

**CHAPTER 18****TRACK AND BALANCE**

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**CHAPTER 18****TRACK AND BALANCE**18-10 Main Rotor Track and Balance**NOTE**

Calibrate track and balance equipment per manufacturer's recommendation, at least once a year, or if equipment is dropped, misused, or calibration is suspect.

**NOTE**

The Chadwick-Helmuth Vibrex system, the TEC ACES system, the Dynamic Solutions Systems' MicroVib system, or equivalent equipment is required to perform dynamic rotor balancing and in-flight track checks.

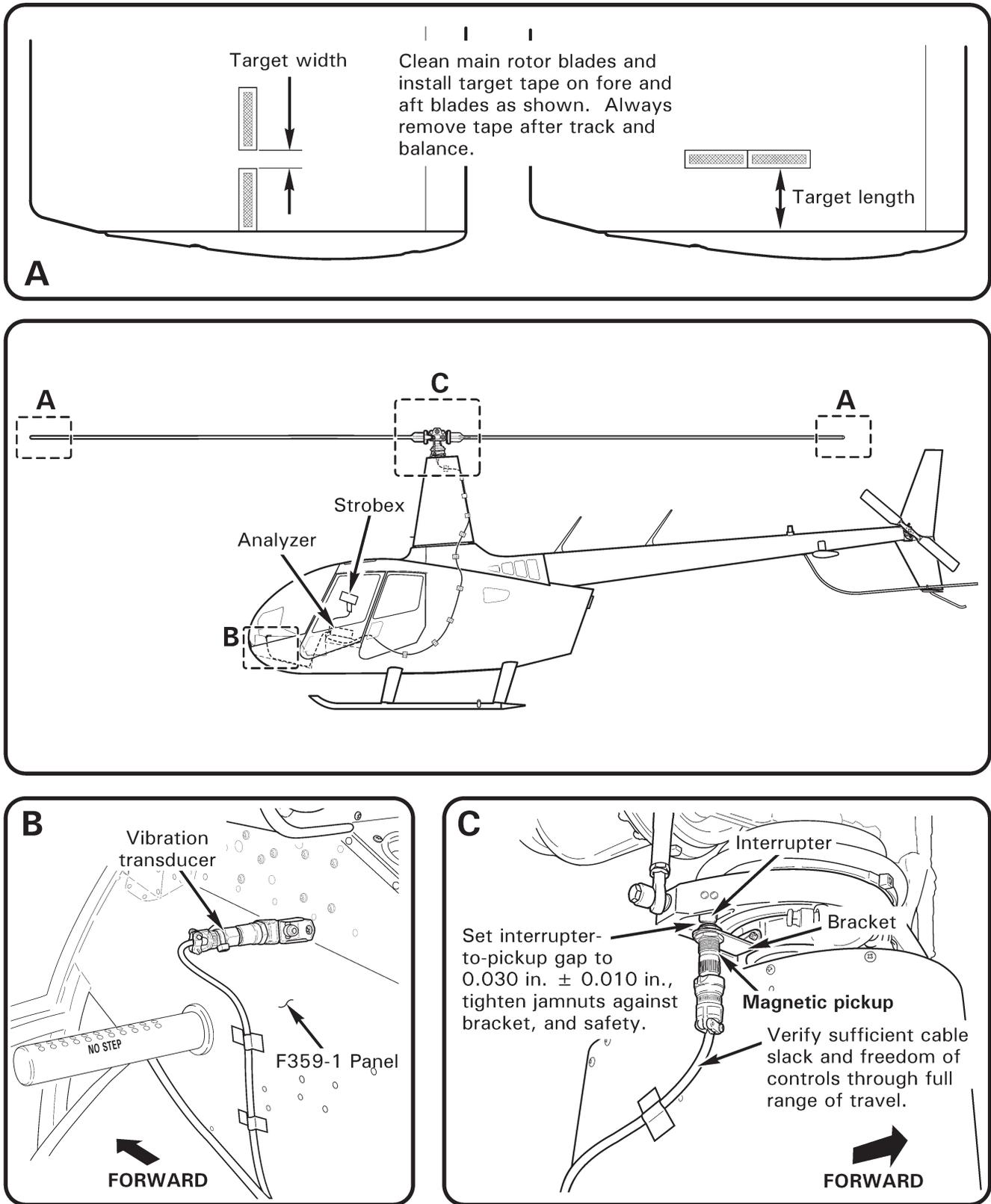


FIGURE 18-1 MAIN ROTOR BALANCING EQUIPMENT INSTALLATION

18-11 Preparing Helicopter for Main Rotor Track and Balance**NOTE**

Use the following track & balance procedures in conjunction with approved equipment manufacturer's balancing instructions.

**CAUTION**

Cable security is critical; helicopter will be flown at  $V_{NE}$ .

1. Perform swashplate and rotor hub inspection per § 5-45. Inspect tail rotor rod ends and elastomeric bearings per §§ 5-33 and 5-34.
2. Clean main and tail rotor blades per § 20-10. Install main rotor blade target tape per Figure 18-1.
3. Refer to Figure 18-1. Using appropriate hardware, attach brackets to vibration transducer and attach assembly to F359-1 panel as shown. Remove removable controls.
4. Install magnetic pickup onto swashplate bracket. Set (swashplate-mounted) interrupter-to-pickup gap to 0.030 inch  $\pm$  0.010 inch and tighten pickup nuts against bracket. Safety nuts using 0.020-inch diameter lockwire. Recheck gap.
5. Pull collective stick full up, push cyclic stick full left, and apply frictions. Connect proper cable to magnetic pickup. Route cable down seam and to base of mast fairing, across the cabin roof left side, and through aft left door vent door. Attach cable to fuselage using MS21919WDG3 clamps and existing fasteners, or secure cable every 12 inches with duct tape. Release control frictions and verify sufficient cable slack and freedom of controls through full range of travel.
6. Connect proper cable to vibration transducer. Connect transducer, magnetic pickup, and tracker or strobe cables to analyzer. If strobe light is used, battery power may be accessed thru auxiliary power socket located on circuit breaker panel. Neatly stow and secure excess cables.
7. Verify security of installation.

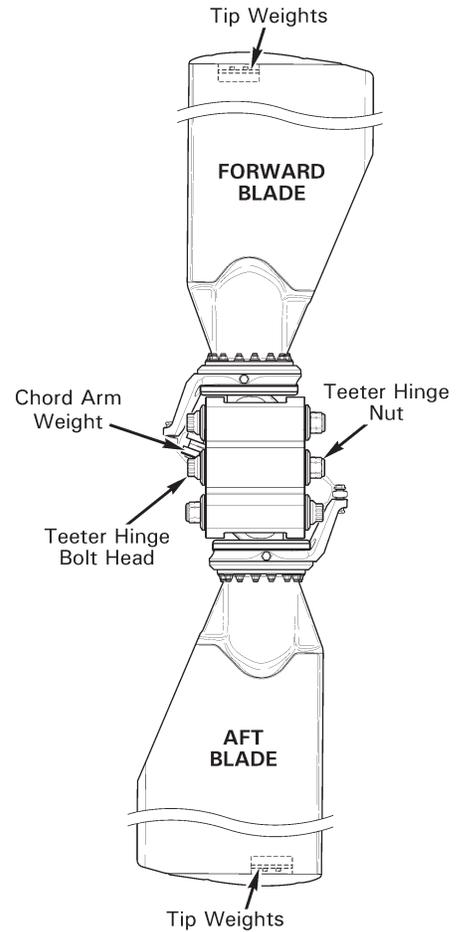
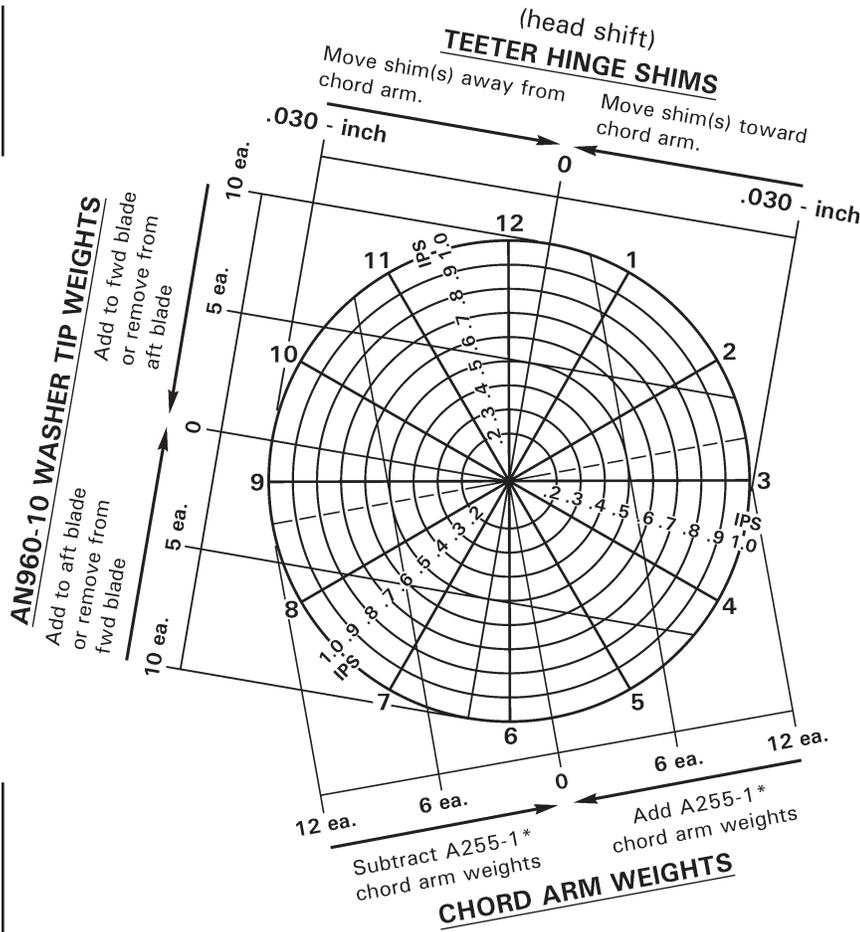
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CHORD ARM WEIGHTS			
(1) A255-1 Weight	=	(8)	AN970-4 Washers
(1) A255-2 Weight	=	(3)	A255-1 Weights

TIP WEIGHTS			
(1) AN960-10 Washer	=	(2)	AN960-10L Washers
(1) C298-2 Weight	=	(5)	AN960-10 Washers
(1) C298-3 Weight	=	(11)	AN960-10 Washers
(1) C298-4 Weight	=	(4)	C298-3 Weights

TEETER HINGE SHIMS	
C117-8	0.012 inch
C117-9	0.015 inch
C117-10	0.020 inch
C117-11	0.025 inch



BALANCE		TRACK (KNOTS)											
CLOCK	IPS	HOVER	50	60	70	80	90	100	110	120	130	140	

Adjustment: \_\_\_\_\_

CLOCK	IPS	HOVER	50	60	70	80	90	100	110	120	130	140

Adjustment: \_\_\_\_\_

CLOCK	IPS	HOVER	50	60	70	80	90	100	110	120	130	140

Adjustment: \_\_\_\_\_

CLOCK	IPS	HOVER	50	60	70	80	90	100	110	120	130	140

**FIGURE 18-2 MAIN ROTOR TRACK AND BALANCE CHART**

18-12 Flight Checks

## NOTE

Run-up and shutdown helicopter throughout procedure as required per R66 Pilot's Operating Handbook (POH) Section 4.

## NOTE

Refer to § 18-15 for track & balance troubleshooting procedures.

