Procedure for use of DynaVibe Propeller Balancer

Introduction

EAA Chapter 245 provides many tools and facilities to its full members for use on their aircraft. The DynaVibe Propeller Balancer is one of these tools and was an expensive acquisition. Due to the delicate nature of this equipment EAA Chapter 245 has chosen to implement strict rules for the use of the DynaVibe Propeller Balancer to protect the equipment and the chapter members who use this device. The rules are in place to ensure a long life for the equipment and to ensure qualified members can use the equipment without delay and in the comfort of knowing the equipment will be functioning correctly when they chose to measure their propeller balance.

Rules

1. Only members who are of Full Membership status, and in good standing, are permitted to use, or benefit the use of, the DynaVibe Propeller Balancer.

2. It is not permissible for a Full Member to use the DynaVibe Propeller Balancer on a non-Full Members aircraft. The DynaVibe Propeller Balancer must only be used on an aircraft where at least one of the owners is an EAA 245 Full Member and is in good standing. The EAA 245 Full Member shall take full responsibility for the equipment and must be present during its usage.

3. Users of the DynaVibe Propeller Balancer must have been “checked out” by the approved EAA 245 personnel. The Operations Manager will have a list of approved EAA 245 personnel if requested

4. Users should read the attached manuals prior to use of the equipment to ensure they understand it function prior to use.

5. The Dynavibe Propeller Balancer is only to be used for balancing aircraft propellers or propeller/engine combinations. The equipment shall not be used, or modified, for other applications.

6. For members who have not been checked out on the DynaVibe Propeller Balancer the Operations manager, or his representative(s), shall endeavour to find a suitable

supervisor in support of the usage. It is up to the Full Member user to conduct, and take full responsibility, for the measurement as indicated in the user manual. The supervisor is present only to support the test and to protect the DynaVibe Propeller Balancer. The Full Member user takes full responsibility for the conduct of the test and its results.

7. The test may be conducted over several days/weeks as a single balancing session may not prove to be successful. This will be determined once the aircraft has been test flown. In the event multiple balance sessions are required for the same propeller configuration, the user will only be required to make a single rental payment providing the test program is not a protracted program. Special cases may apply with approval from the operations manager.

8. After the test is complete, the Full Member shall return the DynaVibe Propeller Balancer to one of the designated EAA 245 personnel. If there is any damage to the equipment, or there are observations regarding the DynaVibe Propeller Balancer's maintenance needs, the user should report it to the designated EAA 245 personnel in particular, the status of the batteries and reflective tape, should be reported.

9. Full Members will endeavour to minimise the usage time to maximize availability to other Full Members.

Note 1: Users are reminded that, for certified aircraft, a certified aviation mechanic with the appropriate certification and that is current, may conduct the work using the DynaVibe Propeller Balancer.

Note 2: The DynaVibe Propeller Balancer is not a certified piece of equipment and the certified aviation mechanic should ensure he/she complies with all legal matters regarding its use.

Note 3: The dynamic balance solution should be documented in the logbook with the mass and location of the corrective weights. A decal should be applied to the spinner or propeller hub to show that the assembly has been dynamically balanced.

Batteries

The batteries do get consumed relatively quickly if the equipment is left in the "ON" state, so it is recommended that the equipment is switched ON only during the test, and then, once the balance reading is obtained, the equipment is switched OFF. Adjusting the balance may take several minutes compared with only ten or fifteen seconds for conducting the measurement. If the equipment is showing some erratic readings the batteries may be reaching the end of their useful life so, please replace the batteries or advise the DynaVibe custodian upon its return.

Payment

The DynaVibe Propeller Balancer was an expensive acquisition and over time EAA 245 anticipates some factory maintenance will be necessary. In order to meet the costs of future maintenance, and possibly re-calibration, the chapter has deemed it necessary to place a $20.00 fee for each usage, where each usage is defined in Rule 7 above.

It is preferable that payment should be made in advance or when the DynaVibe Propeller Balancer is returned to the designated EAA 245 personnel. If the user has not paid the fee for previous usage, he/she shall be refused access to the DynaVibe Propeller Balancer until he/she is in good standing regarding the fee. If this becomes a repeating problem the user maybe be denied usage until a satisfactory solution is discovered.

DynaVibe

DynaVibe Classic
User Manual
Version 1-09

Aug 2015

RPX TECHNOLOGIES

WWW.RPXTECH.COM

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Important Notice

Any system that distracts a pilot while operating an aircraft is a safety hazard.

During the balancing procedure please use extreme caution. Be very careful with cables and components, especially on pusher type aircraft. ALWAYS confirm the ignition is off before rotating the propeller.

Areas of this manual will highlight specific safety concerns while operating the dynamic balancing system. Please review these before operating the system.

Introduction

A rotating mass such as an engine crank, propeller, propeller extension, or starter ring will always have small imbalances and tolerance variations. Those variations, upon assembly, may cause eccentricity in the mass of the rotating components, which generates vibration in the engine and airframe. In most cases, those mass eccentricities are designed to cancel and provide a smooth operation.

Vibration can cause damage throughout the aircraft, including; the crank bearings, engine mounts, firewall, instrument panel, etc. Vibration causes accelerated wear and fatigue on equipment and passengers. The negative effects of vibration can be reduced by dynamically balancing the aircraft's rotating assembly, balancing the crank, prop extension, propeller, spinner, all as one unit.

Dynamic balancing is accomplished by attaching a sensor to the unbalanced equipment. By using a device to monitor the speed and position of the rotating mass (propeller - crank) the dynamic balancer is capable of determining the vibration caused by the unbalanced assembly. Corrections to the assembly can then reduce the vibration.

While not all vibration can be eliminated, any reduction in vibration will reduce fatigue and damage. Some vibration from engine combustion, gear reductions, and accessories will not be affected by dynamic balancing.

Pre-Balance Inspection

The pre-balance inspection is very important. An initial evaluation of the propeller and engine can greatly reduce troubleshooting later in the process. Most dynamic balancing issues can be resolved by a good pre-balance inspection.

Airworthiness Directives / Service Bulletins

The first step in the pre-balance inspection is to review all available Airworthiness Directives (AD) and service bulletins for the propeller and powerplant. ADs and service bulletins will often contain specific information about problems, updates, or other issues pertaining to the particular propeller and powerplant.

> Example: Certain combinations of engines and propellers may require modified dampers due to increased torque impulses.

