



Application Note

Bell 206 A/B

Main Rotor Track and Balance

Part Number: 11-200-0005

AppNote Number: A-BE206B-2020-MR (Rev. 3, Nov 2004)

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Application Note

Application Note Number	A-BE206B-2020-MR
Revision	3 (From Airframe data gathered 2004)
Function	Main Rotor Track and Balance
Airframe	Bell 206 A/B Series
Engine	N/A
E-Setup Number	a-be206b-2020-mr.asf
ACES Systems Analyzer	Model 2020 or Model 2020 with EPS
Firmware Version	2.05c or greater
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 2020 with the Main Rotor Enhanced Performance Software (EPS) option to perform main rotor track and balance on the airframe listed above. General instructions for the use of the Model 2020 can be found in the Model 2020 User Manual #2020-OM-01 (P/N 75-900-2020), Enhanced Performance Software Operational Supplement #2020-OM-01 Supplement 1 (P/N 75-900-2022), 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 2020 Helicopter Kit:

Item	Quantity	Description	Part Number
1.	1	Analyzer, Model 2020	10-100-2020
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	Cable, Sensor 991D-1, 25'	10-320-0162
6.	1	Cable, Sensor 991D-1, 50'	10-320-0163
7.	1	Mount, 1/4X28 Sensor, Vibe 1/4" Hole, S/Stl	22-430-0035
8.	1	Tape, Reflective, Roll, 10'	10-400-0176

*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 2020 Helicopter Kit:

Item	Quantity	Description	Part Number
1.	1	Tracker, Optical, Model 540-2	75-900-0542*
2.	1	Mount, Phototach, Bell 206 M/R	22-430-0087

*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 is NOT found in a standard 2020 Helicopter Kit. It may be used as an alternate, or it may enhance the performance of the 2020 when accomplishing the job.

Item	Quantity	Description	Part Number
1.	1	Option, 2020 Enhanced Main Rotor	11-900-0003**
2.	1	Target Assy., Tip,	10-100-0478
3.	1	Cable, Interf. Assy. Strobe-ACES 2020	10-320-0161
4.	1	Strobelight	As Required

**Using the Enhanced Main Rotor Option will require entries on screens not found in the standard 2020 software. If your 2020 does not display all of the following screens, contact ACES Systems to learn about the benefits and availability of EPS.

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 2020 analyzer.

Equipment Installation Diagram



FIGURE 1



FIGURE 2

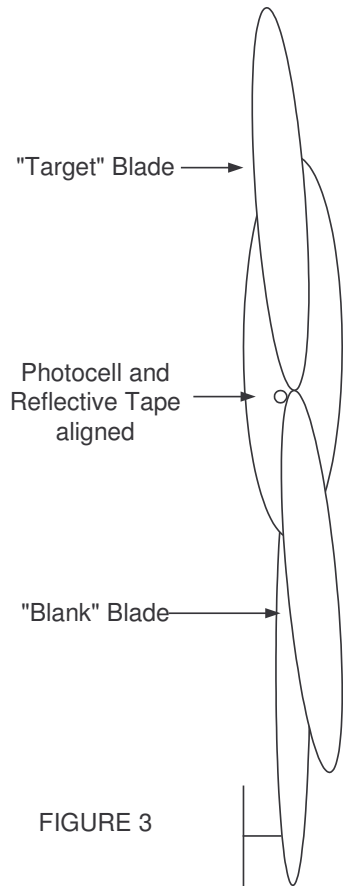


FIGURE 3

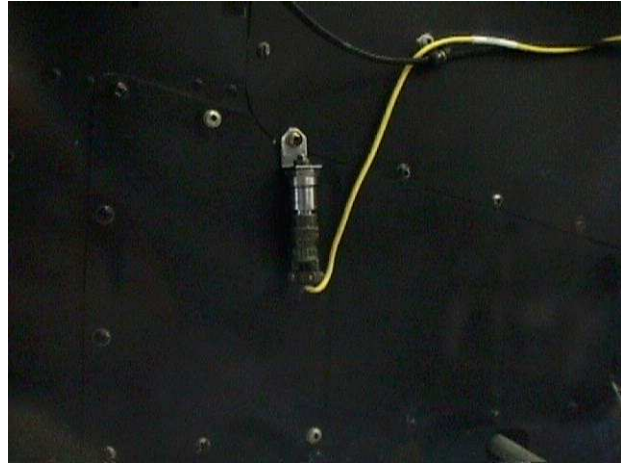
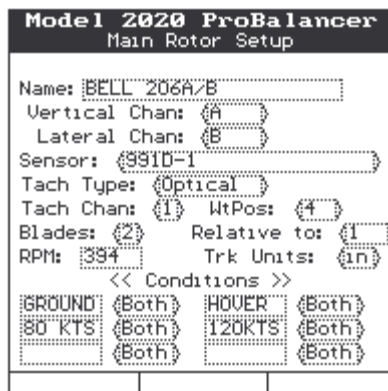


