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John C. Stennis Space Center

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CONCURRENCE SHEET

TUBING SYSTEMS
FOR
AEROSPACE TEST HARDWARE AND
GROUND TEST FACILITY FLUID SYSTEMS

We concur with the above-named standard which becomes a part of Appendix B, Standards and Specifications Plan (CM02) to FOSS Contract NAS13-400.

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SUPERCEDES: SSC-47-220, SSC-47-370, SSC-47-361, SSC-47-371, and SSC-47-450

1.0 PURPOSE

The purpose of this standard is to provide requirements, operating limits, and uniformity for the use of aerospace, aerospace ground equipment, and test facility fluid system tubing and tube fittings used at SSC. These provisions are intended to assure system reliability and safety, cost effective interchangeability between tube system hardware and components.

2.0 SCOPE

This standard establishes requirements for all aerospace, aerospace ground support, and test facility fluid system tube and tube fittings used at SSC. Water, freon, and natural gas tubing systems for facility HVAC (Heating, Ventilation, and Air Conditioning) systems are not governed by this standard.

3.0 GENERAL REQUIREMENTS

3.1 All tubing shall be seamless; tubing with seam welds is not permitted.

3.2 All metallic and non-metallic materials, including lubricating oils and greases used to assemble tube systems, shall be compatible with service media conforming to material traceability and service media compatibility requirements delineated in other SSC standards and NASA Handbooks (NHB's). For example, SSC Standard 79-010 and NHB 8060.1 govern non-metal material compatibility requirements for oxygen and other oxidizer fluid (i.e. fluorine) systems. Metal embrittlement concerns regarding materials and any required welding shall be addressed when selecting materials for hydrogen systems. Guidance regarding hydrogen embrittlement resistant materials is provided in NASA/MSFC Std. 506, NASA/MSFC Handbook 527 and "Hydrogen Safety Handbook" by Paul M. Ordin.

3.3 All tube system sections, components, and connections shall be hydrostatically tested at 1.5 times the system design pressure prior to placing the system into operational service. On a case by case basis and with approval of the NASA Safety representative, pneumatic pressure tests at 1.25 times maximum system operating pressure or at 1.25 times system design pressure is permitted, in lieu of hydrostatic pressure testing. Appropriate measures to reduce or eliminate rapid explosion or gas decompression hazards to personnel and hardware to acceptable risk and hazard abatement levels shall be provided when pneumostatic pressure tests are performed.

3.4 Pneumatic leak tests are required for all fluid tube systems after final assembly of the system. Leak tests shall be performed with test gas at maximum system operating pressure or at system design pressure. Leakage through all system mechanical and welded joints shall be measured by "soap" or

"Leak-Tek" bubble test or mass spectrometer with sensitivity set to 10^{-4} sccm or lower. Leak test gas shall be helium or a nitrogen and helium gas mixture with a minimum of 10% volume (mole) fraction of helium in the mixture for leak tests of hydrogen and helium systems. Nitrogen, air, helium, or a mixture of these gases may be used for leak testing of other service media systems.

Zero or "bubble tight" external system leakage is required for bubble tests. 10^{-4} sccm or less external system leakage is required for mass spectrometer test allowed leakage, unless a higher leakage rate is deemed acceptable by the NASA Systems Engineer or governing CCB.

3.5 Installation of fluid tube systems shall conform to tube routing and external tube system support spacing requirements of USAF TO 00-25-223 (Integrated Pressure Systems and Components). A neat and orderly routing of tube systems; where multiple criss-crossing of tube runs is prevented and where all connections and components are accessible for disassembly and removal from systems; is required.

Tube system routing shall incorporate expansion loops and offsets such that yield stress of pressure retaining materials is not exceeded under the combined stresses from internal fluid pressure, thermal expansions or contraction of system materials, dead weight loads applied to system by system components and external interfaces, and wind loads.

In selected cases, a detailed stress analysis will be required to assure that yield stresses are not exceeded for system pressure retaining materials. Appendix A lists references for obtaining yield stresses and ultimate tensile stresses for a large variety of materials.

4.0 EXTRUDED TUBE

4.1 Extruded tubing made of annealed type 304 CRES (Corrosion Resistant Steel or Stainless Steel) per MIL-T-8504 and MIL-T-8506 and made of annealed type 18-8 CRES per MIL-T-8808 is permitted for all fluid services except as delineated in section 3.1. Maximum allowed system operating pressures for given tube outside diameters and wall thicknesses are provided in Appendix B for service media temperatures between -253°C and 65°C (-423°F and 150°F).

4.2 When materials other than those stated in section 4.1 are used or when the maximum system operating temperature exceeds 66°C (150°F), one of the two following equations shall be used to determine the pressure rating of the tubing:

(1) $$P = \frac{S(D^2-d^2)}{D^2+d^2} + 0.1013$$

(2) $P = \frac{(P_{AB}-0.1013)S}{137.917} + 0.1013$

Where:

P = Pressure rating of tubing (MPa)
$S = 0.006896S_A$ (MPa)
S_A = Allowed stress of selected material per section 9.0 (psi)
D = Outside diameter of tube (mm)
d = Inside diameter of tube (mm)
P_{AB} = Pressure rating from Appendix B (MPa)

For computation of tubing pressure ratings using English units, either of the following two equations apply.

(3) $P_1 = \frac{S_A(D_1^2-d_1^2)}{D_1^2+d_1^2}$

(4) $P_1 = \frac{S_A}{20,000}$

Where:

P_1 = Pressure rating of tubing in psig
D_1 = Outside diameter of tube in inches
d_1 = Inside diameter of tube in inches
S_A = Allowed stress of selected material per section 9.0 (psi)

4.3 Although the tubing may be rated to pressures as described in sections 4.1 and 4.2, system pressure ratings in which this tubing is used will often be limited to lower pressures when this tubing is flared or compression fitted (swaged) for connection to 37° flared or "Swagelok"® flareless type tube fittings. Therefore, when extruded tubing is used for a particular system, the tube pressure rating needs to be compared to the minimum pressure rating of the tube to fitting connections prescribed in sections 5.0 and 6.0 of this standard. The lower of the two pressure ratings is the maximum allowed operating pressure of the tube system.

4.4 Welded tubing connections may be used to obtain the maximum tube pressure rating of the system provided that 100% of welds are non-destructively tested by radiographic, dye-penetrant, or magnetic particle inspection per ASNT-TC-1 and ASME BPV Code Section V. For multipass weldments, dye-penetrant inspection shall be performed on the root and cover passes of each weld.

If 100% non-destructive weld inspections are not performed then reduced tube pressure rating can be computed by equations from section 4.2 but with the value of S computed as follows:

(5) $S = 0.006896\ S_A\ E$

Where:

S_A = Allowed stress of selected material per section 9.0 (psi)

E = Weld efficiency factor defined by ASME BPV Code Section VIII Div. 1 Table UW-12 or by ANSI/ASME B31.3 Table A-1A or Table A-1B

5.0 "SWAGELOK"® FLARELESS TYPE TUBE FITTINGS

5.1 The listing of approved "Swagelok"® flareless type tube fittings allowed for use at SSC is provided in Appendix C.

5.2 The use of "Swagelok"® type tube fittings is restricted to the following types of systems:

a) Systems in which the maximum operating pressure is less than or equal to 6.997 MPa (1000 psig) and the maximum operating temperature is less than or equal to 66°C (150°F). Maximum operating and design pressures up to 34.5 MPa (5000 psig) is permitted if approved by the cognizant CCB.

b) Systems in which the maximum operating pressure is less than or equal to S/4 [S is defined in section 4.2 under equations (1) and (2)] or 34.5 MPa (5000 psig), whichever is less, and operating conditions of the system do not allow for use of 37° flared tube fittings or coned and threaded type tube fittings. For example, a high temperature hydrogen system which is subjected to highly transient thermal conditions may cause overstress conditions due to wall thicknesses of flared tube fittings and coned and threaded tube fittings. Approval of the cognizant CCB is required when maximum operating pressures or design pressures exceed 6.997 MPa (1000 psig).

5.3 All "Swagelok"® flareless type tube fittings shall be type 316 CRES or a material from one of the references in Appendix A.

5.4 Prior to assembly of "Swagelok"® flareless type tube fittings to tubing, sharp edges, burrs, slivers, and contaminant particles shall be completely removed from the tube ends and from all fitting surfaces.

5.5 During assembly of a tube to a "Swagelok"® flareless type tube fitting the tube end shall be inserted to sufficient depth into the fitting such that all ferrules are in working contact with the tube. The tube coupling (B) nut shall be threaded by hand until finger tight [minimum torque values nominally between 0.57 and 1.36 N-m (0.5 to 1.0 ft-lbs.)] and then advanced (tightened) 1¼ turns (450 degrees) by wrench.

6.0 FLARED TUBE FITTINGS

6.1 Table 3 in SAE AIR310 plus the fittings and parts listed in Appendix D are flared type tube fittings approved for use with 37° flared tube. A copy of SAE AIR310 Table 3 is provided in Appendix E. Tube fittings with NPT connections and swivel type fittings are allowed only on a case by case basis with approval of the NASA system engineer or governing CCB.

6.2 Maximum allowed operating pressures for type 304 and 316 CRES 37° flared tube fitting connections at a maximum operating temperature of 38°C (100°F) are provided in Appendix F. For flared tube fittings (such as adaptor fittings) with multiple types or sizes of end connections, the pressure rating of the fitting shall be no greater than that of the end connection having the lowest pressure rating.