Determine Applicable procedure

For aircraft or propeller manufacturers that provide procedures for dynamic balancing, propeller balancing is not considered a major airframe alteration. When approved aircraft and propeller manufacturer's procedures are not available, there are other acceptable dynamic balancing procedures. Dynamic balancing of propellers using FAA-approved or FAA -accepted dynamic propeller balancing procedures is not considered a major propeller repair unless the propeller static balance weights are altered. Reference FAA Advisory Circular 20-37E *"Aircraft Propeller Maintenance."*

Blade Inspection

The propeller blade should be closely inspected for any damage to the propeller and general condition. Any maintenance that needs to be performed should be completed prior to dynamic balancing. Any dent or chip repair, painting, or finish treatments should be completed before proceeding. Reference FAA Advisory Circular 20-37E *"Aircraft Propeller Maintenance"* and FAA Advisory Circular 43.13-1B *"Acceptable Methods, Techniques, and Practices - Aircraft Inspection and Repair"* Chapter 8.

Spinner Installation

Prior to dynamic balancing, the spinner should be removed and inspected. The spinner should be checked for any mass imbalances caused by foreign material, missing screws, or damage. The attachment bulkheads should be inspected for cracks or damage and repaired as required.

> Example: Mud daubers, wasps, and other insects may nest inside the spinner housing in only a few weeks.

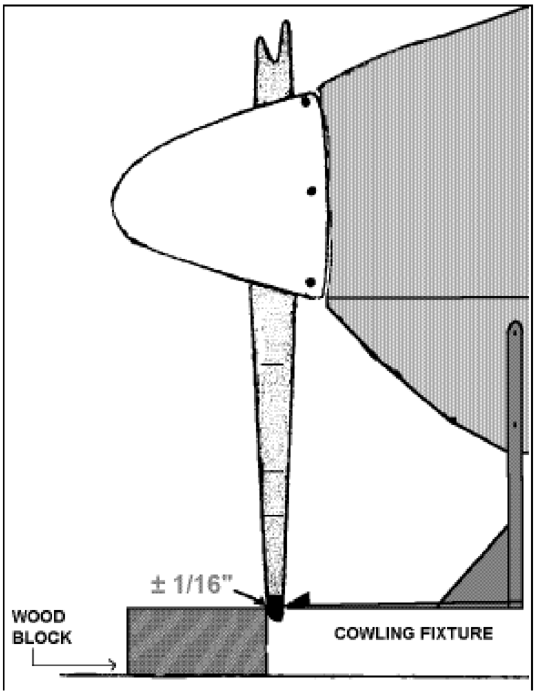
There are instances where spinners have been installed in such a manner as to allow the front of the spinner to move relative to the propeller. If the spinner structure has any flexibility, it will move from one side to another at high RPM, causing the out-of-balance location to shift periodically. The spinner should be firmly mounted and should not move when laterally loaded.

Blade Track and Pitch

It is important to determine that the blade is tracking correctly. If the blade is mounted on an irregular surface, if there is debris under the blade, or the blade is bent it will be impossible to balance the aircraft because the blade will be aerodynamically out of balance. An aerodynamic imbalance is similar to P-factor, an asymmetric lift between the blades.

Example: If a small metal chip or burr is allowed between the propeller and prop flange, then one blade will have a higher angle-of-attack than another blade, causing a vibration.

CAUTION:
Verify ignition and fuel are off prior to moving propeller



Check blade track and pitch

The simplest way to check for blade track is to position a wood block or other rigid structure next to a blade tip. Then rotate the blade carefully (avoid moving the aircraft) to the next blade and verify that the blade tip is in the same relative position as the previous blade. You may need to remove the spark plugs to allow the engine to rotate freely. If one blade is positioned differently from another, this indicates that either the blade is bent or the installation is unacceptable. Again, a dynamic balancer will not adequately correct an aerodynamic imbalance. According to FAA Advisory Circular 43.13-1B, each blade track should be within 1/16 of an inch.

Any error in blade track should be investigated thoroughly and eliminated. This may require that the propeller be pulled off the aircraft and sent to a propeller repair station.

Existing dynamically balanced weights

Once the pre-balance inspection is complete, record the position and weight of each dynamic balance correction weight previously mounted. Remove any existing dynamic balancing weights.

Static balance weights, installed by a propeller repair station, should not be removed. Only a propeller repair station may modify static balance weights.

Equipment Performance and Calibration

Equipment used on certified aircraft must be inspected and calibrated. The DynaVibe is available with National Institute of Standards and Technology (NIST) traceable calibration. Contact RPX for further information.

Precautions

Secure Cabling

Secure all cabling from the accelerometer and the optical pickup to the engine and aircraft using tape and zip ties as needed. Route the cabling into the cabin of the aircraft. Cables should not be allowed to hang free as they may become entangled in rotating equipment. For pusher aircraft and rotorcraft, this can be particularly dangerous. The cabling must always be secured and any doors or loose cowlings should be thoroughly secured to prevent damage during engine run-up.

Secure all cabling

CAUTION:
Verify ignition and fuel are off prior to moving propeller

CAUTION:

Rotate the propeller slowly to confirm clearance of all components.

When you add weight, confirm that you have not introduced any clearance issues.

Confirm that bolts are not protruding into the cowling, starter, alternator, or other components!

Installation of Equipment

Remove Cowling

Remove the cowling, if needed, to gain access to the area immediately behind the propeller. For typical power plant installations, this would require removing the upper cowling of the aircraft, giving access to the top of the engine.

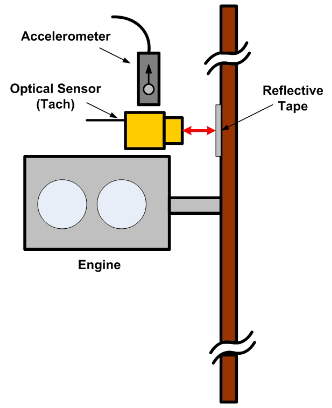
While you have the cowling off, check all the accessories for secure mounting. Any loose components such as an alternator, starter, etc

Mount the Accelerometer and Optical Pickup

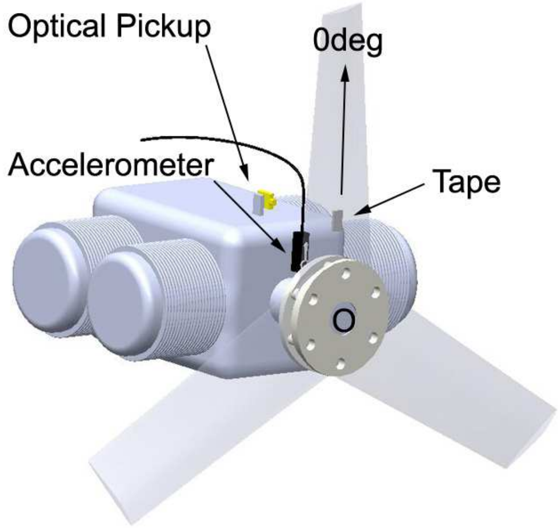
The accelerometer and optical pickup are typically mounted on the top of the engine. The optical pickup should be mounted approximately six inches behind the back of the propeller. The accelerometer should be mounted as far forward as possible for maximum sensitivity.