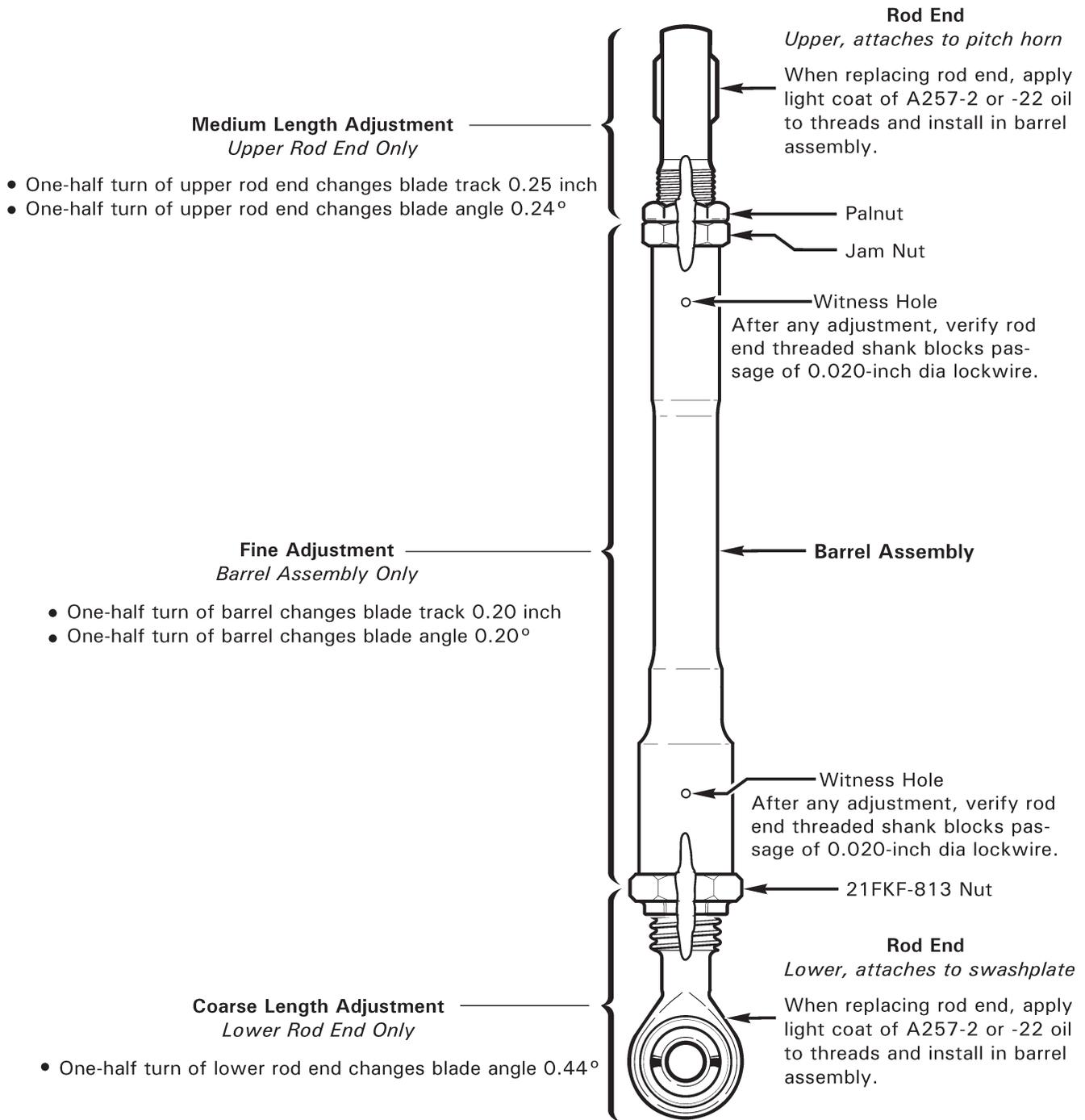
**WARNING**

**Tail rotor balancing equipment must be removed for flight.**

**WARNING**

**Do not exceed  $V_{NE}$  of helicopter during flight checks.**

1. Prepare helicopter for main rotor track and balance per § 18-11.
2. As required, print Figure 18-2; use copy to record flight data. Check main rotor blade track in a hover and record data. Maximum permissible blade track difference in a hover is 0.25 inch. Adjust track per § 18-13 as required, record change, and recheck blade track in a hover. Repeat step as required until blade track is within limits.
3. Check main rotor balance in a hover and record data. Maximum vibration allowance is 0.2 ips (inches per second). Adjust balance per § 18-14 as required, record data, and recheck balance in a hover. Repeat step as required until main rotor balance is within limits.
4. Fly helicopter at 50 knots then increase in 10-knot increments up to  $V_{NE}$ . Check main rotor blade track at each airspeed and record data. Maximum blade spread between airspeeds is 3/8 inch. Adjust trim tab(s) per § 18-13 as required and record data. Repeat step as required until blade track is within limits.
5. Recheck main rotor balance in a hover per step 3.
6. Perform autorotation RPM check per § 18-16. Recheck main rotor balance in a hover per step 3.
7. Evaluate collective trim, longitudinal cyclic trim, and lateral cyclic trim. Replace D918 cord assemblies as required. Recheck main rotor balance in a hover per step 3.
8. Remove track and balance equipment. Torque stripe fasteners per Figure 5-1. Reinstall removable controls, as required.



**FIGURE 18-3A C258-5 MAIN ROTOR PITCH LINK**

## 18-13 Track Adjustment

### A. Main Rotor Blade Pitch Link

**NOTE**

Shorten high pitch blade when adjusting track in a hover.

**NOTE**

During rigging, adjust both pitch links exactly the same for collective adjustments.

1. For fine adjustment:

- a. C258-5 Pitch Link: Adjust barrel assembly only per the following steps:
  - i. Refer to Figure 18-3A. Using backup wrench on barrel assembly, loosen 21FKF-813 nut at lower rod end, and upper rod end palnut and jam nut.
  - ii. Rotate barrel assembly to shorten or lengthen pitch link as required. One-half turn of barrel changes blade track approximately 0.20 inch. One-half turn of barrel changes blade angle approximately 0.20°. For finer adjustment, rotate less than one-half turn as required.
  - iii. Refer to Figure 5-1. Verify rod end threaded shank blocks passage of 0.020-inch diameter lockwire through barrel assembly witness holes.
  - iv. Position rod ends to allow as much pitch link rotation as possible without binding. Using backup wrench on barrel assembly, special torque 21FKF-813 nut per § 20-33, and standard torque upper rod end jam nut and palnut per § 20-32.
  - v. Repeat steps on opposite pitch link as required; torque stripe per Figure 5-1.
- b. C258-1 Pitch Link: Adjust fitting only per the following:
  - i. Refer to Figure 18-3B. Cut and discard pitch link assembly safety wire. Using backup wrench on link assembly, loosen 21FKF-813 nut; using backup wrench on fitting, loosen upper rod end palnut and jam nut.
  - ii. Rotate fitting to shorten or lengthen pitch link as required. One-half turn of fitting changes blade track approximately 0.20 inch. One-half turn of fitting changes blade angle approximately 0.20°. For finer adjustment, rotate less than one-half turn as required.
  - iii. Refer to Figure 5-1. Verify rod end threaded shank blocks passage of 0.020-inch diameter lockwire through pitch link witness holes.
  - iv. Using backup wrench on link assembly, special torque 21FKF-813 nut per § 20-33. Using backup wrench on fitting, standard torque upper rod end jam nut and palnut per § 20-32. Safety fitting to link assembly using 0.032-inch diameter lockwire.
  - v. Repeat steps on opposite pitch link as required; torque stripe per Figure 5-1.

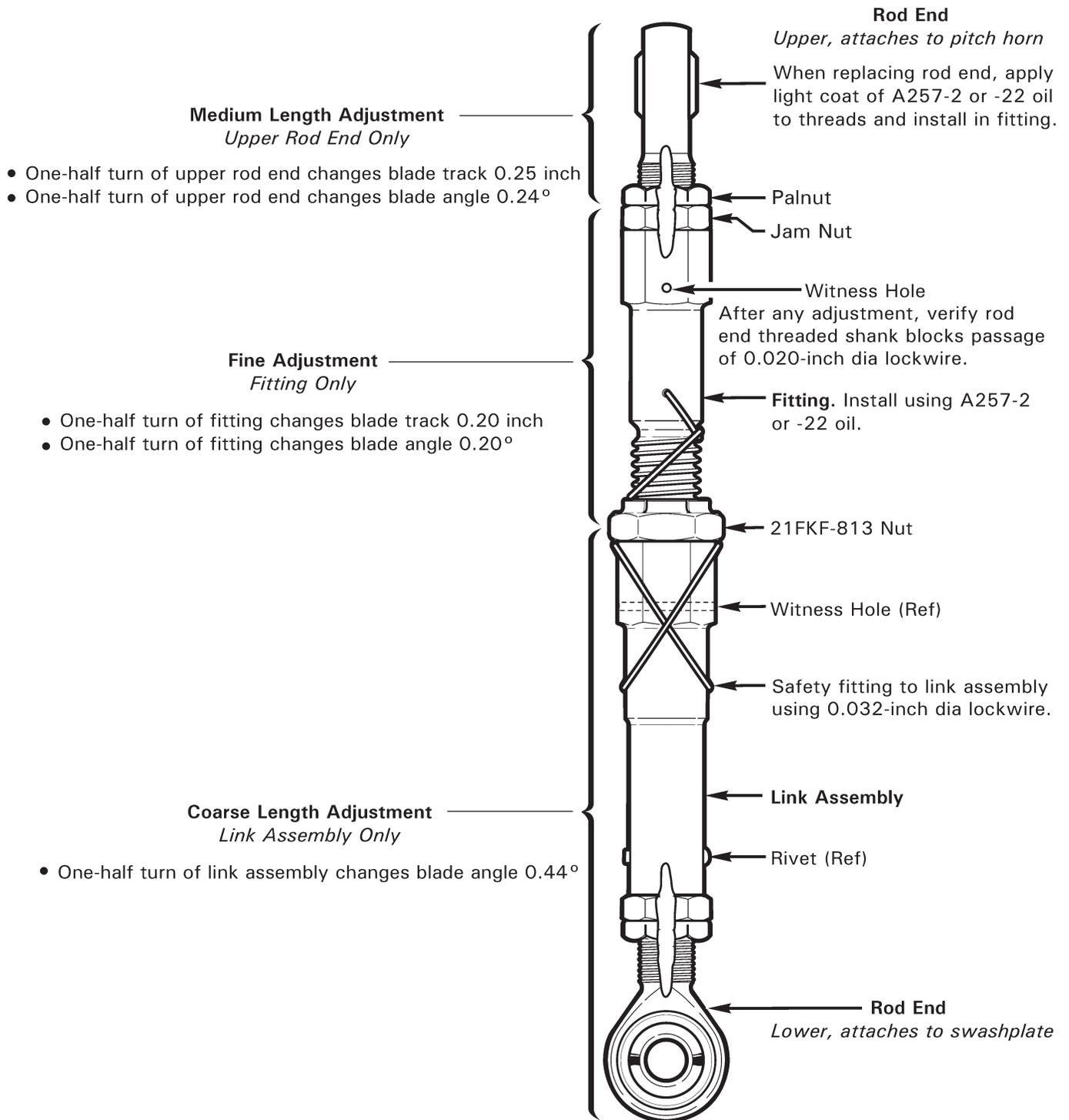


FIGURE 18-3B C258-1 MAIN ROTOR PITCH LINK

18-13 Track Adjustment (continued)**A. Main Rotor Blade Pitch Link (continued)**

2. For medium length adjustment, adjust upper rod end per the following:
  - a. Refer to Figure 18-3A or 18-3B. Using backup wrench on barrel assembly or fitting, loosen upper rod end palnut and jam nut. Remove hardware securing rod end to pitch horn.
  - b. Rotate upper rod end to shorten or lengthen pitch link as required. One-half turn of upper rod end changes blade track approximately 0.25 inch. One-half turn of upper rod end changes blade angle by approximately  $0.24^{\circ}$ .
  - c. Refer to Figure 5-1. Verify rod end threaded shank blocks passage of 0.020-inch diameter lockwire through barrel assembly (upper), or fitting, witness hole. Install hardware securing rod end to pitch horn and standard torque fasteners per § 20-32.
  - d. Position rod ends to allow as much pitch link rotation as possible without binding. Using backup wrench on barrel assembly or fitting, standard torque upper rod end jam nut and palnut per § 20-32.
  - e. Repeat steps on opposite pitch link as required; torque stripe per Figure 5-1.
3. For coarse length adjustment:
  - a. C258-5 Pitch Link: Adjust lower rod end per the following:
    - i. Refer to Figure 18-3A. Using backup wrench on barrel assembly, loosen 21FKF-813 nut at lower rod end. Remove hardware securing lower rod end to swashplate.
    - ii. Rotate lower rod end to shorten or lengthen pitch link as required. One-half turn of lower rod end changes blade angle by approximately  $0.44^{\circ}$ .
    - iii. Refer to Figure 5-1. Verify rod end threaded shank blocks passage of 0.020-inch diameter lockwire through barrel assembly (lower) witness hole. Install hardware securing rod end to swashplate and standard torque fasteners per § 20-32.
    - iv. Position rod ends to allow as much pitch link rotation as possible without binding. Using backup wrench on barrel assembly, special torque 21FKF-813 nut per § 20-33.
    - v. Repeat steps on opposite pitch link as required; torque stripe per Figure 5-1.

18-13 Track Adjustment (continued)**A. Main Rotor Blade Pitch Link (continued)**3. b. C258-1 Pitch Link: Adjust link assembly per the following:

- i. Refer to Figure 18-3B. Cut and discard pitch link assembly safety wire. Using backup wrench on link assembly, loosen 21FKF-813 nut. Remove hardware securing lower rod end to swashplate.
- ii. Rotate link assembly to shorten or lengthen pitch link as required. One-half turn of link assembly changes blade angle by approximately  $0.44^\circ$ .
- iii. Refer to Figure 5-1. Verify rod end threaded shank blocks passage of 0.020-inch diameter lockwire through link assembly witness hole. Install hardware securing rod end to swashplate and standard torque fasteners per § 20-32.
- iv. Position rod ends to allow as much pitch link rotation as possible without binding. Using backup wrench on link assembly, special torque 21FKF-813 nut per § 20-33. Safety fitting to link assembly using 0.032-inch diameter lockwire.
- v. Repeat steps on opposite pitch link as required; torque stripe per Figure 5-1.

