CHAPTER 8 — MISCELLANEOUS PRACTICES

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MISCELLANEOUS PRACTICES

8-1. CLAMPING OF RIGID TUBES AND FLEXIBLE HOSES

Always install clamps (MS21919) in accordance with the procedure of the applicable manual, bulletin, or instruction. The paragraph 8-2 provides additional information to ensure correct installation of new clamps (MS21919) or troubleshooting an installation where evidence of chafing between the tubing and the structure occurred. Refer to the BHT-ELEC-SPM for electrical applications.

8-2. CLAMPING OF RIGID TUBES AND FLEXIBLE HOSES — GENERAL PRACTICES

1. Unless it is specified in the procedure of the applicable manual, bulletin, or instruction, make sure the appropriate materials were selected for the clamp (MS21919), as follows:

a. Material for the clamp band must be as follows, based on other clamps (MS21919) used in a similar environment and consistent with the application:

- Aluminum band (band code D)
- Corrosion Resistant Steel (CRES) band (band code C)

b. Material for the clamp cushion must be compatible with the operating environment:

- Nitrile cushions (yellow) are used for application in fuel immersion and fuel vapors. Not resistant to synthetic hydraulic fluids and not for use on titanium tubings.
- Chloroprene cushions (black) are used for general application in areas contaminated with petroleum-based hydraulic fluid (C-002) and occasional fuel splash. Not resistant to synthetic hydraulic fluids.
- Silicone cushions (white) are used for application at high temperature in areas contaminated with synthetic hydraulic fluid. Not resistant to petroleum-based hydraulic fluid (C-002).
- Fluorosilicone cushions (blue) are used for application at high temperature in areas contaminated with petroleum-based hydraulic fluid (C-002). Not resistant to synthetic hydraulic fluid. Ideal for extreme temperature conditions and exposure to fuel or oil.

c. The size of the clamp (MS21919) should provide a tight fit on the tube or hose without pinching. The clamp (MS21919) should not slide on the tube or hose when you apply a light axial pull.

2. Unless otherwise specified in the procedure of the applicable manual, bulletin, or instruction, the general practices for installation of clamps (MS21919) on rigid tubes and flexible hoses are as follows:

a. Based on the band material used for the clamp (MS21919), make sure the fasteners used are in accordance with the following:

(1) For aluminum clamp bands, use a screw (MS27039-1) of the appropriate length, a spacer (NAS43DD3) of the appropriate length if applicable, a nut (MS21042L3), and a washer (NAS1149D0332J) under the nut.

(2) For CRES clamp bands, use a screw (MS27039C1) of the appropriate length, a spacer (NAS43HT3) of the appropriate length if applicable, a nut (MS21042L3), and a washer (NAS1149C0332R) under the nut.

b. When the tubing runs horizontally, clamps (MS21919) are installed with the mounting holes above the loop to prevent the attachment legs from bending.

c. Clamps (MS21919) are installed with the rear attachment leg resting on the structure.

d. Clamps (MS21919) are installed so the rigid tube or flexible hose they support does not come in contact with the surrounding structure when subject to vibrations.

e. The last clamp (MS21919) on a flexible line must be loose enough to allow movement through full range of the equipment it connects to.

f. Clamps (MS21919) are installed with 24 inches (610 mm) or less of space between.

3. Whenever you do a major inspection in areas subject to a combination of dirt and lubricants, it is a good practice to examine rigid tubes and flexible hoses at areas covered by the clamps.

Attaching screws may be loosened or removed and clamps moved away to allow visual inspection of the rigid tubes or flexible hoses for fretting, corrosion, and mechanical damage.

8-3. CONTROL TUBE (ADJUSTABLE)

8-4. CONTROL TUBE (ADJUSTABLE) — THREAD PROTECTION

MATERIALS REQUIRED

Refer to Chapter 13 for specifications.

NUMBER	NOMENCLATURE
C-101	Corrosion Preventive Compound
C-104	Corrosion Preventive Compound

1. During assembly and adjustment procedures of adjustable control tubes, apply corrosion preventive compound (C-104) to the threads of the rod end.

2. After the adjustment of adjustable control tubes, apply corrosion preventive compound (C-101) to the rod end jam nuts and threads.

8-5. CONTROL TUBE (ADJUSTABLE) — ALIGNMENT

NOTE

Two different types of spherical bearings can be installed on adjustable control tubes. These are self-aligning and/or nonself-aligning bearings.

For control tubes that feature a spherical self-aligning bearing on each end, refer to step 1.

For control tubes that feature a spherical self-aligning bearing on one end and a spherical nonself-aligning bearing on the other end, refer to step 2.

1. Align the control tube between the two spherical self-aligning bearings as follows:

a. Loosen the locknut on the control tube.

b. Turn the control tube and the adjustable end in the same direction until both bottom out.

c. Tighten locknut.

d. Turn the control tube in both directions by hand, and make sure that each end bottoms out at the same time.

e. If one spherical self-aligning bearing has more travel and does not bottom out, loosen the locknut and reposition the adjustable end to provide equal clearance, in each direction, at the bearing having the extra travel. Tighten the locknut and do a check of the alignment again.

f. Move the controls through their full range of travel and make sure the control tube clevises have clearance at all positions.

2. Align the control tube between one spherical self-aligning bearing and one nonself-aligning bearing as follows:

a. Loosen the locknut on the control tube.

b. Position the control tube so the tangs of the clevis are parallel to the flat surface of the spherical self-aligning bearing retaining boss.

c. Tighten the locknut and do a check of the alignment again.

d. Move the controls through their full range of travel and make sure the control tube clevises have clearance at all positions.

8-6. DATA PLATES

MATERIALS REQUIRED

Refer to Chapter 13 for specifications.

NUMBER	NOMENCLATURE
C-305	Aliphatic Naphtha
C-309	MEK
C-317	Adhesive
C-423	Abrasive Cloth or Paper
C-486	Cheese Cloth

CAUTION

ALWAYS STAMP OR VIBROETCH THE DATA PLATE BEFORE BONDING ONTO THE COMPONENT. FAILURE TO DO SO MAY RESULT IN DAMAGE THE COMPONENT.

NOTE

Bell Helicopter does not supply blank data plates through spares.

If the data plate of a part/component is lost or a component is built up from serviceable detail parts, Bell Helicopter recommends that a new data plate be locally manufactured.

The data plate may be made as follows:

- Material: aluminum alloy T0 or T3
- Thickness: 0.025 or 0.032 inch (0.64 or 0.81 mm)
- or adhesive backed aluminum alloy foil

The part number to be vibroetched on the data plate must match the actual configuration of the part/component and the records on hand.

If an existing data plate was lost, you may reproduce the same serial number that appears on the component or the Historical Service Record (HSR).

NOTE

The serial number created is to be used in all of the helicopter records to provide maximum traceability for the life of the part or assembly.

If a “new” component is built up from spare or serviceable detail parts, you may assign a serial number of your choice.

After forming the data plate to the proper contour, bond the data plate on the component as follows:

1. Clean the back side of the data plate and the bonding surface on the component as follows:

a. Abrade lightly with a 400 grit abrasive cloth or paper (C-423).

b. Remove the residue with a clean cloth moistened with aliphatic naphtha (C-305).

NOTE

After cleaning, wear clean, dry gloves to prevent contamination of the parts.

The pot life of adhesive (C-317) is 30 to 50 minutes.

2. Apply a thin coat of adhesive (C-317) to the data plate and to the bonding surface on the component.

3. Place a 4-mil thread in the adhesive (C-317) on the data plate. Two pieces of thread positioned lengthwise on the data plate serve as a spacer and control bond line thickness.

4. Position the data plate on the component.

5. Use rubber bands to maintain a pressure of approximately 10 PSI (69 kPa) on the dataplate during the 24 hour cure period.

NOTE

Refer to Chapter 13 for accelerated cure temperature, time, and pressure data of adhesive (C-317).

6. Before the adhesive (C-317) cures, remove any excess of adhesive (C-317) outside the bonding area with a clean cheesecloth (C-486) moistened with MEK (C-309).

8-7. DE-ICING, ANTI-ICING, AND SNOW REMOVAL

WARNING

DO NOT START OR OPERATE THE HELICOPTER UNTIL YOU HAVE COMPLETED APPROPRIATE DE-ICING, ANTI-ICING, AND SNOW REMOVAL. OPERATING A HELICOPTER WITH CONTAMINATION ON THE SURFACES MAY RESULT IN REDUCED FLIGHT CONTROLABILITY AND CAUSE DEATH OR SERIOUS INJURIES TO PERSONS.

NOTE

Refer to the applicable Flight Manual (FM) for operating limitations under snow or icing conditions.

The purpose of the following section is to provide recommended guidelines for the de-icing, anti-icing, and snow removal of the helicopter. You may refer to the FAA Advisory Circular AC 120-60B, to your local regulatory requirements, or your internal procedures, as applicable, for the appropriate practices.

It is difficult to make an accurate estimate of the amount of time or Holdover Time (HOT) the de-icing/anti-icing fluid will prevent the formation of frost and ice, and accumulation of snow on the helicopter. Fluid quantity, Outside Air Temperature (OAT), precipitation rate, wind speed, and other factors affect the HOT. Table 8-1 provides an approximate HOT for different weather conditions.

8-8. DE-ICING, ANTI-ICING, AND SNOW REMOVAL — SNOW REMOVAL

SPECIAL TOOLS REQUIRED

NUMBER	NOMENCLATURE
Commercial	Soft Bristle Broom or Brush

CAUTION

DO NOT REMOVE SNOW WITH OTHER TOOLS THAN THOSE SPECIFIED. HARD BRISTLE BROOMS OR BRUSHES MAY CAUSE DAMAGE TO SURFACES OF THE HELICOPTER.

1. Remove all deposits of snow from the helicopter with a broom or brush. Make sure snow is removed from the following areas, as applicable:

- Exterior surfaces
- Antennas
- Pitot tubes and static ports
- Engine air inlets, particle separators, and exhausts
- Main and tail rotor blades and controls
- Exposed flight controls
- Drain and vent ports
- Landing gear bays and doors
- Inside cowlings and fairings
- Cabin and cockpit air ventilation inlets

2. If strong wind and blowing snow conditions occurred, pay special attention to inside areas of all cowlings and fairings of the fuselage and the tailboom for snow deposits.

3. Refer to procedures for de-icing (paragraph 8-9) or anti-icing (paragraph 8-10), as applicable.

8-9. DE-ICING, ANTI-ICING, AND SNOW REMOVAL — DE-ICING

SPECIAL TOOLS REQUIRED

NUMBER	NOMENCLATURE
Commercial	Spray Equipment

MATERIALS REQUIRED

Refer to Chapter 13 for specifications.

NUMBER	NOMENCLATURE
C-394	De-icing/Anti-icing Fluid

WARNING

DE-ICING/ANTI-ICING FLUID (C-394) IS POISONOUS. WEAR EYE AND SKIN PROTECTION. DO NOT PUT IN MOUTH AND AVOID BREATHING THE FLUID VAPORS. EXPOSURE TO HIGH CONCENTRATIONS OR INGESTION OF HIGH DOSES CAN BE HARMFUL OR FATAL TO PERSONS. GET EMERGENCY TREATMENT IN CASE OF IRRITATIONS.

NOTE

Using the approved de-icing/anti-icing fluid (C-394) and the following procedure will not damage elastomeric parts.

a. Remove snow from the helicopter (paragraph 8-8).

NOTE

For removal of light icing, a solution with 40% in volume of de-icing/anti-icing fluid (C-394) may be used.

b. Mix a solution of 50% by volume of de-icing/anti-icing fluid (C-394) and 50% of water.

CAUTION

DO NOT APPLY A HOT (180°F(82°C)) SOLUTION OF DE-ICING/ANTI-ICING FLUID (C-394) TO COLD ACRYLIC WINDOWS. THE RESULTING THERMAL SHOCK MAY CAUSE CRAZING OF THE WINDOW. USE FLUID AT OR NEAR 70°F (21°C).

NOTE

The de-icing/anti-icing fluid (C-394) may produce an unacceptable glare for the pilot on the windshield. It is recommended to remove a thin layer of frost with hot water 90 to 100°F (32 to 38°C) instead, providing the Outside Air Temperature (OAT) is not too low.

c. Heat solution to 180°F (82°C) for most efficient and effective ice removal.

CAUTION

DO NOT SPRAY DILUTED OR NON-DILUTED DE-ICING/ANTI-ICING FLUID (C-394) IN THE ENGINE AIR INLETS. IF FLUID ENTERS THE ENGINE AIR INLETS, DO A COMPRESSOR WASH.

d. Spray the diluted solution of de-icing/anti-icing fluid (C-394) to the helicopter with suitable spray equipment as follows:

(1) Start spraying from top to bottom of the helicopter and finish with the critical surfaces (main rotor blades, tail rotor blades, flight controls, horizontal stabilizer, and vertical fin).

(2) Apply a course stream to loosen and remove the ice.

(3) Avoid spraying in the direction of wind.

NOTE

Refer to Table 8-1 for the approximate Holdover Times (HOT).

e. Before you start the helicopter, do a visual inspection of all helicopter surfaces for evidence of ice and snow contamination.

f. After landing, remove the de-icing/anti-icing fluid (C-394) from the helicopter as soon as practical (paragraph 8-11).

8-10. DE-ICING, ANTI-ICING, AND SNOW REMOVAL — ANTI-ICING

SPECIAL TOOLS REQUIRED

NUMBER	NOMENCLATURE
Commercial	Spray Equipment

MATERIALS REQUIRED

Refer to Chapter 13 for specifications.