A common mounting technique is to remove one of the case bolts along the top of the engine. Replace the bolt with the accelerometer and optical pickup bracket installed under the bolt. Position the optical pickup such that the beam projects onto the back of the blade or spinner backplate.

The following Figure shows the relationship between the optical pickup, accelerometer, and the propeller. The optical pickup is pointing to the back of the propeller onto the reflective tape (to be put on in the next step). The accelerometer is mounted vertically, perpendicular to piston travel.



Relationship between optical pickup, accelerometer, and propeller.



Showing a typical installation for a Lycoming engine.

The optical sensor should be at least 6" from the reflective tape, but not so far that the optical sensor cannot obtain a reading from the tape.

Mount Reflective Tape on the Propeller

By placing the small piece of reflective tape (provided in the kit), on only one propeller, that propeller can now be considered the "Master" blade. Cut off approximately 2 inches of tape from the provided roll. Position the tape such that the optical pickup strikes the reflective tape and turns on the small light at the back of the optical pickup

A simple way to verify that the system is working is to position the "Master" blade so that the light on the back of the optical pickup is illuminated. Pass your finger between the beam to cause the light to turn on and off rapidly.

It is also beneficial to move your finger from top to bottom of the tape to verify that the optical pickup is reading the center of the tape. If the optical pickup is reading from one edge of the tape, it is best to readjust the optical pickup to measure in the center of the tape.

The photo pickup is configured to pulse a small light on the back of the photo pickup. When the photo pickup is correctly illuminating the reflective tape, the back of the photo pickup should have a pulsing red LED.

The faster the pulse rate, the better the returned signal. If the light is illuminated when not viewing the reflective tape, then the optical contrast may be insufficient to correctly determine RPM. It will be best to move the tape to a location with greater contrast.

> Example: Some chromed spinner backplates may confuse the photo pickup. Relocate the tape to the starter ring, propeller, or paint the back of the spinner backplate.

Experimental installation, showing reflective tape on spinner backing plate.

For an expected RPM and distance from hub / rotation center, there is a minimum tape width required.

For instance, if the engine cruise RPM is 2400 RPM, we look at the 2500 RPM line (next RPM greater) and we place the reflective tape 6 inches from the center of the hub, the minimum tape length is 1". If the RPM is 2400 with the tape 8 inches from the center of the hub, the minimum tape width required would be 1.9 inches.

	Tape Length Required		
RPM	6" from hub center	12" from hub center	24" from hub center
500	0.2"	0.4"	0.8"
1000	0.4"	0.8"	1.6"
1500	0.6"	1.2"	2.3"
2000	0.8"	1.6"	3.1"
2500	1"	1.9"	3.8"
3000	1.2"	2.3"	4.6"
3500	1.4"	2.7"	5.3"
4000	1.6"	3.1"	6.1"
4500	1.7"	3.4"	6.8"
5000	1.9"	3.8"	7.6"

Alternately, to use a particular tape width, table 2 shows maximum distances from hub center.

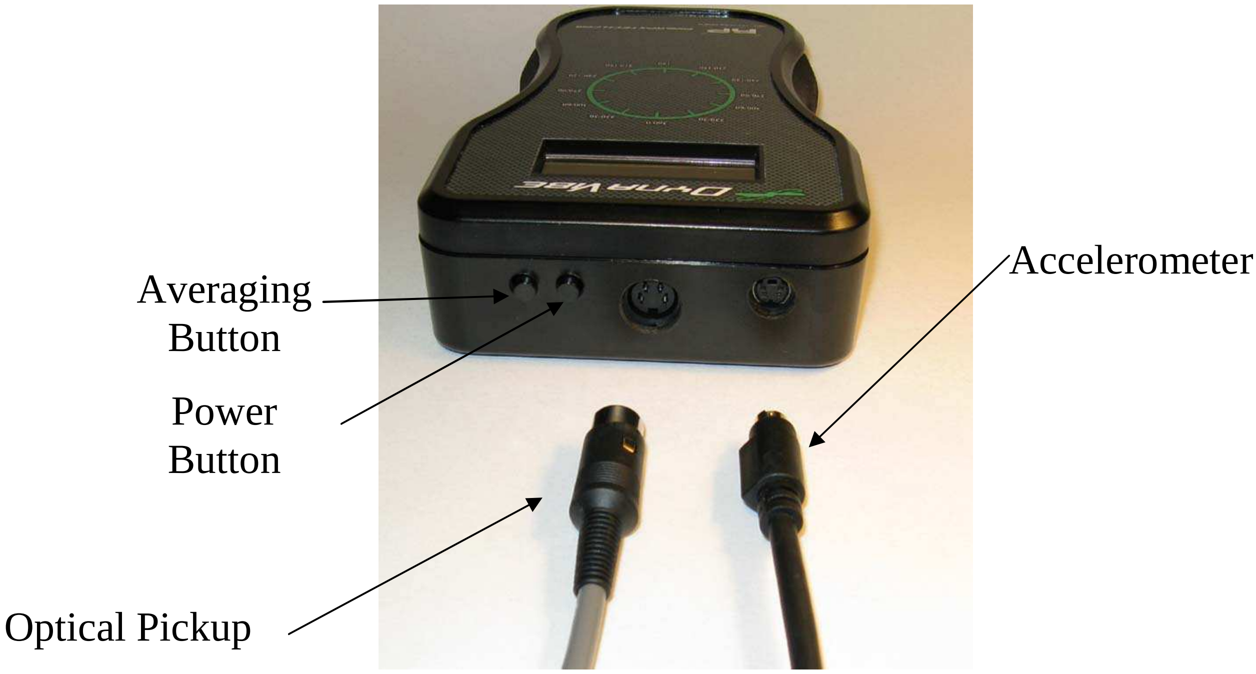
	Maximum Distance From Hub Center		
RPM	1" Tape	2" Tape	3" Tape
500	31"	62"	95"
1000	15"	31"	47"
1500	10"	21"	31"
2000	7"	15"	23"
2500	6"	12"	19"
3000	5"	10"	15"
3500	4"	9"	13"
4000	3"	7"	11"
4500	3"	7"	10"
5000	3"	6"	9"

Insufficient tape width will cause engine RPM to fluctuate and provide erratic readings.