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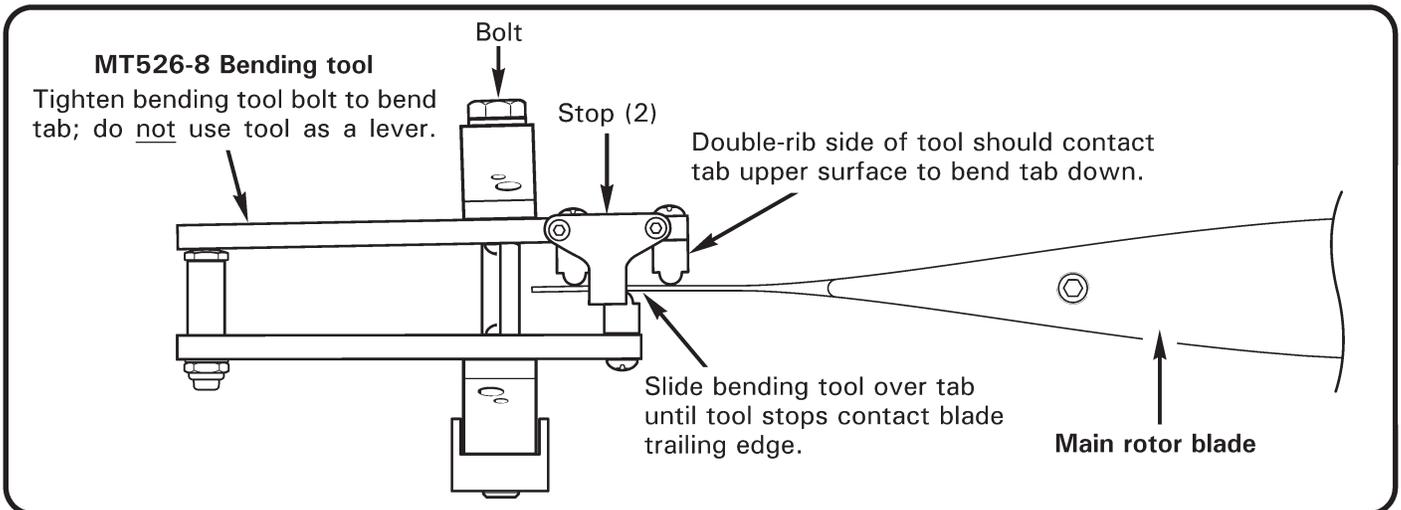
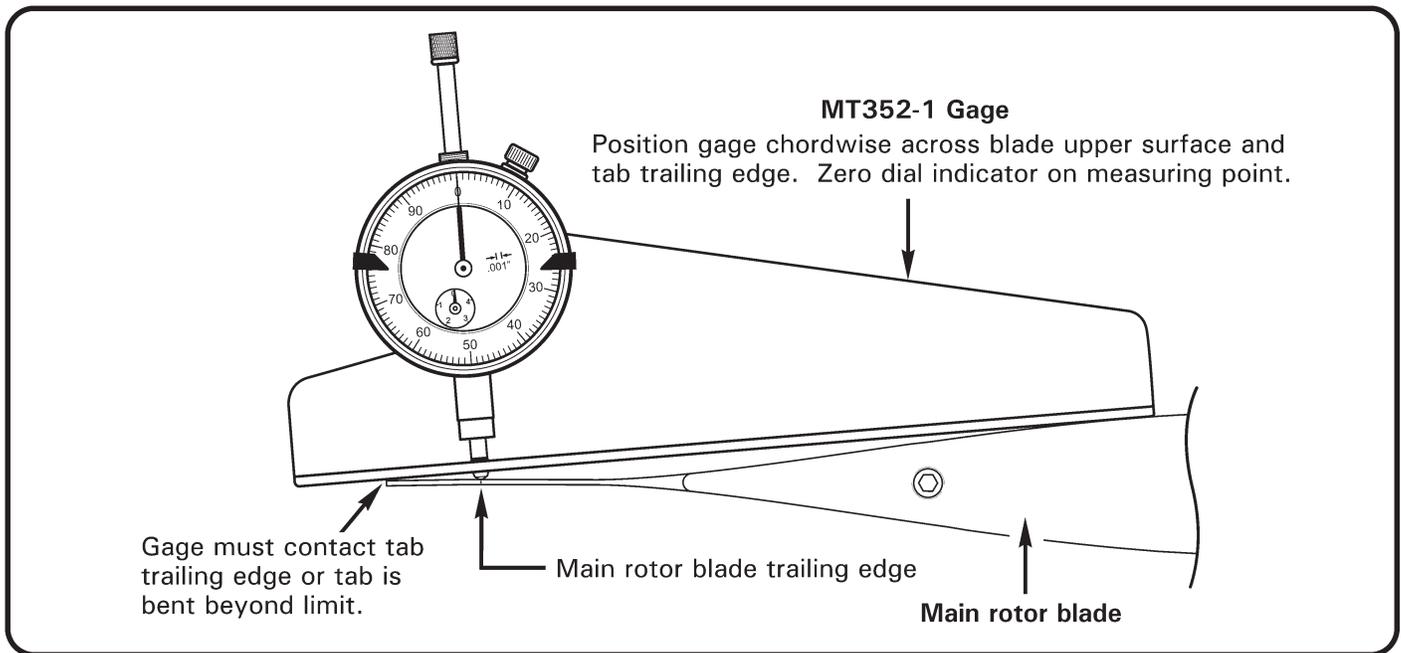
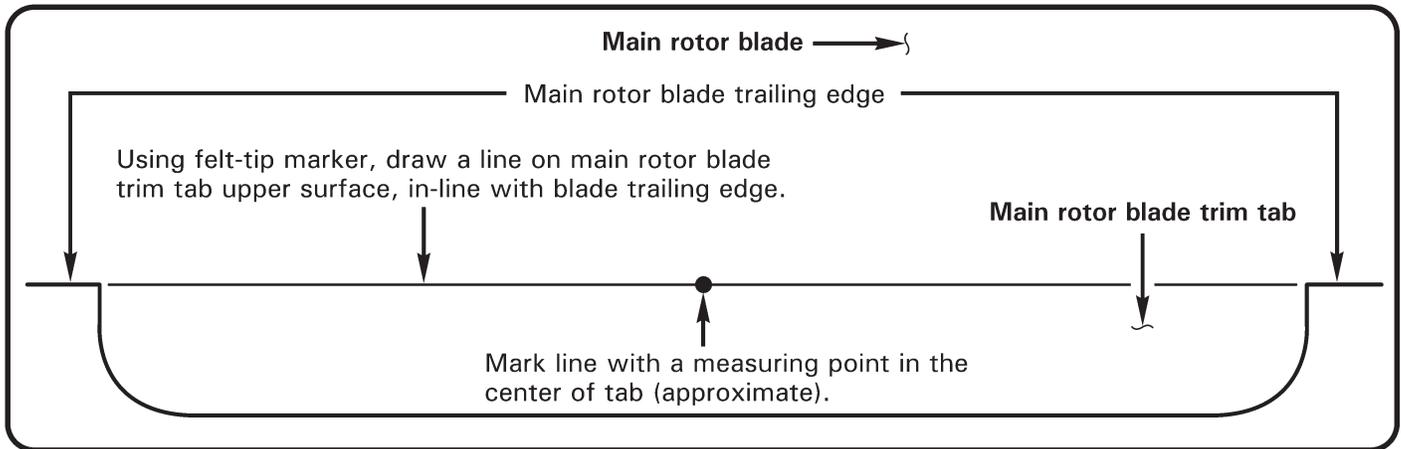


FIGURE 18-4 MAIN ROTOR BLADE TRIM TAB

18-13 Track Adjustment (continued)**B. Main Rotor Blade Trim Tab****NOTE**

To correct for a "climbing" blade condition (blade spread that exceeds 3/8 inch with forward airspeed), bend high blade trim tab down.

**CAUTION**

Do not use other helicopter manufacturers' trim tab bending tools. Use of these tools will damage Robinson blades.

**CAUTION**

MT352-1 gage must contact trim tab trailing edge. If gage does not contact tab trailing edge, tab is bent beyond limit.

**CAUTION**

Tighten MT526-8 bending tool bolt to bend tab; do not use tool as a lever.

**CAUTION**

Bend tab upward only when absolutely necessary; bending tab upward can increase rotor vibration.

1. Using felt tip marker, ink mark main rotor blade trim tab per Figure 18-4. Mark line with a measuring point in the center of the tab (approximate).
2. Position MT352-1 gage chordwise across blade upper surface and tab trailing edge. Zero dial indicator on measuring point.
3. Position MT526-8 bending tool on tab per Figure 18-4. Slide tool completely over tab until tool stops contact blade trailing edge. Double-rib side of tool should contact tab upper surface to bend tab down. Double-rib side of tool should contact tab bottom surface to bend tab up.
4. Tighten MT526-8 bending tool bolt to bend tab. Make slight bends and re-measure tab with MT352-1 gage. Bend trim tab 0.015 inch (down) to effect dynamic movement of main rotor blade tip approximately 0.2 inch (downward).

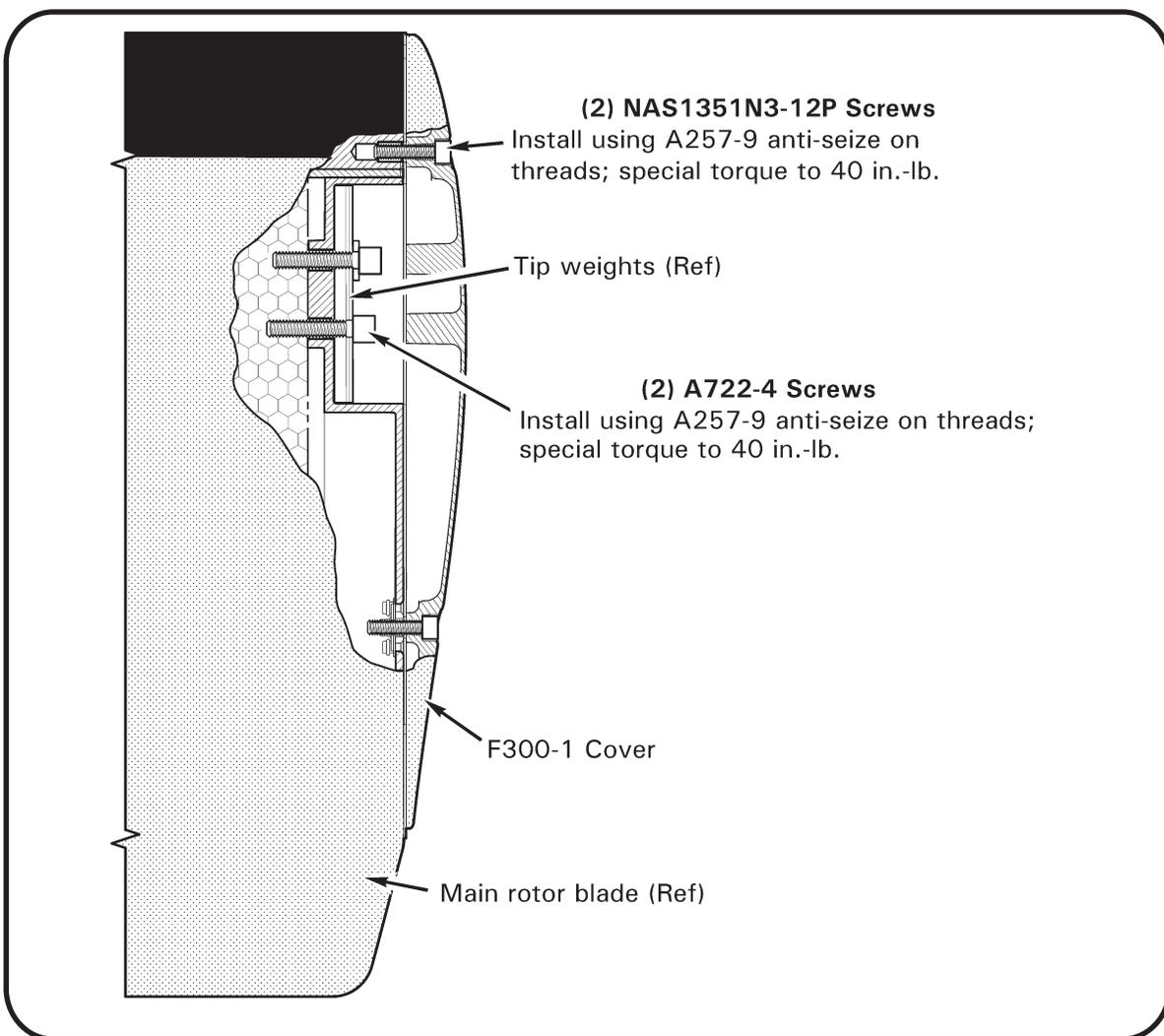


FIGURE 18-4A MAIN ROTOR BLADE TIP

18-14 Balance Adjustment

**WARNING**

**A rotor which is smooth after balancing but goes out of balance within a few flights is suspect and must be examined by RHC before further flight.**

**A. Tip Weights (Spanwise Balance Adjustment)**

1. Remove screws securing tip cover to blade. Balance rotor assembly spanwise by adjusting tip weights as required per Figure 18-2. Washers may be trimmed. Refer to Figure 18-4A. Apply light coat A257-9 anti-seize to threads and install screws securing tip weights to blade; special torque screws to 40 in.-lb. Apply light coat A257-9 anti-seize to threads and install screws securing tip cover to blade; special torque screws to 40 in.-lb.

- |                                      |   |                                        |
|--------------------------------------|---|----------------------------------------|
| (1) AN960-10 or NAS1149F0363P Washer | = | (2) AN960-10L or NAS1149F0332P Washers |
| (1) C298-2 Weight                    | = | (5) AN960-10 or NAS1149F0363P Washers  |
| (1) C298-3 Weight                    | = | (11) AN960-10 or NAS1149F0363P Washers |
| (1) C298-4 Weight                    | = | (4) C298-3 Weights                     |

**B. Teeter Hinge Bolt Shims (Chordwise Balance Adjustment - Coarse Adjustment)**

1. Remove and discard teeter hinge nut cotter pin. Remove nut, thrust washer, and any shims.
2. Have two people cone the main rotor blades. Push out teeter hinge bolt (and any shims) with another bolt.
3. Balance rotor assembly chordwise by moving (or exchanging) existing teeter hinge shims to other side of bolt (under head or under nut) as required per Figure 18-2. Install teeter hinge bolt per § 62-10.

**C. Chord Arm Weight (Chordwise Balance Adjustment - Fine Adjustment)**

1. Balance rotor assembly chordwise by adjusting chord arm weights or washers per Figure 18-2. Total weight not to exceed four A255-2 weights (or equivalent).

- |                   |   |                     |
|-------------------|---|---------------------|
| (1) A255-1 Weight | = | (8) AN970-4 Washers |
| (1) A255-2 Weight | = | (3) A255-1 Weights  |

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18-15 Troubleshooting

The following are some of the symptoms and corrections which occur in the Track and Balance operations of the helicopter. Decide on the various causes of a given trouble and then eliminate causes one by one, beginning with the most probable.

