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BSM DELTA QUALIFICATION 2
FINAL REPORT

Volume II

11 November 1994

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UNITED TECHNOLOGIES CHEMICAL SYSTEMS

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CSD 5597-93-2

BSM DELTA QUALIFICATION 2
FINAL REPORT

Volume II

11 November 1994

Submitted to:

USBI
Huntsville, AL

Prepared by

UNITED TECHNOLOGIES CHEMICAL SYSTEMS

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Volume II

FOREWORD

This report, presented in three volumes, provides the results of a two-motor Delta Qualification 2 program conducted in 1993 to certify the following enhancements for incorporation into Booster Separation Motor (BSM) flight hardware:

- Vulcanized-in-place nozzle aft closure insulation
- New iso-static ATJ bulk graphite throat insert material
- Adhesive EA 9394 for bonding the nozzle throat, igniter grain rod/centering insert/igniter case
- Deletion of the igniter adapter insulator ring
- Deletion of the igniter adapter/igniter case interface RTV
- Deletion of Loctite from igniter retainer plate threads.

The enhancements above directly resulted from (1) the BSM Total Quality Management (TQM) Team initiatives to enhance the BSM producibility, and (2) the necessity to qualify new throat insert and adhesive systems to replace existing materials that will not be available.

Testing was completed at both the component and motor levels. Component testing was accomplished to screen candidate materials (e.g., throat materials, adhesive systems) and to optimize processes (e.g., aft closure insulator vulcanization approach) prior to their incorporation into the test motors. Motor testing — consisting of two motors, randomly selected by USBI's on-site quality personnel from production lot AAY, which were modified to accept the enhancements — were completed to provide the final qualification of the enhancements for incorporation into flight hardware.

This report addresses the motor level test results, with summary discussions of the component level testing where appropriate. Volume I discusses the results obtained from the Delta Qualification 2 testing. Volume II details the environmental testing (vibration and shock) conducted at Marshall Space Flight Center (MSFC) to which the motors were subjected prior to static testing. Volume III provides various supporting documentation to Volumes I and II, including the analyses and plans that governed the testing of the two Delta Qualification units.

BSM MOTOR S/N 1000734
PYROSHOCK TEST PROCEDURE

National Aeronautics and
Space Administration

George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama 35812

BSM-TCP-EP54-001

BSM Delta Qualification Test

Motor to Bracket Assembly / Pyro Shock Simulation Test Procedure

This Procedure Describes **Safety Critical** Operations

MSFC - Cover 2 (Rev. June 1980)

BSM-TCP-EP54-001

BSM Delta Qualification Test

Motor to Bracket Assembly / Pyro Shock Simulation Test Procedure

Prepared by:

Mat Bevill EP-12

08/16/93

Motor SN: 1000734

Test Date: 09/21/93

Motor to Bracket Assembly/Pyro Shock Simulation

Prepared by:

Mat [illegible]/MSFC [illegible] — Date: 9/15/93

Approved by:

Jim McGee/MSFC Vibration Lab TE — Date: 9-14-93

Jim Herring/MSFC Pyro Shock Lab TE — Date: 9-14-93

Richard Leonard/MSFC Safety/CS01 — Date: 9-16-93

Rick Clements/MSFC Quality/CQ06 — Date: 9-15-93

Ben Goldberg/Motor Systems Division/EP11 — Date: 9/15/93

Steve Brewster/Dynamic Test Branch/ED73 — Date: 9/14/93

Chuck Wells/UTC/CSD TE — Date: 9/16/93

Don Wencil/USBI — Date: 9-16-93

Charlie Lovell/PCH Engineer/CN71 — Date: 9/16/93

Motor to Bracket Assembly/Pyro Shock Simulation

Prepared by:	Mat Bevill Mat Bevill/MSFC TE/EP12	09/15/93 Date
Approved by:	Jim McGee Jim McGee/MSFC Vibration Lab TE	9/14/93 Date
	Jim Herring Jim Herring/MSFC Pyro Shock Lab TE	9-14-93 Date
	Richard Y Leonard Richard Leonard/MSFC Safety/CS01	9-16-93 Date
	Rick Clements Rick Clements/MSFC Quality/CQ06	9-15-93 Date
	Benjamin E Goldberg Ben Goldberg/Motor Systems Division/EP11	9/14/93 Date
	Steve Brewster/Dynamic Test Branch/ED73	9/14/93 Date
	Chuck Wells/UTC/CSD TE	Date
	Donald S Wencil Don Wencil/USBI	9-14-93 Date
	Charles W Lovell Charlie Lovell/PCH Engineer/CN71	9/16/93 Date

Table of Contents

1.0 General Information

1.1 Scope

This test procedure addresses all the requirements to perform pyro shock testing on Booster Separation Motors (BSM). Included in this procedure are the steps to assemble the BSM to the aft skirt support brackets.

1.2 Objective

The objective of the pyro shock testing is to verify the physical and functional survivability of the Booster Separation Motors. Of particular interest for these tests are the components bonded using EA9394 adhesive. The components using this adhesive include the throat insert, the centering insert, and the igniter grain support rod.

2.0 Applicable Documents

MSFC-STD-513A	Certification of Equipment Operations and Materials Handling Personnel
EG5300.36A	Safety
29 CFR 1910	Occupational Safety and Health Administration (OSHA)
NSS/GO 1740.9	Safety Standard for Lifting Devices and Equipment
NHB 1700.1(V1)	Basic Safety Manual
AMC-R 385-100	Safety Manual
EP01-SOP-01	Standard Operating Procedure for Safety Critical Operations
MM 1700.4	Safety and Environmental Health Hazards
MMI 1700.17	MSFC Procedures for Acquiring Shipping Permits for Rocket Motors and Igniters
MMI 1710.1	Safety Review and Approval of Hazardous and Potentially Hazardous Facilities and Activities at MSFC
MMI 1710.6	MSFC Program for Personnel Certification
MMI 1711.2	Mishap Reporting and Investigation

MMI 1845.1	Hazard Communication Program
MMI 6400.2	Packaging, Handling, and Moving Program Critical Hardware
MSFC-RQMT-1493	Electrostatic Discharge Control Requirements
MSFC-STD-1800	Electrostatic Discharge (ESD) Control for Propellant and Explosive Devices
MSFC-STD-126E	Inspection, Maintenance, Proof Testing and Certification of Handling Equipment
CSD-5597-93-1 Rev. B	Enhanced Delta Qualification Test Plan for Booster Separation Motor (BSM), Aug. 6, 1993
10SPC-0067 Rev. A	Specification for Booster Separation Motors for Space Shuttle Solid Rocket Booster (thru SCN 014)

3.0 Safety

3.1 The following safety criteria are in accordance with ET01-SOP-01, Rev. A., *"Standard Operation Procedures for Safety Critical Operations"*. If safety rules/regulations are not followed, injury to personnel and/or damage to test items could occur.

Emergency telephone numbers are as follows:

Safety	4-0046
Ambulance	112
Fire	117
Security	4-4357
Utilities	4-3919
Medical Center	4-2390
Communication Repair	4-1771

3.1.1 In the event of serious personnel injury, do not move the injured person unless necessary to prevent further serious injury. Call 112 for ambulance.

3.2 Prior to starting work in 4619 a visual inspection of the work area shall be made for anomalies by the MSFC TE and MSFC SE.

MSFC TE MB MSFC SE RWS

Date / Time: 09/21/93 6:00 p.m.

9-21-93

3.3 Personnel shall not work or position themselves beneath suspended loads unless such loads are securely and adequately blocked up.

3.4 Objects handled by overhead hoist shall be lifted only high enough to clear fixed objects in the path of travel. Spreader bars and slings may be left on the hoist if desired when not in use, but must be raised so that the lowest part of the lifting equipment will be at least seven feet from the floor when not in use.

3.5 Crane, hoist, prime lift operators, and riggers shall be certified according to the latest revision of MMI 1710.6, and shall have in their possession a valid certification card.

Certifications checked by: VTB

Date / Time: 07/21/93 6.00

3.6 Personnel working around suspended loads shall be alert to the possibility of being crushed between the suspended load and a fixed object.

3.7 Loads shall be moved slowly so they will not accumulate more momentum than can be stopped with little or no swing.

3.8 Where handling slings are called out, a sling with more pickup points than required may be used if the weight capacity per point used is equal or greater than the weight capacity of each point of the noted sling and the free pickup point is (are) secured to prevent it (them) from swinging and causing damage to parts.

3.9 Only the area coordinator should direct the crane moves, however, any person determining an immediate danger or problem may request stoppage of activities.

3.10 The lifting or transportation operation shall be halted by the area coordinator at any time the control area cannot be maintained.

3.11 Steel toe shoes are required during lifting operations. Hardhats are required when the lift is at or above the shoulders.

3.12 Tag line operators are to wear leather gloves.

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3.13 The primary safety hazards associated with this operation are:

3.13.1 Lift operations
3.13.2 Solvent Use (See NOTE)
3.13.3 Live (Loaded) Solid Rocket Motor (propellant handling)

NOTE: **Grease and solvent use are only "if needed" as determined by the MSFC TE and CSD TE.**

3.14 Any time a crane is being used, it must be dogged if:

3.14.1 The load will be suspended in a static condition for an extended amount of time.

3.14.2 A crane operator crew change or substitution must be made.

3.15 No electric power tools shall be used near the live test item. Use of pneumatic tools is acceptable.

3.16 All ground cables and ground straps end-to-end resistances shall be verified with a multimeter. These resistances must measure less than 1 ohm.

3.17 All personnel within touching distance of the BSM or ordnance shall wear a wrist strap that has been checked with a wrist strap checker.

3.18 All personnel within touching distance of open grain propellant (and ordnance) shall wear antistatic coveralls.

3.19 Wrist strap connections to facility ground must be verified. This step should be performed each time the wrist strap ground is broken.

3.20 **In case of an accidental BSM ignition, the nearest fire alarm pull station shall be activated in order to evacuate building 4619. Personnel shall stay clear of the test site until the emergency response personnel have given the "all clear" to return to the building.**

4.0 Test Items and Test Requirements

4.1 Test Items

The test item for the qualification pyro shock tests consists of a live BSM which will be tested in the aft motor configuration. The motor will be tested with an aero heat shield over the exit cone. The motor weighs approximately 154 pounds.

4.2 Test Requirements

4.2.1 Test Tolerances

Unless otherwise stated in this procedure, the tolerances applicable to the test conditions described shall be as specified in MIL-STD-810D. These tolerances are as follows:

Shock Response Spectrum: +6dB, -3dB (when analyzed with a 1/3 octave shock spectrum analyzer and 5% damping)

4.2.2 Test Data

All data taken with non-recording instruments will be recorded in ink directly onto data sheets and/or log sheets. The log or data sheets will identify the test being performed, the test item, the item part number, and the applicable test procedure. Corrections or changes will be made by drawing a single line through the original entry. The new entry will be made directly above the old and initialed by the person making the entry. Each page will be signed and dated at the bottom of the page by the person making the entries, and counter signed by the test engineer after review.

4.3 Test Conditions

4.3.0 The pyrotechnic shock tests for both motors will be conducted at the test site's ambient temperature.

4.3.1 The MSFC TE shall check with the Army MET team to ensure that there is no lightning within 10 miles. (MET team phone number....876-2465). [✓]

4.3.1.1 If lightning is within 10 miles during any time that a live BSM is in building 4619, the MSFC TE shall make arrangements to disconnect the motor ground from the facility ground. The motor shall remain ungrounded until the lightning is out of range.

4.3.1.2 When reconnecting the ground after a lightning storm, a 100Kohm resistor should be connected to the ground wire from the motor before connecting to facility ground. This allows any charge on the motor to slowly dissipate to ground. The resistor should be left connected for no less than 30 seconds.

4.3.1.3 After the specified time, disconnect the ground wire from facility ground and remove the resistor. Reconnect the ground strap from the motor to facility ground.

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4.3.2 The test site's relative humidity must be above 20%. If the humidity is below 20%, all test operations must cease until favorable weather conditions resume. [✓]

Test site's relative humidity 52% MSFC TE MB
Time 6:05 9/21/93

4.4 Test Equipment

4.4.1 All measurements shall be made with instruments and equipment whose accuracy and/or calibration has been verified.

Calibration Acceptable MB (MFSC TE)

4.4.2 Proof Loading of Handling Equipment (required for PCH)

4.4.2.1 The heaviest lift during all of the delta qualification testing will be lifting the motor while in its shipping container. The motor and shipping container together weigh about 310 lbs. All forklifts and overhead hoists must be load (break) tested to at least 110% of this weight (i.e. 350 lbs.). This test must be performed prior to any handling of the BSM but does not need to be repeated until something other than the BSM is lifted by the same handling equipment. It is therefore recommended that the break tests be performed each evening before the BSM testing commences. The break tests shall be performed as follows: [✓]

a. The proof load must be at least 350 lbs.

b. Lift the dummy load clear of the ground (less than 1 foot) and lower to ground three times, holding for five minutes on the third lift. Lifting straps and spreader bar should be attached during the lift.

SEE APPENDIX E FOR THE PROOF TEST INSPECTION SHEETS.

4.5 Test Procedure

4.5.1 After review and documented approval, a redline change to this procedure may be performed. Approval shall be by a minimum of MSFC TE, MSFC SE, and the MSFC QA.

4.5.2 As soon as possible after a test failure, a deviation from the specified test environment, or any other incident which affects the test or test item, MSFC will notify the authorized UT/CSD representative of the event verbally and will then generate a Test Procedure Deviation (NASA form 3959). A copy of the Test

Procedure Deviation is presented in Appendix B. Photographs of any discrepancies shall also be taken.

5.0 **Personnel Responsibilities**

5.1 **Test Witnessing**

All tests will be witnessed by the authorized UT/CSD representative and USBI representative. The MSFC test engineer will also witness the testing. Notification of the start of each test shall be communicated to the authorized UT/CSD and USBI representatives and the MSFC safety representative and test engineer at least 2 hours in advance.

MSFC Safety Notified ___MS___

UT/CSD Notified ___MS___

5.2 **The MSFC TE will serve as the area coordinator for the test. All handling of the BSM will be directed by the MSFC TE or cognizant test engineer.**

5.3 **Jim Herring (pyro shock) shall be responsible for photographic coverage of the pyro shock test activities.**

5.4 **The area around the outside of the pyro shock facility shall be secured *before* the live BSM is brought to the pyro shock test site.** [✓]

Area secured? YES NO

MS MSFC TE
MSFC SE

Comments: Doors locked, gates secured. area roped off

5.5 **The MSFC TE shall notify the fire department prior to delivery of the BSM. (Fire dept. phone #...117).** [✓]

5.6 **The MSFC TE shall make arrangements for the live BSM to be delivered from the NASA igloo to the pyro shock test site.** [✓]

5.7 **All involved lab directors and division chiefs shall be notified prior to testing.** [✓]

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6.0 Pyrotechnic Shock Test

6.1 Test Site Preparatory Activities

An inspection shall be made of the hardware to ensure it is all available. Should some hardware be missing the cognizant test engineer shall determine whether those components are required for the safe operation of the procedure. Should they not be required for safe operations, the test engineer shall determine whether an operations halt is required or whether the operations may proceed.

6.1.1 Verify the following components, tools and materials are available and certified (when applicable). All lifting equipment, cables, fixtures, etc... within one year stating the load limit and the date tested stencilled on the equipment. [✓]

Aft BSM Plate Mounting Hardware:

Part Number	Quantity	Nomenclature
EWB0420-8-23	6	Bolts*
EWB0420 - 10-(20,-32)	2	Bolts*
TLN1021CPD2-8	6	Nut (SelfAligning)
TLN1023CD3-10	2	Nut (SelfAligning)
NAS1587-8C	6	Washer
NAS1587-10C	2	Washer

* 10107-XX-XX series bolts are acceptable alternates (-20 for pyro, -32 for vibration)

Aft BSM Bracket Mounting Hardware:

Part Number	Quantity	Nomenclature
NAS1955C10H	8	Bolts
NAS1957C13	12	Bolts
NAS1587-5C	8	Washers
NAS1587-7C	12	Washers
NAS1587-7	12	Washers
VN324BC070	12	Locknuts
NAS1101E08H10	14	Aero Heat Shield Fasteners

Fasteners Accounted For: MB MSFC TE

Breakover brackets 2 [✓]

Lifting D-rings [✓]

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Spreader bar with associated lifting straps and D-rings [✓]

Custom wood supports to horizontally support the BSM [✓]

Tool Box with Assorted Wrenches Rm 170, Bldg. 4619 (See **Appendix D** for detailed tool list) [✓]

Pre-drilled Wood Pallet to fit aft skirt support bracket bolt holes [✓]

Lifting straps (3) [✓]

SN: 3298
SN: 3301
SN: 3208

Desiccant (12, 16 unit size bags) [✓]

Rubber mallet [✓]

Lead wire seal (for security bag) ~~[ ]~~ N/A

Forklift (at least 500 lb. capacity) [✓]

ESD Scanner [✓]

Materials

1,1,1 Trichloroethane; 1 bottle (enough for cleaning) [✓]

MIL-G-4343 grease; 1 container (AHS seal) [✓]

MIL-T-83483 thread compound; 1 container (AHS) [✓]

Conoco HD-2 grease; 1 container (bolts, faying surfaces) [✓]

Other consumables, including rimple cloth, que-tips , tape , bags and towels are also to be supplied if needed.

Gloves (Latex) [✓]
Ground straps [✓]
Wrist stats (5 each) [✓]
Stat gun (1 each) [✓]
Ohm meter (1 each) [✓]
Wrist stat checker (1 each) [✓]
Chemical safety goggles (2 each) [✓]
100 Kohm resistor (1 each) ~~[ ]~~ N/A

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All hardware accounted for: MB all needed for this test MSFC TE

6.1.2 After the truck has arrived with the motor, the engine should be turned off and the emergency brake engaged. Chock at least one of the truck's wheels. [✓]

Truck braked and wheel chocked: MB MSFC TE

6.1.3 A sign with the word "LOADED" should be attached to the motor shipping container. [✓]

6.1.4 Attach a ground strap (long enough to reach the shipping container on the truck) to the pyro facility ground and verify the resistance. Resistance must be less than 1 ohm. [✓]

Resistance measured: 0.2Ω MSFC QA RC

CAUTION: Make New Ground Before Braking Old Ground.

6.1.5 Touch the free end of the ground wire to the truck chassis to make sure the truck and the facility are at the same potential, then, connect the free end of the ground strap to motor shipping container (not to lid or lid bolts). [✓]

6.1.6 Check continuity of shipping container to ground strap using an ohm meter. Resistance should measure less than 1 ohm. [✓]

Resistance Measured 0.1Ω MSFC QA RC

6.1.7 Disconnect shipping container-to-truck tie down apparatus. Move tie down out of the way. [✓]

6.1.8 Disconnect shipping container to truck chassis ground. [✓]

CAUTION: Do Not disconnect the motor's ground wire while removing from the truck.

6.1.9 Using the fork lift, remove shipping container from truck and set container on the floor in the test room where it may be easily accessed by personnel and the overhead crane. If deemed necessary by the MSFC TE, the overhead crane may be used to remove the shipping container from the truck. [✓]

Forklift used: yes no Crane used: yes no

6.1.10 The truck may exit the test area at this time. [✓]

NOTE: If the truck does not leave the site at this time, the driver will coordinate the exit with the MSFC TE.

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6.1.11 The large pyro bay doors should be "closed in" but left "cracked" open during the assembly and pyro test operations. [✓]

6.1.12 Install the shock test control equipment on the pyro plate as illustrated in Figure 1 (see Appendix C). [✓]

Equipment installed __RB__ MSFC TE

6.1.13 The pyrotechnic shock test will be conducted in the aft motor configuration. [✓]

6.2 Pyro Test Setup

6.2.0 Record the test site's temperature and relative humidity. The relative humidity shall be above 20%. If the humidity is not above 20%, all test operations must halt until favorable weather conditions resume. [✓]

Temperature: __80__ °F; Relative Humidity __52__ %

6.2.1 Remove Motor From Shipping Container

6.2.1.0 Verify wrist straps are being used by ALL personnel while working with the live motor. All wrist straps shall be checked with a wrist strap checker before being used. Continuity checks shall be performed on all main ground straps after making any new ground connection. [✓]

MSFC SE __________

6.2.1.1 Position shipping container so that the overhead crane can easily attach to the test item (this step necessary only if fork lift positioning was not adequate for crane attachment.) [✓]

CAUTION: When using the ESD scanner and the electrostatic reading on the motor case surface exceeds 1.0 kilovolt, stop all activities on the case, initiate personnel fall back (a minimum of 4 feet) and notify safety.

After initial reading over 1.0 kilovolt, repeat electrostatic reading at intervals not to exceed 5 minutes until the the voltage has dissipated below 1.0 kilovolt. When the reading is below 1.0 kilovolt, removal operations may continue.

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If after 30 minutes the measured electrostatic charge is in excess of 1.0 kilovolt, Verify facility ground. If connection to facility ground is open, reconnect through larger resistor (100 Kohm min.) to allow a slow discharge of the motor case.

If the electrostatic reading on the case surface exceeds 4.0 kilovolts, STOP all activities on the case, notify safety , and evacuate all personnel to safe locations as directed by safety.

WARNING: Do not remove the nozzle's security bag and weather seal. Removing the bag and seal will expose the propellant grain and increase the risk of motor ignition.

6.2.1.2 Open the shipping container and remove all the packing that interferes with the removal of the test item. Monitor static charge while removing packaging. [✓]

Record Stat Gun reading Ø volts stabilized

Record SN of Stat Gun C10659

CAUTION: Make New Ground Before Braking Old Ground.

6.2.1.3 Attach a ground wire to the pyro facility ground and verify its resistance. Resistance shall measure less than 1 ohm. This wire should be attached at a location close to the BSM. [✓]

Resistance measured 0.1Ω MSFC QA RC

6.2.1.4 Attach the ground wire in step 6.2.1.3 from the facility ground to the live BSM. [✓]

6.2.1.5 Disconnect the motor to shipping container ground wire. [✓]

6.2.1.6 Attach two lifting rings (along with lifting strap) to the BSM's aft section, 180° apart. [✓]

6.2.1.7 Certifications for all lifting fixtures shall be provided: [✓]

Lifting beam assembly certification provided MB

Lifting rings (D-rings) MB

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CAUTION: **When using the ESD scanner and the electrostatic reading on the motor case surface exceeds 1.0 kilovolt, stop all activities on the case, initiate personnel fall back (a minimum of 4 feet) and notify safety.**

After initial reading over 1.0 kilovolt, repeat electrostatic reading at intervals not to exceed 5 minutes until the the voltage has dissipated below 1.0 kilovolt. When the reading is below 1.0 kilovolt, removal operations may continue.

If after 30 minutes the measured electrostatic charge is in excess of 1.0 kilovolt, Verify facility ground. If connection to facility ground is open, reconnect through larger resistor (100 Kohm min.) to allow a slow discharge of the motor case.

If the electrostatic reading on the case surface exceeds 4.0 kilovolts, STOP all activities on the case, notify safety , and evacuate all personnel to safe locations as directed by safety.

CAUTION: **The following step involves working with a suspended load. Keep hands and feet out from under the load.**

6.2.1.8 Slowly, monitoring static charge, no charge noted lift the motor out of the container using the overhead crane. Lower the test item so that the forward end of the motor is at waist height. [✓]

A detailed visual inspection shall be performed by the MSFC test engineer and the CSD test engineer on the live test items before testing. Record the motor's serial number. [✓]

No Damage No damage MB

Damage (detail in attachment) ____________

Serial Number 1000734

CAUTION: **The following step involves working with a suspended load. Keep hands and feet out from under the load.**

6.2.1.9 Attach the "break-over" brackets and lifting strap on the forward end of the motor (see Figure 2, Appendix C). [✓]

CAUTION: **Do Not disconnect the ground wire while breaking the motor to the horizontal position.**

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CAUTION: The following step involves working with a suspended load. Keep hands and feet out from under the load.

6.2.1.10 Lower the motor on its wood supports so that the motor rests horizontally. The MSFC TE will designate someone to hold the lifting strap on the forward end while placing the motor in the horizontal position (see Figure 3, Appendix C). The person holding the strap should be wearing a wrist strap. [✓]

6.2.1.11 Unhook the lifting straps and remove lifting hardware. [✓]

6.2.1.12 Re-attach the lifting hardware for bracket installation. Attach lifting straps in the saddle position (see Figure 4b, Appendix C). [✓]

6.2.2 Attach Motor to the Aft Skirt Support Brackets

Steps 6.2.2.1 and 6.2.2.2 may be skipped if deemed "not necessary" by the MSFC test engineer and the CSD test engineer. However, the fasteners should still be installed with grease applied. If time permits, all of the cleaning and surface preparation may be done *before* the test date.

CAUTION: When using trichloroethane,personnel shall wear chemical goggles and neoprene-Latex gloves. Contaminated materials shall be disposed of as hazardous waste.

CAUTION: When using grease, personnel shall wear Neoprene-Latex gloves. Contaminated materials shall be disposed of as hazardous waste.

6.2.2.1 Wipe faying surfaces clean with 1,1,1 trichloroethane and apply an unbroken film of HD-2 to each surface. After assembly remove excess grease with a lint-free cloth. [✓]

Surfaces wiped at this time: Yes____ No ✓
Grease applied at this time: Yes____ No ✓

CAUTION: When using trichloroethane,personnel shall wear chemical goggles and neoprene-Latex gloves. Contaminated materials shall be disposed of as hazardous waste.

CAUTION: When using grease, personnel shall wear Neoprene-Latex gloves. Contaminated materials shall be disposed of as hazardous waste.

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6.2.2.2 Clean washers and bolts with 1,1,1 trichloroethane and install wet with HD-2 grease. After assembly remove excess grease with a lint-free cloth. [✓]

Washers cleaned at this time: Yes_____ No ✓

CAUTION: Make sure the motor remains properly grounded during the move to position the test item.

6.2.2.3 Position the motor on the wood supports so the forward and aft brackets can be easily attached. Leave lifting straps attached. [✓]

6.2.2.4 At forward end of BSM install NAS1955C10H bolts with NAS1587-5C washers (8 places) through supports and into threaded inserts of BSM and torque to 145 to 170 in-lbs (13 to 14 ft-lbs) above running torque. [✓]

Torque value: 160 in-lbs MSFC QA RC

Record SN of torque wrench: T-267-62 (4-671)

NOTE: The forward attach bracket has an alignment pin so there is only one way it can be installed.

NOTE: Be sure the aft attach bracket is in correct alignment with the forward bracket before installing the aft attach bracket bolts.

6.2.2.5 At aft end of BSM install NAS1957C13 bolts with NAS1587-7C washers (under bolt head), NAS1587-7 washers (under nut) and VN324BC070 locknuts (~~12~~ places)* and torque to 460 to 540 in-lbs (39 to 45 ft-lbs) above running torque. [✓]

Running Torque 50 in-lb (4 ft-lb) S/N 68180

* DUE TO INACCESSABILITY BOLTS WERE TORQUED ON A "BEST EFFORT" BASIS

Torque value: 550 in-lb MSFC QA RC

Record SN of torque wrench: T-267-62 (4-671) (in-lb) BT - 2 RCF (ft-lb) WA

NB 9/21 RC 9-21 PJ 9-21

6.2.3 <u>Bracket Cover Installation</u>

6.2.3.1 Bracket cover required? Yes_____ No ✓

If yes above, the 1/4 inch diameter bolts shall be torqued to 90-110 inch-pounds above running torque. The 5/16 inch diameter bolts shall be torqued to 185-200 inch-pounds (16 to 17 ft-lbs) above running torque.

Torque value: — MSFC QA —

Record SN of torque wrench: —

9-21-93

PJB 9-21-93
RC 9-21-93
MB 9/21/93

Motor 90 Degrees for Pyro Plate Mounting

~~De-torque and remove the bracket to inspection plate fasteners. Place fasteners in a labeled bag.~~ [ ]

~~With the test item resting on the brackets, unhook the belly straps from the horizontal stabilizing bar (lifting straps should still be in the choked position as shown in Figure 4a, Appendix C).~~ [ ]

~~Wrap the belly straps around the motor on each end as shown in Figure 4b (saddle configuration, Appendix C).~~ [ ]

CAUTION: Personnel shall not work under or place any body part under a suspended load.

CAUTION: Be careful not to disconnect the motor's ground wire during the lifting and rotation operation.

Lift the motor and brackets to waist height using the overhead crane so that the motor can be rotated. [✓]

Holding the motor by the support brackets, rotate the motor 90 degrees so that the brackets can be mounted on the pyro plate.

Use the overhead crane to move the test item to the mounting area on the pyro plate. [✓]

Attach the Brackets and Shims to the Pyro Plate

REMINDER: Be sure to put the custom shims in their correct positions and orientation before sliding bolts through the pyro plate.

CAUTION: When using grease, personnel shall wear Neoprene-Latex gloves. Contaminated materials shall be disposed of as hazardous waste.

6.5.1 Install wet with grease (HD-2) EWB0420-8-23 bolts (10107-8-23 alternate) with NAS1587-8C washers and TLN1021CPD2-8 self-aligning nuts at "A", "B", and "D" positions (as marked on supports, 6 places) and torque to 605 to 710 in-lbs above running torque. At the "C" position, install EWB0420-10-20 bolts (10107-10-20 alternate) with NAS1587-10C washers and TLN1023CD3-10 self-aligning nuts (2 places) and torque to 1175 to 1380 in-lbs above running torque. [✓]

ORIGINAL PAGE IS OF POOR QUALITY

Torque value: "C" 105 ft-lbs MSFC QA RC

A, B, D 55 ft-lbs

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Redline:

Aero Heat shield holes on the motor exit cone had to be tapped for Aero Heat shield assembly. This step was performed before the grain inspection.

Record SN of torque wrench: "C" EMJ 00359 A, B, D BTW-2RCE

6.2.5.2 Release the tension from the lifting straps but do not disconnect the straps. These straps may be used to tape off accelerometer wires if necessary. [✓]

6.2.5.3 Place the pyrotechnic debris shield in front of the large bay doors on the north side of the pyro room. [✓]

6.2.6 Perform Grain Inspection

6.2.6.1 Clear area of all nonessential personnel for grain inspection. (Only the grain inspectors (2) and the MSFC TE shall remain.) [✓]

6.2.6.2 Verify grain inspector(s) is(are): [✓]

a. Wearing 100% cotton coveralls, shorts, and undershirts.

b. Wearing a wrist strap.

c. Wearing tethers and/or tape to keep eye glasses, rings, and watches from falling into the motor.

6.2.6.3 The grain inspector shall now remove the security bag and cover from the exit cone. [✓]

6.2.6.4 Perform grain inspection. [✓]

Cracked propellant? yes no

~~If yes, give approximate location and size of crack.~~ TIA

No propellant grain cracks or other defects noted. Small amount of RTV residue on igniter case and main grain. OK to proceed with pyroshock test.

Other comments on grain condition:

MB 09/21/93

Grain inspector TIA 9-21-93 MSFC QA JS Blanton 9-21-93
Grain inspector JS Blanton 9-21-93

6.2.7 Install Aero Heat Shield

CAUTION: When using trichloroethane,personnel shall wear chemical goggles and Neoprene-Latex gloves. Contaminated materials shall be disposed of as hazardous waste.

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6.2.7.1 CLEAN (if necessary) preservative or oil from the aeroheat shield using a lint-free cloth and 1,1,1 Trichloroethane. DO NOT clean over the identification. [✓]

Cleaning performed: Yes ✓ No______

CAUTION: **When using trichloroethane,personnel shall wear chemical goggles and neoprene-Latex gloves. Contaminated materials shall be disposed of as hazardous waste.**

CAUTION: **When using grease, personnel shall wear Neoprene-Latex gloves. Contaminated materials shall be disposed of as hazardous waste.**

NOTE: **Dow Corning Moly Kote 55M Silicone O-ring lubricant meets the MIL-G4343 specification.**

6.2.7.2 Using a lint-free cloth and 1,1,1 Trichloroethane, an operator wearing a properly grounded wrist stat will CLEAN (if necessary) the sealing surface of the aeroheat shield cover and corresponding nozzle surfaces. LUBRICATE (if necessary) the surfaces with MIL-4343 grease.

Surface cleaned: Yes ✓ No______
Surface lubricated: Yes______ No ✓

CAUTION: **When using grease, personnel shall wear neoprene-Latex gloves. Contaminated materials shall be disposed of as hazardous waste.**

6.2.7.3 EXAMINE seal, P/N B12879-02-01 for damage that could effect the results of the pyro shock or vibration tests. APPLY MIL-G-4343 grease. [✓]

Seal damaged? yes no

Decription of damage: ______________________________

NOTE: **Extreme care must be taken when installing the seal. Notice there is a small and large lip on the seal (see Fig. 5, Appendix C). The larger lip is the seal aft face, and the smaller lip is the seal outside diameter.**

6.2.7.4 INSTALL seal, P/N B12879-02-01 on the exit cone of the motor. Reference drawing B14036. [✓]

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CAUTION: **When using thread compound, personnel shall wear neoprene-Latex gloves. Contaminated materials shall be disposed of as hazardous waste.**

6.2.7.5 COAT fourteen (14) screws (NAS1101E08H10) with MIL-T-83483 thread compound. [✓]

CAUTION: **When installing the Aero Heat Shield, personnel shall be extremely careful not to drop any foreign object into the rocket motor (watches, rings, and other jewelry shall be removed; eye glasses shall be tethered if worn).**

6.2.7.6 With the nozzle cant vertically up, a properly grounded operator will INSTALL the aeroheat shield cover with the hinge on the left or right side when aft looking forward as specified by USBI/CSD. Proper alignment in either position is provided by a positioning pin and mating hole. [✓]

(NOTE: DO NOT lockwire the screws.) screws were eventually lockwired to prevent fasteners falling out as they did on the other motor, SN: 1000738. Lockwiring not done at this time, however.

6.2.7.7 INSTALL the 14 screws and TORQUE the fasteners using a standard cross pattern. Record the torque values. [✓]

First Pass:	Finger Tight		MSFC QA RC
Second Pass:	10-15 in-lbs	Value: 10-15	MSFC QA RC
Third Pass:	20-25 in-lbs	Value: 20-25	MSFC QA RC
Fourth Pass:	20-25 in-lbs	Value: 20-25	MSFC QA RC

Record SN of torque wrench: 5492304

6.2.8 <u>Make Sure the Pyro Facility Bay Doors are Open</u> [✓]

6.2.9 <u>Clear Area for Test</u> [✓]

The only personnel allowed in the control room are the pyro shock test conductor, a pyro technician, the MSFC TE, and the MSFC SE (total of four (4) people). All other personnel should move to a clear area. The clear areas are defined as the NORTH hallway of building 4619 and the area outside the pyro control room on the WEST side. Other areas must be cleared with the MSFC TE and the MSFC SE.

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6.2.9.0 Conduct Pyro Shock Test to the Following Parameters:

Test Parameters:

Frequency (Hz)	Level
50	24 g peak
50 to 100	+12 db/octave
100	94 g peak
100 to 4000	+6 db/octave
4000 to 10,000	3750 g peak

6.2.9.1 Turn on the flashing light outside room 170A. [✓]

6.2.9.2 For each measurement location select an accelerometer of a type suitable for the amplitude expected. [✓]

6.2.9.3 Calibrate each accelerometer per ED73-SHK-FOP-008. [✓]

6.2.9.4 Verify test, checkout, and assembly hardware are connected to the facility ground system. [✓]

6.2.9.5 Verify that no leads are connected to the junction box terminals. [✓]

6.2.9.6 Move junction box switch to "BULB" position. [✓]

6.2.9.7 Connect 12 volts to the firing panel. [✓]

6.2.9.8 Insert the firing key and verify panel meter indicates the correct voltage. [✓]

6.2.9.9 Switch key to "ARMED" position and verify power indicator light is illuminated. [✓]

6.2.9.10 Open red cover and flip firing switch, verify bulb on junction box lights. [✓]

6.2.9.11 Close red cover. [✓]

6.2.9.12 Switch key to "SAFE" position. [✓]

6.2.9.13 Move junction box switch to "METER" position. [✓]

6.2.9.14 Switch key to "ARMED" position and verify power indicator light is illuminated. [✓]

6.2.9.15 Open red cover and flip the firing switch, verify that the meter on junction box indicates 12 volts. [✓]

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6.2.9.16 Close red cover.

6.2.9.17 Switch key to "SAFE" position and disconnect voltage source. [✓]

6.2.9.18 Remove firing key. [✓]

6.2.9.19 Verify that no severe weather or electrical storms are within 10 miles of the immediate vicinity (Army Met. Team 876-2465). [✓] [✓]

6.2.9.20 Verify that no flammable solvents, paints, gases, etc., are in the hazardous area. [✓]

6.2.9.21 Verify all non-essential personnel are clear of the test area. [✓]

6.2.9.22 Verify pyro technician is:

a. Wearing 100% cotton coveralls, shorts, and undershirts. [✓]

b. Wearing safety goggles, hearing protection, and a wrist strap when installing explosive items.

c. In possession of the arming key and that the firing panel is in the safe position.

6.2.9.23 The pyro technician shall remove all matches, lighters, jewelry, and all battery-powered devices such as electrical wrist watches, calculators, portable radios, etc. [✓]

6.2.9.24 During periods of connecting blasting caps, MDF, and FLSC, a maximum of two people (to be designated by the MSFC TE) will be permitted to remain in the shock area. [✓]

6.2.9.25 Install required MDF or FLSC on exciter plate. (Total of 26" of ~25 grains per foot) (See Fig. 6 and Fig. 7, Appendix C) [✓]

6.2.9.26 Verify switch on junction box is in "BULB" position. [✓]

WARNING: If bulb glows, there is sufficient radio frequency in the area to possibly cause detonation of the blasting cap. The cap should be left shorted and returned to room 170B storage cabinet. All blasting activities will be curtailed until the RF source is removed.

6.2.9.27 Verify that bulb on junction box is not illuminated. [✓]

6.2.9.28 In room 170B, verify that blasting cap shorting coil is in place and is undamaged before removing from storage container. [✓]

6.2.9.29 Remove blasting cap from container and transport to room 170. [✓]

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6.2.9.30 In room 170, verify that wrist straps are in place. [✓]

6.2.9.31 Install blasting cap on exciter plate. [✓]

6.2.9.32 Press blasting cap shorting coil firmly against facility ground for 1 second. In order to short the leads, remove enough shorting coil from the blasting cap to attach alligator clip. [✓]

6.2.9.34 Remove shorting coil. [✓]

6.2.9.35 Move switch on junction box to "METER" position. [✓]

6.2.9.36 Verify 0 (zero) volts on meter. [✓]

WARNING: If voltage is indicated, the lines to the firing panel are either connected to a voltage source or are picking up voltage from radiation caused by a nearby source. The cap should be left shorted and returned to room 170B storage cabinet. All blasting activities will be curtailed until the voltage source is removed. [✓]

6.2.9.37 Move junction box switch to "BULB" position. [✓]

6.2.9.38 Install blasting cap leads in junction box, move switch to "FIRE" position, and remove alligator clip. [✓]

6.2.9.39 The pyro technician shall now leave the area, close the door, and inform the MSFC TE of the status. [✓]

6.3 Detonation of Pyrotechnics

6.3.1 The lead pyro engineer shall now prepare the data acquisition system to acquire data. [✓]

6.3.2 Start the tape recorder. [✓]

6.3.3 Connect firing lines to the pyro control room junction box. [✓]

6.3.4 The lead pyro engineer, the pyro technician, the MSFC TE, and the MSFC SE shall now leave the pyro control room and move to the clear area outside. [✓]

6.3.5 Connect firing panel voltage supply and insert firing key, verify that the meter indicates the appropriate voltage. [✓]

6.3.6 Begin countdown. [✓]

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6.3.7 On the count of "3", the pyro technician shall put the switch in the "ARMED" position and verify that the power indicator is illuminated. [✓]

6.3.8 On the *FIRE* command, the pyro technician will open the red cover and flip the firing switch. [✓]

6.3.9 After firing, turn the firing panel key to the "UNARMED" position. [✓]

WARNING: If blasting cap does not fire, refer to Section 10.4 in ED73-SHK-FOP-004 (see Appendix A).

Blasting Cap Fired: yes ✓ **no** ___

6.3.10 Remove the arming key and disconnect the voltage supply. [✓]

6.3.11 Test personnel may now return to the control room. [✓]

6.3.12 Wait a minimum of 5 minutes after firing before opening the door to room 170. [✓]

6.3.13 The lead pyro engineer shall now begin to reduce the data. [✓]

6.4 Post Test Inspection

6.4.1 Inform the MSFC TF that the door to room 170 from the control room is to be opened. [✓]

6.4.2 The pyro technician shall enter room 170 and move the junction box switch to the "BULB" position. [✓]

6.4.3 Remove blasting cap leads from junction box. [✓]

6.4.4 Inspect the shock plate to insure all explosive devices fired properly. [✓]

WARNING: If all explosive items did not fire, refer to Section 10.5 in ED73-SHK-FOP-004 (see Appendix A).

6.4.5 The BSM shall be visually inspected for damage resulting from the pyro shock test. Any anomalies will be recorded. All other personnel shall remain in the control room or in the clear area until the "ALL CLEAR" is given by the MSFC TE. No Damage [✓]

6.4.6 MSFC TE indicates all clear for appropriate personnel. [✓]

6.5 Post Test Removal from the Pyro Plate

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6.5.1 Have a certified fork lift (500 pound minimum) ready to load the BSM and pallet onto the transport truck. [✓]

CAUTION: Exercise care not to entangle or tug on the motor grounding strap during the following lifting operations.

6.5.2 Tighten the lifting straps using the overhead crane so that the bolts can be loosened. [✓]

6.5.3 De-torque and remove the bolts that attach the brackets to the pyro plate. [✓]

CAUTION: The following steps involve working with a suspended load. Keep hands and feet out from under the load.

6.5.4 Remove custom shims and place in labeled bag for use in the vibration tests. [✓]

6.5.5 Lower the motor to waist height. [✓]

6.5.6 Rotate the motor 90 degrees so that the brackets can be ~~mounted on the pallet~~. placed on floor, (grounded mat) MB 09/21/93 RC 9-21-93 RW 9-21-93 [✓]

6.5.7 Using the overhead crane, place the motor on the pallet so that it rests on the aft skirt support brackets and is aligned with the pre-drilled bolt holes. [✓]

6.5.8 With the test item resting on the brackets, unhook the belly straps from the horizontal stabilizing bar. [✓]

6.5.9 Bolt the test item to the pallet using the provided fasteners for transport to vibration. [✓]

Motor secured to pallet __OH________ MSFC TE

6.6 Test Report and Data Requirements

A final test report will be submitted to UT/CSD within 30 working days after testing is completed. Three copies plus one reproducible copy of this report will be submitted containing shock response spectrum (SRS) plots (with Q=10 value) and the time history plots. The test tolerances shall be overplotted on the control spectrum.

Model numbers and serial numbers for all instrumentation and test equipment shall be included in the report . Test setup photos should also be included in the report.

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7.0 Post Test Verification

The procedure delineated in the above document has been satisfactorily completed and :

a. All sequences in the procedure have been completed (or deleted by approved deviation)

b. All Procedure changes have been recorded and approved.

Submitted Verified by: Mat Bevill
Test Engineer

Date: 09/21/93

Motor Serial Number: 1000734

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BSM MOTOR S/N 1000734
VIBRATION TEST PROCEDURE

National Aeronautics and
Space Administration

George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama 35812

BSM-TCP-EP54-003

BSM Delta Qualification Test

Vibration Tests and Packaging Procedure

This Procedure Describes
Safety Critical Operations

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BSM-TCP-EP94-003

BSM Delta Qualification Test

Vibration Tests and Packaging Procedure

Prepared by:

Mat Bevill EP-12

08/16/93

Motor SN:

Test Date:

Vibration Tests and Packaging Procedure

Prepared by:

Mat Bevill/MSFC TE/EP12 — 09/15/93 Date

Approved by:

Jim McGee/MSFC Vibration Lab TE — 9-14-93 Date

Jim Herring/MSFC Pyro Shock Lab TE — 9-14-93 Date

Richard Leonard/MSFC Safety/CS01 — 9-16-93 Date

Rick Clements/MSFC Quality/CQ06 — 9-15-93 Date

Ben Goldberg/Motor Systems Division/EP11 — 9/14/93 Date

Steve Brewster/Dynamic Test Branch/ED73 — 9/14/93 Date

Chuck Wells/UTC/CSD TE — 9/16/93 Date

Don Wendel/USBI — 9-14-93 Date

Charlie Lovell/PCH Engineer/CN71 — 9/16/93 Date

Vibration Tests and Packaging Procedure

Prepared by:

Mat Bevill/MSFC TE/EP12 — Date: 09/15/93

Approved by:

Jim McGee/MSFC Vibration Lab TE — Date: 9-14-93

Jim Herring/MSFC Pyro Shock Lab TE — Date: 9-14-93

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Steve Brewster/Dynamic Test Branch/ED73 — Date: 9/14/93

Chuck Wells/UTC/CSD TE — Date:

Don Wencil/USBI — Date: 9-14-93

Charlie Lovell/PCH Engineer/CN71 — Date: 9/16/93

Table of Contents

1.0 General Information

1.1 Scope

This test procedure addresses all the requirements to perform vibration testing on Booster Separation Motors (BSM). The test program consists of lift-off vibration, boost vibration, and vehicle dynamics vibration.

1.2 Objective

The objective of the dynamic testing is to verify the physical and functional survivability of the Booster Separation Motors. Of particular interest for these tests are the components bonded using EA9394 adhesive. The components using this adhesive include the throat insert, the centering insert, and the igniter grain support rod.

2.0 Applicable Documents

MSFC-STD-513A	Certification of Equipment Operations and Materials Handling Personnel
EG5300.36A	Safety
29 CFR 1910	Occupational Safety and Health Administration (OSHA)
NSS/GO 1740.9	Safety Standard for Lifting Devices and Equipment
NHB 1700.1(V1)	Basic Safety Manual
AMC-R 385-100	Safety Manual
EP01-SOP-01	Standard Operating Procedure for Safety Critical Operations
MM 1700.4	Safety and Environmental Health Hazards
MMI 1700.17	MSFC Procedures for Acquiring Shipping Permits for Rocket Motors and Igniters
MMI 1710.1	Safety Review and Approval of Hazardous and Potentially Hazardous Facilities and Activities at MSFC
MMI 1710.6	MSFC Program for Personnel Certification
MMI 1711.2	Mishap Reporting and Investigation

MMI 1845.1	Hazard Communication Program
MMI 6400.2	Packaging, Handling, and Moving Program Critical Hardware
MSFC-RQMT-1493	Electrostatic Discharge Control Requirements
MSFC-STD-1800	Electrostatic Discharge (ESD) Control for Propellant and Explosive Devices
MSFC-STD-126E	Inspection, Maintenance, Proof Testing and Certification of Handling Equipment
CSD-5597-93-1 Rev. B	Enhanced Delta Qualification Test Plan for Booster Separation Motor (BSM), Aug. 6, 1993
10SPC-0067 Rev. A	Specification for Booster Separation Motors for Space Shuttle Solid Rocket Booster (thru SCN 014)

3.0 Safety

3.1 The following safety criteria are in accordance with ET01-SOP-01, Rev. A., *Standard Operation Procedures for Safety Critical Operations*". If safety rules/regulations are not followed, injury to personnel and/or damage to test items could occur.

Emergency telephone numbers are as follows:

Safety	
Ambulance	4-0046
Fire	112
Security	117
Utilities	4-4357
Medical Center	4-3919
Communication Repair	4-2390
	4-1771

3.2 Prior to starting work in 4619 a visual inspection of work area shall be made for anomalies by task supervisor and safety personnel.

MSFC TE MB MSFC SE [signature]

Date / Time: 09/25/93 11:15 a.m.

3.3 Personnel shall not work or position themselves beneath suspended loads unless such loads are securely and adequately blocked up.

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3.4 Objects handled by overhead hoist shall be lifted only high enough to clear fixed objects in the path of travel. Spreader bars and slings may be left on the hoist if desired when not in use, but must be raised so that the lowest part of the lifting equipment will be at least seven feet from the floor when not in use.

3.5 Crane, hoist, lift prime operators, and riggers shall be certified according to the latest revision of MMI 1710.6, and shall have in their possession a valid certification card.

Certifications checked by: WB

Date / Time: 09/25/93 11:15 a.m.

3.6 Personnel working around suspended loads shall be alert to the possibility of being crushed between the suspended load and a fixed object.

3.7 Loads shall be moved slowly so they will not accumulate more momentum than can be stopped with little or no swing.

3.8 Where handling slings are called out, a sling with more pickup points than required may be used if the weight capacity per point used is equal or greater than the weight capacity of each point of the noted sling and the free pickup point is (are) secured to prevent it (them) from swinging and causing damage to parts.

3.9 Only the area coordinator should direct the crane moves, however, any person determining an immediate danger or problem may request stoppage of activities.

3.10 The lifting or transportation operation shall be halted by the area coordinator at any time the control area cannot be maintained.

3.11 Steel toe shoes are required during lifting operations. Hardhats are required when the lift is at or above the shoulders.

3.12 Tag line operators are to wear leather gloves.

3.13 The primary safety hazards associated with this operation are:

3.13.1 Lift operations
3.13.2 Solvent Use (See NOTE)
3.13.3 Live (Loaded) Solid Rocket Motor

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NOTE: **Grease and solvent use are only "if needed" as determined by the MSFC TE and CSD TE.**

3.14 Any time a crane is being used, it must be dogged if:

3.14.1 The load will be suspended in a static condition for an extended amount of time.

3.14.2 A crane operator crew change or substitution must be made.

3.15 No electric power tools shall be used near the live test item. Use of pneumatic tools is acceptable.

3.16 All ground cables and ground straps end-to-end resistances shall be verified with a multimeter. These resistances must measure less than 1 ohm.

3.17 All personnel within touching distance shall wear a wrist strap that has been checked with a wrist strap checker. This step should be performed each time the wrist strap ground is broken.

3.18 All personnel within touching distance of open grain propellant (and ordnance) shall wear antistatic coveralls.

4.0 Test Items and Test Requirements

4.1 Test Items

The test item for the vibration tests consist of a BSM which will be tested in the aft motor configuration. The motor will be tested with an aero heat shield over the exit cone. The motor weighs approximately 154 pounds.

Motor Serial Number 1000734 Conditioning Temp. 25°F $^{+0}_{-5}$ °F

4.2 Test Requirements

4.2.1 Test Tolerances

The tolerances applicable to the test conditions are as follows: (Unless otherwise stated in the procedure)

Vibration Frequency:	± 5%
Test Duration:	+10%, -0%
Temperature:	± 5° F
Sinusoidal Control Signal Maximum Harmonic Distortion	±10%
Sinusoidal Peak Acceleration	+20%, -10%

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Composite Root Mean Square Acceleration ±10%

Acceleration Spectral Density +100%, -25% (+3dB, -1.5dB)

4.2.2 Test Data

All data taken with non-recording instruments will be recorded in ink directly onto data sheets and/or log sheets. The log or data sheets will identify the test being performed, the test item, the item part number, and the applicable test procedure. Corrections or changes will be made by drawing a single line through the original entry. The new entry will be made directly above the old and initialed by the person making the entry. Each page will be signed and dated at the bottom of the page by the person making the entries, and counter signed by the test engineer after review.

4.3 Test Conditions

The live delta qualification motor will be vibration tested at a specific temperature. The motor will either be tested at 25°F (+0, -5 °F) or at 125°F (+5, -0 °F) depending on which qualification motor this procedure controls.

4.3.1 The MSFC TE shall check with the Army MET team to ensure that there is no lighting within 10 miles. (MET team phone number....876-2465). ✓

4.3.1.1 If lightning is within 10 miles during any time that a live BSM is in building 4619, the MSFC TE shall make arrangements to disconnect the motor ground from the facility ground. The motor shall remain ungrounded until the lightning is out of range.

4.3.1.2 When reconnecting the ground after a lightning storm, a 100Kohm resistor should be connected to the ground wire from the motor before connecting to facility ground. This allows any charge on the motor to slowly dissipate to ground. The resistor should be left connected for no less than **30** seconds.

4.3.1.3 After the specified time, disconnect the ground wire from facility ground and remove the resistor. Reconnect the ground strap from the motor to facility ground.

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4.3.2 The test site's relative humidity must be above 20%. If the humidity is below 20%, all test operations must cease until favorable weather conditions resume.

Test site's relative humidity 71% MSFC TE MB 81°F at 11:20 a.m.

4.4 Test Equipment

4.4.1 All measurements shall be made with instruments and equipment whose accuracy and/or calibration has been verified.

Calibration Acceptable MB MSFC TE

CSD TE

4.4.2 Proof Loading of Handling Equipment (required for PCH)

4.4.2.1 The heaviest lift during all of the delta qualification testing will be lifting the motor while in its shipping container. The motor and shipping container together weigh about 310 lbs. All forklifts and overhead hoists must be load (break) tested to at least 110% of this weight (i.e. 350 lbs.). This test must be performed prior to any handling of the BSM but does not need to be repeated until something other than the BSM is lifted by the same handling equipment. It is therefore recommended that the break tests be performed each evening before the BSM testing commences. The break tests shall be performed as follows:

a. The proof load must be at least 350 lbs.

b. Lift the dummy load clear of the ground (less than 1 foot) and lower to ground three times, holding for five minutes on the third lift. Lifting straps and spreader bar should be attached during the lift.

SEE APPENDIX C FOR THE PROOF TEST INSPECTION SHEETS.

4.5 Test Procedure

4.5.1 After review and documented approval, a redline change to this procedure may be performed. Approval shall be by a minimum of the MSFC TE, MSFC QA, and MSFC SE.

4.5.2 As soon as possible after a test failure, a deviation from the specified test environment, or any other incident which affects the test or test item, MSFC will notify the authorized UT/CSD representative of the event verbally and will then generate a Test Procedure Deviation (NASA form 3959). A copy of the Test

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Procedure Deviation is presented in Appendix A. Photographs of any discrepancies shall also be taken.

5.0 **Personnel Responsibilities**

5.1 **Test Witnessing**

All tests will be witnessed by the authorized UT/CSD representative and USBI representative. The MSFC test engineer will also witness the testing. Notification of the start of each test shall be communicated to the authorized UT/CSD and USBI representatives and the MSFC safety representative and test engineer at least 2 hours in advance.

MSFC Safety Notified MB

UT/CSD Notified MB

5.2 **The MSFC TE will serve as the area coordinator for the test. All handling of the BSM will be directed by the MSFC TE or cognizant test engineer.**

5.3 **Jim McGee (vibration) shall be responsible for photographic coverage of the vibration test activities.**

5.4 **All involved lab directors and division chiefs shall be notified prior to testing.** [✓]

5.5 **The area around the outside of the vibration facility shall be secured *before* the live BSM is brought to the pyro shock test site.** [✓]

Area secured? YES NO MB MSFC TE
______ MSFC SE

Comments: Doors locked, security tape up

6.0 **Vibration Tests**

6.0.1 Make sure the CSD TE has reviewed the calibrations for the vibration tests. [✓]

6.0.2 Open the doors that enter the vibration test room from the high bay of bldg. 4619. [✓]

6.1 **Re-check system setup. Verify chamber temperature.** [✓]

9-25-93

6.2 Radial Axis Tests

6.2.1 Assemble the leg supports on the conditioning chamber. [✓]

6.2.2 *Lift Off Vibration*

6.2.2.1 The following levels and conditions apply for the lift off vibration tests. Vibrate the motor only as follows for a duration of 60 seconds: [✓]

Frequency (Hz)	Level
20	0.017 g^2/Hz
20 to 55	+6 db/octave
55 to 200	0.077 g^2/Hz
200 to 280	-11 db/octave
280 to 1200	0.022 g^2/Hz
1200 to 2000	-4.5 db/octave
2000	0.010 g^2/Hz

Composite: 6.9 grms

6.2.3 *Boost Vibration*

6.2.3.1 The following levels and conditions apply for the boost vibration tests. Vibrate the motor only as follows for a duration of 120 seconds: [✓]

Frequency (Hz)	Level
20 to 200	0.54 g^2/Hz
200 to 350	-12 db/octave
350 to 1000	0.060 g^2/Hz
1000 to 2000	-6 db/octave
2000	0.015 g^2/Hz

Composite: 14.0 grms

6.2.4 *Vehicle Dynamics Vibration*

6.2.4.1 The following levels and conditions apply for the vehicle dynamics tests. Vibrate the motor only as follows: [✓]

Frequency (Hz)	Level
5 to 10	0.7 g peak
10 to 40	3.7 g peak

Sweep Rate: 3 octaves per minute

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6.3 Transport Motor From Room 156 to Room 158/ Setup for Tang. Axis

6.3.1 Remove leg supports from conditioning chamber. [✓]

6.3.2 Disconnect the conditioning unit from the conditioning chamber. [✓]

6.3.3 Inspection certifications shall be provided for the overhead cranes in 4619 . see dev. 2

Crane #1, Bldg. 4619 rm. 156 certification provided MB

Crane #2, Bldg. 4619 rm. 158 certification provided MB

6.3.4 Certifications for all lifting fixtures shall be provided:

Lifting beam assembly certification provided MB

Lifting rings (D-rings) MB

CAUTION: Be careful not to disconnect the motor ground while lifting.

CAUTION: The following step involves working with a suspended load. Keep feet and hands out from under the load.

6.3.5 Using the overhead crane, lift the conditioning chamber off of the vibration table and place it on the floor. [✓]

Record time when chamber was removed 12:06 p.m. 09/25/93

6.3.6 Verify motor ground connection on the motor and at the facility ground contact point. [✓]

6.3.7 Disconnect the instrumentation wires. Remove any other instrumentation that is no longer needed or that might interfere with motor transport. [✓]

6.3.8 Attach the lifting straps (as shown in Fig. ~~1a~~ b) to the motor and spreader bar and hook to the overhead crane. [✓] RJB 9-25-93 MB 09/25/93 RL 9-25-93

6.3.9 Remove adapter plate to vibration table fasteners. [✓]

CAUTION: Be careful not to disconnect the motor ground while lifting.

CAUTION: The following step involves working with a suspended load. Keep feet and hands out from under the load.

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Grounds were verified.

BJB 9-25-93

09/25/93

JP 9-25-93

6.3.10 Slowly lift the motor off of the table and place it on the facility's roll cart. [✓]

RC 9-25-93 MB 09/25/93 RyS 9-29-93

6.3.11 ~~Unhook spreader bar from lifting straps.~~ Leave straps wrapped around the motor. [✓]

6.3.12 Open the doors that enter the high bay in room 158. [✓]

CAUTION: Make sure that the ground strap is long enough to reach to room 158 during the transport from one room to the other.

6.3.13 Slowly pull the motor using the roll cart from room 156 to room 158. Be sure to place the cart directly beneath the overhead crane. [✓]

6.3.14 Attach spreader bar to lifting straps and the overhead crane. [✓]

CAUTION: Be careful not to disconnect the motor ground while lifting.

CAUTION: The following step involves working with a suspended load. Keep feet and hands out from under the load.

6.3.15 Using the overhead crane, lift the motor from the pull cart and place it on the vibration table. [✓]

6.3.16 Align the adapter plates with the holes on the table. [✓]

6.3.17 Fasten the adapter plates to the table using the facility supplied fasteners. Torque these fasteners to 65 ft-lbs. [✓]

Record torque value: 65 ft-lbs MSFC QA RC

Torque wrench SN: BTW - 2RCF

6.3.18 Remove all lifting hardware. [✓]

6.3.19 Attach accelerometers to the motor (see Fig. 2) [✓]

6.3.20 Reconnect accelerometer wires. [✓]

6.4 Thermal Conditioning Setup for Tangential and Longitudinal Axis

6.4.1 Use the overhead crane to place the conditioning chamber over the motor. [✓]

6.4.2 Once the chamber is in place, attach the necessary hoses and instrumentation from the conditioning unit to the chamber. [✓]

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6.4.3 Make sure the chamber thermocouple is in the correct position for measuring the air temperature around the motor. [✓]

6.4.4 Make sure the motor ground strap is secured. [✓]

6.4.5 Activate conditioning unit and monitor the temperature until it has stabilized to the desired temperature. [✓]

Record time/temp. when stabilized: 12:28 <25°F temp lowered to -21.9 °F
Record total time out of conditioning: 22.5 min before testing

6.4.6 Recondition motor for twice the time out of conditioning if out more than 30 minutes. [✓]

Reconditioning necessary: Yes No
If yes, how long does motor need reconditioned? N/A

6.5 Tangential Axis Tests

6.5.1 *Lift Off Vibration*

6.5.1.1 The following levels and conditions apply for the lift off vibration tests. Vibrate the motor only as follows for a duration of 60 seconds: [✓]

Frequency (Hz)	Level
20	0.016 g^2/Hz
20 to 75	+3 db/octave
75 to 1000	0.060 g^2/Hz
1000 to 2000	-3 db/octave
2000	0.030 g^2/Hz

Composite: 10.0 grms

6.5.2 *Boost Vibration*

6.5.2.1 The following levels and conditions apply for the boost vibration tests. Vibrate the motor only as follows for a duration of 120 seconds. [✓]

Frequency (Hz)	Level
20 to 800	0.24 g^2/Hz
800 to 2000	-4 db/octave
2000	0.071 g^2/Hz

Composite: 18.4 grms

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6.5.3 *Vehicle Dynamics*

6.5.3.1 The following levels and conditions apply for the vehicle dynamics tests. Vibrate the motor only as follows: [✓]

Frequency (Hz)	Level
5 to 10	0.7 g peak
10 to 40	4.3 g peak

Sweep Rate: 3 octaves per minute

6.6 Axis Change From Tangential to Longitudinal

6.6.1 Disconnect conditioning unit from conditioning chamber. [✓]

6.6.2 Attach overhead crane to the conditioning chamber. [✓]

6.6.3 Slowly lift the conditioning box off of the test item and move it away and move it away from the vibration table and place on the floor. Disconnect lifting hardware. [✓]

Record time of chamber removal: 1:29 p.m. 01/25/93

6.6.4 Verify motor ground connection on the motor and at the facility ground contact point. [✓]

6.6.5 Remove adapter plate to vibration table fasteners. [✓]

6.6.6 Unhook control accelerometer. [✓]

CAUTION: Be careful not to disconnect the ground when changing the axis on the table.

CAUTION: The following step involves working with a suspended load. Keep feet and hands out from under the load.

6.6.7 Rotate the motor and bracket assembly 90° using the overhead crane. Disconnect lifting hardware. [✓]

6.6.8 Re-attach adapter plate to vibration table fasteners. Torque to 65 ft-lbs. [✓]

Record torque value: 65 ft-lbs MSFC QA ec

Torque wrench SN: BTW-2RCF

6.6.9 Reconnect control accelerometer. [✓]

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6.6.10 Reconnect lifting hardware to the conditioning chamber and place it over the motor. Reconnect chamber legs as necessary. [✓]

6.6.11 If necessary, re-attach hoses, instrumentation, etc., before starting conditioning unit. [✓]

6.6.12 Start conditioning unit. Monitor until it has stabilized to the desired temperature. [✓]

Record time/temp. when stabilized: 1:55 p.m. 225°F   stabilized at 225 °F before testing.
Record total time out of tolerance: 26 min

6.6.13 Recondition motor for twice the time out of tolerance if the time out was greater than 30 minutes. [✓]

Reconditioning necessary: Yes No
If Yes, how long does the motor need reconditioning? N/A

6.7 Longitudinal Axis Test

6.7.1 *Lift Off Vibration*

6.7.1.1 The following levels and conditions apply for the lift off vibration test. Vibrate the motor only as follows for a duration of 60 seconds. [✓]

Frequency (Hz)	Level
20	0.016 g^2/Hz
20 to 75	+3 db/octave
75 to 1000	0.060 g^2/Hz
1000 to 2000	-3 db/octave
2000	0.030 g^2/Hz

Composite: 10.0 grms

6.7.2 *Boost Vibration*

6.7.2.1 The following levels and conditions apply for the boost vibration test. Vibrate the motor only as follows for a duration of 120 seconds. [✓]

Frequency (Hz)	Level
20 to 800	0.24 g^2/Hz
800 to 2000	-4 db/octave
2000	0.071 g^2/Hz

Composite: 18.4 grms

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6.7.3 *Vehicle Dynamics*

6.7.3.1 The following levels and conditions apply for the vehicle dynamics test. Vibrate the motor only as follows. [✓]

Frequency (Hz)	Level
5 to 10	0.7 g peak
10 to 40	4.3 g peak

Sweep Rate: 3 octaves per minute

6.8 Post Test Inspection

6.8.1 The BSM test item shall be visually inspected by the MSFC QA, MSFC TE, and the CSD TE for exterior damage resulting from vibration testing. 3 fasteners detorqued slightly [✓]

6.8.2 Remove all instrumentation. [✓]

6.9 Data Requirements

Power Spectral Density (PSD) plots for all control and response accelerometers for lift off and boost tests shall be recorded. The test tolerances shall be overplotted on the control accelerometers plots. Acceleration versus frequency plots shall be recorded for all accelerometers used during vehicle dynamics tests.

7.0 Post Test Disassembly/Prepare for Shipment

7.1 Conditioning Chamber Removal

7.1.1 Disconnect any hoses and instrumentation that hinders the removal of the chamber. [✓]

7.1.2 Using the overhead crane, slowly lift the conditioning chamber off of the vibration table and place on the floor. [✓]

7.1.3 Move chamber out of the way. [✓]

7.1.4 Move the conditioning unit out of the way if necessary. [✓]

7.1.5 Verify motor ground connection on the motor and at the facility ground contact point. [✓]

7.1.6 Remove vibration table insulation. [✓]

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7.2 Aero Heat Shield Removal

WARNING: Removing the Aero Heat Shield exposes the motor's propellant grain. Personnel should use caution during any operations with and exposed grain. Tools, watches, eye glasses, etc., should be tethered (if necessary) to prevent dropping anything into the motor.

7.2.1 Make sure the motor ground is secured. [✓]

7.2.2 Make sure verified wrist straps are being worn by the personnel removing the aero heat shield. [✓]

7.2.3 Remove the fasteners from the Aero Heat Shield. Place the fasteners in a marked bag. [✓]

7.2.3 SLOWLY remove the Aero Heat Shield. [✓]

7.2.5 Remove the heat shield seal. Do not drop the seal into the motor. [✓]

7.3 Post Test Inspection of Motor Propellant Grain

7.3.1 Make sure motor ground wire is secured. [✓]

7.3.2 Clear area of all non-essential personnel. Only the grain inspectors (2) and the MSFC TE shall remain. [✓]

7.3.3 Verify grain inspector(s) is(are): [✓]

a. Wearing 100% cotton coveralls, shorts, and undershirts.

b. Wearing a wrist strap.

c. Wearing tethers and/or tape to keep eye glasses, rings, and watches from falling into the motor.

7.3.4 Perform grain inspection. [✓]

Cracked propellant yes no

If yes, give approximate location and size of crack:

____

____

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Other comments on grain condition:

No cracks or other internal defects noted. No motor external damage attributable to pyroshock or vibration testing.

Grain inspector(s) MSFC QA 9-25-93 9-25-93

7.3.5 A draw-wire, fabric, security bag shall be installed over the nozzle exit cone. The bag shall be closed around the exit cone and secured by inserting the bag wire ends ~~through a standard security lead-seal~~ (i.e. cover the exit cone the same way that it was received). [✓]

7.4 Adapter Plate Removal

7.4.1 Remove the adapter plate to vibration table fasteners. [✓]

7.4.2 Attach lifting straps as shown in Fig. 1b (Appendix B). [✓]

CAUTION: Be careful not to disconnect the ground while lifting the motor.

CAUTION: The following step involves working with a suspended load. Keep hands and feet out from under the load.

7.4.3 Lift the motor off of the vibration table and move to an area near the wood supports. [✓]

7.4.4 Lower the motor so that it rests on the wood supports. [✓]

7.4.5 Rotate the motor 180° so that the adapter plates face up. [✓]

7.4.6 Remove the bracket to adapter plate fasteners. Place fasteners in a marked bag. [✓]

CAUTION: Be careful not to disconnect the ground while lifting the motor.

CAUTION: The following step involves working with a suspended load. Keep hands and feet out from under the load.

7.5 Aft Skirt Bracket Removal

7.5.1 Remove the aft end motor to bracket fasteners (12 places). Place fasteners in a marked bag. [✓]

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CAUTION: Be careful not to disconnect the ground while lifting the motor.

CAUTION: The following step involves working with a suspended load. Keep hands and feet out from under the load.

7.5.2 Lift the motor to waist height using the overhead crane. [✓

7.5.3 Rotate the motor 180° so that the bracket to adapter plate fastener holes face the floor. [✓

7.5.4 Lower the motor so that it rests on the wood supports. [✓

7.5.5 Remove forward end motor to bracket fasteners (8 places). Place fasteners in a marked bag. Light burnishing on fwd face. [✓

8.0 **Return Motor to the Vertical Position**

8.1 Attach 2 D-rings, 180 degrees apart, and one lifting strap to the aft end holes of the motor. [✓

8.2 Attach the "break-over" brackets (and lifting strap) to the appropriate bolt holes on the forward face of the motor case. [✓

8.3 Attach the aft lifting strap to the overhead crane hook. [✓

CAUTION: The following steps involve working with a suspended load. Keep hands and feet out from under the load.

CAUTION: Be careful not to disconnect the ground while lifting the motor.

8.4 One person (as chosen by the MSFC TE) shall hold the lifting strap on the forward end to keep the motor from swinging when lifted from the aft end. Slowly lift the aft end of the motor to bring it to a vertical position. [✓

8.5 Raise the motor so that the aft end is at waist height. [✓

CAUTION: The following steps involve working with a suspended load. Keep hands and feet out from under the load.

8.6 Disconnect the "break-over" brackets. Place brackets in a marked bag. [✓

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9.0 **Place Motor In Shipping Container**

9.1 Remove lid from shipping container by removing the lock-ring bolt and nut, lockring, and cover. (See Fig. 3 for an overall view of the shipping container). [✓]

9.2 Remove top cushion insert. Make sure that the top bearing plate is properly oriented to the relative location of the drum humidity indicator/pressure relief valve (see Fig. 4). If not as shown (the two 1-inch dia. clearance holes must straddle the (imaginary) horizontal center line) the center cushion insert, *as a unit (do not lift center insert...it's keyed to the bottom insert)* must be rotated to bring the top plate into proper position as shown. [✓]

9.3 Remove the bearing plate from the tie rods. DO NOT remove the tie rod nuts. [✓]

9.4 Remove and discard any old bags of desiccant. [✓]

9.5 Drape the loose end of the container ground strap over the edge of the container. [✓]

9.6 Visually inspect the container interior to assure it is free of any foreign matter. Vacuum interior if required. [✓]

9.7 Attach a ground wire to facility ground and verify its resistance. Resistance shall measure less than one (1) ohm. [✓]

Resistance measured: .1Ω MSFC QA RC

9.8 Connect this ground wire to the motor shipping container and verify the resistance (<1 ohm) [✓]

Resistance measured: 0.1Ω MSFC QA ________

9.9 Install the antistatic foamed plastic liner tightly around the motor case, and secure in place by taping the liner's vertical butt joint (trim as required) using 2" wide tape. [✓]
No tape used. NB 09/25/93 PY 9-25-93 RC 9-25-93

9.10 Install the antistatic plastic film bag, up and over the motor. [✓]

9.11 Visually orientate the motor nozzle cant to the side of the container indicated by the marking, "POSITION NOZZLE CANT THIS SIDE" on the cushion insert. [✓]

CAUTION: Be careful not to disconnect the motor ground while lowering the motor into the container.

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CAUTION: **The following steps involve working with a suspended load. Keep hands and feet out from under the load.**

CAUTION: **When using the ESD scanner and the electrostatic reading on the motor case surface exceeds 1.0 kilovolt, stop all activities on the case, initiate personnel fall back (a minimum of 4 feet) and notify safety.**

After initial reading over 1.0 kilovolt, repeat electrostatic reading at intervals not to exceed 5 minutes until the the voltage has dissipated below 1.0 kilovolt. When the reading is below 1.0 kilovolt, removal operations may continue.

If after 30 minutes the measured electrostatic charge is in excess of 1.0 kilovolt, Verify facility ground. If connection to facility ground is open, reconnect through

larger resistor (100 Kohm min.) to allow a slow discharge of the motor case.

If the electrostatic reading on the case surface exceeds 4.0 kilovolts, STOP all activities on the case, notify safety , and evacuate all personnel to safe locations.

9.12 Slowly lower the motor into the container while monitoring static charge. [✓]

Record Stat Gun SN: no reading

CAUTION: Make new ground before breaking old ground.

9.13 Attach the container ground wire to the motor using the 1/4-20 UNC x 3/4 long bolt and nut provided. Torque to 50 in-lbs ±5 in-lbs. Measure resistance to verify ground (should be <1 ohm). [✓]

Record torque value: 50 in-lbs MSFC QA RC

Torque wrench SN: 68180

Resistance Measured 0.1Ω MSFC QA RC

9.14 Disconnect ground wire connecting the motor and facility ground. [✓]

9.15 Remove lifting hardware. [✓]

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9.16 Visually orientate the top bearing plate to the nozzle cant, indicated by the marking on the plate "POSITION THIS SIDE TO THE NOZZLE CANT", and place it over the nozzle and three tie rods and bring it to rest on the motor flange. Tighten and torque tie rod nuts to 20 in-lbs ±2 in-lbs. [✓]

Record torque value: 20 in-lbs MSFC QA RC

Torque wrench SN: 68180

CAUTION: Make sure that the top bearing plate is indexed to the motor case O.D. and is resting flat on the top of the flange.

Also, make sure that the grounding strap terminal and attach nut and bolt head is positioned in the clearance hole in the plate.

9.17 Place twelve (12) 16 unit size bags of fresh desiccant into the container in the cavity around the top bearing plate. [✓]

CAUTION: Once the bagged desiccant has been put into the container, the remaining packaging steps must be completed immediately and the container closed to prevent the desiccant from over exposure to free air circulation.

If, after the desiccant has been placed into the container, the packaging cannot be completed, close the container until packaging can be resumed.

9.18 Install the top cushion insert. Make sure that its index slot, on the bottom face, matches with the index block on the top bearing plate. [✓]

9.19 Place the motor log book and any other required documentation into a suitable size electrostatic free plastic bag (3M velostat or Richmond Pink Poly) and place into the stowage slot provided in the top cushion insert. [✓]

NO log book MB 09/25/93
PYS 9-25-93 RC 9-25-93

9.20 Place the container lid onto the container, making sure that there is no foreign matter on the lid gasket or container rim. [✓]

9.21 Install the lockring, with its bolt flanges positioned (centered) between the container humidity indicator and lifting grip. Install the bolt and nut and torque to 6 ft-lbs ± 1/2 ft-lbs (72 in-lbs). [ ]

Record torque value: 6 ft-lbs MSFC QA RC

9-25-93

Torque wrench SN: 68180

NOTE: The lockring shall be tapped, using a rubber mallet, at various points around the ring during bolt tightening.

9.22 Install a standard wire and lead seal through the provided holes in the lockring bolt flanges. ~~Secure using a QC press die engraved with UTC & No.~~ MS 09/25/93 [✓]
RL 9-25-93 RMS 9-25-93

NOTE: Before shipping, USBI personnel shall make sure the shipping container is properly labeled. Reference CSD's Material Handling Card, Rev. C, dated 5-23-89 sections 10 and subsequent.

10.0 **Test Report**

A final test report will be submitted to UT/CSD within 30 working days after testing is completed. Three copies plus one reproducible copy of this report will be submitted containing the following information as a minimum:

A. A description of test mounting and setup and location of instrumentation with two sets of color still photographs (8-1/2 by 11 inches) of setups and instrumentation close-ups.
B. A list of all instrumentation and equipment with ranges and plot accuracy of all acquired data with objective evidence of calibration status at the time of tests.
C. Sketches of test setups.
D. Power spectral density (PSD) plots of all acceleration data.
E. The results of all inspections and tests performed i.e., data tapes, data plots, and completed data summary sheets.
F. Any alteration or deviation from this procedure will be described in detail by a Notice of Deviation and included in the final report.
G. Model numbers and serial numbers for all instrumentation and test equipment shall be included in the report .

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11.0 Post Test Verification

The procedure delineated in the above document has been satisfactorily completed and :

a. All sequences in the procedure have been completed (or deleted by approved deviation)

b. All Procedure changes have been recorded and approved.

Submitted Verified by: Matt Bewill
Test Engineer

Date: 09/25/93

Motor Serial Number: 1000734

9-25-93

Appendix A

Test Procedure Deviation

Figure 1

TEST PROCEDURE DEVIATION

TEST ENGINEER: Mat Bevill MB 09/25/93	QUALITY: Rick Clements RC 9-25-93	TCP NO.: BSM-TCP-EP54-003
REQUIREMENTS ENGINEER:	OTHER: Richard Leonard (safety) RL 9-25-93	DATE: 09/25/93
TITLE: Fastener Lockwire / Upper temp. Limit violation		SHEET 1 OF

motor SN 1000734

DEV. NO.	PAGE	SEQ.	CHANGE/REASON	PERM/TEMP.
1			Fwd fasteners (motor to bracket) and AHS fasteners were lockwired for the aft motor (1000734).	P
2			Chamber temp. rose above upper tolerance during testing (Radial Axis). Max temp during testing was 28.2°F. Tolerance states 25°F +0°F −5°F. Testing proceeded as planned. CSD and USBI notified before proceeding. Motor chamber temp. was stabilized at ≈22.5°F before testing on Radial Axis Table.	T

ORIGINATOR: Mat Bevill

ABOVE DEVIATION(S) INCREASE HAZARD LEVEL: NO

SAFETY: Richard G Leonard

ORGANIZATION: NASA MSFC EP12

ABOVE DEVIATION(S) AFFECT TEST REQUIREMENTS:

Figure 1

TEST PROCEDURE DEVIATION

TEST PROCEDURE DEVIATION		TCP NO.
TEST ENGINEER:	QUALITY	DATE
REQUIREMENTS ENGINEER:	OTHER:	
TITLE:		SHEET OF

DEV. NO.	PAGE	SEQ.	CHANGE/REASON	PERM/ TEMP.

ORIGINATOR:	ORGANIZATION:
ABOVE DEVIATION(S) INCREASE HAZARD LEVEL: SAFETY:	ABOVE DEVIATION(S) AFFECT TEST REQUIREMENTS.

Figure 1

TEST PROCEDURE DEVIATION		TCP NO.:
EST ENGINEER:	QUALITY	DATE
REQUIREMENTS ENGINEER:	OTHER:	SHEET OF
TITLE:		

DEV. NO.	PAGE	SEQ.	CHANGE/REASON	PERM/ TEMP.

...IGINATOR:		ORGANIZATION:
ABOVE DEVIATION(S) INCREASE HAZARD LEVEL:	SAFETY:	ABOVE DEVIATION(S) AFFECT TEST REQUIREMENTS.

Figure 2

DEVIATION LOG

PROCEDURE ______________ REVISION ______________

DEV NO.	PAGE	PARA STEP	REASON/REMARKS	P/T	DATE ISSUED	DATE SIGNED
1			FWD fasteners and AFT lockwired	P	09/20/93	09/23/93
2			Upper temp violation, radial axis	T	09/23/93	09/23/93

Appendix B

Figures

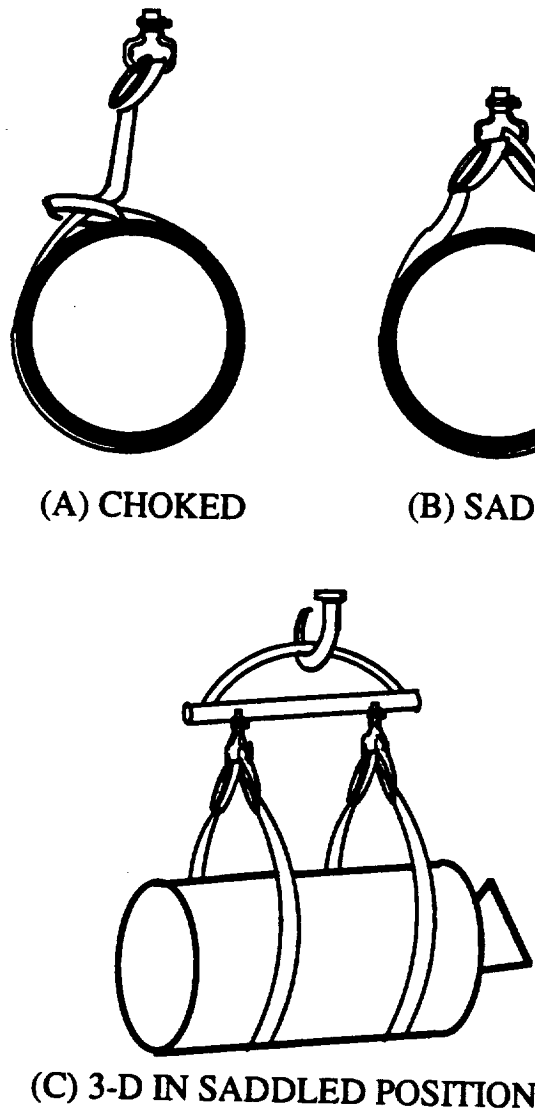
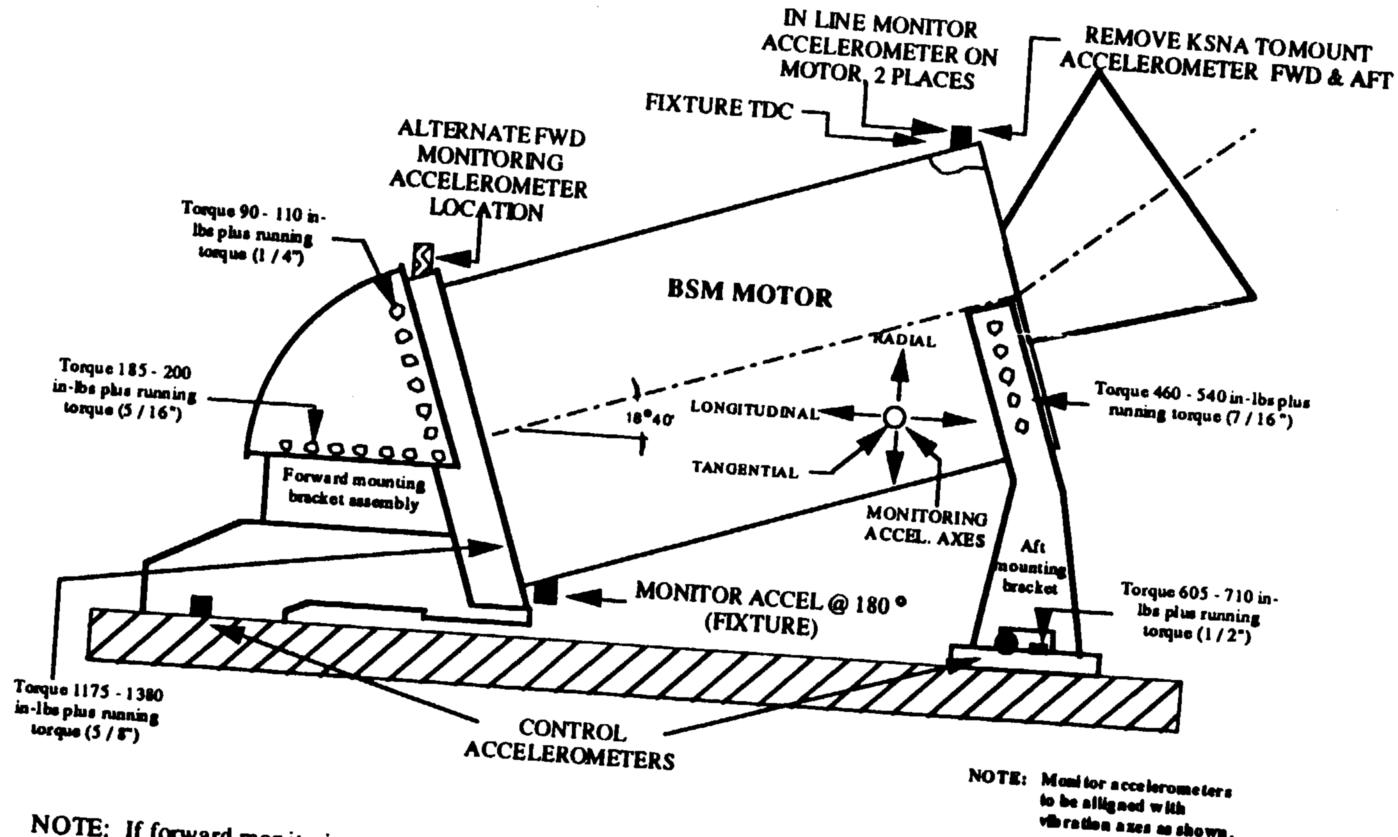


FIGURE 1. LIFTING STRAP ATTACHMENTS

DRAWN BY:
K. MITCHELL/EP54
3/8/93



NOTE: If forward monitoring acceleromenter cannot be mounted to the bracket assembly at fixture 180° location, it may be mounted on the bracket at fixture TDC (forward).

FIGURE 2. VIBRATION TEST SETUP

DRAWN BY:
K.MITCHELL/EP54
4/14/93

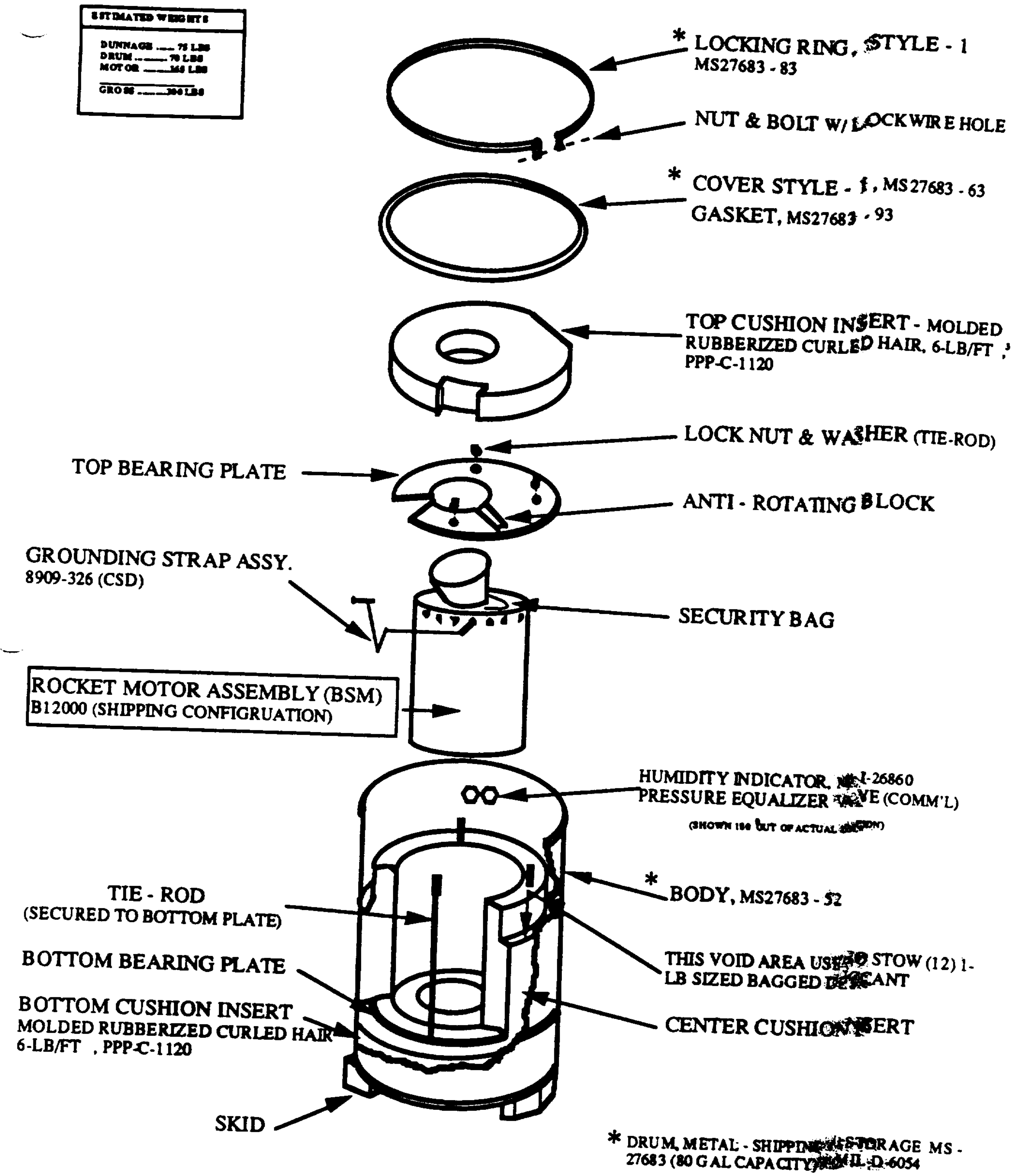


FIGURE 3. OVERALL VIEW OF SHIPPING CONTAINER

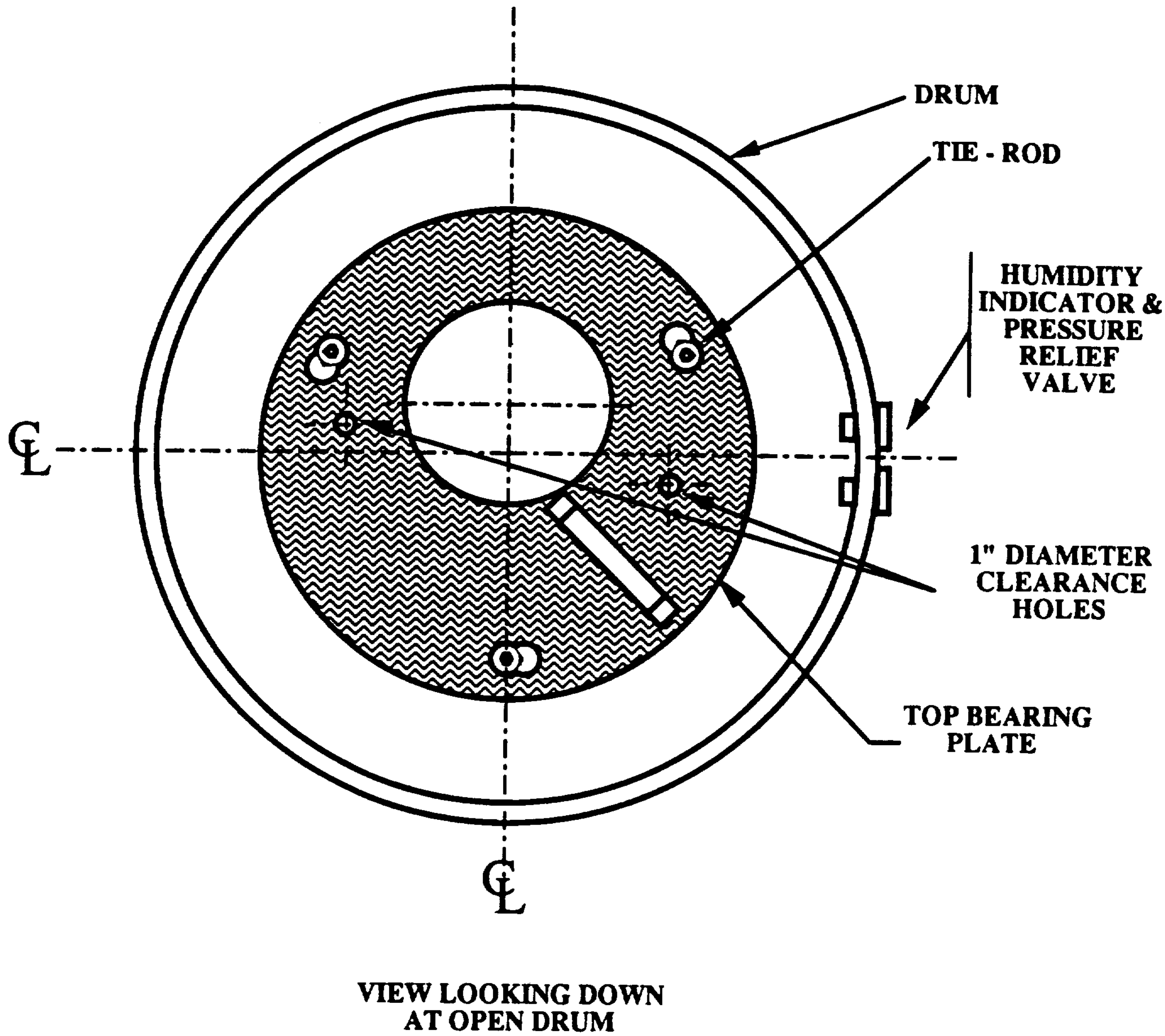


FIGURE 4. Top View of Shipping Container

BSM MOTOR S/N 1000738
PYROSHOCK TEST PROCEDURE

National Aeronautics and Space Administration

George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama 35812

BSM-TCP-EP54-001

BSM Delta Qualification Test

Motor to Bracket Assembly / Pyro Shock Simulation Test Procedure

This Procedure Describes **Safety Critical** Operations

BSM-TCP-EP54-001

BSM Delta Qualification Test

Motor to Bracket Assembly / Pyro Shock Simulation Test Procedure

Prepared by:

Mat Bevill EP-12

08/16/93

Motor SN: 1000738

Test Date: 09/20/93 -

Motor to Bracket Assembly/Pyro Shock Simulation

Prepared by:

Mat Bevill
Mat Bevill/MSFC TE/EP12 — 09/15/93 Date

Approved by:

Jim McGee
Jim McGee/MSFC Vibration Lab TE — 9-14-93 Date

Jim Herring
Jim Herring/MSFC Pyro Shock Lab TE — 9-14-93 Date

Richard Y Leonard
Richard Leonard/MSFC Safety/CS01 — 9-16-93 Date

Rick Clements
Rick Clements/MSFC Quality/CQ06 — 9-15-93 Date

Ben Goldberg/Motor Systems Division/EP11 — 9/14/93 Date

Steve Brewster/Dynamic Test Branch/ED73 — 9/14/93 Date

Charles E. Wells
Chuck Wells/UTC/CSD TE — 9/16/93 Date

Donald Wencil
Don Wencil/USBI — 9-16-93 Date

Charles W. Lovell
Charlie Lovell/PCH Engineer/CN71 — 9/16/93 Date

Motor to Bracket Assembly/Pyro Shock Simulation

Prepared by:

Mat Bevill

Mat Bevill/MSFC TE/EP12 — 09/15/93 Date

Approved by:

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Jim McGee/MSFC Vibration Lab TE — 9-14-93 Date

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Jim Herring/MSFC Pyro Shock Lab TE — 9-14-93 Date

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Steve Brewster/Dynamic Test Branch/ED73 — 9/14/93 Date

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Table of Contents

1.0 General Information

1.1 Scope

This test procedure addresses all the requirements to perform pyro shock testing on Booster Separation Motors (BSM). Included in this procedure are the steps to assemble the BSM to the aft skirt support brackets.

1.2 Objective

The objective of the pyro shock testing is to verify the physical and functional survivability of the Booster Separation Motors. Of particular interest for these tests are the components bonded using EA9394 adhesive. The components using this adhesive include the throat insert, the centering insert, and the igniter grain support rod.

2.0 Applicable Documents

MSFC-STD-513A	Certification of Equipment Operations and Materials Handling Personnel
EG5300.36A	Safety
29 CFR 1910	Occupational Safety and Health Administration (OSHA)
NSS/GO 1740.9	Safety Standard for Lifting Devices and Equipment
NHB 1700.1(V1)	Basic Safety Manual
AMC-R 385-100	Safety Manual
EP01-SOP-01	Standard Operating Procedure for Safety Critical Operations
MM 1700.4	Safety and Environmental Health Hazards
MMI 1700.17	MSFC Procedures for Acquiring Shipping Permits for Rocket Motors and Igniters
MMI 1710.1	Safety Review and Approval of Hazardous and Potentially Hazardous Facilities and Activities at MSFC
MMI 1710.6	MSFC Program for Personnel Certification
MMI 1711.2	Mishap Reporting and Investigation

MMI 1845.1	Hazard Communication Program
MMI 6400.2	Packaging, Handling, and Moving Program Critical Hardware
MSFC-RQMT-1493	Electrostatic Discharge Control Requirements
MSFC-STD-1800	Electrostatic Discharge (ESD) Control for Propellant and Explosive Devices
MSFC-STD-126E	Inspection, Maintenance, Proof Testing and Certification of Handling Equipment
CSD-5597-93-1 Rev. B	Enhanced Delta Qualification Test Plan for Booster Separation Motor (BSM), Aug. 6, 1993
10SPC-0067 Rev. A	Specification for Booster Separation Motors for Space Shuttle Solid Rocket Booster (thru SCN 014)

3.0 **Safety**

3.1 The following safety criteria are in accordance with ET01-SOP-01, Rev. A., *"Standard Operation Procedures for Safety Critical Operations"*. If safety rules/regulations are not followed, injury to personnel and/or damage to test items could occur.

Emergency telephone numbers are as follows:

Safety	4-0046
Ambulance	112
Fire	117
Security	4-4357
Utilities	4-3919
Medical Center	4-2390
Communication Repair	4-1771

3.1.1 In the event of serious personnel injury, do not move the injured person unless necessary to prevent further serious injury. Call 112 for ambulance.

3.2 Prior to starting work in 4619 a visual inspection of the work area shall be made for anomalies by the MSFC TE and MSFC SE.

MSFC TE NB MSFC SE RYL

Date / Time: 09/20/93

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3.3 Personnel shall not work or position themselves beneath suspended loads unless such loads are securely and adequately blocked up.

3.4 Objects handled by overhead hoist shall be lifted only high enough to clear fixed objects in the path of travel. Spreader bars and slings may be left on the hoist if desired when not in use, but must be raised so that the lowest part of the lifting equipment will be at least seven feet from the floor when not in use.

3.5 Crane, hoist, prime lift operators, and riggers shall be certified according to the latest revision of MMI 1710.6, and shall have in their possession a valid certification card.

Certifications checked by: MB

Date / Time: 09/20/93 6.00 p.m.

3.6 Personnel working around suspended loads shall be alert to the possibility of being crushed between the suspended load and a fixed object.

3.7 Loads shall be moved slowly so they will not accumulate more momentum than can be stopped with little or no swing.

3.8 Where handling slings are called out, a sling with more pickup points than required may be used if the weight capacity per point used is equal or greater than the weight capacity of each point of the noted sling and the free pickup point is (are) secured to prevent it (them) from swinging and causing damage to parts.

3.9 Only the area coordinator should direct the crane moves, however, any person determining an immediate danger or problem may request stoppage of activities.

3.10 The lifting or transportation operation shall be halted by the area coordinator at any time the control area cannot be maintained.

3.11 Steel toe shoes are required during lifting operations. Hardhats are required when the lift is at or above the shoulders.

3.12 Tag line operators are to wear leather gloves.

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3.13 The primary safety hazards associated with this operation are:

3.13.1 Lift operations
3.13.2 Solvent Use (See NOTE)
3.13.3 Live (Loaded) Solid Rocket Motor (propellant handling)

NOTE: **Grease and solvent use are only "if needed" as determined by the MSFC TE and CSD TE.**

3.14 Any time a crane is being used, it must be dogged if:

3.14.1 The load will be suspended in a static condition for an extended amount of time.

3.14.2 A crane operator crew change or substitution must be made.

3.15 No electric power tools shall be used near the live test item. Use of pneumatic tools is acceptable.

3.16 All ground cables and ground straps end-to-end resistances shall be verified with a multimeter. These resistances must measure less than 1 ohm.

3.17 All personnel within touching distance of the BSM or ordnance shall wear a wrist strap that has been checked with a wrist strap checker.

3.18 All personnel within touching distance of open grain propellant (and ordnance) shall wear antistatic coveralls.

3.19 Wrist strap connections to facility ground must be verified. This step should be performed each time the wrist strap ground is broken.

3.20 **In case of an accidental BSM ignition, the nearest fire alarm pull station shall be activated in order to evacuate building 4619. Personnel shall stay clear of the test site until the emergency response personnel have given the "all clear" to return to the building.**

4.0 Test Items and Test Requirements

4.1 Test Items

The test item for the qualification pyro shock tests consists of a live BSM which will be tested in the aft motor configuration. The motor will be tested with an aero heat shield over the exit cone. The motor weighs approximately 154 pounds.

4.2 Test Requirements

4.2.1 Test Tolerances

Unless otherwise stated in this procedure, the tolerances applicable to the test conditions described shall be as specified in MIL-STD-810D. These tolerances are as follows:

Shock Response Spectrum:	+6dB, -3dB (when analyzed with a 1/3 octave shock spectrum analyzer and 5% damping)

4.2.2 Test Data

All data taken with non-recording instruments will be recorded in ink directly onto data sheets and/or log sheets. The log or data sheets will identify the test being performed, the test item, the item part number, and the applicable test procedure. Corrections or changes will be made by drawing a single line through the original entry. The new entry will be made directly above the old and initialed by the person making the entry. Each page will be signed and dated at the bottom of the page by the person making the entries, and counter signed by the test engineer after review.

4.3 Test Conditions

4.3.0 The pyrotechnic shock tests for both motors will be conducted at the test site's ambient temperature.

4.3.1 The MSFC TE shall check with the Army MET team to ensure that there is no lightning within 10 miles. (MET team phone number....876-2465). [✓]

4.3.1.1 If lightning is within 10 miles during any time that a live BSM is in building 4619, the MSFC TE shall make arrangements to disconnect the motor ground from the facility ground. The motor shall remain ungrounded until the lightning is out of range.

4.3.1.2 When reconnecting the ground after a lightning storm, a 100Kohm resistor should be connected to the ground wire from the motor before connecting to facility ground. This allows any charge on the motor to slowly dissipate to ground. The resistor should be left connected for no less than 30 seconds.

4.3.1.3 After the specified time, disconnect the ground wire from facility ground and remove the resistor. Reconnect the ground strap from the motor to facility ground.

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4.3.2 The test site's relative humidity must be above 20%. If the humidity is below 20%, all test operations must cease until favorable weather conditions resume. [✓]

Test site's relative humidity 97% MSFC TE [initials]

4.4 Test Equipment

4.4.1 All measurements shall be made with instruments and equipment whose accuracy and/or calibration has been verified.

Calibration Acceptable [initials] (MFSC TE)

4.4.2 Proof Loading of Handling Equipment (required for PCH)

4.4.2.1 The heaviest lift during all of the delta qualification testing will be lifting the motor while in its shipping container. The motor and shipping container together weigh about 310 lbs. All forklifts and overhead hoists must be load (break) tested to at least 110% of this weight (i.e. 350 lbs.). This test must be performed prior to any handling of the BSM but does not need to be repeated until something other than the BSM is lifted by the same handling equipment. It is therefore recommended that the break tests be performed each evening before the BSM testing commences. The break tests shall be performed as follows: [✓]

a. The proof load must be at least 350 lbs.

b. Lift the dummy load clear of the ground (less than 1 foot) and lower to ground three times, holding for five minutes on the third lift. Lifting straps and spreader bar should be attached during the lift.

SEE APPENDIX E FOR THE PROOF TEST INSPECTION SHEETS.

4.5 Test Procedure

4.5.1 After review and documented approval, a redline change to this procedure may be performed. Approval shall be by a minimum of MSFC TE, MSFC SE, and the MSFC QA.

4.5.2 As soon as possible after a test failure, a deviation from the specified test environment, or any other incident which affects the test or test item, MSFC will notify the authorized UT/CSD representative of the event verbally and will then generate a Test Procedure Deviation (NASA form 3959). A copy of the Test

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Procedure Deviation is presented in Appendix B. Photographs of any discrepancies shall also be taken.

5.0 **Personnel Responsibilities**

5.1 **Test Witnessing**

All tests will be witnessed by the authorized UT/CSD representative and USBI representative. The MSFC test engineer will also witness the testing. Notification of the start of each test shall be communicated to the authorized UT/CSD and USBI representatives and the MSFC safety representative and test engineer at least 2 hours in advance.

MSFC Safety Notified MB

UT/CSD Notified MB

5.2 **The MSFC TE will serve as the area coordinator for the test. All handling of the BSM will be directed by the MSFC TE or cognizant test engineer.**

5.3 **Jim Herring (pyro shock) shall be responsible for photographic coverage of the pyro shock test activities.**

5.4 **The area around the outside of the pyro shock facility shall be secured *before* the live BSM is brought to the pyro shock test site.** [✓]

Area secured? YES NO MB MSFC TE
MSFC SE

Comments:

5.5 **The MSFC TE shall notify the fire department prior to delivery of the BSM. (Fire dept. phone #...117).** [✓]

5.6 **The MSFC TE shall make arrangements for the live BSM to be delivered from the NASA igloo to the pyro shock test site.** [✓]

5.7 **All involved lab directors and division chiefs shall be notified prior to testing.** [✓]

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6.0 Pyrotechnic Shock Test

6.1 Test Site Preparatory Activities

An inspection shall be made of the hardware to ensure it is all available. Should some hardware be missing the cognizant test engineer shall determine whether those components are required for the safe operation of the procedure. Should they not be required for safe operations, the test engineer shall determine whether an operations halt is required or whether the operations may proceed.

6.1.1 Verify the following components, tools and materials are available and certified (when applicable). All lifting equipment, cables, fixtures, etc... within one year stating the load limit and the date tested stencilled on the equipment. [✓]

Aft BSM Plate Mounting Hardware:

Part Number	Quantity	Nomenclature
EWB0420-8-23	6	Bolts*
EWB0420 - 10-(20,-32)	2	Bolts*
TLN1021CPD2-8	6	Nut (SelfAligning)
TLN1023CD3-10	2	Nut (SelfAligning)
NAS1587-8C	6	Washer
NAS1587-10C	2	Washer

* 10107-XX-XX series bolts are acceptable alternates (-20 for pyro, -32 for vibration)

Aft BSM Bracket Mounting Hardware:

Part Number	Quantity	Nomenclature
NAS1955C10H	8	Bolts
NAS1957C13	12	Bolts
NAS1587-5C	8	Washers
NAS1587-7C	12	Washers
NAS1587-7	12	Washers
VN324BC070	12	Locknuts
NAS1101E08H10	14	Aero Heat Shield Fasteners

Fasteners Accounted For: MB MSFC TE

Breakover brackets 2 [✓]

Lifting D-rings [✓]

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Spreader bar with associated lifting straps and D-rings [✓]

Custom wood supports to horizontally support the BSM [✓]

Tool Box with Assorted Wrenches Rm 170, Bldg. 4619 [✓]
(See **Appendix D** for detailed tool list)

Pre-drilled Wood Pallet to fit aft skirt support bracket bolt holes [✓]

Lifting straps (3) [✓]

SN: 3298
SN: 3201
SN: 3203

Desiccant (12, 16 unit size bags) [✓]

Rubber mallet [✓]

Lead wire seal (for security bag) [ ]

Forklift (at least 500 lb. capacity) [✓]

ESD Scanner [✓]

Materials

1,1,1 Trichloroethane; 1 bottle (enough for cleaning) [✓]

MIL-G-4343 grease; 1 container (AHS seal) [✓]

MIL-T-83483 thread compound; 1 container (AHS) [✓]

Conoco HD-2 grease; 1 container (bolts, faying surfaces) [✓]

Other consumables, including rimple cloth, que-tips , tape , bags and towels are also to be supplied if needed.

Gloves (Latex) [✓]
Ground straps [✓]
Wrist stats (5 each) [✓]
Stat gun (1 each) [✓]
Ohm meter (1 each) [✓]
Wrist stat checker (1 each) [✓]
Chemical safety goggles (2 each) [✓]
100 Kohm resistor (1 each) [ ]

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All hardware accounted for: MB all needed for this test MSFC TE

6.1.2 After the truck has arrived with the motor, the engine should be turned off and the emergency brake engaged. Chock at least one of the truck's wheels. [✓]

Truck braked and wheel chocked: ✓ MB MSFC TE

6.1.3 A sign with the word "LOADED" should be attached to the motor shipping container. [✓]

6.1.4 Attach a ground strap (long enough to reach the shipping container on the truck) to the pyro facility ground and verify the resistance. Resistance must be less than 1 ohm. [✓]

Resistance measured: .1 MSFC QA RC

CAUTION: Make New Ground Before Braking Old Ground.

6.1.5 Touch the free end of the ground wire to the truck chassis to make sure the truck and the facility are at the same potential, then, connect the free end of the ground strap to motor shipping container (not to lid or lid bolts). [✓]

6.1.6 Check continuity of shipping container to ground strap using an ohm meter. Resistance should measure less than 1 ohm. [✓]

Resistance Measured .1 MSFC QA RC

6.1.7 Disconnect shipping container-to-truck tie down apparatus. Move tie down out of the way. [✓]

6.1.8 Disconnect shipping container to truck chassis ground. [✓]

CAUTION: Do Not disconnect the motor's ground wire while removing from the truck.

6.1.9 **Using the fork lift, remove shipping container from truck and set container on the floor in the test room where it may be easily accessed by personnel and the overhead crane.** If deemed necessary **by the MSFC TE, the overhead crane may be used to remove the shipping container from the truck.** [✓]

Forklift used: yes no Crane used: yes no

6.1.10 The truck may exit the test area at this time. [✓]

NOTE: If the truck does not leave the site at this time, the driver will coordinate the exit with the MSFC TE.

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6.1.11 The large pyro bay doors should be "closed in" but left "cracked" open during the assembly and pyro test operations. [✓]

6.1.12 Install the shock test control equipment on the pyro plate as illustrated in Figure 1 (see Appendix C). [✓]

Equipment installed MB MSFC TE

6.1.13 The pyrotechnic shock test will be conducted in the aft motor configuration. [✓]

6.2 Pyro Test Setup

6.2.0 Record the test site's temperature and relative humidity. The relative humidity shall be above 20%. If the humidity is not above 20%, all test operations must halt until favorable weather conditions resume. [✓]

Temperature: 74 °F; Relative Humidity 97 %

6.2.1 <u>Remove Motor From Shipping Container</u>

6.2.1.0 Verify wrist straps are being used by ALL personnel while working with the live motor. All wrist straps shall be checked with a wrist strap checker before being used. Continuity checks shall be performed on all main ground straps after making any new ground connection. [✓]

MSFC SE ______________

6.2.1.1 Position shipping container so that the overhead crane can easily attach to the test item (this step necessary only if fork lift positioning was not adequate for crane attachment.) [✓]

CAUTION: When using the ESD scanner and the electrostatic reading on the motor case surface exceeds 1.0 kilovolt, stop all activities on the case, initiate personnel fall back (a minimum of 4 feet) and notify safety.

After initial reading over 1.0 kilovolt, repeat electrostatic reading at intervals not to exceed 5 minutes until the voltage has dissipated below 1.0 kilovolt. When the reading is below 1.0 kilovolt, removal operations may continue.

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If after 30 minutes the measured electrostatic charge is in excess of 1.0 kilovolt, Verify facility ground. If connection to facility ground is open, reconnect through larger resistor (100 Kohm min.) to allow a slow discharge of the motor case.

If the electrostatic reading on the case surface exceeds 4.0 kilovolts, STOP all activities on the case, notify safety , and evacuate all personnel to safe locations as directed by safety.

WARNING: Do not remove the nozzle's security bag and weather seal. Removing the bag and seal will expose the propellant grain and increase the risk of motor ignition.

6.2.1.2 Open the shipping container and remove all the packing that interferes with the removal of the test item. Monitor static charge while removing packaging. [✓]

Record Stat Gun reading ~700 Volts

Record SN of Stat Gun C10659

CAUTION: Make New Ground Before Braking Old Ground.

6.2.1.3 Attach a ground wire to the pyro facility ground and verify its resistance. Resistance shall measure less than 1 ohm. This wire should be attached at a location close to the BSM. [✓]

Resistance measured .1 MSFC QA RC

6.2.1.4 Attach the ground wire in step 6.2.1.3 from the facility ground to the live BSM. [✓]

6.2.1.5 Disconnect the motor to shipping container ground wire. see damage note (next page) [✓]

6.2.1.6 Attach two lifting rings (along with lifting strap) to the BSM's aft section, 180° apart. [✓]

6.2.1.7 Certifications for all lifting fixtures shall be provided: [✓]

Lifting beam assembly certification provided MB

Lifting rings (D-rings) MB

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CAUTION: **When using the ESD scanner and the electrostatic reading on the motor case surface exceeds 1.0 kilovolt, stop all activities on the case, initiate personnel fall back (a minimum of 4 feet) and notify safety.**

After initial reading over 1.0 kilovolt, repeat electrostatic reading at intervals not to exceed 5 minutes until the the voltage has dissipated below 1.0 kilovolt. When the reading is below 1.0 kilovolt, removal operations may continue.

If after 30 minutes the measured electrostatic charge is in excess of 1.0 kilovolt, Verify facility ground. If connection to facility ground is open, reconnect through larger resistor (100 Kohm min.) to allow a slow discharge of the motor case.

If the electrostatic reading on the case surface exceeds 4.0 kilovolts, STOP all activities on the case, notify safety , and evacuate all personnel to safe locations as directed by safety.

CAUTION: **The following step involves working with a suspended load. Keep hands and feet out from under the load.**

6.2.1.8 Slowly, monitoring static charge, lift the motor out of the container using the overhead crane. Lower the test item so that the forward end of the motor is at waist height. [✓]

A detailed visual inspection shall be performed by the MSFC test engineer and the CSD test engineer on the live test items before testing. Record the motor's serial number. [✓]

No Damage ______________________

Damage (~~detail in attachment~~) Yes, motor to shipping container ground wire broken.

Serial Number 1000738 Also, small dent/scratch 30° from fwd indicator pin, 3¼" from fwd end.

CAUTION: **The following step involves working with a suspended load. Keep hands and feet out from under the load.**

6.2.1.9 Attach the "break-over" brackets and lifting strap on the forward end of the motor (see Figure 2, Appendix C). [✓]

CAUTION: **Do Not disconnect the ground wire while breaking the motor to the horizontal position.**

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CAUTION: The following step involves working with a suspended load. Keep hands and feet out from under the load.

6.2.1.10 Lower the motor on its wood supports so that the motor rests horizontally. The MSFC TE will designate someone to hold the lifting strap on the forward end while placing the motor in the horizontal position (see Figure 3, Appendix C). The person holding the strap should be wearing a wrist strap. [✓]

6.2.1.11 Unhook the lifting straps and remove lifting hardware. [✓]

6.2.1.12 Re-attach the lifting hardware for bracket installation. Attach lifting straps in the saddle position (see Figure 4b, Appendix C). [✓]

6.2.2 <u>Attach Motor to the Aft Skirt Support Brackets</u>

Steps 6.2.2.1 and 6.2.2.2 may be skipped if deemed "not necessary" by the MSFC test engineer and the CSD test engineer. However, the fasteners should still be installed with grease applied. If time permits, all of the cleaning and surface preparation may be done ***before*** the test date.

CAUTION: When using trichloroethane,personnel shall wear chemical goggles and neoprene-Latex gloves. Contaminated materials shall be disposed of as hazardous waste.

CAUTION: When using grease, personnel shall wear Neoprene-Latex gloves. Contaminated materials shall be disposed of as hazardous waste.

6.2.2.1 Wipe faying surfaces clean with 1,1,1 trichloroethane and apply an unbroken film of HD-2 to each surface. After assembly remove excess grease with a lint-free cloth. [✓]

Surfaces wiped at this time: Yes ✓ No____
Grease applied at this time: Yes ✓ No____

CAUTION: When using trichloroethane,personnel shall wear chemical goggles and neoprene-Latex gloves. Contaminated materials shall be disposed of as hazardous waste.

CAUTION: When using grease, personnel shall wear Neoprene-Latex gloves. Contaminated materials shall be disposed of as hazardous waste.

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6.2.2.2 Clean washers and bolts with 1,1,1 trichloroethane and install wet with HD-2 grease. After assembly remove excess grease with a lint-free cloth. [✓]

Washers cleaned at this time: Yes_____ No ✓

CAUTION: Make sure the motor remains properly grounded during the move to position the test item.

6.2.2.3 Position the motor on the wood supports so the forward and aft brackets can be easily attached. Leave lifting straps attached. [✓]

6.2.2.4 At forward end of BSM install NAS1955C10H bolts with NAS1587-5C washers (8 places) through supports and into threaded inserts of BSM and torque to 145 to 170 in-lbs (13 to 14 ft-lbs) above running torque. [✓]

Torque value: 150 in-lbs MSFC QA RC

Record SN of torque wrench: T-267-62 (4671)

NOTE: The forward attach bracket has an alignment pin so there is only one way it can be installed.

NOTE: Be sure the aft attach bracket is in correct alignment with the forward bracket before installing the aft attach bracket bolts.

6.2.2.5 At aft end of BSM install NAS1957C13 bolts with NAS1587-7C washers (under bolt head), NAS1587-7 washers (under nut) and VN324BC070 locknuts (~~12~~ places)* and torque to 460 to 540 in-lbs (39 to 45 ft-lbs) above running torque. * Due to inaccessability, bolts were torqued on a "best effort" basis. [✓] RJ 9-20-93

Torque value: 570 in-lbs MSFC QA RC WB 9-20-93

Record SN of torque wrench: T-267-62 (4671) CW 9/20/93

6.2.3 Bracket Cover Installation

6.2.3.1 Bracket cover required? Yes_____ No ✓

If yes above, the 1/4 inch diameter bolts shall be torqued to 90-110 inch-pounds above running torque. The 5/16 inch diameter bolts shall be torqued to 185-200 inch-pounds (16 to 17 ft-lbs) above running torque.

Torque value: N/A MSFC QA N/A

Record SN of torque wrench: N/A

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MB 09/20/93 RC RyS

6.2.4 Rotate Motor 90 Degrees for Pyro Plate Mounting

6.2.4.0 De-torque and remove the bracket to inspection plate fasteners. Place fasteners in a labeled bag. [ ]

6.2.4.1 With the test item resting on the brackets, unhook the belly straps from the horizontal stabilizing bar (lifting straps should still be in the choked position as shown in Figure 4a, Appendix C). [ ]

6.2.4.2 Wrap the belly straps around the motor on each end as shown in Figure 4b (saddle configuration, Appendix C). [ ]

CAUTION: Personnel shall not work under or place any body part under a suspended load.

CAUTION: Be careful not to disconnect the motor's ground wire during the lifting and rotation operation.

6.2.4.3 Lift the motor and brackets to waist height using the overhead crane so that the motor can be rotated. [✓]

6.2.4.4 Holding the motor by the support brackets, rotate the motor 90 degrees so that the brackets can be mounted on the pyro plate. ✓

6.2.4.5 Use the overhead crane to move the test item to the mounting area on the pyro plate. [✓]

6.2.5 Attach the Brackets and Shims to the Pyro Plate

REMINDER: Be sure to put the custom shims in their correct positions and orientation before sliding bolts through the pyro plate.

CAUTION: When using grease, personnel shall wear Neoprene-Latex gloves. Contaminated materials shall be disposed of as hazardous waste.

6.2.5.1 Install wet with grease (HD-2) EWB0420-8-23 bolts (10107-8-23 alternate) with NAS1587-8C washers and TLN1021CPD2-8 self-aligning nuts at "A", "B", and "D" positions (as marked on supports, 6 places) and torque to 605 to 710 in-lbs above running torque. At the "C" position, install EWB0420-10-20 bolts (10107-10-20 alternate) with NAS1587-10C washers and TLN1023CD3-10 self-aligning nuts (2 places) and torque to 1175 to 1380 in-lbs above running torque. [✓]

Torque value: "C" 105 ft-lbs MSFC QA RC

A, B, D 650 in-lbs

C-2

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Record SN of torque wrench: "C" EMJ00359 A,B,D T-267-62 (4671)

6.2.5.2 Release the tension from the lifting straps but do not disconnect the straps. These straps may be used to tape off accelerometer wires if necessary. [✓]

6.2.5.3 Place the pyrotechnic debris shield in front of the large bay doors on the north side of the pyro room. [✓]

6.2.6 Perform Grain Inspection

6.2.6.1 Clear area of all nonessential personnel for grain inspection. (Only the grain inspectors (2) and the MSFC TE shall remain.) [✓]

6.2.6.2 Verify grain inspector(s) is(are): [✓]

a. Wearing 100% cotton coveralls, shorts, and undershirts.

b. Wearing a wrist strap.

c. Wearing tethers and/or tape to keep eye glasses, rings, and watches from falling into the motor.

6.2.6.3 The grain inspector shall now remove the security bag and cover from the exit cone. [✓]

6.2.6.4 Perform grain inspection. [✓]

Cracked propellant? yes no

If yes, give approximate location and size of crack.

Other comments on grain condition: No cracks or other defects noted on propellant grain. Small amounts of lint, liner particles and red stain on grain surface. OK to perform pyroshock test.

Grain inspector [signature] 9-20-93 MSFC QA [signature]

Grain inspector [signature] 9-20-93

6.2.7 Install Aero Heat Shield

CAUTION: When using trichloroethane,personnel shall wear chemical goggles and Neoprene-Latex gloves. Contaminated materials shall be disposed of as hazardous waste.

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6.2.7.1 CLEAN (if necessary) preservative or oil from the aeroheat shield using a lint-free cloth and 1,1,1 Trichloroethane. DO NOT clean over the identification. [✓]

Cleaning performed: Yes ______ No ✓

CAUTION: **When using trichloroethane,personnel shall wear chemical goggles and neoprene-Latex gloves. Contaminated materials shall be disposed of as hazardous waste.**

CAUTION: **When using grease, personnel shall wear Neoprene-Latex gloves. Contaminated materials shall be disposed of as hazardous waste.**

NOTE: **Dow Corning Moly Kote 55M Silicone O-ring lubricant meets the MIL-G4343 specification.**

6.2.7.2 Using a lint-free cloth and 1,1,1 Trichloroethane, an operator wearing a properly grounded wrist stat will CLEAN (if necessary) the sealing surface of the aeroheat shield cover and corresponding nozzle surfaces. LUBRICATE (if necessary) the surfaces with MIL-4343 grease.

Surface cleaned: Yes ✓ No ______
Surface lubricated: Yes ______ No ✓

CAUTION: **When using grease, personnel shall wear neoprene-Latex gloves. Contaminated materials shall be disposed of as hazardous waste.**

6.2.7.3 EXAMINE seal, P/N B12879-02-01 for damage that could effect the results of the pyro shock or vibration tests. APPLY MIL-G-4343 grease. [✓]

Seal damaged? yes no

Decription of damage: ______________________________

NOTE: **Extreme care must be taken when installing the seal. Notice there is a small and large lip on the seal (see Fig. 5, Appendix C). The larger lip is the seal aft face, and the smaller lip is the seal outside diameter.**

6.2.7.4 INSTALL seal, P/N B12879-02-01 on the exit cone of the motor. Reference drawing B14036. [✓]

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CAUTION: **When using thread compound, personnel shall wear neoprene-Latex gloves. Contaminated materials shall be disposed of as hazardous waste.**

6.2.7.5 COAT fourteen (14) screws (NAS1101E08H10) with MIL-T-83483 thread compound. [✓]

CAUTION: **When installing the Aero Heat Shield, personnel shall be extremely careful not to drop any foreign object into the rocket motor (watches, rings, and other jewelry shall be removed; eye glasses shall be tethered if worn).**

6.2.7.6 With the nozzle cant vertically up, a properly grounded operator will INSTALL the aeroheat shield cover with the hinge on the left or right side when aft looking forward as specified by USBI/CSD. Proper alignment in either position is provided by a positioning pin and mating hole. [✓]

(NOTE: DO NOT lockwire the screws.)

6.2.7.7 INSTALL the 14 screws and TORQUE the fasteners using a standard cross pattern. Record the torque values. [✓]

First Pass:	Finger Tight			MSFC QA *RC*
Second Pass:	10-15 in-lbs	Value:	*10-15*	MSFC QA *RC*
Third Pass:	20-25 in-lbs	Value:	*20-25*	MSFC QA *RC*
Fourth Pass:	20-25 in-lbs	Value:	*20-25*	MSFC QA *RC*

Record SN of torque wrench: ____________

Primer in holes made AHS assembly very difficult. Primer was removed with [illegible] and que tips.

6.2.8 <u>Make Sure the Pyro Facility Bay Doors are Open</u> [✓]

6.2.9 <u>Clear Area for Test</u> [✓]

The only personnel allowed in the control room are the pyro shock test conductor, a pyro technician, the MSFC TE, and the MSFC SE (total of four (4) people). All other personnel should move to a clear area. The clear areas are defined as the NORTH hallway of building 4619 and the area outside the pyro control room on the WEST side. Other areas must be cleared with the MSFC TE and the MSFC SE.

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6.2.9.0 Conduct Pyro Shock Test to the Following Parameters:

Test Parameters:

Frequency (Hz)	Level
50	24 g peak
50 to 100	+12 db/octave
100	94 g peak
100 to 4000	+6 db/octave
4000 to 10,000	3750 g peak

6.2.9.1 Turn on the flashing light outside room 170A. [✓]

6.2.9.2 For each measurement location select an accelerometer of a type suitable for the amplitude expected. [✓]

6.2.9.3 Calibrate each accelerometer per ED73-SHK-FOP-008. [✓]

6.2.9.4 Verify test, checkout, and assembly hardware are connected to the facility ground system. [✓]

6.2.9.5 Verify that no leads are connected to the junction box terminals. [✓]

6.2.9.6 Move junction box switch to "BULB" position. [✓]

6.2.9.7 Connect 12 volts to the firing panel. [✓]

6.2.9.8 Insert the firing key and verify panel meter indicates the correct voltage. [✓]

6.2.9.9 Switch key to "ARMED" position and verify power indicator light is illuminated. [✓]

6.2.9.10 Open red cover and flip firing switch, verify bulb on junction box lights. [✓]

6.2.9.11 Close red cover. [✓]

6.2.9.12 Switch key to "SAFE" position. [✓]

6.2.9.13 Move junction box switch to "METER" position. [✓]

6.2.9.14 Switch key to "ARMED" position and verify power indicator light is illuminated. [✓]

6.2.9.15 Open red cover and flip the firing switch, verify that the meter on junction box indicates 12 volts. [✓]

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6.2.9.16 Close red cover. [✓]

6.2.9.17 Switch key to "SAFE" position and disconnect voltage source. [✓]

6.2.9.18 Remove firing key. [✓]

6.2.9.19 Verify that no severe weather or electrical storms are within 10 miles of the immediate vicinity (Army Met. Team 876-2465). [✓]

6.2.9.20 Verify that no flammable solvents, paints, gases, etc., are in the hazardous area. [✓]

6.2.9.21 Verify all non-essential personnel are clear of the test area. [✓]

6.2.9.22 Verify pyro technician is: [✓]

a. Wearing 100% cotton coveralls, shorts, and undershirts.

b. Wearing safety goggles, hearing protection, and a wrist strap when installing explosive items.

c. In possession of the arming key and that the firing panel is in the safe position.

6.2.9.23 The pyro technician shall remove all matches, lighters, jewelry, and all battery-powered devices such as electrical wrist watches, calculators, portable radios, etc. [✓]

6.2.9.24 During periods of connecting blasting caps, MDF, and FLSC, a maximum of two people (to be designated by the MSFC TE) will be permitted to remain in the shock area. [✓]

6.2.9.25 Install required MDF or FLSC on exciter plate. (Total of 26" of ~25 grains per foot) (See Fig. 6 and Fig. 7, Appendix C) [✓]

6.2.9.26 Verify switch on junction box is in "BULB" position. [✓]

WARNING: If bulb glows, there is sufficient radio frequency in the area to possibly cause detonation of the blasting cap. The cap should be left shorted and returned to room 170B storage cabinet. All blasting activities will be curtailed until the RF source is removed.

6.2.9.27 Verify that bulb on junction box is not illuminated. [✓]

6.2.9.28 In room 170B, verify that blasting cap shorting coil is in place and is undamaged before removing from storage container. [✓]

6.2.9.29 Remove blasting cap from container and transport to room 170. [✓]

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6.2.9.30 In room 170, verify that wrist straps are in place. [✓]

6.2.9.31 Install blasting cap on exciter plate. [✓]

6.2.9.32 Press blasting cap shorting coil firmly against facility ground for 1 second. In order to short the leads, remove enough shorting coil from the blasting cap to attach alligator clip. [✓]

6.2.9.34 Remove shorting coil. [✓]

6.2.9.35 Move switch on junction box to "METER" position. [✓]

6.2.9.36 Verify 0 (zero) volts on meter. [✓]

WARNING: If voltage is indicated, the lines to the firing panel are either connected to a voltage source or are picking up voltage from radiation caused by a nearby source. The cap should be left shorted and returned to room 170B storage cabinet. All blasting activities will be curtailed until the voltage source is removed.

6.2.9.37 Move junction box switch to "BULB" position. [✓]

6.2.9.38 Install blasting cap leads in junction box, move switch to "FIRE" position, and remove alligator clip. [✓]

6.2.9.39 The pyro technician shall now leave the area, close the door, and inform the MSFC TE of the status. [✓]

6.3 Detonation of Pyrotechnics

6.3.1 The lead pyro engineer shall now prepare the data acquisition system to acquire data. [✓]

6.3.2 Start the tape recorder. [✓]

6.3.3 Connect firing lines to the pyro control room junction box. [✓]

6.3.4 The lead pyro engineer, the pyro technician, the MSFC TE, and the MSFC SE shall now leave the pyro control room and move to the clear area outside. [✓]

6.3.5 Connect firing panel voltage supply and insert firing key, verify that the meter indicates the appropriate voltage. [✓]

6.3.6 Begin countdown. [✓]

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6.3.7 On the count of "3", the pyro technician shall put the switch in the "ARMED" position and verify that the power indicator is illuminated. [✓]

6.3.8 On the *FIRE* command, the pyro technician will open the red cover and flip the firing switch. [✓]

6.3.9 After firing, turn the firing panel key to the "UNARMED" position. [✓]

WARNING: If blasting cap does not fire, refer to Section 10.4 in ED73-SHK-FOP-004 (see Appendix A).

Blasting Cap Fired: **yes** ✓ **no** _____

6.3.10 Remove the arming key and disconnect the voltage supply. [✓]

6.3.11 Test personnel may now return to the control room. [✓]

6.3.12 Wait a minimum of 5 minutes after firing before opening the door to room 170. [✓]

6.3.13 The lead pyro engineer shall now begin to reduce the data. [✓]

6.4 Post Test Inspection

6.4.1 Inform the MSFC TE that the door to room 170 from the control room is to be opened. [✓]

6.4.2 The pyro technician shall enter room 170 and move the junction box switch to the "BULB" position. [✓]

6.4.3 Remove blasting cap leads from junction box. [✓]

6.4.4 Inspect the shock plate to insure all explosive devices fired properly. [✓]

WARNING: If all explosive items did not fire, refer to Section 10.5 in ED73-SHK-FOP-004 (see Appendix A).

6.4.5 The BSM shall be visually inspected for damage resulting from the pyro shock test. Any anomalies will be recorded. All other personnel shall remain in the control room or in the clear area until the "ALL CLEAR" is given by the MSFC TE. No Damage [✓]

6.4.6 MSFC TE indicates all clear for appropriate personnel. [✓]

6.5 Post Test Removal from the Pyro Plate

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6.5.1 Have a certified fork lift (500 pound minimum) ready to load the BSM and pallet onto the transport truck. [✓]

CAUTION: Exercise care not to entangle or tug on the motor grounding strap during the following lifting operations.

6.5.2 Tighten the lifting straps using the overhead crane so that the bolts can be loosened. [✓]

6.5.3 De-torque and remove the bolts that attach the brackets to the pyro plate. [✓]

CAUTION: The following steps involve working with a suspended load. Keep hands and feet out from under the load.

6.5.4 Remove custom shims and place in labeled bag for use in the vibration tests. [✓]

6.5.5 Lower the motor to waist height. [✓]

6.5.6 Rotate the motor 90 degrees so that the brackets can be mounted on the pallet. [✓]

6.5.7 Using the overhead crane, place the motor on the pallet so that it rests on the aft skirt support brackets and is aligned with the pre-drilled bolt holes. [✓]

6.5.8 With the test item resting on the brackets, unhook the belly straps from the horizontal stabilizing bar. [✓]

6.5.9 Bolt the test item to the pallet using the provided fasteners for transport to vibration. [✓]

Motor secured to pallet MB MSFC TE

6.6 Test Report and Data Requirements

A final test report will be submitted to UT/CSD within 30 working days after testing is completed. Three copies plus one reproducible copy of this report will be submitted containing shock response spectrum (SRS) plots (with Q=10 value) and the time history plots. The test tolerances shall be overplotted on the control spectrum.

Model numbers and serial numbers for all instrumentation and test equipment shall be included in the report . Test setup photos should also be included in the report.

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7.0 **Post Test Verification**

The procedure delineated in the above document has been satisfactorily completed and :

a. All sequences in the procedure have been completed (or deleted by approved deviation)

b. All Procedure changes have been recorded and approved.

Submitted Verified by: Mat Bevill
Test Engineer

Date: 09/21/93

Motor Serial Number: 1000738

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BSM MOTOR S/N 1000738
VIBRATION TEST PROCEDURE

NASA
National Aeronautics and
Space Administration

George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama 35812

BSM-TCP-EP54-003

BSM Delta Qualification Test

Vibration Tests and Packaging Procedure

This Procedure Describes
Safety Critical Operations

BSM-TCP-EP54-003

BSM Delta Qualification Test

Vibration Tests and Packaging Procedure

Prepared by:

Mat Bevill EP-12

08/16/93

Motor SN: 1000738

Test Date: 09/22/93

Vibration Tests and Packaging Procedure

Prepared by:

Prepared by:	Mat Bevill/MSFC TE/EP12	09/15/93 Date
Approved by:	Jim McGee/MSFC Vibration Lab TE	9-14-93 Date
	Jim Herring/MSFC Pyro Shock Lab TE	9-14-93 Date
	Richard Leonard/MSFC Safety/CS01	9-16-93 Date
	Rick Clements/MSFC Quality/CQ06	9-15-93 Date
	Ben Goldberg/Motor Systems Division/EP11	9/14/93 Date
	Steve Brewster/Dynamic Test Branch/ED73	9/14/93 Date
	Chuck Wells/UTC/CSD TE	9/16/93 Date
	Don Wencil/USBI	9-14-93 Date
	Charlie Lovell/PCH Engineer/CN71	9/16/93 Date

Vibration Tests and Packaging Procedure

Prepared by:

Mat Bevill
Mat Bevill/MSFC TE/EP12 — 09/15/93 Date

Approved by:

Jim McGee
Jim McGee/MSFC Vibration Lab TE — 9-14-93 Date

Jim Herring
Jim Herring/MSFC Pyro Shock Lab TE — 9-14-93 Date

Richard Y Leonard
Richard Leonard/MSFC Safety/CS01 — 9-16-93 Date

Rick Clements
Rick Clements/MSFC Quality/CQ06 — 9-15-93 Date

Byron E Goldberg
Ben Goldberg/Motor Systems Division/EP11 — 9/14/93 Date

Steve Brewster/Dynamic Test Branch/ED73 — 9/14/93 Date

Chuck Wells/UTC/CSD TE — Date

Donald A Wencil
Don Wencil/USBI — 9-14-93 Date

Charlie W. Lovell
Charlie Lovell/PCH Engineer/CN71 — 9/16/93 Date

Table of Contents

1.0 General Information

1.1 Scope

This test procedure addresses all the requirements to perform vibration testing on Booster Separation Motors (BSM). The test program consists of lift-off vibration, boost vibration, and vehicle dynamics vibration.

1.2 Objective

The objective of the dynamic testing is to verify the physical and functional survivability of the Booster Separation Motors. Of particular interest for these tests are the components bonded using EA9394 adhesive. The components using this adhesive include the throat insert, the centering insert, and the igniter grain support rod.

2.0 Applicable Documents

MSFC-STD-513A	Certification of Equipment Operations and Materials Handling Personnel
EG5300.36A	Safety
29 CFR 1910	Occupational Safety and Health Administration (OSHA)
NSS/GO 1740.9	Safety Standard for Lifting Devices and Equipment
NHB 1700.1(V1)	Basic Safety Manual
AMC-R 385-100	Safety Manual
EP01-SOP-01	Standard Operating Procedure for Safety Critical Operations
MM 1700.4	Safety and Environmental Health Hazards
MMI 1700.17	MSFC Procedures for Acquiring Shipping Permits for Rocket Motors and Igniters
MMI 1710.1	Safety Review and Approval of Hazardous and Potentially Hazardous Facilities and Activities at MSFC
MMI 1710.6	MSFC Program for Personnel Certification
MMI 1711.2	Mishap Reporting and Investigation

MMI 1845.1	Hazard Communication Program
MMI 6400.2	Packaging, Handling, and Moving Program Critical Hardware
MSFC-RQMT-1493	Electrostatic Discharge Control Requirements
MSFC-STD-1800	Electrostatic Discharge (ESD) Control for Propellant and Explosive Devices
MSFC-STD-126E	Inspection, Maintenance, Proof Testing and Certification of Handling Equipment
CSD-5597-93-1 Rev. B	Enhanced Delta Qualification Test Plan for Booster Separation Motor (BSM), Aug. 6, 1993
10SPC-0067 Rev. A	Specification for Booster Separation Motors for Space Shuttle Solid Rocket Booster (thru SCN 014)

3.0 **Safety**

3.1 The following safety criteria are in accordance with ET01-SOP-01, Rev. A., *Standard Operation Procedures for Safety Critical Operations"*. If safety rules/regulations are not followed, injury to personnel and/or damage to test items could occur.

Emergency telephone numbers are as follows:

Safety	4-0046
Ambulance	112
Fire	117
Security	4-4357
Utilities	4-3919
Medical Center	4-2390
Communication Repair	4-1771

3.2 Prior to starting work in 4619 a visual inspection of work area shall be made for anomalies by task supervisor and safety personnel.

MSFC TE MB MSFC SE [signature]

Date / Time: 09/22/93 5:00 p.m.

3.3 Personnel shall not work or position themselves beneath suspended loads unless such loads are securely and adequately blocked up.

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3.4 Objects handled by overhead hoist shall be lifted only high enough to clear fixed objects in the path of travel. Spreader bars and slings may be left on the hoist if desired when not in use, but must be raised so that the lowest part of the lifting equipment will be at least seven feet from the floor when not in use.

3.5 Crane, hoist, lift prime operators, and riggers shall be certified according to the latest revision of MMI 1710.6, and shall have in their possession a valid certification card.

Certifications checked by: MB

Date / Time: 01/22/93 5:00 pm

3.6 Personnel working around suspended loads shall be alert to the possibility of being crushed between the suspended load and a fixed object.

3.7 Loads shall be moved slowly so they will not accumulate more momentum than can be stopped with little or no swing.

3.8 Where handling slings are called out, a sling with more pickup points than required may be used if the weight capacity per point used is equal or greater than the weight capacity of each point of the noted sling and the free pickup point is (are) secured to prevent it (them) from swinging and causing damage to parts.

3.9 Only the area coordinator should direct the crane moves, however, any person determining an immediate danger or problem may request stoppage of activities.

3.10 The lifting or transportation operation shall be halted by the area coordinator at any time the control area cannot be maintained.

3.11 Steel toe shoes are required during lifting operations. Hardhats are required when the lift is at or above the shoulders.

3.12 Tag line operators are to wear leather gloves.

3.13 The primary safety hazards associated with this operation are:

3.13.1 Lift operations
3.13.2 Solvent Use (See NOTE)
3.13.3 Live (Loaded) Solid Rocket Motor

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NOTE: **Grease and solvent use are only "if needed" as determined by the MSFC TE and CSD TE.**

3.14 Any time a crane is being used, it must be dogged if:

3.14.1 The load will be suspended in a static condition for an extended amount of time.

3.14.2 A crane operator crew change or substitution must be made.

3.15 No electric power tools shall be used near the live test item. Use of pneumatic tools is acceptable.

3.16 All ground cables and ground straps end-to-end resistances shall be verified with a multimeter. These resistances must measure less than 1 ohm.

3.17 All personnel within touching distance shall wear a wrist strap that has been checked with a wrist strap checker. This step should be performed each time the wrist strap ground is broken.

3.18 All personnel within touching distance of open grain propellant (and ordnance) shall wear antistatic coveralls.

4.0 Test Items and Test Requirements

4.1 Test Items

The test item for the vibration tests consist of a BSM which will be tested in the aft motor configuration. The motor will be tested with an aero heat shield over the exit cone. The motor weighs approximately 154 pounds.

Motor Serial Number 1000738 Conditioning Temp. 125° $^{+5}_{-0}$ °F

4.2 Test Requirements

4.2.1 Test Tolerances

The tolerances applicable to the test conditions are as follows: (Unless otherwise stated in the procedure)

Vibration Frequency:	± 5%
Test Duration:	+10%, -0%
Temperature:	± 5° F
Sinusoidal Control Signal Maximum Harmonic Distortion	±10%
Sinusoidal Peak Acceleration	+20%, -10%

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Composite Root Mean Square Acceleration	±10%
Acceleration Spectral Density	+100%, -25% (+3dB, -1.5dB)

4.2.2 Test Data

All data taken with non-recording instruments will be recorded in ink directly onto data sheets and/or log sheets. The log or data sheets will identify the test being performed, the test item, the item part number, and the applicable test procedure. Corrections or changes will be made by drawing a single line through the original entry. The new entry will be made directly above the old and initialed by the person making the entry. Each page will be signed and dated at the bottom of the page by the person making the entries, and counter signed by the test engineer after review.

4.3 Test Conditions

The live delta qualification motor will be vibration tested at a specific temperature. The motor will either be tested at 25°F (+0, -5 °F) or at 125°F (+5, -0 °F) depending on which qualification motor this procedure controls.

4.3.1 The MSFC TE shall check with the Army MET team to ensure that there is no lighting within 10 miles. (MET team phone number....876-2465). [✓

4.3.1.1 If lightning is within 10 miles during any time that a live BSM is in building 4619, the MSFC TE shall make arrangements to disconnect the motor ground from the facility ground. The motor shall remain ungrounded until the lightning is out of range.

4.3.1.2 When reconnecting the ground after a lightning storm, a 100Kohm resistor should be connected to the ground wire from the motor before connecting to facility ground. This allows any charge on the motor to slowly dissipate to ground. The resistor should be left connected for no less than 30 seconds.

4.3.1.3 After the specified time, disconnect the ground wire from facility ground and remove the resistor. Reconnect the ground strap from the motor to facility ground.

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4.3.2 The test site's relative humidity must be above 20%. If the humidity is below 20%, all test operations must cease until favorable weather conditions resume. [✓]

Test site's relative humidity 37% at 5:00 pm 09/22/93 MSFC TE MB

4.4 Test Equipment

4.4.1 All measurements shall be made with instruments and equipment whose accuracy and/or calibration has been verified.

Calibration Acceptable MB MSFC TE

___________________ CSD TE

4.4.2 Proof Loading of Handling Equipment (required for PCH)

4.4.2.1 The heaviest lift during all of the delta qualification testing will be lifting the motor while in its shipping container. The motor and shipping container together weigh about 310 lbs. All forklifts and overhead hoists must be load (break) tested to at least 110% of this weight (i.e. 350 lbs.). This test must be performed prior to any handling of the BSM but does not need to be repeated until something other than the BSM is lifted by the same handling equipment. It is therefore recommended that the break tests be performed each evening before the BSM testing commences. The break tests shall be performed as follows: [✓]

a. The proof load must be at least 350 lbs.

b. Lift the dummy load clear of the ground (less than 1 foot) and lower to ground three times, holding for five minutes on the third lift. Lifting straps and spreader bar should be attached during the lift.

SEE APPENDIX C FOR THE PROOF TEST INSPECTION SHEETS.

4.5 Test Procedure

4.5.1 After review and documented approval, a redline change to this procedure may be performed. Approval shall be by a minimum of the MSFC TE, MSFC QA, and MSFC SE.

4.5.2 As soon as possible after a test failure, a deviation from the specified test environment, or any other incident which affects the test or test item, MSFC will notify the authorized UT/CSD representative of the event verbally and will then generate a Test Procedure Deviation (NASA form 3959). A copy of the Test

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Procedure Deviation is presented in Appendix A. Photographs of any discrepancies shall also be taken.

5.0 Personnel Responsibilities

5.1 Test Witnessing

All tests will be witnessed by the authorized UT/CSD representative and USBI representative. The MSFC test engineer will also witness the testing. Notification of the start of each test shall be communicated to the authorized UT/CSD and USBI representatives and the MSFC safety representative and test engineer at least 2 hours in advance.

MSFC Safety Notified MB

UT/CSD Notified MB

5.2 The MSFC TE will serve as the area coordinator for the test. All handling of the BSM will be directed by the MSFC TE or cognizant test engineer.

5.3 Jim McGee (vibration) shall be responsible for photographic coverage of the vibration test activities. [✓]

5.4 All involved lab directors and division chiefs shall be notified prior to testing. [✓]

5.5 The area around the outside of the vibration facility shall be secured *before* the live BSM is brought to the pyro shock test site.

Area secured? YES NO

MSFC TE

MSFC SE

Comments: doors bolted, security tape up.

6.0 Vibration Tests [✓]

6.0.1 Make sure the CSD TE has reviewed the calibrations for the vibration tests. [✓]

6.0.2 Open the doors that enter the vibration test room from the high bay of bldg. 4619. [✓]

6.1 Re-check system setup. Verify chamber temperature.

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6.2 Radial Axis Tests

6.2.1 Assemble the leg supports on the conditioning chamber. [✓]

6.2.2 *Lift Off Vibration*

6.2.2.1 The following levels and conditions apply for the lift off vibration tests. Vibrate the motor only as follows for a duration of 60 seconds: [✓]

Frequency (Hz)	Level
20	0.017 g^2/Hz
20 to 55	+6 db/octave
55 to 200	0.077 g^2/Hz
200 to 280	-11 db/octave
280 to 1200	0.022 g^2/Hz
1200 to 2000	-4.5 db/octave
2000	0.010 g^2/Hz

See Deviation #2

Composite: 6.9 grms

6.2.3 *Boost Vibration*

6.2.3.1 The following levels and conditions apply for the boost vibration tests. Vibrate the motor only as follows for a duration of 120 seconds: [✓]

Frequency (Hz)	Level
20 to 200	0.54 g^2/Hz
200 to 350	-12 db/octave
350 to 1000	0.060 g^2/Hz
1000 to 2000	-6 db/octave
2000	0.015 g^2/Hz

See Deviation #1

Composite: 14.0 grms

6.2.4 *Vehicle Dynamics Vibration*

6.2.4.1 The following levels and conditions apply for the vehicle dynamics tests. Vibrate the motor only as follows: [✓]

Frequency (Hz)	Level
5 to 10	0.7 g peak
10 to 40	3.7 g peak

Sweep Rate: 3 octaves per minute

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Redline ✓ for the repeat of these steps after Deviations 1 and 2

6.3 **Transport Motor From Room 156 to Room 158/ Setup for Tang. Axis**

6.3.1 Remove leg supports from conditioning chamber. [✓] ✓

6.3.2 Disconnect the conditioning unit from the conditioning chamber. [✓] ✓

6.3.3 Inspection certifications shall be provided for the overhead cranes in 4619 . ✓ ✓

Crane #1, Bldg. 4619 rm. 156 certification provided MB

Crane #2, Bldg. 4619 rm. 158 certification provided MB

6.3.4 Certifications for all lifting fixtures shall be provided: [✓] ✓

Lifting beam assembly certification provided MB

Lifting rings (D-rings) MB

CAUTION: Be careful not to disconnect the motor ground while lifting.

CAUTION: The following step involves working with a suspended load. Keep feet and hands out from under the load.

6.3.5 Using the overhead crane, lift the conditioning chamber off of the vibration table and place it on the floor. [✓] ✓

Record time when chamber was removed [redacted] MB 6:42 p.m. 7:30 p.m.

6.3.6 Verify motor ground connection on the motor and at the facility ground contact point. [✓] ✓

6.3.7 Disconnect the instrumentation wires. Remove any other instrumentation that is no longer needed or that might interfere with motor transport. [✓] ✓

6.3.8 Attach the lifting straps (as shown in Fig. ~~1a~~ b) to the motor and spreader bar and hook to the overhead crane. MB 09/22/93 RL 9-22-93 9-22-93 [✓] ✓

6.3.9 Remove adapter plate to vibration table fasteners. [✓] ✓

CAUTION: Be careful not to disconnect the motor ground while lifting.

CAUTION: The following step involves working with a suspended load. Keep feet and hands out from under the load.

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6.3.10 Slowly lift the motor off of the table and place it on the facility's roll cart. [✓]

6.3.11 Unhook spreader bar from ~~lifting straps~~ overhead crane MB 9/22/93 RJS 9-22-93 RC 9-22-93. Leave straps wrapped around the motor. [✓]

6.3.12 Open the doors that enter the high bay in room 158. [✓]

CAUTION: Make sure that the ground strap is long enough to reach to room 158 during the transport from one room to the other.

6.3.13 Slowly pull the motor using the roll cart from room 156 to room 158. Be sure to place the cart directly beneath the overhead crane. [✓]

6.3.14 Attach spreader bar to ~~lifting straps and~~ MB 9/22/93 RJS 9-22-93 RC 9-22-93 the overhead crane. [✓]

CAUTION: Be careful not to disconnect the motor ground while lifting.

CAUTION: The following step involves working with a suspended load. Keep feet and hands out from under the load.

6.3.15 Using the overhead crane, lift the motor from the pull cart and place it on the vibration table. [✓]

6.3.16 Align the adapter plates with the holes on the table. [✓]

6.3.17 Fasten the adapter plates to the table using the facility supplied fasteners. Torque these fasteners to 65 ft-lbs. [✓]

Record torque value: 65 ft·lbs MSFC QA RC

Torque wrench SN: BTW-2RCF

6.3.18 Remove all lifting hardware. [✓]

6.3.19 Attach accelerometers to the motor (see Fig. 2) [✓]

6.3.20 Reconnect accelerometer wires. [✓]

6.4 Thermal Conditioning Setup for Tangential and Longitudinal Axis

6.4.1 Use the overhead crane to place the conditioning chamber over the motor. [✓]

6.4.2 Once the chamber is in place, attach the necessary hoses and instrumentation from the conditioning unit to the chamber. [✓]

9-22-93

6.4.3 Make sure the chamber thermocouple is in the correct position for measuring the air temperature around the motor. [✓]

6.4.4 Make sure the motor ground strap is secured. [✓]

6.4.5 Activate conditioning unit and monitor the temperature until it has stabilized to the desired temperature. [✓]

Record time/temp. when stabilized: 8:30 p.m.
Record total time out of conditioning: 1 hr

6.4.6 Recondition motor for twice the time out of conditioning if out more than 30 minutes. [✓]

Reconditioning necessary: Yes No
If yes, how long does motor need reconditioned? 2 hrs

6.5 Tangential Axis Tests

6.5.1 *Lift Off Vibration*

6.5.1.1 The following levels and conditions apply for the lift off vibration tests. Vibrate the motor only as follows for a duration of 60 seconds: [✓]

Frequency (Hz)	Level
20	0.016 g^2/Hz
20 to 75	+3 db/octave
75 to 1000	0.060 g^2/Hz
1000 to 2000	-3 db/octave
2000	0.030 g^2/Hz

Composite: 10.0 grms

6.5.2 *Boost Vibration*

6.5.2.1 The following levels and conditions apply for the boost vibration tests. Vibrate the motor only as follows for a duration of 120 seconds. [✓]

Frequency (Hz)	Level
20 to 800	0.24 g^2/Hz
800 to 2000	-4 db/octave
2000	0.071 g^2/Hz

Composite: 18.4 grms

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6.5.3 *Vehicle Dynamics*

6.5.3.1 The following levels and conditions apply for the vehicle dynamics tests. Vibrate the motor only as follows: [✓]

Frequency (Hz)	Level
5 to 10	0.7 g peak
10 to 40	4.3 g peak

Sweep Rate: 3 octaves per minute

6.6 Axis Change From Tangential to Longitudinal

6.6.1 Disconnect conditioning unit from conditioning chamber. [✓]

6.6.2 Attach overhead crane to the conditioning chamber. [✓]

6.6.3 Slowly lift the conditioning box off of the test item and move it away and move it away from the vibration table and place on the floor. Disconnect lifting hardware. [✓]

Record time of chamber removal: 11:00 pm. 9-22-9

* Fwd bracket to motor fasteners torque checked OK 09/22/93 9-22-93

6.6.4 Verify motor ground connection on the motor and at the facility ground contact point. [✓]

6.6.5 Remove adapter plate to vibration table fasteners. [✓]

6.6.6 Unhook control accelerometer. [✓]

CAUTION: Be careful not to disconnect the ground when changing the axis on the table.

CAUTION: The following step involves working with a suspended load. Keep feet and hands out from under the load.

6.6.7 Rotate the motor and bracket assembly 90° using the overhead crane. Disconnect lifting hardware. [✓]

6.6.8 Re-attach adapter plate to vibration table fasteners. Torque to 65 ft-lbs. [✓]

Record torque value: 65 ft-lbs MSFC QA RC

Torque wrench SN: BTW-2RCF

6.6.9 Reconnect control accelerometer. [✓]

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6.6.10 Reconnect lifting hardware to the conditioning chamber and place it over the motor. Reconnect chamber legs as necessary. [✓]

6.6.11 If necessary, re-attach hoses, instrumentation, etc., before starting conditioning unit. [✓]

6.6.12 Start conditioning unit. Monitor until it has stabilized to the desired temperature. [✓]

Record time/temp. when stabilized: 11:26
Record total time out of tolerance: 26 min

6.6.13 Recondition motor for twice the time out of tolerance if the time out was greater than 30 minutes. [✓]

Reconditioning necessary: Yes No
If Yes, how long does the motor need reconditioning? N/A

6.7 Longitudinal Axis Test

6.7.1 *Lift Off Vibration*

6.7.1.1 The following levels and conditions apply for the lift off vibration test. Vibrate the motor only as follows for a duration of 60 seconds. [✓]

Frequency (Hz)	Level
20	0.016 g^2/Hz
20 to 75	+3 db/octave
75 to 1000	0.060 g^2/Hz
1000 to 2000	-3 db/octave
2000	0.030 g^2/Hz

Composite: 10.0 grms

6.7.2 *Boost Vibration*

6.7.2.1 The following levels and conditions apply for the boost vibration test. Vibrate the motor only as follows for a duration of 120 seconds. [✓]

Frequency (Hz)	Level
20 to 800	0.24 g^2/Hz
800 to 2000	-4 db/octave
2000	0.071 g^2/Hz

Composite: 18.4 grms

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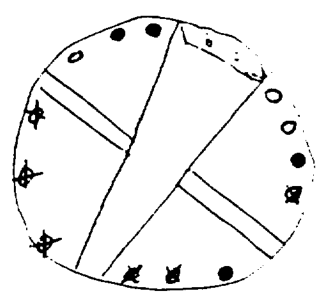
CONDITIONS @ POST TEST INSPECTION (6.8)

LOOSE AERO HEAT SHIELD BOLTS

● - MISSING BOLTS (QTY 4)
o - LOOSE BOLTS (QTY 3)
⊗ - OKAY



6.7.3 *Vehicle Dynamics*

6.7.3.1 The following levels and conditions apply for the vehicle dynamics test. Vibrate the motor only as follows. [✓]

Frequency (Hz)	Level
5 to 10	0.7 g peak
10 to 40	4.3 g peak

Sweep Rate: 3 octaves per minute

6.8 Post Test Inspection

6.8.1 The BSM test item shall be visually inspected by the MSFC QA, MSFC TE, and the CSD TE for exterior damage resulting from vibration testing. [✓]

No damage noted.

6.8.2 Remove all instrumentation.

6.9 Data Requirements [✓]

Power Spectral Density (PSD) plots for all control and response accelerometers for lift off and boost tests shall be recorded. The test tolerances shall be overplotted on the control accelerometers plots. Acceleration versus frequency plots shall be recorded for all accelerometers used during vehicle dynamics tests.

7.0 Post Test Disassembly/Prepare for Shipment

7.1 Conditioning Chamber Removal

7.1.1 Disconnect any hoses and instrumentation that hinders the removal of the chamber. [✓]

7.1.2 Using the overhead crane, slowly lift the conditioning chamber off of the vibration table and place on the floor. [✓]

7.1.3 Move chamber out of the way. [✓]

7.1.4 Move the conditioning unit out of the way if necessary. [✓]

7.1.5 Verify motor ground connection on the motor and at the facility ground contact point. [✓]

7.1.6 Remove vibration table insulation. [✓]

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7.2 Aero Heat Shield Removal

WARNING: Removing the Aero Heat Shield exposes the motor's propellant grain. Personnel should use caution during any operations with and exposed grain. Tools, watches, eye glasses, etc., should be tethered (if necessary) to prevent dropping anything into the motor.

7.2.1 Make sure the motor ground is secured. [✓]

7.2.2 Make sure verified wrist straps are being worn by the personnel removing the aero heat shield. [✓]

7.2.3 Remove the fasteners from the Aero Heat Shield. Place the fasteners in a marked bag. [✓]

7.2.3 SLOWLY remove the Aero Heat Shield. [✓]

7.2.5 Remove the heat shield seal. Do not drop the seal into the motor. [✓]

7.3 Post Test Inspection of Motor Propellant Grain

7.3.1 Make sure motor ground wire is secured. [✓]

7.3.2 Clear area of all non-essential personnel. Only the grain inspectors (2) and the MSFC TE shall remain. [✓]

7.3.3 Verify grain inspector(s) is(are): [✓]

a. Wearing 100% cotton coveralls, shorts, and undershirts.

b. Wearing a wrist strap.

c. Wearing tethers and/or tape to keep eye glasses, rings, and watches from falling into the motor.

7.3.4 Perform grain inspection. [✓]

Cracked propellant yes no

If yes, give approximate location and size of crack:

____

____

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Other comments on grain condition:

NO DIFFERENCES NOTED FROM PRE-TEST INSPECTION.

Grain inspector(s) [signature] [signature]
MSFC QA [signature]

7.3.5 A draw-wire, fabric, security bag shall be installed over the nozzle exit cone. The bag shall be closed around the exit cone and secured by inserting the bag wire ends through ~~a standard security lead-seal~~ (i.e. cover the exit cone the same way that it was received). [✓]

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9-23-93
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7.4 Adapter Plate Removal

7.4.1 Remove the adapter plate to vibration table fasteners. [✓]

7.4.2 Attach lifting straps as shown in Fig. 1b (Appendix B). [✓]

CAUTION: Be careful not to disconnect the ground while lifting the motor.

CAUTION: The following step involves working with a suspended load. Keep hands and feet out from under the load.

7.4.3 Lift the motor off of the vibration table and move to an area near the wood supports. [✓]

7.4.4 Lower the motor so that it rests on the wood supports. [✓]

7.4.5 Rotate the motor 180° so that the adapter plates face up. [✓]

7.4.6 Remove the bracket to adapter plate fasteners. Place fasteners in a marked bag. [✓]

CAUTION: Be careful not to disconnect the ground while lifting the motor.

CAUTION: The following step involves working with a suspended load. Keep hands and feet out from under the load.

7.5 Aft Skirt Bracket Removal

7.5.1 Remove the aft end motor to bracket fasteners (12 places). Place fasteners in a marked bag. * [✓]

* LIGHT SCORING OF SURFACE AT THE AFT BRACKET ATTACHMENTS.

9/23/93
9-23-93
9/23/93
9-23-93

9-23-93

CHATTER MARKS EVIDENT ON MS 09/23/93
FORWARD FACE OF THE MOTOR. JH 9/23/93
RC 9-23-93
RyS 9-23-93

[illegible]

CAUTION: Be careful not to disconnect the ground while lifting the motor.

CAUTION: The following step involves working with a suspended load. Keep hands and feet out from under the load.

