ACCEPTANCE DATA PACKAGE

NASA CONTRACT NAS8-39409

SXI STEPPER MOTOR/ENCODER

AEROFLEX P/N 16187

****

C- QUALIFICATION TEST REPORT

QUALIFICATION TEST REPORT
MOTOR/ENCODER P/N 16187
DRD N° 763QE-001

Qualification testing was not part of this contract and was therefore not performed. Joint Qualification/Acceptance Test was performed in accordance with approved Acceptance Test Procedure.

TABLE OF CONTENTS

SECTION C

SECTION I

HARDWARE IDENTIFICATION & CONFIGURATION

June 12, 1995

DRAWING LIST

Motor/Encoder Documentation
P/N 16187

Document No	Rev	Description
16187	B	Motor/Encoder
PL16187	B	Motor/Encoder
200-88	C	Drawing Tree
200-89	E	Motor/Encoder Assy
PL200-89	E	Motor/Encoder Assy
301-60	E	Housing
PL301-60	E	Housing
301-61	A	Cover
303-216	B	Temp Xducer Filter Cir Assy
PL303-216	B	Temp Xducer Filter Cir Assy
303-217	A	P.W. Board
400-29-6	C	Rotor Assy
PL400-29-6	C	Rotor Assy
402-29-9	B	Rotor Hub & Shaft
403-1-7	B	Bearing, Duplex
404-13-61	B	Liner, Bearing
411-291-2&3	B	Magnet
500-29-9	C	Stator Assy
PL500-29-9	C	Stator Assy
502-29-9	C	Stator Core
PL502-29-9	C	Stator Core
512-11-14	B	Lamination
520-248	A	Inspection Data
521-425	C	Coil Winding
522-472	A	Finish Data
531-56	A	Schematic Temp Xducer Filter Cir
532-2	C	Connection Diagram
607-448	B	Bearing Retainer
607-449	B	Bearing Retainer
607-450	B	Pin, Locking
110E381	B	Encoder, Optical

June 12, 1995

DRAWING LIST

Motor/Encoder Documentation
P/N 16187

Documentation	Rev	Description
5-068-0	A	Bonding Proc - 2650
5-071-0	C	Bonding Proc - 280
5-125-0	-	Bonding Proc - 2651
5-128-0	B	Cleaning Procedure
5-129-0	A	Cleaning Procedure
5-130-0	B	Cleaning Procedure
5-134-0	A	Cleaning Procedure
5-222-0	A	Fluidize Bed Coat Proc
5-258-0	B	Magnet Inspect Proc
5-283-0	A	Bonding Proc - 1564
5-284-0	A	Cleaning Procedure
5-294-0	B	Bond/Staking Procedure
5-296-0	A	Vacuum Bake Procedure
5-297-0	B	Encoder Align. Procedure
5-298-0	B	Vacuum Bake Procedure
5-305-0	A	Cleanliness Control
5-316-0	A	Cleaning Procedure
960-229	B	Bonding Procedure - M620
960-251	C	Bonding Procedure - E645
960-295	C	Assembly Flow Chart
110P371	B	Contamination Control
110P374	B	Packaging Procedure
ATP20049	B	Acceptance Test
612-3	A	Bondmaster E645
612-20	A	Bondmaster M620
612-38-2	D	Stycast Resin
612-54	A	Scotchcast 5230

Aug 9,1995

DRAWING LIST

Motor/Encoder Documentation
P/N 16187
Sequential P/N's - Part of 110E381

Document No.	Rev	Description
19868-21664	D	PW Bd Assy -Encoder
19868-21665	B	PW Board
19868-21667	D	Schematic
19868-21666	A	Reticle, Carrier
19868-21668	A	Isometric
19868-21670	A	Plate
19868-21672	A	Readout Holder
19868-21680	A	Disc. Hub
19868-21759	A	Shield
19868-21760	A	Shield
19868-21761	A	Shield
19868-21764	A	Readout Holder Assy
19868-21765	-	Encoder Mtg Plate Assy
19868-21766	B	Disc & Hub Assy
19868-21770	-	Encoder Assy
19868-21788	D	Disc
19868-21763	A	Reticle & Carrier Assy
19868-21774	D	PW80 Assy Led
19868-21775	B	PW Board
19868-21781	-	Outline - Encoder
19868-21787	D	Reticle
19868-21796	A	Shield
19868-21819	A	Shield
19868-21785	A	Encoder Bd Test Procedure
19868-21786	A	LED Bd Test Procedure

SECTION II

QUALIFICATION SUMMARY

(a) RECORDED MEASUREMENTS

All measurements made during testing are recorded in ATP 20049 - DS data sheets and are included in this log.

(b) TEST SUMMARY

The motor/encoder (henceforth referred to as the UUT) test sequence began with a baseline functional evaluation, which demonstrated that the motor satisfied the operating torque, cogging torque, winding resistance, and mechanical requirements of SOW. In addition, the encoder electrical requirements were verified, as well as the alignment of the encoder outputs relative to the motor shaft position. There were no discrepancies observed in this portion of the test.

The UUT was then exposed to a number of environments, including thermal vacuum, thermal cycling, random and sine vibration, and mechanical shock. During the thermal environments, the performance of the UUT under load was verified at specified points in the cycles, as described in ATP 20049. In addition, the UUT was bench tested between the two thermal environments. No anomalies were observed during the thermal tests.

The vibration and shock tests were performed by East-West Technology Corporation, West Babylon, New York. The UUT was delivered to the lab in a sealed vibration fixture in order to maintain the cleanliness levels required by the SOW. In addition, a three ounce load was attached to the motor shaft. The attachment method of this load caused damage to the shaft and bearing during random vibration of S/N 0003 on April 28,1995, and is described further in NCR 00168.

The load attachment method was subsequently corrected, and vibration of S/N 0002 began while 0003 was being repaired. The performance of the UUT was verified at Aeroflex after each environment was completed, as shown in ATP 20049. No additional failures were noted.

The final test of the UUT was a repeat of the baseline functional tests. Again, no anomalies were observed.

(c) UNACCOMPLISHED TESTS

This section is not applicable.

d) RETEST STATUS

Serial number 0003 was retested after repair on June 1,1995 according to the following paragraphs in ATP -20049 - DS;

1.1 COGGING TORQUE

1.2 OPERATING TORQUE

1.3 STALL TORQUE

3.1 ENCODER POSITION 1 AND OUTPUT VOLTAGE

3.2 ENCODER POSITION VERIFICATION

4.3 RADIAL DEFLECTION

No anomalies were observed, and environmental testing resumed.

(e) SPECIAL TESTING PROBLEMS

The major difficulty encountered during testing was in securing the UUT inside the vibration fixture without causing damage to the wires, shaft, and bearing. These fixturing problems were anticipated prior to vibration, with the exception of the previously mentioned load attachment to the shaft.

(f) FAILURE AND CORRECTIVE ACTION DATA

Refer to NCR 00168 and Corrective Action Report M13640.

SECTION III

QUALIFICATION TEST DATA RESULTS

APPLICATION	
NEXT ASSY	USED ON

REVISIONS

LTR	DESCRIPTION	DATE	APPROVED
B	INITIAL RELEASE	9-1-94	

ACCEPTANCE TEST DATA SHEETS
ATP 20049
P/N 16187
STEP MOTOR/ENCODER

DATA REVIEW AND APPROVAL:

AEROFLEX QUALITY ASSURANCE ______________________

DCAS ______________________

AEROFLEX TEST ENGINEERING ______________________ 6/30/95

S/N 0002

ALL PAGES ARE OF ORIGINAL ISSUE EXCEPT AS NOTED	SHEET	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
	REV.	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B																			

UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES TOLERANCES FRAC. DEC. ANG.	ORIG. DATE OF DWG.	AEROFLEX LABORATORIES INCORPORATED PLAINVIEW N.Y. 11803 AN ARX COMPANY
	DRAWN	Acceptance Test Data Sheets - For P/N 16187 Step Motor/Encoder
	CHECKED	
MATERIAL	ENGNRG. 9-1-94	
	DESIGN 9-1-94	SIZE A | CAGE CODE 88379 | ATP 20049 DS
FINISH	QA	
	MFG.	SCALE | WEIGHT | SHEET 1

0002

1.0 TORQUE AND OPERATING POINT

1.1 DETENT TORQUE

Cogging through three detent positions 0.25 oz-in min

1. 2.0 oz-in.
2. 2.1 oz-in.
3. 2.3 oz-in.

04.27.95

1.2 OPERATING TORQUE

Motor rotates 6 RPM min when 4.8 pps at 22 VDC to 25 VDC is applied with 5.5 oz-in load.

6 RPM

04.27.95

1.3 STALL TORQUE

6 oz-in minimum at 22 VDC

16 oz-in

- Detent torque in 1.1=

Stall torque 13.7 oz-in

04.27.95

2.0 MOTOR ELECTRICAL CHARACTERISTICS

2.1 STEP ANGLE

Motor lead #1(+22 VDC) to motor lead #3 (RTN) cw rotation ✓

7.5 +/- 0.75 degrees ✓

04.27.95

Motor lead #2 (+22 VDC) to motor lead #4 (RTN) cw rotation ✓

7.5 +/-0.75 degrees ✓

2.2 WINDING RESISTANCE AT 20 DEG C

Room ambient temperature 25 deg C

Resistance between wires 1 and 3 82.4 ohms

Resistance calculated for 20 degrees C 80.8 ohms

77.6 ohms minimum

04.27.95

SIZE	CAGE CODE	
A	88379	ATP 20049 DS
SCALE	REV. B	SHEET 2

0002

Resistance between wires 2 and 4 82.1 ohms

Resistance calculated for 20 degrees C 81.1 ohms
77.6 ohms minimum

2.3 WINDING INDUCTANCE

04.27.95

Inductance between wires 1 and 3 19.0 mH

Inductance between wires 2 and 4 19.0 mH
These values are for reference only.

2.4 INSULATION RESISTANCE AND DIELECTRIC STRENGTH POST-IMPREGNATION

Tie together motor leads 1 and 3, 2 and 4

2.4.1 INSULATION RESISTANCE

04.27.9

100 VDC between 1,3 and 2,4 >1000 Megohms
100 Megohms min

100 VDC between 1,3 and housing >1000 Megohms
100 Megohms min

100 VDC between 2,4 and housing >1000 Megohms
100 Megohms min

2.4.2 DIELECTRIC STRENGTH

04.27.9

125 VRMS between 1,3 and 2,4 42 microamps
100 microamps max leakage

125 VRMS between 1,3 and housing 26 microamps
100 microamps max leakage

125 VRMS between 2,4 and housing 27 microamps
100 microamps max leakage

SIZE A	CAGE CODE 88379	ATP 20049 DS
SCALE	REV. B	SHEET 3

3.0 ENCODER ELECTRICAL CHARACTERISTICS

3.1 ENCODER POSITION 1 AND OUTPUT VOLTAGE

04.27.95

Encoder position 1 is according to Table 1 ✓ check

Output voltage across bit 4 is 3.5 Vdc min at 4.8 VDC min
5.0 VDC max ✓ check

3.2 ENCODER POSITION VERIFICATION

Encoder position 2 through 12 is according to Table 1 ✓ check 04.27.95

4.0 MOTOR/ENCODER PHYSICAL CHARACTERISTICS

4.1 SIZE AND CONFIGURATION

Check that critical dimensions from MSFC drawing SXI-201 and Aeroflex drawing 200-38 are satisfied ✓ check

4.2 WEIGHT

Motor/Encoder weight 14.85 ounces
Lead wire weight - 2.8 ounces
= 12.05 ounces
15 ounces max

04.26.95

4.3 RADIAL DEFLECTION

9.0 +/- 0.1 lb force applied on the shaft in accordance with MSFC drawing SXI-201, Proof Load Diagram 0.0014 inches

0.0015 inches max

4/27/95

SIZE	CAGE CODE	
A	88379	ATP 20049 DS
SCALE	REV. B	SHEET 4

0002

5.0 ENVIRONMENTAL TESTS

5.1 THERMAL VACUUM

5.1.1 AMBIENT TEMPERATURE AND PRESSURE

Connect AD590 temperature sensor to the trim circuit in Figure 3. Record the output. 295 mv

Calculate the ambient temperature :
mv output - 273 = temperature in degrees C 22°C

Verify step rotation cw from zero position with wire # 1 (+ 22 VDC) and wire #3 (RTN) ✓ check

Verify encoder output at step 4 in table 1 ✓ check

Seal the vacuum container and remove from the clean room. 4/28/95

5.1.2 THERMAL VACUUM FUNCTIONAL TESTS

5.1.2.1 OPERATION UNDER LOAD

11 VDC min, 12.5 VDC max to the motor drive circuit.
5 VDC +/- 0.2 V to the encoder input wires.

a. Baseline, 25 degrees C recorder trace:

No interruptions in motor or encoder traces ✓ check

3.5 V minimum encoder output ✓ check 5/1/95

b. Cycle 1, 50 degrees C recorder trace:

No interruptions in motor or encoder traces ✓ check

3.5 V minimum encoder output ✓ check 5/4/95

c. Cycle 1, -40 degrees C recorder trace:

No interruptions in motor or encoder traces ✓ check

3.5 V minimum encoder output ✓ check

5/8/95

d. Cycle 2, 50 degrees C recorder trace :

No interruptions in motor or encoder traces ✓ check

3.5 V minimum encoder output ✓ check

5/11/95

e. Cycle 2, -40 degrees C recorder trace :

No interruptions in motor or encoder traces ✓ check

3.5 V minimum encoder output ✓ check

5/12/95

f. Cycle 3, 50 degrees C recorder trace :

No interruptions in motor or encoder traces ✓ check

3.5 V minimum encoder output ✓ check

5/12/95

g. Cycle 3, -40 degrees C recorder trace :

No interruptions in motor or encoder traces ✓ check

3.5 V minimum encoder output ✓ check

5/15/95

h. Final test, 25 degrees C recorder trace:

No interruptions in motor or encoder traces ✓ check

3.5 V minimum encoder output ✓ check

5/15/95

5.1.2.2 STALL OPERATION, THERMAL VACUUM

Disconnect the motor from the test circuit. Apply
200 ma through wires #1 and #3 for 30 seconds.
Repeat according to paragraph 4.1.3.2 of the test procedure.

0002

a. Baseline, 25 degrees C recorder trace:

No interruptions in motor or encoder traces ✓ check

3.5 V minimum encoder output ✓ check

5/1/95

b. Cycle 1, 50 degrees C recorder trace:

No interruptions in motor or encoder traces ✓ check

3.5 V minimum encoder output ✓ check

5/4/95

c. Cycle 1, -40 degrees C recorder trace:

No interruptions in motor or encoder traces ✓ check

3.5 V minimum encoder output ✓ check

5/8/95

d. Cycle 2, 50 degrees C recorder trace :

No interruptions in motor or encoder traces ✓ check

3.5 V minimum encoder output ✓ check

5/11/95

e. Cycle 2, -40 degrees C recorder trace :

No interruptions in motor or encoder traces ✓ check

3.5 V minimum encoder output ✓ check

5/12/95

f. Cycle 3, 50 degrees C recorder trace :

No interruptions in motor or encoder traces ✓ check

3.5 V minimum encoder output ✓ check

5/12/95

g. Cycle 3, -40 degrees C recorder trace :

No interruptions in motor or encoder traces ✓ check

3.5 V minimum encoder output ✓ check

5/15/95

h. Final test, 25 degrees C recorder trace:

No interruptions in motor or encoder traces ✓ check

3.5 V minimum encoder output ✓ check

5/15/95

5.2 THERMAL CYCLING TEST AT AMBIENT PRESSURE

5.2.1 PRE-THERMAL CYCLING PERFORMANCE TEST

5.2.1.1 STALL TORQUE

6 oz-in minimum at 22 VDC 17.5 oz-in

\- Detent torque in 1.1= 2.3 oz in

Stall torque 15.2 oz-in

5.2.1.2 STEP ANGLE

Motor lead #1(+22 VDC) to motor lead #3 (RTN) cw rotation ✓

7.5 +/- 0.75 degrees ✓

Motor lead #2 (+22 VDC) to motor lead #4 (RTN) cw rotation ✓

7.5 +/-0.75 degrees ✓

5.2.1.3 ENCODER POSITION 1 AND OUTPUT VOLTAGE

Encoder position 1 is according to Table 1 ✓ check

Output voltage across bit 4 is 3.5 Vdc min at 4.8 VDC min 5.0 VDC max ✓ check

5.2.1.4 ENCODER POSITION VERIFICATION

Encoder position 2 through 12 is according to Table 1 ✓ check

5/16/95

5.2.2 OPERATION UNDER LOAD

11 VDC min, 12.5 VDC max to the motor drive circuit.
5 VDC +/- 0.2 V to the encoder input wires.

a. Baseline, 25 degrees C recorder trace:

No interruptions in motor or encoder traces ✓ check

3.5 V minimum encoder output ✓ check

STALL OK

5/16/95

b. Cycle 1, 50 degrees C recorder trace:

No interruptions in motor or encoder traces ✓ check

3.5 V minimum encoder output ✓ check

STALL OK

5/16/95

c. Cycle 1, -40 degrees C recorder trace:

No interruptions in motor or encoder traces ✓ check

3.5 V minimum encoder output ✓ check

STALL OK

5/17/95

d. Cycle 24, 50 degrees C recorder trace :

No interruptions in motor or encoder traces ✓ check

3.5 V minimum encoder output ✓ check
STALL OK
5/27/95

e. Cycle 24, -40 degrees C recorder trace :

No interruptions in motor or encoder traces ✓ check

3.5 V minimum encoder output ✓ check
STALL OK
5/27/95

f. Final Test, 25 degree C recorder trace :

No interruptions in motor or encoder traces ✓ check

3.5 V minimum encoder output ✓ check
STALL OK
5/27/95

5.3 VIBRATION AND SHOCK

5.3.1 SINE VIBRATION

Date(s) performed 6/6 - 6/7 1995

Visual Inspection 6/7/95

5.3.1.1 STALL TORQUE

6 oz-in minimum at 22 VDC 19.0 oz-in

\- Detent torque in 1.1= 2.3
Stall torque 16.7 oz-in

5.3.1.2 STEP ANGLE

Motor lead #1(+22 VDC) to motor lead #3 (RTN) cw rotation ✓
7.5 +/- 0.75 ✓
degrees

1002

Motor lead #2 (+22 VDC) to motor lead #4 (RTN) cw rotation ✓
7.5 +/-0.75
degrees ✓

6/7/95

5.3.1.3 ENCODER POSITION 1 AND OUTPUT VOLTAGE

Encoder position 1 is according to Table 1 ✓ check

Output voltage across bit 4 is 3.5 Vdc min at 4.8 VDC min
5.0 VDC max ✓ check

5.3.1.4 ENCODER POSITION VERIFICATION

Encoder position 2 through 12 is according to Table 1 ✓ check

6/7/95

5.3.2 RANDOM VIBRATION

Date(s) performed 5/30/95

Visual Inspection ✓ 5/31/95

5.3.2.1 STALL TORQUE

6 oz-in minimum at 22 VDC 18.0 oz-in
- Detent torque in 1.1= 2.3 oz-in
Stall torque 15.7 oz-in

5.3.2.2 STEP ANGLE

Motor lead #1(+22 VDC) to motor lead #3 (RTN) cw rotation ✓
7.5 +/- 0.75
degrees ✓

Motor lead #2 (+22 VDC) to motor lead #4 (RTN) cw rotation ✓
7.5 +/-0.75
degrees ✓

5/31/95

0002

5.3.2.3 ENCODER POSITION 1 AND OUTPUT VOLTAGE

Encoder position 1 is according to Table 1 ✓ check

Output voltage across bit 4 is 3.5 Vdc min at 4.8 VDC min
5.0 VDC max ✓ check

5.3.2.4 ENCODER POSITION VERIFICATION

Encoder position 2 through 12 is according to Table 1 ✓ check

5/31/95

5.3.3 MECHANICAL SHOCK

Date(s) performed 6/12 - 6/16 1995

Visual Inspection

5.3.3.1 STALL TORQUE

6 oz-in minimum at 22 VDC 18.0 oz-in

- Detent torque in 1.1= 2.3 oz-in
Stall torque 15.7 oz-in

5.3.3.2 STEP ANGLE

06.19.95

Motor lead #1 (+22 VDC) to motor lead #3 (RTN) cw rotation ✓
7.5 +/- 0.75
degrees ✓

Motor lead #2 (+22 VDC) to motor lead #4 (RTN) cw rotation ✓
7.5 +/-0.75
degrees ✓

5.3.3.3 ENCODER POSITION 1 AND OUTPUT VOLTAGE

Encoder position 1 is according to Table 1 ✓ check

06.19.95

Output voltage across bit 4 is 3.5 Vdc min at 4.8 VDC min
5.0 VDC max ✓ check

SIZE A	CAGE CODE 88379	ATP 20049 DS	
SCALE	REV. B	SHEET 12	

0002

5.3.3.4 ENCODER POSITION VERIFICATION

06.19.95

Encoder position 2 through 12 is according to Table 1 ✓ check

5.3.3.5 DIELECTRIC STRENGTH

06.19.95

100 VRMS between 1,3 and 2,4 35 microamps
100 microamps max leakage

100 VRMS between 1,3 and housing 25 microamps
100 microamps max leakage

100 VRMS between 2,4 and housing 25 microamps
100 microamps max leakage

5.4 FINAL FUNCTIONAL TEST

5.4.1 TORQUE AND OPERATING POINT

5.4.1.1 DETENT TORQUE

06.19.95

Cogging through three detent positions 0.25 oz-in min

1. 2.5 oz-in.
2. 2.5 oz-in.
3. 2.0 oz-in.

5.4.1.2 OPERATING TORQUE

06.19.95

Motor rotates 6 RPM min when 4.8 pps at 22 VDC to 25 VDC is applied with 5.5 oz-in load.

6.5 RPM

5.4.1.3 STALL TORQUE

06.19.95

6 oz-in minimum at 22 VDC 18. oz-in
- Detent torque in 1.1= 2.5
Stall torque 15.5 oz-in

SIZE	CAGE CODE	
A	88379	ATP 20049 DS
SCALE	REV. B	SHEET 13

0002

5.4.2 MOTOR ELECTRICAL CHARACTERISTICS

5.4.2.1 STEP ANGLE

Motor lead #1(+22 VDC) to motor lead #3 (RTN) cw rotation ✓
7.5 +/- 0.75 degrees ✓

Motor lead #2 (+22 VDC) to motor lead #4 (RTN) cw rotation ✓
7.5 +/-0.75 degrees ✓

06.19.95

5.4.2.2 WINDING RESISTANCE AT 20 DEG C

Room ambient temperature 24 deg C

Resistance between wires 1 and 3 81.7 ohms

Resistance calculated for 20 degrees C 80.4 ohms
77.6 ohms minimum

Resistance between wires 2 and 4 82.0 ohms

Resistance calculated for 20 degrees C 80.7 ohms
77.6 ohms minimum

06.19.95

5.4.2.3 WINDING INDUCTANCE

Inductance between wires 1 and 3 18.7 mH

Inductance between wires 2 and 4 18.6 mH
These values are for reference only.

06.19.95

SIZE A	CAGE CODE 88379	ATP 20049 DS
SCALE	REV. B	SHEET 14

5.4.3 ENCODER ELECTRICAL CHARACTERISTICS

5.4.3.1 ENCODER POSITION 1 AND OUTPUT VOLTAGE

06.19.95

Encoder position 1 is according to Table 1 ✓ check

Output voltage across bit 4 is 3.5 Vdc min at 4.8 VDC min
5.0 VDC max ✓ check

5.4.3.2 ENCODER POSITION VERIFICATION

06.19.95

Encoder position 2 through 12 is according to Table 1 ✓ check

5.4.4 RADIAL DEFLECTION

9.0 +/- 0.1 lb force applied on the shaft in accordance with MSFC drawing SXI-201, Proof Load Diagram

0.0014 inches

0.0015 inches max

6/19/95

Torque at 12.0 VDC = 10 - 2.5 = 7.5 oz-in

06.19.95

1.0 TORQUE AND OPERATING POINT

1.1 DETENT TORQUE

Cogging through three detent positions 0.25 oz-in min

1. 1.7 oz-in.
2. 1.8 oz-in.
3. 1.7 oz-in.

04.26.95

1.2 OPERATING TORQUE

Motor rotates 6 RPM min when 4.8 pps at ~~22~~ 12 VDC to ~~25~~ 12 VDC is applied with 5.5 oz-in load.

6.5 RPM

04.26.95

1.3 STALL TORQUE

6 oz-in minimum at 22 VDC

15.5 oz-in

\- Detent torque in 1.1=
Stall torque 13.7 oz-in

04.26.95

2.0 MOTOR ELECTRICAL CHARACTERISTICS

2.1 STEP ANGLE

Motor lead #1(+22 VDC) to motor lead #3 (RTN) cw rotation ✓
7.5 +/- 0.75 degrees ✓

04.26.95

Motor lead #2 (+22 VDC) to motor lead #4 (RTN) cw rotation ✓
7.5 +/-0.75 degrees ✓

2.2 WINDING RESISTANCE AT 20 DEG C

Room ambient temperature 25 deg C

Resistance between wires 1 and 3 82.8 ohms

Resistance calculated for 20 degrees C 81.2 ohms
77.6 ohms minimum

04.26.95

SIZE A	CAGE CODE 88379	ATP 20049 A5		
SCALE		REV. B	SHEET 2	

Resistance between wires 2 and 4 83.3 ohms

Resistance calculated for 20 degrees C 81.6 ohms
77.6 ohms minimum

2.3 WINDING INDUCTANCE

Inductance between wires 1 and 3 19.0 mH

Inductance between wires 2 and 4 19.0 mH
These values are for reference only.

