Space Station External Contamination Control Requirements

International Space Station Alpha

Revision D

January 21, 1994

NASDA
National Space Development Agency of Japan

agenzia spaziale italiana
(Italian Space Agency)

esa
european space agency

Canadian Space Agency
Agence spatiale canadienne

National Aeronautics and Space Administration
Space Station Program Office
Johnson Space Center
Houston, Texas

REVISION AND HISTORY PAGE

REV.	DESCRIPTION	PUB. DATE
–	Baseline Issue (Reference SSCBD BB000155, Eff. 11–04–86)	11–19–86
A	Revision A (Reference the electronic baseline reformatted version)	02–15–89
B	Revision B (Reference SSCBDs BB000727 Eff. 09–28–90 and BB003063 Eff. 08–09–91)	07–91
C	Revision C (Reference SSCBDs BB003404 Eff. 05–14–93 and BB003681 Eff. 05–28–93)	06–93
D	Revision D (Reference SSBCD 00002, Dated 2–1–94)	05–13–94

SPACE STATION PROGRAM OFFICE

SPACE STATION EXTERNAL CONTAMINATION CONTROL REQUIREMENTS

JANUARY 21, 1994

PREFACE

The purpose of the Space Station External Contamination Control Requirements is to establish requirements that control the release of neutral gases and particulates into the external environment to ensure the maximum utility of the Space Station capabilities.

The contents of this document are intended to be consistent with the tasks and products to be prepared by NASA Space Station Program Office and Space Station Program (SSP) participants as defined in SSP 41000, System Specification For The Space Station. The Space Station External Contamination Control Requirements shall be implemented on all new SS contractual and internal activities and shall be included in any existing contracts through contract changes. This document is under the control of the Space Station Control Board, and any changes or revisions will be approved by the NASA Space Station Program Manager.

	Signature	ORG	Date
Prepared by:	/s/ Ron Mikatarian		1/26/94
Checked by:	/s/ J. Lambert		1/26/94
Supervised by (Boeing):	/s/ Horold Liemohn		1/26/94
Supervised by (NASA):	/s/ Barry Boswell	OB	1/26/94
Approved by (Boeing):	/s/ C. E. Peterson		1/27/94
Approved by (NASA):	/s/ Barry Boswell	OB	1/26/94
DQA:	/s/ M. Johnson		5/12/94

NASA/ASI

INTERNATIONAL SPACE STATION ALPHA PROGRAM

SPACE STATION EXTERNAL CONTAMINATION CONTROL REQUIREMENTS

JANUARY 21, 1994

/s/ Dale Thomas — 3/11/94

For NASA — DATE

/s/ Andrea Lorenzoni — 3/16/94

For ASI — DATE

NASA/CSA

INTERNATIONAL SPACE STATION ALPHA PROGRAM

SPACE STATION EXTERNAL CONTAMINATION CONTROL REQUIREMENTS

JANUARY 21, 1994

/s/ Dale Thomas 3/11/94

For NASA DATE

/s/ R. Bryan Erb 3/14/94

For CSA DATE

Agreed to in principal subject to completion of detailed review by CSA and its contractor.

NASA/ESA

INTERNATIONAL SPACE STATION ALPHA PROGRAM

SPACE STATION EXTERNAL CONTAMINATION CONTROL REQUIREMENTS

JANUARY 21, 1994

/s/ Dale Thomas — 3/11/94

For NASA — DATE

/s/ Helmut Heusmann — 3/23/94

For ESA — DATE

NASA/NASDA

INTERNATIONAL SPACE STATION ALPHA PROGRAM

SPACE STATION EXTERNAL CONTAMINATION CONTROL REQUIREMENTS

JANUARY 21, 1994

/s/ Dale Thomas 3/11/94

For NASA DATE

/s/ Kuniaki Shiraki 3/16/94

For NASDA Concurrence DATE

Agreed to in principal subject to completion of detailed review by NASDA.

