Hose Products

Dave Sherwood

April 2016

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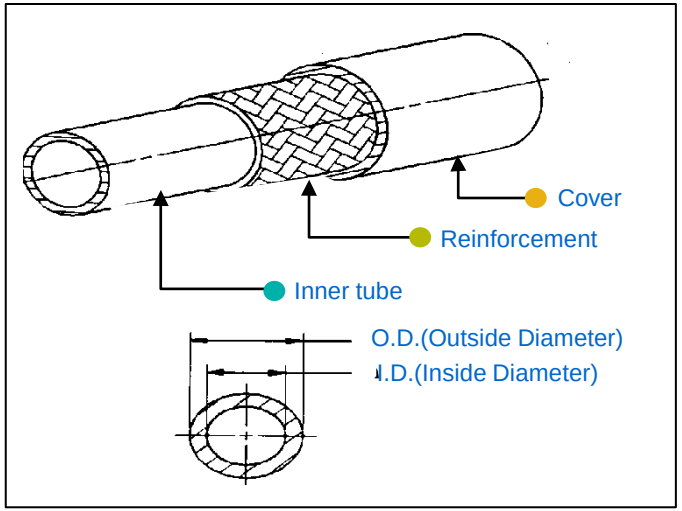
What Is a Hose?

A Hose is a flexible composite consisting of:

Inner Tube	Reinforcement	Cover
Contains/Conveys Liquids or Gases	Supports Inner Tube Against Internal System Pressures	Protects the Reinforcement from External Environment



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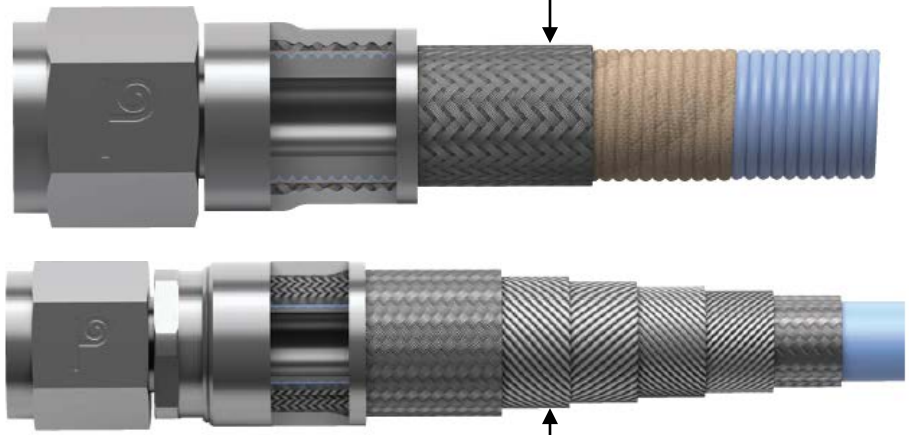
Reinforcement constructions

Types of reinforcement braids



Single braid layer design

Multiple braid layer design

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Advantages of hose

- Can cover a wide range of applications: hydraulic fluids, fuel, oil, coolants / Wide range of pressures
- PTFE lined hoses resistant to almost all chemicals
- Extensive range of hose sizes and end-fitting configurations
- Can take up build tolerances/misalignment
- Can deal with a wide range of in-service movement between connected components.
- Can absorb effects of vibration and reduce transmission of vibration noise.
- Can provide a weight saving over some size rigid tube.
- Can act as a pressure damper
  - This can be a positive or negative aspect depending on your system
  - Due to larger volumetric expansion compared with tube
- Ease of Component Installation or Servicing (maintainability)
- Compensate for Thermal Expansion or Contraction
- Reduce Stresses in a Piping System

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Pro's and Con's of PTFE flexible hose

PROS

- Impervious to Degradation due to Fluid Exposure
- -65° F to 450° F (-54 C to 232 C) Temperature Capability
- Unlimited Shelf Life
- Good Vibration Dampening Characteristics
- Ease of Installation
- Non-Aging Service Life
- Less Subject to Cyclic Fatigue
- Higher Fluid Flow Velocity Compared to Metal Hose
- Tight Bend Radius in Some Series
- Weight Savings in Many Applications
- Can withstand a large range of motion

CONS

- Limited to -65° F to 450° F (-54 C to 232 C)
- Smooth Bore Susceptible to Kinking
- Effusion of Gaseous Medias
- Must Be Protected in a Fire Zone
- Must Be Protected to Damage from Abrasion
- Generally heavier weight than tube for same routing
- Cost may or may not be higher
- Additional design considerations to allow for its more flexible nature

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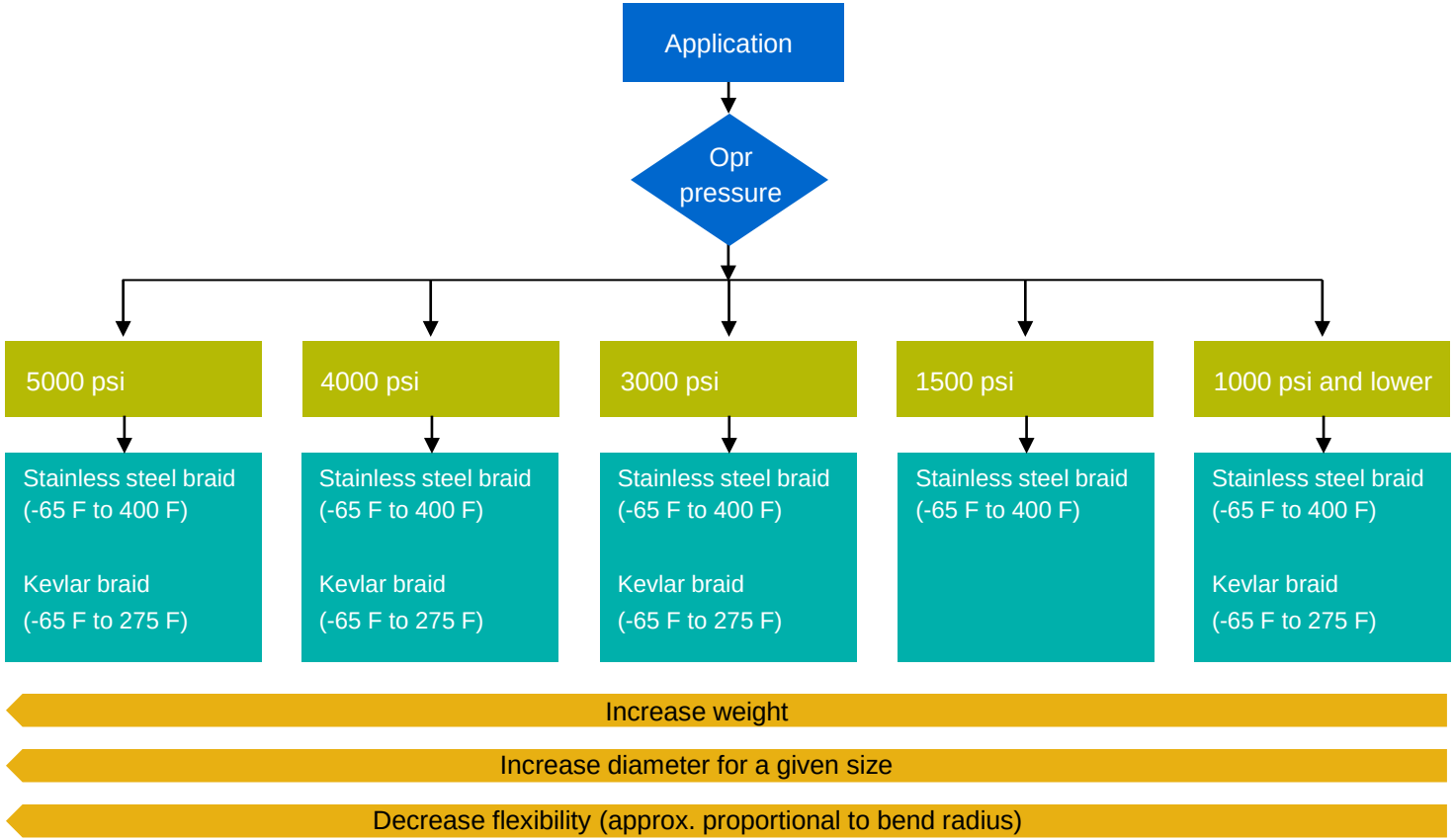

