

# ROBINSON HELICOPTER COMPANY

## R22 MAINTENANCE MANUAL AND INSTRUCTIONS FOR CONTINUED AIRWORTHINESS RTR 060 VOLUME I

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1.009 Assembly Instructions for R22-series Helicopter Crated for Export (continued)

21. During level flight typical cruise altitude (if possible, deviate as required for weather and regulations), MCP, with right trim and governor on:
  - a. Verify longitudinal and lateral cyclic control forces are neutralized (no tendency of cyclic to creep longitudinally or laterally).
  - b. Verify collective control forces are neutralized (no tendency of collective to creep up or down).
  - c. Verify throttle correlation. Set MAP to 22 inches and turn governor off. Without twisting throttle, lower collective to 12 inches MAP then raise it to 22.5 inches MAP. RPM must stay in green arc.
22. Evaluate roughness at minimum power-on RPM, takeoff power per placard, and  $V_{ne}$  per placard.
23. Check all instruments, gauges, and avionics for proper operation.
24. During autorotation at 50 KIAS and 90% rotor RPM, perform 30° right yaw to check for adequate directional control.

| <b>TABLE 1 SCHEDULED INSPECTIONS</b>   | First 25 hours | First 100 hours | Every 50 hours | Every 100 hours | Every 300 hours | Every 500 hours | Every 800 hours | Every 2200 hours | Every 4 months | Every 12 months | Every 4 years | Every 5 years | Every 12 years |
|--|----------------|-----------------|----------------|-----------------|-----------------|-----------------|-----------------|------------------|----------------|-----------------|---------------|---------------|----------------|
| Consult latest revision of listed publications for specific applicability.   |                |                 |                |                 |                 |                 |                 |                  |                |                 |               |               |                |
| Perform inspection per Lycoming Operator’s Manual.*  | •              |                 | •              | •               | •               |                 |                 |                  |                |                 |               |               |                |
| Perform <b>Lycoming SB 480</b><br><i>I. Oil &amp; Filter Change &amp; Screen Cleaning / II. Oil Filter/Screen Content Inspection.</i><br><i>NOTE: Oil filters on D723-1 adapters do not require safety wire.</i> | •              |                 | •              |                 |                 |                 |                 |                  | •              |                 |               |               |                |
| Perform <b>Lycoming SI 1129</b><br><i>Methods of Checking DC Alternator and Generator Belt Tension.</i>  | •              |                 |                | •               |                 |                 |                 |                  |                |                 |               |               |                |
| Perform <b>Lycoming SB 301*</b><br><i>Maintenance Procedures and Service Limitations for Valves.</i>   |                | •               |                |                 | •               |                 |                 |                  |                |                 |               |               |                |
| Perform <b>Lycoming SB 388*</b> (also applies to replacement cylinders)<br><i>Procedure to Determine Exhaust Valve and Guide Condition.</i>  |                | •               |                |                 | •               |                 |                 |                  |                |                 |               |               |                |
| Perform <b>Lycoming SB 366, as applicable</b><br><i>Carburetor Throttle Body Screw Inspection.</i>   |                |                 | •              |                 |                 |                 |                 |                  |                |                 |               |               |                |
| Perform <b>Lycoming SI 1191</b><br><i>Cylinder Compression.</i>  |                |                 |                | •               |                 |                 |                 |                  |                |                 |               |               |                |
| Perform <b>CMI SB 643, as applicable</b><br><i>Maintenance Intervals for All CMI/TCM/Bendix Magnetos &amp; Related Equipment.</i>  |                |                 |                | •               |                 | •               |                 |                  |                |                 |               | •             | •              |
| Perform 100-hour/annual inspection per § 2.400.  |                |                 |                | •               |                 |                 |                 |                  |                | •               |               |               |                |
| Perform main rotor blade tip maintenance per § 26-60.  |                |                 |                | •               |                 |                 |                 |                  |                | •               |               |               |                |
| Lubricate A181-4 Revision K, L, and M bearings per § 22-42.  |                |                 |                |                 | •               |                 |                 |                  |                | •               |               |               |                |
| Lubricate A184 bearing per § 22-41.  |                |                 |                |                 | •               |                 |                 |                  |                | •               |               |               |                |
| Clean gearbox chip detectors per §§ 22-11 & 22-21.   |                |                 |                |                 |                 | •               |                 |                  |                | •               |               |               |                |
| Perform <b>CMI SB 663</b><br><i>Two-Wire Magneto Tach. Breaker Contact (Points) Assy. P/N 10-400507.</i>   |                |                 |                |                 |                 | •               |                 |                  |                |                 |               |               |                |
| Perform clutch assembly lubricant inspection & servicing per § 22-30.  |                |                 |                |                 |                 | •               |                 |                  |                |                 |               |               |                |
| Drain and flush gearboxes per §§ 22-13 & 22-23.  |                |                 |                |                 |                 | •               |                 |                  |                |                 |               |               |                |
| Perform FAA AD 88-26-01 R2 (A158-1 spindles only).   |                |                 |                |                 |                 | •               |                 |                  |                |                 |               |               |                |
| Lubricate A181-4 Revision N and subsequent bearings per § 22-42.   |                |                 |                |                 |                 |                 | •               |                  |                |                 | •             |               |                |
| Perform 2200-hour/12-year inspection per § 2.600.  |                |                 |                |                 |                 |                 |                 | •                |                |                 |               |               | •              |

\* Gray square indicates a shorter interval than published on referenced document.

**CHAPTER 3**

**LIFE-LIMITED COMPONENTS**

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## CHAPTER 3

## LIFE-LIMITED COMPONENTS

3.100 Life-Limited Components3.110 Time-In-Service Records

It is the operator's responsibility to maintain a record of time in service for the airframe, engine, and life-limited components. R22s are equipped with either an oil-pressure-activated hourmeter which records engine run time or a collective-activated hourmeter which records flight (collective up) time. Either method may be used to track time in service, however numerical values for service lives depend on the tracking method used (refer to § 3.300).

Calendar time in service for the airframe and engine begins on the date of the original RHC-issued Export (or Standard) Certificate of Airworthiness for the helicopter. For spares without a storage limit specified in § 23-85, calendar time in service begins on the date of the RHC-issued Airworthiness Approval Tag (Authorized Release Certificate) issued with the invoice.

If a component or an inspection is scheduled for hourly and calendar intervals, comply with whichever requirement comes first, then reset interval unless otherwise specified.

When installing a life-limited part or a part with an overhaul requirement, record in the helicopter maintenance record the installation date, part number, part name, serial number, helicopter total time, and time in service accumulated by part since new or since last overhaul, as applicable.

**WARNING**

**Components with mandatory overhaul times or life limits whose time in service is not reliably documented cannot be considered airworthy and must be removed from service.**

3.120 Fatigue Life-Limited Parts

The Airworthiness Limitations Section (ref. § 3.300) lists the mandatory replacement schedule for fatigue life-limited parts.

Listed items (ref. § 3.300) must be removed from the helicopter at the specified intervals and permanently retired from service, preferably by destroying or damaging each part so it cannot inadvertently be returned to service.

3.200 Type Certificate Data Sheet (TCDS)

TCDS is available at FAA Dynamic Regulatory System website: <https://drs.faa.gov>.

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**CHAPTER 4**

**AIRFRAME**

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#### 4.232 Upper Frame Installation (continued)

- n) Install main rotor gearbox per § 7.120.
- o) Install tailcone per § 4.312.

**NOTE**

On A020-2 upper frames S/N 0002 thru 0399 without welded tailcone straps require A960-1 clamp assembly and A961-1 strap assembly.

- p) Install clutch assembly per § 7.220
- q) Install seat backs and panels after verifying all attaching nuts and screws and secure.

#### 4.240 Strut Assembly Removal and Installation

To remove strut:

- a. Remove upper and lower attaching bolts.
- b. Remove strut.

To install strut:

- a. Line up holes in strut with upper and lower frame tabs. Lower end of strut goes on aft face of lower frame tab.
- b. Install NAS6604-3 attaching bolts wet with B270-1 sealant on shanks.

**CAUTION**

Verify threads are clean and dry.

Special torque per § 23-33. Install palnuts and standard torque per § 23-32 and torque stripe per Figure 2-1.

**4.300 Tailcone****A. Removal**

1. Pull associated circuit breakers for lights and antennas installed on tailcone.
2. Remove A706-1 fairing.
3. Cut and discard ty-raps as required and disconnect tailcone wiring at connectors. Disconnect antenna cables at forward bulkhead, as applicable.
4. Remove hardware securing tail rotor drive shaft assembly forward yoke to A947-2 (intermediate) plate assembly. Support drive shaft using a conspicuous foam block or equivalent, while drive shaft is disconnected from drive train.

**WARNING**

**A193 flex plates, which do not have bonded washers, are obsolete and must be replaced with A947 flex plates having bonded washers. If a bonded washer separates from an A947 flex plate, flex plate is unairworthy and cannot be repaired. Ensure A947-1 forward flex plate is Rev E or subsequent (identified by letter "E" or subsequent letter on two adjacent arms of flex plate).**

5. Remove hardware securing A121-17 push-pull tube to A331-1 intermediate bellcrank assembly.
6. Support tailcone and remove hardware securing tailcone to upper frame. Remove tailcone from helicopter.

4.300 Tailcone (continued)**B. Installation**

1. Inspect tailcone interior. Remove debris. At bulkheads, verify bushings prevent push-pull tube from contacting metal, and wiring is protected by grommets.
2. As required, install tail rotor drive shaft in tailcone assembly per § 7.320. Verify correct damper assembly orientation per Figure 7-11B.
3. As required, position A121-17 push-pull tube in tailcone assembly.
4. Position A023 tailcone assembly on upper frame assembly; do not pinch wiring between tailcone forward bulkhead and frame. Install hardware securing tailcone to frame, standard torque bolts & palnuts per § 23-32, and torque stripe per Figure 2-1.

**NOTE**

All R22 helicopters with upper frame A020-2 S/N 0002 thru 0399 are required to install A960-1 clamp and A961-1 strap assemblies per R22 Service Bulletin 26.

5. Install hardware securing A121-17 push-pull tube to A331-1 bellcrank assembly. Standard torque bolt & palnut per § 23-32 and torque stripe per Figure 2-1.

**WARNING**

**A193 flex plates, which do not have bonded washers, are obsolete and must be replaced with A947 flex plates having bonded washers. If a bonded washer separates from an A947 flex plate, then flex plate is unairworthy and cannot be repaired.**

6. Inspect flex plate per Figure 2-4B. Perform intermediate flex plate installation and shimming per § 7.330.
7. Measure tail rotor drive shaft runout per § 7.340.
8. Connect tailcone wiring at connectors, connect antenna cables at forward bulkhead, as applicable. Individually test and verify correct function of tail position light, strobe, and TR chip light circuits.
9. Refer to Figure 4-2D. Verify clearance between tailcone assembly and upper frame.

