Application Note

Aircraft Type EMBRAER Legacy, 135 & 145

Procedure Fan Trim Balance

Part Number: 11-200-0115

AppNote Number: A-EMB135/145-4040-FB

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Application Note

Application Note Number	A-EMB135/145-4040-FB
Revision	1.3
Function	Fan Trim Balance
Airframe	EMBRAER Legacy, ERJ135 & ERJ145
Engine	Rolls-Royce AE3007E
E-Setup Number	
ACES Systems Analyzer	Viper 4040
Firmware Version	1.04 or Greater
Procedure	N/A

Introduction

This Application Note is number 1 of 1 Application Notes required to perform a fan trim balance on a Embraer Legacy, ERJ135, or ERJ145 with a Rolls-Royce AE3007E engines. This Application Note describes the steps necessary for set up and operation of the Viper 4040 analyzer and associated equipment.

Required Equipment: The following equipment is required to accomplish a single engine fan trim balance.

Item	Quantity	Description	Part Number
1.	1EA	Analyzer, Viper 4040	10-100-4040
2.	1EA	Cable, Vibe, 6 Pin Generic, 50 Ft.	10-320-0127
3.	1EA	Tachometer, Lasetach II, 299 (Reflective tape included)	10-100-1300
4.	1EA	Mount, Lasetach Swivel	10-100-0369
5.	1EA	Cable, Interface, ERJ145 Vibration	10-320-0144
6.	1EA	Cable, Tachometer, Generic, 50 Ft.	10-320-0126
7.	1EA	Option, 4040 Fan Trim Balance	11-900-0006

Optional Equipment: The following items are optional and are required only if you are conducting a dual engine balance job.

7.	2EA	Cable, Vibe, 6 Pin Generic, 50 Ft.	10-320-0127
8.	1EA	Tachometer, Lasetach II, 299 (Reflective tape included)	10-100-1300
9.	1EA	Mount, Lasetach Swivel	10-100-0369

10.	2EA	Cable, Tachometer, Generic, 50 Ft.	10-320-0126

A. Equipment Set Up

1. If connecting to the ERJ145 EVM (Engine Vibration Monitoring) system, remove the flapper valve cover from the pressure blowout door at the aft end of the baggage compartment by removing four (4)-retaining nuts. (REF EMB-135/145 AMM)

2. Route the socket end(s) one vibration cables (item 2.) for each engine you intend to balance, through the flapper valve and into the aft electronics compartment. Place approximately 4 feet of the cable through the valve. Place the excess cable near the lavatory pressure blow out door at the left forward end of the baggage compartment. You may alternately route the cables out the opened access panel 272DR and along the fuselage to the over wing escape hatch. If you exercise this option, secure the cable(s) every 36 inches along the underside of the fuselage with duct tape or speed tape to prevent possible ingestion into the engine. (Ref. EMB135/145 AMM)

3. Open the aft electronics bay door (Access panel 272DR) on the right side of the aft fuselage. Enter the compartment and connect the ERJ145 vibration interface (item 5.) to the EVM Test Connector. The EVM signal conditioner is located on the upper equipment rack adjacent to the Flight Data Recorder.

4. Connect the small connector ends of the ERJ Vibration Interface (item 5.), labeled “Engine 1A vibe” or “Engine 2A vibe” to the 50 Ft. Generic Vibration Sensor Cable(s) (item 2.), that you routed through the flapper valves.

NOTE

When using two cable sets, for two engine balance or vibe survey, it is advisable to identify one of the two cables as the #1 (left engine) with a wrap of electrical tape or a wire tie at each end. As both cables are otherwise identical, this will avoid confusion when connecting to the analyzer.

5. From the lavatory side of the aft lavatory bulkhead, remove the pressure blowout door at the lower left side of the bulkhead. Route the vibration cables (item 2.) from the baggage compartment through the opening and to the cockpit. Drape the cables over passenger seat arms to avoid entanglement with feet. A second 50-foot cable (item 2.) must be connected to the first 50-foot cable in order to reach the cockpit.