04.26.95

2.4 INSULATION RESISTANCE AND DIELECTRIC STRENGTH POST-IMPREGNATION

Tie together motor leads 1 and 3, 2 and 4

2.4.1 INSULATION RESISTANCE

04.26.95

100 VDC between 1,3 and 2,4 >1000 Megohms
100 Megohms min

100 VDC between 1,3 and housing >1000 Megohms
100 Megohms min

100 VDC between 2,4 and housing >1000 Megohms
100 Megohms min

2.4.2 DIELECTRIC STRENGTH

125 VRMS between 1,3 and 2,4 37 microamps
100 microamps max leakage

125 VRMS between 1,3 and housing 25 microamps
100 microamps max leakage

125 VRMS between 2,4 and housing 25 microamps
100 microamps max leakage

SIZE	CAGE CODE	
A	88379	ATP 20049 DS

SCALE	REV. B	SHEET 3

0003

3.0 ENCODER ELECTRICAL CHARACTERISTICS

04.26.95

3.1 ENCODER POSITION 1 AND OUTPUT VOLTAGE

Encoder position 1 is according to Table 1 ✓ check

Output voltage across bit 4 is 3.5 Vdc min at 4.8 VDC min
5.0 VDC max ✓ check

3.2 ENCODER POSITION VERIFICATION

Encoder position 2 through 12 is according to Table 1 ✓ check 04.26.95

4.0 MOTOR/ENCODER PHYSICAL CHARACTERISTICS

4.1 SIZE AND CONFIGURATION

Check that critical dimensions from MSFC drawing SXI-201 and Aeroflex drawing 200-38 are satisfied ✓ check

4.2 WEIGHT

Motor/Encoder weight 14.8 ounces
Lead wire weight − 2.8 ounces
= 12.0 ounces
15 ounces max

04.[illegible].95

4.3 RADIAL DEFLECTION

9.0 +/- 0.1 lb force applied on the shaft in accordance with MSFC drawing SXI-201, Proof Load Diagram 0.0014 inches

0.0015 inches max

4/3/95

SIZE	CAGE CODE	
A	88379	ATP 20049 DS
SCALE	REV. B	SHEET 4

0003 RETEST
NCR 00168

1.0 TORQUE AND OPERATING POINT

1.1. DETENT TORQUE

Cogging through three detent positions 0.25 oz-in min

06.01.95

1. 2.5 oz-in.
2. 1.5 oz-in.
3. 2.0 oz-in.

1.2 OPERATING TORQUE

Motor rotates 6 RPM min when 4.8 pps at 22 VDC to 25 VDC is applied with 5.5 oz-in load.

Checked at 12 V 6.5 RPM

06.01.95

1.3 STALL TORQUE

6 oz-in minimum at 22 VDC 18.0 oz-in

- Detent torque in 1.1= 2.5

Stall torque 15.5 oz-in

06.01.95

2.0 MOTOR ELECTRICAL CHARACTERISTICS

2.1 STEP ANGLE

Motor lead #1(+22 VDC to motor lead #3 (RTN) cw rotation ✓
7.5 +/- 0.75
degrees ✓

06.01.95

Motor lead #2 (+22 VDC) to motor lead #4 (RTN) cw rotation ✓
7.5 +/-0.75
degrees ✓

2.2 WINDING RESISTANCE AT 20 DEG C

Room ambient temperature 22 deg C

06.01.95

Resistance between wires 1 and 3 82.1 ohms

Resistance calculated for 20 degrees C 81.5 ohms
77.6 ohms minimum

SIZE	CAGE CODE	
A	88379	ATP 20049 AS
SCALE	REV. B	SHEET 2

0003 RETEST
NCR 00168

Resistance between wires 2 and 4 83.5 ohms

Resistance calculated for 20 degrees C 82.0 ohms
77.6 ohms minimum

* 2.3 WINDING INDUCTANCE

06.01.95

Inductance between wires 1 and 3 19.0 mH

Inductance between wires 2 and 4 19.0 mH
These values are for reference only.

* 2.4 INSULATION RESISTANCE AND DIELECTRIC STRENGTH POST-IMPREGNATION

Tie together motor leads 1 and 3, 2 and 4

* 2.4.1 INSULATION RESISTANCE

100 VDC between 1,3 and 2,4 >1000 Megohms
100 Megohms min

100 VDC between 1,3 and housing >1000 Megohms
100 Megohms min

100 VDC between 2,4 and housing >1000 Megohms
100 Megohms min

* 2.4.2 DIELECTRIC STRENGTH

125 VRMS between 1,3 and 2,4 37 microamps
100 microamps max leakage

125 VRMS between 1,3 and housing 25 microamps
100 microamps max leakage

125 VRMS between 2,4 and housing 25 microamps
100 microamps max leakage

* PERFORMED DURING ORIGINAL FUNCTIONAL TEST

0003 RETEST
NCR 00168

3.0 ENCODER ELECTRICAL CHARACTERISTICS

3.1 ENCODER POSITION 1 AND OUTPUT VOLTAGE

Encoder position 1 is according to Table 1 ✓ check

06.01.95

Output voltage across bit 4 is 3.5 Vdc min at 4.8 VDC min
5.0 VDC max ✓ check

3.2 ENCODER POSITION VERIFICATION

Encoder position 2 through 12 is according to Table 1 ✓ check

4.0 MOTOR/ENCODER PHYSICAL CHARACTERISTICS

4.1 SIZE AND CONFIGURATION

Check that critical dimensions from MSFC drawing SXI-201 and Aeroflex drawing 200-38 are satisfied ✓ check

4.2 WEIGHT

Motor/Encoder weight 14.6 ounces
Lead wire weight - 2.3 ounces
= 12.3 ounces
15 ounces max

06.01.95

4.3 RADIAL DEFLECTION

9.0 +/- 0.1 lb force applied on the shaft in accordance with MSFC drawing SXI-201, Proof Load Diagram 0.0011 inches

0.0015 inches max

6/1/95

SIZE A	CAGE CODE 88379	ATP 20049 DS
SCALE	REV. B	SHEET 4

0003

5.0 ENVIRONMENTAL TESTS

5.1 THERMAL VACUUM

5.1.1 AMBIENT TEMPERATURE AND PRESSURE

Connect AD590 temperature sensor to the trim circuit in Figure 3. Record the output. 295 mv

Calculate the ambient temperature :
mv output - 273 = temperature in degrees C 22 °C

Verify step rotation cw from zero position with wire # 1 (+ 22 VDC) and wire #3 (RTN) ✓ check

Verify encoder output at step 4 in table 1 ✓ check

Seal the vacuum container and remove from the clean room.

6/1/95

5.1.2 THERMAL VACUUM FUNCTIONAL TESTS

5.1.2.1 OPERATION UNDER LOAD

11 VDC min, 12.5 VDC max to the motor drive circuit.
5 VDC +/- 0.2 V to the encoder input wires.

a. Baseline, 25 degrees C recorder trace:

No interruptions in motor or encoder traces ✓ check

3.5 V minimum encoder output ✓ check

6/12/95

b. Cycle 1, 50 degrees C recorder trace:

No interruptions in motor or encoder traces ✓ check

3.5 V minimum encoder output ✓ check

6/13/95

c. Cycle 1, -40 degrees C recorder trace:

No interruptions in motor or encoder traces ✓ check

3.5 V minimum encoder output ✓ check

6/14/95

d. Cycle 2, 50 degrees C recorder trace :

No interruptions in motor or encoder traces ✓ check

3.5 V minimum encoder output ✓ check

6/15/95

e. Cycle 2, -40 degrees C recorder trace :

No interruptions in motor or encoder traces ✓ check

3.5 V minimum encoder output ✓ check

6/15/95

f. Cycle 3, 50 degrees C recorder trace :

No interruptions in motor or encoder traces ✓ check

3.5 V minimum encoder output ✓ check

6/16/95

g. Cycle 3, -40 degrees C recorder trace :

No interruptions in motor or encoder traces ✓ check

3.5 V minimum encoder output ✓ check

6/16/95

h. Final test, 25 degrees C recorder trace:

No interruptions in motor or encoder traces ✓ check

3.5 V minimum encoder output ✓ check

6/17/95

5.1.2.2 STALL OPERATION, THERMAL VACUUM

Disconnect the motor from the test circuit. Apply 200 ma through wires #1 and #3 for 30 seconds. Repeat according to paragraph 4.1.3.2 of the test procedure.

5.1.2.2

a. Baseline, 25 degrees C recorder trace:

No interruptions in motor or encoder traces ✓ check

3.5 V minimum encoder output ✓ check

6/12/95

b. Cycle 1, 50 degrees C recorder trace:

No interruptions in motor or encoder traces ✓ check

3.5 V minimum encoder output ✓ check 6/13/95

c. Cycle 1, -40 degrees C recorder trace:

No interruptions in motor or encoder traces ✓ check

3.5 V minimum encoder output ✓ check 6/14/95

d. Cycle 2, 50 degrees C recorder trace :

No interruptions in motor or encoder traces ✓ check

3.5 V minimum encoder output ✓ check 6/15/95

e. Cycle 2, -40 degrees C recorder trace :

No interruptions in motor or encoder traces ✓ check

3.5 V minimum encoder output ✓ check

6/15/95

f. Cycle 3, 50 degrees C recorder trace :

No interruptions in motor or encoder traces ✓ check

3.5 V minimum encoder output ✓ check

6/16/95

g. Cycle 3, -40 degrees C recorder trace :

No interruptions in motor or encoder traces ✓ check

3.5 V minimum encoder output ✓ check

6/16/95

h. Final test, 25 degrees C recorder trace:

No interruptions in motor or encoder traces ✓ check

3.5 V minimum encoder output ✓ check

6/17/95

5.2 THERMAL CYCLING TEST AMBIENT PRESSURE

5.2.1 PRE-THERMAL CYCLING PERFORMANCE TEST

5.2.1.1 STALL TORQUE

6 oz-in minimum at 22 VDC 15.0 oz-in

\- Detent torque in 1.1= 2.5

Stall torque ~~13.2~~ oz-in

12.5 ✓ 6/18/95

5.2.1.2 STEP ANGLE

Motor lead #1(+22 VDC) to motor lead #3 (RTN) cw rotation ✓

7.5 +/- 0.75 degrees ✓

Motor lead #2 (+22 VDC) to motor lead #4 (RTN) cw rotation ✓
7.5 +/-0.75
degrees ✓

6/18/95

5.2.1.3 ENCODER POSITION 1 AND OUTPUT VOLTAGE

Encoder position 1 is according to Table 1 ✓ check

Output voltage across bit 4 is 3.5 Vdc min at 4.8 VDC min
5.0 VDC max ✓ check

6/18/95

5.2.1.4 ENCODER POSITION VERIFICATION

Encoder position 2 through 12 is according to Table 1 ✓ check

5.2.2 OPERATION UNDER LOAD

11 VDC min, 12.5 VDC max to the motor drive circuit.
5 VDC +/- 0.2 V to the encoder input wires.

a. Baseline, 25 degrees C recorder trace:

No interruptions in motor or encoder traces ✓ check

3.5 V minimum encoder output ✓ check
STALL TEST OK

6/2/95

b. Cycle 1, 50 degrees C recorder trace:

No interruptions in motor or encoder traces ✓ check

3.5 V minimum encoder output ✓ check
STALL TEST OK

6/2/95

c. Cycle 1, -40 degrees C recorder trace:

No interruptions in motor or encoder traces ✓ check

3.5 V minimum encoder output ✓ check
STALL TEST OK

6/5/95

SIZE	CAGE CODE	
A	88379	ATP 20049 DS
SCALE	REV. 8	SHEET 9

d. Cycle 24, 50 degrees C recorder trace :

No interruptions in motor or encoder traces ✓ check

3.5 V minimum encoder output ✓ check
STALL TEST OK
6/12/95

e. Cycle 24, -40 degrees C recorder trace :

No interruptions in motor or encoder traces ✓ check

3.5 V minimum encoder output ✓ check
STALL TEST OK
6/12/95

f. Final Test, 25 degree C recorder trace :

No interruptions in motor or encoder traces ✓ check

3.5 V minimum encoder output ✓ check
STALL TEST OK
6/12/95

5.3 VIBRATION AND SHOCK

5.3.1 SINE VIBRATION

Date(s) performed 6/19 - 6/21 1995

Visual Inspection

5.3.1.1 STALL TORQUE

6 oz-in minimum at 22 VDC 18.5 oz-in

- Detent torque in 1.1= ~~1.8~~ 2.5

Stall torque ~~16.7~~ oz-in
16.0 DH. 6/21/95

5.3.1.2 STEP ANGLE

Motor lead #1(+22 VDC) to motor lead #3 (RTN) cw rotation ✓

7.5 +/- 0.75 degrees ✓

Motor lead #2 (+22 VDC) to motor lead #4 (RTN) cw rotation ✓
7.5 +/-0.75 degrees ✓

5.3.1.3 ENCODER POSITION 1 AND OUTPUT VOLTAGE

Encoder position 1 is according to Table 1 ✓ check

Output voltage across bit 4 is 3.5 Vdc min at 4.8 VDC min
5.0 VDC max ✓ check

5.3.1.4 ENCODER POSITION VERIFICATION

Encoder position 2 through 12 is according to Table 1 ✓ check

6/21/95

5.3.2 RANDOM VIBRATION

Date(s) performed 6/22 - 6/23/95 RETEST NCR 00168

Visual Inspection

RANDOM WAS FIRST PERFORMED 4/28/95

5.3.2.1 STALL TORQUE

6 oz-in minimum at 22 VDC 18.5 oz-in
\- Detent torque in 1.1= 2.5
Stall torque 16.0 oz-in

5.3.2.2 STEP ANGLE

Motor lead #1(+22 VDC) to motor lead #3 (RTN) cw rotation ✓
7.5 +/- 0.75 degrees ✓

Motor lead #2 (+22 VDC) to motor lead #4 (RTN) cw rotation ✓
7.5 +/-0.75 degrees ✓

0003

5.3.2.3 ENCODER POSITION 1 AND OUTPUT VOLTAGE

Encoder position 1 is according to Table 1 ✓ check

Output voltage across bit 4 is 3.5 Vdc min at 4.8 VDC min
5.0 VDC max ✓ check

6/26/95

5.3.2.4 ENCODER POSITION VERIFICATION

Encoder position 2 through 12 is according to Table 1 ✓ check

5.3.3 MECHANICAL SHOCK

Date(s) performed 6/26 - 6/27/95

Visual Inspection

5.3.3.1 STALL TORQUE

6 oz-in minimum at 22 VDC 18.0 oz-in

- Detent torque in 1.1= 2.5
Stall torque 15.5 oz-in

5.3.3.2 STEP ANGLE

Motor lead #1(+22 VDC) to motor lead #3 (RTN) cw rotation ✓
7.5 +/- 0.75
degrees ✓

Motor lead #2 (+22 VDC) to motor lead #4 (RTN) cw rotation ✓
7.5 +/-0.75
degrees ✓

5.3.3.3 ENCODER POSITION 1 AND OUTPUT VOLTAGE

Encoder position 1 is according to Table 1 ✓ check

Output voltage across bit 4 is 3.5 Vdc min at 4.8 VDC min
5.0 VDC max ✓ check

SIZE	CAGE CODE	ATP 20049 DS	
A	88379		
SCALE	REV. B	SHEET 12	

5.3.3.4 ENCODER POSITION VERIFICATION

Encoder position 2 through 12 is according to Table 1 ✓ check

5.3.3.5 DIELECTRIC STRENGTH

100 VRMS between 1,3 and 2,4 32 microamps
100 microamps max leakage

100 VRMS between 1,3 and housing 21 microamps
100 microamps max leakage

100 VRMS between 2,4 and housing 22 microamps
100 microamps max leakage

6/28/95

5.4 FINAL FUNCTIONAL TEST 6/28/95

5.4.1 TORQUE AND OPERATING POINT

5.4.1.1 DETENT TORQUE

Cogging through three detent positions 0.25 oz-in min

1. 2.5 oz-in.
2. 1.5 oz-in.
3. 2.5 oz-in.

06.28.95

5.4.1.2 OPERATING TORQUE

Motor rotates 6 RPM min when 4.8 pps at ~~22~~ 12 VDC to ~~25~~ VDC is applied with 5.5 oz-in load.

6.5 RPM

06.28.95

5.4.1.3 STALL TORQUE

6 oz-in minimum at ~~22~~ 12 VDC

11,0 oz-in − 2.5
- Detent torque in 1.1=
Stall torque 8.5 oz-in

06.28.95

5.4.2 MOTOR ELECTRICAL CHARACTERISTICS

5.4.2.1 STEP ANGLE

Motor lead #1(+22 VDC) to motor lead #3 (RTN) cw rotation ✓
7.5 +/- 0.75
degrees ✓

Motor lead #2 (+22 VDC) to motor lead #4 (RTN) cw rotation ✓
7.5 +/-0.75
degrees ✓

06.28.95

5.4.2.2 WINDING RESISTANCE AT 20 DEG C

Room ambient temperature 20 deg C

Resistance between wires 1 and 3 81.4 ohms

Resistance calculated for 20 degrees C 81.4 ohms
77.6 ohms minimum

Resistance between wires 2 and 4 82.0 ohms

Resistance calculated for 20 degrees C 82.0 ohms
77.6 ohms minimum

06.28.95

5.4.2.3 WINDING INDUCTANCE

Inductance between wires 1 and 3 18.5 mH

Inductance between wires 2 and 4 18.7 mH
These values are for reference only.

06.28.95

SIZE A	CAGE CODE 88379	ATP 20049 DS	
SCALE	REV. B	SHEET 14	

0003

5.4.3 ENCODER ELECTRICAL CHARACTERISTICS

5.4.3.1 ENCODER POSITION 1 AND OUTPUT VOLTAGE

06.28.95

Encoder position 1 is according to Table 1 ✓ check

Output voltage across bit 4 is 3.5 Vdc min at 4.8 VDC min
5.0 VDC max ✓ check

5.4.3.2 ENCODER POSITION VERIFICATION

Encoder position 2 through 12 is according to Table 1 ✓ check

5.4.4 RADIAL DEFLECTION

9.0 +/- 0.1 lb force applied on the shaft in accordance with MSFC drawing SXI-201, Proof Load Diagram 0.0013 inches

0.0015 inches max

6/28/95

WT 416g w/wires
350g w/o

VIE
E.N.
O.HIQ

SECTION IV

SPECIAL TEST DATA

EAST-WEST TECHNOLOGY CORP.
119 Cabot Street
West Babylon, NY 11704
(516) 420 0530 • Fax (516) 420 8067

QUALIFICATION TEST REPORT

ON

SXI MOTOR/ENCODER ASSEMBLY

P/N 16187

TESTED FOR: **AEROFLEX LABORATORIES INC.**
35 South Service Road
Plainview, NY 11803

PREPARED BY:
J. COHEN
EAST-WEST TECHNOLOGY

QUALITY ASSURANCE BY:
R. BORRELLI
EWT QUALITY ASSURANCE MANAGER

APPROVED BY:
D. LICHTMAN
EWT GENERAL MANAGER

"SURVEILLANCE OF THE ABOVE LISTED ITEM HAS BEEN PERFORMED"

FOR J. MAGNUSON
DCMAO/QAR

EWT Job No. **8286**

ADMINISTRATIVE DATA

TEST PERFORMED FOR:	**Aeroflex Laboratories Inc.** 35 South Service Road Plainview, NY 11803
TESTING PERFORMED:	**Fixture Survey** **Sine Vibration** **Random Vibration** **Pyrotechnical Shock**
TEST ITEM:	**SXI Motor/Encoder Assembly**
PART NUMBER:	16187
SERIAL NUMBERS:	0002; 0003
PRIMARY SPECIFICATION:	N/A
TEST PROCEDURE:	ATP 20049 REV B
PURCHASE ORDER NOS.:	99593; 10901
GOVERNMENT CONTRACT NO.:	NAS9-39408
EWT JOB NOS.:	**8286** **8363 (Random Vibration Rerun)**
TEST REPORT NO.:	33622
TEST REPORT FILE NO.:	**8286.DOC** Disk 144
TEST COMPLETION DATE:	26 June 1995
TEST REPORT DATE:	8 August 1995

TABLE OF CONTENTS

1.0 INTRODUCTION

1.1 Scope

1.1.1 This document describes procedures and results of the **Fixture Survey; and Sine Vibration, Random Vibration** and **Pyrotechnical Shock** tests performed on **two (2) SXI Motor/Encoder Assemblies, P/N 16187, S/N 0002 and 0003,** as submitted for testing by **Aeroflex Laboratories Inc.**. Testing was performed in accordance with ATP 20049 REV B. A Random Vibration retest of test unit S/N 0003 was conducted as per P.O. 10901, and is reflected herein.

1.2 Purpose

1.2.1 The purpose of this test is to demonstrate that the test specimen meets or exceeds the design specification requirements, during and/or upon completion of exposure to the environmental stresses outlined herein.

2.0 APPLICABLE DOCUMENTS

2.1 Military

2.1.1	MIL-STD-45662A	- Calibration System Requirements

2.2 Aeroflex Laboratories Inc.

2.2.1	ATP 20049 REV B	- Acceptance Test Procedure - Motor/Encoder - 16187
2.3.1	P.O. Nos. 99593; 10901	- Aeroflex Laboratories Inc. Purchase Orders Dated 04/04/95 and 06/09/95, respectively

3.0 GENERAL INFORMATION

3.1 Test Equipment Calibration

3.1.1 All test instrumentation was calibrated in accordance with MIL-STD-45662A "Calibration System Requirements" and is traceable to the National Institute of Standards and Technology (NIST).

3.2 Test Conditions

3.2.1 Unless specified herein, all tests and measurements were performed at the room ambient conditions existing at the laboratory during testing:

Temperature:	23°C ± 10°C
Barometric Pressure:	Prevailing site pressure
Relative Humidity:	Room ambient up to 90%

3.3 Test Tolerances

3.3.1 All test conditions were maintained within the tolerances specified in the detailed test procedure or in accordance with the referenced test specification.

3.4 Test Witnessing / Monitoring

3.4.1 All testing was conducted by a qualified EWT technician under the direction and cognizance of a EWT Quality Assurance test engineer. Test surveillance was provided by a DCMAO Quality Assurance representative.

3.5 Recommendation

3.5.1 All recorded data and observations made by East-West Technology personnel during the testing described herein are submitted for your own evaluation.

