP (DEG F)	95.
RADIUS (FT)	52.8	*EFFICIENCY	0.97	ROTORS	21123.	*CT/SIG MAX	0.150
SOLIDITY	0.245	HEL MODE WEIGHT (LB)	23458.	DRIVE SYSTEM	23458.	*MAX ACCELERATION (G)	0.25
BLADE CHORD (FT)	5.09	AIRPLANE WEIGHT (LB)	22301.	POWERPLANT	3099.	*DESIGN CRUISE (MPH)	280.
TOTAL BLADES	16			NACELLES	1059.	*CRUISE ALTITUDE (FT)	15000.
*CT/SIG HOVER	0.120	WING		FUEL SYSTEM	1277.	SOUND SPEED CRSE (FPS)	1058.
*PROFILE DRAG COEFF	0.010	AREA (SF)	2278.	WING	7770.	*MAX DECELERATION (G)	0.20
% DOWNLOAD	5.7	*LOADING (PSF)	50.0	FUSELAGE	8601.	*STRUCT LOAD FACTOR	4.5
*EFFICIENCY HOVER	0.85	ASPECT RATIO	6.23	EMPENNAGE	2221.	*FLIGHT CREW	2.
* CONVER	0.83	SPAN (FT)	119.1	LANDING GEAR	3417.	*CABIN CREW	2.
CRUISE	0.50	MEAN CHORD (FT)	19.12	FLIGHT CONTROLS	7173.	*ATC SPEED LIMIT	YES
HEL MODE WEIGHT (LB)	17193.	*THICKNESS/CHORD RATIO	0.210	HYDRAULICS	437.		
AIRPLANE WEIGHT (LB)	16833.	*TAPER RATIO	0.70	ELECTRICAL	2660.		
*TIP SPEED HOVER	350.	SWEEP (DEG)	-5.6	INSTR+AVIONICS	826.		
* CRUISE	350.	CRUISE LIFT COEFF	0.36	AIR CONDITIONING	1540.		
*FUSELAGE CLEARNCE (FT)	2.0	MAX LIFT COEFF CONVER	2.24	FURNISHINGS	3700.		
*MAX HEL MODE ADV RATIO	0.40	*MAX LIFT COEFF CLEAN	1.40	FLUIDS	570.		
		*FLAP AREA/WING AREA	0.25	FLIGHT CREW	400.		
* INDICATES INPUT VARIABLE		CLIMB SPD/CONVER SPD	1.56	CABIN CREW	300.		

DESIGN MISSION	SPEED MPH	HEIGHT FT	DIST MI	TIME MIN	FUEL LB
TAKEOFF & LANDING				2.00	160.
ACCEL. & CONV.		1500.	0.9	0.72	84.
AIRPLANE CLIMB	149.,184.	13500.	12.9	4.65	440.
ACCEL. TO CRUISE			2.8	0.68	68.
CRUISE	297.		440.5	89.09	6383.
AIRPLANE DESCENT	297.,241.	13500.	42.1	9.45	106.
DECEL. & CONV.		1500.	0.9	1.07	16.
TOTAL			500.0	107.66	7258.
RESERVE				20.00	1600.

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STAGE LENGTH (MI.)	25.	50.	75.	100.	150.	200.	300.	400.	500.			
CRUISE ALTITUDE (FT.)	2000.	4000.	10001.	12500.	15000.	15000.	15000.	15000.	15000.			
CRUISE SPEED (MPH)	296.	305.	305.	300.	297.	297.	297.	297.	297.			
CRUISE L/D	12.27	12.27	13.79	14.51	15.31	15.31	15.31	15.31	15.31			
CRUISE DISTANCE (MI.)	18.2	36.0	38.1	52.3	90.5	140.5	240.5	340.5	440.5			
BLOCK TIME (MIN.)	8.9	14.1	20.1	25.9	36.9	47.0	67.2	87.4	107.7			
BLOCK FUEL (LB.)	712.	1086.	1237.	1536.	2217.	2952.	4406.	5842.	7259.			
BLOCK SPEED (MPH)	168.	213.	223.	232.	244.	255.	268.	274.	279.			

DIRECT OPERATING COST - ANN UTILIZATION(HR)=2000. DEPRECIATION PERIOD(YR)=10. LABOR RATE($/HP)= 7.00
AIRFRAME COST ($/LB)= 80.0 ENGINE COST ($/HP)= 60.0 INSURANCE RATE=0.040 FUEL COST (CENTS/GAL)= 18.0
DOC=1.69+0.0448*SL $/SEAT-TRIP (SL= 25.,500.)
HOP LENGTHS 50+150+ 0+ 0+ 0=200 100+200+ 0+ 0+ 0=300 200+200+ 0+ 0+ 0=400

STAGE LENGTH	25.	50.	75.	100.	150.	200.	300.	400.	500.	200.	300.	400.
NO. CYCLES/STARTS	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	2/1	2/1	2/1
FLIGHT CREW	0.567	0.447	0.426	0.411	0.390	0.372	0.355	0.347	0.341	0.420	0.396	0.380
FUEL & OIL	0.790	0.602	0.458	0.427	0.410	0.410	0.408	0.405	0.403	0.458	0.415	0.410
HULL INSURANCE	0.943	0.743	0.708	0.682	0.648	0.619	0.590	0.576	0.567	0.672	0.640	0.619
TOTAL FLIGHT OPS	2.300	1.792	1.591	1.520	1.448	1.401	1.353	1.328	1.312	1.550	1.451	1.409
LABOR AIRFRAME	0.699	0.456	0.387	0.350	0.309	0.284	0.259	0.246	0.239	0.342	0.304	0.282
MATERIAL AIRFRAME	0.470	0.289	0.235	0.206	0.176	0.158	0.141	0.132	0.127	0.198	0.170	0.155
LABOR ENGINES	0.409	0.223	0.163	0.133	0.102	0.085	0.069	0.061	0.056	0.119	0.093	0.079
MATERIAL ENGINES	0.975	0.525	0.380	0.306	0.231	0.192	0.153	0.133	0.122	0.271	0.208	0.175
MAT. BURDEN	1.441	0.883	0.716	0.627	0.534	0.480	0.426	0.399	0.383	0.600	0.515	0.470
TOTAL MAINTENANCE	3.994	2.376	1.881	1.623	1.351	1.199	1.048	0.972	0.926	1.531	1.289	1.161
DEPRECIATION	2.687	2.117	2.017	1.945	1.846	1.764	1.683	1.642	1.617	1.914	1.825	1.764
TOTAL DIRECT OPERATING COST												
$/AIRCRAFT MILE	8.981	6.284	5.489	5.087	4.645	4.365	4.084	3.942	3.855	4.994	4.565	4.335
$/FLIGHT HOUR	1505.4	1338.1	1226.5	1178.7	1133.9	1114.9	1093.7	1082.0	1074.3	1176.0	1127.6	1107.1
$/SEAT MILE	0.1123	0.0786	0.0686	0.0636	0.0581	0.0546	0.0510	0.0493	0.0482	0.0624	0.0571	0.0542
$/SEAT-TRIP	2.81	3.93	5.15	6.36	8.71	10.91	15.31	19.71	24.10	12.49	17.12	21.67

S-80-80

DEPARTURE PATH TO 10,000 FT MSL

MAX FUSE ANGLE=20. OBSTACLE CLEAR ANGLE=60. OBSTACLE HEIGHT=100. MAX ACCEL ROTATION RATE=20. ACCEL BUILDUP TIME= 5.

TIME SEC	DIST FT	ALT FT	VEL FPS	ACC G	GAM DEG	THRUST LB	LWGO LB	LWGI LB	DWGO LB	DWGI LB	DFUST LB	ALP DEG	THE DEG	AWO DEG	ALV DEG	LAMDA	MU	CT	POWER HP
OBSTACLE CLEARANCE																			
3.1	4.	7.	3.	0.050	60.0	121182.	-2.	-1759.	1.	2258.	2.	29.4	24.6	-35.4	28.5	0.1119	0.0035	0.0238	11958.
4.0	7.	13.	8.	0.171	60.0	133357.	-15.	-2142.	8.	2048.	14.	26.6	24.6	-35.4	24.4	0.1240	0.0096	0.0262	14309.
4.7	12.	20.	13.	0.227	60.0	139027.	-42.	-2371.	21.	1910.	39.	25.5	24.6	-35.4	21.9	0.1332	0.0154	0.0273	15869.
5.3	17.	30.	18.	0.248	60.0	141244.	-83.	-2505.	41.	1801.	76.	25.1	24.6	-35.4	20.1	0.1417	0.0212	0.0277	17052.
5.9	24.	42.	23.	0.250	60.0	141578.	-136.	-2620.	68.	1732.	126.	25.1	24.6	-35.4	18.6	0.1491	0.0272	0.0278	17925.
6.7	34.	59.	28.	0.212	60.0	137794.	-204.	-2652.	101.	1622.	188.	25.8	24.6	-35.4	17.2	0.1563	0.0333	0.0270	18266.
7.6	50.	86.	33.	0.163	60.0	132906.	-294.	-2685.	141.	1569.	263.	26.9	24.6	-35.4	16.2	0.1620	0.0404	0.0261	18266.
7.9	58.	100.	33.	0.115	60.0	128189.	-378.	-2728.	188.	1539.	350.	28.0	24.6	-35.4	15.4	0.1680	0.0484	0.0252	18266.
ACCELERATION AND CONVERSION																			
9.3	92.	153.	43.	0.107	56.9	123893.	-549.	-3113.	227.	1322.	409.	29.4	24.6	-32.3	15.2	0.1737	0.0603	0.0244	18266.
10.4	128.	195.	51.	0.144	49.6	118578.	-948.	-4012.	255.	1080.	405.	33.8	24.6	-25.0	14.8	0.1814	0.0803	0.0234	18266.
11.6	181.	243.	59.	0.126	42.1	119503.	-1499.	-5198.	261.	906.	330.	42.8	24.6	-17.5	16.6	0.1796	0.1108	0.0236	18266.
13.0	256.	298.	66.	0.111	36.3	121052.	-2228.	-6452.	283.	819.	271.	49.9	24.6	-11.7	17.1	0.1769	0.1420	0.0239	18266.
14.4	339.	349.	74.	0.119	31.7	121512.	-962.	-7861.	234.	795.	229.	53.8	24.6	-7.1	16.2	0.1757	0.1701	0.0240	18266.
15.7	438.	402.	83.	0.115	28.1	121713.	718.	-9428.	235.	812.	204.	57.4	24.6	-3.5	14.9	0.1748	0.1984	0.0241	18266.
17.1	556.	457.	92.	0.110	25.1	121773.	2766.	-11205.	285.	861.	195.	60.2	24.6	-0.5	13.5	0.1741	0.2269	0.0242	18266.
18.8	711.	522.	101.	0.093	22.7	119236.	5199.	-10317.	385.	752.	204.	62.2	24.6	1.9	11.7	0.1771	0.2530	0.0237	18266.
20.2	855.	576.	110.	0.111	20.7	112436.	8027.	-4311.	533.	504.	228.	60.4	24.6	3.9	9.6	0.1870	0.2755	0.0224	18266.
21.6	1013.	631.	120.	0.111	19.0	104461.	11260.	2267.	731.	474.	270.	58.9	24.6	5.6	7.7	0.2006	0.2961	0.0208	18266.
23.1	1204.	691.	129.	0.100	17.6	95237.	14900.	9506.	977.	643.	327.	57.2	24.6	7.0	6.1	0.2192	0.3140	0.0190	18266.
25.1	1459.	766.	139.	0.081	16.3	84713.	18947.	17500.	1272.	1003.	401.	55.1	24.6	8.3	4.6	0.2458	0.3266	0.0169	18266.
27.1	1757.	847.	148.	0.075	15.2	73939.	23394.	26089.	1615.	1532.	491.	50.7	24.6	9.3	3.4	0.2814	0.3316	0.0148	18266.
29.5	2113.	938.	158.	0.067	14.3	62653.	28241.	35464.	2006.	2230.	597.	44.1	24.6	10.3	2.3	0.3331	0.3194	0.0126	18266.
31.9	2506.	1032.	168.	0.064	13.4	51957.	33482.	45600.	2444.	3090.	718.	33.6	24.6	11.1	1.4	0.4055	0.2720	0.0105	18266.
34.2	2913.	1123.	178.	0.066	12.7	43637.	39118.	56479.	2930.	4102.	856.	17.4	24.6	11.9	0.6	0.4908	0.1572	0.0088	18266.
37.0	3414.	1230.	187.	0.057	12.0	39868.	45153.	67894.	3463.	5234.	1008.	-4.0	24.6	12.6	-0.1	0.5415	-0.0349	0.0081	18266.
39.9	3978.	1344.	197.	0.053	11.4	37974.	45892.	68029.	3290.	4878.	1014.	-4.9	22.9	11.5	0.0	0.5685	-0.0391	0.0077	18266.
42.8	4581.	1460.	207.	0.052	10.9	36269.	46059.	67862.	3078.	4535.	1019.	-4.5	21.3	10.4	0.0	0.5952	-0.0501	0.0074	18266.
45.9	5226.	1579.	215.	0.051	10.4	34882.	46180.	67741.	2920.	4284.	1034.	-4.4	20.1	9.6	0.0	0.6191	-0.0486	0.0071	18266.
AIRPLANE MODE CLIMB TO 10,000 FT																			
45.9	5226.	1579.	219.	0.0		13.6	34654.												
217.4	45364.	10000.	249.	0.0		11.4	30482.												

THE TOTAL NOISE IMPACT IS 0.129670+06

NOISE AT 500 FT SIDELINE= 86.3 EPNDB

NOISE AT 20,000 FT SIDELINE= 55.5 EPNDB

NOISE 25,000 FT FORWARD OF TAKEOFF POINT= 53.5 EPNDB

NOISE 500 FT FORWARD OF TAKEOFF POINT= 86.9 EPNDB

IHN900I EXECUTION TERMINATING DUE TO ERROR COUNT FOR ERROR NUMBER 217

IHN217I FIOCS - END OF DATA SET ON UNIT 5

TRACEBACK ROUTINE	CALLED FROM ISN	REG. 14	REG. 15	REG. 0	REG. 1
IRCOM		00107D50	00117564	00000000	00000000
MAIN		00013538	01106218	FD000008	001277F8

TILT ROTOR DESIGN PROGRAM 1974

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DESIGN ITERATIONS: 5

OVERALL	
GROSS WEIGHT (LB)	46326.
EMPTY WEIGHT (LB)	31288.
FUEL WEIGHT (LB)	4888.
PAYLOAD (LB)	10150.
CRUISE SPEED (MPH)	440.
L/D CRUISE	10.05
*RANGE (STAT MI)	500.
*PASSENGER SEATS	50.
*CARGO (LB)	0.

ROTORS	
*DISC LOADING (PSF)	12.00
RADIUS (FT)	24.8
SOLIDITY	0.081
BLADE CHORD (FT)	2.10
TOTAL BLADES	6
*CT/SIG HOVER	0.120
*PROFILE DRAG COEFF	0.010
% DOWNLOAD	5.0
*EFFICIENCY HOVER	0.83
* CONVER	0.81
CRUISE	0.78
HEL MODE WEIGHT (LB)	3799.
AIRPLANE WEIGHT (LB)	2923.
*TIP SPEED HOVER	825.
* CRUISE	560.
*FUSELAGE CLEARNCE (FT)	2.0
*MAX HEL MODE ADV RATIO	0.40

* INDICATES INPUT VARIABLE

POWERPLANT	
INST NORMAL PWR (HP)	10480.
*NUMBER OF ENGINES	2.
*EXCESS FACTOR HEL MODE	1.30
*% RATED EMRG HVR	140.
* CONV + CLIMB	120.
* CRUISE	90.
INST PWR EMRG HVR (HP)	10480.
CONVER (HP)	7326.
CRUISE (HP)	8273.
*SFC (LB/HP HR)	0.420

DRIVE SYSTEM	
*EFFICIENCY	0.97
HEL MODE WEIGHT (LB)	3641.
AIRPLANE WEIGHT (LB)	4934.

WING	
AREA (SF)	488.
*LOADING (PSF)	95.0
ASPECT RATIO	7.77
SPAN (FT)	61.6
MEAN CHORD (FT)	7.92
*THICKNESS/CHORD RATIO	0.210
*TAPER RATIO	0.70
SWEEP (DEG)	-5.3
CRUISE LIFT COEFF	0.31
MAX LIFT COEFF CONVER	0.75
*MAX LIFT COEFF CLEAN	1.40
*FLAP AREA/WING AREA	0.25
CLIMB SPD/CONVER SPD	0.76

FUSELAGE	
*LENGTH (FT)	80.0
*DIAMETER (FT)	10.0
*DRAG FACTOR	1.00

FLAT PLATE AREAS (SF)	
WING PROFILE	3.29
FUSELAGE	5.31
EMPENNAGE	1.97
TOTAL PROFILE	12.79
WING INDUCED	2.09

COMPONENT WEIGHTS (LB)	
ROTORS	3799.
DRIVE SYSTEM	4934.
POWERPLANT	2246.
NACELLES	507.
FUEL SYSTEM	461.
WING	3479.
FUSELAGE	5752.
EMPENNAGE	927.
LANDING GEAR	1390.
FLIGHT CONTROLS	2017.
HYDRAULICS	278.
ELECTRICAL	744.
INSTR+AVIONICS	703.
AIR CONDITIONING	1150.
FURNISHINGS	2500.
FLUIDS	232.
FLIGHT CREW	400.
CABIN CREW	150.

STRUCT TECHNOLOGY FACTORS	
*ROTOR	1.05
*TRANSMISSION	0.85
*AIRFRAME	0.80
*ENGINE (HP/LB)	7.00
*ENGINE INSTALLATION	1.50

DESIGN MISSION	
*FIELD ELEVATION (FT)	0.
SOUND SPEED HVR (FPS)	1117.
*STD DAY TEMP (DEG F)	59.
*EMERG HOVER ALT (FT)	2000.
*HOT DAY TEMP (DEG F)	95.
*CT/SIG MAX	0.150
*MAX ACCELERATION (G)	0.25
*DESIGN CRUISE (MPH)	400.
*CRUISE ALTITUDE (FT)	15000.
SOUND SPEED CRSE (FPS)	1058.
*MAX DECELERATION (G)	0.20
*STRUCT LOAD FACTOR	4.5
*FLIGHT CREW	2.
*CABIN CREW	1.
*ATC SPEED LIMIT	YES

DESIGN MISSION	SPEED MPH	HEIGHT FT	DIST MI	TIME MIN	FUEL LB
TAKEOFF & LANDING				2.00	101.
ACCEL. & CONV.		900.	0.9	0.63	39.
AIRPLANE CLIMB	171.,212.	14100.	13.3	4.19	265.
ACCEL. TO CRUISE			13.8	2.30	153.
CRUISE	440.		436.8	59.60	3257.
AIRPLANE DESCENT	440.,292.	14100.	34.2	6.00	52.
DECEL. & CONV.		900.	0.9	1.09	10.
TOTAL			500.0	75.80	3877.
RESERVE				20.00	1011.

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STAGE LENGTH (MI.)	25.	50.	75.	100.	150.	200.	300.	400.	500.
CRUISE ALTITUDE (FT.)	2000.	4000.	10001.	12500.	15000.	15000.	15000.	15000.	15000.
CRUISE SPEED (MPH)	296.	305.	451.	458.	467.	467.	467.	467.	467.
CRUISE L/D	12.66	12.65	8.55	8.76	9.02	9.02	9.02	9.02	9.02
CRUISE DISTANCE (MI.)	17.0	34.9	10.4	37.1	79.0	129.0	229.0	329.0	429.0
BLOCK TIME (MIN.)	8.7	13.7	17.0	20.6	27.3	33.8	46.6	59.5	72.4
BLOCK FUEL (LB.)	337.	493.	728.	929.	1370.	1795.	2632.	3453.	4259.
BLOCK SPEED (MPH)	173.	219.	265.	291.	329.	355.	386.	403.	415.

DIRECT OPERATING COST - ANN UTILIZATION(HR)=2000. DEPRECIATION PERIOD(YR)=10. LABOR RATE($/HR)= 7.00
AIRFRAME COST ($/LB)= 80.0 ENGINE COST ($/HP)= 60.0 INSURANCE RATE=0.040 FUEL COST (CENTS/GAL)= 18.0
DOC=1.81+0.0260*SL $/SEAT-TRIP (SL= 25.,500.)
HOP LENGTHS 50+150+ 0+ 0+ 0=200 100+200+ 0+ 0+ 0=300 200+200+ 0+ 0+ 0=400

STAGE LENGTH	25.	50.	75.	100.	150.	200.	300.	400.	500.	200.	300.	400.
NO. CYCLES/STARTS	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	2/1	2/1	2/1
FLIGHT CREW	0.563	0.446	0.368	0.335	0.296	0.274	0.253	0.242	0.235	0.350	0.305	0.283
FUEL & OIL	0.375	0.274	0.270	0.258	0.254	0.249	0.244	0.240	0.236	0.259	0.252	0.249
HULL INSURANCE	0.341	0.270	0.223	0.203	0.179	0.166	0.153	0.146	0.142	0.202	0.178	0.166
TOTAL FLIGHT OPS	1.278	0.991	0.861	0.796	0.729	0.690	0.649	0.628	0.614	0.811	0.736	0.698
LABOR AIRFRAME	0.486	0.319	0.245	0.211	0.174	0.155	0.135	0.125	0.120	0.208	0.172	0.154
MATERIAL AIRFRAME	0.196	0.121	0.090	0.076	0.060	0.052	0.044	0.040	0.038	0.073	0.058	0.051
LABOR ENGINES	0.329	0.180	0.127	0.101	0.075	0.061	0.048	0.041	0.037	0.091	0.068	0.056
MATERIAL ENGINES	0.579	0.312	0.218	0.171	0.124	0.100	0.076	0.064	0.057	0.151	0.111	0.090
MAT. BURDEN	1.059	0.649	0.484	0.406	0.323	0.280	0.237	0.216	0.203	0.389	0.312	0.273
TOTAL MAINTENANCE	2.650	1.581	1.164	0.984	0.756	0.649	0.541	0.487	0.454	0.913	0.721	0.624
DEPRECIATION	0.992	0.786	0.649	0.590	0.522	0.484	0.445	0.426	0.414	0.588	0.519	0.484
TOTAL DIRECT OPERATING COST												
$/AIRCRAFT MILE	4.920	3.357	2.673	2.350	2.008	1.822	1.635	1.540	1.483	2.312	1.976	1.805
$/FLIGHT HOUR	852.2	733.9	708.1	684.3	660.8	647.3	631.0	621.4	614.8	675.4	653.9	641.3
$/SEAT MILE	0.0984	0.0671	0.0535	0.0470	0.0402	0.0364	0.0327	0.0308	0.0297	0.0462	0.0395	0.0361
$/SEAT-TRIP	2.46	3.36	4.01	4.70	6.02	7.29	9.81	12.32	14.83	9.25	11.85	14.44

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DEPARTURE PATH TO 10,000 FT MSL

MAX FUSE ANGLE=20. OBSTACLE CLEAR ANGLE=60. OBSTACLE HEIGHT=100. MAX ACCEL ROTATION RATE=20. ACCEL BUILDUP TIME= 5.

TIME SEC	DIST FT	ALT FT	VEL FPS	ACC G	GAM DEG	THRUST LB	LWGO LB	LWGI LB	DWGO LB	DWGI LB	DFUST LB	ALP DEG	THE DEG	AWO DEG	ALV DEG	LAMDA	MU	CT	POWER HP
OBSTACLE CLEARANCE																			
3.1	4.	7.	3.	0.050	60.0	49169.	-0.	-616.	0.	807.	1.	29.3	24.6	-35.4	28.8	0.0641	0.0015	0.0079	7219.
4.0	7.	13.	8.	0.171	60.0	54134.	-4.	-753.	2.	738.	10.	26.5	24.6	-35.4	24.8	0.0698	0.0041	0.0087	8420.
5.0	13.	23.	13.	0.163	60.0	53762.	-10.	-763.	5.	688.	28.	26.7	24.6	-35.4	23.6	0.0728	0.0068	0.0086	8676.
6.2	24.	41.	18.	0.128	60.0	52344.	-20.	-766.	10.	643.	54.	27.4	24.6	-35.4	22.5	0.0748	0.0095	0.0084	8676.
7.8	42.	73.	23.	0.095	60.0	50992.	-33.	-765.	17.	617.	90.	28.2	24.6	-35.4	21.9	0.0767	0.0126	0.0082	8676.
8.5	58.	100.	24.	0.059	60.0	49601.	-50.	-764.	25.	590.	134.	29.1	24.6	-35.4	21.2	0.0789	0.0158	0.0080	8676.
ACCELERATION AND CONVERSION																			
9.5	78.	126.	33.	0.155	52.3	48545.	-90.	-1035.	28.	358.	136.	30.2	24.6	-27.8	21.5	0.0806	0.0203	0.0078	8676.
10.4	105.	150.	40.	0.171	41.6	47830.	-179.	-1393.	30.	232.	104.	40.2	24.6	-17.1	25.4	0.0818	0.0309	0.0077	8676.
11.3	141.	174.	48.	0.174	33.7	48077.	-213.	-1730.	30.	185.	73.	48.2	24.6	-9.1	28.2	0.0813	0.0431	0.0077	8676.
12.1	185.	198.	57.	0.176	28.1	48145.	67.	-2021.	27.	163.	54.	53.6	24.6	-3.5	28.3	0.0812	0.0549	0.0078	8676.
13.0	237.	221.	66.	0.179	24.0	48180.	442.	-2301.	36.	156.	46.	57.4	24.6	0.6	27.1	0.0810	0.0666	0.0078	8676.
13.8	294.	243.	75.	0.191	20.9	48226.	920.	-2598.	56.	157.	49.	59.7	24.6	3.7	25.2	0.0809	0.0783	0.0078	8676.
14.6	359.	265.	85.	0.191	18.5	48130.	1504.	-2923.	86.	165.	63.	61.8	24.6	6.1	23.0	0.0809	0.0900	0.0078	8676.
15.5	434.	287.	94.	0.189	16.6	47954.	2196.	-3288.	128.	176.	89.	63.4	24.6	8.0	20.7	0.0811	0.1018	0.0077	8676.
16.3	520.	310.	104.	0.181	15.0	46813.	2997.	-2559.	180.	128.	125.	64.1	24.6	9.6	17.9	0.0829	0.1125	0.0076	8676.
17.2	613.	333.	113.	0.184	13.7	44957.	3908.	-991.	243.	78.	173.	63.1	24.6	10.9	15.2	0.0862	0.1227	0.0073	8676.
18.0	714.	355.	123.	0.184	12.6	42868.	4930.	659.	317.	75.	232.	61.9	24.6	12.0	12.8	0.0902	0.1325	0.0069	8676.
18.9	835.	380.	133.	0.167	11.6	40277.	6063.	2467.	402.	115.	302.	61.3	24.6	12.9	10.6	0.0959	0.1417	0.0065	8676.
19.9	966.	405.	143.	0.165	10.8	37719.	7306.	4338.	498.	192.	383.	59.4	24.6	13.8	8.8	0.1022	0.1505	0.0061	8676.
20.9	1122.	433.	153.	0.150	10.1	34683.	8659.	6401.	605.	307.	475.	57.8	24.6	14.5	7.1	0.1110	0.1578	0.0056	8676.
22.1	1313.	465.	162.	0.130	9.5	31347.	10123.	8629.	723.	458.	578.	55.7	24.6	15.1	5.6	0.1226	0.1632	0.0051	8676.
23.4	1534.	500.	172.	0.119	9.0	28017.	11695.	10975.	851.	637.	692.	52.2	24.6	15.6	4.3	0.1372	0.1661	0.0045	8676.
24.8	1794.	538.	182.	0.108	8.5	24540.	13376.	13489.	991.	849.	817.	47.5	24.6	16.1	3.2	0.1567	0.1640	0.0040	8676.
26.5	2109.	583.	192.	0.094	8.0	21737.	14663.	15385.	1072.	997.	892.	43.7	24.0	16.0	2.4	0.1771	0.1594	0.0035	8676.
28.3	2464.	630.	202.	0.088	7.6	19806.	15637.	16715.	1109.	1077.	927.	40.3	23.1	15.4	1.9	0.1946	0.1567	0.0032	8676.
30.1	2857.	681.	212.	0.083	7.3	17912.	16639.	18116.	1147.	1161.	965.	35.8	22.2	15.0	1.4	0.2156	0.1478	0.0029	8676.
32.1	3277.	732.	222.	0.081	6.9	16148.	17674.	19589.	1187.	1250.	1006.	29.8	21.5	14.5	1.0	0.2401	0.1301	0.0026	8676.
33.9	3705.	782.	232.	0.084	6.6	14703.	18782.	21131.	1234.	1342.	1054.	21.7	20.8	14.2	0.6	0.2649	0.1045	0.0024	8676.
35.8	4149.	831.	242.	0.084	6.4	13508.	19911.	22742.	1281.	1439.	1102.	12.0	20.3	13.9	0.3	0.2895	0.0623	0.0022	8676.
37.6	4615.	882.	248.	0.082	6.2	12937.	20694.	23861.	1314.	1506.	1136.	4.6	19.9	13.7	0.1	0.3035	0.0254	0.0021	8676.
AIRPLANE MODE CLIMB TO 10,000 FT																			
37.6	4615.	882.	250.	0.0	14.0	14875.													
197.5	47564.	10000.	287.	0.0	11.5	12950.													