NUMBER	NOMENCLATURE
C-394	De-icing/Anti-icing Fluid

WARNING

DE-ICING/ANTI-ICING FLUID (C-394) IS POISONOUS. WEAR EYE AND SKIN PROTECTION. DO NOT PUT IN MOUTH AND AVOID BREATHING THE FLUID VAPORS. EXPOSURE TO HIGH CONCENTRATIONS OR INGESTION OF HIGH DOSES CAN BE HARMFUL OR FATAL TO PERSONS. GET EMERGENCY TREATMENT IN CASE OF IRRITATIONS.

CAUTION

DO NOT SPRAY DILUTED OR NON-DILUTED DE-ICING/ANTI-ICING FLUID (C-394) IN THE ENGINE AIR INLETS. IF FLUID ENTERS THE ENGINE AIR INLETS, DO A COMPRESSOR WASH.

NOTE

Using the approved de-icing/anti-icing fluid (C-394) and the following procedure will not damage elastomeric parts.

The non-diluted de-icing/anti-icing fluid (C-394) will freeze at approximately -25°F (-32°C). Some ice or slush may form at or below -25° F (-32°C).

Refer to paragraph 8-9 for instructions on de-icing/anti-icing fluid (C-394) application.

a. Spray or wipe non-diluted de-icing/anti-icing fluid (C-394) on the helicopter to prevent ice and frost from sticking.

NOTE

Refer to Table 8-1 for the approximate Holdover Times (HOT).

b. Before you start the helicopter, do a visual inspection of all helicopter surfaces for evidence of ice and snow contamination.

c. After landing, remove the de-icing/anti-icing fluid (C-394) from the helicopter as soon as practical (paragraph 8-11).

8-11. DE-ICING, ANTI-ICING, AND SNOW REMOVAL — FLUID REMOVAL

MATERIALS REQUIRED

Refer to Chapter 13 for specifications.

NUMBER	NOMENCLATURE
C-355	Detergent

1. Remove the de-icing/anti-icing fluid and residue from the helicopter as follows:

a. Clean the helicopter with freshwater or with a solution of detergent (C-355) and water. Rinse the solution of detergent (C-355) with freshwater.

Table 8-1. Approximate Holdover Times (HOT) for De-icing/Anti-icing Fluid

OAT △1	APPROXIMATE HOT VS. WEATHER CONDITIONS (MINUTES)			
	FROST	FREEZING FOG	LIGHT SNOW △2	MODERATE SNOW △2
>27°F (>-3°C)	45	11 to 17	11 to 16	6 to 11
27 to 21°F (-3 to -6°C)	45	8 to 14	8 to 13	5 to 8
20 to 14°F (-7 to -10°C)	45	6 to 10	6 to 10	4 to 6
<14°F (<-10°C)	45	5 to 9	4 to 6	2 to 4

NOTES:

No HOT exist for heavy snow, snow pellets, ice pellets, moderate and heavy freezing rain, hail.

HOT is reduced in heavy weather conditions (precipitation rate, wind speed, etc.) or when the helicopter skin temperature is lower than the OAT.

The de-icing/anti-icing fluid (C-394) is not intended for and does not provide anti-ice protection during flight. Refer to the applicable Flight Manual (FM) for operating limitations under snow or icing conditions.

△1 Outside Air Temperature (OAT).

△2 To use these Holdover Times (HOT), heat the de-icing/anti-icing fluid (C-394) to a minimum of 140°F (60°C) and apply 2 gallons per 100 square-foot (1 L/m²) of diluted fluid.

8-12. ELASTOMERIC (RUBBER) PARTS

The parts defined as elastomeric are those made of elastomer (ex. packings, O-rings) or those that feature an elastomeric element (ex. seals, hose assemblies).

For the most part, elastomers are synthetic rubbers, with elastic properties used for the sealing of components after installation.

Elastomers are also age sensitive materials or materials subject to deterioration when exposed to environmental factors like oxygen, sunlight, heat, etc.

The following paragraphs provide both required and recommended procedures to follow for correct use of packings or O-rings, seals, seal assemblies, and hose assemblies before and during installation on a component.

8-13. ELASTOMERIC (RUBBER) PARTS — GENERAL PRACTICES

MATERIALS REQUIRED

Refer to Chapter 13 for specifications.

NUMBER	NOMENCLATURE
C-001 ⚠1	Grease
C-002	Hydraulic Fluid
C-003	Turbine Fuel
C-008	Petrolatum
C-024	Assembly Fluid
C-030	Lubricating Oil
C-355	Detergent
C-428	Caps and/or Plugs
C-516	Low-lint Cleaning Cloth

NOTE:

⚠1 Mobilgrease 28 is preferred.

CAUTION

ALWAYS INSTALL NEW PACKINGS OR O-RINGS. FAILURE TO DO SO MAY RESULT IN EQUIPMENT LEAKAGE AND EARLY FAILURE.

NOTE

After installation, packings or O-rings are no longer age controlled.

1. Follow the precautions provided hereafter when you install a new preformed packing, or O-ring:

a. Never use a packing more than once. Make sure you discard the packing after removal from a component and use a new packing at installation.

b. Always examine the new packing for signs of cuts, nicks, manufacturing defects, or twists before installation.

c. Never expose a packing to solvent. This can cause deterioration or hardening of the packing and result in leakage.

d. To install a preformed packing in the groove of an outer or inner diameter, always stretch or collapse the packing, as applicable. Never twist the preformed packing during installation. To prevent a twist in the packing, never roll a preformed packing into a groove. A twist in the packing will reduce its cross section area and causes leakage.

e. Never substitute a preformed packing. A preformed packing can look the same but can be made of a different material that is not compatible with the fluid used in the system or component.

NOTE

Refer to the applicable Flight Manual (FM) for approved fuels and system lubricants.

f. Lubrication of packings must be as follows, unless otherwise specified in the procedure of the applicable manual, bulletin, or instruction:

(1) Always use an assembly fluid (C-024) to lubricate a packing. Exceptions are:

(a) For packings operating in contact with hydraulic fluid, lubricate with hydraulic fluid (C-002) or petrolatum (C-008).

(b) For packings operating in contact with fuel, lubricate with turbine fuel (C-003).

(2) If assembly fluid (C-024) is not available or specified, use the applicable system lubricant as an alternate (ex. lubricating oil (C-030)).

2. Follow the precautions provided hereafter when you remove and install (elastomeric) seals and seal assemblies:

a. Only touch the outer surface of a seal.

b. Never expose a seal to solvent. This can cause deterioration or hardening of the sealing surfaces and result in leakage.

c. If applicable, always keep the protective cup installed on the sealing surfaces, until installation in the next assembly.

d. Always examine the sealing surfaces of a new seal for signs of cuts, nicks, or manufacturing defects before installation.

NOTE

Refer to applicable manual, bulletin or instruction for the brand of grease (C-001) to apply.

e. Lubricate single and double lip seals with grease (C-001). Unless stated otherwise, Mobil 28 is preferred.

3. If necessary, clean (elastomeric) seals as follows:

a. Wipe the sealing surfaces of the seal lightly with a clean low-lint cleaning cloth (C-516) to remove contaminated oil and/or grease.

b. Clean the seal with a detergent (C-355) and water.

c. Rinse the seal with water and dry with a clean low-lint cleaning cloth (C-516).

4. Always put protective caps and/or plugs (C-428) on the open ends of hose assemblies when removed from the helicopter.

8-14. ELASTOMERIC (RUBBER) PARTS — GUIDELINES FOR STORAGE

MATERIALS REQUIRED

Refer to Chapter 13 for specifications.

NUMBER	NOMENCLATURE
C-427	Barrier Material

NOTE

The purpose of the following section is to provide recommendations for the storage of elastomeric parts. You may refer to the latest revision of the SAE specification ARP5316 and AS1933, or to your personal judgment/experience, for the appropriate practices.

Uninstalled (stored) packings or O-rings, hose assemblies, seal assemblies, and seals are age controlled.

1. Follow the precautions provided hereafter for the storage of elastomeric parts:

a. Each elastomeric part should be individually stored in the original heat-sealed envelope or an equivalent that uses barrier material (C-427).

NOTE

If the cure date of an elastomeric part cannot be identified, discard the part.

b. Each envelope should show the cure date (i.e. date of manufacture) of the elastomeric part.

NOTE

If the storage temperature is less than 59°F (15°C), the temperature of an elastomeric part should be raised to 68°F (20°C) before installation on the component.

c. Storage temperature should be 59 to 100°F (15 to 38°C) and humidity not to exceed 75%, or 65% if polyurethanes are being stored.

d. For hose assemblies, the storage temperature must not exceed 125°F (52°C).

e. Stock rotation of elastomeric parts should comply with the First In First Out (FIFO) principle.

f. During storage or when you handle packings, make sure of the following:

(1) Never expose elastomeric parts to direct sources of heat (radiator) or light (sunlight).

(2) Do not let elastomeric parts make contact with liquids or liquid vapors (fuel, oil, grease, solvents, etc.), unless otherwise specified.

(3) Avoid contact between elastomeric parts made of different elastomers, contact with metals (copper, iron, etc.), and contact with adhesive tapes.

(4) Avoid incorrect stacking of elastomeric parts, i.e. compression and/or flattening under heavy

loads and creases could occur when forced against corners and edges of storage containers.

8-15. ELASTOMERIC (RUBBER) PARTS — GUIDELINES FOR DETERMINATION OF THE USEFUL AGE

NOTE

The purpose of the following section is to provide recommendations to determine the useful age of elastomeric parts. You may refer to the latest revision of the SAE specification ARP5316 and AS1933, or to your personal judgment/experience, for the appropriate practices.

The useful age of elastomeric parts is considered the maximum amount of time, from the cure date (date of manufacture) to the date the part is installed in components.

Within the useful age, the elastomeric part is expected to retain its characteristics as originally specified. Examine the part for damage and signs of aging, and discard the part as required, if any of the following conditions occur:

- The age is in question and the part is not yet installed on a component.
- The cure date cannot be identified.
- The heat-sealed envelope used for storage is not correctly sealed or is damaged.

NOTE

After installation in component, elastomeric parts, including packings, O-rings, seals, seal assemblies and hose assemblies, are no longer age controlled.

Please, refer to the latest revision of SAE specification ARP5316, for applicability of the following recommended age to the material specification of the elastomers. SAE specifications may be obtained from:

IHS Inc.
15 Inverness Way East
Englewood, Colorado 80112
http://www.ihs.com

Technical Support:
1-800-447-3352 (USA/Canada)
1-303-397-2295 (Worldwide)
1-303-397-2599 (Fax)
custsvc@ihs.com

Telemarketing:
U.S. and International Phone Number
1-800-525-7052

Using the latest revision of SAE specification ARP5316, the useful age of uninstalled (stored) packings or O-rings, seals, seal assemblies, and hose assemblies (AS1933) is based on the cure date and should not exceed one of the following recommended age limits:

1. Packings (O-rings), seals, and seal assemblies:

From the cure date of the packing to the date of installation on a component, and depending on the type of material, the useful age should not exceed one of the following:

- 12 Quarters (or 3 years)
- 20 Quarters (or 5 years)
- 60 Quarters (or 15 years)
- Unlimited (i.e. on-condition)

2. Hose assemblies:

With reference to AS1933, bulk hose, from the cure date of the bulk hose to the time of installation into hose assemblies, components, accessories, engines or helicopters should not exceed 32 quarters (8 years).

3. Hose assemblies are not preferred to be stored for an extended period of time. Elastomers may take a compression set. If the date of assembly of an unfilled, stored hose assembly is more than one quarter (3 months), before installation or a periodic pressure test, the following is recommended:

NOTE

Refer to the applicable Flight Manual (FM) for approved system fluids.

a. Fill the hose assembly with the applicable system fluid for 24 hours before installation and any pressurization.

8-16. ELECTRIC ARC ETCHING — UNAUTHORIZED PROCEDURE

The electric arc (pencil marking) etching of the components is not authorized for the reasons that follow:

1. Electric arc is a high temperature source.

2. Electric arc blasts away surface metal and causes a notch.

3. Heating causes three zones of weakness:

- Cast zone
- Re-hardened zone
- Tempered zone

4. In service, the notched metal under high residual tensile strength is prone to cracking. Cracks grow in the re-hardened brittle metal below the surface and cause failure of the component.

8-17. GEARS

8-18. GEARS — SPLINE AND TEETH WEAR MEASURING PINS

1. Measuring pins of different diameters are required to examine wear of gear teeth and spline during components and parts overhaul.

Each kit (Table 8-2) includes sets of pins, one set for each size of pin required. Each set of pins is stored in a labeled plastic container and all of the sets are stored in a single container designed to accommodate, protect, and identify each set.

Table 8-2 provides the different sizes of pins required for each model of helicopter and included in each kit.

Diameter of pins has a tolerance of 0 inch to 40 microinches (1.016 µm). Length is not critical.

Figure 8-1 shows the correct position for the pair of measuring pins when measuring the spline/teeth wear of internal and external gears.

2. Measuring pins are procurable as follows:

NOTE

Make sure to specify the kit designation letter and helicopter model when you order (Table 8-2).

a. To order kits, US operators may contact the following:

Machinists Tools and Supplies
1000 Quaker St.,
Dallas, Texas, 75207

b. To order kits, foreign operators may contact the following:

Bell Helicopter Textron, Inc.
Customer Support and Service
Spare Parts Department
P.O. Box 482
Fort Worth, Texas 76101-0482
1-817-280-2919
1-817-280-2551

NOTE

Each set has two pins and the pins are of the same length and diameter.

c. Sets of two pins can also be purchased separately. Make sure to specify the pin length and diameter for each set you may want to order.

8-19. GEARS — WEAR PATTERN CHECK

MATERIALS REQUIRED

Refer to Chapter 13 for specifications.

