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SCIENTIFIC AND TECHNICAL INFORMATION

CAMERON STATION, ALEXANDRIA, VIRGINIA



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SEATTLE, WASHINGTON

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ASD (AS 2PA) WPAFB, X-20 Ohio

APPLICATION				PART NUMBER	REV SYM B
NEXT ASSY	USED ON	SECT. NO	SERIAL NUMBER		
25-82674	X-20	-	-	-1	
25-82674	X-20	-	-	-2	

MS 11-99

ONLY THE ITEM(S) LISTED ON THIS DRAWING AND IDENTIFIED BY VENDOR'S NAME(S), ADDRESS(ES), AND PART NUMBER(S), HAVE BEEN TESTED AND APPROVED BY THE BOEING COMPANY FOR USE IN X-20A
A SUBSTITUTE ITEM SHALL NOT BE USED WITHOUT PRIOR TESTING AND APPROVAL BY THE BOEING COMPANY.

SOURCE CONTROL DRAWING

DRAWN <i>NK Burke Jr</i> N. K. Burke, Jr.		DATE 3-5-63		THE BOEING COMPANY AERO-SPACE DIVISION SEATTLE, WASHINGTON	
CHECKED <i>CBH</i>		3-18-63			
STRUCT				NITROGEN PURGE EQUIPMENT, FIRE PROTECTION AND SAFETY SUBSYSTEM	
ENGR <i>NK Burke Jr</i>		3-5-63			
REL <i>W. Howland</i>		3-18-63			
GROUP <i>Emerson</i>		3-15-63			
PROJ <i>JD Meyer</i>		3-19-63		CODE IDENT NO. 81205	SIZE A
				10-81170	
		SCALE		AF 33(657)-7132	SH 1 OF 32

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BHM
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803-20-63
11-3-20-63

REV B

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	23 - 25	A									
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	28 - 33	+									
NITROGEN PURGE EQUIPMENT, FIRE PROTECTION AND SAFETY SUBSYSTEM										10-81170	
										P NO.	4

REVISIONS				REV. B
SYM	DESCRIPTION		DATE	APPROVAL
A Cont'd	Page 34	Revised Paragraph 4.5.7, Rewrote life test to agree with design life requirements of Paragraph 3.1.4.1.		
	Page 34.1	Added Paragraphs 4.5.12 & 4.5.13 from Page 34.		
	Page 37	Revised Paragraph 6.4.2.C, Deleted "Preliminary" and reference "Paragraph 8.1.1."		
	Page 40	Corrected wiring diagram to be compatible with shut-off operation. Revised Bendix connector "SPO-6CE-10-6S reference" was "SPO-6CE-12-10S reference". Added .13 x 45° Chamfer (2 places) to mounting .11 lugs.		
	Page 41	Corrected wiring diagram to be compatible with dual heaters. Added Bendix connector "SPO6CE 8-4S reference" Redimensioned mounting lug thickness ".65 ± .02" was ".25 maximum." Revised all internal radii. ".50 R" was ".25 R maximum." Revised Notes 5 and 6. Added Notes 7 and 8.		
	Page 46	Revised flow requirement tolerances: + 20, -0% was ± 20%.		
	Page 47	Deleted Figure 9.		
	Page 48	Deleted Figure 10.		
	Page 49	Deleted reference to Figure 10 in Detail "A". Added water wall Detail "B". CHANGE COVERED BY BO-2-9500	8-8-3	89 RWS 8-6-63
B	Page 1	Changed total pages from "51" to "52."		
	Page 8	Added Figure 14 to Index of Figures.		
	Page 4	Recorded Revision "B" pages and changes.		
	Page 18	Revised Paragraph 3.1.4.3.1, "1480°F for -2" was "950°F for -2".		
	Page 26	Revised Paragraph 3.3.3.2.1 for clarity. Revised Paragraph 3.3.3.2.4, Specified Figure 14 for water wall surface emissivity.		
	Pages 5.1, 5.2	Added description of Revision "B".		
NITROGEN PURGE EQUIPMENT, FIRE PROTECTION AND SAFETY SUBSYSTEM		CODE IDENT NO. 81205	SIZE A	10-81170
		SCALE	AF 33(657)-7132	SH 5.1

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8-6-63

REVISIONS						REV. B
SYM	DESCRIPTION			DATE	APPROVAL	
B Cont'd	Page 27	Revised Paragraph 3.3.4.3.4, Revised temperatures and time period.		9-9-63	<i>[Signature]</i>	
		Added Paragraph 3.3.4.6.1, Specified requirements for ground and B-52 electrical operation.		9-9-63	<i>[Signature]</i>	
		Added Paragraph 3.3.4.6.2, Specified requirements for aerodynamic heating.		9-11-63	<i>[Signature]</i>	
	Page 52	Added Figure 14, Emissivity of Hastelloy vs. Temperature.				
	CHANGE COVERED BY BO-2-9500			9-12	<i>[Signature]</i>	

CODE IDENT NO. 81205 SIZE A 10-81170

SCALE AF 33(657)-7132 SH 5.2

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2	Envelope, Valve Assembly, Nitrogen Purge
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4	Preliminary Sinusoidal Vibration Test Envelope
5	Random Vibration Test Envelope
6	Substitute Sine Test Envelope
7	Acoustic Design Environment, Internal, Equipment Bay
8	Flow Rate Vs. Pressure Rate
9	DELETED
10	DELETED
11	Surrounding Structure
12	Example Page Design Check List
13	Acoustic Design Environment, External, Equipment Bay
14	Emissivity of Hastelloy vs. Temperature

CODE IDENT NO. 81205	SIZE 	10-81170
SCALE	AF33(657)-7132	SH 8

3.1.4.3 Environment - The equipment shall be capable of satisfactory performance after exposure to any combination of the following transportation and storage conditions and during exposure to any combination of the following flight conditions:

		Transportation and Storage Conditions	Flight Operation Conditions
3.1.4.3.1	<u>Temperature</u>	-65°F to 160°F	-65°F to 220°F for -1 -65°F to 148°F for -2
3.1.4.3.2	<u>Humidity</u>	0 to 100% including condensation	0 to 100% including condensation
3.1.4.3.3	<u>Pressure</u>	Sea Level to 50,000 Ft. Altitude	Approximately 0 to 15 psia
3.1.4.3.4	<u>Vibration</u>	No Requirement	See Figure 5
3.1.4.3.5	<u>Acceleration</u>	No Requirement	Sustained 2 minutes glider acceleration as follows: Forward 7.0G Aft 2.2G Up 4.5G Down 1.1G Lateral ±1.5G
3.1.4.3.6	<u>Shock</u>		
3.1.4.3.6.1	<u>Normal Shock</u>	Drop per paragraph 5.3	3G for 15 milliseconds duration maximum.
3.1.4.3.6.2	<u>Crash Shock</u>	No Requirement	Glider acceleration for 12 milliseconds maximum as follows: Forward None Aft 20G ±20° Detonated Up 10G Down 5G Lateral ±6.9G ±18.8G Aft
3.1.4.3.7	<u>Acoustics</u>	No Requirement	See Figure 7 for -1 See Figure 7 for -2
3.1.4.3.8	<u>Attitude</u>	Any Attitude	Any Attitude
3.1.4.3.9	<u>Explosive Atmosphere</u>	No Requirement	Stoichiometric mixtures of hydrogen and oxygen.

As packaged for transportation and storage

CODE IDENT NO. 81205	SIZE A	10-81170
SCALE	AF 55(657)-7132	SH 18

3.3.3 Construction

3.3.3.1 Pressure - The design pressure of the -2 heater shall be as required to meet the requirements of the -1 valve assembly and the purging requirements of the Secondary Power Bay and the unpressurized Equipment Bay.

3.3.3.2 Emissivity

3.3.3.2.1 The emissivity of all surfaces of the -2 heater, except that surface specified in Paragraph 3.3.3.2.2, shall not exceed 0.1 at -2 heater temperatures below 950°F.

3.3.3.2.2 The emissivity of the bottom surface of the -2 heater facing the corrugated surface as shown in Figure 11 shall be as required to comply with the performance requirements of Paragraph 3.3.4.

3.3.3.2.3 The emissivity of all Rene 41 surfaces seeing the -2 heater as shown in Figure 11 is 0.70.

3.3.3.2.4 The emissivity of the water wall surface facing the -2 heater will be as noted in Figure 14.

3.3.3.3 Temperature Switch - Deleted

CODE IDENT NO. 81205	SIZE A	10-81170
SCALE	AF 33(657)-7132	SH 26

3.3.4 Performance

3.3.4.1 The performance of the -2 heater shall be as specified in the following paragraphs.

3.3.4.2 Pressure Drop - Deleted

3.3.4.3 Electrical Power Consumption - The total electrical power consumption of the -2 heater shall not exceed 300 watts for ground heating requirements.

The -2 heater shall be capable of operating within the power requirements of Paragraph 3.1.2.10.

3.3.4.3.4 Temperature - The temperature of the inside radiating surface under the -2 heater shall approximate a linear increase of 270°F to 1380°F throughout a period of 34 minutes.

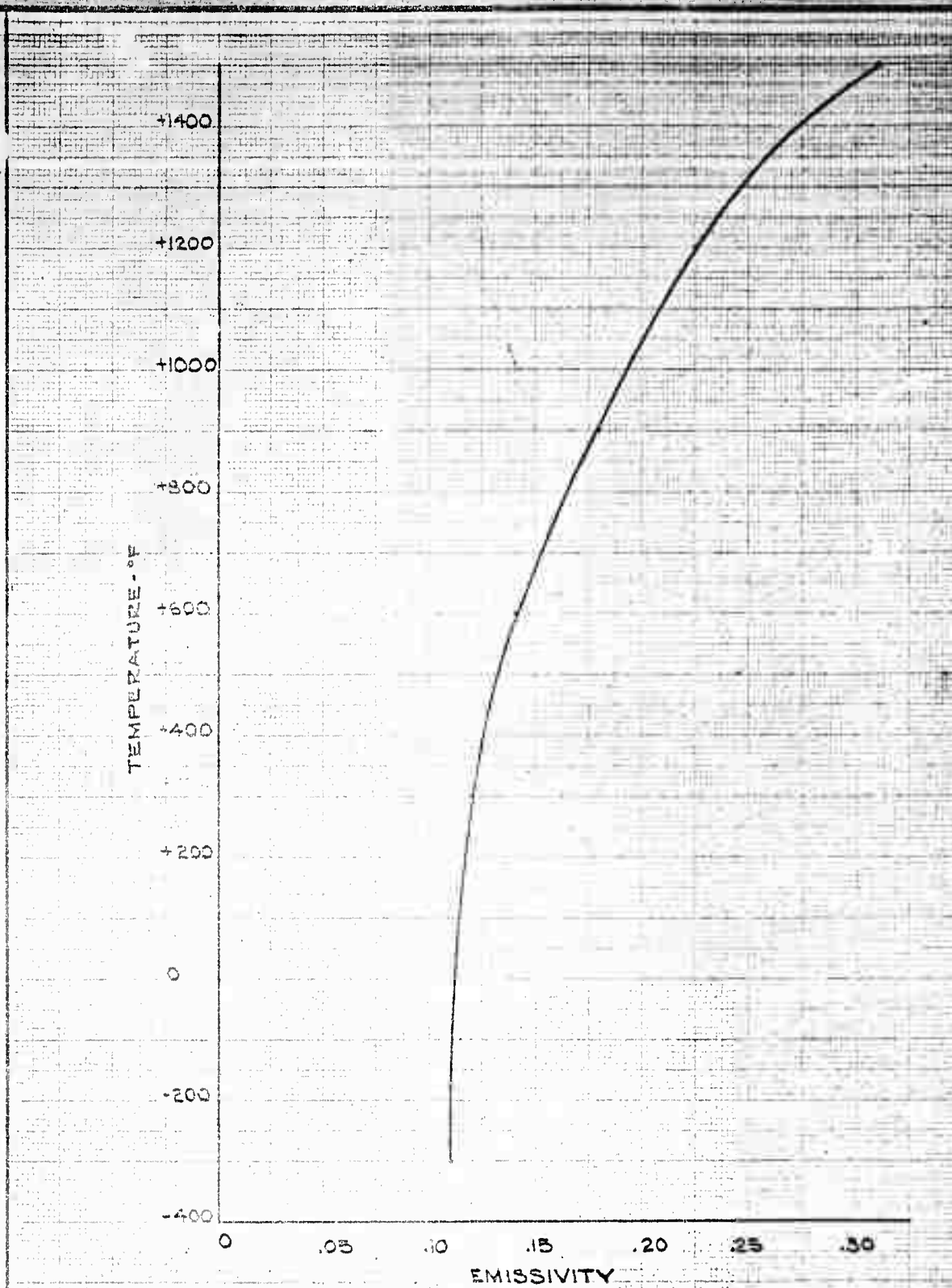
3.3.4.5 Surrounding Structure - The location of structure surrounding the -2 heater will be as shown in Figure 11.

3.3.4.6 Heat Storage Capacity - The minimum heat storage capacity of the -2 heater above an 100°F reference temperature shall be 2800 Btu for vaporization of liquid nitrogen during normal inflight operation after re-entry.

3.3.4.6.1 The minimum heat storage capacity of the -2 heater above a 100°F reference temperature shall be 2800 Btu during ground electrical operation prior to lift-off or during B-52 electrical operation prior to the air drop.

3.3.4.6.2 The -2 heater shall be capable of accumulating 1600 Btu above a 0°F reference temperature as a result of the aerodynamic heating of re-entry.

CODE IDENT NO. 81205	SIZE A	10-81170
SCALE	AF 33(657)-7132	SH 27



CALC	NKB	9-4-3	REVISED	DATE	EMISSIVITY OF HASTELLOY VS TEMPERATURE	10-81170
CHECK						FIG. 14
APR						PAGE
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ASD(CAS2RA)WPAFB, X-20 Ohio

APPLICATION				PART NUMBER	REV SYM B
NEXT ASSY	USED ON	SECT. NO	SERIAL NUMBER		
25-82674	X-20	-	-	-1	
25-82674	X-20	-	-	-2	

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ONLY THE ITEM(S) LISTED ON THIS DRAWING AND IDENTIFIED BY VENDOR'S NAME(S), ADDRESS(ES), AND PART NUMBER(S), HAVE BEEN TESTED AND APPROVED BY THE BOEING COMPANY FOR USE IN X-20A. A SUBSTITUTE ITEM SHALL NOT BE USED WITHOUT PRIOR TESTING AND APPROVAL BY THE BOEING COMPANY.

SOURCE CONTROL DRAWING

DRAWN N K Burke Jr. N. K. Burke, Jr.		DATE 3-5-63	THE BOEING COMPANY AERO-SPACE DIVISION SEATTLE, WASHINGTON		
CHECKED C. B. Hines		DATE 3-18-63			
DESIGNED N. K. Burke Jr.		DATE 3-5-63	NITROGEN PURGE EQUIPMENT, FIRE PROTECTION AND SAFETY SUBSYSTEM		
CHECKED R. J. Howland		DATE 3-18-63			
APPROVED Embreyman		DATE 2-15-63			
PROJ JP Meyer		DATE 3-18-63	CODE IDENT NO. 81205	SIZE A	10-81170
		SCALE	AF 33(657)-7132	SH	1 OF 32

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LIST OF ACTIVE PAGES AND CHANGE RECORD

ACTIVE PAGES			CHANGE RECORD			ACTIVE PAGES			CHANGE RECORD		
REV	PAGE NUMBERS	ISSUE	REVISED	ADDED	DELETED	REV	PAGE NUMBERS	ISSUE	REVISED	ADDED	DELETED
+	1 - 51, 34.1					B	34, 34.1	A			
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	2, 3	+					37	A			
	4, 5, 5.1	A	4, 5	5.1			38, 39	+			
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	8	A	8				42 - 45	+			
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REVISIONS				REV. B
SYM	DESCRIPTION		DATE	APPROVAL
A Cont'd	Page 34	Revised Paragraph 4.5.7, Rewrote life test to agree with design life requirements of Paragraph 3.1.4.1.		
	Page 34.1	Added Paragraphs 4.5.12 & 4.5.13 from Page 34.		
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	B	Page 1	Changed total pages from "51" to "52."	
Page 8		Added Figure 14 to Index of Figures.		
Page 4		Recorded Revision "B" pages and changes.		
Page 18		Revised Paragraph 3.1.4.3.1, "1480°F for -2" was "950°F for -2".		
Page 26		Revised Paragraph 3.3.3.2.1 for clarity. Revised Paragraph 3.3.3.2.4, Specified Figure 14 for water wall surface emissivity.		
	Pages 5.1, 5.2	Added description of Revision "B".		
NITROGEN PURGE EQUIPMENT, FIRE PROTECTION AND SAFETY SUBSYSTEM		CODE IDENT NO. 81205	SIZE A	10-81170
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REVISIONS			REV. B											
SYM	DESCRIPTION	DATE	APPROVAL											
B Cont'd	Page 27 Revised Paragraph 3.3.4.3.4, Revised temperatures and time period. Added Paragraph 3.3.4.6.1, Specified requirements for ground and B-52 electrical operation. Added Paragraph 3.3.4.6.2, Specified requirements for aerodynamic heating. Page 52 Added Figure 14, Emissivity of Hastelloy vs. Temperature. CHANGE COVERED BY BO-2-9500	9/9/63 9-9-63 9-11-63 9-12	<i>[Signature]</i> <i>[Signature]</i> <i>[Signature]</i> <i>[Signature]</i>											
<table border="1"> <tr> <td colspan="2">CODE IDENT NO. 81205</td> <td>SIZE A</td> <td colspan="2">10-81170</td> </tr> <tr> <td colspan="2">SCALE</td> <td>AF 33(657)-7132</td> <td>SH</td> <td>5.2</td> </tr> </table>					CODE IDENT NO. 81205		SIZE A	10-81170		SCALE		AF 33(657)-7132	SH	5.2
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SCALE		AF 33(657)-7132	SH	5.2										

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8	Flow Rate Vs. Pressure Rate
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11	Surrounding Structure
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CODE IDENT NO. 81205	SIZE 	10-81170
SCALE	AF 33(657)-7132	SH 8

3.1.4.3 Environment - The equipment shall be capable of satisfactory performance after exposure to any combination of the following transportation and storage conditions and during exposure to any combination of the following flight conditions:

		Transportation and Storage Conditions	Flight Operation Conditions
3.1.4.3.1	<u>Temperature</u>	-65°F to 160°F	-65°F to 220°F for -1 -65°F to 148°F for -2
3.1.4.3.2	<u>Humidity</u>	0 to 100% including condensation	0 to 100% including condensation
3.1.4.3.3	<u>Pressure</u>	Sea Level to 50,000 Ft. Altitude	Approximately 0 to 15 psia
3.1.4.3.4	<u>Vibration</u>	No Requirement	See Figure 5
3.1.4.3.5	<u>Acceleration</u>	No Requirement	Sustained 2 minutes glider acceleration as follows: Forward 7.0G Aft 2.2G Up 4.5G Down 1.1G Lateral ±1.5G
3.1.4.3.6	<u>Shock</u>		
3.1.4.3.6.1	<u>Normal Shock</u>	Drop per paragraph 5.3	3G for 15 milliseconds duration maximum.
3.1.4.3.6.2	<u>Crash Shock</u>	No Requirement	Glider acceleration for 12 milliseconds maximum as follows: Forward None Aft 20G Up 10G Down 5G Lateral ±6.9G ±18.8G Aft
3.1.4.3.7	<u>Acoustics</u>	No Requirement	See Figure 7 for -1 See Figure 13 for -2
3.1.4.3.8	<u>Attitude</u>	Any Attitude	Any Attitude
3.1.4.3.9	<u>Explosive Atmosphere</u>	No Requirement	Stoichiometric mixtures of hydrogen and oxygen.

