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CONTAMINATION CONTROL REQUIREMENTS MANUAL

Change 1, February 2012

**Responsible Office: Safety and Mission Assurance
Directorate**

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Change History Log

Revision	Date	Originator	Description of Changes
Baseline	9/1970		Initial Release
A	12/1974		Not available
A, Change 1	8/1980		Not available
B	11/1982		Not available
C	2/1994		Not available
C. Change 1	9/1995		Not available
D	5/2000		Not available
E	11/2000		Not available
E, Change 1	8/2001		Not available
F	2/2004	NS/Paul Torrance 483- 1883	Complete rewrite. Changed document type from 'JPG' to 'JPR'.
G	6/2009	NS/Paul Torrance 483- 1883	Deleted section 2.1 Revised cleanliness levels to be in compliance with Shuttle, ISS and Constellation requirements. Revised definition to be in line with CXP 70145, Constellation Program Contamination Control Requirements. Revised language to clean to VC-sensitive level instead of VC level in section 5.5.2.1 & 5.5.2.2. Revised language to always require gloves for handling VC-cleaned hardware. Revised language to require double bagging of VC-cleaned hardware. Revised language to seal precision-cleaned orifices with compatible packaging material rather than tape. Added language to reference the JSC FOD Prevention Program, JPR 5335.5. Revised language of items cleaned to VC level to require double bagging to be consistent with 8.1.5.2.

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			Section 18, Reference Documents section moved to Preface.
Admin Change	7/2010	NS/Paul Torrance 483-1883	Editorial correction to Table V: Changed single bagging to double bagging. Note 1 changed single bag to outer bag.
Change 1	02/2012	NS/Paul Torrance 483-1883	Section 3: Added authority document NPD 8730.5, NASA Quality Assurance Program Policy Section 4: Added applicable documents: JPR 1440.3, JSC Records Management Procedural Requirements; JPR 5322.1 ,JSC Contamination Control Requirements Manual; JWI 8730.4, Quality Assurance Record Center Discrepancy Reporting and Tracking; Society of Automotive Engineers (SAE) AS 9100 SAE Aerospace Standard; National Aerospace Standard NAS 412 Foreign Object Damage/Foreign Object Debris (FOD) Prevention Section 1.4. Added the foreign object debris areas and points of contact. Section 13: The requirements of JPR 5335.5 JSC Foreign Object Debris (FOD) Damage Prevention Program were merged into Section 13 of this manual, so that all contamination control information and guidance (including FOD) are located in one central document. Appendix C: JSC Organization List of FOD Control Areas added. Updated signatory.

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P. PREFACE

P.1 PURPOSE

This JSC Contamination Control Requirements Manual establishes the minimum requirements and controls necessary to establish and maintain an effective contamination control system.

P.2 APPLICABILITY

This manual is applicable to JSC organizations and on-site and off-site contractors who are responsible for designing, developing, manufacturing, inspecting, processing for shipment, and testing of ground, flight and flight-related equipment.

P.3 AUTHORITY

- a. NPD 8730.5 NASA Quality Assurance Program Policy
- b. SSP-30426, "Space Station External Contamination Control Requirements"

P.4 APPLICABLE DOCUMENTS

- a. JPR 1440.3 JSC Records Management Procedural Requirements
- b. JPR 5335.5, "JSC FOD Prevention Program"
- c. JWI 8730.4 Quality Assurance Record Center Discrepancy Reporting and Tracking
- d. MIL-HDBK-408, "Microbial Deterioration in Electronics. Its Origin and Control"
- e. NAS 412, Foreign Object Damage/Foreign Object Debris (FOD) Prevention
- f. SE-S-0073, "NSTS Specification, Fluid Procurement and Use"
- g. SP-5076, "Contamination Control Handbook"
- h. FED-STD-209E, "Airborne Particulate Cleanliness Classes in Cleanrooms and Clean Zones...."
- i. IEST-RP-CC002.2, "Unidirectional Flow Clean Air Devices"
- j. IEST-RP-CC003.2, "Garments Required in Cleanrooms and Controlled Environments"
- k. IEST-RP-CC006.2, "Testing Cleanrooms"
- l. IEST-RP-CC023.1, "Micro-organisms in Cleanrooms"