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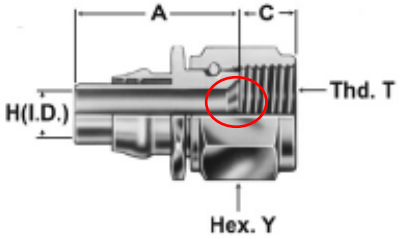
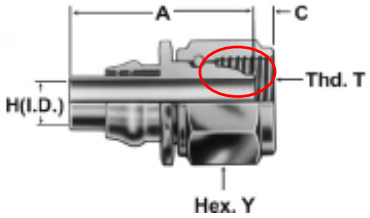
Basic fittings



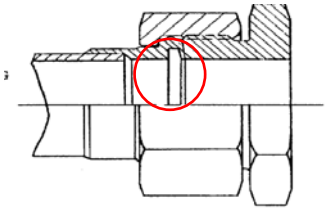
Flared

- Lower pressure capability (used up to 3000 psi)
- Lowest Cost
- Lower weight than flareless



Flareless

- All pressures
- Medium cost
- Heavier than flared
- More reliable joint



Beam seal

- All pressures, pressure assisted
- Highest cost (can not be made
- from standard stainless)
- Lightest fitting
- Sensitive to surface scratches

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Hose assemblies – end fittings

End Fitting Types

There are 6 basic arrangements for hose assemblies:

1	Straight to straight
2	Straight to 45º
3	Straight to 90º
4	45º to 45º
5	45º to 90º
6	90º to 90º

In addition to the standard angles of 45 and 90 degrees, there are special angles to suit customer needs. These are called out on the applicable hose assembly drawing.

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Hose design

Inner tube materials

- Rubber
  - Nitrile(not for aerospace)
  - AQP (CPE)
  - EPDM
  - Neoprene
- **PTFE (Teflon®)**

Reinforcement materials

- Rayon
- Nylon
- **Polyester**
- Carbon Steel Wire (not for aerospace)
- **Stainless Steel (CRES) Wire**
- **Kevlar®**

Protective sleeving

- Abrasion
  - Neoprene (not allowed for aerospace)
  - **Polyolefin (abrasion, but limited, but can not be used above 275 F))**
  - **FEP (Teflon®) (abrasion, but limited, can be used above 275 F)**
  - **Polyester (Integral, braid most common, but can not be used above 275 F**)
- Firesleeve
  - **Tubular (braided fiberglass with silicone)**
  - **Integral (extruded or molded silicone)**

- Items in bold are more commonly used

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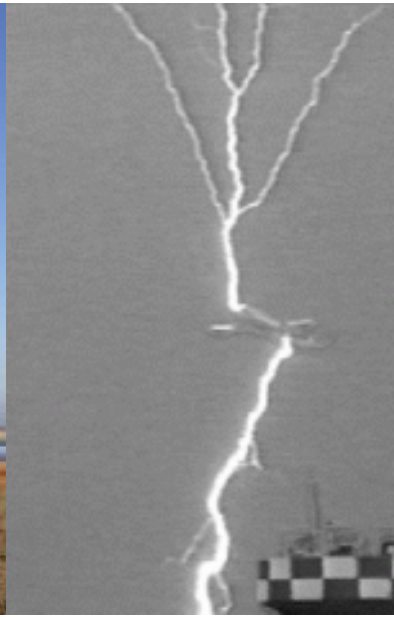
Consider the environment



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Applications

The general system-application categories are:

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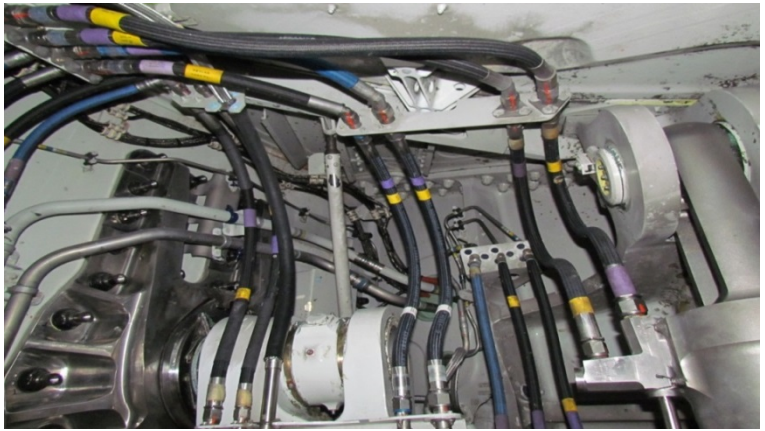
Applications

Hydraulic

- Undercarriage actuation and brake pipes
- Main hydraulic pump and circuitry
- Stairs actuation gear
- Air brake extend and retract
- Nose wheel steering
- Oil cooler supply and return



Ex : AE334 Family

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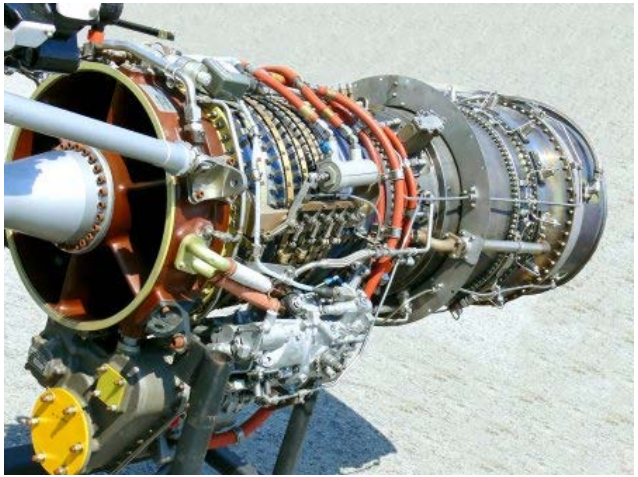
Applications

Fuel

- All fuel supply and return lines including engine manifold hose and all fuel transfer hose.
- Typical connections are to fuel tanks, fuel control units, fuel pumps and auxiliary power units.
- Drain lines



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Applications

Drinkable Water

Water to and from galley and toilets for drinking and waste disposal

Coolant

Electronic coolant supply and return lines – radar installations

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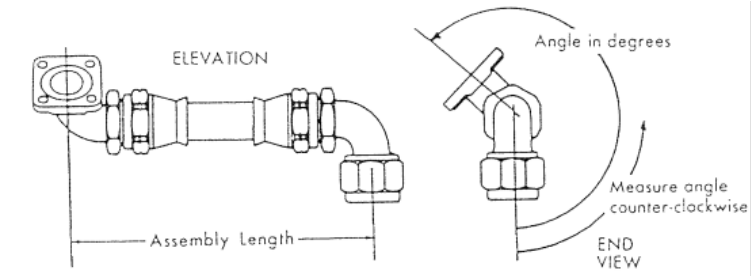
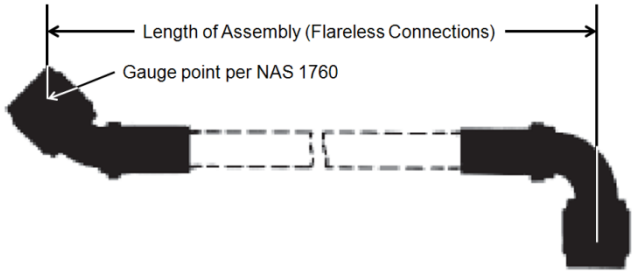
Hose length & orientation



Hose Length is measured from gauge point (where the fittings seals) to gauge point parallel to hose



