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CHAPTER 70 - STANDARD PRACTICES - ENGINE

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TERMS AND ABBREVIATIONS - DESCRIPTION AND OPERATION

1. General
   A. This section defines terms and abbreviations used throughout the power plant sections of the maintenance manual.
2. Terms
   A. Use NOTEs, CAUTIONs, and WARNINGs as follows:

WARNING: WARNINGS CALL ATTENTION TO METHODS, PROCEDURES, OR LIMITS WHICH, IF NOT PRECISELY FOLLOWED, POSE A PARTICULAR RISK OF INJURY OR DEATH TO PERSONS.

(1) The WARNING is above the step to which it applies.

CAUTION: CAUTIONS CALL ATTENTION TO METHODS AND PROCEDURES WHICH, IF NOT PRECISELY FOLLOWED, POSE A PARTICULAR RISK OF EQUIPMENT DAMAGE.

(2) The CAUTION is above the step to which it applies.
(3) The NOTE is below the step to which it applies.

NOTE: Notes call attention to methods which make a task easier, or provide supplementary or explanatory information.

B. The following terms are used to describe/define defects.

Terms	Definition	Associated Terms
Blister	A raised portion of a surface caused by separation of the outer layers of the parent material or of a coating applied to it.	Bubble Flaking Oxide Formation Peeling Scale Slag inclusion (weld)
Brinelling	Indentation of the surface by concentrated loads or impact.	Peening Hammering
Brittle	A material characteristic which makes it likely to break, become fragile and susceptible to impact cracking. It is usually caused by aging, extreme cold, chemical action, or cold-working.	Cold worked hard (like an old O-ring)

Terms	Definition	Associated Terms
Buckle	A large-scale deformation of the original contour of a part, usually caused by pressure or impact from a foreign object, structural stresses, excessive localized heating, high-pressure differentials, or any combinations of these.	Ballooning Bend Bulge Crease Curl Dent (not to be confused with small-area defect in heavy material) Depression Distortion Elongation Fold Indentation Kink Protrusion (hollow) Rupture (result of excessive buckling) Uneven Warpage Wrinkle
Burn	A rapid, destructive, oxidizing action, usually caused by higher temperatures than the parent material can withstand. Change in color appearance often indicates this condition.	Burn out (missing piece) Erosion Corrosion Guttered Heat-check Heat deterioration hole (burn) Hot spot Overheated Oxidation

Terms	Definition	Associated Terms
Burnishing	Smoothing a metal surface by mechanical action, but without a loss of material. Generally found on plain bearing surface. Surface discoloration is sometimes visible around the outer edges. Normal burnishing from operational service is not detrimental if the coverage approximates the carrying load and there is no evidence of burns.	Rub Wear
Burr	A rough edge or a sharp protrusion on the edge or surface of the parent material.	
Chafing	See "Gall" or "Scratch".	
Chip	A breaking away of the edge of the parent material, usually caused by heavy impact from a foreign object.	Break Nick (similar to Chip but no parent material is removed) Notched spalling (usually a broken-away flat surface)
Cold shut	A forging or casting defect resulting from metal flowing into an area from two directions, thereby forming a discontinuity at the meeting line.	Seam
Corrosion	A mass of small pits which cumulatively create a large, shallow cavity (usually rough in the surface of the parent material).	Pit

Terms	Definition	Associated Terms
Crack	A parting or discontinuity in the parent material.	Break Cold shut (castings) Crater (castings) Fatigue damage Fissure
Crack (Fabrications)	A parting of parent metal or of the metal in a welded zone. Parent metal crack limits include all cracks in the parent metal beyond the heat-affected zone, as measured 1/8 inch (3.175 mm) from the weld fusion line. Weld crack limits include all cracks in the heat affected zone.	Fracture Lap (forgings) Rupture Seam Separation Split Tear
Crazing	A mesh of minute hairline cracks found in glazed or baked-on coated surfaces, generally caused by temperature change or by deformation of parent metal. Cracks do not penetrate into parent metal.	
Creep	Gradual continuous distortion or plastic flow under constant stress.	
Deformation	Any alteration or change of shape, dimension or configuration resulting from stress or damage.	Bend Creep Distortion
Dent	A completely smooth surface depression caused by pressure or impact from a smooth, rounded foreign object. The parent material is displaced, but none is separated.	Peen

Terms	Definition	Associated Terms
Deviation	Any condition that causes a part to differ from the manufacturer's blueprint.	Damage Defect Flaw Imperfection Irregularity
Discontinuity	An interruption in the normal physical structure or configuration of a part.	Crack Seam Cold shut Lap
Distortion	Any twisting, bending or permanent strain that results in misalignment or change of shape.	Bend Deformation
Erosion	Gradual wearing away of a surface caused by a fluid (gas or liquid) flowing over the surface. Wear is generally caused by fine particles of foreign material entrained in hot engine gases flowing at a high velocity.	
Fatigue	The progressive fracture of a material under cyclic stress loading.	Crystallization Fretting Flaking
Flaking	See "Spalling".	
Fretting	Wearing away by low amplitude rubbing against another metal (generally associated with press fit or close fitting parts).	Wear Galling

Terms	Definition	Associated Terms
Galling	A defect caused by the movement of two surfaces in contact with each other. In most cases, an accumulation of foreign material is deposited on the parent material.	Pickup
Gouge	A wide, rough scratch or group of scratches, usually with one or more sharply incised corners, and frequently accompanied by deformation or removal of parent material.	
Groove	A long, narrow, continuous depression caused by pressure of a moving surface in contact with the parent material.	If depression is shollow and smooth, see "Wear"; if depression is sharp, see "Scratch".
High spots	Local distortions	Blister Buckle Bubble Out-of-round
High metal	Displaced metal adjacent to a defect such as a scratch, nick or gouge, which is raised above the surrounding.	Burr
Imbalance	The state of being out-of-balance. Unequal distribution of weight about the axis of rotation, which usually results in vibration.	

Terms	Definition	Associated Terms
Inclusion	Foreign material embedded in metal during solidification, or formed by subsequent reaction of the solid metal.	
Indication	The visible evidence that a material defect exists, even though the defect itself may not be visible to the naked eye.	
Looseness	Abnormal movement of a part, or insufficient securing of a part.	Backed out Excessive play Excessive backlash Insufficient torque Shaky Sloppy Unbottomed Unpinned Unwired
Misalignment	A mismatching or malformation of any part which either prevents perfect assembly or results in faulty operation and/or ultimate failure.	Eccentric Out-of-round Out-of-square Mismatched Unmatched
Nick	A surface impression with sharp corners or bottom, usually caused by pressure or impact from a sharp-edged object. The parent material is displaced, but usually none is separated.	Chip Dent Notch
No Apparent Depth	Term used to describe surface defects that can be seen but not felt with fingernail or scriberpoint.	

Terms	Definition	Associated Terms
Noise	An abnormal sound involving moving parts, usually an increase in volume or a change of pitch.	Bumps (sound) Chatters Clicks Grates (usually gears) Grinds Hums Rattles Rubs Scrapes (sound) Screeches Thumps Whistles
Obstruction	Prevention of free flow of a fluid (air, oil, fuel, water) because of foreign material in the flowpath or malformation of the part.	Clogged Contaminated Plugged Restricted
Oil-canning (Snapping action)	Snapping or popping displacement of sheet metal when restained at its edges like a diaphragm, wall, or bottom of an oil can.	Buckling
Parent Metal	All material in a single part except the weld, braze filler, or heat affected zone (within 1/8 inch (3.175 mm) of the fusion line).	
Pickup	Transfer of one material to the contacting surface of another. Usually as a result of friction-heating.	Burr Gall Imbedment Inclusion Pile-up Protrusion Metallization

Terms	Definition	Associated Terms
Pinched	Distortion of one or more surfaces of the parent material, caused by pressure.	Bound Compressed Flattened Seized Smashed (without separation into pieces) Squashed Squeezed
Pit	A minute depression or cavity having no sharp, high-stress corners in the surface of the material. Pits are usually caused by chemical reaction (rusting, chemical corrosion).	Corrosion Crater Electrolytic cavity Inclusion Perforation Pinholes Pock-marked
Porosity	Areas containing numerous pits or pinholes.	Pit Pinholes
Rub	A surface depression or displacement caused by two surfaces moving while in contact with each other.	If impression is shallow and smooth, see "Wear"; if impression is sharp, see "Scratch".
Scale	A layer of metallic oxides formed by chemical action of oxygen on the exposed surface of the metal, usually while hot.	Burn
Scratch	A long, narrow, sharp-cornered impression caused by the movement of a sharp object across the surface of the parent material.	Abrasion Chafe Furrow Groove Score

Terms	Definition	Associated Terms
Seizure	A welding or binding of faces which prevent further movement.	Bound up Frozen Tight Wedged Welded (without external heating)
Spalling	Cracking off or flaking off of small particles of metal from the surface, usually in thin layers or localized spots.	Flaking Fretting Galling
Unbalance	The act of putting a balanced component out of balance. Usually "imbalance" is meant.	
Varnish film	A hard surface-film of partially carbonized hydrocarbon, such as oil, which is built up when the part is heated to or above the breakdown-point of the fluid. oil, which is built up when the	Banded Discolored Oxidized Stained Oxidized
Wear	Relatively slow removal of parent material in the process of operation (not always visible to the naked eye).	Abrasion Attrition Brinnelled Chafed Chattering Erosion Fraying Fretting Friction Galling Glazing Groove Interference Oxidation Roughness Rubbed Scarfed Scuffed Uneven Weak

3. Abbreviations

A. The following abbreviations are used for terms that appear in the power plant sections of the maintenance manual.

ABBREVIATIONS and ACRONYMS	
ac	Alternating Current
ACC	Active Clearance Control
ACMS	Aircraft Condition Monitoring System
ADC	Air Data Computer
AGB	Accessory Gearbox
API	Angle Position Indicator
APU	Auxilary Power Unit
AVM	Airborne Vibration Monitor
BAT	Battery
BITE	Built in Test Equipment
BMS	Boeing Material Standard
CBP	Compressor Bleed Pressure
cc	cubic centimeter
cc/hr	cubic centimeters per hour
CDP	Compressor Discharge Pressure
CDU	Center Drive Unit (Thrust Reverser)
CG	Center of Gravity
CIT	Compressor Inlet Temperature
cm	centimeter
CMCS	Central Maintenance Computer System
Cont	control
CRF	Compressor Rear Frame
dc	Direct Current
Dia	Diameter
dim.	dimension
DCV	Directional Control Valve (thrust reverser)
DPV	Directional Pilot Valve (thrust reverser)

ABBREVIATIONS and ACRONYMS	
ECS	Environmental Control System
ECU	Electronic Control Unit
EEC	Electronic Engine Control
EFIS	Electronic Flight Instrument System
EGT	Exhaust Gas Temperature
EHSV	Electrohydraulic Servo Valve
EICAS	Engine Indicating and Crew Alerting System
EIU	EFIS/EICAS Interface Unit
EMP	Electromagnetic Pulse
ENG	Engine
EPR	Engine Pressure Ratio
EROM	Electronic Readout Machine
FF	fuel flow
FFR	Fuel Flow Rate
Fig.	figure
FLT	Flight
FMC	Flight Management Computer
FOD	Foreign Object Damage
FP	Fuel Pressure
Fwd	Forward
GND	Ground
GRD	
gpm	gallons per minute
GSE	Ground Support Equipment
GW	Gross Weight
HMU	Hydromechanical Unit
HP	High Pressure
HPC	High Pressure Compressor
HPSOV	High Pressure Shutoff Valve
HPT	High Pressure Turbine
Hz	Hertz

ABBREVIATIONS and ACRONYMS	
ID	Inside Diameter
IDG	Integrated Drive Generator
IFSD	In Flight Shutdown
IGB	Inlet Gearbox
IGN	Igniter/Ignition
IGV	Inlet Guide Vane
INOP	Inoperative
IPC	Illustrated Parts Catalog
J	Joules
KIAS	Knots Indicated Air Speed
kg	kilogram
kgph	kilograms per hour
km/hr	kilometers per hour
kN	kiloNewton
kPa	kiloPascal
kPad	kiloPascal differential (pressure)
kV	kiloVolt
LE	Leading Edge
LED	Light Emitting Diode
LH	left hand
LLH	lower left hand
LP	Low Pressure
LPC	Low Pressure Compressor
LPT	Low Pressure Turbine
LRH	lower right hand
LRU	Line Replaceable Unit
LVDT	Linear Variable Differential Transducer
MAC	Mean Aerodynamic Chord
MAX	Maximum
MCD	Magnetic Chip Detector
MHz	Megahertz
MIN	Minimum
MIS	Metal In Screen (Analysis)
mm	millimeter
Mo	Mach Number
MPa	Megapascal
MPA	Maximum Power Assurance
mph	miles per hour

ABBREVIATIONS and ACRONYMS	
N	Newton
No.	number
N1	Low Pressure Rotor (Fan)
N2	High Pressure Rotor (Core)
N.m	Newton-meters
OAT	Outside Air Temperature
OD	Outside Diameter
OGV	Outlet Guide Vane
par.	paragraph
PB	Boost Discharge Pressure (fuel)
PBR	Fuel Control Bypass
pC/g	picoCoulomb per acceleration of gravity (vibration)
PD	Pump Discharge Pressure (fuel)
PFR	Filter Return Pressure (fuel)
PFS	Filter Supply Pressure (fuel)
PG	Heat Exchanger Supply Pressure
PLA	Power Lever Angle
PMUX	Propulsion Multiplexer
Po	Ambient Pressure (fuel)
pph	pounds per hour
PRSOV	Pressure Regulator and Shutoff Valve
PRV	Pressure Regulating Valve
psi	pounds per square inch
psid	pounds per square inch differential
PS14	Fan Discharge Pressure
PS3	11th-Stage Air Pressure
PT	Total Pressure
P25	HPC Inlet Pressure
P49	HPT Exhaust Pressure

ABBREVIATIONS and ACRONYMS	
QAD	Quick Attach Detach
QEC	Quick Engine Change
Ref	Reference
RH	right hand
rms	root mean square
rpm	revolutions per minute
RVDT	Rotary Variable Differential Transducer
SOAP	Spectrographic Oil Analysis Program
SSM	System Schematics Manual
sw	switch
TACH	Tachometer
TAI	Thermal Anti-Ice
TAT	Total Ambient Temperature
TCC	Turbine Clearance Control
TGB	Transfer Gearbox
TLA	Thrust Lever Angle
TLT	Thrust Lever Travel
T/R	Thrust Reverser
TRA	Thrust Resolver Angle
TRF	Turbine Rear Frame
T12	Hydromechanical Fan Inlet Temperature
T2	Electrical Fan Inlet Temperature
T25	Fan Temperature
T3	HPC Exhaust Temperature
T5	LPT Discharge Temperature
ULH	upper left hand
URH	upper right hand

ABBREVIATIONS and ACRONYMS	
V VBV VSV	Volt Variable Bypass Valve Variable Stator Vane
WDM	Wiring Diagram Manual

ASSEMBLY AND DISASSEMBLY TECHNIQUES - MAINTENANCE PRACTICES

1. General

A. Basic disassembly techniques applicable to many procedures are presented in this section. The following subjects are covered:

B. Parts or assemblies designated as matched will be maintained as matched sets throughout the maintenance process. Set numbers, part numbers, and serial numbers will be protected during cleaning or rework to prevent removal. When identification is removed or is no longer legible, item must be re-marked per original marking method.

C. Prior to installation of any part, a quick visual check should be made and any obvious discrepancies noted and reported, so that corrective action can be taken.

D. Observe all applicable precautions for removal and installation of parts as decribed in AMM 70-20-02/001.

TASK 70-20-01-402-001-J00

2. Electrical Bonding Straps Installation

A. General

(1) Electrical bonding strap contact surfaces shall be prepared by removing all anodic film, grease, paint, lacquer, or other high-resistance material from an area at least one and one-half times bonding surface contact area.

(2) For installation procedures for bonding jumpers (straps) and ground leads, refer to 20-11-15/401.

TASK 70-20-01-362-002-J00

3. Correction of Leaks

A. Access

(1) Location Zone

412 Engine 1
422 Engine 2
432 Engine 3
442 Engine 4

B. Procedure

S 032-003-J00

CAUTION: DO NOT OVERTIGHTEN THREADED FASTENERS AS MEANS TO CORRECT LEAKING CONNECTIONS. PARTS FAILURE COULD RESULT.

(1) Disassemble connection.

S 032-004-J00

(2) Discard seal, gasket, or preformed packing, if present.

S 212-005-J00

(3) Examine mating surfaces for contamination, scratches, dents, or other surface defects.

S 212-006-J00

(4) Examine threaded fasteners for thread damage and assure that fasteners seat properly when tightened to specified torque value.

S 432-007-J00

(5) Replace nonserviceable parts and assemble connection using new seals, gaskets, or preformed packings, as required.

TASK 70-20-01-502-008-J00

4. Unpacking and Repacking

A. General

(1) The following general instructions apply during unpacking and repacking to minimize possible part damage and contamination.

B. Access

(1) Location Zone

412 Engine 1
422 Engine 2
432 Engine 3
442 Engine 4

C. Procedure

S 542-009-J00

(1) Initially remove only that portion of pack necessary to mount part. Where possible, remove remainder of the pack, including protective closures, one at a time as each connection (fluid, air, or electrical) is made.

S 542-010-J00

(2) Retain protective closures and reusable pack components for repack purposes.

S 532-011-J00

(3) Install closures on each connection (fluid, air, or electrical) as it is disconnected.

S 532-012-J00

(4) When possible, repack part for storage or shipment using same pack in which replacement part was received.

S 532-013-J00

(5) When original pack components are not available, use locally available packing materials and container to pack part. Make sure that all ports, openings, connections, and mating surfaces are capped or covered and that part is protected from potential handling and environmental damage.

TASK 70-20-01-402-014-J00

5. Use of Jackscrews

A. General

(1) Jackscrew holes are often in flanges only thick enough to accept three or four threads. If regular bolts are used as jackscrews, tips must be blunt and polished. Ends of most standard bolts are chamfered, and first couple of threads are missing or incomplete. These should not be used as jackscrews without modification, since one or two threads will engage, and threads in flange are likely to strip. Jackscrews, frequently designed as such and identified as special tools, are not chamfered and full thread engagement will occur. If specially manufactured jackscrews are not available and must be locally manufactured, be sure that ends are ground to remove chamfers and incomplete threads, so that a maximum number of threads may be engaged.

(2) When using jackscrews to remove components, do not bend flanges or strip threads.

B. Consumable Materials

(1) D00389 Oil - Lubricating, GE Spec D50TF1 (GE C02-019)

C. Access
(1) Location Zone
412 Engine 1
422 Engine 2
432 Engine 3
442 Engine 4

D. Procedure

S 212-015-J00
(1) Check jackscrews for burrs or rough edges.

S 352-016-J00
(2) Remove any burrs or rough edges that are found on jackscrews.

S 422-017-J00
(3) Install jackscrews, lubricated with engine oil, turning evenly and in small increments.

NOTE: Do not allow component to fall free as jackscrews are tightened.

TASK 70-20-01-002-018-J00
6. Use of Protective Closures and Caps
A. General
(1) Use protective closures and caps to prevent foreign material from lodging in drilled passages, fuel lines, oil lines, air lines, and open engine ports. Machined surfaces must be properly protected to prevent damage.
(2) Wrap precision parts and cap or plug all openings and connections. It is most important that all engine parts be kept clean and free of corrosion. All instructions which require special handling of parts must be followed without exception.
(3) Accessories, tubes, and hoses may have oil or fuel in them at time of removal. Drain these fluids from accessory being removed, and cap all connecting hoses or tubes. Do not use tape as a protective cap.
(4) Do not remove plugs, caps, etc., until part is ready for assembly. Check both seating surfaces for removal of plugs, etc., prior to assembly.

TASK 70-20-01-402-019-J00

7. Gaskets and Preformed Packing Seals Practices

A. General

(1) Gaskets and preformed packing seals shall not be reused unless otherwise specified. Refer to 70-25-00/201 for reuse of seals (preformed packings and O-rings) and gaskets.

B. Consumable Materials

(1) D00389 Oil - Lubricating, GE Spec D50TF1 (GE C02-019)

C. Access

(1) Location Zone

412	Engine 1
422	Engine 2
432	Engine 3
442	Engine 4

D. Procedure

S 422-020-J00

(1) Install gasket or preformed packing seal, lightly lubricated with engine oil, unless otherwise specified. Ensure parts are properly seated in special case of a fitting with a jamnut and preformed packing.

TASK 70-20-01-402-021-J00

8. Tube Installation

A. References

(1) AMM 70-50-00/201, Tightening Techniques and Torque Values

B. Access

(1) Location Zone

412	Engine 1
422	Engine 2
432	Engine 3
442	Engine 4

C. Procedure

S 352-022-J00

(1) If tube is reworked, bend tube as follows:

(a) Use bending tools on tubes 1 inch (25.4 mm) or more in diameter to prevent tube from collapsing.

(b) Bend tube in existing straight sections if possible. Do not bend at fitting or weld area. Original bends in tube may be bent in same direction; no reverse bending is allowed.

(c) Bend radius shall not be less than twice tube diameter and bend angles shall not be changed by more than 3 degrees. No kinks or wrinkles are allowed.

S 392-023-J00

(2) Apply sealant if specified. Allow sealant to cure before installing. Wipe off any sealant on inside of tube with a clean cloth and water. Do not allow sealant to enter air systems.

S 422-024-J00

(3) Engage all tube fittings and tighten finger tight. Check that coupling nuts thread freely by hand and mating flanges on tube seat flush.

S 432-025-J00

(4) Install tube clamps per par. 9. and tighten finger tight.

S 212-026-J00

(5) Check that clearance between tube and each adjacent part is maintained.

S 432-027-J00

(6) Tighten the tube fittings and the clamps to the correct torque (AMM 70-50-00/201).

TASK 70-20-01-402-028-J00

9. Clamp Installation (Fig. 201)

A. Access

(1) Location Zone

412	Engine 1
422	Engine 2
432	Engine 3
442	Engine 4

B. Procedure

S 422-029-J00

(1) Chafing of hoses and tubes must be avoided. Clamp parts loosely in place, shift hoses around to obtain best clearance, then tighten clamps. Clamps must be proper size for piping to permit slippage during engine thermal growth.

S 432-030-J00

(2) Refer to Fig. 201 for correct and incorrect clamp installations.

TASK 70-20-01-402-031-J00

10. Electrical Cable Installation and Connections

A. Access

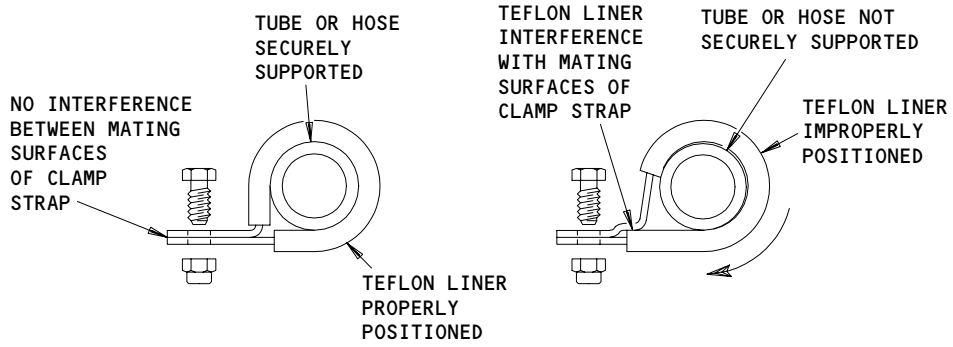
(1) Location Zone

412	Engine 1
422	Engine 2
432	Engine 3
442	Engine 4

B. Procedure

S 422-032-J00

(1) When installing electrical cable, adjust cable through clamps to get smoothest and largest radii. Sharp bends, twists, and kinks must be avoided. Minimum clearance between electrical cable and any component other than hoses or other electrical cables is 0.125 inch (3.2 mm).



Clamp Installation
Figure 201

S 212-033-J00

(2) A seal ring is located in coupling nut of each electrical connector. Check to make sure seal is present and serviceable before attaching connector.

S 962-034-J00

(3) Replace unserviceable seals as follows:
  (a) Remove unserviceable seal.
  (b) Engage new seal over barrel of connector.

  CAUTION: DO NOT ALLOW SEAL TO TIP AND FLATTEN ON CONNECTOR OR SEAL'S USEFULNESS WILL BE DESTROYED.

  (c) Push seal to seated position against internal shoulder in connector using a mating connector or blunt screwdriver.

S 212-035-J00

(4) Check that electrical connector pins are straight before connecting.

S 422-036-J00

CAUTION: DO NOT FORCE CONNECTORS TOGETHER. IF PINS ARE NOT ALIGNED, THEY WILL BE BENT OR DISTORTED AND WILL NOT MAKE COMPLETE CONTACT.

HOLD BOTH MATING CONNECTORS WHEN TIGHTENING CONNECTION OR LEAD MAY BE DAMAGED BY TWISTING.

(5) Install the electrical connectors as follows:
  (a) Put the connectors in their position.
    1) Make sure the pins on one connector are aligned with the holes in the other connector.
    2) Push the connectors together until the pins are fully in to the holes.

(b) Turn the knurled coupling ring with your hand and move the back shell assembly from side to side at the same time.

NOTE: This will put a cover over the witness band.