<u>Symptom</u>	<u>Probable Cause</u>	<u>Correction</u>
1. Excessive Cyclic or Stick Shake	Main rotor (MR) out of track.	Track and balance per Section 18-10.
	Rough or binding A205-7 fork assembly (upper swashplate).	Replace or refer to Section 67-40.
	Brinelled spindle bearing (rough movement).	Send blade(s) to RHC for spindle bearing replacement.
	Rough blade surface (chipped paint).	Repair blades per Section 62-60.
	Rough or binding pitch links.	Replace pitch link rod ends
	MR blade boot misaligned.	Realign or replace boot per Section 62-11.
	MR teeter or coning hinge binding.	Replace bearings per Section 62-21.
	MR blade trim tabs bent upward.	Bend trim tabs evenly down per Section 18-13.
2. Excessive Ship Vibration	Blade mismatch.	Send blade(s) to RHC for replacement.
	MR out of track and balance.	Track and balance per Section 18-10.
	MR teeter or coning hinge friction.	Adjust hinge friction per Section 62-32.
	MR teeter or coning hinge binding.	Replace bearings per Section 62-21.
	Brinelled spindle bearing (rough movement).	Send blade(s) to RHC for spindle bearing replacement.
3. Excessive Cyclic Stick Forces	MR teeter hinge bearings worn.	Replace bearings per Section 62-21.
	Brinelled spindle bearing (rough movement).	Send blade(s) to RHC for spindle bearing replacement.
4. Intermittent Blade Track Picture	Brinelled spindle bearing (rough movement).	Send blade(s) to RHC for spindle bearing replacement.
	MR teeter or coning hinge friction	Adjust hinge friction per Section 62-32.
	MR coning hinge binding.	Replace bearings per Section 62-21.
	MR teeter hinge not "broken-in."	Track and balance per Section 18-10. Adjust track to minimize error.
5. Radical Changes to Cyclic Trim	Brinelled spindle bearing (rough movement).	Send blade(s) to RHC for spindle bearing replacement.
	MR teeter hinge bearings worn.	Replace bearings per Section 62-21.

18-16 Autorotational RPM Adjustment

Use the following procedure for checking and adjusting autorotational RPM:

**WARNING**

**Failure to properly adjust autorotational RPM (RPM too low) may prevent the rotorcraft from achieving proper RPM at low gross weights.**

1. Perform autorotation RPM check at minimum practical gross weight (less than 1900 lb). Calculate the takeoff gross weight of the helicopter. Record the time on the hourmeter.

Take-Off gross weight: \_\_\_\_\_

Take-Off hourmeter reading: \_\_\_\_\_

2. Set the altimeter to 29.92" Hg (1013.2 millibars) prior to performing the autorotation. Autorotate with the collective control firmly held against the down stop with an airspeed of 50 KIAS.

**WARNING**

**Do not allow the rotor to overspeed when performing autorotation checks. Progressively lengthen both main rotor pitch link rod ends until full down collective can be obtained without overspeeding the rotor.**

Take at least 3 RPM readings at 500 to 1000 foot altitude intervals.

Record the following in-flight data:

Test #	Hourmeter Reading	OAT	Pressure Altitude	Test % RPM
1	_____	_____	_____	_____
2	_____	_____	_____	_____
3	_____	_____	_____	_____
4	_____	_____	_____	_____
5	_____	_____	_____	_____

18-16 Autorotational RPM Adjustment (continued)

3. After test flight, determine the following:

Test #	1	2	3	4	5
<b>Elapsed Time</b> ( <i>in-flight hourmeter reading minus take-off hourmeter reading</i> ):					
<b>Pounds of Fuel Consumed</b> ( <i>elapsed time x 140 lb/hr</i> ):					
<b>Test Gross Weight</b> ( <i>take-off gross weight minus fuel consumed</i> ):					
<b>Test Longitudinal Center of Gravity:</b>					
<b>Chart % RPM*:</b>					
<b>Test % RPM</b> ( <i>from in-flight data</i> ):					
<b>RPM Correction</b> ( <i>chart % RPM minus test % RPM</i> ):					

\*Perform step 4 to obtain value.

4. Refer to Figure 18-5. To find Chart % RPM, perform the following:

- a. Start at outside air temperature, and draw a vertical line up to pressure altitude.
- b. Draw a horizontal line from pressure altitude to rotorcraft gross weight at time of autorotation.
- c. Draw a vertical line down from autorotation gross weight to required auto RPM.

5. Adjust pitch links based on average RPM correction required. Lengthen both pitch links to decrease RPM if test RPM is greater than chart RPM; shorten both pitch links to increase RPM. One full rod end turn will change RPM approximately 3 ½ %. Adjust both pitch links exactly the same so track will not be affected.

6. Repeat previous steps as required until the RPM correction is ± 1% of chart RPM.

**AUTOROTATION RPM**

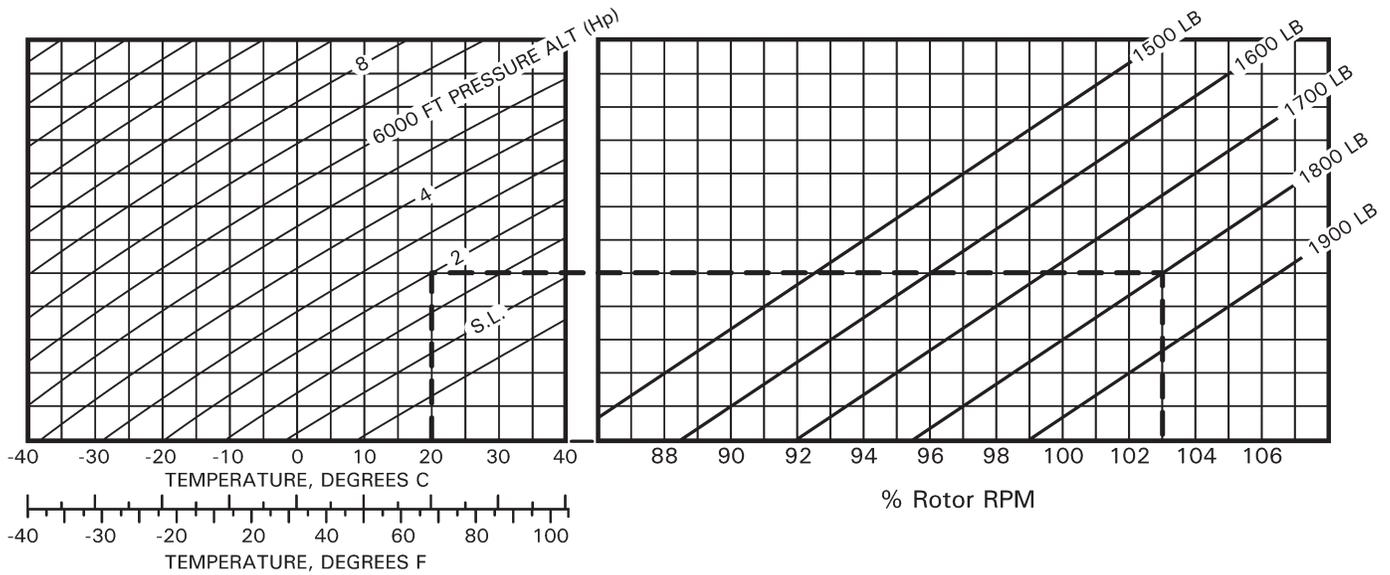
**COLLECTIVE FULL DOWN**

**50 KIAS**

One full turn of rod ends = approximately 3½% RPM change

One full turn of rod end = 1½ turns of barrel

Example: OAT = 20°C, Hp = 2000 ft, GW = 1800 lb, RPM = 103%



**FIGURE 18-5 AUTOROTATION RPM ADJUSTMENT**

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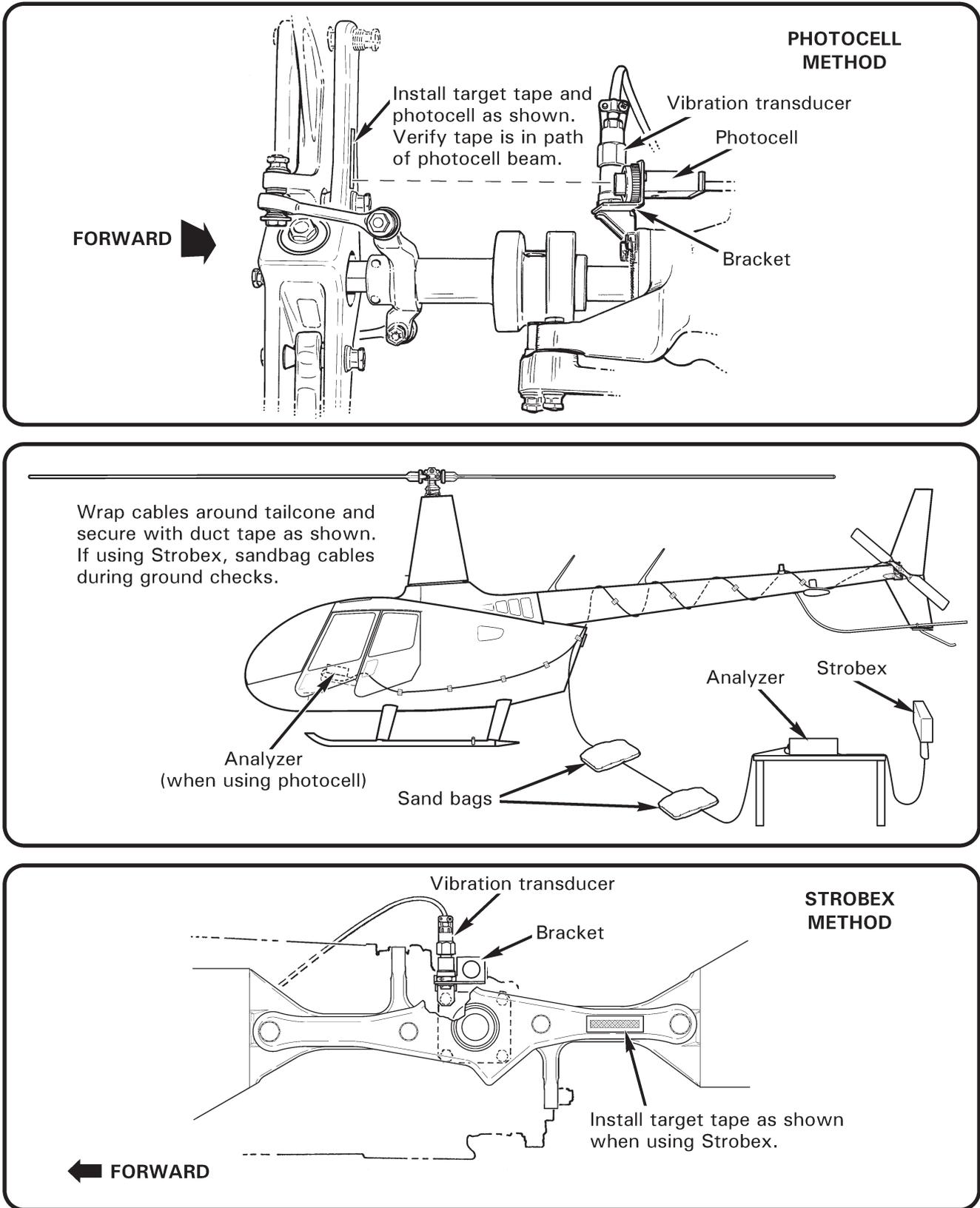


FIGURE 18-6 TAIL ROTOR BALANCING EQUIPMENT INSTALLATION

18-20 Tail Rotor Dynamic Balance

## NOTE

Calibrate track and balance equipment per manufacturer's recommendation, at least once a year, or if equipment is dropped, misused, or calibration is suspect.

## NOTE

The Chadwick-Helmuth Vibrex system, the TEC ACES system, the Dynamic Solutions Systems' MicroVib system, or equivalent equipment is required to perform dynamic rotor balancing and in-flight track checks.

18-21 Preparing Helicopter for Tail Rotor Dynamic Balance

## NOTE

Use the following balance procedures in conjunction with approved equipment manufacturer's balancing instructions.

