



Application Note

MDHI 530 F and 520 N Models

Main Rotor Track and Balance

Part Number: 11-200-0201

AppNote Number: A-MD500FN-4040-MR (Rev. 0, Sep 2005)

This Application Note is provided for information only and does not supersede the requirements or guidelines set forth in the applicable engine or airframe maintenance manual. Technology for Energy Corporation assumes no obligation or liability, either expressed or implied, to the Purchaser arising out of the use of this procedure.

Copyright © 2005, TEC Aviation Division. All rights reserved. This document is to be printed and reproduced for personal use only.



Application Note

Application Note Number	A-MD500FN-4040-MR
Revision	0 (From Airframe Rev 36)
Function	Main Rotor Track and Balance
Airframe	MDHI 530 F and 520 N Models
Engine	N/A
E-Setup Number	a-md500fn-4040-mr.asf
ACES Systems Analyzer	Model 4040
Boot/App Version	Boot 1.04/App 1.05p3 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 Viper Analyzer with the Main Rotor Performance Option to perform main rotor track and balance on the airframe listed above. 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) and Optical Tracker Operational Supplement #540-OM-1 (P/N 75-900-2021). All procedures for track and balance and all adjustments should be made in accordance with the Airframe Maintenance Manual.

A. Equipment Setup

Required Equipment: The following equipment is required to perform a Main Rotor Track and Balance:

Item	Quantity	Description	Part Number
1.	1	Analyzer, Model 4040	10-100-4040
2.	2	Sensor, Vibe, Accel, 991D-1	69-100-0075
3.	1	Cable, Sensor 991D-1, 25'	10-320-0162
4.	1	Cable, Sensor 991D-1, 50'	10-320-0163
5.	1	Cable, Magnetic Pick-Up, 25'	10-320-0052
6.	1	Sensor, Magnetic Passive Speed	75-900-0187
7.	1	Mount, 1/4X28 Sensor, Vibe 1/4" Hole, S/Stl	22-430-0035
8.	1	Mount, 1/4X28 Sensor, Vibe 5/16" Hole, S/Stl	22-430-0036



9.	1	Tracker, Optical, Model 540-2	75-900-0542*
10.	1	Option, 4040 Main and Tail Rotor	11-900-0005

*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
11.	1	Target Assy, Tip	As Required
12.	1	Cable, Interf. Assy, Strobe	10-320-0161
13.	1	Strobelight	As Required
14.	1	Tachometer, Optical, Phototach (New)	10-100-1773*
15.	1	Cable, Tach, Generic, 50'	10-320-0126*
16.	1	Tape, Reflective, Roll, 10'	10-400-0176
17.	1	Mount, Phototach	10-100-0486

Miscellaneous Equipment

Tape or tie wraps to secure cables to airframe.

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

B. Equipment Installation

- Place the Analyzer (Item 1) in the flight compartment.

NOTE

For ACES Balance procedures, the blade numbering does not conform to the blade numbering found in the Airframe Maintenance Manual. This is necessary for proper operation of the ACES Equipment. Interrupter is permanently installed on the swashplate. Blade #1 (white) is positioned over the nose position when the magnetic pickup and single interrupter are aligned. Ensure that no other interrupters are installed.

- The MDHI 500 Series helicopters are permanently fitted with a magnetic pickup bracket for installation of the Pickup. Install the Magnetic Pickup (Item 6) into the bracket. Rotate the main rotor until the interrupter and Pickup are aligned. Adjust the gap to 0.030-0.070" and secure Pickup. Safety wire jam nuts as required. (Figure 1) **The blade that is over the nose is now designated as blade #1. The following blades are labeled 2-5 in passing order.** (Figure 2)

3. Install the Vibration Sensor Mount (Item 7) on the right hand side of the pedestal. Install a 991D-1 Sensor (Item 2) into the Mount, **ensure connector end of sensor faces down.** (Figure 3)
4. Install the Vibration Sensor Mount (Item 8) under the left screw, second from the front on the engine inlet fairing. Install the other Vibration Sensor (Item 2) into the Mount, **the connector must point to the left.** (Figure 4)

NOTE

Secure and route cables as not to interfere with hot or rotating components. Insure there is enough slack in the cables to permit full cyclic and collective inputs.

5. Connect Magnetic Pickup Cable (Item 5) to the Magnetic Pickup and route into cabin area. Secure cable with tape or wire ties. Connect balancer end of Cable to “Tach 1” on the Analyzer.
6. Install the Sensor Cable (Item 3) on the Vertical Vibration Sensor. Route the Cable away from the tail rotor pedals and connect the Analyzer end of the Cable to the “Channel A” connector.
7. Install the Sensor Cable (Item 4) on the Lateral Vibration Sensor. Route the Cable safely into the flight compartment and connect the Analyzer end of the Cable to the “Channel B” connector.
8. Connect the Optical Tracker (Item 9) to the Aux./Comm port on the Analyzer.
9. Reinstall any previously removed cowlings and return aircraft to flying configuration as necessary.