THE TOTAL NOISE IMPACT IS 0.12453D+07

NOISE AT 500 FT SIDELINE=103.2 EPNDB

NOISE AT 20,000 FT SIDELINE= 65.9 EPNDB

NOISE 25,000 FT FORWARD OF TAKEOFF POINT= 83.7 EPNDB

NOISE 500 FT FORWARD OF TAKEOFF POINT=104.5 EPNDB

TILT ROTOR DESIGN PROGRAM 1974

C-85-50

DESIGN ITERATIONS: 5

OVERALL		POWERPLANT		FUSELAGE		STRUCT TECHNOLOGY FACTORS	
GROSS WEIGHT (LB)	39765.	INST NORMAL PWR (HP)	8579.	*LENGTH (FT)	80.0	*ROTOR	0.95
EMPTY WEIGHT (LB)	25857.	*NUMBER OF ENGINES	2.	*DIAMETER (FT)	10.0	*TRANSMISSION	0.81
FUEL WEIGHT (LB)	3758.	*EXCESS FACTOR HEL MODE	1.30	*DRAG FACTOR	1.00	*AIRFRAME	0.76
PAYLOAD (LB)	10150.	*% RATED EMRG HVR	140.			*ENGINE (HP/LB)	10.00
CRUISE SPEED (MPH)	419.	* CONV + CLIMB	120.	FLAT PLATE AREAS (SF)		*ENGINE INSTALLATION	1.50
L/D CRUISE	9.91	* CRUISE	90.	WING PROFILE	2.86		
*RANGE (STAT MI)	500.	INST PWR EMRG HVR (HP)	8579.	FUSELAGE	5.31	DESIGN MISSION	
*PASSENGER SEATS	50.	CONVER (HP)	5997.	EMPENNAGE	1.72	*FIELD ELEVATION (FT)	0.
*CARGO (LB)	0.	CRUISE (HP)	7572.	TOTAL PROFILE	11.96	SOUND SPEED HVR (FPS)	1117.
		*SFC (LB/HP HR)	0.380	WING INDUCED	2.04	*STD DAY TEMP (DEG F)	59.
ROTORS						*EMERG HOVER ALT (FT)	2000.
*DISC LOADING (PSF)	12.00	DRIVE SYSTEM		COMPONENT WEIGHTS (LB)		*HOT DAY TEMP (DEG F)	95.
RADIUS (FT)	23.0	*EFFICIENCY	0.97	ROTORS	2863.	*CT/SIG MAX	0.150
SOLIDITY	0.081	HEL MODE WEIGHT (LB)	2781.	DRIVE SYSTEM	3758.	*MAX ACCELERATION (G)	0.25
BLADE CHORD (FT)	1.94	AIRPLANE WEIGHT (LB)	3758.	POWERPLANT	1287.	*DESIGN CRUISE (MPH)	400.
TOTAL BLADES	6			NACELLES	129.	*CRUISE ALTITUDE (FT)	15000.
*CT/SIG HOVER	0.120	WING		FUEL SYSTEM	294.	SOUND SPEED CRSE (FPS)	1058.
*PROFILE DRAG COEFF	0.010	AREA (SF)	419.	WING	3000.	*MAX DECELERATION (G)	0.20
% DOWNLOAD	4.9	*LOADING (PSF)	95.0	FUSELAGE	5341.	*STRUCT LOAD FACTOR	4.5
*EFFICIENCY HOVER	0.87	ASPECT RATIO	8.02	EMPENNAGE	756.	*FLIGHT CREW	2.
* CONVER	0.85	SPAN (FT)	57.9	LANDING GEAR	1193.	*CABIN CREW	1.
CRUISE	0.79	MEAN CHORD (FT)	7.23	FLIGHT CONTROLS	1627.	*ATC SPEED LIMIT	YES
HEL MODE WEIGHT (LB)	2863.	*THICKNESS/CHORD RATIO	0.210	HYDRAULICS	258.		
AIRPLANE WEIGHT (LB)	2200.	*TAPER RATIO	0.70	ELECTRICAL	599.		
*TIP SPEED HOVER	825.	SWEEP (DEG)	-5.3	INSTR+AVIONICS	703.		
* CRUISE	560.	CRUISE LIFT COEFF	0.33	AIR CONDITIONING	1150.		
*FUSELAGE CLEARNCE (FT)	2.0	MAX LIFT COEFF CONVER	0.75	FURNISHINGS	2500.		
*MAX HEL MODE ADV RATIO	0.40	*MAX LIFT COEFF CLEAN	1.40	FLUIDS	199.		
		*FLAP AREA/WING AREA	0.25	FLIGHT CREW	400.		
* INDICATES INPUT VARIABLE		CLIMB SPD/CONVER SPD	0.74	CABIN CREW	150.		

DESIGN MISSION	SPEED MPH	HEIGHT FT	DIST MI	TIME MIN	FUEL LB
TAKEOFF & LANDING				2.00	75.
ACCEL. & CONV.		900.	0.9	0.65	29.
AIRPLANE CLIMB	166.,206.	14100.	13.0	4.20	196.
ACCEL. TO CRUISE			11.0	1.94	95.
CRUISE	419.		441.5	63.31	2569.
AIRPLANE DESCENT	418.,292.	14100.	32.7	5.80	37.
DECEL. & CONV.		900.	0.9	1.13	8.
TOTAL			500.0	79.02	3010.
RESERVE				20.00	748.

C-85-50

STAGE LENGTH (MI.)	25.	50.	75.	100.	150.	200.	300.	400.	500.			
CRUISE ALTITUDE (FT.)	2000.	4000.	10001.	12500.	15000.	15000.	15000.	15000.	15000.			
CRUISE SPEED (MPH)	296.	305.	430.	439.	448.	448.	448.	448.	448.			
CRUISE L/D	11.96	11.96	8.46	8.69	8.94	8.94	8.94	8.94	8.94			
CRUISE DISTANCE (MI.)	17.1	35.3	24.1	41.5	83.4	133.4	233.4	333.4	433.4			
BLOCK TIME (MIN.)	8.7	13.8	17.2	20.9	27.9	34.6	48.0	61.4	74.8			
BLOCK FUEL (LB.)	259.	382.	555.	710.	1049.	1377.	2023.	2659.	3284.			
BLOCK SPEED (MPH)	172.	217.	262.	287.	322.	347.	375.	391.	401.			

DIRECT OPERATING COST - ANN UTILIZATION(HR)=2000. DEPRECIATION PERIOD(YR)=10. LABOR RATE($/HR)= 7.00
AIRFRAME COST ($/LB)= 80.0 ENGINE COST ($/HP)= 60.0 INSURANCE RATE=0.040 FUEL COST (CENTS/GAL)= 18.0
DOC=1.61+0.0236*SL $/SEAT-TRIP (SL= 25.,500.)
HOP LENGTHS 50+150+ 0+ 0+ 0=200 100+200+ 0+ 0+ 0=300 200+200+ 0+ 0+ 0=400

STAGE LENGTH	25.	50.	75.	100.	150.	200.	300.	400.	500.	200.	300.	400.
NO. CYCLES/STARTS	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	2/1	2/1	2/1
FLIGHT CREW	0.562	0.444	0.369	0.337	0.299	0.278	0.257	0.247	0.241	0.352	0.309	0.287
FUEL & OIL	0.288	0.213	0.206	0.197	0.194	0.191	0.187	0.185	0.183	0.199	0.193	0.191
HULL INSURANCE	0.289	0.228	0.190	0.173	0.154	0.143	0.132	0.127	0.124	0.172	0.153	0.143
TOTAL FLIGHT OPS	1.139	0.885	0.764	0.707	0.648	0.613	0.577	0.559	0.547	0.723	0.655	0.621
LABOR AIRFRAME	0.466	0.305	0.236	0.204	0.169	0.151	0.133	0.123	0.118	0.201	0.167	0.150
MATERIAL AIRFRAME	0.176	0.108	0.081	0.066	0.055	0.048	0.041	0.037	0.035	0.065	0.053	0.046
LABOR ENGINES	0.308	0.170	0.120	0.096	0.071	0.058	0.046	0.039	0.036	0.087	0.065	0.054
MATERIAL ENGINES	0.475	0.256	0.179	0.141	0.102	0.083	0.063	0.053	0.048	0.124	0.091	0.075
MAT. BURDEN	1.006	0.617	0.463	0.389	0.312	0.272	0.232	0.212	0.200	0.374	0.302	0.265
TOTAL MAINTENANCE	2.430	1.456	1.078	0.898	0.709	0.611	0.514	0.465	0.436	0.852	0.678	0.590
DEPRECIATION	0.839	0.663	0.551	0.503	0.447	0.416	0.385	0.369	0.359	0.501	0.445	0.416
TOTAL DIRECT OPERATING COST												
$/AIRCRAFT MILE	4.407	3.004	2.394	2.108	1.804	1.640	1.476	1.392	1.342	2.077	1.778	1.626
$/FLIGHT HOUR	757.3	653.0	626.3	604.1	581.5	568.5	553.1	544.1	538.1	597.2	575.9	563.7
$/SEAT MILE	0.0881	0.0601	0.0479	0.0422	0.0361	0.0328	0.0295	0.0278	0.0268	0.0415	0.0356	0.0325
$/SEAT-TRIP	2.20	3.00	3.59	4.22	5.41	6.56	8.85	11.14	13.42	8.31	10.67	13.01

C-85-50

DEPARTURE PATH TO 10,000 FT MSL

MAX FUSE ANGLE=20. OBSTACLE CLEAR ANGLE=60. OBSTACLE HEIGHT=100. MAX ACCEL ROTATION RATE=20. ACCEL BUILDUP TIME= 5.

TIME SEC	DIST FT	ALT FT	VEL FPS	ACC G	GAM DEG	THRUST LB	LWGO LB	LWGI LB	DWGO LB	DWGI LB	DFUST LB	ALP DEG	THE DEG	AWO DEG	ALV DEG	LAMDA	MU	CT	POWER HP
OBSTACLE CLEARANCE																			
3.1	4.	7.	3.	0.050	60.0	42154.	-0.	-520.	0.	680.	1.	29.3	24.6	-35.4	28.8	0.0641	0.0015	0.0079	5902.
4.0	7.	13.	8.	0.171	60.0	46458.	-3.	-635.	2.	622.	10.	26.5	24.6	-35.4	24.8	0.0698	0.0041	0.0087	6885.
5.0	13.	23.	13.	0.164	60.0	46158.	-9.	-645.	4.	582.	28.	26.6	24.6	-35.4	23.5	0.0728	0.0068	0.0086	7102.
6.2	24.	41.	18.	0.129	60.0	44962.	-18.	-647.	9.	542.	54.	27.4	24.6	-35.4	22.5	0.0748	0.0095	0.0084	7102.
7.8	42.	73.	23.	0.095	60.0	43799.	-29.	-646.	14.	521.	90.	28.2	24.6	-35.4	21.9	0.0768	0.0126	0.0082	7102.
8.4	58.	100.	24.	0.060	60.0	42604.	-44.	-646.	22.	498.	134.	29.0	24.6	-35.4	21.2	0.0789	0.0157	0.0080	7102.
ACCELERATION AND CONVERSION																			
9.5	79.	127.	33.	0.150	52.4	41677.	-78.	-871.	25.	303.	137.	30.4	24.6	-27.8	21.5	0.0807	0.0203	0.0078	7102.
10.4	106.	152.	40.	0.170	41.8	41055.	-156.	-1173.	26.	196.	105.	40.1	24.6	-17.2	25.3	0.0819	0.0309	0.0077	7102.
11.3	142.	176.	48.	0.173	33.8	41268.	-154.	-1457.	26.	156.	74.	48.1	24.6	-9.3	28.2	0.0814	0.0431	0.0077	7102.
12.2	186.	200.	57.	0.175	28.2	41319.	51.	-1703.	24.	137.	54.	53.5	24.6	-3.6	28.3	0.0813	0.0548	0.0078	7102.
13.0	238.	223.	66.	0.181	24.1	41350.	381.	-1939.	32.	131.	45.	57.2	24.6	0.5	27.1	0.0811	0.0666	0.0078	7102.
13.9	295.	245.	75.	0.191	21.0	41368.	800.	-2191.	48.	131.	47.	59.5	24.6	3.6	25.1	0.0810	0.0783	0.0078	7102.
14.7	361.	267.	85.	0.191	18.6	41272.	1312.	-2464.	74.	137.	61.	61.6	24.6	6.0	22.9	0.0811	0.0899	0.0078	7102.
15.5	435.	289.	94.	0.188	16.6	41105.	1920.	-2772.	110.	147.	86.	63.3	24.6	9.0	20.6	0.0813	0.1017	0.0077	7102.
16.4	521.	312.	104.	0.180	15.0	40133.	2623.	-2179.	154.	108.	121.	64.0	24.6	9.5	17.9	0.0831	0.1125	0.0076	7102.
17.2	615.	335.	113.	0.183	13.7	38541.	3423.	-849.	208.	66.	168.	63.0	24.6	10.9	15.2	0.0864	0.1226	0.0073	7102.
18.0	717.	358.	123.	0.183	12.6	36745.	4321.	551.	272.	64.	226.	61.8	24.6	12.0	12.8	0.0905	0.1324	0.0069	7102.
19.0	838.	383.	133.	0.166	11.7	34520.	5316.	2085.	344.	97.	295.	61.2	24.6	12.9	10.6	0.0961	0.1415	0.0065	7102.
19.9	971.	408.	143.	0.164	10.9	32318.	6408.	3674.	427.	160.	375.	59.2	24.6	13.7	8.7	0.1025	0.1503	0.0061	7102.
21.0	1128.	437.	153.	0.148	10.2	29710.	7597.	5424.	518.	256.	466.	57.6	24.6	14.4	7.1	0.1113	0.1576	0.0056	7102.
22.2	1321.	469.	162.	0.129	9.5	26841.	8883.	7316.	619.	380.	568.	55.6	24.6	15.0	5.6	0.1231	0.1629	0.0051	7102.
23.5	1546.	505.	172.	0.117	9.0	23978.	10264.	9307.	729.	529.	680.	52.0	24.6	15.6	4.3	0.1377	0.1656	0.0045	7102.
25.0	1811.	544.	182.	0.106	8.5	20994.	11741.	11442.	849.	704.	804.	47.2	24.6	16.1	3.2	0.1574	0.1633	0.0040	7102.
26.7	2134.	590.	192.	0.092	8.1	18672.	12823.	12973.	913.	818.	871.	43.7	23.9	15.9	2.4	0.1772	0.1593	0.0035	7102.
28.5	2498.	639.	202.	0.085	7.7	17017.	13672.	14093.	943.	884.	905.	40.3	23.0	15.3	1.9	0.1946	0.1566	0.0032	7102.
30.4	2902.	691.	212.	0.081	7.3	15395.	14545.	15273.	976.	953.	941.	35.8	22.2	14.9	1.4	0.2156	0.1479	0.0029	7102.
32.4	3334.	743.	222.	0.079	7.0	13884.	15447.	16513.	1010.	1025.	980.	29.9	21.4	14.5	1.0	0.2400	0.1304	0.0026	7102.
34.3	3773.	795.	232.	0.081	6.7	12646.	16415.	17812.	1050.	1101.	1026.	21.8	20.8	14.1	0.6	0.2647	0.1052	0.0024	7102.
36.2	4225.	846.	240.	0.082	6.4	11779.	17211.	18912.	1082.	1166.	1063.	14.2	20.3	13.8	0.4	0.2854	0.0722	0.0022	7102.
AIRPLANE MODE CLIMB TO 10,000 FT																			
36.2	4225.	846.	243.	0.0	14.4	13116.													
196.9	46160.	10000.	279.	0.0	11.8	11413.													

THE TOTAL NOISE IMPACT IS 0.109670+07

NOISE AT 500 FT SIDELINE=103.1 EPNDB

NOISE AT 20,000 FT SIDELINE= 65.2 EPNDB

NOISE 25,000 FT FORWARD OF TAKEOFF POINT= 63.0 EPNDB

NOISE 500 FT FORWARD OF TAKEOFF POINT=104.5 EPNDB

TILT ROTOR DESIGN PROGRAM 1974

M-75-5C

DESIGN ITERATIONS: 5

OVERALL	
GROSS WEIGHT (LB)	48372.
EMPTY WEIGHT (LB)	33456.
FUEL WEIGHT (LB)	4766.
PAYLOAD (LB)	10150.
CRUISE SPEED (MPH)	442.
L/D CRUISE	10.19
*RANGE (STAT MI)	500.
*PASSENGER SEATS	50.
*CARGO (LB)	0.

ROTORS	
*DISC LOADING (PSF)	12.00
RADIUS (FT)	25.3
SOLIDITY	0.143
BLADE CHORD (FT)	2.85
TOTAL BLADES	8
*CT/SIG HOVER	0.120
*PROFILE DRAG COEFF	0.012
% DOWNLOAD	5.0
*EFFICIENCY HOVER	0.83
* CONVER	0.81
CRUISE	0.70
HEL MODE WEIGHT (LB)	4761.
AIRPLANE WEIGHT (LB)	4591.
*TIP SPEED HOVER	620.
* CRUISE	550.
*FUSELAGE CLEARNCE (FT)	2.0
*MAX HEL MODE ADV RATIO	0.40

* INDICATES INPUT VARIABLE

POWERPLANT	
INST NORMAL PWR (HP)	10590.
*NUMBER OF ENGINES	2.
*EXCESS FACTOR HEL MODE	1.30
*% RATED EMRG HVR	140.
* CONV + CLIMB	120.
* CRUISE	90.
INST PWR EMRG HVR (HP)	10590.
CONVER (HP)	7361.
CRUISE (HP)	8281.
*SFC (LB/HP HR)	0.420

DRIVE SYSTEM	
*EFFICIENCY	0.97
HEL MODE WEIGHT (LB)	4674.
AIRPLANE WEIGHT (LB)	5711.

WING	
AREA (SF)	505.
*LOADING (PSF)	95.0
ASPECT RATIO	7.71
SPAN (FT)	62.7
MEAN CHORD (FT)	8.13
*THICKNESS/CHORD RATIO	0.210
*TAPER RATIO	0.70
SWEEP (DEG)	-5.3
CRUISE LIFT COEFF	0.30
MAX LIFT COEFF CONVER	1.34
*MAX LIFT COEFF CLEAN	1.40
*FLAP AREA/WING AREA	0.25
CLIMB SPD/CONVER SPD	1.02

FUSELAGE	
*LENGTH (FT)	80.0
*DIAMETER (FT)	10.0
*DRAG FACTOR	1.00

FLAT PLATE AREAS (SF)	
WING PROFILE	3.42
FUSELAGE	5.31
EMPENNAGE	2.05
TOTAL PROFILE	13.04
WING INDUCED	2.17

COMPONENT WEIGHTS (LB)	
ROTORS	4761.
DRIVE SYSTEM	5711.
POWERPLANT	2269.
NACELLES	520.
FUEL SYSTEM	441.
WING	3571.
FUSELAGE	5790.
EMPENNAGE	968.
LANDING GEAR	1451.
FLIGHT CONTROLS	2144.
HYDRAULICS	285.
ELECTRICAL	791.
INSTR+AVIONICS	703.
AIR CONDITIONING	1150.
FURNISHINGS	2500.
FLUIDS	242.
FLIGHT CREW	400.
CABIN CREW	150.

STRUCT TECHNOLOGY FACTORS	
*ROTOR	1.05
*TRANSMISSION	0.85
*AIRFRAME	0.80
*ENGINE (HP/LB)	7.00
*ENGINE INSTALLATION	1.50

DESIGN MISSION	
*FIELD ELEVATION (FT)	0.
SOUND SPEED HVR (FPS)	1117.
*STD DAY TEMP (DEG F)	59.
*EMERG HOVER ALT (FT)	2000.
*HOT DAY TEMP (DEG F)	95.
*CT/SIG MAX	0.150
*MAX ACCELERATION (G)	0.25
*DESIGN CRUISE (MPH)	450.
*CRUISE ALTITUDE (FT)	15000.
SOUND SPEED CRSE (FPS)	1058.
*MAX DECELERATION (G)	0.20
*STRUCT LOAD FACTOR	4.5
*FLIGHT CREW	2.
*CABIN CREW	1.
*ATC SPEED LIMIT	YES

DESIGN MISSION	SPEED MPH	HEIGHT FT	DIST MI	TIME MIN	FUEL LB
TAKEOFF & LANDING				2.00	102.
ACCEL. & CONV.		900.	0.9	0.63	38.
AIRPLANE CLIMB	172.,213.	14100.	11.7	3.66	226.
ACCEL. TO CRUISE			10.8	1.82	119.
CRUISE	442.		440.8	59.89	3208.
AIRPLANE DESCENT	442.,252.	14100.	34.9	6.10	47.
DECEL. & CONV.		900.	0.9	1.08	10.
TOTAL			500.0	75.18	3750.
RESERVE				20.00	1017.

M-75-50

STAGE LENGTH (MI.)	25.	50.	75.	100.	150.	200.	300.	400.	500.			
CRUISE ALTITUDE (FT.)	2000.	4000.	10001.	12500.	15000.	15000.	15000.	15000.	15000.			
CRUISE SPEED (MPH)	296.	305.	449.	447.	449.	449.	449.	449.	449.			
CRUISE L/D	12.85	12.85	8.78	9.24	9.79	9.79	9.79	9.79	9.79			
CRUISE DISTANCE (MI.)	17.4	35.4	27.5	46.6	89.5	139.5	239.5	339.5	439.5			
BLOCK TIME (MIN.)	8.6	13.6	16.7	20.4	27.4	34.1	47.5	60.8	74.2			
BLOCK FUEL (LB.)	324.	469.	683.	864.	1248.	1633.	2394.	3143.	3879.			
BLOCK SPEED (MPH)	174.	220.	270.	294.	328.	352.	379.	394.	404.			

DIRECT OPERATING COST - ANN UTILIZATION(HR)=2000. DEPRECIATION PERIOD(YR)=10. LABOR RATE($/HR)= 7.00
AIRFRAME COST ($/LB)= 80.) ENGINE COST ($/HP)= 60.0 INSURANCE RATE=0.04C FUEL COST (CENTS/GAL)= 18.0
DOC=1.83+0.027C*SL $/SEAT-TRIP (SL= 25.,5C0.)
HOP LENGTHS 50+150+ 0+ 0+ 0=200 100+200+ 0+ 0+ 0=300 200+200+ 0+ 0+ 0=400

STAGE LENGTH	25.	50.	75.	100.	150.	200.	300.	400.	500.	200.	300.	400.
NO. CYCLES/STARTS	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	2/1	2/1	2/1
FLIGHT CREW	0.557	0.441	0.360	0.330	0.296	0.276	0.256	0.246	0.240	0.348	0.305	0.284
FUEL & OIL	0.360	0.261	0.253	0.240	0.231	0.227	0.222	0.218	0.215	0.239	0.231	0.227
HULL INSURANCE	0.360	0.285	0.232	0.213	0.191	0.178	0.165	0.159	0.155	0.214	0.190	0.178
TOTAL FLIGHT OPS	1.277	0.987	0.845	0.783	0.718	0.681	0.643	0.623	0.610	0.801	0.725	0.689
LABOR AIRFRAME	0.495	0.324	0.247	0.214	0.178	0.159	0.140	0.130	0.125	0.213	0.176	0.158
MATERIAL AIRFRAME	0.206	0.126	0.094	0.079	0.064	0.055	0.047	0.043	0.041	0.076	0.061	0.054
LABOR ENGINES	0.330	0.181	0.127	0.101	0.075	0.062	0.048	0.041	0.037	0.092	0.068	0.057
MATERIAL ENGINES	0.585	0.315	0.219	0.172	0.125	0.101	0.078	0.066	0.058	0.153	0.112	0.091
MAT. BURDEN	1.072	0.656	0.486	0.409	0.329	0.287	0.244	0.223	0.211	0.395	0.317	0.279
TOTAL MAINTENANCE	2.687	1.603	1.173	0.975	0.771	0.664	0.557	0.504	0.472	0.928	0.734	0.639
DEPRECIATION	1.043	0.826	0.674	0.618	0.554	0.517	0.479	0.461	0.450	0.622	0.550	0.517
TOTAL DIRECT OPERATING COST												
$/AIRCRAFT-MILE	5.007	3.416	2.691	2.376	2.042	1.861	1.679	1.588	1.532	2.352	2.010	1.844
$/FLIGHT HOUR	872.0	751.1	726.0	698.7	670.1	654.7	636.7	626.2	619.2	687.0	663.7	648.7
$/SEAT MILE	0.1001	0.0683	0.0538	0.0475	0.0408	0.0372	0.0336	0.0318	0.0306	0.0470	0.0402	0.0369
$/SEAT-TRIP	2.50	3.42	4.04	4.75	6.13	7.45	10.08	12.70	15.32	9.41	12.06	14.75

M-75-50

DEPARTURE PATH TO 10,000 FT MSL

MAX PUSH ANGLE=20. OBSTACLE CLEAR ANGLE=6C. OBSTACLE HEIGHT=100. MAX ACCEL ROTATION RATE=20. ACCEL BUILDUP TIME= 5.

TIME SEC	DIST FT	ALT FT	VEL FPS	ACC G	GAM DEG	THRUST LB	LWGO LB	LWGI LB	DWGO LB	DWGI LB	DFUST LB	ALP DEG	THE DEG	AWD DEG	ALV DEG	LAMDA	MU	CT	POWER HP
OBSTACLE CLEARANCE																			
3.1	4.	7.	3.	0.050	60.0	51345.	-0.	-647.	0.	846.	1.	29.3	24.6	-35.4	28.8	0.0853	0.0020	0.0139	7227.
4.0	7.	13.	8.	0.171	60.0	56525.	-4.	-789.	2.	774.	10.	26.5	24.6	-35.4	24.8	0.0929	0.0054	0.0154	8480.
5.0	13.	23.	13.	0.162	60.0	56091.	-11.	-803.	5.	725.	28.	26.7	24.6	-35.4	23.6	0.0966	0.0090	0.0152	8717.
6.2	24.	42.	18.	0.122	60.0	54395.	-21.	-795.	10.	668.	54.	27.6	24.6	-35.4	22.5	0.0996	0.0127	0.0148	8717.
7.9	44.	75.	23.	0.091	60.0	53102.	-35.	-799.	17.	649.	90.	28.3	24.6	-35.4	22.0	0.1020	0.0168	0.0144	8717.
8.5	58.	100.	24.	0.057	60.0	51690.	-52.	-801.	26.	621.	134.	29.1	24.6	-35.4	21.3	0.1048	0.0210	0.0141	8717.
ACCELERATION AND CONVERSION																			
9.5	76.	124.	33.	0.169	52.0	50560.	-93.	-1097.	29.	364.	132.	29.7	24.6	-27.4	21.3	0.1071	0.0266	0.0138	8717.
10.4	103.	147.	40.	0.174	41.1	49959.	-136.	-1480.	30.	239.	99.	40.6	24.6	-16.5	25.8	0.1084	0.0413	0.0136	8717.
11.2	139.	171.	46.	0.176	33.2	50198.	-194.	-1832.	29.	191.	69.	48.6	24.6	-8.6	28.6	0.1078	0.0575	0.0137	8717.
12.1	183.	194.	57.	0.177	27.7	50267.	99.	-2135.	28.	169.	51.	54.0	24.6	-3.1	28.6	0.1075	0.0731	0.0137	8717.
13.0	235.	216.	66.	0.181	23.6	50313.	492.	-2425.	38.	162.	45.	57.7	24.6	1.0	27.4	0.1073	0.0888	0.0137	8717.
13.8	292.	236.	75.	0.190	20.6	50346.	992.	-2736.	60.	164.	49.	60.0	24.6	4.0	25.4	0.1070	0.1044	0.0138	8717.
14.6	357.	259.	84.	0.199	18.2	50243.	1603.	-3075.	93.	172.	65.	62.1	24.6	6.4	23.1	0.1075	0.1220	0.0137	8717.
15.4	433.	281.	94.	0.186	16.3	50056.	2326.	-3457.	137.	185.	92.	63.7	24.6	8.3	21.8	0.1072	0.1356	0.0137	8717.
16.4	524.	305.	104.	0.171	14.7	48696.	3162.	-2571.	192.	128.	130.	64.7	24.6	9.9	17.9	0.1100	0.1499	0.0133	8717.
17.2	618.	326.	113.	0.182	13.4	46845.	4113.	-950.	259.	79.	179.	63.2	24.6	11.1	15.2	0.1140	0.1635	0.0128	8717.
18.1	724.	351.	123.	0.175	12.4	44532.	5178.	865.	337.	78.	239.	62.4	24.6	12.2	12.8	0.1197	0.1765	0.0122	8717.
19.0	843.	375.	133.	0.170	11.4	42012.	6358.	2662.	427.	122.	311.	61.1	24.6	13.1	10.6	0.1265	0.1889	0.0115	8717.
20.0	982.	401.	143.	0.157	10.6	39117.	7653.	4671.	528.	208.	394.	59.8	24.6	13.9	8.7	0.1356	0.2003	0.0107	8717.
21.1	1141.	429.	152.	0.147	9.9	36056.	9063.	6807.	641.	330.	487.	57.8	24.6	14.6	7.1	0.1468	0.2105	0.0099	8717.
22.3	1339.	462.	162.	0.125	9.3	32493.	10586.	9161.	765.	492.	592.	55.9	24.6	15.2	5.6	0.1626	0.2174	0.0089	8717.
23.6	1570.	497.	172.	0.115	8.8	29000.	12223.	11624.	900.	684.	707.	52.3	24.6	15.8	4.3	0.1820	0.2212	0.0080	8717.
25.1	1840.	537.	182.	0.103	8.3	25352.	13972.	14268.	1047.	910.	834.	47.4	24.6	16.3	3.2	0.2034	0.2181	0.0070	8717.
26.9	2168.	582.	192.	0.090	7.9	22601.	15219.	16101.	1120.	1049.	899.	44.0	23.9	16.0	2.4	0.2341	0.2137	0.0062	8717.
28.7	2537.	631.	202.	0.084	7.5	20566.	16227.	17497.	1157.	1133.	935.	40.6	23.0	15.5	1.9	0.2575	0.2101	0.0057	8717.
30.7	2944.	682.	212.	0.080	7.1	18588.	17266.	18968.	1197.	1222.	973.	36.0	22.1	15.0	1.4	0.2857	0.1982	0.0051	8717.
32.6	3374.	733.	222.	0.080	6.8	16752.	18339.	20514.	1239.	1316.	1014.	30.0	21.4	14.6	1.0	0.3187	0.1745	0.0046	8717.
34.5	3806.	783.	232.	0.083	6.5	15254.	19498.	22133.	1288.	1414.	1062.	21.8	20.8	14.2	0.6	0.3522	0.1398	0.0042	8717.
36.3	4248.	831.	242.	0.084	6.3	14033.	20664.	23826.	1337.	1517.	1111.	12.1	20.2	13.9	0.3	0.3856	0.0839	0.0039	8717.
38.2	4714.	880.	249.	0.083	6.1	13378.	21610.	25183.	1378.	1599.	1152.	3.5	19.8	13.7	0.1	0.4059	0.0274	0.0037	8717.
AIRPLANE MODE CLIMB TO 10,000 FT																			
38.2	4714.	880.	252.	0.0	15.9	17032.													
178.1	42600.	10000.	290.	0.0	13.2	14828.													