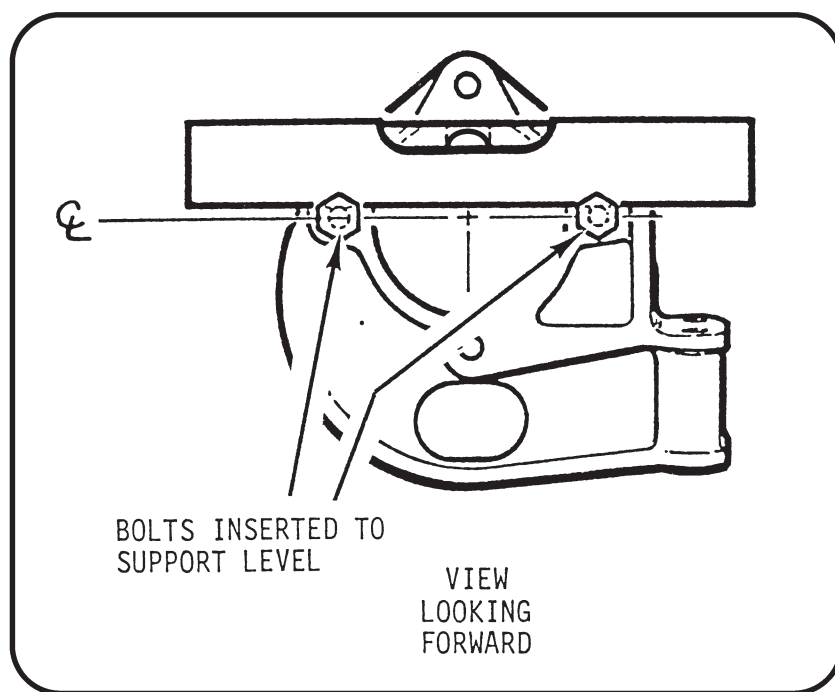


FIGURE 4-2A TAILCONE LATERAL LEVELING

### 4.310 Tailcone Replacement

#### **A. Tailcone Set-up**

1. Level helicopter longitudinally and laterally per § 18-10.
2. Verify tailcone part number is correct for helicopter model. Slide forward end of tailcone over upper steel tube frame and support aft end of tailcone with an adjustable stand.
3. Refer to Figure 4-2A. Insert two bolts into tailcone aft bulkhead left & right mounting holes and place level across bolts. Level tailcone laterally by rotating it on upper frame.
4. Refer to Figure 4-2B. Measure from left and right lower frame vertical strut-to-upper frame attach points to aft end of tailcone. Center tailcone laterally until left and right measurements are equal on both sides.
5. Refer to Figure 4-2C. Use a water level and measure the difference in vertical height between forward end of tailcone (at lowest point) and horizontal centerline (left & right bolt holes) of aft bulkhead's gearbox mounting surface. Using stand, adjust height of tailcone to  $16.21 \pm 0.20$  inches.
6. Refer to Figure 4-2D. Verify 0.010 inch minimum gap between upper frame tubes and tailcone forward edge (4 places). Place a straight edge across forward face of tailcone and verify 0.365 inch minimum between straight edge and mounting bolt shank inserted in frame boss (4 places). Push tailcone forward or pull aft as required to maintain dimensions.
7. Verify tailcone lateral leveling, lateral centering, & height are correct; adjust tailcone position as required per steps 3 thru 6. Drill tailcone per Part B.

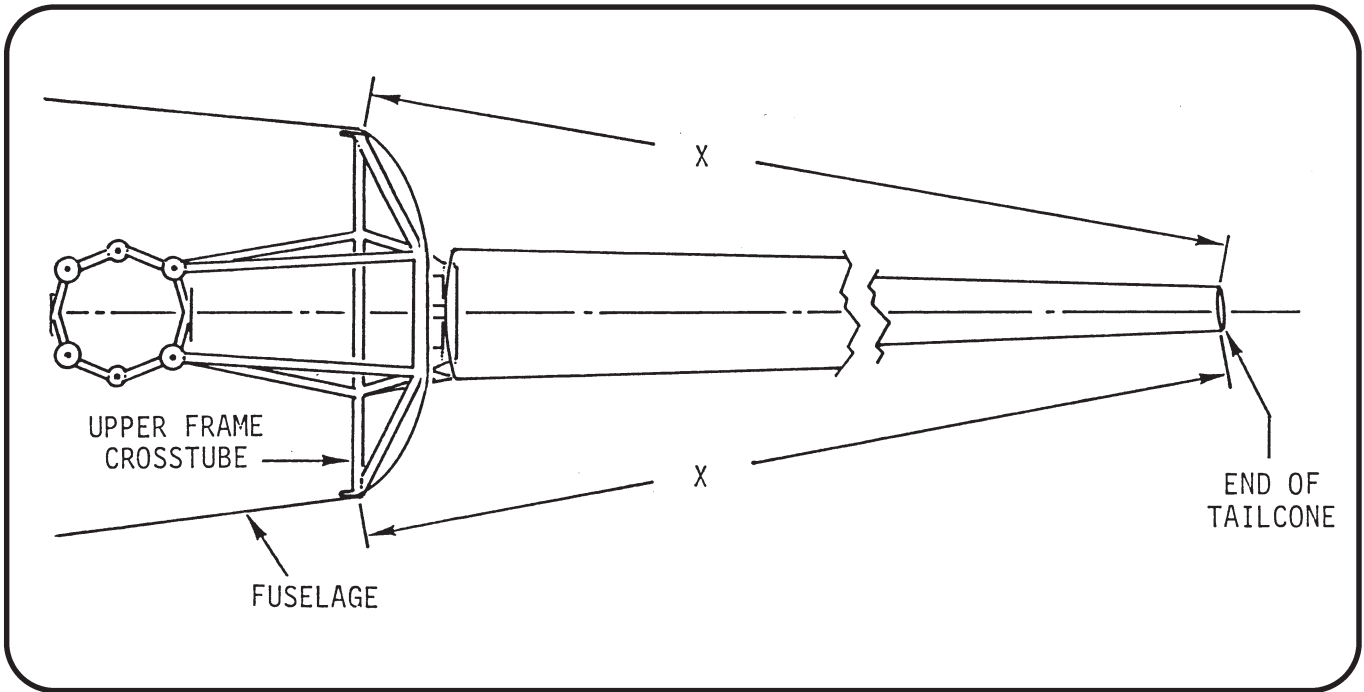


FIGURE 4-2B TAILCONE LATERAL CENTERING

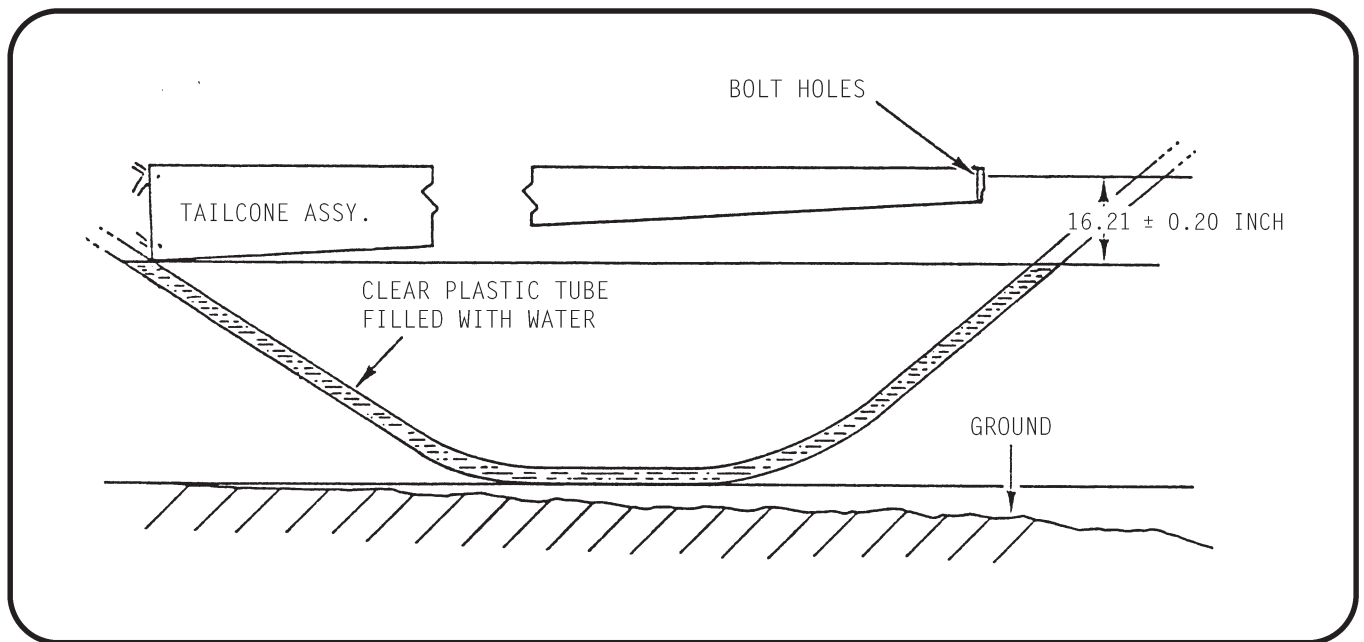
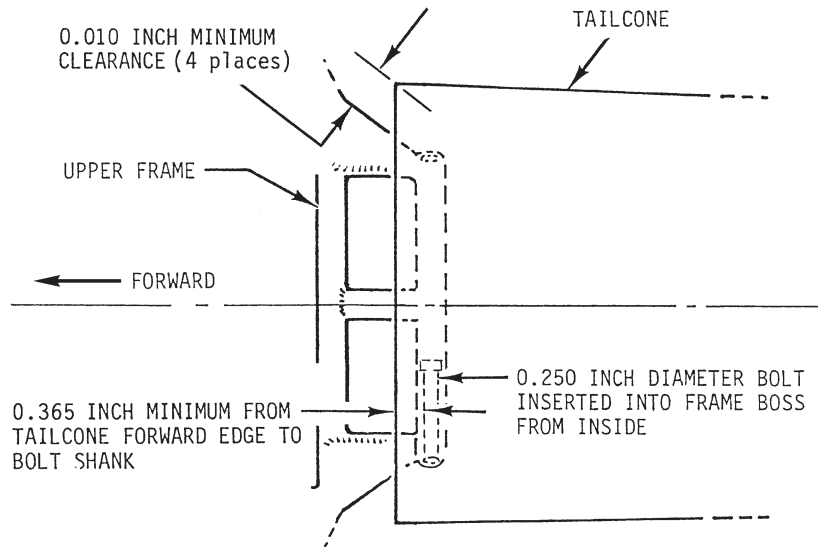


FIGURE 4-2C TAILCONE HORIZONTAL LEVELING

4.310 Tailcone Replacement (continued)**B. Tailcone Drilling****CAUTION**

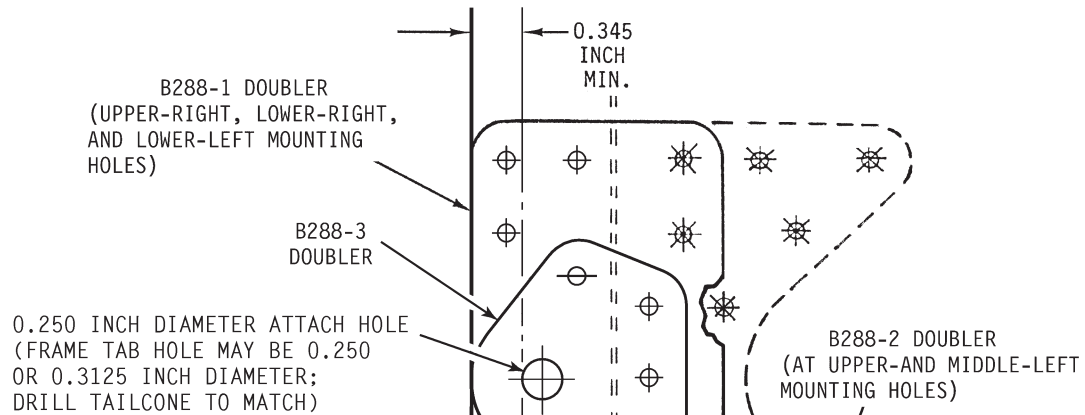
Protect drive belts from drilling debris.

