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Significance of In-Structure Generated Motion in Seismic Qualification Tests of Cabinet Mounted Electrical Devices

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Prepared for
U.S. Nuclear Regulatory
Commission

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ABSTRACT

The Idaho National Engineering Laboratory (INEL) has been conducting a research study to assist the United States Nuclear Regulatory Commission (USNRC) in determining susceptibility of electrical devices to in-structure generated motion sometimes present in electrical cabinets. In Phase I of this study, a survey of past seismic qualification tests conducted at Wyle Laboratories on various electrical and control equipment housed in nuclear grade cabinets was taken to identify components which experienced a rattling environment. The INEL has used several different methods to reduce that data and has determined the existence of a number of device anomalies in the presence of high frequency cabinet response to earthquake-type excitation motion. However, causality between the high frequency content and the malfunctions could not be conclusively confirmed. Phase II of the study consisted of shake table testing for the most prevalent malfunction discovered in the survey, relay chatter, with excitation frequency content in the seismic range and higher. This report will document the results of Phase I and II of the study. Insight into the susceptibility of electrical devices to rattling and characterization of relay chatter mechanisms offers guidance in addressing rattling effects during qualification.

EXECUTIVE SUMMARY

The primary guideline document for the seismic qualification of safety related electrical equipment, IEEE 344, discusses the need to consider nonlinear effects, such as rattling, which may occur in such equipment during seismic events. Besides the suggestion of assembly testing in such cases, little detail is offered as guidance for qualification. The Office of Nuclear Regulatory Research of the United States Nuclear Regulatory Commission (USNRC) has contracted EG&G Idaho, Inc. at the Idaho National Engineering Laboratory (INEL) to address this issue with the intention of offering additional information concerning the presence, effects, and proper consideration of such nonlinear in-structure generated motion when qualifying such equipment.

The term "rattling" refers to vibration generated within a structure which has been externally excited. This internally generated vibration results from components in the structure, which are in close proximity to one another, responding to the external vibration and subsequently causing additional vibration as the result of impact with near components. The response to seismic excitation of a cabinet exhibiting a nonlinear response such as rattling could contain frequency content both within the normal seismic frequency range (<33 Hz) and beyond. If rattling response occurs and all of the safety system devices are installed in the cabinet at the time of the qualification test, the rattling effects will have been considered by the normal testing of that assembly. Some devices, however, are tested separately and when this is done, the additional response at higher frequencies caused by rattling must be addressed.

The idea of simply fixing a rattle assumes that the rattling can be detected during the qualification test, the rattling mechanism can be isolated, and some limit of acceptable rattling motion is known not to affect functionality of supported electrical devices. Without this information, reduction of rattling to acceptable levels in cabinets is uncertain. In addition, consideration must also be given to the effect of the test laboratories' rattling fixes upon the safe operation of the equipment in the plant, e.g., rattling in a door may be reduced to acceptable levels by applying screws all around but this may impede the plant operator significantly during manual operation or inspection of devices in the cabinet.

In an effort to provide more useful information on the character of in-structure generated motion, Wyle Laboratories (Norco Facility) was contracted by EG&G Idaho to provide information from past seismic qualification records of various electrical cabinets tested at both the Norco and Huntsville Facilities. A survey of these records was performed and analyzed to determine the general behavior of the cabinets and their mounted electrical devices in the seismic and rattling environment.

The survey indicated that a wide range of cabinet sizes, functionalities, and electrical devices had been tested. Also, various high frequency (<33 Hz) g-levels in the cabinet responses were encountered. Electrical devices that displayed anomalies during the tests were: relays, switches, circuit breakers, a meter, a starter, a circuit card, a pressure switch, and an indicating light. Anomalous behavior included: contact chatter, breaker trip, output change on the circuit card, short circuit in the indicator light, erroneous readings on the meter, spurious signals, and contact bouncing. One test record indicated cabinet failure. Contact chatter was the most common anomaly. Sources of rattling identified in this survey were loose cabinet doors and loose device-mounting connectors.

