

TEMP LIMITS

-50°F NO PROBLEMS  
-80°F MARGINAL  
-110°F FLOW LIMIT  
-120°F NO FLOW  
-150°F FROZEN

SE-S-0073  
REVISION C  
FEBRUARY 14, 1977

SUPERSEDING  
SE-S-0073B  
FEBRUARY 9, 1975

SPACE SHUTTLE PROGRAM

SPECIFICATION

SPACE SHUTTLE FLUID PROCUREMENT

AND USE CONTROL



*National Aeronautics and Space Administration*  
**LYNDON B. JOHNSON SPACE CENTER**  
*Houston, Texas*

470-0852

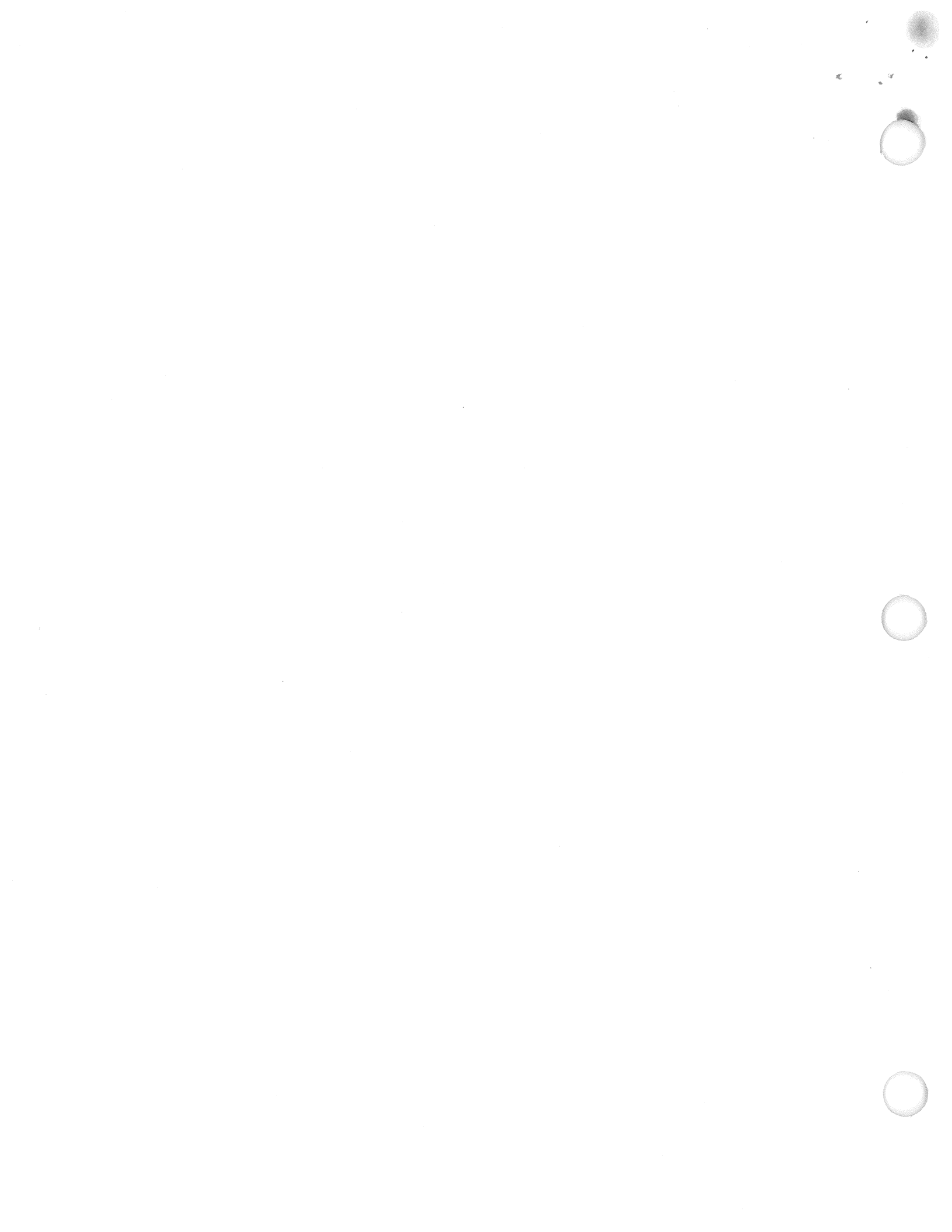


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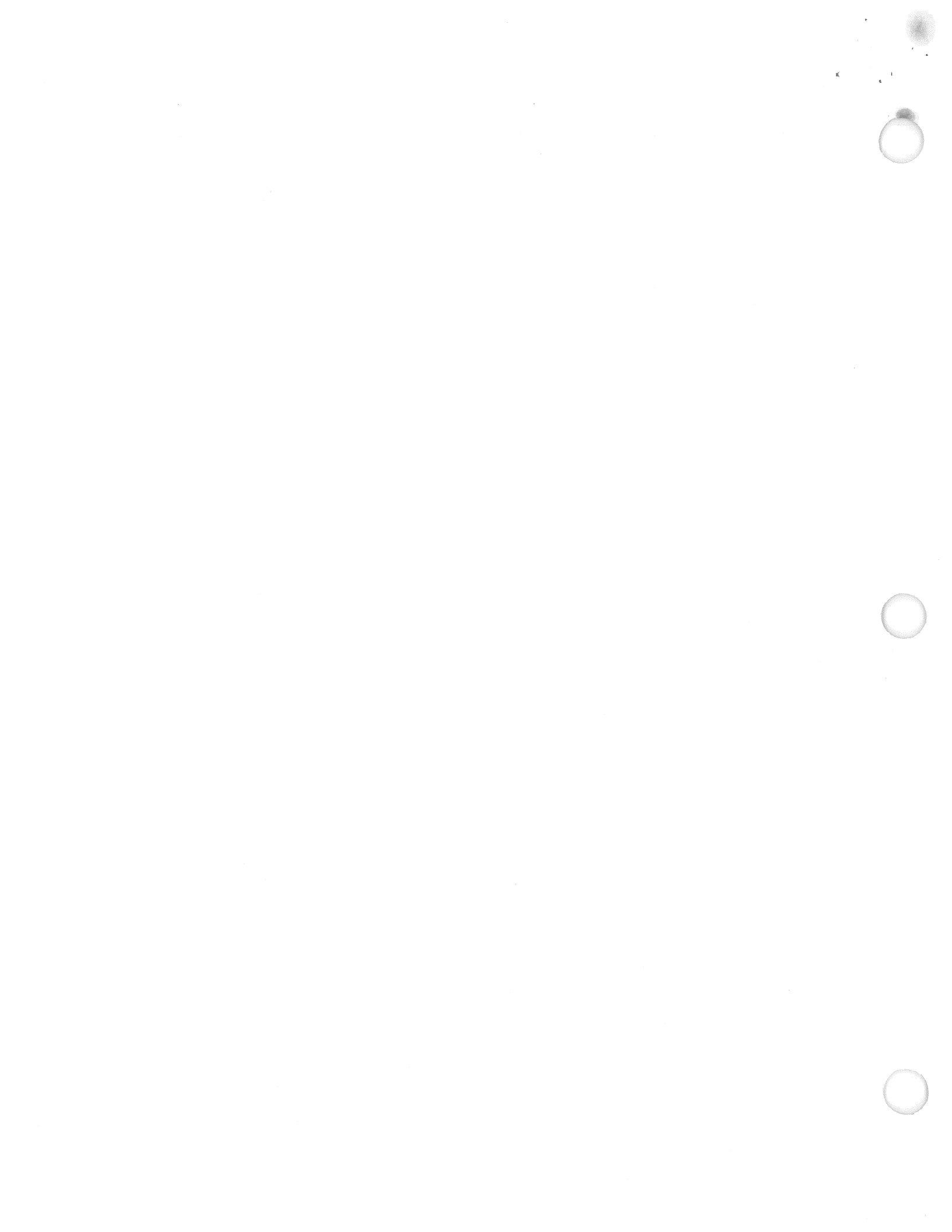
FEBRUARY 14, 1977



REVISION AND CHANGES

REV LTR	CHANGE NO.	DESCRIPTION	DATE
		BASELINE ISSUE	12/08/72
A		PRCBD S00166, DTD 4/23/74	5/22/74
B		PRCBD S01173, DTD 2/9/75	2/09/75
	1	PRCBD S00262C, DTD 7/24/75	9/22/75
	2	PRCBD'S S01173A, DTD 4/12/76; S01173B DTD 2/23/76; S01173C, DTD 3/4/76 AND S01173D, DTD 3/22/76	5/05/76
	3	PRCBD'S S01173A, DTD 4/12/76 AND S01173D, DTD 3/22/76	6/14/76
	4	PRCBD S01148A, DTD 7/8/76	8/11/76
C	5	REVISION C (REFERENCE PRCBD S01173F DTD FEBRUARY 14, 1977) ALSO INCLUDES PRCBD NOS. S00084C, S01173E AND S01173G.	2/14/77