1. Perform tailcone set-up per Part A.
2. Clamp tailcone at (3) mounting locations to prevent tailcone movement during drilling, do not clamp tailcone at frame tab on left side of tailcone.
3. Back drill from inside of tailcone mounting hole (without clamp) using a center drill with a 0.250 inch diameter shank, then use a 0.250 inch diameter twist drill. After drilling hole, secure tailcone to frame with appropriate fastener.
4. Remove (1) clamp from next mounting location and back drill hole per step 3, repeat process for each clamped mounting hole.
5. Match drill left-side frame tab thru tailcone. Protect steel tube frame behind tailcone skin using a piece of scrap metal before drilling.
6. Remove tailcone. Deburr drilled holes.
7. Refer to Figure 4-2E and accompanying "CAUTION" statement. Center B288-1 or -2 doublers over each tailcone mounting hole and flush with tailcone forward edge. Mark doublers from inside tailcone for drilling 0.250 inch diameter hole.
8. Refer to Figure 4-2E. Drill B288-1 or -2 doubler with a 0.250 inch diameter twist drill at spot marked in step 7. Deburr hole and secure doubler to tailcone with a NAS1304-3 bolt. Drill through existing pilot holes in doubler with a #30 drill bit and secure with clecos.
9. Remove each NAS1304-3 bolt. Install B288-3 doubler atop B288-1 or -2 doubler and secure with NAS1304-3 bolt. Drill through existing pilot holes with a #30 drill bit.
10. Remove doublers and deburr holes. Install doublers with clecos then rivet with MS20470AD4 rivets.
11. If B288-3 doubler protrudes past forward edge of tailcone skin, file doubler flush with forward edge of tailcone, as required.
12. Apply B270-1 sealant all around doublers and forward edge of tailcone skin and B070-1 bulkhead.
13. Apply zinc chromate or epoxy primer (ref. § 23-75) per § 23-60 to doublers. Apply topcoat to tailcone, as required.
14. Install tailcone per § 4.300 Part B.



**FIGURE 4-2D**

**VERIFYING MINIMUM EDGE DISTANCE**



**FIGURE 4-2E**

**TAILCONE ATTACH HOLE EDGE DISTANCE AND DOUBLER INSTALLATION**

**CAUTION**

POSITION DOUBLERS TO ENSURE MINIMUM 0.345 INCH DIMENSION SHOWN. RIVET HOLES MUST NOT PIERCE RADIUS OF B070-1 BULKHEAD.

- RIVET CODE:
- ⊖ MS20470AD4-5
  - ⊕ MS20470AD4-4.5
  - ⊗ MS20470AD4-4



4.320 Tailcone Repair

**NOTE**  
Doubler repair is only permissible in Bay 5.

1. Dent Bay 5 only – 0.100 inch to 0.250 inch deep, 0.060 inch or greater radius, not to exceed 5 inches long.

Above described dents may be repaired with 0.032 inch or 0.040 inch thick doubler of same material using rivets as follows:

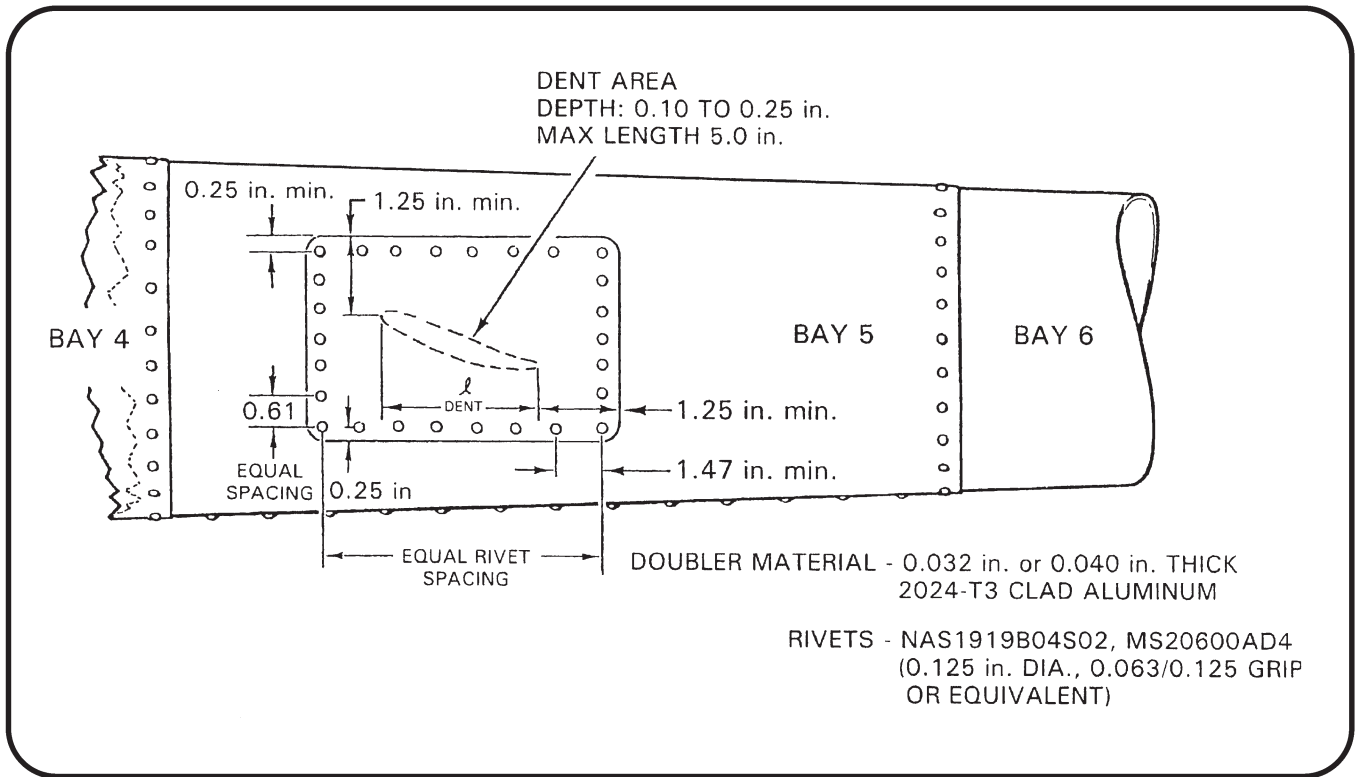


FIGURE 4-2F TAILCONE REPAIR LIMIT

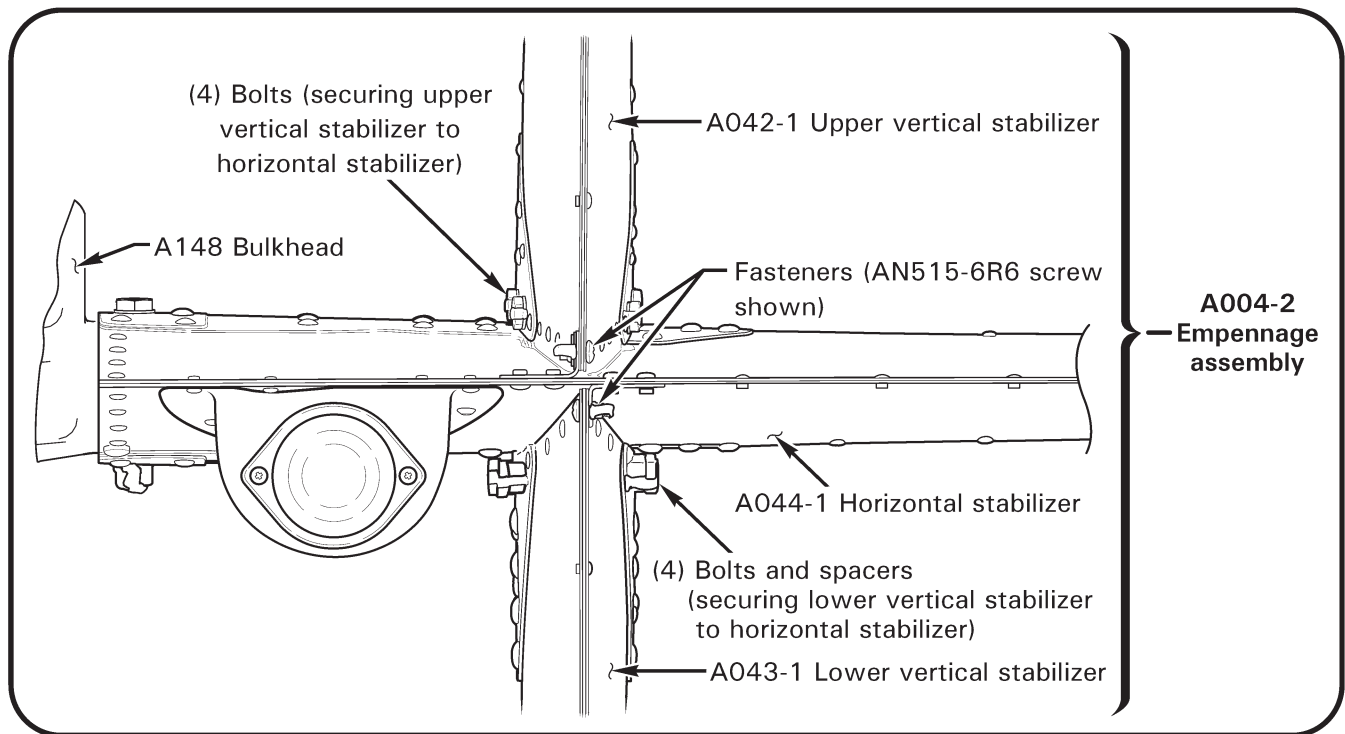


FIGURE 4-3 EMPENNAGE ASSEMBLY INSTALLATION

#### 4.400 Empennage Assembly

##### **A. Removal**

1. Remove hardware securing MS21919WDG2 clamp to A044-1 horizontal stabilizer. Cut and discard ty-raps securing position light and gearbox chip detector wires and connectors together. Disconnect position light at connectors.
2. Refer to Figure 4-3. Supporting empennage assembly, remove hardware securing empennage to tailcone assembly aft bulkhead, and remove empennage.

##### **B. Installation**

1. Refer to Figure 4-3. Position empennage assembly on tailcone assembly aft bulkhead. Install (2) NAS1304-28 bolts & associated hardware securing stabilizer to aft bulkhead. Standard torque bolts and palnuts per § 23-32 and torque stripe per Figure 2-1.
2. Connect position light wire connectors. Secure wires and install hardware securing MS21919WDG2 clamp to A044-1 horizontal stabilizer. Install MS3367-4-9 ty-raps as required to secure wires and connectors together. Cinch ty-raps until snug without over-tightening, and trim tips flush with heads.
3. Test and verify correct function of position and TR chip light circuits.

