

Instruction  
Hardware Engineering

No. LMS 1-8

Subject: Hydraulic and Pneumatic Systems

APPROVED BY Manager, Hardware Engineering

STATUS Maintenance Revision

PURPOSE Defines the requirements and precautions necessary for the proper handling, cleaning, assembly, testing, and transporting of hydraulic and pneumatic system assemblies, subassemblies, and components. This instruction shall be utilized by all L-3 Communications Corporation, Link Simulation & Training Division (hereafter referred to as Link) personnel involved with hydraulic and pneumatic systems.

AFFECTED FUNCTIONS Hardware Engineering  
Manufacturing

REFERENCES

1005474	Specification for Control and Testing of Hydraulic Fluids
*1005479	Hydraulic System Flushing and Pressure Testing Guide (Cascaded Motion Systems)
*1005480	Hydraulic System Flushing and Pressure Testing Guide (6 Degree of Freedom 48 inch [1.22 m] Motion System)
*1005481	Hydraulic System Flushing and Pressure Testing Guide (6 Degree of Freedom 60 inch [1.52 m] Motion System)
*1005608	Procedure for Hydraulic System Flushing and Pressure Testing of 6 Degree of Freedom and New 3 Degree of Freedom Motion Systems
1005721	Utilization and Control of Hydraulic Fluid Transfer Pumps
*1006416	Procedure for Hydraulic System Flushing and Pressure Testing F-16 Seat Shaker Buffet Systems
*1007272	Procedure for Cockpit Control Loading Systems Using McFadden Controls
*1007812	Procedure, Hydraulic System Flushing and Pressure Testing Fokker Control Loading Systems
MPM G9a	Degreasing Solutions
MIL-C-5501	Caps and Plugs, Protective, Dust and Moisture Seal
MIL-F-18866	Fittings, Hydraulic Tube, Flared, 37 Degree and Flareless, Steel

MIL-H-83282 Hydraulic Fluid, Fire Resistant, Synthetic Hydrocarbon  
Base, Aircraft, Metric, NATO Code Number H-537

\*See paragraph 1.6.

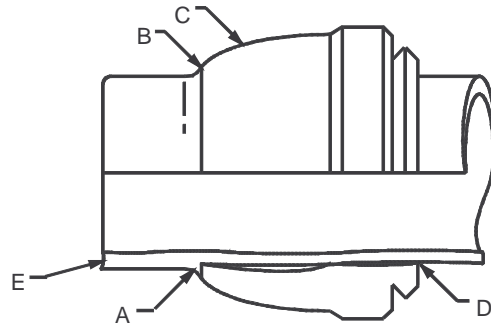
1. Requirements

- 1.1 General. Hydraulic and pneumatic system components shall be cleaned in accordance with this instruction and, where applicable, plugged or capped per MIL-C-5501 prior to being issued to assembly or fabrication. Plugging or capping of pipes, tubes, fittings, and components by the use of paper, tissue, cloths, masking tape, or any material other than the items specifically defined in this instruction is expressly forbidden.
- a. *Purchased Parts.* Incoming purchased parts may be stocked in their original package or container provided they are suitably packaged and in a clean condition. If received unpackaged, damaged, or contaminated with dirt, grease, machine chips, etc., they should be returned to the vendor. If unpackaged and/or contaminated parts cannot be returned to the vendor, they shall be cleaned and plugged, capped or bagged prior to stocking or forwarding to assembly areas. Parts made of steel (except stainless steel) subject to rust shall be completely covered on all surfaces with a uniform film of clean, filtered hydraulic fluid (see paragraph 1.9), then bagged. The bags shall be folded at least two times and stapled.
- b. *Link-fabricated manifolds.* Link-fabricated manifolds shall be thoroughly cleaned and then plugged or capped. Tube fitting plugs, manufactured of steel and suitably plated, shall be used to plug manifold-type bosses which cannot be closed and protected using the plastic-type caps or plugs. These plugs shall be similar to Link PN 259940 through 259948 and MS51840-32.
- 1.2 Cleaning. Cleaning of all items except those containing “O” rings and similar seals may be accomplished by the use of clean Trichloroethane (Manufacturing Processes Manual [MPM] G9a) or equivalent. Parts and components containing “O” rings or seals shall be cleaned using clean, filtered Genesolv D.E.S. Compressed air shall not be used in cleaning or drying processes unless the air provided is filtered and provided with a moisture-removal, desiccant-type trap. Parts cleaned in Trichloroethane or an equivalent chlorinated solvent must be dried prior to assembly.