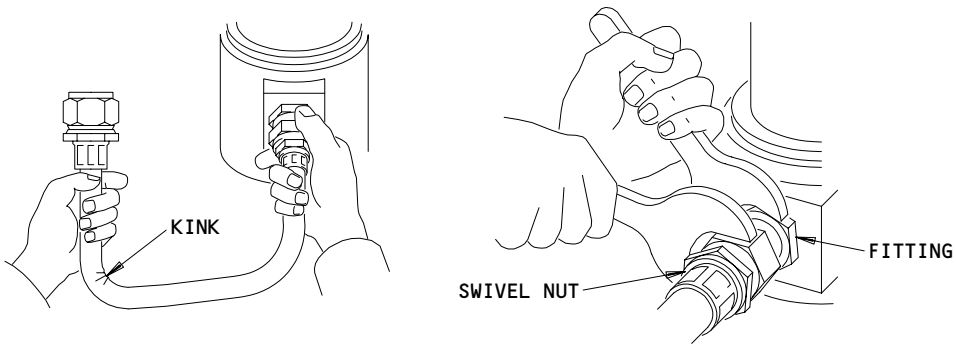
(c) Use the soft-jawed pliers or a strap wrench to tighten approximately 1/8 turn.
(d) Make sure the connector is tight.
1) Try to move the connector backshell assembly with your hand.
2) Make sure the assembly does not move.
3) If the connector is not tight, do the steps to install the connectors again.

S 432-038-J00

(6) Hand tighten the electrical connectors on the flexible harnesses and leads.
(a) Continue to tighten the connector but do not tighten more than 20 degrees.
(b) Tighten until the parts are in solid contact without damage.
(c) Lockwire the connectors only when specified in the procedure.

TASK 70-20-01-402-039-J00

11. Hose Installation (Fig. 202)
A. General
(1) When hoses are removed, open ends should be capped. Use of tape for capping is not allowed.
(2) Preformed hoses or hoses of large diameter must not be bent or straightened.
(3) No hose should be bent during installation, especially when parts are cold. Possible damage to Teflon liners may result.
(4) Kinked hoses must not be used.
(5) During installation, be sure that no hose is twisted or stretched.
(6) Never over-tighten connectors. Do not attempt to correct a leak by excessive tightening.
B. References
(1) AMM 70-50-00/201, Tightening Techniques and Torque Values
C. Consumable Materials
(1) D00389 Oil - Lubricating, GE Spec D50TF1 (GE C02-019)
D. Access
(1) Location Zone
412 Engine 1
422 Engine 2
432 Engine 3
442 Engine 4



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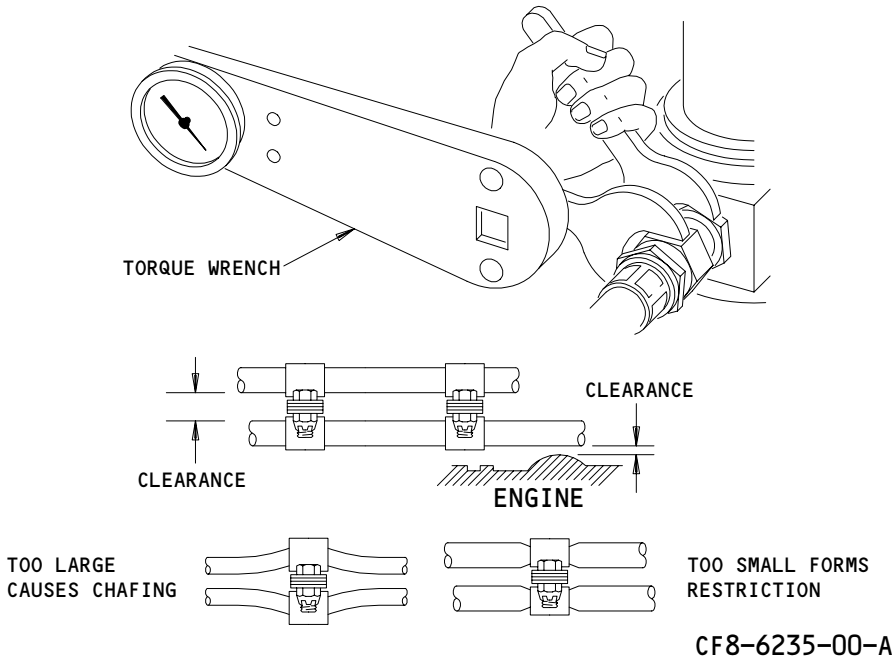

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Hose Installation
Figure 202

E. Procedure

S 212-040-J00

(1) Visually examine interior of preformed hose to assure Teflon lining is not damaged.
(a) Replace hose if lining is damaged.

S 422-041-J00

(2) Lubricate tube-hose coupling nut and ferrule with engine oil and install hose.

S 432-042-J00

(3) Tighten fluid fittings gradually to the necessary torque value (AMM 70-50-00/201), back off 1/4 turn, then tightened again.

NOTE: Use two wrenches when tightening swivel coupling nuts on hoses, tubes, or fittings. Hold stationary part with one wrench while you apply torque with the second wrench.

PRECAUTIONS DURING REMOVAL/INSTALLATION OF ENGINE COMPONENTS - DESCRIPTION AND OPERATION

1. General
   A. Engine Critical Areas
      (1) Special care must be taken each time maintenance operations are performed in engine critical areas. Extensive damage can result from foreign objects (FOD) entering the engine or from engine parts that are not properly secured. It is especially important that all critical areas at the engine and its immediate surrounding area be checked for cleanliness before each engine run.
      (2) The following are engine critical areas requiring special care:
         (a) Air inlet cowl.
         (b) Bleed valve compartments.
         (c) Interfaces with engine bleeds.
   B. General Precautions
      (1) If anything is dropped into an engine component, stop the assembly or disassembly procedure, then locate and remove the object even if complete disassembly is required.
      (2) Lift heavy parts with proper fixtures and hoist to prevent damage to parts or injury to personnel.
      (3) Hands and gloves must be clean when handling machined surfaces.
      (4) Metal hammers and drifts (including brass) shall not be used to force any engine components during maintenance. To prevent damage, plastic, nylon, or rawhide-faced hammers and drifts may be used for driving operations, if necessary.
      (5) Do not remove plugs or coverings from parts until part is to be installed.
      (6) Do not mix plated and unplated hardware. Do not use silver or cadmium plated tools or hardware on titanium parts. Plating contains small quantities of chlorine salts which are harmful to titanium.

      CAUTION: DO NOT USE WIRE BUNDLES, TUBING, DUCT, AND OTHER ENGINE COMPONENTS AS A STEP OR HAND-HOLD. DAMAGE TO EQUIPMENT MAY RESULT.

      (7) Use adequate ladders and work stands when performing maintenance on the engine.
      (8) The engine should not be used as a shelf for holding tools or parts while work is being performed.
      (9) Use of motor-driven hydraulic pumps to operate hydraulically actuated special support equipment other than torque multipliers is not recommended. Equipment damage can result from improper power application. Use hand-operated hydraulic pumps to operate hydraulically actuated special support equipment such as pushers or pullers, unless otherwise specified.
      (10) Before performing maintenance ensure the following have been accomplished:
         (a) Pockets of working clothes have been emptied of their contents.

(b) Soles of footwear are clean.
(c) All critical areas of engine and its immediate surroundings are free of non-essential tools and materials.

(11) After completion of maintenance ensure the following have been accomplished:
(a) All tools, rags, loose parts, and materials are removed.
(b) All clamps and brackets are secure.
(c) All loose wire (instrumentation and lockwire) is removed.
(d) Check that the vicinity of the air inlet cowl and engine variable bypass valve ducts are clear of any foreign objects. Use a vacuum cleaner to clean zones difficult to reach.
(e) Check that protective covers are installed.

2. Components and Accessories Removal
A. The practices related to seals and gaskets are covered in Seals (Preformed Packings and O-rings) and Gaskets (Ref 70-25-00/201).
B. Protect components and accessories against mechanical contact with metallic tools before removal.

WARNING: PROLONGED CONTACT OF LUBRICATING OIL CAN CAUSE DERMATITIS, OIL WILL STAIN CLOTHING AND CAN SOFTEN PAINT.

C. Accessories, tubes, and hoses may have oil or fuel in them at time of removal. Drain fluids from accessories being removed and cap all connecting hoses or tubes.
D. Protect openings with clean covers/caps, as required during removal of a component or accessory.
E. Protect the electrical connections when electrical systems are disconnected.
F. Protect all protruding ends such as the gearshafts and connections when removing a component.

3. Components and Accessories Installation
A. Record type and serial number before installing a component.
B. Visually check the general condition of the component and ensure it has not sustained any damage before installation.
C. All parts should be inspected for cleanliness before being installed.
D. Check that mounting faces and seal grooves are clean and not deteriorated.
E. Mating flanges, fittings, and couplings should be wiped clean to ensure obtaining a good seal.

CAUTION: REMOVE PROTECTIVE COVERS AND PLUGS IMMEDIATELY BEFORE ASSEMBLY.

F. Fit tube assemblies without applying force; however, a slight elastic distortion is allowed to engage connectors.

G. Do not handle bearings with bare hands or with any device that could cause contamination or scarring. Use clean rubber or plastic gloves. During assembly of bearings, do not apply force to balls or rollers.
H. Lubricate all gears and splines with oil before installing them, unless otherwise specified.
I. Use only the tools designed specifically for the operation.
J. Use fiber or plastic blocks to protect engine parts being assembled by means of pressing.

CAUTION: TO PREVENT DAMAGE TO THE HARDWARE, USE TWO WRENCHES TO REMOVE, INSTALL, AND TIGHTEN HOSE AND TUBE COUPLING NUTS: ONE TO RESTRAIN THE NIPPLE, THE OTHER TO LOOSEN OR TIGHTEN THE COUPLING NUT.

K. Check that threaded sections protrude by at least one thread relative to the nuts and chamfers at completion of tightening to final torque.

CAUTION: DO NOT PINCH, SQUEEZE, OR OTHERWISE DEFORM ANY SELF-LOCKING NUT TO OBTAIN OR REGAIN SELF-LOCKING TORQUE.

L. Do not use bolts, screws, or nuts which have damaged threads. Check all beam type (pinched castellated) and elliptically formed self-locking nuts for locking quality per AMM 70-50-00/201.
M. Inspect all blind tapped holes and remove any foreign material before installing stud or screw.
N. Comply with all the tightening torque values specified in the relevant sequence of operations.
O. Use new cotter pins, lockwashers, tab washers, spring washers, preformed packings, and gaskets throughout assembly unless specified. All lockwiring must be performed in accordance with instructions in 70-21-00/201.

LOCKING METHODS - MAINTENANCE PRACTICES

1. General
   A. This section describes standard practices for self-locking, hexagonal, and castellated nut installation, and for securing parts by use of cotter pins, tab washers, and lockwire.
   B. Locking devices are not a means of obtaining or maintaining torque, but are a safety measure to prevent the disengagement of fasteners and other parts by opposing any force tending to disengage the fasteners.
   C. Locking is closely associated with safety and, therefore, must be accomplished according to the best shop practices.

TASK 70-21-00-402-001-J00

2. Install Self-Locking, Hexagonal, or Castellated Nut (Fig. 201)
   A. References
      (1) AMM 70-50-00/201, Tightening Techniques and Torque Values
   B. Access
      (1) Location Zone

412	Engine 1
422	Engine 2
432	Engine 3
442	Engine 4

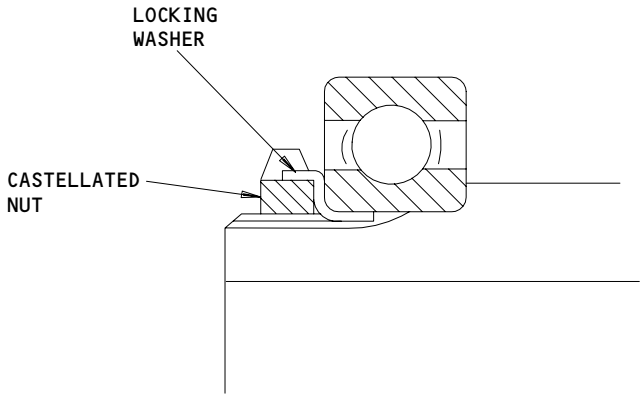
   C. Procedure

      S 212-002-J00
      (1) Check that new or used nuts meet assembly specifications.
         (a) Nuts that do not conform to specifications must be replaced.

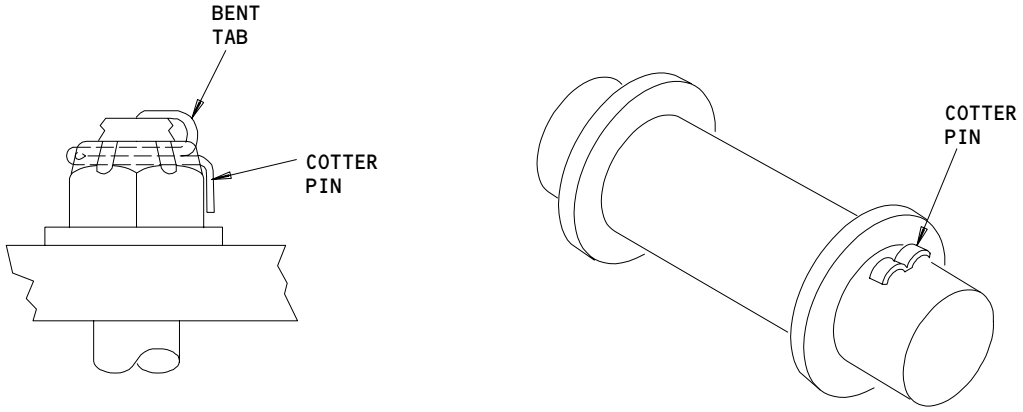
      S 422-003-J00
      (2) Install nut on bolt or stud.

      S 212-004-J00
      (3) Check that stud and bolt threads protrude through nuts by at least one thread (unless otherwise specified).

      S 432-005-J00
      (4) Tighten nut, using a suitable torque wrench, to the prescribed torque value (AMM 70-50-00/201).



Castellated Nut Installation
Figure 201



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Cotter Pin Installation
Figure 202

TASK 70-21-00-402-019-J00

3. Install Cotter Pin (Fig. 202)
   A. References
      (1) AMM 70-50-00/201, Tightening Techniques and Torque Values
   B. Access
      (1) Location Zone
          412 Engine 1
          422 Engine 2
          432 Engine 3
          442 Engine 4

   C. Procedure

      S 432-007-J00

      CAUTION: DO NOT EXCEED RECOMMENDED TORQUE VALUES. MORE THAN THE MAXIMUM TORQUE WILL CAUSE DAMAGE TO THE THREADS OF THE MATING PARTS.

      (1) Install a castellated nut on the bolt or stud and tighten to the minimum torque value (AMM 70-50-00/201).
          (a) Progressively tighten the nut, without more than the maximum torque value, until one slot on the nut is brought in line with the hole provided for the cotter pin.
          (b) If alignment is not possible, unscrew the nut by one-half turn and repeat tightening.
          (c) If correct alignment is still not possible, replace nut.

      S 422-008-J00

      CAUTION: COTTER PINS ARE NOT REUSABLE. USE NEW COTTER PIN FOR EACH ASSEMBLY OPERATION.

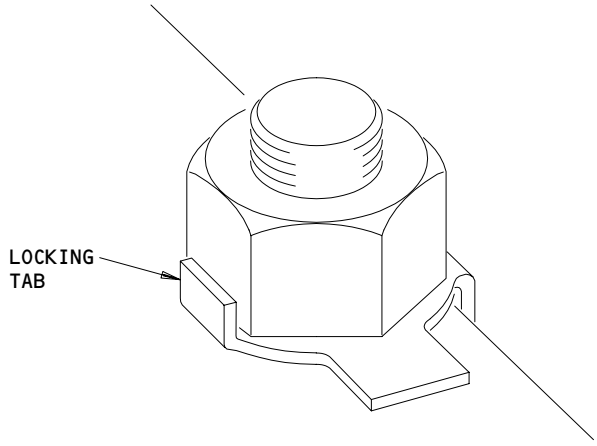
      (2) Install cotter pin with head seated firmly in slot of nut. Bend prongs of cotter pin so that head and upper prong are firmly seated against bolt.

TASK 70-21-00-402-009-J00

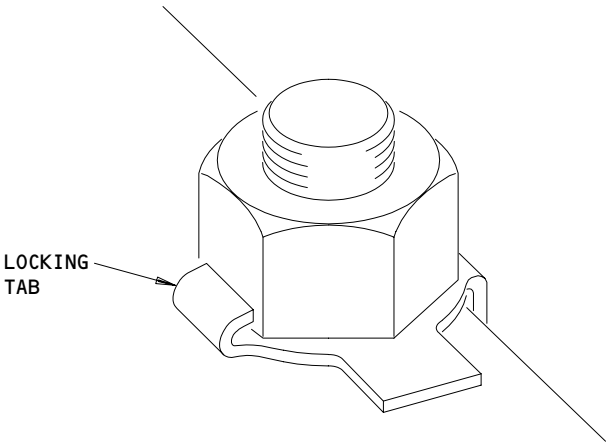
4. Install Tab Washer (Fig. 203)
   A. Access
      (1) Location Zone
          412 Engine 1
          422 Engine 2
          432 Engine 3
          442 Engine 4

   B. Procedure

      S 422-010-J00
      (1) Fit tab washer so that locking tab is butted against part with no tendency to untighten.



CORRECT



INCORRECT

CF8-1030-00-C

Tab Washer Installation
Figure 203

S 432-011-J00

(2) Bend locking tab snugly against flat of nut. Refer to Fig. 203 for correct method of bending tab.

TASK 70-21-00-402-021-J00

5. Install Lockwire

A. General

(1) Lockwiring is the securing of two or more parts with a wire installed so that any tendency of the part to disengage will be counteracted by additional tightening of the wire. When installing lockwire, observe the following general recommendations and specific techniques.

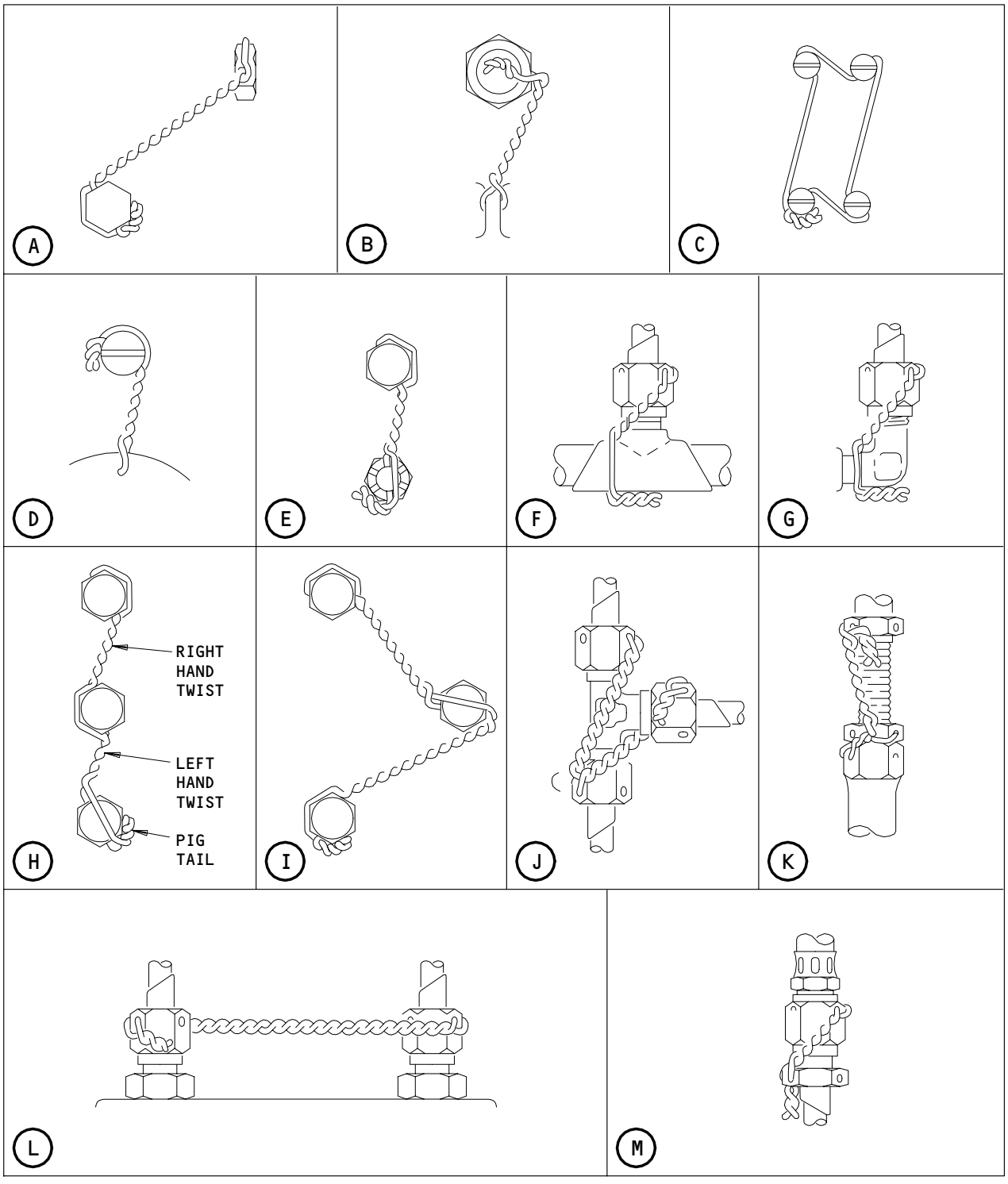
(2) Unless otherwise specified, lockwiring must be performed using NC15Fe wire 0.032 inch (0.81 mm) diameter.

(3) Install lockwire by twisting two strands together (the double-twist method). One twist is defined as that produced by twisting the wires through an arc of 180 degrees and is equal to one-half a complete turn. The single strand method (see C, Fig. 204) may only be used when specified.

(4) Do not install lockwire in such a way as to cause the wire to be subjected to chafing, fatigue through vibration, or additional tension other than the tension imposed on the wire to prevent disengagement.

(5) In all cases, wiring must be installed through holes provided. When no hole is provided, attach wire to a neighboring part so as not to interfere with the function of the parts, and in accordance with the recommendations of this section. See F and G, Fig. 204.

(6) The maximum span of lockwire between tension points is 6 inches (152 mm), unless otherwise specified. Where several fasteners form a group to be lockwired together by either the single-strand or the double-twist method, the maximum number of units in a series is limited to the number of units that can be lockwired by a 24 inch (610 mm) length of wire. When lockwiring widely spaced units in a group, using the double-twist method, not more than three units may be lockwired in a series. See H and I, Fig. 204.



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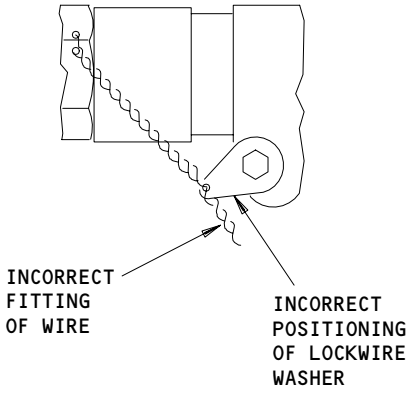
Lockwiring Practices
Figure 204 (Sheet 1)



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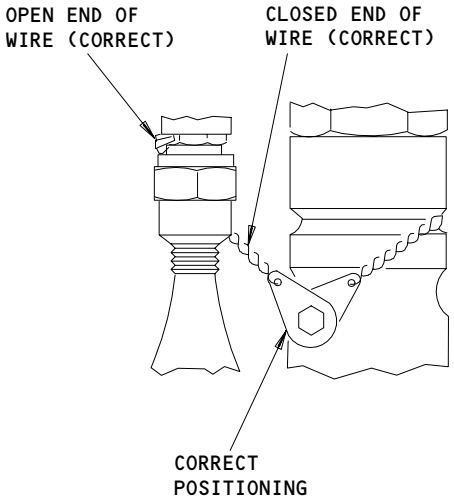
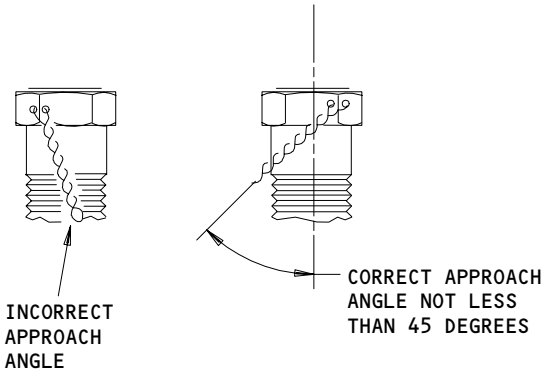
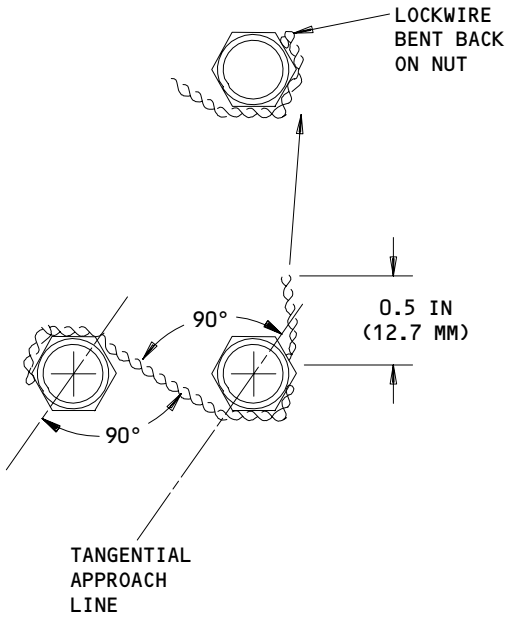


CORRECT



INCORRECT CORRECT



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Lockwiring Practices
Figure 204 (Sheet 2)

CAUTION: DO NOT EXCEED 15 TWISTS PER INCH (25.4 MM). DAMAGE TO LOCKWIRE MAY RESULT.

