CHANGE NOTICE

Date Prepared: 08/24/01

1.	2.	3. Code Ident.	4. Doc. No.
The Boeing Company Post Office Box 58747 Houston, TX 77258	☐ Proposed ☒ Approved	3. Code Ident. 2B945 5. Code Ident. 2B945	4. Doc. No. SSP 30559C 6. CDCN No. 012

7. System Designation	8. Related ECP No./Title	9. Contract No.	10. Contractual Activity
ISS	SSCN 001285	NAS15–10000	SSCN 001285

11. Document Title	12. Effectivity
Structural Design and Verification Requirements	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
012	Revision and History page	X		8/24/01
	Page xiv	X		
	Page 2–1	X		
	Pages 3–5, 3–7, 3–11, and 3–13	X		
	Page 4–4	X		
	Page A–1.	X		
012	Page 3–11a.		X	
	Order of Incorporation DCN 012			

16. Technical Concurrence (Contracting Agency)	Date

* "S" indicates supersedes earlier page. "A" indicates added page.

REVISION AND HISTORY PAGE

REV.	DESCRIPTION	PUB. DATE
	BASELINE ISSE (REFERENCE SSCBD BB003053B EFF. 07–30–91)	06–91
	CHANGE 1 (REFERENCE SSCBD BB003457 EFF. 03–04–93)	03–93
	CHANGE 2 (REFERENCE SSCBD BJ003053C EFF. 03–08–93)	04–93
A	Revision A (Reference SSCBD 000002 dated 2–7–94)	04–18–94
B	Revision B (Reference SSCBD 000008R1 dated 06–03–94	09–30–94
	The following DCNs have been cancelled. The content of the SSCNs authorizing release of the DCNs has been incorporated into Revision C.	
	DCN 001 (SSCN 000480) (Administrative Cancellation)	
	DCN 003 (SSCN 000913) (Administrative Cancellation)	
	DCN 002 (SSCN 000548) (Administrative Cancellation)	
	DCN 004 (SSCN 001356) (Administrative Cancellation)	
	DCN 005 (SSCN 000151) (Administrative Cancellation)	
	DCN 006 (SSCN 000256) (Administrative Cancellation)	
	DCN 007 (SSCN 000258) (Administrative Cancellation)	
	DCN 008 (SSCN 000549) (Administrative Cancellation)	
C	Revision C incorporates SSCDs 000151, 000256, 000258, 000480, 000548, 000549, 000913, 001356, and 001285.	04–16–01
	DCN 012 incorporates SSCN 001285	09–20–01

ERU: M. Hehn 09–20–01

TABLE OF CONTENTS

2.0 APPLICABLE DOCUMENTS

The following documents of the exact date and issue in SSP 50257 form a part of this document to the extent specified herein. Inclusion of applicable documents herein does not in any way supersede the order of precedence specified in 1.6. **DCN 012**

DOCUMENT NO.	TITLE
SSP 41000	System Specification for the Space Station
References	Paragraphs 1.6 and 3.1.5.1
SSP 30233	Space Station Requirements for Materials and Processes
References	Paragraph 3.6.1
SSP 30558	Fracture Control Requirements for Space Station
References	Paragraphs 3.1.3, 3.1.6, 3.1.9, 4.1.4, and Appendix B
SSP 30560	Glass, Window, and Ceramic Structural Design and Verification Requirements
References	Paragraph 3.1.7, and Table 3.3.1–1
D684–10019–01	Space Station Structural Loads Control Plan
References	Paragraph 3.2, 3.2.2, 3.2.3, 3.2.4.1, 3.2.4.2, and 4.2
MIL–HDBK–5	Metallic Materials and Elements for Aerospace Vehicle Structures
References	Paragraph 3.6.2, Appendix B
MIL–HDBK–17	Plastics for Aerospace Vehicles
References	Paragraph 3.6.2
SSP 50005	International Space Station Flight Crew Integration Standards (NASA–STD–3000/T)
References	Paragraph 3.1.5.2
NSTS–21000–IDD–ISS	Space Shuttle System Payload Accommodations
References	Paragraph 3.2.1
NSTS 08307	Criteria for Preloaded Bolts
References	Paragraph 3.5.5
NSTS 14046	Payload Verification Requirements
References	Paragraphs 4.1.2.1.1 and 4.1.3.1
20M02540	Assessment of Flexible Lines for Flow Induced Vibration
References	Paragraph 3.1.9.5
NSTS 08123	Certification of Flex Hose and Bellows for Flow Induced Vibration
References	Paragraph 3.1.9.5