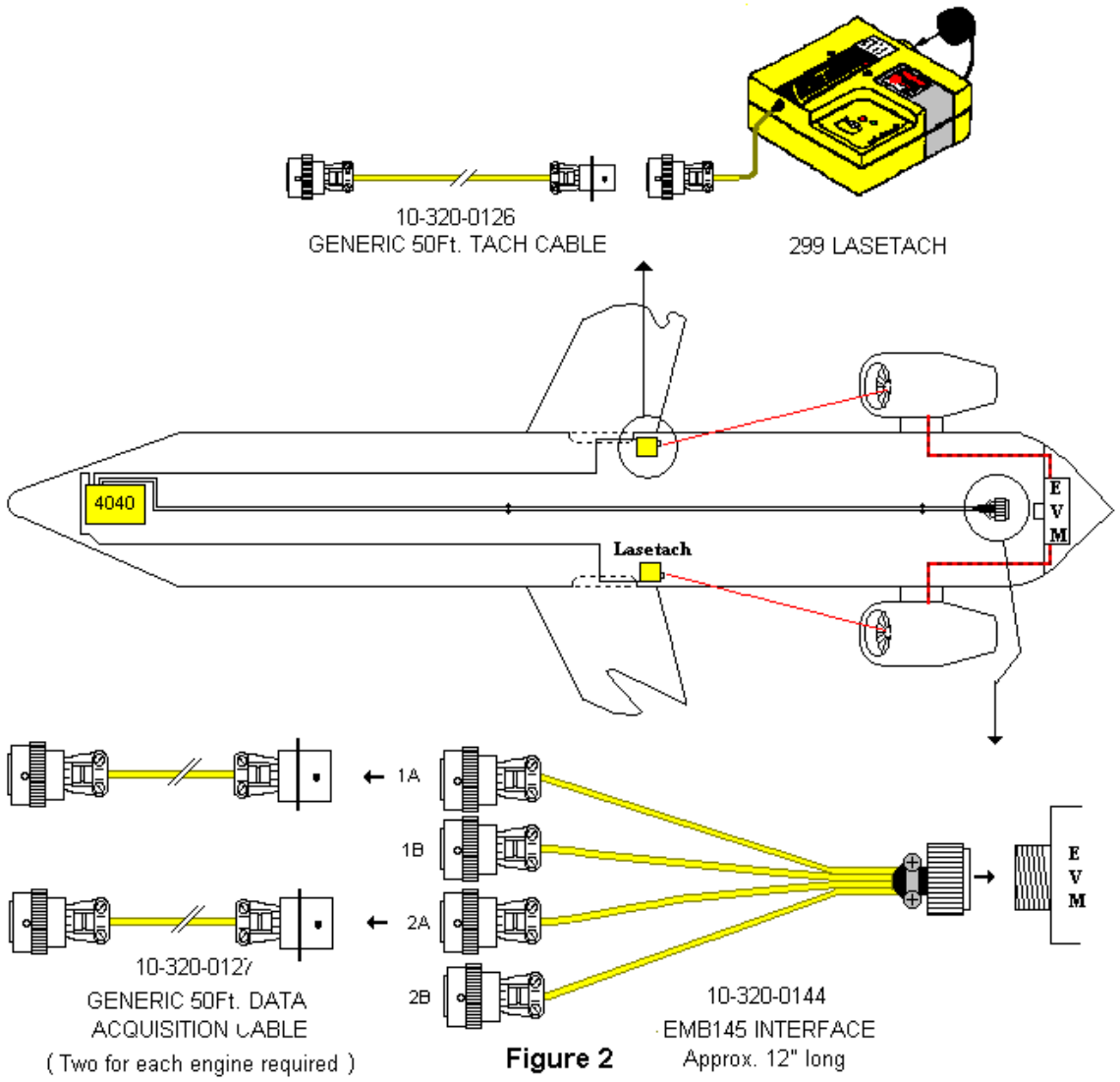


Figure 2

6. Assemble the ACES Model 299 Lasetach (item 3.) and swivel mount (item 4.). Position this assembly on the side of the fuselage, just aft of and adjacent to the top of the over wing escape hatch. Secure the swivel mount base (item 4.) to the fuselage with speed or duct tape.

7. Attach the 50 Ft. TACH CABLE (item 6.) to the Lasetach connector. (SEE Figure 2).

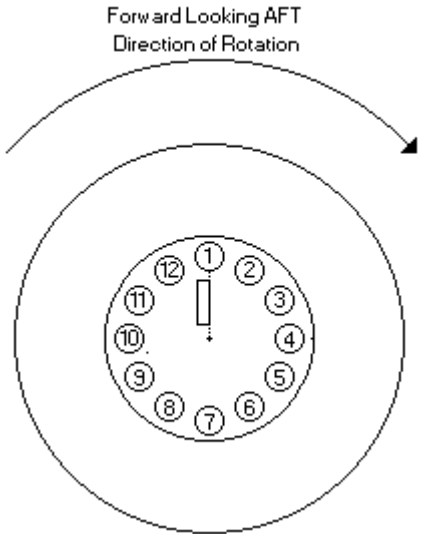
NOTE

When using two cable sets (items 2. And 6.), for two engine balance or vibe survey, it is advisable to identify one of the two sets as the #1 engine set with a wrap of electrical tape at each end. As both cables are otherwise identical, this will avoid confusion when connecting to the analyzer.

8. Route the tachometer cable (item 6.) through the access panel for the exterior emergency release of the over wing escape hatch, then forward to the cockpit, draping them over passenger seat arm rest along the way to avoid entanglement.

NOTE
Reflective quality is not the same for all reflective tape. Use only 3M brand, #7610 for best results.

9. On the engine spinner, draw an imaginary line from the center of the spinner to the center of any one of the twelve weight attachment boltholes. Clean the surface of the spinner with a degreaser and dry thoroughly. Align the leading edge of a two-inch length of reflective tape with the imaginary line. Remove the protective backing from the tape and apply at this location. (See Figure below.) The bolt aligned with the tape is now designated #1. The remaining numbers, 2 through 12, are in a clockwise accending order, from forward looking aft, as shown in the drawing below. Alignment of the laser will be accomplished later in this procedure.



10. Put the analyzer in the cockpit or locate it where the operator will use it. Connect the various cables as follows:

10.1 Left Engine Data Acquisition Cable to the six pin connector marked "**CHANNEL A**"

10.2 Left Engine Tach Cable to the three pin connector marked "**TACH 1**"

10.3 Right Engine Data Acquisition Cable to the six pin connector marked "**CHANNEL D**"

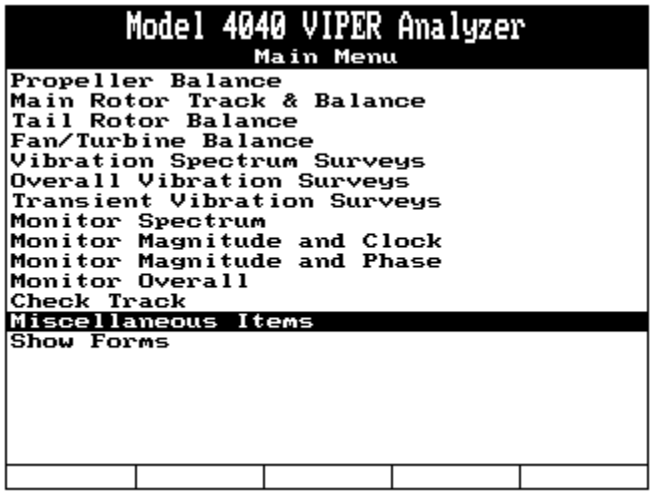
10.4 Right Engine Tach Cable to the three pin connector marked "**TACH 4**"