Using the DynaVibe

Attach the DynaVibe

Attach the DynaVibe dynamic balancer to the accelerometer and optical pickup cables from the engine compartment. The cables are keyed, so look closely at the connectors before plugging them into the DynaVibe.



Back of DynaVibe

CAUTION:
Verify that the area around the propeller is clear of obstructions.

Verify that all cabling is secure.

Start Your Engine

Check with your engine manufacturer for specific information about ground running aircraft engines.

Example: Lycoming recommends that the engine be warmed up at 1000 RPM until oil temperatures have stabilized or reach 140° F. Full-static RPM should be maintained for not more than 10 seconds. After operating at full power, allow the engine to cool down moderately.

CAUTION:

Improper ground running of engines can cause significant damage to the engine.

Start the engine normally, watching for any shifting of cabling or equipment. Let the engine warm up to reduce wear during the high RPM data collection. Slowly increase the RPM of the engine until it has reached the desired RPM (usually peak static RPM, or cruise RPM).

Verify that the DynaVibe RPM reading is accurate relative to the displayed RPM. If the RPM is erratic or incorrect, this may indicate that the optical sensor is not properly in-line with the reflective tape.

The DynaVibe will now display the measured RPM and IPS-phase. Be sure the engine RPM remains constant during this process.

Averaging

Press the averaging button momentarily to have the DynaVibe average multiple rotations. This process will take a few seconds at high RPM, and longer at lower speeds. The DynaVibe will then display the averaged value.

This is the number that you will want to record on your datasheet. It is usually best to record two averages to verify repeatable operation.

Slowly return the engine to idle. Allow the engine to run at the lower RPM for a short period of time to cool.

Limitations

Correction weights should not be attached to a damaged or cracked spinner or spinner backplate.

Trial weights mounted on the outside of the spinner should be moved to the spinner backplate for permanent installation.

Do not use automotive stick-on weights. Only aircraft hardware should be used for balancing.

Propeller assemblies with initial readings above 1.2 IPS should be removed and static balance performed.

All hardware used should be aircraft quality. Hardware should be a minimum #10 size. Retaining nut should be self-locking.

Balance / Analysis

Clock the Prop and Change Weight

CAUTION:
Verify ignition and fuel are off prior to moving propeller

Confirm that the ignitions are off and mixture is full lean. Rotate the propeller carefully until the small light at the back of the optical pickup comes on. This is the 0° position relative to the accelerometer. The angle indicated by the DynaVibe is the angle where the prop assembly is heavy.

The angle is measured from the zero position of the accelerometer to the indicated angle in the direction of propeller rotation.

When the heavy point is identified, remove weight from this point. If there is no weight to remove from the heavy location, add weight on the opposite side of the propeller (indicated angle +/-180°).

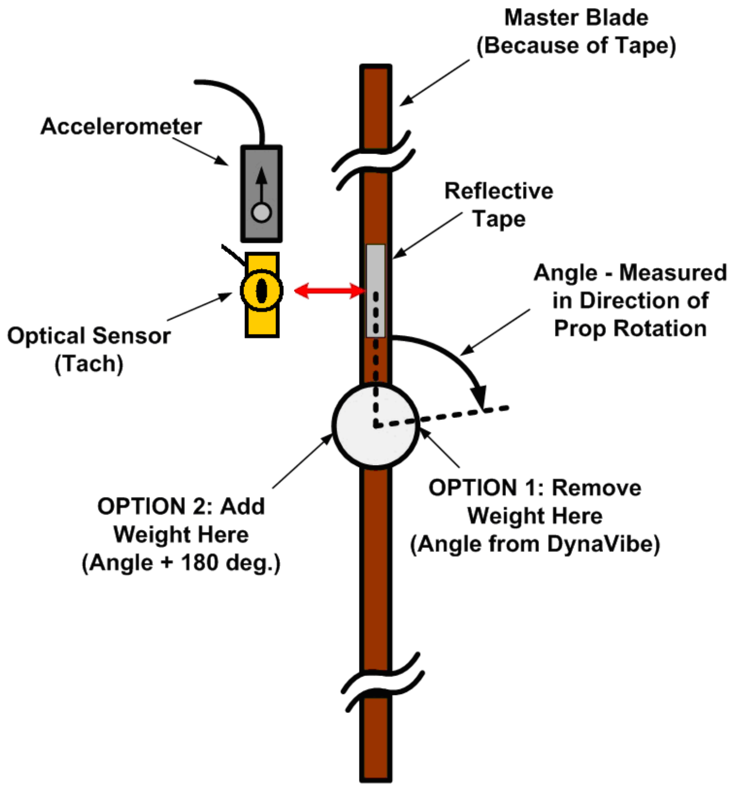
For instance, if the system is displaying 0.25IPS @ 90°, this is the position of excess weight. If there are no extra washers to remove from the spinner, then weight must be added to the opposite side (270°, 90°+180°). A typical O-320 installation with fixed pitch prop and spinner may require two to four AN970 washers to correct this type of vibration.

Every installation is different due to the weight of the engine, propeller, spinner, etc. Therefore, adding weight should be done in small increments and by making notes on the datasheet, the step-by-step correction gives you an indication of future changes.

A good starting point is 50 grams / IPS.

For instance, if in the above example, one AN970 washer is added at the 270 degree position and the system is run again, it is likely that the readout would be 0.17IPS @ 90°. This gives a good indication that the single washer corrected approximately 0.07IPS of vibration. While this would imply that one could quickly add two additional washers to correct the system down to 0.03IPS, it usually isn't that simple.

Take small steps and document as you go.



Showing the phase angle relative to the master blade.

Completing Balance

To move test weights outward or inward, the moment of the weight correct must remain constant. The mass times the radius of the position must remain the same between the trial weights and permanent weights.

For instance, if a trial weight correct is 10 grams at 12 inches, the total moment of the system is (10 grams x 12 inches) 120 gram inches. To move this amount of correction inboard to the spinner backplate, at a radius of 6 inches, the total mass must be increased to 20 grams (20 grams x 6 inches) 120 gram inches.

The table below shows the weight of common AN hardware.

