CHANGE NOTICE

Date Prepared: 2/14/01

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7. System Designation ISS	8. Related ECP No./Title SSCN 002199	9. Contract No. NAS15–10000	10. Contractual Activity SSCN 002199
11. Document Title ISS Flight Crew Integration Standard (NASA–STD–3000/T)		12. Effectivity All Units	

THIS NOTICE INFORMS RECIPIENTS THAT THE DOCUMENT IDENTIFIED BY THE NUMBER (AND REVISION LETTER) SHOWN IN BLOCK 4 HAS BEEN CHANGED. THE PAGES CHANGED BY THIS CDCN BEING THOSE FURNISHED HEREWITH AND CARRYING THE SAME DATE AS THIS CDCN. THE PAGES OF THE PAGE NUMBERS AND DATES LISTED BELOW IN THE SUMMARY OF CHANGED PAGES COMBINED WITH NON–LISTED PAGES OF THE ORIGINAL ISSUE OF THE REVISION SHOWN IN BLOCK 4 CONSTITUTE THE CURRENT VERSION OF THIS DOCUMENT.

13. CDCN No.	14. Pages Changed (Indicate Deletions)	S*	A*	15. Date
008	Revision and History page	X		2/14/01
	Pages xii, xxvii, xxviii, xxxiii, and xxxv	X		
	Pages 2–1, 2–2, 5–16, 5–19, 5–20, 5–21, 5–22, 5–23, 5–24, 5–25, 5–26, 5–27, 5–28, 5–29, 11–29, 11–30, 11–31, 11–32, 11–33, and 11–34.	X		
008	Page xxvii–a		X	
	Pages 2–1a, 2–2a, 5–30, 5–31, 5–32, 11–34a, 11–34b, 11–34c, 11–34d, and 11–34e.		X	
	Order of Incorporation DCN 008			

16. Technical Concurrence (Contracting Agency)	Date

* “S” indicates supersedes earlier page. “A” indicates added page.

REVISION AND HISTORY PAGE

REV.	DESCRIPTION	PUB. DATE
–	Initial Release (Reference SSCBD 000002, Dated 2–7–94)	4–18–94
A	Revision A (Reference SSCBD 000008R1, Dated 6–3–94)	8–09–94
B	Revision B incorporates ECP 145 (SSCBD 000145, Effective 10–31–95)	11–21–95
	DCN–001 incorporates ECP 258 (SSCBD 000258, Effective 08–19–98)	11–17–98
	The following DCNs have been cancelled. The content of the SSCNs authorizing release of the DCNs has been incorporated into Revision C.	
	DCN 002 (SSCN 000354) DCN 006 (SSCN 000549) DCN 005 (SSCN 000721) DCN 003 (SSCN 000434) DCN 004 (SSCN 000554) DCN 007 (SSCN 000821)	
C	Revision C incorporates SSCNs 000354, 000434, 000549, 000554, 000721, 000821, and 001202.	09–27–01
	DCN 008 incorporates SSCN 002199	09–27–01

ERU: /s/Beth Mason 09–27–01

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FIGURES

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FIGURES

2.0 APPLICABLE DOCUMENTS

The following applicable documents of the exact issue shown in the current issue of SSP 50257 form a part of this specification to the extent specified herein. Inclusion of applicable documents herein does not in any way supercede the order of precedence identified in 1.3. The references show where each applicable document is cited in this document.

DOCUMENT NO.	TITLE
ACGIH	American Conference of Governmental Industrial Hygienists Standards, Threshold Limit Values and Biological Exposure Indices for 1997
References:	5.7.3.2.1.B, 5.7.3.2.1.C **DCN 008**
	American Hospital Formulary Service
References:	10.9.3.1.2.B.(2)
ASTM D1003	Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics
References:	11.11.3.1.3.1.C, 11.11.3.1.3.2.C, 11.11.3.2.G **DCN 008**
ASTM D1044	Standard Test Method for Resistance of Transparent Plastics to Surface Abrasion
References:	11.11.3.1.3.1.C, 11.11.3.1.3.2.C, 11.11.3.2.G **DCN 008**
ANSI Z136.1	ANSI Standard for the Safe Use of Lasers
References:	5.7.3.2.1.B, 5.7.3.2.2.A.(1)
CIE	Commision International De L’Eclairage Coordinates Chart Chromaticity Diagram 1931
References:	9.4.2.3.1.1.B.(1), 9.5.3.2
FED–STD–595	Colors Used in Government Procurement
References:	9.2.2.2.4.A, 9.3.3.4.1.2.L.(2), 9.5.3.2.I.(8)a
ISO 2631	Guide for the Evaluation of Human Exposure to Whole Body Vibration
References:	5.5.3.3.4.D
JSC 32283	Nutritional Requirements for Extended Duration Orbiter Missions and Space Station
References:	7.2.2.3.1.A.(1), 7.2.2.3.1.B.(1)

MIL–A–25165	Identification of Aircraft Emergency Escape System
References:	8.8.3.4
MIL–C–25050	Color, Aeronautical Lights and Lighting Equipment, General Requirements for
References:	6.6.3.3.D, 9.5.3.2.I.(4)a, 9.5.3.2.I.(4)b

MIL–G–174	Optical Glass
References:	11.11.3.1.5.A.(3), 11.11.3.1.5.A.(4), 11.11.3.2.B, 11.11.3.2F **DCN 008**
MIL–G–25667	Aircraft Glazing Glass, Monolithic
References:	11.11.3.1.5.B.(1)
MIL–G–25871	Aircraft Glazing Glass, Laminated
References:	11.11.3.1.5.B.(2)
MIL–G–48497	Coating, Single or Multilayer, Interference: Durability Requirements for
References:	11.11.3.1.3.B, 11.11.3.1.3.C, 11.11.3.1.3.D.(1), 11.11.3.1.3.E **DCN 008**
MIL–O–13830	Optical Components for File Control Instruments; General Specification Governing the Maufacturing, Assembly, and Inspection of
References:	11.11.3.1.5.A.(1), 11.11.3.2.C
MIL–STD–210	Climatic Information to Determine Design and Test Requirements for Military Systems and Equipment
References:	11.12.3.B
MIL–STD–1189	TBD
References:	9.5.3.1.15
MIL–STD–1474	Noise Limits for Military Material (Metric)
References:	5.4.3.1.B.(1), 5.4.3.2.4
MIL–STD–2073	DOD Material Procedures for Development and Application of Packaging Requirements
References:	11.12.3.B
NASA–TM–86538	Design and Verification Guidelines for Vibroacoustic and Transient Environmnents
References:	11.12.3.B

NASA–TM–103575	Space Transportation System and Associated Payloads: Glossary, Acronyms and Abbreviations
References:	9.6.2.8.K.(2)

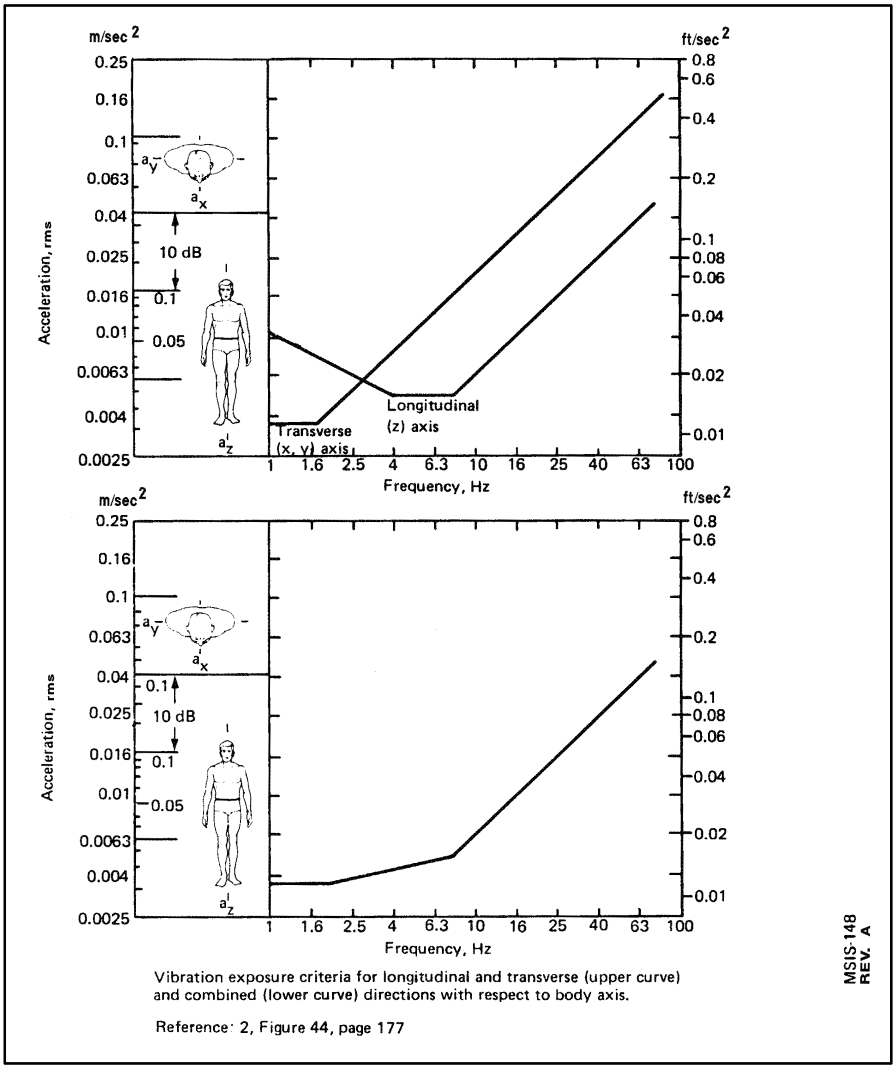


FIGURE 5.5.3.3.3–1 VIBRATION EXPOSURE CRITERIA

C. Interrupted Vibration – If the exposure to vibration is interrupted by pauses during a 24–hour period but the intensity of exposure remains the same, then the effective total daily exposure time shall be determined by adding up the individual exposure times.

