QUALIFICATION TEST REQUIREMENTS: X-20, ELECTRICAL POWER DISTRIBUTION SYSTEM, POWER BOXES AND DIODE ASSEMBLY. MODEL NO. X-20A

Boeing Company
Seattle, Washington

1 February 1963

THE BOEING COMPANY

ASD(ASZRA)

NUMBER D2-80377-1

UNCLASSIFIED TITLE QUALIFICATION TEST REQUIREMENTS: X-20 ELECTRICAL POWER DISTRIBUTION SYSTEM, POWER BOXES AND DIODE ASSEMBLY

MODEL NO. X-20A CONTRACT NO. AF33(657)-7132

ISSUE NO. _____ ISSUED TO _____

CLASSIFIED TITLE _____
(STATE CLASSIFICATION)

_____

_____

_____

CHARGE NUMBER

PREPARED BY J. Evans J. Evans 1-30-63

SUPERVISED BY I. Weiner I. Weiner 1-30-63

APPROVED BY K. [illegible] 31 Jan 63

CLASS. & DISTR. APPROVED BY Operations Staff Office [illegible] 1 Feb 63

DISTRIBUTION STATEMENT A
Approved for public release; Distribution Unlimited

"Approved for public release; distribution unlimited"

VOL NO. _____ OF _____

SECTION NO. _____

page 1 of 16

REVISED

TITLE PAGE

ACTIVE-CHANGED PAGE

ACTIVE			CHANGED					ACTIVE			CHANGED				
				PAGE								PAGE			
SECTION	PAGE	DATE	SECTION	REVISED	ADDED	DELETED	DATE	SECTION	PAGE	DATE	SECTION	REVISED	ADDED	DELETED	DATE
	1														
	2			C											
	3			B											
	3.1				C										
	4														
	5														
	6			C											
	7			B											
	8			B											
	9			C											
	10			C											
	11			C											
	11.1				C										
	12			C											
	13			C											
	14														
	15			C											
	16														
	10.1				B										

REVISED C

BAC 4131 C

page 2

REVISIONS

REVISIONS

SYM	DESCRIPTION	DATE	APPROVED
C	Page 2 - Revised page list to include revision C change.		
	Page 3.1 - Added new page to detail revision C changes.		
	Page 6 - Deleted reference 3.1.		
	Page 9 - Revised TABLE 3: Test sequence		
	Page 10 - Revised 5.8.1.1 and 5.8.1.2 to define configuration requirements.		
	Page 11 - Revised 6.6.1, 6.5 & 6.6 to clarify wording.		
	Page 11.1 - Added new page to define new altitude requirement for the T-R Diodes.		
	Page 12 - Deleted analysis in lieu of test for 6.7 and 6.8.1. Deleted equipment compartment assemblies from 6.8.1.		
	Page 13 - Deleted 6.9.3.1, test modification for Main Power Box		
	Page 15 - Revised 6.13 to show oxidation test as requirement for pilot's compartment assemblies only. Corrected typographical error in 6.10.		

BO-2-9500 Change
J. K. Evans 10-8-3
L. Wenier 10-7-3

1.0 TABLE OF CONTENTS

2.0 ACKNOWLEDGEMENT

The following individuals have made significant contributions to the preparation of this document:

W. Quayle
J. Hess

3.0 REFERENCES

3.1 DELETED

3.2 ASNR 62-18 Preliminary Flight Rating Test Document, Glider/Transition Section Subsystems, Components or Units, SPO; 6 July 1962 Revision.

3.3 D2-80600 Glider/Transition Detail Specification, dated 1 August 1962.

3.4 Source Control Drawing 10-20902, Revision J dated January 4, 1963. "Generator and Controls Unit - Alternating Current"

3.5 DELETED

3.6 DELETED

3.7 Bulletin Nr 520, USAF Specification, dated 17 May 1960

3.8 Proposed Test Code for Aircraft Equipment Electrical Insulation, No. 803 American Institute of Electrical Engineers, July, 1957

4.0 INTRODUCTION

This document contains the qualification test requirements for the Boeing built X-20 electrical power distribution system and electrical system components, reference 3.1, 3.2 and 3.3. Table 1, below, outlines the qualification test documentation for the above equipment, reference 3.1, paragraph 1.1.3.2.

