Application Note

Agusta Westland AW139

Vibration Survey for Vibration Absorber Tuning

Part Number: 11-200-0267

AppNote Number: A-AGAW139-4040-VI (Rev. 3.0, Jul 2009)

ACES Systems/TEC Aviation Division – 10737 Lexington Drive, Knoxville, TN 37932 USA – Web www.acessystems.com – Telephone (865)671-2003

Application Note

Application Note Number	A-AGAW139-4040-VI
Revision	3.0 (From Airframe data obtained 6/2009)
Function	Vibration Survey for Vibration Absorber Tuning
Airframe	Agusta Westland AW139
Engine	N/A
E-Setup Number	a-agaw139-4040-vi.asf
ACES Systems Analyzer	Model 4040
Boot/App Version	3.xx/3.xx or later
Procedure	N/A

Introduction

This Application Note covers the required equipment, equipment installation, analyzer setup, data acquisition and adjustment process for using the ACES Systems Model 4040 to perform a vibration survey for vibration absorber tuning on the Agusta Westland AW139. General instructions for the use of the Model 4040 can be found in the Model 4040 User Manual #4040-OM-01 (P/N 75-900-4040). All procedures and all adjustments should be made in accordance with the Airframe Maintenance Manual.

A. Required Equipment

The following equipment is required to perform a Vibration Survey for Vibration Absorber Tuning*:

Item	Quantity	Description	Part Number
1.	1	Analyzer, Model 4040CE	10-100-4040CE
2.	1	Sensor, Vibe, Accel, 991D-1	69-100-0075
3.	1	Cable, Sensor 991D-1, 50’	10-320-0163
4.	1	Mount, ¼X28 Sensor, Vibe ¼” Hole, S/Stl	22-430-0035

*This listing shows the latest design parts. It is acceptable to perform this task using previous designs with the appropriate accessories. For compatibility issues, contact ACES Systems.

Optional Equipment

The following additional equipment may be used to allow all vibration absorbers to be surveyed simultaneously:

Item	Quantity	Description	Part Number
5.	2	Sensor, Vibe, Accel, 991D-1	69-100-0075

6.	2	Cable, Sensor 991D-1, 50’	10-320-0163
7.	2	Mount, ¼X28 Sensor, Vibe ¼” Hole, S/Stl	22-430-0035
8.	1	Mount, Triaxial Sensor – ¼”	22-430-0109

Miscellaneous Equipment

Tape or tie wraps to secure cables to airframe.

If adjustments are to be made to the Vibration Absorber, use only hardware or balance weights that are specified in the applicable airframe maintenance manual.

B. Equipment Installation

NOTE

This procedure may be performed in conjunction with a Main Rotor Track and Balance. If the exact Main Rotor speed is unknown, it is recommended that a vibration survey be performed on the Main Rotor before beginning the vibration absorber tuning procedure.

1. Park the aircraft on a flat level surface with the nose into the wind. Place the analyzer (Item 1) in the flight compartment.
2. Main Rotor vibration survey procedure:

   2.1 Install Sensor Mount (Item 4 or Item 8) on the floor behind the pilot’s seat. Install the Axial/Vertical Vibration Sensor (Item 2) with the electrical connector facing up. Connect a 50’ Vibe Sensor Cable (Item 3) to the Sensor connector that is point up. Route the Cable safely to the Analyzer. Connect the Analyzer end of the Cable to the “CHANNEL A” connector.

   2.2 Prepare for the vibration survey in accordance with Section C below.

   2.3 Reinstall any previously removed cowlings as required.

   2.4 Remove all test equipment and proceed to Step 3 below.

3. Vibration Absorber vibration survey procedure:

WARNING

DO NOT fly the aircraft with the equipment listed below installed unless safety of flight can be assured.

3.1 Install a Sensor Mount (Item 4) in the front hole used to attach the cover to the airframe structure. Install a Vibration Sensor (Item 2) into the threaded hole in the Sensor Mount. Insure that the Sensor and Mount are installed vertically. Repeat this process for each vibration absorber being tuned. (Figure 1 forward absorbers) (Figure 2 aft absorber)

NOTE

Secure and route cables as not to interfere with hot or rotating components and aircraft controls.

3.2 Install a 50’ Vibe Sensor Cable (Item 3) on the Vibration Sensor. Connect the end of the cable identified as “991D-1” to the Vibration Sensor. Safely route the cable to the location of the analyzer. Connect the analyzer ends of the Vibration Sensor Cables as follows: connect the LEFT absorber Sensor Cable to “CHANNEL B”,

connect the RIGHT absorber Sensor Cable to “CHANNEL C”, and connect the AFT absorber Sensor Cable to “CHANNEL D”.

