SPECIFICATION NUMBER 114

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X353-5B PROPULSION SYSTEM FLIGHTWORTHINESS RATING TEST SPECIFICATION

VZ-11

LIFT FAN FLIGHT RESEARCH AIRCRAFT PROGRAM

CONTRACT NUMBER DA44-177-TC-715

GENERAL ELECTRIC

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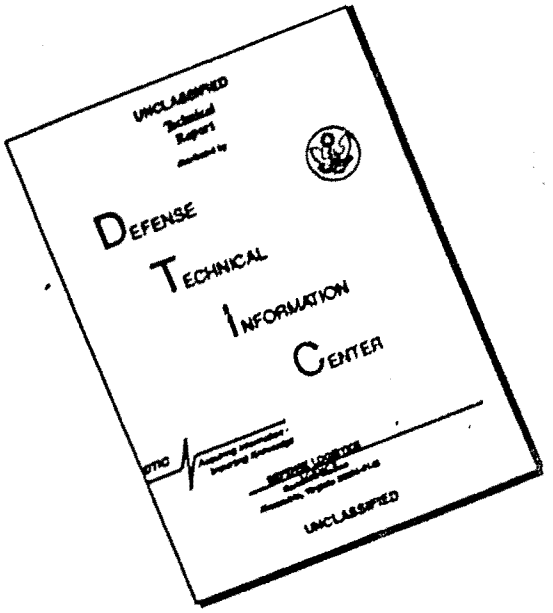

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LIFT FAN FLIGHT RESEARCH AIRCRAFT PROGRAM

CONTRACT DA44-177-TC-715

X353-5B PROPULSION SYSTEM

FLIGHTWORTHINESS RATING TEST

Specification No. 114

March 1, 1962

APPROVAL STATUS: This specification was approved by U.S. Army TRECOM for use on this program with modifications incorporated on pages marked (1) as of April 6, 1962.

GENERAL ELECTRIC COMPANY
FLIGHT PROPULSION LABORATORY DEPARTMENT
CINCINNATI, OHIO

Modification ⟨1⟩ applies to the following pages:

i, 1, 2, 3, 4, 5, 6, 7, 8, 9, 12, 13, 17, 19, 21, 22, 23, and 24.

Spec. No. 114

Date March 1, 1962

Revised _____

X353-5B PROPULSION SYSTEM
FLIGHTWORTHINESS RATING TEST

1. SCOPE

1.1 General. - This specification defines the flightworthiness rating test requirements for the X353-5B convertible, ducted lift fan propulsion system.

1.2 Classification. - The X353-5B propulsion system is comprised of a J85-GE-5 turbojet engine, less afterburner, used as a gas generator plus two additional major components: a diverter valve to direct the gas flow; and an X353-5B lift fan.

2. APPLICABLE DOCUMENTS

2.1 The X353-5B Propulsion System Specification No. 112, and applicable publications from ANA Bulletin 343n form part of this specification in so far as specifically referenced in other paragraphs of this specification.

3. REQUIREMENTS

3.1 Test Approval. - The test shall be considered complete when the X353-5B lift fan system has been subjected to the specified 50 hour test. The flightworthiness rating test shall be considered satisfactory when, in the judgement of the contracting agency, the calibration is adequate, the gas generator, the test diverter valve and lift fan are operating satisfactorily at the end of the test, recalibration does not reveal excessive performance deterioration, and teardown inspection of the diverter valve and lift fan does not disclose part failure nor in-

dicate any imminent failure which might compromise safety of flight.

3.1.1 Penalty Tests. - In lieu of a repetition of the test, in the event there is indication of imminent part failure which would compromise safety of flight, the contracting agency may, at its option, authorize the contractor to reassemble test hardware and conduct an additional 5 hour penalty test to prove the part or parts in question. Reassemblies for such penalty tests shall incorporate only part changes which are approved by the contracting agency. The penalty test shall be considered satisfactory when, in the judgement of the contracting agency, the part or parts in question are operating satisfactorily at the end of the test. Performance recalibration may be performed when appropriate in the judgement of the contractor. Failures or unsatisfactory conditions not related to the part in question shall not prevent the penalty test from being considered satisfactory.

3.1.2 Scope of Approval. - The flightworthiness rating resulting from satisfactory completion of the tests described in this specification shall apply to all X353-5B lift fan systems or major components without distinction as to physical differences because of the direction of rotor rotation and regardless of the direction of rotor rotation used in the test. The flightworthiness rating may, at the contracting agency's option, be extended to include the experimental flight type ducting or nozzles which satisfactorily complete the test. The mechanical performance of such ducting or nozzles shall not affect the flightworthiness rating of the lift fan propulsion system.

3.1.2.1 Gas Generator. - The flightworthiness rating applied to the X353-5B lift fan system shall include the J85-GE-5 turbojet engine, less afterburner, used as a gas generator without the requirements of the engine satisfactorily completing the test defined by this specification except that a J85-GE-5 gas generator shall demonstrate compatibility with the environment of the X353-5B system for 50 hours of operation according to this specification test schedule. This demonstration may,

at the contractor's option, be conducted with a fixed area nozzle simulating the X353-5B system effective exit area to provide the appropriate operating conditions; a test or flight quality diverter valve shall be required to provide transient conditions equivalent to the requirements of Specification No. 112. Prior satisfactory completion of tests defined by applicable military specifications MIL-E-5010 and MIL-E-5009 shall be considered sufficient. Performance, performance deterioration, part failure or indication of imminent failure of any part of the particular gas generator(s) used to provide the conditions of the test shall not have any bearing on the X353-5B lift fan system flight-worthiness rating unless attributable directly to its specific use in this system in which case such problems shall be corrected to the mutual satisfaction of the contractor and the contracting agency.

3.2 Reports.

3.2.1 Test Reports. - Following completion of the specified 50 hour test on any test system or component, a report may be submitted to the contracting agency at the option of the contractor. This report, certified by a contracting agency representative as to proper conduct of the test, shall constitute the basis for approval of the test or any portion thereof. Penalty test required based on the test report or otherwise shall be reported as an addendum to the test report and, along with the test report, shall constitute the basis for approval of the part or parts specifically subject to the penalty test. The test report shall not include recommendations nor justifications thereof for the specific purpose of obtaining approval of any ducting used in the test.