**WARNING**

**Ensure cable(s) cannot entangle tail rotor.**

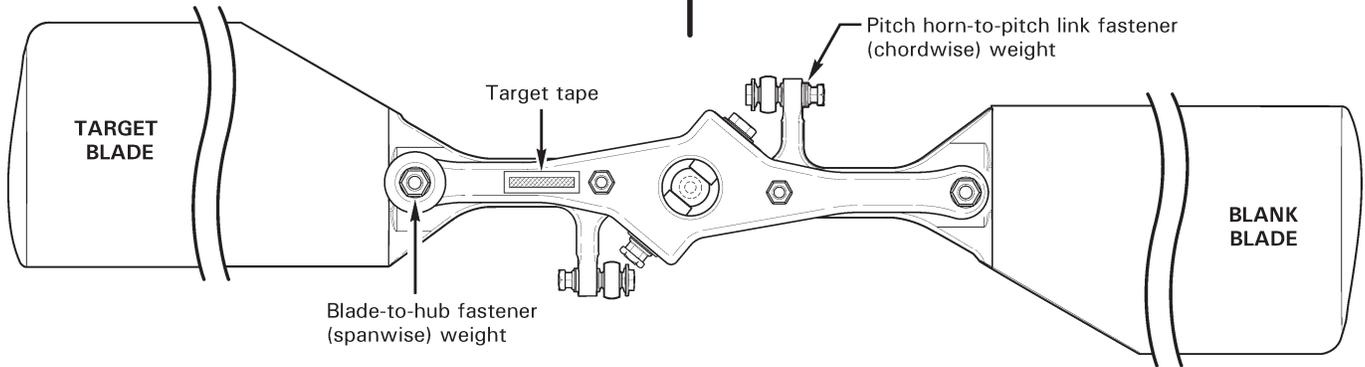
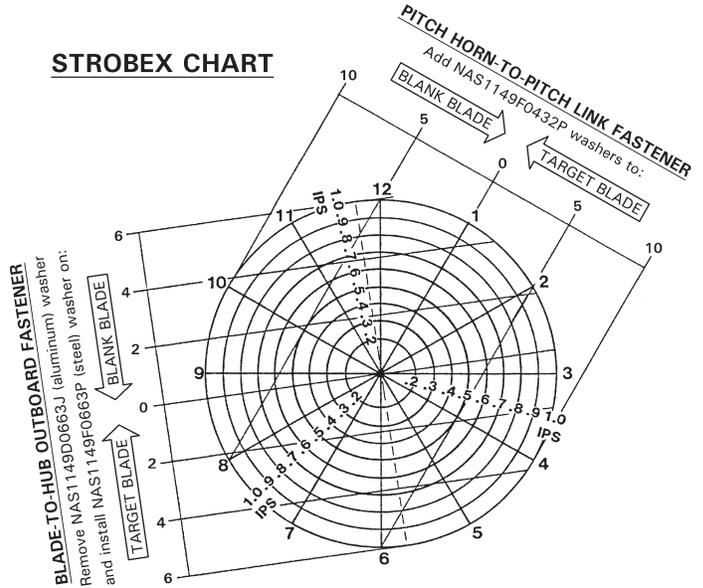
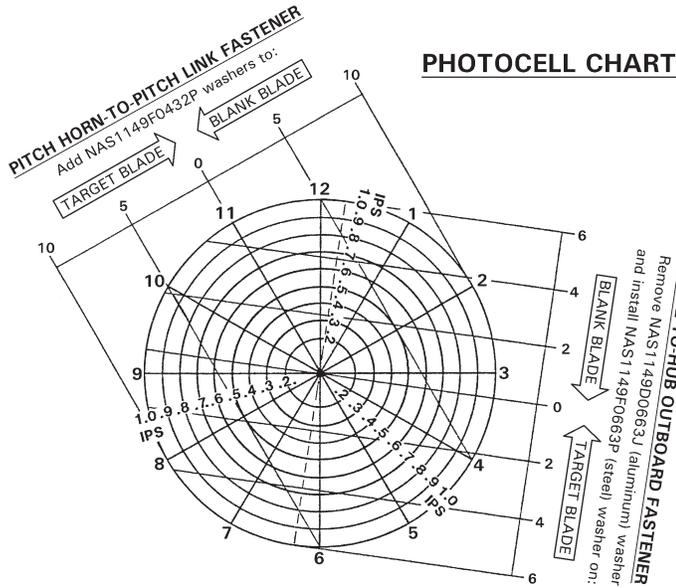
1. Clean tail rotor blades per § 20-10. Inspect tail rotor rod ends and elastomeric bearings per §§ 5-33 and 5-34.
2. Track tail rotor blades per § 18-60, steps 3 & 4. Remove tracking stick.
3. Refer to Figure 18-6. If using photocell to obtain clock angle, install a target tape spanwise on inboard side of one arm of tail rotor hub; if using Strobex, install a target tape spanwise on outboard side of hub.
4. Using appropriate hardware, attach bracket(s) to vibration transducer, and photocell, if used. Secure bracket to tail rotor gearbox output shaft cap at forward, top attachment bolt. Orient vibration transducer vertically.
5. Connect cable(s) to transducer, and photocell, if used. Route cable(s) forward and into cabin; wrap around tailcone several times, and secure with duct tape. If using Strobex, route cable to a position located approximately 20 feet to left of tail rotor. Place sandbags (or similar) on cable to prevent cable movement.
6. Connect cable(s) to balancer. Verify security of installation.

DATE \_\_\_\_\_ SERIAL NO. \_\_\_\_\_

PAGE \_\_\_\_\_

PITCH HORN-TO-PITCH LINK FASTENER (CHORDWISE) WEIGHTS		
(1) NAS1149F0463P Washer	=	(2) NAS1149F0432P Washers
(1) A214-3 Washer	=	(3.5) NAS1149F0432P Washers
(1) A141-14 Washer	=	(5) NAS1149F0432P Washers

BLADE-TO-HUB OUTBOARD FASTENER (SPANWISE) WEIGHTS		
(1) C141-23 Washer	=	(3.5) NAS1149F0663P Washers
(1) C141-24 Washer	=	(7) NAS1149F0663P Washers
(2) NAS1149F0632P	=	(1) NAS1149F0663P Washer



BALANCE	
CLOCK	IPS

ADJUSTMENT: \_\_\_\_\_

ADJUSTMENT: \_\_\_\_\_

ADJUSTMENT: \_\_\_\_\_

ADJUSTMENT: \_\_\_\_\_

**FIGURE 18-7 TAIL ROTOR DYNAMIC BALANCE CHART**

18-22 Ground Checks**NOTE**

Run-up and shutdown helicopter throughout procedure as required per R66 Pilot's Operating Handbook (POH) Section 4.

**NOTE**

Use the following balancing procedures in conjunction with approved equipment manufacturer's balancing instructions.

**WARNING**

**Tail rotor balancing equipment must be removed for flight.**

1. Prepare helicopter for tail rotor dynamic balance per § 18-21.
2. As required, print Figure 18-7; use copy to record ground check data. Check tail rotor balance at 99–101% RPM on ground and record data. Maximum vibration allowance is 0.2 ips (inches per second). (If using Chadwick-Helmuth system, set Function Knob on Balancer to appropriate channel, set balancer RPM Range knob to X10, and set RPM to 231. During ground run, view tail rotor assembly target tape through Strobex and tune Balancer by adjusting RPM dial.)
3. Adjust balance per § 18-23 as required, record change, and recheck balance. Repeat steps 2 and 3 as required until tail rotor balance is within limits.
4. Remove track and balance equipment. Install tail rotor gearbox output shaft cap forward, top attachment bolt and special torque per § 20-33. Install 0.032-inch diameter lockwire securing cap retaining hardware and safety in pairs.

**WARNING**

**A rotor which is smooth after balancing but goes out of balance within a few flights is suspect and must be examined by RHC before further flight.**

### 18-23 Balance Adjustment

Refer to R66 Illustrated Parts Catalog (IPC) Figure 64-1. Refer to § 64-11 for tail rotor assembly static balance procedure.

#### **A. Pitch Horn-to-Pitch Link Fastener (Chordwise Balance Adjustment)**

Chordwise dynamic balance is achieved by varying NAS6604 bolt length and nut-side washers on tail rotor blade pitch horn-to-pitch link fastener. Select bolt length and washers as required to balance tail rotor assembly chordwise per Figure 18-7. Standard torque nut and palnut per § 20-32, but do not torque stripe until after correct balance is achieved.

#### **B. Blade-to-Hub Outboard Fastener (Spanwise Balance Adjustment)**

Spanwise dynamic balance is achieved by varying nut-side washer size on tail rotor blade-to-hub outboard fastener. Four washers are required under outboard nuts. Select a combination of four washers to balance tail rotor assembly spanwise per Figure 18-7, placing largest washers closest to hub assembly. Standard torque nuts and palnuts per § 20-32, but do not torque stripe until after correct balance is achieved.

18-30 Main Rotor Flight Control Rigging

Cyclic stick travel is limited by A211-4 stop and is not adjustable. Collective stick travel is limited by A333-1 stop and is not adjustable. This procedure ensures blade angles are correct at cyclic stick & collective stick travel limits.

**NOTE**

Refer to § 5-33, and Figures 5-1 & 5-2 for standard rod end adjustment procedures. Refer to § 18-13 for main rotor pitch link adjustment procedure.

For collective adjustments, both pitch links must be adjusted exactly the same.

Track and balance helicopter per §§ 18-10 & 18-20 as required after adjusting flight controls.