(7) Pull lockwire taut while twisting it. The twisted wire should have 9 to 12 twists per inch (25.4 mm) for 0.020 inch (0.51 mm) diameter wire, and 7 to 10 twists per inch (25.4 mm) for 0.032 inch (0.81 mm) diameter wire.
(8) Lockwire hose and electrical coupling nuts in the same manner as tube coupling nuts. See F, G, J, K, L, and M, Fig. 204.
(9) Exercise caution during the twisting operation to keep wire tight without overstressing it or permitting it to become nicked, kinked, or otherwise multilated.
(10) Refer to Fig. 204 (Sheet 2) for correct verses incorrect methods of lockwiring practices.
(11) The use of commercially available lockwire twisting tools is recommended. Two such tools are shown on Fig. 205.
(12) Always cut rather than break lockwire so that lockwire holes are not torn or damaged.

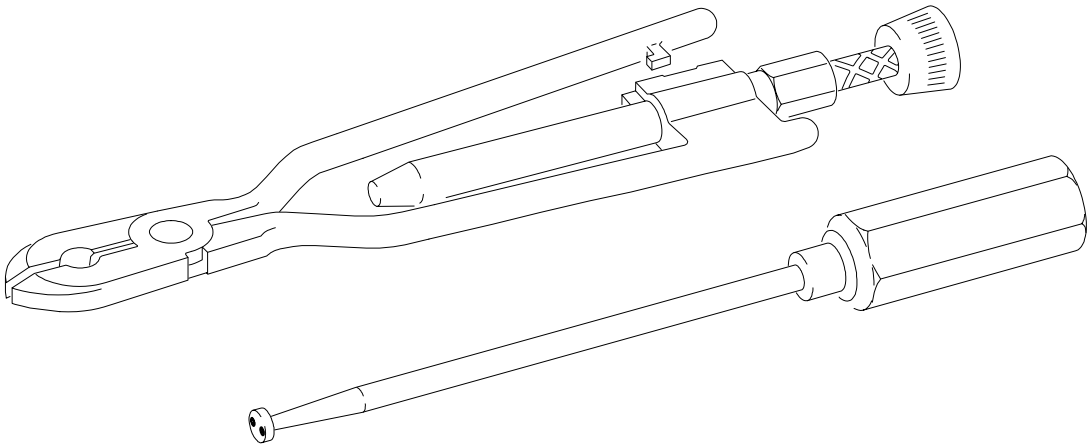
B. Access
(1) Location Zone

412	Engine 1
422	Engine 2
432	Engine 3
442	Engine 4

C. Procedure (Fig. 206)

S 822-012-J00
(1) Check lockwire holes of the parts to be lockwired for proper alignment. If a part has been tightened to the proper torque value, but is improperly aligned, replace it with another part.

NOTE: Proper alignment means that the lockwire holes are aligned so that the installed lockwire will prevent disengagement of the part. Do not exceed torque value limits of any part in an attempt to align the holes.



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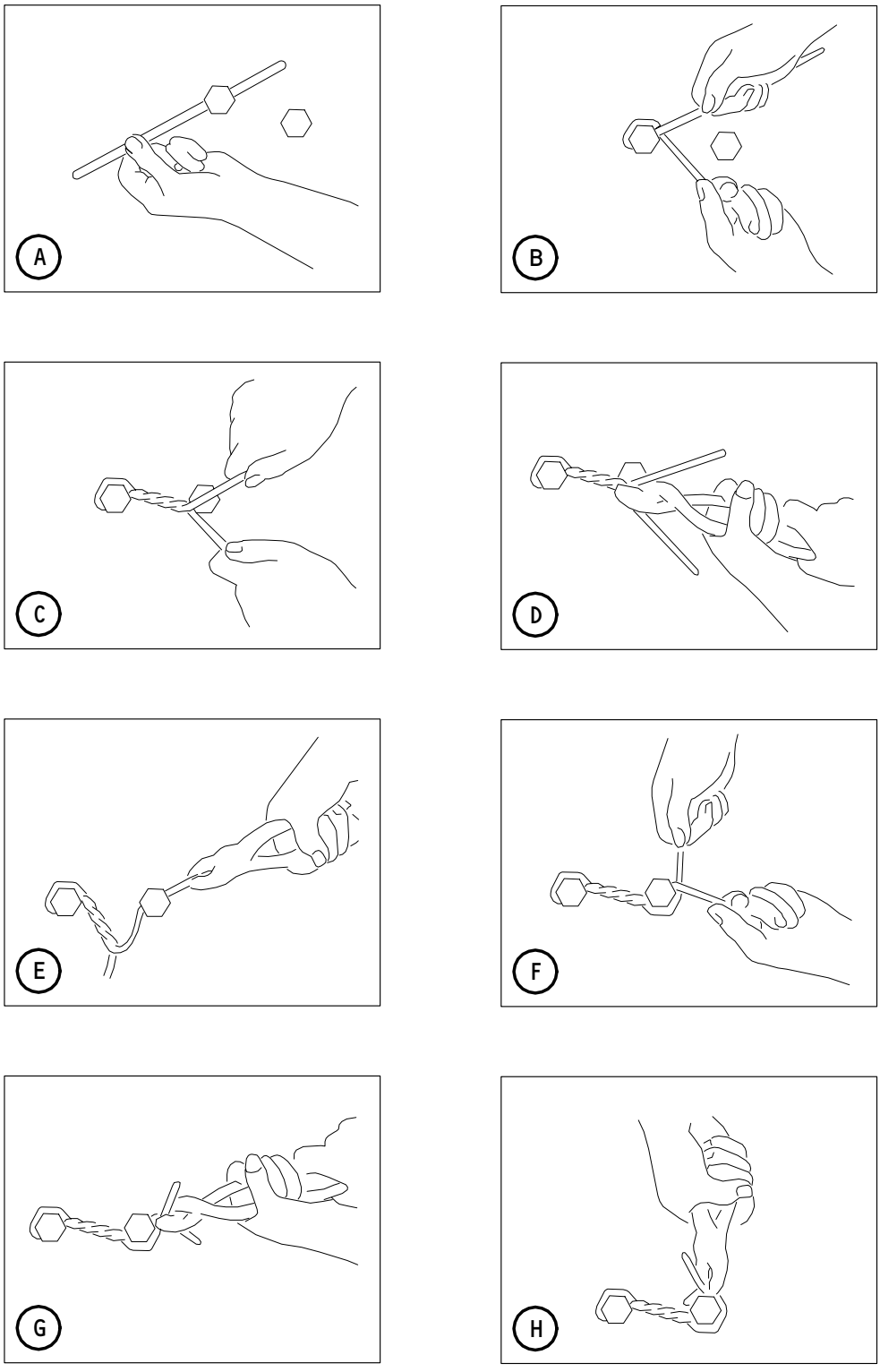
Typical Lockwire Twisting Tools
Figure 205



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Lockwiring Techniques
Figure 206

S 422-013-J00

CAUTION: LOCKWIRE IS NOT REUSABLE. ALWAYS USE NEW LOCKWIRE FOR EACH ASSEMBLY OPERATION.

(2) Insert lockwire through the first part, and bend the upper end either over the head of the part or around it. If bent around it, the direction of wrap and twist of the strands must be such that the loop around the part comes under the strand protruding from the hole. Done this way, the loop will stay down and will not tend to slip up and leave a slack loop. See A and B, Fig. 206.

S 422-014-J00

(3) Twist the strands while taut until the twisted part is just short of a hole in the next part. The twisted portion should be within 0.125 inch (3.18 mm) of the hole in the other part. See C and D, Fig. 206.

S 422-015-J00

(4) If free strand is to be bent around head of second part, insert uppermost strand through hole in this part, then repeat step (2). If free strand is to be bent over unit, the direction of twist is unimportant. If there are more than two units in the series, repeat preceding steps. See E and F, Fig. 206.

S 422-016-J00

(5) After wiring last part, continue twisting wires to form a pigtail of 3 to 6 twists 0.250-0.50 inch (6.4-12.7 mm) long and cut off excess wire. Bend pigtail inwards toward the part to prevent it from becoming a snag. See G and H, Fig. 206.

NOTE: Although every possible combination of lockwiring is not shown in Fig. 204, all lockwiring must conform generally to the examples shown.

S 422-017-J00

(6) If, after lockwiring in accordance with the preceding instructions, the lockwire is not taut, use the following procedure to determine acceptability.
   (a) Apply light finger-pressure to the midpoint of the lockwire span, and flex in both directions.

(b) Measure the maximum flexing observed at the midpoint and compare to the following limits:

Length of Lockwire Between Parts	Maximum Flexing At Center
0.5 inch (12.7 mm)	0.125 inch (3.2 mm)
1.0 inch (25.4 mm)	0.250 inch (6.4 mm)
2.0 inch (50.8 mm)	0.375 inch (9.5 mm)
3.0 inch (76.2 mm)	0.500 inch (12.7 mm)
4.0 inch (101.6 mm)	0.750 inch (19.1 mm)
5.0 inch (127.0 mm)	0.750 inch (19.1 mm)
6.0 inch (152.4 mm)	0.750 inch (19.1 mm)

(c) If lockwire fails to meet these limits, remove it and install new lockwire.

TASK 70-21-00-432-022-J00

6. The Safety Cable

A. General

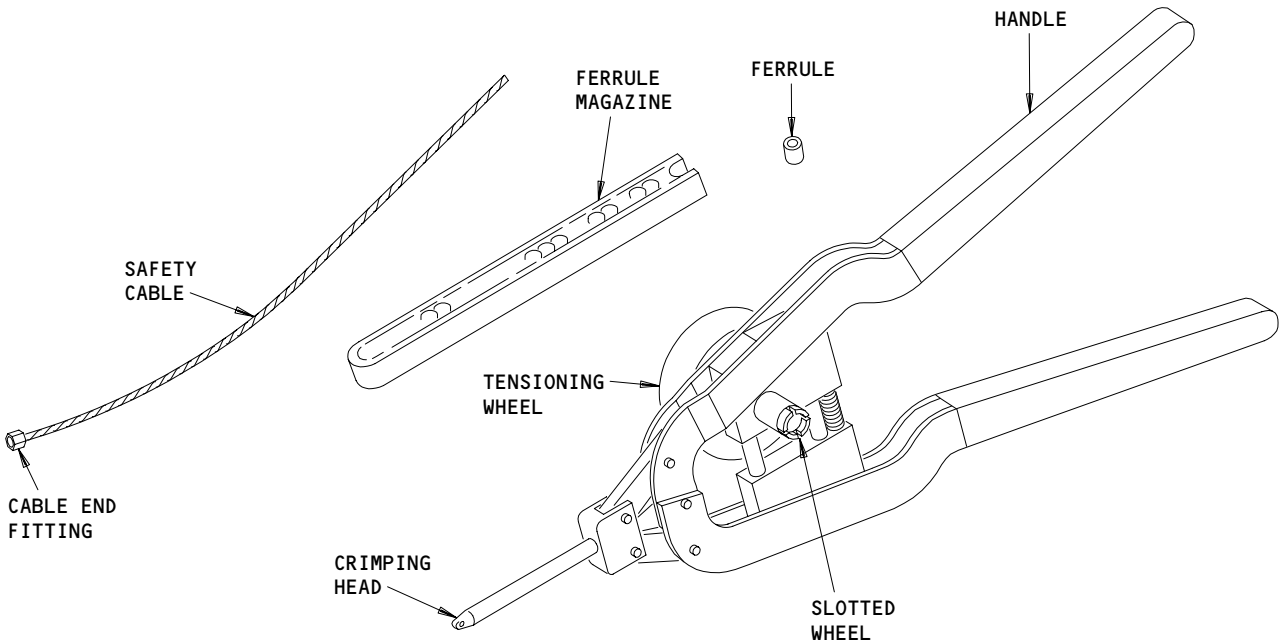
(1) Safety cable is an alternative to lock wire. Safety cable is installed through two or more parts so that as the part loosens, the safety cable will tighten. When the safety cable tightens, it will not let the part turn.

(2) The safety cable system has these three components (Fig. 207 and 208):
(a) the safety cable
(b) the ferrules
(c) the crimping tool.

(3) The safety cable (C10-145) is available in one size, 0.032 inch (0.81 mm), and is made of AMS 5689 (321 stainless steel) material. One end of the cable has a fitting swaged to it. The fitting is made of AMS 5674 (347 stainless steel) material. The strands on the opposite end of the cable are fused together to prevent the cable from fraying.

(4) The ferrules (C10-144) are made of AMS 5674 (347 stainless steel) material and are in a spring-loaded, disposable magazine. When the safety cable is installed, the ferrule is crimped on the open end of the cable.
   (a) There are two types of safety cable tools:
      1) The Bergen crimping tool (C10-148) (Fig. 207). This tool comes in different lengths. The crimping pressure of the tool is set by the manufacturer. The primary parts of the crimping tool are the crimping head, tensioning wheel, slotted wheel, and handles. This tool crimps the ferrule on the end of the safety cable. The crimping tool cuts the safety cable against the ferrule at the same time the ferrule is crimped.
      2) The Snap-on crimping tool (C10-148) Fig. 208). This tool operates in one direction only. It has a cycle-end dead stop to let the operator know when the ferrule is fully crimped. The crimping pressure of the tool is set by the manufacturer. If necessary, you can adjust the crimping pressure with standard hand tools. The snap-on tool has a spring-loaded crimp rod to hold the ferrule in place during the crimping procedure. The internal retraction mechanism controls cable tension automatically.
(5) The steps that follow give the safety cable practices.
   (a) Where possible, install the safety cable so it does not touch other parts.
   (b) Make sure the cable is not damaged or bent when you install it. Frayed cable assemblies are not permitted.
   (c) Install the safety cable only through holes that exist.
   (d) Unless specified differently in the maintenance manual:
      1) The maximum length of the safety cable between safety cabled parts is 6.0 inches (152 mm).
      2) Do not safety more than three bolts with one safety cable.
      3) Do not use the safety cable on titanium fasteners.

B. Equipment
(1) Test Block - Safety Cable (C10-146)



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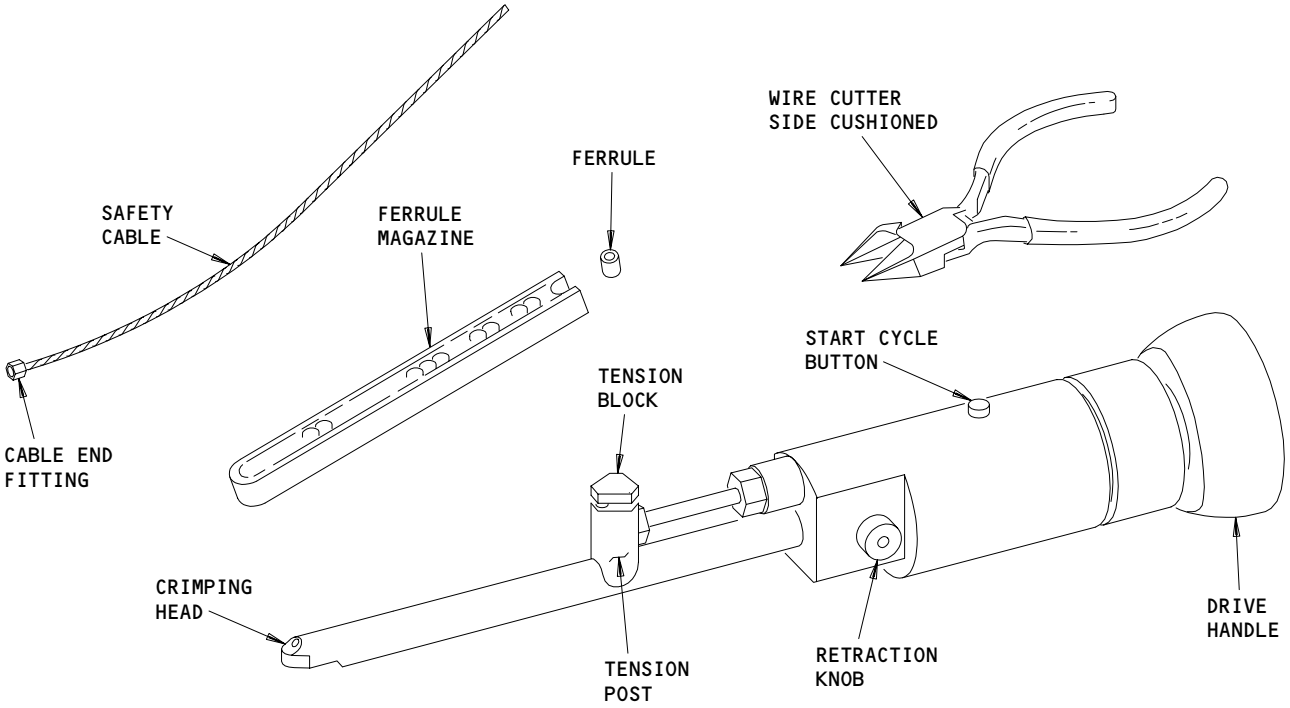
Bergen Crimping Tool (C10-148) - Safety Cable Components
Figure 207

B39677



1105965-01-C

Snap-On Crimping Tool (C10-148) - Safety Cable Components
Figure 208

(2) Tester - Safety Cable (C10-147)
(3) Crimping Tool - Safety Cable (0.032 inch (0.81 mm) Dia wire) (C10-148)
(4) Side-cushioned Diagonal Cutter (C10-149)

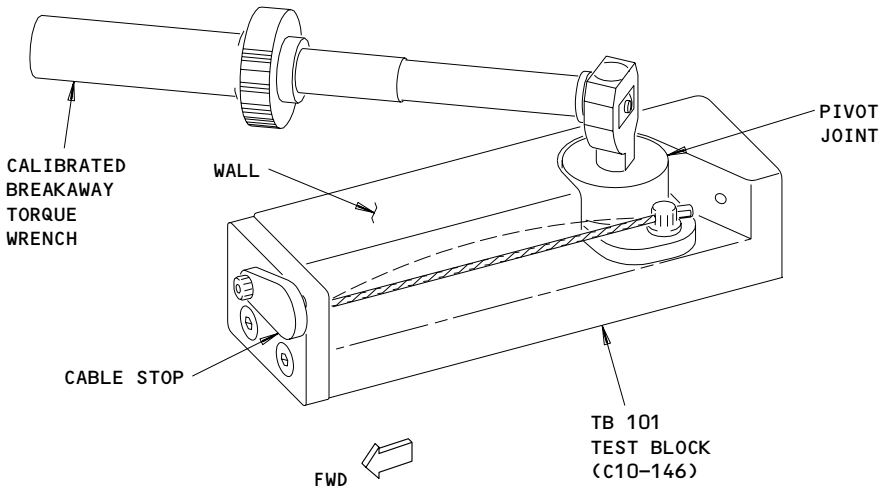
C. Consumable Materials
(1) G02324 Ferrule - Safety Cable (0.032 inch (0.81 mm) Dia) (C10-144)
(2) G02325 Cable - Safety (0.032 inch (0.81 mm) Dia) (C10-145)

D. Crimping Tool Verification - Bergen Tool (C10-148) - Test Block (C10-146) Procedure (Fig. 207 and 209).

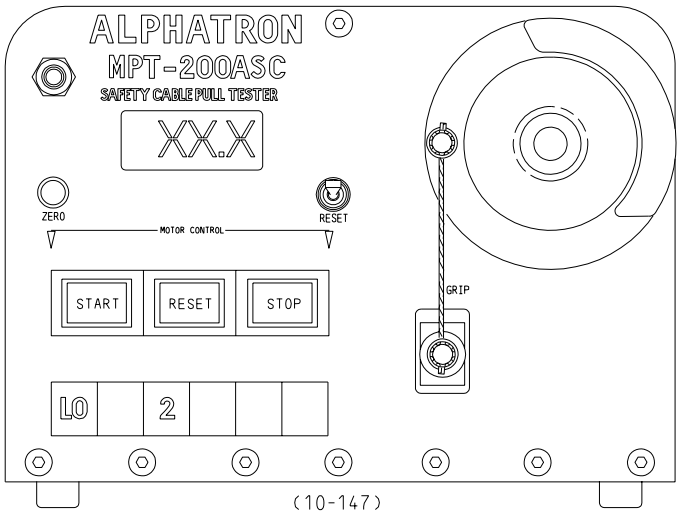
NOTE: You can use the safety cable tester (C10-147) as an alternative to this test. Refer to the manufacturer's instructions.

S 712-023-J00
(1) Do a pulloff load test as often as necessary.
(a) You must make sure the crimp is in the limits.

S 712-024-J00
(2) Prepare for the pulloff load test as follows (Fig. 207 and 209):
(a) Set up the test block (C10-146).
1) Refer to the manufacturer's instructions for set up information.
(b) Make sure the pivot joint is in the forward direction.
(c) Move the cable stop at the end of the test block.
(d) Install the safety cable (C10-145) through the cable stop hole.
(e) Pull the safety cable through the cable stop hole.
(f) Put the safety cable through the hole in the pivot joint and pull the cable through the hole.
(g) Put the end of the safety cable (from the pivot joint) through a ferrule (C10-144) in the ferrule magazine.
(h) Pull the safety cable through the ferrule.
1) Use the safety cable to pull the ferrule out of the ferrule magazine (Fig. 210, step 2).
(i) Put the end of the safety cable through the crimping head of the crimping tool (C10-148) (Fig. 210, Step 3).

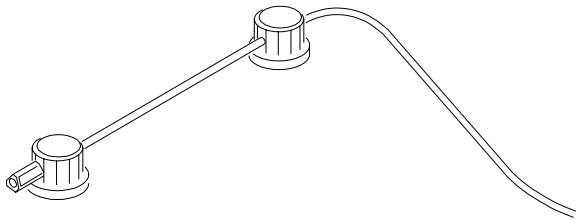


NOTE: WHEN CRIMPED, WIRE MAY NOT TOUCH
WALL WITH LIGHT FINGER PRESSURE.

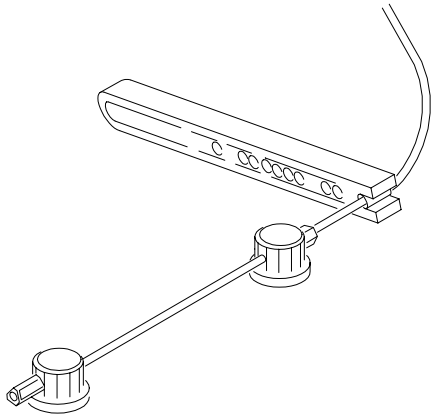


1108126-00-A

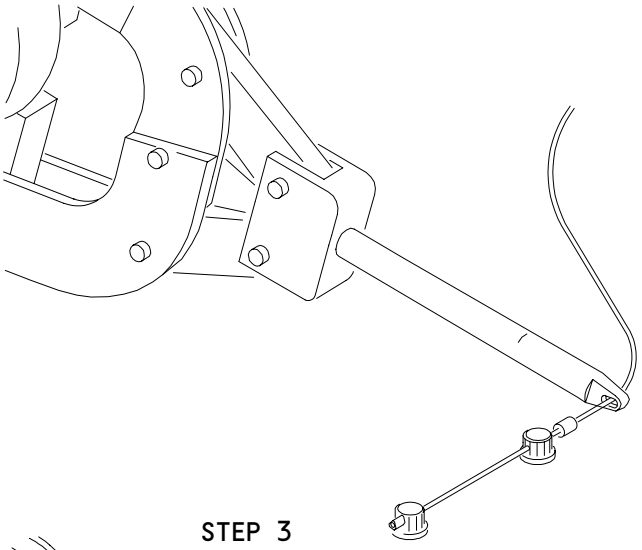
Crimping Tool Verification Equipment
Figure 209



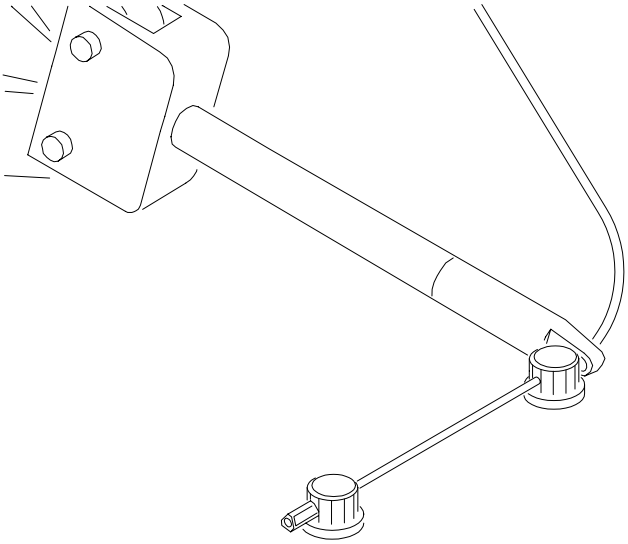
STEP 1



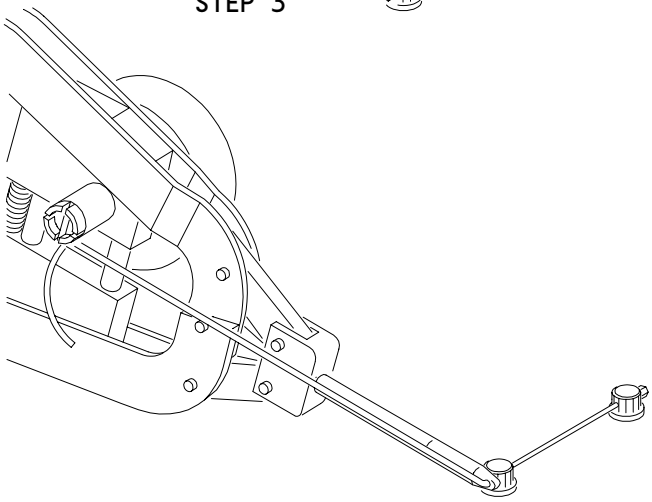
STEP 2



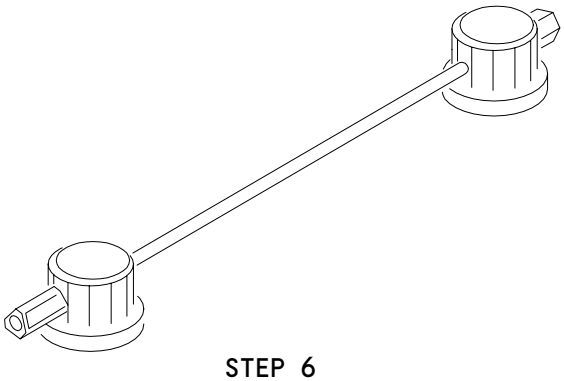
STEP 3



STEP 4



STEP 5



STEP 6

1108127-00-A

Bergen Crimping Tool (C10-148) - Safety Cable Procedure
Figure 210

(j) Make sure the large hole in the crimping head is on the same side as the ferrule.
(k) Move the crimping tool along the safety cable until the crimping head is against the part (Fig. 210, Step 4).
(l) Make sure the ferrule is fully in the hole in the crimping head.
(m) If the ferrule will not go in the crimping head, do the procedure that follows:
    1) Remove the cable from the crimping tool.
    2) Push the handles together.