11. Fan Balance Setup.

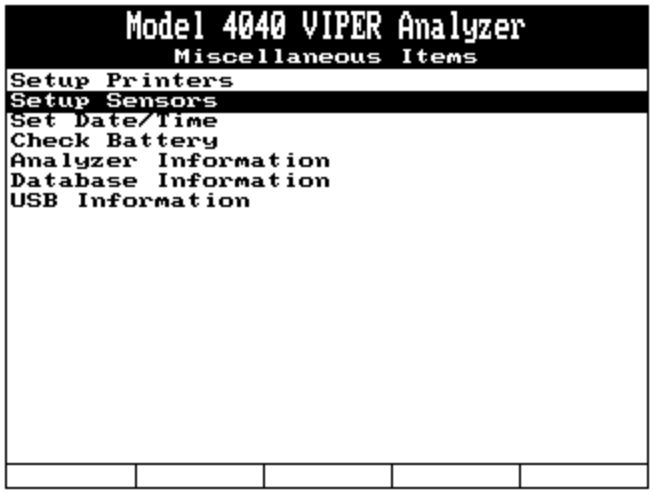
11.1 This section will give you the steps to enter the AE3007 Setup into the Viper Analyzer. If the setup has been previously entered, you need not repeat this step. If the setup is available, go to section B. Data Acquisition. Otherwise proceed to 11.2 below.

11.2 Turn the analyzer on by pressing the ON/OFF key.

11.3 From the Main Menu, select Miscellaneous Items.

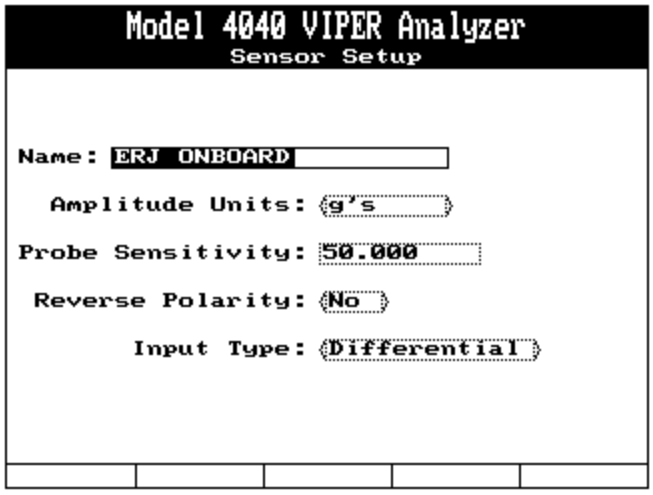


11.4 From the Miscellaneous Items menu, select “Setup Sensors”.



11.4 Complete the Sensor Setup screen, shown below, as follows:

11.4.1 In the **Name:** field, enter “ERJ ONBOARD”. This will indicate this sensor is installed permanently on the engine of the Embraer RJ. Press the ⇓ key to move to the next field.



11.4.2 In the **Amplitude Units:** field, use the ⇒ key to select "g's". This is the engineering unit of output for the onboard sensor. It will be converted to IPS by the analyzer for balancing. Press the ⇓ key to move to the next field.

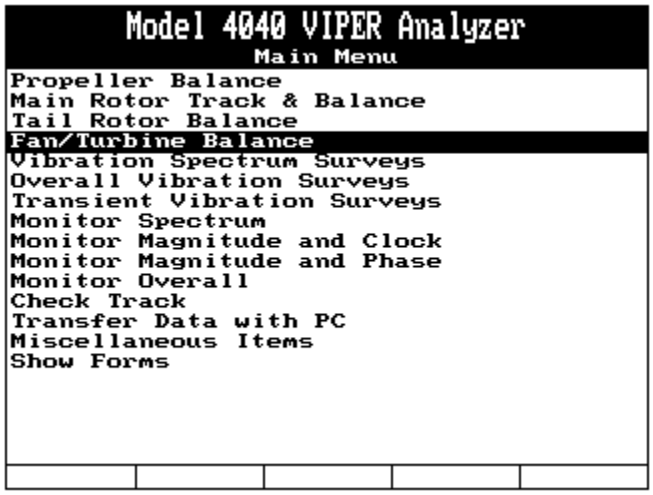
11.4.3 In the **Probe Sensitivity:** field, enter "50". This indicates the output of the onboard sensor is 50 mV/g. Press the ⇓ key to move to the next field.

11.4.4 In the **Reverse Polarity:** field, use the ⇒ key, if necessary, to select "No" indicating the sensor polarity is not reversed. Press the ⇓ key to move to the next field.

11.4.5 In the **Input Type:** field, use the ⇒ key, if necessary, to select "Differential" indicating the type input to the sensor.

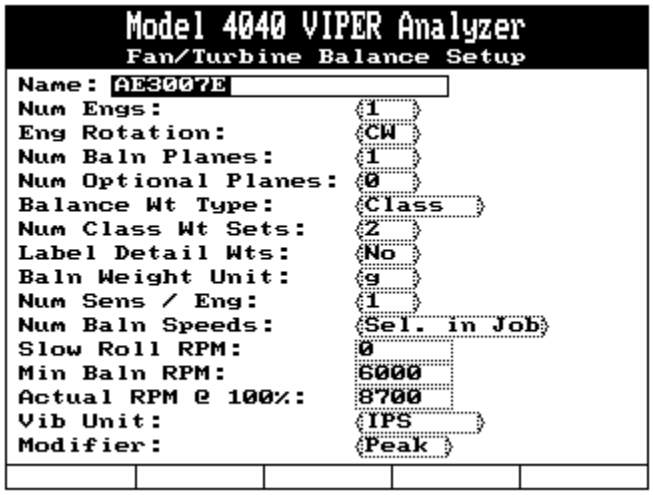
11.4.6 When all fields are complete, press ENTER to accept and save. The screen will return to the "Manage Sensors" screen. From that screen, press [BACKUP] repeatedly until the Main Menu is again displayed.

11.5 From the Main Menu, select "Fan / Turbine Balance"



11.6 If there are other setups already in the analyzer, the Setup List banner screen will be displayed. From that screen, press the [F1] "New" key. If no setups are in the analyzer, the "Fan / Turbine Balance Setup" screen will be displayed. Complete the Balance Setup screen as follows:

11.6.1 Use the keypad to enter "AE3007E" in the **Name:** field. Press the ⇓ key to move to the next field.



11.6.2 In the **Num Engs:** (number of engines) field, use the use the ⇒ key to select a number that indicates the number of engines that will be balanced using this setup. This is typically "1". Press the ⇓ key to move to the next field.

