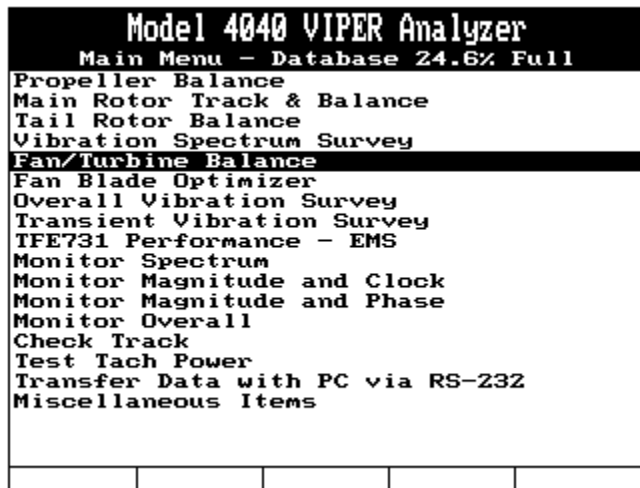

Chapter 7

Fan/Turbine Balance

and Fan Blade Optimizer

(Revision 3.01, Aug 2007)

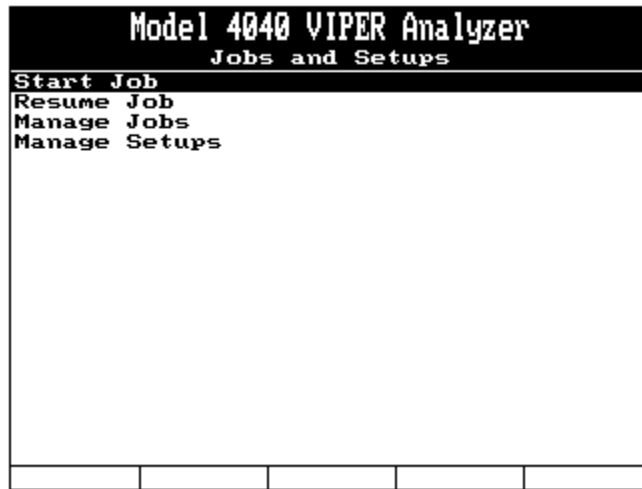
“Fan/Turbine Balance” is an analyzer function that is accessed from the analyzer’s Main Menu banner screen as shown in the illustration below. Selecting this function from the main menu brings up the “Jobs and Setups” banner screen menu (also shown below). Each of the listings on this banner screen menu is an option within the function. Descriptions of each of these options follow, along with the information required to complete the menu screens within the options, and the steps necessary to perform the fan balance function.



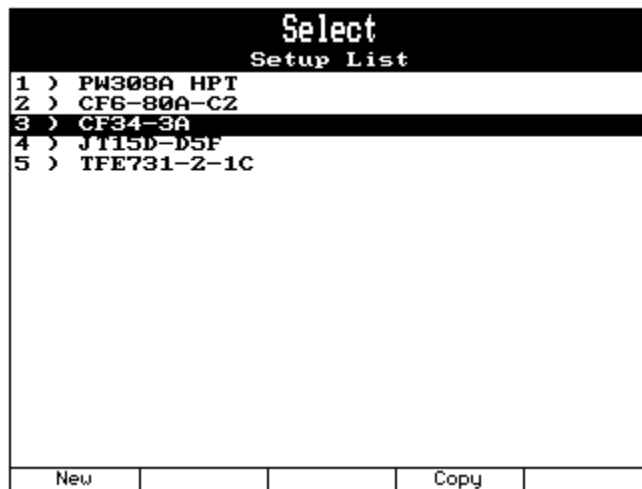
7.1 – Fan/Turbine Balance

- 7.1.1. Start Job. Selecting “Start Job” from the “Jobs and Setups” banner screen allows you to begin a new fan trim balance job. When you select this option, one of three screens will appear depending on whether you are: 1) Starting a new job with no fan setups previously defined in the analyzers memory; 2) Starting a new job with

previously defined fan setups available in the analyzers memory; or 3) Resuming an incomplete fan job being held in the analyzer's memory.



7.1.2. Setup List. *If you are starting a new job with previously defined setups available in the analyzer's memory, the screen will automatically display the Select Setup List banner screen similar to the one shown below. The actual setup names will be those which you have entered into your analyzer.*



7.1.3. Fan/Turbine Balance Setup Screen. *If you are starting a new job with no setups previously defined in the analyzer's memory, the screen will automatically display the Fan/Turbine Balance Setup banner screen shown below. See paragraph 7.1.6 for step-by-step instructions on completing the Fan/Turbine Balance Setup.*

Model 4040 VIPER Analyzer	
Fan/Turbine Balance Setup	
Name :	<input type="text"/>
Eng Rotation:	<input type="text" value="CCW"/>
Num Baln Planes:	<input type="text" value="1"/>
Num Optional Planes:	<input type="text" value="0"/>
Balance Wt Type:	<input type="text" value="Class"/>
Num Class Wt Sets:	<input type="text" value="1"/>
Label Detail Wts:	<input type="text" value="No"/>
Baln Weight Unit:	<input type="text" value="g"/>
Num Sens / Eng:	<input type="text" value="1"/>
Num Baln Speeds:	<input type="text" value="1"/>
Slow Roll RPM:	<input type="text" value="0"/>
Min Baln RPM:	<input type="text" value="5000"/>
Actual RPM @ 100%:	<input type="text" value="10000"/>
Vib Unit:	<input type="text" value="IPS"/>
Modifier:	<input type="text" value="Peak"/>

- 7.1.4. **Incomplete Job.** *If you are resuming an incomplete job being held in the analyzer's memory, the opportunity to do so is presented immediately following the "Start Job" selection. The screen displays the message as shown below. If you press the [F1] "Yes" key, the analyzer will return you to the last logical in-progress step of the job. If you press the [F5] "No" key, the analyzer will proceed as described in the two examples above, depending on your circumstances.*

Model 4040 VIPER Analyzer	
Incomplete Job	
<p>The last job performed is incomplete.</p> <p>Do you want to RESUME work on it?</p>	
Yes	No

- 7.1.5. **Fan/Turbine Balance Setup.** The "Fan/Turbine Balance Setup" banner screen allows you to define and store a Fan/Turbine Balance Setup. The "Fan/Turbine Balance Setup" banner screen displays fill-in and selection fields. The fill-in fields have squared off ends ([]). These fields are filled in using inputs from the analyzer keypad. The selection fields have pointed ends (<>). These fields have two or more preset values that are selected by using the [=>] and [=<] keys. Navigate between the fields on this screen using the [↓] and [↑] keys. (Refer to Chapter 3, "Using the Model 4040 Viper Analyzer" if you are unfamiliar with using the keypad or inputting data.)

Complete the “Fan/Turbine Balance Setup” screen per the following example.

