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National Aeronautics and
Space Administration

George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama 35812

PROCEDURE

GASES, DRYING AND PRESERVATION

CLEANLINESS LEVEL AND INSPECTION METHODS

GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MARSHALL SPACE FLIGHT CENTER, ALABAMA 35812

Custodian:

NASA - George C. Marshall Space
Flight Center

Preparing activity:

George C. Marshall Space
Flight Center

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PROCEDURE, GASES, DRYING AND PRESERVATION CLEANLINESS LEVEL
AND INSPECTION METHODS

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GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

PROCEDURE

GASES, DRYING AND PRESERVATION,

CLEANLINESS LEVEL AND INSPECTION METHODS

This procedure has been approved by the George C. Marshall Space Flight Center (MSFC) and is mandatory for use by MSFC and associated contractors.

1. PURPOSE

1.1 The purpose of this procedure is to establish requirements of cleanliness, and methods of testing to assure that gases used in cleaning, testing, drying, and preservation of space vehicle systems, subsystems, assemblies, components, and support equipment meet these levels at gas utilization points.

2. SCOPE

2.1 This procedure specifies the cleanliness requirements at gas utilization points for gases used in cleaning, testing, drying, and preservation operations of space vehicle systems, subsystems, assemblies, components, and support equipment. Gases having super-critical cleanliness requirements (such as for gas bearings) are specifically exempt. Included are the procedures, materials, and equipment required to verify that gas distribution system cleanliness is adequate to assure the specified cleanliness level of gases at the gas utilization points.

2.2 The analysis performed in this procedure will be conducted at the sampling site. Only the particle count will be carried to a laboratory flow bench for counting. The intent of the routine analysis is on location analysis and reporting. If unusual circumstance arise that will not permit a portable equipment analysis then a grab sample can be taken of the gas and analysis performed back in the laboratory for the total hydrocarbons only.

3. REFERENCES

3.1 The following documents form a part of this procedure to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposals shall apply.

SPECIFICATIONS

Federal

O-E-760 Ethyl Alcohol (Ethanol); Denatured Alcohol, and Proprietary Solvent

Military

MIL-D-16791 Non-Ionic Detergent

George C. Marshall Space Flight Center

MSFC-SPEC-106 Testing Compatibility of Materials for Liquid Oxygen Systems, Specification for

MSFC-SPEC-164 Cleanliness of Components for Use in Oxygen, Fuel, and Pneumatic Systems, Specification for

MSFC-SPEC-237 Solvent, Precision Cleaning Agent

10419906 Cleanliness Levels, Cleaning and Inspection Procedures for Component Parts of Gas Bearing and Slosh Measuring Systems, Specification for

STANDARDS

George C. Marshall Space Flight Center

MSFC-STD-246 Design and Operational Criteria of Controlled Environment Areas, Standards

DRAWINGS

George C. Marshall Space Flight Center

85M01829 Microscope Filter Disc Holder

PUBLICATIONS

National Aeronautics and Space Administration

NPC 200-2 Quality Program Provisions for Space Systems Contractors

NPC 200-3 Inspection System Provisions for Suppliers of Space Materials, Parts, Components, and Services

(Copies of specifications, standards, drawings, and publications required by contractors in connection with the application of this procedure should be obtained from the procuring activity or as directed by the contracting officer.)

4. DEFINITIONS AND ABBREVIATIONS

4.1 *Definitions.* -- For the purpose of this procedure the following definitions shall apply:

- (a) Dew point. -- Dew point is defined as the temperature at which the gas becomes saturated with water vapor.
- (b) Gas supply system qualification. -- Gas supply system qualification is defined as a series of tests which are performed to demonstrate that the distribution system is capable of meeting the established requirements, and to assure delivery of gases within specified cleanliness limits to the gas utilization points.
- (c) Gas supply system inspection. -- Gas supply system inspection is defined as the periodic testing to determine that excessive contamination has not been introduced into a previously qualified gas supply system.
- (d) Significant surfaces. -- Significant surfaces are defined as those surfaces of components, assemblies, subsystems, systems, and ground support equipment that come in contact with the service media (gases) during use.
- (e) Cubic meter of gas. -- A cubic meter of gas is defined as a cubic meter of gas at one atmosphere pressure (760 mm mercury) and 21.11 degrees C (70 degrees F).

4.2 *Abbreviations.* -- For the purpose of this procedure the following abbreviations shall apply.

