



National Aeronautics and
Space Administration

SN-C-0005
REVISION D
JULY 20, 1998

Lyndon B. Johnson Space Center
Houston, Texas 77058

REPLACES
SN-C-0005
REVISION C

SPACE SHUTTLE

CONTAMINATION CONTROL REQUIREMENTS

REVISION LOG

REV LTR	CHANGE NO	DESCRIPTION	DATE
		BASELINE ISSUE	03/74
A	1	REVISION A (Reference: Level II PRCBD S15722A, dated 3/7/82) also includes PRCBDs S15492A and S15722.	03/82
B	2	REVISION B (Reference: Level II PRCBD S40129, dated 7/23/86). NOTE: Published as/with Revision C.	9/86
C	3	REVISION C (Reference: Level II PRCBD S15492E, dated 1/6/89).	2/15/89
D	6	REVISION D (Reference: Space Shuttle PRCBD S015492F, dated 6/20/98) also includes CAR S041880B, dated 4/2/93; SSP DOC-271 and Changes 4 and 5.	07/20/98

CHANGE SHEET
FOR
SN-C-0005 - Space Shuttle
Contamination Control Requirements

CHANGE NO. 12

Program Requirements Control Board Directive No. S063593/(1-1), dated 4/9/07; SSP DOC-630A and SSP DOC-651.(1)

April 19, 2007

Kathleen E. Kaminski
Secretary, Program Requirements
Control Board

CHANGE INSTRUCTIONS

1. Remove the following listed pages and replace with the same numbered attached pages:

<u>Page</u>	<u>PRCBD No.</u>
iii	SSP DOC-630A, SSP DOC-651
iv	
v	S063593
vi	
1-1 - 1-2	S063593
2-5	
2-6 - 2-7	S063593
2-8	

NOTE: A black bar in the margin indicates the information that was changed.

2. Remove the List of Effective Pages, dated July 29, 2005 and replace with List of Effective Pages, dated April 19, 2007.

3. Sign and date this page in the space provided below to show that the changes have been incorporated and file immediately behind the List of Effective Pages.

Signature of person incorporating changes

Date

SN-C-0005 - Space Shuttle
Contamination Control Requirements

*Revision D (Reference PRCBD No. S015492F, dated 6/20/98; CAR S041880B, dated 4/2/93 and SSP DOC-271)

LIST OF EFFECTIVE PAGES

April 19, 2007

The current status of all pages in this document is as shown below:

<u>Page No.</u>	<u>Change No.</u>	<u>PRCBD No.</u>	<u>Date</u>
(i)	11	S063079R1	July 8, 2005
(ii)	Rev. D	*	July 20, 1998
(1)	11	S063079R1	July 8, 2005
(2)	10	S071936R1	June 15, 2005
i - ii	Rev. D	*	July 20, 1998
iii	12	SSP DOC-630A	August 21, 2006,
		SSP DOC-651	August 21, 2006
iv	Rev. D	*	July 20, 1998
v	12	S063593	April 9, 2007
vi	Rev. D	*	July 20, 1998
vii	9	S060614CQ	February 15, 2005
viii	Rev. D	*	July 20, 1998
1-1 - 1-2	12	S063593	April 9, 2007
1-3	10	S071936R1	June 15, 2005
1-4	Rev. D	*	July 20, 1998
2-1 - 2-3	Rev. D	*	July 20, 1998
2-4	9	S060614CQ	February 15, 2005
2-5	Rev. D	*	July 20, 1998
2-6 - 2-7	12	S063593	April 9, 2007
2-8	Rev. D	*	July 20, 1998
A-1 - A-6	Rev. D	*	July 20, 1998
B-1 - B-5	9	S060614CQ	February 15, 2005
B-6	10	S071936R1	June 15, 2005
B-7	11	S063079R1	July 8, 2005
B-8	10	S071936R1	June 15, 2005

**INDEX OF DEVIATIONS/WAIVERS AUTHORIZED FOR REQUIREMENTS
CONTAINED IN THIS DOCUMENT**

<u>Number</u>	<u>Title</u>	<u>Para. No.</u>	<u>Page</u>
1.	Retired per Space Shuttle PRCBD S060614CQ, dated 2/15/05 (Reference Level II PRCBD S41427B, dated 2/2/89)	Apx B	(1)
2.	Retired per Space Shuttle PRCBD S071936R1, dated 6/15/05 (Reference Space Shuttle PRCBD S071936, dated 6/5/01)	Apx B	(1)
3.	Retired per Space Shuttle PRCBD S063079R1, dated 7/8/05 (Reference Space Shuttle PRCBD S063079, dated 1/16/03)	Apx B	(1)

THIS PAGE INTENTIONALLY LEFT BLANK

**DEVIATIONS/WAIVERS AUTHORIZED FOR REQUIREMENTS
CONTAINED IN THIS DOCUMENT**

1. **REQUIREMENT:** Retired per Space Shuttle PRCBD S060614CQ, dated 2/15/05. (Reference Level II PRCBD S41427B, dated 2/2/89.) See Appendix B.

