Application Note

Agusta Westland AW139

Tail Rotor Balance

Part Number: 11-200-0266

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

Application Note

Application Note Number	A-AGAW139-4040-TR
Revision	3.0 (From Airframe information obtained 6/2009)
Function	Tail Rotor Balance
Airframe	Agusta Westland AW139
Engine	N/A
E-Setup Number	a-agaw139-4040-tr.asf
ACES Systems Analyzer	Model 4040
Boot/App Version	Boot 3.xx/App 3.xx or later
Procedure	N/A

Introduction

This Application Note covers the required equipment, equipment installation, analyzer setup, data acquisition and solution process for using the ACES Systems Model 4040 with the Tail Rotor Enhanced Performance Option to perform a tail rotor balance 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 for balance and all adjustments should be made in accordance with the Airframe Maintenance Manual.

A. Required Equipment

The following equipment is required to perform a Tail Rotor Balance*:

Item	Quantity	Description	Part Number
1.	1	Analyzer, Model 4040	10-100-4040
2.	1	Tachometer, Optical, PhotoTach (New)	10-100-1773
3.	1	Cable, Tach, Generic, 50’	10-320-0126
4.	2	Sensor, Vibe, Accel, 991D-1	69-100-0075
5.	1	Mount, ¼X28 Sensor, Vibe ¼” Hole, S/Stl	22-430-0035
6.	1	Tape, Reflective, Roll, 10’	10-400-0176
7.	1	Option, 4040 Main and Tail Rotor	11-900-0005
8.	1	Mount, PhotoTach, AW139	10-100-0170
9.	2	Cable, Sensor 991D-1, 50’	10-320-0163

*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 equipment may be used as an alternate when accomplishing the job:

Item	Quantity	Description	Part Number
10.	1	Shield, PhotoTach Sun	22-430-0096

Miscellaneous Equipment

Tape, tie wraps or Adel clamps to secure cables to airframe.

If adjustments are made to the Tail Rotor Balance, use only hardware or balance weights that are specified in the applicable airframe maintenance manual.

B. Equipment Installation

1. Place the analyzer (Item 1) in the flight compartment.
2. Remove two screws from the fairing on the fin structure. Install the PhotoTach Mount (Item 8) in this position on the tail boom. Install the PhotoTach (Item 2) into the Mount and secure with the nylon nut or sunshield (Item 10). (Figure 1)

NOTE

See Paragraph D.3 below for additional installation instructions of PhotoTach and Tape.

3. Obtain access to the tail rotor gearbox. Install the Vibration Sensor Mount (Item 5) in position on the attachment hole on the tail rotor gearbox. Secure with a Vibration Sensor (Item 4). Attach the second Vibration Sensor (Item 4) to the threaded insert of the Sensor Mount. Insure the second Sensor is installed in a radial position and that it points to the center of the tail rotor hub as shown. (Figure 2).

NOTE

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

4. Connect the end of the 50’ Tach Cable (Item 3) marked “Tach Interface” to the PhotoTach. Use the four holes in the PhotoTach Mount to secure the connection to prevent damage to the aircraft finish. Select one of the 50’ 991D-1 cables (Item 9) and connect the end marked “991D-1” to the “Axial” vibration sensor, the one securing the Vibration Sensor Mount. Connect the end marked “991D-1” of the remaining 50’ 991D-1 cable (Item 9) to the “Radial” vibration sensor. Safely route all three of the cables into the cabin area to the analyzer. Use Adel clamps to safely secure the cables along the length of the tail boom. Connect the end of the Tach Cable marked “Analyzer” to the “TACH 1” connector. Connect the end of the cable attached to the “Axial” Sensor to “CHANNEL A” on the analyzer. Connect the end of the cable attached to the “Radial” Sensor to the “CHANNEL B” connector on the analyzer.
5. Reinstall any previously removed cowlings. Return aircraft to flying configuration.

