SAE Aerospace
An SAE International Group

AEROSPACE STANDARD

SAE AS611 | REV. E

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Superseding AS611D

(R) Hose Assembly and Tubing, Polytetrafluoroethylene, Cleaning Methods for

RATIONALE

Revision E change implements a modification to Class 0 cleaning, para 3.1.2 and 3.4.1.a. This Revision also updates and reformats the Specification.

1. SCOPE

1.1 This SAE Aerospace Standard (AS) describes cleaning methods for four cleanliness levels of polytetrafluoroethylene hose assemblies and rigid tube assemblies for use in aerospace systems.

1.2 Classification

Class 0 Cleaning, Hydraulic & Other General Purpose Applications
Class I Cleaning, Moderate Clean Hydraulic & Similar Applications
Class II Cleaning, Oxygen and Similar Applications
Class III Cleaning, Highly Reactive Fluid Systems

2. APPLICABLE DOCUMENTS

The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other documents shall be the issue in effect on the date of the purchase order. In event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

ARP598 Aerospace Microscopic Sizing and Counting of Particulate Contamination for Fluid Power Systems

AMS-T-22085 Tapes, Pressure-Sensitive, Adhesion, Preservation and Sealing

2.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM D 2109 Methods of Test for Non Volatile Matter in Halogenated Organic Solvents and Their Admixtures

ASTM D 4080 Standard Specification for Trichloroethylene, Technical and Vapor-Degreasing Grade

TO PLACE A DOCUMENT ORDER: Tel: 877-606-7323 (inside USA and Canada)
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: http://www.sae.org

SAE values your input. To provide feedback on this Technical Report, please visit
http://www.sae.org/technical/standards/AS611E

ASTM D 4101 Standard Specification for Propylene Plastic Injection and Extrusion Materials

ASTM D 4126 Standard Specification for Vapor-Degreasing Grade and General Solvent Grade 1,1,1-Trichloroethane (R 1990)

ASTM D 4376 Standard Specification for Vapor-Degreasing Grade Perchloroethylene

2.3 U.S. Government Publications

Available from the Document Automation and Production Service (DAPS), Building 4/D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, Tel: 215-697-6257, http://assist.daps.dla.mil/quicksearch/.

A-A-59282 Chemical, Analytical, General Description

A-A-53880 Alcohol, USP

MIL-PRF-680 Degreasing Solvent

A-A-59503 Nitrogen, Technical

TT-I-735 Isopropyl Alcohol

A-A-1689 Tape, Pressure-Sensitive Adhesive (Plastic Film)

MIL-PRF-27401 Propellant Pressurizing Agent, Nitrogen Gas

MIL-C-81302 Cleaning Compound, Solvent, Trichlorotrifluoroethane

MIL-PRF-81705 Barrier Materials, Flexible,Electrostatic Protective, Heat Sealable

MIL-STD-889 Metals, Definition of Dissimilar

2.4 ANSI/ASQC Standards

Available from American National Standards Institute, 25 West 43rd Street, New York, NY 10036- 8002, Tel: 212-642-4900, www.ansi.org.

ASQ Z1.4 Sampling Procedures and Tables for Inspection by Attributes

3. TECHNICAL REQUIREMENTS

3.1 Cleaning/Preservation

Cleaning and cleanliness pertain only to the wetted surfaces (fluid passage) of the polytetrafluoroethylene hose assemblies. Cleaning tools and equipment shall remove dirt, dust, grit, rust, corrosion, flux, oil, grease and other contaminants, to achieve the cleanliness levels specified under 4.2 and in Table 4. It is particularly important to avoid the entrapment of injurious particles or fluids.

3.1.1 Cleaning Equipment

Equipment and fluids used for the final cleaning procedures shall be of such purity that they will not cause residual contaminant particles larger than final permitted particle size to be deposited in the final rinsing fluids and drying gases. Adequate cleanliness and filtration of new gases and liquids, as well as reusable materials, shall be maintained to insure the attainment of the above objective.