4.0 TEST EQUIPMENT

The following is a list of test equipment used to perform the test outlined herein:

4.1 FIXTURE SURVEY

Test date:04/19/95

4.1.1 **Exciter**
Mfr.: Ling
Model: 335
S/N: 40
EWT Control No.: 218
Calibration not required

4.1.2 **Power Amplifier**
Mfr.: Ling
Model: 8024
S/N: N/A
EWT Control No.: 219
Calibration not required

4.1.3 **Accelerometer**
Mfr.: CRL
Model: 330S
S/N: 279
EWT Control No.: 117
Last Calibration: 07/31/94
Calibration Interval: 1 year

4.1.4 **Charge Amplifier**
Mfr.: Trig Tek
Model: 203M
S/N: 804
EWT Control No.: 1135-06
Last Calibration: 05/31/94
Calibration Interval: 1 year

4.1.5 **Charge Amplifier**
Mfr.: Trig Tek
Model: 203M
S/N: 840
EWT Control No.: 1135-05
Last Calibration: 05/31/94
Calibration Interval: 1 year

4.1.6 **Accelerometer**
Mfr.: CRL
Model: 330S
S/N: 409
EWT Control No.: 123
Last Calibration: 02/06/95
Calibration Interval: 1 year

4.0 TEST EQUIPMENT (continued)

4.2 SINE VIBRATION

Test dates: 06/07/95 (Test Unit S/N 0002); 06/20/95 (Test Unit S/N 0003)
***Used during test conducted 06/07/95**
****Used during test conducted 06/20/95**

4.2.1 **Exciter**
Mfr.: Ling
Model: 335
S/N: 40
EWT Control No.: 218
Calibration not required

4.2.2 **Accelerometer****
Mfr.: CRL
Model: 5011
S/N: 1119
EWT Control No.: 2274
Last Calibration: 01/09/95
Calibration Interval: 1 year

4.2.3 **Charge Amplifier****
Mfr.: Trig Tek
Model: 203M
S/N: 840
EWT Control No.: 1135-05
Last Calibration: 06/13/95
Calibration Interval: 1 year

4.2.4 **Auto Vibration Control**
Mfr.: Spectral Dynamics
Model: SD1201
S/N: 1067
EWT Control No.: 1052
Last Calibration: 11/19/93
Calibration Interval: 2 years

4.2.5 **Power Amplifier**
Mfr.: Ling
Model: 8024
S/N: N/A
EWT Control No.: 219
Calibration not required

4.2.6 **Accelerometer***
Mfr.: CRL
Model: 330S
S/N: 102
EWT Control No.: 395
Last Calibration: 02/06/95
Calibration Interval: 1 year

4.2.7 **Charge Amplifier***
Mfr.: Trig Tek
Model: 203M
S/N: 1289
EWT Control No.: 1135-07
Last Calibration: 05/26/94
Calibration extended 30 days
Calibration Interval: 1 year

4.0 TEST EQUIPMENT (continued)

4.3 RANDOM VIBRATION

Test dates: 04/28/95 (Test Unit S/N 0003); and 05/30/95 (Test Unit S/N 0002)
Retest of test unit S/N 0003: 06/22/95
***Used during test conducted 04/28/95**
****Used during test conducted 05/30/95**
*****Used during retest conducted 06/22/95**

4.3.1 **Exciter**
Mfr.: Ling
Model: 335
S/N: 40
EWT Control No.: 218
Last Calibration: Not required

4.3.2 **Power Amplifier**
Mfr.: Ling
Model: 8024
S/N: N/A
EWT Control No.: 219
Last Calibration: Not required

4.3.3 **Accelerometer***
Mfr.: CRL
Model: 330S
S/N: 409
EWT Control No.: 123
Last Calibration: 02/06/95
Calibration Interval: 1 year

4.3.4 **Charge Amplifier***
Mfr.: Trig Tek
Model: 203M
S/N: 769
EWT Control No.: 1135-02
Last Calibration: 05/26/94
Calibration Interval: 1 year

4.3.5 **Auto Random Control**
Mfr.: Spectral Dynamics
Model: SD1200
S/N: 29
EWT Control No.: 1300
Last Calibration: 08/22/94
Calibration Interval: 2 years

4.3.6 **Charge Amplifier*****
Mfr.: Trig Tek
Model: 203M
S/N: 840
EWT Control No.: 1135-05
Last Calibration: 06/13/95
Calibration Interval: 1 year

4.3.7 **Accelerometer*****
Mfr.: CRL
Model: 5011
S/N: 1119
EWT Control No.: 2274
Last Calibration: 01/09/95
Calibration Interval: 1 year

4.3.8 **Charge Amplifier****
Mfr.: Trig Tek
Model: 203M
S/N: 804
EWT Control No.: 1135-06
Last Calibration: 05/31/94
Calibration Interval: 1 year

4.3.9 **Accelerometer****
Mfr.: CRL
Model: 330S
S/N: 395
EWT Control No.: 102
Last Calibration: 02/06/95
Calibration Interval: 1 year

4.0 TEST EQUIPMENT (continued)

4.4 PYROTECHNICAL SHOCK

Test dates: 06/14/95 (Test Unit S/N 0002); 06/26/95 (Test Unit S/N 0003)
***Used during test conducted 06/14/95**
****Used during test conducted 06/26/95**

4.4.1 **Exciter**
Mfr.: Ling
Model: 335
S/N: 40
EWT Control No.: 218
Last Calibration: Not required

4.4.2 **Power Amplifier**
Mfr.: Ling
Model: 8024
S/N: N/A
EWT Control No.: 219
Last Calibration: Not required

4.4.3 **Accelerometer***
Mfr.: CRL
Model: 5011
S/N: 1119
EWT Control No.: 2274
Last Calibration: 01/09/95
Calibration Interval: 1 year

4.4.4 **Charge Amplifier***
Mfr.: Trig Tek
Model: 203M
S/N: 804
EWT Control No.: 1135-06
Last Calibration: 05/31/94
Calibration extended 30 days
Calibration Interval: 1 year

4.4.5 **Shock Control**
Mfr.: Data Physics
Model: 1919
S/N: N/A
EWT Control No.: 2313
Last Calibration: 05/18/95
Calibration Interval: 2 years

4.4.6 **Accelerometer****
Mfr.: CRL
Model: 5011
S/N: 1118
EWT Control No.: 2273
Last Calibration: 01/09/95
Calibration Interval: 1 year

4.4.7 **Charge Amplifier****
Mfr.: Trig Tek
Model: 203M
S/N: 1289
EWT Control No.: 1135-07
Last Calibration: 06/16/95
Calibration Interval: 1 year

5.0 FIXTURE SURVEY
ATP 20049 REV B

5.1 Test Set-Up

5.1.1 Visual inspection of the test fixture was performed to verify the pre-test condition.

5.1.2 The test fixture was mounted to the vibration shaker table.

5.1.3 Two accelerometers were installed, one for vibration input control and one for monitoring the test fixture response. The control accelerometer was attached to the vibration table near a test fixture mounting point. The response accelerometer was attached directly to the side of the test fixture.

5.1.4 Photographs of a typical set-up along with the axis definitions are included in Appendix A.

5.2 Test Procedure

5.2.1 The test fixture was subjected to a resonance search test performed individually in each of its three (3) orthoganol axes; followed by a resonance dwell test (where applicable). The resonance search was conducted in untimed frequency sweeps from **20** to **2,000** Hz with a random vibration input as defined in the table below:

Frequency	**Amplitude**
20 - 60 Hz	**0.04 g^2/hz rising to 2.56**
60 - 200 Hz	**2.56 g^2/hz**
200 - 300 Hz	**2.56 g^2/hz falling to 0.256**
300 - 600 Hz	**0.256 g^2/hz**
600 - 2000	**0.256 g^2/hz falling to 0.04**
Overall gRMS: 26.6	

5.2.2 All resonances were recorded on the appropriate data sheets which are contained in appendix B herein.

5.2.3 Where necessary, a resonance dwell test was conducted.

5.0 FIXTURE SURVEY (continued)

5.3 Test Results

5.3.1 During mounting of the fixture to the vibration table, it was noted that the fixture was slightly off center in axis, due to the location of the fixture mounting holes.

5.3.2 Results of the resonance search, in the form of either transmissibility or measured output plots with marked resonant points (Q>2) are included in Appendix B. **No** resonances were noted.

5.3.3 **No** physical damage to the fixture was noticed at the end of this test.

6.0 SINE VIBRATION TEST

ATP 20049 REV B

6.1 Test Set-Up

6.1.1 A visual inspection of each test item's exterior was performed to verify the pre-test condition.

6.1.2 The test unit was mounted to the fixture plate described in Section 5.0, which was then rigidly mounted to the vibration shaker in the appropriate axis, as shown in the photographs of the typical set-up included in Appendix A.

6.1.3 A vibration control accelerometer was mounted to the fixture plate to control and monitor the vibration input.

6.1.4 The Sine Vibration test was performed on each unit individually.

6.2 Test Procedure

6.2.1 The test unit was subjected to **one (1)** minute of sinusoidal vibration in each of its **three (3)** orthoganol axes at the levels specified in the table below. The vibration frequency was varied from **5** to **100** Hz at the rate of **two (2)** octaves/minute.

Axis	Frequency (Hz)	Amplitude
X	5 - 22.3*	0.5 in. D.A.
X	22.3 - 40**	12.7 g
X	40 - 100	5.0 g
Y	5 - 24*	0.5 in. D.A.
Y	24 - 40**	14.7g
Y	40 - 100	5.0g
Z	5 - 16.8	0.5 in. D.A.
Z	16.8 - 40	7.2g
Z	40 -100	5.0g

***Substitute the values "5 - 24.0" for the unit tested 06/20/95 (S/N 0003)**
****Substitute the values "24 - 40" for the unit tested 06/20/95 (S/N 0003)**

6.2.2 Upon completion of the Sine Vibration testing, the test sample was inspected for any evidence of exterior physical damage.

6.0 SINE VIBRATION TEST (continued)

6.3 Test Results

6.3.1 No damage to the exterior of the test items was visible during or upon completion of this tests.

6.3.2 Input vibration level plots for each test unit can be be found in Appendix B.

6.3.3 The test units were returned to Aeroflex Laboratories for functional testing and further evaluation.

7.0 RANDOM VIBRATION TEST

ATP 20049 REV B

7.1 Test Set-Up

7.1.1 The mounting and the shaker installation of the test unit for the random vibration test, was the same as in the sine vibration test described previously in Para 6.1.

7.2 Test Procedure

7.2.1 The test units were individually subjected to **one (1)** minute of random vibration in **each** of the **3** orthogonal axes with the vibration spectrum and G-level defined in the table below:

20 - 60 Hz @ 0.04 g^2/Hz rising to 2.5
60 - 200 Hz @ 2.5 g^2/Hz
200 - 300 Hz @ 2.5 g^2/Hz falling to 0.25
300 - 600 Hz @ 0.25 g^2/Hz
600 - 2000 Hz @ 0.25 g^2/Hz falling to 0.04
Overall gRMS: 26.6

7.2.2 Test unit S/N 0003 was retested 06/22/95, and was subjected to the same set-up and test as described in Section 7.1 and step 7.2.1, with the following exception: Overall gRMS was 26.1.

7.2.3 Upon completion of the Random Vibration testing, the test samples were inspected for any evidence of exterior physical damage.

7.3 Test Results

7.3.1 **No** damage to the test items' exterior was visible during or upon completion of this test.

7.3.2 Plots of the actual spectrum applied are included in Appendix B.

7.3.3 The test units were returned to Aeroflex Laboratories for functional testing and further evaluation.

8.0 PYROTECHNICAL SHOCK TEST
ATP 20049 REV B

8.1 Test Set-Up

8.1.1 Visual inspections of the test samples' exteriors were performed to verify the pre-test condition. No anomalies were noted.

8.1.2 Each test unit was individually mounted to the fixture plate described in Section 5.0, which was then rigidly mounted to the shock table in the appropriate axis, as shown in the photographs of the typical set-up included in Appendix A.

8.1.3 An accelerometer was mounted to the test fixture to control and monitor the shock input.

8.2 Test Procedure

8.2.1 Each test unit was subjected to **one (1) bi-directional** shock pulse in each of the **three (3)** orthogonal axis. The shock spectrum and levels were as defined in the following table:

200 Hz @ 57g
400 Hz @ 225g
1400 Hz @ 225g
1600 Hz @ 300g
4000 Hz @ 300g

8.2.2 Plots of the actual shock spectrum of each shock applied are included in the Appendix B.

8.2.3 Upon completion of shock application in each axis, each test unit was visually inspected for any evidence of exterior physical damage.

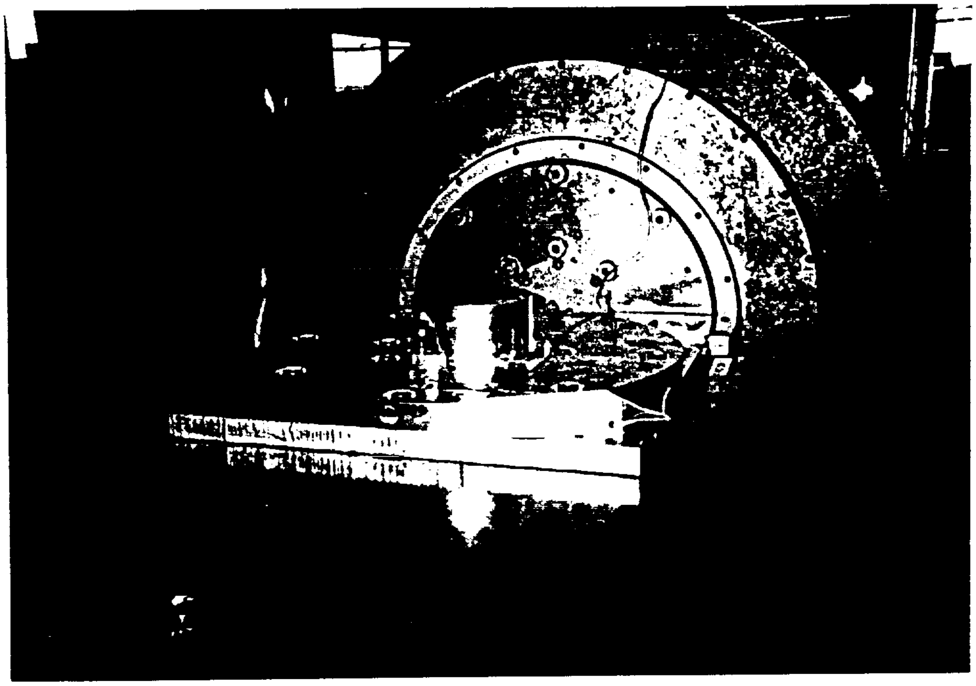
8.3 Test Results

8.3.1 There was no visible exterior physical damage to either test unit.

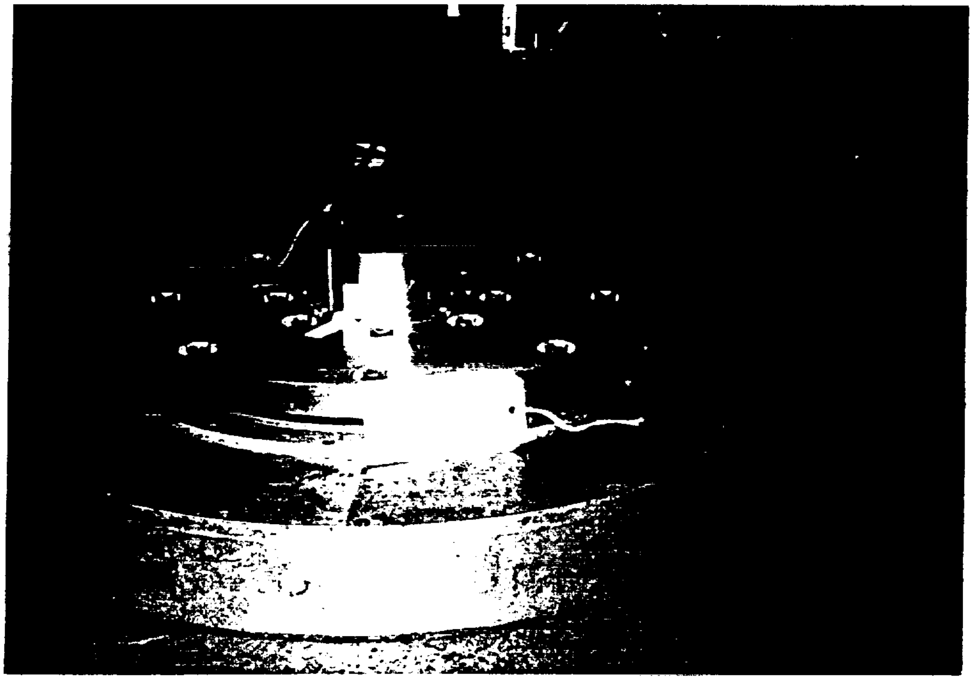
8.3.2 The test units were returned to Aeroflex Laboratories for further evaluation and dissemination.

APPENDIX A: PHOTOGRAPHS

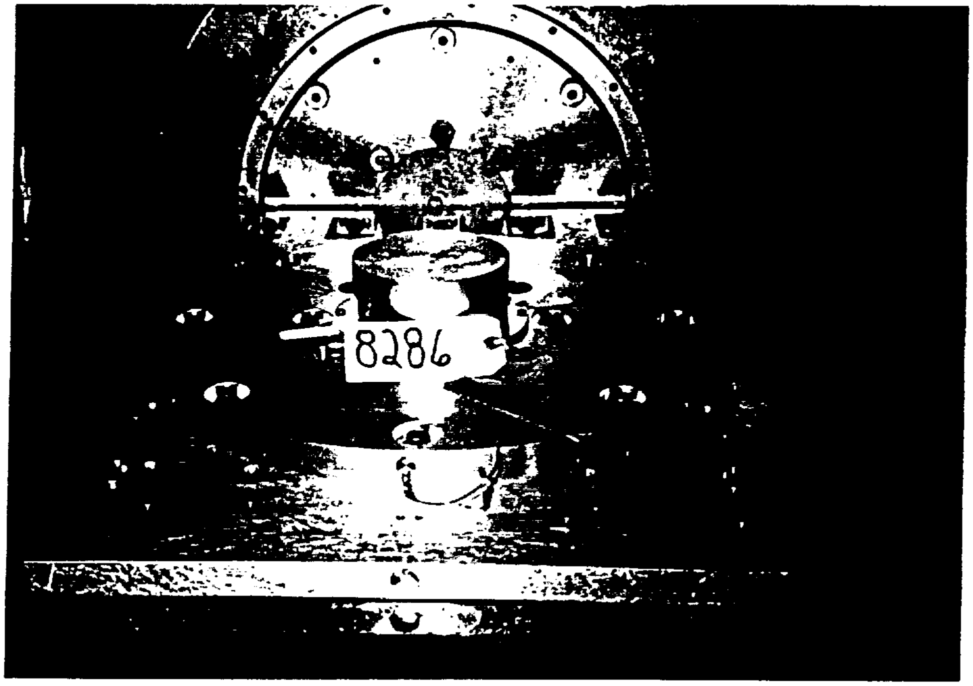
Typical Test Fixture,
Sine and Random Vibration,
and Pyrotechnical Shock
Test Set-Up
"X" Axis



Typical Test Fixture,
Sine and Random Vibration,
and Pyrotechnical Shock
Test Set-Up
"Y" Axis

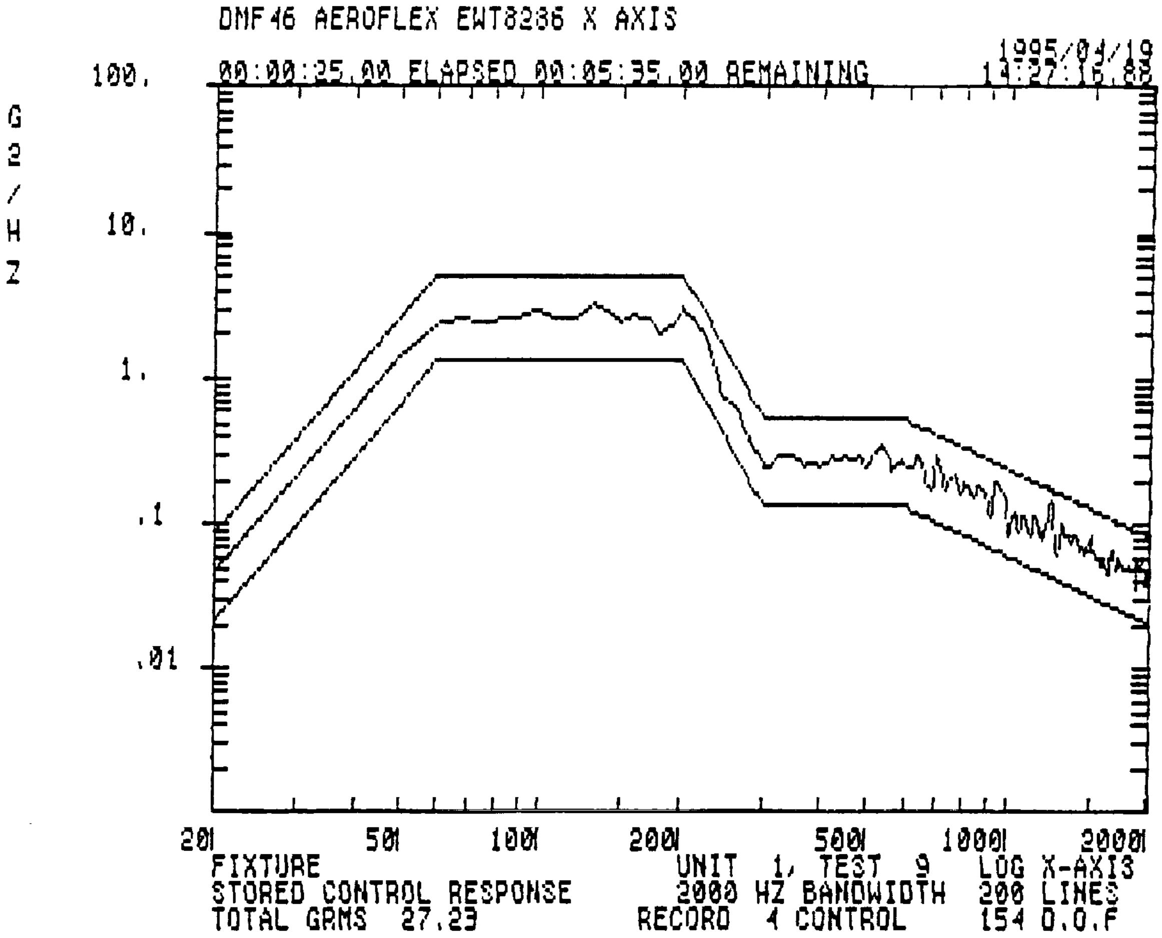


Typical Test Fixture,
Sine and Random Vibration,
and Pyrotechnical Shock
Test Set-Up
"Z" Axis



APPENDIX B: TEST DATA

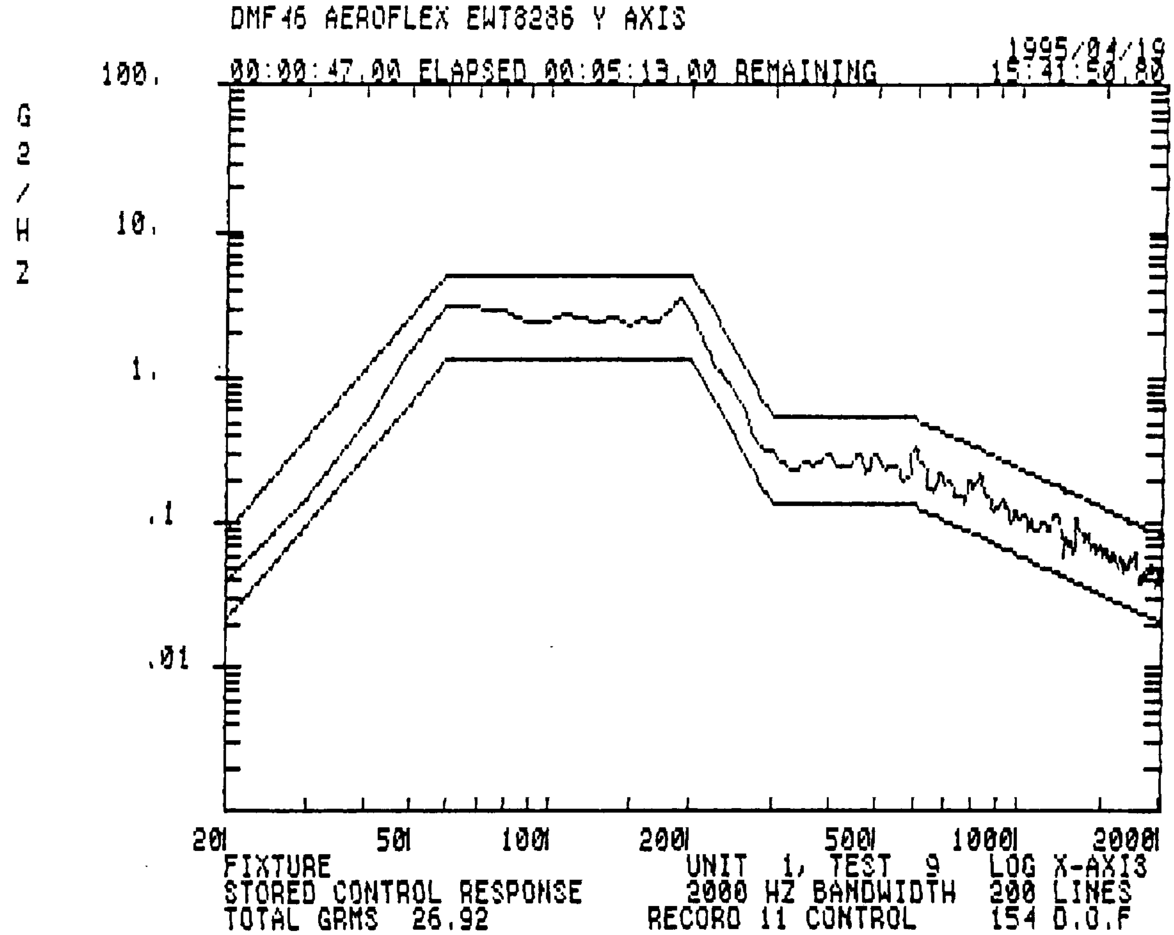
Input Control Spectrum
Fixture Survey
"X" Axis



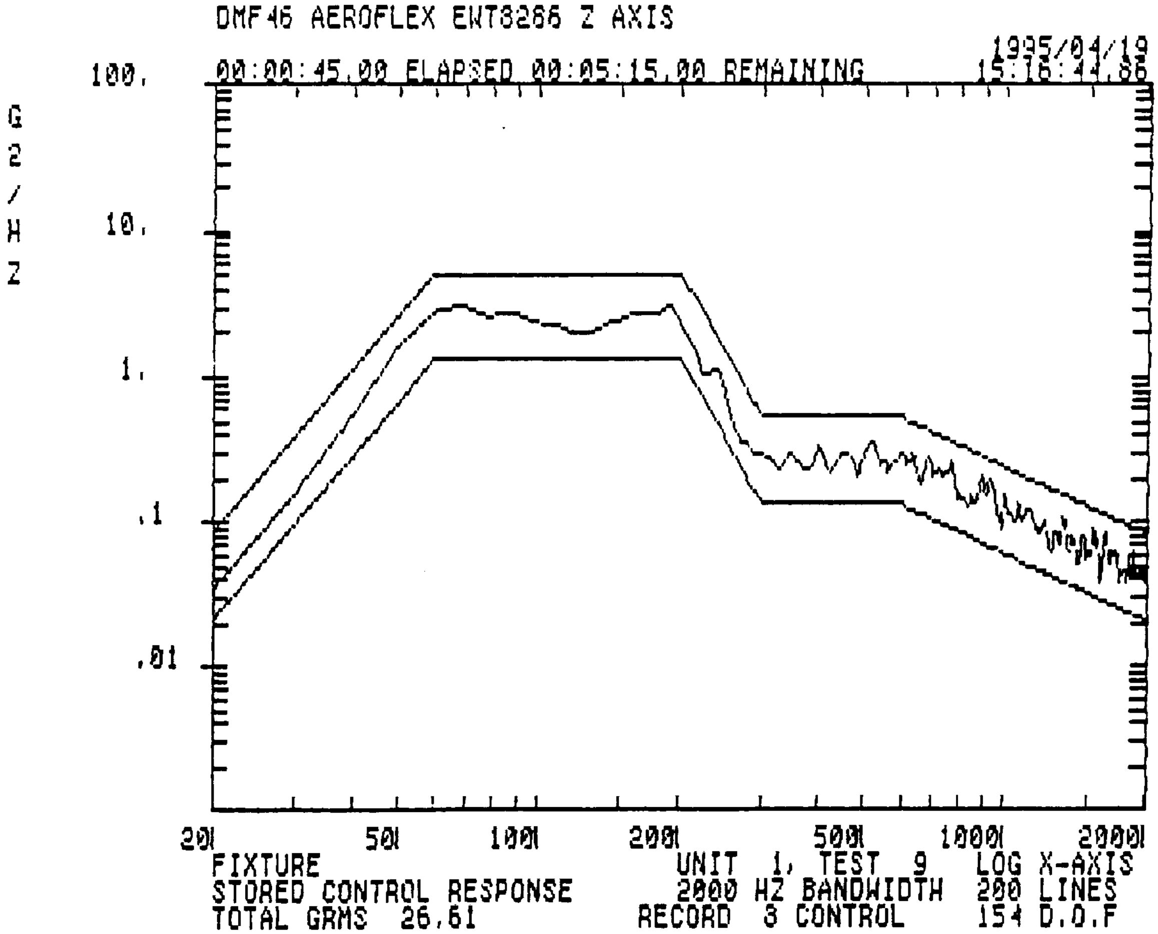
```
DMF46 AEROFLEX EWT8286 X AXIS
                                                          1995/04/19
00:00:25.00 ELAPSED 00:05:35.00 REMAINING                 14:27:16.88
```

```
FIXTURE                            UNIT  1, TEST  9   LOG X-AXIS
STORED CONTROL RESPONSE            2000 HZ BANDWIDTH  200 LINES
TOTAL GRMS   27.23               RECORD  4 CONTROL    154 D.O.F
```