6.3 All metallic pressure retaining materials used for 37° flared tube fittings and parts shall be forged, wrought, or cold worked. Castings are not permitted unless they are 100% radiographically inspected to assure no porous void spaces.

6.4 For fittings made of materials other than 304 or 316 CRES and for maximum system operating temperatures above 38°C (100°F), the following equation shall be used to determine rated pressure:

(6) $$P = \frac{(P_{AF} - 0.1013)S}{137.92} + 0.1013$$

Where:

P = Pressure rating (MPa)
P_{AF} = Pressure rating from Appendix F (MPa)
$S = 0.006896S_A$ (MPa)
S_A = Allowed stress of selected material per section 9.0 (psi)

For computation of pressure ratings of fittings in English system units, the following equation applies:

(7) $$P_1 = \frac{P_{1AF}S_A}{20,000}$$

Where:

P_1 = Pressure rating of fitting in psig
S_A = Allowed stress of selected material per section 9.0 (psi)
P_{1AF} = Pressure rating from Appendix F (psig)

6.5 Prior to assembly of tube to flared tube fittings, the tube end shall be flared to conform to geometric requirements of one of the following reference specifications:

a) MS33584
b) KC154
c) MS33583 (if double flared tube end)

6.6 It is important to remove all burrs, shaving, slivers, sharp edges, and contaminant particles from flared tube ends prior to assembly with a fitting. There shall be no visible cracks allowed after flaring.

7.0 CONED AND (LEFT HAND) THREADED TUBING

7.1 Coned and threaded tubing may be utilized for high pressure services where required operating pressures exceed those of flared and swaged (flareless "Swagelok"®) tubing and tube fitting systems. The pressure ratings for cold worked 316 CRES tubing at maximum service temperature of 38°C (100°F) and that is coned and threaded are shown in the table below:

Nominal Tube Size (inches)	Pressure Rating		Tube Outside Diameter		Tube Inside Diameter	
	(MPa)	(psig)	(mm)	(inches)	(mm)	(inches)
1/4	137.9	20,000	6.17 to 6.30	.243 to .248	2.77	.109
3/8	137.9	20,000	9.27 to 9.40	.365 to .370	5.16	.203
9/16	137.9	20,000	14.02 to 14.15	.552 to .557	7.92	.312
3/4	137.9	20,000	18.80 to 18.92	.740 to .745	11.13	.438
1	137.9	20,000	25.15 to 25.27	.990 to .995	14.27	.562
1/4	413.6	60,000	6.17 to 6.30	.243 to .248	2.11	.083
3/8	413.6	60,000	9.27 to 9.40	.365 to .370	3.18	.125
9/16	413.6	60,000	14.02 to 14.15	.552 to .557	4.75	.187

Note that the minimum yield stress of the Cold Worked 316 CRES used for the above tubing must be greater than 413.8 MPa (60,000 psi) and the minimum ultimate tensile stress must be greater than 758.5 MPa (110,000 psi).

7.2 For materials other than Cold Worked 316 CRES and for operating temperatures above 38°C (100°F), the maximum pressure rating for coned and threaded tubing is determined by the equation below:

$$(8) \quad P = \frac{P_{TBL}-0.1013)S}{275.8} + 0.1013$$

Where:

P = Pressure rating (MPa)
P_{TBL} = Pressure rating from table in section 7.1 (MPa)
$S = 0.006896S_A$ (Mpa)
S_A = Allowed stress of selected material from section 9.0 (psi)

For computation of pressure ratings of coned and threaded tubing in English system units, the following equation applies:

(9) $$P_1 = \frac{P_{1AF}S_A}{40,000}$$

Where:

P_1 = Pressure rating in psig
P_{1AF} = Pressure rating from Appendix F (psig)
S_A = Allowed stress of selected material per section 9.0 (psi)

8.0 CONED AND THREADED TUBE FITTINGS

8.1 Coned and threaded tube fittings are those that utilize end connection geometries specified and illustrated in Appendix G, and where parts listed in Appendix H are used to assemble coned and left hand threaded tubing to the fitting.

Coned and threaded tube fittings may also have male end connections that can be connected to other fittings with end connection geometries shown in Appendix G. For the male end connection the cone angle shall be 59° as it is for the coned and threaded tube end shown in Appendix G. Furthermore it should have an identical geometry to an assembled tube end with attached gland and collar.

8.2 Coned and threaded tubing rated to 137.9 MPa (20,000 psig) pressures in section 7.1 can not be utilized with coned and threaded tube fittings rated to 413.6 MPa (60,000 psig). Conversely coned and threaded tubing rated to 413.6 MPa in section 7.1 can not be utilized with 137.9 MPa rated tube fittings.

8.3 Coned and threaded type tube fittings that also have other types of end connections (such as MS/AN to Autoclave and other Slimline adaptor fittings) may be used, but the pressure rating of the fitting shall be downrated to that of the fitting connection having the lowest pressure rating. See section 5.0 for "Swagelok"® type fitting end connections. See section 6.0 for 37° flared tube fitting end connections.

8.4 Tube ends shall be prepared as shown in Appendix G prior to connecting the respective tube fitting connection. It is

critical that all burrs, shavings, slivers, and contaminant particles be removed from the conical taper end and tip of each tube end prior to connecting a tube to a fitting.

8.5 To achieve improved leak-tight integrity of the coned and threaded type tubing connection it may be desired to hone or wipe the conical surfaces to an 8 RMS or smoother microfinish and to assure that the rim of the conical tip on the tube or male connection is coplaner in a plane that is perpendicular to the tube or fitting bore axial centerline within $\pm\frac{1}{4}°$.

8.6 When materials other than Cold Worked 316 CRES are used for coned and threaded tube fittings, the equation in section 7.2 shall be used to determine the new/revised pressure rating of the fittings.

9.0 ALLOWED MATERIAL STRESS VALUES

9.1 Allowed material stress values; represented by the variable S_A in equations in sections 4.2, 4.4, 6.4, and 7.2; can be determined by one of two methods.

9.2 The primary method for determining the allowed material stress is by referencing one of the applicable tables in Appendix A for the selected material at the maximum system operating temperature.

9.3 In cases where the allowable stress value determined as described in section 9.2 yields tubing and tube fittings with pressure boundary wall thicknesses larger than acceptable design and operating limits, allowed stress may be set to stress value that yields 1% creep at maximum system temperature over the number of operating hours and number of pressure cycles required of the system. In these cases, the number of operational pressure cycles and the operating time of the respective system are to be closely tracked and recorded such that these parameters do not exceed those used to determine the previous 1% creep at maximum system temperature.

APPENDIX A

References for Allowable Stress (S_A) Values of Materials Used for Tubing and Tube Fittings

1. ASME Boiler and Pressure Vessel Code Tables 2A, 2B, 3 and 4 in Subpart 1 of Section II, Part D, together with their maximum allowable design stress intensity values S_m over a range of temperatures (for limits see AD-130), give the data needed for design, as required by the rules of Part AD.

2. ANSI/ASME B31.3, Chemical Plant and Petroleum Refinery Piping Table A-1

For reference, S_A value for annealed type 316 and 304 stainless steels; typically used for tubing, tube fittings, and stainless steel pipe; is 137.917 MPa (20,000 psi).

APPENDIX B

TUBE MAXIMUM ALLOWABLE WORKING PRESSURES (psig)											
Wall Thickness		Tube Outside Diameter (Inches)									
Inches	Millimeters	0.250	0.375	0.500	0.5625	0.625	0.750	0.875	1.00	1.25	1.50
0.025	0.635	4390	2843	2099	1856	1664	1378	1175	1025	816	678
0.028	0.711	4966	3207	2365	2090	1872	1549	1321	1151	916	761
0.032	0.813	5748	3700	2722	2404	2152	1779	1516	1321	1050	872
0.035	0.889	6344	4074	2994	2642	2365	1953	1664	1449	1151	955
0.042	1.067	7761	4966	3638	3207	2867	2365	2012	1750	1389	1151
0.049	1.245	9204	5879	4295	3783	3378	2782	2365	2056	1629	1349
0.058	1.473	11073	7082	5160	4539	4049	3329	2825	2454	1942	1606
0.062	1.575	11898	7624	5551	4880	4352	3576	3033	2632	2082	1721
0.065	1.651	12510	8034	5846	5138	4581	3762	3189	2767	2188	1808
0.072	1.829	13905	8997	6544	5748	5121	4200	3558	3085	2436	2012
0.078	1.981	15045	9827	7149	6277	5590	4581	3878	3360	2650	2188
0.083	2.108	15942	10520	7658	6722	5985	4902	4146	3591	2831	2335
0.094	2.388	17682	12034	8790	7715	6866	5616	4746	4106	3231	2662
0.095	2.413	17821	12170	8893	7806	6947	5682	4801	4153	3268	2692
0.102	2.591		13114	9619	8446	7515	6144	5188	4486	3526	2903
0.109	2.769		14034	10347	9089	8089	6611	5579	4821	3787	3115
0.120	3.048		15411	11486	10104	8997	7352	6201	5355	4200	3452
0.125	3.175		16000	12000	10566	9412	7692	6486	5600	4390	3607
0.152	3.861			14672	13025	11651	9550	8053	6947	5433	4454
0.187	4.750			17612	15962	14445	11966	10124	8738	6825	5584
0.190	4.826				16190	14672	12170	10302	8893	6947	5682

Corrosion resistant stainless steel (CRES) per MIL-T-8808(ASG), MIL-T-8504, or MIL-T-8506 is the required material. Refer to the most recent revision of each standard.