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- m. IEST-RP-CC027.1, "Personnel Practices and Procedures in Cleanroom and Controlled Environments"
- n. ISO 14644-1, "Cleanrooms and associated controlled environments. Part 1: Classification of air cleanliness"
- o. ISO 14644-2, "Cleanrooms and associated controlled environments. Part 2: Specifications for testing and monitoring to prove continued compliance with ISO 14644-1"
- p. ISO 14644-3, "Cleanrooms and associated controlled environments. Part 3: Metrology and test methods"
- q. ISO 14644-5, "Cleanrooms and associated controlled environments. Part 5: Operations"
- r. ISO 14698-1, "Cleanrooms and associated controlled environments – Biocontamination control. Part 1: General principles and methods"
- s. ISO 14698-2, "Cleanrooms and associated controlled environments – Biocontamination control Part 2: Evaluation and Interpretation of biocontamination data"
- t. SAE AS 9100, SAE Aerospace Standard
- u. TO 00-25-203, "Contamination Control of Aerospace Facilities, US Air Force"
- v. JSC Form JF1615, "Clean Room Work Request and Laboratory Report"
- w. NT-PRE-003, "Cleanliness and Cleanroom Certification Contamination Control"
- x. NT-QAS-018, "Quality Assurance Specialist or Designated Verification Personnel Functions in Cleaning Facilities"

P.5 MEASUREMENT/VERIFICATION:

Appropriate contamination control requirements will be included in procurement documents. The contractor will submit a certification of cleanliness. The responsible design or user organization will determine cleanliness levels and visually inspect or verify these levels. All certifications will be maintained.

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P.6 CANCELLATION / RESCISSION:

JPR 5322.1, Revision F, Contamination Control Requirements Manual, dated February 16, 2005, is cancelled.

William S. McArthur
Director, Safety and Mission Assurance

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1.0 INTRODUCTION

1.1 Trade Names

The use of trade names of commercially available products does not constitute an endorsement by NASA nor does it imply that there are no other suitable products available.

1.2 Waivers and Deviations

If compliance with the facility, process, product, or personnel requirements of this manual is not possible, the responsible technical organization shall initiate a waiver or deviation and submit it in sufficient time to allow for proper evaluation and disposition through the formal concurrence and approval process.

Note: All requests for waivers and deviations will be submitted by memorandum to the Director, Safety and Mission Assurance (S&MA), the approval authority. The S&MA Director can delegate the approval authority to the Safety and Test Operations Division by memorandum for individual or all waiver requests.

1.3 Revisions and Changes

All revisions and changes to this manual shall be approved by formal JSC concurrence procedures, as specified in applicable JSC management documentation.

1.4 Foreign Object Debris Control Areas and POCs

Appendix C contains a listing of the FOD control areas and their POCs. This listing is under the control of the Quality and Flight Equipment Division (NT). If changes to the FOD control areas and their POCs are needed, division management will promptly notify NT with updates to keep the list current.

2.0 PROCUREMENT

Appropriate contamination control requirements shall be included in procurement documents for flight and flight-related equipment, environmental test facilities, facility fluid systems, precision-cleaned packaging materials, and garment maintenance services by the requirement initiator.

Note: The Safety and Test Operations Division will, upon request, assist JSC organizations in the selection of cost-effective contamination control requirements.

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2.1 Requirement Initiator

2.1.1 The requirement initiator shall assure that procurement documents for systems, subsystems, and major assemblies require that the contractor submit a certification of cleanliness, which identifies the cleanliness level to which the contract item was cleaned and verified.

2.1.2 The cleanliness level certified by the contractor shall be correlated to the levels identified in Table IV of this document.

2.1.3 The verification methods and data shall be provided by the contractor.

2.2 Review of Procurement Documentation

Contamination control provisions of contracts shall be submitted to the S&MA and Engineering Directorates, or approved alternate, for review and approval prior to procurement.

Note: Remote JSC sites, such as White Sands Test Facility (WSTF), can follow internal contract and procurement processes for review and approval and should provide the final procurement document to S&MA for information.

3.0 ACCOMPANYING DOCUMENTATION

a. The documentation accompanying precision, visibly clean + ultraviolet (VC + UV), or VC level cleaned items shall be reviewed for compliance by the owner of the item with applicable contract requirements, including any certification of cleanliness. Such documentation and/or item certification shall be maintained by the owner of the item as a permanent record traceable to the item received.

Note: This includes items fabricated or assembled on site from externally supplied parts, such as flex hose assemblies.

b. Center-sponsored facilities shall retain certifications records beyond the life of the facility according to agency retention requirements (see Appendix B).

4.0 SURFACE CLEANLINESS LEVELS

The responsible design or user organization shall select cleanliness levels from the following two categories that meet a wide range of cleanliness needs:

a. Visible cleanliness. Visible cleanliness levels are described as “qualitative” in that verification and/or inspection of these levels is visual. However, these levels are not considered inadequate, since the application of these levels must be viewed with respect to hardware design and operation. These levels represent a cost-effective alternative to precision cleanliness levels and offer greater flexibility for the appropriate design or using

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organizations. Visible cleanliness levels may be used as either interim or final cleanliness levels.