D. Variable Amplitude Vibration – If the acceleration amplitude varies with time or if the total daily exposure is composed of several individual exposure times, at different levels, then an ”equivalent total exposure” shall be determined by the procedure given in ISO 2631.

5.6 ULTRAVIOLET RADIATION

Exposure to ultraviolet radiation shall not exceed the values specified by 5.7.3.2.1, Item C(3).
DCN 008

D. Near–continuous near real–time radiation dose and dose rate data shall be provided from the Space Station to the ground to support normal and contingency operations.

E. Deleted.

F. Deleted.

5.7.2.2.3 IONIZING RADIATION MONITORING AND DOSIMETRY DESIGN REQUIREMENTS

A. Crewmember Radiation Dose Monitoring – The radiation dose for each individual crewmember shall be monitored. This data will be used as part of the crewmember's radiation exposure history.

B. Area Radiation Monitoring – The accumulated radiation dose within occupied areas of the space module shall be monitored and recorded for all missions.

C. Effective dose equivalent –

(1) The time resolved Linear Energy Transfer (LET) spectrum shall be measured to determine the effective dose equivalent.

(2) LET spectral monitoring data shall be available through telemetry on the ground and be capable of being read out on command from the ground.

D. Charged particle monitoring –

(1) Proton and other particle fluxes as a function of time and energy spectrum internal and external to the Space Station shall be monitored and recorded.

(2) Particle radiation characteristics such as particle direction and secondary particle flux shall be monitored.

(3) Charged particle spectral monitoring data shall be available through telemetry on the ground and be capable of being read out on command from the ground.

E. Location of Radiation detectors – the location and characteristics of onboard radiation detectors shall be consistent with the expected radiation environment.

F. Deleted.

5.7.2.2.4 IONIZING RADIATION PERSONNEL PROTECTION DESIGN REQUIREMENTS

5.7.3 NONIONIZING RADIATION

5.7.3.1 NONIONIZING RADIATION DESIGN CONSIDERATIONS

A. Procedures for RF Sources and Optical Sources – Procedures for the safe operation of RF sources and optical radiation sources shall be provided. **DCN 008**

B. Based on the mission plan, the possibility of providing power shutoff for applicable RF and optical radiation–emitting equipment shall be considered. **DCN 008**

5.7.3.2 NONIONIZING RADIATION DESIGN REQUIREMENTS

A. Personnel Protective Devices – Based on the safety requirements and the results of the nonionizing radiation hazard analysis, personnel protective devices commensurate with the hazard shall be provided. **DCN 008**

B. Safety Guidelines – Systems employing laser equipment shall be designed and operated in accordance with ANSI Z136.1. **DCN 008**

Where the mission requirements require implementation in violation of these standards, a hazard analysis shall be performed. **DCN 008**

5.7.3.2.1 NONIONIZING RADIATION EXPOSURE LIMITS

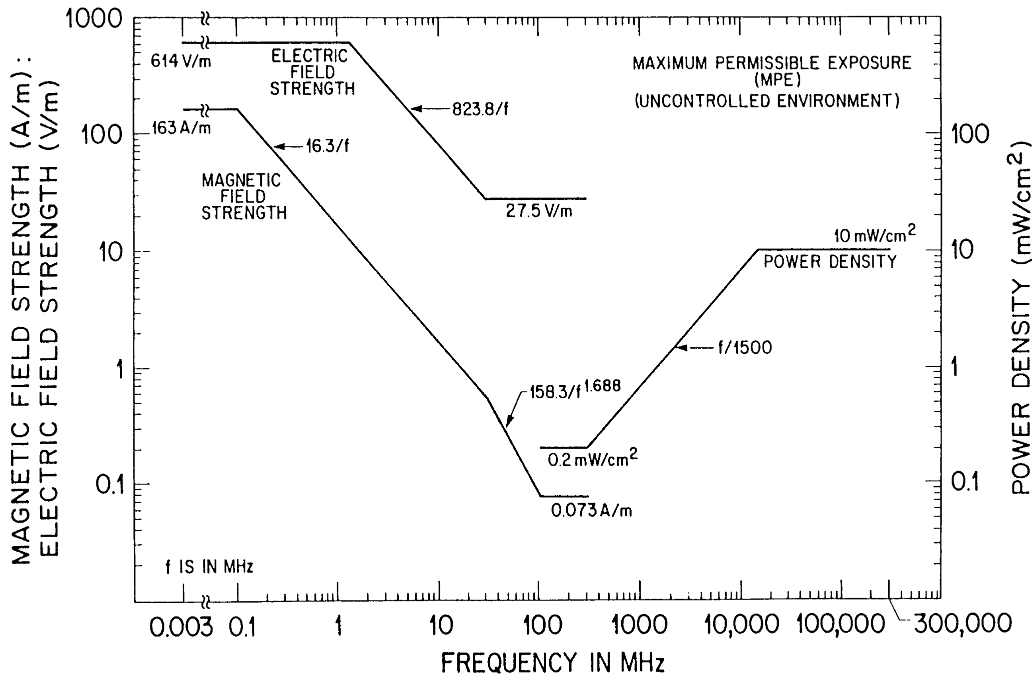
A. Radio–Frequency Electromagnetic Field Exposure Limits – The IEEE C95.1 document shall apply as the standard for radio–frequency nonionizing radiation exposure. These limits are shown in Figures 5.7.3.2.1–1 and 5.7.3.2.1–2. **DCN 008**

1 Frequency Range (MHz)	2 Electric Field Strength (E) (V/m)	3 Magnetic Field Strength (H) (A/m)	4 Power Density (S) E–Field: H–Field (mW/cm^2)	5 Averaging Time (Minutes) $\|E\|^2$, S	or $\|H\|^2$
0.003 – 0.1	614	163	$(100: 1,000,000)^+$	6	6
0.1 – 1.34	614	$163/f$	$(100: 10,000)f^2)^+$	6	6
1.34 – 3.0	$823.8/f$	$16.3/f$	$(180/f^2: 10,000/f^2)^+$	$f^2/0.3$	6
3.0 – 30	27.5	$16.3/f$	$(180/f^2: 10,000/f^2)^+$	30	6
30 – 100	27.5	$158.3/f^{1.668}$	$(0.2: 940,000/f^{3.336})^+$	30	$0.0636f^{1.337}$
100 – 300		0.0729	0.2	30	
300 – 3,000			$f/1,500$	30	
3,000 – 15,000			$f/1,500$	$616,000/f^{1.2}$	
15,000 – 300,000			10	$90.000/f$	

Note:
(1) + The exposure values in terms of electric field and magnetic field strengths are the values obtained by spatially averaging values over an area equivalent to the vertical cross–section area of the human body (projected area).
(2) These plane–wave equivalent power density values, although not appropriate for near–field conditions, are commonly used as a convenient comparison with MPEs at higher frequency and are displayed on some instruments in use.

FIGURE 5.7.3.2.1–1 OCCUPATIONAL EXPOSURE LIMITS FOR RADIO FREQUENCY ELECTROMAGNETIC FIELDS

B. Laser Exposure Limits – The ANSI Z136.1 shall apply as the standard for limiting skin and ocular exposure to both continuous and repetitively pulsed lasers. This standard allows for differing skin and ocular exposure limits, and further allows for differing ocular exposure limits according to the angle subtended by the source measured at the eye. These angles (“alpha minimums”) are shown in Figure 5.7.3.2.1–3. A source subtending an angle less than that shown is to be considered as a “point” source. A source subtending an angle greater than or equal to the value shown is to be considered an “extended” source. **DCN 008**



Graphic Representation of Maximum Permissible Exposure in Terms of Field and Power Density

FIGURE 5.7.3.2.1–2 OCCUPATIONAL EXPOSURE LIMITS ILLUSTRATED TO SHOW WHOLE BODY RESONANCE EFFECTS AROUND 100 MHZ

(1) Point Source Laser Ocular Exposure Limits – The ocular exposure limits given in Figure 5.7.3.2.1–4 shall apply to all point source lasers. **DCN 008**

(2) Extended Source Laser Ocular Exposure Limits – The ocular exposure limits given in Figure 5.7.3.2.1–5 shall apply to all extended source lasers. **DCN 008**

(3) Maximum Permissible Exposure for Skin Exposure to a Laser Beam – The skin exposure limits shown in Figure 5.7.3.2.1–6 shall apply in all cases of laser skin exposure. **DCN 008**

(4) Exposure Limits for Commonly Available Types of Lasers – The eye and skin exposure limits for specific types of lasers given in Figure 5.7.3.2.1–7 shall apply (these limits are derived from the above information). **DCN 008**