- a. Fabricated tubing. The cleaning of fabricated tubes may be accomplished by the use of:
- (1) A solvent cleaning system which forces Trichloroethane through the tubes.
  - (2) Hydraulic tube cleaning tools, Link tool No. AT-7184 and AT-7185. These tools are to be used with patches cut from nonwoven towels which are wet with a solvent or hydraulic oil immediately before being pulled through the inside of the tube. (For large diameter tubing, a sponge filler for the patch must be used.) To remove all chips from the tube, this process must be repeated three to four times, using a new patch each time.
- 1.3 Work areas. Work areas shall be kept clean at all times.
- Tools. Hand tools shall remain free of dirt, grease, and other contaminants when being used on hydraulic and pneumatic systems.
- 1.4 Component Testing. Hydraulic oil used in the testing of parts and components shall conform to the requirements of MIL-H-83282 (Link PN 1004309-01) or Brayco 745 (Link PN 858366), whichever is applicable. Hydraulic oil shall be filtered with equipment rated for 1 micron nominal size or smaller.
- Filters. Filter housings in test equipment shall preferably be a nonbypass type with a filter element condition indicator. If a bypass filter is used, the micronic paper type filter elements which are used shall be changed at intervals not exceeding 50 hours of operation. However, if a filter element condition indicator is available, it may be used to accurately determine when the filter element needs changing.
- 1.5 Assembly. Pipes, tubes, fittings, and components shall not be removed from plastic bags and/or boxes or have the plugs or caps removed until immediately prior to assembly. Each individual cap or plug shall not be removed until just prior to the assembly at that particular point. Care shall be exercised in removing plastic caps and plugs to avoid marring components or scraping off plastic particles that may contaminate the system.
- a. "O" ring installation. "O" rings shall be soaked in MIL-H-83282 (Link PN 1004309-01) hydraulic fluid for a minimum of 30 minutes before

- installation. When installing “O” rings over threads, extreme caution shall be taken to ensure the “O” ring is not damaged. (For example, install the “O” ring over the plastic thread cap.)
- b. Hose assemblies. Hose assemblies shall be installed so that no twists or kinks exist in the line after the end fittings have been tightened. Hose assemblies shall not have any nicks in the outer cover exposing the metal braid.
  - c. Quick disconnects on hose assemblies which are subject to disconnection and reattachment during assembly, test, etc., shall be enclosed in plastic bags and properly secured with rubber bands, or by equivalent means, each time they are disconnected (unless they are immediately reattached). They shall not be permitted to lie on the floor or be exposed to dust, dirt, or other contamination unless properly protected with the plastic bags.
  - d. Protective covers. When simulators are being assembled or installed, or overhead rework is being performed, hydraulic cylinders shall be enclosed within vinyl protective covers available at the Final Assembly tool crib.
  - e. Tubing. Tubing ends shall be cut squarely to within  $\pm 2$  degrees. Debar both inside and outside of tube ends. Do not sand outside of tube.
- 1.6 System Flushing. After assembly, hydraulic systems shall be flushed in accordance with the applicable flushing procedure or as specified on the manufacturing installation drawings. Applicable procedures are those denoted with an asterisk in the References list.
- Oil. Hydraulic oil used for system flushing shall meet the cleanliness requirements of, and be certified to, Link Specification 1005474.
- 1.7 Flareless tube fittings. “Bite-type” flareless tube fittings shall be assembled in accordance with the following requirements.
- a. Presetting ferrules. Use a lubricant such as STP or ferrulube when presetting ferrules.

- b. Joint inspection. After presetting the ferrule, each joint shall be inspected for the following characteristics to determine that a correct bite has been made on the tube.

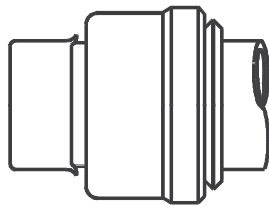


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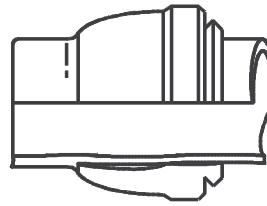
**Figure 1 Flareless Tube Fitting**

- (1) A ridge of metal has been raised above the tube surfaces, to a height of at least 50 percent of the thickness (NOTE: stainless tubing will raise slightly less than 50 percent) of the ferrule's leading edge, completely around the tube. (See A in Figure 1.)
- (2) While the leading edge of the ferrule may be coined flat (see B in Figure 1), there is a slight bow to the balance of the pilot section. (See C in Figure 1.)
- (3) The tail or back end of the ferrule is snug against the tube. (See D in Figure 1.)
- (4) There is a slight indentation all around the end of the tube (see E in Figure 1) that indicates the tube was bottomed in the tool or fitting during presetting. (Unless evidence of this complete contact is visible, the ferrule cannot be considered properly preset.)
- (5) The ferrule should not move back and forth along the tube. Do not rotate the ferrule on the tube.
- (6) Inspect for depth of bite and bow of ferrule. If it looks like Figure 2, and ferrule can slide back and forth on the tube, the

ferrule is underset. Repeat the preset operation to obtain an adequate bite. If the ferrule looks like Figure 3 with a ridge of metal raised to cover at least 50 percent (NOTE: stainless tubing exception) of the ferrule and all around, and the ferrule now has a light bow and the tail section is snug against the tube, the preset is acceptable.