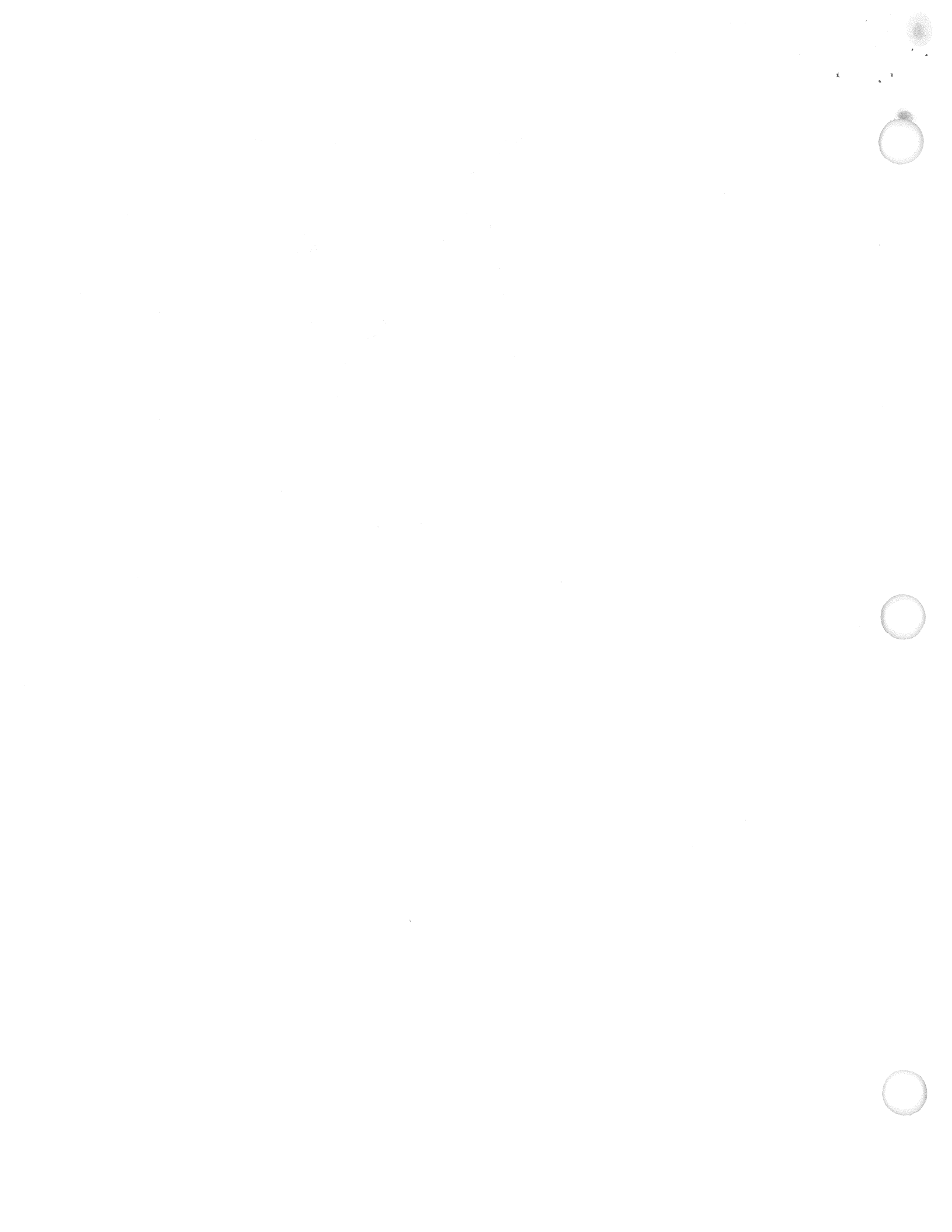


DEVIATION/WAIVER AUTHORIZED FOR REQUIREMENTS  
CONTAINED IN THIS DOCUMENT

1. REQUIREMENT: Paragraphs 3.2A and 6.1.1.1 apply the requirements for fluid control during acceptance testing and forward, i.e. thru qualification and subsequent assembly installation, test or operation.

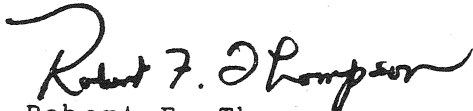
DEVIATION: This requirement is extended to include high temperature (>200°F) development tests of hydraulic components and test articles. The tests shall use hydraulic fluid per Table 6.3-7 and Table 6.4-1.

AUTHORITY: Level II PRCBD S01173C, dated 3/4/76.



FOREWORD

This specification has been approved by the Space Shuttle Program Office and is available for use by the NASA and associated contractors. The Propulsion and Power Division, NASA-JSC, is the Office of Prime Responsibility for this document.



Robert F. Thompson  
Manager, Space Shuttle Program

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## 1.0 SCOPE.

This specification establishes the procurement requirements and the chemical and particulate limitations for fluids used in fluid systems of the Space Shuttle (solid rocket booster (SRB), external tank (ET), Space Shuttle Main Engine (SSME), and Orbiter).

This specification applies to payloads which have fluid interfaces with the Orbiter or Space Shuttle ground support equipment (GSE).

This specification applies throughout all program levels for commonality and to ensure that fluid requirements used for design concepts will be used in verification and operation.

The intent and requirements of this specification apply equally to influents and to effluents to the extent specified herein.

## 2.0 PURPOSE.

The purpose of this specification is to establish and standardize particulate and chemical fluid requirements for the Shuttle Program.

## 3.0 CONTROL.

### 3.1 PROCUREMENT.

The NASA will be responsible for procurement control of fluids used for flight and contractor-required government-furnished fluids.

### 3.2 FLUID USE.

① A. No fluid shall be used or introduced into components or vehicle systems/subsystems during or after acceptance testing, except those specified herein, without prior written approval from the Manager of the Space Shuttle Program.

B. Where the requirements of this document do not reflect a required specification or the system/subsystem requirements specified are inadequate, it shall be the contractor's responsibility to notify the NASA procuring agency so that specifications meeting the system's requirements can be generated and included in this specification.

C. It shall be the contractor's responsibility to ensure his subcontractors comply with the requirements of this specification. It shall be NASA's responsibility to ensure that Government-furnished equipment (GFE) contractors, associate contractors, and Government activities comply with the requirements of this specification.

#### 4.0 APPLICABLE DOCUMENTS.

The specified issue of the following documents form a part of this specification to the extent indicated herein.

#### 4.1 STANDARDS.

##### 4.1.1 Government.

FED-STD-209B Clean Room and Work Station Requirements, Controlled Environment

FED-STD-791B Lubricants, Liquid Fuels, and Related Products, Methods of Testing

##### 4.1.2 Military.

MIL-STD-1201 Alcohol, Denatured and Ethyl, Technical

MIL-STD-1564 Procedure for calibration and analysis of trace contaminants and aviators breathing oxygen by infared spectroscopy.

#### 4.2 SPECIFICATIONS.

##### 4.2.1 Government.

O-E-760b Ethyl Alcohol (Ethanol); Denatued Alcohol; and Proprietary solvent

O-M-232e Methanol (Methyl Alcohol)

BB-C-101a Carbon Dioxide (CO<sub>2</sub>): Technical and U.S.P.

BB-F-1421A Fluorocarbon Refrigerants

TT-I-735a Isopropyl Alcohol

4.2.2 Johnson Space Center.

SPEC-C-20C	Water, High Purity, Specification for
SE-R-0006B	NASA/MSC Requirements for Materials and Processes
SD-W-0020	Potable Water
SE-F-0044A	Filters, Wire Cloth Type
SN-C-0005	Contamination Control Requirements for the Space Shuttle Program
SN-C-0037	Trichlorotrifluoroethane Solvent, Use Requirements

4.2.3 Military.

MIL-A-18455B	Argon
MIL-A-27420	Air, Liquid, For Breathing Purposes
MIL-C-81302B	Cleaning Compound, Solvent, Trichlorotrifluoroethane
MIL-F-8815C	Filter and Filter Elements, Fluid Pressure, Hydraulic line, 15-micron absolute and 5-micron absolute, Type II Systems, General Specification for
MIL-F-51068C	Filter, Particulate, High-efficiency, Fire resistant
MIL-H-5606C	Hydraulic Fluid, Petroleum Base; Aircraft, Missile and Ordnance
MIL-H-83282A	Hydraulic Fluid, Fire Resistant Synthetic Hydrocarbon Base, Aircraft
MIL-L-23699B	Lubrication Oil, Aircraft Turbine Engine, Synthetic Base
MIL-M-12218B	Monobromotrifluoromethane (Liquified)
MIL-O-27210D	Oxygen, Aviator's Breathing, Liquid and Gas
MIL-P-27201B	Propellant, Hydrogen
MIL-P-25508E	Propellant, Oxygen
MIL-P-26536C	Propellant, Hydrazine
MIL-P-26539C	Propellant, Nitrogen Tetroxide
MIL-P-27401C	Propellant, Pressurizing Agent, Nitrogen
MIL-P-27404A	Propellant, Monomethylhydrazine
MIL-P-27406	Propellant, Ammonia
MIL-P-27407	Propellant, Pressurizing Agent, Helium
MIL-P-27408A	Propellant, Mixed Oxides of Nitrogen

MIL-T-27602A Trichloroethylene, Oxygen Propellant  
Compatible

4.2.4 Society of Automotive Engineers.

ARP 599A Filter Cleanliness Test Method

ARP 901 Bubble Point Test Method

4.2.5 Marshall Space Flight Center.

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

MSFC-SPEC-Control  
Drawing 65B23305H Filters

4.2.6 American Society for Testing and Material.

ASTM D86- 76 Standard Method of test for Distilla-  
tion of Petroleum Products

ASTM D97-66 Standard Method of Test for Pour  
Point of Petroleum Oils

ASTM D445-74 Standard Method of Test for Kinematic  
Viscosity of Transparent and Opaque  
Liquids (and the Calculation of Dyna-  
mic Viscosity)

ASTM D888-66 Standard Methods of Test for Dissolved  
Oxygen in Water

ASTM D1298-67 Standard Method of Test for Density,  
Specific Gravity or Crude Petroleum  
and Liquid Petroleum Products by  
Hydrometer Method

4.3 REGULATION.

Part 212, Title 27 Formulas for  
Code of Federal Denatured Alcohol  
Regulations and Rum

5.0 DEFINITIONS.



## 5.1 GENERAL.

The following definitions are included to clarify this specification.