TABLE 1: QUALIFICATION DOCUMENTATION FOR BOEING BUILT ITEMS OF X-20 ELECTRICAL SYSTEM

SUBJECT	DOCUMENT NO.	ITEM
Qualification Test Requirements	D2-80377-1	Aft D.C. Fuse Panel Aft Relay Panel, Blocking Diode, Electrical Distribution Sys., Forward A.C. Fuse Panel Forward D.C. Fuse Panel Forward Relay Panel Main Power Box, and Manual Flight Control Fuse Panel
Qualification Test Procedure	D2-80377-2 Vol.I-IX	Same as above
Qualification Test Report	D2-80377-3 Vol.I-IX	Same as above
Qualification Test Log	D2-80377-4 Vol.I-IX	Same as above

The electrical system operation, performance characteristics and power quality requirements of the X-20 glider are specified in references 3.4, 3.5 and 3.6. Qualification tests are required to verify that the electric system will both deliver the required quantity and quality of electric power necessary for glider operation, and protect the system from abnormal conditions.

Qualification tests for purchased equipment items of the X-20 electric system are to be found in the source control drawings listed in table 2, below.

TABLE 2: PURCHASED EQUIPMENT FOR X-20 ELECTRICAL SYSTEM

ITEM	SOURCE CONTROL DRAWING
APU Restart Battery	10-81139-3 & -4
Dead Facing Switch	10-81116
Generator & Controls Unit	10-20902
Glider/Booster Staging Connector	10-81060
Ground Umbilical Connector	10-81010
Hatch Jettison Battery	10-81139-1 & -2
High Temperature Connector	10-81008
High Temperature Wire	10-81006
Master Warning Light System	10-81134
Overheat Detecting System	10-81112
Thermocouple Sensors	10-20924
Transformer - Rectifier	10-20908

5.0 GENERAL REQUIREMENTS

5.1 Test Facilities The apparatus used in conducting tests shall be capable of producing and maintaining the test conditions required, with the equipment under test installed in the chamber and operating or non-operating as required. Changes in test chamber conditions may be the maximum permitted by the test chamber, but shall not exceed the applicable requirements.

5.1.1 Volume The volume of the test facilities shall be such that the bulk of the equipment under test shall not interfere with the generation and maintenance of test conditions.

5.1.2 Heat Source The heat source of the test facility shall be so located that radiant heat shall not fall directly on the equipment under test.

5.1.3 Standard Conditions Conditions for conducting the equipment operational test shall be as follows:

(a) Temperature: 25 ±10°C (77 ± 18°F)
(b) Relative humidity: 90 per cent or less
(c) Barometric pressure: Local standard (correct to 28 to 32 inches of mercury if so specified in the applicable design requirements.)

5.2 Measurements All measurements shall be made with instruments the accuracy of which conforms to the requirements of Bulletin Nr 520, dated 17 May 1960. Unless otherwise specified, the maximum allowable tolerances on test conditions shall be as follows:

(a) Temperature: Plus or minus 2°C (3.6°F) exclusive of instrument accuracy.
(b) Altitude: Plus or minus 5 per cent (in feet).
(C) Relative humidity: Plus 5 per cent minus 0 per cent of R.H. value.
(d) Vibration amplitude: Plus or minus 10 per cent.
(e) Vibration frequency: Plus or minus 2 per cent.
(f) Additional tolerances: Additional tolerances shall be as specified.

5.3 Test Sequence: The tests shall be performed in the numerical sequence specified in Table 3, page 9.

5.4 Performance Record Prior to conducting any of the tests specified herein, the equipment shall be subjected to a functional test under standard conditions and a record made of all data. This data shall provide the criteria for checking satisfactory performance of the equipment during or after environmental tests. Where the design requirements establish the level of acceptable performance for the test procedure, a detailed pre-exposure performance record shall not be made. Equipment in this latter category shall be operated prior to test to insure that no malfunction exists.