- 7.1.6. Complete the Fan/Turbine Balance Setup. To complete the “Fan/Turbine Balance Setup” banner screen (as shown below), do the following:

```
Model 4040 VIPER Analyzer
Fan/Turbine Balance Setup
Name: CF34-3A
Eng Rotation: CCW Viewed From: FLA
Num Baln Planes: 1
Num Optional Planes: 2
Balance Wt Type: Class
Num Class Wt Sets: 3
Label Detail Wts: No
Baln Weight Unit: g
Num Sens/Eng: 1
Num Baln Speeds: 3
Slow Roll RPM: 0
Min Baln RPM: 6000
Actual RPM @ 100%: 7400
Vib Unit: mils Modifier: Pk-Pk
```

- 7.1.6.1. In the “Name” field, enter a name for this setup using the keypad. (Refer to Chapter 3, “Using the Model 4040 Viper Analyzer” if you are unfamiliar with using the keypad.) The name you choose will aid you in differentiating this setup from other stored setups should you choose to use, review, or print it at a later time. The name should be one of your choosing which will be easily recognized and associated with this setup such as “Citation 10,” “Lear 45,” or “CF34-3A”.
- 7.1.6.2. Using the [↓] key, move down to the “Eng Rotation” field. Use the [⇒] to select the direction of engine rotation. The choices in this field are CW for clockwise or CCW for counter clockwise.
- 7.1.6.3. Using the [↓] key, move to the “Viewed From:” field. This field is used to define the Engine Rotation perspective. The two available perspectives are <FLA> (Forward Looking Aft) and <ALF> (Aft Looking Forward). The <FLA> perspective is determined by standing in front of the engine and noting the direction the fan rotates as viewed looking back into the intake. The <ALF> perspective is determined by noting the direction the fan/turbine rotates as viewed from behind the fan/turbine looking forward out of the intake.
- 7.1.6.4. Using the [↓] key, move to the “Num Baln Planes” field. Use the [⇒] key to select the total number of rotational balance planes on this engine type.
- 7.1.6.5. Using the [↓] key, move to the “Num Optional Planes” field. Use the [⇒] key to select the total number of optional rotational balance planes on this engine type. An optional plane is usually one which you may move to and continue balancing when attempts to balance on the primary balance plane do not yield the desired results.

- 7.1.6.6. Using the [↓] key, move to the “Balance Wt Type:” field. The balance weight type is a description of the balance weights for this application. Use the right arrow key to select from Actual, Class, or Both. Class weights are balance weights designed specifically for use with the engine. Class weights usually have a part number for the set and a designation for each weight in the set. Weights are fixed values for each individually designated weight. Actual means the weights are not designed specifically for the engine, such as standard AN washers or slug weights. The weights are designated as units of measure (grams or ounces) in the solution offered by the analyzer rather than a specific class weight by name.
- 7.1.6.7. Using the [↓] key, move to the “Num Class Wt Sets” field. Use the [⇒] key to select the total number of class weight sets available for use on this engine. If you choose a number here, be prepared to define each class weight on the next screen.
- 7.1.6.8. Use the [↓] key to move to the “Label Detail Wts:” field. Detail weights are those weights that are installed at the factory and cannot be removed. If these weights occupy positions normally used for trim balancing, you may label those occupied positions so that the balance solution will be calculated disregarding those locations.
- 7.1.6.9. Use the [↓] key to move to the “Baln Weight Unit:” field. Use the [⇒] key to select “g” for grams or “oz” for ounces. You will use this unit of measurement to define your class weight set. If using Actual Weights, this defines the units of measure in which the balance solution will be presented.
- 7.1.6.10. Move to the “Num Sens / Eng:” field using the [↓] key. Select the number of sensors you will use on each engine by using the [⇒] key to scroll between the selections. This selection will define total number of sensors being used on each engine for the balance job.
- 7.1.6.11. Move to the “Num Baln Speeds” field using the [↓] key. Use the [⇒] key to select the number of actual speeds (1 to 9) or Sel. In Job. The “Sel in Job” selection in this field will allow you to choose the number of balance speeds as well as the actual speeds themselves in the job. If you always use the same number of speeds and the same speeds to balance this engine, you should select that number of balance speeds here. If the number of speeds can vary with each job using this setup, select the option of “Sel in Job”.
- 7.1.6.12. Move to the “Slow Roll RPM” field by using the [↓] key and use the numeric keys to enter a Slow Roll RPM for this balance job. If no entry is required, leave this field at 0. A Slow Roll RPM may be required when using proximity probes. With these probes you may encounter a phenomenon known as runout. Runout occurs as a result of the physical properties of some shafts. The Slow Roll RPM is used to identify what the actual signal is, and then these measured values are subtracted from all subsequent vibration measurements.
- 7.1.6.13. Move to the “Min Baln RPM:” (minimum balancing speed) field by using the [↓] key. Enter the minimum speed, in RPM, that may be used for this balance setup.

-
- 7.1.6.14. Move to the “Actual RPM @ 100%” field by using the [↓] key. Use the numeric keypad to enter the actual RPM of the fan or turbine being balanced at 100% of its allowable speed.
- 7.1.6.15. Move to the “Vibe Unit:” field by using the [↓] key. Using the [⇒] key, select the engineering units used for this balance setup. Refer to the LMM if you are not familiar with the vibe unit used for this application.
- 7.1.6.16. Using the [↓] key, move to the “Modifier” field. Using the [⇒] key, select the modifier used for this balance setup. Refer to the LMM for verification of required engineering units and modifier to be used for this application. The Vib (engineering) Unit and Modifier are used in conjunction with one another to express a value as in “Mils Pk-Pk, gs RMS, or IPS Peak”. Refer to the LMM if you are not familiar with the modifier used for this application.
- 7.1.6.17. Use the [↓] key to move to the “Solution Iterations:”. The Solution Iterations field is used for varying the weights for the least squares. 1 means take the straight LSQ solution (minimize RMS vib), more than one means adjust the weighting to minimize worst case vib. Solution Iterations only appears when the “Num Baln Planes” in paragraph 7.1.6.4 above is greater than 1.

When all fields are completed as required, press [ENTER] to proceed.

- 7.1.6.18. If you selected a number of balance speeds in paragraph 7.1.6.11 above, the “Fan/Turbine Balance Speeds” banner screen will be displayed. If you selected “Select in Job”, go to paragraph 7.1.7. The number of speeds (Num Baln Speeds:) line will display the number entered in step 7.1.6.11. Press the [↓] key to move the cursor to the “Balance Relative to Defined Peak Speed?” field. The field will be highlighted and defaulted to the “No” answer as illustrated in the first screen below. With the “No” answer displayed, the entered speeds are not relative to the highest peak vibration. In this case, press the [↓] key to move to the “Enter Speeds As N% or Defined RPM” field and enter the speed(s) determined from the fan survey or LMM. You may enter the speed(s) as an actual RPM or %.