FIGURE 4

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 2020 ProBalancer
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 in the appropriate fields exactly as it appears below. When completed, press [ENTER].

```

Model 2020 ProBalancer
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=0 if no adjustment.
Diff charts use diff IDs.
    
```

- The “M/R Adj Symbol Setup” 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 2020 ProBalancer
M/R Adj Symbol Setup

Adjustment
Positive Value Meaning

Weight: (ADD)
Sweep:  (AFT)
Blade:  (UP)
TAB:    (UP)
    
```

- 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 2020 ProBalancer
Main Rotor Chart Setup
Name: Vert: 80 KTS-120KTS
Chart Type: (Regular)
Sweep Only: (No)
Adj. Unit: DEG
Adj./IPS: 3.50
Bld/Pos      Adj @      Bld/Pos
-----
TARGET      2:00
BLANK       8:00

Bld/Pos: in CW or CCW order
+Adj = WtAdd/SwAft/BlUp/TabUp
Help
    
```

- 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 2020 ProBalancer
Main Rotor Chart Setup
Name: Lat: GROUND-HOVER
Chart Type: (Irregular)
Sweep Only: (No)

Bld/Pos Unit  Adj   IPS  Adj @
-----
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
Help
    
```

- 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 2020 ProBalancer
Tracking Influence Setup

Conds      AdjName Unit  Adj./in
-----
GROUND-HOVER PCL  FLT  16.00

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

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

D. Data Acquisition

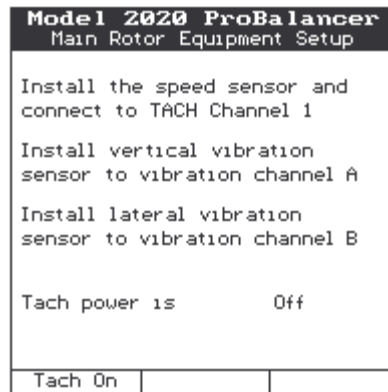
- “Customer Information” screen. To assist with the identification of the job when it is printed and/or stored in the analyzer, it is recommended that this screen be completed. When finished press [ENTER].

Model 2020 ProBalancer		
Customer Information		
Enter the following optional Customer Information.		
Name:	:CUSTOMER NAME:	
A/C Registrations:	:NI234:	
A/C Total Time:	:100:	
Press ENTER to continue.		
Names		

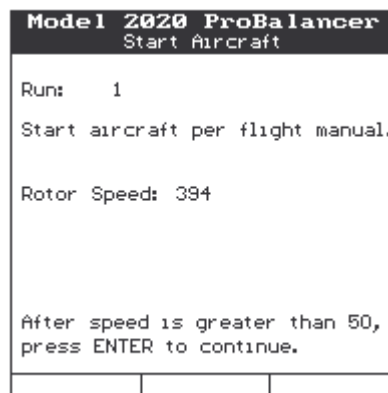
- “Tracking Selections” screen. Allows the user to select a tracking device for this particular job. Select <Tracker> and enter the additional data as displayed below or select <Strobe>. Then press [ENTER].

Model 2020 ProBalancer		
Tracking Selections		
Track Device:	:Tracker:	
- For Optical Tracking Only		
Number of Rotations:	:50:	
Inches To Blade Tip:	:130:	

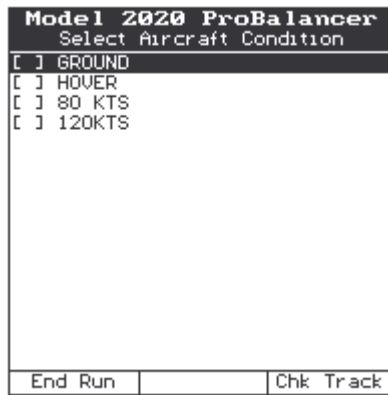
- “Main Rotor Equipment Setup”. Information screen that prompts the user to verify equipment installation has been performed in accordance with channel selections that were specified when building the setup.



4. Install and align reflective tape with Phototach as follows:
 - a. Press **[F1]** “Tach On”. Position one blade over the aircraft’s nose. (See Section B Figure 2 and Figure 3)
 - b. 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.
 - c. 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.
