THESIS

COMPUTER PROGRAM FOR CONCEPTUAL TANDEM ROTOR HELICOPTER DESIGN

by

Bruce A. Vandenbos

September 1987

Thesis Advisor: D. M. Layton

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The conceptual phase of a helicopter design includes comparison of configurations which will meet the specified performance requirements. To perform this comparison, the designer must have the proper tools at hand. This thesis presents an interactive program for the conceptual design of tandem rotor helicopters. It is intended to complement the existing single rotor design program written for the Helicopter Design course, AE-4306, taught at the Naval Postgraduate School, Monterey, CA.

This program manages the myriad of interrelated parameters by prompting for input, providing the opportunity for changes, and displaying the results. This relieves the designer of the tedious calculations and bookkeeping, thus allowing time for a more thorough analysis of the design.
Computer Program for Conceptual Tandem Rotor Helicopter Design

by

Bruce A. Vandenbos
Lieutenant, United States Navy
B.S., Oregon State University, 1980

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Author: Bruce A. Vandenbos

Approved by: Donald M. Layton, Thesis Advisor

M.F. Platzer, Chairman, Department of Aeronautics

Gordon E. Schacher
Dean of Science and Engineering
ABSTRACT

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This program manages the myriad of interrelated parameters by prompting for input, providing the opportunity for changes, and displaying the results. This relieves the (student) designer of the tedious calculations and bookkeeping, thus allowing time for a more thorough analysis of the design.
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No acknowledgement would be complete without expressing one's gratitude to the family who must endure such an undertaking. So, I extend a special thanks to my wife, Rachel, who's selfless devotion of time and energy are greatly appreciated.
I. INTRODUCTION

A. BACKGROUND

Helicopter Design, AE-4306, as taught at the Naval Postgraduate School requires the "Conceptual Design" of a specific mission-capable helicopter as one of the course requirements.

Conceptual Design is the first of five phases where configurations are compared; cost, weight and size are estimated; feasibility is studied, and then follow-on recommendations are made [Ref. 1]. It is the first of these, comparison of configurations, which prompted this thesis.

Tandem rotor helicopters have been successfully employed since March of 1945 when the PV-3 Dogship was developed for the U.S. Navy. As with all else in aviation, humble beginnings give way to technology and ingenuity, so that by the mid 1960's, Boeing Vertol had developed the H-46 Sea Knight and H-47 Chinook. Both are still currently in use, flying today in all four U.S. armed services, various commercial operations (logging, oil production, etc.) as well as servicing in other countries such as Japan, Canada, Great Britain and Sweden.

To the casual observer the appeal of the tandem rotor scheme is obvious--both rotors provide thrust in the correct direction (up) and therefore a fraction of the power isn't wasted pushing the helicopter sideways, as in the tail rotor configuration. Although somewhat true, this observation does require clarification. Tail rotors typically absorb 10 to 20 percent of the engine power required to hover [Ref. 2]. This decreases in forward flight because of translational lift effects which produce a decrease in main rotor
torque. This provides a slight reduction in tail rotor power. Tandems also have a power penalty due to interference effects found where the two rotor disks overlap. Analytically, this is accounted for by correcting induced power with a "rotor interference factor", K, which has been determined empirically to be a function of the rotor shaft spacing ratio [Ref. 3 and Ref. 4]. For forward flight, another factor must be included, $K_u$, the "induced power correction factor". A combination of these factors results in losses comparable to those of the tail rotor configuration, depending on the regime of flight. It is noticeable that tandems appear better in hover and low forward velocities with the single rotor having advantages at medium to high forward velocity. However, these apparent respective advantages are not clearly defined, nor are they easily quantified.

Reference [5] is an interactive program for conceptual helicopter design, but is restricted to the single rotor configuration. This thesis project sought to complete the designer's "tool box" with the development of a Tandem Rotor Helicopter Design program. Configuration selection could then be based upon design superiority and mission requirement rather than philosophical whim.

Aside from the nebulous factors discussed above, there are distinct advantages and disadvantages to a tandem rotor system. Some advantages of the tandem rotor design are:

- Anti-torque is encumbent in the counter-rotating rotor system.
- No tail rotor losses or side force that require compensation.
- Lighter drive system due to smaller diameter, higher rpm rotors (therefore less speed reduction).
Much larger range in center of gravity locations.

Relatively small effect of wind direction on hover capability. [Ref. 2]

As important as the advantages of a given system are, its limitations must be considered also. Disadvantages, relative to single rotor systems, are:

- Greater directional instability, due to decreased distance from center of gravity position to tail surface.
- High moment of inertia about the vertical axis due to transmission mass located at each end.
- Higher induced power required on aft rotor due to the forward rotor downwash.
- Vibration—twice as many rotors tend to produce greater vibration problems than a single rotor configuration. [Ref. 2]

Although some of these are significant problems, none are insurmountable. Furthermore, the technological developments of the past 20 years are updating the previous solutions to these design problems with current computer and material technology. For example, the Army is currently updating its H-47 fleet to the "D" model Chinook and the Navy and Marine Corps are upgrading their H-46's through the Survivability, Reliability and Maintainability (S R & M) program. Both programs are intended to extend service life well into the next century.

B. OBJECTIVES

The primary objective of this thesis project was to write a computer program for the conceptual design of tandem rotor helicopters. Secondary goals included: interactivity for design flexibility; user friendliness so people will use it; compactness, for microcomputer application; and accuracy so the results are meaningful. All of this required the development of a substantial amount of program software.
The program will be available to students taking the Helicopter Design course, AE-4306. This will provide the option to easily design a helicopter of either rotor system scheme depending on the specific mission that it will be required to perform.
II. APPROACH AND SOLUTION

The initial intent of this project was to integrate a tandem rotor design section into the existing Helicopter Design program written by LT Bob Drake [Ref. 5]. This, however, proved hopeless as the differences in design, equations, input and output became apparent. The problem then became to develop the program in a format compatible with reference 5, but be totally independent.

"User friendliness" is a key phrase commonly heard these days in the computer business, and with good reason. People want to use the computer as a tool to accomplish a given task without themselves becoming a slave to the green screen and microchip. To this end, Tandem Rotor Helicopter Design was written as a menu driven, interactive program that would, to the maximum extent possible, trap errors and return to a menu or input field without terminating the program.

Microsoft GWBASIC was chosen as the language, not only to be consistent with Reference 5 but also because of its compatibility with IBM, and all true compatibles. Furthermore, since there was only a small amount of serious number crunching to be done, vast speed was not required; hence, GWBASIC was the logical choice.

The program is formatted into a sequence of chapters that roughly correspond to the Helicopter Design Manual [Ref. 1]. Although tandems are different in some respects, they share many similarities with their single rotor cousins. Therefore, the program references the design manual frequently, and also provides additional, tandem rotor specific, information when appropriate. This provides the student designer
hard copy reference material to complement "information" and "help windows" that are built into the program.

Each chapter is designed to run as a follow-on to the previous, with provisions to make changes as desired. New data is then entered, when prompted, into specific input fields. When data entry is complete the computer will calculate the results and display them on an output field, usually on the same screen, so that input and output can be viewed simultaneously. The "ANY CHANGES?" prompt will then appear allowing the adjustment of parameters to meet design specification. Once a design is refined, a print-screen command gives a hard copy of the results, then the appropriate menu selection proceeds to the next section or returns to the main menu. All chapters are linked via the "chain" command which not only passes control and executes the next program, but also passes all variables.

One important feature of this program is the use of FLASHUP WINDOWS® [Ref. 6] to display menus, information and help to the user. This outstanding application software allows addition of useful documentation that can be easily accessed by the user. By simply pressing ALT-F1, with the cursor on the appropriate line, a "help window" will be displayed for each major input parameter. pressing "Enter" clears the window and returns to the input line. Information windows will display automatically when a particular chapter or section is selected and will remain as long as desired. Again, "Enter" clears the window and proceeds with the program. Menus function in much the same fashion, except that they remain until the user makes a selection, either by pressing the first character (letter or number) in the menu line or by using the
"up"-"down" arrow keys to highlight the item then pressing "Enter" to execute the selection.

For this project the *Helicopter Design Manual* [Ref. 1] and *Helicopter Performance* [Ref. 3] were the primary source of equations. In addition, several other resources were tapped in the development of the analytical routines of the program. Power requirements for tandems are computed using equations developed from a combination of momentum theory and test data. This set of semi-empirical equations was found to be the most accurate when compared to actual H-46 and H-47 test data [Ref. 4]. Weight estimation used parametric equations, specially developed for tandem rotor helicopters in [Ref. 7].
III. RESULTS

Conceptual helicopter design is based on a myriad of interrelated parameters which constantly require changes and iteration to meet the design specification. This program handles the tedious calculations and bookkeeping allowing the designer to delve deeper into the intricacies of the design. Thus the engineer will spend his time evaluating options, optimizing parameters or conducting trade-off studies, instead of performing mindless hand calculations. Furthermore, this program is designed to teach, as well as being a tool. The optional "help windows" and information screens all serve to help the novice helicopter designer learn the process. Once the process is learned, the designer can quickly refresh his memory without interrupting the continuity of the program. In short, the Tandem Rotor Helicopter Design program complements existing software, is easy to use, and gives excellent results for Conceptual Design.

Appendix A contains the "user's guide" to the program. It is intended to help students get started and use the program regardless of their experience level with personal computers.

Appendix B shows results for a conceptual design of a helicopter with design parameters similar to those of the H-46.

Appendix C is the program listing.
IV. CONCLUSIONS AND RECOMMENDATIONS

Computer assisted design is a rapidly expanding aspect of the engineering world—and with good reason. Virtually all aspects of design are easier, faster and more accurate with the advent of the modern digital computer. Furthermore, microcomputers have become so common that the power of the computer is available to virtually everyone.

Tandem Rotor Helicopter Design is a small addition to the vast amount of software that is being developed. With it, the student can work through the conceptual design of several helicopters in a fraction of the time that it previously took for just a single design.

It is recommended as a follow-on to this thesis that graphics routines be integrated into the program that will plot directly the important relationships between parameters. For example, the Power -vs- Velocity graph which shows induced, profile, parasitic, as well as total power and high speed effects could be plotted directly from the results produced in chapter 5. This would provide an immediate visual presentation of how the design should perform.

Another recommendation would be the addition of a "blade optimization" routine similar to the one in the Single Rotor Helicopter Design program [Ref. 5]. This program however, should run separately from the remainder of the program since blade optimization is more "detailed" than "conceptual" design.

Finally it is recommended that microcomputers receive more emphasis in the Aeronautical Engineering curriculum. A course that includes an introduction to personal computers as well as basic operation procedures would be of great value to the students.
APPENDIX A
TANDEM ROTOR HELICOPTER DESIGN
USER’S GUIDE

1. INTRODUCTION

This program is designed as a menu driven, interactive design tool that will perform the bookkeeping and iterative calculations required in a conceptual design. Since no tandem rotor design manual is available, information screens are displayed automatically when amplifying information was deemed appropriate. These will remain until the "Enter" key is pressed to continue. Also available, in most chapters, are "help windows" which are not normally displayed but are there if required. A notice (ALT-F1 for help) will appear to the right of the title if "help" is available. These "help windows" can be accessed by first locating the cursor on the corresponding input line, then press the "Alt" and "F1" keys (ALT-F1). Pressing "Enter" clears the window and restores program execution. Finally the Helicopter Design Manual [Ref. 1] is referenced extensively throughout the program. Though not totally compatible with tandem design, the program does follow this design manual where possible. Thus, the Tandem Rotor Helicopter Design program complements the Helicopter Design Manual [Ref. 1] with additional tandem rotor specific information.
2. BASICS
   a. HARDWARE

   COMPUTER: IBM PC or compatible with 128K of RAM.
   MONITOR: Color if possible, but monochrome will work.
   PRINTER: Any that will respond to the "Shift-PrtSc" option.

   b. GETTING STARTED

   Place the program disk into drive A and turn on the computer. The "system" as well as all other support software are on the disk for user convenience. The program will be loaded and run automatically, so relax and let the system work. If the computer is on, just insert the disk and press the CTRL-ALT-DELETE keys simultaneously to reboot the system.

   c. USING THE PROGRAM

   The main menu is the first display seen and will serve as a road map for progressing through the program. At the end of each chapter, control will be transferred back to the main menu to select the next option or quit if so desired. Selections can be made in one of two ways. First, use the up-down arrow keys to move the cursor to highlight the desired item, then press "Enter". The second option is to simply press the first letter or number key of the desired menu item; program execution will begin immediately.

   Once established within a chapter, follow the prompts and input the data as requested. If a mistake is made -DON'T WORRY- the opportunity will be provided to change any item once all data is entered. Note that some variables require a positive, non-zero value. If zero or a negative number is entered a window will appear to advise you of the error. Press "Enter" to clear the window and then enter the correct number. A similar window appears if an error is made when
selecting an item to change. Again, press "Enter" and continue.

Each chapter is organized into a series of spreadsheet type screens that show input and output together (if possible). When the input parameters have met the requirements, press the Shift-PrtSc keys simultaneously for a hard copy.

d. SPECIAL INSTRUCTIONS

This section provides a brief synopsis of each chapter in the program. Each chapter correlates, by number, directly to a corresponding chapter in the Helicopter Design Manual [Ref. 1], with one notable exception: Chapter 4 is reserved for a future blade optimization program since tail rotors don’t really fit into the tandem rotor design scheme.

(1) CHAPTER ONE

This contains a brief introduction and is included for those who do not have access to this user's guide.