Equipment Installation Diagram

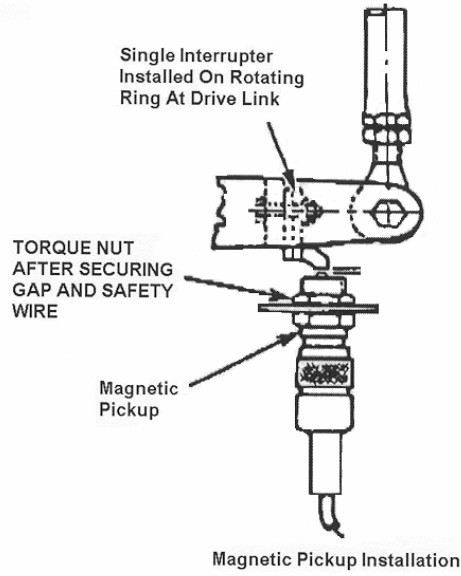


Figure 1

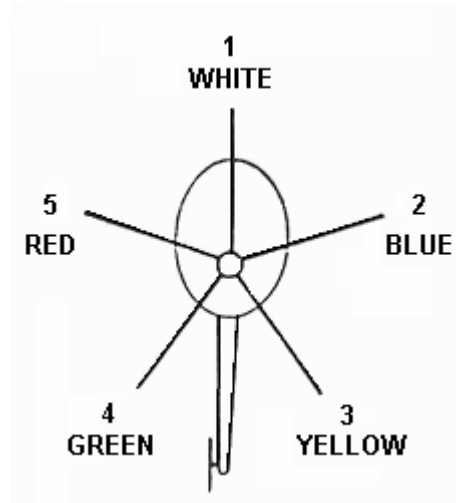


Figure 2

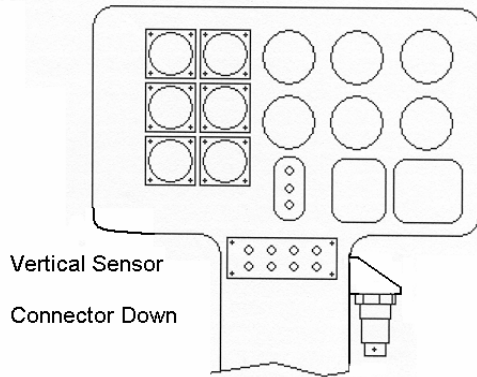


Figure 3

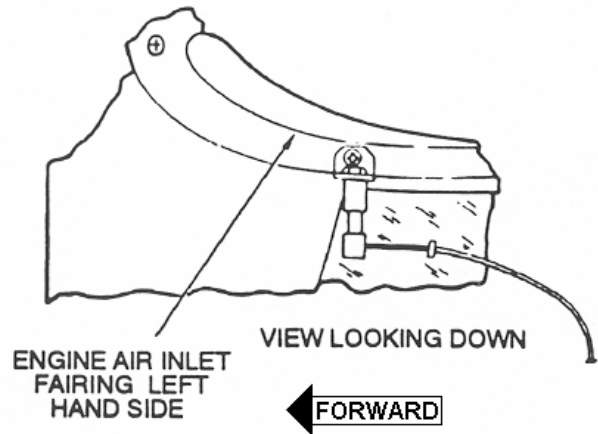
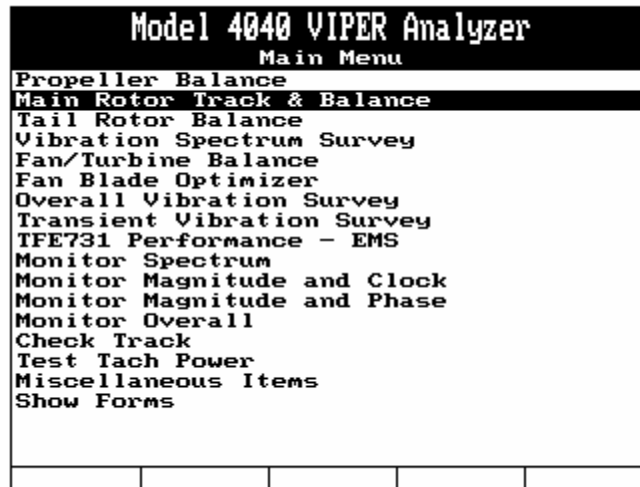


