



# Application Note

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## **Bell 206 A/B**

### **Main Rotor Track and Balance**

**Part Number: 11-200-0181**

**AppNote Number: A-BE206B-4040-MR (Rev. 0, Nov 2004)**

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# Application Note

<b>Application Note Number</b>	A-BE206B-4040-MR
<b>Revision</b>	0 (From Airframe data gathered 2004)
<b>Function</b>	Main Rotor Track and Balance
<b>Airframe</b>	Bell 206 A/B Series
<b>Engine</b>	N/A
<b>E-Setup Number</b>	a-be206b-4040-mr.asf
<b>ACES Systems Analyzer</b>	Model 4040
<b>Firmware Version</b>	1.0 or greater
<b>Procedure</b>	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 Main and Tail 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-OS-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 found in a standard 4040 Helicopter kit:

Item	Quantity	Description	Part Number
1.	1	Analyzer, Model 4040	10-100-4040
2.	1	Option, 4040 Main & Tail Rotor	11-900-0005
3.	1	Tachometer, Optical, Phototach (New)	10-100-1773*
4.	1	Cable, Tach, Generic, 50'	10-320-0126*
5.	2	Sensor, Vibe, Accel, 991D-1	69-100-0075
6.	1	Cable, Sensor 991D-1, 25'	10-320-0162
7.	1	Cable, Sensor 991D-1, 50'	10-320-0163
8.	1	Mount, 1/4X28 Sensor, Vibe 1/4" Hole, S/Stl	22-430-0035
9.	1	Tape, Reflective, Roll, 10'	10-400-0176

10.	1	Tracker, Optical, Model 540-2	75-900-0542*
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\*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.

### Additional Required Equipment

The following equipment is NOT found in a standard 4040 Helicopter Kit:

Item	Quantity	Description	Part Number
1.	1	Mount, Phototach, Bell 206 M/R	22-430-0087

### Optional Equipment

The following equipment is NOT found in a standard 4040 Helicopter Kit but may be used as an alternate to accomplish the job:

Item	Quantity	Description	Part Number
1.	1	Target Assy., Tip, Bell 206	10-100-0478
2.	1	Cable, Interf. Assy. Strobe	10-320-0161
3.	1	Strobelight	As Required

### Miscellaneous Equipment

Tape or tie wraps to secure cables to airframe.

## B. Equipment Installation

1. Remove the forward transmission cowling to gain access to the transmission area.

#### NOTE

**Secure and route cables as not to interfere with hot or rotating components. Allow enough slack in the cable to allow for full collective and cyclic inputs.**

2. Install Bell 206 M/R Phototach Mount (P/N 22-430-0087) on the top of the transmission at the swashplate support attachment bolts in the 9:00 position. Install the Phototach Optical Tachometer (P/N 10-100-1773) into the Mount with the optical eye pointed upward. Secure Phototach with nylon nut. Install 991D-1 Vibe Sensor, Accel (P/N 69-100-0075) into Mount and secure. Sensor should be pointing to the left. (See Figure 1)
3. Connect 50' Generic Tach Cable (P/N 10-320-0126) to Phototach. Connect 50' 991D-1 Sensor Cable (P/N 10-320-0163) to Sensor. Secure Cable and route into cabin area of aircraft. Connect the Sensor Cable to Channel B of the analyzer. Connect the Phototach Cable to the Tach 1 channel of the analyzer.

4. Position a blade over the nose of the aircraft. With blade forward, place a one inch piece of Reflective Tape (P/N 10-400-0176) on the bottom of the rotating swashplate in line with the Phototach. The “Target” blade will be the forward blade when the Phototach and Reflective Tape are aligned. (See Figure 2 and Figure 3)

**NOTE**

**See Paragraph D.4. for additional installation instructions of Phototach and Tape.**

5. Reinstall the forward transmission cowling.
6. Install Vibe Sensor Mount with ¼” Hole (P/N 22-430-0035) to the left-hand side of the center console. Install 991D-1 Vibe Sensor, Accel (P/N 69-100-0075) into the Mount with the connector facing down. (See Figure 4)
7. Connect 25’ 991D-1 Sensor Cable (P/N 10-320-0162) to Sensor and route to analyzer. Connect Cable to Channel A of analyzer.
8. Connect the Optical Tracker (P/N 75-900-0542) to the Aux./Comm port on the Model 4040 analyzer.