        NOTE: When the handles are released they will open automatically.

    3) Put the cable back through the crimping head.
    4) Move the crimping tool along the safety cable until the crimping head is against the part.
    5) Make sure the ferrule goes into the hole in the crimping head.

CAUTION: DO NOT PUT TOO MUCH TENSION ON THE SAFETY CABLE. THE CRIMPING TOOL WILL AUTOMATICALLY SET THE TENSION. TOO MUCH TENSION WILL BREAK THE SAFETY CABLE.

(n) Put the safety cable across the slotted tensioning wheel on the side of the crimping tool.
    1) Make sure the cable is in the two slots in the wheel that are in line with the crimping head.
    2) Hold the crimping tool perpendicular to the cable. Make sure the ferrule is tightly against the bolt head.

    CAUTION: DO NOT CRIMP THE FERRULE UNLESS THE CORRECT TENSION IS APPLIED BY THE TENSIONING WHEEL. THE CRIMP WILL NOT BE CORRECT IF THIS STEP IS NOT DONE CORRECTLY.

    3) Turn the tensioning wheel on the side of the crimping tool until you hear clicks (Fig. 210, Step 5).
    4) Apply constant pressure to close the crimping tool handles until the cable is cut.

        NOTE: Do not try to remove the crimping tool from the ferrule with the handles in the crimped or closed position.

        If the handles on the crimping tool are not completely closed when released, the handles will not open.

    5) Release the pressure on the handles.
    6) Remove and discard the unwanted safety cable from the tensioning wheel.

(o) Do a finger-pressure test as follows (Fig. 209):
1) Find the center of the safety cable in the test block.
2) Use light finger pressure and push the center of the safety cable to the wall on the test block.
a) The safety cable must not touch the wall.

(p) If the safety cable does not touch the wall, then the safety cable is serviceable.
1) Do these steps that follow for the pulloff load test (Fig. 209):
a) Set a calibrated breakaway torque wrench to 70 pound-onches (7.9 Newton-meters).
b) Install the torque wrench in the pivot joint on the test block (C10-146) (Fig. 209).
c) Move the torque wrench handle counterclockwise until the torque wrench clicks or the ferrule moves.
d) If the ferrule moves before you hear the torque wrench click, remove the crimping tool from service.

(q) If the safety cable touches the wall, the safety cable is not serviceable.

(r) Cut the safety cable with the side-cushioned diagonal cutter (C10-149).
1) Remove the safety cable from the test block.

(s) Install a new safety cable and do these steps that follow:
1) Set up the test block (C10-146).
a) Refer to the manufacturer's instructions for set up information.
2) Make sure the pivot joint is in the forward direction.
3) Move the cable stop at the end of the test block.
4) Move the cable stop at the end of the test block.
5) Install the safety cable (C10-145) through the cable stop hole.
6) Pull the safety cable through the cable stop hole.
7) Put the safety cable through the hole in the pivot joint and pull the cable through the hole.
8) Examine for a serviceable crimp as follows:
a) Make sure the tension on the safety cable is correct.
b) When you crimp the ferrule, hold the crimping tool perpendicular to the safety cable.
c) Make sure the ferrule is tightly against the bolt head.
9) If the safety cable touches the wall again, do not use the crimping tool.

S 712-025-J00

(3) Do these steps for the pulloff load test (Fig. 209):
(a) Set a calibrated breakaway torque wrench to 70 pound-onches (7.9 Newton-meters).
(b) Install the torque wrench in the pivot joint on the test block (C10-146) (Fig. 209).
(c) Move the torque wrench handle counterclockwise until the torque wrench clicks or the ferrule moves.

(d) If the ferrule moves before you hear the torque wrench click, remove the crimping tool from service.

S 712-026-J00

(4) Do the finger-pressure test again (Fig. 209).
   (a) Find the center of the safety cable in the test block.
   (b) Use light finger pressure and push the center of the safety cable to the wall on the test block.
   (c) If the safety cable does not touch the wall you can use the crimping tool (C10-148).
   (d) If the safety cable touches the wall, do not use the crimping tool (C10-148).

S 712-027-J00

(5) Do a test to find the amount of pressure necessary to cause the crimped ferrule or safety cable to break.
   (a) We recommend that this test be done a minimum of one time each month.
   (b) Use a safety cable tester (C10-147) to do this test (Fig. 209).
      1) Refer to the manufacturer's instructions.
   (c) This test can also be used as an alternative to the test block (C10-146) test above.

E. Safety Cable Installation - Bergen Crimping Tool (C10-148).

S 432-028-J00

(1) Do the steps that follow to install the safety cable with the Bergen Crimping Tool (C10-148).
   (a) Do a visual inspection of the holes to be safety cabled to find all damage.

      NOTE: Keep the safety cable as straight as possible when you safety cable fasteners or parts together.

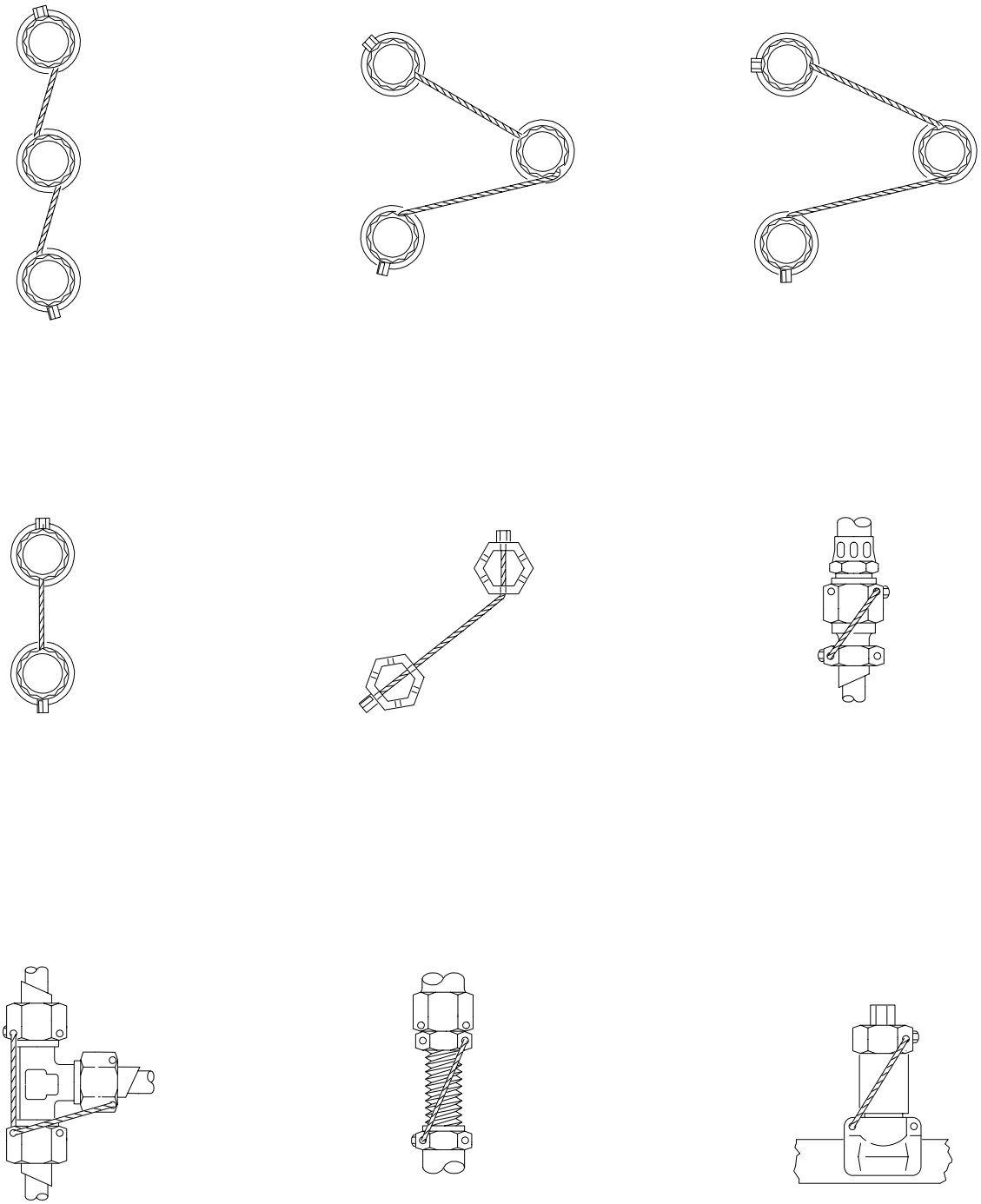
      1) If the hole is damaged, replace the part or, if possible, use another hole to safety cable (Fig. 211).
   (b) Put the end of the safety cable (C10-145) (without the cable end fitting) into the hole in the part.

   CAUTION: ON TWO-BOLT PATTERNS, DO NOT SAFETY CABLE IN A NEGATIVE-PULL DIRECTION. MAKE SURE THE CABLE HAS A POSITIVE OR NEUTRAL PULL.

   (c) Pull the cable through the hole until the cable end fitting is against the part (Fig. 210, Step 1).

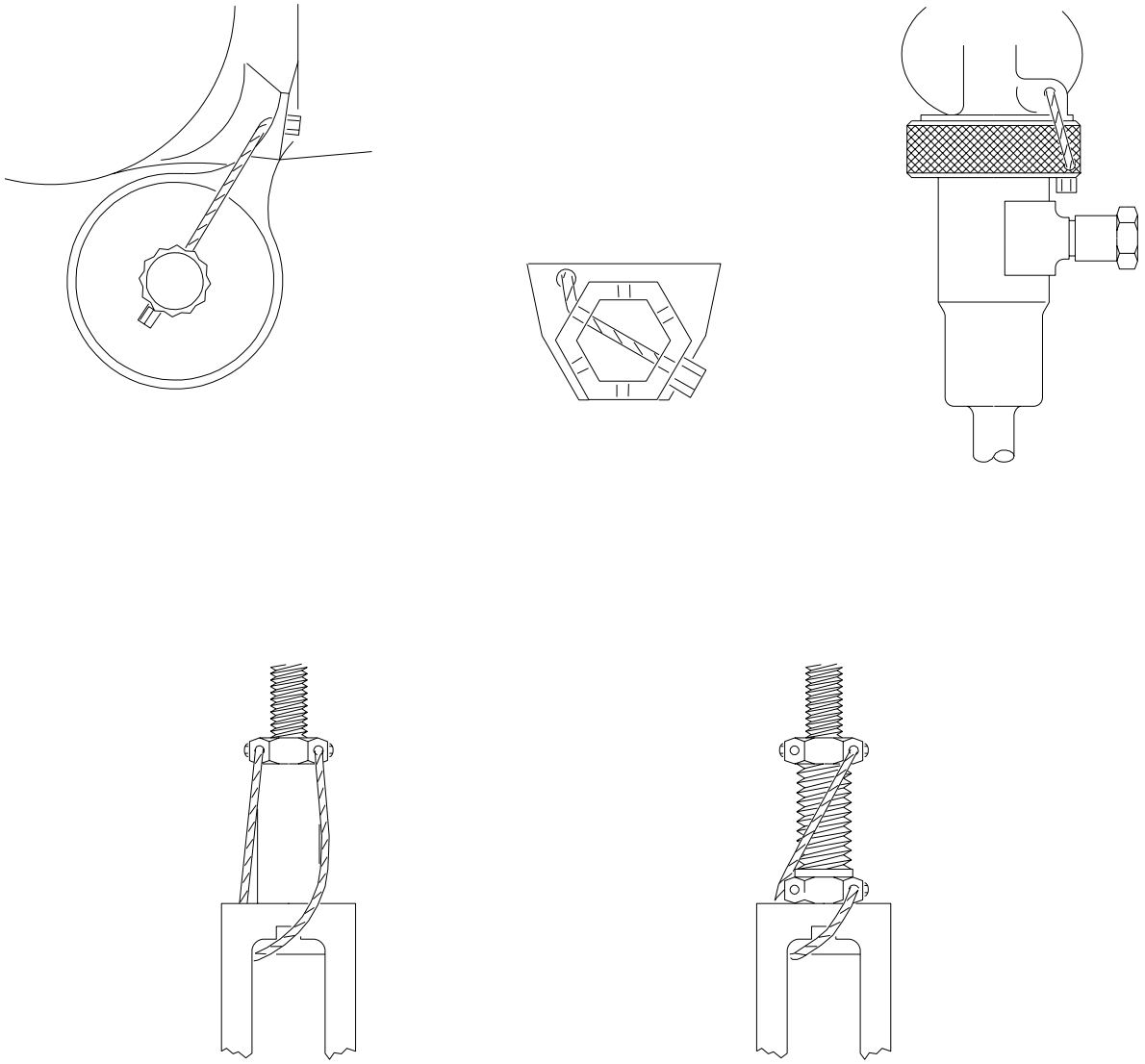
      NOTE: Every type of safety cable procedure is not shown in Fig. 211. However, it is necessary, though, that you do all safety cable procedures generally to the examples shown.

   (d) Insert the end of the cable through the second part.



1101185-00-B

Safety Cable Patterns
Figure 211 (Sheet 1)



NOTE: TYPICAL SAFETY CABLE INSTALLATION
OF THE VSV ACTUATOR LEVER PUSHROD.

1101980-00-B

Safety Cable Patterns
Figure 211 (Sheet 2)

(e) Choose the hole in the part that permits the cable to be as straight as possible.
(f) Pull the cable through the second part.
(g) If three parts must be safety cabled, do the same procedure for the third part.
(h) Put the end of the safety cable (from the last part to be safety cabled) through a ferrule (C10-144).
(i) Pull the safety cable through the ferrule and use the safety cable to pull the ferrule out of the ferrule magazine (Fig. 210, Step 2).
(j) Put the end of the safety cable through the crimping head of the crimping tool (C10-148) (Fig. 210, Step 3).
(k) Make sure the large hole in the crimping head is on the same side as the ferrule.
(l) Move the crimping tool along the safety cable until the crimping head is against the part (Fig. 210, Step 4).
(m) Make sure the ferrule is fully in the hole in the crimping head.
(n) If the ferrule will not go in the crimping head, do the procedure that follows:
    1) Remove the cable from the crimping tool.
    2) Push the handles together.

        NOTE: When the handles are released they will open automatically.

    3) Put the cable back through the crimping head.
    4) Move the crimping tool along the safety cable until the crimping head is against the part.
    5) Make sure the ferrule goes into the hole in the crimping head.

CAUTION: DO NOT PUT TOO MUCH TENSION ON THE SAFETY CABLE. THE CRIMPING TOOL WILL AUTOMATICALLY SET THE TENSION. TOO MUCH TENSION WILL BREAK THE SAFETY CABLE.

(o) Put the safety cable across the slotted tensioning wheel on the side of the crimping tool.
(p) Make sure the cable is in the two slots in the wheel that are in line with the crimping head.
(q) Hold the crimping tool perpendicular to the cable.
(r) Make sure the ferrule is tightly against the bolt head.

CAUTION: DO NOT CRIMP THE FERRULE UNLESS THE CORRECT TENSION IS APPLIED BY THE TENSIONING WHEEL. THE CRIMP WILL NOT BE CORRECT IF THIS STEP IS NOT DONE CORRECTLY.

(s) Turn the tensioning wheel on the side of the crimping tool until you hear clicks (Fig. 210, Step 5).

(t) Apply constant pressure to close the crimping tool handles until the cable is cut.

NOTE: Do not try to remove the crimping tool from the ferrule with the handles in the crimped or closed position.

If the handles on the crimping tool are not completely closed when released, the handles will not open.

(u) Release the pressure on the handles.
(v) Remove and discard the unwanted safety cable from the tensioning wheel.

S 842-035-J00

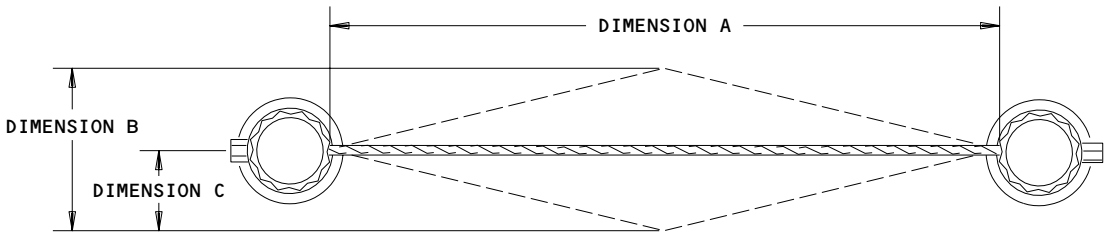
(2) Look at the crimped ferrule to make sure it has a good crimp (Fig. 210, Step 6).
(a) Do a visual inspection of the safety cable for kinks, frayed wires, or incorrect crimps.
1) Replace the safety cable if a problem occurs.
(b) Remove and discard the unwanted safety cable from the slotted tensioning wheel on the side of the crimping tool.
(c) Push against the safety cable with light finger pressure halfway between the safety cabled parts.
(d) If the cable feels loose, do a dimensional inspection as follows to make sure the safety cable is serviceable (Fig. 212):
(e) Measure the distance between the safety-cabled parts.
1) Write this as Dimension A.
(f) If three parts are safety cabled together, measure the distance between each of the parts.
1) Add the two measurements together to get Dimension A.
(g) Push against the safety cable with light finger pressure halfway between two safety-cabled parts.
(h) Measure the distance the safety cable moves laterally in one direction.

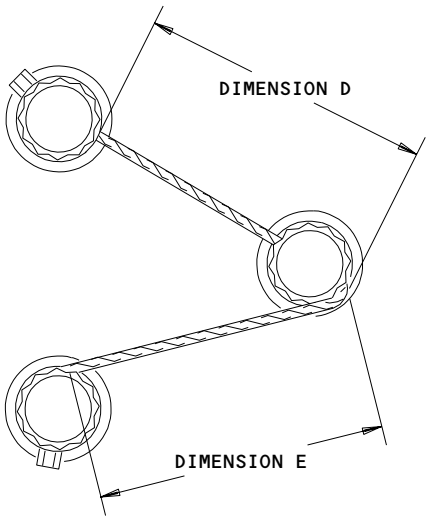
NOTE: If you measure the distance the safety cable moves laterally in the two directions, then write this as Dimension B.

1) Write this as Dimension C.
(i) Compare Dimensions A and C to the limits given in Fig. 212.

CAUTION: DO NOT TRY TO BREAK THE SAFETY CABLE. IF THE SAFETY CABLE MUST BE REMOVED, CUT THE SAFETY CABLE TO AVOID DAMAGE TO THE HOLES IN THE PARTS.

(j) If the safety cable is not in the limits given in Fig. 212, cut the safety cable with side-cushioned diagonal cutter (C10-149).
1) Remove the safety cable.





NOTE: FOR THREE BOLT PATTERNS,
DIMENSION A = DIMENSION D + E

DIMENSION A	DIMENSION B	DIMENSION C
0.5 INCH (13mm)	0.125 INCH (3.18mm)	0.062 INCH (1.57mm)
1.0 INCH (25mm)	0.250 INCH (6.35mm)	0.125 INCH (3.18mm)
2.0 INCH (51mm)	0.375 INCH (9.53mm)	0.188 INCH (4.78mm)
3.0 INCH (76mm)	0.375 INCH (9.53mm)	0.188 INCH (4.78mm)
4.0 INCH (102mm)	0.500 INCH (12.70mm)	0.250 INCH (6.35mm)
5.0 INCH (127mm)	0.500 INCH (12.70mm)	0.250 INCH (6.35mm)
6.0 INCH (152mm)	0.625 INCH (15.88mm)	0.312 INCH (7.92mm)

1108129-00-A

Safety Cable Flex Limits
Figure 212

F. Crimping tool Verification - Snap-On Tool (C10-148) - Test Block (C10-146) Procedure (Fig. 208 and 209).

NOTE: You can use the safety cable tester (C10-147) as an alternative to this test. Refer to the manufacturer's instructions.

S 722-036-J00

(1) Do a pulloff load test as often as necessary.
  (a) You must make sure the crimp is in the limits.

S 842-037-J00

(2) Prepare for the pulloff load test as follows (Fig. 208 and 209):
  (a) Set up the test block (C10-146).
    1) Refer to the manufacturer's instructions for set up information.
  (b) Make sure the pivot joint is in the forward direction.
  (c) Move the cable stop at the end of the test block.
  (d) Install the safety cable (C10-145) through the cable stop hole.
  (e) Pull the safety cable through the cable stop hole.
  (f) Put the safety cable through the hole in the pivot joint and pull the cable through the hole.
  (g) Put the end of the safety cable (from the pivot joint) through a ferrule (C10-144) in the ferrule magazine.
  (h) Pull the safety cable through the ferrule.
    1) Use the safety cable to pull the ferrule out of the ferrule magazine (Fig. 210, Step 2).
  (i) Put the end of the safety cable through the crimping head of the crimping tool (C10-148) (Fig. 210, Step 3).
  (j) Make sure the large hole in the crimping head is on the same side as the ferrule.
  (k) Move the crimping tool along the safety cable until the crimping head is against the ferrule (Fig. 210, Step 4).
  (l) Pull on the retraction knob (Fig. 210, Step 5).
  (m) Put the crimping head on the ferrule and release the retraction knob (Fig. 210, Step 5).
  (n) Make sure the ferrule is fully in the crimping head (Fig. 210, Step 5).
  (o) Pull the safety cable through the tension block (Fig. 210, Step 5).

CAUTION: DO NOT PUT TOO MUCH TENSION ON THE SAFETY CABLE. THE CRIMPING TOOL WILL AUTOMATICALLY SET THE TENSION. TOO MUCH TENSION WILL CAUSE STRESS THAT IS NOT NECESSARY ON THE SAFETY CABLE.

(p) Make sure the safety cable is in the groove in the tension post (Fig. 210, Step 5).
(q) Hold the crimping tool perpendicular to the cable in the bolt head.
(r) Make sure the ferrule is tightly against the bolt head.
(s) Lightly pull on the end of the safety cable to remove slack (Fig. 210, Step 5).
(t) Push the start cycle button.

NOTE: At the start of the cycle, the tension block will move rearward. This movement rearwards gives the cable tension.

(u) Turn the drive handle clockwise and release the start cycle button.
(v) Turn the drive handle until it stops (about two full turns).
(w) Pull up on the end of the safety cable to remove it from the tension block.
(x) Pull on the retraction knob.
    1) Move the crimping tool from the crimped ferrule and the remaining safety cable.
(y) Use the side-cushioned diagonal cutters (C10-149) and cut the unwanted safety cable flat with the crimped ferrule (Fig. 210, Step 6).
    1) Discard the safety cable end.
(z) Do a finger-pressure test as follows (Fig. 209):
    1) Find the center of the safety cable in the test block.
    2) Use light finger pressure and push the center of the safety cable to the wall on the test block.
    3) The safety cable must not touch the wall.
(aa) If the safety cable does not touch the wall, then the safety cable is serviceable.
    1) Do these steps for the pulloff load test (Fig. 209):
        a) Set a calibrated breakaway torque wrench to 70 pound-inches (7.9 Newton-meters).
        b) Install the torque wrench in the pivot joint on the test block (C10-146) (Fig. 209).
        c) Move the torque wrench handle counterclockwise until the torque wrench clicks or the ferrule moves.
        d) If the ferrule moves before you hear the torque wrench click, remove the crimping tool from service.