CAUTION: When flaring or swaging tube for connection to 37° flared or Swagelok® tube fittings, tube system pressure ratings may be less than those shown on the table above. Refer to Section 6.0 and Appendix F for 37° flared tube fitting connection pressure ratings. Refer to Section 5.0 for Swagelok® tube fitting pressure ratings.

APPENDIX B

TUBE MAXIMUM ALLOWABLE WORKING PRESSURES (MPa)											
Wall Thickness		Tube Outside Diameter (Millimeters)									
Millimeters	Inches	6.350	9.525	12.700	14.288	15.875	19.050	22.225	25.400	31.750	38.100
0.635	0.025	30.376	19.704	14.579	12.903	11.574	9.602	8.207	7.169	5.728	4.775
0.711	0.028	34.346	22.215	16.407	14.511	13.010	10.782	9.210	8.041	6.418	5.346
0.813	0.032	39.737	25.613	18.874	16.679	14.943	12.370	10.557	9.210	7.343	6.111
0.889	0.035	43.845	28.198	20.746	18.323	16.407	13.571	11.574	10.092	8.041	6.687
1.067	0.042	53.617	34.346	25.185	22.215	19.870	16.407	13.974	12.171	9.680	8.041
1.245	0.049	63.572	40.645	29.720	26.185	23.398	19.288	16.407	14.276	11.336	9.406
1.473	0.058	76.458	48.935	35.684	31.399	28.025	23.059	19.585	17.021	13.491	11.178
1.575	0.062	82.145	52.676	38.379	33.754	30.113	24.758	21.015	18.254	14.458	11.972
1.651	0.065	86.367	55.502	40.418	35.535	31.692	26.042	22.095	19.185	15.186	12.570
1.829	0.072	95.986	62.143	45.226	39.737	35.416	29.067	24.636	21.374	16.898	13.974
1.981	0.078	103.852	67.868	49.401	43.386	38.650	31.692	26.840	23.271	18.378	15.186
2.108	0.083	110.037	72.645	52.911	46.458	41.374	33.902	28.694	24.865	19.621	16.203
2.388	0.094	122.036	83.087	60.715	53.303	47.447	38.831	32.826	28.415	22.383	18.460
2.413	0.095	122.996	84.027	61.429	53.930	48.004	39.284	33.205	28.741	22.636	18.667
2.591	0.102		90.536	66.436	58.341	51.926	42.470	35.876	31.033	24.417	20.120
2.769	0.109		96.880	71.451	62.778	55.880	45.688	38.573	33.348	26.213	21.584
3.048	0.120		106.372	79.308	69.779	62.143	50.802	42.862	37.028	29.067	23.907
3.175	0.125		110.435	82.852	72.963	65.003	53.146	44.831	38.718	30.376	24.972
3.861	0.152			101.278	89.922	80.445	65.958	55.637	48.004	37.568	30.814
4.750	0.187			121.548	110.170	99.710	82.616	69.916	60.359	47.169	38.605
4.826	0.190				111.748	101.278	84.027	71.144	61.429	48.004	39.284

Corrosion resistant stainless steel (CRES) per MIL-T-8808(ASG), MIL-T-8504, or MIL-T-8506 is the required material. Refer to the most recent revision of each standard.

CAUTION: When flaring or swaging tube for connection to 37° flared or Swagelok® tube fittings, tube system pressure ratings may be less than those shown on the table above. Refer to Section 6.0 and Appendix F for 37° flared tube fitting connection pressure ratings. Refer to Section 5.0 for Swagelok® tube fitting pressure ratings.

APPENDIX C

"Swagelok"® Fittings Approved for Use at SSC

Fitting Type	Fitting Size(s)	Swagelok® Part No.*
SAE/MS Male Connector	1/8	SS-200-1-2ST
	1/4	SS-400-1-4ST
	1/4	SS-400-1-6ST
	1/4	SS-400-1-8ST
	1/4	SS-400-1-10ST
	5/16	SS-500-1-5ST
	3/8	SS-600-1-4ST
	3/8	SS-600-1-6ST
	3/8	SS-600-1-8ST
	3/8	SS-600-1-10ST
	1/2	SS-810-1-6ST
	1/2	SS-810-1-8ST
	1/2	SS-810-1-10ST
	1/2	SS-810-1-12ST
	5/8	SS-1010-1-8ST
	5/8	SS-1010-1-10ST
	3/4	SS-1210-1-8ST
	3/4	SS-1210-1-12ST
	7/8	SS-1410-1-14ST
	1	SS-1610-1-12ST
	1	SS-1610-1-16ST
	$1^1/_4$	SS-2000-1-20ST
	$1^1/_2$	SS-2400-1-24ST
	2	SS-3200-1-32ST
SAE/MS Long Male Connector	1/4	SS-400-1L-4ST
	5/16	SS-500-1L-5ST
	3/8	SS-600-1L-6ST
	1/2	SS-810-1L-8ST
	5/8	SS-1010-1L-10ST
	3/4	SS-1210-1L-12ST
	7/8	SS-1410-1L-14ST
	1	SS-1610-1L-16ST
	$1^1/_4$	SS-2000-1L-20ST
	$1^1/_2$	SS-2400-1L-24ST
	2	SS-3200-1L-32ST
O-Seal Straight Thread Male Connector	1/16	SS-100-1-OR
	1/8	SS-200-1-OR
	3/16	SS-300-1-OR
	1/4	SS-400-1-OR
	5/16	SS-500-1-OR
	3/8	SS-600-1-OR
	1/2	SS-810-1-OR
	3/4	SS-1210-1-OR
	1	SS-1610-1-OR

Fitting Type	Fitting Size(s)	Swagelok® Part No.*
Swagelok® to AN Union	1/16	SS-100-6-2AN
	1/8	SS-200-6-2AN
	1/8	SS-200-6-4AN
	1/4	SS-400-6-4AN
	5/16	SS-500-6-5AN
	3/8	SS-600-6-4AN
	3/8	SS-600-6-6AN
Swagelok® to AN Union	1/2	SS-810-6-8AN
	3/4	SS-1210-6-12AN
	1	SS-1610-6-16AN
Swagelok® to AN Bulkhead Union	1/4	SS-400-61-4AN
	3/8	SS-600-61-6AN
	1/2	SS-810-61-8AN
	3/4	SS-1210-61-12AN
	1	SS-1610-61-16AN
Swagelok® to AN Adapter	1/8	SS-200-A-2ANF
	1/8	SS-200-A-4ANF
	1/4	SS-400-A-4ANF
	3/8	SS-600-A-6ANF
	1/2	SS-810-A-8ANF
Thermocouple Connector	1/8	SS-200-1-2BT
	1/4	SS-400-1-4BT
	1/4	SS-400-1-6BT
	1/4	SS-400-1-8BT
	1/4	SS-400-1-10BT
	5/16	SS-500-1-5BT
	3/8	SS-600-1-4BT
	3/8	SS-600-1-6BT
	3/8	SS-600-1-8BT
	3/8	SS-600-1-10BT
	1/2	SS-810-1-6BT
	1/2	SS-810-1-8BT
	1/2	SS-810-1-10BT
	1/2	SS-810-1-12BT
	5/8	SS-1010-1-8BT
	5/8	SS-1010-1-10BT
	3/4	SS-1210-1-8BT
	3/4	SS-1210-1-12BT
	7/8	SS-1410-1-14BT
	1	SS-1610-1-12BT
	1	SS-1610-1-16BT
Heat Exchanger Tee	$^1/_{16}$ x $^1/_{16}$ x $^1/_8$	SS-100-R-2BT
	$^1/_{16}$ x $^1/_{16}$ x $^1/_4$	SS-100-R-4BT
	$^1/_8$ x $^1/_8$ x $^1/_{16}$	SS-200-R-1BT
	$^1/_8$ x $^1/_8$ x $^1/_8$	SS-200-R-2BT
	$^1/_8$ x $^1/_8$ x $^3/_{16}$	SS-200-R-3BT
	$^1/_8$ x $^1/_8$ x $^1/_4$	SS-200-R-4BT