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Hose construction

1. Heat shrink tube (abrasion resistance not as good as polyester braid normal blue, but can be black), either clear or coloured. These are generally applied to protect attached markings or give a better appearance.
2. Polyester Chafeguard (blue) for superior chafe resistance (AEB221A). (note: Max temp 275 F (135 C)
3. Silicon fire sleeve for fire resistance and fireproof applications (AEB229A)
4. Slip on fire sleeve
5. PBI / Kevlar
6. Spiral wrap (abrasion)

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Mixed, hybrid

Not limited to just a hose

- Hose/tube
- Multiple hose and tube
- Hose/Swivel
- Hose/QD

Why

- Reduced leak paths
- Simplify installation

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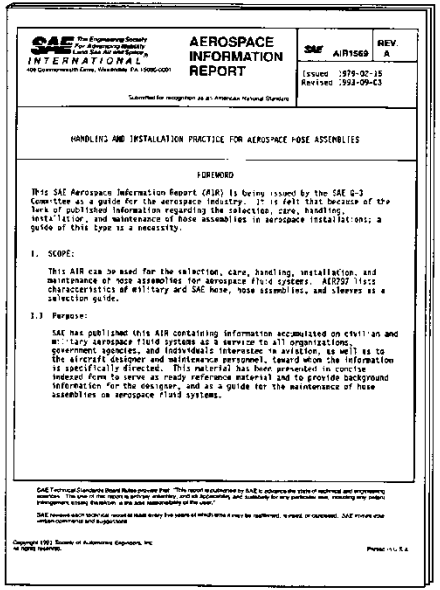
Hose selection process-industry standard

Foreword

This document lists military and industry specifications and standards which are used in aerospace systems and for ground servicing equipment.

The characteristic limitations of the hose, which are of major importance to designers, and the sizes in which the hoses are standard are shown.



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AEROSPACE INFORMATION REPORT

SAE AIR1569 REV. A

Issued 1979-02-15
Revised 1993-09-03

HANDLING AND INSTALLATION PRACTICE FOR AEROSPACE HOSE ASSEMBLIES

FOREWORD

This SAE Aerospace Information Report (AIR) is being issued by the SAE G-3 Committee as a guide for the aerospace industry. It is felt that because of the lack of published information regarding the selection, care, handling, installation, and maintenance of hose assemblies in aerospace installations; a guide of this type is a necessity.

1. SCOPE:

This AIR can be used for the selection, care, handling, installation, and maintenance of hose assemblies for aerospace fluid systems. AIR797 lists characteristics of military and SAE hose, hose assemblies, and sleeves as a selection guide.

1.1 Purpose:

SAE has published this AIR containing information accumulated on civilian and military aerospace fluid systems as a service to all organizations, government agencies, and individuals interested in aviation, as well as to the aircraft designer and maintenance personnel, toward whom the information is specifically directed. This material has been presented in concise indexed form to serve as ready reference material and to provide background information for the designer, and as a guide for the maintenance of hose assemblies on aerospace fluid systems.

For aerospace hose assemblies (SAEAIR797)

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Specific hose types

Wire reinforced Teflon hose

- 666 / 667 Hose
- AE246 Hose
- AE345 Hose
- AE313 Hose
- AE318 Hose
- AE333 Hose
- AE641 Hose

Nomex reinforced Teflon hose

- AE645 Hose

Kevlar reinforced Teflon hose

- AE355 Hose
- AE319 Hose
- AE334 Hose

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Wire reinforced Teflon hose

666 / 667 Hose

Construction:

- Teflon inner tube with a conductive inner liner
- Corrosion resistant stainless steel wire braid reinforcement.

Available with:

- Integral silicone cover
- Integral abrasion cover
- Slip on fire-sleeves
- Slip on or shrinkable abrasion sleeves

Sizes:

- 3 thru –24

Temperature Range:

- 65°F to +450°F (CRES Ftgs)

Temperature Range:

- -65°F to +275°F (Aluminum Ftgs)

Design Features:

- Light-weight hose designed for medium pressures (1000 to 1500 psig).
- Crimp fitting design provides excellent retention and sealing characteristics.
- Field attachable fitting is also available.
- Qualified to SAE AS1946 and MIL-DTL-25579.

Applications:

- Medium Pressure Hydraulic
- Fuel
- Oil
- Coolant
- Pneumatic
- Not recommended for pneumatic storage applications

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Wire reinforced Teflon hose

AE246 Hose

Construction:

- Teflon inner tube with a conductive inner liner
- Corrosion resistant stainless steel wire braid (HiPac)

Available with:

- Integral silicone cover
- Integral abrasion cover
- Slip on fire-sleeves
- Slip on or shrinkable abrasion sleeves

Sizes:

- -4 thru –12

Temperature Range:

- -65°F to +400°F

Design Features:

- Light-Weight hose designed for high pressures (3000 psig)
- Crimp Super-C and Field Attachable fitting designs provides excellent retention and sealing characteristics.
- Qualified to SAE AS1339 (-4 thru -10) -12 meets performance requirements of AS1339. This is a SAE PRI QPL approved product.

Applications:

- High Pressure Hydraulic
- Not recommended for pneumatic storage applications
- Not recommended for pump discharge applications

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Wire reinforced Teflon hose

AE345-12 Hose

Design Features:

- Hose designed for high pressure (3000 psig)
- Crimp fitting design provides excellent retention and sealing characteristics.
- Qualified to SAE AS1339-12 meets dimensional and performance requirements of AS1339.

Applications:

- High Pressure Hydraulic
- Not recommended for pneumatic storage applications
- Not recommended for pump discharge applications

AE313-16 Hose

Design Features:

- Hose designed for high pressure (3000 psig)
- Crimp fitting design provides excellent retention and sealing characteristics.
- Qualified to SAE AS1339-16 meets dimensional and performance requirements of AS1339.

Applications:

- High Pressure Hydraulic
- Not recommended for pneumatic storage applications
- Not recommended for pump discharge applications

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Wire reinforced Teflon hose

AE318 Hose

Construction:

- Teflon inner tube with a conductive inner liner
- Corrosion resistant stainless steel wire braid followed with spiral wire wraps covered by a corrosion resistant steel wire braid reinforcement.

Available with:

- Integral silicone cover
- Integral abrasion cover
- Slip on fire-sleeves
- Slip on or shrinkable abrasion sleeves

Sizes:

- -4 thru –12

Temperature Range:

- -65°F to +400°F

Design Features:

- Heavy-weight hose designed for high pressures (4000 psig)
- Crimp fitting design provides excellent retention and sealing characteristics.
- Qualified to SAE AS614 and meets the performance of AS604 (-4 thru –16)
- Qualified to AS4604 (-20)

Applications:

- High Pressure Hydraulic
- Not recommended for pneumatic storage applications

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Wire reinforced Teflon hose

AE333 Hose

Construction:

- Teflon inner tube with a conductive inner liner
- Corrosion resistant stainless steel wire braid followed with spiral wire wraps covered by a corrosion resistant steel wire braid reinforcement.

Available with:

- Integral silicone cover
- Integral abrasion cover
- Slip on fire-sleeves
- Slip on or shrinkable abrasion sleeves

Sizes:

- -4, -10, -12, -16 and –20

Temperature Range:

- 65°F to +400°F

Design Features:

- Heavy-weight hose designed for very high pressures (5000 psig).
- Crimp fitting design provides excellent retention and sealing characteristics
- Qualified to Eaton Standard ACES 2401 (Similar to SAE AS614 except 5000 psig).
- Uses same minimum bend radius as 3000 psig heavyweight hose.

Applications:

- High Pressure Hydraulic
- Not recommended for pneumatic storage applications

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Wire reinforced Teflon hose

AE641 Hose

Construction:

- Convoluted Teflon inner tube with a conductive inner liner
- Corrosion resistant stainless steel wire braid reinforcement

Available with:

- Integral silicone cover
- Integral abrasion cover
- Slip on fire-sleeves
- Slip on or shrinkable abrasion sleeves

Sizes:

- 4 thru –32

Temperature Range:

- -65°F to +400°F (CRES Ftgs)
- -65°F to +275°F (Aluminum Ftgs)

Design Features:

- Increased flexibility when compared to a smooth bore Teflon hose.
- Light weight, designed for low to medium pressures (1000 psig up to size –20, 750 psig for –24 size, 250 psig for -32 size)
- Crimp fitting design provides excellent retention and sealing characteristics
- Qualified to SAE AS620 and AS1227. This is a SAE PRI QPL approved product.