2. **REQUIREMENT:** Retired per Space Shuttle PRCBD S071936R1, dated 6/15/05. (Reference Space Shuttle PRCBD S071936, dated 6/5/01.) See Appendix B.

3. **REQUIREMENT:** Retired per Space Shuttle PRCBD S063079R1, dated 7/8/05. (Reference Space Shuttle PRCBD S063079, dated 1/16/03.) See Appendix B.

THIS PAGE INTENTIONALLY LEFT BLANK

I

SN-C-0005

SPACE SHUTTLE

CONTAMINATION CONTROL REQUIREMENTS

THIS PAGE INTENTIONALLY LEFT BLANK


FOREWORD

Efficient management of the Space Shuttle Program (SSP) dictates that effective control of program activities be established. Requirements, directives, procedures, interface agreements, and system capabilities shall be documented, baselined, and subsequently controlled by SSP management.

Program requirements controlled by the Manager, Space Shuttle Program, are documented in, attached to, or referenced from Volumes of NSTS 07700.

This specification has been approved by the Space Shuttle Program Office and is available for use by NASA and associated contractors. General questions concerning the requirements herein should be referred to the Office of Primary Responsibility, Manager, Space Shuttle Safety and Mission Assurance, mail code MA at NASA, Johnson Space Center, Houston, Texas 77058.

All elements of the SSP must adhere to these baselined requirements. When it is considered by the Space Shuttle program element/project managers to be in the best interest of the SSP to change, waive or deviate from these requirements, an SSP Change Request (CR) shall be submitted to the Program Requirements Control Board (PRCB) Secretary. The CR must include a complete description of the change, waiver or deviation and the rationale to justify its consideration. All such requests will be processed in accordance with NSTS 07700, Volume IV - Book 1 and dispositioned by the Manager, Space Shuttle Program, on a Space Shuttle PRCB Directive (PRCBD).



N. Wayne Hale, Jr.
Manager, Space Shuttle Program

THIS PAGE INTENTIONALLY LEFT BLANK

CONTENTS

SN-C-0005

1.0	INTRODUCTION	1-1
1.1	PURPOSE	1-1
1.2	SCOPE	1-1
1.3	APPLICABLE DOCUMENTS	1-1
1.4	DEFINITIONS	1-1
2.0	REQUIREMENTS	2-1
2.1	CONTAMINATION CONTROL ACTIVITIES	2-1
2.2	CONTAMINATION CONTROL PLAN	2-1
2.3	DESIGN	2-1
2.4	CLEANLINESS LEVELS	2-2
2.5	MINIMUM INTERNAL CLEANLINESS	2-3
2.6	PROCUREMENT AND SUBCONTRACTING	2-3
2.7	OPERATIONAL, TESTING, AND SYSTEM CLEANING FLUIDS	2-3
2.8	MANUFACTURING	2-3
2.9	CLEANING METHODS AND MATERIALS	2-3
2.10	PRECISION CLEANING	2-3
2.11	CLEANING FLUIDS CONTROL	2-4
2.12	CLEAN ROOMS, CLEAN WORK STATIONS, AND OTHER WORK ENCLOSURES	2-4
2.13	CALIBRATION PROCEDURES	2-4
2.14	PRODUCT PACKAGING	2-5
	2.14.1 Precision Cleanliness Packaging	2-6
	2.14.2 Visual Cleanliness Packaging	2-6
2.15	INSPECTION	2-6
2.16	RECEIVING INSPECTION	2-7
2.17	IN-PROCESS INSPECTION	2-7
2.18	MINIMUM CLEANLINESS INSPECTION	2-7
2.19	CONTAMINATION CONTROL INSPECTION RECORDS	2-7
2.20	PRODUCT TESTING	2-7

CONTENTS

SN-C-0005

2.21	ENVIRONMENT	2-7
2.22	TEST EQUIPMENT	2-7
2.23	STORAGE AND SHIPPING	2-8
2.24	TRAINING	2-8
2.25	SPECIAL REQUIREMENTS	2-8

APPENDICES

SN-C-0005

A	CLEANLINESS LEVELS	A-1
B	ARCHIVED DEVIATIONS/WAIVERS	B-1



TABLES

SN-C-0005

A.1	SURFACE CLEANLINESS LEVELS	A-3
A.2	VC (VISIBLY CLEAN) LEVELS AND INSPECTION CRITERIA FOR THE ORBITER PAYLOAD (CARGO) BAY, PAYLOAD CANISTER, AND PAYLOADS	A-6

1.0 INTRODUCTION

1.1 PURPOSE

The purpose of this specification is to establish common, definitive responsibilities and requirements for contamination control on the Space Shuttle Program (SSP).

1.2 SCOPE

This specification contains contamination control requirements applicable to space vehicles and Ground Support Equipment (GSE) from design concept through procurement, fabrication, assembly, test, storage, delivery, launch/ground operations, and maintenance for the SSP.