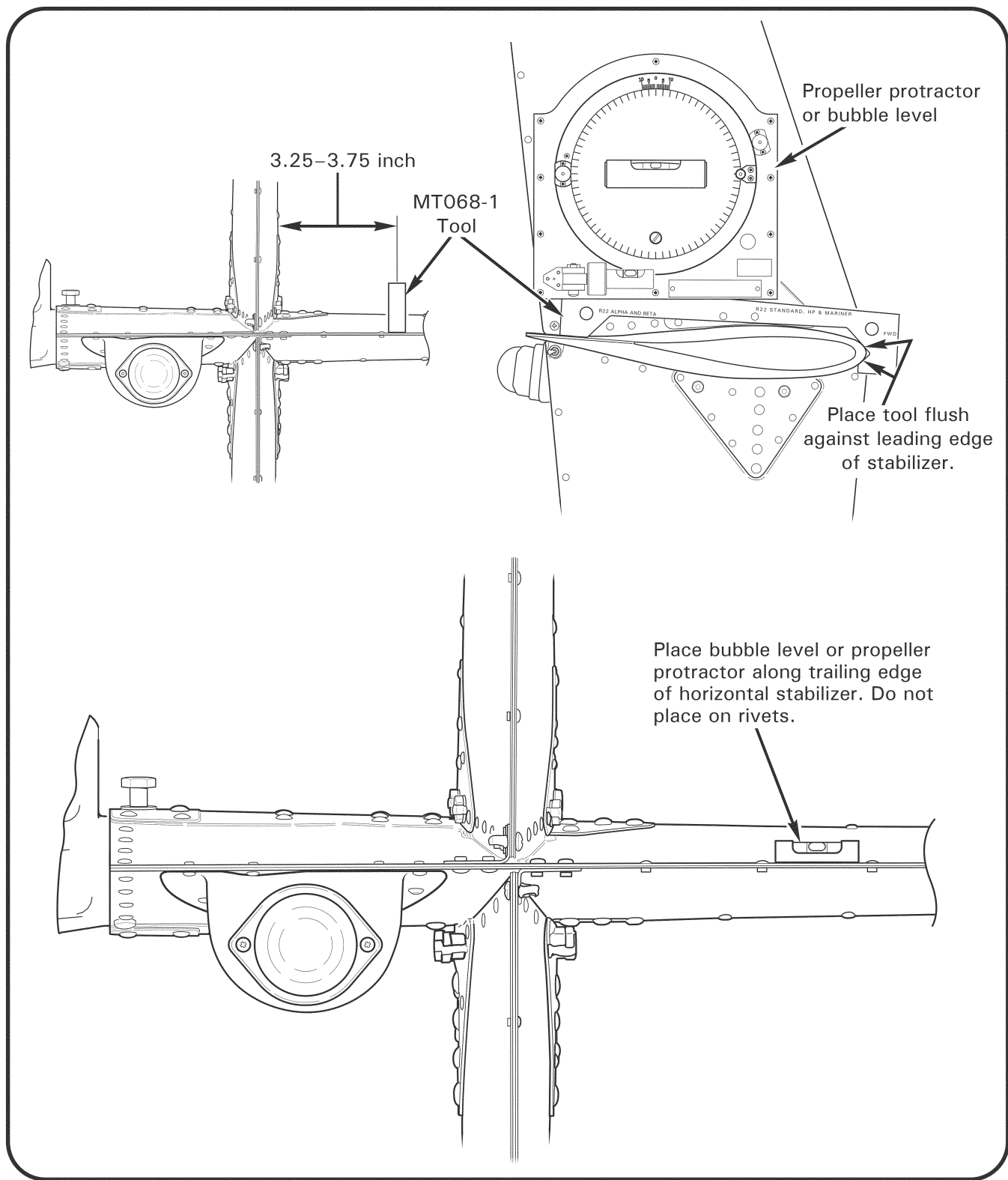


FIGURE 4-4 EMPENNAGE ASSEMBLY REPLACEMENT

4.400 Empennage Assembly (continued)**C. Replacement**

1. Level aircraft per § 18-10.
2. Refer to Figure 4-4. Position empennage assembly on tailcone aft bulkhead. Insert (2) NAS1304-28 bolts thru top mounting holes in A044-1 horizontal stabilizer.

**NOTE**

A large C-clamp and wooden blocks may be used between NAS1304 bolts to prevent empennage moving prior to drilling.

3. Place MT068-1 horizontal stabilizer rigging tool on top of horizontal stabilizer 3.25–3.75 inches from outboard edge of vertical stabilizer.
4. Place propeller protractor or bubble level atop MT068-1 tool forward flat surface if tailcone is A023-1 or -22 (Standard, HP, & Mariner helicopters), or aft flat surface if tailcone is A023-20 or -23 (Alpha & Beta helicopters).
5. Push forward or pull aft slightly on tail skid to adjust horizontal stabilizer angle of incidence until correct flat of MT068-1 tool is level with helicopter.
6. Place propeller protractor or bubble level along trailing edge of horizontal stabilizer. Push up or pull down slightly at outboard end of horizontal stabilizer as required to obtain  $0^\circ \pm 0.5^\circ$  level laterally.
7. Verify angle of incidence performed in step 5. Adjust stabilizer per steps 5 & 6 as required.
8. Remove aft bolt from empennage upper hole; drill thru stabilizer using 0.250 inch diameter drill bit. Temporarily secure stabilizer using NAS1304-28 bolt & D210-4 nut with washers in drilled hole.
9. Verify stabilizer angle of incidence and lateral level, adjust per steps 5 & 6 if required.
10. Remove forward bolt from empennage upper hole; drill thru stabilizer using 0.250 inch diameter drill bit.
11. Remove aft bolt and C-clamp (if used), and remove empennage from tailcone. Deburr holes and install empennage per Part B.

#### 4.410 Upper Vertical Stabilizer Assembly

##### **A. Removal**

1. Refer to Figure 4-3. Remove fastener securing A554 clip to A042-1 upper vertical stabilizer assembly.
2. Supporting A042-1 vertical stabilizer, remove bolts securing vertical stabilizer to A044-1 horizontal stabilizer and remove A042-1 vertical stabilizer.

##### **B. Installation**

1. Refer to Figure 4-3. Position A042-1 upper vertical stabilizer assembly on A044-1 horizontal stabilizer. Verify 0.030–0.120 inch gap between vertical stabilizer skin edges and horizontal stabilizer upper skin. File vertical stabilizer skin edge(s) as required. Conversion coat & prime bare aluminum edges per §§ 23-51 & 23-60.
2. Install bolts securing vertical stabilizer to horizontal stabilizer. Special torque bolts per § 23-33 and torque stripe per Figure 2-1.
3. If replacing vertical stabilizer, match drill clip to stabilizer using 0.144 inch diameter drill. Deburr holes as required, install fastener and torque stripe per Figure 2-1.

#### 4.420 Lower Vertical Stabilizer Assembly

##### **A. Removal**

1. Refer to Figure 4-3. Remove fastener securing A554 clip to A043-1 vertical stabilizer.
2. Supporting A043-1 vertical stabilizer, remove bolts & spacers securing vertical stabilizer to A044-1 horizontal stabilizer and remove A043-1 vertical stabilizer.

##### **B. Installation**

1. Refer to Figure 4-3. Position A043-1 lower vertical stabilizer assembly on A044-1 horizontal stabilizer. Verify 0.030–0.120 inch gap between vertical stabilizer skin edges and horizontal stabilizer lower skin. File vertical stabilizer skin edge(s) as required. Conversion coat & prime bare aluminum edges per §§ 23-51 & 23-60.
2. Install bolts & spacers securing vertical stabilizer to horizontal stabilizer. Special torque bolts per § 23-33 and torque stripe per Figure 2-1.
3. If replacing vertical stabilizer, match drill clip to stabilizer using 0.144 inch diameter drill. Deburr holes as required, install fastener and torque stripe per Figure 2-1.

#### 4.430 A044-1 Horizontal Stabilizer Assembly

##### **A. Removal**

1. Remove A042-1 & A043-1 vertical stabilizer assemblies per §§ 4.410 & 4.420.
2. Remove hardware securing MS21919WGD2 clamp to A044-1 horizontal stabilizer assembly. Cut and discard ty-raps securing position light and gearbox chip detector wires and connectors together. Disconnect position light at connectors.
3. Supporting horizontal stabilizer, remove hardware securing stabilizer to tailcone assembly aft bulkhead and remove stabilizer.
4. If replacing horizontal stabilizer, A554-1 clips may be reused. Drill out two rivets securing each clip to stabilizer and retain clips.

##### **B. Installation**

1. Position A044-1 horizontal stabilizer assembly on tailcone assembly aft bulkhead. Install (2) NAS1304-28 bolts & associated hardware securing stabilizer to aft bulkhead. Standard torque bolts and palnuts per § 23-32 and torque stripe per Figure 2-1.
2. Install A042-1 & A043-1 vertical stabilizer assemblies per §§ 4.410 & 4.420.
3. Connect position light at connectors. Install hardware securing clamp to stabilizer. Install MS3367-4-9 ty-raps as required to secure position light and gearbox chip detector wires and connectors together. Cinch ty-raps until snug without over-tightening, and trim tips flush with heads.
4. Test and verify correct function of position and TR chip light circuits.

##### **C. Replacement**

1. On a padded surface, install A042-1 & A043-1 vertical stabilizer assemblies on A044-1 horizontal stabilizer per §§ 4.410 & 4.420.
2. Refer to Figure 4-3. Position A554-1 clips on horizontal stabilizer, install fastener securing each clip to upper or lower vertical stabilizer. With upper and lower vertical stabilizers in-line, match drill clips to horizontal stabilizer using #30 drill. Deburr holes and install rivets securing clips to horizontal stabilizer. Reinstall fasteners and torque stripe per Figure 2-1.
3. Perform empennage replacement per § 4.400 Part C.

#### 4.500 Tail Skid

##### **A. Removal**

Remove hardware securing tail skid to A043-1 vertical stabilizer and remove skid.

##### **B. Installation**

Position tail skid in bottom of A043-1 vertical stabilizer. Install hardware securing skid. Standard torque bolts & palnuts per § 23-32 and torque stripe per Figure 2-1.