3.3 Reinstall any previously removed cowlings as required.

3.4 Prepare for the vibration survey in accordance with Section C below.

Equipment Installation Diagram

Figure 1

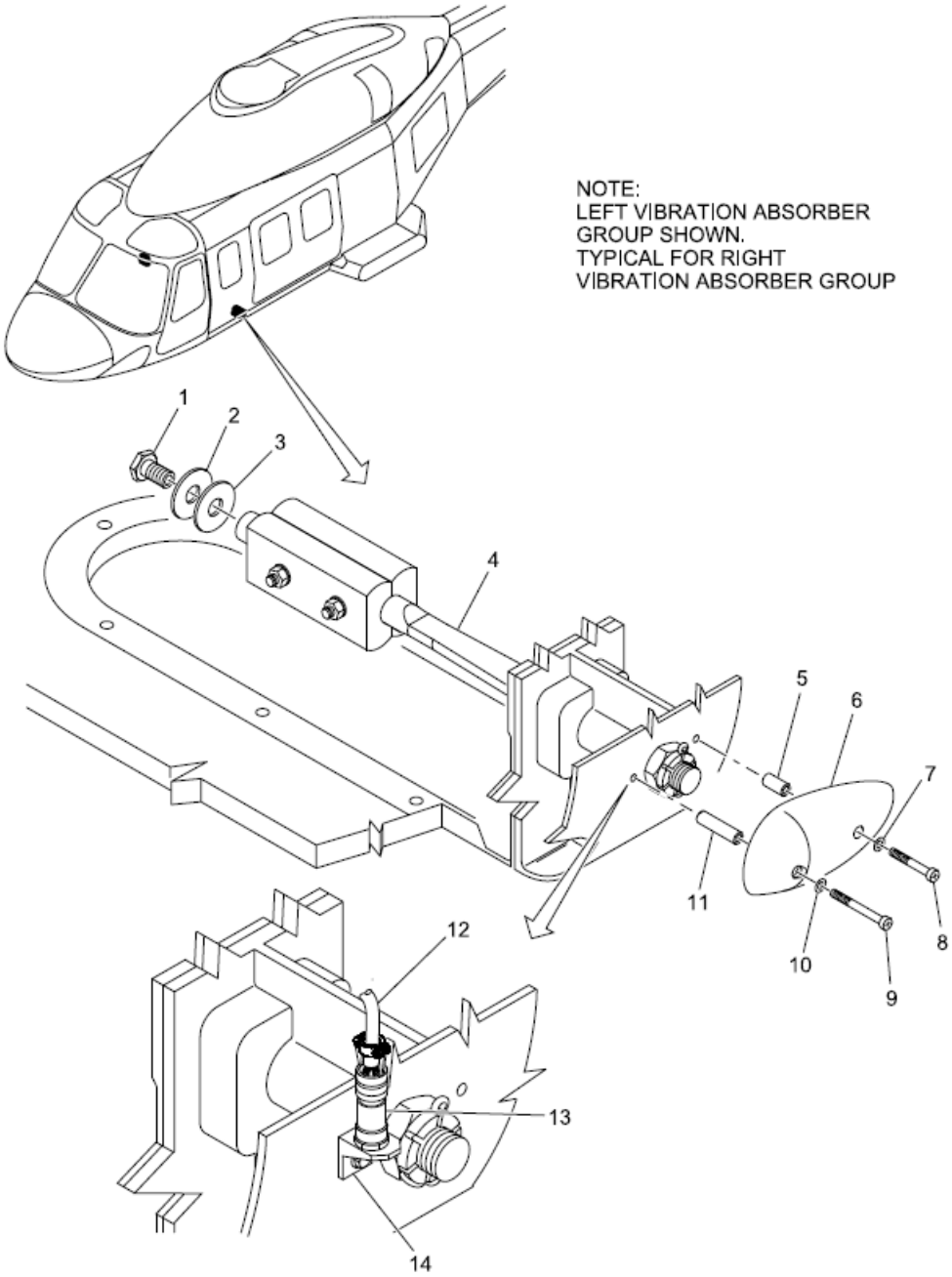
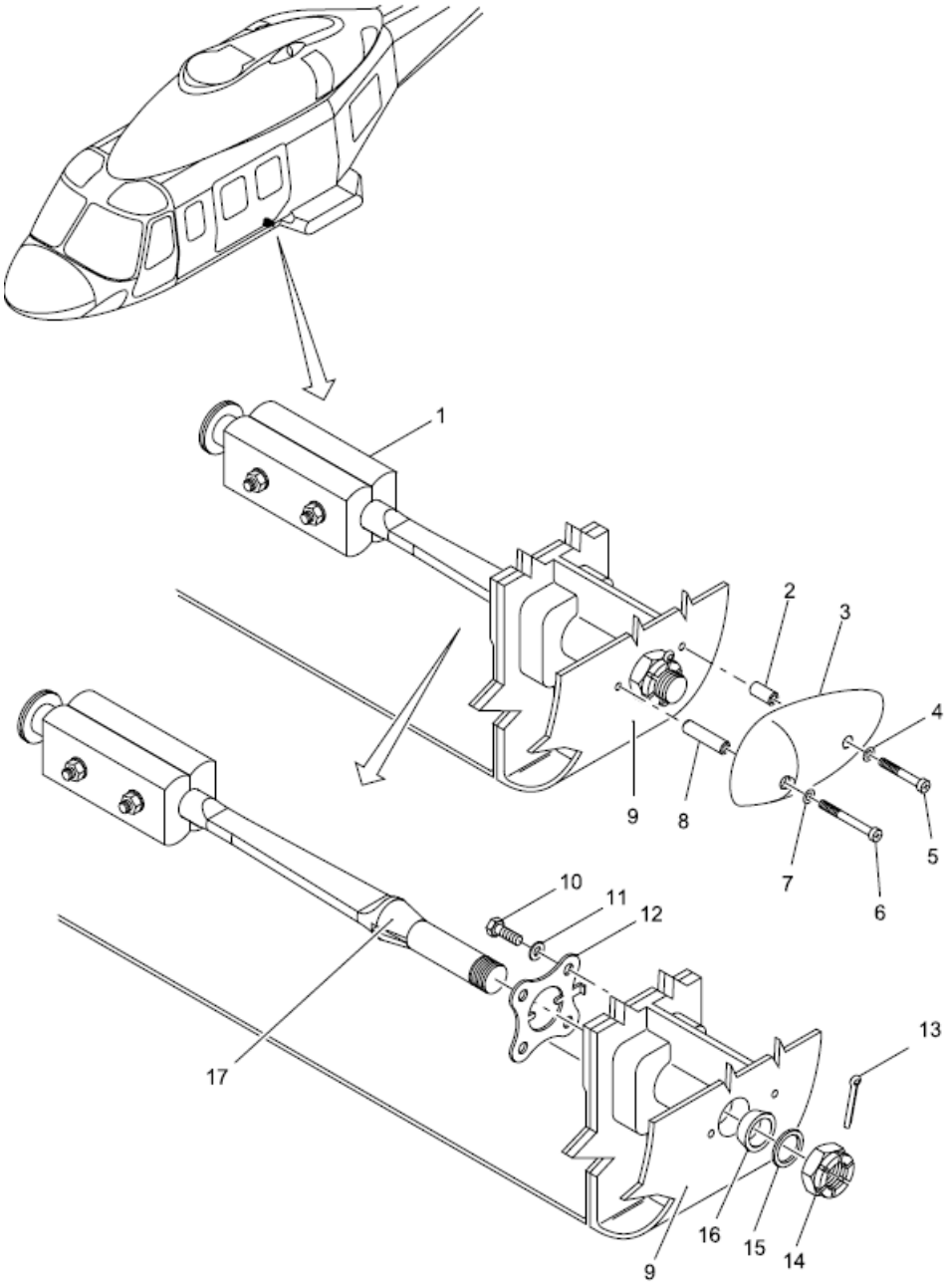


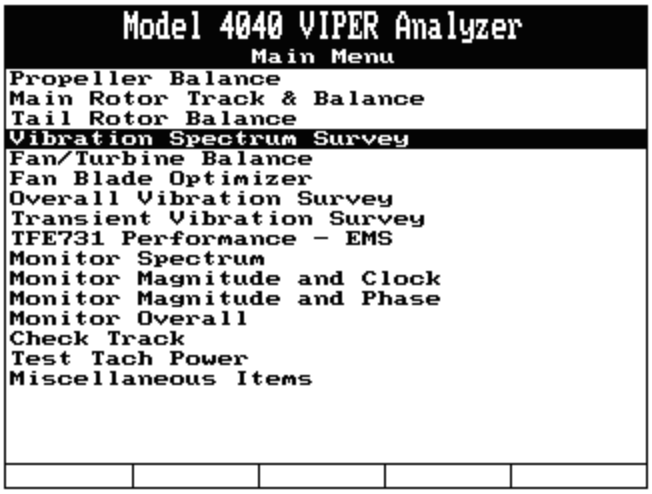
Figure 2



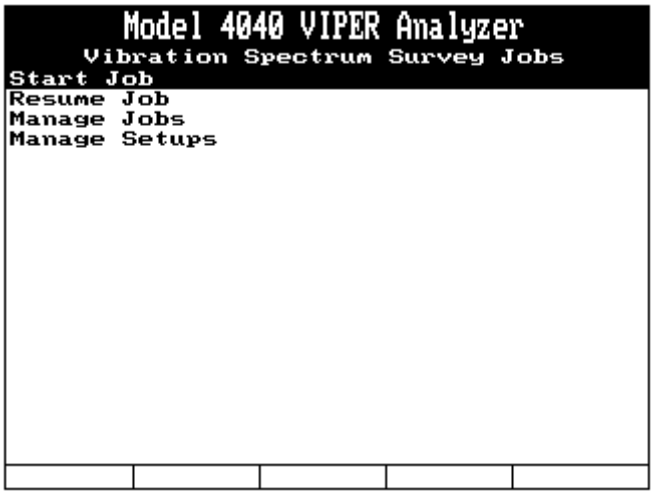
C. Analyzer Set Up

1. Insure the analyzer battery is charged prior to starting the job. See the Model 4040 User Manual #4040-OM-01 (P/N 75-900-4040) Chapter 2 for detailed instructions on battery charging.
2. Turn the analyzer ON by pressing the **[ON/OFF]** key.