(ab) If the safety cable touches the wall, the safety cable is not serviceable.
1) Cut the safety cable with the side-cushioned diagonal cutter (C10-149).
a) Remove the safety cable from the test block.
2) Set up the test block (C10-146).
a) Refer to the manufacturer's instructions for set up information.
3) Make sure the pivot joint is in the forward direction.
4) Move the cable stop at the end of the test block.
5) Install the safety cable (C10-145) through the cable stop hole.
6) Pull the safety cable through the cable stop hole.
7) Put the safety cable through the hole in the pivot joint amd pull the cable through the hole.
8) Put the end of the safety cable (from the pivot joint) through a ferrule (C10-144) in the ferrule magazine.
9) Pull the safety cable through the ferrule.
a) Use the safety cable to pull the ferrule out of the ferrule magazine (Fig. 210, Step 2).
10) Put the end of the safety cable through the crimping head of the crimping tool (C10-148) (Fig. 210, Step 3).
11) Make sure the large hole in the crimping head is on the same side as the ferrule.
12) Move the crimping tool along the safety cable until the crimping head is against the ferrule (Fig. 210, Step 4).
13) Pull on the retraction knob (Fig. 210, Step 5).
14) Put the crimping head on the ferrule and release the retraction knob (Fig. 210, Step 5).
15) Make sure the ferrule is fully in the crimping head (Fig. 210, Step 5).
16) Pull the safety cable through the tension block (Fig. 210, Step 5).

CAUTION: DO NOT PUT TOO MUCH TENSION ON THE SAFETY CABLE. THE CRIMPING TOOL WILL AUTOMATICALLY SET THE TENSION. TOO MUCH TENSION WILL CAUSE STRESS THAT IS NOT NECESSARY ON THE SAFETY CABLE.

17) Make sure the safety cable is in the groove in the tension post (Fig. 210, Step 5).
18) Hold the crimping tool perpendicular to the cable in the bolt head.
19) Make sure the ferrule is tightly against the bolt head.
20) Lightly pull on the end of the safety cable to remove slack (Fig. 210, Step 5).

21) Push the start cycle button.

NOTE: At the start of the cycle, the tension block will move rearward. This movement rearwards gives the cable tension.

22) Turn the drive handle clockwise and release the start cycle button.
    a) Turn the drive handle until it stops (about two full turns).
23) Pull up on the end of the safety cable to remove it from the tension block.
24) Pull on the retraction knob.
    a) Remove the crimping tool from the crimped ferrule and the remaining safety cable.
25) Use the side-cushioned diagonal cutters (C10-149) and cut the unwanted safety cable flat with the crimped ferrule (Fig. 210, Step 6).
    a) Discard the safety cable end.

(ac) After you install a new safety cable, do these steps to make sure the crimp is serviceable:
1) Make sure the tension on the safety cable is correct.
2) When you crimp the ferrule, hold the crimping tool perpendicular to the safety cable.
3) Make sure the ferrule is tightly against the bolt head.
4) If the safety cable touches the wall again, do not use the crimping tool.

S 712-031-J00

(3) Do the pulloff load test as follows (Fig. 209):
(a) Set a calibrated breakaway torque wrench to 70 pound-inches (7.9 Newton-meters).
(b) Install the torque wrench in the pivot joint on the test block (C10-146) (Fig. 209).
(c) Move the torque wrench handle counterclockwise until the torque wrench clicks or the ferrule moves.
(d) If the ferrule moves before you hear the torque wrench click, remove the crimping tool from service.

S 712-032-J00

(4) Do the finger-pressure test again (Fig. 209):
(a) Find the center of the safety cable in the test block.
(b) Use light finger pressure and push the center of the safety cable to the wall on the test block.
(c) If the safety cable does not touch the wall you can use the crimping tool (C10-148).
(d) If the safety cable touches the wall, do not use the crimping tool (C10-148).

S 712-033-J00

(5) Do a test to find the amount of pressure necessary to cause the crimped ferrule or safety cable to break.
   (a) It is recommended that this test be done a minimum of one time each month.
   (b) Use a safety cable tester (C10-147) to do this test (Fig. 209).
      1) Refer to the manufacturer's instructions.
   (c) This test can also be used as an alternative to the test block (C10-146) test above.

G. Safety Cable Installation - Snap-On Crimping Tool (C10-148).

S 432-034-J00

(1) Do the steps that follow to install the safety cable with the Snap-On Crimping Tool (C10-148).
   (a) Do a visual inspection of the holes to be safety cabled to find all damage.

      NOTE: Keep the safety cable as straight as possible when you safety cable the fasteners or parts together.

      1) If the hole is damaged, replace the part or if possible, use another hole to safety cable (Fig. 211).
   (b) Put the end of the cable (C10-145) (without the cable end fitting) into the hole in the part.

   CAUTION: ON TWO-BOLT PATTERNS, DO NOT SAFETY CABLE IN A NEGATIVE-PULL DIRECTION. MAKE SURE THE CABLE HAS A POSITIVE OR NEUTRAL PULL.

   (c) Pull the cable through the hole until the cable end fitting is against the part (Fig. 210, Step 1).

      NOTE: Every type of safety cable procedure is not shown in Fig. 211. However, it is necessary, though, that you do all safety cable procedures generally to the examples shown.

   (d) Insert the end of the cable through the second part.
   (e) Choose the hole in the part that permits the cable to be as straight as possible.
   (f) Pull the cable through the second part.
   (g) If three parts must be safety cabled, do the same procedure for the third part.
   (h) Put the end of the safety cable (from the last part to be safety cabled) through a ferrule (C10-144).
   (i) Pull the safety cable through the ferrule and use the safety cable to pull the ferrule out of the ferrule magazine (Fig. 210, Step 2).
   (j) Put the end of the safety cable through the crimping head of the crimping tool (C10-148) (Fig. 210, Step 3).

(k) Make sure the large hole in the crimping head is on the same side as the ferrule.
(l) Move the crimping tool along the safety cable until the crimping head is against the ferrule.
(m) Pull on the retraction knob (Fig. 210, Step 5).
(n) Put the crimping head on the ferrule and release the retraction knob (Fig. 210, Step 5).
(o) Make sure the ferrule is fully in the crimping head (Fig. 210, Step 5).
(p) Pull the safety cable through the tension block (Fig. 210, Step 5).

CAUTION: DO NOT PUT TOO MUCH TENSION ON THE SAFETY CABLE. THE CRIMPING TOOL WILL AUTOMATICALLY SET THE TENSION. TOO MUCH TENSION WILL CAUSE STRESS THAT IS NOT NECESSARY ON THE SAFETY CABLE.

(q) Make sure the safety cable is in the groove in the tension post (Fig. 210, Step 5).
(r) Hold the crimping tool perpendicular to the cable in the bolt head.
(s) Make sure the ferrule is tightly against the bolt head.
(t) Lightly pull on the end of the safety cable to remove the slack (Fig. 210, Step 5).
(u) Push the start cycle button.

NOTE: At the start of the cycle, the tension block will move rearward. This movement rearwards gives the cable tension.

(v) Turn the drive handle clockwise and release the start cycle button.
(w) Turn the drive handle until it stops (about two full turns).
(x) Pull up on the end of the safety cable to remove it from the tension block.
(y) Pull on the retraction knob.
    1) Remove the crimping tool from the crimped ferrule and the remaining safety cable.
(z) Use the side-cushioned diagonal cutters (C10-149) and cut the unwanted safety cable flat with the crimped ferrule (Fig. 210, Step 6).
    1) Discard the safety cable end.
(aa) Do a visual inspection of the safety cable for kinks, frayed wires, or incorrect crimps.
    1) Replace the safety cable if a problem occurs.
(ab) Push against the safety cable with light finger pressure halfway between the safety cabled parts.
(ac) If the cable feels loose, do a dimensional inspection to make sure the safety cable is serviceable as follows (Fig. 212):
    1) Measure the distance between the safety-cabled parts.
        a) Write this as Dimension A.

2) If three parts are safety cabled together, measure the distance between each of the parts.
   a) Add the two measurements together to get Dimension A.
3) Push against the safety cable with light finger pressure halfway between two safety-cabled parts.
4) Measure the distance the safety cable moves laterally in one direction.

   NOTE: If you measure the distance the safety cable moves laterally in the two directions, then write this as Dimension B.

   a) Write this as Dimension C.
5) Compare Dimensions A and C to the limits given in Fig. 212.

CAUTION: DO NOT TRY TO BREAK THE SAFETY CABLE. IF THE SAFETY CABLE MUST BE REMOVED, CUT THE SAFETY CABLE TO AVOID DAMAGE TO THE HOLES IN THE PARTS.

(ad) If the safety cable is not in the limits given in Fig. 212, cut the safety cable with the side-cushioned diagonal cutter (C10-149).
1) Remove the safety cable.

TEMPORARY MARKING PROCEDURES - DESCRIPTION AND OPERATION

1. General
   A. Temporary marking is used for temporary identification purposes. This is accomplished by the attachment of tags, adhesive lables, or marking directly on the part.
   B. Temporary marking is not intended to withstand engine operation and is normally removed during or following maintenance procedures.
   C. The materials selected for temporary marking should be chosen so that failure to remove the marking will not cause damage failure of the parts marked. Chemical attack from marking materials exposed to high temperature may corrode the part and lead to possible part failure.
2. Application
   A. Typical use for temporary marking are as follows:
      (1) Indicating location of defects during inspection.
      (2) Indicating relative position of parts in an assembly by sequential numbering or matchmarks.
      (3) Identifying the subassembly, module, or engine the part has been removed from.
      (4) Identifying shop operations or inspections performed or to be performed.
3. Marking Methods
   A. Whenever temporary marking is required, the method and location is usually specified. When marking instructions are not specified or the method and/or location not available, the following recommendations should be observed:
      (1) Metal tags must be made from stainless steel and held to part with stainless steel wire.
      (2) Adhesive on tape or labels must be approved by suitability tests to ensure against corrosion to parts when subjected to high temperature.

      CAUTION: GREASE PENCILS OR LEAD (GRAPHITE) PENCILS MUST NOT BE USED TO MARK COMBUSTION SECTION AND HOT SECTION PARTS. THESE MATERIALS PLUS HEAT CAN CAUSE PARTS MATERIAL DAMAGE.

      (3) Marking ink, pencils, paints, etc., must be approved by suitability tests to ensure against corrosion to parts when subjected to high temperature.

TRI-WING FASTENERS - MAINTENANCE PRACTICES

1. General
   A. This section contains two tasks. One task is for the removal of a tri-wing fastener. The other task is for the installation of the tri-wing fastener.
   B. Look at the table that follows to identify the correct Tri-wing fastener.

TRI-WING DRIVERS AND STANDARD-THREAD FASTENERS

SCREW THREAD SIZE	TENSION HEAD	SHEAR HEAD	SCREW THREAD SIZE	TENSION HEAD	SHEAR HEAD
0 - 80	0	--	3/8 - 24	8	7
2 - 56	1	--	7/16 - 20	9	8
4 - 40	2	1	1/2 - 20	10	9
6 - 32	3	2	9/16 - 18	11	10
8 - 32	4	3	5/8 - 18	12	11
10 - 32	5	4	3/4 - 16	13	12
1/4 - 28	6	5	7/8 - 14	14	13
5/16 - 24	7	6	1 - 12	15	14

TASK 70-24-01-002-001-J00

2. Tri-Wing Fastener Removal (Fig. 201)
   A. Access
      (1) Location Zone
          412 Engine 1
          422 Engine 2
          432 Engine 3
          442 Engine 4

   B. Procedure

      S 022-008-J00
      (1) Remove the fastener:
          (a) Make sure you use the correct driver for the fastener.

              NOTE: The driver number should match the recess number of the fastener head as shown in Fig. 201. If the recess of the fastener has a layer of paint or protective coating, use a driver that is one size smaller than usual.

(b) Put the driver into the recess of the fastener.

CAUTION: MAKE SURE THAT THE AXIS OF THE DRIVE IS ALIGNED WITH THE AXIS OF THE FASTENER WHEN YOU INSTALL OR REMOVE THE FASTENER. IF THE DRIVE TOOL IS NOT ALIGNED WITH THE FASTENER, YOU CAN CAUSE DAMAGE TO THE RECESS OF THE FASTENER.

(c) Align the axis of the driver with the axis of the fastener.
(d) Turn the driver counterclockwise.

S 022-002-J00

(2) If the recess of the fastener is damaged, remove the fastener as follows:
(a) Select the correct drill bit and the correct screw removal tool for the dimension of the fastener.
(b) Drill into the fastener to a depth that permits you to use the screw removal tool.

NOTE: The bottom of the fastener recess has a shape that permits the drill to stay in the center.

(c) Install the screw removal tool tightly.
(d) Turn the screw removal tool in a counter-clockwise direction to remove the fastener.

TASK 70-24-01-402-003-J00

3. Tri-Wing Fastener Installation (Fig. 201)
A. Access
(1) Location Zone

412	Engine 1
422	Engine 2
432	Engine 3
442	Engine 4

B. Procedure

S 422-007-J00

(1) Install the fastener:

(a) Make sure you use the correct driver for the fastener.

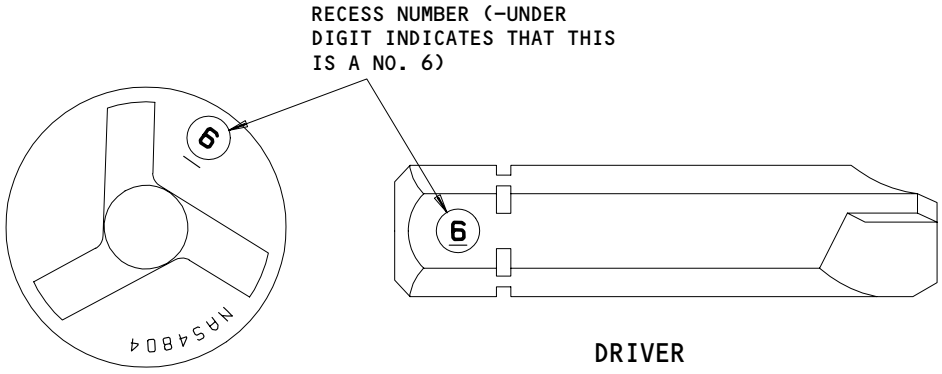
NOTE: The driver number must match the recess number of the fastener head as shown in Fig. 201. If the recess of the fastener has a layer of paint or protective coating, use a driver that is one size smaller than usual.

(b) Put the driver into the recess of the fastener.

CAUTION: MAKE SURE YOU ALIGN THE AXIS OF THE DRIVE WITH THE AXIS OF THE FASTENER WHEN YOU INSTALL OR REMOVE THE FASTENER. IF THE DRIVE TOOL IS NOT ALIGNED WITH THE FASTENER, YOU CAN CAUSE DAMAGE TO THE RECESS OF THE FASTENER.

(c) Align the axis of the driver with the axis of the fastener.

(d) Turn the driver clockwise to install the fastener.



Tri-Wing Fastener and Drive Configuration
Figure 201

CLAMPSHELL TYPE CLAMPS - MAINTENANCE PRACTICES

1. General
   A. This task is for the installation of clampshell-type clamps on these systems:
      (1) Pneumatic system tubing
      (2) Oil system tubing
      (3) Hydraulic system tubing
      (4) Fuel system tubing.
   B. The clampshell clamp has three parts: two clampshells and a cushioned or an uncushioned clamp.
   C. You will use the unplated clampshells in high vibration and high temperature (up to 800°F (427°C)) areas.
   D. You will use the cadmium-plated clampshells on aluminum tubing only.

      NOTE: Do not use the cadmium-plated clampshells in areas that are 400°F (204°C) or more.

   E. You will see worn areas in the clamp and the outer surface of the clampshell. You must replace all three parts of the clamp if you find worn areas or damage on the clamp.

   TASK 70-24-02-402-001-J00

2. Clampshell-Type Clamp Installation (Fig. 201)
   A. Access
      (1) Location Zone

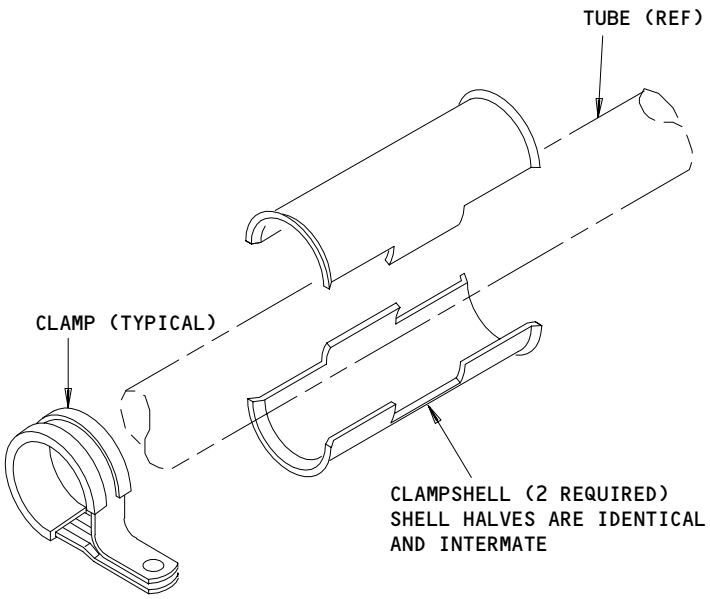
412	Engine 1
422	Engine 2
432	Engine 3
442	Engine 4

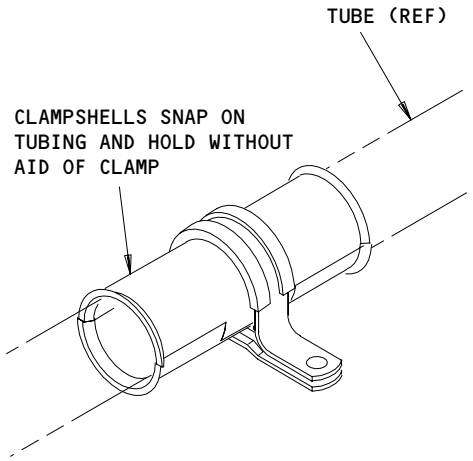
   B. Procedure

      S 422-002-J00

      CAUTION: DO NOT PUT THE CLAMPSHELL ON A BEND IN THE TUBING. YOU CAN CAUSE DAMAGE TO THE CLAMPSHELL OR THE TUBING.

      (1) Put the clampshell-type clamp on the straight part of the tube only.
         (a) Put the clampshell halves on the tube.





Clampshell Type Clamp Installation
Figure 201

(b) Put the clamp on the clampshell.

NOTE: Install the clamp in the center of the clampshells, if it is possible.

S 432-004-J00

(2) Install a number 10 fastener to attach the clampshell-type clamp to the engine.

SEALS (PREFORMED PACKINGS AND O-RINGS) AND GASKETS - MAINTENANCE PRACTICES

1. General
   A. This section contains three tasks. One task is for the removal of seals (packings or O-rings). One task is for the installation of seals. The other task is guidelines to use gaskets more than one time.

TASK 70-25-00-002-001-J00

2. Seal Removal
   A. Procedure

S 022-004-J00

(1) Remove the seal.

NOTE: Do not use a sharp or a pointed tool (such as a knife-blade or a scriber) which can cause damage to the seal or the surface of the parts.

TASK 70-25-00-402-002-J00

3. Seal Installation
   A. Procedure

S 422-005-J00

(1) Install the seal.
   (a) Use only new seals and rubber items when you install components.
   (b) Make sure that the seals are in good condition and do not have cuts or damage.
   (c) Put lubricant on the seals as specified in the component installation procedure.
   (d) Unless specified differently, the seals (O-rings) must be lubricated with engine oil.

NOTE: Too much lubricant can prevent correct seal installation and can cause contamination.

(e) Make sure the groove on the component for the seal does not have nicks, cuts, or other sharp edges.
(f) Put the seal in the correct position on the component.

NOTE: Do not permit the seal to touch threads during the installation of the seal. If the seal touches threads during installation, it can cause damage to the seal. Put a conical sleeve on the threads, if it is necessary, when you install the seal.

TASK 70-25-00-202-003-J00

4. Guidelines for the Reuse of Gaskets

A. General

(1) The guidelines for the use of gaskets more than one time are as follows:

(a) The gaskets are aluminum with a flexible, imbedded material that will seal the component.

1) No nicks, cuts, or gouges across the surface of the sealing material.
2) The material is not hard or brittle.
3) The material is not less than 0.018 inch (0.45 mm) above the metal surface.
4) There is no sealing material extrusion or cold flow in an amount sufficient to interfere with or overlap onto sealing surface.

NOTE: Thin lacy sealing material that extends beyond the normal sealing material configuration may be trimmed, being careful not to cut or loosen the base sealing material.

(b) You can remove the excess metal in the bolt hole area with a fine polishing stone (or equivalent).

NOTE: Make sure you do not touch the seal material with the polishing stone.

CONSUMABLE MATERIALS - MAINTENANCE PRACTICES

1. General
   A. This procedure has a task which gives the consumable materials for the engines.

   TASK 70-30-00-992-001-J00

2. List of Consumable Materials
   A. References
      (1) AMM 20-30-00/201, Specifications and Materials
   B. Procedure

      S 992-002-J00

      (1) The table that follows shows the consumable materials used on the engine.
         (a) If more data is necessary for a consumable material, refer to AMM 20-30-00/201.
         (b) Also, for an equivalent or alternative material, refer to AMM 20-30-00/201.

MATERIAL	SPECIFICATION	MATERIAL NAME AND/OR NUMBER	MANUFACTURER AND ADDRESS
Adhesive, Epoxy Resin	GE Spec A50TF94 Class B	EA934NA (Part A & B) GE Ref C01-011	Dexter Corp Adhesive and Coating Systems 2850 Willow Pass Road P.O. Box 312 Bay Point, CA 94565 USA
		Alternate C01-155 C01-156	NOTE: C01-155 and C01-156 may be used as one way alternates for C01-011. C01-011 may not be used as an alternate for C01-155 or C01-156.

MATERIAL	SPECIFICATION	MATERIAL NAME AND/OR NUMBER	MANUFACTURER AND ADDRESS
Adhesive, Structural Paste		EA9394 Parts A and B GE Ref C01-155	Dexter Corp Adhesive and Coating Systems 2850 Willow Pass Road P.O. Box 312 Bay Point, CA 94565 USA CAGE 33564
Adhesive, Structural Paste		EA9394 Parts A and C2 GE Ref C01-156	Dexter Corp Adhesive and Coating Systems 2850 Willow Pass Road P.O. Box 312 Bay Point, CA 94565 USA CAGE 33564
Adhesive, Silicone Rubber, Black		RTV-103 GE Ref C01-006 732 Black Multi-Purpose Sealant	General Electric Co. Silicone Products Div. 260 Hudson River Road Waterford, NY 12188 USA FSCM-01139 Dow Corning Corp. P.O. Box 994 Midland, MI 48686 USA
Adhesive, Silicone Rubber		RTV-106 Red GE Ref C01-007 736 Red Heat Resistant Sealant	GE Company, Silicone Products Div. 260 Hudson River Road Waterford, NY 12188 USA FSCM-01139 Dow Corning Corp. P.O. Box 994 Midland, MI 48686 USA

MATERIAL	SPECIFICATION	MATERIAL NAME AND/OR NUMBER	MANUFACTURER AND ADDRESS
Adhesive, Silicone Rubber		RTV-108 GE Ref C01-056	GE Company Silicone Products Div. 260 Hudson Rive Road Waterford, NY 12188 USA FSCM-01139
Alcohol, Denatured		GE Ref C04-014	Coml
Alcohol, Isopropyl		GE Ref C04-035	Coml
Alcohol, Isobutyl		GE Ref C04-151	Coml
Ultrachem Assembly Fluid No 1	GE Spec A50TF92	GE Ref C02-007	Ultrachem, Inc. 900 Centerpoint Blvd. New Castle, DE 19720 USA
Coke, Powdered	GE Spec D50TF7	Powdered Jet Shot L340 GE Ref C04-026	J.S. McCormick Co. 650 Smithfield St. Suite 1050 Pittsburg, PA 15222 USA
Compound, Abradable Epoxy	GE Spec P65TF1 Class A	RSP-3 Kit GE Ref C01-060 Resin Pack #039-080055-685	John W. Blair 140 N. Otterbein Ave. Westerville, OH 43801 USA Syon Corporation 280 Eliot Street Ashland, MA 01721 USA

MATERIAL	SPECIFICATION	MATERIAL NAME AND/OR NUMBER	MANUFACTURER AND ADDRESS
Primer, Adhesive - Silicone Sealant		Dow Corning 1200 GE Ref C01-014 Alternate C01-159	Dow Corning Corp. P.O. Box 994 Midland, MI 48686 USA FSCM-71984
Primer RTV		SS4004 GE Ref C01-159	GE Company Silicone Products Div. 260 Hudson River Road Waterford, NY 12188 USA FSCM-01139
Compound, Anti-Seize	MIL-T-5544	GE Ref C02-001 Alternate C02-058 Fel-Pro-C601 Graphite 50 Nyco GA47 Royco 44 Shell Compound No. 8 (Not available in U.S.)	 Deleted. Replaced by C02-001 Graphite 50 Fel-Pro In., Co. 7450 N. McCormick Blvd. Skokie, IL 60076 USA FSCM-73165 Nyco S A 66 Avenue Des Champs Elysees Paris 75008 France Royal Lubricants Co., Inc. P.O. Box 518 215 Merry Lane East Hanover, NJ 07936 USA Shell Intn'l Trading Co. Intn'l Aviation Div. Shell Centre London, SE1, England

MATERIAL	SPECIFICATION	MATERIAL NAME AND/OR NUMBER	MANUFACTURER AND ADDRESS
Compound, Anti-Seize	GE Spec A50TF201 Class A	Acheson GP460 GE Ref C02-058	Acheson Colloids Co. 1600 Washington Ave. P.O. Box 611747 Port Huron, MI 48061 USA GAGE-70079
Compound, Anti-Seize	GE Spec D6Y28C1 or A50TF198	Neverseez Pure Nickel Special BAC 5008 Type 7-3 GE Ref C02-071	Bostik Inc. 211 Boston St. Middleton, MA 01949 USA
Compound, Chem Surface Treatment Corrosion Resistant	MIL-C-5541 Yellow	Alodine No. 1200 GE Ref C03-006 Alodine 1200S Alodine 1200SRTU Alodine 1201 Alochrom 1200	Obsolete. Replaced by C03-006 Alodine 1200S and 1200SRTU. Henkel Surface Tech. 32102 Stephenson Hwy. Madison Heights, MI 48071 USA ICI Paints Div. Wexham Rd. Slough, Berkshire SL2 5OS U.K.
Compound, Chem Surface Treatment		Turcoat 4178 GE Ref C03-045	Deleted. Replaced by C03-006.