▷ As packaged for transportation and storage

CODE IDENT NO. 81205	SIZE A	10-81170
SCALE	AF 55(657)-7132	SH 18

3.3.3 Construction

3.3.3.1 Pressure - The design pressure of the -2 heater shall be as required to meet the requirements of the -1 valve assembly and the purging requirements of the Secondary Power Bay and the unpressurized Equipment Bay.

3.3.3.2 Emissivity

3.3.3.2.1 The emissivity of all surfaces of the -2 heater, except that surface specified in Paragraph 3.3.3.2.2, shall not exceed 0.1 at -2 heater temperatures below 950°F. B
X

3.3.3.2.2 The emissivity of the bottom surface of the -2 heater facing the corrugated surface as shown in Figure 11 shall be as required to comply with the performance requirements of Paragraph 3.3.4.

3.3.3.2.3 The emissivity of all Rene 41 surfaces seeing the -2 heater as shown in Figure 11 is 0.70.

3.3.3.2.4 The emissivity of the water wall surface facing the -2 heater will be as noted in Figure 14. B

3.3.3.3 Temperature Switch - Deleted

CODE IDENT NO. 81205	SIZE 	10-81170
SCALE	AF 33(657)-7132	SH 26

3.3.4 Performance

3.3.4.1 The performance of the -2 heater shall be as specified in the following paragraphs.

3.3.4.2 Pressure Drop - Deleted

3.3.4.3 Electrical Power Consumption - The total electrical power consumption of the -2 heater shall not exceed 300 watts for ground heating requirements.

The -2 heater shall be capable of operating within the power requirements of Paragraph 3.1.2.10.

3.3.4.3.4 Temperature - The temperature of the inside radiating surface under the -2 heater shall approximate a linear increase of 270°F to 1380°F throughout a period of 34 minutes.

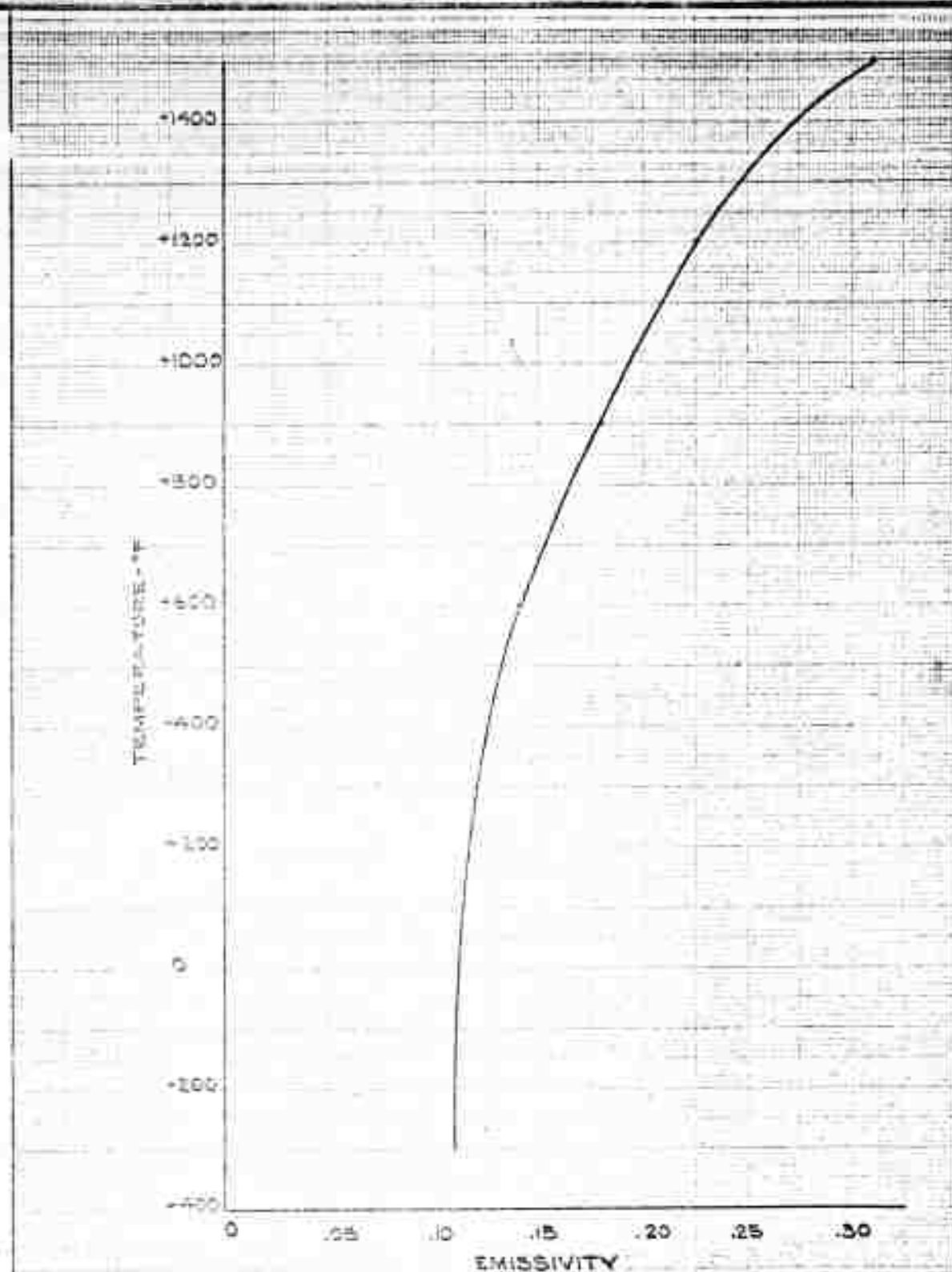
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3.3.4.6.1 The minimum heat storage capacity of the -2 heater above a 100°F reference temperature shall be 2800 Btu during ground electrical operation prior to lift-off or during B-52 electrical operation prior to the air drop.

3.3.4.6.2 The -2 heater shall be capable of accumulating 1600 Btu above a 0°F reference temperature as a result of the aerodynamic heating of re-entry.

CODE IDENT NO. 81205	SIZE A	10-81170
SCALE	AF 33(657)-7132	SH 27



CALC	NKB	REVISED	DATE	EMISSION OF HASTELLOY VS TEMPERATURE	10-81170
CHECK					FIG. 14
APP					PAGE
APP					52
					THE BOEING COMPANY

REV
SYM +

1	10-81170-2	Heater			
1	10-81170-1	Valve Assembly			
REQD	PART OR IDENTIFYING NUMBER	NOMENCLATURE OR DESCRIPTION	MATERIAL	MATERIAL SPEC	WT
LIST OF MATERIAL					
NITROGEN PURGE EQUIPMENT, FIRE PROTECTION AND SAFETY SUBSYSTEM		CODE IDENT NO. 81205	SIZE A	10-81170	
		SCALE	AF 33(657)-1132		SH 3

REV A

LIST OF ACTIVE PAGES AND CHANGE RECORD

ACTIVE PAGES			CHANGE RECORD			ACTIVE PAGES			CHANGE RECORD		
REV	PAGE NUMBERS	ISSUE	REVISED	ADDED	DELETED	REV	PAGE NUMBERS	ISSUE	REVISED	ADDED	DELETED
+	1 - 51, 34.1										
A	1 2, 3 4, 5, 5.1 6, 7 8 9 10, 11 12 13 14 15 16, 17 18 19 20, 21 22 23 - 27 28 - 33 34, 34.1 35, 36 37 38, 39 40, 41 42 - 45 46 - 49 50 - 51	A + A + A + A + A + A + A + A + A + A + A + A + A +	1 4, 5 8 10, 11 13 15 18 20, 21 23-27 34, 34.1 37 40, 41 46-49	5.1							
NITROGEN PURGE EQUIPMENT, FIRE PROTECTION AND SAFETY SUBSYSTEM						10-81170 P NO. 4					

REVISIONS				A
SYM	DESCRIPTION		DATE	APPROVAL
A	Page 8	Revised Index of Figures, Deleted Figures 9 and 10.	8-6-63	NK Burke
	Page 10	Revised Paragraph 2.2, Deleted 10-81006 and BAC 5902.	8-6-63	CF [Signature] RELIABILITY
	Page 11	Revised last paragraph of Paragraph 3.1.1.1.D. "Nitrogen atmosphere" was "slight positive pressure."	8-6-63	ES, [Signature]
	Page 13	Revised Paragraph 3.1.2.17, Clarified wiring schematic to be applicable to the -1 valve assembly only.	8-7-63	Em [Signature]
	Page 15	Revised Paragraph 3.1.2.17, Added coil temperature rise exception to MII-S-4040 Type I.		88-9-63 P+8-9-63
	Page 18	Revised Paragraph 3.1.4.3.1, "950°F for -2" was "1075°F for -2."		
	Page 20	Revised Paragraph 3.2.1.c, "Nitrogen atmosphere" was "slight positive pressure."		
	Page 21	Revised Paragraph 3.2.2.3, Deleted reference to Figure 9.		
	Page 23	Deleted Paragraph 3.2.4.2. Revised Paragraph 3.2.4.5, Added maximum back pressure requirements of the distribution tubing. Revised Paragraph 3.2.4.7, Clarified shut-off operation with respect to glider power and ground power.		
	Page 24	Corrected Paragraph 3.3.1.A, "Purging" was "puring."		
	Page 25	Deleted Paragraph 3.3.2.4, "Flow Direction."		
	Page 26	Revised Paragraph 3.3.3.2.4, Clarified temperature range of water wall surface emissivity. Deleted Paragraph 3.3.3.3, "Temperature Switch."		
	Page 27	Deleted Paragraph 3.3.4.2, "Pressure Drop." Revised Paragraph 3.3.4.3.4, Clarified temperature range of radiating surface. Revised Paragraph 3.3.4.3.5, "100°F reference temperature" was "100°F reference temperature."		
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REVISIONS				
SYM	DESCRIPTION		DATE	APPROVAL
A Cont'd	Page 34	Revised Paragraph 4.5.7, Rewrote life test to agree with design life requirements of Paragraph 3.1.4.1.		
	Page 34.1	Added Paragraphs 4.5.12 & 4.5.13 from Page 34.		
	Page 37	Revised Paragraph 6.4.2.C, Deleted "Preliminary" and reference "Paragraph 8.1.1."		
	Page 40	Corrected wiring diagram to be compatible with shut-off operation. Revised Bendix connector "SPO-6CE-10-6S reference" was "SPO-6CE-12-10S reference" Added .13 x 45° Chamfer (2 places) to mounting .11 lugs.		
	Page 41	Corrected wiring diagram to be compatible with dual heaters. Added Bendix connector "SPO6CE 8-4S reference" Redimensioned mounting lug thickness ".65 ± .02" was ".25 maximum." Revised all internal radii. ".50 R" was ".25 R maximum." Revised Notes 5 and 6. Added Notes 7 and 8.		
	Page 46	Revised flow requirement tolerances: + 20, -0% was ± 20%.		
	Page 47	Deleted Figure 9.		
	Page 48	Deleted Figure 10.		
	Page 49	Deleted reference to Figure 10 in Detail "A". Added water wall Detail "B". CHANGE COVERED BY BO-2-9500	8-8-3	<i>PH 89</i> <i>RWS</i> <i>BM 8-6-63</i>
NITROGEN PURGE EQUIPMENT, FIRE PROTECTION AND SAFETY SUBSYSTEM		CODE IDENT NO. 81205	SIZE A	10-81170
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1.0

SCOPE

1.1 General - This specification covers the design, development, performance, and testing requirements of the Nitrogen Purge Equipment which is a part of the Fire Protection and Safety Subsystem of the X-20 glider.

1.2 Intended Use - The Nitrogen Purge Equipment is utilized to provide a controlled flow of gaseous nitrogen within the Secondary Power Bay and the unpressurized Equipment Bay to prevent a flammable mixture of hydrogen and air from forming during final glider descent.

The Nitrogen Purge Equipment is provided with a means of vaporizing liquid nitrogen used for purging. The equipment is also used for descent after air launch from the B-52 and descent after a boost abort.

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2.0

APPLICABLE DOCUMENTS

2.1 Government - The following documents of the issue and revisions noted form a part of this specification to the extent specified herein. Where conflicting requirements exist, the requirements of this specification shall govern.

MIL-I-26600 Interference Control Requirements,
Aeronautical Equipment, 17 June 1959

MIL-E-5272C Environmental Testing, Aeronautical and Associated
Equipment, General Specification for, 20 January 1960

MIL-P-27401A Propellant, Nitrogen, Pressurizing, 7 November 1960

MIL-S-4040C Solenoid, Electrical, General Specification for,
23 January 1958

MS-33540C Safety Wiring, General Practices for,
17 March 1959

MS-33586 Metals, Definition of Dissimilar,
16 December 1958

2.2 Boeing - The following documents and drawings of the issue established by the purchase order form a part of this specification to the extent specified herein. Where conflicting requirements exist, the requirements of this specification shall govern.

D2-7391 Specification, Characteristics of Glider Electric
Power and General Requirements for Load Equipment

D2-80396 General Requirements Document for Dyna-Soar Source
Control Drawings and Design Procurement Specifications

BAC N18U Fitting End - Self Flaring Fitting Standard Dimensions
For

BAC 5739 Cleaning of Contamination Sensitive Parts

DM 70 Section 14, "Protective Finish", Boeing Design Manual

10-81006 DELETED Insulation Electric Wire - Insulate, Wet 1
Sheet (1000°F)

BAC 5902 DELETED
BAC 5902 Brazing with Nickel and Job at 1000°F

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SCALE	AF 33(697)-7232	SH 10

3.0

REQUIREMENTS

3.1

Nitrogen Purge Equipment

3.1.1 General - Data, interchangeability, selection of standards and specifications, materials and processes, workmanship and reliability requirements shall be as specified in Document D2-80396, "General Requirements Document for Dyna-Soar Source Control Drawings and Design Procurement Specifications" dated April 4, 1962, except as noted in Section 6.0 of this specification.

3.1.1.1 Description - With reference to Figure 1, the nitrogen purge equipment provides for the following:

- A. Shut-Off Control for Purge Operation
- B. Vaporization of Liquid Nitrogen for Purge Operation
- C. Temperature Control of Nitrogen Purging Gas for Purge Operation
- D. Flow Control of Nitrogen Purging Gas for Purge Operation

A system shut-off valve is opened electrically allowing cryogenic nitrogen to flow through the purge system until de-energized after touchdown.

Vaporization of liquid nitrogen for normal inflight operation is assured by a heater located between the water wall and outside structure. The heater absorbs energy by radiation heat transfer from the outside structure prior to purge operation during re-entry.

For the air launch and a boost abort situation the heater utilizes electrical energy for the necessary storage heat to vaporize the cryogenic nitrogen passing through the system.

A temperature control function is provided to assure that gaseous nitrogen will enter the Secondary Power Bay and the unpressurized Equipment Bay within a controlled temperature range.

A flow control function is provided for nitrogen purge flow control during descent. The system will sense the rate of pressure increase and automatically control the flow rate of nitrogen entering the Secondary Power Bay and the unpressurized Equipment Bay in order to assure a ~~nitrogen atmosphere~~ within the bay for any flight profile of the X-20 glider.

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3.1.1.1.1 Components - The Nitrogen Purge Equipment shall consist of the following components:

<u>Nomenclature</u>	<u>Part No.</u>	<u>Para. No.</u>
Valve Assembly, Nitrogen Purge	10-81170-1	3.2
Heater, Nitrogen Purge	10-81170-2	3.3

3.1.1.2 Development - The vendor shall accomplish the design development work necessary to assure that the design meets the requirements of this specification. Design development efforts shall include investigation prior to hardware design to provide a sound basis for the design effort. Development during and after the design stage shall be required to solve the detail problems associated with the design and to check and improve design practicability.