7.5.2 Lift the motor to waist height using the overhead crane. [✓]

7.5.3 Rotate the motor 180° so that the bracket to adapter plate fastener holes face the floor. [✓]

7.5.4 Lower the motor so that it rests on the wood supports. [✓]

7.5.5 Remove forward end motor to bracket fasteners (8 places). Place fasteners in a marked bag. [✓]

8.0 <u>**Return Motor to the Vertical Position**</u>

8.1 Attach 2 D-rings, 180 degrees apart, and one lifting strap to the aft end holes of the motor. [✓]

8.2 Attach the "break-over" brackets (and lifting strap) to the appropriate bolt holes on the forward face of the motor case. [✓]

8.3 Attach the aft lifting strap to the overhead crane hook. [✓]

CAUTION: The following steps involve working with a suspended load. Keep hands and feet out from under the load.

CAUTION: Be careful not to disconnect the ground while lifting the motor.

8.4 One person (as chosen by the MSFC TE) shall hold the lifting strap on the forward end to keep the motor from swinging when lifted from the aft end. Slowly lift the aft end of the motor to bring it to a vertical position. [✓]

8.5 Raise the motor so that the aft end is at waist height. [✓]

CAUTION: The following steps involve working with a suspended load. Keep hands and feet out from under the load.

8.6 Disconnect the "break-over" brackets. Place brackets in a marked bag. [✓]

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9.0 **<u>Place Motor In Shipping Container</u>**

9.1 Remove lid from shipping container by removing the lock-ring bolt and nut, lockring, and cover. (See Fig. 3 for an overall view of the shipping container). [✓]

9.2 Remove top cushion insert. Make sure that the top bearing plate is properly oriented to the relative location of the drum humidity indicator/pressure relief valve (see Fig. 4). If not as shown (the two 1-inch dia. clearance holes must straddle the (imaginary) horizontal center line) the center cushion insert, *as a unit (do not lift center insert...it's keyed to the bottom insert)* must be rotated to bring the top plate into proper position as shown. [✓]

9.3 Remove the bearing plate from the tie rods. DO NOT remove the tie rod nuts. [✓]

9.4 Remove and discard any old bags of desiccant. [✓]

9.5 Drape the loose end of the container ground strap over the edge of the container. [✓]

9.6 Visually inspect the container interior to assure it is free of any foreign matter. Vacuum interior if required. [✓]

9.7 Attach a ground wire to facility ground and verify its resistance. Resistance shall measure less than one (1) ohm. [✓]

Resistance measured: .1 MSFC QA RC

9.8 Connect this ground wire to the motor shipping container and verify the resistance (<1 ohm). [✓]

Resistance measured: .1 MSFC QA RC

9.9 Install the antistatic foamed plastic liner tightly around the motor case, and secure in place ~~by taping the liner's vertical butt joint (trim as required) using 2" wide tape.~~ JH 9-23-93 RC 9-23-93 [✓]
RB 9-23-93 WS 9-23-93

9.10 Install the antistatic plastic film bag, up and over the motor. [✓]

9.11 Visually orientate the motor nozzle cant to the side of the container indicated by the marking, "POSITION NOZZLE CANT THIS SIDE" on the cushion insert. [✓]

CAUTION: Be careful not to disconnect the motor ground while lowering the motor into the container.

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CAUTION: **The following steps involve working with a suspended load. Keep hands and feet out from under the load.**

CAUTION: **When using the ESD scanner and the electrostatic reading on the motor case surface exceeds 1.0 kilovolt, stop all activities on the case, initiate personnel fall back (a minimum of 4 feet) and notify safety.**

After initial reading over 1.0 kilovolt, repeat electrostatic reading at intervals not to exceed 5 minutes until the the voltage has dissipated below 1.0 kilovolt. When the reading is below 1.0 kilovolt, removal operations may continue.

If after 30 minutes the measured electrostatic charge is in excess of 1.0 kilovolt, Verify facility ground. If connection to facility ground is open, reconnect through larger resistor (100 Kohm min.) to allow a slow discharge of the motor case.

If the electrostatic reading on the case surface exceeds 4.0 kilovolts, STOP all activities on the case, notify safety , and evacuate all personnel to safe locations.

9.12 Slowly lower the motor into the container while monitoring static charge. [✓]

Record Stat Gun SN: C 10659

CAUTION: **Make new ground before breaking old ground.**

9.13 Attach the container ground wire to the motor using the 1/4-20 UNC x 3/4 long bolt and nut provided. Torque to 50 in-lbs ±5 in-lbs. Measure resistance to verify ground (should be <1 ohm). [✓]

Record torque value: 50 in-lb MSFC QA RC

Torque wrench SN: 52117

Resistance Measured .1 MSFC QA RC

9.14 Disconnect ground wire connecting the motor and facility ground. [✓]

9.15 Remove lifting hardware. [✓]

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9.16 Visually orientate the top bearing plate to the nozzle cant, indicated by the marking on the plate "POSITION THIS SIDE TO THE NOZZLE CANT", and place it over the nozzle and three tie rods and bring it to rest on the motor flange. Tighten and torque tie rod nuts to 20 in-lbs ±2 in-lbs. [✓]

Record torque value: 20 in-lbs MSFC QA AC

Torque wrench SN: 5492304

CAUTION: Make sure that the top bearing plate is indexed to the motor case O.D. and is resting flat on the top of the flange.

Also, make sure that the grounding strap terminal and attach nut and bolt head is positioned in the clearance hole in the plate.

9.17 Place twelve (12) 16 unit size bags of fresh desiccant into the container in the cavity around the top bearing plate. [✓]

CAUTION: Once the bagged desiccant has been put into the container, the remaining packaging steps must be completed immediately and the container closed to prevent the desiccant from over exposure to free air circulation.

If, after the desiccant has been placed into the container, the packaging cannot be completed, close the container until packaging can be resumed.

9.18 Install the top cushion insert. Make sure that its index slot, on the bottom face, matches with the index block on the top bearing plate. [✓]

9.19 Place the motor log book and any other required documentation into a suitable size electrostatic free plastic bag (3M velostat or Richmond Pink Poly) and place into the stowage slot provided in the top cushion insert. ~~[✓]~~ N/A
AB 09/23/93
PJB 9-23-93
AC 9-23-93

9.20 Place the container lid onto the container, making sure that there is no foreign matter on the lid gasket or container rim. [✓]

9.21 Install the lockring, with its bolt flanges positioned (centered) between the container humidity indicator and lifting grip. Install the bolt and nut and torque to 6 ft-lbs ± 1/2 ft-lbs (72 in-lbs). [✓]

Record torque value: 6 ft-lbs MSFC QA AC

9-23-93

Torque wrench SN: 5492304

NOTE: The lockring shall be tapped, using a rubber mallet, at various points around the ring during bolt tightening.

9.22 Install a standard wire and lead seal through the provided holes in the lockring bolt flanges. ~~Secure using a QC press die engraved with UTC & No.~~ MB 09/23/93 RC 9-23-93 [initials] 9-23-93 [✓]

NOTE: Before shipping, USBI personnel shall make sure the shipping container is properly labeled. Reference CSD's Material Handling Card, Rev. C, dated 5-23-89 sections 10 and subsequent.

10.0 Test Report

A final test report will be submitted to UT/CSD within 30 working days after testing is completed. Three copies plus one reproducible copy of this report will be submitted containing the following information as a minimum:

A. A description of test mounting and setup and location of instrumentation with two sets of color still photographs (8-1/2 by 11 inches) of setups and instrumentation close-ups.
B. A list of all instrumentation and equipment with ranges and plot accuracy of all acquired data with objective evidence of calibration status at the time of tests.
C. Sketches of test setups.
D. Power spectral density (PSD) plots of all acceleration data.
E. The results of all inspections and tests performed i.e., data tapes, data plots, and completed data summary sheets.
F. Any alteration or deviation from this procedure will be described in detail by a Notice of Deviation and included in the final report.
G. Model numbers and serial numbers for all instrumentation and test equipment shall be included in the report .

9-23-93

11.0 **Post Test Verification**

The procedure delineated in the above document has been satisfactorily completed and :

a. All sequences in the procedure have been completed (or deleted by approved deviation)

b. All Procedure changes have been recorded and approved.

Submitted Verified by: Mat Beni [signature]
Test Engineer

Date: 09/23/93

Motor Serial Number: 1000738

9-23-93

Appendix B

Figures

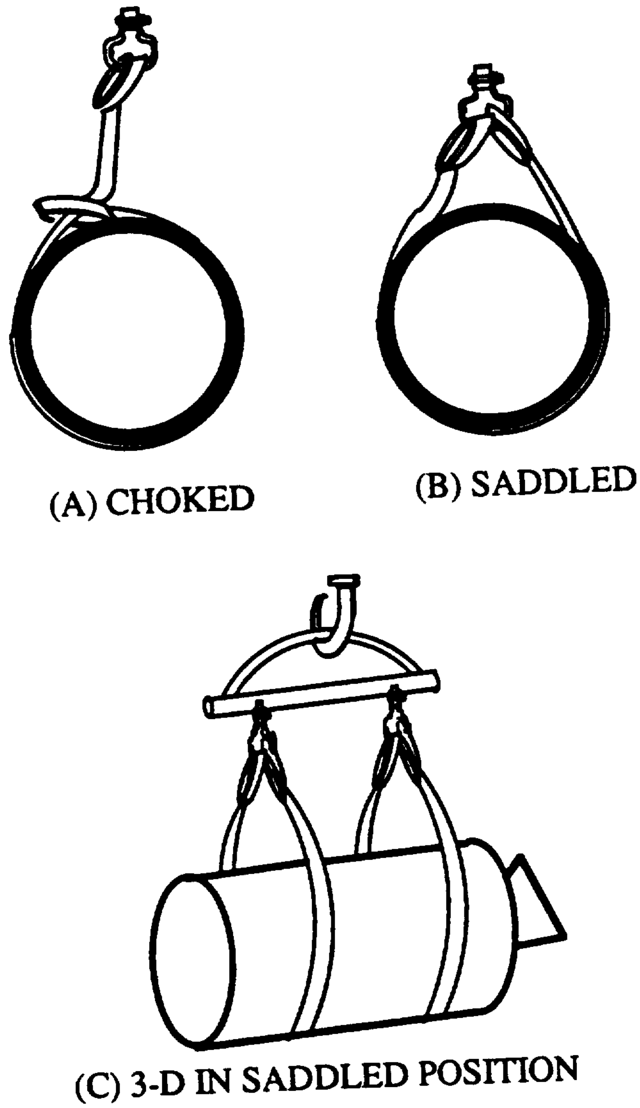
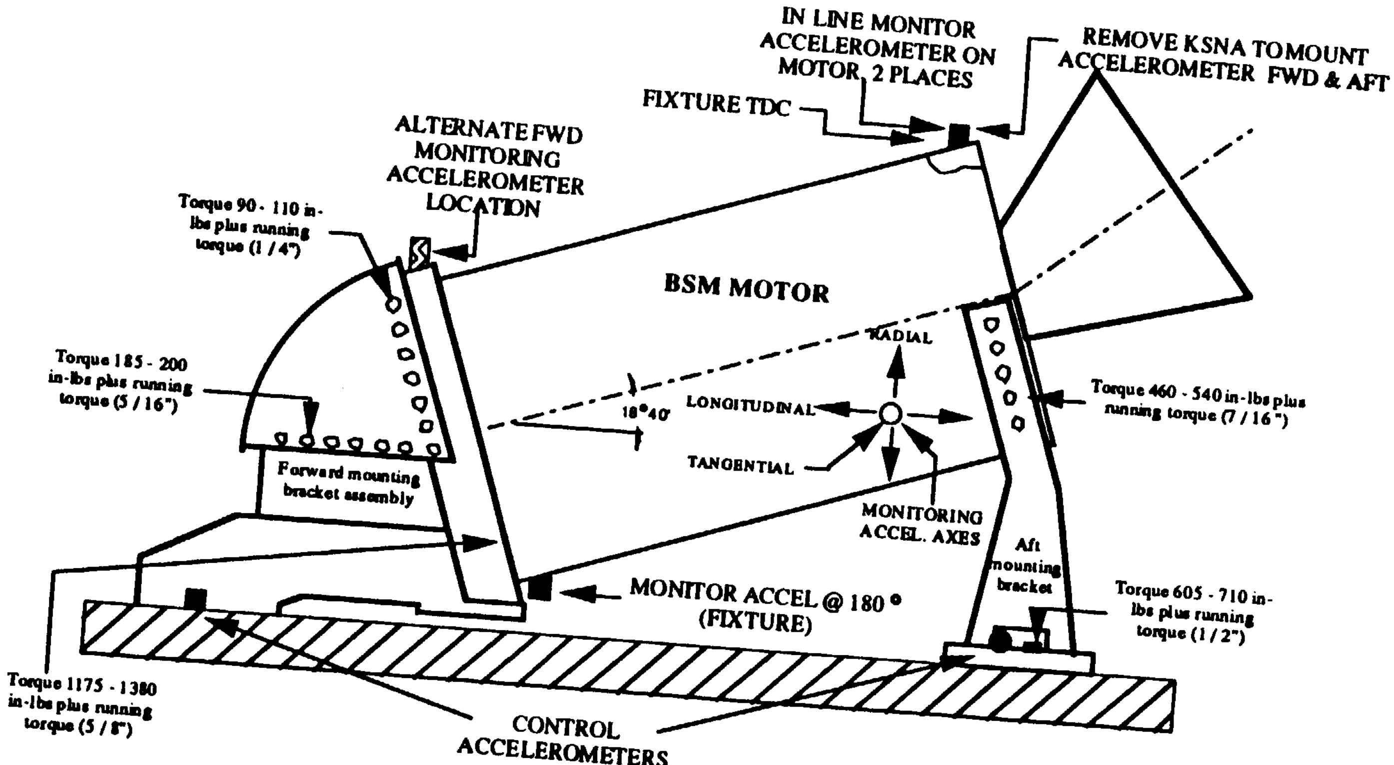


FIGURE 1. LIFTING STRAP ATTACHMENTS

DRAWN BY:
K. MITCHELL/EP54
3/8/93



NOTE: Monitor accelerometers to be alligned with vibration axes as shown.

NOTE: If forward monitoring acceleromenter cannot be mounted to the bracket assembly at fixture 180° location, it may be mounted on the bracket at fixture TDC (forward).

FIGURE 2. VIBRATION TEST SETUP

DRAWN BY:
K.MITCHELL/BP54
4/14/93

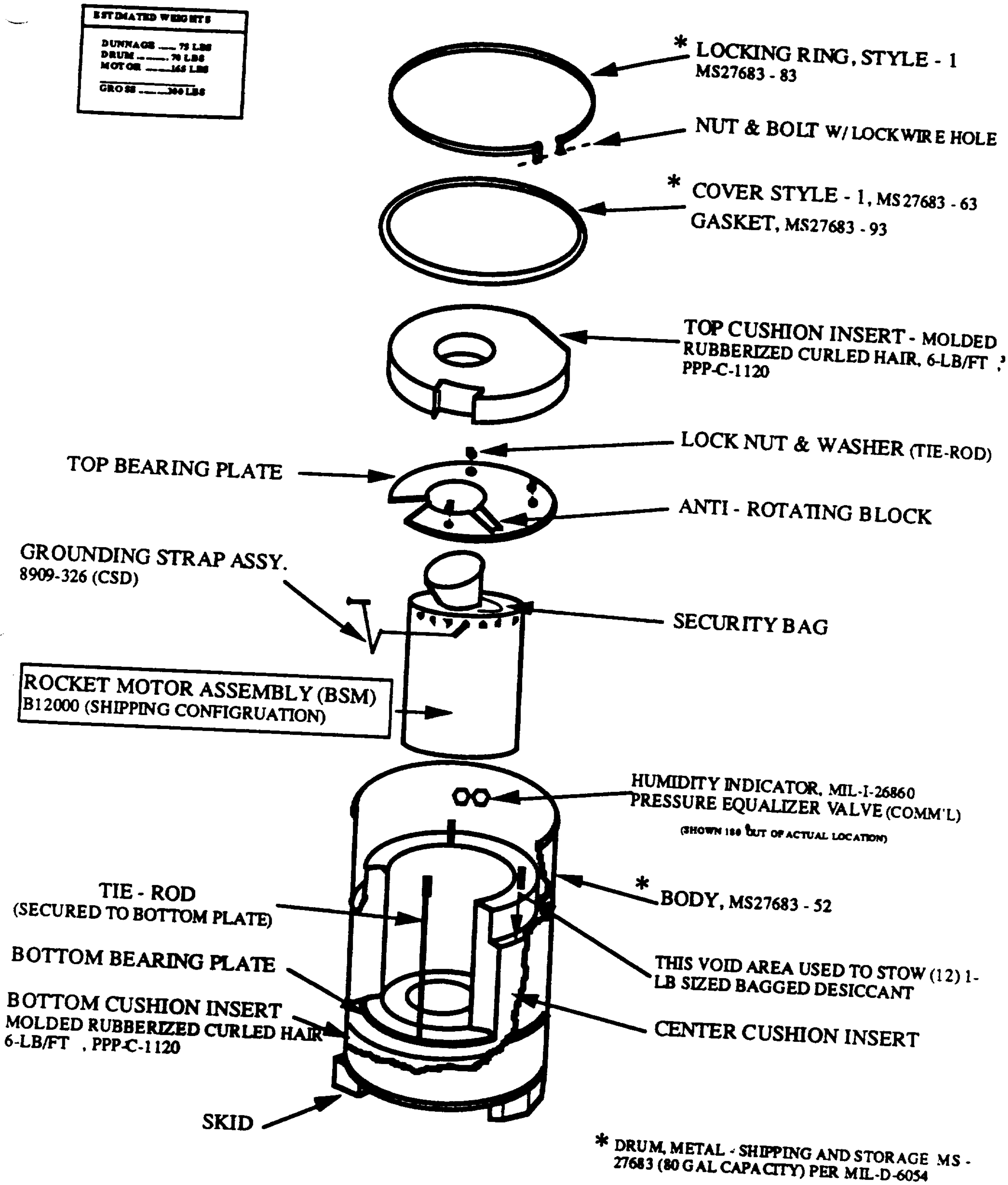
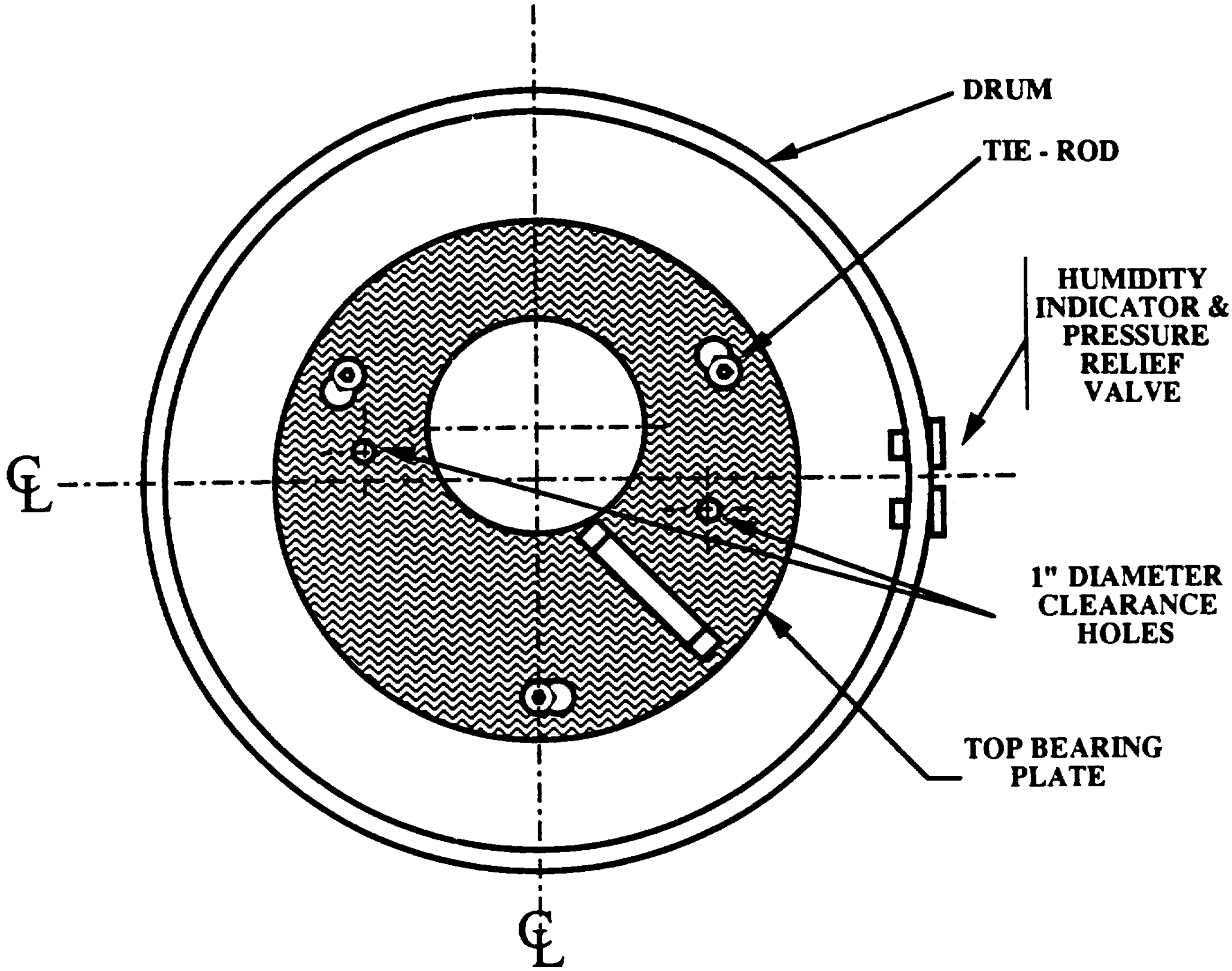


FIGURE 3. OVERALL VIEW OF SHIPPING CONTAINER

DRAWN BY:



VIEW LOOKING DOWN
AT OPEN DRUM

FIGURE 4. Top View of Shipping Container

DRAWN BY:
K.MITCHELL/EP54
4/7/93

BSM MOTORS S/N 1000734 AND S/N 1000738 PYROSHOCK TEST DATA

National Aeronautics and
Space Administration

George C. Marshall Space Flight Center
Marshall Space Flight Center, AL 35812

Reply to Attn of: ED73(93-94)

October 6, 1993

TO: EE11/Mr. Smith

FROM: ED73/Mr. Brewster

SUBJECT: SRB Booster Separation Motor (BSM) Pyrotechnic Shock Qualification Test TCP# SRB-QUAL-ED93-062

Pyrotechnic Shock Qualification tests were completed on two BSM flight units on September 20-21, 1993 at the MSFC Pyrotechnic Shock Test Facility in building 4619. The tests were necessary to flight qualify various BSM hardware modifications. Test 1 was completed on BSM Unit SN 1000738 and test 2 was completed on BSM Unit SN 1000734. The tests were conducted according to BSM Delta Qualification Test Procedure #BSM-TCP-EP54001, dated August 16, 1993.

The test setup consisted of hanging a 4' X 8' X 1/2" steel plate from the ceiling of the blast room and mounting the BSM horizontally approximately in the middle of the plate with the thrust direction pointed to the blast room away from the door. The test setup is shown in enclosure 1 and the photographs in appendix A.

The pyrotechnic shock was generated by two #8 blasting caps and 20 inches of Flexible Linear Shape Charge (FLSC) (25 grains/foot) configured in two parts around each end of a two 3/8" X 13" X 2" thick steel bar and another #8 blasting cap and 6 inches of FLSC mounted to a second steel bar. The pyrotechnics were installed on the opposite side of the plate from the BSM. The pyrotechnic setup is shown in enclosure 2.

The instrumentation consisted of four 4 triaxial accelerometer configurations located in close proximity to the 4 BSM mounting feet. Each triaxial cluster was sensitive to the 3 orthogonal axes, horizontal, vertical, and normal to the panel. The accelerometers were calibrated according to Document #ED73-SHK-FOP-008, entitled "Facility Operating Procedure for calibration of Accelerometers used in Shock Tests," dated August 1992. The hardware list of accelerometers, data acquisition and analysis equipment is shown in enclosure 3.

The calibration dates of pertinent hardware is shown in enclosure 4. At least one measurement point in the horizontal, vertical, and normal direction from the four accelerometer locations was required to meet the shock specification test criteria.

The test data is enclosed in appendix B. The first plot is a time history of the real time shock recorded over a 25 mili-second interval and the units are G peak versus time. The second plot is a Shock Response Spectrum (SRS) analysis computed over the frequency band from 50 to 10,000 Hertz and its units are G's versus frequency. The SRS analysis is completed on both positive and negative data points and both curves are on the plot. The specification and tolerances have been added to the plots.

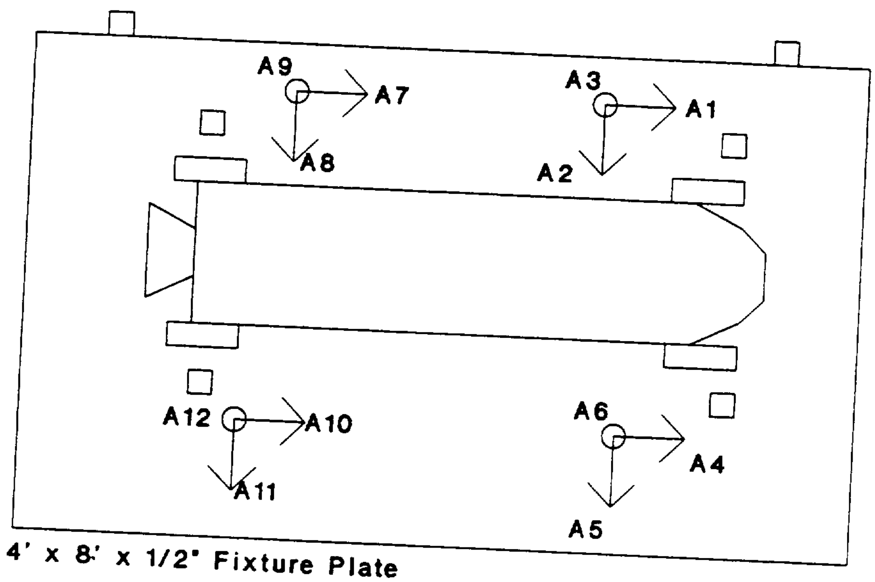
A deviation was issued against the response data being higher than the allowed +6db tolerance level for all axes. These exceedances were in most cases not significantly higher than the allowable tolerance and occurred in narrow bandwidths. Nevertheless, these exceedances were impossible to eliminate. The deviation is enclosed in appendix C.

Steve R Brewster

Steve R. Brewster
Chief, Dynamics Test Branch

Enclosure

cc:
CS01/Richard Leonard
ED13/Roy Winkle
ED23/Robin Ferebee
ED71/Gerald Waggoner - w/o encl.
ED73/Jim Herring
ED73/File Copy
EP54/Jim Niblett
EP54/Matt Bevill (3 copies)
USBI/Don Wencil



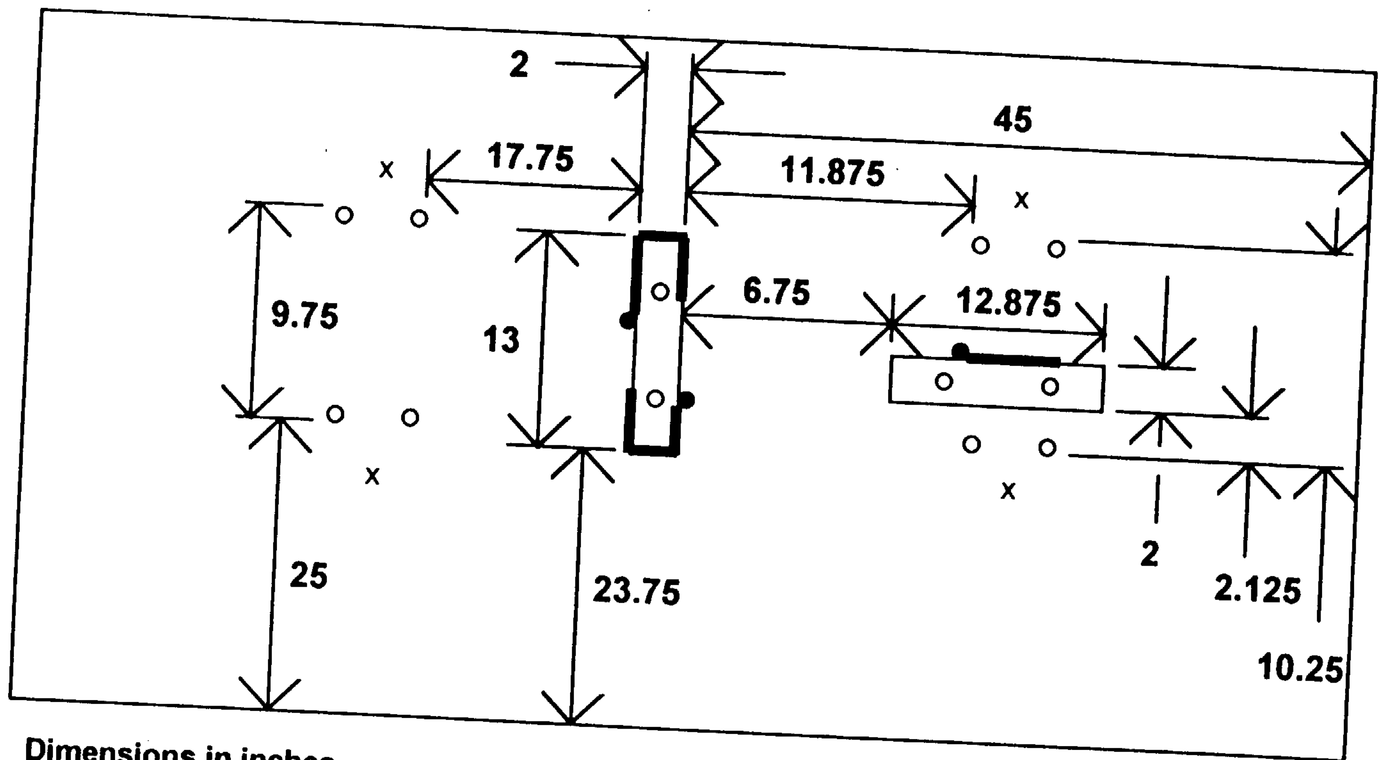
BSM Pyroshock Test Setup
Front View

□ Denotes accelerometer location

NC : 1

BSM Pyroshock Test Setup

Back View



Dimensions in inches
Not to scale
x - Denotes accelerometer location

Linear shape charge
Blasting cap

Data Acquisition / Analysis System

ITEM	MFG	Model	# Req'd
Accelerometer	Endevco	2225M5A	12
Shock amplifier	Endevco	2740B	12
FM Tape Recorder	DataTape	3700J	1
Shock Analyzer	GenRad	2518	1

UC ; 3

SHOCK AMPLIFIER CALIBRATION, MODEL 2740B

S/N	DUE DATE
FT80	1/22/94
FT73	12/25/93
FT77	12/29/93
FT74	12/25/93
FT75	12/25/93
FK21	12/28/93
FT72	10/21/93
FJ05	12/29/93
GB75	12/24/93
GB72	12/29/93
GB73	12/29/93
GB69	12/24/93

SHOCK ACCELEROMETER CALIBRATION, MODEL 2225M5A

S/N	DATE
GN25	8/20/93
GN36	8/20/93
GM66	8/20/93
GM67	8/20/93
NW66	8/20/93
A09H	8/20/93
A22H	8/20/93
A26H	8/20/93
A33H	8/20/93
A42H	8/20/93
A91D	8/20/93
A93G	8/20/93

STANDARD ACCELEROMETER CALIBRATION, MODEL 2270

S/N	DUE DATE
SA04	8/31/93

ENC: 4

Appendix A

Photographs

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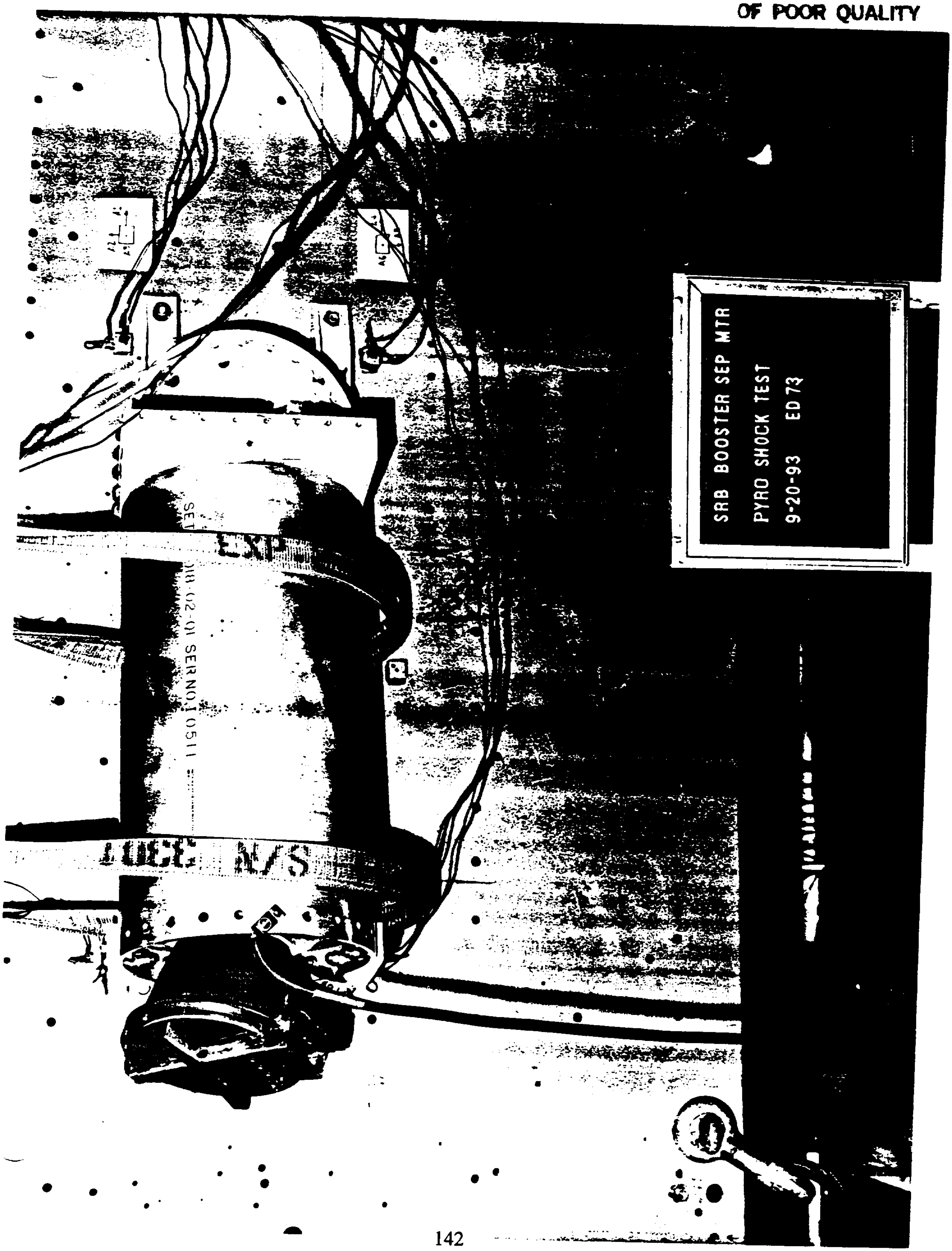
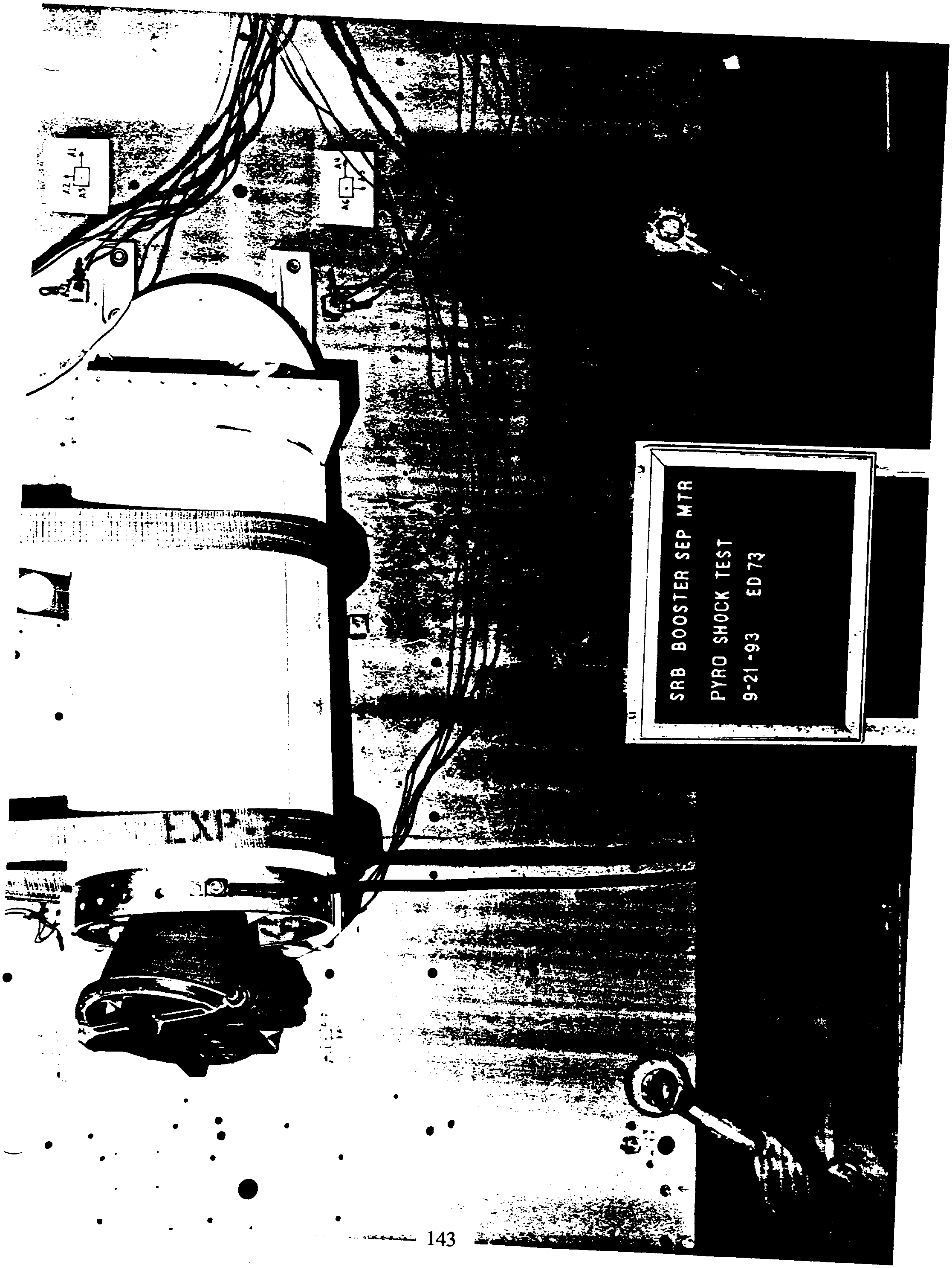


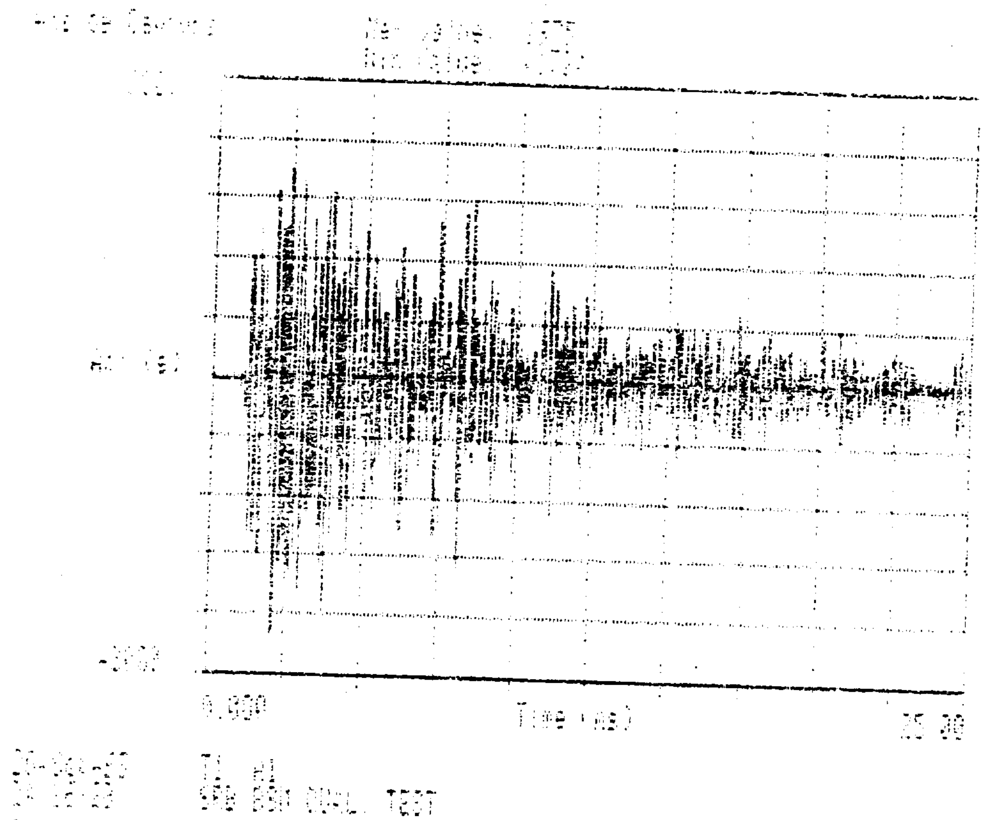

SRB BOOSTER SEP MTR
PYRO SHOCK TEST
9-21-93 ED 73


SRB BOOSTER SEP MTR
PYRO SHOCK TEST
9-21-93 ED 73


SRB BOOSTER SEP MTR
PYRO SHOCK TEST
9-20-93 ED 73

Appendix B

Test Data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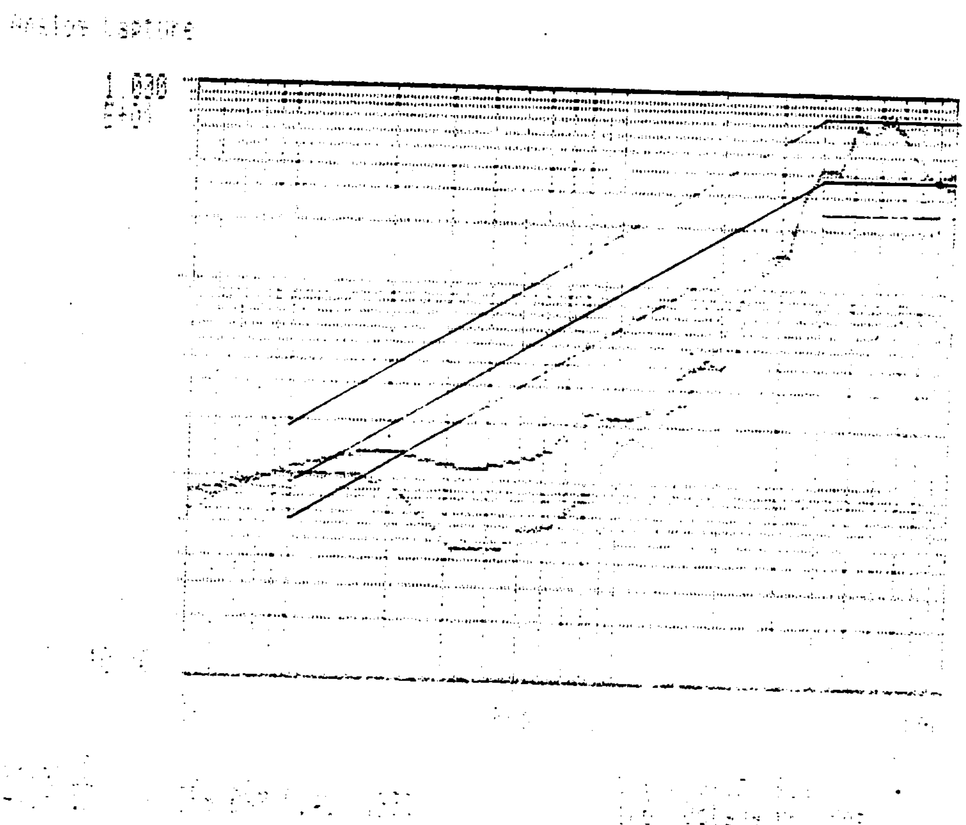
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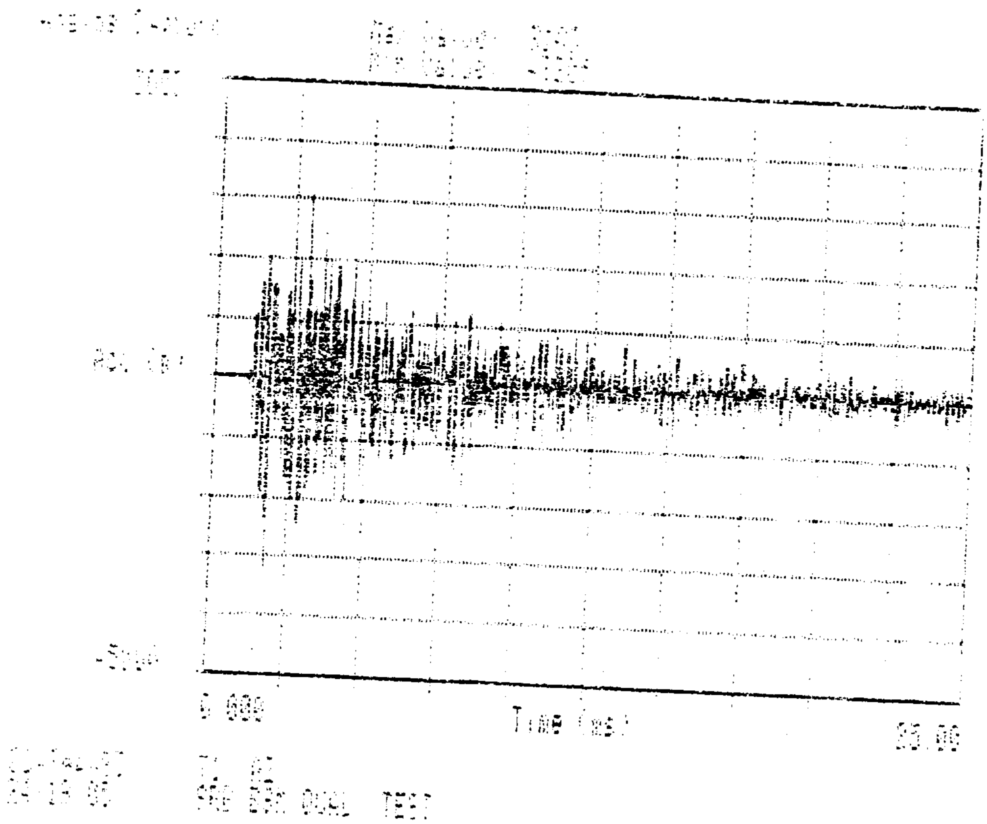

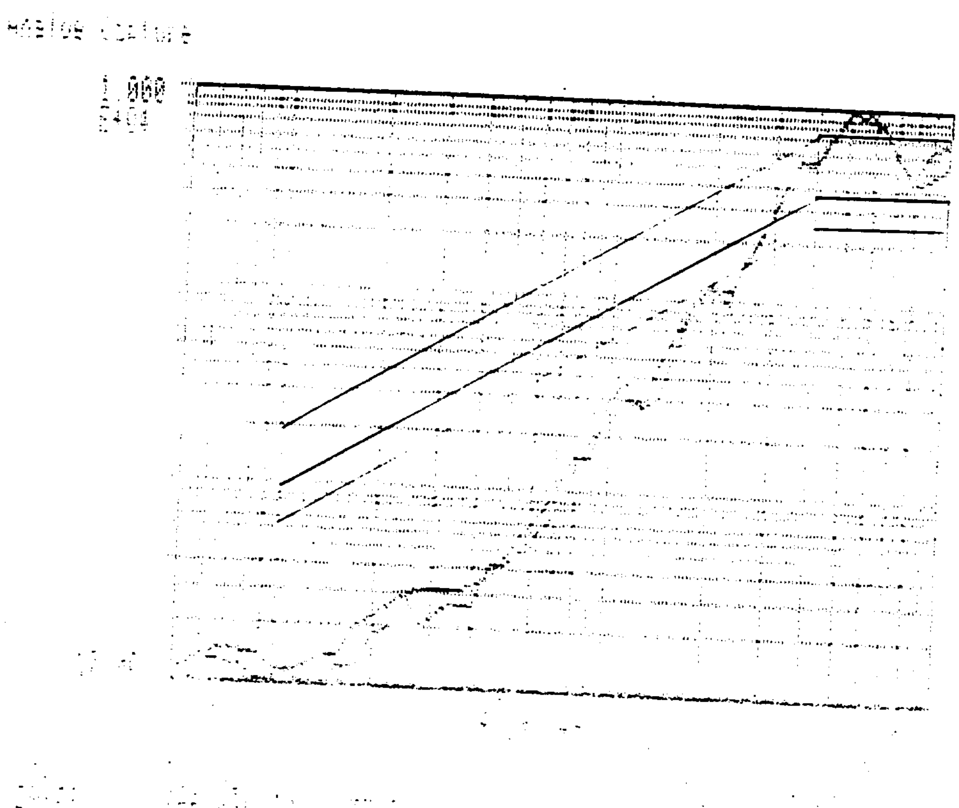

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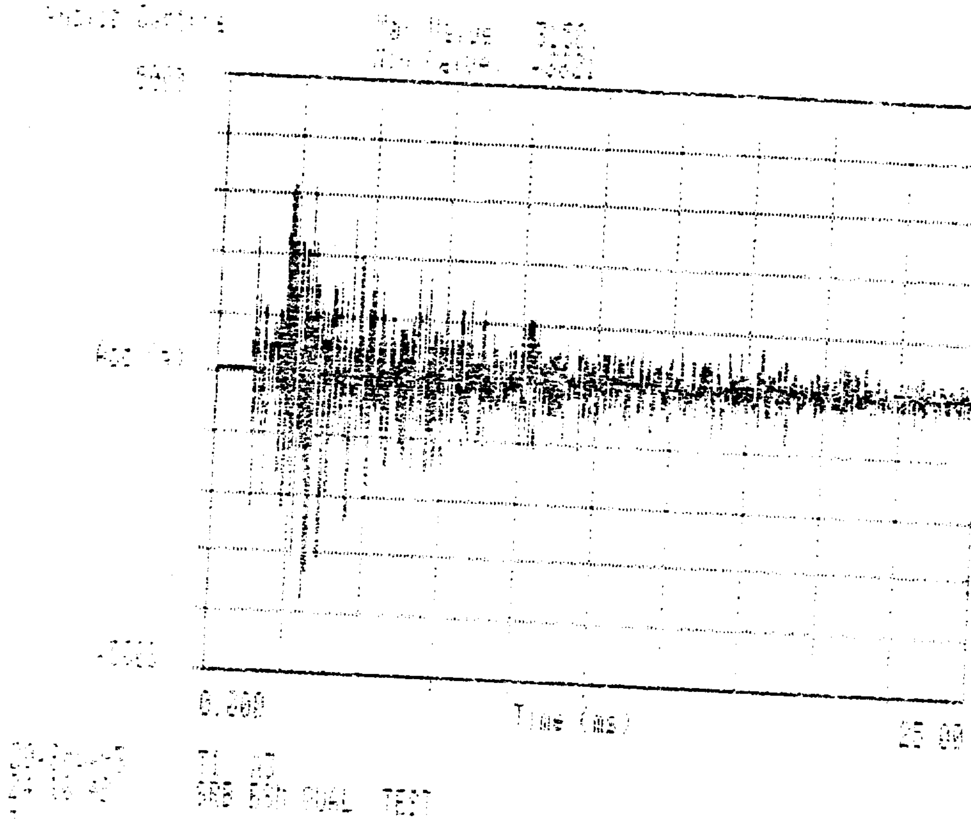

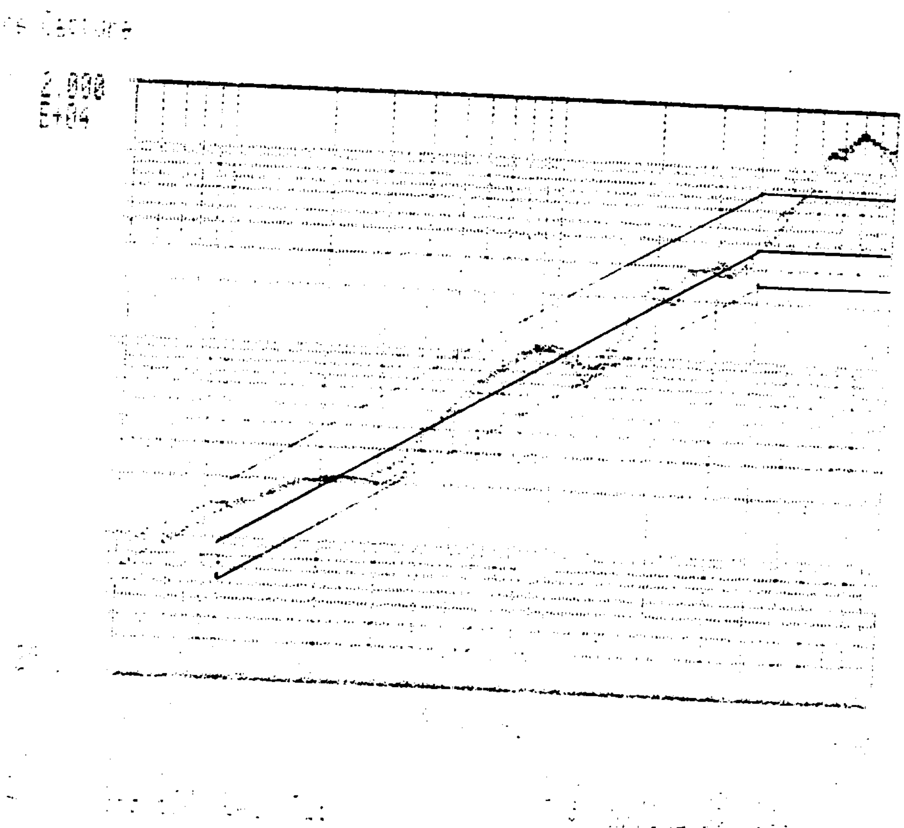

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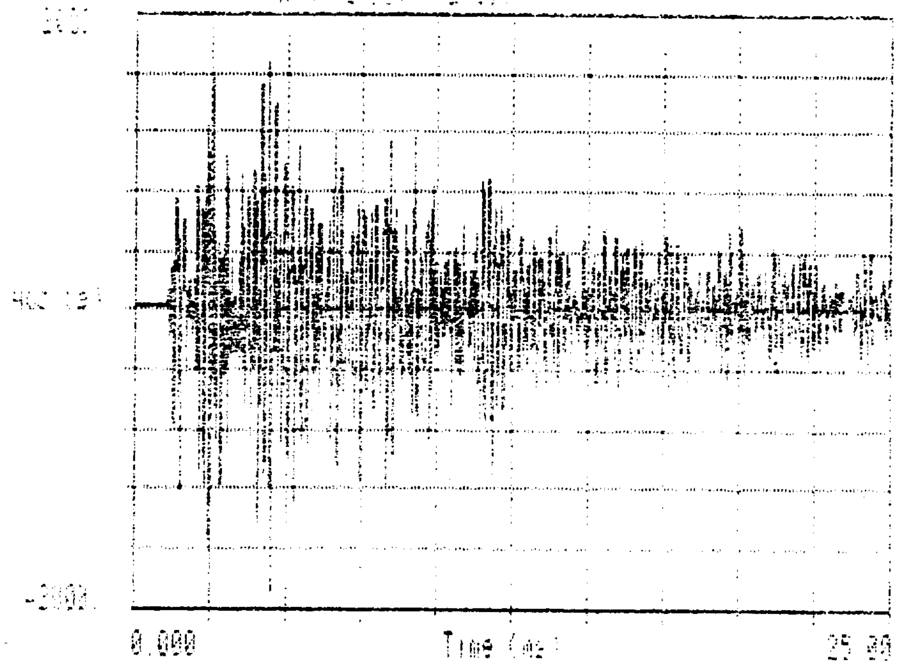

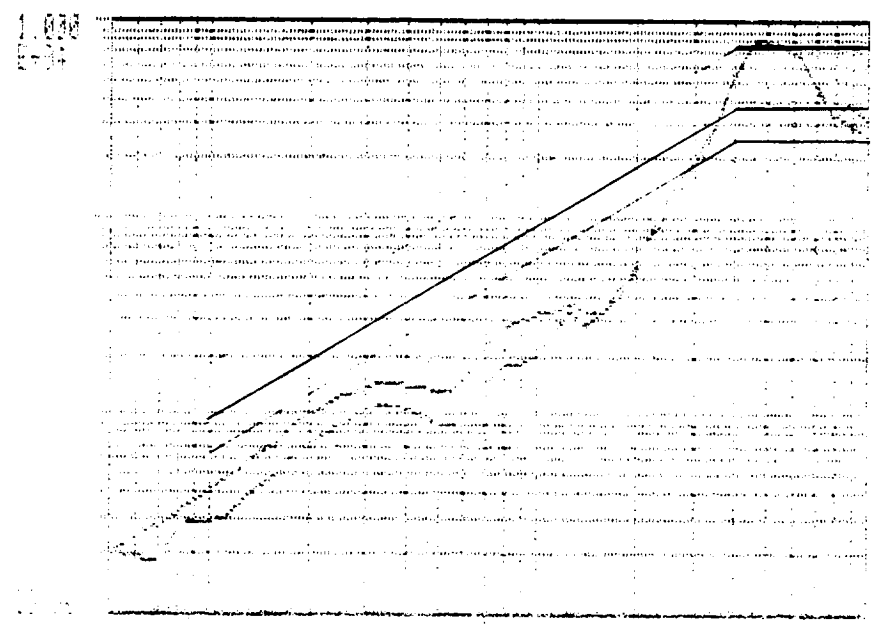

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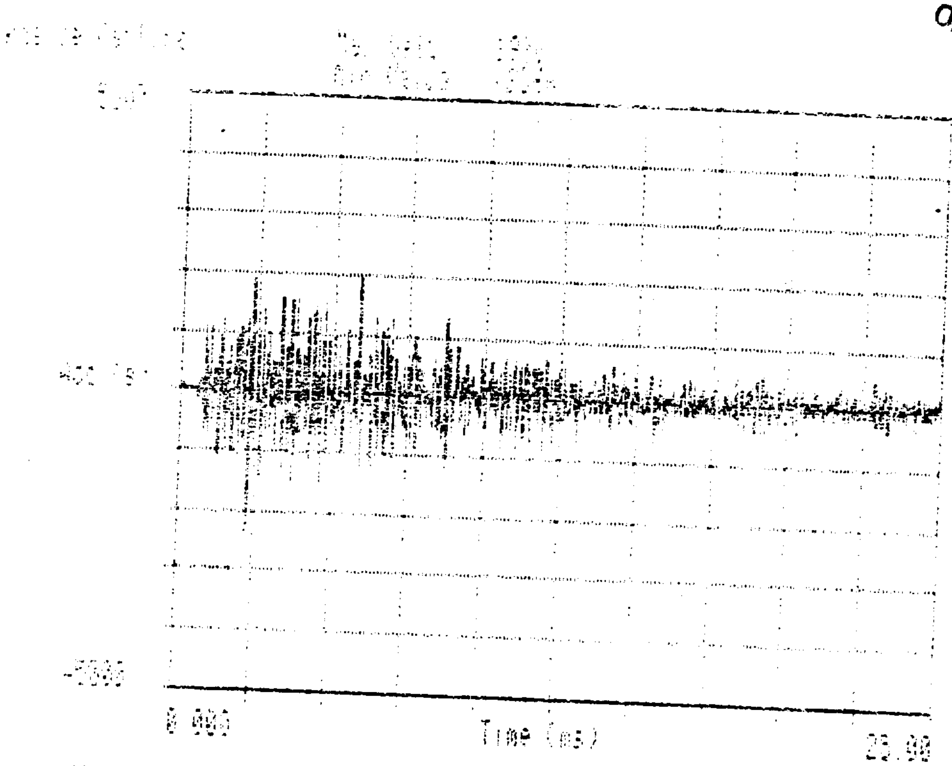

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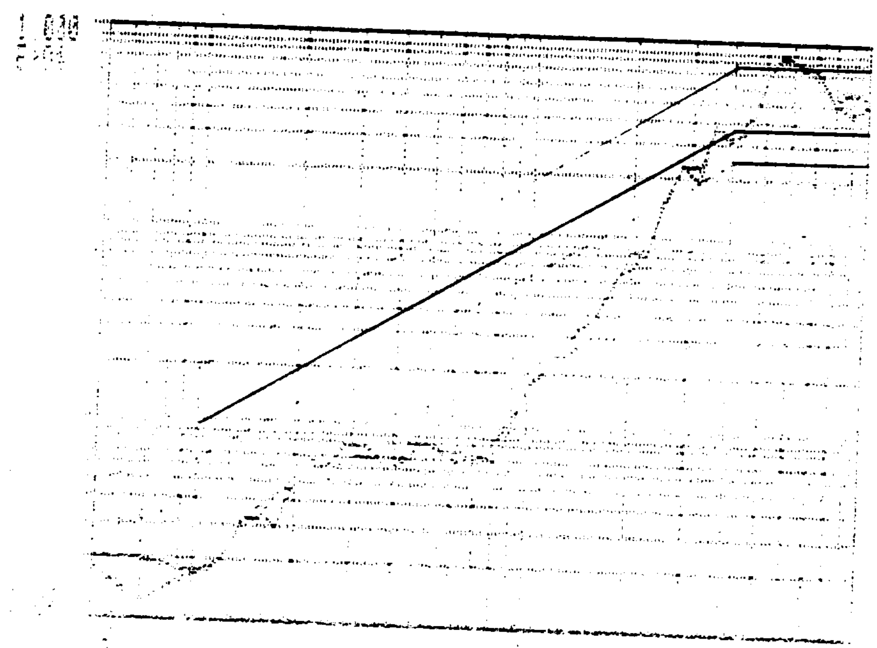

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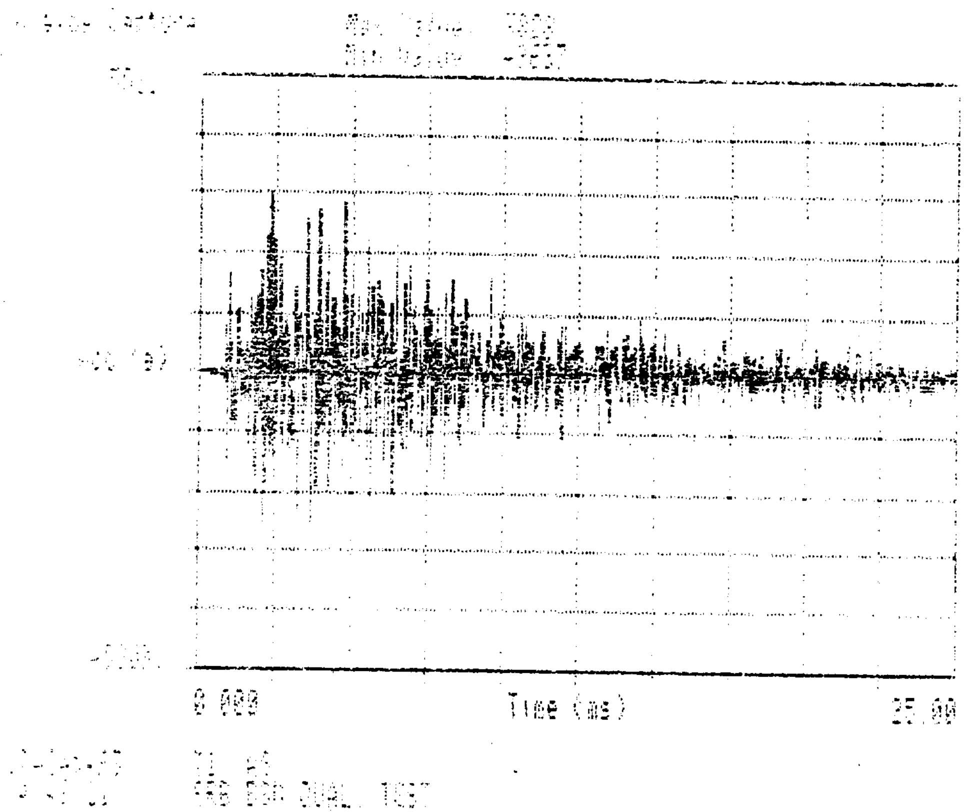
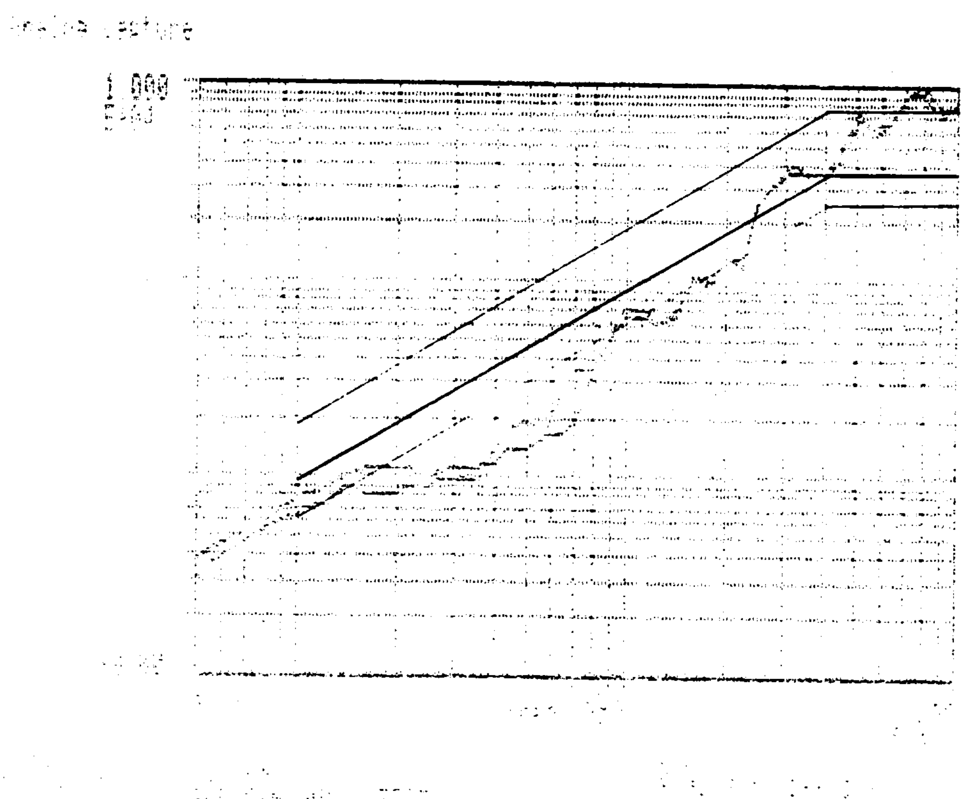
Analog Capture





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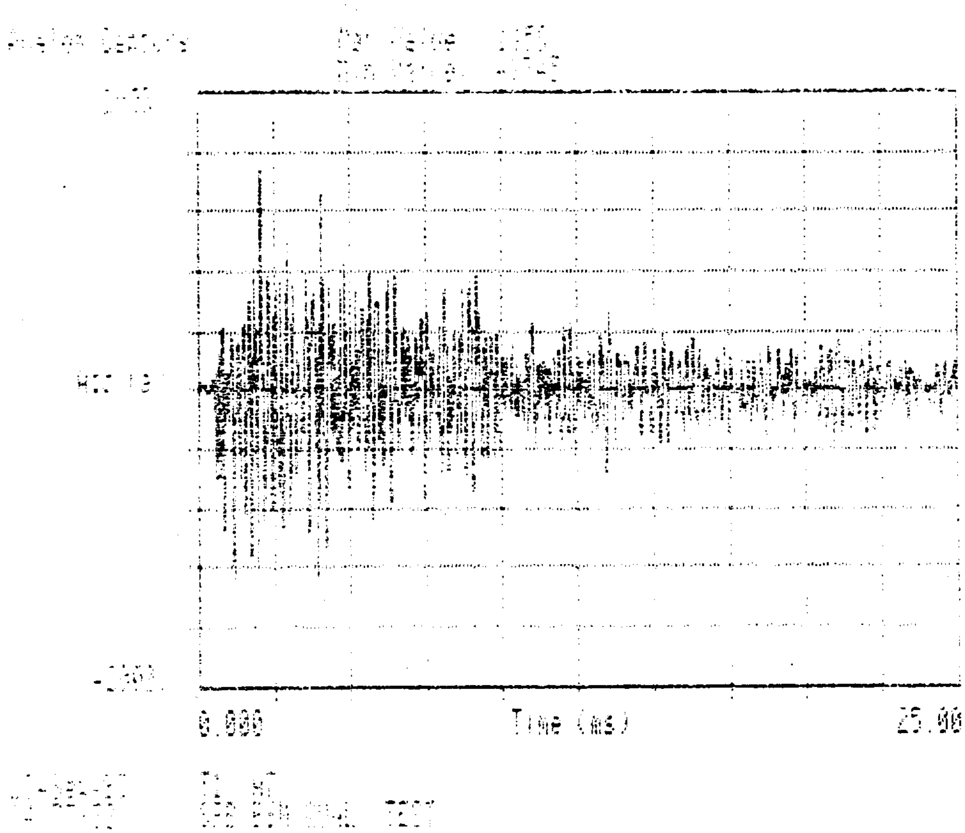

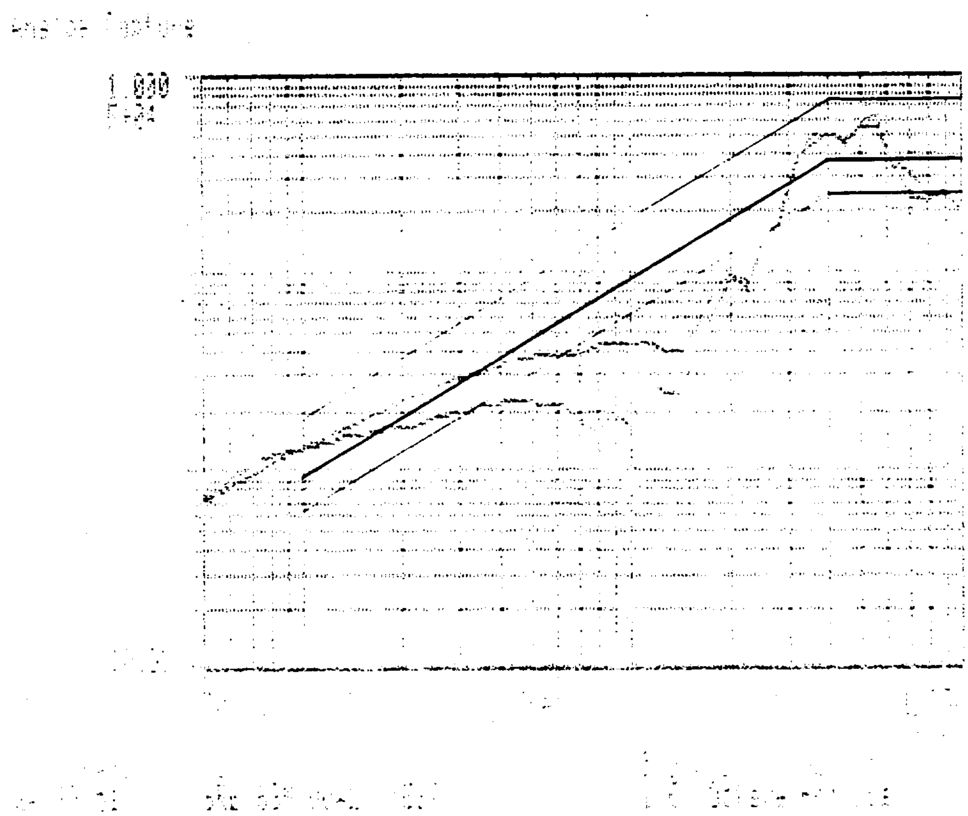

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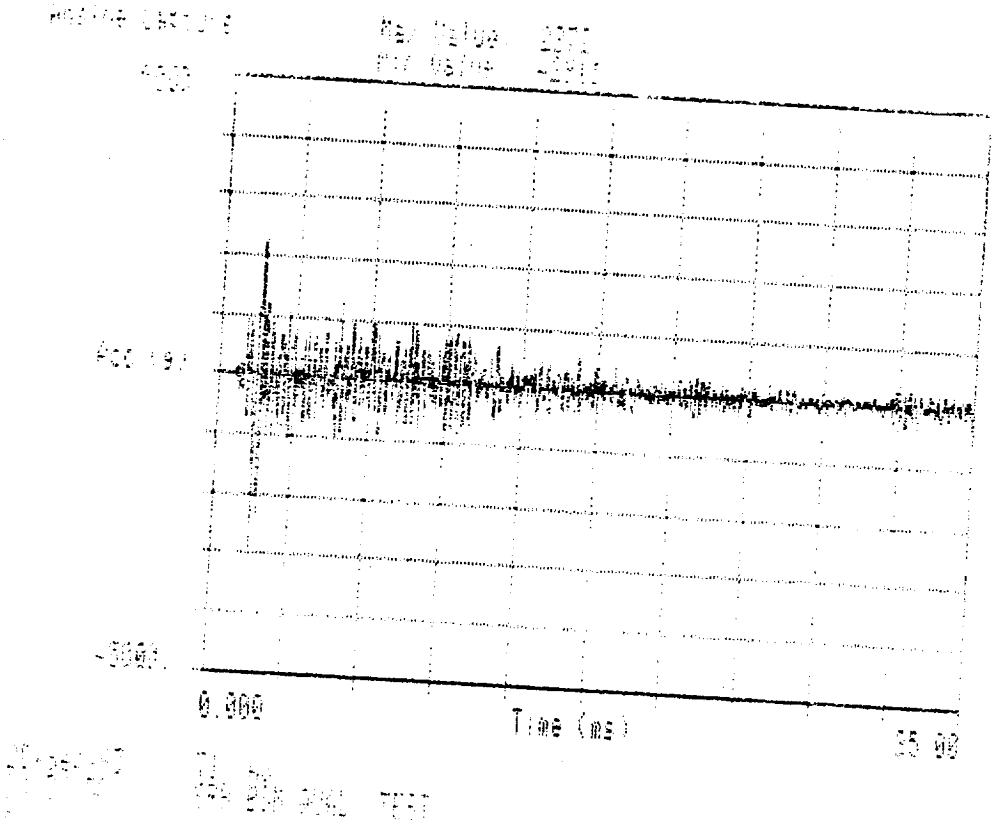
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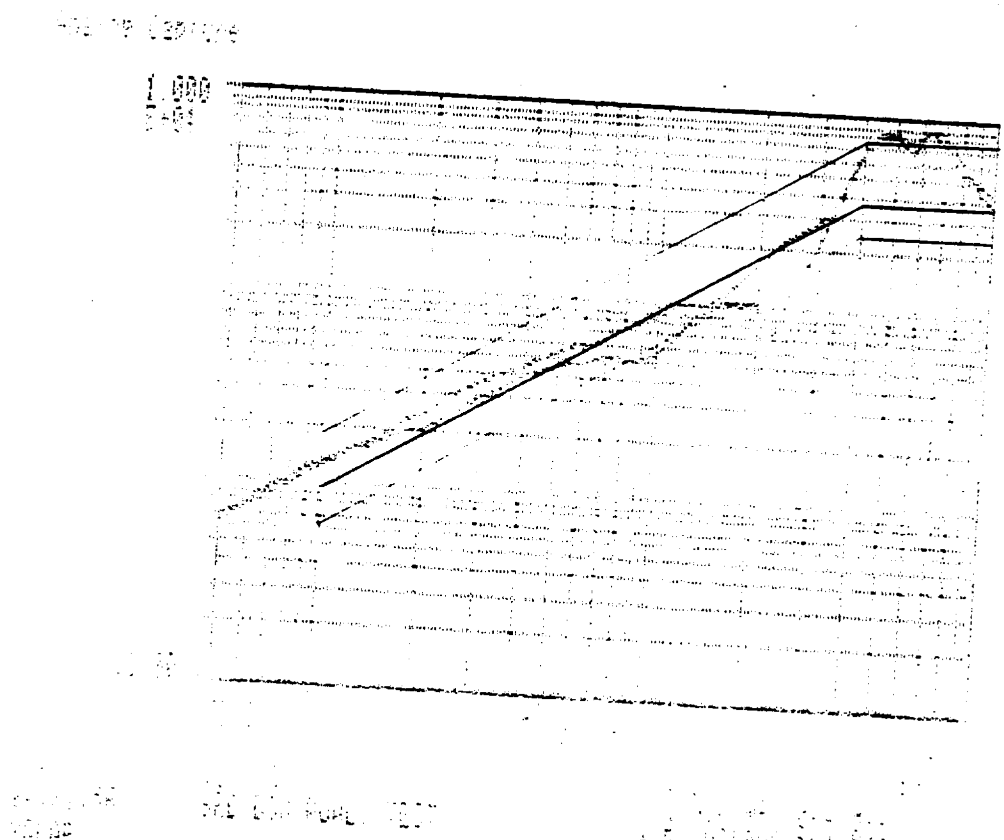

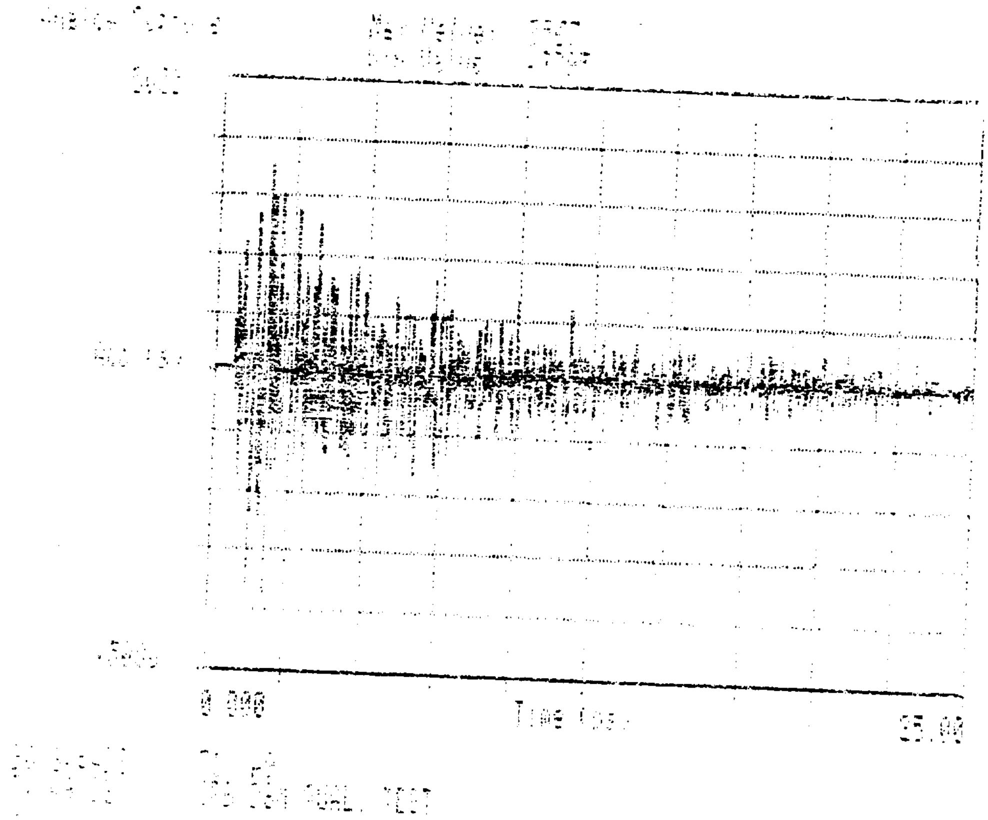

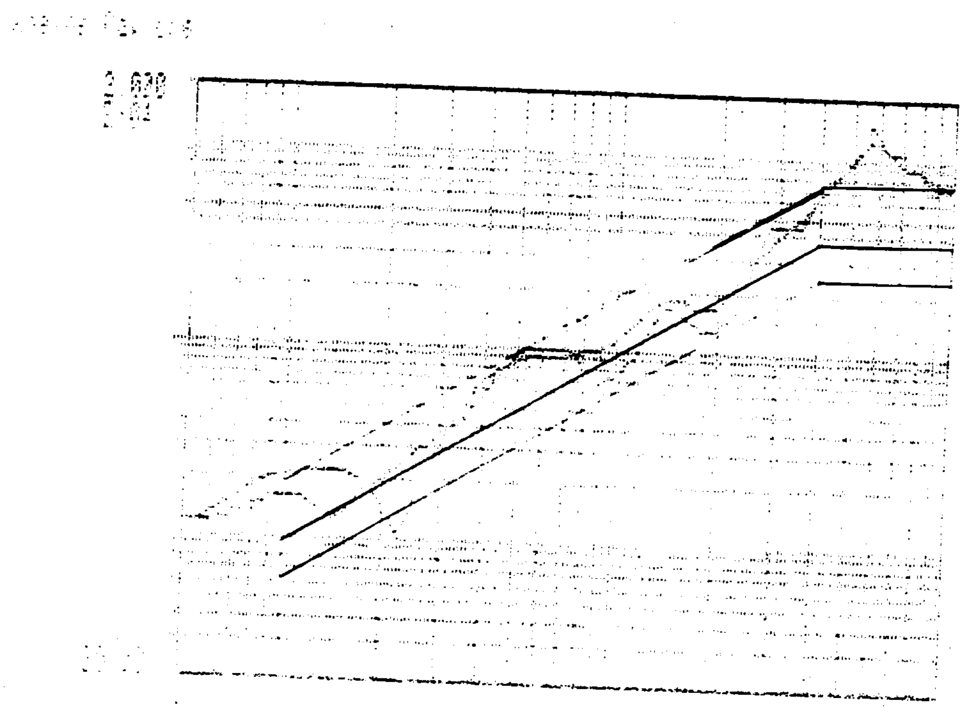

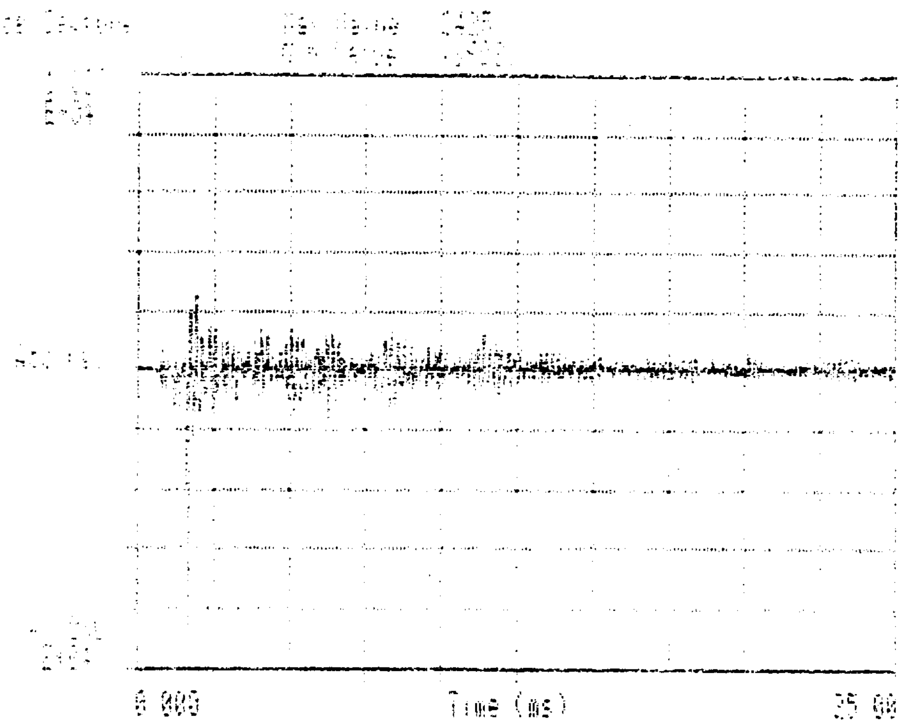
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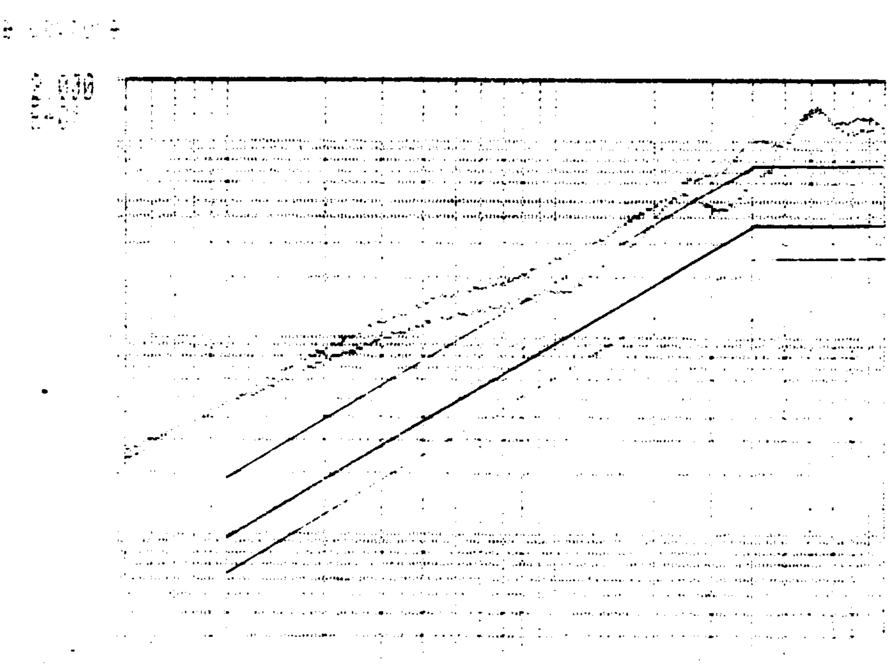
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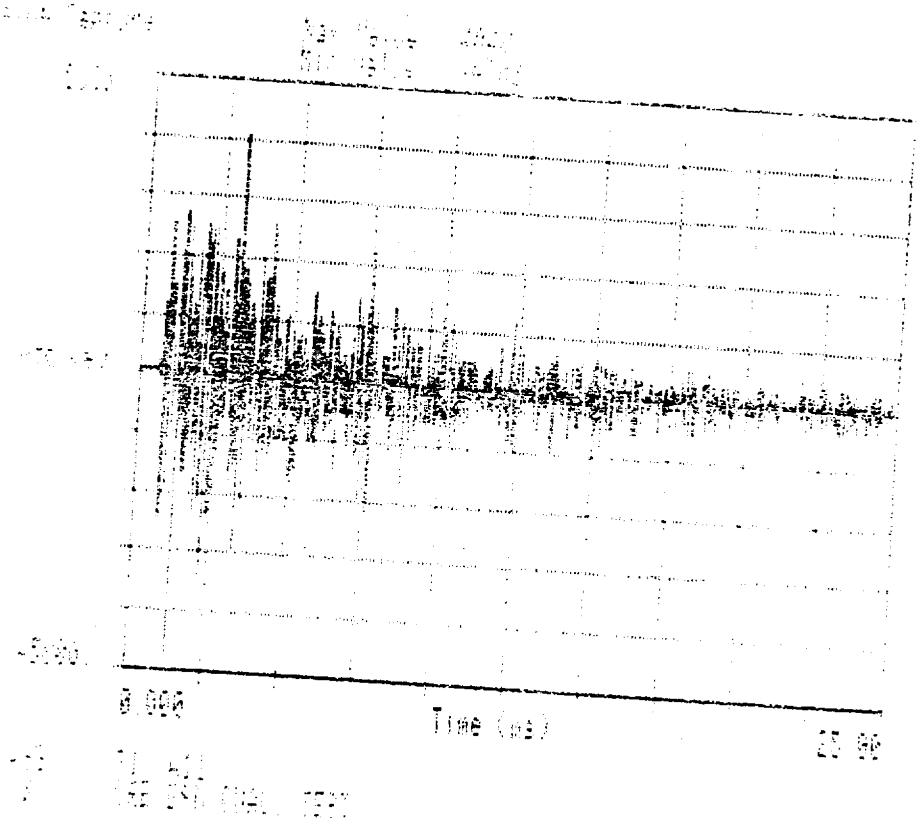
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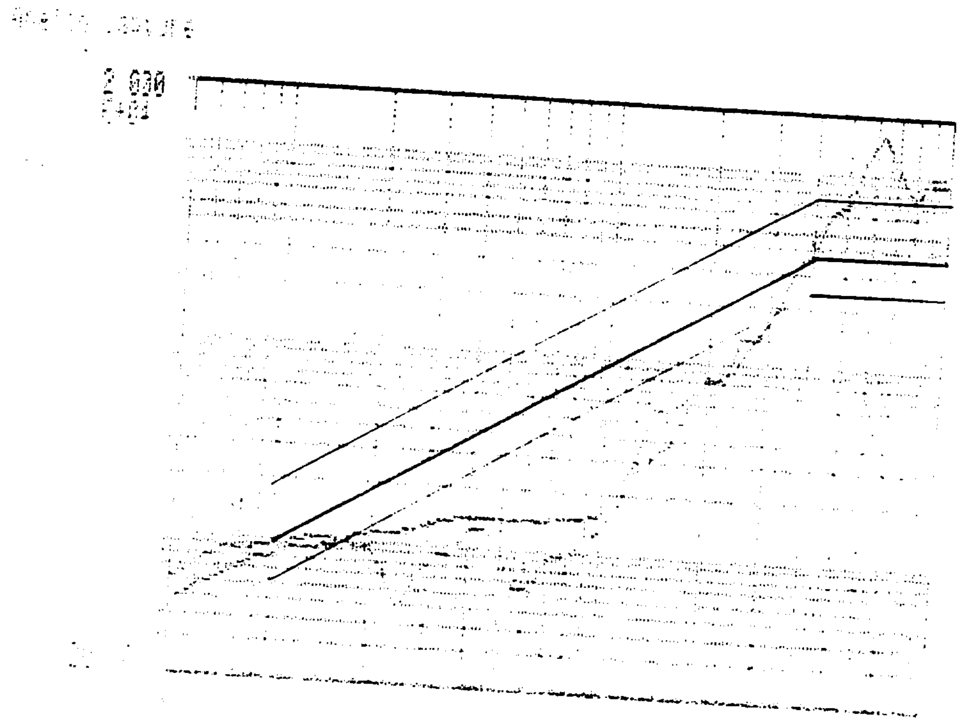
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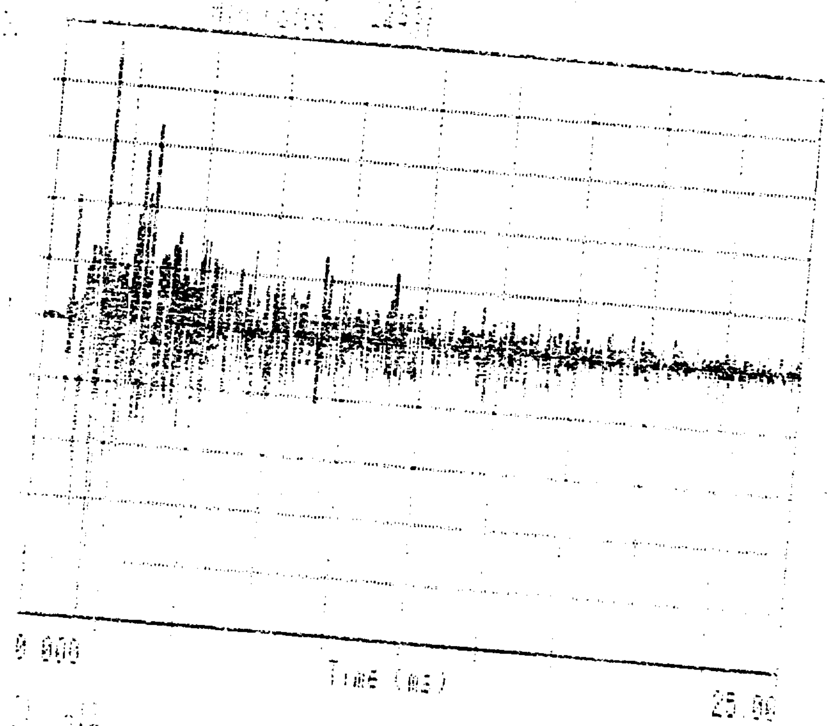
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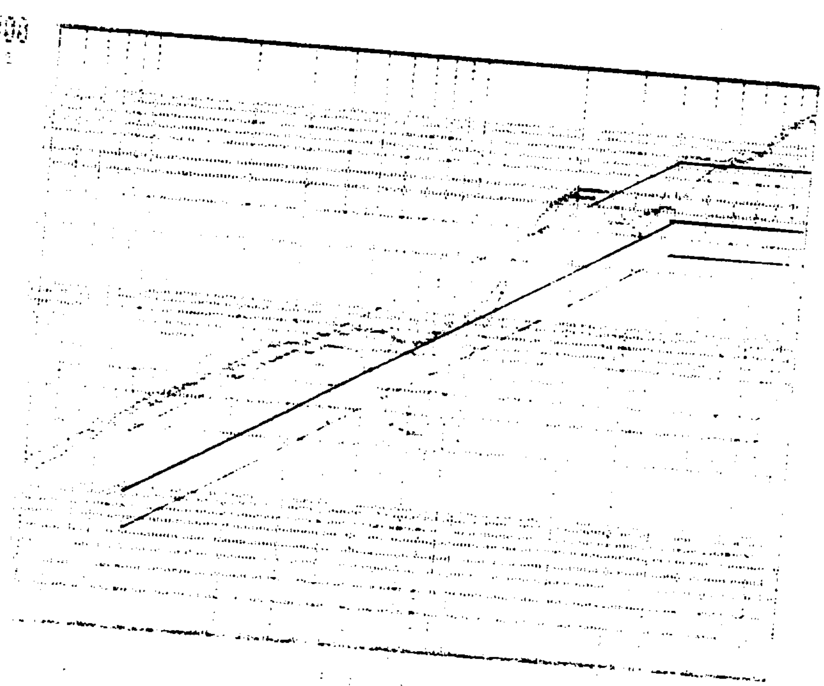
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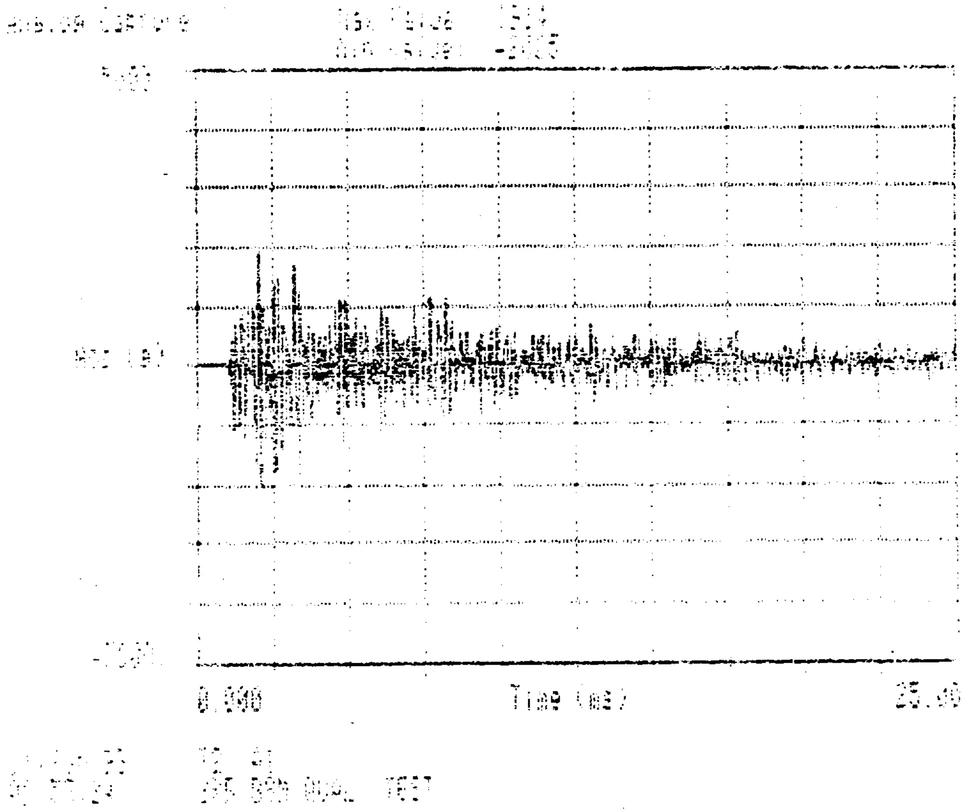
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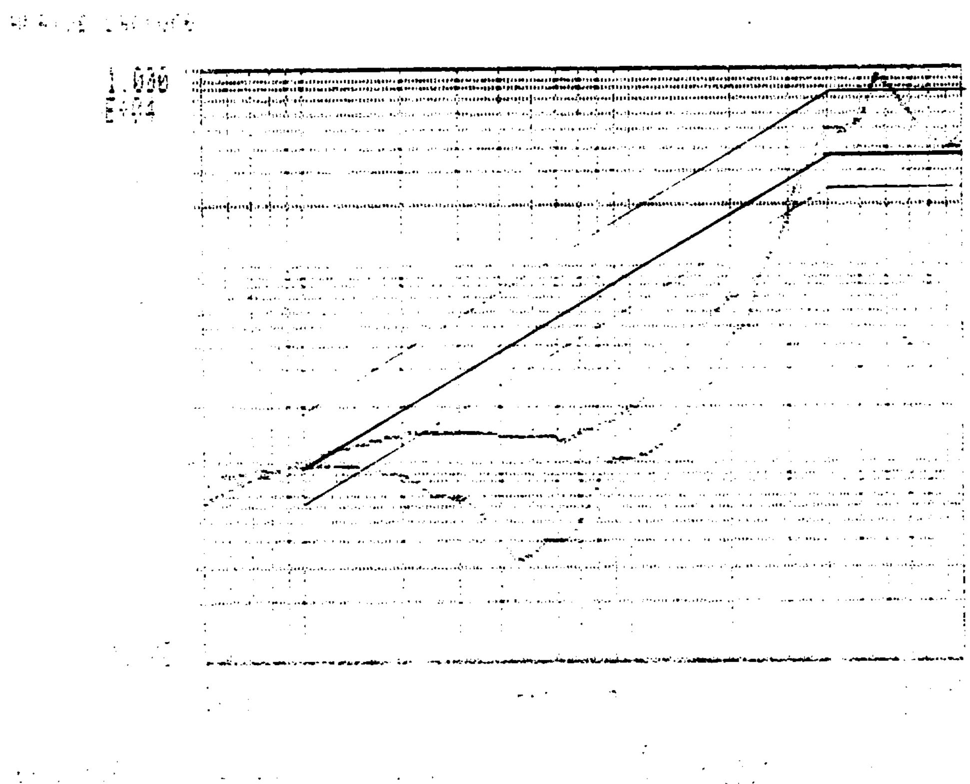
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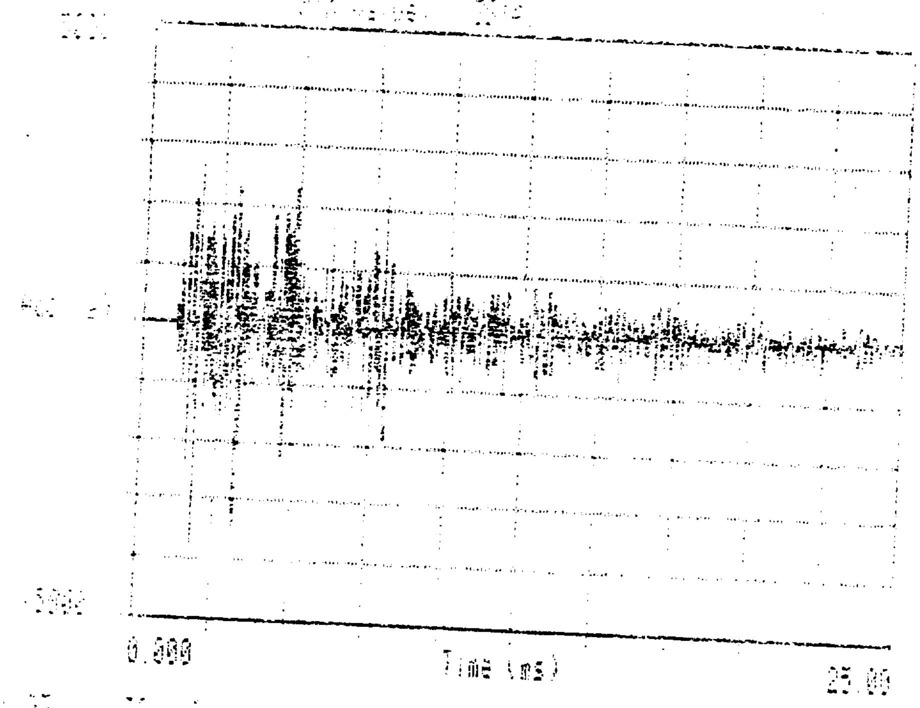
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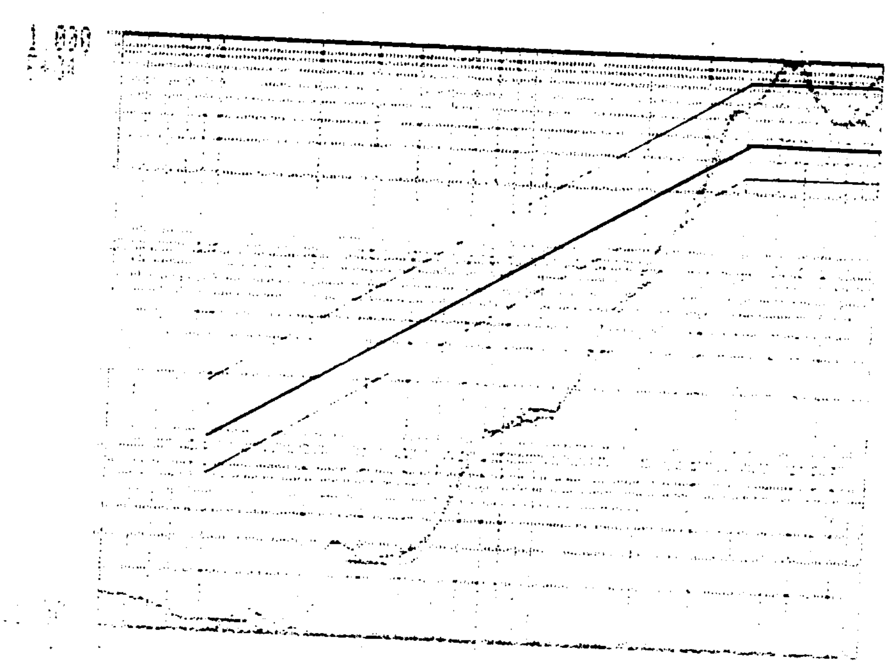

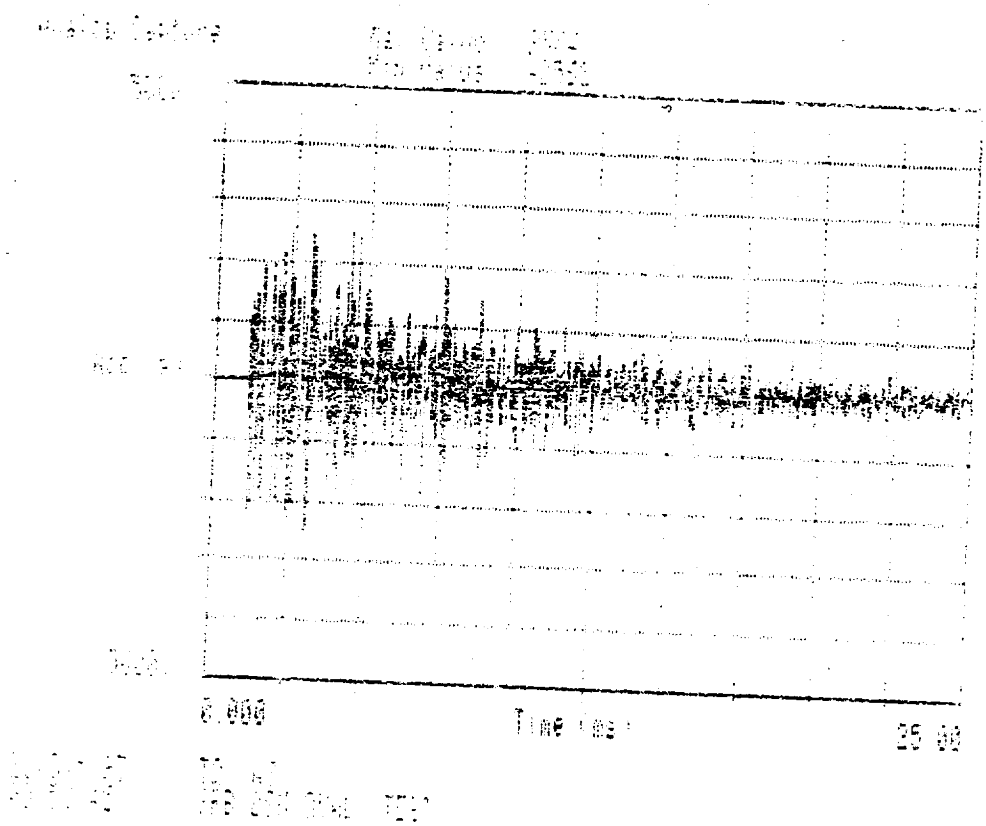

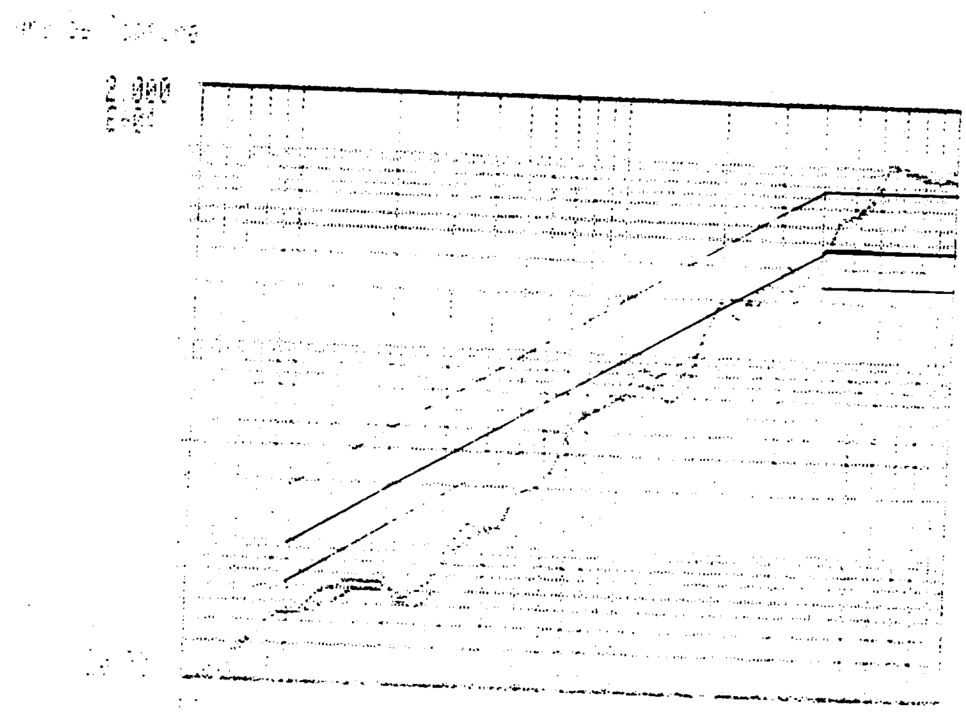

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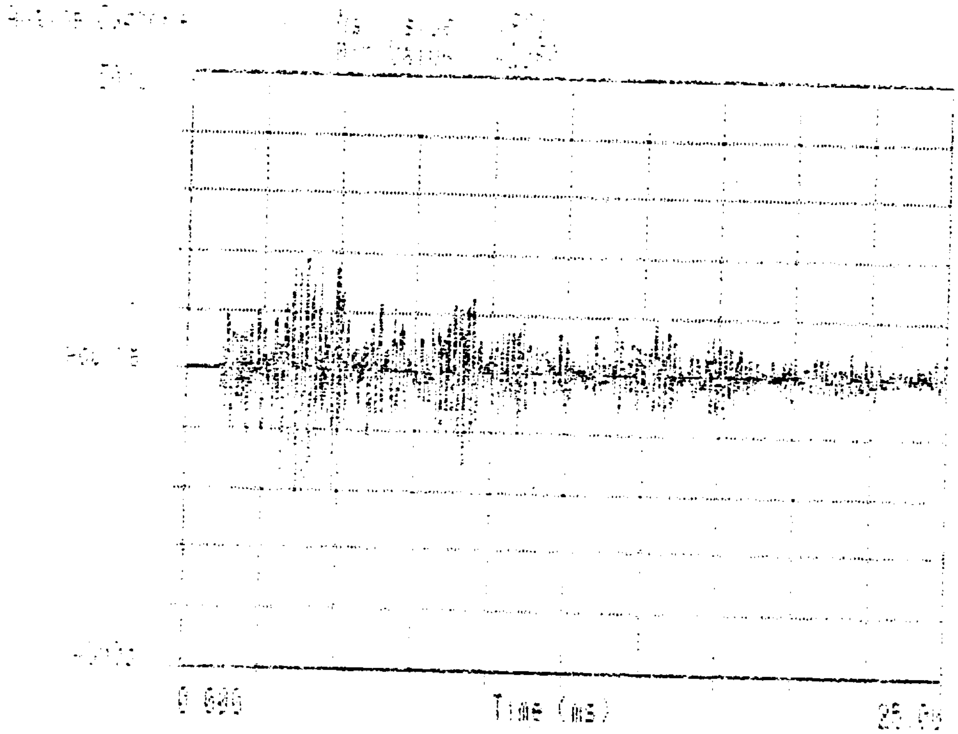
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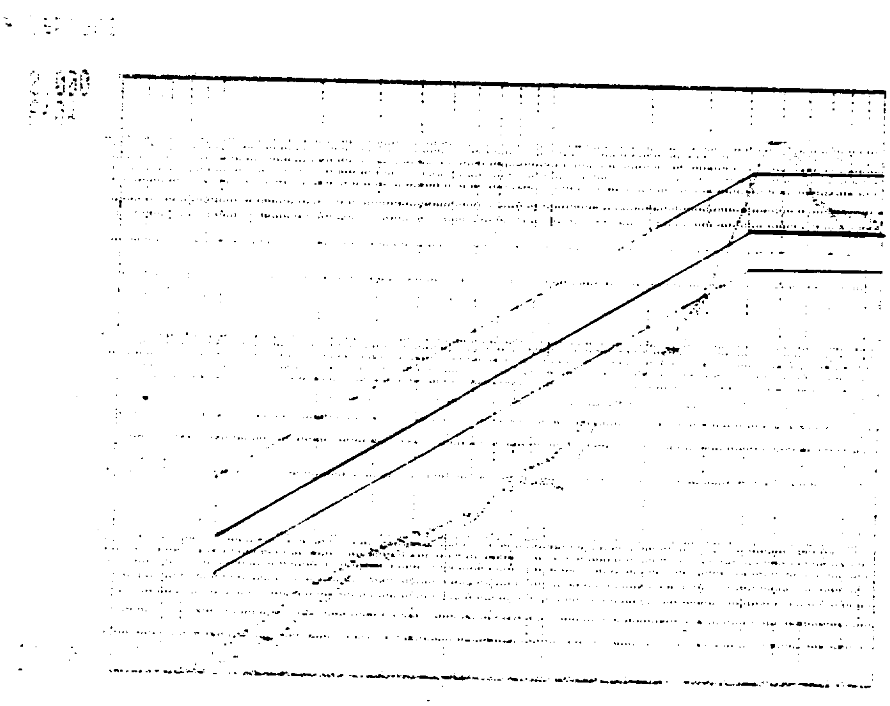
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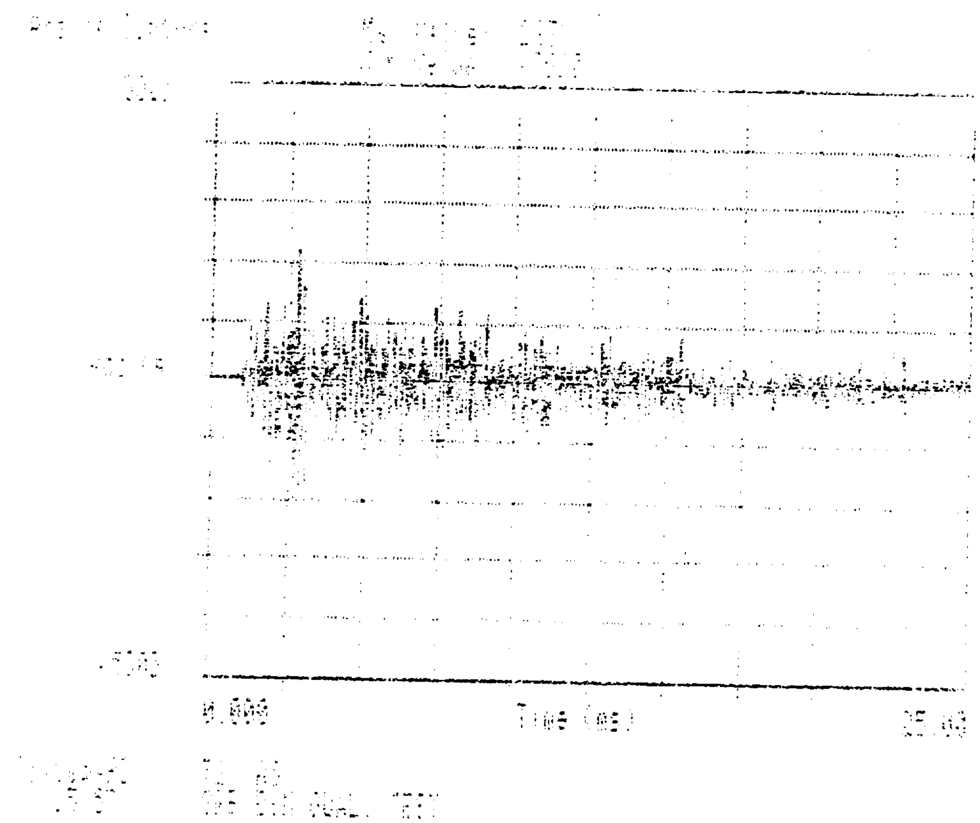

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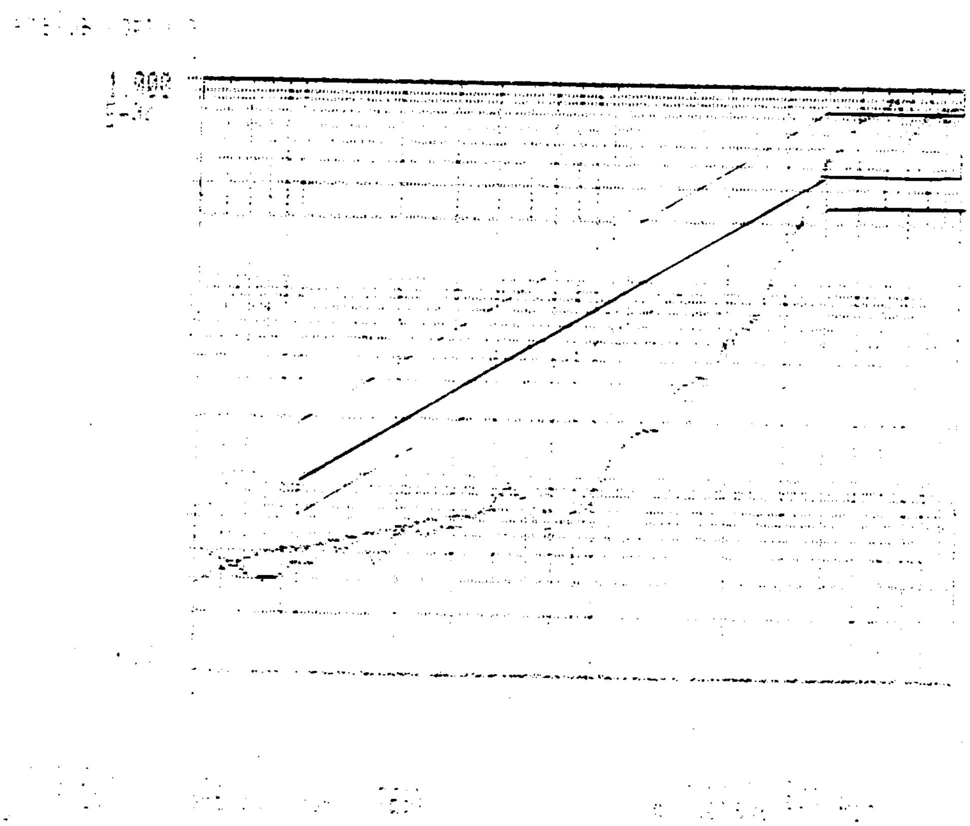

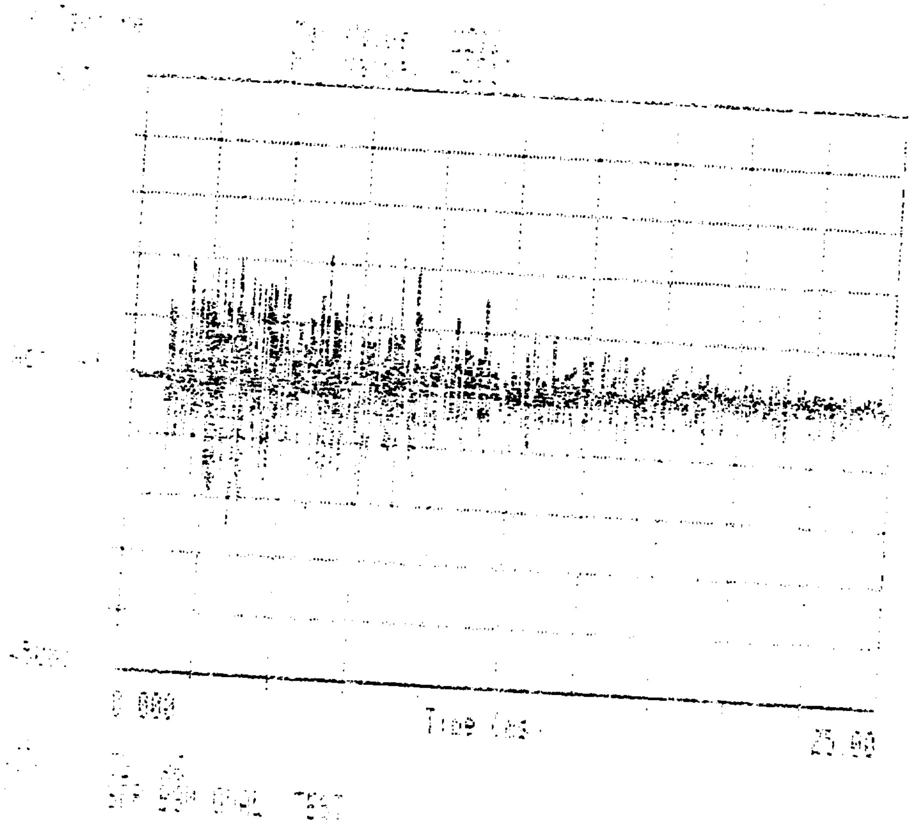
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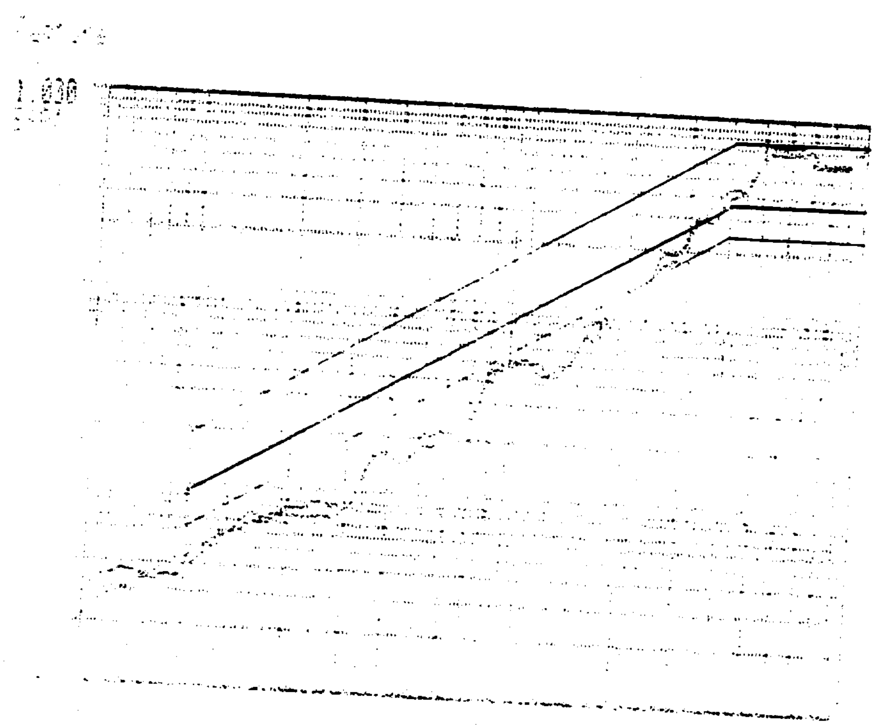
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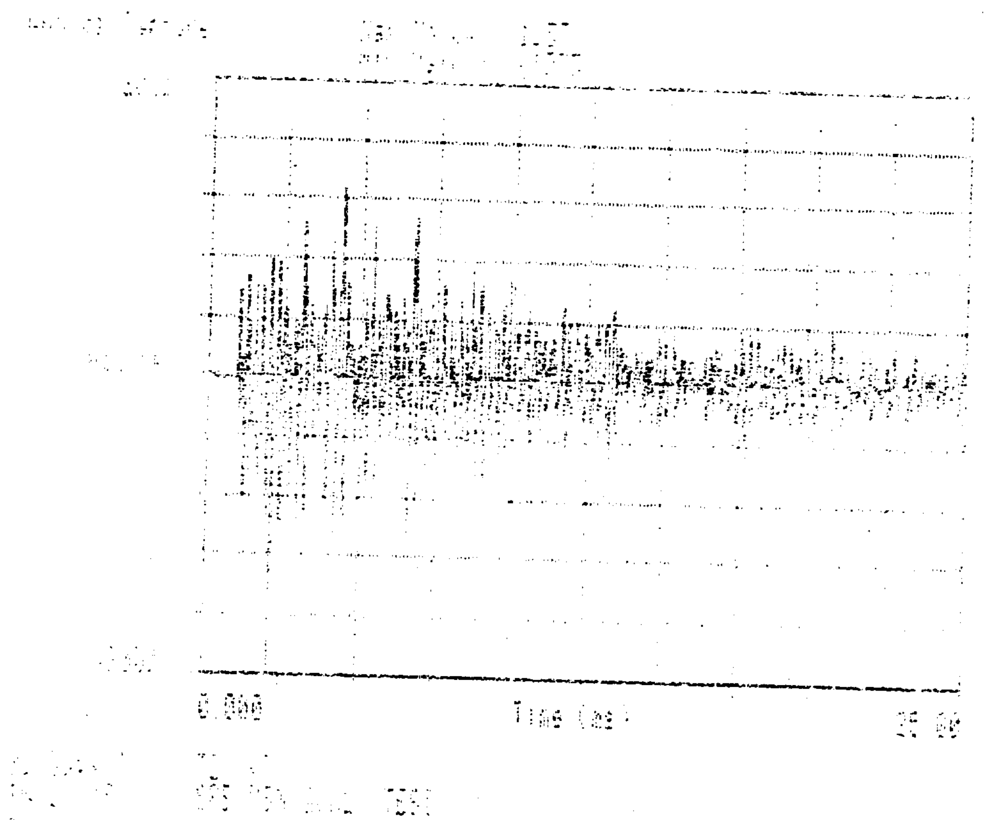

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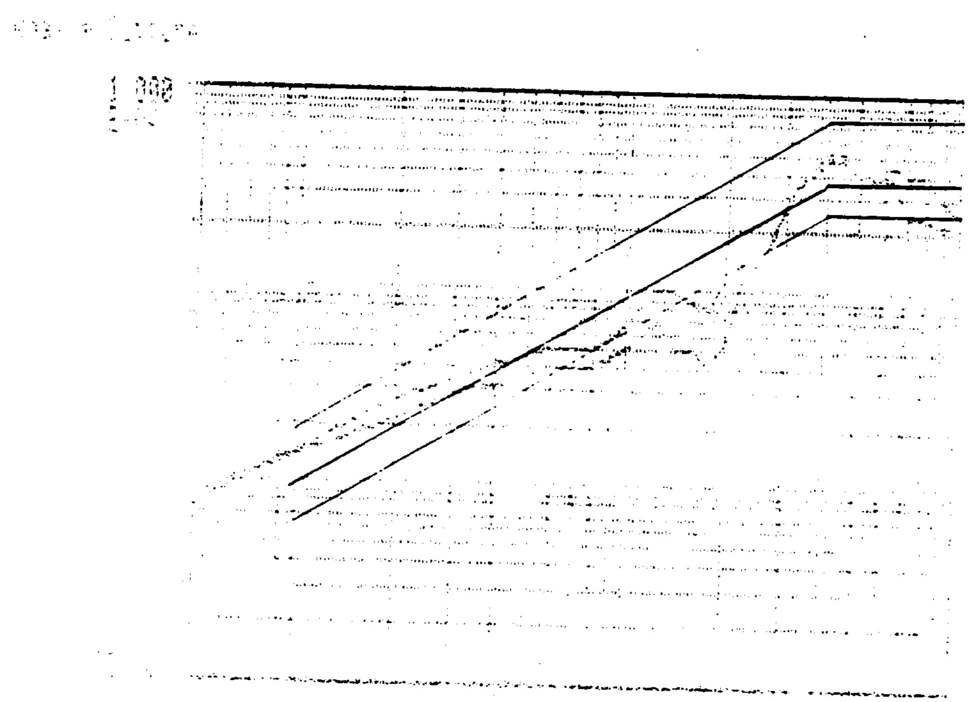

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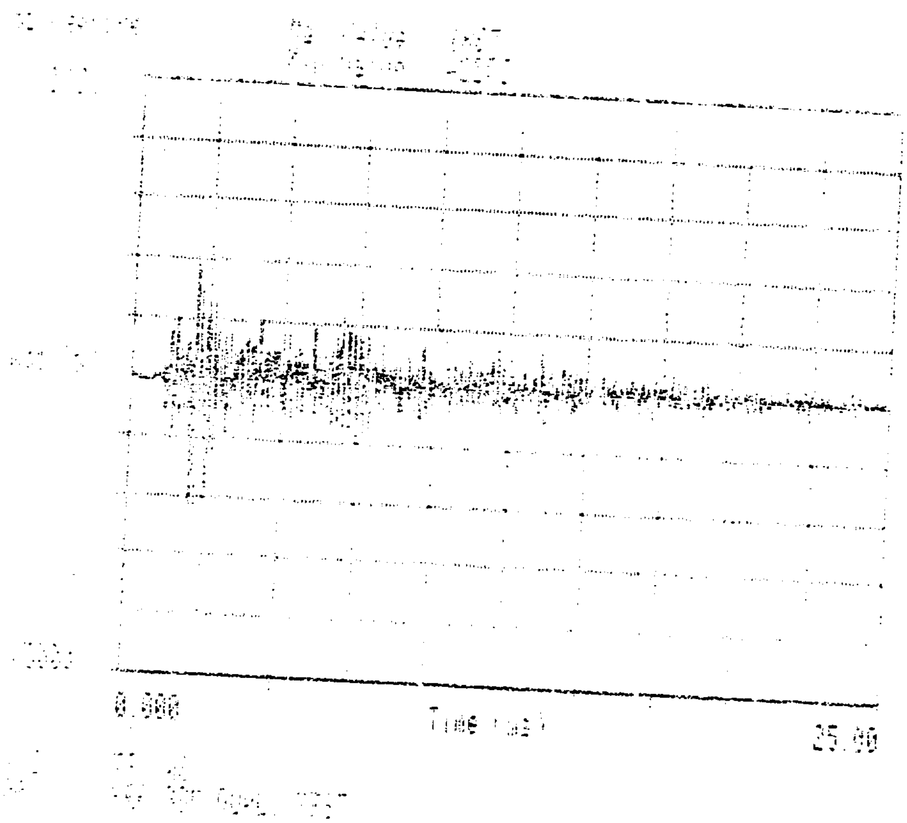
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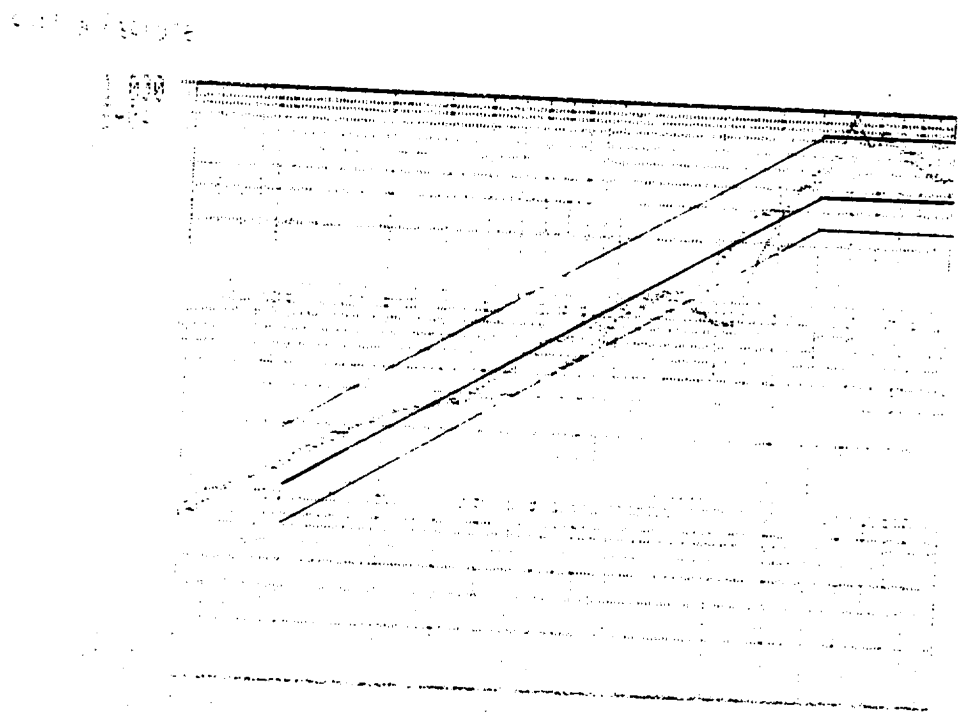

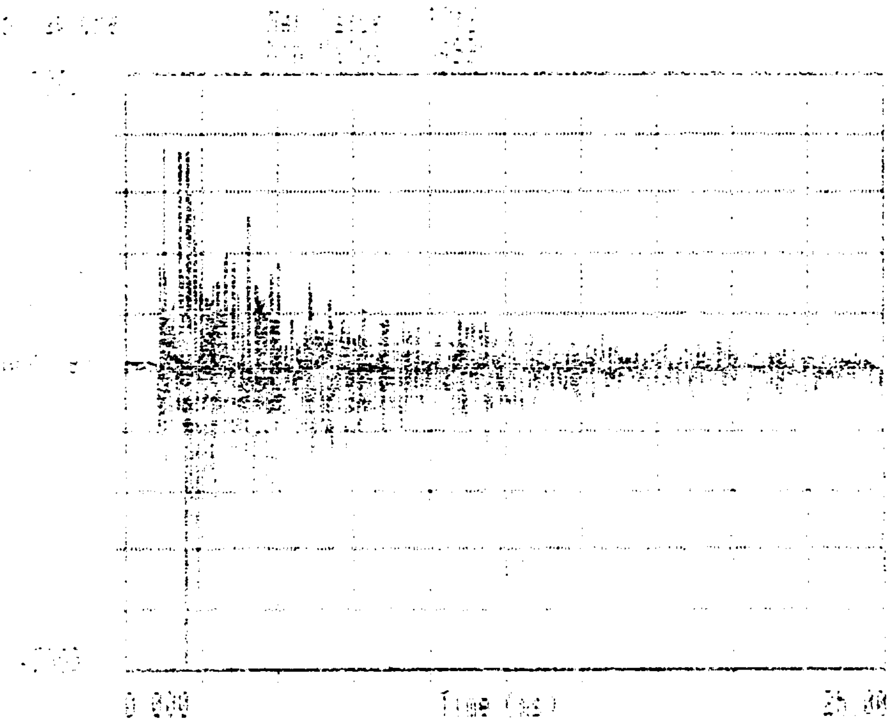
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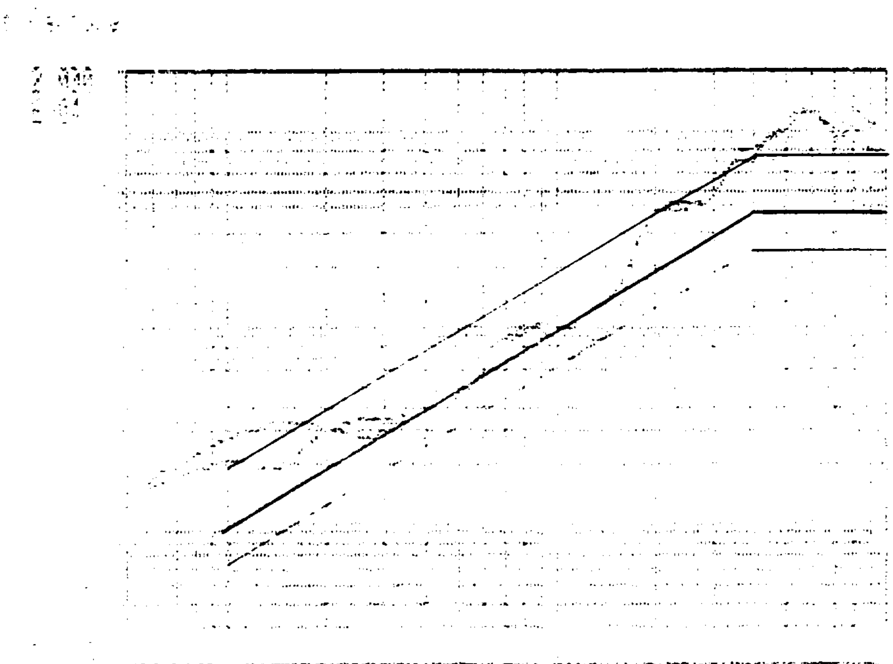

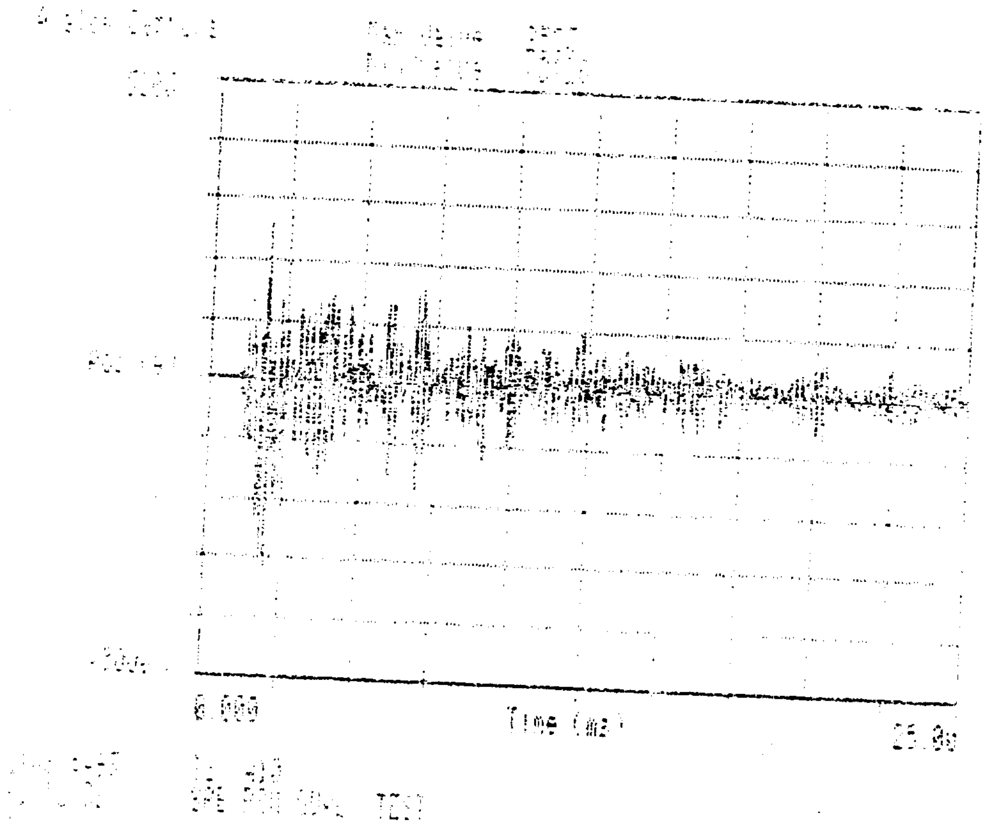

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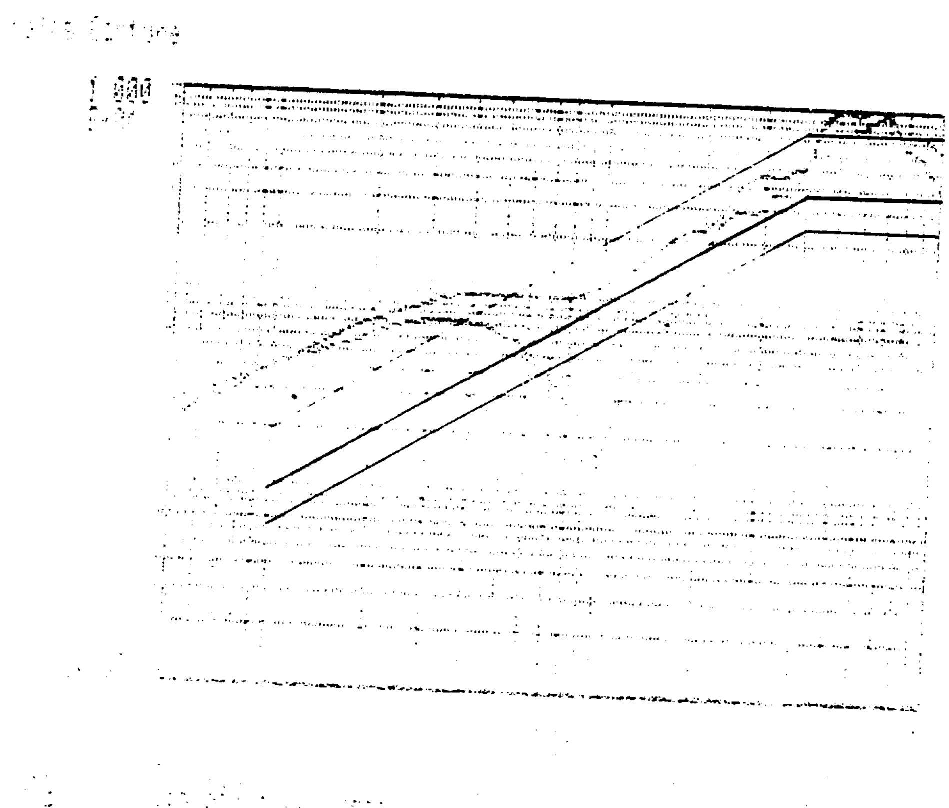

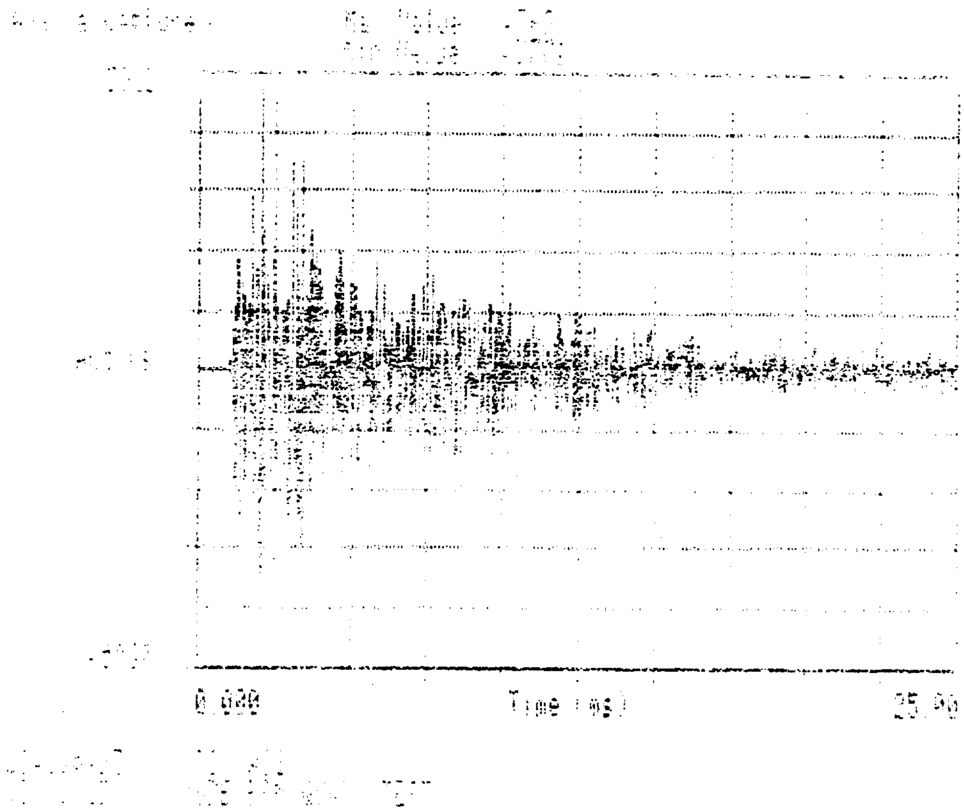

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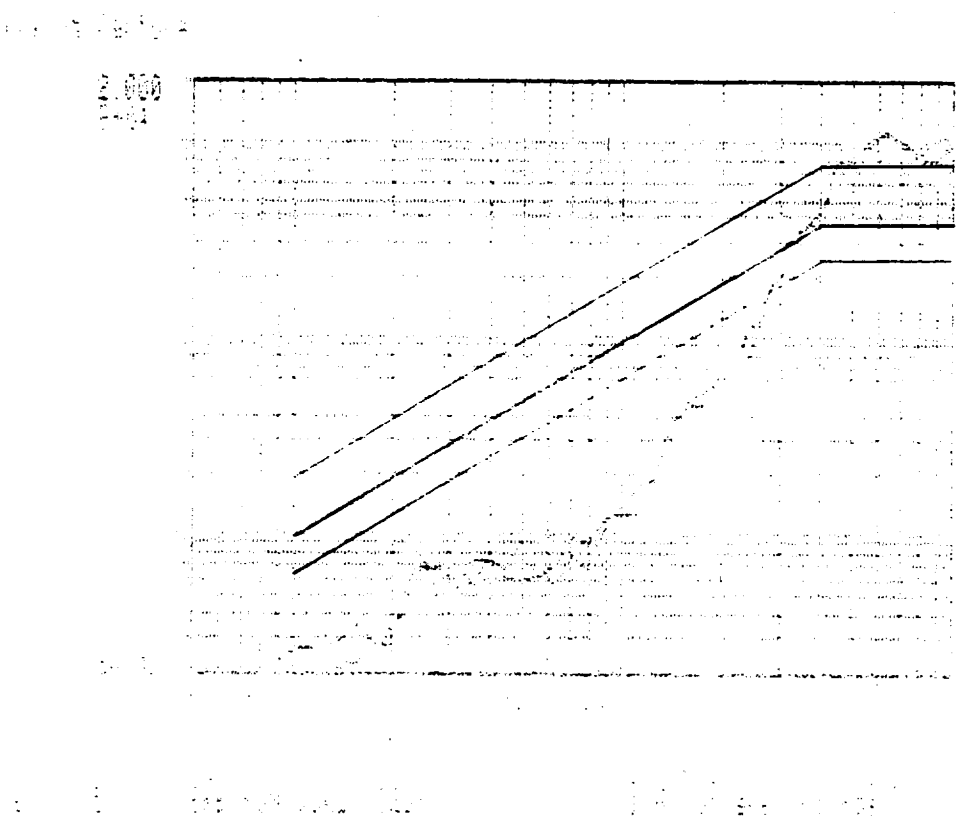

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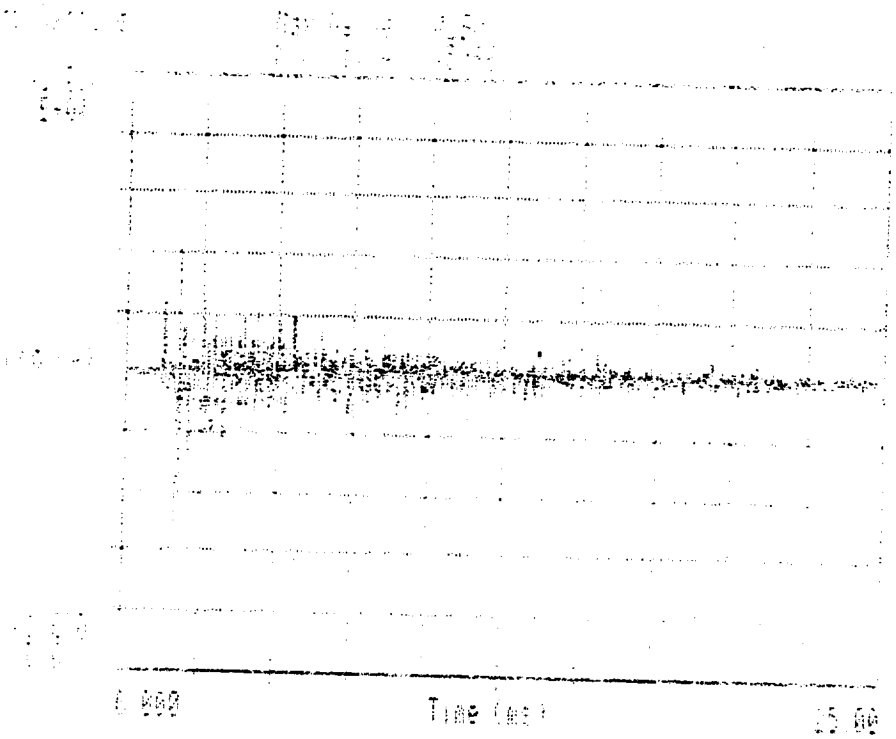
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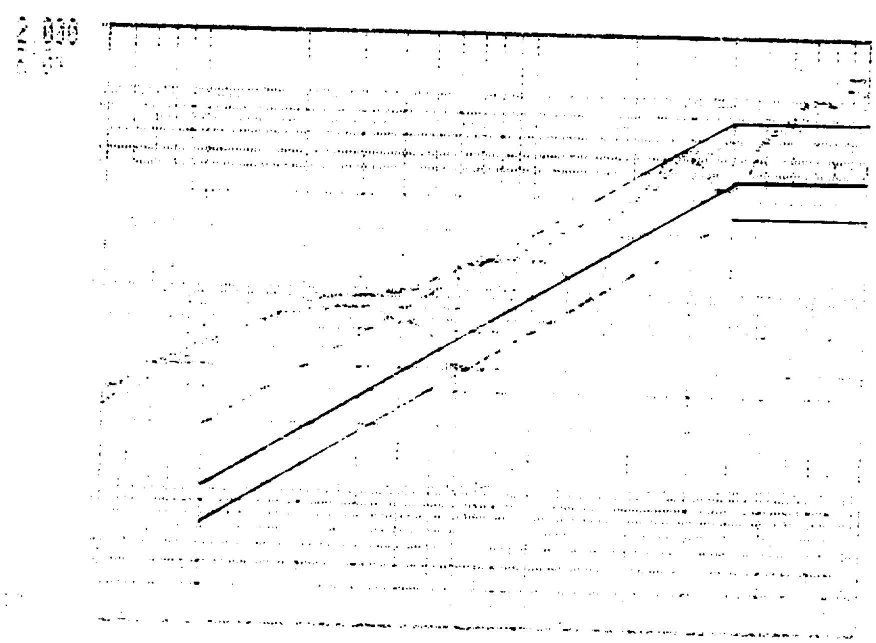
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Appendix C

Specification Exceedance Deviation

Figure 1

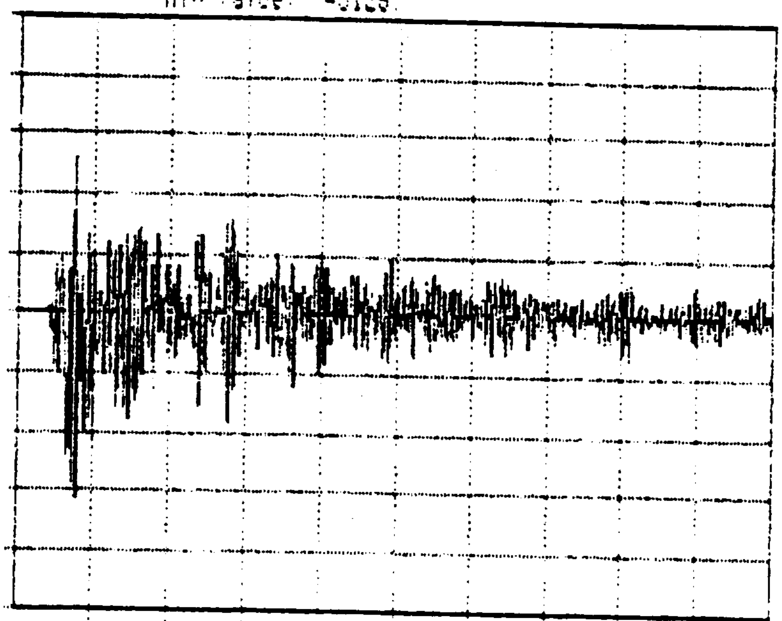
TEST PROCEDURE DEVIATION		TCP NO: BSM-TCP-EPS4-001
TEST ENGINEER: Mat Berill MB 09/29/93	QUALITY: Rick Clements RC 9-29-93	DATE: 09/29/93
REQUIREMENTS ENGINEER: -	OTHER: Richard Leonard (safety) RLf 9-29-93	SHEET 1 OF 7

TITLE: Upper Limit Tolerance Violation for Pyro Shock Simulation Test (SN: ~~10~~00734)

DEV. NO.	PAGE	SEQ.	CHANGE/REASON	PERM/TEMP.
1			Section 4.2.1 in BSM-TCP-EP54-001 states that the test tolerances for shock Response Spectrum are +6 dB and -3 dB when analyzed with a 1/3 octave shock spectrum analyzer and 5% damping. The worst case over test for each axis is shown in the attached graphs. x-axis: accelerometers #10 and #4 y-axis: accelerometer #11 z-axis: accelerometers #12 and #9 Motor SN: 1000734 Jim Herring J.B. Herring ED 13, Lead Pyro Engineer	

ORIGINATOR: Mat Berill	ORGANIZATION: NASA MSFC EP12
ABOVE DEVIATION(S) INCREASE HAZARD LEVEL: N/A / SAFETY: Richard Leonard	ABOVE DEVIATION(S) AFFECT TEST REQUIREMENTS:

Analog Capture   Max Value 2583.   Min Value: -3126.



21-Sep-93   T2 A10
10:12:39   SRB BSM QUAL. TEST
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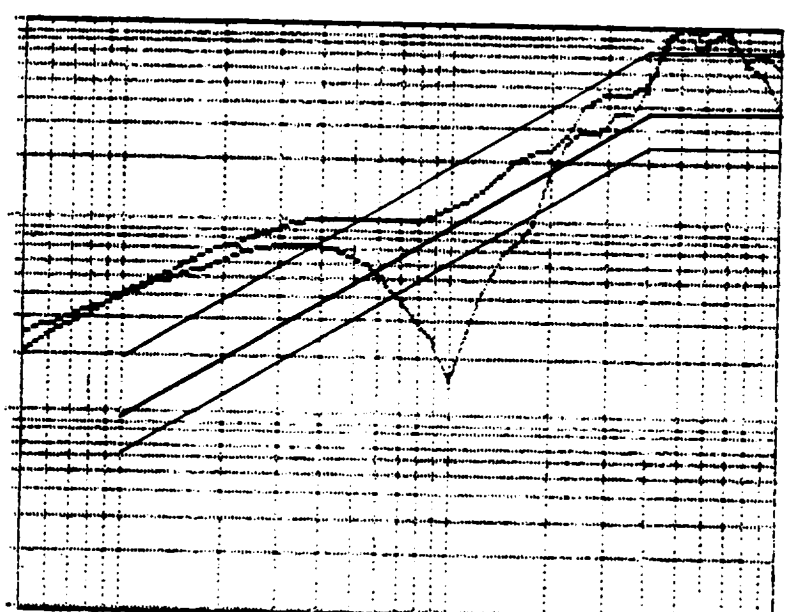
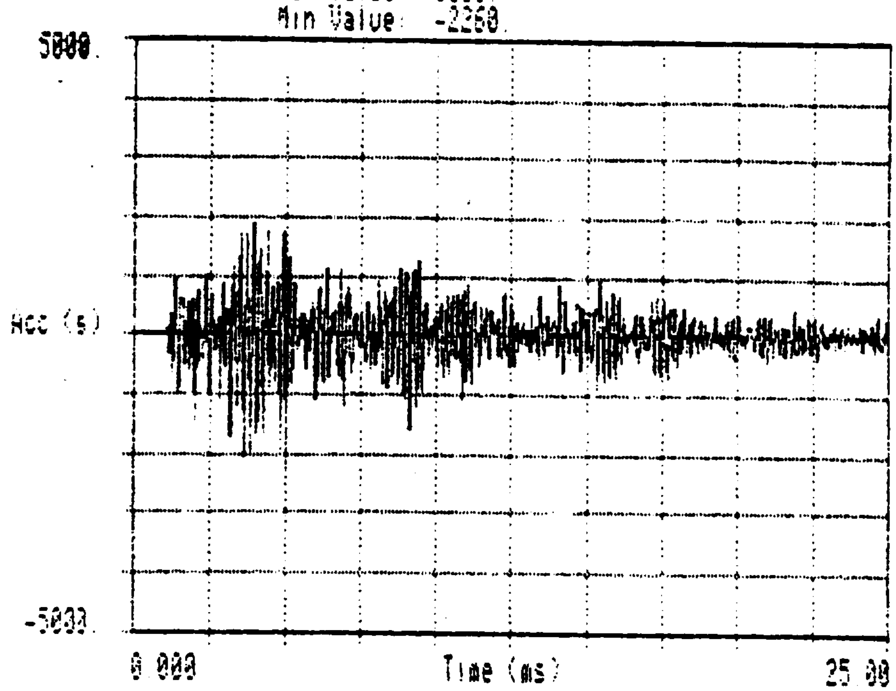
Analog Capture



21-Sep-93   T2 A10   5.0 % Damp Abs Acc
10:13:43   SRB BSM QUAL. TEST   1/6 Octave Pri Pos
?

Analog Capture   Max Value: 1881.
Min Value: -2260.



21-Sep-93 T2, A4
10:01:51 SRB BSM QUAL. TEST
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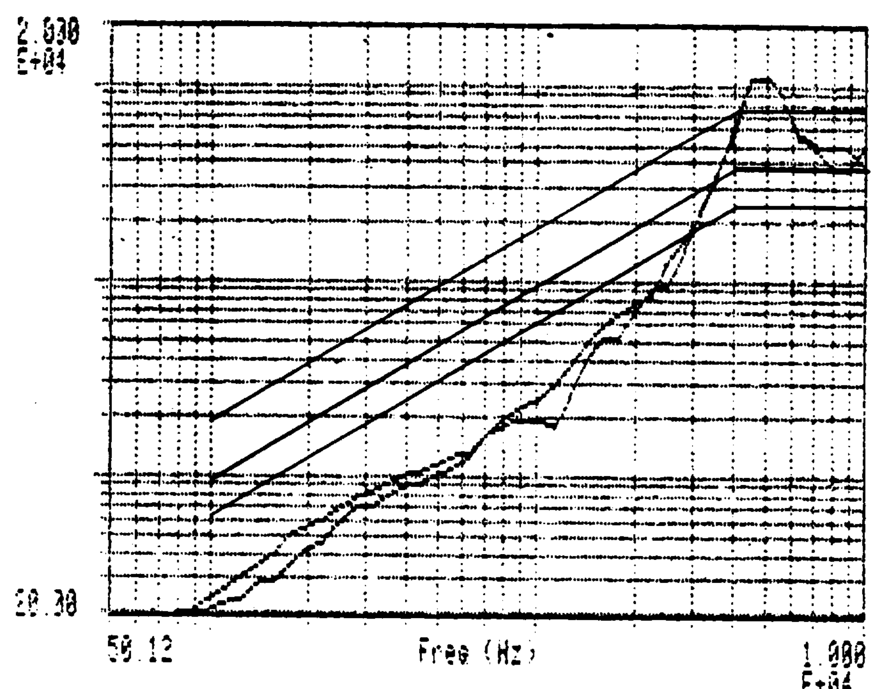
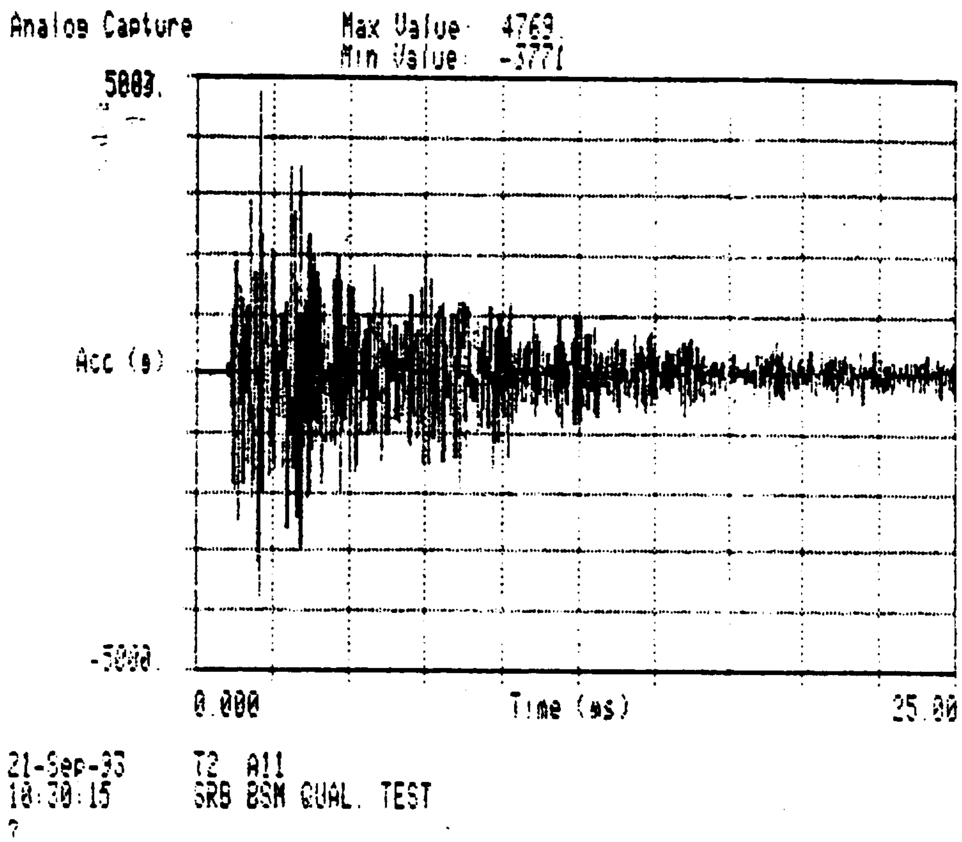
Analog Capture



21-Sep-93 T2, A4 5.0 % Damp Abs Acc
10:02:52 SRB BSM QUAL. TEST 1/6 Octave Pri Pos
?