MATERIAL	SPECIFICATION	MATERIAL NAME AND/OR NUMBER	MANUFACTURER AND ADDRESS
Compound, Cleaning		Turco 4848-92 GE Ref C04-132	Elf Atochem Turco Prod. 2375 State Road Cornwells, Heights PA 19020 USA Export only: Elf Atochem North Aviation Products 2000 Market St. Philadephia, PA 19103 USA
Compound, Sealing High Temp		Epoxylite NO6203 GE Ref C01-077	Epoxylite Corp. 9400 Toledo Way P.O. Box 1971 Irvine, CA 92713 USA FSCM-11147
Compound, Sealing Temperature Resistant	MIL-S-8802	PR1422 GE Ref C01-062	PRC Desoto Intn'l Inc. 5430 San Fernando Road Glendale, CA 91209 USA
Developer		9D6 GE Ref C05-082 9D1B	Obsolete. Replaced by C02-082 9D1B Brent America Inc. 16961 Knott Ave. La Mirada, CA 90638 USA FSCM-23373

MATERIAL	SPECIFICATION	MATERIAL NAME AND/OR NUMBER	MANUFACTURER AND ADDRESS
Developer		GE Ref C05-069	
		NAD-NF	Deleted. Replaced by C05-069 NAD-SB
		NAD-SB	Elf Atochem Turco Prod. 2375 State Road Cornwells Heights, PA 19020 USA Export only: Elf Atochem North America Turco Aviation Products 2000 Market St. Philadelphia, PA 19103 USA
Developer		D499C GE Ref C05-075	No longer available.
Developer		ZL7 GE Ref C05-100	Obsolete.
Developer		ZP9F GE Ref C05-066	ITW Fluids Inc.-Magnaflux 3624 W. Lake Ave. Glenview, IL 60025 USA
Enamel, Polyurethane		Chemglaz 11 White A276 GE Ref C03-004	Lord Corp. Chemical Products Group 2000 W. Grandview Blvd. Erie, PA 16514 USA FSCM-30675

MATERIAL	SPECIFICATION	MATERIAL NAME AND/OR NUMBER	MANUFACTURER AND ADDRESS
Fabric, High Strength Woven	GE Spec A50TF211 Class -B	W-322 Graphite GE Ref C10-112	Cytec Fiberite Product Referral Office 5 Garret Mountain Plaza Patterson, NJ 07424 USA
Fabric, Glass Type	MIL-C-9084 Type VIII or VIIIA	No. 181 GE Ref C10-003	Hexcel Corporation Customer Service Center 5794 W. Las Positas Blvd. Pleasanton, CA 94588 USA FSCM-04621
Ferrule - Safety Cable (347 or 321 Stainless Steel)		GE Ref C10-144 J1286P01 J1286P03	Bergen Cable Technologies, Inc. 170 Gregg St. P.O. Box 1300 Lodi, NJ 07644 USA Daniels Mfg. Corp. 526 Thorpe Road Orlando, FL 32824 USA
Fibers, Milled Graphite Filler		Thornel Mat VMD-obsolete, replaced by C10-116 Thornel Mat VMX-11 GE Ref C10-116	AMOCO Polymers Inc. 4500 McGinnis-Ferry Alpharetta, GA 30005 USA

MATERIAL	SPECIFICATION	MATERIAL NAME AND/OR NUMBER	MANUFACTURER AND ADDRESS
Foam, Convolute Urethane		Urethanap No. 3500 GE Ref C01-025	Coml
Grease, Molybdenum Disulfide	MIL-G-21164	GE Ref C02-015	Deleted. Use C02-014.
Grease, Molybdenum Disulfide	MIL-G-23827	GE Ref C02-016 Aero Shell Grease 7	Shell Oil Co. One Shell Plaza Houston, TX 77002 USA FSCM-93508
		Exxon S114EP	No longer available.
		Exxon 827	No longer available.
		Castrol EASE AI	Castrol Industrial North America Inc. Specialty Products Div. 1001 W. 31st St. Downers Grove, IL 60515 USA
		Royco 27	Royal Lubricants Co. Inc. P.O. Box 518 215 Merry Lane East Hanover, NJ 07936 USA FSCM-07950
		Royco 27A	Obsolete. Replaced by Royco 27.

MATERIAL	SPECIFICATION	MATERIAL NAME AND/OR NUMBER	MANUFACTURER AND ADDRESS
Grease, Molybdenum Disulfide	GE Spec A50TF313 and F50TF106	GE Ref C02-078 Molykote G-n Metal Assembly Paste	Aerospace International Materials (AIM) 264 Center Street Miamiville, OH 45147 USA Phone: 513-831-2938 Fax: 513-831-3859
Grease, Molybdenum Disulfide	MIL-G-21164	GE Ref C02-014 Aero Grease Shell 17	Shell Oil Co. One Shell Plaza Houston, TX 77002 USA FSCM-93508
		Royco 64	Royal Lubricants Co. Inc. P.O. Box 518 215 Merry Lane East Hanover, NJ 07936 USA FSCM 07950
		M-Everlube 211-G	LPS Laboratories, Inc. P.O. Box 105052 Tucker, GA 30085 USA
Adhesive, Liquid Structural		GE Ref C01-157 EA9396 Parts A and C2	Dexter Corp. Adhesive and Coating Systems 2850 Willow Pass Road P.O. Box 312 Bay Point, CA 94565 USA GAGE-33564
Honeycomb Core, Phenolic Reinforced Polyamide Fiber	HRH-10-3/8-3.0 (Specify 3/8 in. (9.53mm) Thickness and Desired Length and Width)	Polyamide Fiber GE Ref C10-008	Hexcel Corp. Customer Service Center 5794 W. Las Positas Blvd. Pleasant, CA 94588 USA

MATERIAL	SPECIFICATION	MATERIAL NAME AND/OR NUMBER	MANUFACTURER AND ADDRESS
Honeycomb Core, Phenolic Reinforced Polyamide Fiber	HRH-10-1/8-3.0 (Specify 1/2 in. (12.7mm) Thickness and Desired Length and Width)	Polyamide Fiber GE Ref C10-113	Hexcel Corp. Customer Service Center 5794 W. Las Positas Blvd. Pleasanton, CA 94588 USA
Inhibitor, Corrosion	GE Spec. D50TF6 Class A	Brayco 599 GE Ref C02-051	Castrol Industrial North America Inc. Specialty Products Div. 1001 W. 31st St. Downers Grove, IL 60515 USA FSCM-98308
Lubricant, Sprayable Air drying	GE Spec A50TF192 Class B	Sandstrom 27A, MoS2 Base and Corrosion Inhibitor GE Ref C02-004	Sandstrom Products Co. 224 Main St. Port Byron, IL 61275 USA FSCM-34227
	GE Spec A50TF192 Class B	Tiolube 70 Organic Solvent Base, Dry Film Lubricant	Tiodize Co., Inc. 5858 Engineer Dr. Huntington Beach CA 92649 USA CAGE-87887
	GE Spec A50TF192 Class B	Tiolube 75/75 Water Base, Dry Film Lubricant	Tiodize Co., Inc. 5858 Engineer Dr. Huntington Beach CA 92649 USA CAGE-87887
	GE Spec A50TF192 Class A	Surfkote A-1625 MoS2 Base MIL-L-23398	Hohman Plating & Mfg., Inc. 814 Hillrose Ave. Dayton, OH 45404 USA
	GE Spec A50TF192 Class C	ZIP D-5460NS MoS2 Colloidal Suspension	Zip-Chem Products 1860 Dobbin Dr. San Jose, CA 95133 USA

MATERIAL	SPECIFICATION	MATERIAL NAME AND/OR NUMBER	MANUFACTURER AND ADDRESS
Fluid, Inspection	ASTM E515	Leak-Tek 16-OX GE Ref C05-005	American Gas & Chemical Co., Ltd. 220 Pegasus Ave. Northvale, NJ 06747 USA FSCM-03530
Jelly, Petroleum	VV-P-236	VV-P-236 GE Ref C02-008 Alternate Co2-033	Coml
Petrolatum, Soft	VV-P-236	White Fonoline GE Ref C02-003 Alternate C02-008	Witco Corp. One American Lane Greenwich, CT 06831 USA FSCM-79394 Ruger Chemical Co. 837 Cordier St. Irvington, NJ 07111 USA
Lockwire, Stainless Steel (0.020 Dia or 0.032 Dia)	AMS 5685 AMS 5687 AMS 5689 AMS 5690	305 Stainless (AMS 5685) Inconel 600 (AMS 5687) 321 Stainless (AMS 5689) 316 Stainless (AMS 5690) GE Ref C10-071	AlliedSignal 1160 South St. Suffield, CT 06078 USA

MATERIAL	SPECIFICATION	MATERIAL NAME AND/OR NUMBER	MANUFACTURER AND ADDRESS
Adhesive, Film	GE Spec A15B41H7	Loctite 592 GE Ref C01-084	Loctite Corp. 1001 Trout Brook Crossing Rocky Hill, CT 06067 USA FSCM-05972
Lubricant, Sprayable Air Drying	D 321 R	Molykote D 321-R GE Ref C02-003	Dow Corning Europe S A 62 Rue General De Gaulle Brussels Belgium Dow Corning France S A Le Britannia 20, bd Eugene Derwelle 69432 Lyon CEDEX 03 France Fournier 11, Rue Des Freres Lumiere ZI Nord 77100 Meaux France
Lubricant		Everlube ESNA 382 GE Ref C02-006	E/M Corporation 100 Cooper Circle P.O. Box 3969 Peachtree City, GA 30269 USA
Lubricant, O-Ring and Assembly Fluid		Acryloid HF825 GE Ref C02-013 Royco HF825	Deleted. Royal Lubricants Co. Inc. P.O. Box 518 215 Merry Lane East Hanover, NJ 07936 USA FSCM-07950

MATERIAL	SPECIFICATION	MATERIAL NAME AND/OR NUMBER	MANUFACTURER AND ADDRESS
Lubricant, Metal Assembly Paste	GE Spec A50TF313	G-n Metal Assembly Paste GE Ref C02-078 Alternate C02-003	Aeerospace International Materials 264 Center Street Miamiville, OH 45147 USA CAGE - 0Y7E4
Pens, Marking		T.E.C. Marker (Black) GE Ref C05-003	Sanford Corp. 2711 Washington Blvd. Bellwood, IL 60104 USA
		Berol Verithin Silver Pencil	Sanford Corp. 2711 Washington Blvd. Bellwood, IL 60104 USA
		LN9051 Red or Blue	Ratioplast GmbH Spitalwald Strasse Be 9 8540 Schwabach West Germany
	D50TF8	Action Marker Nuclear Grade White or Black Felt Tip No. 33 Fine, 44 Medium and 55 Broad Tip.	Mark-Tex Corp. 160 W. Forest Ave. Englewood, NJ 07631 USA
		Y-608 #55 Valve Action Marker - Black (Water Removable Ink)	Mark-Tex Corp. 160 W. Forest Ave. Englewood, NJ 07631 USA

MATERIAL	SPECIFICATION	MATERIAL NAME AND/OR NUMBER	MANUFACTURER AND ADDRESS
Material, Vibration Dampening		Unisorb HB-1/2 GE Ref C10-030	Unisorb Installation Technologies P.O. Box 1000 4117 Felters Road Jackson, MI 49201 USA
Filler, Phenolic Microballoons		BJO-0930 GE Ref C10-093	Asia Pacific Microspheres (manufacturer) SDN BHD P.O. Box 7086 40702 Shah Alam Selangor Darul Ehsan, Malaysia The M.F. Cachat Co. 1391 W. 110th St. Cleveland, OH 44102 USA
Oil, Engine Lubricating	GE Spec D50TF1	GE Ref C02-019	See CF6 Service Bulletin 79-001 for approved oil brands and suppliers.
		Mobil Jet Oil II, Mobil 254 (Mobil 291 is approved for Revenue Service Evaluation only.)	Mobil Chemical Co. Chemical Coatings Div. P.O. Box M-1 Short Hills, NJ 07078

MATERIAL	SPECIFICATION	MATERIAL NAME AND/OR NUMBER	MANUFACTURER AND ADDRESS
Oil, Grade 1010		Brayco 460 GE Ref C02-021	Castrol Industrial North American Inc. Specialty Products Div. 1001 W. 31st St. Downers Grove, IL 60515 USA
		Hydrocol Jet	Delta Petroleum Inc. 10352 River Road St. Rose, LA 70087 USA
		Royco 481 (Aeroshell Turbine Oil II)	Royal Lubricants Co. Inc. P.O. Box 518 215 Merry Lane East Hanover, NJ 07936 USA FSCM-07950
		Windsor L-110	Fuchs Lubricants Co. 17050 Lathrop Ave. Harvey, IL 60426 USA
Oil, Engine Lubricating	MIL-L-23699	GE Ref C02-023	See CF6 Service Bulletin 79-001 for approved oil brands and suppliers.
Oil, Engine Lubricating High Temp Silicone Base with MoS2	DOD-L-25681	GE Ref C02-020 Royco 81MS	 Royal Lubricants Co. Inc. P.O. Box 518 215 Merry Lane East Hanover, NJ 07936 USA FSCM-07950

MATERIAL	SPECIFICATION	MATERIAL NAME AND/OR NUMBER	MANUFACTURER AND ADDRESS
Oil, Preservation	MIL-C-6529C	Brayco 483 GE Ref C02-025	Castrol Industrial North America Inc. Specialty Products Div. 1001 W. 31st St. Downers Grove, IL 60515 USA
		Royco 483 (Shell Storage Oil 3)	Royal Lubricants Co. Inc. P.O. Box 518 215 Merry Lane East Hanover, NJ 07936 USA FSCM-07950
		Aeroshell Fluid 2T	Equilon Enterprise West Hollow Technical Center 3333 Highway 6 South Houston, TX 77082-3101 USA
Pads, Scotch Brite		No. 7447 GE Ref C10-010	3M Company 3M Center, Product Information Center Bldg. 304-0101 St. Paul, MN 55144 USA FSCM-28124
Paint, Intumescent	GE Spec A50TF121 Class A	Flame Control No. 170 (Formerly 1001-98, Mod 8) GE Ref C03-024	Flame Control Coating Inc. P.O. Box 786 4120 Hyde Park Blvd. Niagara Falls, NY 14302 USA

MATERIAL	SPECIFICATION	MATERIAL NAME AND/OR NUMBER	MANUFACTURER AND ADDRESS
Paint, Intumescent		Flame Control No. 190 Top Coat GE Ref C03-025	Flame Control Coatings Inc. P.O. Box 786 4120 Hyde Park Blvd. Niagara Falls, NY 14302 USA
Paint, Epoxy Flat Gray	MIL-C-22750	Color #36231 GE Ref C03-056 4222T36231	Coml T.C. Specialties, Inc. 460 Industrial Way Placentia, CA 92870 USA
Paper, Emery 400 Grit			Coml
Paper, Greaseproof		Grade A, Type 2, Class 2 (Kraft) GE Ref C10-009	Ludlow Corp. Packaging Div. P.O. Box 749 1 Minden Road Homer, LA 71040 USA FSCM-76209
Penetrant		985P2 GE Ref C05-046 985P13	Obsolete. Replaced by 985P13 Brent America Inc. 16961 Knott Ave. La Mirada, CA 90638 USA FSCM-23373

MATERIAL	SPECIFICATION	MATERIAL NAME AND/OR NUMBER	MANUFACTURER AND ADDRESS
Penetrant		P40BGE GE Ref C05-028	Obsolete.
Penetrant		P41 GE Ref C05-029 P41H1	Obsolete. Replaced by P41H1. Elf Atochem Turco Prod. 2375 State Road Cornwells Heights, PA 19020 USA Export only: Elf Autochem North America Turco Aviation Products 2000 Market St. Philadelphia, PA 19103 USA
Penetrant		ZL22A GE Ref C05-023 ZL27A	Obsolete. Replaced by ZL27A ITW Fluids Inc. 3624 W. Lake Ave. Glenview, IL 60025 USA
Penetrant		ZL22C GE Ref C05-092	Obsolete. Replaced by C05-023.

MATERIAL	SPECIFICATION	MATERIAL NAME AND/OR NUMBER	MANUFACTURER AND ADDRESS
Petrolatum, Soft	Fed-Spec VV-P-236	White Fonoline GE Ref C02-033 Alternate C02-008 VV-P-236	Witco Corp. One American Lane Greenwich, CT 06831 USA FSCM-79394 Ruger Chemical Co. 837 Cordier St. Irvington, NJ 07111 USA
Pigment, Coloring		V1747 (Black) GE Ref C03-023 61-860700 Black	Deleted. Replaced by 61-860700. Ferro Corp. Color Division 1301 North Flora Plymouth, IN 46563 USA
Primer, Epoxy Resin Spray Type	GE Spec A50TF107 Class A	463-12-8 (Spray Type) GE Ref C03-005	T.C. Specialties, Inc. 460 Industrial Way Placentia, CA 92870 USA
Primer, Polymide Epoxy	MIL-P-23377 NOTE: Type I-Yellow Type II-Green	P-527 D Primer C-527 D Converter GE Ref C03-017 Dexter 10-P20-13 Catalyst EC-213 Type I, Class 2	Kop-Coat, Inc. P.O. Box 911207 Commerce, CA 90091 USA T.C. Specialties, Inc. 460 Industrial Way Placentia, CA 92870 USA

MATERIAL	SPECIFICATION	MATERIAL NAME AND/OR NUMBER	MANUFACTURER AND ADDRESS
Primer, Silicone		SS 4155 GE Ref C01-092	GE Company Silicone Products Div. 260 Hudson River Road Waterford, NY 12188 USA FSCM-01139 General Electric France BP67 91002 EVRY CEDEX France
Reducer, Catalyst		Diethylene-triamine High Purity Grade GE Ref C01-024	Union Carbide Corp. 10235 West Little York Rd Suite 300 Houston, TX 77040 USA
Adhesive, Epoxy Resin		EA956 GE Ref C01-106 Alternate C01-147	Dexter Corp. Adhesive & Coating Sys 2850 Willow Pass Road P.O. Box 312 Bay Point, CA 94565 USA GAGE-33564
Adhesive, Epoxy Resin		Epibond 8543 (A and B) GE Ref C01-117	Ciba Specialty Chemicals 5121 San Fernando Rd West Los Angeles, CA 90039 USA

MATERIAL	SPECIFICATION	MATERIAL NAME AND/OR NUMBER	MANUFACTURER AND ADDRESS
Adhesive, Epoxy Resin	GE Spec A50TF94 Class B	EA934/NA (Part A and B) GE Ref C01-011	Replaces C01-019 Dexter Corp. Adhesive & Coating Sys 2850 Willow Pass Road P.O. Box 312 Bay Point, CA 94565 USA GAGE-33564
		Alternate C01-155 C01-156	NOTE: C01-155 and C01-156 may be used as one way alternates for C01-011. C01-011 may not be used as an alternate for C0-155 or C0-156.
Adhesive, Structural Paste		EA9394 Parts A and B GE Ref C01-155	Dexter Corp Adhesive & Coating Sys 2850 Willow Pass Road P. O. Box 312 Bay Point, CA 94565 USA GAGE-33564
Adhesive, Structural Paste		EA9394 Parts A and C2 GE Ref C01-156	Dexter Corp Adhesive & Coating Sys 2850 Willow Pass Road P. O. Box 312 Bay Point, CA 94565 USA GAGE-33564

MATERIAL	SPECIFICATION	MATERIAL NAME AND/OR NUMBER	MANUFACTURER AND ADDRESS
Resin, Epoxy		EPON 828 GE Ref C01-017	Shell Chemical Co. One Shell Plaza Houston, TX 77002 USA Miller Stephenson Chemical Co. George Washington Hwy. P.O. Box 950 Danbury, CT 06810 USA FSCM-18598 E.V. Roberts and Assoc P.O. Box 868 8500 Stellar Dr Culver City, CA 90232 USA
Cleaner, Heavy Duty, Alkaline		Turco T-4181 Turco T-418L GE Ref C04-009	Elf Atochem Turco Prod 2375 State Road Cornwells Heights, PA 19020 USA Export only: Elf Atochem North America Turco Aviation Products 2000 Market St. Philadelphia, PA 19103 USA
Seal, Conical		VSF1015-N-4 GE Ref C10-029	Fairfield Fasteners 3000 West Lomita Blvd. Torrence, CA 90505 USA

MATERIAL	SPECIFICATION	MATERIAL NAME AND/OR NUMBER	MANUFACTURER AND ADDRESS
Seal, Conical		VSF1015-N-4 GE Ref C10-029	Coml
Solvent, Chlorothene NU	Fed. Spec. O-T-620A	GE Ref C04-005	Obsolete. Ozone depleting substance.
Solvent, Triethane	Fed. Spec. O-T-620A		Obsolete. Ozone depleting substance.
Solvent, Methyl Ethyl Ketone (MEK)	ASTM D 740	GE Ref C04-001 Alternate, C04-160 or C04-196	Coml
Solvent, General Methyl Propyl-Ketone		GE Ref C04-196	Coml
Solvent, General		Ardrox 1064-K GE Ref C04-160	Brent America, Inc. 16961 Knott Ave. La Mirada, CA 90638 USA FSCM-23373
Solvent, Stoddard	P-D-680, Type I or II	GE Ref C04-002	Coml
Solvent, Trichloroethane 1.1.1. (Technical Inhibited)	Fed. Spec. O-T-620-C MIL-T-81533	GE Ref C04-030	Deleted. Ozone depleting substance.
Solvent, Trichloro- ethylene (Technical)	Fed. Spec. O-T-634	GE Ref C04-004	Coml
Solvent, Cholrothene NU	Fed. Spec. O-T-620A	GE Ref C04-005	Obsolete. Ozone depleting substance.
Solvent, Triethane	Fed. Spec. O-T-620A	GE Ref C04-005	Obsolete. Ozone depleting substance.

MATERIAL	SPECIFICATION	MATERIAL NAME AND/OR NUMBER	MANUFACTURER AND ADDRESS
Solvent, Toluene		Regeant Grade GE Ref C04-102	Coml
Tape, Glass Fiber	GE Spec A23B5A2	GE Ref C10-070 Permacel P21	Permacel U.S. Highway No. 1 New Brunswick, NJ 08903 USA
		Scotch No. 27	3M Company 3M Center Product Information Bldg., 304-0101 St. Paul, MN 55144 USA
		Tuck No. 51	Delted. Replaced by TESA 4616.
		TESA 4616	TESA Tape Inc. (TTI) 5825 Carnegie Blvd Charlotte, NC 28209 USA
Tape, Teflon		Scotch Brand 5490 GE Ref C10-040	3M Company 3M Center Product Information Center Bldg. 304-0101 St. Paul, MN 55144 USA
Thinner, Reducer Epoxy Paint		TL29 GE Ref C03-057	T.C. Specialties, Inc. 460 Industrial Way Placentia, CA 92870 USA

FLUORESCENT PENETRANT INSPECTION - MAINTENANCE PRACTICES

1. General
   A. This fluorescent penetrant inspection procedure provides instructions for examining welded or other localized repair areas.
   B. If a part has previously been inspected with visible nonfluorescent color dye penetrant, contamination by the dye will prevent reliable fluorescent penetrant inspection.
   C. Titanium alloy parts must be thoroughly cleaned with non-halogen compounds after exposure to any halogen containing compound to prevent stress-corrosion, cracking and possible failure of parts. De-ionized water must be used for processing parts made of titanium or titanium alloy.
   D. A list of fluorescent penetrant materials and vendors is found in MIL-I-25135 and Oualified Products List (QPL)-25135. Alternate inspection procedures can be found in the Aerospace Material Specification (AMS) 2647.

TASK 70-31-01-232-001-J00

2. Examine Part
   A. Standard Tools and Equipment
      (1) Hood - Black Cloth, to prevent excessive admission of white light

          NOTE: A test part having a known defect can be used to evaluate effectiveness of white light shielding.

      (2) Air Source - Regulated Compressed, Dry Filtered
      (3) Light - Black (Ultraviolet)
      (4) Light - White
      (5) Time Piece
      (6) Lens - Magnifying, 3x and 10x power
   B. Consumable Materials
      (1) G00596 Compound - Inspection Materials, Penetrants, MIL-I-25135
      (2) Ardrox System
          (a) G02035 Penetrant - Ardrox 985P2
          (b) G02031 Developer - Ardrox 9D6
          (c) G01255 Developer - D499C (optional to G02031)
      (3) Magnaflux System
          (a) G01114 Penetrant - Zyglo, ZL22A
          (b) G02036 Penetrant - Zyglo, ZL22C
          (c) G02033 Developer - Zyglo, ZP9C
          (d) G01255 Developer - D499C (optional to G02033)
      (4) Turco System
          (a) G01153 Penetrant - Fluro Check P40B
          (b) G01206 Penetrant - Fluro Check P41

(c) GO1231 Developer - Fluro Check NAD-NF
(d) GO1255 Developer - D499C (optional to GO1231)
(5) GO0834 Cloth - Cotton, Lint-free
(6) BO0448 Solvent - Trichloroethane 1,1,1, Technical Inhibited, O-T-620A, with Halogen
(7) BO0185 Alcohol - Isopropyl, TT-I-735, Halogen Free
(8) BO0148 Solvent - Methyl Ethyl Ketone (MEK), TT-M-261 (GE C04-001)
(9) BO0062 Solvent - Acetone, O-T-634, Halogen Free
(10) GO0623 Swabs - Cotton
(11) GO0000 Brush - Fine-Hair Art (optional to cotton swabs)

C. Access
(1) Location Zone
412 Engine 1
422 Engine 2
432 Engine 3
442 Engine 4

D. Procedure

S 162-002-J00

CAUTION: AVOID USE OF CLEANING PROCEDURES SUCH AS HEAVY GRINDING, SCRAPING, CHIPPING AND PEENING, THAT CAN SMEAR METALS OVER EXISTING DISCONTINUITIES.

