Rotorwash Analysis Handbook

Volume II - Appendixes

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Documentation, a program listing, and a user's guide are provided for version 2.1 of the FORTRAN 77-based ROTWASH computer program in report appendices. An extensive bibliography of rotorwash related technical documents is also provided. This listing is subdivided into different rotorwash topics.

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TABLE A-1 ROTORCRAFT DATA SUMMARY (Continued)

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<th>Rotor Disk Loading (psf)</th>
<th>Number of Rotors/Blades per Rotor</th>
<th>Rotor Tip Speed (fps)</th>
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<th>Twin Rotor Separation (ft)</th>
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APPENDIX B

SIKORSKY CH-53E HELICOPTER AND ROTORWASH DATA

Sikorsky CH-53E helicopter characteristics used with the ROTWASH analysis program are listed in table B-1 as obtained from reference B-1. Figure B-1 presents a three-view drawing of the helicopter. Table B-2 provides a summary tabulation of parameters defining the conditions for all rotorwash data presented in this appendix. Flight test data used in correlation with the ROTWASH calculated data are obtained from reference 2 and were measured along the 270-degree azimuth (out the left side of the helicopter). Distance from rotor center (DFRC), gross weight (GW), and rotor height above ground level (RHAGL) are the primary independent variables for these measured data. Discussion of results is presented in section 3.1 of this report.

REFERENCES


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<td>Distance from wheels to rotor plane, feet</td>
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FIGURE B-1 THREE-VIEW DRAWING OF THE SIKORSKY CH-53E
### TABLE B-2  EVALUATION MATRIX FOR CH-53E FLIGHT TEST

**MATHEMATICAL MODEL DATA CORRELATION**

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<th>FIGURE NUMBER</th>
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<th>DISK LOADING (lbs/ft²)</th>
<th>ROTOR HEIGHT (feet)</th>
<th>DISTANCE FROM ROTOR CENTER (DFRC) (feet)</th>
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**NOTES:**

1) The values of DFRC are only applicable along the 270-degree azimuth.

2) Ambient winds varied between 0 and 3.5 knots.

3) Atmospheric density ratio was assumed equal to 1.0 since pressure altitude (which was near sea level) was not documented in reference B-2. Ambient temperature was measured from 39 to 45 degrees Fahrenheit during testing.
FIGURE B-2 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 37 FEET AND A GROSS WEIGHT OF 70,000 POUNDS
FIGURE B-2  CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 37 FEET AND A GROSS WEIGHT OF 70,000 POUNDS (continued)
FIGURE B-2 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 37 FEET AND A GROSS WEIGHT OF 70,000 POUNDS (continued)
FIGURE B-2 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 37 FEET AND A GROSS WEIGHT OF 70,000 POUNDS (continued)
FIGURE B-3 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 77 FEET AND A GROSS WEIGHT OF 70,000 POUNDS
FIGURE B-3 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 77 FEET AND A GROSS WEIGHT OF 70,000 POUNDS (continued)
FIGURE B-3 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 77 FEET AND A GROSS WEIGHT OF 70,000 POUNDS (continued)
FIGURE B-3 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 77 FEET AND A GROSS WEIGHT OF 70,000 POUNDS (continued)
FIGURE B-4 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT
270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT
OF 117 FEET AND A GROSS WEIGHT OF 70,000 POUNDS

B-12
FIGURE B-4 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 117 FEET AND A GROSS WEIGHT OF 70,000 POUNDS (continued)
FIGURE B-4 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 117 FEET AND A GROSS WEIGHT OF 70,000 POUNDS (continued)
### SIKORSKY CH-53E HELICOPTER

| GW = 70000 LB | DFRC = 118.5 FT | RADIUS = 39.5 FT |
| DL = 14.28 PSF | RHAGL = 117.0 FT | ROTSEP = 0.0 FT |
| SIGP (\(\sigma^*\)) = 1.0 | WHAGL = 100.0 FT | RIDL = 5.0 PCT |
| AZIMUTH = 270 DEG | WIND < 3.5 KTS |

![Graph](image1)

### SIKORSKY CH-53E HELICOPTER

| GW = 70000 LB | DFRC = 177.9 FT | RADIUS = 39.5 FT |
| DL = 14.28 PSF | RHAGL = 117.0 FT | ROTSEP = 0.0 FT |
| SIGP (\(\sigma^*\)) = 1.0 | WHAGL = 100.0 FT | RIDL = 5.0 PCT |
| AZIMUTH = 270 DEG | WIND < 3.5 KTS |

![Graph](image2)

**Figure B-4 CH-53E Mean and Peak Velocity Profiles for Eight 270-degree Azimuth Radial Stations at a Rotor Height of 117 feet and a Gross Weight of 70,000 Pounds** (continued)
FIGURE B-5 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 37 FEET AND A GROSS WEIGHT OF 56,000 POUNDS
**SIKORSKY CH-53E HELICOPTER**

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<tr>
<td>AZIMUTH</td>
<td>270 DEG</td>
</tr>
<tr>
<td>WIND</td>
<td>&lt; 3.5 KTS</td>
</tr>
</tbody>
</table>

**FIGURE B-5 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 37 FEET AND A GROSS WEIGHT OF 56,000 POUNDS (continued)**
FIGURE B-5 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 37 FEET AND A GROSS WEIGHT OF 56,000 POUNDS (continued)
**FIGURE B-5 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 37 FEET AND A GROSS WEIGHT OF 56,000 POUNDS (continued)**

<table>
<thead>
<tr>
<th>SIKORSKY CH-53E HELICOPTER</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>GW = 56000 LB</strong></td>
</tr>
<tr>
<td><strong>DL = 11.42 PSF</strong></td>
</tr>
<tr>
<td><strong>SIGP (\sigma') = 1.0</strong></td>
</tr>
<tr>
<td><strong>AZIMUTH = 270 DEG</strong></td>
</tr>
</tbody>
</table>
FIGURE B-6 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 77 FEET AND A GROSS WEIGHT OF 56,000 VOUNDS (continued)
FIGURE B-6 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 77 FEET AND A GROSS WEIGHT OF 56,000 POUNDS (continued)
FIGURE B-6 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 117 FEET AND A GROSS WEIGHT OF 56,000 POUNDS (continued)
FIGURE B-6 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 117 FEET AND A GROSS WEIGHT OF 56,000 POUNDS (continued)
FIGURE B-7 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 117 FEET AND A GROSS WEIGHT OF 56,000 POUNDS
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>GW (Gross Weight)</td>
<td>56000 LB</td>
</tr>
<tr>
<td>DFRC (Diameter Front Radius of Curvature)</td>
<td>49.4 FT</td>
</tr>
<tr>
<td>RADIUS (Radius)</td>
<td>39.5 FT</td>
</tr>
<tr>
<td>DL (Downwash)</td>
<td>11.42 PSF</td>
</tr>
<tr>
<td>RHAGL (Rotor Height Above Ground Level)</td>
<td>117.0 FT</td>
</tr>
<tr>
<td>ROTSEP (Rotor Separation)</td>
<td>0.0 FT</td>
</tr>
<tr>
<td>WHAGL (Wing Height Above Ground Level)</td>
<td>100.0 FT</td>
</tr>
<tr>
<td>RIDL (Radius of Influence)</td>
<td>5.0 PCT</td>
</tr>
<tr>
<td>AZIMUTH</td>
<td>270 DEG</td>
</tr>
<tr>
<td>WIND</td>
<td>&lt; 3.5 KTS</td>
</tr>
</tbody>
</table>

**Figure B-7 CH-53E Mean and Peak Velocity Profiles for Eight 270-Degree Azimuth Radial Stations at a Rotor Height of 117 Feet and a Gross Weight of 56,000 Pounds**

(continued)
FIGURE B-7 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 37 FEET AND A GROSS WEIGHT OF 45,000 POUNDS (continued)
FIGURE B-7 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 37 FEET AND A GROSS WEIGHT OF 45,000 POUNDS (continued)
FIGURE B-8 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 37 FEET AND A GROSS WEIGHT OF 45,000 POUNDS
FIGURE B-8 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 37 FEET AND A GROSS WEIGHT OF 45,000 POUNDS (continued)
**FIGURE B-8** CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 77 FEET AND A GROSS WEIGHT OF 45,000 POUNDS (continued)
FIGURE B-8  CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 77 FEET AND A GROSS WEIGHT OF 45,000 POUNDS (continued)
FIGURE B-9 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 77 FEET AND A GROSS WEIGHT OF 45,000 POUNDS
FIGURE B-9 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 77 FEET AND A GROSS WEIGHT OF 45,000 POUNDS (continued)
FIGURE B-9 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 117 FEET AND A GROSS WEIGHT OF 45,000 POUNDS (continued)
FIGURE B-9  CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 117 FEET AND A GROSS WEIGHT OF 45,000 POUNDS (continued)
SIKORSKY CH-53E HELICOPTER

| GW = 45000 LB | DFRC = 31.6 FT | RADIUS = 39.5 FT |
| DL = 9.18 PSF | RHAGL = 117.0 FT | ROTSEP = 0.0 FT |
| SIGP (\( \sigma' \)) = 1.0 | WHAGL = 100.0 FT | RIDL = 5.0 PCT |
| AZIMUTH = 270 DEG | WIND < 3.5 KTS |

**Figure B-10 CH-53E Mean and Peak Velocity Profiles for Eight 270-Degree Azimuth Radial Stations at a Rotor Height of 117 Feet and a Gross Weight of 45,000 Pounds**
FIGURE B-10 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 117 FEET AND A GROSS WEIGHT OF 45,000 POUNDS (continued)
FIGURE B-10 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 117 FEET AND A GROSS WEIGHT OF 45,000 POUNDS (continued)
FIGURE B-10  CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 117 FEET AND A GROSS WEIGHT OF 45,000 POUNDS (continued)
APPENDIX C

A COLLECTION OF REFERENCES PROVIDING INFORMATION OR FURTHER INSIGHT INTO THE ROTORWASH HAZARD ANALYSIS PROBLEM

FULL SCALE AND MODEL DOWNWASH/OUTWASH FLOW FIELD DATA


C-1


13. Leese, G. W., "UH-1H Downwash Velocity Measurements", Army Engineer Waterways Experiment Station, Vicksburg, Mississippi, August 1972.


ROTORWASH AND ROTORWASH HAZARD RELATED ANALYSIS AND PREDICTION TECHNIQUES


14. Leese, G. W., "Helicopter Downwash Blast Effects Study", U.S. Army Engineer Waterways Experiment Station TR-3-664, Vicksburg, Mississippi, October 1964.


HELIPORT/VERTIPORT DESIGN AND SAFETY ISSUES

1. Armstrong, J. P., "Evaluation and Control of Dust and Foreign Object Damage (FOD) at the VTOL Forward Operating Site", Army Engineer Waterways Experiment Station, Vicksburg, Mississippi.


LOW SPEED INTERACTIONAL AERODYNAMICS (I.E., GROUND VORTEX)


**WAKE VORTEX ENCOUNTERS**


**OTHER REFERENCES**


APPENDIX D
USER'S GUIDE

D.1 ROTWASH PROGRAM USER'S GUIDE

The style of the ROTWASH user's guide presented in this appendix is primarily narrative. This format is designed to guide the reader through a step-by-step explanation on the use of each program software option. Example output from each option is presented exactly as it would be viewed by the user on a video terminal for reference purposes. Examples of user keyboard input are presented in <BOLD> text as an aid to the reader.

D.1.1 GETTING STARTED

The ROTWASH program is executed by typing the program name at the DOS system prompt:

<ROTWASH>

To avoid possible system errors, the user should execute the program from the directory containing the program (or set the appropriate DOS system PATH command). The user should also be aware that menu and data printouts to the screen will not work correctly unless the device=C:\DOS\ANSI.SYS command is contained in the CONFIG.SYS file.

The ROTWASH program responds with the screen output presented in figure D-1. This output is the ROTWASH program header page.

<table>
<thead>
<tr>
<th>ROTWASH PROGRAM</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROTORCRAFT DOWNWASH HAZARD ANALYSIS</td>
</tr>
<tr>
<td>EMA / SYSTEMS CONTROL TECHNOLOGY</td>
</tr>
<tr>
<td>*** PROGRAM VERSION 2.1, APRIL 1993 ***</td>
</tr>
</tbody>
</table>

PRESS <RETURN>

FIGURE D-1 ROTWASH PROGRAM HEADER OUTPUT
After typing the carriage return <RETURN> or <ENTER> key, the user is asked to specify the path for ROTWASH program input and output (I/O). The only option for input at the present time is the terminal keyboard. This is specified by typing <CON> for console or keyboard (lower case inputs such as <con> are also permitted). Program output may be sent to one of three different locations. These output locations are:

<table>
<thead>
<tr>
<th>OUTPUT OPTION</th>
<th>TYPING COMMAND</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screen</td>
<td>&lt;CON&gt;</td>
</tr>
<tr>
<td>Printer</td>
<td>&lt;PRN&gt;</td>
</tr>
<tr>
<td>Disk Plotting File</td>
<td>&lt;PLT&gt;</td>
</tr>
</tbody>
</table>

An example of the video screen output for this program menu is presented in figure D-2 where the <CON> option has been chosen for both input and output.

\[
\begin{array}{|c|c|}
\hline
\text{I/O CAN BE DIRECTED TO FILES OR DEVICES} & \\
\hline
\text{VALID DEVICES ARE AS FALLS:} & \\
\hline
<CON> & \text{CONSOLE} \\
<PRN> & \text{PRINTER} \\
<PLT> & \text{GRAPHICS FILE} \\
\hline
\end{array}
\]

ENTER INPUT FILE/DEV NAME ==> CON
ENTER OUTPUT FILE/DEV NAME ==> CON

**FIGURE D-2** ROTWASH PROGRAM INPUT/OUTPUT CONTROL MENU

D.1.2 INPUT DATA REQUIREMENTS

Rotorcraft characteristics and atmospheric conditions that are common to all program options are input to the program using the master input data menu. Four basic configurations of rotor or propeller driven aircraft can be represented using this menu. These configurations include single and tandem rotor helicopters, tiltrotors, and twin-propeller tiltwings. This menu is presented to the user as shown in figure D-3 after the I/O menu is completed. The default values provided in the menu define the Bell XV-15 tiltrotor. Design data describing most other modern types of rotorcraft are provided in appendix A.
ROTWASH USER INPUT DATA MENU

<table>
<thead>
<tr>
<th>CODE</th>
<th>PARAMETER</th>
<th>VALUE</th>
<th>UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>NUMBER OF ROTORS (1 OR 2)</td>
<td>2</td>
<td>ND</td>
</tr>
<tr>
<td>B</td>
<td>HUB TO HUB ROTOR SEPARATION</td>
<td>32.2</td>
<td>FT</td>
</tr>
<tr>
<td>C</td>
<td>ROTOR RADIUS</td>
<td>12.5</td>
<td>FT</td>
</tr>
<tr>
<td>D</td>
<td>GROSS WEIGHT</td>
<td>13000.0</td>
<td>LB</td>
</tr>
<tr>
<td>E</td>
<td>FUSELAGE DOWNLOAD FACTOR</td>
<td>13.0</td>
<td>PCT</td>
</tr>
<tr>
<td>F</td>
<td>ROTOR HEIGHT ABOVE GROUND</td>
<td>37.0</td>
<td>FT</td>
</tr>
<tr>
<td>G</td>
<td>SHAFT TILT ANGLE (&lt;20 DEG)</td>
<td>0.0</td>
<td>DEG</td>
</tr>
<tr>
<td>H</td>
<td>AIR DENSITY RATIO</td>
<td>1.0000</td>
<td>ND</td>
</tr>
<tr>
<td>I</td>
<td>AMBIENT WIND (-10 TO 10 KT)</td>
<td>0.0</td>
<td>KT</td>
</tr>
</tbody>
</table>

ENTER DATA ENTRY CODE OR <RETURN> TO CONTINUE ==> D

GROSS WEIGHT = 13000.0

ENTER NEW VALUE OR <RETURN> TO LEAVE AS IS ==> 13500.0

FIGURE D-3 MASTER INPUT DATA MENU

The first input data variable listed on the menu is the number of rotors (or propellers). This value will always be two except for single main rotor helicopters (the tail rotor is not considered a lifting rotor by the ROTWASH analysis). The next four menu variables define the design details of the rotorcraft configuration. These variables are the hub-to-hub separation distance for twin-rotor configurations (in feet), rotor radius (feet), rotorcraft gross weight (pounds), and the rotor-on-wing download factor (percent). The download factor represents the percent increase in hover rotor thrust required to overcome the rotor-induced vertical drag force on the airframe (where thrust is initially assumed to equal gross weight). For most helicopters, this value is less than 5 percent. Download on tiltrotors can generally be expected to vary from 8 to 13 percent because of the large wing area under the rotor.

The next two input data variables define the position of the rotor with respect to the ground plane. The rotor height (feet) is defined as the distance from the ground surface to the plane of the rotor. The mast angle (degrees) is defined as the tilt of the rotor plane with respect to the ground plane. The mast angle is defined as 0 degrees when the plane of the rotor is parallel to the ground plane and a positive angle is a forward tilt of the mast (which is presently limited in the program to 20 degrees). Since most rotorcraft hover with the plane of the rotor parallel to the ground, it is recommended that caution be exercised when non-zero values are used for mast angle. Non-zero uses of the variable might involve hover investigations for tiltwing aircraft.
with the wing tilted forward (where a pitch fan provides the trim pitching moment). Also, limited rotorwash investigations for takeoff and landing maneuvers might be attempted if approximate rotor thrust levels are known for various segments of the maneuvers.

The last two input data variables on the menu define the atmospheric conditions. The air density ratio is defined as the ratio of the desired air density to the sea level standard air density (0.0023769 slugs/feet$^3$). Ambient wind speed (knots) is specified by the user up to a limit of 10 knots. Values greater than this limit are believed to invalidate several empirically determined mathematical modeling assumptions (limits are discussed in sections 2 and 3 of Volume I of this report).

The mechanics of using the menu are quite simple. The user types in the code value for the variable to be changed and then types <RETURN>. The next prompt asks for the new parameter value. After this value and another <RETURN> are typed, the menu is rewritten to the screen with the new value. This simple process is continued until the user specifies each variable to its desired value. At this point, the <RETURN> key is typed by itself. This menu can also be reached from most of the other menus in the program whenever the user decides that the basic configuration needs to be modified. This is accomplished by typing <N> for NEW CASE when the option is offered.

D.1.3 ANALYSIS PROBLEM DEFINITION

After the master input data menu is completed, the user specifies the desired type of analysis option. Figure D-4 presents the program logic/comment menu and the associated list of default values. This menu has two groupings of parameters which need to be specified.

The first parameter on the menu specifies the choice of either the velocity calculation analysis option or the hazard analysis option. The velocity analysis option is the default option on the menu. This option is otherwise chosen by typing the code <A>, then <RETURN>, then <V>, and finally <RETURN>. The same process is used to specify the hazard analysis option except that <H> is substituted for <V> as the parameter value. The second menu parameter provides an interactive toggle switch for the option which writes out data files to disk for graphics programs. (This parameter is also offered as an option on the initial ROTWASH menu by typing <PLT>). There is no limit to the number of times this switch can be toggled. As long as the parameter has a <Y> or "yes" value, the user must specify output filenames before data files are written to disk. The user is not allowed to write over files previously written to disk by specification of the same filename twice.
The last two lines in the menu are used to specify user comments in all data files that are written to disk. These comments are also written out as header information on screen output sent directly to the printer. Both of the comment lines can be changed at any time during program execution. The only restriction is that the character strings on both lines be less than or equal to 50 characters. The arrowhead symbols above the comment lines in the menu define a 50-space line width.

If the velocity analysis option is specified, the user is then required to choose one of the four analysis options presented in figure D-5. Velocity analysis options reached through this menu are the:

1. simple wall jet (for both single and twin-rotor configurations),
2. interaction plane (twin-rotor only),
3. ground vortex (single rotor only), and
4. disk edge vortex (single rotor only).
SELECT TYPE OF FLOW TO BE ESTIMATED

WALL JET PROFILE, TYPE <W>
INTERACTION PLANE PROFILE, TYPE <I>
GROUND VORTEX, TYPE <G>
DISK VORTEX, TYPE <D>
TO EXIT PROGRAM, TYPE <X>

ENTER DATA ENTRY CODE ==> W

FIGURE D-5 VELOCITY ANALYSIS OPTION MENU

Each of these four options is described with flowfield characteristics sketches in subsequent sections. For technical details and discussion on practical limitations of these options, the user is referred to Sections 2 and 3 of Volume I of this report. The choice of one of these menu options is made by typing the appropriate code and <RETURN>. If one of the five allowable characters is not chosen, the menu will reappear and the user will be forced to choose an acceptable option.

If the hazard analysis option is specified, the user is presented with the figure D-6 menu. This menu allows the user to choose either:

1. human overturning force/moment analysis, or
2. particulate cloud analysis.

Both of these analyses can be applied to either single or twin-rotor configurations. The mechanics of this menu operate exactly like those of the velocity analysis option menu.

D.1.4 THE WALL JET OPTION

Rotorwash velocity jet profiles are calculated for single main rotor helicopter configurations using the wall jet option. Velocity profiles along the 0- and 180-degree azimuths for tandem helicopters and the 90- and 270-degree azimuths for twin-rotor side-by-side configurations are also calculated using this option (90 degrees is out the right wing on a tiltrotor and 0 degrees is along the centerline of the fuselage for tandem rotor helicopters). Figure D-7 provides a three-dimensional view of
The rotorwash flowfields associated with both rotor configurations. Figure D-8 provides a cross-sectional view of the nondimensionalized ROTWASH wall jet velocity profile model. The program menu associated with the use of this option is presented in figure D-9.

The velocity profile status menu provides the user the option to specify four parameters before proceeding with detailed calculations. The horizontal distance on the ground from the center of the rotor to where the velocity profile should be calculated is the first parameter specified on the menu. Figure D-10 is provided to illustrate this geometry graphically using the Bell XV-15, which is the more complex example (flight test data results associated with this figure are documented in reference D-3). To specify the profile station position for the wall jet with the XV-15 (270-degree radial), the user would measure the distance from the aircraft centerline (DFAC) and subtract 16.1 feet (the distance from the centerline to the center of the rotor). The remaining two position-related parameters to be specified are the vertical calculation increment and the maximum height above ground level (AGL) to which the profile should be calculated. The default values for these three parameters are 50 feet, 1 foot, and 10 feet, respectively.
FIGURE D-7 ROTORWASH FLOW FIELDS OF SINGLE- AND TWIN-ROTOR CONFIGURATIONS OPERATING IN CLOSE PROXIMITY TO THE GROUND
FIGURE D-8  NON-DIMENSIONAL WALL JET VERTICAL VELOCITY PROFILE
VELOCITY PROFILE STATUS MENU

<table>
<thead>
<tr>
<th>CODE</th>
<th>PARAMETER</th>
<th>VALUE</th>
<th>UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>PROFILE STATION POSITION</td>
<td>50.00</td>
<td>FT</td>
</tr>
<tr>
<td>B</td>
<td>VERTICAL INCREMENT</td>
<td>1.00</td>
<td>FT</td>
</tr>
<tr>
<td>C</td>
<td>MAXIMUM PROFILE HEIGHT</td>
<td>10.00</td>
<td>FT</td>
</tr>
<tr>
<td>D</td>
<td>MINIMUM BOUNDARY LAYER HEIGHT</td>
<td>1.50</td>
<td>FT</td>
</tr>
<tr>
<td>E</td>
<td>DATA OUTPUT FILENAME</td>
<td>DFRC.PTS</td>
<td></td>
</tr>
</tbody>
</table>

ENTER DATA ENTRY CODE OR <RETURN> TO CONTINUE

**FIGURE D-9 VELOCITY PROFILE STATUS MENU**

An option is also provided to allow the user to specify a minimum boundary layer height based on flight test data. The default value of 1.5 feet for this value will insure that the peak velocity on the profile is always equal to or greater than 1.5 feet (at very close positions to the rotor, the ROTWASH methodology often calculates an unrealistically thin boundary layer if a minimum limit is not specified). Each of the four parameters is input by typing the appropriate code, <RETURN>, the new input data value, and <RETURN> to end the sequence. The last parameter on the menu is the filename for data that is written to disk if the graphics file toggle switch is set to <Y>.

The wall jet velocity profile, calculated by the program using default inputs, is presented in figure D-11 when the <RETURN> key is typed by itself. Output from the analysis describes the shape of both the mean and peak velocity profiles; an example is presented in figure D-12 correlated with Bell XV-15 flight test data (this particular example correlates to a rotor height of 37.5 feet and a DFAC value of 66.1 feet on figure D-10).

The output format provides velocity profile data in units of either feet per second, knots, or pounds per square foot (also referred to as dynamic pressure).

If the specified increment in vertical height is small or the maximum calculated height is large, the quantity of data to be output to the screen may exceed the 10-line limit for 1 screen frame. When this situation occurs, the typing of <C> at the
Values for RHAGL (Feet)

14.5
37.5
62.5

Distance Along Interation Plane (feet)
(for data on 0 Degree and 180 Degree Radial)

28.1
31.7
41.1
53.6
66.1
91.1

Distance from Centerline of Fuselage (feet)
(for data on 270 Degree Radial)

16.1 feet

FIGURE D-10 XV-15 FLIGHT TEST DATA MEASUREMENT LOCATIONS
SINGLE ROTOR VELOCITY PROFILE AT RADIUS = 50.0 FT

PROFILE BOUNDARY HEIGHT = 11.49 FT
HALF-VEL. HEIGHT = 4.10 FT
MAX-VEL HEIGHT = 1.15 FT

<table>
<thead>
<tr>
<th>HEIGHT (FT)</th>
<th>MEAN VELOCITY (FPS)</th>
<th>PEAK VELOCITY (FPS)</th>
<th>MEAN Q (KN)</th>
<th>PEAK Q (PSF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>1.00</td>
<td>42.036</td>
<td>25.077</td>
<td>78.945</td>
<td>46.796</td>
</tr>
<tr>
<td>1.00</td>
<td>27.036</td>
<td>25.077</td>
<td>46.796</td>
<td>2.127</td>
</tr>
<tr>
<td>3.00</td>
<td>32.043</td>
<td>23.887</td>
<td>74.263</td>
<td>44.021</td>
</tr>
<tr>
<td>4.00</td>
<td>24.823</td>
<td>14.714</td>
<td>65.002</td>
<td>38.531</td>
</tr>
<tr>
<td>5.00</td>
<td>18.565</td>
<td>11.005</td>
<td>59.944</td>
<td>35.533</td>
</tr>
<tr>
<td>6.00</td>
<td>13.240</td>
<td>7.848</td>
<td>51.299</td>
<td>30.408</td>
</tr>
<tr>
<td>7.00</td>
<td>8.829</td>
<td>5.233</td>
<td>39.909</td>
<td>23.657</td>
</tr>
<tr>
<td>8.00</td>
<td>5.319</td>
<td>3.153</td>
<td>27.477</td>
<td>16.288</td>
</tr>
<tr>
<td>9.00</td>
<td>2.700</td>
<td>1.600</td>
<td>15.691</td>
<td>9.301</td>
</tr>
<tr>
<td>10.00</td>
<td>.964</td>
<td>.571</td>
<td>6.222</td>
<td>3.688</td>
</tr>
</tbody>
</table>

TYPE <C>ONTINUE, NEXT <P>OINT, <N>EW CASE, E<X>-IT ==>

FIGURE D-11 WALL JET VELOCITY PROFILE OUTPUT FORMAT

prompt (at the bottom of the screen) results in the next 10 lines of data being written to the screen. If the code value <P> is typed, the program returns to the wall jet analysis menu. The typing of code <N> results in the program returning to the master input data menu. If the code <X> is typed, the program returns to the DOS system prompt.