### 5.1.1 Maximum Particle Size Filter Rating.

The maximum particle size filter rating is the size designation applied to a filter unit which requires that filter to retain all solid particles equal to or greater in size than the maximum particle while tested under rated flow conditions.

### 5.1.2 Bubble Point.

The bubble point is the initial pressure in inches of water of that qualification filter that successfully passes the maximum particle size rating requirements using the test method of ARP 901.

### 5.1.3 Silting.

Silting is an accumulation of minute particles, in the size range normally not counted, of sufficient quantity to interfere with sample analysis.

### 5.1.4 Test Fluid.

Test fluid is a fluid that may be used as an alternate to the operational fluid for evaluating performance of a system.

### 5.1.5 Final Filter.

A final filter is a filter located in the GSE as close as practical to the interface between the vehicle/test article and the fluid distribution system to provide vehicle/test article fluid cleanliness as specified herein. Final filters shall not contain any bypasses.

### 5.1.6 Interface Filter.

An interface filter is a filter located in or directly connected to the GSE disconnect at the interface between the vehicle/test article and the fluid distribution system to provide vehicle/test article fluid cleanliness as specified herein. Interface filters shall not contain any bypasses and shall not contain any flexible line between disconnect and filter.

#### 5.1.7 Fiber.

A fiber is a particle the length of which is at least 10 times its width (minimum length of 100 microns) and the size of which is indicated by its length.

#### 5.1.8 Particle Size.

Particle size is expressed as the apparent maximum linear dimension of the particle. This definition includes fibers.

#### 5.1.9 Assembly Fluids.

Fluids used for internal purging during installation or higher level assembly subsequent to acceptance tests.

#### 5.1.10 Major Test Article.

Test articles of those major ground tests which involve the combination of system elements, complex facilities, large or expensive hardware segments or a combination of the above.

#### 5.1.11 High Efficiency Particulate Air (HEPA) Filter.

A filter as specified in MIL-F-51068 with a minimum efficiency of 99.97 percent as determined by test. The test can be by homogeneous dioctylphthalate (DOP) method or other equally sensitive method at an airflow of 100 percent of the rated flow capacity for all size filters and at 20 percent of the rated airflow for sizes 4, 5 and 6.

#### 5.1.12 Microorganism.

An organism of microscopic size, including bacteria, fungi (molds and yeast), algae, and protozoa, either active or dormant.

## 6.0 REQUIREMENTS.

### 6.1 SHUTTLE SYSTEMS/SUBSYSTEMS FLUID SERVICING/VEHICLE INTERFACE REQUIREMENTS.

#### 6.1.1 General.

##### ① 6.1.1.1 Application, Acceptance, and Qualification.

This specification applies throughout all program levels for commonality and to ensure that the fluid requirements that are used for the design concepts will be used in acceptance of components and subsequently in assembly of or used in higher level assemblies, subsystems, or systems for verification and operation.

Qualification and/or certification of components shall include fluids used subsequently in assembly of or used in higher level assemblies, subsystems, or systems for verification and operation. Component qualification test fluids shall meet the procurement and chemical use requirements of this specification. Particulate requirements stated herein shall be considered in establishing qualification requirements; however, these are not the maximum particulate limits. The maximum particulate limits are to be established based on total system/subsystem design and operational considerations.

Off-the-shelf components will have been certified to the requirements of the Master Verification Plan as operable with the fluids to be used and controlled by this specification in assembly of or operations in higher level assemblies, subsystems, or systems for verification and operation.

##### 6.1.1.2 Cleaning, Flushing, and Testing Fluids and Effluents.

Included in control by this specification are fluids for cleaning, testing, and flushing; however, particulate levels of Table 6.1 will be required only in the final cleanliness verification fluid during acceptance test and subsequent fluids introduced in acceptance tests and in higher level assemblies, subsystems, or systems for assembly, test or operation. The intent and requirements of this specification apply equally to influents and to effluents to the extent specified herein.

##### 6.1.1.3 Materials, Processes and Compatibility.

Materials and processes used for assembly, cleaning, purging, testing, flushing, or checkout shall not be detrimental to the performance or design requirements of the subsystem. All potentially harmful residues of these material shall be removed from the subsystem. Fluids to be used in system/subsystems must demonstrate that they do not degrade structural materials

① Refer to Deviation/Waiver page in front of document.

fracture mechanics performance in accordance with the Fracture Control Program Plan required by SE-R-0006B. Listing of use fluids within this specification does not alleviate this requirement.

#### 6.1.2 Particulate Requirements.

##### 6.1.2.1 Element/Major Test Article.

Fluid particulate cleanliness is acceptable if one of the following requirements is met.

A. Qualified Interface Filter. The use of qualified interface filters to ensure cleanliness of fluids being serviced. The filters shall be qualified as required in paragraph 6.1.4, and the filter and filter-interface connections shall be certified as a unit as required in paragraphs 6.1.5 and 6.1.6. The filters shall deliver fluids certified to the maximum particle rating as specified in Table 6.1 or better.

B. Qualified Final Filters. The use of qualified final filters and cleaning/maintaining clean all hardware between the filter and the interface to the level established for the vehicle subsystem as shown in Table 6.1 under column entitled "Subsystem/GSE Surface Cleanliness PER SN-C-0005." This concept shall only be used where it is not cost effective to use interface filters. Qualification, certification, and delivery requirements are the same as for interface filters of A above.

C. Alternate Filter Rationale. In lieu of qualified interface or final filters, alternate filters may be used provided the rationale is developed and approved by the Program Manager, identifying compatibility with the Shuttle System Fluid Cleanliness requirements. The following alternate filters are approved:

(1) Orbiter and SRB hydraulic interface filters, are to be 5-micron depth-type filters qualified per MIL-F-8815.

(2) HEPA filters as defined in paragraph 5.1.11 for PURGE and ECLSS conditioned air and the downstream system cleaned to the subsystem cleanliness level.

(3) Main Propulsion subsystem final filters shall be 175 micron and 70 micron glass bead rated filters (or better) L02 and LH2, respectively.

(4) ET Checkout Pressurization Filters per MSFC Spec Control Drawing 65B23305.

#### 6.1.2.2 Other Test Articles/Components.

The Contamination Control Program Plan required by JSC 07700, Volume X, paragraph 3.6.12.1, shall specify how the contractor/subcontractor satisfies the particulate requirements of Table 6.1. The Contamination Control Program Plan requires NASA procuring activity approval.

#### 6.1.3 Chemical Sampling.

##### 6.1.3.1 Element/Major Test Article.

Fluids supplied to the element/major test article shall have been sampled and verified as meeting the chemical requirements of the appropriate table from paragraph 6.3 as required from Table 6.1 in accordance with the procedures of the applicable procurement specification, unless other analysis procedures are specifically delineated herein. Table 6.3 specifies requirements at the interface; however, verification may be accomplished by sampling at an alternate location(s). The sampling location, frequency, and technique shall provide representative samples of liquid or gas being tested and shall assure that, with the sampling approach utilized, the fluid meets the requirements at the interface.

##### 6.1.3.2 Other Test Articles/Components.

Fluids supplied to other test articles/components shall have been sampled and verified as meeting the chemical requirements of the appropriate table from paragraph 6.3 as required from Table 6.1 in accordance with the procedures of the applicable procurement specification, unless other analysis procedures are specifically delineated herein. Table 6.3 specifies requirements at the interface; however, verification may be accomplished by sampling at an alternate location(s). The sampling location, frequency, and technique shall provide representative samples of the liquid or gas being tested and shall assure that, with the sampling approach utilized, the fluid meets the requirements at the interface.

##### 6.1.4 Interface or Final Filter Qualification.

Qualification shall be in accordance with SE-F-0044 to the maximum particulate rating as specified in Table 6.1, or better, except for those filters delineated in paragraph 6.1.2.1 C.

##### 6.1.5 Final or Interface Filter Certification.

Certification of each GSE/Vehicle interface and final filter requires verification of the maximum particle size filter rating by the test method of ARP 901 to the bubble point as defined by paragraph 5.1.2.

#### 6.1.6 Interface Filter/Disconnect Assembly Certification.

Certification of each interface filter disconnect assembly cleanliness shall be according to ARP 599A to the subsystem cleanliness level specified in Table 6.1 or better.

### 6.2 REQUIREMENTS FOR EFFLUENTS FROM THE SPACE SHUTTLE SYSTEMS/SUBSYSTEMS.

#### 6.2.1 General.

Certain subsystems or systems which remain filled or retain residuals which may normally not be drained, decontaminated, or purged will require periodic sampling to control fluids for fracture mechanics considerations and/or recleaning requirements.

Specific procedures and times for sampling are defined in other documentation; e.g., checkout procedures, etc. This specification defines the fluid limits for effluents when such sampling is required and only for the specific subsystems or systems and fluids specified in Table 6.2.

#### 6.2.2 Particulate Sampling.

Sampling frequencies and techniques shall provide representative samples of liquid or gas for test. When sampled from the vehicle, the maximum particulate allowables are specified in Table 6.2.