1.3 APPLICABLE DOCUMENTS

The following documents form a part of this specification to the extent specified herein:

- a. NASA SP-5076, Contamination Control Handbook
- b. JSCM 5322, Contamination Control Program Requirements Manual
- c. SE-S-0073, Specification, Fluid Procurement and Use Control
- d. FED-STD-209B, Clean Room and Work Station Requirements Controlled Environment
- e. K-STSM-14.2.1, KSC Cargo Facilities Contamination Control Plan
- f. VCP-85-485, Cargo Operations Contamination Control Plan
- g. NASA-STD-6001, Flammability, Odor, Offgassing, and Compatibility Requirements and Test Procedures for Materials in Environments that Support Combustion

1.4 DEFINITIONS

To promote mutual understanding, the following definitions are provided:

Airborne Particulate Matter - Particulate matter suspended in the ambient atmosphere.

Clean Room - A clean room is an enclosed area employing control over the particulate matter in air with temperature, humidity, and pressure control, as required.

Clean Work Station - A clean work station is a work bench or similar working enclosure characterized by having its own filtered air or gas supply.

Cleanliness Level - An established maximum of allowable contaminants based on size distribution or quantity on a given area or in a specific volume.

Contaminant - Any unwanted matter which could be detrimental to the required operation, reliability, or performance of a part, component, subsystem, or system.

Critical and/or Significant Surface - A surface which requires precision cleanliness.

Fiber - A particle whose length-to-width ratio is in excess of 10 to 1 (minimum length of 100 micrometers).

Fluid - A liquid or gaseous material.

Flush - A rinsing of a part, component, subsystem, or system, using a liquid as the rinsing medium.

GC (Generally Clean) - Freedom from manufacturing residue, dirt, oil, grease, processing debris or other extraneous contamination. This level can be achieved by washing, wiping, blowing, vacuuming, brushing, or rinsing. This level shall not be designated for hardware that is sensitive to contamination.

Micron/Micrometer - A unit of measurement equal to 1×10^{-6} meters (3.93×10^{-5} inches), 25 microns being equal to approximately one-thousandth of an inch.

NVR (Non Volatile Residue) - Soluble (or suspended) material and insoluble particulate matter remaining after controlled evaporation of a filtered volatile liquid, usually measured in milligrams. Filtration is normally through a 0.45-micrometer or 0.8-micrometer membrane filter prior to evaporation.

Particle - Matter with observable length, width, and thickness usually measured in micrometers. This definition includes fibers.

Particle Counters - Automatic electronic devices designed to electronically separate, size, and count individual particles.

Particulate Matter - The general term applied to matter with observable length, width, and thickness, as contrasted to nonparticulate film matter without definite dimension.

Precision Cleaning - Final or fine cleaning accomplished in a controlled environment to achieve precision cleanliness.

Precision Cleanliness - The degree of freedom from contaminants that cannot normally be detected by visual means. Detection and measurement of precision cleanliness require special equipment and techniques.

Precision Clean Packaging - Packaging or protection used to preserve precision cleanliness for a specific period and condition.

Purge - To flow gas through a system (or line, tank, etc.) for the purpose of removing a residual fluid, or for providing a positive flow of gas from some opening in the system.

Silting - An accumulation of minute particles in the size range normally not counted but of sufficient quantity to interfere with sample analysis.

Total Solids - The residue from a known volume of liquid which has been evaporated to dryness in an oven.

VC (Visibly Clean) - The absence of all particulate and nonparticulate matter visible to the normal unaided (except corrected vision) eye. Particulate is identified as matter of miniature size with observable length, width, and thickness. Nonparticulate is a film matter without definite dimension. This level, with the exception of the Orbiter payload (cargo) bay, payload canister and payloads, requires precision cleaning methods, but no particle count.

EXCEPTION: The above requirement is excepted to allow the existence of thin films of Braycote 640 AC-MS in the SSME liquid hydrogen system downstream of the high pressure fuel turbopump and the Orbiter main propulsion system gaseous hydrogen pressurization system upstream of the Vacco filters. The above requirement is also excepted to allow the existence of thin films of Braycote 640 AC-MS in the SSME liquid oxygen system downstream of the high pressure oxygen turbopump and in the Orbiter main propulsion system gaseous oxygen pressurization system. Thin film is defined as nonparticulate film with no visually discernable thickness.

VC Levels STANDARD, SENSITIVE, and HIGHLY SENSITIVE - VC (visibly clean) with specified inspection criteria in accordance with Table A.2. Table A.2 options are applicable for the Orbiter payload (cargo) bay, payload canister, and payloads during Space Shuttle Orbiter/payload integrated operations at launch and landing sites.

VC + UV (Visibly Clean Plus Ultraviolet) - VC (visibly clean) and inspected with the aid of an ultraviolet light (black light) of 3200 to 3800 Angstroms wavelength (3.2×10^{-7} to 3.8×10^{-7} meters). This level requires precision cleaning methods, but no particle count.

