



# Application Note

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**MIL Mi-8/14/17/19/171/172/24/25/35 and variants**

**Main Rotor Track and Balance**

**Part Number: 11-200-0060**

**AppNote Number: A-MIMI8trk-4040-MR (Rev. 3.01, Jan 2011)**

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# Application Note

Application Note Number	A-MIMI8trk-4040-MR
Revision	3.01 (From actual data gathered Jan 2002)
Function	Main Rotor Track and Balance
Airframe	MIL Mi-8/14/17/19/171/172/24/25/35 and variants
Engine	N/A
E-Setup Number	a-mimi8trk-4040-mr.asf
ACES Systems Analyzer	Model 4040
Boot/App Version	Boot 3.xx/App 3.xx or later
Procedure	Track Only

## 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 MIL Mi-8/14/17/19/171/172/24/25/35 and variants. 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. Required Equipment

The following equipment is required to perform a Main Rotor Track and Balance\*:

Item	Quantity	Description	Part Number
1.	1	Analyzer, Model 4040CE	10-100-4040CE
2.	1	Tachometer, Optical, PhotoTach (New)	10-100-1773
3.	1	Cable, Tach, Generic, 50'	10-320-0126
4.	1	Tape, Reflective, Roll, 10'	10-400-0176
5.	1	Tracker, Optical, Model 540-2	75-900-0542
6.	1	Option, 4040 Main and Tail Rotor	11-900-0005
7.	1	Mount, PhotoTach	10-100-0486

\*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

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

Item	Quantity	Description	Part Number
8.	1	Target Assy, Tip	As Required
9.	1	Cable, Interf. Assy, Strobe	10-320-0161
10.	1	Strobelight	As Required

## Miscellaneous Equipment

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Tape or tie wraps to secure cables to airframe.

## List of abbreviations

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trk - Track measurement and corrections only.

GND LO - 58-60% Rotor RPM on the Ground    PCL - Pitch Change Link

GND HI - 95% Rotor RPM on the Ground    FLT - 1 Flat on the Pitch Change Link

DEG - Degrees of Trim Tab adjustment

## B. Equipment Installation

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- Place the analyzer ([Item 1](#)) in the flight compartment.
- Install PhotoTach Mount ([Item 7](#)) on the cowling fastener at the 6:00 position. Install the PhotoTach ([Item 2](#)) into the Mount and secure with nylon nut. ([Figure 1](#)) Rotate the Main Rotor until a blade is over the tail. The blade at approximately the 11:00 o'clock position will become "ACES 1" for balancing. The static location of this blade determines the "Aiming Point" for track acquisition. The remaining blades will be identified as, "ACES 2", "ACES 3", "ACES 4", and "ACES 5" in passing order as shown below. ([Figure 2](#))

### NOTE

**Before placing the Reflective Tape, see [Paragraph D.3 below](#) for additional installation instructions.**

- With the Main Rotor in this position, a one inch wide piece of Reflective Tape ([Item 4](#)) will be placed on the bottom of the Aft Blade Feathering Grip in line with the PhotoTach. ([Figure 1](#)) and ([Figure 2](#))

### CAUTION

**Secure and route cables as not to interfere with hot or rotating components and aircraft controls. Insure there is adequate slack in the cables to allow full cyclic and collective inputs.**

- Install Tach Cable ([Item 3](#)) by connecting the end of the cable identified as "TACH INTERFACE" to the PhotoTach. Safely route the cable to the location of the analyzer.

Connect the end of the cable identified as “ANALYZER” to the “TACH 1” connector on the analyzer.

5. Connect the Optical Tracker ([Item 5](#)) to the Aux./Comm port on the Analyzer.
6. Reinstall any previously removed cowlings. Return aircraft to flying configuration.