Flight test data, correlated with output from the wall jet option, are presented in section 3 of Volume I of this report for the Bell XV-15, Bell-Boeing MV-22, Sikorsky CH-53E, Sikorsky SH-60B, and Canadair CL-84. Based on the correlation conducted for references D-1 and D-2, it is generally recommended that the wall jet option be used for calculation of velocity profiles at distances greater than 1.5 times the rotor radius from the center of the rotor. At distances less than this value, the mathematical model is not detailed enough to predict rotorwash flowfield characteristics accurately. This limitation is not serious because distances closer to the rotor tip than 1.5 times the rotor radius have little practical reason for being analyzed for rotorwash effects on the environment. Collision avoidance with respect to objects in close proximity to the rotorcraft is the critical issue at this close a distance.
D.1.5 THE TWIN-ROTOR INTERACTION PLANE OPTION

The twin-rotor interaction plane option calculates the velocity profile contained in the plane which is oriented perpendicular to the ground and to the line segment which connects the center of both rotor hubs (refer to figure D-1). After choosing the interaction plane option on the velocity analysis option menu, the user must specify the same parameters on the velocity profile status menu that are required with the wall jet option. The only difference between the parameters is the reference position for specification of the horizontal location of the velocity profile with respect to the rotor (the first menu option). For the interaction plane analysis, this distance is referenced as 0 at the intersection of the interaction plane and the line connecting the rotors and not directly to the center of one of the two rotors (i.e., the input value for distance along the interaction plane (DAIP) for a tiltrotor is along a line that is an extension of the fuselage centerline as seen in figure D-10). No velocity profile differences are assumed to exist by the mathematical model for points equidistant along the interaction plane but on opposite sides of the line connecting the rotors. For a tiltrotor, this means that the calculated velocity profiles both

D-13
directly in front of and directly aft of the aircraft are the same when equidistant along the interaction plane.

Example output from the interaction plane option is presented in figure D-13. This data format closely resembles that of the wall jet option except that both horizontal and vertical velocity profile components are calculated. The horizontal velocity component is identified by the "H" in the column following the height column and the vertical component by the "V". The mechanics for viewing data on the screen (if more data exist than will fit on one screen frame) and for transferring to other menus are exactly as are described for the wall jet option.

Output from the interaction plane option, correlated with XV-15 flight test data, is presented in figure D-14 as an example. These data are excerpted from reference D-2. Other original flight test data for both the Bell XV-15, Bell-Boeing MV-22, and Canadair CL-84 (tiltwing) are documented in section 3 of Volume I of this report.

Several practical recommendations need to be noted for users of the interaction plane option. When analyzing tiltrotor and tiltwing configurations, the user must be careful to avoid choosing analysis locations that are coincident with components of the nose or tail structure on the aircraft. Also, locations in close proximity to the nose or tail of a real aircraft should not be expected to have rotorwash flowfield characteristics identical to calculated velocity profiles. At these locations unmodeled airframe aerodynamic interferences significantly influence the rotorwash flowfield structure. Flight test data

<table>
<thead>
<tr>
<th>HEIGHT (FT)</th>
<th>MEAN VELOCITY (FPS)</th>
<th>PEAK VELOCITY (FPS)</th>
<th>MEAN Q (PSF)</th>
<th>PEAK Q (PSF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>V</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>1.00 H</td>
<td>63.626</td>
<td>37.715</td>
<td>103.992</td>
<td>4.811</td>
</tr>
<tr>
<td>V</td>
<td>21.760</td>
<td>12.899</td>
<td>35.565</td>
<td>21.082</td>
</tr>
<tr>
<td>2.00 H</td>
<td>66.665</td>
<td>39.517</td>
<td>108.960</td>
<td>64.588</td>
</tr>
<tr>
<td>V</td>
<td>24.133</td>
<td>14.305</td>
<td>39.443</td>
<td>23.381</td>
</tr>
<tr>
<td>3.00 H</td>
<td>65.800</td>
<td>39.004</td>
<td>107.545</td>
<td>63.749</td>
</tr>
<tr>
<td>V</td>
<td>25.136</td>
<td>14.900</td>
<td>41.082</td>
<td>24.352</td>
</tr>
<tr>
<td>4.00 H</td>
<td>64.912</td>
<td>38.478</td>
<td>106.093</td>
<td>62.889</td>
</tr>
<tr>
<td>V</td>
<td>26.094</td>
<td>15.468</td>
<td>42.649</td>
<td>25.281</td>
</tr>
</tbody>
</table>

FIGURE D-13 INTERACTION PLANE VELOCITY PROFILE OUTPUT FORMAT
obtained from the XV-15, MV-22, and Cl-84 indicate that measured mean and peak velocity profiles at points equidistant along the interaction plane (both in front of and aft of an actual aircraft) often do not yield identical results as might be expected. Therefore, output from this analysis option should be calibrated with flight test data whenever possible in an attempt to determine whether positions forward or aft of the aircraft may be more critical for analysis.

D.1.6 GROUND VORTEX ANALYSIS OPTION

A ground vortex structure is formed when ambient wind and/or rotorcraft translational velocity overcome the rotor-induced wall jet flowfield. A diagram of the ground vortex is presented in figure D-15. Due to the elementary nature of the mathematical model formulation used in the ROTWASH program, the ground vortex option should be used with caution. As discussed in section 2 of Volume I of this report, almost no test data exist to validate the mathematical model. Also, the single main rotor helicopter is the only configuration that can be analyzed with the model as presently formulated. Since all examples presented up to this point in the user's guide have been for the XV-15, it is necessary to define input data for a single main rotor helicopter.
before the ground vortex option is explained in detail. The Sikorsky CH-53E configuration has been chosen for this task. The main input data menu for this configuration, as typed into the program, is presented in figure D-16.

The ground vortex analysis option is specified by selection of the character <G> on the velocity analysis option menu as shown in figure D-5. The user is then required to complete the ground/disk vortex input data menu which is presented in figure D-17. Two of the parameters specified on this menu are rotorcraft configuration parameters. These parameters are the rotor tip speed (feet/second) and the number of rotor blades. The next parameter to be specified is the rotorcraft translational velocity with respect to the surrounding air mass (i.e., an input of 15 knots can be either 15 knots ground speed on a no-wind day or 0 knots ground speed on a day with a 15-knot headwind). Each of these values is input with the keyboard using the same techniques that have been previously discussed.

The next four menu parameters define the position in three-dimensional space (feet) where the velocity profile will be calculated (see figure D-18). The positive directions for the coordinate system are aft and right from the center of the rotor. Therefore, in order to calculate a slice of the ground vortex directly in front of the rotor, a negative X-value (longitudinal position) is input along with a zero Y-value (lateral position). The Z-axis increment (feet) and maximum calculation height (feet) parameters define the number of points that are calculated between ground level and the maximum height of interest.
GROUND/DISK VORTEX INPUT DATA MENU
(FOR SINGLE MAIN ROTOR HELICOPTERS ONLY)

<table>
<thead>
<tr>
<th>CODE</th>
<th>PARAMETER</th>
<th>VALUE</th>
<th>UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>ROTOR TIP SPEED</td>
<td>733.00</td>
<td>FPS</td>
</tr>
<tr>
<td>B</td>
<td>NUMBER OF ROTOR BLADES</td>
<td>7.00</td>
<td>-ND-</td>
</tr>
<tr>
<td>C</td>
<td>TRANSLATIONAL SPEED</td>
<td>16.00</td>
<td>KTS</td>
</tr>
<tr>
<td>D</td>
<td>XT POSITION</td>
<td>-60.00</td>
<td>FT</td>
</tr>
<tr>
<td>E</td>
<td>YT POSITION</td>
<td>0.00</td>
<td>FT</td>
</tr>
<tr>
<td>F</td>
<td>ZT CALCULATION INCREMENT</td>
<td>2.00</td>
<td>FT</td>
</tr>
<tr>
<td>G</td>
<td>MAXIMUM CALCULATION HEIGHT</td>
<td>20.00</td>
<td>FT</td>
</tr>
</tbody>
</table>

ENTER DATA ENTRY CODE OR <RETURN> TO CONTINUE ==> 

FIGURE D-17 GROUND/DISK VORTEX INPUT DATA MENU

After each input data parameter has been specified, the user types the <RETURN> key to initiate the analysis. The response of the program is to list three calculated parameters which are followed by a prompt. An example of this response is provided in figure D-19. The calculated values are the nondimensionalized rotor height above ground and two advance ratio parameters. The program prompt following the screen output requires the user to input the ground vortex strength ratio which is obtained from the graph in figure D-20 using the three calculated parameters. Background on the use of this figure is discussed in section 2 of Volume I of this report. The limits presented on the graph in figure D-20 define the advance ratio range wherein the ground vortex would be expected to occur. At advance ratios much less than 0.035, the ground vortex does not have favorable conditions for formation. At advance ratios slightly greater than 0.055, the ground vortex is dispersed by the rotor because the translational velocity relative to the air mass is too high for the vortex to maintain position. After the user has entered the ground vortex strength ratio, the program calculates the ground vortex circulation and the position of the ground vortex core with respect to the axis system presented in figure D-18. This output is also presented in figure D-19 below the prompt for the ground vortex strength ratio.
FIGURE D-18 HORSESHOE VORTEX GEOMETRY FOR CALCULATION OF GROUND VORTEX HAZARD POTENTIAL
ROTOR HEIGHT ABOVE GROUND H/D  .3797
ADVANCE RATIO MU-STAR .5373
ADVANCE RATIO MU .0368

ENTER GROUND VORTEX STRENGTH RATIO
(SEE FIGURE D-20)  == > 3.

GROUND VORTEX CORE POSITION
X-LOCATION (XXGV) = -59.14 FT
Y-LOCATION (ZZGV) = 9.15 FT
GROUND VORTEX CIRCULATION = 732.35 FT**2/SEC

PRESS <RETURN> TO CONTINUE

FIGURE D-19 GROUND VORTEX ANALYSIS INTERMEDIATE OUTPUT

Engineering data from the ground vortex analysis option is obtained by typing the <RETURN> key after the vortex position parameters are displayed. An example of the output format is presented in figure D-21. Calculated field velocities at the various points along the profile z-axis are presented in both a vectorial XYZ component format and as a total resolved magnitude in units of feet per second and knots. These same data are also provided to the user as dynamic pressures in units of pounds per square feet.

D.1.7 DISK EDGE VORTEX ANALYSIS OPTION

The disk edge vortex analysis option was developed to provide a capability to estimate the strength of trailing vortices behind helicopters in forward flight as described by figure D-22. Like the ground vortex option, this option is limited to use with the single main rotor helicopter configuration. Approximations of vortex core size are not calculated by the mathematical model and must be estimated using flight test data. Available flight test data are presented in section 3.6 of Volume I of this report. All examples presented in the user's guide for this analysis option utilize the same CH-53E input data array that was described previously.
FIGURE D-20  CALCULATED GROUND VORTEX CIRCULATION STRENGTH

Transition from recirculation to
ground vortex state

H/D Position

Δ 0.23  • 0.32  ■ 0.44

Ground Vortex Strength, \( \Gamma_g/\Gamma_{tip} \)

Source: Reference 35.
<table>
<thead>
<tr>
<th>HEIGHT (FT)</th>
<th>MEAN VELOCITY (FPS)</th>
<th>MEAN VELOCITY (KN)</th>
<th>MEAN Q (PSF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>.00</td>
<td>X -24.582</td>
<td>-14.572</td>
<td>.718</td>
</tr>
<tr>
<td></td>
<td>Y .000</td>
<td>.000</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>Z .000</td>
<td>.000</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>T 24.582</td>
<td>14.572</td>
<td>.718</td>
</tr>
<tr>
<td>2.00</td>
<td>X -25.790</td>
<td>-15.288</td>
<td>.790</td>
</tr>
<tr>
<td></td>
<td>Y .000</td>
<td>.000</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>Z 1.013</td>
<td>.601</td>
<td>.001</td>
</tr>
<tr>
<td></td>
<td>T 25.810</td>
<td>15.299</td>
<td>.792</td>
</tr>
<tr>
<td>4.00</td>
<td>X -30.173</td>
<td>-17.886</td>
<td>1.082</td>
</tr>
<tr>
<td></td>
<td>Y .000</td>
<td>.000</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>Z 2.868</td>
<td>1.700</td>
<td>.010</td>
</tr>
<tr>
<td></td>
<td>T 30.309</td>
<td>17.966</td>
<td>1.092</td>
</tr>
</tbody>
</table>

Execution of the disk edge vortex option is initiated by choosing <D> on the velocity analysis option menu shown in figure D-5. The ground/disk vortex input data menu, shown in figure D-17, must then be completed as described in the previous section. All sign conventions used in the specification of locations for the calculation of field velocities are the same as for the ground vortex option. After the input data menu is completed, the analysis option is executed by typing the <RETURN> key.

The initial program response, figure D-23, is to write to the screen the calculated values for the vortex circulation and the settling angle of the trailing vortex components as defined in figure D-22 for a forward-flight velocity of 50 knots and a rotor height above ground of 100 feet. When executing this option, it is important that the user confirm that the calculated settling angle is less than approximately 20 degrees. At settling angles larger than this value, the airspeed of the helicopter is probably too slow to sustain the formation of the trailing edge vortex system which is predicted using this mathematical model, and results should be considered suspect. User specified velocity field calculations are presented after the <RETURN> key is typed in the same format as was discussed with the ground vortex option. An example output for the CH-53E is presented in figure D-24.
FIGURE D-22 HORSESHOE VORTEX GEOMETRY FOR CALCULATION OF FORWARD FLIGHT WAKE HAZARD POTENTIAL
Other features of the mathematical model which should be noted are described below.

1. The calculated trailing vortex strength does not decay as a function of increasing distance from the helicopter or with increasing time. This weakness in the model will affect correlation with flight test data and could result in predicted values that are greater than measured values for field velocities.

2. The decay of the trailing vortex structure after impingement with the ground is not modeled. Any prediction of field velocities behind the initial impingement point should not be considered valid. The location of the impingement point with respect to the ground and the location of points specified for velocity field calculations must be checked by hand calculation to ensure that geometry constraints are not violated. This is accomplished by using the rotor height and the settling angle to calculate the horizontal distance behind the helicopter where the impingement occurs.

D.1.8 PERSONNEL OVERTURNING FORCE AND MOMENT ANALYSIS

The personnel overturning force and moment analysis model is formulated for use with both the single main rotor and twin-rotor configurations. The initial task of the model is to calculate the velocity profile for a specified location. The calculated velocity profile is then integrated over the projected area of a human body to obtain estimates of the applied aerodynamic force and moment. This analysis technique is summarized in figure D-25.

Use of the overturning force and moment option is initiated by choosing <H> (for hazard) on the program logic/comment menu. This is followed by the choice of <M> (for overturning force/moment) on the hazard analysis option menu as shown in figure D-6. The user then specifies the parameters listed on the overturning force and moment data menu presented in figure D-26. The first parameter on this menu specifies the use of either the wall jet or the interaction plane analysis for creation of velocity profile data. The second option specifies the use of either the "large" (6 feet in height) or "small" (4 feet in height) human body mathematical model. The third parameter provides the user the capability to specify a graphics output filename (assuming this option has been toggled ON using the program logic/comment menu). If the user executes the option without changing the filename and a file already exists with the same filename, the user is notified and required to change the filename. Three of the last four menu variables define the locations that are to be analyzed using the option. These variables, all in units of feet, are the initial station position for analysis, the increment in station position, and the final
**Disk Vortex Velocity Profile Data**

- **X-Location (XT)** = 150.00 FT
- **Y-Location (YT)** = 0.00 FT

- **Vortex Circulation** = 5441.24 FT**²**/SEC
- **Vortex Circulation** = 505.51 M**²**/SEC
- **5-M Initial Circulation** = 232.37 M**²**/SEC
- **Settling Angle** = 9.29 DEG

Press <RETURN> to continue.

**Figure D-23 Disk Edge Vortex Option Intermediate Output**

<table>
<thead>
<tr>
<th>Height (FT)</th>
<th>Mean Velocity (FPS)</th>
<th>Mean Q (KN)</th>
<th>Mean Q (PSF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>.00 X</td>
<td>-4.052</td>
<td>-2.402</td>
<td>0.020</td>
</tr>
<tr>
<td>Y</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>Z</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>T</td>
<td>4.052</td>
<td>2.402</td>
<td>0.020</td>
</tr>
<tr>
<td>50.00 X</td>
<td>-5.444</td>
<td>-3.820</td>
<td>0.049</td>
</tr>
<tr>
<td>Y</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>Z</td>
<td>27.295</td>
<td>-16.180</td>
<td>0.885</td>
</tr>
<tr>
<td>T</td>
<td>28.046</td>
<td>16.625</td>
<td>0.935</td>
</tr>
<tr>
<td>100.00 X</td>
<td>-5.735</td>
<td>-3.399</td>
<td>0.039</td>
</tr>
<tr>
<td>Y</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>Z</td>
<td>-30.049</td>
<td>-17.812</td>
<td>1.073</td>
</tr>
<tr>
<td>T</td>
<td>30.592</td>
<td>18.134</td>
<td>1.112</td>
</tr>
</tbody>
</table>

Type <C>ontinue, <N>ext <P>oint, <N>ew Case, <E>X>it ==>

**Figure D-24 Velocity Field Output Data From the Disk Edge Vortex Option**

D-25
station position, respectively. The fourth parameter is the user option to specify a minimum boundary layer height (discussed in section D.1.4 of the user's guide). The mechanics for input of the desired values using this menu are as described for previous menus.

After the analysis is executed by typing the <RETURN> key, the calculated results are written out in the format presented in figure D-27. Three columns of data are written using this format. The first column identifies either the distance from rotor center (DFRC) for the wall jet option or the distance along the interaction plane (DAIP) for the interaction plane option.

The second and third columns are the associated total force and total moment values calculated for the projected area of a human body. Example data for the XV-15 using this option are presented in figure D-28 for reference. At the bottom of the screen, the user is required to return to the previous menu by typing <P>,
OVERTURNING FORCE/MOMENT DATA MENU

<table>
<thead>
<tr>
<th>CODE</th>
<th>PARAMETER</th>
<th>VALUE</th>
<th>UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>&lt;W&gt;ALL JET OR &lt;I&gt;INTERACTION PLANE</td>
<td>W</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>&lt;L&gt;LARGE OR &lt;S&gt;SMALL PERSON</td>
<td>L</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>DATA OUTPUT FILENAME</td>
<td>OTDFRC.PTS</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>INITIAL STATION POSITION</td>
<td>50.00</td>
<td>FT</td>
</tr>
<tr>
<td>E</td>
<td>HORIZONTAL INCREMENT</td>
<td>10.00</td>
<td>FT</td>
</tr>
<tr>
<td>F</td>
<td>MAXIMUM STATION POSITION</td>
<td>100.00</td>
<td>FT</td>
</tr>
<tr>
<td>G</td>
<td>MINIMUM BOUNDARY LAYER HEIGHT</td>
<td>1.50</td>
<td>FT</td>
</tr>
</tbody>
</table>

ENTER DATA ENTRY CODE OR <RETURN> TO CONTINUE ==> 

FIGURE D-26 OVERTURNING FORCE AND MOMENT DATA MENU

SUMMARY OF OVERTURNING FORCES AND MOMENTS

<table>
<thead>
<tr>
<th>RADIUS (FT)</th>
<th>TOTF (LB)</th>
<th>TOTM (FT-LB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50.00</td>
<td>42.721</td>
<td>114.596</td>
</tr>
<tr>
<td>60.00</td>
<td>33.708</td>
<td>91.718</td>
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<tr>
<td>70.00</td>
<td>25.046</td>
<td>69.346</td>
</tr>
<tr>
<td>80.00</td>
<td>17.520</td>
<td>49.892</td>
</tr>
<tr>
<td>90.00</td>
<td>11.511</td>
<td>33.382</td>
</tr>
<tr>
<td>100.00</td>
<td>6.926</td>
<td>20.269</td>
</tr>
</tbody>
</table>

TYPE <C>ONTINUE, NEXT <P>INT, <N>EW CASE, E<X>IT ==> 

FIGURE D-27 SIMPLIFIED OUTPUT FORMAT FOR THE OVERTURNING FORCE AND MOMENT ANALYSIS

D-27
the master input data menu by typing <N>, or to exit the program by typing <X>. By typing <C>, the user can view the next video screen of data if more than one screen of data is generated. Otherwise, the <C> option works identically to the <P> option.

The user can examine the detailed calculations used to create the summary output by specifying the desired analysis location as the initial station position. This input must then be followed by specification of the increment value as 0.0 or only the summary output will appear (as shown in figure D-29). The resulting "large" person output using this option is presented on two screen frames as shown in figure D-30. The first output frame presents a summary of the velocity profile calculations as a function of height above ground at the specified station position. The second output frame presents the associated calculations for dynamic pressure, overturning force, and overturning moment. The last two columns in the second table are values of total force and moment summed for the incremental increase in height.

In this example, the force and moment values of 42.7 pounds and 114.6 foot-pounds, respectively, at 5.75 feet are the total force and moment values that would normally be printed out in the summary output (figure D-27). These values are checked by totaling the individual height-related values in the overturning force and moment columns (second and third columns). An example output for the second screen of the "small" person option is presented in figure D-31 for reference.

Both qualitative and quantitative overturning force and moment data are presented in section 5 of volume I of this report correlated with ROTHASH program output for the Bell XV-15, Sikorsky CH-53E, and the Sikorsky S-61. These calculated data all assume a coefficient of drag for a human body of 1.1 (which according to Hoerner, reference D-6, can vary from 1.0 to approximately 1.3).

D.1.9 PARTICULATE CLOUD ANALYSIS OPTION

The methodology used in the calculation of particulate cloud size is presented in section 5.8 of volume I of this report along with a very limited amount of flight test data. This option is applicable to both single main rotor and twin-rotor configurations. The particulate cloud geometry utilized in the analysis option is presented in figure D-32.

The particulate cloud option is initiated with the typing of <C> on the hazard analysis option menu as shown in figure D-6. The screen that is written subsequently presents the user with a prompt for input of the terrain erosion factor. The value for this factor is chosen from the graph in figure D-33.
FIGURE D-28  BELL XV-15 OVERTURNING FORCE AS A FUNCTION OF DISTANCE ALONG THE INTERACTION PLANE (0 DEGREE AZIMUTH)

OVERTURNING FORCE/MOMENT DATA MENU

<table>
<thead>
<tr>
<th>CODE</th>
<th>PARAMETER</th>
<th>VALUE</th>
<th>UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>&lt;W&gt; ALL JET OR &lt;I&gt; INTERACTION PLANE</td>
<td>W</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>&lt;L&gt; LARGE OR &lt;S&gt; SMALL PERSON</td>
<td>L</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>DATA OUTPUT FILENAME</td>
<td>OTDFRC.PTS</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>INITIAL STATION POSITION</td>
<td>50.00</td>
<td>FT</td>
</tr>
<tr>
<td>E</td>
<td>HORIZONTAL INCREMENT</td>
<td>0.00</td>
<td>FT</td>
</tr>
<tr>
<td>F</td>
<td>MAXIMUM STATION POSITION</td>
<td>100.00</td>
<td>FT</td>
</tr>
<tr>
<td>G</td>
<td>MINIMUM BOUNDARY LAYER HEIGHT</td>
<td>1.50</td>
<td>FT</td>
</tr>
</tbody>
</table>

ENTER DATA ENTRY CODE OR <RETURN> TO CONTINUE -->

FIGURE D-29  MENU SPECIFICATION OF DETAILED FORCE/MOMENT OUTPUT

D-29
### SINGLE ROTOR VELOCITY PROFILE AT RADIUS = 50.0 FT

<table>
<thead>
<tr>
<th>HEIGHT (FT)</th>
<th>MEAN VELOCITY (FPS)</th>
<th>PEAK VELOCITY (FPS)</th>
<th>MEAN Q (PSF)</th>
<th>PEAK Q (PSF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>.25</td>
<td>34.705</td>
<td>64.762</td>
<td>1.431</td>
<td>4.984</td>
</tr>
<tr>
<td>.75</td>
<td>40.602</td>
<td>75.767</td>
<td>1.959</td>
<td>6.822</td>
</tr>
<tr>
<td>1.25</td>
<td>43.676</td>
<td>81.502</td>
<td>2.267</td>
<td>7.894</td>
</tr>
<tr>
<td>1.75</td>
<td>42.515</td>
<td>82.535</td>
<td>2.148</td>
<td>8.096</td>
</tr>
<tr>
<td>2.25</td>
<td>38.121</td>
<td>79.742</td>
<td>1.727</td>
<td>7.557</td>
</tr>
<tr>
<td>2.75</td>
<td>34.004</td>
<td>76.248</td>
<td>1.374</td>
<td>6.909</td>
</tr>
<tr>
<td>3.25</td>
<td>30.146</td>
<td>72.134</td>
<td>1.080</td>
<td>6.184</td>
</tr>
<tr>
<td>3.75</td>
<td>26.537</td>
<td>67.491</td>
<td>.837</td>
<td>5.413</td>
</tr>
<tr>
<td>4.25</td>
<td>23.170</td>
<td>63.591</td>
<td>.638</td>
<td>4.806</td>
</tr>
<tr>
<td>4.75</td>
<td>20.041</td>
<td>61.475</td>
<td>.477</td>
<td>4.491</td>
</tr>
<tr>
<td>5.25</td>
<td>17.147</td>
<td>58.134</td>
<td>.349</td>
<td>4.016</td>
</tr>
<tr>
<td>5.75</td>
<td>14.485</td>
<td>53.785</td>
<td>.249</td>
<td>3.438</td>
</tr>
</tbody>
</table>

### TYPE <RETURN> TO CONTINUE

### SINGLE ROTOR FORCE PROFILE AT RADIUS = 50.0 FT

<table>
<thead>
<tr>
<th>HEIGHT (FT)</th>
<th>PEAK Q (PSF)</th>
<th>FOVER (LB)</th>
<th>OVERM (FT-LB)</th>
<th>TOT F (LB)</th>
<th>TOT M (FT-LB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>.25</td>
<td>4.984</td>
<td>3.016</td>
<td>.754</td>
<td>3.016</td>
<td>.754</td>
</tr>
<tr>
<td>.75</td>
<td>6.822</td>
<td>4.128</td>
<td>3.096</td>
<td>7.143</td>
<td>3.850</td>
</tr>
<tr>
<td>1.25</td>
<td>7.894</td>
<td>4.776</td>
<td>5.970</td>
<td>11.919</td>
<td>9.820</td>
</tr>
<tr>
<td>1.75</td>
<td>8.096</td>
<td>4.898</td>
<td>8.571</td>
<td>16.817</td>
<td>18.391</td>
</tr>
<tr>
<td>2.75</td>
<td>6.909</td>
<td>4.180</td>
<td>11.495</td>
<td>25.569</td>
<td>40.174</td>
</tr>
<tr>
<td>3.25</td>
<td>6.184</td>
<td>3.741</td>
<td>12.159</td>
<td>29.311</td>
<td>52.333</td>
</tr>
<tr>
<td>3.75</td>
<td>5.413</td>
<td>3.275</td>
<td>12.282</td>
<td>32.586</td>
<td>64.615</td>
</tr>
<tr>
<td>4.25</td>
<td>4.806</td>
<td>2.908</td>
<td>12.357</td>
<td>35.493</td>
<td>76.972</td>
</tr>
<tr>
<td>4.75</td>
<td>4.491</td>
<td>2.717</td>
<td>12.907</td>
<td>38.211</td>
<td>89.879</td>
</tr>
<tr>
<td>5.25</td>
<td>4.016</td>
<td>2.430</td>
<td>12.757</td>
<td>40.641</td>
<td>102.636</td>
</tr>
<tr>
<td>5.75</td>
<td>3.438</td>
<td>2.080</td>
<td>11.960</td>
<td>42.721</td>
<td>114.596</td>
</tr>
</tbody>
</table>

### TYPE <CONTINUE, NEXT <P>INT, <N>EW CASE, E<X>IT ==>

---

**FIGURE D-30** DETAILED OUTPUT FORMAT FOR THE "LARGE" PERSON ANALYSIS OPTION

---

D-30
### SINGLE ROTOR FORCE PROFILE AT RADIUS = 50.0 FT

<table>
<thead>
<tr>
<th>HEIGHT (FT)</th>
<th>PEAK Q (PSF)</th>
<th>FOVER (LB)</th>
<th>OVERM (FT-LB)</th>
<th>TOT F (LB)</th>
<th>TOT M (FT-LB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>.25</td>
<td>4.984</td>
<td>1.919</td>
<td>.480</td>
<td>1.919</td>
<td>.480</td>
</tr>
<tr>
<td>.75</td>
<td>6.822</td>
<td>2.627</td>
<td>1.970</td>
<td>4.546</td>
<td>2.450</td>
</tr>
<tr>
<td>1.25</td>
<td>7.894</td>
<td>3.039</td>
<td>3.799</td>
<td>7.585</td>
<td>6.249</td>
</tr>
<tr>
<td>1.75</td>
<td>8.096</td>
<td>3.117</td>
<td>5.455</td>
<td>10.702</td>
<td>11.701</td>
</tr>
<tr>
<td>2.25</td>
<td>7.557</td>
<td>2.909</td>
<td>6.546</td>
<td>13.611</td>
<td>18.250</td>
</tr>
<tr>
<td>2.75</td>
<td>6.909</td>
<td>2.660</td>
<td>7.315</td>
<td>16.271</td>
<td>25.565</td>
</tr>
<tr>
<td>3.25</td>
<td>6.184</td>
<td>2.381</td>
<td>7.738</td>
<td>18.652</td>
<td>33.303</td>
</tr>
<tr>
<td>3.75</td>
<td>5.413</td>
<td>2.084</td>
<td>7.816</td>
<td>20.736</td>
<td>41.118</td>
</tr>
</tbody>
</table>

Type <C>ontinue, Next <P>oint, <N>ew Case, <E>Xit ==>

**FIGURE D-31** DETAILED OUTPUT FORMAT FOR THE SECOND SCREEN FRAME OF THE "SMALL" PERSON ANALYSIS OPTION

**FIGURE D-32** PARTICULATE CLOUD ANALYSIS GEOMETRY DEFINITION
FIGURE D-33 APPROXIMATE VALUES FOR THE TERRAIN EROSION FACTOR ($K_t$) AS IDENTIFIED IN THE LITERATURE
The output format for the particulate cloud option is designed for both single main rotor and twin-rotor aircraft as shown in figure D-34. In this example, using the XV-15, the particulate cloud boundaries located at the 90- and 270-degree azimuths (out the span of the wing) are specified by the single rotor or "SR" row of output values. The interaction plane or "IP" row defines the cloud boundaries which exist straight out in front of and directly aft of the aircraft along the aircraft centerline. If a single main rotor configuration is being evaluated, the "IP" row in the printout will contain all zeros.