NASA/RSA

INTERNATIONAL SPACE STATION ALPHA PROGRAM

SPACE STATION EXTERNAL CONTAMINATION CONTROL REQUIREMENTS

JANUARY 21, 1994

/s/ Dale Thomas

For NASA

3/11/94

DATE

For RSA

DATE

SPACE STATION PROGRAM OFFICE

SPACE STATION EXTERNAL CONTAMINATION CONTROL REQUIREMENTS

LIST OF CHANGES

JANUARY 21, 1994

All changes to paragraphs, tables, and figures in this document are shown below:

SSCBD	ENTRY DATE	CHANGE	PARAGRAPH
000002	1–21–94	REVISION D	ALL

TABLE OF CONTENTS

APPENDIXES

1.0 GENERAL

1.1 PURPOSE

This document establishes the requirements that control the release of neutral gases and particulate into the external environment to ensure the maximum utility of the Space Station (SS) capabilities.

1.2 SCOPE

This document contains the requirements that limit the contributions to the external, gaseous, and particulate environment due to the presence of the SS and its hardware. Requirements applicable to Space Shuttle delivery of SS hardware and experiments to space are included. The requirements are derived from previous experience bases and should be achieved at minimum Program costs if they are considered early in design. These requirements reflect the maximum contributions to the neutral particulate and gas environment above the natural environment that can be tolerated in order to make unrestricted measurements for all presently know attached users except some atmospheric composition studies. Requirements as stated are applicable for Space Station hardware including payloads.

1.3 PRECEDENCE

The case of conflict between this document and SSP 41000, System Specification For The Space Station, the requirements of SSP 41000 shall take precedence.

1.4 DELEGATION OF AUTHORITY

This requirements documents is the responsibility of the Space Station Program Office (SSPO).

1.5 WAIVER/DEVIATION

Any request for waiver or deviation from this requirements document shall be made to the SSPO

2.0 APPLICABLE DOCUMENTS

The following documents of the date shown include specifications, models, standards, guidelines, handbooks, and other special publications. The documents in this paragraph are applicable to the extent specified herein. Inclusion of applicable documents herein does not in any way supersede the order of precedence identified in paragraph 1.3. The references show where each applicable document is cited in this document.

DOCUMENT NO.	TITLE
SSP 41000	System Specification For the Space Station
Rev. Basic References	Paragraphs 3.2.6.1.3 and 3.3.10.3
ASTM–E595–84	Standard Test Method for Total Mass Loss and Collected Volatile Condensable Materials from Outgassing in a Vacuum Environment (09–24–85)
Reference	Paragraph 3.3.2.1
JSC SN–C–0005C	Contamination Control Requirements for the Space Shuttle Program (2–15–89)
References	Paragraphs 3.3.1.1 and 3.3.1.2

3.0 REQUIREMENTS

3.1 SPACE STATION TEMPORAL CONSIDERATIONS

The induced environment associated with the Space Station (SS) will be strongly influence by activities associated with its operation. For example, the level of induced environment will be increased during Space Shuttle docking and periodic SS reboost. It is prudent, therefore, for the specification of the induced environment contamination requirements to define two conditions of the inducted environment: quiescent periods and nonquiescent periods. Quiescent periods provide an induced environment consistent with designed measurement capability, and all the requirements of this document are applicable. For nonquiescent periods, it is assumed that the disturbed environment will be unacceptable for some measurements; however, the environment shall not produce conditions that preclude returning to unrestricted measurements as soon as the disturbing activity is terminated. Requirements stated in paragraph 3.4 shall not be applicable during nonquiescent periods. Disturbing activities leading to nonquiescent periods shall be of short duration, resulting in most of the operational time being quiescent. Nonquiescent periods shall be scheduled and users shall be notified in sufficient time to take appropriate action.

3.2 MANUFACTURING AND MATERIALS

The following requirements shall be applicable to the manufacturing phase of SS provided hardware.