 - d. Remove the backing and install the reflective tape on the clean swashplate surface.
 - e. Press **[ENTER]** when finished with Tape installation.
5. “Start Aircraft” screen. This screen allows the user to view the current main rotor rpm. When the rotor speed is stable and above 50 RPM, press **[ENTER]**.



6. “Select Aircraft Condition” screen. Displays the ground and flight regimes that are specified in the setup. Select “GROUND” and press **[ENTER]**.



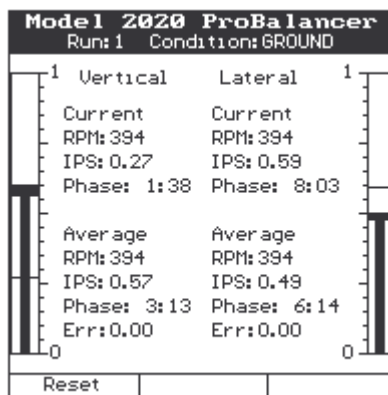
Note

The [F3] “Chk Track” button will allow you to observe the track picture without saving that data as part of the job in progress. Use [F3] “Track” from Paragraph D.8 below to store track readings as part of the job in progress.

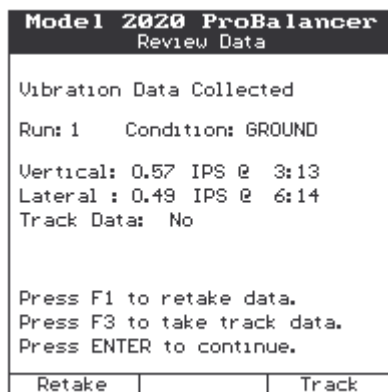
Note

At any time during the flight, if the vibration levels are found to be too severe to continue, the user has the option to “End Run” [F1] and solve for vibration data acquired to that point.

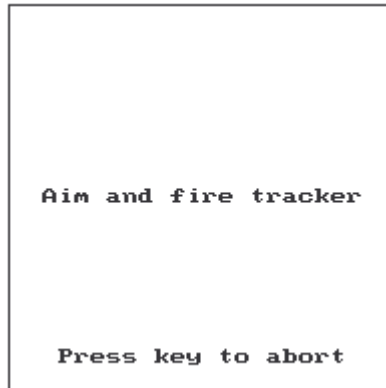
7. “Run: 1 Condition: GROUND” screen. This screen is displayed during the vibration acquisition. The title will change to reflect the current run and condition. When the RPM, IPS and Clock readings under “Average” show minimum change, press [ENTER].



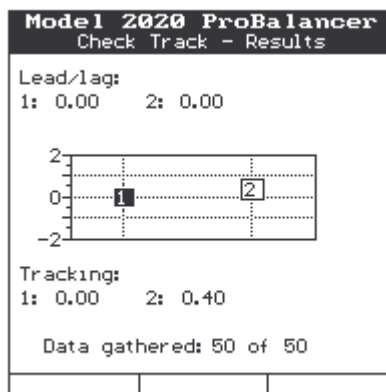
8. “Review Data”. This screen allows the user to view the vibration readings that were acquired during the regime. Press [ENTER] to continue or [F3] to take track readings.



9. If [F3] 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.
- Raise the tracker until the three green LED lights are illuminated.
 - 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.
 - 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.
 - 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.
 - When the amber light extinguishes, data acquisition is complete and you may lower the tracker.
11. The track data will now 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” [F3] 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” [F3] to return to paragraph D.9 above to retake track readings only.

Model 2020 ProBalancer		
Review Data		
Vibration Data Collected		
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 F3 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 2020 ProBalancer		
Select Aircraft Condition		
[x]	GROUND	
[x]	HOVER	
[x]	80 KTS	
[x]	120KTS	
End Run	Adjust	Chk 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 2020 ProBalancer		
M/R Sugg. and Inst. Adj		
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 2020 ProBalancer		
M/R Sugg. and Inst. Adj		
Run 1		
Name: Lat:GROUND-HOVER, GMS, PT		
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

- 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 2020 ProBalancer		
M/R Sugg. and Inst. Adj		
Run 1		
Name: Trk:GROUND-HOVER, PCL, FL		
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