
USACE / NAVFAC / AFCEA / NASA UFGS-22 15 09.00 40 (February 2011)

Preparing Activity: NASA Superseding
UFGS-22 15 09 (August 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2011

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DIVISION 22 - PLUMBING

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GENERAL SERVICE COMPRESSED-AIR SYSTEMS CLEANING PROCEDURES

02/11

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references in the publish print process.

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

- ASTM B 479 (2006) Standard Specification for Annealed Aluminum and Aluminum-Alloy Foil for Flexible Barrier, Food Contact, and Other Applications
- ASTM D 4635 (2008a) Standard Specification for Polyethylene Films Made from Low-Density Polyethylene for General Use and Packaging Applications
- ASTM D 6368 (2006) Standard Specification for Vapor-Degreasing Grade, and General Grade Normal - Propyl Bromide
- ASTM E 1146 (2008) Standard Specification for Muriatic Acid (Technical Grade Hydrochloric Acid)
- ASTM F 312 (2008) Standard Test Methods for Microscopical Sizing and Counting Particles from Aerospace Fluids on Membrane Filters
- ASTM F 331 (2005) Standard Test Method for Nonvolatile Residue of Solvent Extract from Aerospace Components (Using Flash Evaporator)

COMPRESSED GAS ASSOCIATION (CGA)

- CGA G-10.1 (2008) Commodity Specification for Nitrogen; 7th Edition

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

- RCBEA GUIDE (2004) NASA Reliability Centered Building and Equipment Acceptance Guide

SEMICONDUCTOR EQUIPMENT AND MATERIALS INTERNATIONAL (SEMI)

- SEMI C28 (2006) Specifications for Hydrofluoric Acid
- SEMI C35 (2008) Specifications and Guidelines for Nitric Acid

1.2 SUBMITTALS

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project. Submittals should be kept

to the minimum required for adequate quality control.

A "G" following a submittal item indicates that the submittal requires Government approval. Some submittals are already marked with a "G". Only delete an existing "G" if the submittal item is not complex and can be reviewed through the Contractor's Quality Control system. Only add a "G" if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are [for Contractor Quality Control approval.] [for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Submit Pre-Qualification Statement.

SD-03 Product Data

Submit Manufacturer's Catalog Data for the following items:

Demineralized Water

Drying or Preservation Gas

Filter Discs

Nitric Acid

Citric Acid

Muriatic Acid

Hydrofluoric Acid

Normal - Propyl Bromide

Tape

Polyethylene Film

Low Water-Vapor Transmission Film

Aluminum Foil

SD-04 Samples

Submit the following samples:

Polyethylene Film

Certification Tags

Low Water-Vapor Transmission Film

SD-06 Test Reports

Submit Test Reports for [Quality Assurance Tests](#) in accordance with tests described in the paragraph entitled, "Quality Assurance," of this section.

Keep [Inspection Records](#) of examinations and tests current and available to the Contracting Officer.

SD-07 Certificates

Submit Quality Assurance Plan for the following in accordance with paragraph entitled, "Quality Assurance," of this section.

[Inspection Facilities and Services](#)

[Contractor's Procedures](#)

1.3 PRECONSTRUCTION QUALIFICATIONS

Prior to the commencement of any contract work, submit Contractor's [Pre-Qualification Statement](#) verifying previous work experience, references, and statement of selected laboratory and testing entities.

1.4 DEFINITIONS

1.4.1 Cleanliness Level Terms

"Particle" includes all foreign matter except fibers, whether metallic or non-metallic.

"Particle size" is the largest particle dimension, in microns.

"Fiber" includes all foreign matter having a length greater than 100 microns and a length to diameter ratio of at least 10 to 1.

"Significant surfaces" are component surfaces that may come in contact with the service medium.

1.4.2 Cleanliness Level Classifications

NOTE: Edit the following paragraphs, deleting
Classifications not required for the project.

1.4.2.1 Class I - Oxidizers and Oxidizer Pressurants

Significant surfaces of [Liquid and Gaseous Oxygen] [Nitrogen] [Helium]
[Chlorine Trifluoride (CTF)] [_____] Systems are subject to Class I
cleanliness requirements.