**Equipment Installation Diagram**

**Figure 1**



**Figure 2**

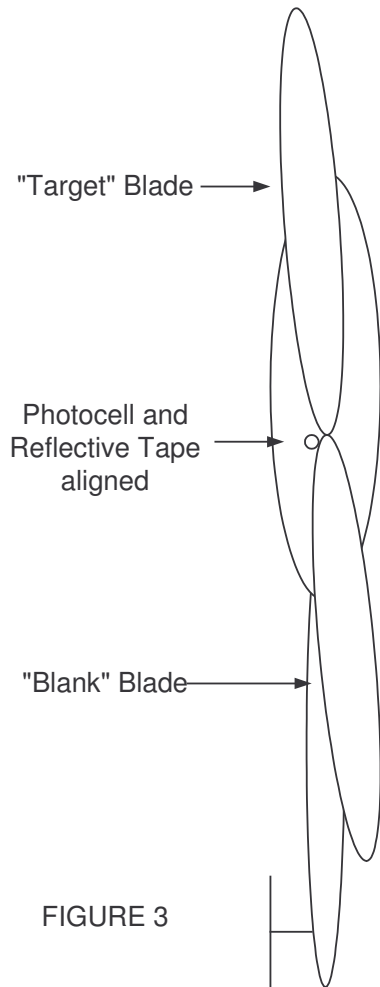


FIGURE 3

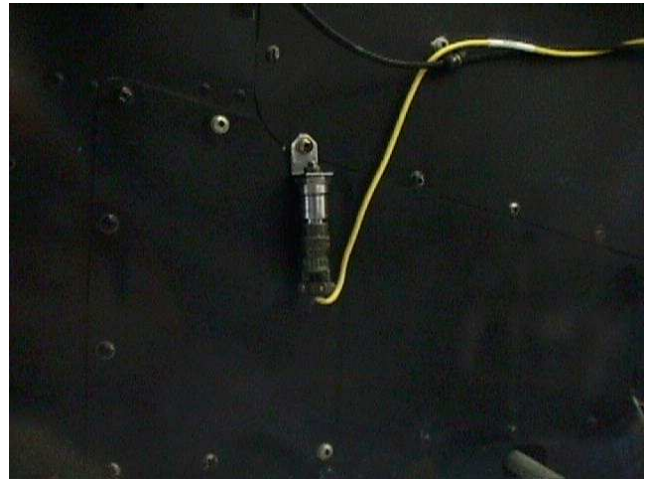
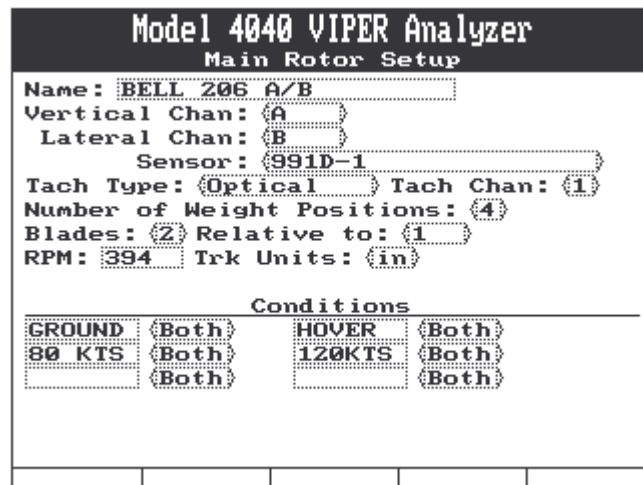


FIGURE 4

### C. Analyzer Set Up

1. Turn the analyzer [ON].
2. Enter a new setup as follows; from the "Main Menu" select "Main Rotor Track and Balance" and press [ENTER]. From the "Main Rotor Tack and Balance" menu, select "Manage Setups" and press [ENTER]. From the "Manage Setups" menu, select "New" and press [ENTER].
3. The "Main Rotor Setup" screen now appears. Enter the main rotor setup as shown below. When completed press [ENTER].