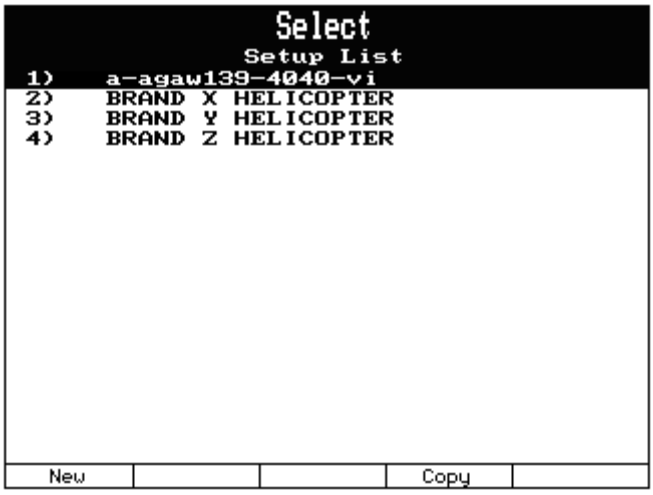
3. From the Main Menu shown below, select “Vibration Spectrum Survey” and press the **[ENTER]** key.



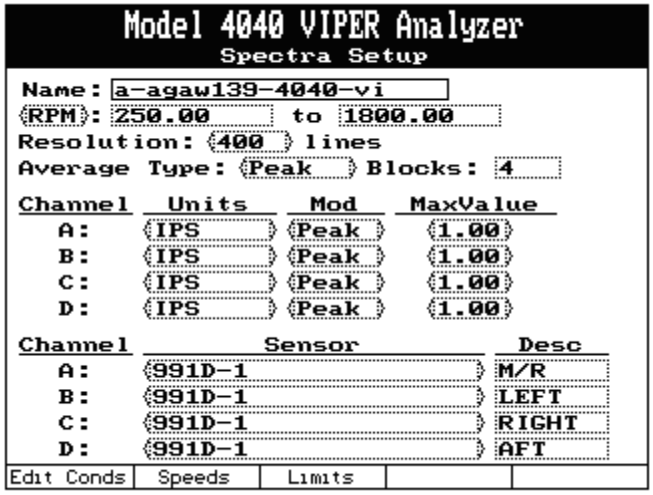
4. From the Vibration Spectrum Survey Jobs Menu shown below, select “Start Job” and press the **[ENTER]** key.



5. If the Agusta Westland AW139 is listed in the Setup List, select it using the **[⇓]** key and press **[ENTER]**. To perform the Main Rotor portion of the vibration survey, continue at Step D.1 below. To perform the Vibration Absorber tuning portion of the vibration survey, continue at Step D.10 below. If the Agusta Westland AW139 is not in the Setup List, press the **[F1]**, “New” key and go to Step 6 below.



6. The "Spectra Setup" screen now appears. Enter the Vibration Survey Setup as shown below. You can enter any name that is convenient for locating the setup in the future. When completed press **[ENTER]**.

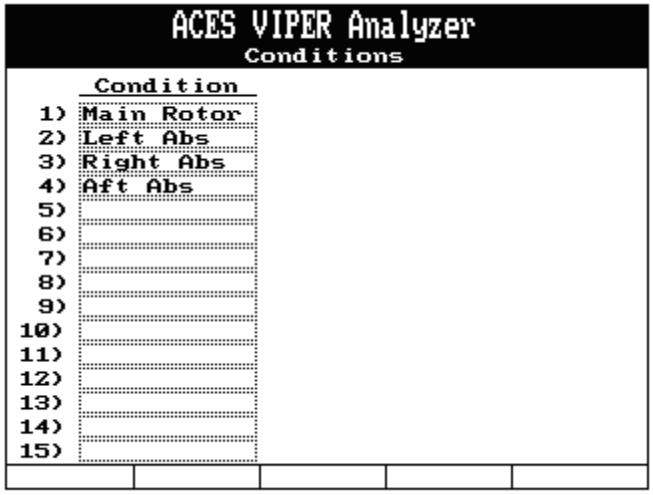


7. The "Conditions" screen will be displayed next. Enter the values as shown in the illustration below. Press **[ENTER]** to continue. The conditions used below are:

- Main Rotor – used to determine the Main Rotor RPM and harmonics.
- Left Abs – used to measure the vibration signature of the Left Absorber.
- Right Abs – used to measure the vibration signature of the Right Absorber.
- Aft Abs – used to measure the vibration signature of the Aft Absorber.

NOTE

If only one sensor is used it will be easiest to collect vibration readings independently. Vibration data can be gathered simultaneously with the correct number of sensors installed using any condition.



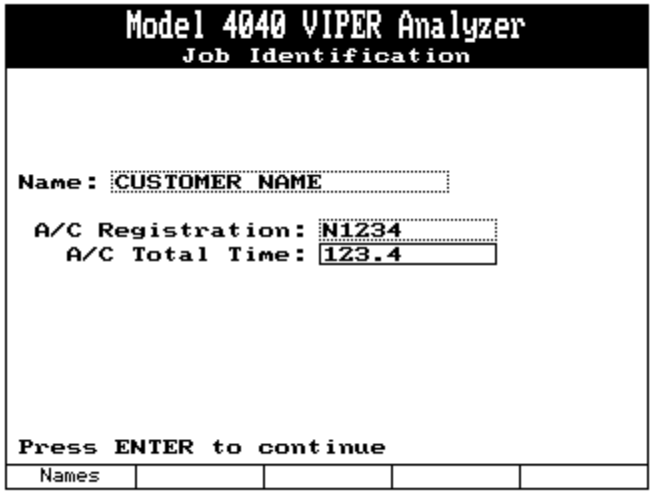
D. Data Acquisition

NOTE

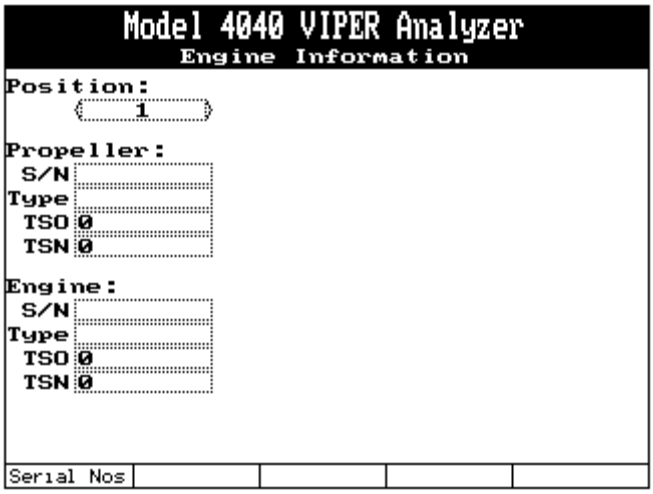
If the exact Main Rotor Speed is unknown; perform Steps 1 thru 9 below before installing the vibration sensors used for tuning the vibration absorbers.