3.1.2 Water

Water used for Class 0 cleaning or as a carrier for detergents shall be clean, grease-free water, containing less than 50 ppm suspended or dissolved solids. The use of water containing impurities which would react chemically with any part of the components, or with the dissolved cleaning compound, is prohibited. . Distilled water or water that has been passed through a 5 micron filter may be used as an acceptable alternate for deionized or demineralized water if it demonstrates a chlorination level below 200 ppm as measured by the local municipality or from samples collected at the point of use on quarterly basis. Water used for testing or for final flushing or cleaning of Class I, II, or III hose assemblies shall be deionized or demineralized water and shall have a specific resistance of at least 50 000 Ω. Distilled water may be used as an acceptable alternate for deionized or demineralized water.

3.1.3 Cleaning Fluids

Cleaning fluids such as ASTM D 4080 Trichloroethylene, ASTM D 4126 Trichloroethane, ASTM D 4376 Perchloroethylene, MIL-C-81302 Trichlorotrifluoroethane and P-D-680 Stoddard's solvents may be used at the supplier's discretion, provided that the cleaned items meet the requirements listed in this specification. Hydrofluroether (3M™ HFE-7100, other grades should be tested for compatibility) fluids may be used, provided that the cleaned items meet the requirements listed in this specification. Chlorinated solvents are not recommended for use in cleaning of titanium alloys which will see service temperature above 500 °F.

3.1.4 Aqueous/Semi-Aqueous Solutions

Alkaline surfactants, non-ionic wetting agents, emulsifiers, detergents (such as trisodium phosphate) and combinations thereof may be used. The pH of the solutions shall be maintained between 8.0 and 12.0. Foaming should be minimized to increase efficiency. The cleaning cycle should be followed by thoroughly rinsing all wetted surfaces with water per 3.1.2 to remove traces of the cleaning solution when dried. Organic solvents such as terpenes, high boiling point alcohols, and petroleum distillates may also be used. Specific process requirements should be obtained from the manufacturer. All aqueous/semi-aqueous cleaning methods should be followed by a final drying operation with purging gases per 3.2 or a suitable oven dry. The use of physical agitation or ultrasonic energy may be beneficial in increasing the efficiency of cleaning methods which utilize aqueous/semi-aqueous solutions.

3.1.5 Preservation Materials

a. Caps and Closures, Threaded

The type closure used for an intimate barrier shall be selected to resist corrosion, deterioration or loosening and shall prohibit installation of the hose assembly unless the closure is removed. Fully threaded, hard plastic caps (high density polyethylene, polypropylene per ASTM D 4101 or acetal copolymer materials are preferred). When metallic closures are used, they shall have a machined or rolled thread or shall be fabricated from a sufficiently hard material to prevent shaving. Metallic closures shall be of a material similar to that of the hose fitting. Similar and dissimilar metals are defined in MIL-STD-889. The closures shall be at least as clean as the internal surfaces of the hose assembly onto which they are installed.

b. Bags, Tubing, and Film - Intimate Barrier

Intimate barrier bags, tubing, and film may be used as an alternative for threaded caps and closures. Materials shall be transparent thermoplastic, low sloughing, anti-static polyamide (modified nylon 6) without talc or starch slip agents; minimum thickness of 2 mil. The bag, tubing, or film shall be at least as clean as the internal surfaces of the hose assembly onto which they are installed.

c. Tape

Material shall be per A-A-1689 or MIL-T-22085 and is used to secure the intimate barrier bag, tubing, or film to the hose assembly. The tape may also be used to close the open ends of bags, tubing, or film when used for an outer barrier.

d. Bags, Tubing, and Films - Outer Barrier

Outer barrier bags, tubing, and films are used as a packaging technique and are not in contact with the cleaned internal surfaces of the hose assembly. Materials may be anti-static PTFE, FEP (fluorinated ethylene-propylene), nylon, or polyethylene with a 4 mil minimum thickness (these outer barrier materials are suitable for use as an intimate barrier for Class 0 and Class I only - due to relatively low criticality of the cleaning levels).

3.2 Purging Gases

Purging, drying and pressure testing of Class I, II and III hose assemblies after cleaning and prior to shipment or use of Class I, II and III hose assemblies shall be done with nitrogen in accordance with MIL-PRF-27401 or BB-N-411, Type I, Class I, Grade A. Clean, dry air may also be used if its purity conforms to the requirements in specified in Table 1.

TABLE 1 - PURITY REQUIREMENTS - AIR

Total Hydrocarbons (PPM max) by Weight as Carbon	Particles Over 100 µm	Max Grams of Water Vapor per Liter of Gas at 70 °F (21.1 °C) and 760 mm Hg
3	0	0.00002[1]

[1] Equivalent Dew Point: at 760 mm Hg -63.5 °F (-53 °C).