Analog Capture
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Min Value: -3771
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Acc (g)
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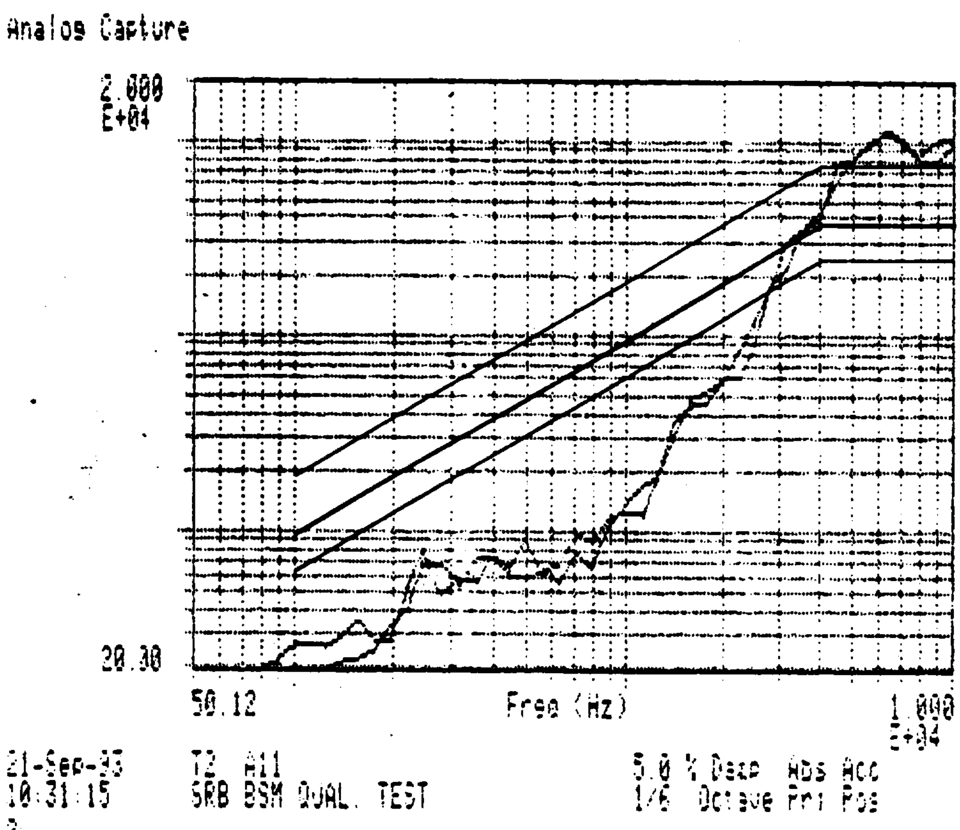
0.000
Time (ms)
25.00
21-Sep-93
10:30:15
?
T2 A11
SRB BSM QUAL. TEST


Analog Capture
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E+04
20.00
50.12
Freq (Hz)
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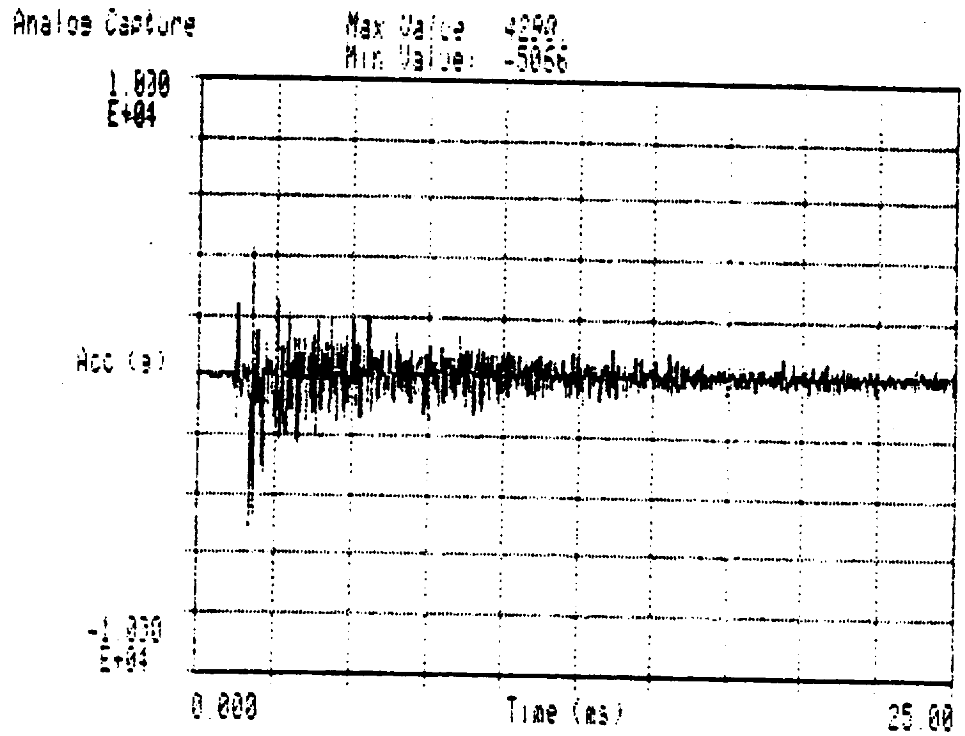
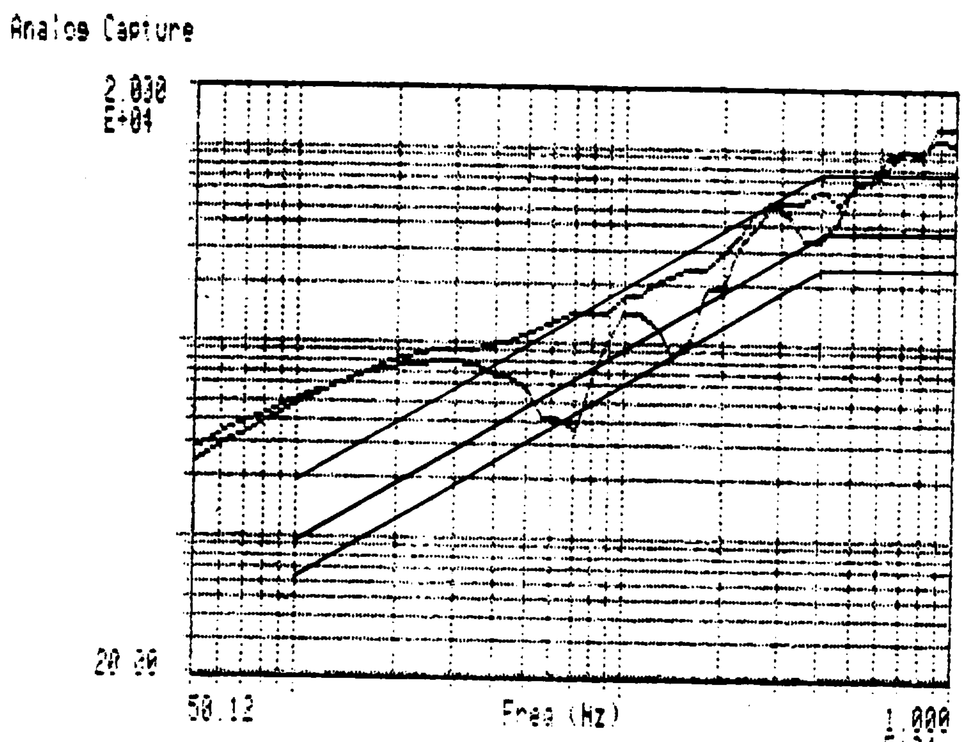
E+04
21-Sep-93
10:31:15
?
T2 A11
SRB BSM QUAL. TEST
5.0 % Damp Abs Acc
1/6 Octave Pri Pos



21-Sep-93
10:33:03
7

T2 A12
SRB BSM QUAL. TEST



21-Sep-93
10:34:20
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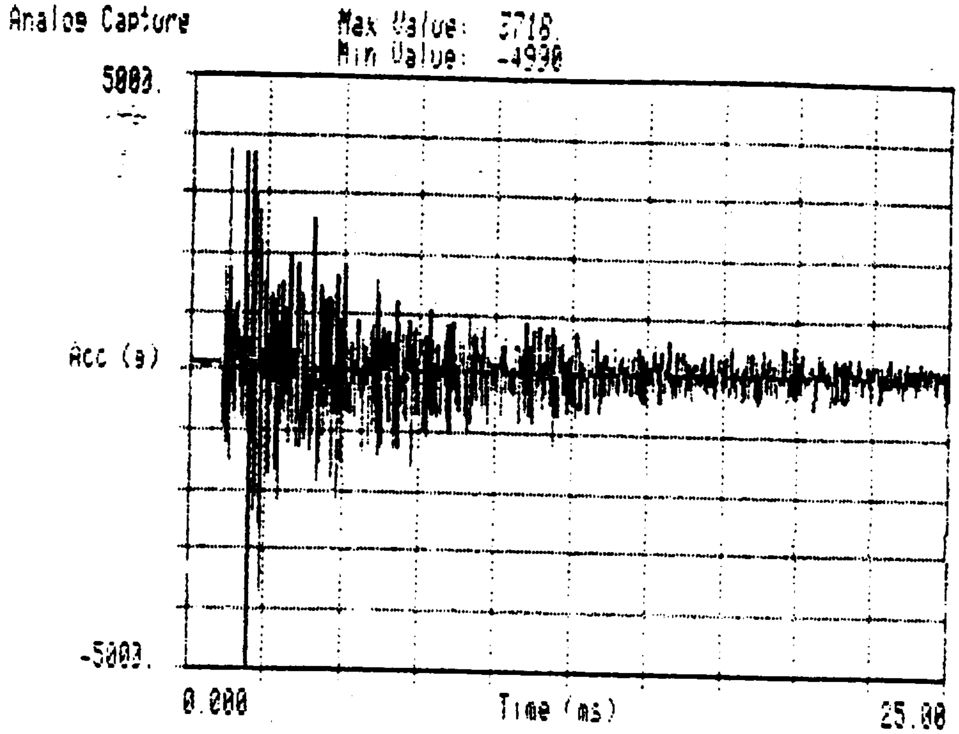
T2 A12
SRB BSM QUAL. TEST

5.0 % Damp Pos Acc
1/6 Octave Pri Pos



21-Sep-93 T2 A9
10:26:28 SRB BSM QUAL. TEST
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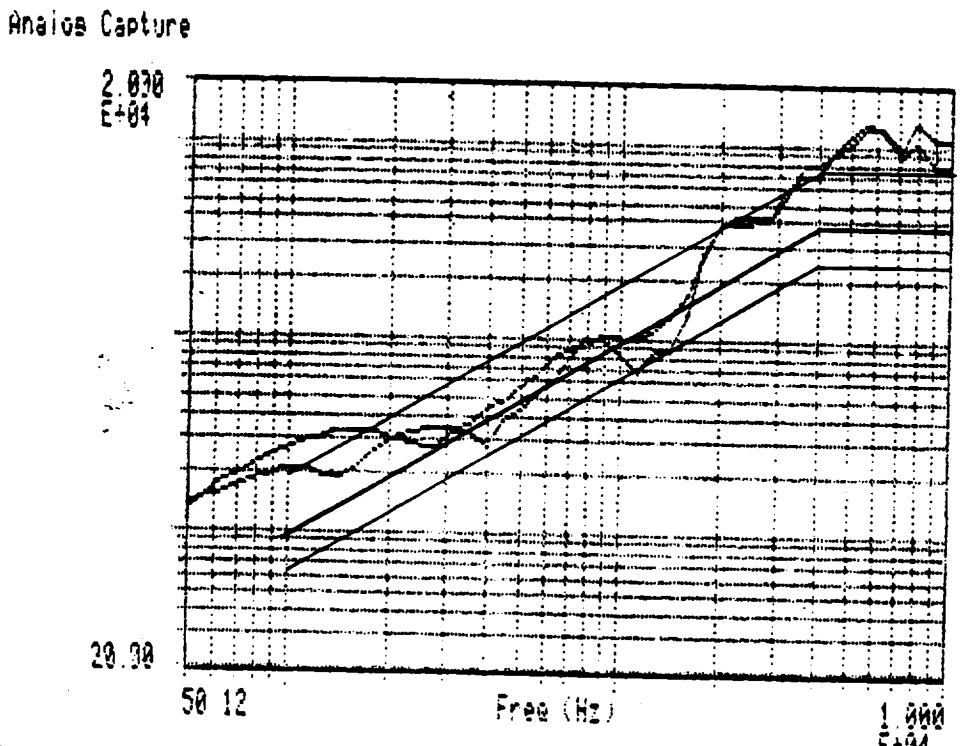


21-Sep-93 T2 A9 5.0 % Damp Abs Acc
10:27:37 SRB BSM QUAL. TEST 1/6 Octave Pri Pos
?

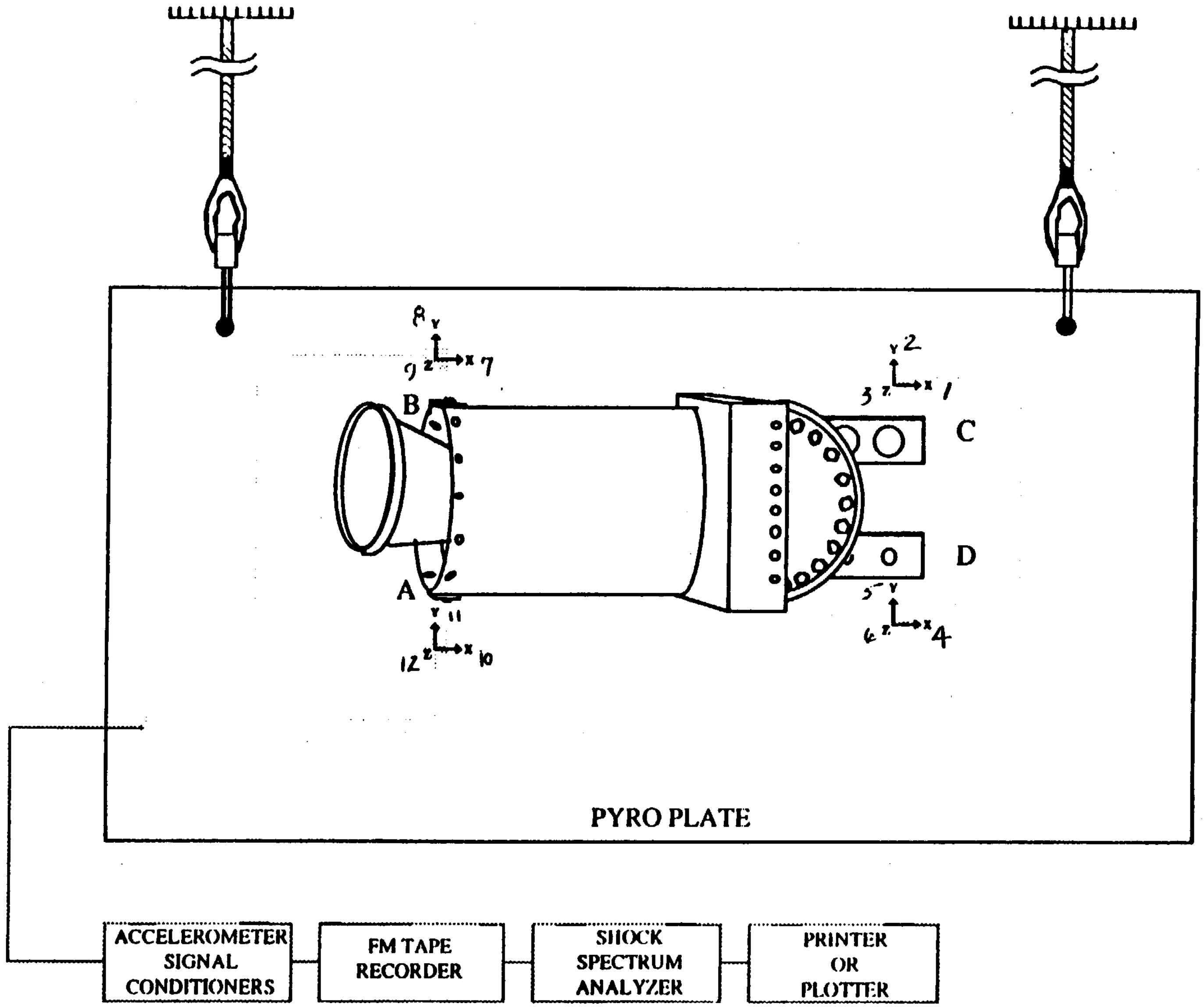


FIGURE 1. PYRO SHOCK CONTROL EQUIPTMENT

DRAWN BY
K MITCHELL /EP54
4/15/91

7 of 7

Figure 1

TEST PROCEDURE DEVIATION		TCP NO.: BSM-TCP-EP54-001
TEST ENGINEER: Mat Bevill MB 09/29/93	QUALITY: Rick Clements RC 9-29-93	DATE: 09/29/93
REQUIREMENTS ENGINEER: —	OTHER: Richard Leonard (safety) RJL 9-29-93	SHEET 1 OF 6

TITLE: Upper Limit Tolerance Violation for Pyro Shock Simulation Test (SN: 1000738)

DEV. NO.	PAGE	SEQ.	CHANGE/REASON	PERM/TEMP.
1			Section 4.2.1 in BSM-TCP-EP54-001 states that the test tolerances for Shock Response Spectrum are +6dB and −3dB when analyzed with a 1/3 octave shock spectrum analyzer and 5% damping. The worst case overtest for each axis is shown in the attached graphs. X-axis: accelerometer #10 Y-axis: accelerometer #11 Z-axis: accelerometers #12 and #3 Motor SN: 1000738 Jim Herring J.B. Herring EV13, Lead Pyro Engineer	

ORIGINATOR: Mat Bevill

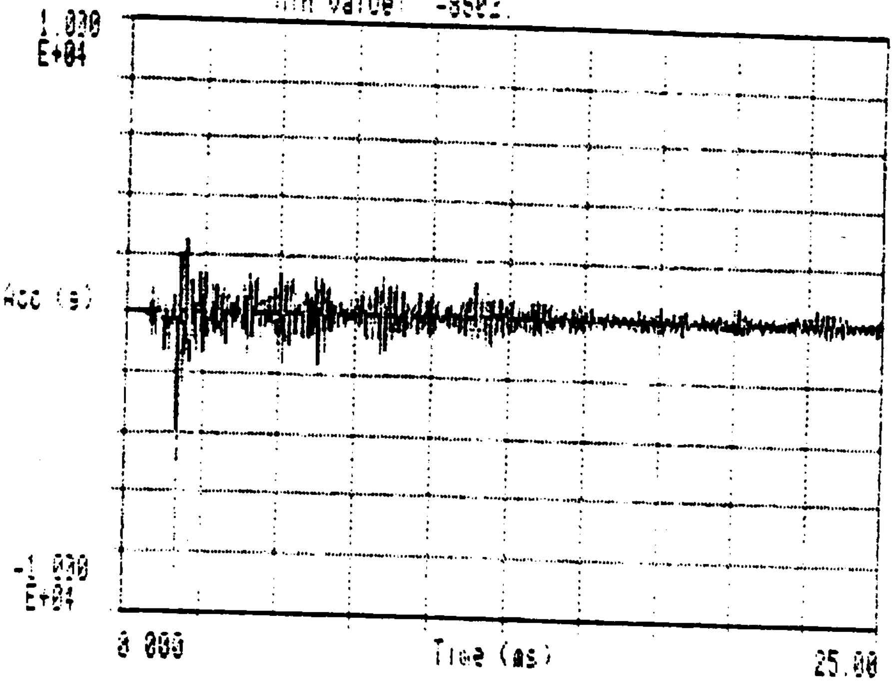
ORGANIZATION: NASA MSFC EP12

ABOVE DEVIATION(S) INCREASE HAZARD LEVEL: N/A

SAFETY: Richard Leonard

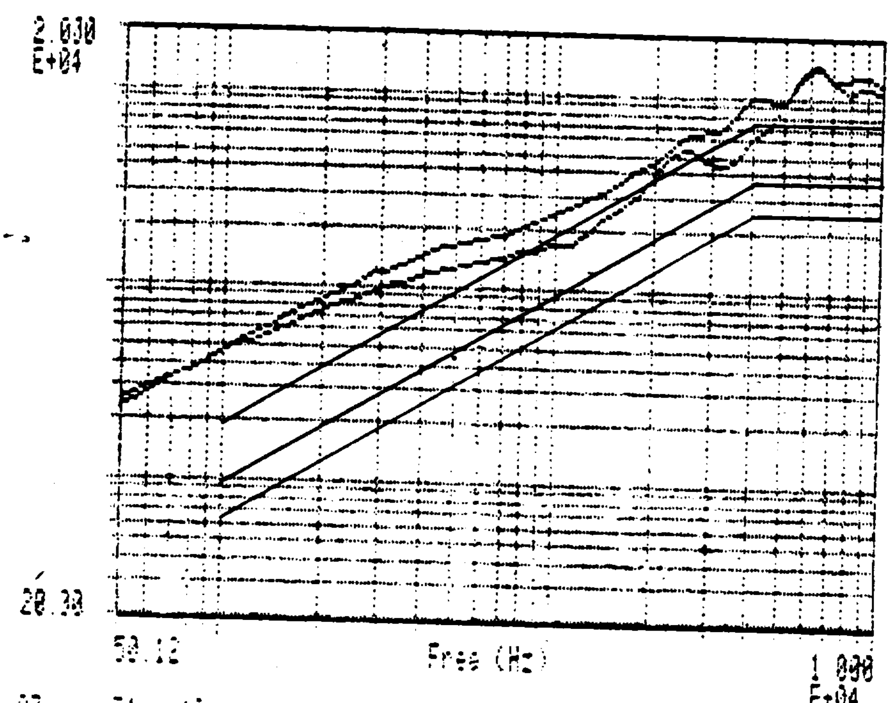
ABOVE DEVIATION(S) AFFECT TEST REQUIREMENTS.

Analog Capture



30-Sep-93
24:33:50
?
T1 410
SRB ESM QUAL. TEST

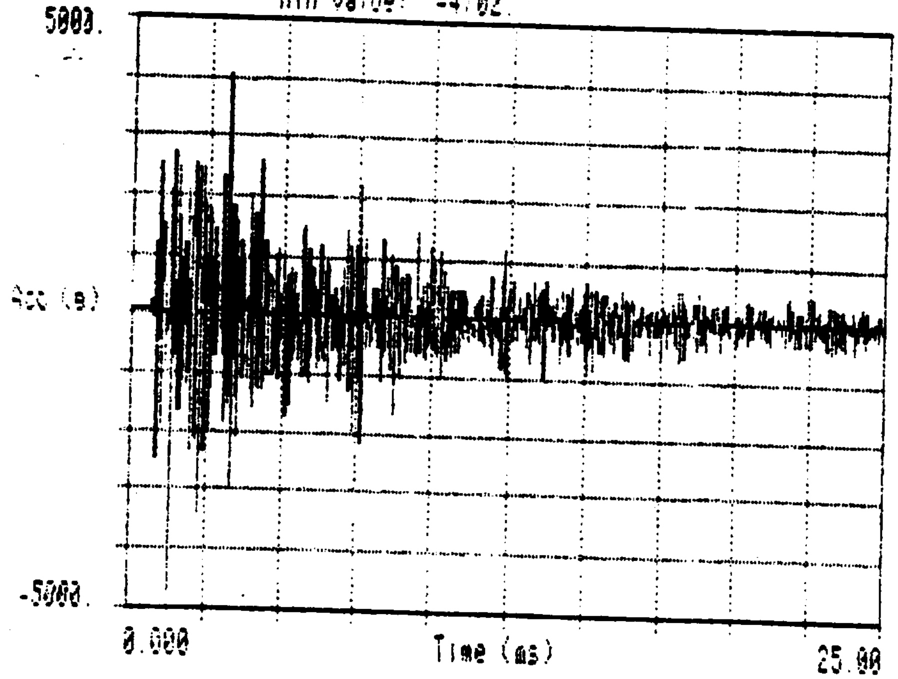
Analog Capture



30-Sep-93
24:35:07
?
T1 410
SRB ESM QUAL. TEST
5.0 % Damp Abs Acc
1/6 Octave Pri Pos

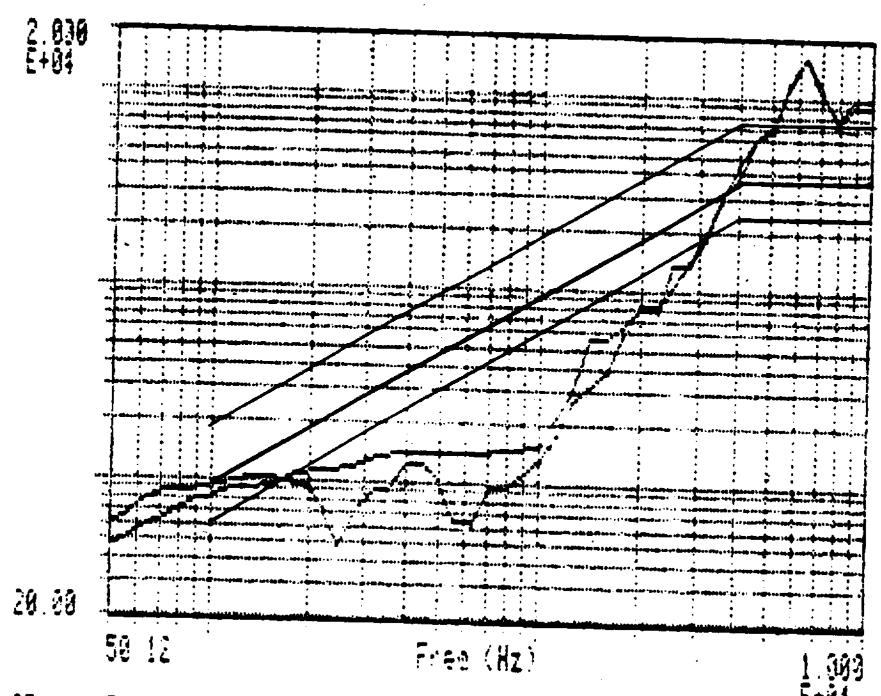
Analog Capture

Max Value: 4040
Min Value: -4702



20-Sep-93 T1 A11
24:51:18 SRB BSM QUAL. TEST
?

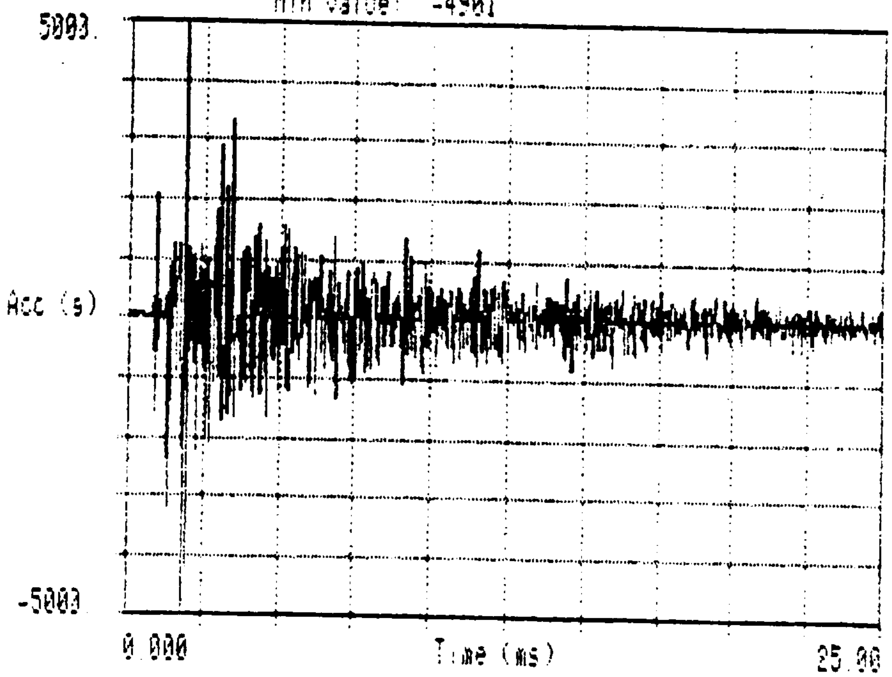
Analog Capture



20-Sep-93 T1 A11
24:52:22 SRB BSM QUAL. TEST
?

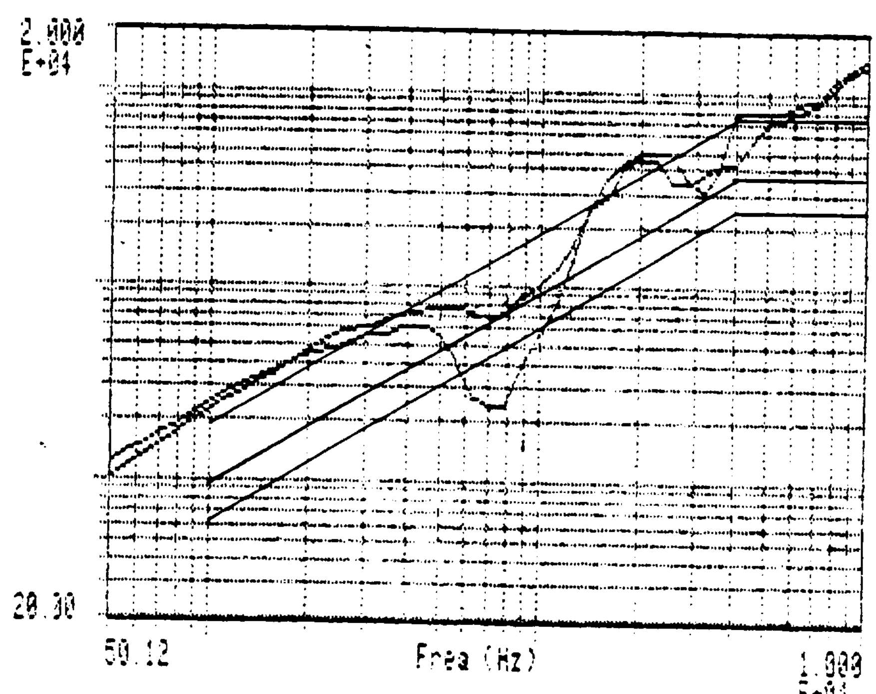
5.0 % Damp Abs Acc
1/6 Octave Pri Pos

Analog Capture Max Value: 4901. Min Value: -4901



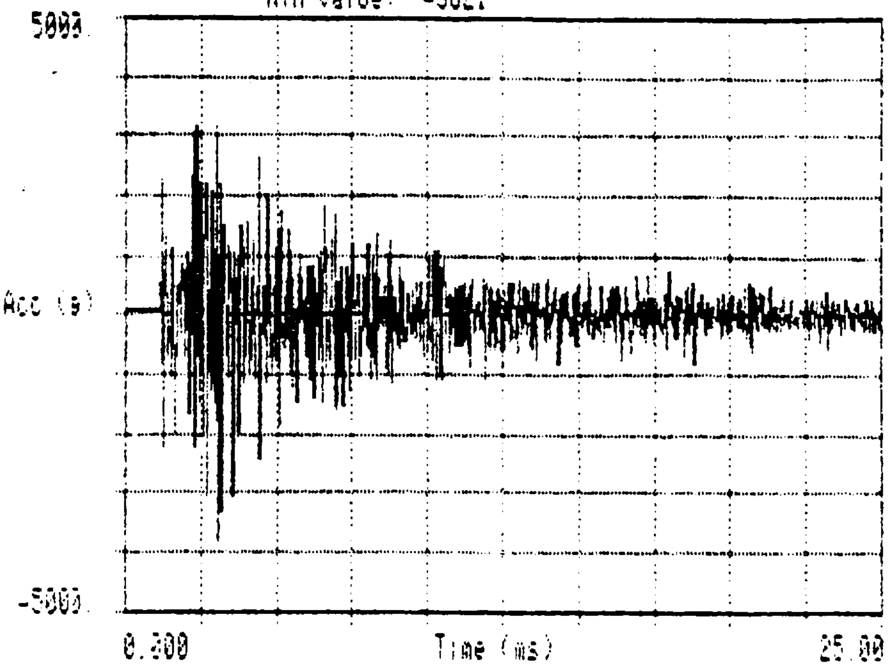
20-Sep-93 T1 A12
24 53:52 SRB BSM QUAL. TEST
?

Analog Capture



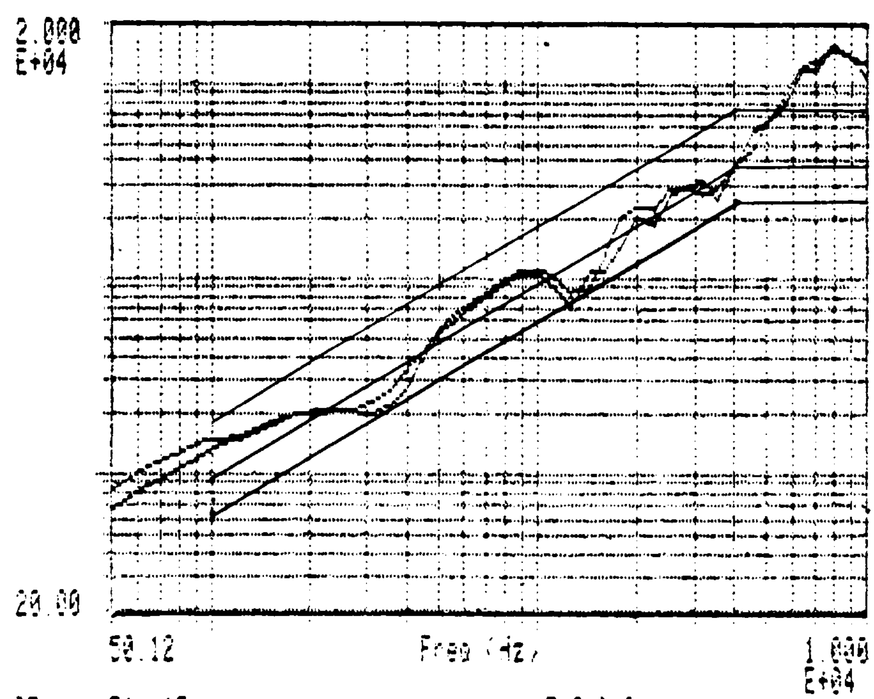
20-Sep-93 T1 A12 5.0 % Damp Abs Acc
24 55:47 SRB BSM QUAL. TEST 1/6 Octave Pri Pos
?GLAB

Analog Capture   Max Value: 3158.
Min Value: -3821



20-Sep-93   T1 A3
24:10:40   SRB BSM QUAL TEST
?

Analog Capture



20-Sep-93   T1 A3   5.0 % Dsap Abs Acc
24:11:44   SRB BSM QUAL TEST   1/6 Octave Pri Pos
?

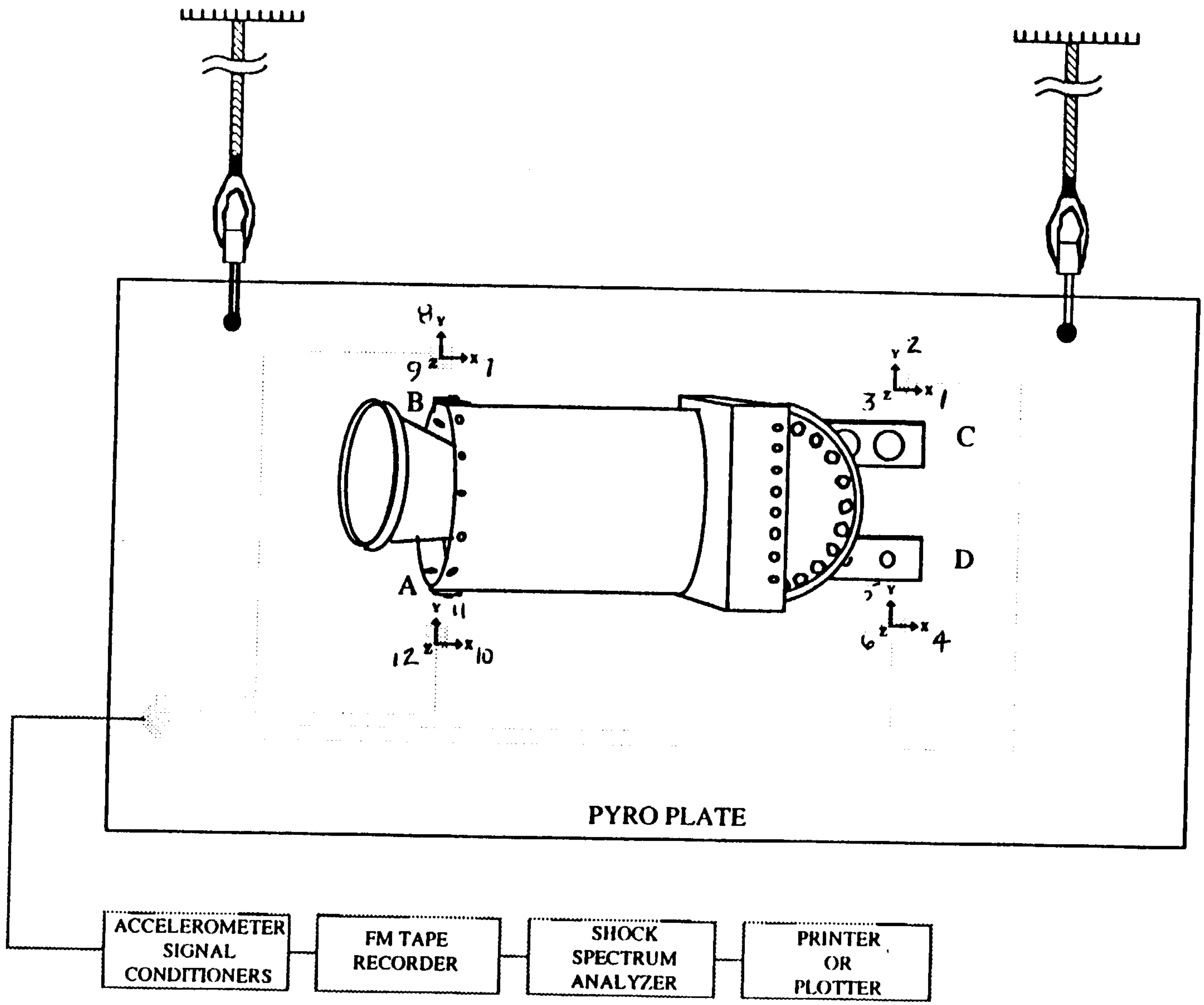


FIGURE 1. PYRO SHOCK CONTROL EQUIPTMENT

DRAWN BY
K MITCHELL / 13P54
4/15/91

NASA-MSFC

BSM MOTORS S/N 1000734 AND 1000738 VIBRATION TEST DATA

National Aeronautics and
Space Administration

George C. Marshall Space Flight Center
Marshall Space Flight Center, AL 35812

Reply to Attn of: ED73(93-101)

November 1, 1993

TO: EE11/Mr. Smith

FROM: ED73/Mr. Brewster

SUBJECT: SRB Booster Separation Motor (BSM) Vibration Qualification Test - SRB-QUAL-ED93-061

The Booster Separation vibration qualification tests were completed on two BSM motors SN 100034 and SN 100038 on September 20, 1993. Vehicle dynamics, random liftoff and random boost tests were performed on each motor in all three axes. The tests were run as specified in Document BSM-TCP-EP54-001, Title "BSM Delta Qualification Test," dated August 16, 1993.

Two control accelerometers and two axial response accelerometers were used for each test. The accelerometer locations and test axes are shown in figure 1. All instrumentation used for the test are shown in table 1.

This report contains all of the required data. Any questions concerning this report should be directed to Mr. J. McGee at 544-1136.

Steve R Brewster

Steve R. Brewster
Chief, Dynamics Test Branch

Enclosure

cc:
ED23/Mr. Ferebee
ED73/Mr. Hofmann (4 copies)
EP54/Mr. Bevill (3 copies)
ED73/File Copy
USBI/Mr. Tieman

TEST AND CHECKOUT PROCEDURE
FOR

VIBRATION QUALIFICATION TEST OF BOOSTER SEPARATION MOTOR (BSM)
SN 1000734 + SN 1000738 – SRB-QUAL-ED93-061

Date of Test: 9-20-93

Test Article Serial Number: SN 1000734 + 1000738

Test Requirements Documents: BSM-TCP-EP54-001

FOP's Attached:

Type of Test: VIBRATION QUALIFICATION

PREPARED BY: J. P. McGee
Test Engineer/ED73

7-20-93
Date

Engineering Technician/ED73

Date

APPROVED BY: Steve R Brewster
Steve R. Brewster/ED73
Chief, Dynamics Test Branch

11-1-93
Date

APPROVED BY: Rick Clements
Quality Assurance

7-20-93
Date

1.0 PURPOSE

This procedure defines the steps necessary to assure the proper check-out for and the execution of vibration and shock tests.

2.0 SCOPE

This procedure includes test levels, instrumentation and documentation necessary for the Test Engineer to conduct vibration and shock tests.

3.0 APPLICABLE DOCUMENTS

DST-FOP-VS-003 FACILITY OPERATION PROCEDURE (MARCH 21, 1993)

4.0 GENERAL REQUIREMENTS

The Test Engineer will be in charge of all preparations and activities during the vibration test phase.

5.0 SAFETY

When safety critical test conditions require personnel access, the Test Engineer will assure that the operation procedures and policies set forth in ET01-SOP-01, "Standard Operating Procedure for Safety Critical Operations" will be adhered to.

The Test Engineer will be responsible for the safety of personnel involved in the test activities; and will be notified immediately of any personnel injury.

TEST CONTROL PROGRAMS

```
1. IDENT:
RSM, LIFT-OFF RADIAL

2. TRUE RANDOM MODE? YES;NO
   YES

3. AVERAGING WEIGHTING FACTOR?
   16

   AVGS/LOOP?
     5

4. 3 SIGMA CLIPPING? YES;NO
   YES

5. MEASUREMENT MODE? YES;NO
   YES

   # OF AVGS?
    20

   AVGS/LOOP?
     5

6. # CONTROL CHANNELS?
     2

   EXTREMAL CONTROL? YES;NO
   NO

7. CALIBRATION? MV/G

    CHANNEL A
 100.00

    CHANNEL B
 100.00

    CHANNEL C
 100.00

8. SYSTEM GAIN? G/VOLT @ INPUT
   14.00

9. SELF CHECK LEVEL? -DB
   -6.00

10. LEVEL SCHEDULE
    LEVEL(-DB),TIME(SEC)?
     1.  -9.00       20.
     2.  -6.00       10.
     3.  -3.00        5.
     4.    .00       62.

11. LINE ABORTS ENABLED? -DB
   -3.00

    ABORT TIME? 10 SEC MAX
    1.00

12. MANUAL MODE ENABLED? YES;NO
    YES

13. LINE ALARM LIMIT? %
    99.00

14. RMS ABORT LIMIT? DB
     3.00

15. # LINES?
    512

16. LOWEST FREQ?
    20.00

17. HIGHEST FREQ?
 2000.00

 MAX FREQ.=  2500.00 HZ

 RESOLUTION=  4.88 HZ

 LOG HORIZ.= 3 DECADES

18. INPUT MODE?
    1=MAG.,FREQ,LIMIT+,LIMIT-(DB);
    2=SLOPE,FREQ,LIMIT+,LIMIT-(DB);
    3=DISC
     1

19. MAGNITUDE? GSQR/HZ, F=  20 HZ
     .017000

20. MAG.,FREQ,LIMIT+,-?
     .077000   55.00  3.00  1.50

21. MAG.,FREQ,LIMIT+,-?
     .077000  200.00  3.00  1.50

22. MAG.,FREQ,LIMIT+,-?
     .022000  280.00  3.00  1.50

23. MAG.,FREQ,LIMIT+,-?
     .022000 1200.00  3.00  1.50

24. MAG.,FREQ,LIMIT+,-?
     .010000 2000.00  3.00  1.50

 RMS VALUE=     6.944 G'S

FUNCTION? /C,/R,/L,/S,DL,PU,/E,??
```

```
1. IDENT:
3SM, BOOST RADIAL

2. TRUE RANDOM MODE? YES;NO
   YES

3. AVERAGING WEIGHTING FACTOR?
    16

   AVGS/LOOP?
     5

4. 3 SIGMA CLIPPING? YES;NO
   YES

5. MEASUREMENT MODE? YES;NO
   YES

   # OF AVGS?
    20

   AVGS/LOOP?
     5

6. # CONTROL CHANNELS?
    2

   EXTREMAL CONTROL? YES;NO
   NO

7. CALIBRATION? MV/G

    CHANNEL A
   30.00

    CHANNEL B
   30.00

    CHANNEL C
   30.00

8. SYSTEM GAIN? G/VOLT @ INPUT
   28.00

9. SELF CHECK LEVEL? -DB
   -6.00

10. LEVEL SCHEDULE
    LEVEL(-DB),TIME(SEC)?
     1.   -9.00      20.
     2.   -6.00      10.
     3.   -3.00       5.
     4.     .00     125.

11. LINE ABORTS ENABLED? -DB
   -3.00

      ABORT TIME? 10 SEC MAX
      1.00

12. MANUAL MODE ENABLED? YES;NO
    YES

13. LINE ALARM LIMIT? %
    99.00

14. RMS ABORT LIMIT? DB
    3.00

15. # LINES?
    512

16. LOWEST FREQ?
    20.00

17. HIGHEST FREQ?
  2000.00

  MAX FREQ.=  2500.00 HZ

  RESOLUTION=  4.88 HZ

  LOG HORIZ.= 3 DECADES

18. INPUT MODE?
    1=MAG.,FREQ,LIMIT+,LIMIT-(DB);
    2=SLOPE,FREQ,LIMIT+,LIMIT-(DB);
    3=DISC
     1

19. MAGNITUDE? GSQR/HZ, F= 20 HZ
    .540000

20. MAG.,FREQ,LIMIT+,-?
    .540000  200.00  3.00  1.50

21. MAG.,FREQ,LIMIT+,-?
    .060000  350.00  3.00  1.50

22. MAG.,FREQ,LIMIT+,-?
    .060000 1000.00  3.00  1.50

23. MAG.,FREQ,LIMIT+,-?
    .015000 2000.00  3.00  1.50

  RMS VALUE=    14.056 G'S

FUNCTION? /C,/R,/L,/S,DL,PU,/E,??
```

```
 1. IDENT?
ISM, V.D., RAD.

 2. LOWER FREQ LIMIT? HZ
      5.0

 3. UPPER FREQ LIMIT? HZ
     40.0

 4. STARTING FREQ? (+UP, -DOWN)
      5.0

 5. NUMBER OF SINGLE SWEEPS?
     1

 6. SWEEP MODE? 1=LOG, 2=LIN
    1

 7. SWEEP TIME OR RATE?
    1=TIME, 2=OCT/MIN, 3=DEC/MIN
    2
    OCT/MIN?
     3.00
    SWEEP TIME =  1.000 MIN

 8. REFERENCE ENVELOPE SPECIFICATION

    UNITS? 1=IN, 2=CM
    1

    FORMAT:
    FREQ,AMPL,TYPE,LIMIT(DB)

    AMPLITUDE TYPES:
    1=G'S P ,2=IN/SEC ,3=IN P-P

    ENTER 0 TO TERMINATE

    POINT # 1?
    5.0      .7000 1  3.00
    .70 G'S,  8.601 IN/S,  .5475 IN)

    POINT # 2?
    9.5      .7000 1  3.00
    .70 G'S.  4.527 IN/S,  .1517 IN)

    POINT # 3?
   10.0     3.7000 1  3.00
   3.70 G'S, 22.730 IN/S,  .7235 IN)

    POINT # 4?
   40.0     3.7000 1  3.00
   3.70 G'S,  5.683 IN/S,  .0452 IN)

 9. MUX? YES;NO
    NO

10. NUMBER OF CONTROL CHANNELS?
     2
    ACCELERATION CALIBRATIONS?
    CHANNEL #, MV/G
     1   300.000
    CHANNEL #, MV/G
     2   300.000

11. CONTROL MEAS METHOD?
    1=PEAK, 2=AVG, 3=RMS, 4=FILTER
    4

12. CONTROL STRATEGY?
    1=MAX, 2=MIN, 3=AVG
    3

13. NUMBER OF LIMIT CHANNELS?
     0

15. NUMBER OF MEAS CHANNELS?
     4
    MEAS SPECIFICATIONS?
    CHANNEL #,MV/UNIT
     1   300.000
    CHANNEL #,MV/UNIT
     2   300.000
    CHANNEL #,MV/UNIT
     3   100.000
    CHANNEL #,MV/UNIT
     4   100.000

16. MEASUREMENT MEAS METHOD?
    1=PEAK, 2=AVG, 3=RMS, 4=FILTER
    4

17. START-UP TIME? SEC
     5.0

18. SHUT-DOWN TIME? SEC
     1.0

19. MANUAL MODE ENABLED? YES;NO
    YES

20. MAX DRIVE? MV PEAK
     5000.

21. SELF CHECK LEVEL? MV PEAK
     500

22. ALARM LEVEL? % ABORT
    99.0

    MAX DISP =     .7235 IN P-P
    MAX VEL  =   22.730 IN/SEC P
    MAX ACCEL=     3.70 G'S P
```

```
1. IDENT;
SSM, LIFT-OFF TANG.

2. TRUE RANDOM MODE? YES;NO
   YES

3. AVERAGING WEIGHTING FACTOR?
    16

    AVGS/LOOP?
      5

4. 3 SIGMA CLIPPING? YES;NO
   YES

5. MEASUREMENT MODE? YES;NO
   YES

   # OF AVGS?
   20

   AVGS/LOOP?
     5

6. # CONTROL CHANNELS?
     2

   EXTREMAL CONTROL? YES;NO
   NO

7. CALIBRATION? MV/G

     CHANNEL A
   100.00

     CHANNEL B
   100.00

     CHANNEL C
    30.00

8. SYSTEM GAIN? G/VOLT @ INPUT
   20.00

9. SELF CHECK LEVEL? -DB
   -6.00

10. LEVEL SCHEDULE
    LEVEL(-DB),TIME(SEC)?
     1.   -9.00      20.
     2.   -6.00      10.
     3.   -3.00       5.
     4.     .00      62.

11. LINE ABORTS ENABLED? -DB
   -3.00

      ABORT TIME? 10 SEC MAX
      1.00

12. MANUAL MODE ENABLED? YES;NO
     YES

13. LINE ALARM LIMIT? %
    99.00

14. RMS ABORT LIMIT? DB
     3.00

15. # LINES?
    512

16. LOWEST FREQ?
    20.00

17. HIGHEST FREQ?
   2000.00

MAX FREQ.=  2500.00 HZ

RESOLUTION=  4.88 HZ

LOG HORIZ.= 3 DECADES

18. INPUT MODE?
    1=MAG.,FREQ,LIMIT+,LIMIT-(DB);
    2=SLOPE,FREQ,LIMIT+,LIMIT-(DB);
    3=DISC
     1

19. MAGNITUDE? GSQR/HZ, F=  20 HZ
     .016000

20. MAG.,FREQ,LIMIT+,-?
     .060000   75.00   3.00  1.50

21. MAG.,FREQ,LIMIT+,-?
     .060000 1000.00   3.00  1.50

22. MAG.,FREQ,LIMIT+,-?
     .030000 2000.00   3.00  1.50

RMS VALUE=     9.969 G'S

FUNCTION? /C,/R,/L,/S,DL,PU,/E,??
```

```
 DENT:
BSN, BOOST TANG.

2. TRUE RANDOM M...      S;NO
   ES

   ERAGI...            FACTOR?
   16

   ..GS/LOOP?
     5

... SIGMA ...PING? YES;NO
   YES

5. MEASUREMENT MODE? YES;NO
   ES

   # OF AVGS?
   20

   .GS/LOOP?
     5

6. # CONTROL CHANNELS?
     2

   .TREMAL .CNTROL? YES;NO

.. .ALIBRAT... ..VG

   .HANNEL A
   ..00

   .HANNEL .
   ..00

   CHANNEL C
  10.00

   .STEM GAIN? G    # INPUT
   ..00

   ..E CHECK LEVEL? -DB
   6.00

   LEVEL SCHEDULE
   LEVEL(-DB  TIME(SEC)?
   1.  -9..       ..0.
   2.  -6.00
   3.  -3.00
   4.    .00      125.

   LINE A...     ...LED? -DB
   .00

   ABORT T..E? 10 SEC MAX
   ..0

   ...      .E ENAB..? YES;NO
   YES

..  ...  ALARM LIM

14. RMS ABORT LIMI.
    3.00

... # LI
   512

16. LOWEST FREQ?
    ..00

1.. HIGHEST FREQ?
 2000.00

 MAX FRE... 2500... HZ

 RESOLUTION= 4.88 ..

 ... HORIZ.= 3 DECADES

18. INPU...?
    1=MAG.,FREQ,LIMIT+,LIMIT-(DP);
    2=SLOPE,FREQ,LIMIT+,LIMIT
    3=D.
     1

1.. MAGN...? GSQR/HZ. ...
    .240000

20. MAG.        LIMI
    .24.      800.     ..

21. MAG.,FREQ,LIMIT+,-?
    .07.000 2000.00  3.00  1.50

  . VAL ..     18.44. G.S

FUNCTION? /C./R,/L,/S,DL,PU,/E,??
```

```
 1. IDENT?
BSM, U.D., TANG.

 2. LOWER FREQ LIMIT? HZ
      5.0

 3. UPPER FREQ LIMIT? HZ
     40.0

 4. STARTING FREQ? (+UP, -DOWN)
      5.0

 5. NUMBER OF SINGLE SWEEPS?
     1

 6. SWEEP MODE? 1=LOG, 2=LIN
    1

 7. SWEEP TIME OR RATE?
    1=TIME, 2=OCT/MIN, 3=DEC/MIN
    2
    OCT/MIN?
     3.00
    SWEEP TIME =  1.000 MIN

 8. REFERENCE ENVELOPE SPECIFICATION

    UNITS? 1=IN, 2=CM
    1

    FORMAT:
    FREQ,AMPL,TYPE,LIMIT(DB)

    AMPLITUDE TYPES:
    1=G'S P ,2=IN/SEC ,3=IN P-P

    ENTER 0 TO TERMINATE

    POINT # 1?
    5.0     .7000 1  3.00
(   .70 G'S,  8.601 IN/S,  .5475 IN)

    POINT # 2?
    9.5     .7000 1  3.00
(   .70 G'S,  4.527 IN/S,  .1517 IN)

    POINT # 3?
   10.0    4.3000 1  3.00
(  4.30 G'S, 26.416 IN/S,  .8409 IN)

    POINT # 4?
   40.0    4.3000 1  3.00
(  4.30 G'S,  6.604 IN/S,  .0526 IN)

 9. MUX? YES;NO
    NO

10. NUMBER OF CONTROL CHANNELS?
     2
    ACCELERATION CALIBRATIONS?
    CHANNEL #, MV/G
     1   300.000
    CHANNEL #, MV/G
     2   300.000

11. CONTROL MEAS METHOD?
    1=PEAK, 2=AVG, 3=RMS, 4=FILTER
    4

12. CONTROL STRATEGY?
    1=MAX, 2=MIN, 3=AVG
    3

13. NUMBER OF LIMIT CHANNELS?
     0

15. NUMBER OF MEAS CHANNELS?
     4
    MEAS SPECIFICATIONS?
    CHANNEL #,MV/UNIT
     1   300.000
    CHANNEL #,MV/UNIT
     2   300.000
    CHANNEL #,MV/UNIT
     3   100.000
    CHANNEL #,MV/UNIT
     4   100.000

16. MEASUREMENT MEAS METHOD?
    1=PEAK, 2=AVG, 3=RMS, 4=FILTER
    4

17. START-UP TIME? SEC
     5.0

18. SHUT-DOWN TIME? SEC
     1.0

19. MANUAL MODE ENABLED? YES;NO
    YES

20. MAX DRIVE? MV PEAK
     5000.

21. SELF CHECK LEVEL? MV PEAK
     500

22. ALARM LEVEL? % ABORT
    99.0

    MAX DISP  =    .8409 IN P-P
    MAX VEL   =  26.416 IN/SEC P
    MAX ACCEL=     4.30 G'S P
```

```
1. IDENT:
BSM, LIFT-OFF LONG.

2. TRUE RANDOM MODE? YES;NO
   YES

3. AVERAGING WEIGHTING FACTOR?
   16

   AVGS/LOOP?
   5

4. 3 SIGMA CLIPPING? YES;NO
   YES

5. MEASUREMENT MODE? YES;NO
   YES

   # OF AVGS?
   20

   AVGS/LOOP?
   5

6. # CONTROL CHANNELS?
   2

   EXTREMAL CONTROL? YES;NO
   NO

7. CALIBRATION? MV/G

   CHANNEL A
 100.00

   CHANNEL B
 100.00

   CHANNEL C
 30.00

8. SYSTEM GAIN? G/VOLT @ INPUT
   20.00

9. SELF CHECK LEVEL? -DB
   -6.00

10. LEVEL SCHEDULE
    LEVEL(-DB),TIME(SEC)?
    1.   -9.(           20.
    2.   -6.            10.
    3.   -3.00           5.
    4.     .00          62.

11. LINE ABORTS ENABLED? -DB
    3.00

    ABORT TIME? 10 SEC MAX
    1.00

12. MANUAL MODE ENABLED? YES;NO
    YES

13. LINE ALARM LIMIT? %
    99.00

14. RMS ABORT LIMIT? DB
    3.00

15. # LINES?
    512

16. LOWEST FREQ?
    20.00

17. HIGHEST FREQ?
  2000.00

  MAX FREQ.=  2500.00 HZ

  RESOLUTION=  4.88 HZ

  LOG HORIZ.= 3 DECADES

18. INPUT MODE?
    1=MAG.,FREQ,LIMIT+,LIMIT-(DB);
    2=SLOPE,FREQ,LIMIT+,LIMIT-(DB);
    3=DISC
    1

19. MAGNITUDE? GSQR/HZ, F=  20 HZ
    .016000

20. MAG.,FREQ,LIMIT+,-?
    .060000   75.00  3.00  1.50

21. MAG.,FREQ,LIMIT+,-?
    .060000 1000.00  3.00  1.50

22. MAG.,FREQ,LIMIT+,-?
    .030000 2000.00  3.00  1.50

 RMS VALUE=      9.969 G'S

FUNCTION? /C,/R,/L,/S,DL,PU,/E,??
```

```
1. IDENT:
BSM. BOOST LONG.

2. TPUE RANDOM MODE? YES;NO
   YES

3. AVERAGING WEIGHTING FACTOR?
    16

   AVGS/LOOP?
     5

4. 3 SIGMA CLIPPING? YES;NO
   YES

5. MEASUREMENT MODE? YES;NO
   YES

   # OF AVGS?
    20

   AVGS/LOOP?
     5

6. # CONTROL CHANNELS?
     2

   EXTREMAL CONTROL? YES;NO
   NO

7. CALIBRATI N? MV/G

    CHANNEL A
   30.00

    CHANNEL B
   30.00

    CHANNEL C
   30.00

8. SYSTEM GAIN? G/VOLT @ INPUT
   37.00

9. SELF CHECK LEVEL? -DB
   -6.00

10. LEVEL SCHEDULE
    LEVEL(-DB),TIME(SEC)?
     1.  -9.00      20.
     2.  -6.00      10.
     3.  -3.00       5.
     4.    .00     125.

11. LINE ABORTS ENABLED? -DB
   -3.00

    ABORT TIME? 10 SEC MAX
    1.00

12. MANUAL MODE ENABLED? YES;NO
   YES

13. LINE ALARM LIMIT? %
   99.00

14. RMS ABORT LIMIT? DB
    3.00

15. # LINES?
   512

16. LOWEST FREQ?
   20.00

17. HIGHEST FREQ?
 2000.00

 MAX FREQ.=  2500.00 HZ

 RESOLUTION=  4.88 HZ

 LOG HORIZ.= 3 DECADES

18. INPUT MODE?
    1=MAG.,FREQ,LIMIT+,LIMIT-(DB);
    2=SLOPE,FREQ,LIMIT+,LIMIT-(DB);
    3=DISC
     1

19. MAGNITUDE? GSQR/HZ, F=  20 HZ
     .240000

20. MAG.,FREQ,LIMIT+,-?
     .240000  800.00  3.00  1.50

21. MAG.,FREQ,LIMIT+,-?
     .071000 2000.00  3.00  1.50

 RMS VALUE=    18.442 G'S

FUNCTION? /C,/R,/L,/S,DL,PU,/E,??
```

```
 1. IDENT?
BSM V.D., LONG.

 2. LOWER FREQ LIMIT? HZ
      5.0

 3. UPPER FREQ LIMIT? HZ
     40.0

 4. STARTING FREQ? (+UP, -DOWN)
      5.0

 5. NUMBER OF SINGLE SWEEPS?
     1

 6. SWEEP MODE? 1=LOG, 2=LIN
    1

 7. SWEEP TIME OR RATE?
    1=TIME, 2=OCT/MIN, 3=DEC/MIN
    2
    OCT/MIN?
     3.00
    SWEEP TIME =  1.000 MIN

 8. REFERENCE ENVELOPE SPECIFICATION

    UNITS? 1=IN, 2=CM
    1

    FORMAT:
    FREQ,AMPL,TYPE,LIMIT(DB)

    AMPLITUDE TYPES:
    1=G'S P ,2=IN/SEC ,3=IN P-P

    ENTER 0 TO TERMINATE

    POINT # 1?
    5.0      .7000 1  3.00
    .70 G'S,  8.601 IN/S,   .5475 IN)

    POINT # 2?
    9.5      .7000 1  3.00
    .70 G'S,  4.527 IN/S,   .1517 IN)

    POINT # 3?
    10.0     4.3000 1  3.00
    4.30 G'S, 26.416 IN/S,   .8409 IN)

    POINT # 4?
    40.0     4.3000 1  3.00
    4.30 G'S,  6.604 IN/S,   .0526 IN)

 9. MUX? YES;NO
    NO

10. NUMBER OF CONTROL CHANNELS?
    2
    ACCELERATION CALIBRATIONS?
    CHANNEL #, MV/G
     1    300.000
    CHANNEL #, MV/G
     2    300.000

11. CONTROL MEAS METHOD?
    1=PEAK, 2=AVG, 3=RMS, 4=FILTER
    4

12. CONTROL STRATEGY?
    1=MAX, 2=MIN, 3=AVG
    3

13. NUMBER OF LIMIT CHANNELS?
    0

15. NUMBER OF MEAS CHANNELS?
    4
    MEAS SPECIFICATIONS?
    CHANNEL #,MV/UNIT
     1    300.000
    CHANNEL #,MV/UNIT
     2    300.000
    CHANNEL #,MV/UNIT
     3    100.000
    CHANNEL #,MV/UNIT
     4    100.000

16. MEASUREMENT MEAS METHOD?
    1=PEAK, 2=AVG, 3=RMS, 4=FILTER
    4

17. START-UP TIME? SEC
     5.0

18. SHUT-DOWN TIME? SEC
     1.0

19. MANUAL MODE ENABLED? YES;NO
    YES

20. MAX DRIVE? MV PEAK
     5000.

21. SELF CHECK LEVEL? MV PEAK
     500

22. ALARM LEVEL? % ABORT
    99.0

    MAX DISP  =    .8409 IN P-P
    MAX VEL   =  26.416 IN/SEC P
    MAX ACCEL=     4.30 G'S P
```

POST-TEST VERIFICATION

: Test and Checkout Procedure SRB-QUAL-ED93-061
; been satisfactorily completed and documented.

Submitted by: J. P. McGee 9-20-93
Test Engineer/ED73 Date

Verified by: Rick Clements 9-20-93
Quality Assurance Monitor Date

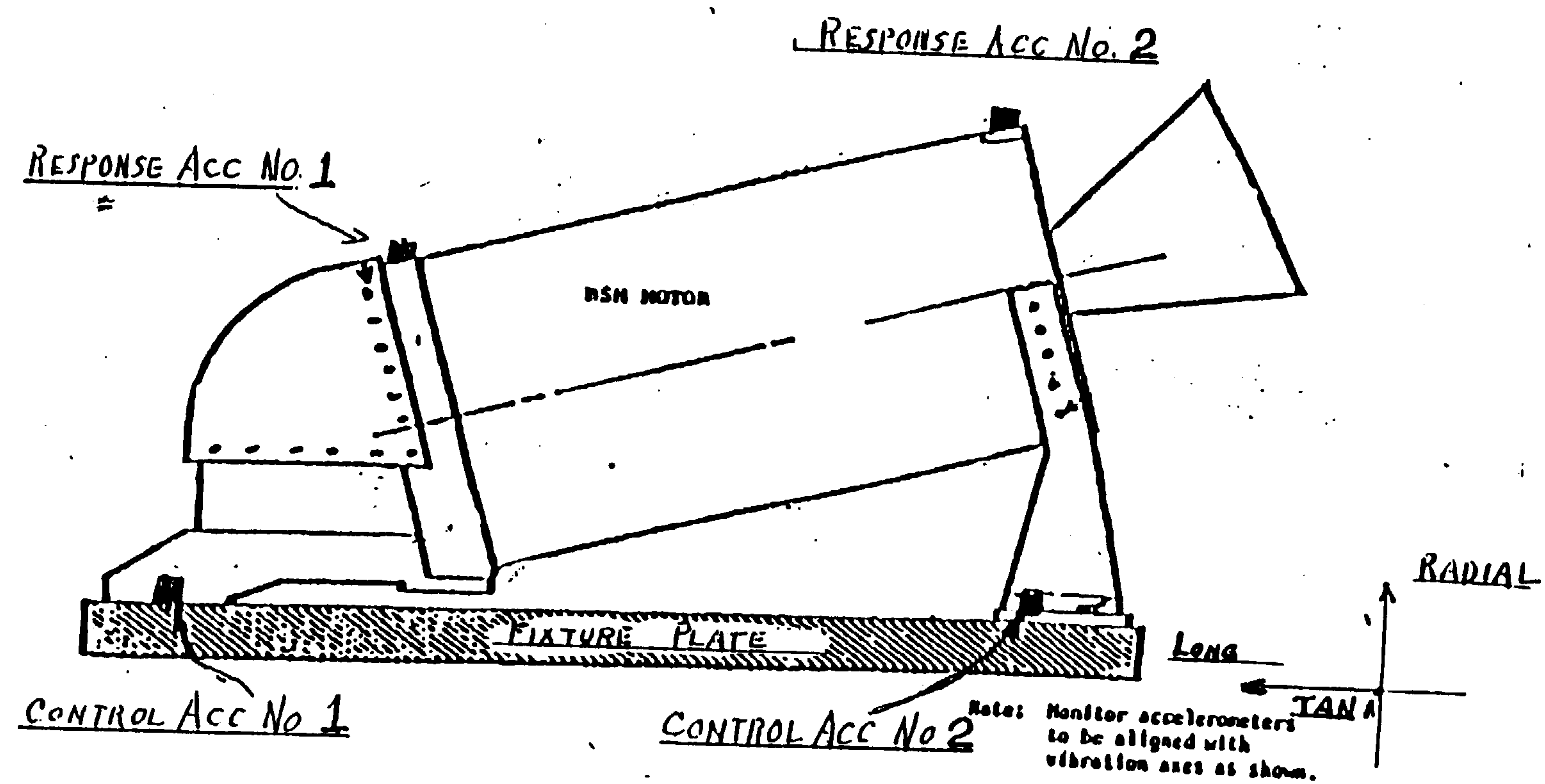

RESPONSE ACC NO. 2
RESPONSE ACC NO. 1
RSM MOTOR
FIXTURE PLATE
RADIAL
LONG
TAN
CONTROL ACC NO 1
CONTROL ACC NO 2
Note: Monitor accelerometers to be aligned with vibration axes as shown.

FIG 1

* Control System - H.P. Model 5427A S/N 1848A00160
* Charge Amp - Endevco Model 2775A S/N 783844
  784074
  784070
  783846
  783850
* Power Amplifier - Ling Model PSE 335 S/N 108
* Shaker - Ling B 335 S/N 628191
* Voltmeter - Keithley 193A S/N 303426
* Counter - HP 5316A S/N 2120A01228
* Tape Recorder - Datatape 37000 S/N 533772
* Shaker - UD T4000 S/N 353906
* Power Amplifier - UD T360 S/N 731628
* Accelerometers - Endevco 2227 S/N CF31
  Endevco 2227 S/N PA73
  Endevco 2226 S/N HA89
  Endevco 2226 S/N AB37

Table 1

SN 100034

CHECK OFF LIST

TEST OPERATIONS SET-UP

		AXIS: RADIAL / LONGITUDINAL / TANGENTIAL
1.1	Verify proper calibration of instruments to be used.	✓ ✓ ✓
1.2	Verify proper calibration of accelerometers to be used.	✓ ✓ ✓
1.3	Install test article on shaker and verify test axis.	✓ ✓ ✓
1.4	Install accelerometer(s) on test article.	✓ ✓ ✓
1.5	Verify continuity from accelerometer(s) to charge amplifier output(s)	✓ ✓ ✓

Torque Values:

Test Fixture: 65 ft lbs

Test Article: Per BSM TEST PLAN

Shaker Used: UD T-4000

Adapters Used: MRAD 48" EXPANDER – 2" PLATE (90M10063-1)

LIFTOFF RANDOM   #1000734

RANDOM CHECK-OUT   AXIS RADIAL

1 Verify test program and record RMS abort limit below. ✓

RMS abort limit 1 dB

2 Perform levels as defined below and verify with plot. ✓

3 Record the following:

Amplifier Gain 60%

Charge Amp. F.S. 30G

		20	Hz @	.017	G^2/Hz,	limits	+3, -1.5db
55	Hz -	200	Hz @	.077	"	limits	"
280	Hz -	1200	Hz @	.022	"	limits	"
	Hz -	2000	Hz @	.010	"	limits	"
	Hz -		Hz @			limits	
	Hz -		Hz @			limits	
	Hz -		Hz @			limits	
	Hz -		Hz @			limits	
	Hz -		Hz @			limits	

Composite = 6.9 Grms

Test Time = 60 Sec.

Test Level Concurrence: ______________________ Component Assessment Branch   ________ Date

BOOST RANDOM SN 1000734

RANDOM CHECK-OUT

AXIS RADIAL

.1 Verify test program and record RMS abort limit below. ✓

RMS abort limit 1 dB

.2 Perform levels as defined below and verify with plot. ✓

.3 Record the following:

Amplifier Gain 75 %

Charge Amp. F.S. 100 G

			Hz @		G^2/Hz,	limits	3, 1.5 db
20	Hz -	200	Hz @	.54	"	limits	"
350	Hz -	1000	Hz @	.06	"	limits	"
	Hz -	2000	Hz @	.015	"	limits	"
	Hz -		Hz @			limits	
	Hz -		Hz @			limits	
	Hz -		Hz @			limits	
	Hz -		Hz @			limits	
	Hz -		Hz @			limits	

Composite = 14 Grms

Test Time = 120 sec.

Test Level Concurrence: ______________________ ______________

Component Assessment Branch Date

SN 1000734

ICLE DYNAMICS CHECK-OUT AXIS RADIAL

1.1 Verify test program and record the abort level below. ✓

Abort Level 1db

1.2 Perform levels as defined below and verify with plot. ✓

1.3 Record the following:

Amplifier Gain 40%

Charge Amp. F.S. 10G

5	-	10	Hz at	.07G	, limit	±1.5	dB
10	-	40	Hz at	3.7G	, limit	±1.5	dB
	-		Hz at		, limit		dB
	-		Hz at		, limit		dB
	-		Hz at		, limit		dB

Sweep Rate = 3 oct/min

Test level concurrence: ______________________ __________

Component Assessment Branch Date

page_____ of _____

LIFT OFF RANDOM SN 1000734

RANDOM CHECK-OUT AXIS TANGENTIAL

1 Verify test program and record RMS abort limit below. ✓

RMS abort limit 1 dB

2 Perform levels as defined below and verify with plot. ✓

.3 Record the following:

Amplifier Gain 70%

Charge Amp. F.S. 30 G

	20 Hz @ .016	G^2/Hz,	limits	+3,-1.5db
75 Hz -	1000 Hz @ .060	"	limits	"
Hz -	2000 Hz @ .030	"	limits	"
Hz -	Hz @		limits	
Hz -	Hz @		limits	
Hz -	Hz @		limits	
Hz -	Hz @		limits	
Hz -	Hz @		limits	
Hz -	Hz @		limits	

Composite = 10 Grms

Test Time = 60 Sec.

Test Level Concurrence: ____________ Component Assessment Branch ____________ Date

BOOST RANDOM SN 1000734

RANDOM CHECK-OUT

AXIS TANGENTIAL

1 Verify test program and record RMS abort limit below. ✓

RMS abort limit 1 dB

2 Perform levels as defined below and verify with plot. ✓

3 Record the following:

Amplifier Gain 80 %

Charge Amp. F.S. 100 G

		Hz @		G^2/Hz,	limits	+3, -1.5 db
20	Hz -	800 Hz @	.24	"	limits	"
	Hz -	2000 Hz @	.017		limits	"
	Hz -	Hz @			limits	
	Hz -	Hz @			limits	
	Hz -	Hz @			limits	
	Hz -	Hz @			limits	
	Hz -	Hz @			limits	
	Hz -	Hz @			limits	

Composite = 18.4 Grms

Test Time = 120 sec.

Test Level Concurrence: ____________________ ____________

Component Assessment Branch Date

SN 1000734

…ICLE DYNAMICS CHECK-OUT

AXIS TANGENTIAL

1.1 Verify test program and record the abort level below. ✓

Abort Level 1 db

1.2 Perform levels as defined below and verify with plot. ✓

1.3 Record the following:

Amplifier Gain 40 %

Charge Amp. F.S. 10 G

5	-	10	Hz at	.7	, limit	±1.5	dB
10	-	40	Hz at	4.3	, limit		dB
	-		Hz at		, limit		dB
	-		Hz at		, limit		dB
	-		Hz at		, limit		dB

Sweep Rate = 3 oct/min

Test level concurrence: ______________________ __________

Component Assessment Branch Date

LIFTOFF RANDOM SN 1000734

RANDOM CHECK-OUT

AXIS LONGITUDINAL

1 Verify test program and record RMS abort limit below. ✓

RMS abort limit 1 dB

2 Perform levels as defined below and verify with plot. ✓

3 Record the following:

Amplifier Gain 70%

Charge Amp. F.S. 30G

		20	Hz @	.016	G^2/Hz,	limits +3, -1.5 db
75	Hz -	1000	Hz @	.06		limits "
	Hz -	2000	Hz @	.03		limits "
	Hz -		Hz @			limits
	Hz -		Hz @			limits
	Hz -		Hz @			limits
	Hz -		Hz @			limits
	Hz -		Hz @			limits
	Hz -		Hz @			limits

Composite = 10 Grms

Test Time = 60 Sec.

Test Level Concurrence: ______________________ ________
Component Assessment Branch Date

BOOST RANDOM SN 1000734

RANDOM CHECK-OUT

AXIS LONGITUDINAL

.1 Verify test program and record RMS abort limit below. ✓

RMS abort limit 1 dB

.2 Perform levels as defined below and verify with plot. ✓

.3 Record the following:

Amplifier Gain 85

Charge Amp. F.S. 100

	Hz @		G^2/Hz,	limits	+3,-1.5 db
20 Hz -	800 Hz @	.24		limits	"
Hz -	2000 Hz @	.017		limits	"
Hz -	Hz @			limits	
Hz -	Hz @			limits	
Hz -	Hz @			limits	
Hz -	Hz @			limits	
Hz -	Hz @			limits	
Hz -	Hz @			limits	

Composite = 18.4 Grms

Test Time = 120 Sec.

Test Level Concurrence: ______________________ ________

Component Assessment Branch Date

SN 1000734

ICLE DYNAMICS CHECK-OUT

AXIS LONGITUDINAL

1.1 Verify test program and record the abort level below. ✓

Abort Level 1 dB

1.2 Perform levels as defined below and verify with plot. ✓

1.3 Record the following:

Amplifier Gain 4070

Charge Amp. F.S. 10 G

5	-	10	Hz at	.7	, limit	+-1.5	dB
10	-	40	Hz at	4.3	, limit	"	dB
	-		Hz at		, limit		dB
	-		Hz at		, limit		dB
	-		Hz at		, limit		dB

Sweep Rate = 3 oct/min

Test level concurrence: ______________________ __________

Component Assessment Branch Date

SN 1000734

RANDOM TEST LIFTOFF

AXIS RADIAL LONGITUDINAL TANGENTIAL

Record a minimum of 30 seconds of calibration signal on tape recorder. ✓ ✓ ✓

Set full scale ranges on instrumentation amplifiers and note on data sheet. ✓ ✓ ✓

Set power amplifier gain to position noted during random test check-out. ✓ ✓ ✓

4 Perform self check of control system. ✓ ✓ ✓

5 Begin test sequence at - 9 dB from full level. ✓ ✓ ✓

6 At -6 dB, start tape recorder. ✓ ✓ ✓

7 Note time when full level is reached. SEE TAPE LOG ✓ ✓ ✓

8 At the completion of the test, set power amplifier gain to off. ✓ ✓ ✓

9 Stop tape recorder. ✓ ✓ ✓

10 Inspect test article for damage or degradation. ✓ ✓ ✓

11 Remove test article from shaker. ✓ ✓ ✓

SN 1000734

RANDOM TEST Boost

AXIS RADIAL / TANGENTIAL / LONGITUDINAL

	Record a minimum of 30 seconds of calibration signal on tape recorder.	✓ ✓ ✓
	Set full scale ranges on instrumentation amplifiers and note on data sheet.	✓ ✓ ✓
	Set power amplifier gain to position noted during random test check-out.	✓ ✓ ✓
	Perform self check of control system.	✓ ✓ ✓
	Begin test sequence at - 9 dB from full level.	✓ ✓ ✓
	At - 6 dB, start tape recorder.	✓ ✓ ✓
7	Note time when full level is reached. SEE TAPE LOG	✓ ✓ ✓
	At the completion of the test, set power amplifier gain to off.	✓ ✓ ✓
9	Stop tape recorder.	✓ ✓ ✓
10	Inspect test article for damage or degradation.	✓ ✓ ✓
11	Remove test article from shaker.	✓ ✓ ✓

SN 1000734

.CLE DYNAMICS TEST

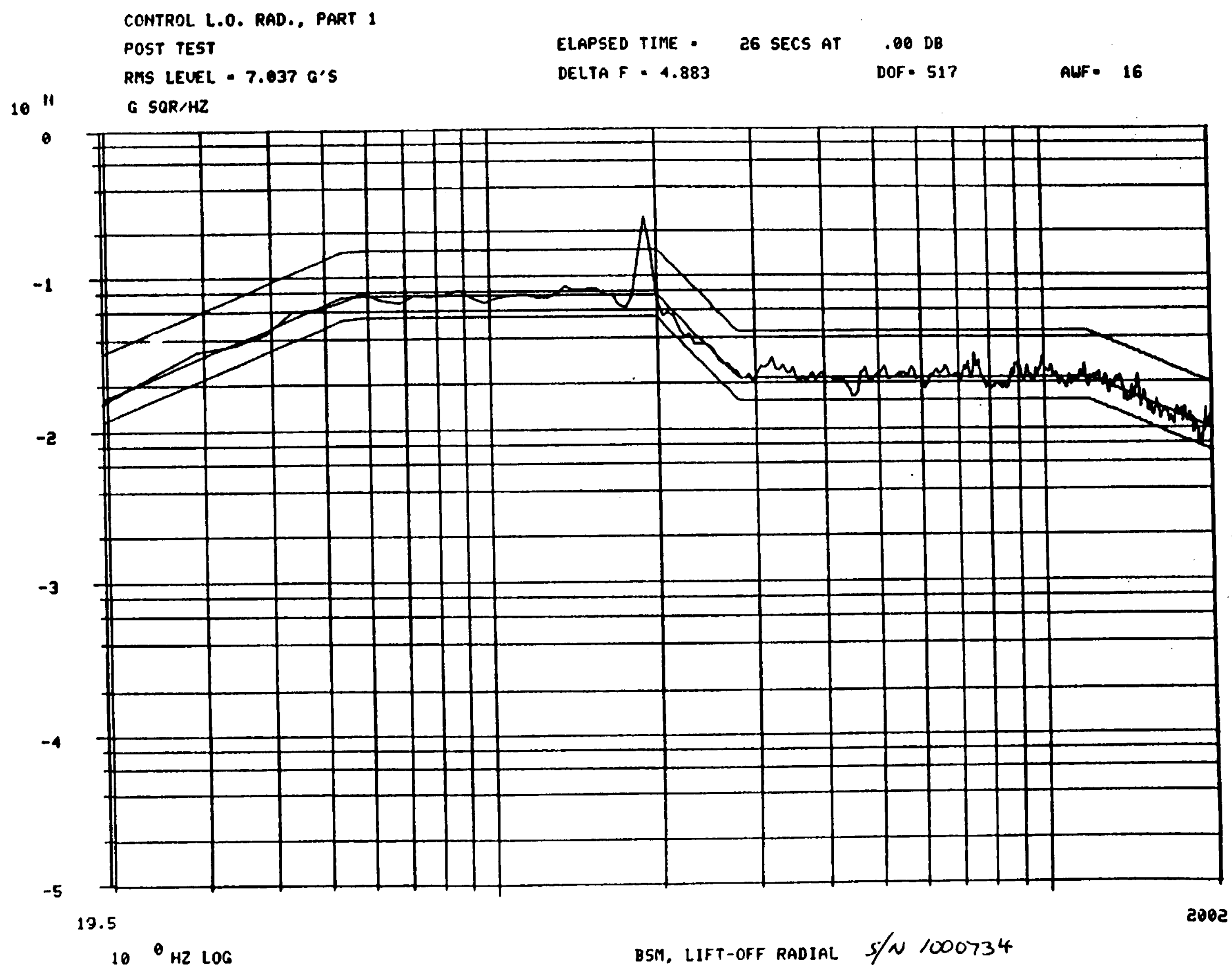
		AXIS RADIAL TANGENTIAL LONGITUDINAL
1.1	Record a minimum of 30 seconds of calibration signal on tape recorder.	✓✓✓
1.2	Set full scale ranges on instrumentation amplifiers and note on data sheet.	✓✓✓
1.3	Set power amplifier gain to position noted during sine test check-out.	✓✓✓
1.4	Perform self check of control system.	✓✓✓
1.5	Start tape recorder.	✓✓✓
1.6	Begin sine sweep.	✓✓✓
1.7	Note time of DCS "SWEEP UP" or "SWEEP DOWN" indication light. SEE TAPE LOG	✓✓✓
1.8	During first sweep, press the "SAVE" button on DCS.	✓✓✓
1.9	If more than one sweep, note time of DCS "SWEEP UP" or "SWEEP DOWN" indication light. ______	—
1.10	At the completion of the sweep, set power amplifier gain to off.	✓✓✓
1.11	Stop tape recorder.	✓✓✓
1.12	Inspect test article for damage or degradation.	✓✓✓

SN 100034

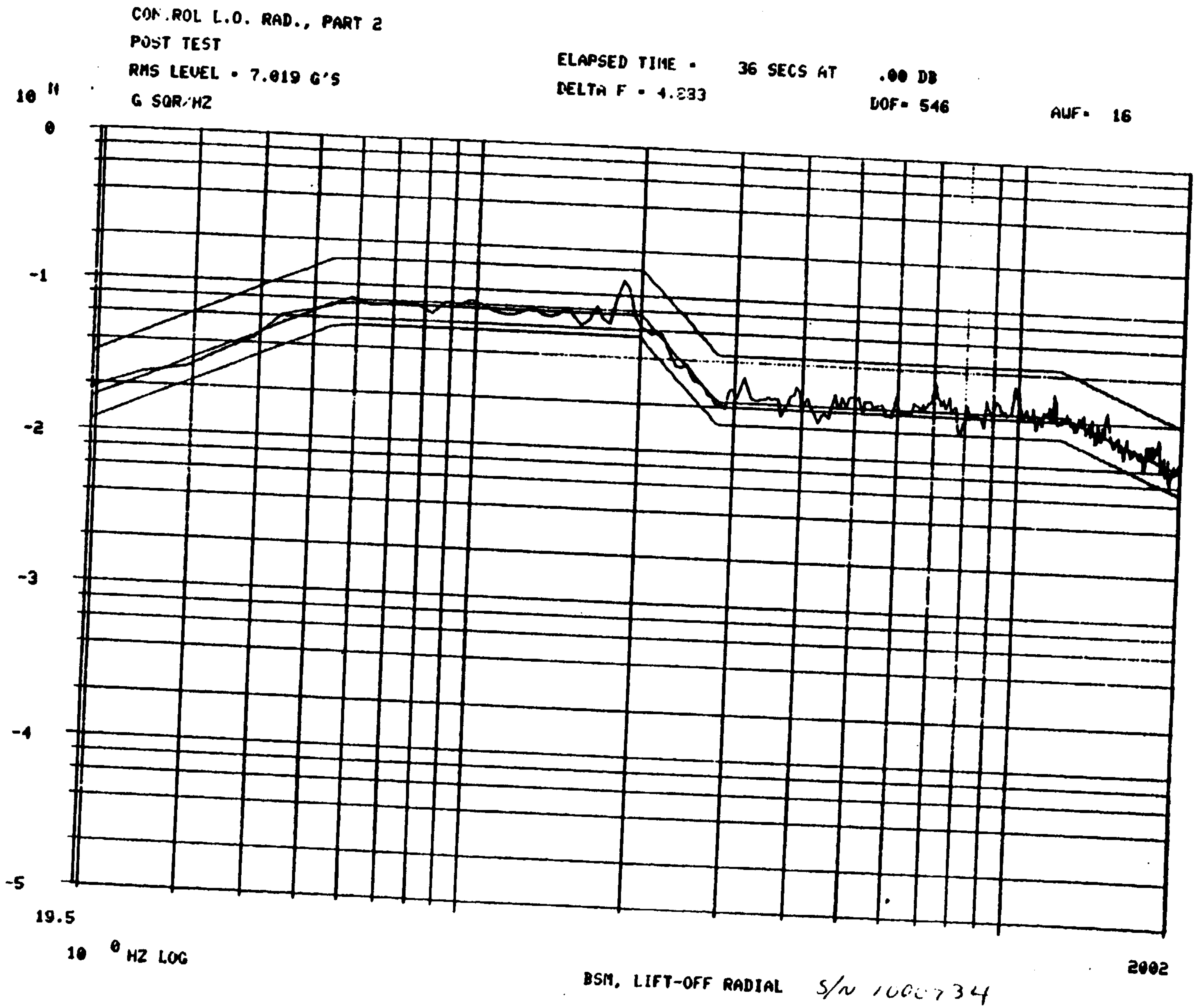
TEST DATA

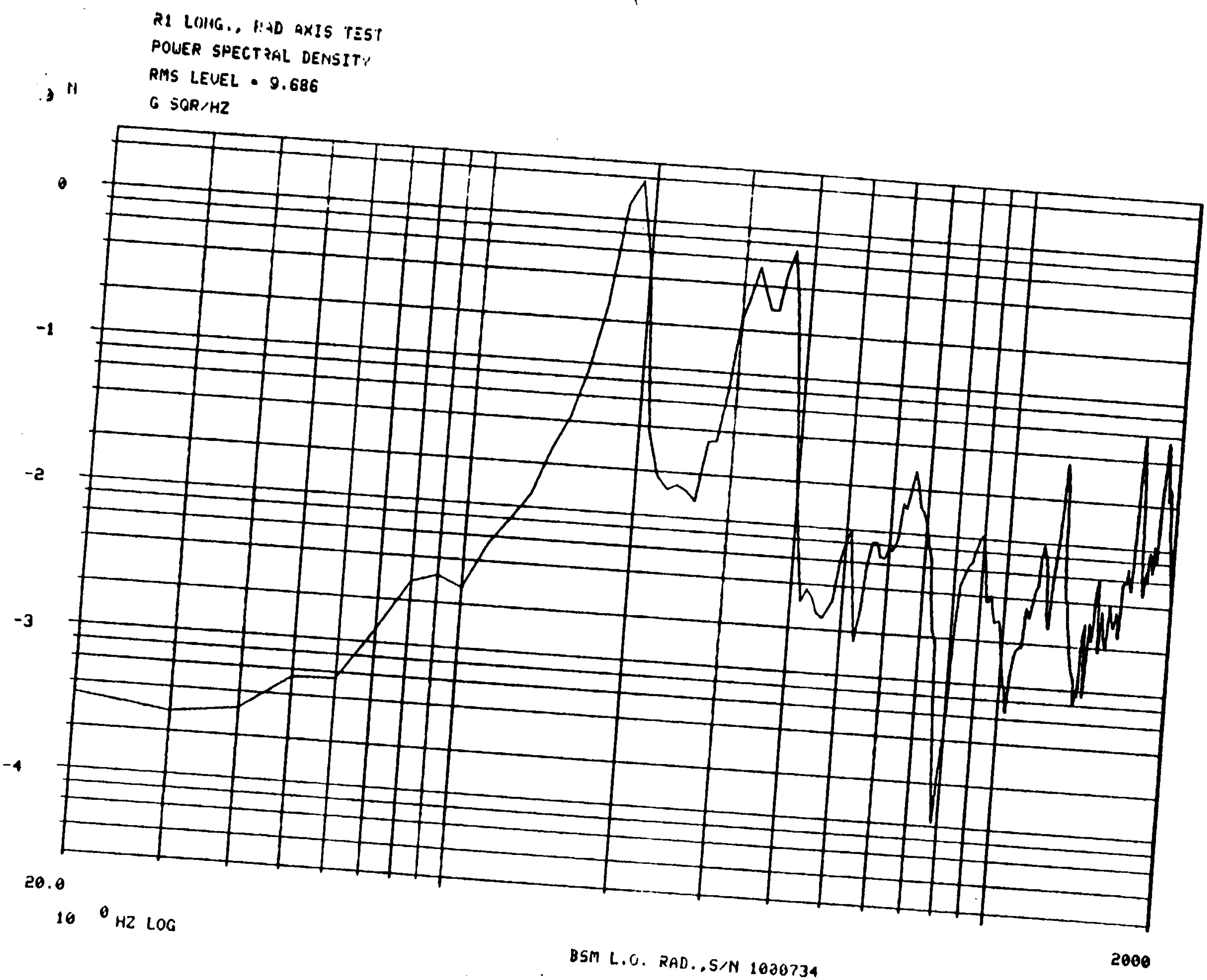
TEST DATA S/N 1000734

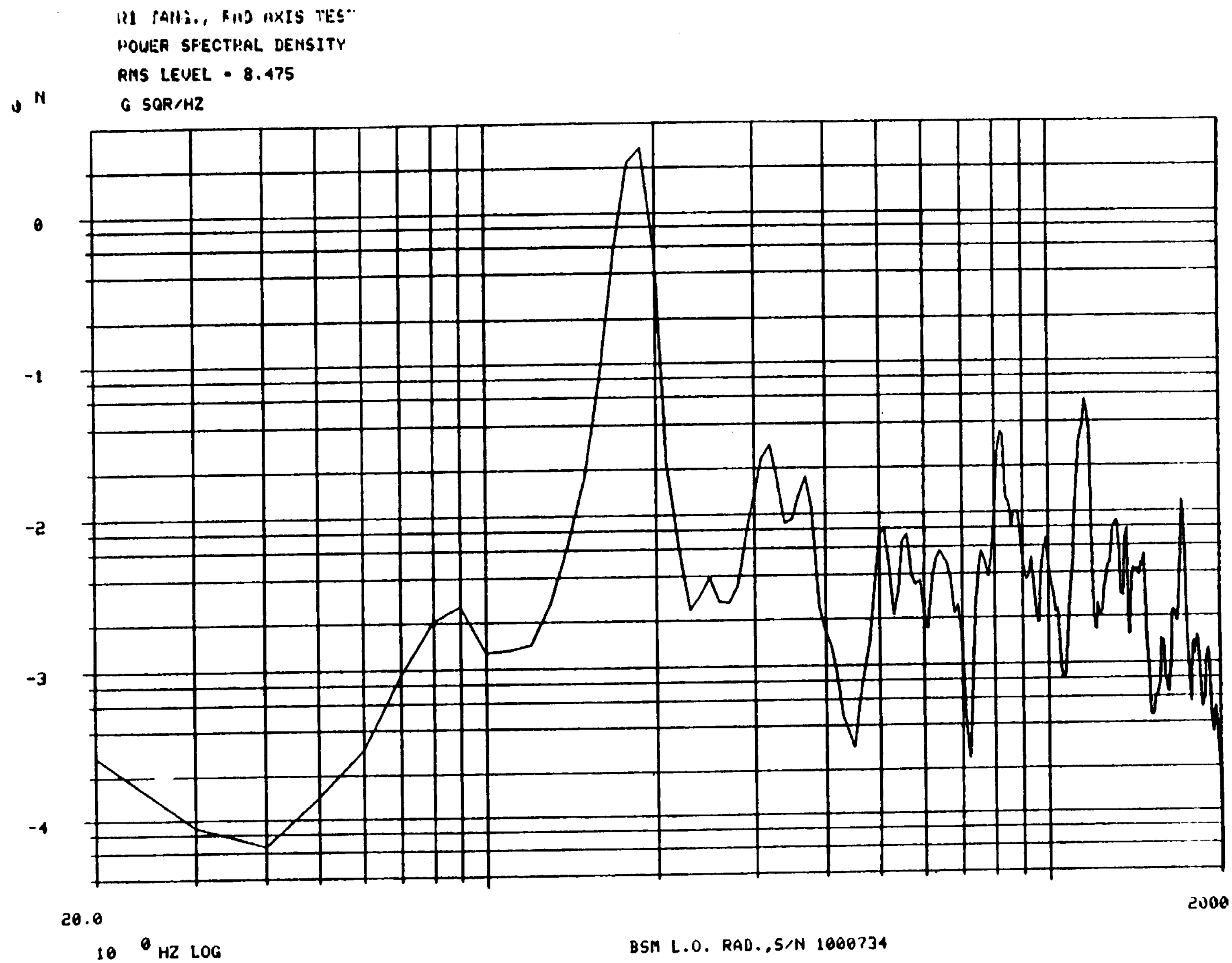
RANDOM, LIFT-OFF, RADIAL AXIS

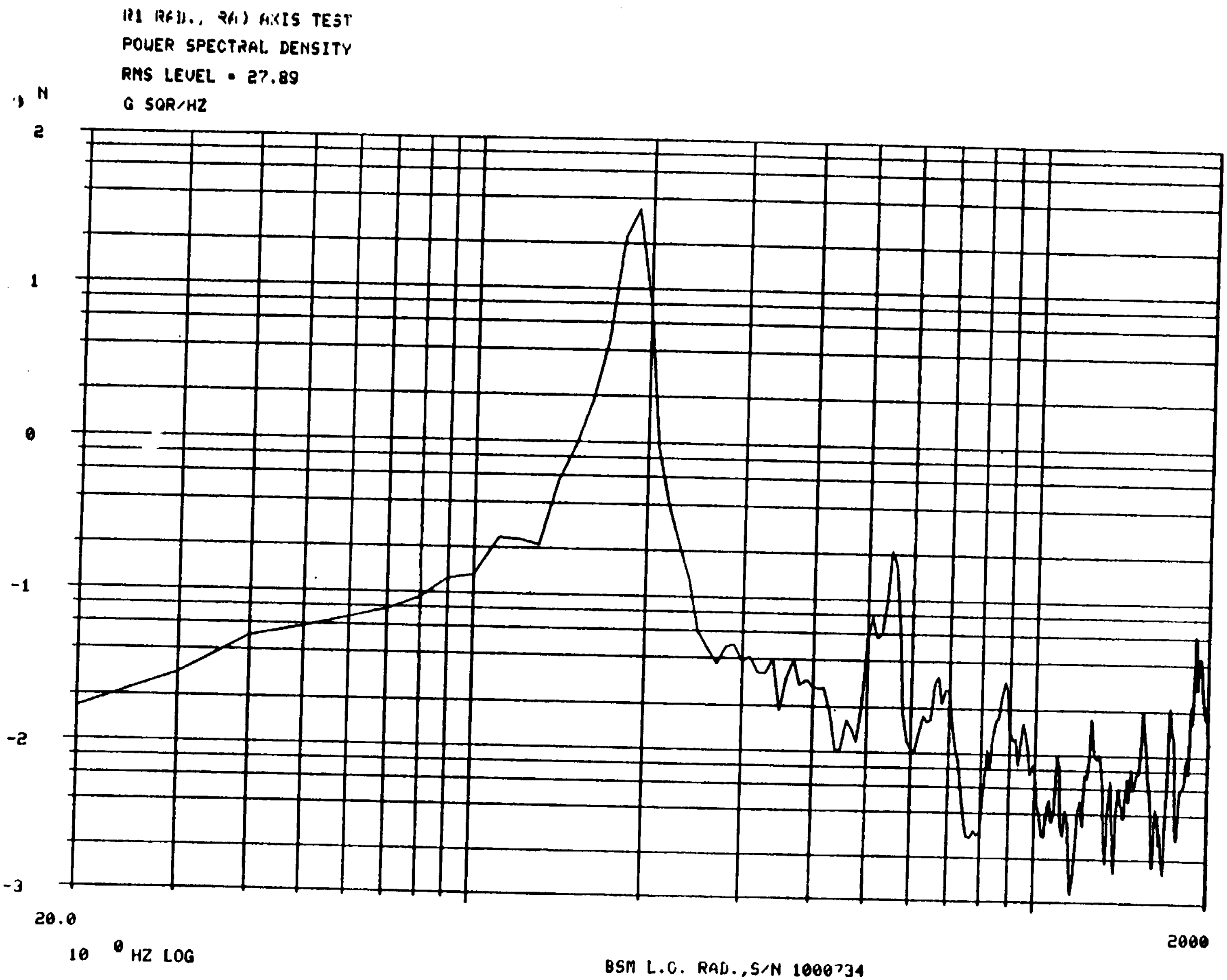


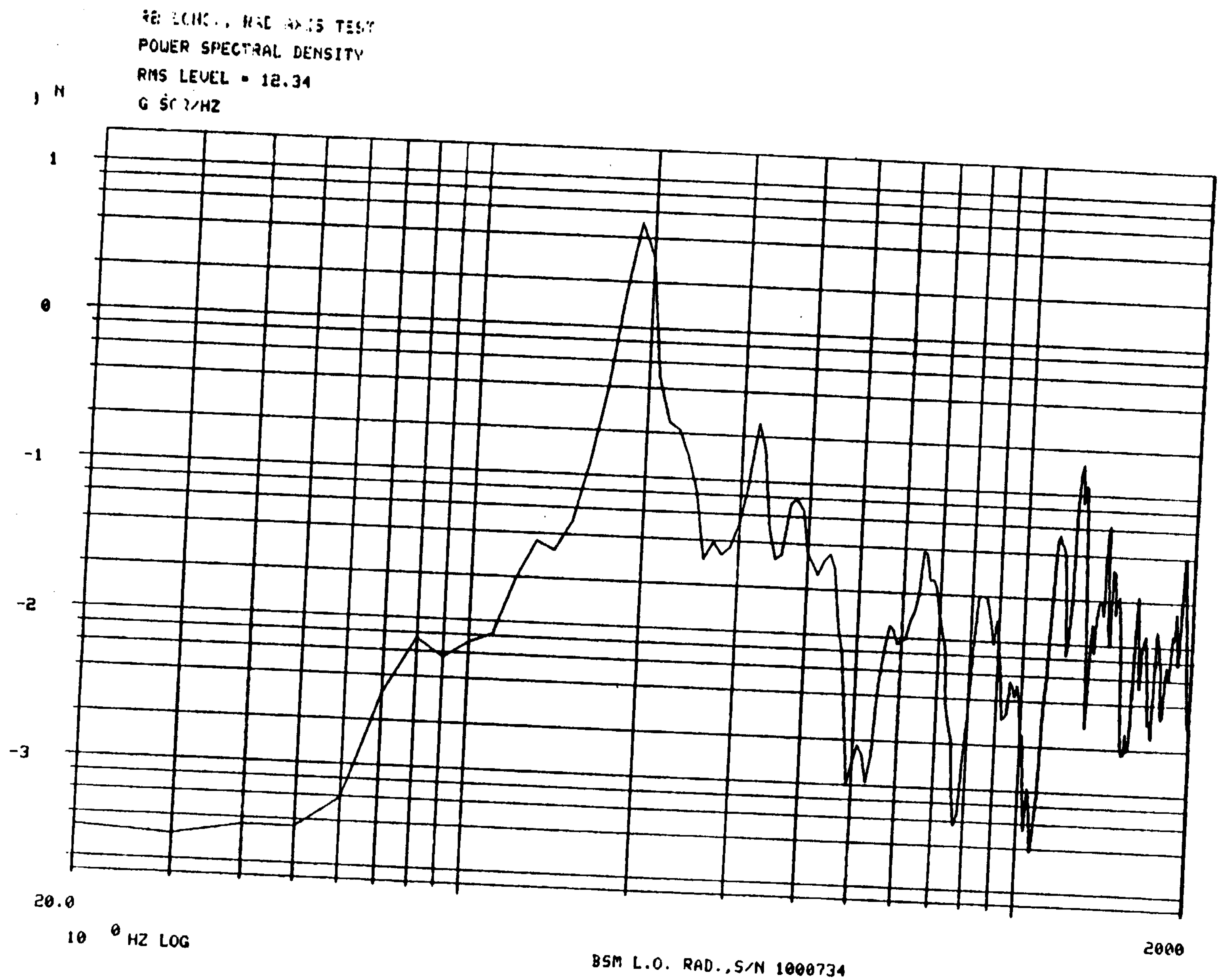
CONTROL L.O. RAD., PART 1
POST TEST
RMS LEVEL = 7.037 G'S
G SQR/HZ
ELAPSED TIME = 26 SECS AT .00 DB
DELTA F = 4.883
DOF= 517
AWF= 16
10 ** 0
-1
-2
-3
-4
-5
19.5
2002
10 0 HZ LOG
BSM, LIFT-OFF RADIAL S/N 100734

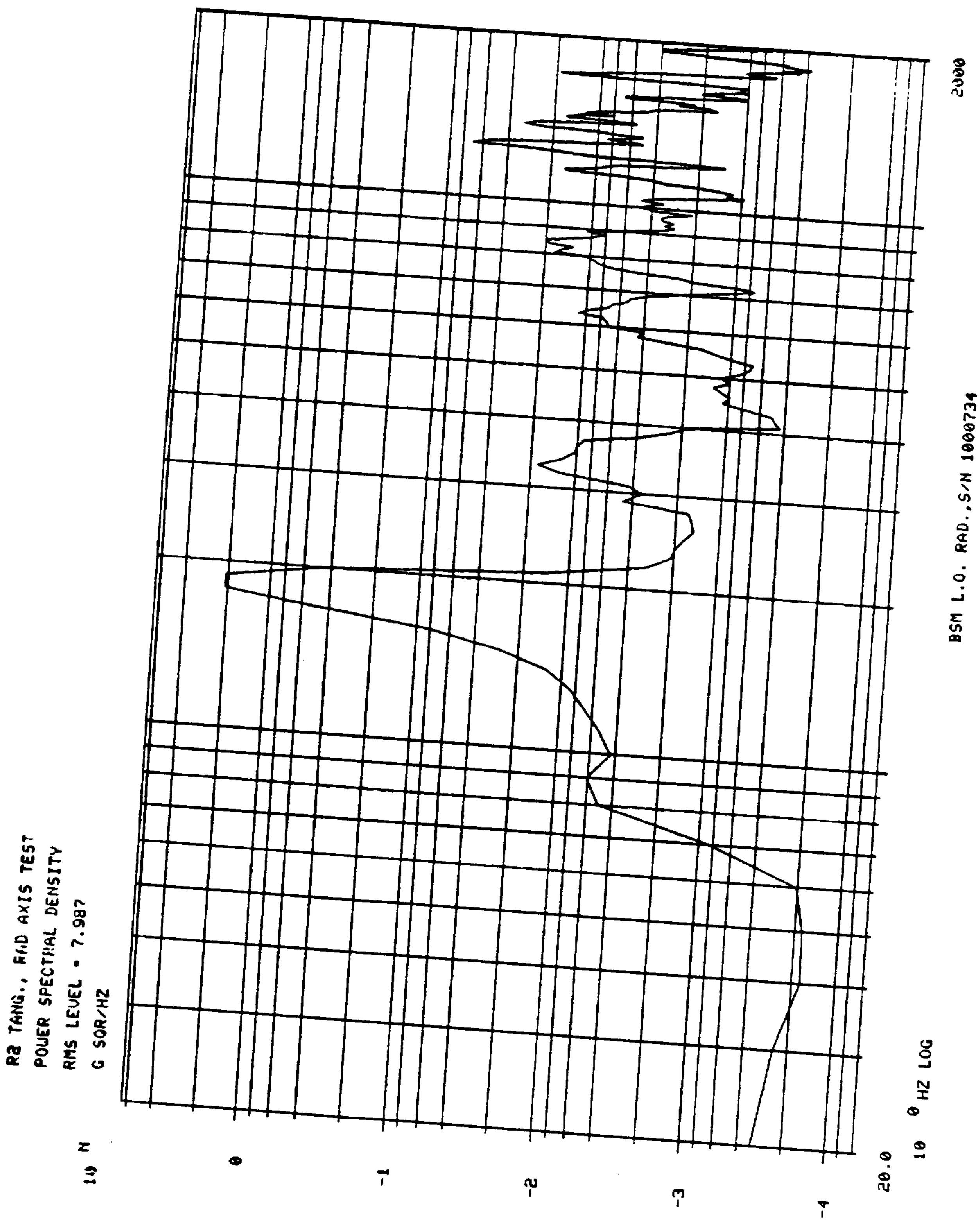

CON.ROL L.O. RAD., PART 2
POST TEST
RMS LEVEL • 7.019 G'S
G SQR/HZ
ELAPSED TIME • 36 SECS AT .00 DB
DELTA F • 4.233
DOF• 546
AVF• 16
10
0
-1
-2
-3
-4
-5
19.5
10 0 HZ LOG
2002
BSM, LIFT-OFF RADIAL
S/N 1000734

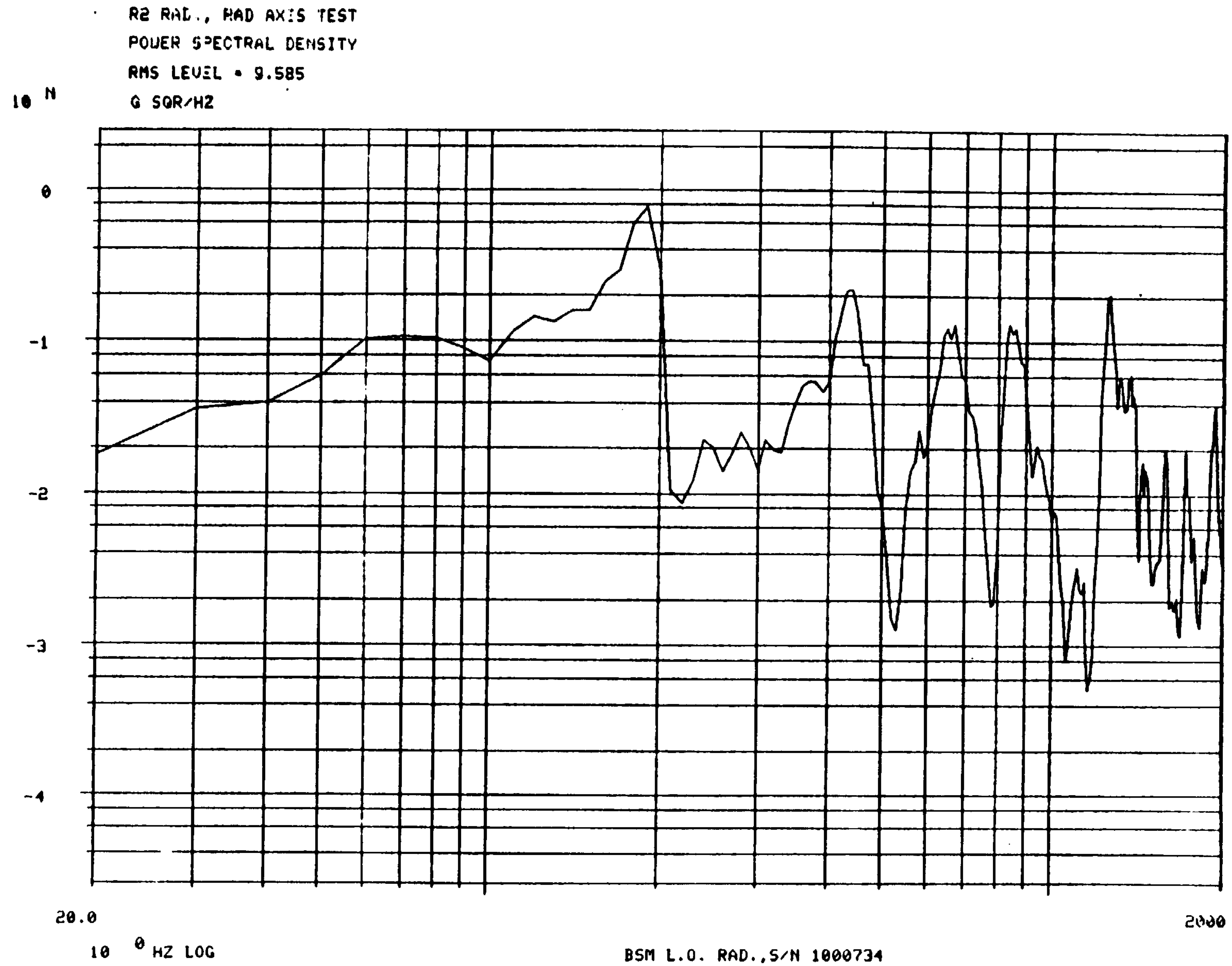

R1 LONG., RAD AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL • 9.686
G SQR/HZ
0
-1
-2
-3
-4
20.0
10
0 HZ LOG
BSM L.O. RAD.,S/N 1000734
2000


POWER SPECTRAL DENSITY
RMS LEVEL = 8.475
G SQR/HZ
0
-1
-2
-3
-4
20.0
2000
10 0 HZ LOG
BSM L.O. RAD.,S/N 1000734

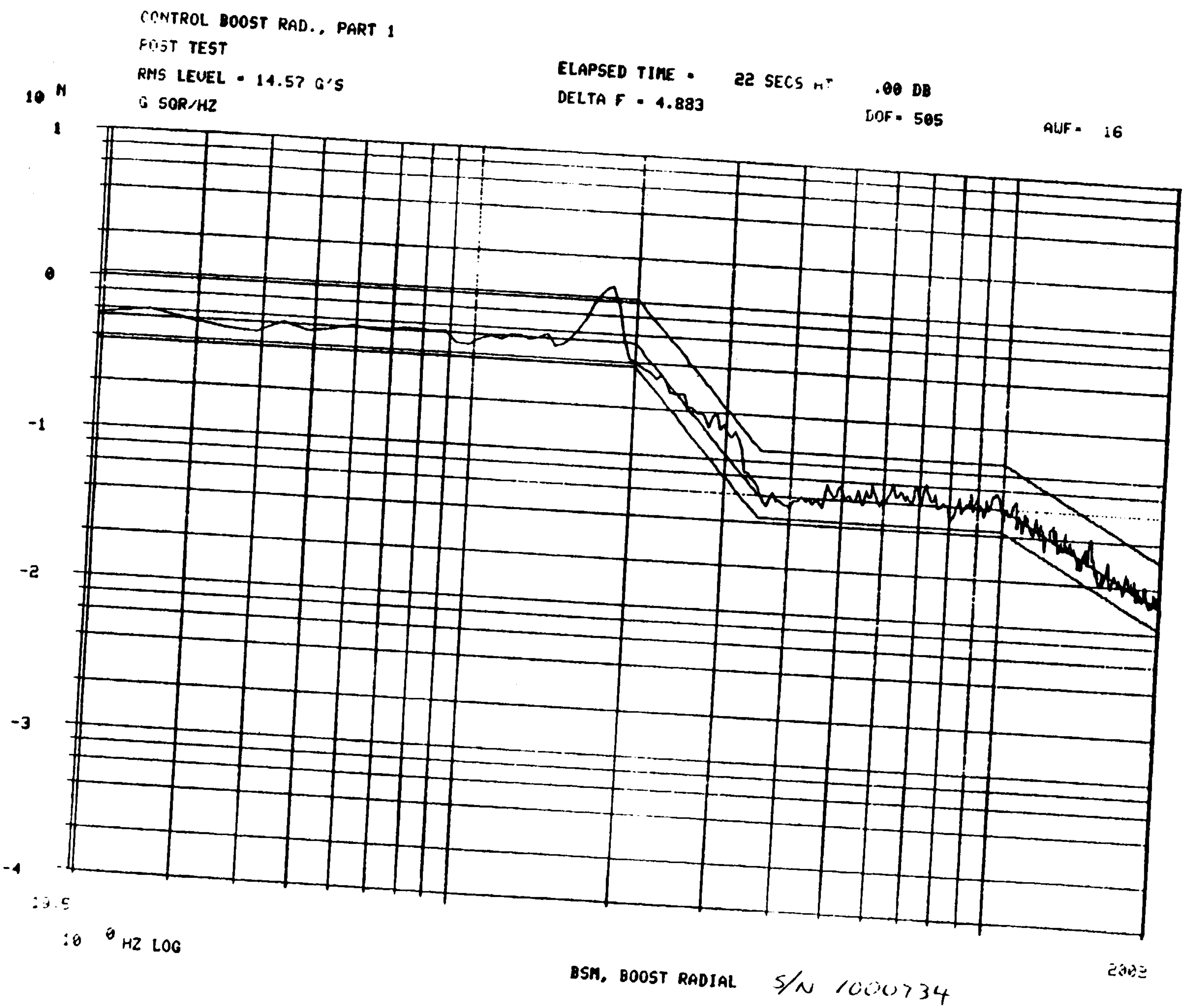

AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL = 27.89
G SQR/HZ
2
1
0
-1
-2
-3
20.0
2000
10 0 HZ LOG
BSM L.C. RAD.,S/N 1000734

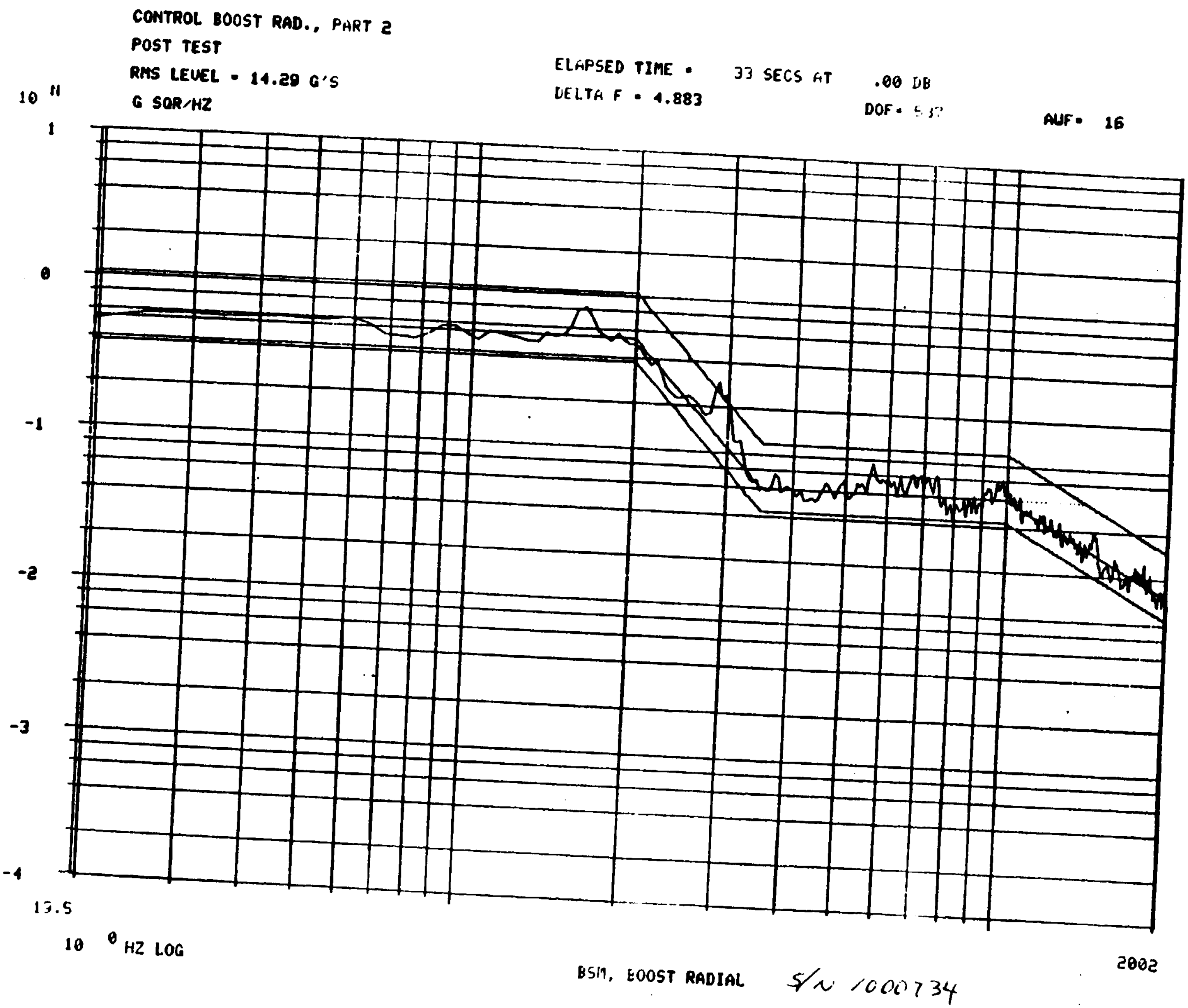

POWER SPECTRAL DENSITY
RMS LEVEL = 12.34
1
0
-1
-2
-3
20.0
10
HZ LOG
2000
BSM L.O. RAD., S/N 1000734


R2 TANG., RAD AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL = 7.987
G SQR/HZ
10 N
0
-1
-2
-3
-4
20.0
10
0 HZ LOG
2000
BSM L.O. RAD., S/N 1000734

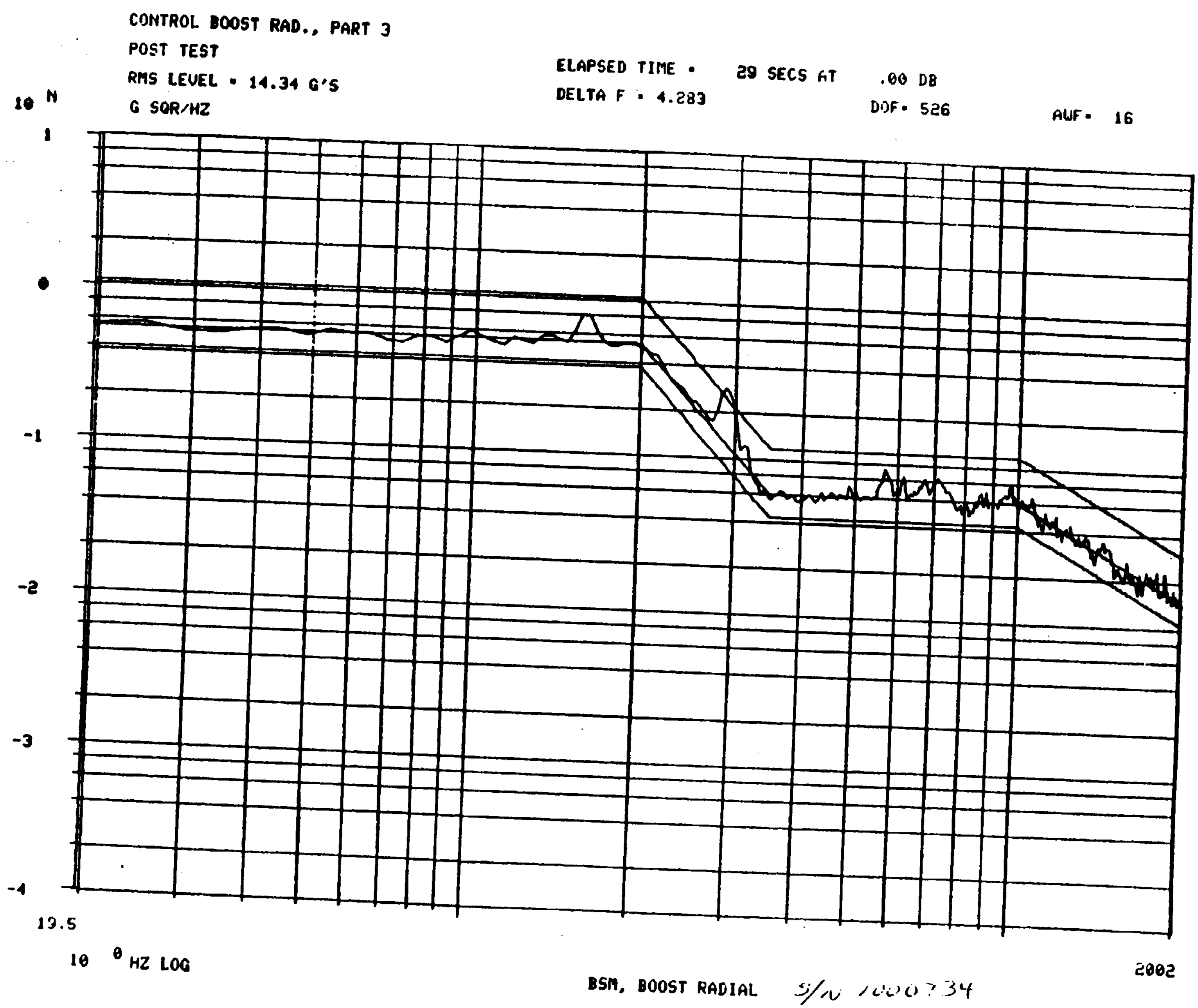

R2 RAD., RAD AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL = 9.585
G SQR/HZ
10 N
0
-1
-2
-3
-4
20.0
2000
10 0 HZ LOG
BSM L.O. RAD.,S/N 1000734

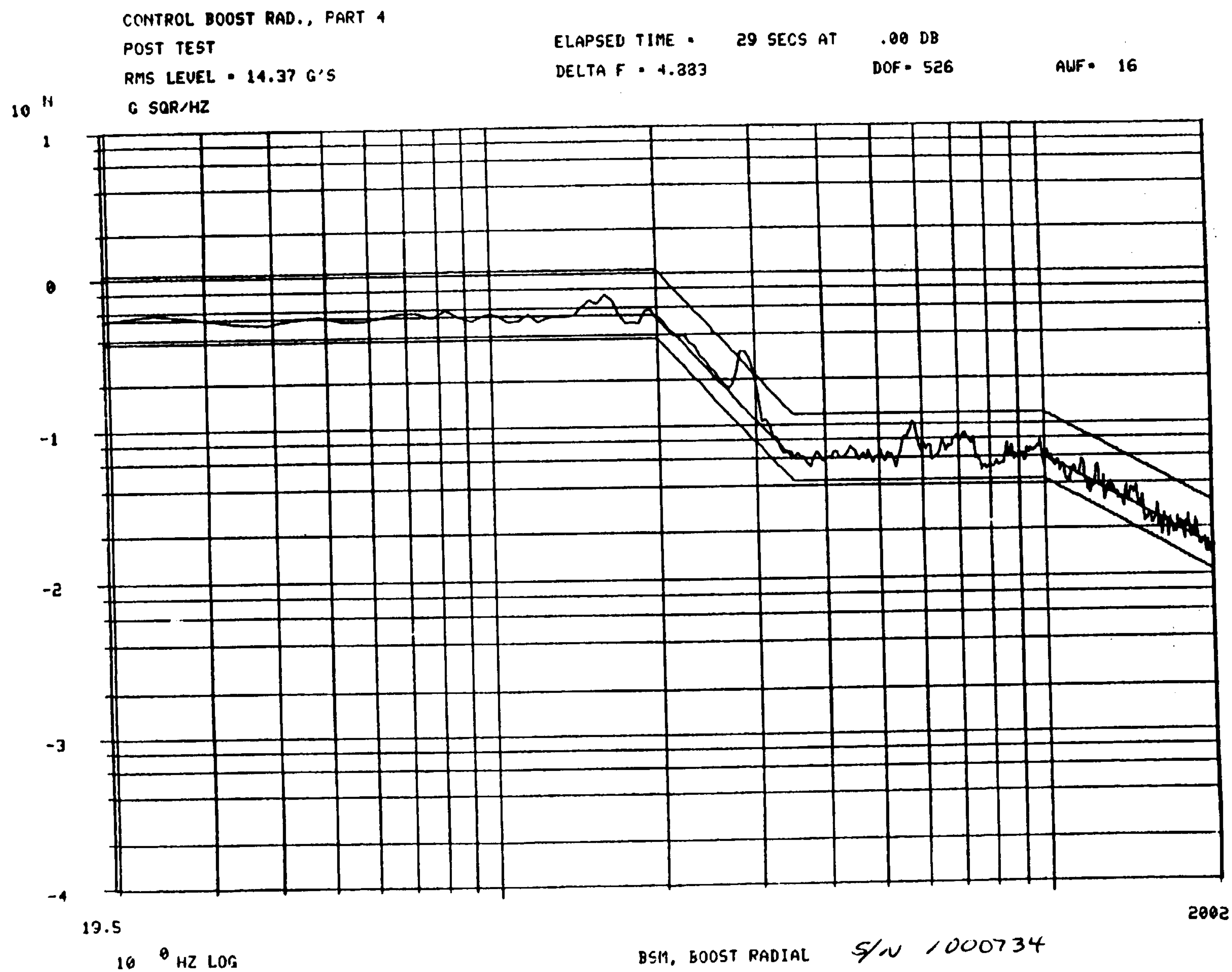
RANDOM, BOOST, RADIAL AXIS

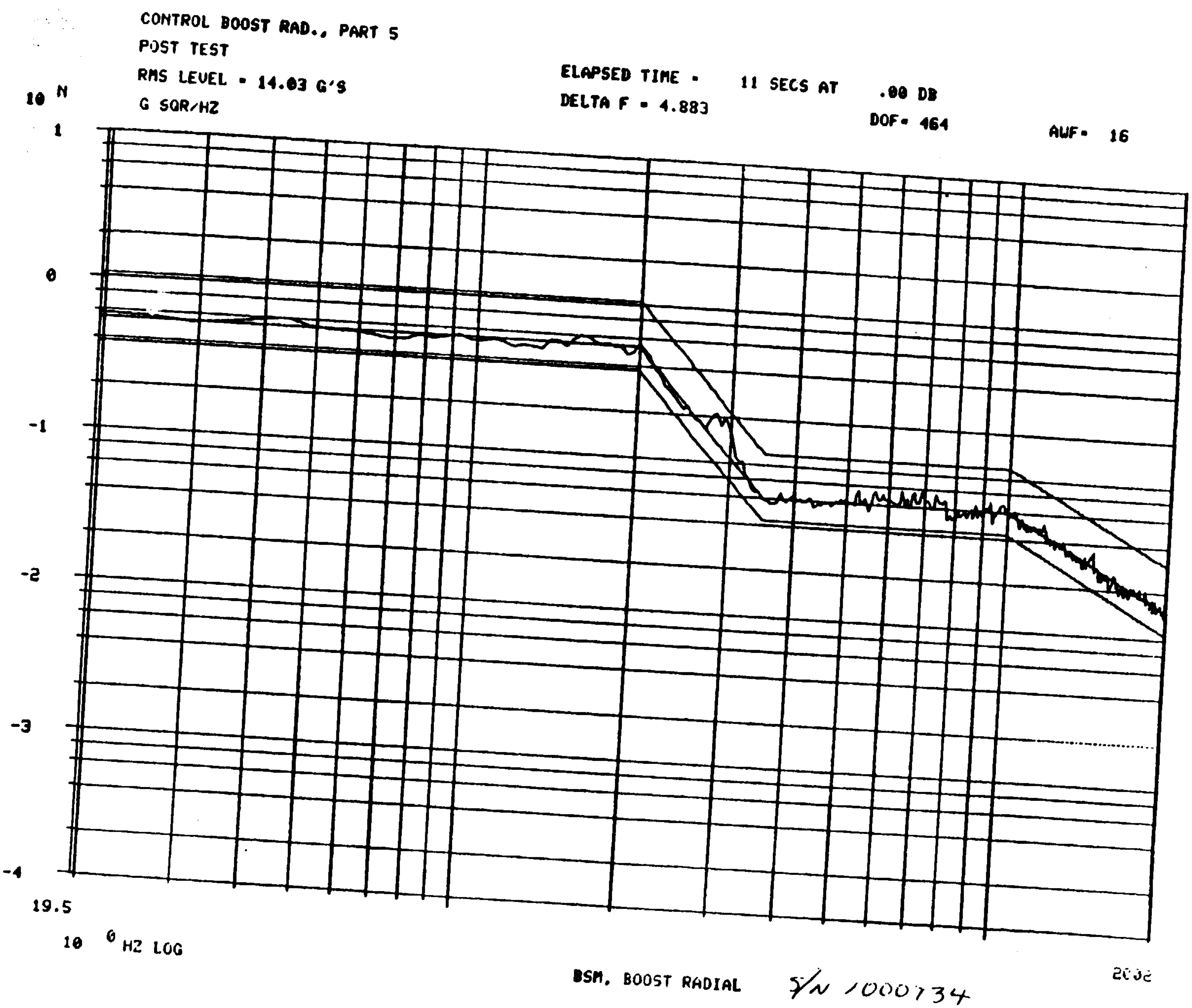

CONTROL BOOST RAD., PART 1
POST TEST
RMS LEVEL = 14.57 G'S
G SQR/HZ
ELAPSED TIME = 22 SECS
.00 DB
DELTA F = 4.883
DOF= 505
AVF= 16
10 N
1
0
-1
-2
-3
-4
10 0 HZ LOG
2003
BSM, BOOST RADIAL
S/N 1000734

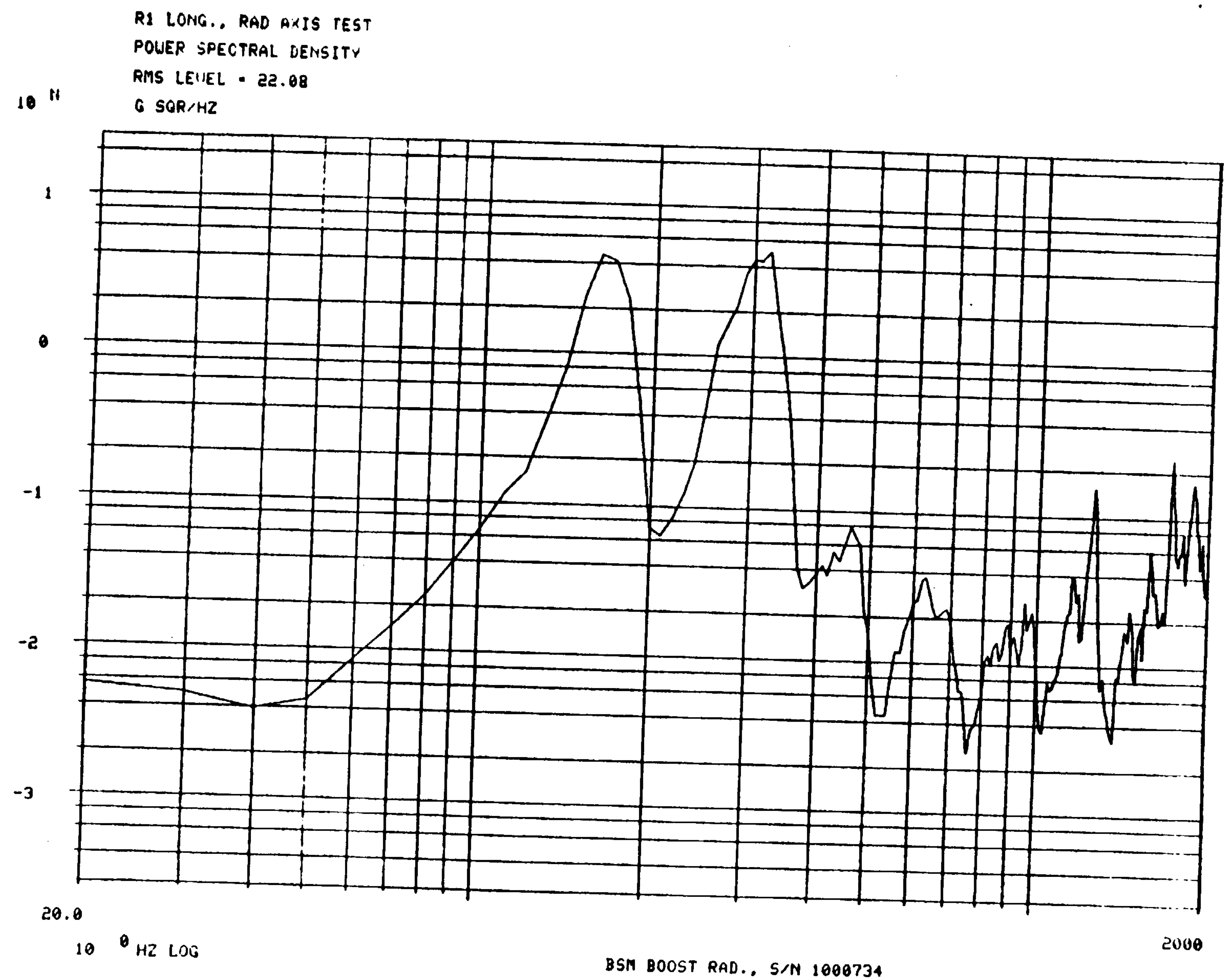


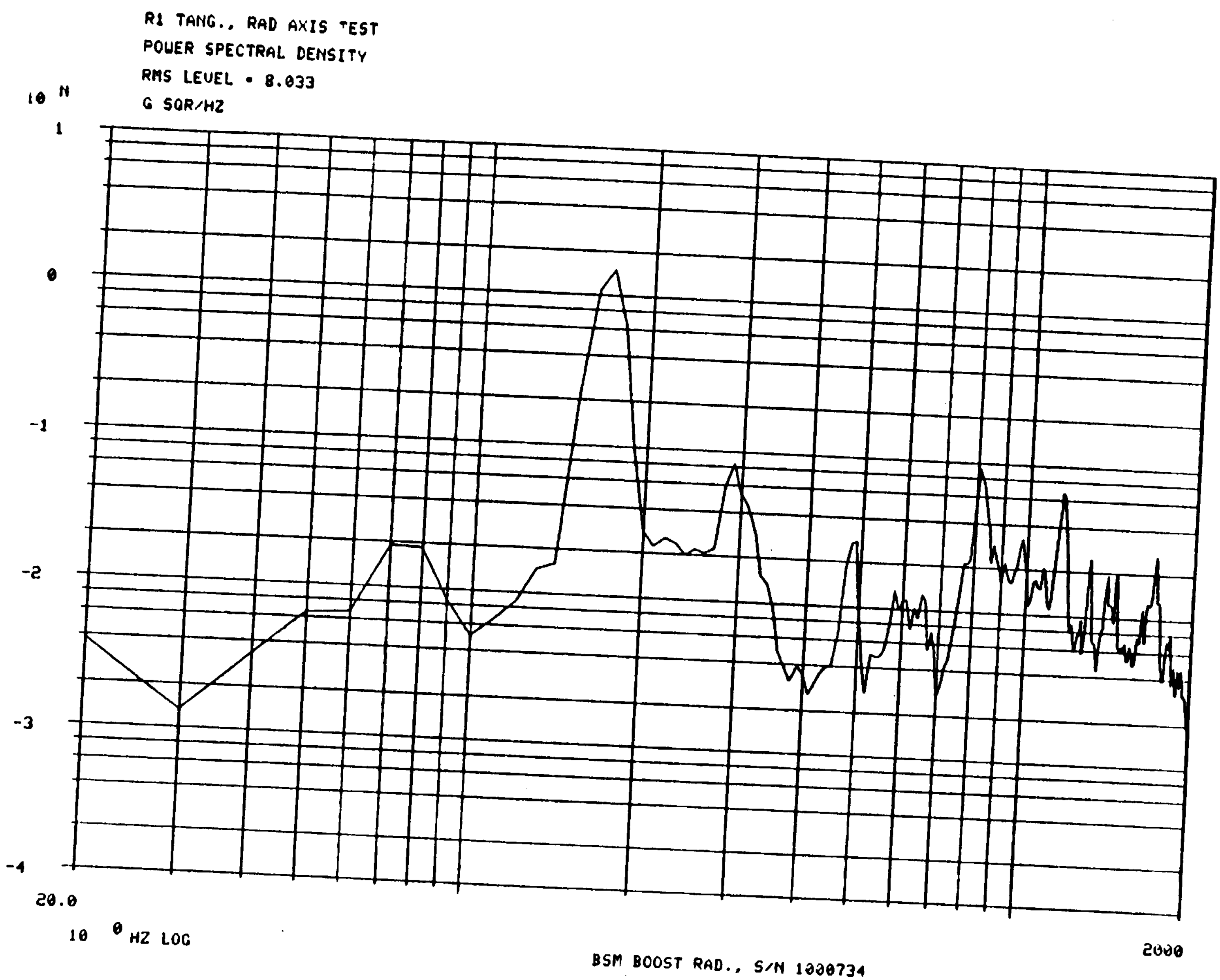
CONTROL BOOST RAD., PART 2
POST TEST
RMS LEVEL = 14.29 G'S
G SQR/HZ
ELAPSED TIME = 33 SECS AT .00 DB
DELTA F = 4.883
AUF = 16
10 N
1
0
-1
-2
-3
-4
13.5
10 0 HZ LOG
2002
BSM, BOOST RADIAL
S/N 1000734

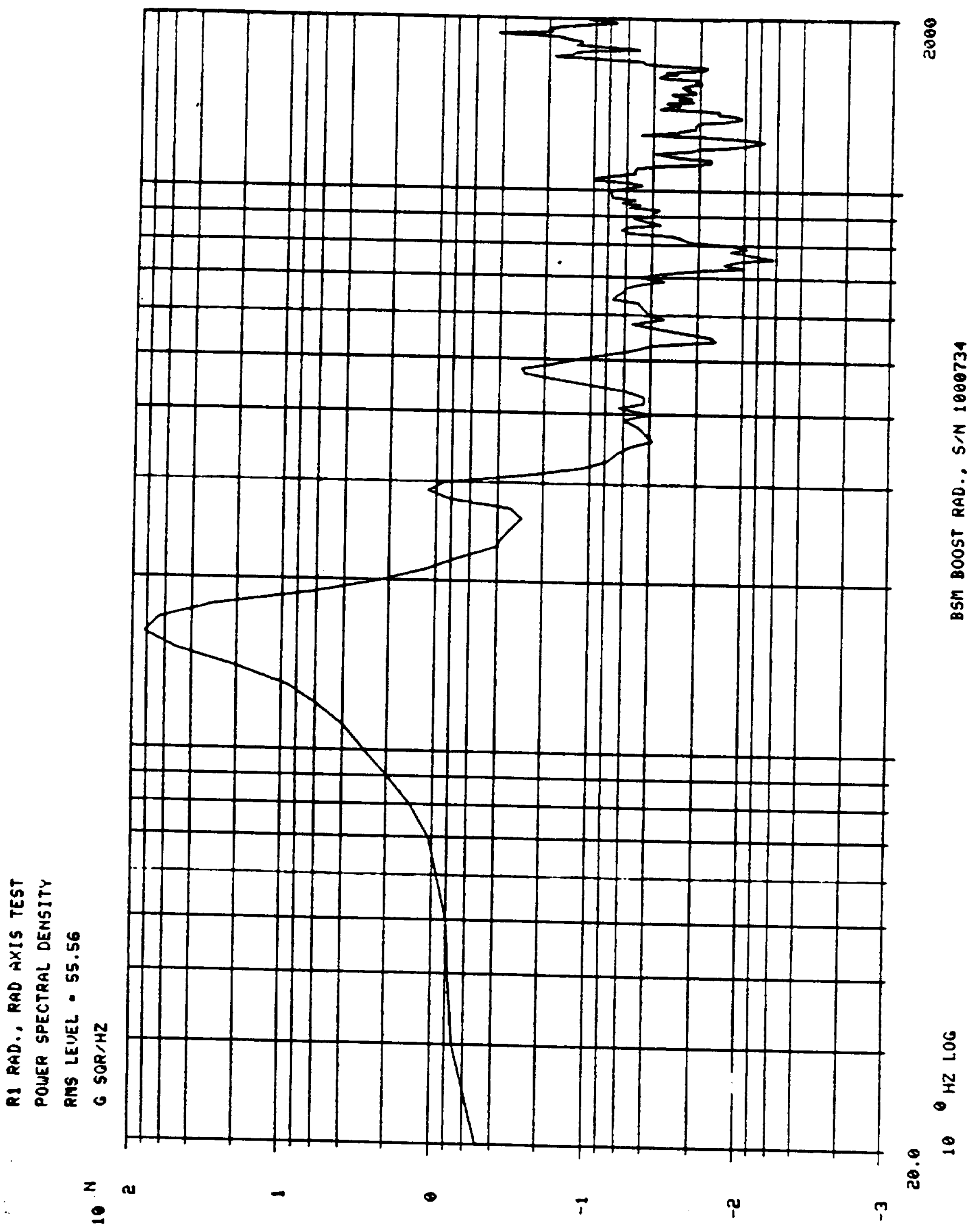

CONTROL BOOST RAD., PART 3
POST TEST
RMS LEVEL = 14.34 G'S
G SQR/HZ
ELAPSED TIME = 29 SECS AT .00 DB
DELTA F = 4.283
DOF= 526
AWF= 16
10 N
1
0
-1
-2
-3
-4
19.5
10 0 HZ LOG
2002
BSM, BOOST RADIAL S/N 1000734


CONTROL BOOST RAD., PART 4
POST TEST
RMS LEVEL • 14.37 G'S
G SQR/HZ
ELAPSED TIME • 29 SECS AT .00 DB
DELTA F • 4.883
DOF• 526
AWF• 16
10 N
1
0
-1
-2
-3
-4
19.5
2002
10 0 HZ LOG
BSM, BOOST RADIAL
S/N 1000734

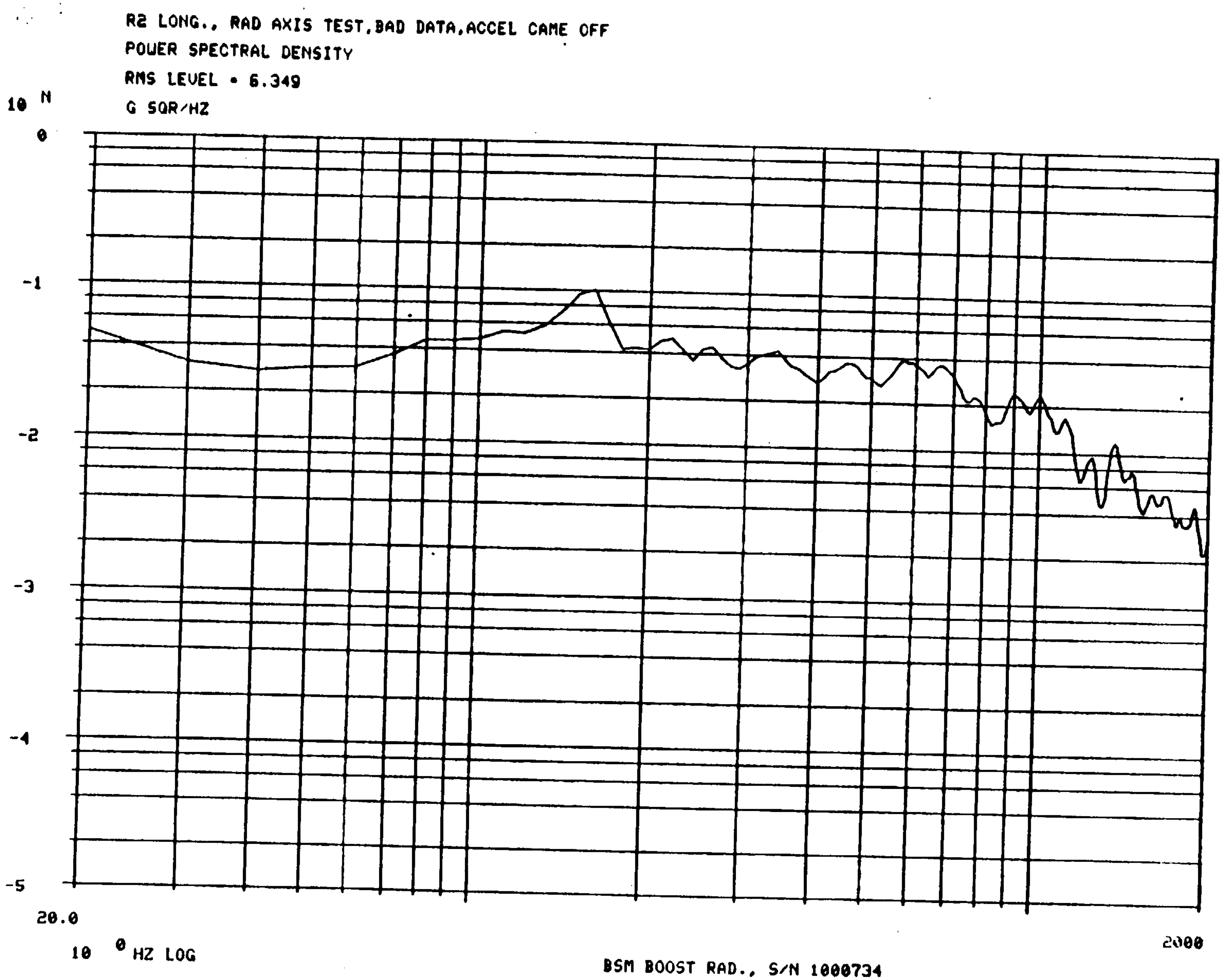

CONTROL BOOST RAD., PART 5
POST TEST
RMS LEVEL = 14.03 G'S
G SQR/HZ
ELAPSED TIME = 11 SECS AT .00 DB
DELTA F = 4.883
DOF= 464
AWF= 16
10^N
1
0
-1
-2
-3
-4
19.5
10^0 HZ LOG
2002
BSM, BOOST RADIAL
S/N 1000734


R1 LONG., RAD AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL = 22.08
G SQR/HZ
10 N
1
0
-1
-2
-3
20.0
10 0 HZ LOG
2000
BSM BOOST RAD., S/N 1000734

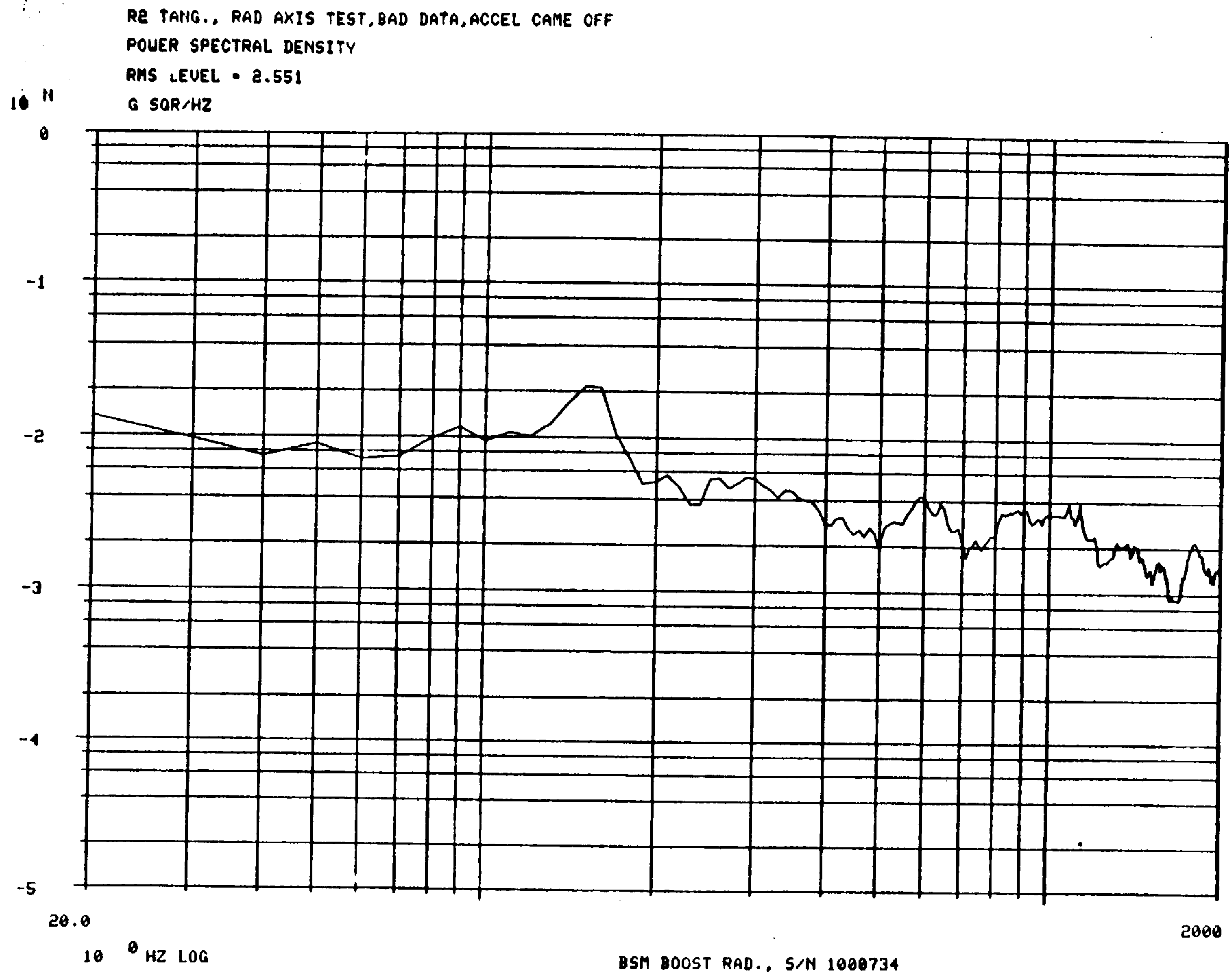

R1 TANG., RAD AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL • 8.033
G SQR/HZ
10 N
1
0
-1
-2
-3
-4
20.0
10 0 HZ LOG
2000
BSM BOOST RAD., S/N 1000734

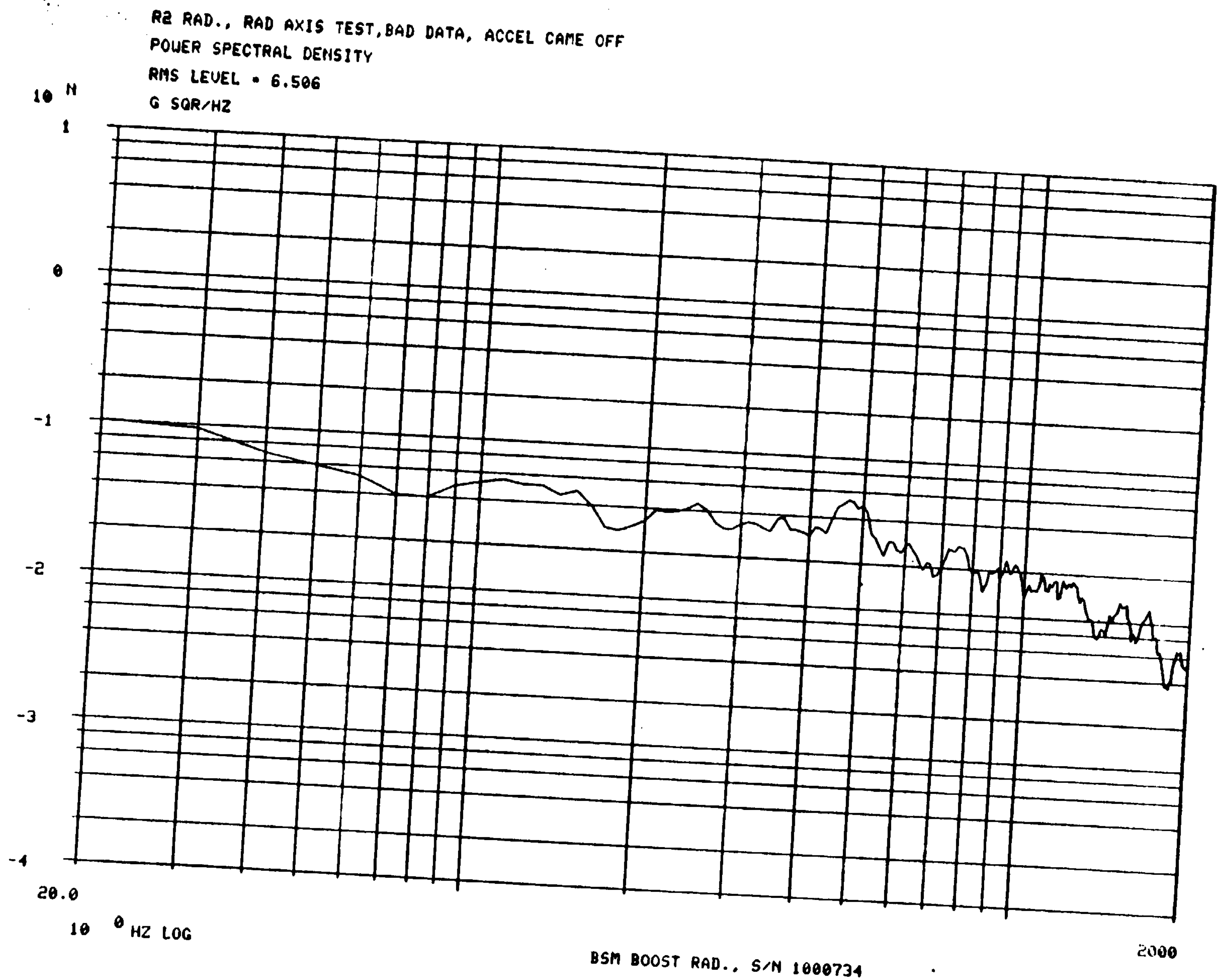


R1 RAD., RAD AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL = 55.56
G SQR/HZ
10 N
2
1
0
-1
-2
-3
20.0
10 0 HZ LOG
2000
BSM BOOST RAD., S/N 1000734



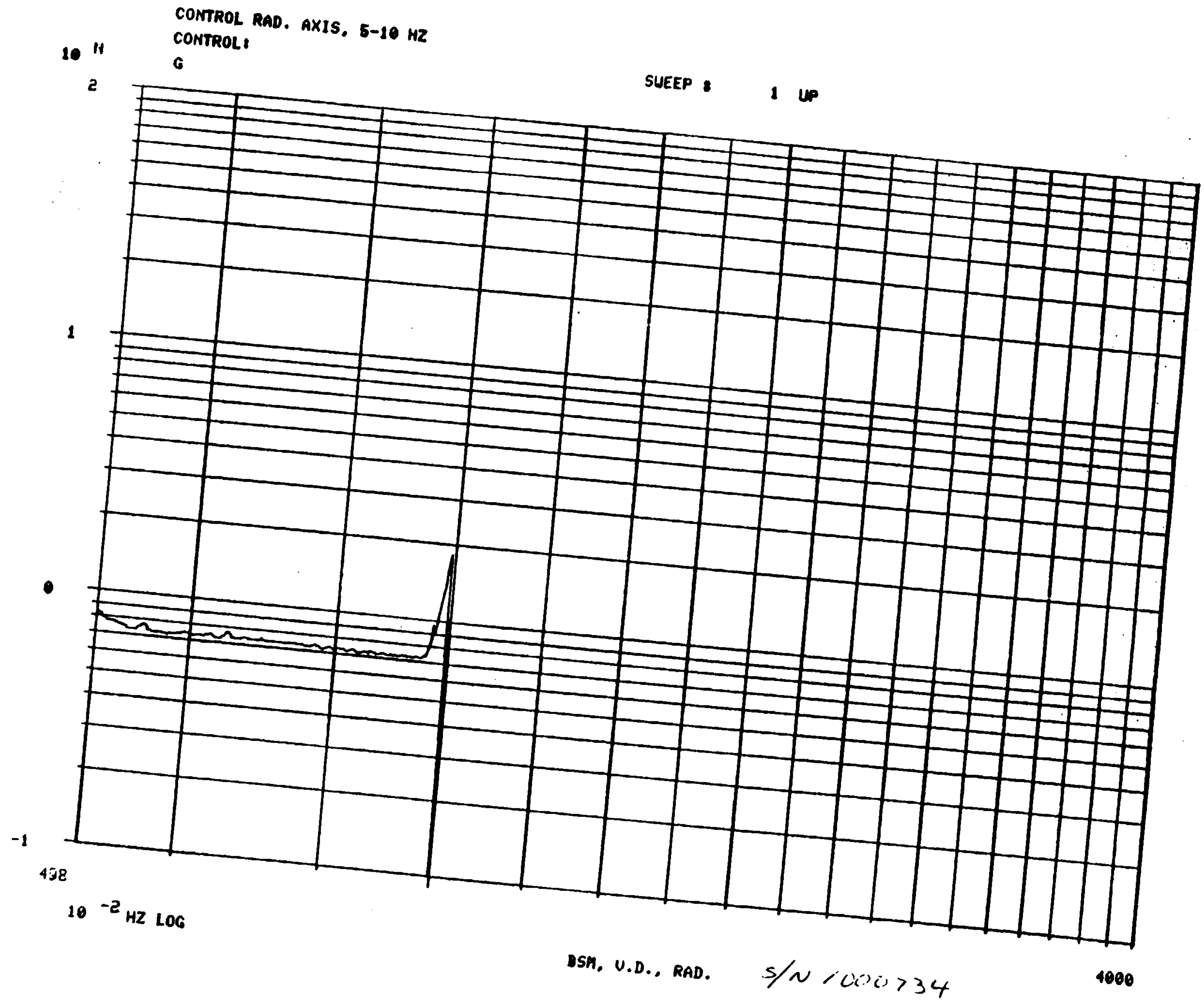
R2 LONG., RAD AXIS TEST, BAD DATA, ACCEL CAME OFF
POWER SPECTRAL DENSITY
RMS LEVEL • 6.349
G SQR/HZ
10 N
0
-1
-2
-3
-4
-5
20.0
10 0 HZ LOG
2000
BSM BOOST RAD., S/N 1000734


R2 TANG., RAD AXIS TEST,BAD DATA,ACCEL CAME OFF
POWER SPECTRAL DENSITY
RMS LEVEL = 2.551
G SQR/HZ
10 N
0
-1
-2
-3
-4
-5
20.0
2000
10 0 HZ LOG
BSM BOOST RAD., S/N 1000734