#### 6.2.3 Chemical Sampling.

Fluid samples taken from the vehicle shall meet the chemical requirements of the applicable table from paragraph 6.4 as specified in Table 6.2 when analyzed in accordance with the procedures of the applicable procurement specification, unless other procedures are specifically delineated herein.

TABLE 6.1.- SHUTTLE SYSTEMS FLUID SERVICING REQUIREMENTS

---

Fluid	Chemical composition (as shown in Table 6.3)	Particulate ----- GSE interface/ final filter max. particle rating	Control ----- Subsystem/GSE surface cleanliness level per SN-C-0005 (6.1.2.1P)
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Main Propulsion Subsystem  
(Orbiter, ET and SSME)

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Operational fluids

Helium/He	Table 6.3-1	25 micron	Level 100A
Hydrogen/LH2 (liquid)	Table 6.3-6	70 micron (Par. 6.1.2.1C)	(Note 4)
Oxygen/LO2 (liquid)	Table 6.3-2	175 micron (Par. 6.1.2.1C)	(Note 4)
Nitrogen/N2	Table 6.3-3	25 micron	Level 100A

Assembly fluids

(Note 1)

Cleaning, flushing and testing fluids (Note 3)

Water (ET only)	Table 6.3-8 Grade B	Same as operational fluid	
Trichlorethylene (ET only)	Table 6.3-28	Same as operational fluid	

TABLE 6.1.- SHUTTLE SYSTEMS  
 FLUID SERVICING REQUIREMENTS - Continued

Fluid	Chemical composition (as shown in Table 6.3)	Particulate GSE interface/ final filter max. particle rating	Control Subsystem/GSE surface cleanliness level per SN-C-0005 (6.1.2.1B)
Aft propulsion subsystem Orbit maneuvering propulsion and reaction control subsystems			
<u>Operational fluids</u>			
Helium/He	Table 6.3-1	25 micron	Level 200
Monomethyl- hydrazine/MMH	Table 6.3-9	25 micron	Level 200
Nitrogen tetroxide/N2O4	Table 6.3-10	Same as MMH	Level 200A
Gaseous nitrogen/ GN2	Table 6.3-3	Same as helium	
<u>Assembly fluids</u>			
Argon/Ar	Table 6.3-12	Same as helium	
<u>Cleaning, flushing and testing fluids</u> (Note 3)			
Isopropyl alcohol	Table 6.3-25	Same as MMH	
Trichlorotrifluoro ethane	Table 6.3-26	Same as N2O4	
Water	Table 6.3-8 Grade A	Same as operational fluid	
Water-OME Injector Tests	Table 6.3-8 Grade B	Same as operational fluid	



**TABLE 6.1.- SHUTTLE SYSTEMS**  
**FLUID SERVICING REQUIREMENTS - Continued**

Fluid	Chemical composition (as shown in Table 6.3)	Particulate GSE interface/ final filter max. particle rating	Control Subsystem/GSE surface cleanliness level per SN-C-0005 (6.1.2.1B)
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Reaction control subsystem

Operational fluids

Helium/He	Table 6.3-1	25 micron	Level 200
Monomethyl- hydrazine/MMH	Table 6.3-9	25 micron	Level 200
Nitrogen tetroxide/N2O4	Table 6.3-10	Same as MMH	Level 200A

Assembly fluids

Argon/Ar	Table 6.3-12	Same as helium	
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Cleaning, flushing and testing fluids (Note 3)

Nitrogen/GN2	Table 6.3-3	Same as helium	
Isopropyl alcohol	Table 6.3-25	Same as MMH	
Trichlorotrifluoro ethane	Table 6.3-26	Same as N2O4	
Water	Table 6.3-8 Grade A	Same as operational fluid	

TABLE 6.1.- SHUTTLE SYSTEMS  
 FLUID SERVICING REQUIREMENTS - Continued

Fluid	Chemical composition (as shown in Table 6.3)	Particulate GSE interface/ final filter max. particle rating	Control Subsystem/GSE surface cleanliness level per SN-C-0005 (6.1.2.1B)
----- Fuel cells/cryo -----			
<u>Operational fluids</u>			
Liquid hydrogen/ LH2	Table 6.3-6	25 micron	Level 200
Liquid oxygen/ LO2	Table 6.3-4	25 micron	Level 200A
Gaseous hydrogen/ GH2	Table 6.3-6	25 micron	Level 200
Gaseous oxygen/ GO2	Table 6.3-4	25 micron	Level 200A
Nitrogen	Table 6.3-5	Same as gaseous oxygen	
Helium (gaseous)/He	Table 6.3-1	Same as gaseous oxygen	
Cooling fluid	Table 6.3-23	25 micron	Level 300
<u>Assembly fluids</u>			
Argon/Ar	Table 6.3-12	Same as operational fluid	
<u>Cleaning, flushing and testing fluids</u> (Note 3)			
Trichloro- fluoroethane	Table 6.3-26	Same as operational fluid	

TABLE 6.1.- SHUTTLE SYSTEMS

FLUID SERVICING REQUIREMENTS - Continued

Fluid	Chemical composition (as shown in Table 6.3)	Particulate GSE interface/ final filter max. particle rating	Control Subsystem/GSE surface cleanliness level per SN-C-0005 (6.1.2.1B)
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Environmental and thermal control/life support subsystems

Operational fluids

Gaseous oxygen/GO2	Table 6.3-4	25 micron	Level 200A
Liquid oxygen/ LO2	Table 6.3-4	Same as fuel cell LO2	
Gaseous nitrogen/ GN2	Table 6.3-5	Same as gaseous oxygen	
Avionic fire extinguishing fluid	Table 6.3-21	(No particulate requirement)	
Potable water	Table 6.3-16	25 micron	Level 300
ARS heat transport water	Table 6.3-32	25 micron (note 6)	Level 300A
Refrigerant 21 ATCS coolant loop	Table 6.3-20	25 micron	Level 300
Refrigerant 21 GSE coolant loop	Table 6.3-20	50 micron	Level 300
Helium (Gaseous)/He	Table 6.3-1	25 micron	Level 300A
Ammonia/NH3	Table 6.3-18	25 micron	Level 300A
Ferry Flight Fluid (ARS water coolant loop)	Table 6.3-31	25 micron (note 6)	Level 300

**TABLE 6.1.- SHUTTLE SYSTEMS**  
**FLUID SERVICING REQUIREMENTS - Continued**

Fluid	Chemical composition (as shown in Table 6.3)	Particulate GSE interface/ final filter max. particle rating	Control Subsystem/GSE surface cleanliness level per SN-C-0005 (6.1.2.1B)
----- Auxiliary power unit (APU) -----			
<u>Operational fluids</u>			
Helium/He	Table 6.3-1	25 micron	Level 100
Hydrazine/N2H4	Table 6.3-11	25 micron	Level 100
Lubricating oil	Table 6.3-14	25 micron	Level 300
<u>Assembly fluids</u>			
Argon/Ar	Table 6.3-12	Same as operational fluid	
<u>Cleaning, flushing and testing fluids</u> (Note 3)			
Isopropyl alcohol	Table 6.3-25	Same as N2H4	
Water	Table 6.3-8 Grade A	Same as N2H4	
Gaseous nitrogen/ GN2	Table 6.3-3	Same as helium	

TABLE 6.1.- SHUTTLE SYSTEMS

FLUID SERVICING REQUIREMENTS - Continued

Fluid	Chemical composition (as shown in Table 6.3)	Particulate GSE interface/ final filter max. particle rating	Control Subsystem/GSE surface cleanliness level per SN-C-0005 (6.1.2.1B)
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SSME, SRB, and Orbiter hydraulic subsystems

Operational fluids

Hydraulic fluid	Table 6.3-7	5 micron (per 6.1.2.1C(1))	Level 190 (Note 5)
Water	Table 6.3-8 Grade A	25 micron	Level 200
Gaseous nitrogen/ GN2 (accumulator precharge)	Table 6.3-3	25 micron	Level 200
Hydraulic fluid- orbiter shock struts only	Table 6.3-33	5 micron (per 6.1.2.1.C(1))	Level 190 (Note 5)

Assembly fluids

(Note 1)

Cleaning, flushing and testing fluids (Note 3)

Gaseous nitrogen/ GN2	Table 6.3-3	25 micron	Level 200
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TABLE 6.1.- SHUTTLE SYSTEMS

FLUID SERVICING REQUIREMENTS - Continued

Fluid	Chemical composition (as shown in Table 6.3)	Particulate	Control
		GSE interface/ final filter max. particle rating	Subsystem/GSF surface cleanliness level per SN-C-0005 (6.1.2.1B)
Environmental and thermal control/life support subsystems (Cont)			
Airlock LCG cooling water	Table 6.3-30	25 micron (note 6)	Level 25A
Conditioned air (Cabin purge air)	Table 6.3-22	FED-STD-209B Class 100,000 HEPA (per 6.1.2.1C(2))	VC
Urinal biocide flush fluid	Table 6.3-19	(TBD)	(TBD)
<u>Assembly fluids</u>			
Argon/Ar	Table 6.3-12	Same as operational fluid	
<u>Cleaning, flushing and testing fluids</u> (Note 3)			
Carbon dioxide/CO2	Table 6.3-17	25 micron	Level 100
Gaseous oxygen/ GO2	Table 6.3-24	Same as operational gaseous oxygen	
Trichlorotrifluoro- ethane	Table 6.3-26	Same as operational fluid	
ARS Heat Transport component test water	Table 6.3-32	Same as operational fluid	
Breathing air mixture	Table 6.3-29	Same as operational fluid	