Visual Cleanliness Levels - A category which includes VC, VC + UV, and GC cleanliness levels.

THIS PAGE INTENTIONALLY LEFT BLANK

2.0 REQUIREMENTS

2.1 CONTAMINATION CONTROL ACTIVITIES

The contractor shall develop a contamination control activity which implements all contamination control requirements of the contract and the requirements of this specification as applicable to the end product being procured. The contractor shall select and assign specific personnel the responsibility of implementation and management of the contamination control activity. The contractor-developed contamination control activity is subject to review by the procuring agency in accordance with the terms of the contract.

2.2 CONTAMINATION CONTROL PLAN

When specified by contract, the contractor shall develop a contamination control plan to describe the manner in which the contamination control requirements of this specification and of the contract are to be implemented and achieved. The plan shall define the type of facilities to be utilized, the specific cleanliness level to be achieved, and the method of certifying the cleanliness levels. The contamination control plan will be subject to review in accordance with the terms of the contract.

2.3 DESIGN

The consideration of contamination control during the design phase is of the utmost importance. To prevent unnecessarily stringent and costly cleanliness requirements, the design's sensitivity to contamination must be limited to the maximum extent possible.

To assure the most effective contamination control at minimum cost, the designer shall provide for:

- a. Reduction of design sensitivity to contamination
- b. Incorporation of features which will minimize or eliminate self-generation of contamination
- c. Materials compatibility for contamination and corrosion control
- d. Incorporation of filtration and/or other design features for contamination control during system operation
- e. Maintainability features to facilitate contamination removal and monitoring during maintenance

Upon selection of the design, the contractor shall establish:

- a. The cleanliness levels required by the design
- b. Manufacturing and processing environmental requirements
- c. Assembly, processing, and test requirements pertaining to contamination control
- d. Cleanliness preservation and storage requirements

Lubricants, sealing and staking compounds, nonmetallic materials, etc., shall be selected, tested, and controlled to ensure preservation of the required cleanliness levels. Selection and evaluation of these materials shall include consideration of out-gassing and degradation resulting from all environmental conditions expected during the life and use of the end product.

NOTE: Contamination control guidelines for designers may be obtained from NASA SP-5076, Contamination Control Handbook.

2.4 CLEANLINESS LEVELS

The contractor shall, unless otherwise specified by contract, establish, document, and adhere to the cleanliness levels for each part, component, subsystem, and system of the end product. The contractor-established cleanliness levels shall provide the cleanliness required for the most contamination sensitive design features of the product. Cleanliness levels shall be selected from Table A.1, Surface Cleanliness Levels, unless otherwise specified or approved by the procuring agency.

NOTE: With respect to the Orbiter payload (cargo) bay, payload canister and payload, the VC baseline as referred to in contractual documents is, unless otherwise stated, "visibly clean level STANDARD" as defined in Table A.2. VC levels SENSITIVE and HIGHLY SENSITIVE are at extra cost and added ground operations time.

VC levels STANDARD, SENSITIVE, and HIGHLY SENSITIVE are to be documented by Operations and Maintenance Requirements and Specifications Documentation (OMRSD) and OMIs (Operations and Maintenance Instructions) with established costs and ground processing schedule impact. Special cleanliness requirements will be evaluated on an individual basis. This is responsive to Paragraph 2.25 of this document. When approved by the procuring agency, appropriate OMRSD and OMI documentation will be generated and maintained.

Analysis methods for NVR fallout from LLS (Launch and Landing Site) facility environments can be found in KSC document K-STSM-14.2.1, and USAF document VCP-85-485.

2.5 MINIMUM INTERNAL CLEANLINESS

Where precision cleanliness or visual cleanliness levels have not been stipulated by the contract and are not required by the design, internal areas shall, as a minimum, be subjected to a cleanliness inspection. This inspection shall verify the absence of loose hardware, soils, and all other extraneous materials, such as excessive lubricant or sealing compound, solder, etc. The presence of such materials shall require appropriate corrective cleaning action(s).

2.6 PROCUREMENT AND SUBCONTRACTING

The contractor shall assure that the applicable contamination control requirements of this specification and of the contract are included in its subcontracts. Cleanliness levels stipulated for subcontract item(s) shall be compatible with the cleanliness requirements of the end product.

2.7 OPERATIONAL, TESTING, AND SYSTEM CLEANING FLUIDS

Fluids used for the operation, testing, and cleaning of Space Shuttle fluid systems shall conform to SE-S-0073, where applicable.

2.8 MANUFACTURING

The contractor shall have procedures which shall establish and maintain the cleanliness requirements for the article being manufactured. The procedures shall give consideration for their potential applicability for use during the operational life of the end product.

2.9 CLEANING METHODS AND MATERIALS

The contractor shall implement detailed methods and procedures for attaining the cleanliness levels required for the product. The cleaning methods selected shall be compatible with the design configuration. The cleaning methods must not be detrimental to the materials of construction and/or to the design requirements of the part or component.