Boeing and the vendor are required by the Air Force to report in full on the development work done and the technological information and discoveries accruing from the development work. All phases of development effort, e.g., system concept, new analysis methods, testing, manufacturing processes shall be covered. All development shall have as its purpose the furnishing of hardware for the X-20 program.

3.1.1.3 Design Responsibility -

3.1.1.3.1 System Effort - The vendor shall perform the necessary study and analysis to assure that the proposed nitrogen purge equipment represents a good technical solution to the X-20 requirements and will function as defined in this specification when they are operated in the integrated nitrogen purge subsystem.

3.1.1.3.2 Configuration Development - The vendor shall perform the necessary design, development, fabrication and testing activities to establish and prove the configuration of the components meeting the requirements of this specification, when operated individually and collectively in the Fire and Safety Subsystem.

3.1.1.3.3 Coordination and Approval - The configuration reflecting the design that best meets the requirements of this specification as determined by analysis and test shall be coordinated with Boeing. Approval of a configuration shall in no way relieve the vendor of the requirements as set forth in paragraphs 3.1.1.3.1 and 3.1.1.3.2 above.

3.1.1.4 Qualification - This specification makes provision for qualification testing.

3.1.1.5 Envelope - Envelope limits, and mounting and interconnection provisions for the nitrogen purge equipments shall be as shown on Figure 2 for the -1 valve assembly and Figure 3 for the -2 heater.

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3.1.2 Design

3.1.2.1 Fail-Safe Design - Each component shall be designed so that failure shall cause the minimum impairment of system operation. No single failure shall result in a lower degree of pilot safety. As a design objective failure of the -1 valve assembly or the -2 heater shall not cause depletion of the nitrogen storage tank.

3.1.2.2 Plumbing Connections - Precision super-finish close-tolerance MIL-Flo fittings per BAC-N18U shall be utilized on all conventional internal plumbing connections. External connections shall be as specified on the envelope drawings per Figures 2 and 3. On all other plumbing connections the connection most suitable for the application shall be used. Reliability, minimum leakage, low weight, and the capability of disconnect and reconnect shall be considered in selecting the connection to be used. In no case shall pipe threads be used.

3.1.2.3 Leakage - Leakage shall be kept to a minimum. As a design objective, the leakage shall be zero.

3.1.2.4 Electrical Connections - All electrical connections which interface with Boeing wiring shall terminate in an electrical receptacle which mates with a Bendix SP06CE__S Pygmy bayonet type plug. All electrical connectors shall be Bendix Pygmy connectors. All internal connections shall be mechanically and electrically sound.

3.1.2.5 Calibration Adjustments - Any calibration (non-operating) adjustments shall be firmly secured to prevent shifts. Calibration adjustments shall be clearly indicated.

3.1.2.6 Lubrication - Lubrication requirements shall be held to a minimum consistent with performance and other requirements of this source control drawing. If periodic lubrication is required, provisions shall be made for easy, controlled application at infrequent intervals.

3.1.2.6.1 Solid firm dry lubricant may be used in areas exposed to cryogenic fluids if qualified for use with the applicable cryogen. Dry film lubricant in direct contact with cryogen must be unaffected by exposure to the cryogen and shall remain effective for the entire life of the equipment. In addition, the lubricant shall not cause contamination of the cryogen which would cause purge equipment failures.

3.1.2.7 Wiring Schematic - Where size and configuration permit, a durable schematic-wiring diagram shall be permanently attached to the -1 valve assembly. The material which the schematic is made of must be compatible with the equipment and its environment during operation.

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3.1.2.8 Condensation - All units shall be designed to minimize internal and external water vapor condensation. Where elimination of water vaporization is not practicable, provision for removal by purging or draining shall be made. Condensation of water vapor either as moisture or ice shall not impair operation.

3.1.2.9 Weight - The weight of the equipment shall be a minimum consistent with the performance requirements and within the limitations of sound design practices. In no case shall the equipment weight's exceed the following:

<u>Nomenclature</u>	<u>Part No.</u>	<u>Weight</u>
Valve Assembly	10-81170-1	} 18 lbs Total
Heater	10-81170-2	

3.1.2.10 Electrical Power - Electrical power from the glider shall be used to meet the electrical requirements of Sections 3.2 only. Equipment utilizing glider electrical power shall conform to the requirements of Section 4 of D2-7391, "Specification, Characteristics of Glider Power and General Requirements for Load Equipment."

10-124V
Electrical power from the ground or the B-52 shall be used to meet the electrical requirements of Section 3.3 only. Ground electrical power is 115V - single phase - 60 CPS. B-52 electrical power is 115 V - single phase - 400 CPS. CONFORMING TO D2-7391 THRU 3.2.2.11 LINE

3.1.2.11 Grounds - All electrical equipment shall be free of internal grounds. All grounds shall be brought out of and insulated from the case to provide for connection externally to an appropriate ground.

3.1.2.12 Seals - As a design objective, a minimum of two (2) seals in series shall be used on every potential leakage path.

3.1.2.13 Positive Locking Devices - The loosening of screw type hardware under conditions of vibrations, shall not occur. Positive locking of screw type hardware on the unit shall be employed where practicable. Safety wiring, in accordance with MS-33540, shall be used where other types of positive locking devices are not employed.

3.1.2.14 Dissimilar Metals - Dissimilar metals in contact shall be avoided unless adequately protected against galvanic corrosion. Dissimilar metals shall be defined in MS-33586.

3.1.2.15 Dielectric Strength - The insulation and spacing of the circuitry in the equipment defined by this specification shall be capable of withstanding without breakdown, the following 60 CPS voltages between current carrying circuits and any non-current carrying part which may be grounded:

- Circuits of 50 volts or less: 500 volts RMS for one minute.
- Circuits over 50 volts: Twice rated voltage plus 1000 volts RMS for one minute.

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3.1.2.16 Finish - As a design objective, organic or other potentially hazardous finishes shall not be used. Where finishes are required, consideration shall be given to the use of finishes which have a temperature capability equal to or greater than that of the material to which they are applied, and in no case lower than that temperature the equipment may reach under failed conditions.

The finishes to be used on the nitrogen purge equipment shall be submitted to Boeing for approval. Finishes in Section 14, Book 70, D-5000 may be used as a design guide.

3.1.2.17 Solenoids - All solenoids shall conform to the requirements of MIL-S-4040 Type II, except the coil temperature rise shall be permitted to exceed 185°F (85°C). However, this temperature must not cause deterioration or damage to the solenoid.

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3.1.3 Construction - The construction of the nitrogen purge equipment shall be adequate to obtain the required performance.

3.1.3.1 Pressures - Equipment manufactured per the requirements of this specification shall be designed for the following working, proof and burst pressures as specified:

INLET TO -1 VALVE ASSEMBLY (PT. "A")

Working Pressure: 50 to 230 psig
Proof Pressure: 345 psig
Burst Pressure: 575 psig

INTERNAL TO -1 VALVE ASSEMBLY

Working Pressure: As Required
Proof Pressure: 1.5 x Max. Working Pressure
(psig)
Burst Pressure: 2.5 x Max. Working Pressure
(psig)

INTERNAL TO -2 HEATER

Working Pressure: As Required
Proof Pressure: 1.5 x Max. Working Pressure
(psig)
Burst Pressure: 2.5 x Max. Working Pressure
(psig)

3.1.3.2 Cleanliness - The cleaning process for surface in contact with cryogenics shall be in accordance with BAC 5739 or an approved vendor cleaning process. The cleanliness shall be such that operation of the equipment throughout its required life shall not be impaired.

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3.1.4 Performance3.1.4.1 Life

3.1.4.1.1 Flight Conditions - The equipment shall have a 10 hour useful life under flight conditions. Flight operation time may be accumulated in 30 minute increments distributed throughout a period of four years.

3.1.4.1.2 Ground Conditions - The unit shall have a 100 hour useful life under ground conditions. Ground test time may be accumulated randomly in 10 hour increments distributed throughout a period of four years.

3.1.4.1.3 Cyclic Life - All valves shall be capable of being cycled between atmospheric and working pressure 500 times. In addition, all valves shall be capable of being cycled open and closed 500 times.

3.1.4.1.4 Storage Life - Storage life shall be one year. The total accumulated storage and operating life capability shall be five years.

3.1.4.1.4.1 Elastomers - Elastomers, if used, shall have a total accumulated storage and operating life capability of two years from the date of manufacture and shall have a replacement schedule.

3.1.4.2 Reliability - Except as modified or deleted by paragraph 6.7 of this specification, requirements of D2-80396, Section 7.0 and 8.0 shall be met. The design reliability requirements of the combined nitrogen purge equipment which is comprised of the -1 valve assembly and the -2 heater shall be 15,000 MTBF  .

 MTBF is mean-time-between-failure in hours

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3.1.4.3 Environment - The equipment shall be capable of satisfactory performance after exposure to any combination of the following transportation and storage conditions and during exposure to any combination of the following flight conditions:

		Transportation and Storage Conditions	Flight Operation Conditions
3.1.4.3.1	<u>Temperature</u>	-65°F to 160°F	-65°F to 220°F for -1 -65°F to 950°F for -2
3.1.4.3.2	<u>Humidity</u>	0 to 100% including condensation	0 to 100% including condensation
3.1.4.3.3	<u>Pressure</u>	Sea Level to 50,000 Ft. Altitude	Approximately 0 to 15 psia
3.1.4.3.4	<u>Vibration</u>	No Requirement	See Figure 5
3.1.4.3.5	<u>Acceleration</u>	No Requirement	Sustained 2 minutes glider acceleration as follows: Forward 7.0G Aft 2.2G Up 4.5G Down 1.1G Lateral ±1.5G
3.1.4.3.6	<u>Shock</u>		
3.1.4.3.6.1	<u>Normal Shock</u>	Drop per paragraph 5.3	3G for 15 milliseconds duration maximum.
3.1.4.3.6.2	<u>Crash Shock</u>	No Requirement	Glider acceleration for 12 milliseconds maximum as follows: Forward None Aft 20G Up 10G Down 5G Lateral ±6.9G ±18.8G Aft
3.1.4.3.7	<u>Acoustics</u>	No Requirement	See Figure 7 for -1 See Figure 13 for -2
3.1.4.3.8	<u>Attitude</u>	Any Attitude	Any Attitude
3.1.4.3.9	<u>Explosive Atmosphere</u>	No Requirement	Stoichiometric mixtures of hydrogen and oxygen.

As packaged for transportation and storage

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3.1.4.3.10 Zero Gravity Operation - The shutoff function within the -1 valve assembly shall be capable of satisfactory operation in a zero gravity environment.

3.1.4.3.11 Radio Noise - The equipment shall comply with the requirements of MIL-1-26600.

3.1.4.3.12 Vibration Isolators - Vibration isolators shall not be used without specific approval of Boeing.

3.1.4.4 Ignition and Explosion Proof - The equipment shall be ignition and explosion proof and shall not cause ignition or explosion when operated in a stoichiometric mixture of hydrogen and air or oxygen.

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3.2 Valve Assembly, Nitrogen Purge (10-81170-1)

3.2.1 Description - The Nitrogen Purge Valve Assembly located in the unpressurized equipment bay accomplishes the following functions:

- A. Controls nitrogen flow through the equipment using a shut-off valve which is opened electrically.
- B. Performs a temperature control function for the nitrogen gas entering the Secondary Power Bay by way of this equipment and the distribution tubing.
- C. Provides a flow control function for nitrogen gas entering the purge distribution tubing in order to assure a nitrogen atmosphere within the unpressurized bays of the X-20 glider during descent.

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SCALE	AFAP33(657)-7132	SH 20

3.2.2 Design

3.2.2.1 Compatibility - The materials used in construction of the -1 valve assembly shall be compatible with liquid and gaseous nitrogen per MIL-P-27401A.

3.2.2.2 Leakage - Internal-to-external leakage on any component within the -1 valve assembly shall not exceed 0.0005 lb/min.

Internal-to-external leakage on any component within the -1 valve assembly shall not exceed 0.0001 lb/min.

3.2.2.3 Flow Rate - With reference to Figure 1 the flow rate at Point "D" of the -1 valve assembly and into the purge distribution tubing shall be 0.5 lb/min until the pressure rate of Figure 8 has been reached; at this point the -1 valve assembly shall modulate the flow rate according to the pressure rate requirements of Figure 8 until touchdown.

3.2.2.4 Flow Direction - The -1 valve assembly shall be capable of flow in the directions shown in Figure 1. A permanent arrow shall be provided on the valve assembly to indicate flow direction. As an option the inlet and outlet may be provided with permanent markings.

3.2.2.5 Purge Volume - The total unoccupied volume within the unpressurized bay is 50 ft³ for nitrogen purging requirements.

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SCALE	AF 55(657)-7152	SH 21

3.2.3

Construction3.2.3.1
3.1.3.1.Pressure - Design pressure shall be as listed in paragraph

3.2.3.2 The construction of the components utilized to meet the requirements of the -1 valve assembly shall be such that when assembled together they shall form a unitized package.

3.2.3.3

Electrical motors if used, shall not contain brushes.

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SCALE	AF33(657)-7132	SH 22

3.2.4 Performance

3.2.4.1 The performance of the -1 valve assembly shall be as specified in the following paragraphs.

3.2.4.2 Pressure Drop - Deleted

3.2.4.3 Electrical Power Consumption - The electrical power consumption of the -1 valve assembly shall not exceed 70 watts.

3.2.4.4 Temperature - The -1 valve assembly shall be designed for temperatures as specified in the following subparagraphs.

3.2.4.4.1 The nitrogen inlet or supply temperature shall be -300°F to -265°F during operation of the nitrogen purge system.

3.2.4.4.2 The temperature leaving the -1 valve assembly and entering the unpressurized bays shall be controlled to $80 \pm 80^\circ\text{F}$.

3.2.4.5 Back Pressure - Back pressure shall not be allowed to enter the nitrogen tank from the -1 valve assembly.

With reference to Figure 1, the back pressure at the interface between the -1 valve assembly at Point "D" and the distribution tubing shall be a maximum of 18 psia. The back pressure is based on a flow of 3.95 lb/min of nitrogen at 0°F.

3.2.4.6 Tubing Segments - With reference to Figure 1, the length of the tubing segments are as specified:

<u>Segment</u>	<u>Length</u>
W - A	40 inches
B - X	48 inches
Y - C	48 inches
D - Z	120 inches

3.2.4.7 Shut-Off Operation - The shut-off function shall be capable of being opened by 23 to 30 VDC glider power and being closed by 23 to 30 VDC ground power.

The shut-off valve shall be controlled by a normally closed solenoid (closed when not energized). A latching type solenoid shall be used to assure that closing of the valve shall not occur during flight.

CODE IDENT NO. 81205	SIZE A	10-81170
SCALE	AF 33(657)-7132	SH 23

3.3

Heater, Nitrogen Purge (10-81170-2)

3.3.1

Description - The -2 heater located underneath the unpressurized Equipment Bay accomplishes the following:

- A. Stores thermal energy absorbed during re-entry to vaporize liquid nitrogen for the unpressurized bay purging requirements during descent. The thermal energy stored results from structural radiation due to aerodynamic heating during re-entry. For the heater position in relation to the radiating surface (see Figure 11).
- B. Stores thermal energy from ground electrical power to vaporize liquid nitrogen for the unpressurized bay purging requirements after a boost abort condition. The thermal energy stored results from electrical resistance incorporated into the heater design.
- C. Stores thermal energy from B-52 electrical power to vaporize liquid nitrogen for the unpressurized bay purging requirements after the air launch.

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SCALE	AF 33(657)-7132	SH 24

3.3.2 Design

3.3.2.1 Compatibility - The materials used in construction of the -2 heater shall be compatible with liquid and gaseous nitrogen per MIL-P-27401A.

3.3.2.2 Leakage - Internal-to-external leakage of the -2 heater shall not exceed .0001 lbs/min.

3.3.2.3 Flow Capacity - The flow capacity through the -2 heater shall be as required to comply with the requirements of Figure 8 and the temperature outputs of Paragraph 3.2.4.4.2.

3.3.2.4 Flow Direction - Deleted

CODE IDENT NO. 81205	SIZE 	10-81170
SCALE	AF 33(657)-7132	SH 25

3.3.3 Construction

3.3.3.1 Pressure - The design pressure of the -2 heater shall be as required to meet the requirements of the -1 valve assembly and the purging requirements of the Secondary Power Bay and the unpressurized Equipment Bay.

3.3.3.2 Emissivity

3.3.3.2.1 The emissivity of all surfaces of the -2 heater, except that surface specified in Paragraph 3.3.3.2.2, shall not exceed 0.1 over a maximum temperature of 950°F for its life.

3.3.3.2.2 The emissivity of the bottom surface of the -2 heater facing the corrugated surface as shown in Figure 11 shall be as required to comply with the performance requirements of Paragraph 3.3.4.

3.3.3.2.3 The emissivity of all René 41 surfaces seeing the -2 heater as shown in Figure 11 is 0.70.

3.3.3.2.4 The average emissivity of the water wall surface is .125 throughout a temperature range of 0° to 1000°F.

3.3.3.3 Temperature Switch - Deleted

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3.3.4 Performance

3.3.4.1 The performance of the -2 heater shall be as specified in the following paragraphs.

3.3.4.2 Pressure Drop - Deleted

3.3.4.3 Electrical Power Consumption - The total electrical power consumption of the -2 heater shall not exceed ~~300~~ ⁴⁰⁰ watts for ground heating requirements.

The -2 heater shall be capable of operating within the power requirements of Paragraph 3.1.2.10.

3.3.4.3.4 Temperature - The temperature of the inside radiating surface under the -2 heater shall approximate a linear increase of 225°F to 950°F throughout a period of 50 minutes.

