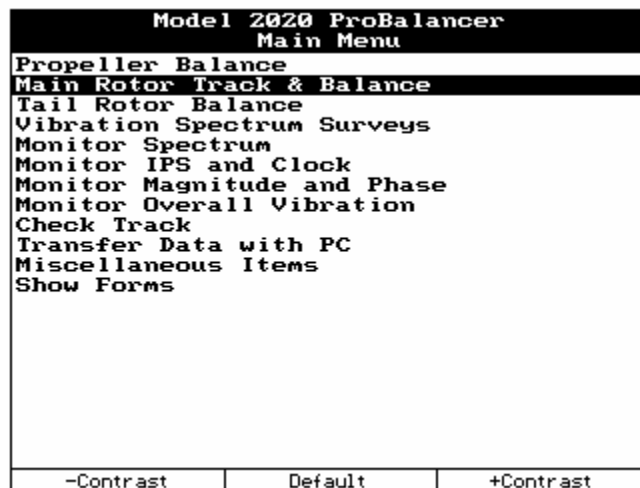

Section 3

Balancing With Enhanced Performance Software

(Revision 2, May 2005)

The section outlines the balance job process for both the main and tail rotor functions using the example setups created in Section 2. The main rotor balance process will be covered first, followed by the tail rotor balance process.

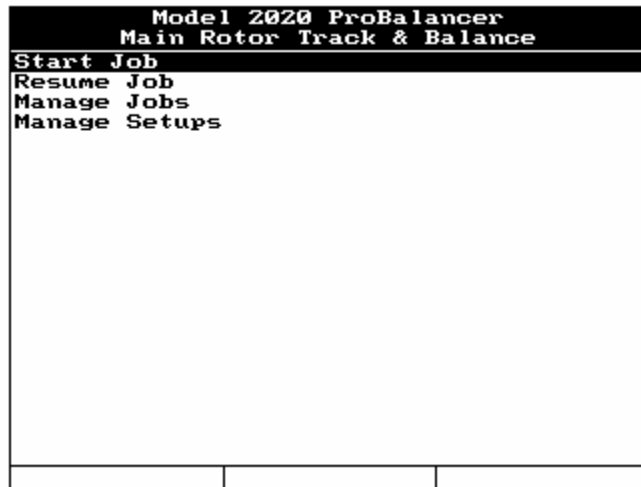
3.1. Main Rotor Balance Process



The following paragraphs present the main rotor track and balance process and its associated screens and is intended to familiarize the user with the data acquisition and correction capabilities of the Main Rotor Enhanced Performance Software.

Prior to starting a new main rotor track and balance job, you must first select the “Main Rotor Track & Balance” option from the main menu. Do this by highlighting the “Main Rotor Track & Balance” option from the “Main Menu” screen using the [↓] key and pressing [ENTER].

3.1.1. Starting a New Job



Selecting “Start Job” from the “Main Rotor Track & Balance” banner screen allows you to begin a main rotor balance job. When you select this option, one of three screens will appear next depending on whether you are using the main rotor function for the first time, have previously defined main rotor setups, or have a previously started job stored in the analyzer.

- *If you are using the analyzer for the first time*, the “Main Rotor Setup” banner screen will appear allowing you to define a new main rotor setup to use. Refer to Section 2 Paragraph 2.2.1. “Main Rotor Setup” for detailed instructions on defining a setup.
- *If you have previously saved setups stored in the analyzer’s memory*, a screen displaying the list of setups will be displayed. You can then select a setup from this list to use for the job. Proceed to Paragraph 3.1.2. “Setup List”
- *If another job was already in progress but not completed*, the “Incomplete Job” banner screen will be displayed and the analyzer will present a message prompting you to verify that you wish to finish the incomplete job or begin a new job. The screen will display the message; “The last job performed is incomplete. Finish it?” If you wish to return to the unfinished job, press the [F1] “Yes” key and you will be returned to the point where the in-progress job was stopped and allowed to complete it. If you wish to continue with starting a new job, press the [F3] “No” key and the screen will then display the “Setup List”. Proceed to Paragraph 3.1.2.

3.1.2. Setup List

Select Setup List	
1)	EXAMPLE 3
2)	EXAMPLE 2
3)	EXAMPLE 1
New	

The setup list presents the stored main rotor setups in analyzer memory. Select the setup you wish to use by highlighting the name of the setup using the [↓] key and pressing [ENTER]. If the setup you need is not present, press the [F1] “New” key to proceed to the “Main Rotor Setup” screen to define a new setup, see Section 2 Paragraph 2.2.1 for detailed instructions on how to complete a setup.