TABLE 3: TEST SEQUENCE (1)

ITEM	Sample No.	Inspection 6.2	Operation 6.3	System Performance 6.4	High Temperature 6.5	Altitude 6.6	Acceleration 6.7	Vibration 6.9	Shock 6.8.2	Shock 6.8.1	Dielectric Strength 6.10	Corona 6.11	Fault Proof 6.12	Oxidation 6.13
Main Power Box	1 2 3	1 1 1	2 2 2	(2)	3	4	3	4	5		6 7	5	6	
Forward A.C. Fuse Panel	1	1	2	(2)	(3)	(3)	4	5	6	8	7	(3)	(3)	3
Forward D.C. Fuse Panel	1	1	2	(2)	(3)	(3)	3	4	5	7	6	(3)	(3)	(4)
Forward Relay Box	1 2	1 1	2 2	(2)	3	4	3	4	5	7	6 5	(3)	(3)	(4)
Aft D.C. Power Box	1 2	1 1	2 2	(2)	3	4	3	4	5		6 5	(3)	(3)	
Manual Flight Control Fuse Panel	1	1	2		(3)	(3)	3	4	5	7	6	(3)	(3)	(4)
Transformer-Rectifier Diode Assy	1 2 3	1 1 1	2 2 2	(2) (2)	3	3 4 3	4	5	6	8	7 6	(3)	(3)	5
Electrical Distribution System		1	2	3										

(1) Items are to be tested in the numerical sequence shown.

(2) Test sample will be used as a component part of system for system tests.

(3) Article will be qualified by similarity to Main Power Box, because of identical materials, parts and processes.

(4) Article will be qualified by similarity to Fwd. A.C. Fuse Panel, because of identical materials, parts and processes.

5.5 Installation Check Following installation in the test facility and prior to test, the equipment shall be operated sufficiently to insure that no malfunction or damage was caused due to faulty installation procedure or handling.

5.6 Criteria for Failure Deterioration or change in performance of any subsystem, component, or unit which in any manner could prevent the equipment from meeting the mission requirements shall provide reason to consider the equipment as having failed to comply with the conditions of the test to which it was subjected.

5.6.1 Failure of Parts When a part fails during test, the test shall be stopped and the failure analyzed and reported through the established failure reporting procedure. Where the failure of the part adversely affects other equipment, then all previous tests shall be rerun on the equipment with the replacement part installed.

5.7 Evaluation of Equipment When so stated, the equipment undergoing test shall be operated to permit performance data to be obtained, or inspected for evidence of deterioration. The performance data of the equipment under test conditions shall be satisfactorily comparable to that obtained in compliance with 5.4. Any deterioration observed shall not exceed that defined in 5.6.

5.8 Quality Assurance R

5.8.1 Configuration Control and Accountability

5.8.1.1 Qualification test power boxes shall be representative of the flight hardware. Differences between the qualification test boxes and the flight hardware for the Glider 01 shall be defined in the qualification test procedures.

5.8.1.2 In cases where availability of BAC standard or 27-XXXX parts (such as resistors, relays, diodes, etc.) are such as to delay substantially the qualification test program, substitutions will be made with parts nearly identical in the characteristics being tested. In no case shall the parts to be used in the qualification test boxes be superior to those used in the flight hardware. These substitutions, along with an explanation of the differences, will be defined in the qualification test procedures. The parts to be used in the flight power boxes will be separately qualified under individual specification control drawings.

5.8.1.3 The electrical power box qualification test samples will be built to drawings released for glider 01. These drawings will also indicate the differences between the flight hardware and the qualification test boxes and will be used to control the configuration of qualification test boxes.

5.8.1.4 ECM and ANCN changes in the flight hardware will not necessarily be incorporated in the qualification test samples. For each change, the Design Project will determine whether the change is of sufficient magnitude to violate 5.8.1.1 above and only if so, will the change be incorporated. The drawings described in item 5.8.1.3 above will be maintained to show the status of change incorporation in qualification test samples.

6.0 TEST REQUIREMENTS

6.1 General The tests outlined in this section shall be performed as specified in Table 3, Page 9.

6.2 Inspection Test A visual inspection shall be conducted to determine equipment conformance with respect to weight, materials, mechanical details, workmanship, dimensional accuracy, electrical circuitry and finish requirements of the applicable specification and production drawings. Actual weights shall be tabulated.