3.3.4.5 Surrounding Structure - The location of structure surrounding the -2 heater will be as shown in Figure 11.

3.3.4.6 Heat Storage Capacity - The minimum heat storage capacity of the -2 heater above an 100°F reference temperature shall be 2800 Btu for vaporization of liquid nitrogen during normal inflight operation after re-entry.

3.3.4.6.1 THE MINIMUM HEAT STORAGE CAPACITY REQUIRED TO MEET THIS REQUIREMENT SHALL BE 2800 Btu STARTING FROM AN INITIAL 100°F TEMP. ~~DELETE 3.3.4.6.2~~

CODE IDENT NO. 81205	SIZE 	10-81170
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4.0

QUALITY ASSURANCE PROVISIONS

4.1

General - Classification and methods of reporting tests, shall be as established by D2-80396, Sections 9, 10, 11 and 13 except as noted in paragraph 6.8.1 of this specification.

4.1.1

General Test Requirements - The following general requirements apply to all tests described under paragraph 4.5 which lists specific requirements.

4.1.1.1

Test Conditions - Unless otherwise specified, testing shall be conducted at room temperature and ambient pressure.

4.1.1.2

Design Changes

4.1.1.2.1

Any design change resulting from failure of an article during testing shall necessitate a complete retest of the affected article unless otherwise approved by Boeing. The tests will be considered as complete when the required number of test articles have satisfactorily passed all tests and the results are consistent with the reliability requirements.

4.1.1.3

Instrument Calibration - Each instrument and other measuring apparatus upon which the accuracy of the test results depend, shall be calibration certified to ensure that performance of the test article can be demonstrated within specified limits. In no case shall the steady-state calibration error exceed $\pm 2\%$ of the specified value of the measurement, while voltage and frequency measurements shall be accurate to within $\pm .25\%$. Calibration records shall be maintained and shall be available to authorized Boeing representatives upon request.

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4.2 Design Development Tests - Design Development Testing shall meet the requirements of D2-80396, Section 9.0.

4.3 Qualification Tests - Qualification Testing in addition to meeting the requirements of D2-80396, Section 10.0, shall comply with the following.

4.3.1 One representative production unit of each article procured by this specification shall be tested. Use of a greater number of articles for qualification testing will be permitted if proposed in the qualification test plan required by D2-80396, Paragraph 10.1, and approved by Boeing. Successful completion of the qualification tests is the responsibility of the vendor and shall be performed at the place of manufacture or at any Boeing-approved testing laboratory.

4.3.2 The qualification test procedures shall include the following data:

1. Boeing SCD and Nomenclature
2. Vendor Part Number and Nomenclature
3. Vendor Name, Address and Individual Responsible
4. Statement of Test Objective (Not Mandatory)
5. Block Diagram of Test Setup
6. Outline of Test Conditions Imposed
7. List of Data to be Recorded and Identified with Items Above or Equal
8. List and Identification by Number of Model of Instrumentation and Test Sets
9. Identify What the Test Is (Note that an acceptance test contains many tests)

4.3.3 Equipment Tests - The equipment tests shall be as specified in the following subparagraphs:

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SCALE	AF 33(657)-7132	SH	29

4.3.3.1 The following tests shall be performed on the 10-81170-1, Nitrogen Purge Valve Assembly in the order listed:

<u>Test</u>	<u>Paragraph</u>
Inspection	4.5.1
Weight	4.5.2
Cycling	4.5.11
High Temperature	4.5.12
Low Temperature	4.5.13
Leak	4.5.4
Operational	4.5.9
Vibration	4.5.3
Dielectric Strength	4.5.10
Radio Interference	4.5.8
Life	4.5.7
Operational	4.5.9
Leak	4.5.4
Proof	4.5.5
Burst	4.5.6
Explosion	4.5.14
Abnormal Shock	
Accelerations	

4.3.3.2 The following tests shall be performed on the 10-81170-2, Nitrogen Purge Heater in the order listed:

<u>Test</u>	<u>Paragraph</u>
Inspection	4.5.1
Weight	4.5.2
Cycling	4.5.11
Vibration	4.5.3
Dielectric Strength	4.5.10
Radio Interference	4.5.8
Life	4.5.7
Operational	4.5.9
Leak	4.5.4
Proof	4.5.5
Burst	4.5.6
Explosion	4.5.14
Abnormal Shock	

4.3.3.3 Assembled Equipments Performance Test - The nitrogen purge equipment shall be assembled in one unitized system and tested to assure that the proper range of design outputs is obtained when the equipment is supplied the range of design inputs. This test shall be conducted using liquid nitrogen and simulating the inservice tubing installation.

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SCALE	AF 33(657)-7132	SH	30

4.4 Acceptance Tests

4.4.1 General - An acceptance test shall be conducted by the vendor on each article delivered to Boeing. Acceptance will be based upon satisfactory completion of the tests defined in this Section.

4.4.1.1 Test Apparatus and Procedures - Schematic drawings and descriptions of all test apparatus, outline drawings showing points of measuring apparatus, and applications shall be furnished prior to initiation of the acceptance tests. Test procedures and methods to be used shall be acceptable to Boeing and shall be qualified in accordance with the requirements of Paragraph 4.4.5.

4.4.2 Individual Tests - Satisfactory completion of the following individual acceptance tests and compliance with D2-80396, Section 11.0, will provide a basis for acceptance of the articles procured by this specification. The tests shall be performed on each article in the order listed.

<u>Test</u>	<u>Paragraph</u>
Inspection	4.5.1
Weight	4.5.2
Cycling	4.5.11
Leak	4.5.4
Proof	4.5.5
Operational	4.5.9
Final	4.5.14

4.4.3 Acceptance Test Committee - The occurrence of a failure during acceptance testing may, at Boeing's option, result in the formation of an acceptance test committee at the vendor's facility. The function of the committee will be to investigate and classify the failure, determine its cause, and recommend corrective action. The committee shall consist of representatives of the vendor's engineering, production, and quality control or inspection departments and, if warranted, a Boeing representative.

If an acceptance test committee is not warranted, the failure shall be investigated and corrective action taken by vendor to Boeing's satisfaction. Any article experiencing a failure during retesting shall not be resubmitted without the approval of Boeing.

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4.4.4 Acceptance Test Summary - The Acceptance Test Summary submitted in compliance with D2-80396, Paragraph 11.4, shall include all significant data as well as calibration. Continuous recordings of critical parameters shall be required.

4.4.5 Acceptance Test Procedures Qualification - The vendor's acceptance test procedures will be evaluated to verify suitability of test equipment and to make sure the procedures are correct and complete.

4.4.5.1 Description - A representative article manufactured by the vendor shall be subjected to a complete acceptance test. The representative article may be the first production article.

4.4.5.2 Boeing Representation - The vendor shall notify Boeing three weeks in advance of the acceptance test procedures qualification so that a Boeing representative can be present to witness the qualification.

4.4.5.3 Acceptance Test Procedures Qualification Report - The vendor shall prepare a report telling how the acceptance test procedures qualification demonstrated the adequacy of the test procedures and equipment for making a satisfactory acceptance test. This report shall be identified by a number assigned by the vendor.

4.4.5.3.1 The acceptance test procedure shall include the following data:

1. Boeing SCD and Nomenclature
2. Vendor Part Number and Nomenclature
3. Vendor Name, Address and Individual Responsible
4. Statement of Test Objective (Not Mandatory)
5. Block Diagram of Test Setup
6. Outline of Test Conditions Imposed
7. List of Data to be Recorded and Identified with Items Above or Equal
8. List and Identification by Number or Model of Instrumentation and Test Sets
9. Identify What the Test Is (Note that an acceptance test contains many test)

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SCALE	AF 33(657)-7132	SH 32

4.5 Test Methods

4.5.1 Inspection Test - A visual inspection shall be conducted to determine conformance with materials, mechanical details, workmanship, dimensional accuracy, cleanliness, electrical circuitry, finish requirements of this specification, the approved production drawings, and D2-80396.

4.5.2 Weight Test - Each article of equipment shall be checked to assure that the maximum weight has not been exceeded. The actual weight shall be recorded and permanently placed on the nameplate of each equipment.

4.5.3 Vibration Test - Preliminary sinusoidal vibration scans shall be conducted in each of three mutually perpendicular axes following the test envelope of Figure 4. Response measurements shall be made by installing several accelerometers on the equipment at locations most likely to resonate. The equipment shall be closely observed during the scans and the frequencies and amplifications at all resonances carefully noted. The scans shall be conducted with the equipment operative at normal working temperature and pressure. All scan data on resonances, including a description of the mounting locations of the response instrumentation and the weight of the moving vibrator assembly and test fixture, but not the test specimen, shall be included in the test report.

After the preliminary sinusoidal scans, the equipment, while operating at normal working temperature and pressure, shall be subjected to random vibration in each of three mutually perpendicular planes per paragraph 3.1.4.3.4. The equipment shall be vibrated in each direction in each plane for $\frac{1}{2}$ hour, and the attachment to the vibrator shall simulate the service installations. The equipment shall operate and shall show no failures malfunctions or out of tolerance performance. The weight of the moving vibrator assembly, including the test fixture but not the test item, shall be determined and noted in the test report.

If suitable random vibration test facilities are not available, a substitute sinusoidal test may be specified by Boeing upon receipt of the preliminary sinusoidal scan data. This information will be used in determining test conditions and vibration levels. The substitute sinusoidal vibration test will consist of two sinusoidal scans using a sweep rate of approximately $\frac{1}{2}$ octave per minute from 5 to 2000 cps for a duration of seventy minutes for each of three mutually perpendicular planes followed by dwells at each resonant frequency. The duration of each dwell will be five minutes for each resonant frequency at a level $\frac{1}{2}$ of that at the same frequency for the sinusoidal scans. The test specimen mounted by its normal mounting provisions will be operative (at normal working temperature and pressure) throughout the test.

If the test specimen is free from resonances, the substitute sinusoidal vibration test may be performed according to the vibration envelope shown in Figure 6. In addition, the test will contain dwells at reduced levels. However, approval from Boeing must be obtained prior to conducting this substitute test.

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4.5.4 Leak Test - Each article shall be pressurized to its maximum design working pressure. The leakage shall not exceed the limits specified in Paragraphs 3.2.2.2 and 3.3.2.2 for each article.

4.5.5 Proof Test - Each article shall be pressurized to its design proof pressure. No permanent deformation or operational failure shall result. The leakage shall not exceed the limits specified in Paragraphs 3.2.2.2 and 3.3.2.2 for each article.

4.5.6 Burst Test - Each article shall be pressurized to its design burst pressure. The leakage shall not exceed the limits specified in Paragraphs 3.2.2.2 and 3.3.2.2 for each article. Permanent deformation and operational degradation is permissible.

4.5.7 Life Test - To determine that the equipment is suitable for the operational life indicated in Paragraph 3.1.4.1, a life test shall be conducted with the equipment operating under nominal flight conditions for a period of 10 hours, and under ground operating conditions for 100 hours, except for rotating parts which shall demonstrate a life capability of 500 hours. All valves shall demonstrate a life capability of being cycled between atmospheric and working pressure 500 times. In addition, all valves shall demonstrate a life capability of being cycled open and closed 500 times. Instrumentation shall be required to show that the equipment operates per the requirements of Section 3 of this source control drawing.

4.5.8 Radio Interference Test - Radio interference tests shall be conducted on each article of equipment in accordance with MIL-I-26600.

4.5.9 Operational Test - Operational tests of the integrated purge equipment shall be conducted to assure that the proper range of design outputs is obtained when the equipment is supplied the range of design inputs. The tests shall show that the equipment operates normally with adequate response. Operation conditions and parameters shall be recorded. Operational tests shall be conducted using a simulated in-service installation.

4.5.10 Dielectric Strength Test - The equipment shall withstand without breakdown, the high potential test voltage requirements of Paragraph 3.1.2.15. Capacitors and semi-conductor devices shall be disconnected for this test if necessary.

4.5.11 Cycling Test - Debugging tests designed to assure that "weak" elements fail shall be conducted. This testing shall be designed to eliminate early failures due to manufacturing-type defects such as faulty components or workmanship and shall be based primarily on elements and operating conditions found during development and qualification testing to be critical to satisfactory operation. Until sufficient data is obtained to establish a minimum value, each article shall be fully cycled 500 times. The vendor may, as experience and improvement reduce the number of initial failures, recommend reductions in the minimum amount of operating time necessary at the manufacturer's facility. Upon approval by the Boeing Engineering Department, the above requirements will be revised.

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4.5.12 High-Temperature Test - The equipment shall be tested in accordance with Paragraph 4.1.2 of MIL-E-5272C except exposure time shall be as required to maintain an equilibrium temperature of 220°F.

4.5.13 Low-Temperature Test - The equipment shall be tested in accordance with Paragraph 4.2.1 of MIL-E-5272C.

4.5.14 Ignition and Explosion Test - The equipment shall be tested in accordance with Paragraph 4.13, Procedure III of MIL-E-5272C, except a stoichiometric mixture of hydrogen and oxygen shall be used in place of gasoline and air.

CODE IDENT NO. 81205	SIZE A	10-81170
SCALE	AF 33(657)-7132	SH 34.1

5.0

PREPARATION FOR DELIVERY

5.1

Packaging and Marking - Packaging and marking of the articles procured by this specification shall be in accordance with the provisions of D2-80396, Section 14.

5.2

Sealing of Ports - Each port shall be sealed with a clean temporary, removable, re-usable cover or plug. Threaded plugs of soft metal, polyethylene or other materials which may flake and cause contamination shall not be used. The equipment shall meet the requirements of 3.1.3.2 as shipped.

5.3

Shipping Container - The shipping container shall be designed such that shocks as a result of dropping the container shall not cause damage to the packaged equipment within or require an increase in the weight of the equipment. The magnitude of the shocks shall be based upon dropping the container with the packaged equipment therein once on each face upon a flat concrete surface. The height of drop shall be determined from the following table:

<u>Weight of Container with Article Installed</u>	<u>Drop Height Inches</u>
0 - 20	42
20 - 50	36
50 - 100	32
100 - 250	30

Shipping container testing shall not be conducted.

CODE IDENT NO. 81205	SIZE 	10-81170
SCALE	AF 33(657)-7132	SH 35~

6.0

NOTES

6.1 Data Required for Tentative or Final Approval - In addition to the data required by Section 16.0 of D2-30396, monthly progress reports shall be submitted to Boeing throughout the developmental period. The first report shall be due 30 days after issuance of the purchase order. These reports shall keep Boeing well informed of the problems and progress and shall show the actual status of work compared with the planned work accomplishment schedule.

6.2 Design Development Program Plan - The vendor shall submit a plan outlining the entire development effort. The plan shall be sufficiently detailed to permit monitoring of the work to be accomplished in meeting the requirements of this specification.

The adequacy of the vendor's development program shall be established by the plan which is to be kept up-to-date (expanded and refined) to clearly retain and show the original plan, schedule, revisions, and shifts of emphasis. The initial release of the plan is due thirty days after issuance of the purchase order.

The following list of data required for monitoring the development tests shall be included in the development plan:

1. Vendor Part Number and Nomenclature
2. Statement of Test Objective
3. Block Diagram of Test Set-Up
4. Outline of Test Conditions Imposed
5. Identification of What the Test Is

6.3 Qualification Test Articles - Articles which have passed the qualification tests shall be sent to Boeing upon completion of the tests.

6.4 Reliability Plan - The supplier shall furnish Boeing a reliability plan including:

6.4.1 A concise description of the supplier's organization outlining the reliability and quality control responsibilities for design, procurement, and manufacturing in compliance with this specification.

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6.4.2 A task list including manhours, individual responsible, and start and completion scheduling to provide control of the following reliability actions required in D2-80396:

- A. Reliability Analysis (Paragraph 7.1.2.1/c/)
- B. Compatibility Factors (Paragraph 7.1.2.1/d/)
- C. Preliminary Critical Design Review (Paragraph 8.1.2 and 8.1.2)
- D. Hardware Review (Paragraph 8.2)
- E. Demonstration Plan (Paragraph 7.1.3.2)

6.4.3 A brief description of the Manufacturing and Quality Control Record System.

6.5 Design Check List - The vendor shall provide a design check list for each article procured by this specification. The list shall comprise a tabulation of items which the vendor considers in the hardware design in order to assure reliability. An example page of a design check list is shown as Figure 12.

The design check list shall be utilized by the vendor during hardware design to ensure that features which assure hardware reliability are incorporated. During the reviews required by paragraph 8.0 of D2-80396, the hardware design, and the actual hardware when available, will be inspected for incorporation of design features contained in the list.

As a minimum, the design check list shall include the following:

- A. Establish design concepts to enable recognition and resolution of problem areas as uncovered by the failure mode and effect analysis. (see paragraph 7.1.2.1c of D2-80396).
- B. New design practices and procedures, fabrication techniques, and processes developed to support the hardware design.
- C. Current standard practices and/or procedures which are considered a normal part of good design and are applicable to the hardware.

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6.5 Design Check List (Continued)

The list shall be complete in itself without reference to other lists or documentation and shall be periodically updated. Initial submittal of the list to Boeing shall be six weeks prior to the Preliminary Design Review (see paragraph 8.1.1 of D2-80396).

6.6 Reliability Reports - Reliability report shall be a section of the periodic design progress report and shall show compliance on all reliability tasks in paragraph 6.4.2 and will include reliability, failure mode and effect, and compatibility factor analyses. A finalized version of the reliability report shall be in The Boeing Company possession at least two weeks prior to the critical design review.