3.1.3. Customer Information

Model 2020 ProBalancer Customer Information	
Enter the following optional Customer Information.	
Name:	CUSTOMER NAME
A/C Registration:	N1234
A/C Total Time:	123.4
Press ENTER to continue.	
Names	

As shown above, the “Customer Information” banner screen appears next allowing entry of the customer name, A/C registration, and A/C total time. This information is optional, but it is suggested that at least a customer name be entered, as it will aid in identifying the job for future use.

If the analyzer has been used previously, a list of customer names will have been stored and are accessed by pressing the [F1] “Names” key. A name can then be selected from this list for use with this job.

When finished, press [ENTER].

3.1.4. Tracking Selections

```
Model 2020 ProBalancer
Tracking Selections

Track Device: Tracker

- For Optical Tracking Only -
Number of Rotations: 50
Inches To Bld Tip: 110
```

The “Tracking Selections” screen is displayed, allowing you to choose a tracking device for use with the job. This screen will always be presented at the start of a new job to allow selection of a tracking device or when resuming a job to ensure the device has not been changed.

- The tracking device field is a toggle selection of either “Tracker” or “Strobe.” Use the [⇒] or [⇐] keys to select the tracking device being used.

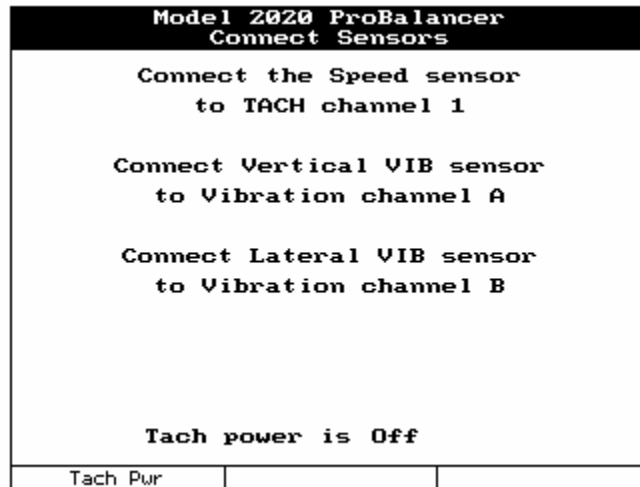
If you select “Tracker,” press the [↓] key and move to the lower portion of the screen to input the following:

- Using the keypad, enter the number of revolutions for which you will acquire track data. The minimum entry is 20 and the maximum is 99, however, it is highly suggested that you use no less than 50 for the number of rotations to measure track. This will result with greater accuracy from the tracker.
- Using the keypad, enter the distance, in inches, from the tracker’s location (usually the cockpit) to the blade tip’s location when the interrupter is over the magnetic pickup, or reflective tape in front of the Phototach.

See the Optical Tracker User Manual, Document Number 540-OM-01, for a detailed description of the optical tracker’s operation.

When finished, press [ENTER].

3.1.5. Connect Sensors



The “Connect Sensors” banner screen will be displayed next. Messages that appear on this screen prompt you to perform the physical installation and connection of the tachometer and vibration sensors to the input channels you specified in the applicable setup.

- You must use the vibration sensor installation locations as specified by the applicable polar charts. The orientation of the sensor is key to the accuracy of the chart, if the sensor is installed in a direction other than that specified, the phase (clock) angles will be incorrect and solutions will not be accurate.
- If you are using a magnetic pickup for the speed sensor, install and set the gap as directed in the applicable maintenance manual or polar chart. The Model 2020 ProBalancer Analyzer only accepts a “single” type interrupter and it is necessary to remove any multiple or double interrupter(s) installed and replace with a single interrupter.
- It is permitted to use the Phototach for the main rotor one per revolution source. If using a Phototach as the tachometer, refer to Paragraph 3.1.5.1. “Optical Tachometer Setup”.
- Also at this time, install any ship’s power and strobe cables as needed.

When completed, press [ENTER].

3.1.5.1. Optical Tachometer Setup (Optional)

To install the optical tachometer, do the following:

- If not specifically provided by an ACES Systems Application Note or manufacture’s directions, locate a position that allows the Phototach to be installed not more than 18 inches away or closer than 4 inches from a rotating main rotor component. This component will be used to install the reflective tape and serve as the once-per-revolution tachometer source for the analyzer. Connect and route the tachometer cable from the Phototach to the analyzer.