On–orbit structural design loads shall be defined to a 3 sigma level for limit load during the Program life for time–consistent loads. When time consistency is unknown, a 3 sigma equivalent load probability for each independent event on each type of load shall be used and load combinations shall be root sum square of the 3 sigma peak independent event consistent loads; or, a monte carlo analysis producing a 3 sigma load combination may be used. For major independent system failures, 2 sigma or equivalent loads shall be used. Random limit loads shall be defined as 3 sigma. A 3 sigma level shall be defined as a 99.73 percentile level for loads which are characterized by a 1–sided Gaussian or non–Gaussian distribution. A 2 sigma level shall be defined as a 95.45 percentile level for loads which are characterized by a 2–sided Gaussian distribution and a 97.72 percentile for loads which are characterized by a 1–sided Gaussian or non–Gaussian distribution. Launch transient and random vibration loads shall be derived in accordance with the Space Station Loads Control Plan, D684–10019–01.

3.2.1 SHUTTLE PAYLOAD CONFIGURATION DESIGN LOADS

For lift–off, ascent, on orbit, descent, and landing using Shuttle, Space Station structure shall be designed to maintain required functionality and positive margins when subjected to all static and dynamic loads and thermal environments as defined in NSTS 21000–IDD–ISS, Shuttle/Payload Interface Definition Document for International Space Station. Space Station structure shall be designed to maintain positive margins when subjected to emergency landing loads as defined in NSTS–21000–IDD–ISS. **DCN 012**

3.2.2 INTEGRATED ON–ORBIT LOADS

The coordination, generation, and dissemination responsibility for Space Station on–orbit, integrated element interface loads is defined in the Space Station Structural Loads Control Plan, D684–10019–01.

For integrated on–orbit flight, ISS Program elements shall be designed to maintain required functionality and positive margins when subjected to all static and dynamic loads and thermal environments. All integrated on–orbit configurations from first launch through assembly complete configuration shall be considered.

3.2.3 DETAILED DESIGN LOADS

Detailed design loads shall be derived for all life cycles of hardware in accordance with the Space Station Structural Loads Control Plan, D684–10019–01.

3.2.4 MATH MODELS

3.2.4.1 ON–ORBIT FLIGHT HARDWARE LOADS MATH MODELS

Structural math models of on–orbit element flight hardware consistent with each phase of the Program shall be forwarded to the Prime Contractor in accordance with the Space Station Structural Loads Control Plan, D684–10019–01.

TABLE 3.3.1–1 Factors of Safety for Test Verified Structure

	Yield	Ultimate
Proof Pressure[1]	=1.50 X MDP	
Ultimate Pressure	=2.00 X MDP	
3. Hydraulic and Pneumatic Systems		
a. Lines and fittings less than 1.5 inches (38 mm) dia. (OD)		
Proof Pressure[1]	=1.50 X MDP	
Ultimate Pressure	=4.00 X MDP	
b. Lines and fittings, 1.5 inches (38 mm) dia. or greaer		
Proof Pressure[1]	=1.50 X MDP	
Ultimate Pressure	=2.00 X MDP	
c. Reservoirs/Presure Vessels		
Proof Pressure[1]	=1.50 X MDP	
Ultimate Pressure	=2.00 X MDP	
d. Actuating cylinders, valves, filters, switches, line–installed allignment bellows and heat pipes		
Proof Pressure[1]	=1.50 X MDP	
Ultimate Pressure	=2.50 X MDP	
e. Flex hoses, all diameters		
Proof Pressure[1,3]	=2.00 X MDP	
Ultimate Pressure	=4.00 X MDP	
4. Doors, Hatches and Habitable Modules		
a. Internal pressure only		
Proof Pressure[1]	=1.50 X MDP	
Yield Pressure	=1.65 X MDP	
Ultimate Pressure	=2.00 X MDP	
b. Negative pressure differential =1.40 X differential pressure		
c. Combined loading conditions (Ref. NSTS 14046, paragraph 5.1.1.5c)		
5. Combined pressure and mechanical loading[2]		
	Yield	Ultimate
Space Shuttle	1.0(pressure+mechanical)	1.4(pressure+mechanical)
On–Orbit	1.1(pressure+mechanical)	1.5(pressure+mechanical)