TABLE 6.1.- SHUTTLE SYSTEMS

FLUID SERVICING REQUIREMENTS - Continued

---

Fluid	Chemical composition (as shown in Table 6.3)	Particulate	Control
----- GSE interface/' Subsystem/GSE final filter ' surface max. particle ' cleanliness rating ' level per ' SN-C-0005 (6.1.2.1B) -----			
Environmental and thermal control/life support subsystems (Conl)			
Denatured ethyl alcohol	Table 6.3-27	25 micron	Level 300

TABLE 6.1.- SHUTTLE SYSTEMS

FLUID SERVICING REQUIREMENTS - Concluded

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Fluid	Chemical composition (as shown in Table 6.3)	Particulate ----- GSE interface/ final filter max. particle rating	Control ----- Subsystem/GSE surface clearliness level per SN-C-0005 (6.1.2.1B)
-------	--	---	---

---

Purge, vent, and drain subsystem

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Operational fluids

Gaseous nitrogen/ GN2	Table 6.3-5	FED-STD-209B Class 5000 HEPA (per 6.1.2.1C(2))	VC
Conditioned air	Table 6.3-15	FED-STD-209B Class 5000 HEPA (per 6.1.2.1C(2))	VC

Assembly fluids

(Note 1)

Cleaning, flushing, and testing fluids

(Notes 2 and 3)



Notes:

1. No assembly fluids have been firmly defined for this subsystem at the present time. This table will be revised to reflect these fluids as they are defined.
2. No cleaning, flushing, or testing fluids have been firmly defined for this subsystem at the present time. This table will be revised to reflect these fluids as they are identified.
3. Fluids utilized for system cleaning on a continuous basis shall be sampled at least every 8 hours and controlled in accordance with paragraph 6.2 of this specification.
4. All LO2 and LH2 Ground Hardware between the Main Propulsion Final Filters and the vehicle interface shall be cleaned to a maximum particle size limit of 800 and 400 microns, respectively. Special precautions and/or procedures to control contamination during assembly, installation and replacement of components and line segments shall be in accordance with established and approved procedures to meet the requirements of the Space Shuttle Contamination Control Plan. During cleaning of the components or subassemblies the cleanliness level shall be verified per the Quality Control Provisions of MSFC-SPEC-164A or equivalent.
5. Hydraulic subsystem surface cleanliness is as follows for 100ml of sampled fluid:

<u>Particulate size, micrometers</u>	<u>Number allowable</u>
<25	Unlimited <sup>1</sup>
25-50	860
>50-100	124
	>100

13

<sup>1</sup>Unlimited as defined by SN-C-0005.

6. All ARS WCL operational fluids (water, alcohol and mixes) shall be filtered through a 0.22 micron filter before introduction into element WCL and this filtered fluid shall be circulated/flushed through all applicable servicing GSE up to and including final/interface filters prior to connection to vehicle WCL.

TABLE 6.2.- SHUTTLE SYSTEMS FLUID EFFLUENT REQUIREMENTS

Fluid	Chemical composition (as shown in Table 6.4)	Particulate Particle size unit microns	Level (Note 1) Number allow- able
Orbiter hydraulic subsystem			
Hydraulic fluid	Table 6.4-1	<25 25-50 >50-100 >100	(Note 2) 1612 232 24
Environmental and thermal control/life support subsystems			
Oxygen	Table 6.4-2		Not req'd
Nitrogen	Table 6.4-3		Not req'd
Heat transport water	Table 6.4-4	<100 100-250 >250-300 >300	(Note 2) 93 3 0
Refrigerant 21 ATCS coolant loop	Table 6.4-5 (Same as Heat Transport Water)		
Potable water	Table 6.4-6	<100 100-250 >250-500 >500	(Note 2) 1073 27 0
Ammonia	Table 6.4-10 (Same as Heat Transport Water)		
Ferry Flight Fluid	Table 6.4-8 (Same as Heat Transport Water)		
Airlock LCG Cooling Fluid	Table 6.4-9	<15 15-25 >25-50 >50	(Note 2) 17 8 0
Fuel cells			
Cooling fluid	Table 6.4-7		(TBD)

TABLE 6.2.- SHUTTLE SYSTEMS FLUID EFFLUENT REQUIREMENTS  
- CONCLUDED

Notes:

1. Particulate levels are per 100 milliliters liquid or 35 standard cubic feet (SCF) gas. Samples shall be taken with the system operating at normal flow rates and dynamic pressure. The gaseous sample of 35 SCF shall be taken in 5 minutes maximum. Sample size may vary based on site/activity normal practice; however, reporting shall be per 100 milliliter liquid and 35 SCF gas for comparison to the requirements stated herein. Particulate values are based on the log-normal Gaussian distribution function.

2. No silting as defined by paragraph 5.1.3 of this specification. No count required.

### 6.3 CHEMICAL AND PHYSICAL CHARACTERISTICS OF SHUTTLE VEHICLE SERVICING FLUIDS

The tables included in this paragraph contain physical and chemical characteristics of fluids that will be used in servicing subsystems of the Space Shuttle. The characteristics of the allowable fluids per Table 6.1 as delivered to the appropriate vehicle/major test article/test article/component subsystem interface, will be found in Tables 6.3-1 to 6.3-33 as follows:

<u>FLUID</u>	<u>TABLE</u>
PROPELLANT PRESSURIZING AGENT, HELIUM . . . . .	6.3-1
LIQUID OXYGEN . . . . .	6.3-2
GASEOUS NITROGEN . . . . .	6.3-3
GASEOUS AND LIQUID OXYGEN . . . . .	6.3-4
GASEOUS AND LIQUID NITROGEN . . . . .	6.3-5
LIQUID HYDROGEN . . . . .	6.3-6
HYDRAULIC FLUID . . . . .	6.3-7
WATER . . . . .	6.3-8
PROPELLANT, MONOMETHYLHYDRAZINE . . . . .	6.3-9
PROPELLANT, NITROGEN TETROXIDE . . . . .	6.3-10
PROPELLANT, HYDRAZINE . . . . .	6.3-11
ARGON . . . . .	6.3-12
PROPELLANT, MIXED OXIDES OF NITROGEN . . . . .	6.3-13
LUBRICATING OIL . . . . .	6.3-14
CONDITIONED AIR - PURGE, VENT, AND DRAIN . . . . .	6.3-15
POTABLE WATER . . . . .	6.3-16
CARBON DIOXIDE . . . . .	6.3-17
AMMONIA . . . . .	6.3-18
URINAL BIOCID FLUSH FLUID . . . . .	6.3-19
REFRIGERANT 21 . . . . .	6.3-20
AVIONICS FIRE EXTINGUISHING FLUID . . . . .	6.3-21

CONDITIONED AIR - ECLSS . . . . .	6.3-22
FUEL CELL COOLING FLUID . . . . .	6.3-23
BREATHING OXYGEN . . . . .	6.3-24
ISOPROPYL ALCOHOL . . . . .	6.3-25
TRICHLOROTRIFLUOROETHANE . . . . .	6.3-26
DENATURED ETHYL ALCOHOL . . . . .	6.3-27
TRICHLORETHYLENE . . . . .	6.3-28
BREATHING AIR MIXTURE . . . . .	6.3-29
AIRLOCK LCG COOLING WATER . . . . .	6.3-30
FERRY FLIGHT FLUID . . . . .	6.3-31
HEAT TRANSPORT WATER . . . . .	6.3-32
SHOCK STRUT HYDRAULIC FLUID - ORBITER . . . . .	6.3-33

TABLE 6.3-1.- PROPELLANT PRESSURIZING AGENT, HELIUM

(Procurement shall be to Specification MIL-P-27407  
with Amendment 1)

Characteristic	Requirement as delivered to interface
Purity	99.990 percent by vol (min.)
Total hydrocarbon content (as methane)	5.0 ppm by vol (max.)
Oxygen content	10.0 ppm by vol (max.)
Nitrogen	50.0 ppm by vol (max.)
Moisture	9.0 ppm by vol (max.)
Total impurities	100 ppm by vol (max.)

TABLE 6.3-2.- LIQUID OXYGEN

(Procurement shall be to Specification MIL-P-25508E,  
Type II Grade A)

Characteristic	Requirement as delivered to interface
Purity	99.2 percent by vol (min.)
Alkynes as acetylene	1.55 ppm (max.)
Total hydrocarbons as CH <sub>4</sub>	75.0 ppm by vol (max.)
Moisture	26.3 ppm by vol (max.)

TABLE 6.3-3.- GASEOUS NITROGEN

(Procurement shall be to Specification MIL-P-27401C,  
Grade A, Type I or Type II)

---

Characteristic	Requirement as delivered to interface
Purity	99.5 percent by vol (min.)
Oxygen	0.5 percent by vol (max.)
Hydrocarbons as CH <sub>4</sub>	58.3 ppm by vol (max.)
Moisture	26.3 ppm by vol (max.)

---



TABLE 6.3-4.- GASEOUS AND LIQUID OXYGEN

(Procurement shall be to Specification MIL-P-25508E  
with Amendment 3, Grade F)

---

Characteristic	Requirement as delivered to interface
Purity	99.989 percent by volume (min.)
Alkyne hydro- carbon	0.05 ppm as acetylene (max.)
Total hydro- carbon	23 ppm as methane (max.)
Moisture	3 ppm (max.)
Nitrous oxide	1 ppm (max.)
Halogenated hydrocarbon	1 ppm (max.)
Chlorinated- hydrocarbon*	0.1 ppm (max.)
Odor	No odor
CO and CO2	1 ppm total (max.)