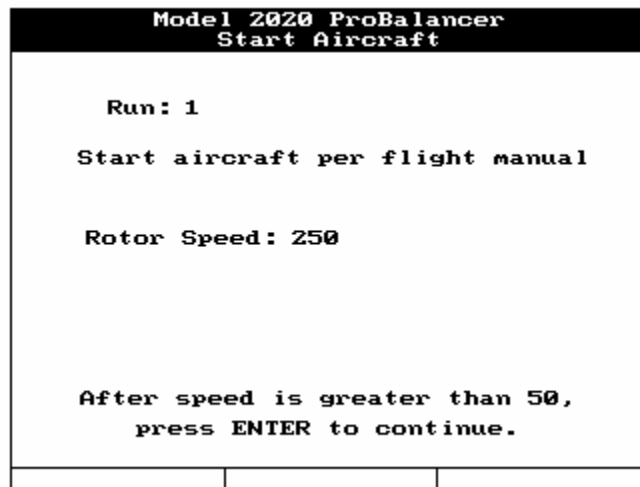
Note

If possible, the location of the Phototach should allow for the reflective tape to trigger it when the main rotor is in the reference position as specified by the balance chart. This will provide a direct correlation of the clock angles produced by the analyzer and the charts. If this is not possible, the clock positions on the chart will have to be rotated based on the vibration results from the first applied correction.

- While still in the “Connect Sensors” banner screen, a message is presented near the bottom that reads “Tach Power is Off”. The Block directly below this statement and corresponding to the [F1] key, is labeled “Tach Pwr”. Pressing the [F1] “Tach Pwr” key will supply power to the Tach. Turning the tachometer power on is not required to start the balance job, this step is only accomplished to verify the proper operation of the Phototach.
- Rotate the main rotor until the target object is aligned with the Phototach. Clean this area thoroughly to insure adhesion of the tape.
- Cut a strip reflective tape (3M Tape, Model 7610) approximately 1.5 to 2 inches long. With the tape backing still in place, hold the tape in position on the target object, then verify the red LED “Gate Light” indicator light on the back end of the Phototach is illuminated. This indicates the position of the tape is correct.
- Remove the tape backing and attach reflective tape at that location. Be sure to smooth out any wrinkles or bubbles in the tape. Insure the edges are smoothed and attached.

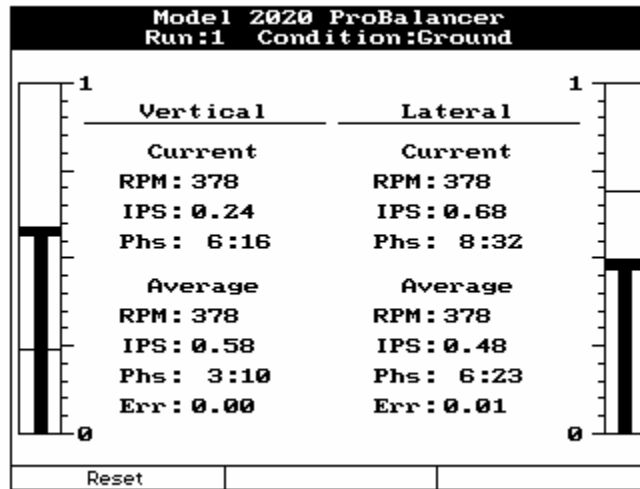
Once the above steps are completed and good “Gate Light” signal is present, press [ENTER] to proceed with the job.

3.1.6. Start Aircraft



The analyzer will now direct the user to “Start aircraft per flight manual”, refer to the aircraft’s flight manual for all aircraft starting and operational instructions. This screen allows you to view the current main rotor RPM. When the aircraft has been started and RPM is greater than 50, press [ENTER] to continue.

3.1.8. Data Acquisition



Upon selecting to acquire a measurement, the data acquisition screen appears. The screen banner will contain the run number as well as the flight condition being measured. Within the screen, the analyzer will present the current and averaged RPM, IPS level, and Phase (Clock) angle. The averaged measurement will be used when calculating solutions. There is also an error indication associated with the averaged measurement.

Note

The error will typically lower rapidly when the amplitude of vibration is high. When the amplitude reaches a lower level (Approx. < 0.05 IPS) the error may remain high. This is a normal response and is not cause for alarm.

- Press the [F1] “Reset” key to restart the measurement and averaging process at any time. This may be performed as a means of validating the quality of a measurement. If, after the reset key is pressed, the average measurement does not return to approximately the same value shown before, the quality of the measurement may be questionable. If this occurs, repeat the averaging process and try it again until the measurement values are similar both before and after resetting.

When the error reaches its lowest level, press [ENTER] to stop the acquisition process.