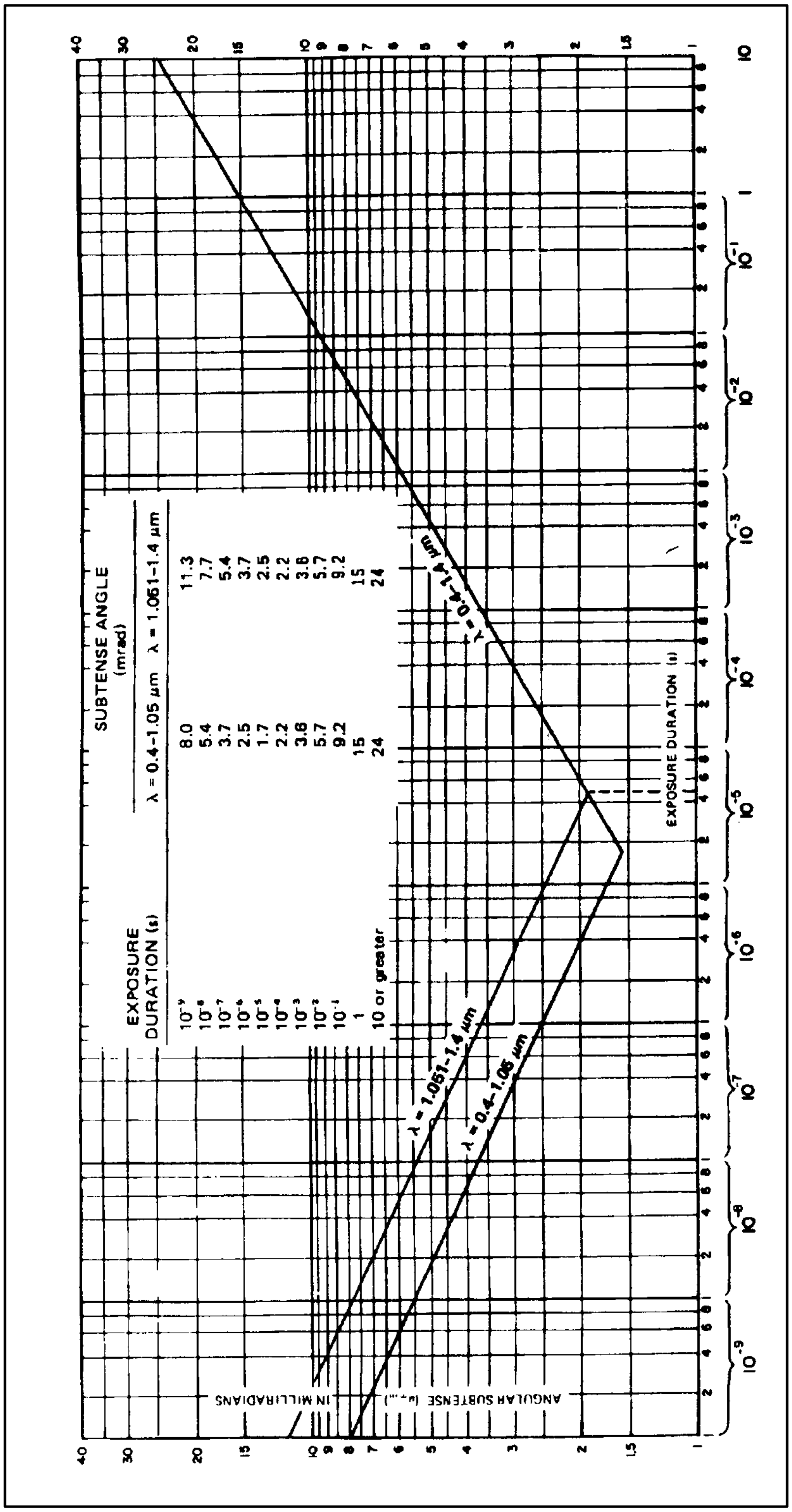


FIGURE 5.7.3.2.1–3 ALPHA–MINIMUM USED TO DETERMINE "POINT SOURCE" OR "EXTENDED SOURCE" LASER EXPOSURES

Wavelength, λ (μm)	Exposure Duration, t (s)	Maximum Permissible Exposure (MPE)	Notes for Calculation and Measurement
Ultraviolet			
0.200 to 0.302	10^{-9} to 3 x 10^4	3 x10^{-3} J • cm^{-2}	
0.303	10^{-9} to 3 x 10^4	4 x10^{-3} J • cm^{-2}	
0.304	10^{-9} to 3 x 10^4	6 x10^{-3} J • cm^{-2}	or 0.56t $^{1/4}$ J •
0.305	10^{-9} to 3 x 10^4	1.0 x10^{-2} J • cm^{-2}	cm^{-2},
0.306	10^{-9} to 3 x 10^4	1.6 x10^{-2} J • cm^{-2}	whichever is lower
0.307	10^{-9} to 3 x 10^4	2.5 x10^{-2} J • cm^{-2}	
0.308	10^{-9} to 3 x 10^4	4.0 x10^{-2} J • cm^{-2}	
0.309	10^{-9} to 3 x 10^4	6.3 x10^{-2} J • cm^{-2}	1 mm limiting aperture
0.310	10^{-9} to 3 x 10^4	1.0 x10^{-1} J • cm^{-2}	
0.311	10^{-9} to 3 x 10^4	1.6 x10^{-1} J • cm^{-2}	
0.312	10^{-9} to 3 x 10^4	2.5 x10^{-1} J • cm^{-2}	
0.313	10^{-9} to 3 x 10^4	4.0 x10^{-1} J • cm^{-2}	
0.314	10^{-9} to 3 x 10^4	6.3 x10^{-1} J • cm^{-2}	
0.315 to 0.400	10^{-9} to 10	0.56 $t^{1/4}$ J • cm^{-2}	
0.315 to 0.400	10 to 3 x 10^4	1 J • cm^{-2}	
0.315 to 0.400	10^3 to 3 x 10^4	1 x 10^{-3} J • cm^{-2}	
Visible & Near Infrared			
0.400 to 0.700	10^{-9} to 1.8 x 10^{-5}	5 x 10^{-7} J • cm^{-2}	
0.400 to 0.700	1.8 x 10^{-5} to 10	1.8 $t^{3/4}$ x 10^{-3} J • cm^{-2}	
0.400 to 0.550	10 to 10^4	10 x 10^{-3} J • cm^{-2}	
0.550 to 0.700	10 to T_1	1.8 $t^{3/4}$ x 10^{-3} J • cm^{-2}	
0.550 to 0.700	T_1 to 10^4	10 C_B x 10^{-3} J • cm^{-2}	
0.400 to 0.700	10^4 to 3 x 10^4	C_B x 10^{-6} W • cm^{-2}	7 mm limiting
0.700 to 1.050	10^{-9} to 1.8 x 10^{-5}	5 C_A x 10^{-7} J • cm^{-2}	aperture
0.700 to 1.050	1.8 x 10^{-5} to 10^3	1.8 $C_A t^{3/4}$ x 10^{-3} J • cm^{-2}	
1.051 to 1.400	10^{-9} to 5 x 10^{-5}	5 x 10^{-6} J • cm^{-2}	
1.051 to 1.400	5 x 10^{-5} to 10^3	9 $t^{3/4}$ x 10^{-3} J • cm^{-2}	
0.700 to 1.400	10^3 to 3 x 10^4	320 C_A x 10^{-6} W • cm^{-2}	
Far Infrared			
1.4 to 10^3	10^{-9} to 10^{-7}	10^{-2} J • cm^{-2}	
	10^{-7} to 10	0.56 $t^{1/4}$ J • cm^{-2}	
	>10	0.1 W • cm^{-2}	
1.54 only	10^{-9} to 10^{-6}	1.0 J • cm^{-2}	

Notes: C_A = 1 for λ = 0.400 to 0.700 μm,
$C_A = 10^{2.0(\lambda-0.700)}$ for λ = 0.700 to 1.050 μm
C_A = 5 for λ = 1.050 to 1.400 μm
C_B = 1 for λ = 0.400 to 0.550 μm
$C_B = 10^{15(\lambda-0.550)}$ for λ = 0.550 to 0.700 μm
$T_1 = 10 \times 10^{20(\lambda-0.550)}$ for λ = 0.550 to 0.700 μm

FIGURE 5.7.3.2.1–4 ”POINT SOURCE” LASER EYE EXPOSURE LIMITS

Wavelength, λ (μm)	Exposure Duration, t (s)	Maximum Permissible Exposure (MPE)	
Ultraviolet			
0.200 to 0.302	10^{-9} to 3 x 10^{4}	3 x 10^{-3} J • cm^{-2}	
0.303	10^{-9} to 3 x 10^{4}	4 x 10^{-3} J • cm^{-2}	or 0.56 $t^{1/4}$ J • cm^{-2}, whichever is lower
0.304	10^{-9} to 3 x 10^{4}	6 x 10^{-3} J • cm^{-2}	
0.305	10^{-9} to 3 x 10^{4}	1.0 x 10^{-2} J • cm^{-2}	
0.306	10^{-9} to 3 x 10^{4}	1.6 x 10^{-2} J • cm^{-2}	
0.307	10^{-9} to 3 x 10^{4}	2.5 x 10^{-2} J • cm^{-2}	
0.308	10^{-9} to 3 x 10^{4}	4.0 x 10^{-2} J • cm^{-2}	
0.309	10^{-9} to 3 x 10^{4}	6.3 x 10^{-2} J • cm^{-2}	1 mm limiting aperture
0.310	10^{-9} to 3 x 10^{4}	1.0 x 10^{-1} J • cm^{-2}	
0.311	10^{-9} to 3 x 10^{4}	1.6 x 10^{-1} J • cm^{-2}	
0.312	10^{-9} to 3 x 10^{4}	2.5 x 10^{-1} J • cm^{-2}	
0.313	10^{-9} to 3 x 10^{4}	4.0 x 10^{-1} J • cm^{-2}	
0.314	10^{-9} to 3 x 10^{4}	6.3 x 10^{-1} J • cm^{-2}	
0.315 to 0.400	10^{-9} to 10	0.56 $t^{1/4}$ J • cm^{-2}	
0.315 to 0.400	10 to 3 x 10^{4}	1 J • cm^{-2}	
Visible	10^{-9} to 10	10 $t^{1/3}$ J • cm^{-2} • sr^{-1}	
0.400 to 0.700	10 to 10^{4}	21 J • cm^{-2} • sr^{-1}	
0.400 to 0.550	10 to T_1	3.83 $t^{3/4}$ J • cm^{-2} • sr^{-1}	
0.550 to 0.700	T_1 to 10^{4}	21 C_B J • cm^{-2} • sr^{-1}	
0.550 to 0.700	10^{3} to 3 x 10^{4}	2.1 C_B x 10^{-3} W • cm^{-2} • sr^{-1}	
0.400 to 0.700			1 mm limiting aperture or α_{min}, whichever is greater
Near Infrared	10^{-9} to 10	*10* C_A $t^{1/3}$ J • cm^{-2} • sr^{-1}	
0.700 to 1.400	10 to 10^{3}	3.83 C_A $t^{3/4}$ J • cm^{-2} • sr^{-1}	
0.700 to 1.400	10^{-3} to 3 x 10^{4}	*0.64* C_A W • cm^{-2} • sr^{-1}	
1.051 to 1.400			
Far Infrared	10^{-9} to 10^{-7}	10^{-2} J • cm^{-2}	
1.4–10^{3}	10^{-7} to 10	0.56 $t^{1/4}$ J • cm^{-2}	
	>10	0.1 W • cm^{-2}	
1.54 Only	10^{-9} to 10^{-6}	1.0 J • cm^{-2}	