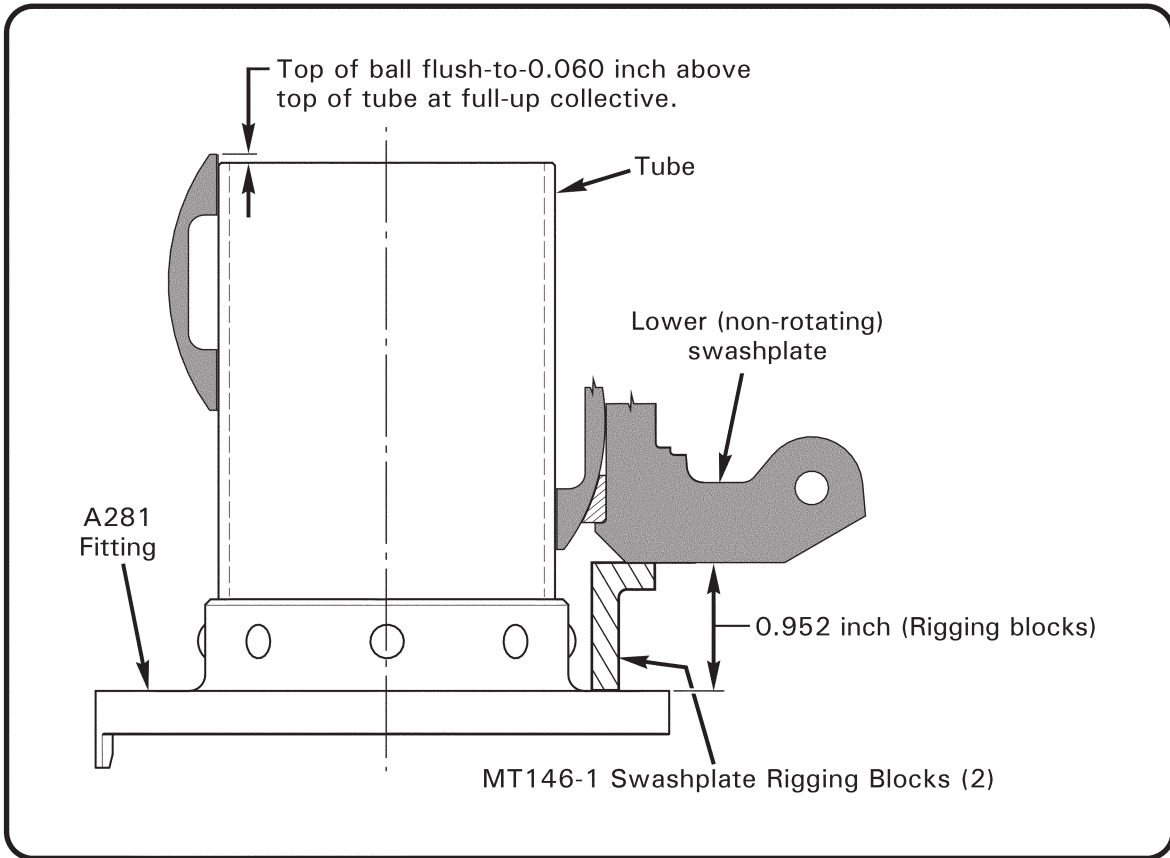


FIGURE 10-2 LOWER SWASHPLATE CLEARANCE

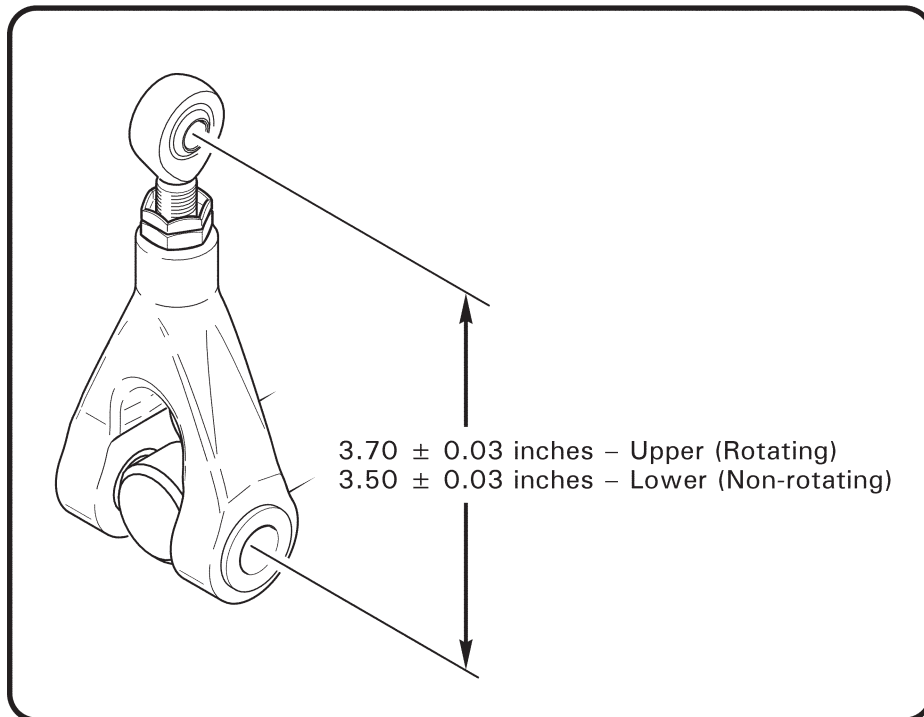


FIGURE 10-3 A205 (-9 SHOWN) DIMENSIONS FOR SWASHPLATE SCISSORS

10.120 Main Rotor**NOTE**

Refer to § 23-34 for push-pull tube rod end adjustment procedure.

The main rotor is rigged by determining average blade angle. Blade angle is measured at 37.75 inches inboard from blade tip (main rotor 0.75 radius).

Main rotor blade angles are measured using MT050-1 rigging fixture and a Kell-Strom KS113 propeller protractor or a comparable protractor (refer to Figure 10-4). Use following procedure to set up for rigging:

1. All main rotor flight control rod ends must meet Figure 2-1 radial play & axial play tolerance.
2. Rig swashplate per § 10.112.
3. Initially, adjust both pitch links to 6.82 inches length between rod end centers (final length is determined during autorotation rpm adjustment).
2. Verify A205 forks at swashplate are set to proper length per Figure 10-3. Lower fork assembly must be  $3.50 \pm 0.03$  inches center-to-center and upper fork assembly must be  $3.70 \pm 0.03$  inches center-to-center.
3. Level helicopter laterally and longitudinally via main rotor hub per § 18-12.
4. Place a tracking stick at end of one rotor blade and mark height of blade tip. Rotate rotor 180° and mark height of opposite blade tip. Teeter main rotor as necessary to obtain a main rotor track of  $\pm 1$  inch.
5. Using tape, conspicuously mark one MR blade tip. Place protractor atop MR hub parallel to teeter hinge bolt and facing tape-marked blade tip. Zero propeller protractor to main rotor hub.

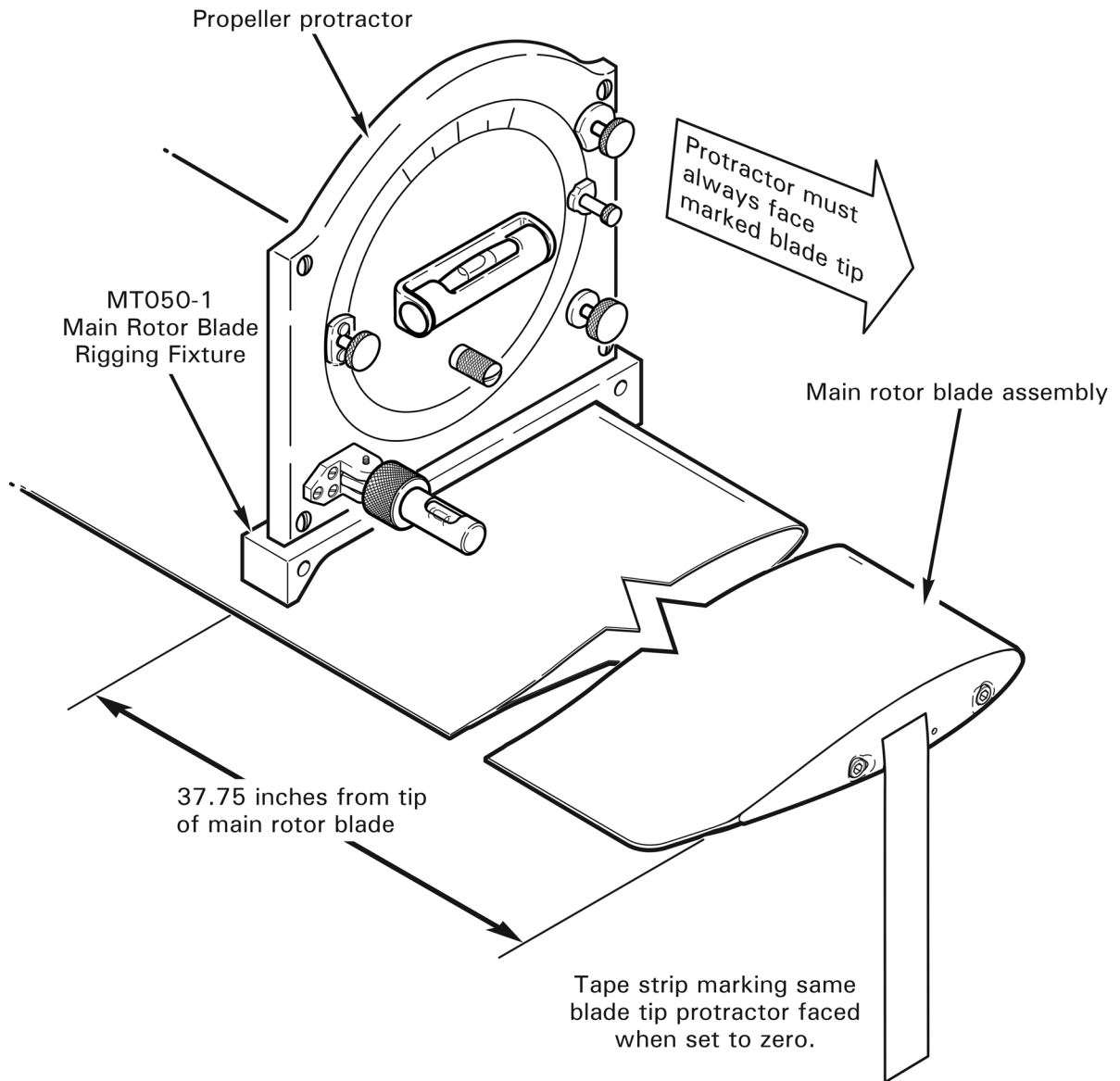
**NOTE**

When measuring blade angles, protractor face or dial must always face marked blade tip to avoid doubling of instrument error.

6. Measure in from tip of each main rotor blade 37.75 inches and temporarily mark one blade with red color and opposite blade with blue color

**WARNING**

**Use masking tape, grease pencil, or soft marker to mark rotor blades. Ball point pens or other sharp instruments can scratch blade skins, causing cracks and fatigue failure of blade.**



**FIGURE 10-4 MAIN ROTOR BLADE RIGGING**

10.121 Cyclic Travel Rigging

1. Refer to Figure 10-1. Place collective control full down. Place cyclic control in neutral position laterally and hold against forward stop.

**NOTE**  
Sand bags may be used to secure cyclic control against forward stop to ensure it will not move.

2. Rotate blades so pitch links are aligned with longitudinal axis of helicopter. Place tracking stick at tip of one blade for reference when rotating rotor.
3. Forward longitudinal cyclic:
  - a. Refer to Figure 10-4. Measure blade angles and record below. Rotate rotor 180° and record blade angles below. Adjust blade angles per step 3.b.

**BLUE BLADE**

**RED BLADE**

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

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

10.5°/11.0° required for R22 Alpha, Beta, and Mariner.  
 8.3°/8.8° required for R22 Standard and HP.

- b. Adjust aft A121-5 push-pull tube at swashplate (one full turn = 0.42°) or both forward A121-7 push-pull tubes at swashplate (both must be adjusted exact same amount), as required to obtain required blade angle averages.
4. Refer to Figure 10-1. Place cyclic control in neutral position laterally and hold against aft stop.

10.121 Cyclic Travel Rigging (continued)

5. Aft longitudinal cyclic:

- a. Refer to Figure 10-4. Measure blade angles and record below. Rotate rotor 180° and record blade angles below. Adjust blade angles per step 5.b.

**BLUE BLADE**

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

**RED BLADE**

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

8.5°/9.5° required.

- b. Adjust aft A121-5 push-pull tube at swashplate (one full turn = 0.42°) or both forward A121-7 push-pull tubes at swashplate (both must be adjusted exact same amount), as required.

**NOTE**

If adjustment is required to obtain aft cyclic control blade angles, forward cyclic must be rechecked.

- 6. Refer to Figure 10-1. Place cyclic control in neutral position longitudinally (mid-travel) and hold cyclic against left stop.
- 7. Rotate rotor until pitch links are aligned with lateral axis of helicopter. Place tracking stick at tip of one blade for reference when rotating rotor.
- 8. Left lateral cyclic:

- a. Refer to Figure 10-4. Measure blade angles and record below. Rotate rotor 180° and record blade angles below. Adjust blade angles per step 8.b.

**BLUE BLADE**

Pitch link right \_\_\_\_\_ °  
 Pitch link left + \_\_\_\_\_ °  
 = \_\_\_\_\_ °  
 ÷ 2 = \_\_\_\_\_ °

**RED BLADE**

Pitch link right \_\_\_\_\_ °  
 Pitch link left + \_\_\_\_\_ °  
 = \_\_\_\_\_ °  
 ÷ 2 = \_\_\_\_\_ °

9.0°/9.5° required.

- b. Adjust right or left (forward) A121-7 push-pull tube at swashplate (one full turn = 0.6°), as required.

10.121 Cyclic Travel Rigging (continued)

9. Refer to Figure 10-1. Place cyclic control in neutral position longitudinally (mid travel) and hold against right stop.

10. Right lateral cyclic:

a. Refer to Figure 10-4. Measure blade angles and record below. Rotate rotor 180° and record blade angles below. Adjust blade angles per step 10.b.

**BLUE BLADE**

**RED BLADE**

Pitch link right \_\_\_\_\_ °  
 Pitch link left + \_\_\_\_\_ °  
 = \_\_\_\_\_ °  
 ÷ 2 = \_\_\_\_\_ °

Pitch link right \_\_\_\_\_ °  
 Pitch link left + \_\_\_\_\_ °  
 = \_\_\_\_\_ °  
 ÷ 2 = \_\_\_\_\_ °

5.5°/6.0° required.

b. Adjust right or left (forward) A121-7 push-pull tube at swashplate (one full turn = 0.6°) as required.

**NOTE**

If adjustment is required to obtain right cyclic control blade angles, left cyclic must be rechecked.