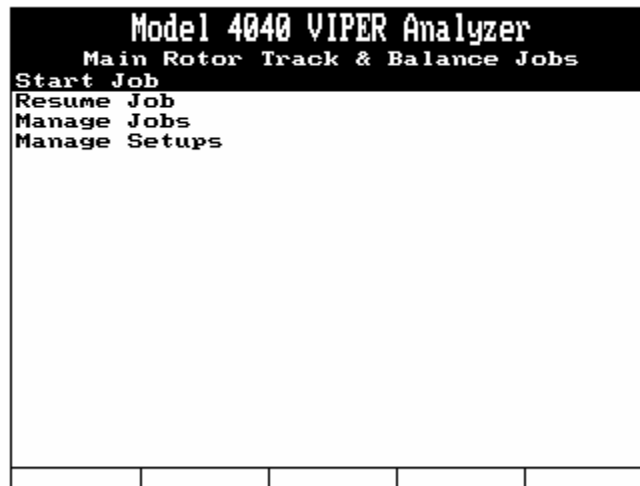
Figure 4

C. Analyzer Set Up

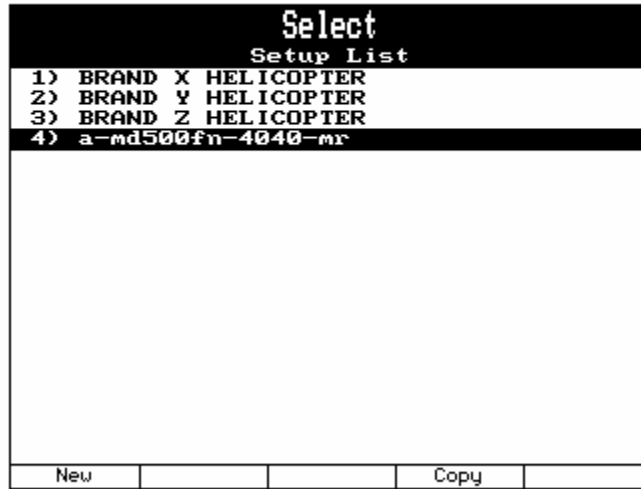
1. Insure the analyzer battery is charged prior to starting the job. See the Model 4040 User Manual #4040-OM-01 (P/N 75-900-4040) Chapter 2 for detailed instructions on battery charging.
2. Turn the analyzer ON by pressing the [ON/OFF] key.
3. From the Main Menu shown below, select “Main Rotor Track & Balance” and press the [ENTER] key.



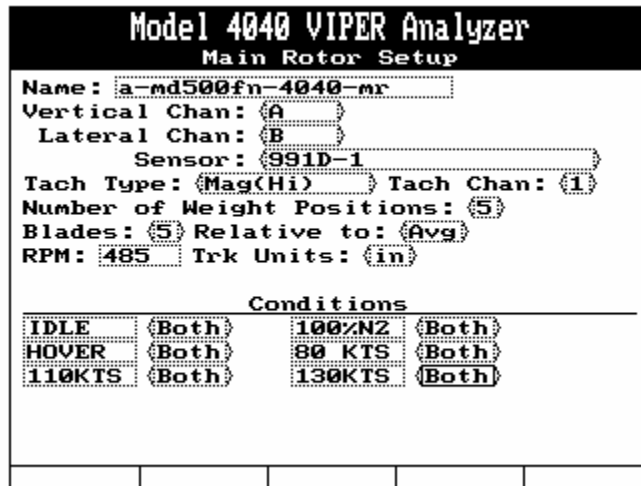
4. From the Main Rotor Track & Balance Menu shown below, select “Start Job” and press the [ENTER] key.



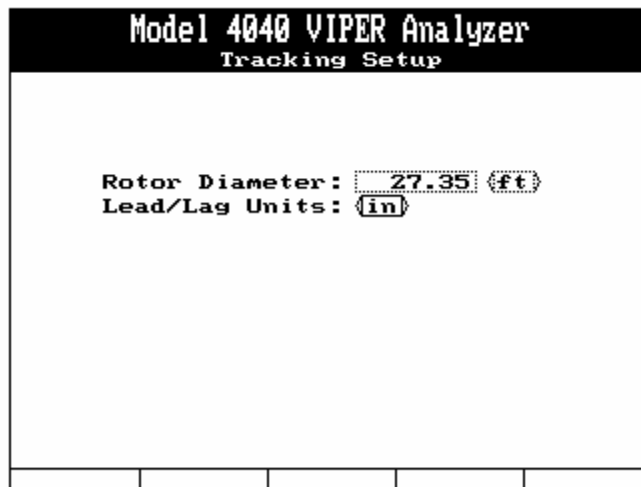
5. If the MDHI 530 F or 520 N is listed in the Setup List, select it using the [↓] key, press [ENTER] and go to Section D below. If the MDHI 530 F or 520 N is not in the Setup List, press the [F1], “New” key and go to step 6 below.



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



- 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. Enter the information as indicated in the illustration below. Press [ENTER] to continue.

Model 4040 VIPER Analyzer			
Main Rotor Conds. Setup			
	Vert	Lat	Track
	Chart	Chart	Adj.
Conds.	ID	ID	ID
IDLE	0	1	1
100%N2	0	1	2
HOVER	0	0	0
80 KTS	1	0	2
110KTS	1	0	2
130KTS	1	0	3
Limit	0.20	0.20	0.125

Enter ID, or 0 if no adjustment.
Different charts use different IDs.

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 a blade AFT, and move the blade UP with both Pitch Change Link (BLADE) and Trim Tab (TAB). Enter the values as shown below. When completed press [ENTER].

Model 4040 VIPER Analyzer	
M/R Adj Symbol & Soln Logic	
Adjustment	Positive Value Meaning
Weight:	ADD
Sweep:	AFT
Blade:	UP
TAB:	UP
Soln:	MAX

10. The first balance chart to define will be the “Vert: 80 KTS – 130KTS” chart. Enter the information as presented below. Press [ENTER] to continue.

```

Model 4040 VIPER Analyzer
Main Rotor Chart Setup
Name: Vert 80 KTS-130KTS
Type: Regular Sweep Only: No
No Adjustment Bld/Pos: None
Max ICF Update: 150 % R(°): 45
Adj Unit: FLI Adj/IPS: 5.000
Bld/Pos MoveLine Bld/Pos
1 1 : 20 5
2 11 : 00
3
4
Bld/Pos: in CW or CCW order

+Adj = WtAdd/SwAft/BIUp/TabUp

Help
    
```