(a) Celsius	C
(b) Fahrenheit	F
(c) Liquid oxygen	LOX
(d) Millimeter(s)	mm
(e) Parts per million	ppm
(f) Pounds per square inch	Psi
(g) Pounds per square inch gauge	Psig
(h) Standard cubic foot	scf
(i) Standard cubic feet per minute	scfm

5. RESPONSIBILITIES

5.1 *MSFC Activities.* -- The implementation of this procedure shall be the responsibility of all activities of MSFC and associated contractors having the responsibility for the engineering design, manufacturing, or quality assurance provisions related to the development of space vehicles and associated equipment.

5.2 *Quality and Reliability Assurance Laboratory.* -- The Quality and Reliability Assurance Laboratory of MSFC or their designated representative shall be responsible for approving the test setup and test procedures utilized by the performing activity, and shall be responsible for monitoring the applicable tests specified herein, both at MSFC and at the associated contractors' facilities.

5.3 *Quality control system.* -- The quality control system shall be in accordance with the National Aeronautics and Space Administration Quality Publications NPC 200-2 or NPC 200-3, as applicable.

6. PROCEDURES

6.1 Gas cleanliness requirements.

6.1.1 *Gas cleanliness requirements.* -- Cleanliness requirements for gases at the gas utilization points shall be specified below:

6.1.1.1 *Particulate matter.* -- The particulate matter, size, and population shall be within the limits specified in Table I.

Table I. Permissible particulate population.

Size of particles in microns (greatest dimension)	Maximum number ¹
30 to 100	25 per gas sample
Larger than 100	0 per gas sample

¹ Sample size shall be in accordance with 6.3.

6.1.1.2 *Moisture content.* -- The moisture content shall be not greater than 24 ppm by volume (equivalent to a dew point of minus 53.89 degrees C (minus 65 degrees F)) at standard pressure.

6.1.1.3 *Total hydrocarbon content.* -- The total hydrocarbon content (expressed as methane) shall be not greater than 5 ppm by volume.

6.1.2 *Cleaning liquids.* -- Solvent, alcohol, and deionized water used in this procedure shall be prefiltered to remove all particles greater than 30 micro meters in any dimension.

6.1.3 *Test areas.* -- Areas where particulate samples are to be evaluated shall conform to requirements of controlled environment areas as specified in Standard MSFC-STD-246.

6.1.4 *Equipment.* -- Hand tools, materials, and equipment used in performing the tests specified herein, that come in contact with significant surfaces or the service media, shall be cleaned utilizing applicable procedures to the levels specified in Specification 10419906.

6.1.5 *Personnel instruction.* -- Personnel involved in evaluating the particulate tests specified herein shall be required if applicable, to wear the attire specified in Standard MSFC-STD-246 for a environmental controlled work area and shall be instructed to exercise precautionary measures necessary to reduce introduction of contaminants.

6.2 *Inspection records.* -- Inspection records shall be maintained in the form of tags or log sheets for each sample point.

6.3 *Sampling.* -- Unless otherwise specified, gas sample volume shall be a minimum of 30 scf. Samples shall be taken downstream of all filters, regulators, valves, and any other equipment normally installed in the line, the sample will be taken at the use point.

6.4 Gas supply system quality assurance requirements.

6.4.1 *Gas supply system qualification.* -- Newly installed gas supply systems, systems which have been disassembled and recleaned, and parts of disassembled and recleaned systems shall be qualified in accordance with Table II. If during the qualification period any of the cleanliness requirements are found out of tolerance, the qualification schedule shall be started over for that specific test item. Gas utilization points on a system in the process of being qualified may be used, provided that each of the test items of Table II have been verified for compliance with cleanliness requirements specified in 6.1.1.

Table II. Gas supply system qualification test schedule

Test Item	Test Frequency	Test Period	Specified Limits	Test Procedure
Particulate matter	daily	5 days	Table I	6.6.1
Moisture content	daily	5 days	6.1.1.2	6.6.2
Total Hydrocarbon Content	weekly	4 weeks	6.1.1.3	6.6.3

6.4.2 *Intermittent usage points.* -- Gas utilization used intermittently with non-use periods exceeding 48 hours duration shall be tested prior to use for compliance with the cleanliness requirements specified in 6.1.1.

6.4.3 *Daily usage points.* -- Gas utilization points that are in daily or continual use shall be tested periodically in accordance with Table III. Tests for moisture, hydrocarbon contents and particulate matter shall be performed at all gas utilization points in the gas supply system though not necessarily at the same time.