## Equipment Installation Diagram

Figure 1

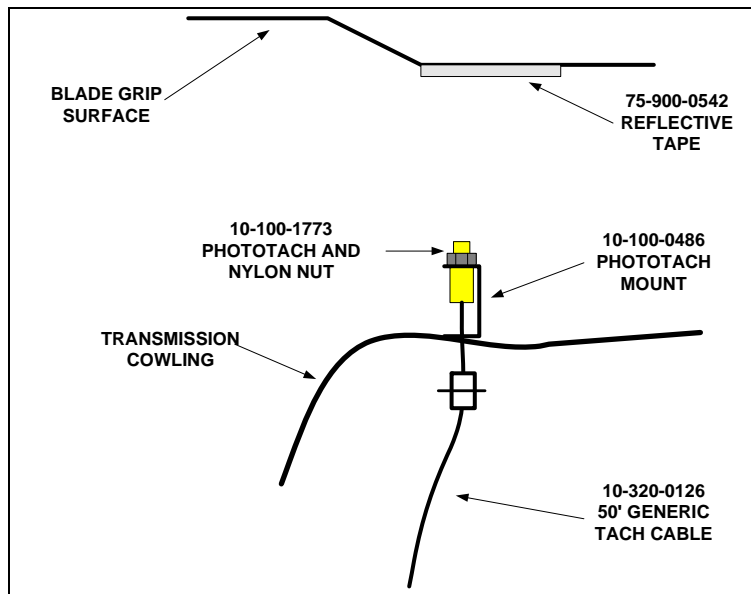
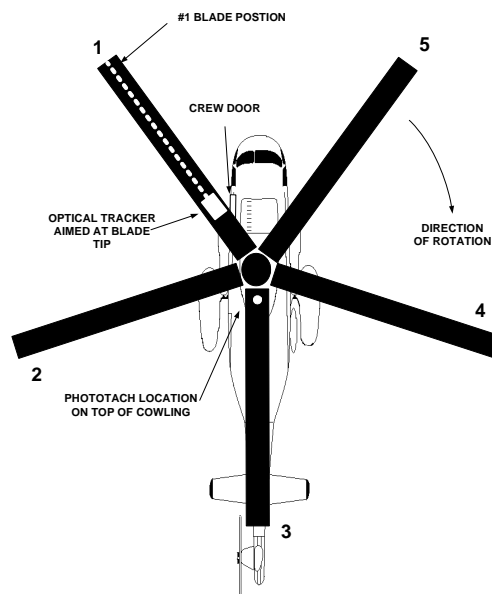


Figure 2



**NOTE**

Blade numbering is in passing order. Other numbers may appear on the blades or grips. Disregard the numbers on the actual aircraft. The blade in the “Aiming Point” when the PhotoTach and Reflective Tape align will be “ACES 1”. The next blade to pass this point in space in normal rotation will become “ACES 2” and so on. Remember this when making corrections to Pitch Change Links and Trim Tabs.

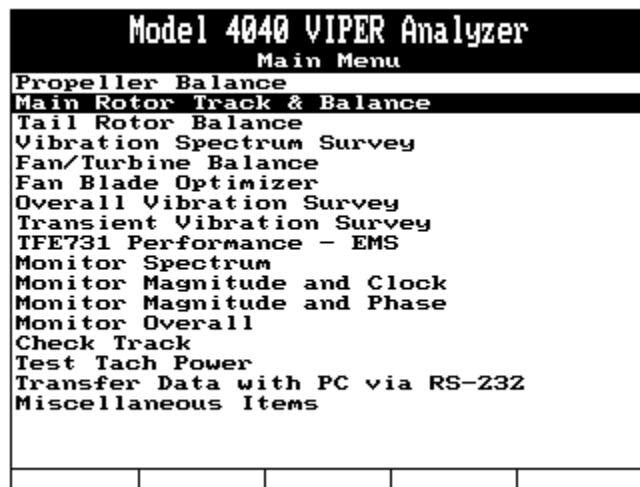
## C. Analyzer Set Up

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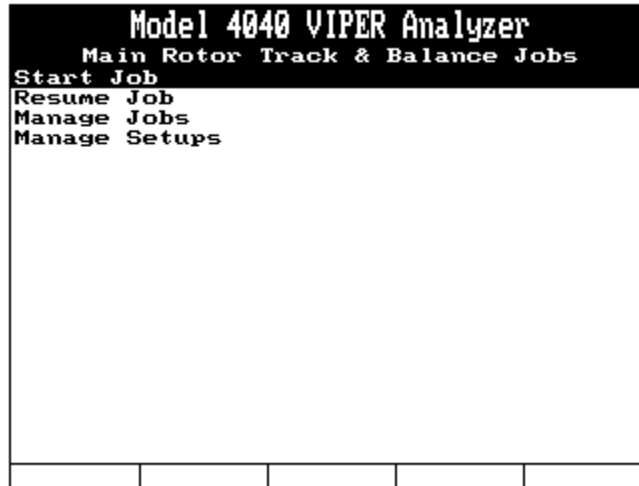
**NOTE**