**SUMMARY OF CLOUD BOUNDARIES**

<table>
<thead>
<tr>
<th>RC AND RV ARE FROM ROTOR CENTER (FT)</th>
<th>RC</th>
<th>RV</th>
<th>ZV</th>
<th>HC</th>
</tr>
</thead>
<tbody>
<tr>
<td>SR</td>
<td>80.1</td>
<td>62.8</td>
<td>26.3</td>
<td>37.6</td>
</tr>
<tr>
<td>IP</td>
<td>113.0</td>
<td>88.7</td>
<td>37.2</td>
<td>53.0</td>
</tr>
<tr>
<td>QSMAX</td>
<td></td>
<td></td>
<td></td>
<td>13.5</td>
</tr>
</tbody>
</table>

**TYPE <C>ONTINUE, NEXT <P>OINT, <N>EW CASE, E<X>IT ==-**

**FIGURE D-34 PARTICULATE CLOUD ANALYSIS OPTION OUTPUT**

D.2 ROTWASH PROGRAM DATA OUTPUT FILE FORMATS

Four data output file formats can be specified from the ROTWASH program for use with computer graphics programs. Two of these output file formats are generated by the wall jet and interaction plane velocity profile analysis options. The other two formats are generated by the personnel overturning force and moment option. These file formats save the summary force and moment data for both the wall jet and interaction plane cases.

The first two lines in each of the four file formats are user-specified comments. These two comment lines are typed in through use of the program logic/comment menu. The rest of the data in each of the file formats is either header information or engineering data. The example files presented in this section are written for direct input to the TECPLOT Graphics Program which is written by AMTEC Engineering. This graphics program is one of several IBM PC/PC-compatible engineering graphics programs.
presently on the market. Users that do not have access to this program can easily modify the ROTWASH FORTRAN code for other types of graphics programs by modifying the appropriate write statements. Table 1 provides the user with a cross reference of the figure number for each of the four output types and the source location for the associated FORTRAN code that can be modified (see program listings in appendix E).

<table>
<thead>
<tr>
<th>FILE OUTPUT TYPE</th>
<th>FIGURE</th>
<th>SOURCE CODE LOCATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wall Jet Velocity Profile Output</td>
<td>D-35</td>
<td>Subroutine WJVEL</td>
</tr>
<tr>
<td>Interaction Plan Velocity Profile Output</td>
<td>D-36</td>
<td>Subroutine IPVEL</td>
</tr>
<tr>
<td>Overturning Force/Moment Summary (Wall Jet)</td>
<td>D-37</td>
<td>Subroutine HWJVEL</td>
</tr>
<tr>
<td>Overturning Force/Moment Summary (Interaction Plan)</td>
<td>D-38</td>
<td>Subroutine HIPVEL</td>
</tr>
</tbody>
</table>
XY-15 CHARACTERISTICS ARE USED AS INPUT DATA
GROSS WEIGHT MIGHT BE ONE OF THE COMMENT STRINGS

TITLE="VELOCITY PROFILE, DFRC = 50.0 FT, GW = 13000 LB, WAGL = 25.0 FT"
VARIABLES = X, NT
ZONE T = "MEAN PROFILE, KTS", I=11, F=POINT
   .0  .00
   25.1 1.00
   23.9 2.00
   19.0 3.00
   14.7 4.00
   13.0 5.00
   7.8  6.00
   5.2  7.00
   3.2  8.00
   1.6  9.00
   .6 10.00

ZONE T = "PEAK PROFILE, KTS", I=11, F=POINT
   .0  .00
   46.8 1.00
   48.2 2.00
   44.0 3.00
   38.5 4.00
   35.5 5.00
   30.4 6.00
   23.7 7.00
   16.3 8.00
   9.3  9.00
   3.7 10.00

ZONE T = "PEAK Q, PSF", I=11, F=POINT
   .0  .00
   7.4  1.00
   7.8  2.00
   6.6  3.00
   5.0  4.00
   4.3  5.00
   3.1  6.00
   1.9  7.00
   .9  8.00
   .3  9.00
   .0 10.00

FIGURE D-35 EXAMPLE WALL JET OPTION GRAPHICS FILE FORMAT
XV-15 CHARACTERISTICS ARE USED AS INPUT DATA
GROSS WEIGHT MIGHT BE ONE OF THE COMMENT STRINGS

TITLE="VELOCITY PROFILE, DAIP = 50.0 FT, GW = 13000 LB, WAGL = 25.0 FT"
VARIABLES = X, HT
ZONE T = "MEAN PROFILE, KTS", I=11, F=POINT
   0.00 0.00
   37.7 1.00
   39.5 2.00
   39.0 3.00
   38.5 4.00
   37.9 5.00
   37.4 6.00
   36.8 7.00
   36.3 8.00
   35.7 9.00
   35.1 10.00
ZONE T = "PEAK PROFILE, KTS", I=11, F=POINT
   0.00 0.00
   61.6 1.00
   64.6 2.00
   63.7 3.00
   62.9 4.00
   62.0 5.00
   61.1 6.00
   60.2 7.00
   59.3 8.00
   58.3 9.00
   57.4 10.00
ZONE T = "PEAK Q, PSF", I=11, F=POINT
   0.00 0.00
   12.9 1.00
   14.1 2.00
   13.7 3.00
   13.4 4.00
   13.0 5.00
   12.6 6.00
   12.3 7.00
   11.9 8.00
   11.5 9.00
   11.1 10.00

FIGURE D-36 EXAMPLE INTERACTION PLANE OPTION GRAPHICS FILE FORMAT

XV-15 CHARACTERISTICS ARE USED AS INPUT DATA
GROSS WEIGHT MIGHT BE ONE OF THE COMMENT STRINGS

TITLE="SINGLE ROTOR DFRC DATA"
VARIABLES = DFRC, TOTF, TOTM
ZONE T = "GW = 13000 LB, WAGL = 25.0 FT", I=6, F=POINT
   50.00 42.72 114.60
   60.00 33.71 91.72
   70.00 25.05 69.35
   80.00 17.52 49.89
   90.00 11.51 33.38
  100.00 6.93 20.27

FIGURE D-37 EXAMPLE PERSONNEL OVERTURNING FORCE AND MOMENT GRAPHICS FILE FORMAT CREATED WITH THE WALL JET ANALYSIS OPTION
XV-15 CHARACTERISTICS ARE USED AS INPUT DATA
GROSS WEIGHT MIGHT BE ONE OF THE COMMENT STRINGS

TITLE="TWIN ROTOR DAIP DATA"
VARIABLES = DAIP,TOTF,TOTM
ZONE T = "GW = 13000 LB, WAGL = 25.0 FT", I=6, F=POINT

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>94.05</td>
<td>288.66</td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>83.94</td>
<td>259.37</td>
<td></td>
</tr>
<tr>
<td>70</td>
<td>73.00</td>
<td>227.47</td>
<td></td>
</tr>
<tr>
<td>80</td>
<td>62.43</td>
<td>196.32</td>
<td></td>
</tr>
<tr>
<td>90</td>
<td>52.82</td>
<td>167.46</td>
<td></td>
</tr>
<tr>
<td>100</td>
<td>44.26</td>
<td>141.31</td>
<td></td>
</tr>
</tbody>
</table>

FIGURE D-38 EXAMPLE PERSONNEL OVERTURNING FORCE
AND MOMENT GRAPHICS FILE FORMAT CREATED
WITH THE INTERACTION PLANE ANALYSIS OPTION
LIST OF REFERENCES


APPENDIX E

ROTWASH PROGRAM FORTRAN 77 LISTINGS

ROTWASH program listings are presented in this appendix for the ROTWASH main program and its 24 subroutines. The listings are for a version of the program that is run on IBM PC/PC-compatible computers using MICROSOFT FORTRAN 77, Version 5.0. The tabular listing below indexes subroutine names and briefly describes functionality for user reference.

<table>
<thead>
<tr>
<th>SUBROUTINE</th>
<th>FUNCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROTWASH</td>
<td>Main Program Driver and Initialization</td>
</tr>
<tr>
<td>CLOUD</td>
<td>Calculates Particle Cloud Boundaries</td>
</tr>
<tr>
<td>DEVTX</td>
<td>Locates Disk Edge Vortex System and Calculates Induced Velocity Field</td>
</tr>
<tr>
<td>FREAD</td>
<td>Prompt/Validate for Floating Point Input Data</td>
</tr>
<tr>
<td>GDVTX</td>
<td>Locates Ground Vortex System and Calculates Induced Velocity Field</td>
</tr>
<tr>
<td>HAZARD</td>
<td>Driver Subroutine for Hazard Analysis</td>
</tr>
<tr>
<td>HIPVEL</td>
<td>Twin Rotor Overturning Forces and Moments</td>
</tr>
<tr>
<td>HOMCLS</td>
<td>Home Cursor and Clear Screen</td>
</tr>
<tr>
<td>HSVTX</td>
<td>Calculates Induced Velocity Field of a Horseshoe Vortex System</td>
</tr>
<tr>
<td>HWJVEL</td>
<td>Single Rotor Overturning Forces and Moments</td>
</tr>
<tr>
<td>INKEY</td>
<td>Menu Input Data Control</td>
</tr>
<tr>
<td>INPUT</td>
<td>Rotorcraft Characteristics Input Data Menu</td>
</tr>
<tr>
<td>INPUTV</td>
<td>Velocity Profile Status Menu</td>
</tr>
<tr>
<td>INPUTX</td>
<td>Ground/Disk Vortex Input Data Menu</td>
</tr>
<tr>
<td>IOFNSH</td>
<td>Close Disk I/O Files</td>
</tr>
<tr>
<td>IOINIT</td>
<td>File I/O Management Menu</td>
</tr>
<tr>
<td>IPVEL</td>
<td>Calculates Interaction Plane Velocity Profile</td>
</tr>
<tr>
<td>IREAD</td>
<td>Prompt/Validate for Integer Input Data</td>
</tr>
<tr>
<td>LEGAL</td>
<td>Check Validity of Input Data Selection Codes</td>
</tr>
<tr>
<td>LOCATE</td>
<td>Locate Cursor Position</td>
</tr>
<tr>
<td>MOMENT</td>
<td>Calculates Personnel Overturning Forces and Moments</td>
</tr>
<tr>
<td>PROPRM</td>
<td>Calculates Radial Wall Jet Velocity Profile</td>
</tr>
<tr>
<td>VLINE</td>
<td>Calculates Induced Velocity from a Line Vortex Field</td>
</tr>
<tr>
<td>WALJET</td>
<td>Defines Initial Wall Jet Position and Growth Parameters</td>
</tr>
<tr>
<td>WJVEL</td>
<td>Calculates Single Rotor Velocity Profile</td>
</tr>
</tbody>
</table>

E-1
PROGRAM ROTWASH

C PROGRAM ROTWASH
C ***********************************************************
C ROTORCRAFT DOWNWASH HAZARD ANALYSIS PROGRAM
C ***********************************************************
C EMA
C SAMUEL W. FERGUSON
C 1 APRIL 1993
C PROGRAM VERSION 2.1
C THIS PROGRAM WAS DEVELOPED USING MICROSOFT FORTRAN 77 FOR
C THE DOS OPERATING SYSTEM. CONSOLE DISPLAY CONTROL IS
C PROVIDED WITH THIS PROGRAM IN SEVERAL SPECIAL SUBROUTINES.
C ***********************************************************
C PARAMETER(NUM = 10)
C CHARACTER*1 OKLIST(NUM)
C CHARACTER*1 KEY,KKEY,FLOW,VELHAZ,HAZTYP
C CHARACTER*1 ICONT(5)
C CHARACTER*1 TEMCHAR
C CHARACTER*12 PTSFIL(4)
C CHARACTER*50 COMM(2)
C REAL*4 KE
C ***********************************************************
C DIMENSION CONT(9),CONTV(7),CONTX(8)
C COMMON /CKEY/ KEY,KKEY
C COMMON /CONSTS/ PI,RHO,FPSPKN,RHOD2,DRC
C COMMON /HELGEO/ H,DL,YSEP,WSPD,RADIUS,SHFTAN,DXO
C COMMON /INPUTC/ ICONT,COMM,PTSFIL
C COMMON /INPUTD/ CONT,CONTV,CONTX,YBDLAY
C COMMON /PROFIL/ RJ,ZBJ,ZHJ,ZMJ,UMJ,ZB,ZM,UM,CU,CY
C COMMON /UNITS/ IOU1,IOU4,IOU5,IOU6,IOU7,IOU8,IGRAPH
C DATA CONT/2.0,32.2,12.5,12475.0,13.0,37.5,0.0,1.0,0.0/
C DATA CH53E
C DATA CONT/1.0,0.0,39.5,56000.0,0.5,600.0,0.0,0.0,0.975,0.0/
C DATA YBDLAY/1.5/
C DATA ICONT/'V','N','N','W','L'/
C DATA CONTV/59.3,1.0,10.0,50.0,10.0,100.0,0.0/
C DATA CONTX/733.0,7.0,50.0,200.0,0.0,20.0,100.0,0.0/
C DATA PTSFIL/'DFRC.PTS','DAIP.PTS','OTDFRC.PTS','OTDAIP.PTS'/'
C DATA COMM/
C DATA OKLIST /'W','w','I','i','G','g','D','d','X','x'/'
C ***********************************************************
C ************************************************************************
C ************************************************************************
C ----------------------
C INITIALIZE I/O SYSTEM
C ----------------------
C CALL IOINIT
C ----------------------
C INITIALIZE MISCELLANEOUS CONSTANTS
C ----------------------
C
PROGRAM ROTWASH

64 C
65 PI = ACOS(-1.0)
66 RHOSL = 0.0023769
67 FPSKRN = 1.687
68 DRC = 0.01745329252
69 C
70 50 CONTINUE
71 C
72 KEY = / / 
73 KKEY = / /
74 C
75 C
76 C
77 OBTAIN INPUT DATA PARAMETERS FROM STATUS SCREEN
78 C
79 C
80 CALL INPUT
81 C
82 C
83 C
84 C
85 C
86 C
87 C
88 C
89 C
90 C
91 C
92 C
93 C
94 C
95 VELHAZ = ICONT(1)
96 C
97 C
98 C
99 C
100 C
101 C
102 C
103 C
104 C
105 C
106 C
107 C
108 C
109 H = HAGL/RADIUS/CSHFTA
110 YSEP = YYSEP/2.0/RADIUS
111 EFFGW = HELGW*(1.0 + (DWNLD/(100.0))
112 DL = EFFGW/ROTORS/PI/RADIUS**2
113 RHO = SIGPR*RHOSL
114 RHOD2 = 0.5*RHO
115 C
116 C
117 C
118 C
119 C
120 C
121 C
122 C
123 KKEY = 'H'
124 CALL HAZARD(HAZTYP)
125 C
126 C
127 IF(VELHAZ.EQ. 'H') THEN
128 IF(KEY.EQ. 'X') GOTO 999

E-3
PROGRAM ROTWASH

127 IF(FLOW.EQ.'X')GOTO 999
128 IF(HAZTYP.EQ.'X')GOTO 999
129 GOTO 50
130 C ELSE
131 C KKEY = 'V'
132 C END IF
133 C
134 C SELECT FLOWFIELD OPTION
135 C
136 C 10 CONTINUE
137 C
138 C HOME CURSOR AND CLEAR SCREEN
139 C
140 C ICD = 0
141 C CALL HOMCLS(ICD)
142 C CALL LOCATE(3,1)
143 C WRITE(IOU1,11)
144 C 11 FORMAT (20X,'SELECT TYPE OF FLOW TO BE ESTIMATED',///,
145 C 1 20X,'WALL JET PROFILE, TYPE <W>',///,
146 C 2 20X,'INTERACTION PLANE PROFILE, TYPE <I>',///,
147 C 2 20X,'GROUND VORTEX, TYPE <G>',///,
148 C 2 20X,'DISK VORTEX, TYPE <D>',///,
149 C 3 20X,'TO EXIT PROGRAM, TYPE <X>',///)
150 C
151 C 40 CONTINUE
152 C WRITE(IOU1,'(23X,A,$)')
153 C 1 ' ENTER DATA ENTRY CODE => '
154 C READ(IOU1,'(A1)') FLOW
155 C IF(LEGAL(FLOW,IOU1,OKLIST,NUM).EQ.1)GOTO 40
156 C
157 C MAKE LEGAL LOWERCASE INPUTS UPPER CASE BEFORE BRANCHING
158 C
159 C IF(FLOW.EQ.'w') FLOW = 'W'
160 C IF(FLOW.EQ.'i') FLOW = 'I'
161 C IF(FLOW.EQ.'g') FLOW = 'G'
162 C IF(FLOW.EQ.'d') FLOW = 'D'
163 C IF(FLOW.EQ.'x') FLOW = 'X'
164 C
165 C HOME CURSOR AND CLEAR SCREEN
166 C
167 C ICD = 0
168 C CALL HOMCLS(ICD)
169 C
E-4
PROGRAM ROTWASH

190 C BRANCH BASED ON CHOSEN OPTION, ALSO
191 C CHECK NUMBER OF ROTORS TO LIMIT SOME OPTIONS
192 C-------------------------------------------------
193 C
194 IF(FLOW.EQ.'X') GOTO 999
195 IF(FLOW.EQ.'W') GOTO 12
196 C
197 IF(FLOW.EQ.'I') THEN
198 IF(ROTORS.GT.1.0) GOTO 12
199 WRITE(IOU1,'(/II I,'14X,A,$)')
200 1 ' REQUIRES TWO ROTORS, TYPE <RETURN> TO CONTINUE '
201 READ(IOU1,'(A1)') TEMCHAR
202 GOTO 10
203 ENDIF
204 C
205 IF(FLOW.EQ.'G') THEN
206 IF(ROTORS.LT.2.0) GOTO 1000
207 WRITE(IOU1,'(/II I,'14X,A,$)')
208 1 ' REQUIRES ONE ROTOR, TYPE <RETURN> TO CONTINUE '
209 READ(IOU1,'(A1)') TEMCHAR
210 GOTO 10
211 ENDIF
212 C
213 IF(FLOW.EQ.'D') THEN
214 IF(ROTORS.LT.2.0) GOTO 1000
215 WRITE(IOU1,'(/II I,'14X,A,$)')
216 1 ' REQUIRES ONE ROTOR, TYPE <RETURN> TO CONTINUE '
217 READ(IOU1,'(A1)') TEMCHAR
218 GOTO 10
219 ENDIF
220 C
221 GOTO 10
222 C
223 12 CONTINUE
224 C
225 C ******************************************************
226 C *************** RADIAL WALL JET FLOWS ***************
227 C ******************************************************
228 C
229 C -------------------------------------------------------
230 C ACCELERATED SLIPSTREAM MEAN VELOCITY
231 C -------------------------------------------------------
232 C
233 UN = SQRT(2.0*DL/RHO)
234 C
235 C -------------------------------------------------------
236 C GROUND EFFECT CORRECTION
237 C -------------------------------------------------------
238 C
239 AKG = 1.0 - 0.9*EXP(-2.0*H)
240 C
241 C -------------------------------------------------------
242 C MEAN VELOCITY AT ROTOR DISK (RATIOED TO UN)
243 C -------------------------------------------------------
244 C
245 UB = AKG/2.0
246 C
247 C -------------------------------------------------------
248 C FIND INITIAL RADIUS OF WALL JET
249 C -------------------------------------------------------
250 C
251 CALL WALJET(H,UB,UN,UMB)
252 C
PROGRAM ROTWASH

      500 CONTINUE
      600 CONTINUE

      WALL JET REGION

      OBTAIN INPUT DATA FOR THE WALL JET OPTION

      CALL INPUTV(FLOW)

      RVZ = (CONTV(1) - DXO)/RADIUS
      DELZ = CONTV(2)/RADIUS
      ZMAX = CONTV(3)/RADIUS
      BDLAYM = YBDLAY/RADIUS

      GENERATE VELOCITY PROFILE AT RVZ IN WALL JET REGION

      CALL WJVEL(H,UN,UMB,RVZ,RADIUS,WSPD,DELZ,ZMAX,DXO,BDLAYM)
      GOTO 500

      700 CONTINUE

      INTERACTION PLANE UPWASH DEFLECTION ZONE

      OBTAIN INPUT DATA FOR THE IPLANE OPTION

      CALL INPUTV(FLOW)

      XIP = (CONTV(1) - DXO)/RADIUS
      DELZ = CONTV(2)/RADIUS
      ZMAX = CONTV(3)/RADIUS
      BDLAYM = YBDLAY/RADIUS

      GENERATE VELOCITY PROFILE AT XIP IN INTERACTION PLANE

      CALL IPVEL(H,UN,RADIUS,UMB,XIP,YSEP,WSPD,DELZ,ZMAX,DXO,BDLAYM)
      GOTO 500

      1100 CONTINUE

      IF(KEY.EQ.'X')GOTO 999
      IF(KEY.EQ.'N')GOTO 50

      *******************
      ** HORSESHOE VORTEX FLOWS **
      *******************
PROGRAM ROTWASH

316 C ---------------------
317 C OBTAIN INPUT DATA FOR VORTEX OPTIONS
318 C ---------------------
319 C CALL INPUTX
320 C
321 C OMEGAR = CONTX(1)
322 C B = CONTX(2)
323 C VF = CONTX(3)
324 C XT = CONTX(4)/RADIUS
325 C YT = CONTX(5)/RADIUS
326 C DELZ = CONTX(6)/RADIUS
327 C ZMAX = CONTX(7)/RADIUS
328 C
329 C VF = VF*FPSPKN
330 C AMU = VF/OMEGAR
331 C CT = DL/RHO/OMEGAR**2
332 C
333 C ITERATE TO GET INFLOW RATIO
334 C ---------------------
335 C
336 C ALOLD = SQRT(CT/2.0)
337 C
338 C DO 1300 ITER=1,100
339 C
340 C ALNEW = CT/2.0/SQRT(ALOLD**2 + AMU**2)
341 C
342 C IF(ABS(ALNEW - ALOLD) .LE.1.0E-05)GOTO 1301
343 C
344 C ALOLD = ALNEW
345 C 1300 CONTINUE
346 C
347 C HOME CURSOR AND CLEAR SCREEN
348 C ---------------------
349 C
350 C ICD = 0
351 C CALL HOMCLS(ICD)
352 C CALL LOCATE(5,1)
353 C
354 C WRITE(IOU1,20)
355 C 20 FORMAT( '************************************',/
356 C '1','ITERATIONS EXCEEDED FOR INFLOW RATIO',/
357 C '2','************************************')
358 C
359 C STOP ' '
360 C
361 C 1301 CONTINUE
362 C
363 C ALAMDA = ALNEW
364 C AMUS = AMU/SQRT(C T/2.0)
365 C GAMT = OMEGAR*RADIUS*2.0*PI*CT/B
366 C CHI = ATAN(ALAMDA/AMU)/2.0
367 C
368 C GAMWP IS FOR UNIFORM LOADING IN FORWARD FLIGHT.
369 C 0.625 FACTOR COMES FROM UNPUBLISHED FAA FLIGHT TEST DATA.
370 C IF SETTLING ANGLE CHI <= 8.0 DEGREES, THEN USE GAMWP AS IS.
371 C IF > 8.0 DEGREES, THEN REDUCE GAMWP BY THE LINEAR
372 C RATE OF 6.5% PER DEGREE OF SETTLING ANGLE. THE REDUCTION
373 C IS A SIMPLE APPROXIMATION FOR THE NEAR TERM THAT IS BASED
374 C
375 C
PROGRAM ROTWASH

379 C ON AN ANALYSIS OF THE UNPUBLISHED FAA FLIGHT TEST DATA.
380 C MODS MADE FEBRUARY 1993.
381 C ---------------------------------------------------------------
382 C KE = 0.625
383 C GAMW = PI*RADIUS*OMEGAR**2*CT/VF/2.0/KE
384 C IF(CHI.LE.0.139616)THEN
385 C GAMW = GAMW
386 C ELSE
387 C GAMW = GAMW*(1.0 - (CHI - 0.139616)*0.065*57.3)
388 C END IF
389 C ----------------------------------------
390 C HOD = H/2.0
391 C ---------------------------------------------------------------
392 C ICD = 0
393 C CALL HOMCLS(ICD)
394 C CALL LOCATE(3,1)
395 C IF(FLOW.EQ.'D')GOTO 1200
396 C ---------------------------------------------------------------
397 C GROUND VORTEX
398 C ---------------------------------------------------------------
399 C WRITE(IOU1,1001) HOD,AMUS,AMU
400 1001 FORMAT( 18X,'ROTOR HEIGHT ABOVE GROUND H/D '/,'2X,F8.4,'/
401 1 ,18X,'ADVANCE RATIO MU-STAR '/,'2X,F8.4,'/
402 2 ,18X,'ADVANCE RATIO MU '/,'2X,F8.4,'/
403 C ---------------------------------------------------------------
404 C THE VALUE INPUT HERE REQUIRES USE OF THE CHART IN FIGURE 18
405 C OF THE ACCOMPANYING DOCUMENTATION FOR THE GROUND VORTEX
406 C ---------------------------------------------------------------
407 C 30 CONTINUE
408 C WRITE(IOU1,31)
409 31 FORMAT( 18X,'ENTER GROUND VORTEX STRENGTH RATIO',/,
410 1 25X,'(SEE FIGURE 18) ==>','$
411 C ---------------------------------------------------------------
412 C READ(IOU1,*),ERR=30) GAMG
413 C IF(GAMG.LT.0.0) GAMG = 0.0
414 C ---------------------------------------------------------------
415 C CONTINUE ANALYSIS
416 C ---------------------------------------------------------------
417 C GAMG = GAMG*GAMT
418 C CALL GDVTX(H,RADIUS,AMU,CT,GAMG,XT,YT,DELZ,ZMAX)
419 C GOTO 1100
420 C 1200 CONTINUE
421 C ---------------------------------------------------------------
442  C    DISK VORTEX
443  C    --------------
444  C    CALL DEVTX(H,RADIUS,GAMW,CHI,XT,YT,DELZ,ZMAX)
446  C    GOTO 1100
448  C    --------------------
449  C    NORMAL PROGRAM EXIT
453  C    999 CONTINUE
454  C    END
457