- The “Tracking Setup” screen will appear next. This screen is used to define the rotor diameter and the units used to describe the lead/lag readings. Enter the information as shown below and press [ENTER].

```

Model 4040 VIPER Analyzer
Tracking Setup

Rotor Diameter: 33.33 ft
Lead/Lag Units: in
    
```

- The “Main Rotor Conds. Setup” screen will determine the charts to be used when calculating corrections for a given measurement. Chart “ID’s” of similar measurements with the same number will average the readings together for use in solutions. The “limit” field under each measurement type will set the point at which the analyzer will determine whether corrections are needed. Enter the information exactly as it appears below in the appropriate fields. When completed, press [ENTER].

```

Model 4040 VIPER Analyzer
Main Rotor Conds. Setup

Vert   Lat   Track
Chart  Chart Adj.
Conds. ID   ID   ID
GROUND 0    1    1
HOVER   0    1    1
80 KTS  1    0    0
120KTS  1    0    0

Limit  0.20  0.20  0.25

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

- The “M/R Adj Symbol Setup & Soln Logic” screen is displayed next. 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) or 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
    
```

- The first main rotor chart to define will be the “Vert: 80 KTS – 120KTS” chart. This chart will determine the Trim Tab adjustments to perform for in-flight vertical vibration reduction. Enter the information exactly as it appears below in the appropriate fields. When completed press [ENTER].

```

Model 4040 VIPER Analyzer
Main Rotor Chart Setup

Name: Vert 80 KTS-120KTS
Type: Regular Sweep Only: No
No Adjustment Bld/Pos: None
Max ICF Update: 150 % R(°): 90
Adj Unit: DEG Adj/IPS: 3.500
Bld/Pos MoveLine Bld/Pos
TARGET 2 : 00
BLANK 8 : 00

Bld/Pos: in CW or CCW order

+Adj = WtAdd/SwAft/BlUp/TabUp
    
```

- The next main rotor chart to define will be the “Lat: GROUND - HOVER” chart. This chart will determine the Weight or Sweep adjustments to perform for ground or hover lateral vibration reduction. Enter the information exactly as it appears below in the appropriate fields. When completed press [ENTER].

```

Model 4040 VIPER Analyzer
Main Rotor Chart Setup

Name: Lat GROUND-HOVER
Type: Irregular Sweep Only: No
No Adjustment Bld/Pos: None
Max ICF Update: 150 % R(°): 90

Bld/Pos Unit Adj IPS MoveLn
T SPAN GMS 750.00 1.00 2 : 40
T SWP PTS 5.00 1.00 11 : 40
B SPAN GMS 750.00 1.00 8 : 40
B SWP PTS 5.00 1.00 5 : 40

+Adj = WtAdd/SwAft/BlUp/TabUp
    
```

9. Last, the “Tracking Influence Setup” screen will appear. This chart will determine the amount of pitch change adjustment required to improve track splits at ground and hover. The “Adj./in.” sensitivity tells the balancer the amount of PCL adjustment required to equal one inch of movement of the blade tip path. Enter the information exactly as it appears below in the appropriate fields. When completed, press [ENTER].

Model 4040 VIPER Analyzer				
Tracking Influence Setup				
Conds	Adj	Name	Unit	Max
			Adj/in	Upd%
GROUND-HOVER	PCL	FLT	16.000	150
No Adjustment Bld/Pos: (None)				
Blade Names:				
1. TARGET				
2. BLANK				
+Adj = WtAdd/SwAft/BlUp/TabUp				

10. Setup complete, press [BACKUP], select “Start Job”, press [ENTER] and then select the “Main Rotor Setup” that was just created.

## D. Data Acquisition

1. “Customer Information” screen. To assist with the identification of the job when it is printed and/or stored in the analyzer, it is recommended that this screen be completed. When finished press [ENTER].

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

2. “Tracking Selections” screen. Allows the user to select a tracking device for this particular job. Select <Tracker> and enter the additional data as displayed below or select <Strobe>. Then press [ENTER].

Model 4040 VIPER Analyzer				
Tracking Selections				
Track Device: <input type="text" value="Tracker"/>				
- For Optical Tracking Only -				
Number of Rotations: <input type="text" value="50"/>				
Inches To Blade Tip: <input type="text" value="130"/>				

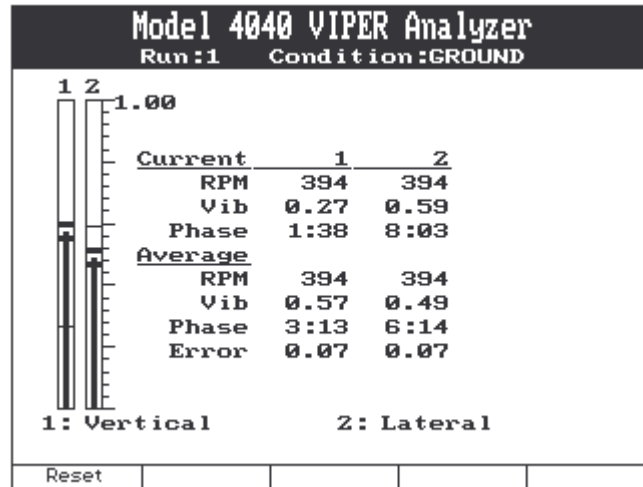
3. “Main Rotor Equipment Setup”. Information screen that prompts the user to verify equipment installation has been performed in accordance with channel selections that were specified when building the setup.