The analyzer requires a different configuration when using English measurement units than when configured using metric measurement units. Where there is a difference the English configuration will be displayed on the left, the metric configuration will be displayed on the right.

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 MIL Mi-8/14/17/19/171/172/24/25/35 and variants is listed in the Setup List, select it using the [↓] key, press [ENTER] and go to [Section D below](#). If the MIL Mi-8/14/17/19/171/172/24/25/35 and variants 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 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].

English

```

Model 4040 VIPER Analyzer
Main Rotor Setup
Name: a-mimi8trkin-4040-mr
Vertical Chan: A
Lateral Chan: B
Sensor: 991D-1
Tach Type: Optical Tach Chan: 1
Number of Weight Positions: 5
Blades: 5 Relative to: Avg
RPM: 192 Trk Units: in

Conditions
GND LO Trk GND HI Trk
Both Both
Both Both
    
```

Metric

```

Model 4040 VIPER Analyzer
Main Rotor Setup
Name: a-mimi8trkmm-4040-mr
Vertical Chan: A
Lateral Chan: B
Sensor: 991D-1
Tach Type: Optical Tach Chan: 1
Number of Weight Positions: 5
Blades: 5 Relative to: Avg
RPM: 192 Trk Units: mm

Conditions
GND LO Trk GND HI Trk
Both Both
Both Both
    
```

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

English

```

Model 4040 VIPER Analyzer
Tracking Setup

Rotor Diameter: 69.88 ft
Lead/Lag Units: in
    
```

Metric

```

Model 4040 VIPER Analyzer
Tracking Setup

Rotor Diameter: 21.30 m
Lead/Lag Units: mm
    
```

- 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.

English

```

Model 4040 VIPER Analyzer
Main Rotor Conds. Setup
Vert Lat Track
Chart Chart Adj.
Conds. ID ID ID
GND LO 1
GND HI 2

Limit 0.20 0.20 .787

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

Metric

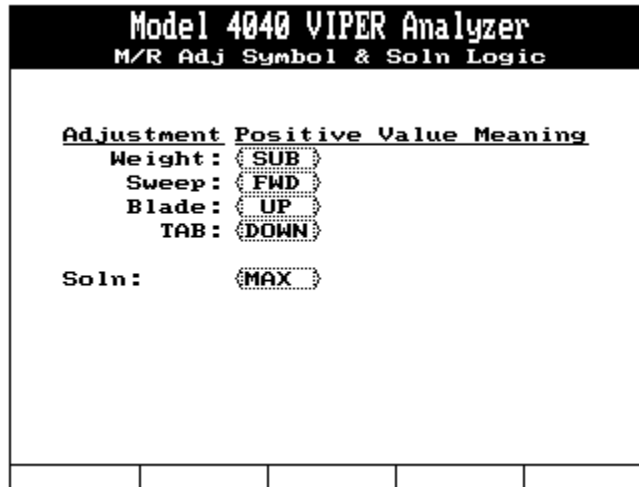
```

Model 4040 VIPER Analyzer
Main Rotor Conds. Setup
Vert Lat Track
Chart Chart Adj.
Conds. ID ID ID
GND LO 1
GND HI 2