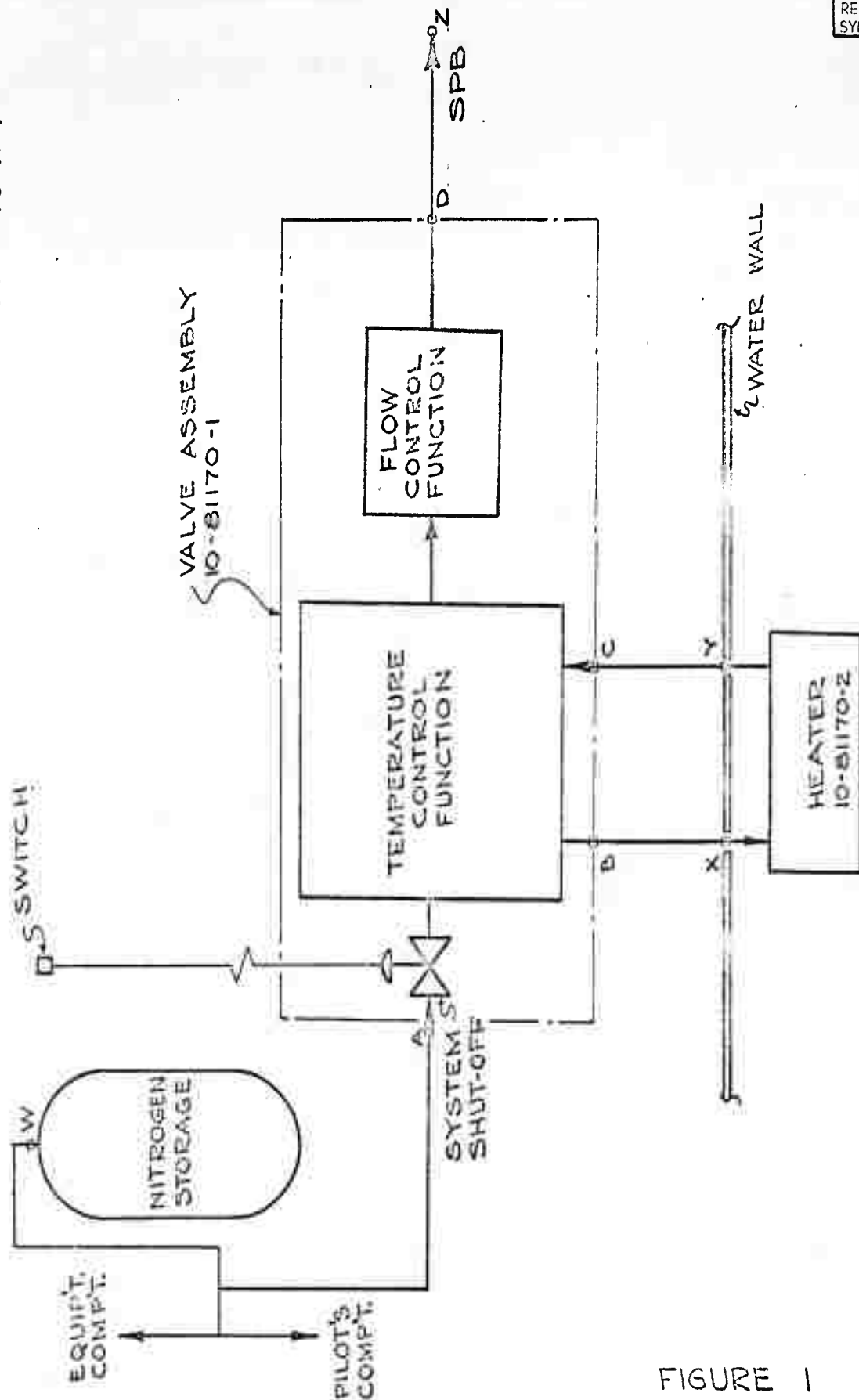
6.7 D2-80396 Compliance

6.7.1 All paragraphs of D2-80396 except the following are applicable to equipment procured by this specification.

<u>Section or Paragraph No.</u>	<u>Subject</u>
3.5.10	Human Factors
7.1	Reliability Plan
7.1.1	Reliability Management
7.1.2.1b	Reliability Definition
7.1.2.1e	Safety Analysis
7.1.3.1	Development and Qualification Testing
7.1.3.2.1	Estimation
7.2d(1)	Reliability Reports
10.2.2	Qualification Test Requirements
11.1.2	Acceptance Test Requirements
12.0	Design Integration Tests
15.1 - 15.7	Logistics Data
16.0 Items 11, 15, 17-19	Exhibits Required for Tentative or Final Approval

CODE IDENT NO. 81205	SIZE 	10-31170
SCALE	AF 33(352)-7132	SH 30

NITROGEN PURGE EQUIPMENT BLOCK DIAGRAM



REV
SYM +

FIGURE 1

CODE IDENT NO. 81205	SIZE A	10-81170	
SCALE	AF		SH 39



10-01170-1 7/25/13 6/5/16

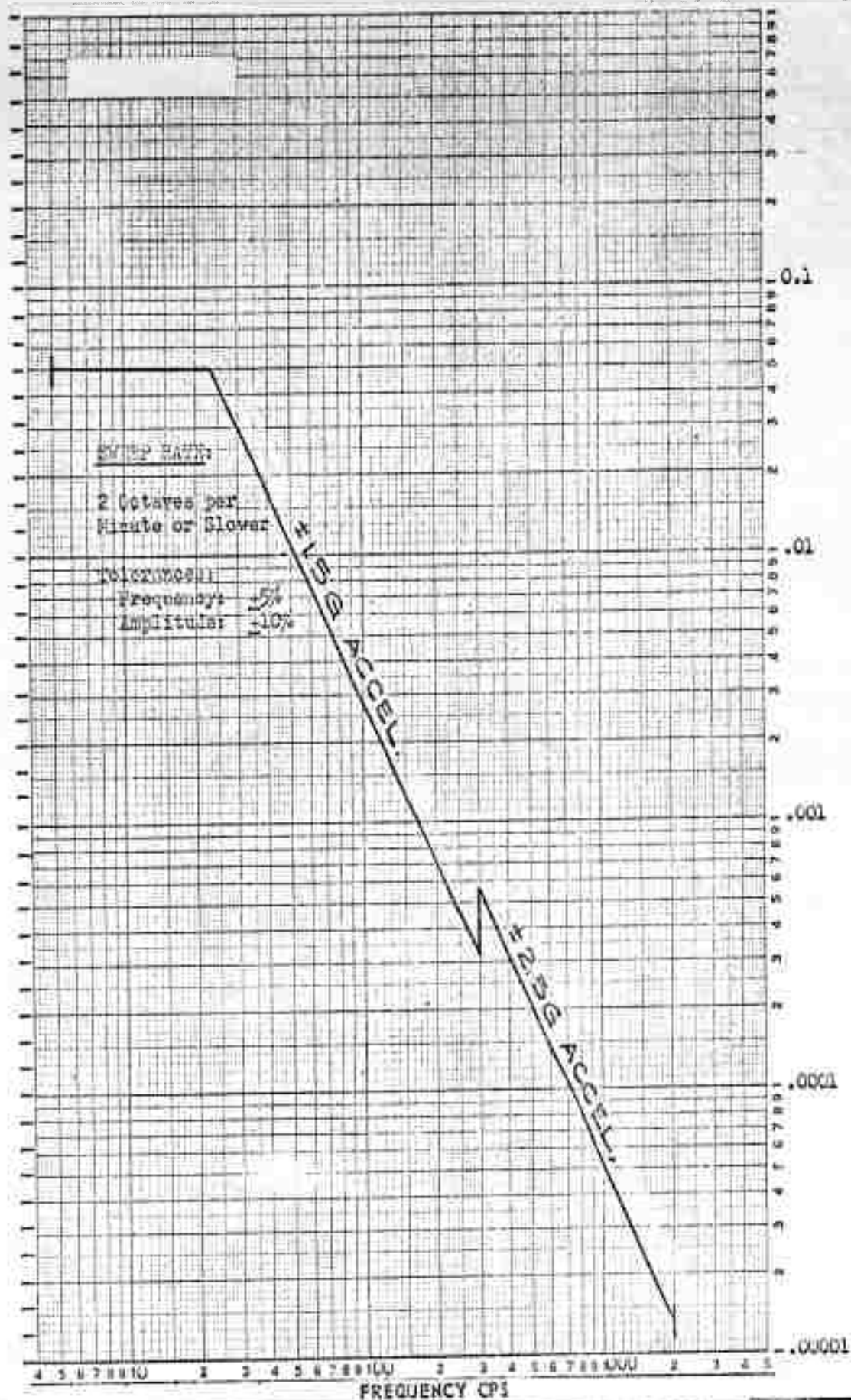
CODE QNT NO 81205	SIZE B	ENVELOPE - VALVE ASSEMBLY, NITROGEN PURGE
SCALE 1/2	AF 33(657)-7138	SH 40



CONDITION NC.

TEST NO.

LEVEL, DB



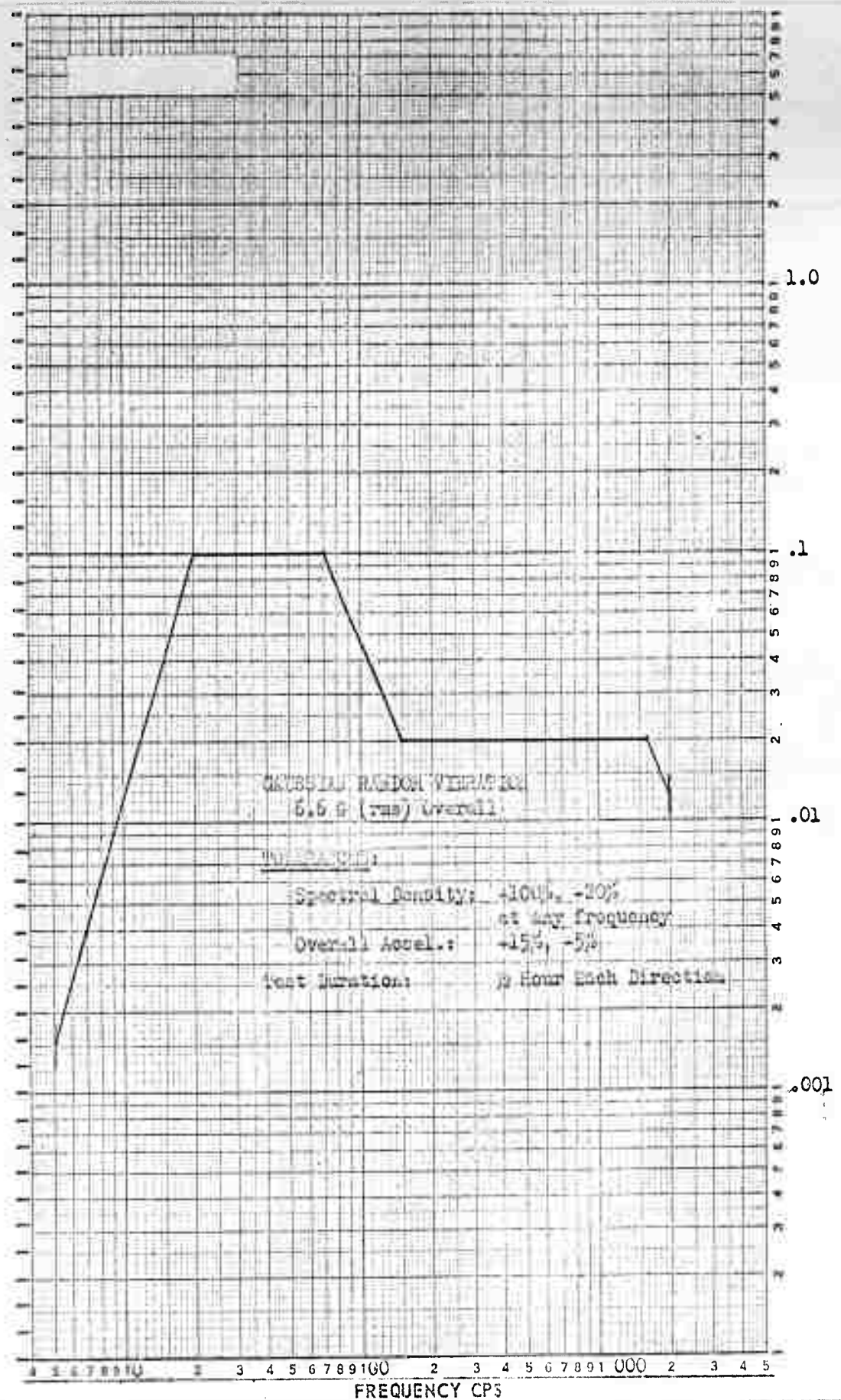
CALC		REVISED	DATE	PRELIMINARY SINUSOIDAL VIBRATION TEST ENVELOPE	10-81170
CHECK					FIGURE 4
APPR					
APPROV					PAGE 42
				BOEING AIRPLANE COMPANY CATTLE BE. & COASTON	

CONDITION NO.

TEST NO.

2-5353-4-29

LEVEL, DB



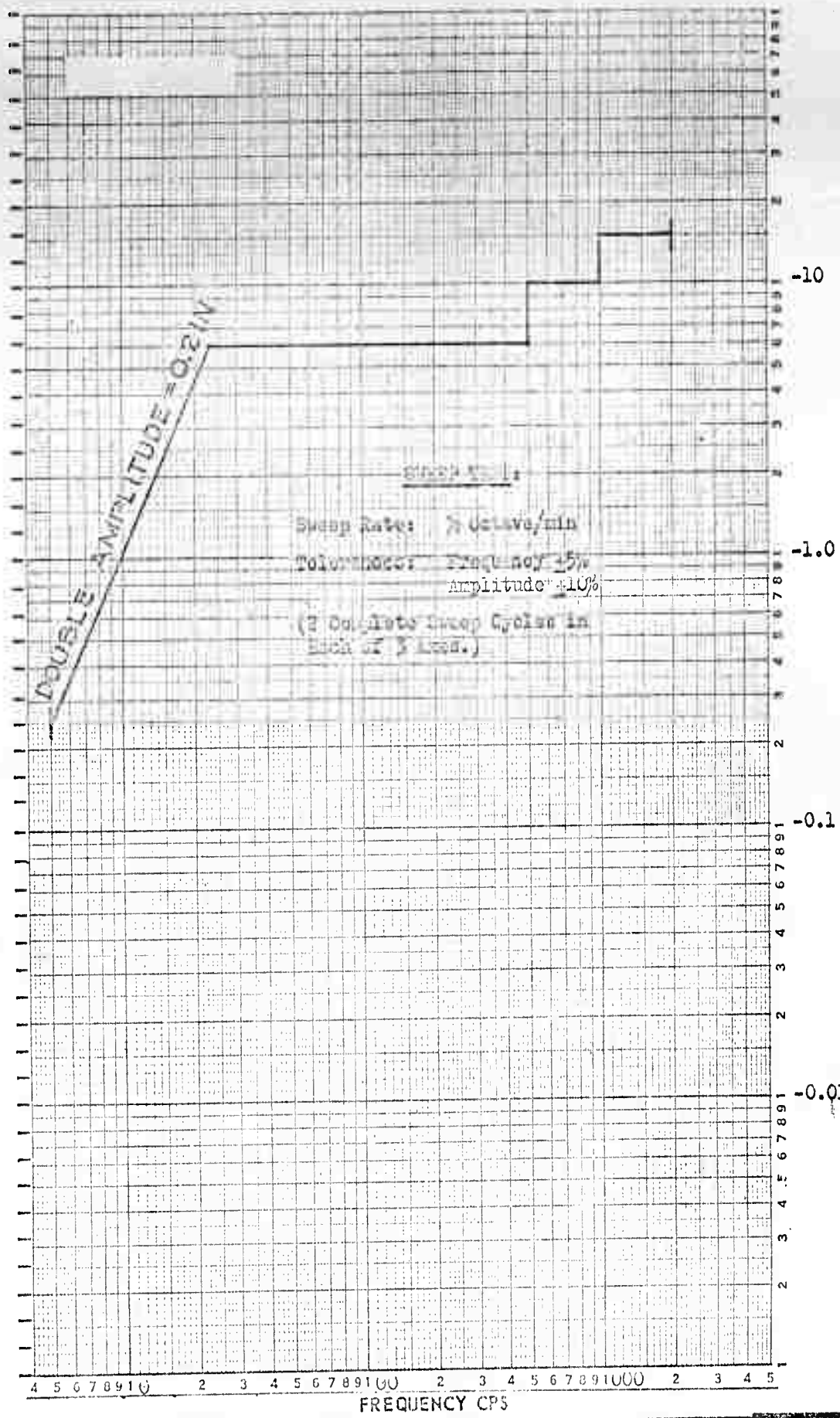
ACCELERATION DENSITY - $g^2/CYCLE$

CALC			REVISED	DATE	RANDOM VIBRATION TEST ENVELOPE	10-81170
CHECK						FIGURE 5
APPR						
APPR					BOEING AIRPLANE COMPANY	PAGE 43
					1 A 110 1 10 11 10	

CONDITION NO.

TEST NO.