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				

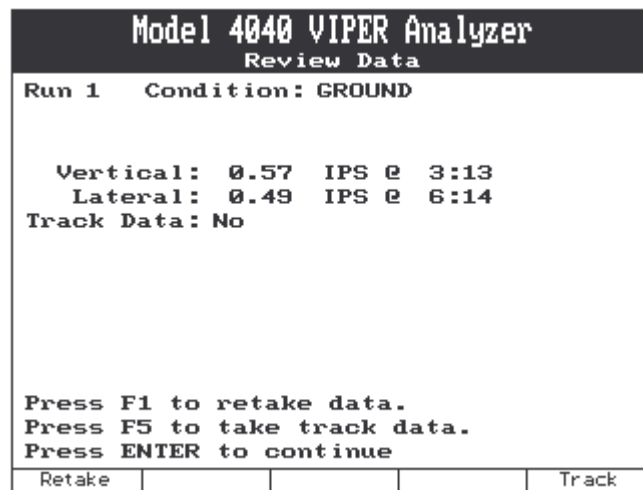
4. Install and align reflective tape with Phototach as follows:
- Press [F1] “Tach On”. Position one blade over the aircraft’s nose. (See Section B Figure 2 and Figure 3)
  - Hold a 1-inch piece of reflective tape, reflective surface facing the Phototach, against the bottom side of the swashplate. Do 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 swashplate in preparation for mounting the reflective tape.
  - Remove the backing and install the reflective tape on the clean swashplate surface.



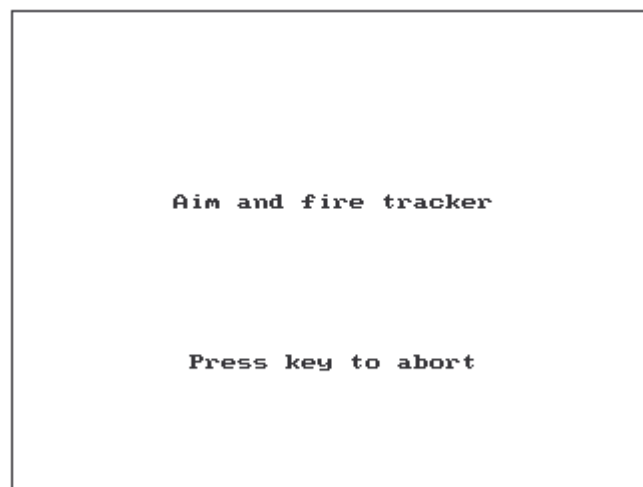
- “Run: 1 Condition: GROUND” screen. This screen is displayed during the vibration acquisition. The title will change to reflect the current run and condition. When the RPM, IPS and Clock readings under “Average” show minimum change, press [ENTER].



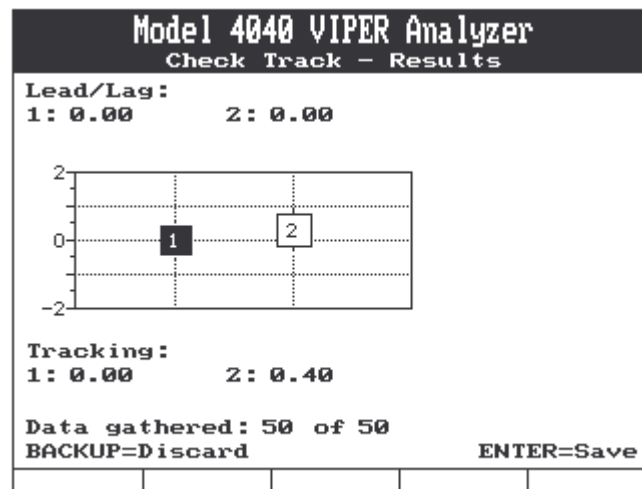
- “Review Data”. This screen allows the user to view the vibration readings that were acquired during the regime. Press [ENTER] to continue or [F5] to take track readings.



- If [F5] was pressed, the “Aim and fire tracker” screen will appear prompting the user to aim and fire the tracker.