Table III. Gas supply system qualification test schedule

Test Item	Test Frequency	Specified Limits	Test Procedure
Particulate matter	weekly	Table I	6.6.1
Moisture content	weekly	6.1.1.2	6.6.2
Total Hydrocarbon Content	weekly	6.1.1.3	6.6.3

6.4.4 *Cylinder supplied gases.* -- Gas utilization points in a system where gas is supplied by cylinders that are in daily or continual use shall be inspected periodically in accordance with 6.4.3. In addition to the periodical inspection of 6.4.3, inspection shall be performed each time the cylinders are replaced.

6.4.5 *Opened systems.* -- When a gas supply system is broken into or when contamination is suspected for any reason, tests shall be performed out of normal test schedule to verify the cleanliness requirements of the gas. If these tests, or normally scheduled inspections, indicated cleanliness requirements out of the limits specified in 6.1.1, necessary corrective action shall be taken to clean or purge the system. The system shall then be requalified as specified in 6.4.1.

6.5 *Test equipment.* -- The test equipment required to perform the tests specified herein shall be approved by the procuring activity and shall conform to the minimum requirements specified in the following sub-paragraphs.

6.5.1 *Particulate tests.* -- Test equipment items required for particle size and quantity determinations are as follows:

- (a) High pressure filter holder (compatible with item (b)).
- (b) Filter disc, 47 mm diameter, 0.45 micron colored membrane, imprinted grid on 3.08 mm centers.
- (c) Flow meter capable of measuring 15 (plus or minus 1) cfm of gas.
- (d) Microscope with an eye piece micrometer and capable of magnifications of 45X minimum. A binocular microscope with mechanical stage is the optimum magnification equipment.
- (e) Microscope filter disc holder conforming to MSFC Drawing 85M01829.

- (f) Stage micrometer with 0.1 mm to 0.01 mm calibrations.
- (g) High intensity microscope lamp with focusing illuminating lens capable of varying the intensity of the light at the filter surface from 500 to 600 illuminance (lux). The lamp is to be used as a source of oblique incident light.
- (h) Forceps with unserrated tips.
- (i) Plastic film, (polyvinyl chloride).
- (j) Solvent, precision cleaning agent conforming to Specification MSFC-SPEC-237.
- (k) Alcohol conforming to Specification O-E-760.
- (l) Non-ionic detergent conforming to Specification MIL-D-16791.

6.5.2 *Moisture tests.* -- The following approved test equipment or equivalent items are required for moisture content determinations:

- (a) *Moisture monitor.* -- Consolidated Electrodynamics Corporation Model 26-350-600, 200 North Sierra Madre Villa, Pasadena California.
- (b) *Electrolytic hygrometer.* -- Beckman Instruments, Inc., 2500 Fullerton Road, Fullerton, California.
- (c) *Aluminum Oxide Hygrometer.* -- Si-Grometers Stephens Equipment Inc., 2750 Brabant-Marineau, Montreal, Que. Canada.

6.5.3 *Total hydrocarbon test equipment.* -- The following approved test equipment or equivalent items are required for total hydrocarbon content determinations:

- (a) Total hydrocarbon analyzers
 - (1) Foxboro Miran 101 Infrared Spectrometer, Foxboro Analytical P.O. Box 5449 South Norwalk, Ct. 06856 Total hydrocarbon detector
 - (2) Sentex Sensing Technology, portable gas chromatograph, 553 Broad Avenue, Ridgefield, New Jersey 07657
 - (3) Perkin Elmer Gas Chromatograph with Flame Ionization detector, Perkin Elmer Corp. Analytical Instruments Div., 761 Main Ave. Norwalk, Ct. 06859
- (b) Standard calibration gas

(c) Compressed air cylinder

(d) Gas samplers

6.6 *Test procedures.* -- The detailed test procedures required to perform tests specified herein shall be approved by the procuring activity. The following procedures have been approved for use:

6.6.1 *Particulate matter determination.* -- The procedure for determining particulate matter shall be as follows:

6.6.1.1 *Preparation of equipment.* -- Test equipment shall be prepared as follows:

(a) Disassemble the high pressure filter holder and clean the filter holder as specified in 6.1.4. Be especially careful to clean the inlet plate and port.

NOTE

If the filter holder is visibly contaminated, wash first with liquid detergent and deionized water followed by alcohol or freon solvent.

(b) Cover the inlet port of the filter holder with several thicknesses of plastic film that have been rinsed with solvent. Secure plastic film with a rubber band or equal.