3.2.1.1 Report Preparation. - The test report shall contain essentially the following information:

a. Cover: (Per the contracting agency, including title, number, source, date, author(s), and contract reference)
b. Title Page: (same information as cover)
c. Abstract: (A brief statement of the contents of the report including the objectives)

d. Table of Contents

e. List of Illustrations

f. Summary: (A brief resume of the test conducted, including objectives, procedures, results, conclusions and recommendations)

g. Body of the report:

1. Brief general description of the X353-5B lift fan propulsion system or major component tested (including differences between the test gas generator(s) configuration and the J85-GE-5 turbojet engine) and a detailed description of all features which in the contractor's opinion significantly differ from the X353-5B Propulsion System Specification No. 112.
2. Method of test (general description of test facility, instrumentation, equipment and methods used in conducting the test).
3. Record of test (chronological history of all events in connection with all of the testing).
4. Tabulated data of all pertinent instrument readings and all required instrument readings taken during test.
5. Calibration and recalibration data (data both in uncorrected and corrected form, if applicable, shall be shown by suitable curves).
6. Description of the condition of tested parts at disassembly inspection.
7. Analysis of results (a complete discussion of all phases of the test, including probable reasons for any failure and unusual wear, comparison of test performance with the X353-5B Propulsion System Specification No. 112, and analysis of general operation).
8. Conclusions and recommendations with respect to contracting agency approval of the X353-5B lift fan system or major component flightworthiness rating test, supplemented by such discussions as

are necessary for their justification.

3.2.1.2 Number and distribution of copies. - Six copies of the test report and applicable addenda shall be forwarded to the contracting agency.

4. QUALITY ASSURANCE PROVISIONS

4.1 General. - All tests defined by this specification shall be conducted at the convenience of the contractor. Systems, components and test apparatus shall be subject to inspection by authorized contracting agency representatives who shall be given all reasonable facilities to determine conformance with this specification. All instructions for testing of the propulsion system shall be available to the contracting agency's representative prior to the test.

4.1.1 Accuracy of data. - For all system and component calibrations reported data shall have a steady state accuracy within the tolerances shown below. The instrumentation systems and calibration methods used by the contractor shall be subject to the approval of an authorized contract agency representative and shall be described in the test report. Calibrations shall be performed as often as necessary in the judgement of the contractor to insure the required degree of accuracy is maintained. Corrected performance data will include instrument system calibrations where appropriate in the judgement of the contractor.

ITEM OF DATA	
Fan speed	± 0.5 per cent of maximum rated speed
Gas generator speed	± 0.5 per cent of maximum rated speed
Fan thrust	± 2.0 per cent of maximum rated thrust
Fuel flow	± 2.0 per cent of maximum rated fuel flow
Component weight	± 2.0 lbs. per major component
Other	Appropriate to the test in the judgement of the contractor

4.2 Propulsion System Test. -

4.2.1 Test Conditions. - The test shall be conducted at the ambient conditions of the contractor's plant at Evendale, Ohio in an outdoor facility. Performance calibrations shall be obtained for wind conditions not to exceed 5 mph and with the components of the system mounted such that, in the judgement of the contractor, there are no appreciable effects of ground proximity influencing the ratings.

4.2.1.1 Test Apparatus. -

4.2.1.1.1 Gas Generator. - The gas generator(s) shall be a J85-GE-5 turbojet engine less afterburner and may be changed and/or maintained to the extent necessary to complete the test. Test ducting connecting the diverter valve to the lift fan and a test cruise nozzle shall be selected such that, in the judgement of the contractor, system conditions essentially as described in the X353-5B Propulsion System Specification No. 112 shall be maintained as appropriate for test of each major component.

4.2.1.1.2 Test Arrangement. - The test arrangement may, at the contractor's option, include one gas generator providing gas for each section of the lift fan scroll, or two gas generators and two diverter valves in which case excess flow from each gas generator shall be discharged as bleed. One of the diverter valves in a two gas generator arrangement shall be considered as "slave" hardware to the system but both shall be of flight quality. The "slave" valve may be changed or maintained to the extent necessary to complete the test, however, deviations in performance or post-test condition of the "slave" diverter valve shall be identified and discussed in the test report. The contractor may, at its option, conduct the tests for each of the major com components separately.

4.2.1.1.3 Vibration Measuring Equipment. - The vibration equipment used for the measurement of component vibration shall have frequency

response characteristics in accordance with the curves in Figure 1. The actual response of the vibration measuring equipment when calibrated by applying known sinusoidal motion to the pickup shall not deviate from the curves shown in Figure 1 by more than 5 per cent at frequencies up to 1000 cps.

4.2.1.1.4 Test Stand Dynamic Characteristics. - Vibratory amplitudes shall be measured with the engine operating on a test stand which has the following dynamic characteristics: the natural frequencies of the installed propulsion system shall be no higher than 50 per cent of the rated fan speed in all modes of motion which can be excited by residual rotor unbalance.

4.2.1.2 Preliminary Data. - The major component weights and centers of gravity, photographs and other pertinent descriptive data shall be obtained at the time the component is being prepared for test.

4.2.1.3 Operating Test Conditions. -

4.2.1.3.1 Lubrication. - The fan bearings shall each be packed with 50 grams of contractor specified grease during initial assembly. Removal of the fan bulletnose cover for bearing lubrication and instrumentation inspection shall be permitted between test cycles in accordance with the requirements of the contractor.

4.2.1.3.2 Accreditable Test Time. - Test time shall not be credited by increments shorter than 15 minutes, except when shorter periods are a test requirement.

4.2.1.3.3 Miscellaneous Data. - The date, operating schedule, test system model designation and serial number(s) shall be recorded on each log sheet. Test configuration details shall be included in the general log.

4.2.1.3.4 Test Notes. - Notes shall be placed on the log sheets of all incidents of the run, such as leaks, vibrations, and other irregular functioning of the propulsion system components or the equip-

ment, and corrective measures taken.

4.2.1.3.5 Trim Bleed Requirement. - A nominal 10.6 per cent diverter valve discharge flow shall be bled from the system during all tests of the lift fan. The bleed flow may, at the contractor's option, be used to power an X376 trim control fan for the purpose of simultaneous test according to the provisions of the X376 Pitch Fan Flightworthiness Rating Test Specification No. 115. In the event that an X376 fan is simultaneously tested with the X353-5B propulsion system, it shall be considered for independent rating and its performance shall in no way effect the rating of the X353-5B system or components.