Notes:
1. Proof factor determined from fracture mechanics service life analysis must be used if greater than minimum factor.
2. See paragraph 3.5.1.1 when pressure loads have a relieving or stabilizing effect on structural capability.
3. In a system with fluid lines and flex hoses, the individual flex hoses to be proof tested to 2.00 X MDP and the assembly level tested to 1.5 X MDP or proof factors as per note 1. **DCN 012**

3.5.4.2 BEARING FACTOR

A bearing factor of 2.0 shall be used in conjunction with the yield and ultimate FS for the design of a joint subjected to shock or hammering action.

3.5.4.3 CASTING FACTOR

If metal castings are utilized as a fabrication process, an appropriate casting factor shall be developed by the design organization. The casting factor shall be applied in conjunction with the FS. Approval for the appropriate casting factor shall be obtained from NASA and/or International Partner. If a casting is a fitting, then the fitting factor shall be applied in conjunction with the casting factor and applied with the respective yield and ultimate FS.

3.5.5 PRELOADED JOINT CRITERIA

Bolt design in preloaded joints shall be in accordance with NSTS 08307, Criteria for Preloaded Bolts. Alternative methods to NSTS 08307 require prior NASA approval. A preloaded joint is a joint in which the preload is necessary to preserve linear structural behavior and to have adequate life due to cyclic loads, or to assure that no joint separation and resulting stiffness change occurs up to limit load, or to assure that no joint separation occurs at limit load which would affect pressure seals.

3.5.6 COMPOSITES/BONDED STRUCTURE DESIGN

Composite/bonded structure shall be designed to the factors of safety listed in Table 3.3.1–1, and to the life verification requirements of paragraph 4.1.3.4.

3.5.7 STRUCTURAL LIFE REQUIREMENTS

All structural components shall be evaluated for their capability to sustain static and cyclic load conditions which are part of the design environment. For those components whose design is subjected to a cyclic or repeated load condition, or a randomly varying load condition, a cyclic life analysis shall be performed.

Fracture analyses per the requirements of 3.1.6 shall be performed to demonstrate structural life for fracture critical structure. Fatigue or durability analyses shall be performed as necessary to demonstrate life for non–fracture critical structure. Structural life is defined as 4.0 times the service life loading environment for safe–life or fatigue analysis and 2.0 times the service life for durability analysis to account for material data scatter. The assumed flaw for durability analysis is a 0.005 inch corner crack or equivalent in the worst location and orientation. **DCN 012**

3.5.7.1 PROOF TEST FOR FLAW SCREENING

When proof tests are used for flaw screening, the proof test factor shall be the larger of the values determined by the fracture mechanics analysis derived proof test requirements to meet service life or those specified in Table 3.3.1–1.

3.5.7.2 FATIGUE

All flight hardware structure shall be designed to preclude failure resulting from cumulative damage due to cyclic loading and sustained stress during the design service life. Structural life shall be demonstrated by analysis and/or test based on a rationally derived cyclic loading spectrum that includes Shuttle transport to and from orbit, on–orbit, transportation, and testing loads.

3.6.2 STRUCTURAL MATERIAL ALLOWABLE PROPERTIES

Space Station material structural properties in the design environment shall be determined from MIL–HDBK–5, Metallic Materials and Elements for Aerospace Vehicle Structures; MIL–HDBK–17, Plastics for Aerospace Vehicles; or other sources which provide reliable and statistically valid data. Structural material property data obtained specifically for Space Station shall be generated by the procedures outlined in MIL–HDBK–5.

3.6.2.1 "A" ALLOWABLES

Material "A" or equivalent allowable values shall be used in all applications where failure of a single load path could result in a loss of structural integrity in primary structure. Equivalent material properties shall be approved by NASA and/or the International Partner.

3.6.2.2 "B" AND "S" ALLOWABLES

Material "B" or "S" or equivalent allowable values may be used in redundant structure in which the failure of a component would result in a safe redistribution of applied loads to other load–carrying structure. MIL–HDBK–5 material "S" allowables may be used for materials in lieu of "A" and "B" allowables where batch lot acceptance testing is a procurement requirement. Equivalent material properties shall be approved by NASA and/or International Partner.