Main Rotor Vibration Survey

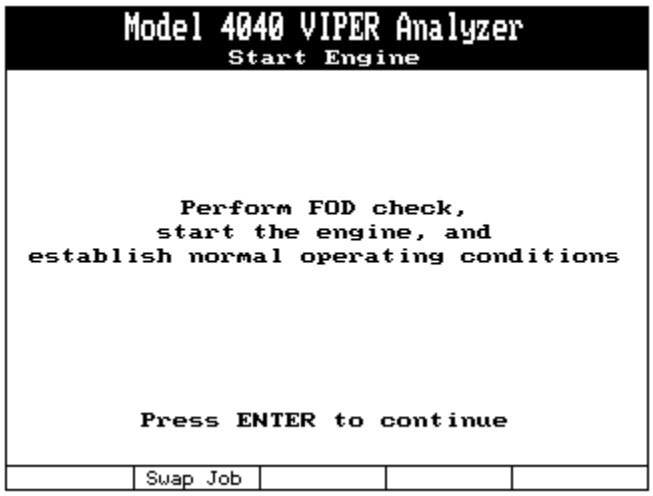
1. The "Job Identification" screen will be displayed, as shown below. Use the analyzer keypad to enter a customer name in the "Name:" field. The analyzer will maintain a list of customer names as new names are entered. If names have been previously entered into this analyzer, you may press the **[F1]** "Names" key and select a customers name from the provided list. Press the **[⇓]** key to move to the next field and use the analyzer keypad to enter the optional aircraft registration and aircraft total time as required. When all fields are complete, press the **[ENTER]** key to accept and continue.



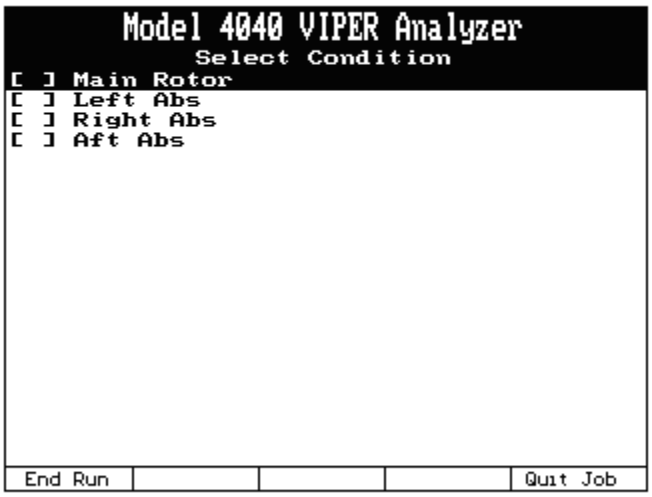
2. The next screen to be displayed will be the “Engine Information” screen as illustrated below. This is an optional screen and does not need to be completed for this job. Press **[ENTER]** to bypass this screen and continue to the next.



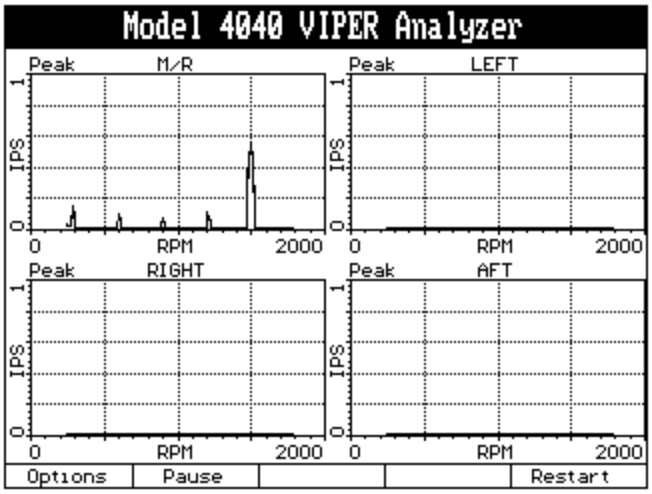
3. The “Start Engine” screen will appear. After the engines are started and normal operating conditions are established, press the **[ENTER]** key to continue. To exit directly to the Main Menu press the **[F2]** “Swap Job” key.



4. The “Select Condition” screen will appear. Use this screen to highlight the condition where you would like to gather vibration readings. Highlight the condition name and press **[ENTER]**.

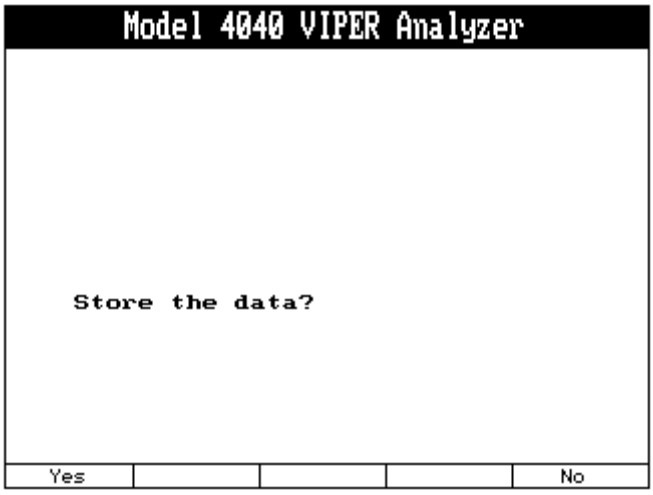


5. The analyzer will present the data acquisition screen as shown below. Operate the aircraft in the configuration for the selected condition and allow the analyzer to collect data. While monitoring the measurement, you may press the **[F5]** "Restart" key to restart the averaging process. Use this feature as a way to validate the quality of the measurement. The indication should be as steady as possible with very little change before you press the **[ENTER]** key to stop acquisition.

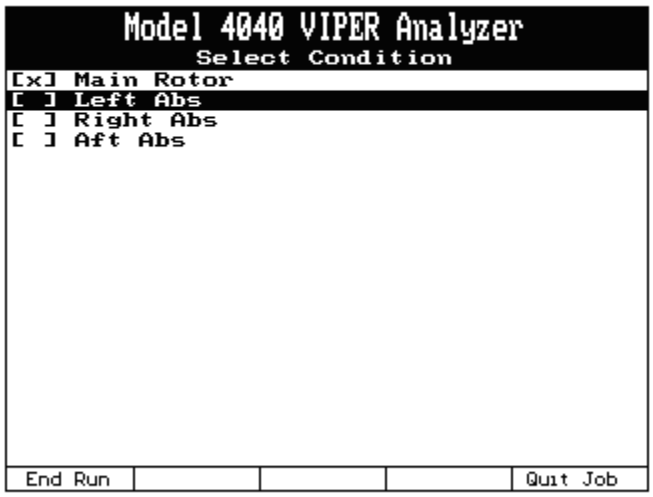


See the Model 4040 User Manual #4040-OM-01 (P/N 75-900-4040) Chapter 20 for detailed instructions on how to read the "X and Y Plotted Vibration Spectrum."