NUMBER	NOMENCLATURE
C-028	Dry Film Lubricant

1. Spray three gear teeth, approximately 120° apart, with dry film lubricant (C-028).

2. Assemble the component only to the extent necessary to rotate the gear.

3. Manually operate the component.

4. Disassemble as required and examine the wear pattern of the gear teeth.

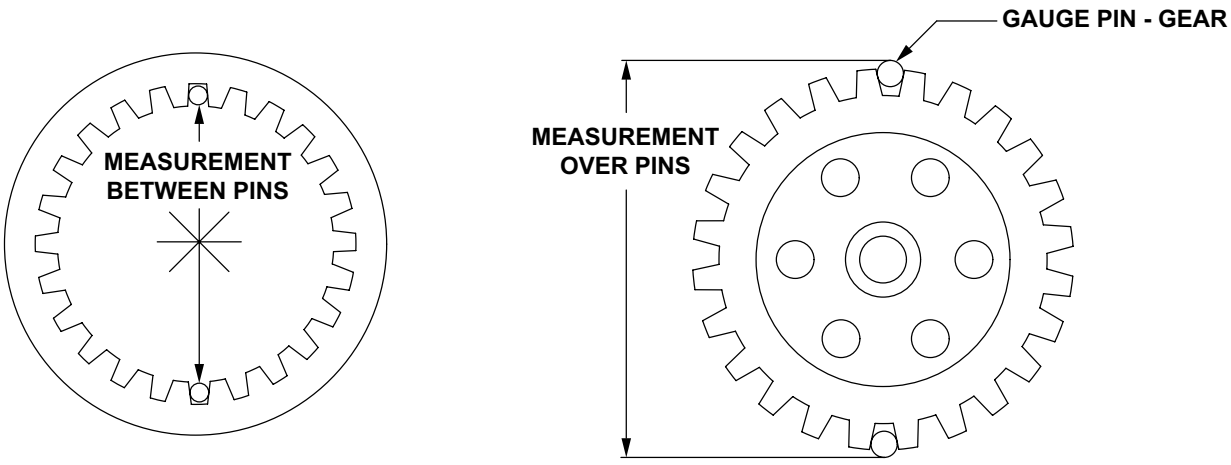

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Figure 8-1. Gears — Methods for Spline and Teeth Wear Measurement

Table 8-2. Gears — Measuring Pins Versus Helicopter Models and Kit Designation Letters

MEASURING PINS		47	206	204 205 212	47 206	47/206 204/205 212	407	427	429
LENGTH (INCH)	DIAMETER (INCH)	KIT A	KIT B	KIT C	KIT D	KIT E	–	–	–
1	0.0240						X	X	X
1	0.0360								X
1	0.0432								X
1	0.0450	X	X	X	X	X			
1	0.0480								X
1	0.0540		X		X	X	X	X	X
1	0.0600		X	X	X	X	X	X	X
1	0.0710			X		X			
1	0.0720			X		X			
1	0.0800						X		X
1	0.0864							X	X
1	0.0900			X		X			
1	0.0960		X	X	X	X	X		X
1	0.1080		X	X	X	X	X	X	X
1	0.1200		X	X	X	X	X	X	X
1	0.1309			X		X			
1/4	0.1440		X	X	X	X	X	X	X
1	0.1440	X	X	X	X	X	X	X	X
1	0.1440	⚠1						X	X
1/4	0.1600		X	X	X	X	X	X	X
1	0.1600	X	X		X	X	X	X	X
1	0.1680	X		X	X	X			
1/4	0.1728		X		X	X	X	X	X
1	0.1728	X	X	X	X	X	X	X	X
1	0.1800						X	X	

Table 8-2. Gears — Measuring Pins Versus Helicopter Models and Kit Designation Letters (Cont)

MEASURING PINS		47	206	204 205 212	47 206	47/206 204/205 212	407	427	429
LENGTH (INCH)	DIAMETER (INCH)	KIT A	KIT B	KIT C	KIT D	KIT E	–	–	–
1	0.1920	X	X	X	X	X	X	X	X
1	0.2057		X		X	X		X	X
1	0.2065	X			X	X			
1	0.2160		X	X	X	X			
1	0.2400	X			X	X			
1	0.2880	X			X	X			
1	0.3000	X							

NOTES:

There is no kit available for the 407, 427, and 429 models. Sets of pins can only be purchased individually.

⚠1 Flattened pins.

8-20. GREASE

8-21. GREASE — CHANGING TYPES OR BRANDS

NOTE

Refer to the procedure of the applicable manual, bulletin, or instruction to make sure the correct grease type or brand is used for the specific component.

MIL-PRF-81322 grease (C-001) is recommended for use in all applications which previously used MIL-G-25537 bearing grease (C-007).

Intermixing of greases is prohibited. When you change from one grease to the other, purge until previous grease is depleted. Be careful the same way when you switch brands of grease as when you switch types of grease.

8-22. GREASE — STORAGE LIFE

1. Grease, 204-040-755-005 lubricant (tube pack) (C-015) has a shelf storage life of 4 years, whether stored in the original container or in a component. If a component is not put into service before expiration of the 4 year shelf life of the grease, the component must be purged and lubricated before installation on the helicopter.

After initial operation of the component on the helicopter, refer to the appropriate lubrication chart for lubrication intervals.

2. Before installation of bearings, lubricated with MIL-G-25013 lubricant (C-026) or MIL-PRF-81322 grease (C-001), do the following:

a. Clean the bearings (Chapter 5).

b. Examine the bearings for corrosion.

c. Lubricate again the bearings with the applicable grease (C-001) or lubricant (C-026).

Components with bearings installed must be purged and lubricated before installation on the helicopter.

After initial operation of the component on the helicopter, refer to the appropriate lubrication chart for lubrication intervals.

8-22A. GREASE FITTING — INSPECTION

Prior to and following grease lubrication, visually examine grease fittings for presence of the spring loaded steel ball. If the steel ball is not visible, does not spring back to the closed position, the grease fitting indicates excessive leakage, or it is difficult to inject grease during lubrication, replace the grease fitting. Refer to paragraph 8-22B for replacement of NAS516 type grease fittings.

If the grease fitting is removed due to the spring loaded steel ball not being visible, insert a small steel probe into the back of the grease fitting to confirm the presence of the steel ball. If it is identified that the steel ball is not present in the grease fitting, further investigation is required to ensure that the steel ball has not migrated into the component and caused damage. Discard grease fittings that have been removed.

8-22B. GREASE FITTING (NAS516) — REPLACEMENT

MATERIALS REQUIRED

Refer to BHT-ALL-SPM for specifications.

NUMBER	NOMENCLATURE
C-204	Epoxy Polyamide Primer
C-304	Drycleaning Solvent
C-516	Clean Cloth

1. If required, disassemble the component to the extent necessary for repair using the instructions provided in the applicable manual.

CAUTION

DO NOT EXCEED THE MAXIMUM ALLOWABLE TEMPERATURE WHEN YOU HEAT A PART OR DAMAGE TO THE PART MAY OCCUR. DO NOT EXCEED 2 HOURS AT THE MAXIMUM SPECIFIED TEMPERATURE.

NOTE

Refer to Table 8-19 for information on material versus maximum temperature. If you are unsure of the material of the part, contact Product Support Engineering.

2. Ensuring not to exceed the specified maximum allowable temperature for the material of the part (Table 8-19), heat the part adjacent to the grease fitting.

CAUTION

ACCESS TO SOME GREASE FITTINGS IS LIMITED DUE TO INSTALLATION IN A COUNTERBORED AREA. DO NOT DAMAGE THE PART OR THE BORE FOR THE GREASE FITTING DURING REMOVAL OF THE GREASE FITTING. DAMAGE TO THE PART MAY REQUIRE REPAIR OR REPLACEMENT.

NOTE

If required, return the part to Bell Helicopter Textron (BHT) for evaluation and possible installation of replacement grease fitting.

Refer to General Information Letter (IL) GEN-04-98 for the applicable shipping information and to obtain a Return Material Authorization (RMA) number.

3. Pull the grease fitting out of the part with a small self-tapping screw and pliers. As an alternate means, good quality pliers may be used to grasp and pull the fitting from the part. Discard the grease fitting.

4. Make sure the bore of the part, for the grease fitting, is not obstructed or damaged.

5. Clean the mating surfaces of the bore and the grease fitting with drycleaning solvent (C-304) and a clean cloth (C-516).

CAUTION

MAKE SURE THE TEMPERATURE OF THE PART DOES NOT EXCEED 265°F (129°C) WHEN WET INSTALLING GREASE FITTING WITH PRIMER. EXCEEDING THE TEMPERATURE LIMIT CAN DAMAGE THE CHARACTERISTICS AND THE CURE OF THE PRIMER.

6. Wet install a new grease fitting in the part with epoxy polyamide primer (C-204) while the area is still heated. Press or use a soft material punch and lightly tap the grease fitting into position.

7. Make sure the grease fitting is tight in the part and functions properly by injecting specified grease.

8. If required, reassemble component using the instructions provided in the applicable manual.

9. Lubricate the part or component per the applicable servicing instructions.

8-23. PLACARDS AND MARKINGS

The requirements and procedures given in paragraph 8-24 concern the application of pressure-sensitive (adhesive-backed) decals to internal and external surfaces of helicopters.

8-24. APPLICATION OF DECALS

MATERIALS REQUIRED

Refer to Chapter 13 for specifications.

NUMBER	NOMENCLATURE
C-233	Polyurethane Enamel
C-305	Aliphatic Naphtha
C-306	Toluene
C-349	Edge Sealer
C-385	Isopropyl Alcohol
C-426	Masking Tape
C-516	Low-lint Cleaning Cloth

NOTE

Bonding surfaces must be nonporous.

1. Remove dirt, grease, wax, or other contaminants from the surfaces to be bonded as follows:

a. For non-metallic and painted surfaces, clean with a clean cloth moistened with aliphatic naphtha (C-305). Dry the surfaces with a clean low-lint cleaning cloth (C-516) before the aliphatic naphtha (C-305) evaporates.

CAUTION

DO NOT ALLOW TOLUENE TO MAKE CONTACT WITH PAINTED OR NON-METALLIC SURFACES OR DAMAGE TO THE SURFACE MAY OCCUR.

b. For bare metal surfaces, clean with a clean cloth moistened with toluene (C-306). Dry the surfaces with a clean low-lint cleaning cloth (C-516) before the toluene (C-306) evaporates.

2. Apply the pressure-sensitive (adhesive-backed) decal to the bonding surface as follows:

a. Apply the decal at temperatures above 60°F (16°C) for best results. Otherwise, first apply solvent (refer to the manufacturer's instructions) or isopropyl alcohol (C-385) to the decal.

b. Remove the adhesive protection from one edge of the decal with a quick smooth movement.

c. Carefully align the decal in the correct position.

d. Put the peeled edge of the decal on the edge of the bonding surface and apply a firm pressure with your finger along the same edge.

NOTE

For application of large decals, use a plastic squeegee with a firm pressure.

e. While you continue to remove the adhesive protection, apply finger pressure to the remaining part of the decal until the entire decal is applied. For best result, hold the opposite edge away from the surface until the entire decal is applied.

f. Make sure there is no air bubbles trapped under the decal. Otherwise, make a hole in the bubble with a pin and press with your finger or a squeegee to remove the air.

3. Edge seal or fully coat the decal with the applicable coating as follows:

a. Apply masking tape (C-426) 1/8 inch (3 mm) away from the edge and all around the decal.

NOTE

A clear polyurethane enamel (C-233) may be used to seal decals applied to all types of exterior finishes.

b. For the sealing of exterior decals, apply the same material used for the exterior painting. For example, if the exterior paint is polyurethane enamel (C-233), then use a clear polyurethane enamel (C-233).

c. For the sealing of interior decals, apply a clear edge sealer (C-349).

d. Remove the masking tape (C-426) from around the decal when the coating is dry.

8-25. RETAINING COMPOUNDS

Retaining compounds are single component liquid materials used in locking, retaining, bonding, and sealing of parts at assembly.

These adhesive/sealants are anaerobic compounds, or compounds that become solid in absence of air. They remain liquid on metal or other surfaces as long as they are in contact with air.

Confining the compound between closely fitting surfaces prevents contact with air and the compound will harden to a strong permanent bond.

Retaining compounds are formulated to give a wide range of strengths, viscosities, degrees of adhesion, and cure time. Refer to the procedure in the applicable manual, bulletin, or instruction for correct selection of the compound.

8-26. RETAINING COMPOUNDS — APPLICATION

1. Apply retaining compounds as follows:

a. Make sure all bonding surfaces are clean. Otherwise, refer to Chapter 5.

b. Mix the compound and use the applicator nozzle provided with the container, or a cotton swab soaked in the compound, to apply the retaining compound to the bonding surfaces.

c. Assemble the parts.

d. When the retaining compound is used for retention of bearings in conjunction with staking, stake the bearing within 30 minutes. Do not stake parts after the retaining compound has cured.

e. If staking of the bearing is not required, allow the compound to fully cure before use.

NOTE

Parts or assemblies with greased bearings may be heated to a maximum of 200°F (93°C).

f. Within 30 minutes after assembly or bearing staking, as applicable, heat cure at one of following times and temperatures.

Table 8-3. Retaining Compounds — Heat Cure Temperature and Time

TEMPERATURE	TIME
300°F (149°C)	5 minutes
250°F (121°C)	10 minutes
200°F (93°C)	15 minutes
175°F (79°C)	20 minutes
150°F (66°C)	30 minutes

8-27. SAFETYING

NOTE

Not all applications of fasteners require safety wire or cotter pins. Refer to the procedure in the specific manual, bulletin, or instruction for applicability.

Unless otherwise specified in the procedure of the applicable manual, bulletin, or instruction, refer to the FAA Advisory Circular AC 43.43-1 and, as applicable, paragraph 8-28 or paragraph 8-29 for proper use of safety wires and cotter pins. Refer to the BHT-ELEC-SPM for electrical applications.