If the speeds are to be entered based on a vibration survey and relative to the highest peak encountered, use the key to toggle the answer to “Yes” in the “Entered RPM Relative to Peak:” field. Press the [↓] key and a new field “Peak Speed:” will appear as shown in the second screen below. Use the keypad to enter the speed at which the highest amplitude peak occurred in the fan survey. Press the [↓] key to move to the “Enter Speeds As N% or Defined RPM” field and enter the variance in speed relative to the Peak Speed entered. For instance, if the Peak speed was entered as “90” indicating 90% RPM, you might enter three speeds in the example screen below as “-1”, “0”, and “1” to indicate speeds of 89, 90, and 91 % respectively.

- 7.1.6.19. Use the [↓] key to move to the toggle field at the bottom of the screen. This field gives you the option to use the Actual Speeds acquired during the first run as the target speeds for all subsequent runs OR use the speeds defined on this screen as the target for ALL runs. Use the [⇒] key to make your selection.

When all fields are completed and set per your requirements, press [ENTER] to accept and continue.

Model 4040 VIPER Analyzer	
Fan/Turbine Balance Speeds	
Num Balance Speeds: 3	
Balance Relative to Defined Peak Speed?	
<input checked="" type="radio"/> No	
Enter Speeds As N% or Defined RPM	
Spd	All Sensors
1	89.0
2	90.0
3	91.0
Use Actual Speeds for Later Runs	

Model 4040 VIPER Analyzer	
Fan/Turbine Balance Speeds	
Num Balance Speeds: 3	
Balance Relative to Defined Peak Speed?	
<input checked="" type="radio"/> Yes Peak Speed: 90.0	
Enter Speeds As N% or Defined RPM	
Spd	All Sensors
1	-1.0
2	0.0
3	1.0
Use These Speeds for ALL Runs	

- 7.1.7. Define Class Weights. The “Define Class Wts” banner screen (if class weight is selected in item 7.1.6.6) will be displayed. To define a class weight set, do the following:

Model 4040 VIPER Analyzer
Define Class Wts

Set ID: MaxErr:

Num Wts: Placement:

Name	Wt	Span	Name	Wt	Span
(The min wt must be a base wt)					
P07	0.000	1			
P01	3.400	1			
P02	6.800	1			
P03	10.20	1			
P04	13.60	1			
P05	17.00	1			
P06	20.80	1			

- 7.1.7.1. In the “**Set ID**” field, use the keypad to enter a name or part number for the class weight set you are about to define. The Set ID should be one that is recognizable and commonly used by everyone who will be using this setup to balance.
- 7.1.7.2. Use the [↓] key to move to the “**MaxErr:**” field. Use the numeric keypad to enter a number that will be used to determine the maximum amount of error between the suggested solution and the available class weight placement combination. The lower this number, the closer the two solutions will match, but the longer it may take to generate a solution during the solution process.
- 7.1.7.3. Use the [↓] key to move to the “**Num Wts:**” (number of weights) field. Use the numeric keypad to enter a number corresponding to the total number of different weights in this class weight set.
- 7.1.7.4. Use the [↓] key to move to the “**Placement**” field. Use the [⇒] key to select from “Continuous” or “Spread”. Selecting “Continuous” will tell the analyzer to match the suggested solution as closely as possible while keeping the installed weights in consecutive positions. Selecting “Spread” will allow the analyzer to insert empty weight positions between weights, as needed, in an attempt to match the suggested solution.
- 7.1.7.5. Use the [↓] key to move to the “**Name**” field. Use the keypad to enter a name or part number to identify each weight in the class weight set.
- 7.1.7.6. Use the [↓] key to move to the “**Wt**” (weight) field. This field defines the exact weight of the individual class weights in the adjacent “Name” field. The unit of measure is that which you defined in item 7.1.6.9 above. Note that just above the Name, Wt, and Span fields, is the statement “The min wt must be a base wt”. This means that the smallest defined class weight in this table must be a base weight. A base weight is one that may be used to occupy a position when an actual balance weight is not required. It may also be the smallest available weight in the class weight set or have a weight value of 0. Normally, if this weight is required to occupy each location not containing a trim balance weight, its weight value should be 0.

- 7.1.7.7. Use the [↓] key to move to the “**Span**” field. This field defines the number of positions or weight mounting locations that will be occupied by this class weight.
- 7.1.7.8. Complete a Name, Wt, and Span field for each of the available fields until the chart is filled. If you find that you have specified too few or too many class weights, use the [↓] key to place the cursor in the “Num Wts:” field and adjust the number accordingly. The number of available fields will be changed per this input. If you have specified more than one class weight set for this setup in item 7.1.6.7 above, another Define Class weight screen will be displayed, such as the two screens below, when you press [ENTER] to store the current screen and continue. Repeat section 7.1.7.1 through 7.1.7.8 for each additional class weight set. If you have specified only one class weight set for this setup, Press [ENTER] and go to item 7.1.8.

Model 4040 VIPER Analyzer
Define Class Wts

Set ID: 3024T53PXX MaxErr: 0.10
 Num Wts: 6 Placement: (Spread)

Name	Wt	Span	Name	Wt	Span
(The min wt must be a base wt)					
BOLT	0.000	1			
P01	6.100	1			
P02	7.000	1			
P03	8.000	1			
P04	9.000	1			
P05	10.00	1			

Model 4040 VIPER Analyzer
Define Class Wts

Set ID: 4096T45PXX MaxErr: 0.10
 Num Wts: 11 Placement: (Spread)

Name	Wt	Span	Name	Wt	Span
(The min wt must be a base wt)					
P01	0.000	1			
P02	1.000	1			
P03	2.000	1			
P04	3.000	1			
P05	4.000	1			
P06	5.000	1			
P07	6.000	1			
P08	7.000	1			
P09	8.000	1			
P10	9.000	1			
P11	10.00	1			

- 7.1.8. Balance Plane Information Setup. To complete the “Balance Plane Information” setup screen(s), as shown below, do the following:

```
Model 4040 VIPER Analyzer
Balance Plane Information

Plane: (1)
Posn Type: (Position)
Num Positions: 28
Num Usable: 15
RivetWt: 0.000
Radius: 10.0
Spacing: (Even)
Position Num Dir: (CCW) from (FLA)
MaxWt/Position: 5.000
MaxWt/Plane: 25.00
Wt Set: (911M35PXX)
Trial Wt: 5.00
Angle of #1 Posn: 0
```

