Table 1: Common Requirement Topics

Topic	Parameter/Value	Required Verification Approach (Summary)	ACBM Reference (S683-29902B)	PCBM Reference (S683-28943E)	Comment
Alignment	Axial Separation: 10” Lateral: 3” Roll: 1.5° Lateral Angle: 1.5°	Geometric analysis of ACBM and PCBM.	3.2.1.2.1 4.3.2.1.2.1	3.2.1.1.2.2 4.3.2.1.1.2.2	At start of pre-berth alignment; values are PCBM relative to ACBM.
Capture (Initial Conditions)	Velocity: Axial <= 0.04 f/s Lateral <= 0.04 f/s Roll <= 0.04 °/s Lateral angle <= 0.04 °/s Axial gap <= 3.8”	Dynamic analysis validated by assembly-level test under temperature and pressure.	3.2.1.2.2 4.3.2.1.2.2	3.2.1.1.2.1 4.3.2.1.2.1	At end of RMS operation/start of capture “...to minimize scrubbing of the seals...” (S683-29902B, 6.8). Values are PCBM relative to ACBM.
Impact Loads	Weight: 43,680 lbf Velocity: Closing: 0.1 f/s Lateral: 0.1 f/s Roll: 0.2 °/s Lateral Angular:0.2 °/s	Analysis based on component static load test	3.2.1.2.3 4.3.2.1.2.3	3.2.1.2.1 4.3.2.1.2.1	Off-nominal collision due to loss of control over RMS
Capture Load Sources	See Tables 2 & 3	Analysis under dynamic RMS loads, validated by assembly level test under pressure and temperature.	3.2.1.2.4.1 4.3.2.1.2.4.1	3.2.1.1.3 4.3.2.1.1.3	Data defining the non-CBM articles involved in a limit case berths. SRMS is as specified in Appendix A of both specifications, with brakes on at high torque values. SSRMS is actively compliant.
Post-rigidization Interface Loads	See Table 4	See Table 5	3.2.1.3.2 4.3.2.1.3.2	3.2.1.4.2 4.3.2.1.4.2	Both specifications contain extensive additional requirements for load spectrum at the assembly and component levels, for different phases of the life cycle.
Post-berth Leakage	ACBM 0.021 sccs (air) @ 14.7 psia PCBM 0.063 sccs (air) @ 14.7 psia		3.2.1.3.1 4.3.2.1.3.1	3.2.1.5 4.3.2.1.5	Requirement imposed at beginning of life. Note that Physics implies that the PCBM rate cannot actually be unilaterally responsible for the leak rate at the CBM/CBM interface, because it mates with ACBM surfaces that can be “imperfect”.
Negative air flow	2.6 lbm/sec, <= 0.009 psid	Analysis	3.2.1.17.1 4.3.2.1.17.1	3.2.1.12.1 4.3.2.1.12.1	Verification requirement is silent on technical details.
Positive air flow	ACBM 0.25 lb_m/sec @ 14.7 psid PCBM 0.25 lb_m/sec @ 15.2 psid	Analysis	3.2.1.17.2 4.3.2.1.17.2	3.2.1.12.2 4.3.2.1.12.2	Verification requirement is silent on technical details. Note that airflow is quoted in both directions, as would be necessary to support launch abort and other landing conditions (see that there are three loading cases in Table 4).
Berthing Temperature Limits	See Figure 4. PCBM-II flange differential <= 70 F at rigidization	Analysis based on test data	3.2.1.20 4.3.2.1.20	3.2.1.14 4.3.2.1.14	Note that PCBM Type II is mated to an ACBM before launch.
Mass Properties	ACBM-I: 540 lb_m ACBM-II: 685 lb_m PCBM: 440 lb_m	Analysis based on component/ assembly test	3.2.2 4.3.2.2	3.2.2.3 4.3.2.2.3	

Geometric Envelope	ACBM: See Figure 5 ACBM c.m.: See Figure 6 PCBM: See Figure 7	Analysis	3.2.2.1.1 4.3.2.2.1.1 3.2.2.4.1 4.3.2.2.4.1	3.2.2.3.1 4.3.2.2.3.1 3.2.2.6 4.3.2.2.6	Verification requirement is silent on technical details.
Utility Jumpers	Per SSP 41004	Analysis ("of drawings")	3.2.2.4.2 4.3.2.2.4.2	3.2.2.7 4.3.2.2.7	
Deberthing	ACBM: React net force and moment of RMS Prevent uncontrolled separation PCBM Provide net force and moment of RMS	Analysis of PCBM Thermal Standoff loads, maximum seal stiction, maximum RMS	3.2.1.12 4.3.2.1.12	3.2.1.6 4.3.2.1.6	
PE Interface	Per SSP 41004	ACBM: Inspection PCBM: Analysis	3.2.2.6 4.3.2.2.6	3.2.2.1 4.3.2.2.1	No rationale given for difference in verification approach.