1.4.2.2 Class II - Fuels, Fuel Pressurants and Hydraulics

Significant surfaces of [Liquid and Gaseous Hydrogen] [Hydraulic] [High
Purity Air] [_____] Systems are subject to Class II cleanliness
requirements.

1.4.2.3 Class III - Air, Control and Instrument Pneumatics

Significant surfaces of [Air-pneumatic Control and Instrument Systems,
Downstream of Regulatory Panels to the Control Units] [_____] are subject
to Class III cleanliness requirements.

1.4.2.4 Class IV - Standard Industrial Cleaning

Significant surfaces of [Potable Water] [Industrial Water] [Vacuum] [_____] are subject to Class IV cleanliness requirements.

1.5 QUALITY ASSURANCE

[Inspection Facilities and Services](#) used by the Contractor for the performance of specified inspection requirements must be approved by the Contracting Officer. Keep [Inspection Records](#) of examinations and tests current and available to the Contracting Officer.

Submit [Six] [_____] copies of the [Contractor's Procedures](#) describing precleaning, cleaning, handling, preservation, and quality assurance processes for approval prior to usage.

1.5.1 Predictive Testing And Inspection Technology Requirements

NOTE: The Predictive Testing and Inspection (PT&I)
tests prescribed in Section 01 86 12.07 40
RELIABILITY CENTERED ACCEPTANCE FOR MECHANICAL
SYSTEMS are MANDATORY for all [NASA] [_____] assets
and systems identified as Critical, Configured, or
Mission Essential. If the system is non-critical,
non-configured, and not mission essential, use sound
engineering discretion to assess the value of adding
these additional test and acceptance requirements.
See Section 01 86 12.07 40 RELIABILITY CENTERED
ACCEPTANCE FOR MECHANICAL SYSTEMS for additional
information regarding cost feasibility of PT&I.

This section contains systems and/or equipment components regulated by

NASA's Reliability Centered Building and Equipment Acceptance Program. This program requires the use of Predictive Testing and Inspection (PT&I) technologies in conformance with **RCBEA GUIDE** to ensure building equipment and systems installed by the Contractor have been installed properly and contain no identifiable defects that shorten the design life of a system and/or its components. Satisfactory completion of all acceptance requirements is required to obtain Government approval and acceptance of the Contractor's work.

Perform PT&I tests and provide submittals as specified in Section **01 86 12.07 40 RELIABILITY CENTERED ACCEPTANCE FOR MECHANICAL SYSTEMS.**

1.5.2 Process Approval

Include in Contractor's Procedures:

- a. Trade names and manufacturer's names, specifications, chemical and physical properties.
- b. Estimated amounts of waste to be generated as a result of the cleaning process for each processing material used.
- c. Processing equipment, including manufacturer, type or model, and size.
- d. In-process control procedures to prevent contamination or latent corrosion, and installation procedures for cleaned components in cleaned systems.
- e. Methods and materials to be used for preservation of cleaned components prior to installation, and of cleaned systems after acceptance.

1.5.3 Cleaning Certification Tags

Apply Tags, as specified, to all cleaned systems, assemblies and components, to certify the cleanliness level of the tagged item.

PART 2 PRODUCTS

2.1 DEMINERALIZED WATER

Use Demineralized Water with a pH of 6.0 to 8.0, and a specific resistance greater than 50 ohms per cubic millimeter for rinsing or operations. Filter water to remove all particles larger than 175 microns in any dimension and yielding not more than 5 particles between 100-175 microns per 500 millimeter sampling.

2.2 DRYING OR PRESERVATION GAS

Filter air and nitrogen gas conforming to **CGA G-10.1**, Grade E, to a 100 microns level (absolute). Oil content must be no greater than 3 parts per million (ppm) by weight and moisture content not greater than 24 ppm by volume.

2.3 FILTER DISCS

Provide polytetrafluoroethylene (PTFE) fiberfilter discs 5 microns size.