2.10 PRECISION CLEANING

When precision cleanliness levels are required, the precision cleaning processes shall be performed in a controlled environment, and shall be controlled to documented procedures. The level of precision cleanliness achieved shall be verified, and evidence of inspection and acceptance documented. The precision cleaned article shall be packaged in accordance with the requirements of the Product Packaging section of this

specification. Packaging shall be conducted immediately after verification of cleanliness and prior to leaving the controlled environment.

2.11 CLEANING FLUIDS CONTROL

The contractor shall establish and implement requirements for all cleaning fluids. All cleaning fluids utilized shall be controlled by documented requirements. The contractor shall procure cleaning fluids in accordance with SE-S-0073, where applicable.

Unless otherwise specified in the contract, the contractor shall select from existing specifications, or shall establish composition requirements for cleaning fluids. All cleaning fluids used shall comply with the specified requirements.

The cleaning fluids selected for use as precleaning solutions shall be controlled during use by analysis, solution replacement, or adjustment, to maintain cleaning effectiveness and compatibility with the type of material being cleaned.

Final flush and verification fluids for precision cleanliness shall be analyzed prior to use to determine compliance with the stipulated specification requirements.

The contractor shall maintain fluid control records. The records shall indicate the scheduled analysis results and any solution replacement or adjustments.

2.12 CLEAN ROOMS, CLEAN WORK STATIONS, AND OTHER WORK ENCLOSURES

Assembly, processing, and functionally testing of the product shall be conducted in facilities which provide airborne contamination levels compatible with the product cleanliness required.

Clean rooms and clean work stations required for product processing shall be classified as described in FED-STD-209B. The operation of all clean rooms, clean work stations, or other environmentally controlled work enclosures shall be controlled by approved documented procedures. These operating procedures for monitoring shall be selected from requirements contained in FED-STD-209B, as applicable for the product. Examples of clean room monitoring and apparel requirements are found in JSCM 5322.

The contractor shall establish and implement the requirements for the periodic certification of clean rooms, clean work stations, and other environmentally controlled work enclosures. The certification process shall be controlled by contractor-established documented procedures.

2.13 CALIBRATION PROCEDURES

The contractor shall establish the requirements and documented procedures for the calibration of facilities and equipment used for the contamination control activity.

NOTE: Automatic liquid-borne particle counters cannot be utilized for final verification of cleanliness of the end product unless the individual counters have demonstrated accuracy and repeatability, and their use is approved by the procuring agency.

2.14 PRODUCT PACKAGING

The contractor shall establish and implement requirements and processes for packaging the cleaned article, interim and final, as necessary to preserve the required cleanliness level. The packaging processes shall be controlled by documented procedures.

Packaging materials selected for cleaning items shall possess:

- a. Qualities which allow for visual inspection and ready identification of the cleaned item.
- b. Flexibility and strength adequate to assure normal handling without rupture.
- c. Compatibility with the cleanliness level required for the item.
- d. Resistance to particle sloughing that is compatible with the required cleanliness levels.
- e. A coefficient of heat sealability that assures the formation of an effective and strong seal.
- f. Low water-vapor-transmission rate to reduce or eliminate corrosion of the item.
- g. Antistatic properties compatible with the item.
- h. Characteristics that, through normal storage periods, will not adversely affect or contaminate the item.

NOTE: NASA SP-5076 contains information on the characteristics of various packaging materials. Examples of acceptable packaging procedures are found in JSCM 5322.

2.14.1 Precision Cleanliness Packaging

Precision cleaned items shall be double-bagged during the packaging process to assure:

- a. The preservation of item cleanliness in the event of damage to one bag.
- b. Both slough resistance and moisture barrier qualities.
- c. The ability to remove the outer bag during transfer of item(s) into a clean room in order to maintain the cleanliness of the packaged items and the clean room environment.

Caps and plugs used to protect internal areas of fluid system components shall be compatible with the system fluid. When caps or plugs are not used, the inner bag material shall be compatible with the system fluid. Compatibility with oxygen shall be determined by testing in accordance with NASA-STD-6001, Flammability, Odor, Offgassing, and Compatibility Requirements and Test Procedures for Materials in Environments that Support Combustion, Test 13A. Oxygen compatibility testing is not required for inner bag materials fabricated from fluorinated ethylene propylene and chlorotrifluoroethylene films, both of which have acceptable oxygen compatibility. Compatibility with other fluids shall be determined from literature data or by testing in accordance with NASA-STD-6001, Test 15. Batch and/or lot testing for tested and approved packaging/bagging materials is not required.

2.14.2 Visual Cleanliness Packaging

2.14.2.1 GC Packaging

GC items are not required to be packaged.

2.14.2.2 VC Packaging

VC items shall be packaged with one bag (disposable or reusable) or equivalently protected in a suitable container. VC items that are moisture sensitive shall be packaged with one bag as a minimum (disposable or reusable). All VC packaging materials shall be in accordance with Paragraphs 2.14a through 2.14h; Paragraphs 2.14a and 2.14e are not applicable for VC containers.