Applications:

- Hydraulic Return
- Fuel
- Engine Oil
- Coolant
- Ground Support
- Not recommended for pneumatic applications

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Wire reinforced Teflon hose

AE645 Hose

Construction:

- Convoluted Teflon inner tube with a conductive inner liner
- Nomex braid reinforcement

Sizes:

- -4 thru –16

Temperature Range:

- -65 °F to +275 °F (Aluminum Ftgs)

Design Features:

- Increased flexibility when compared to a smooth bore Teflon hose and Wire braid Teflon hose.
- Light weight, designed for low pressures (300 psig for -4 and -6 size, 250 psig for -8 and -10 size, 200 psig for -12 and -16 size)
- Crimp fitting design provides excellent retention and sealing characteristics
- Meets the performance requirements of AS1227.

Applications:

- Fuel
- Engine Oil
- Coolant
- Not recommended for pneumatic applications

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Nomex reinforced Teflon hose

AE645 Hose

Construction:

- Convoluted Teflon inner tube with a conductive inner liner
- Nomex braid reinforcement
- Sizes: -4 thru –16

Temperature Range:

- -65º F to +275º F (Aluminum Ftgs)

Design features:

- Increased flexibility when compared to a smooth bore Teflon hose and Wire braid Teflon hose.
- Light weight, designed for low pressures (300 psig for -4 and -6 size, 250 psig for -8 and -10 size, 200 psig for -12 and -16 size)
- Crimp fitting design provides excellent retention and sealing characteristics
- Meets the performance requirements of AS12274

Applications:

- Fuel
- Engine Oil
- Coolant
- Not recommended for pneumatic applications

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Kevlar reinforced Teflon hose

AE355

Construction:

- Teflon inner tube with a conductive inner liner
- Kevlar braid reinforcement covered with a polyester chafe outer-braid
- Available with:
  - Slip on or shrinkable abrasion sleeves
- Sizes: -4, -6, -8 and –10

Temperature Range:

- -65o F to +275o F

Design features:

- Lightweight 3000/4000 psig hose designed for high pressure hydraulics
- Swaged fitting design provides excellent retention and sealing characteristics
- Qualified to SAE AS1975 for 3000 psig and 4000 psig systems. This is a SAE PRI QPL approved product

Applications:

- High pressure hydraulic
- Not recommended for pneumatic storage applications

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Kevlar reinforced Teflon hose

AE319

Construction:

- Teflon inner tube with a conductive inner liner
- Kevlar braid reinforcement followed by an outer cover of PBI/Kevlar or Polyester
- Available with:
  - Slip on or shrinkable abrasion sleeves
- Sizes: -4, -6, -8, -10, -12 and -16

Temperature Range:

- -65° F to +275° F

Design features:

- Heavyweight 3000/4000 hose designed for high pressures.
- Crimp fitting design provides excellent retention and sealing characteristics.
- Qualified to SAE AS4623 performance – 3000psig.
- Qualified to Eaton Standard ACES 2464 – 4000psig

Applications:

- High pressure hydraulic
- Not recommended for pneumatic storage applications

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Kevlar reinforced Teflon hose

AE334

Construction:

- Teflon inner tube with a conductive inner liner
- Kevlar braid(s) reinforcement covered with a PBI/Kevlar chafe outer-braid
- Available with:
  - Slip on or shrinkable abrasion sleeves
- Titanium fittings
- Sizes: -4, -6, -8, -10, -12 and -16

Temperature Range:

- -65o F to +275o F

Design features:

- 5000/5080 psig hose designed for very high pressure hydraulic systems.
- Crimped fitting design provides excellent retention and sealing characteristics.
- Qualified to SAE AS5951 and Airbus spec ABS 1335 for 5080 psig systems. This is a SAE PRI QPL approved product

Applications:

- High pressure hydraulic
- Not recommended for pneumatic storage applications

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Hose installation checklist

- Hoses should be planar to the maximum extent possible.
- Motion should be in plane of hose or torsion of hose will result (Detrimental to hose)
- Try to have at least one straight fitting to avoid installation twist issues
- Minimum Bend radius must be met at all actuation positions and during installation
- Consideration for damage must be made during disconnection to service equipment
- Consider hose may be in other positions when checking clearances, especially S shaped hoses
- Hoses should be supported from bulkhead fittings or component attachments. Support of hoses by tubing should be avoided and must be verified by stress analysis if required.
- Hose assembly tolerance +/- 0.125” up to 18” length, greater for longer hoses
- Check the longest hose with minimum distance between attachments
- Check the shortest hose with the maximum distance between attachments
- Check intermediate case with both extreme hose lengths
- Consider the full kinematic motion of the hose
- Check worse case for installing hose based on fitting insertion depth

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Hose installation checklist

- Minimum bend radius must be determine using Catia flexible element, note hose do not follow what CATIA think they should, be you under stand how the hose will bend in service
- Flexible hose section should be greater than 8 inches long
- All PTFE lined hose flowing product shall contain a carbon additive for Static electricity dissipation
- Hoses connected to external fittings (Drains) on aircraft may need to be non-conductive for lightning insulation
- Prevent Cross Connections by changing fitting size (Jump up not down, -6 hose – 8 Ftgs)
- Hose angle for shaped fittings measured counter-clockwise
- Do the dressings provide hand and footholds? If this cannot be avoided, are there clear instructions to personnel of the consequences of climbing on equipment?
- Designs must consider dissimilar materials, corrosion could occur
- Are hydraulic pipes and electrical cables sufficiently segregated
- Has the affect of a 300mph air-stream on the dressings been considered?
- Are there methods in place to avoid damage from debris impacting the dressings such as, stones, birds, hail stones etc?

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Handling and installation practice

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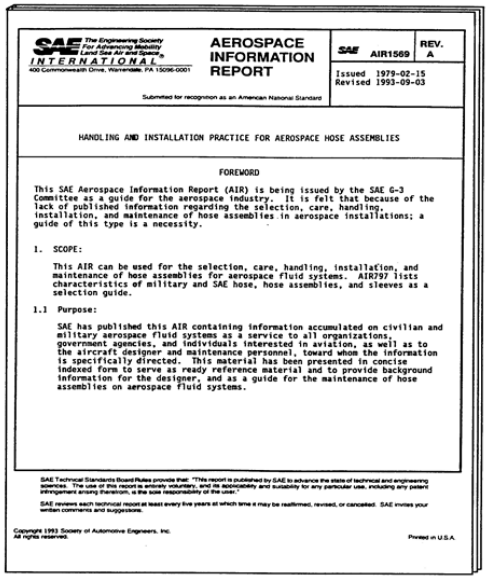

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AEROSPACE INFORMATION REPORT

SAE AIR1569 REV. A

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Submitted for recognition as an American National Standard

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For aerospace hose assemblies(SAEAIR1569)

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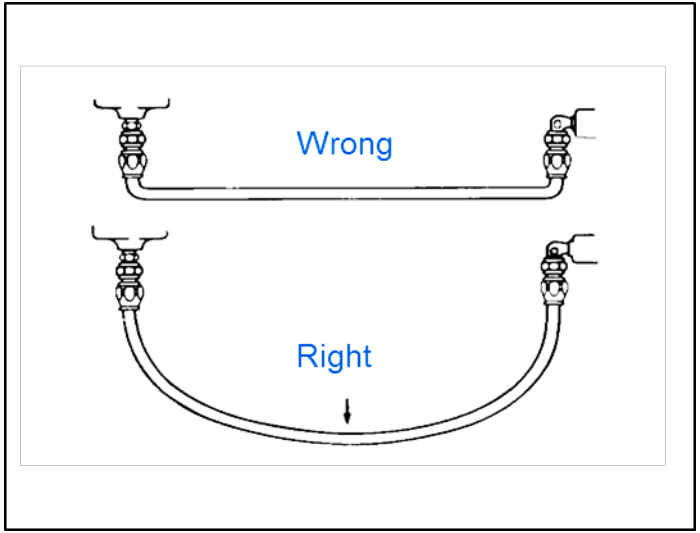
Hose installation tips

Do not exceed minimum bend radius during handling, storage or installation. If the bend radius is exceeded, the hose will tend to flatten and kink. An adequate bend radius will help prevent the hose line from collapsing or restricting flow.