11. The second chart to define will be the “Lat: IDLE – 100%N2” chart. Enter the information as shown below and press [ENTER] to continue.

```

Model 4040 VIPER Analyzer
Main Rotor Chart Setup
Name: Lat IDLE-100%N2
Type: Regular Sweep Only: No
No Adjustment Bld/Pos: None
Max ICF Update: 150 % R(°): 45
Adj Unit: FLI Adj/IPS: 6.000
Bld/Pos MoveLine Bld/Pos
1 6 : 40 5
2 4 : 15
3
4
Bld/Pos: in CW or CCW order

+Adj = WtAdd/SwAft/BIUp/TabUp

Help
    
```

12. The IDLE “Tracking Influence Setup” screen data will be entered as shown below. When completed, press [ENTER] to continue.

```

Model 4040 VIPER Analyzer
Tracking Influence Setup

| Conds | Adj Name | Unit | Adj/in | Max Upd% |
|-------|----------|------|--------|----------|
| IDLE  | PCL      | Flt  | 4.000  | 150      |


No Adjustment Bld/Pos: None
Blade Names:
1. 1
2. 2
3. 3
4. 4
5. 5

+Adj = WtAdd/SwAft/BIUp/TabUp

Help
    
```

13. The 100%N2 - 110KTS “Tracking Influence Setup” screen data will be entered as shown below. When completed, press [ENTER] to continue.

```

Model 4040 VIPER Analyzer
Tracking Influence Setup

      Conds      Adj      Max
      Name Unit Adj/in  Upd%
100%N2-110KT  TAB  DEG  0.500  150
No Adjustment Bld/Pos: (None)
Blade Names:
1.  1
2.  2
3.  3
4.  4
5.  5

+Adj = WtAdd/SwAft/BIUp/TabUp

```

14. The 130KTS “Tracking Influence Setup” screen data will be entered as shown below. When completed, press [ENTER] to continue.

```

Model 4040 VIPER Analyzer
Tracking Influence Setup

      Conds      Adj      Max
      Name Unit Adj/in  Upd%
130KTS      TAB  DEG  0.500  150
No Adjustment Bld/Pos: (None)
Blade Names:
1.  1
2.  2
3.  3
4.  4
5.  5

+Adj = WtAdd/SwAft/BIUp/TabUp

```

D. Data Acquisition

- 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 customer's 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.

Model 4040 VIPER Analyzer				
Job Identification				
Name: CUSTOMER NAME				
A/C Registration: N1234				
A/C Total Time: 123.4				
Press ENTER to continue				
Names				

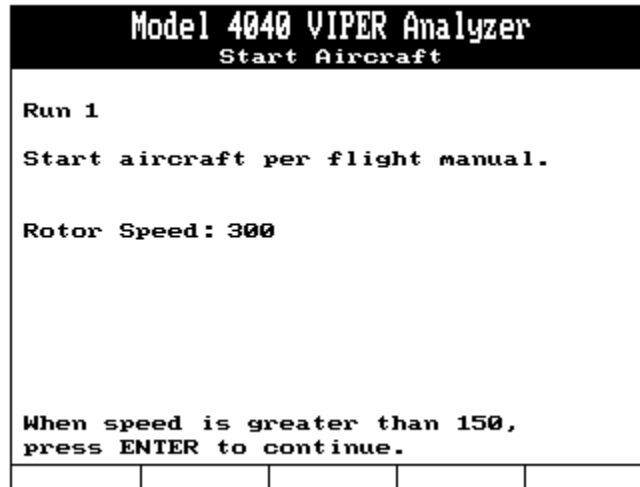
- The next screen to be displayed is the “Tracking Selections”, as shown below. Enter the data as displayed. When all fields are complete, press the [ENTER] key to continue.

Model 4040 VIPER Analyzer				
Tracking Selections				
Track Device: Tracker				
- For Optical Tracking Only -				
Number of Rotations: 50				
Inches To Blade Tip: 119				

- The next screen to be displayed will be the “Main Rotor Equipment Setup” screen as illustrated below. This screen gives instructions on installing sensors and cables. The Tach will be energized automatically when this screen is exited. The [F1] “Tach On” key is only used to power the Phototach for alignment with the reflective tape. When all cables and sensors are connected, press [ENTER] to continue. When all cables and sensors are connected, press [ENTER] to continue.

Model 4040 VIPER Analyzer				
Main Rotor Equipment Setup				
Install the speed sensor and connect to TACH channel 1				
Install vertical vibration sensor to vibration channel A				
Install lateral vibration sensor to vibration channel B				
Tach power is Off				
Tach On				

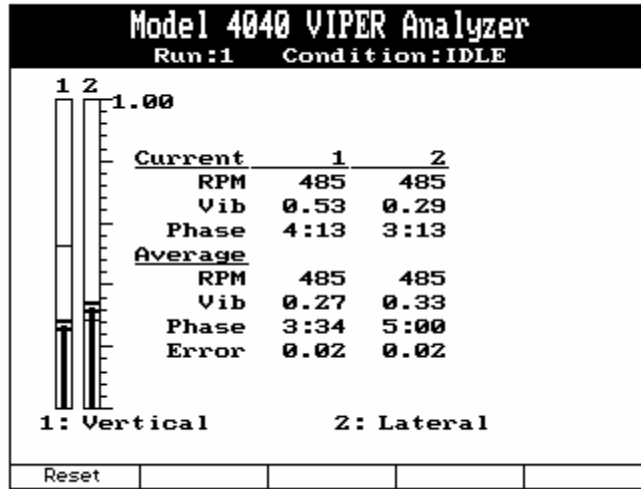
4. The “Start Aircraft” screen will be displayed with instructions to “Start Aircraft per Flight Manual”. When the aircraft is started and normal operating conditions have been established, press the [ENTER] key to continue.