Equipment Installation Diagram

Figure 1

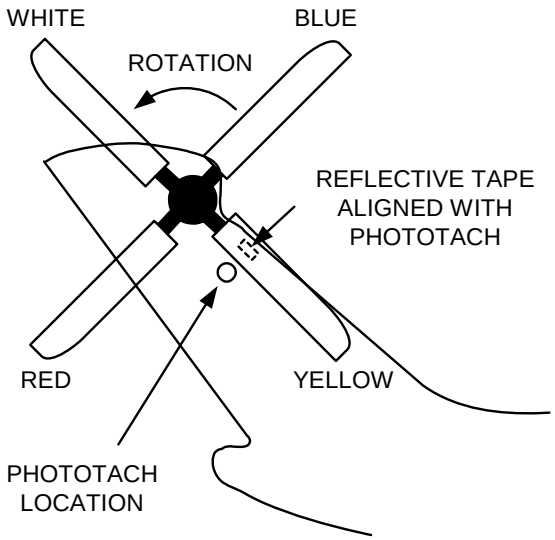
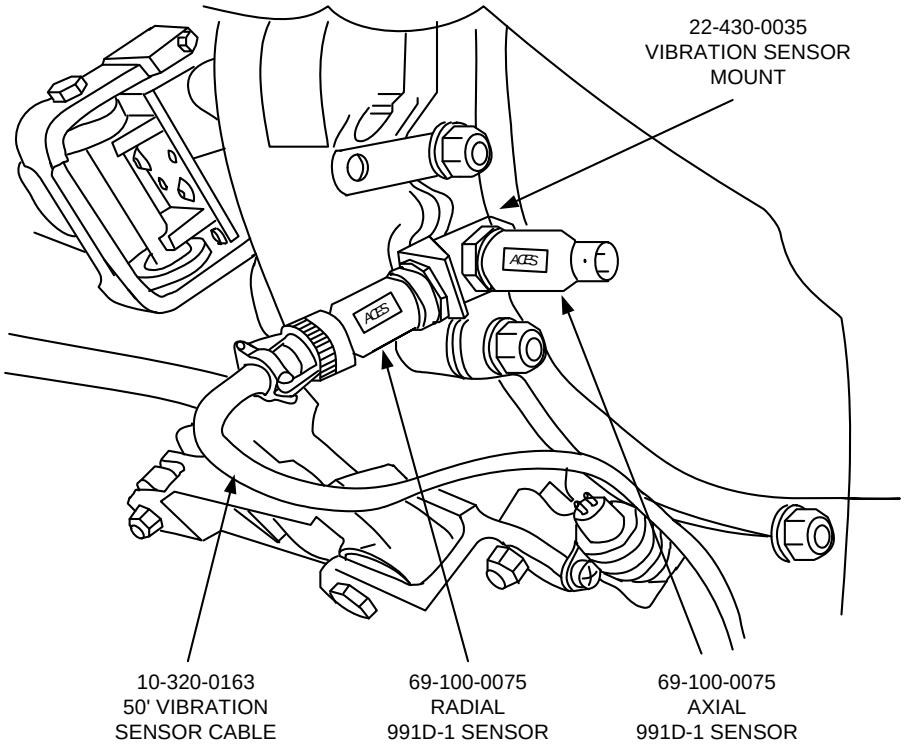
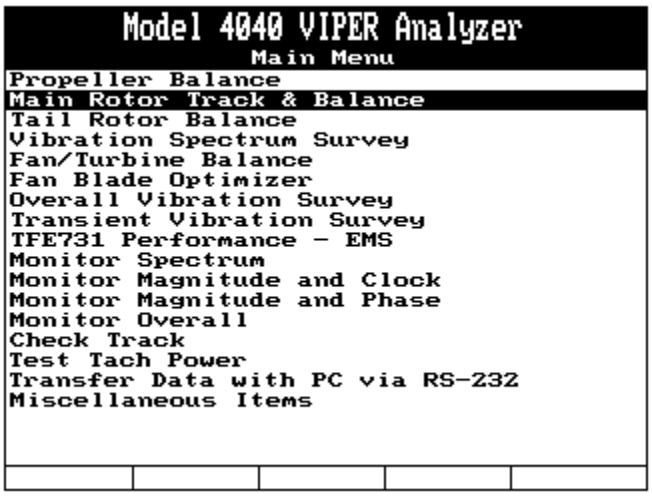


Figure 2

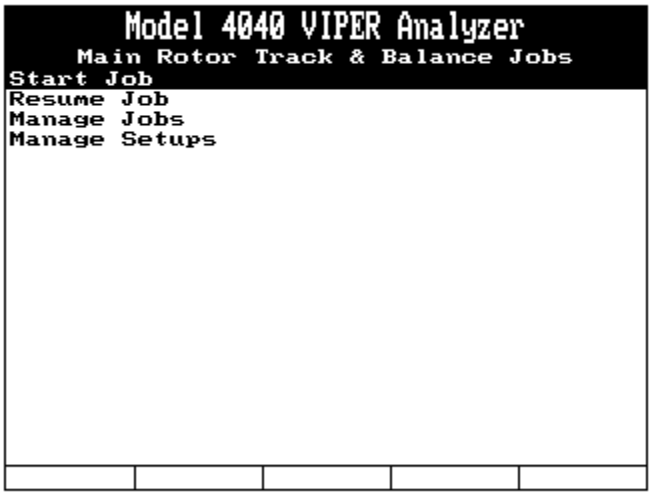


C. Analyzer Set Up

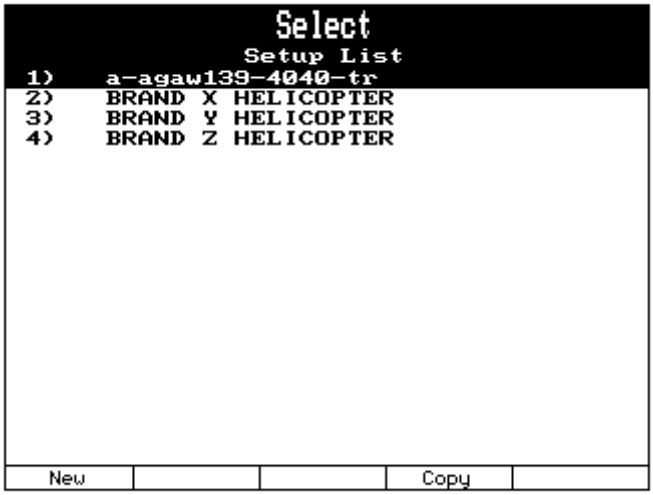
1. Insure the analyzer battery is charged prior to starting the job. See the Model 4040 User Manual #4040-OM-01 (P/N 75-900-4040) Chapter 2 for detailed instructions on battery charging.
2. Turn the analyzer ON by pressing the **[ON/OFF]** key.
3. From the Main Menu shown below, select "Main Rotor Track & Balance" and press the **[ENTER]** key. This procedure must be configured under the Main Rotor Track & Balance option due to the use of two sensors and multiple flight conditions.



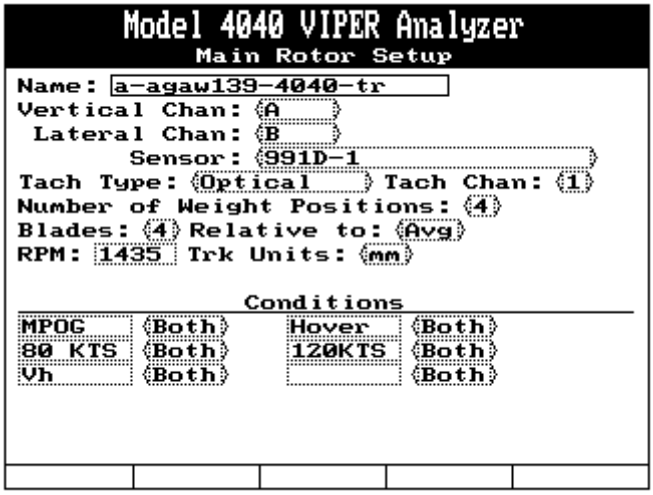
4. From the Main Rotor Track & Balance Menu shown below, select "Start Job" and press the **[ENTER]** key.



