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UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated October 2014

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DIVISION 22 - PLUMBING

SECTION 22 15 09.00 40

GENERAL SERVICE COMPRESSED-AIR SYSTEMS CLEANING PROCEDURES

02/14

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GENERAL SERVICE COMPRESSED-AIR SYSTEMS CLEANING PROCEDURES 02/14

NOTE: This guide specification covers the requirements of four classes of cleanliness for process piping systems, components and tanks.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable items(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

PART 1 GENERAL

1.1 REFERENCES

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically
be deleted from this section of the project
specification when you choose to reconcile
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 B479	(2006) Standard Specification for Annealed Aluminum and Aluminum-Alloy Foil for Flexible Barrier, Food Contact, and Other Applications
ASTM D4635	(2008a) Standard Specification for Polyethylene Films Made from Low-Density Polyethylene for General Use and Packaging Applications
ASTM D6368	(2006; R 2012) Standard Specification for Vapor-Degreasing Grade, and General Grade Normal - Propyl Bromide
ASTM E1146	(2008) Standard Specification for Muriatic Acid (Technical Grade Hydrochloric Acid)
ASTM F312	(2008) Standard Test Methods for Microscopical Sizing and Counting Particles from Aerospace Fluids on Membrane Filters
ASTM F331	(2013) 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
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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

RCBEA GUIDE	(2004) NASA Reliability Centered Building and Equipment Acceptance Guide
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SEMICONDUCTOR EQUIPMENT AND MATERIALS INTERNATIONAL (SEMI)

SEMI C28	(2011) 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.

The Guide Specification technical editors have designated those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, 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.

An "S" following a submittal item indicates that the submittal is required for the Sustainability Notebook to fulfill federally mandated sustainable requirements in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS.

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.] Submittals with an "S" are for inclusion in the Sustainability Notebook, in conformance to Section 01 33 29 SUSTAINABILITY REQUIREMENTS. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Pre-Qualification Statement[; G][; G, [_____]]

SD-03 Product Data

Demineralized Water[; G][; G, [_____]]

Drying or Preservation Gas[; G][; G, [_____]]

Filter Discs[; G][; G, [_____]]

Nitric Acid[; G][; G, [_____]]

Citric Acid[; G][; G, [_____]]

Muriatic Acid[; G][; G, [_____]]

Hydrofluoric Acid[; G][; G, [_____]]

Normal - Propyl Bromide[; G][; G, [_____]]

Tape[; G][; G, [_____]]

Polyethylene Film[; G][; G, [_____]]

Low Water-Vapor Transmission Film[; G][; G, [_____]]

Aluminum Foil[; G][; G, [_____]]

SD-04 Samples

Polyethylene Film[; G][; G, [_____]]

Certification Tags[; G][; G, [_____]]

Low Water-Vapor Transmission Film[; G][; G, [_____]]

SD-06 Test Reports

Quality Assurance Tests[; G][; G, [_____]]

Inspection Records[; G][; G, [_____]]

SD-07 Certificates

Inspection Facilities and Services[; G][; G, [_____]]

Contractor's Procedures[; G][; G, [_____]]

1.3 PRECONSTRUCTION QUALIFICATIONS

Prior to the commencement of any contract work, submit a Pre-Qualification Statement verifying previous work experience, references, and a 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

The list of Inspection Facilities and Services used for specified inspection requirements is approved by 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 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.

1.5.2 Cleaning Certification Tags

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

1.5.3 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 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.

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). Ensure oil content is 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 E1146.

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.

Ensure solvent used for testing or for immersion cleaning conforms to ASTM D6368, except that there cannot be any particle over 175 microns in any dimension and no more than 5 particles from 100 to 175 microns in size.

Ensure solvent used for vapor degreasing cleaning processes of stainless steel components conforms to ASTM D6368.

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

Ensure Polyethylene film conforms to ASTM D4635, Type [1] [_____].

2.11 LOW WATER-VAPOR TRANSMISSION FILM

**NOTE: Ensure material meets 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 cannot be greater than 0.03 grams per 64516 square millimeter 0.03 grams per 100 square inches per 24 hours.

2.12 ALUMINUM FOIL

Ensure aluminum foil conforms to ASTM B479.

2.13 CERTIFICATION TAGS

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 is [white] [_____] [as specified].

2.13.1 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

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 one square foot of significant surface, when determined by the following procedure, cannot 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, use a minimum of 500 milliliter of flushing fluid.
- c. For piping and large components having greater than 836127 square millimeter three square feet of surface area, collect and analyze three separate samples.
- d. Sample piping and piping systems at three separate locations as directed by the Contracting Officer.
- e. During sampling, ensure the flow velocity through the pipe exceeds 2.44 meter 8 feet per second, or as approved by the Contracting Officer.
- f. Catch the entire quantity of flushing fluid in a 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, reclean the entire surface 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. Use a dry, oil-free Nitrogen purge gas. 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. Continue drying process 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. Register a pH between 6.0 and 8.0 acidity or alkalinity along the surface.

3.2 QUALITY ASSURANCE TESTS

Keep Inspection Records of examinations and tests current and available to the Contracting Officer.

3.2.1 Tests Requirements for Class I Cleanliness

3.2.1.1 Solid Particle Contamination

Conduct a Microscopical Particle Population analysis conforming to ASTM F312. 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 cannot 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, ensure the effluent dew point is 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, ensure the dew point of the effluent is 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 F331.
- 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) cannot exceed 0.001 grams per 92903 square millimeter 0.001 grams per square foot of surface area.

3.2.2 Tests Requirements for Class II Cleanliness

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 cannot 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 are minus 43 degrees C 45 degrees F or colder, as measured in the effluent purge gas.

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

3.2.2.3 Acidity or Alkalinity

As specified.

3.2.3 Tests Requirements for Class III Cleanliness

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 cannot 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, cannot exceed 150 ppm by volume as measured in the 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 by the Contracting Officer 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 by the Contracting Officer 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, perform the following inspections 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 for the Contractor to follow, 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 is made by the [____].

Coordinate waste generation activities with the [Hazardous Waste Section] [____]. As a minimum, furnish suitable containers and/or tankage to collect, transport, and offload the collected waste in designated [tankage] [____]. Maintain sufficient storage for a minimum of [7] [30] [____] calendar days after the storage is filled to capacity.

[The Government will dispose of hazardous waste and controlled waste.

] Dispose 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 is not 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

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

-- End of Section --