4.2.1.3.6 Scroll Area Requirement. - The scroll areas of the lift fan shall be trimmed for producing rated gas generator discharge temperature at ambient conditions corresponding to 2500 feet altitude on an ANA 421 standard hot day. For a test arrangement employing two gas generators, the excess flow from each gas generator shall be bled through a separate duct with an effective area adjusted to maintain rated gas generator discharge temperature and with the available gas horsepower (after trim bleed extraction) being divided equally between the lift fan and the bleed system. For this test arrangement, the following conditions at maximum power shall be established as closely as possible by area adjustment; deviations shall be subject to the approval of the contracting agency representative witnessing the test:

a. $W_{B_6} = 0.106\ (0.992)\ (W_a + W_f)$

b. $W_{b\ell} = 0.444\ (W_a + W_f)$ per gas generator

c. rated gas generator discharge temperature

4.2.1.3.7 Bleed Thrust. - The method of accounting for any extraneous thrust from the bleed system(s) shall be subject to the approval of an authorized contracting agency representative and shall be described in the test report.

4.2.1.3.8 Ambient Conditions. - Approval of the contracting agency shall be obtained for location of the barometer pressure and ambient temperature measuring devices. A minimum stabilization time of two hours shall precede any readings for calibration or recalibration checks. Ambient conditions shall be read and recorded at intervals not exceeding one hour.

4.2.1.3.8.1 Barometer Correction. - Barometer readings shall be corrected for the difference between the mercury temperature and 32°F.

4.2.1.3.9 Louver Adjustment. - The lift fan discharge louver position indicator(s) shall be adjusted at the beginning of the test so that zero indicated louver angle yields zero horizontal thrust at the maximum power setting. The actuation system external to the louver connecting rod may be flight or test quality hardware at the contractor's option and its performance shall not affect the flightworthiness rating of the lift fan.

4.2.1.3.10 Diverter Valve Adjustment. - The diverter valve doors shall be adjusted for normal closure at either terminal position. Flight quality actuation hardware shall be tested and the actuation rate shall be adjusted so that the time for full valve travel in either direction at maximum power shall not exceed one second.

4.2.1.3.11 Overspeed Limiter. - The fan overspeed limiter shall be adjusted for 103% rpm limit and shall be operative throughout the test.

4.2.1.3.12 Data Correction. - Readings of thrust, rpm, airflow rate, fuel flow rate, gas pressures, and gas temperatures shall be corrected to ARDC standard sea level atmospheric conditions: Correction for humidity effect will be applied when appropriate in the judgement of the contractor. In order to determine conformance with system performance ratings, the data shall be adjusted for any difference between the test gas conditions and Specification No 112 estimated gas conditions. Corrected values shall be obtained as follows:

Corrected temperature, $T_c = T\left(\frac{518.688}{T_{inlet}}\right) = \frac{T}{\theta}$

Corrected pressure, $P_c = P\left(\frac{14.696}{P_{inlet}}\right) = \frac{P}{\delta}$

Corrected fan speed, $N_{fc} = N_f\sqrt{\frac{518.688}{T_{t_{1.0.0}}}} = \frac{N_f}{\sqrt{\theta_{1.0.0}}} \times C_{1h}$

where: C_{1h} is the humidity correction, Figure 2a.

Corrected g.g. speed, $N_{gc} = N_g\sqrt{\frac{518.688}{T_{t_{2.0}}}} \times C_{1h} = \frac{N_g}{\sqrt{\theta_{2.0}}} \times C_{1h}$

Corrected g.g. thrust, $F_{gc} = F_g\,\frac{14.696}{P_{t_{2.0}}} \times C_{2h} = \left(\frac{F_g}{\delta_{2.0}}\right) \times C_{2h}$

where: C_{2h} is the humidity correction, Figure 3a.

Corrected fan thrust, L_c (also horizontal thrust) $= L\left(\frac{14.696}{P_{t_{1.0.0}}}\right) C_{3h} = \frac{L}{\delta_{1.0.0}} \times C_{3h}$

where: C_{3h} is the humidity correction, Figure 2b.

Corrected g.g. airflow, $W_{ac} = W_a\left(\frac{14.696}{P_{t_{2.0}}}\right)\sqrt{\frac{T_{t_{2.0}}}{518.688}} \times C_{4h} =$

$$\frac{W_a\sqrt{\theta_{2.0}}}{\delta_{2.0}} \times C_{4h}$$

where: C_{4h} is the humidity correction, Figure 3b.

Exhaust gas temperature, $T_{5.1c} = T_{5.1}\left(\frac{518.7}{T_{t2.0}}\right) C_{5h} = \frac{T_{5.1}}{\theta_{2.0}} \times C_{5h}$

where: C_{5h} is the humidity correction, Figure 4a.

Corrected fuel flow, $W_{fc} = W_f \left(\frac{14.696}{P_{t2.0}}\right) \sqrt{\frac{518.7}{T_{t2.0}}} \times C_{6h} =$

$$\frac{W_f}{\delta_{2.0}\sqrt{\theta_{2.0}}} \times C_{6h}$$

where: C_{6h} is the correction for humidity, Figure 4b.

Corrected fuel consumption, $SFC_c = \frac{W_{fc}}{L_c}$
(lift mode)

Corrected fuel consumption, $SFC_c = \frac{W_{fc}}{F_{gc}}$
(turbojet mode)

Corrected horsepower, $HP_{5.1c} = HP_{5.1}\left(\frac{14.696}{P_{t10.0}}\right) \sqrt{\frac{518.7}{T_{t10.0}}} \times C_{7h} =$

$$\frac{HP_{5.1}}{\sqrt{\theta_{10.0}}\ \delta_{10.0}} \times C_{7h}$$

where: C_{7h} is the correction for humidity, Figure 2c

<u>Adjustment for Variation between Test Gas Conditions and Specification No. 112 Estimated Gas Conditions</u>:

a. determine test gas generator flow function, $\left(\frac{W_g\sqrt{T}}{P}\right)_{5.1}$

b. enter Figure 31 Specification No. 112 at level of $HP_{5.1C}$ calculated for test condition

c. determine lift adjustment as difference between lift reading at constant $HP_{5.1C}$ for the test flow function and the line representing $\left(\frac{W\sqrt{T}}{P}\right)_{5.1} = 54.64$

d. if not at rated corrected power condition, extrapolate adjusted lift value using the ideal fan laws: $N^3 \alpha F^{3/2} \alpha HP$

4.2.2 Endurance Tests. -

4.2.2.1 Calibrations, Checks and Adjustments. - System performance during calibration shall be compared with rating points defined in Tables I and II of the X353-5B Propulsion System Specification No. 112. Test data shall be extrapolated to the corrected rating point by application of the ideal fan laws if ambient conditions or the gas generator(s) used in the test preclude actual test demonstration.