- 7.1.8.1. In the “**Plane:**” field, use the [=] key to select the identifying number for the first balance plane information. You will complete one of these information screens for each balance plane as defined in item 7.1.6.4 or 7.1.6.5 above. If you defined only one balance plane, you will only complete one balance information screen.
- 7.1.8.2. Use the [↓] key to move to the “**Posn Type:**” field. This field will define the terminology used to refer to the weight locations throughout the balance job. The choices in this field are <Position>, <Hole> or <Blade>. After you exit this field the remaining references will change to the selected term. Consequently, the fields described in these instructions are identified generically as “Position”. Your screen will display the actual term you selected in this field.
- 7.1.8.3. Use the [↓] key to move to the “**Num Positions:**” (number of weight positions) field. Use the numeric keypad to enter a number equal to the total number of positions where balance weights may be attached for this balance plane only.
- 7.1.8.4. Use the [↓] key to move to the “**Num Usable:**” field. Use the numeric keypad to enter a number that will define the maximum number of positions that can be used for installing weight on a single run.
- 7.1.8.5. Use the [↓] key to move to the “**RivetWt:**” field. Use the numeric keypad to enter a value for the weight in grams or ounces (as defined in item 7.1.6.9 above) of any attaching hardware used to secure the balance weight to the balance plane.
- 7.1.8.6. Use the [↓] key to move to the “**Radius**” field. This field will only appear if an optional balance plane is identified in paragraph 7.1.6.5 above. Use the numeric keypad to enter a value defining the radius of the weight locations on this balance plane.
- 7.1.8.7. Use the [↓] key to move to the “**Spacing:**” field. Use the [=] key to select “Even” or “Uneven”. Your selection is based on the equal or unequal spacing between all

positions. An Even setting is used when each individual position is spaced the same relative to all adjacent positions. The Even selections will automatically assign an angle to each position number based the other information you provide in this screen. Any unequal spacing of even a single position dictates that you use the Uneven setting. If using the Uneven setting, an additional screen displaying a table will be displayed when you leave this screen. You must define each position angle and its sequential number on the next screen as shown in paragraph 7.1.8.14.

- 7.1.8.8. Use the [↓] key to move to the “**Position Num Dir:**” (position numbering direction) field. Use the [⇒] key to select either CW for clockwise or CCW for counter clockwise. The direction is based on the order of ascending value or increasing numbers.
- 7.1.8.9. Pressing the [↓] key will move the cursor to the “**from**” field to the right of the “**Position Num Dir:**” field. Use the [⇒] key to select the perspective used to view the direction of the position numbering. The two available perspectives are <FLA> (Forward Looking Aft) and <ALF> (Aft Looking Forward). The <FLA> perspective is determined by standing in front of the engine and noting the direction the position numbers increase as viewed looking back into the intake. The <ALF> perspective is determined by noting the direction the position numbers increase as viewed from behind the fan/turbine looking forward out of the intake.
- 7.1.8.10. Use the [↓] key to move to the “**MaxWt/Position**” (maximum weight per position) field. Enter a numeric value to define the maximum total number of grams or ounces (as defined in item 7.1.6.9 above) allowed for installation at any one individual position.
- 7.1.8.11. Use the [↓] key to move to the “**MaxWt/Plane**” (maximum weight for this balance plane) field. Enter a numeric value to define the maximum total number of grams or ounces (as defined in item 7.1.6.9 above) allowed for installation on this balance plane. This is the total of all weight at all individual positions on this plane.
- 7.1.8.12. Use the [↓] key to move to the “**Wt Set:**” (weight set) field. If you defined only one weight set in section 7.1.6.7 above, that weight set name will appear in this field and your only possible choice. If you defined more than one weight set, use the [⇒] key to select one of the previously defined sets.

NOTE

If more than one set of class weights is available for this balance plane, you must select, and use ONLY one of the class weight sets for the balance plane. DO NOT MIX CLASS WEIGHTS.

- 7.1.8.13. Use the [↓] key to move to the “**Trial Wt**” field. Use the numeric keypad to enter a weight in grams or ounces (as defined in item 7.1.6.9 above) for the analyzer to use as a trial weight in the first balance run. This trial weight will only be used if an Influence Coefficient is not stored in the setup.
- 7.1.8.14. If you selected “Even” position spacing in paragraph 7.1.8.7 above, use the [↓] key to move to the “**Angle of #1 Posn**” field. Use the keypad to enter the angular location of the first weight position as viewed from the perspective selected in

paragraph 7.1.8.9 above. Determine the angle by rotating the fan to align the tachometer pickup and its triggering device (magnetic interrupter, reflective tape, etc.). With the fan in this position, use the 12:00 position as the “0” or “360 degrees” (index point) and measure opposite the direction of rotation to the angle of position number 1. For example, if the #1 hole is at the 3:00 position (simply as viewed on the face of a clock from the perspective selected in paragraph 7.1.8.9 above) and the engine rotates counterclockwise, the angle would be 90 degrees. If the #1 hole is at the 3:00 position and the engine rotates clockwise it would be 270 degrees. The measurement to position # 1 must always be measured opposite the direction of rotation. If the angle of position #1 is unknown, enter “0”. After entering the angle of the #1 position, press [ENTER] to continue.

Model 4040 VIPER Analyzer					
Balance Plane Information					
Ang	No.	Ang	No.	Ang	No.
0	1	125	11	250	21
12	2	137	12	262	22
25	3	150	13	275	23
37	4	162	14	288	24
50	5	175	15	300	25
62	6	188	16	312	26
75	7	200	17	325	27
88	8	212	18	337	28
100	9	225	19		
112	10	237	20		

If you selected “Uneven” in step 7.1.8.7 above, the “Angle of #1 Posn:” field will not be displayed, but when you press [ENTER] the multiple angle/position number fields are displayed as shown in the example above. Each position angle must be defined individually. Using the keypad, complete each field by entering a position number (“No.”) and its corresponding angular (“Ang”) location as measured opposite the direction of fan rotation as viewed from the perspective selected in paragraph 7.1.8.9 above. Use the [↓] and [↑] keys to move between these fields. To determine these values, do the following. Rotate the fan to align the tachometer pickup and its triggering device (magnetic interrupter, reflective tape, etc.). With the fan in this position, use the 12:00 position as the “0” or “360 degrees” (index point) and measure opposite the direction of rotation to the angle of each position number and record that angle adjacent to the position number. For example, if the number 1 position is near the 6:00 position, the angle may be measured as 174 degrees. On the screen, use the keypad to enter the angle of position number 1 as “174.” Then, using the [↓] key to move to the adjacent field (“No.”), input the number “1.” Next, measure to position number 2. If position number two is measured as 156 degrees, enter that value and “2” in the adjacent field. Continue this process until all angles for all positions are defined. The measurement must always be opposite the direction of rotation of the fan maintaining the perspective selected in paragraph 7.1.8.9 above.

Continue entering Balance Plane Information for all planes described in paragraph(s) 7.1.6.4 and 7.1.6.5 above.

7.1.9. Complete the “Sensor Information” screen as follows:

7.1.9.1. In the Eng ID: (engine identification) use the numeric keypad to enter the number of the engine. Press the [↓] key to move to the next field.