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]. Pressing [F5] “Chk Track” will allow you to view the track picture but will not save the reading as part of the highlighted condition. See paragraph 7 below to record the track picture with the condition’s vibration readings.

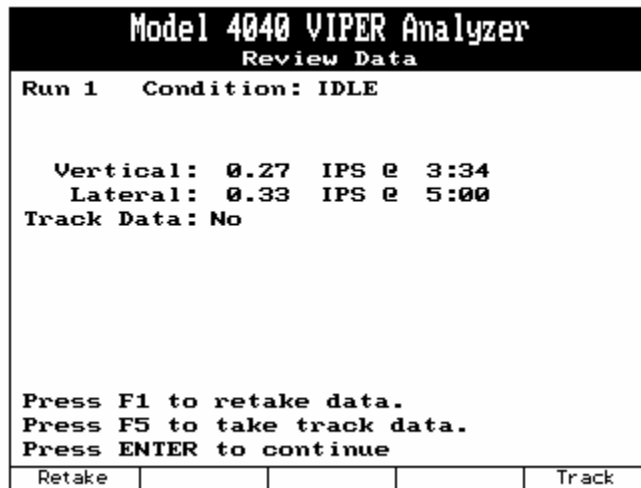


6. After pressing [ENTER] the “Run: 1 Condition: IDLE” screen will be displayed as shown in the example below. Operate the aircraft in the configuration for the selected condition and allow the analyzer to collect data. The “Error:” indication at the bottom of the text portion of the screen should be as steady as possible with very little change before you press [ENTER] to stop acquisition. If the “Error” 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.

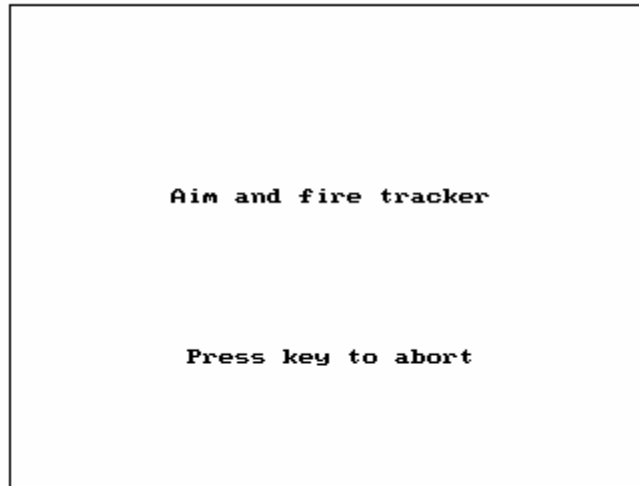


See The Model 4040 User Manual #4040-OM-01 (P/N 75-900-4040) Chapter 20 for detailed instructions on how to read the “Converging Vibration Indicator and Scale”.

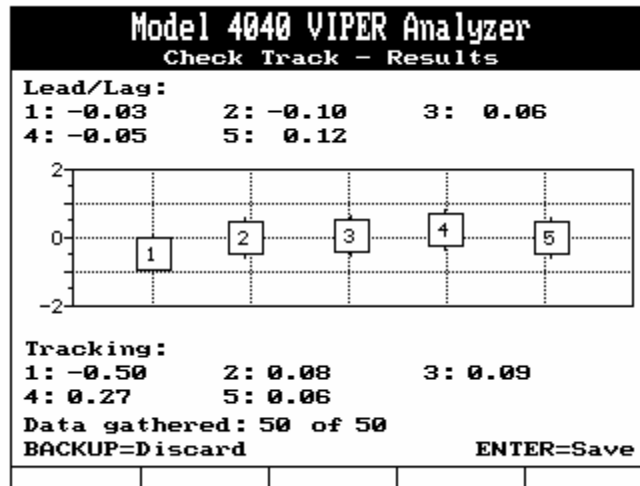
- The “Review Vibe Data” screen will be displayed as shown in the example below. These are the amplitude and clock angle readings for the condition. You may retake the data by pressing the [F1] “Retake” function key as indicated at the bottom of the screen. When satisfied with the acquired data as displayed, press the [ENTER] key to accept the data with “No” track information and continue. To record the track picture for the condition, press [F5] “Track” and proceed to Paragraph 8.