Detailed signal analyses of six selected records, each containing the test table input motion and device location response, were evaluated for acceleration amplitude and frequency content. Time histories, response spectra, power spectral densities (PSD), transfer functions between input and response, and coherence functions were evaluated for each of the records. Analysis of the six records indicated significant levels of high frequency in-structure generated motion but a firm correlation between device malfunctions and rattling environment could not be established. Even though test results indicated high frequency cabinet response, electrical device malfunctions did not always occur. Because the qualification records did not include the time at which the anomalies occurred, the causal effect between the occurrence of high frequency cabinet response and any anomalies was further obscured.

To investigate the possible causal relationship between high frequency cabinet rattling response to earthquake excitation and electrical device malfunction, some testing on a limited scope was performed at Wyle Laboratories. Since the existence of a rattling environment did not necessarily

determine the malfunctioning of devices, an attempt was made to establish if *any* device might malfunction under such conditions. This meant selecting a device which was most likely to fail, exposing it to excitation with frequency content beyond the seismic range, and closely monitoring its response for evidence of malfunction. Relays were selected because it was the most prevalent device with malfunctions in the seismic qualification survey taken at Wyle Labs. The Westinghouse model AR660 and General Electric model CR 120B relays[a] were selected because of their widespread usage throughout the nuclear industry. Three relays from each manufacturer were tested simultaneously to offer statistical reliability in the results.

The testing focus was on random excitation of the relays with equal acceleration input levels throughout three frequency ranges (measured by response spectra at 2% damping): 3 to 15 Hz, 15 to 100 Hz, and 3 to 100 Hz. The choice of the breakdown of excitation into these frequency bands was based upon the existence of typical seismic floor spectra having amplified response up to about 15 Hz. With this cutoff, evaluations were made of the minimum response spectrum peak accelerations required to induce relay chatter by increasing g-levels in each broadband test until chatter occurred. Thus, the effects of only low frequency (3 to 15 Hz), only high frequency (15 to 100 Hz) and the composite of frequency (3 to 100 Hz) content bands could be evaluated. In addition to the random excitation, swept sine testing in the 4 to 100 Hz range was performed at successively increasing input g-levels to give some relative measure of frequency sensitivity of the relays up to 100 Hz.

It was recognized that relay functionality might be based upon the relationship of chatter duration and electrical response of the system in which it interfaces. A computer monitoring system was employed to detect and quantify relay chatter durations of: 2 to 5, 5 to 10, 10 to 20, 20 to 40, 40 to 80, and >80 ms. This monitoring system was employed on, not only the on-table relays undergoing the vibration excitations, but also a set of off-table relays energized through individual on-table relays. These off-table relays represented components of different (alternating current) coil sizes.

a. "Mention of specific products and/or manufacturers in this document implies neither endorsement or preference nor disapproval by the U.S. Government, any of its agencies, or EG&G Idaho, Inc., of the use of a specific product for any purpose."

In addition to measuring the table response, accelerometers were used to measure fixture and relay casing response. Detailed characterizations of the relay casing responses during the random excitation tests were made. Velocity and displacement histories were examined along with the acceleration at inception of chatter to more clearly identify causal relationships between excitation and relay chatter response.

Observation of relay responses to this series of tests affirms several characteristics which have been determined by other research on relays. Relays with normally closed contacts tend to be more susceptible to chatter than those with normally open contacts. Energized relays in this series of tests did not chatter. Relays excited in a direction coincident with their contact's line of action were more susceptible to chatter than when excited in a direction orthogonal to that line of action.