THE TOTAL NOISE IMPACT IS 0.54242D+06

NOISE AT 500 FT SIDELINE= 95.2 EPNDB

NOISE AT 20,000 FT SIDELINE= 61.1 EPNDB

NOISE 25,000 FT FORWARD OF TAKEOFF POINT= 58.9 EPNDB

NOISE 500 FT FORWARD OF TAKEOFF POINT= 96.4 EPNDB

TILT ROTOR DESIGN PROGRAM 1974

M-85-50

DESIGN ITERATIONS: 5

OVERALL	
GROSS WEIGHT (LB)	41200.
EMPTY WEIGHT (LB)	27410.
FUEL WEIGHT (LB)	3640.
PAYLOAD (LB)	10150.
CRUISE SPEED (MPH)	420.
L/D CRUISE	10.04
*RANGE (STAT MI)	500.
*PASSENGER SEATS	50.
*CARGO (LB)	0.

ROTORS	
*DISC LOADING (PSF)	12.00
RADIUS (FT)	23.4
SOLIDITY	0.143
BLADE CHORD (FT)	2.63
TOTAL BLADES	8
*CT/SIG HOVER	0.120
*PROFILE DRAG COEFF	0.010
% DOWNLOAD	4.9
*EFFICIENCY HOVER	0.87
* CONVER	0.85
CRUISE	0.71
HEL MODE WEIGHT (LB)	3558.
AIRPLANE WEIGHT (LB)	3426.
*TIP SPEED HOVER	620.
* CRUISE	550.
*FUSELAGE CLEARANCE (FT)	2.0
*MAX HEL MODE ADV RATIO	0.40

POWERPLANT	
INST NORMAL PWR (HP)	8602.
*NUMBER OF ENGINES	2.
*EXCESS FACTOR HEL MODE	1.30
*% RATED EMRG HVR	140.
* CONV + CLIMB	120.
* CRUISE	90.
INST PWR EMRG HVR (HP)	8602.
CONVER (HP)	5979.
CRUISE (HP)	7532.
*SFC (LB/HP HR)	0.380

DRIVE SYSTEM	
*EFFICIENCY	0.97
HEL MODE WEIGHT (LB)	3537.
AIRPLANE WEIGHT (LB)	4369.

WING	
AREA (SF)	434.
*LOADING (PSF)	95.0
ASPECT RATIO	7.96
SPAN (FT)	58.8
MEAN CHORD (FT)	7.38
*THICKNESS/CHORD RATIO	0.210
*TAPER RATIO	0.70
SWEEP (DEG)	-5.3
CRUISE LIFT COEFF	0.33
MAX LIFT COEFF CONVER	1.34
*MAX LIFT COEFF CLEAN	1.40
*FLAP AREA/WING AREA	0.25
CLIMB SPD/CONVER SPD	0.99

FUSELAGE	
*LENGTH (FT)	80.0
*DIAMETER (FT)	10.0
*DRAG FACTOR	1.00

FLAT PLATE AREAS (SF)	
WING PROFILE	2.95
FUSELAGE	5.31
EMPENNAGE	1.77
TOTAL PROFILE	12.14
WING INDUCED	2.10

COMPONENT WEIGHTS (LB)	
ROTORS	3558.
DRIVE SYSTEM	4309.
POWERPLANT	1290.
NACELLES	130.
FUEL SYSTEM	278.
WING	3100.
FUSELAGE	5369.
EMPENNAGE	783.
LANDING GEAR	1236.
FLIGHT CONTROLS	1710.
HYDRAULICS	263.
ELECTRICAL	630.
INSTR+AVIONICS	703.
AIR CONDITIONING	1159.
FURNISHINGS	2500.
FLUIDS	206.
FLIGHT CREW	400.
CABIN CREW	150.

STRUCT TECHNOLOGY FACTORS	
*ROTOR	0.95
*TRANSMISSION	0.81
*AIRFRAME	0.76
*ENGINE (HP/LB)	10.00
*ENGINE INSTALLATION	1.50

DESIGN MISSION	
*FIELD ELEVATION (FT)	0.
SOUND SPEED HVR (FPS)	1117.
*STD DAY TEMP (DEG F)	59.
*EMERG HOVER ALT (FT)	2000.
*HOT DAY TEMP (DEG F)	95.
*CT/SIG MAX	0.150
*MAX ACCELERATION (G)	0.25
*DESIGN CRUISE (MPH)	400.
*CRUISE ALTITUDE (FT)	15000.
SOUND SPEED CRSE (FPS)	1058.
*MAX DECELERATION (G)	0.20
*STRUCT LOAD FACTOR	4.5
*FLIGHT CREW	2.
*CABIN CREW	1.
*ATC SPEED LIMIT	YES

* INDICATES INPUT VARIABLE

DESIGN MISSION	SPEED MPH	HEIGHT FT	DIST MI	TIME MIN	FUEL LB
TAKEOFF & LANDING				2.00	75.
ACCEL. & CONV.		900.	0.9	0.65	29.
AIRPLANE CLIMB	167.,207.	14100.	11.4	3.67	166.
ACCEL. TO CRUISE			8.8	1.56	75.
CRUISE	420.		444.7	63.56	2508.
AIRPLANE DESCENT	420.,292.	14100.	33.2	5.89	33.
DECEL. & CONV.		900.	0.9	1.12	8.
TOTAL			500.0	78.45	2893.
RESERVE				20.00	747.

M-85-50

STAGE LENGTH (MI.)	25.	50.	75.	100.	150.	200.	300.	400.	500.
CRUISE ALTITUDE (FT.)	2000.	4000.	10001.	12500.	15000.	15000.	15000.	15000.	15000.
CRUISE SPEED (MPH)	296.	305.	432.	432.	433.	433.	433.	433.	433.
CRUISE L/D	12.13	12.12	8.72	9.22	9.75	9.75	9.75	9.75	9.75
CRUISE DISTANCE (MI.)	17.5	35.9	30.8	49.8	92.6	142.6	242.6	342.6	442.6
BLOCK TIME (MIN.)	8.7	13.7	16.9	20.7	28.0	34.9	48.8	62.7	76.6
BLOCK FUEL (LB.)	247.	362.	519.	654.	947.	1241.	1823.	2396.	2961.
BLOCK SPEED (MPH)	173.	219.	266.	290.	321.	343.	369.	383.	392.

DIRECT OPERATING COST - ANN UTILIZATION(HR)=2000. DEPRECIATION PERIOD(YR)=10. LABOR RATE($/HR)= 7.00
AIRFRAME COST ($/LB)= 80.0 ENGINE COST ($/HP)= 60.0 INSURANCE RATE=0.040 FUEL COST (CENTS/GAL)= 18.0
DOC=1.62+0.0243*SL $/SEAT-TRIP (SL= 25.,500.)
HOP LENGTHS 50+150+ 0+ 0+ 0=200 100+200+ 0+ 0+ 0=300 200+200+ 0+ 0+ 0=400

STAGE LENGTH	25.	50.	75.	100.	150.	200.	300.	400.	500.	200.	300.	400.
NO. CYCLES/STARTS	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	2/1	2/1	2/1
FLIGHT CREW	0.556	0.439	0.361	0.331	0.299	0.280	0.260	0.251	0.245	0.350	0.308	0.288
FUEL & OIL	0.276	0.201	0.192	0.182	0.176	0.173	0.169	0.167	0.165	0.182	0.176	0.173
HULL INSURANCE	0.302	0.238	0.196	0.180	0.162	0.152	0.141	0.136	0.133	0.181	0.161	0.152
TOTAL FLIGHT OPS	1.133	0.879	0.748	0.693	0.637	0.604	0.571	0.554	0.543	0.713	0.644	0.612
LABOR AIRFRAME	0.472	0.309	0.237	0.205	0.172	0.155	0.137	0.128	0.122	0.205	0.170	0.154
MATERIAL AIRFRAME	0.183	0.112	0.083	0.073	0.057	0.050	0.043	0.039	0.037	0.068	0.055	0.049
LABOR ENGINES	0.308	0.169	0.119	0.095	0.071	0.059	0.046	0.040	0.036	0.087	0.065	0.054
MATERIAL ENGINES	0.476	0.256	0.178	0.141	0.103	0.083	0.064	0.054	0.048	0.125	0.091	0.075
MAT. BURDEN	1.014	0.623	0.463	0.391	0.317	0.277	0.238	0.218	0.206	0.379	0.306	0.270
TOTAL MAINTENANCE	2.453	1.470	1.082	0.903	0.720	0.623	0.527	0.479	0.450	0.863	0.687	0.601
DEPRECIATION	0.874	0.691	0.567	0.521	0.470	0.440	0.410	0.395	0.385	0.525	0.467	0.440
TOTAL DIRECT OPERATING COST												
$/AIRCRAFT MILE	4.461	3.039	2.397	2.118	1.826	1.667	1.507	1.427	1.378	2.102	1.799	1.653
$/FLIGHT HOUR	776.6	664.6	638.7	613.7	586.9	572.5	555.9	546.3	540.1	604.4	581.8	567.7
$/SEAT MILE	0.0892	0.0608	0.0479	0.0424	0.0365	0.0333	0.0301	0.0285	0.0276	0.0420	0.0360	0.0331
$/SEAT-TRIP	2.23	3.04	3.60	4.24	5.48	6.67	9.04	11.42	13.78	8.41	10.79	13.23

N-65-5C

DEPARTURE PATH TO 10,000 FT MSL

MAX FUSE ANGLE=20. OBSTACLE CLEAR ANGLE=60. OBSTACLE HEIGHT=100. MAX ACCEL ROTATION RATE=20. ACCEL BUILDUP TIME= 5.

TIME SEC	DIST FT	ALT FT	VEL FPS	ACC G	GAM DEG	THRUST LB	LWGO LB	LWGI LB	DWGO LB	DWGI LB	DFUST LB	ALP DEG	THE DEG	AWO DEG	ALV DEG	LAMDA	MU	CT	POWER HP
OBSTACLE CLEARANCE																			
3.1	4.	7.	3.	0.050	60.0	43719.	-0.	-541.	0.	707.	1.	29.3	24.6-35.4	28.8		0.0852	0.0020	0.0139	5863.
4.0	7.	13.	8.	0.171	60.0	48137.	-3.	-661.	2.	647.	10.	26.5	24.6-35.4	24.7		0.0929	0.0054	0.0154	6880.
5.0	13.	23.	13.	0.159	60.0	47678.	-9.	-667.	5.	600.	28.	26.7	24.6-35.4	23.5		0.0968	0.0090	0.0152	7080.
6.2	24.	42.	18.	0.126	60.0	46457.	-18.	-670.	9.	564.	54.	27.5	24.6-35.4	22.5		0.0994	0.0127	0.0148	7080.
7.9	43.	75.	23.	0.092	60.0	45258.	-30.	-670.	15.	541.	90.	28.3	24.6-35.4	21.9		0.1020	0.0167	0.0145	7080.
8.5	58.	100.	24.	0.057	60.0	44020.	-45.	-669.	22.	518.	134.	29.1	24.6-35.4	21.2		0.1049	0.0210	0.0141	7080.
ACCELERATION AND CONVERSION																			
9.4	76.	123.	33.	0.172	51.9	43069.	-81.	-920.	25.	303.	132.	29.5	24.6-27.4	21.2		0.1072	0.0265	0.0138	7080.
10.3	103.	147.	40.	0.175	41.0	42569.	-162.	-1241.	26.	199.	98.	40.5	24.6-16.4	25.8		0.1084	0.0412	0.0136	7080.
11.2	138.	170.	48.	0.177	33.2	42765.	-170.	-1535.	25.	159.	68.	48.5	24.6 -8.6	28.5		0.1078	0.0574	0.0137	7080.
12.1	182.	193.	57.	0.178	27.6	42814.	87.	-1789.	24.	141.	50.	53.9	24.6 -3.1	28.6		0.1076	0.0731	0.0137	7080.
12.9	233.	215.	66.	0.183	23.6	42842.	431.	-2032.	33.	134.	43.	57.6	24.6 1.0	27.3		0.1074	0.0887	0.0137	7080.
13.7	290.	236.	75.	0.192	20.5	42856.	868.	-2252.	51.	136.	47.	59.9	24.6 4.0	25.3		0.1072	0.1043	0.0138	7080.
14.5	355.	258.	84.	0.191	18.2	42751.	1401.	-2576.	80.	142.	63.	61.9	24.6 6.4	23.0		0.1072	0.1199	0.0137	7080.
15.4	430.	279.	94.	0.187	16.3	42573.	2033.	-2895.	117.	152.	89.	63.6	24.6 8.3	20.7		0.1075	0.1355	0.0137	7080.
16.3	520.	303.	104.	0.172	14.7	41404.	2764.	-2141.	165.	106.	127.	64.5	24.6 9.9	17.9		0.1102	0.1497	0.0133	7080.
17.1	614.	326.	113.	0.182	13.4	39811.	3595.	-773.	222.	66.	175.	63.1	24.6 11.2	15.2		0.1144	0.1633	0.0128	7080.
18.0	721.	349.	123.	0.175	12.3	37840.	4526.	704.	289.	66.	235.	62.2	24.6 12.2	12.7		0.1201	0.1763	0.0122	7080.
18.9	840.	373.	133.	0.170	11.4	35682.	5558.	2269.	365.	103.	306.	60.9	24.6 13.2	10.6		0.1270	0.1886	0.0115	7080.
19.9	979.	399.	143.	0.157	10.6	33212.	6690.	3962.	452.	174.	388.	59.6	24.6 14.0	8.7		0.1361	0.2000	0.0107	7080.
21.0	1139.	427.	153.	0.146	9.9	30593.	7921.	5763.	548.	275.	480.	57.6	24.6 14.7	7.0		0.1475	0.2100	0.0099	7080.
22.2	1339.	460.	162.	0.124	9.3	27550.	9253.	7748.	654.	409.	584.	55.6	24.6 15.3	5.5		0.1635	0.2168	0.0089	7080.
23.6	1572.	496.	172.	0.113	8.8	24568.	10683.	9825.	769.	567.	699.	52.0	24.6 15.8	4.3		0.1832	0.2203	0.0079	7080.
25.1	1847.	536.	182.	0.102	8.3	21461.	12211.	12053.	894.	753.	824.	47.0	24.6 16.3	3.1		0.2100	0.2167	0.0069	7080.
26.9	2180.	582.	192.	0.089	7.9	18267.	13817.	13461.	945.	852.	877.	44.0	23.8 15.9	2.4		0.2341	0.2137	0.0062	7080.
28.8	2557.	632.	202.	0.082	7.5	17535.	14089.	14627.	977.	921.	911.	40.6	22.9 15.4	1.9		0.2575	0.2101	0.0057	7080.
30.7	2974.	684.	212.	0.078	7.1	15852.	14989.	15857.	1010.	993.	947.	36.1	22.0 14.9	1.4		0.2856	0.1985	0.0051	7080.
32.7	3414.	736.	222.	0.078	6.8	14290.	15918.	17148.	1045.	1069.	987.	30.1	21.3 14.5	1.0		0.3185	0.1749	0.0046	7080.
34.6	3855.	787.	232.	0.081	6.5	13016.	16914.	18501.	1086.	1149.	1033.	22.0	20.7 14.1	0.6		0.3518	0.1408	0.0042	7090.
36.5	4304.	836.	241.	0.083	6.3	12059.	17827.	19770.	1124.	1224.	1075.	13.4	20.1 13.8	0.3		0.3822	0.0917	0.0039	7080.
AIRPLANE MODE CLIMB TO 10,000 FT																			
36.5	4304.	836.	244.	0.0		16.3	14916.												
177.3	41292.	10000.	281.	0.0		13.5	12978.												

THE TOTAL NOISE IMPACT IS 0.48394D+06

NOISE AT 500 FT SIDELINE= 94.8 EPNDB

NOISE AT 20,000 FT SIDELINE= 60.4 EPNDB

NOISE 25,000 FT FORWARD OF TAKEOFF POINT= 96.2 EPNDB

NOISE 500 FT FORWARD OF TAKEOFF POINT= 96.1 EPNDB

TILT ROTOR DESIGN PROGRAM 1974

C-75-50

DESIGN ITERATIONS: 4

OVERALL	
GROSS WEIGHT (LB)	52827.
EMPTY WEIGHT (LB)	38029.
FUEL WEIGHT (LB)	4648.
PAYLOAD (LB)	10150.
CRUISE SPEED (MPH)	417.
L/D CRUISE	10.52
*RANGE (STAT MI)	500.
*PASSENGER SEATS	50.
*CARGO (LB)	0.

ROTORS	
*DISC LOADING (PSF)	9.00
RADIUS (FT)	30.6
SOLIDITY	0.179
BLADE CHORD (FT)	2.87
TOTAL BLADES	12
*CT/SIG HOVER	0.120
*PROFILE DRAG COEFF	0.010
% DOWNLOAD	4.5
*EFFICIENCY HOVER	0.83
* CONVER	0.81
CRUISE	0.70
HEL MODE WEIGHT (LB)	6196.
AIRPLANE WEIGHT (LB)	6436.
*TIP SPEED HOVER	480.
* CRUISE	480.
*FUSELAGE CLEARANCE (FT)	2.0
*MAX HEL MODE ADV RATIO	0.40

POWERPLANT	
INST NORMAL PWR (HP)	9906.
*NUMBER OF ENGINES	2.
*EXCESS FACTOR HEL MODE	1.40
*% RATED EMRG HVR	140.
* CONV + CLIMB	120.
* CRUISE	90.
INST PWR EMRG HVR (HP)	9906.
CONVER (HP)	7412.
CRUISE (HP)	8799.
*SFC (LB/HP HR)	0.420

DRIVE SYSTEM	
*EFFICIENCY	0.97
HEL MODE WEIGHT (LB)	6695.
AIRPLANE WEIGHT (LB)	7331.

WING	
AREA (SF)	764.
*LOADING (PSF)	75.0
ASPECT RATIO	7.59
SPAN (FT)	73.1
MEAN CHORD (FT)	9.63
*THICKNESS/CHORD RATIO	0.210
*TAPER RATIO	0.70
SWEEP (DEG)	-5.3
CRUISE LIFT COEFF	0.26
MAX LIFT COEFF CONVER	1.76
*MAX LIFT COEFF CLEAN	1.40
*FLAP AREA/WING AREA	0.25
CLIMB SPD/CONVER SPD	1.22

FUSELAGE	
*LENGTH (FT)	80.0
*DIAMETER (FT)	10.0
*DRAG FACTOR	1.00

FLAT PLATE AREAS (SF)	
WING PROFILE	4.62
FUSELAGE	5.31
EMPENNAGE	2.77
TOTAL PROFILE	15.36
WING INDUCED	2.29

COMPONENT WEIGHTS (LB)	
ROTORS	6436.
DRIVE SYSTEM	7331.
POWERPLANT	2123.
NACELLES	444.
FUEL SYSTEM	423.
WING	4389.
FUSELAGE	5867.
EMPENNAGE	1157.
LANDING GEAR	1585.
FLIGHT CONTROLS	2428.
HYDRAULICS	297.
ELECTRICAL	896.
INSTR+AVIONICS	703.
AIR CONDITIONING	1150.
FURNISHINGS	2500.
FLUIDS	264.
FLIGHT CREW	400.
CABIN CREW	150.

STRUCT TECHNOLOGY FACTORS	
*ROTOR	1.05
*TRANSMISSION	0.85
*AIRFRAME	0.80
*ENGINE (HP/LB)	7.00
*ENGINE INSTALLATION	1.54

DESIGN MISSION	
*FIELD ELEVATION (FT)	0.
SOUND SPEED HVR (FPS)	1117.
*STD DAY TEMP (DEG F)	59.
*EMERG HOVER ALT (FT)	2000.
*HOT DAY TEMP (DEG F)	95.
*CT/SIG MAX	0.150
*MAX ACCELERATION (G)	0.25
*DESIGN CRUISE (MPH)	400.
*CRUISE ALTITUDE (FT)	15000.
SOUND SPEED CRSE (FPS)	1058.
*MAX DECELERATION (G)	0.20
*STRUCT LOAD FACTOR	4.5
*FLIGHT CREW	2.
*CABIN CREW	1.
*ATC SPEED LIMIT	YES

* INDICATES INPUT VARIABLE

DESIGN MISSION	SPEED MPH	HEIGHT FT	DIST MI	TIME MIN	FUEL LB
TAKEOFF & LANDING				2.00	95.
ACCEL. & CONV.		1000.	0.8	0.60	36.
AIRPLANE CLIMB	160.,198.	14000.	11.7	3.94	225.
ACCEL. TO CRUISE			9.8	1.76	106.
CRUISE	417.		442.2	63.65	3185.
AIRPLANE DESCENT	417.,292.	14000.	34.6	6.14	41.
DECEL. & CONV.		1000.	0.8	1.10	10.
TOTAL			500.0	79.19	3698.
RESERVE				20.00	950.

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STAGE LENGTH (MI.)	25.	50.	75.	100.	150.	200.	300.	400.	500.			
CRUISE ALTITUDE (FT.)	2000.	4000.	13001.	12500.	15000.	15000.	15000.	15000.	15000.			
CRUISE SPEED (MPH)	296.	305.	417.	415.	417.	417.	417.	417.	417.			
CRUISE L/D	12.79	12.78	9.43	9.93	10.52	10.52	10.52	10.52	10.52			
CRUISE DISTANCE (MI.)	17.6	35.5	30.8	49.1	91.5	141.5	241.5	341.5	441.5			
BLOCK TIME (MIN.)	8.7	13.8	17.2	21.3	28.8	36.0	50.4	64.8	79.2			
BLOCK FUEL (LB.)	317.	462.	655.	826.	1189.	1555.	2278.	2991.	3694.			
BLOCK SPEED (MPH)	173.	218.	261.	282.	312.	333.	357.	370.	379.			

DIRECT OPERATING COST - ANN UTILIZATION(HR)=2000. DEPRECIATION PERIOD(YR)=10. LABOR RATE($/HR)= 7.00
AIRFRAME COST ($/LB)= 80.0 ENGINE COST ($/HP)= 60.0 INSURANCE RATE=0.040 FUEL COST (CENTS/GAL)= 18.0
DOC=1.84+0.0299*SL $/SEAT-TRIP (SL= 25.,500.)
HOP LENGTHS 50+150+ 0+ 0+ 0=200 100+200+ 0+ 0+ 0=300 200+200+ 0+ 0+ 0=400

STAGE LENGTH	25.	50.	75.	100.	150.	200.	300.	400.	500.	200.	300.	400.
NO. CYCLES/STARTS	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	2/1	2/1	2/1
FLIGHT CREW	0.556	0.441	0.368	0.341	0.308	0.289	0.269	0.260	0.254	0.357	0.317	0.297
FUEL & OIL	0.353	0.257	0.243	0.230	0.220	0.216	0.211	0.208	0.205	0.230	0.221	0.216
HULL INSURANCE	0.401	0.318	0.266	0.246	0.222	0.208	0.194	0.187	0.183	0.246	0.221	0.208
TOTAL FLIGHT CPS	1.310	1.016	0.877	0.816	0.751	0.713	0.675	0.655	0.642	0.833	0.758	0.721
LABOR AIRFRAME	0.518	0.339	0.263	0.229	0.193	0.173	0.153	0.144	0.138	0.227	0.190	0.172
MATERIAL AIRFRAME	0.229	0.141	0.106	0.090	0.073	0.064	0.055	0.051	0.048	0.087	0.070	0.062
LABOR ENGINES	0.322	0.177	0.125	0.100	0.075	0.062	0.049	0.042	0.038	0.091	0.068	0.057
MATERIAL ENGINES	0.548	0.295	0.206	0.163	0.119	0.097	0.075	0.063	0.057	0.144	0.107	0.088
MAT. BURDEN	1.093	0.672	0.505	0.429	0.348	0.305	0.263	0.242	0.229	0.414	0.336	0.298
TOTAL MAINTENANCE	2.710	1.624	1.206	1.011	0.808	0.701	0.595	0.541	0.509	0.963	0.772	0.677
DEPRECIATION	1.155	0.915	0.765	0.707	0.640	0.595	0.559	0.539	0.527	0.708	0.635	0.595
TOTAL DIRECT OPERATING COST												
$/AIRCRAFT MILE	5.176	3.554	2.848	2.534	2.198	2.014	1.828	1.735	1.679	2.504	2.165	1.997
$/FLIGHT HOUR	894.3	775.4	743.1	715.1	685.9	670.5	652.6	642.3	635.6	705.5	680.1	665.0
$/SEAT MILE	0.1035	0.0711	0.0570	0.0507	0.0440	0.0403	0.0366	0.0347	0.0336	0.0501	0.0433	0.0399
$/SEAT-TRIP	2.59	3.55	4.27	5.07	6.59	8.05	10.97	13.88	16.79	10.02	12.99	15.98

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DEPARTURE PATH TO 10,000 FT MSL

MAX FUSE ANGLE=20. OBSTACLE CLEAR ANGLE=60. OBSTACLE HEIGHT=100. MAX ACCEL ROTATION RATE=20. ACCEL BUILDUP TIME= 5.