2.4 NITRIC ACID

Conform technical grade Nitric acid to SEMI C35.

2.5 CITRIC ACID

Provide industrial grade Citric acid.

2.6 MURIATIC ACID (HYDROCHLORIC)

Conform Muriatic acid to ASTM E 1146.

2.7 HYDROFLUORIC ACID

Conform Hydrofluoric acid to SEMI C28.

2.8 NORMAL - PROPYL BROMIDE

NOTE: Do not use Normal - Propyl Bromide for vessel
cleaning where tank entry is required or with oxygen
related services.

Do not use Normal - Propyl Bromide with oxygen service.

Conform Solvent used for testing or for immersion cleaning to ASTM D 6368,
except that there must be no particle over 175 microns in any dimension and
no more than 5 particles from 100 to 175 microns in size.

Conform Solvent used for vapor degreasing cleaning processes of stainless
steel components to ASTM D 6368.

2.9 TAPE

Provide waterproof, pressure-sensitive tape, with plastic film backing
material, suitable for a temperature range of minus 54 to 71 degrees C
minus 65 to plus 160 degrees F.

2.10 POLYETHYLENE FILM

Conform Polyethylene film to ASTM D 4635, Type [1] [_____].

2.11 LOW WATER-VAPOR TRANSMISSION FILM

NOTE: This material must meet the requirements of
MIL B-22191C, Type 1. ACLAR 33C, as manufactured by
Allied Chemical Corp. to comply with this
requirement.

Provide a transparent, flexible, thermoplastic film material, made from
fluorinated-chlorinated resins, and having high resistance to chemicals and
liquid oxygen. Water vapor transmission rate must be not greater than 0.03
grams per 64516 square millimeter 0.03 grams per 100 square inches per 24
hours.

2.12 ALUMINUM FOIL

Conform aluminum foil to ASTM B 479.

2.13 CERTIFICATION TAGS

NOTE: Coordinate with schedule for tags at the end
of this Section.

Provide Certification tags made of 100 percent bleached chemical wood pulp, coated, with reinforced hole, and 300 millimeter 12-inch long tying [wire] [twine]. Color must be [white] [] [as specified].

PART 3 EXECUTION

3.1 TEST PROCEDURES

NOTE: If the specified system is identified as
critical, configured, or mission essential, use
Section 01 86 12.07 40 RELIABILITY CENTERED
ACCEPTANCE FOR MECHANICAL SYSTEMS to establish
predictive and acceptance testing criteria, above
and beyond that listed below.

Perform PT&I tests and provide submittals as specified in Section
01 86 12.07 40 RELIABILITY CENTERED ACCEPTANCE FOR MECHANICAL SYSTEMS.

3.1.1 Particle Size Determination

Determine the size distribution and quantity of solid particles retained on significant surfaces by removing and measuring particles on a minimum 5 percent representative sample of the total surface.

Solid particle contamination per 92903 square millimeter onr square foot of significant surface, when determined by the following procedure, must not exceed the specified amount:

- a. Flush the selected sample surface of measured or estimated area with approximately 500 milliliter 33 ounces of demineralized water per 92903 square millimeter one square foot.
- b. For individual small components having less than 92903 square millimeter one square foot of surface, a minimum of 500 milliliter of flushing fluid shall be used.
- c. For piping and large components having greater than 836127 square millimeter three square feet of surface area, three separate samples must be collected and analyzed.
- d. Sample piping and piping systems at three separate locations as directed by the Contracting Officer.
- e. During sampling, the flow velocity through the pipe must exceed 2.44 meter 8 feet per second, or as approved by the Contracting Officer.

- f. Catch the entire quantity of flushing fluid in precleaned container.
- g. Transfer an equal quantity of unused flushing fluid into a second precleaned container.
- h. Filter both samples of flushing fluid through filter disc, and examine the residue under a 10 to 45 power stereomicroscope. The difference in particle count in each size range constitutes the solid particle contamination of the entire surface represented. If the allowable limit is exceeded in any range, the entire surface must be recleaned and the test repeated.