E-9
SUBROUTINE CLOUD

SUBROUTINE CLOUD(UN, UMB)

**********************************************************************

SUBROUTINE CLOUD

THIS SUBROUTINE MAKES THE CALCULATIONS REQUIRED IN ESTIMATING
THE PARTICLE CLOUD BOUNDARIES (NO DENSITIES) FOR SINGLE AND
TWIN ROTOR CONFIGURATIONS

**********************************************************************~***

CHARACTER*1 KEY, KKEY
CHARACTER*1 ICONT(S)
CHARACTER*12 PTSFIL(4)
CHARACTER*80 COMMON ICONT, COMM, PTSFIL
COMMON /UNITS/ IOU1, IOU4, IOU5, IOU6, IOU7, IOU8, IGRAPH

**********************************************************************

CLEAR SCREEN AND HOME CURSOR

I 0
CALL HOMCLS(ICD)
CALL LOCATE(3, 1)

READ IN THE TERRAIN FACTOR CONSTANT
(SEE FIGURE 30 OF USER'S GUIDE)

10 CONTINUE
WRITE(IOU1, 20)
20 FORMAT(' ENTER TERRAIN EROSION FACTOR (-ND-) ==> ', 8)
READ(IOU1, *, ERR=10) XKT

VALIDATE REAL INPUT VALUE
IF(XKT.LE.0.0.OR.XKT.GT.500.0) GOTO 10

DEFINE CLOUD BOUNDARY CONSTANTS

XKT = SQRT(XKT)
QSMX = RHOD2*((SQRT(QSMAX)*UN)**2)
ERC = -0.437
XUM = (UMB*UN)**2
XCU = CU*CU

E-10
SUBROUTINE CLOUD

C1 = 1.0
C2 = 2.2

SINGLE ROTOR CLOUD BOUNDARY CALCULATIONS

RCR = RADIUS*((XKT/(C1*RHOD2*XUM*XCU))**ERC)
RVR = 0.785*RCR
ZVR = 0.329*RCR
RCVR = RCR - RVR
AR = (2.0/PI)*ALOG(ZVR/RCVR)
PHIR = (PI/2.0)*ALOG(RCVR)/ALOG(ZVR/RCVR)
AXLV = AR*(-PI/2.0) + PHIR
XLV = EXP(AXLV)
HCR = XLV + ZVR

INITIALIZE INTERACTION PLANE BOUNDARIES

RCI = 0.0
RVI = 0.0
ZVI = 0.0
HCI = 0.0

IF(YSEP.LE.0.1)GOTO 30

RCI = RADIUS*((XKT/(C2*RHOD2*XUM*XCU))**ERC)
RVI = 0.785*RCI
ZVI = 0.329*RCI
RCVR = RCI - RVI
AR = (2.0/PI)*ALOG(ZVI/RCVR)
PHIR = (PI/2.0)*ALOG(RCVR)/ALOG(ZVI/RCVR)
AXLV = AR*(-PI/2.0) + PHIR
XLV = EXP(AXLV)
HCI = XLV + ZVI

CONTINUE

PRINTOUT OF BOUNDARY LIMITS

IF(IOU6.NE.IOU1) WRITE(IOU6,'(1X)')
WRITE(IOU6,40) COMM(1),COMM(2)

40 FORMAT( 10X,A50,/,10X,A50,//)

WRITE(IOU6,50)

50 FORMAT( 10X,' SUMMARY OF CLOUD BOUNDARIES\\',10X,'RC AND RV ARE FROM ROTOR CENTER (FT)',10X,'R ',7X,' RV ',7X,' SV ',7X,' HC ',7X)

WRITE(IOU6,60) RCR, RVR, ZVR, HCR

E-11
SUBROUTINE CLOUD

60 FORMAT( 13X,'SR',F10.1,3F11.1)
C
WRITE(IOU6,70) RCI,RVI,ZVI,HCI
70 FORMAT( 13X,'IP',F10.1,3F11.1)
C
WRITE(IOU6,80) QSMX
80 FORMAT( /,12X,'QSMAX =',F7.1,' PSF' ,//)
C
-----------------------------------------------
C DECIDE NEXT OPTION WITH INKEY
-----------------------------------------------
C
CALL INKEY
C
RETURN
C
END
C
SUBROUTINE DEVTX

SUBROUTINE DEVTX(H,RADIUS,GAMW,CHI,XT,YT,DELZ,ZMAX)

*******************************************************************
SUBROUTINE DEVTX
THIS SUBROUTINE LOCATES THE DISK EDGE VORTEX SYSTEM, AND
DIRECTS THE CALCULATION OF ITS INDUCED VELOCITY FIELD
*******************************************************************

CHARACTER*1 TEMCHAR
CHARACTER*1 KEY,KKEY
CHARACTER*1 ICONT(5)
CHARACTER*12 PTSFIL(4)
CHARACTER*50 COMM(2)

COMMON / CKLEY/ KEY,KKEY
COMMON /CHSVTX/ XL1,YL1,ZL1,XL2,YL2,ZL2,XL3,YL3,ZL3,
                XR1,YR1,ZR1,XR2,YR2,ZR2,XR3,YR3,ZR3
COMMON /CONSTS/ PI,RHO,FPSPKN,RHOD2,DRC
COMMON /INPUTC/ ICONT,COMM,PTSFIL
COMMON /UNITS/ IOU1,IOU4,IOU5,IOU6,IOU7,IOU8,IGRAPH

*******************************************************************
ASSUME HORSESHOE SHAPE - ASSIGN LEFT AND RIGHT CORNERS

XL1 = 0.0
YL1 = -1.0
ZL1 = H

XR1 = 0.0
YR1 = 1.0
ZR1 = H

SET UP DIRECTION POINTERS FOR TRAILER ELEMENTS

POINT 2 IS AT GROUND IMPINGEMENT

XL2 = XL1 + H/TAN(CHI)
YL2 = YL1
ZL2 = 0.0

XR2 = XR1 + H/TAN(CHI)
YR2 = YR1
ZR2 = 0.0

POINT THREE EXTENDS TRAILER PARALLEL TO GROUND

XL3 = XL2 + 1.0
YL3 = YL2
ZL3 = ZL2

XR3 = XR2 + 1.0
YR3 = YR2
ZR3 = ZR2

E-13
SUBROUTINE DEVTX

XT = XT*RADIUS
YT = YT*RADIUS

C --------------------------------------
C CALL HOMCLS(ICD)
C CALL LOCATE(4,1)
C --------------------------------------
C IF(IOU6 .NE. IOU1) WRITE(IOU6, '"1"')
C WRITE(IOU6, 1000) XT, YT

1000 FORMAT( 21X,'DISK VORTEX VELOCITY PROFILE DATA',
   1 '///,14X,' X-LOCATION (XT) = ',2X,F8.2,2X, 'FT',,
   1 2 /,14X, 'Y-LOCATION (YT) = ',2X,F8.2,2X, 'FT',/)

C --------------------------------------
C GAMMW = GAMW*0.092903
C --------------------------------------
C 5-METER INITIAL CIRCULATION BASED ON 0.1D OR 0.2R CORE SIZE
C 5-METERS = 16.4042 FEET
C --------------------------------------
C RCD5M = 0.2*RADIUS/16.4042
C GAMW5M = GAMMWME*(1.0 - RCD5M*ATAN(1.0/RCD5M))
C WRITE(IOU6, 1001)

1001 FORMAT( 15X,'VORTEX CIRCULATION',
   1 15X,'5-M INITIAL CIRCULATION CHID
   1 15X,'CHI'*180.0/PI

1005 FORMAT( 15X,'SETTLING ANGLE',
   1 '///',14X, '"1"')

1006 FORMAT( 12X,'HEIGHT' ,8X,'MEAN VELOCITY',6X,'MEAN Q',,
   1 '0',12X, '"1"')

C -----------------------------------------------
C SET UP SWEEP OF Z AT SPECIFIED X,Y
C DELZ AND ZMAX COME FROM A MAINLINE STATUS MENU
SUBROUTINE DEVTX

127 C -----------------------------------------------
128 C XT = XT/RADIUS
129 C YT = YT/RADIUS
130 C NPTS = IFIX(ZMAX/DELZ) + 2
131 C LINES = 0
132 C DO 200 I=1,NPTS
133 C LINES = LINES + 4
134 C ZT = (I - 1)*DELZ
135 C CALL HSVTX(XT,YT,ZT,VXF,VYF,VZF,GAMW,RADIUS)
136 C ZZ = ZT*RADIUS
137 C VTF = SQRT(VXF**2 + VYF**2 + VZF**2)
138 C VXK = VXF/FPSPKN
139 C VYK = VYF/FPSPKN
140 C VZK = VZF/FPSPKN
141 C VX = RHOD2*VXF**2
142 C VY = RHOD2*VYF**2
143 C VZ = RHOD2*VZF**2
144 C QT = RHOD2*VTF**2
145 C QX = RHOD2*VXF**2
146 C QY = RHOD2*VYF**2
147 C QZ = RHOD2*VZF**2
148 C WRITE(IOU6,1100)
149 C ENDIF
150 C 100 CONTINUE
151 C -----------------------------------------------
152 C KEEP OUTPUT PAGE LENGTH TO SIZE OF SCREEN
153 C -----------------------------------------------
154 C IF(IOU6.EQ.IOU1)THEN
155 C IF(LINES.LE.12)GOTO 100
156 C CALL INKEY
157 C IF(KEY.NE.'C')GOTO 999
158 C WRITE(IOU6,1100)
159 C ENDIF
160 C -------------------------------
161 C REPORT X COMPONENT OF VELOCITY
162 C -------------------------------
163 C WRITE(IOU6,1101) ZZ,VXF,VXK,QX
164 C 1101 FORMAT( 9X,F8.2,2X,'X',3F10.3)
165 C -------------------------------
166 C REPORT Y COMPONENT OF VELOCITY
167 C -------------------------------
168 C WRITE(IOU6,1102) VYF,VYK,QY
169 C 1102 FORMAT( 19X,'Y',3F10.3)
170 C -------------------------------
171 C REPORT Z COMPONENT OF VELOCITY
172 C -------------------------------
173 C WRITE(IOU6,1103) VZF,VZK,QZ
174 C 1103 FORMAT( 19X,'Z',3F10.3)
175 C -------------------------------
176 C REPORT TOTAL VELOCITY
177 C
SUBROUTINE DEVTX

190 C ----------------------
191 C
192 WRITE(IOU6,1104) VTF,VTX,QT
193 1104 FORMAT(19X,'T',3F10.3)
194 C
195 200 CONTINUE
196 C
197 CALL INKEY
198 C
199 999 CONTINUE
200 C
201 RETURN
202 END
203 C
SUBROUTINE FREAD

SUBROUTINE FREAD(IOUL,PROMPT,VALUE,CONST)

***********************************************************************
SUBROUTINE FREAD PROMPTS USER FOR A FLOATING POINT DATA ENTRY AND CHECKS
VALIDITY OF ENTRY
***********************************************************************

PARAMETER(LAST=50)

CHARACTER*50 PROMPT,SHOWIT
CHARACTER*15 ENTRY,BLANK

DATA BLANK ' / ' ' /

************************************************************************

PROMPT USER FOR SCALED FLOATING POINT ENTRY.

FIND POSITION OF LAST NON-BLANK CHARACTER IN PROMPT,
THEN STORE RIGHT JUSTIFIED IN SHOWIT.

************************************************************************

N = LAST + 1

10 IF(N.EQ.1)GOTO 20

N = N - 1

IF(PROMPT(N:N).EQ.' ')GOTO 10

20 JS = LAST - N

WRITE(SHOWIT,' (50Al)') (' ',J=1,JS),(PROMPT(I:I),I=1,N)

NOW ASK USER FOR DATA ENTRY

30 WRITE(IOUL,' (/,1X,A,G13.6)') SHOWIT,VALUE*CONST

1 ' ENTER NEW VALUE OR <RETURN> TO LEAVE AS IS  ==> '

40 READ(IOUL,'(A)') ENTRY

41 IF(ENTRY.EQ.BLANK)RETURN

42 READ(ENTRY,' (BN,Fl5.0)',ERR=30) TEMP

CONSTANT CAN BE USED TO SCALE OR OR CONVERT UNITS OF AN INPUT VALUE

50 VALUE = TEMP/CONST

51 END
SUBROUTINE GDVTX

SUBROUTINE GDVTX(H, RADIUS, AMU, CT, GAMG, XT, YT, DELZ, ZMAX)

***********************************************************************
SUBROUTINE GDVTX

THIS SUBROUTINE LOCATES THE GROUND VORTEX BASED ON THE EXPERIMENTS BY SUN AND CURTIS (PRINCETON UNIV.), AND THEN DIRECTS THE CALCULATION OF ITS INDUCED VELOCITY FIELD.

THE OUTPUT FROM THIS SUBROUTINE SHOULD BE USED CAREFULLY FOR GROSS ESTIMATION PURPOSES ONLY.

***********************************************************************

CHARACTER*1 ICONT(5)
CHARACTER*1 TEMCHAR
CHARACTER*1 KEY, KKEY
CHARACTER*12 PTSFIL(4)
CHARACTER*50 COMM(2)

COMMON / CKEY/ KEY, KKEY
COMMON /CHSVTX/ XL1, YL1, ZL1, XL2, YL2, ZL2, XL3, YL3, ZL3,
1 XR1, YR1, XR1, YR2, ZR2, XR3, YR3, ZR3
COMMON /consts/ PI, RHO, FPSKN, RHOD2, DRC
COMMON /INPUTC/ ICONT, COMM, PTSFIL
COMMON /UNITS/ IOU1, IOU4, IOU5, IOU6, IOU7, IOU8, IGRAPH

***********************************************************************

HOD = H/2.0
C1 = 1.0 + 1.2086*HOD**0.4374
C2 = -0.2786*HOD**0.6757
ZGV = -10.0*AMU + 0.6
XGV = -(C1 + C2*(AMU/CT))**2
XXGV = XGV*RADIUS
ZZGV = ZGV*RADIUS

ASSUME HORSESHOE SHAPE - ASSIGN LEFT AND RIGHT CORNERS

XL1 = XGV
YL1 = -1.0
ZL1 = ZGV

XR1 = XGV
YR1 = 1.0
ZR1 = ZGV

SET UP DIRECTION POINTERS FOR TRAILER ELEMENTS

XL2 = XL1 + 1.0
YL2 = YL1
ZL2 = ZL1

XR2 = XR1 + 1.0
YR2 = YR1
ZR2 = ZR1

XL3 = XL2 + 1.0

E-18
SUBROUTINE GDVTX

64     YL3 = YL2
65     ZL3 = ZL2
66     C
67     XR3 = XR2 + 1.0
68     YR3 = YR2
69     ZR3 = ZR2
70     C
71     C
72     C
73     WRITE(OUT,1001) XXGV,ZZGV
74     C
75     IF(IOU6.NE.IOU1) WRITE(IOU6,'(1X)')
76     C
77     WRITE(IOU6,10001) XXGV,ZZGV
78     C
79     WRITE(IOU6,10002) GAMG
80     C
81     END

1001 FORMAT(//,24X,'GROUND VORTEX POSITION/STRENGTH DATA',/)
1002 FORMAT(//,18X,'GROUND VORTEX CIRCULATION = ',1X,F8.2,2X,'FT**2/SEC',/)
1100 FORMAT(//,12X,'HEIGHT',8X,'MEAN VELOCITY',SX,'MEAN Q',/)
1101 FORMAT(//,12X,'HEIGHT',8X,'MEAN VELOCITY',SX,'MEAN Q',/)
1102 FORMAT(//,12X,'HEIGHT',8X,'MEAN VELOCITY',SX,'MEAN Q',/)
1103 FORMAT(//,12X,'HEIGHT',8X,'MEAN VELOCITY',SX,'MEAN Q',/)
1104 FORMAT(//,12X,'HEIGHT',8X,'MEAN VELOCITY',SX,'MEAN Q',/)
1105 FORMAT(//,12X,'HEIGHT',8X,'MEAN VELOCITY',SX,'MEAN Q',/)
1106 FORMAT(//,12X,'HEIGHT',8X,'MEAN VELOCITY',SX,'MEAN Q',/)
1107 FORMAT(//,12X,'HEIGHT',8X,'MEAN VELOCITY',SX,'MEAN Q',/)
1108 FORMAT(//,12X,'HEIGHT',8X,'MEAN VELOCITY',SX,'MEAN Q',/)
1109 FORMAT(//,12X,'HEIGHT',8X,'MEAN VELOCITY',SX,'MEAN Q',/)
1110 FORMAT(//,12X,'HEIGHT',8X,'MEAN VELOCITY',SX,'MEAN Q',/)
1111 FORMAT(//,12X,'HEIGHT',8X,'MEAN VELOCITY',SX,'MEAN Q',/)
1112 FORMAT(//,12X,'HEIGHT',8X,'MEAN VELOCITY',SX,'MEAN Q',/)
1113 FORMAT(//,12X,'HEIGHT',8X,'MEAN VELOCITY',SX,'MEAN Q',/)
1114 FORMAT(//,12X,'HEIGHT',8X,'MEAN VELOCITY',SX,'MEAN Q',/)
1115 FORMAT(//,12X,'HEIGHT',8X,'MEAN VELOCITY',SX,'MEAN Q',/)
1116 FORMAT(//,12X,'HEIGHT',8X,'MEAN VELOCITY',SX,'MEAN Q',/)
1117 FORMAT(//,12X,'HEIGHT',8X,'MEAN VELOCITY',SX,'MEAN Q',/)
1118 FORMAT(//,12X,'HEIGHT',8X,'MEAN VELOCITY',SX,'MEAN Q',/)
1119 FORMAT(//,12X,'HEIGHT',8X,'MEAN VELOCITY',SX,'MEAN Q',/)
1120 FORMAT(//,12X,'HEIGHT',8X,'MEAN VELOCITY',SX,'MEAN Q',/)
1121 FORMAT(//,12X,'HEIGHT',8X,'MEAN VELOCITY',SX,'MEAN Q',/)
1122 FORMAT(//,12X,'HEIGHT',8X,'MEAN VELOCITY',SX,'MEAN Q',/)
1123 FORMAT(//,12X,'HEIGHT',8X,'MEAN VELOCITY',SX,'MEAN Q',/)
1124 FORMAT(//,12X,'HEIGHT',8X,'MEAN VELOCITY',SX,'MEAN Q',/)
1125 FORMAT(//,12X,'HEIGHT',8X,'MEAN VELOCITY',SX,'MEAN Q',/)
1126 FORMAT(//,12X,'HEIGHT',8X,'MEAN VELOCITY',SX,'MEAN Q',/)

E-19
SUBROUTINE GDVTX

QX = RHOD2*VXF**2
QY = RHOD2*VYF**2
QZ = RHOD2*VZF**2
QT = RHOD2*VTF**2

C IF (IOU6.EQ.IOU1) THEN
  IF(LINES.LE.12)GOTO 100
  LINES = 4
  CALL INKEY
  IF(KEY.NE.'C')GOTO 999
  WRITE(IOU6,1100)
ENDIF

100 CONTINUE

C REPORT X COMPONENT OF VELOCITY
C
1100 FORMAT(9X,F8.2,2X,'X',3F10.3)

C REPORT Y COMPONENT OF VELOCITY
C
1101 FORMAT(19X,'Y',3F10.3)

C REPORT Z COMPONENT OF VELOCITY
C
1102 FORMAT(19X,'Z',3F10.3)

C REPORT TOTAL VELOCITY
C
1103 FORMAT(19X,'T',3F10.3)

1104 FORMAT(19X,'T',3F10.3)

200 CONTINUE

CALL INKEY

999 CONTINUE

RETURN
END
SUBROUTINE HAZARD

SUBROUTINE HAZARD(HAZTYP)

**********************************************************************

SUBROUTINE HAZARD IS THE MAINLINE DRIVER FOR THE
CALCULATION OF SPECIFIC HAZARDS
**********************************************************************

PARAMETER(NUM1 = 6)
PARAMETER(NUM2 = 15)
PARAMETER(NUM3 = 4)
PARAMETER(NUM4 = 4)

CHARACTER*1 OKLST1(NUM1)
CHARACTER*1 OKLST2(NUM2)
CHARACTER*1 OKLST3(NUM3)
CHARACTER*1 OKLST4(NUM4)

CHARACTER*1 KEY,KKEY,HAZTYP,HUMTYP
CHARACTER*1 CHDOL,CVALUE
CHARACTER*1 ICONT(5)
CHARACTER*12 PTSFIL(4)
CHARACTER*12 TMPFIL
CHARACTER*50 COMM(2)
CHARACTER*50 PROMPT

DIMENSION CONT(9),CONTV(7),CONTX(8)

COMMON /CKEY/ KEY,KKEY
COMMON /CONSTS/ PI,RHO,FPSPKN,RHOD2,DRC
COMMON /HELGEO/ H,DL,YSEP,WSPD,RADIUS,SHFTAN,DXO
COMMON /INPUTC/ ICONT,COMM,PTSFIL
COMMON /INPUTD/ CONT,CONTV,CONTX,YBDLAY
COMMON /PROFIL/ RJ,ZBJ,ZHJ,ZMJ,UMJ,ZB,ZH,ZM,UM,CU,CY
COMMON /UNITS/ IOU1,IOU4,IOUS,IOU6,IOU7,IOU8,IGRAPH

**********************************************************************

DATA OKLST1 '/C', 'c', 'M', 'm', 'X', 'x'/
DATA OKLST2 '/A', 'a', 'B', 'b', 'C', 'c', 'D', 'd',
1 'E', 'e', 'F', 'f', 'G', 'g',
DATA OKLST3 '/W', 'w', 'I', 'i', 'L', 'l'/
DATA OKLST4 '/S', 's'/

-------------------------------------------------------------------

CLEAR SCREEN AND HOME CURSOR
-------------------------------------------------------------------

ICD = 0
CALL HOMCLS(ICD)
CALL LOCATE(4,1)

-------------------------------------------------------------------

DETERMINE THE TYPE OF HAZARD ANALYSIS
OPTION THAT WILL BE EXECUTED
-------------------------------------------------------------------

WRITE(IOU1,10)
10 FORMAT ('25X,'SELECT TYPE OF HAZARD',//,
1 '1X,'OVERTURNING FORCE/MOMENT, TYPE <M>',//,
2 '1X,'PARTICULATE CLOUDS, TYPE <C>',//,
3 '1X,'TO EXIT PROGRAM, TYPE <X>',//)
SUBROUTINE HAZARD

64 C
65 C -------------------------------
66 C INQUIRE, OBTAIN, AND CHECK FOR VALID MENU CODE
67 C
68 C 11 CONTINUE
69 C
70 C WRITE(IOU1,'(23X,A,$)') ' ENTER HAZARD CODE --> '
71 C
72 C READ(IOU1,'(A1)') HAZTYP
73 C
74 C IF(LEGAL(HAZTYP,IOU1,OKLIST,NUM1).EQ.1)GOTO 11
75 C
76 C CORRECT LOWER CASE LETTERS TO UPPER CASE
77 C TO USE AS VALID FLAGS IN PARENT SUBROUTINE
78 C
79 C IF(HAZTYP.EQ.'c') HAZTYP = 'C'
80 C IF(HAZTYP.EQ.'m') HAZTYP = 'M'
81 C IF(HAZTYP.EQ.'x') HAZTYP = 'X'
82 C
83 C BRANCH IF EXIT OPTION CHOSEN
84 C
85 C 18 CONTINUE
86 C
87 C *********************************************************
88 C RADIAL WALL JET FLOW INFORMATION
89 C *********************************************************
90 C
91 C ACCELERATED SLIPSTREAM MEAN VELOCITY
92 C
93 C UN = SQRT(2.0*DL/RHO)
94 C
95 C GROUND EFFECT CORRECTION
96 C
97 C AKG = 1.0 - 0.9*EXP(-2.0*H)
98 C
99 C MEAN VELOCITY AT ROTOR DISK (RATIOED TO UN)
100 C
101 C UB = AKG/2.0
102 C
103 C FIND INITIAL RADIUS OF WALL JET
104 C
105 C CALL WALJET(H,UB,UN,UMB)
106 C
107 C 500 CONTINUE
108 C
109 E-22
SUBROUTINE HAZARD

127 C IF(KEY.EQ.'X')GOTO 999
128 C IF(KEY.EQ.'N')GOTO 999
129 C
130 C ---------------
131 C BRANCH IF CLOUD OPTION CHOSEN
132 C ---------------
133 C IF(HAZTYP.EQ.'C')GOTO 800
134 C
135 C ***********************
136 C OVERTURNING FORCES/MOMENTS
137 C ***********************
138 C
139 C DETERMINE:
140 C
141 C 1. THE AXIS ALONG WHICH THE OVERTURNING
142 C FORCES/MOMENTS WILL BE CALCULATED
143 C
144 C 2. THE SIZE OF THE PERSON AFFECTED
145 C
146 C 3. THE DISTANCES AT WHICH THE OVERTURNING
147 C FORCES/MOMENTS WILL BE CALCULATED
148 C
149 C 20 CONTINUE
150 C
151 C ICD = 0
152 C CALL HOMCLS(ICD)
153 C CALL LOCATE(2,1)
154 C
155 C WRITE(IOU1,12)
156 C 12 FORMAT( 20X,'OVERTURNING FORCE/MOMENT DATA MENU',//,157 C 1 10X,'CODE PARAMETER VALUE',158 C 2 ' UNITS',/)
159 C
160 C PRINT OUT MENU VARIABLES AS BASED ON THE WALL JET
161 C OPTION OR INTERACTION PLANE OPTION SWITCH SETTING
162 C
163 C IF(ICONT(4) .EQ.'W')THEN
164 C WRITE(IOU1,14) ICONT(4),ICONT(5),PTSFIL(3),
165 C 1 CONTV(4),CONTV(5),CONTV(6),YBDLAY
166 C ELSE
167 C WRITE(IOU1,14) ICONT(4),ICONT(5),PTSFIL(4),
168 C 1 CONTV(4),CONTV(5),CONTV(6),YBDLAY
169 C END IF
170 C
171 C 14 FORMAT( 11X,'A <W>ALL JET OR <I>NTERACTION PLANE',5X,A2,/,172 C 1 11X,'B <L>ARGE OR <S>MALL PERSON',5X,A2,/,173 C 2 11X,'C DATA OUTPUT FILENAME',2X,A12,/,174 C 3 11X,'',/,
175 C 4 11X,'D INITIAL STATION POSITION',5X,F7.2,4X,'FT',/,176 C 5 11X,'E HORIZONTAL INCREMENT',5X,F7.2,4X,'FT',/,177 C 6 11X,'F MAXIMUM STATION POSITION',5X,F7.2,4X,'FT',/,178 C 6 11X,'G MINIMUM BOUNDARY LAYER HEIGHT',5X,F7.2,4X,'FT',/)
179 C
180 C E-23
SUBROUTINE HAZARD