Part Number	Weight, Grams	Description	Type
AN960-10L	0.5	Flat Washer 3/16 Light	washer
AN960-10	0.9	Flat Washer 3/16	washer
AN970-3	3.9	Flat Washer 3/16	washer
AN365-1032A	2.2	Elastic Stop Nut 10-32	nut
AN525-10R6	2.1	Washer Head Screw 10-32 x 3/8	screw
AN525-10R7	2.3	Washer Head Screw 10-32 x 7/16	screw
AN525-10R8	2.6	Washer Head Screw 10-32 x 1/2	screw
AN525-10R9	2.7	Washer Head Screw 10-32 x 9/16	screw
AN525-10R10	3.0	Washer Head Screw 10-32 x 5/8	screw
AN525-10R12	3.4	Washer Head Screw 10-32 x 3/4	screw
AN525-10R14	4.1	Washer Head Screw 10-32 x 7/8	screw
AN525-10R16	4.4	Washer Head Screw 10-32 x 1	screw
AN525-10R18	4.8	Washer Head Screw 10-32 x 1 1/8	screw
AN525-10R20	5.4	Washer Head Screw 10-32 x 1 1/4	screw

Documentation

The dynamic balance solution should be documented in the logbook with the mass and location of the corrective weights. A decal should be applied to the spinner or propeller hub to show that the assembly has been dynamically balanced.

Troubleshooting

Tach Readings

- Be sure you have a stable tach reading. A tach error will show up in the IPS reading!
- If RPM appears unstable check that the minimum tape width is correct.
- Mounting the reflective tape on a polished spinner back plate can give extra reflections. Relocate the tape or paint the back of the plate.
- The optical pickup must be at least 6 inches from the reflective tape to get a good signal.
- You can test the tape/pickup alignment by wiggling your finger between the tape and sensor. The tach reading should become live if your accelerometer is also plugged in. Also note that when aligned, a red light will glow on the back of the optical pickup.
- Remove the tape from metal props when finished to avoid corrosion under the tape. Use as little tape as possible (i.e. 1 inch strip) and mount the tape inboard toward that hub so the balance is not affected by removing the mass.

Accelerometer Mounting

- The accelerometer mount MUST be short, and rigid. If the results after weight additions don't make sense, your accelerometer/mount may be resonating.
- If the accelerometer cable is pointing away from the center of the hub, then the angle reported by the DynaVibe is the HEAVY spot (where to remove weight, or 180 degrees from where to add weight). If you flip it so the accelerometer cable is pointing toward the hub, then the reading will indicate the light spot (where to ADD weight).
- If possible, align the axis of the accelerometer so it goes through the center of the hub. If you have to shift it more than an inch, review the DynaVibe manual for interpreting the phase angle.
- If a long mount is needed for the tach, make two mounts and keep the accelerometer mount short and stiff.

Inconsistent Readings

- As indicated above, if the results after weight additions don't make sense, your accelerometer/mount may be resonating. Keep the mount short.
- Be sure something isn't moving! A common example is the spinner. If not securely mounted it can relocate during each run-up. In that case, multiple readings during one run-up may be consistent. After shutting down and restarting the angle could move due to the spinner shift. Also, if the spinner has packing, it may be shifting as well.
- If you're trying to get below 0.10 IPS, the reading may become "noisy". Take multiple readings, throw out any anomalies, then average the results.
- It doesn't matter if you measure the angle while standing in front of or behind the prop. This ambiguity is eliminated by simply measuring in the direction of prop rotation.
- The engine RPM must be stable for a valid vibration reading. Hold RPM as stable as possible when balancing.
- The engine should be running smoothly from idle to max RPM. Do NOT try to balance a prop with a rough engine!
- Route all of the DynaVibe wires well away (4" or more if possible) from spark plug wires or other sources of electrical noise.

Good Readings, Still have Vibrations

- Check blade tracking and pitch. Aerodynamic imbalance will change the vibration magnitude with RPM.
- Be sure other mounts, such as the alternator etc., are not vibrating.
- There are many sources of vibrations. The DynaVibe will zero in on the prop frequency. Balancing will not correct aerodynamic imbalances, vibrations at other frequencies, or vibrations from an unbalanced engine.

Batteries

- When in doubt, change the batteries! The unit takes two 9V batteries that can be accessed by removing the two screws on the back of the unit.

Error Messages

- "Sensor Error" - This indicates that there is a problem with the accelerometer signal. Check the cables and be sure the accelerometer is completely plugged into the DynaVibe.
- "No Tach" - This means that the DynaVibe is not receiving tach pulses. Note that a continuous signal will generate this message. To test the optical pickup, reflect the light from a piece of reflective tape that is statically positioned at least 6 inches from the optical pickup. The red light on back of the pickup should come on. Then pass your finger back and forth quickly to break the beam. The tach reading should become live. Note that the accelerometer MUST be plugged in for this procedure.

Doesn't Balance as Expected

- Verify compression on all cylinders, a weak cylinder will cause significant vibration.
- Verify that all cylinders are operating correctly by reviewing cylinder head temperatures. If cylinder temperatures are drastically different, it may indicate bad spark plug wires, fowled plugs, intake leaks, poor fuel distribution, etc.
- Verify that the spinner is balanced by placing it on a smooth surface and determine if it has a heavy position. The spinner must be statically balanced to balance the propeller. Unbalanced spinners may cause spinner plate cracks.
- Check that the spinner attachment plates are not cracked or damaged and that the spinner attaches snug on the propeller. Cracks indicate fatigue caused by flexing of the backplate. A loose spinner will shift in operation and cause variable readings.
- Check for cracks in the engine mount tubing and attach points. Look for cracking or structural damage on the firewall and engine mounts. Verify that the engine isolators are not cracked, compressed, or damaged.
- Check that the engine cowling does not show signs of significant wear caused by a part of the engine touching or component touching the cowling. Verify that the exhaust has not be in contact with the cowling.
- Consider using a DynaVibe GX2 system to determine the source of the vibration.

We maintain troubleshooting and balancing tips on our website so they can be continually updated. Check www.rpxtech.com/dv-tips for the latest tips!