11.6.3 In the **Eng Rotation:** field, use the ⇒ key to select "CW" indicating the fan rotates clockwise as viewed from the front looking into the intake. Press the ⇓ key to move to the next field.

11.6.4 In the **Num Balan Planes:** (number of balance planes) field, use the ⇒ key to select "1". Press the ⇓ key to move to the next field.

11.6.5 In the **Num Optional Planes:** (number of optional balance planes), use the ⇒ key to select "0". Press the ⇓ key to move to the next field.

11.6.6 In the **Balance Wt Type:** field, use the ⇒ key to select "Class". The class weights will be defined on another page. Press the ⇓ key to move to the next field.

11.6.7 In the **Num Class Wt Sets:** (number of class weight sets), use the ⇒ key to select "2". The AE3007 has two class weight sets that may be used to trim balance the engine. Press the ⇓ key to move to the next field.

11.6.8 In the **Label Detail Wts:** field, use the ⇒ key to select "No". Detail weights are those weights which cannot be removed and occupy holes normally used for adding trim balance weights. If the answer is yes in this field, the analyzer will optimize the balance solution on available holes only. Press the ⇓ key to move to the next field.

11.6.9 In the **Baln Weight Units:** field, use the ⇒ key to select "g' for grams. The class weights for the AE3007 are measured in grams. Press the ⇓ key to move to the next field.

11.6.10 In the **Num Sens / Eng:** field, use the ⇒ key to select 1. There are two sensors on the engine, however; only sensor A is used in the fan trim balance. . Press the ⇓ key to move to the next field.

11.6.11 In the **Num Baln Speeds:** field, use the ⇒ key to select the total number of speeds (up to 9) you will use for this setup. Optionally, you may choose "Select in Job" which will allow you to specify the number of balance speeds with each new job rather than defaulting to a number you select here in the setup. Three speeds are recommended for balancing the AE3007E. . Press the ⇓ key to move to the next field.

11.6.12 In the **Slow Roll RPM:** field, use the keypad to enter "0". Slow roll is a compensating RPM for use in engine applications where proximity probes are used and does not apply to this engine. Press the ⇓ key to move to the next field.

11.6.13 In the **Min Baln RPM:** field, use the keypad to enter the minimum speed at which this engine can be balanced. This speed will normally be a speed in the flight range. Press the ⇓ key to move to the next field.

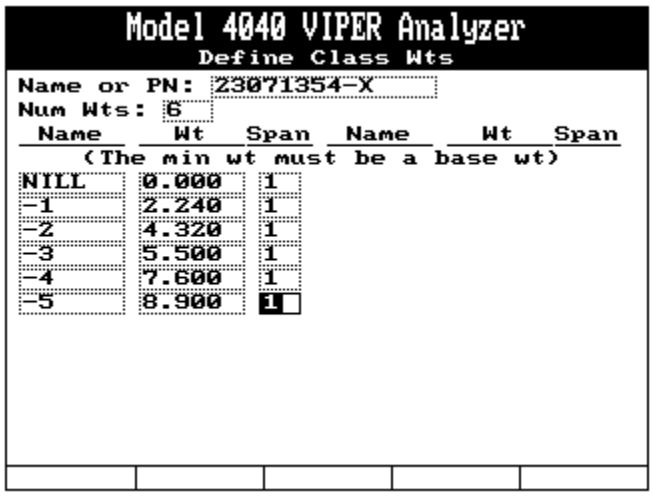
11.6.14 In the **Actual RPM @ 100%:** field, use the keypad to enter the speed of the fan at 100% rpm. For the AE3007E, this is 8700. Press the ⇓ key to move to the next field.

11.6.15 In the **Vib Unit:** field, use the ⇒ key to select "IPS". The AE3007E engine is balanced using velocity units of inches per second. Press the ⇓ key to move to the next field.

11.6.16 In the **Modifier:** field, use the ⇒ key to select "Peak". When all fields are complete, press [ENTER] to accept and continue.

11.7 The Define Class Weights banner screen will be displayed where each of the class weights used for the AE3007 fan trim balance will be added to the setup. Complete each field in the screen as follows:

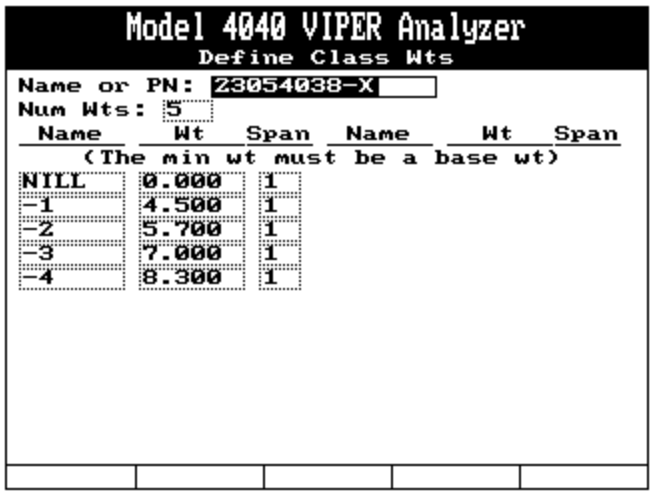
11.7.1 In the **Name or PN:** field, use the keypad to enter "23071354-X". This is the part number, which identifies one of two class weight sets used for the AE3007E. The "-X" at the end of the number represents a digit (1 through 5) of the individual weights. Press the ⇓ key to move to the next field.