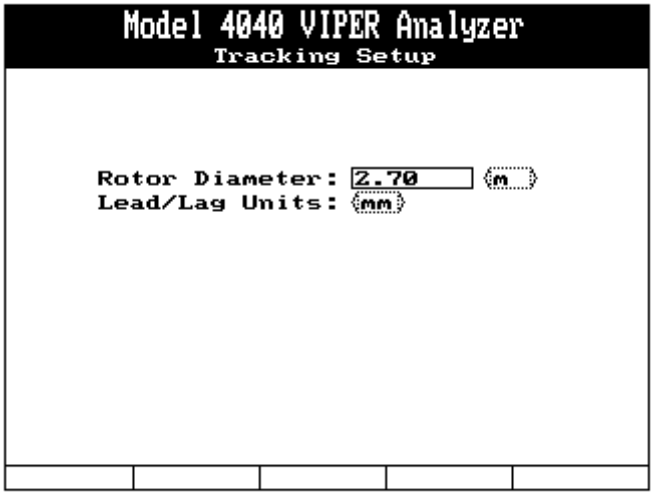
5. If the Agusta Westland AW139 is listed in the Setup List, select it using the **[⇓]** key, press **[ENTER]** and go to Section D below. If the Agusta Westland AW139 is not in the Setup List, press the **[F1]**, "New" key and go to Step 6 below.



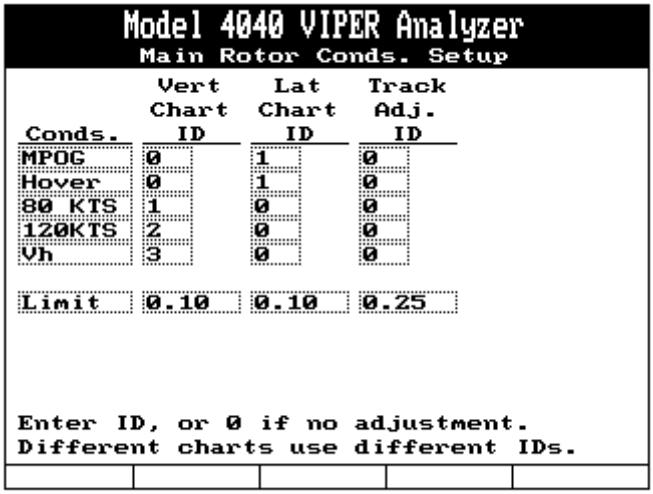
6. The “Main Rotor Setup” screen now appears. Enter the Tail Rotor Setup as shown below. You can enter any name that is convenient for locating the setup in the future. When completed press **[ENTER]**.



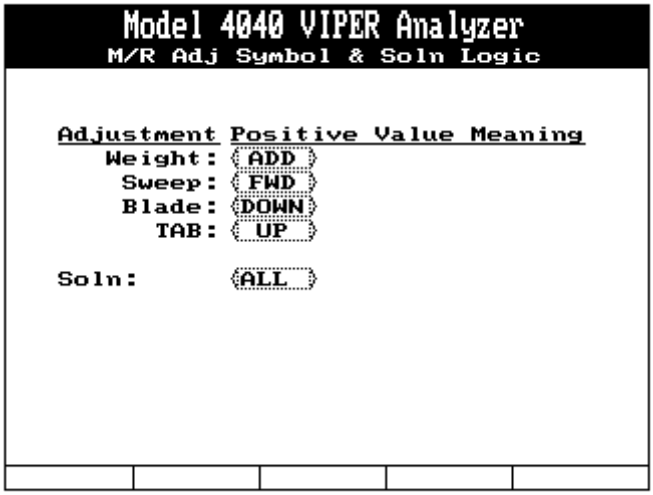
7. The “Tracking Setup” screen will be displayed next. Enter the values as shown in the illustration below. Press **[ENTER]** to continue.



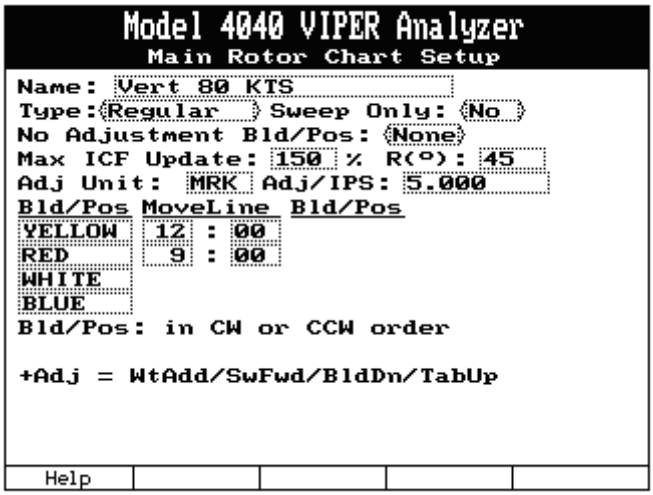
8. The “Main Rotor Conds. Setup” screen will appear next as displayed below. The “limit” field under each measurement type will set the point at which the analyzer will determine whether corrections are needed. This is not reflective of a limit imposed by the manufacturer. See the applicable Maintenance Manual for the track and vibration levels required for return to service. Enter the information as indicated in the illustration below. Press **[ENTER]** to continue.