2.14.2.3 VC + UV Packaging

VC + UV items shall be packaged in accordance with Paragraph 2.14.1.

2.15 INSPECTION

The contractor shall assure compliance to the contamination control requirements and procedures by performing verification inspections, and shall retain inspection records.

2.16 RECEIVING INSPECTION

The contractor shall establish procedures and appropriate environmental controls for receiving inspection of procured items. The inspection of procured items shall assure that storage, transit, and handling of the packaged items have not violated the required cleanliness.

2.17 IN-PROCESS INSPECTION

During manufacturing and assembly of the product and/or operational use, inspections shall be performed to assure the achieved cleanliness has not been degraded or jeopardized.

2.18 MINIMUM CLEANLINESS INSPECTION

The inspection required by Paragraph 2.5 shall be performed prior to such assembly processes as potting, foaming, final closure, and the incorporation of subassemblies into higher order assemblies.

2.19 CONTAMINATION CONTROL INSPECTION RECORDS

The contractor shall maintain records of contamination control processing which are traceable to the articles processed. Traceable records shall also be maintained for contamination control facility tests and certification of flush or test fluids. Certification of cleanliness shall accompany the product upon delivery of the procuring agency.

2.20 PRODUCT TESTING

Testing requirements and procedures shall include contamination controls. The testing controls shall assure that testing equipment, techniques, and materials do not degrade the previously achieved product cleanliness.

2.21 ENVIRONMENT

The test environment shall be established and controlled as required for product cleanliness. Whenever critical surfaces of the item are exposed (for example, when connecting or disconnecting equipment), either the entire test environment shall be controlled or effective localized environmental controls shall be implemented.

2.22 TEST EQUIPMENT

Test equipment used shall have contamination controls compatible with the cleanliness required for the product. Particular attention shall be given to cleanliness of interfacing components. Liquids, gases, and other materials used in the test equipment systems which interface with the product shall meet the purity, cleanliness, and physical properties required for the product.

2.23 STORAGE AND SHIPPING

The contractor shall establish and utilize a storage and shipping procedure which maintains the required cleanliness of the product(s).

2.24 TRAINING

The contractor shall select, assign, and train personnel in all areas required to satisfactorily meet the requirements of the contamination control activity.

The contractor training shall assure that all personnel responsible for contamination control functions shall be trained as required to assure proficiency within their assigned task. Manufacturing and support personnel shall be trained or indoctrinated to the extent necessary to prevent compromise of contamination control. Retraining of all personnel shall be accomplished, as required. The contractor shall establish personnel certification with traceable documentation.

2.25 SPECIAL REQUIREMENTS

The contractor shall determine if special requirements (for example, radiation, microbial, total organics, etc.) are required by the product design or application. As applicable, these requirements shall be established and implemented when approved by the procuring agency.

APPENDIX A
CLEANLINESS LEVELS

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE A.1
SURFACE CLEANLINESS LEVELS

VISUAL CLEANLINESS LEVELS

- GC (Generally Clean) (1) Freedom from manufacturing residue, dirt, oil, grease, processing debris or other extraneous contamination. This level can be achieved by washing, wiping, blowing, vacuuming, brushing, or rinsing. The GC level shall not be designated for hardware that is sensitive to contamination.
- VC (Visibly Clean) (2) The absence of all particulate and nonparticulate matter visible to the normal unaided (except corrected vision) eye. Particulate is identified as matter of miniature size with observable length, width, and thickness. Nonparticulate is film matter without definite dimension. This level, with the exception of the Orbiter payload (cargo) bay, payload canister and payloads, requires precision cleaning methods, but no particle count.
- VC + UV (Visible Clean Plus Ultraviolet) (2) Visibly clean (as defined above) and inspected with the aid of an ultraviolet light (black light) of 3200 to 3800 Angstroms wavelength (3.2×10^{-7} TO 3.8×10^{-7} meters).

NOTE: Any evidence of fluorescence shall be cause for recleaning. If recleaning does not reduce the fluorescence, an investigation shall be made to determine whether the fluorescing material is contamination or the basic materials. This level requires precision cleaning methods, but no particle count.