Fitting Type	Fitting Size(s)	Swagelok® Part No.*
Heat Exchanger Tee	$^1/_8$ x $^1/_8$ x $^3/_8$	SS-200-R-6BT
	$^1/_8$ x $^1/_8$ x $^1/_2$	SS-200-R-8BT
	$^3/_{16}$ x $^3/_{16}$ x $^1/_8$	SS-300-R-2BT
	$^3/_{16}$ x $^3/_{16}$ x $^1/_4$	SS-300-4-4BT
	$^1/_4$ x $^1/_4$ x $^1/_8$	SS-400-R-2BT
	$^1/_4$ x $^1/_4$ x $^3/_{16}$	SS-400-R-3BT
	$^1/_4$ x $^1/_4$ x $^1/_4$	SS-400-R-4BT
	$^1/_4$ x $^1/_4$ x $^5/_{16}$	SS-400-R-5BT
	$^1/_4$ x $^1/_4$ x $^3/_8$	SS-400-R-6BT
	$^1/_4$ x $^1/_4$ x $^1/_2$	SS-400-R-8BT
	$^1/_4$ x $^1/_4$ x $^5/_8$	SS-400-R-10BT
	$^1/_4$ x $^1/_4$ x $^3/_4$	SS-400-R-12BT
	$^5/_{16}$ x $^5/_{16}$ x $^3/_8$	SS-500-R-6BT
	$^5/_{16}$ x $^5/_{16}$ x $^1/_2$	SS-500-R-8BT
	$^3/_8$ x $^3/_8$ x $^1/_4$	SS-600-R-4BT
	$^3/_8$ x $^3/_8$ x $^3/_8$	SS-600-R-6BT
	$^3/_8$ x $^3/_8$ x $^1/_2$	SS-600-R-8BT
	$^3/_8$ x $^3/_8$ x $^5/_8$	SS-600-R-10BT
	$^3/_8$ x $^3/_8$ x $^3/_4$	SS-600-R-12BT
	$^1/_2$ x $^1/_2$ x $^1/_4$	SS-810-R-4BT
	$^1/_2$ x $^1/_2$ x $^3/_8$	SS-810-R-6BT
	$^1/_2$ x $^1/_2$ x $^1/_2$	SS-810-R-8BT
	$^1/_2$ x $^1/_2$ x $^5/_8$	SS-810-R-10BT
	$^1/_2$ x $^1/_2$ x $^3/_4$	SS-810-R-12BT
	$^1/_2$ x $^1/_2$ x 1	SS-810-R-16BT
	$^5/_8$ x $^5/_8$ x $^3/_4$	SS-1010-R-12BT
	$^5/_8$ x $^5/_8$ x $^7/_8$	SS-1010-R-14BT
	$^5/_8$ x $^5/_8$ x 1	SS-1010-R-16BT
	$^3/_4$ x $^3/_4$ x $^1/_2$	SS-1210-R-8BT
	1 x 1 x $1^1/_4$	SS-1610-R-20BT
	1 x 1 x $1^1/_2$	SS-1610-R-24BT
	1 x 1 x 2	SS-1610-R-32BT
SAE/MS Positionable Male Elbow	1/4	SS-400-2-4ST
	5/16	SS-500-2-5ST
	3/8	SS-600-2-6ST
	3/8	SS-600-2-8ST
	1/2	SS-810-2-8ST
	5/8	SS-1010-2-10ST
	3/4	SS-1210-2-12ST
	7/8	SS-1410-2-14ST
	1	SS-1610-2-16ST
	$1^1/_4$	SS-2000-2-20
	$1^1/_2$	SS-2400-2-24
	2	SS-3200-2-32
45° SAE/MS Positionable Male Elbow	1/4	SS-400-5-4ST
	3/8	SS-600-5-6ST
	1/2	SS-810-5-8ST
	3/4	SS-1210-5-12ST
	1	SS-1610-5-16ST
	$1^1/_4$	SS-2000-2-20ST

Fitting Type	Fitting Size(s)	Swagelok® Part No.*
45° SAE/MS Positionable Male Elbow	$1^1/_2$	SS-2400-2-24ST
	2	SS-3200-2-32ST
SAE/MS Positionable Male Run Tee	1/4	SS-400-3TST
	3/8	SS-600-3TST
	1/2	SS-810-3TST
	3/4	SS-1210-3TST
	1	SS-1610-3TST
SAE/MS Positionable Male Branch Tee	1/4	SS-400-3TTS
	3/8	SS-600-3TTS
	1/2	SS-810-3TTS
	3/4	SS-1210-3TTS
	1	SS-1610-3TTS
Union	1/16	SS-100-6
	1/8	SS-200-6
	3/16	SS-300-6
	1/4	SS-400-6
	5/16	SS-500-6
	3/8	SS-600-6
	1/2	SS-810-6
	5/8	SS-1010-6
	3/4	SS-1210-6
	7/8	SS-1410-6
	1	SS-1610-6
	$1^1/_4$	SS-2000-6
	$1^1/_2$	SS-2400-6
	2	SS-3200-6
Bulkhead Union	1/16	SS-100-61
	1/8	SS-200-61
	3/16	SS-300-61
	1/4	SS-400-61
	5/16	SS-500-61
	3/8	SS-600-61
	1/2	SS-810-61
	5/8	SS-1010-61
	3/4	SS-1210-61
	1	SS-1610-61
Metric to Fractional Inch Tube Union	3mm x 1/8	SS-3M0-6-2
	6mm x 1/8	SS-6M0-6-2
	6mm x 1/8	SS-6M0-6-4
	8mm x 1/4	SS-8M0-6-4
	10mm x 3/8	SS-10M0-6-6
	12mm x 1/2	SS-12M0-6-8
	16mm x 5/8	SS-16M0-6-10
	18mm x 3/4	SS-18M0-6-12

Fitting Type	Fitting Size(s)	Swagelok® Part No.*
Reducing Union	$^1/_8$ x $^1/_{16}$	SS-200-6-1
	$^3/_{16}$ x $^1/_{16}$	SS-300-6-1
	$^3/_{16}$ x $^1/_8$	SS-300-6-2
	$^1/_4$ x $^1/_{16}$	SS-400-6-1
	$^1/_4$ x $^1/_8$	SS-400-6-2
	$^1/_4$ x $^3/_{16}$	SS-400-6-3
	$^5/_{16}$ x $^1/_8$	SS-500-6-2
	$^5/_{16}$ x $^1/_4$	SS-500-6-4
	$^3/_8$ x $^1/_{16}$	SS-600-6-1
	$^3/_8$ x $^1/_8$	SS-600-6-2
	$^3/_8$ x $^1/_4$	SS-600-6-4
	$^3/_8$ x $^5/_{16}$	SS-600-6-5
	$^1/_2$ x $^1/_8$	SS-810-6-2
	$^1/_2$ x $^1/_4$	SS-810-6-4
	$^1/_2$ x $^3/_8$	SS-810-6-6
	$^5/_8$ x $^3/_8$	SS-1010-6-6
	$^5/_8$ x $^1/_2$	SS-1010-6-8
	$^3/_4$ x $^1/_4$	SS-1210-6-4
	$^3/_4$ x $^3/_8$	SS-1210-6-6
	$^3/_4$ x $^1/_2$	SS-1210-6-8
	$^3/_4$ x $^5/_8$	SS-1210-6-10
	1 x $^1/_2$	SS-1610-6-8
	1 x $^3/_4$	SS-1610-6-12
Union Elbow	1/16	SS-100-9
	1/8	SS-200-9
	3/16	SS-300-9
	1/4	SS-400-9
	5/16	SS-500-9
	3/8	SS-600-9
	1/2	SS-810-9
	5/8	SS-1010-9
	3/4	SS-1210-9
	7/8	SS-1410-9
	1	SS-1610-9
	$1^1/_4$	SS-2000-9
	$1^1/_2$	SS-2400-9
	2	SS-3200-9
Union Tee	1/16	SS-100-3
	1/8	SS-200-3
	3/16	SS-300-3
	1/4	SS-400-3
	5/16	SS-500-3
	3/8	SS-600-3
	1/2	SS-810-3
	5/8	SS-1010-3
	3/4	SS-1210-3
	7/8	SS-1410-3
	1	SS-1610-3
	$1^1/_4$	SS-2000-3
	$1^1/_2$	SS-2400-3

Fitting Type	Fitting Size(s)	Swagelok® Part No.*
Union Tee	2	SS-3200-3
Union Cross	1/8	SS-200-4
	1/4	SS-400-4
	5/16	SS-500-4
	3/8	SS-600-4
	1/2	SS-810-4
	3/4	SS-1210-4
	1	SS-1610-4
Swagelok® to Male Pipe Weld Connector	1/8 x 1/8	SS-200-1-2W
	3/16 x 1/8	SS-300-1-2W
	1/4 x 1/8	SS-400-1-2W
	1/4 x 1/4	SS-400-1-4W
	5/16 x 1/8	SS-500-1-2W
	5/16 x 1/4	SS-500-1-4W
	3/8 x 1/4	SS-600-1-4W
	3/8 x 3/8	SS-600-1-6W
	3/8 x 1/2	SS-600-1-8W
	1/2 x 3/8	SS-810-1-6W
	1/2 x 1/2	SS-810-1-8W
	1/2 x 3/4	SS-810-1-12W
	5/8 x 1/2	SS-1010-1-8W
	3/4 x 3/4	SS-1210-1-12W
	1 x 1	SS-1610-1-16W
	1 1/4 x 1 1/4	SS-2000-1-20W
	1 1/2 x 1 1/2	SS-2400-1-24W
	2	SS-3200-1-32W
Swagelok® to Male Pipe Weld Elbow	1/4 x 1/8	SS-400-2-2W
	1/4 x 1/4	SS-400-2-RW
	3/8 x 1/4	SS-600-2-4W
	1/2 x 1/2	SS-810-2-8W
	3/4 x 3/4	SS-1210-2-12W
Reducer	1/16 x 1/8	SS-100-R-2
	1/16 x 1/4	SS-100-R-4
	1/8 x 1/16	SS-200-R-1
	1/8 x 1/8	SS-200-R-2
	1/8 x 3/16	SS-200-R-3
	1/8 x 1/4	SS-200-R-4
	1/8 x 3/8	SS-200-R-6
	1/8 x 1/2	SS-200-R-8
	3/16 x 1/8	SS-300-R-2
	3/16 x 1/4	SS-300-R-4
	1/4 x 1/8	SS-400-R-2
	1/4 x 3/16	SS-400-R-3
	1/4 x 1/4	SS-400-R-4
	1/4 x 5/16	SS-400-R-5
	1/4 x 3/8	SS-400-R-6
	1/4 x 1/2	SS-400-R-8
	1/4 x 5/8	SS-400-R-10