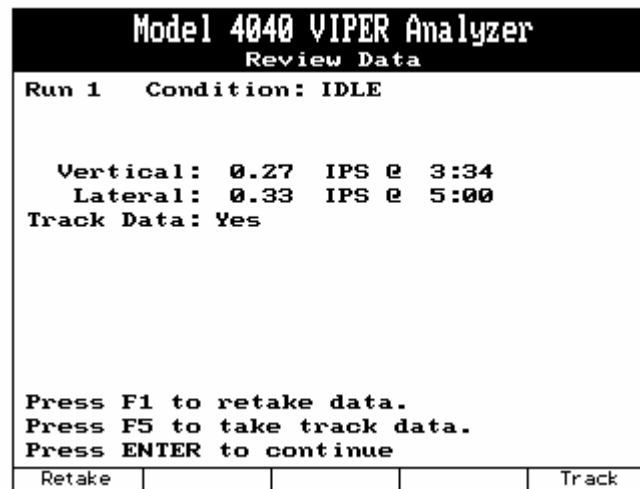
- The “Aim and fire tracker” screen will be displayed as shown in the example below. Aim the tracker at the point in space occupied by blade #1 when the magnetic pick-up and interrupter are aligned. (See Section B Figure 2 above) Raise the tracker smoothly towards the rotating rotor disk while observing the LEDs on the back of the tracker.



- 8.1. Raise the tracker until the three green LED lights are illuminated.
- 8.2. Raise the tracker further to verify the upper set of three red LEDs illuminate. Illumination of the three upper LEDs verifies there is enough contrast to operate the tracker. If the upper set of red LEDs does not illuminate, there is not enough contrast for the tracker to operate properly.
- 8.3. If sufficient contrast is verified, slowly lower the tracker to a point where the center green LED is illuminated. Hold the tracker steady in this position.
- 8.4. To activate the tracker, press and release the trigger one time. It is not necessary to hold the trigger down. Continue to hold the tracker steady (green lights illuminated) while acquiring data. The amber light will pulsate during data acquisition.
- 8.5. When the amber light extinguishes, data acquisition is complete and you may lower the tracker.
9. The track picture will be displayed on the “Check Track – Results” screen. Lead/lag readings will be displayed at the top of the screen. A negative number (-) indicates a “Lead” condition as this blade is the indicated measurement less than the average interval. A positive number (no sign) indicates a “Lag” condition as this blade is the indicated measurement more than the average interval. Readings will be displayed graphically in the center of the screen. Lead readings will be indicated to the Left of the average interval marking vertical line. Lag readings will be displayed to the Right of the line. Track readings will be displayed above or below the line relative to the average of all blades or in relation to the blade specified in the setup, Paragraph C.6. The bottom of the screen will give a numeric reading of the blade track elevation. The bottom line will display the number of data samples gathered. If the total number of data samples gathered is less than 75% of the total number of samples requested (the last value on the line) the results are questionable and should be retaken. When you are happy with the quality of the data, press [ENTER] to continue.



10. The “Review Vibe Data” screen will reappear as shown in the example below. This time the “Track Data” line will read “Yes” indicating that track data has been taken and stored in this condition. You may retake vibration data by pressing the [F1] “Retake” function key as indicated at the bottom of the screen. You may retake the track data by pressing the [F5] “Track” key. If you are satisfied with the current measurements, press [ENTER] to continue.



11. 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 12 below.

Model 4040 VIPER Analyzer				
Select Aircraft Condition				
[x]	IDLE			
[x]	100%N2			
[x]	HOVER			
[x]	80 KTS			
[x]	110KTS			
[x]	130KTS			
End Run	Adjust			Track

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.

12. The analyzer will display the “Shut Down Aircraft” screen. When this process is complete, press the [F5] “Continue” key to review the data or view the suggested solutions.

Model 4040 VIPER Analyzer				
Shut Down Aircraft				
Shut Down Aircraft per flight manual instructions				
				Continue

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.

13. 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.

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 is designed to implement one solution per run. Even though multiple solution screens are presented, the user must pick the single solution to implement between runs. Entering solutions from multiple screens on the same run will corrupt the Influence Coefficient Update during the job.

1. The first possible solution screen is the “Vert: 80 KTS – 130KTS, FLT” solution. This screen will suggest Pitch Change Link Flat (FLT) adjustments based on the measured vertical vibration readings. These solutions will be implemented after the track adjustments have been finalized.

In the example below, it is suggested to adjust the #1 Blade Pitch Change Link UP 0.18 FLT. #5 Blade Pitch Change Link up 1.28 FLT. The adjustment to the #1 Blade was determined to be immeasurable and was not made. The closest possible adjustment to the #5 Blade was 1.50 FLT. These adjustments were made and entered into the analyzer.

Model 4040 VIPER Analyzer				
M/R Suggested/Installed Adjustments				
Run 2				
Name: Vert 80 KTS-130KTS, FLT				
Bld/Pos	Suggested	Installed		
1	0.18	0.00		
2	0.00	0.00		
3	0.00	0.00		
4	0.00	0.00		
5	1.28	1.50		
+Adj = WtAdd/SwAft/BlUp/TabUp				
Inst=Sugg	Inst=None			Quit Job

2. The second possible solution screen available is from the “Lat: IDLE – 100%N2, FLT” chart. This screen suggests the corrections to make to improve Lateral vibration readings by sweeping the blade AFT.

In the example below, the suggestion is to sweep the #1 Blade AFT (see reminder line at the bottom of the screen) 0.64 Flats (FLT). The closest measurable value was 0.50 FLT. This move was made and entered into the Analyzer. It is also necessary to adjust the #2 Blade AFT 1.68 FLT. Again, the closest measurable value was 1.50 FLT. This move was also made and entered into the Analyzer. (No (-) sign is required because the defined Sweep direction is AFT. In this case the positive move is AFT.)