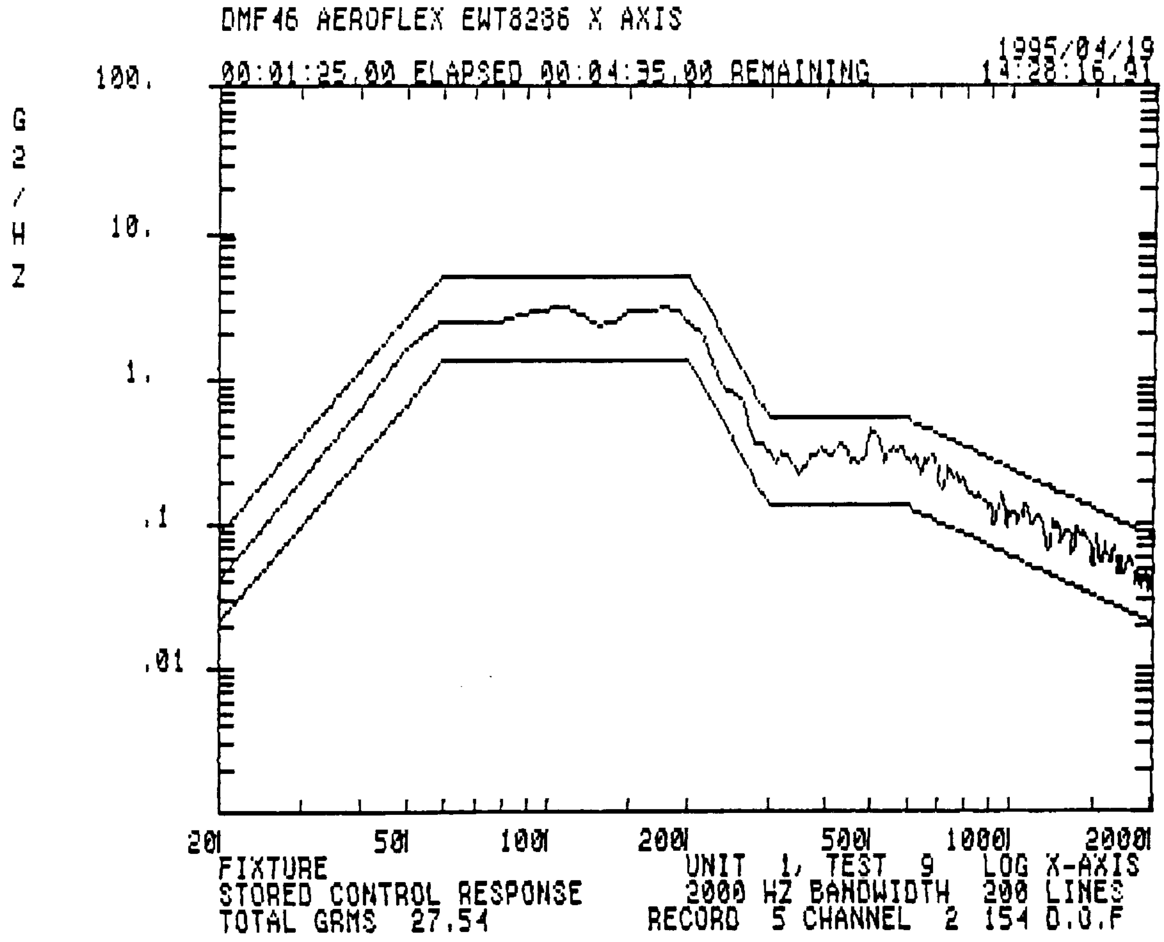
Input Control Spectrum
Fixture Survey
"Y" Axis



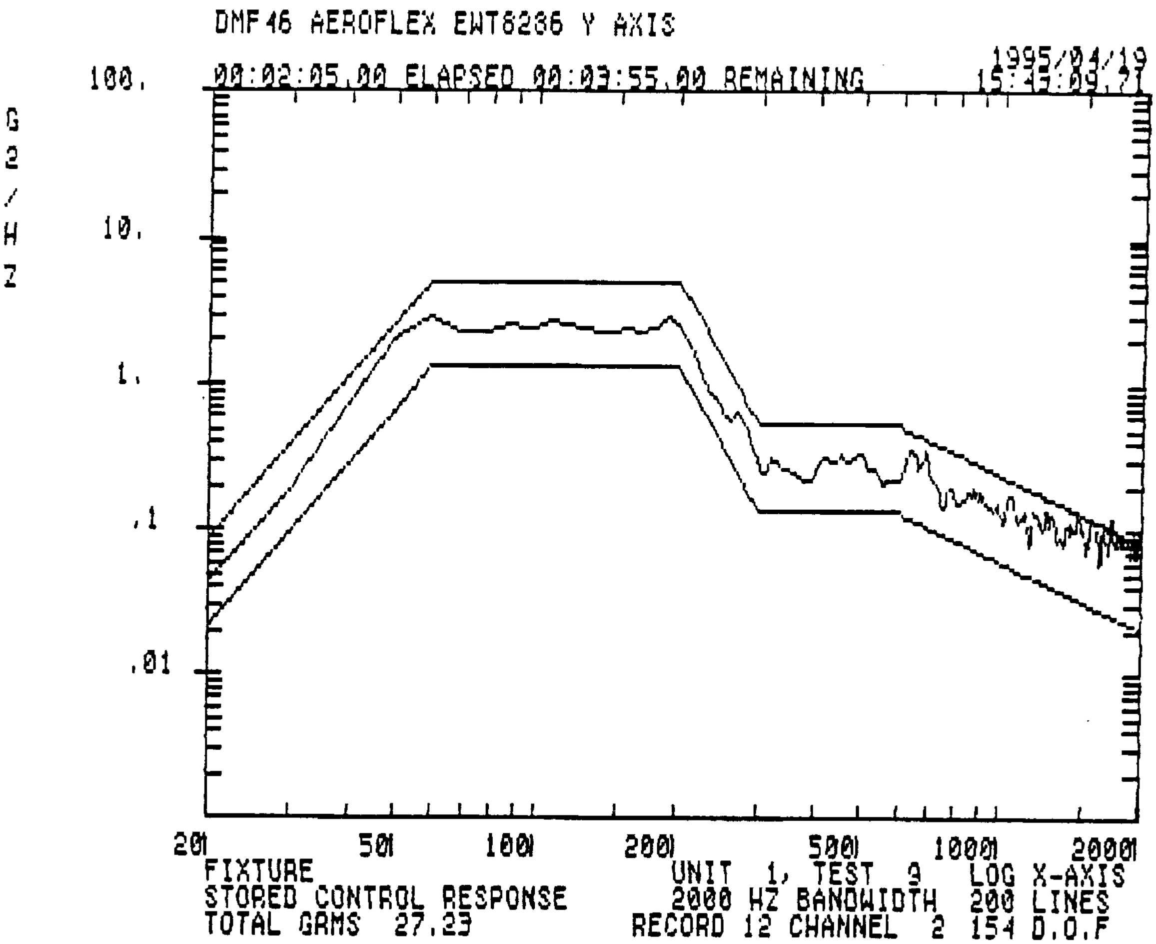
Input Control Spectrum
Fixture Survey
“Z” Axis



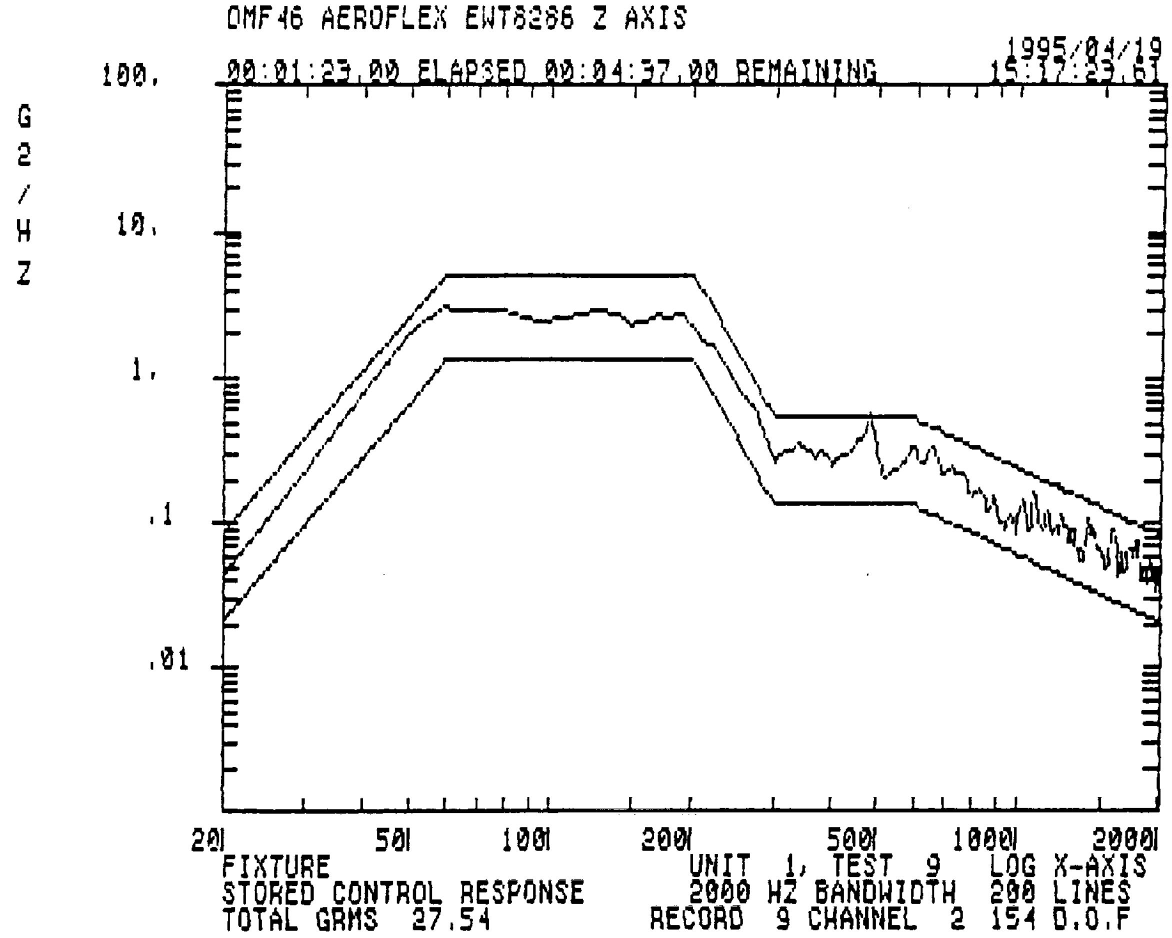
Output Response Spectrum
Fixture Survey
"X" Axis



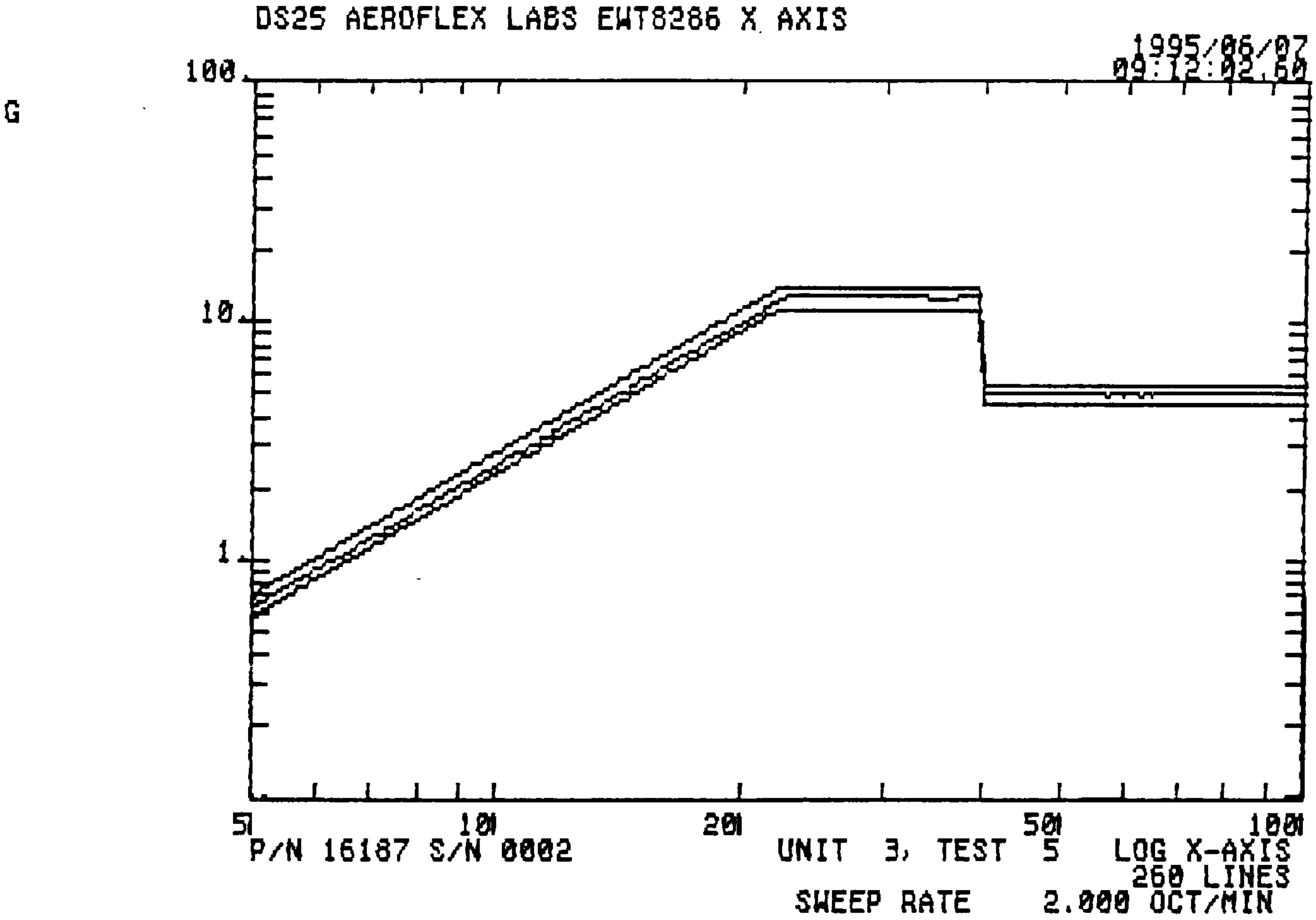
Output Response Spectrum
Fixture Survey
"Y" Axis



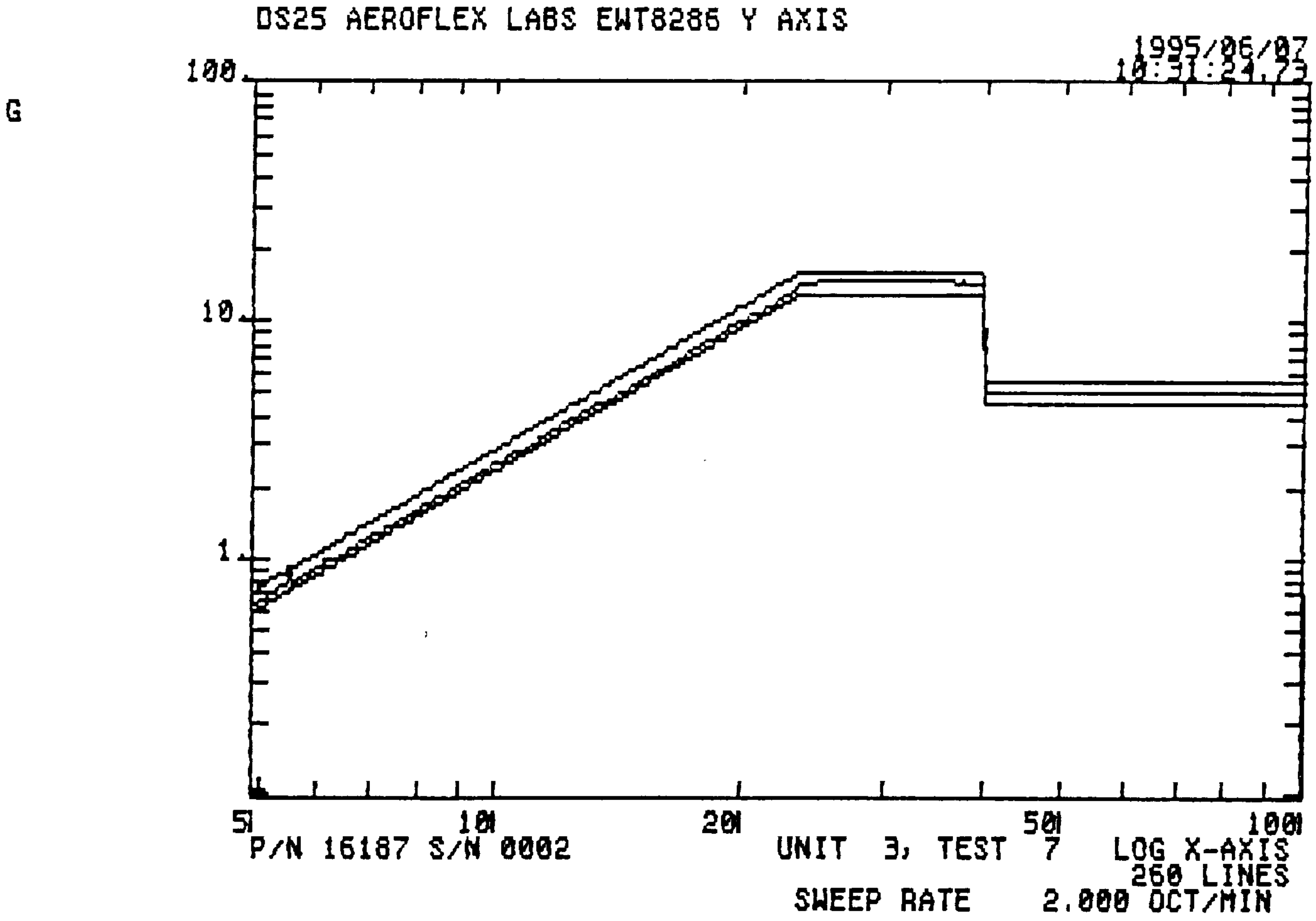
Output Response Spectrum
Fixture Survey
“Z” Axis



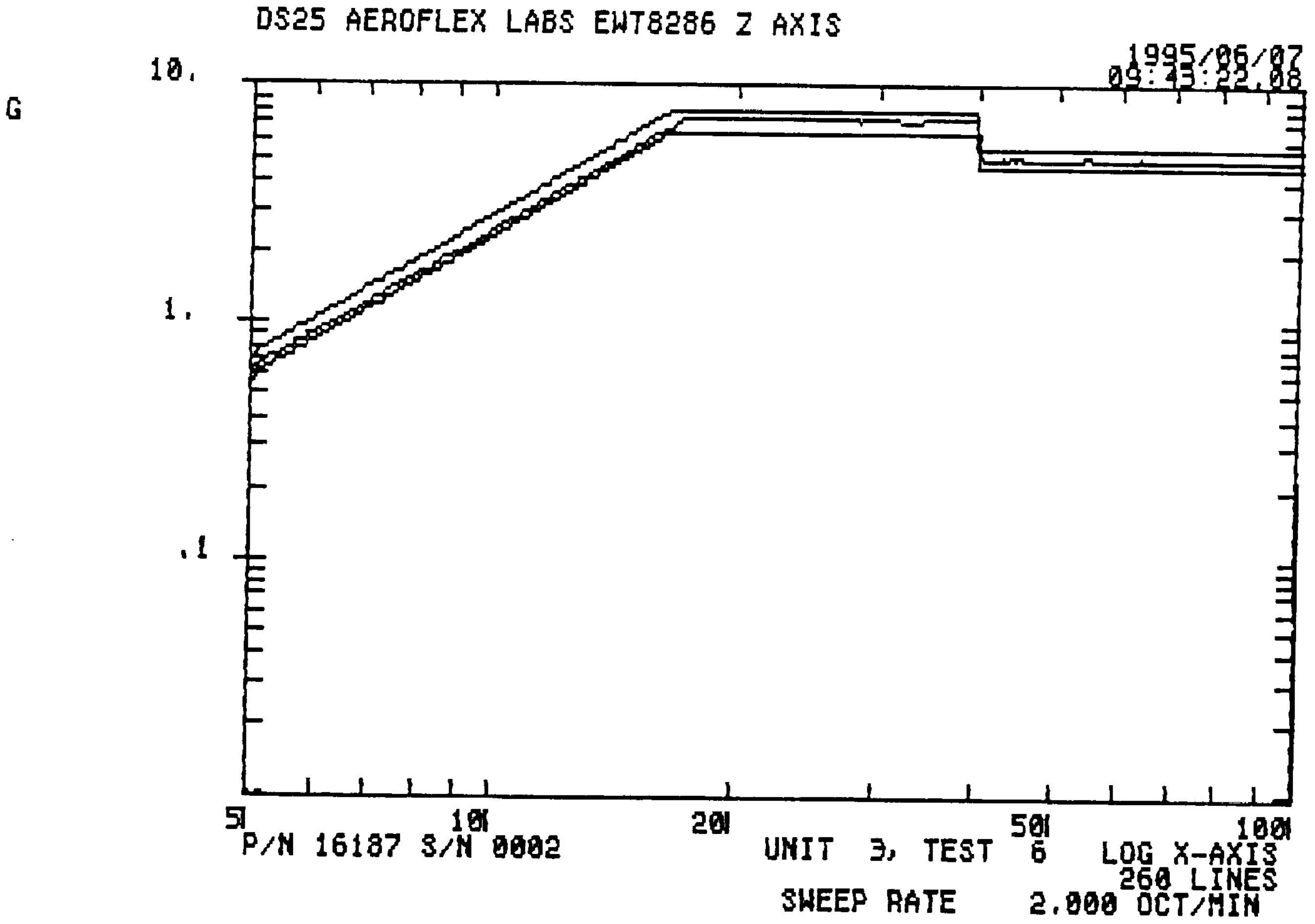
Sine Vibration Input Spectrum
"X" Axis - S/N 0002 Tested 06/07/95