190 C
191 C -----------------------------------------------
192 C PROMPT FOR, OBTAIN, AND CHECK FOR LEGAL INPUT DATA
193 C -----------------------------------------------
194 C 16 CONTINUE
195 C
196 C WRITE(IOU1,'(8X,A,$)')
197 C ' ENTER DATA ENTRY CODE OR <RETURN> TO CONTINUE ==> '
198 C
199 C READ(IOU1,'(A1)') CHDOL
200 C
201 C IF(LEGAL(CHDOL,IOUI,OKLST2,NUM2).EQ.1)GOTO 16
202 C
203 C -------- DIRECT OPTIONS BASED ON CHOICE FOR "CHDOL"
204 C --------
205 C
206 C IF(CHDOL.EQ.' ')GOTO 30
207 C
208 C ------------
209 C
210 C CHOOSE WALJET OR IPLANE OPTION
211 C ------------
212 C
213 C IF(CHDOL.EQ.'A'.OR.CHDOL.EQ.'a')THEN
214 C
215 C 40 CONTINUE
216 C
217 C WRITE(IOU1,'(/,35X,A,1X,A2/)') ' ANALYSIS TYPE = ',ICONT(4)
218 C WRITE(IOU1,'(37X,A,$)') ' ENTER NEW CODE ==> '
219 C READ(IOU1,'(A1)') CVALUE
220 C
221 C IF(LEGAL(CVALUE,IOU1,OKLST3,NUM3).EQ.1)GOTO 40
222 C
223 C ICONT(4) = CVALUE
224 C IF(ICONT(4).EQ.'w') ICONT(4) = 'W'
225 C IF(ICONT(4).EQ.'l') ICONT(4) = 'I'
226 C GOTO 20
227 C
228 C ENDIF
229 C
230 C CHOOSE LARGE OR SMALL PERSON
231 C ------------
232 C
233 C IF(CHDOL.EQ.'B'.OR.CHDOL.EQ.'b')THEN
234 C
235 C 41 CONTINUE
236 C
237 C WRITE(IOU1,'(/,35X,A,1X,A2/)') ' PERSON TYPE = ',ICONT(5)
238 C WRITE(IOU1,'(37X,A,$)') ' ENTER NEW CODE ==> '
239 C READ(IOU1,'(A1)') CVALUE
240 C
241 C IF(LEGAL(CVALUE,IOU1,OKLST4,NUM4).EQ.1)GOTO 41
242 C
243 C ICONT(5) = CVALUE
244 C IF(ICONT(5).EQ.'l') ICONT(5) = 'L'
245 C IF(ICONT(5).EQ.'s') ICONT(5) = 'S'
246 C GOTO 20
247 C
248 C ENDIF
249 C
250 C ------------
251 C
252 C CHOOSE GRAPHICS FILENAME
SUBROUTINE HAZARD

253 C
254 C
255 C IF(CHDOL.EQ.'C' .OR.CHDOL.EQ.'c') THEN
256 C IF(ICONT(4) .EQ.'W') THEN
257 C WRITE(IOU1,'(/,25X,A,1X,A12/)')
258 C 'FILENAME = ',PTSFIL(3)
259 C ELSE
260 C WRITE(IOU1,'(/,25X,A,1X,A12/)')
261 C 'FILENAME = ',PTSFIL(4)
262 C ENDIF
263 C WRITE(IOU1,'(/,20X,A,$)')
264 C 'ENTER NEW FILENAME (xxxxxxxx.xxx) ==> '
265 C READ(IOU1,'(A12)') TMPFIL
266 C IF(ICONT(4) .EQ.'W') PTSFIL(3) = TMPFIL
267 C IF(ICONT(4) .EQ.'I') PTSFIL(4) = TMPFIL
268 C GOTO 20
269 C ENDIF

270 C IF(CHDOL.EQ.'D' .OR.CHDOL.EQ.'d') THEN
271 C PROMPT = 'INITIAL STATION POSITION = '
272 C CALL FREAD(IOU1,PROMPT,CONTV(4),1.0)
273 C IF(CONTV(4).LT.0.0) CONTV(4) = 0.0
274 C GOTO 20
275 C ENDIF

276 C IF(CHDOL.EQ.'E' .OR.CHDOL.EQ.'e') THEN
277 C PROMPT = 'HORIZONTAL INCREMENT = '
278 C CALL FREAD(IOU1,PROMPT,CONTV(5),1.0)
279 C IF(CONTV(5).LT.0.0) CONTV(5) = 0.0
280 C GOTO 20
281 C ENDIF

282 C IF(CHDOL.EQ.'F' .OR.CHDOL.EQ.'f') THEN
283 C PROMPT = 'MAXIMUM STATION POSITION = '
284 C CALL FREAD(IOU1,PROMPT,CONTV(6),1.0)
285 C IF(CONTV(6).LT.CONTV(4)) CONTV(6) = CONTV(4)
286 C GOTO 20
287 C ENDIF

288 C CHOOSE INITIAL STATION POSITION
289 C CHOOSE HORIZONTAL INCREMENT
290 C CHOOSE HORIZONTAL INCREMENT
291 C CHOOSE HORIZONTAL INCREMENT
292 C CHOOSE HORIZONTAL INCREMENT
293 C CHOOSE HORIZONTAL INCREMENT
294 C CHOOSE HORIZONTAL INCREMENT
295 C CHOOSE HORIZONTAL INCREMENT
296 C CHOOSE HORIZONTAL INCREMENT
297 C CHOOSE HORIZONTAL INCREMENT
298 C CHOOSE HORIZONTAL INCREMENT
299 C CHOOSE HORIZONTAL INCREMENT
300 C CHOOSE HORIZONTAL INCREMENT
301 C CHOOSE HORIZONTAL INCREMENT
302 C CHOOSE HORIZONTAL INCREMENT
303 C CHOOSE HORIZONTAL INCREMENT
304 C CHOOSE HORIZONTAL INCREMENT
305 C CHOOSE HORIZONTAL INCREMENT
306 C CHOOSE HORIZONTAL INCREMENT
307 C CHOOSE HORIZONTAL INCREMENT
308 C CHOOSE HORIZONTAL INCREMENT
309 C CHOOSE HORIZONTAL INCREMENT
310 C CHOOSE HORIZONTAL INCREMENT
311 C CHOOSE HORIZONTAL INCREMENT
312 C CHOOSE HORIZONTAL INCREMENT
313 C CHOOSE HORIZONTAL INCREMENT
314 C GOTO 20
315 C
SUBROUTINE HAZARD

316   ENDIF
317   C    IF(CHDOL.EQ.'G' .OR.CHDOL.EQ.'g') THEN
318   C
319   C     PROMPT = 'MINIMUM BOUNDARY LAYER HEIGHT = '
320   C     CALL FREAD(IOU1,PROMPT,YBDLAY,1.0)
321   C
322   C     IF(YBDLAY.LT.0.0) YBDLAY = 0.0
323   C     GOTO 20
324   C
325   C     ENDIF
326   C    GOTO 20
329   C
330   C     30 CONTINUE
331   C
332   C     ICD = 0
333   C     CALL HOMCLS(ICD)
334   C
335   C     IF(ICONT(4).EQ.'I') GOTO 700
336   C
337   C     600 CONTINUE
338   C
339   C     ----------------------------------
340   C     WALL JET REGION
341   C
342   C     ----------------------------------
343   C     OBTAIN DATA FOR THE HWJVEL OPTION
344   C
345   C     RVZ = (CONTV(4) - DXO)/RADIUS
346   C     DELH = CONTV(5)
347   C     HMAX = CONTV(6)
348   C     HUMTYP = ICONT(5)
349   C     BDLAYM = YBDLAY/RADIUS
350   C
351   C     ----------------------------------
352   C     GENERATE VELOCITY PROFILE AT RVZ IN WALL JET REGION
353   C
354   C     CALL
355   C     HWJVEL(H,UN,UMB,RVZ,RADIUS,WSPD,DELH,HMAX,HUMTYP,DXO,BDLAYM)
356   C
357   C     GOTO 500
358   C
359   C     700 CONTINUE
360   C
361   C     ----------------------------------
362   C     INTERACTION PLANE UPWASH DEFLECTION ZONE
363   C
364   C     OBTAIN INPUT DATA FOR THE HIPVEL OPTION
365   C
366   C     ----------------------------------
367   C     XIP = (CONTV(4) - DXO)/RADIUS
368   C     DELH = CONTV(5)
369   C     HMAX = CONTV(6)
370   C     HUMTYP = ICONT(5)
371   C     BDLAYM = YBDLAY/RADIUS
372   C
373   C     ----------------------------------
374   C     GENERATE VELOCITY PROFILE AT XIP IN INTERACTION PLANE
375   C
376   C     ----------------------------------
377   C     CALL HIPVEL(H,UN,RADIUS,UMB,XIP,YSEP,WSPD,DELH,HMAX,
SUBROUTINE HAZARD

379 * HUMTYP, DXO, BDLAYM)
380 C GOTO 500
381 C
382 C 800 CONTINUE
383 C ***************************************
384 C CALCULATE PARTICULATE CLOUD BOUNDARIES
385 C ***************************************
386 C
387 C CALL CLOUD(UN, UMB)
388 C GOTO 500
389 C
390 C
391 C
392 C
393 C -------------------------
394 C NORMAL PROGRAM EXIT
395 C -------------------------
396 C
397 C 999 CONTINUE
398 C RETURN
399 C 400 END
401 C
SUBROUTINE HIPVEL

SUBROUTINE HIPVEL(H,UN,RADIUS,UMB,XIP,YSEP,WSPD,DELH,
  HMAX,HUMTYP,DXO,BDLAYM)

*** SUBROUTINE HIPVEL GENERATES THE VELOCITY PROFILE AND THE FORCES
AND OVERTURNING MOMENTS FOR A HUMAN BEING ALONG THE INTERACTION PLANE FOR THE TWIN ROTOR CASE ***

CHARACTER*1 TEMCHAR
CHARACTER*1 KEY,KKEY,HUMTYP
CHARACTER*1 ICONT(5)
CHARACTER*12 PTSFIL(4)
CHARACTER*50 COMM(2)
COMMON / CKEY/ KEY,KKEY
COMMON /CONSTS/ PI,RHO,FPSPKN,RHOD2,DRC
COMMON /INPUTC/ ICONT,COMM,PTSFIL
COMMON /PERSON/ QP(12),DSET
COMMON /PROFIL/ RJ,ZBJ,ZHJ,ZMJ,UMJ,ZB,ZH,ZM,UM,CU,CY
COMMON /UNITS/ IOU1,IOU4,IOU5,IOU6,IOU7,IOU8,IGRAPH

ICD = 0
CALL HOMCLS(ICD)

-- INPUT FOR DELH AND HMAX COMES FROM INPUTV STATUS MENU --

DSET = DELH
IF(DSET.EQ.0.)DELH = HMAX
DELH = DELH/RADIUS
HMAX = HMAX/RADIUS
NHPTS = IFIX((HMAX- XIP)/DELH) + 1
IF(DSET.EQ.0.)GOTO 33

-- WRITE OUTPUT HEADER (FOR PLOT FILE, SEE BELOW) --

IF(IOU6 .NE. IOU1) WRITE(IOU6,'(''1''')
IF(IOU6.EQ.6) WRITE(IOU6,93)
93 FORMAT( 12X, 'SUMMARY OF OVERTURNING FORCES AND MOMENTS',//,
1 19X, 'RADIUS', 6X, 'TOTF', 6X, 'TOTM', //,
2 20X, ' (FT) ', 7X, ' (LB) ', 5X, ' (FT-LB) ')
33 CONTINUE

-- WRITE OUT GRAPHICS FILES IF SWITCH IS SET BY USER --

WRITE(IOU6,1001)
1001 FORMAT( 12X, 'SUMMARY OF OVERTURNING FORCES AND MOMENTS',//,
1 19X, 'RADIUS', 6X, 'TOTF', 6X, 'TOTM', //,
2 20X, ' (FT) ', 7X, ' (LB) ', 5X, ' (FT-LB) ')
33 CONTINUE

WRITE OUT GRAPHICS FILES IF SWITCH IS SET BY USER

E-28
SUBROUTINE HIPVEL

64 C IF(IGRAPH.EQ.1) THEN
65 C -----------------------------------------------
66 C OPEN GRAPHICS FILE AND WRITE FILE HEADER
67 C -----------------------------------------------
68 C OPEN(IOU8,FILE=PTSFILE(4),STATUS='NEW',ERR=2000)
69 C WRITE(IOU8,83) COMM(1),COMM(2)
70 C 83 FORMAT ( 10X,A50,,10X,A50,//)
71 C WRITE(IOU8,80)
72 C 80 FORMAT ( 1X,'TITLE="TWIN ROTOR DAIP DATA"')
73 C WRITE(IOU8,81)
74 C 81 FORMAT ( 1X,'VARIABLES = DAIP,TOTF,TOTM')
75 C WRITE(IOU8,88)
76 C 88 FORMAT ( 1X,'ZONE T = "GW = xxxxx LB, WAGL = xx FT",',
77 C * ' I=x, F=POINT')
78 C ENDIF
79 C -----------------------------------------------
80 C BEGIN LOOP INCREMENTING THE RADIAL POINTS AT WHICH
81 C THE OVERTURNING MOMENT CALCULATIONS ARE MADE
82 C -----------------------------------------------
83 C DO 565 K = 1,NHPTS
84 C -----------------------------------------------
85 C TF IS INTERACTION PLANE AMPLIFICATION FACTOR
86 C (SEE NOTE IN IPVEL.FOR FOR VERSION 2.1)
87 C -----------------------------------------------
88 C TF = 1.65 - (0.65)*EXP(-0.5*XIP)
89 C -----------------------------------------------
90 C GET PARAMETERS AT BASE RADIUS FOR 'BOUNDARY LAYER'
91 C -----------------------------------------------
92 C RIPO = SQRT(XIP**2 + YSEP**2)
93 C -----------------------------------------------
94 C 'PROPRM' PROVIDES THE VELOCITY PROFILE PARAMETERS
95 C OF A RADIAL WALL JET (WITHOUT INTERACTION PLANE)
96 C -----------------------------------------------
97 C CALL PROPRM(H,UMB,RIPO)
98 C -----------------------------------------------
99 C ZIPB = ZB
100 C ZIPH = ZM
101 C -----------------------------------------------
102 C RIPM = SQRT(XIP**2 + (YSEP + ZIPM)**2)
103 C -----------------------------------------------
104 C CALL PROPRM(H,UMB,RIPM)
105 C -----------------------------------------------
106 C UMM = UM
107 C -----------------------------------------------
108 C OUTPUT HEADER
109 C -----------------------------------------------
110 C E-29
SUBROUTINE HIPVEL

127 C  ------------------------
128 C IF(DSET.NE.0.)GOTO 78
129 C  XXIP = RADIUS*XIP
130 C XIPOUT = XXIP + DXO
131 C  IF(IOU6.NE.IOU1) WRITE(IOU6,'(14)')
132 C IF(IOU6.EQ.6) WRITE(IOU6,93) COMM(1),COMM(2)
133 C  WRITE(IOU6,1000) XIPOUT
134 C  1000 FORMAT( 2X,'TWIN ROTOR INTERACTION PLANE VELOCITY PROFILE',
135 C  ' AT DISTANCE = ',F7.1,' FT',//
136 C  WRITE(IOU6,1002)
137 C  1002 FORMAT( 3X,'HEIGHT',6X,'MEAN VELOCITY',7X,'PEAK VELOCITY',6X,
138 C  1 'MEAN Q',4X,'PEAK Q',6X,'MEAN Q',4X,'PEAK Q',//,
139 C  2 3X,'(FPS)',7X,'(FPS)',6X,'(KN)',5X,'(PSF)',//,
140 C  3 '(PSF)',5X,'(PSF)',//)
141 C  78 CONTINUE
142 C  'AN' IS ACTUALLY ' = 1.0/7.0'
143 C ---------------
144 C AN = 0.142857142
145 C DELZ = 0.5/RADIUS
146 C NPTS = 12
147 C DO 500 I = 1,NPTS
148 C ZIP = DELZ*(I - 1) + (0.25/RADIUS)
149 C CALL PROPRM(H,UMB,RIP)
150 C VN = UN
151 C VZ = UM
152 C ----------------------------------------------
153 C GET MAX WALL JET VELOCITY AT EFFECTIVE RADIUS
154 C ----------------------------------------------
155 C ZIPl = BDLAYM
156 C IF(ZIP.LT.ZIPl.OR.ZIP.LT.ZIPM)THEN
157 C IF(ZIP1.LT.ZIPM)THEN
158 C VZ = UMM*(ZIP/ZIPM)**AN
159 C ELSE
160 C E-30
161 C INTERACTION PLANE 'BOUNDARY LAYER'
162 C CODE MODIFIED IN MAY 1992 FOR USER SPECIFIED
163 C MINIMUM BOUNDARY LAYER THICKNESS (BDLAYM)
164 C ----------------------------------------------
165 C ZIPl = BDLAYM
166 C IF(ZIP.LT.ZIPl.OR.ZIPl.LT.ZIPM)THEN
167 C IF(ZIP1.LT.ZIPM)THEN
168 C VZ = UMM*(ZIP/ZIPM)**AN
169 C ELSE
170 C E-30
171 C
SUBROUTINE HIPVEL

190   VZ = UM*(ZIP/ZIP1)**AN
191   ENDIF
192
193   ENDIF
194
195   DEVELOPED INTERACTION PLANE JET
196
197   VH = TF*VZ*XIP/RIP
198
199   ZZ = ZIP*RADIUS
200
201   MEAN HORIZONTAL VELOCITIES AND DYNAMIC PRESSURE
202
203   VHMF = VH*IN
204
205   PEAK VELOCITIES (BOTH FT/SEC AND KNOTS)
206
207   EQUATION FOR VMFD31 UPDATED FROM 1st TO
208
209   2nd ORDER POLYNOMIAL FOR VERSION 2.1
210
211   VMFD31 = 0.712887 + 0.304369*XIP - 0.018496*XIP*XIP
212
213   IF(VMFD31.LT.1.2) VMFD31 = 1.2
214
215   VHFF = VMFD31*VHMF
216
217   THE EFFECT OF WIND IS TO ADD (DOWNWIND SIDE) OR SUBTRACT
218   (UPWIND SIDE) 'XWK' TIMES THE AMBIENT WIND VELOCITY TO
219   THE HORIZONTAL PROFILE VELOCITY (EMPIRICAL, CH-53E BASED)
220
221   XKW = (-0.5*H) + 2.5
222
223   IF(XKW.LT.1.0)XKW = 1.0
224
225   WSPD2 = WSPD*XKW
226
227   DYNAMIC PRESSURE
228
229   QHM = RHOD2*VHMF**2
230
231   IF(DSET.NE.0.)GOTO 77
232
233   REPORT HORIZONTAL COMPONENTS
SUBROUTINE HIPVEL

WRITE (IOU6,1003) ZZ,VHMF,VHMK,VHPF,VHPK,QHM,QP(I)
1003 FORMAT (F8.2,2X,6F10.3)

CONTINUE

IF(DSET.NE.0.)GOTO 520
WRITE (IOU1,73)
73 FORMAT(

WRITE(IOU1,'(19X,A,$)')
READ(IOU1,')') TEMCHAR
ICD = 0
CALL HOMCLS(ICD)
IF(IOU6.NE.IOU1) WRITE(IOU6,('1'''))
IF(IOU6.EQ.6) WRITE(IOU6,93)
CALL MOMENTS(COMM(1),COMM(2))
WRITE(IOU6,1007) XIPOUT
1007 FORMAT(12X,'TWIN ROTOR FORCE PROFILE AT DISTANCE ','F7.1,' FT',6X,'I')
WRITE(IOU6,1008)
1008 FORMAT(2X,'HEIGHT',6X,'PEAK Q',6X,'OVERM',7X,'TOT F',7X,'TOT M',1,2X,'(FT)',1X,'(PSF)',7X,'(LB)',6X,'(FT-LB)',7X,'(LB)',6X,'(FT-LB)')</X>

520 CONTINUE

CALL SUBROUTINE TO CALCULATE THE FORCES AND MOMENTS ON A HUMAN BEING

CALL MOMENT(NPTS,HUMTYP,TOTF,TOTM)
IF(DSET.EQ.0.)GOTO 545
HH = XIP*RADIUS
HHOUT = HH + DXO
WRITE(IOU6,1014) HHOUT,TOTF,TOTM
1014 FORMAT(18X,F8.2,2F10.3)
IF(IGRAPH.EQ.1)THEN
WRITE(IOU8,90) HHOUT,TOTF,TOTM
90 FORMAT(1X,F7.2,1X,F7.2,1X,F8.2)
ENDIF
XIP = XIP + DELH
545 CONTINUE
565 CONTINUE
CLOSE AN OPEN GRAPHICS FILE
SUBROUTINE HIPVEL

316 C --------------------------------------------------
317 C IF (IGRAPH.EQ.1) THEN
318 C      CLOSE (IOU8, STATUS='KEEP')
319 C ENDIF
320 C CALL INKEY
321 C GOTO 999
322 C --------------------------------------------------
323 C THE ERROR LOGIC ALLOWS FOR THE HANDLING OF FILE
324 C OPEN ERRORS BY RETURNING THE USER TO A MENU
325 C --------------------------------------------------
326 C 2000 CONTINUE
327 C CALL HOMCLS (0)
328 C WRITE (IOU1, 2001)
329 C 2001 FORMAT (///,8X,
330      1 '*** ERROR *** PLEASE CHOOSE A NEW OUTPUT FILENAME',
331      2 ///,8X,' TYPE <RETURN> TO CONTINUE',8)
332 C READ (IOU1,'(A1)') TEMCHAR
333 C KEY = 'P'
334 C 999 CONTINUE
335 C RETURN
336 C END
337 C

---

E-33
SUBROUTINE HOMCLS

SUBROUTINE HOMCLS (CODE)

*****************************************************************************
SUBROUTINE HOMCLS

THIS SUBROUTINE HOMES THE CURSOR AND CLEARS THE TERMINAL
SCREEN (CODE=0) OR HOMES THE CURSOR ONLY (CODE=1)
*****************************************************************************

COMMON / UNITS/ IOU1, IOU4, IOU5, IOU6, IOU7, IOU8, IGRAPH

INTEGER*4 CODE

CHARACTER*4 ED
CHARACTER*1 EED(4)
EQUIVALENCE (ED, EED(1))

CHARACTER*3 EE
CHARACTER*1 EEE(3)
EQUIVALENCE (EE, EEE(1))

*****************************************************************************

IF (CODE.EQ.1) GOTO 20

HOME CURSOR AND CLEAR SCREEN
------------------------------------------
EED (1) = CHAR(27)
EED (2) = CHAR(91)
EED (3) = CHAR(50)
EED (4) = CHAR(74)

WRITE(IOU1,*) ED

20 CONTINUE

HOME CURSOR ONLY
------------------------------------------
EEE (1) = CHAR(27)
EEE (2) = CHAR(91)
EEE (3) = CHAR(72)

WRITE(IOU1,*) EE

RETURN

END
SUBROUTINE HSVTX

SUBROUTINE HSVTX(XT,YT,ZT,VX,VY,VZ,GAMMA,RADIUS)

C******************************************************************************
C SUBROUTINE HSVTX
C******************************************************************************
C THIS SUBROUTINE DIRECTS THE CALCULATION OF THE INDUCED VELOCITY FIELD DUE TO A HORSESHOE VORTEX SYSTEM OF UNIT STRENGTH. POINT (LEFT = L1, RIGHT = R1) DEFINE THE EXTENT OF THE BOUND PORTION OF THE HORSESHOE. THE TRAILERS START AT POINT 1 AND EXTEND THROUGH POINT 2, AND THEN ON TO POINT 3. THIS ALLOWS TWO ELEMENTS FOR EACH TRAILER SO THAT IT CAN 'BEND' TO ACCOUNT FOR GROUND CONTACT.
C******************************************************************************
C COMMON /CHSVTX/ XL1,YL1,ZL1,XL2,YL2,ZL2,XL3,YL3,ZL3,
C XR1,YR1,ZR1,XR2,YR2,ZR2,XR3,YR3,ZR3
C COMMON /CVLINE/ IFI, XA, YA, ZA, XB, YB, ZB, XC, YC, ZC, Q1, Q2, Q3
C******************************************************************************
C AT SPECIFIED (X,Y,Z) TARGET POINT IN VICINITY OF ROTOR, CALCULATE THE VECTOR VELOCITY
C******************************************************************************

C IFI = 0
XA = XL1
YA = YL1
ZA = ZL1
XB = XL2
YB = YL2
ZB = ZL2
CALL VLINE

VX = VX - Q1
VY = VY - Q2
VZ = VZ - Q3
C
C LEFT TRAILER IMAGE
C
C

E-35
SUBROUTINE HSVTX

64
65
66 C
67 C
68 C
69 C
70 C
71 C
72 C
73 C
74 C
75 C
76 C
77 C
78 C
79 C
80 C
81 C
82 C
83 C
84 C
85 C
86 C
87 C
88 C
89 C
90 C
91 C
92 C
93 C
94 C
95 C
96 C
97 C
98 C
99 C
100 C
101 C
102 C
103 C
104 C
105 C
106 C
107 C
108 C
109 C
110 C
111 C
112 C
113 C
114 C
115 C
116 C
117 C
118 C
119 C
120 C
121 C
122 C
123 C
124 C
125 C
126 C

ZA = -ZA
ZB = -ZB

CALL VLINE

VX = VX + Q1
VY = VY + Q2
VZ = VZ + Q3

-----------

LEFT TRAILER CONTRIBUTION, POINT 2 TO POINT 3
-----------

IFI = 1
XA = XL2
YA = YL2
ZA = ZL2
XB = XL3
YB = YL3
ZB = ZL3

CALL VLINE

VX = VX - Q1
VY = VY - Q2
VZ = VZ - Q3

-----------

LEFT TRAILER IMAGE
-----------

ZA = -ZA
ZB = -ZB

CALL VLINE

VX = VX + Q1
VY = VY + Q2
VZ = VZ + Q3

-----------

SPANWISE VORTEX CONTRIBUTION
-----------

IFI = 0
XA = XL1
YA = YL1
ZA = ZL1
XB = XR1
YB = YR1
ZB = ZR1

CALL VLINE

VX = VX + Q1
VY = VY + Q2
VZ = VZ + Q3

-----------

SPANWISE VORTEX IMAGE
-----------

ZA = -ZA

E-36
SUBROUTINE HSVTX

127 C
128 C ZB = -ZB
129 C CALL VLINE
130 C VX = VX - Q1
131 C VY = VY - Q2
132 C VZ = VZ - Q3
133 C
134 C RIGHT TRAILER CONTRIBUTION, POINT 1 TO POINT 2
135 C
136 C IFI = 0
137 C XA = XR1
138 C YA = YR1
139 C ZA = ZR1
140 C XB = XR2
141 C YB = YR2
142 C ZB = ZR2
143 C
144 C CALL VLINE
145 C VX = VX + Q1
146 C VY = VY + Q2
147 C VZ = VZ + Q3
148 C
149 C RIGHT TRAILER IMAGE
150 C
151 C ZA = -ZA
152 C ZB = -ZB
153 C CALL VLINE
154 C VX = VX - Q1
155 C VY = VY - Q2
156 C VZ = VZ - Q3
157 C
158 C RIGHT TRAILER CONTRIBUTION, POINT 2 TO POINT 3
159 C
160 C IFI = 1
161 C XA = XR2
162 C YA = YR2
163 C ZA = ZR2
164 C XB = XR3
165 C YB = YR3
166 C ZB = ZR3
167 C
168 C CALL VLINE
169 C VX = VX + Q1
170 C VY = VY + Q2
171 C VZ = VZ + Q3
172 C
173 C RIGHT TRAILER IMAGE
174 C
175 C ZA = -ZA
176 C ZB = -ZB
177 C
178 C
179 C
180 C
181 C
182 C
183 C
184 C
185 C
186 C
187 C
188 C
189 C

E-37
SUBROUTINE HSVTX

190 C CALL VLINE
191 C VX = VX - Q1
192 C VY = VY - Q2
193 C VZ = VZ - Q3
194 C
195 C DIMENSIONIZE
196 C
197 C GDR = GAMMA/RADIUS
198 C VX = VX*GDR
199 C VY = VY*GDR
200 C VZ = VZ*GDR
201 C RETURN
202 C END
203 C
204 C
205 C
206 C
207 C
208 C
SUBROUTINE HWJVEL

SUBROUTINE HWJVEL(H, UN, UMB, RVZ, RADIUS, WSPD, DELH, HMAX, HUMTYP, DXO, BDLAYM)

************************************************************************************
SUBROUTINE HWJVEL GENERATES THE VELOCITY PROFILE AND THE FORCES AND OVERTURNING MOMENTS FOR A HUMAN BEING AT A GIVEN RADIUS
************************************************************************************