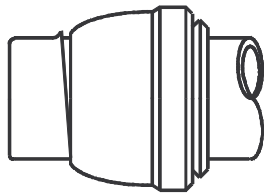
**Figure 2 Underset Ferrule**



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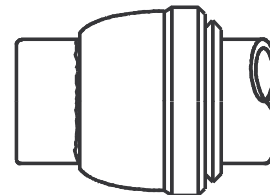
**Figure 3 Acceptable Preset**

- c. Unacceptable conditions. The tube shall be scrapped if any of the conditions depicted in Figure 4 through 6 exist after presetting.



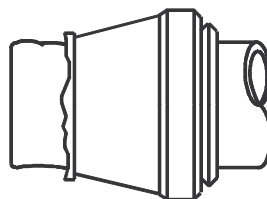
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**Figure 3 Misaligned Ferrules**



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**Figure 3 Tube not Bottomed on Shoulder in Fitting Body**



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**Figure 6 Excessive Preset Pressure or Wrench Force**

- 1.8 Teflon pipe tape (ribbon dope thread sealant). When teflon tape is used to seal threaded pipe fittings, it shall be installed in accordance with the following procedure.
- NOTE: Teflon tape shall be applied to tapered pipe threads only.
- a. Teflon pipe tape installation
- (1) Leaving first two (2) threads of pipe untaped, lay end of tape on threads and hold down with thumb.
  - (2) Wrap tape around threads in direction of threads, stretching slightly so that tape conforms to shape of threads.
  - (3) Overlap first end by approximately .50 inch (1.27 cm).
  - (4) Break tape and wipe broken end into threads.
- 1.9 Hydraulic Oil. Hydraulic oil used in hydraulic systems shall be either new oil or oil that has been purified and is certified in accordance with Link Specification 1005474. Unless approved by the Plant Facility Safety Officer, only Brayco 745 (Link PN 858366) or MIL-H-83282 (Link PN 1004309-01) fluid shall be used in-house.
- a. Hydraulic fluid shipped out of house shall be certified clean oil that has not been mixed with other fluid nor recirculated through the Pall Purifier.
- b. Drums used for hydraulic fluid storage or transfer of hydraulic fluids shall be controlled in accordance with Link Specification 1005474.
- 1.10 Pall Purifier. Operation and control of the Pall Purifier shall be accomplished in accordance with Link Specification 1005474.
- 1.11 Transfer pumps. Transfer pumps used for the transfer of hydraulic fluid to and from drums, reservoirs, catch pans, etc., shall be used and controlled in accordance with the requirements of Link Specification 1005721.
- 1.12 Hydraulic assembly/test operating rules.
- a. All cylinder units shall be uncrated in a clean, uncluttered space away from the hydraulic assembly area.

- b. The area shall be cleaned immediately after uncrating operation is complete.
  - c. All cutting, drilling, and grinding operations shall be performed in a designated area.
  - d. The area shall be cleaned immediately after using drill press, saw, or grinder.
  - e. All incoming fittings shall be cleaned and capped. Do not sand the inside of the fitting's body cone to improve fit.
  - f. Hydraulic components shall be kept in plastic box-bins until ready for use.
  - g. Caps used to plug or cap orifices shall be cleaned before using. Keep caps covered when not in use.
  - h. Use appropriate caps on hydraulic cylinders with orifices. Under no circumstances are Kimwipes to be used in place of caps.
  - i. Hand tools shall be clean or cleaned before using.
  - j. Before using vapor degreaser, be sure fluid is at proper level.
  - k. Gloves shall be worn when using vapor degreaser.
  - l. Vapor degreaser shall be kept covered when not in use.
2. Quality Assurance Requirements
- 2.1 The Quality Assurance organization shall be responsible for assuring that all requirements of this instruction are met. Any evidence of contamination or nonconformance shall be cause for rejection.
3. Preparation For Delivery
- 3.1 All pipes, tubes, components, and fittings that are disassembled for shipment shall be drained and immediately plugged, capped, bagged, and/or boxed in accordance with the requirements of this instruction.