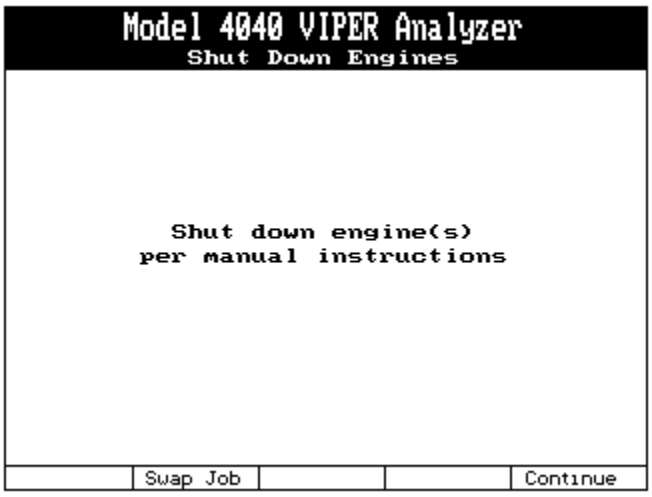
6. The analyzer will ask if you want to "Store the data?" Select **[F1]** for "Yes" to store the data and continue to the next condition. Select **[F5]** for "No" to return to Step 4 above to retake data for the present condition.



7. The “Select Condition” screen will reappear. Conditions with data readings will be displayed with an **[x]** symbol. To retake data for this condition, press the **[⇑]** key to move the highlight bar to the Main Rotor condition and press the **[ENTER]** key. If you are satisfied with the data from this run press the **[F1]** “End Run” key to continue with the next step in this test.



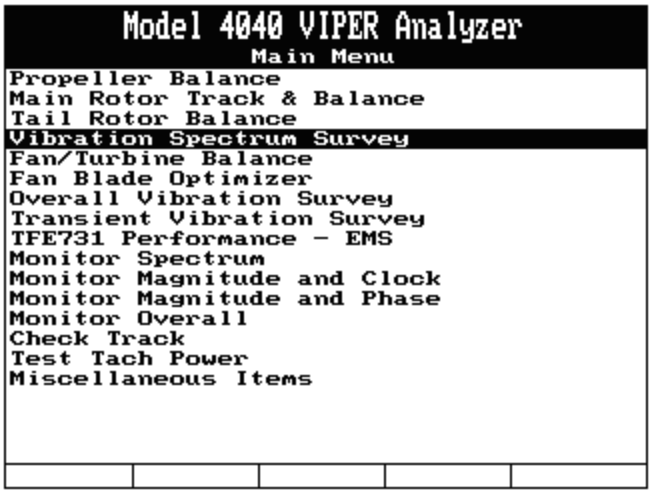
8. The analyzer will present the “Shut Down Engines” screen. Land the aircraft. Continue with a normal shut down then press the **[ON/OFF]** key to turn the analyzer off.



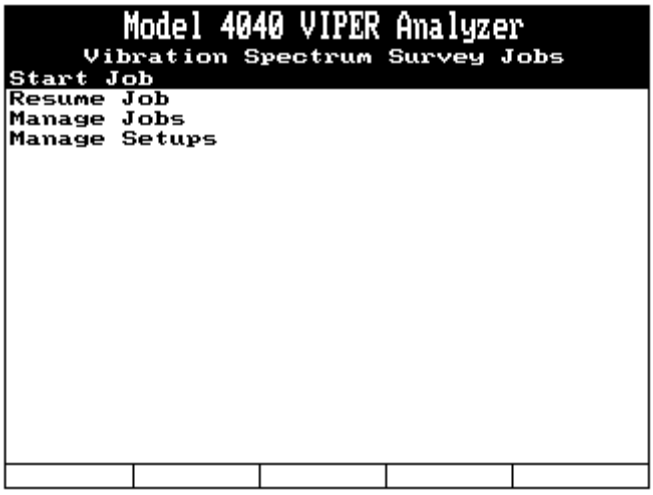
9. Remove the vibration equipment from the Main Rotor and install it in accordance with Step B.3 above for any or all vibration absorbers to be tuned. See Section E below for instructions on how to review the results from the Main Rotor vibration survey. This information will be necessary to complete the vibration absorber tuning task.

Vibration Absorber Survey

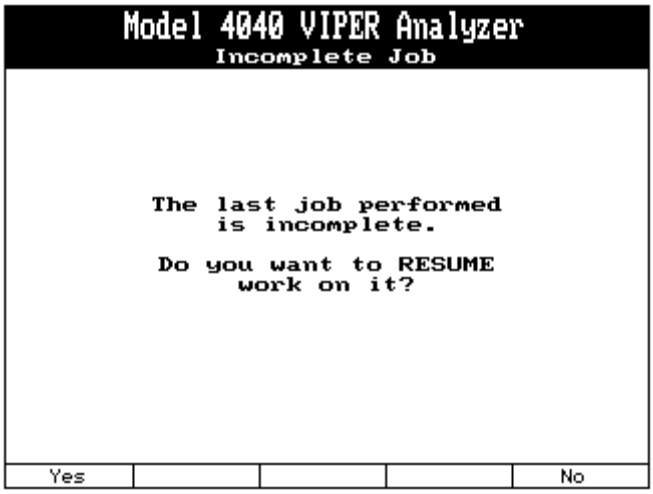
10. Turn the analyzer ON by pressing the **[ON/OFF]** key.
11. From the Main Menu shown below, select "Vibration Spectrum Survey" and press the **[ENTER]** key.



12. From the Vibration Spectrum Survey Menu shown below, select "Start Job" and press the **[ENTER]** key.



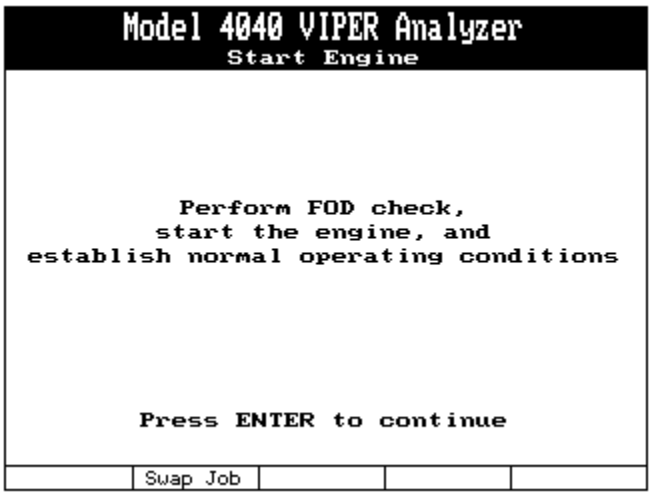
13. The analyzer will display the “Incomplete Job” screen. Since the last job should be the job from the Main Rotor Readings, select **[F1]** “Yes” to continue the prior job. If the Main Rotor readings are not in the last job, select **[F5]** “No” to start a new job. You will be taken to the “Setup List” screen. Select the correct setup for the Vibration Survey on the Agusta Westland AW139 and press **[ENTER]** to continue. You must know the exact RPM of the main rotor to complete the tuning procedure.