4.2.2.1.1 Temperature Sensing System Calibration. - The engine gas temperature sensing system for the purpose of adjusting tail pipe temperature and nozzle area shall be a standard J85-GE-5 engine T_5 harness located in the diverter valve inlet in the same relative position to the gas generator and engine seal leakage recovery tubes as in the standard engine configuration. For the purpose of fan performance calculations, the indicated temperature shall be compared with a test array of thermocouples located downstream of the diverter valve. Harness calibration shall be in accordance with 4.1.1.

4.2.2.1.2 Overspeed Limiter Calibration. - Prior to initiation of the propulsion system calibration specified in 4.2.2.1.3; the lift fan overspeed limiter shall undergo bench calibration to determine conformance with the design tolerance range defined in Specification No. 112.

4.2.2.1.3 Propulsion System Calibration. - The procedure during the calibration shall be such as to establish ARDC standard sea level static performance characteristics of the X353-5B propulsion system prior to the endurance run. Calibrations shall be made with the system trimmed in accordance with 4.2.1.3.5 and 4.2.1.3.6; deviations in fan performance which can be directly attributed to variations in actual gas generator performance shall be permitted. The following data shall be obtained:

a. Steady state data: Data required to establish compliance with applicable sea level performance characteristics displayed by Tables I and II of the X353-5B Propulsion System Specification No. 112.

b. Transient data: Data required to demonstrate thrust transients (as estimated) in paragraph 3.4.11 of Specification No. 112.

4.2.2.2 Procedure. - Following the calibration run, the control(s) shall be adjusted while in the turbojet mode to produce the rated steady state gas temperature and rotor speed with the power lever in the maximum thrust position and these values shall be re-established at the beginning of each cycle. With the diverter valve positioned for the lift mode, a schedule of fan speed and lift versus power lever setting shall be determined which will form the basis for setting test conditions in 4.2.2.2.1 and 4.2.2.2.2.

The propulsion system shall be subjected to an endurance test consisting of 10 cycles of five hours each in accordance with 4.2.2.2.1 and 4.2.2.2.2 using fuel in accordance with MIL-F-5624D. The test runs shall be conducted in the order given unless otherwise approved by the contracting agency. Changes in order shall be considered by the contracting agency if facility utilization is thereby improved. The time

for changing thrust shall be charged to the duration at the lower setting. For all power lever movements, the power lever shall be advanced or retarded, as applicable, in not more than one second. Full diverter valve travel in either direction shall likewise be accomplished in not more than one second. The maximum and idle thrusts shall be as established by the gas generator control. During transient operations the gas generator control(s) may be adjusted, as necessary, to avoid exceeding maximum allowable conditions, provided the adjustments are within the mechanical adjustment limits furnished with the propulsion system.

The test shall consist of two parts defined in 4.2.2.2.1 and 4.2.2.2.2.

4.2.2.2.1 Part 1. - Part 1 is a cyclic power endurance test and shall consist of six five-hour cycles to be conducted in accordance with the schedule listed below, using inlet fuel and air at ambient temperature. The exit louvers will be positioned for a continuous stagger with $\beta_s = 20^\circ$ except as noted in any specific run:

a. Maximum-idle thrust run (60 minutes):
This run shall consist of six successive periods of 10 minutes each, including 5 minutes with the power lever in the maximum thrust position and 5 minutes with the power lever in the idle position as follows:

first 3 periods - turbojet mode
final 3 periods - lift mode, $\beta_v = 0^\circ$

b. Incremental rotational speed run (72 minutes):
This run shall consist of 12 periods of 6 minutes duration each in the lift mode at approximately equal fan rotational

speed increments between maximum and idle speed conditions, as follows: 1000, 1150, 1300, 1450, 1600, 1750, 1900, 2050, 2200, 2350, 2500, 2640 rpm, each with $\beta_v = 0^o$. The number of increments chosen may be altered at the option of the contracting agency to increase the amount of running time obtained at the peak vibration points up to an amount not to exceed 50 per cent of the total time of the incremental run.

c. Thrust transients run (44 minutes):
This run shall consist of six periods in each mode, turbojet and lift with $\beta_v = 0^o$, as follows: (1) Four periods from idle power lever position to maximum lift power lever position, maintained at maximum lift power lever position for 30 $\pm$ 3 seconds, and retarded to the idle power lever position and maintained at idle conditions for approximately 3 minutes. (2) Two periods, each consisting of approximately 2 minutes of operation with the power lever in the military thrust position, then retarding toward the idle power lever position, and as soon as the engine reaches the anticipated condition of minimum surge margin (i.e., rpm or gas temperature), advancing the power lever again to the maximum lift position and maintaining this condition for approximately 2 minutes.

d. Thrust vectoring and spoiling run (26 minutes):
This run shall consist of 13 periods of 2 minutes each in the lift mode, as follows:

Power Lever Position	β_s	β_v	
Maximum	0^o	0^o	
"	40^o	0^o	
"	20^o	0^o	
"	20^o	10^o	($\beta_v = -10^o$ optional)
"	20^o	20^o	
"	0^o	30^o	
"	0^o	40^o	
"	0^o	Max.	
"	0^o	40^o	
"	0^o	30^o	
"	20^o	20^o	
"	20^o	10^o	($\beta_v = -10^o$ optional)
"	20^o	0^o	

e. Extended maximum thrust run (18 minutes):
This run shall consist of one period in the turbojet mode at maximum power lever setting.

f. Normal thrust run (18 minutes):
This run shall consist of one period in the turbojet mode at the normal continuous power lever setting.

g. Short maximum lift run (8 minutes):
This run shall consist of one period in the lift mode, $\beta_s = 0^o$, $\beta_v = 35^o$, at maximum lift.