CHARACTER*1 ICONT(S)
CHARACTER*1 TEMCHAR
CHARACTER*1 KEY, KKEY, HUMTYP
CHARACTER*12 PTSFIL(4)
CHARACTER*50 COMM(2)
COMMON / CKEY/ KEY, KKEY
COMMON /CONSTS/ PI, RHO, FPSKOH, RHO2, DRC
COMMON /INPUTC/ ICONT, COMM, PTSFIL
COMMON /PERSON/ QP(12), DSET
COMMON /PROFIL/ RJ, ZBJ, ZMj, ZMJ, ZB, ZH, ZM, UM, CU, CY
COMMON /UNITS/ IOUl, IOU4, IOUS, IOU6, IOU7, IOU8, IGRAPH

************************************************************************************

ICD = 0
CALL HOMCLS(ICD)

-----------------------------------------------------
INPUT FOR DELH AND HMAX COMES FROM INPUTV STATUS MENU
-----------------------------------------------------

DSET = DELH

IF(DSET.EQ.0.) DELH = HMAX

DELH = DELH/RADIUS
HMAX = HMAX/RADIUS

NHPTS = IFIX((HMAX - RVZ)/DELH) + 1

IF(DSET.EQ.0.) GOTO 50

IF(IOU6 .NE. IOU1) WRITE(IOU6, (''1''))

IF(IOU6.EQ.6) WRITE(IOU6,93) COMM(1), COMM(2)

93 FORMAT( 10X, A50, //, 10X, A50, //)

WRITE(IOU6, 1001)

1001 FORMAT( 12X, 'SUMMARY OF OVERTURNING FORCES AND MOMENTS', //,
3 1X, 'RADIUS', 6X, 'TOTF', 6X, 'TOTM', //,
51 2X, 'I', 20X, '(FT)', 7X, '(LB)', 5X, '(FT-LB)', //)

50 CONTINUE

WRITE(IOU6,1001)

1001 FORMAT( 12X, 'SUMMARY OF OVERTURNING FORCES AND MOMENTS', //,
3 1X, 'RADIUS', 6X, 'TOTF', 6X, 'TOTM', //,
51 2X, 'I', 20X, '(FT)', 7X, '(LB)', 5X, '(FT-LB)', //)

50 CONTINUE

END
OPEN(IOU8,FILE=PTSFIL(3),STATUS='NEW',ERR=2000)
WRITE(IOU8,83) COMM(1),COMM(2)
83 FORMAT( 10X,A50,/,10X,A50,//)
WRITE(IOU8,80)
80 FORMAT( 1X,'TITLE="SINGLE ROTOR DFRC DATA"')
WRITE(IOU8,81)
81 FORMAT( 1X,'VARIABLES DFRC,TOTF,TOTM')
WRITE(IOU8,88)
88 FORMAT( lX,'ZONE' T = "GW = xxxxx LB, WAGL = xx FT",',
I=X, F=POINT')
SUBROUTINE HWJVEL
BEGIN
LOOP
INCREMENTING THE RADIAL POINTS AT WHICH
THE OVERTURNING MOMENT CALCULATIONS ARE MADE
DO 565 K = 1,NHPTS
'PROPRM' PROVIDES THE VELOCITY PROFILE PARAMETERS
OF A RADIAL WALL JET (WITHOUT INTERACTION PLANE)
CALL PROPRM(H,UMB,RVZ)
ZETAM = ZM/ZB
ZETAH = ZH/ZB
CALCULATION OF THE NON-DIMENSIONALIZED MINIMUM ALLOWED
BOUNDARY LAYER THICKNESS SO THAT THE BOUNDARY LAYER CAN
BE ADJUSTED IF THE ZM POSITION IS PHYSICALLY TOO LOW
(BDLAYM, IN FEET, COMES FROM A MENU INPUT PARAMETER)
ZETAL1 = BDLAYM/ZB
BOUNDARY LAYER REGION EXPONENT
'AN' IS ACTUALLY ' = 1.0/7.0'
AN = 0.142857142
SHEAR LAYER REGION EXPONENT, TO MEET EDGE CONDITIONS
(ALPW = ALOG(1.0 - 1.0/SQRT(2.0))/ALOG((ZH - ZM)/(ZB - ZM))
VN = UN
VMN = UN
PRINT DETAILED REPORT IF DSET = 0.0 INSTEAD OF SIMPLE REPORT
E-40
SUBROUTINE HWJVEL

127 C IF(DSET.NE.0.)GOTO 78
128 C RRVZ = RVZ*RADIUS
129 RVZOUT = RRVZ + DXO
130 C IF(IOU6.NE.IOU1) WRITE(IOU6,'("1")')
131 C IF(IOU6.EQ.6) WRITE(IOU6,93) COMM(1),COMM(2)
132 C WRITE(IOU6,1000) RVZOUT
133 1000 FORMAT( 10X,'SINGLE ROTOR VELOCITY PROFILE AT RADIUS = ',
134 1 F7.1,' FT',//)
135 WRITE(IOU6,1005)
136 1005 FORMAT( 2X,'HEIGHT',5X,'MEAN VELOCITY',7X,'PEAK VELOCITY',6X,
137 1 'MEAN Q',4X,'PEAK Q' ,/,
138 2 3X, '(FT)',5X,'(FPS)',6X,'(KN)',5X,'(PSF)' ,/,
139 3 ' (PSF)',5X,'(PSF)' ,/)
140 78 CONTINUE
141 C SET UP ABILITY TO CALCULATE AT 0.5 FT.
142 C INCREASES UP THE VELOCITY PROFILE
143 C DELZ = 0.5/RADIUS
144 NPTS = 12
145 C DO 500 I = 1,NPTS
146 C Z = DELZ*(I - 1) + (0.25/RADIUS)
147 ZETA = Z/ZB
148 C IF(ZETA.LT.ZETAM.OR.ZETA.LT.ZETA1)THEN
149 C
150 C -------------------------------
151 C Z IS WITHIN BOUNDARY LAYER
152 C -------------------------------
153 C NOTE THAT THE BOUNDARY LAYER CALCULATIONS NOW USE
154 C THE MINIMUM THICKNESS PARAMETER AND THE PEAK TO
155 C MEAN VELOCITY PARAMETER IS THE MAXIMUM VELOCITY
157 C
158 C VIM = 0.0
159 C IF(ZETAM.GT.0.0)THEN
160 C VIM = (ZETA/ZETAM)**AN
161 C IF(ZETA1.GT.ZETAM)THEN
162 C VIM1 = (1.0 - ((ZETA1 - ZETAM)/(1.0 - ZETAM))**ALPW)**2
163 C VIM = VIM1*(ZETA/ZETA1)**AN
164 C ENDIF
165 C
166 C VMTOPK = 1.04653 + 0.373894*RVZ - 0.0422525*RVZ*RVZ
167 C IF(VMTOPK.LT.1.2) VMTOPK = 1.2
168 C ENDIF
169 C
170 C
171 C
172 C
173 C
174 C
175 C
176 C
177 C
178 C
179 C
180 C
181 C
182 C
183 C
184 C
185 C
186 C
187 C
188 C
189 C

E-41
SUBROUTINE HWJVEL

GOTO 400

ENDIF

********************************************************************************

Z IS WITHIN SHEAR LAYER

THE PEAK TO MEAN VELOCITY RATIO EQUATIONS ARE
SUBSTANTIALLY IMPROVED OVER THOSE USED PRIOR TO
MAY 1992. EQUATIONS ARE NOW USED FOR BOTH THE
MAXIMUM VELOCITY HEIGHT (ZM) AND THE 1/2 VELOCITY
HEIGHT (ZH). VALUES BETWEEN ARE INTERPOLATED AND
VALUES ABOVE ZH USE THE ZH RATIO*(ZETA/ZETAH).

THESE 2nd ORDER EQUATION SUBSTANTIALLY IMPROVED
CORRELATION WITH MODEL AND FLIGHT TEST DATA
DURING THE MAY 1992 EFFORT FOR V2.1.

VZM = 0.0

IF(Z.LE.ZB)THEN
    VZM = (1.0 - ((ZETA - ZETAM)/(1.0 - ZETAM))**ALPW)**2
    IF(ZETA.GE.ZETAH)THEN
        VMTOPK = (1.48086 + 0.569177*RVZ - 0.0692514*RVZ*RVZ)*
            *(ZETA/ZETAH)
        1
        IF(VMTOPK.LT.1.2) VMTOPK = 1.2
    ELSE
        VMPK12 = 1.48086 + 0.569177*RVZ - 0.0692514*RVZ*RVZ
        FRAC = (ZETA- ZETAM)/(ZETAH- ZETAM)
        IF(ZETAl.GT.ZETAM)THEN
            FRAC = (ZETA- ZETAl)/(ZETAH- ZETAl)
        END IF
        VMTOPK = FRAC*VMPK12 + (1.0 - FRAC)*VMPKMX
        IF(VMTOPK.LT.1.2) VMTOPK = 1.2
    END IF
ELSE
    VMPKMX = 1.04653 + 0.373894*RVZ - 0.0422525*RVZ*RVZ
    VMPK12 = 1.48086 + 0.569177*RVZ - 0.0692514*RVZ*RVZ
    FRAC = (ZETA - ZETAM)/(ZETAH - ZETAM)
    IF(ZETAl.GT.ZETAM)THEN
        FRAC = (ZETA - ZETAl)/(ZETAH - ZETAl)
    END IF
    VMTOPK = FRAC*VMPK12 + (1.0 - FRAC)*VMPKMX
    IF(VMTOPK.LT.1.2) VMTOPK = 1.2
END IF

END IF

400 CONTINUE

VZN = VZM*VMN

********************************************************************************

DIMENSIONAL HEIGHT

********************************************************************************

ZZ = Z*RADIUS

E-42
SUBROUTINE HWJVEL

253 C ------------------------
254 C MEAN VELOCITIES
255 C ------------------------
256 C VMF = VIN*VN
257 C VMK = VMF/FPSPKN
258 C ------------------------
259 C PEAK VELOCITIES
260 C ------------------------
261 C VPF = VMF*VMTOPK
262 C VPK = VPF/FPSPKN
263 C ------------------------
264 C THE EFFECT OF WIND IS TO ADD (DOWNWIND SIDE) OR SUBTRACT
265 C (UPWIND SIDE) 'XKW' TIMES THE AMBIENT WIND VELOCITY TO
266 C THE HORIZONTAL PROFILE VELOCITY (EMPirical, CH-53E BASED)
267 C ------------------------
268 C XKW = (-0.5*H) + 2.5
269 C IF(XKW.LT.1.0) XKW = 1.0
270 C WSPD2 = WSPD*XKW
271 C VMK = VMK + WSPD2
272 C VMF = VMF*FPSPKN
273 C VPK = VPK + WSPD2
274 C VPF = VPF/FPSPKN
275 C ------------------------
276 C DYNAMIC PRESSURE
277 C ------------------------
278 C QM = RHOD2*VMF**2
279 C QP(I) = RHOD2*VPF**2
280 C IF(DSET.NE.0.)GOTO 77
281 C WRITE(IOU6,1002) ZZ,VMF,VMK,VPF,VPK,QM,QP(I)
282 C 1002 FORMAT( F8.2,6F10.3)
283 C CONTINUE
284 C 77 CONTINUE
285 C ------------------------
286 C WRITE(IOU1,73)
287 C 73 FORMAT(15X, A,$)
288 C WRITE(IOU1,('TYPE <RETURN> TO CONTINUE ')
289 C READ(IOU1,'(A1)') TEMCHAR
290 C !CD = 0
291 C CALL HOMCLS(IDC)
292 C IF(IOU6.NE.IOU1) WRITE(IOU6,('"I'')')
293 C 310 C IF(IOU6.EQ.6) WRITE(IOU6,93) COMM(1),COMM(2)
294 C 312 C WRITE(IOU6,1007) RVZOUT
295 C 1007 FORMAT( 12K,'SINGLE ROTOR FORCE PROFILE AT RADIUS = ',
296 C E-43
SUBROUTINE HWJVEL

1 F7.1,' FT',//

WRITE(IOU6,1008)

1008 FORMAT( 2X,'HEIGHT',6X,'PEAK Q',6X,'POVER',7X,'OVERM',7X,
1 'TOT F',7X,'TOT M',//,
2 '3X,'(FT)',8X,'(PSF)',7X,'(LB)',6X,'(FT-LB)',7X,
3 ' (LB)',6X,'(FT-LB)',//)

C 520 CONTINUE
C CALL SUBROUTINE TO CALCULATE THE
C FORCES AND MOMENTS ON A HUMAN BEING
C CALL MOMENT(NPTS,HUMTYP,TOTF,TOTM)
C IF(DSET.EQ.0.)GOTO 545
C HH = RVZ*RADIUS
C HHOUT = HH + DXO
C WRITE(IOU6,1014) HHOUT,TOTF,TOTM
1014 FORMAT( 18X,F8.2,2Fl0.3)
C IF(IGRAPH.EQ.1)THEN
C WRITE(IOU8,90) HHOUT,TOTF,TOTM
90 FORMAT( 1X,F7.2,1X,F7.2,1X,F8.2)
C ENDIF
C 545 CONTINUE
C RVZ = RVZ + DELH
C 565 CONTINUE

C ----------------------------
C CLOSE AN OPEN GRAPHICS FILE
C ----------------------------
C IF(IGRAPH.EQ.1)THEN
C CLOSE(IOU8,STATUS='KEEP')
C ENDIF
C CALL INKEY
C GOTO 999
C
C 2000 CONTINUE
C CALL HOMCLS(0)
C WRITE(IOU1,2001)
2001 FORMAT( /////,8X,
1 '*** ERROR *** PLEASE CHOOSE A NEW OUTPUT FILENAME',
E-44
SUBROUTINE HWJVEL

379  2 ///,8X,' TYPE <RETURN> TO CONTINUE ',S)
380  READ(IOU1, '(A1)') TEMCHAR
381  KEY = 'F'
382  C
383  999 CONTINUE
384  C
385  RETURN
386  C
387  END
388

E-45
SUBROUTINE INKEY

***********************************************************************
SUBROUTINE INKEY

PARAMETER(NUM = 8)

CHARACTER*1 KEY, KKEY
CHARACTER*1 OKLIST(NUM)

COMMON / CKEY/ KEY, KKEY
COMMON / UNITS/ IOU1, IOU4, IOU5, IOU6, IOU7, IOU8, IGRAPH

***********************************************************************

DATA OKLIST /'C','c','P','p','N','n','X','x'/

INQUIRE, OBTAIN, AND CHECK FOR VALID MENU OPTION

-----------------------------------------------------------------------

WRITE(IOU1,20)

20 FORMAT(//,7X,'TYPE <C>ONTINUE, NEXT <P>POINT, <N>EW CASE,'1,' E<X>IT ==> ',8)

READ(IOU1,'(A1)') KEY

IF(LEGAL(KEY,IOU1,OKLIST,NUM).EQ.1) GOTO 10

CORRECT LOWER CASE LETTERS TO UPPER CASE

IF(KEY.EQ.'c') KEY = 'C'
IF(KEY.EQ.'p') KEY = 'P'
IF(KEY.EQ.'n') KEY = 'N'
IF(KEY.EQ.'x') KEY = 'X'

CLEAR SCREEN AND HOME CURSOR

ICD = 0
CALL HOMCLS(ICD)

RETURN

END
SUBROUTINE INPUT

********************************************************
SUBROUTINE INPUT
THIS SUBROUTINE PRESENTS THE INPUT STATUS MENU
AND MANIPULATES THE DATA FOR PROGRAM USE
********************************************************
PARAMETER(NUM1 = 19)
PARAMETER(NUM2 = 9)
PARAMETER(NUM3 = 4)
PARAMETER(NUM4 = 4)
CHARACTER*1 CHDOL
CHARACTER*1 CENTRY
CHARACTER*l OKLST1(NUM1)
CHARACTER*1 OKLST2(NUM2)
CHARACTER*1 OKLST3(NUM3)
CHARACTER*1 OKLST4(NUM4)
CHARACTER*1 ICONT(5)
CHARACTER*12 PTSFIL(4)
CHARACTER*50 COMM(2), LENTRY
CHARACTER*50 PROMPT
DIMENSION CONT(9), CONTY(7), CONTX(8)
COMMON /INPUTC/ ICONT, COMM, PTSFIL
COMMON /INPUTD/ CONT, CONTY, CONTX, YBDLAY
COMMON /UNITS/ IOU1, IOU4, IOU5, IOU6, IOU7, IOU8, IGRAPH
********************************************************
SET DATA TO CHECK FOR ILLEGAL DATA INPUT
DATA OKLST1 / ' ', 'a', 'a', 'b', 'w', 'c', 'c', 'd', 'd',
1 'e', 'f', 'f', 'g', 'h', 'h', 'i', 'i' /
DATA OKLST2 / ' ', 'a', 'a', 'b', 'w', 'c', 'c', 'd' /
DATA OKLST3 / 'v', 'v', 'h', 'h' /
DATA OKLST4 / 'v', 'v', 'n', 'n' /
10 CONTINUE
CLEAR SCREEN AND HOME CURSOR
CALL HOMCLS(0)
CALL LOCATE(2,1)
WRITE FIRST ENGINEERING DATA MENU
CALL HOMCLS(0)
CALL LOCATE(2,1)
WRITE(IOU1, '(24X,A/)') ' ROTWASH USER INPUT DATA MENU'

E-47
SUBROUTINE INPUT

64 WRITE(IOUL,'(T7,A,T25,A,T51,A,T61,A/)') ' CODE', ' PARAMETER',
65 1 ' VALUE', ' UNITS'
66 1 ' A NUMBER OF ROTORS (1 OR 2) ', IROTOR, '-ND'
67 WRITE(IOUL,'(8X,A,T50,F8.1,6X,A)')
68 1 ' B HUB TO HUB ROTOR SEPARATION', CONT(2), ' FT'
69 WRITE(IOUL,'(8X,A,T50,F8.1,6X,A)')
70 1 ' C ROTOR RADIUS ', CONT(3), ' FT'
71 WRITE(IOUL,'(8X,A,T50,F8.1,6X,A)')
72 1 ' D GROSS WEIGHT ', CONT(4), ' LB'
73 WRITE(IOUL,'(8X,A,T50,F8.1,6X,A)')
74 1 ' E FUSELAGE DOWNLOAD FACTOR ', CONT(5), ' PCT'
75 WRITE(IOUL,'(8X,A,T50,F8.1,6X,A)')
76 1 ' F ROTOR HEIGHT ABOVE GROUND ', CONT(6), ' FT'
77 WRITE(IOUL,'(8X,A,T50,F8.1,6X,A)')
78 1 ' G SHAFT TILT ANGLE (<20 DEG) ', CONT(7), ' DEG'
79 WRITE(IOUL,'(8X,A,T50,F8.1,6X,A)')
80 1 ' H AIR DENSITY RATIO ', CONT(8), ' ND'
81 WRITE(IOUL,'(8X,A,T50,F8.1,6X,A/)')
82 1 ' I AMBIENT WIND (-10 TO 10 KT)', CONT(9), ' KT'
83 c ---------------------------------------------------
84 c PROMPT FOR, OBTAIN, AND CHECK FOR LEGAL INPUT DATA
85 c ---------------------------------------------------
86 20 WRITE(IOUL,'(8X,A,$)')
87 1 ' ENTER DATA ENTRY CODE OR <RETURN> TO CONTINUE --> '
88 c ---------------------------------------------------
89 c READ(IOUL, '(A1)') CHDOL
90 c IF(LEGAL(CHDOL, IOUL, OILST1, NUM1).EQ.1) GOTO 20
91 c IF(CHDOL.EQ.'A' .OR.CHDOL.EQ.'a')THEN
92 c PROMPT = 'ROTORS = ' CALL IREAD(IOUL, PROMPT, IROTOR)
93 c IF(IROTOR.LT.1) !ROTOR= 1
94 c IF(IROTOR.GT.2) !ROTOR= 2
95 c CONT(1) = FLOAT(IROTOR)
96 c GOTO 10
97 c ENDIF
98 c IF(CHDOL.EQ.'B' .OR.CHDOL.EQ.'b')THEN
99 c PROMPT = 'ROTOR SEPARATION = '
100 c CALL FREAD(IOUL, PROMPT, CONT(2), 1.0)
101 c GOTO 10
102 c ENDIF
103 c IF(CHDOL.EQ.'C' .OR.CHDOL.EQ.'c')THEN
104 c PROMPT = 'ROTOR RADIUS = '
105 c CALL FREAD(IOUL, PROMPT, CONT(3), 1.0)
106 c GOTO 10
107 c ENDIF
108 c ENDIF
109 c IF(CHDOL.EQ.'A'.OR.CHDOL.EQ.'a')THEN
110 c CALL IREAD(IOUL, PROMPT, IROTOR)
111 c IF(IROTOR.LT.1) IROTOR = 1
112 c IF(IROTOR.GT.2) IROTOR = 2
113 c CONT(1) = FLOAT(IROTOR)
114 c GOTO 10
115 c ENDIF
116 c IF(CHDOL.EQ.'B'.OR.CHDOL.EQ.'b')THEN
117 c PROMPT = 'ROTOR SEPARATION = '
118 c CALL FREAD(IOUL, PROMPT, CONT(2), 1.0)
119 c GOTO 10
120 c ENDIF
121 c IF(CHDOL.EQ.'C'.OR.CHDOL.EQ.'c')THEN
122 c PROMPT = 'ROTOR RADIUS = '
123 c CALL FREAD(IOUL, PROMPT, CONT(3), 1.0)
124 c GOTO 10
125 c ENDIF
126 c
SUBROUTINE INPUT

127 IF(CHDOL.EQ.'D' .OR.CHDOL.EQ.'d')THEN
128 PROMPT = 'GROSS WEIGHT = '
129 CALL FREAD(IOU1,PROMPT,CONT(4),1.0)
130 GOTO 10
131
132 ENDIF
133
134 IF(CHDOL.EQ.'E' .OR.CHDOL.EQ.'e')THEN
135 PROMPT = 'DOWNLOAD FACTOR = '
136 CALL FREAD(IOU1,PROMPT,CONT(5),1.0)
137 GOTO 10
138
139 ENDIF
140
141 IF(CHDOL.EQ.'F' .OR.CHDOL.EQ.'f')THEN
142 PROMPT = 'HEIGHT ABOVE GROUND = '
143 CALL FREAD(IOU1,PROMPT,CONT(6),1.0)
144 GOTO 10
145
146 ENDIF
147
148 IF(CHDOL.EQ.'G' .OR.CHDOL.EQ.'g')THEN
149 PROMPT = 'SHAFT TILT = '
150 CALL FREAD(IOU1,PROMPT,CONT(7),1.0)
151 IF(CONT(7).LT. 0.0) CONT(7) = 0.0
152 IF(CONT(7).GT. 20.0) CONT(7) = 20.0
153 GOTO 10
154
155 ENDIF
156
157 IF(CHDOL.EQ.'H' .OR.CHDOL.EQ.'h')THEN
158 PROMPT = 'DENSITY RATIO = '
159 CALL FREAD(IOU1,PROMPT,CONT(8),1.0)
160 GOTO 10
161
162 ENDIF
163
164 IF(CHDOL.EQ.'I' .OR.CHDOL.EQ.'i')THEN
165 PROMPT = 'WIND VELOCITY = '
166 CALL FREAD(IOU1,PROMPT,CONT(9),1.0)
167 IF(CONT(9).LT.-10.0) CONT(9) = -10.0
168 IF(CONT(9).GT. 10.0) CONT(9) = 10.0
169 GOTO 10
170
171 ENDIF
172
173 ENDIF
174
175 ENDIF
176
177 ENDIF
178
179 ENDIF
180
181 GOTO 10
182
183 30 CONTINUE
184
185 CLEAR SCREEN AND HOME CURSOR
186 -----------------------------
187 CALL HOMCLS(0)
188
189 E-49
SUBROUTINE INPUT

CALL LOCATE(2,1)

WRITE SECOND ENGINEERING DATA MENU

WRITE(IOU1,40)

CALL LOCATE(2,1)

WRITE(IOU1,50) ICONT(1),ICONT(2),COMM(1),COMM(2)

W

WRITE(IOU1,'(8X,A,$)')

1' ENTER CODE FOR DATA INPUT OR <RETURN> TO CONTINUE ==> '

READ(IOU1,'(Al)') CHDOL

IF(LEGAL(CHDOL,IOU1,OKLST2,NUM2).EQ.1)GOTO 60

IF(CHDOL.EQ.'B')GOTO 70

WRITE(IOU1,'(/,35X,A,1X,A2/)') 'ANALYSIS TYPE=' ,ICONT(1)

WRITE(IOU1,'(40X,A,$)') 'ENTER NEW VALUE ==> '

READ(IOU1,'(Al)') CENTRY

IF(LEGAL(CENTRY,IOU1,OKLST3,NUM3).EQ.1)GOTO 80

ICONT(1) = CENTRY

IF(ICONT(1).EQ.'V') ICONT(1) = 'V'

IF(ICONT(1).EQ.'H') ICONT(1) = 'H'

GOTO 30

END IF

WRITE(IOU1,'(/,35X,A,1X,A2/)') 'GRAPHICS FLAG=' ,ICONT(2)

WRITE(IOU1,'(40X,A,$)') 'ENTER NEW VALUE ==> '

READ(IOU1,'(Al)') CENTRY

E-50
SUBROUTINE INPUT

253 C IF(LEGAL(CENTRY,IOUl,OKLST4,NUM4).EQ.1)GOTO 90

255 C ICONT(2) = CENTRY
256 C IF(ICONT(2).EQ.'y') ICONT(2) = 'Y'
257 C IF(ICONT(2).EQ.'n') ICONT(2) = 'N'
259 C IF(ICONT(2).EQ.'Y') IGRAPH = 1
260 C IF(ICONT(2).EQ.'N') IGRAPH = 0
261 C GOTO 30

262 C ENDF
264 C ---------------------------------------
266 C CHOOSE COMMENT STRINGS FOR OUTPUT DATA
268 C ---------------------------------------
269 C IF(CHDOL.EQ.'C'.OR.CHDL.EQ.'c')THEN
270 C WRITE(IOUl,'(/,5X,A,A50/)') 'COMMENT STRING = ',COMM(1)
271 C WRITE(IOU1,'(5X,A,$)') 'ENTER STRING==> '
272 C READ(IOU1,'(A50)') LENTRY
274 C COMM(1) = LENTRY
276 C GOTO 30
277 C ENDF
279 C IF(CHDOL.EQ.'D'.OR.CHDOL.EQ.'d')THEN
281 C WRITE(IOUl,'(/,5X,A,A50/)') 'COMMENT STRING = ',COMM(2)
282 C WRITE(IOU1,'(5X,A,$)') 'ENTER STRING==> '
284 C READ(IOU1,'(A50)') LENTRY
285 C COMM(2) = LENTRY
287 C GOTO 30
288 C ENDF
290 C GOTO 30
292 C 70 CONTINUE
293 C RETURN
296 C END

E-51
SUBROUTINE INPUTV

SUBROUTINE INPUTV(FLOW)

******************************************************************************

SUBROUTINE INPUTV

THIS SUBROUTINE PRESENTS THE INPUT STATUS MENU AND MANIPULATES DATA FOR THE WALLJET AND IPLANE PROGRAM OPTIONS

******************************************************************************

PARAMETER(NUM = 11)

CHARACTER*1 OKLIST(NUM)

CHARACTER*1 CHDOL, FLOW

CHARACTER*12 TMPFIL

CHARACTER*50 COMM(2)

CHARACTER*50 PROMPT

DIMENSION CONT(9), CONTV(?), CONTX(?)