TABLE A.1
SURFACE CLEANLINESS LEVELS - Continued

<u>PRECISION PARTICULATE LEVELS</u>			<u>PRECISION PARTICULATE LEVELS</u>		
<u>Level</u>	<u>Particle Size Micrometers</u>	<u>Range (3) (4)</u>	<u>Level</u>	<u>Particle Size Micrometers</u>	<u>Range (3) (4)</u>
1000	<500	Unlimited (5)	25	<5	Unlimited (5)
	500 thru 750	34		5 thru 15	19
	>750 thru 1000	5		>15 thru 25	4
	>1000	0		>25	0
750	<250	Unlimited (5)	Example: Level 300 would be particulate level 300. Level 300 C would be particulate level 300 plus NVR level C.		
	250 thru 500	205			
	>500 thru 750	9			
	>750	0			
500	<100	Unlimited (5)	<u>NVR (NONVOLATILE RESIDUE) LEVELS</u>		
	100 thru 250	1073	Maximum Quantity NVR Per 0.1 Square Meters		
	>250 thru 500	27	<u>Level</u>	<u>(1 Sq. Ft.) (3)</u>	
	>500	0	A	1 mg.	
300	<100	Unlimited (5)	B	2 mg.	
	100 thru 250	93	C	3 mg.	
	>250 thru 300	3	D	4 mg.	
	300	0			
250	<100	Unlimited (5)			
	100 thru 200	39			
	>200 thru 250	3			
	>250	0			
200	<50	Unlimited (5)			
	50 thru 100	154			
	>100 thru 200	16			
	>200	0			
150	<50	Unlimited (5)			
	50 thru 100	47			
	>100 thru 150	5			
	>150	0			
100	<25	Unlimited (5)			
	25 thru 50	68			
	>50 thru 100	11			
	>100	0			
50	<15	Unlimited (5)			
	15 thru 25	17			
	>25 thru 50	8			
	>50	0			

TABLE A.1

SURFACE CLEANLINESS LEVELS - Concluded

- NOTES: (1) Inspection criteria shall be specified at the discretion of the procuring agency. In the event that cleaning is necessary to achieve the GC level, evidence that cleaning was performed will constitute verification of the GC level.
- (2) Inspection criteria shall be specified at the discretion of the procuring agency. Refer to Table A.2 for inspection criteria options that are applicable for the Orbiter payload (cargo) bay, payload canister, and payloads during Space Shuttle Orbiter/payload integrated operations at launch and landing sites.
- (3) Particulate and NVR allowables are based on 0.1 square meters (1 square foot) of surface area. Flush fluid quantity for sampling shall be 100 milliliters per 0.1 square meters (1 square foot) of surface area. Small parts should be grouped together to obtain 0.1 square meters (1 square foot) of surface area. For determination of NVR fallout in environmentally controlled areas, see Paragraph 2.4.
- (4) Maximum quantity per 1.0 standard cubic meters (35 standard cubic feet) of effluent gas when systems are being evaluated by purging. If feasible, the sampling must be accomplished at maximum system operational flow rate.
- (5) Unlimited means particulate in this size range is not counted; however, if the accumulation of this silt is sufficient to interfere with the analysis, the sample shall be rejected.

TABLE A.2

VC (VISIBLY CLEAN) LEVELS AND INSPECTION CRITERIA FOR THE ORBITER PAYLOAD (CARGO) BAY, PAYLOAD CANISTER, AND PAYLOADS

Three levels of VC requirements are available for the Orbiter payload (cargo) bay, payload canister and payloads during Space Shuttle Orbiter/payload integrated operations at launch and landing sites. VC STANDARD is baseline as referred to in contractual documentation. The VC definition in Table A.1 is applicable to this table with the understanding that incident light levels and inspection distances are specified herein:

VC Level	Incident Light Level (1)	Observation Distance	Remarks
Standard	≥ 50 foot-candles	5 to 10 feet	(2) (3) (5)
Sensitive	≥ 50 foot-candles	2 to 4 feet	(2) (3) (5)
Highly Sensitive	≥ 100 foot-candles	6 to 18 inches	(3) (4)

- NOTES: (1) One-foot candle (lumens per square foot) is equivalent to 10.76 lumens per square meter.
- (2) Cleaning is required if the surface in question does not meet VC under the specified incident light and observation distance conditions.
- (3) Exposed and accessible surfaces only.
- (4) Initial cleaning is mandatory; Note (2) applies thereafter.
- (5) Areas of suspected contamination may be examined at distances closer than specified for final verification.

APPENDIX B
ARCHIVED DEVIATIONS/WAIVERS

THIS PAGE INTENTIONALLY LEFT BLANK

I

APPENDIX B
ARCHIVED DEVIATIONS/WAIVERS

1.0 PURPOSE AND SCOPE

The purpose of this appendix is to retain those Deviations/Waivers retired due to the expiration of effectivity.

1.1 RETIRED DEVIATIONS/WAIVERS

The Deviations/Waivers contained in this section have been removed from the list of active Deviations/Waivers because of expiration of effectivity.

THIS PAGE INTENTIONALLY LEFT BLANK

I

**ARCHIVED DEVIATIONS/WAIVERS AUTHORIZED FOR
REQUIREMENTS CONTAINED IN THIS DOCUMENT**

- 1. REQUIREMENT:** Paragraph 1.4 DEFINITIONS, specifies that to promote mutual understanding, the following definitions are provided:

GC (Generally Clean) - Freedom from manufacturing residue, dirt, oil, grease, processing debris or other extraneous contamination. This level can be achieved by washing, wiping, blowing, vacuuming, brushing, or rinsing. This level shall not be designated for hardware that is sensitive to contamination.