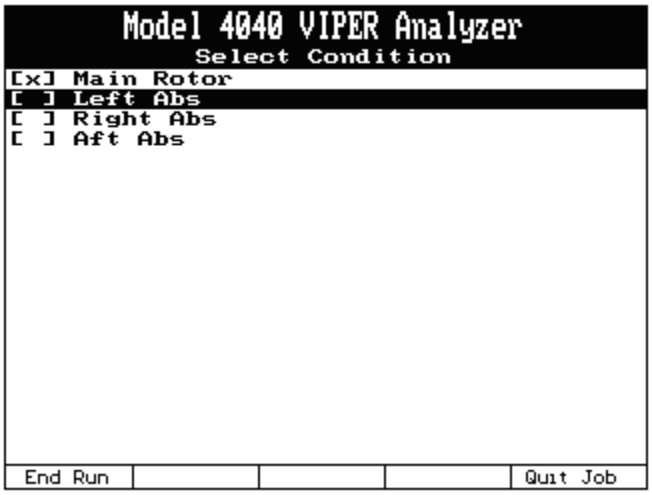
14. The “Start Engine” screen will appear. It will not be necessary to start the engines for the actual absorber tuning portion of this job. Simply acknowledge this message by pressing the **[ENTER]** key to continue. To exit directly to the Main Menu press the **[F2]** “Swap Job” key.

NOTE

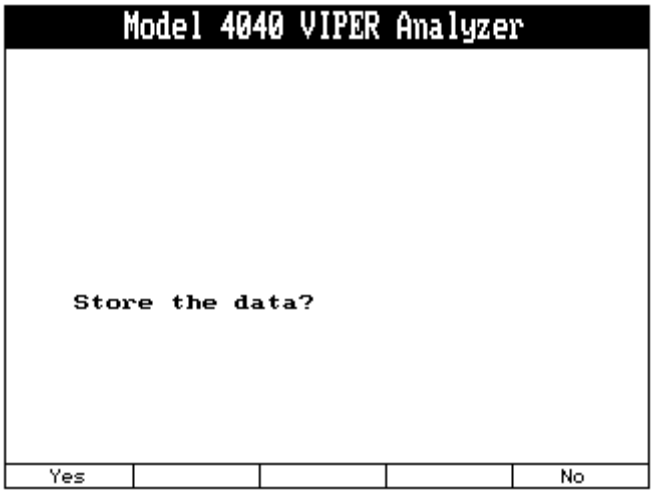
Engine start is not required for this portion of the procedure.



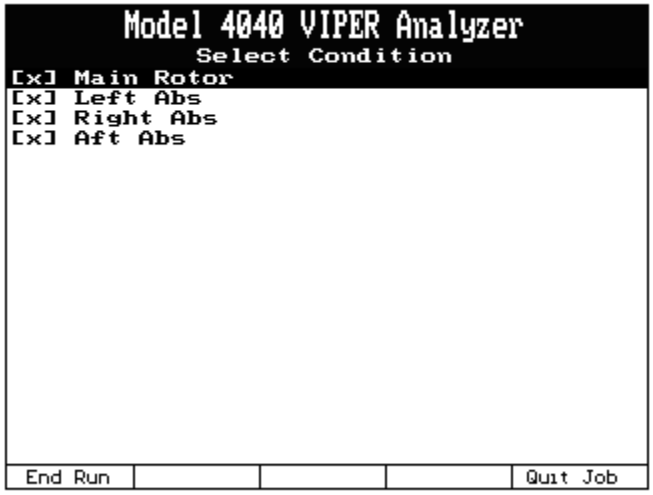
15. The “Select Condition” screen will reappear. Conditions with data readings will be displayed with am **[x]** symbol. Highlight the appropriate “Absorbers” condition name and press the **[ENTER]** key to take data for this condition. Excite the absorber as described in the appropriate Maintenance Manual. The analyzer will repeat Step 5 above for this condition. When data have been gathered for all necessary conditions, press **[F1]** “End Run” or **[F5]** “Quit Job” to continue.



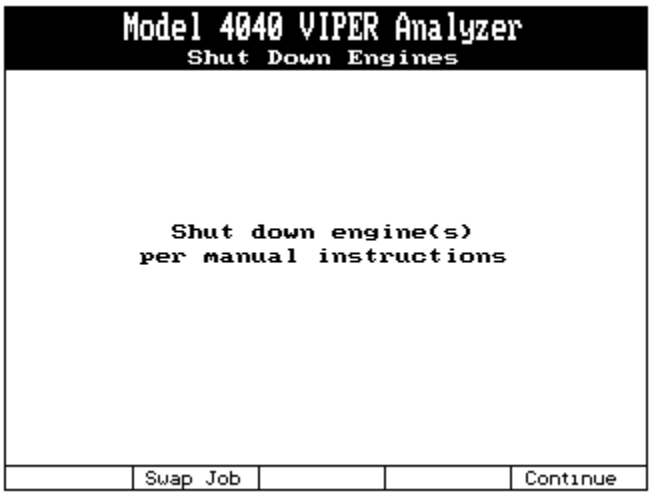
16. The analyzer will ask if you want to “Store the data?” Select **[F1]** for “Yes” to store the data and continue to the next condition. Select **[F5]** for “No” to return to Step 4 above to retake the present condition.



17. Gather data for all required absorbers removing and reinstalling equipment as necessary per Section B above. When finished, press the **[F1]** "End Run" key or the **[F5]** "Quit Job" key to exit the job.



18. You will be prompted to "Shut down engine(s) per manual instructions" as shown below. Use the **[F2]** "Swap Job" key to return directly to the Main Menu without rebooting the analyzer. Press **[F5]** to proceed after engine shut down.