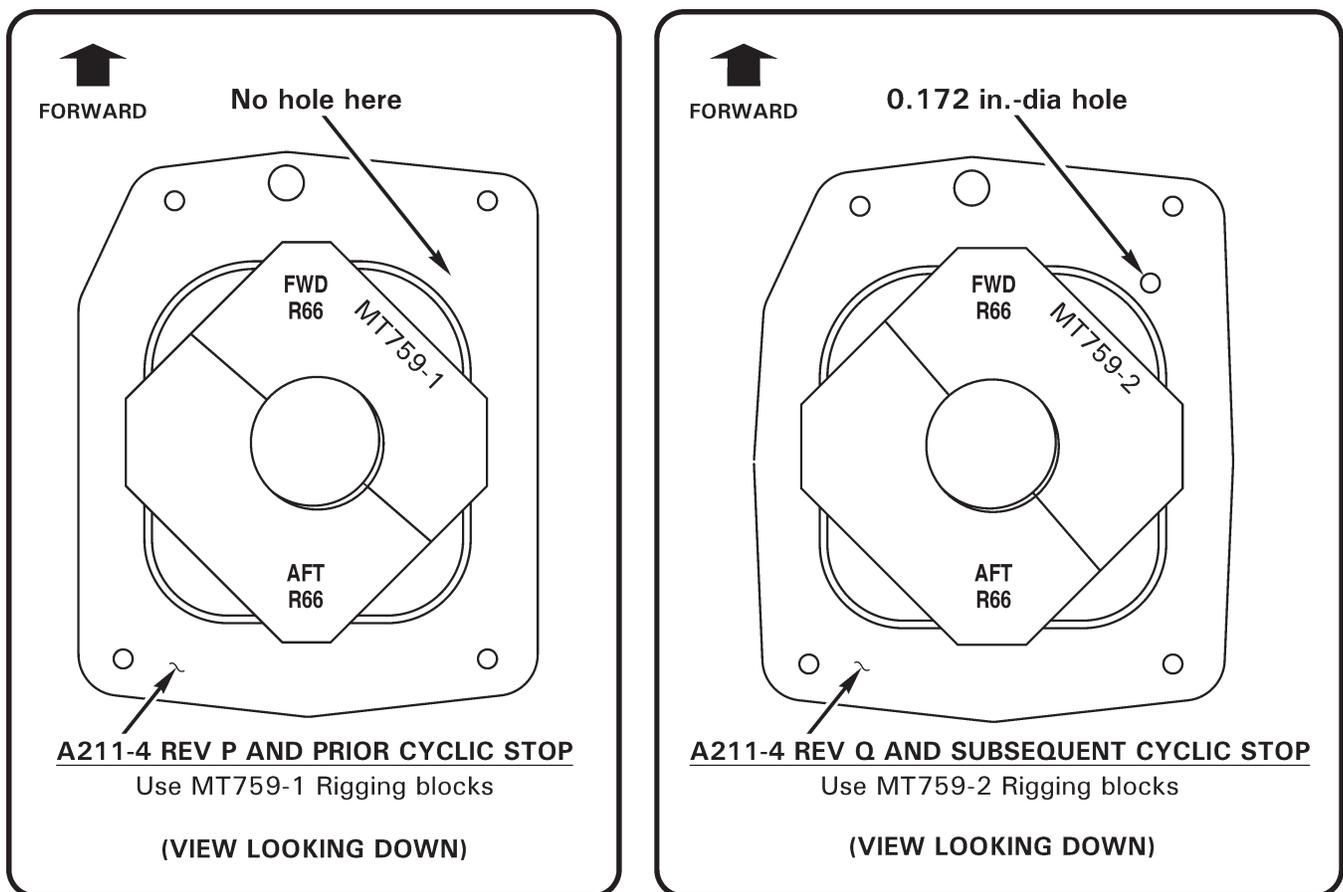


FIGURE 18-7A CYCLIC RIGGING

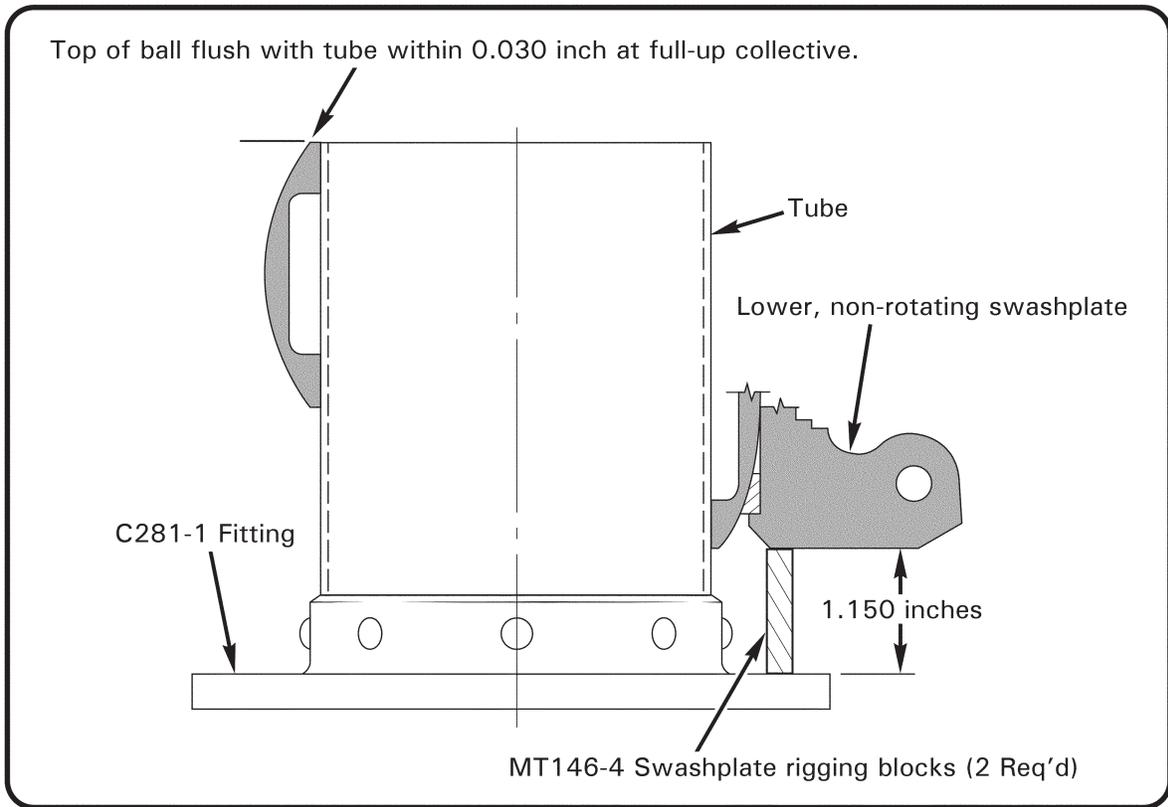


FIGURE 18-8 LOWER SWASHPLATE CLEARANCE

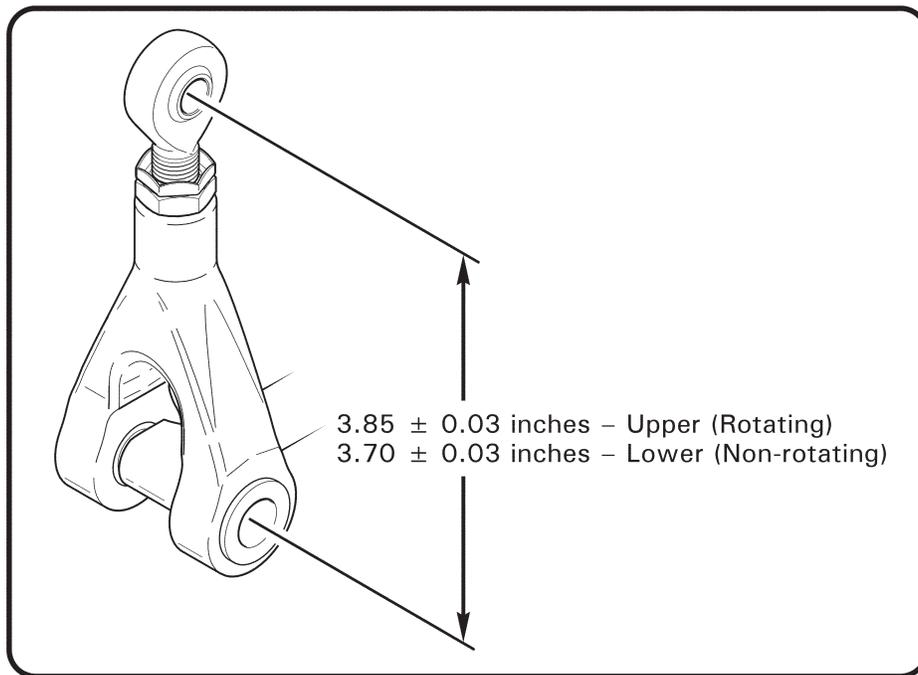


FIGURE 18-9 A205-7 FORK DIMENSIONS FOR SWASHPLATE SCISSORS

18-30 Main Rotor Flight Control Rigging (continued)

1. Refer to Figure 18-9. Adjust swashplate A205-7 lower fork assembly (non-rotating) to  $3.70 \pm 0.03$  inches, and upper fork assembly (rotating) to  $3.85 \pm 0.03$  inches.
2. Adjust the following push-pull tube assemblies and fork assembly, located between keel panels, to the noted rod end centerline-to-centerline dimensions:

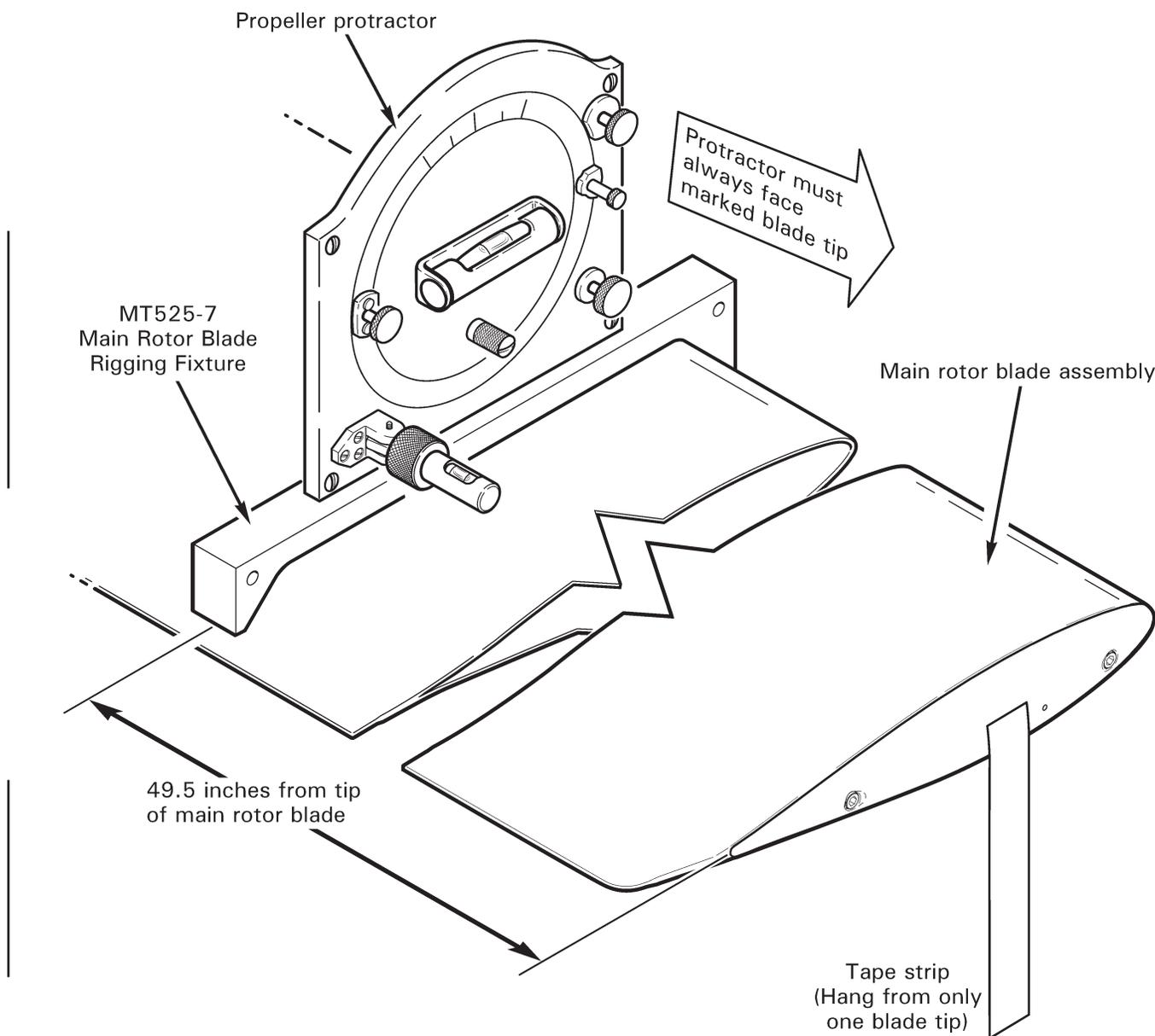
PART NUMBER	=	DIMENSION
C121-1	=	$51.13 \pm 0.03$ inches
F121-1	=	$32.26 \pm 0.03$ inches
G205-1	=	$5.40 \pm 0.03$ inches

3. With collective full up, adjust length of F121-1 tube so there is a  $0.50 \pm 0.03$  inch gap between G205-1 yoke and F334-1 support assembly.
4. Verify hydraulic servo rigging meets Figure 29-3 requirements; adjust per § 29-30 Part B, as required.
5. Refer to Figure 18-7A. Install MT759-1 or MT759-2 rigging blocks inside A211-4 cyclic stop. Apply cyclic stick friction. Raise collective approximately half way.
6. Refer to Figure 18-8. Position MT146-4 swashplate rigging blocks between lower, non-rotating swashplate and C281-1 fitting.
7. Slowly lower collective stick full down or until lower swashplate contacts rigging blocks, whichever occurs first.
8. Disconnect (3) F121-3 push-pull tubes from lower swashplate. Ensure swashplate rests on rigging blocks.

**CAUTION**

Do not pressurize hydraulic system while any hydraulic system component is disconnected or removed.

9. Pressurize hydraulics per § 12-34 steps 1 thru 3. Position collective stick full down and apply collective stick friction. Turn off hydraulic pump.
10. Adjust each of (3) F121-3 push-pull tube rod ends to lowest/shortest position that allows installing connecting hardware without preload per Figure 5-1, and centered per Figure 5-2. Standard torque per § 20-32 and torque stripe per Figure 5-1.
11. Cut and discard ty-rap securing boot to swashplate.
12. Pressurize hydraulics per § 12-34 steps 1 thru 3. Position collective stick full up and apply collective friction. Turn off hydraulic pump. Verify top of C201-1 ball assembly is flush with top edge of C208-1 tube within 0.030 inch. Adjust push-pull tube rod ends in or out equally to raise or lower swashplate as required.
13. Remove swashplate rigging blocks. Disconnect hydraulic pump per § 12-34.
14. Position boot on swashplate, secure boot with MS3367-6-0 ty-rap, cinch ty-rap until snug without over-tightening, and trim tip flush with head.



**FIGURE 18-10 MAIN ROTOR BLADE RIGGING**

## 18-40 Main Rotor Blade Angle Rigging

### A. Procedure

#### NOTE

Refer to § 5-33, and Figures 5-1 & 5-2 for standard rod end adjustment procedures. Refer to § 18-13 for main rotor pitch link adjustment procedure.

1. Perform main rotor flight control rigging per § 18-30.
2. Level helicopter laterally and longitudinally via main rotor hub per § 8-12.
3. Adjust rotor track per § 18-40 Part B step 1.
4. Perform collective travel rigging per § 18-41 Parts A and B.
5. Perform cyclic travel rigging per § 18-42 Parts A, B, C, and D.
6. Perform track and balance per § 18-10 as required.

### B. Measuring Blade Angles

#### NOTE

Hydraulic flight controls must be pressurized while measuring blade angles.

#### CAUTION

Do not pressurize hydraulic system while any hydraulic system component is disconnected or removed.

#### WARNING

**Never adjust flight controls while hydraulics are pressurized. Hydraulic forces can cause injury.**

1. Adjust rotor track per the following: Rotate blades so pitch links are aligned with helicopter longitudinal axis. Teeter main rotor hub until blade tips are approximately level. Place a tracking stick at end of one blade and mark stick where blade tip passes. Rotate rotor 180° and mark tracking stick where opposite blade passes. Teeter main rotor hub as required until both blade tips pass tracking stick within 1 inch vertically.
2. Refer to Figure 18-10. Using felt tip marker, mark upper surface of both main rotor blades 49.5 inches inboard of seam between blade tip and tip cover. Lay 1-inch wide length of masking tape chordwise on each blade, centered over marking. Mark each rotor blade with a different designation, such as red and blue.
3. Conspicuously mark one blade tip with tape or cardboard for reference. Zero Kell-Strom KS113 propeller protractor (or equivalent) on top of main rotor hub, parallel to teeter hinge bolt, at location marked "LEVEL HERE". During zeroing, and when taking blade angle readings, always point protractor face toward marked blade.

18-40 Main Rotor Blade Angle Rigging (continued)

**B. Measuring Blade Angles (continued)**

4. Position MT525-7 fixture on top of the blade’s tape at 49.5 inches, and tight against leading edge. Position protractor on top of fixture, point protractor face toward marked blade, and measure blade angle.

18-41 Collective Travel

**NOTE**

Lengthening pitch links increases blade angles.

**NOTE**

When making adjustments, keep pitch links as close to neutral (mid-travel) position as possible to preserve the adjustment range for flight checks.

**A. Collective Down**

1. Refer to Figures 18-7A and 18-8. Install MT759-1 or MT759-2 rigging blocks inside A211-4 cyclic stop. Position collective stick full down and apply friction.
2. Rotate blades so pitch links are aligned with helicopter longitudinal axis.
3. Measure and record blade angles per § 18-40 Part B to determine the values below. Rotate blades 180° and align per step 2 as required.

**BLUE BLADE**

Pitch horn forward    \_\_\_\_\_ °

Pitch horn aft        + \_\_\_\_\_ °

= \_\_\_\_\_ °

÷ 2 = \_\_\_\_\_ °

**RED BLADE**

Pitch horn forward    \_\_\_\_\_ °

Pitch horn aft        + \_\_\_\_\_ °

= \_\_\_\_\_ °

÷ 2 = \_\_\_\_\_ °

4. Blade angles must average between 0.0° and 1.0° for collective down position. (Final blade angle for collective down position is determined during autorotation rpm adjustment.) Adjust main rotor blade pitch links per § 18-13 as required (one full barrel turn = 0.72°) until blade angles, when blades are positioned pitch horn forward, are within 0.2°. Adjust pitch links until blade angles, when blades are positioned pitch horn aft, are also within 0.2°.

**NOTE**

After making adjustments, position collective stick full up and apply friction. Verify top of swashplate ball is flush with tube within 0.030 inch per Figure 18-8. Adjust all swashplate push-pull tubes exactly the same amount as required (one full turn = 0.48°). Lengthening all push-pull tubes increases blade angles.

18-41 Collective Travel (continued)

**B. Collective Up**

1. Refer to Figure 18-7A. Install MT759-1 or MT759-2 rigging blocks inside A211-4 cyclic stop. Position collective stick full up and apply friction.
2. Rotate blades so pitch links are aligned with helicopter longitudinal axis.
3. Measure and record blade angles per § 18-40 Part B to determine the values below. Rotate blades 180° and align per step 2 as required.