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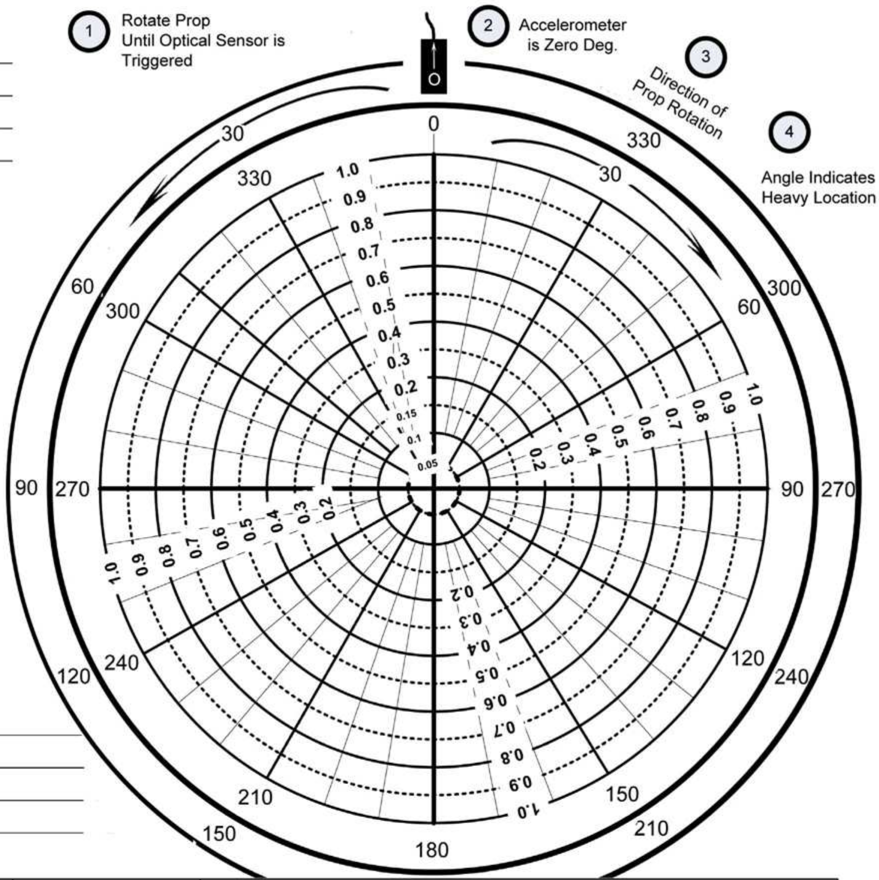
DynaVibe
Dynamic Propeller Balancer

Aircraft: ____________________

Owner: ____________________

Date: ____________________

Engine Hours: ____________________



1.25	Extreme Check Prop & Static Balance
1.00	Rough
0.25	
0.15	Fair
0.07	Good
0.04	Excellent
0.00	Perfect

Final Reading: ____________________

Final Weights: ____________________

Weight Locations: ____________________

Mechanic & Cert Number: ____________________

RPM	Magnitude (IPS)	Location (Angle)	Notes (Weight added, Location, etc)

Per AC20-37E: Install a placard on the propeller hub or bulkhead stating that the propeller has been dynamically balanced and the assembly of the power train rotating components is an indexed assembly. Make an entry in the logbook with the date, engine hours, final balance vibration, location of the dynamic balance weights, signature and certificate number of the maintenance person.

For balancing tips, see www.rpxtech.com/dv-tips

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To download and print this chart, please visit WWW.RPXTECH.COM/CHART

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Application Note:

DynaVibe Procedure for Aircraft Propellers

RPX-AFA-PR-BAL-00-A

September 2016

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Important Notice

Any system that distracts a pilot while operating an aircraft is a safety hazard.

During the balancing procedure please use extreme caution. Be very careful with cables and components, especially on pusher type aircraft. ALWAYS confirm the ignition is off before rotating the propeller.

Areas of this manual will highlight specific safety concerns while operating the dynamic balancing system. Please review these before operating the system.

1.1 Equipment required:

Quantity	RPX Part Number	Description
1	GX2	DynaVibe GX2
	or	*or*
	GX3	DynaVibe GX3
1	A01S30AP	Accelerometer
1	LIGHT-30	Optical tach
1	TAPE	Reflective tape
1	B01	Angle bracket
1	B03	Optical tach bracket

2 Introduction

A rotating mass such as an engine crank, propeller, propeller extension, or starter ring will always have small imbalances and tolerance variations. Mass variations will cause vibration in the engine and airframe.

Vibration can cause damage throughout the aircraft, including: the crank bearings, engine mounts, firewall, instrument panel, exhaust, intake, etc. Vibration causes accelerated wear and fatigue on equipment and passengers. The negative effects of vibration can be reduced by dynamically balancing the aircraft's rotating assembly. This will balance the crank, prop extension, propeller, and spinner as a combined unit.

Dynamic balancing is accomplished by monitoring an accelerometer and an optical tach attached to the unbalanced equipment. By using these sensors to monitor rotational speed and detect movement as the assembly rotates, the dynamic balancer is capable of quantifying the vibration caused by the mass imbalance. Based on this measured vibration magnitude and location, corrections to the assembly increase alignment of the center of mass to the rotational axis and thereby reduce the vibration.

While not all vibration can be eliminated, any reduction in vibration will reduce fatigue and damage. Some vibration from engine combustion, gear reductions, and accessories will not be affected by dynamic balancing.

3 Pre-Balance Inspection

Most dynamic balancing issues can be avoided by performing a thorough pre-balance propeller and engine inspection and rectifying any problems found. Any time saved by skipping the inspection steps could result in much more time spent troubleshooting and could allow unsafe conditions.

3.1 Airworthiness Directives / Service Bulletins

The first step in the pre-balance inspection is to review all available Airworthiness Directives (AD) and service bulletins for the propeller and powerplant. ADs and service bulletins will contain specific information about problems, updates, or issues pertaining to the particular propeller and powerplant.

Example: Certain combinations of engines and propellers may require modified dampers due to increased torque impulses.

3.2 Determine Applicable Procedure

For aircraft or propeller manufacturers that provide procedures for dynamic balancing, propeller balancing is not considered a major airframe alteration. When approved aircraft and propeller manufacturer's procedures are not available, there are other acceptable dynamic balancing procedures. Dynamic balancing of propellers using FAA-approved or FAA-accepted dynamic propeller balancing procedures is not considered a major propeller repair unless the propeller static balance weights are altered. Reference *FAA Advisory Circular 20-37E "Aircraft Propeller Maintenance."*

3.3 Blade Inspection

The propeller blade should be closely inspected for any damage to the propeller and general condition. Any maintenance that needs to be performed should be completed prior to dynamic balancing. Any dent or chip repair, painting, or finish treatments should be completed before proceeding.

Reference *FAA Advisory Circular 20-37E "Aircraft Propeller Maintenance"* and *FAA Advisory Circular 43.13-1B "Acceptable Methods, Techniques, and Practices - Aircraft Inspection and Repair"* Chapter 8.

3.4 Spinner Installation

Prior to dynamic balancing, the spinner should be removed and inspected. The spinner should be checked for any mass imbalances caused by foreign material, missing screws, or damage. The attachment bulkheads should be inspected for cracks or damage and repaired as required.

NOTE: Mud daubers, wasps, and other insects or small animals may quickly build a nest inside the spinner housing; often in as short as a few days. These must be removed prior to balancing.

There are instances where spinners have been installed in such a manner as to allow the front of the spinner to move relative to the propeller. If the spinner structure has any flexibility, it may move from one side to another at high RPM, causing the out-of-balance location to shift periodically. The spinner should be firmly mounted and should not move when laterally loaded.