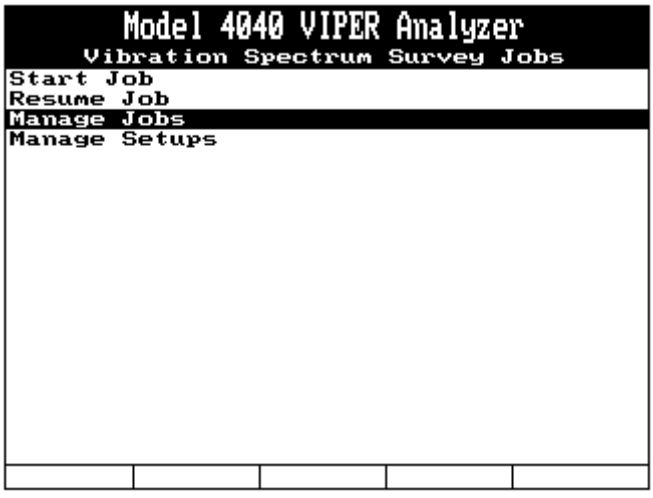


E. Review Job

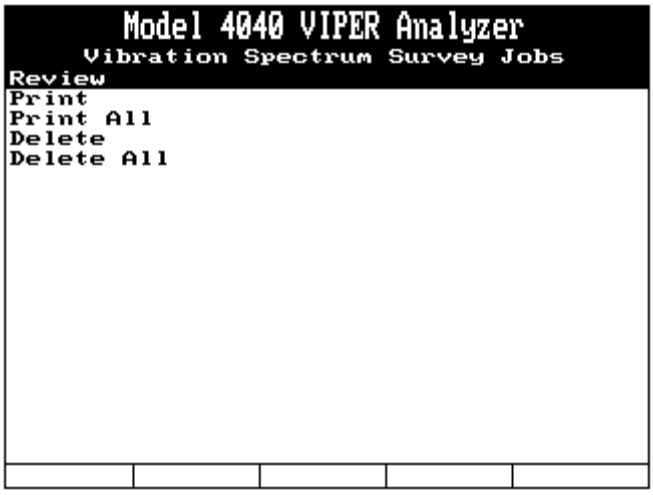
NOTE

The data shown below is only for illustration purposes and is not intended to be actual aircraft data. Actual aircraft data may vary from the samples displayed.

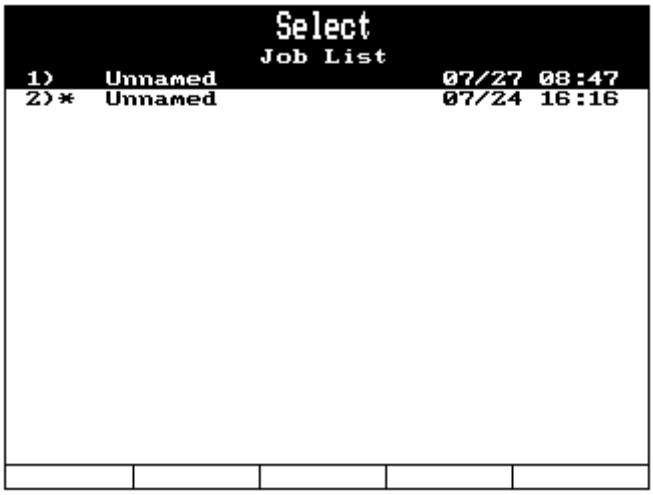
1. The analyzer will return to the “Vibration Spectrum Survey Jobs” menu. Select “Manage Jobs” from this menu and press **[ENTER]**.



2. From the next menu select “Review” and press **[ENTER]**



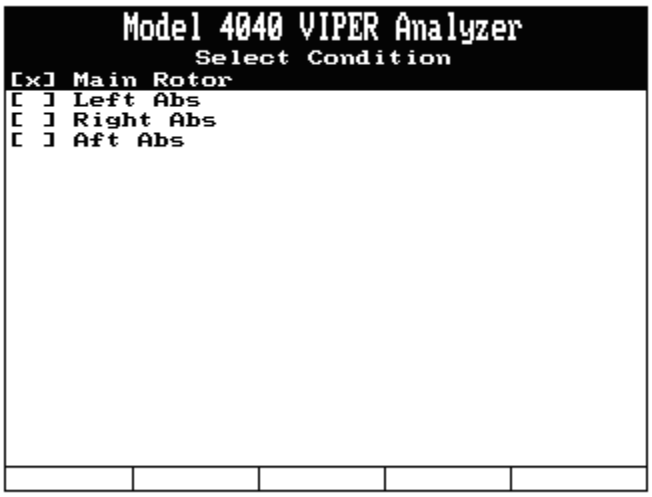
3. Select the previous job name from the list. If multiple jobs with the same name exist, use the date/time stamp adjacent to each name to help identify the correct job. A (*) before the job name indicates that this job is incomplete. Highlight the correct job name and press **[ENTER]**.



4. The list of conditions will be presented. Conditions containing data will have an **[x]** in the box before the condition name. Select the condition you would like to review, highlight the condition name and press **[ENTER]**.

NOTE

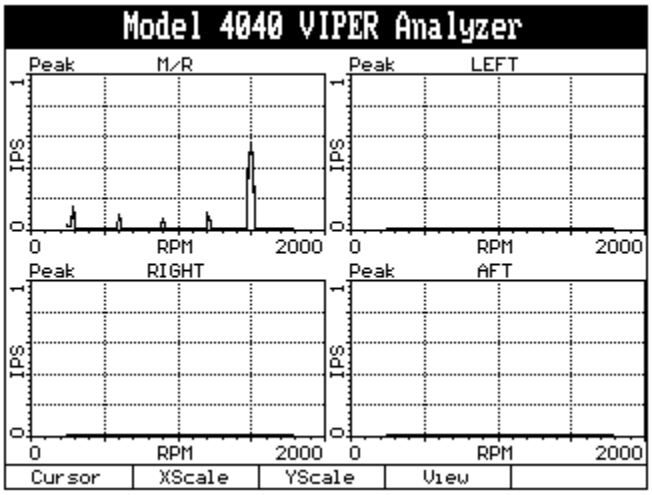
If only one condition contains data, the analyzer will immediately display the Spectrum as presented in Step 5 below.



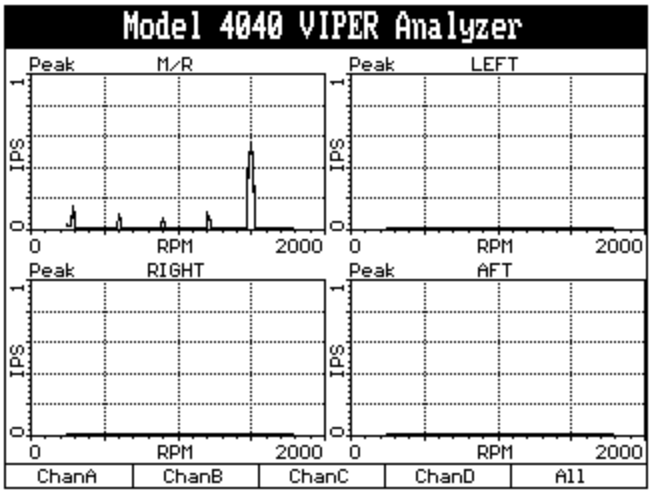
NOTE

The sample below uses the "Main Rotor" condition but the review process will be similar regardless of the condition selected.