(c) Using forceps remove a filter disc from the container. Carefully rinse the grid-marked surface of the filter disc with solvent.

(d) With the back-up screen in place, position the filter disc in the outlet plate of the filter holder (grid side up) and reassemble the filter holder.

(e) Thoroughly clean fittings to be used in the setup of test apparatus as specified in 6.1.4; wrap rinsed fittings in plastic film.

6.6.1.2 *Sampling.* -- Gas shall be sampled at the gas utilization point as follows:

(a) Purge the sampling port at the rate of 10.0 (plus or minus 1) scfm for a minimum of 2 minutes prior to sampling. Systems not having 10.0 scfm flow capability shall be purged at the maximum flow rate.

(b) Reduce the flow rate to approximately 0.5 scfm and carefully rinse the sample port with filtered solvent from a wash bottle.

- (c) Remove the plastic film covering from the filter holder inlet port. Fold the film to protect the inside surfaces from contamination, save plastic film for reuse after sampling.
- (d) Use the necessary fittings and attach the inlet port of the high pressure filter holder to the sample port. Attach a flow meter capable of measuring 15.0 scfm downstream of the filterholder. (See figure 1 for suggested testsetup.)

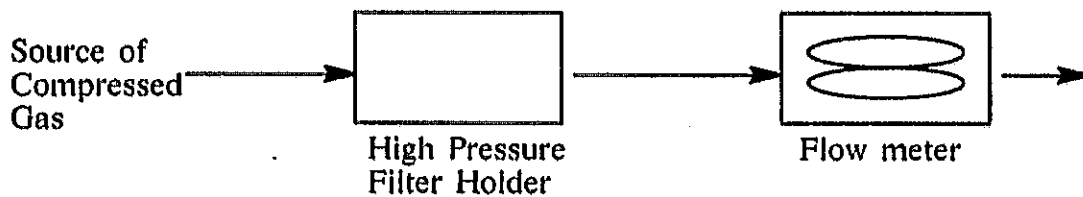


Figure 1. Suggested Test Setup

- (e) Increase the flow rate to 10.0 (plus or minus 1) scfm or maximum flow rate for systems not capable of 0.5 scfm. Allow flow to continue until a minimum of 30.0 scfm of gas passes through the test apparatus.
- (f) Reduce the flow rate to approximately 0.5 scfm and disconnect the test apparatus.
- (g) Replace the plastic film cover on the filter holder inlet port.

NOTE

Although particles should be embedded in the filter disc surface, handle the filter holder so as not to jar particles from the filter. Hold the filter holder with the inlet port up.

- (h) Reduce gas system flow to zero.

6.6.1.3 *Analysis.* -- Particulate matter, size and population shall be analyzed as follows:

- (a) Transport the filter holder to a clean room area conforming to the requirements as specified in 6.1.3.
- (b) Hold the filter holder in an upright position, inlet port up, carefully disassemble the filter holder and carefully remove the filter disc from the outlet plate using forceps with unserrated tips and position it in the microscope filter disc holder.

- (c) Use a microscope, (6.5.1.d) and an illuminating lamp (6.5.1.g) to examine the entire filter disc to determine particle population as specified in 6.1.1.1.
- (d) If contamination level is found to be in excess of that allowed in Table I, repeat procedure 6.6.1.2 and steps (a) through (c) of above analysis procedure.
- (e) If additional purges fail to render acceptable test results, reject the system or its portion under test and reclean in accordance with Specification MSFC-SPEC-164 or other approved cleaning method.

6.6.2 Moisture content determination. -- Moisture content shall be determined at the point of use by using an approved electrolytic hygrometer or dew point tester to determine conformance to 6.1.1.2. Recommended vendor's test procedure shall be used.

6.6.3 Total hydrocarbon content determination. -- The total hydrocarbon content shall be determined at the point of use by an approved hydrocarbon detector to determine conformance to 6.1.1.3.

7.0 REPORTS

7.1 Tests. -- Test results shall be recorded on data or log sheet and test reports shall be made available upon request.

8.0 MODIFICATIONS OR CHANGES

8.1 Any substitutions, deviations, or modifications to this procedure shall be made only with approval of the cognizant activity. Recommendations for modification or changes shall be submitted in writing to the Chief, Analytical and Physical Chemistry Branch, EH-32 of the Materials and Processes Laboratory, MSFC.