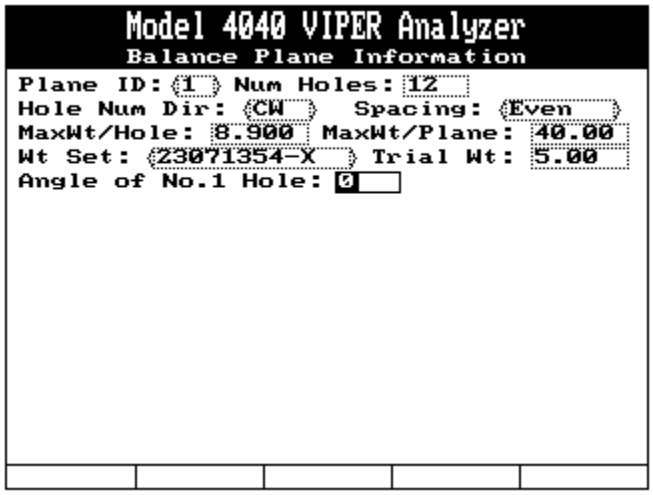
11.7.1 In the **Num Wts:** field, use the keypad to enter a total number of weights in this class weight set 5, plus 1 for a total of 6. The sixth weight will be the NILL weight which means a negative or null weight having no influence on the balance. Press the ⇓ key to move to the next field.

11.7.2 In the **Name, Wt,** and **Span** columns, enter the information as shown in the illustration above for the six class weights. The name will be the dash (-) number of the individual weights, the weight is measured in grams for each individual class weight and the span is the number of holes each individual weight covers when installed. When all information is entered as shown, press [ENTER] to accept and continue.

11.8 The Define Class Weights banner for the second class weight set will be displayed. Using the directions in paragraph 11.7 above, complete the second class weight set using the information exactly as contained in the screen below.

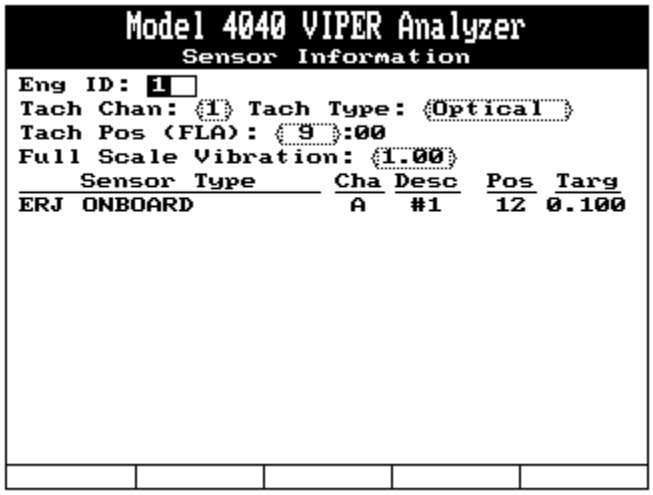


11.8.1 When all information is completed, press [ENTER] to accept and continue.



11.9 The Sensor Information screen will be displayed. Complete the screen as follows:

11.9.1 In the **Eng ID:** field, use the keypad to enter a single alphanumeric character to identify this engine such as L, R, 1 or 2. . Press the ⇓ key to move to the next field.



11.9.2 In the **Tach Chan:** field, use the use the ⇒ key to select the tach channel you wish to use. This must be the tach channel, 1, 2, 3, or 4, where you connect the tach input cable for this engine. Press the ⇓ key to move to the next field.

11.9.3 In the **Tach Type:** field, use the ⇒ key to select the type of tachometer you are using. If using a Lasetach or Phototach, select Optical. Press the ⇓ key to move to the next field.

11.9.4 In the **Tach Pos (FLA):** (tachometer position as viewed from forward looking aft), use the ⇒ key to select a clock position where the laser beam strikes the spinner when power to the laser is on. This should be approximately 9:00 for #1 engine and 3:00 for #2 engine. Press the ⇓ key to move to the next field.

11.9.5 In the **Full Scale Vibration:** field, use the ⇒ key to select the highest amplitude you reasonably expect to experience for this balance job. Amplitude of 1 IPS is sufficient for the AE3007. Press the ⇓ key to move to the next field.

11.9.6 In the **Sensor Type** column, use the ⇒ key to select a sensor from those sensors programmed into your analyzer. If using the ERJ145, 135 or Legacy installed sensor, select the Onboard sensor as programmed in paragraph 11.4 of this document. Press the ⇓ key to move to the next field.

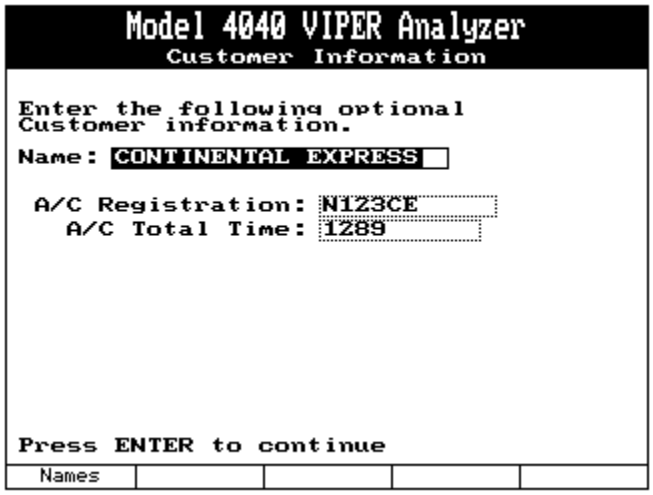
11.9.7 In the **Cha** field, use the ⇒ key to select the channel you will connect the incoming vibration signal to, A, B, C, or D. Press the ⇓ key to move to the next field.

11.9.8 In the **Desc** field, use the keypad to enter a description of the channel identified sensor such as #1 or L. Press the ⇓ key to move to the next field.

11.9.9 In the **Pos** (position) field, use the ⇒ key to select the approximate clock position of the vibration sensor on the engine as viewed from forward looking aft into the intake. If you are not sure of the position, select “UNK” for unknown. The analyzer will compensate for the unknown position and locate it automatically with one additional engine run. Press the ⇓ key to move to the next field.