3.1.9. Review Data

Model 2020 ProBalancer Review Vib Data	
Run: 1	
Condition: Ground	
Vertical: 0.58	IPS @ 3:10
Lateral: 0.48	IPS @ 6:23
Track Data: No	
Press F1 to retake data.	
Press F3 to take track data.	
Press ENTER to continue.	
Retake	Track

The “Review Data” screen will now appear presenting the vibration data for the current run / flight condition.

- This screen also offers a chance to retake the measurement by pressing the [F1] “Retake” key. Pressing this key returns you to the data acquisition screen as shown in Paragraph 3.1.8.
- If you wish to measure and record track for this run and flight condition, press the [F3] “Track” key. Proceed to Paragraph 3.1.9.1.

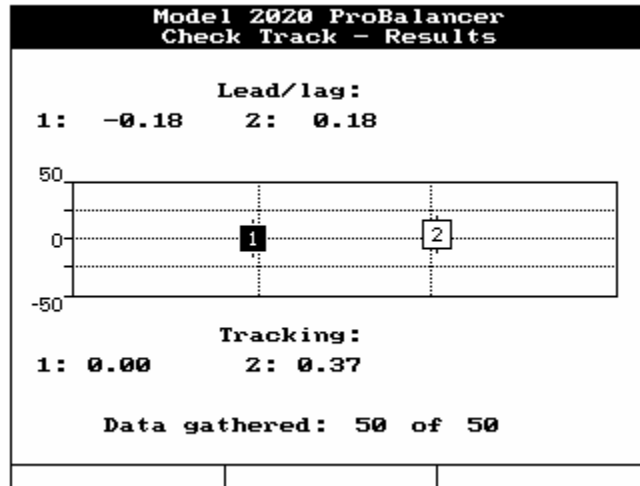
When you have finished reviewing the data, press [ENTER] to return to the “Select Conditions” screen in order to acquire more measurements or to end the run. See Paragraph 3.1.7. “Select Conditions”.

3.1.9.1. Track Measurement

<p>Aim and fire tracker</p> <p>Press key to abort</p>

If you select to measure track, a screen will appear prompting you to “Aim and Fire Tracker”. At this point, the tracker is energized and ready to use. Verify the presence of a solid amber light at the bottom of the LED aiming lights. See the Optical Tracker User Manual, Document Number 540-OM-01 for complete background light requirements and aiming instructions for using the Optical Tracker. When the amber LED is completely extinguished the tracker has measured the desired number of revolutions as entered at the start of the job.

3.1.9.2. Check Track – Results



The “Check Track – Results” screen will appear presenting the track data just acquired. These data will be shown in both graphical and numerical format. See the Optical Tracker User Manual, Document Number 540-OM-01 for complete instruction on how to interpret the results presented by the Optical Tracker. The lower portion of the screen shows the number of valid data packets the tracker sent to the analyzer.

Note

If the number of data packets gathered is less than 75 percent of the total, select the [F3] “Track” option again upon returning to the review data screen as described in Paragraph 3.1.9.

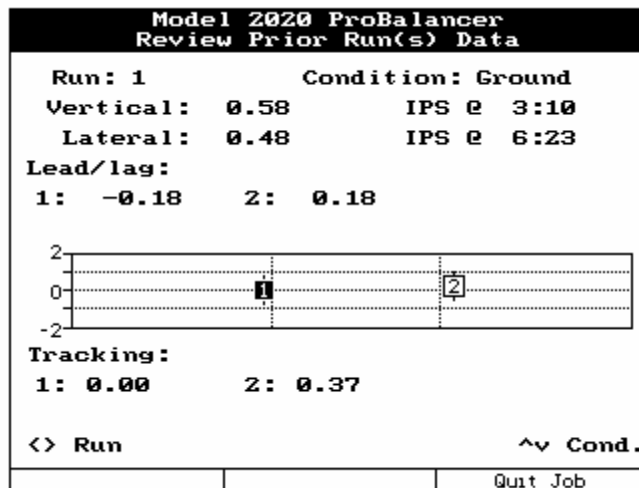
When you have finished reviewing the track, press [ENTER] to return to the “Review Data” screen.

3.1.10. Shutdown Aircraft



When you have chosen to end the current run, the analyzer will prompt you to shutdown the aircraft. Press [F3] “Continue”.

3.1.11. Review Prior Run(s) Data



The “Review Prior Run(s) Data” screen appears as shown above. The data will be displayed in the order of the current run and first flight condition measured. From this first screen, press the [↓] key to proceed to the next condition measured for the current run. Press the [↑] key to return to the previous condition.