TIME SEC	DIST FT	ALT FT	VEL FPS	ACC G	GAM DEG	THRUST LB	LWGO LB	LWGI LB	DWGO LB	DWGI LB	DFUST LB	ALP DEG	THE DEG	AWO DEG	ALV DEG	LAMDA	MU	CT	POWER HP
OBSTACLE CLEARANCE																			
3.1	4.	7.	3.	0.050	60.0	56061.	-1.	-762.	0.	914.	1.	29.3	24.6	-35.4	28.7	0.0954	0.0026	0.0174	6737.
4.0	7.	13.	8.	0.171	60.0	61711.	-5.	-854.	3.	822.	10.	26.5	24.6	-35.4	24.5	0.1050	0.0070	0.0192	7994.
4.7	12.	20.	13.	0.220	60.0	64063.	-14.	-912.	7.	801.	28.	25.5	24.6	-35.4	23.2	0.1119	0.0116	0.0199	8764.
5.6	19.	33.	18.	0.178	60.0	62017.	-28.	-929.	14.	705.	55.	26.3	24.6	-35.4	21.0	0.1156	0.0157	0.0193	8764.
6.7	32.	56.	23.	0.136	60.0	60085.	-46.	-923.	23.	673.	90.	27.3	24.6	-35.4	20.3	0.1193	0.0208	0.0187	8764.
8.4	55.	95.	28.	0.093	60.0	58116.	-69.	-920.	34.	641.	135.	28.2	24.6	-35.4	19.6	0.1234	0.0262	0.0181	8764.
8.5	58.	100.	28.	0.055	60.0	56432.	-96.	-930.	47.	622.	188.	29.2	24.6	-35.4	18.9	0.1270	0.0320	0.0176	8764.
ACCELERATION AND CONVERSION																			
9.5	80.	129.	37.	0.157	52.6	54934.	-152.	-1213.	49.	392.	174.	29.6	24.6	-28.1	18.2	0.1305	0.0374	0.0171	8764.
10.4	109.	156.	44.	0.172	42.5	54731.	-284.	-1646.	50.	288.	133.	30.3	24.6	-17.9	22.0	0.1309	0.0570	0.0171	8764.
11.4	150.	185.	52.	0.159	35.0	55022.	-422.	-2054.	52.	235.	98.	47.8	24.6	-10.4	24.0	0.1300	0.0784	0.0172	8764.
12.3	201.	213.	60.	0.169	29.5	55107.	-30.	-2447.	45.	212.	74.	53.1	24.6	-4.9	23.7	0.1296	0.0989	0.0172	8764.
13.3	259.	241.	69.	0.169	25.4	55195.	490.	-2859.	53.	206.	62.	56.5	24.6	-1.8	22.3	0.1291	0.1193	0.0173	8764.
14.2	326.	268.	78.	0.167	22.2	55147.	1147.	-3309.	76.	211.	62.	59.5	24.6	2.3	20.4	0.1290	0.1396	0.0173	8764.
15.1	404.	296.	87.	0.163	19.8	55009.	1947.	-3816.	115.	225.	73.	61.8	24.6	4.8	18.3	0.1289	0.1601	0.0173	8764.
16.1	497.	326.	97.	0.154	17.8	53972.	2893.	-3375.	168.	187.	95.	63.1	24.6	6.8	15.9	0.1310	0.1793	0.0169	8764.
17.0	590.	353.	107.	0.171	16.1	51798.	3987.	-1405.	237.	116.	129.	61.5	24.6	8.5	13.4	0.1361	0.1971	0.0163	8764.
18.1	712.	385.	116.	0.143	14.8	48670.	5230.	851.	320.	109.	174.	62.0	24.6	9.8	11.0	0.1444	0.2130	0.0153	8764.
19.3	849.	418.	126.	0.139	13.6	45559.	6622.	3175.	419.	161.	230.	60.7	24.6	11.0	9.0	0.1538	0.2290	0.0143	8764.
20.5	1010.	454.	136.	0.127	12.6	41994.	8165.	5721.	533.	268.	297.	59.2	24.6	12.0	7.2	0.1664	0.2432	0.0132	8764.
21.8	1201.	494.	145.	0.116	11.7	38107.	9857.	8477.	662.	424.	376.	57.0	24.6	12.8	5.7	0.1829	0.2549	0.0120	8764.
23.3	1428.	538.	155.	0.105	11.0	33954.	11697.	11456.	806.	626.	465.	53.8	24.6	13.6	4.4	0.2049	0.2625	0.0107	8764.
25.0	1698.	587.	165.	0.093	10.3	29573.	13684.	14673.	965.	874.	566.	49.2	24.6	14.3	3.2	0.2353	0.2625	0.0093	8764.
26.8	2011.	641.	175.	0.085	9.7	25175.	15818.	18130.	1138.	1166.	678.	42.3	24.6	14.8	2.2	0.2774	0.2482	0.0080	8764.
28.7	2359.	697.	185.	0.081	9.2	21542.	17776.	21267.	1284.	1430.	774.	33.8	24.3	15.1	1.4	0.3264	0.2172	0.0068	8764.
30.7	2746.	757.	195.	0.077	8.7	19204.	19623.	23217.	1332.	1551.	812.	27.7	23.3	14.6	0.9	0.3684	0.1845	0.0061	8764.
32.7	3142.	815.	204.	0.079	8.3	17418.	20338.	25270.	1393.	1677.	859.	19.0	22.5	14.2	0.5	0.4090	0.1393	0.0055	8764.
34.6	3560.	873.	214.	0.079	7.9	16043.	21801.	27427.	1455.	1810.	908.	8.4	21.8	13.9	0.2	0.4471	0.0676	0.0051	8764.
36.6	4044.	937.	224.	0.071	7.6	15250.	23287.	29540.	1523.	1932.	961.	-3.2	21.2	13.6	0.0	0.4712	-0.0347	0.0049	8764.
39.0	4553.	1003.	232.	0.070	7.3	14755.	23338.	29489.	1451.	1834.	931.	-3.2	21.1	12.7	0.0	0.4871	-0.0273	0.0047	8764.
AIRPLANE MODE CLIMB TO 10,000 FT																			
39.0	4553.	1003.	234.	0.0		15.6	18093.												
188.8	42241.	10000.	269.	0.0		13.0	15780.												

THE TOTAL NOISE IMPACT IS 0.23886D+06

NOISE AT 500 FT SIDELINE= 90.3 EPNDB

NOISE AT 20,000 FT SIDELINE= 57.0 EPNDB

NOISE 25,000 FT FORWARD OF TAKEOFF POINT= 54.9 EPNDB

NOISE 500 FT FORWARD OF TAKEOFF POINT= 91.3 EPNDB

TILT ROTOR DESIGN PROGRAM 1974

Q-85-50

DESIGN ITERATIONS: 5

OVERALL		POWERPLANT		FUSELAGE		STRUCT TECHNOLOGY FACTORS	
GROSS WEIGHT (LB)	44477.	INST NORMAL PWR (HP)	7954.	*LENGTH (FT)	80.0	*ROTOR	0.95
EMPTY WEIGHT (LB)	30853.	*NUMBER OF ENGINES	2.	*DIAMETER (FT)	10.0	*TRANSMISSION	0.81
FUEL WEIGHT (LB)	3474.	*EXCESS FACTOR HEL MODE	1.40	*DRAG FACTOR	1.00	*AIRFRAME	0.76
PAYLOAD (LB)	10150.	*% RATED EMRG HVR	140.			*ENGINE (HP/LB)	10.00
CRUISE SPEED (MPH)	403.	* CONV + CLIMB	120.	FLAT PLATE AREAS (SF)		*ENGINE INSTALLATION	1.54
L/D CRUISE	10.54	* CRUISE	90.	WING PROFILE	3.95		
*RANGE (STAT MI)	500.	INST PWR EMRG HVR (HP)	7954.	FUSELAGE	5.31	DESIGN MISSION	
*PASSENGER SEATS	50.	CONVER (HP)	5951.	EMPENNAGE	2.37	*FIELD ELEVATION (FT)	0.
*CARGO (LB)	0.	CRUISE (HP)	7916.	TOTAL PROFILE	14.06	SOUND SPEED HVR (FPS)	1117.
		*SFC (LB/HP HR)	0.380	WING INDUCED	2.27	*STD DAY TEMP (DEG F)	59.
ROTORS						*EMERG HOVER ALT (FT)	2000.
*DISC LOADING (PSF)	9.00	DRIVE SYSTEM		COMPONENT WEIGHTS (LB)		*HOT DAY TEMP (DEG F)	95.
RADIUS (FT)	26.00	*EFFICIENCY	0.97	ROTORS	4745.	*CT/SIG MAX	0.150
SOLIDITY	0.179	HEL MODE WEIGHT (LB)	4997.	DRIVE SYSTEM	5458.	*MAX ACCELERATION (G)	0.25
BLADE CHORD (FT)	2.63	AIRPLANE WEIGHT (LB)	5458.	POWERPLANT	1193.	*DESIGN CRUISE (MPH)	400.
TOTAL BLADES	12			NACELLES	108.	*CRUISE ALTITUDE (FT)	15000.
*CT/SIG HOVER	0.120	WING		FUEL SYSTEM	257.	SOUND SPEED CRSE (FPS)	1058.
*PROFILE DRAG COEFF	0.010	AREA (SF)	593.	WING	3848.	*MAX DECELERATION (G)	0.20
% DOWNLOAD	4.9	*LOADING (PSF)	75.0	FUSELAGE	5431.	*STRUCT LOAD FACTOR	4.5
*EFFICIENCY HOVER	0.87	ASPECT RATIO	7.82	EMPENNAGE	845.	*FLIGHT CREW	2.
* CONVER	0.85	SPAN (FT)	68.1	LANDING GEAR	1335.	*CABIN CREW	1.
CRUISE	0.71	MEAN CHORD (FT)	8.71	FLIGHT CONTROLS	1905.	*ATC SPEED LIMIT	YES
HEL MODE WEIGHT (LB)	4572.	*THICKNESS/CHORD RATIO	0.210	HYDRAULICS	273.		
AIRPLANE WEIGHT (LB)	4745.	*TAPER RATIO	0.70	ELECTRICAL	703.		
*TIP SPEED HOVER	480.	SWEEP (DEG)	-5.3	INSTR+AVIONICS	703.		
* CRUISE	480.	CRUISE LIFT COEFF	0.29	AIR CONDITIONING	1150.		
*FUSELAGE CLEARNCE (FT)	2.0	MAX LIFT COEFF CONVER	1.76	FURNISHINGS	2500.		
*MAX HEL MODE ADV RATIO	0.40	*MAX LIFT COEFF CLEAN	1.40	FLUIDS	222.		
		*FLAP AREA/WING AREA	0.25	FLIGHT CREW	400.		
* INDICATES INPUT VARIABLE		CLIMB SPD/CONVER SPD	1.19	CABIN CREW	150.		

DESIGN MISSION	SPEED MPH	HEIGHT FT	DIST MI	TIME MIN	FUEL LB
TAKEOFF & LANDING				2.00	69.
ACCEL. & CONV.		1000.	0.8	0.62	27.
AIRPLANE CLIMB	155.,193.	14000.	11.4	3.94	163.
ACCEL. TO CRUISE			8.9	1.64	72.
CRUISE	403.		444.9	66.33	2417.
AIRPLANE DESCENT	402.,292.	14000.	33.2	5.94	29.
DECEL. & CONV.		1000.	0.8	1.14	7.
TOTAL			500.0	81.60	2784.
RESERVE				20.00	690.

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STAGE LENGTH (MI.)	25.	50.	75.	100.	150.	200.	300.	400.	500.
CRUISE ALTITUDE (FT.)	2000.	4000.	10001.	12500.	15000.	15000.	15000.	15000.	15000.
CRUISE SPEED (MPH)	296.	305.	398.	400.	402.	402.	402.	402.	402.
CRUISE L/D	12.04	12.04	9.34	9.93	10.53	10.53	10.53	10.53	10.53
CRUISE DISTANCE (MI.)	17.7	36.0	34.7	52.3	94.2	144.2	244.2	344.2	444.2
BLOCK TIME (MIN.)	8.7	13.8	17.5	21.6	29.4	36.9	51.8	66.7	81.6
BLOCK FUEL (LB.)	242.	354.	493.	618.	891.	1166.	1711.	2250.	2781.
BLOCK SPEED (MPH)	172.	217.	257.	277.	306.	325.	347.	360.	368.

DIRECT OPERATING COST - ANN UTILIZATION(HR)=2000. DEPRECIATION PERIOD(YR)=10. LABOR RATE($/HR)= 7.00
AIRFRAME COST ($/LB)= 80.0 ENGINE COST ($/HP)= 60.0 INSURANCE RATE=0.040 FUEL COST (CENTS/GAL)= 18.0
DOC=1.62+0.0267*SL $/SEAT-TRIP (SL= 25.,500.)
HOP LENGTHS 50+150+ 0+ 0+ 0=200 100+200+ 0+ 0+ 0=300 200+200+ 0+ 0+ 0=400

STAGE LENGTH	25.	50.	75.	100.	150.	200.	300.	400.	500.	200.	300.	400.
NO. CYCLES/STARTS	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	2/1	2/1	2/1
FLIGHT CREW	0.555	0.438	0.371	0.343	0.311	0.293	0.274	0.265	0.259	0.359	0.320	0.301
FUEL & OIL	0.268	0.197	0.183	0.172	0.165	0.162	0.159	0.156	0.155	0.173	0.166	0.162
HULL INSURANCE	0.332	0.263	0.222	0.205	0.186	0.175	0.164	0.158	0.155	0.206	0.185	0.175
TOTAL FLIGHT CPS	1.155	0.898	0.775	0.721	0.663	0.630	0.597	0.579	0.569	0.738	0.671	0.638
LABOR AIRFRAME	0.492	0.322	0.252	0.220	0.186	0.167	0.149	0.140	0.134	0.218	0.183	0.166
MATERIAL AIRFRAME	0.200	0.123	0.093	0.079	0.064	0.057	0.049	0.045	0.043	0.076	0.062	0.055
LABOR ENGINES	0.301	0.166	0.118	0.095	0.071	0.059	0.047	0.041	0.037	0.086	0.065	0.055
MATERIAL ENGINES	0.440	0.237	0.166	0.132	0.096	0.079	0.061	0.052	0.046	0.117	0.086	0.071
MAT. BURDEN	1.031	0.635	0.481	0.409	0.334	0.294	0.254	0.235	0.223	0.395	0.323	0.287
TOTAL MAINTENANCE	2.464	1.483	1.110	0.934	0.751	0.656	0.560	0.512	0.483	0.891	0.720	0.634
DEPRECIATION	0.956	0.755	0.638	0.591	0.536	0.504	0.472	0.456	0.446	0.591	0.533	0.504
TOTAL DIRECT OPERATING COST												
$/AIRCRAFT MILE	4.574	3.136	2.524	2.245	1.951	1.790	1.628	1.547	1.498	2.220	1.924	1.776
$/FLIGHT HOUR	784.6	680.7	648.2	623.0	596.3	582.0	565.7	556.5	550.5	615.8	591.7	577.7
$/SEAT MILE	0.0515	0.0627	0.0505	0.0449	0.0390	0.0358	0.0326	0.0309	0.0300	0.0444	0.0385	0.0355
$/SEAT-TRIP	2.29	3.14	3.79	4.49	5.85	7.16	9.77	12.38	14.98	8.88	11.54	14.21

C-85-5C

DEPARTURE PATH TO 10,000 FT MSL

MAX FUSE ANGLE=20. OBSTACLE CLEAR ANGLE=60. OBSTACLE HEIGHT=1[illegible]0. MAX ACCEL ROTATION RATE=20. ACCEL BUILDUP TIME= 5.

TIME SEC	DIST FT	ALT FT	VEL FPS	ACC G	GAM DEG	THRUST LB	LWGO LB	LWGI LB	DWGO LB	DWGI LB	DFUST LB	ALP DEG	THE DEG	AWO DEG	ALV DEG	LAMDA	MU	CT	POWER HP
OBSTACLE CLEARANCE																			
3.1	4.	7.	3.	0.050	60.0	47187.	-0.	-581.	0.	757.	1.	29.3	24.6	-35.4	28.7	0.0953	0.0026	0.0174	5403.
4.0	7.	13.	8.	0.171	60.0	51947.	-4.	-707.	2.	681.	10.	26.5	24.6	-35.4	24.5	0.1049	0.0070	0.0192	6411.
4.7	12.	20.	13.	0.221	60.0	53969.	-12.	-756.	6.	664.	28.	25.4	24.6	-35.4	23.2	0.1120	0.0116	0.0200	7037.
5.6	19.	33.	18.	0.179	60.0	52245.	-24.	-770.	12.	584.	54.	26.3	24.6	-35.4	20.9	0.1157	0.0157	0.0193	7037.
6.7	32.	55.	23.	0.137	60.0	50617.	-39.	-766.	20.	557.	90.	27.2	24.6	-35.4	20.3	0.1194	0.0208	0.0187	7037.
8.4	55.	95.	28.	0.094	60.0	48958.	-59.	-762.	29.	531.	134.	28.2	24.6	-35.4	19.5	0.1234	0.0262	0.0181	7037.
8.5	58.	100.	28.	0.056	60.0	47539.	-82.	-771.	41.	515.	187.	29.2	24.6	-35.4	18.8	0.1271	0.0320	0.0176	7037.
ACCELERATION AND CONVERSION																			
9.5	80.	130.	37.	0.154	52.7	46269.	-130.	-1005.	42.	325.	173.	29.7	24.6	-28.1	18.2	0.1306	0.0374	0.0172	7037.
10.4	110.	156.	44.	0.171	42.5	46087.	-244.	-1362.	43.	239.	132.	39.2	24.6	-17.9	22.0	0.1310	0.0570	0.0171	7037.
11.4	151.	186.	52.	0.158	35.0	46332.	-370.	-1701.	45.	194.	97.	47.8	24.6	-10.4	24.0	0.1301	0.0784	0.0172	7037.
12.4	202.	214.	60.	0.159	29.5	46393.	-32.	-2026.	39.	174.	73.	53.1	24.6	-4.9	23.7	0.1297	0.0988	0.0172	7037.
13.3	260.	242.	69.	0.169	25.4	46456.	416.	-2368.	46.	169.	60.	56.4	24.6	-0.9	22.3	0.1293	0.1192	0.0173	7037.
14.2	327.	269.	78.	0.167	22.3	46397.	982.	-2740.	65.	173.	59.	59.4	24.6	2.3	20.4	0.1292	0.1395	0.0173	7037.
15.2	405.	297.	87.	0.163	19.8	46260.	1672.	-3160.	97.	184.	69.	61.7	24.6	4.8	18.3	0.1292	0.1599	0.0172	7037.
16.2	498.	327.	97.	0.154	17.8	45389.	2487.	-2814.	142.	154.	91.	63.0	24.6	6.8	15.9	0.1313	0.1792	0.0169	7037.
17.1	591.	354.	107.	0.171	16.2	43553.	3431.	-1169.	200.	96.	123.	61.4	24.6	8.4	13.4	0.1364	0.1969	0.0163	7037.
18.2	713.	387.	116.	0.143	14.8	40921.	4503.	705.	270.	91.	167.	61.9	24.6	9.8	10.9	0.1448	0.2128	0.0153	7037.
19.3	851.	420.	126.	0.138	13.6	38291.	5704.	2643.	354.	134.	222.	60.6	24.6	11.0	8.9	0.1542	0.2288	0.0143	7037.
20.5	1013.	456.	136.	0.126	12.6	35283.	7035.	4765.	449.	220.	288.	59.0	24.6	12.0	7.2	0.1669	0.2429	0.0132	7037.
21.9	1206.	496.	145.	0.114	11.8	32004.	8494.	7061.	558.	347.	365.	56.8	24.6	12.8	5.7	0.1835	0.2545	0.0120	7037.
23.4	1435.	541.	155.	0.103	11.0	28501.	10082.	9543.	680.	512.	453.	53.6	24.6	13.6	4.3	0.2057	0.2618	0.0107	7037.
25.1	1709.	591.	165.	0.092	10.3	24809.	11796.	12224.	814.	714.	552.	49.0	24.6	14.2	3.2	0.2364	0.2615	0.0093	7037.
26.9	2028.	646.	175.	0.084	9.8	21105.	13637.	15106.	960.	952.	662.	41.9	24.6	14.8	2.2	0.2789	0.2466	0.0079	7037.
28.9	2393.	705.	185.	0.077	9.2	18063.	15230.	17600.	1071.	1154.	748.	34.2	24.2	14.9	1.4	0.3282	0.2145	0.0068	7037.
31.0	2788.	766.	195.	0.076	8.8	16190.	16321.	19211.	1114.	1250.	786.	27.8	23.2	14.5	0.9	0.3682	0.1849	0.0061	7037.
33.0	3191.	825.	204.	0.078	8.3	14690.	17491.	20909.	1165.	1352.	831.	19.1	22.4	14.1	0.6	0.4086	0.1494	0.0056	7037.
35.0	3614.	884.	214.	0.078	7.9	13526.	18701.	22692.	1217.	1459.	877.	8.6	21.7	13.8	0.2	0.4469	0.0694	0.0051	7037.
37.1	4096.	949.	224.	0.071	7.6	12867.	19882.	24429.	1269.	1564.	924.	-2.7	21.1	13.5	-0.0	0.4738	-0.0186	0.0049	7037.
AIRPLANE MODE CLIMB TO 10,000 FT																			
37.1	4096.	949.	228.	0.0	16.0	15645.													
188.0	40988.	10000.	261.	0.0	13.4	13634.													

THE TOTAL NOISE IMPACT IS 0.2010D+06

NOISE AT 500 FT SIDELINE= 89.8 EPNDB

NOISE AT 20,000 FT SIDELINE= 56.2 EPNDB

NOISE 25,000 FT FORWARD OF TAKEOFF POINT= 54.2 EPNDB

NOISE 500 FT FORWARD OF TAKEOFF POINT= 90.8 EPNDB

TILT ROTOR DESIGN PROGRAM 1974

D-75-50

DESIGN ITERATIONS: 5

OVERALL		POWERPLANT		FUSELAGE		STRUCT TECHNOLOGY FACTORS	
GROSS WEIGHT (LB)	57227.	INST NORMAL PWR (HP)	9404.	*LENGTH (FT)	80.0	*ROTOR	1.05
EMPTY WEIGHT (LB)	42449.	*NUMBER OF ENGINES	2.	*DIAMETER (FT)	10.0	*TRANSMISSION	0.85
FUEL WEIGHT (LB)	4628.	*EXCESS FACTOR HEL MODE	1.50	*DRAG FACTOR	1.00	*AIRFRAME	0.80
PAYLOAD (LB)	10150.	*% RATED EMRG HVR	140.			*ENGINE (HP/LB)	7.00
CRUISE SPEED (MPH)	360.	* CONV + CLIMB	120.	FLAT PLATE AREAS (SF)		*ENGINE INSTALLATION	1.60
L/D CRUISE	12.58	* CRUISE	90.	WING PROFILE	6.07		
*RANGE (STAT MI)	500.	INST PWR EMRG HVR (HP)	9404.	FUSELAGE	5.43	DESIGN MISSION	
*PASSENGER SEATS	50.	CONVER (HP)	7576.	EMPENNAGE	3.60	*FIELD ELEVATION (FT)	0.
*CARGO (LB)	0.	CRUISE (HP)	8304.	TOTAL PROFILE	18.18	SOUND SPEED HVR (FPS)	1117.
		*SFC (LB/HP HR)	0.420	WING INDUCED	3.85	*STD DAY TEMP (DEG F)	59.
ROTORS						*EMERG HOVER ALT (FT)	2000.
*DISC LOADING (PSF)	7.00	DRIVE SYSTEM		COMPONENT WEIGHTS (LB)		*HOT DAY TEMP (DEG F)	95.
RADIUS (FT)	36.1	*EFFICIENCY	0.97	ROTORS	7704.	*CT/SIG MAX	0.150
SOLIDITY	0.200	HEL MODE WEIGHT (LB)	8958.	DRIVE SYSTEM	9193.	*MAX ACCELERATION (G)	0.25
BLADE CHORD (FT)	2.83	AIRPLANE WEIGHT (LB)	9193.	POWERPLANT	2015.	*DESIGN CRUISE (MPH)	340.
TOTAL BLADES	16			NACELLES	393.	*CRUISE ALTITUDE (FT)	15000.
*CT/SIG HOVER	0.120	WING		FUEL SYSTEM	420.	SOUND SPEED CRSE (FPS)	1058.
*PROFILE DRAG COEFF	0.010	AREA (SF)	908.	WING	5143.	*MAX DECELERATION (G)	0.20
% DOWNLOAD	4.7	*LOADING (PSF)	63.0	FUSELAGE	5937.	*STRUCT LOAD FACTOR	4.5
*EFFICIENCY HOVER	0.83	ASPECT RATIO	7.79	EMPENNAGE	1144.	*FLIGHT CREW	2.
* CONVER	0.81	SPAN (FT)	84.1	LANDING GEAR	1717.	*CABIN CREW	1.
CRUISE	0.64	MEAN CHORD (FT)	10.80	FLIGHT CONTROLS	2717.	*ATC SPEED LIMIT	YES
HEL MODE WEIGHT (LB)	7621.	*THICKNESS/CHORD RATIO	0.210	HYDRAULICS	310.		
AIRPLANE WEIGHT (LB)	7704.	*TAPER RATIO	0.70	ELECTRICAL	1004.		
*TIP SPEED HOVER	400.	SWEEP (DEG)	-5.3	INSTR+AVIONICS	703.		
* CRUISE	400.	CRUISE LIFT COEFF	0.31	AIR CONDITIONING	1150.		
*FUSELAGE CLEARNCE (FT)	2.0	MAX LIFT COEFF CONVER	2.16	FURNISHINGS	2500.		
*MAX HEL MODE ADV RATIO	0.40	*MAX LIFT COEFF CLEAN	1.40	FLUIDS	286.		
		*FLAP AREA/WING AREA	0.25	FLIGHT CREW	400.		
* INDICATES INPUT VARIABLE		CLIMB SPD/CONVER SPD	1.37	CABIN CREW	150.		

DESIGN MISSION	SPEED MPH	HEIGHT FT	DIST MI	TIME MIN	FUEL LB
TAKEOFF & LANDING				2.00	90.
ACCEL. & CONV.		1400.	1.0	0.80	49.
AIRPLANE CLIMB	150.,184.	13600.	12.3	4.43	237.
ACCEL. TO CRUISE			6.4	1.31	75.
CRUISE	360.		443.4	73.90	3225.
AIRPLANE DESCENT	360.,292.	13600.	35.9	6.66	41.
DECEL. & CONV.		1400.	1.0	1.34	11.
TOTAL			500.0	90.44	3728.
RESERVE				20.00	901.

D-75-50

STAGE LENGTH (MI.)	25.	50.	75.	100.	150.	200.	300.	400.	500.
CRUISE ALTITUDE (FT.)	2000.	4000.	10001.	12500.	15000.	15000.	15000.	15000.	15000.
CRUISE SPEED (MPH)	296.	305.	359.	359.	360.	360.	360.	360.	360.
CRUISE L/D	12.36	12.36	11.11	11.80	12.58	12.58	12.58	12.58	12.58
CRUISE DISTANCE (MI.)	17.9	35.8	36.6	53.4	93.4	143.4	243.4	343.4	443.4
BLOCK TIME (MIN.)	9.1	14.2	18.7	23.3	32.1	40.4	57.1	73.8	90.4
BLOCK FUEL (LB.)	352.	520.	677.	843.	1198.	1566.	2296.	3017.	3728.
BLOCK SPEED (MPH)	166.	211.	241.	257.	280.	297.	315.	325.	332.

DIRECT OPERATING COST - ANN UTILIZATION(HR)=2000. DEPRECIATION PERIOD(YR)=10. LABOR RATE($/HR)= 7.00
AIRFRAME COST ($/LB)= 80.0 ENGINE COST ($/HP)= 60.0 INSURANCE RATE=0.040 FUEL COST (CENTS/GAL)= 18.0
DOC=1.87+0.0354*SL $/SEAT-TRIP (SL= 25.,500.)
HOP LENGTHS 50+150+ 0+ 0+ 0=200 100+200+ 0+ 0+ 0=300 200+200+ 0+ 0+ 0=400

STAGE LENGTH	25.	50.	75.	100.	150.	200.	300.	400.	500.	200.	300.	400.
NO. CYCLES/STARTS	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	2/1	2/1	2/1
FLIGHT CREW	0.570	0.446	0.392	0.367	0.337	0.318	0.299	0.290	0.284	0.380	0.345	0.326
FUEL & OIL	0.391	0.289	0.251	0.234	0.222	0.218	0.213	0.210	0.207	0.239	0.223	0.218
HULL INSURANCE	0.459	0.359	0.316	0.295	0.271	0.256	0.241	0.234	0.229	0.293	0.269	0.256
TOTAL FLIGHT OPS	1.419	1.094	0.959	0.896	0.830	0.792	0.753	0.733	0.721	0.912	0.837	0.800
LABOR AIRFRAME	0.550	0.359	0.288	0.254	0.218	0.197	0.177	0.167	0.161	0.251	0.215	0.196
MATERIAL AIRFRAME	0.255	0.156	0.121	0.104	0.086	0.076	0.066	0.062	0.059	0.100	0.083	0.074
LABOR ENGINES	0.319	0.176	0.126	0.102	0.077	0.064	0.052	0.045	0.041	0.092	0.071	0.060
MATERIAL ENGINES	0.523	0.282	0.200	0.159	0.118	0.096	0.075	0.065	0.058	0.141	0.105	0.087
MAT. BURDEN	1.130	0.695	0.539	0.463	0.383	0.340	0.297	0.276	0.263	0.446	0.371	0.332
TOTAL MAINTENANCE	2.776	1.667	1.275	1.082	0.881	0.774	0.667	0.614	0.582	1.029	0.845	0.750
DEPRECIATION	1.313	1.028	0.903	0.845	0.776	0.733	0.690	0.668	0.655	0.839	0.770	0.733
TOTAL DIRECT OPERATING COST												
$/AIRCRAFT MILE	5.508	3.790	3.137	2.823	2.486	2.299	2.110	2.015	1.958	2.780	2.452	2.282
$/FLIGHT HOUR	912.3	801.4	755.1	726.6	696.9	682.0	665.1	655.6	649.5	720.5	692.2	677.2
$/SEAT MILE	0.1102	0.0758	0.0627	0.0565	0.0497	0.0460	0.0422	0.0403	0.0392	0.0556	0.0490	0.0456
$/SEAT-TRIP	2.75	3.79	4.71	5.65	7.46	9.19	12.66	16.12	19.58	11.12	14.71	18.26

D-75-5C

DEPARTURE PATH TO 10,000 FT MSL

MAX FUSE ANGLE=20. OBSTACLE CLEAR ANGLE=6C. OBSTACLE HEIGHT=1CC. MAX ACCEL ROTATION RATE=2C. ACCEL BUILDUP TIME= 5.