6.3 Operational Checks Operational checks such as energization, de-energization, interlocks, switching functions, transfer functions, limiting devices, etc., shall be conducted to demonstrate equipment performance in compliance with the limits and tolerance specified in the design requirements. This data shall be recorded.

6.4 System Performance Tests shall be performed, using standard conditions of environment to assure the proper functioning and compatibility of all system elements when interconnected to simulate the glider installation.

(a) Take into account all possible normal operating conditions.

(b) Take into account emergency and abnormal conditions such as faults, malfunctions of equipment and improper operating procedures.

(c) Demonstrate that the system fulfills its design requirements. This shall entail the functioning of all system requirements.

6.5 High Temperature The test specimen shall be subjected to a temperature of 160°F for a period of 48 hours. A relative humidity of not more than 15 percent shall be maintained in the test chamber throughout the exposure period. At the conclusion of the exposure period and while still at the test temperature. The equipment shall be operated as specified in 5.7. The temperature shall be returned to that of standard conditions and the equipment again operated and inspected visually as specified in 5.7. <1

6.6 Altitude The test specimen shall be subjected to an ambient pressure of 0.02 psia (150,000 feet) or less and an ambient temperature of 160°F. The equipment shall be maintained under these conditions for one hour. At the conclusion of this period and while altitude and temperature conditions are maintained, the test specimen shall be operated for two hours with load followed by operation as specified in 5.7. <1

6.6.1 Test Modification for T-R Diode Assembly

1> The Forward A.C. Fuse Panel, Forward D.C. Fuse Panel, and Manual Flight Control Fuse Panel will not be tested to this requirement because they contain materials, parts and processes identical to those of the Main Power Box and will, therefore, be qualified by similarity to the Main Power Box, see TABLE 3.

6.6.1.1 Altitude. The test shall be conducted per 6.6 with a 50 ± 0.5 watt load and cooling air flow of 0.2 ± 0.02 pounds per minute at 85° ± 2°F with a pressure drop across the 20-81267-1 assembly of 2.0 $^{+0}_{-2.0}$ inches of water when load is required. Diode case temperature must not exceed 120° ± 2°C (248°F).

6.6.1.2 Loss of Cooling. Test operation per 5.7 of 6.6 must include operation with no forced air cooling and the following load conditions: 5 to .5 minutes at 30 ± 0.5 watts load followed by 3 hours ± 0.5 minute at a load of 1 ± 0.1 watt. Diode case temperature per this test must not exceed 140° ± 2°C (284°F).

6.7 Acceleration The test specimen shall be mounted in a suitable centrifuge and subjected to the following steady accelerations, in succession:

Direction of Acceleration (Glider Reference Axes)	Acceleration G's ($\pm^{10}_{5}$% Tolerance)
Forward	7
Aft	2.2
Vertical	4.5
Vertical	1.1
Lateral	±1.5

The accelerations shall be maintained for two minutes in each direction, or longer if required to check the operation of the item. The test specimen shall be operated following the test as specified in 5.7. The acceleration shall be continuously monitored during the tests, and the acceleration-time data included in the test report. The test specimen shall show no failures, malfunctions, or out-of-tolerance performance as a result of the tests.

6.8 Shock

6.8.1 Crash Safety Shock The test item shall be capable of withstanding the accelerations as follows:

Fwd A.C. Fuse Panel, Fwd D.C. Fuse Panel, Fwd Relay Box, T/R Diode Assy, Manual F/C Fuse Panel

40g	Aft Acceleration
40g	Accelerations 20° to right of the aft direction
40g	Acceleration 20° to left of the aft direction
10g	Acceleration down
20g	Acceleration upward

During this loading the test item shall not break apart nor break loose from its mountings. The test item shall not be expected to perform during or after such loading.