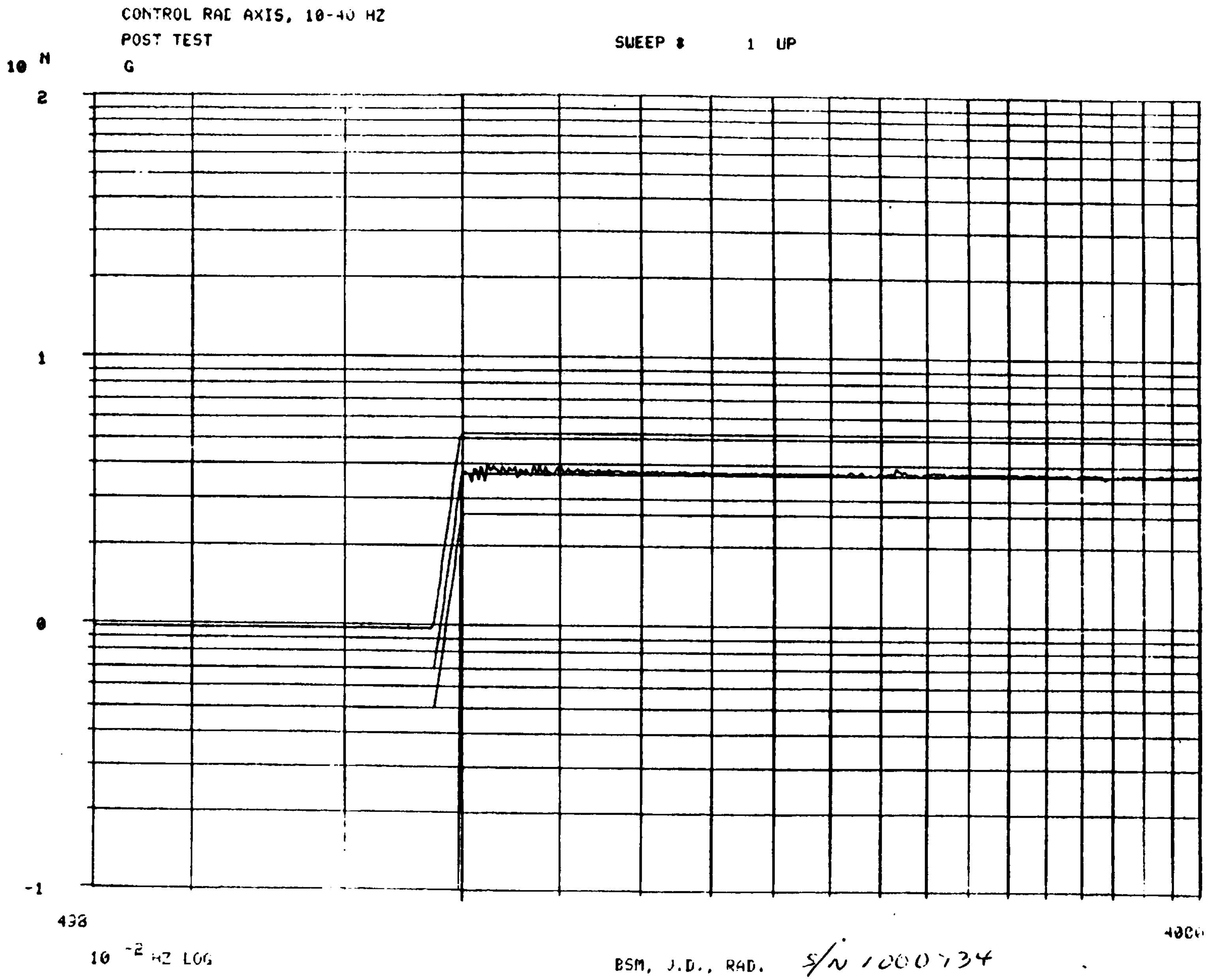

R2 RAD., RAD AXIS TEST,BAD DATA, ACCEL CAME OFF
POWER SPECTRAL DENSITY
RMS LEVEL = 6.506
G SQR/HZ
10 N
1
0
-1
-2
-3
-4
20.0
10 0 HZ LOG
2000
BSM BOOST RAD., S/N 1000734

RADIAL AXIS

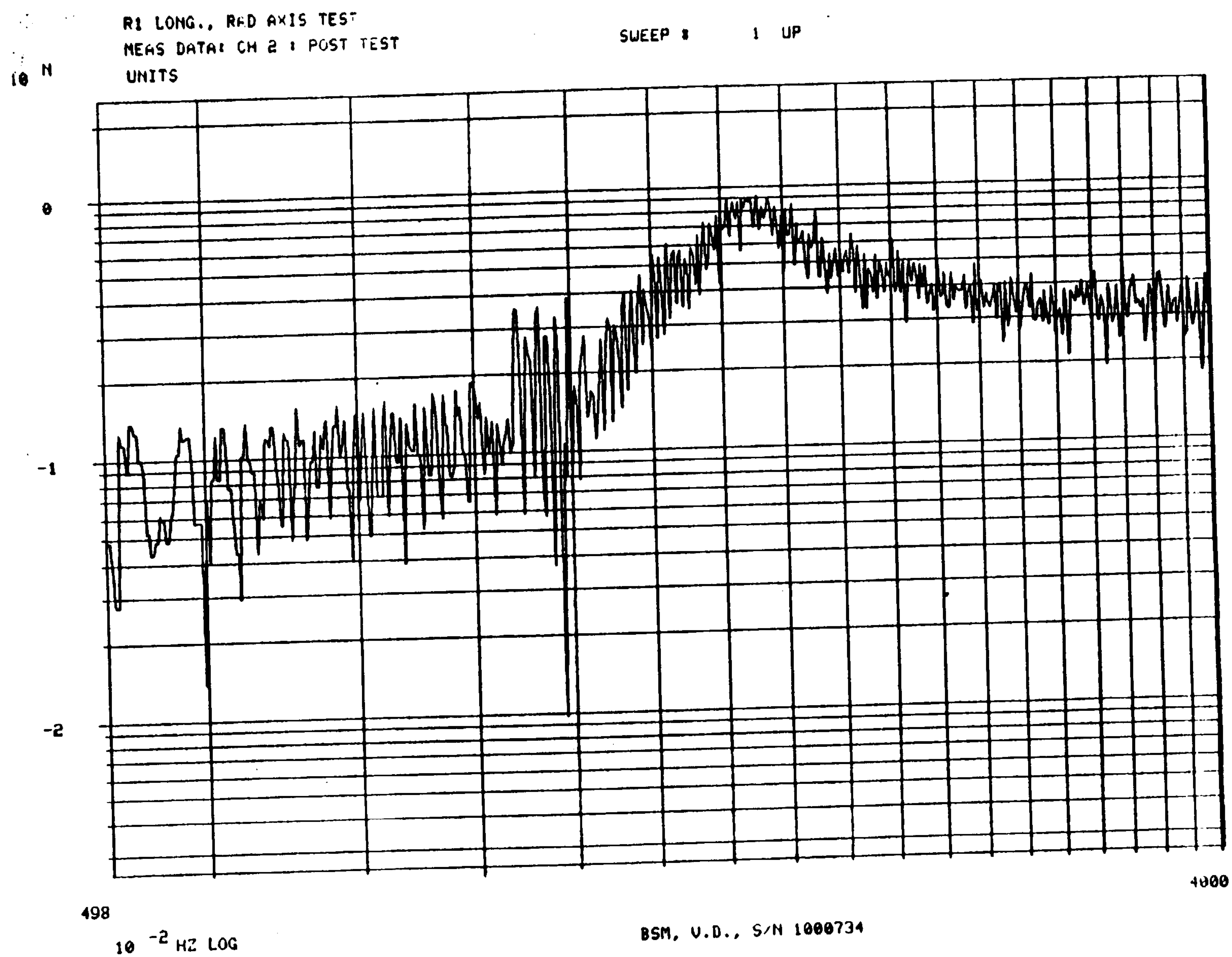
VEHICLE DYNAMICS



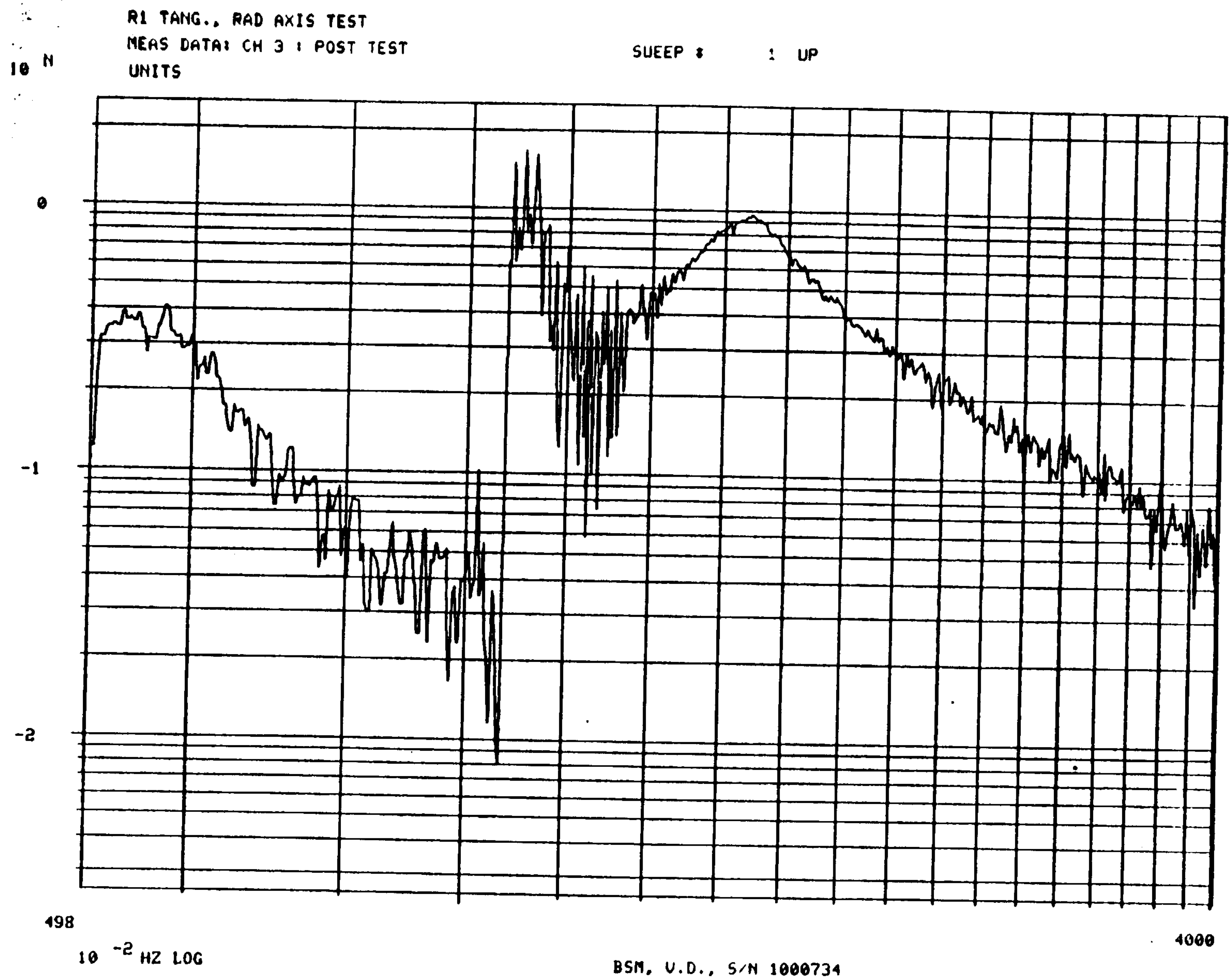
CONTROL RAD. AXIS, 5-10 HZ
CONTROL:
G
SWEEP # 1 UP
10 N
2
1
0
-1
498
10 -2 HZ LOG
BSM, V.D., RAD.
S/N 1000734
4000

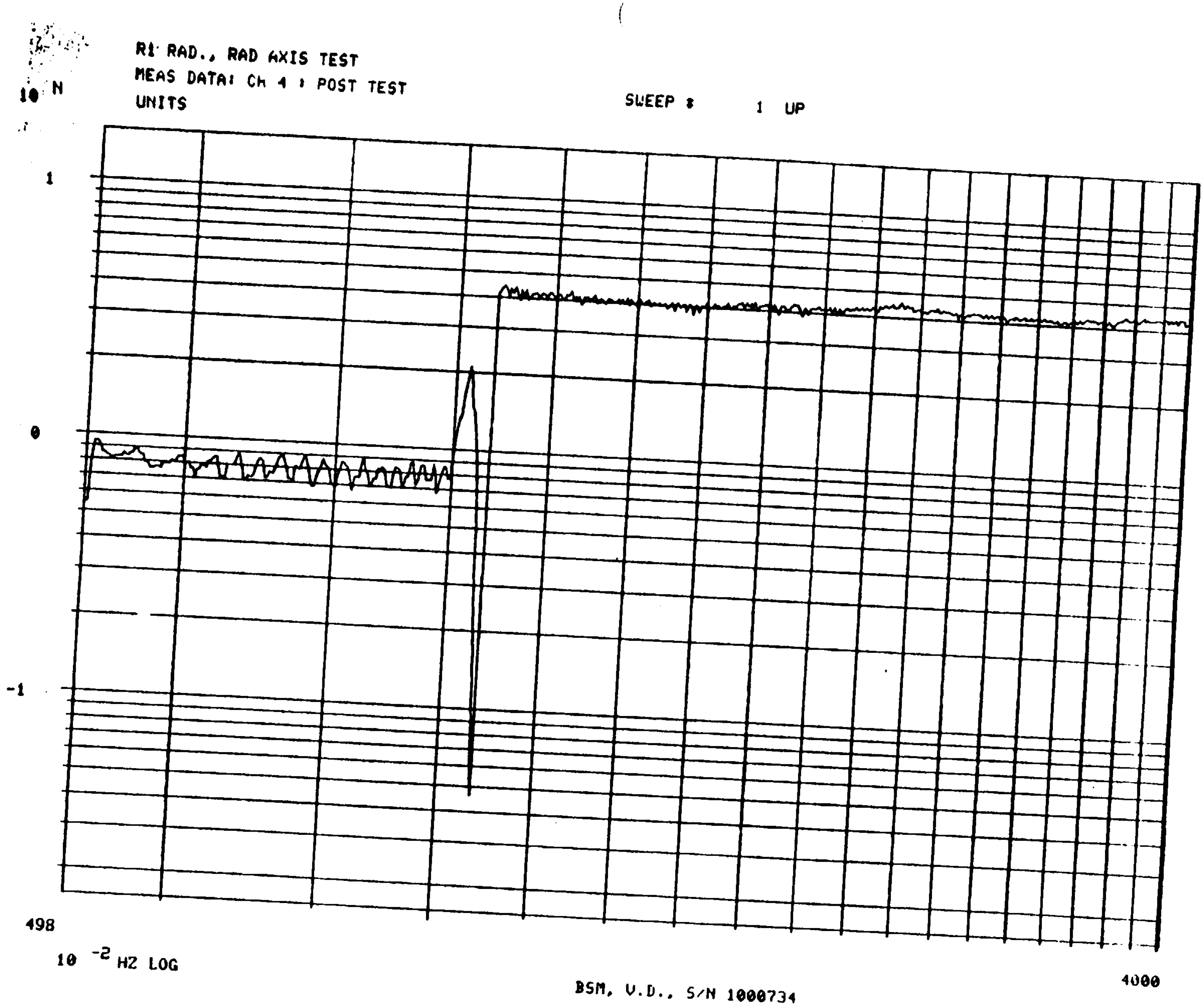


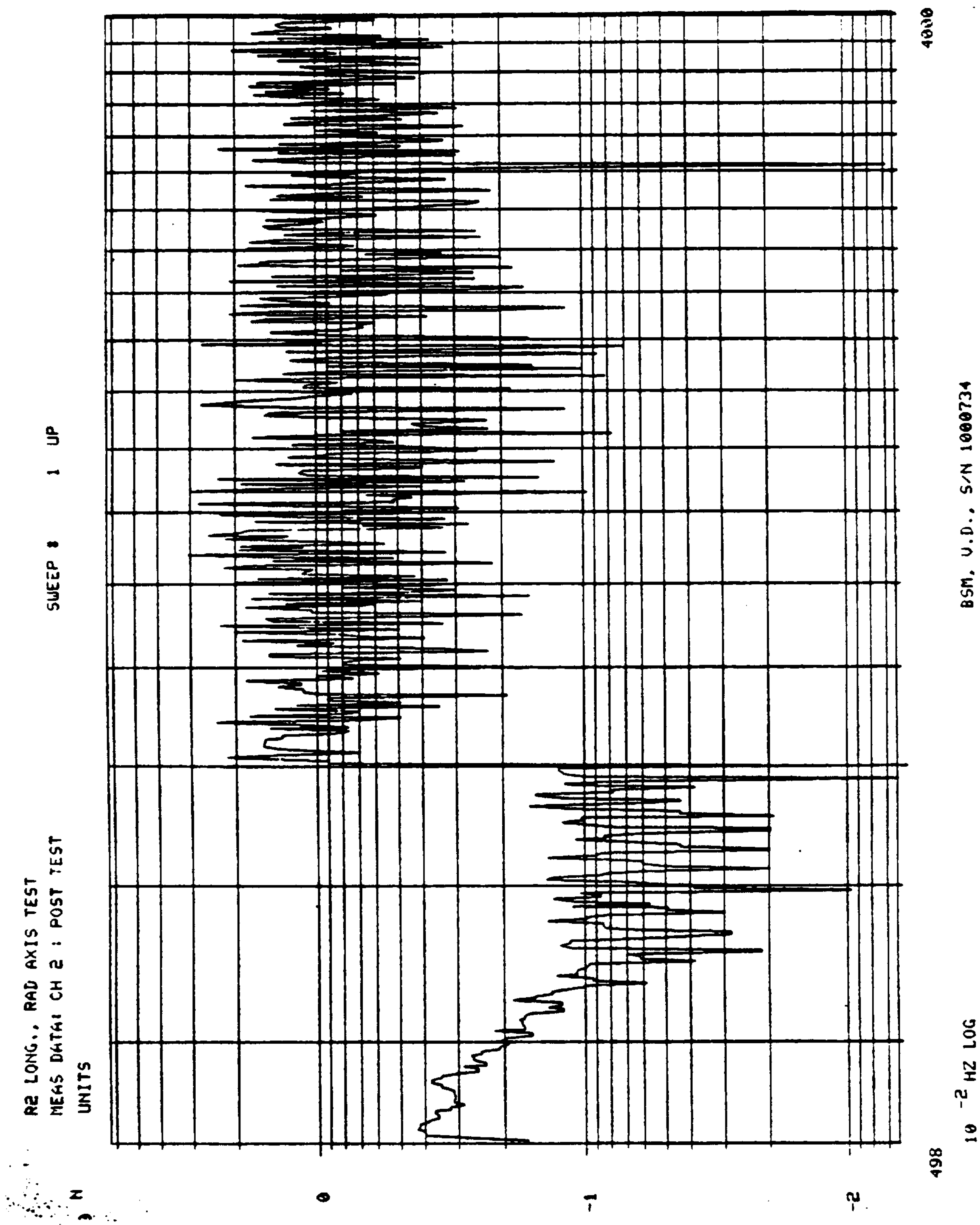
CONTROL RAD AXIS, 10-40 HZ
POST TEST
G
SWEEP # 1 UP
10 N
2
1
0
-1
438
4000
10 -2 HZ LOG
BSM, J.D., RAD.
S/N 1000734



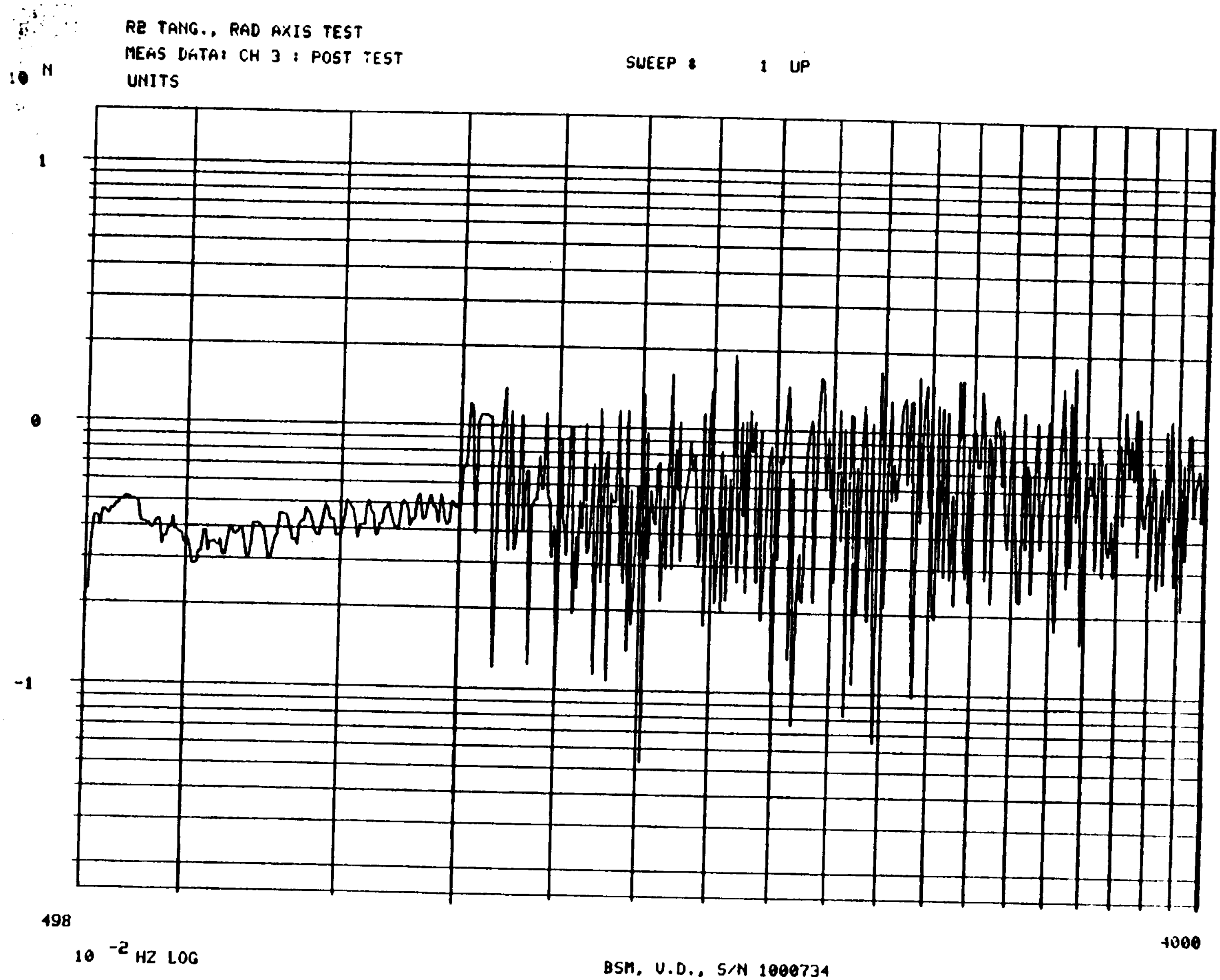
R1 LONG., RAD AXIS TEST
MEAS DATA: CH 2 : POST TEST
UNITS
SWEEP # 1 UP
10 N
0
-1
-2
498
4000
10 -2 HZ LOG
BSM, V.D., S/N 1000734

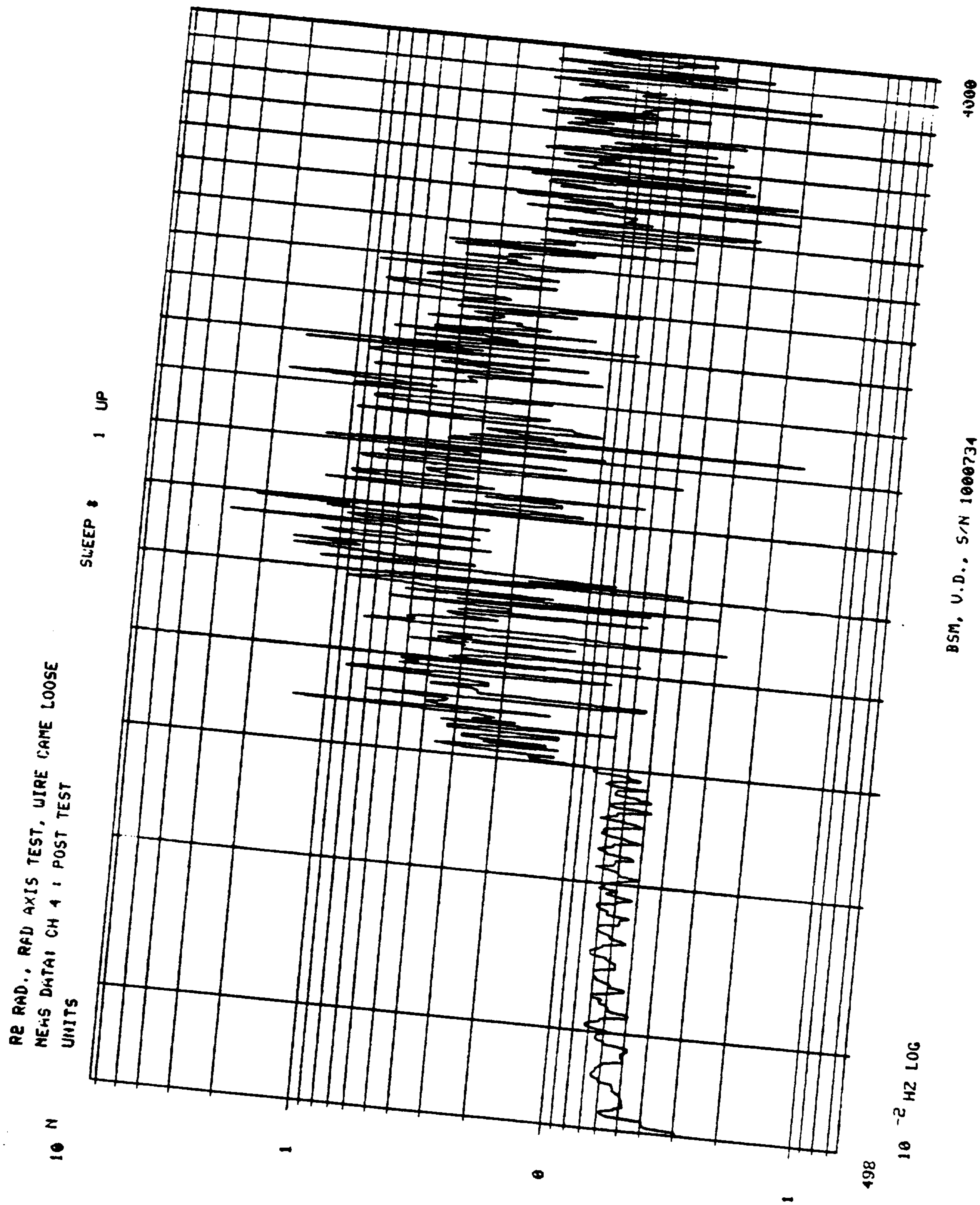

R1 TANG., RAD AXIS TEST
MEAS DATA: CH 3 : POST TEST
UNITS
SWEEP # 1 UP
10 N
0
-1
-2
498
4000
10 -2 HZ LOG
BSM, V.D., S/N 1000734

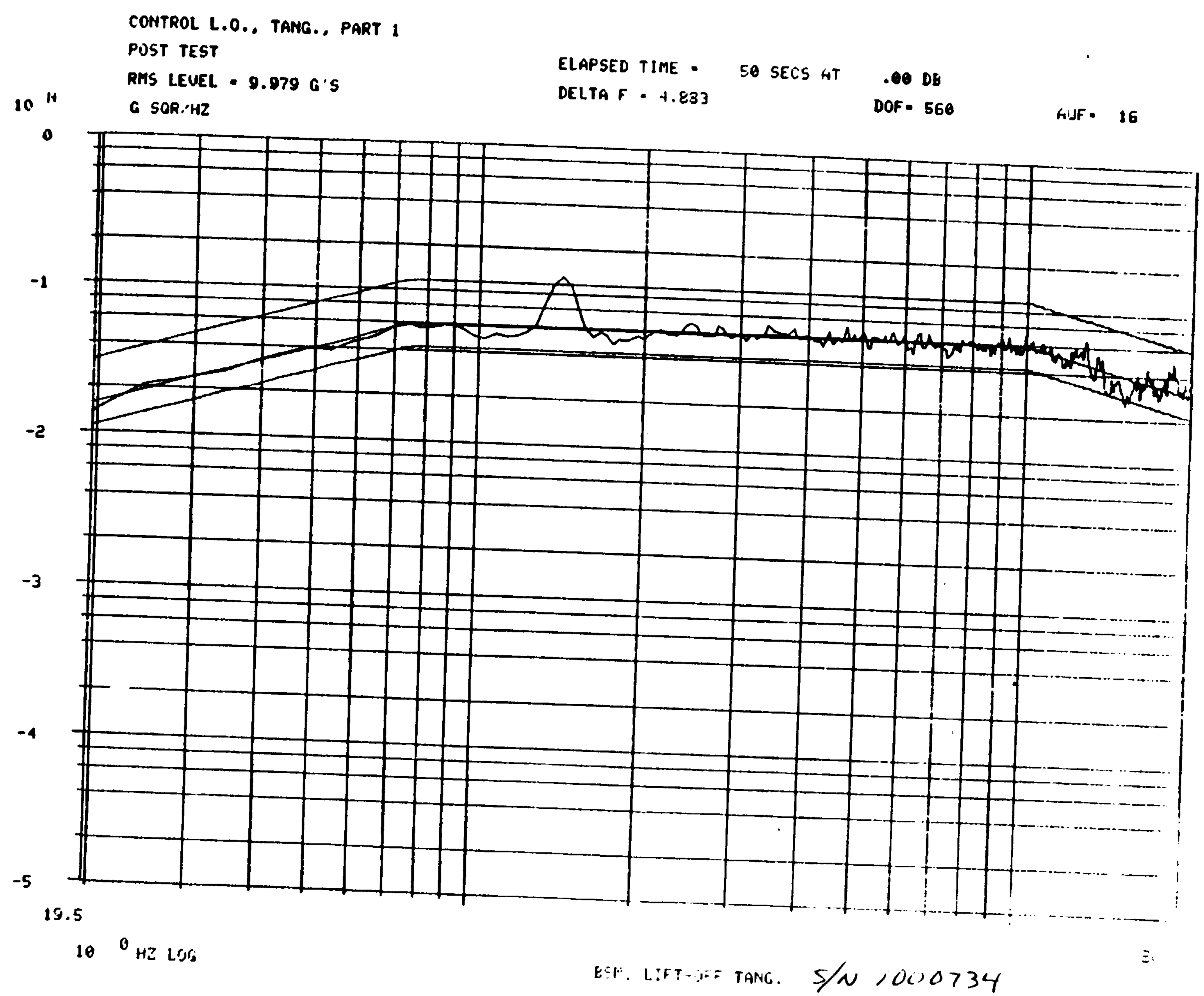

R1 RAD., RAD AXIS TEST
MEAS DATA: Ch 4 : POST TEST
UNITS
10 N
SWEEP # 1 UP
1
0
-1
498
10 -2 HZ LOG
4000
BSM, V.D., S/N 1000734

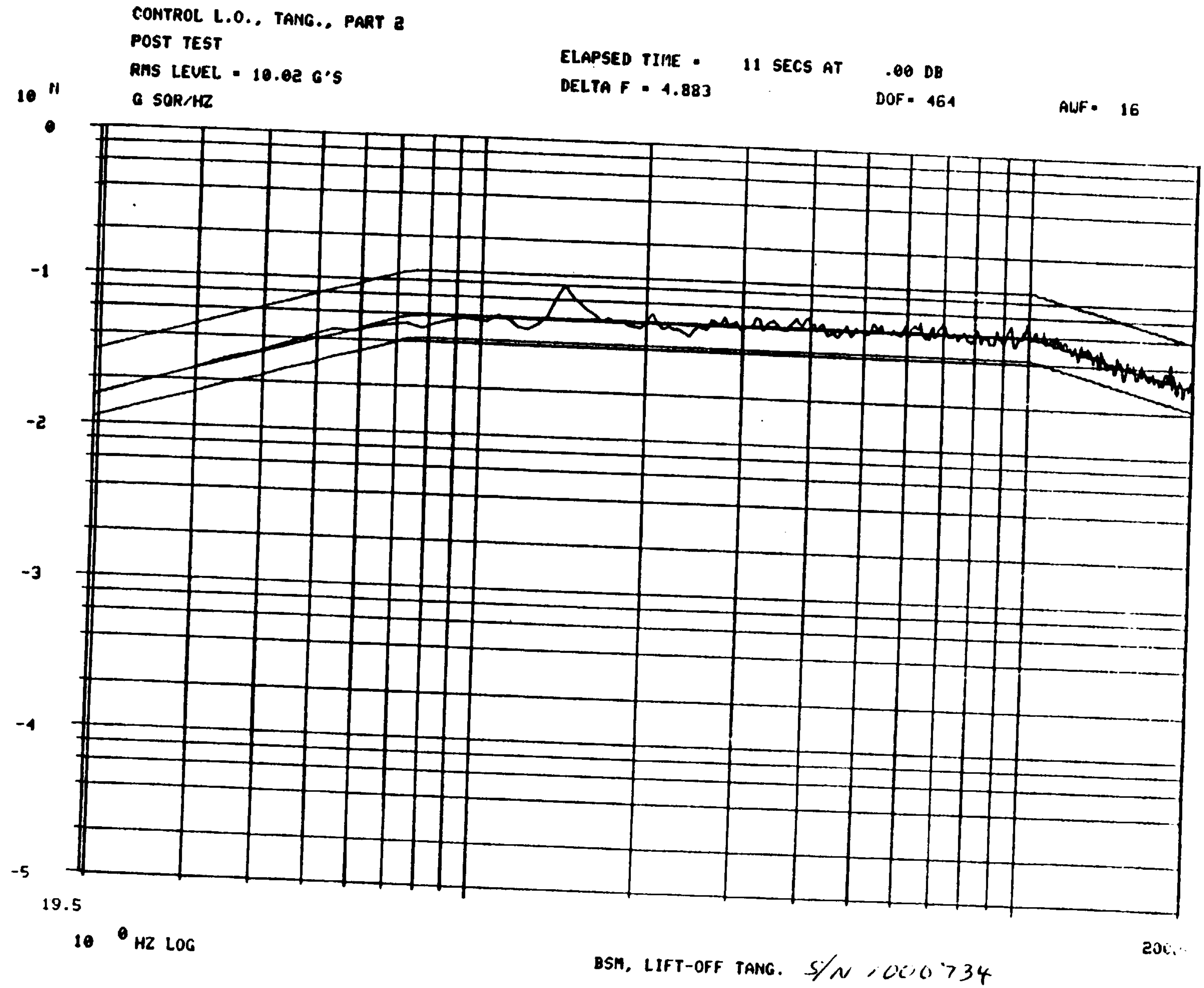


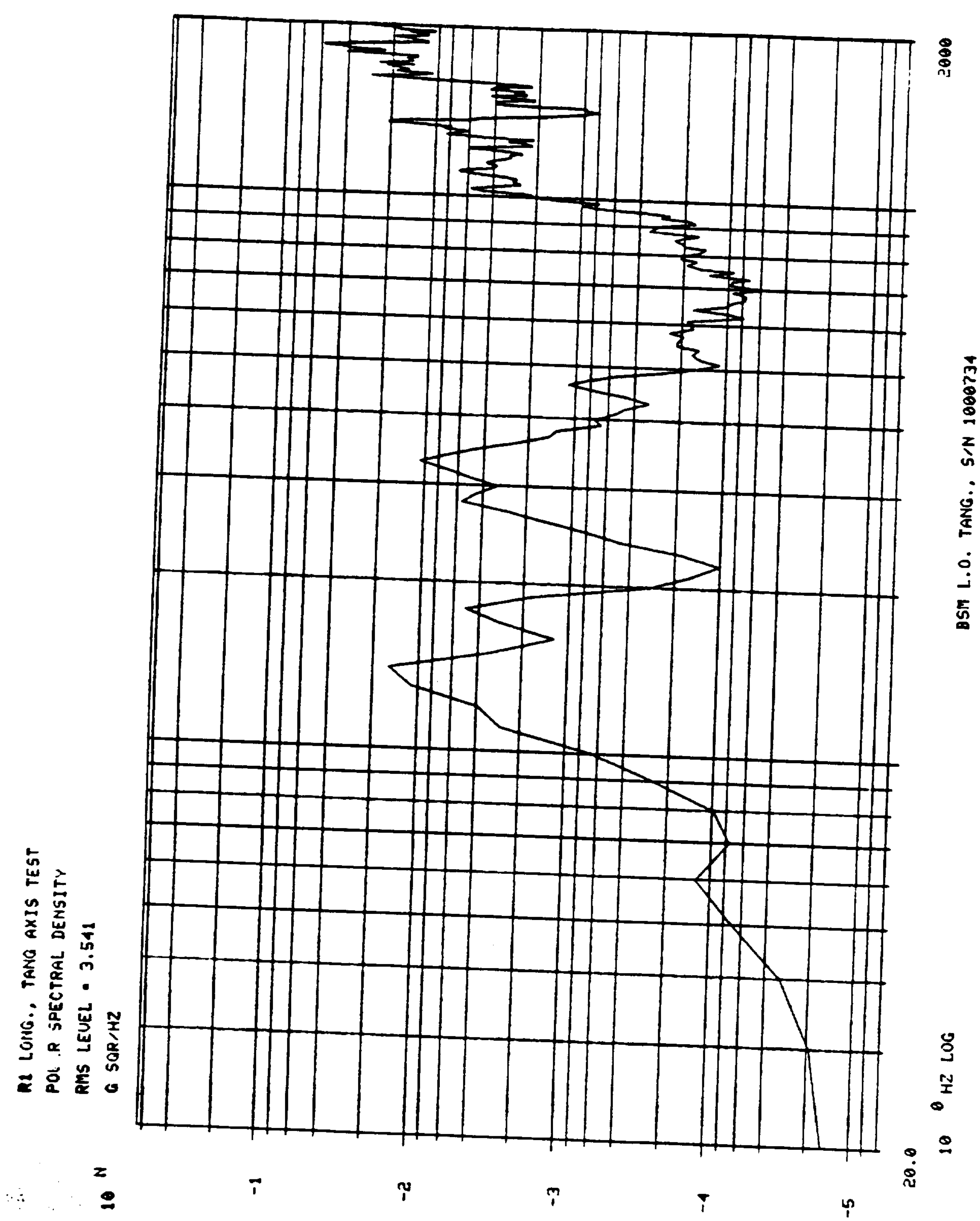
R2 LONG., RAD AXIS TEST
MEAS DATA: CH 2 : POST TEST
UNITS
SWEEP # 1 UP
BSM, U.D., S/N 1000734
10 -2 HZ LOG
498
4000
0
-1
-2

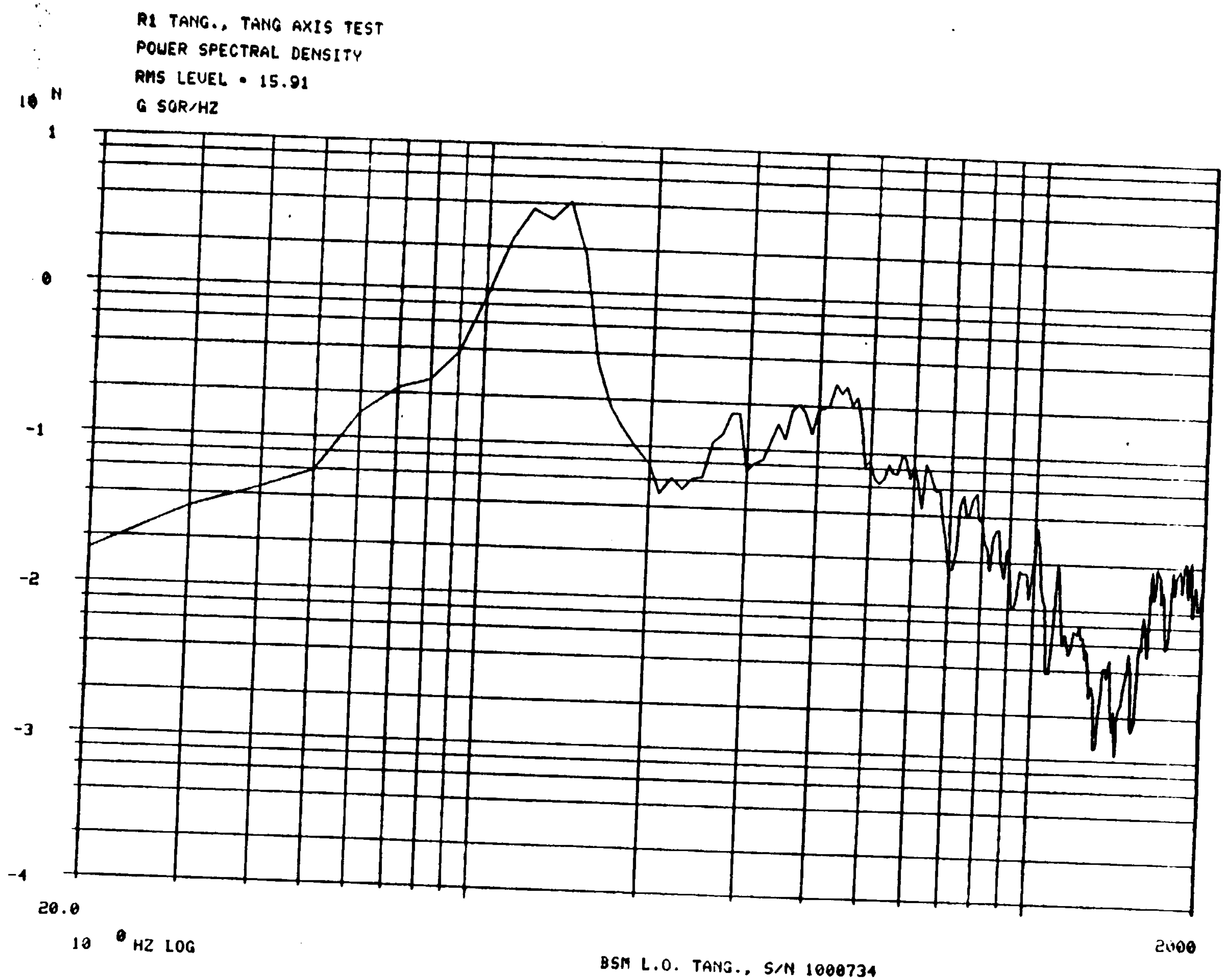

R2 TANG., RAD AXIS TEST
MEAS DATA: CH 3 : POST TEST
UNITS
10 N
SWEEP # 1 UP
1
0
-1
498
10 -2 HZ LOG
1000
BSM, V.D., S/N 1000734

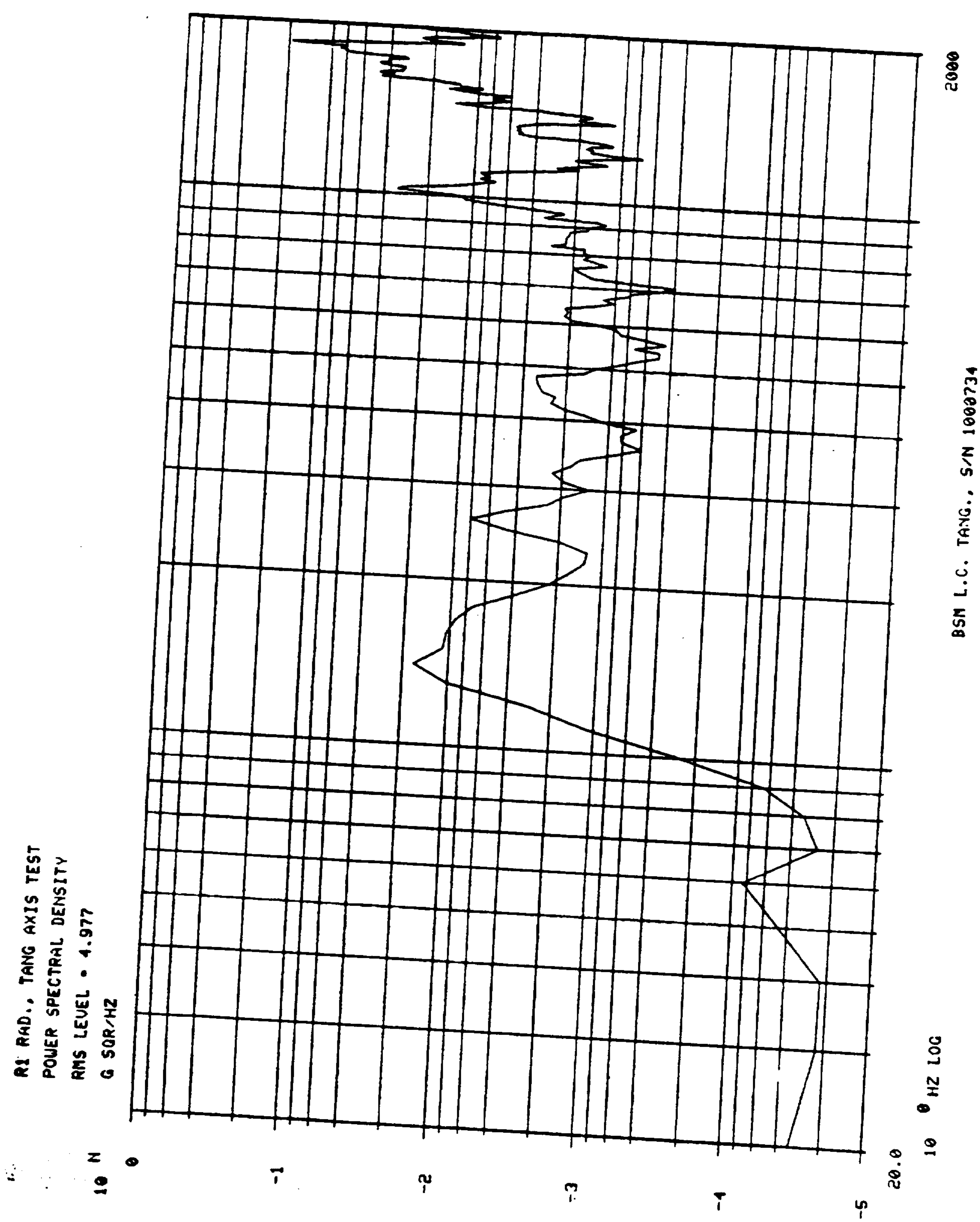

RE RAD., RAD AXIS TEST, WIRE CAME LOOSE
NEWS DATA: CH 4 : POST TEST
UNITS
SWEEP # 1 UP
BSM, V.D., S/N 1000734
10 N
1
0
-1
498
10 -2 HZ LOG
1000

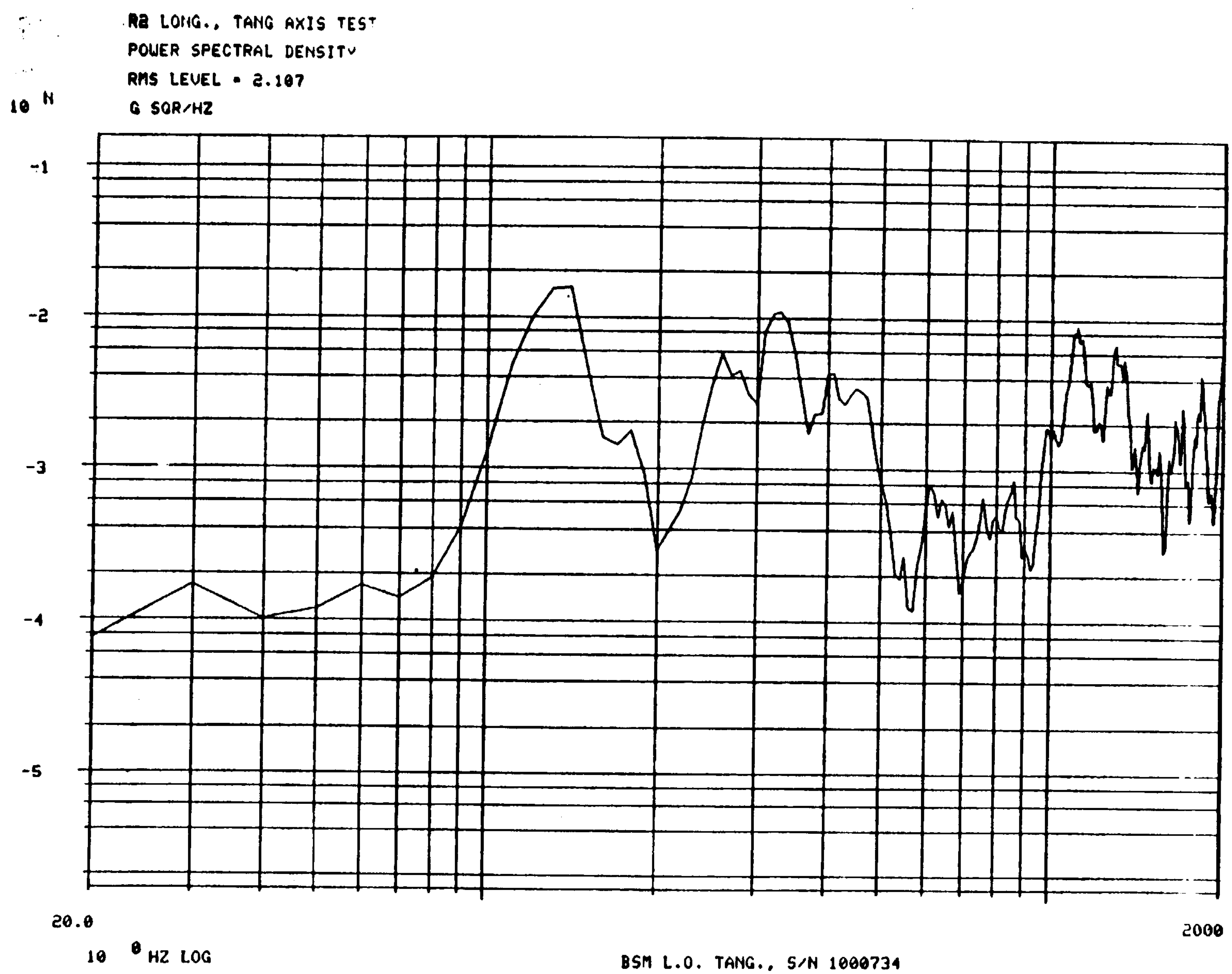

CONTROL L.O., TANG., PART 1
POST TEST
RMS LEVEL = 9.979 G'S
G SQR/HZ
ELAPSED TIME = 50 SECS AT .00 DB
DELTA F = 4.833
DOF= 560
AUF= 16
10 N
0
-1
-2
-3
-4
-5
19.5
10 0 HZ LOG
BSM. LIFT-OFF TANG.
S/N 1000734


CONTROL L.O., TANG., PART 2
POST TEST
RMS LEVEL = 10.02 G'S
G SQR/HZ
ELAPSED TIME = 11 SECS AT .00 DB
DELTA F = 4.883
DOF= 464
AWF= 16
10 N
0
-1
-2
-3
-4
-5
19.5
10 0 HZ LOG
BSM, LIFT-OFF TANG. S/N 1000734

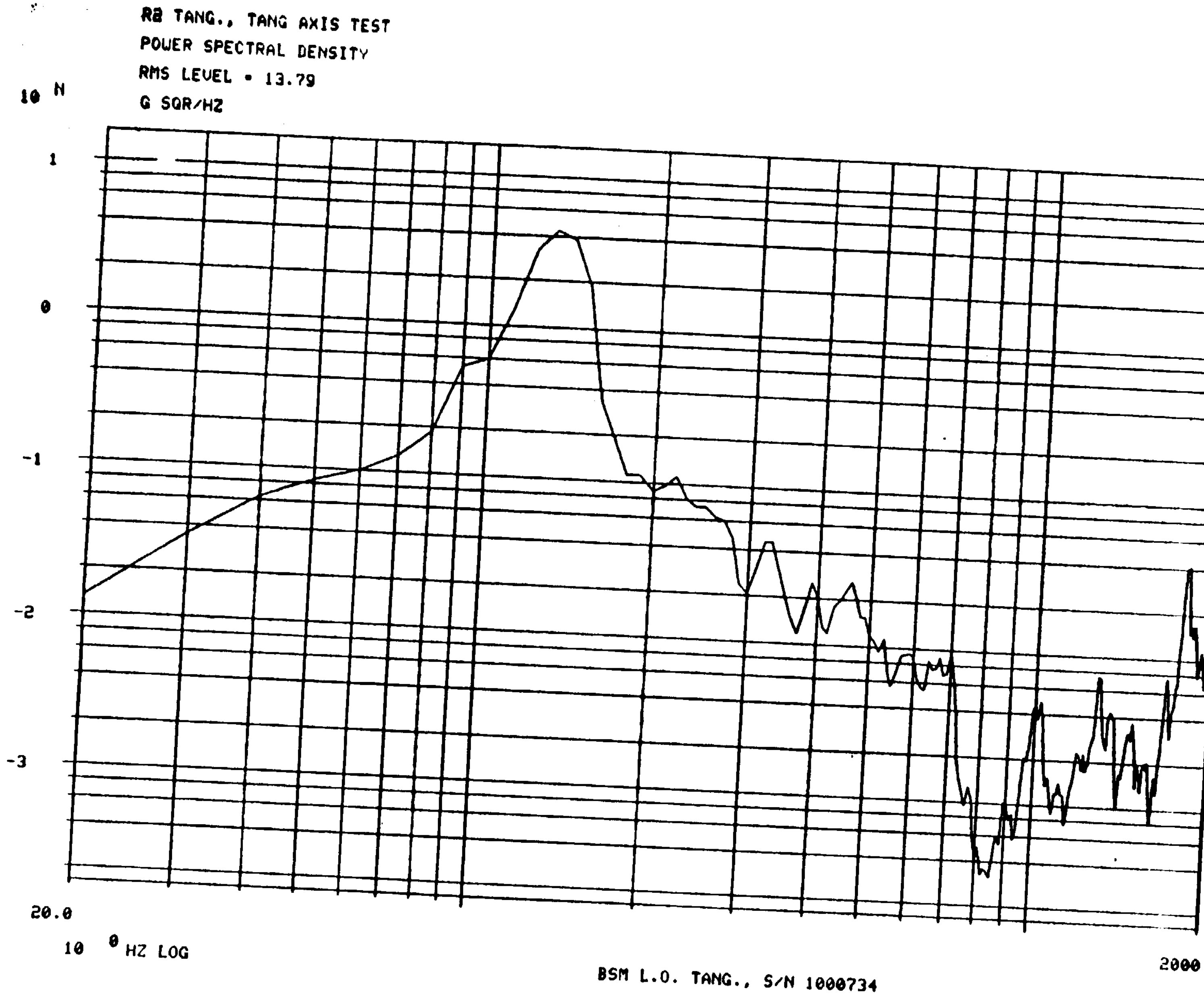

R1 LONG., TANG AXIS TEST
POL .R SPECTRAL DENSITY
RMS LEVEL = 3.541
G SQR/HZ
10 N
-1
-2
-3
-4
-5
20.0
10 0 HZ LOG
2000
BSM L.O. TANG., S/N 1000734

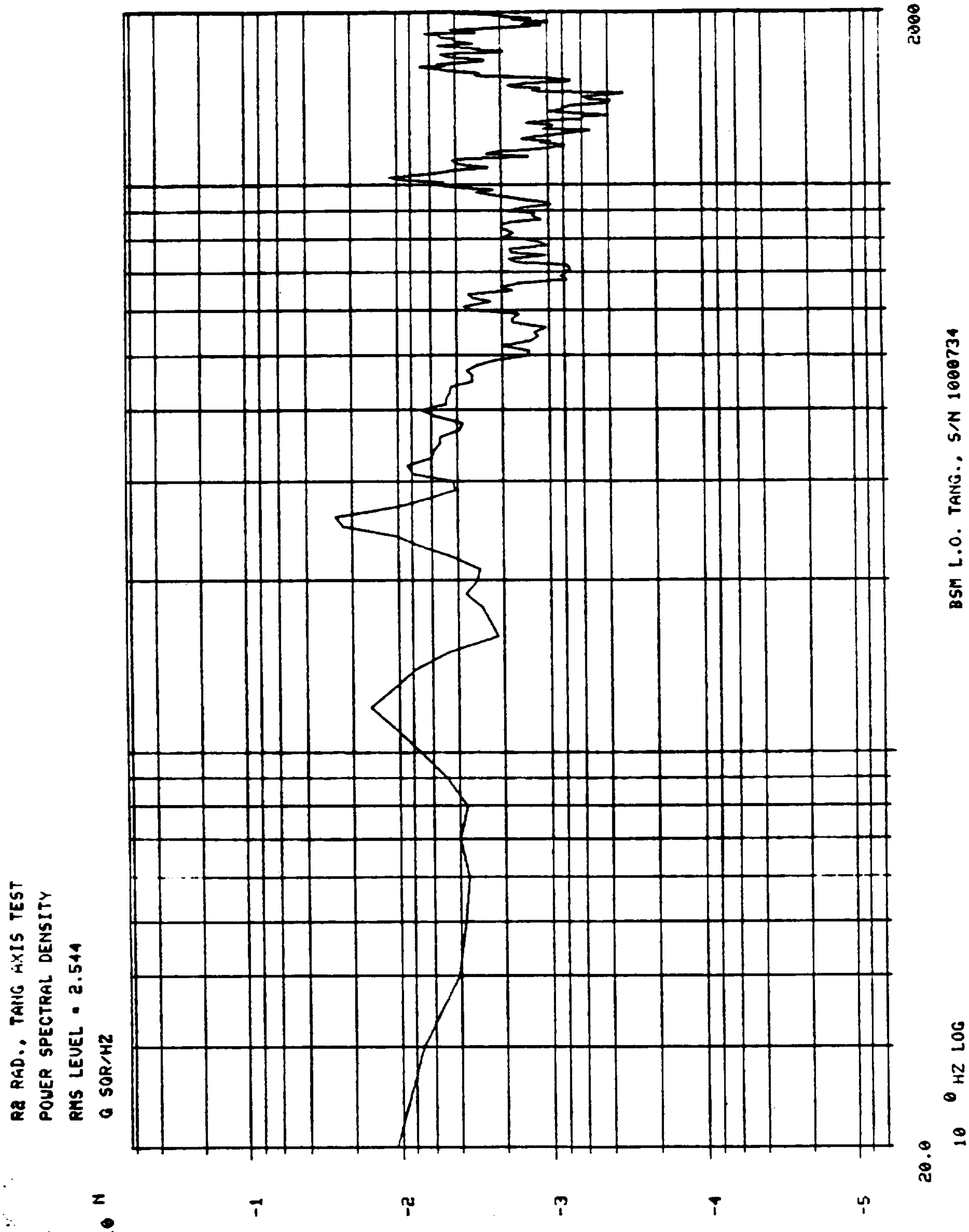

R1 TANG., TANG AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL • 15.91
G SQR/HZ
10 N
1
0
-1
-2
-3
-4
20.0
10 0 HZ LOG
2000
BSM L.O. TANG., S/N 1000734


R1 RAD., TANG AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL • 4.977
G SQR/HZ
10 N
0
-1
-2
-3
-4
-5
20.0
10 0 HZ LOG
2000
BSM L.C. TANG., S/N 1000734



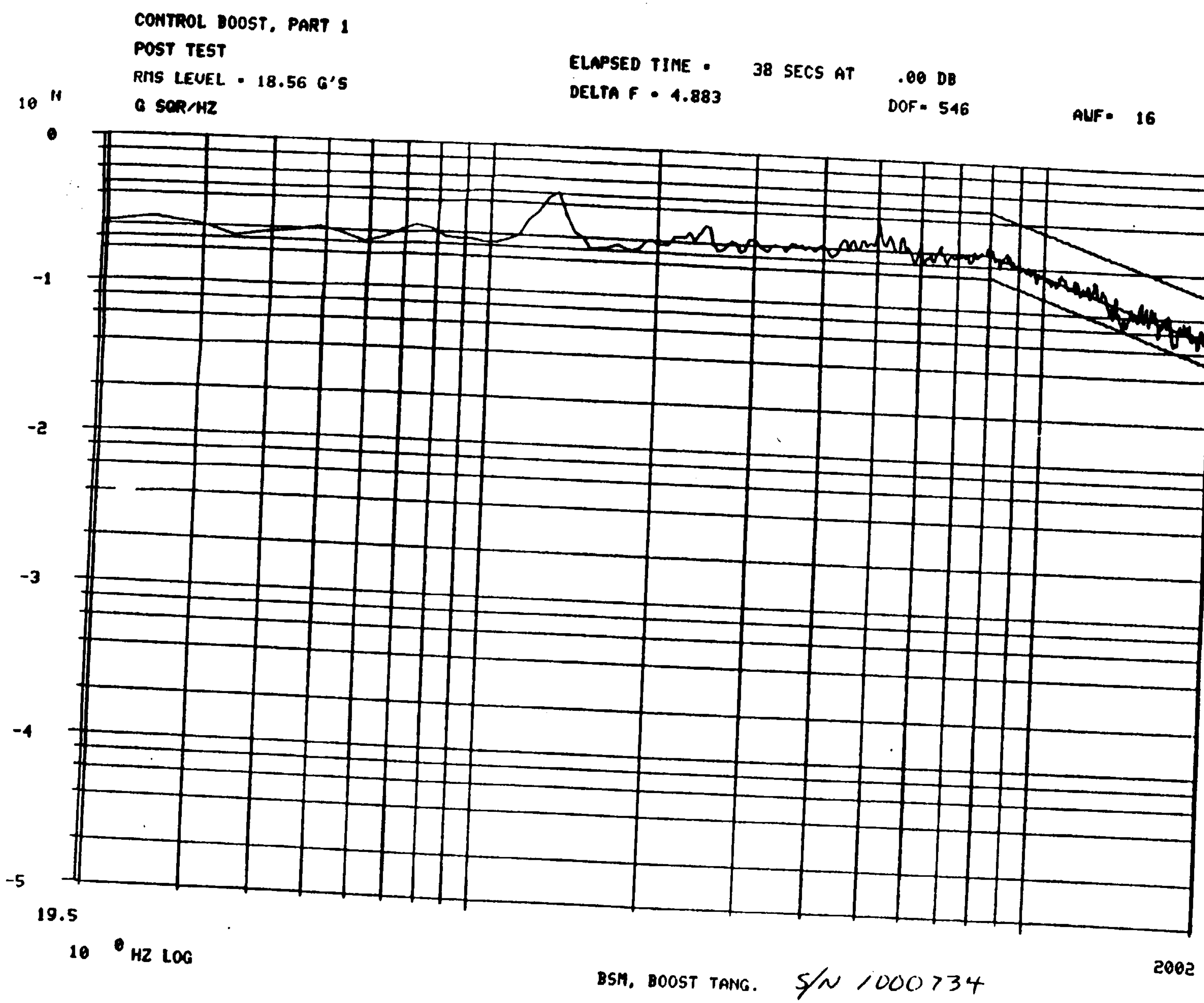
R2 LONG., TANG AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL = 2.107
G SQR/HZ
10 N
-1
-2
-3
-4
-5
20.0
2000
10 0 HZ LOG
BSM L.O. TANG., S/N 1000734

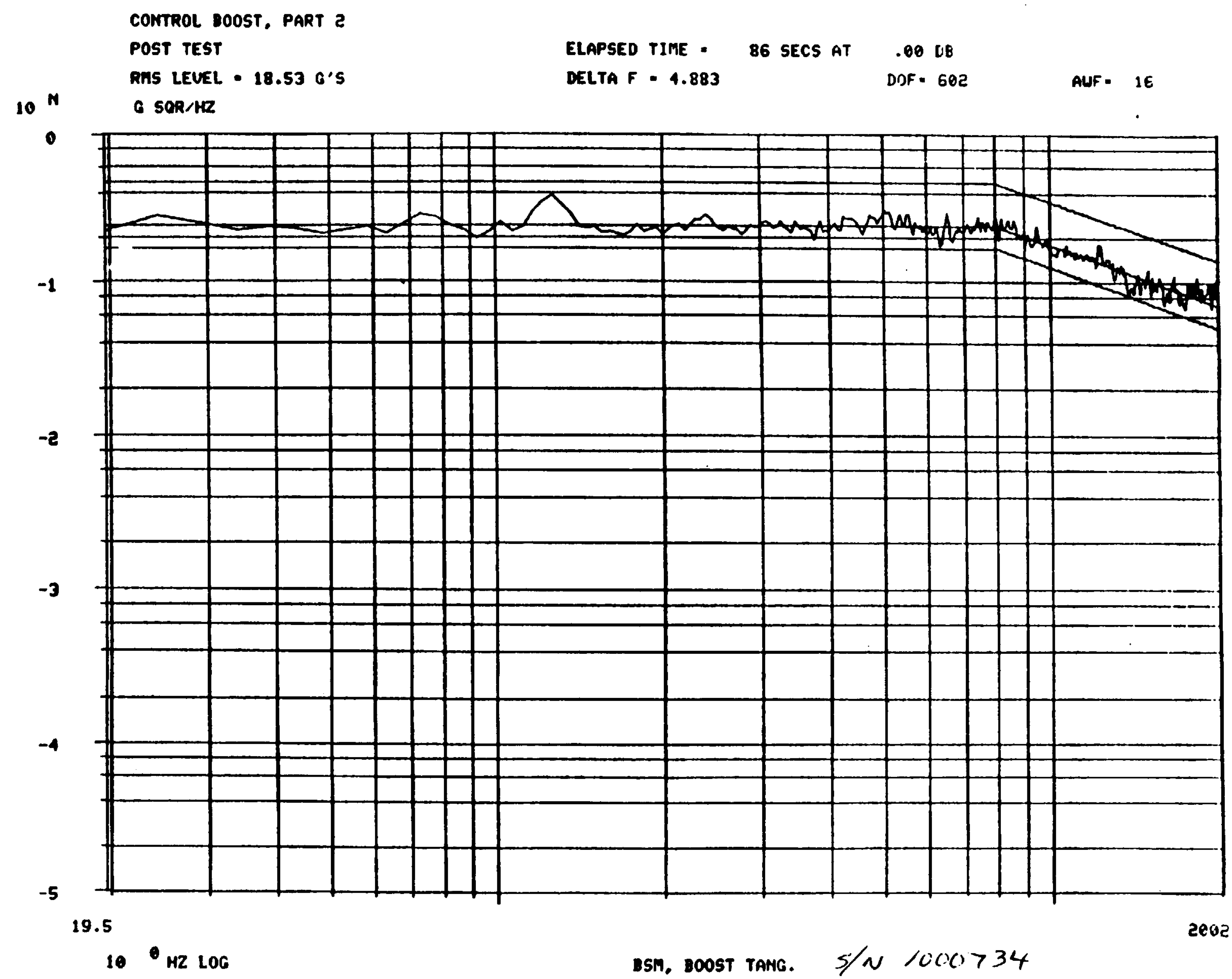

R2 TANG., TANG AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL • 13.79
G SQR/HZ
10 N
1
0
-1
-2
-3
20.0
10 0 HZ LOG
2000
BSM L.O. TANG., S/N 1000734

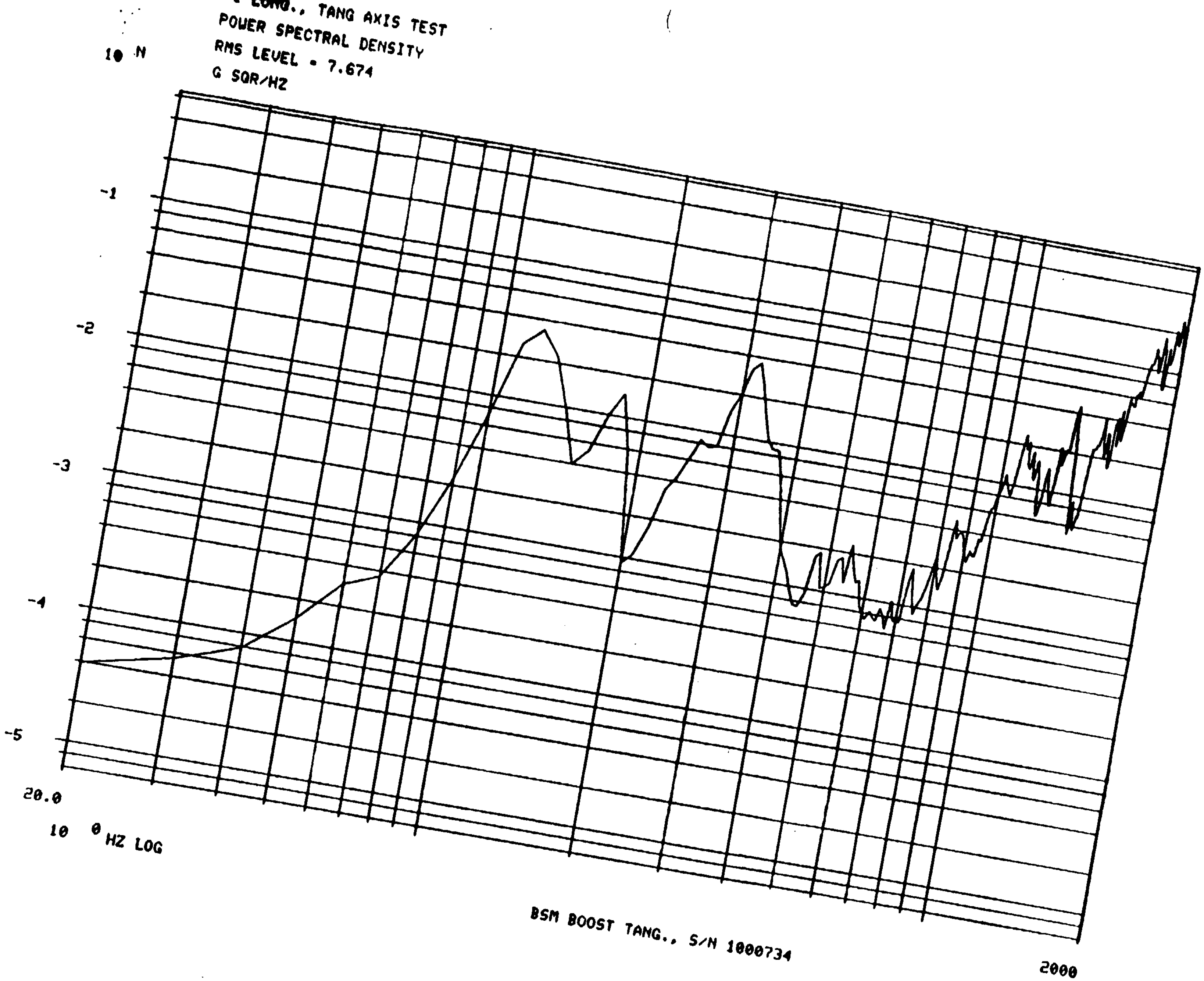

R8 RAD., TANG AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL = 2.544
G SQR/HZ
10 N
-1
-2
-3
-4
-5
20.0
10 0 HZ LOG
2000
BSM L.O. TANG., S/N 1000734

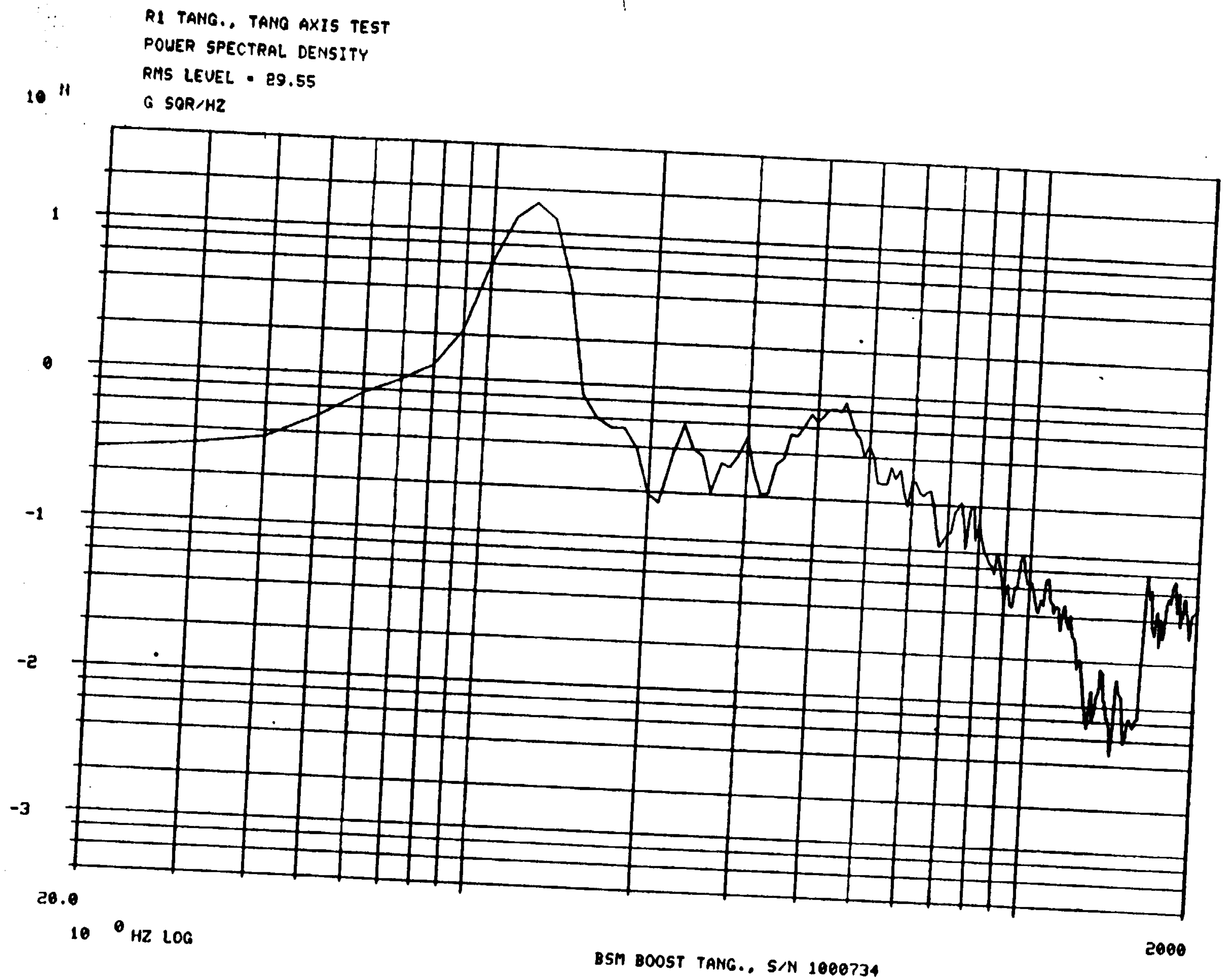
TANGENTIAL AXIS

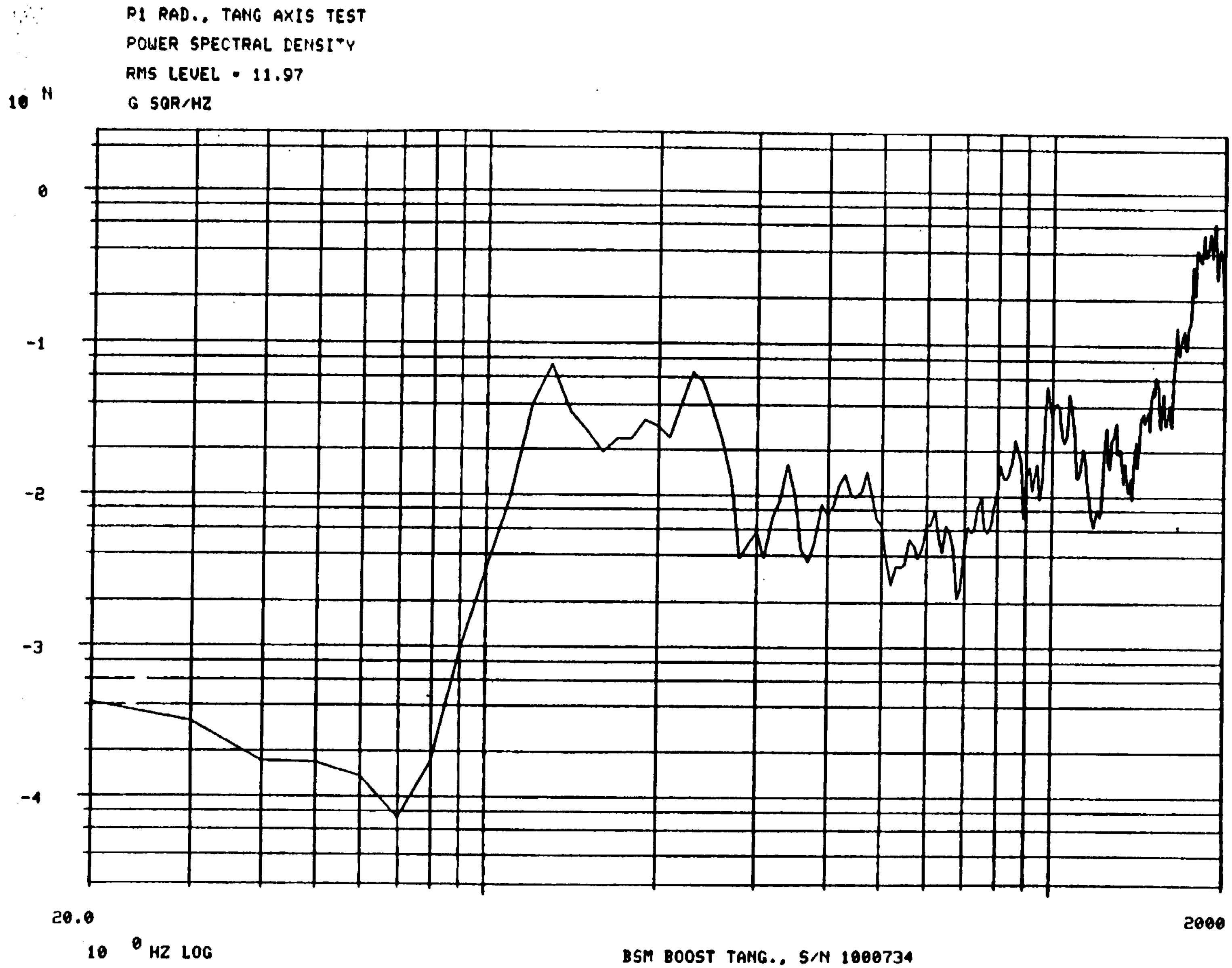
RANDOM, BOOST

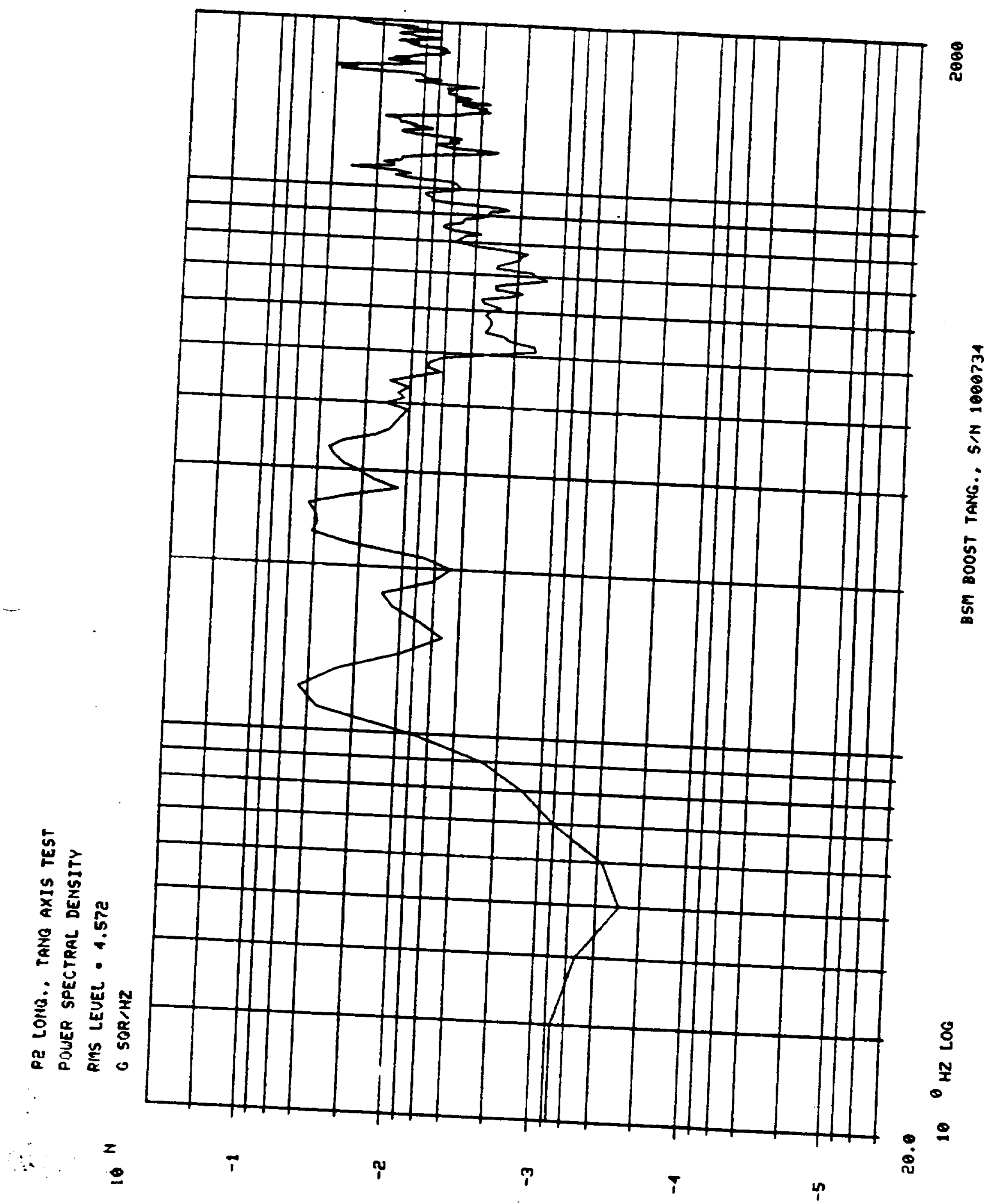

CONTROL BOOST, PART 1
POST TEST
RMS LEVEL • 18.56 G'S
G SQR/HZ
ELAPSED TIME • 38 SECS AT .00 DB
DELTA F • 4.883
DOF• 546
AWF• 16
10 N
0
-1
-2
-3
-4
-5
19.5
10 0 HZ LOG
2002
BSM, BOOST TANG. S/N 1000734

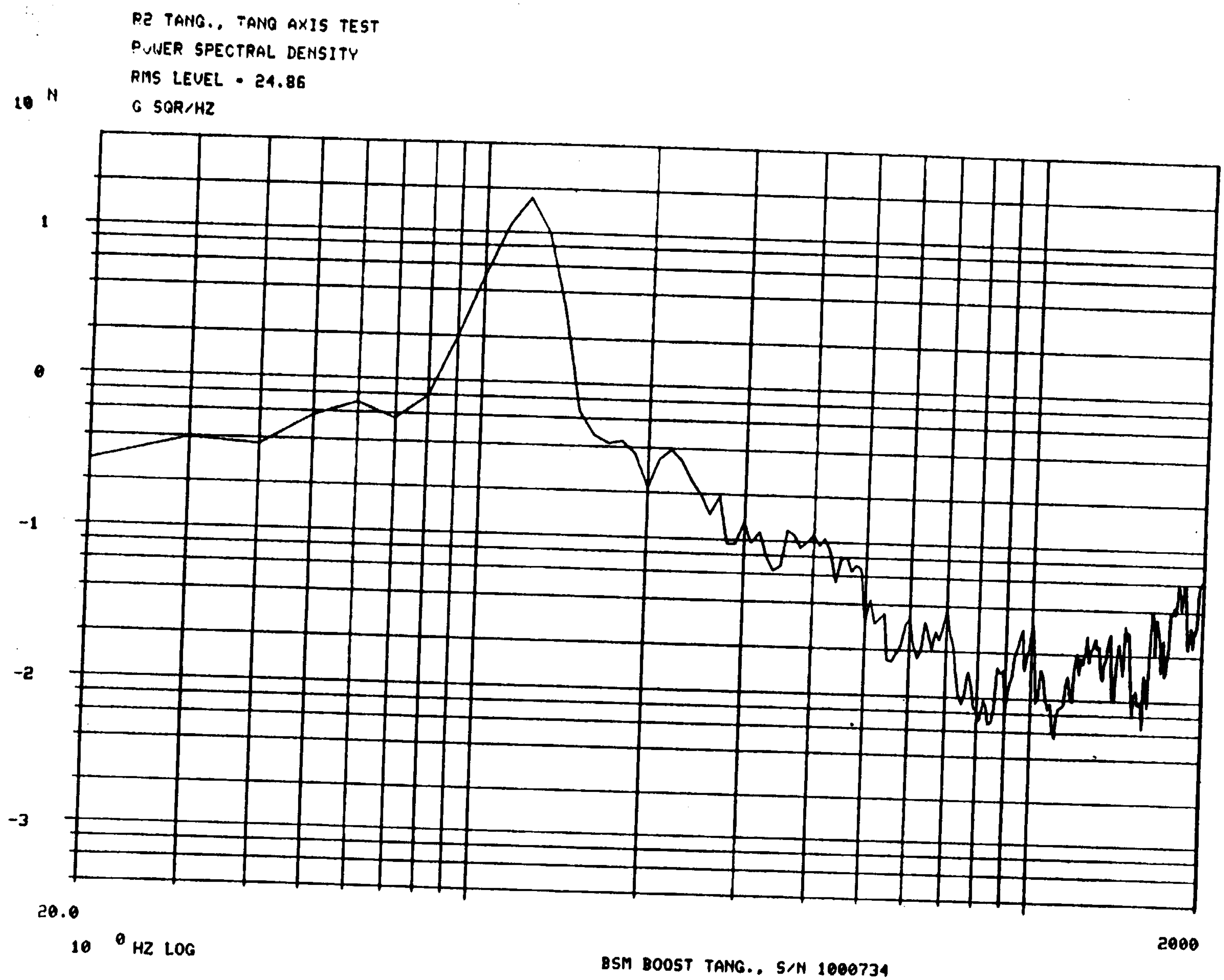

CONTROL BOOST, PART 2
POST TEST
RMS LEVEL = 18.53 G'S
G SQR/HZ
ELAPSED TIME = 86 SECS AT .00 DB
DELTA F = 4.883
DOF= 602
AVF= 16
10 N
0
-1
-2
-3
-4
-5
19.5
2002
10 0 HZ LOG
BSM, BOOST TANG.
S/N 1000734


... LONG., TANG AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL = 7.674
G SQR/HZ
10 N
-1
-2
-3
-4
-5
20.0
10 0 HZ LOG
BSM BOOST TANG., S/N 1000734
2000

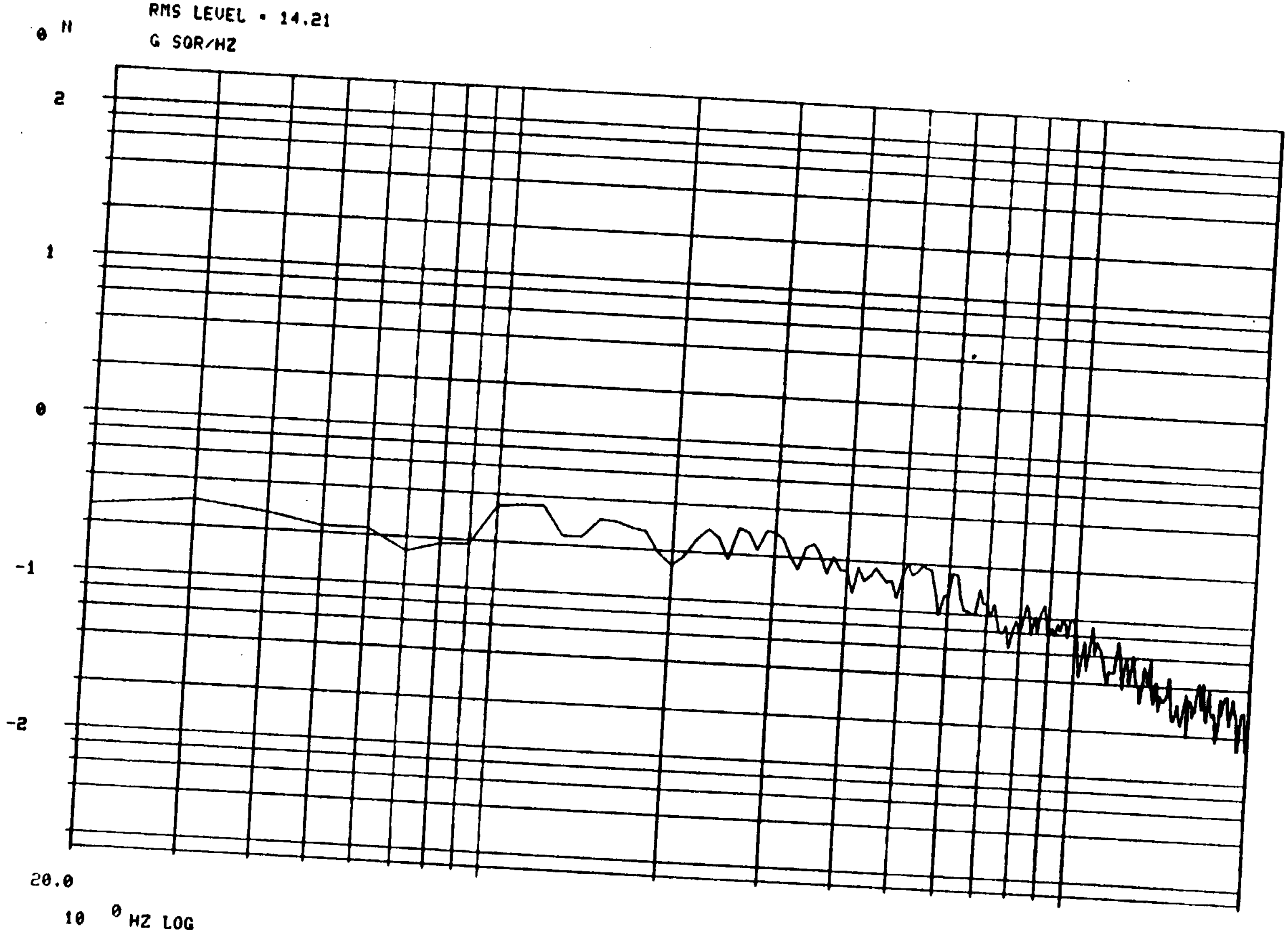

R1 TANG., TANG AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL = 29.55
G SQR/HZ
10 N
1
0
-1
-2
-3
20.0
10 0 HZ LOG
2000
BSM BOOST TANG., S/N 1000734


P1 RAD., TANG AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL • 11.97
G SQR/HZ
10 N
0
-1
-2
-3
-4
20.0
2000
10 0 HZ LOG
BSM BOOST TANG., S/N 1000734


P2 LONG., TANG AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL = 4.572
G SQR/HZ
10 N
-1
-2
-3
-4
-5
20.0
10 0 HZ LOG
2000
BSM BOOST TANG., S/N 1000734


R2 TANG., TANG AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL = 24.86
G SQR/HZ
10 N
1
0
-1
-2
-3
20.0
10 0 HZ LOG
2000
BSM BOOST TANG., S/N 1000734

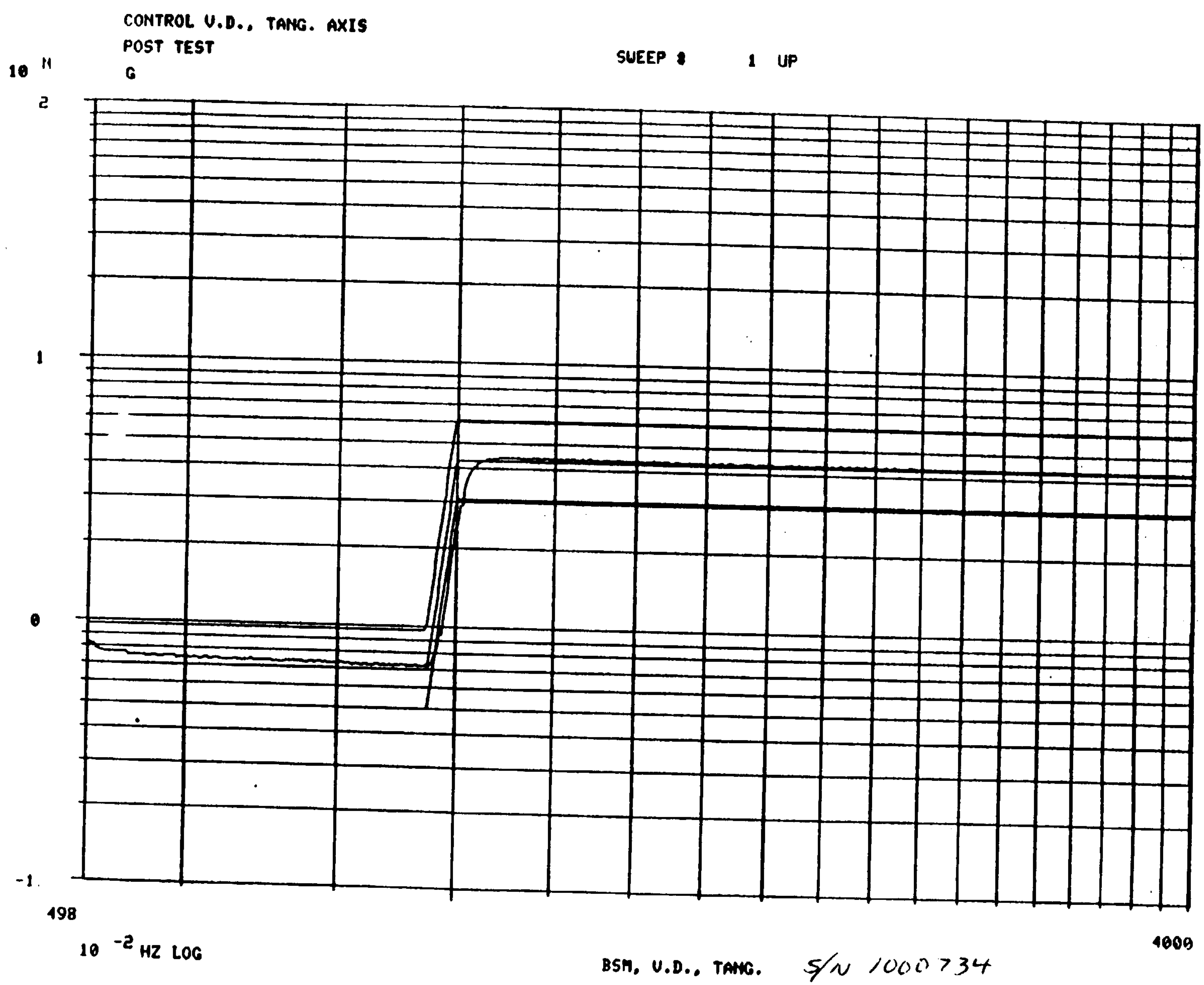
R2 RAD., TANG AXIS TEST,BAD DATA, ACCEL WIRE LOOSENED
POWER SPECTRAL DENSITY
RMS LEVEL • 14.21
G SQR/HZ

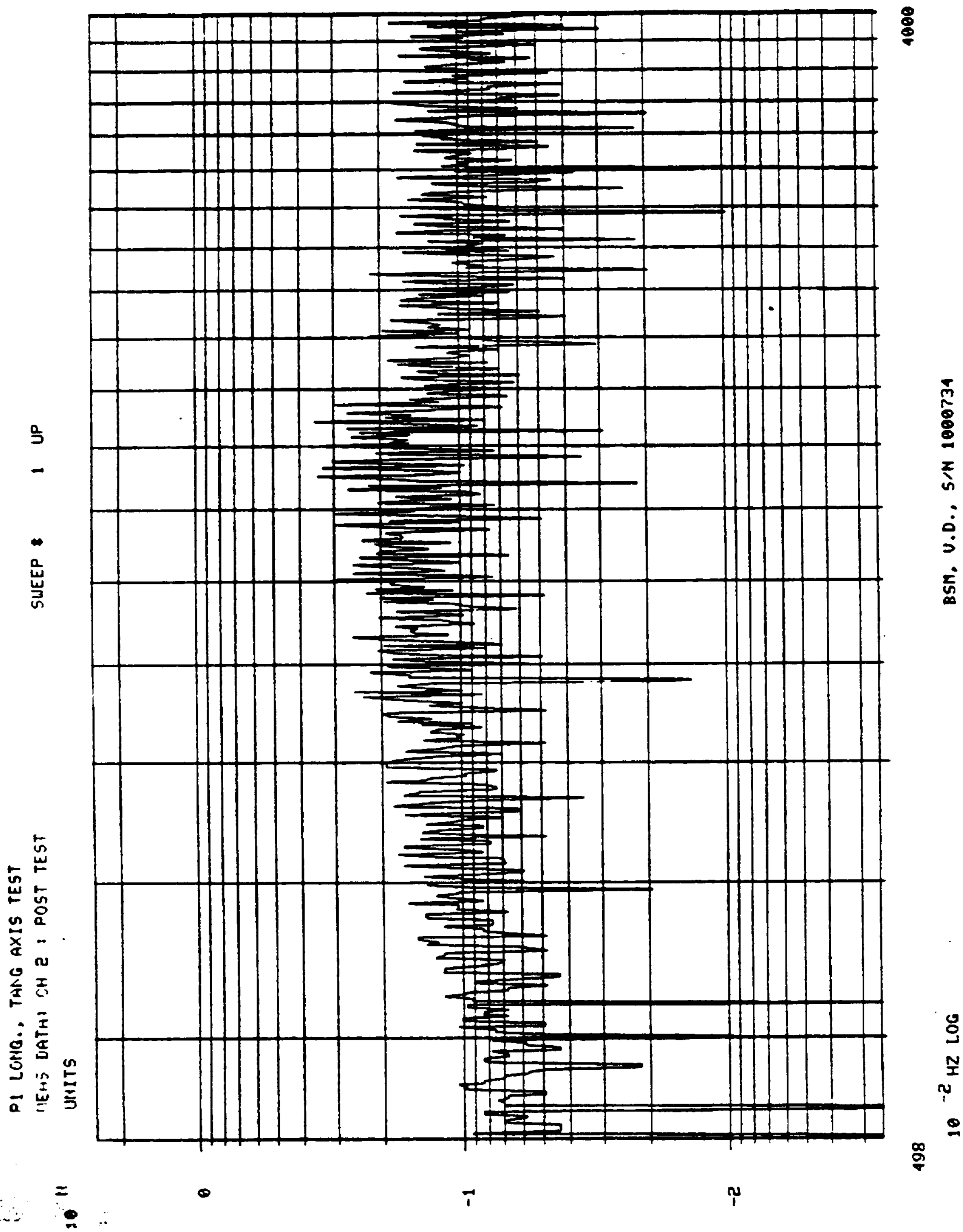


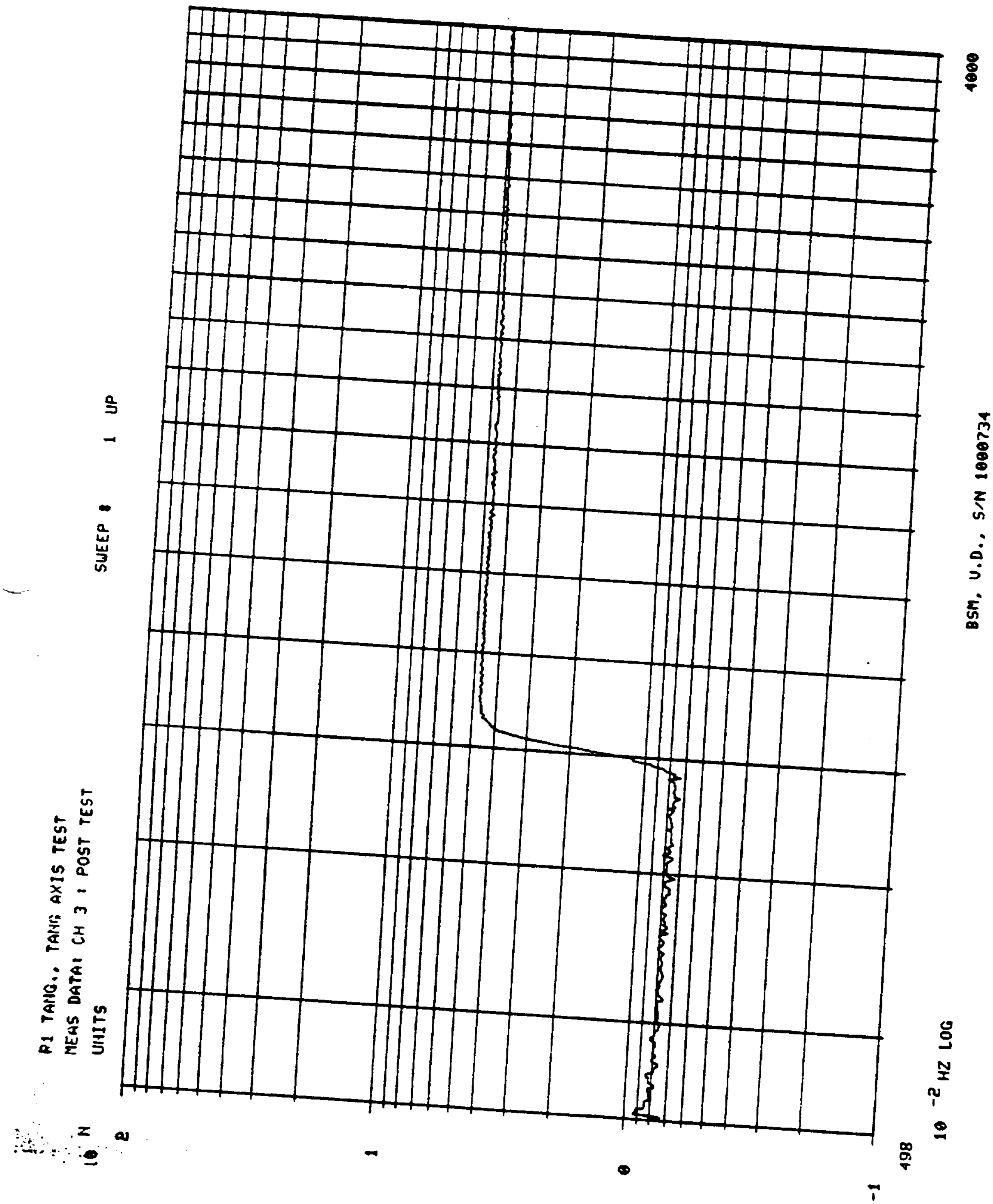
BSM BOOST TANG., S/N 1000734

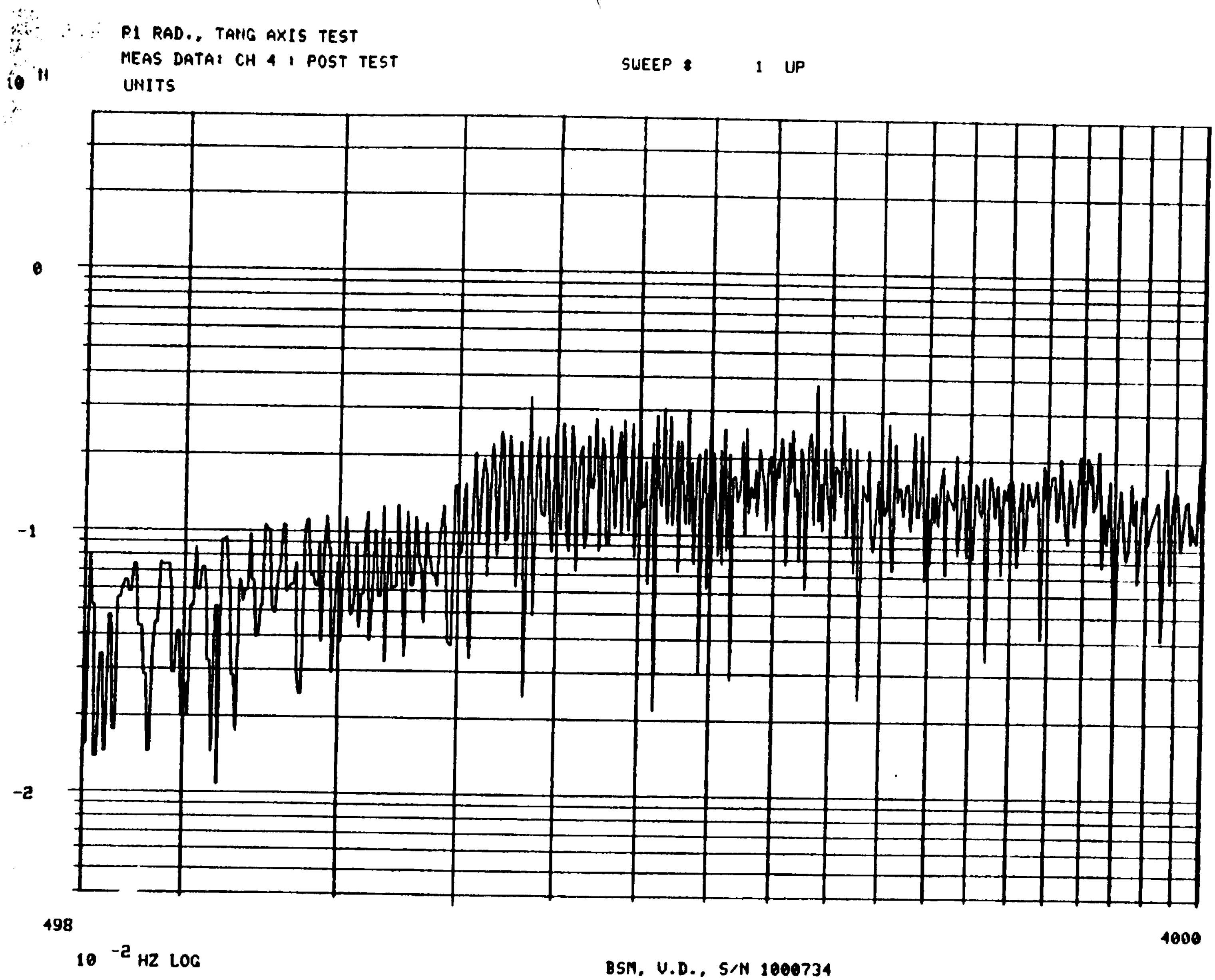
TANGENTIAL AXIS

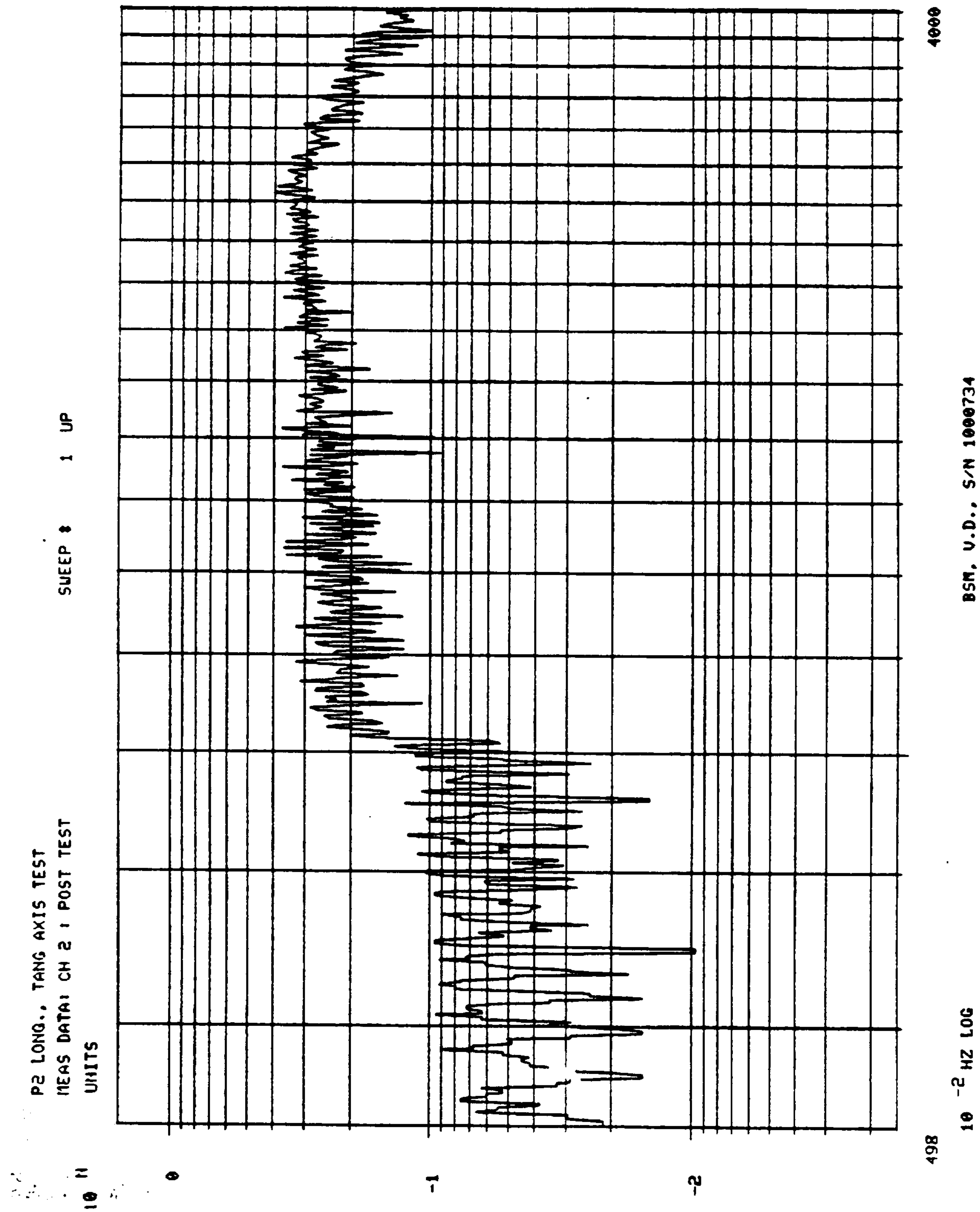
VEHICLE DYNAMICS

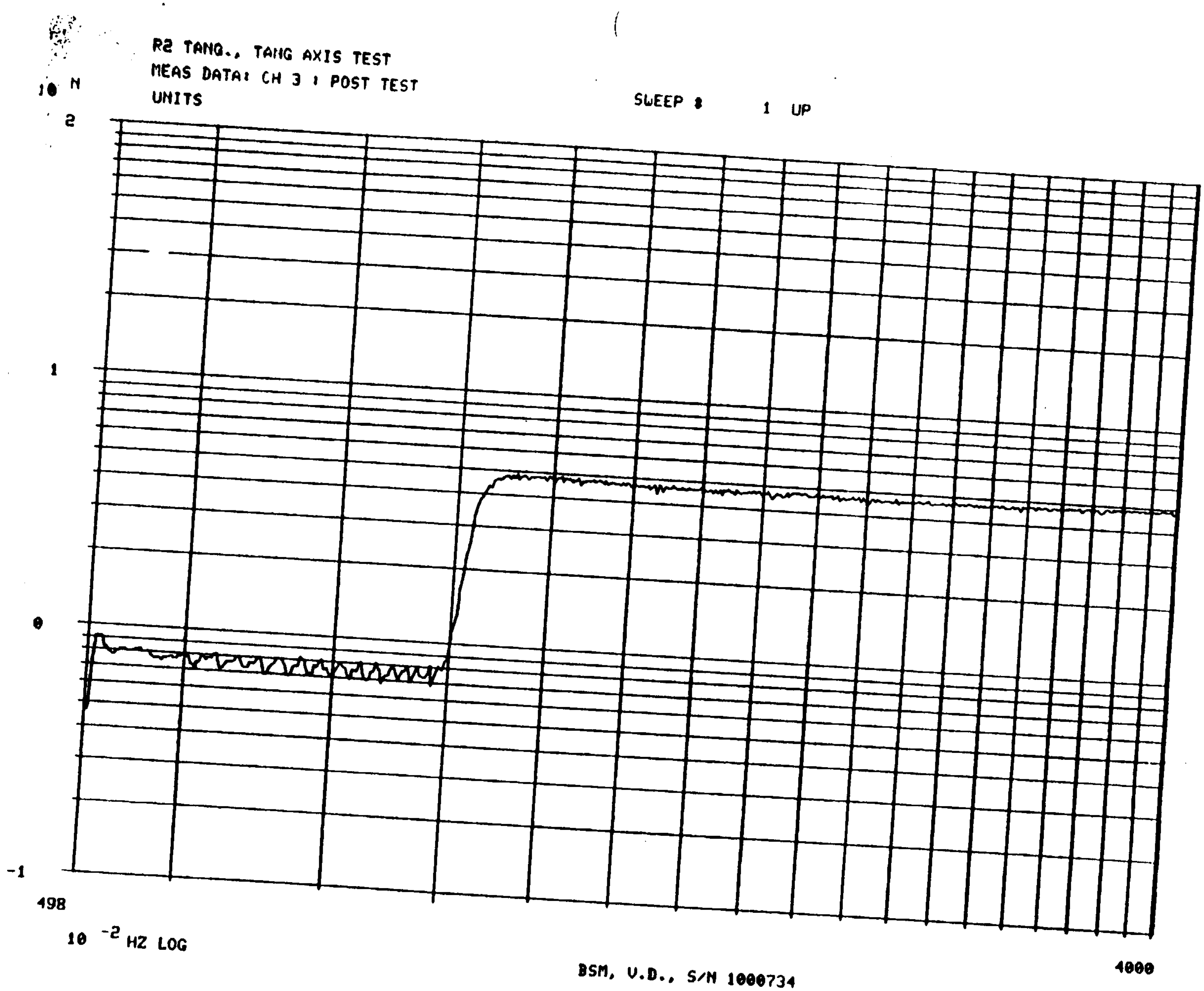

CONTROL V.D., TANG. AXIS
POST TEST
G
SWEEP # 1 UP
10 N
2
1
0
-1
498
10 -2 HZ LOG
4000
BSM, V.D., TANG.
S/N 1000734

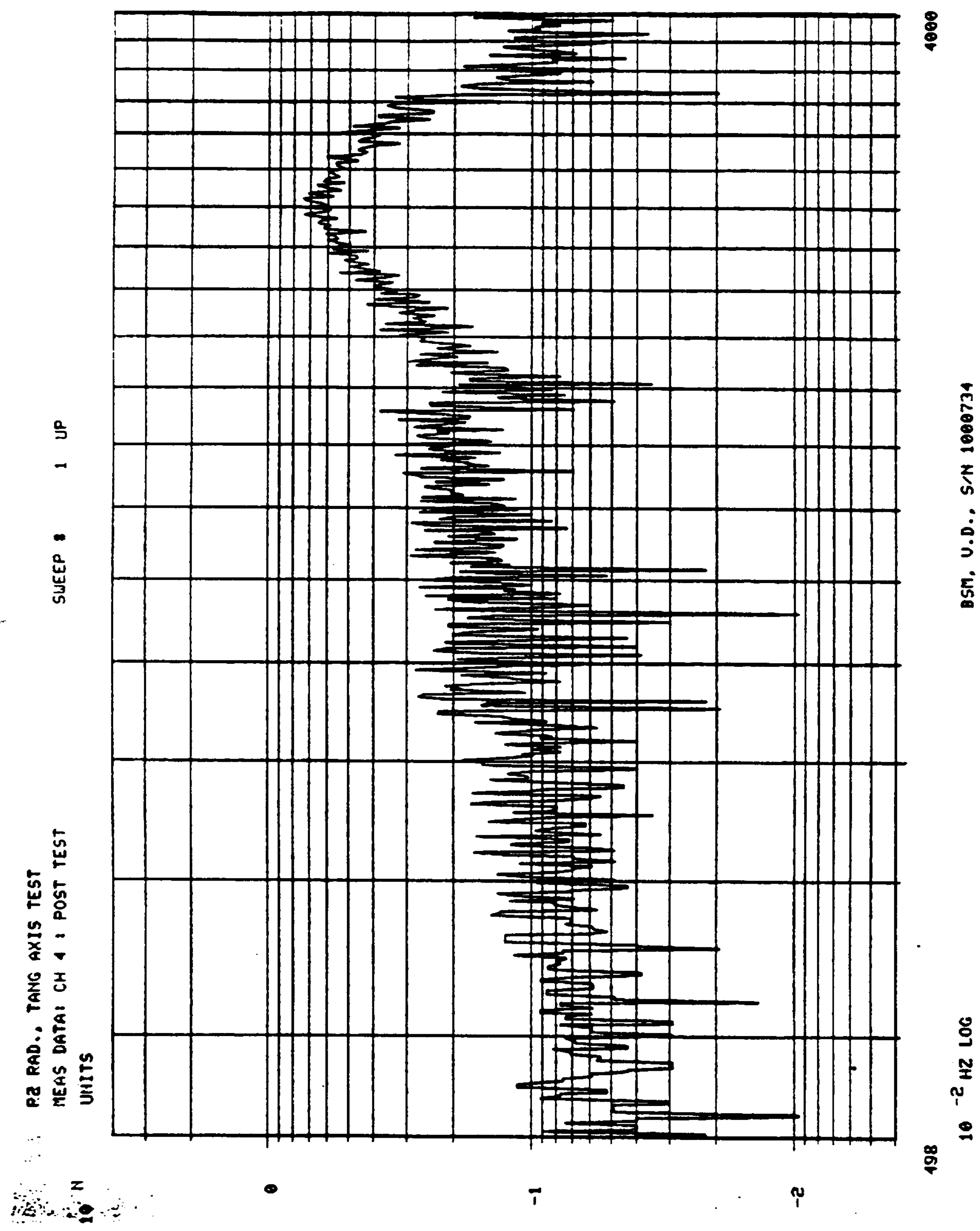

P1 LONG., TANG AXIS TEST
CH 2 : POST TEST
UNITS
SWEEP # 1 UP
BSM, V.D., S/N 1000734
10 -2 HZ LOG
498
4000
0
-1
-2


R1 TANG., TANG AXIS TEST
MEAS DATA: CH 3 : POST TEST
UNITS
SWEEP # 1 UP
BSM, V.D., S/N 1000734
10 N
2
1
0
-1
498
10 -2 HZ LOG
4000


P1 RAD., TANG AXIS TEST
MEAS DATA: CH 4 : POST TEST
UNITS
10 N
SWEEP # 1 UP
0
-1
-2
498
4000
10 -2 HZ LOG
BSM, V.D., S/N 1000734

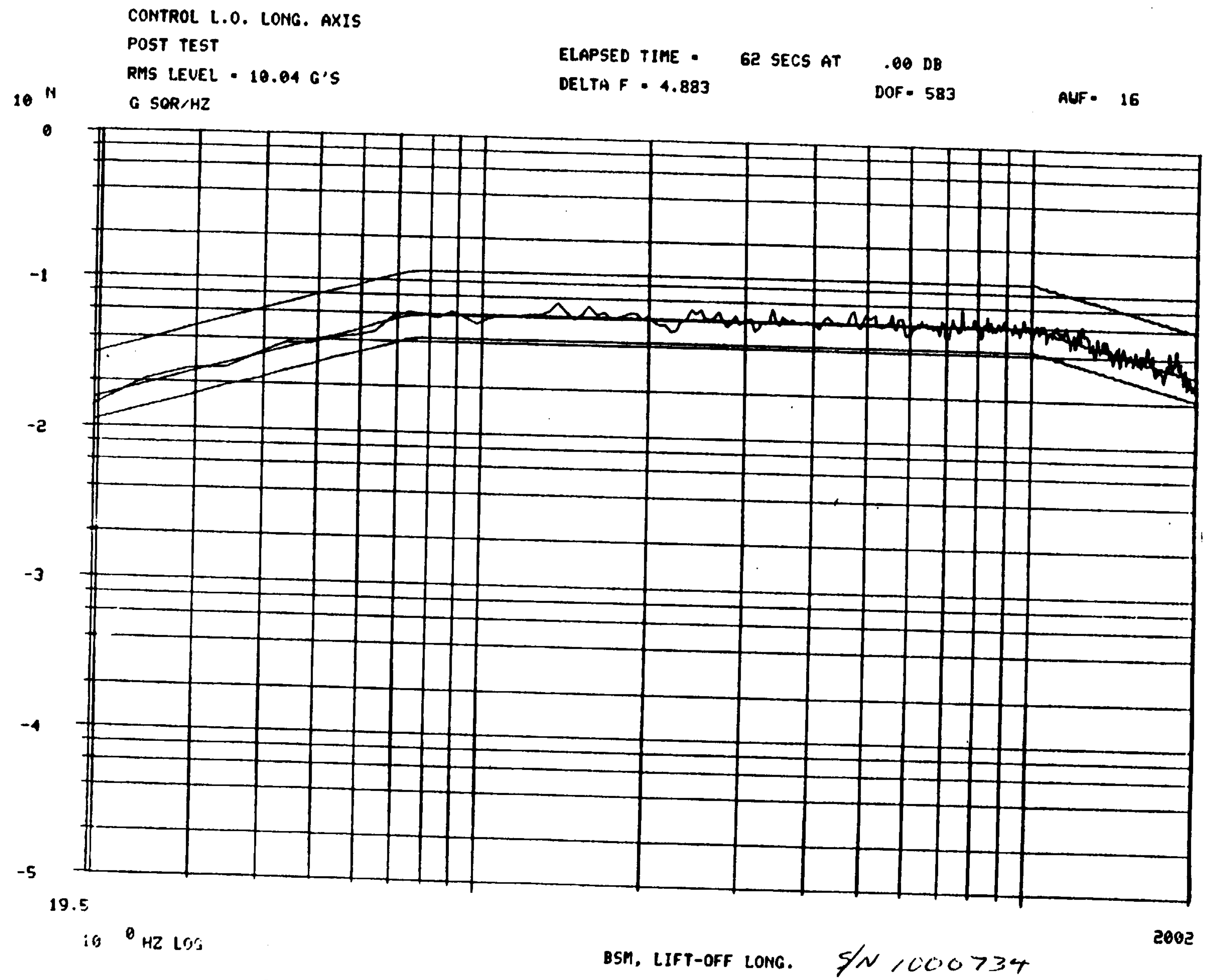

P2 LONG., TANG AXIS TEST
MEAS DATA: CH 2 : POST TEST
UNITS
SWEEP # 1 UP
BSM, V.D., S/N 1000734
10 -2 HZ LOG
498
4000
10 N
0
-1
-2

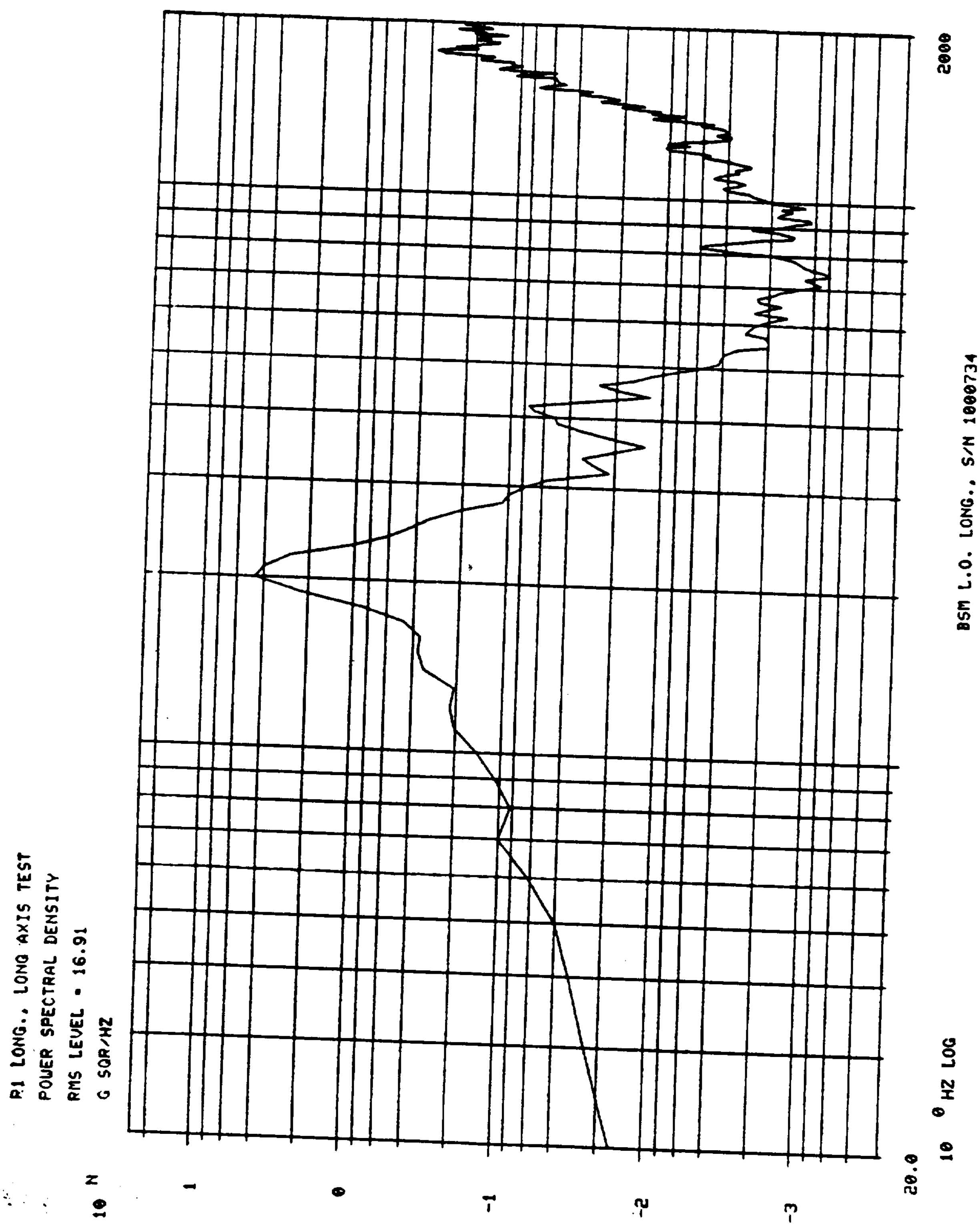

R2 TANG., TANG AXIS TEST
MEAS DATA: CH 3 : POST TEST
UNITS
SWEEP # 1 UP
10 N
2
1
0
-1
498
10 -2 HZ LOG
BSM, V.D., S/N 1000734
4000

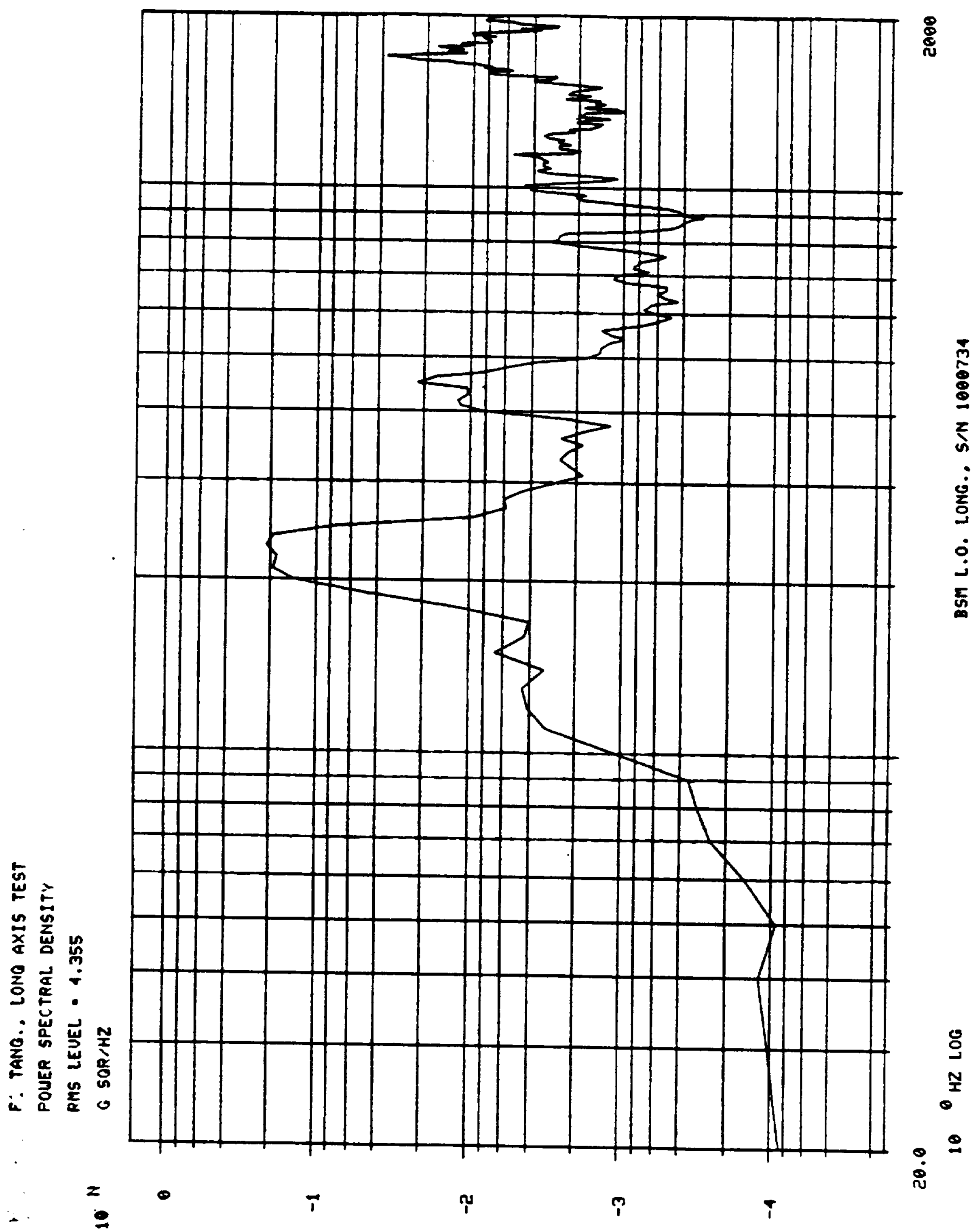

R2 RAD., TANG AXIS TEST
MEAS DATA: CH 4 : POST TEST
UNITS
SWEEP # 1 UP
10 N
0
-1
-2
498
4000
10 -2 HZ LOG
BSM, U.D., S/N 1000734

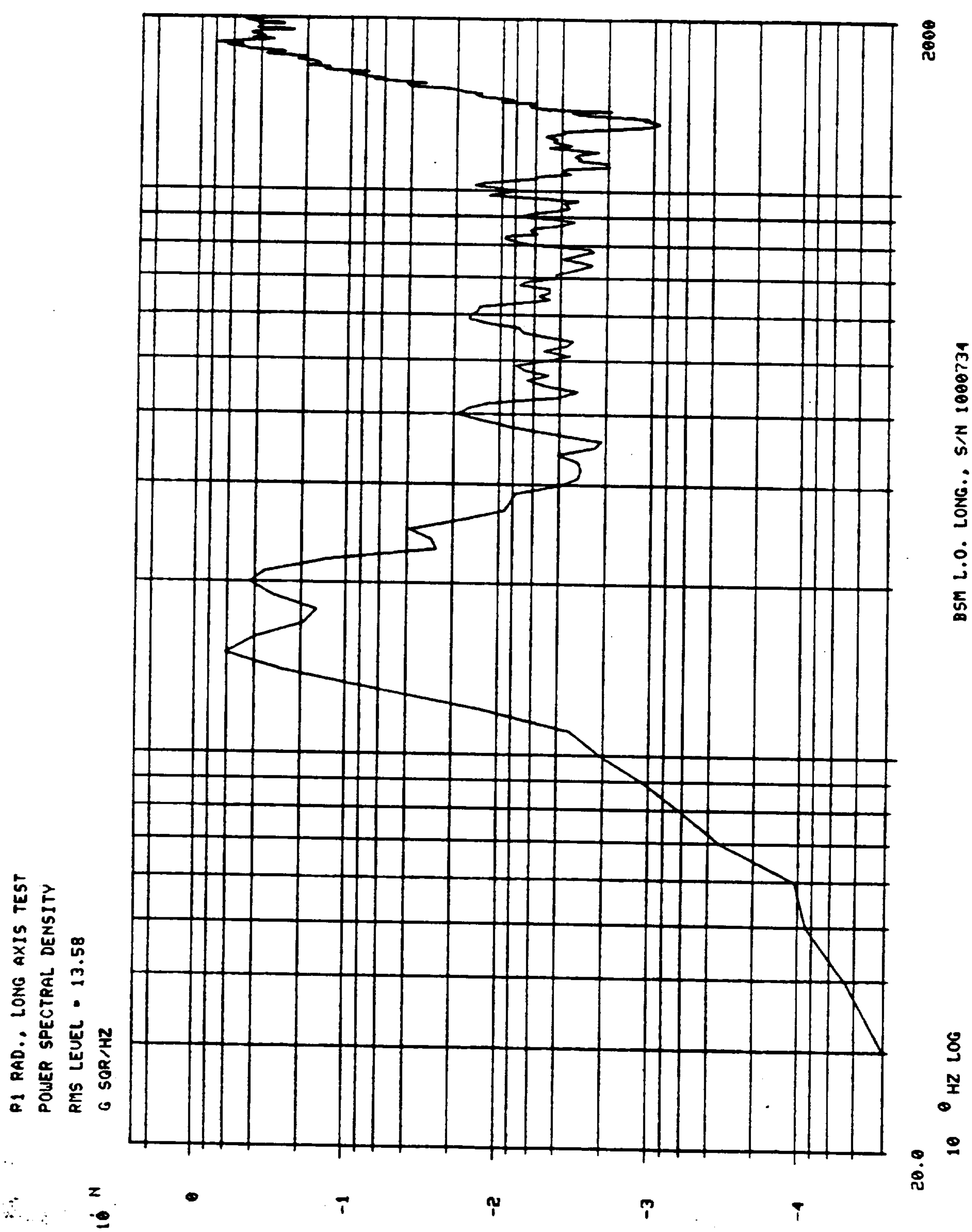
LONGITUDINAL AXIS

RANDOM, LIFT-OFF

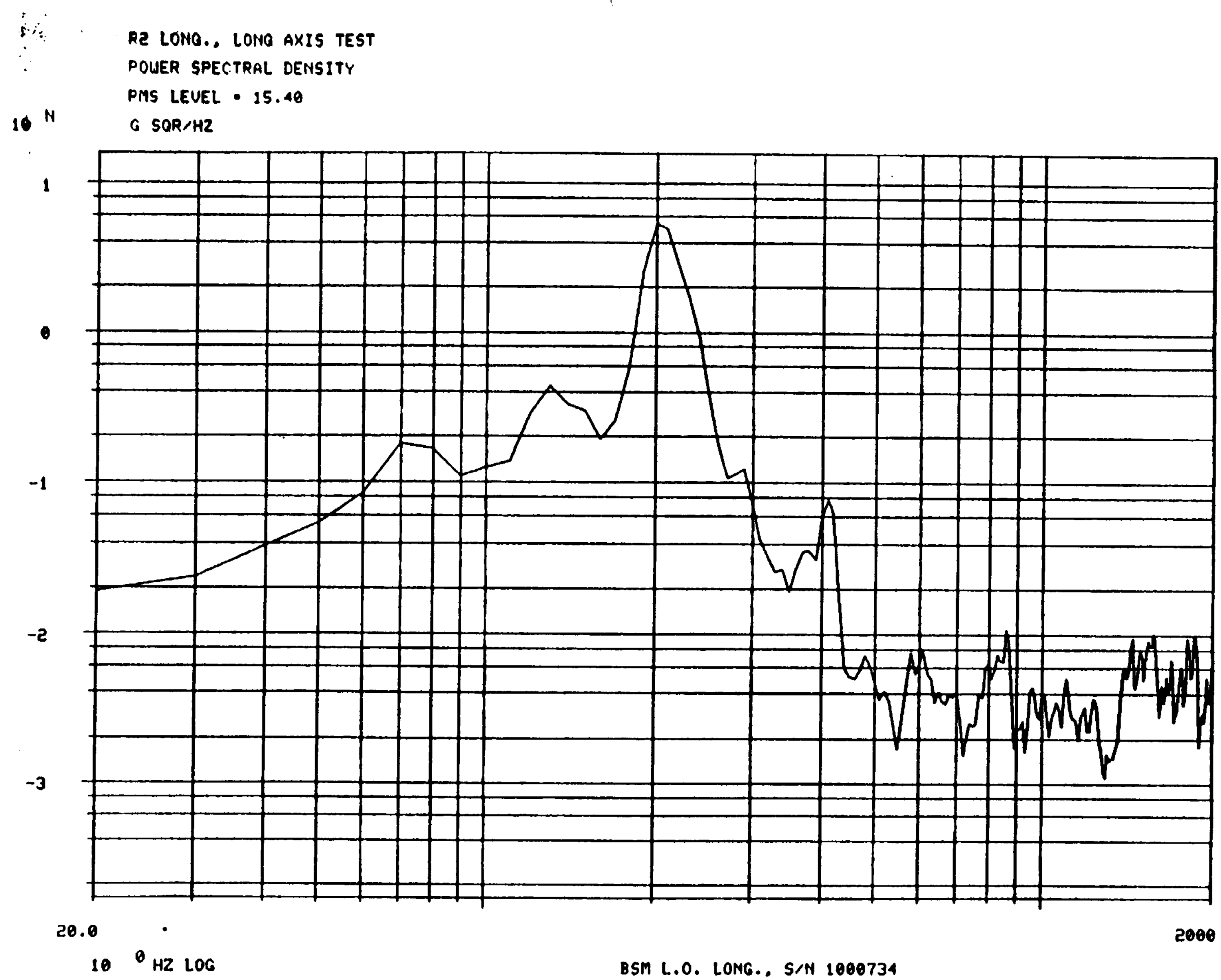

CONTROL L.O. LONG. AXIS
POST TEST
RMS LEVEL = 10.04 G'S
G SQR/HZ
ELAPSED TIME = 62 SECS AT .00 DB
DELTA F = 4.883
DOF= 583
AWF= 16
10 N
0
-1
-2
-3
-4
-5
19.5
10 0 HZ LOG
2002
BSM, LIFT-OFF LONG.
S/N 1000734

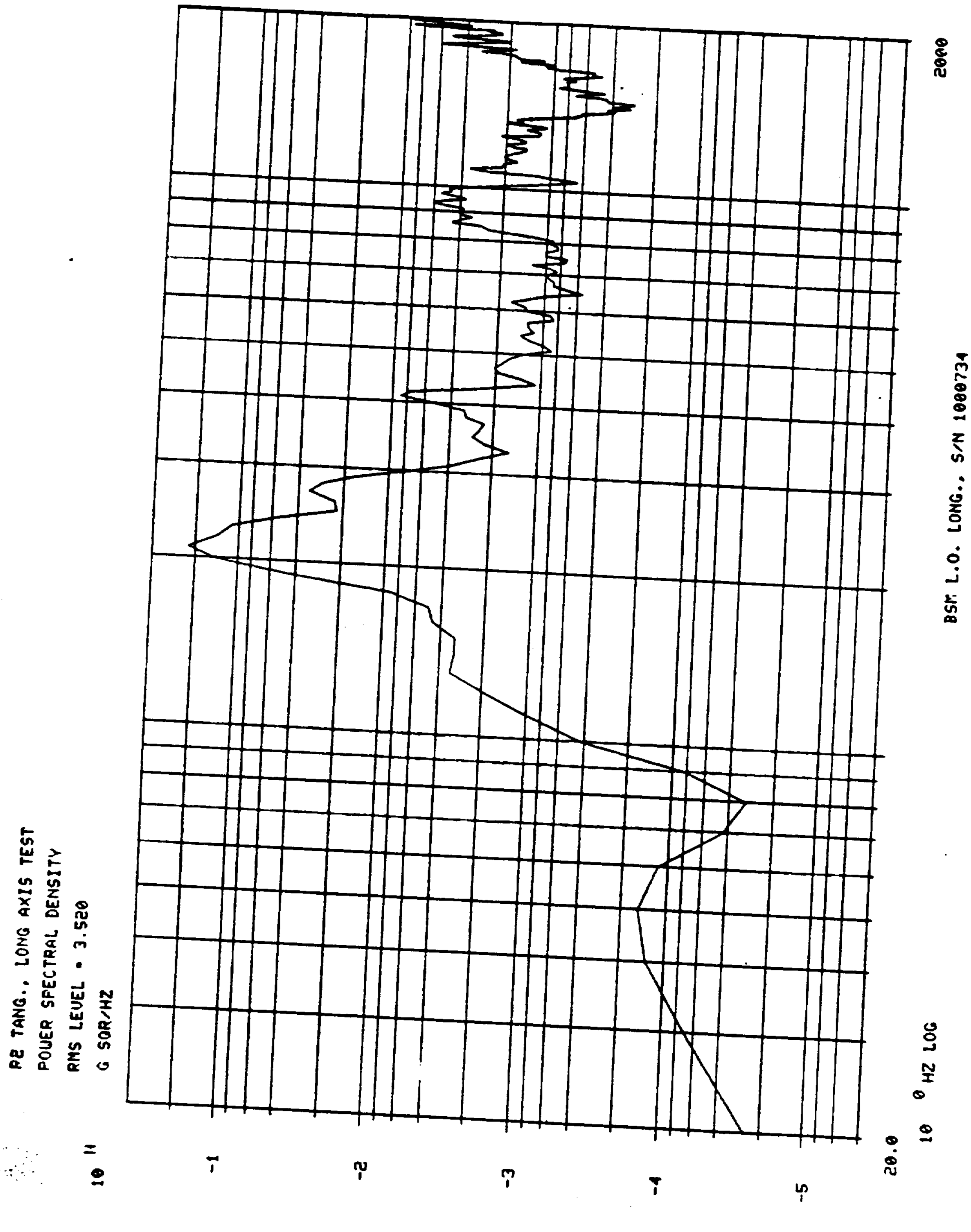

R1 LONG., LONG AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL = 16.91
G SQR/HZ
10 N
1
0
-1
-2
-3
20.0
2000
10 0 HZ LOG
BSM L.O. LONG., S/N 1000734


F: TANG., LONG AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL = 4.355
G SQR/HZ
10 N
0
-1
-2
-3
-4
20.0
10 0 HZ LOG
2000
BSM L.O. LONG., S/N 1000734

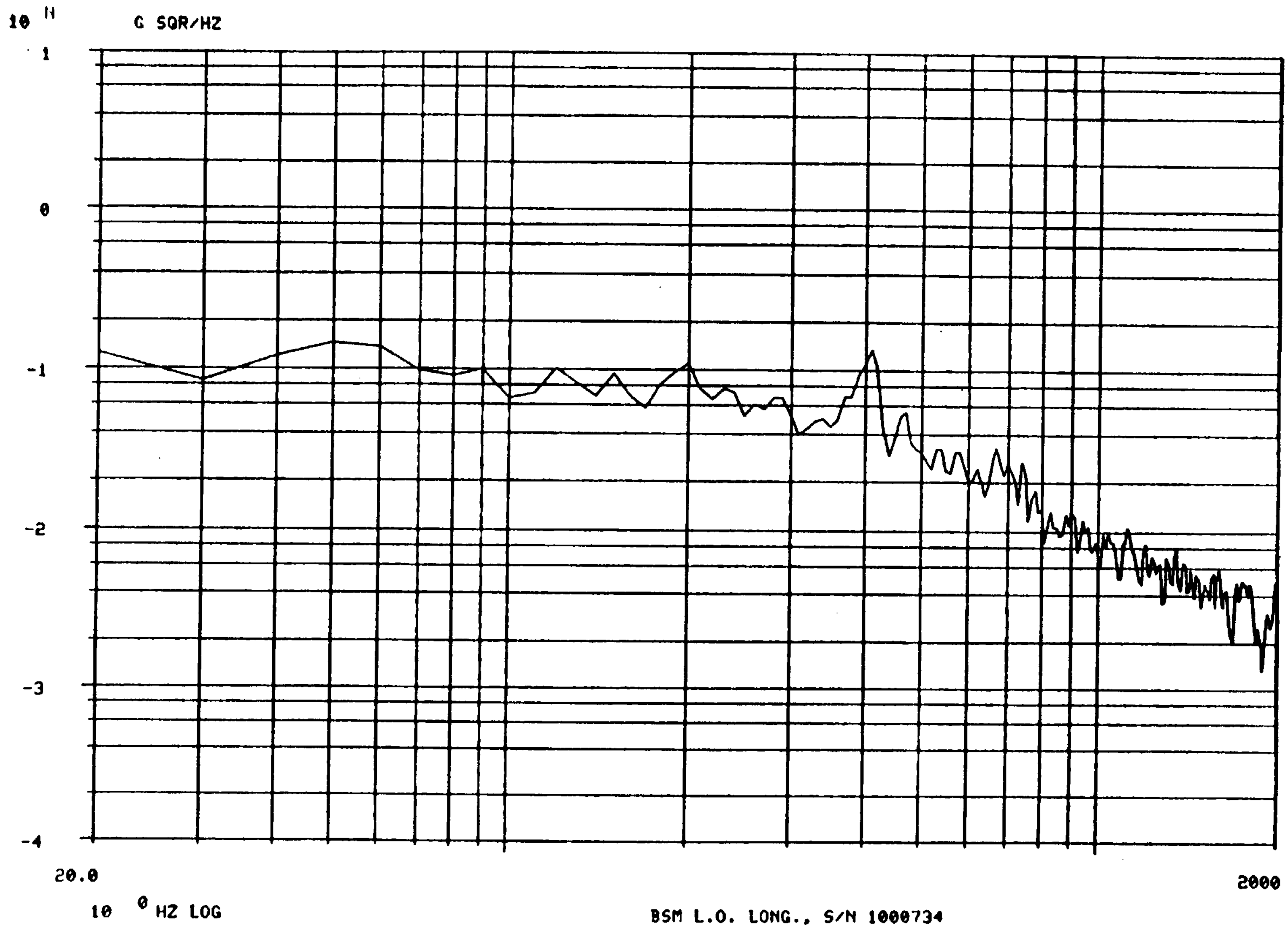


P1 RAD., LONG AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL = 13.58
G SQR/HZ
10 N
0
-1
-2
-3
-4
20.0
10 0 HZ LOG
2000
BSM L.O. LONG., S/N 1000734


R2 LONG., LONG AXIS TEST
POWER SPECTRAL DENSITY
PMS LEVEL • 15.40
G SQR/HZ
10 N
1
0
-1
-2
-3
20.0
2000
10 0 HZ LOG
BSM L.O. LONG., S/N 1000734


R2 TANG., LONG AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL = 3.520
G SQR/HZ
10
-1
-2
-3
-4
-5
20.0
10 0 HZ LOG
2000
BSM L.O. LONG., S/N 1000734

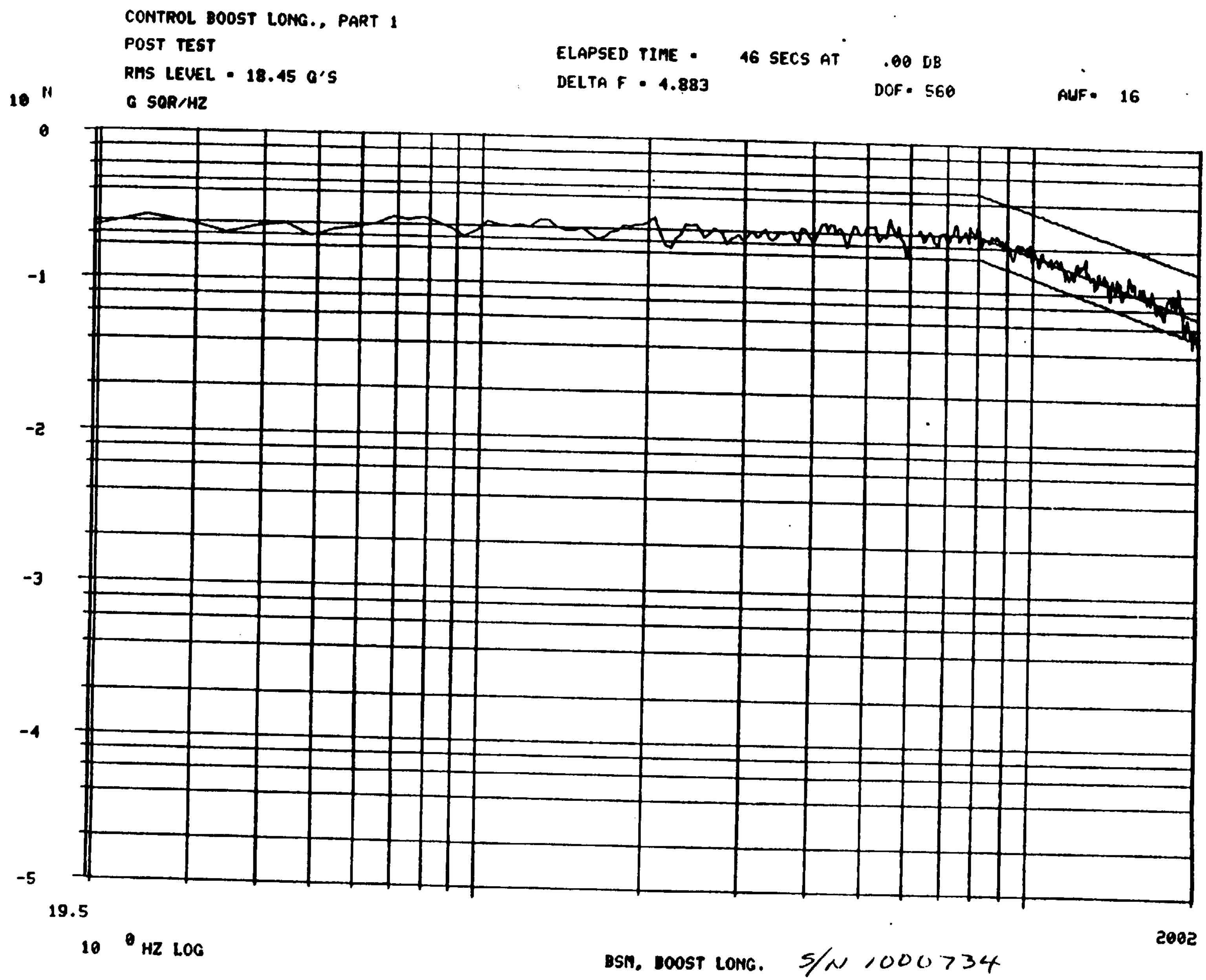
RØ RAD., LONG AXIS TEST,BAD DATA,WIRE LOOSE
POWER SPECTRAL DENSITY
RMS LEVEL • 7.014
G SQR/HZ

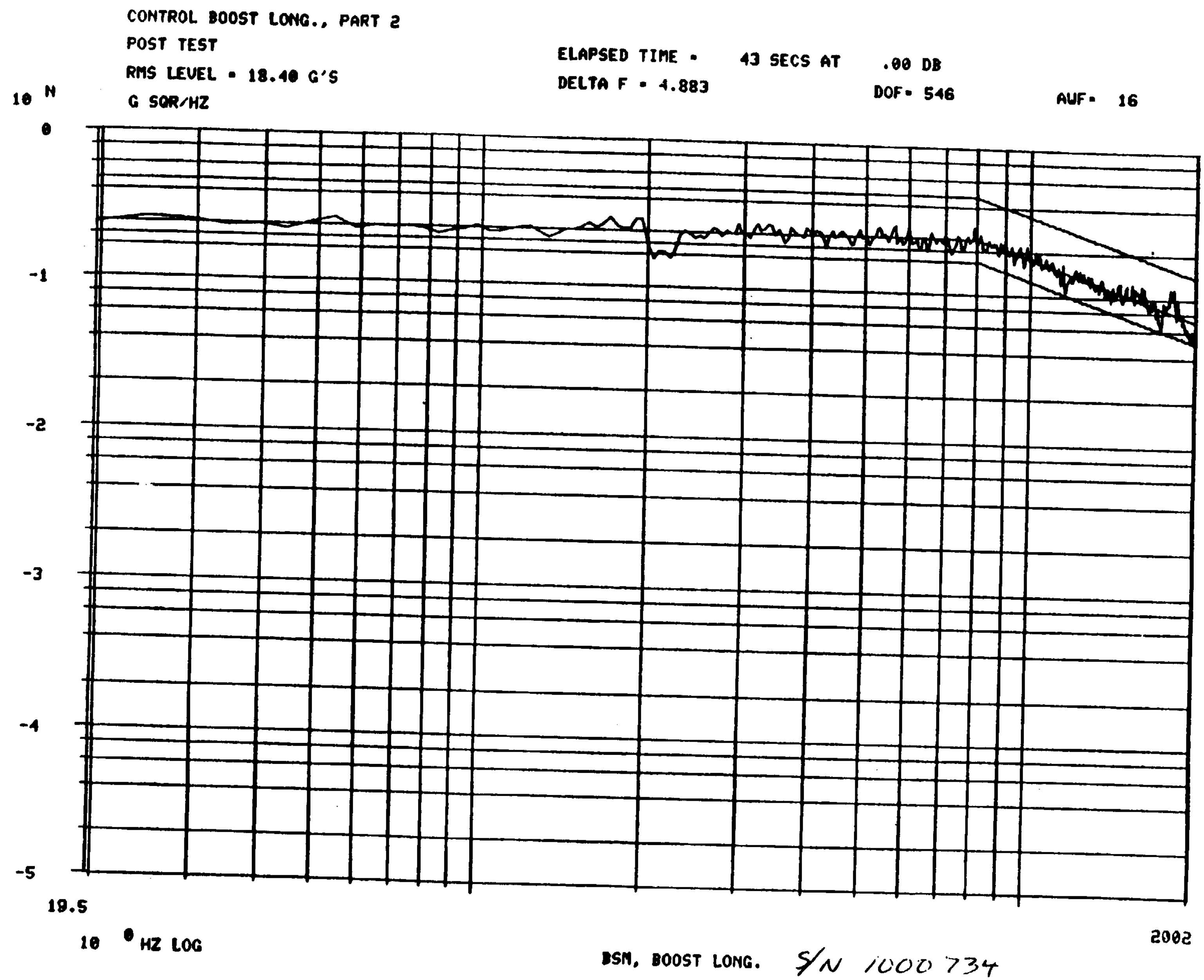


BSM L.O. LONG., S/N 1000734

LONGITUDINAL AXIS

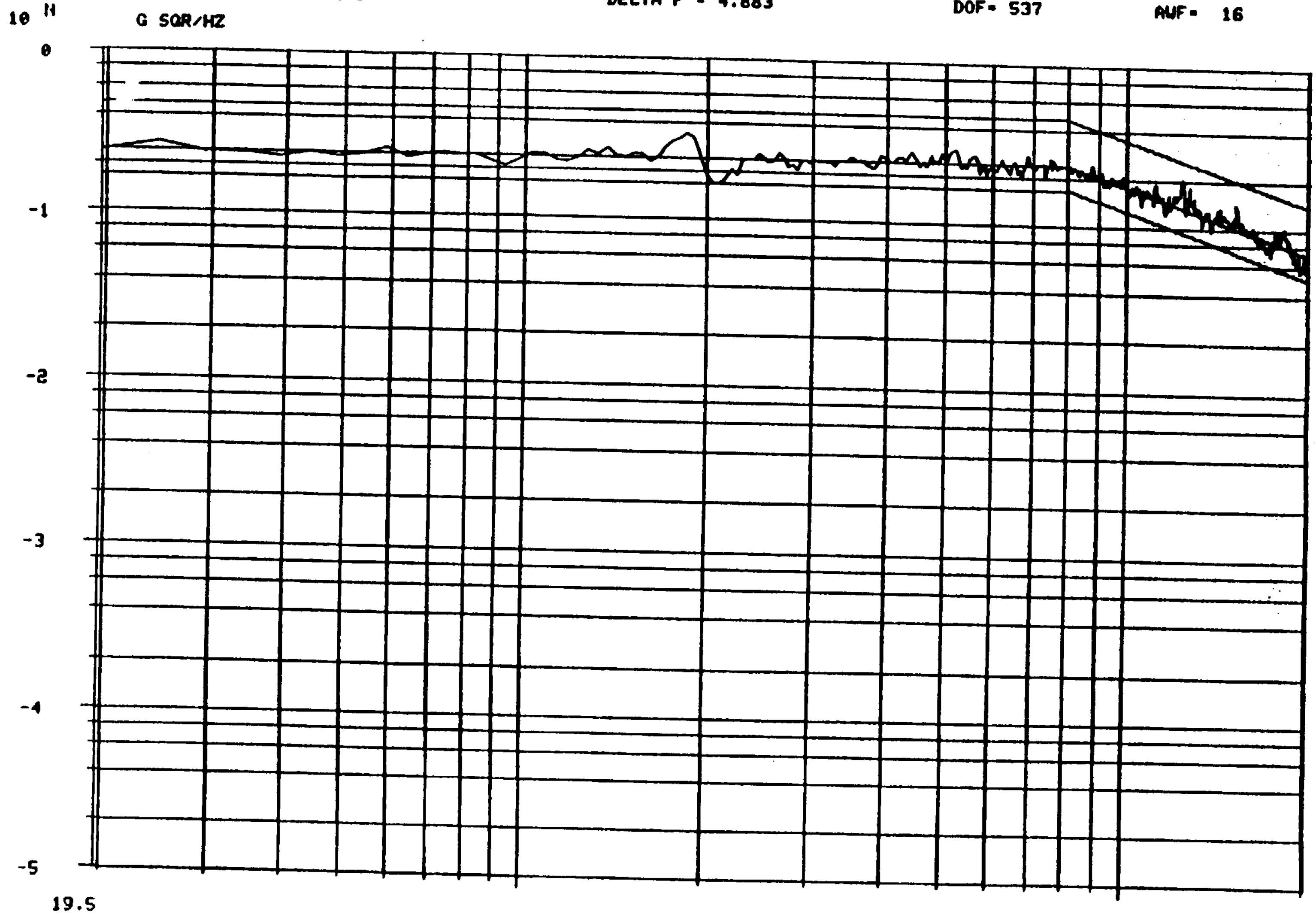
RANDOM, BOOST


CONTROL BOOST LONG., PART 1
POST TEST
RMS LEVEL = 18.45 G'S
G SQR/HZ
ELAPSED TIME = 46 SECS AT .00 DB
DELTA F = 4.883
DOF= 560
AWF= 16
10 N
0
-1
-2
-3
-4
-5
19.5
10 0 HZ LOG
2002
BSM, BOOST LONG. S/N 1000734