New facets of relay chatter response were also discovered. Even though the major portion of relay chatter responding to random excitation was because of accelerations with frequency content <15 Hz, swept sine tests indicated relay frequency sensitivity at not only <15 Hz but also in the 45 to 85 Hz range. *Testing the relays with random excitations of low, high, and a composite of these frequency ranges indicated that high frequency content did not contribute to the reduction of functionality of these relays based upon peak response spectrum acceleration. However, the characterization of the mechanism causing relay chatter under broadbanded excitation pointed to a critical difference in results, depending upon whether peak response spectrum acceleration values or acceleration levels on the relay sustained for a typical duration are used to measure excitation level. The second measure appears to be more closely correlated to chatter on these relays than the first. If the second measure is used, the addition of high frequency content in the excitation does degrade the acceleration-to-chatter levels.*

Relay chatter and its subsequent effects on interfacing electrical equipment requires some consideration beyond the present seismic qualification test procedures and broadly affects important assumptions in seismic probabilistic risk assessments (PRA's) of safety systems. These test data indicate that chattering relays induce adverse electrical-mechanical response in interfacing electrical equipment; therefore, the PRA procedure of neglecting chatter effects on such equipment may lead to inaccurate conclusions.

Results indicate that relays interfacing with chattering relays are induced to chatter for durations longer than those of the initiating, chattering relays. It is speculated that this increase in duration could be the result of a couple of possibilities. One possible explanation is that chains of short duration electrical pulses occur which appear to the off-table relay as a much longer pulse because of the relay's relatively long response time. A second possibility is that the pulsing might appear as an alternating current which affects the relay coil and, thus, chatter duration. Seismic qualification criteria presently require registering chatter durations of 2 ms or greater during the tests. In light of these results, some consideration should be given in the qualification test to the relationship between the relay's interfacing system response time, the occurrence of critical length chatter durations, and the time interval between those events.

These test results provide the following insight to qualification testing in the seismic-induced rattling environment:

1. The rattling environment is indeed real in some equipment qualification tests of cabinets.
2. There are analytical tools available that provide some qualitative measure of the existence of cabinet in-structure generated motion outside the normal seismic range of interest. Comparisons of table input and device location and output response spectra is one such set of tools. Comparisons of the transfer function between the two locations and its corresponding coherence function can offer some additional insight into the phenomenon. Typically, the quality of the transfer function and the coherence function in resonant frequency ranges tends to degrade with the presence of nonlinear structural response.
3. The occurance of rattling does not necessarily mean that a cabinet mounted device is going to malfunction during seismic excitation. Dynamic characteristics of the device of concern must be considered as well as the possibility of any narrow-banded frequency characteristics in the rattling environment.
4. Depending upon the device functional mechanisms, there may be dynamic characteristics which better reflect functional operability than the commonly used peak acceleration parameter. This parameter is inferred from the comparison of test response spectra (TRS) to required response spectra (RRS), presently utilized in IEEE 344 to indicate structural integrity under seismic excitation. In this limited testing to characterize relay chatter, levels of sustained acceleration seemed more critical than peak acceleration response.
5. Presently, IEEE 344 requires only the recording of chatter durations >2 ms. Observations of relay interaction infer that seismic qualification testing should base its chatter measurement requirements on the joint considerations of relay chatter duration, time intervals between chatter incidents, and response characteristics of interfacing equipment.

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SIGNIFICANCE OF IN-STRUCTURE GENERATED MOTION IN SEISMIC QUALIFICATION TESTS OF CABINET MOUNTED ELECTRICAL DEVICES

1. INTRODUCTION

The United States Nuclear Regulatory Commission (USNRC), Office of Nuclear Regulatory Research, has contracted EG&G Idaho, Inc. at the Idaho National Engineering Laboratory (INEL) to conduct a research program to improve guidance for the environmental and dynamic qualification of safety related equipment. One identified research topic concerns the current guidance for dynamic qualification of equipment mounted on support structures when rattling occurs in the support structure. Cabinets supporting various electrical devices and exhibiting rattling when subjected to seismic motion are an example of this concern. Wyle Laboratories was subcontracted by EG&G Idaho to survey past seismic qualification tests which they had performed to identify components most susceptible to rattling, and to provide testing facilities required in the second phase of this study to simulate the rattling environment. Results and conclusions are based upon data from Wyle's test report,[1] herein referred to as *the test report*. A microfiche copy of this report is included as Appendices A through H. The following section describes the background of this research program, identifies its objectives, and outlines the tasks that were performed.