---

\*Analysis required for manned test and flight use only.

TABLE 6.3-5.- GASEOUS AND LIQUID NITROGEN

(Procurement shall be to Specification MIL-P-27401C Grade B with direct method and CO and CO2 requirements specified)

Characteristic	Requirement as delivered to interface
Purity	99.99 percent by vol (min.) by indirect method 95.0 percent by vol. (min.) by direct method
Total impurities	100 ppm by vol (max.)
Oxygen content	50 ppm by vol (max.)
Total hydrocarbon content (as methane)	5 ppm by vol (max.)
Moisture content	11.5 ppm by vol (max.)
<u>Required analysis for manned test and flight use only</u>	
CO	5 ppm (max.)
CO2	5 ppm (max.)
Aromatic hydrocarbons (as benzene)	0.5 ppm (max.)
Halogenated hydrocarbons	1 ppm (max.)
Chlorinated hydrocarbons	0.1 ppm (max.)
Nitrous oxide	1 ppm (max.)
Odor	None detectable

Note: Analysis procedures for impurities shall be per MIL-STD-1564.

TABLE 6.3-6.- LIQUID AND GASEOUS HYDROGEN

(Procurement shall be to Specification MIL-P-27201B)

Characteristic	Requirement as delivered to interface
Purity	99.994 percent by vol (min.)
Total gaseous impurities	60 ppm by vol (max.)
Total (nitrogen, water, and volatile hydrocarbons)	9 ppm by vol (max.)
Specific impurities	
Oxygen plus argon	5 ppm by vol (max.)
Helium	45 ppm by vol (max.)
Carbon-bearing gases other than CH <sub>4</sub> (carbon monoxide + carbon dioxide)	1 ppm by vol (max.)

$$\begin{array}{r} -54 \\ 1.8 \\ \hline 43.2 \\ 54 \\ \hline -97.2 \\ +32 \\ \hline 65 \end{array}$$

$$\begin{array}{r} -74 \\ 1.8 \\ \hline 57.2 \\ 74 \\ \hline -131.2 \\ 32 \\ \hline -100 \end{array}$$

F

NELSON Lingle

TABLE 6.3-7.- HYDRAULIC FLUID

(Procurement shall be to Specification MIL-H-83282A only from Bray Oil Co. to their formulation 882)

Characteristic	Requirement as delivered to interface		
		(Orbiter and SSME)	(SPB)
Pour point	- 74°C	-54° C (max.)	NR (3)
Flash point	425°F	204.4° C (min.)	204.4° (min.)
Fire point	495°F	246.1° C (min.)	NR
Specific gravity	0.84	Report value	NR
Viscosity @ 37.8° C (100° F)	15.7	14.0 centi-stokes (min.)	14.0 centi-stokes (min.)
Water		100 ppm (max.)	400 ppm (max.)
Acid & base number (max.)	0.22	0.10 <sup>KBA/MG</sup> check	0.10
Dissolved air		1% by vol (max.)	NR
Formulation IR scan		(TBD) ask Rosenbaum	NR
Trace Contaminants			
1,1,2 Trichloro			
1,2,2 Trifluoroethane (1)		100 ppm (max.)	100 ppm (max.)
Sulphur (2)		25 ppm (max.)	NR
X-Ray Fluorescence			

Notes:

1. Analysis for 1,1,2 Trichloro 1,2,2 trifluoroethane per (TBD).
2. Analysis for sulphur per (TBD).
3. NR - Not Required

ASTM D 974

Hugh Stewart

Vincent Viaz

Seton-Wilson aerometer

TABLE 6.3-8.- WATER

(Procurement shall be to Specification JSC-SPEC-C20C  
Grade A or Grade B as required)

Characteristic	Requirement as delivered to interface	
	Grade A	Grade B
Conductivity, $\text{ohm}^{-1} \text{cm}^{-1}$ (max.)	$3.3 \times 10^{-6}$	$2.0 \times 10^{-5}$
pH	6.00 to 7.50	6.0 - 8.0
Chlorides, ppm (max.)	1.0	1.0
Surface tension, (min.)	71.72 dynes per cm	Not required

TABLE 6.3-9.- PROPELLANT, MONOMETHYLHYDRAZINE

(Procurement shall be to Specification MIL-P-27404A  
with Amendment 2)

Characteristic	Requirement as delivered to interface
Monomethylhydrazine assay	98.0 percent by weight (min.)
Density at 77° F (25° C)	Determine for engineering information only
Water plus soluble impurities	2.0 percent by weight (max.)

TABLE 6.3-10.- PROPELLANT, NITROGEN TETROXIDE

(Procurement shall be to Specification MIL-P-26539C  
with Amendment 2)

Characteristic	Requirement as delivered to interface
Nitrogen tetroxide assay (N2O4)	97.0 percent by weight (min.)
Nitric oxide assay (NO)*	1.5 (min.) to 3.0 (max.) percent by weight
N2O4 + NO	99.5 percent (min.)
Water equivalent	0.20 percent by weight (max.)
Chloride content	0.040 percent by weight (max.)
Density	Determine for engineering info only

\*The nitric oxide (NO) content may be raised (enriched) by the addition of a specific quantity of MON-10 (Table 6.3-13) as determined by the following formula:

$$D = \frac{A(E-B)}{(C-E)}$$

Where

- A = Total quantity N2O4 being enriched (lbs)
- B = Percent by WT NO in N2O4
- C = Percent by WT NO in MON-10
- D = Quantity of MON-10 to be added (lbs)
- E = Desired final NO percent by weight

TABLE 6.3-11.- PROPELLANT, HYDRAZINE

(Procurement shall be to Specification MIL-P-26536C  
with Amendment 1, monopropellant grade)

Characteristic	Requirement as delivered to interface
Hydrazine assay	98.3 percent by weight (min.)
Water	1.2 percent by weight (max.)
Density at 77° F (25° C)	Determine for engineering info only
Chloride	0.0005 percent by weight (max.)
Aniline	0.50 percent by weight (max.)
Iron	0.002 percent by weight (max.)
NVR	0.005 percent by weight (max.)
CO2	0.02 percent by weight (max.)
Other volatile carbonaceous material	0.02 percent by weight (max.)



TABLE 6.3-12.- ARGON

(Procurement shall be to Specification MIL-A-18455-B)

Characteristic	Requirement as delivered to interface
Purity	99.985% by vol (min.)
Oxygen	0.005% by vol (max.)
Hydrogen	0.005% by vol (max.)
Nitrogen	0.005% by vol (max.)
Moisture (dew point)	-85° F or less

Utilized in welding or brazing operations for internal system purge.

TABLE 6.3-13.- PROPELLANT, MIXED OXIDES OF NITROGEN  
 (Procurement shall be to Specification MIL-P-27408A-MON-10)

Characteristic	Requirement as delivered to interface
Nitrogen tetroxide assay (N2O4)	88.8 percent by wt (min.)
Nitric oxide assay (NO)	10 percent by wt (min.) 11 percent by wt (max.)
Water equivalent	0.20 percent by wt (max.)
Chloride	0.040 percent by wt (max.)

To be used for enrichment of NO in MIL-P-26539 MON-3 as required.

TABLE 6.3-14.- LUBRICATING OIL

(Procurement shall be to Specification MIL-L-23699B  
with Amendment 2)

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Characteristic

Requirement as delivered  
to interface

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(TBD)

(TBD)

TABLE 6.3-15.- CONDITIONED AIR-PURGE, VENT, AND DRAIN

Characteristic	Requirement as delivered to interface
Moisture content	43 grains/lb dry air (max.)
Hydrocarbons as methane	15 ppm (max.)

TABLE 6.3-16.- POTABLE WATER

(Procurement shall be to Specification SD-W-0020)

Characteristic	Requirement as delivered to interface
<u>Prior to biocide addition:</u>	
Electrical conductivity	0.33 micromhos/cm @ 25° C (max.)
pH	6.0 - 8.0 @ 25° C
Total solids	2 mg/liter (max.)
Total organic solids	1 mg/liter (max.)
Taste & odor	None at threshold (odor no. of 3)
Turbidity	11 units (max.)
Color, true	15 units (max.)
<u>Ionic species</u>	
Cadmium	0.01 mg/liter (max.)
Chromium	0.05 mg/liter (max.)
Copper	1.0 mg/liter (max.)
Iron	0.3 mg/liter (max.)
Lead	0.05 mg/liter (max.)
Manganese	0.05 mg/liter (max.)
Mercury	0.005 mg/liter (max.)
Nickel	0.05 mg/liter (max.)
Silver	0.05 mg/liter (max.)
Zinc	5.0 mg/liter (max.)

TABLE 6.3-16.- POTABLE WATER - Concluded  
 (Procurement shall be to Specification SD-W-0020)

Characteristic	Requirement as delivered to interface
Selenium	0.01 mg/liter (max.)
Sterility	Determine viable organism count for reference only
Dissolved gas	No free gas when subjected to one (1) atmosphere pressure at 37° C

After biocide addition:

Sterility	Free of viable microorganisms
Electrical conductivity	Measure for reference only
Iodine	3-5 ppm by weight
pH	Measure for reference only

**TABLE 6.3-17.- CARBON DIOXIDE**

(Procurement shall be to Specification BB-C-101a  
Grade A, Type 1)

---

Characteristic	Requirement as delivered to interface
Purity	99.0 (min.)
Moisture	0.092 mg/liter of gas (max.) @ 70° F and 760 mm Hg

---

TABLE 6.3-18.- AMMONIA

(Procurement shall be to Specification MIL-P-27406)

---

Characteristic	Requirement as delivered to interface
Purity	99 percent by weight (min.)
Moisture	1 percent by weight (max.)
Oil	5 ppm (max.)