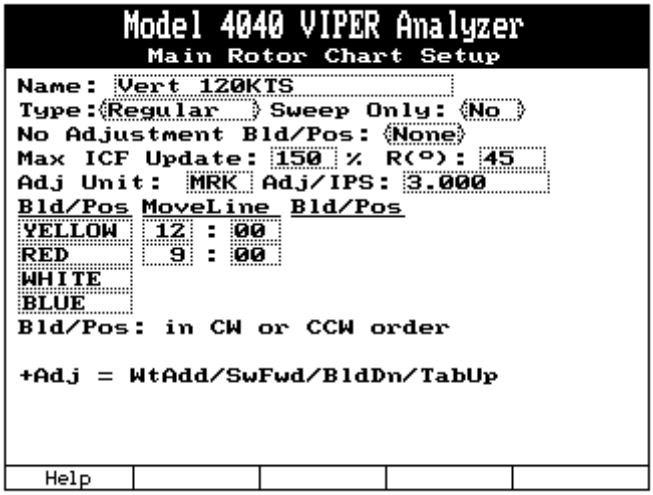
9. The next screen to appear will be the “M/R Adj Symbol Setup” screen. The function of this screen is to determine the direction of movement for a positive (+) adjustment. In this application, a positive move indication means to ADD weight, sweep will not apply and can be left as FWD, you will move the blade DOWN with Pitch Change Link (BLADE) and the Trim Tab (TAB) adjustments will not apply and can be left as UP. Enter the values as shown below. When completed press **[ENTER]**. Next, the balance charts will be entered into the analyzer.



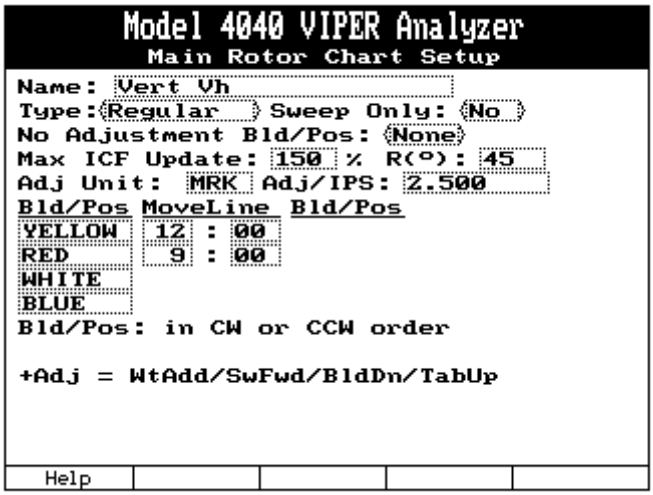
10. The first balance chart to define will be the “Vert: 80 KTS” chart. Enter the information as presented below. Press **[ENTER]** to continue.



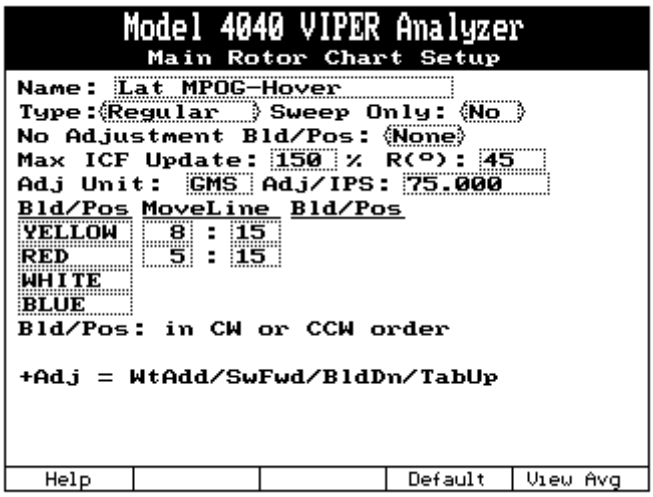
11. The second chart to define will be the “Vert: 120KTS” chart. Enter the information as shown below and press **[ENTER]** to continue.



12. The third chart to define will be the “Vert: Vh” chart. Enter the information as shown below and press **[ENTER]** to continue.

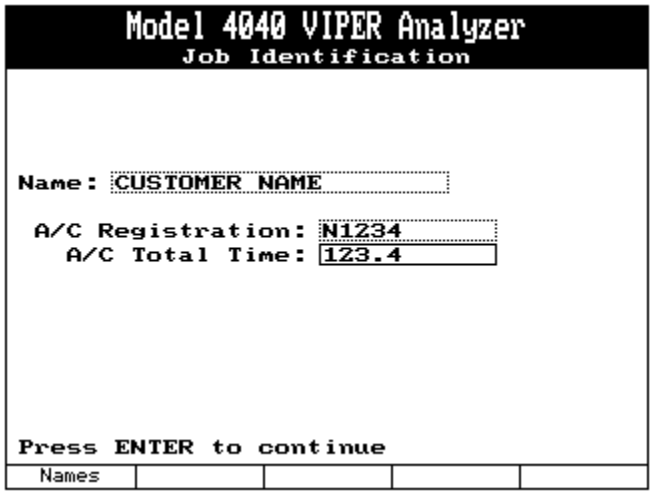


13. The final chart to define will be the “Lat: MPOG – Hover” chart. Enter the information as shown below and press **[ENTER]** to continue.