Notes: C_A = 1 for λ = 0.400 to 0.700 μm,
$C_A = 10^{2.0(\lambda - 0.700)}$ for λ = 0.700 to 1.050 μm
C_A = 5 for λ = 1.051 to 1.400 μm
C_B = 1 for λ = 0.400 to 0.550 μm
$C_B = 10^{15(\lambda - 0.550)}$ for λ = 0.550 to 0.700 μm
$T_1 = 10 \times 10^{20(\lambda - 0.550)}$ for λ = 0.550 to 0.700 μm

FIGURE 5.7.3.2.1–5 "EXTENDED SOURCE" LASER EYE EXPOSURE LIMITS

Wavelength, λ (μm)	Exposure Duration, t (s)	Maximum Permissible Exposure (MPE)	Notes for Calculation and Measurement
Ultraviolet			
0.200 to 0.302	10^{-9} to 3 x 10^{4}	3 x 10^{-3} J • cm^{-2}	0.56 $t^{1/4}$ J • cm^{-2}, whichever is lower
0.303	10^{-9} to 3 x 10^{4}	4 x 10^{-3} J • cm^{-2}	
0.304	10^{-9} to 3 x 10^{4}	6 x 10^{-3} J • cm^{-2}	
0.305	10^{-9} to 3 x 10^{4}	1.0 x 10^{-2} J • cm^{-2}	
0.306	10^{-9} to 3 x 10^{4}	1.6 x 10^{-2} J • cm^{-2}	
0.307	10^{-9} to 3 x 10^{4}	2.5 x 10^{-2} J • cm^{-2}	
0.308	10^{-9} to 3 x 10^{4}	4.0 x 10^{-2} J • cm^{-2}	
0.309	10^{-9} to 3 x 10^{4}	6.3 x 10^{-2} J • cm^{-2}	1 mm limiting aperture
0.310	10^{-9} to 3 x 10^{4}	1.0 x 10^{-1} J • cm^{-2}	
0.311	10^{-9} to 3 x 10^{4}	1.6 x 10^{-1} J • cm^{-2}	
0.312	10^{-9} to 3 x 10^{4}	2.5 x 10^{-1} J • cm^{-2}	
0.313	10^{-9} to 3 x 10^{4}	4.0 x 10^{-1} J • cm^{-2}	
0.314	10^{-9} to 3 x 10^{4}	6.3 x 10^{-1} J • cm^{-2}	
0.315 to 0.400	10^{-9} to 10	0.56 $t^{1/4}$ J • cm^{-2}	
0.315 to 0.400	10 to 10^{3}	1 J • cm^{-2}	
0.315 to 0.400	10^{3} to 3 x 10^{4}	1 x10^{-3} J • cm^{-2}	
Visible & Near Infrared			
0.400 to 1.400	10^{-9} to 10^{-7}	*2* C_A x 10^{-2} J • cm^{-2}	1 mm limiting aperture
	10^{-7} to 10	*1.1* C_A $t^{1/4}$ J • cm^{-2}	
	10 to 3 x 10^{4}	0.2 C_A W • cm^{-2}	
Far Infrared			
1.4 to 10^{3}	10^{-9} to 10^{-7}	10^{-2} J • cm^{-21}	1 mm limiting aperture for 1.4 to 100 μm
	10^{-7} to 10	0.56 $t^{1/4}$ J • cm^{-2}	
	>10	0.1 W • cm^{-2}	11 mm limiting aperture for 0.1 to 1 mm
1.54 Only	10^{-9} to 10^{-6}	1.0 J • cm^{-2}	

FIGURE 5.7.3.2.1–6 MAXIMUM PERMISSIVE EXPOSURE FOR SKIN EXPOSURE TO A LASER BEAM

Helium–Cadmium Argon	441.6 488/514.5	a) 2.5 mW • cm^{-2} for 0.25 s b) 10 mJ • cm^{-2} for 10 to 10^4 s c) 1 μ W • cm^{-2} for t > 10^4 s	0.2 W • cm^{-2} for t >10s
Helium–Neon	632.8	a) 2.5 mW • cm^{-2} for 0.25 s b) 10 mJ • cm^{-2} for 10 s c) 170 mJ • cm^{-2} for t > 453 s d) 17 μW • cm^{-2} for t > 10^4 s	0.2 W • cm^{-2} for t >10s
Krypton	647	a) 2.5 mW • cm^{-2} for 0.25 s b) 10 mJ • cm^{-2} for 10 s c) 280 mJ • cm^{-2} for t > 871 s d) 28 μW • cm^{-2} for t > 10^4 s	0.2 W • cm^{-2} for t >10s
Neodymium: YAG Gallium–Arsenide at room temp	1,064 905	1.6 m W • cm^{-2} for t >1000 s 0.8 m W • cm^{-2} for t >1000 s	1.0 W • cm^{-2} 0.5 W • cm^{-2} for t > 10s
Helium–Cadmium Nitrogen	325 337.1	1 J • cm^{-2} for 10 to 3 x 10^4s	a) 1 J • cm^{-2} for 10 to 1000s b) 1 mW • cm^{-2} for t > 1000s
Carbon–dioxide (and other lasers 1.4 μm to 1000 μm)	10,600	0.1 W • cm^{-2} for t > 10 s	0.1 W • cm^{-2} for t > 10 s

FIGURE 5.7.3.2.1–7 INTRABEAM MPE FOR THE EYE AND SKIN FOR SELECTED LASERS

C. Limits on Exposure to Incoherent Electromagnetic Radiation (200 nm – 3 μm) – For the purposes of limiting crew exposure to the electromagnetic spectrum from the ultraviolet to the far infrared, the methodology given in the American Conference of Industrial Hygienists (ACGIH) Standards, Threshold Limit Values and Biological Exposure Indices, shall be adopted. These standards allow for the quantification of the relationship between source strength and acceptable exposure times for each of four potential injury pathways (retinal thermal injury due to exposure to visible light, retinal photochemical injury due to chronic exposure to blue–light, thermal injury to the ocular lens and cornea due to infrared exposure, and exposure of the unprotected skin or eye to ultraviolet radiation). These limits DO NOT apply to laser exposure (see laser exposure limits). Because of the difference in the ambient environment in space and the environment on the Earth's surface, the numerical values used by the ACGIH are amended for use by NASA by the insertion of a factor of one–fifth in the source term of each calculation, with the exception of the calculation for ultraviolet exposure, which is not amended, as follows: **DCN 008**

(1) Exposure Limits for the Prevention of Retinal Thermal Injury from a Visible Light Source (400–1400 nm). **DCN 008**

The spectral radiance of the source weighted against the Retinal Thermal Hazard Function R_λ (given in Figure 5.7.3.2.1–8) shall not exceed: **DCN 008**

$$\sum_{400}^{1400} 0.2 * L_\lambda * R_\lambda * \Delta\lambda \leq \frac{5}{\alpha * t^{1/4}}$$ **DCN 008**

Where L_λ is the source spectral radiance expressed in $W/cm^2 \bullet sr \bullet nm$, R_λ is the dimensionless retinal thermal hazard function, t is the viewing duration expressed in seconds, and α is the angular subtense of the source in radians. **DCN 008**

(2) Exposure Limits to Prevent Retinal Photochemical Injury Caused by Chronic Exposure to Blue–Light (400–700 nm). **DCN 008**

Blue–light sources are to be distinguished according to their angular subtense. **DCN 008**

a. Exposures to blue–light sources subtending an angle less than 11 milliradians are limited such that the spectral irradiance weighted against the blue–light hazard function B_λ (given in Figure 5.7.3.2.1–8) shall not exceed: **DCN 008**

$$\sum_{400}^{700} 0.2 * E_\lambda * t * B_\lambda * \Delta\lambda \le 10\, mJ/cm^2 \quad \text{for } t \le 10^4 s$$ **DCN 008**

or

$$\sum_{400}^{700} 0.2 * E_\lambda * B_\lambda * \Delta\lambda \le 1.0\, \mu W/cm^2 \quad \text{for } t > 10^4 s$$ **DCN 008**

Note that the maximum weighted irradiance above is 2 μW per centimeter squared. For a source whose weighted irradiance exceeds 2 μW per centimeter squared, the maximum permissible exposure duration is given by: **DCN 008**

$$t_{\max} \le \frac{10\, mJ/cm^2}{\sum_{700}^{400} 0.2 * E_\lambda * B_\lambda * \Delta\lambda}$$ **DCN 008**

b. Exposures to blue–light sources subtending an angle equal to or greater than 11 mradians are limited such that: **DCN 008**

$$\sum_{400}^{700} 0.2 * E_\lambda * t * B_\lambda * \Delta\lambda \le 100\, J/\left(cm^2 * sr\right) \quad \text{for } t \le 10^4 s$$ **DCN 008**

or

$$\sum_{400}^{700} 0.2 * E_\lambda * B_\lambda * \Delta\lambda \le 10^{-2}\, W/\left(cm^2 * sr\right) \quad \text{for } t > 10^4 s$$ **DCN 008**