3.3 Handling After Cleaning

3.3.1 All hose assemblies shall be sealed immediately or as specified after the level of cleanliness is achieved and testing, inspection and drying are completed. See 3.5 for preservation requirements.

3.3.2 All handling after cleaning and sealing shall be planned to maintain the clean condition of the hose assembly during the packaging, shipment and storage. Handling and preservation after cleaning shall be done in areas away from high manufacturing contamination; for example: areas of high solvent use, grinding, blasting or other abrasion processes.

3.3.3 Class II hose assemblies shall be processed after cleaning in a dust control area as described in 3.3.4 or in a normal manufacturing area if hose assembly parts are sealed immediately after drying.

3.3.4 Class III hose assemblies shall be processed after cleaning in a dust control area:

The area shall be enclosed and kept clean from dust, dirt, oil and such contaminants.

Smoking or eating shall not be allowed within the area.

A slight positive air pressure shall be maintained with respect to adjacent, lesser controlled areas, the input air shall be filtered.

Floor, walls and ceiling, benches and tables shall be painted or have non-dusting, non-flaking and easily cleaned surfaces.

Parts and equipment not related to the work function shall be kept from the work area.

3.4 Cleaning Procedures

3.4.1 Class 0 Cleaning

Hose assemblies for use in hydraulic and other general purpose applications (that require minimum cleaning) shall be cleaned in the following manner:

a. Immerse or flush the hose assemblies, using a suitable cleaning solution in accordance with 3.1.2, 3.1.3 or 3.1.4.

b. If using 3.1.4 fluids other than organic solvents, rinse inside surfaces thoroughly with 3.1.2 water.

c. Drain hose assemblies and blow dry with shop air. Gas in accordance with 3.2 may be used instead of or in addition to shop air.

d. See Section 4 and Table 4 for Quality Assurance Provisions. Accepted hose assemblies shall be preserved for shipment per 3.5.

3.4.2 Class I Cleaning

Hose assemblies for use in hydraulic and/or other systems where a moderate degree of cleanliness is required shall be cleaned in the following manner:

a. Prior to assembly, all fittings shall be cleaned with a 3.1.3 or 3.1.4 fluid. If using 3.1.4 fluids other than organic solvents, follow with a thorough water rinse per 3.1.2. Dry with purging gas in accordance with 3.2 or by heating for 60 min at 250 to 275 °F (121 to 135 °C) in a suitably designed oven.

b. Immerse or flush hose assemblies in a cleaning fluid in accordance with 3.1.3 or 3.1.4 and brush bore of fittings and first inch of hose with a nylon or similar synthetic bristle brush with a diameter at least 0.06 in (1.59 mm) larger than the fitting bore.

   For hose sizes -08 and smaller, the brush size may be reduced but must be greater than hose bore. The brush should have a corrosion resistant core. On hose assemblies incorporating tight elbow end fittings, the brushing operation may be eliminated.

c. Subject hose assembly to a flood of cleaning fluid in accordance with 3.1.3 or 3.1.4 through the bore of the hose assembly for a minimum of 1 min.

d. If using 3.1.4 fluids other than organic solvents, rinse inside surfaces thoroughly with 3.1.2 water.

e. Dry the hose assembly with purging gas in accordance with 3.2 both internally and externally (the external drying need not coincide with that for internal surface) for a minimum of 1 min or by heating for 45 min (minimum) at 250 to 275 °F (121 to 135 °C) in a suitably designed oven.

f. See Section 4 and Table 4 for Quality Assurance Provisions. Accepted hose assemblies shall be preserved for shipment per 3.5.

3.4.3 Class II Cleaning

Hose assemblies for use in cleanliness controlled systems or systems not compatible with oil, such as oxygen systems, shall be cleaned as follows:

a. Prior to assembly, all fittings shall be cleaned with a 3.1.3 or 3.1.4 (except do not use organic solvents in the processing of Class II components) fluid. If using 3.1.4 fluids, follow with a thorough water rinse per 3.1.2. Dry with purging gas in accordance with 3.2 or by heating for 45 min (minimum) at 250 to 275 °F (121 to 135 °C) in an oven free from all vapors except water and that of the solution used in cleaning.

b. Handling practices shall be consistent with requirements under 3.3.3 or 3.3.4. Parts and assemblies shall be stored and handled during manufacture in clean, grease free and oil free containers.

c. Proof testing shall be done with clean water in accordance with 3.1.2. Any gas pressure testing shall be done with gases in accordance with 3.2 or equivalent.

d. Immerse hose assemblies in a cleaning fluid in accordance with 3.1.3 or 3.1.4 (except do not use organic solvents in the processing of Class II assemblies) and brush bore of fittings and first inch of hose with a nylon or similar synthetic bristle brush with a diameter at least 0.06 in (1.59 mm) larger than the fitting bore.