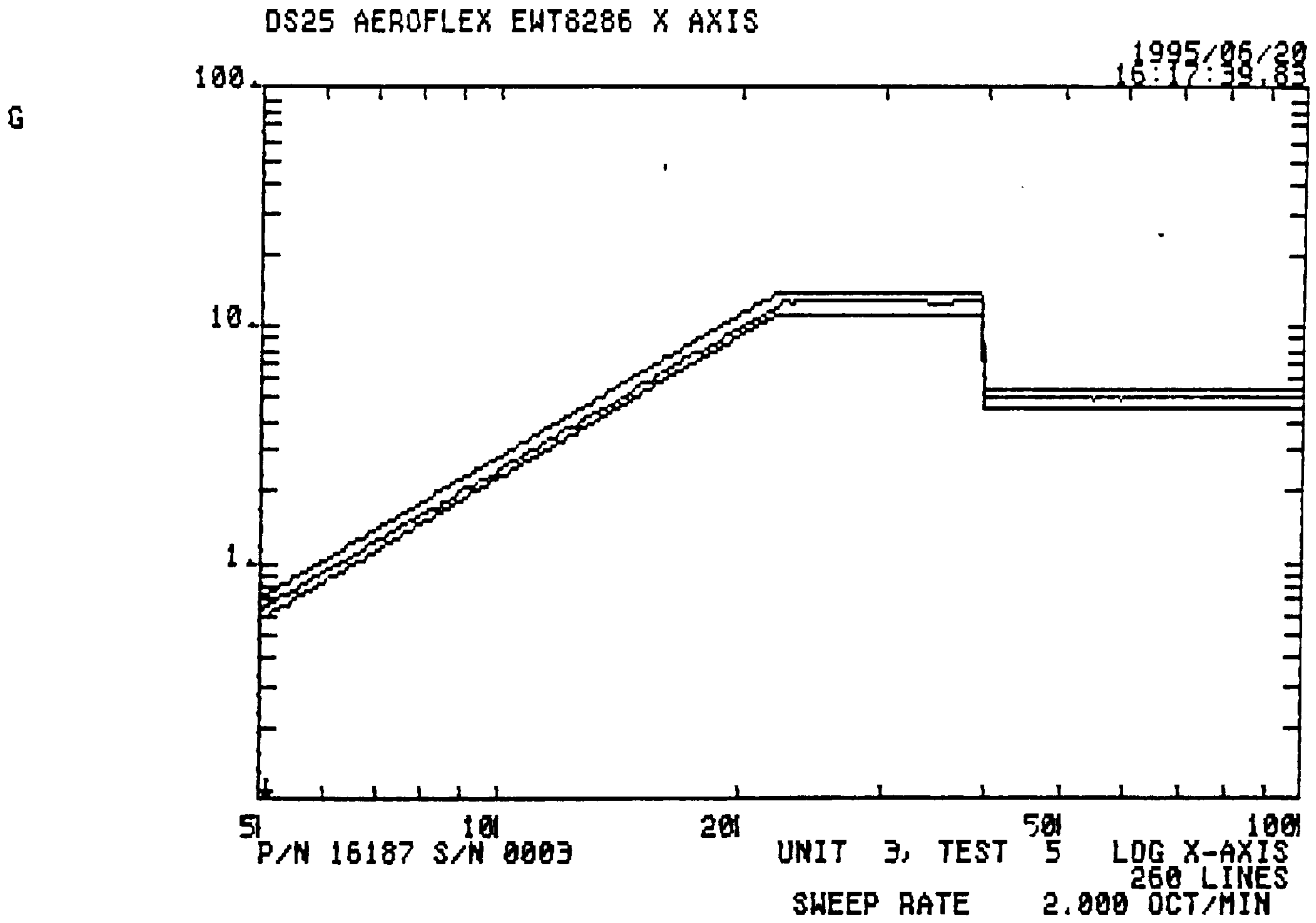
Sine Vibration Input Spectrum
"Y" Axis - S/N 0002 Tested 06/07/95



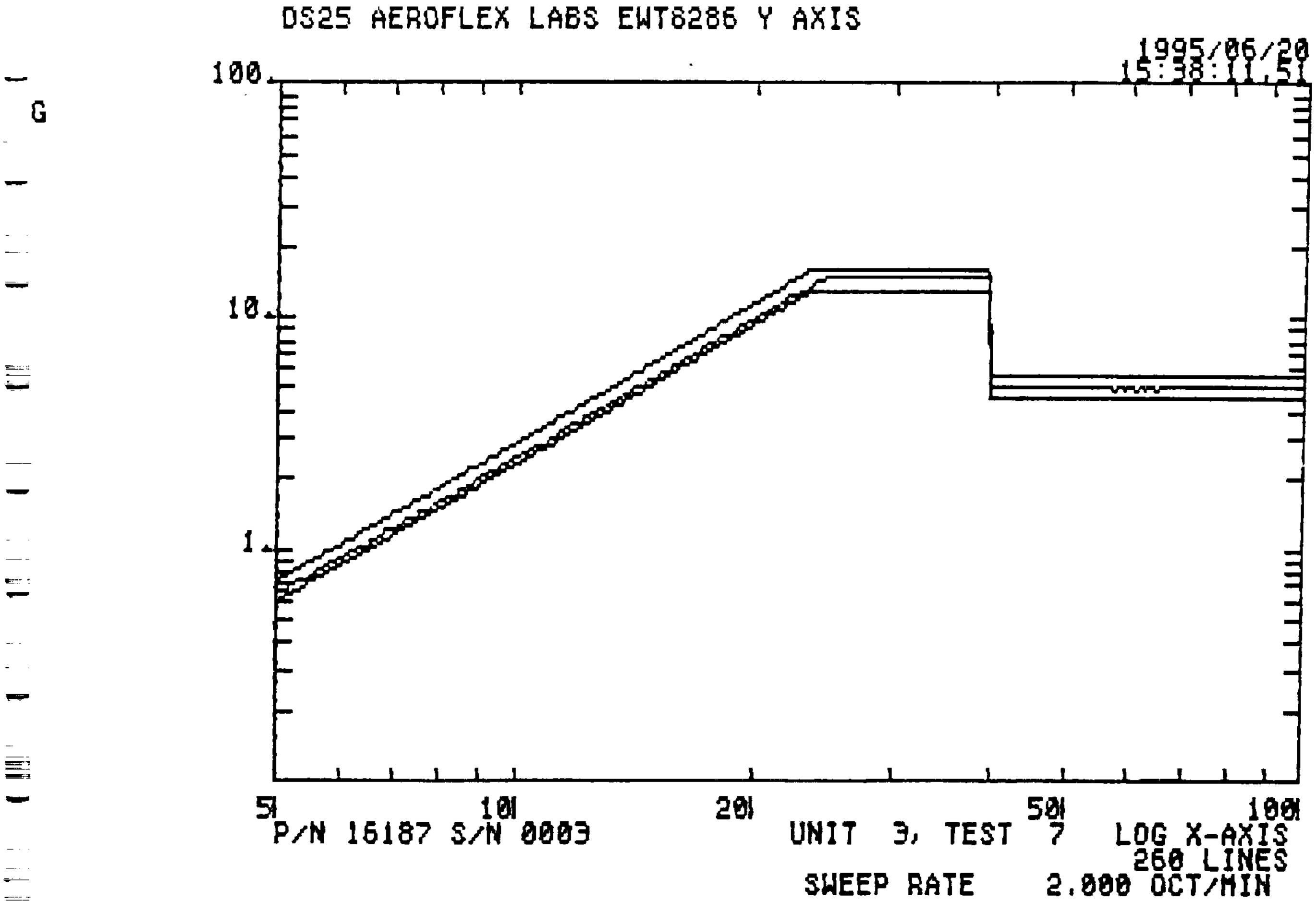
Sine Vibration Input Spectrum
"Z" Axis - S/N 0002 Tested 06/07/95



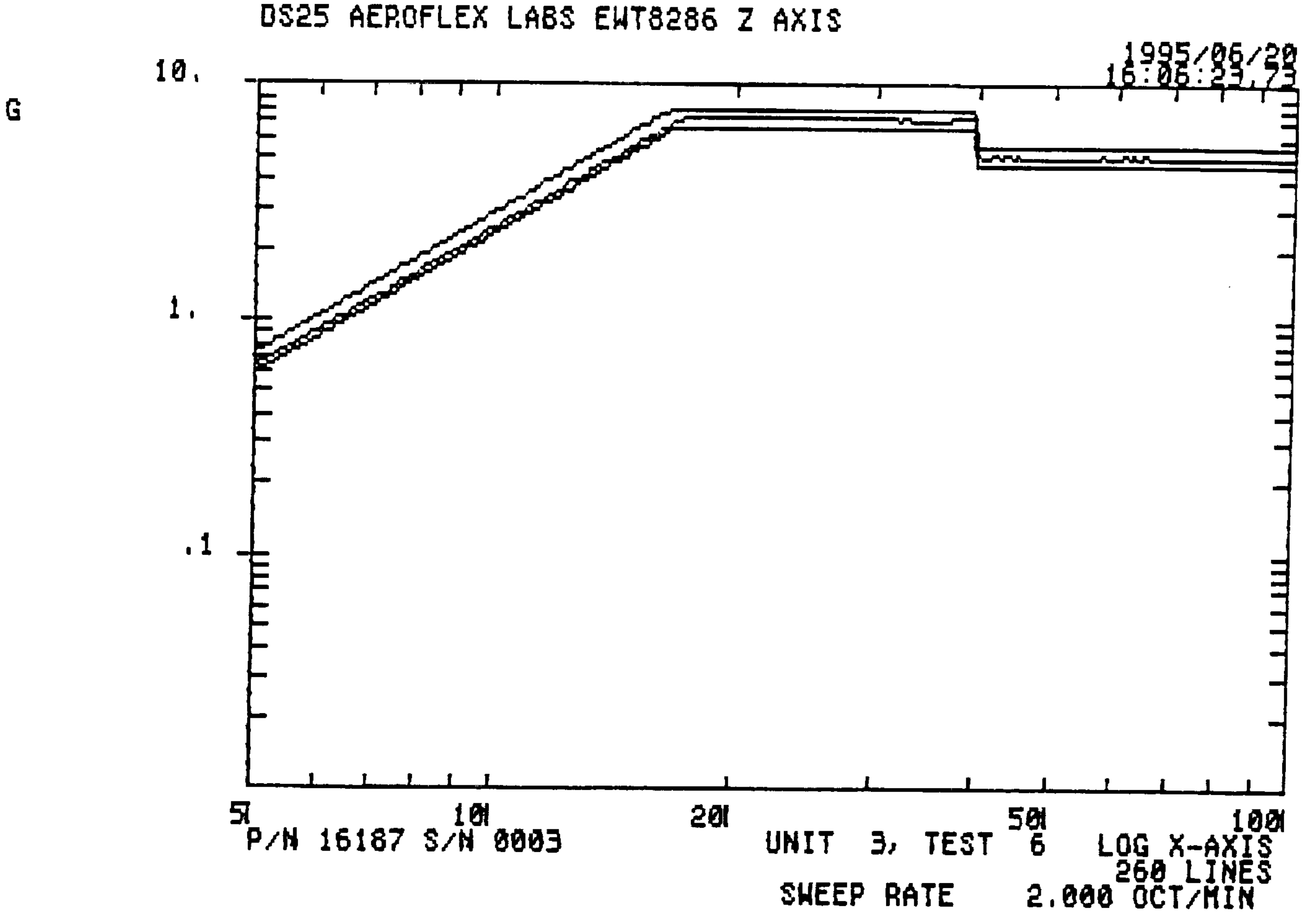
Sine Vibration Input Spectrum
"X" Axis - S/N 0003 Tested 06/20/95



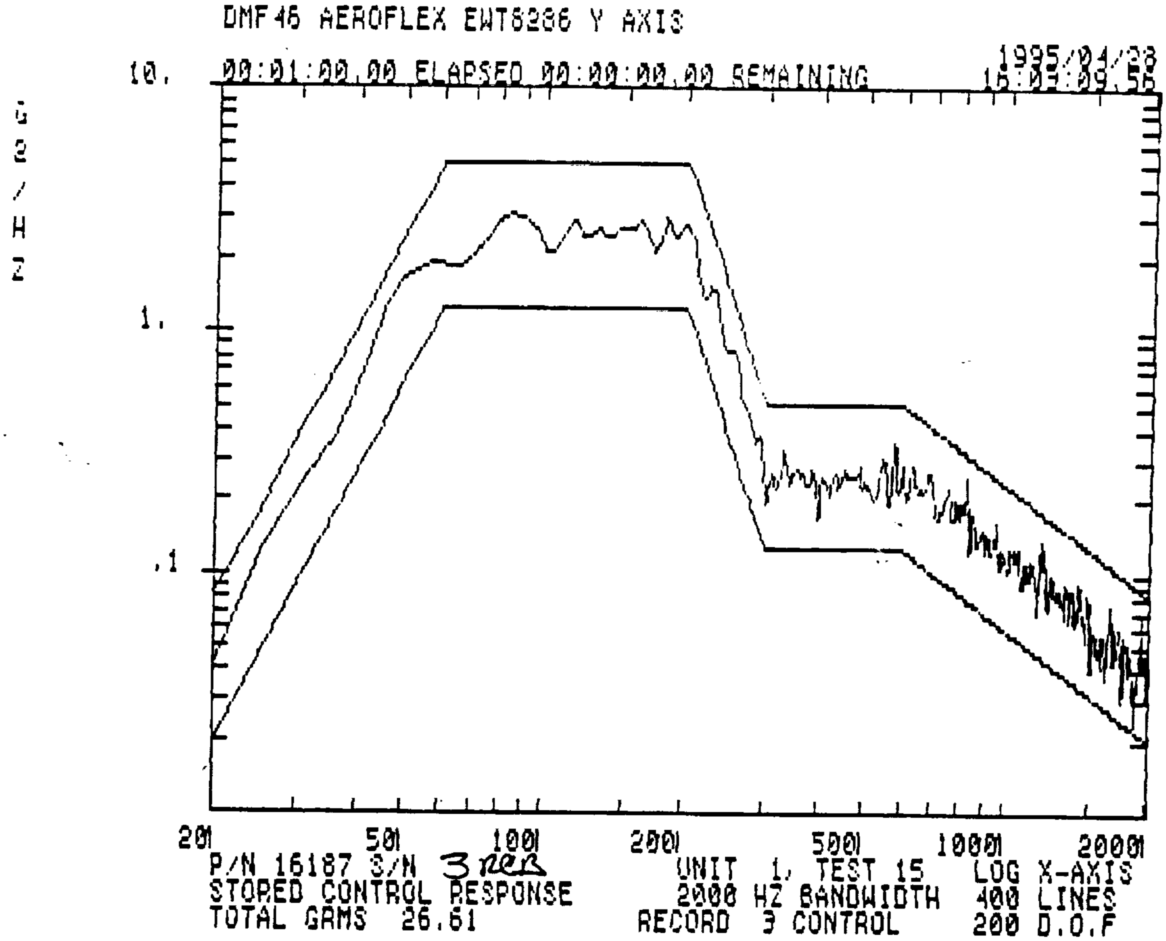
Sine Vibration Input Spectrum
"Y" Axis - S/N 0003 Tested 06/20/95



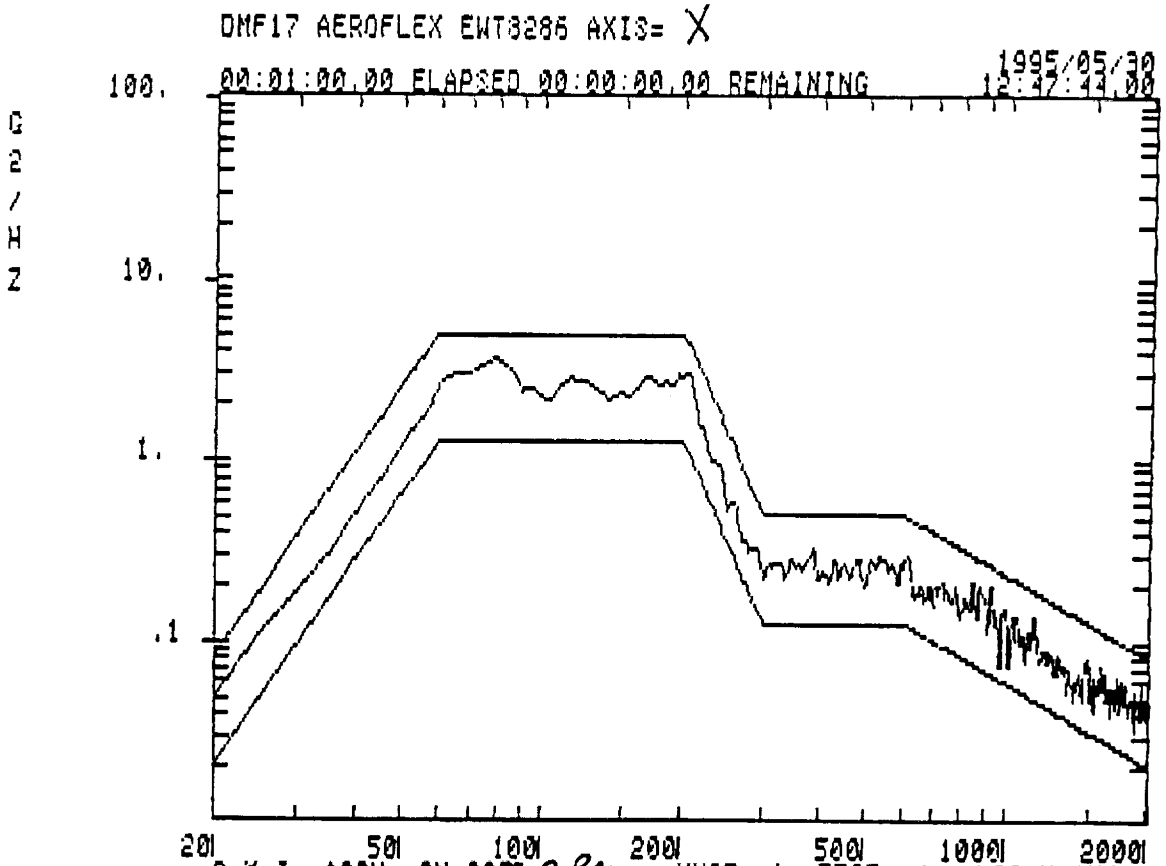
Sine Vibration Input Spectrum
..."Z" Axis - S/N 0003 Tested 06/20/95



Typical Random Vibration Input Spectrum
S/N 0003 Tested 04/28/95

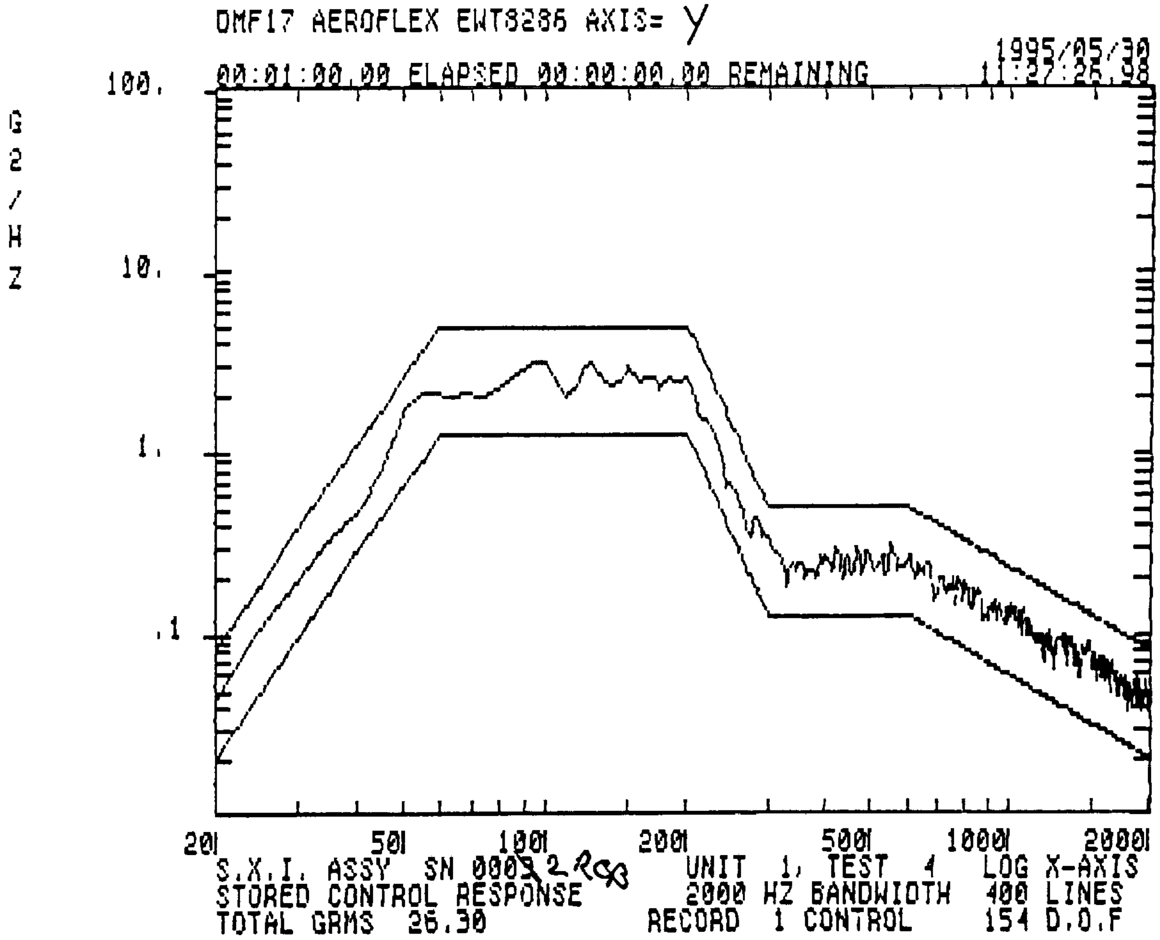


Random Vibration Input Spectrum
"X" Axis - S/N 0002 Tested 05/30/95

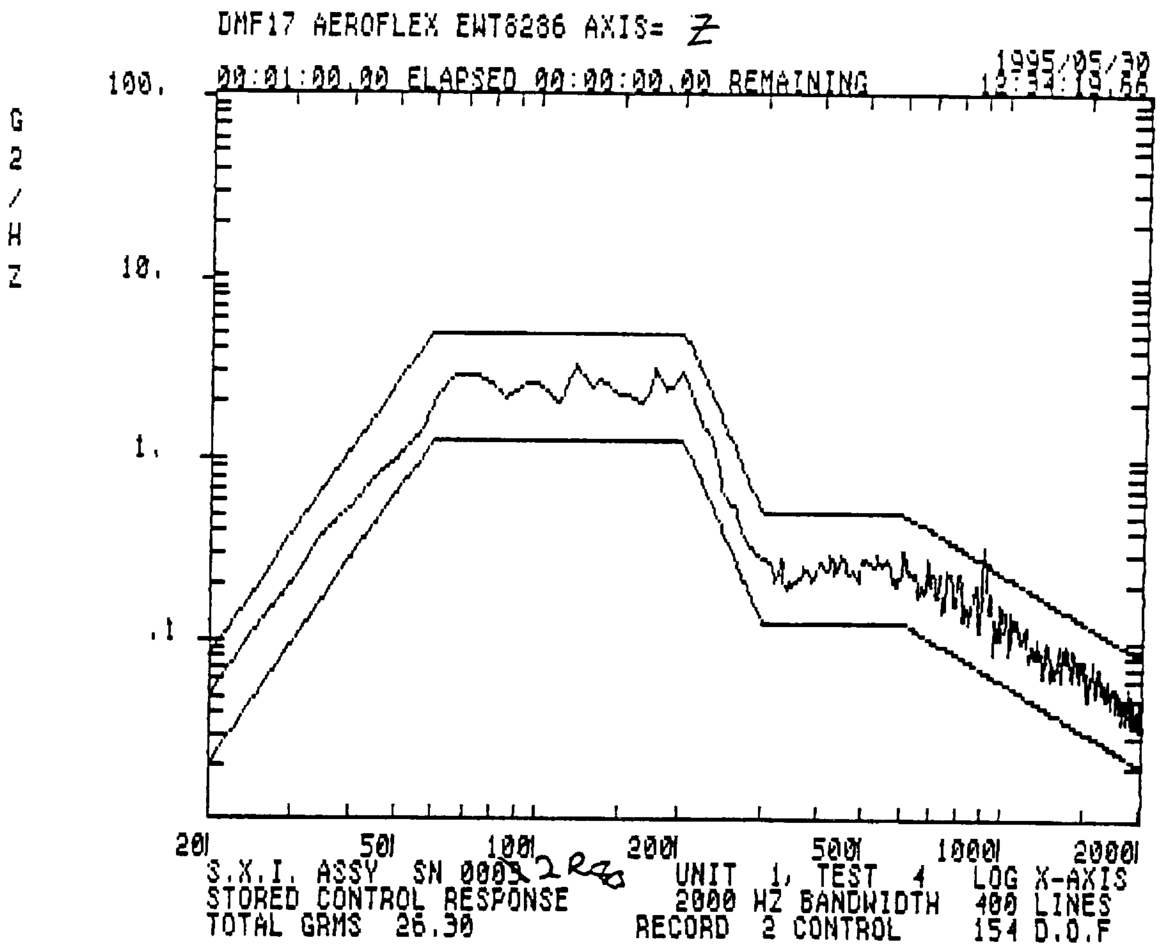


S.X.I. ASSY SN ~~0005~~ 2Rep UNIT 1, TEST 4 LOG X-AXIS
STORED CONTROL RESPONSE 2000 HZ BANDWIDTH 400 LINES
TOTAL GRMS 26.61 RECORD 3 CONTROL 154 D.O.F