(1) Clean part(s) to be examined.

S 952-003-J00
(2) Plug or cap tubes and holes in area to be examined to prevent examination materials from being entrapped.

S 232-011-J00

WARNING: PENETRANT IS FLAMMABLE. WHEN YOU USE IT AS A FINE SPRAY, OBSERVE THE PRECAUTIONS AGAINST FIRE. IF YOU DO NOT FOLLOW THIS PROCEDURE, YOU CAN CAUSE INJURY TO PERSONS OR DAMAGE TO THE EQUIPMENT.

CAUTION: DO THE PENETRANT TEST ONLY IF THE PART, THE PENETRANT, AND THE AIR TEMPERATURE ARE ABOVE 40 DEGREES F (6 DEGREES C). IF YOU DO NOT OBEY THIS PROCEDURE, YOU CAN CAUSE DAMAGE TO THE EQUIPMENT.

(3) Use one of the options that follow to apply the penetrant by spray or with a brush:

NOTE: Make sure you use the correct temperature and time for the penetrant to dwell.

You can use any penetrant listed above or the equivalent. But, the developer that you use must be in the same system as the penetrant.

(a) Use option 1 when the part, the penetrant, and the air temperature are between 60°F and 100°F (16°C-38°C):
1) Let the penetrants dwell for a minimum of 30 minutes for penetration.
(b) Use option 2 when the part, the penetrant, and the air temperature are between 40°F and 60°F (6°C-16°C):
1) Double the penetrants dwell time for penetration.

S 232-005-J00

(4) Remove excess penetrant.
(a) Remove excess penetrant by wiping with a clean dry cloth.

WARNING: DO NOT GET SOLVENT OR ALCOHOL IN YOUR MOUTH OR EYES, OR YOUR SKIN. DO NOT BREATHE THE FUMES FROM SOLVENT OR ALCOHOL. PUT ON A PROTECTIVE SPLASH GOGGLE AND GLOVES WHEN YOU USE SOLVENT OR ALCOHOL. KEEP SOLVENT OR ALCOHOL AWAY FROM SPARKS, FLAME, AND HEAT. SOLVENT AND ALCOHOL ARE POISONOUS AND FLAMMABLE SUBSTANCES WHICH CAN CAUSE INJURY OR DAMAGE.

CAUTION: USE A HALOGEN-FREE SOLVENT OR ALCOHOL ON PARTS MADE OF TITANIUM OR TITANIUM ALLOY.

(b) Remove background fluorescence by wiping with a clean cloth dampened with solvent or alcohol.

(c) Observe part under ultraviolet light to make sure excess penetrant has been removed.

NOTE: The use of light-sensitive glasses by personnel is prohibited when working with ultraviolet light because of darkening effects.

CAUTION: APPLY SOLVENT OR ALCOHOL SPARINGLY. INDICATIONS OF DEFECTS CAN BE LOST BY EXCESSIVE SOLVENT OR ALCOHOL SPRAYING.

(d) If excessive background fluorescence persists, apply solvent or alcohol as a fine mist while observing under ultraviolet light. Direct spray at an angle and spray over area only once.

S 232-006-J00

(5) Apply developer.

WARNING: AVOID BREATHING OF VAPORS. DEVELOPER IS TOXIC.

CAUTION: USE DEVELOPER THAT IS IN SAME SYSTEM AS THE PENETRANT.

(a) Apply developer by spray only to a dry part at ambient temperature. Apply a fine thin coating by holding spray nozzle about 8-10 inches (200-250 mm) from part surface. Normally 2 passes are adequate. Coverage should be uniform and a metallic background should be visible through the developer.

NOTE: When using aerosol container, follow manufacturer's directions.

(b) Allow minimum of 10 minutes for developer to absorb penetrant.

S 232-007-J00

(6) Examine parts.

(a) Direct ultraviolet light on part while under a black cloth hood.

NOTE: The use of light sensitive glasses by personnel is prohibited when working with ultraviolet light because of darkening effects.

(b) Examine questionable indications as follows.
1) Wipe area once with solvent or alcohol, using cotton swab or fine hair brush.
2) Apply developer to suspected area after solvent or alcohol has dried.
3) Examine under ultraviolet light. Indications that reappear within 2 minutes shall be considered as valid indications.
4) If indications do not reappear, examine part under white light using magnifying lens.
5) Identify location of defects using an approved marking method.
6) Reject parts that contain surface defects in excess of acceptance limits. If acceptance limits are not specified, rejectable surface defects are any of the following: shrinkage cracks or porosity, cold shuts, fatigue cracks, forming cracks, grinding and heat treat cracks, seams, laps, and bursts.
7) Unless otherwise specified, base acceptance of machined castings on raw casting procurement specification. If radiographic inspection of castings is required, base disposition of doubtful penetrant indications of microshrinkage or porosity on radiographic inspection results. If radiographic inspection is not required, either destructive cross-sectioning or radiographic inspection may be used to disposition doubtful penetrant indications. If destructive cross-sectioning is the process chosen, use parts that represent typical penetrant indications.
8) Unless otherwise specified, microshrinkage or porosity on the surface of magnesium alloy castings shall not be cause for rejection.
9) Inspect welds and accept/reject in accordance with applicable weld specifications.
10) Parts or areas of parts reworked as a result of penetrant indications shall be reinspected in accordance with this specification prior to acceptance.

S 232-008-J00

(7) Clean parts after examination.

CAUTION: ALL RESIDUAL PENETRANTS AND DEVELOPER MATERIAL MUST BE REMOVED FROM PART AS SOON AS POSSIBLE. UNREMOVED MATERIAL CAN CAUSE SEVERE CORROSION OF PARTS AT ELEVATED TEMPERATURES AND PROBLEMS DURING WELDING.

WHEN CLEANING PARTS MADE OF TITANIUM OR TITANIUM ALLOYS WITH SOLVENT, USE ONLY SOLVENTS THAT DO NOT CONTAIN HALOGENS.

WHEN CLEANING PARTS MADE OF TITANIUM OR TITANIUM ALLOYS WITH WATER, USE ONLY DEIONIZED WATER.

(a) Remove developer and penetrant by water spray washing or scrubbing the part with brush and water.

WARNING: DO NOT GET SOLVENT OR ALCOHOL IN YOUR MOUTH OR EYES, OR ON YOUR SKIN. DO NOT BREATHE THE FUMES FROM SOLVENT OR ALCOHOL. PUT ON A PROTECTIVE SPLASH GOGGLE AND GLOVES WHEN YOU USE SOLVENT OR ALCOHOL. KEEP SOLVENT OR ALCOHOL AWAY FROM SPARKS, FLAME, AND HEAT. SOLVENT AND ALCOHOL ARE POISONOUS AND FLAMMABLE SUBSTANCES WHICH CAN CAUSE INJURY OR DAMAGE.

(b) Remove penetrant residue by spraying or by soaking in solvent or alcohol.

CAUTION: LIMIT DRYER TEMPERATURE TO 160°F (71°C) MAXIMUM. HIGHER TEMPERATURES CAN DEGRADE BRIGHTNESS OF FLUORESCENT DYE IN PENETRANT.

(c) Make sure all internal passages and recesses are completely cleaned and dry. Blow out passages and recesses with dry air.

S 232-009-J00

(8) Check part under ultraviolet light to make sure all penetrants and developer materials have been removed.

S 232-010-J00

(9) Assure that residues of processing compounds are completely removed from titanium and titanium alloy parts.

ETCH PROCEDURES - MAINTENANCE PRACTICES

1. General

A. You must use the chemical etch procedure on the stable weldments before you do a fluorescent-penetrant inspection. Tarnished parent metal caused by an operations such as filing a weld can cause problems. This damage can put covers on cracks and defects in metal parts that prevent identification during the inspection. You must use etchants to remove this unwanted material and find the defects. Put the etchants in groups by the procedure used to apply the etchants to specified metals. When it is approved, you can use other procedures for the groups that follow:

B. Etchant Classes

NOTE: You must use a swab to apply the etchants on these metals, unless it is specified differently.

CLASS	METALS
Class A	Magnesium alloys
Class B	Titanium alloys
Class C	Stainless Steel Etchants (Schantz Reagent): 300- and 400- series stainless steels, precepitation hardening steels A-286 maginal steels Rene' 77, 80, 95, 100 and 125 Udiment 500 Sel and Sel 15 TD-Ni-Cr Waspalloy M152 17-4 PH Hastelloy B, C, and W
Class D	Superalloy Etchant Rene' 41 Astrology Hastelloy X HS 188 Inconel 718 all other Inconel metals
Class E	Carbon steel, bearing and gear alloys
Class F	Aluminum alloys

CLASS	METALS
Class G	Inconel 718 (Alternative)

TASK 70-31-02-232-014-J00

2. The Swab Etch Procedures for the Fluorescent-Penetrant Inspection

A. General

(1) These instructions give the materials and procedures to use a swab to etch the surfaces before you do a fluorescent-penetrant inspection. Unless it is given differently, use these etchants as specified for each part.

B. Procedure

S 552-016-J00

(1) Keep all stock etchant solutions in plastic containers, (polypropylene, acid-resistant quality) as recommended.
(a) Class B etchant attacks glass.
(b) You must keep Class B and Class F etchants in plastic bottles.
(c) Class A, C, D, E, and G etchants can be kept in glass bottles, if it is necessary.
(d) Store away from heat and do not permit the etchant solutions to freeze.

S 552-020-J00

(2) The shelf life of each class of etchant follows:

Class A	1 year
Class B	1 month in a plastic bottle that has a stopper. Permit 60 minutes for the gas to be released after you make the solution and before you replace the bottle stopper
Class C	6 months
Class D	60 minutes (after you mix the solution), hydrochloric acid has a shelf life of 1 year
Class E	6 months
Class F	1 year
Class G	1 year.

S 552-021-J00

(3) You must label each container of the stock solution with the Class identification of the contents, and the expiration data of the shelf-life period.

S 172-022-J00

(4) A supply of distilled water must be available to mix the etchants, and to flush them from the etched area of the work.

NOTE: You can use clean tap water to flush the Class G etchant.

S 282-017-J00

WARNING: YOU MUST MONITOR THE SHORT SHELF LIFE OF THE CLASS D ETCHANT. IT CAN BECOME DANGEROUS TO PERSONS. AFTER ONE HOUR, THE MIXTURE CAN BECOME NOT SERVICEABLE AND GIVE OFF NITROUS OXIDE. IF THE CAP IS TOO TIGHT, THE CONTAINER CAN BREAK OPEN. THE MIXTURE CAN ALSO BECOME HOT. IF YOU DO NOT OBEY THIS PROCEDURE, YOU CAN CAUSE INJURIES TO PERSONS AND DAMAGE TO EQUIPMENT.

WARNING: DO NOT GET THE ETCHANTS IN YOUR MOUTH OR EYES, OR ON YOUR SKIN. DO NOT BREATHE THE FUMES FROM THE ETCHANTS. THE ETCHANT AGENTS MIX AND GIVE OFF DANGEROUS GASES THAT CAN CAUSE CORROSION. USE THEM IN AN AREA THAT IS OPEN TO THE AIR, PUT ON PROTECTION CLOTHES, GLOVES, AND A FACE SHIELD. IF THE SOLUTION GETS IN YOUR EYES, FLUSH FULLY WITH COOL WATER BELOW THE EYE LIDS AND GET MEDICAL AID IMMEDIATELY. IF YOU DO NOT OBEY THIS PROCEDURE, YOU CAN CAUSE INJURIES TO PERSONS AND DAMAGE THE EQUIPMENT.

(5) Do these steps to etch the metal surfaces unless it is specified differently:
   (a) You must clean all of the surfaces that you will etch.
      1) Make sure you remove these materials:
         a) the oil
         b) the grease
         c) the scale
         d) all the other unwanted material.
   (b) Put a small quantity of the stock solution into a clean plastic beaker or dish.
      1) This quantity will be the etch solution, and you do not put this solution back into the stock bottle.
   (c) Soak a cotton swab with the solution.
      1) Rub the surface that you will etch for 60-90 seconds for all Classes A thru F.
   (d) The etch time for the Class G is 3-4 minutes.
      1) Keep the etch solution in the limits that you will etch.

2) Put the tape around the area to contain the solution in the applicable area that you will etch.

NOTE: Use more solution to keep the metal wet at all times. Put the swab momentarily into the solution regularly. Rub the swab continuously on the metal that you etch.

(f) After you etch the metal, remove the etch solution.
1) Dry the metal surface with a clean paper towel or cloth.
(g) Lightly clean the etched area a minimum of three times with a cloth or paper towel that is moist with clean water.
1) Dry the etched area with a cloth or paper towel.

WARNING: DO NOT PUT THE SOLUTION BACK INTO THE STOCK CONTAINER. ALTHOUGH THE SMALL QUANTITIES ARE NOT DANGEROUS TO THE ENVIRONMENT, FLUSH THE DISCARDED SOLUTION TWO OR MORE TIMES WITH WATER. IF YOU DO NOT OBEY THIS PROCEDURE, YOU CAN CAUSE DAMAGE TO THE MATERIAL.

(h) Discard the used solution.
(i) Flush and dry the plastic container to use it again.

TASK 70-31-02-232-018-J00

3. Consumable Materials for the Etch Solutions

A. General

(1) The reagents that follow are necessary to make the etchants that you use to prepare metals before a fluorescent-penetrant inspection.

COMPOUND *[1]	STRENGTH
Acetic Acid	99.7%
Ferric Chloride (FeC13.6H20)	
Hydrochloric acid (Muratic) 20°Be	36.5-38%
Hydrofluoric acid	48%
Nitric acid	69-71%
Oxalic Acid	
Sodium Hydroxide	Pellets
Sulfuric Acid	95-98%
Tartaric Acid	
Water	Distilled or de-ionized

*[1] These reagents are available locally.
* Commercial grade or better is satisfactory, if the concentration or strength is the same.

B. Instructions for the Etch Procedure

S 232-019-J00

WARNING: DO NOT GET THE ETCHANTS IN YOUR MOUTH OR EYES, OR ON YOUR SKIN. DO NOT BREATHE THE FUMES FROM THE ETCHANTS. THE ETCHANT AGENTS MIX AND GIVE OFF DANGEROUS GASES THAT CAN CAUSE CORROSION. USE THEM IN AN AREA THAT IS OPEN TO THE AIR, PUT ON PROTECTION CLOTHES, GLOVES, AND A FACE SHIELD. IF THE SOLUTION GETS IN YOUR EYES, FLUSH FULLY WITH COOL WATER BELOW THE EYE LIDS AND GET MEDICAL AID IMMEDIATELY. IF YOU DO NOT OBEY THIS PROCEDURE, YOU CAN CAUSE INJURIES TO PERSONS AND DAMAGE THE EQUIPMENT.

CAUTION: DO NOT ADD WATER TO ACID. ALWAYS ADD ACIDS TO THE WATER WHILE YOU MIX THE SOLUTION. IF YOU DO NOT OBEY THIS PROCEDURE, YOU CAN CAUSE INJURIES TO PERSONS AND DAMAGE TO THE EQUIPMENT.

(1) Add the reagents in the sequence and proportions given in the formulas that follow:
(a) Fully mix each before you add the subsequent reagent.

S 232-023-J00

(2) You use ferric chloride that is usually supplied in a solid shape to make the Class C and Class G etchants.
(a) You can use it in the molten condition to help the mixture.
(b) The melting point is 98.6°F or (37°C).
(c) It can also be crushed and added in a granular or powdery condition with a constant mix until dissolved.
(d) Ferric chloride is extremely hygroscopic (changes to a liquid very fast).
1) You must keep the supply that you do not use sealed very tight.

NOTE: Ferric chloride dissolves quickly when you use hot water 150°-190°F (65.6°-87.8°C).

S 232-024-J00

(3) Glacial (99.7%) acetic acid freezes at immediately below room temperature 62°F (16.7°C).
   (a) To help mix the acid, put the container in the warm water for not less than two minutes.
      1) The mixture will have an easier flow.

S 232-025-J00

(4) Loosen the stopper or caps of the bottles carefully to prevent a spray from the solution while you open the bottles.

C. The Formulas and Swab Etchants

S 232-026-J00

(1) With the average use, these formulas are for quantities with estimates to continue until the shelf-life time of the etchant.
   (a) You can make larger or smaller quantities when you use the equal proportions to those given.

CLASS *[1]	FORMULAS *[2] *[3]
Class A	Magnesium Alloys Oxalic acid ..... 10 grams or Tartaric acid ..... Distilled water ..... 90 ml
Class B	Titanium Alloys Distilled water ..... 62 ml Nitric acid ..... 35 ml Hydrofluoric acid ..... 3 ml
Class C	Stainless Steels (Schantz Reagent) Distilled water..... 750 ml Sulfuric acid..... 150 ml Hydrochloric acid..... 1800 ml Nitric acid..... 500 ml Acetic acid..... 750 ml Ferric chloride..... 454 grams (1 lb)
Class D	Superalloys Schantz Reageant (Class C)..... 10 ml Hydrochloric acid..... 10 ml
Class E	Carbon steels, bearing and gear alloys Distilled water..... 95 ml Nitric acid..... 5 ml
Class F	Aluminum alloys Distilled water..... 60 ml Sodium hydroxide..... 20 grams Distilled water to make..... 100 ml
Class G	Inconel 718 Ferric chloride..... 38 grams Tap water..... 23 ml Hydrochloirc acid..... 28 ml Tap water to make..... 76 ml

CLASS *[1]	FORMULAS *[2] *[3]

*[1] Refer to the shelf life limits of each Class above

*[2] Add ferric chloride immediately.

*[3] Let the solution cool to room temperature before you add more water.

Use distilled or de-ionized water unless the instructions tell you differently.

TIGHTENING PRACTICES AND TORQUE VALUES - MAINTENANCE PRACTICES

1. General
   A. This procedure gives the instructions that you must follow when you tighten the fasteners with threads (bolts, nuts, and fittings).
   B. Torque is the turn force that you apply to the fastener to install a part.
      (1) The units of torque are in pound-inches (lb-in.) or newton meters (N.m).
      (2) This torque correctly attaches the part.
      (3) This torque is not more than the strength in tension of the material.
      (4) It is also not more than the strength (in shear) of the threads.
   C. One pound-inch (lb-in.) newton meter (N.m) of torque is the turn force when you apply one pound (0.45 kg) to a one inch (25.4 mm) lever.
   D. Torque is the result when you multiply a force in pounds (kilograms) by the length of a lever in inches (millimeters).

      NOTE: Torque values have the units of lb-in. (N.m). This is different from work, that applies a force in a straight line for a distance. Units of work are the inch-pound (in.-lb), foot-pound (ft-lb), or the joule (J). One ft-lb (J) of work is the energy to lift one pound (0.45 kg) through a distance of one foot (0.305 m).

TASK 70-50-00-912-034-J00

2. Instructions For Torque
   A. General
      (1) These are the names or the properties of a part.
         (a) Bolt
            1) A bolt is a fastener with an external thread.
         (b) Breakaway-Torque
            1) This torque is the necessary torque to start the removal of a nut without an axial load on the nut.
         (c) Gross Torque
            1) Gross torque includes the run-on torque and the seated torque.
         (d) Installed Nut
            1) You install a nut, when the chamfer plus a minimum of 1.5 bolt threads extends through the nut.
            2) It is not necessary for the bolt to extend above the top of the locknuts with a middle-length nylon lock (or other locks).
               a) Make sure that the chamfer and 1.5 bolt threads extend through the lock.

(e) Maximum Installation Torque
1) This is the highest torque, when you initial install a locknut, and the bolt expands the locknut.
(f) Minimum Prevailing-Torque
1) This is the minimum removal torque of a fastener, during the second full turn.
(g) Removed Nut
1) You remove a locknut, when you disengage the lock from the bolt (the nut can stay on the bolt).
(h) Run-On Torque
1) This is the torque that turns a fastener, before you tighten it against the seat.
(i) Seated-Torque
1) This is the torque that is necessary to correctly tighten a fastener.
a) It must apply a necessary compression force on a spacer element or an axial load to a bolt.
(j) Spacer/Spacer Element
1) These are parts of all functions, dimensions, shapes, and materials, that the fasteners with threads hold together.
(k) Unseated-Nut/Bolt
1) This is a nut or a bolt that you have removed a one turn minimum from the seated position.
a) This removes the axial load from the fastener.
(l) Unseated-Torque
1) This is the torque to remove a fastener from the bearing surface of a spacer.
a) This removes the axial load from the fastener.

B. Standard Procedures

S 912-035-J00

CAUTION: WHEN YOU INCREASE/DECREASE THE TEMPERATURE OF A PART FOR ASSEMBLY, APPLY THE TORQUE AFTER THE PART TEMPERATURES ARE EQUAL. WHEN A HOT PART BECOMES COOL, THE FASTENER CAN LOOSEN. YOU CAN TIGHTEN THE FASTENERS TO INSTALL A PART, IF YOU THEN LOOSEN THE FASTENERS WHILE THE TEMPERATURE BECOMES EQUAL.

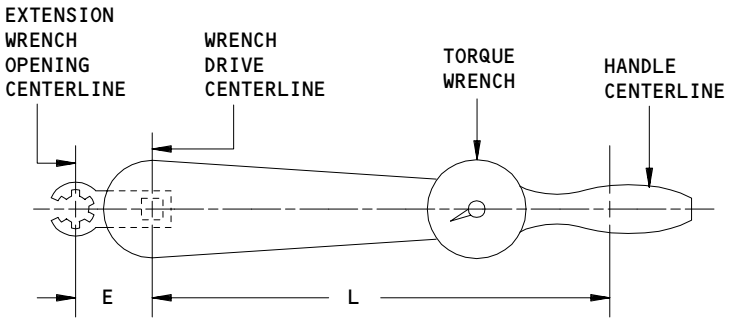
(1) Procedure to tighten a part.
(a) Turn the fastener at a constant rate, until you get the necessary torque.
1) If the torque compresses a gasket or a part after you install it, then apply the torque again.

(b) When you install a part, do these steps:
1) Tighten the parts to less torque than the necessary torque.
a) Tension that is not equal can cause a distortion or too much load.
2) Tighten the fasteners together, until the part touches the seat.
a) Tighten the opposite fasteners in pairs.
3) Loosen one fastener at a time.
4) Tighten the fastener to the necessary torque.
5) Do not tighten the fasteners more than the specified torque of the engine manual.

S 912-036-J00
(2) Torque-wrench selection.
(a) This procedure does not include the torque multipliers for higher torques.
1) You can find the data on them in the manual of the manufacturer.
(b) Table 201 that follows recommends the best torque wrench for different torque limits:
(c) A larger wrench has a larger tolerance that causes more error.

Table 201

Torque Wrench	Torque Limits	Tolerances
30 lb-in. (3.39 N.m)	0-25 lb-in. (0.000-2.82 N.m)	± 1 lb-in. (0.11 N.m)
150 lb-in. (16.94 N.m)	26-140 lb-in. (2.93-15.82 N.m)	± 5 lb-in. (0.56 N.m)
600 lb-in. (67.79 N.m)	141-550 lb-in. (15.83-62.14 N.m)	± 20 lb-in. (2.26 N.m)
1800 lb-in. (203.37 N.m)	360-1680 lb-in. (40.87-189.81 N.m)	± 60 lb-in. (6.78 N.m)
3000 lb-in. (338.95 N.m)	1692-2880 lb-in. (189.82-325.39 N.m)	± 120 lb-in. (13.56 N.m)
12000 lb-in. (1355.00 N.m)	2892-12000 lb-in. (325.40-1355.00 N.m)	± 240 lb-in. (27.12 N.m)

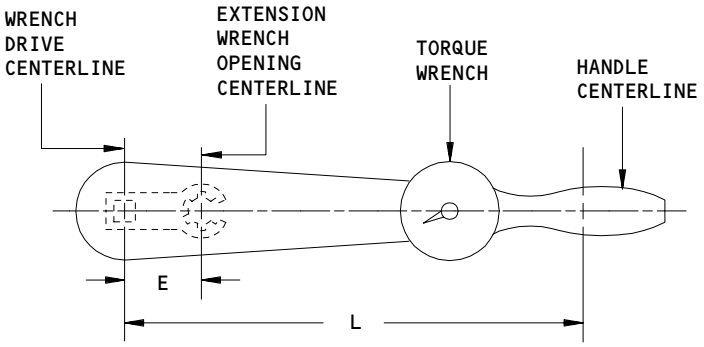


FORMULA $\frac{T \times L}{L + E} = Y$

EXAMPLE: (WITH "E" AS PLUS DIMENSION)

$Y = \frac{135 \times 10}{10 + 1.5} = \frac{1350}{11.5} = 117.39$ LB-IN.

T = 135 LB-IN. L = 10.0 IN.
E = 1.5 IN.