- b. Precision cleanliness. Precision cleanliness levels specify the maximum quantity of particulate and/or nonvolatile residue (NVR) permitted on external or internal surfaces of the hardware after cleaning.

4.1 Visible Cleanliness Level Requirements

Visible cleanliness levels defined for JSC hardware are: Generally Clean (GC), Visibly Clean (VC), and Visibly Clean, Ultraviolet (VC+UV).

4.1.1 GC Level

Piece parts cleaned to GC level shall be free of manufacturing residue, dirt, oil, grease, processing debris, or other extraneous contamination.

Note: Cleaning is required only if the item does not pass inspection. Heat-sealed bagging protection is not required, but normal protection is required for handling, shipping, and storage. The GC level should be specified for hardware that is not sensitive to contamination and is easily and quickly cleaned or re-cleaned.

- a. VC level cleaned hardware shall meet the requirements of the GC Level.
- b. VC cleaned hardware shall be cleaned and qualitatively verified to be free of all particulate and non-particulate material visible to the normal unaided eye.
- c. Hardware cleaned to VC levels shall be continuously protected using heat-sealed double bagging.
- d. Items which cannot be heat sealed because of size, weight, or configuration and which have VC cleaned critical surfaces shall be prepackaged to cover all exposed critical surfaces.

Notes:

(1) Levels of VC requirements defined within the VC cleanliness category based on incident light levels and inspection distances include:

- (a) VC Standard: Incident light level $\geq 500 \text{ lm/m}^2$ (50 ft-candles). Inspection distance 1.5 to 3 m (5 to 10 feet).
- (b) VC Sensitive: Incident light level $\geq 500 \text{ lm/m}^2$ (50 ft-candles). Inspection distance 0.6 to 1.2 m (2 to 4 feet).
- (c) VC Highly Sensitive: Incident light level $\geq 1000 \text{ lm/m}^2$ (100 ft-candles). Inspection distance 0.15 to 0.45 m (6 to 18 inches).

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(2) For all VC levels, areas of suspected contamination may be inspected at closer distances than specified above.

(3) VC level inspections are limited to exposed and accessible surfaces. The use of inspection aids such as wipes, mirrors, borescopes, or tape lifts is permissible for those areas of suspect condition with limited or no direct line of sight.

(4) When inspection of piece parts at the minimum inspection distance specified for the required cleanliness level is impractical (for example, having to hold parts cleaned to level VC Standard 1.524 m [5 feet] away), closer inspection is permitted.

(5) When interior volumes do not provide sufficient access to physically conduct an inspection within the defined VC range, the inspection can be conducted at a distance that deviates from the defined range only to the extent required to physically perform the inspection.

4.1.2 VC + UV Level

a. For the VC + UV cleanliness level, the hardware shall be free of all visible particulate and non-particulate contamination augmented by inspection under UV light (UV light of 3,200 to 3,800 angstroms wavelength).

b. Any evidence of fluorescence during UV inspection shall be cause for re-cleaning.

c. If the surface to be inspected is inaccessible, a wipe test will be performed and the wiping medium shall be inspected under UV light.

d. All items cleaned to VC+UV level will be continuously protected using heat-sealed double bagging, unless it is not practical.

Note: The VC + UV cleanliness level provides a surface condition free of all visible particulate and non-particulate contamination augmented by inspection under UV light (Ultraviolet light of 3,200 to 3,800 angstroms wavelength).

4.2 Precision Cleanliness Level Requirements

The responsible design or user organization shall select the precision cleanliness level from Table IV.

Note: Personnel trained in accordance with Section 17.0 of this document will perform sampling and verification tasks to attain the specified precision cleanliness levels. Evidence of inspection and acceptance will be documented by the cleanroom management.

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5.0 ENVIRONMENTALLY CONTROLLED AREAS

a. Areas designated as environmentally controlled areas (ECAs) include cleanrooms, laminar flow clean workstations, and controlled work areas (CWAs).

b. All cleanrooms used for final cleanliness verification, assembly, testing, and packaging of precision, VC + UV, and VC level cleaned articles, and all laminar flow clean work stations used to process flight or flight-related equipment shall be certified by a documented procedure to meet the requirements in Table II.

5.1 Types and Classification of ECAs

5.1.1 Laminar Flow Clean Work Stations

a. Laminar flow clean workstations shall be certified and maintained to the ISO Class cleanliness level determined by its application within the user organization.

b. In addition, the laminar flow clean workstations shall meet the requirements specified in Sections 5.2 and 5.4.