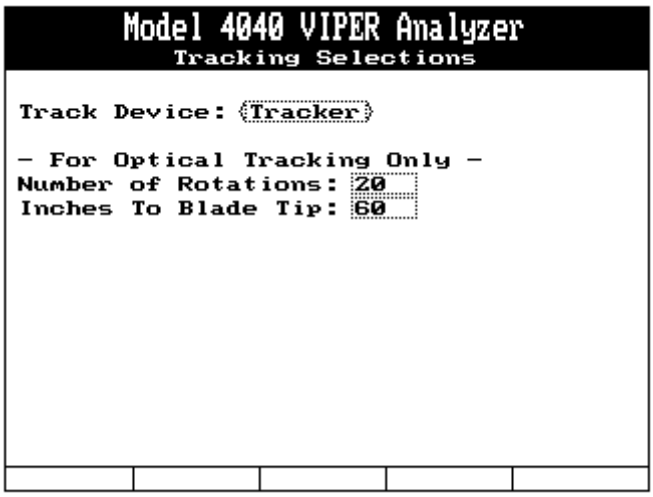


D. Data Acquisition

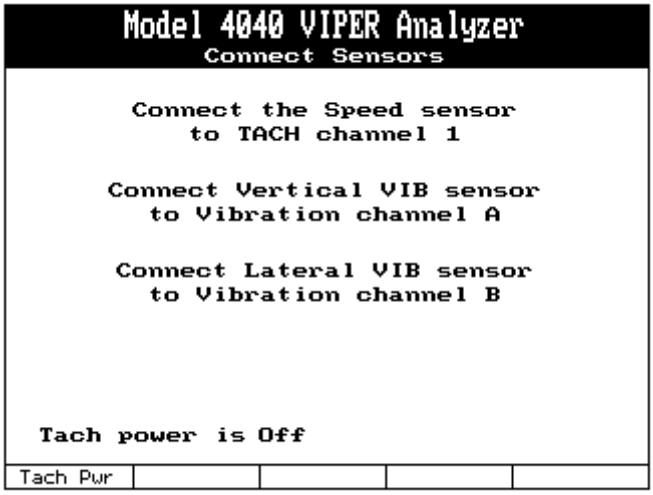
1. The “Job Identification” screen will be displayed, as shown below. Use the analyzer keypad to enter a customer name in the “Name:” field. The analyzer will maintain a list of customer names as new names are entered. If names have been previously entered into this analyzer, you may press the **[F1]** “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 is the “Tracking Selections”, as shown below. The track will not be obtained with the Optical Tracker for this procedure, so this page can be left set at the defaults. When all fields are complete, press the **[ENTER]** key to continue.



3. The next screen to be displayed will be the "Connect Sensors" screen as illustrated below. This screen gives instructions on installing sensors and cables. You may also check the PhotoTach alignment by pressing the **[F1]** "Tach Pwr" key which supplies power to the optical tachometer for checking alignment with the reflective tape.



3.1 Press **[F1]** "Tach Pwr". The YELLOW blade will be identified as the target blade. Rotate the tail rotor until the YELLOW blade is aligned with the PhotoTach. (See Section B Figure 1 above)

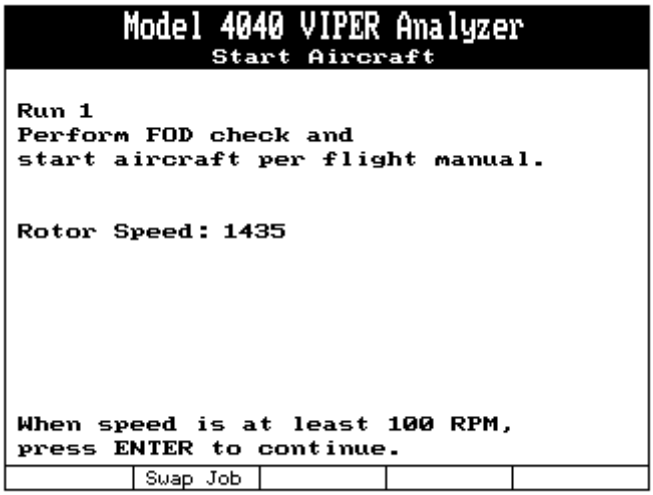
3.2 Hold a 6-inch piece of reflective tape (Item 6), reflective surface facing the PhotoTach, against the backside of the blade. Do not remove backing at this point.

3.3 The red "Gate" light on the back of the PhotoTach should illuminate as the reflective tape is properly aligned in front of the LED. Clean an area of the blade in preparation for mounting the reflective tape.

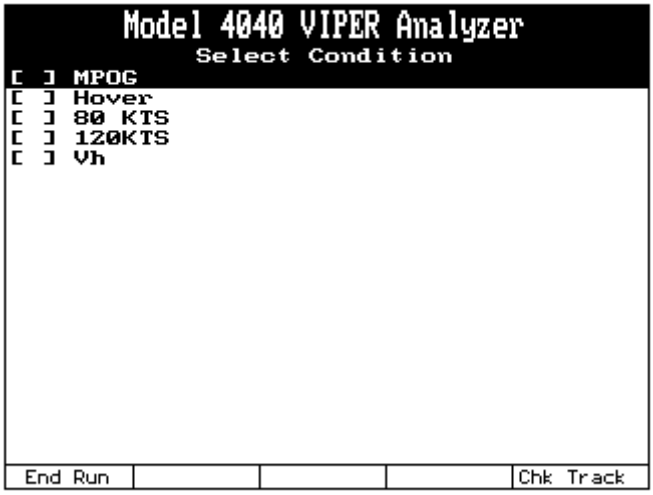
3.4 Remove the backing and install the reflective tape on the clean blade surface.

3.5 Press **[ENTER]** when finished with Tape installation.

4. The “Start Aircraft” screen will be displayed with instructions to “Perform FOD check and start aircraft per flight manual”. When the aircraft is started and normal operating conditions have been established, press the **[ENTER]** key to continue. Use the **[F2]** “Swap Job” key to return directly to the Main Menu without rebooting the analyzer.

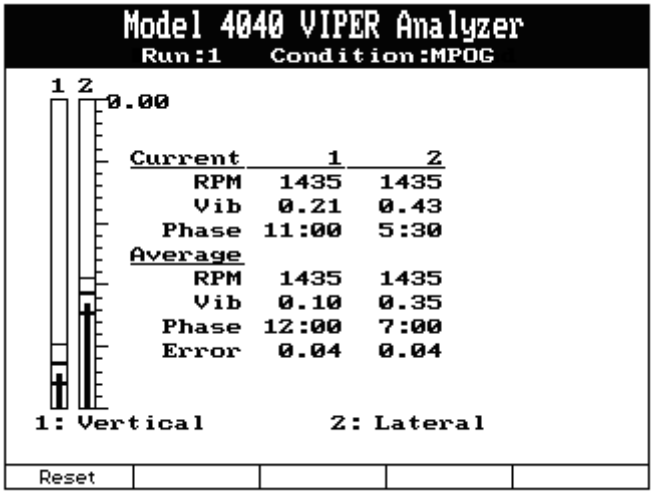


5. The analyzer will display the “Select Aircraft Condition” screen as displayed below. Select the condition that you want to gather data for using the **[⇑] [⇓]** arrows and press **[ENTER]**. Track readings will not be acquired during this process so do not press the **[F5]** “Chk Track” key.