Limit 0.20 0.20 20.00

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

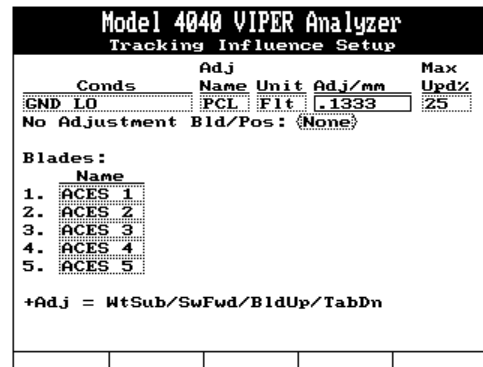
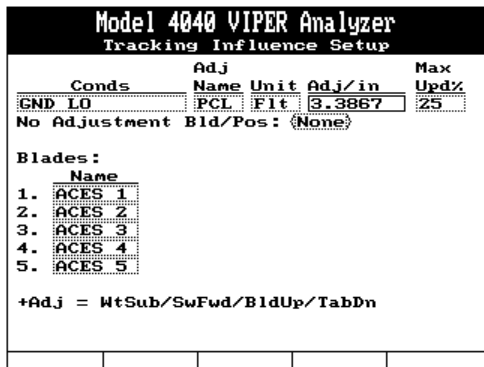
- The next screen to appear will be the “M/R Adj Symbol & Soln Logic” screen. The function of this screen is to determine the direction of movement for a positive (+) adjustment. In this application, a positive move indication means to SUBTRACT weight, sweep a blade FORWARD, move the blade UP with the Pitch Change Link (BLADE) and DOWN with the Trim Tab (TAB). Enter the values as shown below. When completed press [ENTER]. Next, the balance charts will be entered into the analyzer.



- The first main rotor chart to define will be the “Tracking Influence Setup” chart for the “GND LO” condition. This chart will determine the Pitch Change Link (PCL) Flat (FLT) adjustments to perform to reduce the track split on the Ground at the Low Rotor RPM condition. Enter the information exactly as it appears in the appropriate fields. When completed press [ENTER].

English

Metric



- The next main rotor chart to define will be the “Tracking Influence Setup” chart for the “GND HI” condition. This chart will determine the Trim Tab (TAB) adjustments to make to reduce a track split on the Ground at the High RPM condition. Enter the information exactly as it appears in the appropriate fields. The analyzer will round the entries when you exit the field. The analyzer will store the original value and use it when making calculations. This is normal. When completed press [ENTER].

## English

Model 4040 VIPER Analyzer				
Tracking Influence Setup				
Conds	Adj Name	Unit	Adj/in	Max Ued%
GND HI	IAB	Deg	1.1288	25
No Adjustment Bld/Pos: (None)				

## Metric

Model 4040 VIPER Analyzer				
Tracking Influence Setup				
Conds	Adj Name	Unit	Adj/mm	Max Ued%
GND HI	IAB	Deg	0.444	25
No Adjustment Bld/Pos: (None)				

## 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. Complete the first two fields as shown below. Then, rotate the Main Rotor head so that the PhotoTach and Reflective Tape align (Figure 2). Measure the distance from the location where the Optical Tracker will be held to the tip of the “ACES 1” blade. Enter the distance, in inches, into the “Inches To Blade Tip” field. When all fields are complete, press the [ENTER] key to continue.

### NOTE

The entry on this screen for “Inches To Blade Tip” will ALWAYS be entered in inches. This field

does not change when the measurement units changes. The two different entries are related to the aircraft type being tracked.

MI-8/17

Model 4040 VIPER Analyzer				
Tracking Selections				
Track Device: <input type="text" value="Tracker"/>				
- For Optical Tracking Only -				
Number of Rotations: <input type="text" value="20"/>				
Inches To Blade Tip: <input type="text" value="308"/>				