7.1.9.2. Use the [⇒] to select the Tach Chan (tachometer channel) you will use for this job. Be sure the channel you select here is the channel you actually connect the tachometer-input signal to when setting up the equipment. Press the [↓] key to move to the next field.

Sensor Type	Cha Desc	Pos	Targ
797V	A	12	2.100

7.1.9.3. Use the [⇒] key to select the “**Tach Type:**” The analyzer will process the signal of several tooth types as well as tachometer generators and optical sensors. Optical sensors include the Phototach and Lasetach. Press the [↓] key to move to the next field.

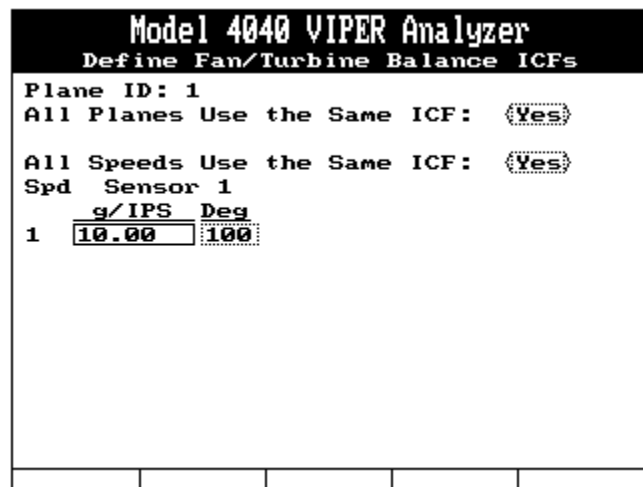
7.1.9.4. Use the [⇒] to select “**Tach Pos (FLA):**” (Tachometer position, from Forward Looking Aft). This is the clock position where the tachometer triggers during the fan rotation as viewed from forward of the engine looking aft into the intake. The selections are in whole hours from 1 to 12. If you are unsure of the location of the tach trigger event, use the [⇒] key to select “UNK”. Press the [↓] key to move to the next field.

7.1.9.5. Use the [⇒] key to select the “**Full Scale Vibration**”. This should be the highest amplitude of vibration you would reasonably expect to see during a typical balance job. This value should be enough above the maximum allowable vibration for the engine so that any amplitude in excess of that limit can be readily seen. Use the [↓] key to move to the next field.

7.1.9.6. Use the [⇒] key to select the “**Sensor Type**” you will use for this balance. If the sensor you intend to use is not among those listed, see Chapter 18, Miscellaneous

Items, paragraph 18.1.2 on setting up a new sensor. Use the [↓] key to move to the next field.

- 7.1.9.7. Use the [=] key to select the “Ch” (Channel A, B, C, or D) where you will connect the sensor input from the vibration sensor in this same row. Use the [↓] key to move to the next field.
- 7.1.9.8. Use the keypad to enter a name in the “Desc” field. The name should reflect the source, location, or other common attribute of this sensor input. Some suggestions are FRONT, REAR, VERT, HORIZ, or FFV, FFH. Use the [↓] key to move to the next field.
- 7.1.9.9. In the “Pos” field, use the [=] key to select the clock position of the sensor on the engine as viewed from forward of the engine looking into the intake. Use the [↓] key to move to the next field.
- 7.1.9.10. Use the keypad to enter a value in the “Targ” field. The value will define the point where the analyzer provides a suggestion to terminate the balance job. When all fields are complete, press ENTER to accept and continue.
- 7.1.10. The define “Fan/Turbine Balance ICFs” screen is shown below. Use the [=] to toggle the YES / NO answer field to indicate if you wish to use the same influence coefficient for all planes. If using a single balance plane, this option will not be presented. Use the [=] to toggle the YES / NO answer field to indicate if you wish to use the same influence coefficient for all speeds. If using a single speed balance, this option will not be presented. Use the [↓] key to move to the next field. Enter an established or calculated influence for this setup from the keypad. In the “(Balance weight units)/(Vib units)” field, enter the units of weight, grams or ounces as designated in the setup, required to reduce one engineering unit of vibration to the lowest possible level. In the “Deg” field, enter the phase correction in degrees. If you have selected multiple planes or sensors, repeat these steps for the next screens. When all fields are complete per your requirements, press [ENTER] to accept and continue.



- 7.1.11. **Job Identification Screen.** The Job Identification screen will be displayed where you may enter the optional information of Name, A/C Registration and AC/Total Time. Complete each field as necessary using the analyzer keypad. If Names have previously been entered in this analyzer, you may optionally press the [F1] “Names” key and select a name from the stored list of names. When all fields are complete per your requirements, press [ENTER] to accept and continue.

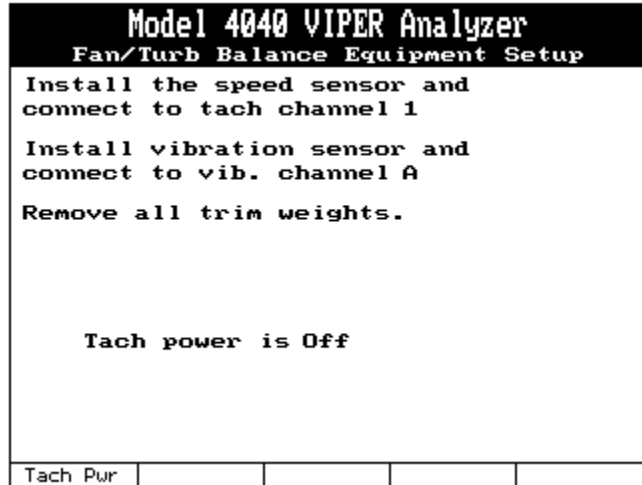
Model 4040 VIPER Analyzer				
Job Identification				
Name: <input type="text" value="Joan Jet"/>				
A/C Registration: <input type="text" value="N123JJ"/>				
A/C Total Time: <input type="text" value="1625"/>				
Press ENTER to continue				
Names				

- 7.1.12. **Engine Information.** The Engine Information screen will be displayed where you may enter the optional information of Position, Engine S/N, Type, TSO, TSN, Cyc. Complete each field as necessary using the analyzer keypad. If Serial Nos have previously been entered in this analyzer, you may optionally press the [F1] “Serial Nos” key and select a serial number from the stored list of serial numbers. When all fields are complete per your requirements, press [ENTER] to accept and continue.