8-28. SAFETYING — SAFETY WIRE

SPECIAL TOOLS REQUIRED

NUMBER	NOMENCLATURE
Commercial	Wire Twister
Commercial	Wire Cutter
Commercial	Pliers

MATERIALS REQUIRED

Refer to Chapter 13 for specifications.

NUMBER	NOMENCLATURE
C-405	Lockwire
C-414	Shear Wire
C-447	Lockwire
C-508	Lockwire

WARNING

ALWAYS WEAR EYE PROTECTION WHEN YOU REMOVE AND INSTALL SAFETY WIRE. FAILURE TO DO SO MAY RESULT IN INJURIES TO PERSONS.

1. Unless it is specified in the procedure of the applicable manual, bulletin, or instruction, select the appropriate wire to use as follows:

a. Select a material for the wire, based on the application:

NOTE

Shear wiring of emergency equipment is used to prevent actuation of the equipment.

Seal wiring of equipment is used to report actuation of the equipment.

- For shear and seal wiring, use a copper shear wire (C-414) (MS20995CY).
- For safety (or lock) wiring, use a Corrosion Resistant Steel (CRES) safety wire (AS1000).

NOTE

Wire sizes provided hereafter are to be used for safety wiring with the double-twist method, except where indicated.

b. Select the size of the safety wire as follows:

- For general safety wiring, use a 0.032 inch (0.81 mm) diameter lockwire (C-405).
- For safety wiring of a part with a hole diameter more than 0.062 inch (1.57 mm), use a 0.040 inch (1.02 mm) diameter lockwire (C-447).
- For safety wiring of a part with a hole diameter less than 0.045 inch (1.14 mm), use a 0.020 inch (0.51 mm) diameter lockwire (C-508).
- For safety wiring of parts with 2 inches (50.80 mm) or less of space between, use a 0.020 inch (0.51 mm) diameter lockwire (C-508).
- For safety wiring of closely-spaced fasteners, 0.25 inch (6.35 mm) diameter and less, use a 0.020 inch (0.51 mm) diameter lockwire (C-508).
- For safety wiring with the single-wire method, use the largest size of wire that the hole can accommodate.

NOTE

The single-wire method may be used if there is less than 2 inches (50.80 mm) between holes in a closed-geometrical pattern (triangle, rectangle, circle, etc.).

Procedure for the single-wire method is the same as the double-twist method except that the wire is not twisted.

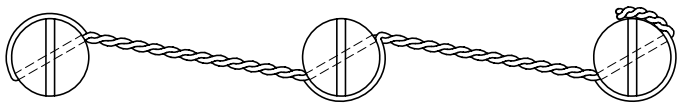
2. Safety wire the part(s) using the double-twist method as follows (Figure 8-2):

CAUTION

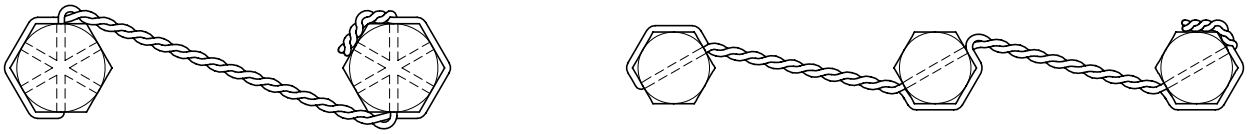
ALWAYS INSTALL A NEW WIRE WHEN YOU SAFETY WIRE EQUIPMENT OR FASTENERS. FAILURE TO DO SO WILL RESULT IN UNSAFE SECURING AND POSSIBLE DAMAGE TO THE EQUIPMENT.

a. Make sure to use new safety wire.

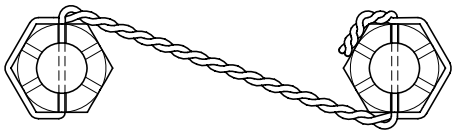
b. Loop the wire through and around the part to be secured.



SCREW HEADS EXAMPLE

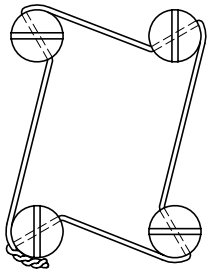


BOLT HEADS EXAMPLES

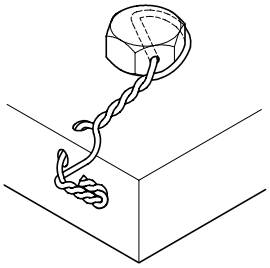


CASTELLATED NUTS EXAMPLE

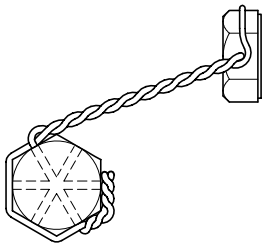
SAFETY WIRING OF FASTENERS
DOUBLE-TWIST METHOD



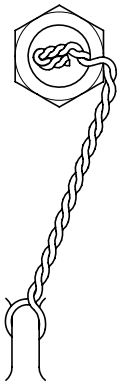
SAFETY WIRING
SINGLE-WIRE METHOD



SAFETY WIRING OF
SINGLE PARTS



SAFETY WIRING IN
DIFFERENT PLANES



SAFETY WIRING OF
HOLLOW-HEAD PLUGS

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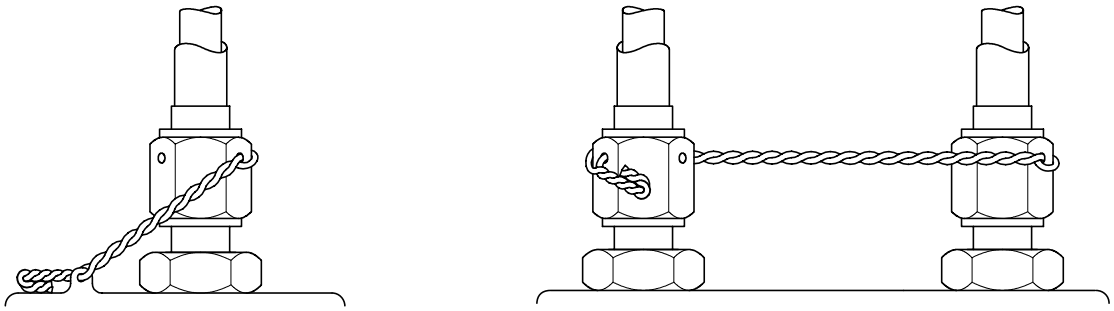
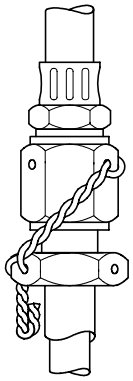
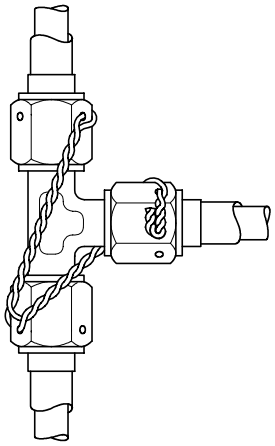
Figure 8-2. Safetying — Safety Wire Installation (Sheet 1 of 3)



STRAIGHT CONNECTIONS

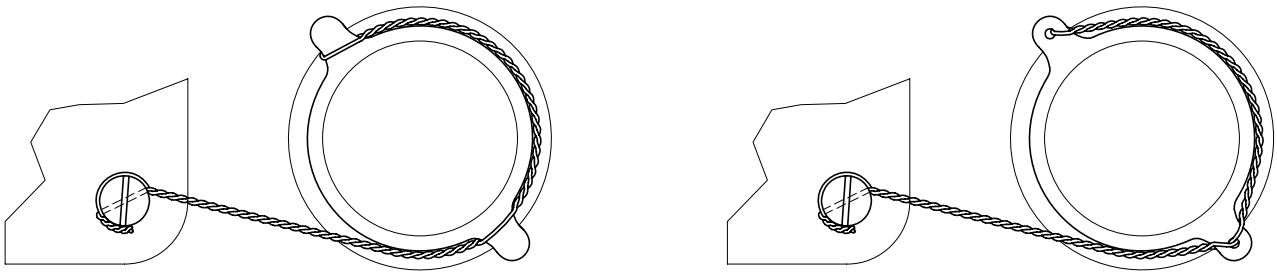


FLEXIBLE HOSE
TO RIGID TUBE
CONNECTION



TEE FITTING
CONNECTION

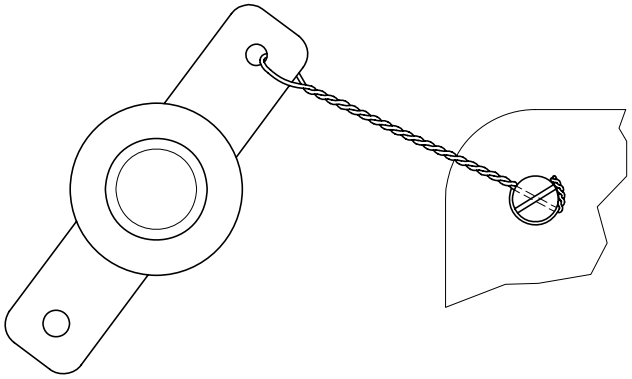
SAFETY WIRING
APPLICATION TO COUPLING NUTS



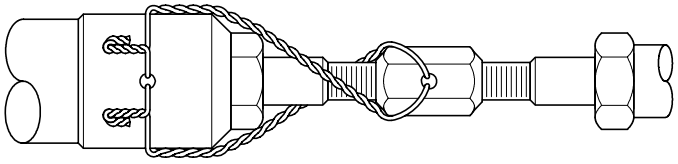
SAFETY WIRING
APPLICATION TO OIL CAPS

ALL_SPM_08_0002

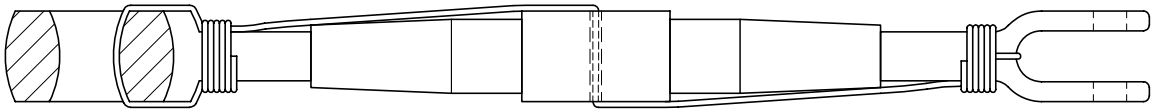
Figure 8-2. Safetying — Safety Wire Installation (Sheet 2 of 3)



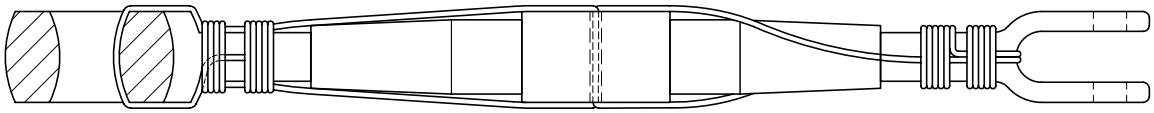
**SAFETY WIRING
APPLICATION TO DRAIN
COCKS AND PLUGS**



**SAFETY WIRING
APPLICATION TO CONTROL LINKS**



SINGLE WRAP METHOD



DOUBLE WRAP METHOD

ALL_SPM_08_0003

Figure 8-2. Safetying — Safety Wire Installation (Sheet 3 of 3)

c. Twist the wire 6 to 8 twists per inch (3 twists per centimeter) and make sure the loop around the head of the fastener(s) stays down and fits closely to the contour.

d. Route the twisted wire in a manner that prevents the part(s) from loosening.

e. Apply a light tension to the twisted-wire so it is tight but not over-stressed.

f. Wire single parts to another adjacent part. Wire multiple parts as follows:

(1) Wire together a maximum of three parts if the groups of parts are 4 to 6 inches (102 to 152 mm) spaced.

(2) For groups of parts with 2 inches (50 mm) or less of space between, the maximum number of parts that can be wired together is the number of parts that can be wired with a 24 inch (610 mm) long wire.

g. Connect the wire ends together so it makes a pigtail of 0.25 to 0.5 inch (6.35 to 12.70 mm) in length (3 to 6 twists).

h. Always bend and fold the pigtail in a manner that prevents snags and possible injuries to persons.

3. Ensure the installed position of the safety wire and pigtail will not cause chafing or interference with adjacent parts or installations.

8-29. SAFETYING — COTTER PINS

SPECIAL TOOLS REQUIRED

NUMBER	NOMENCLATURE
Commercial	Wire Cutter
Commercial	Plier

1. Unless it is specified in the procedure, select the appropriate cotter pin to use as follows:

a. Select a material for the cotter pin, based on the application:

- For any of the following, use a Corrosion Resistant Steel (CRES) cotter pin (MS24665). Refer to Table 8-4 for the dash number.

  - Non-magnetic requirements

  - Contact with CRES fasteners

  - Exposure to the relative wind

  - Operation in corrosive environments

  - Exposure to high temperatures, up to 800°F (426°C)

- For general applications, use a cadmium plated steel cotter pin (MS24665). Refer to Table 8-5 for the dash number.

b. For the size of the cotter pin, select the largest diameter that the hole can accommodate. The length must be compatible with the installation method used.

2. Install cotter pins in castellated nuts using the general installation method that follows (Figure 8-3):

a. Tighten the nut to the minimum of the specified or calculated torque range (Chapter 2), unless otherwise specified.

CAUTION

MAKE SURE YOU DO NOT EXCEED THE MAXIMUM PERMITTED TORQUE VALUE. OTHERWISE THE FASTENERS MAY OVERSTRESS (CHAPTER 2).

b. Continue to torque the nut until a slot aligns with the hole in the bolt. Do not exceed the maximum permitted torque value.

