

Table 1 Minimum Margin of Safety Summary for AMS-02

Part / Dwg Number	Part Name / Description	Material & Heat Treatment	Critical Load Condition	Failure Mode	Margin of Safety	Reference Page	Comments
Vacuum Case							
SDG39135779	Outer Cylinder	7050-T7452 forging	Landing	Buckling	0.11		Load case 2058, $\theta=153.28$, skin 15, Model 6-02a
SDG39135779	Outer Cylinder flanges	7050-T7452 forging	Landing	Axial and Bending	0.22	1.1.3.1-9	Load case 2020, Model 6-02a
SDG39135782	Inner Cylinder	2219-T852 forging	Liftoff	Axial and Bending	0.134	1.1.2-8	Load case 1045 Model 6-02a
SDG39135782	Inner Cylinder closeout weld	2219-T852 forging	Liftoff	Axial and Bending	0.116		Load case 1045 Model 2-03.
SDG39135782	Inner Cylinder	2219-T852 forging	Internal pressure	Buckling	0.17	1.1.2-15	0.8 atm. pressure
SEG39135778	Conical flanges	2219-T62	Liftoff	Axial and Bending	0.14 yield	1.1.1-4	Load case 1016 Model 6-02a
SEG39135778	Conical flanges	2219-T62	Internal pressure	Buckling	0.14	1.1.1-15	0.8 atm. pressure
SEG39135784	Upper Support Rings	7050-T7452 forging	Liftoff	Axial and Bending	0.075	1.1.4-8	Load case 1016 Model 6-02a
SEG39135784	Lower Support Rings	7050-T7452 forging	Landing	Axial and Bending	0.03	1.1.4-9	Load case 2020 Model 6-02a
SEG39135789	Lower I/F plate shear pin	Custom 455 H950 AMS5617	Landing	Shear	0.19	1.1.5.7-9	Load case 2020 Model 6-02a
SEG39135789	Lower I/F plate bolts	NAS1958C	Landing	Shear and Tension	0.59	1.1.5.7-8	Load case 2058 Model 6-02a
	Support ring to conical flange bolts	A-286 AMS5726	Liftoff	Shear and Tension	0.11		Load case 1016 EWB 0420 200 ksi bolts
	Support Ring to Outer chord bolts	A-286 AMS5726	Landing	Shear and Tension	0.16		Load case 2054 EWB 0420 200 ksi bolts. 1.25 uncertainty factor

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Upper USS-02							
SDG39135738	Sill Bracket	7050-T7451	Launch	Axial , bending and shear	0.41	1.2.1.1-6	Load case 1032, Model 6-02a
SDG39135740	Diagonal Sill bracket	7050-T7451	Launch	Axial , bending and shear	0.07	1.2.1.2-4	Load case 1032, Model 6-02a
SDG39135739	Sill Trunnion	Custom 455 H1000, AMS 5617	Landing	Axial , bending and shear	0.05 Yield	1.2.1.3-8	Load case 2016, Model 6-02a
SDG39135754	Sill joints	7050-T7451	Landing	Axial and bending	0.63	1.2.1.13-9	Load case 2016, Model 10-01
SDG39135744	Upper VC interface joint	7050-T7451		Axial and bending			
Friction stir welded tubes							
SDG39135728	Upper Trunnion bridge	7050-T7451	Launch	Column Buckling	0.32	1.2.1.4-11	Load case 1016, Model 6-02a
SDG39135735	Lower Trunnion Bridge	7050-T7451	Landing	Column Buckling	0.65	1.2.1.4-12	Load case 2038, Model 6-02a
SDG39135764	Lower Angle Tube	7050-T7451	Landing	Column Buckling	0.77	1.2.1.4-13	Load case 2037, Model 6-02a
Tube Buckling							
SEG39135759	Diagonal strut	6061-T6	Liftoff	Buckling	0.15	1.2.1.12-7	Load case 1045, Model 6-02a
SDG39135757	Sill tube	7075-T73511	Liftoff	Buckling	1.86	1.2.1.12-9	Load case 1032, Model 6-02a
SDG39135808	Lower USS tubes	7075-T73511	Landing	Buckling	0.63	1.2.1.12-11	Load case 2023, Model 6-02a
SDG39135820	Keel tubes	7075-T73511	Landing	Buckling	1.31	1.2.1.12-12	Load case 2037, Model 6-02a
Lower USS-02							
SDG39135724	Lower VC interface joint	7050-T7451	Landing	Axial and bending	0.004	1.2.2.5-9	Load case 2016, Model 11-02
SDG39135806, 5807	Lower centerbody joints	7050-T7451	Landing	Axial and bending	0.18	1.2.2.6-13	Load case 2058, model 2-03
SDG39135762	Upper USS to lower USS joint	7050-T7451					