Note that the above maximum radiance in this case is 100 $J/(cm^2 \bullet sr)$, so that the maximum permissible viewing time becomes: **DCN 008**

$$t_{\max} \le \frac{100\ J/(cm^2 * sr)}{\sum_{700}^{400} 0.2 * E_\lambda * B_\lambda * \Delta\lambda}$$ **DCN 008**

For individuals who have had a lens removal as corrective surgery for cataract treatment, B_λ is not an accurate indicator if the increase in risk of photochemical injury. In this case the alternate Aphakic Hazard Function A_λ (also given in Figure 5.7.3.2.1–8) should be inserted into the above calculations in the place of B_λ. **DCN 008**

Wavelength, (nm)	Aphakic Hazard	Blue–Light Hazard	Retinal Thermal Hazard
	Function, A_λ	Function, B_λ	Function, R_λ
305	6.00	—	—
310	6.00	—	—
315	6.00		—
320	6.00	—	—
325	6.00	—	—
330	6.00	—	—
335	6.00	—	—
340	5.88	—	—
345	5.71	—	—
350	5.46	—	—
355	5.22	—	—
360	4.62	—	—
365	4.29	—	—
370	3.75	—	—
375	3.56	—	—
380	3.19	—	—
385	2.31	—	—
390	1.88	—	—
395	1.58	—	—
400	1.43	0.10	1.0
405	1.30	0.20	2.0
410	1.25	0.40	4.0
415	1.20	0.80	8.0
420	1.15	0.90	9.0
425	1.11	0.95	9.5
430	1.07	0.98	9.8
435	1.03	1.0	10.0
440	1.0	1.0	10.0

FIGURE 5.7.3.2.1–8 BLUE–LIGHT, RETINAL THERMAL, AND APHAKIC HAZARD FUNCTIONS FOR USE IN ASSESSING EXPOSURE LIMITS FOR BROADBAND OPTICAL SOURCES (PAGE 1 OF 2)

DCN 008

Wavelength, (nm)	Aphakic Hazard	Blue–Light Hazard	Retinal Thermal Hazard
	Function, A_λ	Function, B_λ	Function, R_λ
445	0.97	0.97	9.7
450	0.94	0.94	9.4
455	0.90	0.90	9.0
460	0.80	0.80	8.0
465	0.70	0.70	7.0
470	0.62	0.62	6.2
475	0.55	0.55	5.5
480	0.45	0.45	4.5
485	0.40	0.40	4.0
490	0.22	0.22	2.2
495	0.16	0.16	1.6
500 to 600	$10^{-\frac{(450-\lambda)}{50}}$	$10^{-\frac{(450-\lambda)}{50}}$	1.0
500 to 700	0.001	0.001	1.0
700 to 1050	—	—	$10^{\frac{(1700-\lambda)}{500}}$
1050 to 1400	—	—	0.2

FIGURE 5.7.3.2.1–8 BLUE–LIGHT, RETINAL THERMAL, AND APHAKIC HAZARD FUNCTIONS FOR USE IN ASSESSING EXPOSURE LIMITS FOR BROADBAND OPTICAL SOURCES (PAGE 2 OF 2)

DCN 008

(3) Exposure Limits to Protect the Eye from Thermal Injury Caused by Overexposure to Infrared Radiation (770 to 3000 nm) – **DCN 008**

To protect the eye from thermal injury caused by overexposure to infrared radiation, including delayed effects to the lens (cataractogenesis), the infrared radiation exposure should be limited to: **DCN 008**

$$10 mW/cm^2 \text{ for } \textit{exposures longer than } 1000s$$ **DCN 008**

and to

$$\sum_{400}^{3000} 0.2 * E_\lambda * \Delta\lambda \leq 1.8 * t^{-3/4}\, W/cm^2 \quad \text{for } t < 1000s$$ **DCN 008**

Please note that this TLV applies to an environment with an ambient temperature of 37 degrees Celsius, and can be increased by 0.8 mW per centimeter squared for every degree Celsius below 37. **DCN 008**

(4) Exposure Limits for Ultraviolet Exposure of the Unprotected Eye or Skin (200–400 nm) – **DCN 008**

To protect the eye and skin from injury caused by overexposure to ultraviolet radiation, the spectral irradiance weighted against the spectral effectiveness function S_λ (given in Figure 5.7.3.2.1–9) should be limited to: **DCN 008**

$$\sum_{200}^{400} E_\lambda * S_\lambda * t * \Delta\lambda \leq 3\, mJ/cm^2 \text{ in any 24 hr period}$$ **DCN 008**

A table of weighted spectral irradiances versus recommended exposure times is given in Figure 5.7.3.2.1–10. **DCN 008**

Wavelength	TLV (J/m^2)	TLV (mJ/cm^2)	Relative Spectral Effectiveness, S_λ
180	2500	250	0.012
190	1600	160	0.019
200	1000	100	0.030
205	590	59	0.051
210	400	40	0.075
215	320	32	0.095
220	250	25	0.120
225	200	20	0.150
230	160	16	0.190
235	130	13	0.240
240	100	10	0.300
245	83	8.3	0.360
250	70	7.0	0.430
255	58	5.8	0.520
260	46	4.6	0.650
265	37	3.7	0.810
270	30	3.0	1.000
275	31	3.1	0.960
280	34	3.4	0.880
285	39	3.9	0.770
290	47	4.7	0.640
295	56	5.6	0.540
300	100	10	0.300
305	500	50	0.06
310	2000	200	0.015
315	$1.0*10^4$	1000	0.003

FIGURE 5.7.3.2.1–9 ULTRAVIOLET RADIATION EXPOSURE TLV AND SPECTRAL WEIGHTING FUNCTION (PAGE 1 OF 2)

DCN 008

Wavelength	TLV (J/m^2)	TLV (mJ/cm^2)	Relative Spectral Effectiveness, S_λ
320	$2.9*10^4$	2900	0.0024
325	$6.0*10^4$	6000	0.00050
330	$7.3*10^4$	7300	0.00041
335	$8.8*10^4$	8800	0.00034
340	$1.1*10^5$	$1.1*10^4$	0.00028
345	$1.3*10^5$	$1.3*10^4$	0.00024
350	$1.5*10^5$	$1.5*10^4$	0.00020
355	$1.9*10^5$	$1.9*10^4$	0.00016
360	$2.3*10^5$	$2.3*10^4$	0.00013
365	$2.7*10^5$	$2.7*10^4$	0.00011
370	$3.2*10^5$	$3.2*10^4$	0.000093
375	$3.9*10^5$	$3.9*10^4$	0.000077
380	$4.7*10^5$	$4.7*10^4$	0.000064
385	$5.7*10^5$	$5.7*10^4$	0.000053
390	$6.8*10^5$	$6.8*10^4$	0.000044
395	$8.3*10^5$	$8.3*10^4$	0.000036
400	$1.0*10^6$	$1.0*10^5$	0.000030

FIGURE 5.7.3.2.1–9 ULTRAVIOLET RADIATION EXPOSURE TLV AND SPECTRAL WEIGHTING FUNCTION (PAGE 2 OF 2)

DCN 008

Duration of Exposure per Day	Effective Irradiance, $\mu W/cm^2$
8 hrs.	0.1
4 hrs.	0.2
2 hrs.	0.4
1 hr.	0.8
30 min.	1.7
15 min.	3.3
10 min.	5
5 min.	10
1 min.	50
30 sec.	100
10 sec.	300
1 sec.	3000
0.5 sec.	6000
0.1 sec.	30000

FIGURE 5.7.3.2.1–10 PERMISSABLE ULTRAVIOLET EXPOSURES

DCN 008

5.8 THERMAL ENVIRONMENT

5.8.1 INTRODUCTION

This paragraph is not applicable for this document.

5.8.2 THERMAL ENVIRONMENT DESIGN CONSIDERATIONS

This paragraph is not applicable for this document.

5.8.3 THERMAL ENVIRONMENT DESIGN REQUIREMENTS

5.8.3.1 TEMPERATURE, HUMIDITY, AND VENTILATION DESIGN REQUIREMENTS

5.8.3.2 THERMAL MONITORING AND CONTROL DESIGN REQUIREMENTS

The following requirements shall apply to the monitoring and control of the space cabin thermal environment:

A. Routine monitoring of Thermal Environment –

(1) Monitoring of cabin temperature and relative humidity shall be provided.

(2) Routine monitoring of the thermal environment shall be automated.

The number, type, and location of temperature sensors and the frequency of monitoring shall be such as to ensure measurement of representative cabin temperature and to allow stable control of those temperatures.

(3) Visual and audible alarms shall be automatically initiated when thermal parameters exceed the limits.

B. Adjustment of Thermal Environment by the Crew – Crewmembers shall be provided with controls that allow them to modify temperatures, humidity, and ventilation rates inside the Space Station.

C. Sleep Compartment, Personal Hygiene Area, and Waste Management Compartment Thermal Environment Controls – Temperature and ventilation shall be maintained in each of the private crew accommodations and the waste management compartment and be controllable within the range of these parameters.

D. Exercise Station Perspiration Control – Each exercise station shall be provided with a method of sweat removal and collection.

5.9 DELETED

H. Loose Hoses or Cables –

(1) If the connectors on the ends of a loose electrical cable are not identical, each end shall be identified.

(2) The loose ends of electrical cables or fluid lines shall be restrained.

I. Connector Caps or Plugs for Dead–Facing, Terminating, and Shorting – Individual connector caps or plugs used for dead–facing, terminating, and shorting shall be identified by its applicable P– and J–number followed by a dash and D (dead–facing), or T (terminating), or S (shorting) (e.g., terminating plug for line P21 would be labeled as P21–T).