(2) CHAPTER TWO

Chapter Two performs the preliminary rotor design for the helicopter. This follows the Helicopter Design Manual [Ref. 1] in determining the major parameters that will effect the eventual performance of the helicopter. Note that one rotor is designed to carry half the gross weight and the two rotor system is assembled in Chapter Three.

(3) CHAPTER THREE

This is the Tandem Rotor System Design segment of the program where two identical counter-rotating rotors are put together as a system. Any of the 13 input variables can be adjusted to observe its effect on power, figure of merit, disk loading, etc. When
these are acceptable, proceed to the weight estimation portion of the program.

Weight estimation is based primarily on power required, but power is a function of weight, hence an iterative process. As with previous sections, input the requisite information at the prompts and the computer does the rest.

(4) CHAPTER FOUR

Blade optimization is to be included at a later date.

(5) CHAPTER FIVE

This chapter incorporates the effects of retreating blade stall, advancing blade shock losses, high altitude hover, and various survivability/safety additions to the total power required. Total power required will be needed to select the engines in the next chapter.

(6) CHAPTER SIX

Engine and transmission selection are the topic of this chapter. To complete the analysis, specific engine data is required. Table VI-1 in the Helicopter Design Manual [Ref. 1] provides a summary of six generic engines that are representative of currently available, power plants. If a specific manufacturer's data is available it too can be used.

(7) CHAPTER SEVEN

This section computes the range and endurance for the helicopter being designed. Chapter 7 should be reviewed before beginning. Once the data is entered it will take a few minutes to solve the equations, so be patient: the computer will beep when it is done.

(8) CHAPTER EIGHT

This chapter is reserved to calculate all of those requirements that don't fit elsewhere. Due to
the differences between tandem and single rotor design
some of these are completed in earlier chapters. Check
the design gross and empty weight as determined back in
Chapter 3.

Maximum hover altitude was specified back in
Chapter 5 and used in determining engine power
required. However, the maximum power is often in
forward flight, thus a higher than specification hover
ceiling will be available.

(9) CHAPTER NINE
This provides a final summary of the
helicopter's designed performance and geometric
parameters.

(10) CHAPTER TEN
Chapter 10 computes an estimate of cost based
on a set of parametric equations that incorporate
component weights (Chapter 3), the inflation rate and
expected production quantity.
APPENDIX B
PROGRAM RESULTS

* PRELIMINARY ROTOR DESIGN *

1. DESIGN MAX GROSS WEIGHT [lbs] (2.1) .......... MGM = 23000
   2. ESTIMATE OF EMPTY WEIGHT [lbs] (2.2) ....... MTW = 12000
   3. ROTOR TIP VELOCITY (700 fps recommended) [ft/s] (2.3) ....... VT = 20000
   4. ROTATIONAL VELOCITY [rpm] (2.4) ............ RPM = 256,500
   5. SPECIFICATION MAX AIRSPEED [K] (2.5) ...... MU = 0.3619
   6. ADVANCE RATIO (2.7) ; FIG. 2-3; CT/S = 0.0544
   7. BLADE CHORD [ft] (2.8) ..................... BL = 459
   8. AVERAGE INDUCTION [ft] (2.9) ............... AR = 1.4531
   9. AVER. LIFT COEFF [2.10] ..................... CL = 0.5400

RETURN TO MAIN MENU

WHICH PARAMETER DO YOU WISH TO CHANGE / SELECT ?

* FOR HARD COPY <SHIFT-PTEST> BEFORE RETURNING TO MAIN MENU ***
* TANDEM ROTOR SYSTEM DESIGN *

1. DESIGN MAX GROSS WEIGHT [lbs] .......... MGW = 23000.0
2. ROTOR RADIUS [ft] ......................... R = 25.3
3. BLADE CHORD [ft] ......................... C = 1.4
4. BLADE PROFILE DRAG COEFFICIENT .......... CD0 = 0.0090
5. NUMBER OF ROTOR BLADES PER HEAD ........ B = 3
6. OPERATING RPM [rpm] ....................... RPM = 263.8
7. ROTOR SHAFT SPACING [ft] .................. S1 = 33.8
8. ROTOR HEAD VERTICAL SPACING [ft] ........ GAP = 4.0
9. HEIGHT OF FORWARD HEAD ABOVE WHEELS [ft] FHH = 12.0
10. PRESSURE ALTITUDE [ft MSL] ............... PA = 0
11. HOVER ALTITUDE [ft AGL] ................... AGL = 10
12. TRUE AIRSPEED [knots] (0 FOR HOVER) ....... TAS = 0
13. EQUIVALENT FRONTAL AREA [ft^2] .......... FF = 44.0
14. COMPONENT WEIGHT ESTIMATES

-- RESULTS --

PI = 1209.82  
PO = 365.92  
PP = 0.00  
PT = 1575.75 HP  

FM = 0.77 (.75 to .85) *HOVER  
DL = 4.20 (5 to 15) ONLY  
CL = 0.42 (CLmax: 1.55)  
AR = 17.56 (15 to 20)  
BL = 0.070 (BLmax: 0.12)  

WHICH PARAMETER DO YOU WISH TO SELECT / CHANGE ? 15
**COMPONENT WEIGHT APPROXIMATIONS**

1. **TYPE LNDG GEAR (TRICYCLE STYLE)**
   1 = FIXED    2 = RETRACTABLE ....... 1
2. NUMBER OF ENGINES (2 or more) .... 2
3. ESTIMATED FUEL CAPACITY (lbs) .... 2600
4. NUMBER OF CREW AND PASSENGERS .... 25
5. WT OF SPECIAL AVIONICS (lbs) .... 120
6. SPECIFICATION USEFUL LOAD (lbs) .... 1800
7. RETURN TO TANDEM ROTOR SYSTEM DESIGN

SELECTION? (1 thru 6 for changes)

<table>
<thead>
<tr>
<th>SPEC MAX GROSS WT (MGW)</th>
<th>23000.0 lbs</th>
</tr>
</thead>
<tbody>
<tr>
<td>NEW A/C EMPTY WT</td>
<td>12093.4</td>
</tr>
<tr>
<td>FUEL WT</td>
<td>2600.0</td>
</tr>
<tr>
<td>PERSONNEL WT</td>
<td>6250.0</td>
</tr>
<tr>
<td>USEFUL LOAD</td>
<td>1800.0</td>
</tr>
</tbody>
</table>

NEW GROSS WT ESTIMATE = 22743.4 lbs

TOTAL POWER FOR HOVER = 2023.9 SHP

<table>
<thead>
<tr>
<th>* COMPONENT *</th>
<th>* WEIGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. MAIN ROTORS</td>
<td>2554.9</td>
</tr>
<tr>
<td>2. FUSELAGE</td>
<td>3097.2</td>
</tr>
<tr>
<td>3. LANDING GEAR</td>
<td>577.1</td>
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<tr>
<td>4. ENGINE NACELLES</td>
<td>201.4</td>
</tr>
<tr>
<td>5. ENGINES</td>
<td>844.3</td>
</tr>
<tr>
<td>6. DRIVE TRAIN</td>
<td>1479.8</td>
</tr>
<tr>
<td>7. FUEL TANKS</td>
<td>323.9</td>
</tr>
<tr>
<td>8. FLIGHT CONTROLS</td>
<td>717.1</td>
</tr>
<tr>
<td>9. AUX POWER (APU)</td>
<td>139.0</td>
</tr>
<tr>
<td>10. INSTRUMENTS</td>
<td>131.8</td>
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<tr>
<td>11. HYDRAULIC SYSTEM</td>
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<td>12. ELECTRICAL SYSTEM</td>
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<tr>
<td>13. AVIONICS</td>
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<td>14. FURNISHINGS</td>
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</tr>
<tr>
<td>15. AC / DE-ICE EQUIP</td>
<td>145.9</td>
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<tr>
<td>16. LOAD HANDLING EQUIP</td>
<td>175.1</td>
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TOTAL COMPONENT WEIGHT = 12093.4

* press <Shift-PrtSc> for hard copy *
* HIGH SPEED EFFECTS AND POWER SUMMARY *  (Alt-F1 for HELP)

1. GROSS WEIGHT [lbs] ...........................................GW = 23000.0
2. ROTOR RADIUS [ft] ...........................................R = 25.3
3. BLADE DATA: CHORD [ft] .................................C = 1.4
4. PROFILE DRAG COEFFICIENT .........................CD0 = 0.0090
5. LIFT CURVE SLOPE [per RAD] .................CLALFA = 5.73
6. STALL ANGLE OF ATTACK [deg] ...............AOAST = 12
7. GEOMETRIC TWIST [deg with sign] ..............TWIST = -8
8. CRITICAL MACH NUMBER .........................MCRT = .73
9. NUMBER OF ROTOR BLADES PER HEAD ..............B = 3
10. OPERATING RPM [rpm] .................................RPM = 263.8
11. ROTOR SHAFT SPACING [ft] .........................S1 = 33.8
12. ROTOR HEAD VERTICAL SPACING [ft] ..........GAP = 4.0
13. HEIGHT OF FORWARD HEAD ABOVE WHEELS [ft] ...FHH = 12.0
14. SPEC PRESSURE ALT [normally 4000 ft MSL]..PASPEC = 4000
15. HOVER ALTITUDE [ft AGL] ..........................AGL = 10
16. SPEC CRUISE AIRSPEED [knots] ..................TASCR = 130
17. SPEC MAX AIRSPEED [knots] ......................TASMX = 150
18. EQUIVALENT FRONTAL AREA [ft^2] ..............FF = 44.0
19. SPEC MAX HOVER ALTITUDE (IGE) [ft] ........MXHVR = 10000
20. COMPUTE NEW POWER REQUIREMENTS 21. RETURN TO MAIN MENU

press <Shift-PrtSc> for hard copy, ENTER to continue
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<td>663</td>
<td>2671</td>
<td>2077</td>
<td>887</td>
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</tr>
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</table>

MINIMUM POWER = 1,449 SHP AT 70 knots
MAXIMUM POWER = 3,839 SHP AT 150 knots
POWER AT HOVER CEILING = 1,926 SHP AT 10000 ft MSL
press <Shift-PrtSc> for hard copy, ENTER to continue
I. - INLETS AND INLET DUCTING -
   1. -S- TYPE (5%)
   2. ICE SHIELD (10%)
   *** 3. STRAIGHT-IN (2%)

   INLET LOSSES = 77 SHP 2.0%

II. - ENGINE AIR PARTICLE SEPARATORS - EAPS
   4. FOAM TYPE BARRIER FILTERS (10%)
   *** 5. POWER (HYDRAULIC) SEPARATORS (2-6%)
   6. NONE INSTALLED

   EAPS LOSSES = 154 SHP 4.0%

III. - ENGINE EXHAUST DEVICES - EEDS
   7. SIMPLE HEAT DIFFUSER (3%)
   8. INFRA-RED SupPRESSOR (5%)
   *** 9. NONE INSTALLED

   EEDS LOSSES = 0 SHP 0.0%

   ENGINE, XMSN and MISC INSTALLATION LOSSES = 509 SHP 13.3%

   TOTAL LOSSES (percent of ESHP) = 740 SHP 16.1%

   MAXIMUM POWER REQUIRED (RSHP) = 3,839 SHP

   * ENGINE SHAFT HORSEPOWER REQUIRED (ESHP) = 4,579 SHP

press <Shift-PrtSc> for hard copy, ENTER to continue
1. NUMBER OF ENGINES = 2  (specified in Chapter 3)

2. NUMBER OF ENGINES COMPETING FOR SELECTION = 2

* ENGINE SELECTION PARAMETERS *

<table>
<thead>
<tr>
<th>ENGINE:</th>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. DRY WEIGHT (lbs)......</td>
<td>709</td>
<td>580</td>
</tr>
<tr>
<td>4. SHP (ssl) military.....</td>
<td>1800</td>
<td>2500</td>
</tr>
<tr>
<td>5. SFC (ssl) military.....</td>
<td>0.595</td>
<td>0.615</td>
</tr>
<tr>
<td>6. INITIAL COST......</td>
<td>$360</td>
<td>$640</td>
</tr>
<tr>
<td>7. OP COST/HR/ENG.....</td>
<td>$35</td>
<td>$40</td>
</tr>
<tr>
<td>8. PREV MAINT/HR/ENG..</td>
<td>$125</td>
<td>$160</td>
</tr>
<tr>
<td>9. MTBMA (hrs)..........</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>10. MDT (hrs)...........</td>
<td>1.3</td>
<td>2</td>
</tr>
<tr>
<td>11. MTBF (hrs)..........</td>
<td>285</td>
<td>280</td>
</tr>
<tr>
<td>12. MTBR (hrs)...........</td>
<td>800</td>
<td>1000</td>
</tr>
</tbody>
</table>

13. SPECIFICATION AVERAGE FLIGHT HOURS PER YEAR ......... = 120
14. SPECIFICATION AVERAGE AIRFRAME SERVICE LIFE IN YEARS = 9
15. AVERAGE FLIGHT HOURS PER FLIGHT .................... = .7

press <Shift-PrtSc> for hard copy, ENTER to continue
**ENGINE SELECTION CRITERIA** *(6.3 & 6.4)*