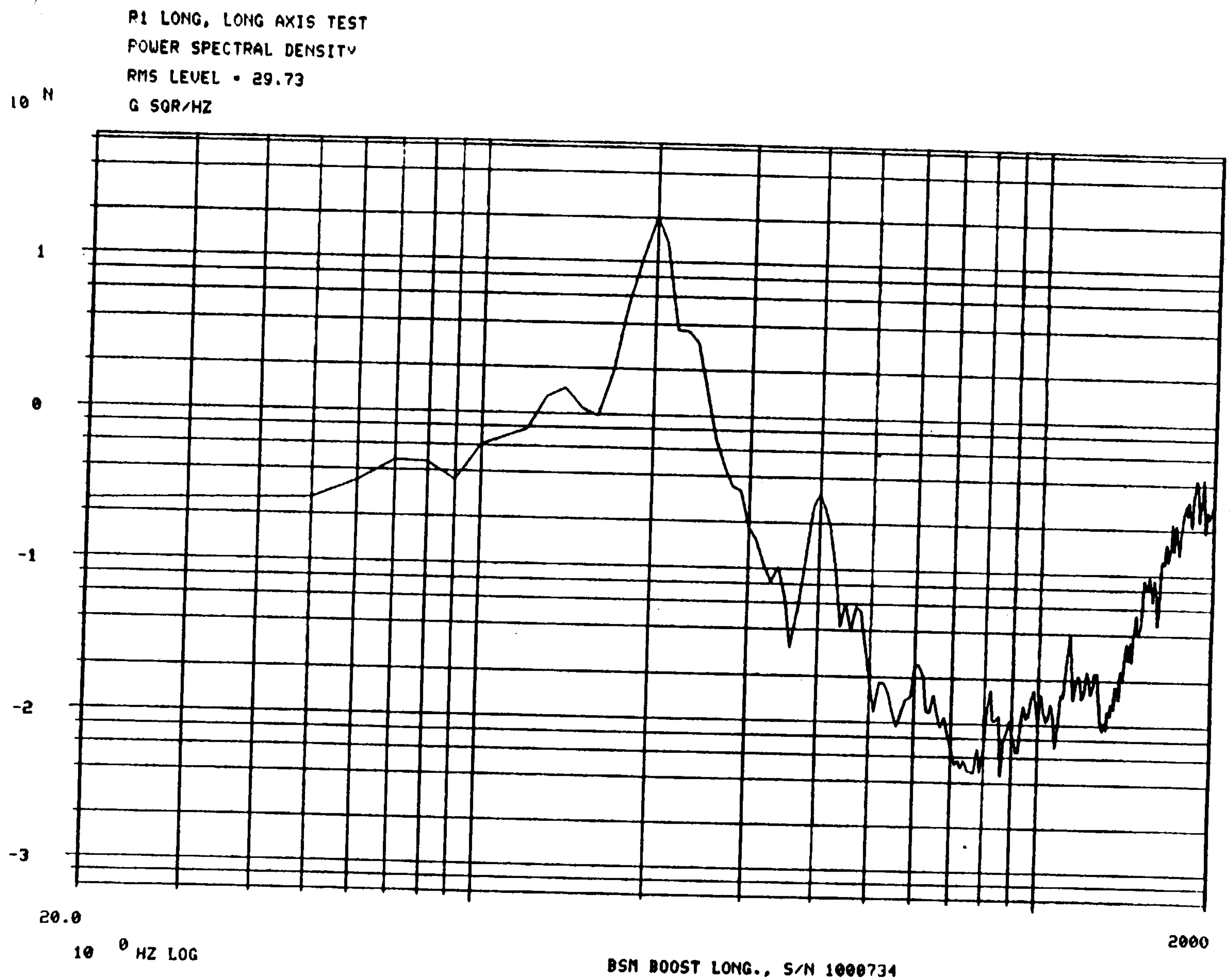

CONTROL BOOST LONG., PART 2
POST TEST
RMS LEVEL = 18.40 G'S
G SQR/HZ
ELAPSED TIME = 43 SECS AT .00 DB
DELTA F = 4.883
DOF= 546
AWF= 16
10 N
0
-1
-2
-3
-4
-5
19.5
10 0 HZ LOG
2002
BSM, BOOST LONG. S/N 1000734

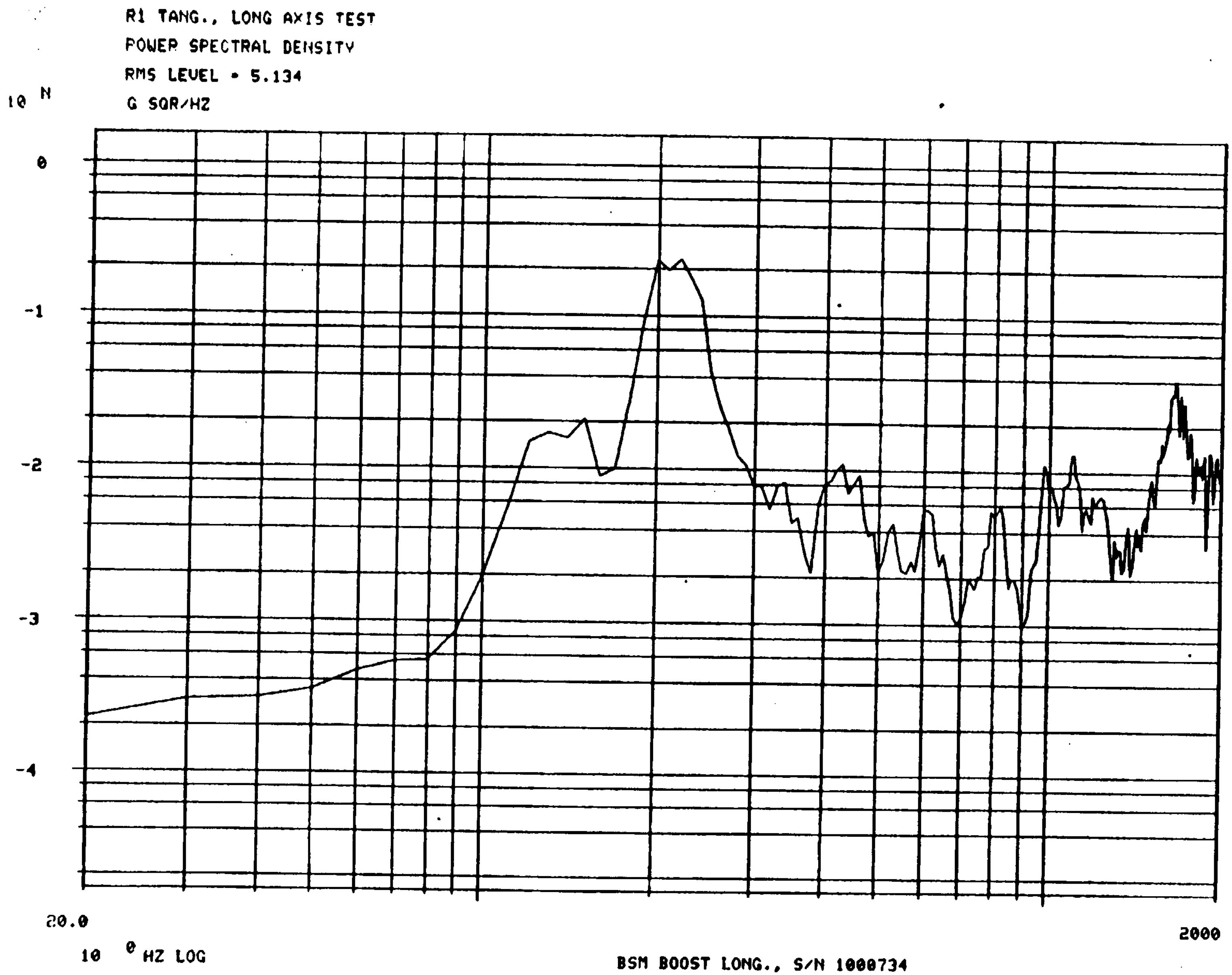
CONTROL BOOST LONG., PART 3
POST TEST
RMS LEVEL = 18.59 G'S
G SQR/HZ

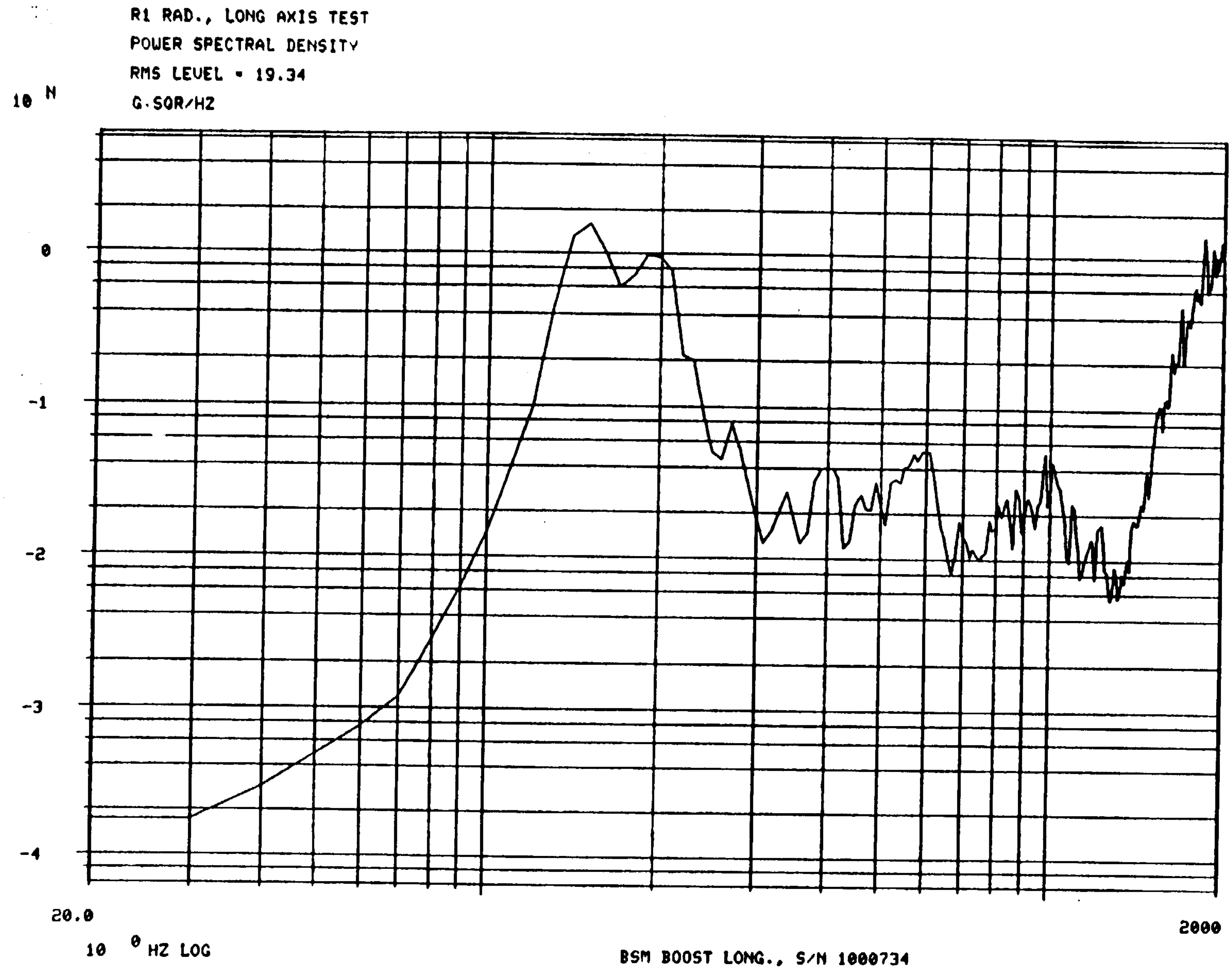
ELAPSED TIME = 36 SECS AT .00 DB
DELTA F = 4.883
DOF= 537
AVF= 16



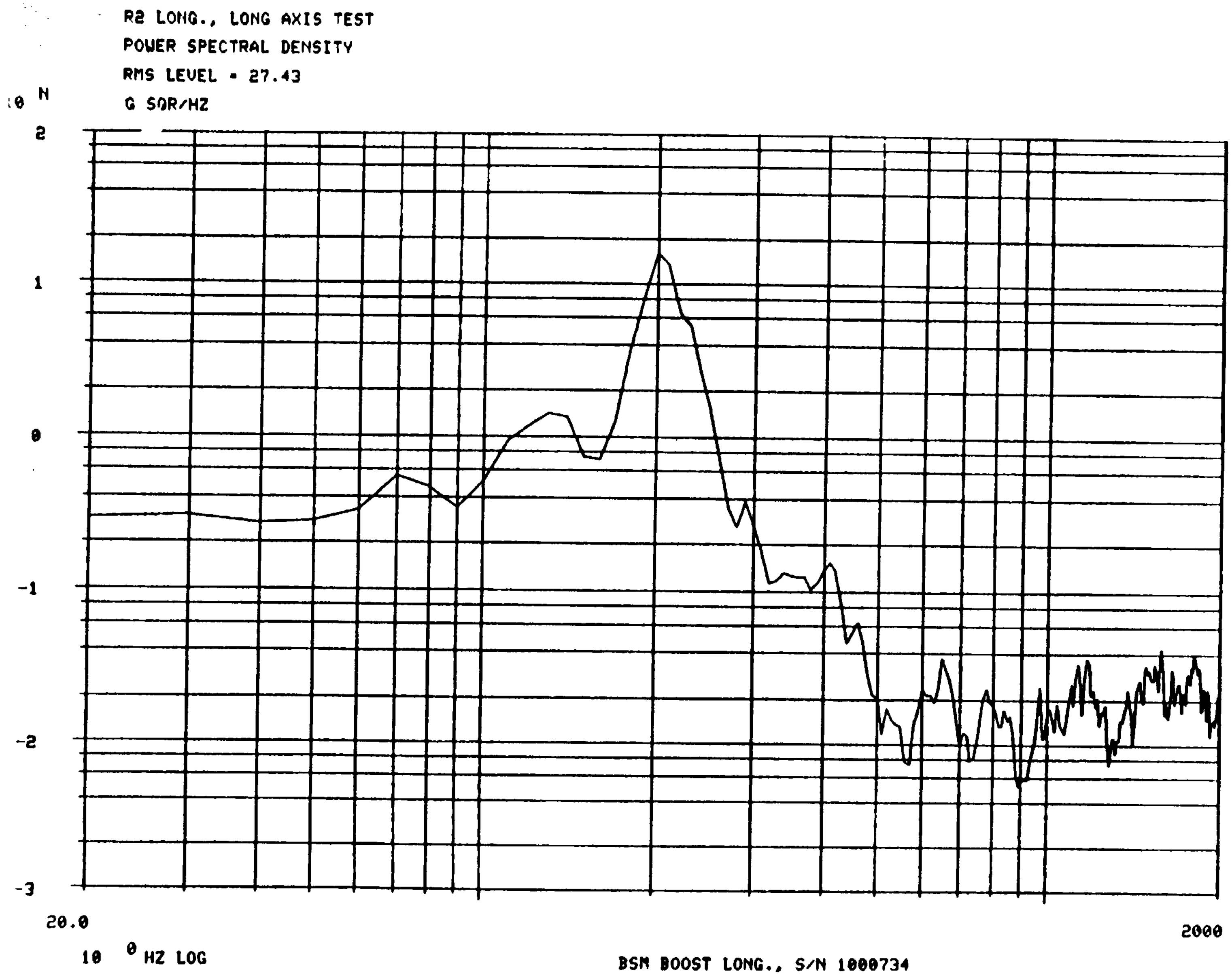
BSM, BOOST LONG. S/N 1000734

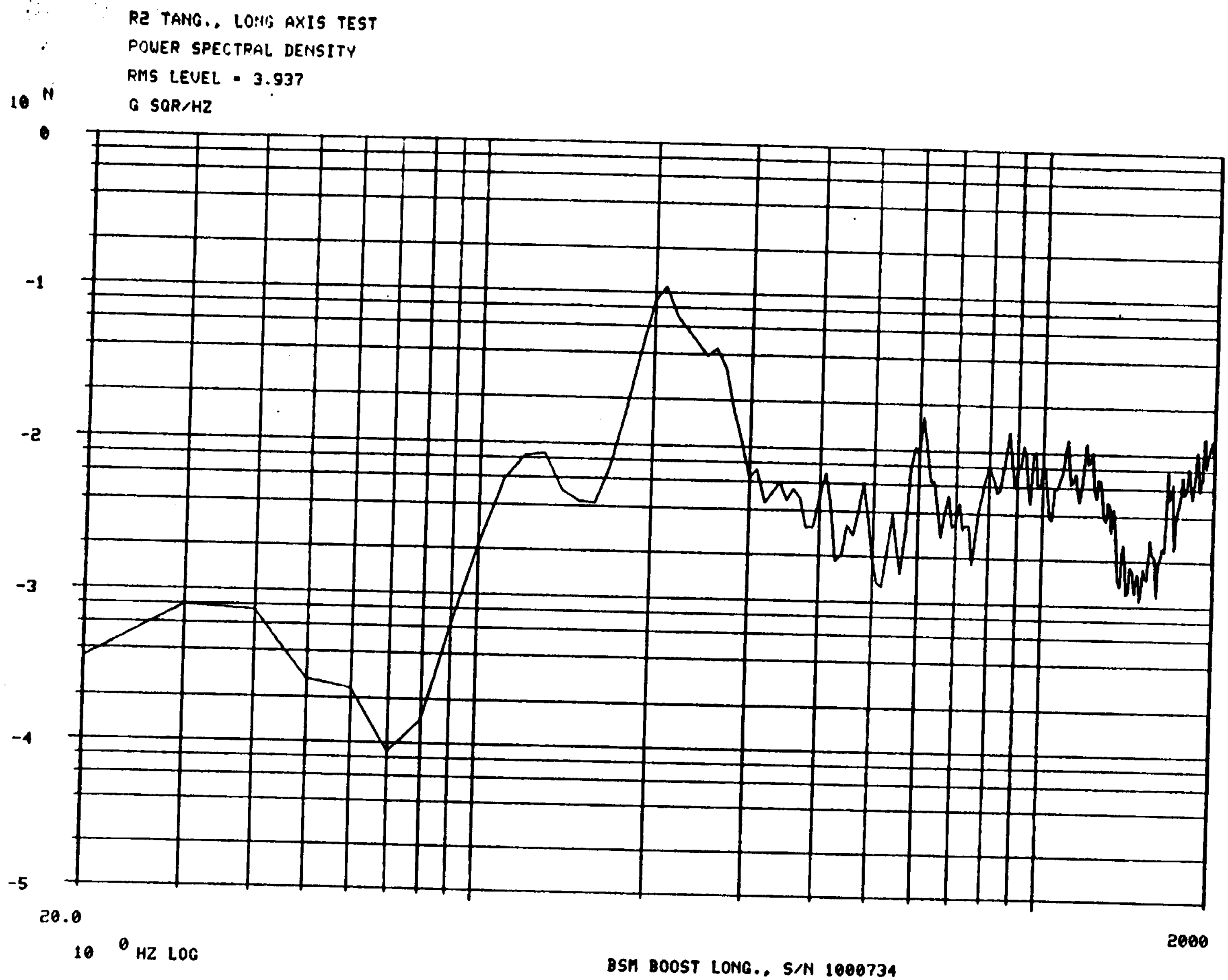

R1 LONG, LONG AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL = 29.73
G SQR/HZ
10 N
1
0
-1
-2
-3
20.0
10 0 HZ LOG
2000
BSM BOOST LONG., S/N 1000734

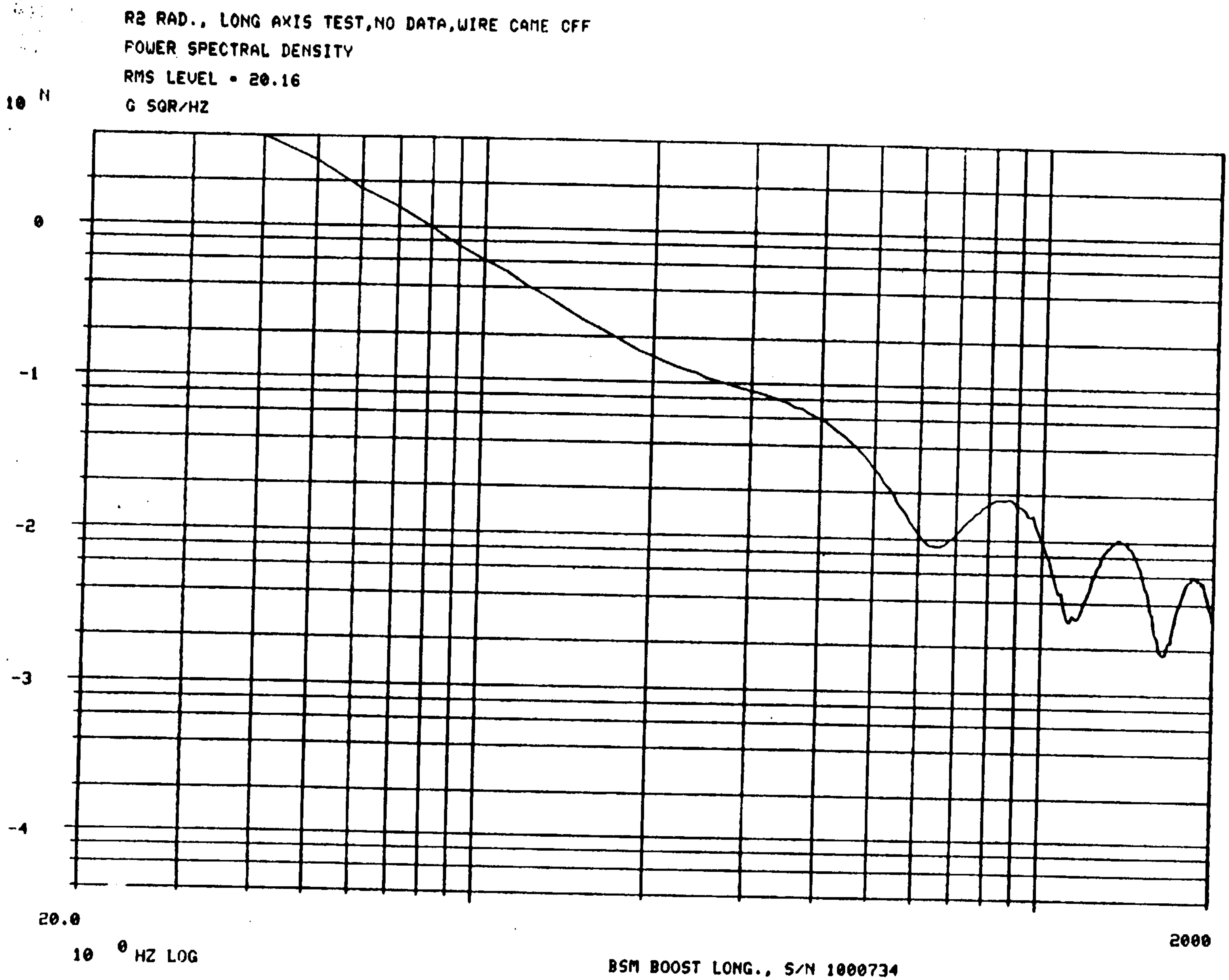

R1 TANG., LONG AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL • 5.134
G SQR/HZ
10 N
0
-1
-2
-3
-4
20.0
2000
10 0 HZ LOG
BSM BOOST LONG., S/N 1000734



R1 RAD., LONG AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL = 19.34
G.SQR/HZ
10 N
0
-1
-2
-3
-4
20.0
2000
10 0 HZ LOG
BSM BOOST LONG., S/N 1000734

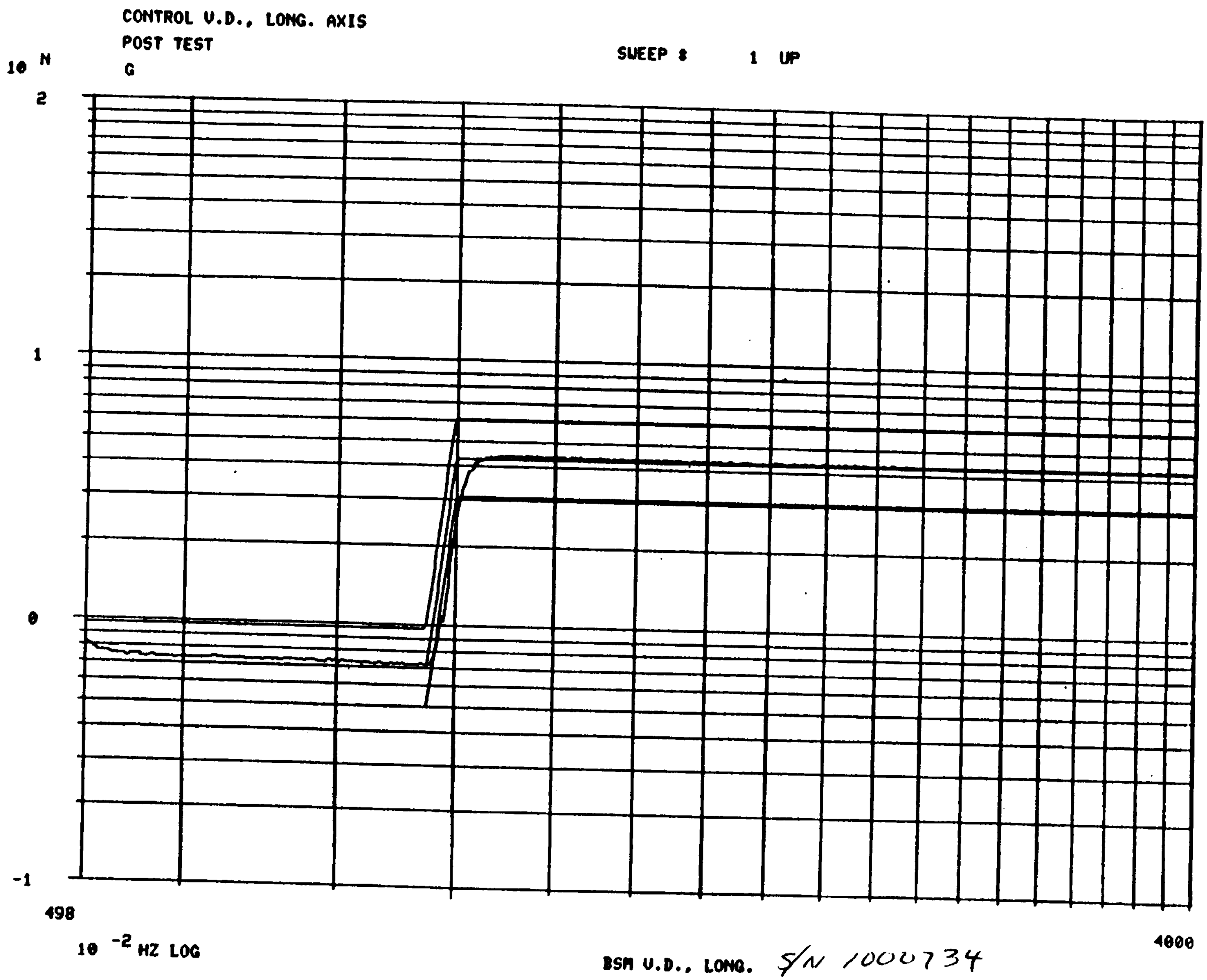

R2 LONG., LONG AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL = 27.43
G SQR/HZ
10 N
2
1
0
-1
-2
-3
20.0
2000
10 0 HZ LOG
BSM BOOST LONG., S/N 1000734

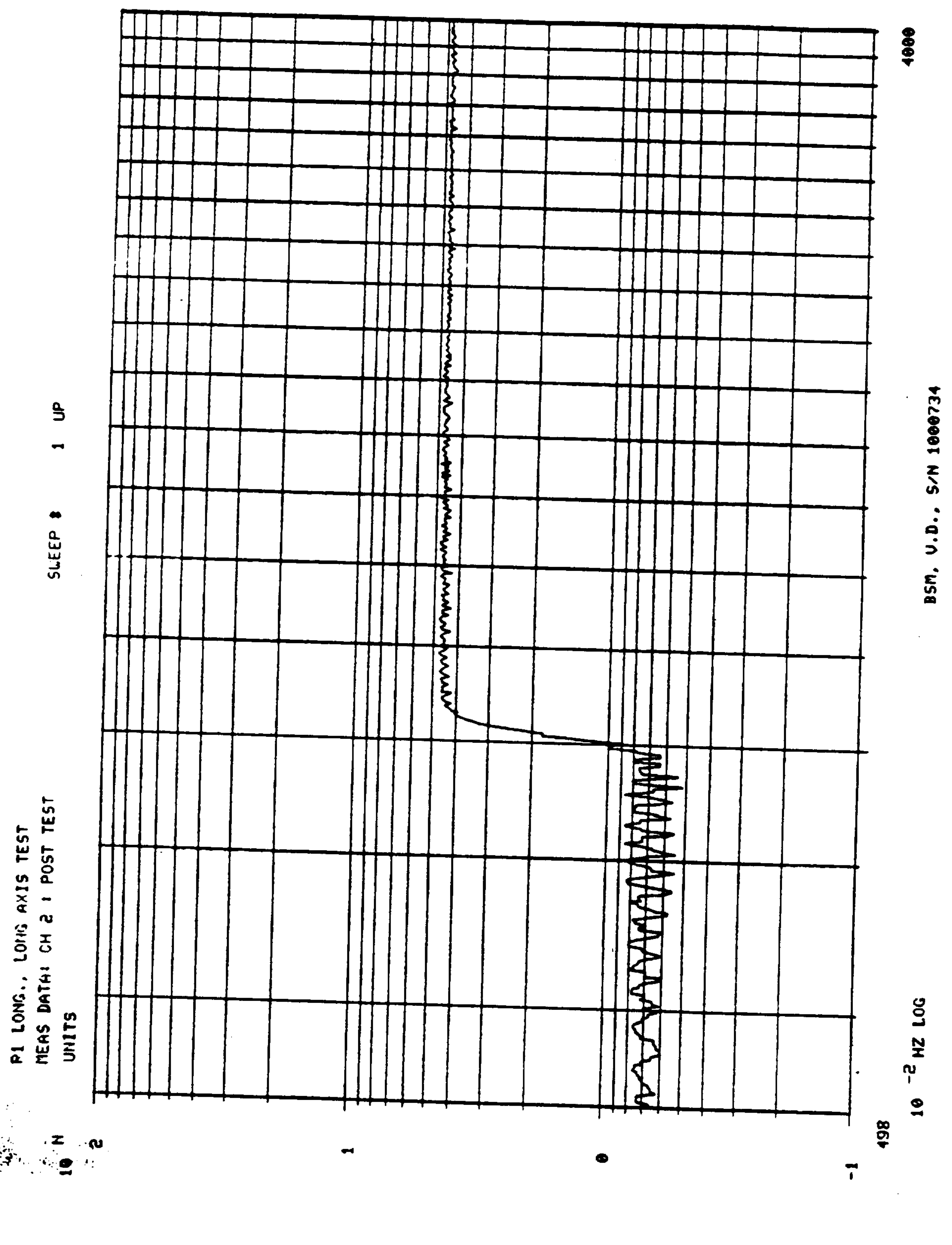

R2 TANG., LONG AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL = 3.937
G SQR/HZ
10 N
0
-1
-2
-3
-4
-5
20.0
10 0 HZ LOG
2000
BSM BOOST LONG., S/N 1000734

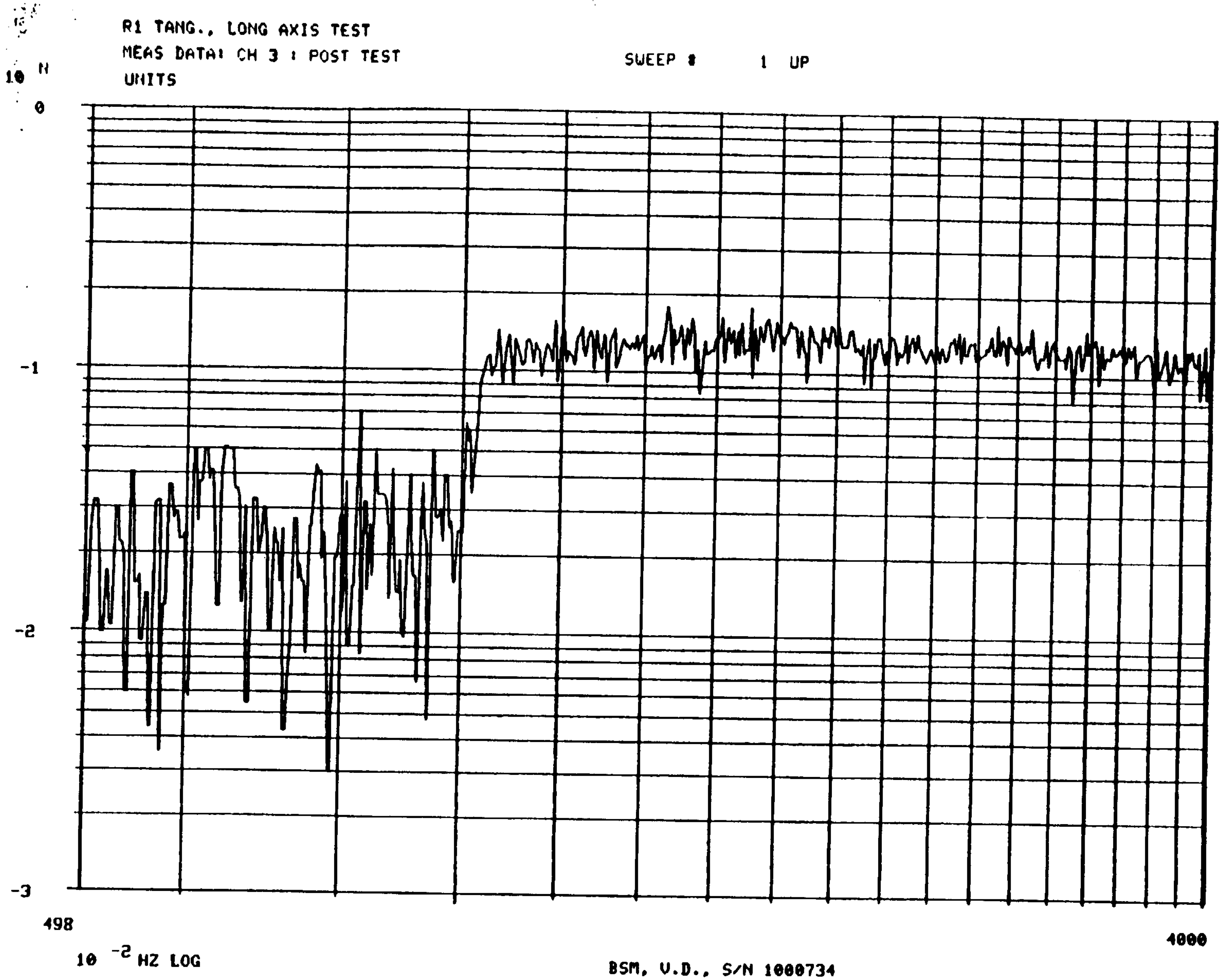

R2 RAD., LONG AXIS TEST,NO DATA,WIRE CAME CFF
FOWER SPECTRAL DENSITY
RMS LEVEL • 20.16
G SQR/HZ
10 N
0
-1
-2
-3
-4
20.0
2000
10 0 HZ LOG
BSM BOOST LONG., S/N 1000734

LONGITUDINAL AXIS

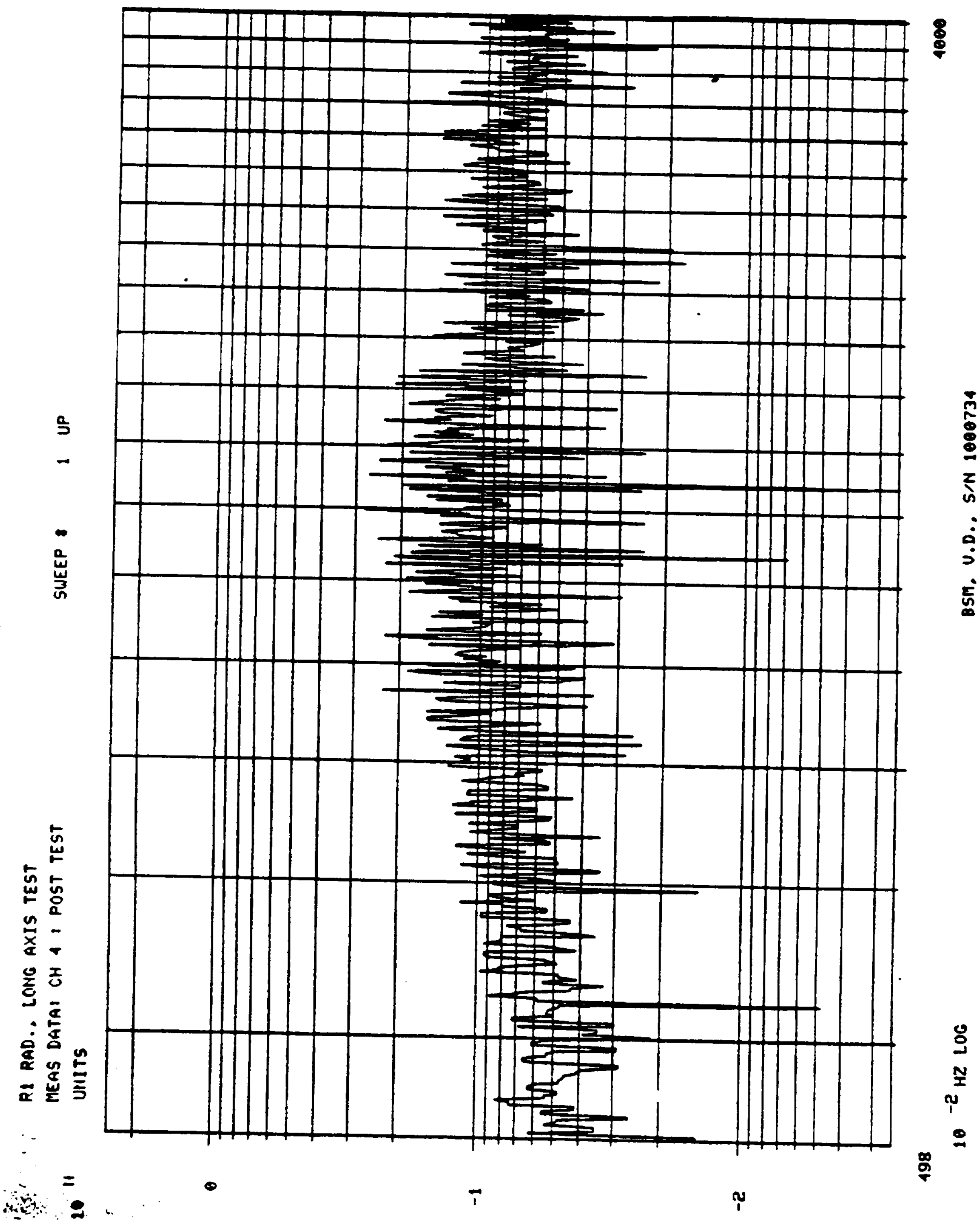
VEHICLE DYNAMICS

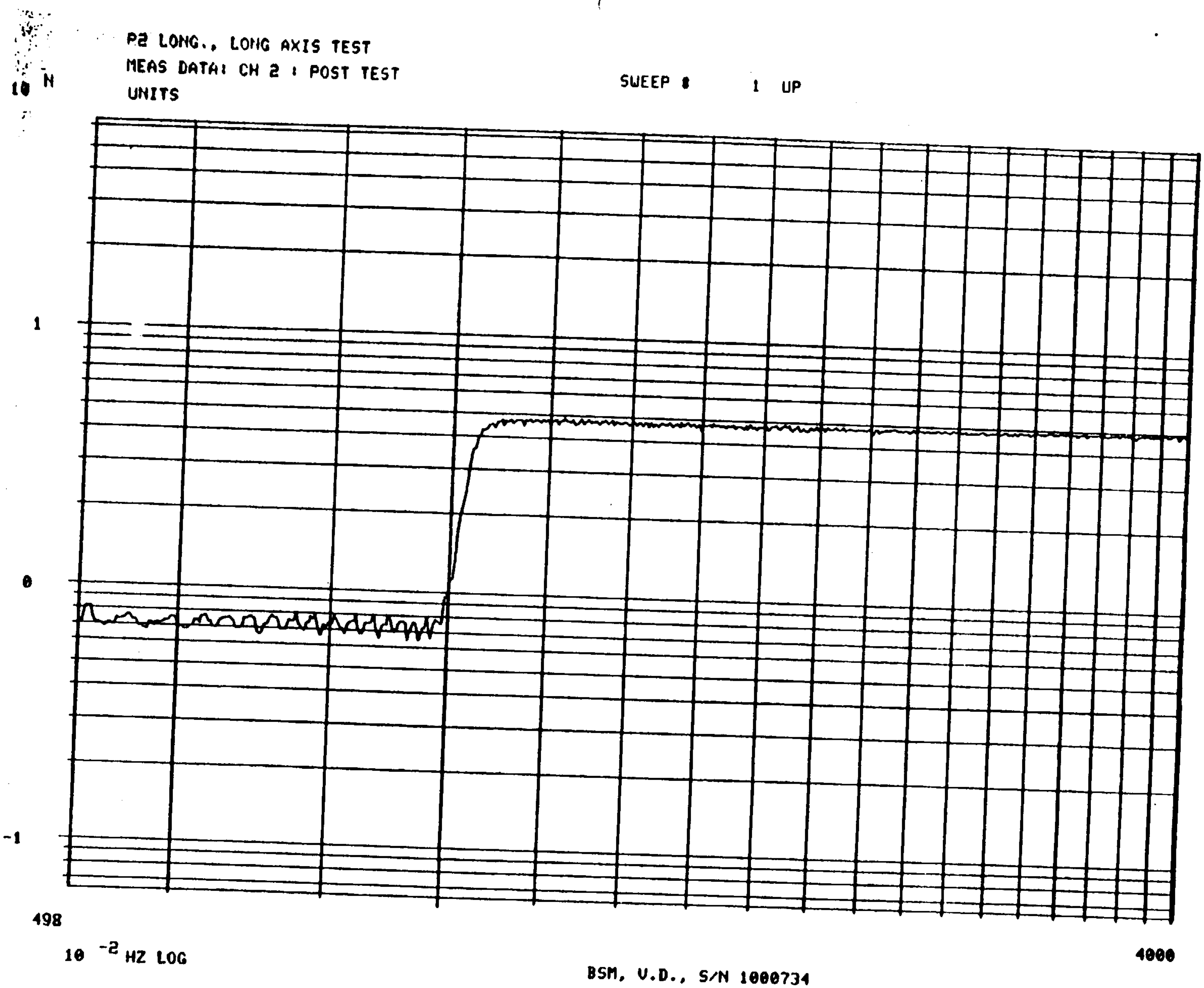

CONTROL V.D., LONG. AXIS
POST TEST
G
SWEEP # 1 UP
10 N
2
1
0
-1
498
10 -2 HZ LOG
4000
BSM V.D., LONG. S/N 1000734


P1 LONG., LONG AXIS TEST
MEAS DATA: CH 2 : POST TEST
UNITS
SWEEP # 1 UP
BSM, V.D., S/N 1000734
10 -2 HZ LOG
498
4000
10 N 2
1
0
-1



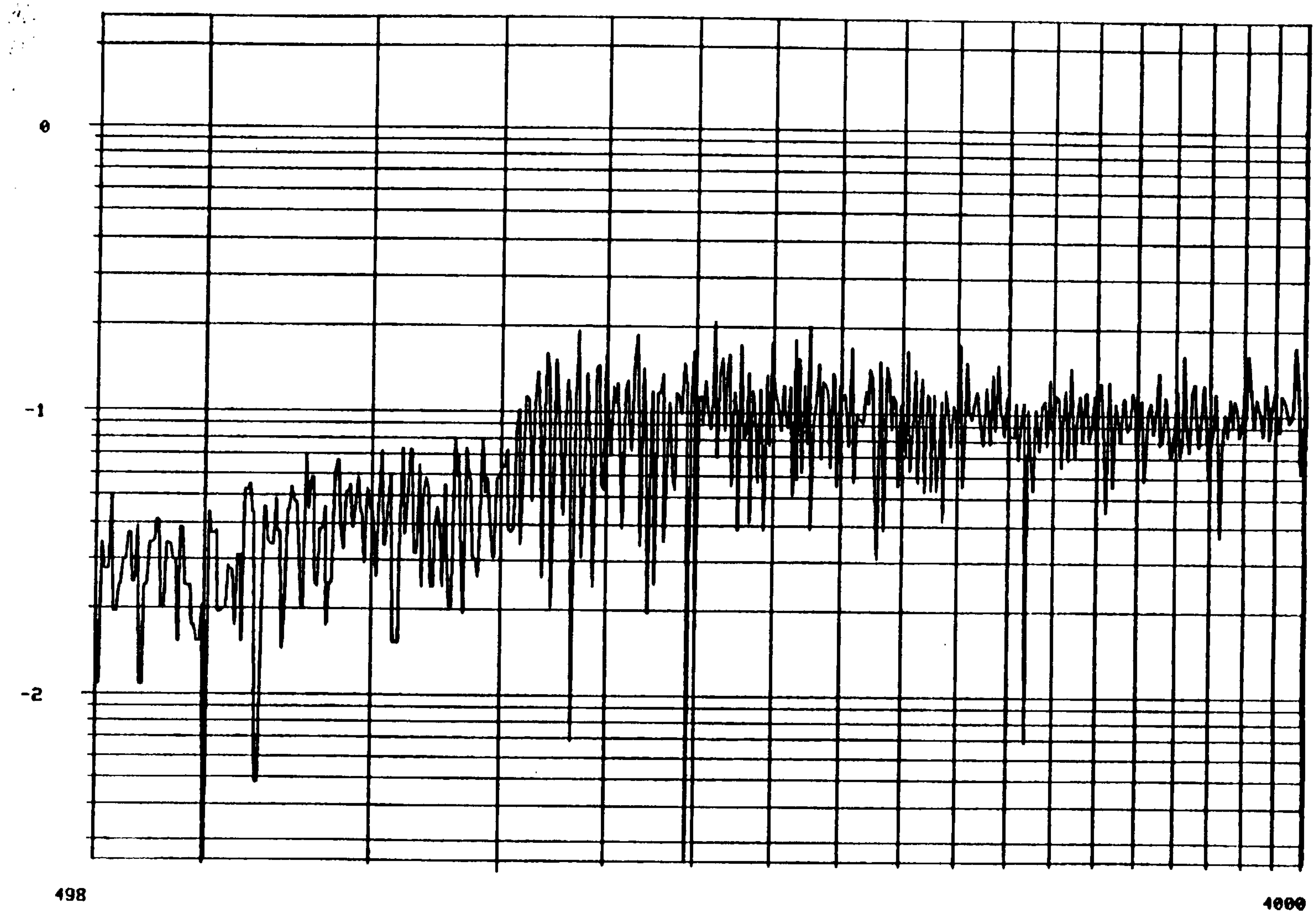
R1 TANG., LONG AXIS TEST
MEAS DATA: CH 3 : POST TEST
UNITS
SWEEP # 1 UP
10 N
0
-1
-2
-3
498
4000
10 -2 HZ LOG
BSM, V.D., S/N 1000734


R1 RAD., LONG AXIS TEST
MEAS DATA: CH 4 : POST TEST
UNITS
SWEEP # 1 UP
BSM, V.D., S/N 1000734
10 -2 HZ LOG
498
4000
10
0
-1
-2


P2 LONG., LONG AXIS TEST
MEAS DATA: CH 2 : POST TEST
UNITS
SWEEP # 1 UP
10 N
1
0
-1
498
10 -2 HZ LOG
4000
BSM, V.D., S/N 1000734

R2 TANG., LONG AXIS TEST
MEAS DATA: CH 3 : POST TEST
UNITS

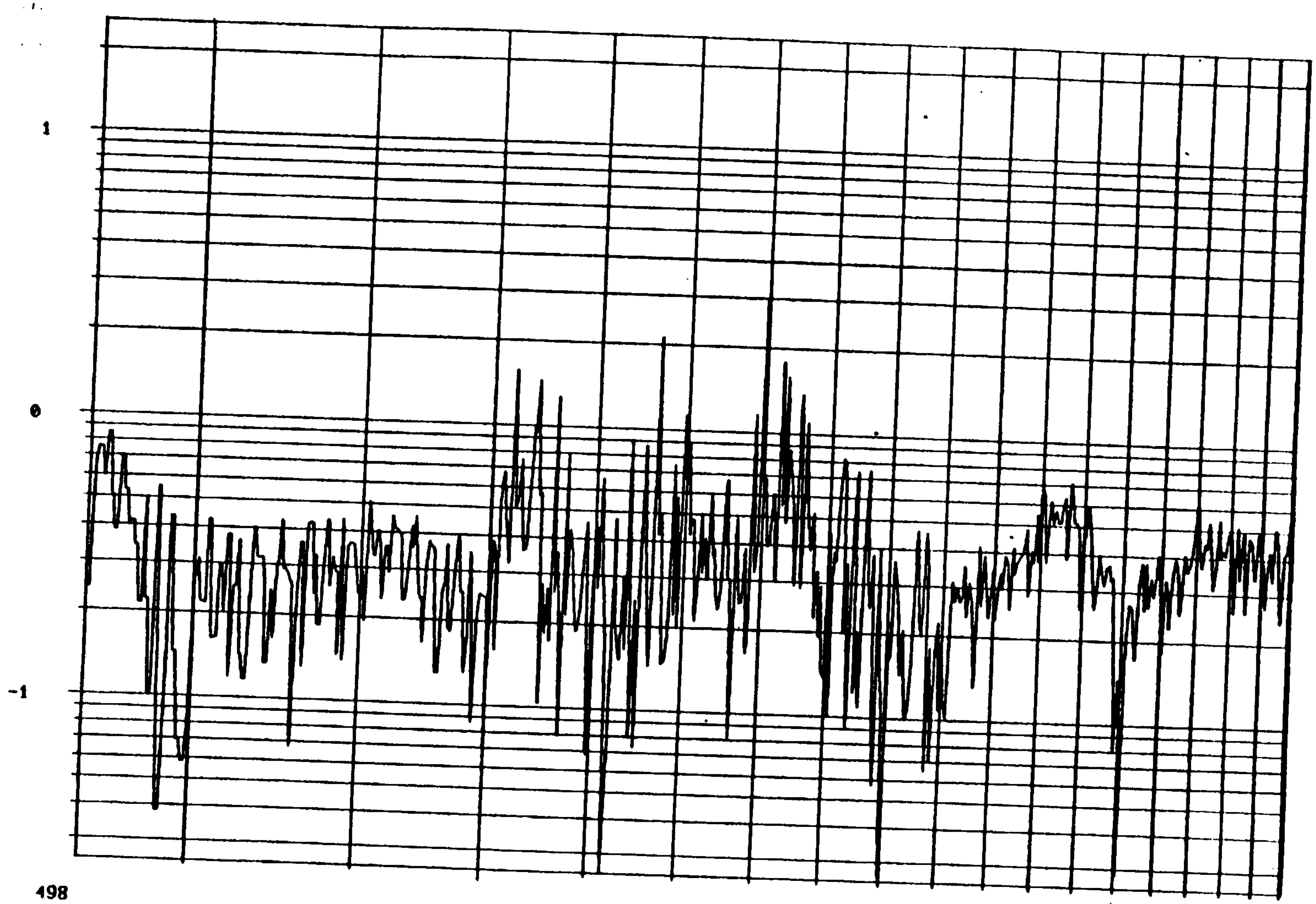
SWEEP # 1 UP



BSM, V.D., S/N 1000734

Pa RAD., LONG AXIS TEST
MEAS DATA: CH 4 : POST TEST
UNITS

SWEEP # 1 UP



SN 1000738

CHECK OFF LIST

SN 1000734

TEST OPERATIONS SET-UP

		AXIS RADIAL LONGITUDINAL TANGENTIAL
1.1	Verify proper calibration of instruments to be used.	✓ ✓ ✓
1.2	Verify proper calibration of accelerometers to be used.	✓ ✓ ✓
1.3	Install test article on shaker and verify test axis.	✓ ✓ ✓
1.4	Install accelerometer(s) on test article.	✓ ✓ ✓
1.5	Verify continuity from accelerometer(s) to charge amplifier output(s)	✓ ✓ ✓

Torque Values:

Test Fixture: 65 ft lbs

Test Article: PER BSM TEST PLAN

Shaker Used: UD T-4000

Adapters Used: MRAD 48" EXPANDER - 2" PLATE (90M110063-1)

SN 1000738

TEST OPERATIONS SET-UP

RAVIAL
LONGITUDINAL
AXIS TANGENTIAL

1.1	Verify proper calibration of instruments to be used.	✓ ✓ ✓
1.2	Verify proper calibration of accelerometers to be used.	✓ ✓ ✓
1.3	Install test article on shaker and verify test axis.	✓ ✓ ✓
1.4	Install accelerometer(s) on test article.	✓ ✓ ✓
1.5	Verify continuity from accelerometer(s) to charge amplifier output(s)	✓ ✓ ✓

Torque Values:

Test Fixture: 65 ft lbs

Test Article: PER DMS, TEST PLAN

Shaker Used: UD T-4000

Adapters Used: MRAD-48" EXPANDER – 2" PLATE (90M10063-1)

LIFTOFF RANDOM SN 1000738

RANDOM CHECK-OUT

AXIS RADIAL

.1 Verify test program and record RMS abort limit below. ✓

RMS abort limit 1 dB

.2 Perform levels as defined below and verify with plot. ✓

.3 Record the following:

Amplifier Gain 60%

Charge Amp. F.S. 30 G

		20 Hz @	.017	G^2/Hz,	limits	+3, -1.5 db
55	Hz -	200 Hz @	.077	"	limits	"
280	Hz -	1200 Hz @	.022	"	limits	"
	Hz -	2000 Hz @	.010	"	limits	"
	Hz -	Hz @			limits	
	Hz -	Hz @			limits	
	Hz -	Hz @			limits	
	Hz -	Hz @			limits	
	Hz -	Hz @			limits	

Composite = 6.9 Grms

Test Time = 60 Sec.

Test Level Concurrence: ______________________ ____________
Component Assessment Branch Date

BOOST RANDOM SN 1000738

RANDOM CHECK-OUT

AXIS RADIAL

1.1 Verify test program and record RMS abort limit below. ✓

RMS abort limit 1 dB

1.2 Perform levels as defined below and verify with plot. ✓

1.3 Record the following:

Amplifier Gain 75 %

Charge Amp. F.S. 100 G

		Hz @		G^2/Hz,	limits	3, 1.5 db
20 Hz -	200	Hz @	.54	"	limits	"
350 Hz -	1000	Hz @	.06	"	limits	"
Hz -	2000	Hz @	.015	"	limits	"
Hz -		Hz @			limits	
Hz -		Hz @			limits	
Hz -		Hz @			limits	
Hz -		Hz @			limits	
Hz -		Hz @			limits	

Composite = 14 Grms

Test Time = 120 sec.

Test Level Concurrence: ______________________ ________
Component Assessment Branch Date

SN 1000738

EHICLE DYNAMICS CHECK-OUT

AXIS Radial

1.1 Verify test program and record the abort level below. ✓

Abort Level 1db

1.2 Perform levels as defined below and verify with plot. ✓

1.3 Record the following:

Amplifier Gain 40%

Charge Amp. F.S. 10 G

5	-	10	Hz at	.07G	, limit	±1.5	dB
10	-	40	Hz at	3.7 G	, limit	±1.5	dB
	-		Hz at		, limit		dB
	-		Hz at		, limit		dB
	-		Hz at		, limit		dB

Sweep Rate = 3 oct/min

Test level concurrence: ______________________ __________

Component Assessment Branch Date

LIFT OFF RANDOM 1000738

RANDOM CHECK-OUT

AXIS TANGENTIAL

1.1 Verify test program and record RMS abort limit below. ✓

RMS abort limit 1 dB

1.2 Perform levels as defined below and verify with plot. ✓

1.3 Record the following:

Amplifier Gain 70%

Charge Amp. F.S. 30 G

	20 Hz @	.016	G^2/Hz,	limits	+3,-1.5db
75 Hz -	1000 Hz @	.060	"	limits	"
Hz -	2000 Hz @	.030	"	limits	"
Hz -	Hz @			limits	
Hz -	Hz @			limits	
Hz -	Hz @			limits	
Hz -	Hz @			limits	
Hz -	Hz @			limits	
Hz -	Hz @			limits	

Composite = 10 Grms

Test Time = 60 sec.

Test Level Concurrence: ______________________ ________

Component Assessment Branch Date

BOOST RANDOM SN 1000778

RANDOM CHECK-OUT

AXIS TANGENTIAL

.1 Verify test program and record RMS abort limit below. ✓

RMS abort limit 1 dB

..2 Perform levels as defined below and verify with plot. ✓

..3 Record the following:

Amplifier Gain 80 %

Charge Amp. F.S. 100 G

			Hz @		G^2/Hz,	limits	+3, -1.5 db
20	Hz -	800	Hz @	.24	"	limits	"
	Hz -	2000	Hz @	.017		limits	"
	Hz -		Hz @			limits	
	Hz -		Hz @			limits	
	Hz -		Hz @			limits	
	Hz -		Hz @			limits	
	Hz -		Hz @			limits	
	Hz -		Hz @			limits	

Composite = 18.4 Grms

Test Time = 120 sec.

Test Level Concurrence: ____________________ ________

Component Assessment Branch Date

SN 1000738

VEHICLE DYNAMICS CHECK-OUT AXIS TANGENTIAL

1.1 Verify test program and record the abort level below. ✓

Abort Level 1 db

1.2 Perform levels as defined below and verify with plot. ✓

1.3 Record the following:

Amplifier Gain 40 70

Charge Amp. F.S. 10 G

5	-	10	Hz at	.7	, limit	±1.5	dB
10	-	40	Hz at	4.3	, limit		dB
	-		Hz at		, limit		dB
	-		Hz at		, limit		dB
	-		Hz at		, limit		dB

Sweep Rate = 3 oct/min

Test level concurrence: ____________________ ________

Component Assessment Branch Date

LIFTOFF RANDOM SN 1000738

RANDOM CHECK-OUT

AXIS LONGITUDINA

1.1 Verify test program and record RMS abort limit below. ✓

RMS abort limit 1 dB

1.2 Perform levels as defined below and verify with plot. ✓

1.3 Record the following:

Amplifier Gain 70%

Charge Amp. F.S. 30G

		20 Hz @	.016	G^2/Hz,	limits	+3, -1.5 dB
75 Hz -		1000 Hz @	.06		limits	"
Hz -		2000 Hz @	.03		limits	"
Hz -		Hz @			limits	
Hz -		Hz @			limits	
Hz -		Hz @			limits	
Hz -		Hz @			limits	
Hz -		Hz @			limits	
Hz -		Hz @			limits	

Composite = 10 Grms

Test Time = 60 Sec.

Test Level Concurrence: ______________________ ____________
Component Assessment Branch Date

B22-T RANDOM SN 1000738

RANDOM CHECK-OUT

AXIS LONGITUDINAL

1.1 Verify test program and record RMS abort limit below. ✓

RMS abort limit 1 dB

1.2 Perform levels as defined below and verify with plot. ✓

1.3 Record the following:

Amplifier Gain 85

Charge Amp. F.S. 100

		Hz @		G^2/Hz,	limits +3,-1.5 db
20 Hz -	800	Hz @	.24		limits "
Hz -	2000	Hz @	.017		limits "
Hz -		Hz @			limits
Hz -		Hz @			limits
Hz -		Hz @			limits
Hz -		Hz @			limits
Hz -		Hz @			limits
Hz -		Hz @			limits

Composite = 18.4 Grms

Test Time = 120 Sec.

Test Level Concurrence: ______________________ ______________

Component Assessment Branch Date

SN 1000734 + 1000738

VEHICLE DYNAMICS CHECK-OUT AXIS LONGITUDIN.

1.1 Verify test program and record the abort level below. ✓

Abort Level = 1db

1.2 Perform levels as defined below and verify with plot. ✓

1.3 Record the following:

Amplifier Gain 4070

Charge Amp. F.S. 10 G

5	-	10	Hz at	.7	, limit	+-1.5	dB
10	-	40	Hz at	4.3	, limit	"	dB
	-		Hz at		, limit		dB
	-		Hz at		, limit		dB
	-		Hz at		, limit		dB

Sweep Rate = 3 oct/min

Test level concurrence: ______________________ __________

Component Assessment Branch Date

SN 1000738

RANDOM TEST LIFT OFF

		AXIS	RADIAL / LONGITUDINAL / TANGENTIAL
.1	Record a minimum of 30 seconds of calibration signal on tape recorder.		✓ ✓ ✓
.2	Set full scale ranges on instrumentation amplifiers and note on data sheet.		✓ ✓ ✓
..3	Set power amplifier gain to position noted during random test check-out.		✓ ✓ ✓
1.4	Perform self check of control system.		✓ ✓ ✓
1.5	Begin test sequence at - 9 dB from full level.		✓ ✓ ✓
1.6	At - 6 dB, start tape recorder.		✓ ✓ ✓
1.7	Note time when full level is reached. SEE TAPE LOG		✓ ✓ ✓
1.8	At the completion of the test, set power amplifier gain to off.		✓ ✓ ✓
1.9	Stop tape recorder.		✓ ✓ ✓
1.10	Inspect test article for damage or degradation.		✓ ✓ ✓
1.11	Remove test article from shaker.		✓ ✓ ✓

SN 1000738

RANDOM TEST Boost

AXIS RADIAL TANGENTIAL LONGITUDINAL

.1	Record a minimum of 30 seconds of calibration signal on tape recorder.	✓ ✓ ✓
.2	Set full scale ranges on instrumentation amplifiers and note on data sheet.	✓ ✓ ✓
.3	Set power amplifier gain to position noted during random test check-out.	✓ ✓ ✓
.4	Perform self check of control system.	✓ ✓ ✓
.5	Begin test sequence at - 9 dB from full level.	✓ ✓ ✓
.6	At - 6 dB, start tape recorder.	✓ ✓ ✓
.7	Note time when full level is reached. See TAPE LOG	✓ ✓ ✓
.8	At the completion of the test, set power amplifier gain to off.	✓ ✓ ✓
1.9	Stop tape recorder.	✓ ✓ ✓
1.10	Inspect test article for damage or degradation.	✓ ✓ ✓
1.11	Remove test article from shaker.	✓ ✓ ✓

SN 1000738

VEHICLE DYNAMICS TEST

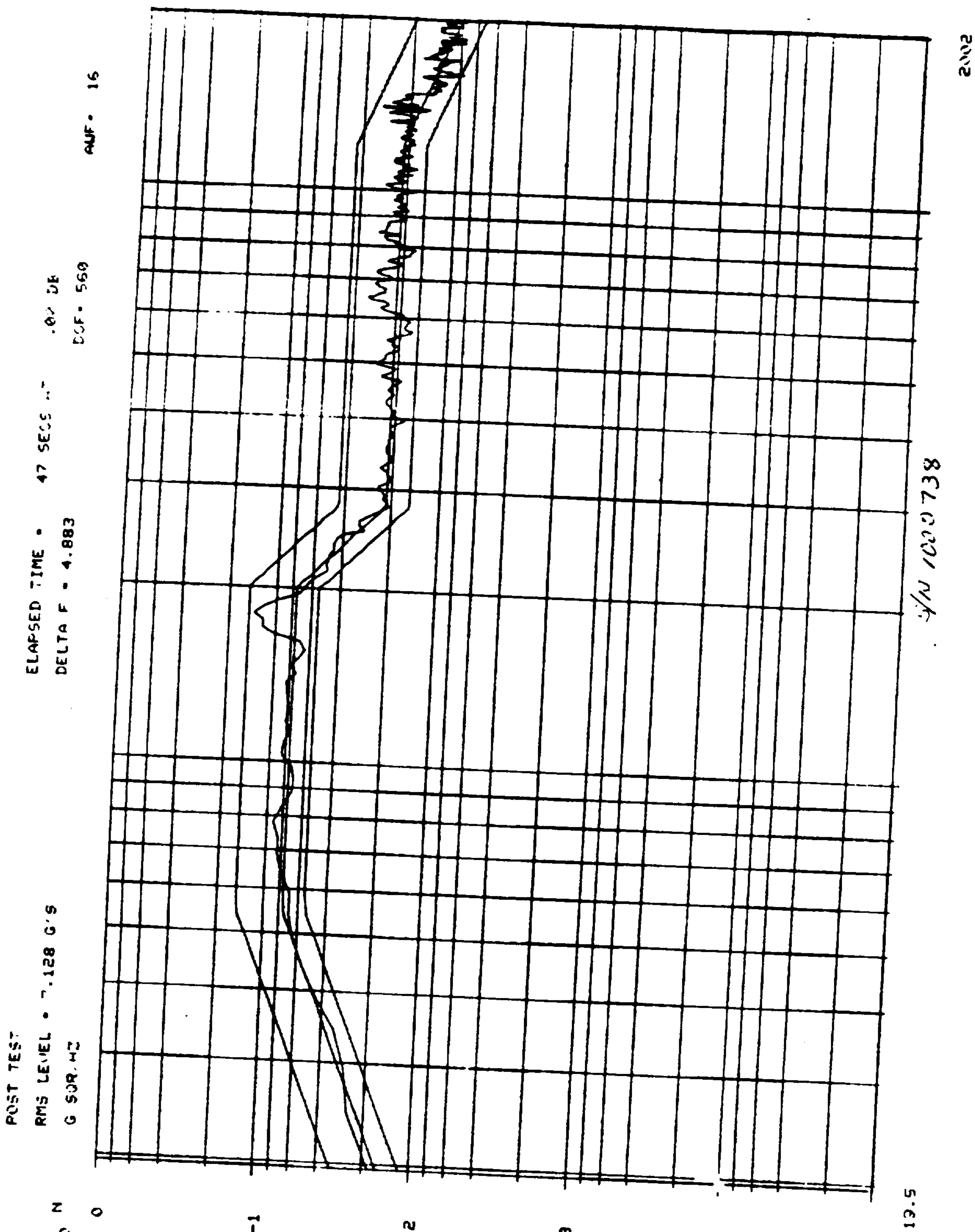
		AXIS	RADIAL TANGENT
1.1	Record a minimum of 30 seconds of calibration signal on tape recorder.		✓ ✓ ✓
1.2	Set full scale ranges on instrumentation amplifiers and note on data sheet.		✓ ✓ ✓
1.3	Set power amplifier gain to position noted during sine test check-out.		✓ ✓ ✓
1.4	Perform self check of control system.		✓ ✓ ✓
1.5	Start tape recorder.		✓ ✓ ✓
1.6	Begin sine sweep.		✓ ✓ ✓
1.7	Note time of DCS "SWEEP UP" or "SWEEP DOWN" indication light. SEE TAPE LOG		✓ ✓ ✓
1.8	During first sweep, press the "SAVE" button on DCS.		✓ ✓ ✓
1.9	If more than one sweep, note time of DCS "SWEEP UP" or "SWEEP DOWN" indication light. —		—
1.10	At the completion of the sweep, set power amplifier gain to off.		✓ ✓ ✓
1.11	Stop tape recorder.		✓ ✓ ✓
1.12	Inspect test article for damage or degradation.		✓ ✓ ✓

SN 1000738

TEST DATA

RADIAL AXIS

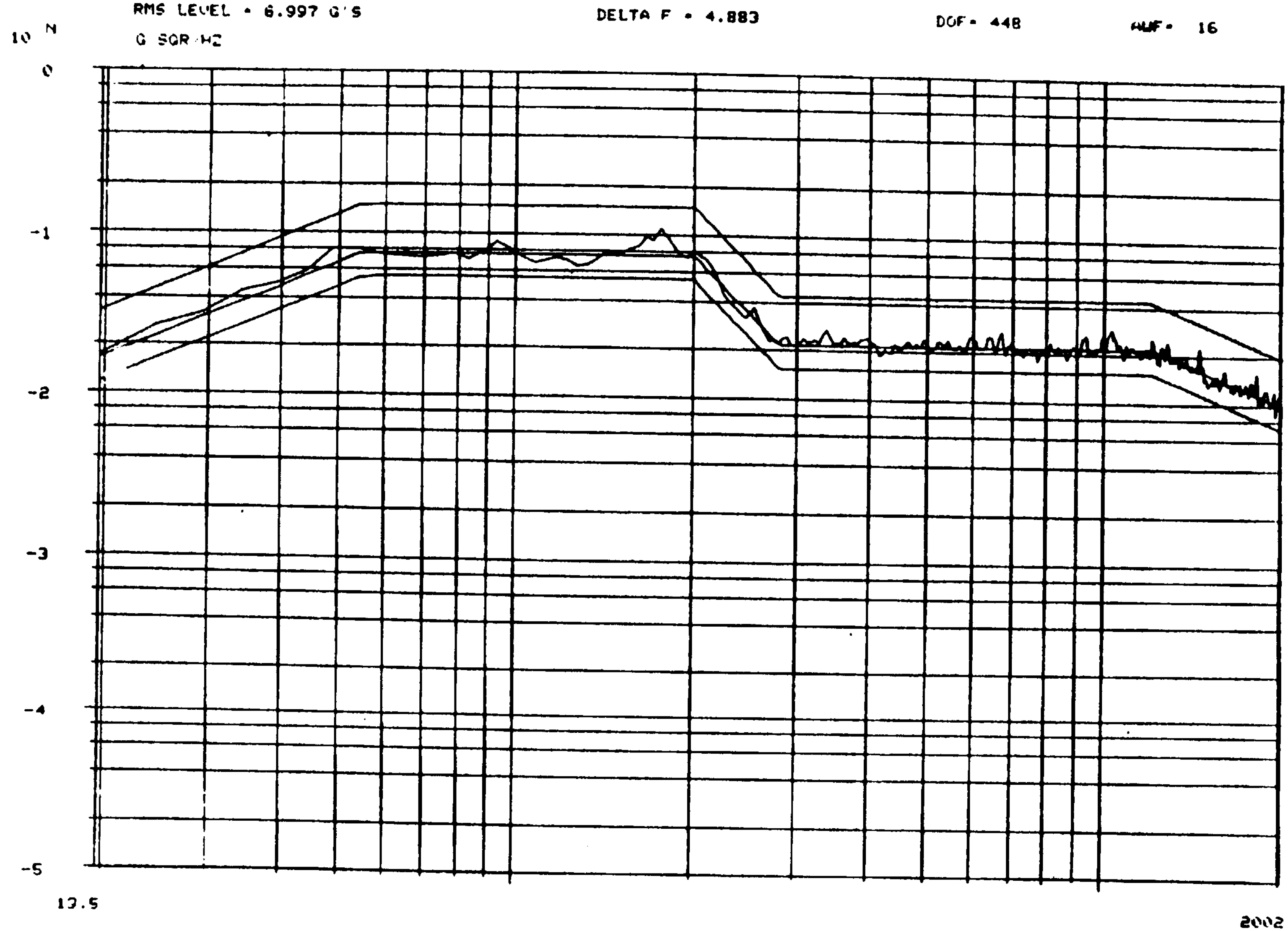
RANDOM, LIFT-OFF



POST TEST
G SQR/HZ
ELAPSED TIME = 47 SECS
DELTA F = 4.883
DOF = 560

POST TEST
RMS LEVEL = 6.997 G'S
G SQR/HZ

ELAPSED TIME = 12 SECS AT .02 DB
DELTA F = 4.883
DOF = 448
AVF = 16



POST TEST

RMS LEVEL = 6.981 G'S

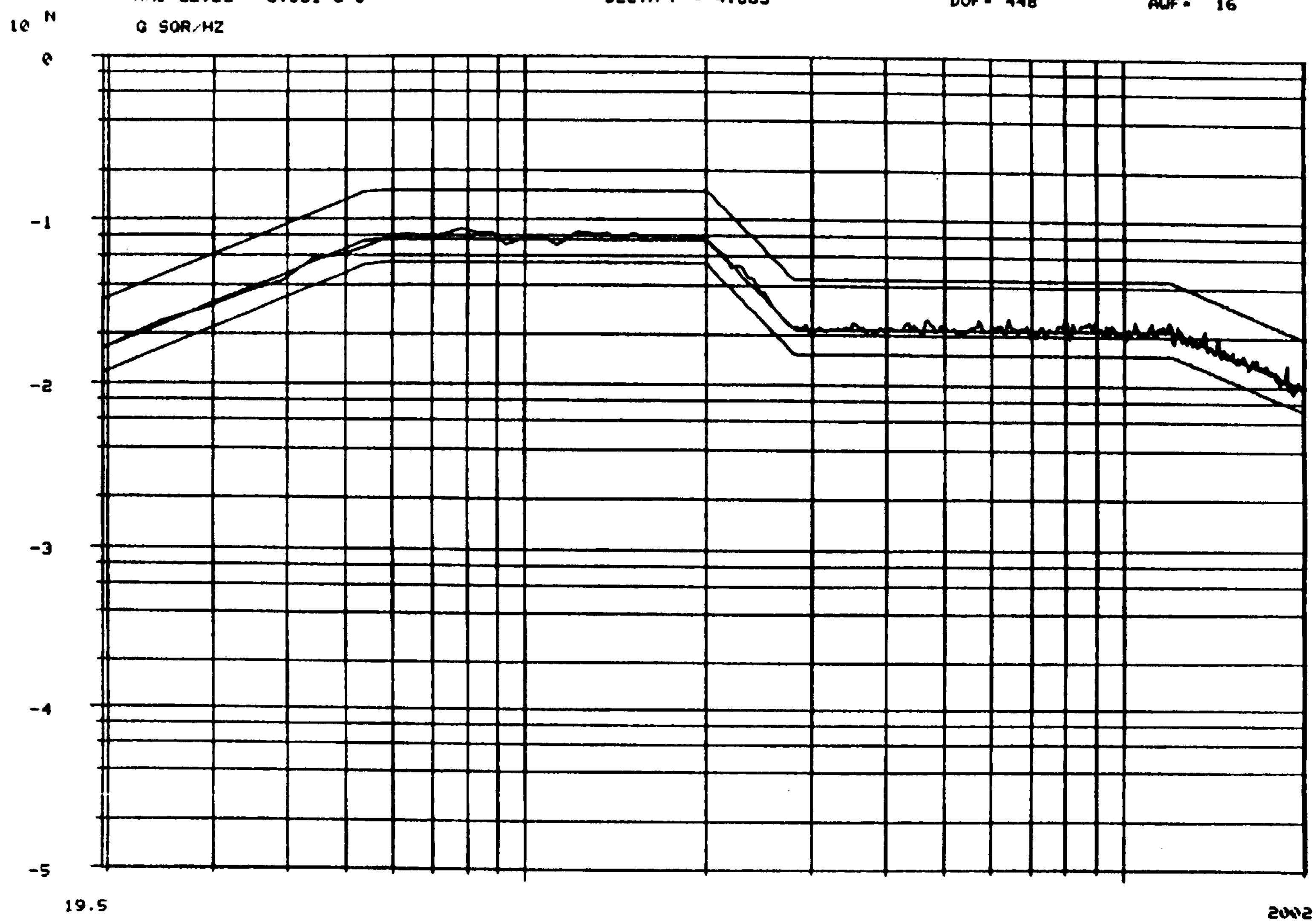
G SQR/HZ

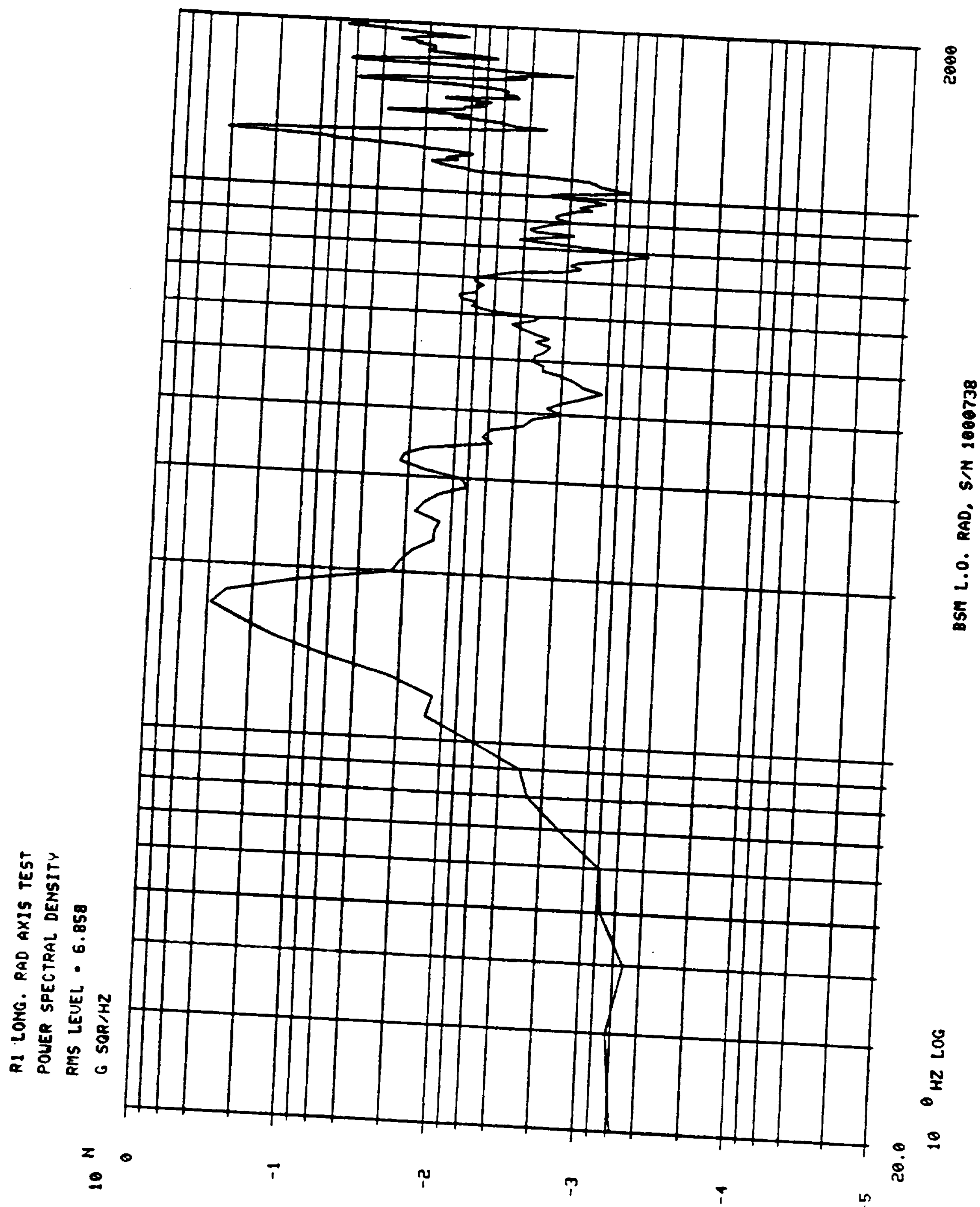
ELAPSED TIME = 3 SECS AT .00 DB

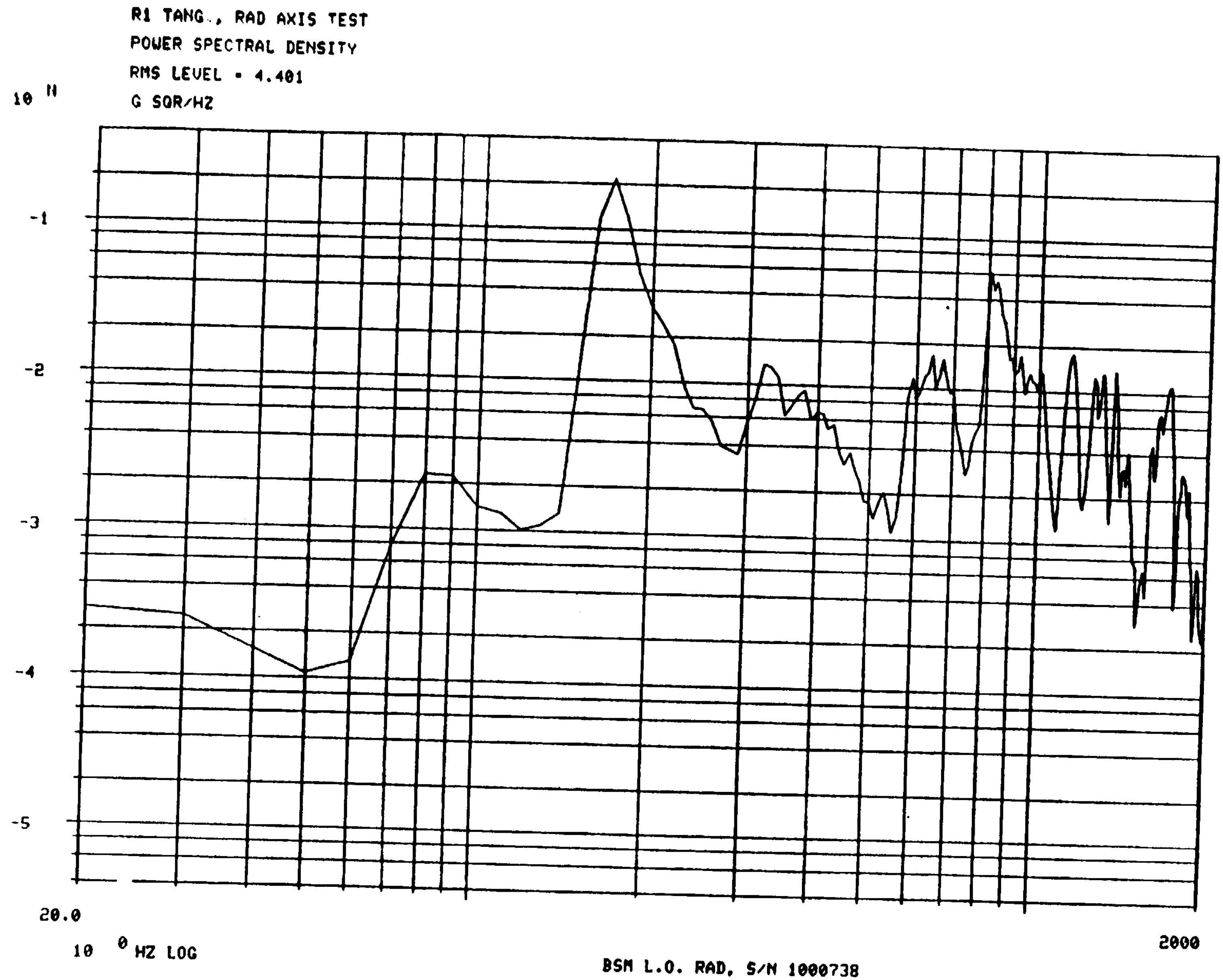
DELTA F = 4.883

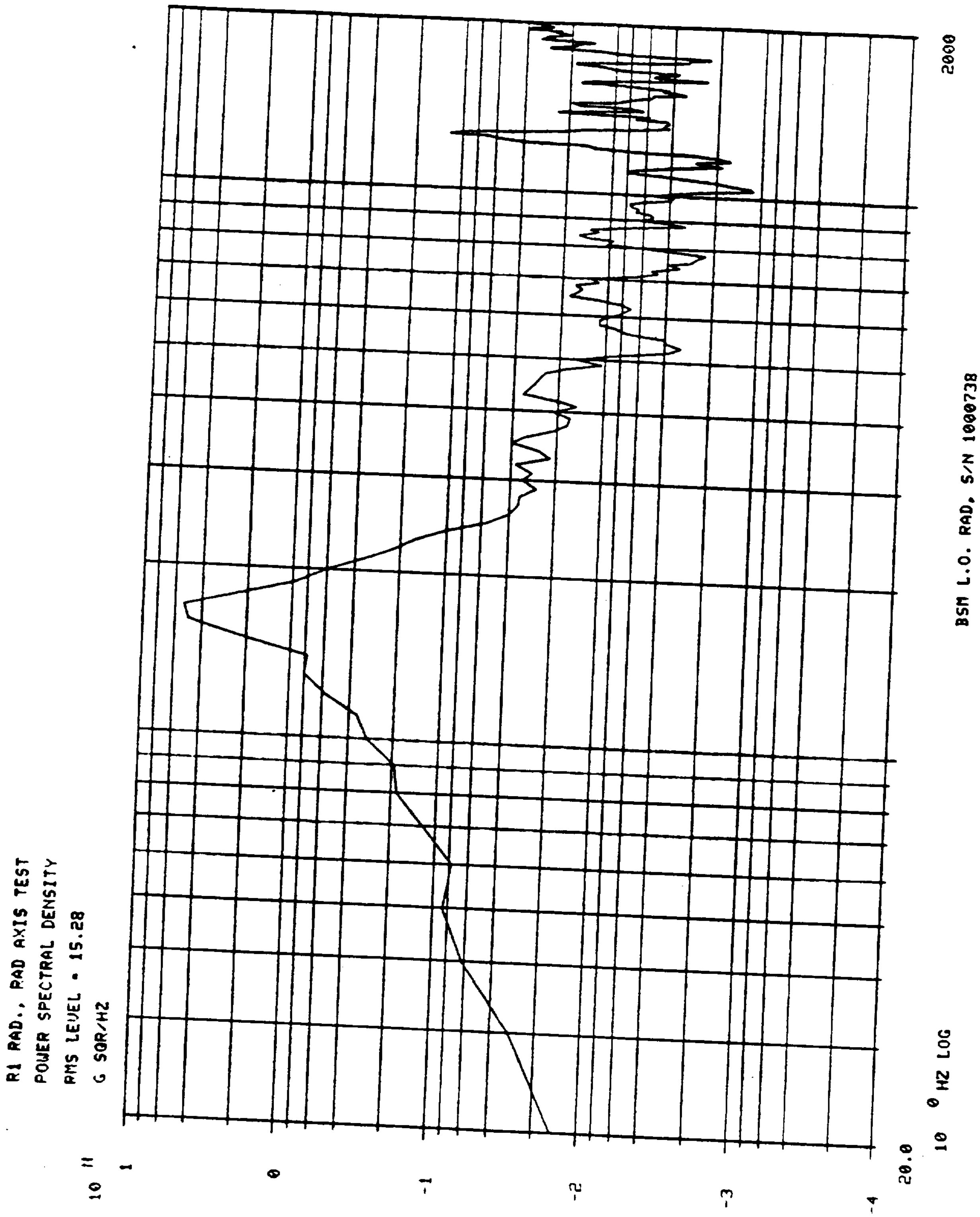
DOF= 448

AWF= 16

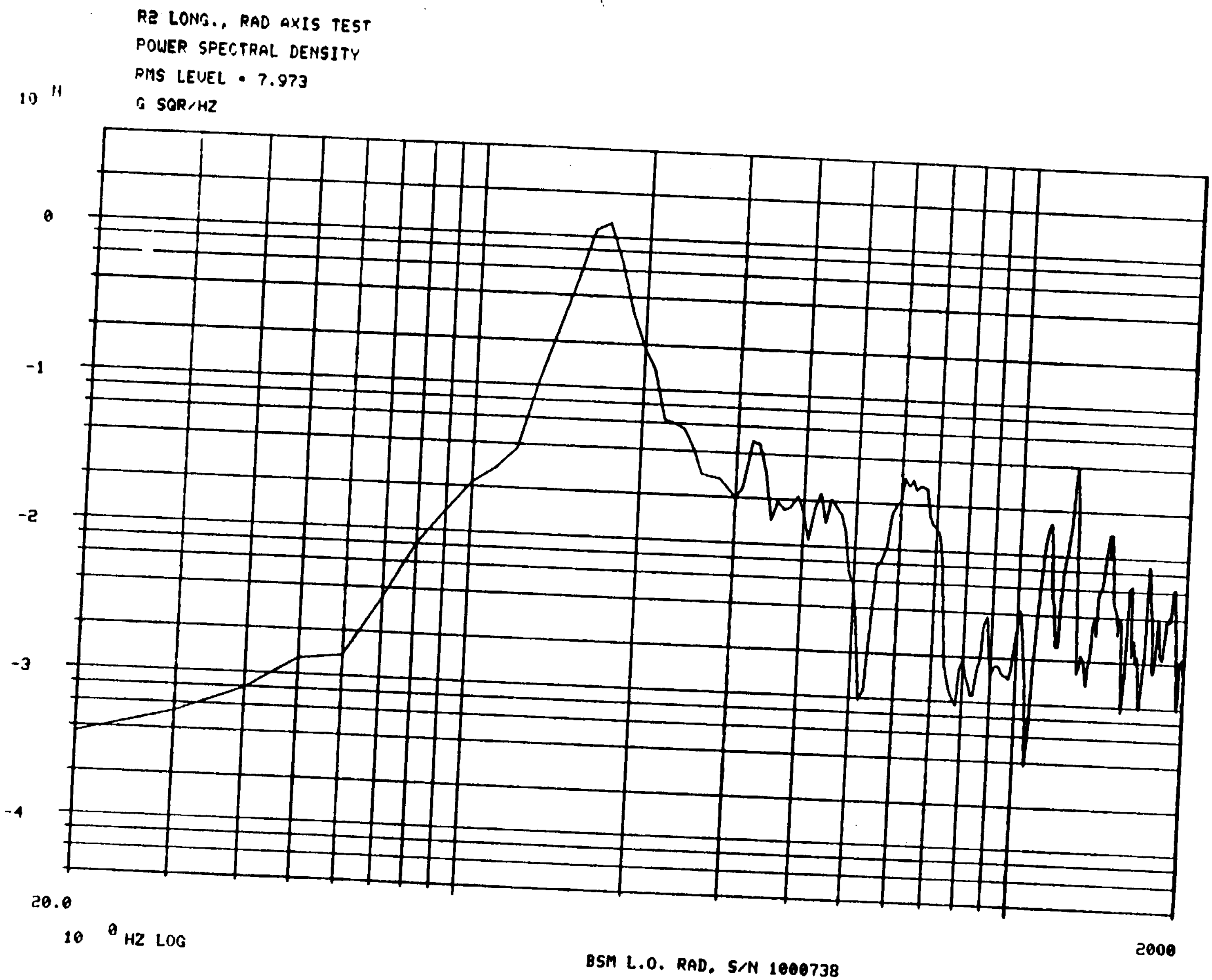


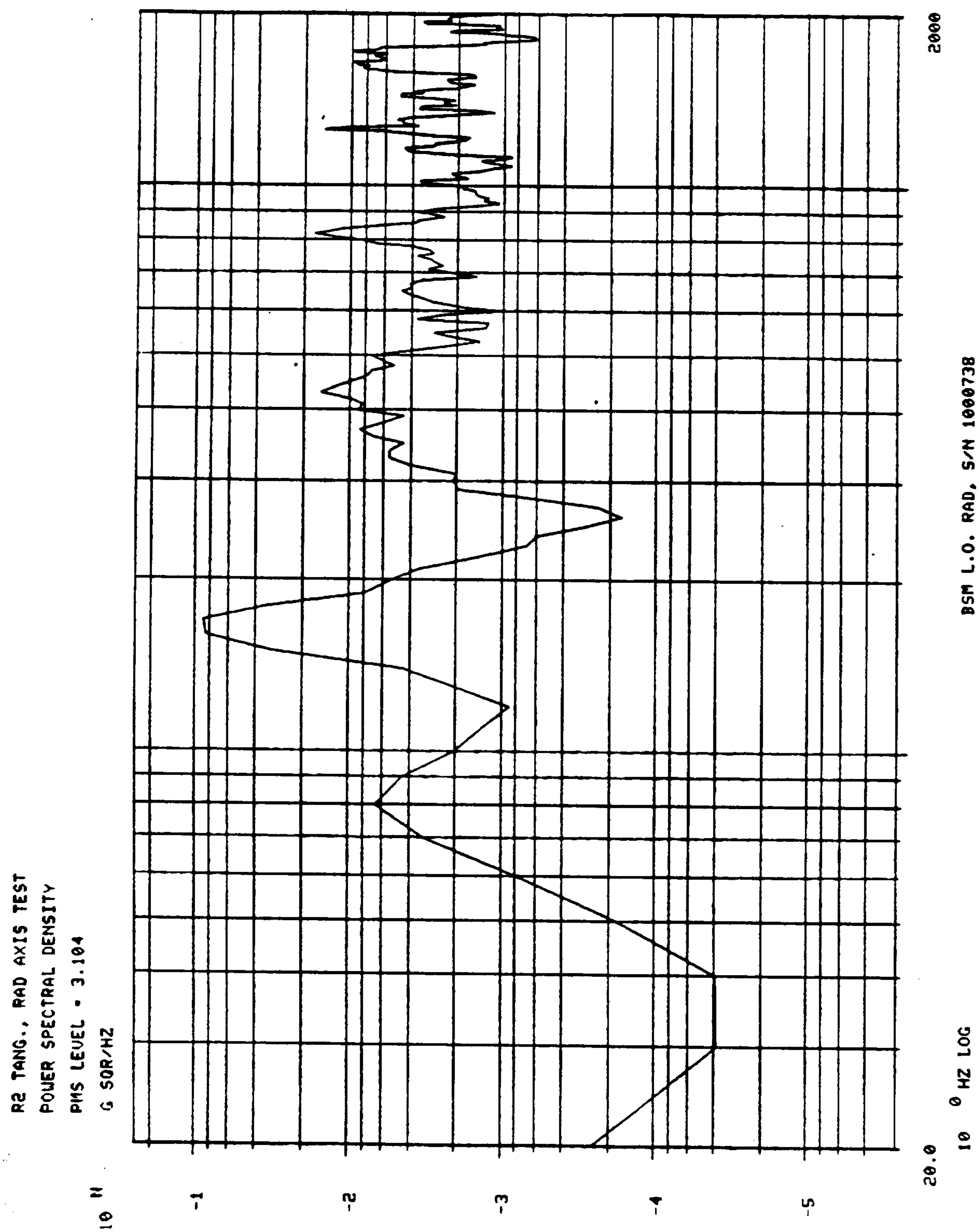

R1 LONG. RAD AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL = 6.858
G SQR/HZ
10 N
0
-1
-2
-3
-4
-5
20.0
10 0 HZ LOG
2000
BSM L.O. RAD, S/N 1000738

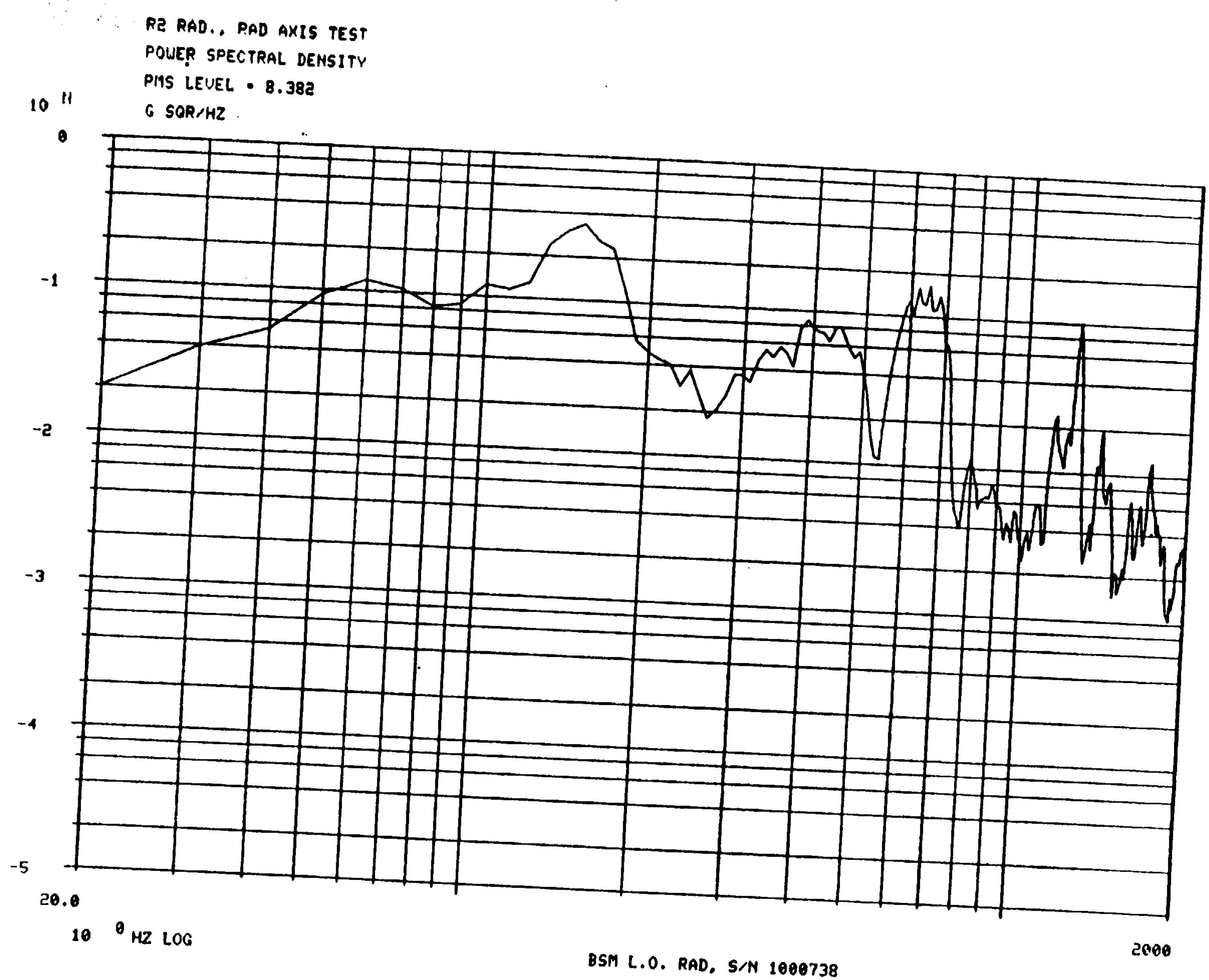

R1 TANG., RAD AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL = 4.401
G SQR/HZ
10 N
-1
-2
-3
-4
-5
20.0
10 0 HZ LOG
2000
BSM L.O. RAD, S/N 1000738



R1 RAD., RAD AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL = 15.28
G SQR/HZ
10 **
1
0
-1
-2
-3
-4
20.0
10 0 HZ LOG
2000
BSM L.O. RAD, S/N 1000738


R2 LONG., RAD AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL • 7.973
G SQR/HZ
10 N
0
-1
-2
-3
-4
20.0
10 0 HZ LOG
2000
BSM L.O. RAD, S/N 1000738

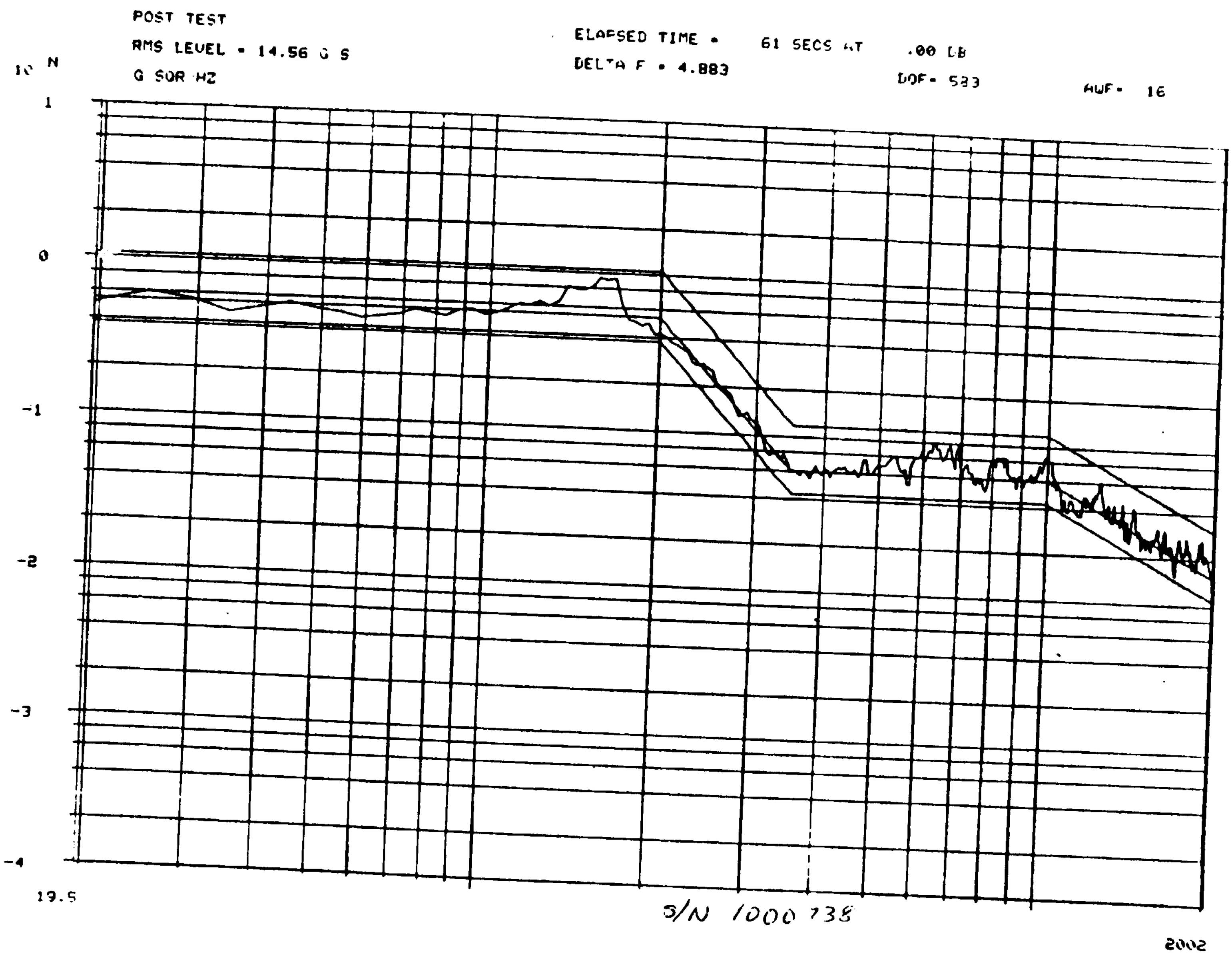

R2 TANG., RAD AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL = 3.104
G SQR/HZ
10 N
-1
-2
-3
-4
-5
20.0
10 0 HZ LOG
2000
BSM L.O. RAD, S/N 1000738



R2 RAD., RAD AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL = 8.382
G SQR/HZ
10 N
0
-1
-2
-3
-4
-5
20.0
10 0 HZ LOG
2000
BSM L.O. RAD, S/N 1000738

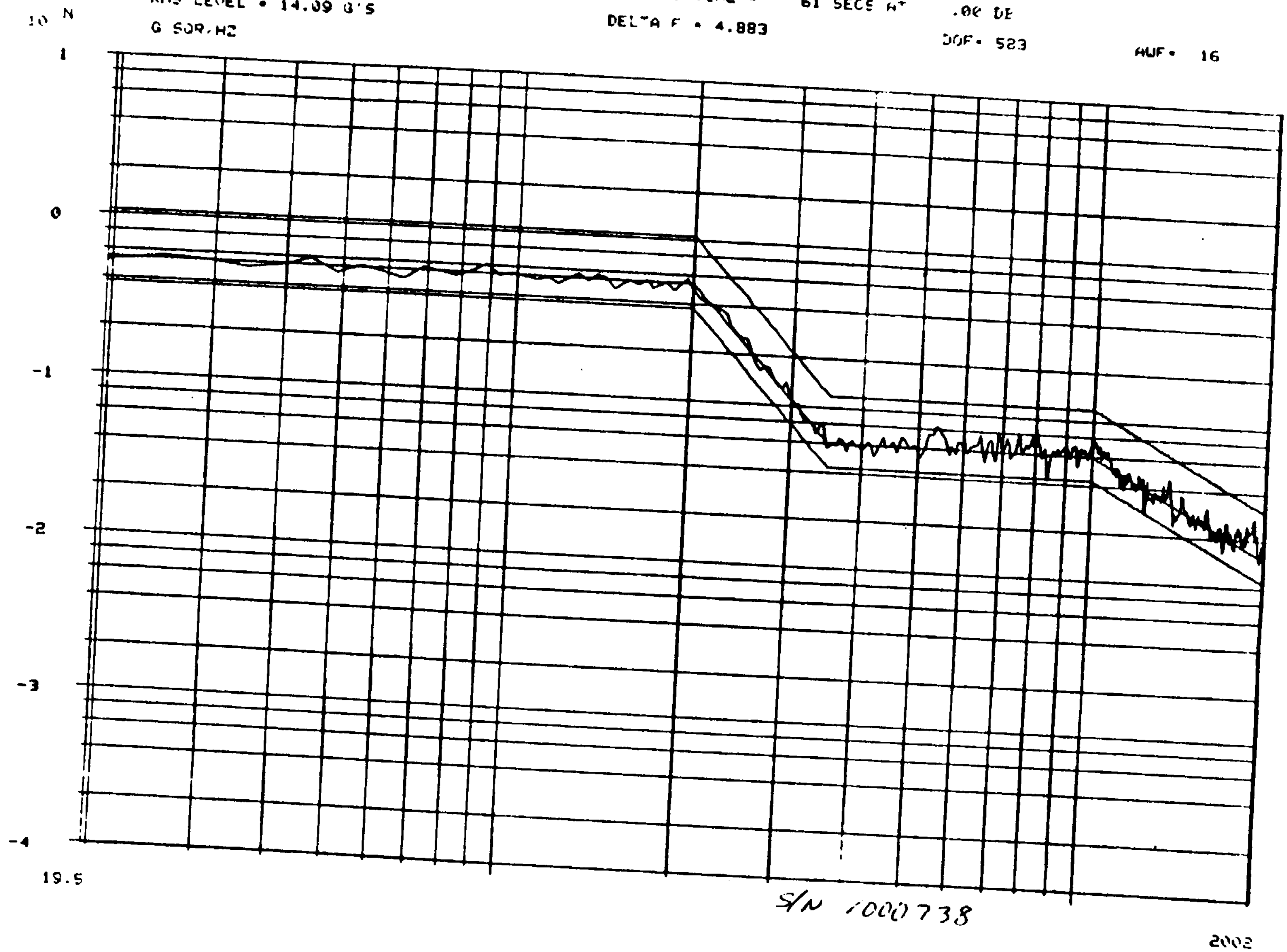
RADIAL AXIS

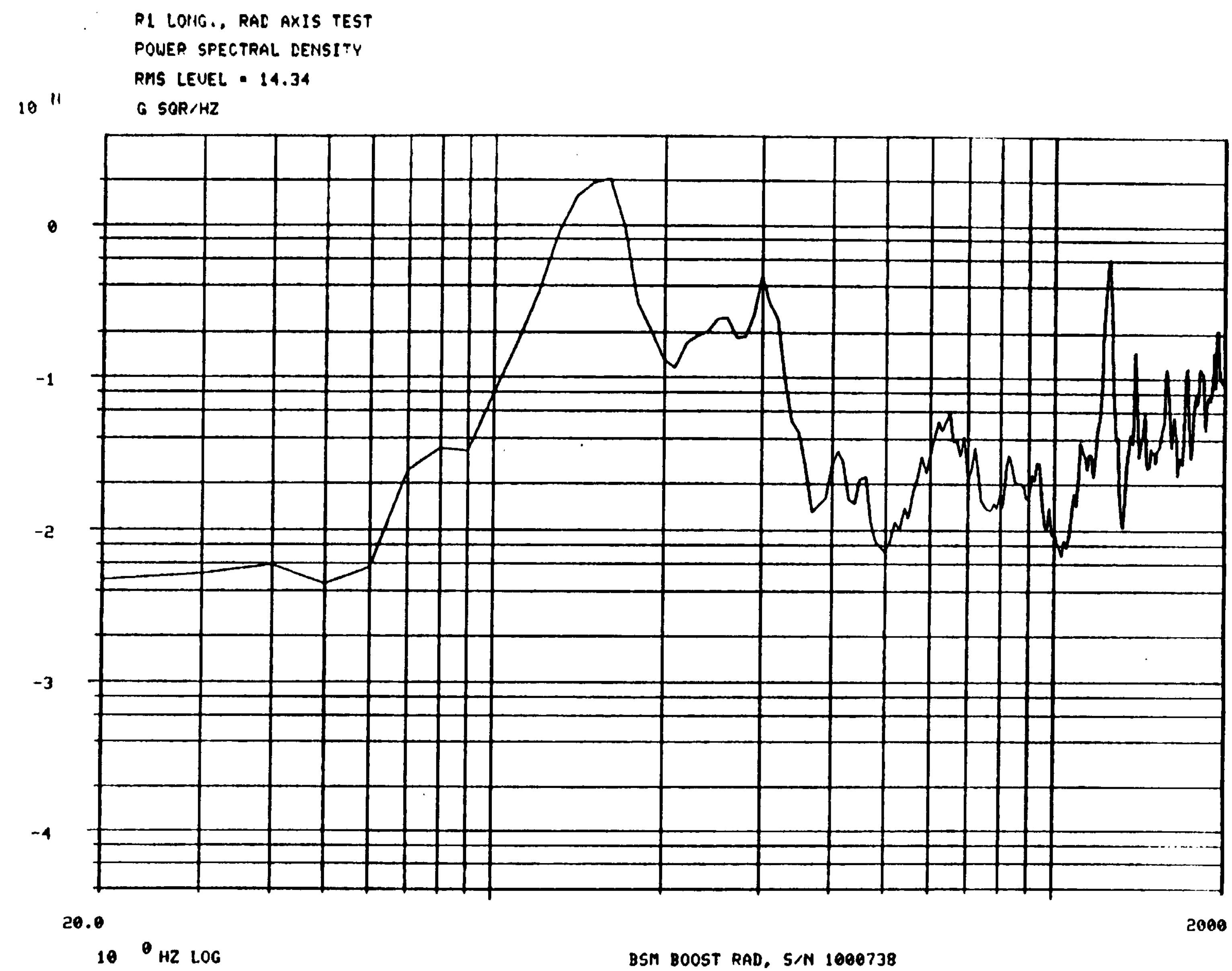
RANDOM, BOOST

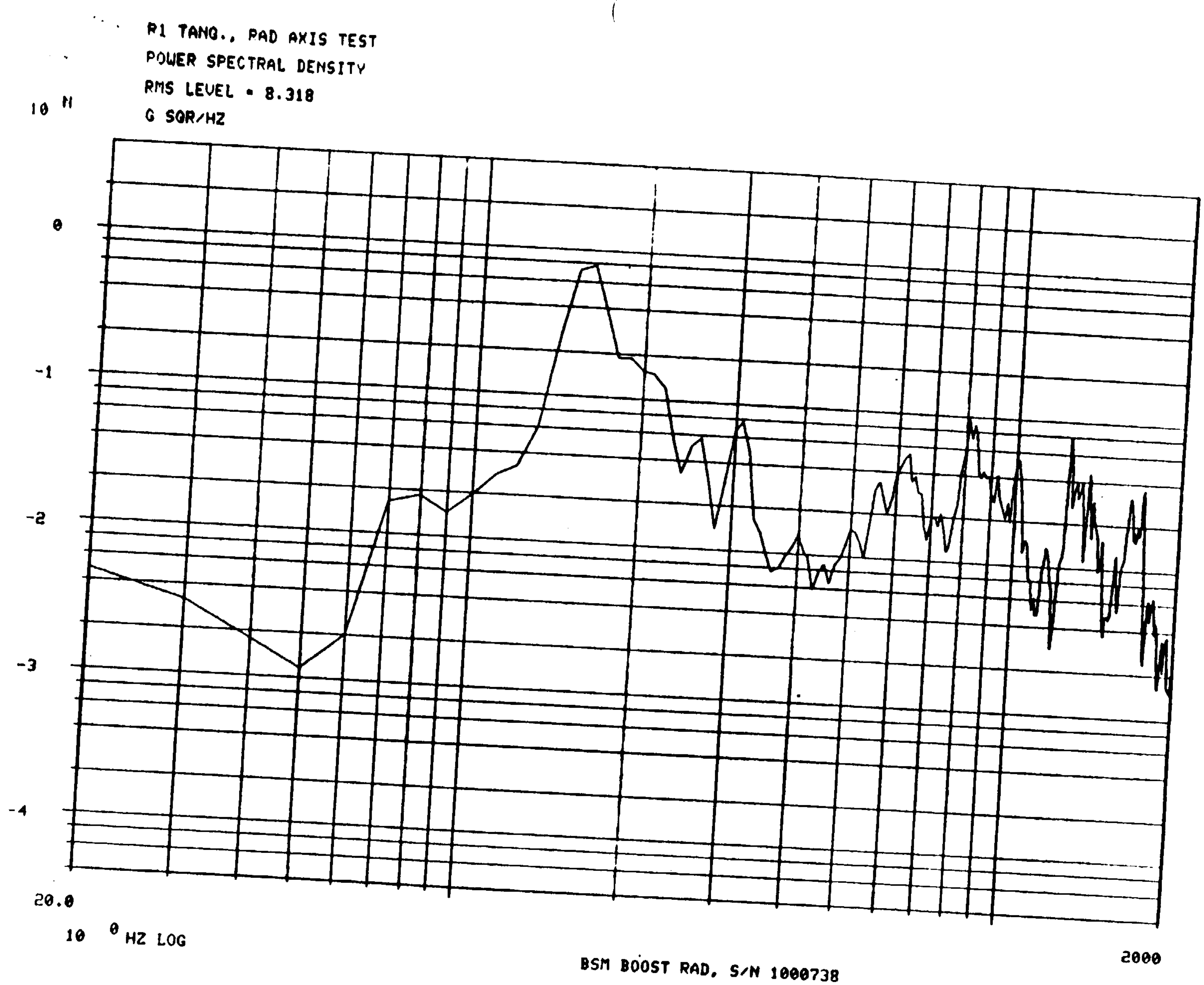

POST TEST
RMS LEVEL = 14.56 G S
G SQR HZ
ELAPSED TIME = 61 SECS AT .00 DB
DELTA F = 4.883
DOF= 583
AWF= 16
10 N
1
0
-1
-2
-3
-4
19.5
2002
S/N 1000 738

POST TEST
RMS LEVEL = 14.09 G'S
G SQR/HZ

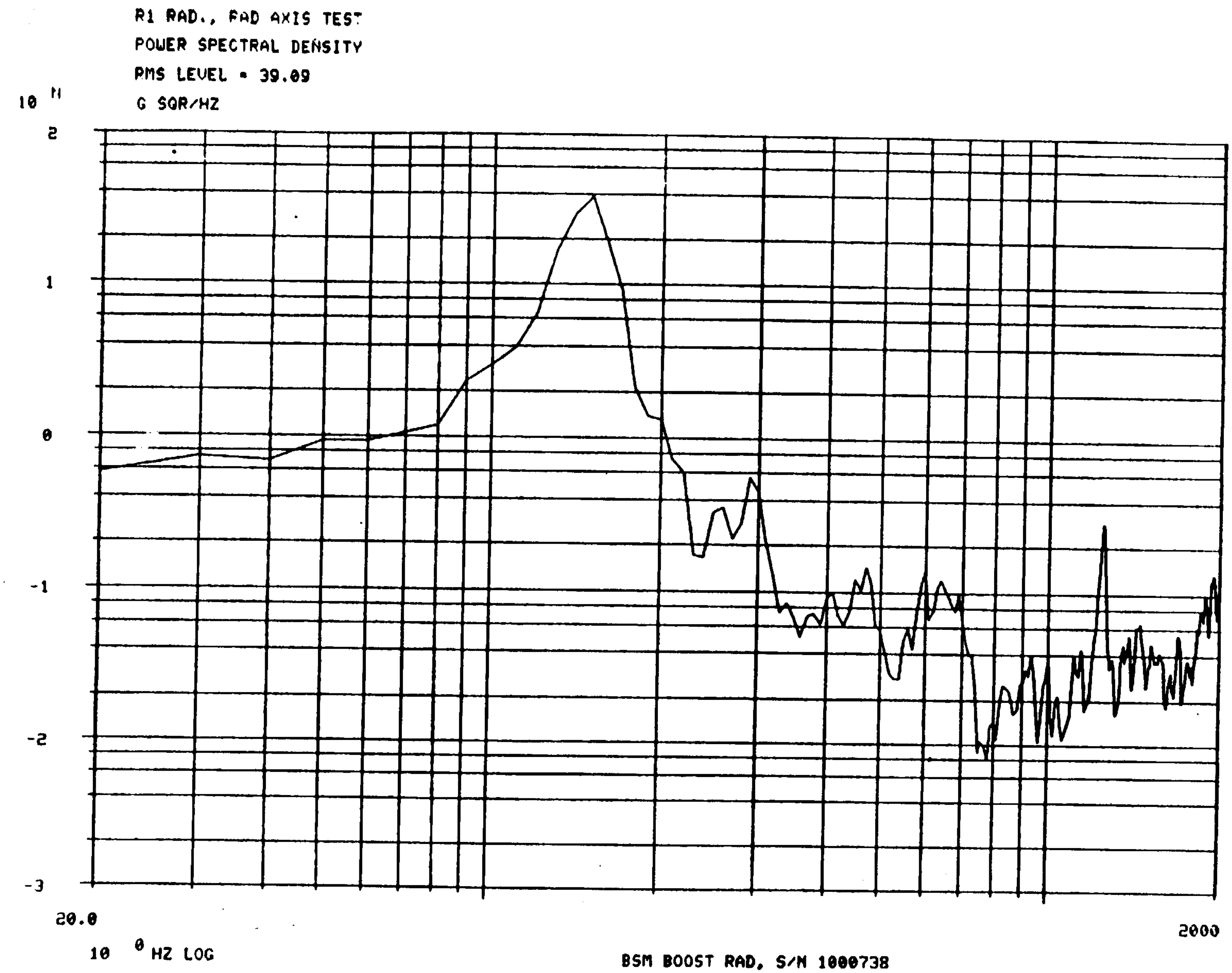
ELAPSED TIME = 61 SECS AT .00 DB
DELTA F = 4.883
DOF = 523
AVG = 16



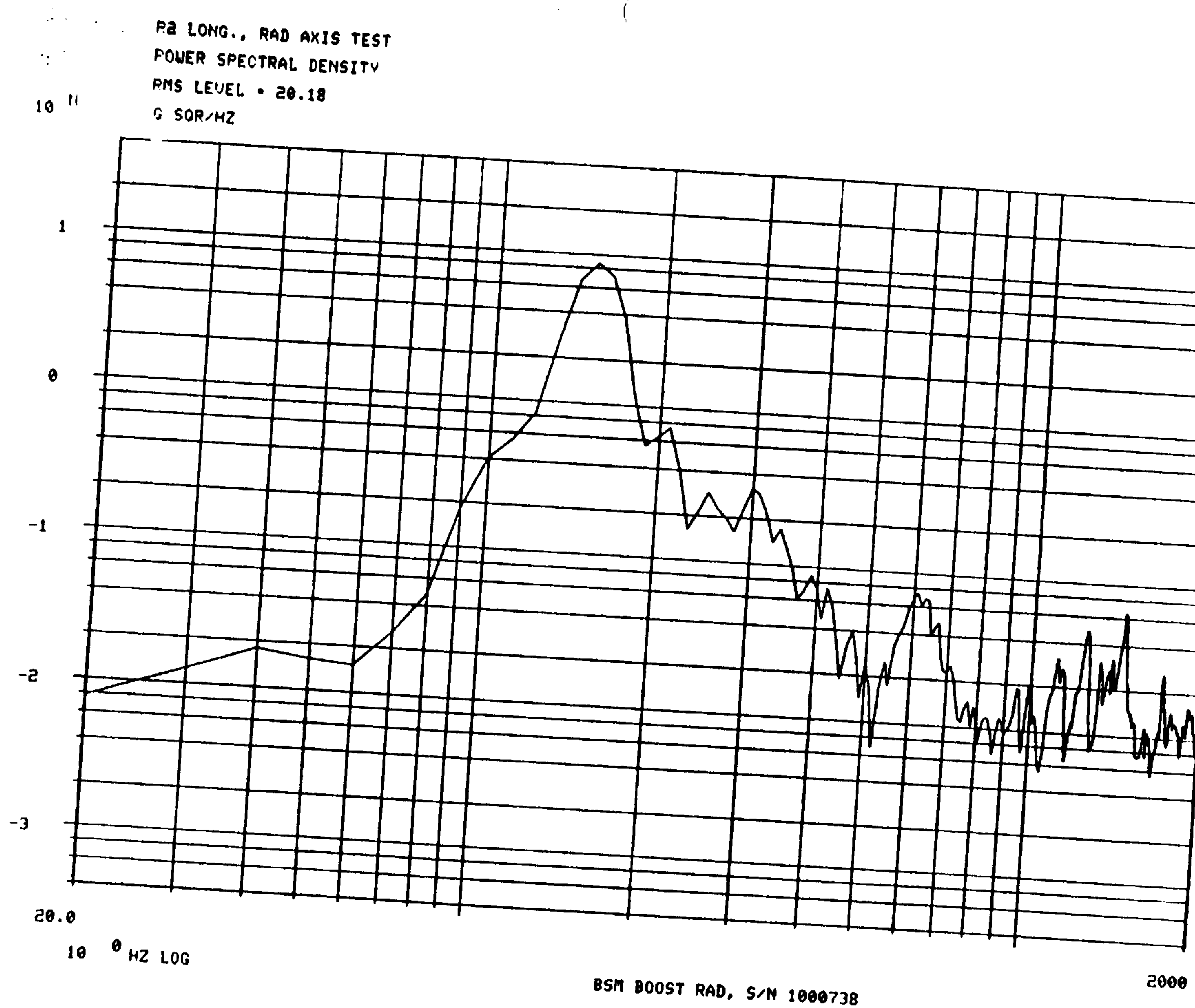

R1 LONG., RAD AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL = 14.34
G SQR/HZ
10
0
-1
-2
-3
-4
20.0
2000
10 0 HZ LOG
BSM BOOST RAD, S/N 1000738

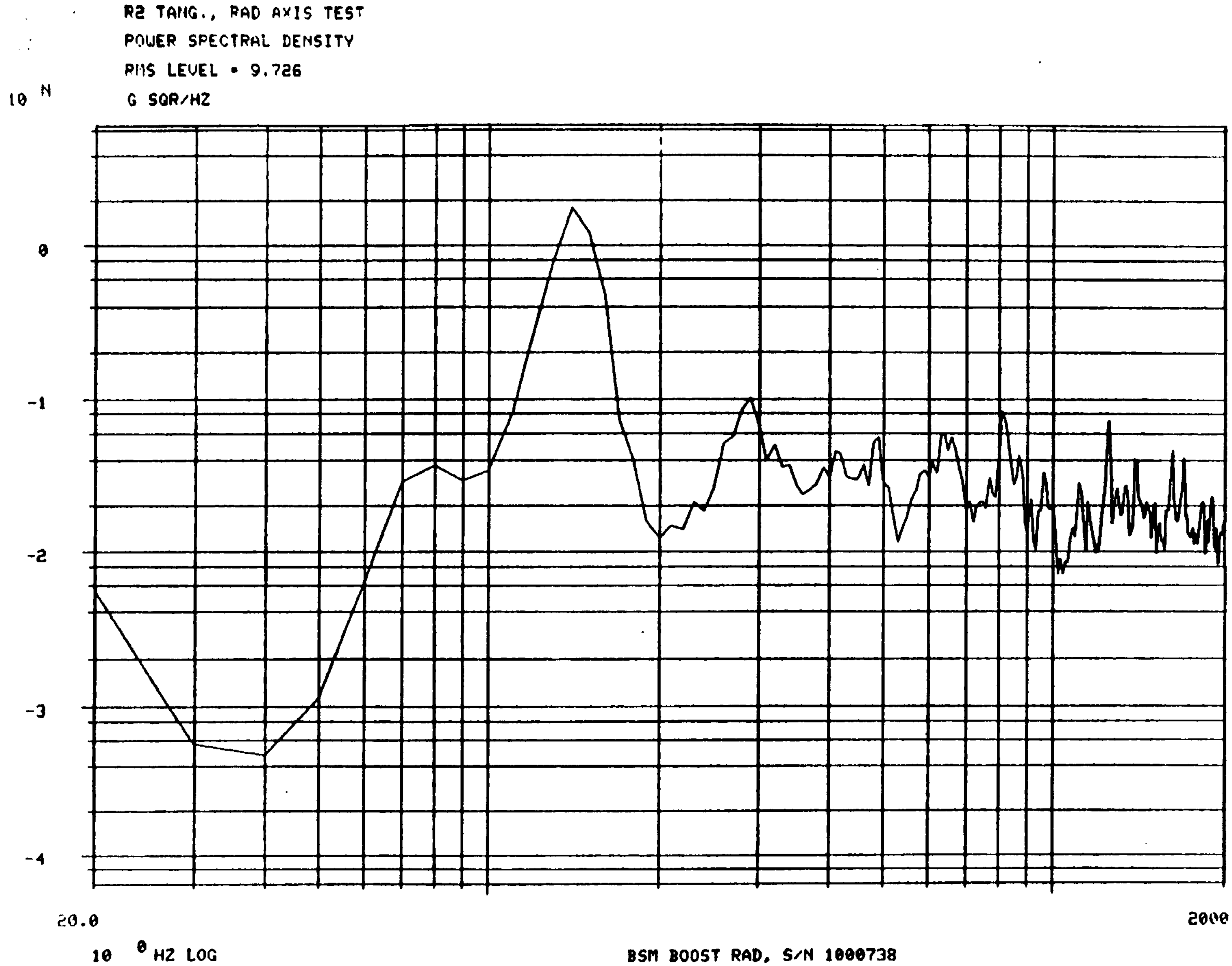


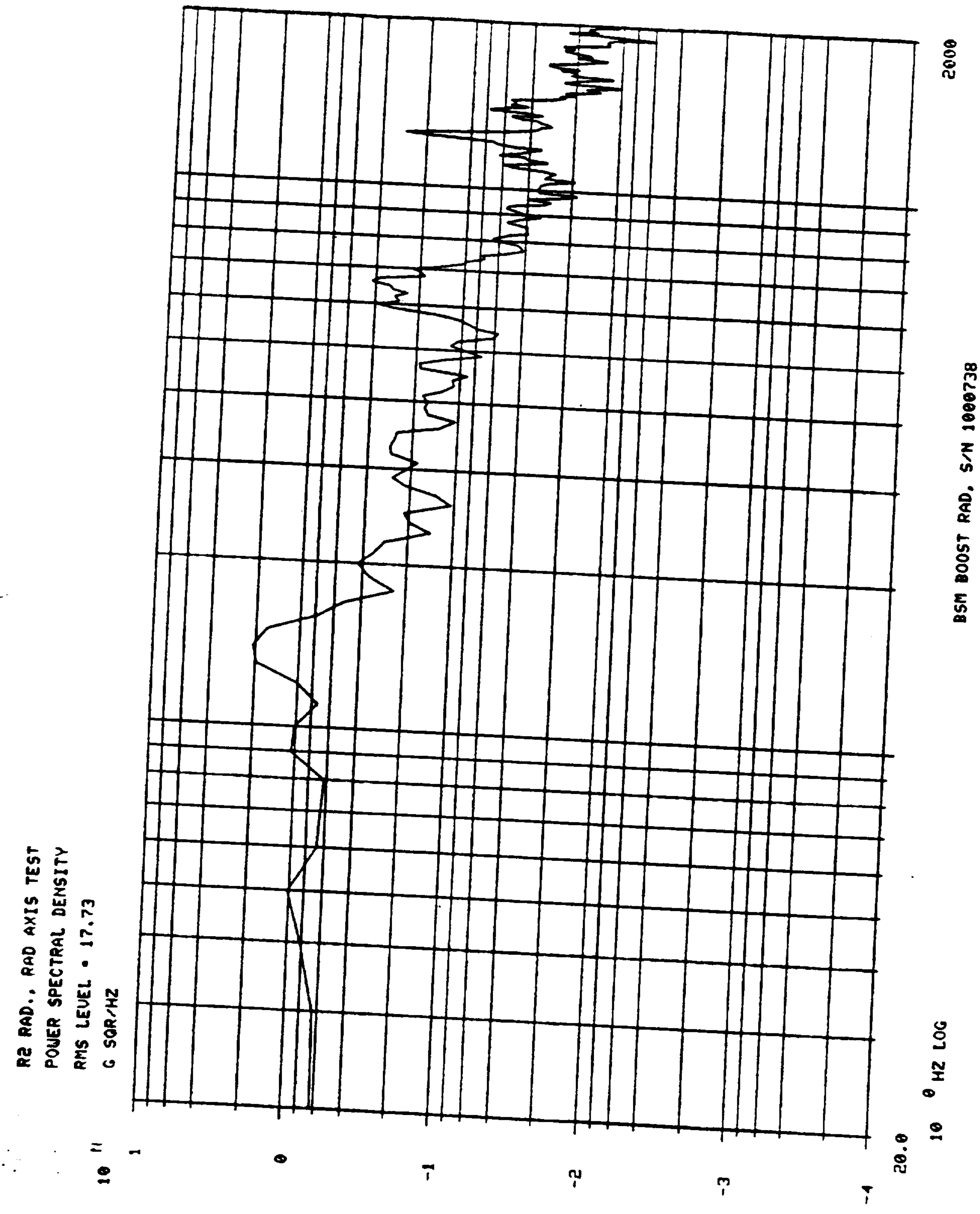
R1 TANG., RAD AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL = 8.318
G SQR/HZ
10 N
0
-1
-2
-3
-4
20.0
10 0 HZ LOG
2000
BSM BOOST RAD, S/N 1000738



R1 RAD., RAD AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL = 39.09
G SQR/HZ
10 N
2
1
0
-1
-2
-3
20.0
2000
10 0 HZ LOG
BSM BOOST RAD, S/N 1000738

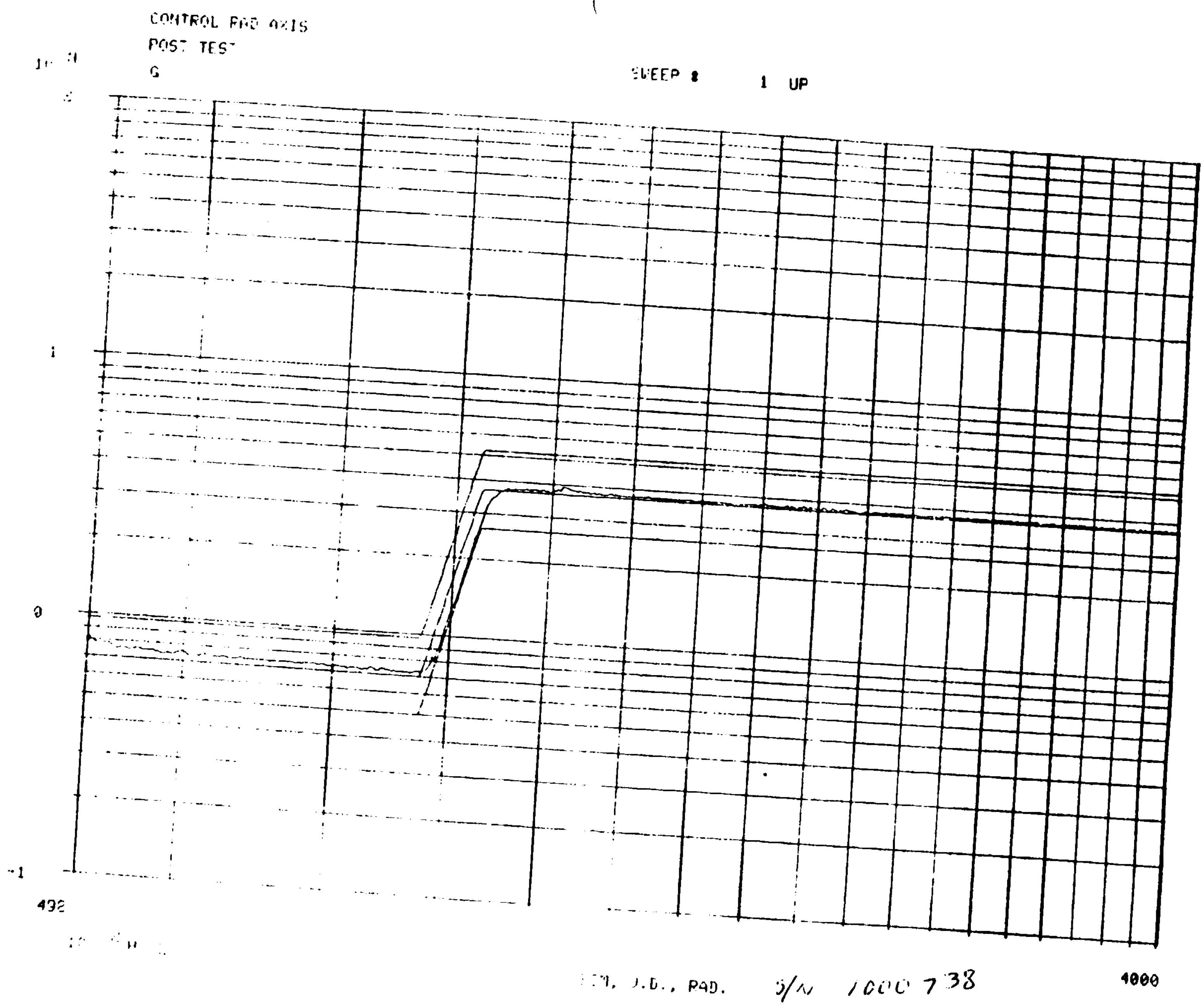

R2 LONG., RAD AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL = 20.18
G SQR/HZ
10
1
0
-1
-2
-3
20.0
10 0 HZ LOG
2000
BSM BOOST RAD, S/N 1000738

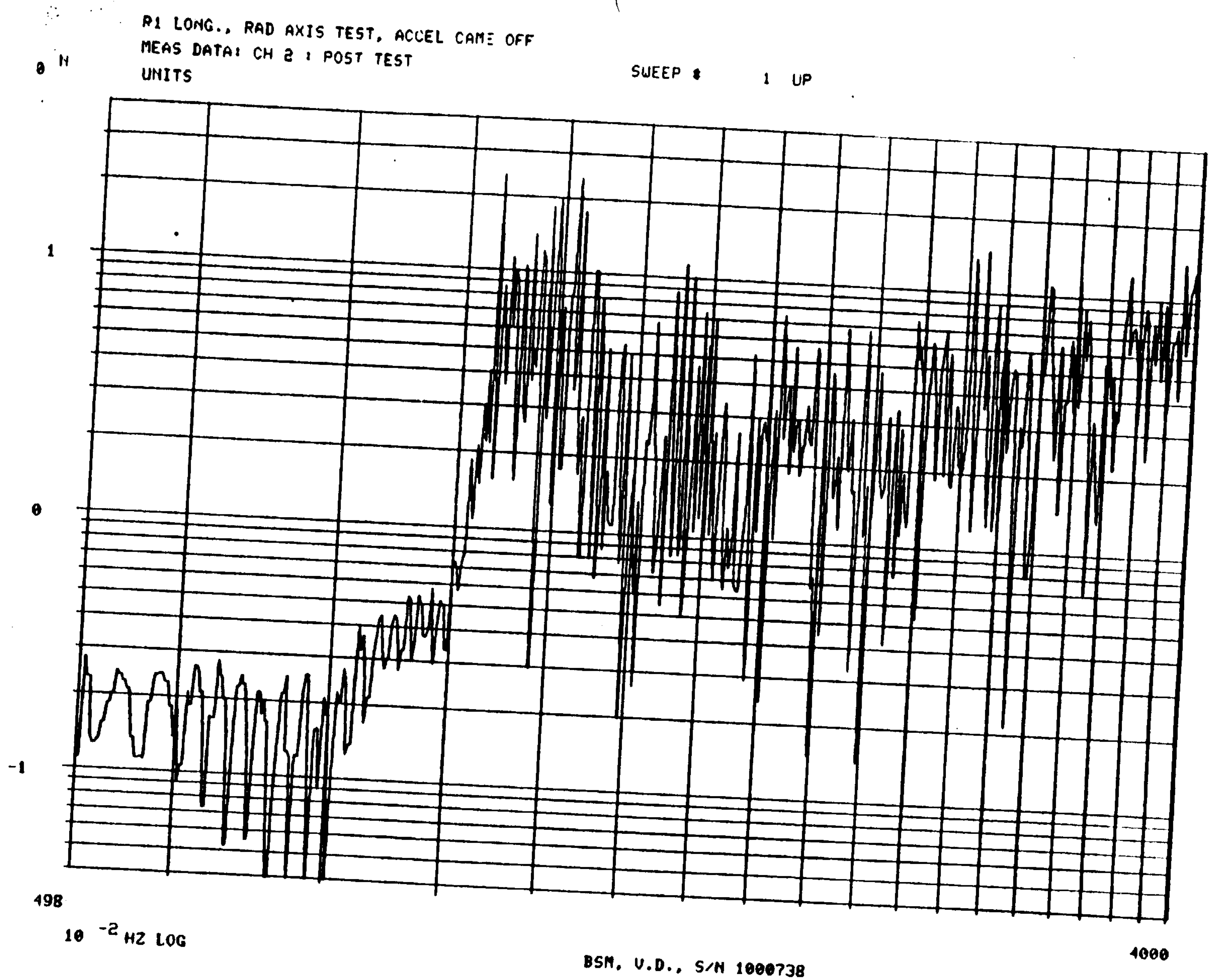

R2 TANG., RAD AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL = 9.726
G SQR/HZ
10 N
0
-1
-2
-3
-4
20.0
2000
10 0 HZ LOG
BSM BOOST RAD, S/N 1000738

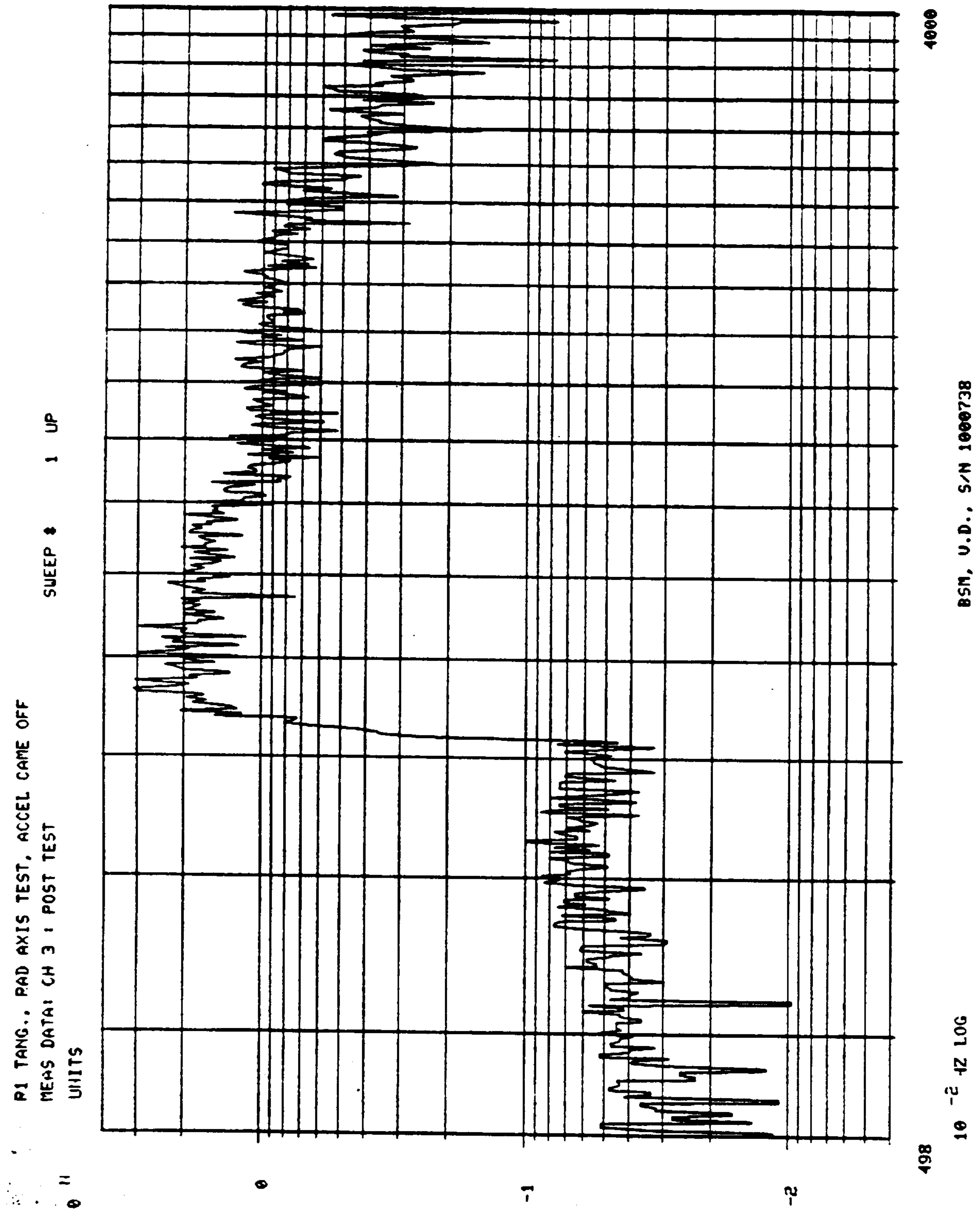

R2 RAD., RAD AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL • 17.73
G SQR/HZ
10
1
0
-1
-2
-3
-4
20.0
10 0 HZ LOG
2000
BSM BOOST RAD, S/N 1000738

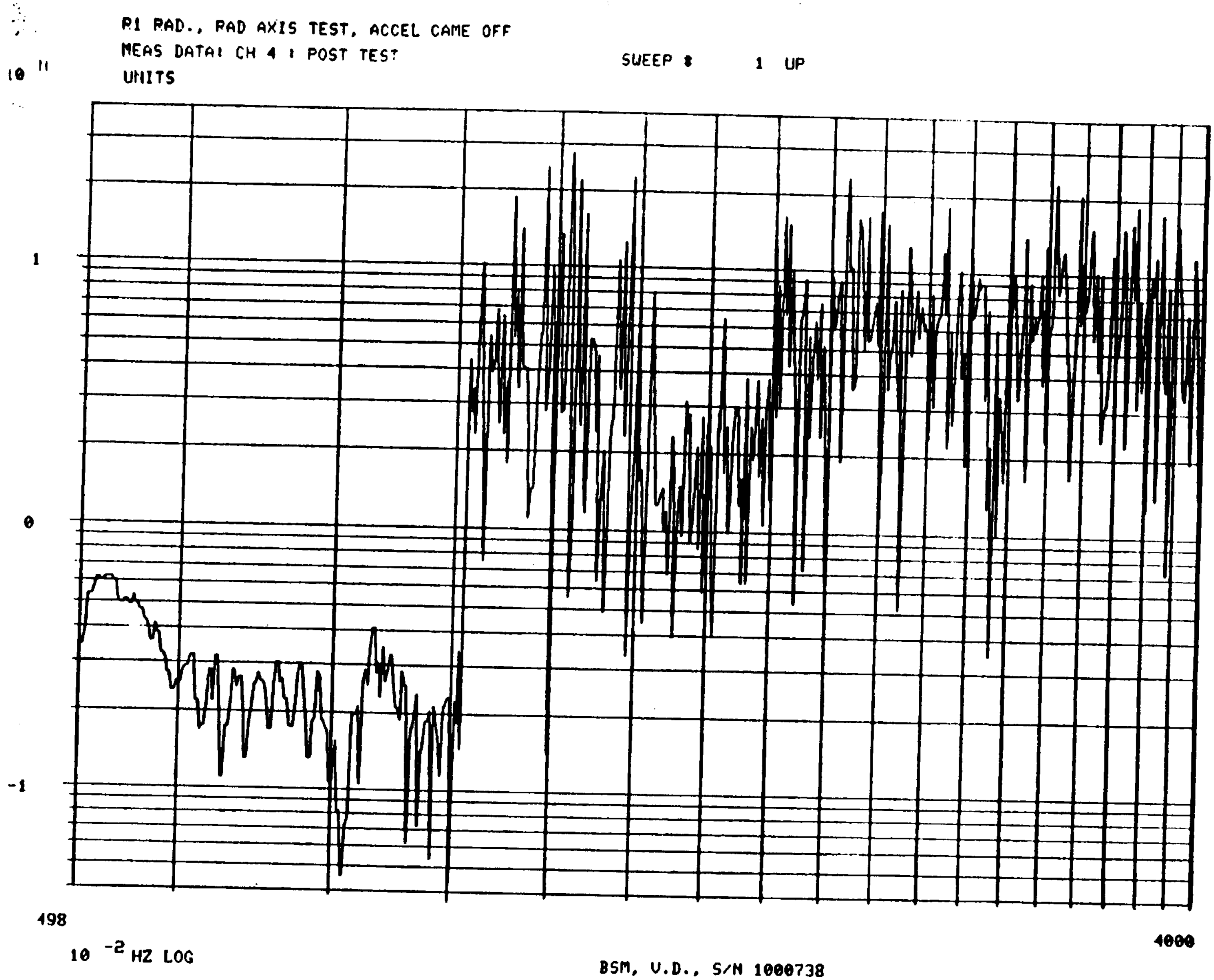
RADIAL AXIS

VEHICLE DYNAMICS

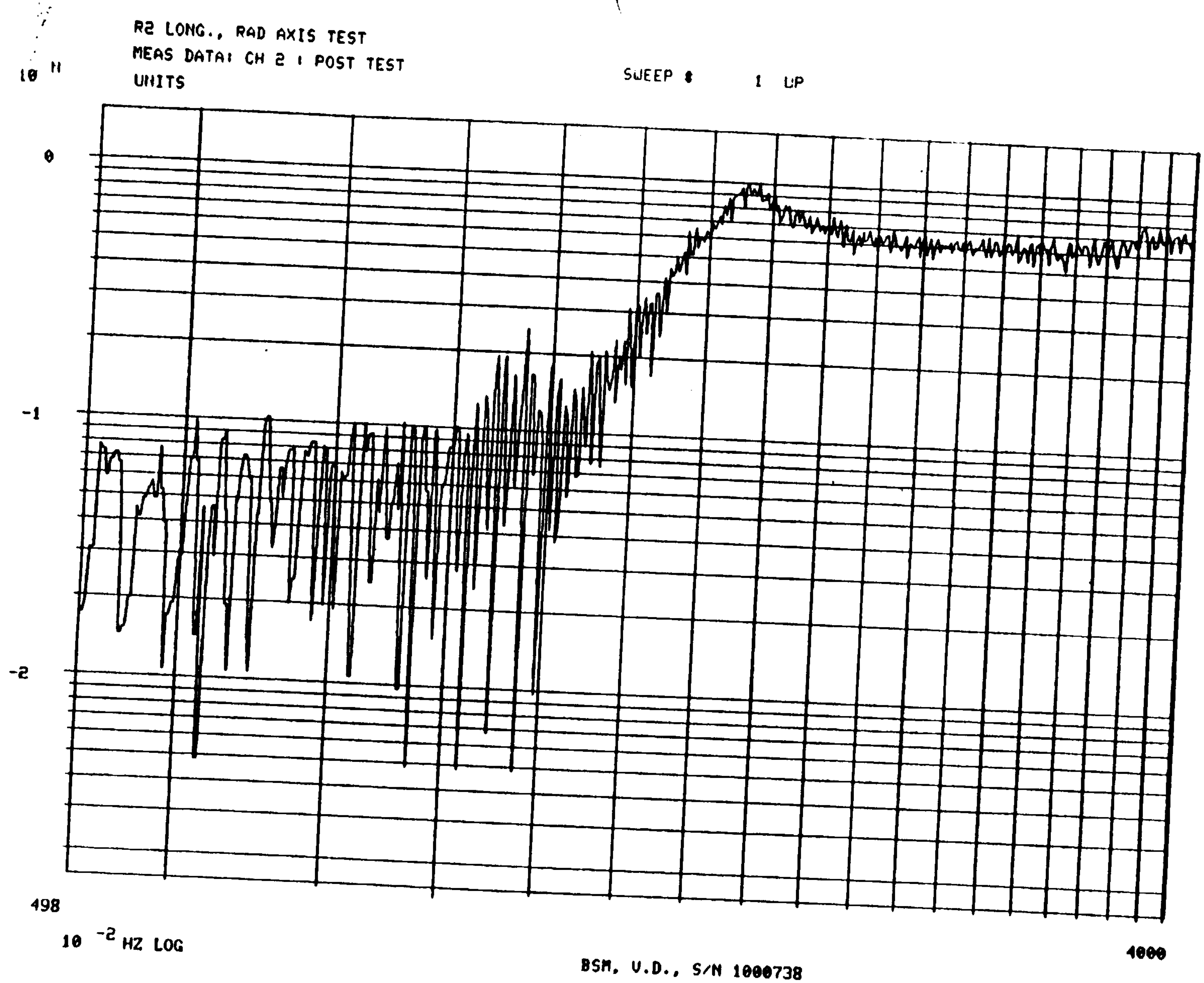

CONTROL PAD AXIS
POST TEST
G
SWEEP # 1 UP
1
0
-1
492
4000
RAD.
S/N 1000738


R1 LONG., RAD AXIS TEST, ACCEL CAME OFF
MEAS DATA: CH 2 : POST TEST
UNITS
SWEEP # 1 UP
0 N
1
0
-1
498
10 -2 HZ LOG
4000
BSM, V.D., S/N 1000738

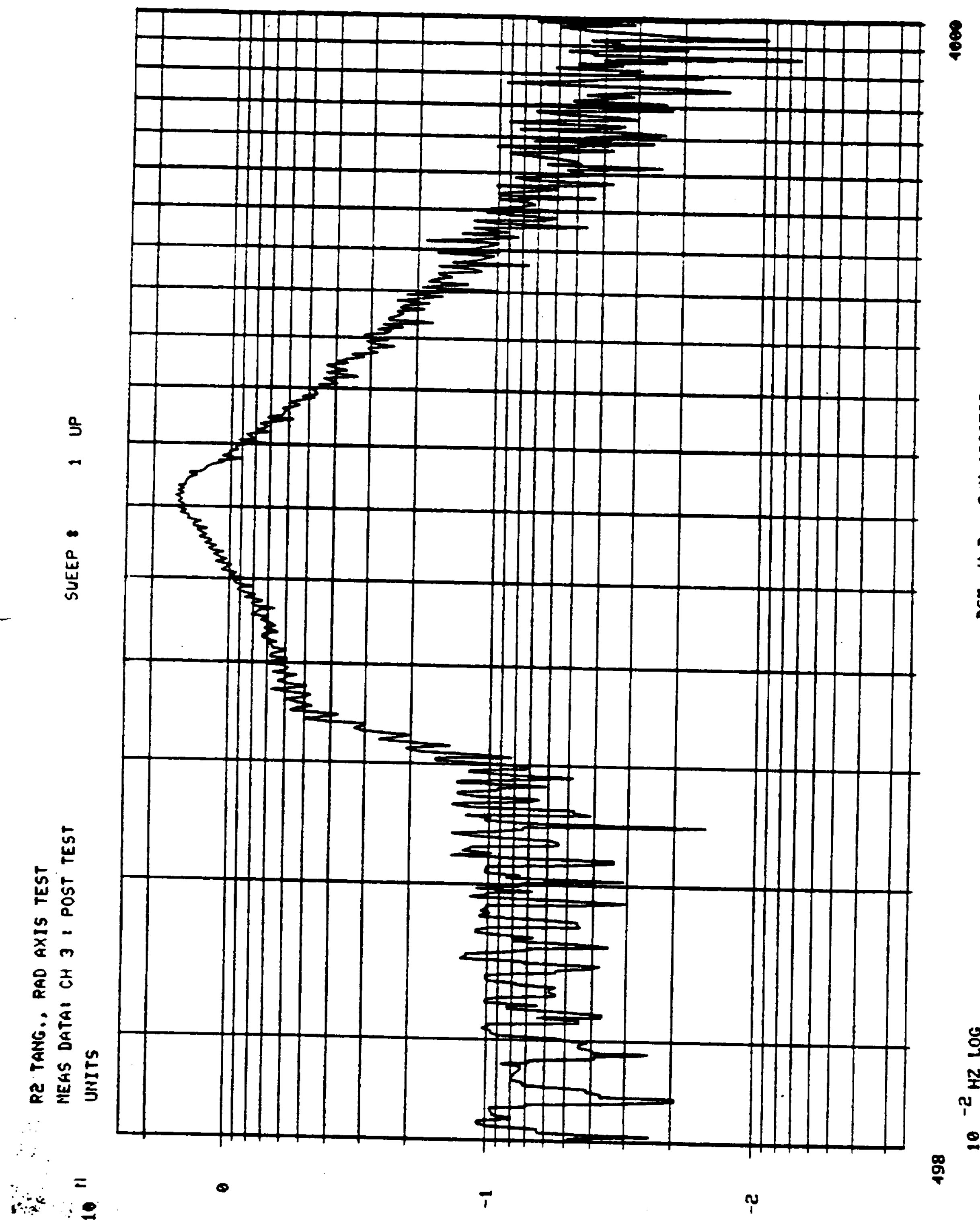

R1 TANG., RAD AXIS TEST, ACCEL CAME OFF
MEAS DATA: CH 3 : POST TEST
UNITS
SWEEP # 1 UP
BSM, V.D., S/N 1000738
10 -2 HZ LOG
498
4000
0
-1
-2



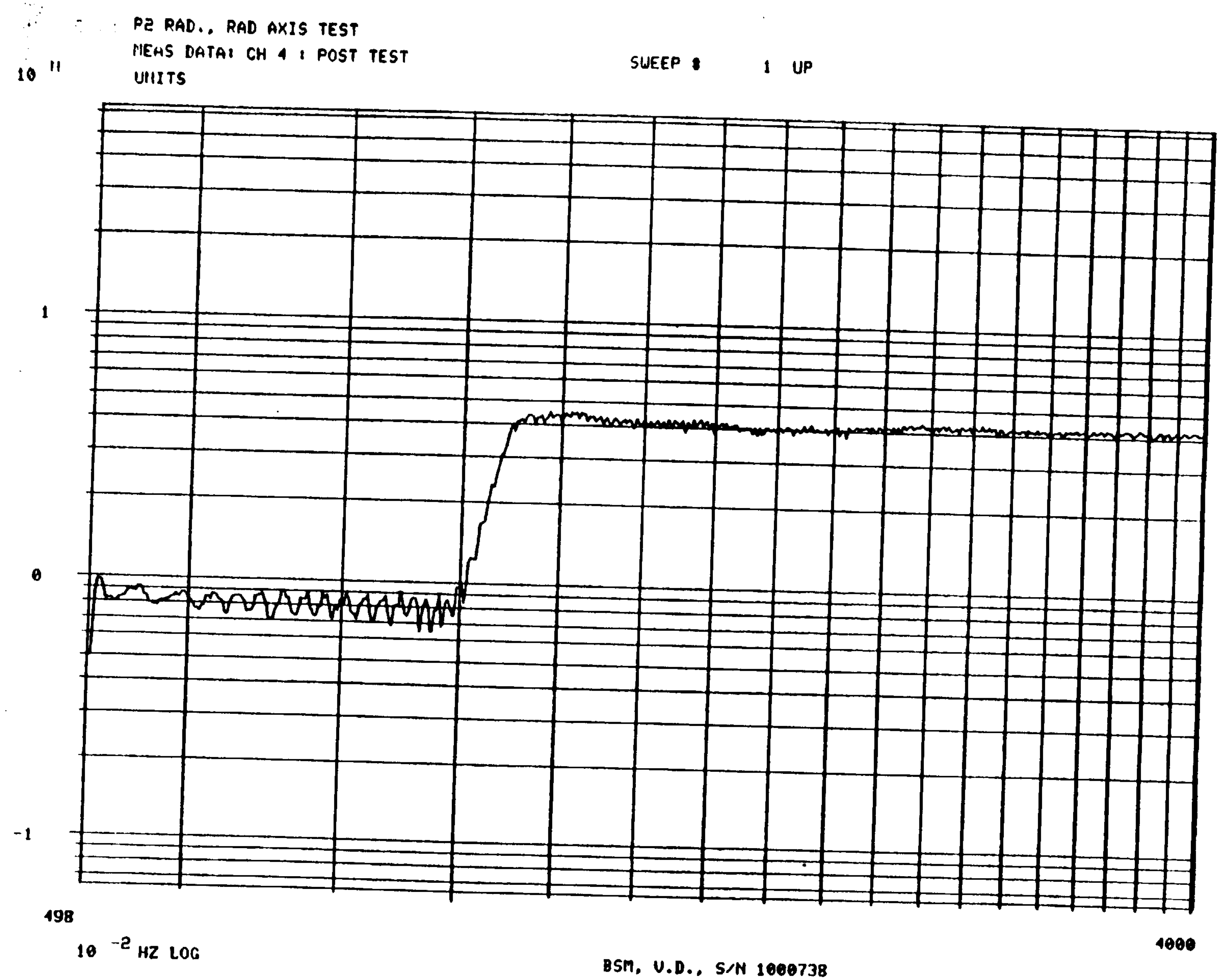
R1 RAD., RAD AXIS TEST, ACCEL CAME OFF
MEAS DATA: CH 4 : POST TEST
UNITS
SWEEP # 1 UP
10 ''
1
0
-1
498
10 -2 HZ LOG
4000
BSM, V.D., S/N 1000738



R2 LONG., RAD AXIS TEST
MEAS DATA: CH 2 : POST TEST
UNITS
SWEEP # 1 UP
10 H
0
-1
-2
498
10 -2 HZ LOG
4000
BSM, V.D., S/N 1000738



R2 TANG., RAD AXIS TEST
MEAS DATA: CH 3 : POST TEST
UNITS
SWEEP # 1 UP
10
0
-1
-2
498
4000
10 -2 HZ LOG
BSM, V.D., S/N 1000738


P2 RAD., RAD AXIS TEST
MEAS DATA: CH 4 : POST TEST
UNITS
10 ''
SWEEP # 1 UP
1
0
-1
498
10 -2 HZ LOG
4000
BSM, V.D., S/N 1000738