Model 4040 VIPER Analyzer				
M/R Suggested/Installed Adjustments				
Run 1				
Name: Lat IDLE-100%N2, FLT				
Bld/Pos	Suggested	Installed		
1	0.64	0.50		
2	1.68	1.50		
3	0.00	0.00		
4	0.00	0.00		
5	0.00	0.00		
+Adj = WtAdd/SwAft/BlUp/TabUp				
Inst=Sugg	Inst=None			Quit Job

3. The final three possible solutions come from the “Tracking Influence Setup” screens. The analyzer will present a suggested correction to the Pitch Change Link (PCL) in Flats (Flt) OR the trim tab (TAB) in Degrees (Deg) to bring the track within limits.

The example shown below is generated by the Track picture at IDLE. The suggestion shows adjusting the #1 Blade UP by 2.00 Flt and bringing the #4 Blade DOWN by 1.00 Flt should correct the track split. The adjustments on the remaining three blades are determined to be

immeasurable and are not made. The actual adjustments are made and entered into the analyzer. To enter a negative (-) number press the [SPACE] key once.

Model 4040 VIPER Analyzer		
M/R Suggested/Installed Adjustments		
Run 1		
Name: Trk IDLE, PCL, Flt		
Bld/Pos	Suggested	Installed
1	2.00	2.00
2	-0.52	0.00
3	-0.36	0.00
4	-1.08	-1.00
5	-0.24	0.00
+Adj = WtAdd/SwAft/BlUp/TabUp		
Inst=Sugg	Inst=None	Quit Job

In the example shown below, generated by the Track split from 100%N2 through 110KTS, adjusting the #5 Blade UP by 1.00 Deg should correct the track split. The adjustment is made and entered into the analyzer. To enter a negative (-) number press the [SPACE] key once. Refer to the Blade Station diagram below to determine where to apply the suggested solution.

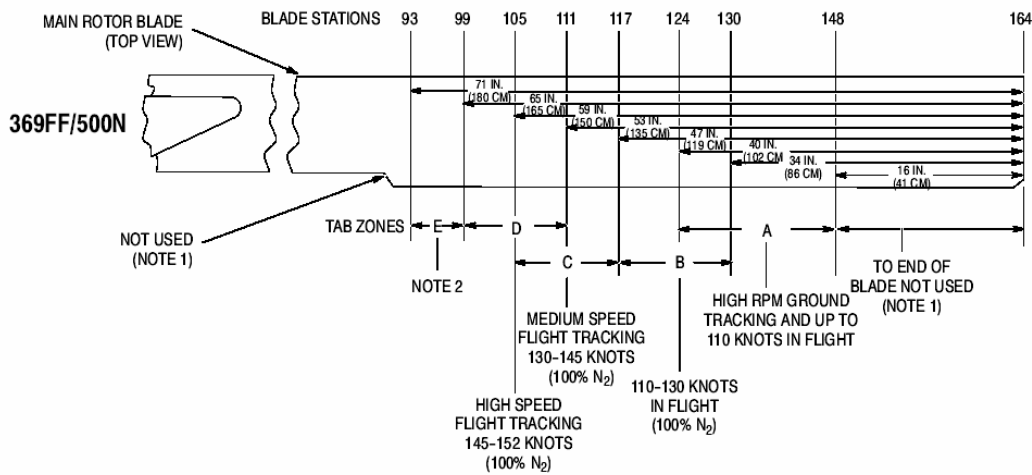
Model 2020 ProBalancer		
M/R Sugg. and Inst. Adj		
Run 2		
Name: Trk 100%N2-110KTS, TAB,		
Bld/Pos	Suggested	Installed
1	0.00	0.00
2	-0.02	0.00
3	0.00	0.00
4	0.03	0.00
5	1.15	1.00
+Adj = WtAdd/SwAft/BlUp/TabUp		
Inst=Sugg	Inst=None	Quit Job

In the example shown below, generated by the Track split at 130KTS, adjusting the #1 Blade UP by 0.50 Deg should correct the track split. The adjustment to the #4 blade is determined to be immeasurable and is not made. The adjustment is made and entered into the analyzer. To enter a negative (-) number press the [SPACE] key once. Refer to the Blade Station diagram below to determine where to apply the suggested solution.