If the current run is number two or greater, pressing the [←] key will move to the same condition as on the previous run. Press the [⇒] key to return to the current run. Always observe the run number and condition name at the top of the screen to identify the data you are viewing.

When you have completed reviewing the data, press [ENTER] to continue to the solution screens.

3.1.12. Solution Screens

The number and type of solutions presented will depend upon the data gathered and the limits that were set for each of the measurement types in the “Conditions Setup” screen when the setup was defined. Solutions will be presented in the following order: Vertical, Lateral, then Track.

The analyzer will present all of the solutions that are possible from the data gathered for the current run. This means that it is possible for the analyzer to give two adjustments that would affect the other adversely. The user will ultimately be responsible for determining which adjustments to make and which to discard.

For instance, in the following sample screens, the analyzer will recommend solutions for both the pitch change links and the main rotor blade trim tabs for the same run. If you were to make both of these adjustments, chances are, this would over-correct causing counter-adjustments on the next run. Most likely in this case, and depending on the amount of PCL adjustment, the trim tab adjustment would be skipped and only the pitch change link adjustment would be made.

As stated earlier, the solutions presented by the analyzer are based on the charts defined in the setup and the measurements acquired for the current run. These influences will be updated each time the analyzer is used. For the updates to be accurate, you must enter exactly the adjustments performed, or skipped. If the analyzer presents a solution and you choose not to apply it on the current run, you are required to zero out the adjustment entries in the recording screen for that particular adjustment.

The examples shown below are for explanation only. They do not reflect actual aircraft run data. Each solution should be implemented independently in different runs. The Model 2020 is not designed to implement multiple solutions in a single run. The individual “Suggested” entries are for demonstration only and cannot be assumed to have been accomplished in a single run.

3.1.12.1. Example Solution Screen #1

Model 2020 ProBalancer M/R Sugg. and Inst. Adj		
Run 1		
Name: Vert :HOVER, FLT		
Bld/Pos	Suggested	Installed
TARGET	1.04	1.00
BLANK	0.00	0.00
+Adj = WtAdd/SwAft/BlUp/TabUp		
Inst=Sugg	Inst=None	Quit Job

For our sample job, the first adjustment given is for a vertical measurement at HOVER. The adjustment type to be applied is “FLT” or flats of a pitch change link. The line at the bottom of the screen serves as a reminder that a positive adjustment is intended to move the blade up.

For this measurement, the analyzer’s recommended adjustment is to raise the TARGET blade by 1.04 FLT. It is determined that measuring 1.04 flats is unrealistic. In the sample case a 1.00 FLT adjustment was the closest measurable adjustment that could be made on the pitch change link. In the Installed column, 1.00 was entered before exiting the screen. Keep in mind that the analyzer requires an entry that reflects the actual adjustment made to update the ICF.

- Pressing the [F1] “Inst=Sugg” key will return any “Installed” field that has been edited to the original values presented by the analyzer.
- Pressing the [F2] “Inst=None” key will delete all “Installed” field entries. This function is used when a particular adjustment is to be skipped on the current run.
- Pressing the [F3] “Quit Job” key will exit the current job and store it as complete.

Warning

Using the [F3] “Quit Job” function will close the job and not allow resuming at a later time. If you wish to stop the job temporarily, press the “Main Menu” key or simply turn the analyzer off.

When you have finished entering the adjustments performed, press [ENTER] to continue to the next screen.

3.1.12.2. Example Solution Screen #2

Model 2020 ProBalancer M/R Sugg. and Inst. Adj		
Run 1		
Name: Vert:FLT 80-FLT120, DEG		
Bld/Pos	Suggested	Installed
TARGET	0.00	0.00
BLANK	4.01	0.00
+Adj = WtAdd/SwAft/BLUp/TabUp		
Inst=Sugg	Inst=None	Quit Job

The second solution the analyzer gave for our sample job is for the average vertical measurement from flight at 80 knots and flight at 120 knots. The adjustment type for this chart is degrees of trim tab. This is expressed on the screen as “Vert: FLT 80 – FLT120, DEG”. For the current run, if you chose to make the pitch link adjustment as recommended in the previous screen, you would skip the trim tab adjustment. Do this by pressing the [F2] “Inst=None” key and then [ENTER].