11. Perform collective travel rigging per § 10.122.

10.122 Collective Travel Rigging

1. Rotate main rotor to align pitch links with longitudinal axis of helicopter. Place tracking stick at tip of one blade for reference when rotating rotor.
2. Refer to Figure 10-1. Place cyclic control in neutral position or install MT376-1 rigging blocks. Place collective control full down. Apply cyclic and collective friction.
3. Collective full down:
  - a. Refer to Figure 10-4. Measure blade angles and record below. Rotate rotor 180° and record blade angles below. Adjust blade angles per steps 3.b.

**BLUE BLADE**

Pitch link forward \_\_\_\_\_ °  
 Pitch link aft + \_\_\_\_\_ °  
 = \_\_\_\_\_ °  
 ÷ 2 = \_\_\_\_\_ °  
 2° ± 0.5° nose  
 up required.

**RED BLADE**

Pitch link forward \_\_\_\_\_ °  
 Pitch link aft + \_\_\_\_\_ °  
 = \_\_\_\_\_ °  
 ÷ 2 = \_\_\_\_\_ °  
 2° ± 0.5° nose  
 up required.

- b. Adjust pitch links so blue blade and red blade measurements are within 0.2° of each other when each blade pitch link is in forward position, and when each pitch link is in aft position.

**NOTE**  
 Final collective down blade angles are determined by autorotation RPM requirements per § 10.250.

4. Raise collective control to full up position. Apply collective friction.
5. Collective full up:
  - a. Refer to Figure 10-4. Measure blade angles and record below. Rotate rotor 180° and record blade angles below.

**BLUE BLADE**

Pitch link forward \_\_\_\_\_ °  
 Pitch link aft + \_\_\_\_\_ °  
 = \_\_\_\_\_ °  
 ÷ 2 = \_\_\_\_\_ °  
 14° ± 0.5° nose  
 up required.

**RED BLADE**

Pitch link forward \_\_\_\_\_ °  
 Pitch link aft + \_\_\_\_\_ °  
 = \_\_\_\_\_ °  
 ÷ 2 = \_\_\_\_\_ °  
 14° ± 0.5° nose  
 up required.

6. Verify top of swashplate ball is flush-to-0.060 inch above top of tube per Figure 10-2.
7. Perform track and balance per § 10.200.

### 10.130 Tail Rotor Flight Controls

**NOTE**

Refer to § 23-34 for push-pull tube rod end adjustment procedure.

### 10.131 Pedals

1. Refer to Figure 10-5. Insert a 3/16-inch diameter rigging pin (a long AN3 or NAS6603 bolt suffices) thru hole in right-side keel panel and rigging pin holes in A317-1 bellcrank.
2. Adjust A121-9 and -11 push-pull tubes as required to obtain a dimension of 2.90 ± 0.03 inches from each pedal to stops located on each side of forward console. Remove rigging pin (or bolt, as applicable).

### 10.132 A316-1 Bellcrank

1. Refer to Figure 10-5. Place left pedal against forward stop.
2. Adjust vertical A121-13 push-pull tube to obtain a minimum of 0.060 inch between A316-1 bellcrank arm and vertical firewall control tunnel.

### 10.133 A331-1 Bellcrank

Place right pedal against forward stop. Adjust horizontal A121-15 push-pull tube to obtain a minimum clearance of 0.100 inch between A331-1 bellcrank and actuator gearbox housing (See Figure 10-6).



**CHAPTER 23**

**STANDARD PRACTICES**

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### 23-42 Fluorescent Penetrant Inspection

This specification provides for surface inspection of parts fabricated from nonmagnetic materials to detect discontinuities open to the surface, such as cracks, cold shuts, laps, porosity and other surface defects.

Applicable requirements and limitations of ASTM E1417 shall apply. After inspection is complete, solvent clean parts.

The step-by-step procedure and equipment used to perform the inspection shall be accomplished per ASTM E1417. The following types, methods, and sensitivity levels are recommended:

Type: 1–Fluorescent dye  
Method: A–Water washable  
Sensitivity: Level 2–Medium  
Form: A–Dry powder

#### **A. Inspection Criteria**

Parts inspected by fluorescent penetrant method shall be accepted or rejected on basis of acceptance limits specified. If acceptance limits are not specified, rejectable surface defects and any of the following:

- Cracks
- Seams
- Cold shuts or laps
- Surface inclusions
- In castings, aligned discontinuous surface indications other than cracks, cold shuts and inclusions are rejectable if more than 3/8 inch in length.

### 23-50 Corrosion Control

#### 23-51 Conversion Coat – Aluminum

Use the following procedures to prepare and apply conversion coat to aluminum alloys. Conversion coat improves corrosion resistance and adherence of paint and adhesives.

#### **CAUTION**

Do not allow Bonderite C-IC 33 Aero or M-CR 1201/1132 Aero to contact bonded joints.

#### **A. Procedure**

1. Unless otherwise specified, lightly scuff clean surface with 320-grit aluminum-oxide abrasive paper to remove corrosion or other contaminants.
2. Apply Bonderite C-IC 33 Aero to surface for 2–5 minutes. DO NOT allow Bonderite C-IC 33 Aero to dry; re-apply as required.
3. Rinse thoroughly with clean, potable water.

23-51 Conversion Coat – Aluminum (continued)**A. Procedure (continued)**

4. Apply Bonderite M-CR 1201 Aero to surface for 2–5 minutes (should be light golden brown). DO NOT allow Bonderite M-CR 1201 Aero to dry; re-apply as required.
5. Rinse thoroughly with clean, potable water. Gently wipe with clean & dry cloth, blow dry, or allow to air dry.

**B. Felt Tip Applicator**

Apply Bonderite M-CR 1132 Aero per manufacturer’s recommendations.

23-60 Priming and Painting

This specification outlines preparation and application requirements for primers and topcoat. Primers provide corrosion protection and a final finish or a base for topcoat. Approved materials are listed in § 23-70.

Unless directed, do not prime or paint the following:

- Sliding friction joints.
- Stainless steel parts.
- Swivel joints and adjustable rod ends.
- Plastic, rubber, electrical components and wires or similar materials.
- Bolted joints where torque is a specific requirement for clamping action.
- Bearing press-fit, or close tolerance slip-fit, joints (except where wet primer is part of the assembly procedure).

**WARNING**

**Review appropriate Safety Data Sheet (SDS) when working in proximity to hazardous materials. Specific recommendations for use of personal protective equipment are located in the SDS.**

**A. Priming**

1. Preparing Aluminum (for Steel parts see step 2)

Unless otherwise specified, conversion coating per § 23-51 is standard treatment before priming aluminum. If bare aluminum is primed without conversion coating, the following procedure must be used:

- a. Alkaline clean if immersion is practical, otherwise wipe clean with an approved degreasing agent. Do not allow alkaline cleaner to contact bonded joints.
- b. Lightly scuff the surface with Scotch-Brite pads.
- c. Wipe with a tack rag to remove any foreign material or damp wipe with an approved solvent.
- d. Air dry. Do not touch parts with bare hands until primed.

23-60 Priming and Painting (continued)**A. Priming (continued)**

## 2. Preparing Steel (for Aluminum see step 1)

Alkaline clean is the preferred method for cleaning stainless steel. Alternately, stainless steel may be cleaned using an approved solvent. Do not allow alkaline cleaner to contact bonded joints.

Steel parts should only be cleaned using an approved solvent; using an alkaline cleaning process on steel may cause a corrosive reaction.

Where immersion is not practical or for extremely greasy or dirty parts, a preclean in a solvent vapor degreaser may be used.

Air or blow dry using filtered, dry, compressed air.

## 3. Application

Apply primer after mixing per manufacturer's recommendations. Primer coating is not to exceed 0.0005–0.0020 inch thickness per coat. For parts with internal openings, such as tubes, prime the inside as follows:

- a. Thin primer to watery consistency using required reducer.
- b. Pour in primer, slosh around, then drain immediately.
- c. Dry parts at least (6) hours before using.

## 4. Inspection

Inspect for complete coverage and excessive thickness. If primer is excessively thick, strip part and re-prime. Refer to § 23-70 for approved materials.

**NOTE**

Primed areas that have been sanded to bare metal must have conversion coating (if required) and primer re-applied prior to topcoat to restore anti-corrosion properties.

**B. Painting Topcoat**

Prior to liquid topcoat application, ensure surfaces have been cleaned and primed. In general, most parts will be cleaned and primed as detail parts. However, in some cases, such as the gearbox assembly, this is not practical and primer and topcoat are applied on the assembled component.

Previously primed surfaces, or primed surfaces that have completely cured require the following preparation before paint:

1. Lightly sand using 220-grit or finer aluminum-oxide abrasive paper.
2. Lightly scuff with Scotch Brite pads (optional).
3. Wipe with clean cloth and approved solvent.
4. Wipe with tack cloth.
5. Apply topcoat.

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**REVISION LOG**

**DEC 2023**

The R22 Maintenance Manual (MM) list of effective pages and effective dates are given below. If a previously issued page is not listed below, it is no longer an effective page and must be discarded. The issue or revision date is in bold at the top of each revision log page.

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| 4.11        | 5/22/87     | 6.ii        | NOV 2020    | 6.30        | APR 2007    |
| 4.12        | APR 2007    | 6.1         | OCT 2014    |             |             |
| 4.13        | 5/22/87     | 6.2         | OCT 2014    | 7.i         | OCT 2018    |
| 4.14        | 29 MAR 93   | 6.3         | APR 2007    | 7.ii        | OCT 2018    |
| 4.15        | DEC 2023    | 6.4         | APR 2007    | 7.1         | OCT 2014    |
| 4.16        | DEC 2023    | 6.5         | NOV 2020    | 7.2         | OCT 2014    |
| 4.17        | DEC 2023    | 6.6         | NOV 2020    | 7.3         | JUN 2006    |
| 4.18        | DEC 2023    | 6.7         | NOV 2020    | 7.4         | 5/22/87     |
| 4.19        | DEC 2023    | 6.8         | NOV 2020    | 7.5         | NOV 2020    |
| 4.20        | DEC 2023    | 6.9         | OCT 2018    | 7.6         | NOV 2020    |
| 4.21        | DEC 2023    | 6.10        | OCT 2018    | 7.7         | OCT 2018    |
| 4.22        | DEC 2023    | 6.11        | 26 JUL 96   | 7.8         | OCT 2018    |
| 4.23        | DEC 2023    | 6.12        | 30 JUN 99   | 7.9         | NOV 2020    |
| 4.24        | DEC 2023    | 6.13        | 19 SEP 97   | 7.9A        | NOV 2020    |