11.10.3.6 CONNECTOR ARRANGEMENT DESIGN REQUIREMENTS

All types of IVA and EVA connectors shall comply with the following arrangement and spacing requirements:

A. Deleted.

B. Connectors and Adjacent Obstructions – Space between connectors and adjacent obstructions shall be a minimum of 25.0 mm (1.0 in.) for IVA and 40.6 mm (1.6 in.) for EVA access.

C. Connectors in Rows Which Are Removed Sequentially –

(1) Connectors in a single row or staggered rows which are removed sequentially by the crew (IVA) shall provide 25.0 mm (1.0 in.) of clearance from other connectors and/or adjacent obstructions for 270 degrees of sweep around each connector beginning at the start of its removal/replacement sequence.

(2) For single rows or staggered rows of EVA connectors, 40.6 mm (1.6 in.) of clearance for 270 degrees sweep shall be provided.

D. Deleted.

E. Deleted.

11.11 WINDOWS

11.11.1 INTRODUCTION

This paragraph is not applicable for this document.

11.11.2 WINDOW DESIGN CONSIDERATIONS

Requirements for three different categories of window ports are provided in this section. A window port is defined as the finished assembly which includes all window panes that would normally be used at a specific location. For each specific requirement it will be stated whether the requirement applies to individual window panes or to the entire window port which includes all finished window panes. The three categories of window ports will be referred to by the designated letter: **DCN 008**

A. Window ports to support crew viewing and limited crew photography (i.e. hatch windows). **DCN 008**

B. Window ports to support crew viewing and crew photography. **DCN 008**

C. Window ports to support crew viewing and science including support of telescopes with aperture diameters of at least six inches. **DCN 008**

11.11.3 WINDOW DESIGN REQUIREMENTS

All window port and window pane designs shall meet the requirements of SSP 30560. **DCN 008**

11.11.3.1 DESIGN REQUIREMENTS FOR ALL WINDOWS

These requirements apply to test conditions prior to launch. The verification of optical requirements can be performed in the unloaded condition. **DCN 008**

11.11.3.1.1 WINDOW SIZE

A. Category A (Hatch) Window Ports – **DCN 008**

(1) Category A (Hatch) window ports shall have a minimum clear viewing area equal to that of an 8.0 inch (20.3 cm) diameter circle. **DCN 008**

(2) The length to width aspect ratio shall not exceed 1:1.7. **DCN 008**

B. Category B and C (Observation) Window Ports – **DCN 008**

(1) Category B and C (observation) window ports shall have a minimum clear viewing area equal to that of a 20.0 inch (50.8 cm) diameter circle. **DCN 008**

(2) The length to width aspect ratio shall not exceed 1:1.7. **DCN 008**

11.11.3.1.2 SURFACE REFLECTIONS

A. Anti–Reflection Coatings – When anti–reflection coatings are applied to window panes, they shall not cause resolution degradation exceeding 0.007 milliradians (1.5 arc seconds). **DCN 008**

B. Specular Reflectance – Window panes shall be designed such that the specular reflectance from each anti–reflection coated surface, disregarding red–reflector coated surfaces, from 450 to 700 nanometers normally incident light shall not exceed 2.0 percent absolute. **DCN 008**

11.11.3.1.3 OPTICAL AND DURABILITY CHARACTERISTICS FOR ALL WINDOWS

All finished window panes, with accepted coatings, and completed tempering and lamination processes, if applicable, shall meet the following requirements: **DCN 008**

A. Parallelism – Each surface of a multi–element window shall be parallel to all other surfaces to within 1.5 degrees. **DCN 008**

B. Visual Uniformity Requirements – All window coatings will be uniform in quality and condition and hence shall conform to MIL–C–48497, paragraphs 3.3.1, 3.3.2, and 3.3.3. **DCN 008**

C. Verification of Uniformity Requirements – Visual uniformity requirements shall be verified by following the test procedures described in MIL–C–48497, paragraphs 4.5.2.1, 4.5.2.2, and 4.5.2.3. **DCN 008**

D. Durability for Window Surfaces Exposed to Crew Contact – **DCN 008**

(1) Windows with coatings deposited on glass substrates – Window coatings exposed to crew contact shall exhibit durability per MIL–C–48497, section 3.4, with the following exceptions: (1) paragraph 3.4.2.1, shall be amended to require exposure of +20 and –20 degrees Fahrenheit be added to the maximum and minimum design temperatures, (2) paragraph 3.4.3.1, shall be eliminated, and (3) paragraph 3.4.3.2, shall be eliminated. **DCN 008**

(2) Windows with coatings deposited on substrates other than glass – Window coatings exposed to crew contact shall exhibit durability per MIL–C–48497, section 3.4, with the following exceptions: (1) paragraph 3.4.2.1, shall be amended to require exposure of +20 and –20 degrees Fahrenheit be added to the maximum and minimum design temperatures, (2) paragraph 3.4.2.2, shall be amended to eliminate immersion in trichloroethylene and acetone, (3) paragraph 3.4.3.1, shall be eliminated, (4) paragraph 3.4.1.3, shall be eliminated, and instead the coating shall be required to pass a Taber abrasion resistance test per ASTM D1044 with no more than 4.27 percent haze after 100 revolutions and no more than 27.06 percent haze after 500 revolutions of a CS10F wheel under a load of 500 grams, and (5) the requirement to exhibit salt resistance, per paragraph 3.4.3.2, shall be eliminated. **DCN 008**

E. Durability for Window Surfaces Not Exposed to Crew Contact – The window coatings shall exhibit durability per MIL–C–48497, section 3.4, with the following exceptions: (1) paragraph 3.4.2.1, shall be amended to require exposure of +20 and –20 degrees Fahrenheit be added to the maximum and minimum design temperatures, (2) paragraph 3.4.3.1, shall be eliminated, and (3) the requirement to exhibit salt resistance, per paragraph 3.4.3.2, shall be eliminated. **DCN 008**

11.11.3.1.3.1 OPTICAL CHARACTERISTICS OF CATEGORY A WINDOWS

All finished Category A window panes with accepted coatings will meet the following optical requirements within the specified clear viewing area. **DCN 008**

A. Deviation – **DCN 008**

(1) Light at normal incidence at any point on nontempered window panes shall not be deviated by more than 1.45 milliradians (5.0 arc minutes). **DCN 008**

(2) Light at normal incidence at any point on tempered window panes shall not be deviated by more than 2.9 milliradians (10.0 arc minutes). **DCN 008**

B. Wedge – The wedge of any individual window pane shall be limited to 5 arc minutes in any direction. **DCN 008**

C. Haze – The haze, after all coatings have been applied, shall be less than 1.0 percent per ASTM D1003, Procedure A. **DCN 008**

11.11.3.1.3.2 OPTICAL CHARACTERISTICS OF CATEGORY B WINDOWS

A. Wavefront – **DCN 008**

(1) The peak–to–valley transmitted wavefront error through the combination of all window panes for the window port shall not exceed four waves over any 101.6 mm (4.0 inches) diameter sub–aperture within the central 80 percent (minimum) of the physical diameter (excluding flight loads and pressure loads), where the reference wavelength is 632.8 nm. **DCN 008**

Note (a): Wavefront variation of 1 wave over any 101.6 mm (4.0 inch) diameter sub–aperture is highly desirable. **DCN 008**

Note (b): For viewing angles of 30 degrees from normal incidence, it is a goal that the wavefront variation not exceed 5 waves peak–to–valley over any 4.0 inch diameter sub–aperture within the central 60 percent (minimum) of the physical diameter. **DCN 008**

(2) The transmitted wavefront error shall not exceed 1 wave per inch up to a 4 inch diameter sub–aperture peak–to–valley over the central 80 percent (minimum) of the physical diameter with a reference wavelength of 632.8 nm. **DCN 008**

(3) Wavefront requirements shall be met after all optical coatings have been applied, and if applicable, all tempering and lamination steps have been completed. **DCN 008**

(4) Wavefront requirements shall apply when viewing through the window port at normal incidence. **DCN 008**

B. Wedge – The wedge of any individual window pane shall be limited to 30.0 arc–seconds in any direction. **DCN 008**

C. Haze – The haze, after all coatings have been applied, shall be less than 0.5 percent per ASTM D1003, Procedure A. **DCN 008**

11.11.3.1.3.3 WAVEFRONT VERIFICATION

Either Method A or Method B shall be used to demonstrate wavefront compliance for Category B and C Window Ports. **DCN 008**

11.11.3.1.3.3.1 METHOD A OF WAVEFRONT VERIFICATION

A. Each individual pane shall be tested over at least six sub–apertures distributed within the test area (defined as a minimum of 80 percent of the physical diameter of the pane) with one test aperture being nominally located in the center of this area, and with one test aperture being nominally located over the optically worst part of the pane within the test area. This test will measure the wavefront error at a nominal angle of zero degrees for the six sub–apertures. **DCN 008**

Note: The transmitted wavefront error should be tested over the full test area defined, but may be tested over smaller sub–apertures if the wavefront errors are too large, or instrumentation is not available to test over the entire test area. **DCN 008**

B. An additional test shall be conducted to measure wavefront of four sub–apertures distributed over the central 60 percent of the physical diameter for a nominal view angle of +/– 30 degrees. **DCN 008**

C. To demonstrate compliance with the wavefront requirement specification, the worst area of each individual pane shall be summed via a root–sum–square and this total shall be less than the specified wavefront requirement. For example, if the worst measured wavefront for three panes are values "a", "b", and "c", then the total wavefront will be: **DCN 008**

Wavefront total = $\sqrt{a^2 + b^2 + c^2}$ **DCN 008**

D. Each surface of all individual panes shall be tested in reflectance at normal incidence over at least the test area in order to record the surface figure for Category C Window Ports only. **DCN 008**