h. Maximum lift - maximum thrust run (40 minutes):
This run shall consist of eight periods of 5 minutes each at alternate conditions of maximum lift and maximum turbojet thrust via power transfers with the diverter valve, as follows:

Mode	β_s	β_v	Diverter Valve Schedule
L	0^o	35^o	
TJ			simultaneous
L	0^o	35^o	simultaneous
TJ			simultaneous
L	0^o	35^o	simultaneous
TJ			sequential - 10 sec. delay (optional)
L	0^o	35^o	simultaneous
TJ/L	0^o	35^o	{one valve TJ mode / one valve L mode} (optional)

i. Idle thrust - idle lift - maximum lift run (14 minutes): This run shall consist of seven periods of 2 minutes duration each at alternate conditions of idle turbojet thrust and lift via power transfer with the diverter valve, including lift mode throttle bursts, as follows:

Power Setting	Mode	β_s	β_v	Diverter Valve Schedule
Idle	TJ			
"	L	0^o	35^o	simultaneous
Max.	L	0^o	35^o	
"	TJ			simultaneous
Idle	TJ			
"	L	0^o	35^o	simultaneous
Max.	L	0^o	35^o	

4.2.2.2.1.1 Overspeed Limiter Demonstration. - Following each five-hour cycle in 4.2.2.2.1, the overspeed limiter shall be adjusted for 90% rpm limit. Demonstration of limiter action shall be accomplished by first establishing maximum thrust in the turbojet mode and then accomplishing a power transfer to the lift mode with diverter valve movement in not more than one second.

4.2.2.2.2 Part 2. - Part 2 is a constant power endurance test and shall consist of four five-hour cycles in accordance with the schedule listed below using inlet air and fuel at ambient conditions. Fan inlet distortion shall be simulated during one cycle in this part:

a. Take off simulation run (90 minutes):
This run shall consist of nine periods of 10 minutes duration each, as follows:

Power Setting	Mode	β_s	β_v
Idle	TJ		
"	L	20°	0°
Max.	L	20°	0°
"	L	20°	10°
"	L	20°	20°
"	L	0°	35°
"	L	0°	Max.
Normal Continuous	L	0°	Max.
Max.	L	0°	Max.

b. Conversion simulation run (100 minutes):
This run shall consist of five periods of 20 minutes duration each, as follows:

Power Setting	Mode	β_s	β_v	Diverter Valve Schedule	
Max.	L	0°	Max.		
"	TJ/L	20°	20°	one valve TJ one valve L	(optional)
"	TJ			both valves	
Idle	TJ				
"	L	0°	Max.	simultaneous	

c. Landing simulation run (110 minutes):
This run shall consist of 11 periods of 10 minutes duration each, as follows:

Power Setting	Mode	β_s	β_v	
2200 rpm	L	0^o	Max.	
2300 rpm	L	0^o	30^o	
2400 rpm	L	20^o	20^o	
2500 rpm	L	20^o	10^o	
Max.	L	20^o	0^o	
"	L	20^o	-10^o	($\beta_v = 0^o$ optional)
"	L	20^o	0^o	
2500 rpm	L	20^o	0^o	
Max.	L	20^o	0^o	
Idle	L	20^o	0^o	
"	TJ			(valves, simultaneous)

4.2.2.2.3 Starts. - A minimum of 25 starts shall be made on the propulsion system. There will be at least 10 starts each preceded by a two-hour minimum shutdown. If necessary, additional starts required to bring the total to 25 may be made at the end of the endurance test. Starts shall be performed with the standard engine air impingement system using the contractor's shop air supply system.

4.2.2.2.4 Test Options. -

4.2.2.2.4.1 Inlet Closure. - An inlet closure may be installed during portions of part 2 of the endurance test at the contractor's option.

4.2.2.2.4.2 Maximum Bleed Flow. - One cycle of part 1 and one cycle of part 2 may be run at maximum diverter valve discharge bleed flow at the contractor's option.

4.2.2.2.5 Additional Runs. - Additional runs may be incorporated as part of the endurance test upon mutual agreement by the contractor and the contracting agency. This test time shall be deducted from the endurance test time at the nearest equivalent condition.

4.2.2.2.6 Data. -

4.2.2.2.6.1 Steady State Data. - During the endurance test, except for the transient runs, the following data shall be recorded at intervals not greater than 30 minutes:

Time of day
Total endurance time, hours:minutes
Ambient dry bulb temperature, ^{o}F
Ambient wet bulb temperature, ^{o}F
Wind velocity, mph
Wind direction
Power lever position, degrees
Fan discharge louver position (β_1 and β_2), degrees
Diverter valve position, degrees
Scroll area, sq. in.
Cruise nozzle area, sq. in. } if readjusted
Data for determining trim bleed flow
Engine(s) rotor speed, rpm
Fan rotor speed, rpm
Vertical lift, lb.
Horizontal thrust, lb.
Fuel consumption, lb/hr.
Data for determining engine(s) air flow
Engine inlet total temperature, ^{o}F
Fan inlet total temperature, ^{o}F
Engine turbine discharge total pressure, psig

Engine turbine discharge total temperature, EGT, ^{o}F

Engine and fan vibrations, mils peak to peak

Optional:

Fan bearing temperatures, ^{o}F

J85 lube oil temperature, ^{o}F

J85 lube oil pressure, psig

J85 compressor discharge pressure, psig

Fuel manifold pressure, psig

4.2.2.2.6.2 Transient Data. - For each transient test performed in 4.2.2.1.3 "b", 4.2.2.2.1 "c" and 4.2.2.2.1.1 the maximum values of measured engine T_5 harness temperature, fuel flow, engine speed, fan speed and power lever position or diverter valve position attained during the transient shall be read and recorded. Periodic checks of fuel boost pressure and diverter valve actuator pressure shall be read and recorded throughout the test.

4.2.2.2.6.3 Starting Data. - During the starts performed under 4.2.2.2.3 the following data shall be recorded for each start performed:

Start number

Time to ignition, sec.

Time to starter cut out, sec.

Time to stabilize idle rpm, sec.

Speed of engine and fan, rpm, at:

ignition

starter cut out

idle

Maximum measured EGT, ^{o}F

Running time during which the measured EGT exceeds a temperature $20^{o}F$ below the maximum allowable starting temperature for the particular engine model used, sec.