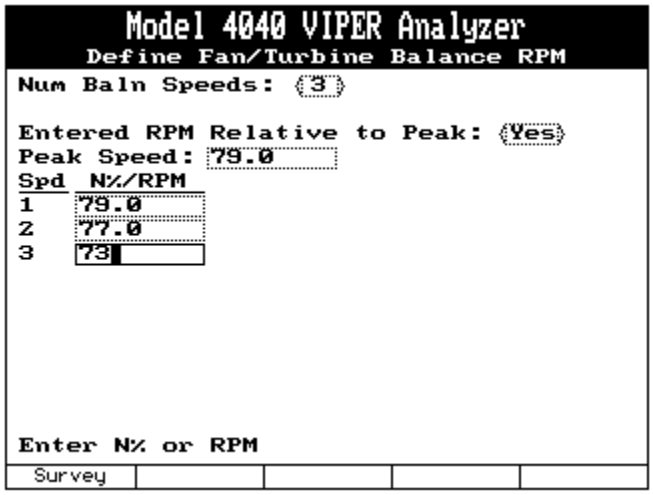
11.9.10 In the **Targ** (target amplitude) field, use the keypad to input an amplitude you wish to achieve as a minimum acceptable using this setup. When all fields are complete, press [ENTER] to accept. The screen below will be displayed asking “Store this new setup?”. Press the [F1] “Yes” key to save or the [F5] “No” key to return to the setup.

11.10 After the setup is stored you may turn the analyzer off or proceed to the balance procedure. If you continue with the balance, the customer information screen below will be displayed. The information on this screen is optional and need not be filled in to continue with the job, however; this information will assist you in your record keeping efforts and greatly reduce the effort in recalling the job later from the analyzers memory or for the AvTrend database. Use the keypad to enter the Name, Aircraft Registration, and total aircraft time. If you have entered other names in the Name field previously, you may press the [F1] key and select from a list containing those stored names. When all fields are complete, press [ENTER] to accept and continue.



11.11 If you elected to Select Balance Speeds in the Job (see item 11.6.11 above) the “Define Fan/Turbine Balance RPM” banner, shown here, will be displayed. use the ⇒ key to select the number of balance speeds for this job. You may choose up to nine speeds. If

you have completed a survey for this engine and know the balance speeds you will use, enter those speeds in the "N% RPM" column. Press the ⇓ key to move to the next field.

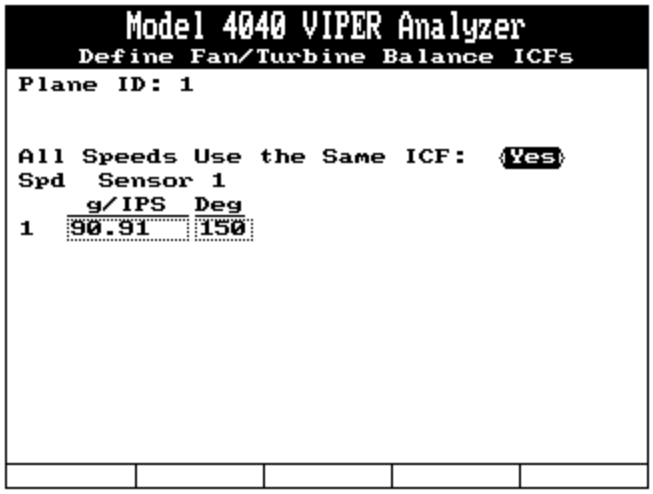


11.11.1 In the **Entered PRM Relative to Peak:** field, use the ⇒ key to toggle the answer field to Yes or No as appropriate indicating whether or not the speeds are relative to the peak vibration of a survey. This is normally the case unless the engine manufacturer specifies the balance speeds without reference to any survey information. Press the ⇓ key to move to the next field.

11.11.2 In the **Peak Speed:** field, enter the speed of the highest peak vibration of the survey. You may enter either a %RPM or the actual RPM. The analyzer will make the distinction. Press the ⇓ key to move to the next field.

11.11.3 The **Spd** column will contain a number of rows relative to the number of balance speeds you specified. Immediately to the right of those numbers, in the **N%RPM** column, use the keypad to enter the balance speeds. If you wish to conduct a Fan Vibration Survey at this point to determine the balance speeds, press the [F1] "Survey" key and follow the directions on screen. When all fields are complete as necessary, press [ENTER] to accept and continue.

11.12 The Define Fan / Turbine Balance ICFs banner screen will be displayed. In the **All Speeds Use the Same ICF:** field, use the ⇒ key to toggle the answer field to Yes or No as appropriate. If you have individual coefficient influences for each speed, answer No, otherwise answer Yes. Press the ⇓ key to move to the next field.

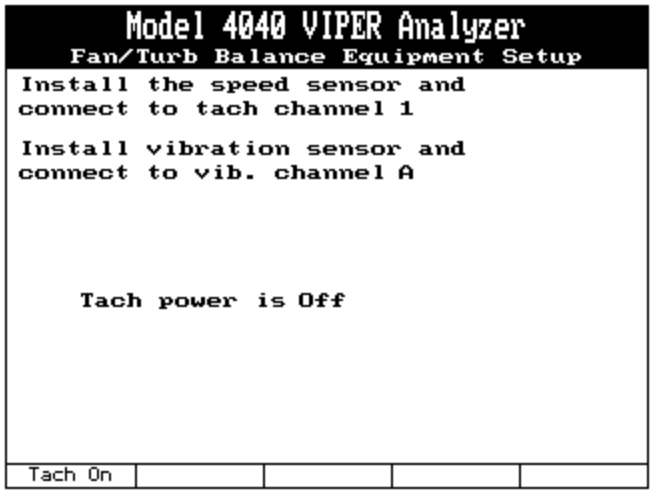


11.12.1 In the **g/IPS** column, use the keypad to enter the influence in grams per IPS. If you do not know the influence, leave it at zero. The analyzer will require one extra run to automatically calculate an influence for the engine. Press the ⇓ key to move to the next field.