3.5 Blade Track and Pitch

It is important to determine that the blade is tracking correctly. If the blade is mounted on an irregular surface, if there is debris under the blade, or if the blade is bent it will be impossible to balance the aircraft because the blade will be aerodynamically out of balance.

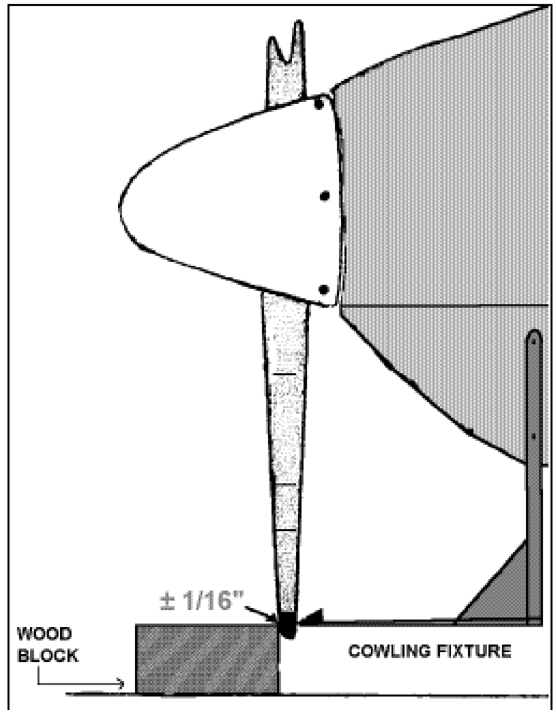
NOTE: If a small metal chip or burr is allowed between the propeller and prop flange, then one blade will have a higher angle-of-attack than another blade, causing a vibration.

CAUTION:

Verify ignition and

fuel are off

prior to moving propeller



Check blade track and pitch AC20-37

The simplest way to check blade track is to position a wood block or other rigid structure next to a blade tip. Then rotate the blade carefully (avoid moving the aircraft) to the next blade and verify that the blade tip is in the same relative position as the previous blade. You may need to remove the spark plugs to allow the engine to rotate freely.

If one blade is positioned differently from another, this indicates that either the blade is bent or the installation is unacceptable. Again, a dynamic balancer will not adequately correct an aerodynamic imbalance. According to *FAA Advisory Circular 43.13-1B*, each blade track should be within 1/16 of an inch.

Any error in track should be investigated thoroughly and eliminated. This may require that the propeller be pulled off the aircraft and sent to a propeller repair station.

3.6 Existing Dynamic Balance Weights

Once the pre-balance inspection is complete, record the position and weight of each dynamic balance correction weight previously mounted. Remove any existing dynamic balancing weights.

3.7 Static balance weights

Weights installed by a propeller repair station, should **not** be removed. Only a propeller repair station may modify static balance weights.

4 NIST Traceability on Certified Ships

Equipment used on certified aircraft must be inspected and calibrated. The DynaVibe is available with National Institute of Standards and Technology (NIST) traceable calibration. Contact RPX for further information.

5 Precautions

Secure All Cabling

Secure all cabling from the accelerometer and the optical tach to the engine and aircraft using tape and zip ties as needed. Route the cabling into the cabin of the aircraft. Cables should not be allowed to hang free as they may become entangled in rotating equipment. For pusher aircraft and rotorcraft, this can be particularly dangerous. The cabling must always be secured and any doors or loose cowlings should be thoroughly secured to prevent damage during engine run-up.

Secure all cabling

Tie-down the Aircraft

Propeller dynamic balance measurements are performed with the aircraft stationary on the ground. Wheel chocks alone will typically be insufficient to counteract the thrust generated during runup. Therefore, the tail of the aircraft should be securely tied down during the entire procedure and brakes should be applied during any runup.

CAUTION:

Verify ignition and fuel are off

CAUTION:

After you add, remove, or otherwise change weight, rotate the propeller slowly to confirm clearance of all components to confirm that you have not introduced any clearance issues.

Confirm that no bolts are protruding into the cowling, starter, alternator, or other components!

6 Installation of Equipment

6.1 Access Sensor Mounting Area

Remove the cowling, if needed, to gain access to the area immediately behind the propeller. For typical powerplant installations, this would require removing the upper cowling of the aircraft, giving access to the top of the engine.

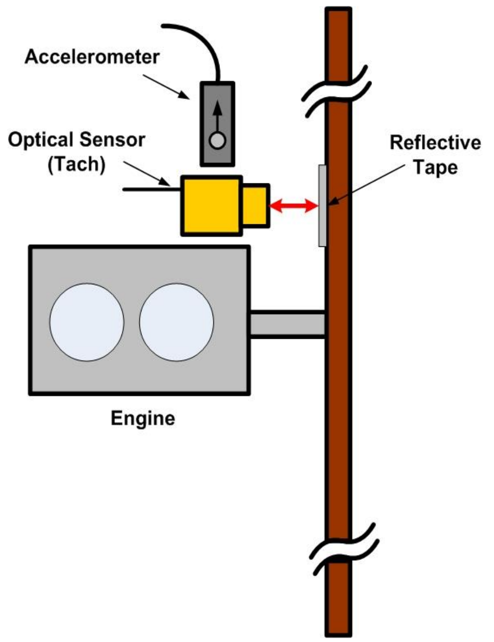
While you have the cowling off, check all the accessories for secure mounting. Check the cowling and baffling for damage that may indicate inadequate clearances. Check for any loose components such as an alternator, starter, etc.

6.2 Mount the Accelerometer and Optical Tach

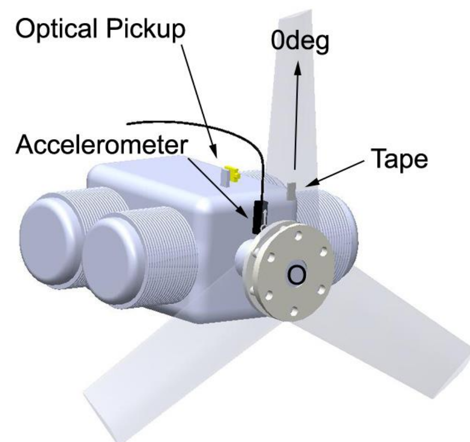
The accelerometer and optical tach are typically mounted on the top of the engine. The optical tach should be mounted approximately six inches behind the back of the propeller. The accelerometer should be mounted as far forward as is safely possible. This will provide maximum sensitivity.

A common mounting technique is to attach an adapter to one of the case bolts along the top of the engine. Mount an accelerometer mounting bracket to the bolt adapter and mount the accelerometer to the bracket. The optical tach bracket can be installed under the bolt or at a different location. Position the optical tach such that the beam projects onto the back of the blade or spinner backplate.