11.11.3.1.3.3.2 METHOD B OF WAVEFRONT VERIFICATION

A. An interferometric test shall be performed on all panes together of the window port configuration. This test will measure the wavefront error over at least six sub–apertures distributed within the test area of the assembly (defined as a minimum of 80 percent of the physical diameter of the assembly) with one test aperture being nominally located in the center of the clear aperture, and with one test aperture being nominally located over the optically worst area of the pane within the test area. **DCN 008**

Note: The transmitted wavefront error should be tested over the full test aperture defined, but may be tested over smaller sub–apertures if the wavefront errors are too large, or instrumentation is not available to test entire test area. **DCN 008**

B. An additional test shall be conducted to measure wavefront of four sub–apertures distributed over 60 percent of the physical diameter for a nominal view angle of +/– 30 degrees. **DCN 008**

C. Each surface of all individual panes shall be tested in reflectance at normal incidence over at least the test area defined in order to record the surface figure for Category C Window Ports only. **DCN 008**

11.11.3.1.3.3.3 DATA REQUIREMENTS FOR BOTH METHODS

The data pack shall include images of the interferograms recorded at all test apertures (including the large apertures), the total peak–to–valley wavefront error measured at each test aperture, and a breakdown of the total wavefront error measured at each test aperture into the individual third order aberrations (tilt, power, coma, spherical aberration, and astigmatism). Any spare panes fabricated shall also be tested by Method A or Method B. **DCN 008**

11.11.3.1.4 OPTICAL TRANSMITTANCE FOR ALL WINDOW PORTS

A. Crew Safety Considerations – **DCN 008**

(1) For the purposes of ensuring crew safety, the transmittance of the window assembly shall be evaluated according to the limits specified in 5.7.3. **DCN 008**

(2) This evaluation shall be carried out assuming that the solar spectrum is modeled by that given in Figure 11.11.3.1.4–1, and further that the Sun subtends an angle of 9.3E–03 radians and a solid angle of 6.8E–05 steradians at the eye of the observer in Low Earth Orbit (LEO). **DCN 008**

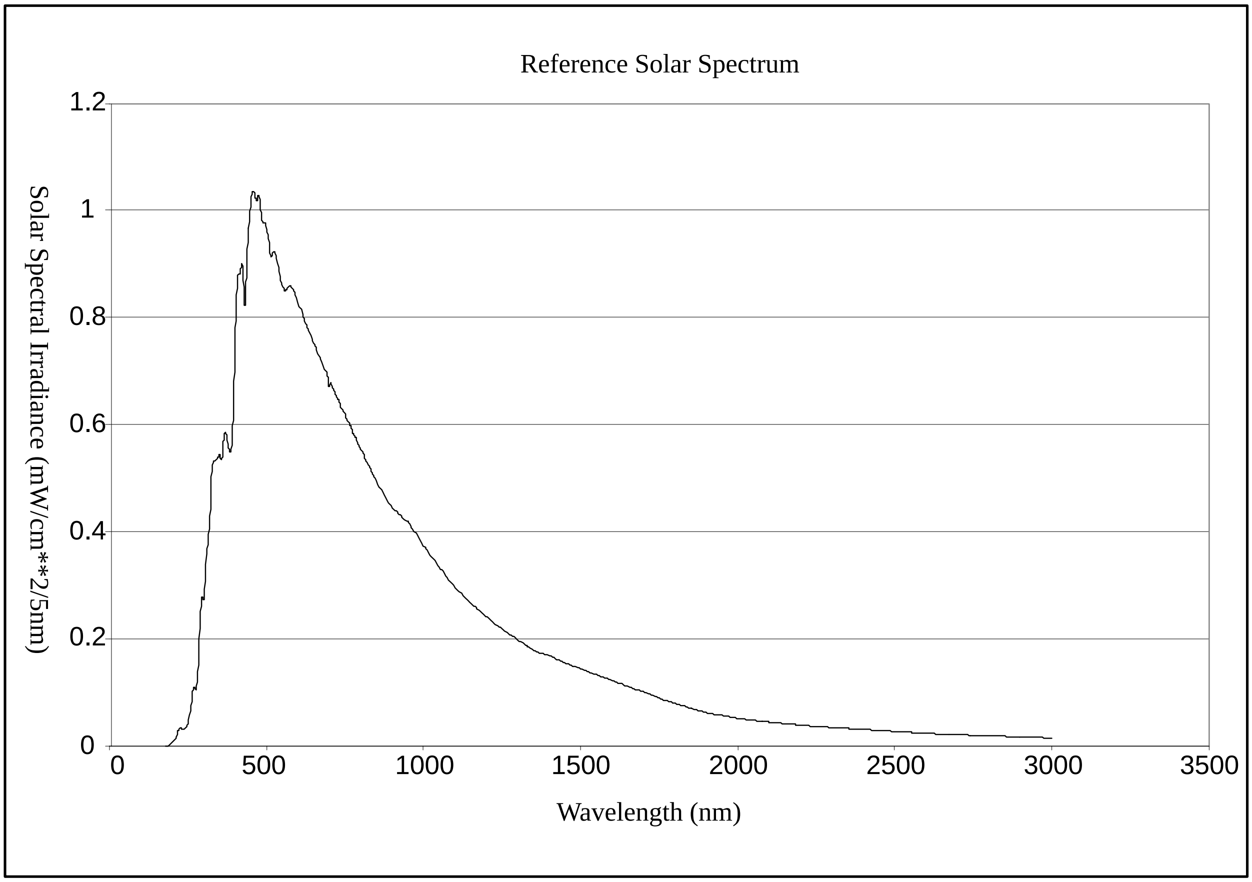


FIGURE 11.11.3.1.4–1 SOLAR SPECTRUM

DCN 008

B. Damage Mechanism Exposure Limits – The requirements of 5.7.3 are considered to have been met if the window port being considered has transmittance values which yield acceptable viewing times that are less than or equal to those specified in Figure 11.11.3.1.4–2 when using the source terms discussed in 11.11.3.1.4, Item A. The infrared requirement is applicable to cases where a strong visual stimulus is present. If the window port does not meet the values defined in Figure 11.11.3.1.4–2, additional means (sunglasses, additional films, etc.) can be used to meet the required attenuation. To utilize alternate means, the Radiation Health Officer shall concur. **DCN 008**

	Solar Irradiance
Mechanism	Exposure Time Limit
Retinal Thermal Damage	3 seconds
Retinal Photochemical Damage	5 seconds
Infrared Exposure	10 minutes
Ultraviolet Exposure	8 hours

FIGURE 11.11.3.1.4–2 EXPOSURE LIMITS FOR DIFFERENT DAMAGE MECHANISMS

DCN 008

C. Color Balance for Category B and C Window Ports – The maximum allowable color shift for a D65 Standard Illuminant, when viewed through Category B or C windows, is bounded by a rectangular color space on the 1931 CIE Chromaticity Diagram. The boundaries of the rectangular color space range between 0.312 and 0.321 (inclusive) in the x coordinate, and between 0.329 and 0.340 (inclusive) in the y coordinate. The bounding box representing the allowable color shift, along with the location of the unshifted D65 Standard Illuminant, are illustrated schematically in Figure 11.11.3.1.4–3. **DCN 008**

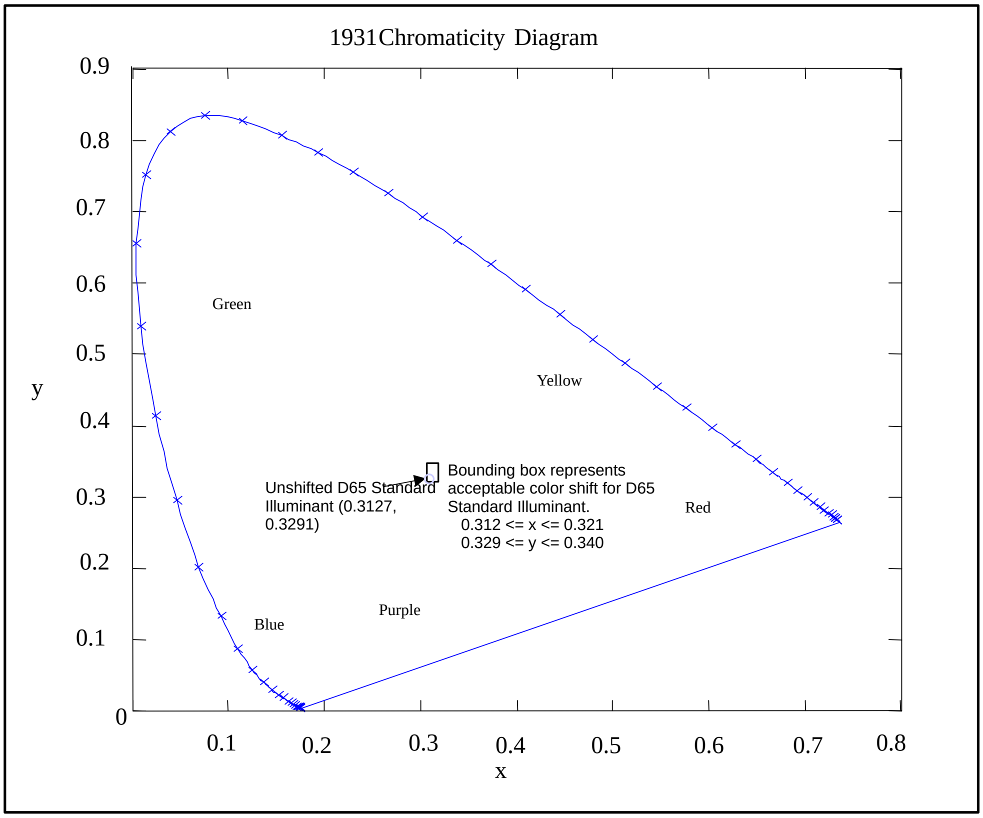


FIGURE 11.11.3.1.4–3 CHROMATICITY DIAGRAM

DCN 008

D. Transmittance Requirements in the Visible Spectrum for Category B and C Window Ports – The transmittance shall be greater than or equal to 75.0 percent for wavelengths between 425 and 700 nanometers for all Category B and C window ports. **DCN 008**