MI-24

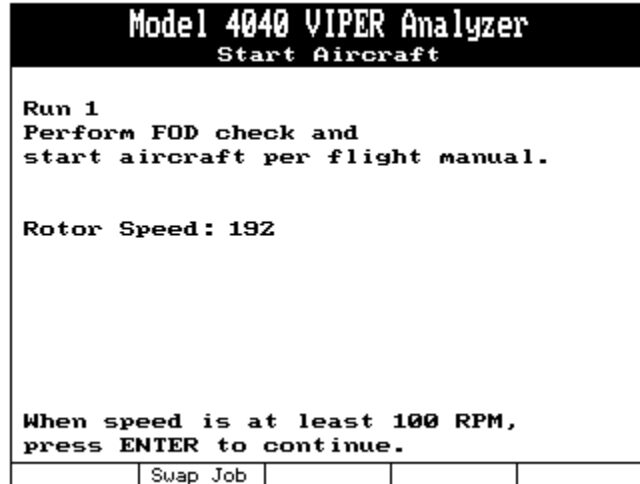
Model 4040 VIPER Analyzer				
Tracking Selections				
Track Device: <input type="text" value="Tracker"/>				
- For Optical Tracking Only -				
Number of Rotations: <input type="text" value="20"/>				
Inches To Blade Tip: <input type="text" value="228"/>				

- The next screen to be displayed will be the “Connect Sensors” screen as illustrated below. This screen gives instructions on installing sensors and cables. The Tach will be automatically energized when this screen is exited. 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.

Model 4040 VIPER Analyzer				
Connect Sensors				
Connect the Speed sensor to TACH channel 1				
Connect Vertical VIB sensor to Vibration channel A				
Connect Lateral VIB sensor to Vibration channel B				
Tach power is Off				
Tach Pwr				

- Press [F1] “Tach Pwr”. Position one blade over the aircraft’s tail. (See Section B [Figure 2](#) above)
- Hold a 2-inch piece of reflective tape, reflective surface facing the PhotoTach, against the bottom side of the feathering grip. Do not remove backing at this point.
- 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 feathering grip in preparation for mounting the reflective tape.
- Remove the backing and install the reflective tape on the clean feathering grip surface.
- Press [ENTER] when finished with Tape installation.

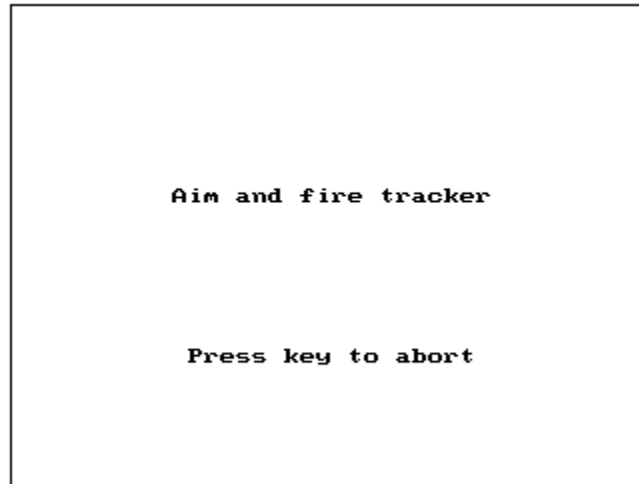
4. The “Start Aircraft” screen will be displayed with instructions to “Perform FOD check and start aircraft per flight manual”. When the aircraft is started and normal operating conditions have been established, press the [ENTER] key to continue. Use the [F2] “Swap Job” key to return directly to the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



5. The analyzer will display the “Select Aircraft Condition” screen as displayed below. Select the condition where you want to gather data by 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. To save the track reading as part of the job, simply highlight the condition’s name and press [ENTER] to record the track picture with the condition’s vibration readings.

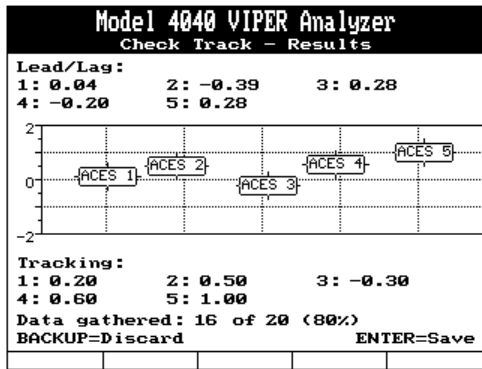


6. The “Aim and fire tracker” screen will be displayed as shown in the example below. Aim the tracker at the point in space that will lead the “ACES 1” blade when the PhotoTach and Reflective Tape are aligned. (See Section B Figure 2 above) Raise the tracker smoothly towards the rotating rotor disk while observing the LEDs on the back of the tracker.