6.8.2 Bench Handling Shock The test specimen shall show no damage and shall operate as specified in 5.7 after performance of the following tests:

a. The test specimen shall be placed in a suitable position on a smooth, hard bench top. Using one edge as a pivot, tilt up the equipment so that the opposite bottom edge is 4 inches from the bench top, or as high as practicable without unbalance, whichever is less, and permit the specimen to drop freely to drop freely to the bench top, repeat for a total of two such drops. Repeat using all other practicable edges of the same horizontal face as pivots.

b. Repeat (a), with the equipment resting on all other faces on which the equipment could be placed during servicing.

c. Subject the equipment to two-inch free drops on each face on which the equipment could be dropped during servicing and handling. Use the same bench surface as above.

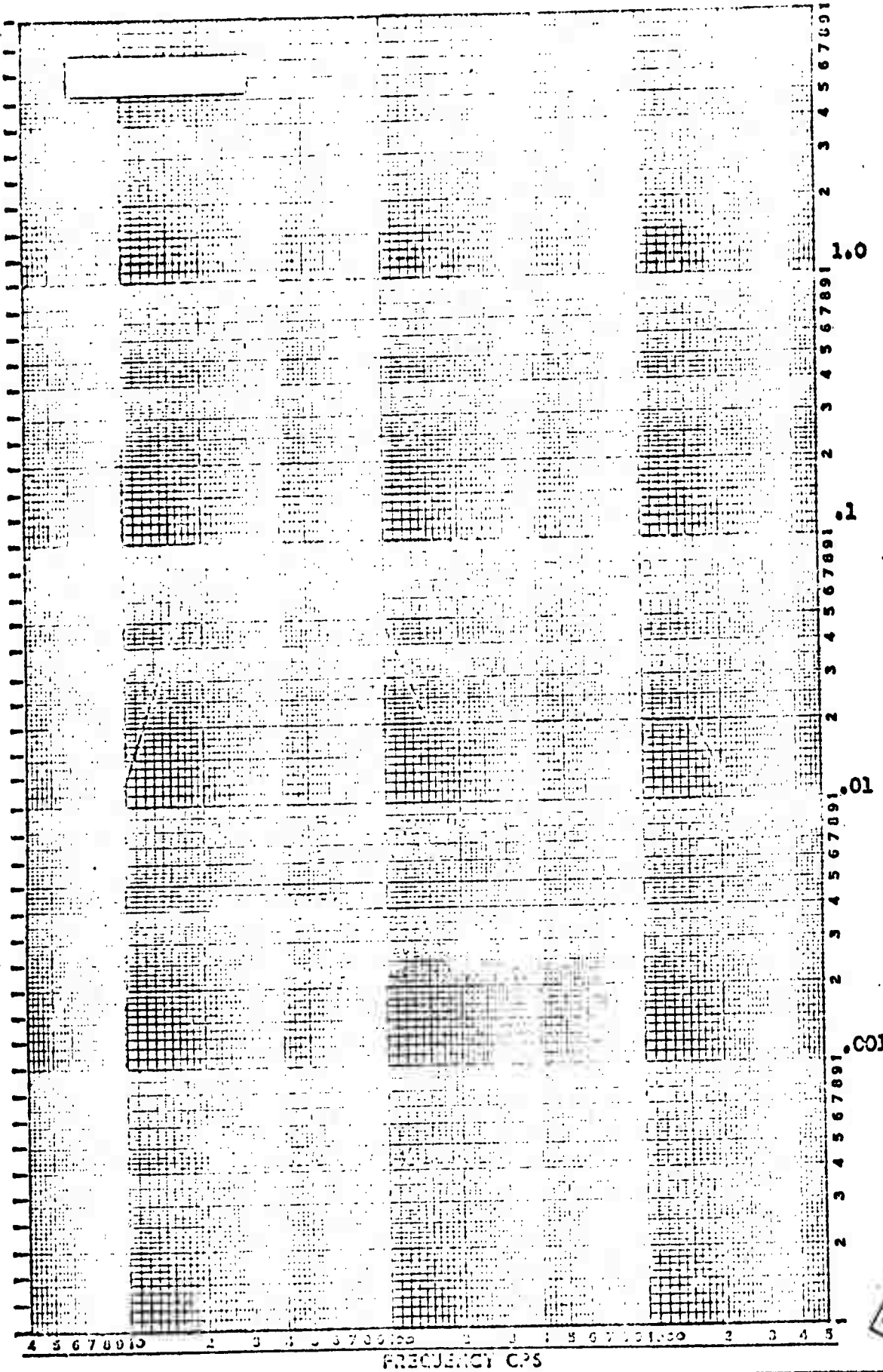
6.9 Vibration

6.9.1 Test Installation The equipment shall be mounted on a suitable vibrator using actual mounting brackets, if feasible, or a rigid fixture.