The following Figure shows the relationship between the optical tach, accelerometer, and the propeller. The optical tach is pointing to the back of the propeller onto the reflective tape (to be put on in the next step). The accelerometer is mounted vertically, perpendicular to piston travel.



Relationship between the optical tach's optical pickup, accelerometer, and propeller.



A typical installation for a Lycoming engine.

The optical tach's optical pickup should be at least six inches from the reflective tape, but not so far that the optical tach cannot obtain a reading from the tape.

6.3 Mount Reflective Tape on One of the Propeller Blades

By placing the small piece of reflective tape (provided in the kit), on only one propeller blade, that blade can now be considered the "Master" blade. Cut off approximately 2 inches of tape from the provided roll. Position the tape on a flat, non-rounded surface such that the light emitted from the front of the optical tach strikes the reflective tape and is reflected back to the optical tach's optical pickup.

The optical tach has a red indicator LED on the rear to both indicate alignment with the reflective tape and to indicate signal strength. When the optical tach is correctly illuminating the reflective tape, the back of the optical tach should have a pulsing red LED. The faster the pulse rate, the better the returned signal.

If the LED is illuminated when the reflective tape is not in the optical tach field of view, then there is probably a highly reflective surface opposite the optical tach. It will be best to move the tape to a location with greater contrast.

A simple way to verify that the system is working is to position the “Master” blade so that the light on the back of the optical tach is illuminated. Pass your finger between the beam to cause the light to turn on and off rapidly.

It is also beneficial to move your finger from top to bottom of the tape to verify that the optical tach is reading the center of the tape radially. If the optical tach is reading from the top or bottom edge of the tape, it is best to readjust the optical tach to measure in the center of the tape.

NOTICE: Some chromed spinner backplates may overwhelm the optical tach with strong reflections. Relocate the tape to the starter ring, propeller, or paint the back of the spinner backplate black.

Experimental installation, showing reflective tape on spinner backing plate.

For an expected RPM and tape distance from the hub / rotation center, there is a minimum tape width required indicated in the table below. First, find the smallest RPM entry in the table that is at least as large as the cruise RPM of the engine. For instance, if the cruise RPM is 2400, then use 2500 RPM. The tape length is then determined by the distance the tape will be mounted at radially from the center of the hub. For an example, assume 6 inches. At the intersection of the “6 inches from hub center” column and the 2500 RPM row is 1 inch. Therefore, when placed six inches from the center of the hub, the minimum tape length is one (1.0) inch. If the tape is eight inches from the center of the hub with 2400 RPM, using the next step up (12 inches and 2500 RPM), the minimum tape width required would be 1.9 inches.

	Tape Length Required by RPM and Tape Distance from Hub Center		
RPM	Tape up to 6" from hub center	Tape up to 12" from hub center	Tape up to 24" from hub center
500	0.2"	0.4"	0.8"
1000	0.4"	0.8"	1.6"
1500	0.6"	1.2"	2.3"
2000	0.8"	1.6"	3.1"
2500	1.0"	1.9"	3.8"
3000	1.2"	2.3"	4.6"
3500	1.4"	2.7"	5.3"
4000	1.6"	3.1"	6.1"
4500	1.7"	3.4"	6.8"
5000	1.9"	3.8"	7.6"

Insufficient tape width will cause displayed engine RPM to fluctuate and provide erratic readings.

6.4 Setup the GX for AutoBalance

Turn on the GX system and refer to the DynaVibe GX user manual for the proper use of the AutoBalance mode. The initial run will typically be done without any dynamic balance weights installed (static balance weights should not be altered).

CAUTION:

Verify that the area around the propeller is clear of obstructions.

Verify that all cabling is secure.

Start Engine

CAUTION:

Improper ground running can cause significant damage to the engine.

Check with your engine manufacturer for specific information about ground running aircraft engines.

Example: Lycoming recommends that the engine be warmed up at 1000 RPM until oil temperatures have stabilized or reach 140° F. Full-static RPM should be maintained for not more than 10 seconds. After operating at full power, allow the engine to cool down moderately.

Start the engine normally, watching for any shifting of cabling or equipment. Let the engine warm up to reduce wear during the high RPM data collection. Slowly increase the RPM of the engine until it has reached the desired RPM.

6.5 Collect Run Data

Follow the DynaVibe user manual to collect data for a run then follow the aircraft manufacturer's cool down and shut down procedures. Multiple runs will be needed to complete the AutoBalance process. Care must be taken to follow the engine manufacturer's procedures and to do no damage to the engine.

6.6 Mount Trial Balance Weights

Automated Solutions (DynaVibe GX2/GX3)

After the first run, select "Adjust" and the DynaVibe will calculate a trial dynamic balance weight solution. Weigh, then safely and securely mount your trial weights. Enter the actually installed trial balance weight parameters into "Addition 1" and "Addition 2".

Manual Solutions (DynaVibe Classic)

Determine the mass to be added. On the first run, a trial weight is needed to determine the mass/IPS sensitivity of the assembly. Consider using 50 g/IPS as a trial weight on most GA aircraft.

Note: Dynamic balance weights should always be aircraft-grade hardware (such as AN970 or AN960 washers).

6.7 Collect Run Data with Trial Weights

Repeat the "Collect Run Data" process using the installed trial weights. This is typically run 2.

6.8 Mount Adjusted Balance Weights and Test with Additional Runs

Subsequent runs will calculate dynamic balance weight solutions based on the weight sensitivity calculated during the previous run. Continue to follow all safety and manufacturer's procedures and repeat the process until the vibration magnitude is at or below your target vibration magnitude.

6.9 Move Final Weights to Permanent Mount

FAA or manufacturer procedures may require dynamic balance weights to be mounted in specific locations (generally not on external spinner bolts). If the permanent mounts differ in distance from the hub center compared to the mounting locations used during the dynamic balance process, then a simple calculation to determine the adjusted mass of the dynamic balance weights may be necessary.

6.10 Verify Balance

If the balance weights were moved to a new mounting location, initiate a new run to verify the magnitude is within acceptable limits. If the magnitude changes significantly, verify the mount locations from hub center have not changed. If the distance from hub center changed, verified that the new weight calculations are correct.

6.11 Save Report

Once the vibration magnitude is at or below your target vibration magnitude, select "Finished" and then "Report" to generate an HTML report for the balance. The report may be opened in a browser and printed.

6.12 Update Log and Placard Aircraft

For certified aircraft, requirements include the A&P logging the dynamic balance process and final dynamic balance weights and placarding the aircraft. It is recommended that the dynamic balance also be entered in the log book for experimental aircraft.

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