---



**TABLE 6.3-19.- URINAL BIOCIDES FLUSH FLUID**  
**(Procurement shall be to Specification TBD)**

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Characteristic

Requirement as delivered  
to interface

---

(TBD)

(TBD)

TABLE 6.3-20.- REFRIGERANT 21

(Procurement shall be to Specification BB-F-1421A Type 21)

Characteristic	Requirement as delivered to vehicle interface
<b>ATCS Coolant Loop</b>	
Boiling point	48.1°F ± 2°F
Water	30 ppm by weight (max.)
Chloride ion	0.3 ppm by weight (max.)
Air in vapor phase	2.0 percent by volume (max.)
<b>Ground Coolant Loop</b>	
Boiling Point	48.1 ± 2°F
Water	30 ppm by weight (max.)
Chloride ion	0.3 ppm by weight (max.)

TABLE 6.3-21.- AVIONICS FIRE EXTINGUISHING FLUID

(Procurement shall be to Specification MIL-M-12218B)

---

Characteristic	Requirement as delivered to interface
Purity (less solids, dissolved air, moisture, and non-volatiles)	99.6 percent by vol. (min.)
High boiling residue	0.05 percent by vol. (max.)
Moisture	0.001 percent by wt. (max.)
Air in vapor phase	1.5 percent by vol. (max.)
Suspended matter	None

---

TABLE 6.3-22.- CONDITIONED AIR - ECLSS

Characteristic	Requirement as delivered to interface
Moisture	37 grains/lb. dry air (max.)
Hydrocarbons as methane	50 ppm (max.)

TABLE 6.3-23.- FUEL CELL COOLING FLUID

(Procurement shall be for Minnesota Mining  
and Manufacturing Company FC-40)

---

Characteristic	Requirement as delivered to interface	Test Procedure
Boiling Range	95 percent between 139°C and 189°C	ASTM D86-87
Pour Point	-60°F (max.)	ASTM D97-66
Viscosity @ 25°C	2.2 + 0.6 centistokes	ASTM D445-74
Density @ 25°C	1.87 ± 0.02 gm/cc	ASTM D1298-67

---

TABLE 6.3-24.- BREATHING OXYGEN

(Procurement shall be to Specification MIL-0-27210D  
with Amendment 1, Type 1)

Characteristic	Requirement as delivered to interface
Purity	99.5 percent by vol. (min.)
CO <sub>2</sub>	10 ppm (max.)
Methane	50 ppm (max.)
Acetylene	0.1 ppm (max.)
Ethylene	0.4 ppm (max.)
Ethane and other hydrocarbons	6 ppm as ethane (max.)
Nitrous oxide	2 ppm (max.)
Halogenated hydrocarbons	2 ppm (max.)
Chlorinated hydrocarbons	0.2 ppm (max.)
Odor	No odor
Moisture	10 ppm (max.)

TABLE 6.3-25.- ISOPROPYL ALCOHOL

(Procurement shall be to Specification TT-I-735a Grade A with Amendment 2)

Characteristic	Requirement as delivered to interface
Appearance	Clear and free of sediment when examined by transmitted light
Acidity (as acetic acid)	0.003 percent by weight (max.)
Water	0.5 percent by weight (max.)
Nonvolatile residue	5 mg/100 milliliters (max.)
Specific gravity at 20°/20° C	0.7862 - 0.788
Color (platinum cobalt scale)	10 (max.)
Distillation range:	
Initial boiling point	81.3° C (min.)
Dry point	83.0° C

TABLE 6.3-26.- TRICHLOROTRIFLUOROETHANE

(Procurement shall be to Specification MIL-C-81302B  
with Amendment 1, Type II)

Characteristic	Requirement as delivered to interface (Notes 1, 2, 3, 4)
Chemical purity	99.6 percent by weight (min.)
Non-volatile residue	5 mg/100 milliliters (max.)
Chloride ion	0.3 ppm (max.)
Moisture	60 ppm (max.)
Alcohol	0.3 percent by weight (max.) (Note 2)

Notes:

1. Use limits apply to both new and reclaimed trichlorotrifluoroethane.

2. Test for alcohol by Ferrox Test of Specification SN-C-0037.

3. Representative samples of the solvent used in recirculating equipment shall be taken at the point of use for each 8 hours of operating time when in continuous use, or for each individual application when not used on a continuous basis, to assure these use limits are met.

4. Whenever the solvent has been used in a system/subsystem including GSE (or any portion thereof) and is to be used for any other system/subsystem, or whenever 8 hours have elapsed since the cessation of its last approved use, the solvent shall be considered as not being used on a continuous basis, and shall, therefore, be sampled and certified prior to use.



TABLE 6.3-27.- DENATURED ETHYL ALCOHOL

(Procurement shall be to Specification O-E-760B with Amendment 2 Grade III. Denaturing shall be by the addition of 5 gallons of methyl alcohol procured to Specification O-M-232E with Amendment 1 Grade A to 100 gallons of ethyl alcohol procured to Specification O-E-760B Grade II Class B. This mixture conforms to MIL-STD-1201 and part 212 of Title 27, Code of Federal Regulation for specially denature alcohol (SDA) formula No. 3-A).

Characteristic	Requirement as delivered to interface
Ethyl alcohol	90.5 percent by vol. (min.)
Acidity as acetic acid	0.0014 gm/100 ml. (max.)
Non-volatile residue	0.003 gm/100 ml. (max.)
Permanganate reducing time	10 minutes (min.)
Methyl alcohol	4.8 percent by vol. (max.)
Water	4.8 percent by vol. (max.)
Dissolved oxygen	0.3 ppm (max.)

Note:

1. This alcohol shall be used undiluted as an ARS WCL drying fluid or diluted per Table 6.3-31 for preparation of WCL Ferry Flight Fluid.

TABLE 6.3-28.- TRICHLOROETHYLENE

(Procurement shall be to Specification MIL-T-27602A)

Characteristic	Requirement as delivered to interface
Color (Saybolt)	+24 (min.)
Specific gravity (20°/20°C)	1.450 to 1.470
Distillation range (760 mm Hg)	
Initial boiling point,	86.0°C (186.8°F) (min.)
Dry point,	88.0°C (190.4°F) (max.)
Water content (cloud point)	-10°C (14°F) (max.)
Acidity (pH of water extract)	6.5 (min.)
Residue soluble in CCL <sup>4</sup> (% by wt, as iso-octane)	0.0005 (max.)

TABLE 6.3-29.- BREATHING AIR MIXTURE

(To be made by mixture of oxygen procured to the requirements of Table 6.3-4 or Table 6.3-24 and nitrogen procured to the requirements of Table 6.3-5 or by procurement of liquid air to specification MIL-A-27420 Grade A)

Characteristic	Requirement as delivered to interface
Oxygen	20 percent by vol. (min.) 23.8 percent by vol. (max.)
Nitrogen	75.2 percent by vol. (min.) 79 percent by vol. (max.)
Rare gases (argon, krypton, hydrogen, xenon, helium, neon)	1 percent by vol. (max.)
Carbon monoxide	5 ppm (max.)
Carbon dioxide	50 ppm (max.)
Water	0.3 mg/liter (max.)
Odor	None
Gaseous hydrocarbons, as methane	50 ppm (max.)
Acetylene	0.5 ppm (max.)
Halogenated hydrocarbons	2.0 ppm (max.)
Nitrous oxide	2.0 ppm (max.)
Aeromatic hydrocarbons as benzene	0.5 ppm (max.)

Note:

1. Analysis procedures shall be per the procurement specifications and/or MIL-STD-1564.

TABLE 6.3-32.- HEAT TRANSPORT WATER

(Procurement shall be to specification JSC-SPEC-C-20C Grade A)

Characteristic	Requirement as delivered to interface
Conductivity, $\text{ohm}^{-1} \text{cm}^{-1}$	$3.3 \times 10^{-6}$
pH	6.0 x 7.5
Chlorides, ppm by wt. (max.)	1.0
Surface tension, dynes per cm (min.) (6)	71.72
Total solids, mg/100 ml (max.) (1)	1.0
Total halocarbons (2,6)	Measure for reference only
Dissolved oxygen, ppm by wt. (max.) (3,6)	0.3
Ionic species(6)	
Dissolved iron(4)	Measure for reference only
Dissolved nickel(5)	Measure for reference only

Notes:

1. Determine total solids per FED Test Methods Standard No. 791B, Method 3290, Procedure A.
2. Analysis for total halocarbons per (TBD).
3. Analysis for dissolved oxygen per ASTM D 888-66, Procedure (TBD).
4. Analysis for dissolved iron per (TBD).
5. Analysis for dissolved nickel per (TBD).
6. Not required for component testing (acceptance or qualification) where the component is serviced with test fluid for periods of less than six months.