3.1.12.3. Example Solution Screen #3

Model 2020 ProBalancer M/R Sugg. and Inst. Adj		
Run 1		
Name : Lat :HOVER, GMS,PTS		
Bld/Pos	Suggested	Installed
TARGET	41.78	42.00
T AFT	0.00	0.00
BLANK	0.00	0.00
B AFT	0.86	1.00
+Adj = WtAdd/SwAft/BlUp/TabUp		
Inst=Sugg	Inst=None	Quit Job

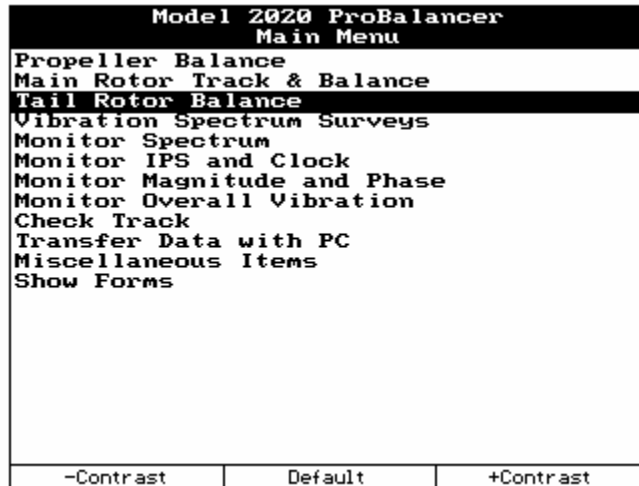
The last correction given for our sample job is for the lateral ground measurement. The solution type for this adjustment is grams of weight and points of sweep. This was entered in the name of the blade position during setup. The name for this solution screen reflects these two adjustments, “Lat: HOVER, GMS, PTS”. The solution presented for this screen was to add 41.78 GMS to the TARGET blade and sweep the BLANK blade aft by 0.86 PTS. Looking at the “Installed” fields you can see that 42.00 grams of weight has been added to the TARGET blade and the BLANK blade has been swept aft by 1.00 point. Note the reminder at the bottom of the screen showing that for this chart, a positive solution means to sweep the blade AFT.

Note

The analyzer will attempt to give solutions that “resolve to zero” in all cases. This may nullify the ability to make some adjustments with any degree of accuracy. If this occurs, it is the user’s responsibility to adjust the amount either up or down to achieve a quantifiable adjustment. Remember that the analyzer will update the influence co-efficient between every run based on the vibration results from the previous adjustment.

When the last solution screen has been updated, pressing [ENTER] will take you to the “Start Aircraft” screen for the next run.

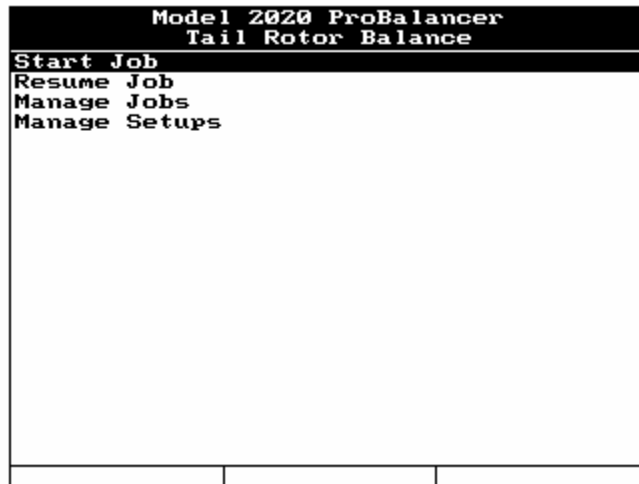
3.2. Tail Rotor Balance Process



The following paragraphs present the tail rotor balance process and its associated screens. It is intended to familiarize the user with the data acquisition and correction capabilities of the Tail Rotor Enhanced Performance Software.

Prior to starting a new tail rotor balance job, you must first select the “Tail Rotor Balance” option from the main menu by using the [↓] key and press [ENTER].

3.2.1. Starting a New Job



As shown in the example above, selecting “Start Job” from the “Tail Rotor Balance” banner screen allows you to begin a tail rotor balance job. When you select this option, one of three screens will appear next depending on whether you are using the tail rotor function for the first

time, have previously defined tail rotor setups, or have a previously started job stored in the analyzer.

- *If you are using the analyzer for the first time*, the “Tail Rotor Setup” banner screen will appear allowing you to define a new tail rotor setup to use. Refer to Section 2 Paragraph 2.2.2. “Tail Rotor Setup” for detailed instructions on defining a setup.
- *If you have previously saved setups stored in the analyzer’s memory*, a screen displaying the list of setups will be displayed. You can then select a setup from this list to use for the job. Proceed to Paragraph 3.2.2. “Setup List”.
- *If another job was already in progress but not completed*, the “Incomplete Job” banner screen will be displayed and the analyzer will present a message prompting you to verify that you wish to finish the incomplete job or begin a new job. The screen will display the message; “The last job performed is incomplete. Finish it?” If you wish to return to the unfinished job, press the [F1] “Yes” key and you will be returned to the point where the in-progress job was stopped and allowed to complete it. If you wish to continue with starting a new job, press the [F3] “No” key, and the screen will then display the “Setup List” for selection of a setup to use for the new job. Proceed to Paragraph 3.2.2. “Setup List”.