1.1 Background

Seismic qualification testing of safety class equipment is typically conducted with the assumption that the equipment primarily responds in a linear fashion. Theoretically, this implies that for an input excitation over a specified frequency band, the excited component will only contain frequency response in that band. Seismic floor response spectra typically have significant dynamic amplification in the frequency range of 3 to 15 Hz. A linear structure thus excited would not respond dynamically above that frequency range. However, a nonlinear structure could induce additional frequency response, both within the range of frequency content of the input as well as outside that frequency range. Rattling of the structure is an example of this nonlinear behavior. The term "rattling" refers to vibration generated within a structure which has been externally excited. This internally generated vibration results from components in the structure, which are in close proximity to one another, responding to the external vibration and subsequently causing additional vibration as the result of impact with near components.

IEEE 344,[2] the prime document for guidance in seismic qualification of safety related equipment, recommends accounting for such in-structure generated response but offers very little guidance for either its detection or its adequate consideration. The standard does recommend assembly testing if possible when rattling does exist.

This effectively presents a problem for some common testing scenarios. Oftentimes, testing of a support structure, such as a cabinet, and the devices which might be used in it are performed in separate qualification tests. Typically, this is because different devices are retrofitted into the cabinet after the original qualification test or simply that plant equipment acquisition schedules necessitates separate qualification testing. While the effect of rattling on the cabinet itself is addressed in the original qualification test, the Required Response Spectrum (RRS) for the retrofitted or separately tested device may not necessarily consider amplified frequency content above 33 Hz. This may result because the RRS for the device was derived by analysis using table motion and a linear model for the cabinet or it may be caused by testing the retrofitted device only in a frequency range below 33 Hz. Depending upon the device's characteristics and functionality requirements, neglecting excitation frequencies above 33 Hz raises the question of whether the component is qualified seismically, since it is possible that rattling can introduce response in the cabinet at frequencies higher than 33 Hz as well as within the seismic frequency range.

1.2 Objectives

This study has focused upon determining the extent to which rattling may exist in electrical cabinets (if high frequency cabinet response resulting from rattling exists and there are electrical devices which are susceptible to such rattling) and providing some guidance for qualification testing that would adequately and feasibly address this phenomenon. The limited scope of testing in this study demanded evaluation of a worst-case scenario to give some indication of the severity of the problem. Thus, the results of this study offer a qualitative assessment of rattling on devices deemed most susceptible to that environment.

1.3 Description of Tasks Performed

To meet the objectives of the study, typical cabinet frequency response due to in-structure generated motions during seismic qualification tests was determined. Then tests were conducted to evaluate the rattling effects on a device functional anomaly, judged most likely to occur in this environment and had plant safety implications. From the outset of the program, it was assumed that structural integrity was not the primary concern but that device functionality would be most sensitive to such situations.

The study was divided into two main tasks:

1. Evaluation of existing test data related to seismic qualification of various electrical and control equipment used in nuclear power plants.
2. Limited testing of typical electrical equipment to demonstrate susceptibility to low and high frequency excitation.

Selection of relays as the type of electrical equipment to be tested in the second task was based upon the fact that relay chatter was the most prevalent anomaly detected in the survey included in the initial task of the study.

Section 2 of this report describes the survey of existing seismic qualification test records and Section 3 is a more detailed analysis of six records taken from that surveyed group. The basis for selecting the test items is outlined in Section 4, while Section 5 describes the testing procedure and Section 6 details the results. Conclusions of the study are discussed in Section 7.