After satisfactory completion of the particle size determination, dry all surfaces and protect against corrosion or recontamination in accordance with accepted procedures, and marked as specified in the appropriate section.

3.1.2 Moisture Determination

Visually examine small components and assemblies with all significant surfaces exposed for the presence of surface moisture. Determine moisture content of surfaces in tanks, piping sections and systems as follows:

- a. Set up a flow of purge gas through the tank or system to provide contact with all significant surfaces. Several checks may be run covering different portions of the system in order to assure the flow of purge gas over all significant surfaces.
- b. Purge gas must be dry, oil-free Nitrogen. While flowing, do not allow the velocity of purge gas at any point in the system being checked to exceed 0.30 meter 60 feet per minute.
- c. Maintain system under a static lockup for at least 8 hours prior to sampling.
- d. Measure the moisture content of the effluent gas using a dew point meter.
- e. Moisture vapor level above the specification in any tank, system, or sub-system is cause for rejection and correction. Achieve correction by continuing the flow of purge gas, or heating the gas and system if preferred, until a satisfactory moisture vapor level is measured.

3.1.3 Acidity or Alkalinity

Test the external and internal surfaces of cleaned and rinsed components with pH-indicating paper while the component is still wet from the last rinse or after wetting the test surface with a few drops of distilled water. Surface acidity or alkalinity must register a pH between 6.0 and 8.0.

3.2 QUALITY ASSURANCE TESTS

3.2.1 Tests for Class I Cleanliness Requirements

3.2.1.1 Solid Particle Contamination

Conform Microscopical Particle Population analysis to ASTM F 312. Comply with the following criteria:

- a. No particles greater than 500 microns in any dimension.
- b. Not more than five particles between 150 and 500 microns.
- c. Not more than one-hundred particles between 5 and 150 microns.
- d. Fewer than ten fibers per 92903 square millimeter onr square foot of significant surface.
- e. Maximum fiber length shall not exceed [500] [_____] microns.

Particle Population Analysis (Automatic Particle Counters) may be used for final verification of cleanliness of the end product, provided the individual counters have demonstrated accuracy and repeatability, which correlates with accepted analytical methods, and their use is approved by the Contracting Officer.

3.2.1.2 Moisture Content

If the influent air at the point of delivery has a dew point of minus 62 degrees C 80 degrees F or colder, the effluent dew point must be minus 51 degrees C 60 degrees F or colder, as measured in effluent purge gas.

If the dew point of the furnished gas is warmer than minus 62 degrees C 80 degrees F, the dew point of the effluent must be within minus 7 degrees C 20 degrees F of the influent.

3.2.1.3 Acidity or Alkalinity

As specified.

3.2.1.4 Non-Volatile Residue Contamination

Prepare and perform Non-Volatile Residue Contamination (NVRC) Solvent Flush testing as a final flush and cleanliness verification test. Conform test procedures to the following accepted method:

- a. Gravimetric NVR Analysis Method - evaporate the filtered solvent sample to determine the NVR content in accordance with ASTM F 331.
- b. Solvent Purity Meter - Use solvent purity meter Model SP-1000, as manufactured by the Virtis Co., Gardiner, New York, which correlates with accepted analytical methods for demonstrated accuracy and repeatability, and is approved by the Contracting Officer.
- c. Infrared Spectrophotometric NVR Analysis Method - Infrared (IR) spectrophotometric NVR analysis of solvent samples may be used if the following apply:
 - (1) The method quantifies hydrocarbons and other contaminants which are reactive with liquid oxygen.
 - (2) The analysis method has demonstrated accuracy and repeatability and the method is approved by the Contracting Officer.

Non-Volatile Residue Contamination (NVRC) must not exceed 0.001 grams per 92903 square millimeter 0.001 grams per square foot of surface area.

3.2.2 Tests for Class II Cleanliness Requirements

3.2.2.1 Solid Particle Contamination

Comply with the following criteria:

- a. No particles greater than 500 microns in any dimension.
- b. Not more than five particles between 150 and 500 microns.
- c. Not more than one-hundred particles between 5 and 150 microns.
- d. Fewer than ten fibers per 92903 square millimeter one square foot of significant surface.
- e. Maximum fiber length must not exceed [500] [_____] microns.