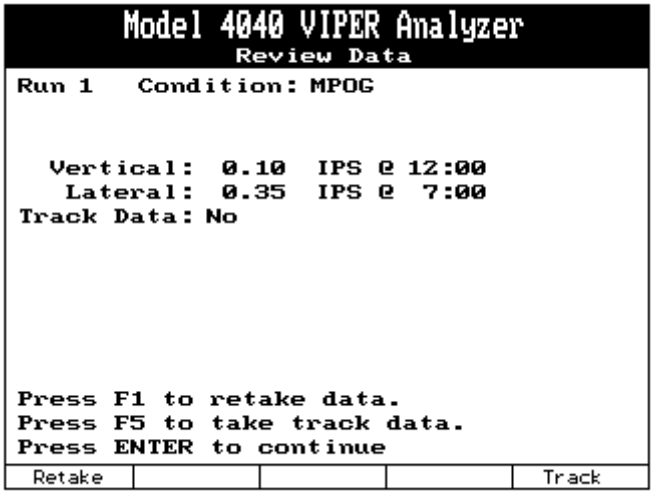
6. After pressing **[ENTER]** the “Run: 1 Condition: MPOG” screen will be displayed as shown in the example below. This screen allows you to monitor both the current and averaged vibration readings. Operate the aircraft in the configuration for the selected condition and allow the analyzer to collect data. While monitoring the measurement, you may press the **[F1]** “Reset” key to restart the averaging process. Use this feature as a way to validate the quality of the measurement. If the averaged readings return to a value similar to the displayed value prior to being “Reset”, the measurement can be considered good. If the measurement is not similar, you may choose to “Reset” the average again. If the “Error” at

the bottom of the text portion of the screen is not “0”, this is not an indication of failure or fault, only that the vibration averaging errors cannot be resolved below the displayed level. This “Error” value will typically be higher as the balancing process reduces the vibration amplitude. The “Error” indication should be as steady as possible with very little change before you press the **[ENTER]** key to stop acquisition.



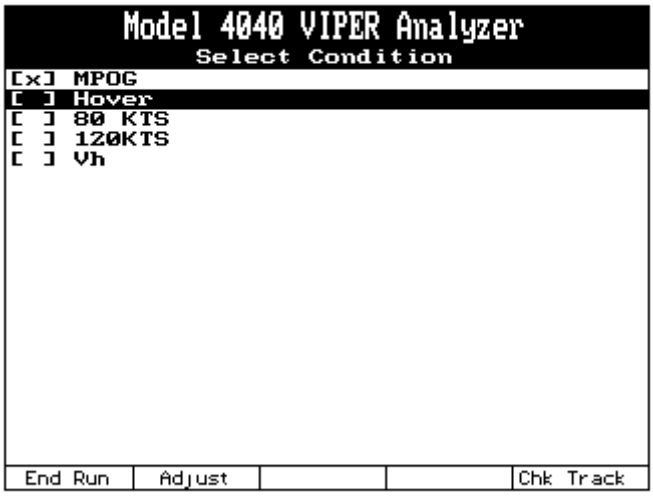
See the Model 4040 User Manual #4040-OM-01 (P/N 75-900-4040) Chapter 20 for detailed instructions on how to read the “Converging Vibration Indicator and Scale”.

7. The “Review Data” screen will be displayed as shown in the example below. These are the amplitude and clock angle readings for the condition. You may retake the data by pressing the **[F1]** “Retake” function key as indicated at the bottom of the screen. When satisfied with the acquired data as displayed, press the **[ENTER]** key to accept the data with “No” track information and continue. Track readings are not required as part of this procedure. Do not press the **[F5]** “Track” key as part of this procedure.



8. The “Select Aircraft Condition” screen will reappear as shown in the example below. This time any condition that has stored vibration and/or track data will have an **[x]** preceding the

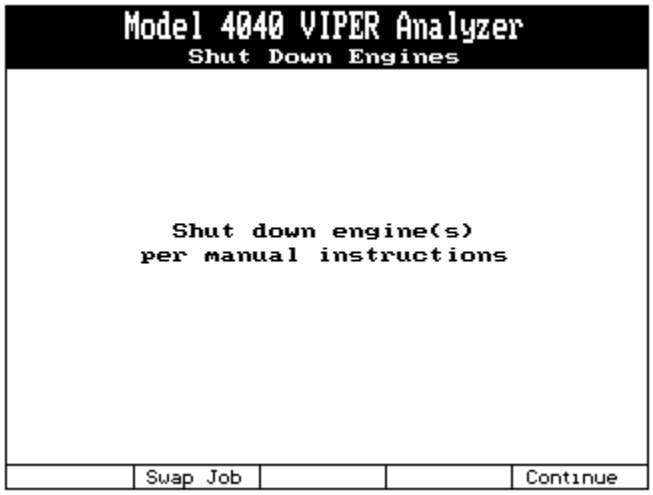
condition name. Repeat sequence through all flight regimes. You can choose to "End Run" at any time by pressing the **[F1]** "End Run" key. This sequence will allow you to review all previous measurements before proceeding to the suggested solutions. If a condition has recorded a vibration or track reading that is in excess of the limits defined in Paragraph C.8 above, the word "Adjust" will appear above the **[F2]** key. Pressing **[F2]** "Adjust" will bypass the review process and move directly to the suggested solution screens. In either case you will be taken to Paragraph 9 below.



NOTE

The [F1] "End Run" and [F2] "Adjust" keys are the only ways to exit this screen. Pressing [ENTER] will restart the data collection process for the highlighted condition.

9. The analyzer will display the "Shut Down Aircraft" screen as shown below. Use the **[F2]** "Swap Job" key to return directly to the Main Menu without rebooting the analyzer. When the engine shut down process is complete, press the **[F5]** "Continue" key to review the data or view the suggested solutions.