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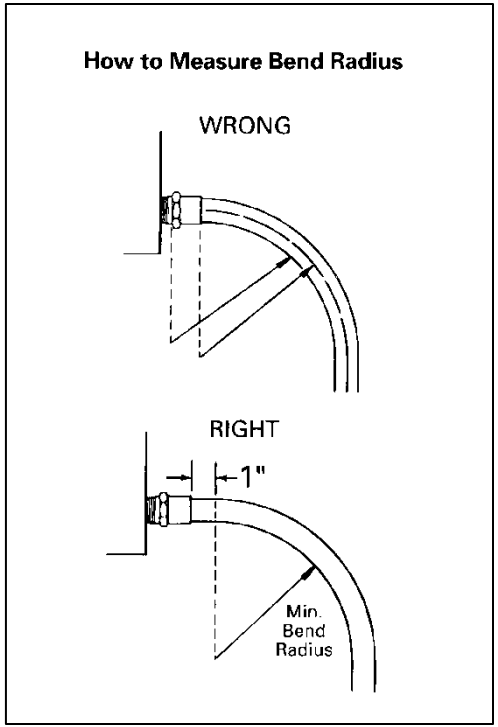
Hose installation tips (Cont.)

During installation, assemblies should be positioned so that the flexible portion of the hose extends at least one inch behind the socket before the start of the bend.



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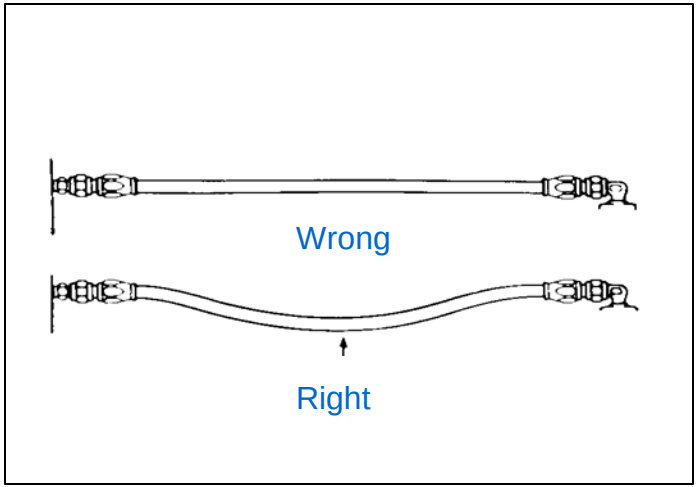
Hose installation tips (Cont.)

Remember that the hose will change in length (up to 4% shorter or 2% longer) when pressurized to the maximum operating pressure. Provide slack or bend in the hose to compensate for any changes that might occur.



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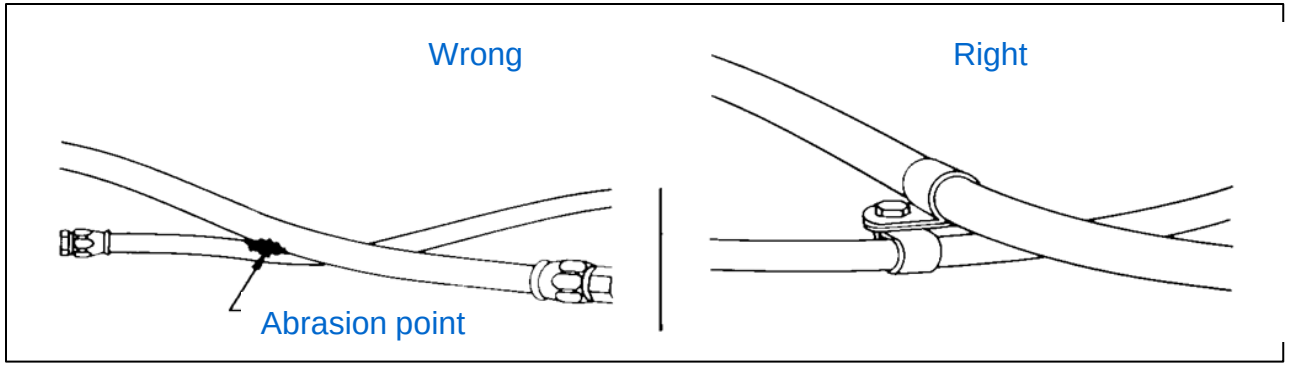
Hose installation tips (Cont.)

Route and clamp the hose to prevent it from contacting another hose line or abrasion point. Care should be exercised in distributing hose slack between the hose connections and the clamps. Do not bend or force the hose to a sharp angle at any location. Be sure that gradual curves are used for all routing.



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Hose installation tips (Cont.)

Remember!

1. Always lubricate threads before installation.
2. Use gradual curves and bends when you are routing the hose. Do not force the hose into a sharp angle (make sure the hose extends at least the equivalent diameter of the hose before bending).
3. Use care when determining the amount of slack when attaching support clamps.
4. Avoid using undersize clamps.

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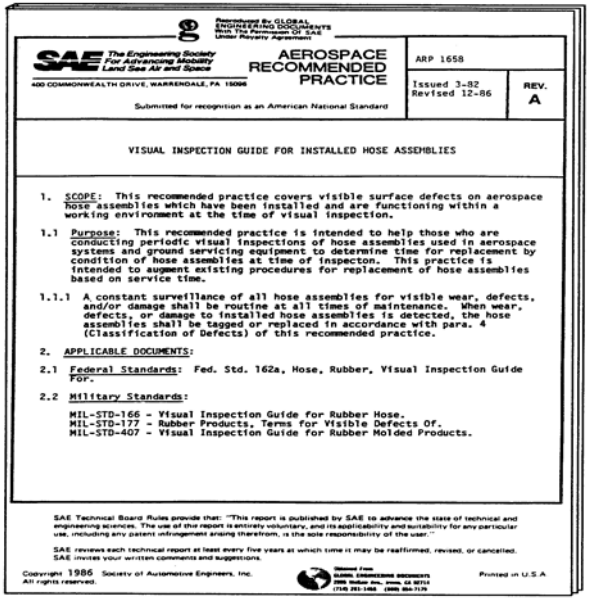
Visual inspection guide for installed hose assemblies (SAE ARP 1658)

1.1 Purpose: This recommended practice is intended to help those who are conducting periodic visual inspections of hose assemblies used in aerospace systems and ground servicing equipment to determine time for replacement by condition of hose assemblies at time of inspection. This practice is intended to augment existing procedures for replacement of hose assemblies based on service time.

1.1.1 A constant surveillance of all hose assemblies for visible wear, defects, and/or damage shall be routine at all times of maintenance. When wear, defects or damage to installed hose assemblies is detected, the hose assemblies shall be tagged or replaced in accordance with paragraph 4 (Classification of Defects) of this recommended practice.



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SAE The Engineering Society For Advancing Mobility Land Sea Air and Space

400 COMMONWEALTH DRIVE, WARRENDALE, PA 15096

AEROSPACE RECOMMENDED PRACTICE

ARP 1658

Issued 3-82
Revised 12-86

REV. A

Submitted for recognition as an American National Standard

VISUAL INSPECTION GUIDE FOR INSTALLED HOSE ASSEMBLIES

1. SCOPE: This recommended practice covers visible surface defects on aerospace hose assemblies which have been installed and are functioning within a working environment at the time of visual inspection.

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2. APPLICABLE DOCUMENTS:

2.1 Federal Standards: Fed. Std. 162a, Hose, Rubber, Visual Inspection Guide For.

2.2 Military Standards:

MIL-STD-166 - Visual Inspection Guide for Rubber Hose.
MIL-STD-177 - Rubber Products, Terms for Visible Defects Of.
MIL-STD-407 - Visual Inspection Guide for Rubber Molded Products.