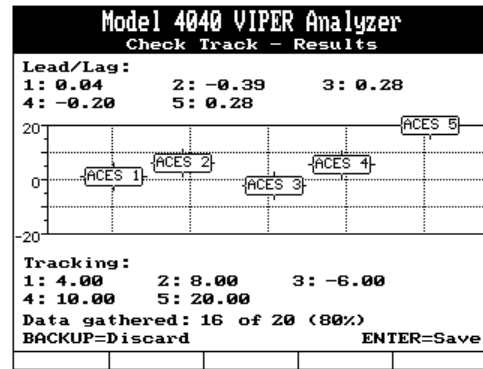


- 6.1 Raise the tracker until the three green LED lights are illuminated.
- 6.2 Raise the tracker further to verify the upper set of three red LEDs illuminate. Illumination of the three upper LEDs verifies there is enough contrast to operate the tracker. If the upper set of red LEDs does not illuminate, there is not enough contrast for the tracker to operate properly.
- 6.3 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.
- 6.4 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.
- 6.5 When the amber light extinguishes, data acquisition is complete and you may lower the tracker.
7. 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 above](#). 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 results are questionable and should be retaken. When you are happy with the quality of the data, press **[ENTER]** to continue.

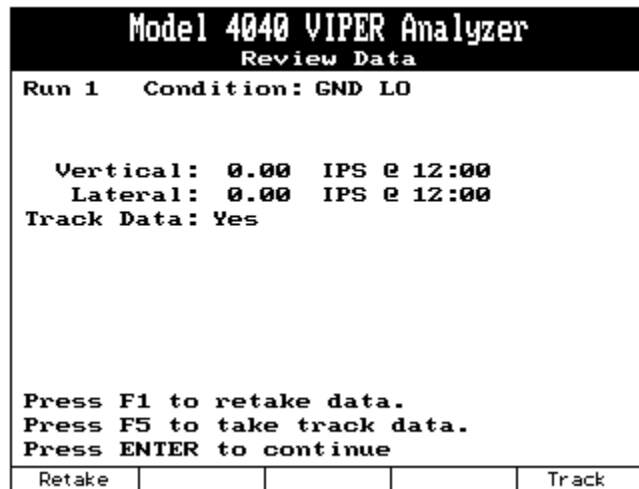
## English



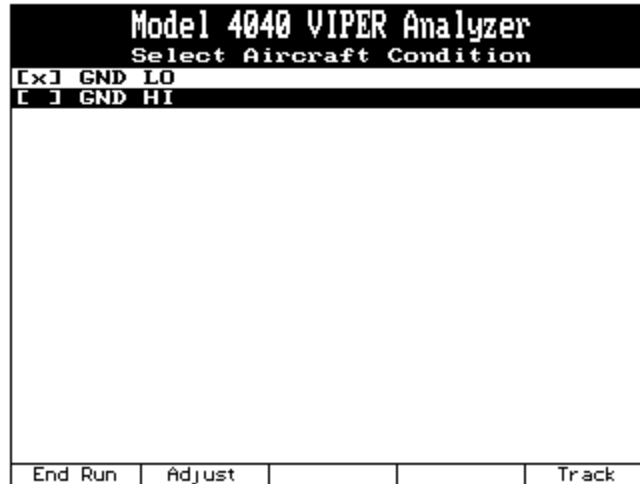
## Metric



8. The “Review Data” screen will appear as shown in the example below. The “Track Data” line will read “Yes” indicating that track data has been taken and stored in this condition. You may retake the track data by pressing the [F5] “Track” key. If you are satisfied with the current measurements, press [ENTER] to continue.