Fitting Type	Fitting Size(s)	Swagelok® Part No.*
Reducer	$^1/_4$ x $^3/_4$	SS-400-R-12
	$^5/_{16}$ x $^3/_8$	SS-500-R-6
	$^5/_{16}$ x $^1/_2$	SS-500-R-8
	$^3/_8$ x $^1/_4$	SS-600-R-4
	$^3/_8$ x $^3/_8$	SS-600-R-6
	$^3/_8$ x $^1/_2$	SS-600-R-8
	$^3/_8$ x $^5/_8$	SS-600-R-10
	$^3/_8$ x $^3/_4$	SS-600-R-12
	$^1/_2$ x $^1/_4$	SS-810-R-4
	$^1/_2$ x $^3/_8$	SS-810-R-6
	$^1/_2$ x $^1/_2$	SS-810-R-8
	$^1/_2$ x $^5/_8$	SS-810-R-10
	$^1/_2$ x $^3/_4$	SS-810-R-12
	$^1/_2$ x 1	SS-810-R-16
	$^5/_8$ x $^3/_4$	SS-1010-R-12
	$^5/_8$ x $^7/_8$	SS-1010-R-14
	$^5/_8$ x 1	SS-1010-R-16
	$^3/_4$ x $^1/_2$	SS-1210-R-8
	$^3/_4$ x 1	SS-1210-R-16
	1 x $1^1/_4$	SS-1610-R-20
	1 x $1^1/_2$	SS-1610-R-24
	1 x 2	SS-1610-4-32
	$1^1/_4$ x $1^1/_2$	SS-2000-R-24
	$1^1/_4$ x 2	SS-2000-R-32
	$1^1/_2$ x 2	SS-2400-R-32
Bulkhead Reducer	1/8	SS-200-R1-2
	1/4	SS-400-R1-4
	3/8	SS-600-R1-6
	1/2	SS-810-R1-8
Male Adapter	$1^1/_4$ x $1^1/_4$	SS-2000-A-20ST
	$1^1/_2$ x $1^1/_2$	SS-2400-A-24ST
	2 x 2	SS-3200-A-32ST
Port Connector	1/16	SS-101-PC
	1/8	SS-201-PC
	1/4	SS-401-PC
	5/16	SS-501-PC
	3/8	SS-601-PC
	1/2	SS-811-PC
	3/4	SS-1211-PC
	1	SS-1611-PC
Reducing Port Connector	$^1/_8$ x $^1/_{16}$	SS-201-PC-1
	$^1/_4$ x $^1/_{16}$	SS-401-PC-1
	$^1/_4$ x $^1/_8$	SS-401-PC-2
	$^3/_8$ x $^1/_8$	SS-601-PC-2
	$^3/_8$ x $^1/_4$	SS-601-PC-4
	$^1/_2$ x $^1/_4$	SS-811-PC-4
	$^1/_2$ x $^3/_8$	SS-811-PC-6
	$^3/_4$ x $^1/_2$	SS-1211-PC-8

Fitting Type	Fitting Size(s)	Swagelok® Part No.*
Cap	1/16	SS-100-C
	1/8	SS-200-C
	3/16	SS-300-C
	1/4	SS-400-C
	5/16	SS-500-C
	3/8	SS-600-C
	1/2	SS-810-C
	5/8	SS-1010-C
	3/4	SS-1210-C
	7/8	SS-1410-C
	1	SS-1610-C
	$1^1/_4$	SS-2000-C
	$1^1/_2$	SS-2400-C
	2	SS-3200-C
Plug	1/16	SS-100-P
	1/8	SS-200-P
	3/16	SS-300-P
	1/4	SS-400-P
	5/16	SS-500-P
	3/8	SS-600-P
	1/2	SS-810-P
	5/8	SS-1010-P
	3/4	SS-1210-P
	1	SS-1610-P
	$1^1/_4$	SS-2000-P
	$1^1/_2$	SS-2400-P
	2	SS-3200-P
Nut	1/16	SS-102-1
	1/8	SS-202-1
	3/16	SS-302-1
	1/4	SS-402-1
	5/16	SS-502-1
	3/8	SS-602-1
	1/2	SS-812-1
	5/8	SS-1012-1
	3/4	SS-1212-1
	7/8	SS-1412-1
	1	SS-1612-1
	$1^1/_4$	SS-2002-1
	$1^1/_2$	SS-2402-1
	2	SS-3202-1
Back Ferrule	1/16	SS-104-1
	1/8	SS-204-1
	3/16	SS-304-1
	1/4	SS-404-1
	5/16	SS-504-1
	3/8	SS-604-1
	1/2	SS-814-1
	5/8	SS-1014-1

Fitting Type	Fitting Size(s)	Swagelok® Part No.*
Back Ferrule	3/4	SS-1214-1
	7/8	SS-1414-1
	1	SS-1614-1
	$1^1/_4$	SS-2004-1
	$1^1/_2$	SS-2404-1
	2	SS-3204-1
Front Ferrule	1/16	SS-103-1
	1/8	SS-203-1
	3/16	SS-303-1
	1/4	SS-403-1
	5/16	SS-503-1
	3/8	SS-603-1
	1/2	SS-813-1
	5/8	SS-1013-1
	3/4	SS-1213-1
	7/8	SS-1413-1
	1	SS-1613-1
	$1^1/_4$	SS-2003-1
	$1^1/_2$	SS-2403-1
	2	SS-3203-1
Knurled Nut	1/16	SS-102-1K
	1/8	SS-202-1K
	3/16	SS-302-1K
	1/4	SS-402-1K
	5/16	SS-502-1K
	3/8	SS-602-1K
	1/2	SS-812-1K
	5/8	SS-1012-1K
	3/4	SS-1212-1K
	7/8	SS-1412-1K
	1	SS-1612-1K
	$1^1/_4$	SS-2002-1K
	$1^1/_2$	SS-2402-1K
	2	SS-3202-1K
Swagelok® to Female	$^1/_4$ x $^1/_{16}$	SS-400-6-1FGC
Swagelok® Union	$^3/_8$ x $^1/_{16}$	SS-600-6-1FGC
Reducing Union	$^1/_8$ x $^1/_{16}$	SS-200-6-1ZV
	$^1/_4$ x $^1/_{16}$	SS-400-6-1LV
	$^1/_4$ x $^1/_{16}$	SS-400-6-1ZV
	$^3/_8$ x $^1/_{16}$	SS-600-6-1ZV
	$^1/_2$ x $^1/_{16}$	SS-810-6-1ZV

*Or an approved equal. Equals are only permitted for fitting types and sizes that have been connected to compatible Swagelok® fittings and have been pressure and leak tested through a series of 50 or more pressure cycles. A pressure cycle is defined as pressurization from ambient atmospheric pressure to maximum operating pressure followed by depressurization to ambient

atmospheric pressure. Furthermore equals are only permitted with approval of the cognizant CCB or NASA systems engineer.

Note: All "Swagelok®" fitting part numbers listed above have "SS" as the prefix indicating that the part is made of (Type 316) stainless steel material. To specify fittings made of brass, substitute "B" for "SS". To specify fittings made of Monel 400, substitute "M" for "SS". Special orders are required for fittings made of other materials. Fittings made of (Carbon) Steel, Nylon, TFE are not permitted by virtue of this standard.

APPENDIX D

Flared tube fittings and parts approved for use at SSC in addition to those listed in SAE AIR310 Table 3

AN790
AN819
AN822
AN823
AN825
AN826
AN901
AN909
AN932
AN960
AN6285
AN10050
KC104
KC105
KC136 #
KC137 #
KC138 #
KC140 #
KC141 #
KC167
MC240
MS21908
MS21917
MS21925
MS33649
TRTX

Limited to pressure ratings of tube fittings with AN/MS male to AN/MS female or AN/MS to male flared tube connections.