COMMON /INPUTC/ ICONT, COMM, PTSFIL

COMMON /INPUTD/ CONTV, CONT, CONTX, YBDLAY

COMMON /UNITS/ IOU1, IOU4, IOU5, IOU6, IOU7, IOU8, IGRAPH

******************************************************************************

DATA OKLIST /' ', 'A', 'a', 'B', 'b', 'C', 'c', 'D', 'd', 'E', 'e'/

CLEAR SCREEN AND HOME CURSOR

ICD = 0

20 CONTINUE

CALL HOMCLS(ICD)

CALL LOCATE(1, 1)

WRITE(IOU1, 12)

12 FORMAT( 22X, ' VELOCITY PROFILE STATUS MENU', ///,
10X, 'CODE PARAMETER', 3X, 'UNITS', '/)

PRINT OUT MENU VARIABLES AS BASED ON THE WALL JET OPTION OR INTERACTION PLANE OPTION SWITCH SETTING

IF (FLOW.EQ.'W') THEN

WRITE(IOU1, 14) (CONTV(I), I=1, 3), YBDLAY, PTSFIL(1)

ELSE

WRITE(IOU1, 14) (CONTV(I), I=1, 3), YBDLAY, PTSFIL(2)

ENDIF

14 FORMAT( 12X, 'A PROFILE STATION POSITION ', 5X, F7.2, E-52)
SUBROUTINE INPUTV

64 1 4X,'FT',/,
65 2 12X,'B' VERTICAL INCREMENT ',4X,F7.2,4X,'FT',/,
66 3 12X,'C' MAXIMUM PROFILE HEIGHT ',4X,F7.2,4X,'FT',/,
67 4 12X,'D' MINIMUM BOUNDARY LAYER
68 HEIGHT',1X,F7.2,4X,'FT',/,
69 5 12X,'E' DATA OUTPUT FILENAME ',7X,A12,/
70 C
71 C -------------------------------
72 C PROMPT FOR, OBTAIN, AND CHECK FOR LEGAL INPUT DATA
73 C -------------------------------
74 C 10 CONTINUE
75 C WRITE(IOUl, '(8X,A,$)')
76 C ' ENTER DATA ENTRY CODE OR <RETURN> TO CONTINUE ==> ' 
77 C READ(IOUl,' (A1)') CHDOL
78 C IF(LEGAL(CHDOL,IOUl,OKLIST,NUM).EQ.1)GOTO 10
79 C IF(CHDOL.EQ. 'A' .OR.CHDOL.EQ. 'a')THEN
80 C PROMPT = 'PROFILE STATION POSITION = '
81 C CALL FREAD(IOUl,PROMPT,CONTV(1),1.0)
82 C IF(CONTV(1).LT.0.0) CONTV(1) = 0.0
83 C GOTO 20
84 C ENDIF
85 C IF(CHDOL.EQ. 'B' .OR.CHDOL.EQ. 'b')THEN
86 C PROMPT = 'VERTICAL INCREMENT = '
87 C CALL FREAD(IOUl,PROMPT,CONTV(2),1.0)
88 C IF(CONTV(2).LT.0.0) CONTV(2) = 0.0
89 C GOTO 20
90 C ENDIF
91 C IF(CHDOL.EQ. 'C' .OR.CHDOL.EQ. 'c')THEN
92 C PROMPT = 'MAXIMUM PROFILE HEIGHT = '
93 C CALL FREAD(IOUl,PROMPT,CONTV(3),1.0)
94 C IF(CONTV(3).LT.0.0) CONTV(3) = 0.0
95 C GOTO 20
96 C ENDIF
97 C IF(CHDOL.EQ. 'D' .OR.CHDOL.EQ. 'd')THEN
98 C PROMPT = 'MINIMUM BOUNDARY LAYER HEIGHT = '
99 C CALL FREAD(IOUl,PROMPT,YBDLAY,1.0)
100 C IF(YBDLAY.LT.0.0) YBDLAY = 0.0
101 C GOTO 20
102 C ENDIF
103 C IF(CHDOL.EQ. 'E' .OR.CHDOL.EQ. 'e')THEN
104 C DATA OUTPUT FILENAME ',7X,A12,/
105 C ENDIF
106 C E-53
SUBROUTINE INPUTV

127 C CHOOSE GRAPHICS FILENAME
128 C ---------------------------------------
129 C IF(CHDOL.EQ.'E' .OR.CHDOL.EQ.'e') THEN
130 C IF(FLOW.EQ.'W') THEN
131 C 1 WRITE(IOUl,'(/,25X,A,1X,A12/)')
132 C 'FILENAME = ',PTSFIL(1)
133 C ELSE
134 C WRITE(IOUl,'(/,25X,A,1X,A12/)')
135 C 1 'FILENAME = ',PTSFIL(2)
136 C ENDIF
137 C WRITE(IOUl,
138 C 1 ' ENTER NEW FILENAME (xxxxxxxx.xxx) =>'
139 C 1 ' ENTER NEW FILENAME (xxxxxxxx.xxx) =>'
140 C 1 ' ENTER NEW FILENAME (xxxxxxxx.xxx) =>'
141 C 1 ' ENTER NEW FILENAME (xxxxxxxx.xxx) =>'
142 C 1 ' ENTER NEW FILENAME (xxxxxxxx.xxx) =>'
143 C 1 ' ENTER NEW FILENAME (xxxxxxxx.xxx) =>'
144 C 1 ' ENTER NEW FILENAME (xxxxxxxx.xxx) =>'
145 C 1 ' ENTER NEW FILENAME (xxxxxxxx.xxx) =>'
146 C 1 ' ENTER NEW FILENAME (xxxxxxxx.xxx) =>'
147 C 1 ' ENTER NEW FILENAME (xxxxxxxx.xxx) =>'
148 C 1 ' ENTER NEW FILENAME (xxxxxxxx.xxx) =>'
149 C 1 ' ENTER NEW FILENAME (xxxxxxxx.xxx) =>'
150 C 1 ' ENTER NEW FILENAME (xxxxxxxx.xxx) =>'
151 C 1 ' ENTER NEW FILENAME (xxxxxxxx.xxx) =>'
152 C 1 ' ENTER NEW FILENAME (xxxxxxxx.xxx) =>'
153 C 1 ' ENTER NEW FILENAME (xxxxxxxx.xxx) =>'
154 C 1 ' ENTER NEW FILENAME (xxxxxxxx.xxx) =>'
155 C 1 ' ENTER NEW FILENAME (xxxxxxxx.xxx) =>'
156 C 1 ' ENTER NEW FILENAME (xxxxxxxx.xxx) =>'
157 C 1 ' ENTER NEW FILENAME (xxxxxxxx.xxx) =>'
158 C 1 ' ENTER NEW FILENAME (xxxxxxxx.xxx) =>'
159 C 1 ' ENTER NEW FILENAME (xxxxxxxx.xxx) =>'
160 C 1 ' ENTER NEW FILENAME (xxxxxxxx.xxx) =>'

E-54
SUBROUTINE INPUTX

******************************************************************************
SUBROUTINE INPUTX PRESENTS THE INPUT STATUS MENU AND MANIPULATES DATA FOR PROGRAM USE WITH THE GROUND AND DISC VORTEX OPTIONS******************************************************************************
PARAMETER(NUM = 15)
CHARACTER*1 OKLIST(NUM)
CHARACTER*1 CHDOL
CHARACTER*1 ICONT(5)
CHARACTER*12 PTSFIL(4)
CHARACTER*50 COMM(2)
CHARACTER*50 PROMPT
DIMENSION CONT(9),CONTV(7),CONTX(8)
COMMON /INPUTC/ ICONT,COMM,PTSFIL
COMMON /INPUTD/ CONT,CONTV,CONTX,YBDLAY
COMMON /UNITS/ IOU1,IOU4,IOU5,IOU6,IOU7,IOU8,IGRAPH
******************************************************************************
DATA OKLIST /' ','A','a','B','b','C' ,'c','D','d',
1 'E' ,'e' ,'F'
1 'G' ,'g'
CLEAR SCREEN AND HOME CURSOR
ICD = 0
20 CONTINUE
CALL HOMCLS(ICD)
CALL LOCATE(1,1)
WRITE(IOU1,10)
10 FORMAT(18X,'GROUND/DISK VORTEX INPUT DATA MENU',/,15X,'(FOR SINGLE MAIN ROTOR HELICOPTERS ONLY)',///,PARAMETER VALUE',WRITE(IOUl,11)
11 FORMAT(10X,'A ROTOR TIP SPEED ',5X,F8.2,
1 4X,'FPS',/,
2 10X,'B NUMBER OF ROTOR BLADES ',5X,F8.2,4X,'-ND-',/,
3 10X,'C TRANSLATIONAL SPEED ',5X,F8.2,4X,'KTS',/,
4 10X,'D XT POSITION ',5X,F8.2,4X,'FT',/,
5 10X,'E YT POSITION ',5X,F8.2,4X,'FT',/,
6 10X,'F ZT CALCULATION INCREMENT ',5X,F8.2,4X,'FT',/,
7 10X,'G MAXIMUM CALCULATION HEIGHT',5X,F8.2,4X,'FT',///)
INQUIRE, OBTAIN, AND CHECK FOR VALID MENU OPTION
40 CONTINUE
SUBROUTINE INPUTX

64          WRITE(IOU1, '(8X,A,$)')
65          ' ENTER DATA ENTRY CODE OR <RETURN> TO CONTINUE ==> '
66          C
67          READ(IOU1, '(A1)') CHDOL
68          C
69          IF(LEGAL(CHDOL, IOU1, OKLIST, NUM) .EQ.1) GOTO 40
70          C
71          IF(CHDOL.EQ.' ') GOTO 30
72          C
73          IF(CHDOL.EQ.'A'.OR.CHDOL.EQ.'a') THEN
74          C
75          PROMPT = 'ROTOR TIP SPEED = '
76          CALL FREAD(IOU1, PROMPT, CONTX(1), 1.0)
77          C
78          IF(CONTX(1).LT.0.0) CONTX(1) = 0.0
79          GOTO 20
80          C
81          ENDIF
82          C
83          IF(CHDOL.EQ.'B'.OR.CHDOL.EQ.'b') THEN
84          C
85          PROMPT = 'NUMBER OF ROTOR BLADES = '
86          CALL FREAD(IOU1, PROMPT, CONTX(2), 1.0)
87          C
88          IF(CONTX(2).LT.2.0) CONTX(2) = 2.0
89          GOTO 20
90          C
91          ENDIF
92          C
93          IF(CHDOL.EQ.'C'.OR.CHDOL.EQ.'c') THEN
94          C
95          PROMPT = 'TRANSLATIONAL SPEED = '
96          CALL FREAD(IOU1, PROMPT, CONTX(3), 1.0)
97          C
98          IF(CONTX(3).LT.0.0) CONTX(3) = 0.0
99          GOTO 20
100         C
101         ENDIF
102         C
103         IF(CHDOL.EQ.'D'.OR.CHDOL.EQ.'d') THEN
104         C
105         PROMPT = 'XT POSITION = '
106         CALL FREAD(IOU1, PROMPT, CONTX(4), 1.0)
107         GOTO 20
108         C
109         ENDIF
110         C
111         IF(CHDOL.EQ.'E'.OR.CHDOL.EQ.'e') THEN
112         C
113         PROMPT = 'YT POSITION = '
114         CALL FREAD(IOU1, PROMPT, CONTX(5), 1.0)
115         GOTO 20
116         C
117         ENDIF
118         C
119         IF(CHDOL.EQ.'F'.OR.CHDOL.EQ.'f') THEN
120         C
121         PROMPT = 'ZT CALCULATION INCREMENT = '
122         CALL FREAD(IOU1, PROMPT, CONTX(6), 1.0)
123         C
124         IF(CONTX(6).LT.0.0) CONTX(6) = 0.0
125         GOTO 20
126         C

E-56
SUBROUTINE INPUT

127      ENDIF
128      C
129      IF (CHDOL.EQ.'G' .OR. CHDOL.EQ.'g') THEN
130      C
131      PROMPT = 'MAXIMUM CALCULATION HEIGHT = '
132      CALL FREAD(IOU1,PROMPT,CONTX(7),1.0)
133      C
134      IF (CONTX(7).LT.0.0) CONTX(7) = 0.0
135      GOTO 20
136      C
137      ENDIF
138      C
139      GOTO 20
140      C
141      30 CONTINUE
142      C
143      ICD = 0
144      CALL HOMCLS(ICD)
145      C
146      RETURN
147      END
148      C
149

E-57
SUBROUTINE IOFNSH

   SUBROUTINE IOFNSH
   ***************************************************
   SUBROUTINE IOFNSH CLOSES FILES OPENED FOR DISK I/O
   ***************************************************
   COMMON / UNITS/ IOUl,IOU4,IOU5,IOU6,IOU7,IOU8,IGRAPH
   ****************************************************
   KEEP STANDARD I/O FILES IF ON DISK, ELSE DELETE
   ---------------------------------------------------
   IF(IOU5.EQ.5) CLOSE(IOU5,STATUS='KEEP')
   IF(IOU6.EQ.6) CLOSE(IOU6,STATUS='KEEP')
   RETURN
   END
SUBROUTINE IOINIT

***********************************************
SUBROUTINE IOINIT DISPLAYS THE OPENING BANNER
AND OPENS THE FILES FOR DISK I/O, FILENAMES
ARE PROMPTED FROM THE TERMINAL
***********************************************

CHARACTER*3 IPFILE,OPFILE
CHARACTER*1 TEMCHAR
COMMON / UNITS/ IOU1,IOU4,IOU5,IOU6,IOU7,IOU8,IGRAPH

***********************************************
ASSIGN DEFAULT VALUES TO I/O UNIT PointERS

-------------------------------
IOU1 = 0
IOU4 = 0
IOU5 = 0
IOU6 = 6
IOU7 = 0
IOU8 = 8
IGRAPH = 0

-------------------------------
HOME CURSOR AND CLEAR THE DISPLAY

-------------------------------
ICD = 0
CALL HOMCLS(ICD)

-------------------------------
DISPLAY BANNER

-------------------------------
CALL LOCATE(5,1)

ORIGINAL ROTHAZ PROGRAM WAS VERSION 1.0
FIRST VAX MENU VERSION OF ROTHAZ WAS VERSION 1.1
PROGRAM ROTWASH REPLACES ROTHAZ AT VERSION 2.0

-------------------------------
WRITE(IOU1,10)
10 FORMAT( 27X,'ROTWASH PROGRAM',//
1 /,17X,'ROTORCRAFT DOWNWASH HAZARD ANALYSIS',//
2 /,15X,'EMA / SYSTEMS CONTROL TECHNOLOGY',
3 /,15X,'*** PROGRAM VERSION 2.1, APRIL 1993 ***
4 ///////)

-------------------------------
WRITE(IOU1,'(A,$)')

-------------------------------
READ(IOU1,'(A1)') TEMCHAR

-------------------------------
HOME CURSOR AND CLEAR THE DISPLAY

E-59
SUBROUTINE IOINIT

64 ICD = 0
65 CALL HOMCLS(ICD)
66 CALL LOCATE(3,1)
67 C -----------------------------------------------
68 C PROMPT FOR I/O FILES AND READ USER RESPONSE
69 C -----------------------------------------------
70 C
71 C
72 WRITE(IOU1,12)
73 12 FORMAT(14X,' I/O CAN BE DIRECTED TO FILES OR DEVICES',//,
74 1 19X,' VALID DEVICES ARE AS FOLLOWS:',//,
75 2 22X,' <CON> => CONSOLE',//,
76 2 22X,' <PRN> => PRINTER',//,
77 4 22X,' <PLT> => GRAPHICS FILE',///)
78 C
79 16 CONTINUE
80 C
81 WRITE(IOU1,13)
82 13 FORMAT(16X,' ENTER INPUT FILE/DEV NAME ==> ',$/
83 11 FORMAT(A)
84 READ(IOU1,11) IPFILE
85 C
86 C -----------------------------------
87 C CHECK FOR DATA ENTRY ERROR
88 C -----------------------------------
89 IF(IPFILE.NE.'CON'.AND.IPFILE.NE.'con')THEN
90 WRITE(IOU1,15)
91 15 FORMAT(/,16X,'** INPUT ERROR, PLEASE REENTER **',//)
92 GOTO 16
93 ENDIF
94 C
95 C -------------------
96 C REDIRECT INPUT/OUTPUT FILES IF REQUESTED
97 C -------------------
98 IF(IPFILE.EQ.'CON'.OR.IPFILE.EQ.'con')IOUS IOU1
99 IF(OPFILE.EQ.'CON'.OR.OPFILE.EQ.'con')IOU6 = IOU1
100 IF(OPFILE.EQ.'PRN'.OR.OPFILE.EQ.'prn')IOU6 = 6
101 IF(OPFILE.EQ.'PLT'.OR.OPFILE.EQ.'plt')IGRAPH = 1
102 IF(OPFILE.EQ.'PLT'.OR.OPFILE.EQ.'plt')IOU6 = 8
103 C
104 C -------------------------
105 C OPEN STANDARD I/O FILES
106 C -------------------------
107 C
SUBROUTINE IOINIT

127 C IOU5 = STD. INPUT
128 C IOU6 = STD. OUTPUT
129 C ---------------
130 C IF(IOU5.EQ.5) OPEN(IOU5,FILE=IPFILE,STATUS='OLD')
131 C IF(IOU6.EQ.6) OPEN(IOU6,FILE=OPFILE,STATUS='NEW')
132 C ------------------
133 C HOME CURSOR AND CLEAR THE DISPLAY
134 C ------------------
135 C ICD = 0
136 C CALL HOMCLS(ICD)
137 C RETURN
138 C END
139 C
140 C
141 C
142 C
143 C
144 C

E-61
SUBROUTINE IPVEL

SUBROUTINE IPVEL(H, UN, RADIUS, UMB, XIP, YSEP, WSPD, DELZ, 
1, ZMAX, DXO, BDLAYM)

******************************************************************
SUBROUTINE IPVEL GENERATES THE VELOCITY PROFILE V(X,Z) AT 
XVZ ALONG THE INTERACTION PLANE FOR THE TWO ROTOR CASE 
******************************************************************

CHARACTER*1 TEMCHAR
CHARACTER*1 ICONT(5)
CHARACTER*1 KEY, KKEY
CHARACTER*12 PTSFIL(4)
CHARACTER*50 COMM(2)
DIMENSION ZZ(60), VHMF(60), VHMK(60), VHPF(60), VHPK(60), 
QHM(60), QHP(60), VVMF(60), VVMK(60), VVPF(60), 
VVPK(60), QVM(60), QVP(60)

COMMON / CKEY/ KEY, KKEY
COMMON /CONSTS/ PI, RHO, FPSKRN, RHOD2, DRC
COMMON /INPUTC/ ICONT, COMM, PTSFIL
COMMON /PROFIL/ R, ZBJ, ZHJ, ZMJ, UMJ, ZB, ZM, UM, CU, CY
COMMON /UNITS/ IOU1, IOU4, IOU5, IOU6, IOU7, IOU8, IGRAPH

******************************************************************
TF IS THE INTERACTION PLANE AMPLIFICATION FACTOR 
(ORIGINALLY DEVELOPED BY M. GEORGE IN USAAVLABS TR 68-52)

ORIGINAL EQUATION FOR TF FACTOR WAS:

TF = 1.55 - 0.55*EXP(-1.35*XIP)

REPLACED WITH MODIFIED EXPRESSION (SEE BELOW) DURING 
CORRELATION EFFORT OF MAY 1992 FOR VERSION 2.1

TF = 1.65 - 0.65*EXP(-0.5*XIP)

OBTAIN PARAMETERS AT BASE RADIUS FOR THE 'BOUNDARY LAYER'

RIP0 = SQRT(XIP**2 + YSEP**2)

'PROPRM' PROVIDES THE VELOCITY PROFILE PARAMETERS 
OF A RADIAL WALL JET (WITHOUT INTERACTION PLANE)

CALL PROPRM(H, UMB, RIP0)

ZIPB = ZB
ZIPM = ZM
ZIPH = ZH

RIPM = SQRT((XIP**2 + (YSEP + ZIPM)**2)

CALL PROPRM(H, UMB, RIPM)

E-62
SUBROUTINE IPVEL

UMM = UM

INCREMENT AND MAXIMUM HEIGHT ARE DELZ AND ZMAX

NPTS = IFIX(ZMAX/DELZ) + 2
IF(NPTS.GT.60) NPTS = 60

DIMENSIONALIZE VELOCITY PROFILE PARAMETERS

XXIP = RADIUS*XIP
ZPB = ZIPB*RADIUS
ZPH = ZIPH*RADIUS
ZPM = ZIPM*RADIUS

OUTPUT THE VELOCITY AND DYNAMIC PRESSURE PROFILE HEADER

ICD = 0
CALL HOMCLS(ICD)
IF(IOU6.NE.IOU1) WRITE(IOU6,"(1X,'1')")
IF(IOU6.EQ.6) WRITE(IOU6,93) COMM(l),COMM(2)

FORMAT( 10X,A50,/,10X A50,//)
XIPOUT = XXIP + DXO
WRITE(IOU6,1000) XIPOUT

1000 FORMAT( 2X,'TWIN ROTOR INTERACTION PLANE VELOCITY PROFILE',
'AT STATION=',F7.1,' FT',//)

WRITE(IOU6,1002)

1002 FORMAT( 2X,'HEIGHT',8X,'MEAN VELOCITY',7X,'PEAK VELOCITY',6X,
' MEAN Q',4X,'PEAK Q',3X,
' (FT)',5X,'(FPS)',6X,'(KN)',5X,'(KN)',5X,'(PSF)',5X,'(PSF)',//)

LINES = 0

'AN' IS ACTUALLY ' = 1.0/7.0'
AN = 0.142857142
CALCULATE THE VELOCITY PROFILE POINTS FOR OUTPUT
'NPTS' IS THE NUMBER OF VERTICAL STATION POINTS

DO 500 I = 1,NPTS

LINES = LINES + 2
ZIP = DELZ*FLOAT(I - 1)

GET MAX WALL JET VELOCITY AT EFFECTIVE RADIUS
SUBROUTINE IPVEL

--------------------------------------------------------------------------------
RIP = SQRT(XIP**2 + (YSEP + ZIP)**2)

CALL PROPRT(H,UMB,RIP)

VN = UN
VZ = UM

--------------------------------------------------------------------------------
INTERACTION PLANE 'BOUNDARY LAYER'
CODE MODIFIED IN MAY 1992 FOR USER SPECIFIED
MINIMUM BOUNDARY LAYER THICKNESS (BDLAYM)
--------------------------------------------------------------------------------
ZIP1 = BDLAYM
IF(ZIP.LT.ZIPL.OR.ZIP.LT.ZIP1)THEN
  IF(ZIPL.LT.ZIPM)THEN
    VZ = UMM*(ZIP/ZIPM)**AN
  ELSE
    VZ = UMM*(ZIP/ZIPL)**AN
  END IF
END IF

DEVELOPED INTERACTION PLANE JET
CONTAINS BOTH HORIZONTAL AND VERTICAL VELOCITY COMPONENTS
--------------------------------------------------------------------------------
VH = TF*VZ*XIP/RIP
VV = TF*VZ*(YSEP + ZIP)/RIP
ZZ(i) = ZIP*RADIUS
MEAN VELOCITIES (BOTH FT/SEC AND KNOTS)
--------------------------------------------------------------------------------
VHMF(i) = VH*UN
VVMF(i) = VV*UN
VHMF(i)/FPSPKN
VVMF(i)/FPSPKN
PEAK VELOCITIES (BOTH FT/SEC AND KNOTS)
EQUATION FOR VMFD3I UPDATED FROM 1st TO
2nd ORDER POLYNOMIAL FOR VERSION 2.1
VMFD3I = 0.712887 + 0.304369*XIP - 0.018496*XIP*XIP
IF(VMFD3I.LT.1.2) VMFD3I = 1.2
VHPF(i) = VMFD3I*VHMF(i)

--------------------------------------------------------------------------------

E-64
SUBROUTINE IPVEL

190 VVPF(I) = VMFD3I*VVMF(I)
191 VHPK(I) = VHPF(I)/FPSPKN
192 VVPK(I) = VVPF(I)/FPSPKN
193 C
194 IF(VVMF(I).EQ.0.)GOTO 55
195 C
196 C
197 C THE EFFECT OF WIND IS TO ADD (DOWNWIND SIDE) OR SUBTRACT (UPWIND SIDE) 'XWK' TIMES THE AMBIENT WIND VELOCITY TO THE HORIZONTAL PROFILE VELOCITY (EMPirical, CH-53E BASED)
198 C
199 C
200 C
201 C
202 XXW = (-0.5*H) + 2.5
203 C
204 IF(XXW.LT.1.0) XXW = 1.0
205 C
206 WSPD2 = WSPD*XXW
207 VHKM(I) = VHKM(I) + WSPD2
208 VHPF(I) = VHKM(I)*FPSPKN
209 VHPK(I) = VHPF(I) + WSPD2
210 C
211 C
212 C
213 C
214 C
215 C
216 C
217 C
218 QHM(I) = RHOD2*VHKM(I)**2
219 QVM(I) = RHOD2*VVMF(I)**2
220 QHP(I) = RHOD2*VHPF(I)**2
221 QVP(I) = RHOD2*VVPF(I)**2
222 C
223 C
224 C IF(LINES.LT.12)GOTO 450
225 C
226 LINES = 2
227 C
228 C
229 C
230 C
231 C
232 C
233 C
234 C
235 C
236 C
237 C
238 C
239 WRITE(IOU6,1003) ZZ(I), VHKM(I), VHPF(I), QHM(I), QHP(I)
240 * 1003 FORMAT ( F8.2,2X,'H',6F10.3)
241 C
242 C
243 C
244 C
245 C
246 C
247 WRITE(IOU6,1004) VVMF(I), VVPF(I), QVM(I), QVP(I)
248 * 1004 FORMAT ( 10X,'V',6F10.3)
249 C
250 C
251 C
252 C
SUBROUTINE IPVEL

253 C  ------------------------------------------------------
254 C  WRITE OUT GRAPHICS FILES IF SWITCH IS SET BY USER
255 C  ------------------------------------------------------
256 C  IF(IGRAPH.EQ.1)THEN
257 C  ------------------------------------------
258 C  OPEN GRAPHICS FILE
259 C  -----------------------
260 C  OPEN(IOU8,FILE=PTSFIL(2),STATUS='NEW',ERR=2000)
261 C  -----------------------
262 C  WRITE(IOU8,89) COMM(1),COMM(2)
263 C  89 FORMAT( 10X,A50,/,10X,A50,/) 
264 C  WRITE(IOU8,80) XIPOUT
265 C  80 FORMAT( IX,'TITLE="VELOCITY PROFILE, DAIP =',F5.1,' FT,]
266 C  * GW = xxxxx LB, WAGL = xx.xx FT"')
267 C  -----------------------
268 C  PRINT OUT MEAN VELOCITY, PEAK VELOCITY, AND PEAK
269 C  DYNAMIC PRESSURE PROFILES VERSUS PROFILE HEIGHT (AGL)
270 C  -----------------------
271 C  WRITE(IOU8,88)
272 C  88 FORMAT( IX,'VARIABLES = X,HT')
273 C  WRITE(IOU8,81)
274 C  81 FORMAT( IX,'ZONE T = "MEAN PROFILE, KTS", I=xx, F=POINT')
275 C  DO 82 I = 1,NPTS
276 C  WRITE(IOU8,83) VHMK(I),ZZ(I)
277 C  83 FORMAT( 1X,F6.1,1X,F6.2)
278 C  CONTINUE
279 C  WRITE(IOU8,84)
280 C  84 FORMAT( IX,'ZONE T = "PEAK PROFILE, KTS", I=xx, F=POINT')
281 C  DO 85 I = 1,NPTS
282 C  WRITE(IOU8,83) VHPK(I),ZZ(I)
283 C  85 CONTINUE
284 C  WRITE(IOU8,86)
285 C  86 FORMAT( IX,'ZONE T = "PEAK Q, PSF", I=xx, F=POINT')
286 C  DO 87 I = 1,NPTS
287 C  WRITE(IOU8,83) QHP(I),ZZ(I)
288 C  87 CONTINUE
289 C  CLOSE GRAPHICS FILE
290 C  -----------------------
291 C  CLOSE(IOU8,STATUS='KEEP')
292 C  -----------------------
293 C  ENDIF
294 C  CALL INKEY
295 C  GOTO 999
296 C  THE ERROR LOGIC ALLOWS FOR THE HANDLING OF FILE
297 C  OPEN ERRORS BY RETURNING THE USER TO A MENU
298 C  -----------------------
299 C  E-66
SUBROUTINE IPVEL