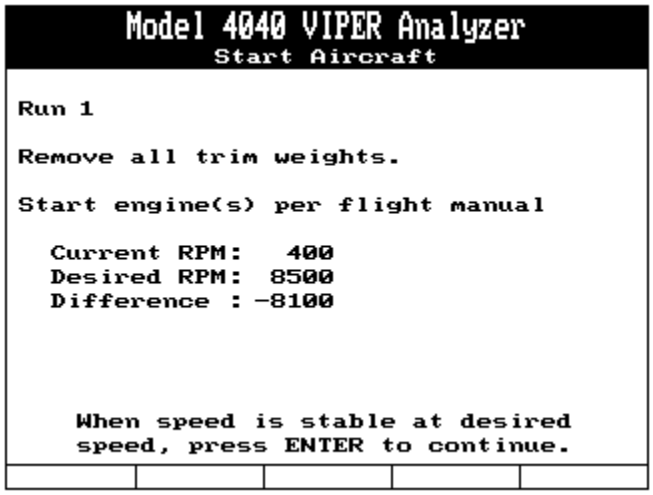
11.12.2 In the **Deg** field, use the keypad to enter the phase lag, if known. If you do not know the phase lag, leave this field at zero. The analyzer will calculate the phase lag automatically during the job. Press [ENTER] to accept your settings and proceed.

11.13 The Fan / Turb Balance Equipment Setup screen will be displayed. Follow the on screen instructions for installing and attaching sensors and cables. Notice that there is a message near the center of the screen reading “Tach power is off”. This indicates the tachometer circuit is currently not powered for alignment of the Lasetach. If you are ready to align the Lasetach, press the [F1] “Tach On” key to power the laser and proceed tot he LASER ALIGNMENT section at the end of this document. When the laser alignment is complete, return to this point and continue.

11.14 If the laser alignment is complete, press [ENTER] to continue. The power indication for the tach may be left in either the on or off position when exiting this screen.

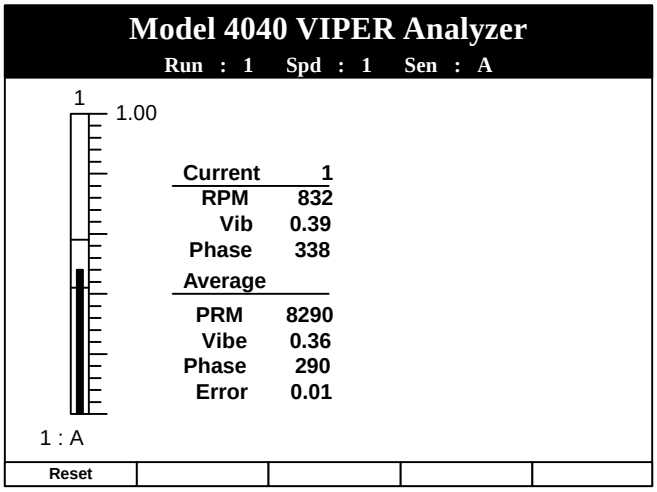


11.15 The Start Aircraft banner screen will be displayed. The Run number is indicated at the top left of the screen followed by the information message “Remove all trim weights.” Insure all previously installed trim balance weights have been removed. Start the engine(s) and watch for the Current RPM indication on the analyzer screen. When an indication of RPM is noted, allow the engine to warm up to normal operating temperature then accelerate the engine until the Current RPM and the Desired PRM on screen match as closely as possible. The Difference indication will show how many RPM difference there is between the Current and the Desired RPM. When the speeds are matched, allow the engine to stabilize for a short time and make any minor adjustments necessary, and then press [ENTER] to continue.

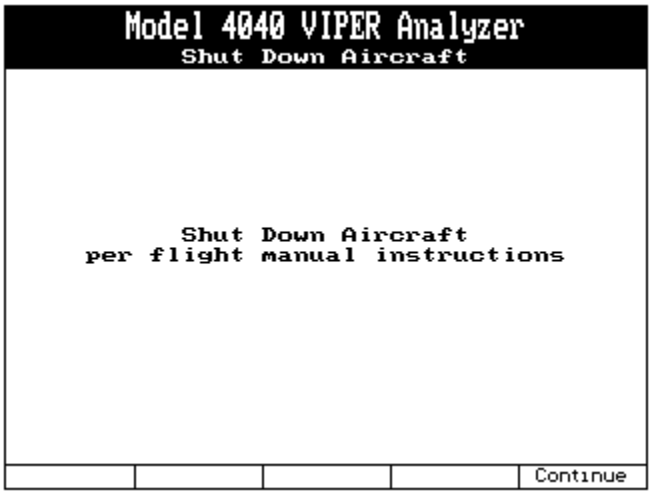


B. Data Acquisition

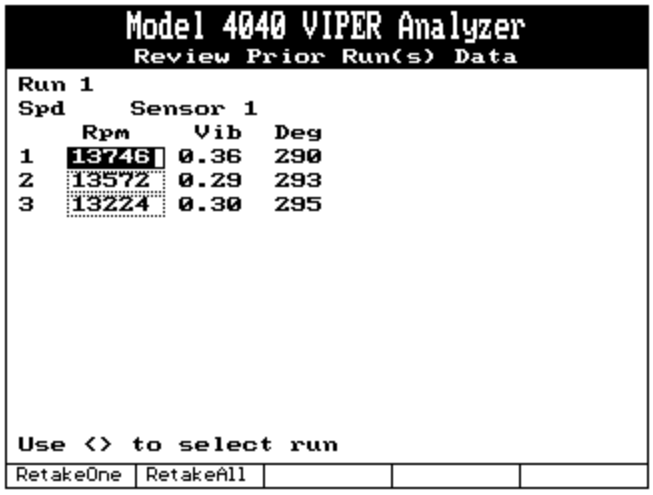
11.16 The Run 1, Spd 1, Sen 1 banner screen shown below will display the information for the first run. Indications of the Current and Average RPM, Vibration amplitude, and phase angel are displayed to the right of the converging scale. See the Viper 4040 User manual, chapter 20, Reading Spectrum and Scales for a detailed description of how to read the converging scale. After indications are stable, press [ENTER] to accept the collected data and continue. This screen will repeat for each of the speeds specified for balance. When all speeds are collected, the screen will automatically proceed to the shutdown message below in 11.17.