Table 8-4. Safetying — CRES (MS24665) Cotter Pin Dash Numbers

COTTER PIN LENGTH INCH (MM)	COTTER PIN DIAMETER INCH (MM)				
	0.031 (0.79)	0.047 (1.19)	0.062 (1.59)	0.094 (2.38)	0.125 (3.17)
0.250 (6.35)	-18	-82	-1010	-	-
0.312 (7.93)	-1001	-	-1011	-	-
0.375 (9.52)	-1002	-	-1012	-	-
0.437 (11.11)	-1003	-	-1013	-	-
0.500 (12.70)	-22	-86	-151	-298	-366
0.750 (19.05)	-24	-88	-153	-300	-368
1.000 (25.40)	-26	-90	-155	-302	-370
1.250 (31.75)	-27	-91	-157	-304	-372
1.500 (38.10)	-28	-92	-159	-306	-374
1.750 (44.45)	-29	-93	-161	-308	-376
2.000 (50.80)	-30	-94	-162	-309	-377

Table 8-5. Safetying — Cadmium Plated Steel (MS24665) Cotter Pin Dash Numbers

COTTER PIN LENGTH INCH (MM)	COTTER PIN DIAMETER INCH (MM)				
	0.031 (0.79)	0.047 (1.19)	0.062 (1.59)	0.094 (2.38)	0.125 (3.17)
0.5000(12.70)	-5	-69	-132	-281	-349
1.000 (25.40)	-9	-73	-136	-285	-353
1.500 (38.10)	-11	-75	-140	-289	-357
2.000 (50.80)	-13	-77	-143	-292	-360

CAUTION

ALWAYS INSTALL A NEW COTTER PIN WHEN YOU SECURE FASTENERS. FAILURE TO DO SO WILL RESULT IN UNSAFE SECURING AND POSSIBLE DAMAGE TO THE EQUIPMENT.

c. Make sure to use a new cotter pin.

d. Insert the cotter pin in the slot of the nut and through the hole of the bolt. Do not flatten the eye

e. Turn the cotter pin so the axis of the eye is at a right angle (90°) to the bolt shank.

f. Bend the upper prong over the end of the bolt and cut so it does not extend beyond the diameter.

g. Bend the lower prong down and cut so it does not rest on the washer or any other material.

3. If the upper prong may act as a snag or if a clearance is required at the end of the bolt, you may want to use one of the following alternate installation methods:

a. Bend the tip of the upper prong sideways and insert it into an adjacent slot of the nut, or

b. Cut the upper prong flush with the top of the bolt, or

c. Turn the cotter pin so the axis of the eye is parallel to the shank of the bolt and bend the prongs around the contour of the nut.

4. Install cotter pins in pins using the installation procedure that follows (Figure 8-3):

CAUTION

ALWAYS INSTALL A NEW COTTER PIN WHEN YOU SECURE FASTENERS. FAILURE TO DO SO WILL RESULT IN UNSAFE SECURING AND POSSIBLE DAMAGE TO THE EQUIPMENT.

a. Make sure to use a new cotter pin.

b. Insert the cotter pin in the slot of the pin. Do not flatten the eye.

c. Turn the cotter pin so the axis of the eye is parallel to the shank of the pin.

d. Bend the prongs around the shank of the pin.

e. Make sure the installed position of the cotter pin will not chafe or interfere with adjacent parts or installations.

8-30. STUDS AND INSERTS

8-31. STUDS AND INSERTS — STANDARD STUDS IDENTIFICATION

1. Studs are identified with a mark on both ends (AN studs) or on one end only (Bell studs) (Figure 8-4). Characteristics for each type of stud is identified as follows:

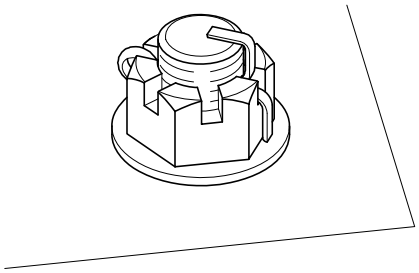
a. AN studs have a mark on the top end of the stud to give the stud material. The mark is visible when the stud is installed.

b. AN studs have a mark on the opposite end of the stud. The mark shows if the stud is oversized or undersized.

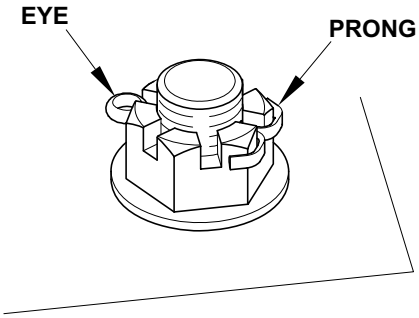
c. Bell studs have no mark on the top end of the stud.

d. Bell studs have a mark on the opposite end of the stud. The mark shows if the stud is oversized or undersized.

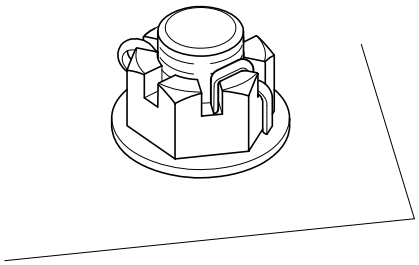
e. Studs installed during manufacturing are usually standard size. If it is not possible to get the required height and torque with a standard size stud, an oversized or undersized stud can be installed.



PREFERED METHOD

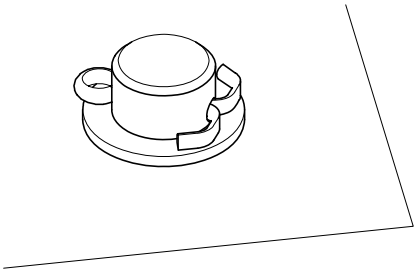


ALTERNATE METHOD NO. 1



ALTERNATE METHOD NO. 2

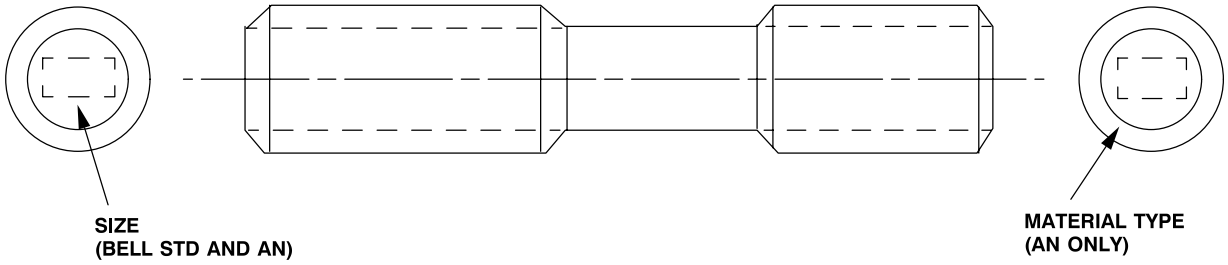
COTTER PINNING - APPLICATION
TO CASTELLATED NUT ON BOLT



COTTER PINNING
PIN APPLICATION

ALL_SPM_08_0004

Figure 8-3. Safetying — Cotter Pin Installation



	-.003	STANDARD	+.003	+.006	+.009	+.012
UNDERSIZE AND OVERSIZE IDENTIFICATION	-3		3	6	9	12

AN STUD

	-.003	STANDARD	+.003	+.006	+.009	+.012
	-101	-103	-105	-107	-109	-111
UNDERSIZE AND OVERSIZE IDENTIFICATION						

BELL HELICOPTER STUD

SPM-00080-00010-001-C00

Figure 8-4. Studs and Inserts — Standard Studs Identification

8-32. STUDS AND INSERTS — STANDARD STUDS REPLACEMENT

MATERIALS REQUIRED

Refer to Chapter 13 for specifications.

NUMBER	NOMENCLATURE
C-204	Epoxy Polyamide Primer

CAUTION

DO NOT REPAIR A DAMAGED STUD OR A STUD THAT DOES NOT MEET THE MINIMUM INSTALLATION TORQUE AND HEIGHT REQUIREMENTS. ONLY THE STUD REPLACEMENT IS PERMITTED.

NOTE

The following instructions are applicable to studs of the standard type, which thread directly into cases or sleeves.

1. Measure and record the height of the damaged stud before removal.

NOTE

If the stud is broken off, drill a hole in the center of the stud and extract with an "EZY-Out" type of extractor.

2. Grip the damaged stud with an appropriate tool and turn it slowly to avoid seizure and breakage.

NOTE

The correct size for a replacement stud is the size that allows the stud to meet the minimum driving torque requirement.

Usually, the correct size for a replacement stud is the next larger size of stud.

The applicable Illustrated Parts Breakdown (IPB) manual provides the list of the standard studs and four oversize studs by increments of 0.003 inch (0.076 mm).

3. Select the correct size for the replacement stud.

4. Finger tighten the new stud in the tapped hole. If the stud fails to engage in one or two turns, remove the stud and select the next oversized stud.

5. Temporarily remove the stud and coat the course threaded end of the stud with wet unreduced epoxy polyamide primer (C-204).

6. Clean out the small vent hole in the bottom of the tapped hole.

NOTE

Refer to Chapter 2 for the standard torque range of values applicable to the stud.

7. At the same time, install the stud with the applicable stud driving tool and make sure the driving torque is within the required torque range.

8-33. STUDS AND INSERTS — RING LOCKED STUDS AND INSERTS REPLACEMENT

SPECIAL TOOLS REQUIRED

NUMBER	NOMENCLATURE
△1 △2	Removal Tool
	Step Drill
	Wrench
	Lockring Drive Tool

NOTES:

△1 Refer to the stud/insert manufacturer for the special tools applicable part numbers. Ex. Rosan Products, P.O. Box 25225, 3130 W. Harvard St., Santa-Anna, California, 92799

△2 If special tools are not available, replacement is possible with other tools. Be careful when you use other tools for replacement of studs/inserts.

MATERIALS REQUIRED

Refer to Chapter 13 for specifications.

NUMBER	NOMENCLATURE
C-204	Epoxy Polyamide Primer

NOTE

The following instructions are applicable to studs and threaded inserts installed with a lockring. The lockring inner teeth engage the serrated collar on the stud or insert and the lockring outer teeth broach into the material of the case.

1. Remove a ring locked insert as follows:

a. Select a drill, same diameter as the serrations between the lockring and the insert.

b. Drill to a depth equal to the lockring thickness.

c. Remove the insert and the remaining portion of the lockring.

2. Remove a ring locked stud as follows:

NOTE

If no tool is available to mill the lockring, saw off the stud, drill a hole in the stud center, and extract the stud with an "EZY-Out" type of extractor.

a. Select the applicable removal tool. If not available, select a hollow mill with an outside diameter 0.015 inch (0.381 mm) less than the root diameter of the lockring outer serrations.

b. Mill to a depth equal to the lockring thickness. For best results, do not mill completely through the lockring.

c. Apply the removal torque to the stud. If you did not mill completely through the lockring, removal torque will jack out the lockring.

NOTE

Holes are tapped with a standard class 3 tap and the counter bore has a 90° shoulder.

3. Examine the tapped hole and the counterbore for condition. If necessary, clean up minor damage but do not enlarge the holes.

4. Apply a layer of unreduced epoxy polyamide primer (C-204) to the threads of the new stud or insert that will contact the case.

5. Wet install the stud or insert in the tapped hole until the upper surface of the serrated collar is 0.010 to 0.020 inch (0.254 to 0.508 mm) below the case surface.

6. Apply a layer of unreduced epoxy polyamide primer (C-204) to the new lockring.

7. Align the lockring serrations with the stud/insert serrations.

8. Wet install the lockring into the case with the drive tool until it is flush with the upper surface of the stud/insert serrations.

8-34. SURFACE ROUGHNESS

SPECIAL TOOLS REQUIRED

NUMBER	NOMENCLATURE
2 to 250 microinches	Surface Roughness Tester
2 to 250 microinches	Surface Finish Scales or Microfinish Comparators

Surface roughness may be identified in one of the following nomenclatures:

- Root Mean Square (RMS)
- Roughness Height Rating (RHR)
- Microinches

The three nomenclatures refer to the average linear deviation of the actual surface. The surface roughness height is the arithmetical average deviation expressed in microinches measured normal to the center line. A microinch is one millionth of an inch (0.000001) inch. Table 8-6 gives the different machining methods and corresponding roughness numbers that will normally be achieved.