APPENDIX E

AN/MS Type Tube Fittings Approved For Use at SSC

AN		AS		KC		MA (Metric)		MS		NAS	
Drawing No.	Configuration Heading	Drawing No.	Configuration Heading	Drawing No.	Configuration Heading	Drawing No.	Configuration Heading	Drawing No.	Configuration Heading	Drawing No.	Configuration Heading
AN774	A.1, B.2	AS893	A.1, B.19	KC103	A.1, B.16	MA2025	1.7, B.20	MS9015	A.16, B.15	NAS424	A.16, B.7
AN775	A.1, B.2	AS894	A.9, B.19	KC106	A.1, B.1	MA2026	A.7, B.9	MS9016	A.16, B.3	NAS551	A.17, B.2
AN776	A.17, B.9	AS895	A.9, B.3	KC107	A.1, B.18	MA2027	A.7, B.19		A.16, B.8	NAS552	A.17, B.9
AN777	A.17, B.9	AS896	A.9, B.1	KC108	A.2, B.9	MA2028	A.7, B.8	MS9099	A.16, B.11	NAS553	A.17, B.9
AN778	A.17, B.9	AS897	A.9, B.3	KC109	A.1, B.19	MA2029	A.7, B.9	MS9100	A.16, B.11	NAS554	A.17, B.9
AN779	A.17, B.19	AS931	A.8, B.1	KC110	A.2, B.19	MA2030	A.7, B.9	MS9194	A.2, B.9	NAS591	A.1, B.7
AN780	A.15, B.1	AS932	A.8, B.1	KC111	A.2, B.19	MA2031	A.7, B.19	MS9195	A.2, B.9	NAS592	A.1, B.16
AN783	A.2, B.9	AS933	A.2, B.1	KC112	A.2, B.1	MA2032	A.8, B.19	MS9196	A.2, B.19	NAS593	A.1, B.14
AN784	A.2, B.19	AS934	A.2, B.1	KC113	A.1, B.9	MA2033	A.8, B.19	MS9197	A.1, B.14	NAS594	A.1, B.7
AN785	A.15, B.7	AS1000	A.7, B.4	KC114	A.1, B.18	MA2034	A.7, B.15	MS9198	A.1, B.14	NAS596	A.1, B.14
AN791	A.15, B.9	AS1001	A.8, B.19	KC115	A.1, B.3	MA2035	A.7, B.15	MS9199	A.1, B.14	NAS652	A.1, B.7
AN795	A.15, B.19	AS1002	A.8, B.19	KC116	A.5, B.1	MA2036	A.7, B.4	MS9200	A.16, B.11	NAS1410	A.16, B.11
AN801	A.14, B.10	AS1003	A.7, B.19	KC117	A.1, B.8	MA2038	A.7, B.20	MS9201	A.16, B.11	NAS1564	A.1, B.1
AN802	A.14, B.10	AS1004	A.7, B.9	KC118	A.1, B.9	MA2039	A.16, B.15	MS9313	A.1, B.4	NAS1565	A.7, B.1
AN803	A.14, B.10	AS1005	A.7, B.19	KC119	A.2, B.19	MA2040	A.7, B.14	MS9314	A.1, B.4	NAS1566	A.7, B.1
AN804	A.1, B.18	AS1006	A.7, B.8	KC120	A.2, B.19	MA2041	A.7, B.18	MS9315	A.1, B.4	NAS1761	A.7, B.9
AN805	A.15, B.14	AS1007	A.7, B.20	KC121	A.5, B.19	MA2043	A.7, B.20	MS9405	A.16, B.15	NAS1762	A.7, B.9
AN806	A.1, B.14	AS1008	A.7, B.9	KC122	A.5, B.19	MA2044	A.7, B.9	MS9553	A.16, B.11	NAS1763	A.7, B.19
AN807	A.4, B.1	AS1009	A.7, B.19	KC123	A.1, B.19	MA2045	A.7, B.9	MS9769	A.1, B.19	NAS1764	A.7, B.19
AN814	A.16, B.15	AS1010	A.7, B.9	KC124	A.1, B.20	MA2046	A.7, B.1	MS9953	A.16, B.15		
AN815	A.1, B.20	AS1027	A.16, B.11	KC125	A.1, B.20	MA2047	A.7, B.18	MS9954	A.16, B.15		
AN816	A.5, B.1	AS1028	A.1, B.14	KC126	A.1, B.20	MA2048	A.7, B.19	MS16267	A.7, B.9		
AN817	A.1, B.14	AS1031	A.1, B.19	KC127	A.1, B.19	MA2049	A.7, B.19	MS20756	A.13, B.10		

APPENDIX E

AN/MS Type Tube Fittings Approved For Use at SSC

AN		AS		KC		MA (Metric)		MS		NAS	
Drawing No.	Configuration Heading	Drawing No.	Configuration Heading	Drawing No.	Configuration Heading	Drawing No.	Configuration Heading	Drawing No.	Configuration Heading	Drawing No.	Configuration Heading
AN818	A.1, B.14	AS1032	A.2, B.19	KC128	A.1, B.9	MA2050	A.7, B.9	MS20757	A.14, B.18		
AN821	A.1, B.9	AS1033	A.1, B.19	KC129	A.2, B.9	MA2051	A.7, B.19	MS20758	A.14, B.9		
AN824	A.1, B.18	AS1034	A.1, B.9	KC130	A.1, B.15	MA2053	A.8, B.19		A.14, B.10		
AN827	A.1, B.8	AS1035	A.1, B.18	KC131	A.1, B.9	MA2054	A.7, B.19	MS20759	A.14, B.9		
AN832	A.1, B.20	AS1036	A.1, B.8	KC132	A.1, B.9	MA2056	A.8, B.19		A.14, B.10		
AN833	A.1, B.9	AS1037	A.1, B.20	KC133	A.2, B.1	MA2058	A.7, B.20	MS20760	A.1, B.10		
AN834	A.1, B.19	AS1038	A.1, B.9	KC134	A.2, B.1	MA2064	A.10, B.18	MS20761	A.1, B.10		
AN837	A.1, B.9	AS1039	A.1, B.19	KC135	A.2, B.1	MA2065	A.10, B.10	MS20762	A.1, B.10		
AN838	A.4, B.9	AS1040	A.1, B.9		A.2, B.3	MA2066	A.18, B.20	MS20819	A.1, B.17		
AN839	A.4, B.9	AS1041	A.7, B.14	KC139	A.1, B.14	MA2067	A.10, B.18	MS20822	A.5, B.9		
AN840	A.12, B.1	AS1097	A.1, B.12	KC142	A.1, B.14	MA2068	A.8, B.1	MS20823	A.5, B.9		
AN841	A.4, B.1	AS1100	A.1, B.20	KC143	A.1, B.17	MA2069	A.18, B.9	MS20825	A.5, B.19		
AN842	A.12, B.9	AS1249	A.1, B.9	KC144	A.1, B.20	MA2070	A.18, B.19	MS20826	A.5, B.19		
AN844	A.12, B.9	AS1250	A.1, B.9	KC150	A.1, B.4	MA2071	A.18, B.8	MS20913	A.11, B.15		
AN846	A.14, B.9	AS1251	A.1, B.20	KC164	A.1, B.3	MA2072	A.7, B.14	MS21264	A.16, B.11		
AN848	A.14, B.9	AS1252	A.1, B.19		A.2, B.3	MA2073	A.7, B.14	MS21900	A.3, B.1		
AN849	A.14, B.20	AS1253	A.1, B.19	KC165	A.1, B.22	MA2074	A.7, B.16	MS21902	A.7, B.20		
AN871	A.16, B.10	AS1365	A.1, B.19	KC170	A.16, B.1	MA2111	A.22, B.1	MS21904	A.7, B.9		
AN876	A.14, B.6	AS1366	A.1, B.19	KC171	A.1, B.20	MA2112	A.8, B.1	MS21905	A.7, B.19		
AN893	A.16, B.3	AS1367	A.1, B.8	KC172	A.1, B.1	MA2113	A.20, B.1	MS21906	A.7, B.8		
AN894	A.1, B.3	AS1368	A.1, B.20	KC173	A.16, B.7	MA2115	A.7, B.20	MS21907	A.7, B.9		
	A.2, B.1	AS1369	A.1, B.15	KC174	A.16, B.15	MA2116	A.7, B.20	MS21909	A.7, B.19		
	A.2, B.3	AS1580	A.18, B.16			MA2117	A.7, B.22	MS21910	A.8, B.19		
AN910	A.11, B.7	AS1581	A.7, B.18			MA2118	A.16, B.11	MS21911	A.8, B.19		

AN/MS Type Tube Fittings Approved For Use at SSC

AN		AS		KC		MA (Metric)		MS		NAS	
Drawing No.	Configuration Heading	Drawing No.	Configuration Heading	Drawing No.	Configuration Heading	Drawing No.	Configuration Heading	Drawing No.	Configuration Heading	Drawing No.	Configuration Heading
AN911	A.11, B.13	AS1582	A.10, B.1			MA2157	A.7, B.8	MS21912	A.7, B.19		
AN912	A.11, B.3	AS1583	1.18, B.19			MA2158	A.7, B.8	MS21913	A.7, B.15		
AN914	A.11, B.9	AS1584	A.18, B.9					MS21914	A.7, B.4		
AN915	A.11, B.9	AS1790	A.7, B.14					MS21915	A.8, B.3		
AN916	A.11, B.9	AS1791	A.7, B.22					MS21916	A.7, B.20		
AN917	A.11, B.19	AS1792	A.7, B.14					MS21918	A.7, B.18		
AN918	A.11, B.8	AS1860	A.7, B.14					MS21921	A.7, B.14		
AN919	A.1, B.20	AS1861	A.1, B.14					MS21922	A.7, B.18		
AN924	A.16, B.11	AS1893	A.18, B.16					MS21923	A.3, B.1		
AN929	A.1, B.4	AS1985	A.2, B.1					MS21924	A.7, B.9		
AN933	A.11, B.15	AS1986	A.22, B.1						A.7, B.20		
AN937	A.16, B.8	AS3077	A.16, B.16					MS21926	A.7, B.9		
AN938	A.16, B.19	AS3078	A.16, B.16					MS21937	A.1, B.5		
AN939	B.16, B.9	AS4099	A.8, B.1						A.7, B.15		
AN941	A.16, B.9							MS21938	A.7, B.2		
AN6204	A.16, B.21								A.7, B.5		
AN6289	A.16, B.11							MS21939	A.7, B.2		
AN7023	A.12, B.1								A.7, B.5		
								MS21940	A.7, B.2		
									A.7, B.5		
								MS21942	A.7, B.2		
								MS21943	A.7, B.5		
								MS21944	A.7, B.5		
								MS21945	A.7, B.5		

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AN		AS		KC		MA (Metric)		MS		NAS	
Drawing No.	Configuration Heading	Drawing No.	Configuration Heading	Drawing No.	Configuration Heading	Drawing No.	Configuration Heading	Drawing No.	Configuration Heading	Drawing No.	Configuration Heading
								MS21946	A.16, B.5		
								MS21949	A.1, B.2		
									A.1, B.5		
								MS21950	A.1, B.2		
								MS21951	A.1, B.2		
									A.1, B.5		
								MS21953	A.1, B.5		
								MS21954	A.1, B.5		
								MS21955	A.1, B.5		
								MS21956	A.1, B.5		
								MS21958	A.16, B.5		
								MS21959	A.16, B.5		
								MS21960	A.16, B.5		
								MS24387	A.1, B.2		
								MS24388	A.2, B.19		
								MS24389	A.2, B.19		
								MS24390	A.1, B.19		
								MS24391	A.16, B.15		
								MS24392	A.1, B.20		
								MS24393	A.1, B.20		
								MS24394	A.1, B.9		
								MS24395	A.1, B.19		
								MS24396	A.1, B.9		
								MS24397	A.16, B.3		