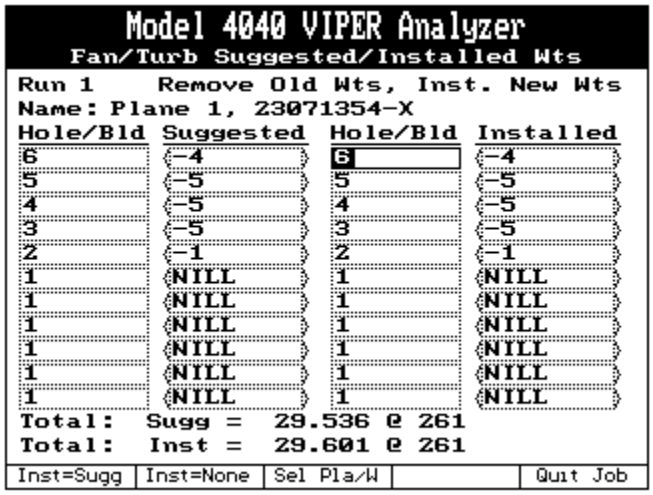
11.17 The Shutdown Aircraft message will be displayed. Press the [F5] “Continue key to acknowledge and proceed with a normal engine shutdown procedure.



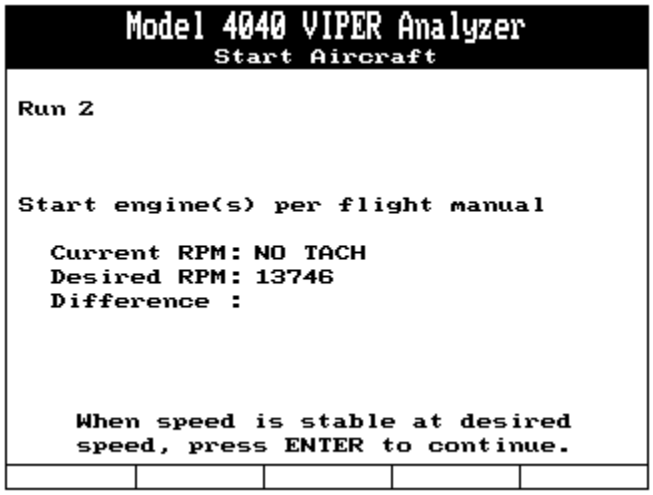
11.18 The Review Prior Run(s) Data will be displayed for your review of the data collected up to this point. You may view data from all runs by scrolling through the available run data using the ⇐ and ⇒ keys. Optionally you may use the [F1] and [F2] keys to Retake one or all data as required. When you are satisfied with the review, press [ENTER] to continue.



11.19 The Fan / Turb Suggested / Installed Wts screen will be displayed. Notice the first line of text in the screen shows the Run number and the message “Remove Old Wts, Inst. New Wts.” Remove all previously installed trim weights for the previous run and install the weights in the “Suggested” column in the hole numbers indicated to their immediate left. The right side of the screen reflects what you actually installed. Be sure the information in the Hole/Bld and Installed column are correct before exiting this screen. If you install the exact suggested weight, you need only press the [ENTER] key to exit this screen with that information. If you installed different weights or installed weights in different holes than those suggested, use the arrow key to navigate the matrix and indicate your exact installation. This is very important in that the analyzer will use this information to calculate an influence for all subsequent runs. Notice the the function keys at the bottom of the screen are labeled for the options of “Inst=Sugg” (install the suggested weights in the suggested holes), “Inst=None” (Install None or no weights), “Sel Pla/W” (select a different Plane or weight set), and “Quit Job” When all fields are complete, press [ENTER] to accept and continue.



11.19 The Start Aircraft banner screen will be displayed for the next sequential run as indicated in the upper left portion of the screen. From this point, the sequence of events from paragraph 11.15 through 11.18 repeat until the fan vibration is reduced to an acceptable level. Normally this goal will be attained in one to three runs.



LASER ALIGNMENT

1. Rotate the fan until the reflective tape on the spinner is positioned at the 9:00 position for number 1 (left engine) or 3:00 for the number 2 (right engine). Clock position is from the Front of the engine, looking aft into the intake.

2. Ensure the Lasetach is securely mounted and connected as described in Equipment Setup. Also check to make sure the Lasetach is securely mounted to the Swivel Head of the Lasetach Mount. (See figure 3 below). If it is loose, tighten by turning the Lasetach clockwise on the mounting stud while holding the Swivel head with the other hand.

3. Remove the plastic aperture cap from the Lasetach.

4. Turn the Laser **ON/OFF** switch on top of the Lasetach to the **ON** position.

5. The **BEAM ON** indicator (red) light adjacent to the Laser **ON/OFF** switch should now be illuminated.

6. Place the open palm of your hand in front of the aperture. The laser beam should be visible on your palm.

WARNING

Do not look into the aperture of the Lasetach. Avoid direct eye exposure. Eye damage may occur due to direct exposure to laser radiation.

7. Loosen the Locking Handle of the Lasetach mount (see figure below) so that the Lasetach swivels with a slight friction. Using the “gunsight” method, sight along the side of the

Lasetach using one hand while holding the Locking Handle with the other. If you have trouble acquiring the laser beam visually, you may use a free hand to sight on. No injury will occur as a result of the laser being projected on your skin. You may also choose to have someone hold a sheet of white bond paper near the target for easier acquisition. When the laser beam strikes the tape, it will be very visible. When the laser is on target, center the beam on the length of the tape and immediately tighten the Locking handle by turning it clockwise. Release both hands and recheck the alignment.

8. The laser should now be approximately in the center of the two-inch span of the tape. If minor adjustments are necessary, loosen the Locking Handle only SLIGHTLY. Make adjustments as necessary and re-tighten.

9. When satisfied with the laser position, rotate the fan several times. When the tape passes through the laser position, the GATE (green) light on the Lasetach should turn on as the tape enters the beam and off as it exits. If this test is successful, return to the cockpit and select the opposite Tach. Repeat steps **1.** through **9.** above for the second Lasetach. When complete, return to the cockpit and continue with the Equipment Setup section of this document.