TIME SEC	DIST FT	ALT FT	VEL FPS	ACC G	GAM DEG	THRUST LB	LWGO LB	LWGI LB	DWGO LB	DWGI LB	DFUST LB	ALP DEG	THE DEG	AWO DEG	ALV DEG	LAMDA	MU	CT	POWER HP
OBSTACLE CLEARANCE																			
3.1	4.	7.	3.	0.050	60.0	60675.	-1.	-724.	0.	936.	1.	29.3	24.6	-35.4	28.6	0.1014	0.0031	0.0195	6412.
4.0	7.	13.	8.	0.171	60.0	66798.	-6.	-885.	3.	836.	10.	26.4	24.6	-35.4	24.2	0.1121	0.0084	0.0215	7653.
4.7	12.	20.	13.	0.227	60.0	69658.	-18.	-978.	9.	782.	28.	25.3	24.6	-35.4	21.8	0.1202	0.0134	0.0224	8469.
5.4	18.	30.	18.	0.229	60.0	69785.	-35.	-1014.	17.	741.	55.	25.3	24.6	-35.4	20.4	0.1267	0.0187	0.0225	8906.
6.3	28.	48.	23.	0.174	60.0	66993.	-57.	-1008.	28.	671.	91.	26.4	24.6	-35.4	18.8	0.1320	0.0240	0.0216	8906.
7.5	44.	77.	28.	0.128	60.0	64705.	-85.	-1011.	42.	649.	136.	27.4	24.6	-35.4	18.1	0.1367	0.0306	0.0209	8906.
7.9	58.	100.	29.	0.084	60.0	62546.	-119.	-1026.	59.	630.	189.	28.5	24.6	-35.4	17.3	0.1414	0.0374	0.0202	8906.
ACCELERATION AND CONVERSION																			
9.7	95.	154.	38.	0.090	55.3	60566.	-191.	-1234.	71.	483.	216.	31.1	24.6	-30.7	17.5	0.1459	0.0488	0.0195	8906.
11.0	138.	199.	46.	0.116	46.6	58987.	-350.	-1634.	78.	364.	197.	38.0	24.6	-22.0	18.5	0.1497	0.0695	0.0191	8906.
12.4	197.	247.	53.	0.110	38.8	59437.	-578.	-2098.	82.	296.	151.	46.5	24.6	-14.2	20.4	0.1483	0.0956	0.0192	8906.
13.9	272.	295.	62.	0.107	33.0	59819.	-495.	-2583.	77.	265.	118.	52.6	24.6	-8.4	20.2	0.1471	0.1216	0.0194	8906.
15.2	351.	338.	70.	0.121	28.5	59951.	106.	-3115.	72.	256.	96.	56.1	24.6	-3.9	18.8	0.1464	0.1447	0.0195	8906.
16.4	443.	382.	79.	0.121	25.1	59946.	868.	-3705.	87.	261.	86.	59.2	24.6	-0.5	17.1	0.1460	0.1691	0.0195	8906.
17.8	551.	426.	88.	0.118	22.3	59849.	1801.	-4375.	120.	277.	88.	61.8	24.6	2.3	15.2	0.1457	0.1938	0.0195	8906.
19.2	681.	473.	98.	0.110	20.1	59348.	2911.	-3525.	171.	220.	101.	63.0	24.6	4.5	13.0	0.1489	0.2164	0.0190	8906.
20.5	818.	519.	107.	0.115	18.3	55420.	4200.	-1104.	240.	154.	126.	62.2	24.6	6.3	10.7	0.1562	0.2371	0.0191	8906.
21.9	976.	566.	117.	0.110	16.7	51988.	5672.	1532.	328.	161.	162.	61.3	24.6	7.9	8.3	0.1659	0.2569	0.0170	8906.
23.4	1154.	615.	126.	0.106	15.4	48149.	7326.	4406.	434.	234.	209.	59.3	24.6	9.2	7.0	0.1784	0.2752	0.0158	8906.
25.0	1369.	670.	136.	0.095	14.3	43783.	9164.	7562.	558.	368.	268.	58.0	24.6	10.3	5.6	0.1955	0.2912	0.0143	8906.
27.1	1661.	739.	146.	0.075	13.3	39822.	11184.	11042.	701.	564.	338.	55.8	24.6	11.3	4.2	0.2200	0.3023	0.0127	8906.
29.4	2009.	816.	155.	0.068	12.5	33807.	13381.	14764.	861.	810.	419.	51.5	24.6	12.1	3.1	0.2524	0.3167	0.0111	8906.
32.0	2426.	902.	165.	0.060	11.7	28667.	15756.	18799.	1039.	1110.	511.	45.1	24.6	12.9	2.1	0.2991	0.2959	0.0094	8906.
34.6	2877.	990.	175.	0.059	11.1	23693.	18304.	23140.	1234.	1461.	614.	34.8	24.6	13.5	1.3	0.3647	0.2542	0.0078	8906.
37.1	3322.	1072.	185.	0.063	10.5	19841.	21027.	27779.	1447.	1859.	728.	18.3	24.6	14.1	0.6	0.4428	0.1532	0.0066	8906.
39.5	3796.	1155.	195.	0.063	9.9	18160.	22627.	30352.	1518.	2015.	776.	8.1	23.7	13.8	0.2	0.4874	0.0711	0.0060	8906.
42.4	4367.	1250.	204.	0.055	9.4	17217.	24343.	32884.	1598.	2159.	830.	-3.9	22.9	13.5	0.0	0.5148	-0.0442	0.0057	8906.
45.2	4978.	1347.	214.	0.054	9.0	16432.	24418.	32809.	1494.	2007.	801.	-3.8	21.3	12.3	0.0	0.5397	-0.0360	0.0055	8906.
48.2	5612.	1445.	219.	0.053	8.8	16067.	24451.	32776.	1448.	1941.	791.	-3.7	20.6	11.8	0.0	0.5521	-0.0360	0.0054	8906.
AIRPLANE MODE CLIMB TO 10,000 FT																			
48.2	5612.	1445.	220.	0.0	14.3	18105.													
213.2	44360.	10000.	250.	0.0	12.0	15894.													

THE TOTAL NOISE IMPACT IS 0.11503D+06

NOISE AT 500 FT SIDELINE= 87.1 EPNDB

NOISE AT 20,000 FT SIDELINE= 54.8 EPNDB

NOISE 25,000 FT FORWARD OF TAKEOFF POINT= 52.9 EPNDB

NOISE 500 FT FORWARD OF TAKEOFF POINT= 87.8 EPNDB

TILT ROTOR DESIGN PROGRAM 1974

D-85-50

DESIGN ITERATIONS: 5

OVERALL		POWERPLANT		FUSELAGE		STRUCT TECHNOLOGY FACTORS	
GROSS WEIGHT (LB)	47902.	INST NORMAL PWR (HP)	7508.	*LENGTH (FT)	80.0	*ROTOR	0.95
EMPTY WEIGHT (LB)	34276.	*NUMBER OF ENGINES	2.	*DIAMETER (FT)	10.0	*TRANSMISSION	0.81
FUEL WEIGHT (LB)	3474.	*EXCESS FACTOR HEL MODE	1.50	*DRAG FACTOR	1.00	*AIRFRAME	0.76
PAYLOAD (LB)	10150.	*% RATED EMRG HVR	140.			*ENGINE (HP/LB)	10.00
CRUISE SPEED (MPH)	342.	* CONV + CLIMB	120.	FLAT PLATE AREAS (SF)		*ENGINE INSTALLATION	1.60
L/D CRUISE	12.46	* CRUISE	90.	WING PROFILE	5.10		
*RANGE (STAT MI)	500.	INST PWR EMRG HVR (HP)	7508.	FUSELAGE	5.43	DESIGN MISSION	
*PASSENGER SEATS	50.	CONVER (HP)	6049.	EMPENNAGE	3.06	*FIELD ELEVATION (FT)	0.
*CARGO (LB)	0.	CRUISE (HP)	7351.	TOTAL PROFILE	16.44	SOUND SPEED HVR (FPS)	1117.
		*SFC (LB/HP HR)	0.380	WING INDUCED	3.66	*STD DAY TEMP (DEG F)	59.
ROTORS						*EMERG HOVER ALT (FT)	2000.
*DISC LOADING (PSF)	7.00	DRIVE SYSTEM		COMPONENT WEIGHTS (LB)		*HOT DAY TEMP (DEG F)	95.
RADIUS (FT)	33.0	*EFFICIENCY	0.97	ROTORS	5647.	*CT/SIG MAX	0.150
SOLIDITY	0.200	HEL MODE WEIGHT (LB)	6641.	DRIVE SYSTEM	6801.	*MAX ACCELERATION (G)	0.25
BLADE CHORD (FT)	3.46	AIRPLANE WEIGHT (LB)	6801.	POWERPLANT	1126.	*DESIGN CRUISE (MPH)	340.
TOTAL BLADES	12			NACELLES	94.	*CRUISE ALTITUDE (FT)	15000.
*CT/SIG HOVER	0.120	WING		FUEL SYSTEM	257.	SOUND SPEED CRSE (FPS)	1058.
*PROFILE DRAG COEFF	0.010	AREA (SF)	760.	WING	4582.	*MAX DECELERATION (G)	0.20
% DOWNLOAD	4.6	*LOADING (PSF)	63.0	FUSELAGE	5492.	*STRUCT LOAD FACTOR	4.5
*EFFICIENCY HOVER	0.87	ASPECT RATIO	8.00	EMPENNAGE	910.	*FLIGHT CREW	2.
* CONVER	0.85	SPAN (FT)	78.0	LANDING GEAR	1437.	*CABIN CREW	1.
CRUISE	0.64	MEAN CHORD (FT)	9.75	FLIGHT CONTROLS	2115.	*ATC SPEED LIMIT	YES
HEL MODE WEIGHT (LB)	5590.	*THICKNESS/CHORD RATIO	0.210	HYDRAULICS	283.		
AIRPLANE WEIGHT (LB)	5647.	*TAPER RATIO	0.70	ELECTRICAL	780.		
*TIP SPEED HOVER	400.	SWEEP (DEG)	-5.3	INSTR+AVIONICS	703.		
* CRUISE	400.	CRUISE LIFT COEFF	0.33	AIR CONDITIONING	1150.		
*FUSELAGE CLEARNCE (FT)	2.0	MAX LIFT COEFF CONVER	2.16	FURNISHINGS	2500.		
*MAX HEL MODE ADV RATIO	0.40	*MAX LIFT COEFF CLEAN	1.40	FLUIDS	240.		
		*FLAP AREA/WING AREA	0.25	FLIGHT CREW	400.		
*. INDICATES INPUT VARIABLE		CLIMB SPD/CONVER SPD	1.34	CABIN CREW	150.		

DESIGN MISSION	SPEED MPH	HEIGHT FT	DIST MI	TIME MIN	FUEL LB
TAKEOFF & LANDING				2.00	65.
ACCEL. & CONV.		1400.	1.0	0.82	36.
AIRPLANE CLIMB	146.,180.	13600.	12.0	4.44	171.
ACCEL. TO CRUISE			5.2	1.13	46.
CRUISE	342.		445.5	78.09	2466.
AIRPLANE DESCENT	342.,277.	13600.	35.3	6.87	31.
DECEL. & CONV.		1400.	1.0	1.32	8.
TOTAL			500.0	94.68	2824.
RESERVE				20.00	651.

D-85-50

STAGE LENGTH (MI.)	25.	50.	75.	100.	150.	200.	300.	400.	500.
CRUISE ALTITUDE (FT.)	2000.	4000.	10001.	12500.	15000.	15000.	15000.	15000.	15000.
CRUISE SPEED (MPH)	296.	305.	346.	343.	342.	342.	342.	342.	342.
CRUISE L/D	11.64	11.64	11.15	11.74	12.46	12.46	12.46	12.46	12.46
CRUISE DISTANCE (MI.)	17.9	36.0	39.0	55.8	95.5	145.5	245.5	345.5	445.5
BLOCK TIME (MIN.)	9.1	14.3	19.0	23.9	33.3	42.1	59.6	77.1	94.7
BLOCK FUEL (LB.)	266.	397.	505.	630.	897.	1177.	1733.	2281.	2824.
BLOCK SPEED (MPH)	164.	210.	237.	251.	270.	285.	302.	311.	317.

DIRECT OPERATING COST - ANN UTILIZATION(HR)=2000. DEPRECIATION PERIOD(YR)=10. LABOR RATE($/HR)= 7.00
AIRFRAME COST ($/LB)= 80.0 ENGINE COST ($/HP)= 60.0 INSURANCE RATE=0.040 FUEL COST (CENTS/GAL)= 18.0
DOC=1.62+0.0321*SL $/SEAT-TRIP (SL= 25.,500.)
HOP LENGTHS 50+150+ 0+ 0+ 0=200 100+200+ 0+ 0+ 0=300 200+200+ 0+ 0+ 0=400

STAGE LENGTH	25.	50.	75.	100.	150.	200.	300.	400.	500.	200.	300.	400.
NO. CYCLES/STARTS	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	2/1	2/1	2/1
FLIGHT CREW	0.567	0.443	0.394	0.372	0.345	0.327	0.309	0.300	0.294	0.385	0.352	0.335
FUEL & OIL	0.296	0.221	0.187	0.175	0.166	0.164	0.161	0.159	0.157	0.180	0.168	0.164
HULL INSURANCE	0.377	0.295	0.262	0.247	0.230	0.218	0.206	0.199	0.196	0.246	0.228	0.218
TOTAL FLIGHT OPS	1.240	0.959	0.843	0.795	0.742	0.709	0.675	0.658	0.647	0.812	0.748	0.716
LABOR AIRFRAME	0.520	0.339	0.275	0.245	0.212	0.193	0.174	0.164	0.159	0.241	0.209	0.192
MATERIAL AIRFRAME	0.220	0.135	0.106	0.091	0.076	0.068	0.059	0.055	0.053	0.088	0.073	0.066
LABOR ENGINES	0.299	0.165	0.119	0.097	0.074	0.062	0.050	0.044	0.041	0.088	0.068	0.058
MATERIAL ENGINES	0.418	0.225	0.160	0.128	0.095	0.078	0.061	0.053	0.048	0.113	0.085	0.071
MAT. BURDEN	1.064	0.655	0.513	0.444	0.371	0.331	0.291	0.271	0.259	0.428	0.359	0.324
TOTAL MAINTENANCE	2.520	1.520	1.173	1.004	0.828	0.732	0.636	0.588	0.559	0.959	0.795	0.711
DEPRECIATION	1.079	0.843	0.749	0.707	0.657	0.622	0.588	0.570	0.560	0.703	0.651	0.622
TOTAL DIRECT OPERATING COST												
$/AIRCRAFT MILE	4.840	3.323	2.766	2.506	2.226	2.063	1.898	1.816	1.766	2.474	2.193	2.049
$/FLIGHT HOUR	795.6	698.9	654.9	628.5	601.3	588.1	573.1	564.9	559.5	623.9	597.9	584.3
$/SEAT MILE	0.0968	0.0665	0.0553	0.0501	0.0445	0.0413	0.0380	0.0363	0.0353	0.0495	0.0439	0.0410
$/SEAT-TRIP	2.42	3.32	4.15	5.01	6.68	8.25	11.39	14.53	17.66	9.90	13.16	16.40

D-85-50

DEPARTURE PATH TO 10,000 FT MSL

MAX ELSE ANGLE=20. OBSTACLE CLEAR ANGLE=60. OBSTACLE HEIGHT=100. MAX ACCEL ROTATION RATE=20. ACCEL BUILDUP TIME= 5.

TIME SEC	DIST FT	ALT FT	VEL FPS	ACC G	GAM DEG	THRUST LB	LWGD LB	LWGI LB	DWGD LB	DWGI LB	DFUST LB	ALP DEG	THE DEG	AWD DEG	ALV DEG	LAMDA	MU	CT	POWER HP
OBSTACLE CLEARANCE																			
3.1	4.	7.	3.	0.050	60.0	50777.	-1.	-597.	0.	772.	1.	29.3	24.6	-35.4	28.6	0.1013	0.0031	0.0195	5112.
4.0	7.	13.	8.	0.171	60.0	55905.	-5.	-730.	3.	690.	10.	26.4	24.6	-35.4	24.2	0.1121	0.0083	0.0215	6103.
4.7	12.	20.	13.	0.227	60.0	58302.	-15.	-807.	7.	645.	28.	25.3	24.6	-35.4	21.8	0.1202	0.0134	0.0224	6754.
5.4	17.	30.	18.	0.230	60.0	58484.	-30.	-838.	15.	612.	55.	25.2	24.6	-35.4	20.3	0.1267	0.0187	0.0225	7111.
6.3	27.	48.	23.	0.175	60.0	56117.	-45.	-822.	24.	554.	90.	26.4	24.6	-35.4	18.8	0.1321	0.0240	0.0216	7111.
7.5	44.	76.	28.	0.129	60.0	54205.	-73.	-835.	36.	535.	135.	27.4	24.6	-35.4	18.1	0.1367	0.0305	0.0209	7111.
7.9	58.	100.	29.	0.084	60.0	52395.	-102.	-847.	50.	520.	189.	28.4	24.6	-35.4	17.3	0.1414	0.0374	0.0202	7111.
ACCELERATION AND CONVERSION																			
9.7	96.	155.	38.	0.090	55.3	50728.	-163.	-1018.	61.	399.	215.	31.0	24.6	-30.7	17.5	0.1460	0.0488	0.0196	7111.
11.0	138.	200.	46.	0.115	46.7	49393.	-299.	-1347.	67.	301.	196.	38.0	24.6	-22.1	18.5	0.1498	0.0695	0.0191	7111.
12.4	197.	248.	54.	0.110	38.9	49764.	-493.	-1730.	70.	244.	150.	46.5	24.6	-14.3	20.3	0.1485	0.0955	0.0192	7111.
13.9	273.	296.	62.	0.107	33.0	50082.	-433.	-2130.	66.	218.	116.	52.6	24.6	-8.4	20.1	0.1472	0.1205	0.0194	7111.
15.2	352.	340.	70.	0.120	28.6	50177.	81.	-2569.	62.	210.	94.	56.0	24.6	-4.0	19.8	0.1466	0.1446	0.0195	7111.
16.5	444.	383.	79.	0.121	25.1	50153.	734.	-3056.	74.	214.	83.	59.1	24.6	-0.5	17.0	0.1462	0.1690	0.0195	7111.
17.8	552.	427.	88.	0.118	22.4	50049.	1532.	-3609.	101.	227.	83.	61.7	24.6	2.2	15.2	0.1460	0.1926	0.0195	7111.
19.2	682.	475.	98.	0.110	20.1	48801.	2483.	-2931.	144.	182.	95.	62.9	24.6	4.5	13.0	0.1492	0.2163	0.0190	7111.
20.6	820.	521.	107.	0.114	18.3	46346.	3587.	-924.	202.	128.	118.	62.1	24.6	6.3	10.7	0.1565	0.2369	0.0181	7111.
21.9	972.	566.	117.	0.115	16.7	43525.	4847.	1252.	276.	133.	153.	60.9	24.6	7.8	8.8	0.1660	0.2567	0.0170	7111.
23.5	1163.	619.	126.	0.099	15.4	40144.	6265.	3664.	365.	193.	199.	60.1	24.6	9.2	7.0	0.1794	0.2748	0.0157	7111.
25.2	1401.	680.	136.	0.086	14.3	36440.	7838.	6289.	469.	303.	256.	58.4	24.6	10.3	5.5	0.1969	0.2903	0.0143	7111.
27.3	1689.	748.	146.	0.077	13.3	32473.	9567.	9136.	588.	460.	324.	55.5	24.6	11.2	4.2	0.2204	0.3019	0.0127	7111.
29.7	2043.	826.	155.	0.066	12.5	28220.	11449.	12232.	723.	661.	403.	51.3	24.6	12.1	3.1	0.2534	0.3058	0.0111	7111.
32.3	2467.	914.	165.	0.059	11.7	23815.	13482.	15576.	872.	904.	493.	44.8	24.6	12.8	2.1	0.3005	0.2946	0.0094	7111.
35.0	2924.	1004.	175.	0.058	11.1	19773.	15664.	19175.	1036.	1189.	594.	34.4	24.6	13.5	1.3	0.3664	0.2518	0.0078	7111.
37.5	3379.	1088.	185.	0.062	10.5	16582.	17905.	22900.	1204.	1498.	699.	19.1	24.5	14.0	0.5	0.4442	0.1491	0.0066	7111.
40.0	3859.	1172.	195.	0.062	9.9	15224.	19285.	25012.	1265.	1623.	746.	8.3	23.6	13.7	0.2	0.4872	0.0727	0.0060	7111.
42.8	4437.	1268.	204.	0.054	9.5	14428.	20767.	27135.	1334.	1743.	798.	-3.8	22.9	13.4	0.0	0.5148	-0.0441	0.0057	7111.
45.7	5046.	1366.	212.	0.053	9.1	13941.	22014.	27089.	1271.	1654.	775.	-3.8	21.7	12.6	0.0	0.5331	-0.0354	0.0056	7111.
AIRPLANE MODE CLIMB TO 10,000 FT																			
45.7	5046.	1366.	214.	0.0	14.7	15547.													
212.4	43153.	10000.	244.	0.0	12.3	13622.													

THE TOTAL NOISE IMPACT IS 0.9004ED+05

NOISE AT 500 FT SIDELINE= 85.8 EPNDB

NOISE AT 20,000 FT SIDELINE= 54.1 EPNDB

NOISE 25,000 FT FORWARD OF TAKEOFF POINT= 52.2 EPNDB

NOISE 500 FT FORWARD OF TAKEOFF POINT= 86.6 EPNDB

IHN900I EXECUTION TERMINATING DUE TO ERROR COUNT FOR ERROR NUMBER 217

IHA217I FIOCS - END OF DATA SET ON UNIT 5

TRACEBACK	ROUTINE	CALLED FROM ISN	REG. 14	REG. 15	REG. 0	REG. 1
	IBCOM		00099550	000A8D64	00000000	30000000
	MAIN		00013750	01097A18	FOCC00C8	000B0FF8

ENTRY POINT= 01097A18

TILT ROTOR DESIGN PROGRAM 1974

S-75-50

DESIGN ITERATIONS: 6

OVERALL	
GROSS WEIGHT (LB)	66951.
EMPTY WEIGHT (LB)	51121.
FUEL WEIGHT (LB)	5680.
PAYLOAD (LB)	10150.
CRUISE SPEED (MPH)	291.
L/D CRUISE	14.63
*RANGE (STAT MI)	500.
*PASSENGER SEATS	50.
*CARGO (LB)	0.

ROTORS	
*DISC LOADING (PSF)	6.50
RADIUS (FT)	40.5
SOLIDITY	0.245
BLADE CHORD (FT)	3.90
TOTAL BLADES	16
*CT/SIG HOVER	0.120
*PROFILE DRAG COEFF	0.010
% DOWNLOAD	5.6
*EFFICIENCY HOVER	0.83
* CONVER	0.81
CRUISE	0.50
HEL MODE WEIGHT (LB)	10191.
AIRPLANE WEIGHT (LB)	9967.
*TIP SPEED HOVER	350.
* CRUISE	350.
*FUSELAGE CLEARNCE (FT)	2.0
*MAX HEL MODE ADV RATIO	0.40

* INDICATES INPUT VARIABLE

POWERPLANT	
INST NORMAL PWR (HP)	10562.
*NUMBER OF ENGINES	2.
*EXCESS FACTOR HEL MODE	1.65
*% RATED EMRG HVR	140.
* CONV + CLIMB	120.
* CRUISE	90.
INST PWR EMRG HVR (HP)	10562.
CONVER (HP)	9360.
CRUISE (HP)	5875.
*SFC (LB/HP HR)	0.420

DRIVE SYSTEM	
*EFFICIENCY	0.97
HEL MODE WEIGHT (LB)	12932.
AIRPLANE WEIGHT (LB)	12264.

WING	
AREA (SF)	1339.
*LOADING (PSF)	50.0
ASPECT RATIO	6.46
SPAN (FT)	93.0
MEAN CHORD (FT)	14.40
*THICKNESS/CHORD RATIO	0.210
*TAPER RATIO	0.70
SWEEP (DEG)	-5.6
CRUISE LIFT COEFF	0.37
MAX LIFT COEFF CONVER	2.24
*MAX LIFT COEFF CLEAN	1.40
*FLAP AREA/WING AREA	0.25
CLIMB SPD/CONVER SPD	1.51

FUSELAGE	
*LENGTH (FT)	80.0
*DIAMETER (FT)	10.0
*DRAG FACTOR	1.00

FLAT PLATE AREAS (SF)	
WING PROFILE	8.72
FUSELAGE	5.58
EMPENNAGE	5.23
TOTAL PROFILE	23.65
WING INDUCED	9.91

COMPONENT WEIGHTS (LB)	
ROTORS	10191.
DRIVE SYSTEM	12932.
POWERPLANT	2263.
NACELLES	517.
FUEL SYSTEM	596.
WING	5465.
FUSELAGE	6079.
EMPENNAGE	1339.
LANDING GEAR	2008.
FLIGHT CONTROLS	3390.
HYDRAULICS	335.
ELECTRICAL	1253.
INSTR+AVIONICS	703.
AIR CONDITIONING	1150.
FURNISHINGS	2500.
FLUIDS	335.
FLIGHT CREW	400.
CABIN CREW	150.

STRUCT TECHNOLOGY FACTORS	
*ROTOR	1.05
*TRANSMISSION	0.85
*AIRFRAME	0.80
*ENGINE (HP/LB)	7.00
*ENGINE INSTALLATION	1.70

DESIGN MISSION	
*FIELD ELEVATION (FT)	0.
SOUND SPEED HVR (FPS)	1117.
*STD DAY TEMP (DEG F)	59.
*EMERG HOVER ALT (FT)	2000.
*HOT DAY TEMP (DEG F)	95.
*CT/SIG MAX	0.150
*MAX ACCELERATION (G)	0.25
*DESIGN CRUISE (MPH)	280.
*CRUISE ALTITUDE (FT)	15000.
SOUND SPEED CRSE (FPS)	1058.
*MAX DECELERATION (G)	0.20
*STRUCT LOAD FACTOR	4.5
*FLIGHT CREW	2.
*CABIN CREW	1.
*ATC SPEED LIMIT	YES

DESIGN MISSION	SPEED MPH	HEIGHT FT	DIST MI	TIME MIN	FUEL LB
TAKEOFF & LANDING				2.00	101.
ACCEL. & CONV.		1500.	0.5	0.75	55.
AIRPLANE CLIMB	144.,178.	13500.	12.5	4.66	278.
ACCEL. TO CRUISE			2.7	0.67	43.
CRUISE	291.		442.9	91.27	4117.
AIRPLANE DESCENT	291.,236.	13500.	40.1	9.18	65.
DECEL. & CONV.		1500.	0.5	1.10	11.
TOTAL			500.0	109.63	4669.
RESERVE				20.00	1011.

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STAGE LENGTH (MI.)	25.	50.	75.	100.	150.	200.	300.	400.	500.
CRUISE ALTITUDE (FT.)	2000.	4000.	10001.	12500.	15000.	15000.	15000.	15000.	15000.
CRUISE SPEED (MPH)	296.	303.	299.	294.	291.	291.	291.	291.	291.
CRUISE L/D	11.39	11.44	13.18	13.86	14.63	14.63	14.63	14.63	14.63
CRUISE DISTANCE (MI.)	18.1	36.5	17.0	54.3	92.9	142.9	242.9	342.9	442.9
BLOCK TIME (MIN.)	9.0	14.2	21.3	26.3	37.5	47.8	68.4	89.0	109.6
BLOCK FUEL (LB.)	463.	710.	628.	558.	1438.	1910.	2843.	3763.	4669.
BLOCK SPEED (MPH)	166.	211.	211.	228.	240.	251.	263.	270.	274.