3.2.2. Setup List



As shown above, the setup list presents the stored tail rotor setups in analyzer memory. Select the setup you wish to use by highlighting the name of the setup using the [↓] key and pressing [ENTER]. If the setup you need is not present, press the [F1] “New” key to proceed to the “Tail Rotor Setup” screen as outlined in Section 2 Paragraph 2.2.2.

3.2.3. Customer Information

Model 2020 ProBalancer Customer Information		
Enter the following optional Customer Information.		
Name:	CUSTOMER NAME	
A/C Registration:	N1234	
A/C Total Time:	123.4	
Press ENTER to continue.		
Names		

The “Customer Information” banner screen, shown above, appears next allowing entry of the customer name, A/C registration, and A/C total time. This information is optional, but it is suggested that at least a customer name be entered, as it will aid in identifying the job for future use.

If the analyzer has been used previously, a list of customer names will have been stored and are accessed by pressing the [F1] “Names” key. A name can then be selected from this list for use with the new job.

When finished, press [ENTER].

3.2.4. Connect Sensors

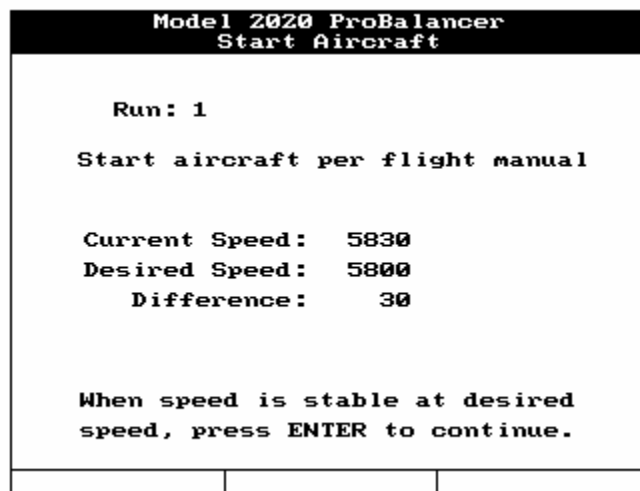
Model 2020 ProBalancer Connect Sensors		
Connect the Speed sensor to TACH channel 1		
Connect the VIB sensor to Vibration channel A		
Tach power is Off		
Tach Pwr		

The “Connect Sensors” banner screen will be displayed next. Messages that appear on this screen prompt you to perform the physical installation and connection of the tachometer and vibration sensors to the input ports you specified in the applicable setup.

- You must use the vibration sensor installation location as specified by the applicable polar chart. The orientation of the sensor is key to the accuracy of the chart, if the sensor is installed in a direction other than that specified, the phase (clock) angle will be incorrect and any solution will not be accurate.

When completed, press [ENTER].

3.2.5. Start Aircraft



The “Start Aircraft” screen appears. The current run number is displayed at the top of the screen, followed by both the current and desired speed in RPM. The differential speed is also displayed. When the current speed matches the desired speed, press [ENTER] to begin acquiring the measurement.

3.2.5.1 Select Tail Rotor Condition (Optional)

Model 2020 ProBalancer		
Select Tail Rotor Condition		
[]	IDLE	[0.00 @ 12:00]
[]	FULL	[0.00 @ 12:00]
End Run		

If the aircraft you are balancing requires multiple power or pitch settings, it is possible to gather multiple data points during one run. An example would be an aircraft that required a vibration reading at idle and one at full power. See Section 2 Paragraph 2.2.2.1. “Tail Rotor Setup” for defining multiple conditions in the setup.

The next screen to appear in a multiple condition Tail Rotor Balance job will be the “Select Tail Rotor Condition” screen similar to the example above. Use the [↓] or [↑] arrows to highlight the condition where the reading will be made and press [ENTER].