TANGENTIAL AXIS

RANDOM, LIFT-OFF

CONTROL L.O. TANG., PART 1

POST TEST

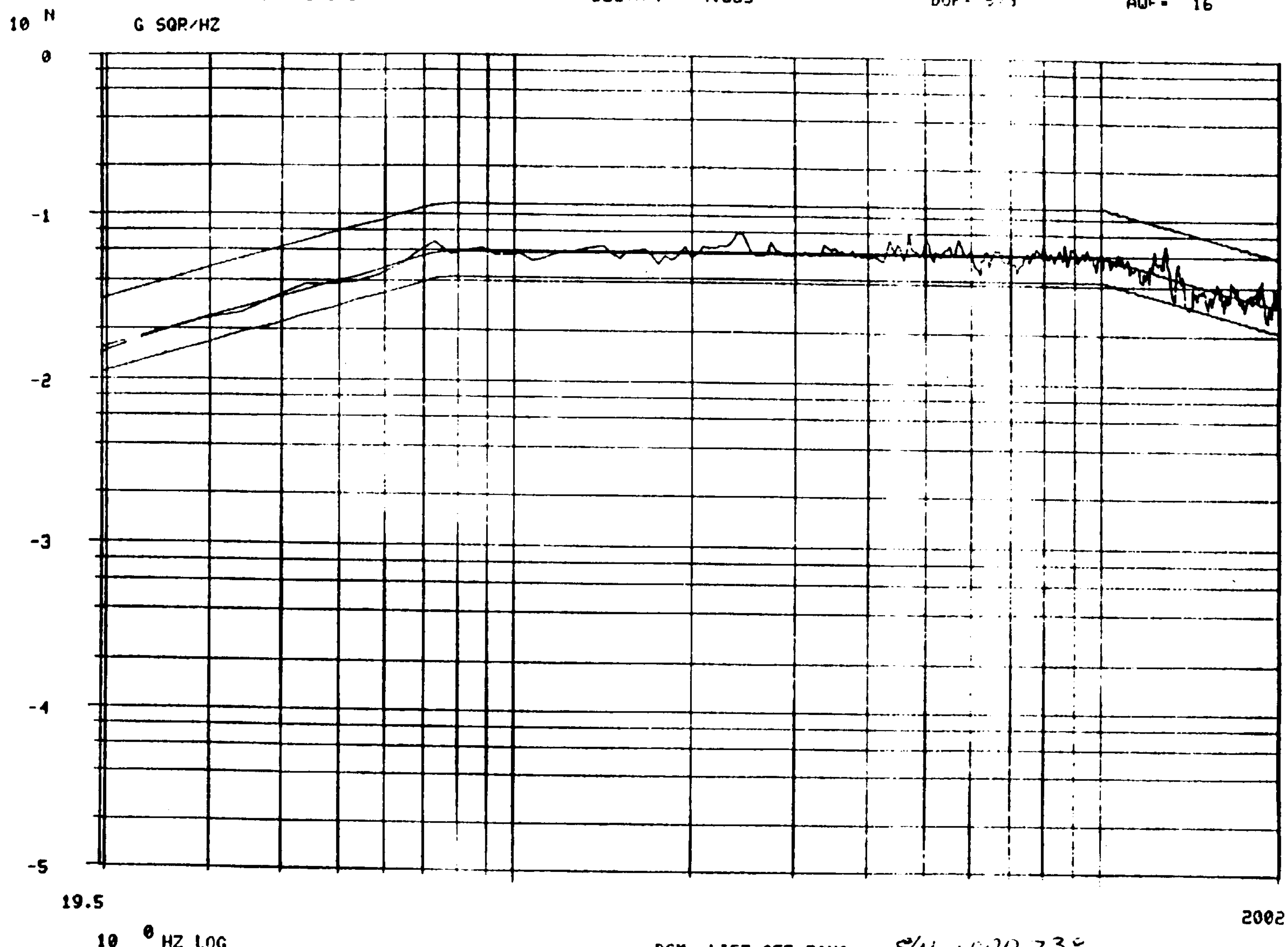
RMS LEVEL • 9.941 G'S

ELAPSED TIME • 58 SECS AT .00 DB

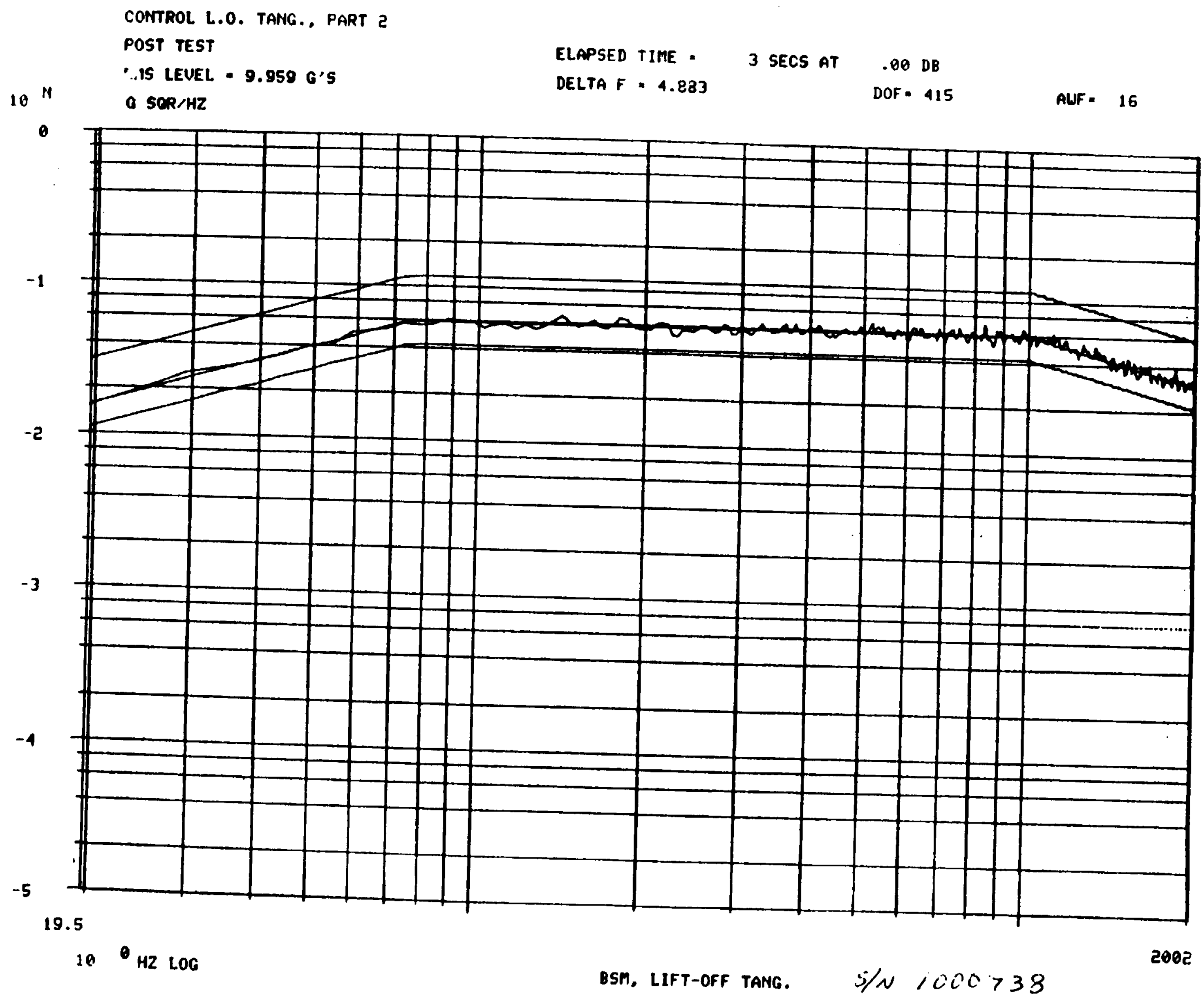
DELTA F • 4.883

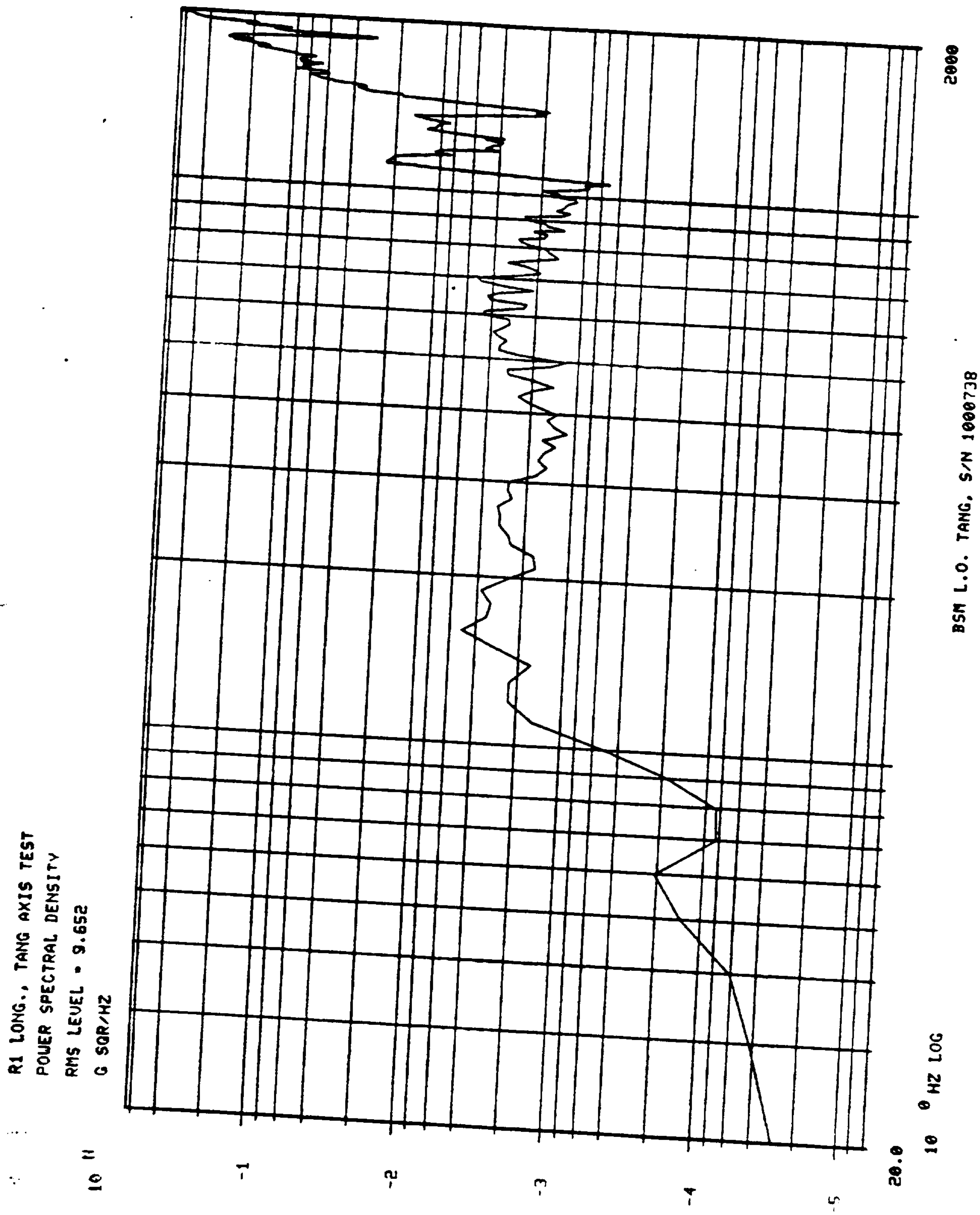
DOF• 573

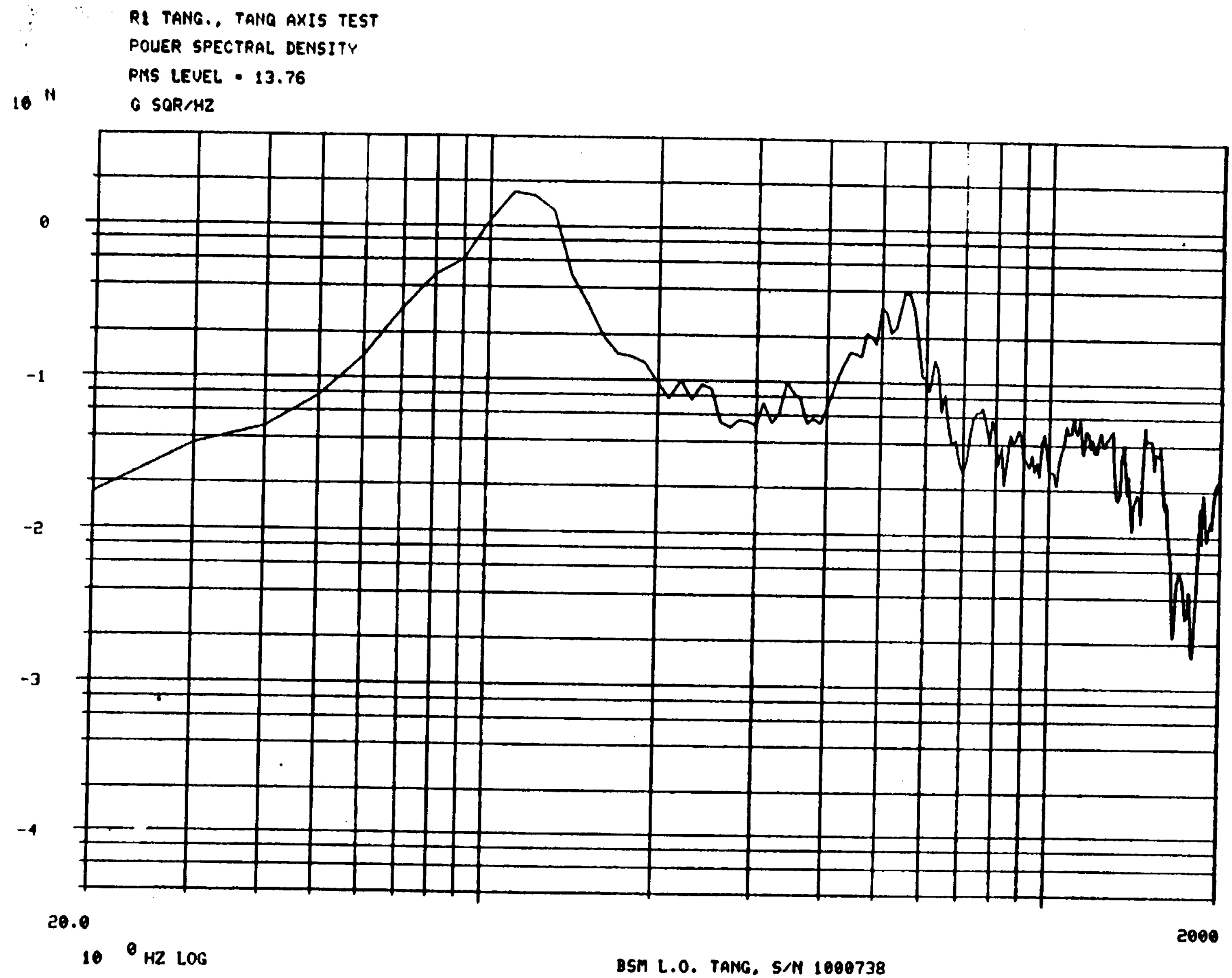
AWF• 16



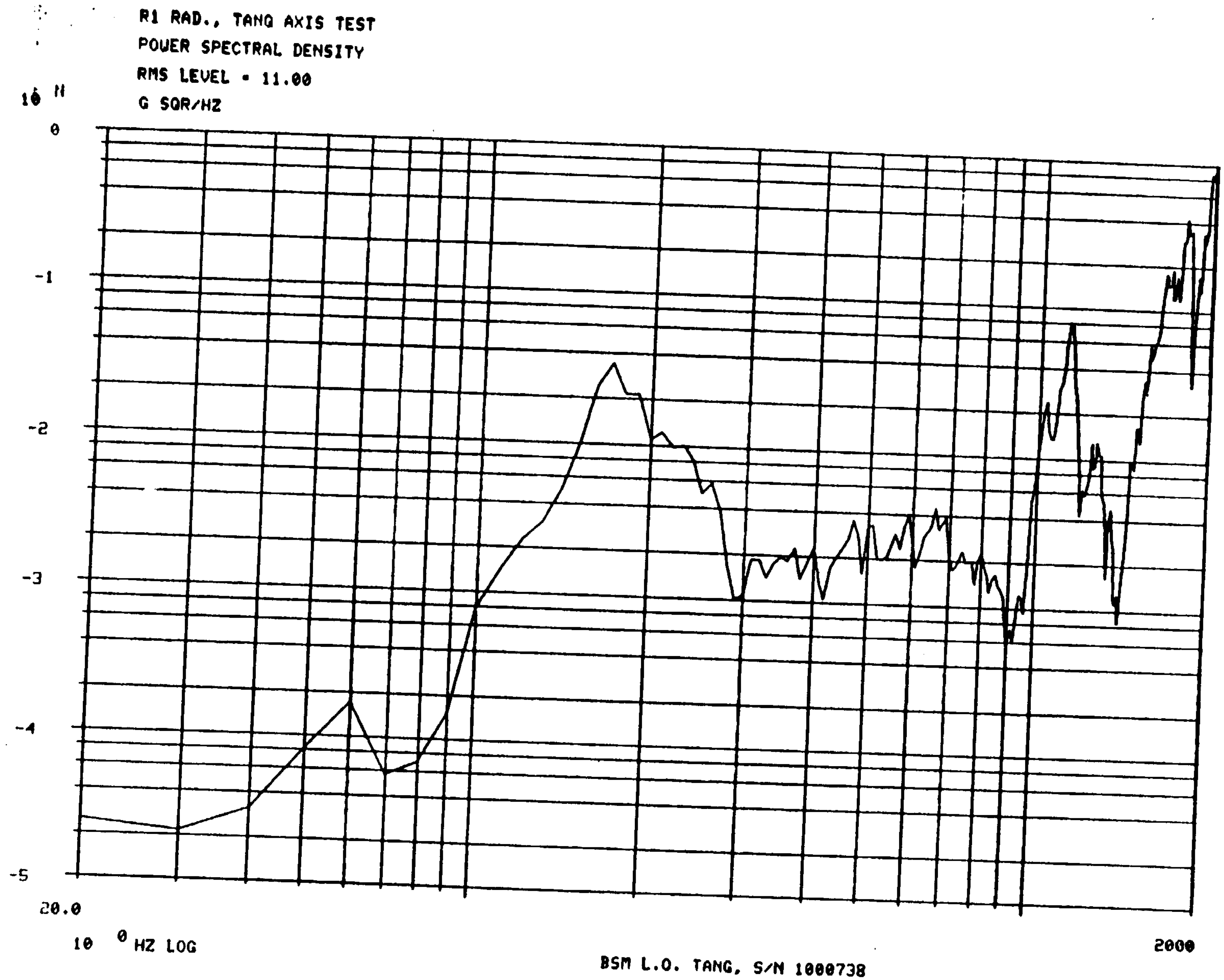
BSM, LIFT-OFF TANG. S/N 1000 738

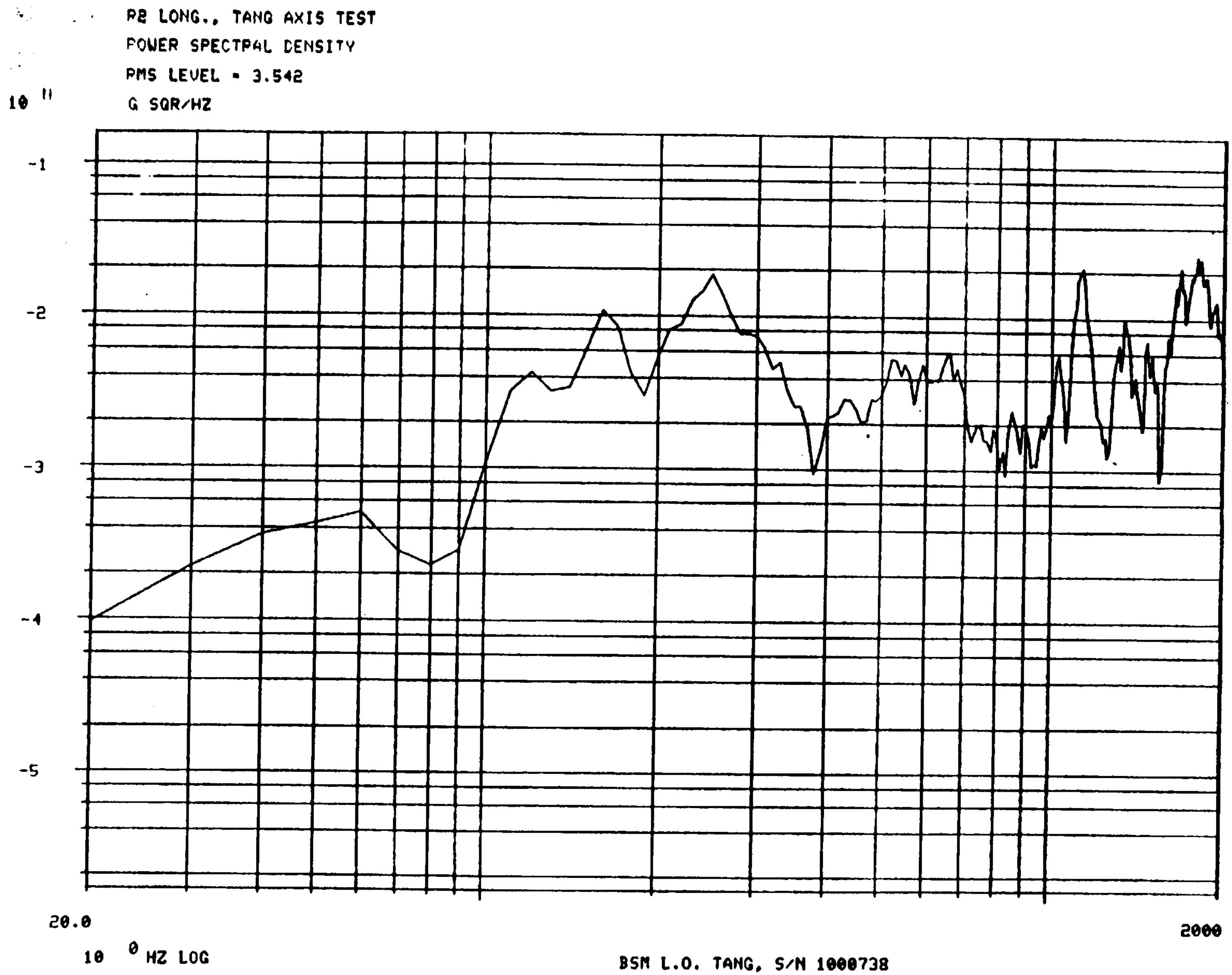

CONTROL L.O. TANG., PART 2
POST TEST
'.IS LEVEL = 9.959 G'S
G SQR/HZ
ELAPSED TIME = 3 SECS AT .00 DB
DELTA F = 4.883
DOF= 415
AWF= 16
10 N
0
-1
-2
-3
-4
-5
19.5
10 0 HZ LOG
2002
BSM, LIFT-OFF TANG.
S/N 1000738

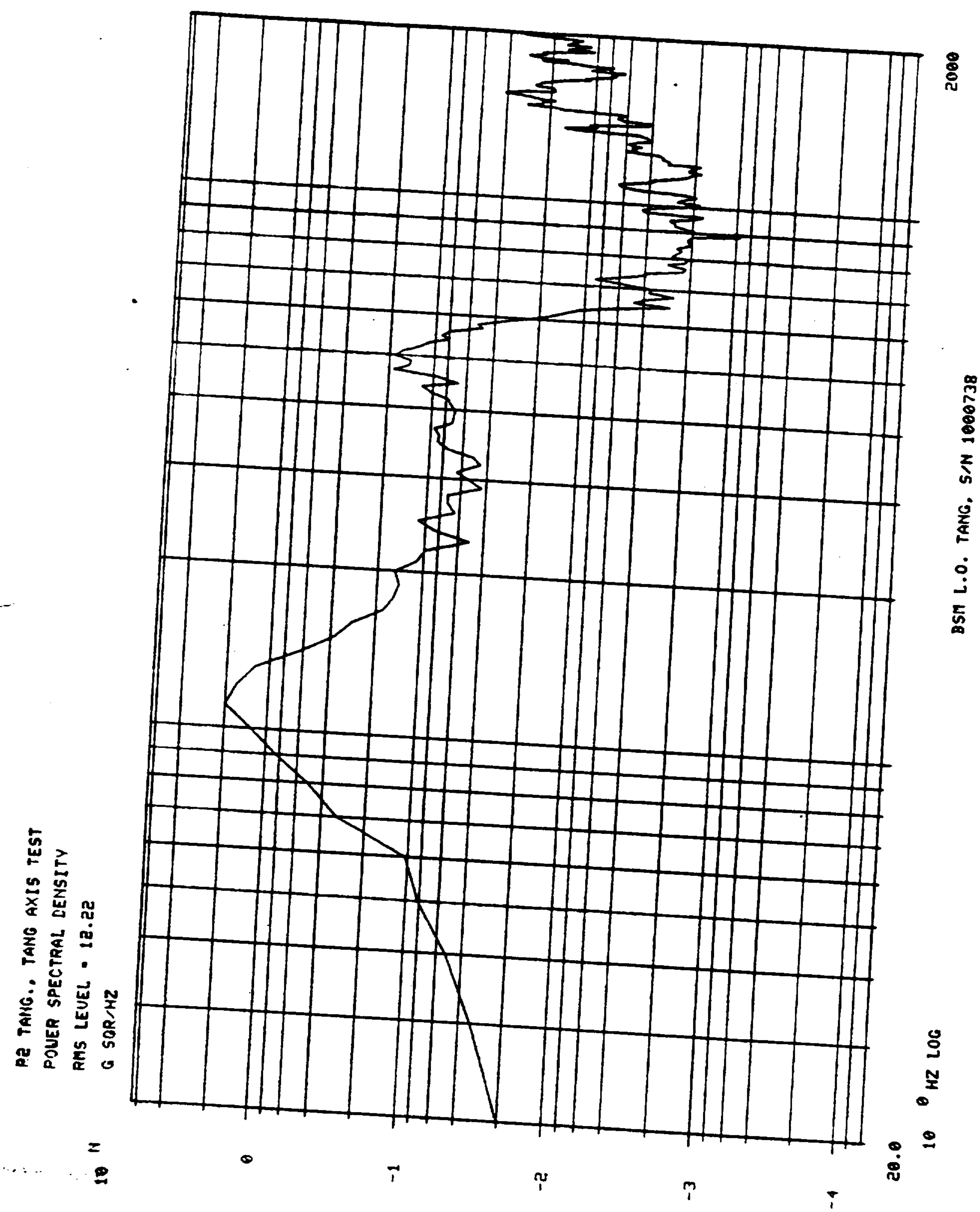

R1 LONG., TANG AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL = 9.652
G SQR/HZ
BSM L.O. TANG. S/N 1000738
10 0 HZ LOG
20.0
2000
-1
-2
-3
-4
-5

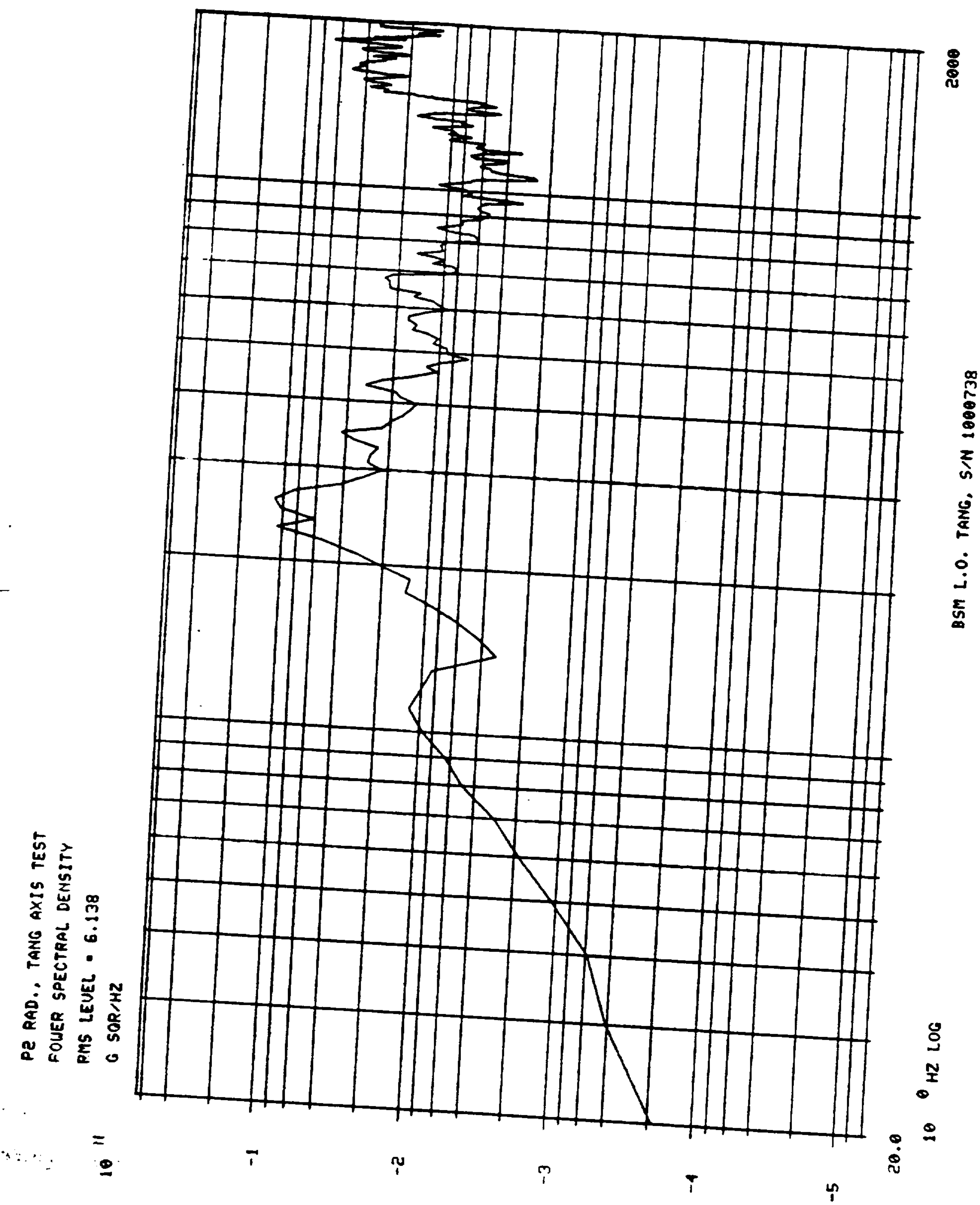


R1 TANG., TANG AXIS TEST
POWER SPECTRAL DENSITY
PMS LEVEL • 13.76
G SQR/HZ
10 N
0
-1
-2
-3
-4
20.0
2000
10 0 HZ LOG
BSM L.O. TANG, S/N 1000738


R1 RAD., TANG AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL = 11.00
G SQR/HZ
10 N
0
-1
-2
-3
-4
-5
20.0
10 0 HZ LOG
2000
BSM L.O. TANG, S/N 1000738

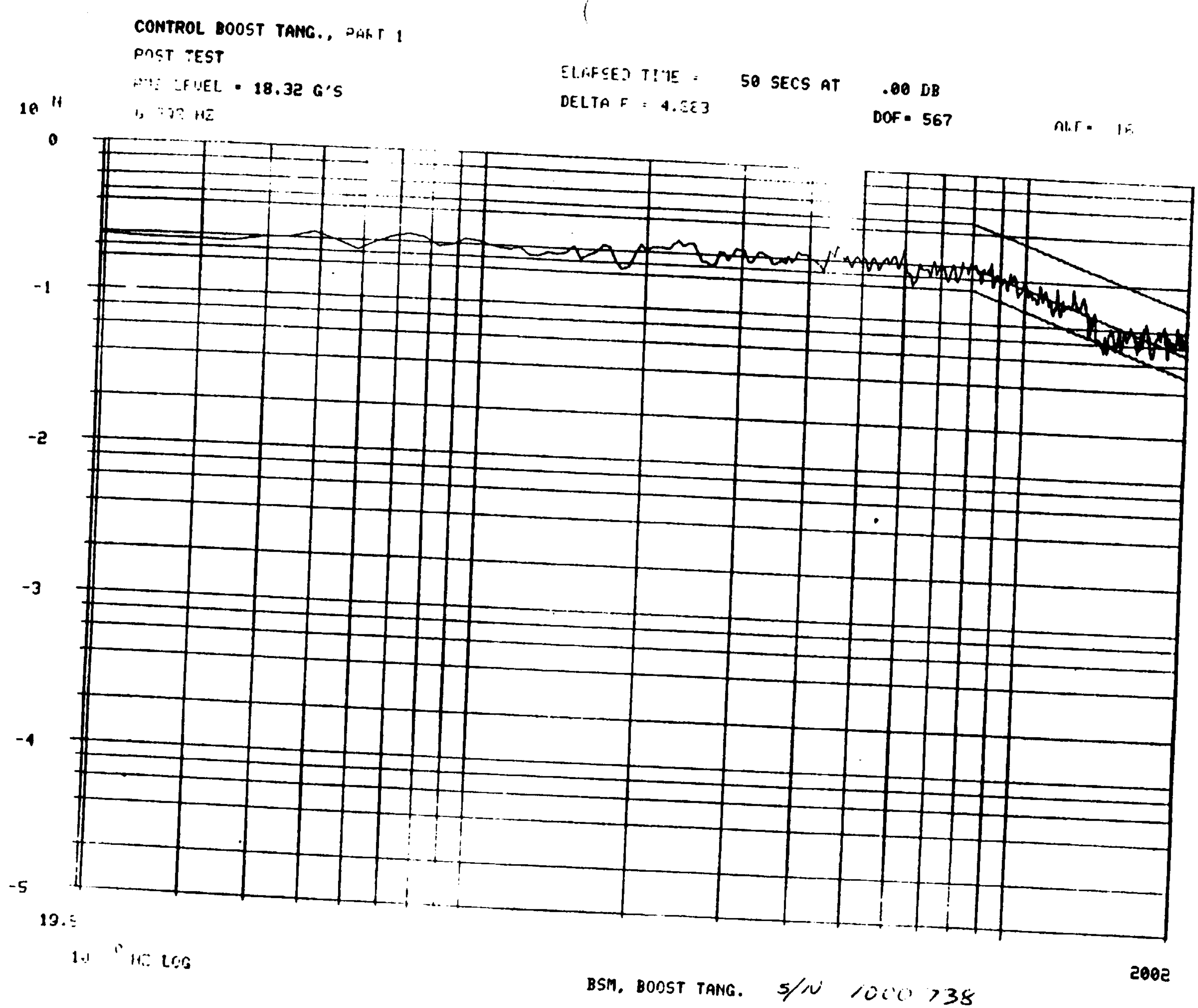

R2 LONG., TANG AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL = 3.542
G SQR/HZ
10 ''
-1
-2
-3
-4
-5
20.0
2000
10 0 HZ LOG
BSM L.O. TANG, S/N 1000738

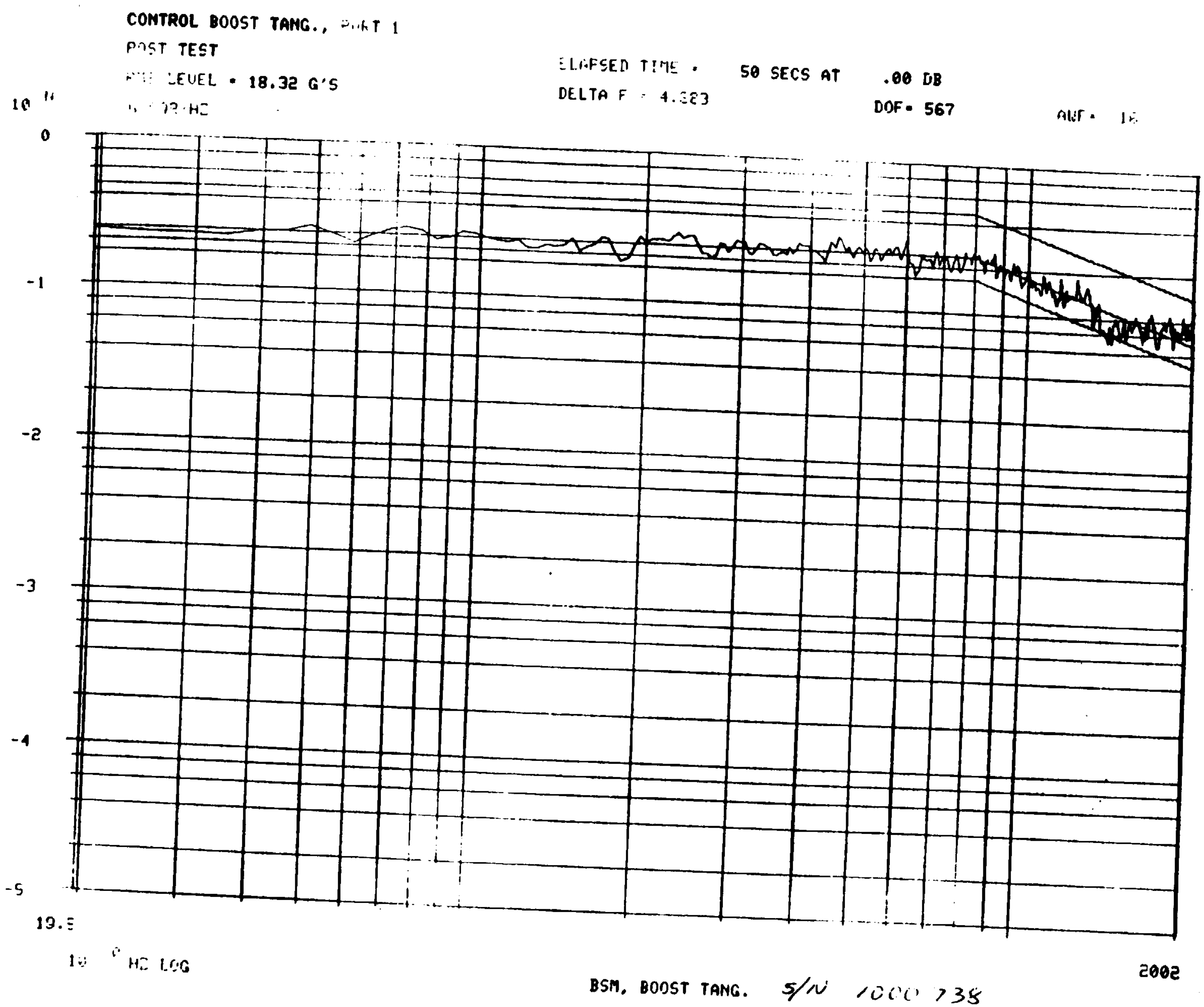

R2 TANG., TANG AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL = 12.22
G SQR/HZ
BSM L.O. TANG. S/N 1000738
10 N
0
-1
-2
-3
-4
20.0
10 0 HZ LOG
2000


P2 RAD., TANG AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL = 6.138
G SQR/HZ
10
-1
-2
-3
-4
-5
20.0
10 0 HZ LOG
2000
BSM L.O. TANG, S/N 1000738

TANGENTIAL AXIS

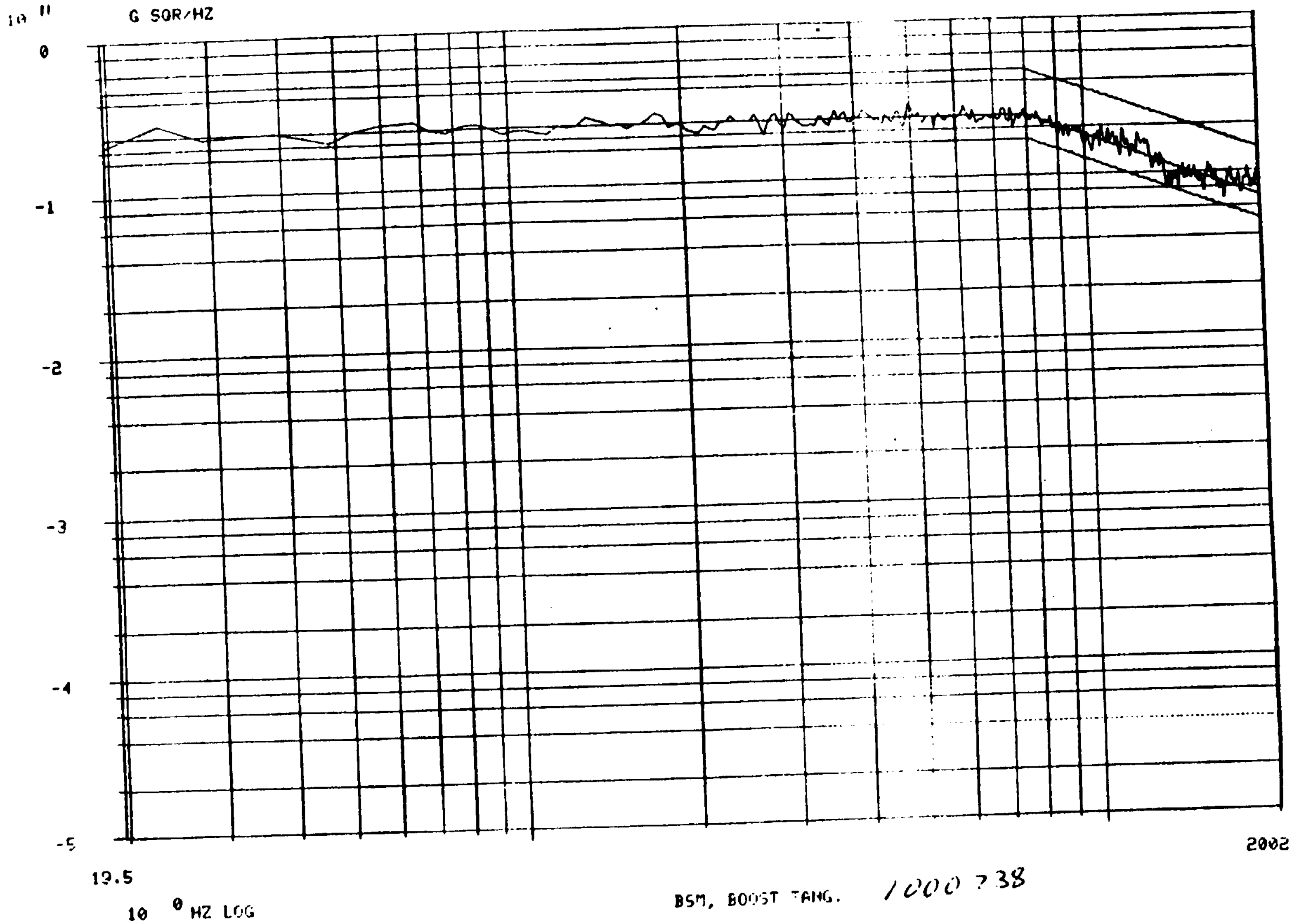
RANDOM, BOOST


CONTROL BOOST TANG., PART 1
POST TEST
RMS LEVEL • 18.32 G'S
ELAPSED TIME = 50 SECS AT .00 DB
DELTA F = 4.883
DOF• 567
10 N
0
-1
-2
-3
-4
-5
19.5
HZ LOG
2002
BSM, BOOST TANG. S/N 1000 738

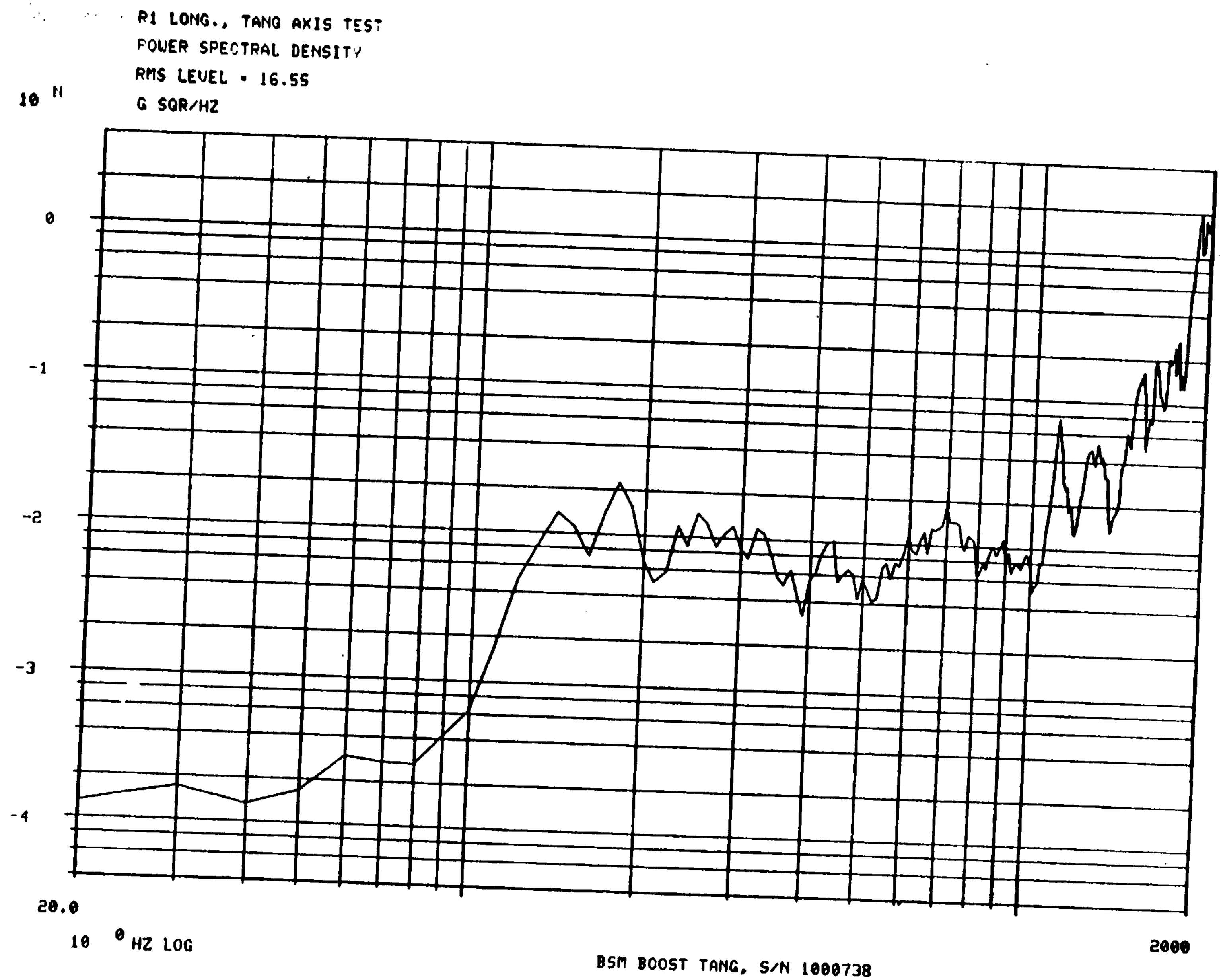

CONTROL BOOST TANG., PART 1
POST TEST
LEVEL • 18.32 G'S
ELAPSED TIME • 50 SECS AT .00 DB
DELTA F 4.383
DOF• 567
10
0
-1
-2
-3
-4
-5
19.5
HZ LOG
2002
BSM, BOOST TANG. S/N 1000 738

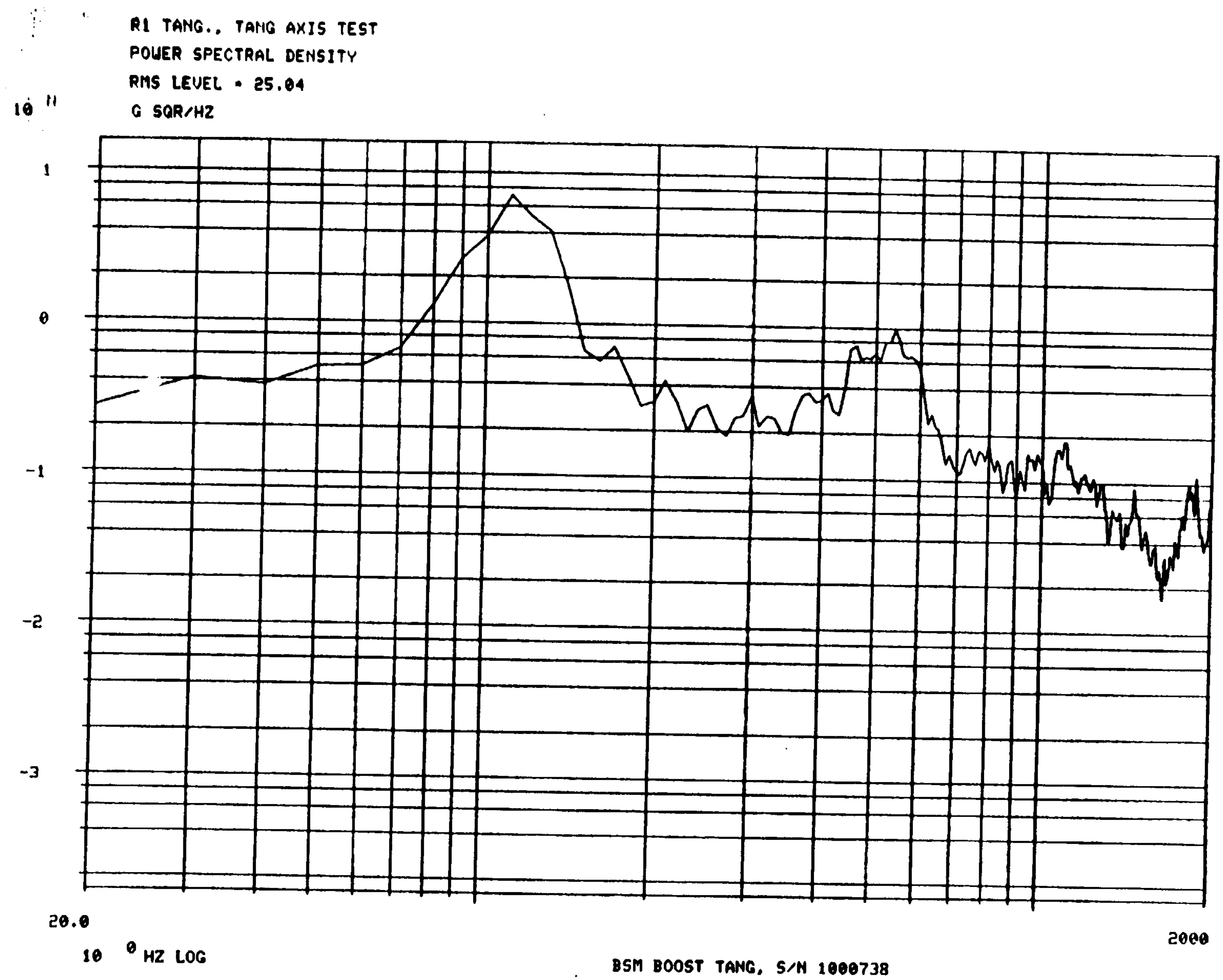
CONTROL BOOST TANG., PART 2
POST TEST
RMS LEVEL = 18.47 G'S
G SQR/HZ

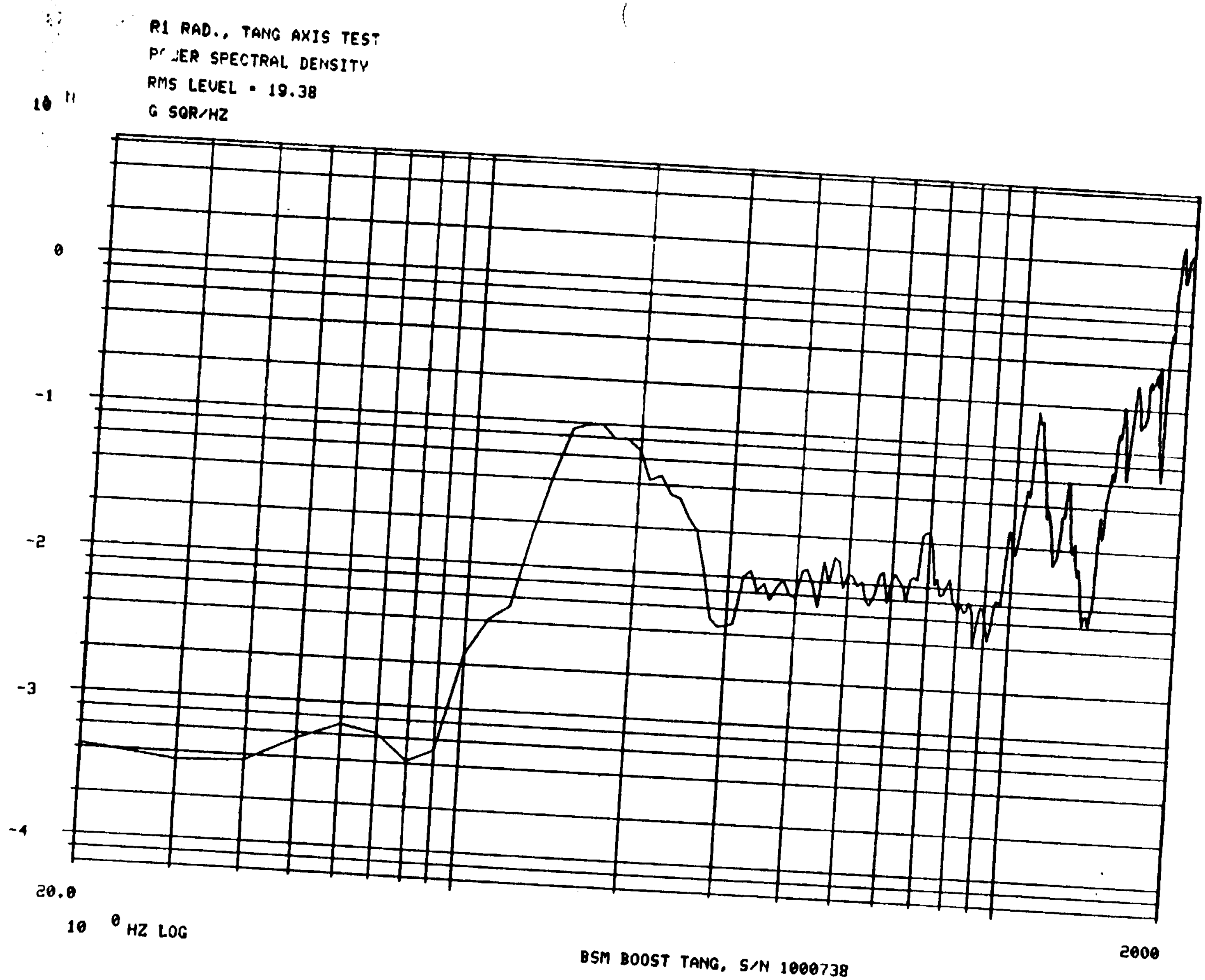
ELA..ED TIME = 74 SECS AT .00 DB
DELTA F = 4.883 DOF= 593 AUF= 16

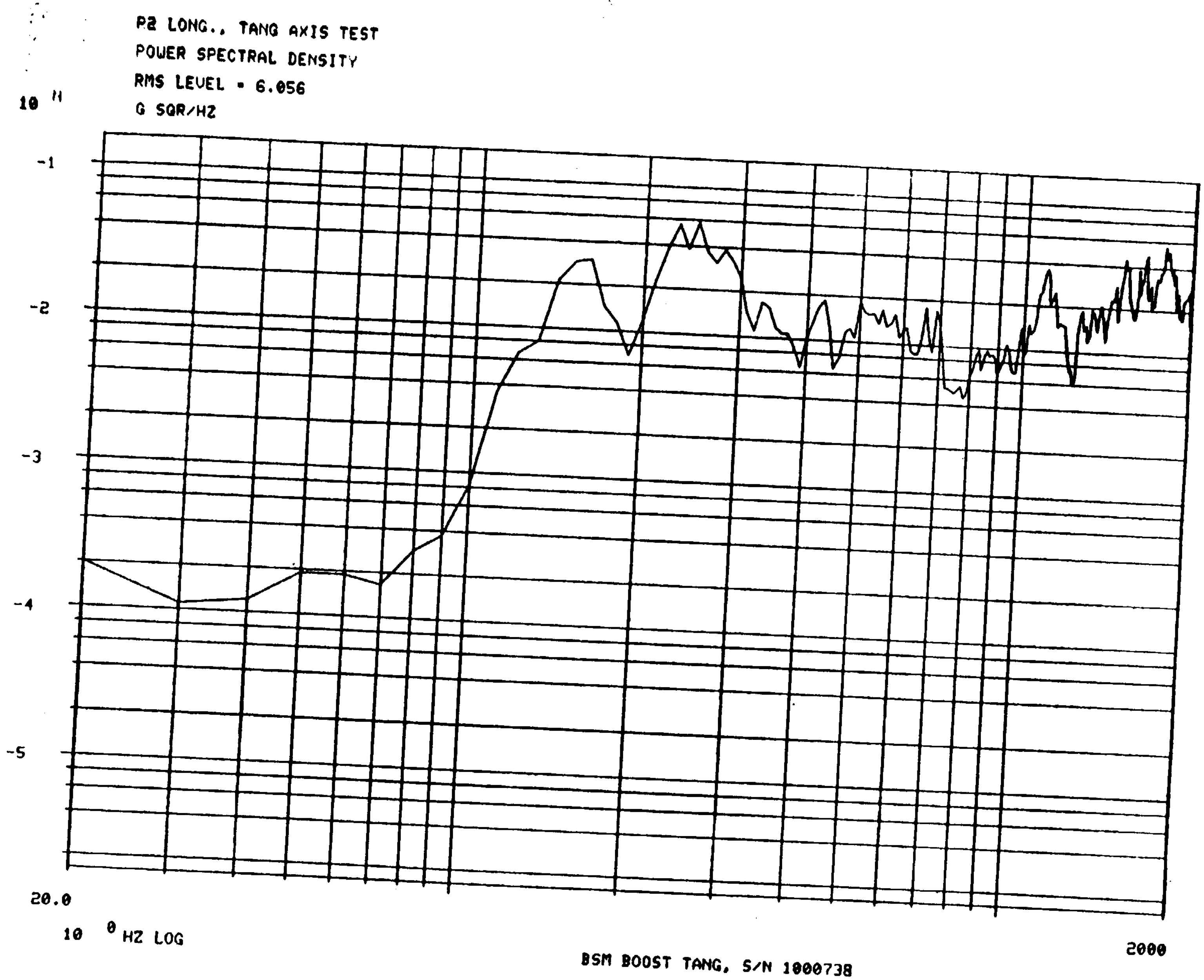


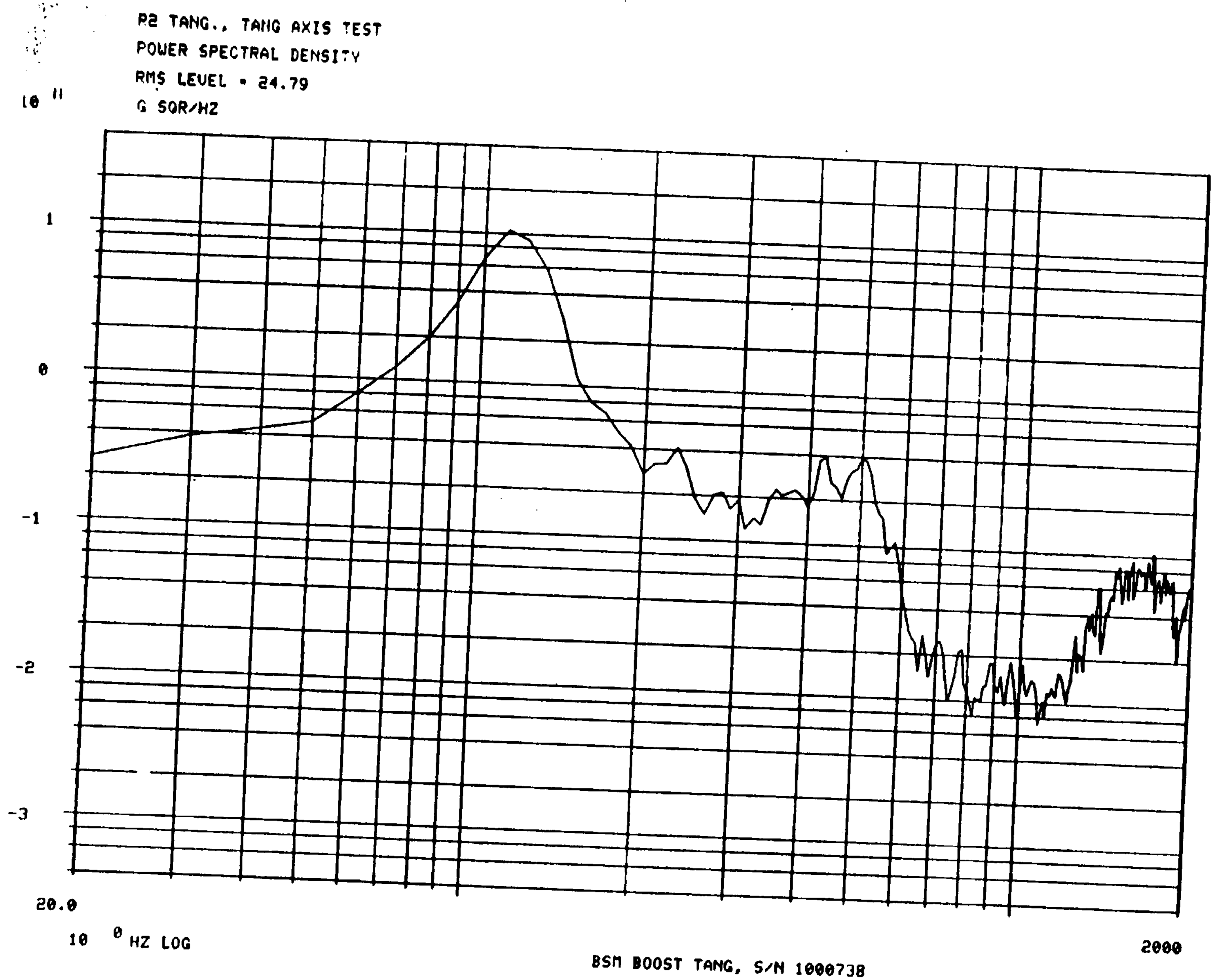
BSM, BOOST TANG. 1000 738

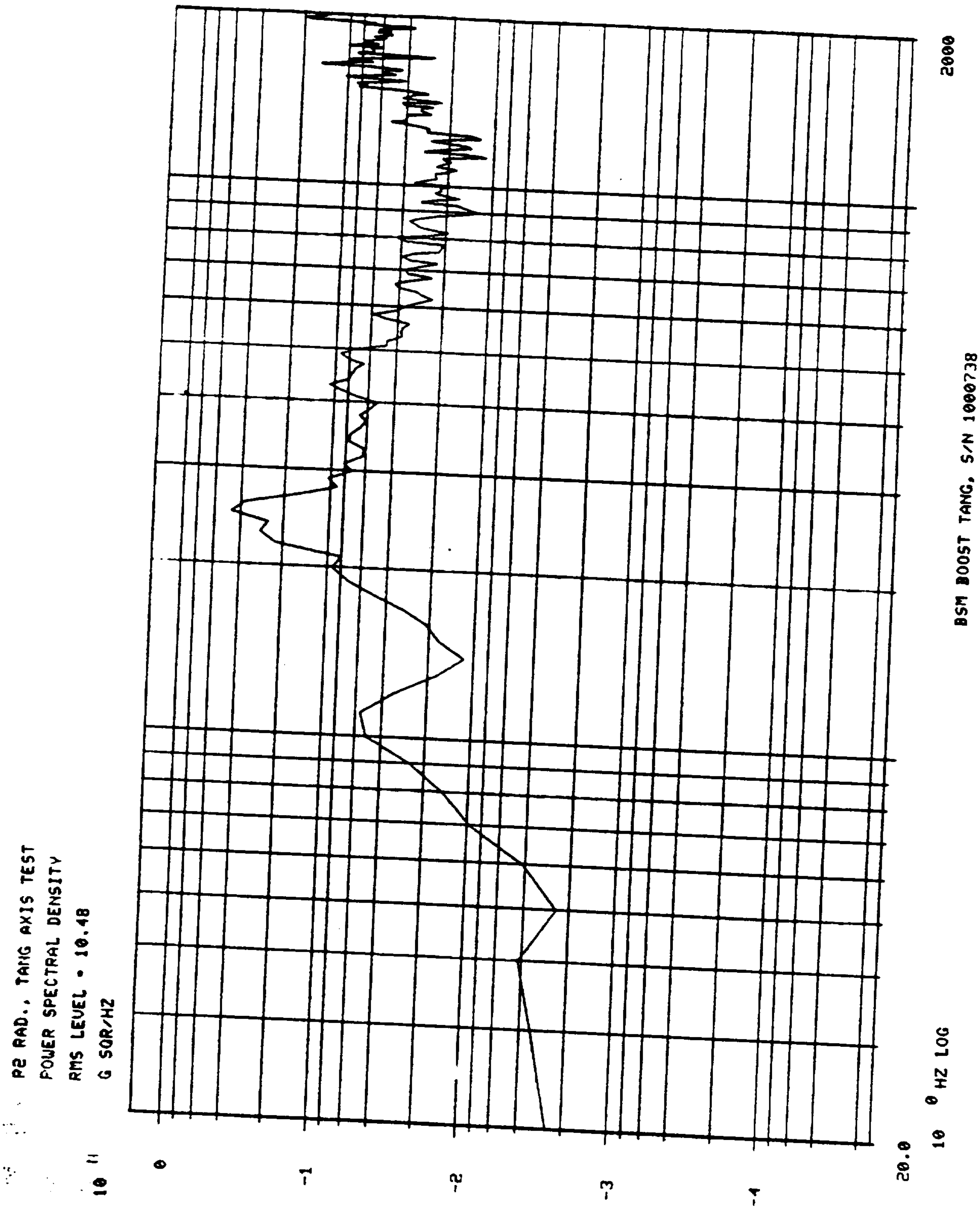

R1 LONG., TANG AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL = 16.55
G SQR/HZ
10 N
0
-1
-2
-3
-4
20.0
10 0 HZ LOG
2000
BSM BOOST TANG, S/N 1000738


R1 TANG., TANG AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL = 25.04
G SQR/HZ
10 N
1
0
-1
-2
-3
20.0
10 0 HZ LOG
2000
BSM BOOST TANG, S/N 1000738


R1 RAD., TANG AXIS TEST
P' ER SPECTRAL DENSITY
RMS LEVEL • 19.38
G SQR/HZ
10 N
0
-1
-2
-3
-4
20.0
10 0 HZ LOG
2000
BSM BOOST TANG, S/N 1000738

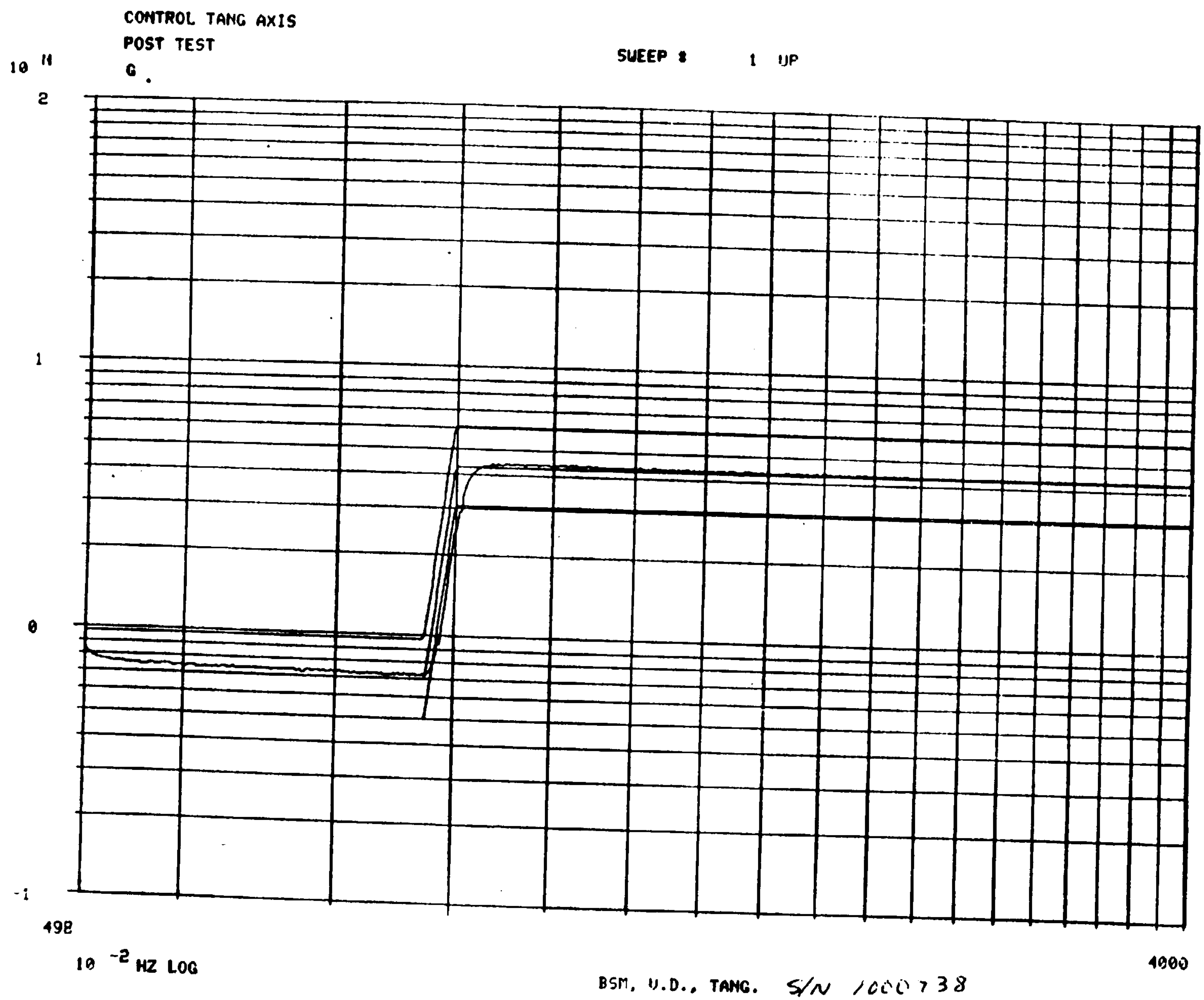

P2 LONG., TANG AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL = 6.056
G SQR/HZ
10 N
-1
-2
-3
-4
-5
20.0
10 0 HZ LOG
2000
BSM BOOST TANG, S/N 1000738

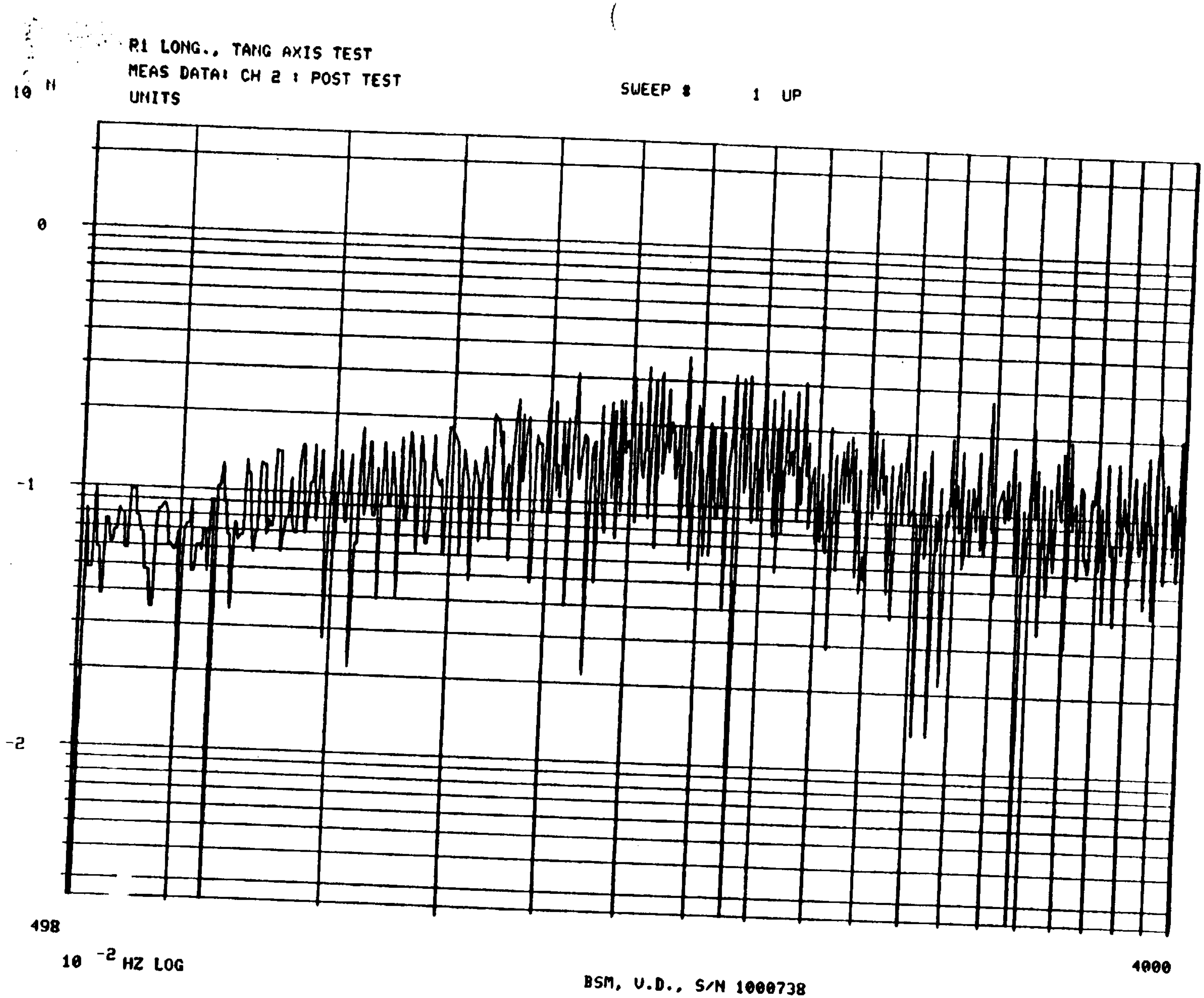

P2 TANG., TANG AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL = 24.79
G SQR/HZ
10
1
0
-1
-2
-3
20.0
10 0 HZ LOG
2000
BSM BOOST TANG, S/N 1000738


P2 RAD., TANG AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL • 10.48
G SQR/HZ
10
0
-1
-2
-3
-4
20.0
10 0 HZ LOG
2000
BSM BOOST TANG, S/N 1000738

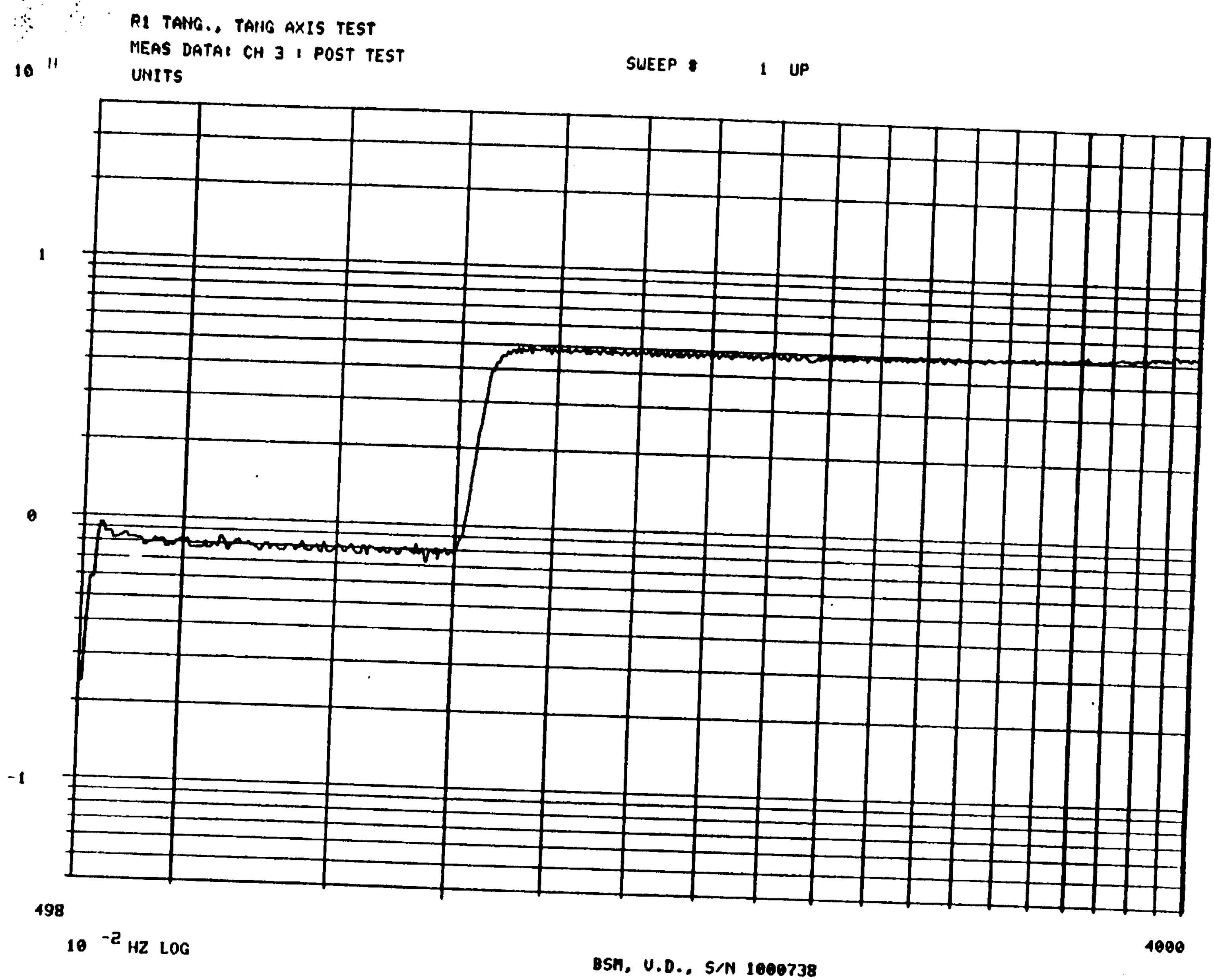
TANGENTIAL AXIS

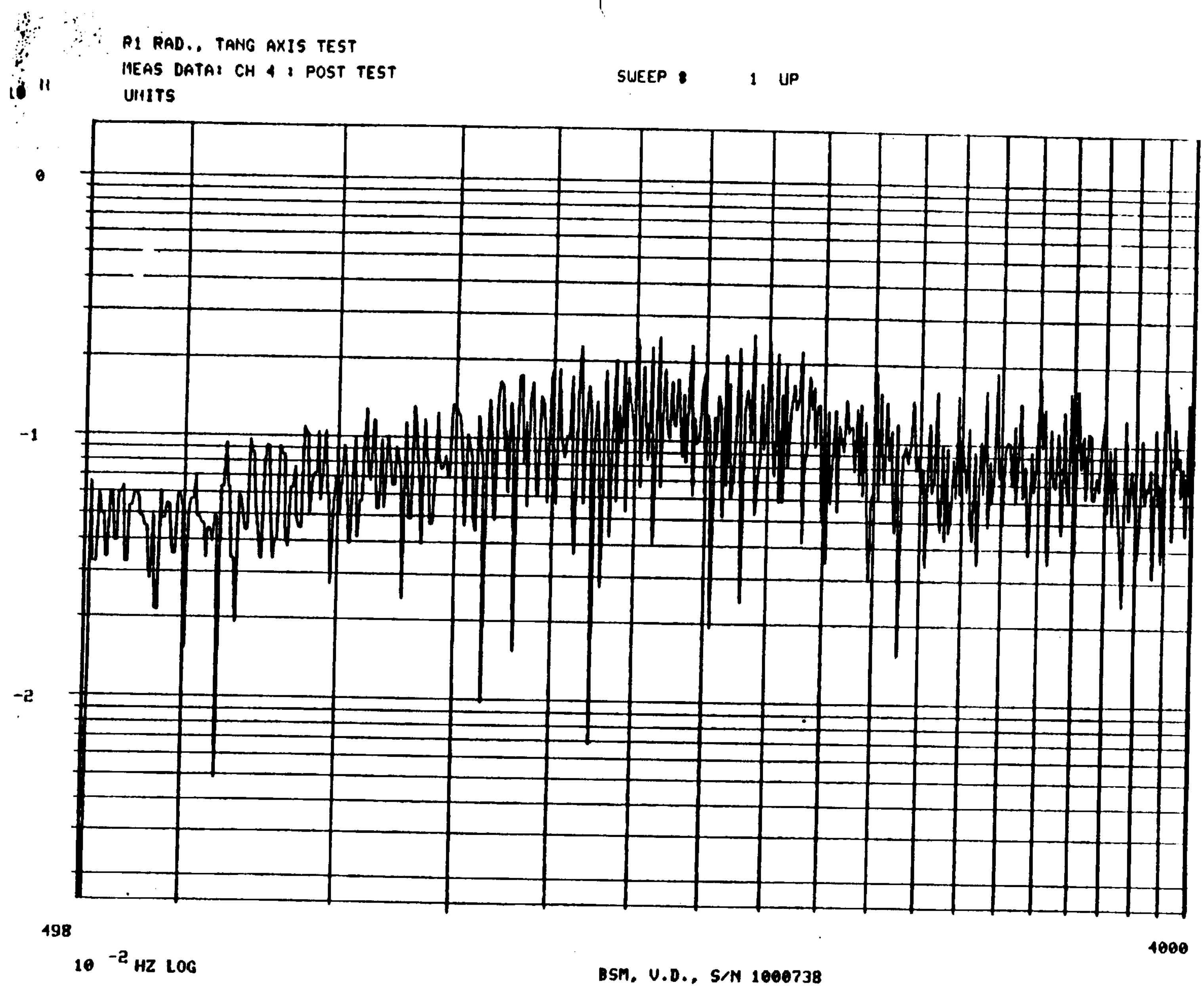
VEHICLE DYNAMICS


CONTROL TANG AXIS
POST TEST
G .
SWEEP 8 1 UP
10 N
2
1
0
-1
498
10 -2 HZ LOG
4000
BSM, U.D., TANG. S/N 1000738

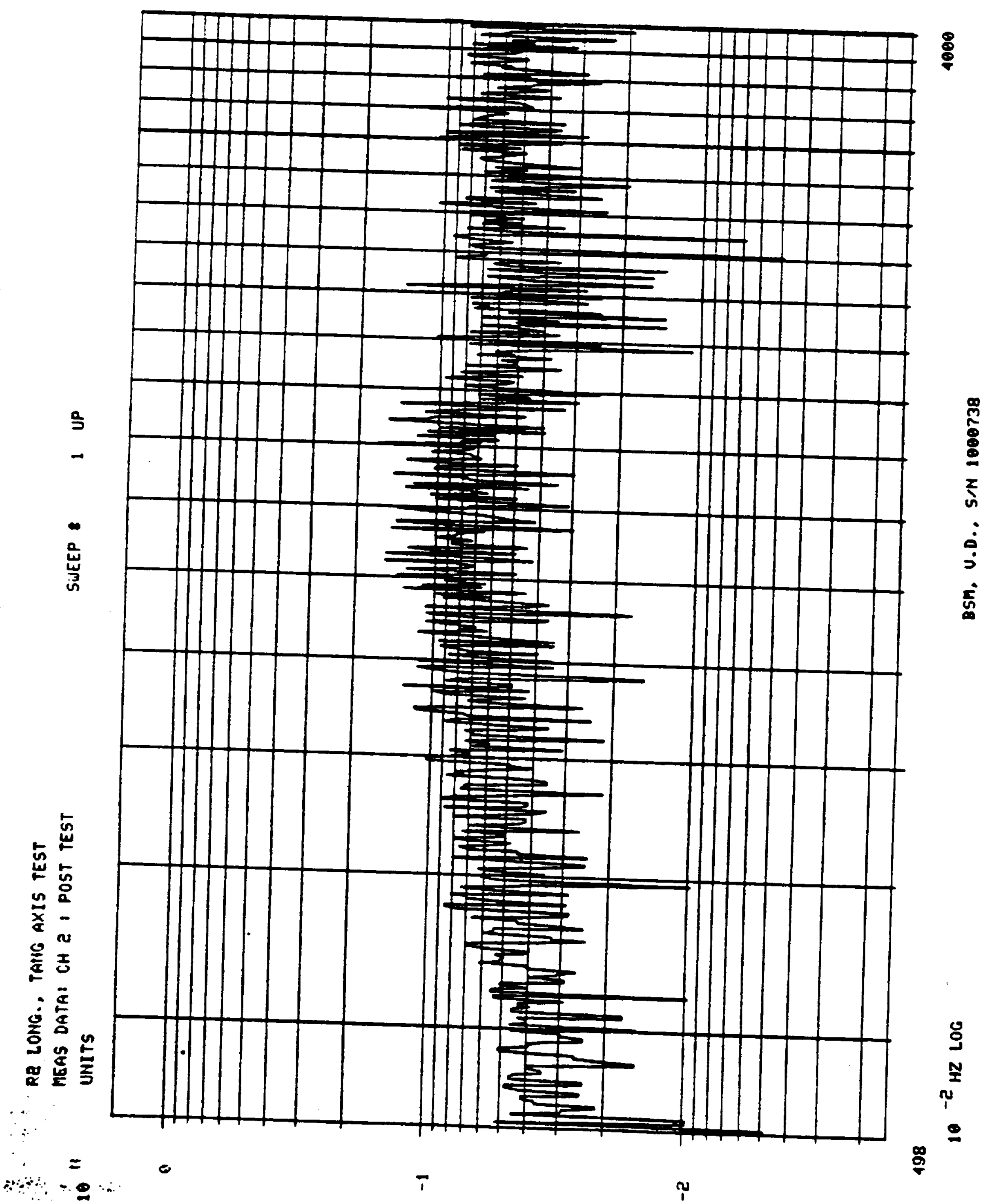


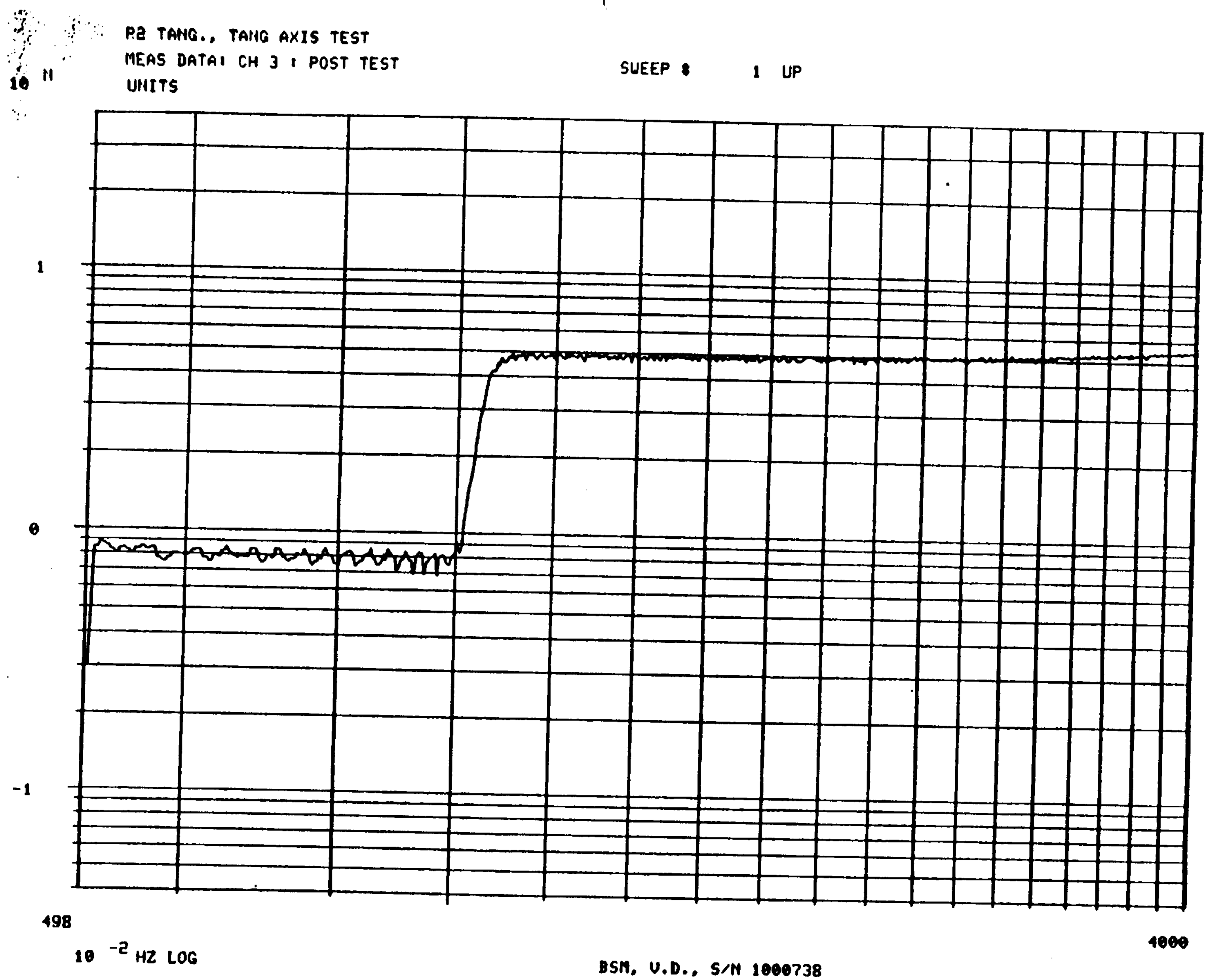
R1 LONG., TANG AXIS TEST
MEAS DATA: CH 2 : POST TEST
UNITS
SWEEP # 1 UP
10 N
0
-1
-2
498
10 -2 HZ LOG
4000
BSM, V.D., S/N 1000738


R1 TANG., TANG AXIS TEST
MEAS DATA: CH 3 : POST TEST
UNITS
SWEEP # 1 UP
10 ''
1
0
-1
498
10 -2 HZ LOG
4000
BSM, V.D., S/N 1000738



R1 RAD., TANG AXIS TEST
MEAS DATA: CH 4 : POST TEST
UNITS
SWEEP # 1 UP
10 ''
0
-1
-2
498
4000
10 -2 HZ LOG
BSM, V.D., S/N 1000738

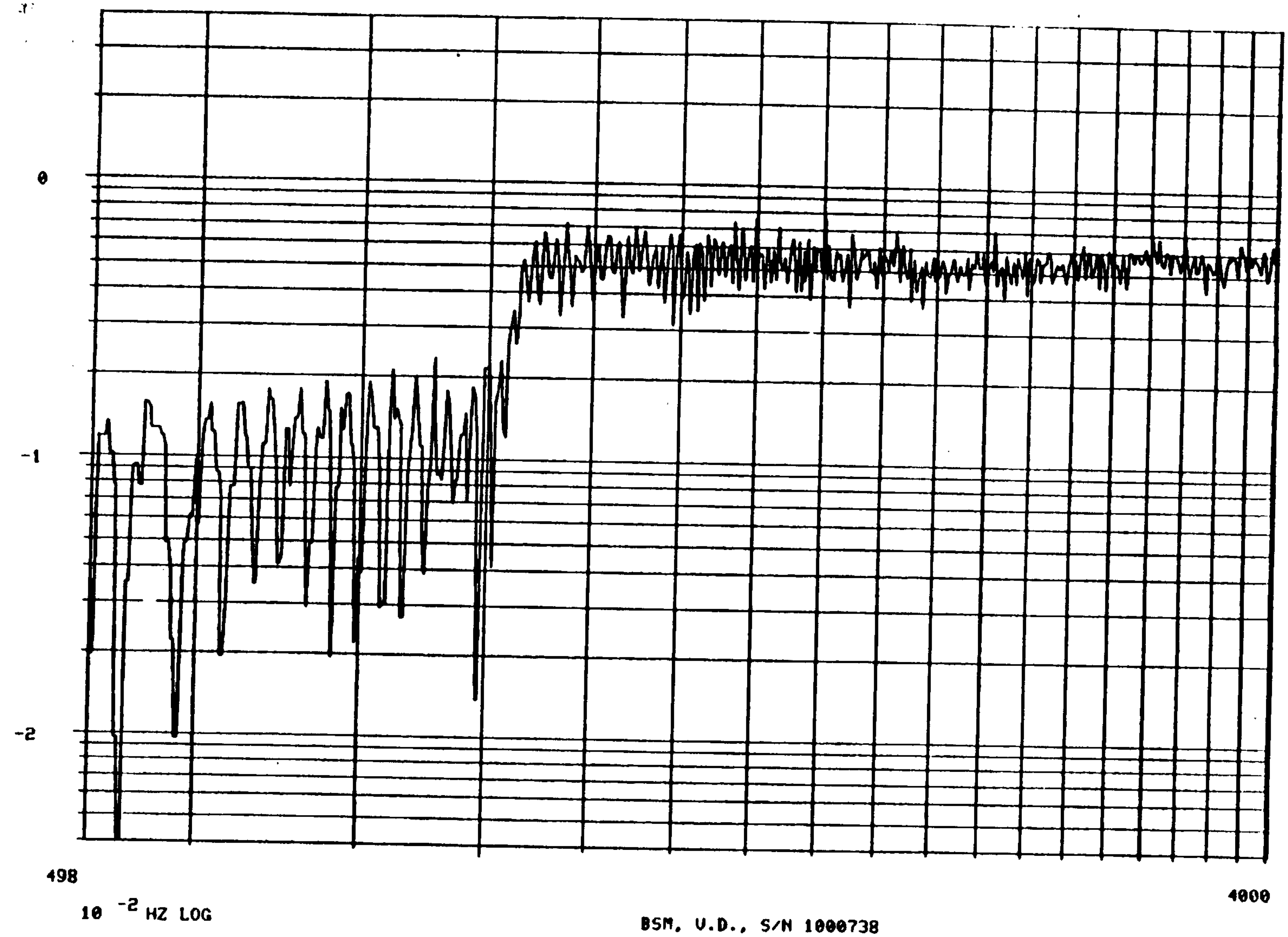

RB LONG., TANG AXIS TEST
MEAS DATA: CH 2 : POST TEST
UNITS
SWEEP # 1 UP
BSM, V.D., S/N 1000738
10 -2 HZ LOG
498
4000
0
-1
-2
10 ::



R2 TANG., TANG AXIS TEST
MEAS DATA: CH 3 : POST TEST
UNITS
10 N
SWEEP # 1 UP
1
0
-1
498
4000
10 -2 HZ LOG
BSM, V.D., S/N 1000738

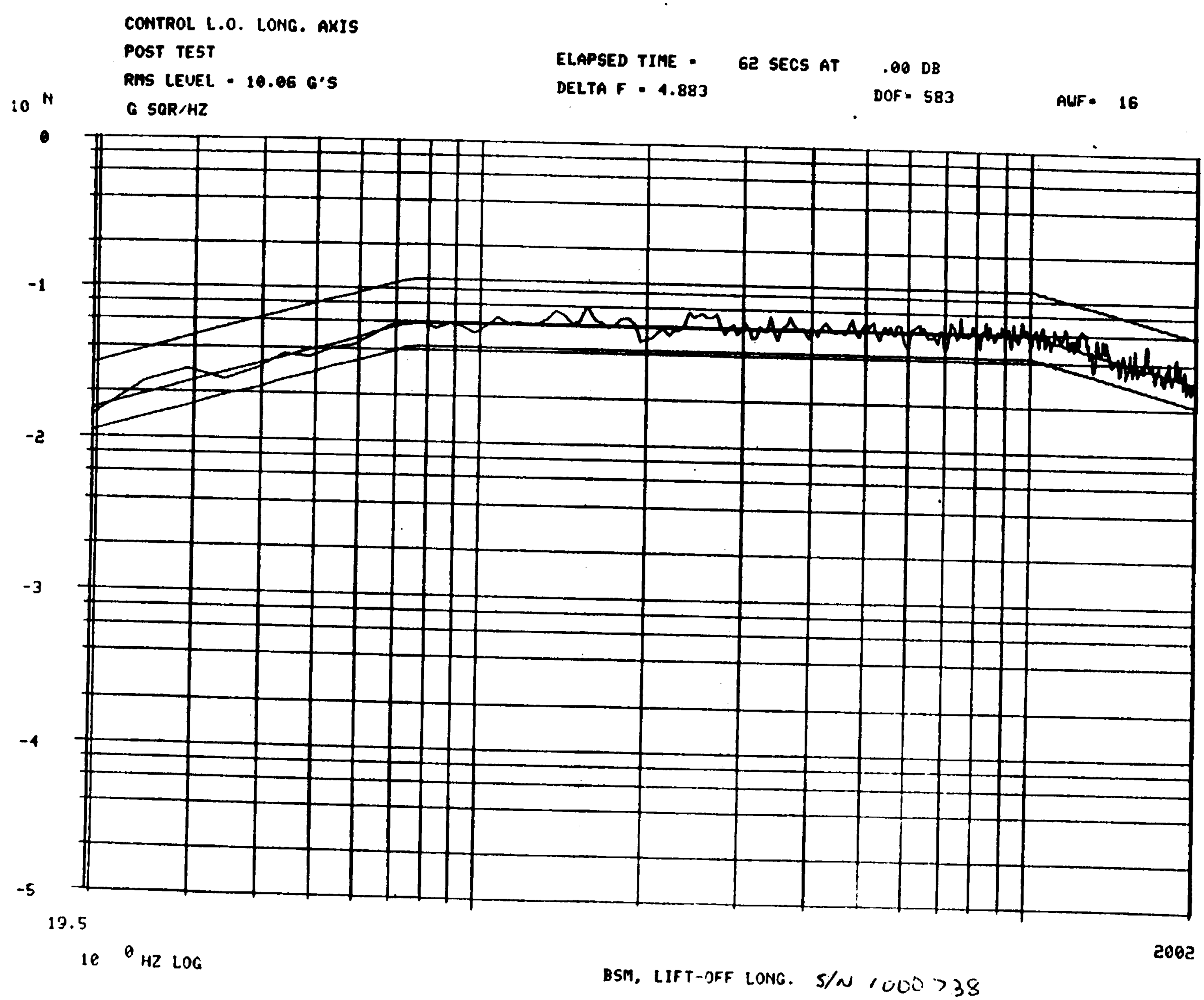
P2 RAD., TANG AXIS TEST
MEAS DATA: CH 4 : POST TEST
UNITS

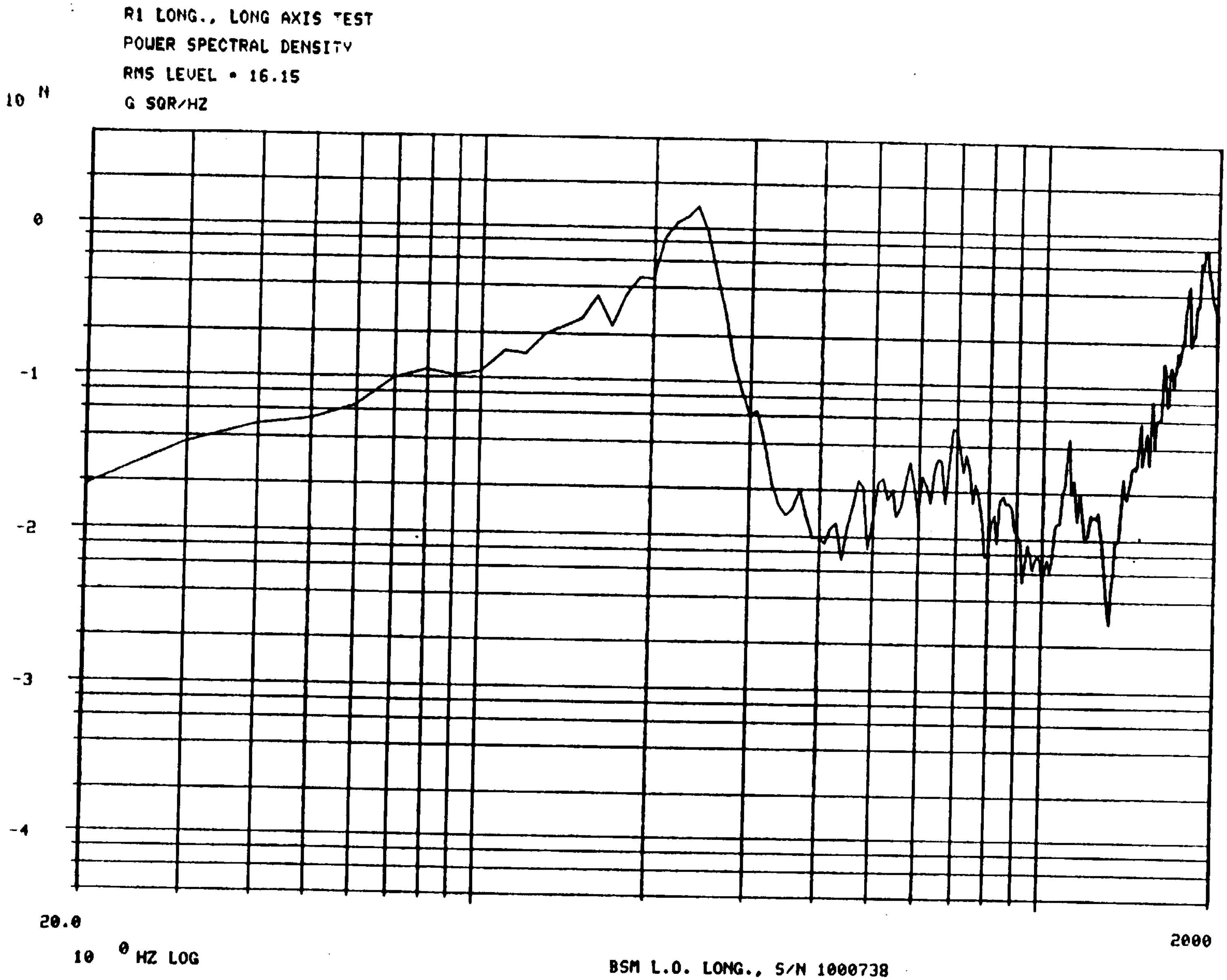
SWEEP # 1 UP

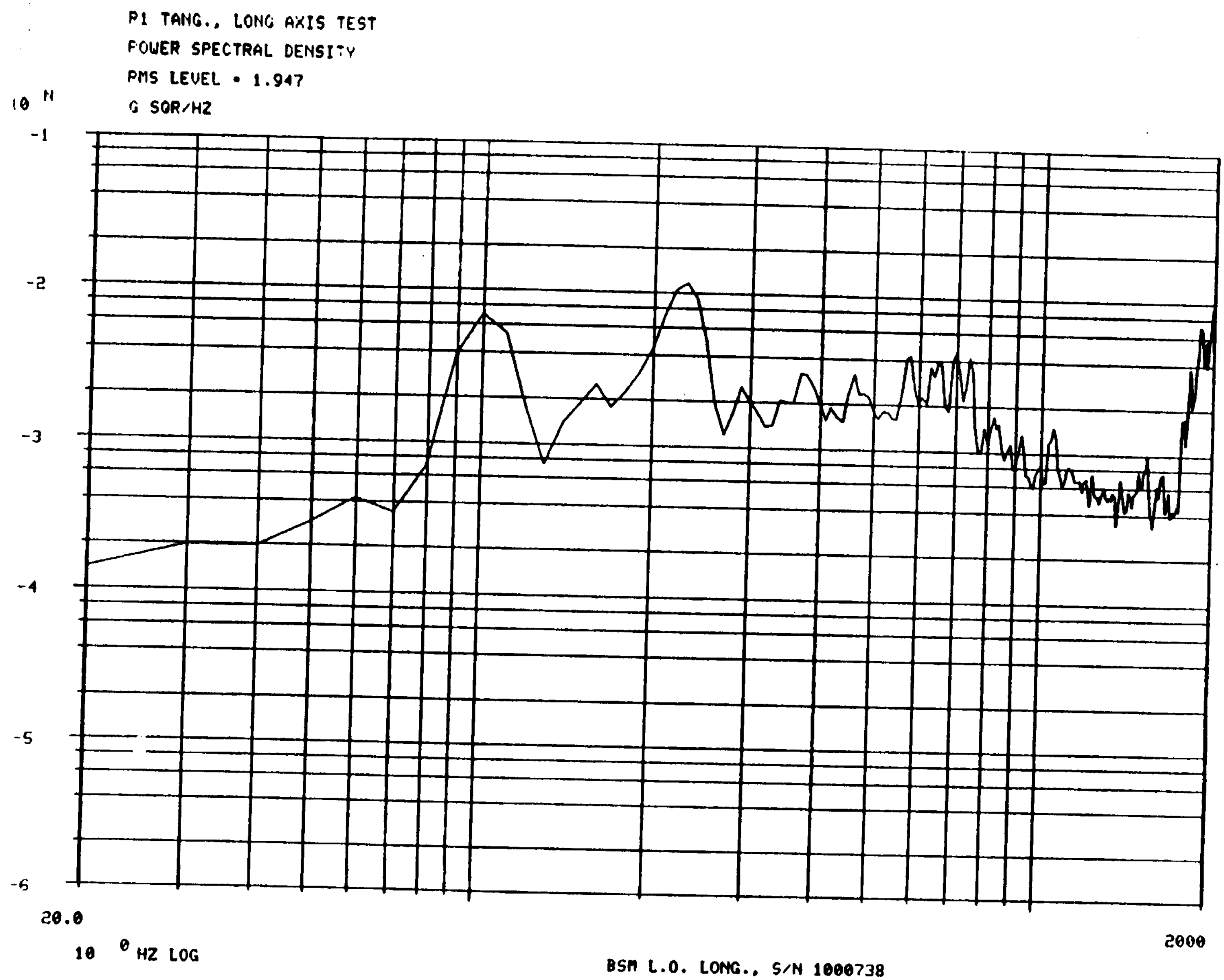


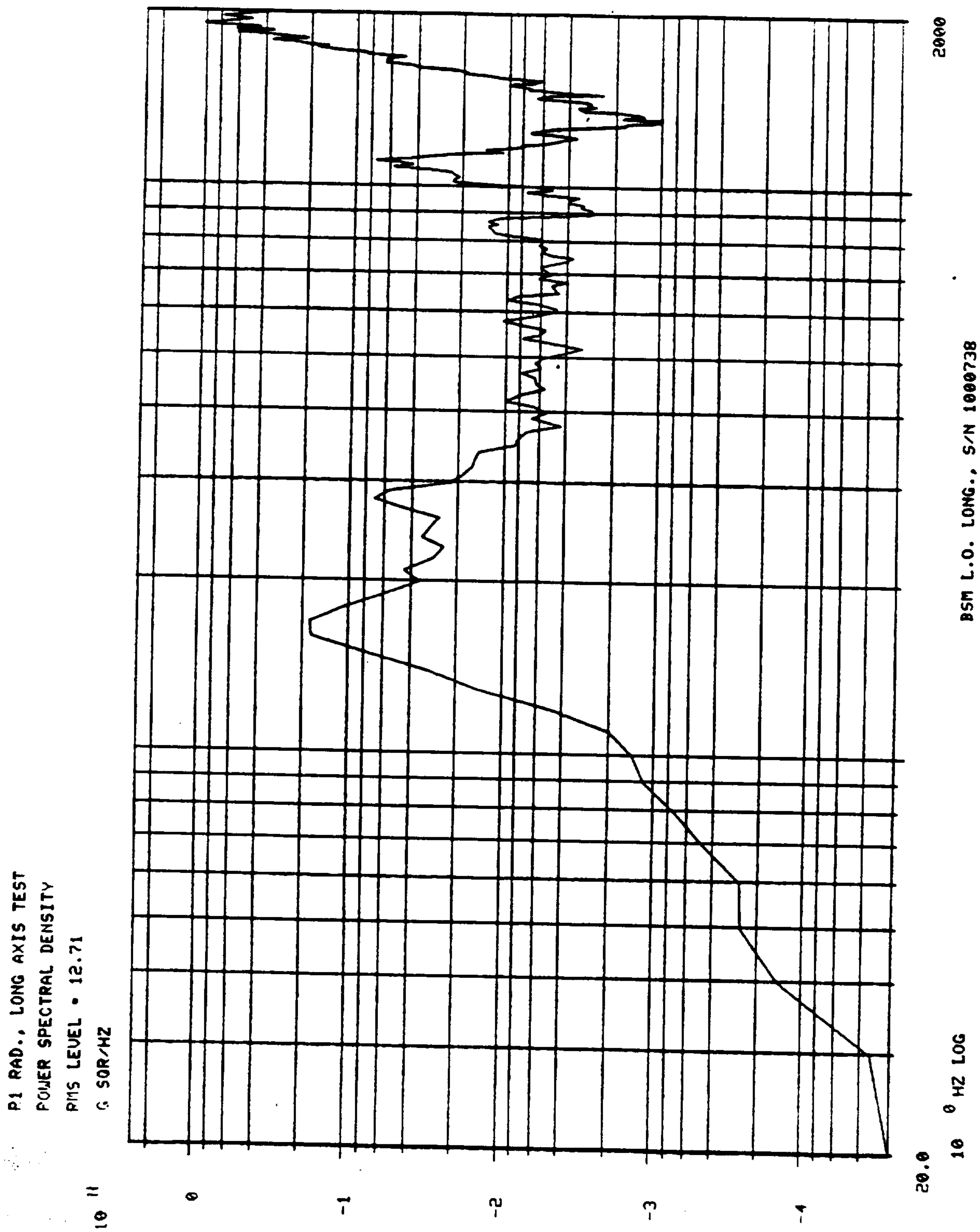
LONGITUDINAL AXIS

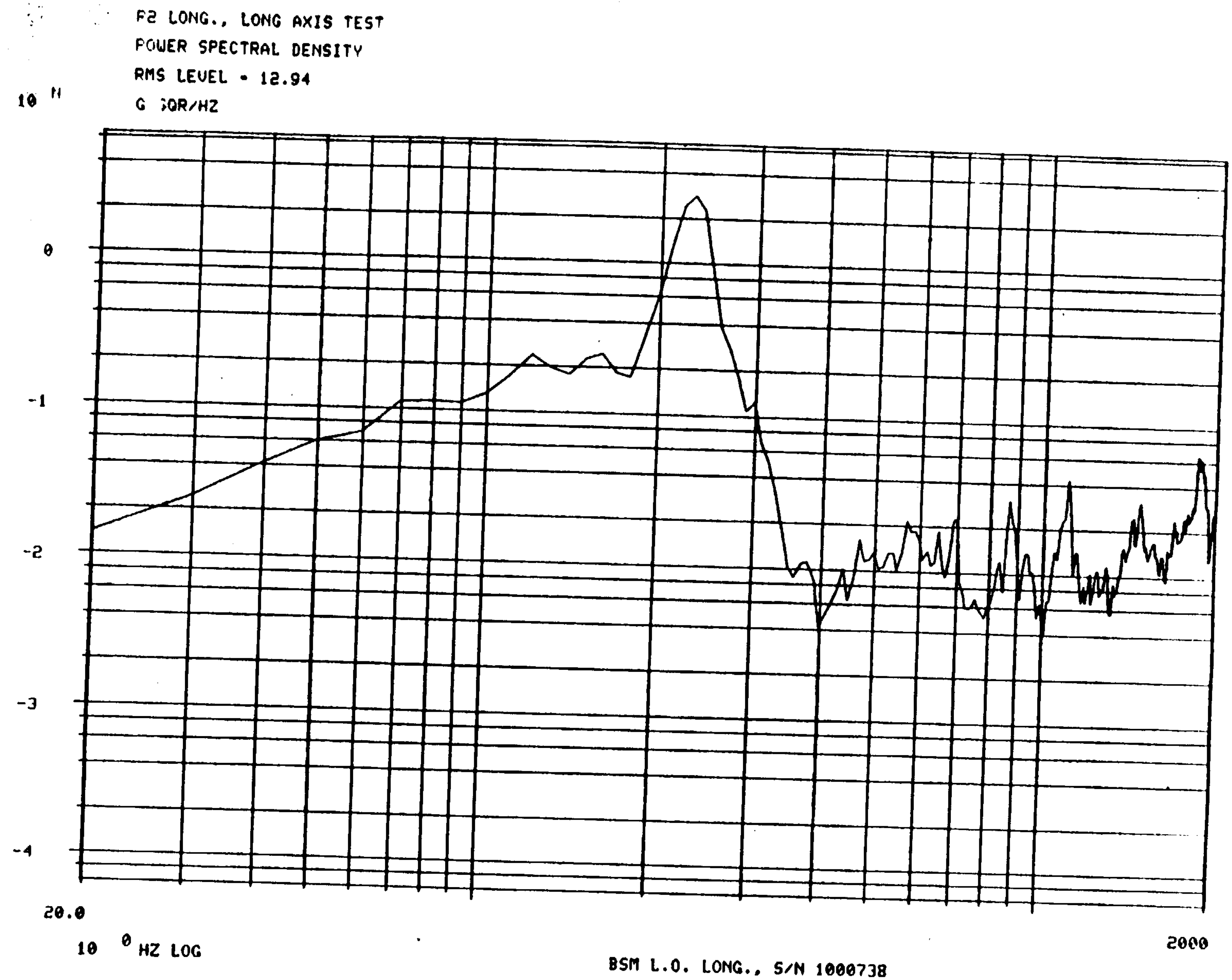
RANDOM, LIFT-OFF

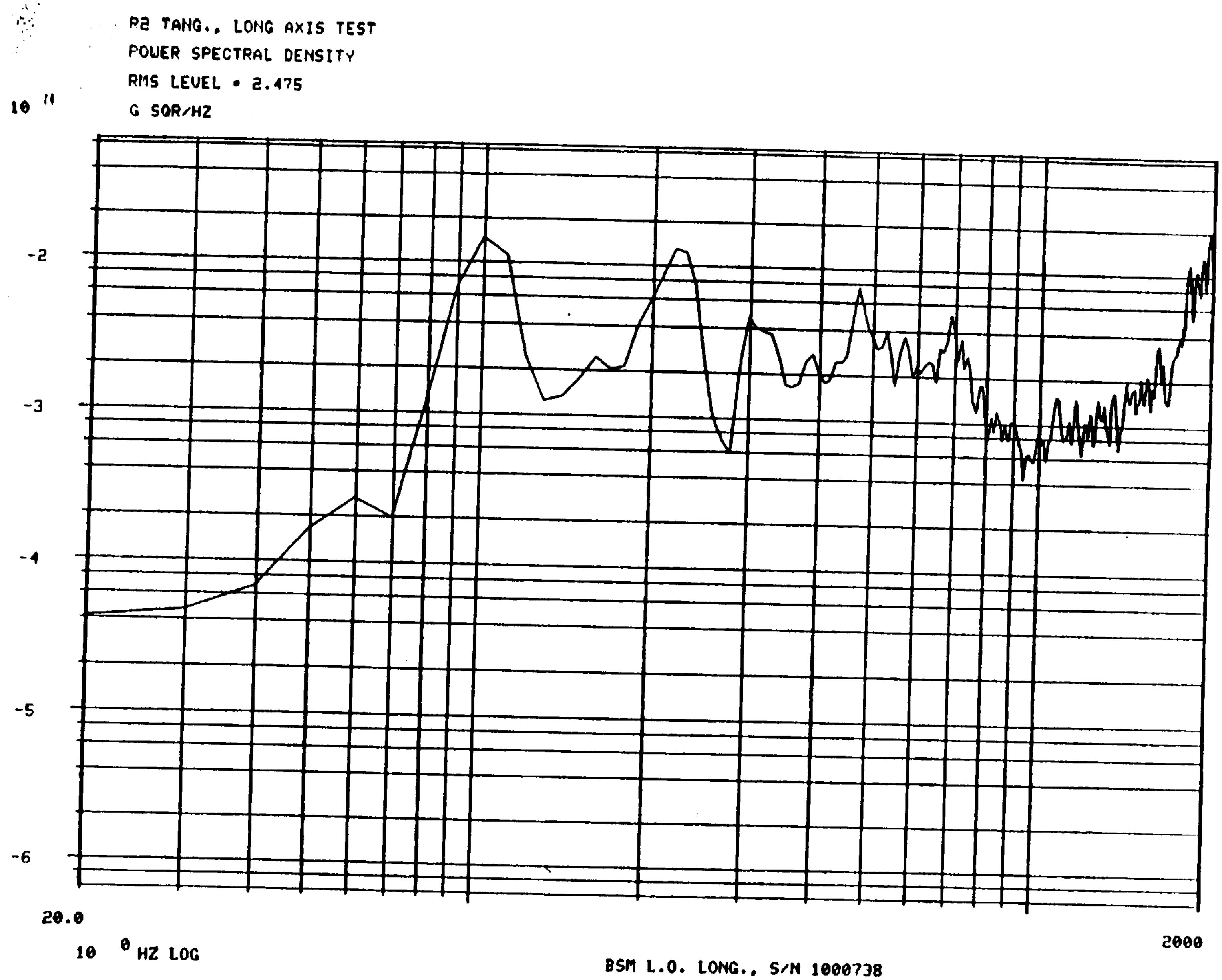

CONTROL L.O. LONG. AXIS
POST TEST
RMS LEVEL • 10.06 G'S
G SQR/HZ
ELAPSED TIME • 62 SECS AT .00 DB
DELTA F • 4.883
DOF• 583
AWF• 16
10 N
0
-1
-2
-3
-4
-5
19.5
10 0 HZ LOG
2002
BSM, LIFT-OFF LONG. S/N 1000738


R1 LONG., LONG AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL • 16.15
G SQR/HZ
10 N
0
-1
-2
-3
-4
20.0
10 0 HZ LOG
2000
BSM L.O. LONG., S/N 1000738

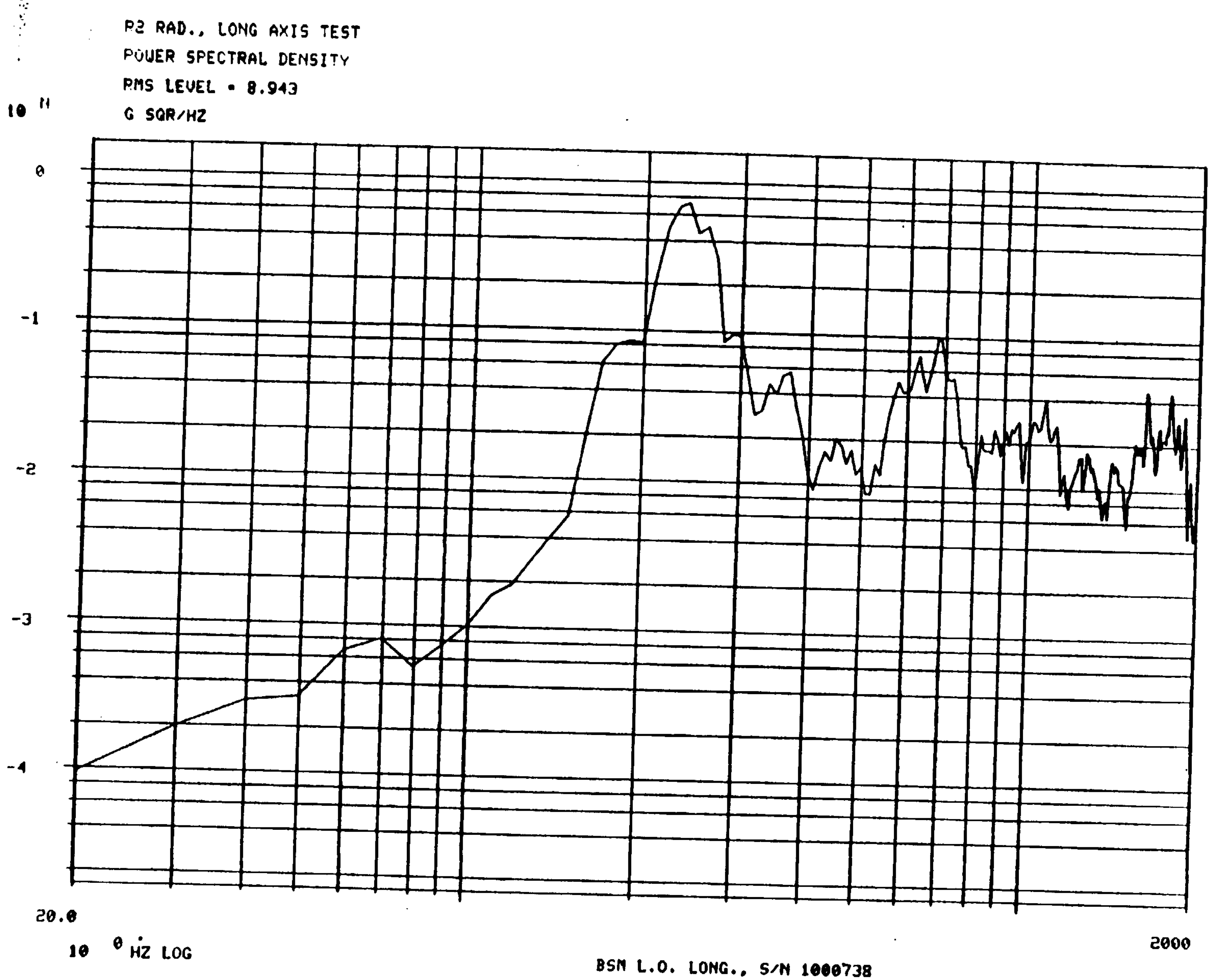

P1 TANG., LONG AXIS TEST
POWER SPECTRAL DENSITY
PMS LEVEL • 1.947
G SQR/HZ
10 N
-1
-2
-3
-4
-5
-6
20.0
10 0 HZ LOG
2000
BSM L.O. LONG., S/N 1000738


P1 RAD., LONG AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL • 12.71
G SQR/HZ
10
0
-1
-2
-3
-4
20.0
10 0 HZ LOG
2000
BSM L.O. LONG., S/N 1000738


F2 LONG., LONG AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL = 12.94
G SQR/HZ
10 N
0
-1
-2
-3
-4
20.0
10 0 HZ LOG
2000
BSM L.O. LONG., S/N 1000738

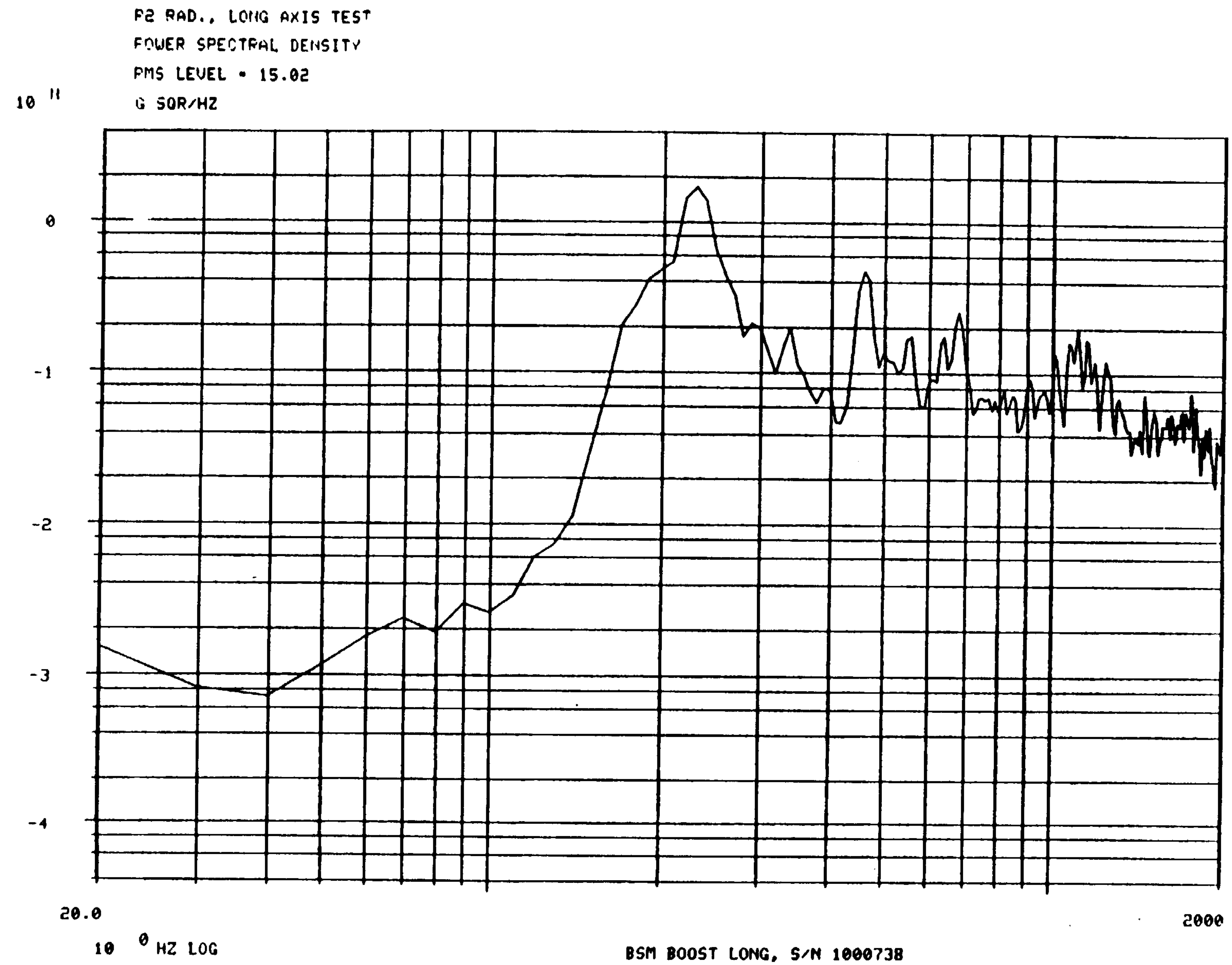


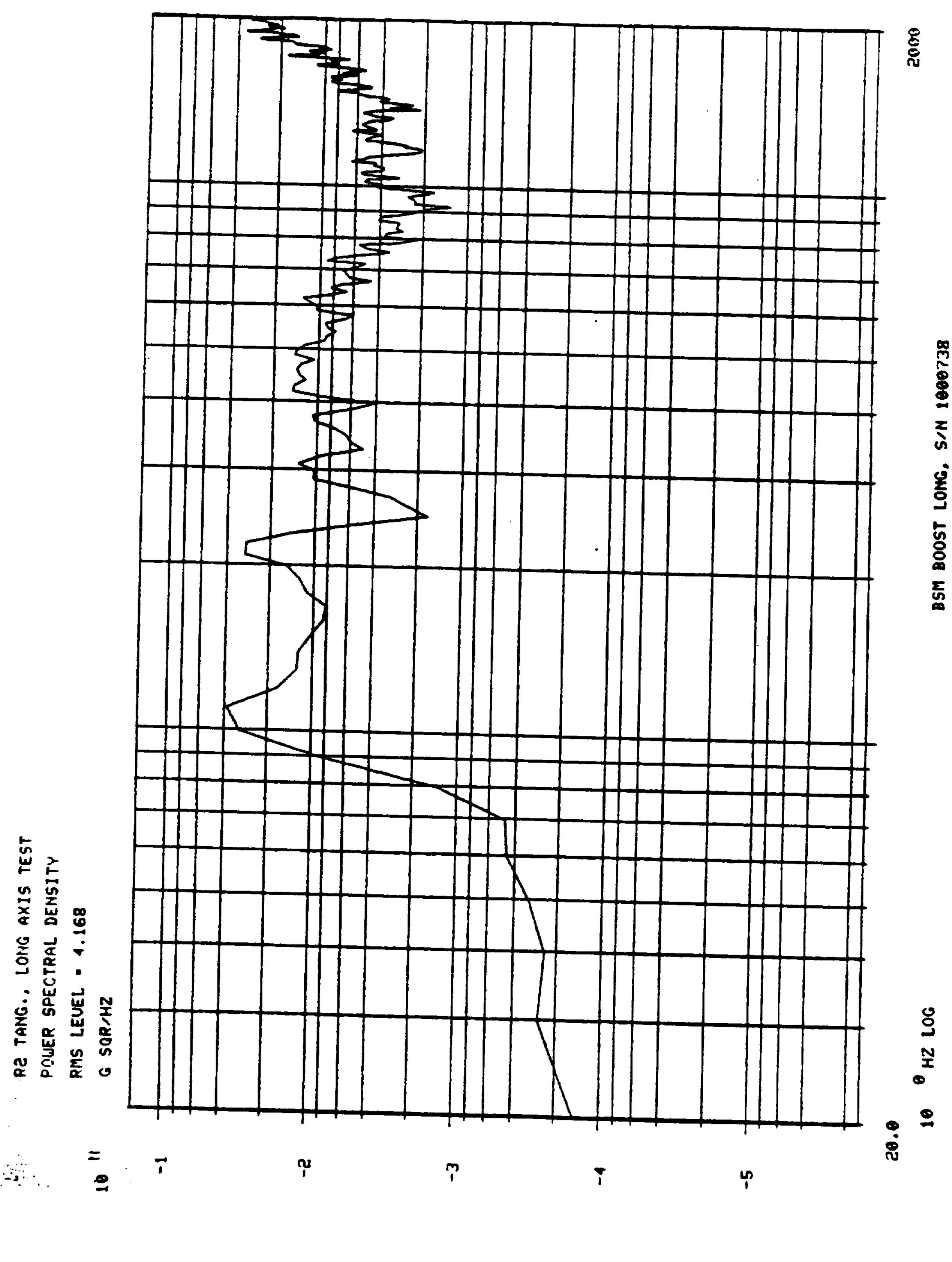
P2 TANG., LONG AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL • 2.475
G SQR/HZ
10
-2
-3
-4
-5
-6
20.0
10 0 HZ LOG
2000
BSM L.O. LONG., S/N 1000738


R2 RAD., LONG AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL = 8.943
G SQR/HZ
10 N
0
-1
-2
-3
-4
20.0
10 0 HZ LOG
2000
BSN L.O. LONG., S/N 1000738

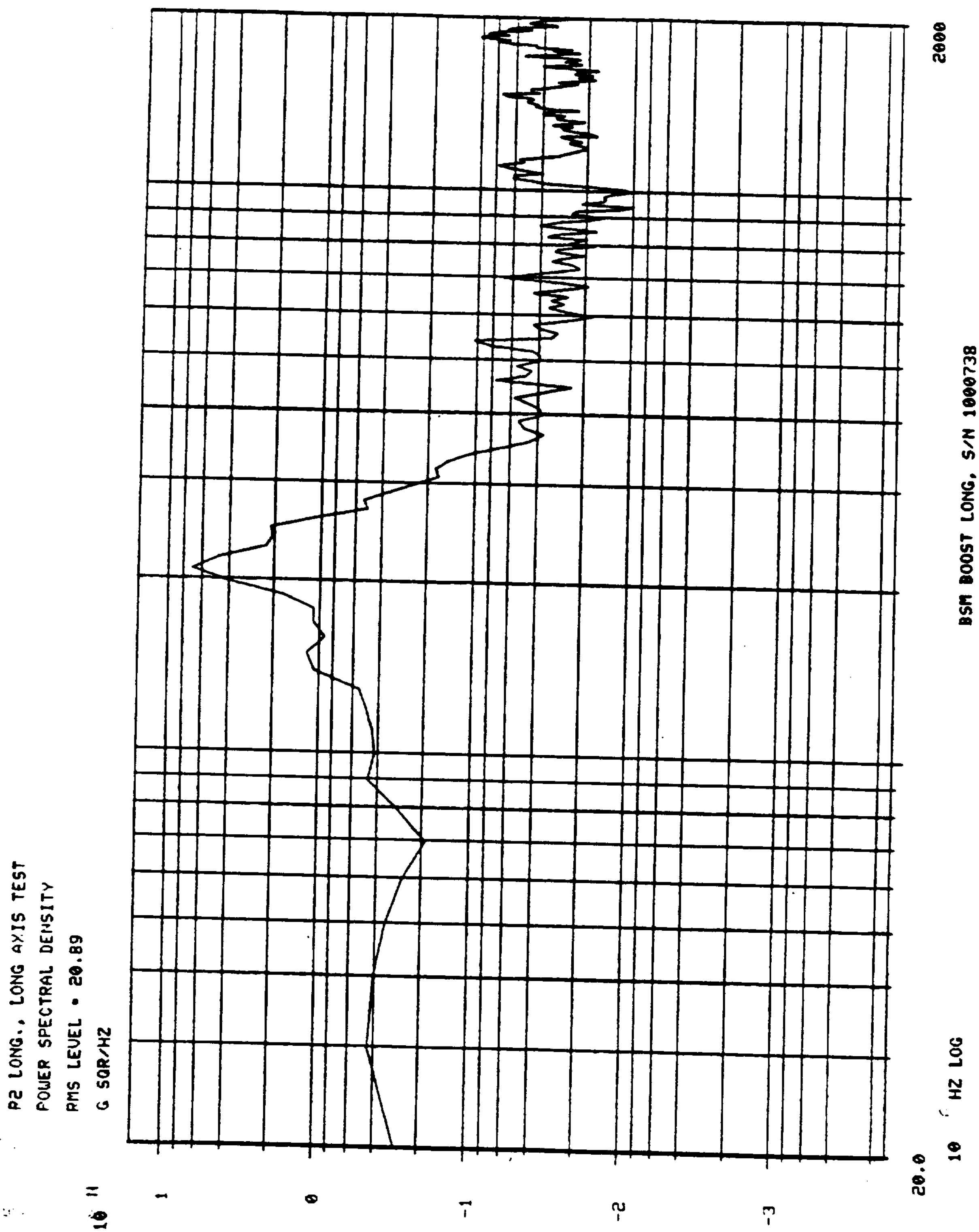
LONGITUDINAL AXIS

VEHICLE DYNAMICS

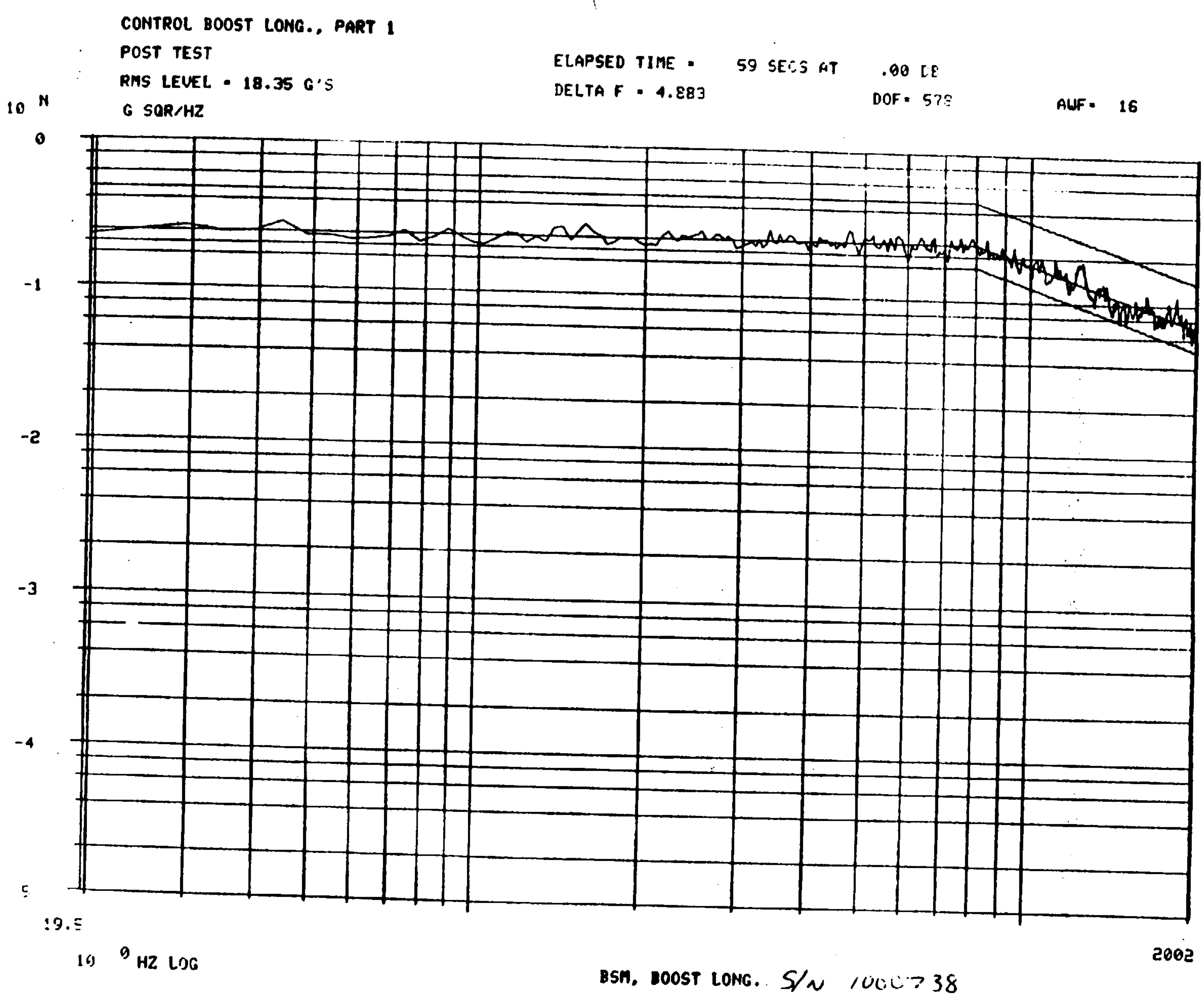

P2 RAD., LONG AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL • 15.02
G SQR/HZ
10 ^11
0
-1
-2
-3
-4
20.0
2000
10 ^0 HZ LOG
BSM BOOST LONG, S/N 1000738



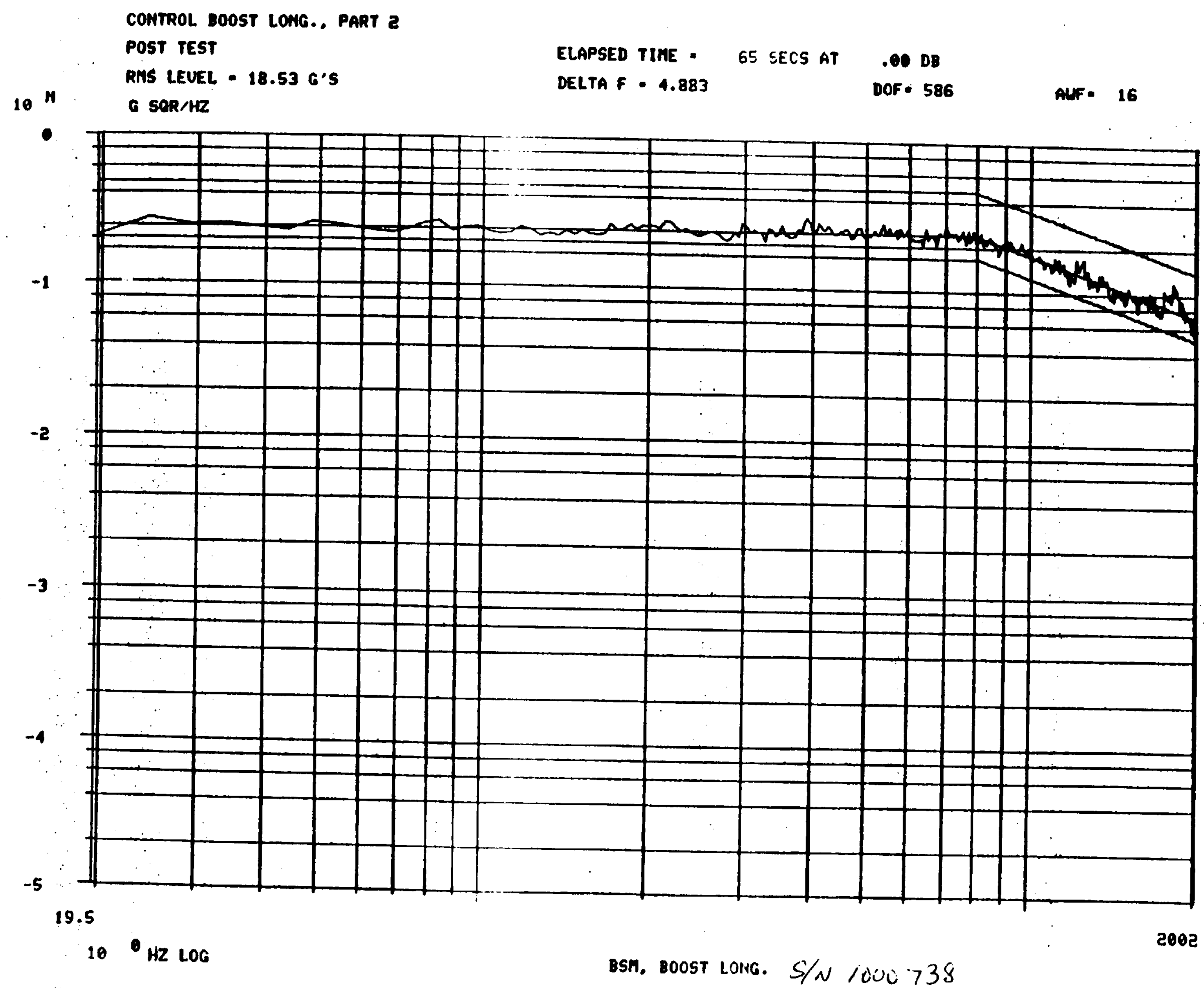
R2 TANG., LONG AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL = 4.168
G SQR/HZ
10
-1
-2
-3
-4
-5
20.0
10 0 HZ LOG
2000
BSM BOOST LONG, S/N 1000738

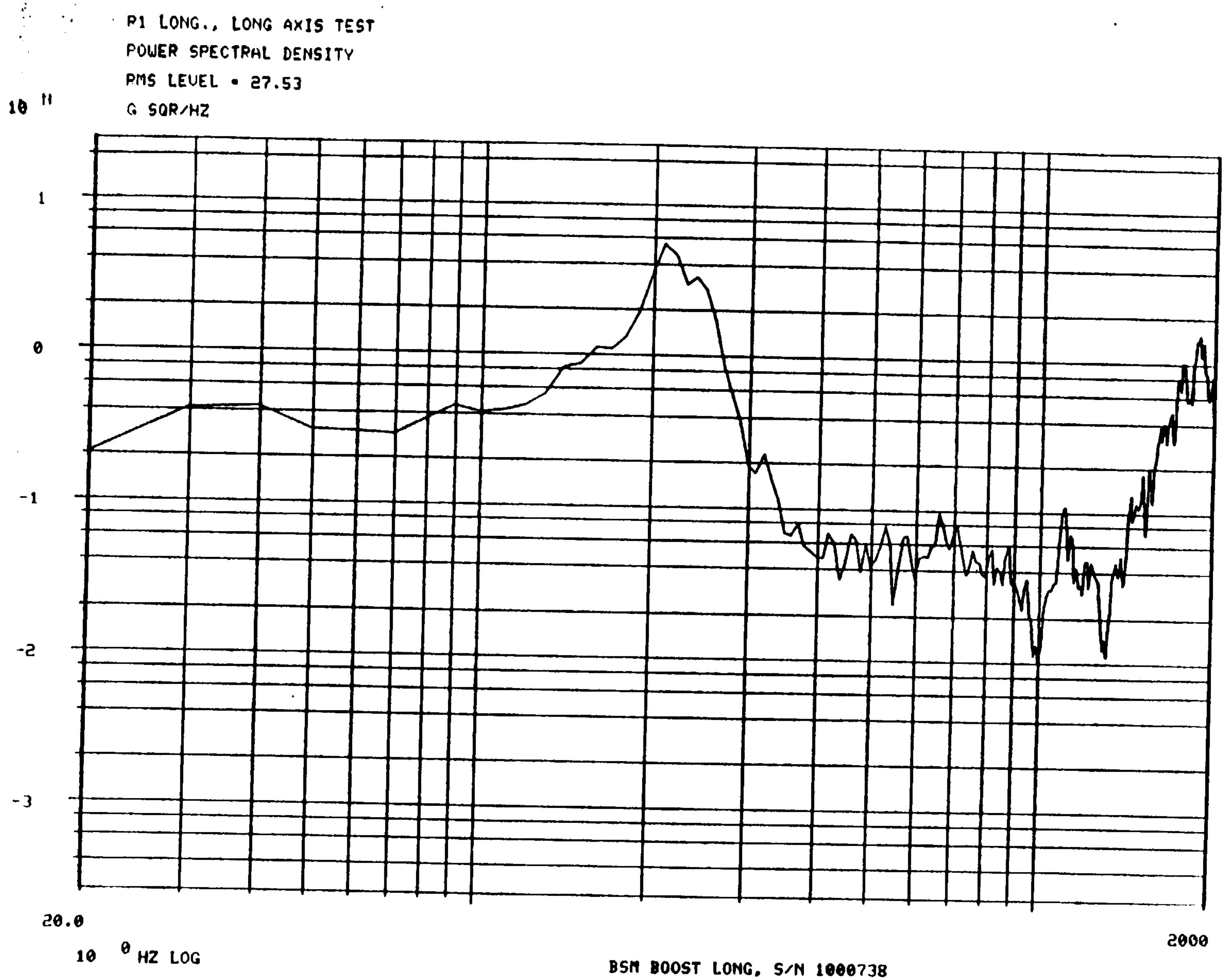

P2 LONG., LONG AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL • 20.89
G SQR/HZ
10
1
0
-1
-2
-3
20.0
10
HZ LOG
2000
BSM BOOST LONG, S/N 1000738

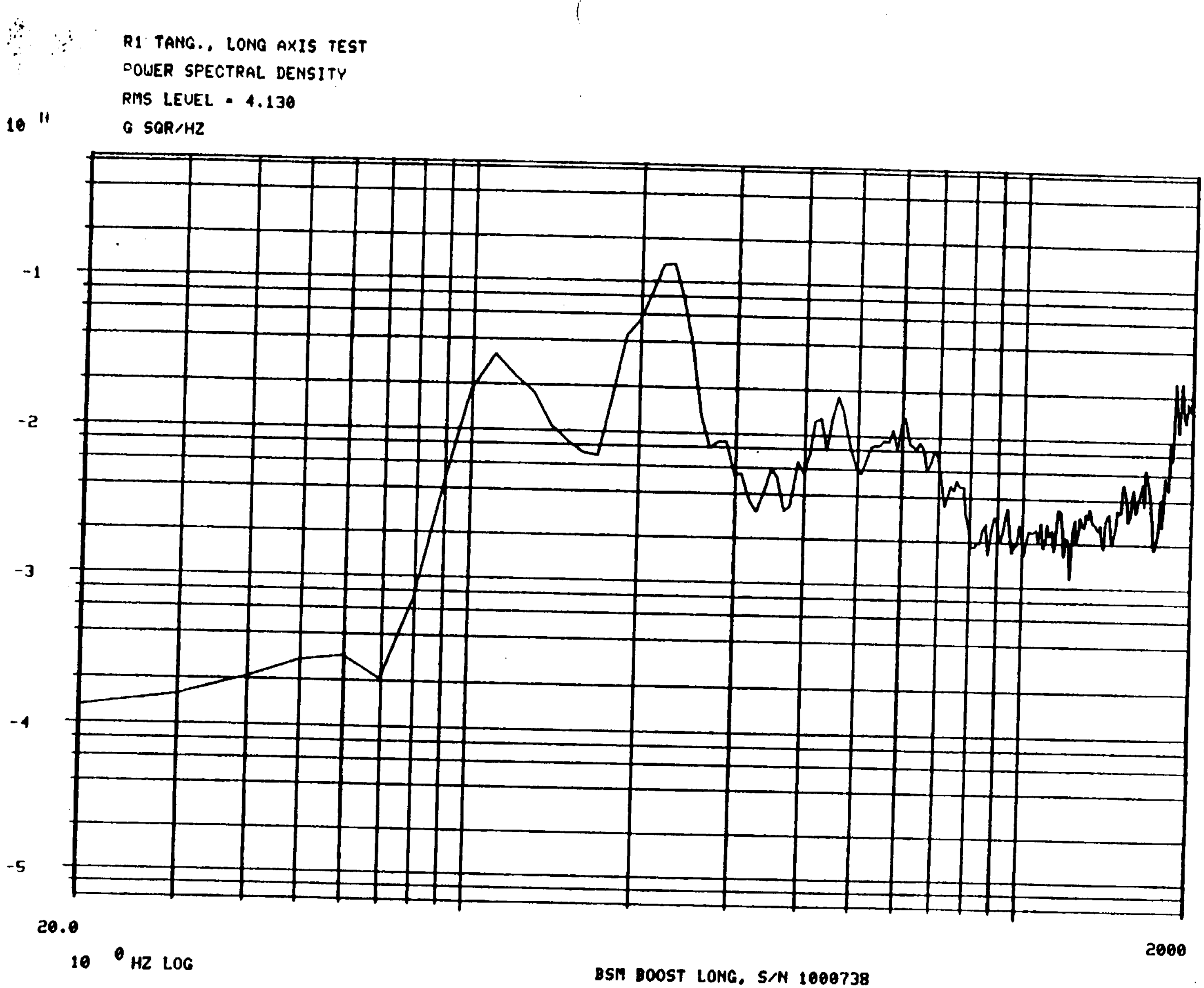
C-5

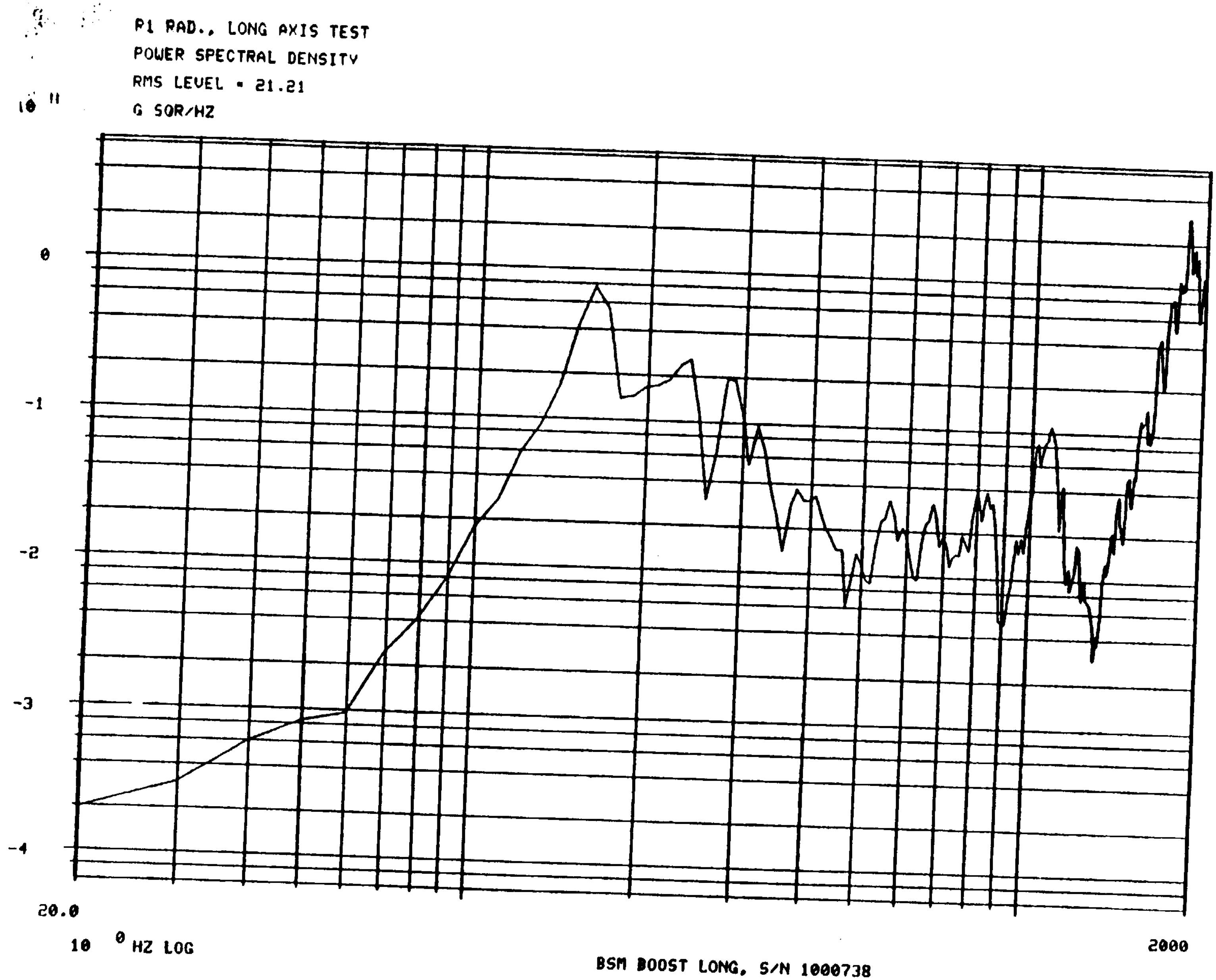


CONTROL BOOST LONG., PART 1
POST TEST
RMS LEVEL = 18.35 G'S
G SQR/HZ
ELAPSED TIME = 59 SECS AT .00 DB
DELTA F = 4.883
DOF = 578
AWF = 16
10 N
0
-1
-2
-3
-4
5
19.5
10 0 HZ LOG
2002
BSM, BOOST LONG. S/N 1000738


CONTROL BOOST LONG., PART 2
POST TEST
RMS LEVEL = 18.53 G'S
G SQR/HZ
ELAPSED TIME = 65 SECS AT .00 DB
DELTA F = 4.883
DOF= 586
AWF= 16
10 M
0
-1
-2
-3
-4
-5
19.5
10 0 HZ LOG
2002
BSM, BOOST LONG. S/N 1000738


P1 LONG., LONG AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL • 27.53
G SQR/HZ
10 ''
1
0
-1
-2
-3
20.0
10 0 HZ LOG
2000
BSM BOOST LONG, S/N 1000738


R1 TANG., LONG AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL = 4.130
G SQR/HZ
10 ^
-1
-2
-3
-4
-5
20.0
10 ^0 HZ LOG
2000
BSM BOOST LONG, S/N 1000738

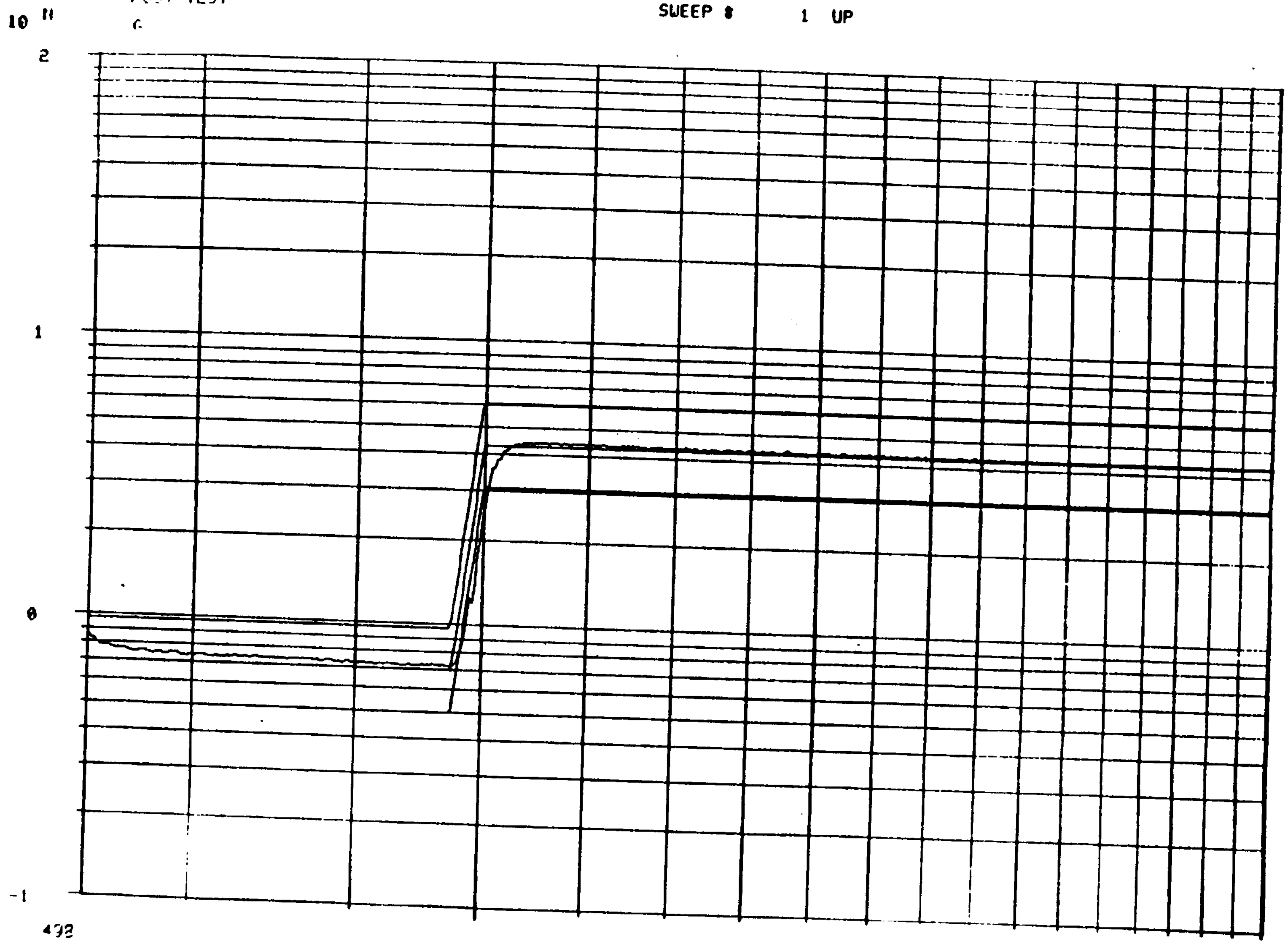

P1 RAD., LONG AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL = 21.21
G SQR/HZ
10
0
-1
-2
-3
-4
20.0
10 0 HZ LOG
2000
BSM BOOST LONG, S/N 1000738

LONGITUDINAL AXIS

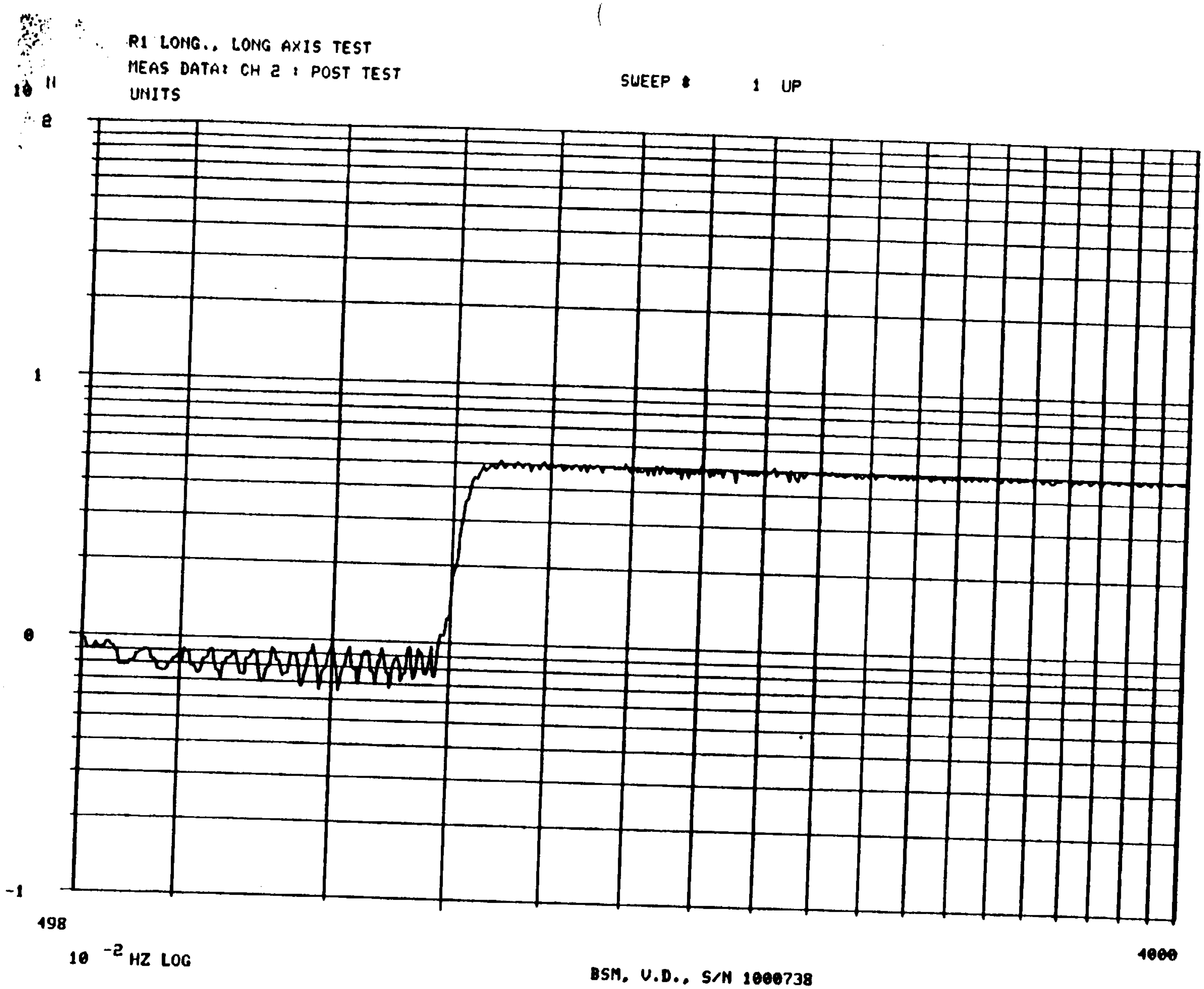
RANDOM, BOOST

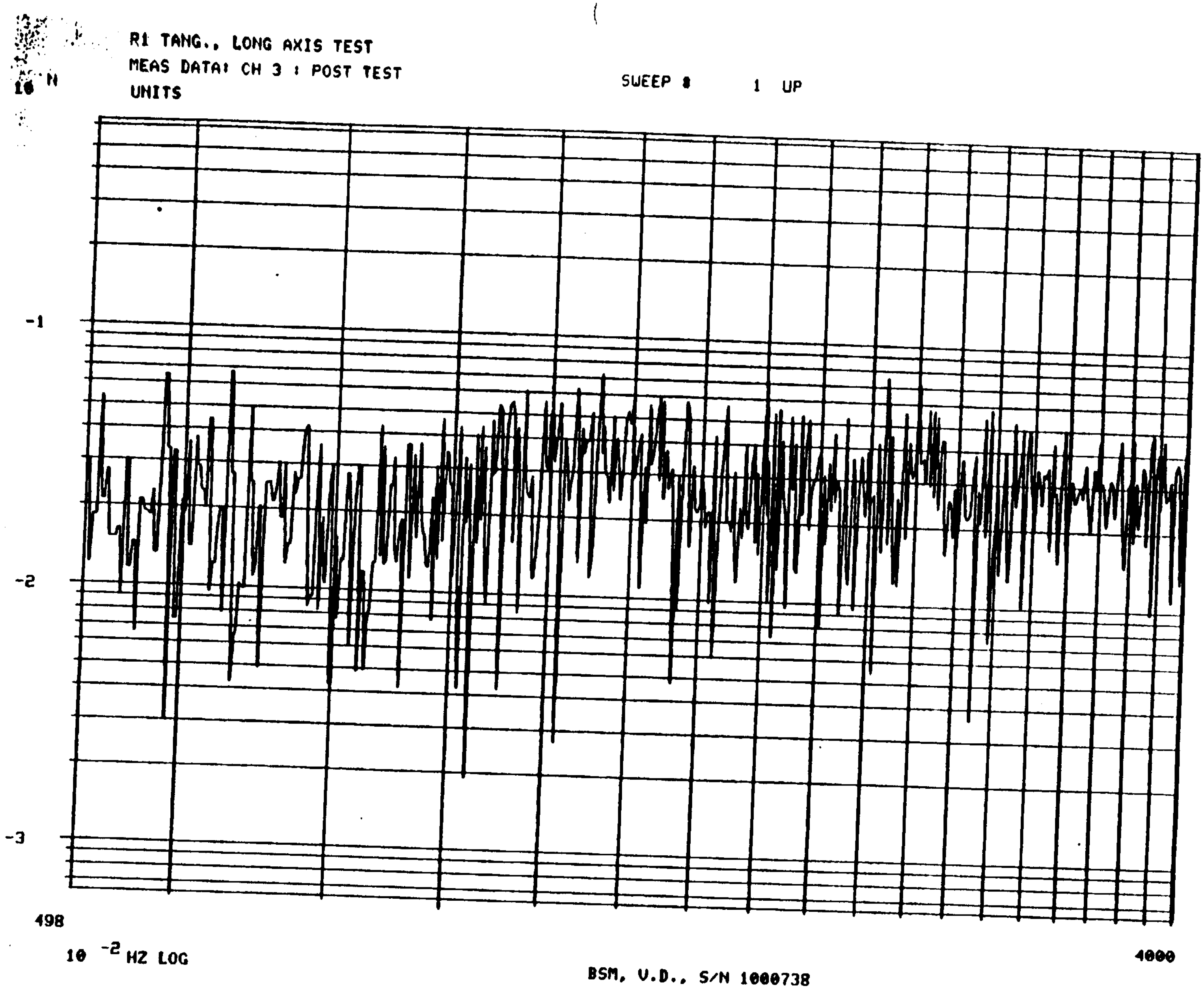
CONTROL LONG. AXIS
POST TEST

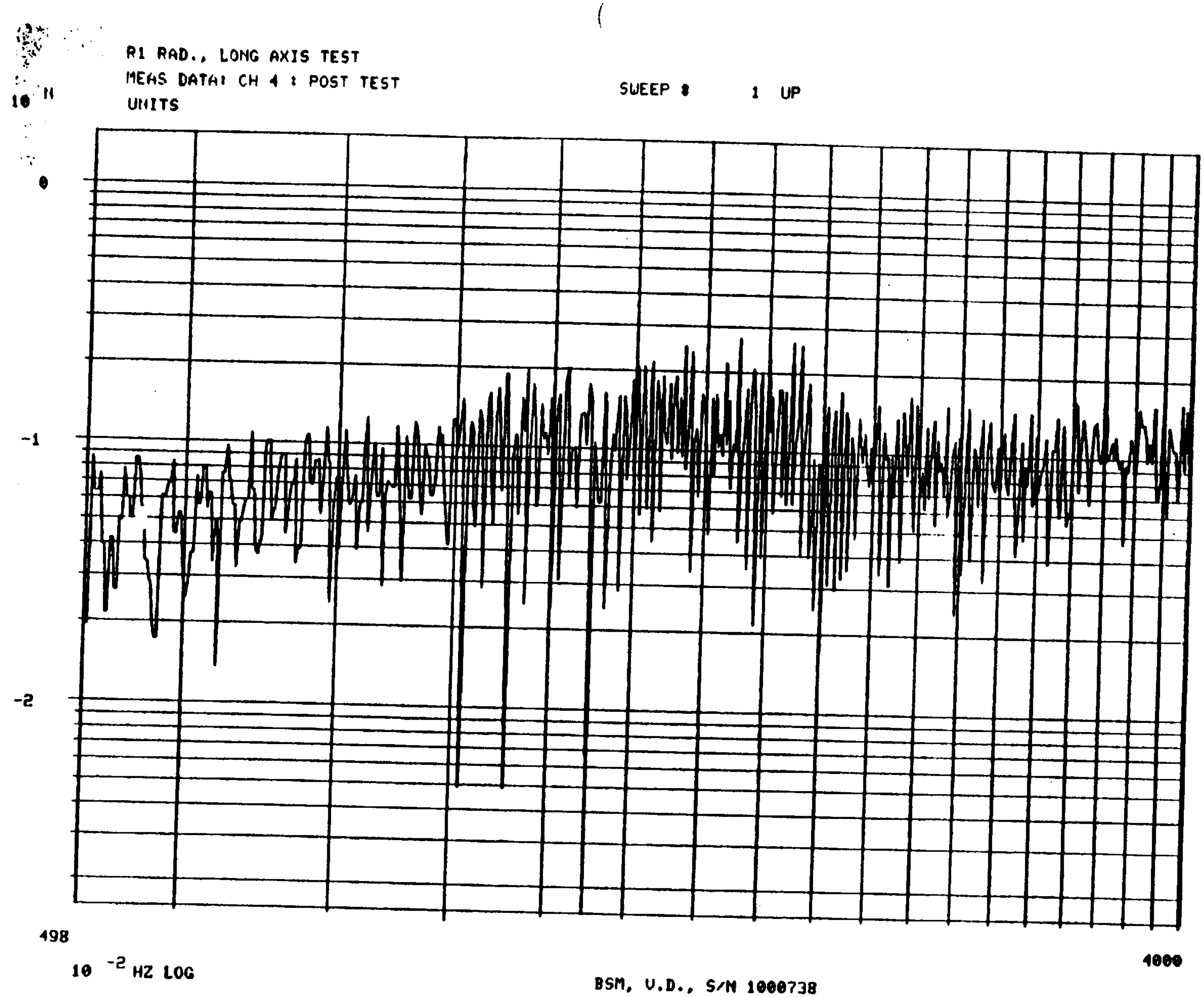
SWEEP # 1 UP

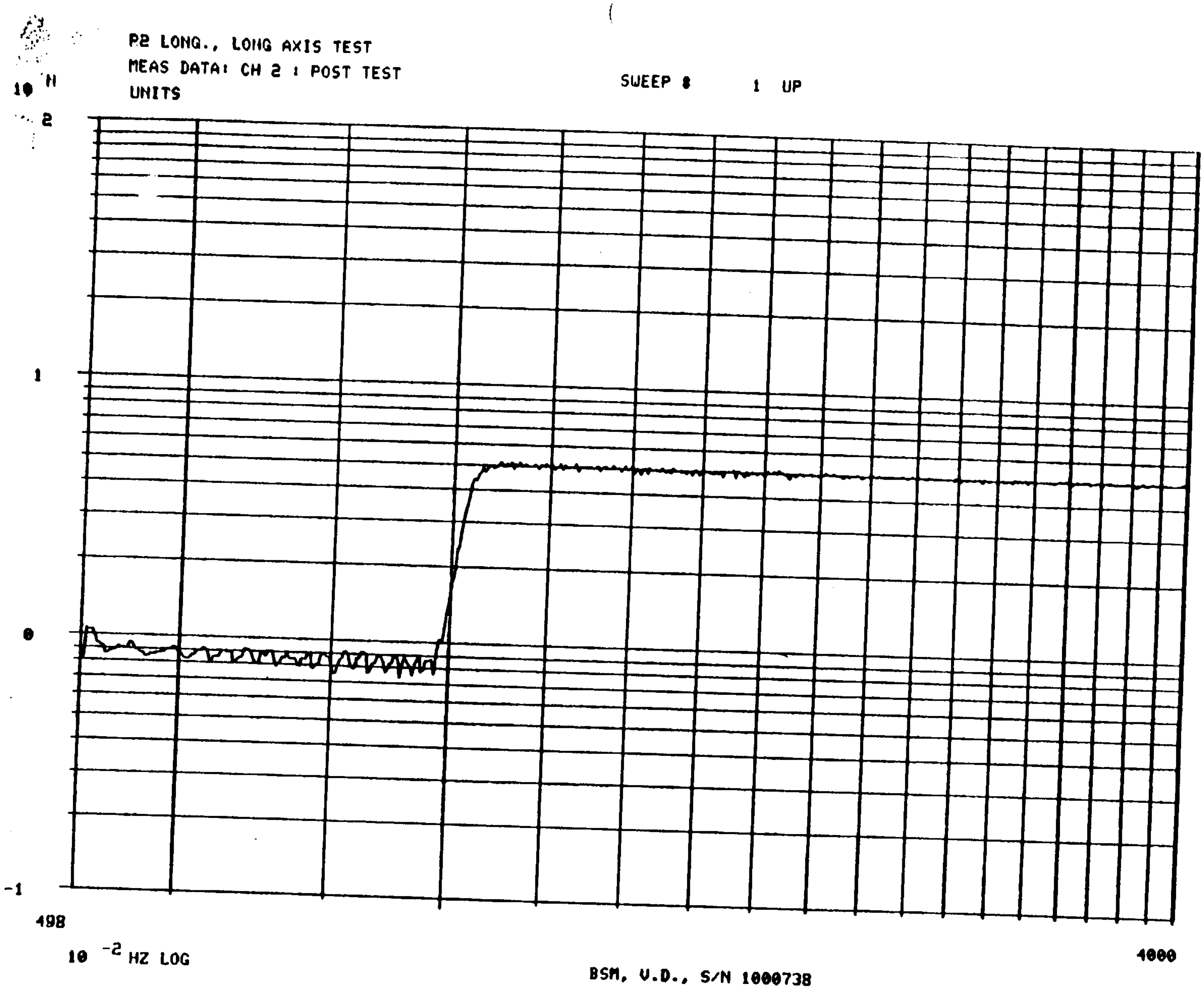


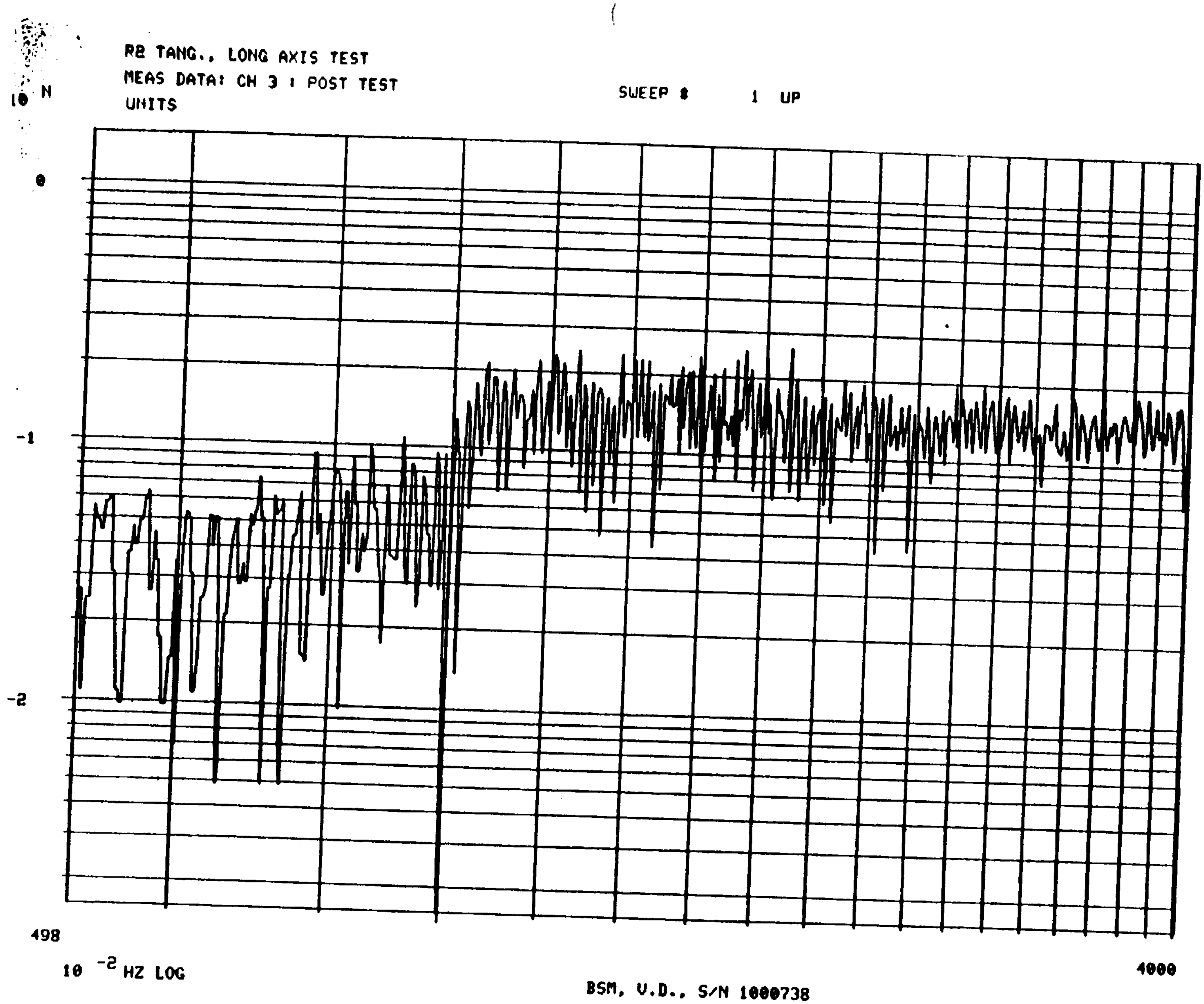
BSM U.D., LONG. S/N 1000738


R1 LONG., LONG AXIS TEST
MEAS DATA: CH 2 : POST TEST
UNITS
SWEEP # 1 UP
10 N
2
1
0
-1
498
10 -2 HZ LOG
4000
BSM, V.D., S/N 1000738

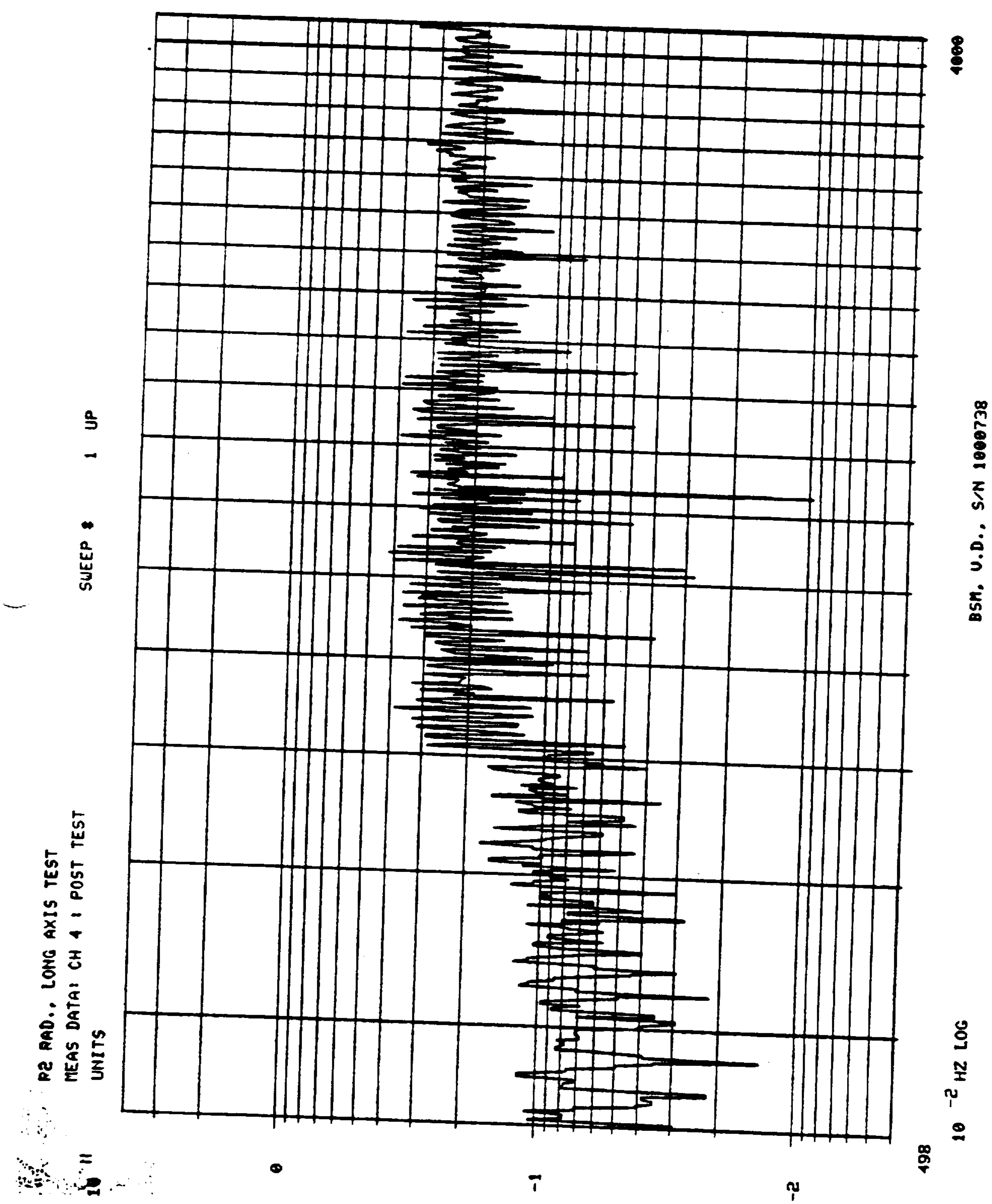

R1 TANG., LONG AXIS TEST
MEAS DATA: CH 3 : POST TEST
UNITS
SWEEP # 1 UP
10 N
-1
-2
-3
498
10 -2 HZ LOG
4000
BSM, V.D., S/N 1000738


R1 RAD., LONG AXIS TEST
MEAS DATA: CH 4 : POST TEST
UNITS
SWEEP # 1 UP
10 N
0
-1
-2
498
10 -2 HZ LOG
4000
BSM, V.D., S/N 1000738


P2 LONG., LONG AXIS TEST
MEAS DATA: CH 2 : POST TEST
UNITS
SWEEP # 1 UP
10 N
2
1
0
-1
498
10 -2 HZ LOG
4000
BSM, V.D., S/N 1000738



R2 TANG., LONG AXIS TEST
MEAS DATA: CH 3 : POST TEST
UNITS
SWEEP # 1 UP
10 N
0
-1
-2
498
10 -2 HZ LOG
4000
BSM, V.D., S/N 1000738


R2 RAD., LONG AXIS TEST
MEAS DATA: CH 4 : POST TEST
UNITS
SWEEP # 1 UP
10
0
-1
-2
498
4000
10 -2 HZ LOG
BSM, U.D., S/N 1000738

NASA-MSFC

BSM MOTOR S/N 1000734
OBSERVATION AND DEVIATION SUMMARY

BSM Observation and Deviation Summary
1993 Delta Qualification Tests at MSFC

Motor SN: 1000734

#1. Reference step 6.2.1.8 in BSM-TCP-EP54-001. No damage was noted. Motor and container in good shape.