NOTE

It is important to remember that when installing or removing weights and recording their positions the influence used for the next run will be updated by the result from the previous run's solution. Therefore, be as accurate as possible when recording adjustments made regardless whether the recommended solution is implemented. The only entries on these screens should reflect the actual solution implemented.

10. The analyzer will present all of the solutions possible from the data gathered. It is possible for the analyzer to give two adjustments that would adversely affect the other. The user is ultimately responsible for determining which adjustments to implement and which to discard. If a suggested correction is determined unnecessary, use "Inst=None" **[F2]** to eliminate data in the "Installed" column. Make the desired adjustments to the rotor system as called for by analyzer and press **[ENTER]**. The user will now be prompted to start the engine and continue with Run #2.

E. Solution Examples

This section contains samples of the solution screens possibly encountered during the job. The corrections are examples only and do not reflect actual aircraft data. The actual solution screens encountered by the user will vary depending upon data acquired.

CAUTION

At no point should a correction be made that contradicts information in the maintenance manual. The analyzer will attempt to resolve the vibration and/or track level to 0.00. This may require adjustments that are not practical to duplicate. The technician must determine the closest possible match to the suggestion.

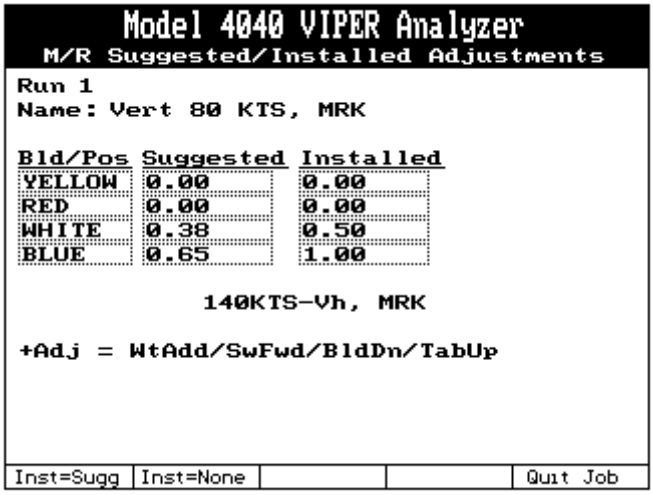
NOTE

Solutions will only be presented for readings that exceed the limits set in Paragraph C.8 above. It is necessary to add the closest measurable amount of correction and record the actual correction in the "Installed" column.

The Model 4040 analyzer can only update internal Influence Coefficients when one solution per run is implemented. Even though multiple solution screens are presented, entering solutions from multiple screens on the same run will disable the Influence Coefficient Update during the job.

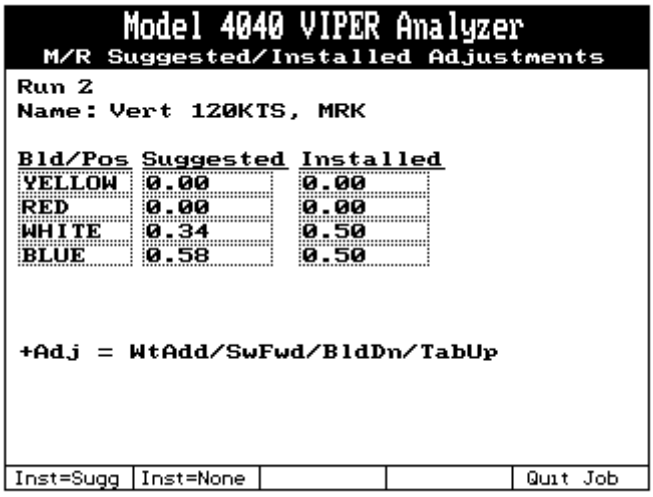
1. The first possible solution screen is the "Vert: 80 KTS, MRK" solution. This screen suggests the corrections to make to improve Vertical vibration readings at 80 KTS by adjusting the Pitch Change Links in Marks (MRK). You will adjust the PCL DOWN the indicated number of marks to reduce pitch in the blades. See the reminder line at the bottom of the screen.

   In the example below, it is suggested to adjust the "WHITE" PCL DOWN 0.38 MRK and the "BLUE" PCL DOWN 0.65 MRK. The closest measurable adjustment is to adjust the "WHITE" PCL DOWN 0.50 MRK and adjust the "BLUE" PCL DOWN 1.00 MRK. This adjustment was made and entered into the analyzer.



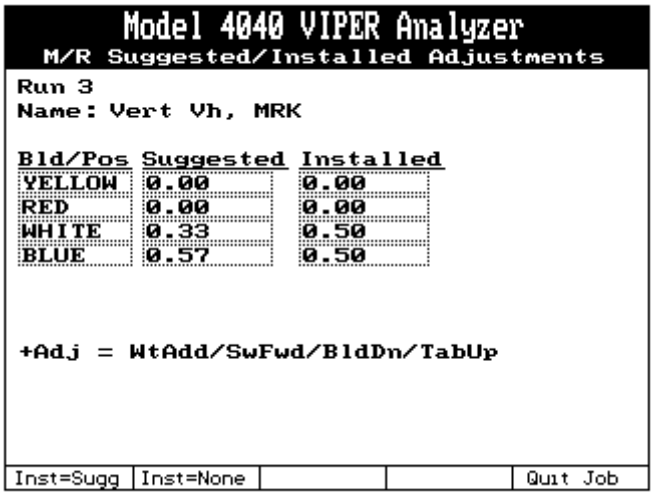
2. The second possible solution screen available is from the “Vert: 120KTS, MRK” chart. This screen suggests the corrections to make to improve Vertical vibration readings at 120KTS by adjusting the Pitch Change Links in Marks (MRK). You will adjust the PCL DOWN the indicated number of marks to reduce pitch in the blades. See the reminder line at the bottom of the screen.