TABLE 6.3-33.- SHOCK STRUT HYDRAULIC FLUID - ORBITER

(Procurement shall be to specification MIL-H-5606C)

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Characteristic	Requirement as delivered to interface
Pour point	-75°F (max.)
Flash point	200°F (min.)
Specific gravity	Determine for engineering info only
Viscosity @ 100°F	14.0 centistokes (min.)
Viscosity @ -40°F	500 centistokes (max.)
Acid or Base No.	0.20 (max.)
Water	100 ppm (max.)
Trichlorotrifluoroethane(1)	100 ppm (max.)

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Note:

1. Analysis for trichlorotrifluoroethane per (TBD).

TABLE 6.3-30.- AIRLOCK LCG COOLING WATER

(Procurement shall be to Specification JSC-SPEC-C-20C, Grade A)

Characteristic	Requirement as delivered to interface
Conductivity	$3.3 \times 10^{-6} \text{ ohm}^{-1} \text{ cm}^{-1}$ (max.)
pH	6.0 - 7.5
Surface tension	71.72 dynes per cm (min.) @20°C (68°F) (Note 6, Table 6.3-32)
Total solids	1.0 mg/100 ml (max.) (Note 1, Table 6.3-32)

TABLE 6.3-31.- FERRY FLIGHT FLUID

(This ferry flight fluid shall be made by mixing Table 6.3-32 Grade A water and Table 6.3-27 ethyl alcohol) (1)

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Characteristic	Requirement as delivered to interface
Denatured ethyl alcohol	56.5 ± 2 percent by weight
Water	Balance
Dissolved oxygen	TBD

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Notes:

- Mixing of water and alcohol may be accomplished by:
  - Injecting the required amount of ethyl alcohol into the WCL and mixing by circulation with the WCL Pumps (provided that the effluent from the WCL is first determined to be in compliance with Table 6.4-9)or
  - Preparing the proper mix in WCL servicing GSE and then filling the WCL.

In either case the water-alcohol proportions must be verified by final effluent analysis of samples from the WCL.

## 6.4 CHEMICAL AND PHYSICAL CHARACTERISTICS OF SHUTTLE EFFLUENTS

The tables included in this section contain physical and chemical characteristics of fluids taken from vehicle subsystems (SRB, ET, orbiter, SSME, and payloads) when specified in Table 6.2 of this specification. The characteristics of these effluents when sampled from appropriate subsystem test, drain, fill or sample point, will be found in Tables 6.4-1 to 6.4-10 as follows:

<u>FLUID</u>	<u>TABLE</u>
ORBITER HYDRAULIC FLUID . . . . .	6.4-1
GASEOUS OXYGEN . . . . .	6.4-2
GASEOUS NITROGEN . . . . .	6.4-3
HEAT TRANSPORT WATER . . . . .	6.4-4
REFRIGERANT . . . . .	6.4-5
POTABLE WATER . . . . .	6.4-6
COOLING FLUID (FUEL CELLS) . . . . .	6.4-7
FERRY FLIGHT FLUID . . . . .	6.4-8
AIRLOCK LCG COOLING WATER . . . . .	6.4-9
AMMONIA . . . . .	6.4-10



TABLE 6.4-1.- ORBITER HYDRAULIC FLUID

Characteristic	Requirement as sampled from Orbiter reservoir (Orbiter/SSME)
Water	200 ppm (max.)
Acid Number	0.2
Dissolve Air	1 percent by vol. (max.)
1,1,2 Trichloro 1,2,2 Trifluoroethane	100 ppm (max.)
Viscosity @37.8°C (100°F)	14.0 centistokes (min.)

TABLE 6.4-2.- GASEOUS OXYGEN

Characteristic	Requirement as sampled from inlet to cabin
Purity	99.5 percent by vol. (min.)
CO	5 ppm (max.)
CO <sub>2</sub>	5 ppm (max.)
Hydrocarbons (as methane)	29 ppm (max.) (Note 1)
Propane and higher hydrocarbons (as propane)	1 ppm (max.)
Alkyne hydrocarbons (as acetylene)	0.05 ppm (max.)
Aromatic hydrocarbons (as benzene)	0.5 ppm (max.)
Halogenated hydrocarbons (Note 2)	
a. Chlorinated	0.1 ppm (max.)
b. Fluorinated and fluorinated-chlorinated	1 ppm (max.) (Note 1)
c. 1,1,2-trichloro-1,2,2-trifluoroethane	100 ppm (max.)
Nitrous oxide	1 ppm (max.)
Odor	None detectable
Water vapor	10 ppm (max.)
Other	5.0 percent over instrument background noise using I.R. analysis with a 10 meter cell pressurized to 6.8 atm.

Notes:

1. Exclusive of 1,1,2-trichloro-1,2,2-trifluoroethane.
2. Analysis required for Manned Test and Flight use only.
3. Analysis procedures for impurities are per MIL-STD-1564. Purity is by difference.

TABLE 6.4-3.- GASEOUS NITROGEN

Characteristic	Requirements as sampled from inlet to cabin
Purity	95 percent by volume, (min.) (direct method only)
CO	5 ppm (max.)
CO <sub>2</sub>	5 ppm (max.)
Hydrocarbons (as methane)	29 ppm (max.) (Note 1)
Aromatic hydrocarbons (as benzene)	0.5 ppm (max.)
Halogenated hydrocarbons	
a. Chlorinated	0.1 ppm (max.)
b. Fluorinated and fluorinated-chlorinated	1 ppm (max.) (Note 1)
c. 1,1,2-trichloro -1,2,2-trifluoroethane	100 ppm (max.)
Nitrous oxide	1 ppm (max.)
Odor	None detectable
Oxygen	50 ppm (max.)
Water vapor	11.5 ppm (max.)
Other	5 percent over instrument background noise using I.R. analysis with a 10 meter cell pressurized to 6.8 atm.

Notes:

1. Exclusive of 1,1,2-trichloro-1,2,2-trifluoroethane.
2. Analysis procedures for purity shall be the direct method of MIL-P-27401. Analysis procedures for impurities shall be per MIL-STD-1564.

TABLE 6.4-8.- FERRY FLIGHT FLUID

Characteristic	Requirement
Conductivity	$40 \times 10^{-6} \text{ ohm}^{-1} \text{ cm}^{-1}$ (max.)
pH	(TBD)
Total solids	2.0 mg/100 ml max.
Chlorides	(TBD)
Refrigerant (21)	60 ppm (max.)
Alcohol content	$56.5 \pm 2.0$ percent by wt.
Dissolved oxygen	0.5 ppm max.

TABLE 6.4-9.- AIRLOCK LCG COOLING WATER

Characteristic	Requirement
Conductivity	40 x 10 <sup>-6</sup> ohm <sup>-1</sup> cm <sup>-1</sup> (max.)
pH	6.0 - 8.0
Total solids	2.0 mg/100 m/(max.)

TABLE 6.4-6.- POTABLE WATER

Characteristic	Requirement as delivered to cabin use port
Electrical conductivity	Reference only (procedure per ASTM D-1125)
pH	Reference only
Total solids	Reference only
Total organic solids	1 mg/liter maximum
Taste and odor	None at threshold no. of 3
Turbidity	11 units
Color, true	15 units
<u>Ionic species</u>	
Cadmium	0.01 mg/liter (max.)
Chromium (hexavalent)	0.05 mg/liter (max.)
Copper	1.0 mg/liter (max.)
Iron	0.3 mg/liter (max.)
Lead	0.05 mg/liter (max.)
Manganese	0.05 mg/liter (max.)
Mercury	0.005 mg/liter (max.)
Nickel	0.05 mg/liter (max.)
Selenium	0.01 mg/liter (max.)
Silver	0.1 mg/liter (max.)
Zinc	5.0 mg/liter (max.)
Sterility	Free of viable microorganisms
Dissolved gas	No free gas when subjected to one (1) atmosphere at 37° C. (Procedure TBD)
Bactericide	Measure for reference only

TABLE 6.4-7.- COOLING FLUID

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Characteristic

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Requirement

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(TBD)

(TBD)

TABLE 6.4-4.- HEAT TRANSPORT WATER

Characteristic	Requirement
Conductivity	40 x 10 <sup>-6</sup> ohm <sup>-1</sup> cm <sup>-1</sup> (max.)
pH	6.0 - 8.0
Total solids	2.0 mg/100 ml (max.)
Chlorides	1.0 ppm (max.)
Halocarbons <sup>2</sup>	60 ppm (max.)
Dissolved oxygen <sup>3</sup>	0.5 ppm (max.)
Odor	No detectable odor
Dissolved iron <sup>4</sup>	Measure for information only
Dissolved nickel <sup>5</sup>	Measure for information only
Ethyl alcohol <sup>6</sup>	5 percent by volume (max.)

NOTES:

1. Analyze for total solids per Fed. Test Methods Standard No. 791B, Method 3290, Procedure A.
2. Analyze for halocarbons per (TBD)
3. Analyze for dissolved oxygen per ASTM D 888-66, Procedure (TBD)
4. Analyze for dissolved iron per (TBD)
5. Analyze for dissolved nickel per (TBD)
6. Analyze for ethyl alcohol per (TBD)



TABLE 6.4-5.- REFRIGERANT 21

Characteristic	Requirement	
	ACTS Coolant Loop	GSE Coolant Loop
Boiling point	48.1°F ± 2°F	48.1°F ± 2°F
Water	60 ppm by wt. (max.)	60 ppm by wt. (max.)
Chloride ion	0.3 ppm by wt. (max.)	0.3 ppm by wt. (max.)
Dissolved gas/air	5 percent by vol (max.)	No requirement

TABLE 6.4-10.- AMMONIA

Characteristic	Requirement
Oil	(TBD)

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