For hose sizes -08 and smaller, the brush size may be reduced but must be greater than hose bore. The brush should have a corrosion resistant core. On hose assemblies incorporating tight elbow end fittings, the brushing operation may be eliminated.

e. Subject the hose assembly to a flood of cleaning fluid in accordance with 3.1.3 or 3.1.4 (except do not use organic solvents in the processing of Class II assemblies) through the bore of the hose assembly for a minimum of 3 min. The minimum flow rate shall be in accordance with Table 2:

TABLE 2 - MINIMUM FLOW RATES

Size	Flow gpm	Size	Flow gpm
-03	0.5	-10	6.0
-04	1.0	-12	9.5
-05	1.5	-16	19.0
-06	2.5	-20	30.0
-08	4.0	-24	40.0

f. If using 3.1.4 fluids, rinse inside surfaces thoroughly with 3.1.2 water.

g. Dry the hose assembly with purging gas in accordance with 3.2 both internally and externally (the external drying need not coincide with the internal) for a minimum of 3 min or by heating for 45 min (minimum) at 250 to 275 °F (121 to 135 °C) in a suitably designed oven.

h. See Section 4 and Table 4 for Quality Assurance Provisions. Accepted hose assemblies shall be preserved for shipment per 3.5.

3.4.4 Class III Cleaning

Hose assemblies for use in contaminant free or highly reactive fluid systems shall be cleaned in the following manner:

a. Follow steps a. through f. of 3.4.3.

b. Passivate assemblies internally with the following solution heated to 120 to 140 °F (49 to 60 °C) for 20 to 30 min:

(1) Nitric Acid (Reagent Grade 69-71 by weight): 25 to 35% by volume

(2) Sodium Dichromate: 1.5 to 2.5% by weight

(3) Water in accordance with 3.1.2: Remainder

NOTE: Sodium dichromate may be omitted from the solution if only 300 Series stainless steel metal components are to be passivated.

c. Rinse assemblies in 170 to 190 °F (77 to 88 °C) water in accordance with 3.1.2 for a minimum of 5 min; parts should be agitated during rinsing.

d. Dry hose assemblies with drying gas in accordance with 3.2 or by heating for 45 min (minimum) at 250 to 275 °F (121 to 135 °C) in a suitably designed oven.

The next three steps (e, f, and g) to take place in a dust control area.

e. Flush assemblies internally with clean, filtered, or distilled O-E-760 Ethyl Alcohol, MIL-F-5566 Anti-Icing Fluid, ASTM D 4376 Perchloroethylene, ASTM D 4080 Trichloroethylene, ASTM D 4126 1,1,1 Trichloroethane, TT-I-735 Isopropyl Alcohol, Hydrofluroether (3M™ HFE-7100, other grades should be tested for compatibility), MSFC 237 solvent or equivalent.

f. Dry hose assemblies with drying gas in accordance with 3.2 or by heating for 45 min (minimum) at 250 to 275 °F (121 to 135 °C) in a suitably designed oven.

g. See Section 4 and Table 4 for Quality Assurance Provisions. Accepted hose assemblies shall be preserved for shipment per 3.5.

3.5 Preservation

The objective of the preservation process is to maintain the cleanliness level of the hose assembly during subsequent packaging, shipment, handling, and storage. In the case of Class II and III cleaned assemblies, identification of the precision clean status of the hose assemblies is also provided. Unit packaging requirements for shipment is a separate issue which is not addressed in this specification.

3.5.1 Preservation for Class 0 and Class I Assemblies

a. Each hose assembly shall be preserved with threaded caps and closures (3.1.5(a)) or bags (3.1.5(b) or 3.1.5(d)). If threaded caps or closures are used, they should be installed hand tight. If bags are used, the bag should be heat sealed or taped (3.1.5(c)) shut. Preservation materials should be clean and dry.