Model 4040 VIPER Analyzer				
Engine Information				
Position: <input type="text" value="1"/>				
Engine:				
S/N <input type="text"/>				
Type <input type="text"/>				
TSO <input type="text" value="0"/>				
TSN <input type="text" value="0"/>				
Cyc <input type="text" value="0"/>				
Serial Nos				

- 7.1.13. **Fan/Turbine Balance Equipment Setup.** The Fan/Turbine Balance Equipment Setup banner screen, shown below, will be displayed. Install the speed sensor, vibration sensor, and cables as indicated. Near the center of the screen, the

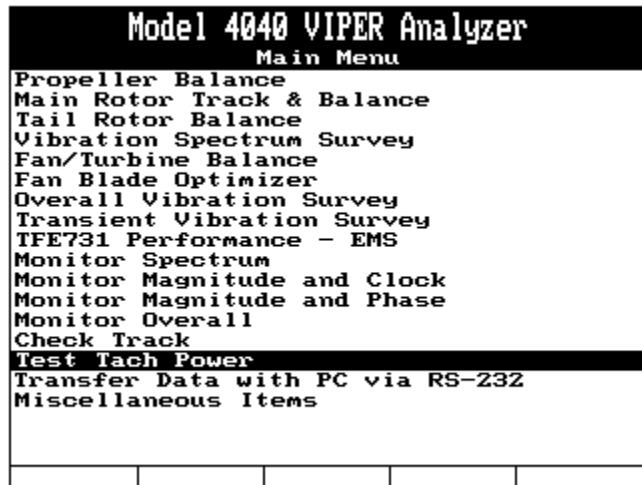
information message “Tach power is off” will be displayed. This indicates that power to the optical tachometer is currently not available to check alignment with the reflective target. If you wish to do the alignment at this point, press the [F1] “Tach Pwr” key to provide power to the optical tachometer being used. When all installations and connections are made, and tachometer checks completed as necessary, press [ENTER] to accept settings and exit this screen.



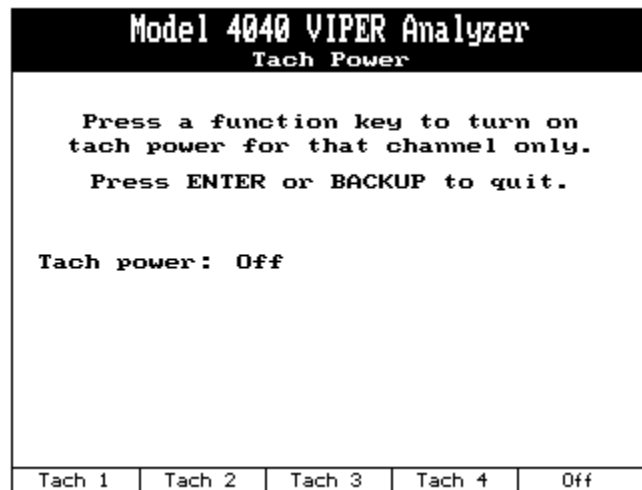
NOTE

The option to turn tach power on or off using the [F1] function key is for tachometer alignment only and will not affect the tachometer’s operational condition, regardless of selection, once this screen is exited.

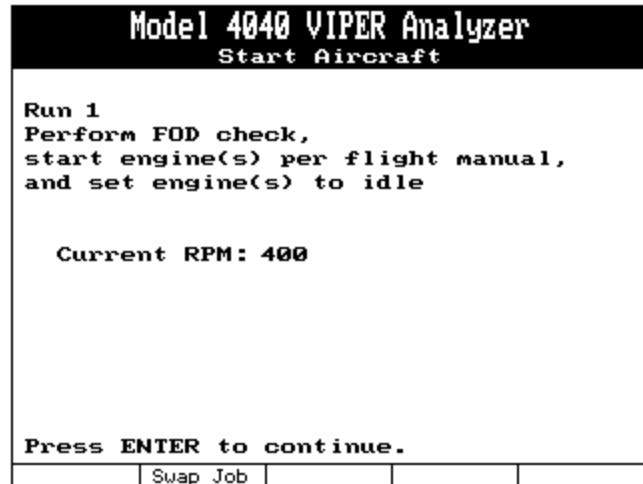
7.1.14. The Tach Power may also be checked from the Main Menu option “Test Tach Power” as shown below. Highlight the “Test Tach Power” item and press [ENTER] to access the “Tach Power” screen.



- 7.1.14.1. Each function key on the “Tach Power” screen corresponds to a Tach channel. By pressing the corresponding function key, power will be routed to that tach channel for testing or alignment purposes. Only one tach channel can be powered at a time. The powered tach will be identified following the “Tach Power:” statement. To turn off power to any tach channel press [F5] “Off”. Exit the “Tach Power” screen by pressing [ENTER] or [BACKUP]. Tach power will automatically be turned off to all channels when the screen is exited.



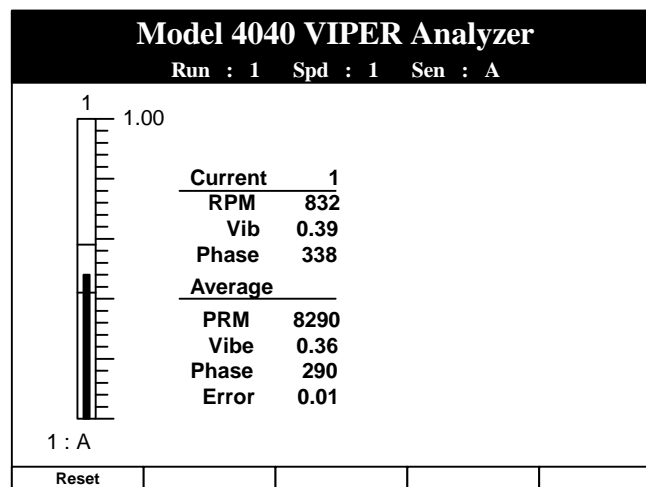
- 7.1.15. Start Aircraft. The “Start Aircraft” banner screen, shown below, will be displayed with several informational messages. The Run number indicates which run of the balance job is currently being collected. The second line states “Perform FOD check, start engine(s) per flight manual, and set engine(s) to idle.” Before starting the engine, make sure all previously installed trim balance jobs have been removed. On some engines, there may be detail or factory installed weights, which must not be removed. Check the LMM prior to removing weights if you are not familiar with this engine and the balancing procedures. Start the engine using normal procedures and allow the engine to warm up to normal operating temperatures. When warm up is complete, allow the engine to stabilize at speed, make any minor adjustments as necessary, then press [ENTER] to continue. Use the [F2] “Swap Job” key to return directly to the Main Menu without rebooting the analyzer.