Table 8-6. Surface Roughness — Machining Method Versus Roughness

MACHINING METHOD	ROUGHNESS (MICROINCHES)
Rough Machine	250 (6.350 µm)
Medium Machine, Drill	125 (3.175 µm)
Smooth Machine, Ream	63 (1.600 µm)
Grind, Fine Machine	32 (0.813 µm)
Grind, Hone	16 (0.406 µm)
Hone	8 (0.203 µm)
Lap, Polish	4 (0.102 µm)
Polish, Superfinish	2 (0.051 µm)

8-35. SYSTEMS OF UNITS

The following charts (Table 8-7 through Table 8-18) provide formulas and tables to convert a quantity to one of the following systems, as applicable:

- Metric or International System of Units (SI)
- US or English System of units
- Imperial System of units

Table 8-7. Systems of Units — Conversion Formulas

MULTIPLY	BY	TO GET
LENGTH OR DISTANCE (US TO SI)		
microinch	0.0254	micrometers (μm)
mil	25.4	micrometers
	0.0254	millimeters (mm)
inch	25.4	millimeters
foot	0.3048	meters (m)
yard	0.9144	meters
mile	1.609	kilometers (km)
LENGTH OR DISTANCE (SI TO US)		
micrometer	3.937	microinches
	0.0394	mils
millimeter	39.37	mils
	0.0394	inches
meter	3.281	feet
	1.0936	yards
kilometer	0.6214	miles
AREA OR SURFACE (US TO SI)		
square-inch	645.16	mm^2
	6.4516	cm^2
square-foot	0.0929	m^2
square-yard	0.8361	m^2
AREA OR SURFACE (SI TO US)		
mm^2	0.0015	square-inches
cm^2	0.1550	square-inches
m^2	10.764	square-feet
	1.196	square-yards
VOLUME OR CAPACITY (US TO SI)		
cubic-inch	16.387	cm^3
	16.387	milliliters (ml)
	0.0164	liters (l)

Table 8-7. Systems of Units — Conversion Formulas (Cont)

MULTIPLY	BY	TO GET
VOLUME OR CAPACITY (US TO SI) (CONT)		
fluid-ounce	29.574	milliliters
pint	0.4732	liters
quart	0.9464	liters
gallon	3.7854	liters
cubic-foot	0.0283	m^3
cubic-yard	0.7646	m^3
VOLUME OR CAPACITY (SI TO US)		
cm^3	0.0610	cubic-inch
milliliters	0.0610	cubic-inch
	0.0338	fluid-ounce
liters	61.024	cubic-inch
	2.1134	pint
	1.0567	quart
	0.2642	gallon
m^3	35.315	cubic-foot
	1.3080	cubic-yard
VOLUME OR CAPACITY (US TO IMPERIAL)		
fluid-ounce	1.041	fluid-ounces
pint	0.833	pints
quart	0.833	quarts
gallon	0.833	gallons
VOLUME OR CAPACITY (IMPERIAL TO SI)		
fluid-ounce	28.413	milliliters
pint	0.5683	liters
quart	1.136	liters
gallon	4.546	liters
MASS OR WEIGHT (US TO SI)		
ounce (oz)	28.35	grams (g)
pound (lb)	0.4536	kilograms (kg)

Table 8-7. Systems of Units — Conversion Formulas (Cont)

MULTIPLY	BY	TO GET
MASS OR WEIGHT (SI TO US)		
gram	0.0353	ounces
kilogram	2.2046	pounds
FORCE (US TO SI)		
ounce-force (ozf)	0.278	newtons (N)
pound-force (lbf)	4.448	newtons
FORCE (SI TO US)		
newton	3.597	ounce-force
	0.225	pound-force
TORQUE (US TO SI)		
inch-pound	0.1129	newton-meters (Nm)
foot-pound	1.3558	newton-meters
TORQUE (SI TO US)		
newton-meter	8.8507	inch-pounds
	0.7375	foot-pounds
POWER		
horsepower (hp)	0.7457	kilowatts (kW)
kilowatt	1.3410	horsepower
PRESSURE OR STRESS (US TO SI)		
inches of mercury	3.3864	kilopascals (kPa)
pound-force per square-inch (PSI)	6.8947	kilopascals
PRESSURE OR STRESS (SI TO US)		
kilopascal	0.2953	inches of mercury
	0.1450	pound-force per square-inch
TEMPERATURE		
Degree Fahrenheit (°F)	(°F - 32) x 0.555	Degrees Celsius (°C)
Degree Celsius	(°C x 1.8) + 32	Degrees Fahrenheit

Table 8-8. Systems of Units — Inch (Fraction) to Millimeter (MM) Conversions

INCH (FRACTION)	INCH (DECIMAL)	MM
1/64	0.015625	0.39688
1/32	0.03125	0.79375
3/64	0.046875	1.19062
1/16	0.0625	1.58750
5/64	0.078125	1.98437
3/32	0.09375	2.38125
7/64	0.109375	2.77812
1/8	0.125	3.17500
9/64	0.140625	3.57187
5/32	0.15625	3.96875
11/64	0.171875	4.36562
3/16	0.1875	4.76250
13/64	0.203125	5.15937
7/32	0.21875	5.55625
15/64	0.234375	5.95312
1/4	0.250	6.35000
17/64	0.265625	6.74687
9/32	0.28125	7.14375
19/64	0.296875	7.54062
5/16	0.3125	7.93750
21/64	0.328125	8.33437
11/32	0.34375	8.73125
23/64	0.359375	9.12812
3/8	0.375	9.52500
25/64	0.390625	9.92187
13/32	0.40625	10.31875
27/64	0.421875	10.71562
7/16	0.4375	11.11250
29/64	0.453125	11.50937
15/32	0.46875	11.90625
31/64	0.484375	12.30312
1/2	0.500	12.70000

INCH (FRACTION)	INCH (DECIMAL)	MM
33/64	0.515625	13.09687
17/32	0.53125	13.49375
35/64	0.546875	13.89062
9/16	0.5625	14.28750
37/64	0.578125	14.68437
19/32	0.59375	15.08125
39/64	0.609375	15.47812
5/8	0.625	15.87500
41/64	0.640625	16.27187
21/32	0.65625	16.66875
11/16	0.6875	17.46250
45/64	0.703125	17.85937
23/32	0.71875	18.25625
47/64	0.734375	18.65312
3/4	0.750	19.05000
49/64	0.765625	19.44687
25/32	0.78125	19.84375
51/64	0.796875	20.24062
13/16	0.8125	20.63750
53/64	0.828125	21.03437
27/32	0.84375	21.43125
55/64	0.859375	21.82812
7/8	0.875	22.22500
57/64	0.890625	22.62187
29/32	0.90625	23.01875
59/64	0.921875	23.41562
15/16	0.9375	23.81250
61/64	0.953125	24.20937
31/32	0.96875	24.60625
63/64	0.984375	25.00312
1	1.00	25.40000

Table 8-9. Systems of Units — Inch to Millimeter (MM) Conversions

INCH	0	.0001	.0002	.0003	.0004	.0005	.0006	.0007	.0008	.0009
	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
.0000	–	.00254	.00508	.00762	.01016	.01270	.01524	.01778	.02032	.02286
.0010	.02540	.02794	.03048	.03302	.03556	.03810	.04064	.04318	.04572	.04826
.0020	.05080	.05334	.05588	.05842	.06096	.06350	.06604	.06858	.07112	.07366
.0030	.07620	.07874	.08128	.08382	.08636	.08890	.09144	.09398	.09652	.09906
.0040	.10160	.10414	.10668	.10922	.11176	.11430	.11634	.11938	.12192	.12446
.0050	.12700	.12954	.13208	.13462	.13716	.13970	.14224	.14478	.14732	.14986
.0060	.15240	.15494	.15748	.16002	.16256	.16510	.16764	.17018	.17272	.17526
.0070	.17780	.18034	.18288	.18542	.18796	.19050	.19304	.19558	.19812	.20066
.0080	.20320	.20574	.20828	.21082	.21336	.21590	.21844	.22098	.22352	.22606
.0090	.22860	.23114	.23368	.23622	.23876	.24130	.24384	.24638	.24892	.25146

INCH	0	.0010	.0020	.0030	.0040	.0050	.0060	.0070	.0080	.0090
	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
.0100	.2540	.2794	.3048	.3302	.3556	.3810	.4064	.4318	.4572	.4826
.0200	.4080	.5334	.5588	.5842	.6096	.6350	.6604	.6858	.7112	.7366
.0300	.7620	.7874	.8128	.8382	.8636	.8890	.9144	.9398	.9652	.9906
.0400	1.0160	1.0414	1.0668	1.0922	1.1176	1.1430	1.1684	1.1938	1.2192	1.2446
.0500	1.2700	1.2954	1.3208	1.3462	1.3716	1.3970	1.4224	1.4478	1.4732	1.4986
.0600	1.5240	1.5494	1.5748	1.6002	1.6256	1.6510	1.6764	1.7018	1.7272	1.7526
.0700	1.7780	1.8034	1.8288	1.8542	1.8796	1.9050	1.9304	1.9558	1.9812	2.0066
.0800	2.0320	2.0574	2.0828	2.1082	2.1336	2.1590	2.1844	2.2098	2.2352	2.2606
.0900	2.2860	2.3114	2.3368	2.3622	2.3876	2.4130	2.4384	2.4638	2.4892	2.5146

INCH	0	.0100	.0200	.0300	.0400	.0500	.0600	.0700	.0800	.0900
	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
.1000	2.540	2.794	3.048	3.302	3.556	3.810	4.064	4.318	4.572	4.826
.2000	5.080	5.334	5.588	5.842	6.096	6.350	6.604	6.858	7.112	7.366
.3000	7.620	7.874	8.128	8.382	8.636	8.890	9.144	9.398	9.652	9.906
.4000	10.160	10.414	10.668	10.922	11.176	11.430	11.684	11.938	12.192	12.446
.5000	12.700	12.954	13.208	13.462	13.716	13.970	14.224	14.478	14.732	14.986
.6000	15.240	15.494	15.748	16.002	16.256	16.510	16.764	17.018	17.272	17.526
.7000	17.780	18.034	18.288	18.542	18.796	19.050	19.304	19.558	19.812	20.066
.8000	20.320	20.574	20.828	21.082	21.336	21.590	21.844	22.098	22.352	22.606
.9000	22.860	23.114	23.368	23.622	23.876	24.130	24.384	24.638	24.892	25.146

Table 8-10. Systems of Units — Ounce-Force (OZF) and Pound-Force (LBF) to Newtons (N) Conversions

OZF	0	1	2	3	4	5	6	7	8	9
	N	N	N	N	N	N	N	N	N	N
0	–	0.28	0.56	0.83	1.11	1.39	1.67	1.95	2.22	2.50
10	2.78	3.06	3.34	3.61	3.89	4.17	4.45	4.73	5.00	5.28

LBF	0	1	2	3	4	5	6	7	8	9
	N	N	N	N	N	N	N	N	N	N
0	–	4.4	8.9	13.3	17.8	22.2	26.7	31.1	35.6	40.0
10	44	49	53	58	62	67	71	76	80	85
20	89	93	98	102	107	111	116	120	125	129
30	133	138	142	147	151	156	160	165	169	173
40	178	182	187	191	196	200	205	209	214	218
50	222	227	231	236	240	245	249	254	258	262
60	267	271	276	280	285	289	294	298	302	307
70	311	316	320	325	329	334	338	343	347	351
80	356	360	365	369	374	378	383	387	391	396
90	400	405	409	414	418	423	427	431	436	440
100	445	449	454	458	463	467	472	476	480	485

LBF	0	10	20	30	40	50	60	70	80	90
	N	N	N	N	N	N	N	N	N	N
200	890	934	979	1023	1068	1112	1157	1201	1246	1290
300	1334	1379	1423	1468	1512	1557	1601	1646	1690	1735
400	1779	1824	1868	1913	1957	2002	2046	2091	2135	2180
500	2224	2269	2313	2358	2402	2447	2491	2535	2580	2624
600	2669	2713	2758	2802	2847	2891	2936	2980	3025	3069
700	3114	3158	3203	3247	3292	3336	3381	3425	3470	3514
800	3559	3603	3648	3692	3737	3781	3825	3870	3914	3959
900	4003	4048	4092	4137	4181	4226	4270	4315	4359	4404
1000	4448	4493	4537	4582	4626	4671	4715	4760	4804	4849

Table 8-10. Systems of Units — Ounce-Force (OZF) and Pound-Force (LBF) to Newtons (N) Conversions (Cont)

LBF	0	100	200	300	400	500	600	700	800	900
	N	N	N	N	N	N	N	N	N	N
1000	4448	4893	5338	5783	6228	6672	7117	7562	8007	8452
2000	8896	9341	9786	10,231	10,676	11,121	11,565	12,010	12,455	12,900
3000	13,345	13,789	14,234	14,679	15,124	15,569	16,014	16,458	16,903	17,348
4000	17,793	18,238	18,683	19,127	19,572	20,017	20,462	20,907	21,351	21,796
5000	22,241	22,686	23,131	23,576	24,020	24,465	24,910	25,355	25,800	26,245
6000	26,689	27,134	27,579	28,024	28,469	28,913	29,358	29,808	30,248	30,693
7000	31,138	31,582	32,027	32,472	32,917	33,362	33,806	34,251	34,696	35,141
8000	35,586	36,031	36,475	36,920	37,365	37,810	38,255	38,700	39,144	39,589
9000	40,034	40,479	40,924	41,368	41,813	42,258	42,703	43,148	43,593	44,037
10,000	44,482	44,927	45,372	45,817	46,262	46,706	47,151	47,596	48,041	48,486
11,000	48,930	49,375	49,820	50,265	50,710	51,155	51,599	52,044	52,489	52,934
12,000	53,379	53,823	54,268	54,713	55,158	55,603	56,048	56,492	56,937	57,382
13,000	57,827	58,272	58,717	59,161	59,606	60,051	60,496	60,941	61,385	61,830
14,000	62,275	62,720	63,165	63,610	64,054	64,499	64,944	65,389	65,834	66,279
15,000	66,723	67,168	67,613	68,058	68,503	68,947	69,392	69,837	70,282	70,727
16,000	71,172	71,616	72,061	72,506	72,951	73,396	73,840	74,285	74,730	75,175
17,000	75,620	76,065	76,509	76,954	77,399	77,844	78,289	78,734	79,178	79,623
18,000	80,068	80,513	80,958	81,402	81,847	82,292	82,737	83,182	83,627	84,071
19,000	84,516	84,961	85,406	85,851	86,296	86,740	87,185	87,630	88,075	88,520
20,000	88,964	89,409	89,854	90,299	90,744	91,189	91,633	92,078	92,523	92,968

Table 8-11. Systems of Units — Ounce (OZ) and Pound (LB) to Kilogram (KG) Conversions

OZ	0	1	2	3	4	5	6	7	8	9
	KG	KG	KG	KG	KG	KG	KG	KG	KG	KG
0	–	0.028	0.057	0.085	0.113	0.142	0.170	0.198	0.227	0.255
10	0.283	0.312	0.340	0.369	0.397	0.425	0.454	0.482	0.510	0.539