Table 2: SRMS Berthing Data Matrix

Base Mass Properties	Mass: 12,560 sl	Inertial Tensor ($sl\text{-}ft^2$) I_{xx}: 4.734 E7 I_{yy}: 5.585 E6 I_{zz}: 4.985 E7 I_{xy}: -9.210 E6 I_{yz}: 1.400 E6 I_{xz}: 4.540 E6	SRMS Base Location (inch) (1) X: -111.95 Y: -29.16 Z: 161.80	ACBM Location (2) (inch) X: 183.50 Y: 20.44 Z: 56.00
Payload Mass Properties	Mass: 1161.341 sl	Inertial Tensor ($sl\text{-}ft^2$) I_{xx}: 37,640 I_{yy}: 95,824 I_{zz}: 93,350 I_{xy}: -1,904 I_{yz}: -198 I_{xz}: -1,688	SRMS Grapple Fixture Location (inch) X: -39.77 Y: -64.70 Z: -60.50	PCBM Location (2) (inch) X: 173.90 Y: 4.20 Z: -2.60
SRMS Geometry(4)	SRMS Joint Angles(3) (degree) SHY: 71.34 SHP: -94.04 ELP: 48.08 WRP: 73.38 WRY: 65.91 WRR: -15.16 End Effector Orientation(5) (degree) Pitch: -180.0 Yaw: -41.0 Roll: -180.0			

Notes
(1) Longeron attach point: (679.5,-96.5,410.0) inches in OSR frame. In this context, "base" refers to the mounting point of the SRMS on the NSTS Orbiter.
(2) Point at center of CBM in the berthing plane
(3) SRMS joint dynamics frame
(4) At 6-inch axial separation between ACBM and PCBM berthing planes.
(5) Euler Angles of the tip with respect to the SRMS base (ORAS_EEOP Euler angles in 2-3-1).

Pitch, Yaw, Roll are about Y,Z,X axes, respectively.

Table 3: SSRMS Backdrive Threshold[1]

Force[2]	49.458 lb_f (220 N)
Moment[3]	147.512 ft-lb_f (200 N-m)
Notes: (1) The SSRMS provides for backdriving when forces and moments exceed these values, provided its elbow joint is at least 15 degrees from the straight arm configuration. (2) Force in any direction (3) Moment about any axis.	

Table 4: Vestibule Loads

Case	Axial (lb_f)	RSS Shear (lb_f)	RSS-Bending ($in\text{-}lb_f$)	Torsion ($in\text{-}lb_f$)
On-orbit (Axial Port)	6,480	5,220	772,900	687,200
On-orbit (Radial Port)	4,500	5,900	442,000	500,000
Launch(1)	14,500	24,700	1,746,600	383,600
Landing(1)	6,270	23,910	968,450	227,800
Ascent/Descent	11,140	11,430	396,860	87,400
Notes: (1) One cycle only.				

Table 5: Vestibule Load Verification

Level of Integration	Summary of Required Approach
Sub-assembly	Analysis of load carrying capability and test of de-rigidization after peak load
Assembly	Validate techniques used to model the reaction to vestibule pressurization given pre- and post-berth temperatures
Assembly	Demonstrate mechanical functionality under temperature and pressure. IC of demonstration following without interruption from Ready-to-Latch indication through capture
Element	Validate techniques for modeling pressure- and thermally-induced deflections on primary structure at the CBM/CBM joint

Table 6: Vestibule Leakage Verification

Sealed Joint	Summary of Required Approach
CBM/PE	Analysis with gapping and temperature excursion sensitivity. Validate analysis by test as gapped to maximum pressure-induced deflection. PCBM analysis based on ACBM-level validation.
CBM/CBM	Analysis with gapping, sensitivity to pre- and post-berth environment after exposure to dynamics of establishing the joint. Validate by test as gapped to maximum pressure-induced deflection, including ovality, seal contact stress (pre- and post-berth sequence), temperature.
Replacement (“IVA” Seal)	Analysis with gapping, mismatch, and temperature excursion sensitivity. Validate by test of CBM/PE at maximum mismatch.