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>POWERPLANT WEIGHT (installed)</td>
<td>879</td>
<td>737</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LIFE-CYCLE COST</td>
<td>1066</td>
<td>1712</td>
<td>800</td>
<td>1000</td>
<td></td>
</tr>
<tr>
<td>ENG. LIFE (hrs)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NO. OF REPLACEMENTS</td>
<td>0</td>
<td>1000</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>R/D COSTS</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INIORIAL COSTS</td>
<td>360</td>
<td>640</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ANNUAL MAINT. COST</td>
<td>15</td>
<td>19</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ANNUAL OPERATING COST</td>
<td>4</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>REPLACEMENT COST</td>
<td>486</td>
<td>864</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SALVAGE VALUE</td>
<td>288</td>
<td>512</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AVAILABILITY (per engine)</td>
<td>0.698</td>
<td>0.667</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RELIABILITY (per engine)</td>
<td>0.998</td>
<td>0.998</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAINTAINABILITY (per engine)</td>
<td>0.212</td>
<td>0.233</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PERFORMANCE (military SHP)</td>
<td>1800</td>
<td>2500</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

ENTER THE LETTER OF THE SELECTED ENGINE *(i.e. A, B, C)* 

press <Shift-PrtSc> for hard copy, ENTER to continue
**TRANSMISSION SELECTION** *(6.5)*

<table>
<thead>
<tr>
<th>Engines:</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Shaft HP</td>
<td>4579.0 SHP</td>
<td></td>
</tr>
<tr>
<td>Number Installed</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Installed Weight</td>
<td>879.2 lbs</td>
<td></td>
</tr>
<tr>
<td>Transmission: Power Rating</td>
<td>1900.0 SHP</td>
<td></td>
</tr>
<tr>
<td>Weight</td>
<td>1100.0 lbs</td>
<td></td>
</tr>
</tbody>
</table>

**REVISED WEIGHT ESTIMATES**

<table>
<thead>
<tr>
<th>A/C Empty WT</th>
<th>11561.7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel WT</td>
<td>2600.0</td>
</tr>
<tr>
<td>Personnel WT</td>
<td>6250.0</td>
</tr>
<tr>
<td>Useful Load</td>
<td>1800.0</td>
</tr>
</tbody>
</table>

**GROSS WT ESTIMATE** = 22211.7 lbs

<table>
<thead>
<tr>
<th>Total Power for HoGE</th>
<th>1948.1 SHP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disk Loading</td>
<td>5.5046 psf</td>
</tr>
<tr>
<td>Figure of Merit</td>
<td>0.8142</td>
</tr>
</tbody>
</table>

**REVISED COMPONENT WT** *(6.6)*

<table>
<thead>
<tr>
<th>Component</th>
<th>Weight (lbs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Rotors</td>
<td>2554.9</td>
</tr>
<tr>
<td>Fuselage</td>
<td>2485.5</td>
</tr>
<tr>
<td>Landing Gear</td>
<td>501.7</td>
</tr>
<tr>
<td>Engine Nacelles</td>
<td>158.6</td>
</tr>
<tr>
<td>Engines</td>
<td>772.5</td>
</tr>
<tr>
<td>Drive Train/XMSN</td>
<td>1163.7</td>
</tr>
<tr>
<td>Fuel Tanks</td>
<td>323.9</td>
</tr>
<tr>
<td>Flight Controls</td>
<td>554.5</td>
</tr>
<tr>
<td>Aux Power (APU)</td>
<td>139.0</td>
</tr>
<tr>
<td>Instruments</td>
<td>114.7</td>
</tr>
<tr>
<td>Hydraulic System</td>
<td>58.5</td>
</tr>
<tr>
<td>Electrical System</td>
<td>448.1</td>
</tr>
<tr>
<td>Avionics</td>
<td>445.0</td>
</tr>
<tr>
<td>Furnishings</td>
<td>644.7</td>
</tr>
<tr>
<td>AC / DE-ICE Equip</td>
<td>125.1</td>
</tr>
<tr>
<td>Load Handling Equip</td>
<td>149.2</td>
</tr>
</tbody>
</table>

**REVISED COMPONENT WEIGHT = 11561.7**

Press <Shift-PrtSc> for hard copy, ENTER returns to MENU
* RANGE and ENDURANCE *  

(Chap 7)

1. SFC (lb/hr/shp)  
   MILITARY:  .595  
   NORMAL:  .606  
   CRUISE:  .661  

2. SHP  
   1800  
   1530  
   1148  

3. FUEL FLOW (lb/hr)  
   2142.00  
   1854.36  
   1517.66

3. SPECIFICATION CONDITIONS:  
   ALTITUDE = 4000  
   TEMP = 95  
   ZERO HP INTERCEPT = +418.35 (ssl)  
   (+373.64 (spec)  
   PHANTOM HORSEPOWER = +873.76 (ssl)  
   (+780.39 (spec)

* MAX RANGE *  
   AIRSPEED = 120 kts  
   POWER = 2,183 SHP  
   FUEL FLOW = 1,463 lb/hr

* MAX ENDURANCE *  
   AIRSPEED = 70 kts  
   POWER = 1,449 SHP  
   FUEL FLOW = 1,112 lb/hr

* CRUISE PWR & FUEL FLOW: 130 kts *  
   (ssl)  
   (spec)  
   2,624 SHP  
   2,675 lb/hr  
   2,697 SHP  
   1,665 lb/hr

* TOTAL FUEL REQUIREMENTS *  
   4. SPEC MAX RANGE (NM) = 200  
   TOTAL FUEL REQUIRED = 2,954 lbs  
   DESIGN FUEL CAPACITY = 2,600 lbs  
   FUEL DEFICIENCY = 354 lbs

ANY CHANGES? (0=NO, 1=YES) 0
APPENDIX C

VARIABLE DEFINITIONS AND PROGRAM LISTING

1. Units and Constants

- weight = pounds
-airspeed = knots
-velocity = feet per second
-length = feet
-angles = degrees
-power = horsepower
-fuelflow = pounds per hour
-temperature = degrees Fahrenheit

- PIE = 3.1415927
- RHO = sea level density
- MACH = mach number at sea level

2. Chapter Two Variables

- MGW = specification maximum gross weight
- GW = rough estimate gross weight
- MTW = estimate of manufacturer's empty weight
- VTIPMAX = maximum tip velocity
- R = rotor radius
- RPM = revolutions per minute
- RV = rotational velocity in radians per second
- CT = thrust coefficient
- S = blade solidity
- B = number of blades
- C = main rotor blade chord
- AR = main rotor blade aspect ratio
- CI = average lift coefficient
- CDO = blade drag coefficient
- DL = disk loading
- MU = advance ratio
- MBL = maximum blade loading
- VMAX = maximum forward velocity in feet per second
- TASMX = maximum true airspeed in knots

3. Chapter Three Variables

- TIPLOSS = main rotor blade tiploss
- PI = induced power
- PO = profile power
- PP = parasite power
- PT = total power
- FM = figure of merit
- PDW = percent difference in weight
- PF = equivalent flat plate area
- PEOPLE = number of people, including crew
- PAX = weight of passengers and crew
- SPECIAL = weight of special equipment
- AV = vertical area presented by 2 rotors as seen from the front
- AF = total main rotor blade area
- W(N,N) = component weight
- UL = useful load
- FUEL = fuel weight in pounds
- GEAR = type of landing gear
- FHH = forward rotor height above the ground
- VF = airspeed in feet per second
- PI(I) = induced power in forward flight
- PO(I) = profile power in forward flight
PP(I) = parasite power in forward flight
PT(I) = total power in forward flight
I = airspeed counter in knots
ENGN = number of engines installed

4. Chapter Four Variables
Blade optimization program to be added at a later date.

5. Chapter Five Variables
CLALFA = blade lift curve slope
TWIST = main rotor twist angle in degrees
T7 = main rotor twist angle in radians
AOAST = stall angle of attack for rotor blades in degrees
PASPEC = specification altitude
AE = effective disk area
VT = main rotor tip velocity
TAS(I) = airspeed in knots
MD = advance ratio
AOA270 = blade angle of attack at 270 degree position
MACHVEL = local mach number as a function of altitude
MTIP = main rotor blade tip mach number
M90 = mach number advancing at 90 degree position
MCRT = main rotor blade critical mach number
DMD = difference between M90 and MCRT
MD = main rotor blade critical mach number for drag divergence
MTIPHVR = local tip mach number in hover
MTIPFLT = local tip mach number in forward flight
MXHVR = specification hover ceiling
CTHC = thrust coefficient at hover ceiling
TIPHC = tiploss at hover ceiling
PIHC = main rotor induced power at hover ceiling
BI = tiploss
COLANGLE = collective angle in degrees
H8 = collective angle in radians
CYCLIC = cyclic angle in degrees
H2 = cyclic angle in radians
TASCR = cruise airspeed in knots, specification
TASMX = maximum airspeed in knots, specification
TASMXP = airspeed for maximum power required
TASMINP = airspeed for minimum power required
PSPECHVR = total power to HIGE at hover ceiling
DELTA = pressure ratio
THETA = temperature ratio
RSHP = maximum rotor shaft horsepower required
INLET = inlet losses
PINLET = percent loss due to inlets
RSHPINLET = added horsepower for inlets
EAPS = losses due to engine air particle separators
PEAPS = percent loss due to EAPS
RSHPEAPS = added horsepower for EAPS
EEDS = losses due to engine exhaust diffusers
PEEDS = percent loss due to EEDS
RSHPEEDS = added horsepower with EEDS
ENGNLOST = horsepower required to operate engine devices
PCTENGN = percent power required for engine devices
MICSLOST - horsepower absorbed by engine, transmissions and accessories
PCITMISC - percent power required for engines, transmissions and accessories
RSHPLOST - total power lost between engines and rotors
PCITLOST - percent power lost between engines and rotors
ESHP - engine shaft horsepower required to provide rotor power

6. Chapter Six Variables

NENGSEL - number of engines competing for selection
MDT - maintenance down time
MTBF - mean time between failure
MTBR - mean time between replacement
D(W) - engine dry weight
SHP (X) - engine shaft horsepower at military
SFC(X) - specific fuel consumption at military
ENG - number of engines
IC (X) - initial cost
OC (X) - operating cost per hour
PMA(X) - preventative maintenance per engine per hour
MTBMA(X) - mean time between maintenance action
AFL - average flight hours per year
SL - aircraft service life
TAV - average flight hour per flight
YM(X) - engine yearly maintenance cost
YO(X) - engine yearly operating cost
NRPL(X) - number of engine replacements
LC(X) - engine life-cycle cost
RD(X) - engine research and development costs
AVAIL(X) - engine availability
MAINT(X) - engine maintainability
RELY(X) - engine reliability
RC(X) - replacement costs
SC(X) - salvage costs
EWT(X) - installation engines weight
XMSNWP - transmission weight
XMSNP - transmission power rating

7. Chapter Seven Variables

SFC(X) - specific fuel consumption
SHP - shaft horsepower
WDOTF(X) - fuel flow in pounds per hour
BETAH - slope of the fuel flow versus horsepower curve
ALPHAH - zero horsepower intercept
DELTAA - pressure ratio
THETA - temperature ratio
ALT - specification altitude
TEMP - specification temperature
PF - phantom horsepower
TASMXR - maximum range velocity in knots
FFMXR - maximum range fuel flow
RHPMXR - maximum range horsepower
TASMNXP - maximum endurance velocity in knots
PTMIN - SHP for maximum endurance
RHPMXE - maximum endurance referred horsepower
FFMXE - maximum endurance fuel flow
TASCR = cruise velocity
PTCR = cruise power in horsepower
FFCR = cruise fuel flow
MXR = specification maximum range
TFUEL = total fuel required

8. Chapter Eight Variables
   See program listing for variable definition.

9. Chapter Nine Variables
   All variables are the same as above.

10. Chapter Ten Variables
    C(X) = component cost
         CF(X) = total cost
         IFR = inflation rate
        Q = quantity to be produced
'PROGRAM "TRI.BAS"
KEY OFF: FLG2=0

* TANDEM ROTOR HELICOPTER DESIGN *

*** ADMIN / CONTROL ***

PRINT"L=TANDEM/";
COLOR 1:1:PRINT"C=ALL/";CLS: LOCATE 1,1,0
PRINT"W=T_R_MENU/"; INPUT"XX"; PRINT"C=ALL/";
CLS ON XX GOSUB
100,3000,4000,5000,6000,7000,8000,9000,9500,95
GOTO 25
50 LOCATE 1,0: PRINT"W=INTRO/"; INPUT"X1";
PRINT"C=ALL/" : RETURN 25
95 COLOR 1,1,1:LOCATE 1,1,0:PRINT"W=R U SURE/"
96 INPUT"ANS:"; ANS: IF ANS = 1 THEN 25 ELSE SYSTEM
97
98
** PRELIMINARY ROTOR DESIGN **
110 COLOR 1,1,1:LOCATE 1,1,0: PRINT"C=ALL/";
PRINT"W=PRELIM/"; INPUT X2
120 COLOR 15,1 : PRINT"C=ALL/"
130 CNT = 0
140 CLS: LOCATE 1,27 : PRINT "* PRELIMINARY ROTOR DESIGN *"
150 PRINT "1. DESIGN MAX GROSS WEIGHT [lbs] (2.1)
160 PRINT "MTW = "
(2.2) "2. ESTIMATE OF EMPTY WEIGHT [lbs]
170 PRINT "MTW = "
180 PRINT "3. ROTOR TIP VELOCITY (2.3; 700 fps
190 PRINT "VT = "
200 PRINT "4. DISC LOADING [lbs/ft\^2] (2.4; FIG.
210 PRINT "R = "
220 PRINT "ROTOR RADIUS [ft]
230 PRINT "RPM = "
240 PRINT "THRUST COEFFICIENT
250 PRINT "CT = 
260 PRINT "S. SPECIFICATION MAX AIRSPEED [knots]
270 PRINT "TASMX = "
280 PRINT "ADVANCE RATIO (2.7)
290 PRINT "CT/S)"; MBL = "
300 PRINT "MBL = "
310 PRINT "6. MAX BLADE LOADING (2.7; FIG.2-3;
320 PRINT "S = "
330 PRINT "ROTOR SOLIDITY (2.7)
340 PRINT "B = "
350 PRINT "7. NUMBER OF ROTOR BLADES PER HEAD
360 PRINT "AR = "
370 PRINT "BREAKS CHORD [ft] (2.9)
380 PRINT "ASPECT RATIO (2.9)
390 PRINT "B"; AR = "
400 PRINT "AVG LIFT COEFF (2.10)
410 PRINT "CL = "
420 PRINT "COLOR 14,1
430 PRINT "RETURN TO MAIN MENU."
440 LOCATE 23,6: PRINT"*** FOR HARD COPY PRESS
<Shift-PrtSc> BEFORE RETURNING TO MAIN MENU ***": COLOR
R = SQR(ABS(5 * MGW/(DL * PIE)))