2. REVIEW AND ANALYSIS OF EXISTING QUALIFICATION TEST PROGRAMS

This part of the task consisted of surveying existing seismic qualification test reports and analyzing the test data to offer some description of rattling response. Since the scope of the program was limited, the decision was made to limit the survey to electrical devices in the cabinets.

2.1 Description of Test Report Review

One hundred test reports were selected from the seismic qualification programs conducted at both the Norco and Huntsville facilities of Wyle Laboratories in the last few years. These reports addressed the seismic qualification of typical cabinet-mounted electrical devices used in nuclear power plants. The reports were reviewed and the data evaluated in order to establish general behavior of the control equipment under typical seismic excitation.

A format was developed for summarizing the pertinent seismic qualification test data. This format includes a description of equipment, anomalies, tests performed and equipment response amplification at frequencies higher than 33 Hz. Appendix A of the test report contains a typical summary form used to collect data and a table that summarizes the pertinent data. In this summary table, a brief physical description of each cabinet qualification test that was considered is listed in the column marked *structure* while electrical devices of interest in the cabinet during the test are described under the *component* column. Tests performed on the structure and maximum zero period acceleration (ZPA) g-levels on the test response spectra (TRS) are subsequently listed. Next, a description of any anomalies which occurred during the test is given. An indicator of frequency response of the cabinet above 33 Hz was measured as a percent increase in amplitude above the amplitude at 33 Hz.

2.2 Results of the Test Report Survey

The summary indicated that a wide range of cabinet size and functionality had been tested. Correspondingly, a wide range of electrical devices were mounted in the cabinets. Input ZPA g-levels ranged from 0.1 to 25 g's. Cabinet response at elevated device locations showed up to 2300% amplification above the 33 Hz frequency amplitude for frequencies above 33 Hz.

Mounted devices exhibiting anomalous behavior included: a meter, relays, switches, circuit breakers, a starter, a circuit card, a pressure switch, and an indicating light. Relays, switches, and circuit breakers made up the majority of devices exhibiting anomalous behavior. The anomalous behavior of mounted devices included: contact chatter, breaker trip, output change (on the circuit card), short circuit on the indicator light, erroneous readings on the meter, spurious signals, and contact bouncing. One record indicated cabinet failure. Contact chatter was typically monitored and recorded for durations of 2 ms and greater. Sources of rattling determined in this survey were loose cabinet doors and loose device-mounting connectors.

The review showed equipment response amplification at frequencies higher than 33 Hz and demonstrated that electromechanical devices are more sensitive to seismic motion than components without moving parts. From the 100 reports reviewed, 30 anomalies were detected and 29 of them were related to device operability. Twenty-five of the anomalies involved contact chatter, change of state, or bouncing.

Notably, most of the qualification tests reviewed were conducted with random multifrequency motion and designed to demonstrate that the specimen met its acceptance criteria. The instrumentation monitored the occurrence of the device anomaly during the test but did not record the time at which the anomaly occurred or the corresponding component response frequency. Furthermore, most of the evaluated reports traditionally addressed equipment performance at seismic frequency range, i.e., below 33 Hz. Therefore, the recorded data at frequencies above 33 Hz are far from perfect, being influenced by test equipment limitations and control system noise.

The review gives possible indication, but does not give conclusive proof, of causal effect between rattling and anomalies.

3. DETAILED SIGNAL ANALYSIS OF SELECTED TEST RECORDS

3.1 Description of the Signal Analysis

Six records of input/response time histories were selected from a subset of the original 100 test records, which were available for detailed computerized analysis. The selection was based on the character of time histories, comparison between input and output motions, and performance of tested equipment, especially in the high frequency range. Location of response accelerometers and availability of data tapes with nonfiltered time histories were also taken into consideration.