3.2.1 SURFACE CLEANLINESS LEVELS

3.2.1.1 SPACE STATION COMPONENTS AND USER HARDWARE

Areas that are inaccessible in the final assembly and that may act as contamination sources while on orbit shall be cleaned to the visibly clean sensitive level of JSC SN–C–0005, Contamination Control Requirements for the Space Shuttle Program, before close–out. Prior to shipment for Space Shuttle integration, all exposed external surfaces shall be cleaned to the visibly clean sensitive level of JSC SN–C–0005.

3.2.1.2 SPACE SHUTTLE INTEGRATION

SS and user hardware shall be inspected and, if required, be cleaned to the visibly clean standard level as defined in JSC SN–C–0005 as a minimum prior to launch.

3.2.2 OUTGASSING CHARACTERISTICS

3.2.2.1 HARDWARE EXPOSED TO THE SPACE STATION ENVIRONMENT

All materials used in hardware which will be exposed to space vacuum shall have low outgassing characteristics as defined by a total mass loss of $\leq$ 1.0 percent and a volatile

condensable material of ≤ 0.1 percent when tested per ASTM–E595, Standard Test Method for Total Mass Loss and Collected Volatile Condensable Materials from Outgassing in a Vacuum Environment, as covered in SSP 30233, Space Station Requirements for Materials and Processes.

3.2.2.2 MATERIALS USED IN AIRLOCKS AND VACUUM CHAMBERS

All materials used in airlocks and laboratory vacuum chambers that will be vented to space shall be selected on the basis of low outgassing rates as defined in paragraph 3.2.2.1.

3.2.2.3 MATERIALS USED IN DESIGNATED AREA

Lower outgassing rates than specified in paragraph 3.2.2.1 may be required for hardware which has large view factors to other hardware (see requirements in paragraph 3.4.3) and for local regions such as window cavities.

3.3 AMBIENT/SURFACE INTERACTIONS

As the SS moves through the Earth's rarefied environment, a ram–wake effect is created, i.e., density build–up preceding forward facing surfaces and a density decrease on aft facing surfaces. Buildup on surface which have some exposure to ram can be as high as 60 times the ambient density. Instrument and SS hardware which are sensitive to such density shall be carefully located relative to large surfaces to preclude interferences. A change in the composition of the surface local environment can be expected due to either reaction with the surface or recombination occurring on or near these surfaces.

3.4 QUIESCENT PERIODS

3.4.1 MOLECULAR COLUMN DENSITY

The contribution to the molecular column density created by the presence of SS contamination sources along any unobstructed line of sight shall not exceed $1x10^{14}$ molecular–cm^{-2} for individual released species. This includes contributions from outgassing, venting, leakage, and other SS contamination sources but does not include ram–wake effects. Molecular column density requirements may be exceeded for line of sight through volumes in space of high molecular density near gas vents.. Specifically, the molecular column density limit may be exceeded for all lines of sight parallel to and within one meter from the vent axis. The vent axis will be oriented to precluded direct plume impingement on the JEM's exposed facility and attached payload truss locations.

3.4.2 PARTICULATE BACKGROUND

The release of particulates from the SS shall be limited to one particle 100 microns or larger per orbit per $1x10^{-5}$ steradian field of view as seen by a 1 meter diameter aperture

telescope. This includes contributions of particulates originating from external SS surfaces, compartments vented to space, movable joints, vents (of solids, liquids and gases) and other SS particulate sources but excludes particulates in the natural environment and their effect on SS hardware (e.g, their impact on SS surfaces).

3.4.3 MOLECULAR DEPOSITION

The flux of molecules emanating from the SS shall be limited such that the 300K mass deposition rate on sampling surfaces shall be limited to $1x10^{-14}$ g–cm^{-2}–sec^{-1} (daily average). The sampling surfaces shall be located at the Prime Measurement Points (see Glossary) and shall have two orientations: one whose surface normal is parallel to the plus or minus z axis, and another whose surface normal lies in the horizontal plane. The acceptance angle of each of these surfaces is 2 pi steradians.

3.5 NONQUIESCENT PERIODS

3.5.1 MOLECULAR DEPOSITION

Total deposition at 300K on the sampling surfaces described in paragraph 3.4.3 shall not exceed $1x10^{-6}$ g–cm^{-2}–yr^{-1}.