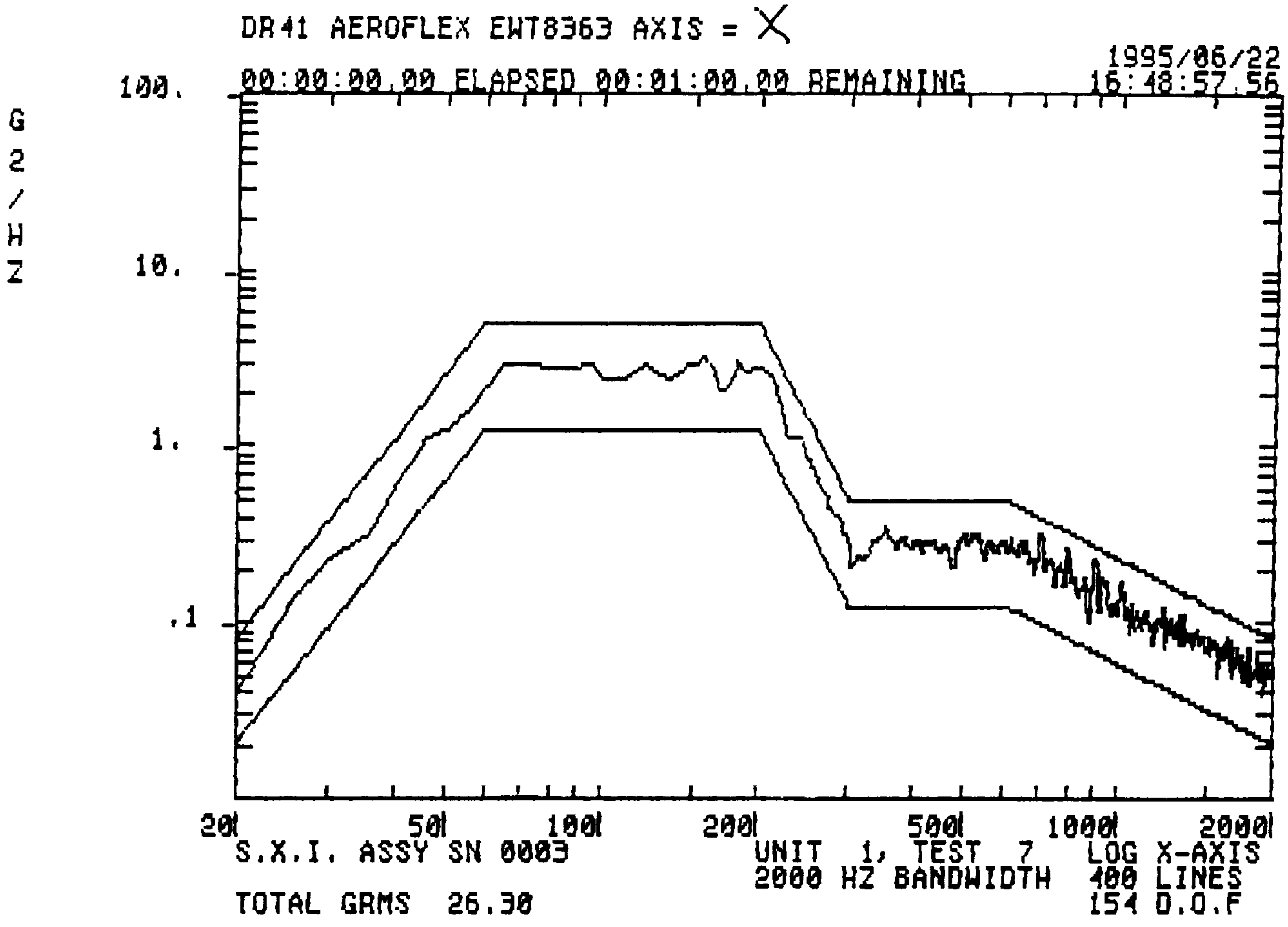
Random Vibration Input Spectrum
"Y" Axis - S/N 0002 Tested 05/30/95



Random Vibration Input Spectrum
"Z" Axis - S/N 0002 Tested 05/30/95



Random Vibration Input Spectrum
"X" Axis - S/N 0003 Re-Tested 06/22/95



DR41 AEROFLEX EWT8363 AXIS = X

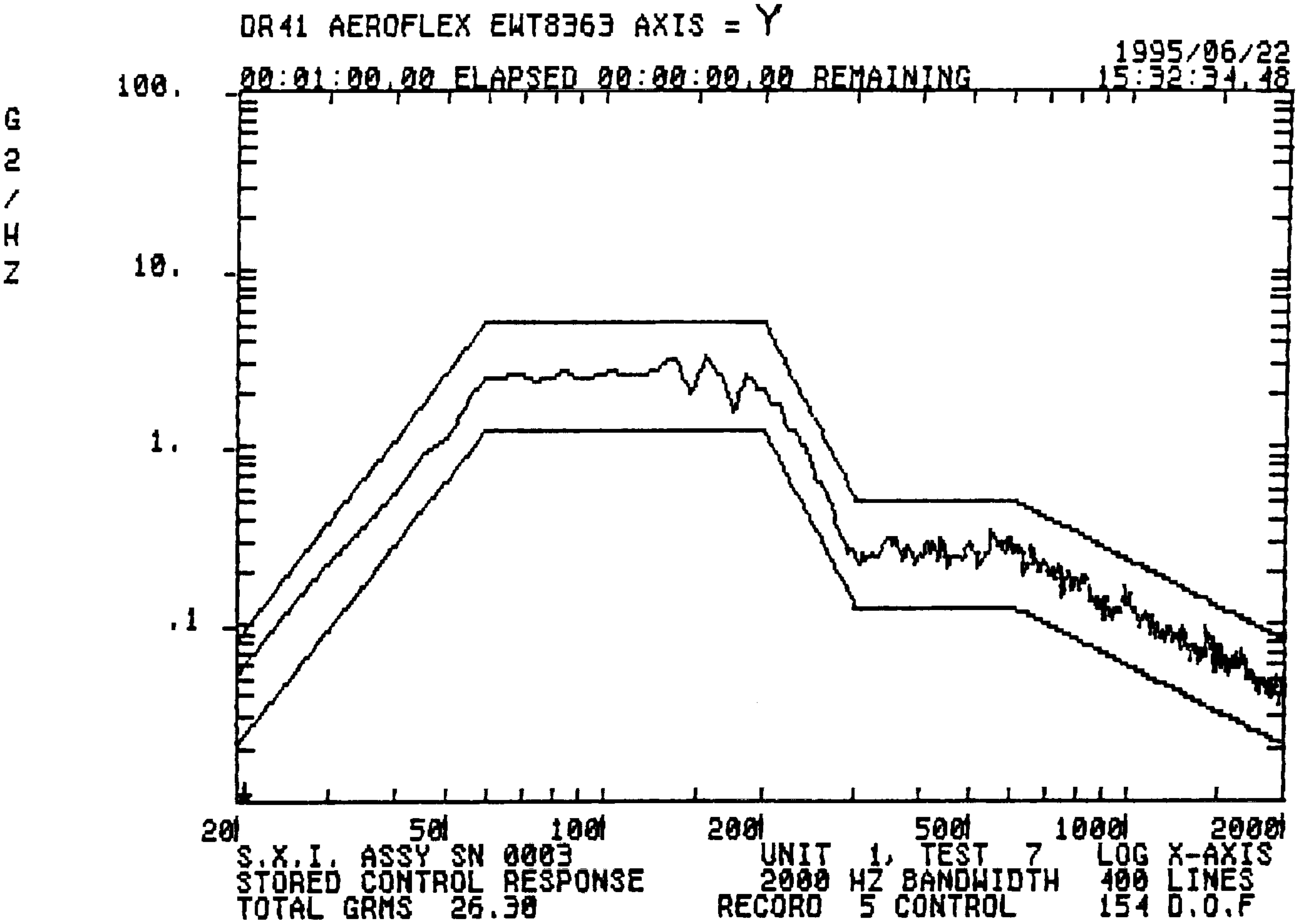
00:00:00.00 ELAPSED 00:01:00.00 REMAINING 1995/06/22 16:48:57.56

S.X.I. ASSY SN 0003

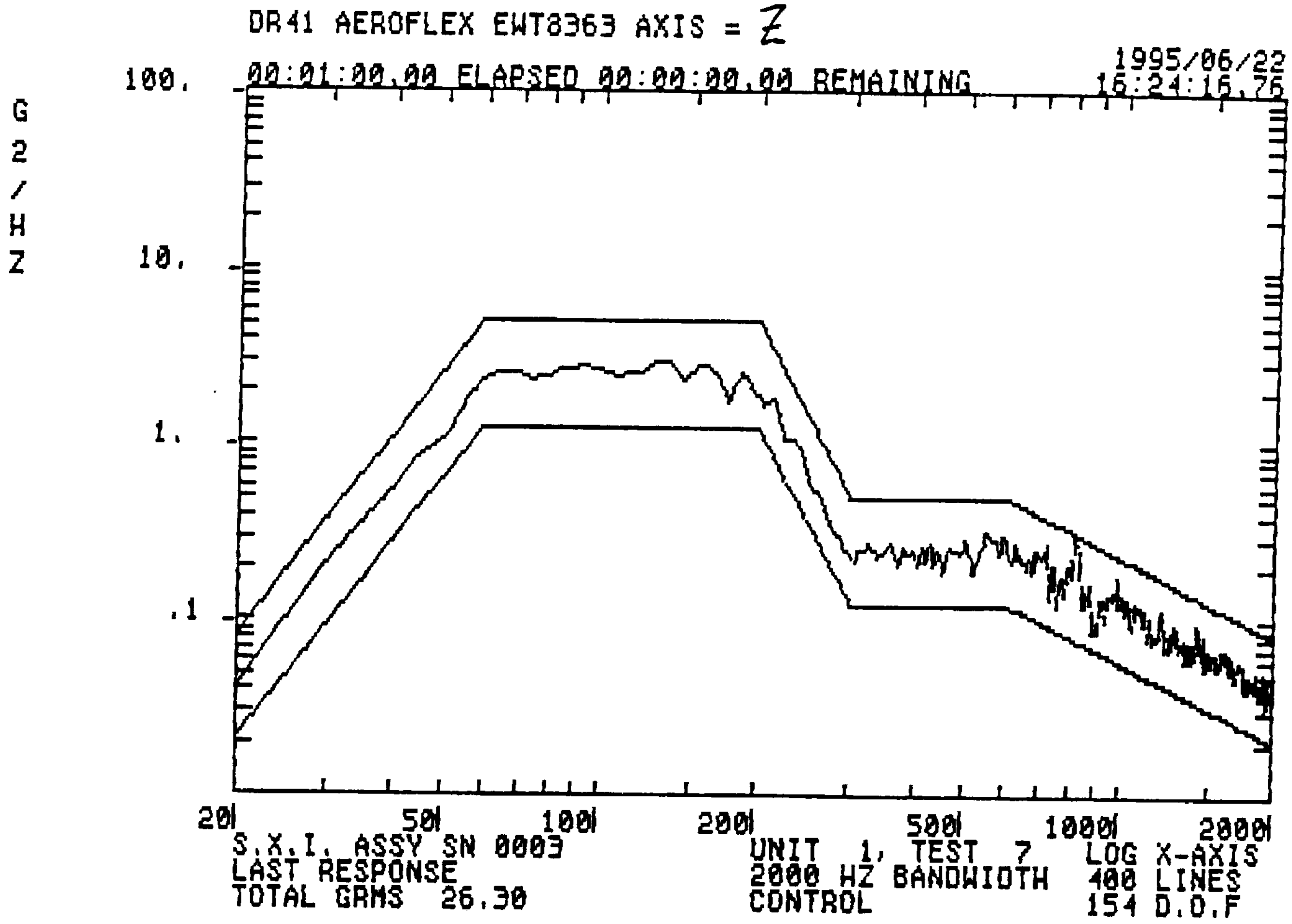
TOTAL GRMS 26.30

UNIT 1, TEST 7 LOG X-AXIS
2000 HZ BANDWIDTH 400 LINES
154 D.O.F

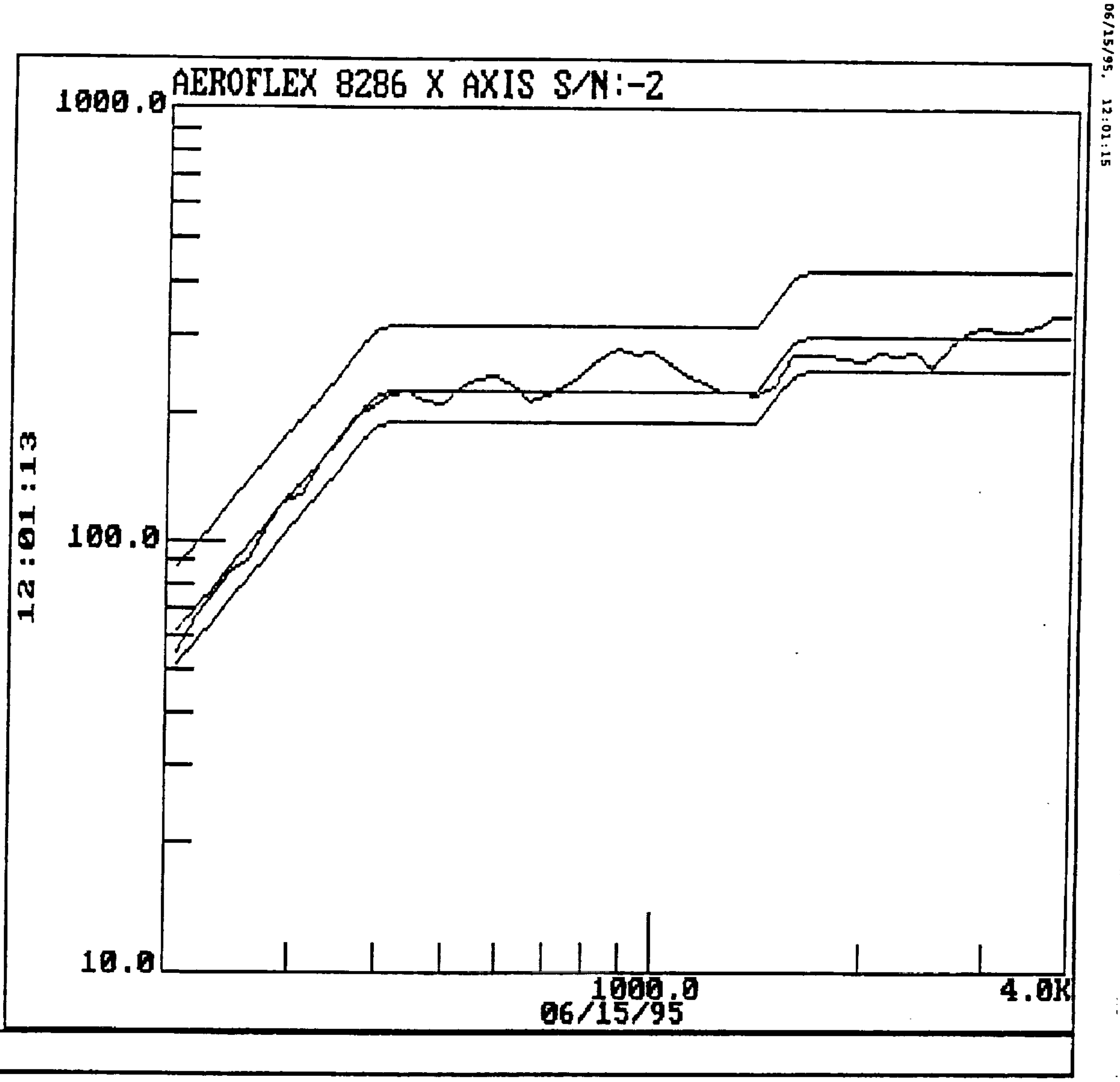
Random Vibration Input Spectrum
"Y" Axis - S/N 0003 Re-Tested 06/22/95



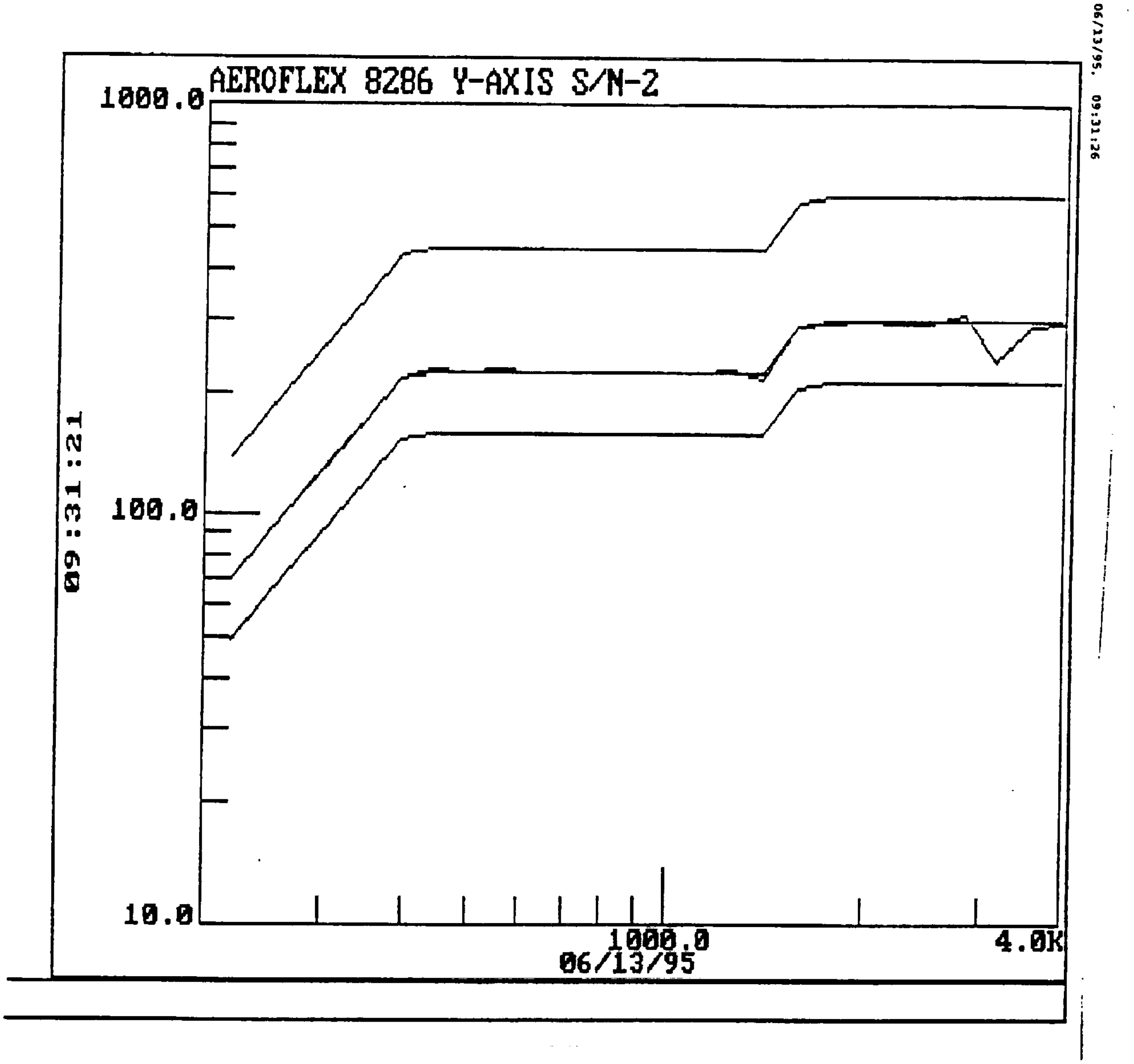
Random Vibration Input Spectrum
"Z" Axis - S/N 0003 Re-Tested 06/22/95