6.9.2 Preliminary Scans Sinusoidal vibration scans shall be conducted in each of three mutually perpendicular axes, following the envelope of Figure 2, page 16. The equipment shall be non-operating. The equipment shall be closely observed during t e scans, and the frequencies and mode shapes of all resonances below 200 cps carefully noted. The preliminary scans shall be repeated with the equipment operating, and any changes of resonant frequencies or mode shapes shall be noted. All data on resonances below 200 cps shall be included in the final test report.

6.9.3 Random Vibration Test Following completion of the preliminary scans, a random vibration test shall be conducted in succession in each of three mutually perpendicular axes under appropriate vibration conditions within the vibration envelope of Figure 1, page 14. The test duration shall be 1/2 hour in each axis. The equipment shall operate throughout the test as specified in 5.7.

6.9.3.1 DELETED



			REVISED	DATE
CALC				
CHECK				
APPR				
APPR				

VIBRATION TEST ENVELOPE FOR EQUIPMENT IN PRESSURE COMPARTMENTS

FIG. 1

D2-30377-1

THE BOEING COMPANY

PAGE 24

2-3334-23

6.10 Dielectric The insulation and spacing of the test specimen shall be capable of withstanding without breakdown a 60 cps potential of 1500 volts RMS, applied for one minute, between current carrying circuits and any non-current carrying metal part which may be grounded; capacitors, semiconductors and ground connections may be disconnected as required. This potential value applies to the first application only, where succeeding test applications are specified a value of 1125 volts RMS shall be used ref. 3.8.

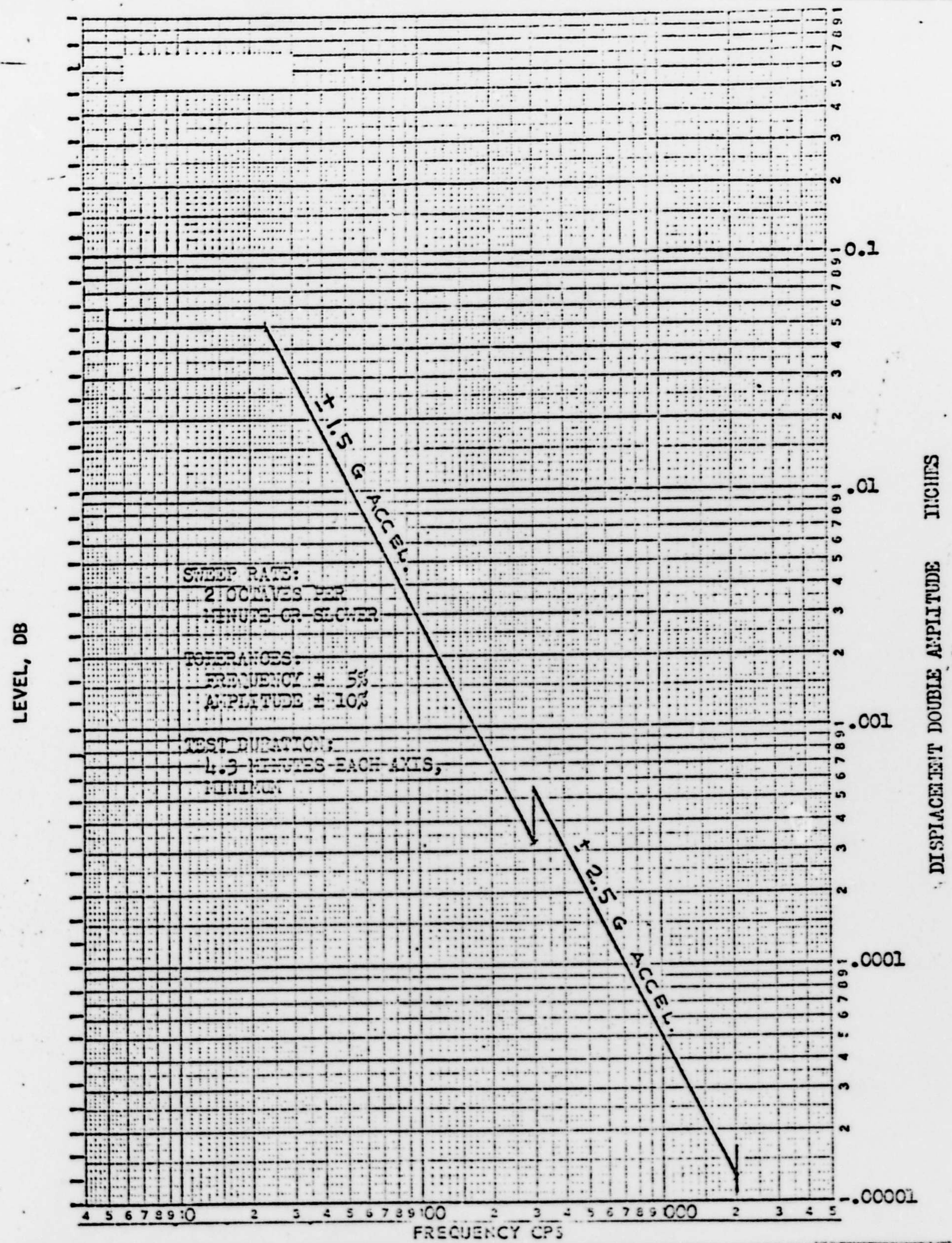
6.11 Corona Note: This requirement applies to Main Power Box only.