DIRECT OPERATING COST - ANN UTILIZATION(HR)=2000. DEPRECIATION PERIOD(YR)=10. LABOR RATE($/HR)= 7.00
AIRFRAME COST ($/LB)= 80.0 ENGINE COST ($/HP)= 60.0 INSURANCE RATE=0.040 FUEL COST (CENTS/GAL)= 18.0
DOC=1.87+0.0485*SL $/SEAT-TRIP (SL= 25.,500.)
HOP LENGTHS 50+150+ 0+ 0+ 0=200 100+200+ 0+ 0+ 0=300 200+200+ 0+ 0+ 0=400

STAGE LENGTH	25.	50.	75.	100.	150.	200.	300.	400.	500.	200.	300.	400.
NO. CYCLES/STARTS	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	2/1	2/1	2/1
FLIGHT CREW	0.556	0.439	0.438	0.406	0.385	0.368	0.351	0.343	0.338	0.414	0.391	0.376
FUEL & OIL	0.515	0.394	0.233	0.277	0.266	0.265	0.263	0.261	0.259	0.298	0.269	0.265
HULL INSURANCE	0.547	0.431	0.430	0.399	0.379	0.362	0.345	0.337	0.332	0.392	0.374	0.362
TOTAL FLIGHT OPS	1.617	1.264	1.101	1.082	1.030	0.996	0.960	0.941	0.929	1.104	1.035	1.003
LABOR AIRFRAME	0.582	0.381	0.336	0.295	0.261	0.241	0.220	0.210	0.203	0.289	0.257	0.239
MATERIAL AIRFRAME	0.295	0.182	0.152	0.130	0.111	0.100	0.089	0.084	0.081	0.125	0.108	0.098
LABOR ENGINES	0.332	0.183	0.137	0.111	0.086	0.072	0.059	0.053	0.049	0.100	0.079	0.067
MATERIAL ENGINES	0.587	0.317	0.232	0.185	0.140	0.116	0.093	0.081	0.074	0.164	0.126	0.106
MAT. BURDEN	1.188	0.733	0.614	0.528	0.451	0.407	0.363	0.341	0.328	0.505	0.436	0.399
TOTAL MAINTENANCE	2.984	1.755	1.471	1.249	1.049	0.937	0.824	0.768	0.734	1.183	1.006	0.910
DEPRECIATION	1.560	1.231	1.228	1.139	1.081	1.033	0.986	0.962	0.948	1.118	1.068	1.033
TOTAL DIRECT OPERATING COST												
$/AIRCRAFT MILE	6.162	4.290	3.800	3.470	3.160	2.965	2.770	2.671	2.611	3.406	3.109	2.947
$/FLIGHT HOUR	1024.2	904.0	802.4	790.4	758.4	744.3	728.7	720.1	714.5	789.8	754.7	739.7
$/SEAT MILE	0.1232	0.0858	0.0760	0.0694	0.0632	0.0593	0.0554	0.0534	0.0522	0.0681	0.0622	0.0589
$/SEAT-TRIP	3.08	4.29	5.70	6.94	9.48	11.86	16.62	21.37	26.11	13.62	18.65	23.57

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DEPARTURE PATH TO 10,000 FT MSL

MAX FUSE ANGLE=20. OBSTACLE CLEAR ANGLE=60. OBSTACLE HEIGHT=100. MAX ACCEL ROTATION RATE=20. ACCEL BUILDUP TIME= 5.

TIME SEC	DIST FT	ALT FT	VEL FPS	ACC G	GAM DEG	THRUST LB	LWGO LB	LWGI LB	DWGO LB	DWGI LB	DFUST LB	ALP DEG	THE DEG	AWO DEG	ALV DEG	LAMDA	MU	CT	POWER HP
OBSTACLE CLEARANCE																			
3.1	4.	7.	3.	0.050	60.0	71193.	-1.	-1013.	1.	1300.	1.	29.4	24.6	-35.4	28.5	0.1119	0.0035	0.0238	7197.
4.0	7.	13.	8.	0.171	60.0	78352.	-9.	-1234.	5.	1179.	10.	26.6	24.6	-35.4	24.4	0.1240	0.0096	0.0261	8613.
4.7	12.	20.	13.	0.227	60.0	81690.	-25.	-1366.	13.	1099.	28.	25.5	24.6	-35.4	21.8	0.1331	0.0154	0.0273	9554.
5.3	17.	30.	18.	0.248	60.0	83000.	-50.	-1443.	25.	1037.	56.	25.1	24.6	-35.4	20.0	0.1417	0.0212	0.0277	10267.
5.9	24.	42.	23.	0.250	60.0	83204.	-82.	-1510.	41.	998.	92.	25.0	24.6	-35.4	18.6	0.1491	0.0272	0.0278	10794.
6.7	34.	59.	28.	0.211	60.0	80900.	-123.	-1526.	61.	933.	137.	25.8	24.6	-35.4	17.2	0.1563	0.0333	0.0270	10987.
7.6	50.	86.	33.	0.162	60.0	78040.	-172.	-1545.	85.	904.	192.	26.9	24.6	-35.4	16.2	0.1620	0.0404	0.0261	10987.
7.9	58.	100.	33.	0.113	60.0	75269.	-229.	-1570.	113.	887.	255.	28.0	24.6	-35.4	15.4	0.1679	0.0484	0.0252	10987.
ACCELERATION AND CONVERSION																			
9.3	92.	153.	43.	0.106	56.8	72776.	-331.	-1794.	137.	760.	297.	29.5	24.6	-32.3	15.2	0.1736	0.0603	0.0244	10987.
10.4	129.	196.	51.	0.141	49.5	69714.	-573.	-2314.	154.	621.	292.	34.0	24.6	-25.0	14.9	0.1811	0.0806	0.0234	10987.
11.7	183.	245.	58.	0.123	42.0	70258.	-906.	-2997.	157.	520.	236.	43.0	24.6	-17.4	16.7	0.1793	0.1109	0.0236	10987.
13.1	260.	301.	66.	0.108	36.2	71175.	-1347.	-3720.	170.	469.	192.	50.0	24.6	-11.6	17.2	0.1766	0.1422	0.0239	10987.
14.5	344.	353.	74.	0.116	31.6	71421.	-581.	-4531.	142.	454.	161.	53.9	24.6	-7.0	16.2	0.1755	0.1701	0.0240	10987.
15.9	445.	406.	83.	0.113	28.0	71501.	442.	-5434.	142.	463.	141.	57.4	24.6	-3.4	14.9	0.1747	0.1984	0.0241	10987.
17.3	565.	463.	92.	0.108	25.1	71487.	1689.	-6457.	173.	490.	134.	60.2	24.6	-0.5	13.5	0.1741	0.2268	0.0241	10987.
19.0	723.	529.	101.	0.092	22.7	69981.	3172.	-5966.	232.	431.	138.	62.2	24.6	1.9	11.7	0.1771	0.2529	0.0237	10987.
20.4	871.	584.	110.	0.108	20.7	65961.	4894.	-2473.	321.	292.	155.	60.4	24.6	3.9	9.6	0.1872	0.2754	0.0224	10987.
21.9	1033.	640.	120.	0.109	19.0	61263.	6863.	1349.	439.	276.	183.	58.8	24.6	5.6	7.7	0.2008	0.2959	0.0208	10987.
23.5	1231.	703.	129.	0.097	17.5	55799.	9080.	5563.	585.	374.	223.	57.1	24.6	7.1	6.1	0.2197	0.3136	0.0190	10987.
25.5	1497.	780.	139.	0.078	16.3	49585.	11545.	10211.	761.	579.	275.	54.9	24.6	8.3	4.6	0.2466	0.3260	0.0169	10987.
27.6	1810.	865.	148.	0.071	15.2	43222.	14252.	15207.	965.	880.	338.	50.4	24.6	9.4	3.4	0.2827	0.3305	0.0148	10987.
30.1	2182.	960.	158.	0.064	14.3	36571.	17203.	20660.	1197.	1278.	413.	43.7	24.6	10.3	2.3	0.3351	0.3172	0.0125	10987.
32.6	2586.	1056.	168.	0.063	13.4	30300.	20392.	26555.	1457.	1767.	499.	33.0	24.6	11.2	1.4	0.4085	0.2674	0.0104	10987.
34.9	2993.	1148.	178.	0.066	12.7	25497.	23822.	32882.	1745.	2342.	596.	16.3	24.6	11.9	0.5	0.4936	0.1484	0.0088	10987.
37.8	3515.	1259.	187.	0.055	12.0	23436.	27623.	39328.	2079.	2959.	709.	-5.0	24.7	12.7	0.0	0.5406	-0.0467	0.0081	10987.
40.6	4074.	1371.	197.	0.054	11.4	22317.	27742.	39209.	1936.	2736.	699.	-4.8	22.8	11.4	0.0	0.5677	-0.0494	0.0077	10987.
43.6	4678.	1487.	207.	0.052	10.8	21292.	27641.	39110.	1814.	2548.	699.	-4.5	21.2	10.4	0.0	0.5952	-0.0491	0.0074	10987.
AIRPLANE MODE CLIMB TO 10,000 FT																			
43.6	4678.	1487.	212.	0.0	14.0	20986.													
217.4	44020.	10000.	241.	0.0	11.8	18434.													

THE TOTAL NOISE IMPACT IS 0.669570+05

NOISE AT 500 FT SIDELINE= 84.4 EPNDB

NOISE AT 20,000 FT SIDELINE= 53.1 EPNDB

NOISE 25,000 FT FORWARD OF TAKEOFF POINT= 51.2 EPNDB

NOISE 500 FT FORWARD OF TAKEOFF POINT= 85.0 EPNDB

TILT ROTOR DESIGN PROGRAM 1974

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DESIGN ITERATIONS: 3

OVERALL	
GROSS WEIGHT (LB)	54497.
EMPTY WEIGHT (LB)	40165.
FUEL WEIGHT (LB)	4182.
PAYLOAD (LB)	10150.
CRUISE SPEED (MPH)	281.
L/D CRUISE	14.42
*RANGE (STAT MI)	500.
*PASSENGER SEATS	50.
*CARGO (LB)	0.

ROTORS	
*DISC LOADING (PSF)	6.50
RADIUS (FT)	36.5
SOLIDITY	0.245
BLADE CHORD (FT)	3.51
TOTAL BLADES	16
*CT/SIG HOVER	0.120
*PROFILE DRAG COEFF	0.010
% DOWNLOAD	5.5
*EFFICIENCY HOVER	0.87
* CONVER	0.85
CRUISE	0.51
HEL MODE WEIGHT (LB)	7251.
AIRPLANE WEIGHT (LB)	7137.
*TIP SPEED HOVER	350.
* CRUISE	350.
*FUSELAGE CLEARNCE (FT)	2.0
*MAX HEL MODE ADV RATIO	0.40

* INDICATES INPUT VARIABLE

POWERPLANT	
INST NORMAL PWR (HP)	8379.
*NUMBER OF ENGINES	2.
*EXCESS FACTOR HEL MODE	1.65
*% RATED EMRG HVR	140.
* CONV + CLIMB	120.
* CRUISE	90.
INST PWR EMRG HVR (HP)	8201.
CONVER (HP)	7267.
CRUISE (HP)	8379.
*SFC (LB/HP HR)	0.380

DRIVE SYSTEM	
*EFFICIENCY	0.97
HEL MODE WEIGHT (LB)	9271.
AIRPLANE WEIGHT (LB)	8928.

WING	
AREA (SF)	1090.
*LOADING (PSF)	50.0
ASPECT RATIO	6.64
SPAN (FT)	85.1
MEAN CHORD (FT)	12.81
*THICKNESS/CHORD RATIO	0.210
*TAPER RATIO	0.70
SWEEP (DEG)	-5.5
CRUISE LIFT COEFF	0.39
MAX LIFT COEFF CONVER	2.24
*MAX LIFT COEFF CLEAN	1.40
*FLAP AREA/WING AREA	0.25
CLIMB SPD/CONVER SPD	1.47

FUSELAGE	
*LENGTH (FT)	80.0
*DIAMETER (FT)	10.0
*DRAG FACTOR	1.00

FLAT PLATE AREAS (SF)	
WING PROFILE	7.22
FUSELAGE	5.58
EMPENNAGE	4.33
TOTAL PROFILE	20.74
WING INDUCED	9.09

COMPONENT WEIGHTS (LB)	
ROTORS	7251.
DRIVE SYSTEM	9271.
POWERPLANT	1257.
NACELLES	122.
FUEL SYSTEM	353.
WING	5113.
FUSELAGE	5599.
EMPENNAGE	1036.
LANDING GEAR	1635.
FLIGHT CONTROLS	2537.
HYDRAULICS	302.
ELECTRICAL	937.
INSTR+AVIONICS	703.
AIR CONDITIONING	1150.
FURNISHINGS	2500.
FLUIDS	273.
FLIGHT CREW	400.
CABIN CREW	150.

STRUCT TECHNOLOGY FACTORS	
*ROTOR	0.95
*TRANSMISSION	0.81
*AIRFRAME	0.76
*ENGINE (HP/LB)	10.00
*ENGINE INSTALLATION	1.70

DESIGN MISSION	
*FIELD ELEVATION (FT)	0.
SOUND SPEED HVR (FPS)	1117.
*STD DAY TEMP (DEG F)	59.
*EMERG HOVER ALT (FT)	2000.
*HOT DAY TEMP (DEG F)	95.
*CT/SIG MAX	0.150
*MAX ACCELERATION (G)	0.25
*DESIGN CRUISE (MPH)	280.
*CRUISE ALTITUDE (FT)	15000.
SOUND SPEED CRSE (FPS)	1058.
*MAX DECELERATION (G)	0.20
*STRUCT LOAD FACTOR	4.5
*FLIGHT CREW	2.
*CABIN CREW	1.
*ATC SPEED LIMIT	YES

DESIGN MISSION	SPEED MPH	HEIGHT FT	DIST MI	TIME MIN	FUEL LB
TAKEOFF & LANDING				2.00	71.
ACCEL. & CONV.		1500.	0.9	0.77	40.
AIRPLANE CLIMB	141.,173.	13500.	11.8	4.53	194.
ACCEL. TO CRUISE			2.3	0.60	27.
CRUISE	281.		444.7	95.00	3082.
AIRPLANE DESCENT	281.,228.	13500.	39.3	9.34	48.
DECEL. & CONV.		1500.	0.9	1.10	8.
TOTAL			500.0	113.33	3469.
RESERVE				20.00	713.

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STAGE LENGTH (MI.)	25.	50.	75.	100.	150.	200.	300.	400.	500.
CRUISE ALTITUDE (FT.)	2000.	4000.	10001.	12500.	15000.	15000.	15000.	15000.	15000.
CRUISE SPEED (MPH)	294.	295.	287.	285.	281.	281.	281.	281.	281.
CRUISE L/D	10.78	11.37	12.94	13.69	14.42	14.42	14.42	14.42	14.42
CRUISE DISTANCE (MI.)	18.3	37.0	41.0	55.7	94.7	144.7	244.7	344.7	444.7
BLOCK TIME (MIN.)	9.1	14.5	21.0	27.0	38.6	49.2	70.6	92.0	113.3
BLOCK FUEL (LB.)	344.	517.	589.	730.	1059.	1410.	2105.	2791.	3469.
BLOCK SPEED (MPH)	165.	207.	214.	223.	233.	244.	255.	261.	265.

DIRECT OPERATING COST - ANN UTILIZATION(HR)=2000. DEPRECIATION PERIOD(YR)=10. LABOR RATE($/HR)= 7.00
AIRFRAME COST ($/LB)= 80.0 ENGINE COST ($/HP)= 60.0 INSURANCE RATE=0.040 FUEL COST (CENTS/GAL)= 18.0
DOC=1.59+0.0424*SL $/SEAT-TRIP (SL= 25.,500.)
HOP LENGTHS 50+150+ 0+ 0+ 0=200 100+200+ 0+ 0+ 0=300 200+200+ 0+ 0+ 0=400

STAGE LENGTH	25.	50.	75.	100.	150.	200.	300.	400.	500.	200.	300.	400.
NO. CYCLES/STARTS	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	2/1	2/1	2/1
FLIGHT CREW	0.555	0.442	0.427	0.411	0.392	0.375	0.359	0.350	0.345	0.419	0.397	0.383
FUEL & OIL	0.382	0.288	0.219	0.203	0.196	0.196	0.195	0.194	0.193	0.219	0.199	0.196
HULL INSURANCE	0.439	0.349	0.338	0.325	0.310	0.297	0.284	0.277	0.273	0.320	0.306	0.297
TOTAL FLIGHT OPS	1.376	1.078	0.984	0.939	0.898	0.868	0.838	0.822	0.812	0.958	0.902	0.876
LABOR AIRFRAME	0.545	0.360	0.310	0.281	0.250	0.231	0.211	0.202	0.196	0.275	0.246	0.230
MATERIAL AIRFRAME	0.248	0.153	0.126	0.111	0.095	0.086	0.077	0.072	0.070	0.106	0.092	0.084
LABOR ENGINES	0.308	0.170	0.127	0.104	0.081	0.069	0.057	0.051	0.047	0.095	0.075	0.065
MATERIAL ENGINES	0.466	0.252	0.183	0.148	0.112	0.094	0.075	0.066	0.060	0.131	0.101	0.086
MAT. BURDEN	1.109	0.689	0.568	0.501	0.431	0.390	0.349	0.329	0.316	0.481	0.417	0.382
TOTAL MAINTENANCE	2.675	1.625	1.315	1.145	0.969	0.869	0.769	0.719	0.689	1.088	0.931	0.847
DEPRECIATION	1.252	0.997	0.964	0.928	0.884	0.847	0.810	0.791	0.780	0.912	0.874	0.847
TOTAL DIRECT OPERATING COST												
$/AIRCRAFT MILE	5.304	3.700	3.263	3.012	2.752	2.584	2.416	2.332	2.281	2.959	2.707	2.569
$/FLIGHT HOUR	874.1	766.2	698.6	670.1	642.2	629.8	616.1	608.5	603.7	669.3	639.3	626.1
$/SEAT MILE	0.1061	0.0740	0.0653	0.0602	0.0550	0.0517	0.0483	0.0466	0.0456	0.0592	0.0541	0.0514
$/SEAT-TRIP	2.65	3.70	4.89	6.02	8.25	10.34	14.50	18.65	22.81	11.83	16.24	20.55

S-85-50

DEPARTURE PATH TO 10,000 FT MSL

MAX FUSE ANGLE=20. OBSTACLE CLEAR ANGLE=60. OBSTACLE HEIGHT=100. MAX ACCEL ROTATION RATE=20. ACCEL BUILDUP TIME= 5.

TIME SEC	DIST FT	ALT FT	VEL FPS	ACC G	GAM DEG	THRUST LB	LWGO LB	LWGI LB	DWGO LB	DWGI LB	DFUST LB	ALP DEG	THE DEG	AWD DEG	ALV DEG	LAMDA	MU	CT	POWER HP
OBSTACLE CLEARANCE																			
3.1	4.	7.	3.	0.050	60.0	57934.	-1.	-812.	0.	1041.	1.	29.4	24.6	-35.4	28.5	0.1119	0.0035	0.0237	5580.
4.0	7.	13.	8.	0.171	60.0	63764.	-8.	-989.	4.	944.	10.	26.6	24.6	-35.4	24.4	0.1240	0.0096	0.0261	6678.
4.7	12.	20.	13.	0.227	60.0	66465.	-21.	-1095.	10.	881.	28.	25.5	24.6	-35.4	21.8	0.1331	0.0154	0.0273	7408.
5.3	17.	30.	18.	0.248	60.0	67557.	-41.	-1157.	21.	831.	55.	25.1	24.6	-35.4	20.0	0.1416	0.0212	0.0277	7963.
5.9	24.	42.	23.	0.250	60.0	67730.	-68.	-1210.	34.	800.	91.	25.0	24.6	-35.4	18.6	0.1491	0.0272	0.0278	8373.
6.7	34.	59.	28.	0.212	60.0	65909.	-102.	-1225.	51.	749.	136.	25.8	24.6	-35.4	17.2	0.1563	0.0332	0.0270	8530.
7.6	50.	86.	33.	0.162	60.0	63571.	-143.	-1240.	71.	724.	190.	26.8	24.6	-35.4	16.2	0.1620	0.0404	0.0261	8530.
7.9	58.	100.	33.	0.113	60.0	61313.	-190.	-1260.	94.	711.	253.	27.9	24.6	-35.4	15.4	0.1680	0.0483	0.0252	8530.
ACCELERATION AND CONVERSION																			
9.3	92.	153.	43.	0.106	56.9	59277.	-276.	-1439.	114.	610.	295.	29.4	24.6	-32.3	15.1	0.1737	0.0662	0.0244	8530.
10.4	129.	196.	51.	0.141	49.6	56781.	-476.	-1855.	128.	498.	290.	34.0	24.6	-25.0	14.9	0.1812	0.0805	0.0234	8530.
11.7	184.	245.	58.	0.123	42.0	57213.	-753.	-2403.	130.	416.	233.	42.9	24.6	-17.4	16.6	0.1795	0.1109	0.0236	8530.
13.2	260.	301.	66.	0.108	36.2	57953.	-1119.	-2982.	141.	375.	188.	50.0	24.6	-11.6	17.2	0.1767	0.1421	0.0239	8530.
14.5	345.	354.	74.	0.116	31.6	58143.	-497.	-3633.	118.	362.	155.	53.9	24.6	-7.1	16.2	0.1757	0.1700	0.0240	8530.
15.9	446.	407.	83.	0.113	28.0	58179.	357.	-4357.	119.	369.	134.	57.3	24.6	-3.4	14.9	0.1750	0.1983	0.0241	8530.
17.3	560.	463.	92.	0.108	25.1	58133.	1399.	-5177.	143.	389.	125.	60.1	24.6	-0.5	13.4	0.1744	0.2266	0.0241	8530.
19.0	723.	529.	101.	0.092	22.7	56911.	2637.	-4818.	192.	345.	128.	62.1	24.6	1.9	11.6	0.1775	0.2527	0.0236	8530.
20.4	872.	585.	110.	0.108	20.7	53628.	4076.	-2000.	264.	235.	142.	60.3	24.6	3.9	9.5	0.1876	0.2751	0.0223	8530.
21.9	1034.	641.	120.	0.108	19.0	49799.	5722.	1083.	361.	223.	168.	58.7	24.6	5.6	7.7	0.2013	0.2956	0.0208	8530.
23.5	1233.	704.	129.	0.096	17.5	45331.	7574.	4485.	481.	300.	205.	57.0	24.6	7.0	6.1	0.2204	0.3132	0.0189	8530.
25.5	1501.	782.	139.	0.077	16.3	40261.	9633.	8237.	624.	462.	254.	54.7	24.6	8.3	4.6	0.2475	0.3253	0.0168	8530.
27.7	1817.	868.	148.	0.070	15.2	35068.	11896.	12270.	791.	701.	315.	50.2	24.6	9.4	3.4	0.2840	0.3294	0.0147	8530.
30.2	2191.	963.	158.	0.064	14.3	29650.	14361.	16671.	981.	1015.	386.	43.4	24.6	10.3	2.3	0.3370	0.3153	0.0125	8530.
32.6	2595.	1060.	168.	0.063	13.4	24563.	17026.	21431.	1194.	1402.	469.	32.4	24.6	11.2	1.3	0.4109	0.2638	0.0104	8530.
35.0	3001.	1151.	178.	0.066	12.7	20710.	19893.	26537.	1430.	1857.	563.	15.6	24.6	11.9	0.5	0.4955	0.1420	0.0088	8530.
37.8	3520.	1261.	187.	0.055	12.0	19100.	22961.	31536.	1689.	2319.	668.	-5.0	24.6	12.6	0.0	0.5404	-0.0483	0.0081	8530.
40.7	4078.	1374.	197.	0.054	11.4	18185.	23058.	31439.	1574.	2146.	654.	-4.8	22.8	11.4	0.0	0.5678	-0.0493	0.0077	8530.
43.6	4668.	1489.	204.	0.053	11.0	17569.	23118.	31379.	1501.	2038.	651.	-4.6	21.6	10.6	0.0	0.5878	-0.0485	0.0075	8530.
AIRPLANE MODE CLIMB TO 10,000 FT																			
43.6	4668.	1489.	206.	0.0	14.8	17884.													
212.5	41934.	10000.	235.	0.0	12.4	15710.													

THE TOTAL NOISE IMPACT IS 0.50535D+05

NOISE AT 500 FT SIDELINE= 83.7 EPNDB

NOISE AT 20,000 FT SIDELINE= 52.2 EPNDB

NOISE 25,000 FT FORWARD OF TAKEOFF POINT= 50.3 EPNDB

NOISE 500 FT FORWARD OF TAKEOFF POINT= 84.3 EPNDB

TILT ROTOR DESIGN PROGRAM 1974

QP-80-50

DESIGN ITERATIONS: 4

OVERALL		POWERPLANT		FUSELAGE		STRUCT TECHNOLOGY FACTORS	
GROSS WEIGHT (LB)	53649.	INST NORMAL PWR (HP)	10500.	*LENGTH (FT)	80.0	*ROTOR	1.00
EMPTY WEIGHT (LB)	38938.	*NUMBER OF ENGINES	2.	*DIAMETER (FT)	10.0	*TRANSMISSION	0.83
FUEL WEIGHT (LB)	4561.	*EXCESS FACTOR HEL MODE	2.00	*DRAG FACTOR	1.00	*AIRFRAME	0.78
PAYLOAD (LB)	10150.	*% RATED EMRG HVR	140.			*ENGINE (HP/LB)	8.50
CRUISE SPEED (MPH)	427.	* CONV + CLIMB	120.	FLAT PLATE AREAS (SF)		*ENGINE INSTALLATION	1.54
L/D CRUISE	10.36	* CRUISE	90.	WING PROFILE	4.69		
*RANGE (STAT MI)	500.	INST PWR EMRG HVR (HP)	9823.	FUSELAGE	5.31	DESIGN MISSION	
*PASSENGER SEATS	50.	CONVER (HP)	10500.	EMPENNAGE	2.81	*FIELD ELEVATION (FT)	0.
*CARGO (LB)	0.	CRUISE (HP)	8885.	TOTAL PROFILE	15.49	SOUND SPEED HVR (FPS)	1117.
		*SFC (LB/HP HR)	0.400	WING INDUCED	2.21	*STD DAY TEMP (DEG F)	59.
ROTORS						*EMERG HOVER ALT (FT)	2000.
*DISC LOADING (PSF)	9.00	DRIVE SYSTEM		COMPONENT WEIGHTS (LB)		*HOT DAY TEMP (DEG F)	95.
RADIUS (FT)	30.8	*EFFICIENCY	0.97	ROTORS	6739.	*CT/SIG MAX	0.150
SOLIDITY	0.179	HEL MODE WEIGHT (LB)	8692.	DRIVE SYSTEM	8692.	*MAX ACCELERATION (G)	0.25
BLADE CHORD (FT)	2.89	AIRPLANE WEIGHT (LB)	7548.	POWERPLANT	1853.	*DESIGN CRUISE (MPH)	400.
TOTAL BLADES	12			NACELLES	314.	*CRUISE ALTITUDE (FT)	15000.
*CT/SIG HOVER	0.120	WING		FUEL SYSTEM	409.	SOUND SPEED CRSE (FPS)	1058.
*PROFILE DRAG COEFF	0.010	AREA (SF)	715.	WING	4122.	*MAX DECELERATION (G)	0.20
% DOWNLOAD	4.9	*LOADING (PSF)	75.0	FUSELAGE	5733.	*STRUCT LOAD FACTOR	4.5
*EFFICIENCY HOVER	0.85	ASPECT RATIO	7.57	EMPENNAGE	1046.	*FLIGHT CREW	2.
* CONVER	0.83	SPAN (FT)	73.6	LANDING GEAR	1610.	*CABIN CREW	1.
CRUISE	0.70	MEAN CHORD (FT)	9.72	FLIGHT CONTROLS	2481.	*ATC SPEED LIMIT	YES
HEL MODE WEIGHT (LB)	6709.	*THICKNESS/CHORD RATIO	0.210	HYDRAULICS	300.		
AIRPLANE WEIGHT (LB)	6324.	*TAPER RATIO	0.70	ELECTRICAL	916.		
*TIP SPEED HOVER	480.	SWEEP (DEG)	-5.3	INSTR+AVIONICS	703.		
* CRUISE	480.	CRUISE LIFT COEFF	0.26	AIR CONDITIONING	1150.		
*FUSELAGE CLEARNCE (FT)	2.0	MAX LIFT COEFF CONVER	1.76	FURNISHINGS	2500.		
*MAX HEL MODE ADV RATIO	0.40	*MAX LIFT COEFF CLEAN	1.40	FLUIDS	268.		
		*FLAP AREA/WING AREA	0.25	FLIGHT CREW	400.		
* INDICATES INPUT VARIABLE		CLIMB SPD/CONVER SPD	1.22	CABIN CREW	150.		

DESIGN MISSION	SPEED MPH	HEIGHT FT	DIST MI	TIME MIN	FUEL LB
TAKEOFF & LANDING				2.00	91.
ACCEL. & CONV.		1000.	0.8	0.60	47.
AIRPLANE CLIMB	160.,199.	14000.	10.8	3.61	208.
ACCEL. TO CRUISE			9.8	1.72	105.
CRUISE	427.		443.1	62.26	3149.
AIRPLANE DESCENT	427.,292.	14000.	34.7	6.11	41.
DECEL. & CONV.		1000.	0.8	1.10	10.
TOTAL			500.0	77.40	3652.
RESERVE				20.00	910.

CP-80-50

STAGE LENGTH (MI.)	25.	50.	75.	100.	150.	200.	300.	400.	500.
CRUISE ALTITUDE (FT.)	2000.	4000.	10001.	12500.	15000.	15000.	15000.	15000.	15000.
CRUISE SPEED (MPH)	296.	305.	425.	426.	427.	427.	427.	427.	427.
CRUISE L/D	12.85	12.85	9.25	9.79	10.36	10.36	10.36	10.36	10.36
CRUISE DISTANCE (MI.)	17.9	35.9	31.5	50.1	92.4	142.4	242.4	342.4	442.4
BLOCK TIME (MIN.)	8.7	13.7	17.0	20.9	28.3	35.3	49.3	63.4	77.4
BLOCK FUEL (LB.)	318.	459.	652.	817.	1176.	1536.	2250.	2953.	3648.
BLOCK SPEED (MPH)	173.	219.	265.	288.	318.	340.	365.	379.	387.