3.2.2.2 Moisture Content

If the influent air at the point of delivery has a dew point of minus 54 degrees C 65 degrees F or colder, the effluent dew point must be minus 43 degrees C 45 degrees F or colder, as measured in effluent purge gas.

If the dew point of the furnished gas is warmer than minus 54 degrees C 65 degrees F, the dew point of the effluent gas must be within minus 7 degrees C 20 degrees F of the influent.

3.2.2.3 Acidity or Alkalinity

As specified.

3.2.3 Tests for Class III Cleanliness Requirements

3.2.3.1 Solid Particle Contamination

Comply with the following criteria:

- a. No particles greater than 1500 microns in any dimension.
- b. Not more than fifty particles between 150 and 1500 microns.
- c. Not more than five-hundred particles between 5 and 150 microns.
- d. Fewer than fifty fibers per 92903 square millimeter one square foot of significant surface.
- e. Maximum fiber length shall not exceed [_____] microns.

3.2.3.2 Moisture Content

Total quantity of moisture solvents, and products, including both absorbed surface film and vapor present in the entire system subject to Class III cleanliness requirements, must not exceed 150 ppm by volume as measured in effluent purge gas.

3.3 INSPECTION PROCEDURES

The Government reserves the right to perform any inspections set forth in the specification where such inspections are deemed necessary to ensure

that the work conforms to the prescribed requirements.

3.3.1 Visual Examination

Visually inspect significant surfaces of cleaned components for the presence of moisture and foreign material such as corrosion, scale, dirt, hydrocarbons, crayon, and similar foreign materials. Use a flashlight or borescope to examine internal surfaces. The presence of visible contamination will result in rejection and necessitate recleaning of the item. Scale-free discoloration due to welding and passivation is permitted.

3.3.2 Ultra-violet Light Examination

Examine significant surfaces of cleaned components using an ultra-violet light having a power of at least 100 watts and producing a wave length of approximately 366 nanometer 3660 angstrom units. Presence of fluorescent particles on areas of any surface, metallic or non-metallic, will result in rejection and necessitate recleaning of the item. Any component or material, either metallic or non-metallic, from which fluorescence cannot be eliminated will be rejected and replaced at no further cost to the Government.

3.4 QUALITY ASSURANCE INSPECTIONS

Except as specified herein, the following inspections shall be performed on all components, assemblies, and systems.

3.4.1 Inspections for Class I Cleanliness Requirements

- a. Visual Examination: As specified, under a strong white light.
- b. Ultra-violet Light Examination: As specified.

3.4.2 Inspections for Class II Cleanliness Requirements

- a. Visual Examination: As specified, under a strong white light.
- b. Ultra-violet Light Examination: As specified.

3.4.3 Inspections for Class III Cleanliness Requirements

- a. Visual Examination: As specified, under a strong white light.
- b. Ultra-violet Light Examination: As specified.

3.4.4 Inspections for Class IV Cleanliness Requirements

Visual Examination: As specified, under normal shop lighting conditions.

3.5 WASTE DISPOSAL

NOTE: Furnish specific waste collection criteria,
defining waste management guidelines that must be
followed, to the Contractor no later than the
pre-construction conference.

Determination as to whether waste fluids or materials generated during

cleaning operations are hazardous, controlled, non-hazardous, or non-controlled will be made by the [_____].

Contractor is responsible for coordinating waste generation activities with the [Hazardous Waste Section] [_____]. As a minimum, the Contractor is required to furnish suitable containers and/or tankage to collect, transport, and offload the collected waste in designated [tankage] [_____]. Contractor is responsible for maintaining sufficient storage for a minimum of five (7) calendar days after the storage is filled to capacity.

- [The Government will dispose of hazardous waste and controlled waste.
-] Contractor must dispose of non-hazardous wastes and non-controlled wastes at no additional cost to the Government. Dispose of non-hazardous or non-controlled waste [offsite as approved by the Government] [_____]. [Disposal of these fluids or materials will not be permitted at [_____].