C 2000 CONTINUE
C CALL HOMECLS(0)
C WRITE(IOU1,2001)
C 2001 FORMAT( '*** ERROR *** PLEASE CHOOSE A NEW OUTPUT FILENAME',
  2     ' TYPE <RETURN> TO CONTINUE','$')
C READ(IOU1,'(A1)') TEMCHAR
C KEY = 'P'
C 999 CONTINUE
C RETURN
C END
SUBROUTINE IREAD

PARAMETER(LAST=50)

CHARACTER*50 PROMPT,SHOWIT
CHARACTER*15 ENTRY,BLANK

DATA BLANK /'

PROMPT USER FOR INTEGER ENTRY. FIND POSITION OF LAST NON-BLANK CHARACTER IN PROMPT, THEN STORE RIGHT JUSTIFIED IN SHOWIT

N = LAST + 1

IF(N.EQ.1)GOTO 20
N = N - 1
IF(PROMPT(N:N) .EQ.' ')GOTO 10

JS = LAST - N

WRITE(SHOWIT,' (50Al)') (' ',J=1,JS), (PROMPT(I:I),I=1,N)

NOW ASK USER FOR DATA ENTRY

WRITE(IOUl,'(/,1X,A,I3)') SHOWIT,IVALUE

WRITE(IOUl,'(/,8X, A,$)') 1 ' ENTER NEW VALUE OR <RETURN> TO LEAVE AS IS ==> '

READ(IOUl,'(/,A)') ENTRY
IF(ENTRY.EQ.BLANK)RETURN
READ(ENTRY,' (BN,I7)',ERR=30) ITEMP
IVALUE = ITEMP
RETURN
END
FUNCTION LEGAL(CHDOL, IOU1, OKLIST, NUM)

******************************************************************************
FUNCTION LEGAL DETERMINES IF THE VALUE FOR CHDOL IS A VALID INPUT. THIS VALUE IS CHECKED AGAINST THE LIST OF LEGAL VALUE IN ARRAY OKLIST(NUM)
******************************************************************************

CHARACTER*1 CHDOL, OKLIST(NUM)

******************************************************************************

LEGAL = 0
DO 10 I = 1, NUM
   IF(CHDOL.EQ.OKLIST(I)) RETURN
10 CONTINUE
LEGAL = 1
WRITE(IOU1,'(/,T9,A,A1,A/)') '*** ', CHDOL, ' IS NOT A VALID INPUT ***'
RETURN
END
SUBROUTINE LOCATE

SUBROUTINE LOCATE(IROW,ICOL)

**********************************************************************
SUBROUTINE LOCATE LOCATES THE CURSOR POSITION
**********************************************************************

COMMON / UNITS/ IOU1,IOU4,IOU5,IOU6,IOU7,IOU8,IGRAPH

CHARACTER*8 CUP
CHARACTER*1 ECUP(8)
EQUIVALENCE (CUP,ECUP(1))

CHARACTER*10 FMT
CHARACTER*1 EFMT(10)
EQUIVALENCE (FMT,EFMT(1))

DATA FMT /I ,"",A? / 

**********************************************************************
------------------------------------------------- ANSI CONTROL SEQUENCE: CUP = ESC('ROW';'COLUMN'
------------------------------------------------- IR1 = IROW/10
IR2 = IROW - IR1*10
IC1 = ICOL/10
IC2 = ICOL - IC1*10

ECUP(1) = CHAR(27)
ECUP(2) = CHAR(91)
IPOS = 3

IF(IR1.GT.0)THEN
ECUP(IPOS) = CHAR(IR1 + 48)
IPOS = IPOS + 1
END IF

ECUP(IPOS) = CHAR(IR2 + 48)
IPOS = IPOS + 1

ECUP(IPOS) = CHAR(59)
IPOS = IPOS + 1

IF(IC1.GT.0)THEN
ECUP(IPOS) = CHAR(IC1 + 48)
IPOS = IPOS + 1
END IF

ECUP(IPOS) = CHAR(IC2 + 48)
IPOS = IPOS + 1

ECUP(IPOS) = CHAR(72)
EFMT(7) = CHAR(IPOS + 48)

WRITE(IOU1,* ) CUP
RETURN
END
SUBROUTINE MOMENT

SUBROUTINE MOMENT(NPTS,HUMTYP,TOTF,TOTM)

******************************************************************************
SUBROUTINE MOMENT CALCULATES THE TOTAL OVERTURNING
FORCE AND MOMENT ON A MAN OR YOUNG PERSON AND PRINTS
OUT THE RESULTS.
******************************************************************************

CPAX DIMENSION PAXMAN(12)
CHARACTER*1 HUMTYP

COMMON /PERSON/ QP(12),DSET
COMMON /UNITS/ IOU1,IOU4,IOU5,IOU6,IOU7,IOU8,IGRAPH

******************************************************************************
IN THE SUBROUTINE TO CALCULATE FORCES AND MOMENTS:
"CDP" IS THE COEFFICIENT OF DRAG OF THE PERSON:
CDP = 1.1 FOR HAZARD ANALYSES
CDP = 1.0 FOR CORRELATION WITH NATC FLIGHT TEST DATA
"WIDTHP" IS THE WIDTH OF THE PERSON WHERE:
WIDTHP IS 'L' TYPE IF 1.1 FT
WIDTHP IS 'S' TYPE IF 0.7 FT

WIDTHP = 1.1
CDP = 1.1

******************************************************************************
INITIALIZE AREAS FOR NATC MAN FROM ROTORWASH FLIGHT TESTS
(UNITS ARE FEET2)

CPAX CDF = 1.1
CPAX PAXMAN(1) = 0.41
CPAX PAXMAN(2) = 0.37
CPAX PAXMAN(3) = 0.365
CPAX PAXMAN(4) = 0.42
CPAX PAXMAN(5) = 0.5425
CPAX PAXMAN(6) = 0.685
CPAX PAXMAN(7) = 0.8
CPAX PAXMAN(8) = 0.845
CPAX PAXMAN(9) = 0.7875
CPAX PAXMAN(10) = 0.625
CPAX PAXMAN(11) = 0.3
CPAX PAXMAN(12) = 0.00625

******************************************************************************
INITIALIZE INTEGRATION STEP SIZE AND ZERO SUMMATION VARIABLES

DELZZ = 0.5
TOTM = 0.0
TOTF = 0.0

******************************************************************************
CHOOSE HUMAN SIZE TYPE

******************************************************************************

E-71
SUBROUTINE MOMENT

IF(HUMTYP.EQ.'S')THEN
  WIDTHP = 0.7
  NPTS = 8
END IF

C INTEGRATE DYNAMIC PRESSURE PROFILE OVER THE HEIGHT OF THE PERSON CHOSEN

DO 10 J = 1,NPTS

C FOVER = QP(J)*DELZZ*WIDTHP*CDP
CPAX FOVER = QP(J)*PAXMAN(J)*CDP
ZZ = 0.5*(J - 1) + 0.25
OVERM = FOVER*ZZ
TOTF = TOTF + FOVER
TOTM = TOTM + OVERM
C PRINT OUT RESULTS
IF(DSET.NE.0.)GOTO 10
WRITE(IOU6,20) ZZ,QP(J),FOVER,OVERM,TOTF,TOTM
20 FORMAT( F8.2,5(2X,FL0.3))
C
10 CONTINUE
RETURN
END

E-72
SUBROUTINE PROPRM

** SUBROUTINE PROPRM(H,UMB,RVZ) **

** ****************************************************************** **

SUBROUTINE PROPRM

THIS SUBROUTINE CALCULATES THE VELOCITY PROFILE V(R,Z)
PARAMETERS OF THE RADIAL WALL JET FOR THE NON-INTERACTING ROTOR CASE

****************************************************************** **

C COMMON /PROFIL/ RJ,ZBJ,ZHJ,ZMJ,UMJ,ZB,ZH,ZM,UM,CU,CY

****************************************************************** **

IF(RVZ.GE.RJ)GOTO 600

RVZ LT. RJ ==>

TRANSITION REGION EQUATIONS, EMPIRICALLY APPLIED BY JDK PRIOR TO VERSION 2.1, WERE SIGNIFICANTLY IMPROVED BY THE FOLLOWING CHANGES FOR V2.1 IN MAY 1992.

OLD OR REPLACED EQUATIONS:

UM = UMJ*RVZ
IF(RVZ.GT.1.0) UM UMJ
ZH = ZHJ*RVZ
IF(RVZ.GT.1.0) ZH ZHJ
ZM = ZMJ*RVZ
IF(RVZ.GT.1.0) ZM ZMJ

UM = UMJ*(RVZ/RJ)**0.5

----------------------------------------------

BOUNDARY GROWTH IN TRANSITION REGION
SEE NOTE ABOVE

OLD OR REPLACED EQUATIONS:

ZBO = 1.5
IF(H.LT.1.5) ZBO = H
ZH = (ZH0 - ZHJ)/RJ**2*(RJ - RVZ)**2 + ZHJ

----------------------------------------------

ZBO = H**0.5
ZH0 = ZBO/2.5
ZH = (ZH0 - ZHJ)/RJ**2*(RJ - RVZ)**1.5 + ZHJ
ZB = 2.5*ZH
ZM = 0.33*ZH

GOTO 700

---------------------------------------------

RVZ LT. RJ ==>

DEVELOPED WALL JET REGION

E-73
SUBROUTINE PROPRM

SEVERAL COEFFICIENTS IN THE GROWTH EQUATIONS WERE MODIFIED IN MAY 1992 FOLLOWING THE CORRELATION EFFORT (SEE NOTES IN SUBROUTINE WALJET FOR DETAILS).

OLD EQUATIONS:

\[
\begin{align*}
U_M &= C_U \cdot R V Z^{-1.143} \cdot U M B \\
Z_H &= C_Y \cdot R V Z^{1.028} \\
Z_M &= 0.1944 \cdot Z_H
\end{align*}
\]

----------------------------------------

\[
\begin{align*}
U_M &= C_U \cdot R V Z^{-1.0} \cdot U M B \\
Z_H &= C_Y \cdot R V Z^{1.0} \\
Z_B &= 2.8 \cdot Z_H \\
Z_M &= 0.28 \cdot Z_H
\end{align*}
\]

----------------------------------------

600 CONTINUE

RETURN

END
SUBROUTINE VLINE

******************************************************************

SUBROUTINE VLINE

THIS SUBROUTINE APPLIES THE BIOT-SAVART LAW TO
CALCULATE THE VELOCITY INDUCED BY A LINE VORTEX

XA,YA,ZA = STARTING POINT OF VORTEX
XB,YB,ZB = ENDING POINT, OR DIRECTION POINTER
XC,YC,ZC = TARGET POINT WHERE VELOCITY IS INDUCED

IFI = 0  VORTEX IS FINITE, FROM POINT A TO POINT B
IFI = 1  VORTEX IS SEMI-INFINITE FROM POINT A THROUGH B

******************************************************************

COMMON /CONSTS/ PI,RHO,FPSPKQ,RHOD2,DRC
COMMON /CVLINE/ IFI,XA,YA,ZA,XB,YB,ZB,XC,YC,ZC,Q1,Q2,Q3

******************************************************************

A = (XA-XC)**2 + (YA-YC)**2 + (ZA-ZC)**2
B = 2.0*( (XA-XB)*(XC-XA) + (YA-YB)*(YC-YA) + (ZA-ZB)*(ZC-ZA) )
C = (XA-XB)**2 + (YA-YB)**2 + (ZA-ZB)**2

Cl = (XC-YB)*ZA + (YA-YC)*ZB + (YB-YA)*ZC
C2 = (ZC-ZB)*XA + (ZA-ZC)*XB + (ZB-ZA)*XC
C3 = (XC-XB)*YA + (XA-XC)*YB + (XB-XA)*YC

Q = 4.0*A*C - B**2

CHECK FOR COLINEAR TARGET POINT

QB = 0.0
IF(ABS(Q) .LT. 1.0E-06) GOTO 100

FINITE LENGTH VORTEX

QB = 1.0/Q*((2.0*C + B)/SQRT(A + B + C) - B/SQRT(A))/2.0/PI
ENDIF

SEMI-INFINITE VORTEX

QB = 1.0/Q*(2.0*SQRT(C) - B/SQRT(A))/2.0/PI
ENDIF

100 CONTINUE
SUBROUTINE VLINE

64 C
65 C VELOCITY COMPONENTS
66 C
68 C1 = C1*QB
69 C2 = C2*QB
70 C3 = C3*QB
71 C
72 RETURN
73 END
74 C
SUBROUTINE WALJET(H,UB,UN,UMB)

*****************************************************************
C SUBROUTINE WALJET
C THIS SUBROUTINE CALCULATES THE STARTING POSITION OF THE WALL JET AND GROWTH PARAMETERS FOR WALL JET DECAY
C*****************************************************************
C C COMMON /CLOUDK/ QSMAX
C COMMON /PROFIL/ RJ,2BJ,2HJ,2MZJ,UNJ,2ZJ,2M,UM,CU,CY
C COMMON /UNITS/ IOU1,IOU4,IOU5,IOU6,IOU7,IOU8,IGRAPH
C*****************************************************************
C C Initialization of exponents
C CZM, the profile peak velocity location, was increased from the Glauert value (0.1944) to the present value based on data and assumptions presented in FAA report for version 2.1, May 1992. The other coefficients were modified when it was demonstrated that correlation was improved with both model and flight test data.

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>VALUE FOR V2.1</th>
<th>BEFORE V2.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXU</td>
<td>-1.0</td>
<td>-1.143</td>
</tr>
<tr>
<td>EXY</td>
<td>1.0</td>
<td>1.028</td>
</tr>
<tr>
<td>CZM</td>
<td>0.28</td>
<td>0.1944</td>
</tr>
<tr>
<td>QSMAX0</td>
<td>1.077</td>
<td>1.0</td>
</tr>
</tbody>
</table>

(SEE NOTE BELOW)

C ITERATE TO FIND INITIAL RADIUS OF WALL JET, RJ
TOL = 1.0E-05
RJ = 2.0
QSMAX0 = 1.077
DO 100 I=1,20
C Calculation of equivalent jet length
TR = H + (RJ - 1.0)
TDE = 0.707*TR

E-77
SUBROUTINE WALJET

OLD TR 68-52 EQUATIONS:

QSMAX0 = 1.0
QSMAX = QSMAX0 + (0.6 - QSMAX0)/16.0*TDE**2

IF(TDE.LE.4.0)
QSMAX = 2.4/TDE

RJNEW COEFFICIENTS ROUNDED OFF DURING MAY 1992 CORRELATION
EFFORT WHICH PRODUCED IMPROVED RESULTS WHEN SIMPLIFICATIONS
WERE INTRODUCED

OLD EQUATION:

RJNEW = 2.508078*(UB/UM)**(0.486)

----

RJNEW = 2.5*(UB/UM)**(0.5)

IF(ABS(RJNEW - RJ).LE.TOL)GOTO 200

RJ = RJNEW

100 CONTINUE

WRITE(IOU1,10)
10 FORMAT('***********************************************',/
127 '1','ITERTIONS EXCEEDED FOR WALL JET INITIAL RADIUS',/
306 '2','***********************************************')

STOP

200 CONTINUE

RJ = RJNEW

101 C

200 CONTINUE

RJ = RJNEW

104 C

VELOCITY GROWTH FUNCTION CONSTANTS

TWO CONSTANTS WERE ROUNDED OFF TO SIMPLIFY THE FOLLOWING
TWO EQUATIONS DURING THE CORRELATION EFFORT OF MAY 1992
FOR VERSION 2.1

OLD EQUATIONS:

UMB = ((0.3586*RJ**EXM*(UM*UN)*(UB*UN)**(0.14))**(0.88))/UN
ZHJ = 0.654/(UM/UMB)**2/RJ

UMB = ((0.36*RJ**EXM*(UM*UN)*(UB*UN)**(0.14))**(0.88))/UN
ZHJ = 0.65/(UM/UMB)**2/RJ
CU = UM/UMB*RJ**(-EXU)
CY = ZHJ*RJ**(-EXY)

MAX VELOCITY AND BOUNDARY PARAMETERS AT RJ

E-78
SUBROUTINE WALJET

127 C
128 UMJ = CU*RU**2*EXU*UMB
129 ZHJ = CY*RU**2*EXY
130 ZHJ = CMZ*ZHJ
131 ZBJ = CBZ*ZHJ
132 C
133 RETURN
134 END
135 C
SUBROUTINE WJVEL

SUBROUTINE WJVEL(H,UN,UMB,RVZ,RADIUS,WSFD,DELZ,ZMAX,DXO,BDLAYM)

*******************************************************
SUBROUTINE WJVEL GENERATES THE VELOCITY PROFILE V(R,Z)
AT RVZ FOR THE NON-INTERACTING ROTOR CASE
*******************************************************

CHARACTER*1 TEMCHAR * 
CHARACTER*50 COMM(2)

DIMENSION ZZ(60),VMF(60),VMK(60),VPF(60),VPK(60),QM(60),QP(60)

COMMON /CKEY/ KEY,KKEY
COMMON /INPUTC/ ICONT,COMM,PTSFIL
COMMON /PROFIL/ RJ,ZBJ,ZHJ,ZMJ,UMJ,ZB,ZH,ZM,UM,CU,CY
COMMON/ UNITS/ IOU1,IOU4,IOU5,IOU6,IOU7,IOU8,IGRAPH

*******************************************************
'PROPRM' PROVIDES THE VELOCITY PROFILE PARAMETERS
OF A RADIAL WALL JET (WITHOUT INTERACTION PLANE)
-------------------------------------------------------

CALL PROPRM(H,UMB,RVZ)

DIMENSIONALIZE VELOCITY PROFILE PARAMETERS
---------------------------------------------

RRVZ = RADIUS*RVZ
ZZB = ZB*RADIUS
ZZH = ZH*RADIUS
ZZM = ZM*RADIUS
ZETAH = ZH/ZB
ZETAM = ZM/ZB

OUTPUT THE VELOCITY AND DYNAMIC PRESSURE PROFILE HEADER
--------------------------------------------------------

ICD = 0
CALL HOMCLS(ICD)
IF(IOU6.NE.IOU1) WRITE(IOU6,'(1X,A50,/,1X,A50,/,1X,A50,/)')
IF(IOU6.EQ.6) WRITE(IOU6,93) COMM(1),COMM(2)
93 FORMAT( 10X,ASO,/,10X,ASO:///)

RVZOUT = RRVZ + DXO
WRITE(IOU6,1000) RVZOUT
1000 FORMAT( 9X,'SINGLE ROTOR VELOCITY PROFILE AT RADIUS = ', 1 F7.1,' FT',/) 
WRITE(IOU6,1001) ZZB,ZZH,ZZM

E-80
SUBROUTINE WJVEL

1001 FORMAT( 15X,'PROFILE BOUNDARY HEIGHT = ',F7.2,' FT',/)
1 15X,'HALF-VEL. HEIGHT = ',F7.2,' FT',/)
2 15X,'MAX-VEL HEIGHT = ',F7.2,' FT',/)

67 C
68 C INCREDENTS AND HEIHT ARE FROM DELZ AND ZMAX
70 C
71 C NPTS = IFIX(ZMAX/DELZ) + 1
72 C
73 C BOUNDARY LAYER REGION EXPONENT
74 C 'AN' IS ACTUALLY = 1.0/7.0
75 C
76 C AN = 0.142857142
77 C
78 C SHEAR LAYER REGION EXPONENT, TO MEET EDGE CONDITIONS
79 C (FROM FIGURE 7, USAVLABS TECHNICAL REPORT 68-52, JULY 1968)
80 C
81 C ALPW = ALOG(1.0 - 1.0/SQRT(2.0))/ALOG((ZH - ZM)/(ZB - ZM))
82 C
83 C VN = UN
84 VMN = UM
85 C
86 C CALCULATION OF THE NON-DIMENSIONALIZED MINIMUM ALLOWED
87 C BOUNDARY LAYER THICKNESS SO THAT THE BOUNDARY LAYER CAN
88 C BE ADJUSTED IF THE ZM POSITION IS PHYSICALLY TOO LOW
89 C (BDLAYM, IN FEET, COMES FROM A MENU INPUT PARAMETER)
90 C
91 C ZETA1 = BDLAYM/ZB

96 C
97 C OUTPUT THE VELOCITY AND DYNAMIC PRESSURE PROFILE HEADER
98 C
99 C WRITE(IOU6,1005)
100 C 1005 FORMAT( 2X,'HEIGHT',5X,'MEAN VELOCITY',7X,'PEAK VELOCITY',6X,
101 C 'MEAN Q',4X,'PEAK Q',/)
102 C 2 3X,'(FT)',5X,'(FPS)',6X,'(KN)',5X,'(PSF)',/)
103 C 3 X,'(PSF)',5X,'(PSF)',/)
104 C
105 C CALCULATE THE VELOCITY PROFILE POINTS FOR OUTPUT
106 C
107 C LINES = 0
108 C
109 C DO 500 I = 1,NPTS
110 C
111 C LINES = LINES + 1
112 C
113 C Z = DELZ*FLOAT(I - 1)
114 C
115 C IF(ZETA.LT.ZETAM.OR.ZETA.LT.ZETA1)THEN
116 C
117 C Z IS WITHIN BOUNDARY LAYER
118 C
119 C E-81
SUBROUTINE WJVEL

NOTE THAT THE BOUNDARY LAYER CALCULATIONS NOW USE
THE MINIMUM THICKNESS PARAMETER AND THE PEAK TO
MEAN VELOCITY PARAMETER IS THE MAXIMUM VELOCITY

VZM = 0.0

IF(ZETAM.GT.0.0) THEN

VZM = (ZETA/ZETAM)**AN

IF(ZETA1.GT.ZETAM) THEN

VZM1 = (1.0 - ((ZETA1 - ZETAM)/(1.0 - ZETAM)))**ALPW)**2

VZM = VZM1*(ZETA/ZETA1)**AN

ENDIF

VMTOPK = 1.04653 + 0.373894*RVZ - 0.0422525*RVZ*RVZ

IF(VMTOPK.LT.1.2) VMTOPK = 1.2

ENDIF

GOTO 400

ELSE

Z IS WITHIN SHEAR LAYER

THE PEAK TO MEAN VELOCITY RATIO EQUATIONS ARE
SUBSTANTIALLY IMPROVED OVER THOSE USED PRIOR TO
MAY 1992. EQUATIONS ARE NOW USED FOR BOTH THE
MAXIMUM VELOCITY HEIGHT (ZM) AND THE 1/2 VELOCITY
HEIGHT (ZH). VALUES BETWEEN ARE INTERPOLATED AND
VALUES ABOVE ZH USE THE ZH RATIO*(ZETA/ZETAH).
THESE 2nd ORDER EQUATION SUBSTANTIALLY IMPROVED
CORRELATION WITH MODEL AND FLIGHT TEST DATA
DURING THE MAY 1992 EFFORT FOR V2.1.

VZM = 0.0

IF(Z.LE.ZB) THEN

VZM = (1.0 - ((ZETA - ZETAM)/(1.0 - ZETAM))**ALPW)**2

IF(ZETA.GE.ZETAH) THEN

VMTOPK = (1.48086 + 0.569177*RVZ - 0.0692514*RVZ*RVZ)

*(ZETA/ZETAH)

IF(VMTOPK.LT.1.2) VMTOPK = 1.2

ELSE

VMPKMX = 1.04653 + 0.373894*RVZ - 0.0422525*RVZ*RVZ

VMPK12 = 1.48086 + 0.569177*RVZ - 0.0692514*RVZ*RVZ

FRAC = (ZETA - ZETAM)/(ZETAH - ZETAM)

E-82
SUBROUTINE WJVEL

IF(ZETA1.GT.ZETAM) THEN
  FRAC = (ZETA - ZETA1)/(ZETAH - ZETA1)
END IF

VMTOPK = FRAC*VMPK12 + (1.0 - FRAC)*VMPKMX
IF(VMTOPK.LT.1.2) VMTOPK = 1.2
END IF

CONTINUE

VZN = VZN*VMN

DIMENSIONAL HEIGHT

ZL(I) = Z*RADIUS

MEAN VELOCITIES

VMF(I) = VZN*VN
VMK(I) = VMF(I)/FPSPKN

PEAK VELOCITIES

VPF(I) = VMF(I)*VMTOPK
VPK(I) = VPF(I)/FPSPKN
IF(VPK(I).EQ.0.0) GOTO 55

THE EFFECT OF WIND IS TO ADD (DOWNWIND SIDE) OR SUBTRACT (UPWIND SIDE) 'XWK' TIMES THE AMBIENT WIND VELOCITY TO
THE HORIZONTAL PROFILE VELOCITY (EMPIRICAL, CH-53E BASED)

XKW = (-0.5*H) + 2.5
IF(XKW.LT.1.0) XKW = 1.0

WSPD2 = WSPD*XKW
VMK(I) = VMK(I) + WSPD2
VMF(I) = VMK(I)*FPSPKN
VPK(I) = VPK(I) + WSPD2
VPF(I) = VPK(I)*FPSPKN
CONTINUE

DYNAMIC PRESSURE
SUBROUTINE WJVEL

QM(I) = RHOD2*VMF(I)**2
QP(I) = RHOD2*VPF(I)**2

IF(IOU6.EQ.IOU1) THEN
    IF(LINES.LT.12) GOTO 450
    LINES = 1
    CALL INKEY
    IF(KEY.NE.'C') GOTO 999
    WRITE(IOU6,1005)
    END IF
CONTINUE

WRITE(IOU6,1002) ZZ(I),VMF(I),VMK(I),VPF(I),VPK(I),QM(I),QP(I)
FORMAT( F8.2,6F10.3)
CONTINUE

WRITE OUT GRAPHICS FILES IF SWITCH IS SET BY USER

IF(IGRAPH.EQ.1) THEN
    OPEN GRAPHICS FILE
    OPEN(IOU8,FILE=PTSFIL(I),STATUS='NEW',ERR=2000)
    WRITE(IOU8,89) COMM(I),COMM(2)
    FORMAT( 10X,A50,/,10X,A50,//)
    WRITE(IOU8,80) RVZOUT
    FORMAT( 1X,'TITLE="VELOCITY PROFILE, DFRC =',F5.1,' FT, GW = xxxxx LB, WAGL = xx.x FT"')
    PRINT OUT MEAN VELOCITY, PEAK VELOCITY, AND PEAK DYNAMIC PRESSURE PROFILES VERSUS PROFILE HEIGHT (AGL)
    WRITE(IOU8,88)
    FORMAT( 1X,'VARIABLES = X,HT')
    WRITE(IOU8,81)
    FORMAT( 1X,'ZONE T = "MEAN PROFILE, KTS", I=xx, F=POINT')
    DO 82 I = 1,NPTS
        WRITE(IOU8,83) VMK(I),ZZ(I)
        FORMAT( 1X,F6.1,1X,F6.2)
    CONTINUE
    DO 85 I = 1,NPTS
        WRITE(IOU8,84)
        FORMAT( 1X,'ZONE T = "PEAK PROFILE, KTS", I=xx, F=POINT')
        DO 82 I = 1,NPTS
            WRITE(IOU8,83) VPK(I),ZZ(I)
        CONTINUE

E-84
SUBROUTINE WJVEL

85 CONTINUE

86 WRITE(ION8,86)

87 FORMAT( 1X,'ZONE T = "PEAK Q, PSF", I-xx, F=POINT')

88 DO 87 I = 1,NPTS

89 WRITE(ION8,83) QP(I),ZZ(I)

90 CONTINUE

91 C

92 C C C C C

93 C

94 C

95 C C C C C C

96 E-85

2000 CONTINUE

2001 FORMAT( '///,8X,' *** ERROR *** PLEASE CHOOSE A NEW OUTPUT FILENAME' ,

2002 ' ///,8X,' TYPE <RETURN> TO CONTINUE ',S)

2003 READ(ION1,'(A1)') TEMCHAR

2004 KEY = 'P'

2005 C

2006 999 CONTINUE

2007 C

2008 999 RETURN

2009 C

2010 END