Note: The coating designer should consider the field–of–view requirements of instruments designed for viewing or acquiring images through Category B and C windows, together with the maximum tilt of the instrument with respect to the window, to design a coating which will accommodate the expected range of incident angles of light through the window, or exhibit the appropriate off–angle transmittance characteristics. **DCN 008**

E. Transmittance Requirements in the Visible Spectrum for Category A Window Ports – The transmittance shall be greater than or equal to 70.0 percent for wavelengths between 450 and 700 nanometers for all Category A window ports. **DCN 008**

11.11.3.1.5 GLASS QUALITY FOR CATEGORY A AND B WINDOW PANES

A. Annealed Glass Window Pane Material – **DCN 008**

(1) Surface Finish – The surface of each window pane shall be polished to meet or exceed the requirements of a scratch dig code of 80–50 or better as defined in MIL–O–13830. **DCN 008**

(2) Open Inclusions – **DCN 008**

a. The maximum number of open inclusions per surface shall not exceed three and shall not exceed 0.050 inches (1.27 mm) in diameter. Open inclusions separated by less than two inches are not permitted. **DCN 008**

b. Open inclusions equal or less than 0.00315 inches (0.08 mm) in diameter shall be disregarded. **DCN 008**

(3) Inclusions – Inclusions shall be per MIL–G–174, Class 1, Inclusion number 2, with the following exceptions: **DCN 008**

a. The maximum size inclusion diameter shall be limited to 0.50 mm. **DCN 008**

b. The permissible number of maximum diameter inclusions shall be one per 100 cubic centimeters of glass. **DCN 008**

c. Inclusions with a cross–section equal to or less than 0.08 mm diameter shall be disregarded when evaluating the maximum total cross–section area (mm squared per 100 cubic centimeters). **DCN 008**

(4) Striae – Striae shall be per MIL–G–174 Grade A or better. **DCN 008**

(5) Birefringence – Birefringence shall be 12.0 nanometers per centimeter maximum or equivalent. **DCN 008**

B. Tempered Float Glass Window Pane Material – **DCN 008**

(1) Tempered float glass shall be aircraft quality or better per MIL–G–25667, or better.

(2) Laminated tempered float glass shall be per MIL–G–25871, or better. **DCN 008**

11.11.3.1.6 DELETED **DCN 008**

11.11.3.1.7 VISUAL PROTECTION DESIGN REQUIREMENTS

A. Sun Shades/Shields –

(1) Observation windows shall be provided with crew–operated, opaque sun shields that are capable of restricting all sunlight from entering the habitable compartments. **DCN 008**

(2) External Sun Shade Repositioning – If external sun shades are designed to cast a shadow over a window, they shall be provided with a means to be positioned by the window user. **DCN 008**

B. Heat Rejection – The sun shade, whether internal or external, shall be capable of rejecting radiant energy away from the window assembly.

C. Deleted.

11.11.3.1.8 PHYSICAL PROTECTION DESIGN REQUIREMENTS

A. Contamination Protection – Window design shall take into account all sources of external contamination. Window design shall provide a means for cleaning and replacing. **DCN 008**

B. Between Pane Contamination Protection – **DCN 008**

(1) Window design shall take into account all sources of contamination that can occur between the panes. **DCN 008**

(2) Window design shall provide a means for reduction of optical degradation due to these contaminants. **DCN 008**

C. Internal Surface Contamination Protection – Window design shall take into account all sources of internal contamination and provide a means for cleaning. **DCN 008**

(1) Anti–fogging – All innermost panes, except hatch, shall be designed for anti–fog protection such that breath condensation does not occur from a mouth–to–pane distance of 4.0 inches (10.0 cm). **DCN 008**

(2) Inner Pane Coatings – The innermost surface of the innermost pane shall have no coatings except for anti–reflective coatings. **DCN 008**

D. Crew Induced Environment – **DCN 008**

(1) IVA – The Window Assembly hardware exposed to the IVA environment shall be capable of withstanding a crew induced limit load of 125 lbs force distributed evenly over 16 square inches in diameter at any point on the exposed surface and normally incident to that surface. **DCN 008**

(2) EVA – The Window Assembly hardware exposed to the EVA environment shall be capable of withstanding a crew induced limit load of 125 lbs force distributed evenly over a circle 1.0 inch in diameter at any point on the exposed surface and normally incident to that surface. **DCN 008**

E. Protective Covers – Removable or retractable covers shall be provided where the window assembly does not meet crew and equipment impact load criteria or the launch and reentry pressure profiles. **DCN 008**

F. Retractable External Protective Covers – If external protective covers are opaque, then IVA controls shall be provided with backup EVA capability to override the IVA system. **DCN 008**

11.11.3.1.9 WINDOW MAINTENANCE DESIGN REQUIREMENTS

A. Window Servicing – Equipment and supplies shall be provided for contingency window cleaning.

B. Protective Covers – Where surface scratching, pitting, or staining cannot be prevented by other means, removable window protective surfaces shall be provided.

C. Window Replacement –

(1) Window assemblies shall be designed to eliminate the need for depressurization of the Space Station in order to replace window panes or the entire window assembly.

(2) Partial depressurization during change–out shall be allowed for pre–launch verification purposes.

(3) Depressurization of the cupola shall be allowed for the installation of an external pressure cover.

11.11.3.1.10 DELETED

11.11.3.2 OPTICAL CHARACTERISTICS FOR CATEGORY C WINDOWS

A. Wavefront – **DCN 008**

(1) The peak–to–valley transmitted wavefront error through the combination of all window panes for the window port shall not exceed 1/7 wave over any 152.4 mm (6.0 inch) diameter sub–aperture within the central 80 percent (minimum) of the physical diameter (excluding flight loads, pressure loads, and temperature gradients), where the reference wavelength is 632.8 nm. **DCN 008**

Note (a): Removal of protective window pane(s) is permissible. **DCN 008**

Note (b): For viewing angles of 30 degrees nominal incidence, it is a goal that the wavefront variation not exceed 1/4 wave peak–to–valley over any 6 inch diameter sub–aperture within the central 60 percent (minimum) of the physical diameter. **DCN 008**

(2) Wavefront requirements shall be met after all optical coatings have been applied, and if applicable, all tempering and laminating steps. **DCN 008**

(3) The wavefront requirement may be met by rotating the window panes. **DCN 008**

(4) Wavefront requirements shall apply when viewing through the window port at normal incidence. **DCN 008**

B. Glass Quality – The glass shall meet or exceed Inclusion Number 2 as defined in MIL–G–174 with the following exceptions: **DCN 008**

(1) The maximum size inclusion diameter shall be limited to 0.50 mm. **DCN 008**

(2) The permissible number of maximum diameter inclusions shall be one per 100 cubic centimeters glass. **DCN 008**

(3) Inclusions with a cross–section equal to or less than 0.08 mm diameter shall be disregarded when evaluating the maximum total cross–section area (mm squared per 100 cubic centimeters). **DCN 008**

C. Surface Finish – The surface of each window pane shall be polished to meet or exceed the requirements of a scratch–dig code of 80 to 50 as defined in MIL–O–13830. **DCN 008**

D. Wedge – The wedge of any individual window pane shall be limited to 2.5 arc–seconds in any direction. **DCN 008**

E. Open Inclusions – The maximum number of open inclusions per surface shall not exceed three and shall not exceed 0.020 inch (0.51 millimeters) in diameter. Open inclusions separated by less than 2.0 inches are not permitted. Open inclusions equal to or less than 0.00315 inch (0.08 millimeters) in diameter will be disregarded. **DCN 008**

F. Striae – Striae shall be per MIL–G–174 Grade A, or better. **DCN 008**

G. Haze – The haze, after all coatings have been applied, shall be less than 0.5 percent per ASTM D1003, Procedure A. **DCN 008**

H. Birefringence – Birefringence shall be 12 nanometers per centimeter maximum, or equivalent. **DCN 008**

11.12 PACKAGING

11.12.1 INTRODUCTION

This paragraph is not applicable for this document.

11.12.2 PACKAGING DESIGN CONSIDERATIONS

This paragraph is not applicable for this document.

11.12.3 PACKAGING DESIGN REQUIREMENTS

All IVA and EVA packaging will meet the following design requirements:

A. Deleted.

B. Compatible With Environments – All packaging shall withstand the physical environments to which it will be exposed during handling, during ground and air transportation, during launch, on–orbit, and (if returnable) reentry per MIL–STD–210, SSP 41047, NASA–TM–86538, and MIL–STD–2073.

C. Compatible With Contents – All packaging shall resist the physical characteristics of the contents for the 10 year Station, or mission life/use, expectancy for which the contents must be packaged.

D. Compatible With Trash Disposal System – All nonreusable packaging shall be compatible with the trash collection and disposal system.

E. Packaging Restraint – A means shall be provided for physically attaching or restraining the package at all designated use locations.

F. Labeling – All packages shall be labeled according to 9.5.3.1.

G. Inventory Control Compatibility – All packages shall be designed to incorporate the coding features required by the Inventory Management System labeling requirements per SSP 50007.

   (1) Deleted.

H. Deleted.

I. Deleted.

J. Hazards –

   (1) Packaging features shall be designed to preclude injury to the crewmember.

   (2) Packaging materials shall not introduce contaminants into the atmosphere.