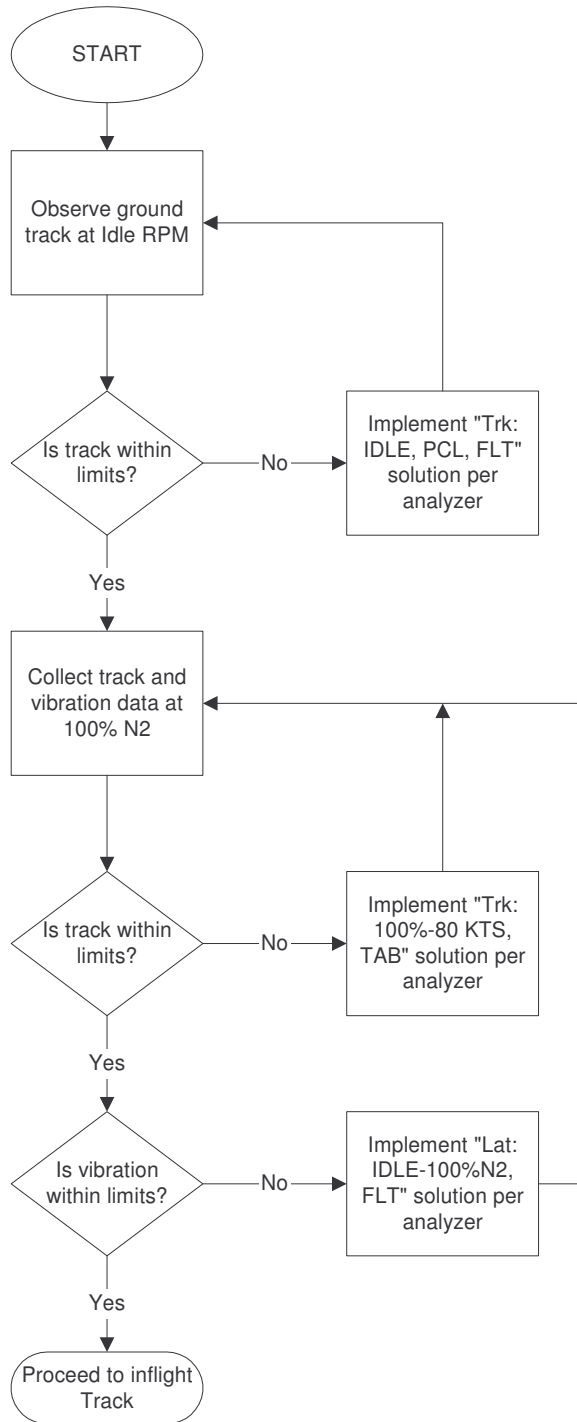
Model 4040 VIPER Analyzer		
M/R Suggested/Installed Adjustments		
Run 1		
Name: Trk 130KTS, TAB, DEG		
Bld/Pos	Suggested	Installed
1	0.40	0.50
2	0.00	0.00
3	0.00	0.00
4	-0.10	0.00
5	0.00	0.00
+Adj = WtAdd/SwAft/BlUp/TabUp		
Inst=Sugg	Inst=None	Quit Job

It is important to understand that only ONE track correction screen will be presented with each solution set. The condition that has the greatest track split will be used to generate the track solution.

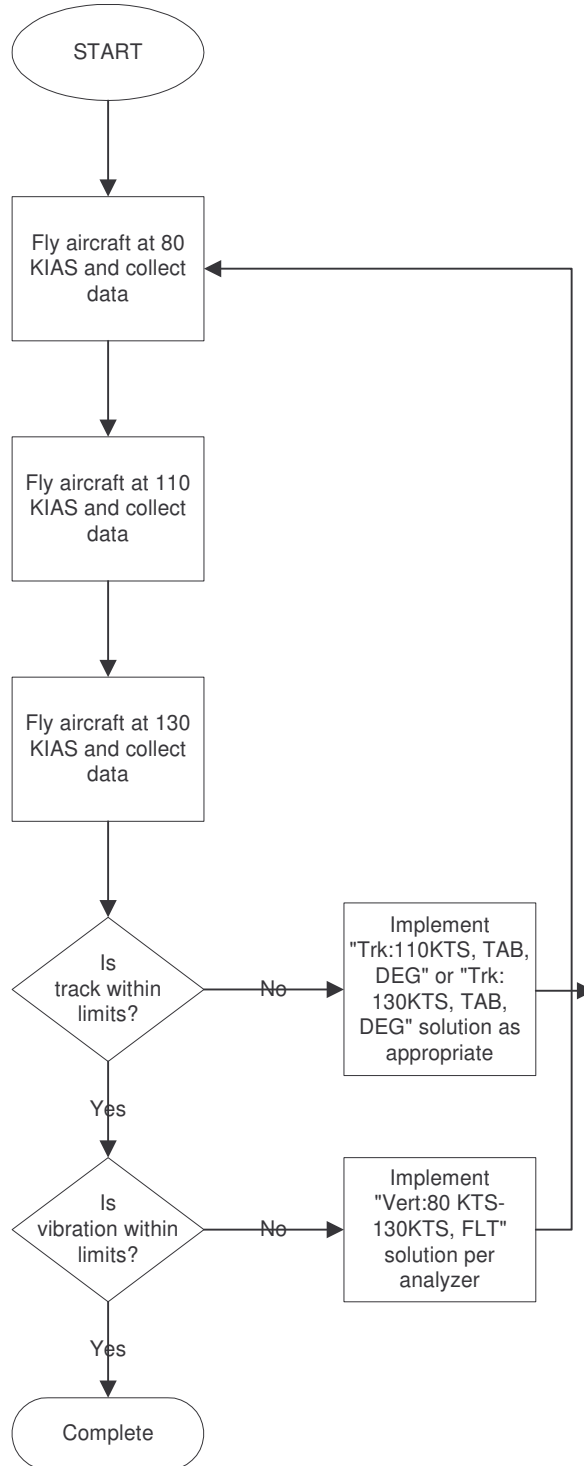
Use the chart below to determine which station to apply the TAB solution to. This will be determined by the airspeed where the Track split occurred.



Use the flow charts below to determine how to apply the solutions presented in this section.



Ground Idle/100% N2 Track and Balance Flowchart



80/130 Knots Inflight Track and Balance Flowchart



F. Quit Job

1. Repeat steps D.4 through D.13 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.