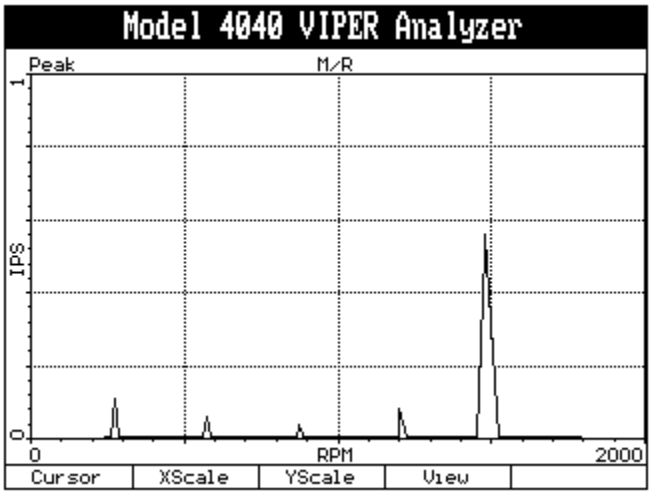
5. For easier reading, you can zoom in on a specific plot. To expand a single plot to occupy the entire screen, press the **[F3]** "View" key. The Function Key menu will change.



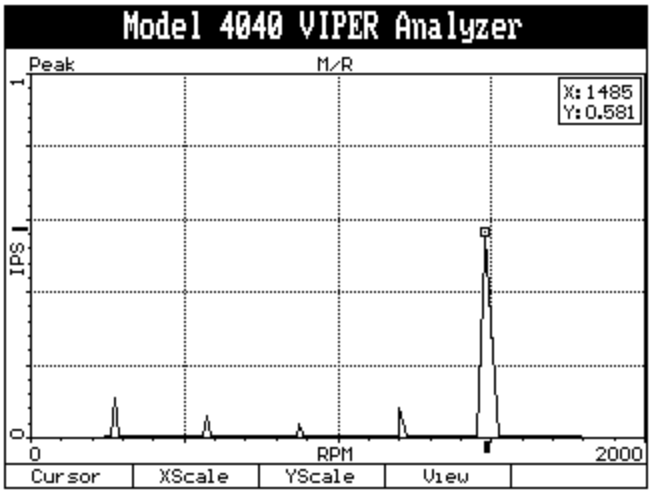
6. Now press the desired channel to expand. In this example, select **[F1]** "ChanA" to expand the M/R vibration spectra plot.



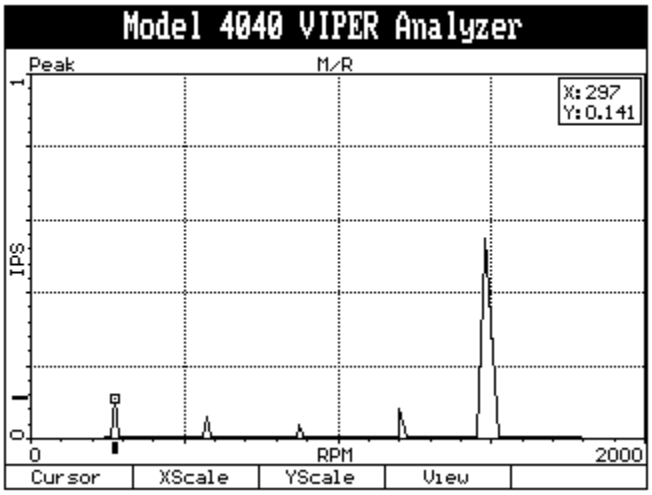
7. The screen will now show the single plot for Channel A which contains the Main Rotor vibration spectrum survey data. Notice the condition name displayed at the top of the plot.



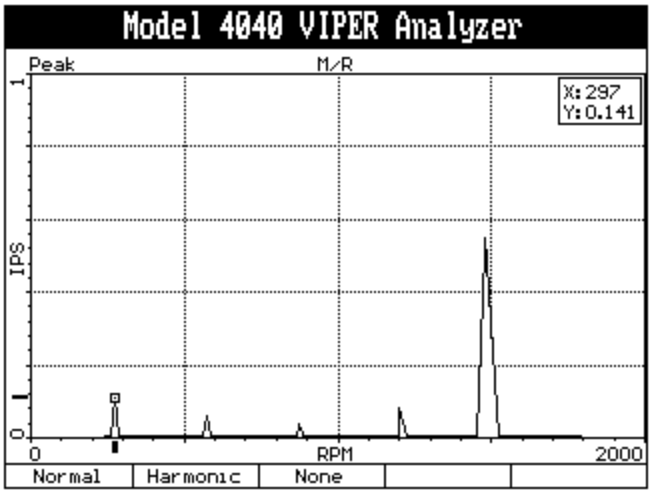
8. Press the **[⇒]** key once to activate a normal cursor. By pressing the **[⇒]** key the cursor will automatically indicate the highest peak on the entire survey. In the example below, the cursor is over the farthest right-hand peak. The X and Y scale location of the cursor appears in the upper right-hand corner of the survey plot. In the example below the cursor is located at 1485 RPM on the X-axis and 0.581 IPS on the Y-axis. This is in the range of the Main Rotor fifth harmonic. Note this RPM for tuning the vibration absorbers. If the cursor does not automatically appear over the fifth harmonic of the Main Rotor, use the **[⇐]** or **[⇒]** keys to move the cursor as necessary.



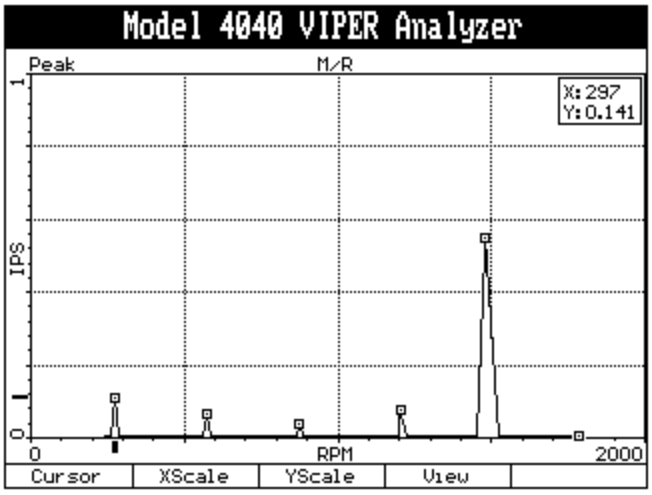
9. To confirm that the peak shown above is the fifth harmonic of the main rotor frequency, use the **[⇐]** key to move the cursor until the X and Y values in the upper right-hand corner indicate Main Rotor RPM, somewhere near 297 RPM.



10. Then, use the **[F1]** "Cursor" key to access the cursor menu. The function keys will now display the options listed below. Press the **[F2]** "Harmonic" key to display the harmonic type of cursor.



11. The harmonic cursor should position a square over each multiple of the primary frequency. Count the number of squares beginning with the square farthest to the left. The fifth square should be positioned at or near the top of the peak farthest to the right. This is the fifth harmonic of the Main Rotor frequency.



CAUTION

At no point should a correction be made that contradicts information in the maintenance manual.

12. Use the Main Rotor fifth harmonic frequency recorded in Step 8 above to tune the vibration absorbers. Install the appropriate sensor and perform the excitation procedure per the maintenance manual. Adjust the vibration absorber until the excitation frequency matches the peak as shown in Step 8 above.

F. Quit Job

1. Repeat Steps D.10 through E.12 above applying corrections as necessary. Remove all test equipment and return the aircraft to airworthy condition.