3.5.2 SOLIDS, PARTICULATES, AND LIQUID RELEASES

Solids, particulates and liquids releases shall not result in residual deposits as indicated in paragraph 3.5.1 or damage to the SS surfaces from either direct or subsequent orbital impingement.

3.6 THERMAL/CHEMICAL REQUIREMENTS

In cases where molecular contamination condenses on surfaces with temperatures which vary considerably, particularly below 300K, calculations for surfaces deposition shall take into account the entire orbital temperature cycle, characteristics of the deposit and effects of the environmental factors on the deposits. Specifically, the balance of reevaporation/resublimation (cleaning), and deposition during each time step of the orbital temperature cycle shall be calculated and then averaged over time. Additionally, removal of deposits by atomic oxygen shall be calculated for deposits that are reactive. Ultraviolet fixing effects on deposits which may enhance the deposition rate and potentially the sticking characteristics of the contaminates on the surface shall also be taken into account.

3.7 MONITORING OF THE ENVIRONMENT

Monitoring of the on–orbit environment shall be acquired. This requirement to monitor the environment is derived from requirements to monitor the performance of Space

Station systems as; e.g., the Active Thermal Control System and the Plasma Contractor. In addition, this requirement is necessary in order to provide service to the attached payload community who require monitoring of the on–orbit operational conditions.

Monitoring shall be performed by measurements which consider molecular deposition, composition, local and directional pressure, gas column density, gas flux, particulate rebase, plama properties and structure potential.

APPENDIX A ABBREVIATIONS AND ACRONYMS

cm	Centimeter
g	Gram
JEM	Japanese Experiment Module
K	Kelvin
m	Meter
PMP	Prime Measurement Point
sec	Second
SS	Space Station
SSP	Space Station Program
SSPO	Space Station Program Office
yr	Year

APPENDIX B GLOSSARY

ATTACHED PAYLOAD

Flight equipment provided by the scientific community, attached to the Space Station (SS) external to the SS–pressurized habitable volume, and used to obtain information for scientific investigations of the space environment.

CONTAMINATION

Any effect arising from the inducted environment, gaseous, particulate, or light background that interferes with or degrades the results of the intended measurement or that degrades Space Station Program and user performance such that refurbishment is required before continued use.

DEPOSITION–MASS

The mass of contaminant collected by a unit area of a surface. The deposition process depends on the incident mass flux of the contaminant, the surface temperature, solar exposure, and the properties of the surface and the contaminant. Mass deposition units are g/cm^2.

DEPOSITION THICKNESS

The thickness of a contaminant collected on a surface. Since the deposition thickness is not typically uniform, this quantity is usually the average. It is assumed that mass density is 1 g/cm^3. Deposition thickness units are cm or Angstrom (1 Angstrom = 10^{-10}m).,

INDUCTED ENVIRONMENT

The molecular and particulate environment in the vicinity of and created by the presence of the SS. Ambient atmospheric perturbations which are caused by space craft flight and create a ram–wake effect are covered in this definition.

MOLECULAR COLUMN DENSITY

The integral of the number density (number of molecules of a particular species per unit volume) along a specified line of sight originating from one of the Prime Measurement Points (PMPs). Molecular column density units are number/cm^2.

NONQUIESCENT PERIODS

Time periods when measurement may be perturbed by the induced environment to the extent described in this document.

PRIME MEASURING POINTS

Locations at which contamination fluxes are assessed. Typical PMP location are solar arrays, thermal radiators, observation windows, truss attached payloads, and the JEM Exposed Facility.

QUIESCENT PERIODS

Time periods when minimum perturbations to the environment occur: generally this includes all times except such activities as Space Shuttle docking and undocking and periodic reboost.

APPENDIX C REFERENCE DOCUMENTS

The documents in this appendix are provided as reference material for background information only. In case of conflict, this document shall take precedence.

DOCUMENT NO.	TITLE
SSP 30233	Space Station Requirements for Materials and Processes
Reference	Paragraph 3.3.2.1