3.2.6. Data Acquisition

Model 2020 ProBalancer	
Run: 1	
	Vibration
	Current
	RPM: 5830
	IPS: 0.77
	Phs: 3:10
	Average
	RPM: 5830
	IPS: 0.50
	Phs: 6:00
	Err: 0.01
Reset	

The data acquisition screen will appear next, displaying the both the current and averaged rotor speed, vibration amplitude (IPS), and phase angle (in clock format). There will also be an error indication associated with the averaged measurement. The error will typically lower rapidly

3.2.8.1 Review Prior Run(s) Data for Multiple Conditions

Model 2020 ProBalancer			
Review Prior Run(s) Data			
Condition: IDLE			
Run	RPM	IPS	Clock
1	2500	0.700	12:00

Retake #1	Next Cond	Quit Job
-----------	-----------	----------

If the setup defined multiple conditions, the above screens will be presented. Use the [F1] “Retake #1” key to retake readings for run 1 data. Use the [F2] “Next Cond” key to review data for the next condition. Use the [F3] “Quit Job” to end the job, you will not be able to resume at a later time. To exit the “Review Prior Run(s) Data” screen and proceed to the solution process, press [ENTER].

3.2.8.2 Maximum Weight Warning

Model 2020 ProBalancer	
* WARNING *	
The maximum tail rotor weight defined in the setup is 12.00 grams.	
You must ensure that the total weight does not exceed 12.00 grams, regardless of what the analyzer suggests.	

Continue

After the review screen, the analyzer will present the above warning. This is a reminder as the analyzer has no way of knowing the running total of weight accumulated on the tail rotor. Since weight installed at the start of the job is not recorded prior to the start of a job, it is the user’s responsibility to keep track of how much weight has accumulated on the tail rotor.

3.2.9. Tail Rotor Suggested and Installed Weights

Model 2020 ProBalancer T/R Sugg. & Inst. Wts			
Run 1		Suggestion:	
B	1.9	C	2.1
Enter Installed Wts			
A	-2.0		
B	0.0		
C	0.0		
Inst=Sugg		Inst=None	
		Quit Job	

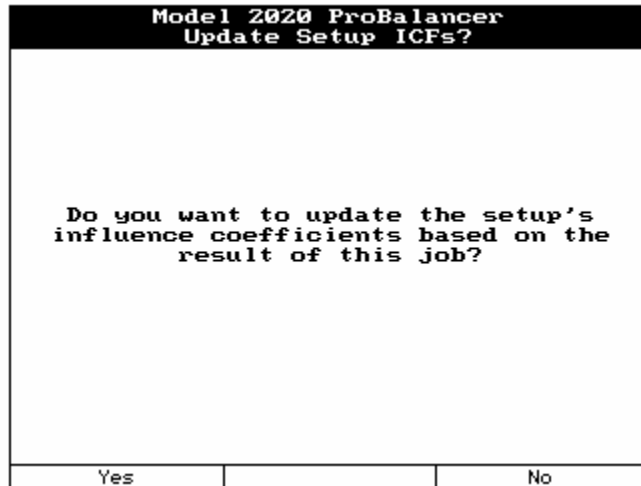
The “Tail Rotor Suggested and Installed Weights” screen appears displaying the suggested adjustments and providing for input of the actual changes made to the tail rotor prior to the next run. It is extremely important that these changes are entered, as they will be used to update the influence co-efficient for the next run. Use the keypad to enter changes. If weight is removed from a location, use the negative symbol [-] when entering the adjustment performed.

- Pressing the [F1] “Inst=Sugg” key will return any “Installed” field that has been edited to the original values presented by the analyzer.
- Pressing the [F2] “Inst=None” key will delete all “Installed” entries. This function is used when an adjustment is to be skipped on the current run.
- Pressing the [F3] “Quit Job” key will exit the current job and store it as complete.

Warning

Using the [F3] “Quit Job” function will close the job and not allow you the resume option at a later time. If you wish to pause the job temporarily, press the “Main Menu” key or simply turn the analyzer off. You may then use the “Resume” function to complete the job.

3.3 Quit Job



At the completion of either a Main Rotor or Tail Rotor balance job, you will be presented with the option to save the ICF updated during the job. This allows the ICF to be stored into the setup. This can be a useful tool when using the same setup in the future. The setup will store the ICF and begin to use the ICF from the point of the last update. This has the potential of reducing the number of runs required to balance the aircraft.

When the [F3] “Quit Job” key is pressed at any point during the job, the analyzer will compare the job’s current ICF with the default ICF from the original setup. If there is a significant difference, the analyzer will present the screen above. You will have to decide if you want to update the ICF stored in the setup by pressing the [F1] “Yes” key. The job’s ICF can also be discarded without updating the default ICF by pressing the [F3] “No” key. This is a good way to keep mistakes, mechanical looseness, or other outside factors from corrupting the ICF stored in the setup.