Torque versus rpm calibration shall not be required, data presented in Figures 48 and 49, X353-5B Propulsion System Specification No. 112 shall be considered adequate.

4.2.2.3 Recalibrations. -

4.2.2.3.1 Propulsion System Recalibration. - After completion of the tests specified in 4.2.2.2, a recalibration check run in accordance with the requirements of 4.2.2.1.3 "a" and "b" shall be made on the endurance test propulsion system. The recalibration check run shall be conducted with the gas generator adjusted to produce as closely as possible under standard sea level static conditions the values of measured gas temperature and engine speed obtained during the initial calibration. During this run the corrected lift and thrust shall be not less than 95% of the initial calibration exclusive of changes attributable directly to the gas generator. Transient performance shall be demonstrated. The check run may be preceded by a run-in period during which a cleaning procedure recommended for field use by the contractor and approved by the contracting agency may be applied.

4.2.2.3.2 Temperature Sensing System Recalibration. - Prior to the propulsion system recalibration specified in 4.2.2.3.1 the indicated temperature shall be compared with a test array of thermocouples located downstream of the diverter valve. Harness calibration shall be in accordance with 4.1.1.

4.3 Propulsion System Accessories Test. -

4.3.1 Previous Components Approval. - System components requiring testing as specified herein may have these tests waived at the option of the contracting agency if the component has been previously approved for Service use on another engine or by other equivalent tests. All such components must be substantially identical with the components previously approved with exception of provisions for engine mounting.

4.3.2 Electrical Components Proof Test. - Environmental proof tests shall be required on the overspeed limiter equipment provided with the propulsion system.

4.4 Teardown Inspection. - After completion of the tests, the lift fan and diverter valve shall be completely disassembled for examination of all parts and measured as necessary to disclose excessively worn, distorted, or weakened parts. These measurements shall be compared with the contractor's drawing dimensions and tolerances, or with similar measurements made prior to the test when available.

4.5 General Inspection. - All tests shall be subject to witnessing by a contracting agency representative. At convenient times prior to the tests and during the teardown inspection the propulsion system components shall be examined to determine if they conform to all requirements of the contract and specifications under which they were built. At no time during the test shall any part of the lift fan or diverter valve components be disassembled or removed for examination or cleaning without prior approval of the contracting agency except as specified in 4.2.1.3.1. Field maintenance and minor part replacement to the extent identified in the X353-5B Maintenance Instructions applicable to the flightworthiness rating test shall be permitted between five-hour test cycles without penalty to the accumulated test time.

5. PREPARATION FOR DELIVERY

5.1 Not applicable

6. NOTES

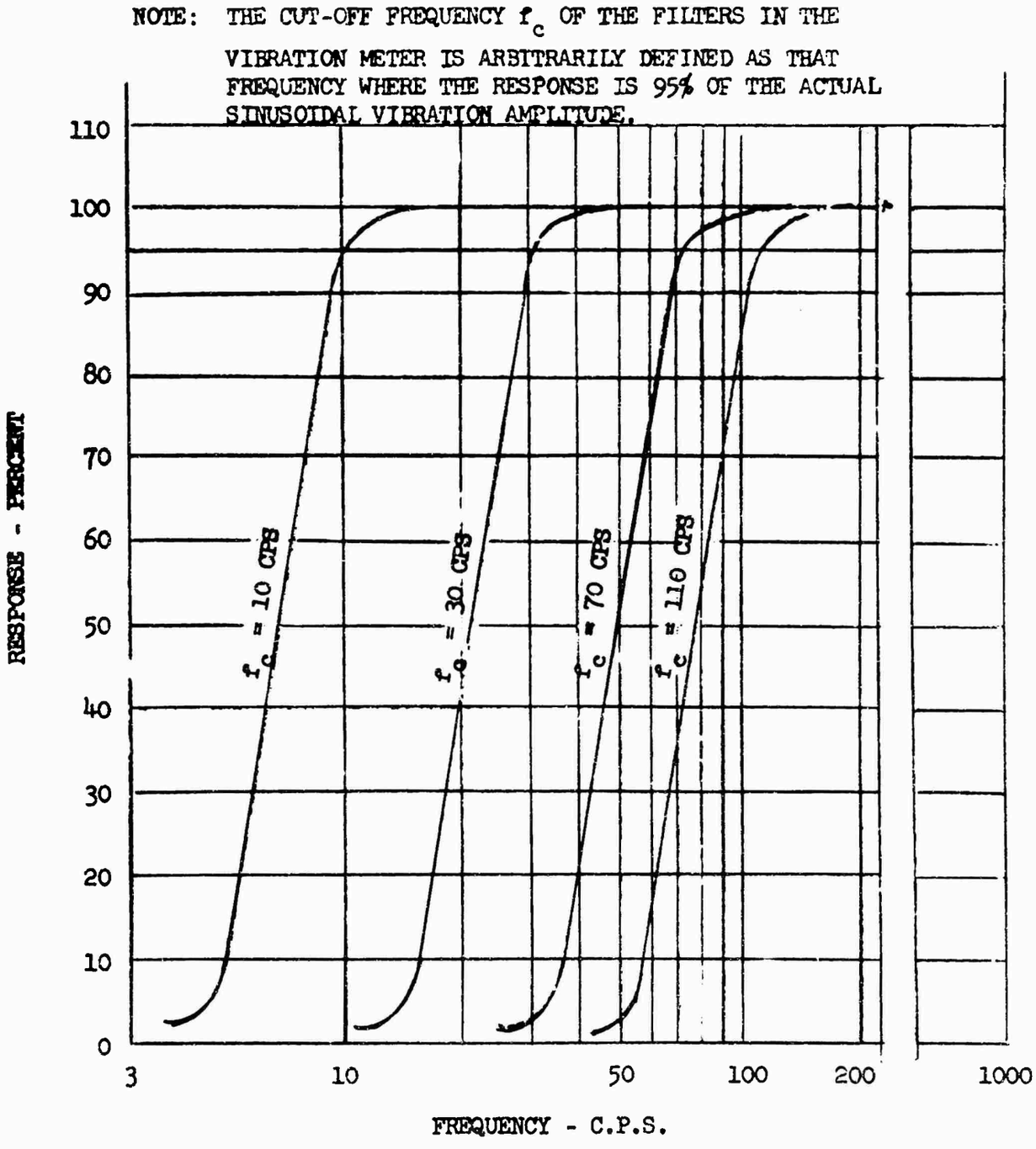
6.1 Intended Use. - This specification defines the test requirements for a convertible, ducted, lift fan propulsion system, which will have a flightworthiness rating established with the objective of

insuring that the propulsion system has a sufficient durability and reliability to permit experimental flight test.