DCN 012

3.7 SECONDARY STRUCTURE ACCOMMODATION FOR HUMAN INTERFACE

3.7.1 INSPECTION, MAINTENANCE, AND REPAIR

Interior secondary structures, stand–offs, attachment hardware, utility runs, partitions, walls, and close–out structure of the Space Station shall be designed for accessibility to other hardware for inspection, maintenance, and repair.

3.7.2 INTERIOR CLOSE OUT

Close–out structure shall be used on the Space Station to prevent items from becoming lost in the low–gravity environment.

3.7.3 GROUND AND ON–ORBIT OPERATIONAL ACCESS DOORS

Secondary structures such as compartment doors and access panels which provide access shall be operational in both ground and Earth orbit environments.

3.8 NONSTANDARD FASTENERS

NASA and/or International Partner approval shall be obtained for the use of nonstandard or specially manufactured fasteners.

4.1.4 FUNCTIONAL CONFIGURATION AUDIT/PHYSICAL CONFIGURATION AUDIT

DCN 012

The responsible design organizations shall provide stress analysis documentation of all structure to assure compliance with strength and deformation requirements. Stress analysis reports shall be submitted to NASA in support of the following four design reviews: Preliminary Design Review (PDR); Critical Design Review (CDR); Functional Configuration Audit/Physical Configuration Audit (FCA/PCA); and Flight Readiness Review (FRR), as delineated in the following paragraphs. These analyses shall be current with respect to loads and the design at the time of the review. Fatigue analyses shall be submitted with the stress analysis reports. Current stress analyses shall be available to support interim reviews. The stress analysis reports shall be prepared in accordance with standard aerospace industry practices for flight hardware.

Guidelines for stress analysis reports are documented in JSC 19652, Instructions for the Preparation of Stress Analysis Reports. If the results from other than closed form solutions, e.g., computer models, are presented in a stress analysis, both the logic and sufficient checks shall be present to assure that the data presented is a solution to the configuration and condition being analyzed.

4.1.4.1 STRESS ANALYSIS FOR PRELIMINARY DESIGN REVIEW

The PDR stress analysis shall be sufficiently detailed to assure the structural integrity of all major structure elements and the credibility of weight calculations.

4.1.4.2 STRESS ANALYSIS FOR CRITICAL DESIGN REVIEW

This analysis shall fully substantiate the structural integrity of each detailed part and provide the basis for stress signatures required on all drawings. Life requirements shall be addressed in this analysis.

4.1.4.3 FORMAL FCA/PCA STRESS REPORT **DCN 012**

A formal stress report shall be submitted to and approved by NASA and/or international partner prior to the FCA/PCA. **DCN 012**

4.1.4.4 STRESS ANALYSIS FOR FCA/PCA **DCN 012**

This analyses shall include changes or additions to the formal CDR stress analysis data package and shall fully substantiate the structural integrity of each detailed part, including structural verification tests, life verification, and detailed evaluation of the “as–built” hardware.

4.1.4.5 STRESS ANALYSIS FOR FLIGHT READINESS REVIEW

These data shall include only revisions to update the stress analysis reports for the flight design configuration with all significant changes from the FCA/PCA.

APPENDIX A ABBREVIATIONS AND ACRONYMS

CDR	Critical Design Review
EVA	Extravehicular Activity
FCA/PCA	Functional Configuration Audit/Physical Configuration Audit **DCN 012**
FRR	Flight Readiness Review
FS	Factor of Safety
HDBK	Handbook
IVA	Intravehicular Activity
ISS	International Space Station
LBB	Leak Before Burst
MIL	Military
mm/od	Micro–Meteoroid / Orbital Debris
MDP	Maximum Design Pressure
MS	Margin of Safety
NASA	National Aeronautics and Space Administration
NSTS	National Space Transportation System
ORU	Orbital Replacement Unit
PDR	Preliminary Design Review
psia	Pounds per square inch absolute
REV	Revision
S/N	Stress versus cycle life
STD	Standard
SSCBD	Space Station Change Board Directive
SSCM	Space Station Change Memorandum
SSP	Space Station Program