CT = MGW / (RHO * PIE * R * R * VT * VT)

RPM = 267.4

S = 34:

DIM W(20, 20), GW(20), WE(20), W6A(10), W6B(10), W6C(10), PDW(9)

PIE = 3.141592:

W6P = 23000:

R = 25.5:

C = 1.5:

CDO = .0089999:

B = 3:

FHH = 16:

PA = 1:

TAS = 1:

FF = 44:

A$ = "######.#":

B$ = "######":

PRINT L = TANDEM3 L:

'FLG2 = 1: FLG3 = 0

PRINT "W=TRYAGAIN/": LOCATE 23, 1:

PRINT SPC(77): RETURN

PROGRAM "TR3.BAS". SEPT 87

PLEASE NOTE: USING BASICA TO RUN THIS PROGRAM WILL CAUSE THE INPUT LINE TO BE DELETED IF THE FLASHUP HELPWINDOW IS DISPLAYED!
1180 PRINT "* TANDEM ROTOR SYSTEM DESIGN *
(Alt-F1 for help)"
1190 PRINT
1200 PRINT "1. DESIGN MAX GROSS WEIGHT [lbs] ............ MGW = ".
1210 PRINT "2. ROTOR RADIUS [ft] R = .
1220 PRINT "3. BLADE CHORD [ft] C = "
1230 PRINT "4. BLADE PROFILE DRAG COEFFICIENT [CD] = "
1240 PRINT "5. NUMBER OF ROTOR BLADES PER HEAD B = ".
1250 PRINT "6. OPERATING RPM [rpm] RPM = "
1260 PRINT "7. ROTOR SHAFT SPACING [ft] S1 = ".
1270 PRINT "8. ROTOR HEAD VERTICAL SPACING [ft] GAP = "
1280 PRINT "9. HEIGHT OF FORWARD HEAD ABOVE WHEELS [ft] FHH = "
1290 PRINT "10. PRESSURE ALTITUDE [ft MSL] PA = "
1300 PRINT "11. HOVER ALTITUDE [ft AGL] AGL = "
1310 PRINT "12. TRUE AIRSPEED [knots] (0 FOR HOVER) TAS = "
1320 PRINT "13. EQUIVALENT FRONTAL AREA [ft^2] FF = "
1325 COLOR 14,1
1330 PRINT "14. COMPONENT WEIGHT ESTIMATES"
1331 COLOR 15,1
1332 IF FLG2 = 1 THEN 1335 ELSE 1375
1335 'load data from previous chapter, if applicable; or allows input'
1336 IF MGW <> 0 THEN LOCATE 3, 61: PRINT USING A$; MGW
1340 IF R <> 0 THEN LOCATE 4, 61: PRINT USING A$; R
1344 IF CDO <> 0 THEN LOCATE 5, 61: PRINT USING C$: CDO
1346 IF B <> 0 THEN LOCATE 7, 61: PRINT USING B$: B
1350 IF RPM <> 0 THEN LOCATE 8, 61: PRINT USING A$; RPM
1354 IF S1 <> 0 THEN LOCATE 9, 61: PRINT USING A$; S1
1358 IF GAP <> 0 THEN LOCATE 10, 61: PRINT USING A$; GAP
1360 IF FHH <> 0 THEN LOCATE 11, 61: PRINT USING A$; FHH
1364 IF PA <> 0 THEN LOCATE 12, 61: PRINT USING B$: PA
1368 IF AGL <> 0 THEN LOCATE 13, 61: PRINT USING B$: AGL
1372 IF CDO <> 0 THEN LOCATE 14, 61: PRINT USING B$: CDO
1376 IF B <> 0 THEN LOCATE 15, 61: PRINT USING A$: B
1380 IF FF <> 0 THEN LOCATE 16, 61: PRINT USING A$: FF
1384 COLOR 15,1
1386 RETURN TO MAIN MENU"
1380 FOR J = 1 TO 13
1390 LOCATE 23, 20: PRINT "ENTER YOUR VALUE FOR ITEM NUMBER " : J
1400 X = J: GOTO 1440
1420 LOCATE 23, 11: INPUT " WHICH PARAMETER DO YOU WISH TO SELECT / CHANGE " ; X
1440 IF X < 1 OR X > 15 THEN GOSUB 4500: IF J = 0 THEN NEXT J
1450 IF J = 1 THEN GOTO 1390
1470 FLG2 = 1: GOTO 1370
1480 DATA ENTRY SUBROUTINES
1500 LOCATE 1, 10: PRINT " K= (ALT-F1), HW1/"
1510 IF MGW <= 0 THEN PRINT " W= DVN0/": GOTO 1500
1520 LOCA TE 4, 60: PRINT SPC(8): LOCATE 4, 60: INPUT " ", MGW: PRINT " K= (ALT-F1)/" 
1530 IF CNT > 1 THEN GOSUB 1770: GOSUB 2140: RETURN ELSE RETURN
1540 LOCATE 1, 10: PRINT " K= (ALT-F1),HW2/"
1550 LOCATE 5, 60: PRINT SPC(8): LOCATE 5, 60: INPUT " ", R: PRINT " K= (ALT-F1)/" 
1560 IF C < 0 THEN PRINT " W= DVN0/": GOTO 1540: ELSE 
1570 IF CNT > 1 THEN GOSUB 1770: GOSUB 2140: RETURN ELSE RETURN
1580 LOCATE 1, 10: PRINT " K= (ALT-F1),HW3/"
1590 LOCATE 4, 60: PRINT SPC(8): LOCATE 4, 60: INPUT " ", C: PRINT " K= (ALT-F1)/" 
1600 IF C <= 0 THEN PRINT " W= DVN0/": GOTO 1580 ELSE 
1610 IF CNT > 1 THEN GOSUB 1770: GOSUB 2140: RETURN ELSE RETURN
1620 LOCATE 1, 10: PRINT " K= (ALT-F1),HW4/"
1630 LOCATE 6, 60: PRINT SPC(8): LOCATE 6, 60: INPUT " ", B: PRINT " K= (ALT-F1)/" 
1640 IF B <= 0 THEN PRINT " W= DVN0/": GOTO 1620 ELSE 
1650 IF CNT > 1 THEN GOSUB 1770: GOSUB 2140: RETURN ELSE RETURN
1660 LOCATE 1, 10: PRINT " K= (ALT-F1),HW5/"
1670 LOCATE 7, 60: PRINT SPC(8): LOCATE 7, 60: INPUT " ", B: PRINT " K= (ALT-F1)/" 
1680 IF B <= 0 THEN PRINT " W= DVN0/": GOTO 1660 ELSE 
1690 IF CNT > 1 THEN GOSUB 1770: GOSUB 2140: RETURN ELSE RETURN
1700 LOCATE 1, 10: PRINT " K= (ALT-F1),HW6/"
1710 LOCATE 8, 60: PRINT SPC(8): LOCATE 8, 60: INPUT " ", RPM: PRINT " K= (ALT-F1)/" 
1720 IF RPM <= 0 THEN PRINT " W= DVN0/": GOTO 1700 ELSE 
1730 IF CNT > 1 THEN GOSUB 1770: GOSUB 2140: RETURN ELSE RETURN
1740 LOCATE 1, 10: PRINT " K= (ALT-F1),HW7/"
1750 LOCATE 9, 60: PRINT SPC(8): LOCATE 9, 60: INPUT " ", S1 
1760 PRINT " K= (ALT-F1)/" : IF CNT > 1 THEN GOSUB 1770: GOSUB 2140: RETURN ELSE RETURN
1770 LOCATE 1, 10: PRINT " K= (ALT-F1),HW8/"
1780 LOCATE 10, 60: PRINT SPC(8): LOCATE 10, 60: INPUT " ".GAP 
1790 PRINT " K= (ALT-F1)/" : IF CNT > 1 THEN GOSUB 1770: GOSUB 2140: RETURN ELSE RETURN
1800 LOCATE 1, 10: PRINT " K= (ALT-F1),HW9/"
1810 LOCATE 11, 60: PRINT SPC(8): LOCATE 11, 60: INPUT " ", FHH: PRINT " K= (ALT-F1)/" 
1820 IF FHH <= 0 THEN PRINT " W= DVN0/": GOTO 1800 ELSE 
1830 IF CNT > 1 THEN GOSUB 1770: GOSUB 2140: RETURN ELSE RETURN
1840 LOCATE 1, 10: PRINT " K= (ALT-F1),HW10/"
LOCATE 12, 61: PRINT SPC(8): LOCATE 12, 60: INPUT"
1670 PRINT "K=(ALT-F1)/": IF CNT>1 THEN GOSUB 1770: GOSUB 2140: RETURN ELSE RETURN
1700 LOCATE 1, 10: PRINT SPC(8): LOCATE 13, 60: INPUT"
1710 PRINT "K=(ALT-F1)/": IF CNT>1 THEN GOSUB 1770: GOSUB 2140: RETURN ELSE RETURN
1720 LOCATE 1, 10: PRINT SPC(8): LOCATE 14, 60: INPUT"
1730 PRINT "K=(ALT-F1)/": IF CNT>1 THEN GOSUB 1770: GOSUB 2140: RETURN ELSE RETURN
1740 LOCATE 1, 10: PRINT SPC(8): LOCATE 15, 60: INPUT"
1750 IF FF <= 0 THEN PRINT "W=DFN0/": GOTO 1740 ELSE GOSUB 1770: GOSUB 2140: RETURN '1460
1760 '******************************************************************** POWER COMPUTATION SUBR
1770 N = 1 : CW(1) = MGW: 'subr access from line 1755
1780 'N = 1 thru 5 as sent from weight comp admin subr.
1790 CW(1) = .5 : MGW
1800 CNT = CNT + 1
1810 NREHT = FHH + .5 * GAP
1820 PGE = (AGL+HTRHT)/(2*R)
1830 PGE = 5147 + 1.3452*GT - 1.4512*GT^2 + .7086*GT^3 - .1276*GT^4
1840 RRH = RPM/9.55 : VT = RV * R : VF = TAS * 1.6883
1850 SIGMA = (1 - 6.8753E-06 * PA)^4.2561
1860 IF PA=0 THEN RHO=RHO0 ELSE IF PA=4000 THEN
1870 MU = VF/VT
1880 B = 1.05 / CGW(N)
1890 STIPLOSS = ((PIF + R) - SQR(2 * CT) / B)
1900 R = SQR(2*CT - SQR(2 + CT) / B)
1910 SR = R/S1
1920 SQRT = (2*CT - SQR(2 + CT) / B)
1930 RHO = S1 / R
1940 AE = 2*(PIF/180)*ACOS(S1/(2*RE))
1950 CT = SQR(T / (2*R^2 - 2^R * GAP)
1960 VI = (AV/AE)*(VF/VI)**4 - (.25*(AV/AE)*(VF/VI)**2)
1970 KU = CW(N)**(-1/4)
1980 AB = CT/S
1990 IF B > C > S1 THEN 3.75 THEN COLOR 1111: LOCATE 1, 10;
2000 PRINT "W=BDSTK/": INPUT X4: PRINT "媱=ALL/": COLOR 15,1
2010 **POWER CALCULATION **
2020 IF GE <= 2 THEN PI = PGE + PI * VI * K * KU / 550
2030 ELSE PI = T * VI * K * KU / 550
2040 PO = (CD* B * C * R / VT^3 * RHO / 2200)*(1 + 4.3
2050 LG = VF^3 * FF * RHO / 1100
2060 FM = PI / (PI + PO)
2070 39
2110 PT = PI + PO + PP + PC
2120 RETURN
2130 '*************************************************************************
2140 ' POWER RESULTS OUTPUT SUBR
2150 '*************************************************************************
2160 LOCATE 17, 34: PRINT "-- RESULTS --";
2170 LOCATE 18, 14: PRINT USING"PI = ######.####"; PI
2180 LOCATE 19, 14: PRINT USING"PO = ######.####"; PO
2190 LOCATE 20, 14: PRINT USING"PP = ######.####"; PP
2200 LOCATE 21, 14: PRINT USING"PC = ######.####"; PC
2210 LOCATE 22, 14: PRINT USING"PT = ######.####"; PT:LOCATE
2220 PRINT "HP"
2230 LOCATE 18, 46: PRINT USING"FM = ######.####"; FM:LOCATE
2240 LOCATE 20, 46: PRINT USING"DL = ######.####"; DL:LOCATE
2250 LOCATE 22, 46: PRINT USING"BL = ######.####"; BL:LOCATE
2260 RETURN 'returns to 1366 or 1460
2270 '*************************************************************************
2280 ' COMPONENT WEIGHT APROX INPUT SUBR
2290 '*************************************************************************
2300 'FLG3=1: GEAR=1: ENGN=1: FUEL=2500: PEOPLE=25: SPECIAL=100: UL=1000: remove before flight
2310 IF FLG3 = 1 THEN 2360: ELSE 2320
2325 IF FLG3 = 1 THEN 2360 ELSE
2330 ON X GOSUB 2320, 2325, 2330, 2335, 2340, 2345, 2350, 2355, 2360:
2340 RETURN 7300: GOTO 2296 ELSE
2350 GOTO 1100: GOSUB 3000: GOTO 2296
2360 GOTO 2296:
2370 LOCATE 3, 2: PRINT"1. TYPE LNDG GEAR (TRICYCLE STYLE)"
2380 LOCATE 4, 2: PRINT" 1=FIXED 2=RETRACTABLE"
2390 LOCATE 5, 2: INPUT"2. NUMBER OF ENGINES (2 or more)"
2400 LOCATE 6, 2: INPUT"3. ESTIMATED FUEL CAPACITY (1bs)"
2410 LOCATE 7, 2: INPUT"4. NUMBER OF CREW AND PASSENGERS"
2420 LOCATE 8, 2: INPUT"5. WT OF SPECIAL AVIONICS (1bs)"
2430 LOCATE 9, 2: INPUT"6. SPECIFICATION USEFUL LOAD (1bs)"
2440 LOCATE 10, 2: PRINT"7. RETURN TO TANDEM ROTOR SYSTEM DESIGN"
2450 LOCATE 12, 2: PRINT SPC(40); FLG3 = 1
2460 LOCATE 12, 2: PRINT" SELECTION ? (1 thru 6 for changes)"
2470 IF X < 1 OR X > 7 THEN BEEP: GOTO 2310: ELSE
2480 ON X GOSUB 2315, 2320, 2325, 2330, 2335, 2340, 2345, 1100:
2490 GOSUB 3000; GOTO 2296
2500 LOCATE 4, 39: PRINT SPC(6): LOCATE 4, 38: INPUT"
2510 'GEE:RETURN
2520 LOCATE 5, 39: PRINT SPC(6): LOCATE 5, 38: INPUT"
LOCATE 6,39: PRINT SPC(6): LOCATE 6,38: INPUT "FUEL:RETURN
LOCATE 7,39: PRINT SPC(6): LOCATE 7,38: INPUT "PEOPLE:RETURN
LOCATE 8,39: PRINT SPC(6): LOCATE 8,38: INPUT "SPECIAL:RETURN
LOCATE 9,39: PRINT SPC(6): LOCATE 9,38: INPUT "TOTAL:RETURN