VC (Visibly Clean) - The absence of all particulate and non-particulate matter visible to the normal unaided (except corrected vision) eye. Particulate is identified as matter of miniature size with observable length, width, and thickness. Nonparticulate is a film matter without definite dimension. This level, with the exception of the Orbiter payload (cargo) bay, payload canister and payloads, requires precision cleaning methods, but no particle count.

VC + UV (Visibly Clean Plus Ultraviolet) - VC (visibly clean) and inspected with the aid of an ultraviolet light (black light) of 3200 to 3800 Angstroms wavelength (3.2×10^{-7} to 3.8×10^{-7} meters). This level requires precision cleaning methods, but no particle count.

Visual Cleanliness Levels - A category which includes VC, VC + UV, and GC cleanliness levels.

Paragraph 2.10 PRECISION CLEANING, specifies that when precision cleanliness levels are required, the precision cleaning processes shall be performed in a controlled environment, and shall be controlled to documented procedures. The level of precision cleanliness achieved shall be verified, and evidence of inspection and acceptance documented. The precision cleaned article shall be packaged in accordance with the requirements of the Product Packaging section of this specification. Packaging shall be conducted immediately after verification of cleanliness and prior to leaving the controlled environment.

- WAIVER:** This waiver allows pre-shipment cleaning of the following EMU hardware to the specified visual cleanliness level without utilization of a "controlled environment" facility for STS-26 and subsequent.

**ARCHIVED DEVIATIONS/WAIVERS AUTHORIZED FOR
REQUIREMENTS CONTAINED IN THIS DOCUMENT - Continued**

<u>Nomenclature</u>	<u>Drawing Number</u>
Comm. Carrier Assy (CCA)	0101-10001
Gloves	0106-10006
Hard Upper Torso (HUT)	0102-10002
Arms	0103-10003
Lower Torso Assy (LTA)	0104-10004
Helmet	0105-10005
Liquid Cooling Ventilation Garment (LCVG)	0107-10007
Extravehicular Visor Assy (EVVA)	0108-10008
Insuit Drink Bag (IDB)	0110-10010

EFFECTIVITY: STS-26 thru STS-999.

AUTHORITY: Level II PRCBD S41427B, dated 2/2/89.

2. REQUIREMENT: Paragraph 1.4 DEFINITIONS. VC (Visibly Clean) - The absence of all particulate and nonparticulate matter visible to the normal unaided (except corrected vision) eye. Particulate is identified as matter of miniature size with observable length, width, and thickness. Nonparticulate is a film matter without definite dimension. This level, with the exception of the Orbiter payload (cargo) bay, payload canister and payloads, requires precision cleaning methods, but no particle count.

WAIVER: The above requirement is waived to allow the existence of thin films of Braycote 640 AC-MS in the SSME liquid hydrogen system downstream of the High Pressure Fuel Turbopump/Alternate Turbopump and the Orbiter Main Propulsion System gaseous hydrogen pressurization system upstream of the vacco filters. Thin film is defined as nonparticulate film with no visually discernable thickness.

RATIONALE: Braycote 640 AC-MS used in the HPFTP/AT as an anti-gallant has been determined to migrate and deposit a thin film of lubricant on the downstream portions of the SSME LH₂ and Orbiter MPS GH₂ systems. Testing has established that limited quantities of this material do not interfere with engine and Orbiter pressurization system operation.

**ARCHIVED DEVIATIONS/WAIVERS AUTHORIZED FOR
REQUIREMENTS CONTAINED IN THIS DOCUMENT – Concluded**

EFFECTIVITY: STS-104, STS-105, STS-107 thru STS-114

AUTHORITY: Space Shuttle PRCBD S071936, dated 6/5/01.

- 3. REQUIREMENT:** Paragraph 2.14.1 Precision Cleanliness Packaging.
Precision cleaned items shall be double-bagged during the packaging process to assure:
- a. The preservation of item cleanliness in the event of damage to one bag.
 - b. Both slough resistance and moisture barrier qualities.
 - c. The ability to remove the outer bag during transfer of item(s) into a clean room in order to maintain the cleanliness of the packaged items and the clean room environment.

Caps and plugs used to protect internal areas of fluid system components shall be compatible with the system fluid. When caps or plugs are not used, the inner bag material shall be compatible with the system fluid.

WAIVER: The above requirement is waived to allow the user of Aclar 22A film as the primary protective packaging layer for KSC precision cleaned hardware.

RATIONALE: Aclar 22A material which did not meet the definition of LOX compatibility per NASA-STD-6001, was placed in KSC inventory and subsequently issued for flight hardware processing. The material is normally issued as a bench stock item making precise use tracking impossible.

Actual test results indicate that the failed material is acceptable as a LOX compatible material for KSC flight hardware processing applications and introduces no additional risk.

EFFECTIVITY: STS-107, STS-114, STS-115, STS-118 and STS-121.

AUTHORITY: Space Shuttle PRCBD S063079, dated 1/16/03.

THIS PAGE INTENTIONALLY LEFT BLANK

I