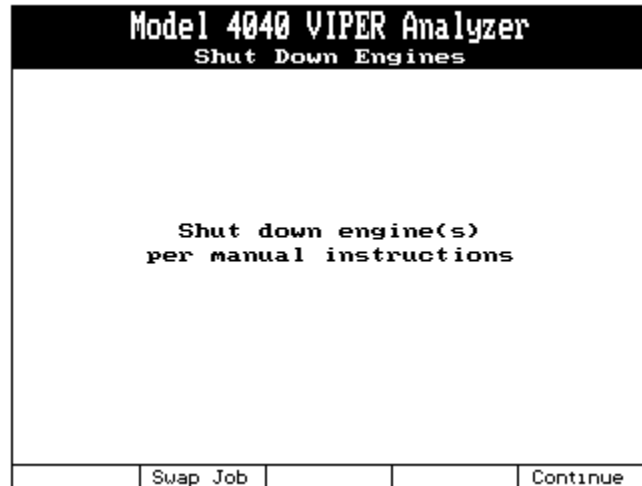
- 7.1.16. Data Acquisition. A data acquisition screen similar to the one shown below will be displayed. If you are unfamiliar with reading this screen, see Chapter 20 of this manual, “Reading Spectrum and Scales”. Allow the analyzer to average the acquired data until the indications are stable. The term STABLE is used here to indicate that the Average indications are not widely fluctuating and that the Error indication is as low as possible and not increasing. Press [F1] “Reset”, to clear the averaged data to this point and begin the averaging process anew or press [ENTER] to stop the acquisition and proceed.

NOTE

While collecting data, if the amplitude is high, the Error number will decrease toward and possible to 0.00 very rapidly. This indicates the numbers of errors in the indication are averaged out. As the amplitude is decreased in the balancing process on subsequent runs, the Error indication may not drop as rapidly and will most likely not reach a 0.00 reading because the amplitude is so low. In lower amplitude situations, watch for the Error indication to be stable as an indication of acceptable data rather than waiting for it to decrease further.



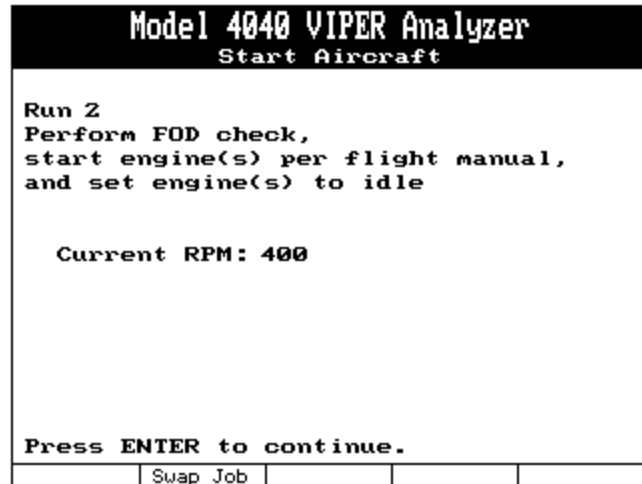
- 7.1.17. **Shut Down Engines.** The screen will display the message “Shut Down engine(s) per flight manual instructions”. Press [F2] “Swap Job” to return directly to the Main Menu without rebooting the analyzer. Press the [F5] “Continue” key to acknowledge the message and shut down the engine(s).



- 7.1.18. **Review Prior Run(s) Data.** The Review Prior Run(s) Data screen, shown below, will be displayed showing the RPM, Vib (amplitude) and Deg (phase angle) collected on all runs up to this point. Pressing the [←] or [→] keys will allow you to navigate through the readings from all runs of the current job. Use the text on the first line to determine the run number. Review as necessary then either press [F1] to retake data, or press [ENTER] to accept and continue.



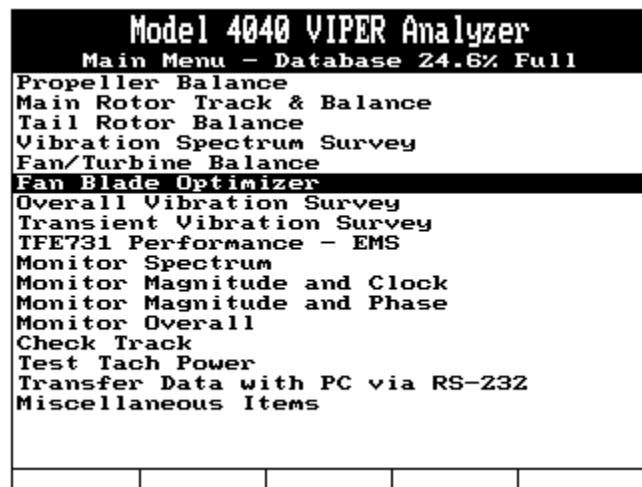
- 7.1.19. The Fan/Turbine Suggested /Installed Wts screen will be displayed. If this is the first suggested weight screen, the weights will be test weights unless an established influence was entered in the setup. Notice at the top of the screen that the message “Remove Old Wts” is shown. All previously installed weights must be removed EACH TIME a new solution is installed. This means that weights installed on the

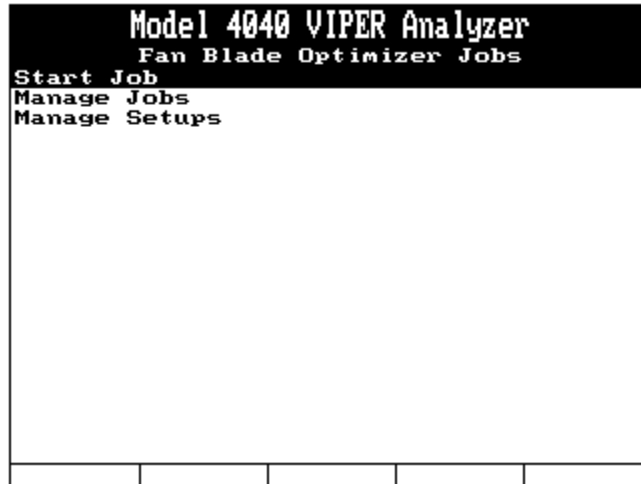


7.2. Fan Blade Optimizer

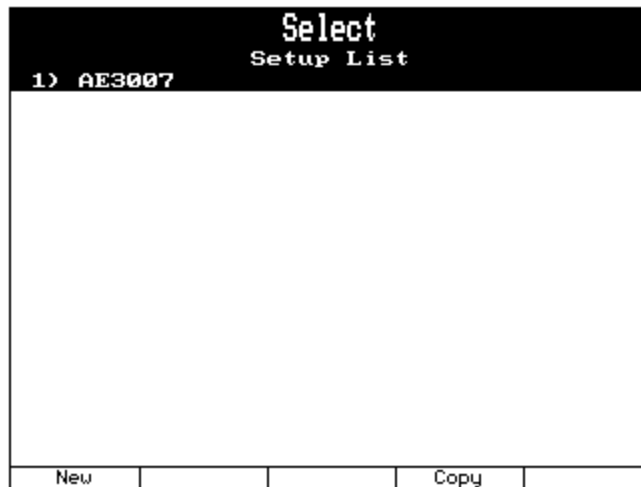
The Fan Blade Optimizer is an accessory program that is activated with the licensing of the Fan/Turbine Balance option in the analyzer. Fan Blade optimizer allows you to remove a single blade from a fan disk then enter the weight moment information for the new blade and all other blades currently installed on the disk. The program will shuffle the entire set and display a new placement location for each blade in the set to attain the best possible balance through weight distribution. This negates the necessity for changing matched pairs of blades when one of the blades is not damaged and still serviceable. The program is not limited by the number of new blades that can be combined with the remaining serviceable blades in a set. To use the Fan Blade Optimizer, proceed as follows:

- 7.2.1. Start Job: From the Fan Blade Optimizer Jobs, use the [↑] or [↓] keys as necessary to select “Start Job” and press [ENTER].