LEVEL, DB



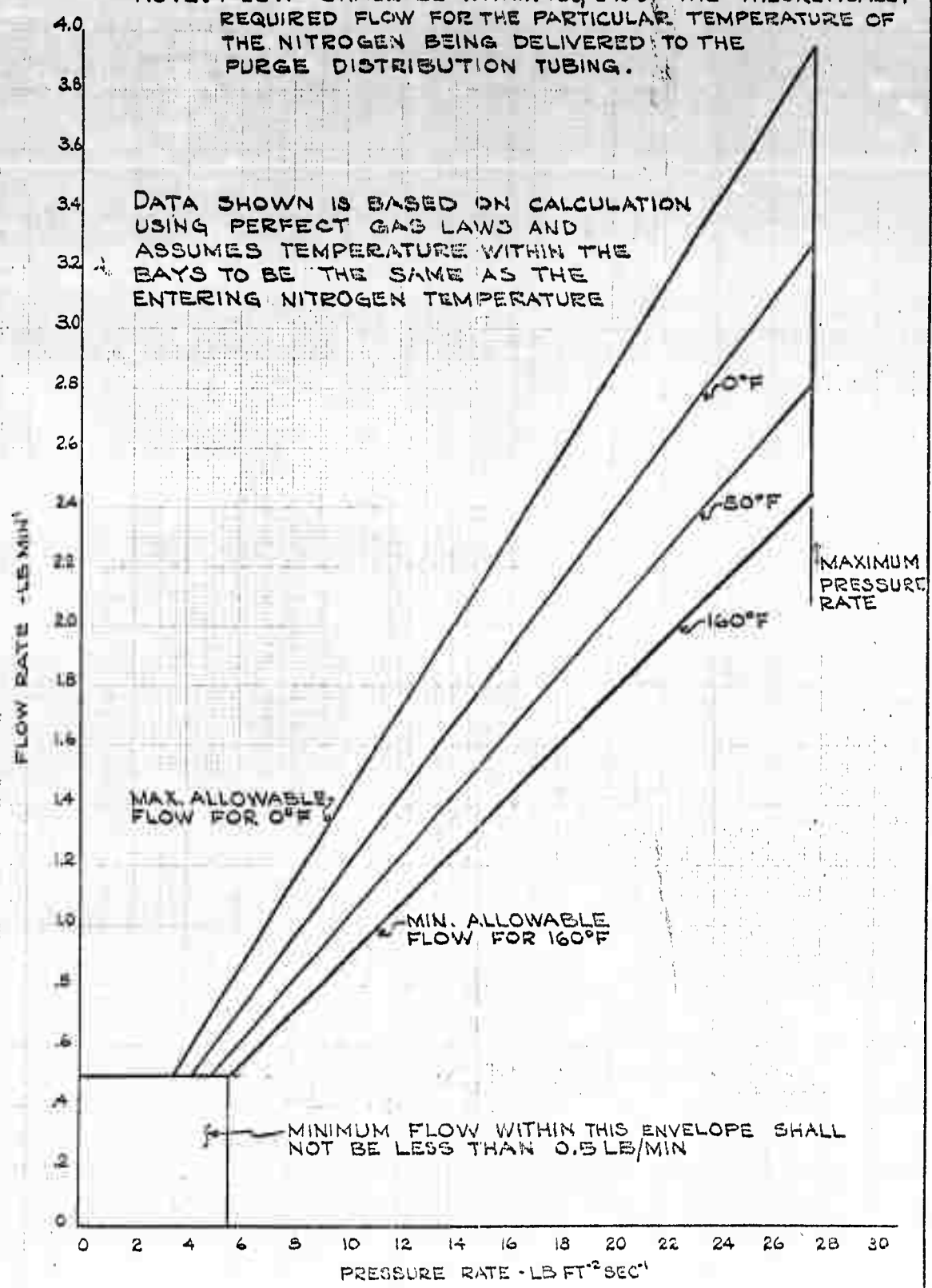
2-5353-4-23

CALC		REVISED	DATE	SUBSTITUTE SINE VIBRATION TEST ENVELOPE	10-81170
CHECK					FIGURE 6
APPR					PAGE 44
APPR					
				BOEING AIRPLANE COMPANY	

A

NOTE: FLOW SHALL BE WITHIN +20.0% OF THE THEORETICALLY REQUIRED FLOW FOR THE PARTICULAR TEMPERATURE OF THE NITROGEN BEING DELIVERED TO THE PURGE DISTRIBUTION TUBING.

DATA SHOWN IS BASED ON CALCULATION USING PERFECT GAS LAWS AND ASSUMES TEMPERATURE WITHIN THE BAYS TO BE THE SAME AS THE ENTERING NITROGEN TEMPERATURE



CALC	N. K. B.	3-5-63	REVISED	DATE	ENVELOPE, FLOW RATE VS AMBIENT PRESSURE RATE	10-81170
CHECK						FIGURE 8
APR						
APR						
					THE BOEING COMPANY	PAGE 46

32

DELETED

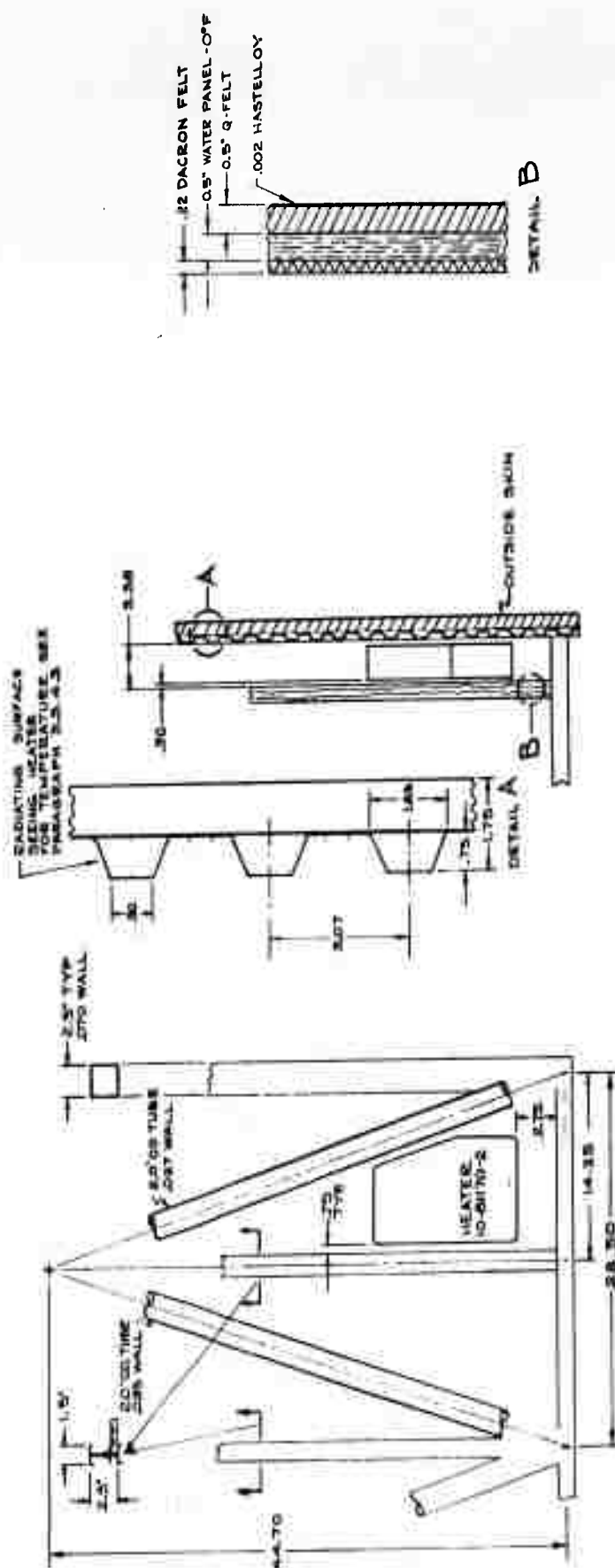
FIGURE 9

CODE IDENT NO. 81205	SIZE A	10-81170
SCALE	AF 33(657)-7132	SH 47

DELETED

FIGURE 10

CODE IDENT NO. 81205	SIZE 	10-81170
SCALE	AF 33(657)-7132	SH 48



SURROUNDING STRUCTURE

FIGURE 11

NOTES:
ALL MATERIALS SURROUNDING HEATER ARE RENE 41

CODE IDENT NO. 81205	SIZE B	10-8117C
SCALE	AF	SH 49

DESIGN CHECK LIST - MECHANICAL			
DRAWING NUMBER		DRAWING TITLE	
ITEM		INITIALS	DATE
1. <u>Bearings</u>			
a. Are bearings protected from corrosion and galling due to dirt, moisture, carbon, dust, and insufficient lubricant?			
b. Are bearings protected from brinelling due to vibration, shock, or soft metal?			
2. <u>Blower Blades</u>			
Are blades made of high strength, stiff, lightweight material in which blade angle or pitch is not easily upset?			
3. <u>Clutches</u>			
Will friction type clutches stick or operate intermittently due to breakdown of friction material, or effect of environmental temperature and vibration cycling?			
4. <u>Dials</u>			
Are dial pointers so installed that they cannot become loose on shafts?			
5. <u>Filters</u>			
Are filters used in hydraulic systems? Contamination has caused servo valve clogging and system failure. (Bomarc)			
6. <u>Gears</u>			
a. Are selected gear combinations resistant to excessive wear?			
b. Have gear trains been evaluated and tolerances established for backlash?			
REMARKS			
PAGE NUMBER			

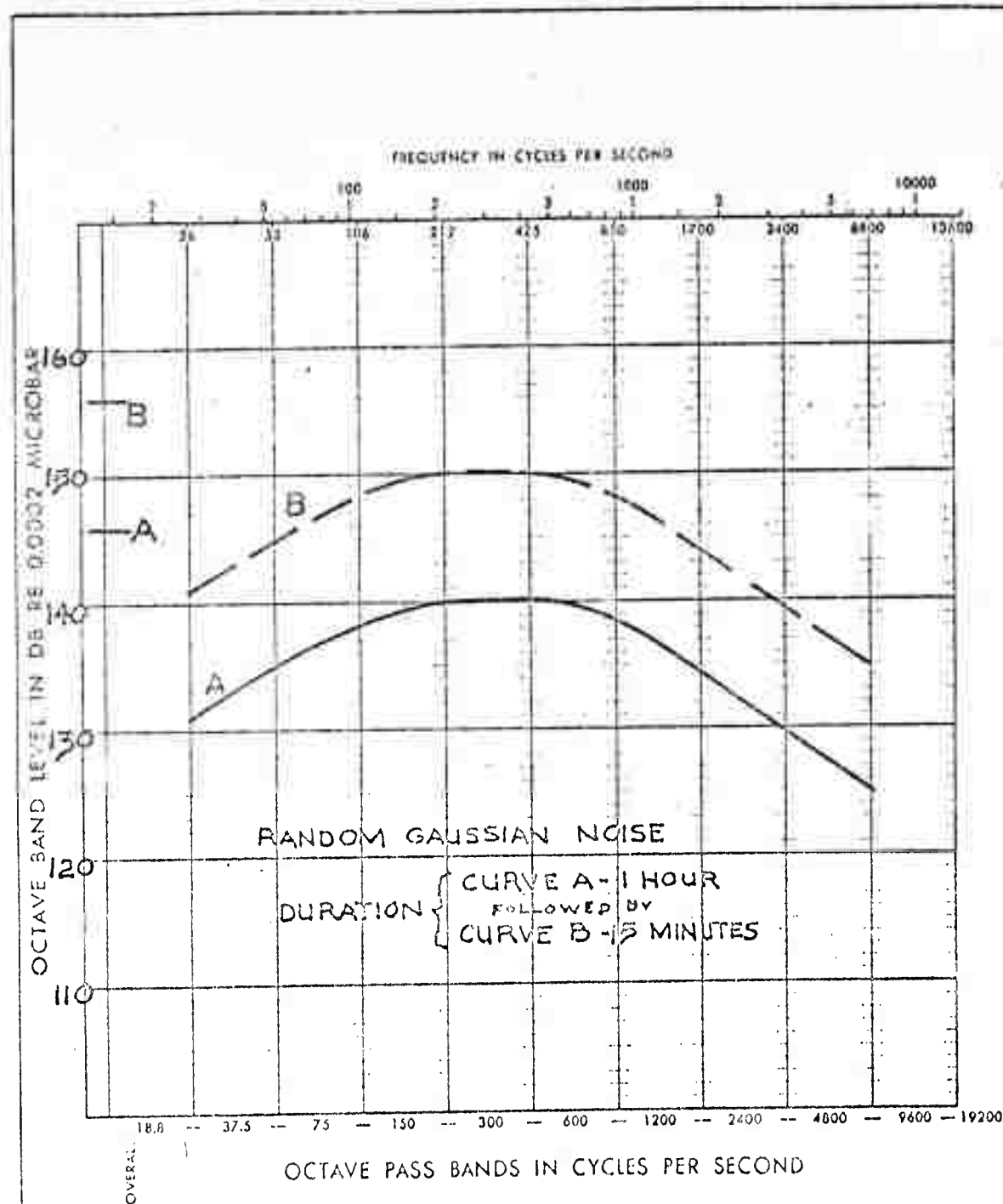
Figure 12

EXAMPLE PAGE -
DESIGN CHECK LIST

THE BOEING COMPANY

10-61170

P NO. 50



X-20

ACOUSTIC DESIGN ENVIRONMENT
FOR
SECONDARY POWER BAY WATER WALL
AND
EQUIPMENT BAY WATER WALL

DRAWN B.W.
REVISED L.C.S. 12-7-61

FIGURE 13

APPLICATION				PART NUMBER	REV SYM	+
NEXT ASSY	USED ON	SECT. NO.	SERIAL NUMBER			
25-82674	X-20	-	-	-1		
25-82674	X-20	-	-	-2		

*ASD-ASZRA-WPAFB
Ohio*

ONLY THE ITEM(S) LISTED ON THIS DRAWING AND IDENTIFIED BY VENDOR'S NAME(S), ADDRESS(ES), AND PART NUMBER(S), HAVE BEEN TESTED AND APPROVED BY THE BOEING COMPANY FOR USE IN X-20A
A SUBSTITUTE ITEM SHALL NOT BE USED WITHOUT PRIOR TESTING AND APPROVAL BY THE BOEING COMPANY.

SOURCE CONTROL DRAWING

DRAWN <i>W.K. Burke, Jr.</i> R. K. Burke, Jr. DATE <i>3-5-63</i> 3-5-63 3-18-63 3-5-63 3-18-63 3-15-63 3-19-63	THE BOEING COMPANY AERO-SPACE DIVISION SEATTLE, WASHINGTON NITROGEN PURGE EQUIPMENT, FIRE PROTECTION AND SAFETY SUBSYSTEM CODE IDENT NO. 81205 SCALE AF 37(557)-7132 SH 1 OF 5	SIZE  10-81170
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3-19-63*

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LIST OF ACTIVE PAGES AND CHANGE RECORD

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REVISIONS			
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2.0

APPLICABLE DOCUMENTS

Government - The following documents of the issue and revisions noted form a part of this specification to the extent specified herein. Where conflicting requirements exist, the requirements of this specification shall govern.

- MIL-I-26600 Interference Control Requirements, Aeronautical Equipment, 17 June 1959
- MIL-E-5272C Environmental Testing, Aeronautical and Associated Equipment, General Specification for, 20 January 1960
- MIL-P-27401A Propellant, Nitrogen, Pressurizing, 7 November 1960
- MIL-S-4040C Solenoid, Electrical, General Specification for, 23 January 1958
- MS-33540C Safety Wiring, General Practices for, 17 March 1959
- MS-33586 Metals, Definition of Dissimilar, 16 December 1958

2.2

Boeing - The following documents and drawings of the issue established by the purchase order form a part of this specification to the extent specified herein. Where conflicting requirements exist, the requirements of this specification shall govern.

- D2-7391 Specification, Characteristics of Glider Electric Power and General Requirements for Load Equipment
- D2-80396 General Requirements Document for Dyna-Soar Source Control Drawings and Design Procurement Specifications
- BAC N18U Fitting End - Self Flaring Fitting Standard Dimensions For
- BAC 5739 Cleaning of Contamination Sensitive Parts
- DM 70 Section 14, "Protective Finish", Boeing Design Manual
- 10-81006 High Temperature Electric Wire - Insulated, Metal Sheathed (1800°F)
- BAC 5902 Brazing with Nickel and Cobalt Base Filler Metals

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3.0

REQUIREMENTS

3.1

Nitrogen Purge Equipment

3.1.1 General - Data, interchangeability, selection of standards and specifications, materials and processes, workmanship and reliability requirements shall be as specified in Document D2-80396, "General Requirements Document for Dyna-Soar Source Control Drawings and Design Procurement Specifications" dated April 4, 1962, except as noted in Section 6.0 of this specification.

3.1.1.1 Description - With reference to Figure 1, the nitrogen purge equipment provides for the following:

- A. Shut-Off Control for Purge Operation
- B. Vaporization of Liquid Nitrogen for Purge Operation
- C. Temperature Control of Nitrogen Purging Gas for Purge Operation
- D. Flow Control of Nitrogen Purging Gas for Purge Operation

A system shut-off valve is opened electrically ^{by pilot} allowing cryogenic nitrogen to flow through the purge system until de-energized after touchdown.

Vaporization of liquid nitrogen for normal inflight operation is assured by a heater located between the water wall and outside structure. The heater absorbs energy by radiation heat transfer from the outside structure prior to purge operation during re-entry.

For the air launch and a boost abort situation the heater utilizes electrical energy for the necessary storage heat to vaporize the cryogenic nitrogen passing through the system.

A temperature control function is provided to assure that gaseous nitrogen will enter the Secondary Power Bay and the unpressurized Equipment Bay within a controlled temperature range.

A flow control function is provided for nitrogen purge flow control during descent. The system will sense the rate of pressure increase and automatically control the flow rate of nitrogen entering the Secondary Power Bay and the unpressurized Equipment Bay in order to assure a slight positive pressure within the bay for any flight profile of the X-20 glider.

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3.1.2 Design

3.1.2.1 Fail-Safe Design - Each component shall be designed so that failure shall cause the minimum impairment of system operation. No single failure shall result in a lower degree of pilot safety. As a design objective failure of the -1 valve assembly or the -2 heater shall not cause depletion of the nitrogen storage tank.

3.1.2.2 Plumbing Connections - Precision super-finish close-tolerance MIL-Flo fittings per BAC-N18U shall be utilized on all conventional internal plumbing connections. External connections shall be as specified on the envelope drawings per Figure 2 and 3. On all other plumbing connections the connection most suitable for the application shall be used. Reliability, minimum leakage, low weight, and the capability of disconnect and reconnect shall be considered in selecting the connection to be used. In no case shall pipe threads be used.