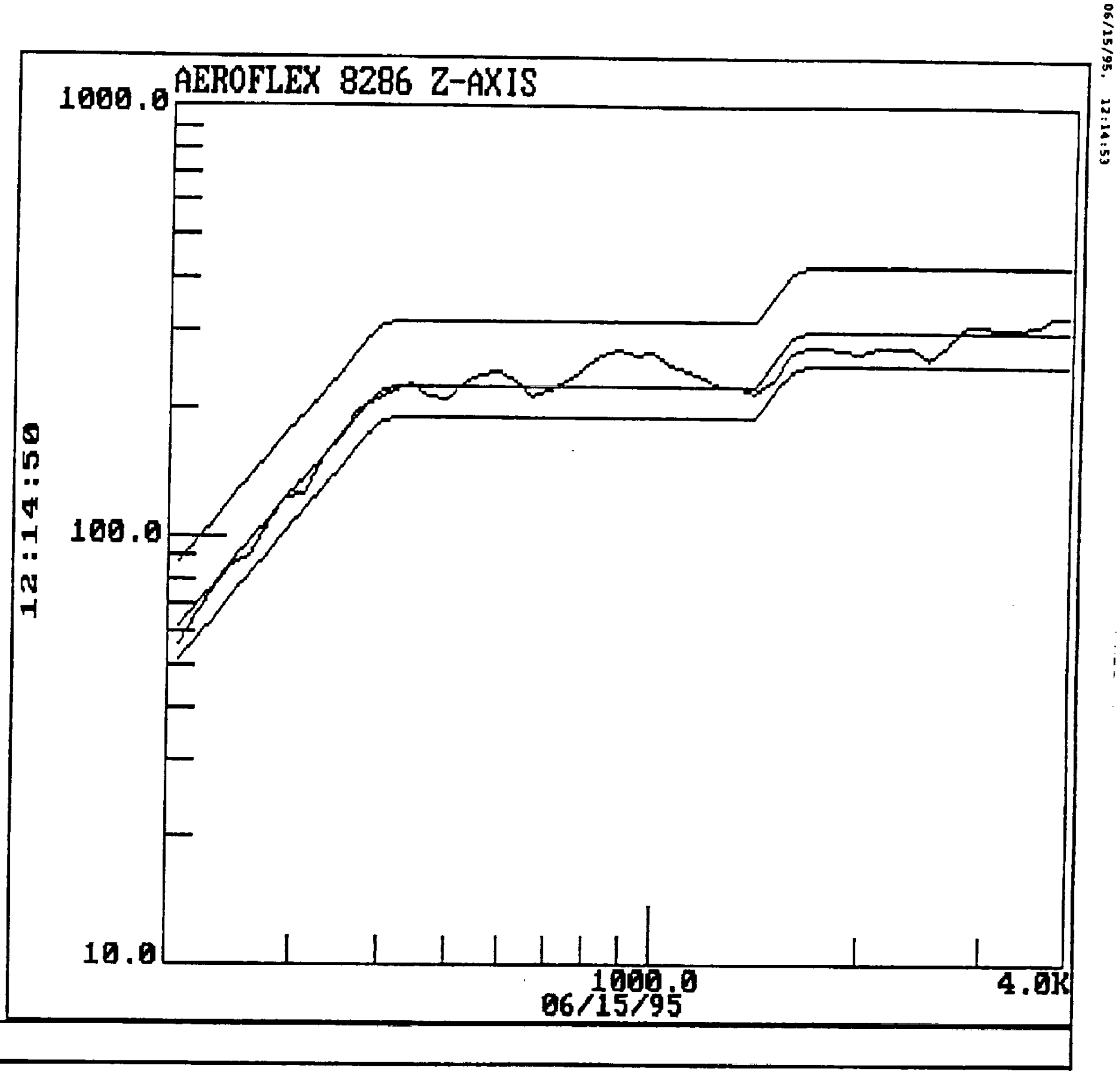
Input Shock Spectrum
"X" Axis, S/N 0002



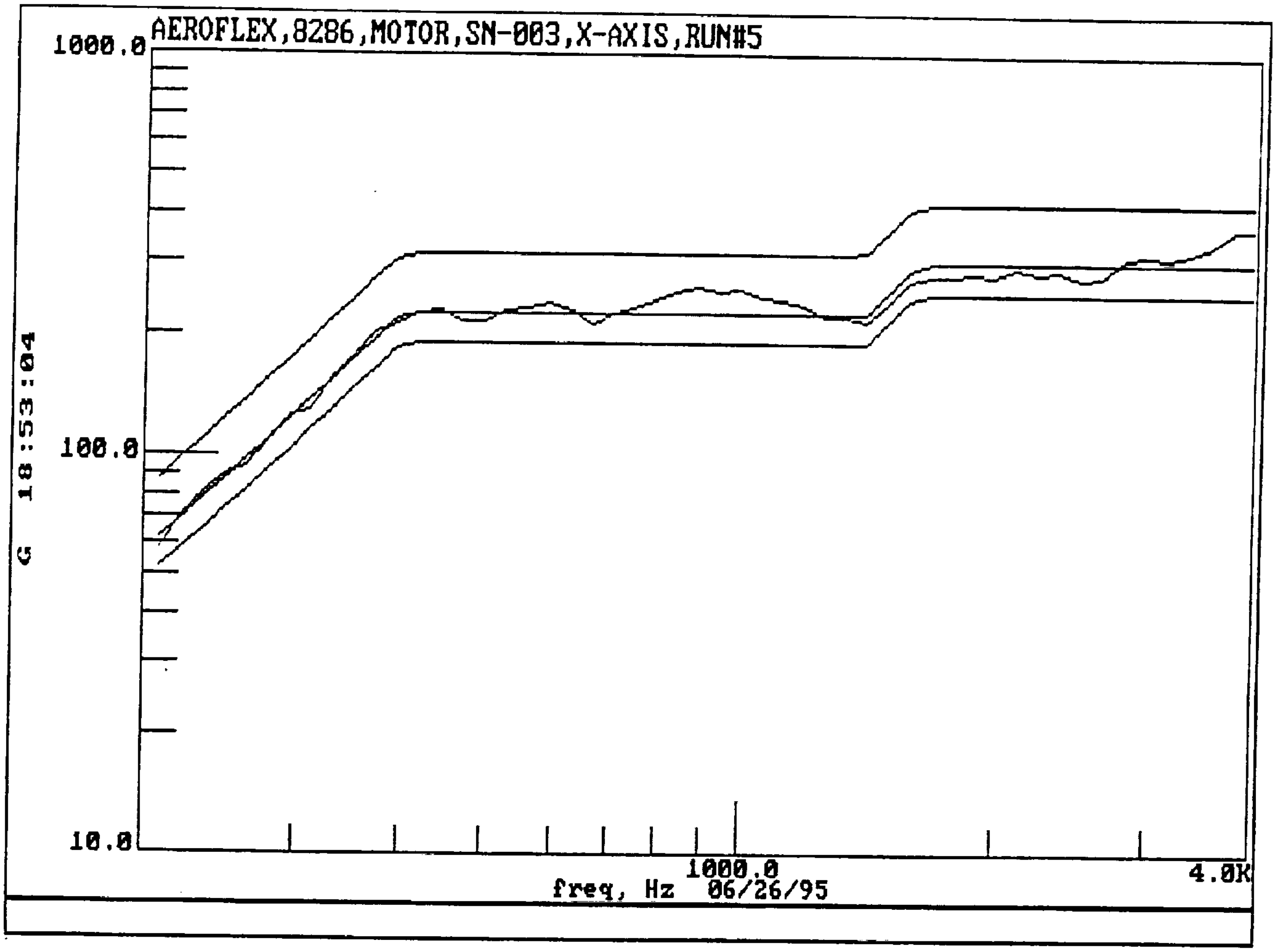
Input Shock Spectrum
"Y" Axis, S/N 0002



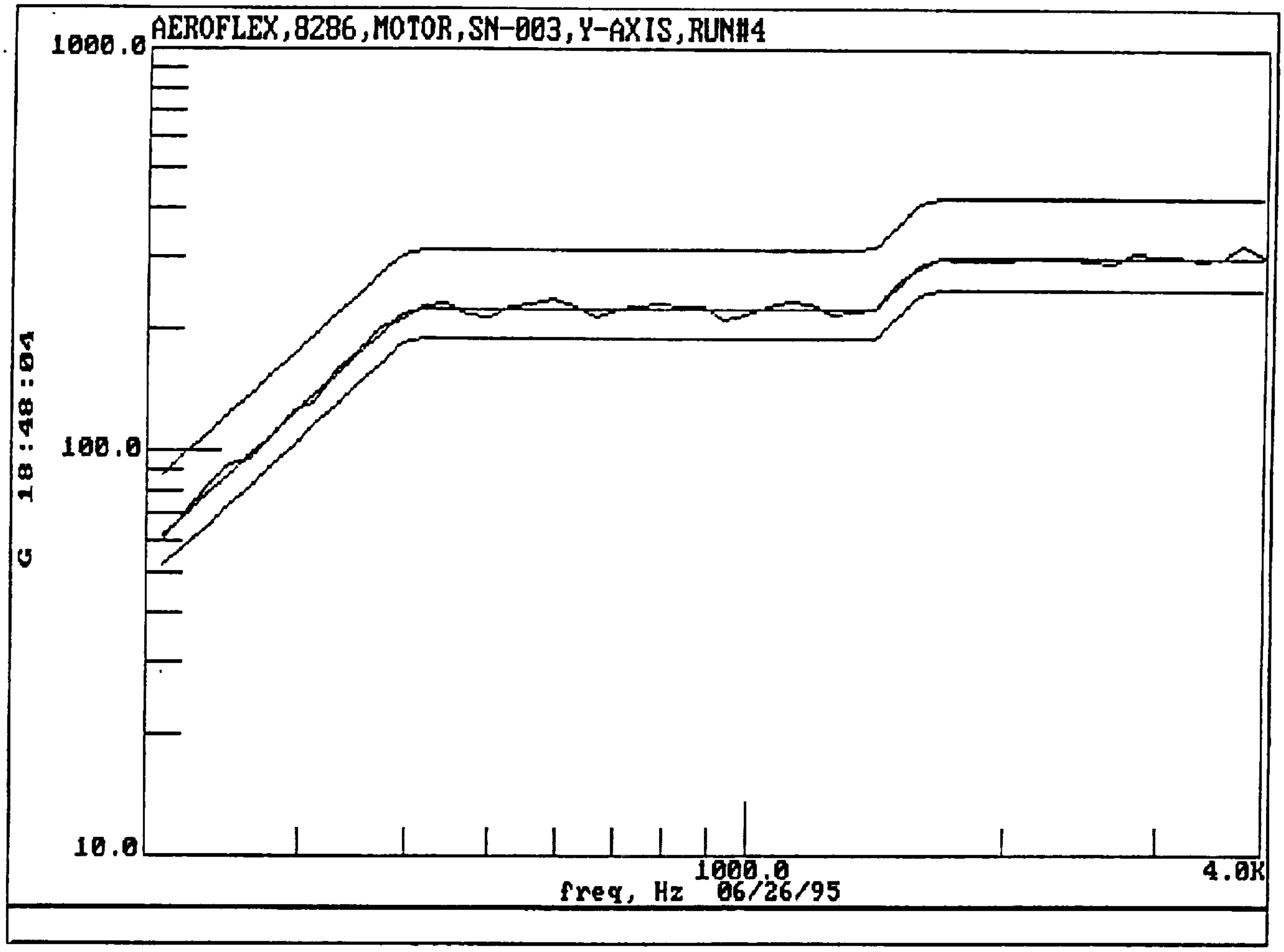
Input Shock Spectrum
"Z" Axis, S/N 0002



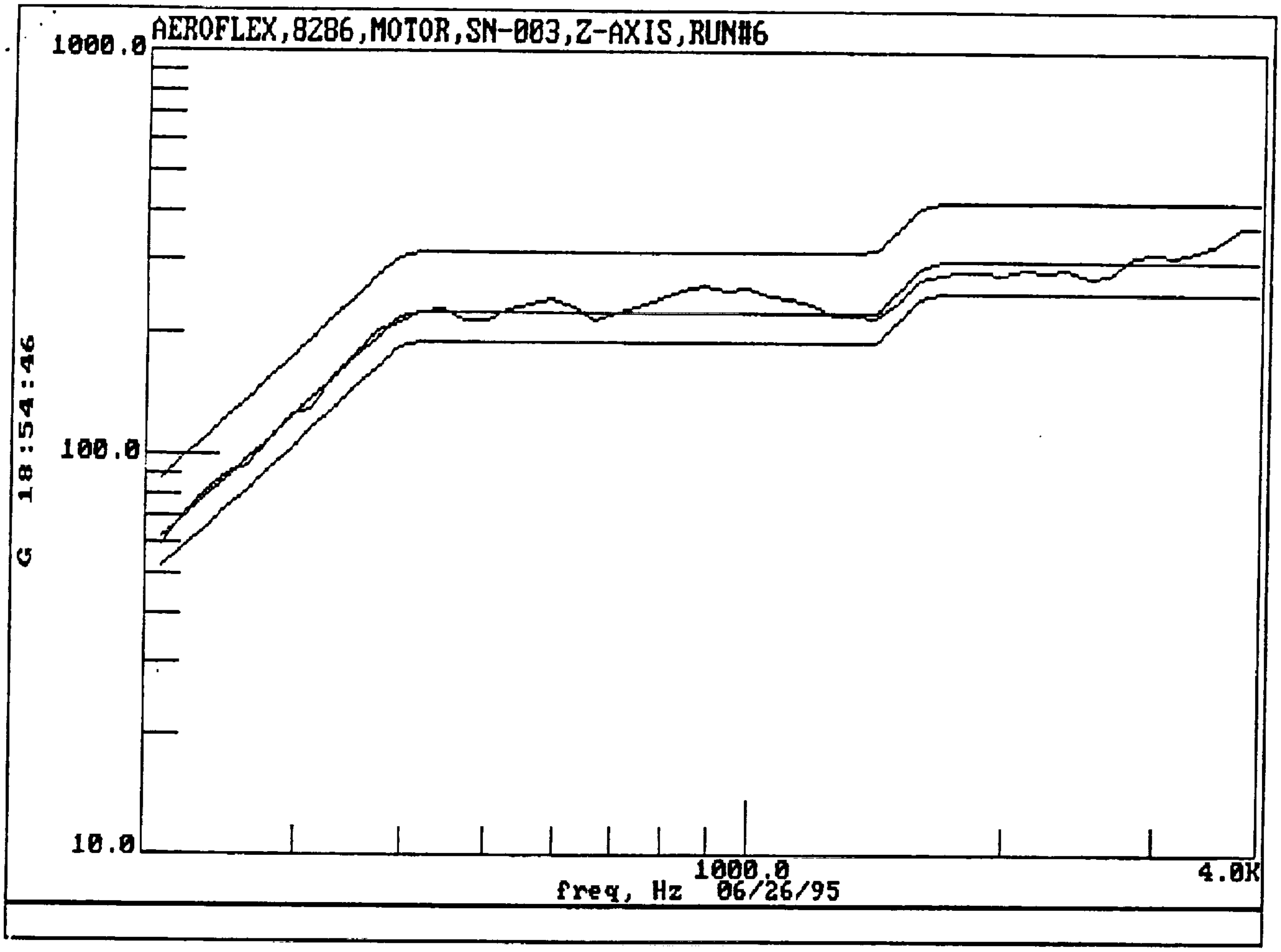
Input Shock Spectrum
"X" Axis, S/N 0003



Input Shock Spectrum
"Y" Axis, S/N 0003



Input Shock Spectrum
"Z" Axis, S/N 0003



APPLICATION	
NEXT ASSY	USED ON
	16187

REVISIONS

LTR	DESCRIPTION	DATE	APPROVED
B	INITIAL RELEASE	8-22-94	

ALL PAGES ARE OF ORIGINAL ISSUE EXCEPT AS NOTED																																			
SHEET	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
REV.	B	B	B	B	B	B	B	B	B	B	B	B	B	B																				

UNLESS OTHERWISE SPECIFIED
ALL DIMENSIONS ARE IN INCHES
TOLERANCES:
FRAC. ~ DEC. ~ ANG. ~

MATERIAL ~

FINISH ~

ORIG. DATE OF DWG.
DRAWN I.A 2-1-94
CHECKED
ENGNRG. 8-22-94
DESIGN
QA 8-29-94
MFG. 8/22/94

AEROFLEX LABORATORIES INCORPORATED
PLAINVIEW N.Y. 11803

ACCEPTANCE TEST PROCEDURE - MOTOR / ENCODER - 16187

SIZE A
FSCM NO. 88379
ATP 20049

SCALE ~
WEIGHT ~
SHEET 1 OF 14

1.0 SCOPE

1.1 INTRODUCTION

This procedure describes the tests and environments required to establish acceptance of the Aeroflex Brushless Step Motor/Encoder, Part Number 16187 in accordance with MSFC Drawing SXI-201 and NAS8-39409, Appendix A.

1.2 APPLICABLE DOCUMENTS

NAS8-39409 Appendix A	All referenced documents in Par. 2.1
Aeroflex Procedure 5-297-0	Procedure for Alignment of Motor and Encoder

2.0 TEST EQUIPMENT

Waters 1.2 in-oz full scale bidirectional Torque Watch

Waters 20 in-oz full scale bidirectional Torque Watch

Leeds and Northrup resistance Bridge

Hewlett Packard LCR meter Model 4261A

General Radio Model 1864 megohmmeter

AR Hypot Model 4006

Digital Multimeter HP 3466A

DC Power Supply Hewlett Packard Model 6111A

Lambda regulated Power Supply Model LH124BFM

Tektronix 2445 oscilloscope

Gould Model RS 3200 Chart Recorders

Tenney TTRG Environmental Chamber

Veeco Diffusion Pump

Vibration,Noise, and Shock Equipment TBD by Testing Labs

3.0 MECHANICAL AND ELECTRICAL CHARACTERISTICS

3.1 TORQUE AND OPERATING POINT

3.1.1 DETENT TORQUE

Using a torque watch with a 0-40 oz-in. range, measure the detent torque of the motor through three cogging positions, rotating ccw. The detent torque shall be 0.25 oz-in minimum at each position.

3.1.2 OPERATING TORQUE

Connect the motor as per Figure 1. Using an oscilloscope, adjust the test circuit until it is operating at 4.8 pulses per second at 22 VDC minimum, 25 VDC maximum, measured at the motor leads. Attach a thin thread to the motor shaft, and attach weights equivalent to 5.5 oz-in to the other end of the thread. The weight equivalent is determined by dividing the 5.5 oz-in requirement by the shaft radius in inches.Apply the proper voltage to the test circuit, and count the number of shaft revolutions in one minute. The motor shall lift the weights and rotate at 6 rpm minimum.

3.1.3 STALL TORQUE

Apply the required voltage to the test circuit, and using a torque watch with a 0-40 oz-in range, measure the torque required to stall the motor. The stall torque shall be 6.0 oz-in minimum at 22 VDC.

3.2 MOTOR ELECTRICAL CHARACTERISTICS

3.2.1 STEP ANGLE

Attach fixture 527-191- 1 to the motor housing mounting screws. Attach indicator arm 527-191-2 to the motor shaft. Align the indicator arm with the zero degree position on the fixture. Apply 22 VDC to the winding labeled #1 (+22 VDC) and #3 (RTN). The motor shall step 7.5 degrees +/-0.75 degrees clockwise when viewed from the indicator arm. Repeat with wires #2 and #4, and verify clockwise rotation 7.5 degrees +/- 0.75 degrees. Continue with reverse polarity on #1 and # 3, #2 and #4.Repeat procedure for one full rotation cw. The angle indicator shall return to the zero position +/- 0.75 degrees.

3.2.2 WINDING RESISTANCE AT 20 DEGREES C.

Using a Wheatstone bridge , measure the winding resistance between wires #1 and #3 and between wires #2 and #4. Record these readings and the room temperature. The resistance for each phase shall then be calculated to verify 77.6 ohms minimum at 20 degrees C.

3.2.3 WINDING INDUCTANCE

Using a digital LCR bridge, measure the inductance between wires #1 and #3, and between wires #2 and #4. This value shall be recorded for reference only.

3.2.4 INSULATION RESISTANCE AND DIELECTRIC STRENGTH

3.2.4.1 STATOR WINDING TEST PRE-IMPREGNATION

Tie together wires 1 and 3,2 and 4. Using a megohmmeter, apply 100 VDC between the tied together motor windings and the stator core for one minute. The insulation resistance shall be 100 Megohms minimum.Measure the insulation resistance (100 Megohms minimum) between the tied together motor windings. Using a Hypot, apply 250 VRMS, 60 Hz between the tied together motor leads and the stator core for one minute. Next, apply 250 VRMS 60 Hz between the tied together motor leads. The leakage current shall not exceed 100 microamperes for both cases.

3.2.4.2 MOTOR TEST POST-IMPREGNATION

Tie together wires 1 and 3,2 and 4. Using a megohmmeter, apply 100 VDC between the tied together motor windings and the housing for one minute. Next, apply 100 VDC between the tied together motor windings for 1 minute. The insulation resistance shall be 100 Megohms minimum for both cases. Using a Hypot, apply 125 VRMS, 60 Hz between the tied together motor leads and the stator for one minute. Next, apply 125 VRMS, 60 Hz between the tied together motor leads for one minute. The leakage current shall not exceed 100 microamperes for both cases.

3.3 ENCODER ELECTRICAL CHARACTERISTICS

3.3.1 ENCODER POSITION 1 AND OUTPUT VOLTAGE

Realign the indicator arm to the zero position. Connect test circuit to the encoder output wires, as shown in Figure 2. Apply +5 VDC +/- 0.2 V to the input wires and verify the output is according to Table 1 for encoder position 1. In addition, measure the output voltage across bit 4 and verify this voltage is not less than 3.5 VDC with 4.8 VDC at the input.

3.3.2 ENCODER POSITION VERIFICATION

With the encoder input voltage as in 3.3.1, apply 22 VDC to alternating phases according to the Table 1, and stop at step 4 .The encoder output shall be in accordance with

Table 1 at this step. Verify the remaining encoder outputs according to Table 1. The requirement that the encoder position shall be +/- one half the motor's step angle has been verified in procedure 5-297-0.

3.4 MOTOR/ENCODER PHYSICAL CHARACTERISTICS

3.4.1 SIZE AND CONFIGURATION

The size and configuration of the motor/encoder shall be in accordance with MSFC Drawing SXI- 201 and Aeroflex Drawing 200-38. These dimensions shall be verified at final inspection.

3.4.2 WEIGHT

The weight of the motor/encoder shall not exceed 15 ounces.

3.4.3 RADIAL DEFLECTION

Assemble the motor/encoder in fixture 527-192 . Adjust a dial indicator capable of reading 0.0001 inch deflection to its zero reading on the motor shaft. Using a force gauge, apply a 9.0 +/- 0.1 lb. force on the shaft, in accordance with Drawing SXI-201, Proof Load Diagram. The resulting deflection shall be 0.0015 inches maximum.

4.0 ENVIRONMENTAL TESTS

4.1 CHARACTERISTICS AT THERMAL VACUUM CONDITIONS

4.1.1 MOTOR/ENCODER CONNECTIONS

Attach a three oz-in^2 load simulator to the motor shaft. Place the motor/encoder in a clean thermal vacuum container. Connect the motor windings and encoder wires to the feedthrough connections in the container and connect the test circuits to the outside,as per Figure 3. In addition, connect the AD590 temperature sensor leads to a feedthrough connection and connect a trim circuit to the outside,as per Figure 3. Verify step rotation of the motor as per paragraph 3.2.1,and verify encoder output, as per paragraph 3.3.2. In addition, check the room ambient temperature in degrees Kelvin (Degrees C + 273) is equivalent to the temperature sensor mv output. Once this is done , the container can be sealed and transported to the thermal vacuum location.

4.1.2 THERMAL VACUUM OPERATION

Set a controlled temperature environmental chamber to 25

Table 1 at this step. Verify the remaining encoder outputs according to Table 1. The requirement that the encoder position shall be +/- one half the motor's step angle has been verified in procedure 5-297-0.

~~3.4 MOTOR/ENCODER PHYSICAL CHARACTERISTICS~~

~~3.4.1 SIZE AND CONFIGURATION~~

~~The size and configuration of the motor/encoder shall be in accordance with MSFC Drawing SXI- 201 and Aeroflex Drawing 200-38. These dimensions shall be verified at final inspection.~~

~~3.4.2 WEIGHT~~

~~The weight of the motor/encoder shall not exceed 15 ounces.~~

Duplicate of Sheet 5

~~3.4.3 RADIAL DEFLECTION~~

~~Assemble the motor/encoder in fixture 527-192 . Adjust a dial indicator capable of reading 0.0001 inch deflection to its zero reading on the motor shaft. Using a force gauge, apply a 9.0 +/- 0.1 lb. force on the shaft, in accordance with Drawing SXI-201, Proof Load Diagram. The resulting deflection shall be 0.0015 inches maximum.~~

See Sheet #5

~~4.0 ENVIRONMENTAL TESTS~~

~~4.1 CHARACTERISTICS AT THERMAL VACUUM CONDITIONS~~

~~4.1.1 MOTOR/ENCODER CONNECTIONS~~

~~Attach a three oz-in^2 load simulator to the motor shaft. Place the motor/encoder in a clean thermal vacuum container. Connect the motor windings and encoder wires to the feedthrough connections in the container and connect the test circuits to the outside,as per Figure 3. In addition, connect the AD590 temperature sensor leads to a feedthrough connection and connect a trim circuit to the outside,as per Figure 3. Verify step rotation of the motor as per paragraph 3.2.1,and verify encoder output, as per paragraph 3.3.2. In addition, check the room ambient temperature in degrees Kelvin (Degrees C + 273) is equivalent to the temperature sensor mv output. Once this is done , the container can be sealed and transported to the thermal vacuum location.~~

4.1.2 THERMAL VACUUM OPERATION

Set a controlled temperature environmental chamber to 25 degrees C. Place a humidity indicator in the chamber. Seal the porthole, and fill the chamber with dry nitrogen gas. When the relative humidity (RH) goes below 70 %, place the vacuum container in the temperature chamber. Verify the RH is still < 70% . Connect the container pipe to a diffusion pump, and begin mechanical roughing. Follow the manufacturer's operation sequence for the diffusion pump in order to achieve 1 x 10 -5 torr. Follow the cycle and test points in Figure 4. Verify temperature soaks using the AD590 sensor. Perform all functional tests after one hour soak at the indicated temperatures.

4.1.3 MOTOR/ ENCODER FUNCTIONAL TESTS AT THERMAL VACUUM CYCLES

4.1.3.1 VERIFICATION OF OPERATION UNDER LOAD

Connect chart recorder channels across current sensing shunts in series with the motor leads, as shown in Figure 3. In addition , connect one recorder channel to each encoder output. Apply the operating voltage to the test circuits for motor and encoder, and record the motor current and encoder output "high" voltage (3.5 VDC minimum) for one minute. There shall be no interruptions in the recorder traces during this time.

4.1.3.2 STALL OPERATION

Disconnect the motor from the test circuit. Apply 200 mA through wires #1 and #3 for 30 seconds. This current corresponds to the current at stall. Keep the power off for 60 seconds, repeat power on, and continue this sequence ten times. After this cycle, check operation as per paragraph 4.1.3.1 .

4.1.3.3 PROCEDURE FOR ENDING THERMAL VACUUM CYCLE

Soak the container at 25 C for 1 hour minimum. Verify RH < 70% , and proceed to shut down the diffusion pump and mechanical roughing according to the manufacturer's operating sequence. When the input gauge reads 450-760 torr, the container can be vented and disconnected from the pump. Return the sealed container to the clean room.

4.2 THERMAL CYCLING TEST AMBIENT PRESSURE

Perform a preliminary functional test at ambient temperature in a Class 100 environment in accordance with paragraphs 3.1.3, 3.2.1, 3.3.1 and 3.3.2 .
Place the motor (in a clean sealed container) in a air convection environmental chamber . The container and connections shall be per Figure 3. Fill the chamber with dry nitrogen. Ramp the temperature up to 50 degrees C at a rate of 3 degree C per hour, allow the motor to stabilize at this temperature for 1 hour minimum, and perform the functional

tests as in 4.1.3.1 and 4.1.3.2. After this test, ramp the temperature down to -40 degrees C. Stabilize and test the unit in the same manner as in the hot cycle . Repeat for 24 cycles, performing functional tests at the final cycle.

4.3 TEST SEQUENCE FOR VIBRATION AND SHOCK

Check that the load simulation disk is securely attached to the motor shaft. Fasten the motor to the base of container 527-193 and seal the container cover. Transport the container to the environmental testing facility, and perform the sine ,random vibration, and shock according to Table 2. The functional tests after each environment must be done in a class 100 clean area. The noise test must also be conducted in a class 100 clean room with the cover off. In addition to the functional tests, visually inspect the motor for any damage.