- 7.2.2. Select Setup List. If a Blade Optimizer setup has previously been entered for the engine model you are currently working, you may select it from the Select, Setup List as illustrated in the screen sample below and proceed to step 7.2.4. If your engine model is not listed, press the [F1] “New” key and proceed to step 7.2.3. If no setups were previously entered, the analyzer will open a new setup screen. If this is the case, go to step 7.2.3 below.



- 7.2.3. In the Fan Blade Optimizer Setup screen, shown below, use the [↓] key to move from field to field and complete the screen as follows
- 7.2.3.1. In the **Name:** field, use the analyzer keypad to enter a name for this setup. The engine model is usually a good choice for this name.
- 7.2.3.2. In the **Number of Blades:** field, use the analyzer keypad to enter the total number of blades on the disk. The field will accept values from 5 to 99.

- 7.2.3.3. In the **Blade Num Style:** Use the [=] key to select the numbering style you would prefer to use for this setup. The choices are <A – Z>, which will allow up to 26 blades, or <B1 – B99> which will allow up to 99 blades in a set. This numbering style is how you will identify each blade in the set for weight and later for location placement.
- 7.2.3.4. In the **Units of Measure:** field, use the keypad to enter the units of measure you wish to use for the blades, such as Inch Grams.
- 7.2.3.5. In the **Max Total Error:** field, use the analyzer keypad to enter the maximum total error for the assembly AFTER the blades have been reshuffled. If you do not know the maximum allowable error, enter 0.1 which is generally acceptable for all assemblies. This error is used as the target for the reshuffle and keys the analyzer to continue calculations until this limit is either met, or cannot be achieved.

When all fields are complete as necessary, press [ENTER] to accept your settings and continue.

Model 4040 VIPER Analyzer	
Fan Blade Optimizer Setup	
Name:	CITATION 10
Number of Blades:	24
Blade Num Style:	B1-B99
Units of Measure:	Inch Grams
Max Total Error:	0.10

- 7.2.4. The Job Identification screen, shown below will be displayed. Use the [↓] key to move from field to field. Use the analyzer keypad to enter a Name, and optional Aircraft (A/C) Registration and Aircraft Total Time. If Names have previously been entered in this analyzer, you may optionally press the [F1] “Names” key and select a name from the stored list of names. When all fields are complete as necessary, press [ENTER] to accept your settings and continue.

Model 4040 VIPER Analyzer				
Job Identification				
Name: STAR PUBLISHING				
A/C Registration: N123SP				
A/C Total Time: 4312				
Press ENTER to continue				
Names				

7.2.5. The Engine Information screen, shown below will be displayed. This is a generic form used for various analyzer features. Use the [=>] key to select the Position for the engine (1, 2, 3, or 4). Enter the optional Engine Serial Number (S/N), Type, Time Since Overhaul (TSO) and Time Since New (TSN) as required. When the cursor is in the S/N field, you may alternately press the [F1] "Serial Nos" key to select from a list of previously entered serial numbers. When all fields are complete as necessary, press [ENTER] to accept your settings and continue.

Model 4040 VIPER Analyzer				
Engine Information				
Position:				
	1			
Propeller:				
S/N				
Type				
TSO	0			
TSN	0			
Engine:				
S/N				
Type				
TSO	0			
TSN	0			
Serial Nos				

7.2.6. The Fan Blade Optimizer Job screen, shown below will be displayed. Notice that there are two columns, one for the Blade identifier (A-Z or B1 – B99) and one for the Weight. There are a number of rows equal to the total number of blades in the set as identified earlier in paragraph 7.2.3.2 above. The Weight column will display all zeros (0.00). Use the [↑] and [↓] key to move from field to field in the Weight column. Use the analyzer keypad to enter a value for the selected measurement type corresponding to the identified blade number. When all values are entered, recheck to insure accurate entries for each blade. When you are

satisfied that all entries are correct, press [ENTER] to accept your entries and continue.

Model 4040 VIPER Analyzer			
Fan Blade Optimizer Job			
Blade	Weight	Blade	Weight
B1	625.60	B16	623.30
B2	622.10	B17	610.00
B3	620.00	B18	623.30
B4	611.40	B19	619.40
B5	630.50	B20	621.10
B6	622.90	B21	611.50
B7	633.90	B22	612.20
B8	621.80	B23	616.50
B9	620.20	B24	620.00
B10	626.50		
B11	617.90		
B12	621.10		
B13	625.40		
B14	634.10		
B15	618.10		

- 7.2.7. A momentary screen reading “Stand-by, Optimizing” will be displayed along with a progression bar. When the progression bar is completely darkened, the process will be complete (about 30 seconds to one minute) and the Fan Blade Optimizer Result screen, shown below, will be displayed. This is the screen that displays the optimal blade placement for each blade in the set to achieve the best weight distribution and balance. There are now three columns shown on screen, the Order, Bld (Blade number), and Wt (Weight). The Order is the order of placement; the blade number is the identifying number of the blade which should be placed in the corresponding position shown in the Order column. At the bottom of the screen you will see the Total Error for the new placement. If you notice that any of the weights shown is not correct, or if you wish to replace one of the blades with a new blade and its new weight, press the [F1] “Edit Wt” key. The screen will revert to that shown in paragraph 7.2.6 above. Go to that paragraph and repeat the process as directed. Otherwise, when placement is complete, you may press [ENTER] to exit the screen and turn the analyzer off. A record of the job will be stored in the analyzer for later reference if required.

NOTE

The screen below is for illustration purposes only and does not reflect accurate values for an actual Blade Optimizer Job.

Model 4040 VIPER Analyzer					
Fan Blade Optimizer Result					
Order	Bld	Wt	Order	Bld	Wt
1	B11	517.90	15	B12	521.10
2	B4	511.40	16	B9	520.20
3	B15	518.10	17	B7	533.90
4	B5	530.50	18	B2	522.10
5	B3	520.00	19	B23	516.50
6	B22	512.20	20	B19	519.40
7	B14	534.10	21	B24	520.00
8	B13	525.40	22	B18	523.30
9	B16	523.30	23	B10	526.50
10	B8	521.80	24	B17	510.00
11	B21	511.50			
12	B6	522.90			
13	B20	521.10			
14	B1	525.60			
Total Error:		0.31	Inch Grams		
Edit	Wt				

- 7.2.8. Once the blade placement is complete, a vibration survey should be completed to insure the balance is acceptable. If the balance is not acceptable, proceed to the Fan/Turbine Balance section of this chapter.