] 3.6 CLEANING

Notify the Contracting Officer at least 48 hours prior to the time Government-furnished air, gaseous nitrogen, and demineralized water is required for cleaning purposes.

Remove all gross contamination by mechanical processes, flushing, or high velocity blowdown prior to final cleaning. Accomplish Mechanical and electrical testing after precleaning and before final cleaning. Preclean all lengths of pipe, fittings, and piping system components prior to welding and assembly.

Treat corrosion resistant steel assemblies using pickling and passivating processes to prevent latent corrosion or contamination.

Disassemble and clean assemblies (or clean prior to original assembly) not suitable for cleaning as assembled. This applies to assemblies composed of materials requiring different cleaning procedures, or assemblies from which cleaning solutions cannot be adequately drained.

Loosen flanged joints as required during the cleaning procedure to assure complete drainage of cleaning and rinsing solutions.

3.7 PROTECTION

For [Class I,] [and] [Class II,] [and] [Class III] cleaning levels, place protected components that are not installed in a clean polyethylene bag. Purge bag with dry, oil-free gas and heat-seal the ends of the bag to ensure an inert package during storage. Place bagged component in a second heat-sealed and purged polyethylene bag with a cleaning certification tag placed in the second bag. Give equivalent protection to components which cannot be placed in a polyethylene bag and tag near each sealed opening used in the cleaning procedure.

3.7.1 Protection for Class I Cleanliness Requirements

Immediately after precleaning, cleaning and drying, protect significant surfaces subject to Class I cleanliness requirements from recontamination by covering the surfaces or openings with a minimum of two layers of Low Water-Vapor Transmission Film. Secure film and reinforce with pressure-sensitive tape.

3.7.2 Protection for Class II Cleanliness Requirements

Immediately after cleaning and drying, protect significant surfaces subject to Class II cleanliness requirements from recontamination by covering the surfaces or openings with [aluminum foil] [or] [a minimum of two layers of polyethylene film] [or] [precleaned dry covers], secured and reinforced with pressure-sensitive tape.

3.7.3 Protection for Class III Cleanliness Requirements

Immediately after cleaning and drying, protect significant surfaces subject to Class III cleanliness requirements from recontamination by covering the surfaces or openings with [aluminum foil] [or] [a minimum of two layers of polyethylene film] [or] [precleaned dry covers], secured and reinforced with pressure-sensitive tape.

3.7.4 Protection for Class IV Cleanliness Requirements

Drain liquids from all parts of the system and seal openings with [aluminum foil] [or] [polyethylene bags] [or] [approved devices].

3.8 CERTIFICATION TAG SCHEDULE

NOTE: Edit list as necessary for tags required for
the project.

CERTIFICATION TAGS

Tag Type	Thickness (millimeter)	Note "A" (kilograms)	Note "B" (grams)	[Tie Wire] [millimeter]
20	0.51 to 0.56	91 to 109	1,130	[0.64]
15	0.38 to 0.43	68 to 86	850	[0.64]
13	0.33 to 0.38	59 to 77	610	[0.46]

CERTIFICATION TAGS

Tag Type	Thickness (inches)	Note "A" (pounds)	Note "B" (grams)	[Tie Wire] [inches]
20	0.020 to 0.022	200 to 240	1,130	[0.025]
15	0.015 to 0.017	150 to 190	850	[0.025]
13	0.013 to 0.015	130 to 170	610	[0.018]

Note "A": Basis weight, 500 sheets, 22-1/2 by 28-1/2 inches 572 by 724 millimeter.

Note "B": Tearing Resistance. Total of both directions, (minimum).

Provide pre-printed spaces for the following information, as applicable. Size tags such that the information is legible when entered by indelible marking pen:

Part or identification number

Manufacturer's serial number

Contractor identification

Cleaning classification and specification identification

Date of cleaning

Service medium or intended use

Pressurizing medium and initial pressure

Title, date, and number of this specification

-- End of Section --