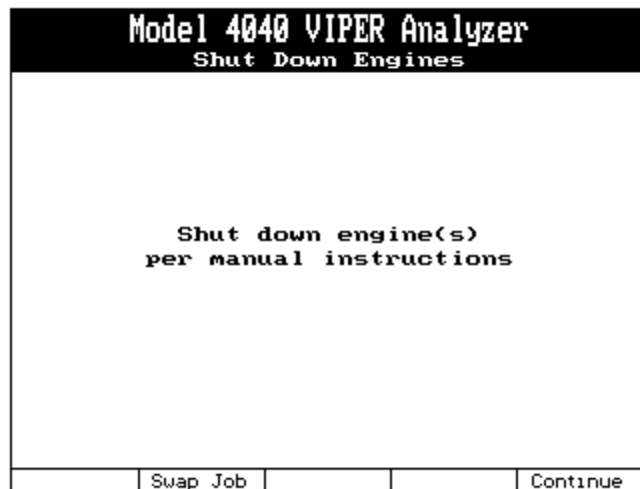


9. The “Select Aircraft Condition” screen will reappear as shown in the example below. This time any condition that has stored vibration and/or track data will have an [x] preceding the condition name. Repeat sequence through all flight regimes. You can choose to “End Run” at any time by pressing the [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 10 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.

10. 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.

11. 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

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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. Regardless of the measurement units selected, the adjustments should be similar.

### 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 “M/R Suggested/Installed Adjustments” screen will display suggestions to correct track splits. This screen will suggest adjustments to the Pitch Change Links (PCL) based on the measured track in the GND LO condition.

In the example below, it is suggested to adjust “ACES 1” UP 0.52 Flts (Flt), adjust “ACES 3” UP 1.87 Flt, and adjust “ACES 5” DOWN 1.60 Flt. It was determined that the closest measurable adjustment was to adjust “ACES 1” UP 0.50 Flt, adjust “ACES 3” UP 2.00 Flt, and adjust “ACES 5” DOWN 1.50 Flt. These adjustments were made and entered into the analyzer.

### NOTE

**See the reminder line at the bottom of the screen to determine the direction of a positive move. In this case, BldUp (Blade, Up using PCL)**

Model 4040 VIPER Analyzer		
M/R Suggested/Installed Adjustments		
Run 1		
Name: Trk GND LO, PCL, Flt		
Bld/Pos	Suggested	Installed
ACES 1	0.52	0.50
ACES 2	-0.00	0.00
ACES 3	1.87	2.00
ACES 4	0.00	0.00
ACES 5	-1.60	-1.50
+Adj = WtSub/SwFwd/BldUp/TabDn		
Inst=Sugg	Inst=None	Quit Job

2. The second “M/R Suggested/Installed Adjustments” screen will also display suggestions to correct track splits. This screen will suggest adjustments to the Trim Tabs (TAB) based on the measured track in the GND HI condition.

In the example below, it is suggested to adjust “ACES 1” UP 0.18 degrees (DEG), adjust “ACES 3” UP 0.62 DEG, and adjust “ACES 5” DOWN 0.53 DEG. See the reminder line at the bottom of the screen to determine the direction of a positive move. In this case, TabDn (Tab, Down in DEG). It was determined that the closest measurable adjustment was to adjust “ACES 1” UP 0.25 DEG, adjust “ACES 3” UP 0.50 DEG and adjust “ACES 5” DOWN 0.50 DEG. These adjustments were made and entered into the analyzer.

**NOTE**

The suggested corrections should split evenly between the Trim Tabs. Both tabs should be adjusted together. For example, in the suggestion below, each of the “ACES 5” Tabs should be adjusted DOWN 0.25 DEG.

**NOTE**

See the reminder line at the bottom of the screen to determine the direction of a positive move. In this case, TabDn (Tab, Down in DEG)

Model 4040 VIPER Analyzer		
M/R Suggested/Installed Adjustments		
Run 2		
Name: Trk GND HI, TAB, Deg		
Bld/Pos	Suggested	Installed
ACES 1	-0.18	-0.25
ACES 2	-0.00	-0.00
ACES 3	-0.62	-0.50
ACES 4	-0.00	-0.00
ACES 5	0.53	0.50
+Adj = WtSub/SwFwd/BldUp/TabDn		
Inst=Sugg	Inst=None	Quit Job

## F. Quit Job

- Repeat [Steps D.4](#) through [D.11](#) 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.

Model 4040 VIPER Analyzer		
M/R Track & Balance		
No solutions are recommended.		
Press BACKUP to view data.		
Press F5 to quit job.		
Press ENTER for next Run.		
		Quit Job

- 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.

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