There shall be no evidence of corona when the Main Power Box is operated in a 100% ± .5% nitrogen atmosphere per 5.7 with line to line voltages from 200 to 230 volts rms and ambient pressures from 14.7 psia to 0.01 psia (170,000 feet). Those circuits used to connect the 10-20902-1 generators to the 10-20902-6 circuit breakers (2) shall be tested with line to line voltages from 200 to 330 volts rms. Low voltage parts which may be overstressed at the high voltage condition and which never experience voltages at or above the minimum corona onset voltage may be disconnected during this test.

6.12 Fault Proof Note: This requirement applies to Main Power Box only.

There shall be no fault or short result from tumbling the Main Power Box in a chamber filled with 1 ± 0.1 pounds of metallic particles composed of steel and aluminum filings, shavings, nuts and bolts. The chamber shall be tumbled 300 times each in such a manner that the metal particles fall into and through the box (1) from the top and the bottom and (2) from the left and the right. A 60 cps potential of 600/200 volts rms shall be applied between all 115 and 200 volt AC/28 volt DC terminals and the metal structure of the Main Power Box during the above tumbling. A three phase test potential shall be used for the 600 volt circuits.

6.13 Oxidation Note: This requirement applies only to equipment in the pilot's compartment. Of the equipment in the pilot's compartment, only the Forward A.C. Fuse Panel and T/R Diode will be tested. The assemblies shall be capable of withstanding exposure to a 100 percent oxygen environment at sea level pressure and 160°F for a period of two hours. The assemblies shall operate during the test per 5.7. The Manual Flight Control Fuse Panel, Forward D.C. Fuse Panel and the Forward Relay Box have the same materials and processes as the Forward A.C. Fuse Panel and will, therefore, be qualified by similarity. The ambient shall be returned to that of standard conditions, and the test article operated and inspected visually as specified in 5.7.



CONDITION NO.

TEST NO.

2-5353-4-29

CALC			REVISED	DATE	PRELIMINARY SINUSOIDAL VIBRATION TEST FOR EQUIPMENT INSTALLED IN CONTROLLED ENVIRONMENT COMPARTMENTS AND UNPRESSURIZED ... BAY	FIG. 2
CHECK			WDT	1-9-62		
APPR						D2-80377-1
APPR					BOEING AIRPLANE COMPANY SEATTLE 24, WASHINGTON	PAGE 16