6.2 Definitions and Symbols. - The definitions and symbols used in this specification are as specified in the X353-5B Propulsion System Specification No. 112 and, where this is not inclusive, in MIL-E-5007B.

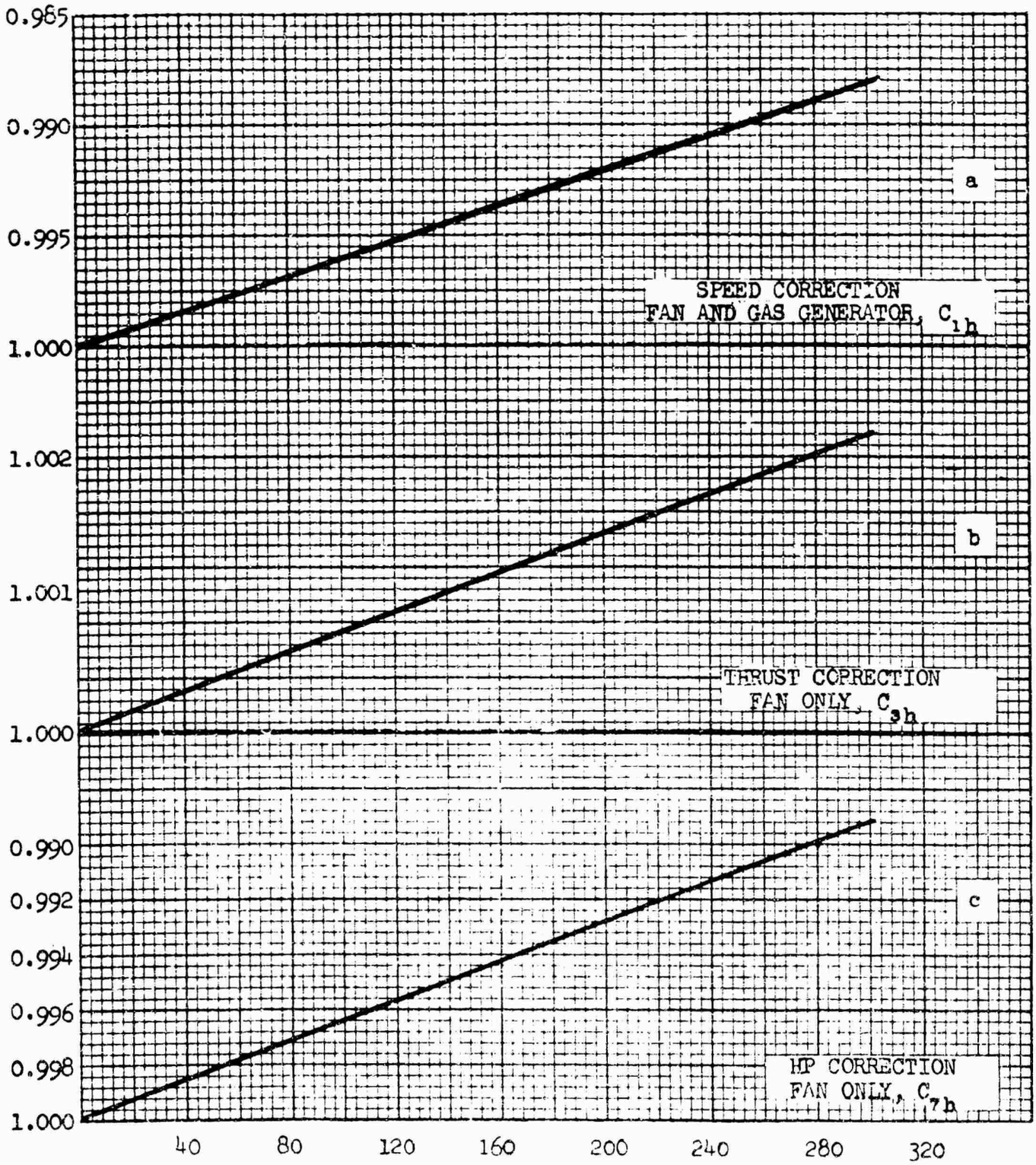
Custodian:
U.S. Army (TRECOM)