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AN		AS		KC		MA (Metric)		MS		NAS	
Drawing No.	Configuration Heading	Drawing No.	Configuration Heading	Drawing No.	Configuration Heading	Drawing No.	Configuration Heading	Drawing No.	Configuration Heading	Drawing No.	Configuration Heading
								MS24398	A.1, B.3		
									A.2, B.1		
									A.2, B.3		
								MS24399	A.1, B.20		
								MS24401	A.1, B.9		
								MS24402	A.1, B.19		
								MS24403	A.1, B.8		
								MS24404	A.1, B.15		
								MS24405	A.3, B.1		
								MS24487	A.2, B.1		
								MS24518	A.12, B.9		
								MS24519	A.12, B.9		
								MS24520	A.14, B.20		
								MS24521	A.14, B.19		
								MS24522	A.12, B.1		
								MS24651	A.3, B.9		
								MS24652	A.3, B.9		
								MS24654	A.3, B.9		
								MS27073	A.1, B.14		
									A.7, B.14		
								MS27074	A.1, B.22		
									A.7, B.22		
								MS27584	A.1, B.1		
								MS27585	A.1, B.12		

AN/MS Type Tube Fittings Approved For Use at SSC

AN		AS		KC		MA (Metric)		MS		NAS	
Drawing No.	Configuration Heading	Drawing No.	Configuration Heading	Drawing No.	Configuration Heading	Drawing No.	Configuration Heading	Drawing No.	Configuration Heading	Drawing No.	Configuration Heading
									A.16, B.1		
								MS27586	A.1, B.12		
									A.16, B.1		
								MS27587	A.1, B.1		
									A.1, B.12		
								MS27588	A.1, B.1		
									A.1, B.12		
								MS27589	A.1, B.12		
								MS27590	A.1, B.1		
									A.1, B.12		
								MS27591	A.1, B.1		
									A.1, B.12		
								MS27592	A.1, B.12		
								MS27593	A.1, B.12		
								MS27607	A.1, B.1		
									A.1, B.12		
								MS27608	A.1, B.12		
								MS27691	A.16, B.21		
								MS27612	A.16, B.1		
								MS27769	A.11, B.15		
AN10050								MS33649			MC249
								MS39322	A.1, B.1		
								MS39323	A.1, B.1		
								MS39324	A.2, B.1		

AN/MS Type Tube Fittings Approved For Use at SSC

AN		AS		KC		MA (Metric)		MS		NAS	
Drawing No.	Configuration Heading	Drawing No.	Configuration Heading	Drawing No.	Configuration Heading	Drawing No.	Configuration Heading	Drawing No.	Configuration Heading	Drawing No.	Configuration Heading
								MS51500	A.5, B.1		
								MS51501	A.1, B.20		
								MS51502	A.1, B.20		
								MS51503	A.5, B.1		
								MS51504	A.5, B.9		
								MS51505	A.1, B.9		
								MS51506	A.5, B.9		
								MS51507	A.1, B.9		
								MS51508	A.5, B.9		
								MS51509	A.1, B.9		
								MS51510	A.1, B.19		
								MS51511	A.5, B.19		
								MS51512	A.5, B.19		
								MS51513	A.5, B.19		
								MS51514	A.5, B.19		
								MS51515	A.1, B.19		
								MS51516	A.1, B.19		
								MS51517	A.1, B.8		
								MS51518	A.1, B.15		
								MS51519	A.1, B.20		
								MS51520	A.1, B.20		
								MS51521	A.1, B.9		
								MS51522	A.1, B.9		
								MS51523	A.1, B.19		

AN/MS Type Tube Fittings Approved For Use at SSC

AN		AS		KC		MA (Metric)		MS		NAS	
Drawing No.	Configuration Heading	Drawing No.	Configuration Heading	Drawing No.	Configuration Heading	Drawing No.	Configuration Heading	Drawing No.	Configuration Heading	Drawing No.	Configuration Heading
								MS51524	A.1, B.19		
								MS51525	A.2, B.1		
								MS51526	A.2, B.1		
								MS51527	A.2, B.9		
								MS51528	A.2, B.9		
								MS51529	A.2, B.19		
								MS51530	A.2, B.19		
								MS51531	A.1, B.14		
								MS51532	A.1, B.4		
								MS51533	A.1, B.18		
								MS51534	A.1, B.1		
								MS51811	A.7, B.19		
								MS51812	A.7, B.20		
								MS51813	A.9, B.3		
								MS51814	A.7, B.20		
								MS51815	A.9, B.3		
								MS51816	A.9, B.1		
								MS51817	A.9, B.3		
								MS51818	A.9, B.19		
								MS51819	A.9, B.1		
								MS51820	A.7, B.9		
								MS51821	A.9, B.19		
								MS51822	A.9, B.19		
								MS51824	A.9, B.19		

AN/MS Type Tube Fittings Approved For Use at SSC

AN		AS		KC		MA (Metric)		MS		NAS	
Drawing No.	Configuration Heading	Drawing No.	Configuration Heading	Drawing No.	Configuration Heading	Drawing No.	Configuration Heading	Drawing No.	Configuration Heading	Drawing No.	Configuration Heading
								MS51825	A.7, B.18		
								MS51839	A.8, B.9		
								MS51840	A.16, B.15		
								MS51841	A.8, B.19		
								MS51842	A.8, B.9		
								MS51843	A.8, B.1		
								MS51852	A.7, B.9		
								MS51853	A.7, B.19		
								MS51854	A.7, B.19		
								MS51860	A.16, B.11		
								MS51888	A.16, B.11		
								MS51890	A.7, B.4		
								MS51891	A.7, B.15		
								MS51892	A.8, B.19		
								MS51893	A.8, B.1		
								MS51894	A.7, B.8		
								MS51895	A.7, B.20		

APPENDIX F

Pressure Ratings of Connection Types on 304 or 316 CRES 37° Flared Tube Fittings at 38°C (100°F) Maximum Temperature

Connection Type	Nominal Size (inches)	Maximum Allowed Operating Pressure (MPa)	(psig)
Male KC to Female KC, Female AN/MS, and Flared Tube	1/4	66.2	9600
Male KC to Female KC, Female AN/MS, and Flared Tube	3/8	66.2	9600
Male KC to Female KC, Female AN/MS, and Flared Tube	1/2	51.1	7400
Male KC to Female KC, Female AN/MS, and Flared Tube	3/4	49.5	7150
Male KC to Female KC, Female AN/MS, and Flared Tube	1	36.6	5300
Male KC to Female KC, Female AN/MS, and Flared Tube	1¼	36.0	5200
Male KC to Female KC, Female AN/MS, and Flared Tube	1½ through 2	31.8	4600
Male AN/MS to Female KC, AN, MS Fitting Connector	¼ through ¾	49.4	7150
Male AN/MS to Female KC, AN, MS Fitting Connector	1 through 1¼	31.1	4500
Male AN/MS to Female KC, AN, MS Fitting Connector	1½ through 2	17.9	2600
Male AN/MS to Flared Tube	¼ through ¾	45.6	6600

Connection Type	Nominal Size (inches)	Maximum Allowed Operating Pressure (MPa)	(psig)
Male AN/MS to Flared Tube	1 through 1¼	31.1	4500
Male AN/MS to Flared Tube	1½ through 2	17.9	2600
NPT*	All	20.8	3000

*NPT connections limited to 3.27 MPa (230 psig) with cryogenic service media.

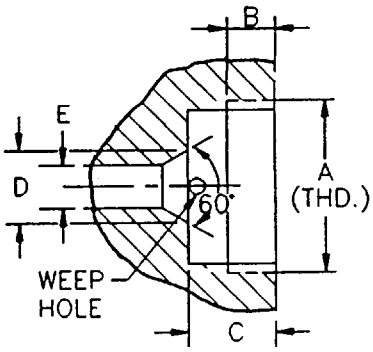
Approval of cognizant CCB or Systems Engineer required for use of NPT connections in cryogenic and gaseous hydrogen, helium, nitrogen, air, oxygen, and flourine systems.

CAUTION: Pressure rating of tubing connected to flared tube fittings may be less than maximum allowed operating pressures in table above. Refer to Section 4.0 and Appendix B for tubing pressure ratings.