'** routine to list these parameters first with option to change.

LOCATE 5,2: PRINT"1. TYPE LNDG GEAR (TRICYCLE STYLE)
LOCATE 6,2: PRINT USING" 1=FIXED
2=RETRACTABLE: GEAR
LOCATE 7,2: PRINT USING"2. NUMBER OF ENGINES (2 or more)
LOCATE 8,2: PRINT USING"3. ESTIMATED FUEL CAPACITY (lbs)
LOCATE 9,2: PRINT USING"4. NUMBER OF CREW AND PASSENGERS
LOCATE 10,2: PRINT USING"5. WT OF SPECIAL AVIONICS (lbs)
LOCATE 11,2: PRINT USING"6. SPECIFICATION USEFUL LOAD (lbs)

GOSUB 3000: GOTO 2296

LOCATE 3,53: PRINT "COMP WT RESULTS OUTPUT SUBR

LOCATE 4,47: PRINT USING" 1. MAIN ROTORS...... #.#": W(1,NN)
LOCATE 5,47: PRINT USING" 2. FUSELAGE...... #.#": W(2,NN)
LOCATE 6,47: PRINT USING" 3. LANDING GEAR...... #.#": W(3,NN)
LOCATE 7,47: PRINT USING" 4. ENGINE NACELLES...... #.#": W(4,NN)
LOCATE 8,47: PRINT USING" 5. ENGINES......... #.#": W(5,NN)
LOCATE 9,47: PRINT USING" 6. DRIVE TRAIN...... #.#": W(6,NN)
LOCATE 10,47: PRINT USING" 7. FUEL TANKS...... #.#": W(6C(NN))
LOCATE 11,47: PRINT USING" 8. FLIGHT CONTROLS...... #.#": W(7,NN)
LOCATE 12,47: PRINT USING" 9. AUX POWER
LOCATE 13,47: PRINT USING"10. INSTRUMENTS...... #.#": W(8,NN)
LOCATE 14,47: PRINT USING"11. HYDRAULIC SYSTEM...... #.#": W(9,NN)
LOCATE 15,47: PRINT USING"12. ELECTRICAL SYSTEM...... #.#": W(10,NN)
LOCATE 16,47: PRINT USING"13. AVIONICS...... #.#": W(11,NN)
LOCATE 17,47: PRINT USING"14. FURNISHINGS...... #.#": W(12,NN)
LOCATE 18,47: PRINT USING"15. AC / DE-ICE EQUIP...... #.#": W(13,NN)
LOCATE 19,47: PRINT USING"16. LOAD HANDLING EQUIP...... #.#": W(14,NN)
LOCATE 20,47: PRINT "-------------------------------"

LOCATE 21,47: PRINT USING" TOTAL COMPONENT WEIGHT = #.#": WE(NN)
LOCATE 13,2: PRINT "========================================`
LOCATE 14,5: PRINT USING"SPEC MAX GROSS FT (MGW)
= "ibs":MGW
LOCATE 15,5: PRINT USING" NEW A/C EMPTY FT
= "WE(NN)":WE(NN)
LOCATE 16,5: PRINT USING" FUEL FT
= "FUEL":FUEL
LOCATE 17,5: PRINT USING" PERSONNEL FT
= "PAK":PAK
LOCATE 18,5: PRINT USING" USEFUL LOAD
= "L":L
LOCATE 19,5: PRINT USING" NEW GROSS FT ESTIMATE
= "lbs":NGWE(NN)
LOCATE 20,5: PRINT USING" TOTAL POWER FOR HOVER
= "SHP":PT
LOCATE 21,5: PRINT USING" press (Shift-PrtSc) for
LOCATE 22,5: PRINT USING" hard copy
LOCATE 23,5: PRINT USING"

LOCATE 3,1: WE=-COMP/
FOR N = 1 TO 5
IF MTW<>0 THEN WE(1)=MTW ELSE
GW(N) = .7407*MGW-2500
GOSUB 1800 : 'computes PT,PI and PO based on
PREVIOUS GW and HP
NEXT N
IF PDW(N) < 10 THEN 3130 ELSE 3140
NEXT N
IF NN = 0 THEN LOCATE 1,1 : PRINT"-W=NOTCONVG/":
INPUT",X1: NN = 1
PRINT"-C=ALL/": GOSUB 2465 : RETURN : 'output
results

HELO COMPONENT WT EQN'S SUBR

PAX = PEOPLE * 250
SB = 567.688 * EXP(.000041 * GW(N))
W(1,N) = 1414.348 * EXP(.00539*B*C*R) + W(2,N)
W(2,N) = 3467.29 + LOG(SB) - 3140
W(4,N) = .9013 * GW(N)^.6662 * GEAR * 3^.536
W(5,N) = .014 * (.2014 * GW(N))^.136
W(9,N) = .999 * (HP)^.959
W(6C,N) = .454.619*(FUEL /6.5)^-.0566 + W(6,N)
W(7,N) = .09334 * GW(N)^1.224
W(8,N) = .09334 * GW(N)^1.224
W(9,N) = 68.226 * LOG(HP) - 387.598
W(10,N) = 6.63E-07 * (GW(N))^-1.863
W(11,N) = .978 * (SB)^.539
W(12,N) = 325 + SPECIAL
W(13,N) = .159 * SB +18.11 * PEOPLE
W(14,N) = 117.771 * LOG(SB) -710.594
**POWER REFINEMENTS PROGRAM w/HIGH SPEED EFFECTS**

40 DIM TAS(300), PI(300), PO(300), PP(300), PT(300), PS(300), PM(300)
50 KEY OFF: AS="#####.#": BS="#####

51 IF ENGN=0 THEN ENGN=2
52 GW = 23000: R = 25.5 : C = 1.5 : CDO = 8.999999E-03
53 RPM = 267.4: SI = 34: FLG3 = 1: PW = 44: E = 9.5: MXHVR = 10000
58 PASPEC = 4000: CLALFA = 5.73: AOAST = 14: TWIST = -9.5: MCRT = .8
70 S = 130: TASM = 150
80 **INPUT VARIABLES**
90 1. GROSS WEIGHT [lbs]...........GW
110 2. ROTOR RADIUS [ft]............R
130 3. BLADE DATA: CHORD [ft]......C
150 4. PROFILE DRAG COEFFICIENT...CDO
170 5. LIFT CURVE SLOPE [per RAD]...CLALFA
190 6. STALL ANGLE OF ATTACK [deg]...AOAST
210 7. GEOMETRIC TWIST [deg with
230 8. CRITICAL MACH NUMBER......MCRT
250 9. NUMBER OF ROTOR BLADES PER HEAD...B
270 10. OPERATING RPM [rpm]........RPM
290 11. ROTOR SHAFT SPACING [ft]....S1
310 12. ROTOR HEAD VERTICAL SPACING [ft]..GAP
330 13. HEIGHT OF FORWARD HEAD ABOVE WHEELS [ft]...FHH
350 14. SPEC PRESSURE ALT [normally 4000 ft MSL]. PASPEC
370 15. HOVER ALTITUDE [ft AGL]......AGL
390 16. SPEC CRUISE AIRSPEED [knots]..TASCR