#2. Reference step 6.2.6.4 in BSM-TCP-EP54-001. No propellant grain cracks or other defects noted. A small amount of RTV residue was observed on the igniter case and main propellant grain.

#3. Reference step 6.4.5 in BSM-TCP-EP54-001. No damage was observed due to the pyro shock test.

#4. Due to the loose fastener problem on SN 1000738, the forward bracket fasteners and the aero-heat shield fasteners were lockwired on SN 1000738. Torque stripes were also drawn on the bolt head so that any rotation during testing could be detected. Bolts torqued to 160 in-lbs.

#5. Reference Test Procedure Deviation item 1 for BSM-TCP-EP54-003. Conditioning chamber temperature for this motor is 25° F, +0° F, -5°F. During the radial axis testing, the chamber temperature exceeded the 25° F upper limit. The maximum temperature reached 28.2° F. The total time the chamber was out of tolerance was approximately ten minutes. After the radial axis testing was complete, the chamber temperature resumed to within tolerances. USBI, CSD, and MSFC agreed that the motor could not respond to the small change in temperature in that short amount of time. Testing was resumed.

#6. Reference step 6.8.1 in BSM-TCP-EP54-003. No damage was observed to the BSM due to vibration testing. This inspection was performed before bracket removal. It was noticed during this inspection that three of the forward bracket fasteners had de-torqued slightly (recall these were lockwired). The aero-heat shield fasteners remained torqued.

#7. Reference step 7.3.4 in BSM-TCP-EP54-003. No cracks or other internal defects noted on the propellant grain.

#8. Reference step 7.5.5 in BSM-TCP-EP54-003. Light burnishing marks were observed on the forward face of the BSM.

Mat Bevill
10/5/93

Figure 1

TEST PROCEDURE DEVIATION		TCP NO.: BSM-TCP-EP54-001
TEST ENGINEER: Mat Berill MB 09/29/93	QUALITY: Rick Clements RC 9-29-93	DATE: 09/29/93
REQUIREMENTS ENGINEER: –	OTHER: Richard Leonard (safety) RL 9-29-93	SHEET 1 OF 7

TITLE: Upper Limit Tolerance Violation for Pyro Shock Simulation Test (SN: 1000734)

DEV. NO.	PAGE	SEQ.	CHANGE/REASON	PERM/TEMP.
1			Section 4.2.1 in BSM-TCP-EP54-001 states that the test tolerances for shock Response Spectrum are +6 dB and −3 dB when analyzed with a 1/3 octave shock spectrum analyzer and 5% damping. The worst case over test for each axis is shown in the attached graphs. X-axis: accelerometers #10 and #4 Y-axis: accelerometer #11 Z-axis: accelerometers #12 and #9 Motor SN: 1000734 Jim Herring J.B. Herring ED23, Lead Pyro Engineer	

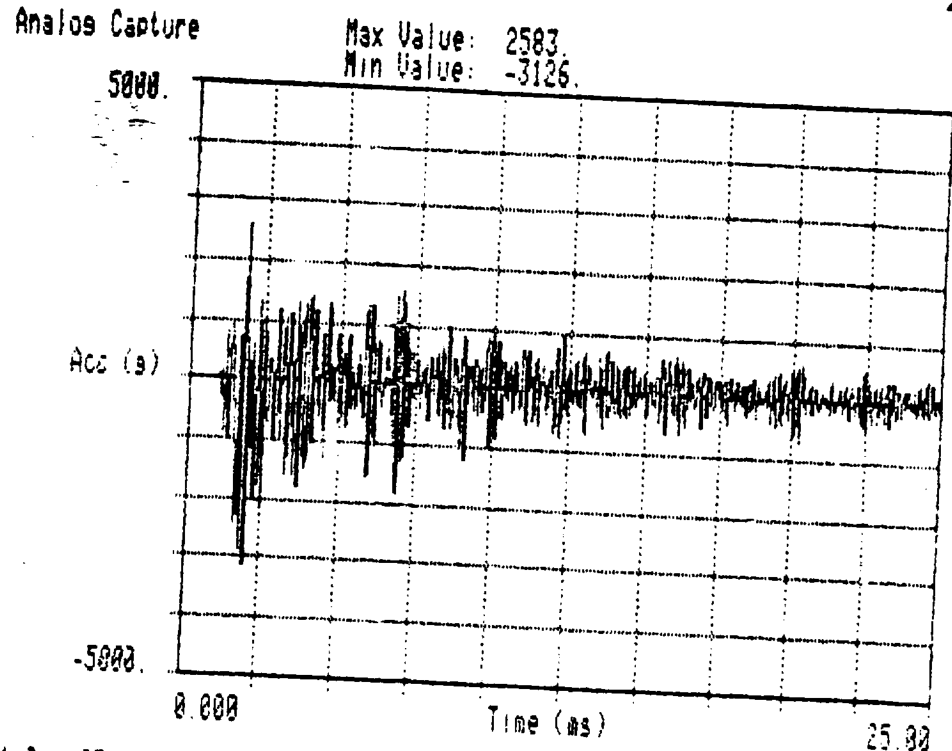
ORIGINATOR: Mat Berill

ORGANIZATION: NASA MSFC EP12

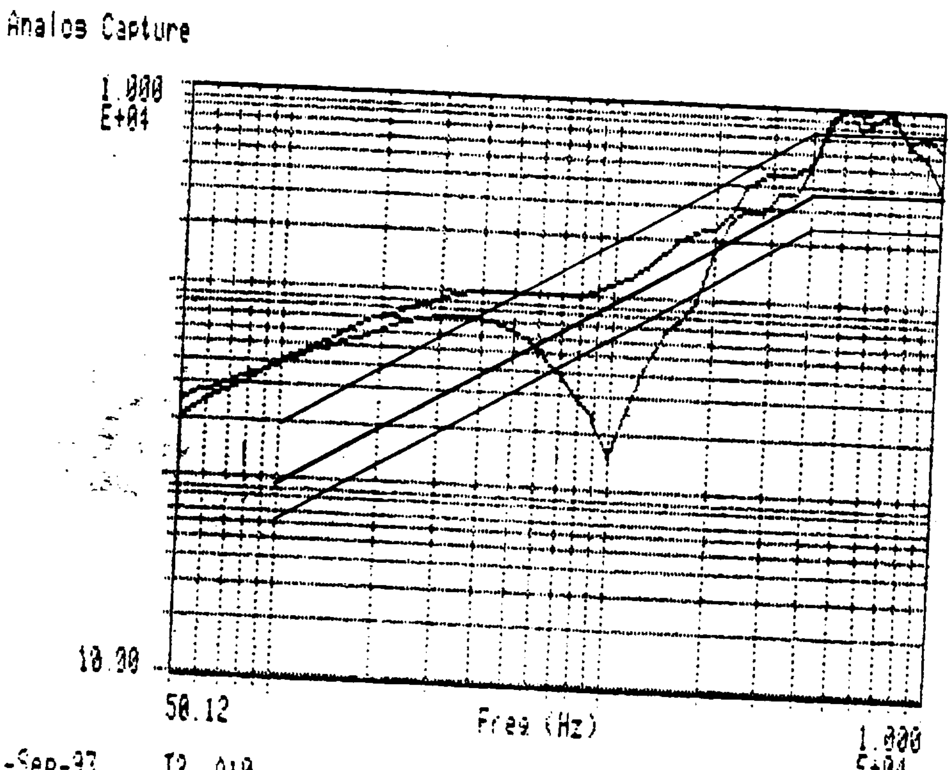
ABOVE DEVIATION(S) INCREASE HAZARD LEVEL: N/A

SAFETY: Richard Leonard

ABOVE DEVIATION(S) AFFECT TEST REQUIREMENTS:

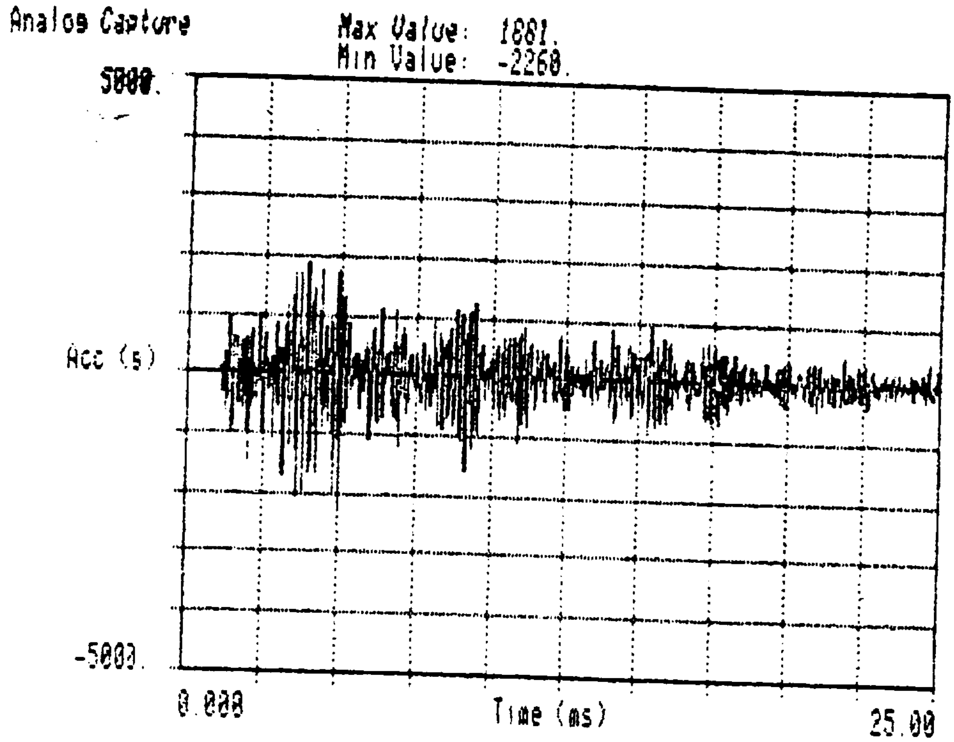


21-Sep-93 T2 A10
10:12:39 SRB BSM QUAL. TEST
?

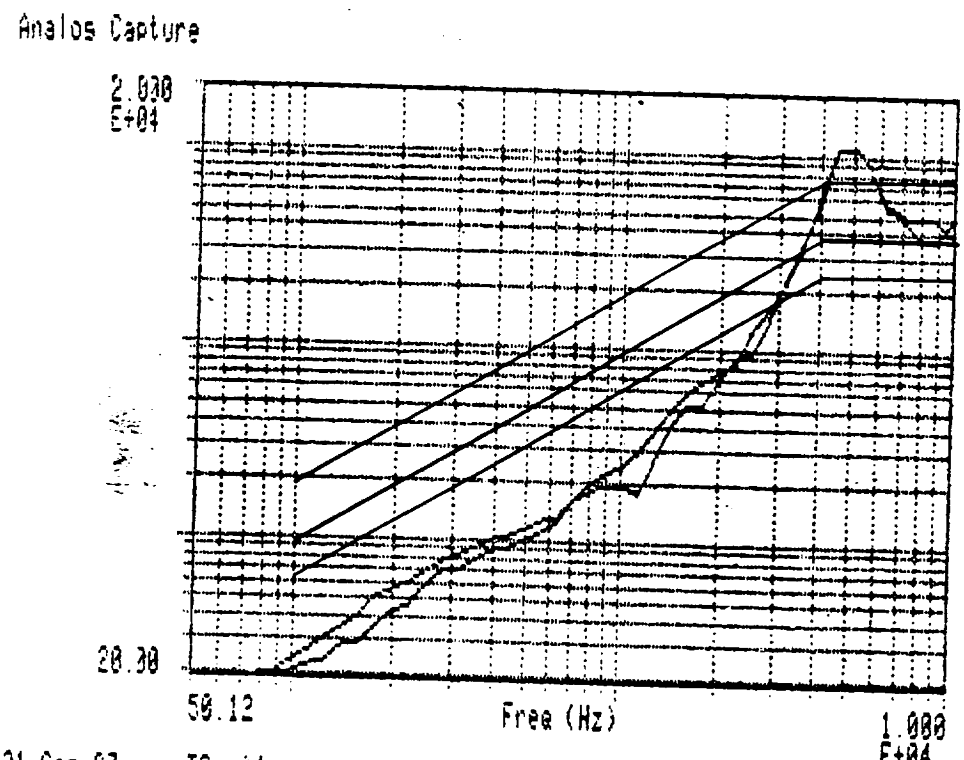


21-Sep-93 T2 A10
10:13:43 SRB BSM QUAL. TEST
?

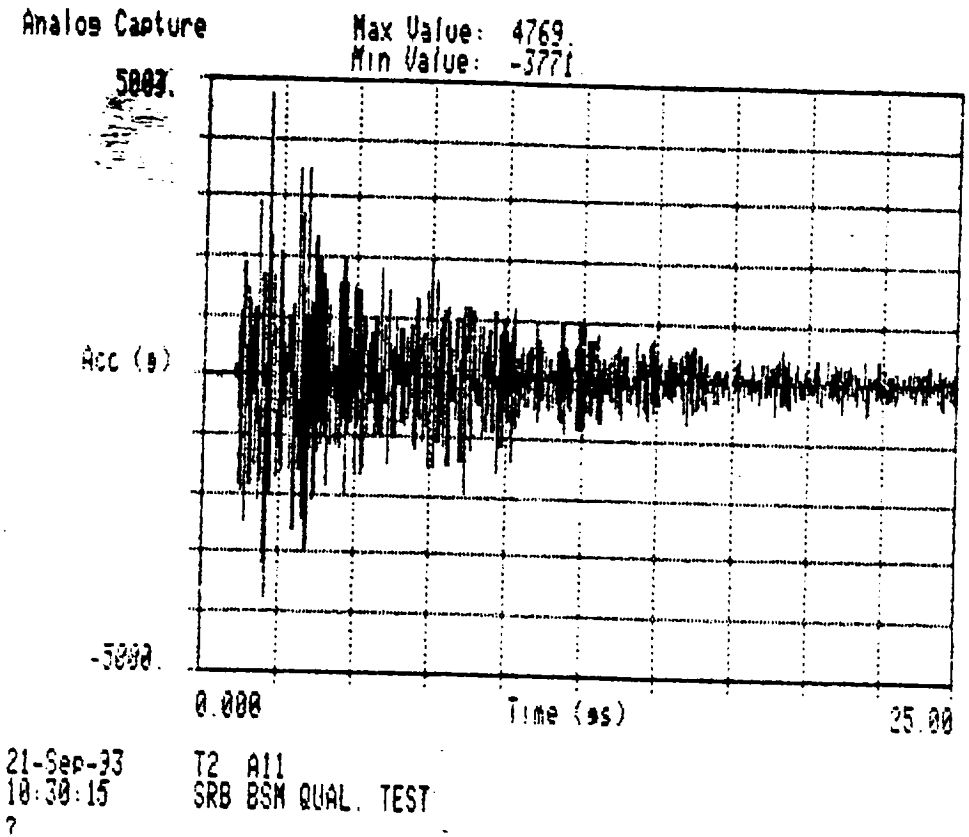
5.0 % Damp Abs Acc
1/6 Octave Pri Pos

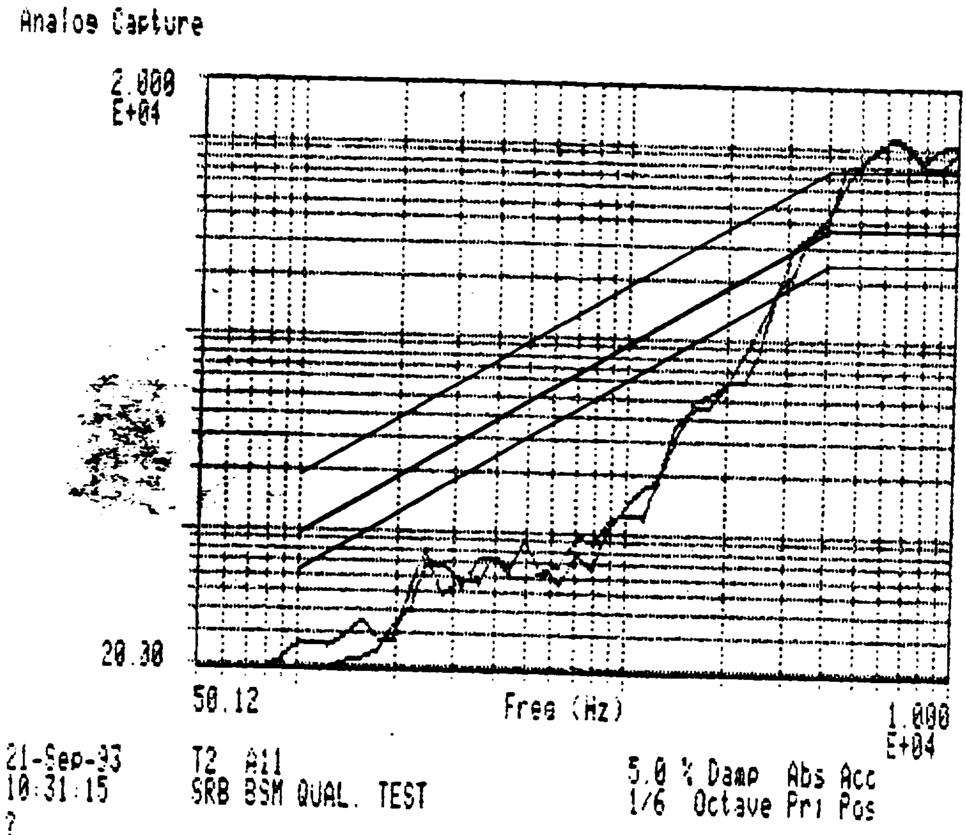


21-Sep-93 T2 A4
10:01:51 SRB BSM QUAL. TEST
?



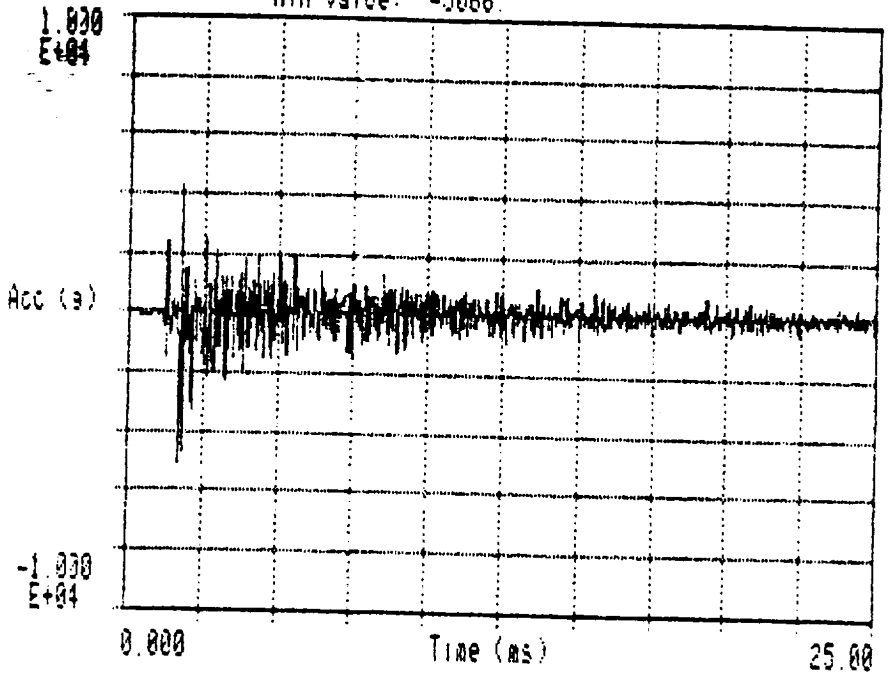
21-Sep-93 T2 A4 5.0 % Damp Abs Acc
10:02:52 SRB BSM QUAL. TEST 1/6 Octave Pri Pos
?


Analog Capture
Max Value: 4769.
Min Value: -3771.
5003.
Acc (g)
-5000.
0.000
Time (ms)
25.00
21-Sep-93
10:30:15
?
T2 A11
SRB BSM QUAL. TEST


Analog Capture
2.000
E+04
20.30
50.12
Freq (Hz)
1.000
E+04
21-Sep-93
10:31:15
?
T2 A11
SRB BSM QUAL. TEST
5.0 % Damp Abs Acc
1/6 Octave Pri Pos

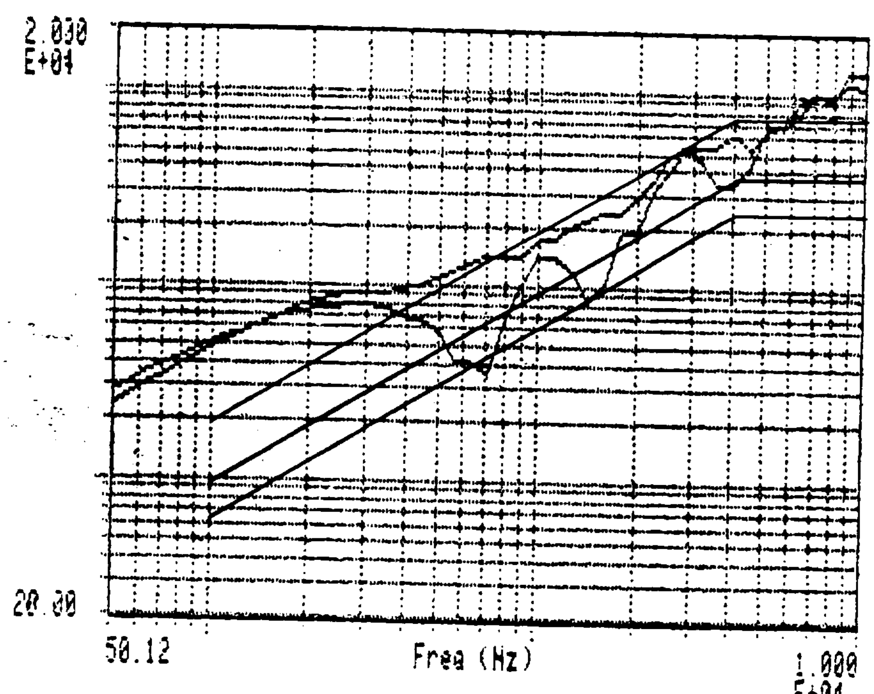
Analog Capture

Max Value: 4290.
Min Value: -5066.



21-Sep-93 T2 A12
10:33:03 SRB BSM QUAL. TEST
?

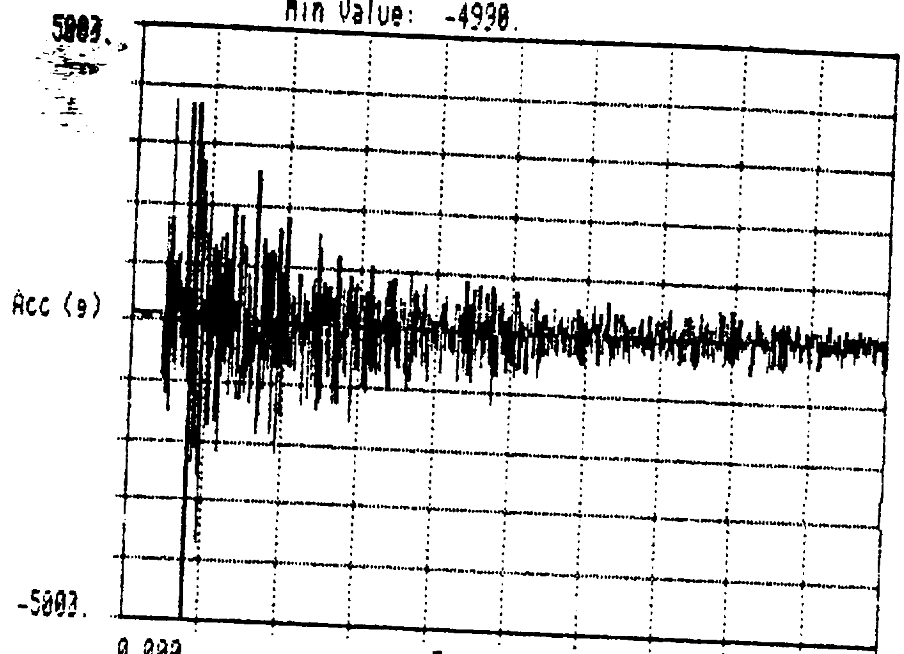
Analog Capture



21-Sep-93 T2 A12 5.0 % Damp Abs Acc
10:34:20 SRB BSM QUAL. TEST 1/6 Octave Pri Pos
?

Analog Capture

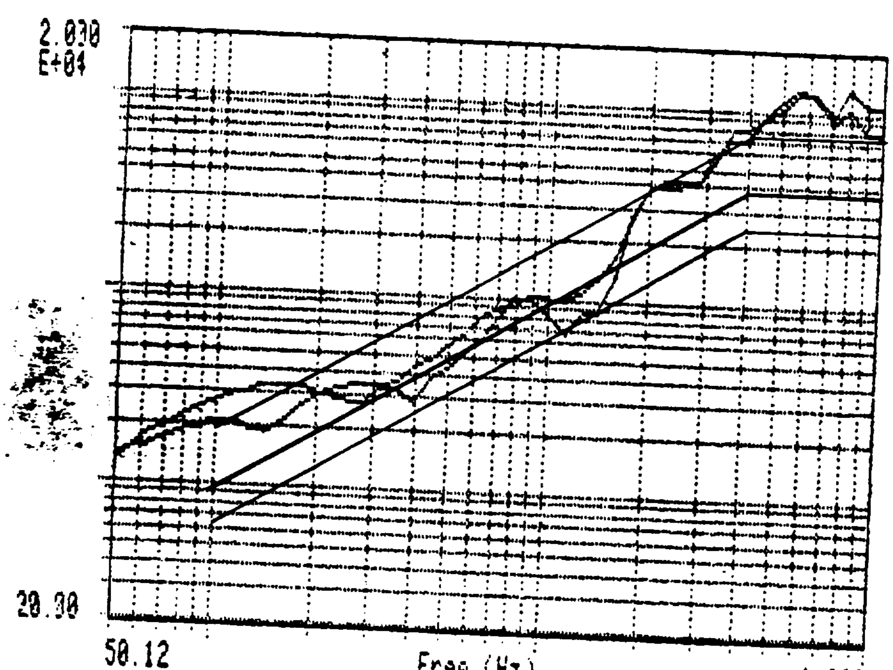
Max Value: 3718.
Min Value: -4998.



21-Sep-93
10:26:28
?

T2 A9
SRB BSM QUAL. TEST

Analog Capture



21-Sep-93
10:27:37
?

T2 A9
SRB BSM QUAL. TEST

5.0 % Damp Abs Acc
1/6 Octave Pri Pos

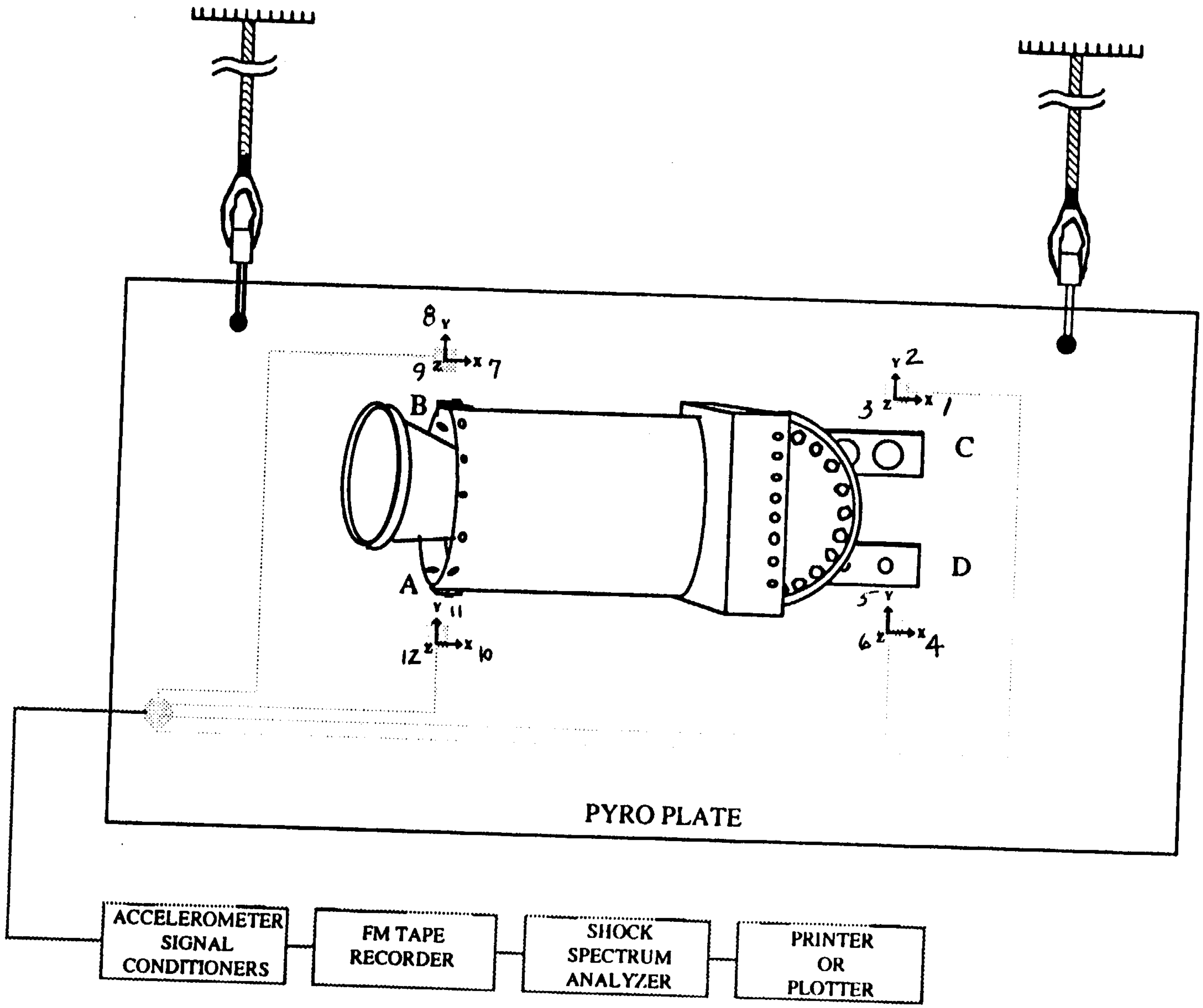


FIGURE 1. PYRO SHOCK CONTROL EQUIPTMENT

DRAWN BY :
K.MITCHELL / EP54
4/15/93

7 of 7

Figure 1

TEST PROCEDURE DEVIATION		TCP NO.: BSM-TCP-EP54-003
TEST ENGINEER: Mat Bevill MB 09/29/93	QUALITY: Rick Clements RC 9-29-93	DATE: 09/29/93
REQUIREMENTS ENGINEER: —	OTHER: Richard Leonard (Safety) RL 9-29-93	SHEET 1 OF 2

TITLE: Temperature Violation for Radial Axis Test (SN: 1000734)

DEV. NO.	PAGE	SEQ.	CHANGE/REASON	PERM/TEMP.
1			Section 8.0 in BSM-TCP-EP54-002 states the conditioning chamber temperatures for the delta qualification motors. The "cold" motor is to be conditioned at 25°F $^{+0°F}_{-5°F}$.	

At 11:38:42 a.m. on 09/25/93 the conditioning chamber temperature exceeded its 25°F upper limit. The chamber was out of temp. for 8 min, then out again at 11:58:42 and 12:04:42 for ~2 min. respectively. These violations occured DURING the radial axis vibration test. USBI, CSD, and MSFC all agreed that the motor could not respond in the short amount of time at that low of temperature.

SN: 1000734

Max temp. during testing was 28.2°F.

ORIGINATOR: Mat Bevill

ORGANIZATION: NASA MSFC EP12

ABOVE DEVIATION(S) INCREASE HAZARD LEVEL: N/A

SAFETY: Richard Y Leonard

ABOVE DEVIATION(S) AFFECT TEST REQUIREMENTS:

1000734

CAUTION: **When using the ESD scanner and the electrostatic reading on the motor case surface exceeds 1.0 kilovolt, stop all activities on the case, initiate personnel fall back (a minimum of 4 feet) and notify safety.**

After initial reading over 1.0 kilovolt, repeat electrostatic reading at intervals not to exceed 5 minutes until the the voltage has dissipated below 1.0 kilovolt. When the reading is below 1.0 kilovolt, removal operations may continue.

If after 30 minutes the measured electrostatic charge is in excess of 1.0 kilovolt, Verify facility ground. If connection to facility ground is open, reconnect through larger resistor (100 Kohm min.) to allow a slow discharge of the motor case.

If the electrostatic reading on the case surface exceeds 4.0 kilovolts, STOP all activities on the case, notify safety , and evacuate all personnel to safe locations as directed by safety.

CAUTION: **The following step involves working with a suspended load. Keep hands and feet out from under the load.**

6.2.1.8 Slowly, monitoring static charge, no charge noted lift the motor out of the container using the overhead crane. Lower the test item so that the forward end of the motor is at waist height. [✓]

A detailed visual inspection shall be performed by the MSFC test engineer and the CSD test engineer on the live test items before testing. Record the motor's serial number. [✓]

No Damage No damage MB

Damage (detail in attachment) ______

Serial Number 1000734

CAUTION: **The following step involves working with a suspended load. Keep hands and feet out from under the load.**

6.2.1.9 Attach the "break-over" brackets and lifting strap on the forward end of the motor (see Figure 2, Appendix C). [✓]

CAUTION: **Do Not disconnect the ground wire while breaking the motor to the horizontal position.**

7-21-93

1000734

Record SN of torque wrench: EMJ00359 A, B, D BTW-2RCE

6.2.5.2 Release the tension from the lifting straps but do not disconnect the straps. These straps may be used to tape off accelerometer wires if necessary. [✓]

6.2.5.3 Place the pyrotechnic debris shield in front of the large bay doors on the north side of the pyro room. [✓]

6.2.6 Perform Grain Inspection

6.2.6.1 Clear area of all nonessential personnel for grain inspection. (Only the grain inspectors (2) and the MSFC TE shall remain.) [✓]

6.2.6.2 Verify grain inspector(s) is(are): [✓]

a. Wearing 100% cotton coveralls, shorts, and undershirts.

b. Wearing a wrist strap.

c. Wearing tethers and/or tape to keep eye glasses, rings, and watches from falling into the motor.

6.2.6.3 The grain inspector shall now remove the security bag and cover from the exit cone. [✓]

6.2.6.4 Perform grain inspection. [✓]

Cracked propellant? yes no

~~If yes, give approximate location and size of crack.~~ TEN

No propellant grain cracks or other defects noted. Small amount of RTV residue on igniter case and main grain. OK to proceed with pyroshock test.

Other comments on grain condition:

MB 09/21/93

Grain inspector T. Ward 9-21-93 MSFC QA J.S. Blanton 9-21-93

Grain inspector J.S. Blanton 9-21-93

6.2.7 Install Aero HeatShield

CAUTION: **When using trichloroethane, personnel shall wear chemical goggles and Neoprene-Latex gloves. Contaminated materials shall be disposed of as hazardous waste.**

9-21-93

1000734

6.3.7 On the count of "3", the pyro technician shall put the switch in the "ARMED" position and verify that the power indicator is illuminated. [✓]

6.3.8 On the *FIRE* command, the pyro technician will open the red cover and flip the firing switch. [✓]

6.3.9 After firing, turn the firing panel key to the "UNARMED" position. [✓]

WARNING: If blasting cap does not fire, refer to Section 10.4 in ED73-SHK-FOP-004 (see Appendix A).

Blasting Cap Fired: yes ✓ **no** _____

6.3.10 Remove the arming key and disconnect the voltage supply. [✓]

6.3.11 Test personnel may now return to the control room. [✓]

6.3.12 Wait a minimum of 5 minutes after firing before opening the door to room 170. [✓]

6.3.13 The lead pyro engineer shall now begin to reduce the data. [✓]

6.4 Post Test Inspection

6.4.1 Inform the MSFC TF that the door to room 170 from the control room is to be opened. [✓]

6.4.2 The pyro technician shall enter room 170 and move the junction box switch to the "BULB" position. [✓]

6.4.3 Remove blasting cap leads from junction box. [✓]

6.4.4 Inspect the shock plate to insure all explosive devices fired properly. [✓]

WARNING: If all explosive items did not fire, refer to Section 10.5 in ED73-SHK-FOP-004 (see Appendix A).

6.4.5 The BSM shall be visually inspected for damage resulting from the pyro shock test. Any anomalies will be recorded. All other personnel shall remain in the control room or in the clear area until the "ALL CLEAR" is given by the MSFC TE. No Damage [✓]

6.4.6 MSFC TE indicates all clear for appropriate personnel. [✓]

6.5 Post Test Removal from the Pyro Plate

7/5/3

1000734

6.7.3 *Vehicle Dynamics*

6.7.3.1 The following levels and conditions apply for the vehicle dynamics test. Vibrate the motor only as follows. [✓]

Frequency (Hz)	Level
5 to 10	0.7 g peak
10 to 40	4.3 g peak

Sweep Rate: 3 octaves per minute

6.8 Post Test Inspection

6.8.1 The BSM test item shall be visually inspected by the MSFC QA, MSFC TE, and the CSD TE for exterior damage resulting from vibration testing. [✓]
3 fasteners detorqued slightly

6.8.2 Remove all instrumentation. [✓]

6.9 Data Requirements

Power Spectral Density (PSD) plots for all control and response accelerometers for lift off and boost tests shall be recorded. The test tolerances shall be overplotted on the control accelerometers plots. Acceleration versus frequency plots shall be recorded for all accelerometers used during vehicle dynamics tests.

7.0 Post Test Disassembly/Prepare for Shipment

7.1 Conditioning Chamber Removal

7.1.1 Disconnect any hoses and instrumentation that hinders the removal of the chamber. [✓]

7.1.2 Using the overhead crane, slowly lift the conditioning chamber off of the vibration table and place on the floor. [✓]

7.1.3 Move chamber out of the way. [✓]

7.1.4 Move the conditioning unit out of the way if necessary. [✓]

7.1.5 Verify motor ground connection on the motor and at the facility ground contact point. [✓]

7.1.6 Remove vibration table insulation. [✓]

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7.2 Aero Heat Shield Removal

WARNING: Removing the Aero Heat Shield exposes the motor's propellant grain. Personnel should use caution during any operations with and exposed grain. Tools, watches, eye glasses, etc., should be tethered (if necessary) to prevent dropping anything into the motor.

7.2.1 Make sure the motor ground is secured. [✓]

7.2.2 Make sure verified wrist straps are being worn by the personnel removing the aero heat shield. [✓]

7.2.3 Remove the fasteners from the Aero Heat Shield. Place the fasteners in a marked bag. [✓]

7.2.3 SLOWLY remove the Aero Heat Shield. [✓]

7.2.5 Remove the heat shield seal. Do not drop the seal into the motor. [✓]

7.3 Post Test Inspection of Motor Propellant Grain

7.3.1 Make sure motor ground wire is secured. [✓]

7.3.2 Clear area of all non-essential personnel. Only the grain inspectors (2) and the MSFC TE shall remain. [✓]

7.3.3 Verify grain inspector(s) is(are): [✓]

a. Wearing 100% cotton coveralls, shorts, and undershirts.

b. Wearing a wrist strap.

c. Wearing tethers and/or tape to keep eye glasses, rings, and watches from falling into the motor.

7.3.4 Perform grain inspection. [✓]

Cracked propellant yes no

If yes, give approximate location and size of crack:

____

____

?-25-93

1000734

Other comments on grain condition:

No cracks or other internal defects noted. No motor external damage attributable to pyroshock or vibration testing.

Grain inspector(s) [signature] 9-25-93 [signature] 9-25-93
MSFC QA [signature]

7.3.5 A draw-wire, fabric, security bag shall be installed over the nozzle exit cone. The bag shall be closed around the exit cone and secured by inserting the bag wire ends ~~through a standard security lead seal~~ (i.e. cover the exit cone the same way that it was received). [✓]

7.4 Adapter Plate Removal

7.4.1 Remove the adapter plate to vibration table fasteners. [✓]

7.4.2 Attach lifting straps as shown in Fig. 1b (Appendix B). [✓]

CAUTION: Be careful not to disconnect the ground while lifting the motor.

CAUTION: The following step involves working with a suspended load. Keep hands and feet out from under the load.

7.4.3 Lift the motor off of the vibration table and move to an area near the wood supports. [✓]

7.4.4 Lower the motor so that it rests on the wood supports. [✓]

7.4.5 Rotate the motor 180° so that the adapter plates face up. [✓]

7.4.6 Remove the bracket to adapter plate fasteners. Place fasteners in a marked bag. [✓]

CAUTION: Be careful not to disconnect the ground while lifting the motor.

CAUTION: The following step involves working with a suspended load. Keep hands and feet out from under the load.

7.5 Aft Skirt Bracket Removal

7.5.1 Remove the aft end motor to bracket fasteners (12 places). Place fasteners in a marked bag. [✓]

9-25-93

1000734

CAUTION: **Be careful not to disconnect the ground while lifting the motor.**

CAUTION: **The following step involves working with a suspended load. Keep hands and feet out from under the load.**

7.5.2 Lift the motor to waist height using the overhead crane. [✓

7.5.3 Rotate the motor 180° so that the bracket to adapter plate fastener holes face the floor. [✓

7.5.4 Lower the motor so that it rests on the wood supports. [✓

7.5.5 Remove forward end motor to bracket fasteners (8 places). Place fasteners in a marked bag. Light burnishing on fwd face [✓

8.0 Return Motor to the Vertical Position

8.1 Attach 2 D-rings, 180 degrees apart, and one lifting strap to the aft end holes of the motor. [✓

8.2 Attach the "break-over" brackets (and lifting strap) to the appropriate bolt holes on the forward face of the motor case. [✓

8.3 Attach the aft lifting strap to the overhead crane hook. [✓

CAUTION: **The following steps involve working with a suspended load. Keep hands and feet out from under the load.**

CAUTION: **Be careful not to disconnect the ground while lifting the motor.**

8.4 One person (as chosen by the MSFC TE) shall hold the lifting strap on the forward end to keep the motor from swinging when lifted from the aft end. Slowly lift the aft end of the motor to bring it to a vertical position. [✓

8.5 Raise the motor so that the aft end is at waist height. [✓

CAUTION: **The following steps involve working with a suspended load. Keep hands and feet out from under the load.**

8.6 Disconnect the "break-over" brackets. Place brackets in a marked bag. [✓

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BSM MOTOR S/N 1000738
OBSERVATION AND DEVIATION
SUMMARY

BSM Observation and Deviation Summary
1993 Delta Qualification Tests at MSFC

Motor SN: 1000738

#1. Reference step 6.2.1.8 in BSM-TCP-EP54-001. It was noticed after opening the shipping container that the motor to shipping container ground strap was broken. The motor did not appear to have rotated much during shipment. The broken ground strap was placed in the "mass simulator" shipping container and shipped back to CSD.

#2. Reference step 6.2.1.8 in BSM-TCP-EP54-001. A small dent/scratch was observed on the motor case. This dent/scratch was located at approximately 30° from the forward indicator pin, 3 1/4" from forward end.

#3. Reference step 6.2.6.4 in BSM-TCP-EP54-001. No cracks or other defects were noted on the propellant grain. A small amount lint and liner particles were observed on the grain. A red stain was also noticed on the grain surface.

#4. Reference step 6.2.7.7 in BSM-TCP-EP54-001. The aero-heat shield fasteners were very difficult to torque due to the primer in the holes on the exit cone. The primer was removed with 1,1,1 trichloroethane and que-tips.

#5. Reference step 6.4.5 in BSM-TCP-EP54-001. No damage was observed to the BSM due to the pyro shock test.

#6. Reference step 6.8.1 in BSM-TCP-EP54-003. No damage was observed to the BSM due to vibration testing. This inspection was performed before any bracket disassembly.

#7. Reference step 7.3.4 in BSM-TCP-EP54-003. Post-test grain inspection revealed no differences from the pre-test inspection.

#8. Reference step 7.5.1 in BSM-TCP-EP54-003. Light burnishing marks were observed on the motor case after removal of the aft attach bracket.

#9. Reference Test Procedure Deviation item 3 for BSM-TCP-EP54-003. The forward bracket attach fasteners were torqued per step 6.2.2.4 in BSM-TCP-EP54-001 (150 in-lbs). These fasteners were *not* lockwired on this motor. After finishing the radial axis tests, the lead vibration engineer noticed two fasteners laying in the forward bracket. Further inspection showed that in addition to the two fasteners out, four were loose.

Mat Bevill
10/5/93

Photographs were taken. USBI, CSD, and MSFC agreed to re-torque the fasteners and proceed with the testing. The torques were verified with a different torque wrench after re-torquing with the same wrench used at assembly. The test team also decided to re-check these torques after each axis.

A deviation was also written for the test sequence of the radial axis tests (see Test Procedure Deviation items 1 and 2 for BSM-TCP-EP54-003). The boost vibration time duration should be 120 seconds as stated in BSM-TCP-EP54-003 step 6.2.3.1. However, a USBI representative noticed that the boost vibration test was only conducted for 60 seconds. He also noticed that the lift-off vibration test was one second short (test tolerance on test duration is +10%, -0%). This deviation was discovered after the motor had already been unfastened from the table. So, the motor was re-connected to the table and brought back to temperature. Conditioning chamber temperature was resumed 24.5 minutes after chamber removal so no re-conditioning time was necessary. The final 60 seconds of the boost test and the one second on lift-off were then completed. The response data indicated that the forward fasteners probably came loose at about 30 seconds into the boost sequence. This means that the forward fasteners were probably already loose before the chamber was re-connected to finish the last 60 seconds.

#10. Reference step 7.5.5 in BSM-TCP-EP54-003. Chatter marks were evident on the forward face of the motor case. These marks were caused by the forward fasteners coming loose during the radial axis test allowing the bracket and the motor to rub. Burnishing marks were also evident on the forward face of the motor.

#11. Reference step 6.8 in BSM-TCP-EP54-003. After all of the vibration testing was complete, the post-test inspection revealed four aero-heat shield fasteners were missing. Several other fasteners were loose. The aero-heat shield was still secured to the exit cone, however, and did not appear to move during testing.

Mat Bevill
10/5/93

Figure 1

TEST PROCEDURE DEVIATION		TCP NO.: BSM-TCP-EP54-001
TEST ENGINEER: Mat Bevill MB 09/29/93	QUALITY: Rick Clements RC 9-29-93	DATE: 09/29/93
REQUIREMENTS ENGINEER: —	OTHER: Richard Leonard (safety) RJL 9-29-93	SHEET 1 OF 6

TITLE: Upper Limit Tolerance Violation for Pyro Shock Simulation Test (SN: 1000738)

DEV. NO.	PAGE	SEQ.	CHANGE/REASON	PERM/TEMP.
1			Section 4.2.1 in BSM-TCP-EP54-001 states that the test tolerances for Shock Response Spectrum are +6dB and −3dB when analyzed with a 1/3 octave shock spectrum analyzer and 5% damping. The worst case overtest for each axis is shown in the attached graphs. X-axis: accelerometer #10 Y-axis: accelerometer #11 Z-axis: accelerometers #12 and #3 Motor SN: 1000738 Jim Herring J.B. Herring EP13, Lead Pyro Engineer	

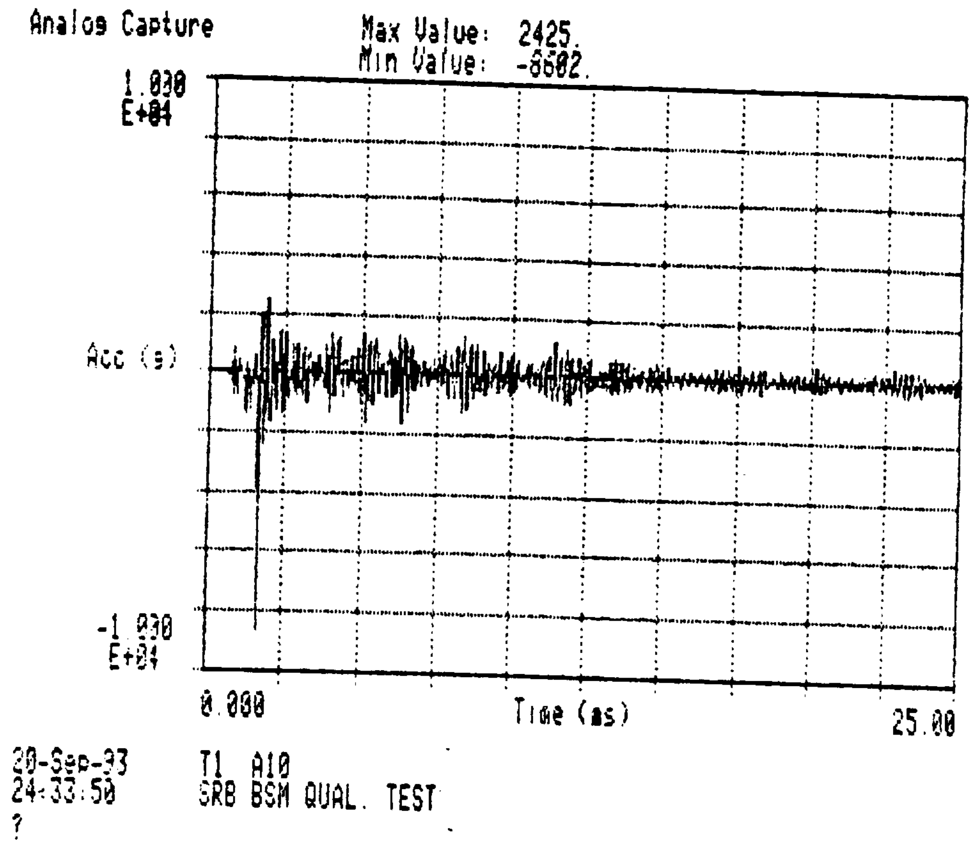
ORIGINATOR: Mat Bevill

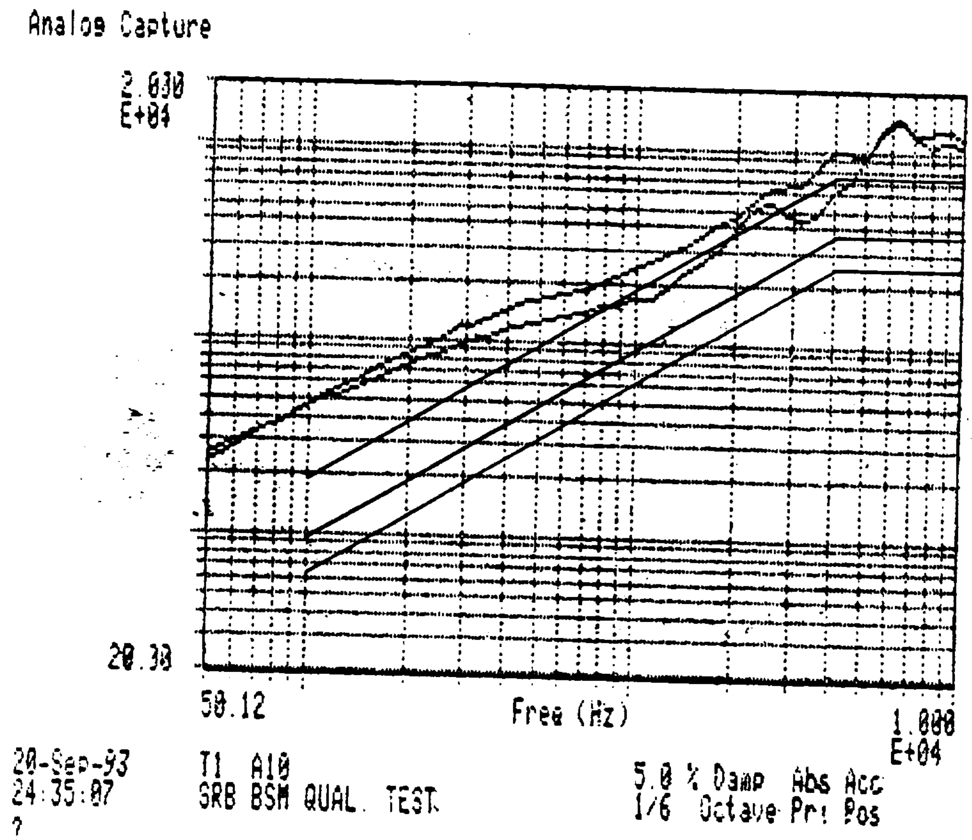
ORGANIZATION: NASA MSFC EP12

ABOVE DEVIATION(S) INCREASE HAZARD LEVEL: N/A

SAFE: Richard Y Leonard

ABOVE DEVIATION(S) AFFECT TEST REQUIREMENTS.


Analog Capture
Max Value: 2425.
Min Value: -8602.
1.030
E+04
Acc (g)
-1.030
E+04
0.000
Time (ms)
25.00
20-Sep-93
24:33:50
?
T1 A10
SRB BSM QUAL. TEST


Analog Capture
2.030
E+04
20.30
50.12
Freq (Hz)
1.000
E+04
20-Sep-93
24:35:07
?
T1 A10
SRB BSM QUAL. TEST
5.0 % Damp Abs Acc
1/6 Octave Pr: Pos

Analog Capture

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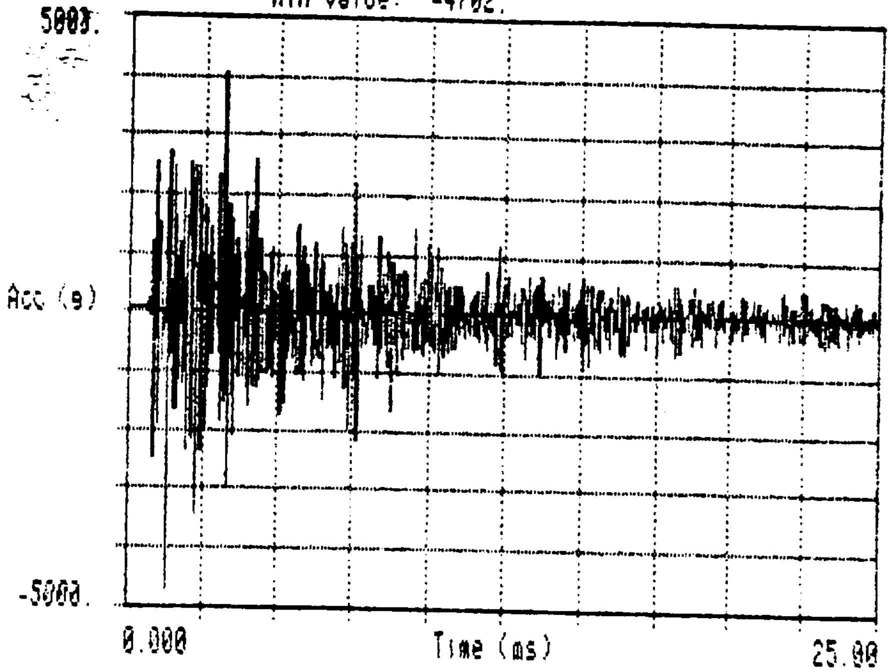
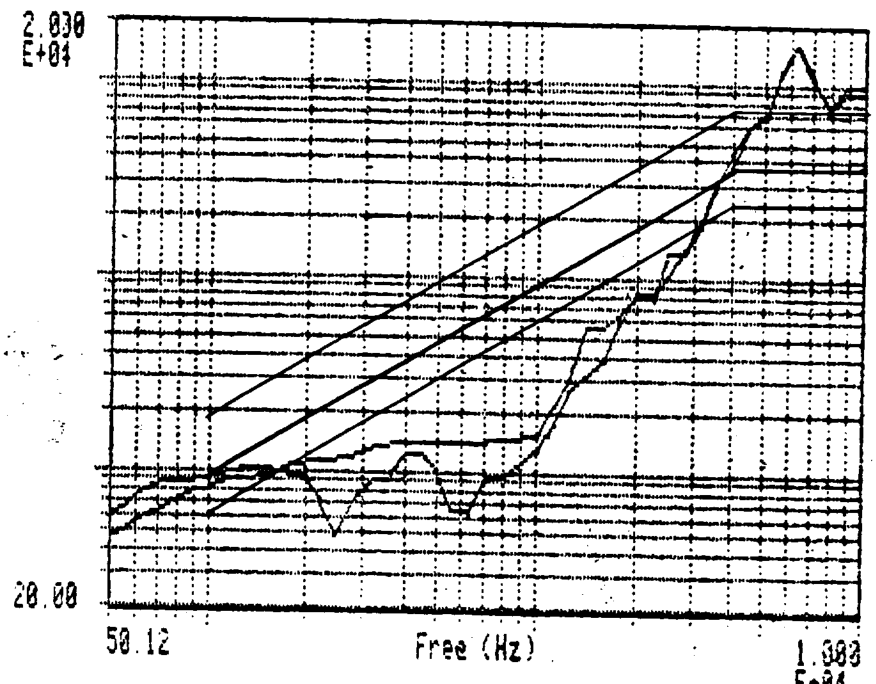
Min Value: -4702.

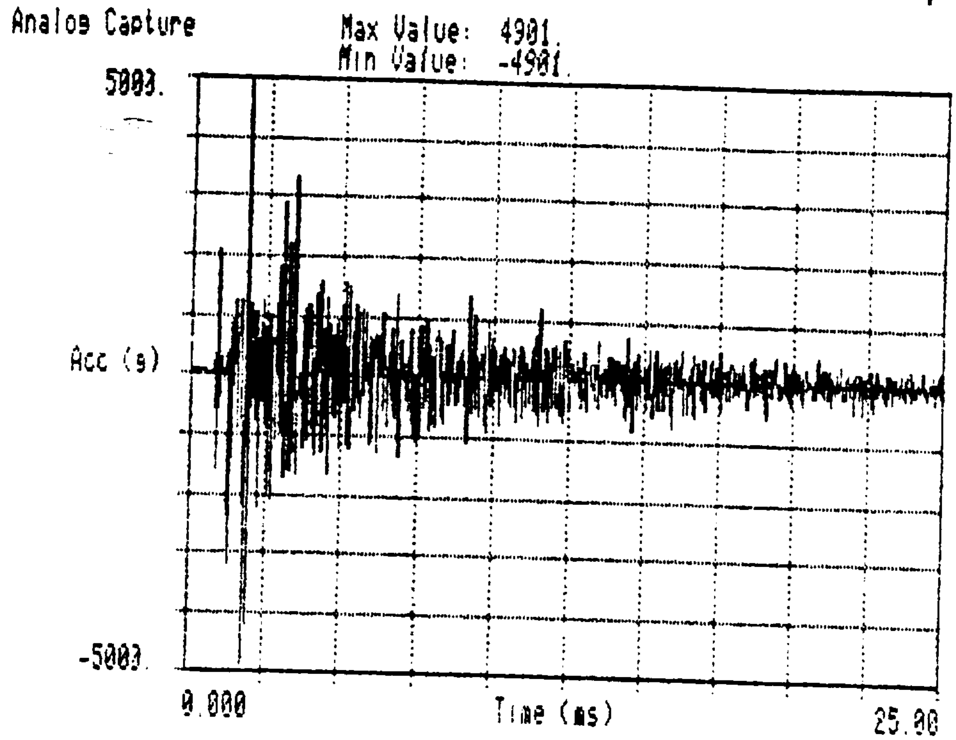


20-Sep-93 T1 A11
24:51:18 SRB BSM QUAL. TEST
?

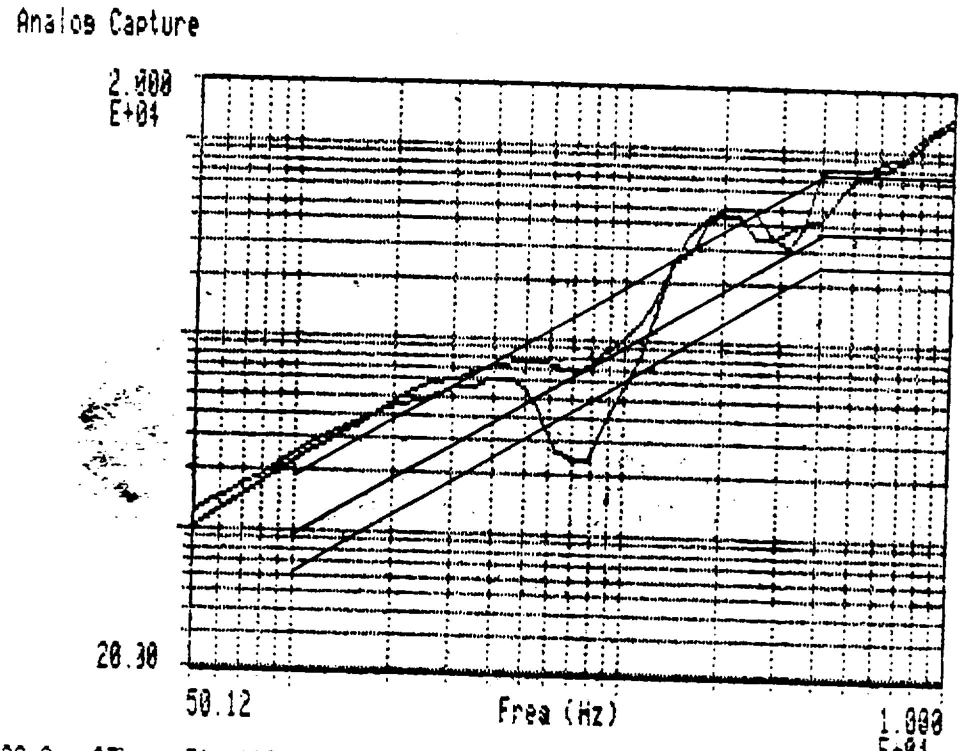
Analog Capture



20-Sep-93 T1 A11 5.0 % Damp Abs Acc
24:52:22 SRB BSM QUAL. TEST 1/6 Octave Pri Pos
?

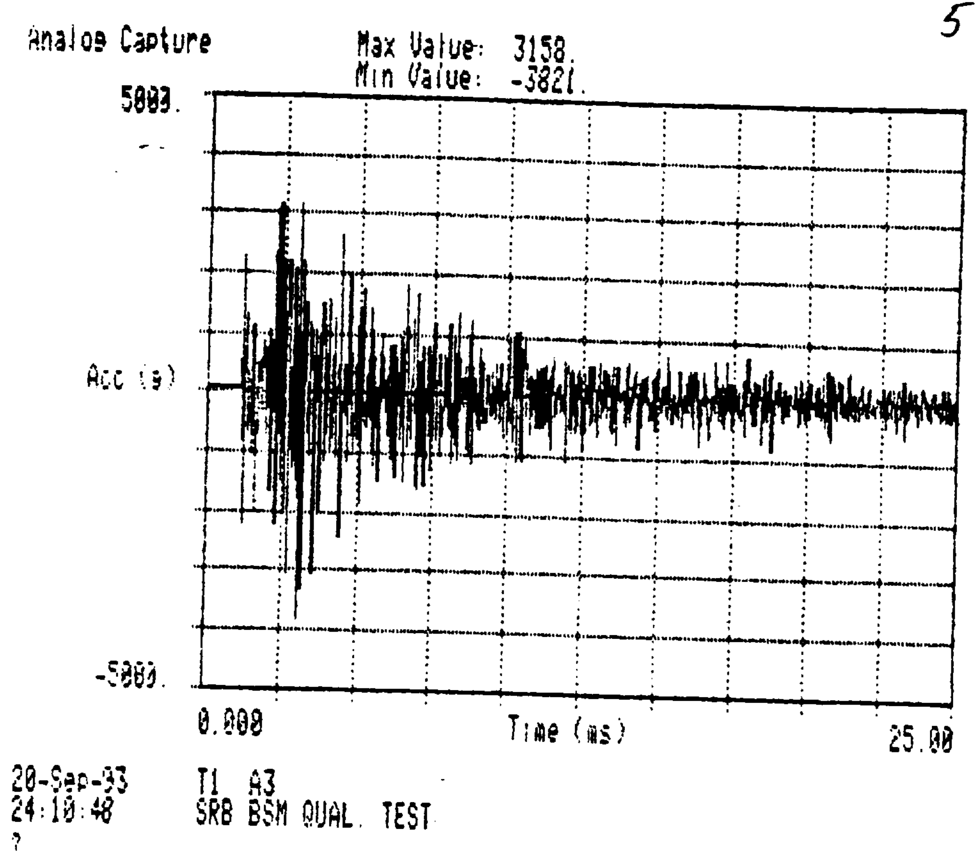


20-Sep-93 T1 A12
24:53:52 SRB BSM QUAL. TEST
?



20-Sep-93 T1 A12
24:55:47 SRB BSM QUAL. TEST
?GLAB

5.0 % Damp Abs Acc
1/6 Octave Pri Pos


Analog Capture
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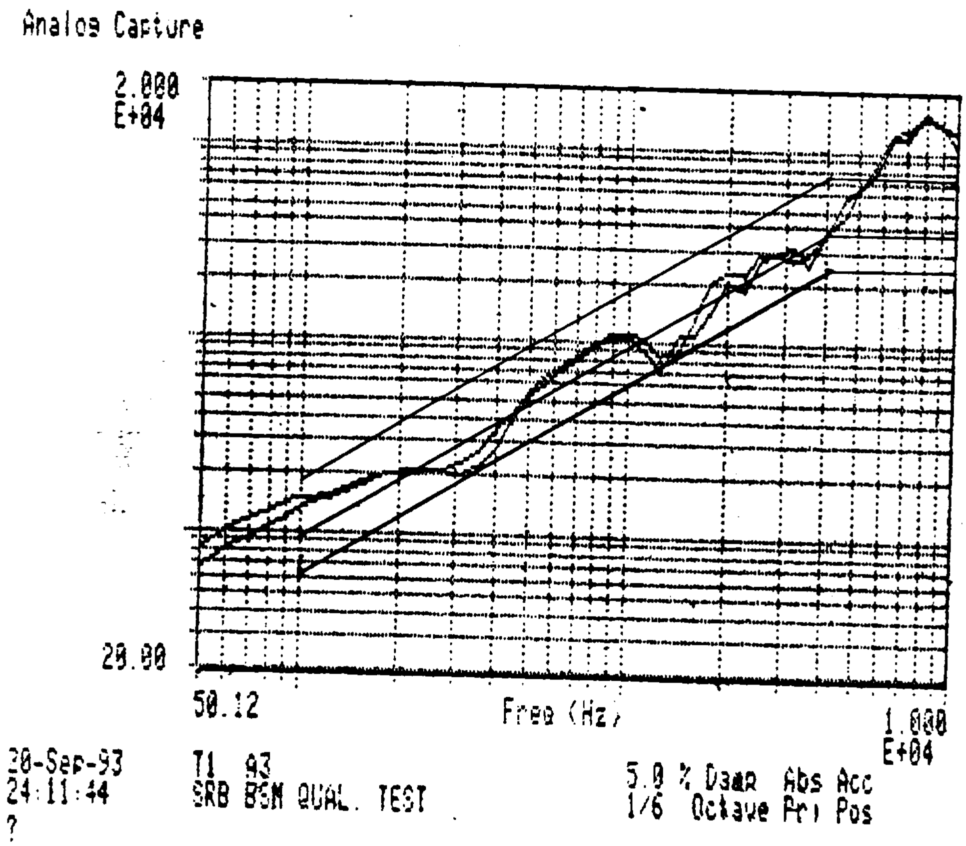
Min Value: -3821.
5000.
Acc (g)
-5000.
0.000
Time (ms)
25.00
20-Sep-93
24:10:48
?
T1 A3
SRB BSM QUAL. TEST


Analog Capture
2.000
E+04
20.00
50.12
Freq (Hz)
1.000
E+04
20-Sep-93
24:11:44
?
T1 A3
SRB BSM QUAL. TEST
5.0 % Damp Abs Acc
1/6 Octave Pri Pos

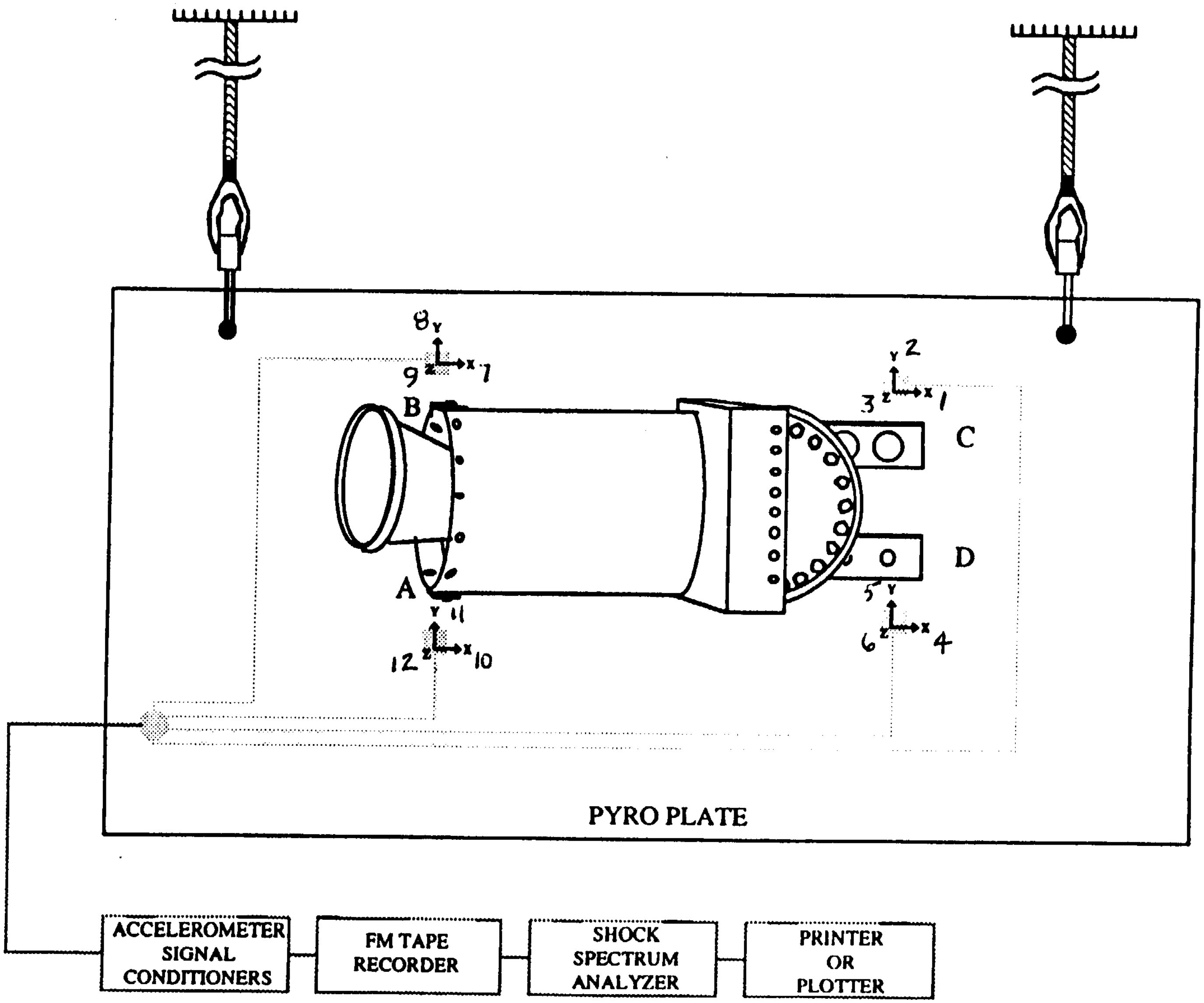


FIGURE 1. PYRO SHOCK CONTROL EQUIPTMENT

DRAWN BY:
K.MITCHELL/EP54
4/15/93

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1000738

CAUTION: When using the ESD scanner and the electrostatic reading on the motor case surface exceeds 1.0 kilovolt, stop all activities on the case, initiate personnel fall back (a minimum of 4 feet) and notify safety.

After initial reading over 1.0 kilovolt, repeat electrostatic reading at intervals not to exceed 5 minutes until the the voltage has dissipated below 1.0 kilovolt. When the reading is below 1.0 kilovolt, removal operations may continue.

If after 30 minutes the measured electrostatic charge is in excess of 1.0 kilovolt, Verify facility ground. If connection to facility ground is open, reconnect through larger resistor (100 Kohm min.) to allow a slow discharge of the motor case.

If the electrostatic reading on the case surface exceeds 4.0 kilovolts, STOP all activities on the case, notify safety , and evacuate all personnel to safe locations as directed by safety.

CAUTION: The following step involves working with a suspended load. Keep hands and feet out from under the load.

6.2.1.8 Slowly, monitoring static charge, lift the motor out of the container using the overhead crane. Lower the test item so that the forward end of the motor is at waist height. [✓]

A detailed visual inspection shall be performed by the MSFC test engineer and the CSD test engineer on the live test items before testing. Record the motor's serial number. [✓]

No Damage ____________________

Damage (~~detail in attachment~~) Yes, motor to shipping container ground wire broken.

Serial Number 1000738 | Also, small dent/scratch 30° from fwd indicator pin, 3 1/4" from fwd end.

CAUTION: The following step involves working with a suspended load. Keep hands and feet out from under the load.

6.2.1.9 Attach the "break-over" brackets and lifting strap on the forward end of the motor (see Figure 2, Appendix C). [✓]

CAUTION: Do Not disconnect the ground wire while breaking the motor to the horizontal position.

6-20-93

1000738

Record SN of torque wrench: "C" EMJ00359 A,B,D T-261-62 (4671)

6.2.5.2 Release the tension from the lifting straps but do not disconnect the straps. These straps may be used to tape off accelerometer wires if necessary. [✓]

6.2.5.3 Place the pyrotechnic debris shield in front of the large bay doors on the north side of the pyro room. [✓]

6.2.6 Perform Grain Inspection

6.2.6.1 Clear area of all nonessential personnel for grain inspection. (Only the grain inspectors (2) and the MSFC TE shall remain.) [✓]

6.2.6.2 Verify grain inspector(s) is(are): [✓]

a. Wearing 100% cotton coveralls, shorts, and undershirts.

b. Wearing a wrist strap.

c. Wearing tethers and/or tape to keep eye glasses, rings, and watches from falling into the motor.

6.2.6.3 The grain inspector shall now remove the security bag and cover from the exit cone. [✓]

6.2.6.4 Perform grain inspection. [✓]

Cracked propellant? yes no

If yes, give approximate location and size of crack.

Other comments on grain condition: No cracks or other defects noted on propellant grain. Small amounts of lint, liner particles and red stain on grain surface. OK to perform pyro shock test.

Grain inspector [signature] 9-20-93 MSFC QA [signature]

Grain inspector [signature] 9-20-93

6.2.7 Install Aero Heat Shield

CAUTION: **When using trichloroethane, personnel shall wear chemical goggles and Neoprene-Latex gloves. Contaminated materials shall be disposed of as hazardous waste.**

9-20-93

1000738

6.3.7 On the count of "3", the pyro technician shall put the switch in the "ARMED" position and verify that the power indicator is illuminated. [✓]

6.3.8 On the *FIRE* command, the pyro technician will open the red cover and flip the firing switch. [✓]

6.3.9 After firing, turn the firing panel key to the "UNARMED" position. [✓]

WARNING: If blasting cap does not fire, refer to Section 10.4 in ED73-SHK-FOP-004 (see Appendix A).

Blasting Cap Fired: **yes** ✓ **no** ____

6.3.10 Remove the arming key and disconnect the voltage supply. [✓]

6.3.11 Test personnel may now return to the control room. [✓]

6.3.12 Wait a minimum of 5 minutes after firing before opening the door to room 170. [✓]

6.3.13 The lead pyro engineer shall now begin to reduce the data. [✓]

6.4 Post Test Inspection

6.4.1 Inform the MSFC TE that the door to room 170 from the control room is to be opened. [✓]

6.4.2 The pyro technician shall enter room 170 and move the junction box switch to the "BULB" position. [✓]

6.4.3 Remove blasting cap leads from junction box. [✓]

6.4.4 Inspect the shock plate to insure all explosive devices fired properly. [✓]

WARNING: If all explosive items did not fire, refer to Section 10.5 in ED73-SHK-FOP-004 (see Appendix A).

6.4.5 The BSM shall be visually inspected for damage resulting from the pyro shock test. Any anomalies will be recorded. All other personnel shall remain in the control room or in the clear area until the "ALL CLEAR" is given by the MSFC TE. [✓]

No Damage

6.4.6 MSFC TE indicates all clear for appropriate personnel. [✓]

6.5 Post Test Removal from the Pyro Plate

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1000738

6.7.3 *Vehicle Dynamics*

6.7.3.1 The following levels and conditions apply for the vehicle dynamics test. Vibrate the motor only as follows. [✓]

Frequency (Hz)	Level
5 to 10	0.7 g peak
10 to 40	4.3 g peak

Sweep Rate: 3 octaves per minute

6.8 Post Test Inspection

6.8.1 The BSM test item shall be visually inspected by the MSFC QA, MSFC TE, and the CSD TE for exterior damage resulting from vibration testing. [✓]
No damage noted.

6.8.2 Remove all instrumentation. [✓]

6.9 Data Requirements

Power Spectral Density (PSD) plots for all control and response accelerometers for lift off and boost tests shall be recorded. The test tolerances shall be overplotted on the control accelerometers plots. Acceleration versus frequency plots shall be recorded for all accelerometers used during vehicle dynamics tests.

7.0 Post Test Disassembly/Prepare for Shipment

7.1 Conditioning Chamber Removal

7.1.1 Disconnect any hoses and instrumentation that hinders the removal of the chamber. [✓]

7.1.2 Using the overhead crane, slowly lift the conditioning chamber off of the vibration table and place on the floor. [✓]

7.1.3 Move chamber out of the way. [✓]

7.1.4 Move the conditioning unit out of the way if necessary. [✓]

7.1.5 Verify motor ground connection on the motor and at the facility ground contact point. [✓]

7.1.6 Remove vibration table insulation. [✓]

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7.2 Aero Heat Shield Removal

WARNING: Removing the Aero Heat Shield exposes the motor's propellant grain. Personnel should use caution during any operations with and exposed grain. Tools, watches, eye glasses, etc., should be tethered (if necessary) to prevent dropping anything into the motor.

7.2.1 Make sure the motor ground is secured. [✓]

7.2.2 Make sure verified wrist straps are being worn by the personnel removing the aero heat shield. [✓]

7.2.3 Remove the fasteners from the Aero Heat Shield. Place the fasteners in a marked bag. [✓]

7.2.3 SLOWLY remove the Aero Heat Shield. [✓]

7.2.5 Remove the heat shield seal. Do not drop the seal into the motor. [✓]

7.3 Post Test Inspection of Motor Propellant Grain

7.3.1 Make sure motor ground wire is secured. [✓]

7.3.2 Clear area of all non-essential personnel. Only the grain inspectors (2) and the MSFC TE shall remain. [✓]

7.3.3 Verify grain inspector(s) is(are): [✓]

a. Wearing 100% cotton coveralls, shorts, and undershirts.

b. Wearing a wrist strap.

c. Wearing tethers and/or tape to keep eye glasses, rings, and watches from falling into the motor.

7.3.4 Perform grain inspection. [✓]

Cracked propellant yes no

If yes, give approximate location and size of crack:

____

____

-3-93

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Other comments on grain condition:

NO DIFFERENCES NOTED FROM PRE-TEST INSPECTION.

Grain inspector(s) J. S. Blanton Ben Selby
MSFC QA J. S. Blanton

7.3.5 A draw-wire, fabric, security bag shall be installed over the nozzle exit cone. The bag shall be closed around the exit cone and secured by inserting the bag wire ends through ~~a standard security lead seal~~ (i.e. cover the exit cone the same way that it was received). [✓]

7.4 Adapter Plate Removal

7.4.1 Remove the adapter plate to vibration table fasteners. [✓]

7.4.2 Attach lifting straps as shown in Fig. 1b (Appendix B). [✓]

CAUTION: Be careful not to disconnect the ground while lifting the motor.

CAUTION: The following step involves working with a suspended load. Keep hands and feet out from under the load.

7.4.3 Lift the motor off of the vibration table and move to an area near the wood supports. [✓]

7.4.4 Lower the motor so that it rests on the wood supports. [✓]

7.4.5 Rotate the motor 180° so that the adapter plates face up. [✓]

7.4.6 Remove the bracket to adapter plate fasteners. Place fasteners in a marked bag. [✓]

CAUTION: Be careful not to disconnect the ground while lifting the motor.

CAUTION: The following step involves working with a suspended load. Keep hands and feet out from under the load.

7.5 Aft Skirt Bracket Removal

7.5.1 Remove the aft end motor to bracket fasteners (12 places). Place fasteners in a marked bag. * [✓]

* LIGHT SCORING OF SURFACE AT THE AFT BRACKET ATTACHMENTS.

JH 9/23/93
BC 9-23-93
NB 9/23/93

9-23-93

1000738

CHATTER MARKS EVIDENT ON MS 09/23/93
FORWARD FACE OF THE MOTOR. JH 9/23/93
RC 9-23-93
RYS 9-23-93

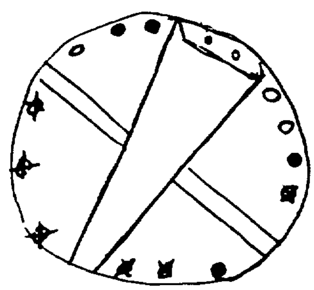
DIGHT

1000738

CONDITIONS @ POST TEST INSPECTION (6.E)

LOOSE AERO HEAT SHIELD BOLTS

● - MISSING BOLTS (QTY 4)
o - LOOSE BOLTS (QTY 3)
⊗ - OKAY



1000738

Figure 1

TEST PROCEDURE DEVIATION

TEST ENGINEER: Mat Berill MB 9-22-93	QUALITY: Rick Clements RC 9-22-93	TCP NO.: BSM-TCP-EP54-003
		DATE: 09/22/93
REQUIREMENTS ENGINEER:	OTHER: Richard Leonard RLS 9-22-93	SHEET 1 OF 2

TITLE: Radial Axis, Boost Vibration time Limit (motor 1000738)

DEV. NO.	PAGE	SEQ.	CHANGE/REASON	PERM/TEMP.
1			Boost vibration time duration should be 120 sec as stated in BSM-TCP-EP54-003 step 6.2.3.1. Boost vibration test was only conducted for 60 sec. Conditioning equipment and instrumentation were re-connected. Chamber temp was resumed 24.5 minutes after chamber removal. Testing was resumed per NOTE: in section 8.0 in BSM-TCP-EP54-002. The final 60 secs. were finished after chamber resumed temp.	Temp
2			Lift off vibration time (Radial Axis) was short by 1 sec. Once the chamber resumed temperature (see Dev. 1 above) the test was resumed. (i.e. Lift off vibration was performed for one more second.) Time tolerance as stated in 4.2.1 has time tolerance of +10%, -0%	Temp

ORIGINATOR: Mat Berill

ORGANIZATION: EP12

ABOVE DEVIATION(S) INCREASE HAZARD LEVEL: NO

SAFETY: Richard V. Leonard

ABOVE DEVIATION(S) AFFECT TEST REQUIREMENTS: Yes

1000738

Figure 1

TEST PROCEDURE DEVIATION		TCP NO: Bsm-TCP-EP54-003
TEST ENGINEER: Mat Bevill MB 9/22/93	QUALITY: Rick Clements RC 9-22-93	DATE: 09/22/93
REQUIREMENTS ENGINEER: —	OTHER: Richard Leonard RJL 9-22-93	SHEET 2 OF 2

TITLE: FWD Bracket to motor attach fasteners loosened during Vibration

DEV. NO.	PAGE	SEQ.	CHANGE/REASON	PERM/TEMP.
3			The fwd bracket to motor attach bolts were torqued per step 6.2.2.4 in BSM-TCP-EP54-001. (150 in-lbs.) After finishing ~~During~~ the radial axis boost vibration test (see dev. 1) ~~the~~ it was noticed that 4 fasteners were in but loose, 2 were completely out, and 2 were tight. Photographs were taken. Fasteners were re-torqued per 6.2.2.4 in BSM-TCP-EP54-001 (150 in-lbs with the same torque wrench). These torques were then verified with another torque wrench SN: BTW-2RCF. * RETORQUEING THE BOLTS PER STEP 6.2.2.4 DOES NOT INCREASE THE HAZARD LEVEL. HOWEVER, AS STATED ABOVE THE FACT THAT THEY CAME LOOSE DURING VIBRATION TESTING DID INCREASE THE HAZARD LEVEL. PRECAUTIONS WILL BE TA[KEN] TO AVOID THIS HAPPEN[ING] AGAI[N]	T

ORIGINATOR: Mat Bevill	ORGANIZATION: EP12
ABOVE DEVIATION(S) INCREASE HAZARD LEVEL. ✓ A D	SAFETY: [illegible signature]
	ABOVE DEVIATION(S) AFFECT TEST REQUIREMENTS.

SN 1000738

EHICLE DYNAMICS CHECK-OUT

AXIS Radial

1.1 Verify test program and record the abort level below. ✓

Abort Level 1db

1.2 Perform levels as defined below and verify with plot. ✓

1.3 Record the following:

Amplifier Gain 40%

Charge Amp. F.S. 10G

5	-	10	Hz at	.07G	, limit	±1.5	dB
10	-	40	Hz at	3.7G	, limit	±1.5	dB
	-		Hz at		, limit		dB
	-		Hz at		, limit		dB
	-		Hz at		, limit		dB

Sweep Rate = 3 oct/min

Test level concurrence: ______________________ __________

Component Assessment Branch Date

LIFT OFF RANDOM   1000738

RANDOM CHECK-OUT

AXIS TANGENTIAL

1.1 Verify test program and record RMS abort limit below. ✓

RMS abort limit 1 dB

1.2 Perform levels as defined below and verify with plot. ✓

1.3 Record the following:

Amplifier Gain 70%

Charge Amp. F.S. 30 G

		20 Hz @	.016	G^2/Hz,	limits	+3,-1.5db
75	Hz -	1000 Hz @	.060	"	limits	"
	Hz -	2000 Hz @	.030	"	limits	"
	Hz -	Hz @			limits	
	Hz -	Hz @			limits	
	Hz -	Hz @			limits	
	Hz -	Hz @			limits	
	Hz -	Hz @			limits	
	Hz -	Hz @			limits	

Composite = 10 Grms

Test Time = 60 Sec.

Test Level Concurrence: ______________________ ______

Component Assessment Branch   Date

BOOST RANDOM SN 1000778

RANDOM CHECK-OUT

AXIS TANGENTIAL

.1 Verify test program and record RMS abort limit below. ✓

RMS abort limit 1 dB

..2 Perform levels as defined below and verify with plot. ✓

..3 Record the following:

Amplifier Gain 80 %

Charge Amp. F.S. 100 G

			Hz @		G^2/Hz,	limits	+3, -1.5 dB
20	Hz -	800	Hz @	.24	"	limits	"
	Hz -	2000	Hz @	.017		limits	"
	Hz -		Hz @			limits	
	Hz -		Hz @			limits	
	Hz -		Hz @			limits	
	Hz -		Hz @			limits	
	Hz -		Hz @			limits	
	Hz -		Hz @			limits	

Composite = 18.4 Grms

Test Time = 120 sec.

Test Level Concurrence: ____________________ ____________

Component Assessment Branch Date

SN 1000738

VEHICLE DYNAMICS CHECK-OUT

AXIS TANGENTIAL

1.1 Verify test program and record the abort level below. ✓

Abort Level 1db

1.2 Perform levels as defined below and verify with plot. ✓

1.3 Record the following:

Amplifier Gain 4090

Charge Amp. F.S. 10 G

5	-	10	Hz at	.7	, limit	±1.5	dB
10	-	40	Hz at	4.3	, limit		dB
	-		Hz at		, limit		dB
	-		Hz at		, limit		dB
	-		Hz at		, limit		dB

Sweep Rate = 3 oct/min

Test level concurrence: ______________________ __________

Component Assessment Branch Date

LIFTOFF RANDOM SN 1000738

RANDOM CHECK-OUT

AXIS LONGITUDINA

1.1 Verify test program and record RMS abort limit below. ✓

RMS abort limit 1 dB

1.2 Perform levels as defined below and verify with plot. ✓

1.3 Record the following:

Amplifier Gain 70%

Charge Amp. F.S. 30G

		20	Hz @	.016	G^2/Hz,	limits	+3, -1.5 dB
75	Hz -	1000	Hz @	.06		limits	"
	Hz -	2000	Hz @	.03		limits	"
	Hz -		Hz @			limits	
	Hz -		Hz @			limits	
	Hz -		Hz @			limits	
	Hz -		Hz @			limits	
	Hz -		Hz @			limits	
	Hz -		Hz @			limits	

Composite = 10 Grms

Test Time = 60 Sec.

Test Level Concurrence: ______________ ________

Component Assessment Branch   Date

B02-I RANDOM SN 1000738

RANDOM CHECK-OUT

AXIS LONGITUDINAL

1.1 Verify test program and record RMS abort limit below. ✓

RMS abort limit 1 dB

1.2 Perform levels as defined below and verify with plot. ✓

1.3 Record the following:

Amplifier Gain 85

Charge Amp. F.S. 100

		Hz @		G^2/Hz,	limits +3,-1.5 db
20 Hz -	800	Hz @	.24		limits "
Hz -	2000	Hz @	.017		limits "
Hz -		Hz @			limits
Hz -		Hz @			limits
Hz -		Hz @			limits
Hz -		Hz @			limits
Hz -		Hz @			limits
Hz -		Hz @			limits

Composite = 18.4 Grms

Test Time = 120 Sec.

Test Level Concurrence: ______________________ ______________

Component Assessment Branch Date

SN 1000734 + 1000738

VEHICLE DYNAMICS CHECK-OUT

AXIS LONGITUDINAL

1.1 Verify test program and record the abort level below. ✓

Abort Level ____ 12db ____

1.2 Perform levels as defined below and verify with plot. ✓

1.3 Record the following:

Amplifier Gain ____ 4070 ____

Charge Amp. F.S. ____ 10 G ____

5	-	10	Hz at	.7	, limit	+-1.5	dB
10	-	40	Hz at	4.3	, limit	"	dB
	-		Hz at		, limit		dB
	-		Hz at		, limit		dB
	-		Hz at		, limit		dB

Sweep Rate = 3 oct/min

Test level concurrence: ______________________ ____________

Component Assessment Branch   Date

SN 1000738

RANDOM TEST LIFTOFF

		AXIS RADIAL LONGITUDINAL TANGENTIAL
.1	Record a minimum of 30 seconds of calibration signal on tape recorder.	✓ ✓ ✓
.2	Set full scale ranges on instrumentation amplifiers and note on data sheet.	✓ ✓ ✓
.3	Set power amplifier gain to position noted during random test check-out.	✓ ✓ ✓
1.4	Perform self check of control system.	✓ ✓ ✓
1.5	Begin test sequence at - 9 dB from full level.	✓ ✓ ✓
1.6	At - 6 dB, start tape recorder.	✓ ✓ ✓
1.7	Note time when full level is reached. SEE TAPE LOG	✓ ✓ ✓
1.8	At the completion of the test, set power amplifier gain to off.	✓ ✓ ✓
1.9	Stop tape recorder.	✓ ✓ ✓
1.10	Inspect test article for damage or degradation.	✓ ✓ ✓
1.11	Remove test article from shaker.	✓ ✓ ✓

SN 1000738

RANDOM TEST Boost

AXIS RADIAL TANGENTIAL LONGITUDINAL

.1	Record a minimum of 30 seconds of calibration signal on tape recorder.	✓ ✓ ✓
.2	Set full scale ranges on instrumentation amplifiers and note on data sheet.	✓ ✓ ✓
.3	Set power amplifier gain to position noted during random test check-out.	✓ ✓ ✓
.4	Perform self check of control system.	✓ ✓ ✓
.5	Begin test sequence at - 9 dB from full level.	✓ ✓ ✓
.6	At - 6 dB, start tape recorder.	✓ ✓ ✓
7	Note time when full level is reached. See TAPE LOG	✓ ✓ ✓
.8	At the completion of the test, set power amplifier gain to off.	✓ ✓ ✓
1.9	Stop tape recorder.	✓ ✓ ✓
1.10	Inspect test article for damage or degradation.	✓ ✓ ✓
1.11	Remove test article from shaker.	✓ ✓ ✓

SN 1000738

VEHICLE DYNAMICS TEST

AXIS RADIAL TANGENT

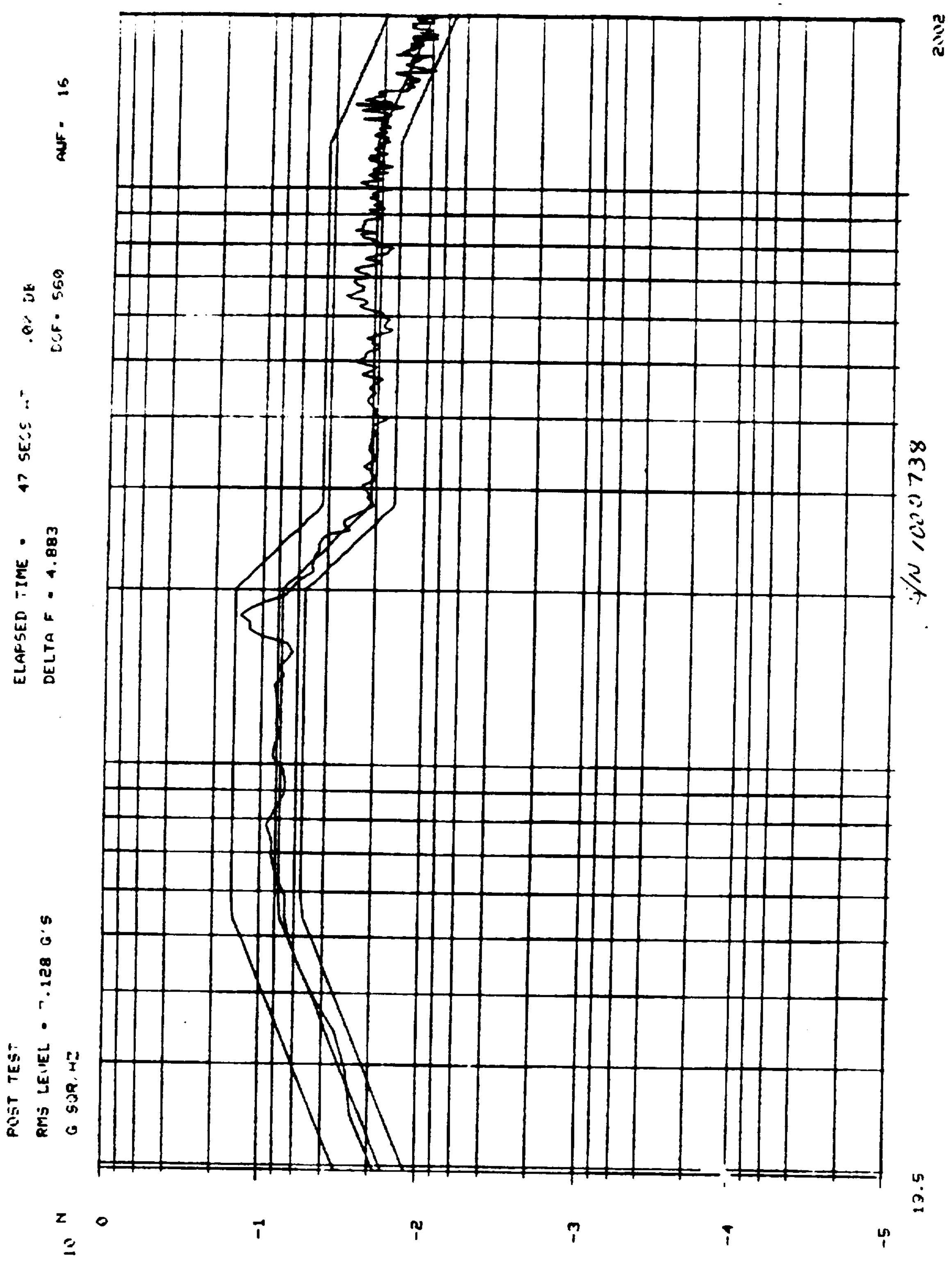
1.1	Record a minimum of 30 seconds of calibration signal on tape recorder.	✓ ✓ ✓
1.2	Set full scale ranges on instrumentation amplifiers and note on data sheet.	✓ ✓ ✓
1.3	Set power amplifier gain to position noted during sine test check-out.	✓ ✓ ✓
1.4	Perform self check of control system.	✓ ✓ ✓
1.5	Start tape recorder.	✓ ✓ ✓
1.6	Begin sine sweep.	✓ ✓ ✓
1.7	Note time of DCS "SWEEP UP" or "SWEEP DOWN" indication light. SEE TAPE LOG	✓ ✓ ✓
1.8	During first sweep, press the "SAVE" button on DCS.	✓ ✓ ✓
1.9	If more than one sweep, note time of DCS "SWEEP UP" or "SWEEP DOWN" indication light. —	—
1.10	At the completion of the sweep, set power amplifier gain to off.	✓ ✓ ✓
1.11	Stop tape recorder.	✓ ✓ ✓
1.12	Inspect test article for damage or degradation.	✓ ✓ ✓

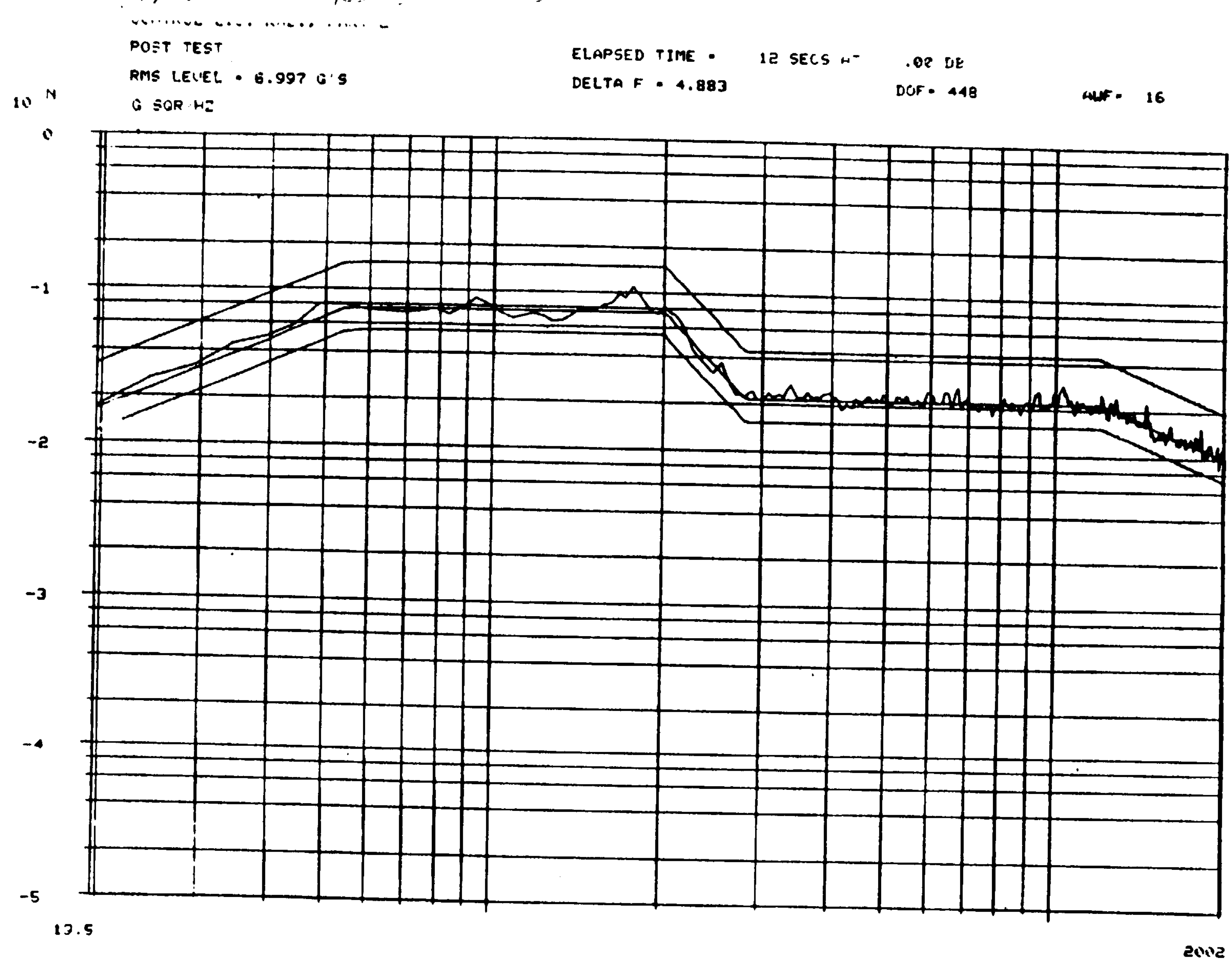
SN 1000738

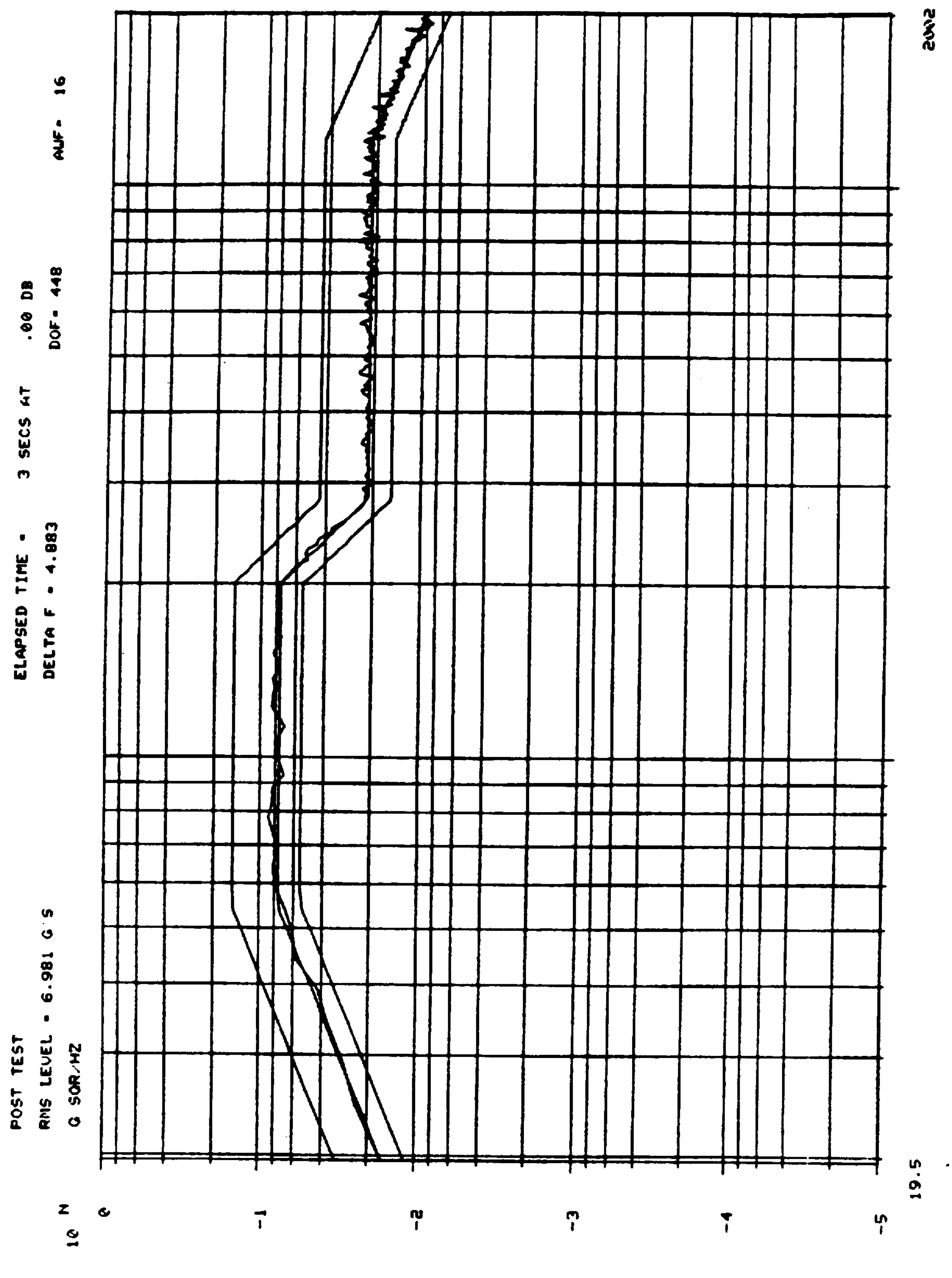
TEST DATA

RADIAL AXIS

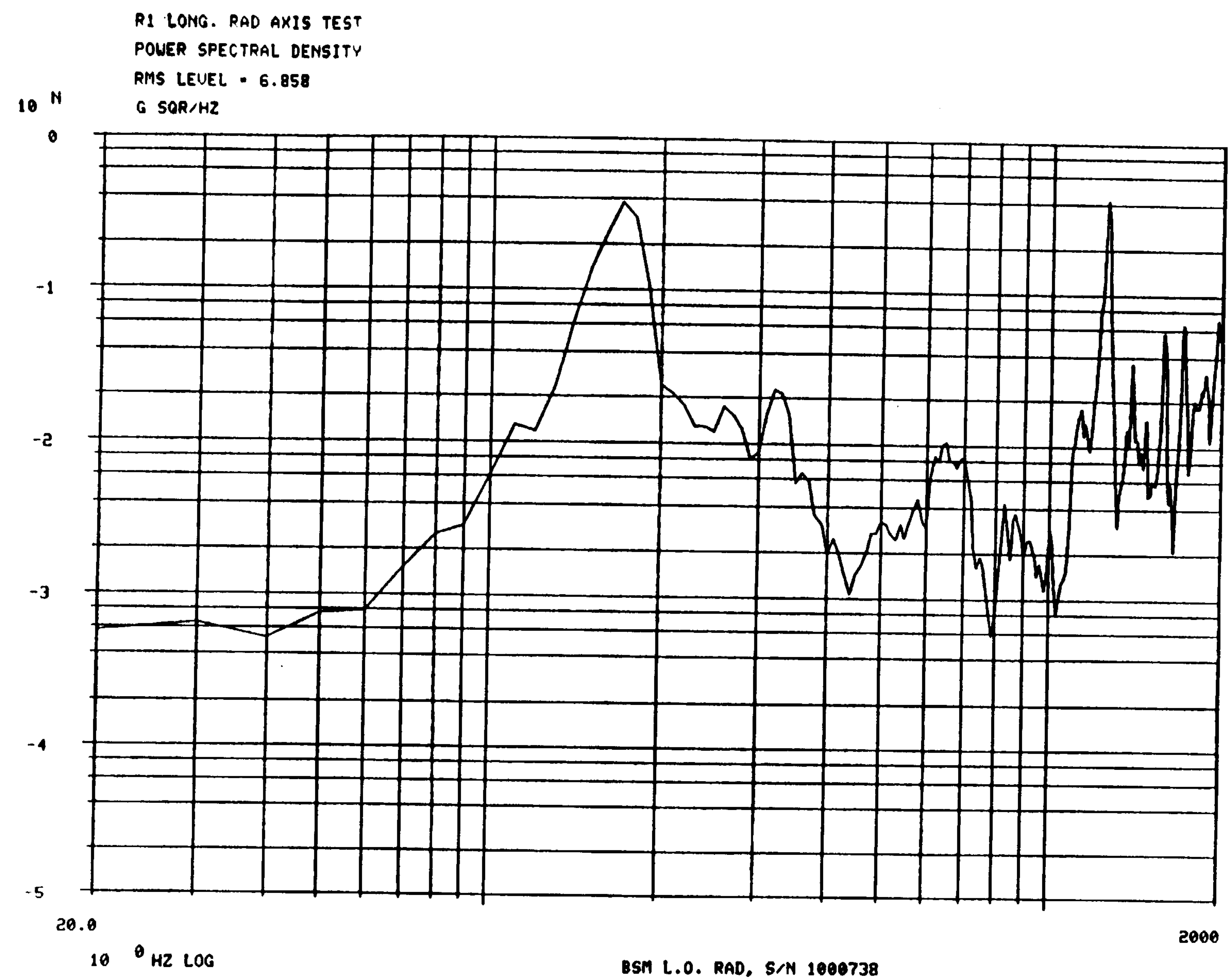
RANDOM, LIFT-OFF

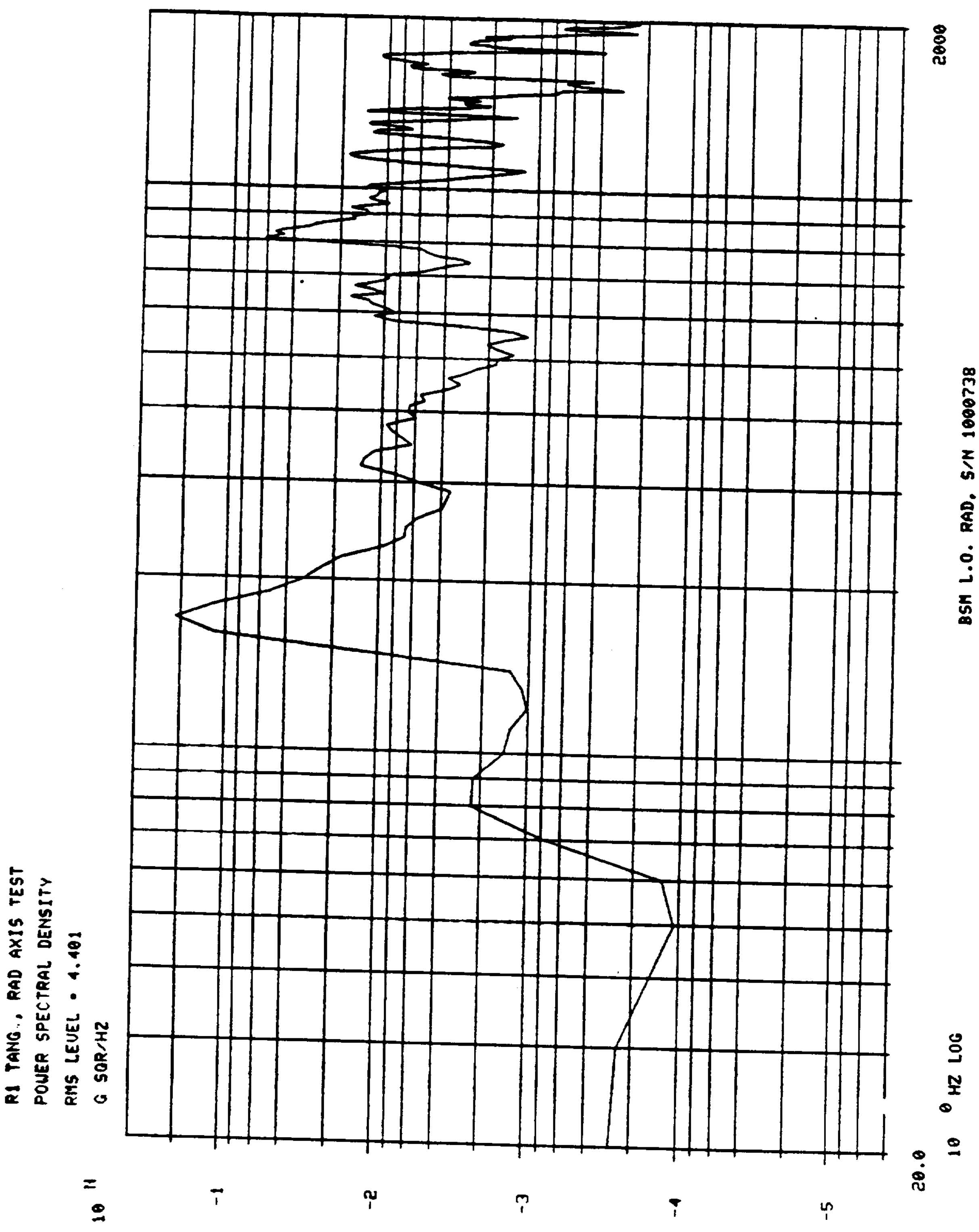

POST TEST
RMS LEVEL
.128 G'S
G SQR/HZ
ELAPSED TIME
47
DELTA F
4.883
DOF
560
AVF
16
0
-1
-2
-3
-4
-5
19.5
S/N 1000738

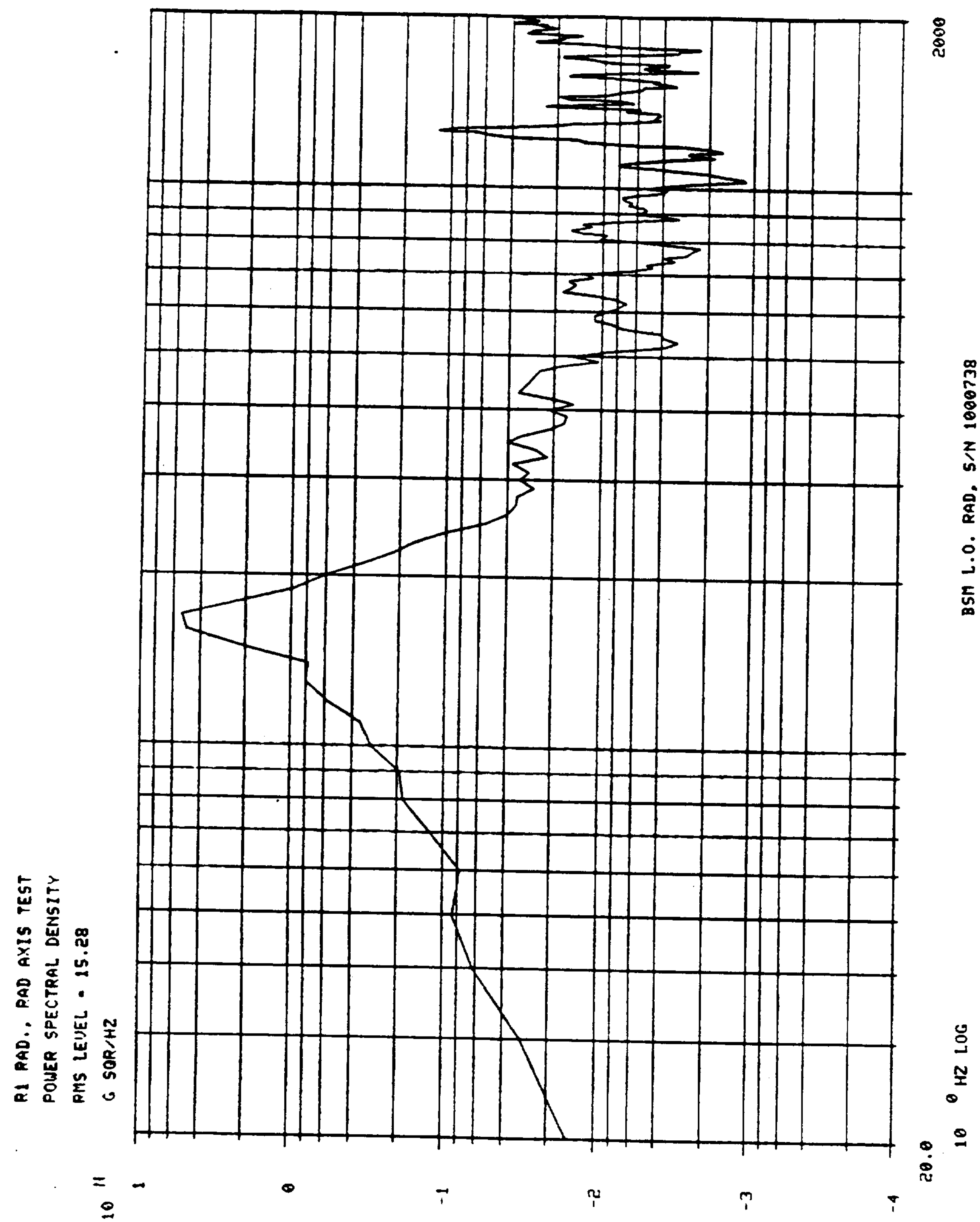

POST TEST
RMS LEVEL = 6.997 G'S
G SQR/HZ
ELAPSED TIME = 12 SECS
DELTA F = 4.883
.02 DB
DOF= 448
AVF= 16
10 N
0
-1
-2
-3
-4
-5
13.5
2002

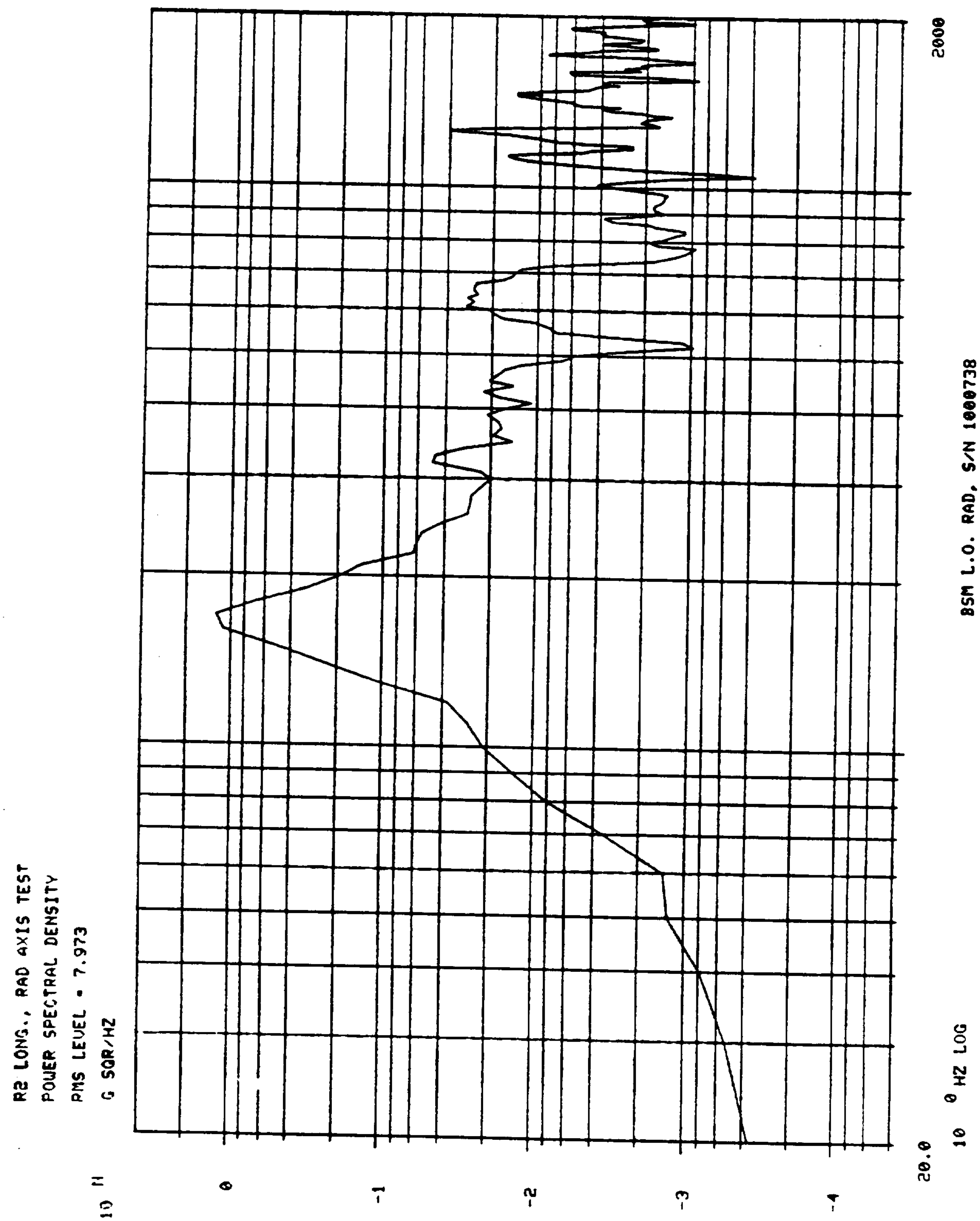


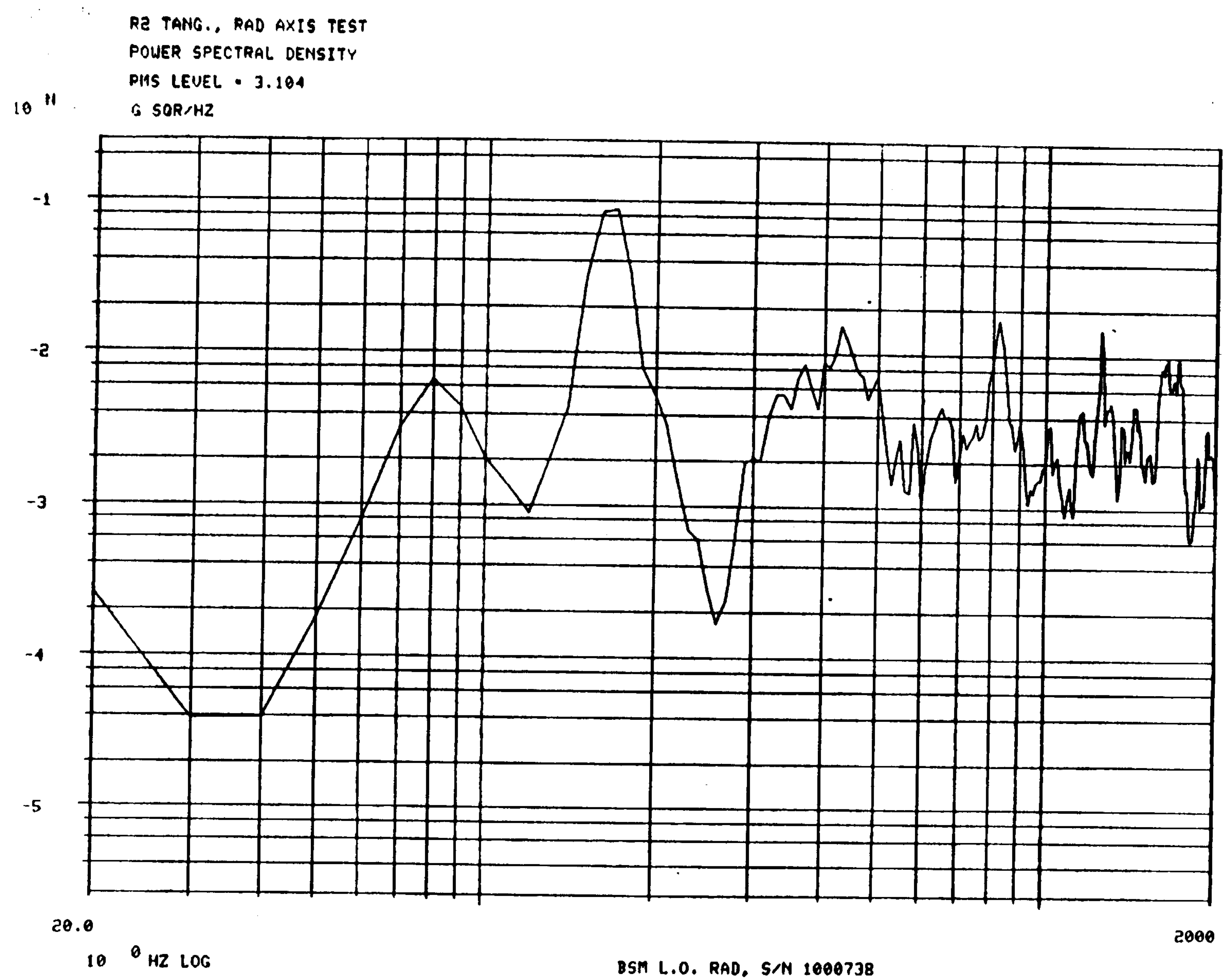
POST TEST
RMS LEVEL = 6.981 G'S
G SQR/HZ
ELAPSED TIME = 3 SECS AT .00 DB
DELTA F = 4.883 DOF= 448 AVF= 16
10 N
0
-1
-2
-3
-4
-5
19.5

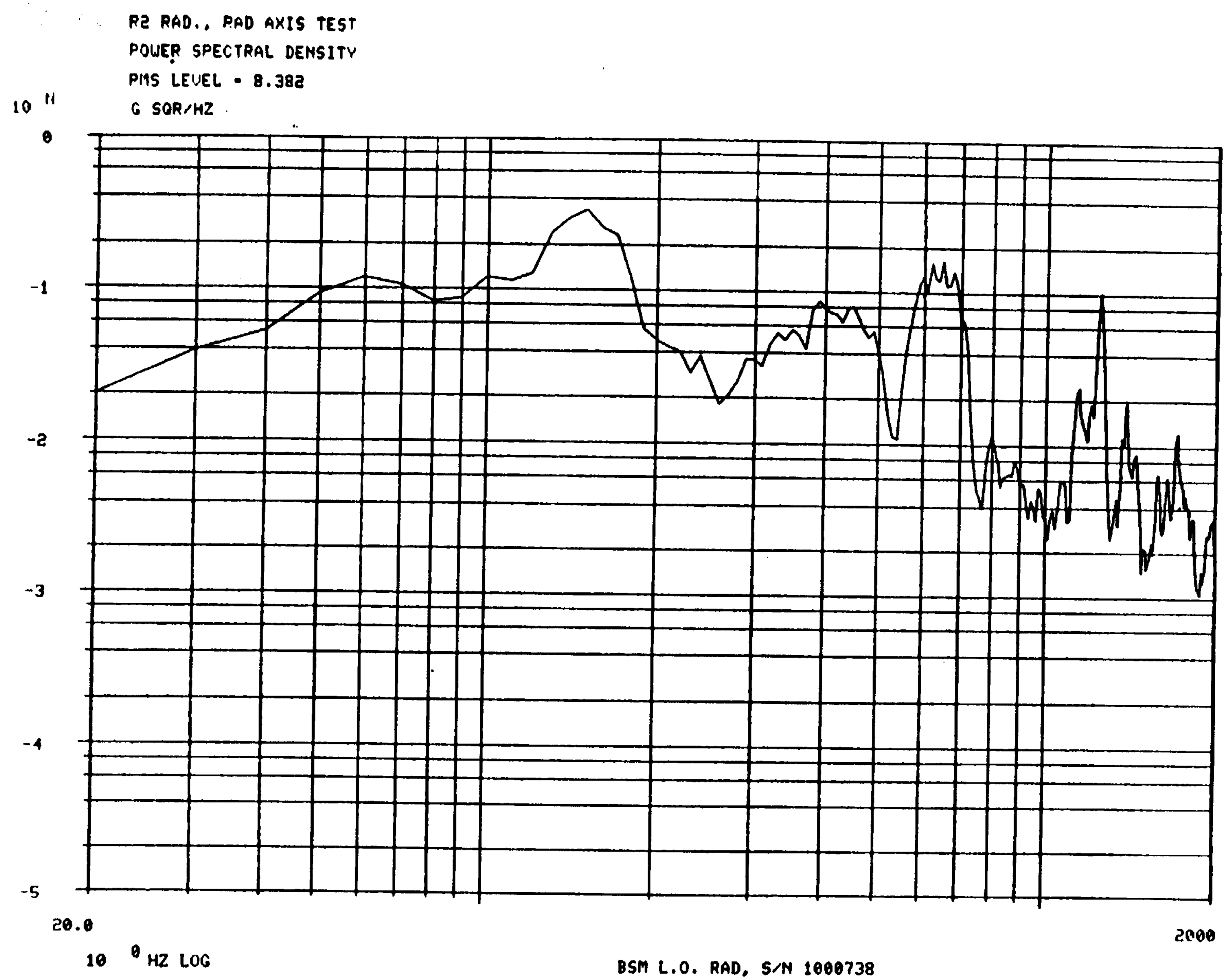

R1 LONG. RAD AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL = 6.858
G SQR/HZ
10 N
0
-1
-2
-3
-4
-5
20.0
2000
10 0 HZ LOG
BSM L.O. RAD, S/N 1000738


R1 TANG., RAD AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL = 4.401
G SQR/HZ
BSM L.O. RAD, S/N 1000738
10 0 HZ LOG
20.0
2000
10
-1
-2
-3
-4
-5


R1 RAD., RAD AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL = 15.28
G SQR/HZ
10
1
0
-1
-2
-3
-4
20.0
10 0 HZ LOG
2000
BSM L.O. RAD, S/N 1000738

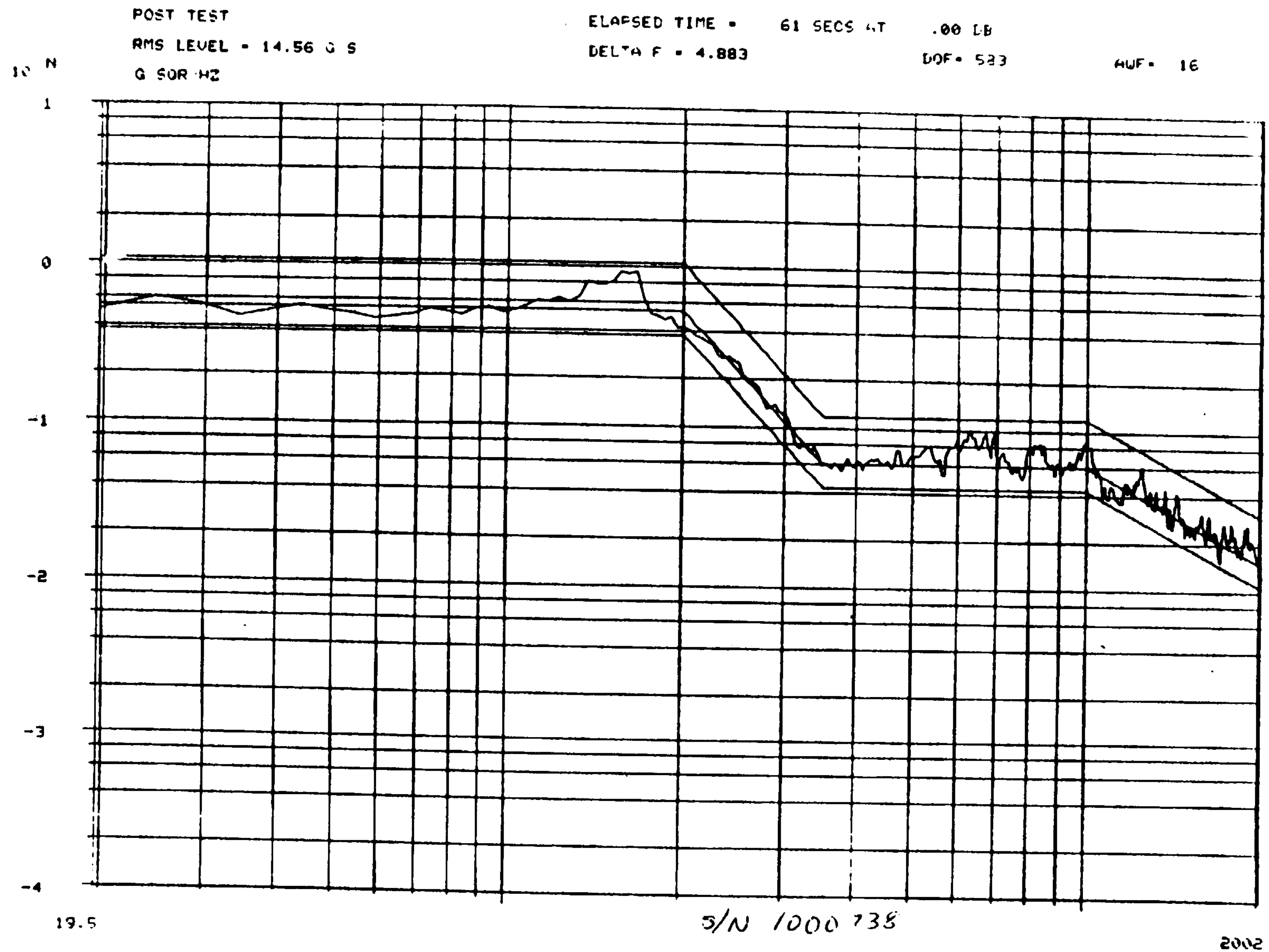

R2 LONG., RAD AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL = 7.973
G SQR/HZ
BSM L.O. RAD, S/N 1000738
HZ LOG
20.0
2000
0
-1
-2
-3
-4

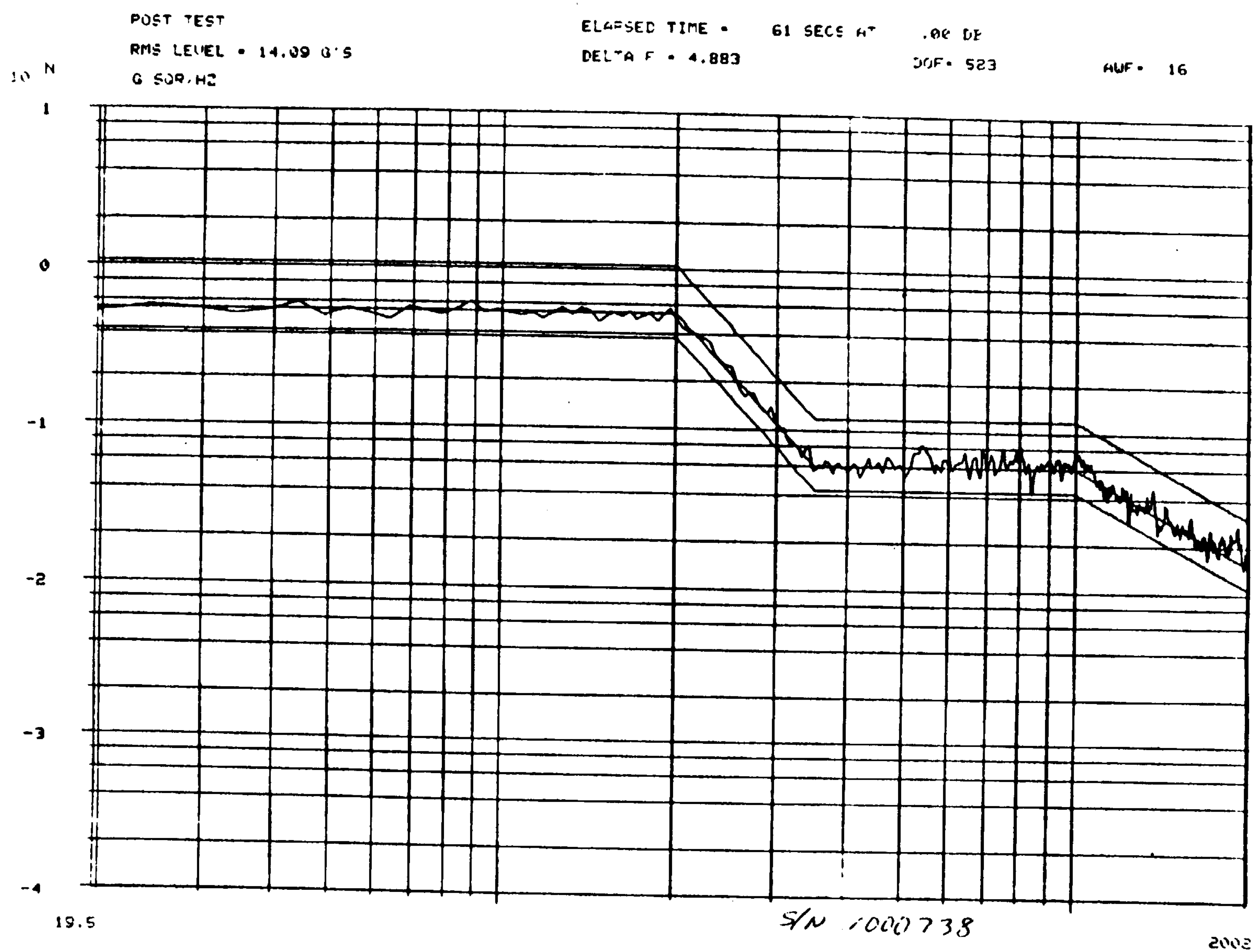

R2 TANG., RAD AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL • 3.104
G SQR/HZ
10 N
-1
-2
-3
-4
-5
20.0
2000
10 0 HZ LOG
BSM L.O. RAD, S/N 1000738

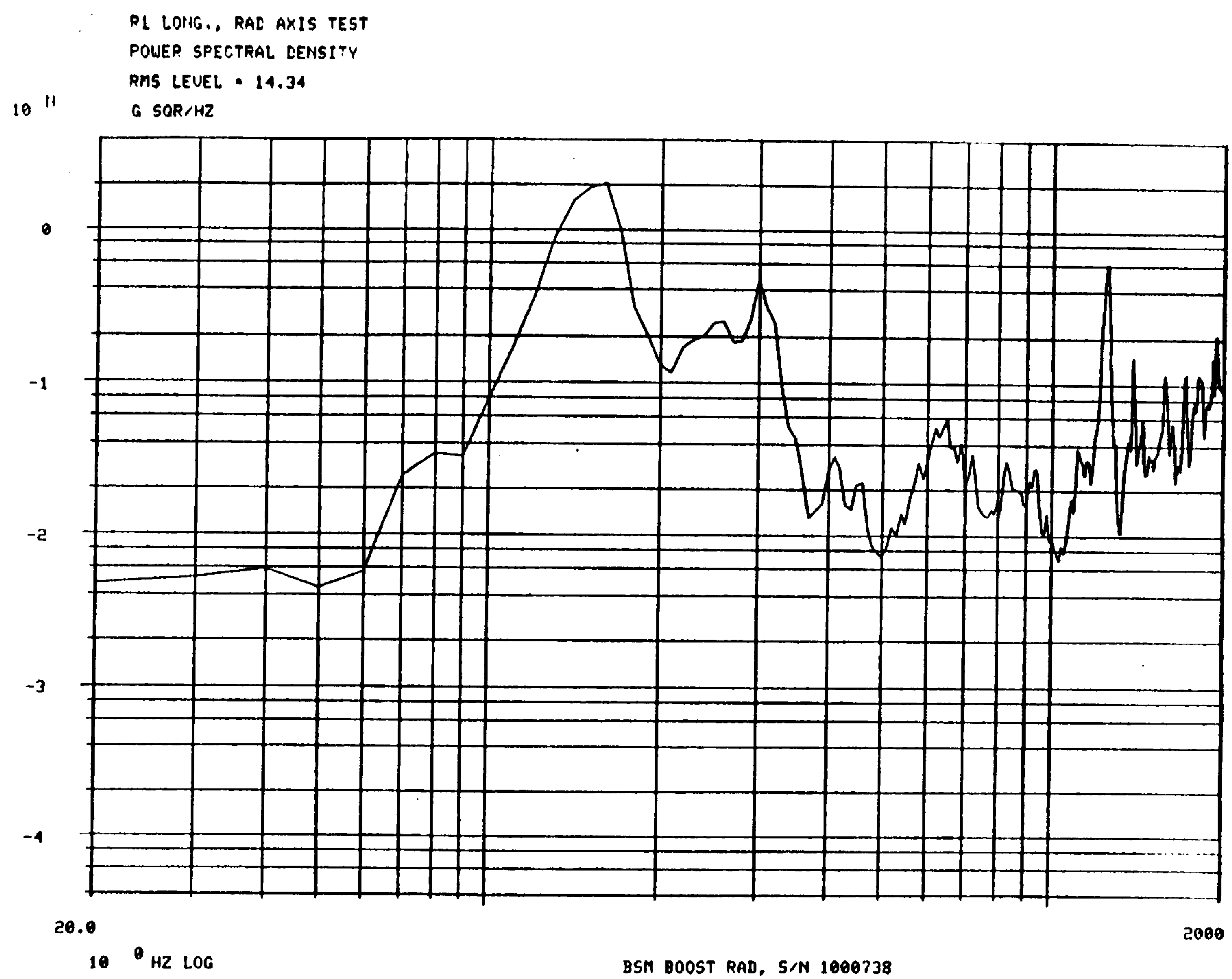

R2 RAD., RAD AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL = 8.382
G SQR/HZ
10 N
0
-1
-2
-3
-4
-5
20.0
2000
10 0 HZ LOG
BSM L.O. RAD, S/N 1000738