APPENDIX G

CONNECTIONS

CONED AND THREADED TUBE FITTINGS FEMALE END CONNECTION DIMENSIONS

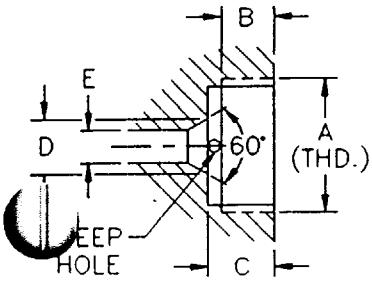


20,000 PSI RATED

CONNECTION	A (THD.)	B	C	D (DIA.)	E1 (DIA.)	E2 (DIA.)
1/4 M/P	7/16 – 20	.28	.50	.19	.109	
3/8 M/P	9/16 – 18	.38	.62	.31	.203	
9/16 M/P	13/16 – 16	.44	.75	.50	.312	.359
3/4 M/P	3/4 – 14 *	.50	.94	.62	.437	.516
1" M/P	1–3/8 – 12	.81	1.31	.88	.562	.687

* = NPSM

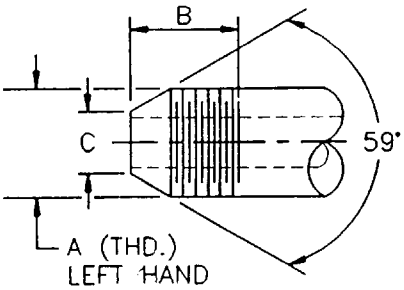
E1 = 20,000 P.S.I.
E2 = 10,000 P.S.I. (OPTIONAL MACHINING)



60,000 PSI RATED

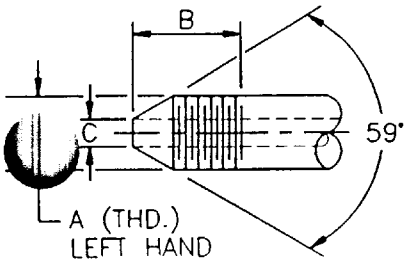
CONNECTION	A (THD.)	B	C	D (DIA.)	E (DIA.)
1/4 H/P	9/16 – 18	.38	.44	.17	.093
3/8 H/P	3/4 – 16	.53	.62	.26	.125
9/16 H/P	1–1/8 – 12	.62	.75	.38	.188

CONED AND THREADED TUBING PREPARATION



20,000 PSI RATED

CONNECTION	TUBE SIZE O.D. X I.D.	DIMENSIONS		
		A (THD.)	B	C (DIA.)
1/4 M/P	1/4 X .109	1/4 – 28 L.H.	.34	.140
3/8 M/P	3/8 X .203	3/8 – 24 L.H.	.44	.250
9/16 M/P	9/16 X .312	9/16 – 18 L.H.	.50	.406
3/4 M/P	3/4 X .438	3/4 – 16 L.H.	.62	.562
1" M/P	1" X 562	1" – 14 L.H.	.78	.718



60,000 PSI RATED

CONNECTION	TUBE SIZE O.D. X I.D.	DIMENSIONS		
		A (THD.)	B	C (DIA.)
1/4 H/P	1/4 X .083	1/4 – 28 L.H.	.56	.125
3/8 H/P	3/8 X .125	3/8 – 24 L.H.	.75	.219
9/16 H/P	9/16 X .188	9/16 – 18 L.H.	.94	.281

ALL DIMENSIONS IN INCHES.
*MATERIAL: COLD WORKED 316 S.S.

APPENDIX H

Approved Glands, Collars, and Plugs for use with 137.9 MPa (20,000 psig) rated coned and threaded tube (Autoclave Slimline® and Butech M/P® Type) and tube fittings

Description	Nom. Tube/ Fitting Size (inches)	Butech® Part Number*	Autoclave® Part Number
Gland	1/4	20G4-316	CGLX(40)
Gland	3/8	20G6-316	CGLX(60)
Gland	9/16	20G9-316	CGLX(90)
Gland	3/4	20G12-316	CGLX(120)
Gland	1	20G16-316	CGLX(160)
Collar	1/4	20C4-316	CCLX(40)
Collar	3/8	20C6-316	CCLX(60)
Collar	9/16	20C9-316	CCLX(90)
Collar	3/4	20C12-316	CCLX(120)
Collar	1	20C16-316	CCLX(160)
Plug	1/4	20P4	CPX(40)
Plug	3/8	20P6	CPX(60)
Plug	9/16	20P9	CPX(90)
Plug	3/4	20P12	CPX(120)
Plug	1	20P16	CPX(160)
Anti-Vibration Collet Gland Assembly	1/4	1/4MP AVCG Assembly	KCBGLX40316MC#
Anti-Vibration Collet Gland Assembly	3/8	3/8MP AVCG Assembly	KCBGLX60316MC#
Anti-Vibration Collet Gland Assembly	9/16	9/16MP AVCG Assembly	KCBGLX90316MC#
Anti-Vibration Collet Gland Assembly	3/4	3/4MP AVCG Assembly	KCBGLX120316MC#
Anti-Vibration Collet Gland Assembly	1	1 MP AVCG Assembly	KCBGLX160316MC#

*The -316 suffix on Butech Part Nos. will change when materials other than type 316 stainless steel are used for the part.
#The "316MC" portion of the part number will change when a material other than type 316 stainless steel is used for the part.

APPENDIX H (continued)

Approved Glands, Collars, and Plugs for use with 413.6 MPa (60,000 psig) rated coned and threaded tube (Aminco Superpressure®, Autoclave Slimline® and Butech M/P® Type) and tube fittings

Description	Nom. Tube/ Fitting Size inches)	Butech® Part Number*	Autoclave® Part Number	Aminco Superpressure® Part Number	HIP@ Part Number
Gland	1/4	60G4-316	AGL(40)	45-11314	60-2HM4
Gland	3/8	60G6-316	AGL(60)	45-11334	60-2HM6
Gland	9/16	60G9-316	AGL(90)	45-11364	60-2HM9
Collar	1/4	60C4-316	ACL(40)	45-11317	60-2H4
Collar	3/8	60C6-316	ACL(60)	45-11337	60-2H6
Collar	9/16	60C9-316	ACL(90)	45-11367	60-2H9
Plug	1/4	60P4	AP(40)	45-11320	60-7HM4
Plug	3/8	60P6	AP(60)	45-11340	60-7HM6
Plug	9/16	60P9	AP(90)	45-11370	60-7HM9
Anti-Vibration Collet Gland Assembly	1/4	1/4HP AVCG Assembly	KCGL40 174# or KCGL40 316	- 45-11311	- -
Anti-Vibration Collet Gland Assembly	3/8	3/8HP AVCG Assembly	KCGL60 174# or KCGL60 316	- 45-11331	- -
Anti-Vibration Collet Gland Assembly	9/16	9/16HP AVCG Assembly	KCGL40 174# or KCGL40 316	- 45-11361	- -

*The -316 suffix on Butech Part Numbers will change when materials other than type 316 stainless steel are used for the part.

#The "316" suffix on Autoclave Part Numbers will change when materials other than type 316 stainless steel are used for the part.

@HIP is a registered trademark of the High Pressure Equipment Company.

National Aeronautics and Space Administration
John C. Stennis Space Center
Stennis Space Center, MS 39529-6000

DEVIATION/WAIVER/VARIANCE REQUEST

IMPLEMENTED BY SSC STANDARD 99-016

1. REQUESTER NAME, TITLE, AND ORGANIZATION	2. DATE
Larry DeQuay, Project Manager NASA/SSC Mail Code RA30	8/11/97
	3. CONTRACT NO.
	4. REQUEST NO. 5

5. ☐ DEVIATION ☐ WAIVER XX ☐ VARIANCE

6. ARTICLE	7. I.D. NO.	8. VALID TO *(Date)*
E-1 Test Facility Gas Regulator Panels		Indefinite

9. SPECIFIED REQUIREMENTS

SSC Standard 47-220 Appendix B requires flared tubing used with AN/MS tube fittings to be made of corrosion resistant stainless steel (CRES) conforming to MIL-T-8808 (ASG), MIL-T-8504, or MIL-T-8506. Section 4.0 of this standard makes provisions for use of other materials.

10. DESCRIPTION OF DEVIATION/WAIVER/VARIANCE

In the gas regulator panels on the E-1 Test Facility it is desired to use flared tubing of type 304 stainless steel conforming to ASTM A269.

11. REASON FOR REQUEST

Lead time to procure tubing of material certified to ASTM A269 is 2 to 3 weeks as opposed to a 10 to 12 week procurement lead time for tubing made to military specifications stated in block 9. Cost for ASTM A269 tubing will be approx. $1,200 to $1,600 less than military spec. tubing. (Approximately 400' of tubing will be procured)

12. PROPOSED ACTION TO PREVENT RECURRENCE

SSC Standard 47-220 Appendix B needs to be revised to allow tubing materials fabricated to accepted industry standards, such as ASTM A269 for stainless steels, to comply with agency directives to utilize industry standards in lieu of government standards when the former meets safety and engineering needs and requirements. In this case, tubing that conforms to ASTM A269 Type 304, 304L, 316, 316L, 321, 347, XM-11, and XM-19 should be allowed for tubing with restrictions to permit welded construction only for type 304L, 316, 321, or 347 materials.

DEVIATION/WAIVER/VARIANCE REQUEST (Continued)

IMPLEMENTED BY SSC STANDARD 99-016

13. EFFECT ON PERFORMANCE

There will be no degradation of performance provided that hydrostatic and leakage tests are performed for all tubing systems in accordance with SSC Standard 47-220.

14. EFFECT ON SAFETY/RELIABILITY/MAINTAINABILITY/QUALITY

There will be no detrimental effects to system safety provided that stipulations stated in blocks 12 and 13 are followed.

15. ~~CONTRACTOR~~ SRAQA REPRESENTATIVE *(SIGNATURE)*

M. D. Carroll NASA SAFETY

16. EFFECT ON SCHEDULE

17. CCB-APPROVED CHANGE REQUEST (CR) ATTACHED ☒ YES ☐ NO

18. APPROPRIATE CCB CHAIRPERSON *(SIGNATURE)*

19. FRB NOTICE TO REQUESTER

THIS REQUEST IS: ☒ APPROVED ☐ REJECTED

20. FACILITIES REVIEW BOARD CHAIRPERSON *(SIGNATURE)*

Kathleen Barnett

21. MAIL STOP

2A00

22. DATE

8/20/97

SSC-517 (11/93) (REVERSE) PREVIOUS EDITION OBSOLETE