LB	0	1	2	3	4	5	6	7	8	9
	KG	KG	KG	KG	KG	KG	KG	KG	KG	KG
0	–	0.45	0.91	1.36	1.81	2.27	2.72	3.18	3.63	4.08
10	4.5	5.0	5.4	5.9	6.4	6.8	7.3	7.7	8.2	8.6
20	9.1	9.5	10.0	10.4	10.9	11.3	11.8	12.2	12.7	13.2
30	13.6	14.1	14.5	15.0	15.4	15.9	16.3	16.8	17.2	17.7
40	18.1	18.6	19.1	19.5	20.0	20.4	20.9	21.3	21.8	22.2
50	22.7	23.1	23.6	24.0	24.5	24.9	25.4	25.9	26.3	26.8
60	27.2	27.7	28.1	28.6	29.0	29.5	29.9	30.4	30.8	31.3
70	31.8	32.2	32.7	33.1	33.6	34.0	34.5	34.9	35.4	35.8
80	36.3	36.7	37.2	37.6	38.1	38.6	39.0	39.5	39.9	40.4
90	40.8	41.3	41.7	42.2	42.6	43.1	43.5	44.0	44.5	44.9
100	45	46	46	47	47	48	48	49	49	49

LB	0	10	20	30	40	50	60	70	80	90
	KG	KG	KG	KG	KG	KG	KG	KG	KG	KG
200	91	95	100	104	109	113	118	122	127	132
300	136	141	145	150	154	159	163	168	172	177
400	181	186	191	195	200	204	209	213	218	222
500	227	231	236	240	245	249	254	259	263	268
600	272	277	281	286	290	295	299	304	308	313
700	318	322	327	331	336	320	345	349	354	358
800	363	367	372	376	381	386	390	395	399	404
900	408	413	417	422	426	431	435	440	445	449
1000	454	458	463	467	472	476	481	485	490	494

Table 8-11. Systems of Units — Ounce (OZ) and Pound (LB) to Kilogram (KG) Conversions (Cont)

LB	0	100	200	300	400	500	600	700	800	900
	KG	KG	KG	KG	KG	KG	KG	KG	KG	KG
1000	454	499	544	590	635	680	726	771	816	862
2000	907	953	998	1043	1089	1134	1179	1225	1270	1315
3000	1361	1406	1451	1497	1542	1588	1633	1673	1724	1769
4000	1814	1860	1905	1950	1996	2041	2087	2132	2177	2223
5000	2268	2313	2359	2404	2449	2495	2540	2585	2631	2676
6000	2722	2767	2812	2858	2903	2948	2994	3039	3084	3130
7000	3175	3221	3266	3311	3357	3402	3447	3493	3538	3583
8000	3629	3674	3719	3765	3810	3856	3901	3946	3992	4037
9000	4082	4128	4173	4218	4264	4309	4354	4400	4445	4491
10,000	4536	4581	4627	4672	4717	4763	4808	4853	4899	4944
11,000	4990	5035	5080	5126	5171	5216	5262	5307	5352	5398
12,000	5443	5488	5534	5579	5625	5670	5715	5761	5806	5851
13,000	5897	5942	5987	6033	6078	6123	6169	6214	6260	6305
14,000	6350	6396	6441	6486	6532	6577	6622	6668	6713	6759
15,000	6804	6849	6895	6940	6985	7031	7076	7121	7167	7212
16,000	7257	7303	7348	7394	7439	7484	7530	7575	7620	7666
17,000	7711	7756	7802	7847	7893	7938	7983	8029	8074	8119
18,000	8165	8210	8255	8301	8346	8391	8437	8482	8528	8573
19,000	8618	8664	8709	8754	8800	8845	8890	8936	8981	9026
20,000	9072	9117	9163	9208	9253	9299	9344	9389	9435	9480

Table 8-12. Systems of Units — Microinch (µIN) to Micrometer (µM) Conversions

µIN	0	1	2	3	4	5	6	7	8	9
	µM	µM	µM	µM	µM	µM	µM	µM	µM	µM
0		0.0254	0.051	0.076	0.102	0.127	0.152	0.178	0.203	0.229
10	0.254	0.279	0.305	0.330	0.356	0.381	0.406	0.432	0.458	0.483
20	0.508	0.533	0.559	0.584	0.610	0.635	0.660	0.686	0.711	0.737
30	0.762	0.787	0.813	0.838	0.864	0.889	0.914	0.940	0.965	0.991
40	1.02	1.04	1.07	1.09	1.12	1.14	1.17	1.19	1.22	2.24
50	1.27	1.30	1.32	1.35	1.37	1.40	1.42	1.45	1.47	1.50
60	1.52	1.55	1.57	1.60	1.63	1.65	1.68	1.70	1.73	1.75
70	1.78	1.80	1.83	1.85	1.88	1.91	1.93	1.96	1.98	2.01
80	2.03	2.06	2.08	2.11	2.13	2.16	2.18	2.21	2.24	2.26
90	2.29	2.31	2.34	2.36	2.39	2.41	2.44	2.46	2.49	2.51
100	2.54	2.57	2.59	2.62	2.64	2.67	2.69	2.72	2.74	2.77
110	2.79	2.82	2.84	2.87	2.90	2.92	2.95	2.97	3.00	3.02
120	3.05	3.07	3.10	3.12	3.15	3.18	3.20	3.23	3.25	3.28

Table 8-13. Systems of Units — Pound-Force per Square-Inch (PSI) to Kilopascal (KPA) Conversions

PSI	0	1	2	3	4	5	6	7	8	9
	KPA	KPA	KPA	KPA	KPA	KPA	KPA	KPA	KPA	KPA
		6.9	13.8	20.7	27.6	34.5	41.4	48.3	55.2	62.1
10	69	76	83	90	97	103	110	117	124	131
20	138	145	152	159	165	172	179	186	193	200
30	207	214	221	228	234	241	248	255	262	269
40	276	283	290	296	303	310	317	324	331	338
50	345	352	359	365	372	379	386	393	400	407
60	414	421	427	434	441	448	455	462	469	476
70	483	490	496	503	510	417	524	531	538	545
80	552	558	565	572	579	586	593	600	607	614
90	621	627	634	641	648	655	662	669	676	683
100	689	696	703	710	717	724	731	738	745	752

Table 8-14. Systems of Units — Inch-Pound (IN-LB) and Foot-Pound (FT-LB) to Newton-Meter (NM) Conversions

IN-LB	0	1	2	3	4	5	6	7	8	9
	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
	–	0.11	0.23	0.34	0.45	0.56	0.68	0.79	0.90	1.02
10	1.13	1.24	1.36	1.47	1.58	1.69	1.81	1.92	2.03	2.15
20	2.26	2.37	2.49	2.60	2.71	2.82	2.94	3.05	3.16	3.28
30	3.39	3.50	3.62	3.73	3.84	3.95	4.07	4.18	4.29	4.41
40	4.52	4.63	4.75	4.86	4.97	5.08	5.20	5.31	5.42	5.54
50	5.65	5.76	5.88	5.99	6.10	6.21	6.33	6.44	6.55	6.67
60	6.78	6.89	7.01	7.12	7.23	7.34	7.46	7.57	7.68	7.80
70	7.91	8.02	8.13	8.25	8.36	8.47	8.59	8.70	8.81	8.93
80	9.04	9.15	9.26	9.38	9.49	9.60	9.72	9.83	9.94	10.06
90	10.17	10.28	10.39	10.51	10.62	10.73	10.85	10.96	11.07	11.19
100	11.30	11.41	11.52	11.64	11.75	11.86	11.98	12.09	12.20	12.32

IN-LB	0	10	20	30	40	50	60	70	80	90
	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
200	22.60	23.73	24.86	25.99	27.12	28.25	29.38	30.51	31.64	32.77
300	33.90	35.03	36.16	37.28	38.41	39.54	40.67	41.80	42.93	44.06
400	45.19	46.32	47.45	48.58	49.71	50.84	51.97	53.10	54.23	55.36
500	56.49	57.62	58.75	59.88	61.01	62.14	63.27	64.40	65.53	66.66

FT-LB	0	1	2	3	4	5	6	7	8	9
	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
	–	1.4	2.7	4.1	5.4	6.8	8.1	9.5	10.8	12.2
10	14	15	16	18	19	20	22	23	24	26
20	27	28	30	31	33	34	35	37	38	39
30	41	42	43	45	46	47	49	50	52	53
40	54	56	57	48	60	61	62	64	65	66
50	68	69	71	72	73	75	76	77	79	80
60	81	83	84	85	87	88	89	91	92	94
70	95	96	98	99	100	102	103	104	106	107
80	108	110	111	113	114	115	117	118	119	121
90	122	123	125	126	127	129	130	132	133	134

FT-LB	0	100	200	300	400	500	600	700	800	900
NM	–	136	271	407	542	678	813	949	1085	1220
FT-LB	**0**	**1000**	**2000**	**3000**	**4000**	**5000**	**6000**	**7000**	**8000**	**9000**
NM	–	1356	2712	4067	5423	6779	8135	9491	10,847	12,202

Table 8-15. Systems of Units — Fluid-Ounce (OZ) to Milliliter (ML) Conversions

OZ (US)	OZ (IMPERIAL)	ML
0.1	0.1	3.0
0.2	0.2	5.9
0.3	0.3	8.9
0.4	0.4	11.8
0.5	0.5	14.8
0.6	0.6	17.7
0.7	0.7	20.7
0.8	0.8	23.7
0.9	0.9	26.6
1.0	1.0	29.6
2.0	2.1	59
3.0	3.1	89
4.0	4.2	118
5.0	5.2	148
6.0	6.2	177
7.0	7.3	207
8.0	8.3	237
9.0	9.4	266
10.0	10.4	296
20.0	20.8	591
30.0	31.2	887
40.0	41.6	1 183
50.0	52.0	1 479

Table 8-16. Systems of Units — Gallon (GAL) to Liter (L) Conversions

GAL (US)	GAL (IMPERIAL)	L
1	0.83	3.79
2	1.67	7.57
3	2.50	11.36
4	3.33	15.14
5	4.16	18.93
6	5.00	22.71
7	5.83	26.50
8	6.66	30.28
9	7.49	34.07
10	8.3	37.85
20	16.7	76
30	25.0	114
40	33.3	151
50	41.6	189

Table 8-17. Systems of Units — Degree Fahrenheit (°F) to Degree Celsius (°C) Conversions

°F	°C	°F	°C	°F	°C	°F	°C
-100	-73.3	425	218.1	950	509.5	1475	800.9
-85	-64.9	440	226.4	965	517.8	1490	809.2
-70	-56.6	455	234.8	980	526.1	1505	817.5
-55	-48.3	470	243.1	995	534.5	1520	825.8
-40	-40.0	485	251.4	1010	542.8	1535	834.2
-25	-31.6	500	259.7	1025	551.1	1550	842.5
-10	-23.3	515	268.1	1040	559.4	1565	850.8
5	-15.0	530	276.4	1055	567.8	1580	859.1
20	-6.7	545	284.7	1070	576.1	1595	867.5
35	1.7	560	293.0	1085	584.4	1610	875.8
50	10.0	575	301.4	1100	592.7	1625	884.1
65	18.3	590	309.7	1115	601.1	1640	892.4
80	26.6	605	318.0	1130	609.4	1655	900.8
95	35.0	620	326.3	1145	617.7	1670	909.1
110	43.3	635	334.7	1160	626.0	1685	917.4
125	51.6	650	343.0	1175	634.4	1700	925.7
140	59.9	665	351.3	1190	642.7	1715	934.1
155	68.3	680	359.6	1205	651.0	1730	942.4
170	76.6	695	368.0	1220	659.3	1745	950.7
185	84.9	710	376.3	1235	667.7	1760	959.0
200	93.2	725	384.6	1250	676.0	1775	967.4
215	101.6	740	392.9	1265	684.3	1790	975.7
230	109.9	755	401.3	1280	692.6	1805	984.0
245	118.2	770	409.6	1295	701.0	1820	992.3
260	126.5	785	417.9	1310	709.3	1835	1000.7
275	134.9	800	426.2	1325	717.6	1850	1009.0
290	143.2	815	434.6	1340	725.9	1865	1017.3
305	151.5	830	442.9	1355	734.3	1880	1025.6
320	159.8	845	451.2	1370	742.6	1895	1034.0
335	168.2	860	459.5	1385	750.9	1910	1042.3
350	176.5	875	467.9	1400	759.2	1925	1050.6
365	184.8	890	476.2	1415	767.6	1940	1058.9
380	193.1	905	484.5	1430	775.9	1955	1067.3
395	201.5	920	492.8	1445	784.2	1970	1075.6
410	209.8	935	501.2	1460	792.5	1985	1083.9

Table 8-18. Systems of Units — Degree Celsius (°C) to Degree Fahrenheit (°F) Conversions

°C	°F	°C	°F	°C	°F	°C	°F
-100	-148	180	356	460	860	740	1364
-90	-130	190	374	470	878	750	1382
-80	-112	200	392	480	896	760	1400
-70	-94	210	410	490	914	770	1418
-60	-76	220	428	500	932	780	1436
-50	-58	230	446	510	950	790	1454
-40	-40	240	464	520	968	800	1472
-30	-22	250	482	530	986	810	1490
-20	-4	260	500	540	1004	820	1508
-10	14	270	518	550	1022	830	1526
0	32	280	536	560	1040	840	1544
10	50	290	554	570	1058	850	1562
20	68	300	572	580	1076	860	1580
30	86	310	590	590	1094	870	1598
40	104	320	608	600	1112	880	1616
50	122	330	626	610	1130	890	1634
60	140	340	644	620	1148	900	1652
70	158	350	662	630	1166	910	1670
80	176	360	680	640	1184	920	1688
90	194	370	698	650	1202	930	1706
100	212	380	716	660	1220	940	1724
110	230	390	734	670	1238	950	1742
120	248	400	752	680	1256	960	1760
130	266	410	770	690	1274	970	1778
140	284	420	788	700	1292	980	1796
150	302	430	806	710	1310	990	1814
160	320	440	824	720	1328	1000	1832
170	338	450	842	730	1346	1010	1850

8-36. THERMAL FIT PARTS

Unless otherwise specified in the procedure of the applicable manual, bulletin, or instruction, the cooling of the inner (male) part should be enough to get the required dimensional changes (paragraph 8-37).