Notice. -- When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

Custodian:

NASA - George C. Marshall Space
Flight Center

Preparing activity:

George C. Marshall Space
Flight Center

PACKAGE NO. 10443R

DOCUMENTATION RELEASE LIST
GEORGE C. MARSHALL SPACE FLIGHT CENTER

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PAGE 1

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C H	DOCUMENT NUMBER	DRL DRL DSH REV	TITLE	CCBD NO.	PCN	PC	EFFECTIVITY
*	MSFC-PROC-404	202 -	GASES, DRYING PRESERVATION LEVEL INSPECTION	000-00-0000	0000000	ZA	NONE

CHG NO.	CHG REV	CHG NOTICE	RESPONSIBLE ENGINEER	RESPONSIBLE ORGANIZATION	ACTION DATE	DESCRIPTION	
	A	DCN000	B. H. NERREN	EH32	02/23/94	REVISION 'A' RELEASED 01/31/90.	
*	1	A	DCN000	EUGENA GOGGANS	EO03	02/22/07	DOCUMENT RELEASED THRU PDS. NO LONGER TRACKED IN ICMS.

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			MSFC-HDBK-1453		202	-			
			MSFC-HDBK-1674		202	-			
			MSFC-HDBK-2221		203	-			
			MSFC-HDBK-505		202	-			
			MSFC-HDBK-670		202	-			
			MSFC-MNL-1951		209	-			
			MSFC-PROC-1301		202	-			
			MSFC-PROC-1721		202	-			
			MSFC-PROC-1831		202	-			
			MSFC-PROC-1832		202	-			
			MSFC-PROC-404		202	-			
			MSFC-PROC-547		202	-			
			MSFC-QPL-1918		204	-			
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			MSFC-SPEC-1198		202	-			
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			MSFC-SPEC-1443		202	-			
			MSFC-SPEC-164		202	-			
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			MSFC-SPEC-1918		203	-			
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			MSFC-SPEC-2223		202	-			
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			MSFC-SPEC-2497		211	-			
			MSFC-SPEC-250		202	-			
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			MSFC-SPEC-708		202	-			
			MSFC-SPEC-766		202	-			
			MSFC-STD-1249		202	-			
			MSFC-STD-1800		202	-			
			MSFC-STD-246		202	-			
			MSFC-STD-2594		203	-			

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DWG SIZE	DRAWING NUMBER	DWG REV	EPL/DRL/DDS NUMBER	DWG REV	EPL DSH	EPL REV	EO DASH NUMBER	EO REV	PART NUMBER
			MSFC-STD-2903		202	-			
			MSFC-STD-2904		202	-			
			MSFC-STD-2905		202	-			
			MSFC-STD-2906		202	-			
			MSFC-STD-2907		202	-			
			MSFC-STD-366		202	-			
			MSFC-STD-383		202	-			
			MSFC-STD-486		202	-			
			MSFC-STD-506		203	-			
			MSFC-STD-531		202	-			
			MSFC-STD-557		202	-			
			MSFC-STD-561		203	-			
			MSFC-STD-781		202	-			

SUBMITTED BY ENGINEERING AREA:	BASIC	CHANGE	PARTIAL	COMPLETE	CLOSES	ACTION
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PREPARED BY:
EUGENA GOGGANS
12/19/06

SUBMITTED BY:

CONCURRENCE:

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MSFC DOCUMENTATION REPOSITORY - DOCUMENT INPUT RECORD

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14. SPECIAL INSTRUCTIONS:				
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II. ENGINEERING DRAWINGS

20. REVISION:	21. ENGINEERING ORDER:	22. PARTS LIST:	23. CCBD:
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III. REPORTS, SPECIFICATIONS, ETC.

24. REVISION: <i>A</i>	25. CHANGE:	26. VOLUME:	27. BOOK:	28. PART:	29. SECTION:
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IV. EXPORT AND DISTRIBUTION RESTRICTIONS

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| <input type="checkbox"/> Privacy Act (see MWI 1382.1) | <input type="checkbox"/> EAR (see MPG 2220.1) |
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V. ORIGINATING ORGANIZATION APPROVAL

40. ORG. CODE: ED31	41. PHONE NUMBER: (256) 544-2529	42. NAME: DeWitt Burns	43. SIGNATURE/DATE: <i>DeWitt Burns 10/17/02</i>
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VI. TO BE COMPLETED BY MSFC DOCUMENTATION REPOSITORY

44. RECEIVED BY: <i>Dammy Weis</i>	45. DATE RECEIVED: <i>10-15-03</i>	46. WORK ORDER:
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