3.1.2.3 Leakage - Leakage shall be kept to a minimum. As a design objective, the leakage shall be zero.

3.1.2.4 Electrical Connections - All electrical connections which interface with Boeing wiring shall terminate in an electrical receptacle which mates with a Bendix SP06CE S Pygmy bayonet type plug. All electrical connectors shall be Bendix Pygmy connectors. All internal connections shall be mechanically and electrically sound.

3.1.2.5 Calibration Adjustments - Any calibration (non-operating) adjustments shall be firmly secured to prevent shifts. Calibration adjustments shall be clearly indicated.

3.1.2.6 Lubrication - Lubrication requirements shall be held to a minimum consistent with performance and other requirements of this specification. If periodic lubrication is required, provisions shall be made for easy, controlled application at infrequent intervals.

3.1.2.6.1 Solid film dry lubricant may be used in areas exposed to cryogenic fluids if qualified for use with the applicable cryogen. Dry film lubricant in direct contact with cryogens must be unaffected by exposure to the cryogen and shall remain effective for the entire life of the equipment. In addition, the lubricant shall not cause contamination of the cryogen which would cause purge equipment failures.

3.1.2.7 Wiring Schematic - Where size and configuration permit, a durable schematic-wiring diagram shall be permanently attached to each electrical or electronic unit. The material which the schematic is made of must be compatible with the equipment and its environment during operation.

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3.1.2.16 Finish - As a design objective, organic or other potentially hazardous finishes shall not be used. Where finishes are required, consideration shall be given to the use of finishes which have a temperature capability equal to or greater than that of the material to which they are applied, and in no case lower than that temperature the equipment may reach under failed conditions.

The finishes to be used on the nitrogen purge equipment shall be submitted to Boeing for approval. Finishes in MIL-STD-1312, Section 14, Book 70, D-5000 may be used as a design guide.

3.1.2.17 Solenoids - All solenoids shall conform to the requirements of MIL-S-4040 Type II.

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3.1.4.3 Environment - The equipment shall be capable of satisfactory performance after exposure to any combination of the following transportation and storage conditions and during exposure to any combination of the following flight conditions:

		<u>Transportation and Storage Conditions</u>	<u>Flight Operation Conditions</u>
3.1.4.3.1	<u>Temperature</u>	-65°F to 160°F	-65°F to 220°F for -1 -65°F to 107.5°F for -2
3.1.4.3.2	<u>Humidity</u>	0 to 100% including condensation	0 to 100% including condensation
3.1.4.3.3	<u>Pressure</u>	Sea Level to 50,000 Ft. Altitude	Approximately 0 to 15 psia
3.1.4.3.4	<u>Vibration</u>	No Requirement	See Figure 5
3.1.4.3.5	<u>Acceleration</u>	No Requirement	Sustained 2 minutes glider acceleration as follows: Forward 7.0G Aft 2.2G Up 4.5G Down 1.1G Lateral ±1.5G
3.1.4.3.6	<u>Shock</u>		
3.1.4.3.6.1	<u>Normal Shock</u>	Drop per paragraph 5.3	3G for 15 milliseconds duration maximum.
3.1.4.3.6.2	<u>Crash Shock</u>	No Requirement	Glider acceleration for 12 milliseconds maximum as follows: Forward None Aft 20G ±20% aft Up 10G Down 5G Lateral ±6.9G ±18.8G aft
3.1.4.3.7	<u>Acoustics</u>	No Requirement	See Figure 7 for -1 See Figure 13 for -2
3.1.4.3.8	<u>Attitude</u>	Any Attitude	Any Attitude
3.1.4.3.9	<u>Explosive Atmosphere</u>	No Requirement	Stoichiometric mixtures of hydrogen and oxygen.

As packaged for transportation and storage

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3.2 Valve Assembly, Nitrogen Purge (10-81170-1)

3.2.1 Description - The Nitrogen Purge Valve Assembly located in the unpressurized equipment bay accomplishes the following functions:

- A. Controls nitrogen flow through the equipment using a shut-off valve which is opened electrically.
- B. Performs a temperature control function for the nitrogen gas entering the Secondary Power Bay by way of this equipment and the distribution tubing.
- C. Provides a flow control function for nitrogen gas entering the purge distribution tubing in order to assure a slight positive pressure within the unpressurized bays of the X-20 glider during descent.

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3.2.2. Design

3.2.2.1 Compatibility - The materials used in construction of the -1 valve assembly shall be compatible with liquid and gaseous nitrogen per MIL-P-27401A.

3.2.2.2 Leakage - Internal-to-external leakage on any component within the -1 valve assembly shall not exceed 0.0005 lb/min.

Internal-to-internal leakage on any component within the -1 valve assembly shall not exceed 0.0001 lb/min.

3.2.2.3 Flow Rate - With reference to Figure 1 the flow rate at Point "D" of the -1 valve assembly and into the purge distribution tubing shall be 0.5 lb/min until the pressure rate of Figure 8 has been reached; at this point the -1 valve assembly shall modulate the flow rate according to the pressure rate requirements of Figure 8 and 9 until touchdown.

3.2.2.4 Flow Direction - The -1 valve assembly shall be capable of flow in the directions shown in Figure 1. A permanent arrow shall be provided on the valve assembly to indicate flow direction. As an option the inlet and outlet may be provided with permanent markings.

3.2.2.5 Purge Volume - The total unoccupied volume within the unpressurized bay is 50 ft³ for nitrogen purging requirements.

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3.2.4 Performance

3.2.4.1 The performance of the -1 valve assembly shall be as specified in the following paragraphs.

3.2.4.2 Pressure Drop - With reference to Figure 1, the pressure drop through the -1 valve assembly and the -2 heater shall not exceed the values specified below for the flow path.

<u>Flow Path</u>	<u>Pressure Drop - Psi</u>
A to D	10

3.2.4.3 Electrical Power Consumption - The electrical power consumption of the -1 valve assembly shall not exceed 70 watts.

3.2.4.4 Temperature - The -1 valve assembly shall be designed for temperatures as specified in the following subparagraphs.

3.2.4.4.1 The nitrogen inlet or supply temperature shall be -300°F to -265°F during operation of the nitrogen purge system.

3.2.4.4.2 The temperature leaving the -1 valve assembly and entering the unpressurized bays shall be controlled to $60 \pm 80^\circ\text{F}$.

3.2.4.5 Back Pressure - Back pressure shall not be allowed to enter the nitrogen tank from the -1 valve assembly.

3.2.4.6 Tubing Segments - With reference to Figure 1, the length of the tubing segments are as specified:

<u>Segment</u>	<u>Length</u>
W - A	40 inches
B - X	48 inches
Y - C	48 inches
D - Z	120 inches

3.2.4.7 Shutoff Operation - The shut-off function shall be capable of satisfactory operation using 23 to 30 VDC power.

The shut-off function shall be controlled by a normally closed solenoid (closed when not energized). A latching type solenoid shall be used to assure that closing of the valve shall not occur after being opened. Energization of the latching solenoid from ground power shall permit the shut-off function to close.

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3.3 Heater, Nitrogen Purge (10-81170-2)

3.3.1 Description - The -2 heater located underneath the unpressurized Equipment Bay accomplishes the following:

- A. Stores thermal energy absorbed during re-entry to vaporize liquid nitrogen for the unpressurized bay purging requirements during descent. The thermal energy stored results from structural radiation due to aerodynamic heating during re-entry. For the heater position in relation to the radiating surface (see Figure 11).
- B. Stores thermal energy from ground electrical power to vaporize liquid nitrogen for the unpressurized bay purging requirements after a boost abort condition. The thermal energy stored results from electrical resistance incorporated into the heater design.
- C. Stores thermal energy from B-52 electrical power to vaporize liquid nitrogen for the unpressurized bay purging requirements after the air launch.

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SCALE	AF 33(657)-7132	SH 24

3.3.2 Design

3.3.2.1 Compatibility - The materials used in construction of the -2 heater shall be compatible with liquid and gaseous nitrogen per MIL-P-27401A.

3.3.2.2 Leakage - Internal-to-external leakage of the -2 heater shall not exceed .0001 lbs/min.

3.3.2.3 Flow Capacity - The flow capacity through the -2 heater shall be as required to comply with the requirements of Figure 8 and 9 and the temperature outputs of paragraph 3.2.4.4.2.

3.3.2.4 Flow Direction - The -2 heater shall be capable of flow in the direction shown in Figure 1. The inlet and outlet shall be provided with a permanent marking to indicate flow direction.

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SCALE	AF 33(557)-7-32	SH 25

3.3.3 Construction

3.3.3.1 Pressure - The design pressure of the -2 heater shall be as required to meet the requirements of the -1 valve assembly and the purging requirements of the Secondary Power Bay and the unpressurized Equipment Bay.

3.3.3.2 Emissivity

3.3.3.2.1 The emissivity of all surfaces of the -2 heater, except that surface specified in paragraph 3.3.3.2.2, shall not exceed 0.1 over a maximum temperature of 950°F for its life.

3.3.3.2.2 The emissivity of the bottom surface of the -2 heater facing the corrugated surface as shown in Figure 11 shall be as required to comply with the performance requirements of paragraph 3.3.4.

3.3.3.2.3 The emissivity of all Rene 41 surfaces seeing the -2 heater as shown in Figure 11 is 0.70.

3.3.3.2.4 The average emissivity of the water wall surface is .125 throughout the temperature range of Figure 10.

3.3.3.3 Temperature Switch - A temperature switch, which shall be capable of operating from ground power as specified in paragraph 3.1.2.10, shall be provided to control the -2 heater temperature to $375 \pm 25^\circ\text{F}$. A snap action type switch shall be used utilizing the power requirements of paragraph 3.3.4.3 and capable of withstanding the ambient temperature of paragraph 3.1.4.3.1 (for -2) without loss of its calibration point.

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SCALE	AF 33(657)-7-32	SH 26

3.3.4 Performance

3.3.4.1 The performance of the -2 heater shall be as specified in the following paragraphs.

3.3.4.2 Pressure Drop - The pressure drop across the -2 heater shall comply with the requirements of paragraph 3.2.4.2.

3.3.4.3 Electrical Power Consumption - The total electrical power consumption of the -2 heater shall not exceed 300 watts for ground heating requirements.

The -2 heater shall be capable of operating within the power requirements of paragraph 3.1.2.10.

3.3.4.4 Temperature - The temperature of the inside radiating surface under the -2 heater for any time after launch will be as specified in Figure 10.

3.3.4.5 Surrounding Structure - The location of structure surrounding the -2 heater will be as shown in Figure 11.

3.3.4.6 Heat Storage Capacity - The minimum heat storage capacity of the -2 heater above a 100°F reference shall be 2300 Btu. for vaporization of liquid nitrogen during normalinflight operation after re-entry.

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4.5.4 Leak Test - Each article shall be pressurized to its maximum design working pressure. The leakage shall not exceed the limits specified in Paragraphs 3.2.2.2 and 3.3.2.2 for each article.

4.5.5 Proof Test - Each article shall be pressurized to its design proof pressure. No permanent deformation or operational failure shall result. The leakage shall not exceed the limits specified in Paragraphs 3.2.2.2 and 3.3.2.2 for each article.

4.5.6 Burst Test - Each article shall be pressurized to its design burst pressure. The leakage shall not exceed the limits specified in Paragraphs 3.2.2.2 and 3.3.2.2 for each article. Permanent deformation and operational degradation shall be acceptable.

4.5.7 Life Test - To determine that the equipment is suitable for the operational life indicated in 3.1.4.1, a life test shall be conducted with the equipment operating under nominal flight conditions for a period of 100 hours, except for rotating parts which shall demonstrate a life capability of 2000 hours. Servicing shall be accomplished at 500 hour intervals, except for cryogenic bearings which shall be serviced every 100 hours. Instrumentation shall be required to show that the equipment operates per the requirements of Section 3 of this specification.

4.5.8 Radio Interference Test - Radio interference tests shall be conducted on each article of equipment in accordance with MIL-1-26600.

4.5.9 Operational Test - Operational tests of the integrated purge equipment shall be conducted to assure that the proper range of design outputs is obtained when the equipment is supplied the range of design inputs. The tests shall show that the equipment operates normally with adequate response. Operation conditions and parameters shall be recorded. Operational tests shall be conducted using a simulated inservice installation.

4.5.10 Dielectric Strength Test - The equipment shall withstand without breakdown, the high potential test voltage requirements of Paragraph 3.1.2.15. Capacitors and semiconductor devices shall be disconnected for this test if necessary.

4.5.11 Cycling Test - Debugging tests designed to assure that "weak" elements fail shall be conducted. This testing shall be designed to eliminate early failures due to manufacturing type defects such as faulty components or workmanship and shall be based primarily on elements and operating conditions found during development and qualification testing to be critical to satisfactory operation. Until sufficient data is obtained to establish a minimum value, each article shall be fully cycled 500 times. The vendor may, as experience and improvement reduce the number of initial failures, recommend reductions in the minimum amount of operating time necessary at the manufacturer's facility. Upon approval by the Boeing Engineering Department, the above requirements will be revised.

4.5.12 High-Temperature Test - The equipment shall be tested in accordance with paragraph 4.1.2 of MIL-E-5272C except exposure time shall be as required to maintain an equilibrium temperature of 220°F.

4.5.13 Low-Temperature Test - The equipment shall be tested in accordance with paragraph 4.2.1 of MIL-E-5272C.

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4.5.14 Ignition and Explosion Test - The equipment shall be tested in accordance with paragraph 4.13, Procedure III of MIL-E-5272C, except a stoichiometric mixture of hydrogen and oxygen shall be used in place of gasoline and air.

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5.0

PREPARATION FOR DELIVERY

5.1

Packaging and Marking - Packaging and marking of the articles procured by this specification shall be in accordance with the provisions of D2-80396, Section 14.

5.2

Sealing of Ports - Each port shall be sealed with a clean temporary, removable, re-usable cover or plug. Threaded plugs of soft metal, polyethylene or other materials which may flake and cause contamination shall not be used. The equipment shall meet the requirements of 3.1.3.2 as shipped.

5.3

Shipping Container - The shipping container shall be designed such that shocks as a result of dropping the container shall not cause damage to the packaged equipment within or require an increase in the weight of the equipment. The magnitude of the shocks shall be based upon dropping the container with the packaged equipment therein once on each face upon a flat concrete surface. The height of drop shall be determined from the following table:

<u>Weight of Container with Article Installed</u>	<u>Drop Height Inches</u>
0 - 20	42
20 - 50	36
50 - 100	32
100 - 250	30

Shipping container testing shall not be conducted.

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6.4.2 A task list including manhours, individual responsible, and start and completion scheduling to provide control of the following reliability actions required in D2-80396:

- A. Reliability Analysis (Paragraph 7.1.2.1/c/)
- B. Compatibility Factors (Paragraph 7.1.2.1/d/)
- C. Preliminary and Critical Design Reviews (Paragraph 8.1.1 and 8.1.2)
- D. Hardware Review (Paragraph 8.2)
- E. Demonstration Plan (Paragraph 7.1.3.2)

6.4.3 A brief description of the Manufacturing and Quality Control Record System.

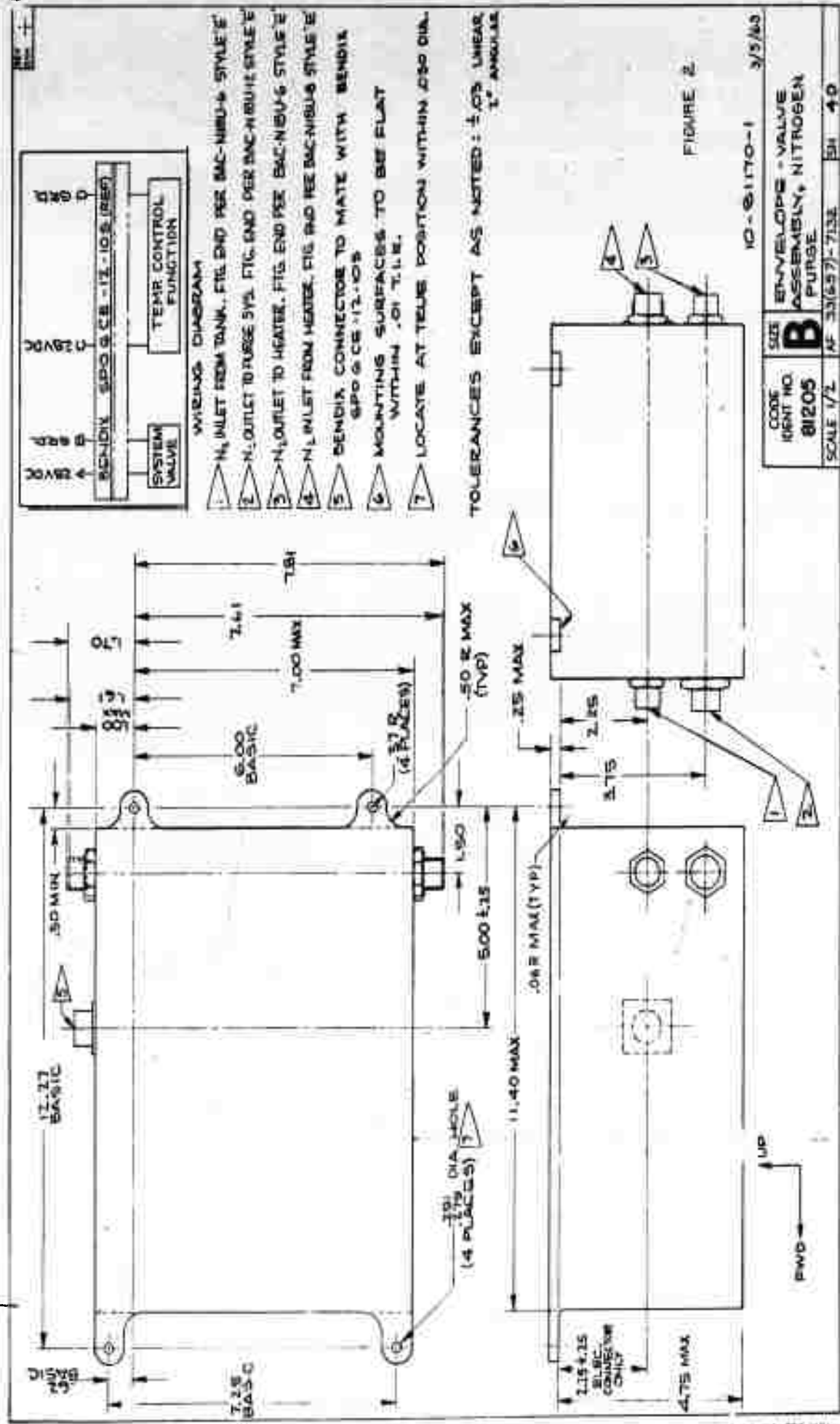
6.5 Design Check List - The vendor shall provide a design check list for each article procured by this specification. The list shall comprise a tabulation of items which the vendor considers in the hardware design in order to assure reliability. An example page of a design check list is shown as Figure 12.