If necessary, it is permitted to heat the outer (female) part provided the following restrictions:

- Do not exceed the maximum temperature specified in Table 8-19 for the material.
- Do not heat the outer part to the maximum temperature specified in Table 8-19 for more than 2 hours.

8-37. THERMAL FIT PARTS — METHODS OF SECURING DIMENSIONAL CHANGES

MATERIALS REQUIRED

Refer to Chapter 13 for specifications.

NUMBER	NOMENCLATURE
C-020	Lubricating Oil
C-326	Denatured Alcohol
C-516	Clean Cloth
C-517	Nitrogen (Liquid)

1. Parts shall be clean prior to assembly (Chapter 5).

NOTE

When the instructions specify the use of primers or sealant on the thermal fit assembly, the specified primer or sealant shall be applied in lieu of oil, and may be applied before or after cooling or may be applied to the housing. If primer/sealant is applied to the housing, the housing temperature shall not be greater than 265°F (129°C).

NOTE

When using liquid nitrogen for cooling, oiling of the inner part is not practical.

2. Apply a film of lubricating oil (C-020) by dipping, brushing, or wiping with an oil-saturated clean cloth (C-516) to either the outer part (e.g., housing, sleeve, etc.) or the inner part (e.g., bushing, liner, etc.).

3. Cooling shall be accomplished as follows:

a. Cool inner parts, as required, using a refrigerator, cold box, a mixture of dry ice and denatured alcohol (C-326), or nitrogen (liquid) (C-517).

4. If necessary, heating shall be accomplished as follows:

a. Heat outer parts by placing in an oven, using a heat lamp, or by immersion in a bath of hot lubricating oil (C-020). Parts shall not be allowed to remain at the temperature specified in Table 8-19 for longer than 2 hours.

5. Assemble the parts immediately after you remove the part(s) from the cooling and/or heating media, as applicable.

8-38. UNWANTED PARTICLES

Particles can be found in any of the following parts:

- Chip detector(s) of the component
- Oil drained from the component
- Oil filter element for transmission assemblies
- Screen housing at the oil pump inlet of transmission assemblies
- Screens on the oil jets of transmission assemblies

The presence of unwanted particles may indicate the failure of one or more parts of the component. However, it does not necessarily mean that the component is not serviceable.

To determine the serviceability of a component, you must consider the following:

- Quantity, source, form, and type of material found
- Amount of time in service since the component was new or overhauled
- Previous failures
- Type of operation

Table 8-19. Thermal Fit Parts — Material Versus Maximum Temperature

MATERIAL	MATERIAL ALLOY	HEAT TEMPER GRADE	MAXIMUM TEMPERATURE
Magnesium	AZ61	T6	275°F (135°C)
	AZ63	T6	275°F (135°C)
	AZ80	T6	275°F (135°C)
	AZ91	T6	275°F (135°C)
	AZ92	T6	275°F (135°C)
	ZK60A	T5	275°F (135°C)
	ZE41A	T5	275°F (135°C)
	QE22A	T6	275°F (135°C)
	WE-43	T6	275°F (135°C)
	EV-31A	T6	275°F (135°C)
Aluminum	40E	T5	300°F (149°C)
	195	T6	300°F (149°C)
	A357/357	T6X	300°F (149°C)
	2014	T6	300°F (149°C)
	2024	T6	300°F (149°C)
	6061	T6	300°F (149°C)
	7050	T7X	300°F (149°C)
	7075	T73	300°F (149°C)
	7075	T6	250°F (121°C)
	7075	T76	250°F (121°C)
	A356/356	T6	295°F (146°C)
	A357/357	T6X	295°F (146°C)
	2024	T3	200°F (93°C)
	2024	T4	200°F (93°C)
	△1	–	200°F (93°C)
Steel	△2	△2	275°F (135°C)
	All other steel parts	All other steel parts	450°F (232°C)
Titanium	All	All	450°F (232°C)

NOTES:

△1 All shot peened aluminum.

△2 Carburized parts, induction hardened parts, and parts tempered at 300° to 450°F (149° to 232°C).

The type of material for the particles can be steel, silver, aluminum, magnesium, bronze, copper, phenolic, or rubber (paragraph 8-39).

8-39. UNWANTED PARTICLES — VISUAL IDENTIFICATION

1. Visually identify the unwanted particles in shape, size, quantity, and type of material as follows:

a. Visually examine the color and hardness of the particles.

b. Refer to Table 8-20 to determine the probable cause and the corrective action to perform after you identify the particles.

NOTE

There is evidence of ferrous metal particles on a chip detector if the related caution indication (message/annunciator) is shown on the display unit or caution and warning panel, as applicable.

c. Identify and collect ferrous metal particles from screens or filter elements with a permanent magnet.

d. Refer to Figure 8-5 to identify the ferrous particles on chip detectors, the probable cause, and the corrective action to perform.

e. A small amount of minute particles is a sign of normal wear. If the particles are too small to be visually identified, do a chemical identification of the particles (paragraph 8-40).

2. When the particles are large enough to be identified as fragments of a part such as a gear, a bearing, etc., you must replace or repair the component. Refer to the applicable Component Repair and Overhaul manual (CR&O).

3. If there is evidence of metallic particles but you are not sure about the serviceability of the component, do a serviceability check. Refer to the applicable Maintenance Manual (MM).

8-40. UNWANTED PARTICLES — CHEMICAL IDENTIFICATION

SPECIAL TOOLS REQUIRED

NUMBER	NOMENCLATURE
Commercial	Test Tubes (Qty 2)

MATERIALS REQUIRED

Refer to Chapter 13 for specifications.

NUMBER	NOMENCLATURE
C-431	Hydrochloric Acid
C-432	Nitric Acid
C-501	Sodium Chloride

NOTE

The process of chemical identification allows you to identify minute particles that are too small to be examined for color and hardness.

NOTE

Identification of silver plate flakes in the oil is not cause for replacement of the component.

Silver plate is a soft material that is used as an additional lubricant for gear meshing, therefore it is not critical to the component.

1. To identify a silver particle, do the following:

WARNING

ALWAYS ADD ACID TO WATER. NEVER ADD WATER TO ACID. IF WATER IS ADDED TO ACID, A VIOLENT CHEMICAL REACTION CAN OCCUR AND CAUSE INJURIES TO PERSONS.

a. Mix a solution of 50% by volume of nitric acid (C-432) and 50% of water in a test tube.

b. Mix a solution of 5% by weight of sodium chloride (C-501) and 95% of water in a second test tube.

Table 8-20. Unwanted Particles — Visual Identification

MATERIAL	DESCRIPTION	CORRECTIVE ACTION	CAUSE
Aluminum Magnesium	Particles are in granular form or particles look like miniature lathe turnings.	No action is required if the quantity is small and the particles are found at the first inspection after an overhaul or major maintenance. Replace or repair the component if the quantity is large or if particles are found at subsequent inspections. ⚠1	This can be the result of the use of mallets or drifts at assembly. It can also indicate wear on the oil pump internal surfaces or an unusual interference.
Silver	Small amount of particles in flake form or powder.	No action is required if you find the particles during the first 100 hours of operation, at overhaul, or at first inspection. Replace or repair the component if you find the particles after the first inspection of the first 100 hours and the quantity is large. ⚠1	This can be the result of wear on silver plated parts such as bearing cages and input pinion gear teeth. The quantity can be relatively large until the part is fully "broken-in".
Copper (Bronze)	Particles are in a granular form.	Replace or repair the component if the quantity is large. ⚠1	This can be the result of wear on the oil pump sleeve bearings or the bronze cages.
	Chips.	None	This can be the result of the use of mallets or drifts at assembly.
Phenolic	Chips, flakes, or powder.	None	This can be the result of the use of mallets or drifts at assembly.
Rubber	Different shapes and sizes; usually have one rounded side.	None	Material cut from the packings at assembly.

NOTE:

⚠1 Refer to the applicable Component Repair and Overhaul manual (CR&O) for repair information.

MATERIAL (STEEL) FOUND ON THE CHIP DETECTORS

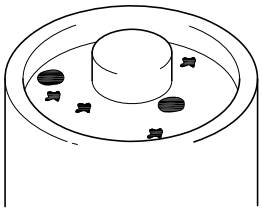
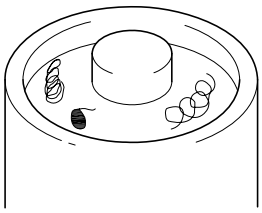
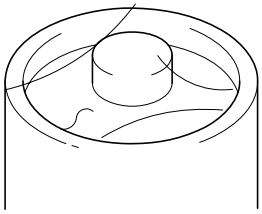
DETAIL	DESCRIPTION	SIGNIFICANCE	CORRECTIVE ACTION
	Tiny whisker-like particles. Groups of dark microscopic particles. Chips disappear into a large black smudge when removed. The common term for this condition is sludge or fuzz.	Insignificant debris. Generally microscopic wear particles caused by normal wear within the drive system components. The particles are often grouped by the magnetic field of the chip detector magnet and take on the shape of apparently larger chips.	If the component has several hundred operating hours, no maintenance is necessary. Clean and install the chip detector. If the component is relatively new or recently overhauled, do a serviceability check.
	Spiral curls or comma-shaped particles. Under magnification, the particles are often smooth and shiny on their convex surfaces and quite rough on other surfaces and edges. The color of the particles is usually dull gray on the rough surfaces. The common term for this condition is manufacture debris.	Insignificant debris. The particles are fragments of chips or shavings caused by machining of ferrous metal components. Such contamination is often introduced into the drive system components on the tools at the compressed air dust operations within the component assembly area.	The same procedure as above if you find the particles within the first 50 hours of operation of a new or overhauled component. If you find the particles after the first 50 hours of operation, do a serviceability check.
	Hair-like ferrous debris. Subject debris can have a rectangular or triangular cross section gradually reaching 0.080 inch (2.03 mm) or less in thickness. The length can range from 0.10 inch (2.54 mm) to over 1.0 inch (25.4 mm). The color of the debris is usually light gray, although one or more sides can have a black appearance. The common name for this condition is hairs.	Insignificant debris. This debris is normally scrap that is made as the components are interference fitted together at the assembly of the drive system components. The debris of this general shape is also made after a long term operation at the corners of the wear surfaces. This type of debris can also be made at the opening of lubrication oil cans and can be introduced into the components at the fill procedure.	The same procedure as above.

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Figure 8-5. Visual Identification of Ferrous Particles on Chip Detectors (Sheet 1 of 2)

MATERIAL (STEEL) FOUND ON THE CHIP DETECTORS

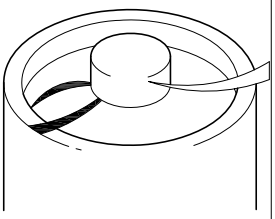
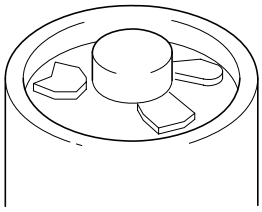
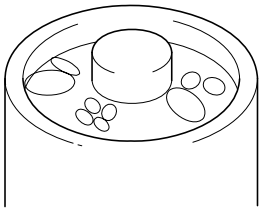
DETAIL	DESCRIPTION	SIGNIFICANCE	CORRECTIVE ACTION
	Irregular shaped ferrous metal particles. The particles are usually trlangular In cross section. The particles are often spike-like in appearance. Under magnification, one side of a triangular section will usually look sheared. The color of the particles can be silver gray or black with one or more silver sides. Existence of two or more particles of this type on the chip detector at one time is rare. The common name for this condition is manufacture debris.	Insignificant debris. The particles of this type are commonly a result of tool slippage at assembly of the drive system components.	The same procedure as above.
	Irregular shaped ferrous chunks of different sizes and shapes. Under magnification, one or more sIdes of the particles look rough and grainy. The color of the partIcles Is often sIlvery gray with one or more black sides. No common term for this condition.	Significant debris. Existence of this type of debris shows that the gear and/or bearing is damaged within the drive system components.	Repair or replace the component.
	Few moderately sized and/or numerous small nearly flat pieces. Under magnification, one side of the flake appears very smooth. The flakes are silvery in color with black sides. The common name for this condition is flakes.	Significant debris. The particles of this description are classic signs of the rolling element bearing fallure. They are also less common signs of gear tooth spalling.	Repair or replace the component.

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Figure 8-5. Visual Identification of Ferrous Particles on Chip Detectors (Sheet 2 of 2)

c. Add a particle of the material to be tested to the nitric acid solution. If the particle does not dissolve, slightly warm the solution.

d. When the particle dissolves, add a few drops of the sodium chloride solution to the nitric acid solution.

e. If a white precipitate forms, the particle is silver.

2. Empty the two test tubes and rinse with water until they are clean.

3. To identify a copper or bronze particle, do the following:

a. Put a small quantity of nitric acid (C-432) in a test tube.

b. Add a particle of the material to be tested to the nitric acid (C-432).

c. If a green precipitate forms, the particle is copper or bronze.

4. Empty the test tube and rinse with water until it is clean.

5. To identify an aluminum particle, do the following:

a. Put a small quantity of Hydrochloric acid (C-431) in a test tube.

b. Add a particle of the material to be tested to the Hydrochloric acid (C-431).

c. If the particle gradually disintegrates with a rapid emission of bubbles and forms a black residue (aluminum chloride), then it is aluminum.

6. Empty the test tube and rinse with water until it is clean.

7. To identify a magnesium particle, do the following:

a. Put a small quantity of nitric acid (C-432) in a test tube.

b. Add a particle of the material to be tested to the nitric acid (C-432).

NOTE

If the particle is aluminum, there will be no effect with the nitric acid (C-432).

c. If a rapid emission of bubbles occurs, the particle is magnesium.

8. Empty the test tube and rinse with water until it is clean.