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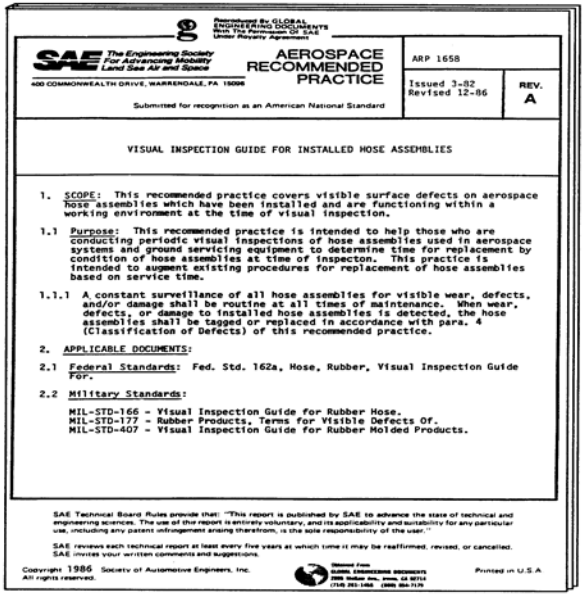
SAE ARP 1658 (Sec. 4. Classification of Defects)

4. **Classification of defects:** Defects observed shall fall into two classifications, minor and major.

4.1 **Minor Defects:** Minor defects, when observed, should be tagged for future observations and/or replacement.

4.2 **Major Defects:** Major defects should be replaced immediately.



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SAE ARP 1658 (Sec. 5. Identification of Defects)

5. Identification of defects:

5.1 Kinked: Minor in body of low pressure hose. Major if near fitting, indicating possible heavy stress or in high pressure hose assemblies.

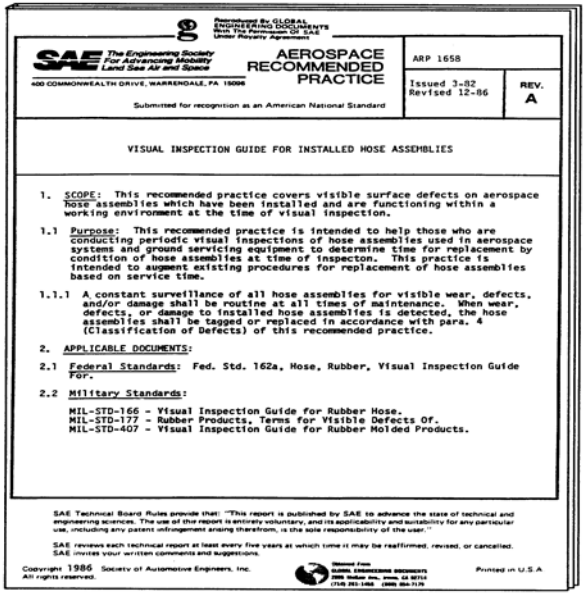
5.2 Broken wires: Minor if isolated random occurrence. Major if two or more wires in one plait broken (see para. 6.3) or if breakage of several wires is concentrated in
one section.

5.3 Abrasion: Minor if confined to no more than two wires. Major if extended throughout one plait or from one plait to another. Minor for rubber covered hose if confined to rubber cover of hose. Major for rubber covered hose if wire is exposed.

5.4 Corrosion: Major: If any corrosion of wire is detectable. Minor: A discoloration of the hose cover or reinforcement but no physical corrosion is detectable.

5.5 Twisted: Major: If wires are broken or liner cannot be rounded out. Minor: On all spirally reinforced hose.

5.10 Leakers: Major: A tear or defect in the hose assembly or fitting causing a leak. Any leak that cannot be overcome by tightening swivel nut or retaining bolts (flange) to maximum recommended torque (ARP 908). Minor: A leak which can be stopped by tightening a loose swivel nut to maximum recommended torque of ARP 908.



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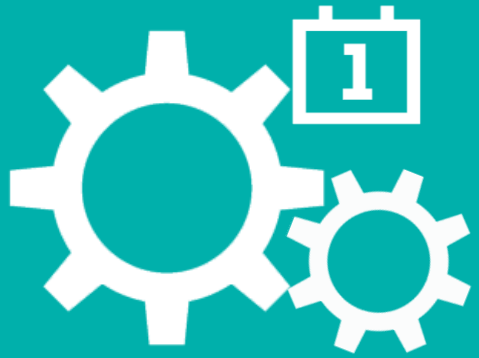
Pro-active maintenance

Refer to SAE ARP 1658

- Check All Hoses at Regular Intervals - At Least at Every Annual Inspection - Not Every 35 Years!
- Check All Hoses - by Hand and Visually
- Look for Kinks - Reduced Flow May Result (Also Check for Kinks under Firesleeves)
- Make Sure Hose Lines Are Not Twisted (This Can Cause Torsion Loads at End Fittings)
- Look for Scuffs and Abrasions - These Can Be Avoided by Proper Clamping and Routing during Installation



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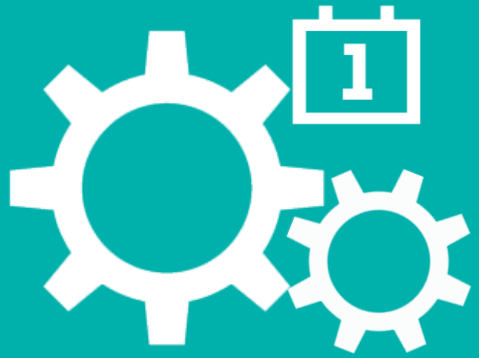
Pro-active maintenance (cont.)

- During inspection, look for seeping and slow leaks (these can occur around fittings or clamps)
- Look for Any rusting or corrosion
- Inspect Visually and by Hand for Any Broken Braid Wires - Broken Braid Wires Can Weaken the Hose to the Point of Eventually Causing Leaks

Caution: Be sure to exercise care when examining steel braided hose to avoid cuts from sharp broken braids

- Rubber Hose Can Become Weak and Brittle over Time - These Hoses Have Heat Limitations and Cracks Can Develop during Flexing



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Hose construction

Inner Tube

- Rubber (Various types), PTFE, Nylon, Hytrel,

Considerations

1. Flexibility
2. Temperature Range
3. Permeation characteristics
4. Pressure Drop Considerations
5. Chemical Compatibility
6. Age Requirements

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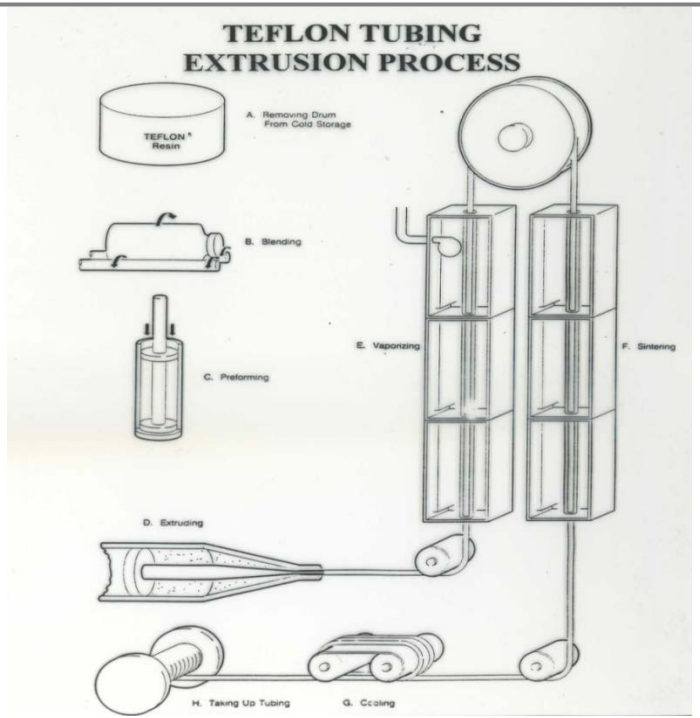

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Types of PTFE Hose

Smooth vs. Convoluted Innerliner

- **Smooth Innerliner-** Fabricated by cold extrusion then sintered. Hose inside diameter is structured to be compatible with rigid tube inside diam.
- **Convoluted Innerliner-** Fabricated by either of (2) methods
  - to utilize a tape wrap process then sintered
  - to utilize a pre-extruded PTFE tube and reform by utilizing a process of vacuum forming during regel.