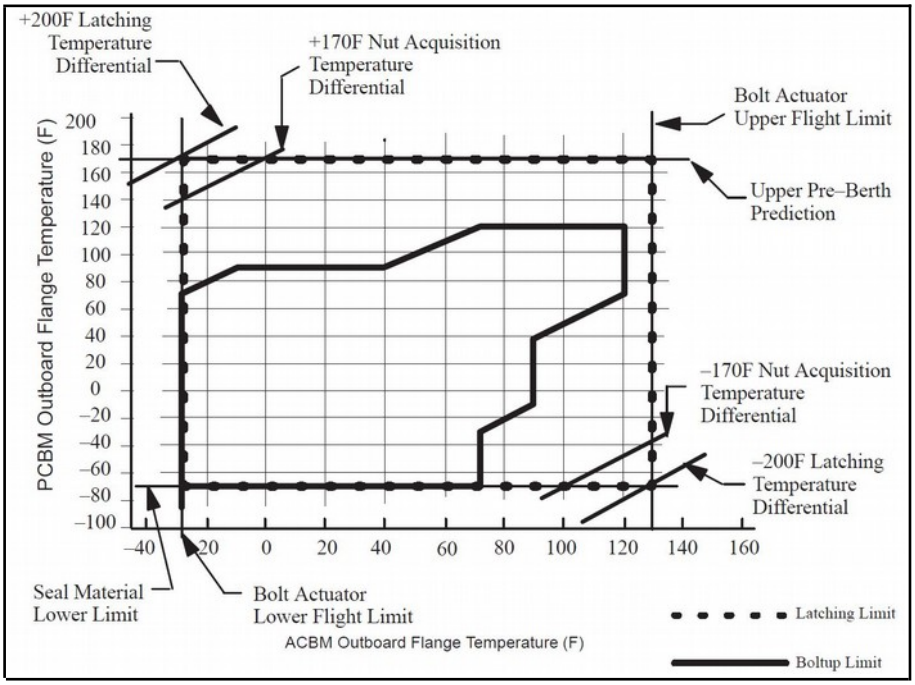

Figure 4: Specified Thermal Limits for CBM Operations

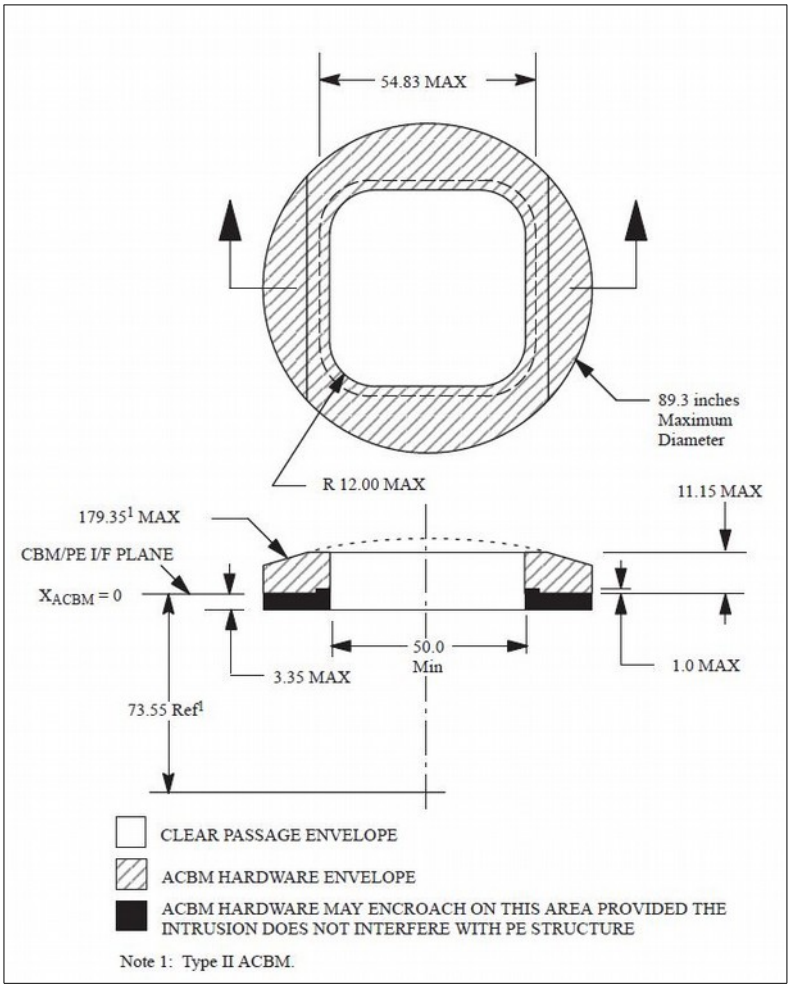

Figure 5: Required ACBM Geometric Envelope