RADIAL AXIS

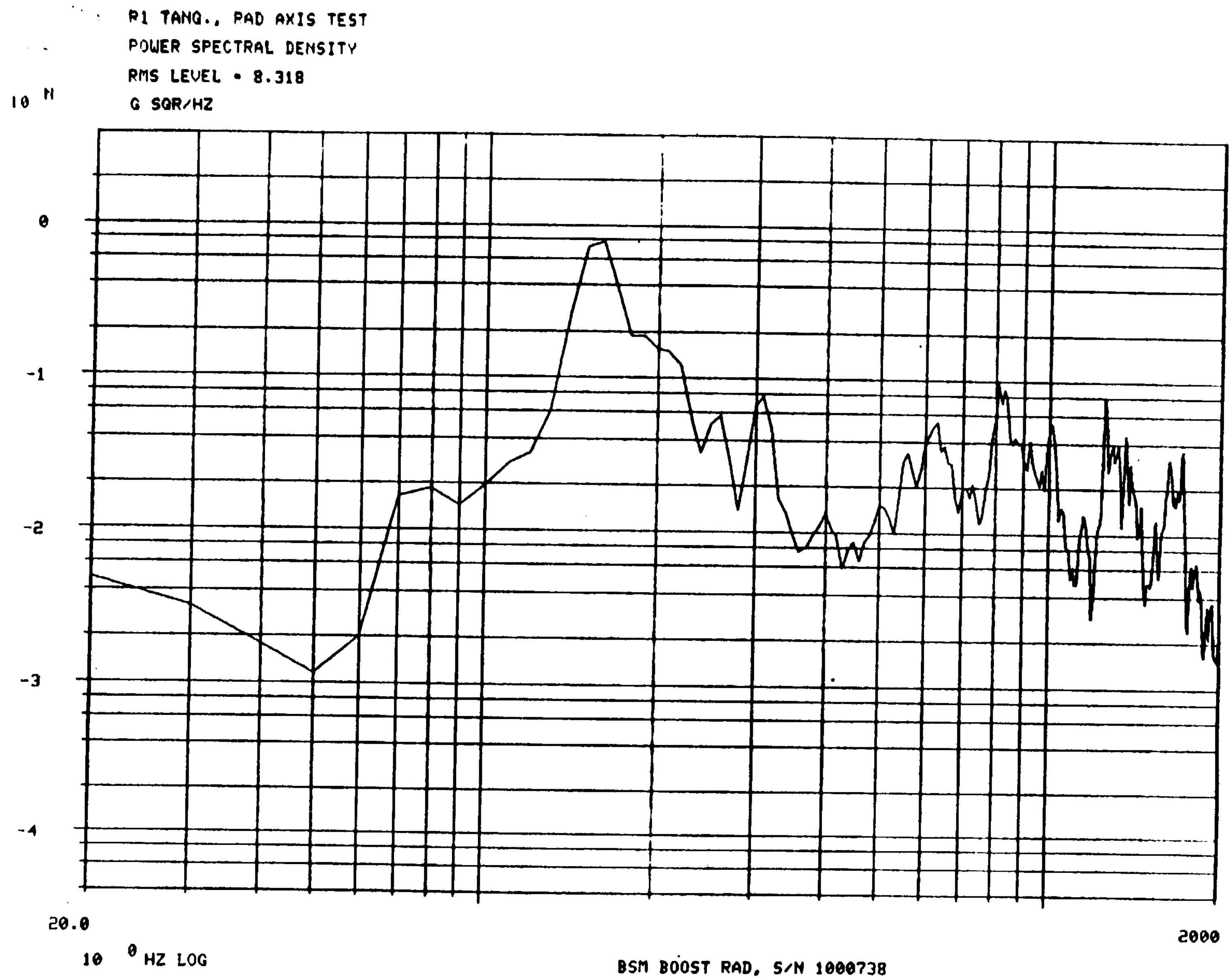
RANDOM, BOOST

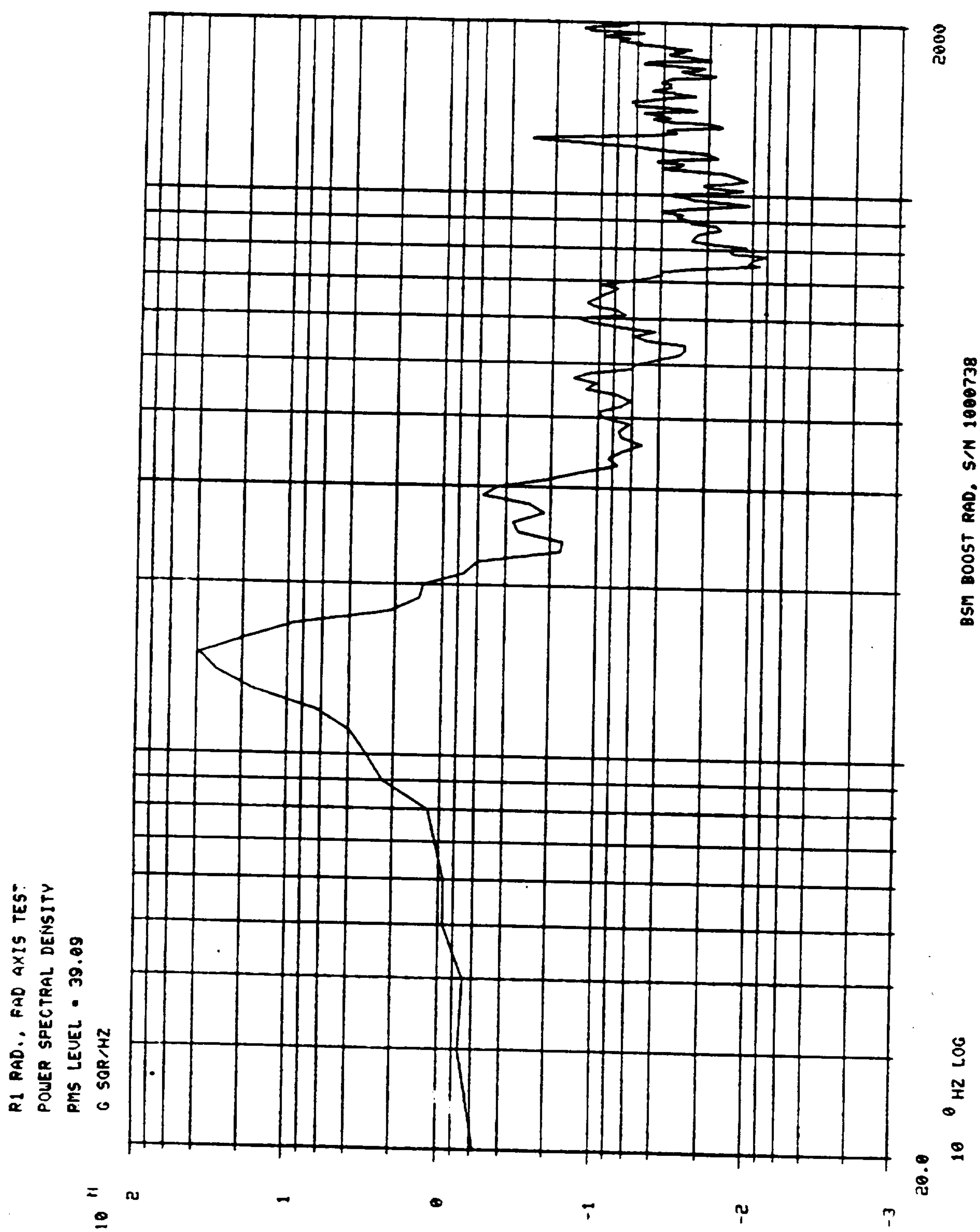

POST TEST
RMS LEVEL = 14.56 G S
G SQR HZ
ELAPSED TIME = 61 SECS AT .00 DB
DELTA F = 4.883
DOF = 533
AWF = 16
10 N
1
0
-1
-2
-3
-4
19.5
2002
S/N 1000 738

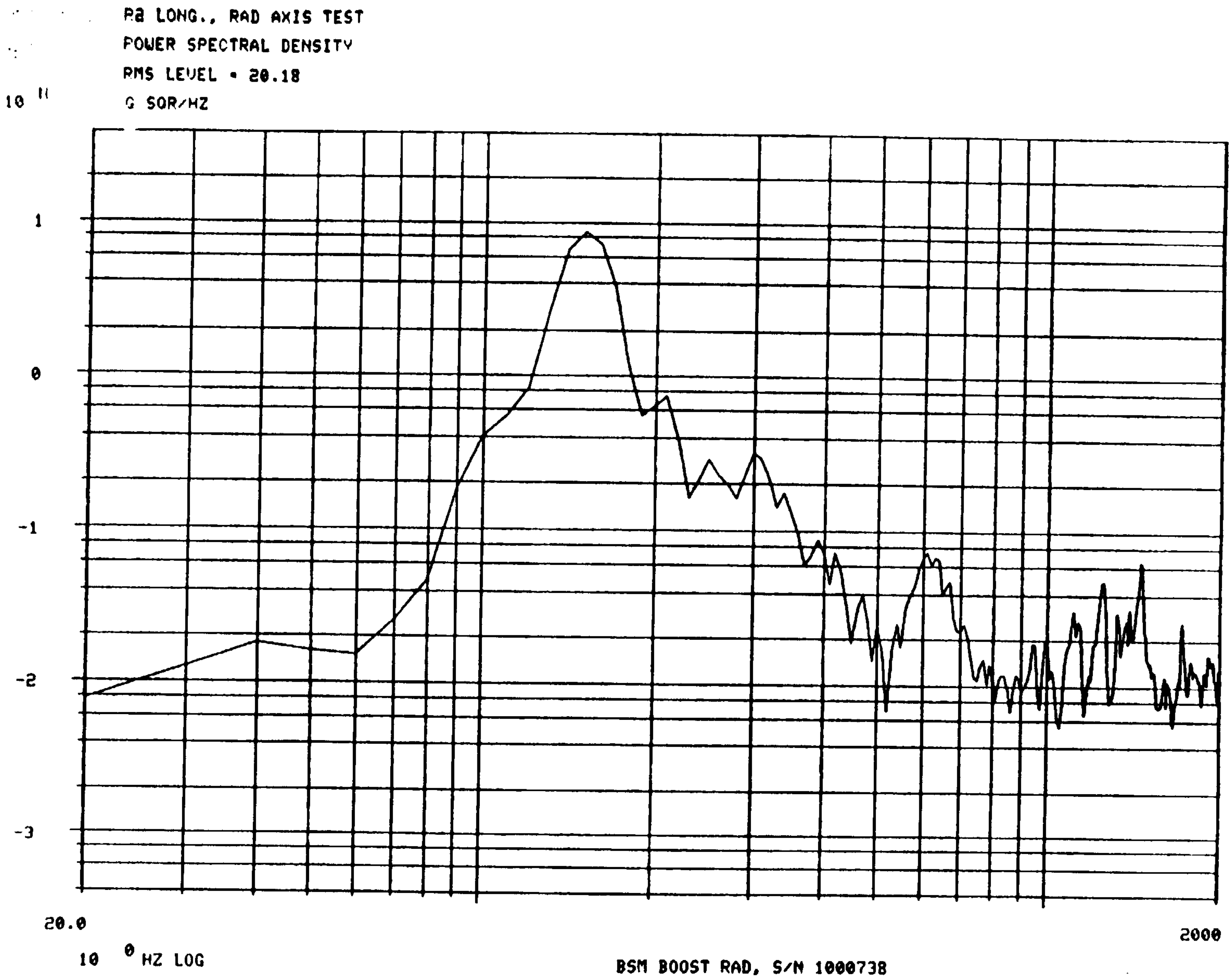

POST TEST
RMS LEVEL • 14.09 G'S
G SQR/HZ
ELAPSED TIME • 61 SECS AT .00 DB
DELTA F • 4.883
DOF• 523
AVF• 16
10 N
1
0
-1
-2
-3
-4
19.5
2002
S/N 1000738



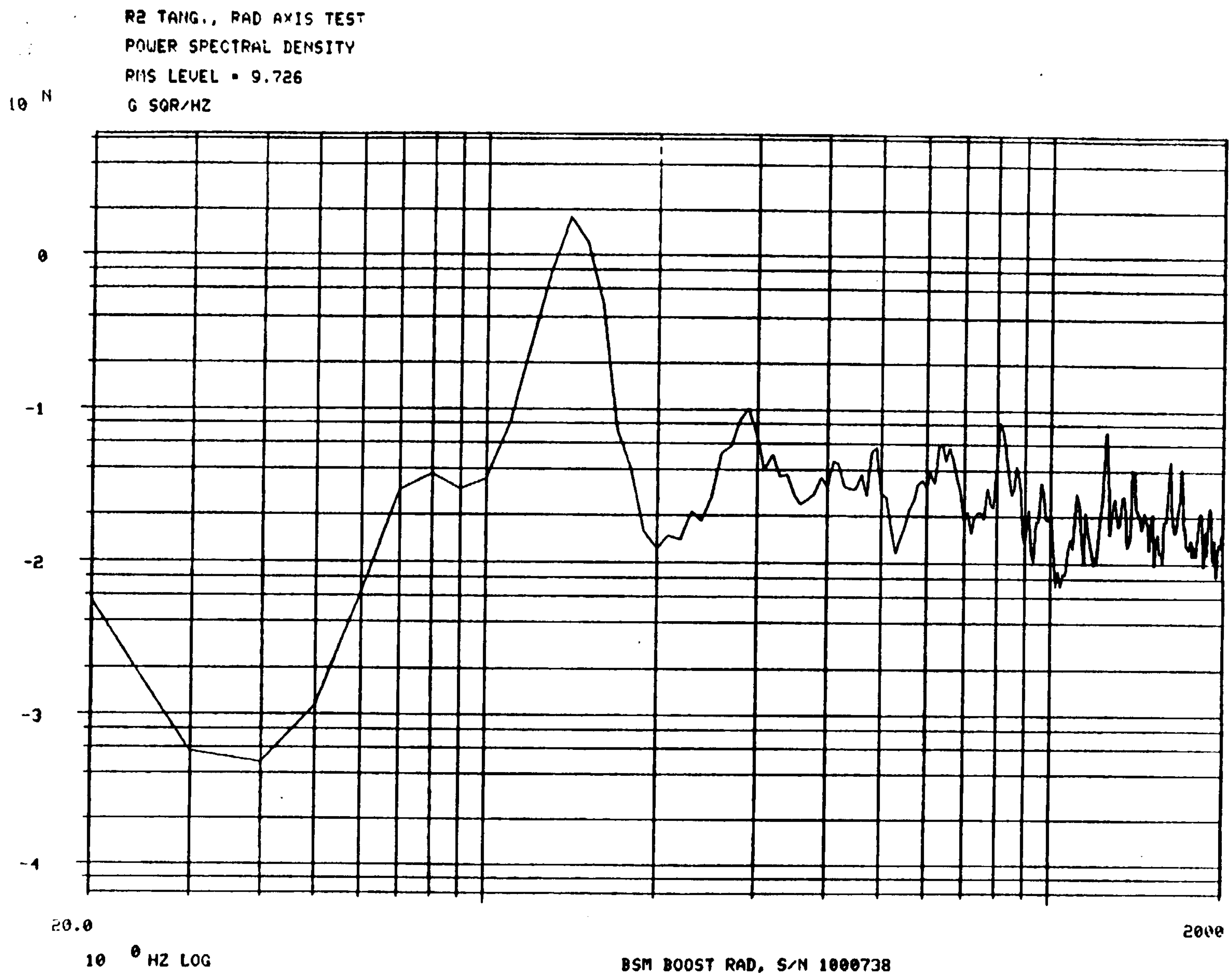
P1 LONG., RAD AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL = 14.34
G SQR/HZ
10 ¹¹
0
-1
-2
-3
-4
20.0
2000
10 ⁰ HZ LOG
BSM BOOST RAD, S/N 1000738

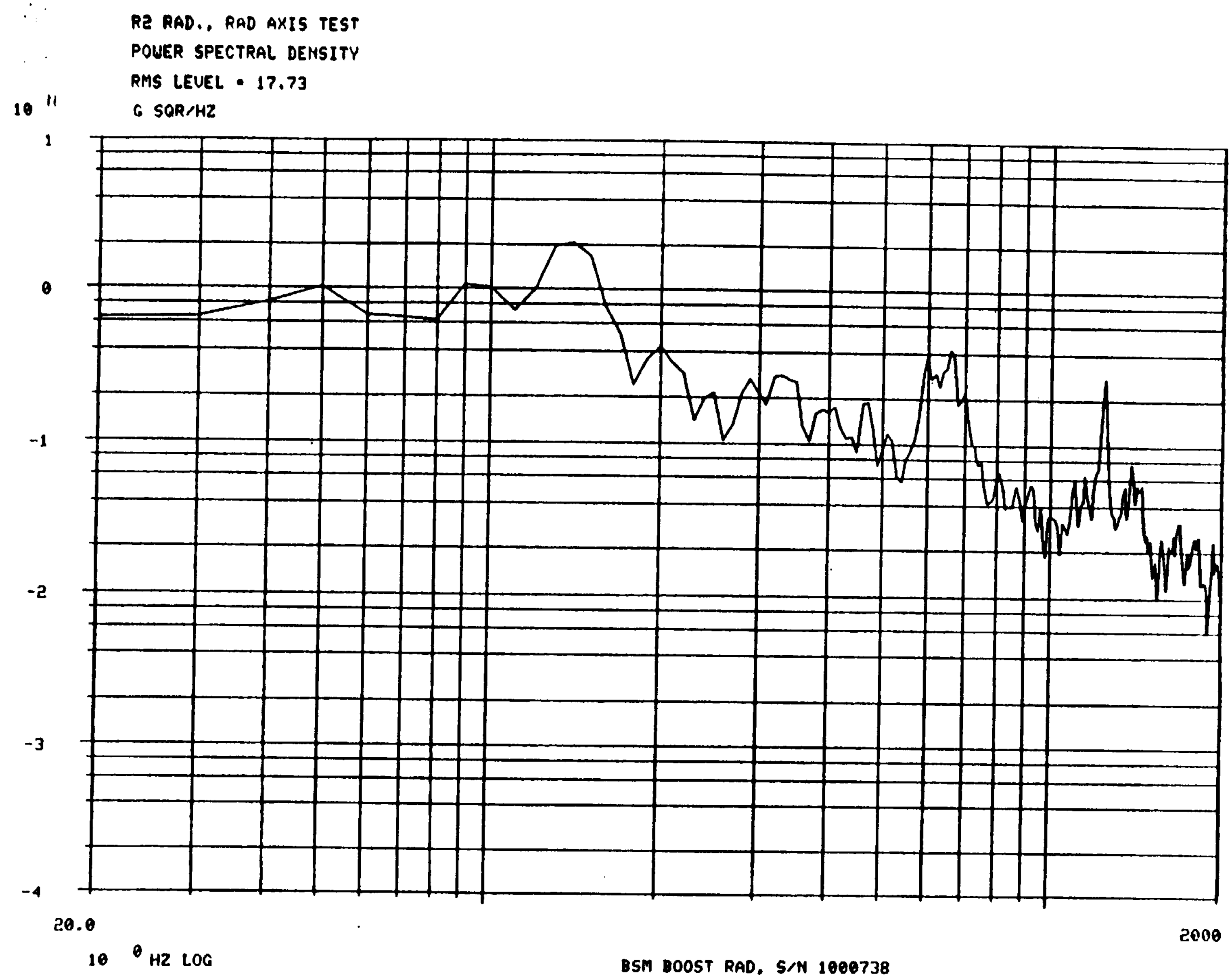

R1 TANQ., PAD AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL • 8.318
G SQR/HZ
10 N
0
-1
-2
-3
-4
20.0
2000
10 0 HZ LOG
BSM BOOST RAD, S/N 1000738


R1 RAD., RAD AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL = 39.09
G SQR/HZ
10
2
1
0
-1
-2
-3
20.0
10
0
HZ LOG
2000
BSM BOOST RAD, S/N 1000738



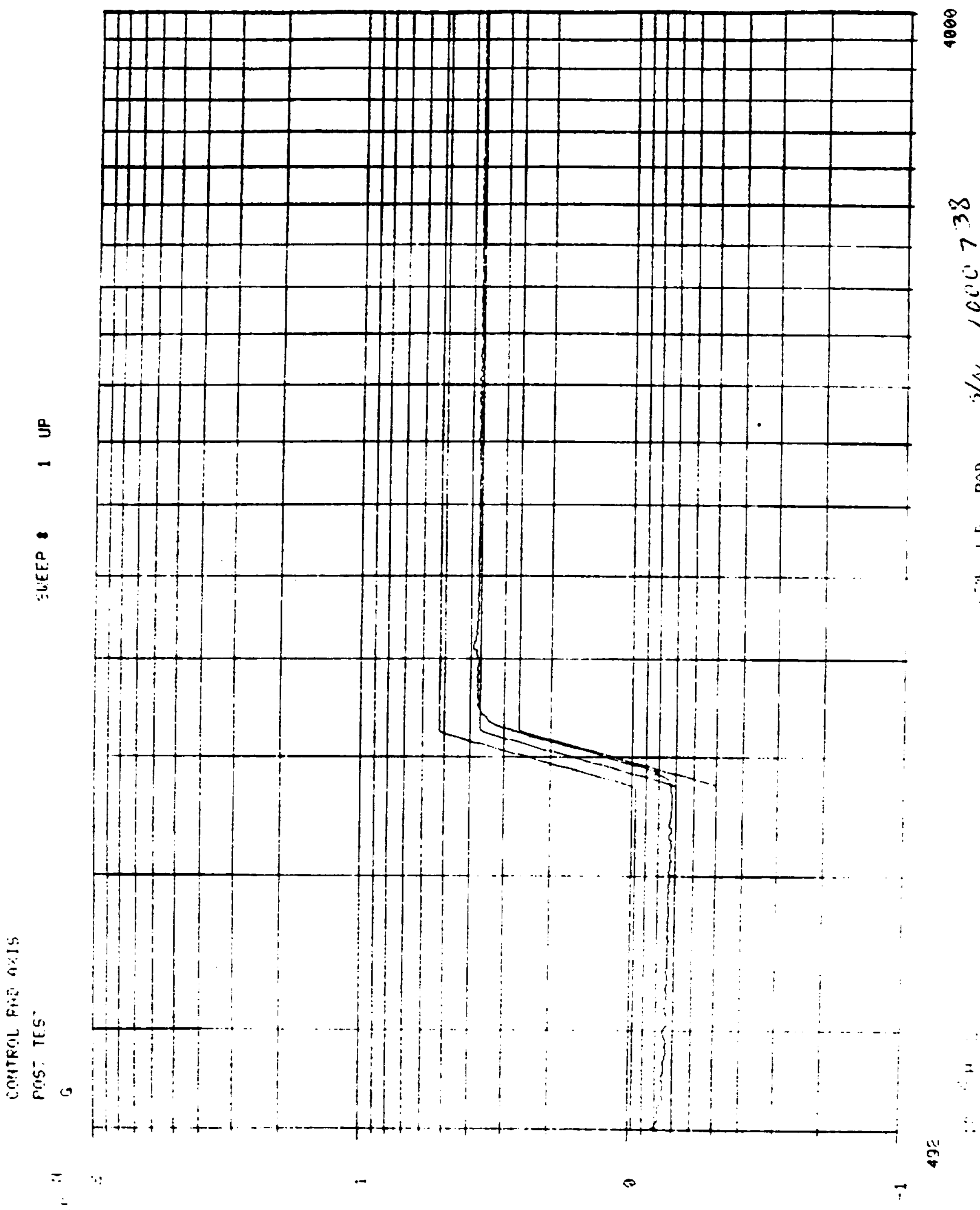
R2 LONG., RAD AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL = 20.18
G SQR/HZ
10
1
0
-1
-2
-3
20.0
2000
10
0
HZ LOG
BSM BOOST RAD, S/N 1000738


R2 TANG., RAD AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL • 9.726
G SQR/HZ
10 N
0
-1
-2
-3
-4
20.0
2000
10 0 HZ LOG
BSM BOOST RAD, S/N 1000738

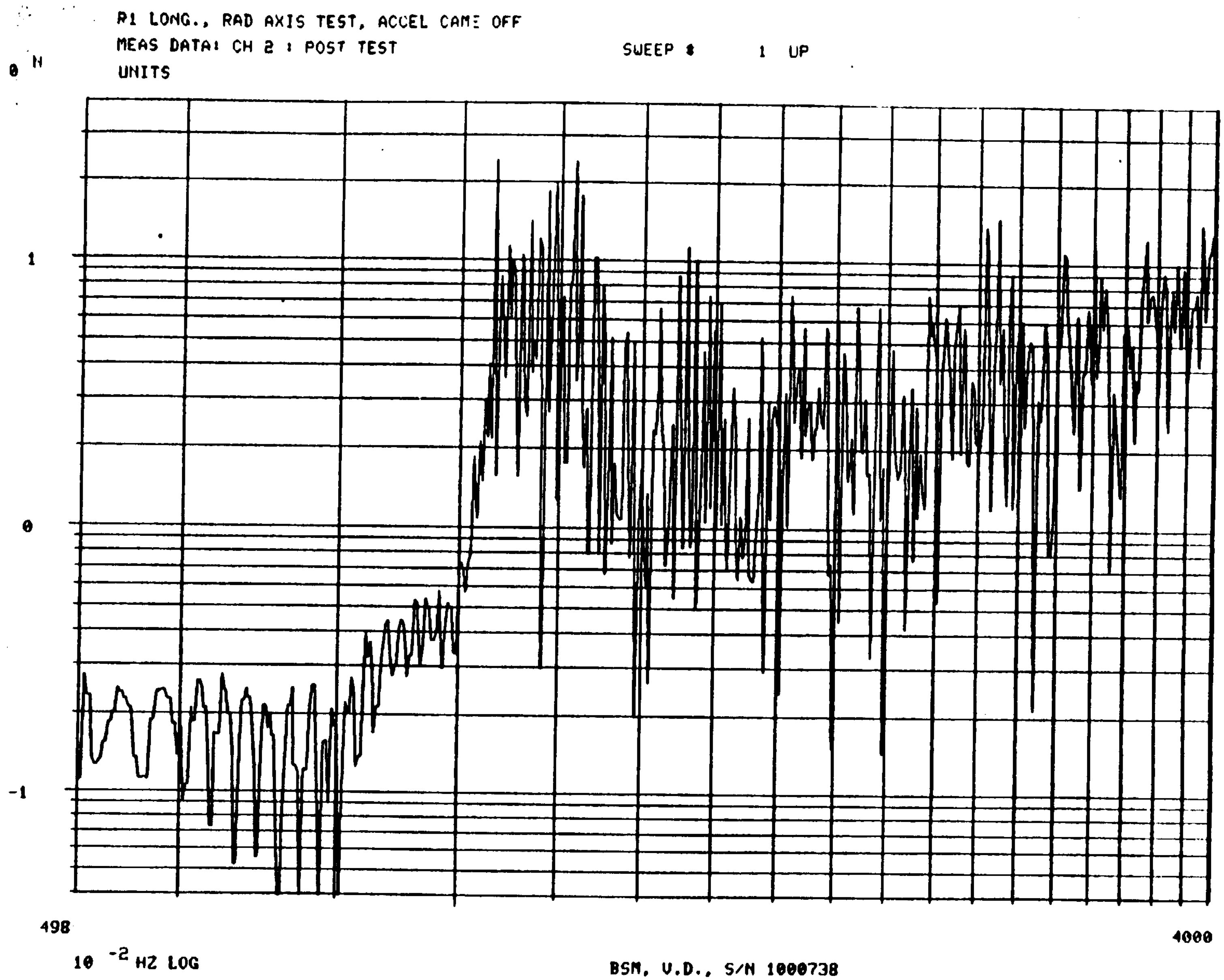

R2 RAD., RAD AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL • 17.73
G SQR/HZ
10
1
0
-1
-2
-3
-4
20.0
2000
10 0 HZ LOG
BSM BOOST RAD, S/N 1000738

RADIAL AXIS

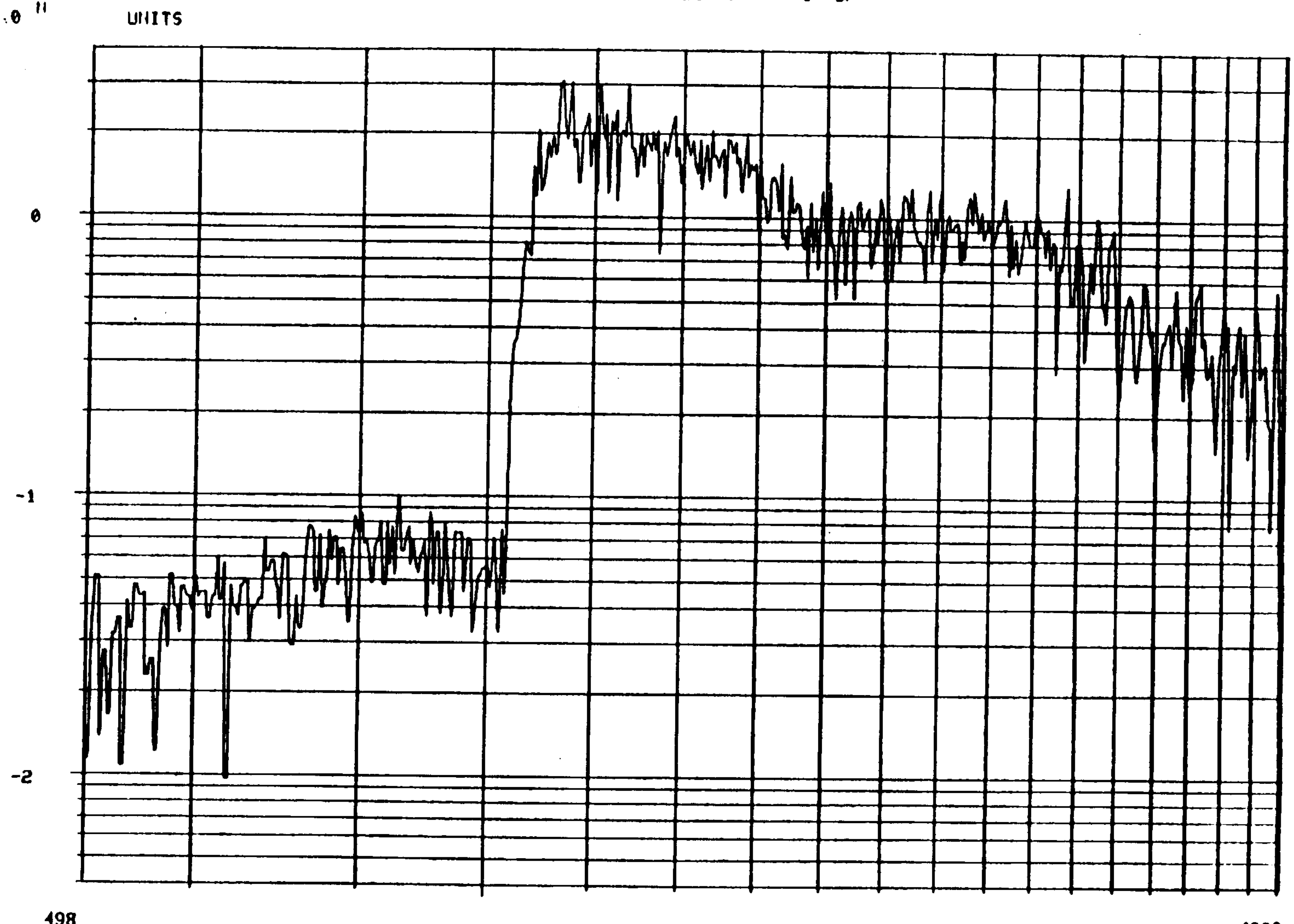
VEHICLE DYNAMICS



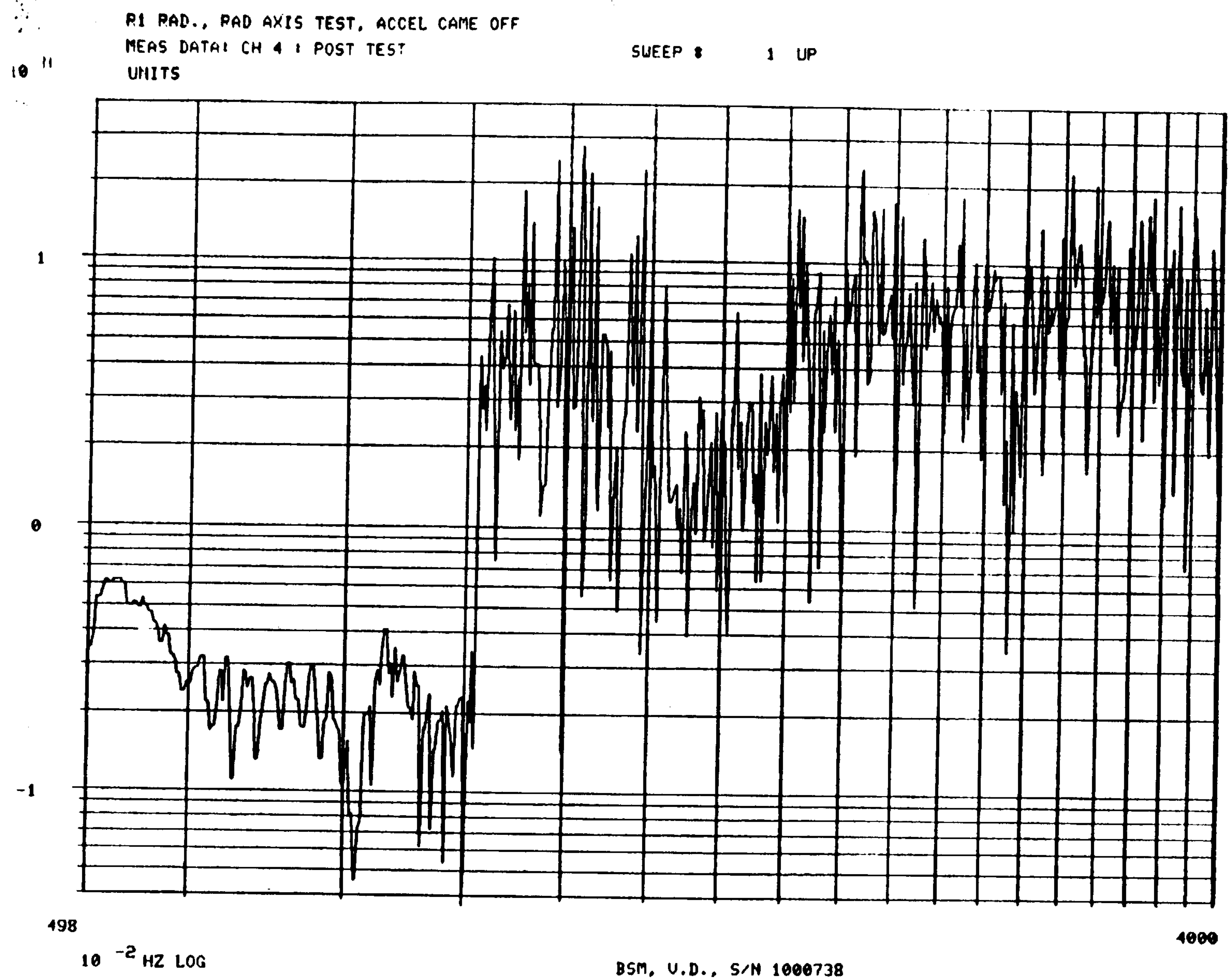
POST TEST
SWEEP # 1 UP
4000
492
1
0
-1


R1 LONG., RAD AXIS TEST, ACCEL CAME OFF
MEAS DATA: CH 2 : POST TEST
UNITS
SWEEP # 1 UP
0 N
1
0
-1
498
4000
10 -2 HZ LOG
BSM, V.D., S/N 1000738

R1 TANG., RAD AXIS TEST, ACCEL CAME OFF
MEAS DATA: CH 3 : POST TEST SWEEP # 1 UP
UNITS

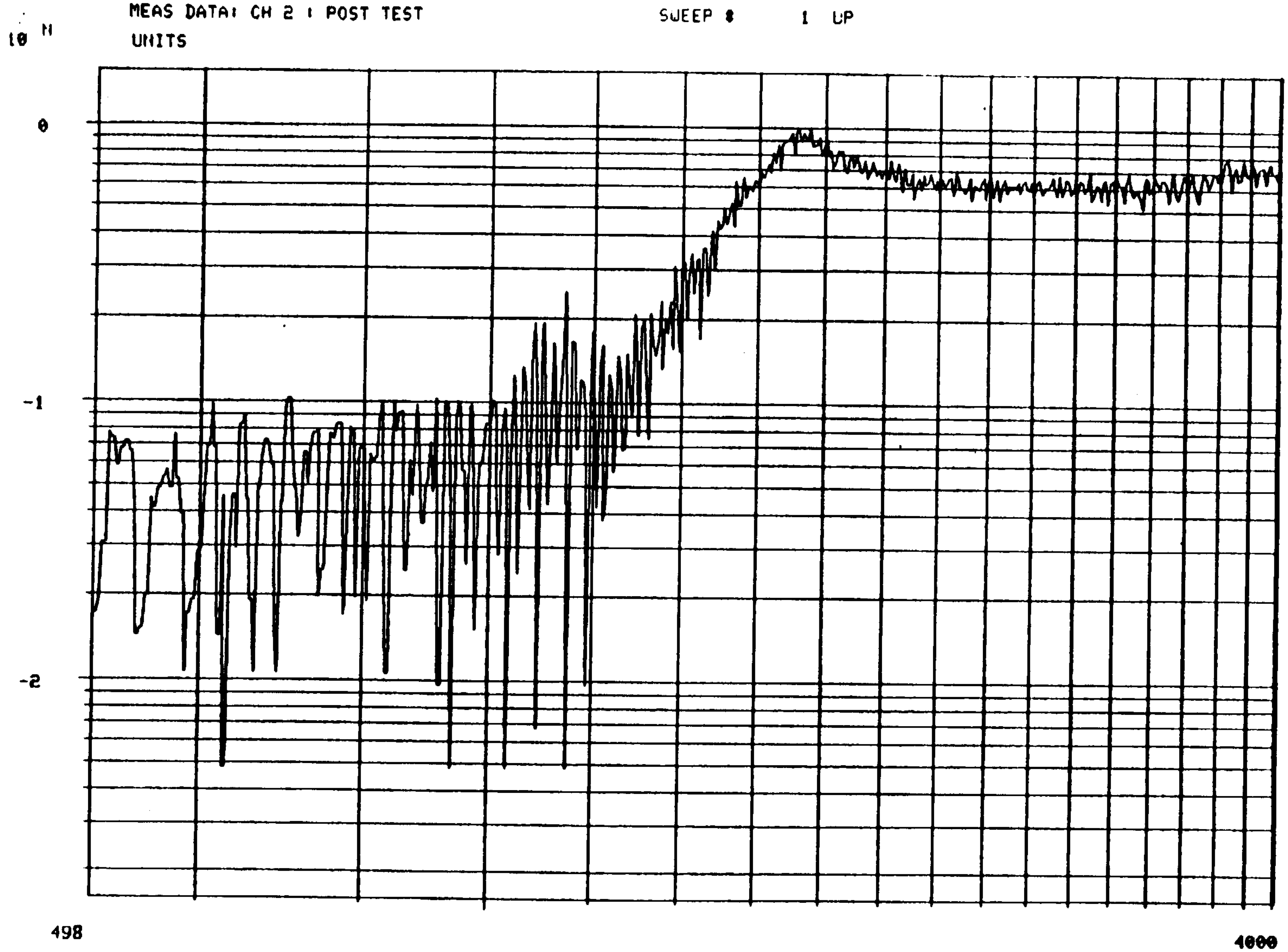


10 $^{-2}$ HZ LOG BSM, V.D., S/N 1000738

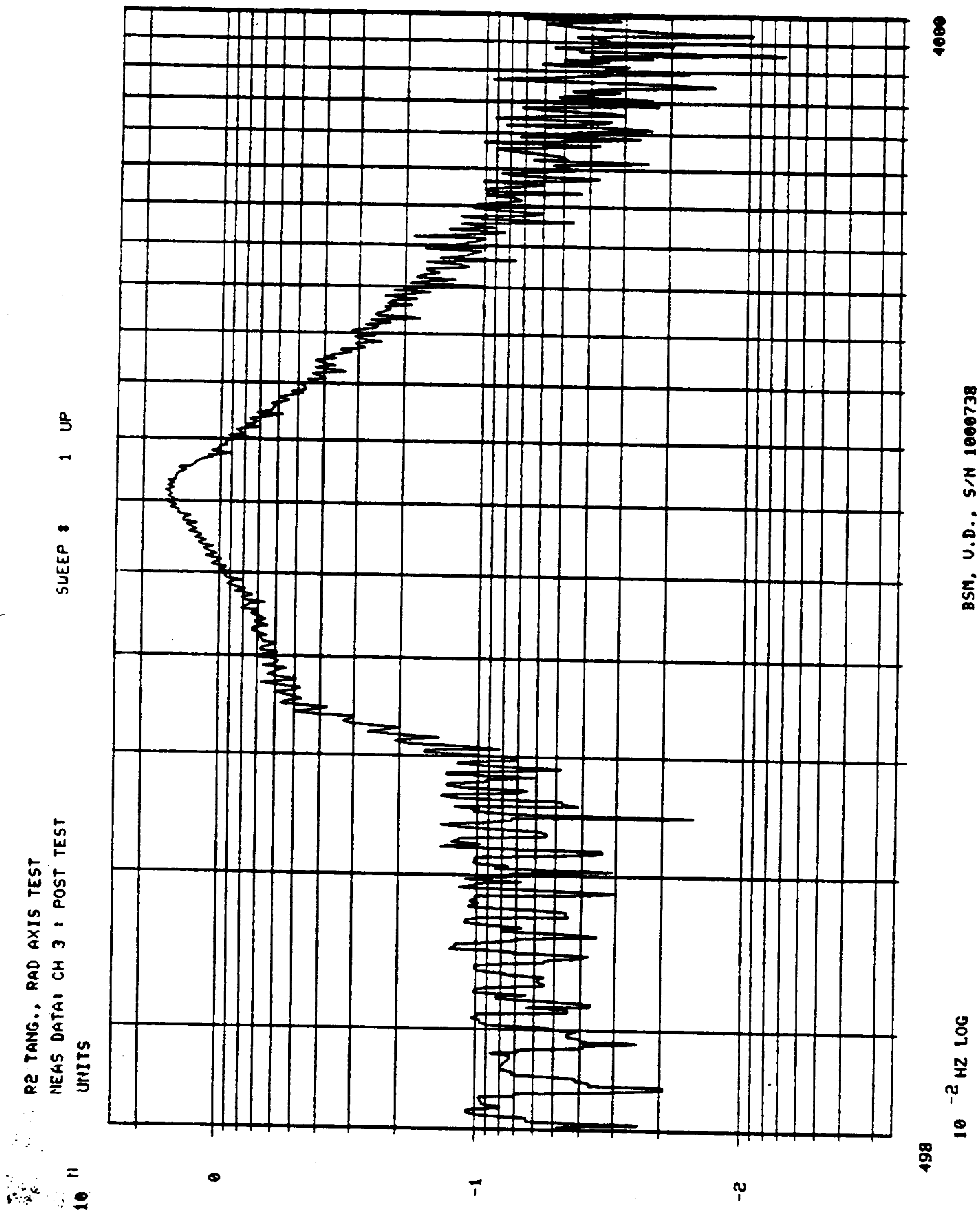

R1 RAD., RAD AXIS TEST, ACCEL CAME OFF
MEAS DATA: CH 4 : POST TEST
UNITS
SWEEP # 1 UP
10 "
1
0
-1
498
4000
10 -2 HZ LOG
BSM, V.D., S/N 1000738

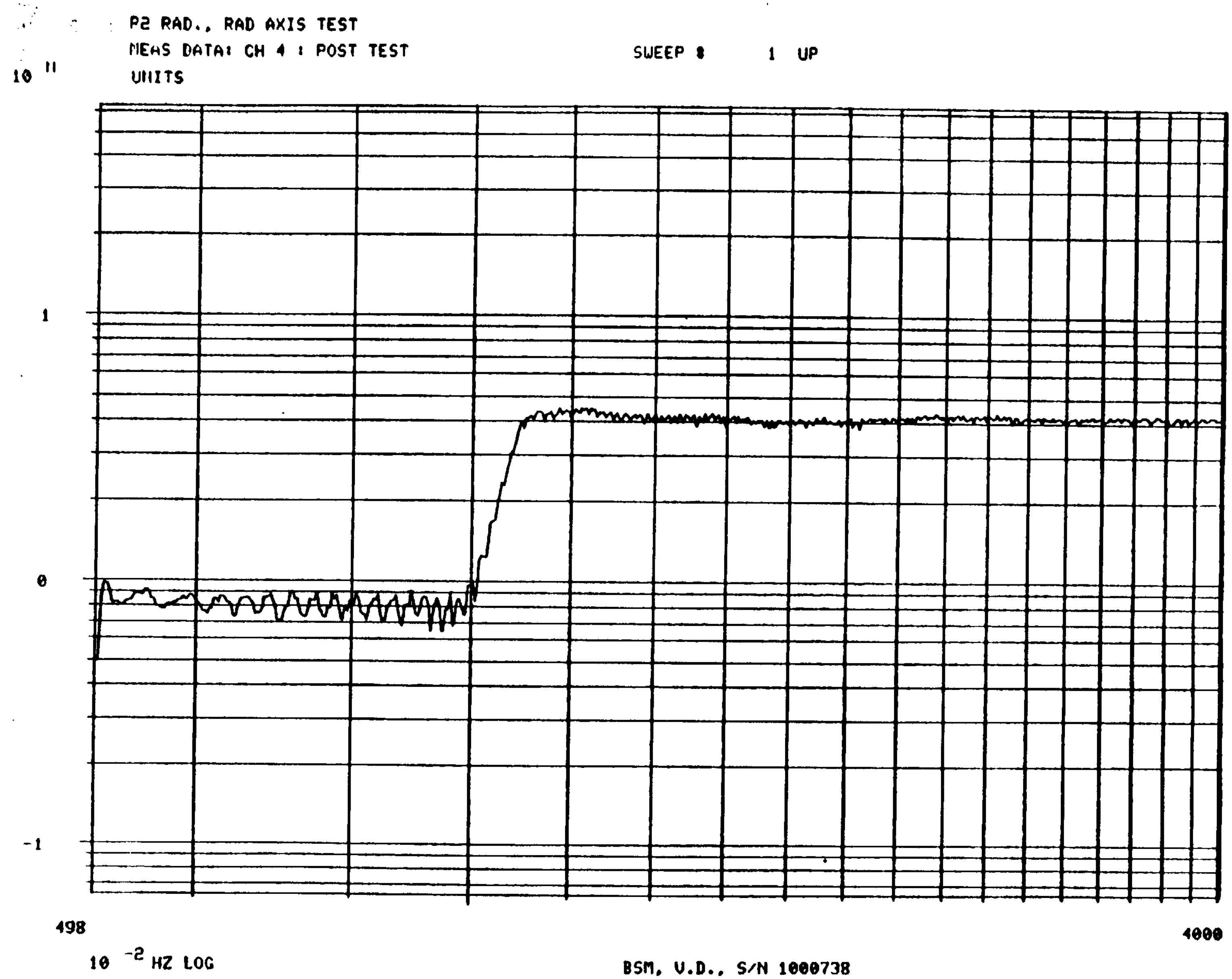
R2 LONG., RAD AXIS TEST
MEAS DATA: CH 2 : POST TEST
UNITS

SWEEP # 1 UP



BSM, V.D., S/N 1000738


R2 TANG., RAD AXIS TEST
MEAS DATA: CH 3 : POST TEST
UNITS
SWEEP # 1 UP
BSM, V.D., S/N 1000738
10 -2 HZ LOG
498
4000
10 N
0
-1
-2

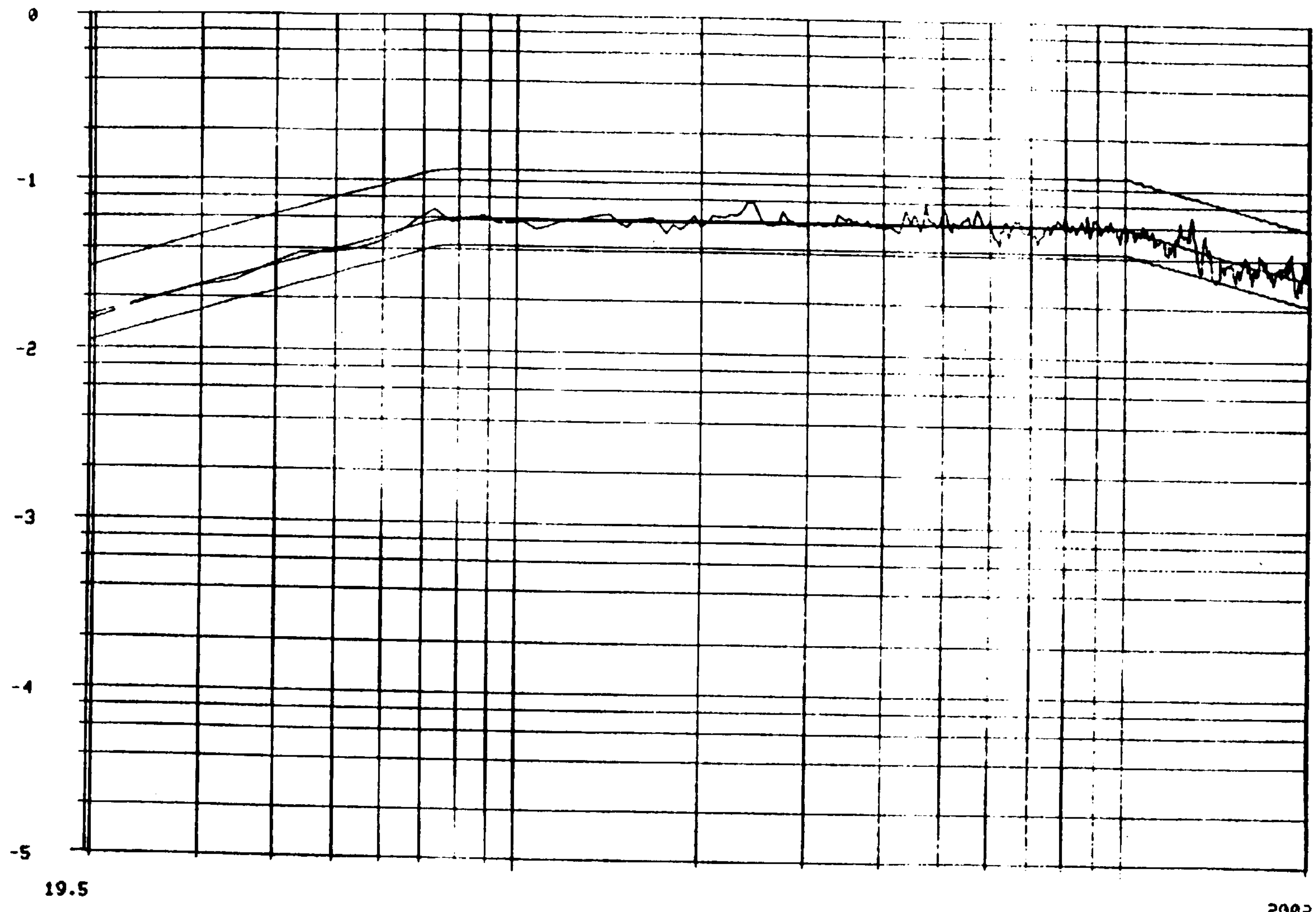

P2 RAD., RAD AXIS TEST
MEAS DATA: CH 4 : POST TEST
SWEEP # 1 UP
10 ''
UNITS
1
0
-1
498
4000
10 -2 HZ LOG
BSM, V.D., S/N 1000738

TANGENTIAL AXIS

RANDOM, LIFT-OFF

CONTROL L.O. TANG., PART 1
POST TEST
RMS LEVEL • 9.941 G'S
G SQR/HZ

ELAPSED TIME • 58 SECS AT .00 DB
DELTA F • 4.883 DOF• 573 AWF• 16

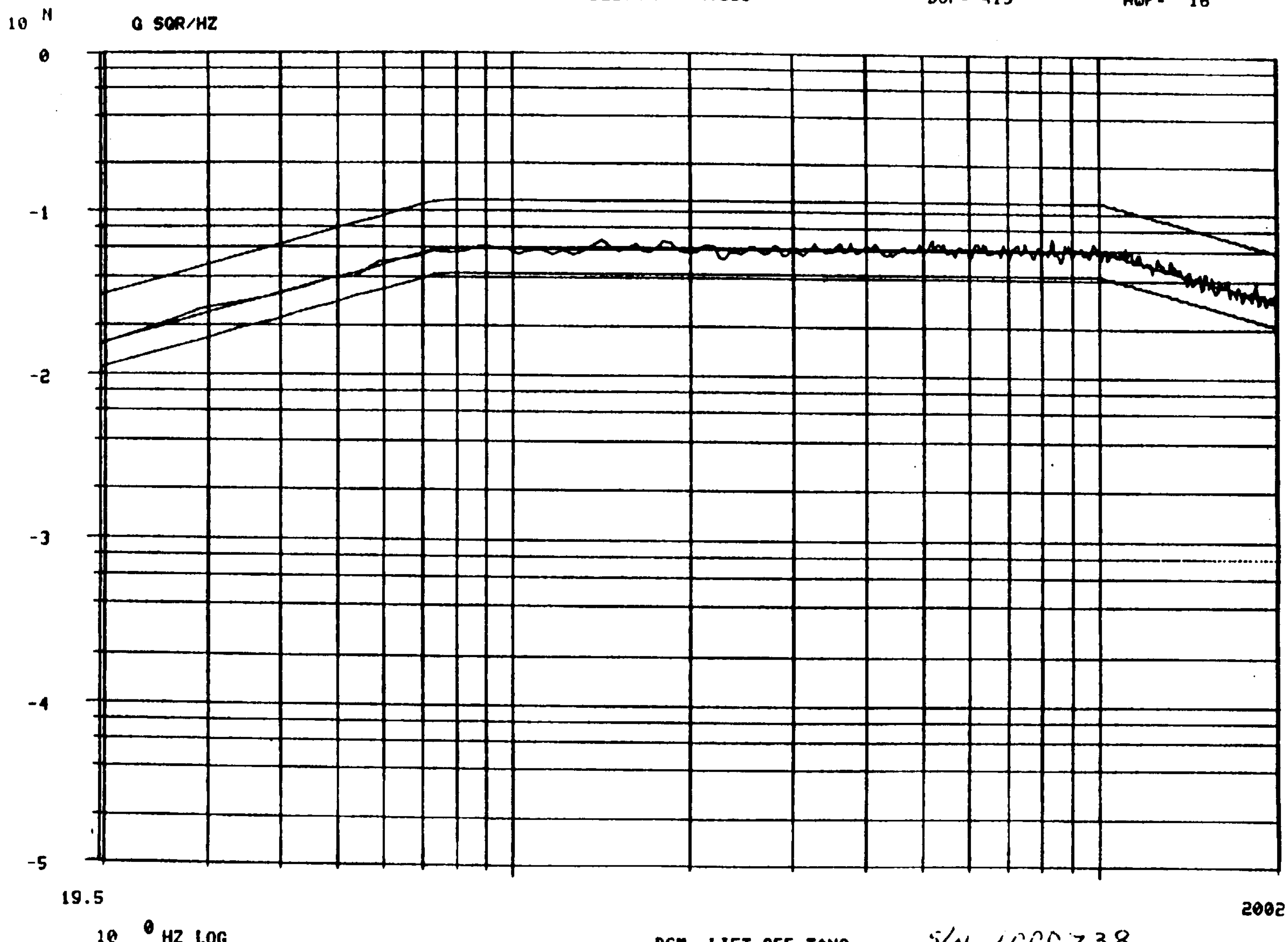


10 0 HZ LOG

BSM, LIFT-OFF TANG. S/N 1000 738

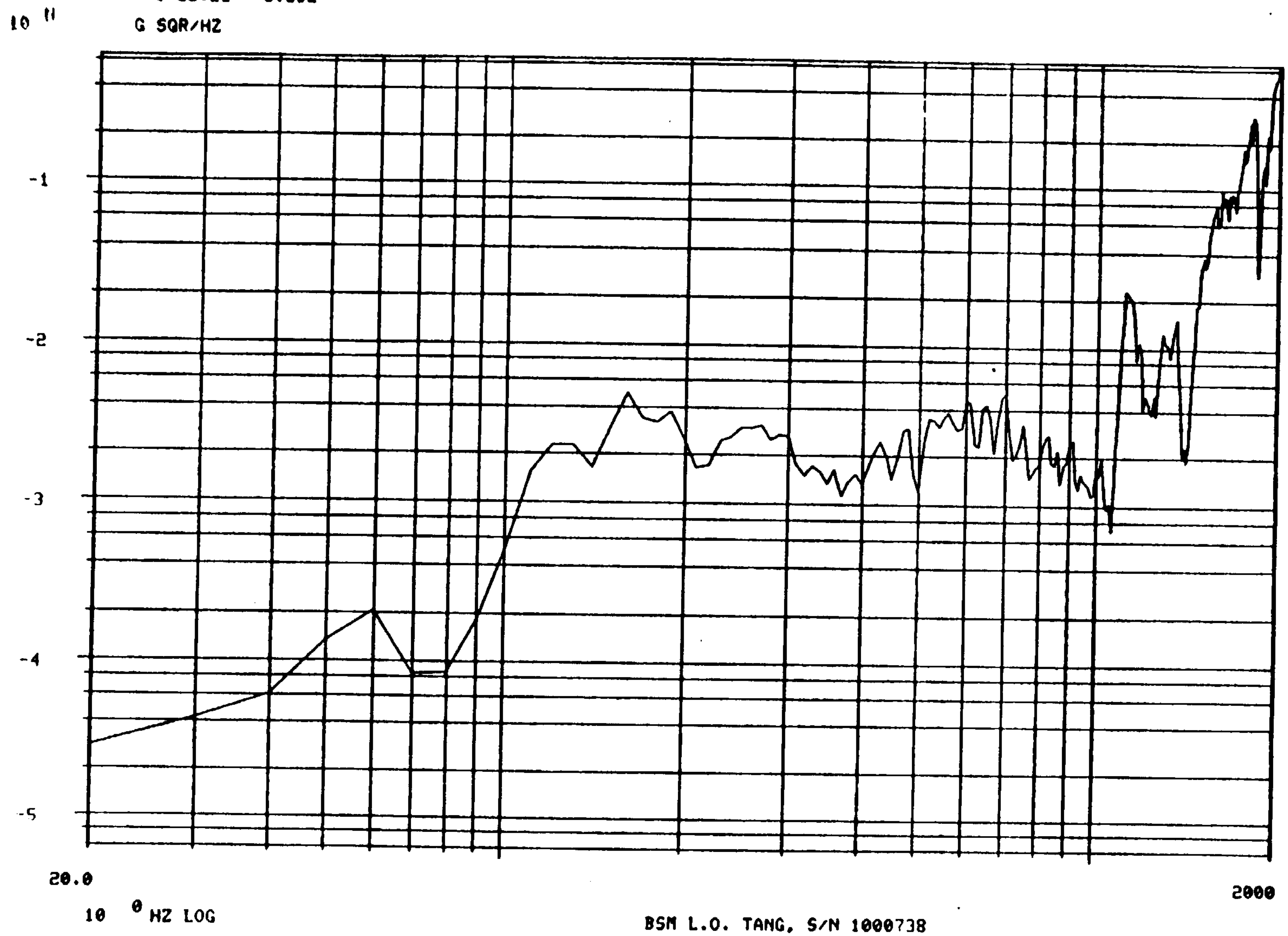
CONTROL L.O. TANG., PART 2
POST TEST
'..1S LEVEL = 9.959 G'S
G SQR/HZ

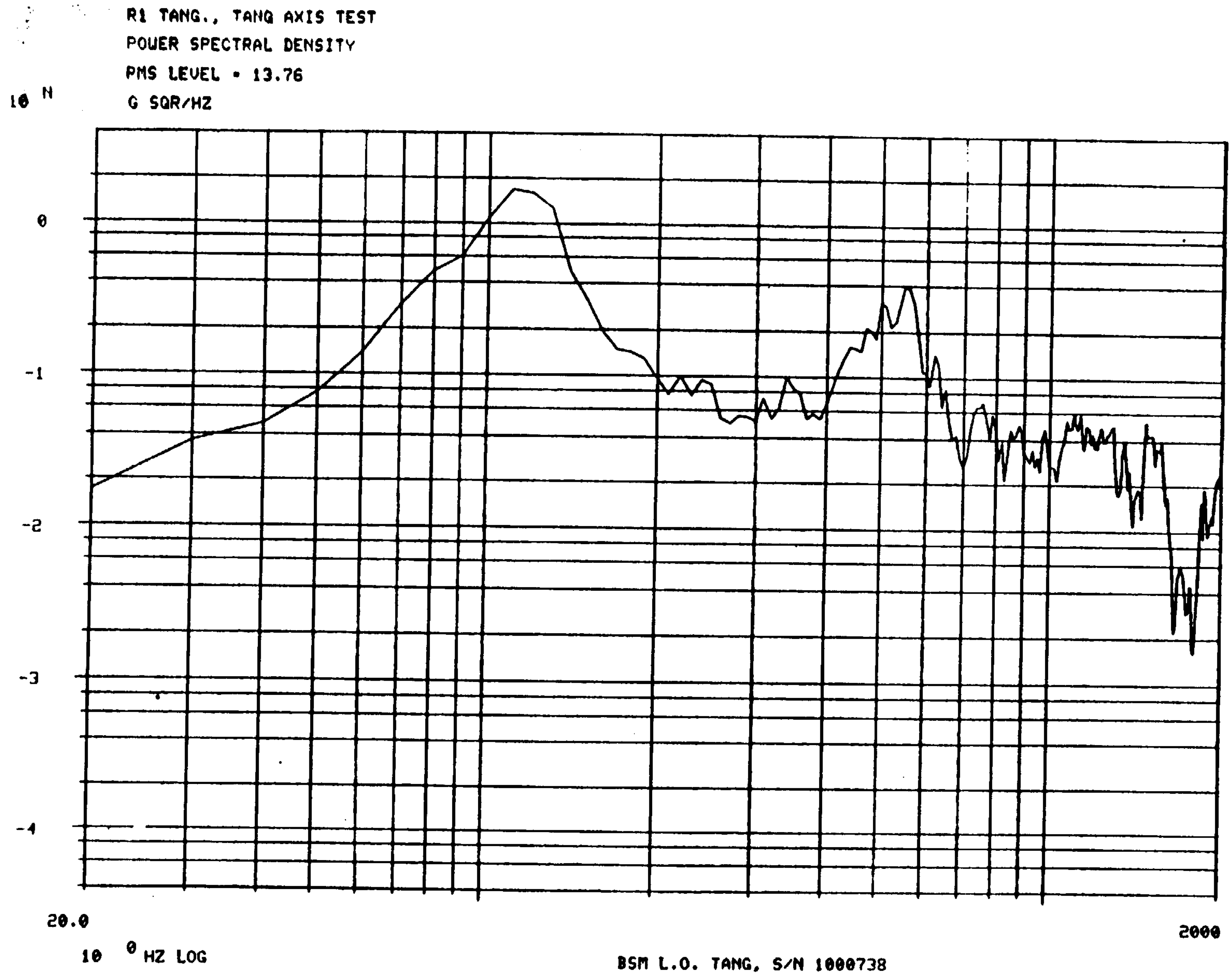
ELAPSED TIME = 3 SECS AT .00 DB
DELTA F = 4.883 DOF= 415 AWF= 16

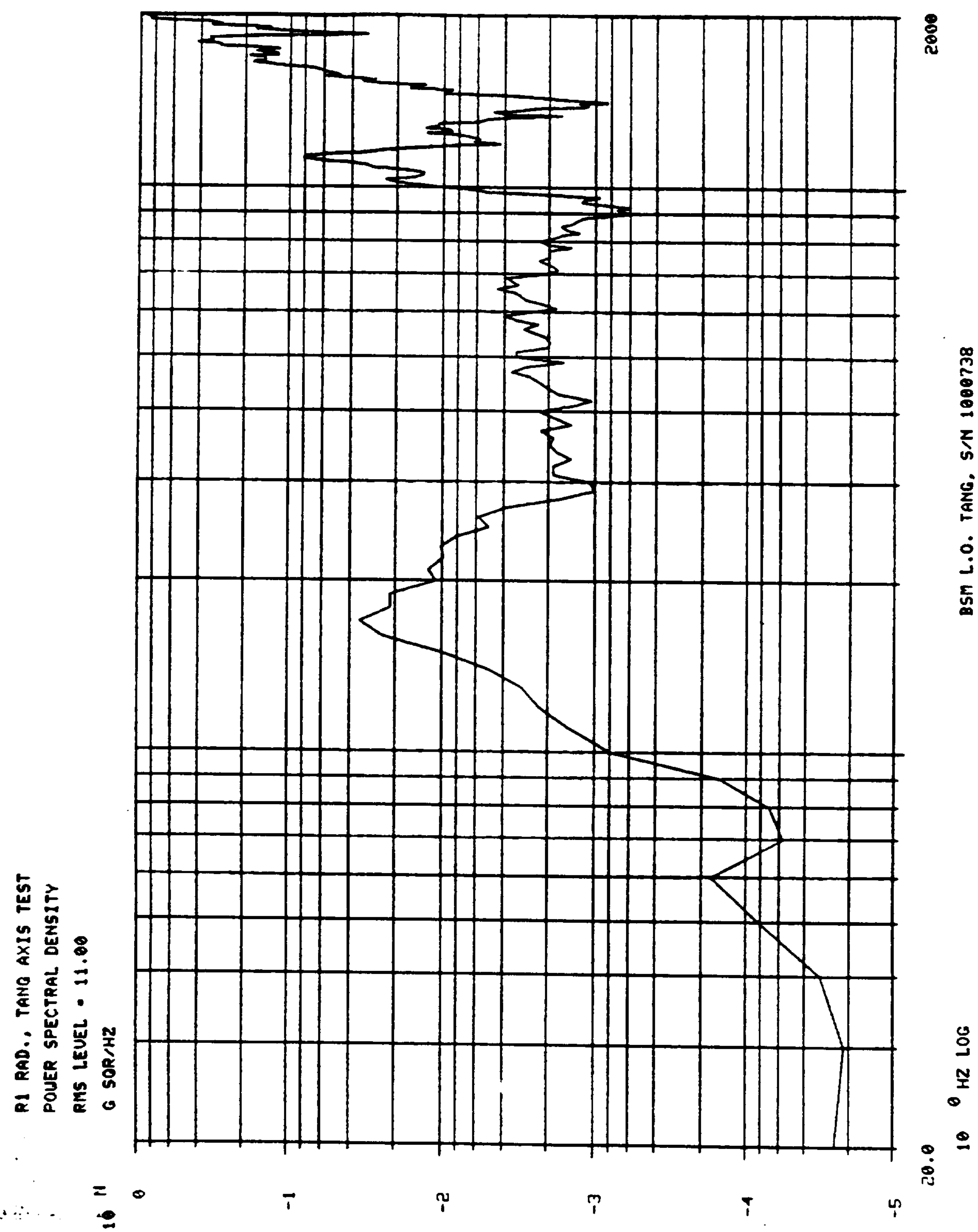


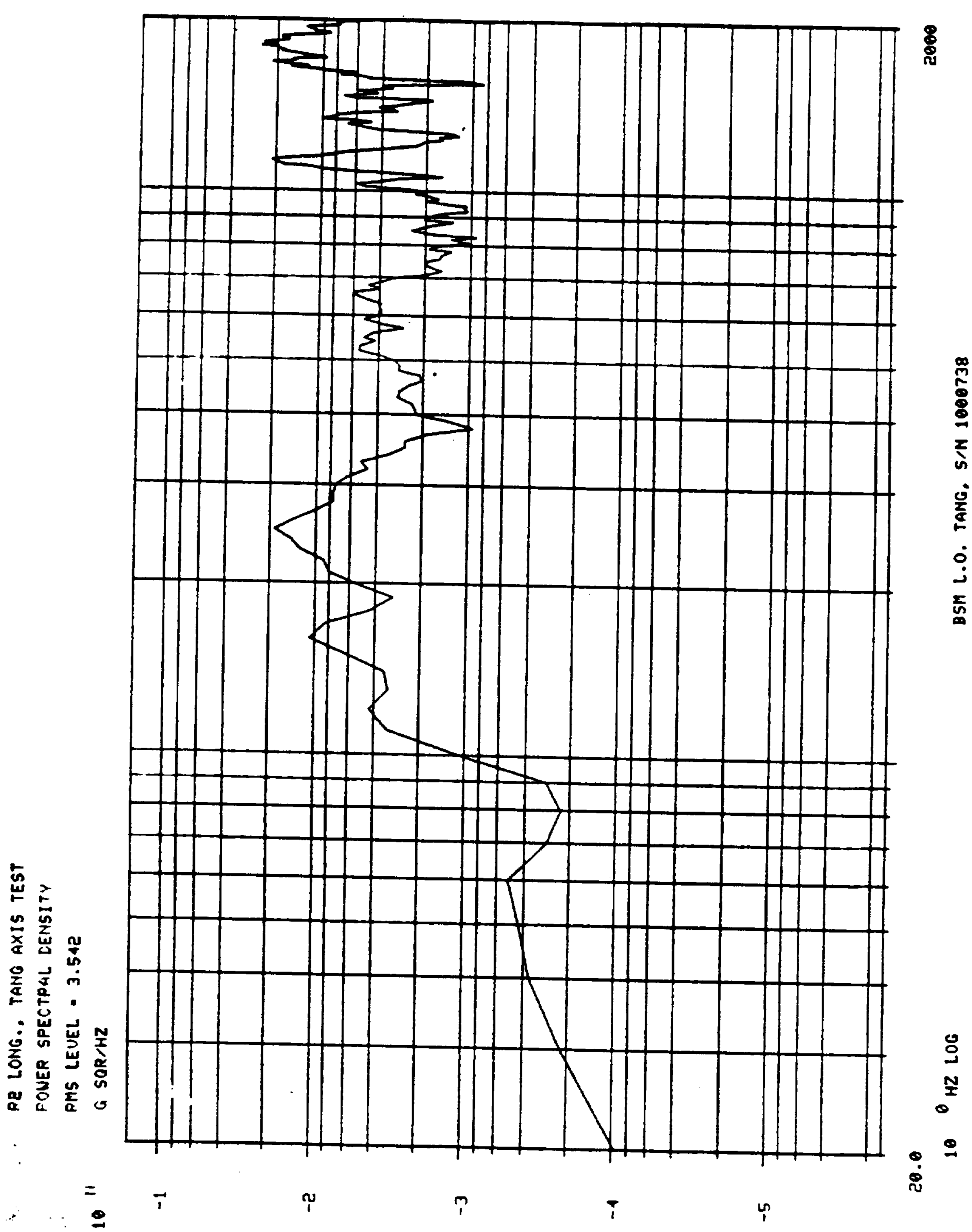
BSM, LIFT-OFF TANG. S/N 1000738

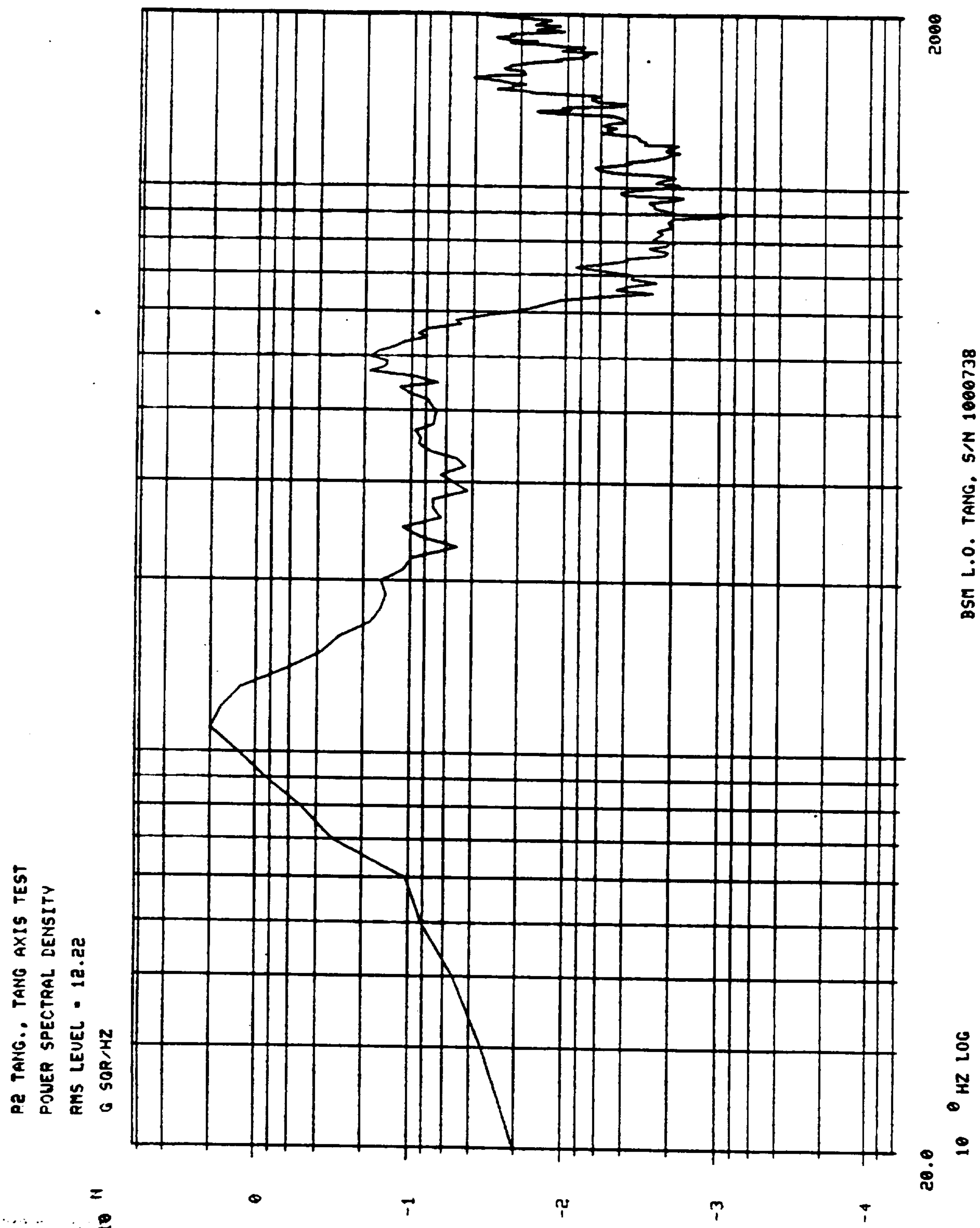
R1 LONG., TANG AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL = 9.652
G SQR/HZ

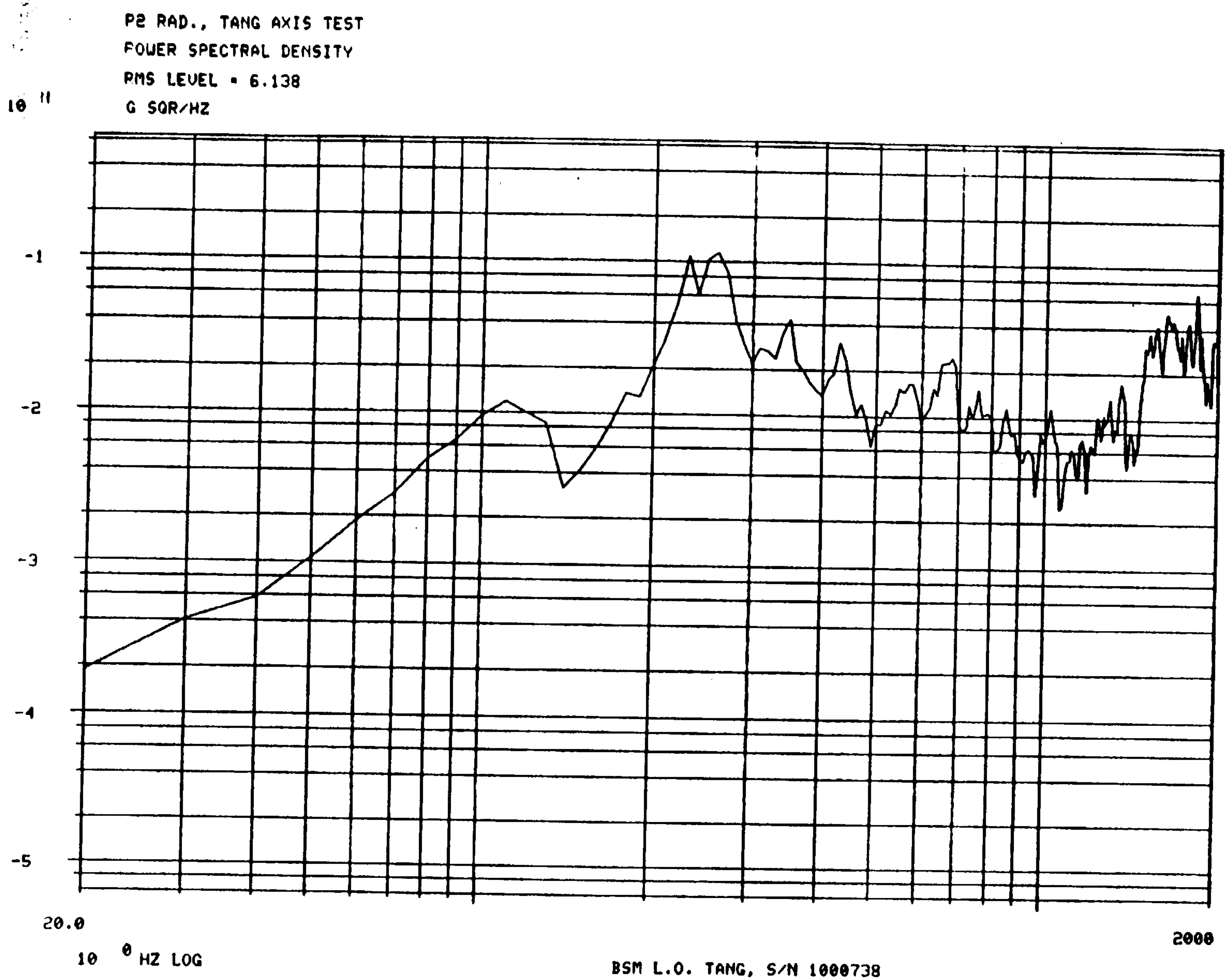



R1 TANG., TANG AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL = 13.76
G SQR/HZ
10 N
0
-1
-2
-3
-4
20.0
10 0 HZ LOG
2000
BSM L.O. TANG, S/N 1000738


R1 RAD., TANG AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL = 11.00
G SQR/HZ
10 N
0
-1
-2
-3
-4
-5
20.0
10 0 HZ LOG
2000
BSM L.O. TANG, S/N 1000738

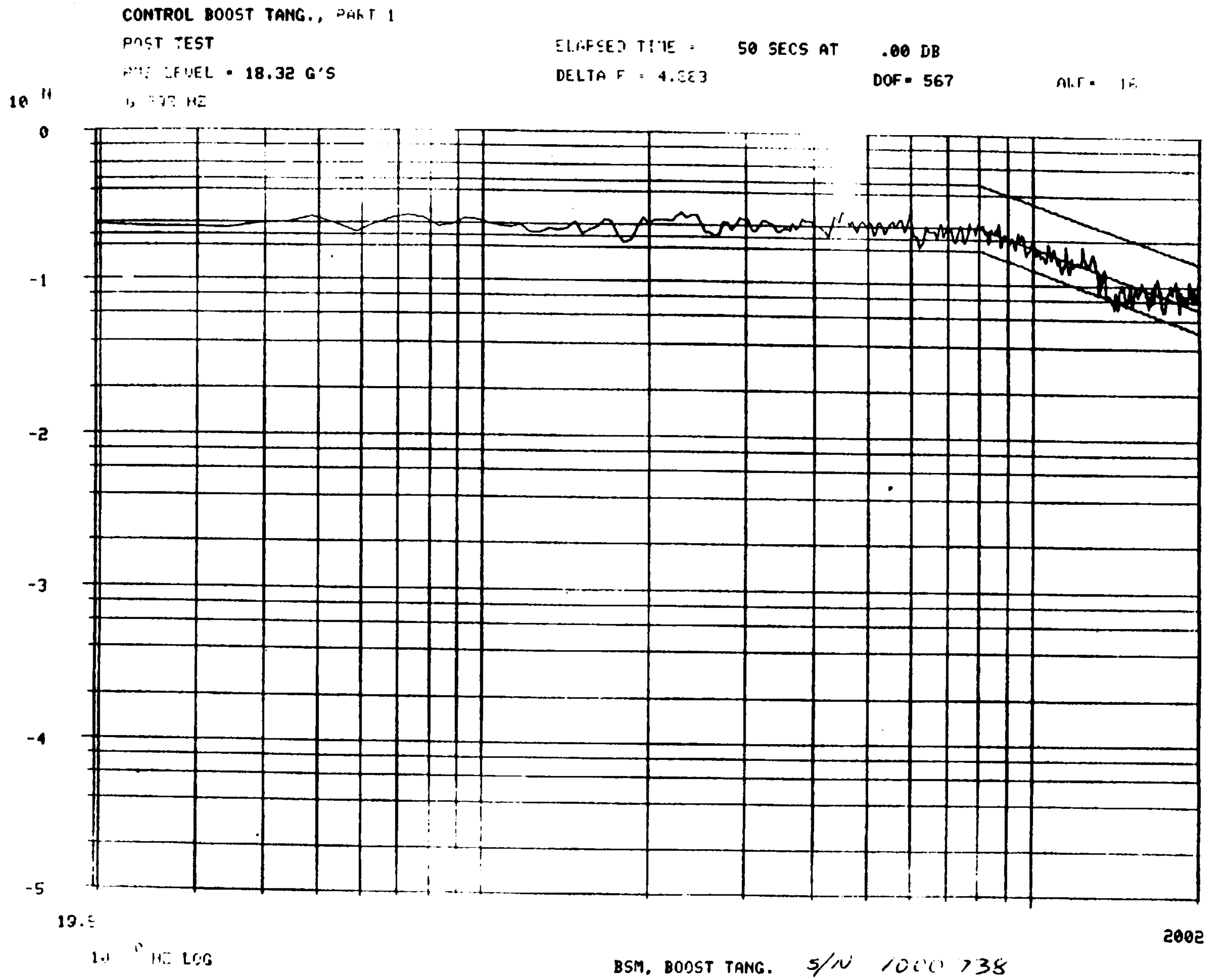

R2 LONG., TANG AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL = 3.542
G SQR/HZ
10
-1
-2
-3
-4
-5
20.0
2000
10 0 HZ LOG
BSM L.O. TANG, S/N 1000738

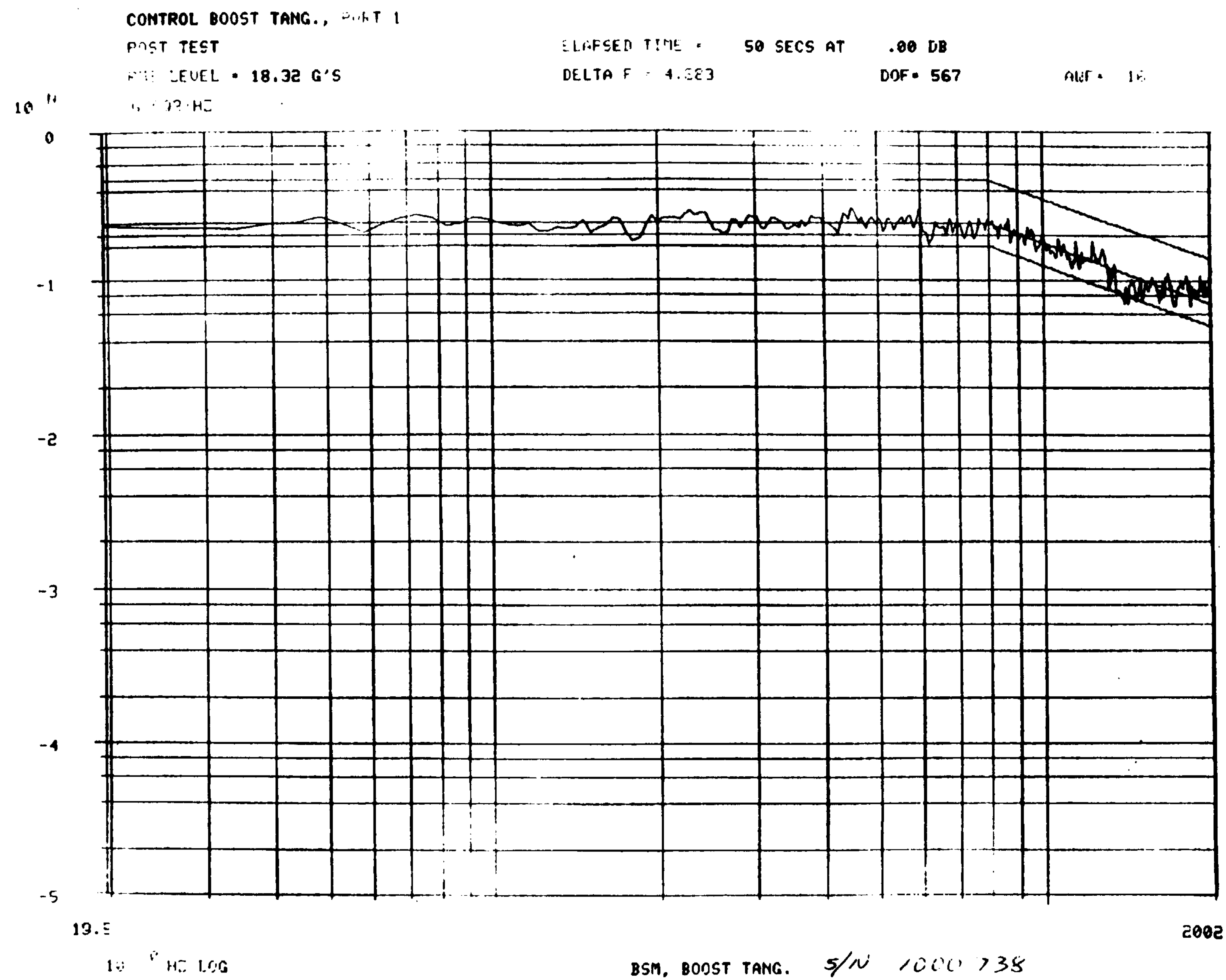

R2 TANG., TANG AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL = 12.22
G SQR/HZ
10 N
0
-1
-2
-3
-4
20.0
2000
10 0 HZ LOG
BSM L.O. TANG. S/N 1000738


P2 RAD., TANG AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL = 6.138
G SQR/HZ
10
-1
-2
-3
-4
-5
20.0
2000
10 0 HZ LOG
BSM L.O. TANG, S/N 1000738

TANGENTIAL AXIS

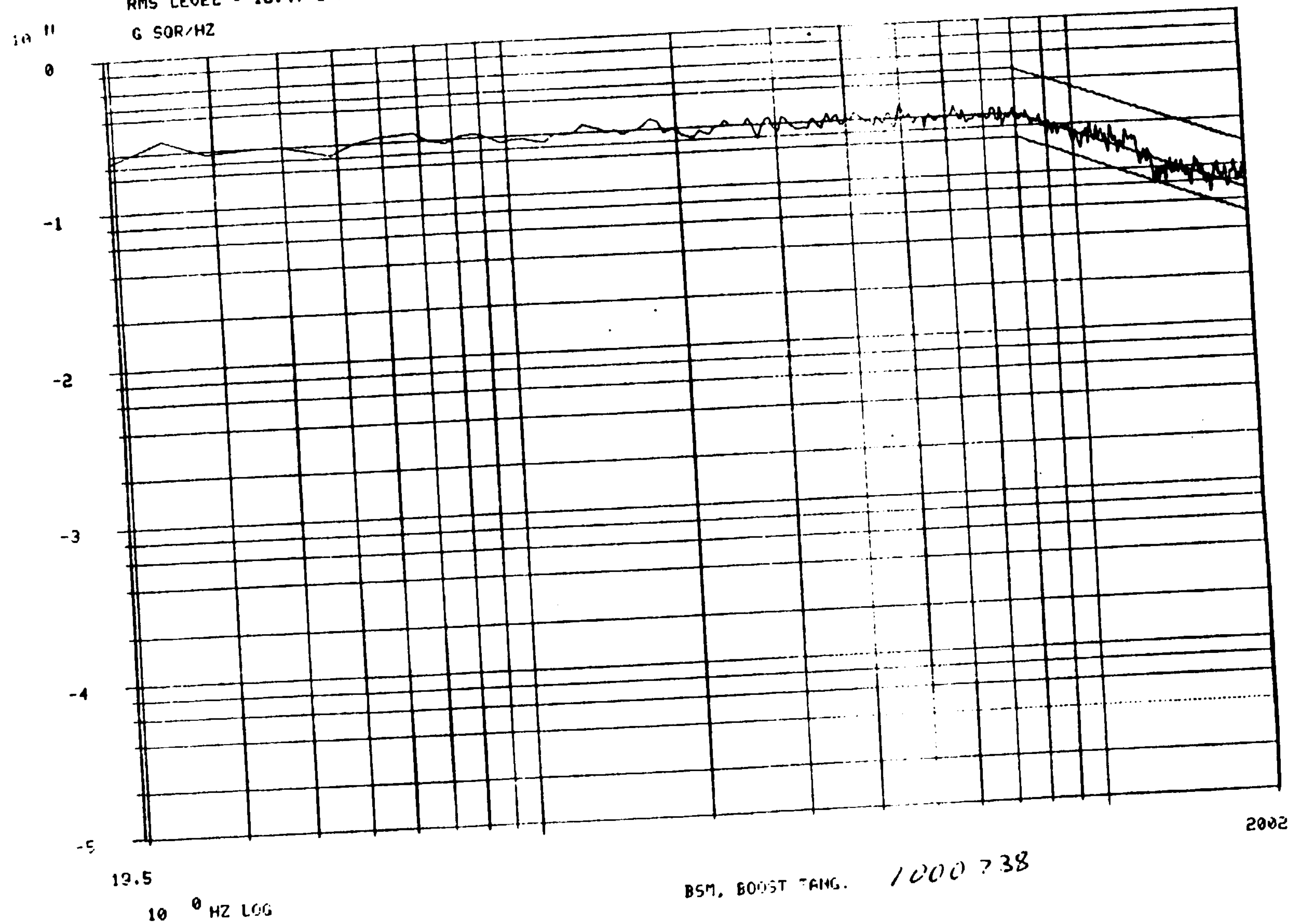
RANDOM, BOOST


CONTROL BOOST TANG., PART 1
POST TEST
LEVEL • 18.32 G'S
ELAPSED TIME = 50 SECS AT .00 DB
DELTA F = 4.883
DOF• 567
10
0
-1
-2
-3
-4
-5
19.5
2002
HZ LOG
BSM, BOOST TANG. S/N 1000 738

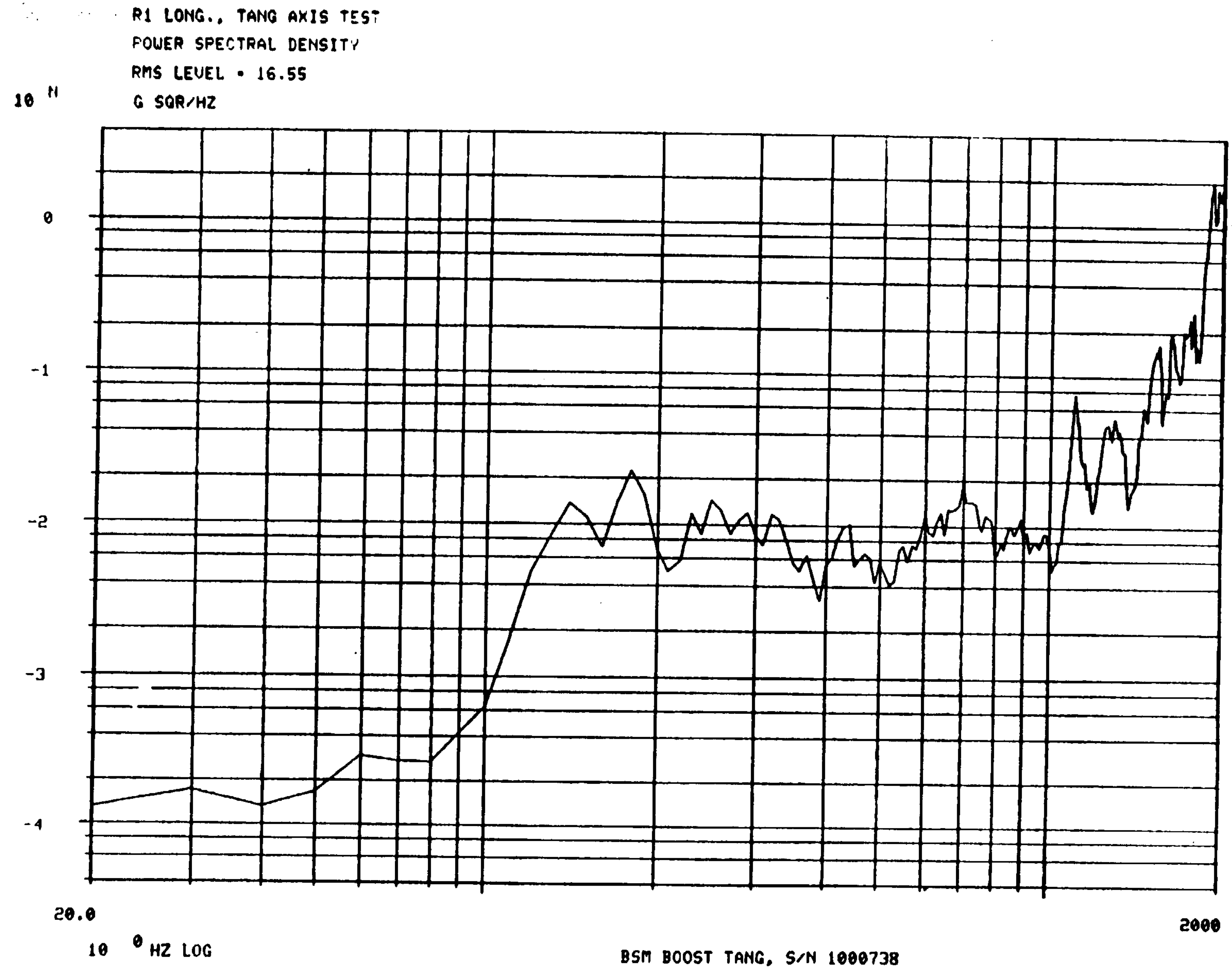

CONTROL BOOST TANG., PART 1
POST TEST
LEVEL • 18.32 G'S
ELAPSED TIME • 50 SECS AT .00 DB
DELTA F • 4.883
DOF• 567
AVF• 16
10
0
-1
-2
-3
-4
-5
19.5
2002
HZ LOG
BSM, BOOST TANG. S/N 1000738

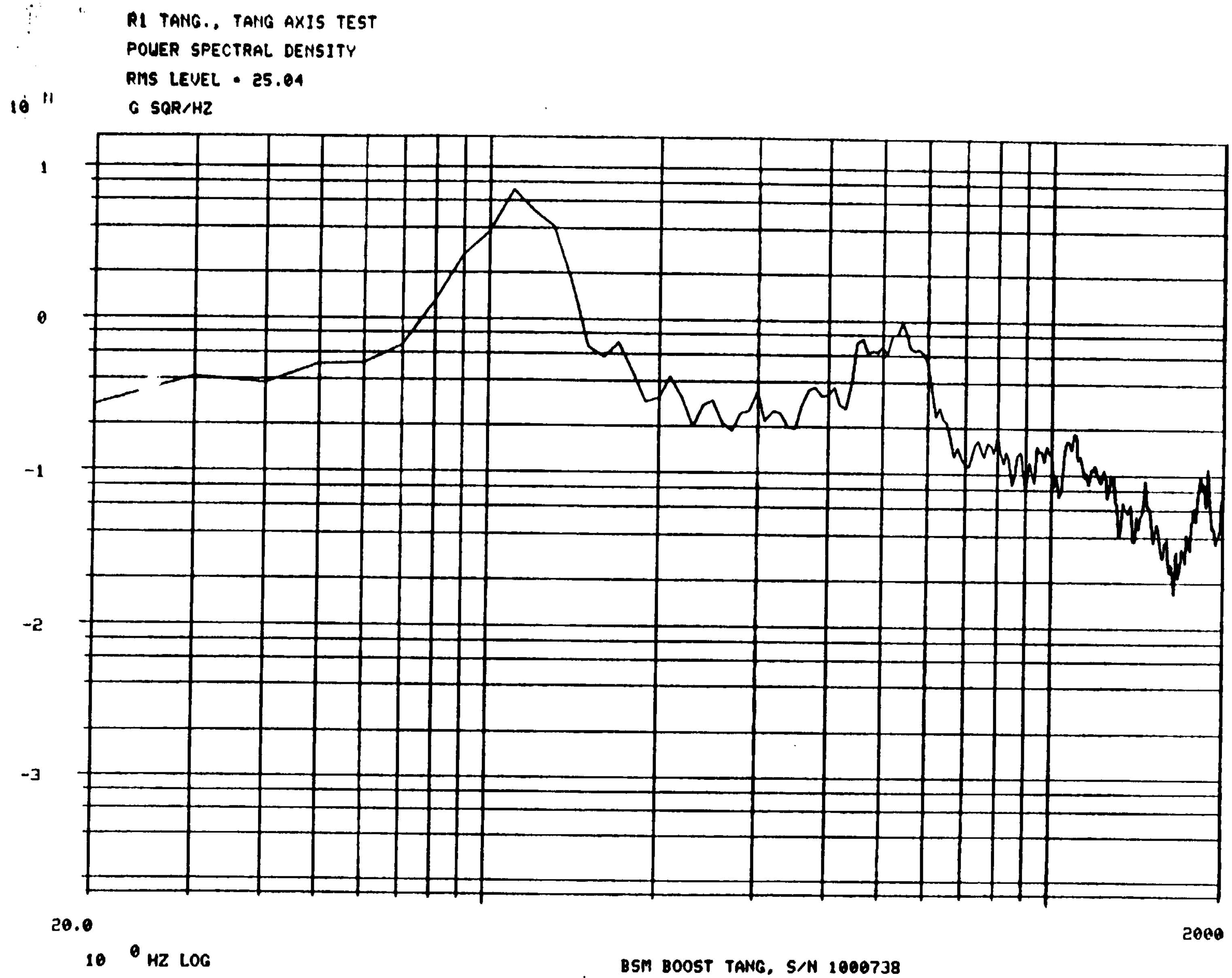
CONTROL BOOST TANG., PART 2
POST TEST
RMS LEVEL = 18.47 G'S

EL. D TIME = 74 SECS AT .00 DB
DELTA F = 4.883
DOF = 593
AWF = 16

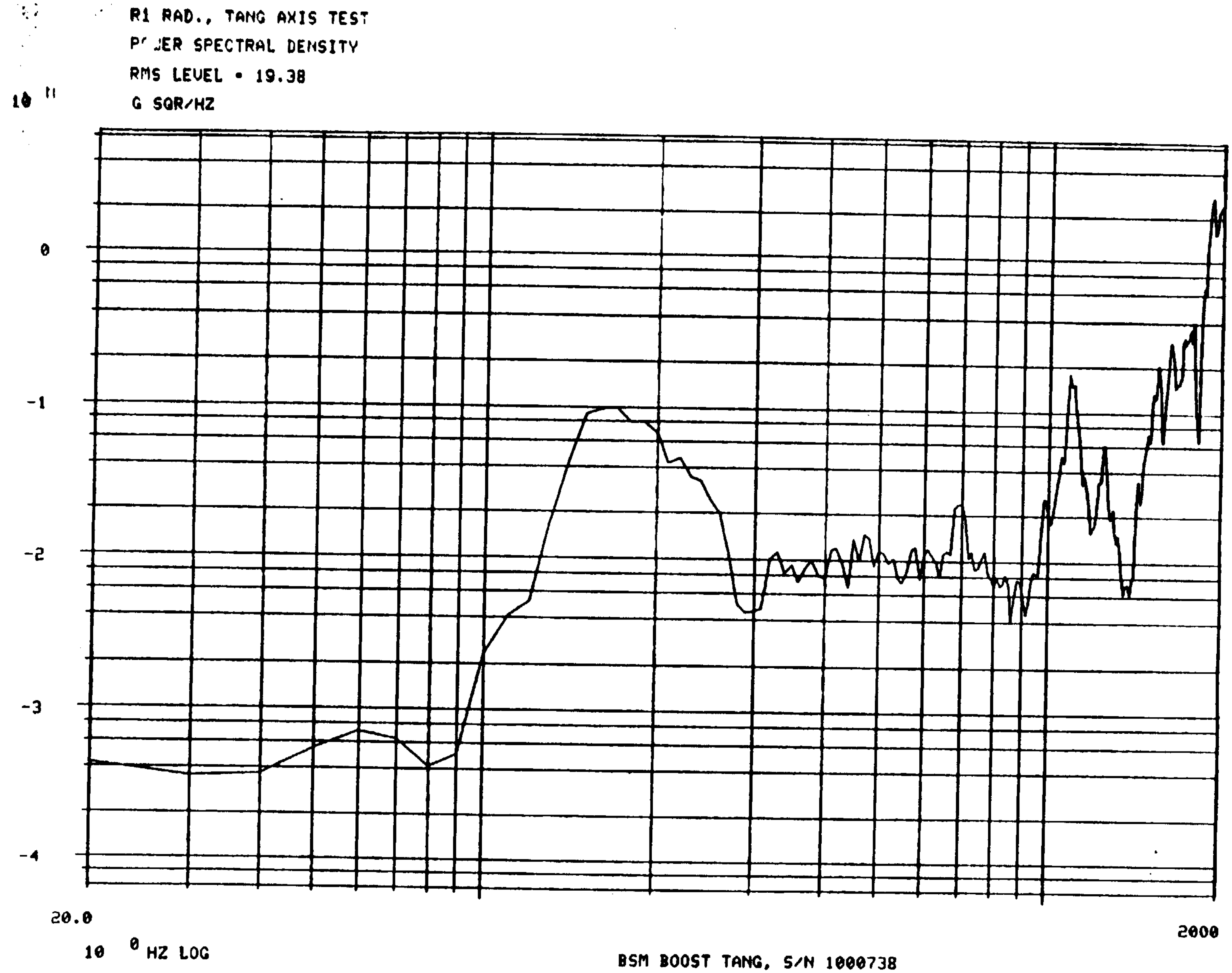


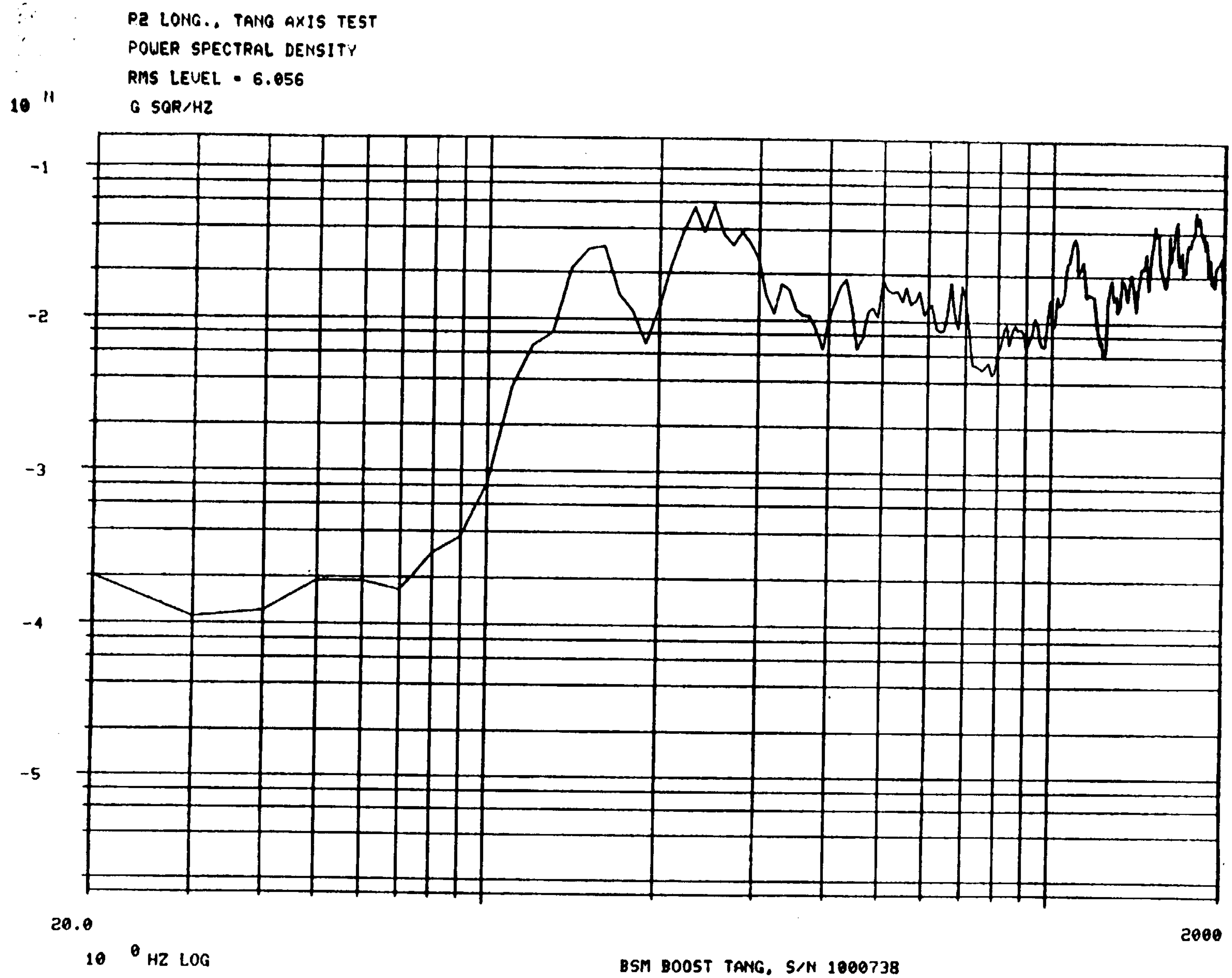
BSM, BOOST TANG. 1000 738

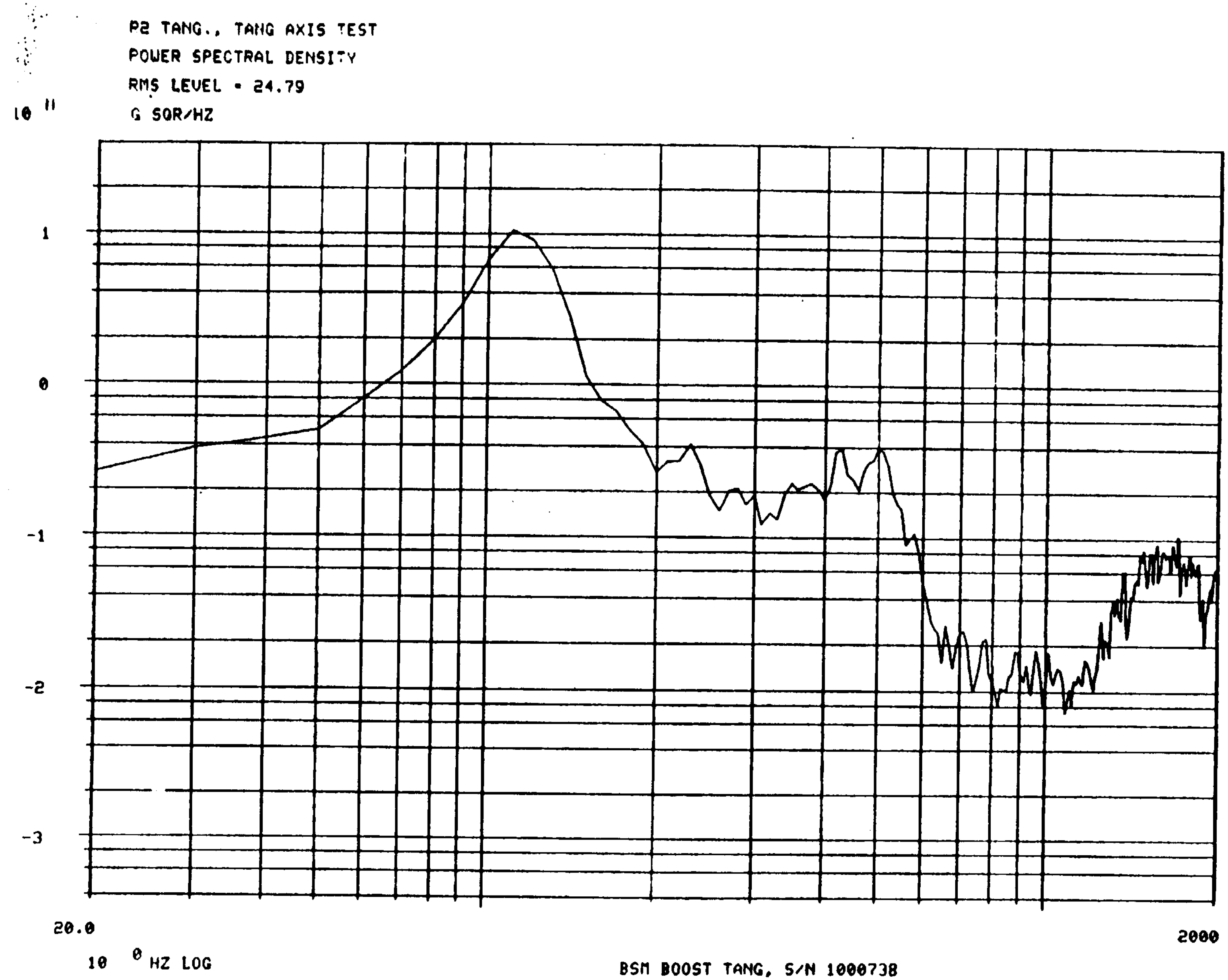

R1 LONG., TANG AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL • 16.55
G SQR/HZ
10 N
0
-1
-2
-3
-4
20.0
2000
10 0 HZ LOG
BSM BOOST TANG, S/N 1000738

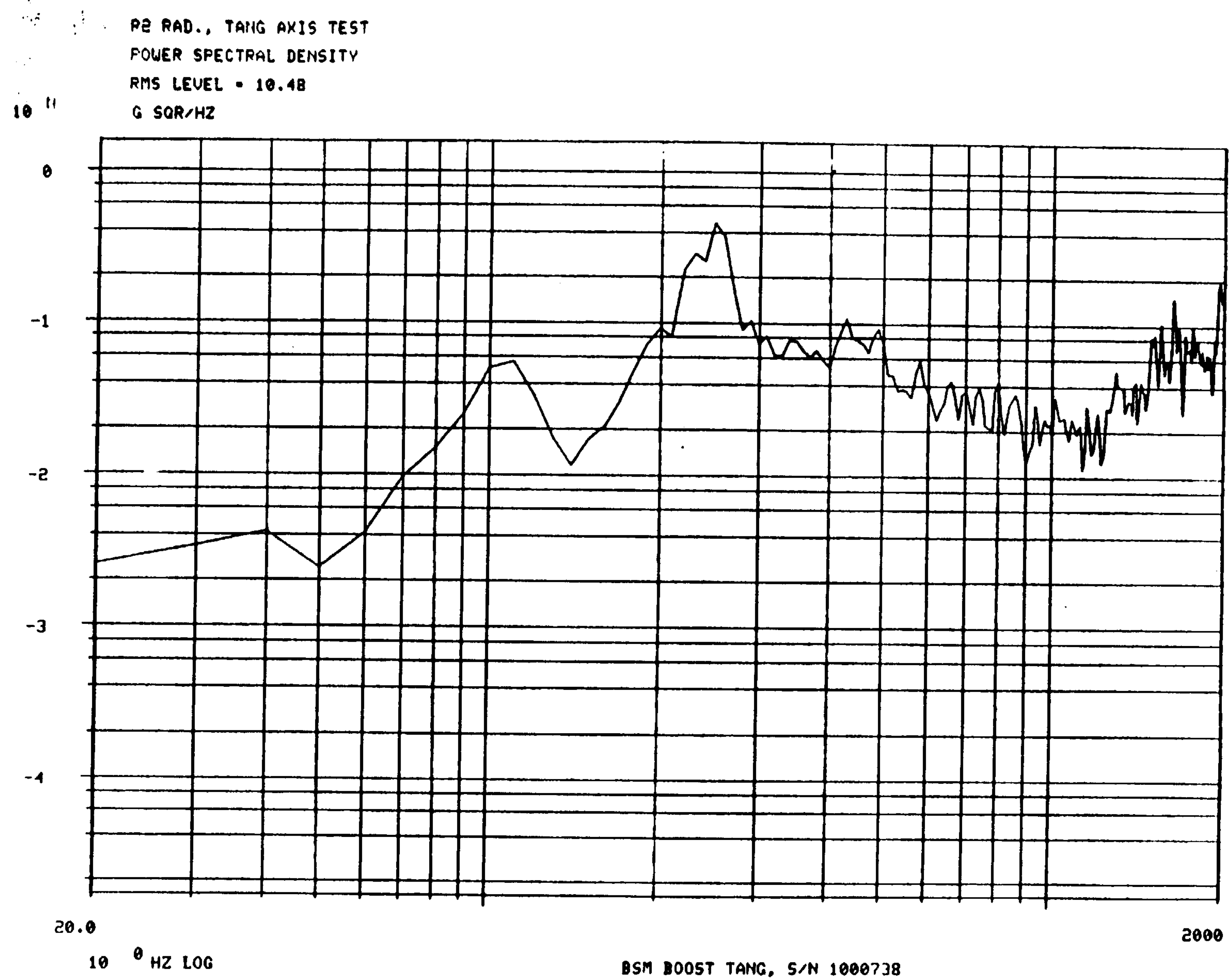


R1 TANG., TANG AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL • 25.04
G SQR/HZ
10 **
1
0
-1
-2
-3
20.0
2000
10 0 HZ LOG
BSM BOOST TANG, S/N 1000738


R1 RAD., TANG AXIS TEST
P'JER SPECTRAL DENSITY
RMS LEVEL • 19.38
G SQR/HZ
10
0
-1
-2
-3
-4
20.0
10 0 HZ LOG
2000
BSM BOOST TANG, S/N 1000738

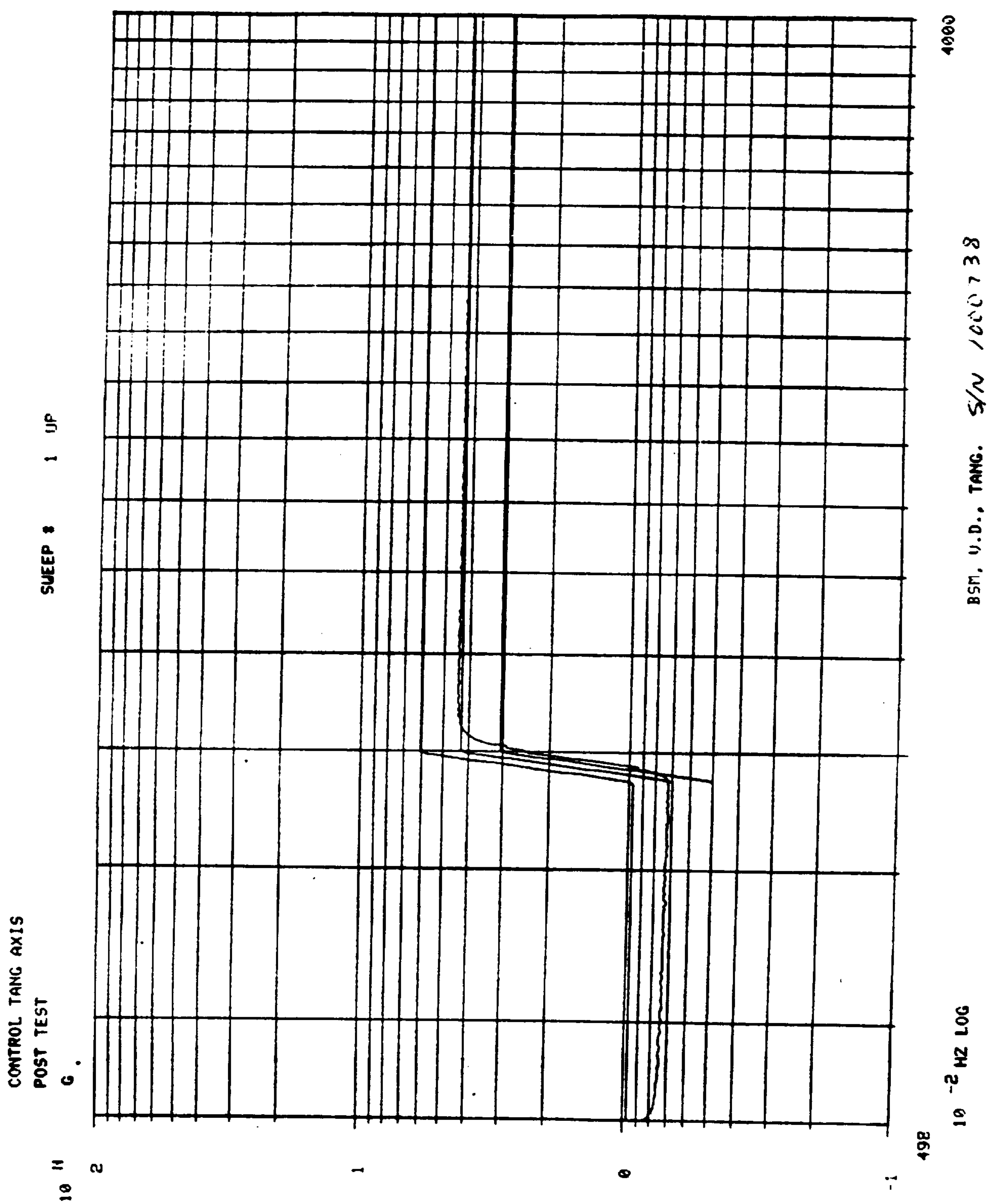

P2 LONG., TANG AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL = 6.056
G SQR/HZ
10 N
-1
-2
-3
-4
-5
20.0
2000
10 0 HZ LOG
BSM BOOST TANG, S/N 1000738

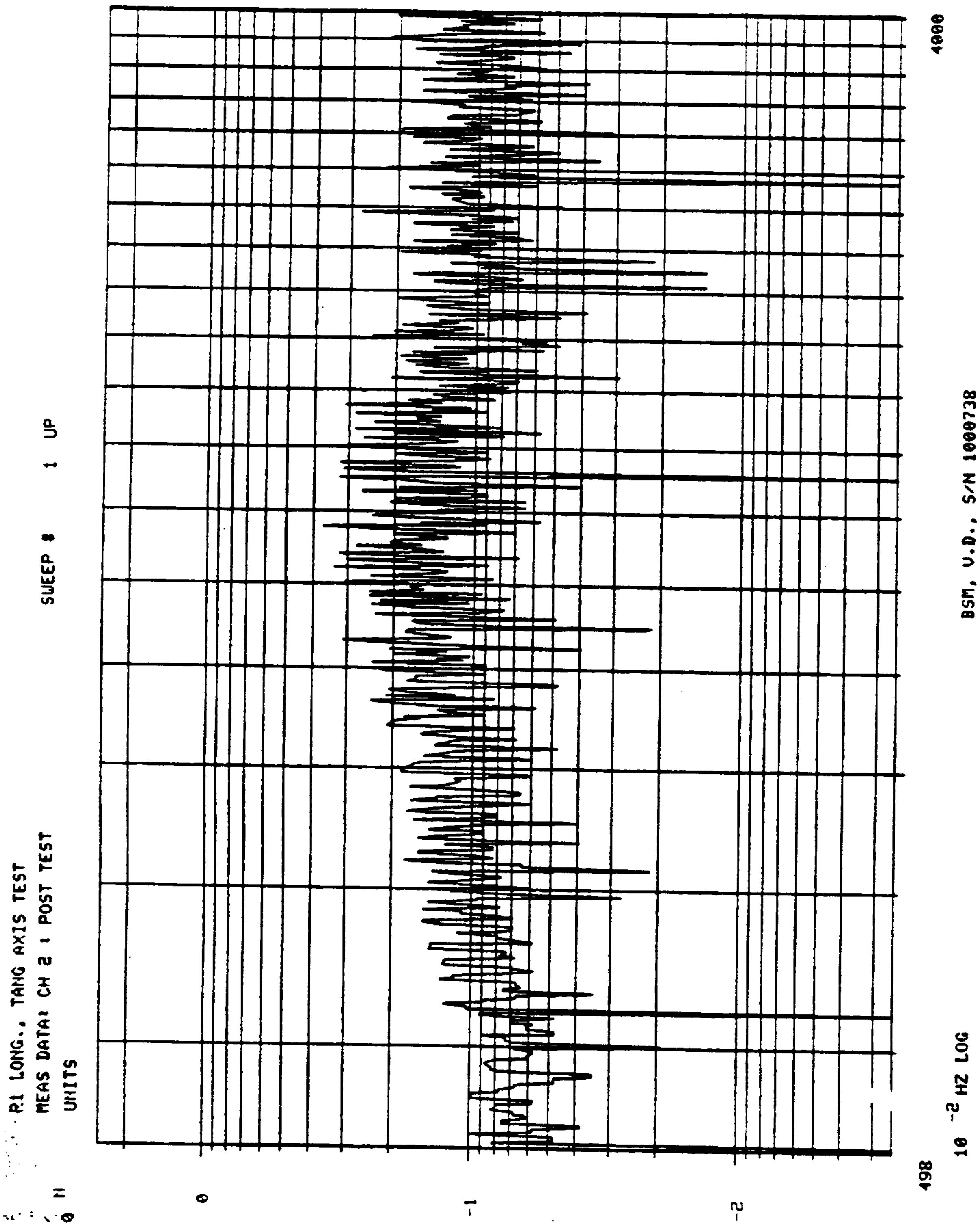

P2 TANG., TANG AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL = 24.79
G SQR/HZ
10
1
0
-1
-2
-3
20.0
2000
10 0 HZ LOG
BSM BOOST TANG, S/N 1000738

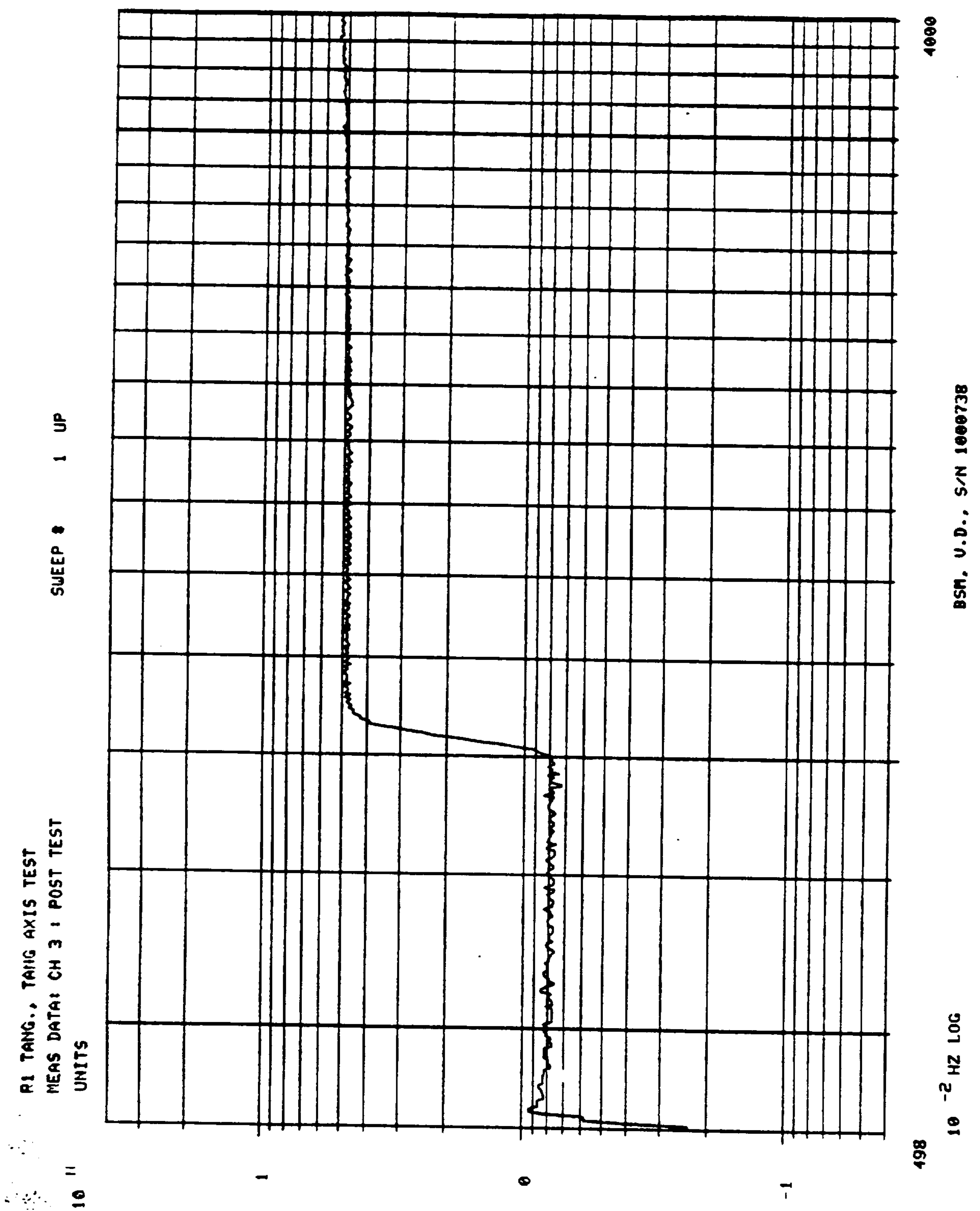

R2 RAD., TANG AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL = 10.4B
G SQR/HZ
10
0
-1
-2
-3
-4
20.0
2000
10 0 HZ LOG
BSM BOOST TANG, S/N 1000738

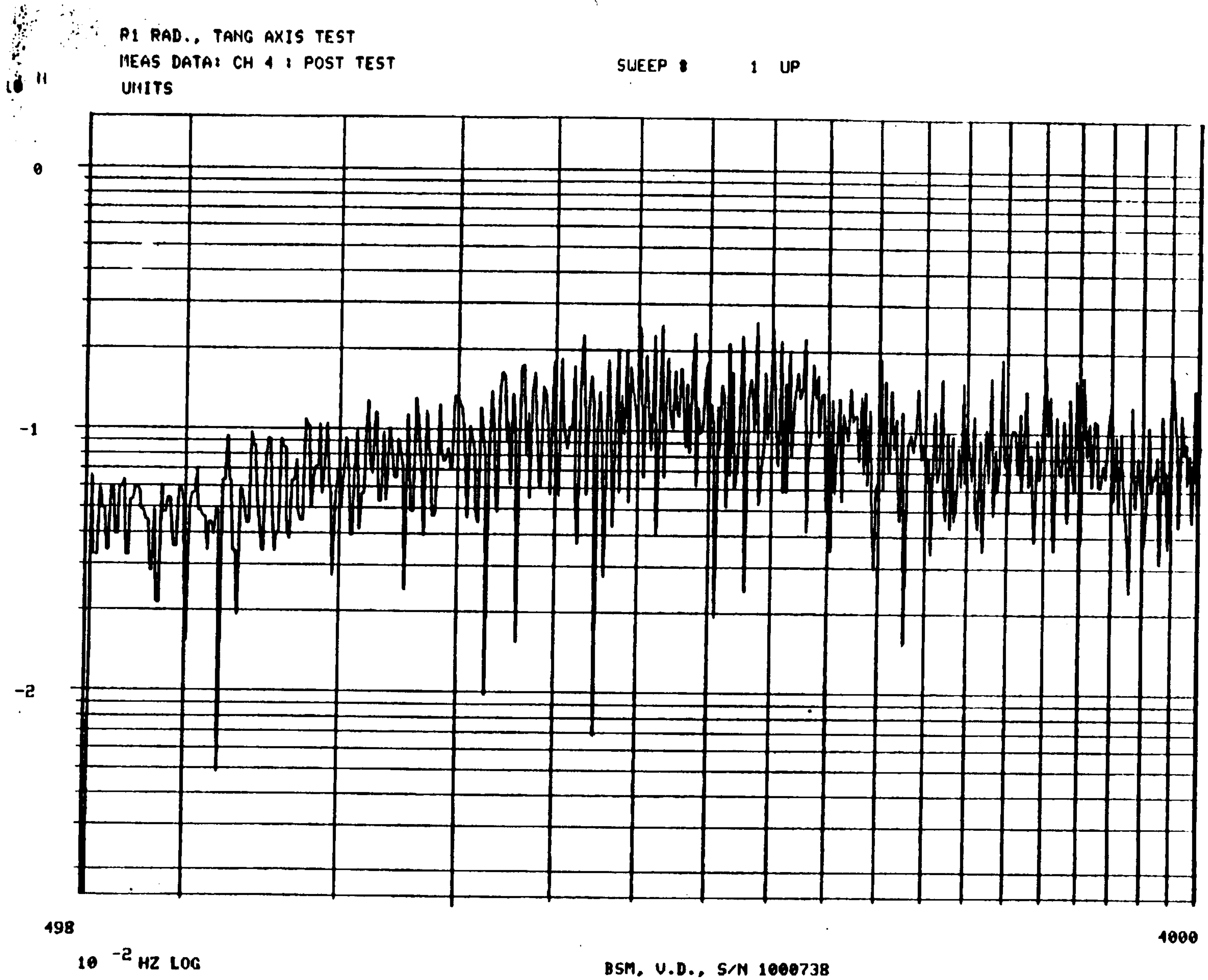
TANGENTIAL AXIS

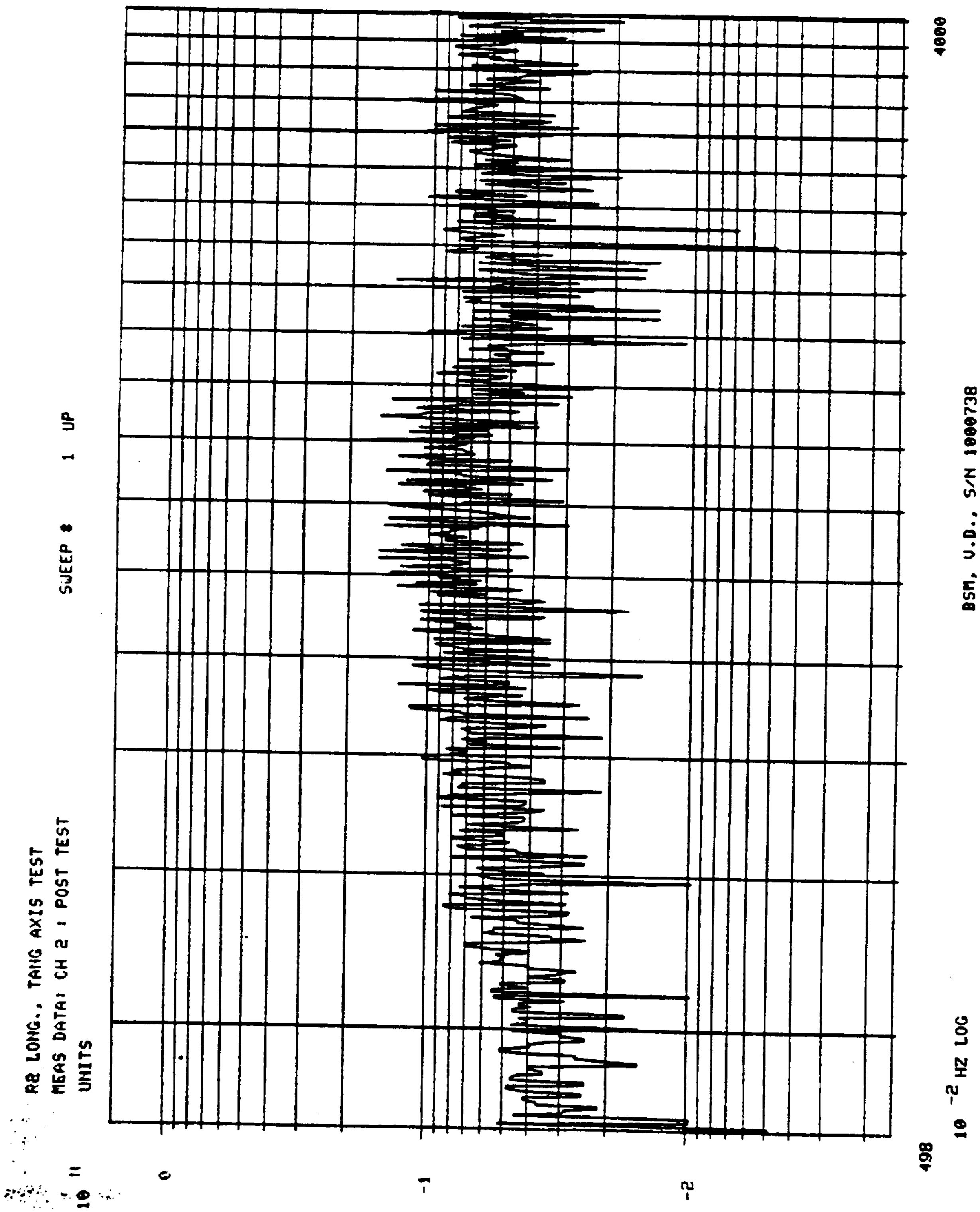
VEHICLE DYNAMICS


CONTROL TANG AXIS
POST TEST
G
SWEEP # 1 UP
BSM, U.D., TANG. S/N 1000738
10 -2 HZ LOG
498
4000
10 ^N
2
1
0
-1

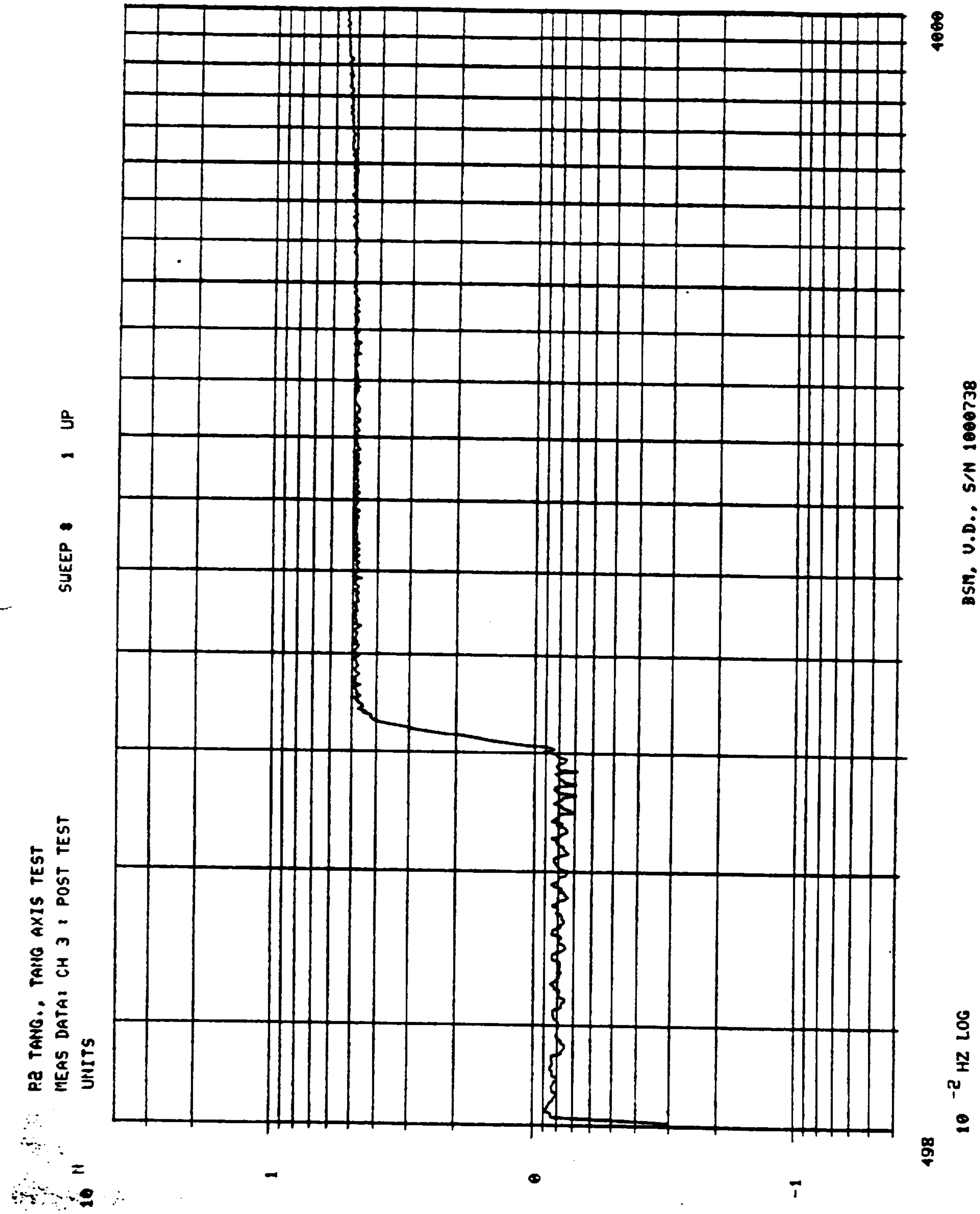

R1 LONG., TANG AXIS TEST
MEAS DATA: CH 2 : POST TEST
UNITS
SWEEP # 1 UP
BSM, V.D., S/N 1000738
10 N
0
-1
-2
498
4000
10 $^{-2}$ HZ LOG


R1 TANG., TANG AXIS TEST
MEAS DATA: CH 3 : POST TEST
UNITS
SWEEP # 1 UP
10
1
0
-1
498
10 -2 HZ LOG
BSM, V.D., S/N 1000738
4000

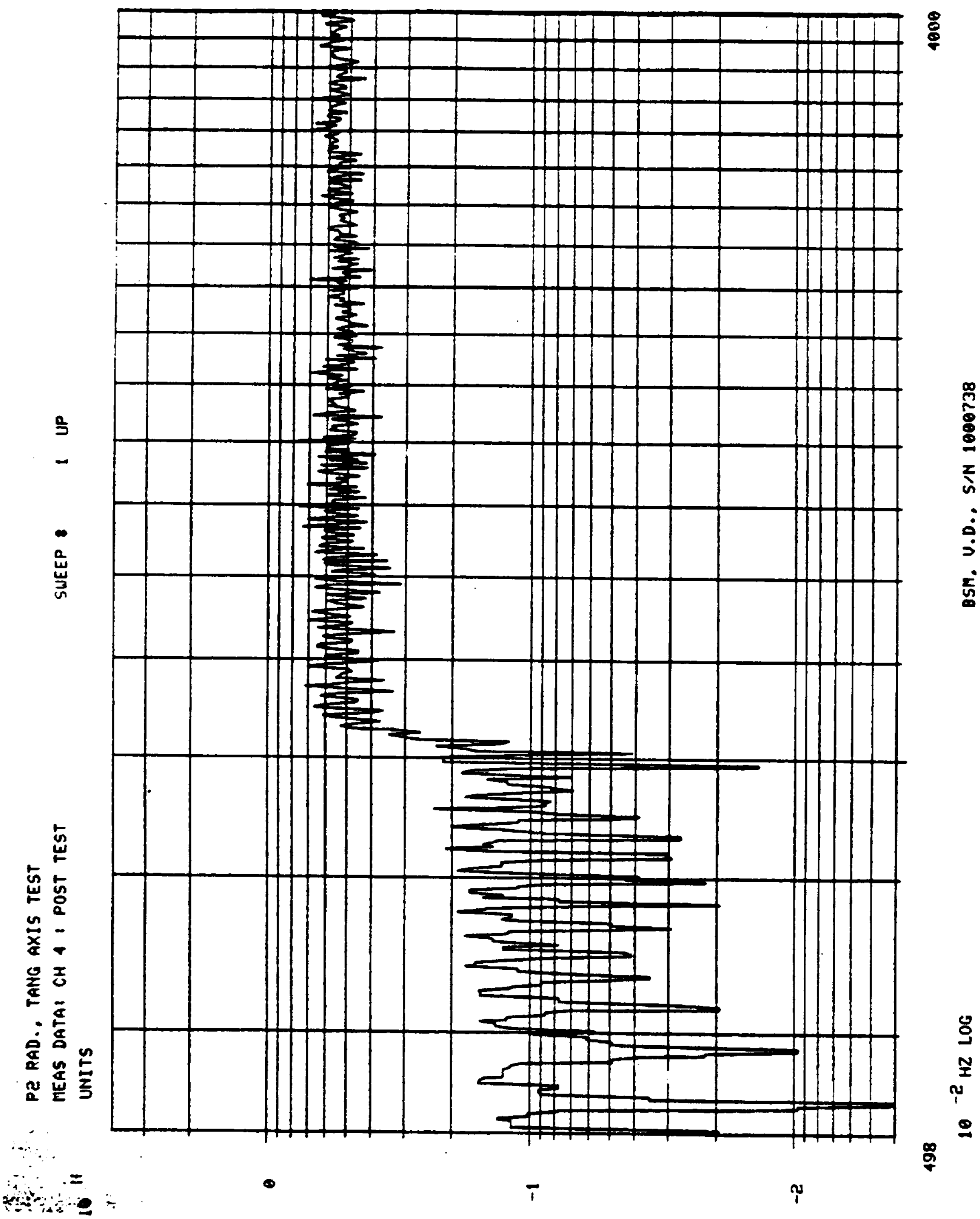

R1 RAD., TANG AXIS TEST
MEAS DATA: CH 4 : POST TEST
UNITS
SWEEP # 1 UP
0
-1
-2
498
4000
10 -2 HZ LOG
BSM, V.D., S/N 1000738



R8 LONG., TANG AXIS TEST
MEAS DATA: CH 2 : POST TEST
UNITS
SWEEP # 1 UP
10 ^-2 HZ LOG
BSM, V.D., S/N 1000738
498
4000
0
-1
-2



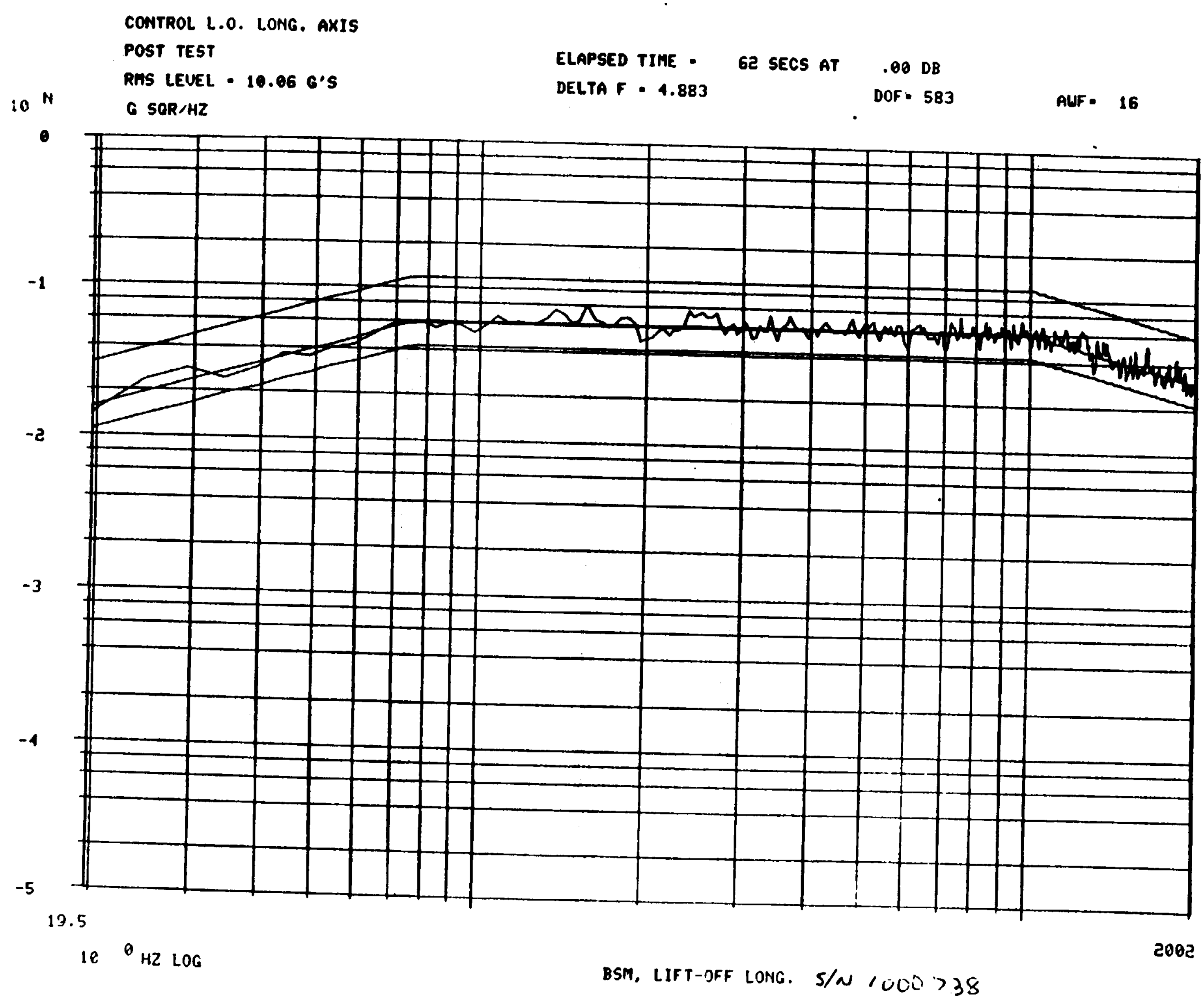
R2 TANG., TANG AXIS TEST
MEAS DATA: CH 3 : POST TEST
UNITS
SWEEP # 1 UP
10 N
1
0
-1
498
4000
10 -2 HZ LOG
BSM, V.D., S/N 1000738

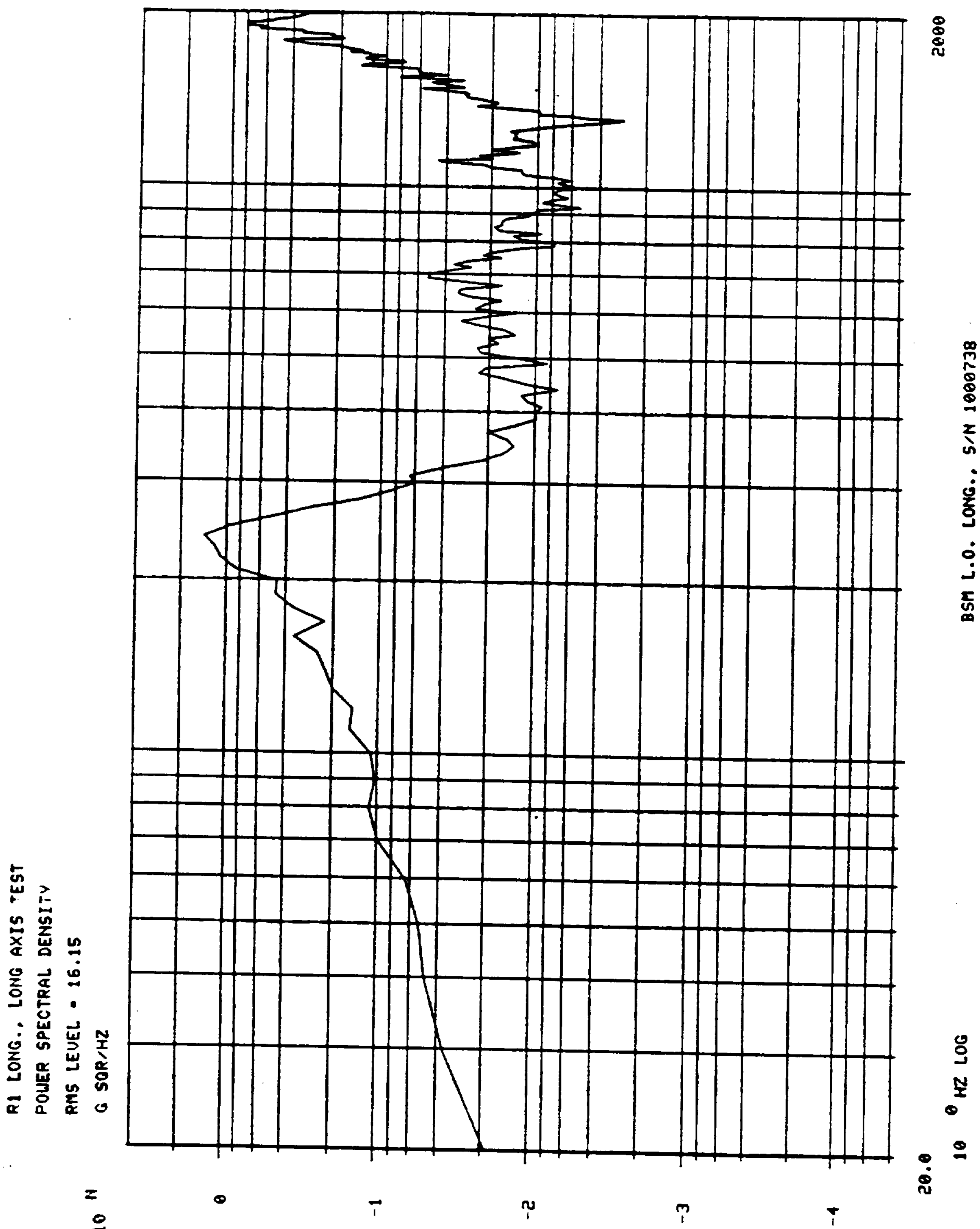


P2 RAD., TANG AXIS TEST
MEAS DATA: CH 4 : POST TEST
UNITS
SWEEP # 1 UP
BSM, V.D., S/N 1000738
10 -2 HZ LOG
498
4000
10
0
-1
-2

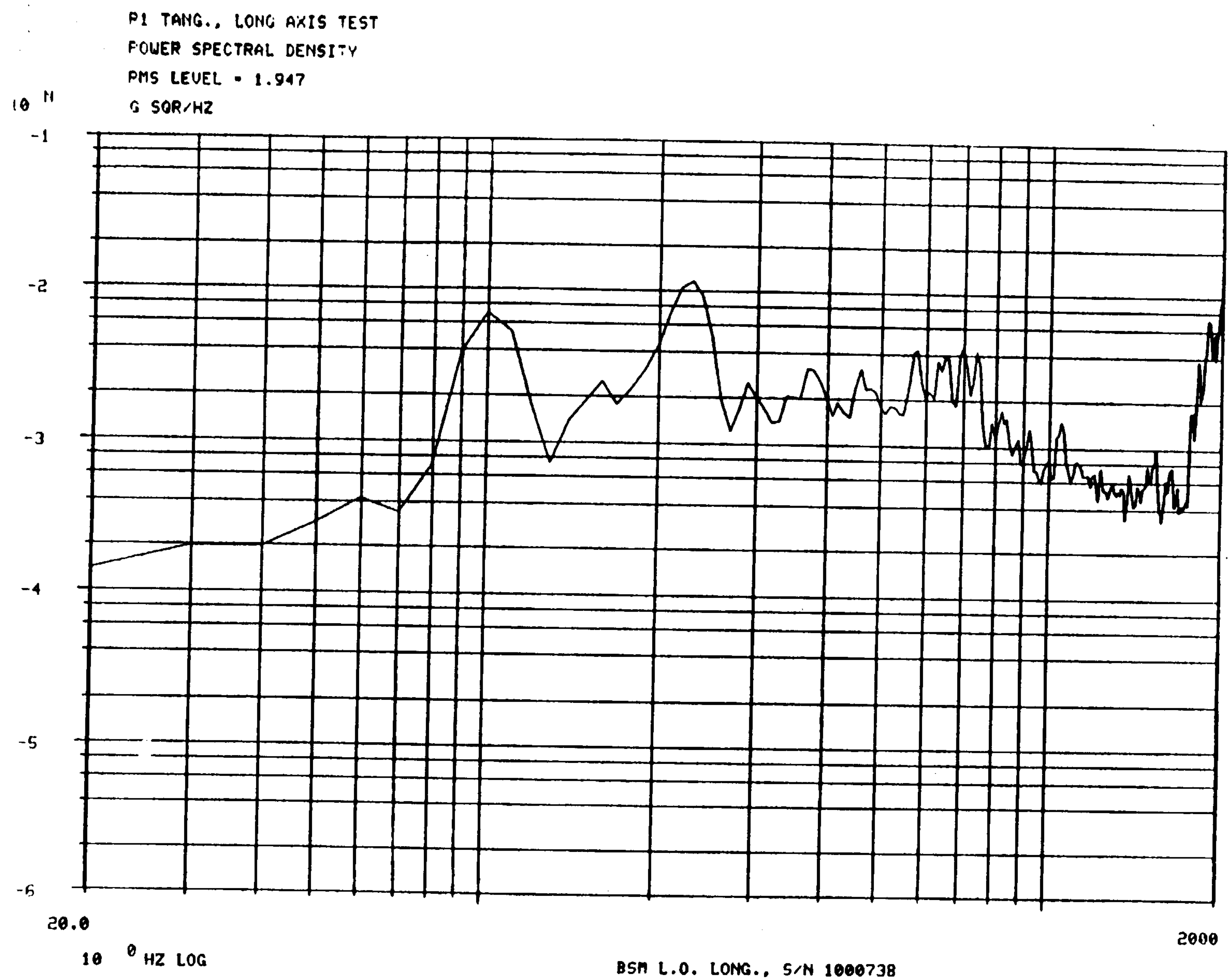
LONGITUDINAL AXIS

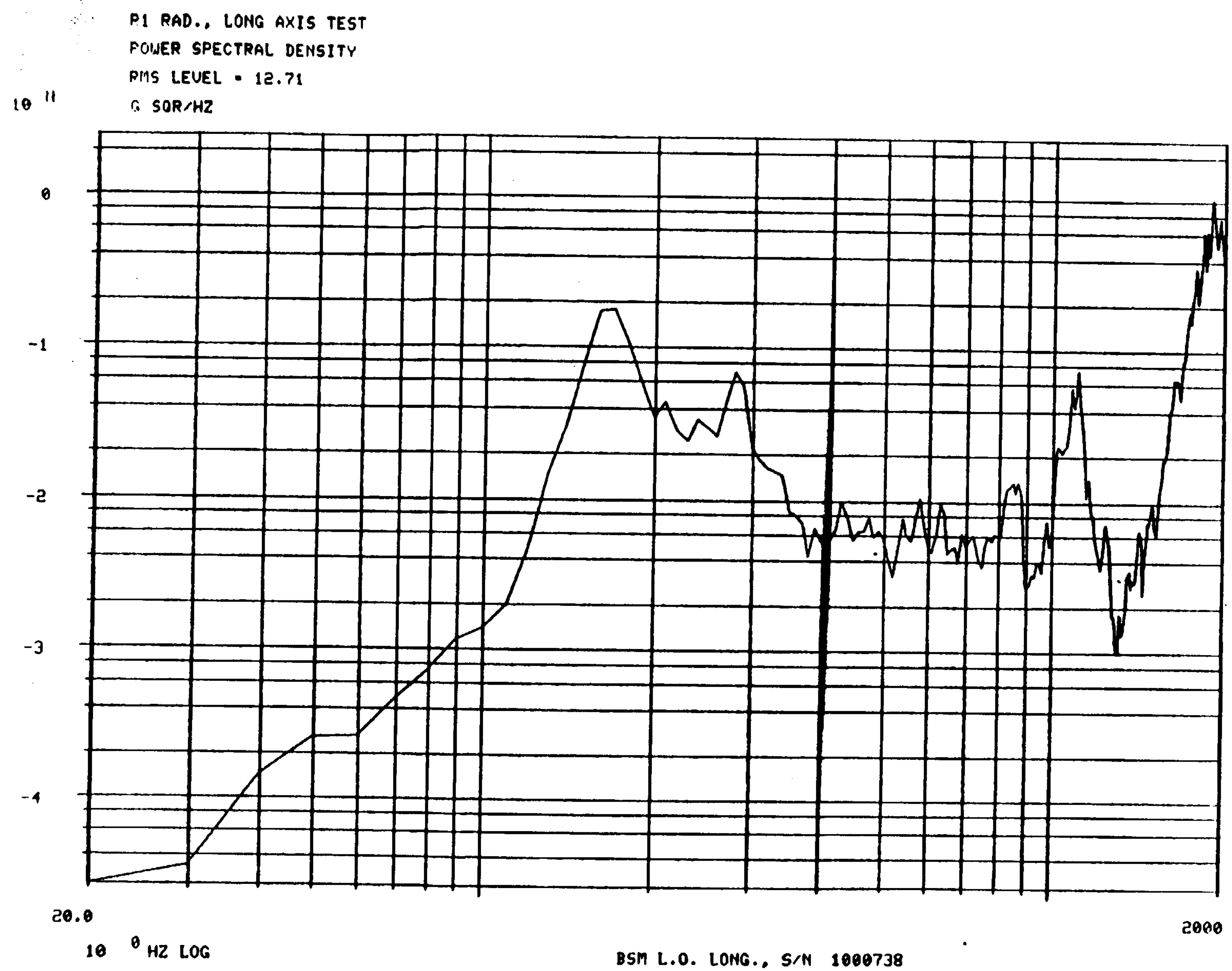
RANDOM, LIFT-OFF


CONTROL L.O. LONG. AXIS
POST TEST
RMS LEVEL = 10.06 G'S
G SQR/HZ
ELAPSED TIME = 62 SECS AT .00 DB
DELTA F = 4.883
DOF = 583
AWF = 16
10 N
0
-1
-2
-3
-4
-5
19.5
10 0 HZ LOG
2002
BSM, LIFT-OFF LONG. S/N 1000238



R1 LONG., LONG AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL = 16.15
G SQR/HZ
10 N
0
-1
-2
-3
-4
20.0
10 0 HZ LOG
BSM L.O. LONG., S/N 1000738
2000


P1 TANG., LONG AXIS TEST
POWER SPECTRAL DENSITY
PMS LEVEL = 1.947
G SQR/HZ
10 N
-1
-2
-3
-4
-5
-6
20.0
2000
10 0 HZ LOG
BSM L.O. LONG., S/N 1000738


P1 RAD., LONG AXIS TEST
POWER SPECTRAL DENSITY
RMS LEVEL = 12.71
G SQR/HZ
10 **
0
-1
-2
-3
-4
20.0
2000
10 0 HZ LOG
BSM L.O. LONG., S/N 1000738

1000738

CAUTION: **When using thread compound, personnel shall wear neoprene-Latex gloves. Contaminated materials shall be disposed of as hazardous waste.**

6.2.7.5 COAT fourteen (14) screws (NAS1101E08H10) with MIL-T-83483 thread compound. [✓]

CAUTION: **When installing the Aero Heat Shield, personnel shall be extremely careful not to drop any foreign object into the rocket motor (watches, rings, and other jewelry shall be removed; eye glasses shall be tethered if worn).**

6.2.7.6 With the nozzle cant vertically up, a properly grounded operator will INSTALL the aeroheat shield cover with the hinge on the left or right side when aft looking forward as specified by USBI/CSD. Proper alignment in either position is provided by a positioning pin and mating hole. [✓]

(NOTE: DO NOT lockwire the screws.)

6.2.7.7 INSTALL the 14 screws and TORQUE the fasteners using a standard cross pattern. Record the torque values. [✓]

First Pass:	Finger Tight			MSFC QA RC
Second Pass:	10-15 in-lbs	Value:	10-15	MSFC QA RC
Third Pass:	20-25 in-lbs	Value:	20-25	MSFC QA RC
Fourth Pass:	20-25 in-lbs	Value:	20-25	MSFC QA RC

Record SN of torque wrench: ______________

Primer in holes made AHS assembly very difficult. Primer was removed with 1,1,1 trich and que-tips.

6.2.8 <u>Make Sure the Pyro Facility Bay Doors are Open</u> [✓]

6.2.9 <u>Clear Area for Test</u> [✓]

The only personnel allowed in the control room are the pyro shock test conductor, a pyro technician, the MSFC TE, and the MSFC SE (total of four (4) people). All other personnel should move to a clear area. The clear areas are defined as the NORTH hallway of building 4619 and the area outside the pyro control room on the WEST side. Other areas must be cleared with the MSFC TE and the MSFC SE.

4-21-93