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Types of PTFE Hose (Cont.)

Conductive vs. Non-Conductive Innerliner

- **Conductive-** Innerliner is constructed from pure natural PTFE with the addition of conductive carbon particles. The carbon particles allow the electrical charge to dissipate to the end fittings. This type of innerliner is used throughout the aerospace industry in the fuel, oil, and hydraulic systems.
- **Non-Conductive-** Innerliner is constructed from pure natural PTFE. Used in chemical, hypergolic fuels, potable water, and food transfer systems.

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Hose construction

Reinforcement (1)

- The reinforcement is the strength member of the hose and gives the hose its pressure handing capability.
- This capability depends upon the type and quantity of materials used as reinforcement:

1. Fabric (Cotton, Rayon, Dacron)
2. Wire (high carbon steel or stainless steel)
3. Kevlar, Nomex

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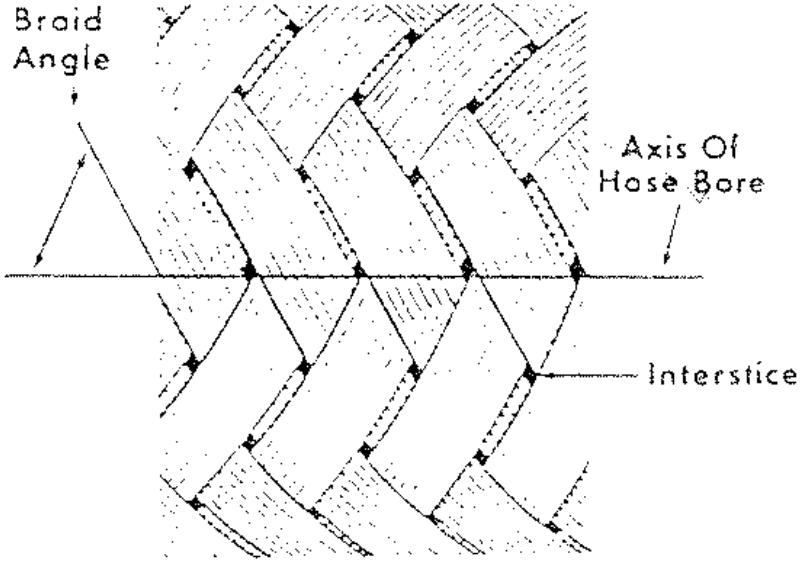
Hose construction

Reinforcement (2)

- These materials are placed over the inner tube and are either braided or wrapped in various combinations and layers, depending upon the pressure requirements or design of the hose.
- When the reinforcement is applied to the hose, it is done at a specific angle to the axis of the hose. This angle is sometimes referred to as the “braid angle”



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Braid construction

The primary braid construction utilizes a 2/2 braid construction to minimize the effects of wire shear at the interweave contact points.

The braid can be constructed from Stainless Steel, wire in varying degrees of hardness ranging from full anneal to full hard, or from non-metallic fibers such as Para-Aramid (KEVLAR®), Polyaryl Amide (NOMEX®, or other synthetic fibers. The type of braid material and wire hardness used is dependent on the service parameters.

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Braid construction (cont.)

- **Single Layer Braid-** The braid construction consist of only one layer of wire, fiber, or braid. A wire braid design will have all of the wires laying side by side within a wire plait or bundle.
- **High Density Braid-** The braid construction consists of a dense pack of small diameter wires within a wire plait or bundle. This type of braid construction allows the use of a smaller bend radius, a lower force to bend, and reduced hose weight for 3000 psig hydraulic operating systems. However, it is not recommended for Pump Discharge Applications due to its low axial column strength which will allow the hose to deflect axially due to pump ripple excitation.
- **Multi-layer Braid-** This braid construction consists of multiple layers of braids and inner spiral wraps. This type of braid construction is utilized for heavy duty high pressure applications ranging from 3000 to 8000 psig pressures.

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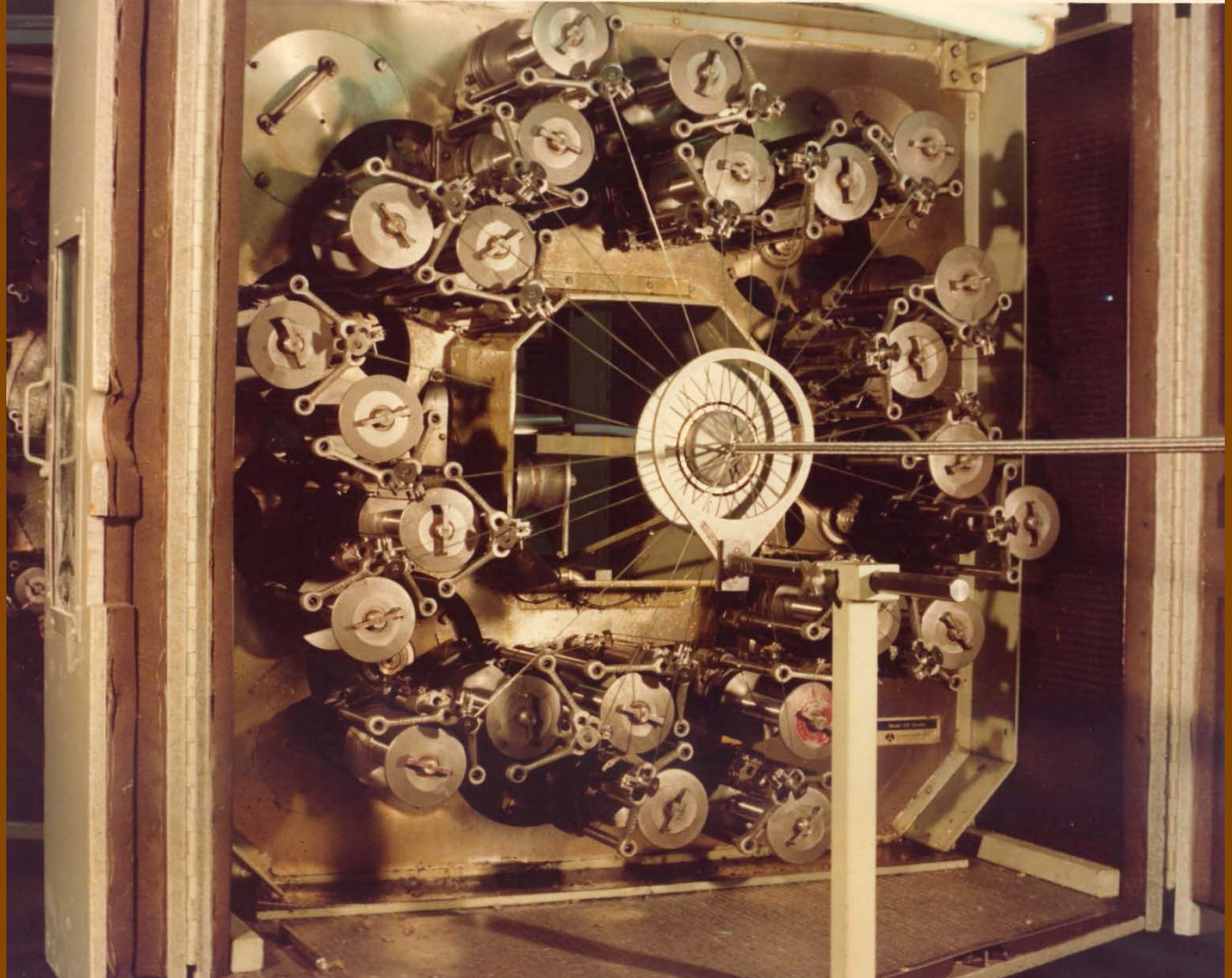

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Hose design considerations

- Operating pressure
- Minimum burst requirements
- Ambient temperatures
- Fluid temperatures
- Bend radius requirements
- Size
- Weight
- Abrasion resistance
- Impulse life
- Fire resistance
- Tensile strength
- Corrosion resistance
- Special application needs (I.E.: Gun Fire)
- Cost

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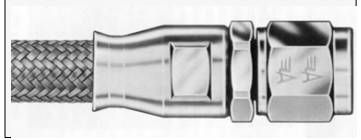
Hose assemblies – end fittings

Completed hose assemblies are made up for each particular application.
The application is defined and the appropriate hose and fitting combination is selected.