**BLUE BLADE**

Pitch horn forward \_\_\_\_\_°  
 Pitch horn aft + \_\_\_\_\_°  
                                           = \_\_\_\_\_°  
                                           ÷ 2 = \_\_\_\_\_°

**RED BLADE**

Pitch horn forward \_\_\_\_\_°  
 Pitch horn aft + \_\_\_\_\_°  
                                           = \_\_\_\_\_°  
                                           ÷ 2 = \_\_\_\_\_°

4. For collective up position, blade angles must average between 12.5° and 13.5° more than collective down position average. Adjust main rotor blade pitch links per § 18-13 as required (one full barrel turn = 0.72°) until blade angles, when blades are positioned pitch horn forward, are within 0.2°. Adjust pitch links until blade angles, when blades are positioned pitch horn aft, are also within 0.2°.

**NOTE**

Remeasure collective down blade angles after making adjustment for collective up blade angles.

**NOTE**

After making adjustments, position collective stick full up and apply friction. Verify top of swashplate ball is flush with tube within 0.030 inch per Figure 18-8. Adjust all swashplate push-pull tubes exactly the same amount as required (one full turn = 0.48°). Lengthening all push-pull tubes increases blade angles.



18-42 Cyclic Travel (continued)

**C. Cyclic Forward**

1. Position collective stick full down. Position cyclic stick in the lateral neutral (5 inches to left of right stop) position, and against forward stop. Apply control frictions; sandbag cyclic stick as required.
2. Rotate blades so pitch links are aligned with helicopter longitudinal axis.
3. Measure and record blade angles per § 18-40 Part B to determine the values below. Rotate blades 180° and align per step 2 as required.

**BLUE BLADE**

Pitch horn forward \_\_\_\_\_°  
 Pitch horn aft + \_\_\_\_\_°  
 = \_\_\_\_\_°  
 ÷ 2 = \_\_\_\_\_°

**RED BLADE**

Pitch horn forward \_\_\_\_\_°  
 Pitch horn aft + \_\_\_\_\_°  
 = \_\_\_\_\_°  
 ÷ 2 = \_\_\_\_\_°

4. Blade angles must average between 13.50° and 14.25° for cyclic forward position. Adjust swashplate aft push-pull tube as required (one full turn = 0.44°). A coarse adjustment can be made by adjusting swashplate forward push-pull tubes exactly the same amount (one full turn = 0.6°).

**D. Cyclic Aft**

1. Position collective stick full down. Position cyclic stick in the lateral neutral (5 inches to left of right stop) position, and against aft stop. Apply control frictions; sandbag cyclic stick as required.
2. Rotate blades so pitch links are aligned with helicopter longitudinal axis.
3. Measure and record blade angles per § 18-40 Part B to determine the values below. Rotate blades 180° and align per step 2 as required.

**BLUE BLADE**

Pitch horn forward \_\_\_\_\_°  
 Pitch horn aft + \_\_\_\_\_°  
 = \_\_\_\_\_°  
 ÷ 2 = \_\_\_\_\_°

**RED BLADE**

Pitch horn forward \_\_\_\_\_°  
 Pitch horn aft + \_\_\_\_\_°  
 = \_\_\_\_\_°  
 ÷ 2 = \_\_\_\_\_°

4. Blade angles must average between 13.50° and 14.25° for cyclic aft position. Adjust swashplate aft push-pull tube as required (one full turn = 0.44°). A coarse adjustment can be made by adjusting swashplate forward push-pull tubes exactly the same amount (one full turn = 0.6°).

**NOTE**

Remeasure cyclic forward blade angles after making adjustment for cyclic aft blade angles.

18-50 Tail Rotor Flight Control Rigging

Refer to R66 Illustrated Parts Catalog (IPC) Figures 67-29 thru 67-39.

18-51 Pedals

1. Refer to Figure 67-4. Insert a 3/16-inch diameter rigging pin through the hole in the right-hand keel panel and the rigging pin holes in the C317-7 bellcrank.
2. Adjust the F121-9 push-pull tube as required to obtain a dimension of  $5.24 \pm 0.03$  in. from the lower forward NAS6604-9 bolt in C317-5 or C317-9 bellcrank and horizontal pedal torque tube.

18-52 Forward Bellcrank

Remove the rigging pin and place the left pedal against its stop. Adjust the F121-11 push-pull tube to obtain 1.08 - 1.18 inches between the end of the rod end and the bulkhead.

18-53 Intermediate Bellcrank

With left pedal at stop, adjust the C121-17 push-pull tube length as required to obtain  $0.35 \pm 0.03$  inch between two faces of pitch control assembly and the housing.

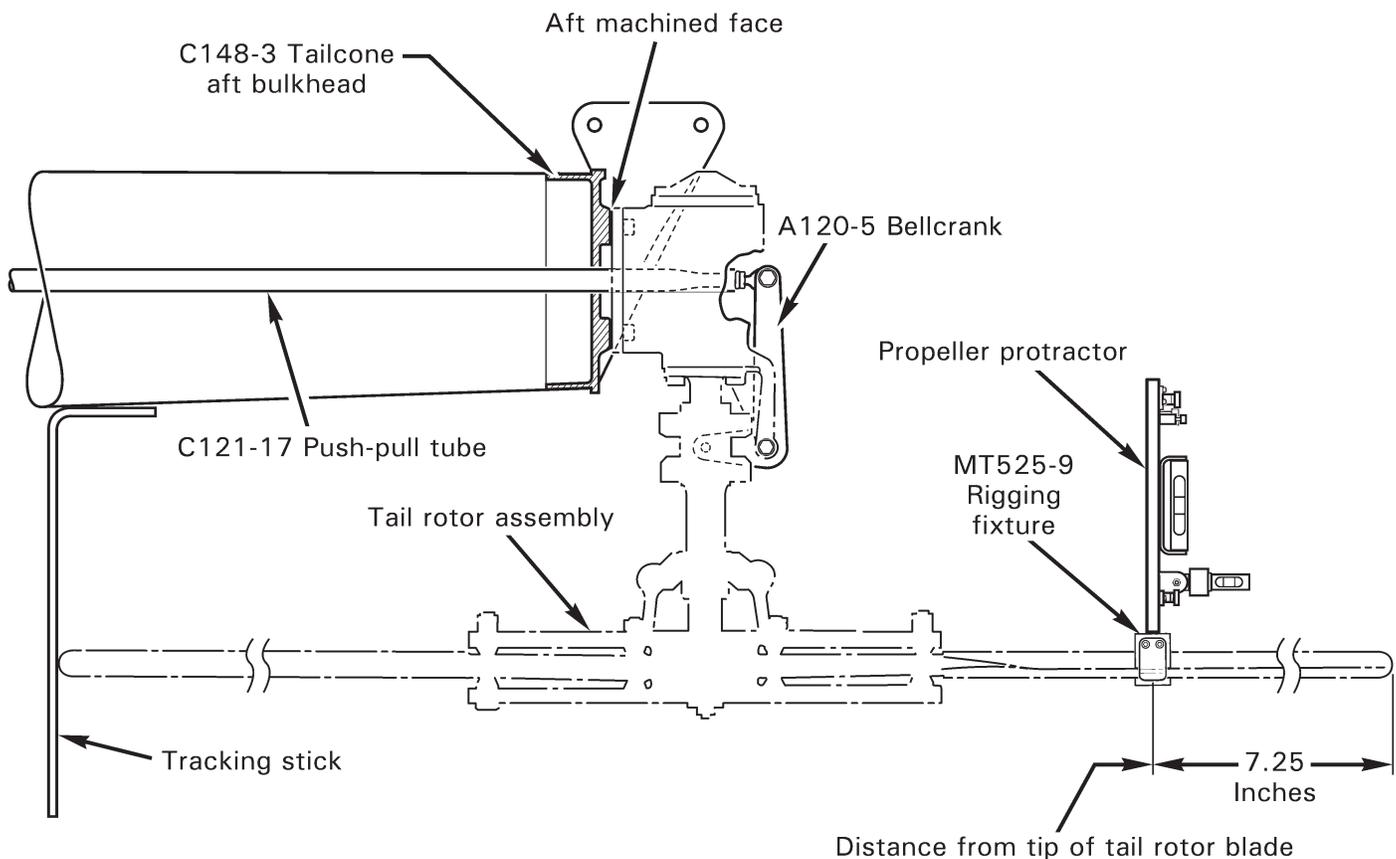


FIGURE 18-11 TAIL ROTOR BLADE RIGGING

18-60 Tail Rotor Blade Rigging

1. Level helicopter laterally, and longitudinally via main rotor hub, per § 8-12.
2. Place left (or right) pedal against its stop. Position tail rotor blades parallel with tailcone axis.
3. Refer to Figure 18-11. Tape a tracking stick to tailcone at blade tip. A tracking stick can be made using a 1" x 12" strip of aluminum with a 90° bend 2 inches from one end.
4. Rotate tail rotor shaft weldment and mark tracking stick where each blade tip drain hole passes. Adjust (teeter) tail rotor hub on output shaft until both blade tips pass the same point on the tracking stick.
5. Using felt tip marker, mark inboard surface of both tail rotor blades 7.25 inches from each blade tip. Lay 1-inch wide strip of masking tape chordwise on each blade, centered over marking. Mark each blade with a different color designation, such as red or blue.
6. Have a second person hold one blade tip at left pedal track mark with left pedal against its stop. Position MT525-9 rigging fixture on aft blade, against inboard surface. Position propeller protractor against fixture, measure blade angle, and record data below. Rotate tail rotor 180°, and record opposite blade angle.

Pedals Full Left

Blue Blade	_____	°	
Red Blade	+ _____	°	
	= _____	°	
	÷ 2 = _____	°	(18.5/19.0° required)

7. Difference between blue and red blade angles may not exceed 0.4°. If blade angles exceed this limit, remove tail rotor assembly per § 64-10, rotate assembly one-half revolution, and install assembly per § 64-10. Repeat previous steps. If blade angles still exceed relative limit, contact RHC Technical Support for replacement blade assistance.
8. Adjust C121-17 push-pull tube rod ends per § 5-33 and Figures 5-1 & 5-2 as required to obtain blade angle between 18.5° and 19.0°. One full turn of the rod end will change the blade angle 0.33°.
9. Have a second person hold one blade tip at right pedal track mark with right pedal against its stop. Position MT525-9 rigging fixture on aft blade, against inboard surface. Position propeller protractor against fixture, measure blade angle, and record data below. Rotate tail rotor 180°, and record opposite blade angle.

Pedals Full Right

Blue Blade	_____	°	
Red Blade	+ _____	°	
	= _____	°	
	÷ 2 = _____	°	(15.5/16.5° required)

10. Adjust C121-17 push-pull tube rod ends per § 5-33 and Figures 5-1 & 5-2 as required to obtain blade angle between 15.5° and 16.5°. If adjusted, recheck left pedal blade angles per previous steps.

18-60 Tail Rotor Blade Rigging (continued)

11. If the blade angle range for left and right pedal settings cannot be obtained using the preceding steps, pedal total travel is either too great or too small. Use the following procedure to check and adjust pedal travel:
- a. Add right and left pedal blade angles together. If total is less than  $34.0^\circ$ , pedal total travel is too small. If total is greater than  $35.5^\circ$ , pedal total travel is too great.
  - b. If pedal total travel is too small, increase C343-11 push-pull tube length and/or decrease C343-13 push-pull tube length.
  - c. If pedal total travel is too great, decrease C343-11 push-pull tube length and/or increase C343-13 push-pull tube length.
  - d. Recheck left and right pedal blade angles per previous steps.
12. Balance tail rotor per § 18-20.

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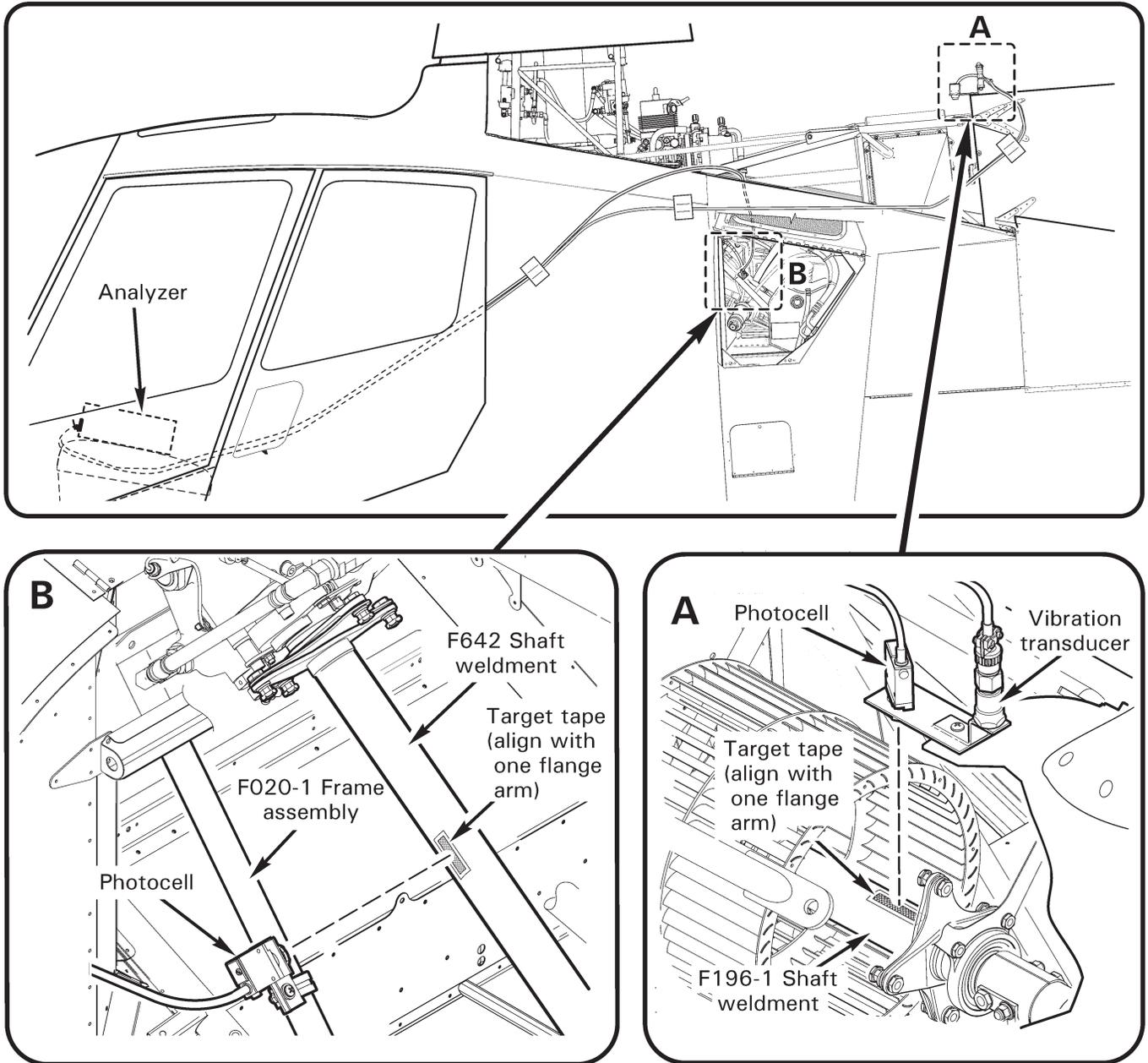


FIGURE 18-12 FAN SHAFT AND ENGINE SHAFT BALANCING

18-70 Fan Shaft and Engine Shaft Balancing

## NOTE

Calibrate track and balance equipment per manufacturer's recommendation, at least once a year, or if equipment is dropped, misused, or calibration is suspect.