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Keel							
SDG39135772	Keel trunnion	Custom 455 H1000, AMS 5617	Landing	Axial , bending and shear	0.19 yield	1.2.3.2-1-6	Load case 2020, Model 6-02a
SDG39135770	Keel Block	7050-T7451		Axial , bending and shear	0.07	1.2.3.1-7	Max. y load = 2g
SDG39135769	Keel Angle joint						
Bolts							
SDG39135762	Lower Uss to Upper USS bolts	NAS1958C 0.50-20UNF	Landing	Tension and shear	0.76	1.2.2.2-15	Load case 2015, Model 6-02a
SDG39135769	Keel angle joint to lower USS bolts	EWB 0420-8 0.5—20UNJF A-286	Landing	Tension and shear	0.48	1.2.3.3-10	Load case 2015, Model 6-02a
SDG39135767	Lower angle beam flange bolts	EWB 0420-8 0.5—20UNJF A-286	Landing	Tension and shear	0.29	1.2.2.4-10	Load case 2015, Model 6-02a
Rivets							
SDG39135727	Upper Trunnion Bridge to upper VC joint rivets	NAS1400 M8 Monel	Landing	Shear	0.22	1.2.1.6-7	Load case 2016, Model 6-02a
SDG39135754	Upper Trunnion Bridge to Sill joint rivets	NAS1398M8 Monel	Launch	Shear	0.24	1.2.1.7-6	Load case 1016, Model 6-02a
SDG39135730	Sill joint to upper elbow rivets	NAS1400M8 Monel	Landing	Shear	0.17	1.2.1.8-4	Load case 2015, Model 6-02a
SDG39135732	Lower Trunnion bridge to elbow rivets	NAS1400M8 Monel	Landing	Shear	0.23	1.2.1.9-7	Load case 2015, Model 6-02a
SDG39135737	Lower Trunnion Bridge to lower VC joint rivets	NAS1400M8 Monel	Launch	Shear	0.16	1.2.2.7-7	Load case 1038, Model 6-02a
SDG39135756, 5757	Sill bracket to sill tube	NAS1398M8 Aluminum	Launch	Shear	1.59		Load case 1032, Model 6-02a
SDG39135757, 5758	Diagonal sill bracket to sill tube	NAS1398M8 Aluminum	Launch	Shear	1.37		Load case 1016, Model 6-02a
SDG39135724, 5764	Lower angle beam to lower VC joint	NAS1398M8 Aluminum	Landing	Shear	0.27		Load case 2015, Model 6-02a

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SDG39135724, 5806	Lower angle beam to flange	NAS1398M8 Aluminum	Landing	Shear	0.34		Load case 2037, Model 6-02a
SDG39135806, 5808	Lower centerbody joint to EMC box tubes	NAS1400M8 Monel	Landing	Shear	0.25		Load case 2020, Model 6-02a
SDG39135819, 5820	Keel tube to keel block	NAS1398M8 Aluminum	Landing	Shear	0.64		Load case 2037, Model 6-02a
SDG39135818, 5820	Keel tube to keel angle joint	NAS1398M8 Aluminum	Landing	Shear	0.27		Load case 2037, Model 6-02a
PAS							SEE NOTE 2
SDG39135822	BCS Avionics Bracket	7075-T7351	Liftoff/Landing		HIGH	1.3-37-4	Low loads and large cross section. Use Engineering Judgment
SDG39135827	Keyway Hardware	15-5 PH98	EVA Handling Load		HIGH	1.3-38	No significant loading
SDG39135823	Handle Retainer Bracket	7075-T7351	EVA Handling Load		HIGH	1.3-38	No significant loading
SDG39135829	Cover Assembly	7075-T3751	EVA Handling Load		HIGH	1.3-39	No significant loading
SDG39135830	EVA Extension	A286	EVA Handling Load		HIGH	1.3-39	No Significant Loading
SDG39135831	Release Screw Plate Assembly	7075-T3751	EVA Handling Load		HIGH	1.3-40	No Significant Loading
SDG39135834	Lock Mechanism Base	15-5 PH	EVA Handling Load		HIGH	1.3-40	No Significant Loading
SDG39135835	Lock Mechanism Retractor	A286	EVA Handling Load		HIGH	1.3-41	No Significant Loading
SDG39135854	Handle	6061-T651	50 lbf handling load	Max Principal	HIGH	1.3-27-10	
SDG39135855	Handle Pin	A286	50 lbf handling load		HIGH	1.3-41	No significant loading
SDG39135851	Handle Base	15-5 PH	50 lbf handling load		HIGH	1.3-37-22	No significant loading
SDG39135852	Handle Bushing	Aluminum Bronze	50 lbf handling load		HIGH	1.3-41	No significant loading
SDG39135853	Handle Extension Assembly	6061-T6	50 lbf handling load	Max Principal	1.8	1.3-27-18	
SDG39135842	Bushings	Aluminum Bronze			HIGH	1.3-42	Compression Only