40 '*** POWER REFINEMENTS PROGRAM w/HIGH SPEED EFFECTS***
300 PRINT "17. SPEC MAX AIRSPEED [knots]";TASMX =
310 PRINT "18. EQUIVALENT FRONTAL AREA [ft^2]";FF =
320 PRINT "19. SPEC MAX HOVER ALTITUDE (IGE) [ft]";MXHVR =
325 COLOR 14,1
330 PRINT "20. COMPUTE NEW POWER REQUIREMENTS"
335 COLOR 15,1
340 IF FLG3 = 1 THEN 350 ELSE 560
350 "load data from previous chapter, if applicable; or allows input!"
360 IF GW <>0 THEN LOCATE 3,61: PRINT USING A$; GW ELSE GOSUB 710
370 IF R <>0 THEN LOCATE 4,61: PRINT USING A$; R ELSE GOSUB 750
380 IF C <>0 THEN LOCATE 5,61: PRINT USING A$; C Else GOSUB 790
400 IF CDO <>0 THEN LOCATE 6,61: PRINT USING C$; CDO ELSE GOSUB 830
410 IF CLALFA <>0 THEN LOCATE 7,61: PRINT USING A$;CLALFA ELSE GOSUB 870
420 IF AOAST <>0 THEN LOCATE 8,61: PRINT USING A$;AOAST ELSE GOSUB 910
430 IF TWIST <>0 THEN LOCATE 9,61: PRINT USING A$;TWIST ELSE GOSUB 950
440 IF MCRT <>0 THEN LOCATE 10,61: PRINT USING A$;MCRT ELSE GOSUB 980
450 IF B <>0 THEN LOCATE 11,61: PRINT USING B$; B ELSE GOSUB 1010
460 IF RPM <>0 THEN LOCATE 12,61: PRINT USING A$; RPM ELSE GOSUB 1050
470 IF S1 <>0 THEN LOCATE 13,61: PRINT USING A$; S1 ELSE GOSUB 1080
480 IF GAP <>0 THEN LOCATE 14,61: PRINT USING A$; GAP ELSE GOSUB 1110
490 IF FHH <>0 THEN LOCATE 15,61: PRINT USING A$; FHH ELSE GOSUB 1140
500 IF PASPEC <>0 THEN LOCATE 16,61: PRINT USING B$; PASPEC ELSE GOSUB 1170
510 IF AGL <>0 THEN LOCATE 17,61: PRINT USING B$; AGL ELSE GOSUB 1190
520 IF TASCR <>0 THEN LOCATE 18,61: PRINT USING B$; TASCR ELSE GOSUB 1200
530 IF TASMX <>0 THEN LOCATE 19,61: PRINT USING B$; TASMX ELSE GOSUB 1210
540 IF FF <>0 THEN LOCATE 20,61: PRINT USING A$; FF ELSE GOSUB 1220
550 CNT = 1: J = 0
560 IF CNT = 0 THEN 570 ELSE LOCATE 23,1: PRINT SPC(77):
570 FOR J = 1 TO 19
580 LOCATE 23,20: PRINT "ENTER YOUR VALUE FOR ITEM NUMBER "; J
590 X = J: GOTO 630
610 LOCATE 23,18: INPUT "WHICH DO YOU WISH TO CHANGE / SELECT X";X
620 IF X < 1 OR X > 21 THEN GOSUB 4500: IF J = 0 THEN 610 ELSE 580
640 ON X GOSUB 710, 750, 790, 830, 870, 910, 950, 980,
1010, 1050, 1080, 1110, 1140, 1180, 1190, 1200, 1210, 1220, 1225,
1230, 1300, 1400, 1450, 1500, 1550, 1600, 1650, 1700, 1750, 1800,
1850, 1900, 1950, 2000, 2050, 2100, 2150, 2200, 2250, 2300, 2350,
2400, 2450, 2500, 2550, 2600, 2650, 2700, 2750, 2800, 2850, 2900,
2950, 3000, 3050, 3100, 3150, 3200, 3250, 3300, 3350, 3400, 3450,
3500, 3550, 3600, 3650, 3700, 3750, 3800, 3850, 3900, 3950, 4000,
4050, 4100, 4150, 4200, 4250, 4300, 4350, 4400, 4450, 4500, 4550,
4600, 4650, 4700, 4750, 4800, 4850, 4900, 4950, 5000, 5050, 5100,
5150, 5200, 5250, 5300, 5350, 5400, 5450, 5500, 5550, 5600, 5650,
5700, 5750, 5800, 5850, 5900, 5950, 6000, 6050, 6100, 6150, 6200,
6250, 6300, 6350, 6400, 6450, 6500, 6550, 6600, 6650, 6700
**DATA ENTRY SUBROUTINES**

```
680 ' *** DATA ENTRY SUBROUTINES ***
710 LOCATE 1,1,0: PRINT "~K=(ALT-F1),HW1/" : LOCATE 3,61:
PRINT "SPC(8): LOCATE 3,60: INPUT" "",GW:
PRINT "~K=(ALT-F1)/" : IF GW <= 0 THEN PRINT "~W=DN0/"
GOTO 710 ELSE RETURN
720 LOCATE 1,1,0: PRINT "~K=(ALT-F1),HW2/" : LOCATE 4,61:
PRINT "SPC(8): LOCATE 4,60: INPUT" "",R:
PRINT "~K=(ALT-F1)/" : IF R <= 0 THEN PRINT "~W=DN0/"
GOTO 720 ELSE RETURN
750 LOCATE 1,1,0: PRINT "-K=(ALT-F1),HW2/"
LOCATE 3,61: PRINT "K=ALT-F1) I,CLALPHA/": LOCATE 6,60: INPUT"
980 IF CDO <= 0 THEN PRINT "~W=DN0/" : GOTO 980 ELSE RETURN
830 LOCATE 1,1,0: PRINT "~K=(ALT-F1),HW3/" : LOCATE 5,61:
PRINT "SPC(8): LOCATE 5,60: INPUT" ": C:
PRINT "~K=(ALT-F1)/" : IF C <= 6 THEN PRINT "W=DN0/"
GOTO 830 ELSE RETURN
870 LOCATE 1,1,0: PRINT "~K=(ALT-F1),ACLALPHA/": LOCATE 7,61:
PRINT "SPC(8): LOCATE 7,60: INPUT" ": CLALFA: PRINT "~K=(ALT-F1)/"
910 LOCATE 1,1,0: PRINT "~K=(ALT-F1),STALLAOA/": LOCATE 8,61:
PRINT "SPC(8): LOCATE 8,60: INPUT" ": AOAAT: PRINT "~K=(ALT-F1)/"
950 LOCATE 1,1,0: PRINT "~K=(ALT-F1),BLDTWIST/": LOCATE 9,61:
PRINT "SPC(8): LOCATE 9,60: INPUT" ": TWIST: PRINT "~K=(ALT-F1)/"
1000 IF MCRT <= 0 THEN PRINT "~W=DN0/" : GOTO 1000 ELSE RETURN
1010 LOCATE 1,1,0: PRINT "~K=(ALT-F1),HW5/": LOCATE 10,61:
PRINT "SPC(8): LOCATE 10,60: INPUT" ": B:
PRINT "~K=(ALT-F1)/" : IF B <= 0 THEN PRINT "~W=DN0/"
GOTO 1010 ELSE RETURN
1050 LOCATE 1,1,0: PRINT "~K=(ALT-F1),HW6/": LOCATE 11,61:
PRINT "SPC(8): LOCATE 11,60: INPUT" ": RPM:
PRINT "~K=(ALT-F1)/" : IF RPM <= 0 THEN PRINT "~W=DN0/"
GOTO 1050 ELSE RETURN
1080 LOCATE 1,1,0: PRINT "~K=(ALT-F1),HW7/": LOCATE 12,61:
PRINT "SPC(8): LOCATE 12,60: INPUT" ": A:
PRINT "~K=(ALT-F1)/" : IF A <= 0 THEN PRINT "~W=DN0/"
GOTO 1080 ELSE RETURN
1110 LOCATE 1,1,0: PRINT "~K=(ALT-F1),HW8/": LOCATE 13,61:
PRINT "SPC(8): LOCATE 13,60: INPUT" ": S1:
PRINT "~K=(ALT-F1)/" : IF S1 <= 0 THEN PRINT "~W=DN0/"
GOTO 1110 ELSE RETURN
1140 LOCATE 1,1,0: PRINT "~K=(ALT-F1),HW9/": LOCATE 14,61:
PRINT "SPC(8): LOCATE 14,60: INPUT" ": GAP:
PRINT "~K=(ALT-F1)/" : IF GAP <= 0 THEN PRINT "~W=DN0/"
GOTO 1140 ELSE RETURN
1180 LOCATE 1,1,0: PRINT "~K=(ALT-F1),HW10/": LOCATE 15,61:
PRINT "SPC(8): LOCATE 15,60: INPUT" ": FHH:
PRINT "~K=(ALT-F1)/" : IF FHH <= 0 THEN PRINT "~W=DN0/"
GOTO 1180 ELSE RETURN
1210 LOCATE 1,1,0: PRINT "~K=(ALT-F1),HW11/": LOCATE 16,61:
PRINT "SPC(8): LOCATE 16,60: INPUT" ": AGL:
PRINT "~K=(ALT-F1)/" : IF AGL <= 0 THEN PRINT "~W=DN0/"
GOTO 1210 ELSE RETURN
```

200 LOCATE 1,10: PRINT "-K=(ALT-F1),TASCRUZ/" : LOCATE 3,61: PRINT SP(8) RETURN
205 LOCATE 18,60: INPUT "",TASCR: PRINT "-K=(ALT-F1)/" RETURN
210 LOCATE 1,10: PRINT "-K=(ALT-F1),HW12/" : LOCATE 216: PRINT SP(8) RETURN
220 LOCATE 1,10: PRINT "-K=(ALT-F1),HW13/" : LOCATE 226: PRINT SP(8) IF FF < = 0 THEN PRINT "W=DNV0/" : GOTO 1220 ELSE RETURN
225 LOCATE 1,10: PRINT "-K=(ALT-F1),HW12/" : LOCATE 228: IF MXHVR <=0 THEN PRINT "W=DNV0/" : GOTO -1225 ELSE RETURN
1220 ADMIN/CONTROL SLJBR 123.
1225 LOCATE 23,1: PRINT SPC(77) LOCATE 23,13: INPUT "press <Shift-PrtSc> for hard copy to continue",X5
1226 LOCATE 23,1: PRINT SPC(77)
1228 LOCATE 23,13: INPUT "press <Shift-PrtSc> for hard copy. ENTER to continue",X5
1229 GOTO 4000
1230 LOCATE 23,1: PRINT SPC(77)
1232 LOCATE 23,1: PRINT SPC(77)
1234 LOCATE 23,1: PRINT SPC(77)
1236 LOCATE 23,1: PRINT SPC(77)
1238 LOCATE 23,1: PRINT SPC(77)
1240 LOCATE 23,1: PRINT SPC(77)
1242 LOCATE 23,1: PRINT SPC(77)
1244 LOCATE 23,1: PRINT SPC(77)
1246 LOCATE 23,1: PRINT SPC(77)
1248 LOCATE 23,1: PRINT SPC(77)
1250 LOCATE 23,1: PRINT SPC(77)
1252 LOCATE 23,1: PRINT SPC(77)
1254 LOCATE 23,1: PRINT SPC(77)
1256 LOCATE 23,1: PRINT SPC(77)
1258 LOCATE 23,1: PRINT SPC(77)
1260 FOR I = 0 TO TASMX + 30 STEP 10
1262 TAS(I) = I : GOSUB 1300 : GOSUB 1800 : NEXT I:
1264 PRINT "C=ALL/" : BEEP: CLS: GOSUB 3000 :
1266 LOCATE 23,1: PRINT SPC(77)
1268 LOCATE 23,1: PRINT SPC(77)
1270 LOCATE 23,1: PRINT SPC(77)
1272 LOCATE 23,1: PRINT SPC(77)
1274 LOCATE 23,1: PRINT SPC(77)
1276 LOCATE 23,1: PRINT SPC(77)
1278 LOCATE 23,1: PRINT SPC(77)
1280 NEXT I :
1282 LOCATE 23,1: PRINT SPC(77)
1284 LOCATE 23,1: PRINT SPC(77)
1286 LOCATE 23,1: PRINT SPC(77)
1288 LOCATE 23,1: PRINT SPC(77)
1290 LOCATE 23,1: PRINT SPC(77)
1292 LOCATE 23,1: PRINT SPC(77)
1294 GOTO 4000 :" calc losses due to inlets,EAPS and ZEDS
1300 "************* POWER COMPUTATION SUBR
1302 "************* POWER COMPUTATION SUBR
1304 DELTA=(1-6.87535E-06*PA)^5.256 : THETA =
1306 MA = DELTA / THETA : RHO =
1308 SFCT = VF / VT : T = GW : S = B * C /
1310 RF : RE = R * RE:
1312 OSST = ( SQRT(2 * CT) / B) : SR = S1 / R
1314 S1 = 2*R-2*(PIE-(PIE/180)*ACOS(S1/(2*RE)))+
1316 S2 = S1-2/4
1318 GW = RHO*AE ) : RE = R*AE
1320 SQ = 1.46-253SR : AV = PIE*R^2 -2*R*GAP
1322 B) E) ^ 2*(VP/VI)^2
1324 L = 6*CT/S : AR = R/C : BL=CT/S : DL =
1326 GE = 1*VI*K*KU / 550
1328 GE < = 2 THEN PI(I) = PG * T * VI * K * KU / 550
1330 PIE = 3.141592: RH00 = 2.37691E-03 : RAD = 57.296
1332 VVF = FPM/60 = 0 : PA = MXHVR:TEMP=59: GOSUB 1300:
1334 GE = 5.4147 + 1.3432*GE - 1.457*GE^2 + .708*GE^3 -
1336 RE = R/9.55 : VT = RV * R : VF = TAS(I) *
1338 DELTA=1-6.87535E-06*PA)^5.256 : THETA =
1340 MA = DELTA / THETA : RHO =
1342 SFCT = VF / VT : T = GW : S = B * C /
1344 RF : RE = R * RE:
1346 OSST = ( SQRT(2 * CT) / B) : SR = S1 / R
1348 S1 = 2*R-2*(PIE-(PIE/180)*ACOS(S1/(2*RE)))+
1350 S2 = S1-2/4
1352 GW = RHO*AE ) : RE = R*AE
1354 SQ = 1.46-253SR : AV = PIE*R^2 -2*R*GAP
1356 B) E) ^ 2*(VP/VI)^2
1358 L = 6*CT/S : AR = R/C : BL=CT/S : DL =
1360 GE = 1*VI*K*KU / 550
1362 GE < = 2 THEN PI(I) = PG * T * VI * K * KU / 550
46
1630 PO(I) = (CDO * B * C * R * VT^3 * RHO / 2200)*(1 + 4.3 * MU^2)
1640 PP(I) = VF^3 * FF * RHO / 1100
1650 PT(I) = PI(I) + PO(I) + PP(I) : FM = PI(I) / (PT(I) + PO(I))
1680 RETURN
1800 '*********** HIGH SPEED EFFECTS ROUTINE w/ CONTROL ANGLES
1835 IF TAS(I)=0 THEN
1840 PTMIN=PT(I): PTMAX=PT(I): TASMINP=TAS(I): TASMAXP=TAS(I):
1850 RETURN
1810 IF TAS(I) > 59 THEN RETURN
1820 B1 = TPLOSS : T7 = TWIST/RAD : VIFF = (T/(2 * RHO) * AE * VF)
1830 T1 = .5*(B1^2 + 5*MU^2)
1840 T3 = .25*(B1^2 + B1^2 + MU^2) : T4 = .5* MU*(B1^2 + MU^2)
1890 LAMDA=-PP(I)*550/GW + VIFF)/VT
1900 T1.5=(B1^2 + .5*MU^2)
1920 T3 M=.5*(B1^2 + B1^2 + MU^2)
1960 J5 = -LAMDA * A11 - (T7*A13)
1970 A12 = 8*MU*B1/(3*(B1^2 + 5*MU^2))
1980 A13 = (2*B1^2 + MU)/(B1^2 - 5*MU^2)
1985 A14=(B1^2 + 1.5*MU^2)/(B1^2 - 5*MU^2)
200180 J2 = 2*T3 / (CLALFA * S) : J3 = LAMDA * T1 : J4 = J2 - J3 - (T7^T3)
2010 A11 = (4*((MU*(B1^2)/2)-(MU^3/8)))/(B1^2*(B1^2 + MU^2))
2020 J5 = -LAMDA / (1+MU) : F = H8-H2+K0+T7 : AOA270 = 0
2030 IF AOA270 < AAOAST THEN PS(I)=0: GOTO 2060
2050 PS(I) = PO(I)*((AAOA270 - AAOAST)/4)
2060 GG = H8+H2+K0+T7 : AOA90 = GG*RAD
2070 MTIHPVR = (RV*R)/MACHVEL
2080 M90 = MTIHPVR*(1+MU) : IF MTIPLFT < MCRT THEN
2090 PM(I) = 0: GOTO 2120
2100 DMD = M90-MCRT : CPM=S*(.12*DMD+.1*(DMD^3)) : PM(I)=(CPM*AE*RHO*VT^3)/550
2120 IF PT(I) < PTMIN THEN PTMIN = PT(I) : TASMINP = I
2140 IF PT(I) > PTMAX THEN PTMAX = PT(I) : TASMAXP = I
2150 IF PT(I) > PTMAX THEN PTMAX = PT(I) : TASMAXP = I
2180 RETURN
3000 '*********** HIGH SPEED EFFECTS/POWER RESULTS
3003 IF PSPECHVR > PTMAX THEN PTMAX = PSPECHVR: TASMAXP = 0
3004 RSHP = PTMAX
3005 FOR I = 0 TO TASMX + 30 STEP 10
3010 IF TAS(I) = 0 THEN 3020
3011 IF TAS(I) = TASMINP THEN 3050
3012 IF TAS(I) = TASCR THEN 3050
3014 IF TAS(I) = TASMX THEN 3050
3018 I2 = (I+20)/20 : IF I2 - FIX(I2) = 0 THEN 3050
3020 PRINT" TOTAL POWER (SHP) REQUIRED WITH
3025 PRINT" HIGH SPEED EFFECTS "
3030 PRINT" PM TAS(Kts) PI PO PP
3035 RETURN
47
I. - INLETS AND INLET DUCTING -