3.5.2 Preservation for Class II and Class III Assemblies

a. Each hose assembly shall be preserved with an intimate barrier consisting of a threaded cap or closure (3.1.5(a)) or a nylon barrier (3.1.5(b)) secured with tape (3.1.5(c)). The closure shall be at least as clean as the internal surfaces of the hose assembly onto which they are installed. If threaded caps and closures are used, they should be installed hand tight. If nylon is used, it should be constructed from film or tubing into a bag shape with one end left open. The closed sides may be sealed via tape or heat sealing technique. Slide the open end of the bag over the end fitting and seal/secure in place with tape (3.1.5(c)). The tape is applied at the interface between the nylon bag and the collar or socket.

b. Each hose assembly shall be preserved with an outer barrier consisting of a bag (3.1.5(d)) with two compartments separated by a heat sealed divider. The hose assembly with intimate barriers is placed inside one compartment and partially sealed with tape (3.1.5(c)) or with heat (continuous 0.06 in (1.59 mm) seam, minimum). Purge the interior of the partially sealed compartment with nitrogen (3.2). Remove as much gas as practical from the compartment and complete the seal. Install and seal the appropriate identification tag per Table 3 in the remaining separate compartment of the outer bag.

TABLE 3 - IDENTIFICATION

Class	Identification Tag Color	Identification Tag Legend
II	Green	Not to be opened except by authorized personnel - This assembly is specially cleaned in accordance with AS611, Class II.
III	Tan	Not to be opened except by authorized personnel - This assembly specially cleaned in accordance with AS611, Class III.

4. QUALITY ASSURANCE PROVISIONS

4.1 Frequency of Tests

Each lot of hose assemblies shall be subjected to the conformance tests shown in 4.2 as specified in 4.3.

A lot consists of all hose assemblies processed at one time, not to exceed 100 pieces.

If the tested assembly fails to pass the conformance test requirements, the entire lot of assemblies shall be recleaned and a new sample taken for test. This procedure is to be followed until the conformance test is passed.

4.2 Conformance Test

4.2.1 Particle Size Determination Test

Particle size determination shall be performed on Class III hose assemblies as specified below. For more detailed description of apparatus, see ARP598.

a. Fill the cleaned hose assembly with cleaning fluid in accordance with 3.1.3 or clean, filtered alcohol (O-E-760, TT-I-735 or equivalent), agitate vigorously, and drain into a clean beaker which has been previously rinsed at least three times with small volumes of the cleaning fluid. If the test is not to be conducted immediately, the hose may be drained into a clean, pre-rinsed Erlenmeyer flask fitted with a standard taper glass stopper.

b. Filter the entire sample through an appropriate millipore filter (or equivalent) into a clean pre-rinsed flask or beaker. Care shall be exercised to prevent contamination of the filter from airborne particles during filtering. Vacuum may be employed to increase filtration rates.

c. The filters shall be thoroughly dried being careful to protect the filter from airborne contamination both during the filtering and drying process.

d. The dried filter should be protected by sandwiching between clean glass plates and taping the edges or by enclosing in appropriate clean glass or disposable plastic petri dishes.

e. The entire filter area shall be examined under oblique light with a microscope employing at least 40X magnification. The microscope shall be equipped with a calibrated ocular micrometer. Any particle whose major axis which may be larger than permitted in Table 4 shall be examined and measured at a magnification sufficiently large to assure accurate measurement.

f. Any particle whose size on any axis is greater than specified in Table 4 shall be cause for rejection.

4.2.2 Reaction Test

The reaction test shall be performed on Class III hose assemblies only and carried out as follows:

a. Fill inclined hose assembly with hydrogen peroxide - 30% minimum in water using compatible similar metal plugs or polyethylene film covered rubber stoppers to plug lower opening. Connect upper end with length of polyethylene or polytetrafluoroethylene tubing to inverted water filled graduate.

b. After 10 min, feel dry external surfaces with bare hand to check hidden activity areas (hot spots) and check rate of water displacement from the inverted graduate. Hidden activity areas of decomposition rate of 30 cc/min per 100 cc of test fluid shall be cause for rejection.

c. Drain assembly of hydrogen peroxide and flush for at least 2 minutes with water in accordance with 3.1.2.

d. Comply with Steps f. and g. of 3.4.4.