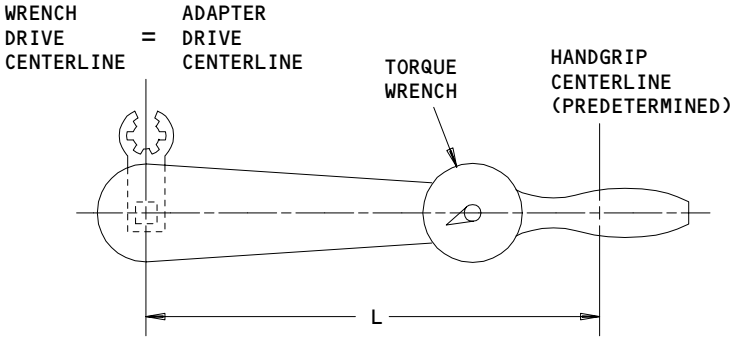


FORMULA $\frac{T \times L}{L - E} = Y$

EXAMPLE: (WITH "E" AS MINUS DIMENSION)

$Y = \frac{135 \times 10}{10 - 1.5} = \frac{1350}{8.5} = 158.82$ LB-IN.

T = 135 LB IN. L = 10.0 IN.
E = 1.5 IN.



A CORRECTED TORQUE READING IS NOT REQUIRED WHEN AN ADAPTER IS USED WHICH DOES NOT CHANGE THE EFFECTIVE LENGTH OF THE TORQUE WRENCH

LEGEND:

T = NECESSARY TORQUE
Y = INDICATION OF TORQUE ON WRENCH
L = LENGTH OF THE TORQUE WRENCH
E = LENGTH OF THE EXTENSION

Offset Extension Wrench
Figure 201

S 912-037-J00

(3) Offset extension wrench (Fig. 201).

(a) When you use an offset extension wrench (example: crowfoot extension), you change the effect of the length of the torque wrench.

1) The dial gives a torque indication that is different from the necessary torque.

(b) You must calculate the indication of torque as follows:

1) The Figure 201 shows the length of the torque wrench (L) and the length of the extension (E).

2) When the extension points in the same direction as the torque wrench, add their lengths together (L + E).

3) When the extension points to the handle of the torque wrench, subtract the length of the extension (L - E).

4) When the extension points 90° from the torque wrench, it has no effect on the length of the torque wrench.

5) The manual of the manufacturer gives the length (L) of the torque wrench.

6) Measure the length of an extension from the center of the drive opening to the center of the wrench opening.

7) Multiply the necessary torque (T) by the length of the torque wrench (L).

8) Divide this result by (L + E) or (L - E).

9) This value is the indication of torque (Y) on the torque wrench, that gives the necessary torque on the fastener.
a) Example:

Given: Necessary torque (T) = 265 lb-in. (29.94 N.m)
Length of the torque wrench (L) = 8.4 inches (213.36 mm)
Length of the extension (E) = 1.5 inches (38.1 mm)

$$Y = \frac{T \times L}{L + E}$$

Then: (T) x (L) = 265 x 8.4 = 2226.0
(29.94 N.m X 213.36 mm = 6388.00)
(L + E) = 8.4 + 1.5 = 9.9 inches
(213.36 mm + 38.1 mm = 251.46 mm)

$$Y = \frac{2226.0}{12\ 9.9} = 224.85 \text{ lb-in.}$$

$$\frac{6388.00}{251.46} = 25.404 \text{ N.m}$$

Thus: An indication of torque on the wrench of 225 lb-in. (25.42 N.m) gives the necessary torque of 265 lb-in. (29.94 N.m).

C. Standard Torque Values

S 912-038-J00
(1) Table 202 shows the standard torque limits for different thread sizes.

NOTE: Use one-half of the limits in the table for these fasteners:
- Thin steel hexagonal nuts with a height that is less than 0.6 the pitch-diameter for a nut without a lock.
- Thin steel hexagonal nuts with a height of less than 0.8 the pitch-diameter for a locknut.
- Nuts and bolts of nonferrous alloys.

Table 202

Thread	UNC and -8 Series		UNF and -12 Series	
	Threads Per Inch	Torque	Threads Per Inch	Torque
No. 4	40	3 - 5 lb-in. 0.339 - 0.565 N.m		------- -----------
No. 6	32	8 - 10 lb-in. 0.904 - 1.130 N.m	40	10 - 12 lb-in. 1.130 - 1.356 N.m
No. 8	32	13 - 16 lb-in. 1.469 - 1.808 N.m	36	16 - 19 lb-in. 1.808 - 2.147 N.m
No. 10	24	20 - 23 lb-in. 2.260 - 2.599 N.m	32	24 - 27 lb-in. 2.712 - 3.031 N.m
No. 12 1/4 in.	20	40 - 60 lb-in. 4.520 - 6.780 N.m	28	55 - 70 lb-in. 6.215 - 7.910 N.m
5/16	18	70 - 110 lb-in. 7.910 - 12.430 N.m	24	100 - 130 lb-in. 11.300 - 14.690 N.m
3/8	16	160 - 210 lb-in. 18.080 - 23.730 N.m	24	190 - 230 lb-in. 21.470 - 25.990 N.m
7/16	14	250 - 320 lb-in. 28.250 - 36.160 N.m	20	300 - 360 lb-in. 33.900 - 40.680 N.m
1/2	13	420 - 510 lb-in. 47.460 - 57.630 N.m	20	480 - 570 lb-in. 54.240 - 64.410 N.m
9/16	12	575 - 685 lb-in. 48 - 57 lb ft 64.975 - 77.405 N.m 840 - 960 lb-in.	18	660 - 780 lb-in. 55 - 65 lb ft 74.580 - 88.140 N.m 985 - 1140 lb-in.
5/8	11	70 - 80 lb ft 94.920 - 108.480 N.m	18	82 - 95 lb ft 111.300 - 128.820 N.m
3/4	10	1620 - 1800 lb-in. 135 - 150 lb ft 183.060 - 203.400 N.m	16	1800 - 2270 lb-in. 150 - 165 lb ft 203.400 - 256.510 N.m
7/8	9	2460 - 2750 lb-in. 205 - 230 lb ft 277.980 - 311.880 N.m	14	2820 - 3180 lb-in. 235 - 265 lb ft 318.660 - 359.340 N.m

Table 202

Thread	UNC and -8 Series		UNF and -12 Series	
	Threads Per Inch	Torque	Threads Per Inch	Torque
1.000	8	3600 - 4080 lb-in. 300 - 340 lb ft 406.800 - 461.040 N.m	14	4200 - 4800 lb-in. 350 - 400 lb ft 474.600 - 542.400 N.m
1 1/8	7	5000 - 5720 lb-in. 415 - 480 lb ft 565.000 - 646.360 N.m	12	5820 - 6780 lb-in. 485 - 565 lb ft 657.660 - 766.140 N.m
1 1/4	7	7200 - 8400 lb-in. 600 - 700 lb ft 813.600 - 949.200 N.m	12	8280 - 9600 lb-in. 690 - 800 lb ft 935.640 - 1084.800 N.m
1 3/8	6	9600 - 11100 lb-in. 800 - 930 lb ft 1084.800 - 1254.300 N.m	12	10800 - 12720 lb-in. 900 - 1060 lb ft 1220.400 - 1437.360 N.m
1 1/2	6	12000 - 14400 lb-in. 1000 - 1200 lb ft 1356.000 - 1627.200 N.m	12	14400 - 16800 lb-in. 1200 - 1400 lb ft 1627.200 - 1898.400 N.m
1 1/8	8	5280 - 6120 lb-in. 440 - 510 lb ft 596.640 - 691.560 N.m		-------- ----------

Table 202

Thread	UNC and -8 Series		UNF and -12 Series	
	Threads Per Inch	Torque	Threads Per Inch	Torque
1 1/4	8	7500 - 8700 lb-in. 625 - 725 lb ft 847.500 - 983.100 N.m		-------- ----------
1 3/8	8	10100 - 12000 lb-in. 842 - 1000 lb ft 1141.300 - 1356.000 N.m		-------- ----------
1 1/2	8	13800 - 16200 lb-in. 1150 - 1350 lb ft 1559.400 - 1830.600 N.m		-------- ----------
		POUND-INCHES x 0.113 OR POUND FEET x 1.356 = N.m		

S 912-039-J00

(2) Aluminum or magnesium bolts, studs, or a stud with a step.

(a) Table 203 shows the standard torque limits for bolt or stud threads.

NOTE: You must tighten the studs with a different thread on opposite ends to the torque limit of the smaller diameter.

Table 203

Bolt or Stud Thread	Pound-inches	Newton meters
3/16 - 24	35 - 40	(3.955 - 4.520)
1/4 - 20	75 - 80	(8.475 - 9.040)
5/16 - 18	135 - 145	(15.255 - 16.385)
3/8 - 16	240 - 250	(27.120 - 28.250)
7/16 - 14	370 - 380	(41.810 - 42.940)
1/2 - 13	580 - 600	(65.540 - 67.800)

S 912-040-J00

(3) Flared Tube and Hose Fittings

(a) Table 204 shows the standard torque limits for aluminum and steel parts.

NOTE: Use these limits when the internal seal surface is aluminum. The external connector and nut can be steel or aluminum.

NOTE: Use these limits, when the brazed-ferrule on a flared-tube and their connector are steel. The external fitting and the nut can be steel or aluminum.

Table 204

Tube OD (inch)	Thread (inch)-(number)	Torque for Aluminum Parts Note (1)	Torque for Steel Tube Note (2)
1/8	15/16 - 24	------ --------	40 - 50 lb-in. 4.520 - 5.650 N.m
3/16	3/8 - 24	30 - 50 3.390 - 5.650	90 - 100 lb-in. 10.170 - 11.300 N.m
1/4	7/16 - 20	40 - 65 4.520- 7.345	135 - 150 lb-in. 15.255 - 16.950 N.m
5/16	1/2 - 20	60 - 80 6.780 - 9.040	180 - 200 lb-in. 20.340 - 22.600 N.m
3/8	9/16 - 18	75 - 125 8.475 - 14.125	270 - 300 lb-in. 30.510 - 33.900 N.m
1/2	3/4 - 16	150 - 250 16.950 - 28.250	450 - 550 lb-in. 50.850 - 62.150 N.m
5/8	7/8 - 14	200 - 350 22.600 - 39.550	650 - 770 lb-in. 73.450 - 87.010 N.m
3/4	1 1/16 - 12	300 - 490 25 - 41 33.900 - 55.370	900 - 1090 lb-in. 75 - 91 lb ft 101.700 - 123.170 N.m
1.000	1 5/16 - 12	492 - 696 41 - 58 55.596 - 78.648	1340 - 1536 lb-in. 112 - 128 lb ft 151.420 - 173.568 N.m
1 1/4	1 5/8 - 12	600 - 900 50 - 75 67.800 - 101.700	1600 - 1800 lb-in. 133 - 150 lb ft 180.800 - 203.400 N.m
1 1/2	1 7/8 - 12	600 - 900 50 - 75 67.800 - 101.700	1900 - 2200 lb-in. 158 - 183 lb ft 214.700 - 248.600 N.m

S 912-041-J00

(4) Plugs and Tube Fittings

(a) Table 205 shows the standard torque limits for different size fittings.

Table 205

Fitting	Thread (inch) (pitch)	Torque Limits	Torque Unit
-2	5/16 - 24	40 - 50	lb-in.
		4.514 - 5.643	N.m
-3	3/8 - 24	90 - 100	lb-in.
		10.158 - 11.387	N.m
-4	7/16 - 20	135 - 150	lb-in.
		11.25 - 12.50	lb ft
		15.012 - 16.930	N.m
-5	1/2 - 20	155 - 175	lb-in.
		12.91 - 14.66	lb ft
		17.474 - 19.751	N.m
-6	9/16 - 18	180 - 200	lb-in.
		15.00 - 16.66	lb ft
		20.316 - 22.574	N.m
-8	3/4 - 16	270 - 300	lb-in.
		22.50 - 25.00	lb ft
		30.475 - 33.861	N.m
-10	7/8 - 14	360 - 400	lb-in.
		30.00 - 33.32	lb ft
		40.633 - 45.148	N.m
-12	1 1/16 - 12	540 - 600	lb-in.
		45.00 - 50.00	lb ft
		60.950 - 67.722	N.m
-16	1 5/16 - 12	700 - 850	lb-in.
		58.31 - 70.80	lb ft
		79.010 - 95.940	N.m
-20	1 5/8 - 12	900 - 1050	lb-in.
		75.00 - 87.56	lb ft
		101.584 - 118.515	N.m
-24	1 7/8 - 12	1000 - 1200	lb-in.
		83.30 - 100.00	lb ft
		112.871 - 135.445	N.m

D. Tighten all coupling nuts for the tubes, manifolds and hose assemblies.

S 912-042-J00

(1) Tighten all coupling nuts for the tubes, manifolds and hose assemblies up to 0.75 in. (19.05 mm) diameter as follows:
   (a) Tighten all sizes shown in Table 204.
   (b) Break the torque and loosen the nut.
      1) Tighten the coupling nut as specified in Table 204.
      2) Break the torque again and loosen the nut.
      3) Tighten the coupling nut again as specified in Table 204.

E. Tighten Plugs and Tube Fittings (Fig. 202).

S 912-043-J00

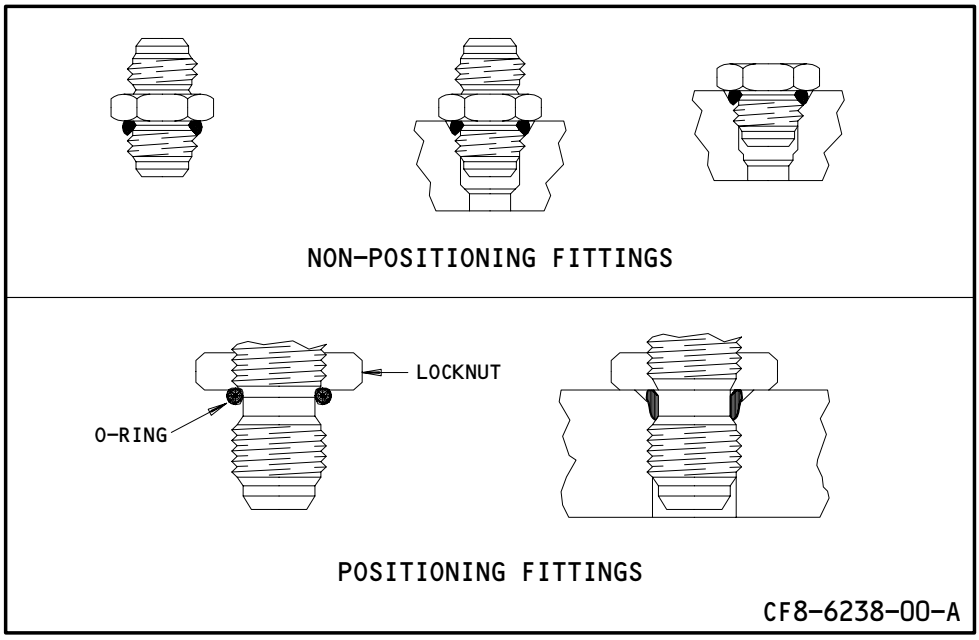
(1) This procedure gives the instructions for the installation of the three types of tube fittings.
   (a) You can install a nonpositioning fitting that uses a preformed-packing or a compression-packing for a seal
   (b) You can install a positioning-fitting, that can use a backup-washer.
   (c) You can install a universal bulkhead fitting with a locknut.

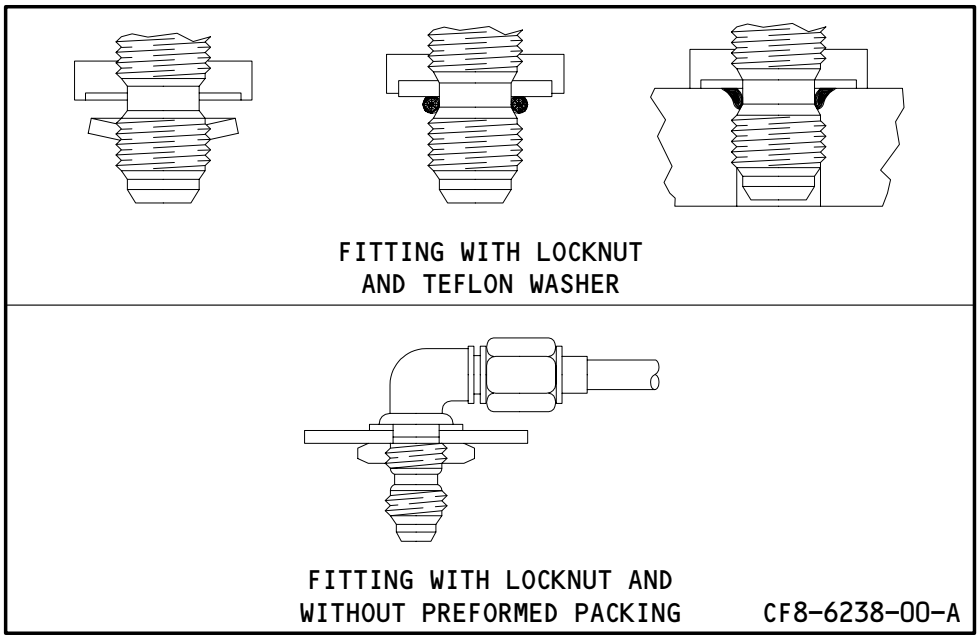
S 912-044-J00

(2) Assembly Procedures.
   (a) Installation of a preformed packing on a fitting.
      1) When the ratio of the diameter to the cross-section of a preformed-packing is larger than 20, do this:
         a) Install a conical sleeve on the fitting.
         b) Roll the packing into the groove of the fitting.

            NOTE: This prevents a damage of the packing.

      2) If the ratio is below 20, use a conical sleeve to roll the packing over a thread or a spline.
      3) Lubricate the preformed-packing with a petrolatum to roll it into the groove on the fitting.
   (b) Lubrication
      1) Do not use a lubricant on the threads or on the friction surfaces, unless it is specified by the engine manual.
   (c) Nonpositioning Fittings
      1) Lubricate the packing lightly to prevent the damage by the sharp threads.
         a) Install the packing on the fitting, until the packing is in the groove of the fitting.
         b) Install the fitting into the boss.
         c) Tighten the fitting to the specified torque limits.





Installation and Torque of Plugs and Tube Fittings
Figure 202

(d) Positioning-Fittings (without Backup-Washers)
  1) Install the locknut through the first section of the threads on the fitting.
    a) Continue through the packing-groove.
    b) Then continue to the second section of the threads on the fitting.
  2) Lubricate the packing to prevent a damage by the sharp threads.
  3) Install it carefully through the first section of the threads into the packing groove.
    a) It must be against the second section of the threads.
  4) Turn the locknut, until it touches the packing.
  5) Install the fitting in the boss, until the packing touches the countersunk surface.
  6) Turn the fitting counterclockwise (not more than one turn) to get the necessary position.
  7) Hold the fitting, while you tighten the locknut to the specified torque limit.

(e) Positioning-Fittings (with Backup Washers)
  1) Install the locknut through the first section of the threads on the fitting.
    a) Continue through the packing-groove.
    b) Then continue to the second section of the threads of the fitting.
    c) The washer recess must point to the packing-groove.
  2) Hold the backup washer tightly by its outer edge to turn the fitting into the backup washer.
    a) Do not use a lubricant.
    b) Continue to turn the washer on the fitting, until the washer is in the packing groove.
    c) Remove the pieces of plastic material that the fitting cut from the washer.
    d) Push the edge of the washer into the recess in the locknut, until they fully touch.
    e) Make sure that the threads of the fitting do not keep the washer from its seat.
  3) Lubricate the packing to prevent a damage by the sharp threads.
  4) Install it carefully through the first section of the threads into the packing groove.
    a) It must be against the washer.
  5) Install the fitting in the boss, until the packing touches the countersunk surface.
  6) Hold the locknut in its position with a wrench.
    a) Turn the fitting into the boss by 1.5 turns.

7) Turn the fitting a maximum of one more turn into its correct position in the boss (total of 1.5 to 2.5 turns).
8) Hold the fitting, while you tighten the locknut to the specified torque limit.

(f) Universal Bulkhead Fittings.
1) Attach the bulkhead fitting to a bulkhead with its locknut.
2) Connect and tighten the tube nut or the hose nut.
3) Hold the fitting with a wrench to tighten the locknut to the specified torque limit.

F. Net Torque

S 912-045-J00

(1) Engine manuals will give a net torque value, when the axial force that you apply to a fastener is very important.
(a) Make sure that you use these smaller limits for a specified extension or an axial force.

S 912-046-J00

(2) Net torque is equal to the gross torque minus the run-on torque.
(a) Find the net torque as follows:
1) You must tighten a nut on a bolt to a net torque of 20-40 lb-in. (2.46-4.52 N.m).
2) Turn the nut on the bolt.
a) Find the torque that turns the nut, before it touches its seat.
3) Keep this value as the run-on torque.
a) Use the value of 15 lb-in. (1.69 N.m).
4) Add the run-on torque value to the minimum and maximum specified torque values.

Then:	20 lb-in. (2.26 N.m)	40 lb-in. (4.52 N.m)
	+15 lb-in. (+1.69 N.m)	+15 lb-in. (+1.69 N.m)
	35 lb-in. (3.95 N.m)	55 lb-in. (6.21 N.m)

Thus: to get a net torque of 20-40 lb-in. (2.26-4.52 N.m), you must apply a gross torque of 35-55 lb-in. (3.95-6.21 N.m) to the nut.

G. Torque-Check for the Re-Use of Self-Locking Nuts

NOTE: This data does not apply to nuts, that you must use one time only (refer to the maintenance manual).

S 912-047-J00

(1) Self-locking nuts must have a specified minimum breakaway-torque, if you use them again.

S 912-048-J00
(2) The torque-check procedure follows:

CAUTION: DO NOT BEND A SELF-LOCKING NUT TO GET THE NECESSARY SELF-LOCKING TORQUE. FAILURE OF THE NUT CAN OCCUR.

(a) To get the minimum breakaway-torque, install the nut on a bolt with 2 to 5 threads through the nut.
1) Measure the torque that is necessary, when you turn the nut on the bolt.
(b) Table 206 gives the minimum breakaway-torque for the self-locking nuts.
1) It applies to self-locking nuts that have a silver plate, a dry-film cover, or a lubricant.
2) Table 206 gives the values for the nuts without an axial load.

Table 206

Thread Diameter	Threads per Inch	Minimum Breakaway Torque	
0.136 (6)	32-40	1.0 lb-in.	(0.11 N.m)
0.164 (8)	32-36	1.5 lb-in.	(0.17 N.m)
0.190 (10)	32	2.0 lb-in.	(0.22 N.m)
1/4	28	3.5 lb-in.	(0.40 N.m)
5/16	24	6.5 lb-in.	(0.73 N.m)
3/8	24	9.5 lb-in.	(1.07 N.m)
7/16	20	14.0 lb-in.	(1.58 N.m)
1/2	20	18.0 lb-in.	(2.03 N.m)
9/16	18	24.0 lb-in.	(2.71 N.m)
5/8	18	32.0 lb-in.	(3.62 N.m)
3/4	16	50.0 lb-in.	(5.65 N.m)

(c) Replace all the nuts that do not have these minimum torque values.

H. Torque-Procedure for V-Band Clamps

S 912-049-J00
(1) Install the V-band clamp on the flanges of the duct.

S 912-050-J00
(2) Tighten the nut to 50 percent of the necessary torque.

S 912-051-J00
(3) Make sure that the V-band clamp has the correct fit on the flange.
  (a) If you install a seal, make sure that it has the correct fit.

S 912-052-J00
(4) Lightly hit the outer surface of the V-band with a plastic mallet to cause equal tension.

S 912-053-J00
(5) While you continue to hit the V-band clamp, tighten the nut to the necessary torque.

S 912-054-J00
(6) Hit (again lightly) the outer surface of the V-band clamp.

S 912-055-J00
(7) Tighten the nut to the necessary torque.

I. Torque for Nonaligned Joint Couplings

S 912-056-J00
(1) Lubricate the bolt threads and the seat surface of the joint coupling nut with an antiseize compound.

S 912-057-J00
(2) Assemble the two tube ends together.
  (a) Make sure that you install the internal end correctly in the center of the external fitting around the full circumference.
  (b) If you use a metal gasket seal, make sure that it has the correct fit.

S 912-058-J00
(3) Tighten the joint-coupling nut to 50 percent of the necessary torque.

S 912-059-J00
(4) Lightly hit the joint-coupling around the full circumference with a plastic mallet.
  (a) This will apply the force equally around the full circumference.

S 912-060-J00
(5) While you continue to hit the joint-coupling, tighten the nut to the necessary torque.

S 912-061-J00
(6) Hit (again lightly) the circumference of the joint-coupling.

S 912-062-J00
(7) Loosen the coupling nut.
(a) Loosen the nut for one-half turn.

S 912-063-J00
(8) Tighten the joint-coupling nut to the necessary torque.

S 912-064-J00
(9) Table 207 gives the standard torque limits for nonaligned joint couplings.

Table 207

Tube Diameter	Pound-foot	Newton meters
0.750 - 1.000 in. (19.05 - 25.40 mm)	24 - 26	(32.5 - 35.3)
1.125 - 1.500 in. (28.58 - 38.10 mm)	60 - 70	(81.3 - 94.9)
1.625 - 2.000 in. (41.28 - 50.80 mm)	70 - 80	(94.9 - 108.5)
2.125 in. and up (53.98 mm and up)	80 - 90	(108.5 - 122.0)