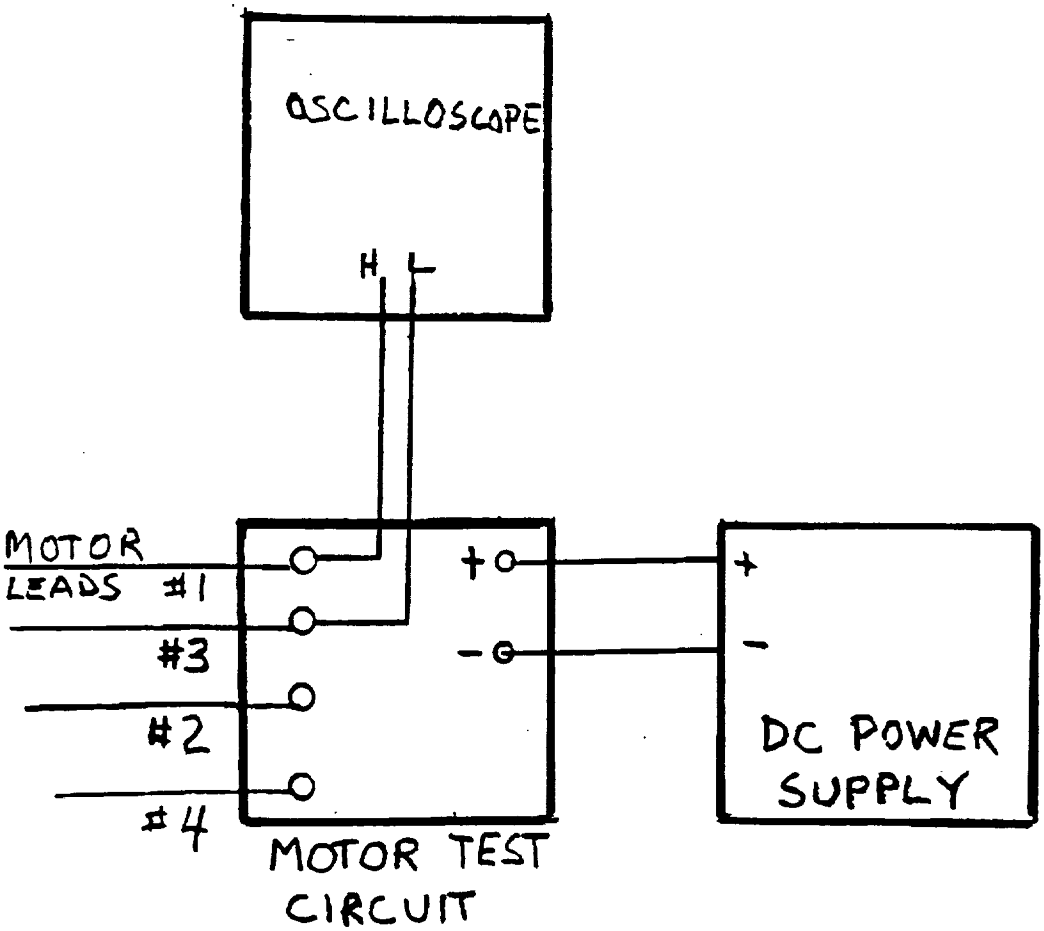


FIGURE 1

SIZE A	FSCM NO. 88379	ATP20049

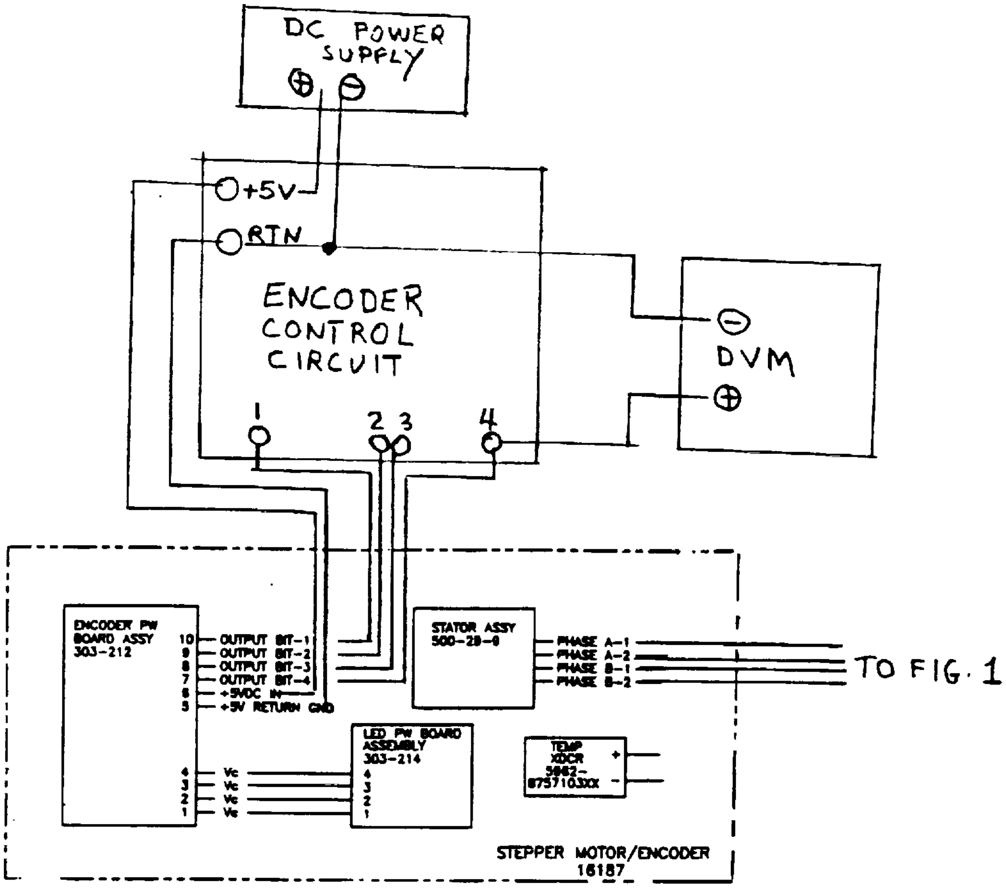


FIGURE 2

SIZE A	FSCM NO. 88379	ATP 20049

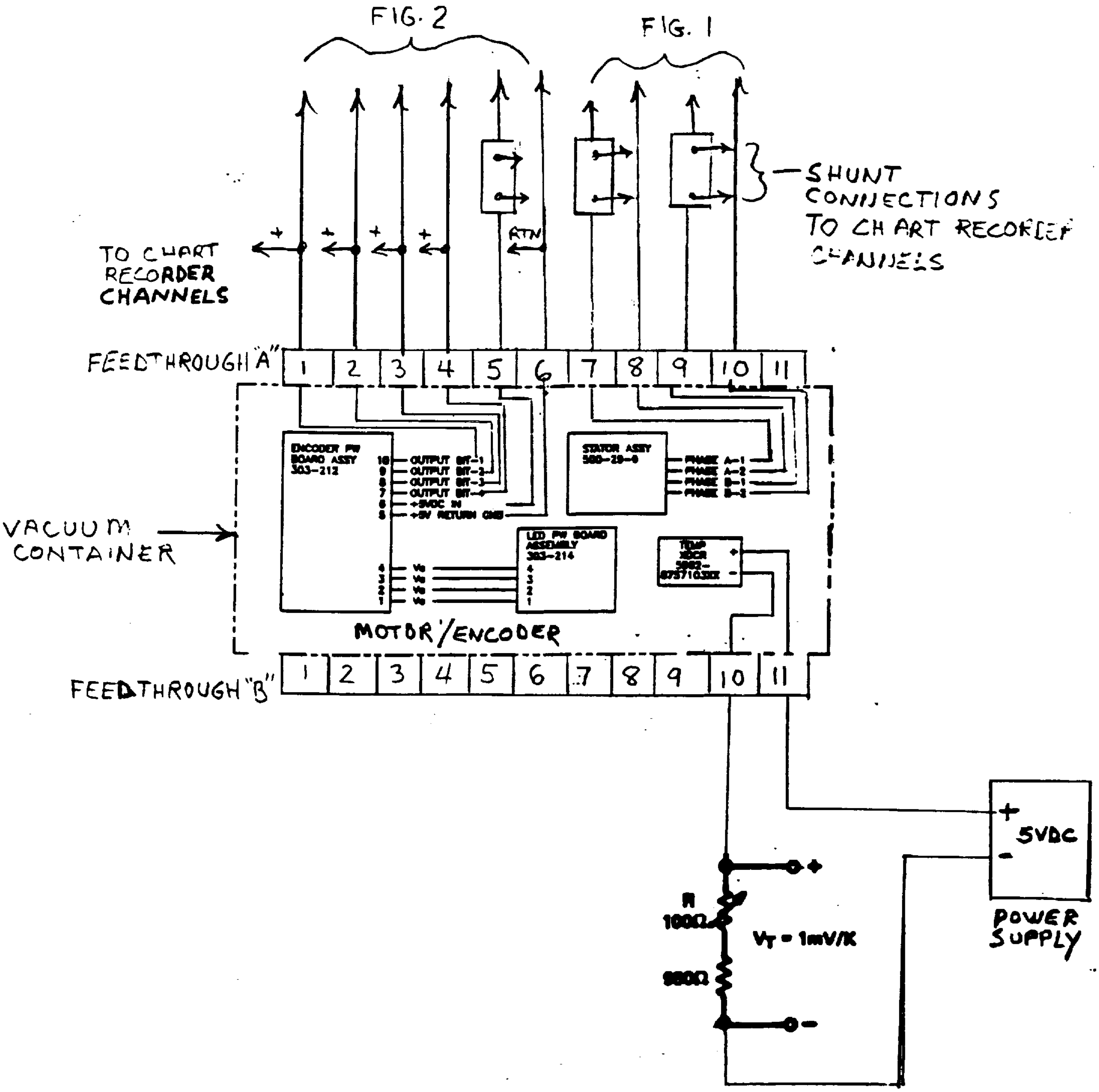


FIGURE 3

SIZE	FSCM NO.	
A	88379	ATP20049

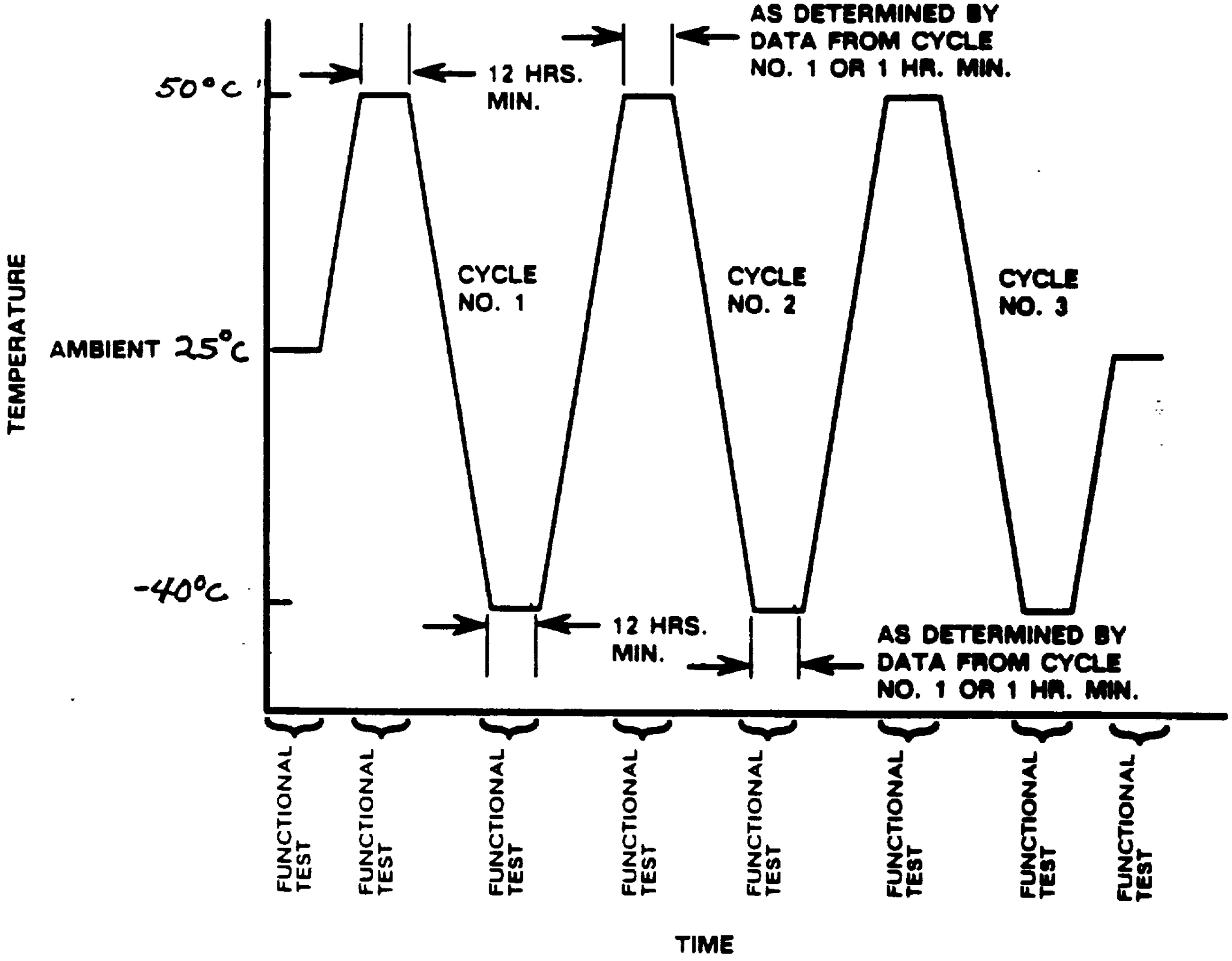


FIGURE 4 COMPONENT QUALIFICATION TEST (THERMAL/VACUUM)

SIZE	FSCM NO.	
A	88379	ATP20049
SCALE	REV. 8	SHEET 12

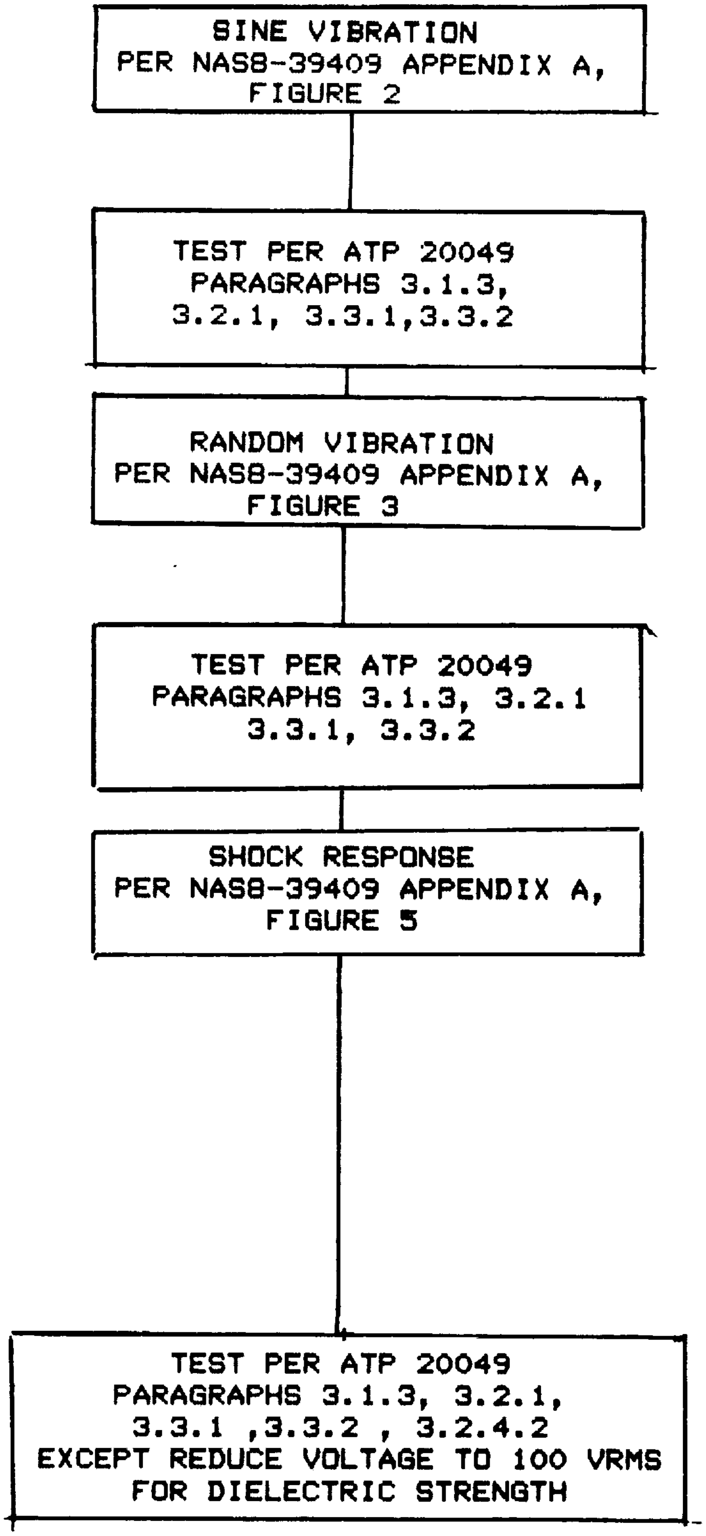
MOTOR					ENCODER				
Step	1	2	3	4	Pos.	1	2	3	4
1	+		RTN		–	0	0	0	0
2		+		RTN	–	0	0	0	0
3	RTN		+		–	0	0	0	0
4		RTN		+	2	0	0	1	0
5	+		RTN						
6		+		RTN					
7	RTN		+						
8		RTN		+	3	0	0	1	1
9									
10	RE	PEAT							
11									
12		RTN		+	4	0	1	0	0
13									
14	RE	PEAT							
15									
16		RTN		+	5	0	1	0	1
17									
18	RE	PEAT							
19									
20		RTN		+	6	0	1	1	0
21									
22	RE	PEAT							
23									
24		RTN		+	7	0	1	1	1
25									
26	RE	PEAT							
27									
28		RTN		+	8	1	0	0	0
29									
30	RE	PEAT							
31									
32		RTN		+	9	1	0	0	1
33									
34	RE	PEAT							
35									
36		RTN		+	10	1	0	1	0
37									
38	RE	PEAT							
39									
40		RTN		+	11	1	0	1	1
41									
42	RE	PEAT							
43									
44		RTN		+	12	1	1	0	0
45									
46	RE	PEAT							
47									
48		RTN		+	1	0	0	0	1

TABLE I
MOTOR STEP SEQUENCE
AND ENCODER POSITIONS

SIZE	FSCM NO.	
A	88379	ATP 20049

TABLE 2.

TEST SEQUENCE FOR VIBRATION AND SHOCK



SINE VIBRATION
PER NAS8-39409 APPENDIX A,
FIGURE 2

TEST PER ATP 20049
PARAGRAPHS 3.1.3,
3.2.1, 3.3.1,3.3.2

RANDOM VIBRATION
PER NAS8-39409 APPENDIX A,
FIGURE 3

TEST PER ATP 20049
PARAGRAPHS 3.1.3, 3.2.1
3.3.1, 3.3.2

SHOCK RESPONSE
PER NAS8-39409 APPENDIX A,
FIGURE 5

TEST PER ATP 20049
PARAGRAPHS 3.1.3, 3.2.1,
3.3.1 ,3.3.2 , 3.2.4.2
EXCEPT REDUCE VOLTAGE TO 100 VRMS
FOR DIELECTRIC STRENGTH

SECTION V

ENGINEERING RATIONALE TO SUPPORT ANALYSIS VS TESTING

15.3 d. Verification Plan

The verification plan outlines the methods used to prove the motor/encoder meets the characteristics of Appendix A, paragraph 3 of the SOW for contract NAS8-39409.

PARAGRAPH NUMBER AND CHARACTERISTIC	METHOD OF VERIFICATION
3.2.1.1 Torque and Operating Point	Test
3.2.1.2-3.2.1.2.2 Operating Duty, Continuous Duty,and Intermittent Duty	Analysis
3.2.1.2.3 Stall Operation	Test
3.2.1.3 Stepper Motor Power	Test
3.2.1.4 Encoder Power	Test
3.2.2.1 Size and Configuration	Inspection
3.2.2.2 Weight	Inspection
3.2.2.3 Mounting	Inspection
3.2.2.4 Electrical Interface	Inspection
3.2.2.4.1 Insulation Resistance and Dielectric Strength	Test
3.2.2.5 Thermal Design	Analysis

3.2.2.6 Lubrication	Verification of records
3.2.2.7.1 Step angle	Test
3.2.2.7.2 Number of Phases	Test
3.2.2.7.3 Winding Resistance	Test
3.2.2.7.4 Winding Inductance	Test
3.2.2.7.5 Encoder	Test
3.2.2.7.8 Bearings	Verification of records
3.2.2.9 Output Shaft	Inspection
3.2.2.9.1 Radial Deflection	Inspection
3.2.2.9.2 Alignment	Test
3.2.2.10 Magnets	Verification of records
3.2.3 Reliability	Verification of records, Inspection
3.2.4.1 and 3.2.4.2 Storage and Operating Life	Analysis and Test

3.2.4.2.1
Storage and handling environments
(Non-operating).............................Test

3.2.4.2.2
Prelaunch environment.......................Test

3.2.4.2.3
Launch and ascent environment..............Analysis(Survival Load)
Test (Sine,random vibration, acoustic noise, shock)

3.2.4.2.4
Orbital Operation...........................Analysis (Radiation)
Test (Pressure,Temp)

3.2.5
Transportability............................Inspection ,records verification

EAST-WEST TECHNOLOGY CORP.
119 Cabot Street
West Babylon, NY 11704
(516) 420 0530 • Fax (516) 420 8067

LETTER OF CERTIFICATION

Prepared For:

AEROFLEX LABORATORIES, INCORPORATED
35 South Service Road
Plainview, New York 11803

This is to certify that items listed herein were subjected to **Random Vibration, Sine Vibration, and Pyroshock** testing in accordance with the Aeroflex Laboratories Acceptance Test Procedure 20049, Revision B, as required by the referenced Purchase Orders. The test items were subjected to all of the tests in each of the 3 orthogonal axes.

Test Results: No damage or deterioration of the test items was noted during or upon completion of the referenced testing.

Test Specimens:

Motor/Encoder Assembly - 16187, Serial number 0003 (Subjected to Random Vibration only)

Motor/Encoder Assembly - 16187, Serial number 0002 (subjected to all tests)

Motor/Encoder Assembly - 16187 Test Fixture (subjected to Survey only using Random Vibration profile)

EWT Job No.:	**8363/8286**	Certificate No.:	**8363.CRT**
Purchase Order No.:	**10901 and 99593**	Certificate File No.:	**8363.CRT** Disk 143
Test Completion Date:	26 June 1995	Certificate Issue Date:	19 July 1995

CERTIFIED BY : ________________ R. Borrelli, Quality Assurance Manager
EAST-WEST TECHNOLOGY

SECTION VI

QUALIFICATION FAILURE & CORRECTIVE ACTION

13640	5/8/95		P.O.	OPER.	VENDOR ARX	
PART NO. 16187	REV. B	PART NAME MOTOR/ENCODER	LOT SIZE 1	SAMPLE SIZE 1 / QTY WITHHELD 1	TOT. ACC. 0	TOTAL WITHHELD 1
S/N - UNIT 0003	TEST SPEC. NO. ATP-20049	REV. B	PARA 4.3	INSP. POINT	RECEIVING ○ IN-PROCESS ○	FINAL ○ OTHER ○

No. 00168

PAGE 1 OF 1

CODES
- V- VENDOR
- E- ENGINEERING
- T- TEST
- I- INSPECTION
- A- ASSEMBLY
- S- SHOP
- W- WIRING
- P- SPEC. PROC.
- N- UNKNOWN

DEFECT CODES

11	SOLDERING	34	DIM OUT	51.	EXPIRED LIFE
12	WIRING	41	POTTING/COATING	52	DOCUMENTATION
13.	HARNESS/CABLE	42	WELDING	53	PACKAGING
14	POLARITY/ORIENT	43	FINISHES	54.	DRAWING/SPEC
21	IMPROPER ASS'Y	44	CORROSION	61	ELEC PARA OUT
22	WRONG PART	45	CASTING	62	COMP FAIL
23	DAMAGED PART	48	MARKING	71	GEN APPEAR
24	MISSING PART				
25.	EXTRA PART				
31.	MATERIAL				
32.	INCOMPL. OPN				
33	MAT'L HANDLING				

ITEM NO	QTY WITH HELD	INSP LEVEL AQL	REASONS FOR WITHHOLDING	RESP	FREQ	DEFECT CLASS	DEFECT CODE	SCREEN	USE AS IS	RE WORK	SCRAP	RET TO VEN	MRB
1	1	100%	After subjecting the Motor / Encoder Assembly part number 16187, serial number 0003 to the random vibration portion of the ATP, the vibration fixture cover was removed to expose the shaft end of the Motor / Encoder in preparation to remove the Motor / Encoder from the fixture to run a functional test of the unit. At this point, it was observed that the retaining ring which holds the dummy load to the shaft, had become loose and permitted the dummy load to travel on the shaft during vibration. The fixture cover prevented the dummy load from coming completely off the shaft. This up and down movement of the dummy load caused a scraping of the shaft which left small whisker like magnetic particles to become attached to the magnetic field in the shaft and the two bearing retainer units. The above anomaly was caused by the mis-application of the ATP fixture hardware.	T	1x	MAJ	71						*
			TOTAL →										

R. Sanger 35 5-8-95 CV Podesta 5/12/95 Brian Mur 5/12/95

OPER NO	DEPT	QTY	SET UP	TOT RT	RWK ACC	RWK RET	REWORK INSTRUCTIONS DISPOSITION RATIONALE (MUST BE COMPLETED FOR ALL USE AS IS DISPOSITIONS)
							Submit NCR to NASA for concurrence on Corrective Action Request & Report #M 13640
							All rework for the disassembly and the reassembly of the Motor / Encoder, 16187, will be accomplished in accordance with Assembly Flow Chart 960-295. As indicated on the flow chart, all the rework will be accomplished in a Class 100 environment.

AEROFLEX LABORATORIES, INC.
NONCONFORMANCE REPORT
FORM QA-515 (12/94)

TRAVELER

AEROFLEX LABORATORIES INCORPORATED
SOUTH SERVICE ROAD, PLAINVIEW, L.I., NEW YORK

NO. M 13640

CORRECTIVE ACTION REQUEST AND REPORT

TO EMO Division
Aeroflex Laboratories

ATTN. A FERRI - PROGRAM MANAGER

OUR PURCHASE ORDER NO.
PART NO 16187
DESCRIPTION MOTOR / ENCODER
DATE RECEIVED R.R. NO.
QUANTITY REJECTED 1 REJECT. NO. 00168
PART RETURNED YES NO
SERIAL NUMBER 0003
FROM

DISCREPANCY OR CONDITION: SEE NCR # 00168.

ACTION REQUIRED BY DATE

SIGNED C.V. Jodasko DATE 5/12/95

REPLY

CAUSE OF DISCREPANCY OR CONDITION: The root cause of the vibration fixture failure was the improper installation of the retaining ring which secures the dummy load to the Motor / Enclder shaft plus the lack of shims under the retaining ring to remove the end play.

CORRECTIVE ACTION: (NOTE EFFECTIVE DATES AND REFERENCE DOCUMENTS)

a) Shim clearances between retaining ring and dummy load to eliminate end play
b) Install retaining ring per manufacturer's specification by adjusting and setting stops on installation tool.

DO NOT WRITE BELOW THIS LINE

EVALUATION OF CORRECTIVE ACTION

CORRECTIVE ACTION SATISFACTORY YES NO	FOLLOW UP YES NO DATE	NEW C.A.R.R. NO.

REMARKS

SIGNED DATE

Attachment No.00168

After subjecting the Motor / Encoder Assembly part number 16187, serial number 0003 to the random vibration portion of the ATP, the vibration fixture cover was removed to expose the shaft end of the Motor / Encoder in preparation to remove the Motor / Encoder from the fixture to run a functional test of the unit. At this point, it was observed that the retaining ring which holds the dummy load to the shaft, had become loose and permitted the dummy load to travel on the shaft during vibration. The fixture cover prevented the dummy load from coming completely off the shaft. This up and down movement of the dummy load caused a scraping of the shaft which left small whisker like magnetic particles to become attached to the magnetic field in the shaft and the two bearing retainer units. The above anomaly was caused by the mis-application of the ATP fixture hardware.

All rework for the disassembly and the reassembly of the Motor / Encoder, 16187, will be accomplished in accordance with Assembly Flow Chart 960-295. As indicated on the flow chart, all the rework will be accomplished in a Class 100 environment.

Dis-assemble the Motor/Encoder to permit the replacement of the Rotor Assembly 400-29-6 and the Duplex Bearings (403-1-7) SSRI-8516LLDB10RA7P68LY328UB. Re-assemble the Motor/Encoder in accordance with assembly flow chart 960-295 starting with housing and bearing assembly 200-89.

SECTION VII

QUALIFICATION CERTIFICATE

The qualification certificate is not applicable, as the units were tested in a Joint Qualification/ Acceptance mode.