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| 7.9B        | 19 SEP 97   | 7.41        | 19 SEP 97   | 8.11        | 5/22/87     |
| 7.10        | JUN 2000    | 7.42        | 19 SEP 97   | 8.12        | 5/22/87     |
| 7.11        | 5/22/87     | 7.43        | 19 SEP 97   | 8.13        | 5/22/87     |
| 7.12        | 3 MAR 99    | 7.44        | 19 SEP 97   | 8.14        | 4/15/88     |
| 7.13        | 3 MAR 99    | 7.44A       | 4/15/88     | 8.15        | 5/22/87     |
| 7.14        | JUN 2000    | 7.44B       | 5 JUL 90    | 8.16        | 5/22/87     |
| 7.15        | OCT 2018    | 7.44C       | 26 JUL 96   | 8.17        | 5/22/87     |
| 7.16        | OCT 2018    | 7.44D       | 7 AUG 92    | 8.18        | 7 AUG 92    |
| 7.17        | APR 2005    | 7.45        | OCT 2018    | 8.19        | 12 JAN 90   |
| 7.18        | MAR 2004    | 7.46        | OCT 2018    | 8.20        | 12 JAN 90   |
| 7.19        | OCT 2018    | 7.47        | DEC 2022    | 8.21        | 5/22/87     |
| 7.20        | OCT 2018    | 7.48        | DEC 2022    | 8.22        | 5/22/87     |
| 7.21        | OCT 2018    | 7.48A       | NOV 2020    | 8.23        | 5/22/87     |
| 7.22        | OCT 2018    | 7.48B       | NOV 2020    | 8.24        | 5/22/87     |
| 7.23        | OCT 2018    | 7.49        | OCT 2018    | 8.25        | 5/22/87     |
| 7.24        | OCT 2018    | 7.50        | OCT 2018    | 8.26        | MAR 2004    |
| 7.25        | NOV 2020    | 7.51        | OCT 2018    | 8.27        | 26 JUL 96   |
| 7.26        | NOV 2020    | 7.52        | OCT 2018    | 8.28        | MAR 2004    |
| 7.27        | OCT 2018    | 7.53        | OCT 2018    | 8.29        | 5/22/87     |
| 7.28        | OCT 2018    | 7.54        | OCT 2018    | 8.30        | MAR 2004    |
| 7.29        | NOV 2020    | 7.55        | OCT 2018    | 8.31        | 19 SEP 97   |
| 7.29A       | NOV 2020    | 7.56        | OCT 2018    | 8.32        | 5 JUL 90    |
| 7.29B       | NOV 2020    | 7.57        | 31 JAN 89   | 8.33        | OCT 2018    |
| 7.30        | NOV 2020    |             |             | 8.34        | OCT 2018    |
| 7.31        | OCT 2018    | 8.i         | NOV 2020    | 8.34A       | NOV 2020    |
| 7.32        | OCT 2018    | 8.ii        | NOV 2020    | 8.34B       | NOV 2020    |
| 7.33        | NOV 2020    | 8.iii       | OCT 2014    | 8.34C       | MAR 2004    |
| 7.33A       | NOV 2020    | 8.iv        | OCT 2014    | 8.34D       | MAR 2004    |
| 7.33B       | MAR 2004    | 8.1         | OCT 2014    | 8.35        | 5/22/87     |
| 7.34        | 5/22/87     | 8.2         | OCT 2014    | 8.36        | 5/22/87     |
| 7.35        | 26 JUL 96   | 8.3         | 5/22/87     | 8.37        | JUN 2006    |
| 7.36        | MAR 2004    | 8.4         | 5/22/87     | 8.38        | JUN 2006    |
| 7.37        | 26 JUL 96   | 8.5         | 5/22/87     | 8.39        | OCT 2018    |
| 7.38        | 26 JUL 96   | 8.6         | 5/22/87     | 8.40        | OCT 2018    |
| 7.38A       | 26 JUL 96   | 8.7         | 5/22/87     | 8.41        | OCT 2018    |
| 7.38B       | 26 JUL 96   | 8.8         | 5/22/87     | 8.42        | OCT 2018    |
| 7.39        | 19 SEP 97   | 8.9         | 5/22/87     | 8.43        | OCT 2018    |
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| 8.45        | OCT 2018    | 10.11       | DEC 2023    | 10.37       | JAN 2005    |
| 8.46        | OCT 2018    | 10.12       | DEC 2023    | 10.38       | JAN 2005    |
| 8.47        | 19 SEP 97   | 10.13       | 5/22/87     | 10.39       | JAN 2005    |
| 8.48        | 26 JUL 96   | 10.14       | 5/22/87     | 10.40       | JAN 2005    |
| 8.49        | MAR 2004    | 10.15       | APR 2007    |             |             |
| 8.50        | 5/22/87     | 10.16       | APR 2007    | 11.i        | OCT 2018    |
| 8.51        | 5/22/87     | 10.17       | 5/22/87     | 11.ii       | OCT 2018    |
| 8.52        | 5/22/87     | 10.18       | 5/22/87     | 11.1        | OCT 2018    |
| 8.53        | 5/22/87     | 10.19       | 5/22/87     | 11.2        | OCT 2018    |
| 8.54        | 5/22/87     | 10.20       | MAR 2004    | 11.3        | OCT 2018    |
| 8.55        | JAN 2005    | 10.21       | OCT 2018    | 11.4        | OCT 2018    |
| 8.56        | JAN 2005    | 10.22       | OCT 2018    | 11.5        | OCT 2018    |
| 8.57        | 5/22/87     | 10.23       | 28 JUL 89   | 11.6        | OCT 2018    |
| 8.58        | 5/22/87     | 10.24       | 30 JUN 99   |             |             |
| 8.59        | JUN 2006    | 10.25       | 5/22/87     | 12.i        | OCT 2018    |
| 8.60        | JUN 2006    | 10.25A      | 28 JUL 89   | 12.ii       | OCT 2018    |
| 8.61        | 22 JAN 93   | 10.25B      | 28 JUL 89   | 12.1        | OCT 2018    |
| 8.62        | 22 JAN 93   | 10.26       | 28 JUL 89   | 12.2        | OCT 2018    |
| 8.63        | APR 2005    | 10.26A      | JUN 2006    | 12.3        | OCT 2014    |
| 8.64        | APR 2005    | 10.26B      | JUN 2006    | 12.4        | OCT 2014    |
|             |             | 10.27       | NOV 2020    | 12.5        | OCT 2014    |
| 9.i         | DEC 2022    | 10.28       | NOV 2020    | 12.6        | OCT 2014    |
| 9.ii        | DEC 2022    | 10.29       | NOV 2020    | 12.7        | OCT 2014    |
| 9.1         | DEC 2022    | 10.30       | NOV 2020    | 12.8        | OCT 2014    |
| 9.2         | DEC 2022    | 10.31       | NOV 2020    | 12.9        | OCT 2018    |
|             |             | 10.32       | NOV 2020    | 12.9A       | OCT 2018    |
| 10.i        | NOV 2020    | 10.32A      | NOV 2020    | 12.9B       | OCT 2018    |
| 10.ii       | NOV 2020    | 10.32B      | NOV 2020    | 12.10       | OCT 2018    |
| 10.1        | NOV 2020    | 10.32C      | NOV 2020    | 12.11       | OCT 2014    |
| 10.2        | NOV 2020    | 10.32D      | NOV 2020    | 12.12       | OCT 2014    |
| 10.3        | 5/22/87     | 10.32E      | NOV 2020    | 12.13       | NOV 2020    |
| 10.4        | 5/22/87     | 10.32F      | NOV 2020    | 12.14       | NOV 2020    |
| 10.5        | DEC 2023    | 10.32G      | NOV 2020    | 12.15       | OCT 2014    |
| 10.6        | DEC 2023    | 10.32H      | NOV 2020    | 12.16       | OCT 2014    |
| 10.7        | DEC 2023    | 10.33       | 5/22/87     | 12.17       | OCT 2014    |
| 10.8        | DEC 2023    | 10.34       | 5/22/87     | 12.18       | OCT 2014    |
| 10.9        | DEC 2023    | 10.35       | JAN 2005    |             |             |
| 10.10       | DEC 2023    | 10.36       | JAN 2005    | 13.i        | NOV 2020    |

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| 13.ii       | NOV 2020    | 14.17       | 12 JAN 90   | 14.26K      | MAR 2004    |
| 13.1        | OCT 2018    | 14.17A      | 12 JAN 90   | 14.26L      | MAR 2004    |
| 13.2        | OCT 2018    | 14.17B      | 12 JAN 90   | 14.27       | 5 JUL 90    |
| 13.3        | OCT 2018    | 14.17C      | 12 JAN 90   | 14.28       | 5/22/87     |
| 13.4        | OCT 2018    | 14.17D      | 12 JAN 90   | 14.28A      | 5 JUL 90    |
| 13.5        | OCT 2018    | 14.18       | 5/22/87     | 14.28B      | 5 JUL 90    |
| 13.6        | OCT 2018    | 14.18A      | 30 JUN 99   | 14.29       | 5/22/87     |
| 13.7        | NOV 2020    | 14.18B      | 30 JUN 99   | 14.30       | 5/22/87     |
| 13.8        | NOV 2020    | 14.19       | OCT 2018    | 14.31       | 5/22/87     |
| 13.9        | OCT 2018    | 14.20       | OCT 2018    | 14.32       | 5/22/87     |
| 13.10       | OCT 2018    | 14.20A      | OCT 2018    | 14.33       | 5/22/87     |
| 13.11       | OCT 2018    | 14.20B      | OCT 2018    | 14.34       | 5/22/87     |
| 13.12       | OCT 2018    | 14.21       | 30 JUN 99   | 14.35       | 5/22/87     |
| 13.13       | OCT 2018    | 14.21A      | 30 JUN 99   | 14.36       | 5/22/87     |
| 13.14       | OCT 2018    | 14.21B      | 30 JUN 99   | 14.37       | 5/22/87     |
| 13.15       | OCT 2018    | 14.22       | 5/22/87     | 14.38       | 5/22/87     |
| 13.16       | OCT 2018    | 14.23       | OCT 2018    | 14.39       | 28 JUL 89   |
| 13.17       | OCT 2018    | 14.23A      | OCT 2018    | 14.40       | 5/22/87     |
| 13.18       | OCT 2018    | 14.23B      | OCT 2018    | 14.40A      | JUN 2000    |
| 13.19       | OCT 2018    | 14.23C      | OCT 2018    | 14.40B      | JUN 2000    |
| 13.20       | OCT 2018    | 14.23D      | OCT 2018    | 14.40C      | JUN 2000    |
| 13.21       | NOV 2020    | 14.23E      | OCT 2018    | 14.40D      | JUN 2000    |
| 13.22       | NOV 2020    | 14.23F      | OCT 2018    | 14.41       | 9/25/87     |
| 13.23       | NOV 2020    | 14.23G      | OCT 2018    | 14.42       | 9/25/87     |
| 13.24       | NOV 2020    | 14.23H      | OCT 2018    | 14.43       | 5/22/87     |
|             |             | 14.24       | OCT 2018    | 14.44       | 5/22/87     |
| 14.i        | OCT 2018    | 14.25       | NOV 2020    | 14.45       | 5/22/87     |
| 14.ii       | OCT 2018    | 14.26       | NOV 2020    | 14.46       | 5/22/87     |
| 14.1        | OCT 2018    | 14.26A      | NOV 2020    | 14.47       | 5/22/87     |
| 14.2        | OCT 2018    | 14.26B      | NOV 2020    | 14.48       | 5/22/87     |
| 14.11B      | OCT 2018    | 14.26C      | NOV 2020    | 14.49       | 9/25/87     |
| 14.12       | OCT 2018    | 14.26D      | NOV 2020    | 14.50       | 5/22/87     |
| 14.13       | 5/22/87     | 14.26E      | JUN 2000    | 14.51       | 7 AUG 92    |
| 14.14       | 5/22/87     | 14.26F      | JUN 2000    | 14.52       | 5/22/87     |
| 14.15       | 5/22/87     | 14.26G      | JUN 2000    | 14.53       | 5/22/87     |
| 14.16       | 12 JAN 90   | 14.26H      | JUN 2000    | 14.54       | 4/22/87     |
| 14.16A      | 12 JAN 90   | 14.26I      | JUN 2000    | 14.55       | 5/22/87     |
| 14.16B      | 12 JAN 90   | 14.26J      | JUN 2000    | 14.56       | 5/22/87     |