DIRECT OPERATING COST - ANN UTILIZATION(HR)=2000. DEPRECIATION PERIOD(YR)=10. LABOR RATE($/HR)= 7.00
AIRFRAME COST ($/LB)= 80.0 ENGINE COST ($/HP)= 60.0 INSURANCE RATE=0.040 FUEL COST (CENTS/GAL)= 18.0
DOC=1.90+0.0298*SL $/SEAT-TRIP (SL= 25.,500.)
HOP LENGTHS 50+150+ 0+ 0+ 0=200 100+200+ 0+ 0+ 0=300 200+200+ 0+ 0+ 0=400

STAGE LENGTH	25.	50.	75.	100.	150.	200.	300.	400.	500.	200.	300.	400.
NO. CYCLES/STARTS	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	2/1	2/1	2/1
FLIGHT CREW	0.557	0.441	0.364	0.336	0.303	0.284	0.265	0.255	0.249	0.354	0.312	0.292
FUEL & OIL	0.354	0.255	0.241	0.227	0.218	0.213	0.208	0.205	0.203	0.227	0.218	0.213
HULL INSURANCE	0.415	0.329	0.272	0.250	0.226	0.212	0.197	0.190	0.186	0.252	0.224	0.212
TOTAL FLIGHT OPS	1.326	1.025	0.878	0.813	0.747	0.709	0.670	0.650	0.637	0.832	0.754	0.717
LABOR AIRFRAME	0.523	0.342	0.263	0.228	0.192	0.172	0.152	0.142	0.136	0.227	0.189	0.171
MATERIAL AIRFRAME	0.234	0.144	0.108	0.091	0.074	0.065	0.055	0.051	0.048	0.088	0.071	0.063
LABOR ENGINES	0.329	0.180	0.127	0.102	0.076	0.062	0.049	0.042	0.038	0.092	0.069	0.057
MATERIAL ENGINES	0.580	0.312	0.218	0.172	0.126	0.102	0.078	0.066	0.059	0.152	0.112	0.092
MAT. BURDEN	1.107	0.679	0.507	0.429	0.347	0.304	0.261	0.240	0.227	0.415	0.335	0.296
TOTAL MAINTENANCE	2.773	1.658	1.223	1.021	0.814	0.705	0.596	0.541	0.509	0.974	0.776	0.679
DEPRECIATION	1.196	0.947	0.783	0.721	0.651	0.609	0.568	0.547	0.535	0.725	0.647	0.609
TOTAL DIRECT OPERATING COST												
$/AIRCRAFT MILE	5.296	3.629	2.884	2.555	2.211	2.023	1.834	1.739	1.681	2.531	2.177	2.005
$/FLIGHT HOUR	917.5	794.6	763.6	734.8	704.2	687.9	669.1	658.3	651.2	723.8	697.9	682.0
$/SEAT MILE	0.1059	0.0726	0.0577	0.0511	0.0442	0.0405	0.0367	0.0348	0.0336	0.0506	0.0435	0.0401
$/SEAT-TRIP	2.65	3.63	4.33	5.11	6.63	8.09	11.00	13.91	16.81	10.12	13.06	16.04

CP-80-50

DEPARTURE PATH TO 10,000 FT MSL

MAX FUSE ANGLE=20. OBSTACLE CLEAR ANGLE=60. OBSTACLE HEIGHT=100. MAX ACCEL ROTATION RATE=20. ACCEL BUILDUP TIME= 5.

TIME SEC	DIST FT	ALT FT	VEL FPS	ACC G	GAM DEG	THRUST LB	LWGO LB	LWGI LB	DWGO LB	DWGI LB	DFUST LB	ALP DEG	THE DEG	AWO DEG	ALV DEG	LAMDA	MU	CT	POWER HP
OBSTACLE CLEARANCE																			
3.1	4.	7.	3.	0.050	60.0	56931.	-1.	-717.	0.	922.	1.	29.3	24.6	-35.4	28.6	0.0954	0.0026	0.0174	6677.
4.0	7.	13.	8.	0.171	60.0	62673.	-5.	-869.	3.	834.	10.	26.5	24.6	-35.4	24.5	0.1050	0.0070	0.0192	7923.
4.7	12.	20.	13.	0.227	60.0	65349.	-14.	-950.	7.	781.	28.	25.4	24.6	-35.4	22.2	0.1122	0.0112	0.0200	8742.
5.3	17.	30.	18.	0.248	60.0	66410.	-28.	-1002.	14.	754.	55.	25.0	24.6	-35.4	20.8	0.1181	0.0154	0.0204	9293.
5.9	24.	42.	23.	0.250	60.0	66564.	-47.	-1036.	23.	722.	90.	24.9	24.6	-35.4	19.6	0.1237	0.0197	0.0204	9721.
6.6	33.	56.	28.	0.250	60.0	66631.	-70.	-1076.	34.	700.	135.	24.9	24.6	-35.4	18.4	0.1292	0.0241	0.0204	10125.
7.2	43.	74.	33.	0.250	60.0	66716.	-97.	-1115.	48.	683.	188.	24.9	24.6	-35.4	17.3	0.1352	0.0285	0.0205	10571.
7.8	54.	94.	38.	0.250	60.0	66820.	-129.	-1157.	64.	672.	250.	24.9	24.6	-35.4	16.2	0.1416	0.0329	0.0205	11053.
7.9	58.	100.	38.	0.250	60.0	66947.	-166.	-1206.	82.	670.	321.	25.0	24.6	-35.4	15.1	0.1481	0.0374	0.0206	11541.
ACCELERATION AND CONVERSION																			
8.5	73.	126.	48.	0.250	58.7	65621.	-221.	-1307.	101.	616.	392.	24.1	24.6	-34.1	13.5	0.1548	0.0410	0.0202	11805.
9.1	94.	155.	57.	0.250	54.7	61733.	-353.	-1520.	128.	551.	469.	24.6	24.6	-30.1	11.8	0.1644	0.0499	0.0190	11799.
9.8	121.	185.	65.	0.250	48.7	57104.	-538.	-1820.	136.	459.	438.	28.9	24.6	-24.1	12.1	0.1678	0.0656	0.0176	11190.
10.4	154.	215.	72.	0.250	42.7	57489.	-774.	-2260.	137.	400.	364.	35.3	24.6	-18.1	13.4	0.1694	0.0868	0.0177	11370.
11.0	193.	246.	80.	0.250	37.8	58061.	-1072.	-2736.	144.	366.	303.	40.6	24.6	-13.2	13.9	0.1707	0.1081	0.0179	11572.
11.6	238.	276.	88.	0.250	33.8	58483.	-989.	-3250.	137.	350.	252.	44.7	24.6	-9.2	13.7	0.1723	0.1288	0.0181	11767.
12.2	290.	307.	96.	0.250	30.5	58557.	-336.	-3812.	125.	347.	214.	47.8	24.6	-5.9	13.0	0.1746	0.1486	0.0181	11946.
12.9	347.	337.	105.	0.250	27.7	59590.	442.	-4435.	128.	354.	186.	50.2	24.6	-3.2	12.1	0.1773	0.1682	0.0181	12150.
13.5	411.	367.	114.	0.250	25.4	58575.	1353.	-5130.	147.	373.	171.	52.2	24.6	-0.8	11.1	0.1812	0.1871	0.0181	12416.
14.2	490.	401.	123.	0.223	23.4	56714.	2402.	-3864.	181.	295.	166.	53.7	24.6	1.2	9.7	0.1868	0.2042	0.0176	12416.
14.9	575.	435.	132.	0.226	21.7	54438.	3592.	-1805.	230.	233.	173.	52.8	24.6	2.9	8.4	0.1942	0.2209	0.0169	12416.
15.6	670.	470.	142.	0.216	20.2	51627.	4925.	486.	294.	219.	191.	52.0	24.6	4.4	7.2	0.2043	0.2351	0.0160	12416.
16.4	785.	509.	151.	0.194	18.9	48248.	6405.	3019.	373.	253.	221.	51.4	24.6	5.7	5.9	0.2183	0.2469	0.0150	12416.
17.2	912.	550.	161.	0.187	17.7	44900.	8029.	5677.	468.	332.	261.	49.3	24.6	6.9	4.9	0.2342	0.2573	0.0140	12416.
18.1	1057.	594.	170.	0.174	16.7	41126.	9800.	8591.	577.	456.	313.	46.8	24.6	7.9	3.9	0.2555	0.2629	0.0128	12416.
19.1	1231.	643.	180.	0.154	15.8	36896.	11718.	11794.	701.	628.	376.	43.6	24.6	8.8	3.0	0.2849	0.2598	0.0115	12416.
20.2	1425.	695.	189.	0.146	15.0	32889.	13781.	15163.	841.	837.	451.	38.3	24.6	9.6	2.2	0.3203	0.2473	0.0103	12416.
21.3	1637.	748.	199.	0.141	14.2	29017.	15988.	18774.	995.	1087.	536.	30.9	24.6	10.4	1.5	0.3647	0.2162	0.0091	12416.
22.4	1863.	803.	209.	0.140	13.5	25684.	18341.	22616.	1164.	1377.	632.	20.7	24.6	11.0	0.8	0.4150	0.1566	0.0080	12416.
23.5	2108.	859.	219.	0.135	12.9	23360.	20840.	26662.	1348.	1702.	739.	7.4	24.6	11.7	0.3	0.4592	0.0606	0.0073	12416.
24.9	2401.	923.	228.	0.118	12.4	22357.	23392.	30257.	1537.	1987.	851.	-6.3	24.6	12.2	0.0	0.4800	-0.0529	0.0070	12416.
26.2	2707.	988.	234.	0.116	12.1	21825.	23446.	30203.	1486.	1914.	837.	-6.1	23.6	11.6	0.0	0.4918	-0.0535	0.0069	12416.
AIRPLANE MODE CLIMB TO 10,000 FT																			
26.2	2707.	988.	235.	0.0	17.0	19612.													
163.7	37399.	10000.	269.	0.0	14.2	17101.													

NOISE AT 500 FT SIDELINE= 90.1 EPNDB

TIME	1.5	4.5	7.5	10.5	13.5	16.5	19.5	22.5	25.5
PNL	88.5	89.6	89.6	87.0	84.4	79.3	72.9	65.0	57.2

NOISE 500 FT FORWARD OF TAKEOFF POINT= 90.6 EPNDB

NOISE AT 20,000 FT SIDELINE= 56.7 EPNDB

NOISE 25,000 FT FORWARD OF TAKEOFF POINT= 54.5 EPNDB

THE TOTAL NOISE IMPACT IS 0.25120D+06

TILT RCTOR DESIGN PRCGRAM 1974

HOVER EXAMPLE

DESIGN ITERATIONS: 5

OVERALL	
GROSS WEIGHT (LB)	43572.
EMPTY WEIGHT (LB)	29295.
FUEL WEIGHT (LB)	4127.
PAYLOAD (LB)	10150.
CRUISE SPEED (MPH)	432.
L/D CRUISE	10.01
*RANGE (STAT MI)	500.
*PASSENGER SEATS	50.
*CARGO (LB)	0.

ROTORS	
*DISC LCADING (PSF)	12.00
RADIUS (FT)	24.0
SOLIDITY	0.122
BLADE CHORD (FT)	2.29
TOTAL BLADES	8
*CT/SIG HOVER	0.120
*PROFILE DRAG COEFF	0.010
% DCWNLOAD	5.0
*EFFICIENCY HOVER	0.85
* CONVER	0.83
CRUISE	0.74
HEL MODE WEIGHT (LB)	3811.
AIRPLANE WEIGHT (LB)	3425.
*TIP SPEED HOVER	673.
* CRUISE	550.
*FUSELAGE CLEARNCE (FT)	2.0
*MAX HEL MODE ADV RATIO	0.40

* INDICATES INPUT VARIABLE

POWERPLANT	
INST NCRMAL PWR (HP)	9393.
*NUMBER OF ENGINES	2.
*EXCESS FACTOR HEL MODE	1.30
*% RATED EMRG HVR	140.
* CONV + CLIMB	120.
* CRUISE	90.
INST PWR EMRG HVR (HP)	9393.
CONVER (HP)	6539.
CRUISE (HP)	7749.
*SFC (LB/HP HR)	0.400

DRIVE SYSTEM	
*EFFICIENCY	0.97
HEL MODE WEIGHT (LB)	3728.
AIRPLANE WEIGHT (LB)	4688.

WING	
AREA (SF)	459.
*LOADING (PSF)	95.0
ASPECT RATIO	7.87
SPAN (FT)	60.1
MEAN CHORD (FT)	7.63
*THICKNESS/CHORD RATIO	0.210
*TAPER RATIO	0.70
SWEEP (DEG)	-5.3
CRUISE LIFT COEFF	0.32
MAX LIFT COEFF CONVER	1.13
*MAX LIFT COEFF CLEAN	1.40
*FLAP AREA/WING AREA	0.25
CLIMB SPD/CONVER SPD	0.92

FUSELAGE	
*LENGTH (FT)	80.0
*DIAMETER (FT)	10.0
*DRAG FACTOR	1.00

FLAT PLATE AREAS (SF)	
WING PROFILE	3.11
FUSELAGE	5.31
EMPENNAGE	1.87
TOTAL PROFILE	12.44
WING INDUCED	2.08

COMPCNENT WEIGHTS (LB)	
ROTORS	3811.
DRIVE SYSTEM	4688.
POWERPLANT	1658.
NACELLES	241.
FUEL SYSTEM	345.
WING	3282.
FUSELAGE	5557.
EMPENNAGE	850.
LANDING GEAR	1307.
FLIGHT CONTROLS	1850.
HYDRAULICS	270.
ELECTRICAL	682.
INSTR+AVIONICS	703.
AIR CONDITIONING	1150.
FURNISHINGS	2500.
FLUIDS	218.
FLIGHT CREW	400.
CABIN CREW	150.

STRUCT TECHNOLOGY FACTORS	
*RCTOR	1.00
*TRANSMISSION	0.83
*AIRFRAME	0.78
*ENGINE (HP/LB)	8.50
*ENGINE INSTALLATION	1.50

DESIGN MISSION	
*FIELD ELEVATION (FT)	0.
SOUND SPEED HVR (FPS)	1117.
*STD DAY TEMP (DEG F)	59.
*EMERG HOVER ALT (FT)	2000.
*HOT DAY TEMP (DEG F)	95.
*CT/SIG MAX	0.150
*MAX ACCELERATICN (G)	0.25
*DESIGN CRUISE (MPH)	400.
*CRUISE ALTITUDE (FT)	15000.
SOUND SPEED CRSE (FPS)	1058.
*MAX DECELERATION (G)	0.20
*STRUCT LCAD FACTOR	4.5
*FLIGHT CREW	2.
*CABIN CREW	1.
*ATC SPEED LIMIT	YES

DESIGN MISSION	SPEED MPH	HEIGHT FT	DIST MI	TIME MIN	FUEL LB
TAKEOFF & LANDING				2.00	86.
ACCEL. & CONV.		900.	0.9	0.64	33.
AIRPLANE CLIMB	169.,209.	14100.	12.0	3.83	201.
ACCEL. TO CRUISE			10.9	1.87	104.
CRUISE	432.		441.5	61.32	2795.
AIRPLANE DESCENT	432.,292.	14100.	33.7	5.93	40.
DECEL. & CONV.		900.	0.9	1.11	9.
TOTAL			500.0	76.71	3267.
RESERVE				20.00	860.

HOVER EXAMPLE

STAGE LENGTH (MI.)	25.	50.	75.	100.	150.	200.	300.	400.	500.
CRUISE ALTITUDE (FT.)	2000.	4000.	10001.	12500.	15000.	15000.	15000.	15000.	15000.
CRUISE SPEED (MPH)	296.	305.	440.	445.	446.	446.	446.	446.	446.
CRUISE L/D	12.38	12.38	8.48	8.89	9.42	9.42	9.42	9.42	9.42
CRUISE DISTANCE (MI.)	17.4	35.5	27.2	45.5	89.2	139.2	239.2	339.2	439.2
BLOCK TIME (MIN.)	8.7	13.7	16.9	20.6	27.7	34.4	47.8	61.3	74.7
BLOCK FUEL (LB.)	282.	412.	601.	763.	1106.	1448.	2123.	2788.	3442.
BLOCK SPEED (MPH)	173.	219.	267.	291.	325.	349.	376.	392.	401.

DIRECT OPERATING COST - ANN UTILIZATION(HR)=2000. DEPRECIATION PERIOD(YR)=10. LABOR RATE($/HR)= 7.00
AIRFRAME COST ($/LB)= 80.0 ENGINE COST ($/HP)= 60.0 INSURANCE RATE=0.040 FUEL COST (CENTS/GAL)= 18.0
DOC=1.71+0.0251*SL $/SEAT-TRIP (SL= 25.,500.)
HOP LENGTHS 50+150+ 0+ 0+ 0=200 100+200+ 0+ 0+ 0=300 200+200+ 0+ 0+ 0=400

STAGE LENGTH	25.	50.	75.	100.	150.	200.	300.	400.	500.	200.	300.	400.
NO. CYCLES/STARTS	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	2/1	2/1	2/1
FLIGHT CREW	0.559	0.442	0.363	0.332	0.297	0.277	0.257	0.247	0.241	0.349	0.306	0.285
FUEL & OIL	0.314	0.229	0.223	0.212	0.205	0.201	0.197	0.194	0.191	0.211	0.205	0.201
HULL INSURANCE	0.321	0.254	0.208	0.190	0.171	0.159	0.147	0.142	0.138	0.191	0.169	0.159
TOTAL FLIGHT OPS	1.193	0.925	0.794	0.734	0.673	0.637	0.601	0.582	0.570	0.752	0.680	0.645
LABOR AIRFRAME	0.479	0.314	0.241	0.208	0.173	0.155	0.136	0.127	0.121	0.207	0.171	0.154
MATERIAL AIRFRAME	0.190	0.117	0.087	0.073	0.059	0.051	0.044	0.040	0.038	0.071	0.057	0.050
LABOR ENGINES	0.317	0.174	0.123	0.098	0.073	0.060	0.047	0.040	0.036	0.089	0.066	0.055
MATERIAL ENGINES	0.519	0.280	0.195	0.153	0.112	0.090	0.069	0.058	0.052	0.136	0.099	0.081
MAT. BURDEN	1.035	0.635	0.472	0.397	0.320	0.279	0.238	0.217	0.205	0.384	0.308	0.271
TOTAL MAINTENANCE	2.540	1.519	1.117	0.929	0.736	0.635	0.534	0.483	0.453	0.885	0.702	0.612
DEPRECIATION	0.931	0.736	0.604	0.553	0.495	0.462	0.428	0.411	0.401	0.555	0.492	0.462
TOTAL DIRECT OPERATING COST												
$/AIRCRAFT MILE	4.664	3.180	2.515	2.216	1.904	1.734	1.563	1.477	1.424	2.192	1.874	1.718
$/FLIGHT HOUR	807.2	695.7	670.4	645.9	619.2	604.9	588.0	578.3	571.8	635.7	613.6	599.6
$/SEAT MILE	0.0933	0.0636	0.0503	0.0443	0.0381	0.0347	0.0313	0.0295	0.0285	0.0438	0.0375	0.0344
$/SEAT-TRIP	2.33	3.18	3.77	4.43	5.71	6.93	9.38	11.81	14.24	8.77	11.24	13.75

HOVER EXAMPLE

HOVER @ 100 FT ABOVE TAKEOFF FOR 1 MIN

TIME SEC	DIST FT	ALT FT	VEL FPS	ACC G	GAM DEG	THRUST LB	LWGO LB	LWGI LB	DWGO LB	DWGI LB	DFUST LB	ALP DEG	THE DEG	AWO DEG	ALV DEG	LAMDA	MU	CT	POWER HP
0.0	0.	100.	0.	0.000	90.0	43572.													
60.0	0.	100.	0.	0.000	90.0	43572.													

NOISE AT 500 FT SIDELINE=102.8 EPNDB

TIME	1.5	4.5	7.5	10.5	13.5	16.5	19.5	22.5	25.5	28.5	31.5	34.5	37.5	40.5	43.5	46.5	49.5	52.5	55.5	58.5
PNL	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0

NOISE 500 FT FORWARD OF TAKEOFF POINT=102.8 EPNDB

NOISE AT 20,000 FT SIDELINE= 65.6 EPNDB

NOISE 25,000 FT FORWARD OF TAKEOFF POINT= 63.6 EPNDB

THE TOTAL NOISE IMPACT IS 0.774810 06

HOVER EXAMPLE
DEPARTURE PATH TO 10,000 FT MSL
MAX FUSE ANGLE=20. OBSTACLE CLEAR ANGLE=60. OBSTACLE HEIGHT=100. MAX ACCEL ROTATION RATE=20. ACCEL BUILDUP TIME= 5.

TIME SEC	DIST FT	ALT FT	VEL FPS	ACC G	GAM DEG	THRUST LB	LWGO LB	LWGI LB	DWGO LB	DWGI LB	DFUST LB	ALP DEG	THE DEG	AWO DEG	ALV DEG	LAMDA	MU	CT	POWER HP
OBSTACLE CLEARANCE																			
3.1	4.	7.	3.	0.050	60.0	46242.	-0.	-576.	0.	753.	1.	29.3	24.6	-35.4	28.8	0.0785	0.0018	0.0118	6422.
4.0	7.	13.	8.	0.171	60.0	50913.	-4.	-703.	2.	689.	10.	26.5	24.6	-35.4	24.8	0.0856	0.0050	0.0130	7524.
5.0	13.	23.	13.	0.160	60.0	50448.	-10.	-710.	5.	640.	28.	26.7	24.6	-35.4	23.5	0.0892	0.0083	0.0129	7743.
6.2	24.	42.	18.	0.126	60.0	49151.	-19.	-714.	9.	601.	54.	27.5	24.6	-35.4	22.5	0.0916	0.0117	0.0126	7743.
7.9	43.	74.	23.	0.093	60.0	47882.	-32.	-713.	16.	576.	90.	28.3	24.6	-35.4	21.9	0.0940	0.0154	0.0123	7743.
8.5	58.	100.	24.	0.057	60.0	46574.	-47.	-713.	23.	551.	134.	29.1	24.6	-35.4	21.2	0.0967	0.0193	0.0119	7743.
ACCELERATION AND CONVERSION																			
9.4	76.	124.	33.	0.168	52.0	45573.	-85.	-976.	26.	325.	133.	29.7	24.6	-27.4	21.3	0.0908	0.0245	0.0117	7743.
10.3	103.	147.	40.	0.175	41.2	45013.	-170.	-1317.	27.	213.	99.	40.4	24.6	-16.6	25.7	0.1000	0.0380	0.0116	7743.
11.2	139.	171.	48.	0.177	33.3	45227.	-183.	-1630.	27.	170.	69.	48.4	24.6	-8.7	28.5	0.0994	0.0529	0.0116	7743.
12.1	182.	194.	57.	0.178	27.7	45283.	85.	-1900.	26.	151.	51.	53.9	24.6	-3.2	28.5	0.0992	0.0673	0.0116	7743.
12.9	234.	216.	66.	0.182	23.7	45318.	445.	-2160.	35.	144.	44.	57.5	24.6	0.9	27.3	0.0990	0.0817	0.0117	7743.
13.7	290.	237.	75.	0.192	20.6	45340.	902.	-2437.	54.	145.	48.	59.8	24.6	4.0	25.3	0.0988	0.0961	0.0117	7743.
14.5	356.	259.	84.	0.191	18.2	45237.	1461.	-2739.	83.	152.	63.	61.9	24.6	6.4	23.0	0.0989	0.1104	0.0117	7743.
15.4	430.	281.	94.	0.188	16.3	45058.	2122.	-3079.	123.	163.	89.	63.6	24.6	8.3	20.7	0.0991	0.1248	0.0116	7743.
16.3	521.	305.	104.	0.171	14.8	43824.	2887.	-2294.	173.	114.	127.	64.6	24.6	9.8	17.9	0.1016	0.1379	0.0113	7743.
17.1	614.	327.	113.	0.184	13.5	42170.	3757.	-849.	233.	70.	176.	63.1	24.6	11.1	15.2	0.1054	0.1505	0.0109	7743.
18.0	720.	350.	123.	0.176	12.4	40084.	4732.	721.	304.	70.	235.	62.2	24.6	12.2	12.7	0.1107	0.1624	0.0104	7743.
18.9	838.	374.	133.	0.171	11.5	37816.	5812.	2381.	384.	109.	306.	60.9	24.6	13.1	10.6	0.1170	0.1738	0.0098	7743.
19.9	976.	400.	143.	0.158	10.7	35208.	6997.	4178.	476.	184.	388.	59.6	24.6	13.9	8.7	0.1254	0.1842	0.0091	7743.
20.9	1133.	428.	153.	0.148	10.0	32450.	8287.	6088.	577.	291.	481.	57.6	24.6	14.6	7.1	0.1358	0.1935	0.0084	7743.
22.2	1330.	460.	162.	0.126	9.4	29241.	9682.	8193.	689.	434.	584.	55.7	24.6	15.2	5.5	0.1505	0.1998	0.0076	7743.
23.5	1559.	496.	172.	0.116	8.8	26095.	11179.	10396.	810.	603.	699.	52.1	24.6	15.8	4.3	0.1685	0.2032	0.0068	7743.
25.0	1828.	535.	182.	0.104	8.3	22813.	12780.	12760.	942.	802.	824.	47.1	24.6	16.2	3.2	0.1930	0.2001	0.0059	7743.
26.7	2153.	580.	192.	0.091	7.9	20397.	13886.	14341.	1004.	918.	884.	43.9	23.8	15.9	2.4	0.2160	0.1965	0.0053	7743.
28.6	2522.	629.	202.	0.084	7.5	18569.	14805.	15583.	1037.	991.	919.	40.5	22.9	15.4	1.9	0.2376	0.1932	0.0048	7743.
30.5	2929.	680.	212.	0.080	7.2	16787.	15751.	16891.	1072.	1069.	956.	36.0	22.1	14.9	1.4	0.2635	0.1824	0.0044	7743.
32.5	3361.	732.	222.	0.079	6.8	15132.	16729.	18267.	1110.	1151.	996.	30.0	21.3	14.5	1.0	0.2937	0.1607	0.0040	7743.
34.3	3796.	782.	232.	0.082	6.5	13780.	17777.	19707.	1154.	1237.	1043.	21.9	20.7	14.2	0.6	0.3243	0.1292	0.0036	7743.
36.2	4242.	831.	242.	0.084	6.3	12665.	18847.	21213.	1198.	1326.	1091.	12.2	20.1	13.8	0.3	0.3551	0.0779	0.0033	7743.
38.1	4703.	881.	247.	0.083	6.1	12232.	19424.	22028.	1222.	1375.	1117.	6.5	19.8	13.7	0.2	0.3688	0.0432	0.0032	7743.
AIRPLANE MODE CLIMB TO 10,000 FT																			
38.1	4703.	881.	247.	0.0	15.4	15093.													
184.6	43609.	10000.	284.	0.0	12.8	13140.													

NOISE AT 500 FT SIDELINE= 97.5 EPNDB

TIME	1.5	4.5	7.5	10.5	13.5	16.5	19.5	22.5	25.5	28.5	31.5	34.5	37.5	42.0
PNL	95.8	96.6	96.0	94.7	93.2	90.1	84.9	78.7	72.1	67.2	63.2	58.7	53.9	52.1

NOISE 500 FT FORWARD OF TAKEOFF POINT= 98.8 EPNDB

NOISE AT 20,000 FT SIDELINE= 62.1 EPNDB

NOISE 25,000 FT FORWARD OF TAKEOFF POINT= 59.9 EPNDB

THE TOTAL NOISE IMPACT IS 0.65024D+06

Appendix 2

Departure Noise Maps for

Basic Variation Aircraft

C-80-50

NOISE FOOTPRINT IN EPNDB. FLIGHT DIRECTION IS DOWN THE PAGE. 125 FT GRID.

81. 81. 81. 81. 81. 81. 81. 81. 81. 80. 80. 80. 80. 80. 80. 79. 79. 79. 79. 79. 79. 78. 78. 78.

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91. 91. 91. 90. 90. 90. 89. 88. 88. 87. 86. 86. 85. 84. 84. 83. 83. 82. 82. 82. 81. 81. 81. 81.

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94. 94. 93. 93. 92. 92. 91. 90. 89. 89. 88. 87. 86. 85. 85. 84. 83. 83. 83. 82. 82. 81. 81. 81.

95. 95. 95. 94. 94. 93. 92. 91. 90. 89. 89. 88. 87. 86. 85. 84. 84. 83. 83. 82. 82. 82. 81. 81.

97. 97. 96. 96. 95. 94. 93. 92. 91. 90. 89. 88. 87. 86. 86. 85. 84. 83. 83. 82. 82. 82. 81. 81.

99. 99. 98. 97. 96. 95. 94. 93. 92. 91. 90. 89. 88. 87. 86. 85. 84. 84. 83. 83. 82. 82. 82. 81.