1. -S- TYPE (5%)
2. ICE SHIELD (10%)
3. STRAIGHT-IN (2%)

II. - ENGINE AIR PARTICLE SEPARATORS

4. FOAM TYPE BARRIER FILTERS (10%)
5. POWER (HYDRAULIC) (2-6%)
6. NONE INSTALLED

III. - ENGINE EXHAUST DEVICES -

7. SIMPLE HEAT DIFFUSER (3%)
8. INFRA-RED SUPPRESSOR (5%)
9. NONE INSTALLED

GOSUB 4200: GOSUB 4230: GOSUB 4260: GOSUB 4280:
04250 EAPS = .04: LOCATE 10,9: PRINT"***":LOCATE
0.9:PRINT"":LOCATE 11,9:PRINT"":RETURN
04252 EAPS = 0 : LOCATE 11,9: PRINT"***":LOCATE
0.9:PRINT"":LOCATE 10,9:PRINT"":RETURN
42560 LOCATE 23,1: PRINT SPC(77)
4261 LOCATE 23,10: INPUT"SELECT THE DESIRED EEDS
4262 SYSTEM "Y1: Y1=Y1-6
4263 IF Y1 < 1 OR Y1 > 3 THEN GOSUB 4500: GOTO 4260
4264 ON Y1 GOSUB 4277, 4278, 4279
4265 PEEDS = EEDS * 100 / RSHPEEDS = RSHP * EEDS
4274 LOCATE 16,42: PRINT USING "EEDS LOSSES = #
4276 RETURN
4277 EEDS = .03: LOCATE 14,9: PRINT"***":LOCATE
4278 EEDS = .05: LOCATE 15,9: PRINT"***":LOCATE
4279 EEDS = 0 : LOCATE 16,9: PRINT"***":LOCATE
4280 total losses computation subr
4281 ENGNLOST = RSHP*(INLET+EAPS+EEDS) : MISCLOST =
4282 PCTENGN = ENGNLOST*100/RSHP : PCTMISC =
4284 RSHPLOST = ENGNLOST + MISCLOST
4286 ESHP = RSHP + RSHPLOST : PCTLOST =
4288 LOCATE 18,12: PRINT USING"ENGINE, XMSN and MISC
4289 INSTALLATION LOSSES = ####### SHP
4290 LOCATE 19,12: PRINT USING"TOTAL LOSSES
4292 LOCATE 19,12: PRINT USING"TOTAL LOSSES
4294 LOCATE 20,12: PRINT USING"MAXIMUM POWER
4296 MAXIMUM POWER REQUIRED [RSHP] = ####,# SHP";RSHP
4298 ESHP REQUIRED [ESHP] = #,# SHP";ESHP
4299 FLG3 = 1 : RETURN
4300 LOCATE 23,1: PRINT SPC(77)
4305 LOCATE 23,13: INPUT"ANY CHANGES ? (0=N0, 1=YES)
4310 IF ANS=0 THEN 4370 ELSE IF ANS=1 THEN 4340 ELSE
GOSUB 4500; GOTO 4320
4340 LOCATE 19,12: PRINT "WHICH ITEM ? (1, 2 or 3)
4344 IF X5 < 1 OR X5 > 3 THEN GOSUB 4500: GOTO 4340
4346 GOSUB 4280 : GOTO 4300
4350 LOCATE 23,1: PRINT SPC(77)
4355 LOCATE 23,13: INPUT"Press <Shift-PrtSc> for hard
4356 GOTO 100
4360 LOCATE 1,1,0: PRINT"W=TRYAGAIN/" : LOCATE 23,1:
4375 LOCATE 23,13: INPUT"PRESS <Shift-PrtSc> for hard
4380 GOTO 100
4390 CHAIN "TR1", ALL
4399 END
10 'PROGRAM "TR6.BAS" 17 SEPT 87
20 KEY OFF : B$="###": C$="#."###
30 "*" ENGINE & XMSN SELECTION ***
40 **
70 ' *** CHAPTER SIX MAIN PROGRAM
80 ' 10 PRINT"~C=ALL/":PRINT"~L=TANDEM6/"
120 COLOR 1,1,1:CLS:LOCATE
23 1,0:PRINT"~W=ENGMENU/":INPUT",X
130 COLOR 14,1: ON X GOSUB 200,300,400 : GOTO 120
160 ',
230 1,0:PRINT"~W=ENGSELELN/":INPUT",X6 :RETURN
210 ' temporary data for weight summation, power etc.
310 'ENGN = 2 : W(1,1)=2625 : W(3,1)=3333 : W(4,1)=600
320 'W(11,1)=500 : W(12,1)=400 : W(13,1)=7000:
330 'W(14,1)=150 : W(15,1)=190
340 'W6A(1)=900 : W6B(1)=1600 : W6C(1)=300:
341 'MGW=23000 : R=25.5 : C=1.5 : CD0=.009
342 'B=3 : RPM=267.4 :
343 'S=3 : GAP=4 : FHH=12 : PA=0 : TAS=0 : AGLE10 : NENG=2 : ESHP=2600
344
345 'PA=6250 : FUEL=2500 : UL=1000 : RHO=.002377 : PIE=3.14159 : RH00=.002377
350 GOTO 500
360 ' 400 LOCATE
230 1 :0:PRINT"~W=LOADNOTE/":CHAIN"TR1", ALL
260 ' 500 ', SECTION 6.1 & 6.2

510 CLS
520 LOCATE 1,28 : PRINT"* NUMBER OF ENGINES *
516 LOCATE 2,10 : PRINT": NUMBER OF ENGINES = ":ENGN
520 LOCATE 2,44 : PRINT"(specified in Chapter 3)"
530 LOCATE 3,28 : PRINT": TYPE OF ENGINES *
540 LOCATE 4,10 : PRINT"FOR SELECTION ":NENGSEL
550 LOCATE 23,33 : PRINT":LOCATE 23,5 : INPUT"ANY
560 IF ANS=0 THEN 605 ELSE IF ANS=1 THEN 570 ELSE
565 BEEP : GOTO 550
570 LOCATE 23,38 : INPUT"WHICH ITEM ? (1 or 2) ",X6
580 ON X6 GOSUB 590,595 : LOCATE 23,1 : PRINT"SPC(75)
523 5 50
590 LOCATE 23,33 : PRINT SPC(3) : LOCATE 2,34:
595 LOCATE 4,55 : PRINT SPC(3) : LOCATE 4,56:
600 PRINT"* ENGINE SELECTION PARAMETERS *
600 LOCATE 5,2:

*** SECTION 6.1 & 6.2 ***
606 LOCATE 23,1 : PRINT"ENGINE SELECTION PARAMETERS *
610 LOCATE 6,25 : PRINT": ENGINE SELECTION PARAMETERS *
613 PRINT" 3. DRY WEIGHT (lbs) ......."
614 PRINT" 4. SHP (ssl) military ......."
615 PRINT" 5. SFC (ssl) military ......."
616 PRINT" 6. INITIAL COST ...... $K"
620 PRINT" 7. OP COST/HR/ENG ...... $"
622 PRINT" 8. Prev MAINT/HR/ENG ...... $

50
631 PRINT" 9. MTBMA (hrs)............"
640 PRINT" 10. MDT (hrs)............."
650 PRINT" 11. MTBF (hrs)............."
660 PRINT" 12. MTBR (hrs)............."
670 PRINT" ANY CHANGES ? (0=NO, 1=YES) " : ANS
680 IF ANS=0 THEN 720 ELSE IF ANS=1 THEN 690 : ELSE BEEP: GOTO 710
690 PRINT" WHICH ITEM ? (3 thru 12) " : X6 = X6 - 2
700 ON X6 GOSUB 780,784,788,792,794,796,798,800,802,804
710 LOCATE 23,1: PRINT SPC(75): GOTO 670
720 K = K + 10 : KK = KK + 10 : LOCATE 23,1: PRINT SPC(75): NEXT I
730 FOR I = 1 TO 3: LOCATE 18+I,67: PRINT SPC(9): NEXT I
732 INPUT" 13. SPECIFICATION AVERAGE FLIGHT HOURS PER YEAR ....... " : AFL
734 LOCATE 20,10
735 INPUT" 14. SPECIFICATION AVERAGE AIRFRAME SERVICE LIFE IN YEARS " : SL
737 LOCATE 21,10
738 INPUT" 15. AVERAGE FLIGHT HOURS PER FLIGHT ......... " : TAV
740 LOCATE 23,5: INPUT" ANY CHANGES ? (0=NO, 1=YES) " : ANS
747 IF ANS=0 THEN 750 ELSE IF ANS=1 THEN 730 ELSE BEEP: LOCATE 23,1: PRINT SPC(38): GOTO 745
750 LOCATE 23,1: PRINT SPC(75): GOTO 752
752 LOCATE 23,13: PRINT" press <Shift-PrtSc> for hard copy; ENTER to continue",X6
760 FOR I = 1 TO NENGSEL : RD(I) = 0 : 'R & D costs included in the IC
764 YM(I) = PMA(I)*AFL/1000: YO(I) = OC(I)*AFL/1000:
766 NRPL1 = AFL*SL/MTBR(I)
767 NRPL(I) = NENG*(CINT(NRPL1))
769 LC(I) = ENGN*(RD(I)+IC(I)+(SL*(YO(I)+YM(I)))+(NRPL(I) *
770 (((1.35*IC(I))-0.8*IC(I)))))
773 AVAL(I) = MTBMA(I)/(MTBMA(I)+MDT(I))
776 MAINT(I) = MDT(I)/(MTBMA(I)+MDT(I))
777 RELY(I) = EXP(-TAV/MTBF(I))
779 RCI(I) = 1.35*IC(I)*S(V(I)) = 0.8*IC(I)
782 NEXT I : GOTO 840
784 ' * * * * * * * * * * ENGINE SELECTION PARAMETER INPUT
787 ' CHANGE SUBR * * * * * * *
789 ' LOCATE 8,KK: PRINT SPC(7):LOCATE 8,KK:INPUT; "",DW(I) : RETURN

FOR I=1 TO NENGSEL
     IF DW(I)<=300 THEN GOTO 850 ELSE IF DW(I)>300 AND DW(I)<=700 GOTO 860 ELSE IF DW(I)>700 AND DW(I)<=1100 GOTO 870 ELSE IF DW(I)>1100 GOTO 880
     EWT(I)=DW(I)*1.29: GOTO 890
     EWT(I)=DW(I)*1.27: GOTO 890
     EWT(I)=DW(I)*1.24: GOTO 890
     EWT(I)=DW(I)*1.2: GOTO 890
     NEXT I

*** SECTION 6.3 & 6.4 ***

CLS: LOCATE 1, 25: PRINT "ENGINE SELECTION CRITERIA * 6.3 & 6.4 */ ENGINE
LOCATE 3, 38: PRINT "------------------
LOCATE 4, 39: PRINT "A B C D
PRINT "POWERPLANT WEIGHT (installed)........ K$
PRINT "LIFE-CYCLE COST .................... K$
PRINT "ENGINE LIFE (hrs) ................... K$
PRINT "NO. OF REPLACEMENTS ............... K$
PRINT "P/D COSTS ......................... K$
PRINT "INITIAL COSTS ..................... K$
PRINT "ANNUAL MAINT. COST ............... K$
PRINT "ANNUAL OPERATING COST ............ K$
PRINT "REPLACEMENT COST ................ K$
PRINT "SALVAGE VALUE ................... K$
PRINT "AVAILABILITY (per engine) ......... 
PRINT "RELIABILITY (per engine) ......... 
PRINT "MAINTAINABILITY (per engine) ...... 
PRINT "PERFORMANCE (military SHP) ........ 