The design check list shall be utilized by the vendor during hardware design to ensure that features which assure hardware reliability are incorporated. During the reviews required by paragraph 8.0 of D2-80396, the hardware design, and the actual hardware when available, will be inspected for incorporation of design features contained in the list.

As a minimum, the design check list shall include the following:

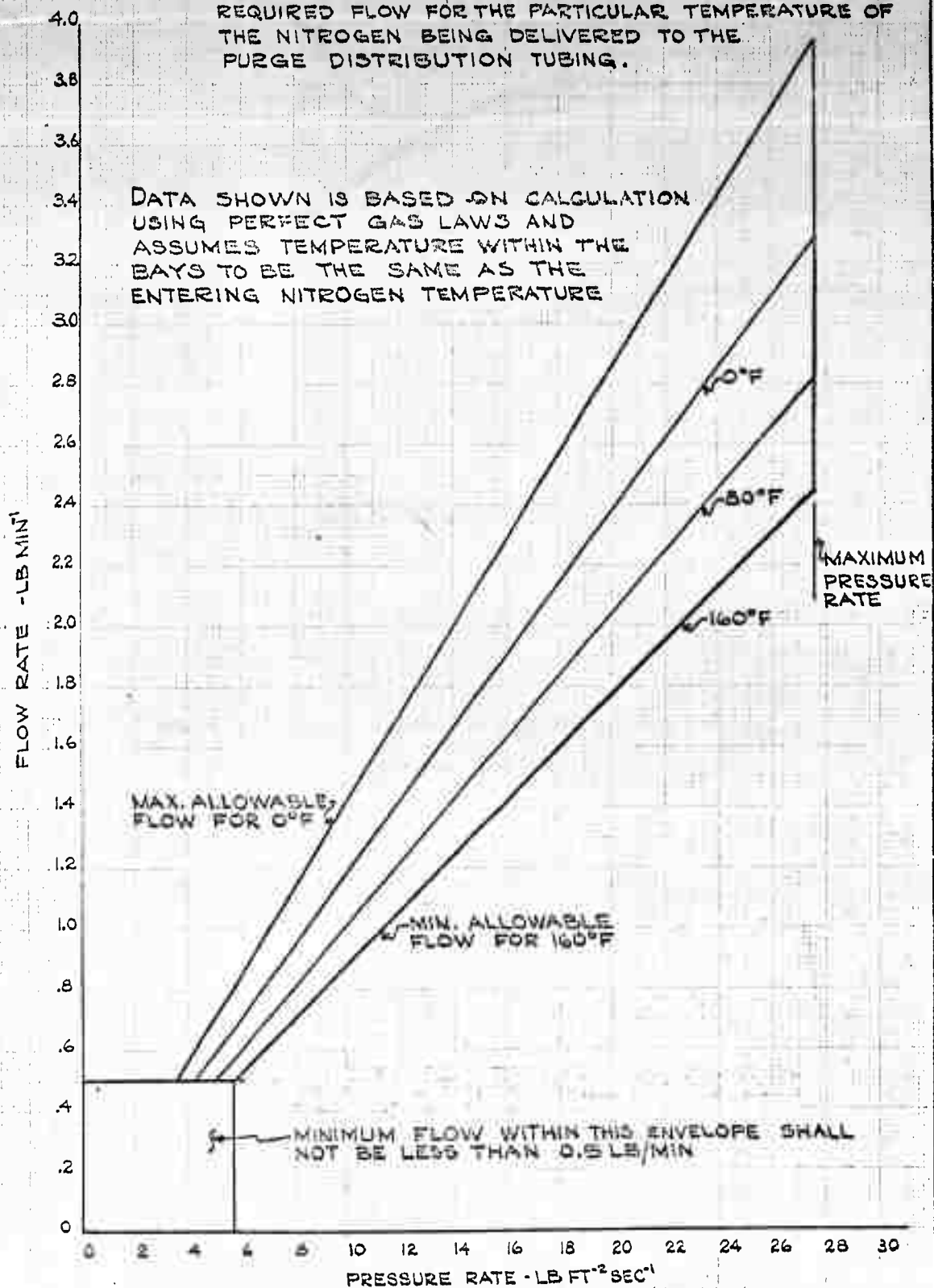
- A. Establish design concepts to enable recognition and resolution of problem areas as uncovered by the failure mode and effect analysis. (see paragraph 7.1.2.1c of D2-80396).
- B. New design practices and procedures, fabrication techniques, and processes developed to support the hardware design.
- C. Current standard practices and/or procedures which are considered a normal part of good design and are applicable to the hardware.

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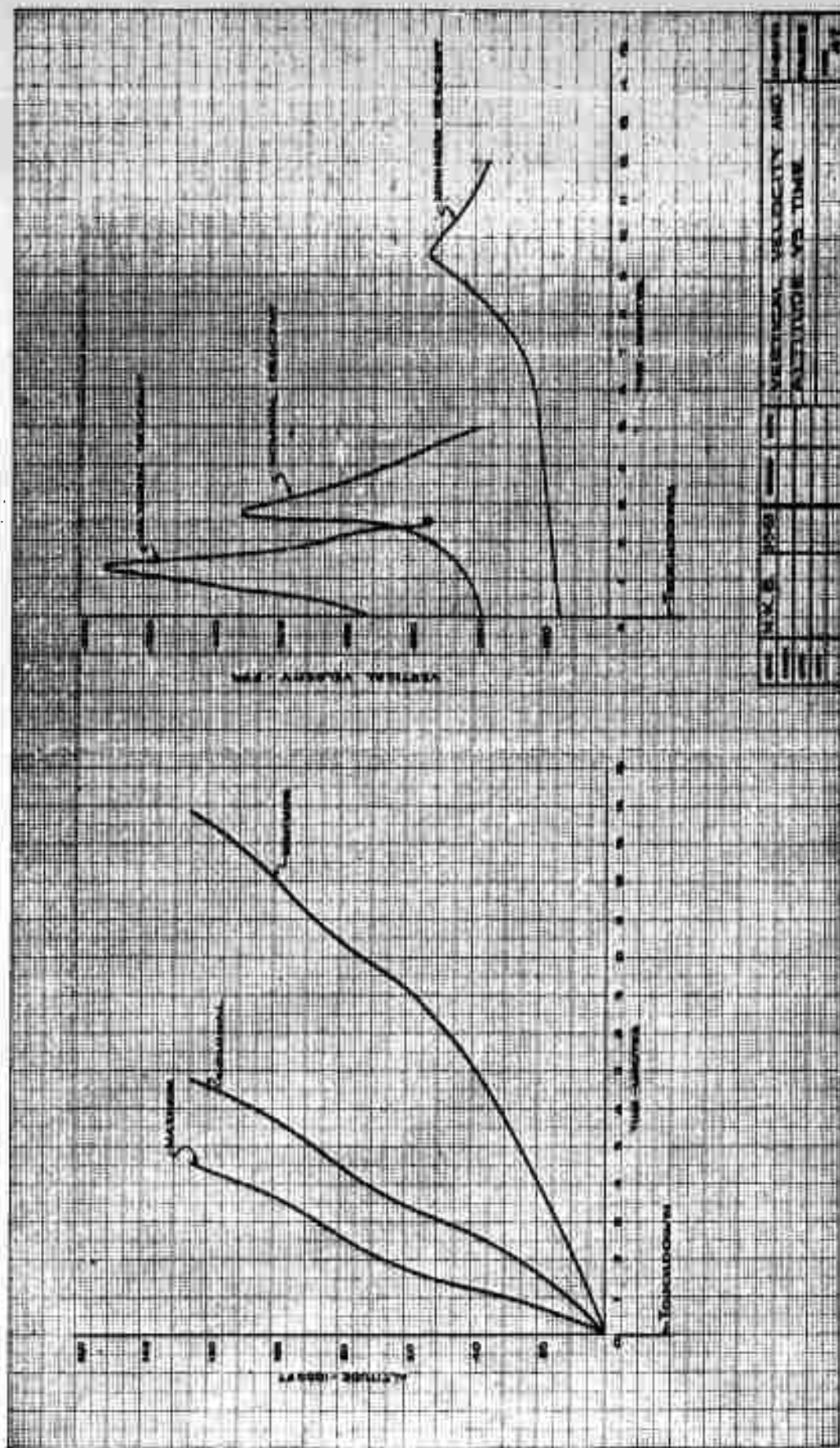


NOTE: FLOW SHALL BE WITHIN $\pm 20\%$ OF THE THEORETICALLY REQUIRED FLOW FOR THE PARTICULAR TEMPERATURE OF THE NITROGEN BEING DELIVERED TO THE PURGE DISTRIBUTION TUBING.

DATA SHOWN IS BASED ON CALCULATION USING PERFECT GAS LAWS AND ASSUMES TEMPERATURE WITHIN THE BAYS TO BE THE SAME AS THE ENTERING NITROGEN TEMPERATURE

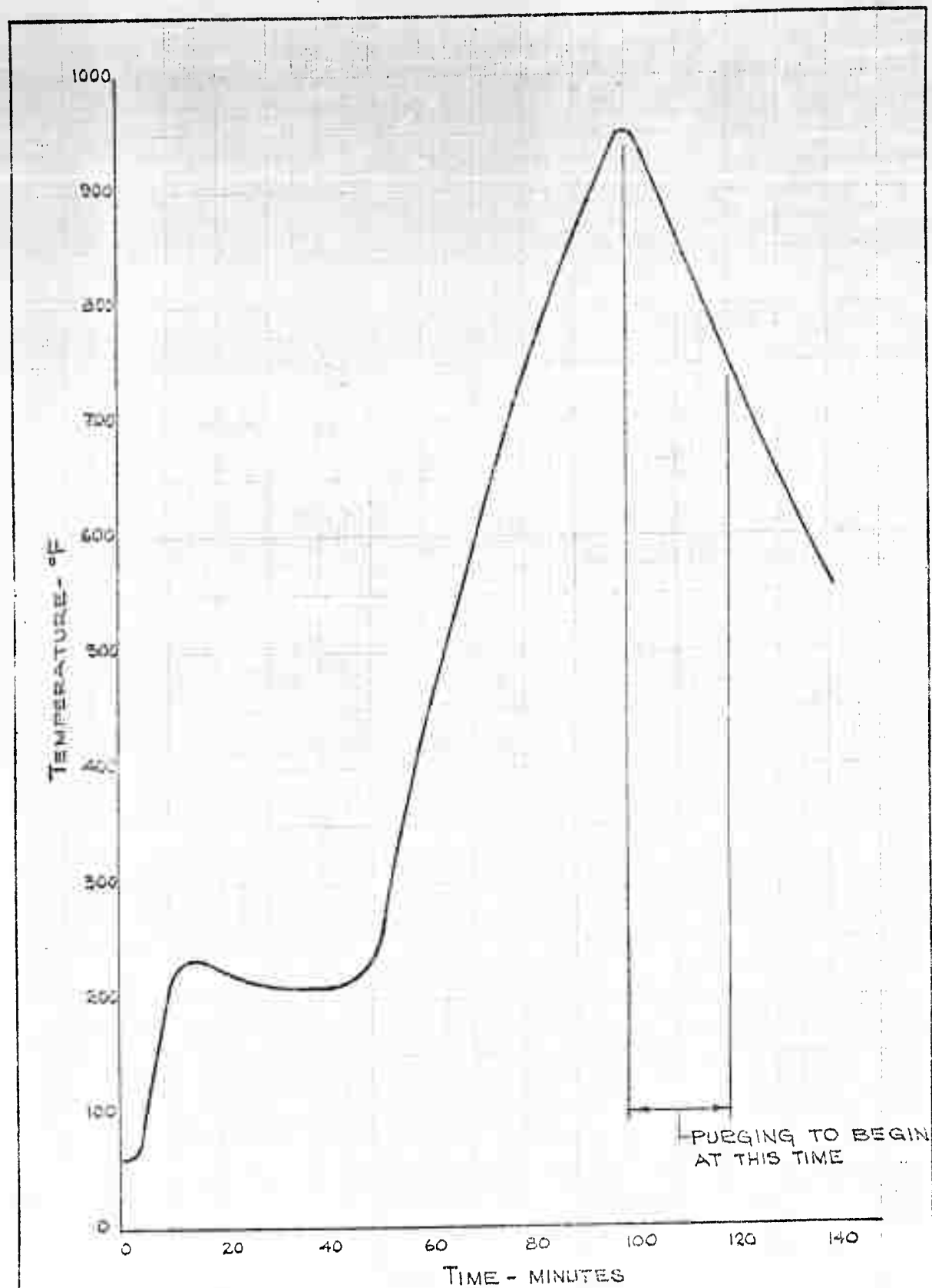


CALC	N. K. B.	3-5-63	REVISED	DATE	ENVELOPE, FLOW RATE VS AMBIENT PRESSURE RATE	10-81170
CHECK						FIGURE 8
APR						
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					THE BOEING COMPANY .	PAGE 46



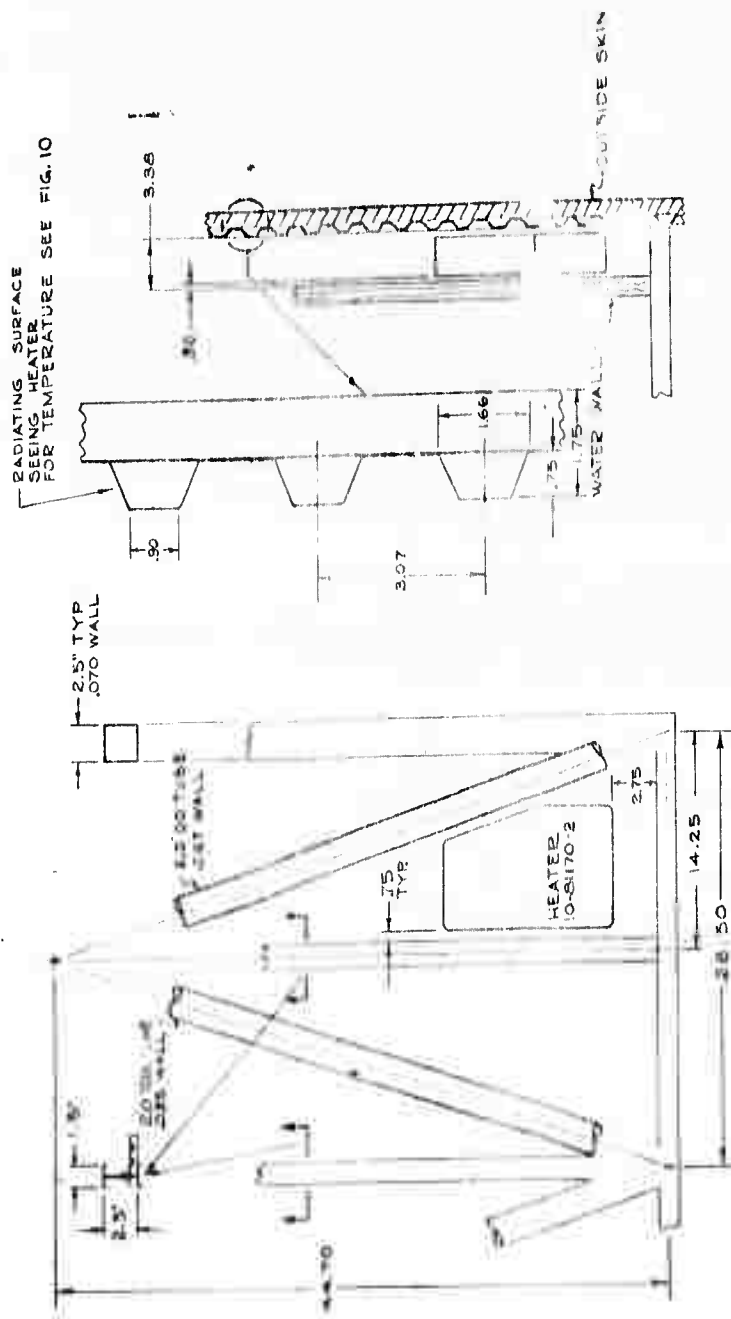
VELOCITY - VELOCITY AND ALTITUDE VS TIME	
TIME	VELOCITY
0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
10	10

US 400 1000



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CHECK						FIGURE 10
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SURROUNDING STRUCTURE

FIGURE 11

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NOTES:
ALL MATERIALS SURROUNDING HEATER ARE RENE 41

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