Fitting types

Reusable

Screw together



Permanent

Compression crimp

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Hose assemblies – end fittings

Characteristics of the reusable fittings

- As the name implies, the end fitting is screwed onto the hose to provide a leak-tight connection.
- Its main advantage is ease of assembly, many hose styles requiring only a vice and spanners to assemble.
- These have gained much use with the armed services as hose assemblies can be made as required, reducing inventory.
- Although theoretically able to be disassembled, they can be difficult, especially with older rubber hose product. Teflon is normally fully re-useable.

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Hose assemblies – end fittings

Screw together fittings are applicable to the following hoses:

System pressure = Design pressure = Operating pressure

Proof pressure = 2 X Operating pressure

Minimum burst pressure = 4 X Operating pressure

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Hose assemblies – end fittings

Screw together fittings are applicable to the following hoses:

303 /302A, 306, 309	Rubber
601, AE701	
666/667, AE240-3, AE116, AE466, AE566	Teflon
AE206, AE207, AE318	
AE246, AE446, AE346, AE546	

To help identify the different hose types, the socket part number can also be used

HOSE	Re-useable Socket
666/667, AE240-3, AE116, AE466, AE566	F506-
AE206, AE207, AE318	793
AE246, AE446, AE346, AE546	AE18915

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Hose assemblies – end fittings

End fitting types

There are 6 basic arrangements for hose assemblies

1	Straight to straight
2	Straight to 45º
3	Straight to 90º
4	45º to 45º
5	45º to 90º
6	90º to 90º

In addition to the standard angles of 45 and 90 degrees, there are special angles to suit customer needs. These are called out on the applicable hose assembly drawing.

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Hose assemblies – end fittings

Jump size fittings

- For each hose dash size, there are end fittings of the same dash size e.g. AE246-4 hose has standard end fittings of -4 size.
- In many cases there are good reasons to supply non-standard (“jump size”) end fittings. The main reason is to prevent cross connection of similar hose assemblies in adjacent positions.
- Generally sizes are jumped up rather than down e.g. a -6 hose may be fitted with end fitting that would normally interface with a -8 connection. The hose to fitting interface still remains at -6.

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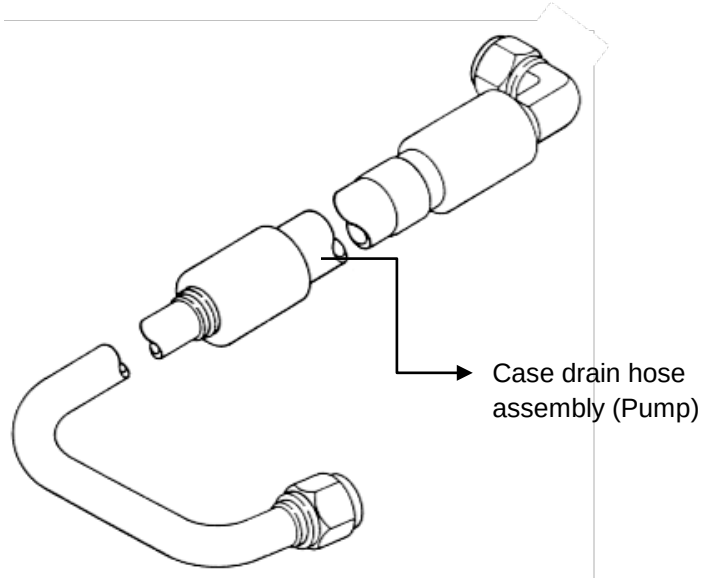
Hose assembly terms

Integral or compound hose assembly

Either term is used to describe a hose assembly that is permanently attached to a length of rigid metal tube at either or both ends of the hose. Generally the rigid tube is of greater length than a normal elbow assembly.



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Life expectancy

The actual service life of a given hose assembly in a given application is dependent on many variable factors. These variable factors may include, but are not limited to, operating pressure, pressure surges, operating temperatures (both fluid and ambient), installed bend radius, cleaning solutions, ozone and assembly routing.

Due to the variety of operating conditions and applications, the user, through their own analysis, testing and/or review of maintenance records and data, is ultimately responsible for making the final selection of or decisions about replacement hose assemblies and assuring that all performance, safety and warning requirements of the application are met.

Generally speaking, unless otherwise directed by company, user or airline maintenance procedures, OEM maintenance manual instructions, Federal Aviation Administration (FAA) advisory circulars or airworthiness directives or other similar maintenance document(s), it is recommended that hose assembly maintenance and/or replacement be conducted on an “on-condition” basis. Nothing in this statement nor in the above shall be construed so as to permit or encourage any violation of applicable regulations.

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Life expectancy… continued

Hose Assembly applications may be thought of in three general categories:

- Normal duty
- Moderate or heavy Duty
- Demanding or severe duty

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Life expectancy… continued

Normal duty hoses: typically those hose assemblies in less demanding applications, such as in-body, in-wing or other applications not normally exposed to the environment, cleaning fluids, continuous temperature extremes, heavy pressure pulsation, etc., and having infrequent maintenance actions associated with their installation.

Recommended maintenance approach: on condition

Moderate or heavy duty hoses: typically those hoses exposed to more frequent maintenance activity or major system removal, or hoses occasionally exposed to environmental conditions (e.g., upper wheel well hoses, APU hoses)

Recommended maintenance approach: either on- condition or based on user data and maintenance records

Demanding or severe duty hoses: typically those hoses continuously or routinely exposed to environmental, cleaning, or other harsh operating variables such as landing gear brake hoses, EDP (Engine Driven Pump) hoses, etc., and associated with major systems requiring regular removal, repair or overhaul.

Recommended maintenance approach: Strongly consider replacement at time of major system overhaul

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Aircraft flexible fuel hoses … continued

FAA – General aviation aids summary, August, 1976)

1. For those aircraft having an auxiliary fuel pump, pressurize the flexible fuel line with the fuel boost pump operating in high position. The fuel system of certain models of aircraft equipped with fuel-injected engines can be pressurized by activating the electric primer. Examine the hose exterior for evidence of leakage or wetness.

***Note**: Place the mixture control in the idle cutoff position, prior to using either the boost pump or the electric primer for fuel system pressurization.*

2. Inspect for discoloration of the hoses and/or color bleaching of the end fittings.
3. Check the hoses for evidence of stiffness.
4. After pressure testing, allow sufficient time for excess fuel to drain overboard, before attempting to start the engine.
5. On those aircraft having a gravity flow fuel system, the inspection procedures in steps 2-4 apply.

It is suggested that any flexible hoses that are found leaking or that show a noticeable amount of stiffness be replaced. It is further suggested that all flexible hoses carrying flammable fluid in the engine compartment be replaced at engine overhaul or every five years, whichever occurs first. The aircraft manufacturer's service information, however, should always be followed, if different from the above procedures.

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Aircraft flexible fuel hoses … continued

During reinstallation of flexible hose assemblies, consider the following precautions:

1. Ensure that the hose is not twisted. High pressures applied to a twisted hose can cause a failure of the hose or loosening of the B-nut.
2. Provide as large a bend radius as possible. However, never use a bend radius less than the minimum as specified in the hose specifications.
3. Do not attempt to straighten a hose having a bend as this could result in damage to the hose. Rubber hoses will take a permanent set during extended service periods. Care should be taken also during removal and reinstallation of such hoses, to ensure that they are not bent excessively and that they are returned to their original position.

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Questions/Comments

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