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| 14.57       | 5/22/87     | 15.8        | NOV 2020    | 19.2        | OCT 2018    |
| 14.58       | 5/22/87     |             |             | 19.3        | OCT 2018    |
| 14.59       | 5/22/87     | 16.i        | OCT 2018    | 19.4        | OCT 2018    |
| 14.60       | 5/22/87     | 16.ii       | OCT 2018    | 19.5        | OCT 2018    |
| 14.61       | 5/22/87     | 16.1        | OCT 2018    | 19.6        | OCT 2018    |
| 14.62       | 5/22/87     | 16.2        | OCT 2018    | 19.7        | OCT 2018    |
| 14.63       | 5/22/87     | 16.3        | OCT 2018    | 19.8        | OCT 2018    |
| 14.64       | 19 SEP 97   | 16.4        | OCT 2018    |             |             |
| 14.65       | NOV 2020    | 16.5        | OCT 2018    | 20.i        | OCT 2018    |
| 14.65A      | NOV 2020    | 16.6        | OCT 2018    | 20.ii       | OCT 2018    |
| 14.65B      | NOV 2020    | 16.7        | OCT 2018    | 20.1        | OCT 2018    |
| 14.65C      | NOV 2020    | 16.8        | OCT 2018    | 20.2        | OCT 2018    |
| 14.66       | NOV 2020    |             |             | 20.3        | DEC 2022    |
| 14.66A      | NOV 2020    | 17.i        | OCT 2018    | 20.4        | DEC 2022    |
| 14.67       | OCT 2018    | 17.ii       | OCT 2018    |             |             |
| 14.68       | OCT 2018    | 17.1        | OCT 2018    | 21.i        | OCT 2018    |
| 14.69       | OCT 2018    | 17.2        | OCT 2018    | 21.ii       | OCT 2018    |
| 14.70       | OCT 2018    | 17.3        | OCT 2018    | 21.1        | OCT 2018    |
| 14.71       | OCT 2018    | 17.4        | OCT 2018    | 21.2        | OCT 2018    |
| 14.72       | OCT 2018    | 17.5        | OCT 2018    |             |             |
| 14.73       | NOV 2020    | 17.6        | OCT 2018    | 22.i        | OCT 2018    |
| 14.73A      | NOV 2020    |             |             | 22.ii       | OCT 2018    |
| 14.74       | NOV 2020    | 18.i        | OCT 2018    | 22.1        | NOV 2020    |
| 14.74A      | NOV 2020    | 18.ii       | OCT 2018    | 22.1A       | NOV 2020    |
| 14.75       | OCT 2018    | 18.1        | OCT 2018    | 22.1B       | NOV 2020    |
| 14.76       | OCT 2018    | 18.2        | OCT 2018    | 22.2        | NOV 2020    |
| 14.77       | OCT 2018    | 18.3        | NOV 2020    | 22.3        | NOV 2020    |
| 14.78       | OCT 2018    | 18.4        | NOV 2020    | 22.4        | NOV 2020    |
|             |             | 18.5        | OCT 2018    | 22.5        | NOV 2020    |
| 15.i        | OCT 2018    | 18.6        | OCT 2018    | 22.6        | NOV 2020    |
| 15.ii       | OCT 2018    | 18.7        | OCT 2018    | 22.7        | NOV 2020    |
| 15.1        | NOV 2020    | 18.8        | OCT 2018    | 22.8        | NOV 2020    |
| 15.2        | NOV 2020    | 18.9        | OCT 2018    | 22.9        | OCT 2018    |
| 15.3        | OCT 2018    | 18.10       | OCT 2018    | 22.10       | OCT 2018    |
| 15.4        | OCT 2018    |             |             | 22.11       | OCT 2018    |
| 15.5        | OCT 2018    | 19.i        | OCT 2018    | 22.12       | OCT 2018    |
| 15.6        | OCT 2018    | 19.ii       | OCT 2018    | 22.13       | OCT 2018    |
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|             |             | 23.36 ..... | NOV 2020    | 26.7 .....   | OCT 2018    |
| 23.i .....  | DEC 2023    | 23.37 ..... | NOV 2020    | 26.8 .....   | OCT 2018    |
| 23.ii ..... | DEC 2023    | 23.38 ..... | NOV 2020    | 26.9 .....   | OCT 2018    |
| 23.1 .....  | NOV 2020    | 23.39 ..... | NOV 2020    | 26.10 .....  | OCT 2018    |
| 23.2 .....  | NOV 2020    | 23.40 ..... | NOV 2020    | 26.11 .....  | NOV 2020    |
| 23.3 .....  | NOV 2020    | 23.41 ..... | NOV 2020    | 26.12 .....  | NOV 2020    |
| 23.4 .....  | NOV 2020    | 23.42 ..... | NOV 2020    | 26.13 .....  | OCT 2018    |
| 23.5 .....  | NOV 2020    | 23.43 ..... | NOV 2020    | 26.14 .....  | OCT 2018    |
| 23.6 .....  | NOV 2020    | 23.44 ..... | NOV 2020    | 26.15 .....  | OCT 2018    |
| 23.7 .....  | NOV 2020    |             |             | 26.16 .....  | OCT 2018    |
| 23.8 .....  | NOV 2020    | 24.i .....  | OCT 2018    | 26.17 .....  | OCT 2018    |
| 23.9 .....  | NOV 2020    | 24.ii ..... | OCT 2018    | 26.18 .....  | OCT 2018    |
| 23.10 ..... | NOV 2020    | 24.1 .....  | OCT 2018    | 26.19 .....  | NOV 2020    |
| 23.11 ..... | NOV 2020    | 24.2 .....  | OCT 2018    | 26.20 .....  | NOV 2020    |
| 23.12 ..... | NOV 2020    | 24.3 .....  | OCT 2018    | 26.21 .....  | OCT 2018    |
| 23.13 ..... | NOV 2020    | 24.4 .....  | OCT 2018    | 26.22 .....  | OCT 2018    |
| 23.14 ..... | NOV 2020    |             |             | 26.23 .....  | NOV 2020    |
| 23.15 ..... | NOV 2020    | 25.i .....  | NOV 2020    | 26.23A ..... | NOV 2020    |
| 23.16 ..... | NOV 2020    | 25.ii ..... | NOV 2020    | 26.23B ..... | NOV 2020    |
| 23.17 ..... | NOV 2020    | 25.1 .....  | NOV 2020    | 26.24 .....  | NOV 2020    |
| 23.18 ..... | NOV 2020    | 25.2 .....  | NOV 2020    | 26.25 .....  | OCT 2018    |
| 23.19 ..... | NOV 2020    | 25.3 .....  | NOV 2020    | 26.26 .....  | OCT 2018    |
| 23.20 ..... | NOV 2020    | 25.4 .....  | NOV 2020    | 26.27 .....  | OCT 2018    |
| 23.21 ..... | NOV 2020    | 25.5 .....  | NOV 2020    | 26.28 .....  | OCT 2018    |
| 23.22 ..... | NOV 2020    | 25.6 .....  | NOV 2020    | 26.29 .....  | OCT 2018    |
| 23.23 ..... | NOV 2020    | 25.7 .....  | NOV 2020    | 26.30 .....  | OCT 2018    |
| 23.24 ..... | NOV 2020    | 25.8 .....  | NOV 2020    | 26.31 .....  | NOV 2020    |
| 23.25 ..... | NOV 2020    | 25.9 .....  | NOV 2020    | 26.32 .....  | NOV 2020    |
| 23.26 ..... | NOV 2020    | 25.10 ..... | NOV 2020    | 26.33 .....  | NOV 2020    |
| 23.27 ..... | DEC 2023    |             |             | 26.34 .....  | NOV 2020    |
| 23.28 ..... | DEC 2023    | 26.i .....  | NOV 2020    | 26.35 .....  | NOV 2020    |
| 23.29 ..... | DEC 2023    | 26.ii ..... | NOV 2020    | 26.36 .....  | NOV 2020    |
| 23.30 ..... | DEC 2023    | 26.1 .....  | OCT 2018    |              |             |
| 23.31 ..... | NOV 2020    | 26.2 .....  | OCT 2018    | 27.i .....   | OCT 2018    |
| 23.32 ..... | NOV 2020    | 26.3 .....  | OCT 2018    | 27.ii .....  | OCT 2018    |
| 23.33 ..... | NOV 2020    | 26.4 .....  | OCT 2018    | 27.1 .....   | OCT 2018    |
| 23.34 ..... | NOV 2020    | 26.5 .....  | NOV 2020    | 27.2 .....   | OCT 2018    |
| 23.35 ..... | NOV 2020    | 26.6 .....  | NOV 2020    |              |             |

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| 28.i        | DEC 2022    | 32.i        | OCT 2018    | 33.32       | NOV 2020    |
| 28.ii       | DEC 2022    | 32.ii       | OCT 2018    |             |             |
| 28.1        | DEC 2022    | 32.1        | OCT 2018    | 34.i        | OCT 2018    |
| 28.2        | DEC 2022    | 32.2        | OCT 2018    | 34.ii       | OCT 2018    |
| 28.3        | DEC 2022    |             |             | 34.1        | OCT 2018    |
| 28.4        | DEC 2022    | 33.i        | NOV 2020    | 34.2        | OCT 2018    |
| 28.5        | DEC 2022    | 33.ii       | NOV 2020    | 34.3        | OCT 2018    |
| 28.6        | DEC 2022    | 33.1        | NOV 2020    | 34.4        | OCT 2018    |
| 28.7        | DEC 2022    | 33.2        | NOV 2020    | 34.5        | OCT 2018    |
| 28.8        | DEC 2022    | 33.3        | OCT 2018    | 34.6        | OCT 2018    |
| 28.9        | DEC 2022    | 33.4        | OCT 2018    | 34.7        | OCT 2018    |
| 28.10       | DEC 2022    | 33.5        | OCT 2018    | 34.8        | OCT 2018    |
| 28.11       | DEC 2022    | 33.6        | OCT 2018    | 34.9        | OCT 2018    |
| 28.12       | DEC 2022    | 33.7        | OCT 2018    | 34.10       | OCT 2018    |
| 28.13       | DEC 2022    | 33.8        | OCT 2018    |             |             |
| 28.14       | DEC 2022    | 33.9        | OCT 2018    | 35.i        | OCT 2018    |
| 28.15       | DEC 2022    | 33.10       | OCT 2018    | 35.ii       | OCT 2018    |
| 28.16       | DEC 2022    | 33.11       | OCT 2018    | 35.1        | OCT 2018    |
| 28.17       | DEC 2022    | 33.12       | OCT 2018    | 35.2        | OCT 2018    |
| 28.18       | DEC 2022    | 33.13       | OCT 2018    |             |             |
| 28.19       | DEC 2022    | 33.14       | OCT 2018    | 36.i        | OCT 2018    |
| 28.20       | DEC 2022    | 33.15       | OCT 2018    | 36.ii       | OCT 2018    |
|             |             | 33.16       | OCT 2018    | 36.1        | OCT 2018    |
| 29.i        | OCT 2018    | 33.17       | OCT 2018    | 36.2        | OCT 2018    |
| 29.ii       | OCT 2018    | 33.18       | OCT 2018    | 36.3        | OCT 2018    |
| 29.1        | OCT 2018    | 33.19       | OCT 2018    | 36.4        | OCT 2018    |
| 29.2        | OCT 2018    | 33.20       | OCT 2018    | 36.5        | OCT 2018    |
|             |             | 33.21       | OCT 2018    | 36.6        | OCT 2018    |
| 30.i        | OCT 2018    | 33.22       | OCT 2018    | 36.7        | OCT 2018    |
| 30.ii       | OCT 2018    | 33.23       | NOV 2020    | 36.8        | OCT 2018    |
| 30.1        | OCT 2018    | 33.24       | NOV 2020    | 36.9        | OCT 2018    |
| 30.2        | OCT 2018    | 33.25       | NOV 2020    | 36.10       | OCT 2018    |
|             |             | 33.26       | NOV 2020    |             |             |
| 31.i        | OCT 2018    | 33.27       | NOV 2020    | 37.i        | NOV 2020    |
| 31.ii       | OCT 2018    | 33.28       | NOV 2020    | 37.ii       | NOV 2020    |
| 31.1        | OCT 2018    | 33.29       | NOV 2020    | 37.1        | DEC 2023    |
| 31.2        | OCT 2018    | 33.30       | NOV 2020    | 37.2        | DEC 2023    |
|             |             | 33.31       | NOV 2020    | 37.3        | DEC 2023    |

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