10. To aim the tracker, raise the tracker smoothly towards the rotating rotor disk while observing the LEDs on the back of the tracker.
  - a. Raise the tracker until the three green LED lights are illuminated.
  - b. 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.
  - c. 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.
  - d. 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.
  - e. When the amber light extinguishes, data acquisition is complete and you may lower the tracker.
  
11. The “Check Track – Results” screen will appear on the screen. The track split will be shown. If the “Data Gathered” is less than 75% of the total “Number of Rotations” defined in paragraph D.2 above, press [ENTER] and then “Track” [F5] to retake the track reading. After successfully gathering enough data, press [ENTER] to continue.



12. The “Review Data” screen will reappear, if the readings are acceptable, press [ENTER] to continue. If the readings are unsatisfactory, use “Retake” [F1] to return to paragraph D.7 above. Use “Track” [F5] to return to paragraph D.9 above to retake track readings only.

Model 4040 VIPER Analyzer				
Review Data				
Run 1 Condition: GROUND				
Vertical: 0.57 IPS @ 3:13				
Lateral: 0.49 IPS @ 6:14				
Track Data: Yes				
Press F1 to retake data.				
Press F5 to take track data.				
Press ENTER to continue				
Retake				Track

13. Repeat sequence through all flight regimes. After all data is acquired press the “Adjust” [F2] button, shut down the aircraft and review the solution options.

Model 4040 VIPER Analyzer				
Select Aircraft Condition				
[x]	GROUND			
[x]	HOVER			
[x]	80 KTS			
[x]	120KTS			
End Run	Adjust			Track

#### 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.

14. 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. Sample Solutions

This section contains samples of the solution screens presented by the analyzer. The corrections are examples only and do not reflect actual aircraft data.

### 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.5 above. All solutions may not appear after every run. It is necessary to add the closest measurable amount of correction and record the actual correction in the “Installed” column.

The Model 2020 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 – 120KTS” solution. This screen will suggest Outboard Trim Tab adjustments based on the measured vertical vibration readings. If the aircraft you are working on only has Outboard Trim Tabs or if the IPS and Phase readings place the imbalance point in the white section of the “Main Rotor Vertical Balance Chart” in the maintenance manual, the analyzer solutions may be used directly.

If the aircraft you are working on has Inboard Trim Tabs, it may be necessary to refer to the “Main Rotor Vertical Balance Chart” in the Maintenance Manual. If IPS and Phase readings place the imbalance point in the shaded area of this chart, solutions will need to be obtained from the Maintenance Manual chart.

In the example below, it is suggested to adjust the “Target” trim tab up 1.75 degrees. The closest possible adjustment was 1.50 degrees. This adjustment was made and entered into the analyzer.

Model 4040 VIPER Analyzer			
M/R Suggested/Installed Adjustments			
Run 1			
Name: Vert 80 KTS-120KTS, DEG			
Bld/Pos	Suggested	Installed	
TARGET	1.75	1.50	
BLANK	0.00	0.00	
+Adj = WtAdd/SwAft/BlUp/TabUp			
Inst=Sugg	Inst=None		Quit Job

2. The second possible solution screen available is from the “Lat: GROUND - HOVER” chart. This screen suggests the corrections to make to improve Lateral vibration readings. In the example below, the suggestion is to sweep the Target blade AFT (see reminder line at the bottom of the screen) 1.29 Points (PTS). The closest measurable value was 1.50 PTS. This move was made and entered into the analyzer. (A negative (-) sign is not 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 GROUND-HOVER, GMS, P			
Bld/Pos	Suggested	Installed	
T SPAN	0.00	0.00	
T SWP	1.29	1.50	
B SPAN	0.00	0.00	
B SWP	0.00	0.00	
+Adj = WtAdd/SwAft/BlUp/TabUp			
Inst=Sugg	Inst=None		Quit Job

3. The final possible solution comes from the “Tracking Influence Setup” screen. The analyzer will present a suggested correction to the Pitch Change Link (PCL) in flats to bring the track within limits. In this case, adjusting the Blank Blade DOWN by 6.40 flats should correct the track split. It was determined that the closest measurable adjustment was to move the Blank Blade DOWN by 6.50 flats. The adjustment is 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 GROUND-HOVER, PCL, F			
Bld/Pos	Suggested	Installed	
TARGET	0.00	0.00	
BLANK	-6.40	-6.50	
+Adj = WtAdd/SwAft/BlUp/TabUp			
Inst=Sugg	Inst=None		Quit Job