Preparing Organization:
The General Electric Company



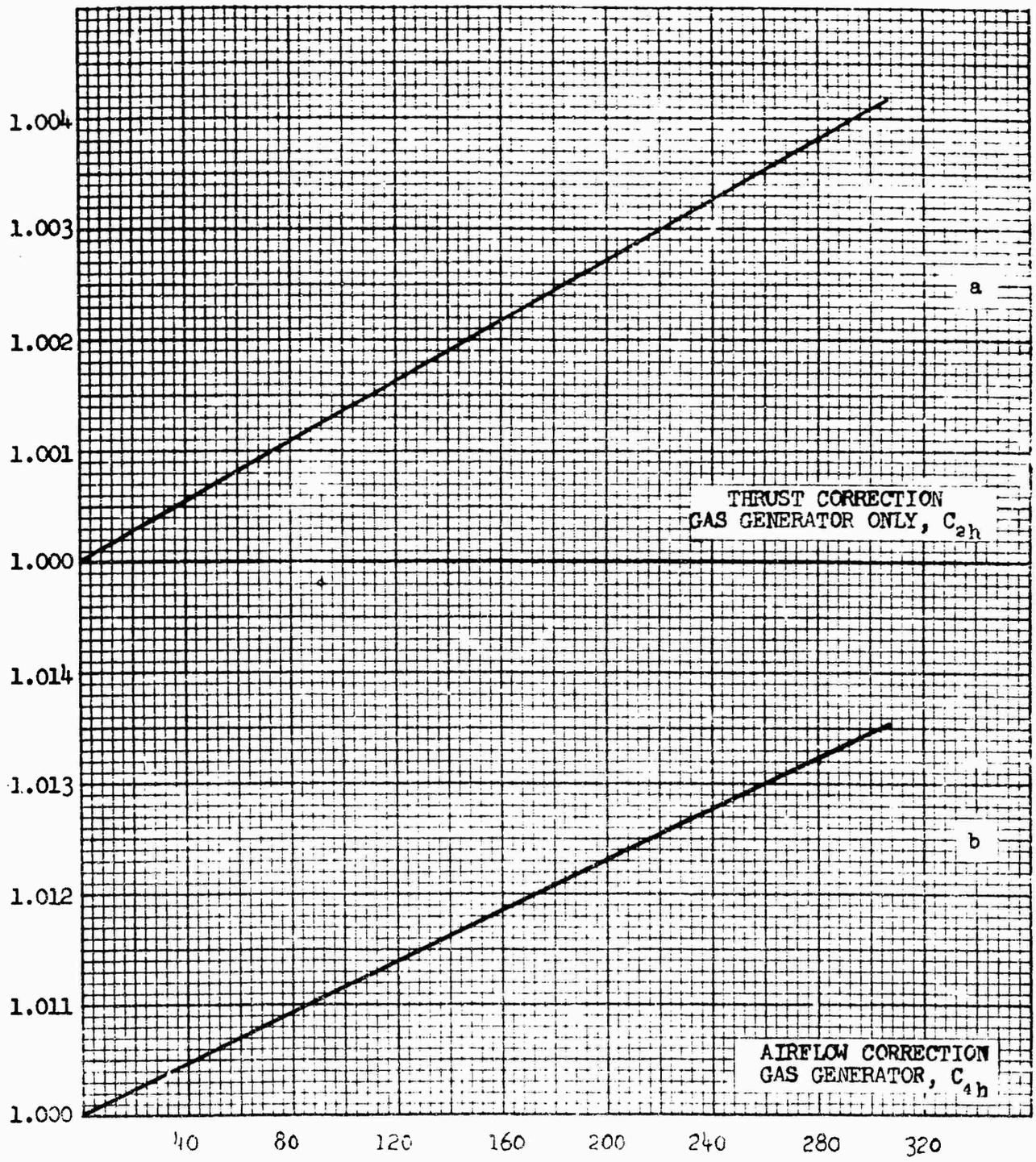
Frequency response characteristics

Figure 1



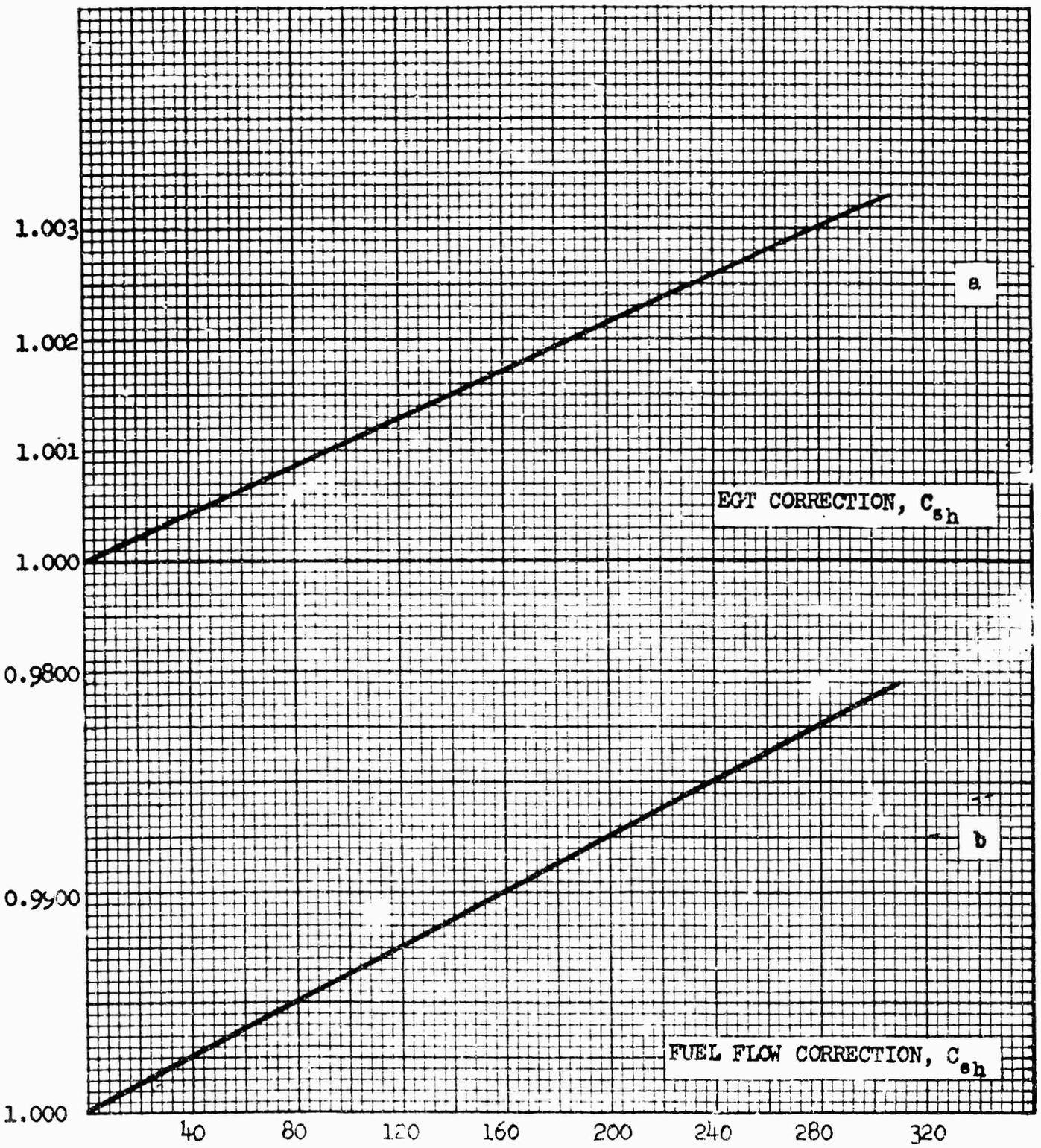
HUMIDITY CORRECTION FACTORS

Figure 2 a, b, c



HUMIDITY CORRECTION FACTORS

Figure 3 a, b



GRAINS OF MOISTURE PER LB OF DRY AIR

HUMIDITY CORRECTION FACTORS

Figure 4 a, b