## NOTE

The Chadwick-Helmuth Vibrex system, the TEC ACES system, the Dynamic Solutions Systems' MicroVib system, or equivalent equipment is required to perform dynamic rotor balancing and in-flight track checks.

18-71 Preparing Helicopter for Fan Shaft and Engine Shaft Balancing

## NOTE

Use the following balance procedures in conjunction with approved equipment manufacturer's balancing instructions.

1. Remove tailcone cowling per § 53-23. Clean F196-1 fan shaft weldment, G174-1 fanwheel assembly, and F642 shaft weldment. Inspect condition of flex plates, weldment flanges, and adjacent yokes. Verify proper fastener installation and unbroken torque stripe.
2. Refer to Figure 18-12.
  - a. Fan Shaft: Using a #8 screw, attach vibration transducer and photocell (cables pointed up) to mounting bracket(s). Secure bracket(s) to top of tailcone at the forward nutplate, aiming photocell toward center of shaft.
  - b. Engine Shaft: Using appropriate hardware, attach photocell (cable pointed outboard toward access door) to mounting bracket. Secure bracket to F020-1 frame assembly using MS21919WDG16 clamp and associated hardware, aiming photocell toward center of shaft.
3. Install a target tape on each shaft weldment and align tape with a flange arm. Verify photocell beam will hit target tape. (Tape becomes the 12 o'clock position.)
4. Route cable(s) forward into cabin; secure cables to cabin with duct tape.
5. Connect cable(s) to balancer. Verify security of installation.

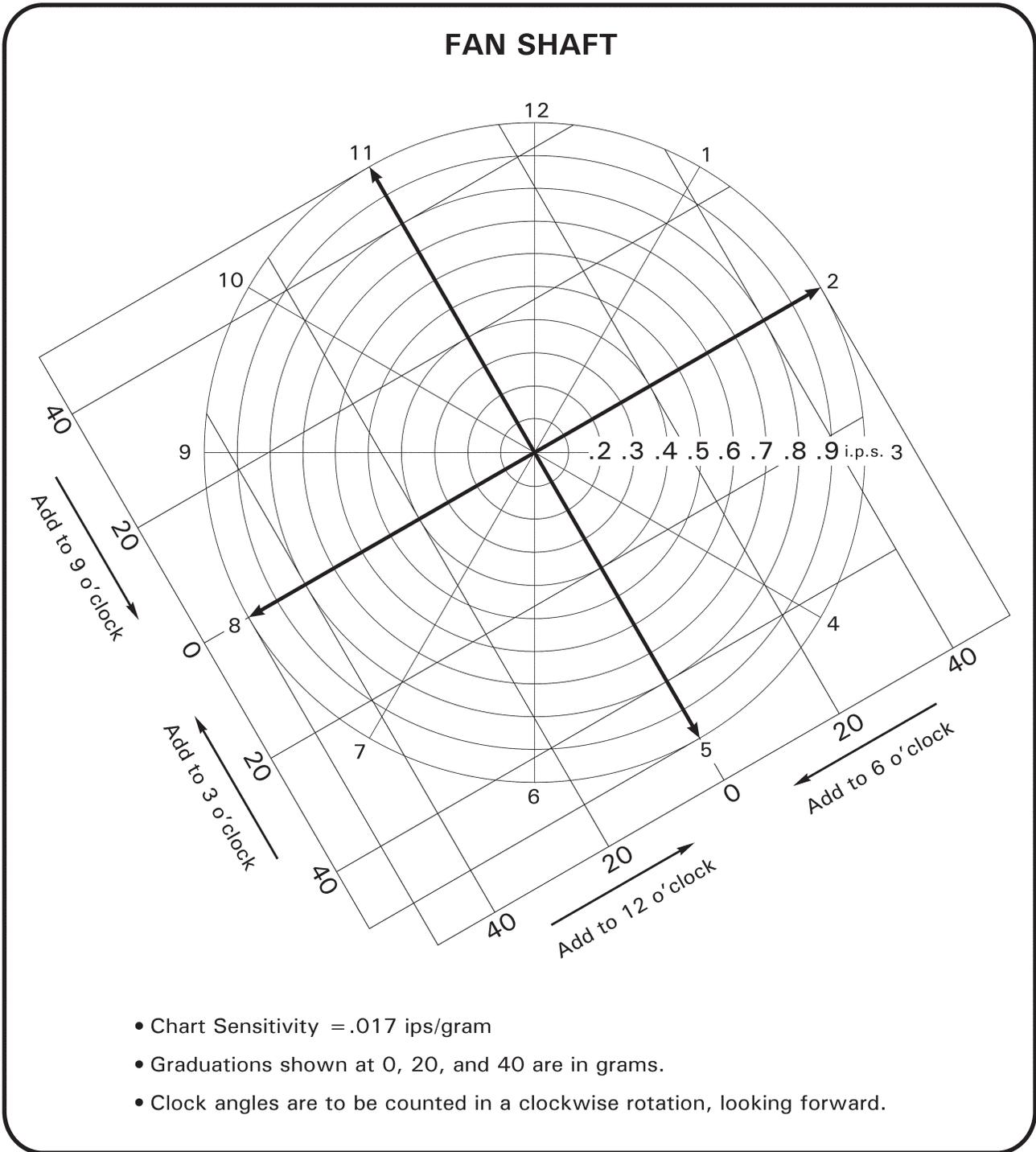


FIGURE 18-13 FAN SHAFT BALANCING CHART

18-72 Ground Checks**A. Balancing Procedure****NOTE**

Run-up and shutdown helicopter throughout procedure as required per R66 Pilot's Operating Handbook (POH) Section 4.

**NOTE**

Use the following balancing procedures in conjunction with approved equipment manufacturer's balancing instructions.

**WARNING**

**Fan shaft and engine shaft balancing equipment must be removed for flight.**

1. Prepare helicopter for fan shaft and engine shaft balance per § 18-71.
2. Configure balance equipment per manufacturer's instructions.
3. Ground run helicopter at 100% RPM (2114 fan shaft RPM and 6016 engine shaft RPM). Verify cyclic stick and tail rotor pedals are in neutral position.
4. Determine vibration level per balance equipment manufacturer's instructions. Maximum vibration allowance is 0.2 IPS (inches per second). If reading is over 0.2 IPS, adjust balance per Part B. Repeat Part A steps 3 and 4 as required until balance is within limits.
5. Remove balance equipment. Standard torque fasteners per § 20-32 and torque stripe per Figure 5-1.
6. Install tailcone cowling per § 53-23.

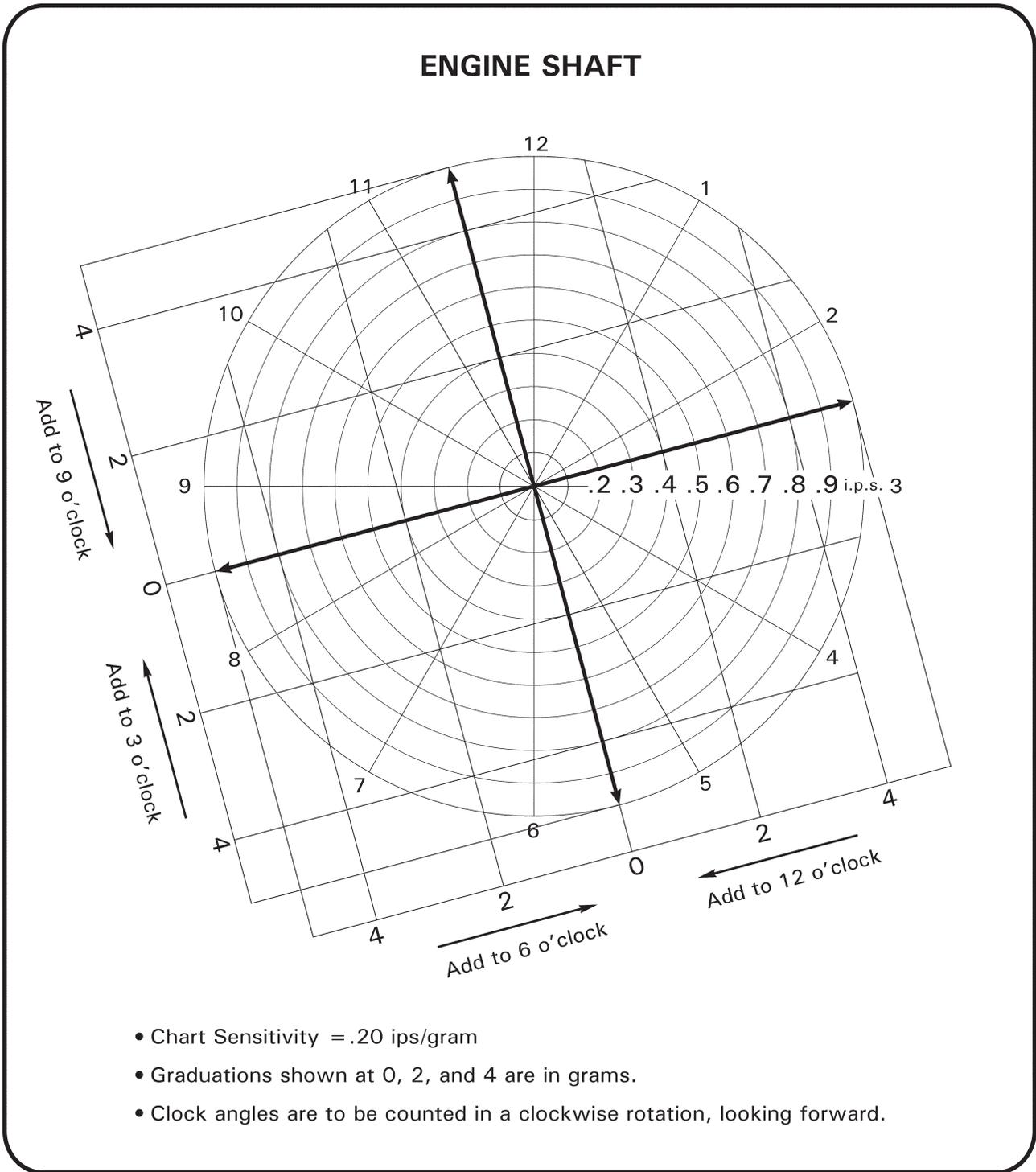


FIGURE 18-14 ENGINE SHAFT BALANCING CHART

18-72 Ground Checks (continued)**B. Balance Adjustments**

1. Fan Shaft: Refer to Figure 18-13. Adjust balance by selecting one or more NAS1149D0463J, NAS1149F0432P, NAS1149F0463P, A214-3, or A141-14 washers as required and install under one nut of intermediate flex plate (tail rotor driveline) fastener. Standard torque fasteners per § 20-32, but do not torque stripe.

**NOTE**

If a large diameter washer is installed at a shaft flange, also install one NAS1149F0432P washer against flange to provide clearance between flange & edge of large diameter washer (not required for flat flange). Additionally, an NAS6604-5, -6, -7, or -8 bolt may be used as a flex plate fastener to accommodate balance washers; verify thread engagement meets torque requirements per § 20-30.

2. Engine Shaft: Refer to Figure 18-14. Adjust balance by selecting one or more NAS1149D0463J, NAS1149F0432P, NAS1149F0463P, A214-3, or A141-14 washers as required and install under one nut of aft flex plate (engine driveline) fastener. After first adjustment, if engine shaft does not respond correctly to balance weight, verify runout of F018 clutch housing's largest diameter; radial runout must not exceed 0.005 inch TIR (rotate TR backwards by hand to rotate clutch housing) before making further weight changes. If runout exceeds TIR limit, contact RHC Technical Support. Standard torque fasteners per § 20-32, but do not torque stripe.

**NOTE**

If a large diameter washer is installed at a shaft flange, also install one NAS1149F0432P washer against flange to provide clearance between flange & edge of large diameter washer (not required for flat flange). Additionally, an NAS6604-5, -6, -7, or -8 bolt may be used as a flex plate fastener to accommodate balance washers; verify thread engagement meets torque requirements per § 20-30.

**NOTE**

Large diameter balance washer(s) used to balance F642 engine shaft can sometimes cause a "humming" sound at 100% RPM. If hum is encountered, disconnect shaft at engine flex plate, rotate shaft 180 degrees, then reconnect shaft & secure to flex plate without large diameter washer(s) before resuming balancing.

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