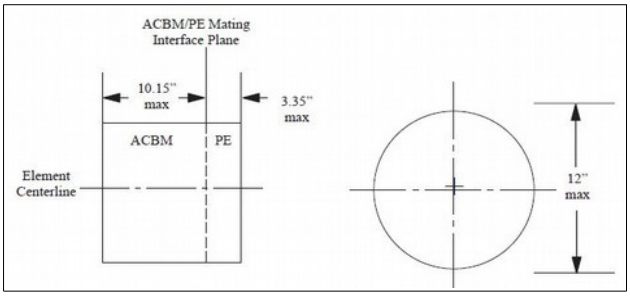

Figure 6: Required ACBM Center of Mass

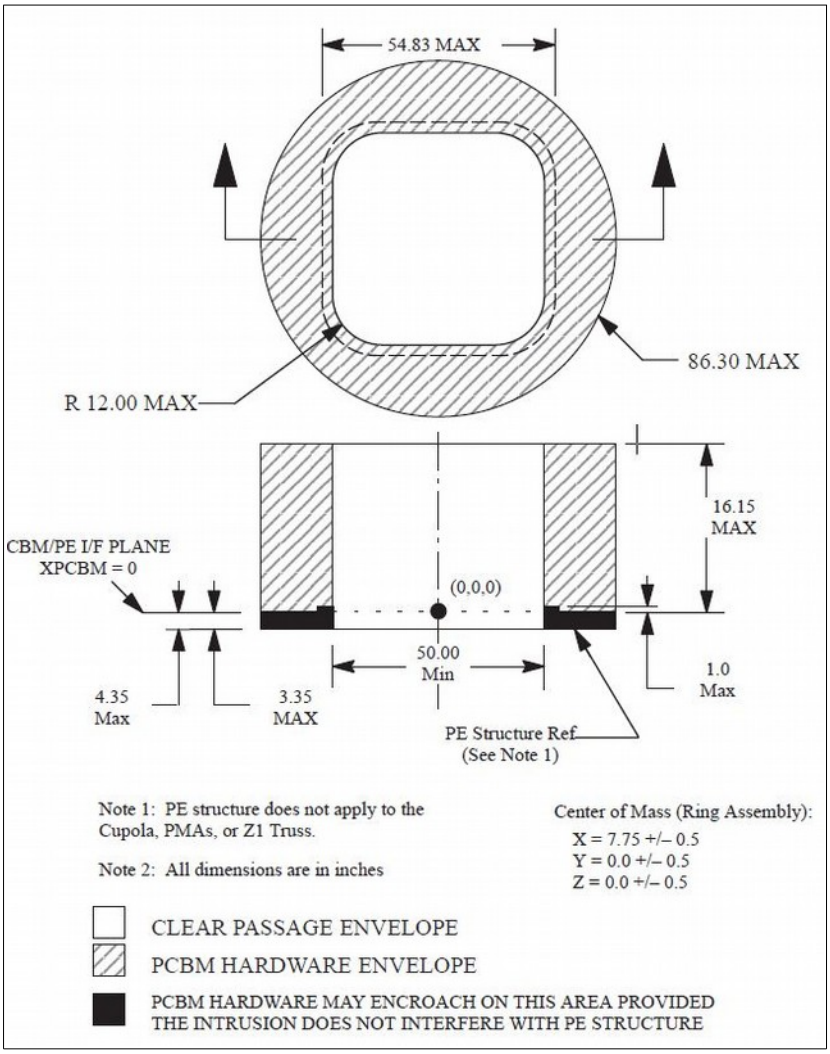

Figure 7: Required PCBM Geometric Characteristics