101. 101. 100. 99. 98. 96. 95. 94. 93. 92. 91. 89. 88. 87. 86. 85. 85. 84. 83. 83. 82. 82. 82. 81.

0. 0. 0. 0. 99. 97. 96. 95. 93. 92. 91. 90. 89. 88. 87. 86. 85. 84. 83. 83. 83. 82. 82. 81.

Information Processing Center

Information Processing Center

0.	0.	0.	0.	99.	97.	96.	95.	93.	92.	91.	90.	89.	88.	87.	86.	85.	84.	83.	83.	83.	82.	81.
0.	0.	0.	0.	100.	98.	97.	95.	94.	93.	92.	90.	89.	88.	87.	86.	85.	84.	83.	83.	83.	82.	81.
0.	0.	0.	0.	101.	99.	98.	96.	95.	93.	92.	91.	89.	88.	87.	86.	85.	84.	84.	83.	83.	82.	82.
0.	0.	0.	0.	102.	100.	98.	96.	95.	93.	92.	91.	90.	89.	87.	86.	85.	84.	84.	83.	83.	82.	82.
0.	0.	0.	0.	102.	100.	98.	97.	95.	94.	92.	91.	90.	89.	88.	87.	85.	85.	84.	83.	83.	82.	82.
0.	0.	0.	0.	102.	100.	98.	97.	95.	94.	92.	91.	90.	89.	88.	87.	86.	85.	84.	83.	83.	82.	82.
0.	0.	0.	0.	101.	100.	98.	96.	95.	94.	92.	91.	90.	89.	88.	87.	86.	85.	84.	83.	83.	82.	82.
0.	0.	0.	0.	101.	99.	98.	96.	95.	93.	92.	91.	90.	89.	88.	86.	85.	84.	84.	83.	83.	82.	82.
103.	103.	102.	101.	100.	98.	97.	96.	94.	93.	92.	91.	90.	88.	87.	86.	85.	84.	84.	83.	83.	82.	82.
102.	102.	101.	100.	99.	98.	96.	95.	94.	93.	92.	90.	89.	88.	87.	86.	85.	84.	84.	83.	83.	82.	82.
101.	100.	100.	99.	98.	97.	96.	95.	93.	92.	91.	90.	89.	88.	87.	86.	85.	84.	84.	83.	83.	82.	82.
99.	99.	99.	98.	97.	96.	95.	94.	93.	92.	91.	90.	89.	88.	87.	86.	85.	84.	83.	83.	83.	82.	82.
98.	98.	98.	97.	96.	95.	94.	93.	92.	91.	90.	89.	88.	87.	86.	85.	84.	84.	83.	83.	83.	82.	82.
97.	97.	97.	96.	95.	95.	94.	93.	92.	91.	90.	89.	88.	87.	86.	85.	84.	84.	83.	83.	82.	82.	82.
96.	96.	96.	95.	95.	94.	93.	92.	91.	90.	89.	88.	87.	86.	86.	85.	84.	83.	83.	83.	82.	82.	82.
95.	95.	95.	94.	94.	93.	92.	91.	90.	90.	89.	88.	87.	86.	85.	84.	84.	83.	83.	83.	82.	82.	82.
94.	94.	94.	93.	93.	92.	91.	91.	90.	89.	88.	87.	86.	86.	85.	84.	84.	83.	83.	82.	82.	82.	81.
93.	93.	93.	93.	92.	91.	91.	90.	89.	88.	88.	87.	86.	85.	85.	84.	83.	83.	83.	82.	82.	82.	81.
92.	92.	92.	92.	91.	91.	90.	89.	88.	88.	87.	86.	85.	85.	84.	84.	83.	83.	82.	82.	82.	81.	81.
91.	91.	91.	91.	90.	90.	89.	89.	88.	87.	86.	86.	85.	84.	84.	83.	83.	83.	82.	82.	82.	81.	81.
90.	90.	90.	90.	90.	89.	89.	88.	87.	87.	86.	85.	85.	84.	84.	83.	83.	82.	82.	82.	81.	81.	81.
90.	90.	90.	89.	89.	88.	88.	87.	87.	86.	85.	85.	84.	84.	83.	83.	83.	82.	82.	81.	81.	81.	81.
89.	89.	89.	89.	88.	88.	87.	87.	86.	86.	85.	84.	84.	83.	83.	83.	82.	82.	82.	81.	81.	81.	80.

89. 88. 88. 88. 88. 87. 87. 86. 86. 85. 85. 84. 84. 83. 83. 82. 82. 82. 81. 81. 81. 81. 80. 80.

88. 88. 88. 87. 87. 87. 86. 86. 85. 85. 84. 84. 83. 83. 82. 82. 82. 81. 81. 81. 81. 80. 80. 80.

87. 87. 87. 87. 87. 86. 86. 85. 85. 84. 84. 83. 83. 83. 82. 82. 82. 81. 81. 81. 80. 80. 80. 80.

87. 87. 87. 86. 86. 86. 85. 85. 84. 84. 84. 83. 83. 82. 82. 82. 81. 81. 81. 81. 80. 80. 80. 80.

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83. 83. 83. 83. 83. 83. 82. 82. 81. 81. 81. 81. 80. 80. 80. 80. 79. 79. 79. 78. 78. 78. 78. 78.

83. 83. 83. 83. 82. 82. 82. 82. 81. 81. 81. 80. 80. 80. 80. 79. 79. 79. 78. 78. 78. 78. 78. 78.

Information Processing Center

M-80-50

NOISE FOOTPRINT IN EPNDB. FLIGHT DIRECTION IS DOWN THE PAGE. 125 FT GRID.

76.	76.	76.	76.	76.	76.	76.	75.	75.	75.	75.	75.	75.	75.	75.	74.	74.	74.	74.	73.	73.	73.	73.	72.
76.	76.	76.	76.	76.	76.	76.	76.	76.	76.	75.	75.	75.	75.	75.	75.	74.	74.	74.	74.	73.	73.	73.	73.
77.	77.	77.	76.	76.	76.	76.	76.	76.	76.	76.	76.	75.	75.	75.	75.	75.	75.	74.	74.	74.	74.	73.	73.
77.	77.	77.	77.	77.	77.	77.	76.	76.	76.	76.	76.	76.	76.	75.	75.	75.	75.	75.	74.	74.	74.	74.	73.
78.	78.	78.	77.	77.	77.	77.	77.	77.	77.	76.	76.	76.	76.	76.	75.	75.	75.	75.	75.	74.	74.	74.	74.
78.	78.	78.	78.	78.	78.	78.	77.	77.	77.	77.	77.	76.	76.	76.	76.	75.	75.	75.	75.	75.	74.	74.	74.
79.	79.	79.	78.	78.	78.	78.	78.	78.	78.	77.	77.	77.	76.	76.	76.	76.	75.	75.	75.	75.	75.	74.	74.
79.	79.	79.	79.	79.	79.	79.	78.	78.	78.	78.	77.	77.	77.	77.	76.	76.	76.	75.	75.	75.	75.	75.	74.
80.	80.	80.	80.	80.	79.	79.	79.	79.	78.	78.	78.	78.	77.	77.	77.	76.	76.	76.	75.	75.	75.	75.	74.
81.	81.	81.	81.	80.	80.	80.	80.	79.	79.	78.	78.	78.	78.	77.	77.	77.	77.	76.	76.	75.	75.	75.	75.
82.	82.	82.	81.	81.	81.	81.	80.	80.	79.	79.	79.	78.	78.	78.	77.	77.	77.	76.	76.	76.	75.	75.	75.
83.	83.	82.	82.	82.	82.	81.	81.	80.	80.	80.	79.	79.	78.	78.	78.	77.	77.	77.	76.	76.	76.	75.	75.
84.	84.	83.	83.	83.	82.	82.	82.	81.	81.	80.	80.	79.	79.	78.	78.	78.	77.	77.	77.	76.	76.	75.	75.
85.	85.	84.	84.	84.	83.	83.	82.	82.	81.	81.	80.	80.	79.	79.	78.	78.	77.	77.	77.	77.	76.	76.	75.
86.	86.	85.	85.	85.	84.	84.	83.	83.	82.	81.	81.	80.	80.	79.	78.	78.	78.	77.	77.	77.	76.	76.	75.
87.	87.	87.	86.	86.	85.	85.	84.	83.	83.	82.	81.	81.	80.	79.	79.	78.	78.	78.	77.	77.	77.	76.	76.
88.	88.	88.	87.	87.	86.	85.	84.	84.	83.	83.	82.	81.	80.	80.	79.	79.	78.	78.	77.	77.	77.	76.	76.
90.	89.	89.	88.	88.	87.	86.	85.	85.	84.	83.	82.	82.	81.	80.	79.	79.	78.	78.	78.	77.	77.	76.	76.
91.	91.	90.	90.	89.	88.	87.	86.	85.	85.	84.	83.	82.	81.	81.	80.	79.	78.	78.	78.	77.	77.	77.	76.
93.	93.	92.	91.	90.	89.	88.	87.	86.	85.	84.	83.	83.	82.	81.	80.	79.	79.	78.	78.	77.	77.	77.	76.
0.	0.	0.	0.	91.	90.	89.	88.	87.	86.	85.	84.	83.	82.	81.	80.	80.	79.	78.	78.	78.	77.	77.	76.

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95. 95. 94. 93. 92. 91. 90. 88. 87. 86. 85. 84. 84. 83. 82. 81. 80. 79. 79. 78. 78. 77. 77. 77.

94. 94. 93. 92. 91. 90. 89. 88. 87. 86. 85. 84. 83. 82. 82. 81. 80. 79. 79. 78. 78. 77. 77. 76.

93. 93. 92. 91. 91. 90. 89. 88. 87. 86. 85. 84. 83. 82. 81. 81. 80. 79. 79. 78. 78. 77. 77. 76.

91. 91. 91. 91. 90. 89. 88. 87. 86. 85. 84. 84. 83. 82. 81. 80. 80. 79. 78. 78. 78. 77. 77. 76.

90. 90. 90. 90. 89. 88. 87. 87. 86. 85. 84. 83. 82. 82. 81. 80. 79. 79. 78. 78. 78. 77. 77. 76.

90. 90. 89. 89. 88. 88. 87. 86. 85. 84. 84. 83. 82. 81. 81. 80. 79. 79. 78. 78. 77. 77. 76. 76.

89. 89. 88. 88. 88. 87. 86. 85. 85. 84. 83. 83. 82. 81. 80. 80. 79. 78. 78. 78. 77. 77. 76. 76.

88. 88. 88. 87. 87. 86. 86. 85. 84. 83. 83. 82. 81. 81. 80. 79. 79. 78. 78. 78. 77. 77. 76. 76.

87. 87. 87. 86. 86. 86. 85. 84. 84. 83. 82. 82. 81. 80. 80. 79. 79. 78. 78. 77. 77. 77. 76. 76.

86. 86. 86. 86. 85. 85. 84. 84. 83. 82. 82. 81. 81. 80. 79. 79. 78. 78. 77. 77. 77. 77. 76. 76.

85. 85. 85. 85. 85. 84. 84. 83. 83. 82. 81. 81. 80. 80. 79. 79. 78. 78. 77. 77. 77. 76. 76. 75.

85. 85. 85. 84. 84. 84. 83. 83. 82. 81. 81. 80. 80. 79. 79. 78. 78. 77. 77. 77. 76. 76. 76. 75.

84. 84. 84. 84. 83. 83. 83. 82. 82. 81. 80. 80. 79. 79. 79. 78. 78. 77. 77. 77. 76. 76. 75. 75.

83. 83. 83. 83. 83. 82. 82. 81. 81. 81. 80. 80. 79. 79. 78. 78. 77. 77. 77. 76. 76. 75. 75. 75.

83. 83. 83. 82. 82. 82. 81. 81. 81. 80. 80. 79. 79. 78. 78. 77. 77. 77. 76. 76. 76. 75. 75. 75.

82. 82. 82. 82. 82. 81. 81. 81. 80. 80. 79. 79. 78. 78. 78. 77. 77. 76. 76. 76. 75. 75. 75. 75.

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80. 80. 80. 80. 79. 79. 79. 79. 78. 78. 78. 77. 77. 76. 76. 75. 75. 75. 75. 74. 74. 74. 73. 73.

79. 79. 79. 79. 79. 79. 79. 78. 78. 78. 77. 77. 76. 75. 75. 75. 75. 75. 74. 74. 74. 73. 73. 73.

79. 79. 79. 79. 79. 78. 78. 78. 78. 77. 77. 76. 76. 75. 75. 75. 75. 74. 74. 73. 73. 73. 73. 72.

78. 78. 78. 78. 78. 78. 78. 77. 77. 77. 76. 75. 75. 75. 75. 74. 74. 74. 73. 73. 73. 73. 72. 70.

78. 78. 78. 78. 77. 77. 77. 77. 76. 76. 76. 75. 75. 74. 74. 74. 74. 73. 73. 73. 72. 71. 68. 68.

77. 77. 77. 77. 77. 77. 76. 76. 76. 76. 75. 74. 74. 74. 74. 73. 73. 73. 73. 72. 71. 68. 68. 65.

77. 77. 77. 77. 77. 77. 76. 76. 76. 75. 75. 74. 74. 73. 73. 73. 73. 72. 71. 71. 68. 65. 65. 65.

77. 77. 77. 76. 76. 76. 76. 76. 75. 75. 74. 73. 73. 73. 73. 72. 71. 71. 68. 68. 65. 65. 65. 0.

Q-80-50

NOISE FOOTPRINT IN EPNDB. FLIGHT DIRECTION IS DOWN THE PAGE. 125 FT GRID.

65.	65.	65.	65.	65.	65.	65.	65.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
68.	68.	68.	68.	68.	65.	65.	65.	65.	65.	65.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
70.	70.	70.	70.	70.	68.	68.	68.	68.	65.	65.	65.	65.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
72.	72.	72.	71.	70.	70.	70.	70.	68.	68.	68.	65.	65.	65.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
73.	73.	73.	72.	72.	72.	72.	71.	70.	70.	70.	68.	68.	65.	65.	65.	0.	0.	0.	0.	0.	0.	0.	0.
73.	73.	73.	73.	73.	73.	73.	72.	72.	72.	70.	70.	68.	68.	65.	65.	65.	0.	0.	0.	0.	0.	0.	0.
74.	74.	74.	74.	74.	73.	73.	73.	73.	73.	72.	71.	70.	70.	68.	65.	65.	65.	0.	0.	0.	0.	0.	0.
75.	75.	75.	74.	74.	74.	74.	74.	73.	73.	73.	72.	72.	70.	70.	68.	65.	65.	65.	0.	0.	0.	0.	0.
76.	76.	76.	75.	75.	75.	75.	74.	74.	74.	73.	73.	73.	72.	70.	70.	68.	65.	65.	65.	0.	0.	0.	0.
76.	76.	76.	76.	76.	76.	76.	75.	75.	74.	74.	73.	73.	73.	72.	70.	70.	68.	65.	65.	0.	0.	0.	0.
77.	77.	77.	77.	77.	76.	76.	76.	75.	75.	75.	74.	73.	73.	73.	72.	70.	70.	68.	65.	65.	0.	0.	0.
78.	78.	78.	78.	78.	77.	77.	77.	76.	76.	75.	75.	74.	73.	73.	73.	72.	70.	68.	68.	65.	65.	0.	0.
79.	79.	79.	79.	78.	78.	78.	77.	77.	76.	76.	75.	75.	74.	73.	73.	73.	72.	70.	68.	65.	65.	0.	0.
80.	80.	80.	80.	79.	79.	78.	78.	77.	77.	76.	76.	75.	75.	74.	73.	73.	73.	71.	70.	68.	65.	65.	0.
81.	81.	81.	81.	80.	80.	79.	79.	78.	78.	77.	76.	76.	75.	75.	74.	73.	73.	72.	70.	68.	65.	65.	0.
82.	82.	82.	82.	81.	81.	80.	80.	79.	78.	78.	77.	76.	76.	75.	74.	74.	73.	73.	71.	69.	68.	65.	65.
83.	82.	81.	81.	80.	75.	0.	0.	80.	79.	78.	77.	77.	76.	75.	75.	74.	73.	73.	72.	70.	68.	65.	65.
84.	84.	83.	83.	82.	81.	76.	0.	80.	80.	79.	78.	77.	76.	76.	75.	75.	74.	73.	73.	70.	68.	65.	65.
86.	86.	85.	85.	83.	82.	81.	75.	81.	80.	79.	79.	78.	77.	76.	75.	75.	74.	74.	73.	72.	69.	68.	65.
88.	87.	87.	86.	85.	83.	82.	80.	81.	81.	80.	79.	78.	77.	76.	76.	75.	74.	74.	73.	72.	70.	68.	65.
0.	0.	0.	0.	86.	85.	83.	82.	82.	81.	80.	79.	78.	78.	77.	76.	75.	75.	74.	74.	73.	70.	68.	65.

0. 0. 0. 0. 86. 85. 83. 82. 82. 81. 80. 79. 78. 78. 77. 76. 75. 75. 74. 74. 73. 70. 68. 65.

0. 0. 0. 0. 87. 86. 84. 82. 82. 81. 80. 80. 79. 78. 77. 76. 75. 75. 74. 74. 73. 70. 68. 65.

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0. 0. 0. 0. 89. 87. 85. 84. 83. 82. 81. 80. 79. 78. 77. 77. 76. 75. 74. 74. 73. 72. 68. 65.

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0. 0. 0. 0. 89. 87. 86. 84. 83. 82. 81. 80. 79. 78. 78. 77. 76. 75. 74. 74. 73. 72. 68. 65.

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90. 90. 89. 88. 87. 86. 84. 83. 83. 82. 81. 80. 79. 78. 77. 77. 76. 75. 74. 74. 73. 71. 68. 65.

89. 88. 88. 87. 86. 85. 84. 81. 82. 81. 81. 80. 79. 78. 77. 76. 76. 75. 74. 74. 73. 71. 68. 65.

87. 87. 87. 86. 85. 85. 82. 75. 82. 81. 80. 79. 79. 78. 77. 76. 75. 75. 74. 73. 73. 68. 68. 65.

86. 86. 86. 85. 85. 83. 78. 0. 82. 81. 80. 79. 78. 78. 77. 76. 75. 75. 74. 73. 73. 68. 65. 65.

85. 85. 85. 85. 84. 83. 83. 82. 81. 80. 80. 79. 78. 77. 77. 76. 75. 74. 74. 73. 71. 68. 65. 65.

84. 84. 84. 84. 83. 83. 82. 81. 81. 80. 79. 78. 78. 77. 76. 75. 75. 74. 73. 73. 68. 68. 65. 0.

84. 84. 83. 83. 83. 82. 81. 81. 80. 79. 79. 78. 77. 77. 76. 75. 75. 74. 73. 72. 68. 65. 65. 0.

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82. 82. 82. 82. 81. 81. 80. 80. 79. 78. 78. 77. 76. 76. 75. 74. 74. 73. 71. 68. 65. 65. 0. 0.

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79. 79. 79. 79. 79. 78. 78. 77. 77. 76. 76. 75. 75. 74. 73. 71. 68. 65. 65. 0. 0. 0. 0. 0.

78. 78. 78. 78. 78. 78. 77. 77. 76. 76. 75. 75. 74. 73. 71. 70. 65. 65. 0. 0. 0. 0. 0. 0.

78. 78. 78. 78. 77. 77. 77. 76. 76. 75. 75. 74. 71. 71. 70. 65. 65. 0. 0. 0. 0. 0. 0. 0.

77.	77.	77.	77.	77.	77.	76.	76.	75.	74.	74.	71.	71.	68.	65.	65.	0.	0.	0.	0.	0.	0.	0.	0.
76.	76.	76.	76.	76.	76.	76.	75.	74.	72.	71.	70.	65.	65.	65.	0.	0.	0.	0.	0.	0.	0.	0.	0.
76.	76.	75.	76.	76.	75.	74.	72.	71.	70.	68.	65.	65.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
74.	74.	74.	73.	73.	73.	72.	70.	68.	65.	65.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
73.	73.	72.	71.	70.	70.	65.	65.	65.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
69.	69.	69.	68.	68.	65.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

D-80-50

NOISE FOOTPRINT IN EPNDB. FLIGHT DIRECTION IS DOWN THE PAGE. 125 FT GRID.

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
65.	65.	65.	65.	65.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
70.	70.	68.	68.	68.	65.	65.	65.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
71.	71.	71.	71.	70.	70.	68.	65.	65.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
73.	73.	72.	72.	72.	72.	71.	70.	68.	65.	65.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
74.	74.	74.	74.	73.	73.	72.	72.	71.	70.	68.	65.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
75.	75.	75.	74.	74.	74.	74.	73.	72.	71.	70.	68.	65.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
76.	76.	76.	76.	75.	75.	74.	74.	73.	72.	72.	70.	68.	65.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
77.	77.	77.	77.	76.	76.	75.	75.	74.	74.	73.	72.	70.	68.	65.	0.	0.	0.	0.	0.	0.	0.	0.	0.
78.	78.	78.	78.	77.	77.	76.	76.	75.	75.	74.	73.	72.	70.	65.	65.	0.	0.	0.	0.	0.	0.	0.	0.
79.	79.	79.	79.	78.	78.	77.	76.	76.	75.	75.	74.	73.	71.	68.	65.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	76.	76.	75.	75.	73.	72.	70.	68.	65.	0.	0.	0.	0.	0.	0.	0.
80.	76.	75.	0.	0.	0.	0.	0.	77.	77.	76.	75.	74.	73.	72.	68.	65.	0.	0.	0.	0.	0.	0.	0.
82.	81.	81.	80.	75.	0.	0.	0.	78.	77.	76.	75.	75.	74.	73.	70.	65.	0.	0.	0.	0.	0.	0.	0.
84.	84.	83.	81.	80.	75.	0.	0.	79.	78.	77.	76.	75.	74.	73.	70.	68.	65.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	81.	80.	0.	0.	79.	78.	77.	76.	76.	75.	74.	72.	68.	65.	0.	0.	0.	0.	0.	0.

Information Processing Center

0. 0. 0. 0. 81. 80. 0. 0. 79. 78. 77. 76. 76. 75. 74. 72. 68. 65. 0. 0. 0. 0. 0. 0.

0. 0. 0. 0. 83. 81. 75. 0. 80. 79. 78. 77. 76. 75. 74. 73. 69. 65. 0. 0. 0. 0. 0. 0.

0. 0. 0. 0. 85. 82. 78. 0. 80. 79. 78. 77. 76. 75. 74. 73. 70. 65. 0. 0. 0. 0. 0. 0.

0. 0. 0. 0. 85. 83. 80. 0. 80. 79. 78. 77. 76. 75. 74. 73. 70. 65. 0. 0. 0. 0. 0. 0.

0. 0. 0. 0. 85. 83. 80. 0. 80. 79. 78. 77. 76. 76. 75. 74. 70. 65. 0. 0. 0. 0. 0. 0.

0. 0. 0. 0. 85. 83. 79. 0. 80. 79. 78. 78. 76. 76. 75. 74. 70. 65. 0. 0. 0. 0. 0. 0.

0. 0. 0. 0. 85. 83. 78. 0. 80. 79. 78. 77. 76. 76. 75. 73. 69. 65. 0. 0. 0. 0. 0. 0.

0. 0. 0. 0. 84. 82. 75. 0. 80. 79. 78. 77. 77. 75. 75. 73. 69. 65. 0. 0. 0. 0. 0. 0.

86. 86. 85. 84. 83. 78. 0. 0. 80. 79. 78. 77. 76. 75. 75. 73. 68. 65. 0. 0. 0. 0. 0. 0.

85. 85. 84. 83. 78. 0. 0. 0. 80. 79. 78. 77. 76. 75. 74. 73. 68. 0. 0. 0. 0. 0. 0. 0.

83. 83. 82. 78. 0. 0. 0. 0. 79. 79. 78. 77. 76. 75. 74. 71. 65. 0. 0. 0. 0. 0. 0. 0.

78. 75. 0. 0. 0. 0. 0. 0. 79. 78. 77. 76. 76. 75. 74. 70. 65. 0. 0. 0. 0. 0. 0. 0.

82. 82. 82. 82. 81. 81. 80. 79. 78. 78. 77. 76. 75. 74. 73. 65. 0. 0. 0. 0. 0. 0. 0. 0.

81. 81. 81. 81. 81. 80. 79. 79. 78. 77. 77. 76. 75. 74. 71. 65. 0. 0. 0. 0. 0. 0. 0. 0.

80. 80. 80. 80. 80. 79. 79. 78. 77. 77. 76. 75. 75. 72. 70. 0. 0. 0. 0. 0. 0. 0. 0. 0.

80. 80. 80. 79. 79. 79. 78. 78. 77. 76. 76. 75. 74. 70. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.

79. 79. 79. 79. 78. 78. 78. 77. 76. 76. 75. 74. 71. 65. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.

78. 78. 78. 78. 78. 77. 77. 77. 76. 75. 73. 71. 68. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.

77. 77. 78. 77. 77. 77. 76. 76. 75. 74. 71. 68. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.

76. 76. 77. 77. 76. 76. 75. 74. 74. 71. 70. 65. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.

76. 76. 76. 76. 75. 74. 74. 72. 70. 68. 65. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.

74. 75. 74. 74. 73. 72. 71. 70. 68. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.

71. 71. 71. 70. 70. 70. 68. 65. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.

68.	68.	68.	68.	68.	65.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
65.	65.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

S-80-50

NOISE FOOTPRINT IN EPNDB. FLIGHT DIRECTION IS DOWN THE PAGE. 125 FT GRID.

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
68.	68.	68.	65.	65.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
70.	70.	70.	70.	68.	68.	65.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
72.	72.	71.	71.	71.	70.	69.	68.	65.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
74.	73.	73.	73.	72.	72.	71.	70.	68.	65.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
74.	74.	74.	74.	74.	73.	72.	71.	70.	69.	68.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
76.	76.	75.	75.	74.	74.	74.	73.	72.	71.	69.	68.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
77.	77.	76.	76.	76.	75.	74.	74.	73.	72.	71.	68.	65.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	74.	73.	72.	70.	68.	65.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	75.	74.	73.	71.	69.	68.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
75.	0.	0.	0.	0.	0.	0.	0.	75.	75.	74.	72.	70.	68.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
81.	80.	76.	0.	0.	0.	0.	0.	76.	75.	74.	73.	72.	69.	65.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	76.	76.	75.	73.	72.	70.	68.	0.	0.	0.	0.	0.	0.	0.	0.	0.

0. 0. 0. 0. 0. 0. 0. 0. 78. 76. 75. 74. 72. 70. 68. 0. 0. 0. 0. 0. 0. 0. 0. 0.

0. 0. 0. 0. 78. 0. 0. 0. 77. 76. 75. 74. 73. 70. 68. 0. 0. 0. 0. 0. 0. 0. 0. 0.

0. 0. 0. 0. 81. 0. 0. 0. 77. 77. 75. 74. 73. 71. 68. 0. 0. 0. 0. 0. 0. 0. 0. 0.

0. 0. 0. 0. 81. 75. 0. 0. 78. 77. 76. 75. 74. 72. 68. 65. 0. 0. 0. 0. 0. 0. 0. 0.

0. 0. 0. 0. 81. 75. 0. 0. 78. 77. 76. 75. 74. 72. 68. 65. 0. 0. 0. 0. 0. 0. 0. 0.

0. 0. 0. 0. 81. 0. 0. 0. 78. 77. 76. 75. 74. 72. 68. 0. 0. 0. 0. 0. 0. 0. 0. 0.

0. 0. 0. 0. 79. 0. 0. 0. 78. 77. 76. 75. 74. 72. 68. 0. 0. 0. 0. 0. 0. 0. 0. 0.

0. 0. 0. 0. 0. 0. 0. 0. 78. 77. 76. 75. 74. 71. 68. 0. 0. 0. 0. 0. 0. 0. 0. 0.

83. 83. 80. 78. 0. 0. 0. 0. 78. 76. 76. 75. 74. 70. 68. 0. 0. 0. 0. 0. 0. 0. 0. 0.

78. 78. 0. 0. 0. 0. 0. 0. 77. 76. 75. 75. 73. 68. 65. 0. 0. 0. 0. 0. 0. 0. 0. 0.

0. 0. 0. 0. 0. 0. 0. 0. 77. 76. 75. 74. 71. 68. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.

0. 0. 0. 0. 0. 0. 0. 0. 76. 76. 75. 74. 71. 65. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.

79. 79. 79. 79. 79. 78. 77. 77. 76. 75. 74. 72. 70. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.

78. 78. 78. 78. 78. 77. 77. 76. 76. 75. 73. 72. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.

78. 78. 78. 77. 77. 77. 76. 76. 75. 73. 72. 65. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.

77. 76. 77. 76. 76. 76. 75. 75. 74. 72. 70. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.

76. 76. 76. 76. 76. 75. 74. 73. 72. 68. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.

75. 75. 75. 75. 74. 74. 73. 72. 68. 65. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.

74. 74. 74. 73. 73. 72. 69. 68. 65. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.

72. 72. 70. 69. 69. 68. 65. 65. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.

69. 68. 68. 68. 65. 65. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.

65. 65. 65. 65. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.

0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.