5.1.2 Controlled Work Area (CWA) Classification

Laboratories, special work rooms, vacuum chambers, or other facilities that require environmental and contamination controls, which are not cleanrooms but do meet the minimum requirements of Sections 5.2 and 5.5, shall be identified as CWAs.

5.1.3 Cleanrooms

Cleanliness classes of cleanrooms used at JSC and offsite contractors providing cleanliness certified items shall comply with the airborne particle cleanliness requirements in Table I.

Notes:

1. FED-STD-209E was cancelled on November 29, 2001. It has been superseded by ISO 14644 Parts 1 and 2. ISO 14644 describes several types of cleanrooms, which include conventional and laminar airflow designs. Table I provides a comparison of cleanroom classes defined in ISO 14644, Part 1 and FED-STD-209E for the common JSC cleanroom classifications. Existing cleanrooms using FED-STD-209E may be acceptable for continued use to meet existing cleanliness specifications. The Safety and Test Operations Division will, upon request, assist JSC organizations and offsite contractors with the selection of an appropriate cleanroom design.

2. The Safety and Test Operations Division will concur in the selection of cleanroom classes for flight and flight-related equipment.

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5.2 ECA Operating Requirements

The operations shall be controlled by approved protocols and procedures to meet these requirements for the ECA in each facility.

Notes:

1. Table II provides a ready reference matrix of requirements relating to ECAs.
2. Minimum garment requirements for ECAs are listed in Table III. The Safety and Test Operations Division will approve cleanroom garment requirements for ECAs.
3. Personnel training requirements are specified in Section 17.0.

5.3 Cleanroom Requirements

5.3.1 Cleanroom operating requirements shall be established to ensure effective contamination control of the item to be processed.

5.3.2 The requirements described below shall be mandatory for JSC cleanrooms:

- a. Airborne Particle Monitoring. Airborne particle monitoring shall be performed to ensure continued compliance with Table I.
- b. Positive Pressure. The minimum positive pressure differential between the cleanroom and any adjacent area subject to lesser cleanliness requirements shall be 1.27 millimeters (0.05 inches) of water, with all entryways closed.

Note: When the entryways are open, there should be adequate blower capacity to maintain an outward flow of air from the cleanroom to minimize contaminants migrating into the room.

- c. Temperature Range. The temperature in the cleanrooms shall be maintained in the range 19-24 C (67-75 F) with the exception of those laboratories or work areas for which other temperatures are actually required by the items being processed.
- d. Relative Humidity (RH). The RH in cleanrooms shall be maintained between 30% and 70 % unless other ranges are actually required for the items being processed.

Note: Corrosion of parts can occur at RH above 50%. At low RH, surface static charge on dielectric materials or parts can result in particle deposition on the surface due to electrostatic attractive forces.

- e. Cleanroom Lighting. At all work locations within the cleanroom, shadowless uniform incident lighting of 800 to 1,000 lumens (75 to 100 ft-candles, 24 to 30 meter-candles) per square meter shall be provided.

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Notes:

1. Certain hardware may require higher luminosity.
2. Cleanroom requirements may be selected from, but are not limited to, those contained in ISO 14644, Parts 1, 3, and 5.

5.3.3 Operating Procedures

Documented operating procedures shall be required for all classes of cleanrooms, which describe the cleanroom monitoring, personnel discipline, packaging, and garmenting functions to comply with the Tables II, III, V and VI. [Records created by these procedures shall be maintained according to Appendix B.]

5.4 Laminar Flow Clean Work Station Requirements

5.4.1 In addition to ECA requirements specified in Section 5.2, airflow velocity shall be maintained at 27.5 meters per minute (90 ft per minute) average with a uniformity of $\pm 20\%$ across the entire area of the exit.

5.4.2 The laminar flow clean work station shall be monitored at regular intervals to verify continued compliance with the requirements in Table II.

5.4.3 Monitoring and maintenance records shall be maintained for each laminar flow clean work station.

5.4.4 Documented and approved procedures, required for all operations of laminar flow clean workstations, shall describe the monitoring, personnel discipline, packaging, and garmenting functions for each facility.

Note: The requirements for certification of laminar flow clean workstations are specified in Section 6.0.

5.5 Controlled Work Area (CWA) Requirements

5.5.1 The requirements stated below are in addition to ECA operating requirements specified in Section 5.2 and shall be used where a high degree of shop cleanliness is required.

5.5.2 Housekeeping procedures, personnel controls, and contaminant-generation constraints shall be specified in operating procedures for CWAs to obtain and maintain an acceptable level of work area cleanliness and to protect work piece cleanliness.

5.5.3 Although annual certification is not required for CWAs, the minimum facility requirements stated below shall be observed.

- a. The environment in and around the CWA shall be filtered.

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