   In the example below, it is suggested to adjust the “WHITE” PCL DOWN 0.34 MRK and the “BLUE” PCL DOWN 0.58 MRK. The closest measurable adjustment is to adjust the “WHITE” PCL DOWN 0.50 MRK and adjust the “BLUE” PCL DOWN 0.50 MRK. This adjustment was made and entered into the analyzer.



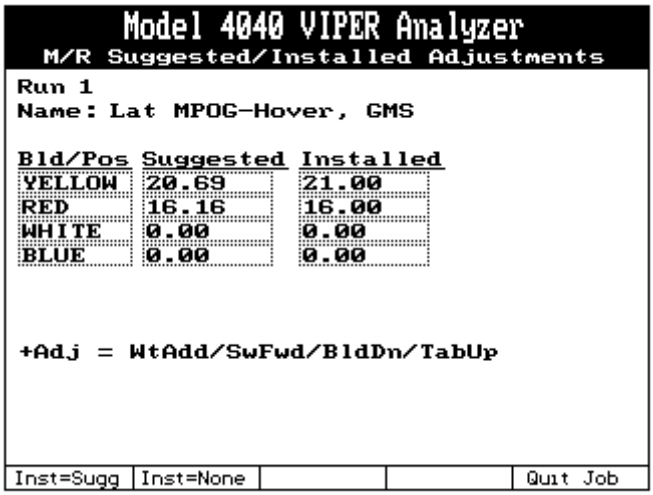
3. The third possible solution screen available is from the “Vert: Vh, MRK” chart. This screen suggests the corrections to make to improve Vertical vibration readings at Vh by adjusting the Pitch Change Links in Marks (MRK). You will adjust the PCL DOWN the indicated number of marks to reduce pitch in the blades. See the reminder line at the bottom of the screen.

In the example below, it is suggested to adjust the “WHITE” PCL DOWN 0.33 MRK and the “BLUE” PCL DOWN 0.57 MRK. The closest measurable adjustment is to adjust the “WHITE” PCL DOWN 0.50 MRK and adjust the “BLUE” PCL DOWN 0.50 MRK. This adjustment was made and entered into the analyzer.



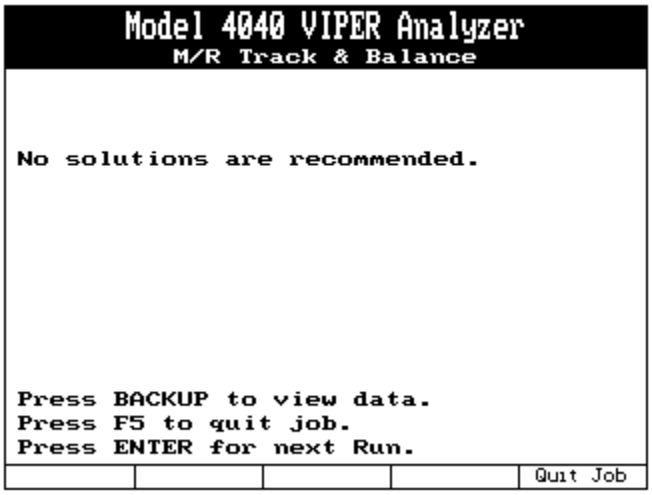
4. The final possible solution is from the “Lat: MPOG-Hover, GMS” chart. This screen suggests the corrections to make to improve Lateral vibration readings by adding weight in grams (GMS).

   In this case, adding 20.69 GMS to the “YELLOW” blade and adding 16.16 GMS to the “RED” blade should correct the lateral vibration. The closest measurable adjustment is determined to be to add 21.00 GMS to the “YELLOW” blade and to add 16.00 GMS to the “RED” blade. The adjustment is made and entered into the analyzer. (To enter a negative (-) number if removing weight from a location, press the **[SPACE]** key once.)

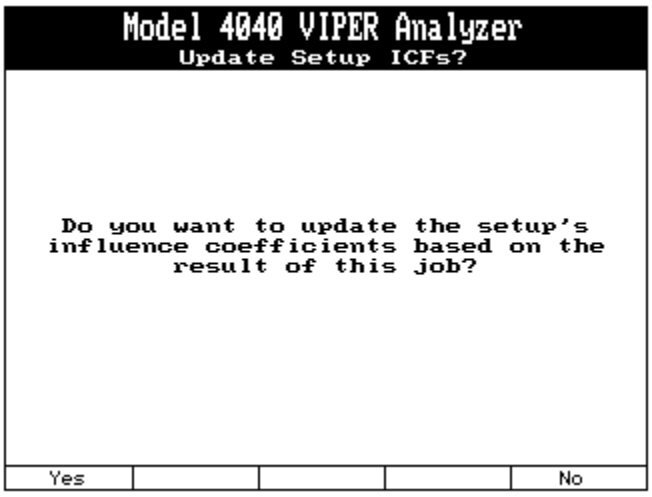


F. Quit Job

1. Repeat Steps D.4 through D.10 above applying the solutions as necessary. If all measurements in all conditions are below the limits set in Paragraph C.8 above, the message below will appear. Pressing the **[BACKUP]** key will allow you to return to review the measurements from all runs. Pressing the **[ENTER]** key will allow you to take additional readings if you choose. Pressing **[F5]** "Quit Job" will mark the job as complete and take you to Paragraph 2 below.



2. From the screen shown below, decide if you would like to update the ICF used in the original setup. Pressing **[F1]** "Yes" will add the chart corrections from this job to the ICF from the original setup. This can be a powerful tool when using this setup in the future. The chart corrections learned as a result of the previous job will be applied from the beginning of the next job that uses the same setup. This can reduce the number of runs required to balance the helicopter. If you select **[F5]** "No" any chart corrections applied during the previous job will be discarded. The setup will revert to the chart settings in place before the job was started. This can be useful if the helicopter didn't respond as others of the same model or if a mistake was made somewhere during the job that caused extra runs to balance the helicopter.


Model 4040 VIPER Analyzer
Update Setup ICFs?
Do you want to update the setup's influence coefficients based on the result of this job?
Yes
No