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Dwg Number	Description	Heat Treatment	Condition				
SDG39135843	Wedge Release Screw	A286	EVA Handling Load		HIGH	1.3-42	No Significant loading
SDG39135845	Bearing Housing	15-5 PH	Liftoff/Landing	Max Principal	.245	1.3-36-7	
SDG39135846	Bearing Housing Cover	15-5 PH			HIGH	1.3-43	No significant loading
SDG39135847	Limit Screws	A286	EVA Handling Load		HIGH	1.3-43	No significant loading
SDG39135845	Bearing Housing	15-5 PH	Liftoff/Landing	Max Principal	.245	1.3-36-7	
SDG39135846	Bearing Housing Cover	15-5 PH			HIGH	1.3-43	No significant loading
SDG39135847	Limit Screws	A286	EVA Handling Load		HIGH	1.3-43	No significant loading
SDG39135848	Release Screw Cover	7075-T7351	EVA Handling Load		HIGH	1.3-44	No significant loading
SDG39135837	Bridge Assembly	7050-T7451	Capture Bar plus on-orbit loading	Max Principal	.084	1.3-34-7	
SDG39135838	Housing Assembly, Release Mechanism	7075-T7351	Capture Bar plus on-orbit loading		HIGH	1.3-44	Much larger cross section (closed) than Bridge Beam
SDG39135839	Slip Plate	15-5 PH	Capture Bar plus on-orbit loading		High	1.3-45	No significant loading
SDG39135840	Wedge	15-5 PH	Capture Bar plus on-orbit loading		HIGH	1.3-45	Block Compression Only
SDG39135841	Wedge Components	15-5 PH	Capture Bar plus on-orbit loading		HIGH	1.3-46	Block Compression Only
SDG39135857	Locating Pins	A286/6061-T6			HIGH	1.3-46	No significant loading
SDG39135856	Guide Pin Shim	AL Shim Stock			HIGH	1.3-47	No significant loading
SDG39135819	Scuff Plates	7075-T7351	EVA Kick Load		HIGH	1.3-47	No significant loading
SDG39135820	Capture Bar Retainer Brackets	15-5 PH	Capture Bar plus on-orbit loading	Max principal	HIGH	1.3-47	No Significant loading
SDG39135818	Guide Pins	7050-T7451	Capture Bar plus on-orbit loading	Max principal (bending)	HIGH	1.3-29-3	No significant loading
SDG39135817	PAS Base Assembly	7050-T7451	Capture Bar plus on-orbit loading	Max principal	.072	1.3-25	
SDG39135826	Bridge Pin	A286	Capture Bar plus on-orbit loading	Shear (max principal)	HIGH	1.3-35-3	Loading is double shear, which gives a resultant maximum principal stress

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SDG39135850	Capture Bar	A286	Capture Bar plus on-orbit loading	Bending	.052 ((ult)	1.3-27-6	
NAS1956	Guide Pin Attachment	A286 .375-24 UNRF-3A x 1.75 L	Capture Bar plus on-orbit loading	Tension/Shear	1.377	1.3-30-6	
NAS1805	Guide Pin Attachment Nut	A286	Capture Bar plus on-orbit loading	Shear	.819	1.3-30-7	
NAS1956	Front USS Support Fasteners	A286 .375-24 UNRF-3A x 1.75 L	Capture Bar plus on-orbit loading	Tension/Shear	1.1	1.3-31-8	
NAS1805	Front USS Support Nut	A286	Capture Bar plus on-orbit loading	Shear	.61	1.3-31-9	
NAS1956	Back USS Support Fasteners	A286 .375-24 UNRF-3A x 1.75 L	Capture Bar plus on-orbit loading	Tension/Shear	.97	1.3-32-8	
NAS1805	Back USS Support Nut	A286	Capture Bar plus on-orbit loading	Shear	.54	1.3-32-9	

Notes:

1. Factor of safety is 1.40 for ultimate and 1.10 yield for USS-02
2. Factor of Safety is 2.0 for Ultimate and 1.25 for Yield for PAS
3. Margins > 5.0 are given as HIGH