FOR I=1 TO NENGSEL
     LOCATE 6, K1: PRINT USING "B$: EWT(I)"
     LOCATE 7, K1: PRINT USING "B$: LC(I)"
     LOCATE 8, K1: PRINT USING "B$: MTBF(I)"
     LOCATE 9, K1: PRINT USING "B$: NRPL(I)"
     LOCATE 10, K1: PRINT USING "B$: RD(I)"
     LOCATE 11, K1: PRINT USING "B$: IC(I)"
     LOCATE 12, K1: PRINT USING "B$: YM(I)"
     LOCATE 13, K1: PRINT USING "B$: YO(I)"
     LOCATE 14, K1: PRINT USING "B$: SV(I)"
     LOCATE 15, K1: PRINT USING "B$: YP(I)"
     LOCATE 16, K1: PRINT USING "B$: AVIL(I)"

52
1035  LOCATE 17,K1:PRINT USING C$:RELY(I)
1040  LOCATE 18,K1:PRINT USING C$:MAINT1(I)
1041  LOCATE 19,K1:PRINT USING BS;SHP(I):K1=K1+9
1050  NEXT 1
1060  IF ENGSEL=1 THEN EN=1:GOTO 1080 ELSE
1061  LOCATE 21,1:PRINT SPC(77):LOCATE 21,12
1065  INPUT"ENTER THE LETTER OF THE SELECTED ENGINE
1070  (A,B,C)" "D$"
1074  IF D$="A" THEN EN=1:GOTO 1080 ELSE IF D$="b"
1078  IF D$="B" THEN EN=2:GOTO 1080 ELSE IF D$="c"
1082  IF D$="C" THEN EN=3:GOTO 1080 ELSE IF D$="d"
1086  IF D$="D" THEN EN=4:GOTO 1080 ELSE IF D$="e"
1090  IF ANS=0 THEN 1095 ELSE IF ANS=1 THEN 1061 ELSE
1095  BEEP:GOTO 1080
1100  LOCATE 23,1:PRINT SPC(77):
1105  ENTER to continue",X6
1110  *** SECTION 6.5 ***
1130  CLS
1150  LOCATE 2,5: PRINT"* TRANSMISSION SELECTION *
1155  LOCATE 4,3: PRINT USING"ENGINES: TOTAL SHAFT HP
1160  LOCATE 5,3: PRINT USING" NUMBER INSTALLED
1165  LOCATE 6,3: PRINT USING" INSTALLED WEIGHT
1170  LOCATE 7,3: PRINT USING" TRANSMISSION: POWER RATING
1175  LOCATE 8,3: PRINT USING" WEIGHT
1180  LOCATE 9,2: PRINT"REVISED WEIGHT ESTIMATES"
1185  LOCATE 10,2: PRINT"A/C EMPTY WT
1190  LOCATE 11,3: PRINT USING" FUEL WT
1195  LOCATE 12,3: PRINT USING" PERSONNEL WT
1200  LOCATE 13,3: PRINT USING" USEFUL LOAD
1205  LOCATE 14,3: PRINT USING" DISK LOADING
1210  LOCATE 15,3: PRINT USING" GROSS WT ESTIMATE
1215  LOCATE 16,3: PRINT USING" TOTAL POWER FOR HOGE
1198 LOCATE 20,3: PRINT USING" FIGURE OF MERIT
1199 = "##".####":FM
1200 " "
1203 LOCATE 23,13:INPUT"press <Shift-PrtSc> for hard
1204 ENTER returns to MENU":X6
1205 GOTO 120
1206
1207 XMSNP = 1150 : XMSNW = 700 : RETURN
1208 XMSNP = 1900 : XMSNW = 1100 : RETURN
1209 XMSNP = 3100 : XMSNW = 1700 : RETURN
1210 XMSNP = 4400 : XMSNW = 2000 : RETURN
1211 XMSNP = 5700 : XMSNW = 2400 : RETURN
1212 XMSNP = 8500 : XMSNW = 6500 : RETURN
1213 ' ***SECTION 6.6***
1214 '********** NEW WEIGHT SUMMATION SUBR
1215 LOCATE 1,1,0: PRINT"~W=COMP/
1216 FOR I=1 TO 15
1217 WE2=WE2+W(I,NN)
1218 NEXT I
1219 NGW=WE2+FUEL+UL+PAX
1220 N = NN : GW(N) = NGW : RETURN
1221 '********** POWER COMPUTATION SUBR
1222 '********** POWER CALCULATION ***
1223 LOCATE 1,1,0: PRINT"~W=BLDSTRK/":INPUT X4 :PRINT"~C=ALL/": COLOR 1,1,1:LOCATE 1,1,0:
1224 PRINT":INPUT X4:PRINT"~C=ALL/":COLOR 1,1,1:LOCATE 1,1,0:
1225 IF GE <= 2 THEN PI = PGE * T * VI * K * KU /550
1226 ELSE
1227 IF PI = T * VI * K * KU / 550
1228 PO = (CDO * B * C * R * VT^3 * RHO / 2200)*(1+ 4.3
1229 * MU/2)
1230 IF PI = PGE / 2200
1231 PC = (T * VT^3 * FF * RHO / 1100
1232 ***
2100 FM = PI / (PI + PO)
2110 PT = PI + PO + PP + PC
2120 RETURN

2465 ', ************ COMP WT RESULTS OUTPUT SUBR

2468 ' LOCATE 2.47: PRINT" * REVISED COMPONENT WT

2470 ' LOCATE 4.47: PRINT USING" 1. MAIN ROTORS

2475 ' LOCATE 5.47: PRINT USING" 2. FUSELAGE

2480 ' LOCATE 6.47: PRINT USING" 3. LANDING GEAR

2485 ' LOCATE 7.47: PRINT USING" 4. ENGINE NACELLES

2490 ' LOCATE 8.47: PRINT USING" 5. ENGINES

2495 ' LOCATE 9.47: PRINT USING" 6. DRIVE TRAIN/XMSN

2500 ' LOCATE 10.47: PRINT USING" 7. FUEL TANKS

2505 ' LOCATE 11.47: PRINT USING" 8. FLIGHT CONTROLS

2510 ' LOCATE 12.47: PRINT USING" 9. AUX POWER (APU)

2515 ' LOCATE 13.47: PRINT USING" 10. INSTRUMENTS

2520 ' LOCATE 14.47: PRINT USING" 11. HYDRAULIC SYSTEM

2525 ' LOCATE 15.47: PRINT USING" 12. ELECTRICAL SYSTEM

2530 ' LOCATE 16.47: PRINT USING" 13. AVIONICS

2535 ' LOCATE 17.47: PRINT USING" 14. FURNISHINGS

2540 ' LOCATE 18.47: PRINT USING" 15. AC / DE-ICE EQUIP

2545 ' LOCATE 19.47: PRINT USING" 16. LOAD HANDLING

2550 ' LOCATE 20.47: PRINT"----------

2555 ' LOCATE 21.46: PRINT USING"REVISED COMPONENT WEIGHT

2560 RETURN

9999 END

10 ' PROGRAM TR7.BAS........19 SEPT 1987

30 ' ****************************

40 ' ****************************

50 KEY OFF: PRINT" L=TANDEM7": PRINT" C=ALL/

60 COLOR 15:1

70 DIM ANG(200):IF ENGN=0 THEN ENGN=2 'FUEL=2400:

80 'TASMINP=70: TASC=130: TASMX=150:

90 'PT(70)=1400; PT(80)=1500; PT(90)=1610; PT(100)=1730; PT(110)=1860; PT(120)=2050; PT(130)=2300; PT(140)=2600; PT(150)=3000

90 'CLS

110 LOCATE 1.27: PRINT" * RANGE and ENDURANCE *

{Chap 7}"

120 PRINT"
1. SFC (lb/hr/shp)  2. SHP

1. SFC (lb/hr/shp)

2. SHP

3. SPECIFICATION CONDITIONS: ALTITUDE

3. SPECIFICATION CONDITIONS: ALTITUDE

TOTAL FUEL REQUIREMENTS

TOTAL FUEL REQUIREMENTS

SFC INPUT SUBR

SFC INPUT SUBR

SHP RATING INPUT SUBR

SHP RATING INPUT SUBR

FOR I = 1 TO 3

FOR I = 1 TO 3

WDOTF(I) = SFC(I) * SHP(I) * ENGN

WDOTF(I) = SFC(I) * SHP(I) * ENGN

NEXT I

NEXT I

LOCATE 4,53: PRINT USING" ##########";WDOTF(1)

LOCATE 4,53: PRINT USING" ##########";WDOTF(1)

LOCATE 5,53: PRINT USING" ##########";WDOTF(2)

LOCATE 5,53: PRINT USING" ##########";WDOTF(2)
LOCATE 6,53: PRINT USING"#####.##";WDOTF(3)
RETURN

LOCATE 23,1: PRINT SPC(77): COLOR 14,1
LOCATE 23,6: PRINT "3. ENTER SPECIFICATION CONDITIONS -- NORMALLY 4000 ft MSL 95 deg F": COLOR 15
LOCATE 8,49: PRINT ": LOCATE 8,49: INPUT" ",
ALT
LOCATE 8,65: PRINT ": LOCATE 8,65: INPUT" ",
TEMP
RETURN

:compute & output 0 HP intercept and phantom HP

BETAH=(WDOTF(1)-WDOTF(3))/((ENGN*(SHP(1)-SHP(3)))
DELTA(I)=I: DELTA(2)=1.68755E-6*ALT^-5.2561
THETA(I)=I: THETA(2)=(459.688+TEMP)/518.688
FOR I=1 TO 2:
ALPHAH(I)=ALPHAH*DELTA(I)*SQR(THETA(I)): NEXT I
FOR I=1 TO 2: PF(I)=ALPHAH(I)/BETAR: NEXT I
LOCATE 23,1: PRINT SPC(77): COLOR 14,1
LOCATE 23,5: INPUT"ANY CHANGES ? (0=NO,1=YES)
ANS
IF ANS=0 THEN 800 ELSE IF ANS=1 THEN 790 ELSE BEEP: GOTO 798
LOCATE 23,3: INPUT"WHICH ITEM (1 thru 3) ",X7
ON X7 GOSUB 400,450,600
GOTO 780

: COMPUTE Range airspeed and power then output

ANG(TASMINP-10)=999
PWR = PF(I) + PT(I) : TAS(I) = I
ANG(I) = PWR/TAS(I)
IF ANG(I) < ANG(I-10) THEN
RHPMXR=PWR: PTMXR=PWR-PF(I): TASMXR=TAS(I)
NEXT I
FFMXR = RHPMXR * BETAH : PRINT"~C=ALL/
LOCATE 13,8 : PRINT USING" AIRSPEED = ###
SHP":PTMXR
LOCATE 14,8 : PRINT USING" POWER = #######
LOCATE 15,8 : PRINT USING"FUEL FLOW = #######
1h/hr":FFMXR
LOCATE 13,8 : PRINT USING" AIRSPEED = ###
SHP":PTMXR
LOCATE 14,48 : PRINT USING" POWER = #######
SHP":PTMXR
LOCATE 15,48 : PRINT USING"FUEL FLOW = #######
1h/hr":FFMXR
57
950 ' *** COMPUTE SPEC cruise pwr and fuel flow
1000 '**************************************************************************
1010 RHPCR(1) = PF(1) + PTCR ; FFCR = RHPCR(1) * BETAH
1020 RHPCR(2) = PF(2) + PTCR ; FFCRSP = RHPCR(2) * BETAH
1030 LOCATE 18, 29: PRINT USING"### kts"; TASCR
1040 LOCATE 20.3: PRINT USING"###.### SHP ###.###
1050 PRINT USING"###.### lb/hr ###.###
1060 RETURN
1100 ' *** input max range for total fuel reqmnt
1105 LOCATE 23.1: PRINT SPC(77): COLOR 14,1
1106 LOCATE 23.10: PRINT "4. ENTER SPECIFICATION MAX RANGE IN NAUTICAL MILES";
1107 LOCATE 19.42: PRINT SPC (36)
1108 LOCATE 19.43: INPUT "4. SPEC MAX RANGE (NM) = ", MXR
1109 RETURN
1110 ' *** compute total fuel required
1115 TIME = MXR/TASCR
1120 TFUEL= (.1*BETAH*(SHP(2)+PF(1)))+
1125 *(RHPMXE*BETAH)+(TIME*FFCRSP)
1130 LOCATE 21,43: PRINT USING"TOTAL FUEL REQUIRED =
1135 "###.### lbs"; TFUEL
1140 LOCATE 21.45: PRINT USING"DESIGN FUEL CAPACITY =
1145 "###.### lbs"; FUEL
1150 FUELDIF = ABS(TFUEL - FUEL)
1160 IF TFUEL < FUEL THEN 1165 ELSE 1170
1170 LOCATE 22, 48: PRINT USING"EXCESS FUEL =
1175 "###.### lbs"; FUELDIF
1180 LOCATE 22, 48: PRINT USING"FUEL DEFICIENCY =
1185 "###.### lbs"; FUELDIF
1190 RETURN
1200 ' *** input changes
1205 LOCATE 23.1: PRINT SPC(77): COLOR 14,1
1210 LOCATE 23.5: INPUT "ANY CHANGES ? (0=NO, 1=YES)
1215 " ANS
1220 IF ANS=0 THEN 1300 ELSE IF ANS=1 THEN 1230 ELSE
1225 GOTO 1200
1230 LOCATE 23.38: INPUT "WHICH ITEM (1 thru 4) ", X7
1235 IF X7 < 1 OR X7 > 4 THEN GOSUB 8000: GOTO 1230
1240 COLOR 5, 1: ON X7 GOSUB 400, 450, 600, 1100
1250 GOSUB 1120: GOSUB 500: GOSUB 630: GOSUB 800: GOSUB 1000:
1260 GOSUB 1120: GOTO 1200
1270 ' LOCATE 23.1: PRINT SPC(77): COLOR 14,1
1280 LOCATE 23.5: INPUT "Press <Shift-PrtSc> for hard
1290 , ENTER to continue", X5
1300 COLOR 16, 1: GOTO 9000
1305 LOCATE 1.10: PRINT "W=TRYAGAIN/": LOCATE 23.1:
1310 PRINT SPC(77): RETURN
1315 LOCATE 1.10: PRINT "W=LOADNOTE/": CHAIN"TR1", ALL
1320 RETURN
1330 CLS: PRINT "W=LOADNOTE/": CHAIN"TR1", ALL
1340 END
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LIST OF REFERENCES