Table 1 identifies the six selected records from the 100 reports. Each record consists of the input acceleration time history from the control accelerometer located at the test table close to the support of the test specimen (Accelerometer 1) and the response acceleration time history from a selected location. Selection of the response location (and corresponding accelerometer number) was based upon performance of the tested equipment. Only one run from each report in the study was selected for detailed evaluation; the run number is also presented in Table 1. Each record set consists of shake table input spectra, based upon the control accelerometer reading and the cabinet response spectra at a specified location, based upon the corresponding response accelerometer reading. Input and response acceleration time histories of 30 s duration are also presented in each record as well as 5 s duration portions of those time histories to show more detail. All of the above information was gathered from selected test reports. Based upon this information, frequency domain functions were derived using the VAMP[3] software on the Wyle in-house computer, a Digital Equipment PDP-11. These data are included in Appendix B of the test report.

In the frequency domain analyses, each thirty-second time history was divided into six five-second time ensembles. Then the Fast Fourier Transform (FFT) analysis of input and response acceleration was performed for each ensemble and the ensembles were averaged in the frequency domain. Power Spectral Densities (PSD) of the input and response acceleration were then calculated. Finally, coherence, transmissibility and transfer functions between input, X, and response, Y, acceleration were calculated as follows:

Coherence (γ^2) is the amplitude of the cross-power spectrum squared divided by the product of the two autospectra ($XY^{*2}/X^2 \cdot Y^2$).

Transmissibility is the Fourier spectrum of the response divided by the Fourier spectrum of the input (Y/X).

The transfer function was calculated by dividing the cross-power spectrum of the response and the input by the autospectrum of the input (XY/XX^*).

In these definitions, the autospectrum refers to the spectrum derived from the multiplication of the real part of the FFT and its complex conjugate (XX^*).

Table 1. Selected records for detailed signal analysis

Record Number	Report Number (See Appendix A)	Accelerometer Number: Input	Accelerometer Number: Response	Run Number
1	NOR01	1	7	11
2	NOR07	1	5	12
3	NOR08	1	7	6
4	NOR15	1	15	44
5	NOR37	1	21	15
6	NOR47	1	3	16

No filtering or smoothing was used. The initial data and results of calculation of a total of 13 plots for each of the six records are presented graphically in Appendix B of the test report in the following order:

1. Shake table input spectra and the cabinet response spectra. (2 plots)
2. Thirty second input and response time histories. (2 plots)
3. Input and response time histories for five second duration to present more details of the time histories. (2 plots)
4. FFT analysis of input and response accelerations. (2 plots)
5. PSD of input and response accelerations. (2 plots)
6. Coherence between input and response acceleration. (1 plot)
7. Transmissibility between input and response acceleration. (1 plot)
8. Transfer function between input and response acceleration. (1 plot)

3.2 Detailed Signal Analysis Results

Comparisons of response spectra and time histories show that levels of acceleration at elevated device locations were significantly higher in the upper frequency range when compared to input acceleration levels at the test table. FFT and PSD plots also served to characterize the input and response motion as a function of frequency. Obviously, because of motion amplification in tested equipment, the amplitude of the PSD for the response motion is higher than for the input motion, but the more important fact is that both response spectral acceleration and the PSD for the response motion indicate substantial motion and energy in the higher frequency range, while input motion generally shows a downward trend in amplitude as frequency increases above 15 Hz.

While the PSDs offer some measure of energy content in the table input and device location response, causality, or the absence of noise, is best determined by examining the transfer functions and corresponding coherence functions between the table input and cabinet response. Transfer functions indicate frequency ranges of cabinet amplification caused by resonant conditions and the coherence functions indicate the degree to which a designated response is caused by a specified input such as table motion.

Because coherence is a function of frequency, highly causal response of some resonant frequencies can be shown in the transfer function ($\gamma^2 \cong 1.0$) yet at other resonances, low causality from the input ($\gamma^2 < 0.5$) is indicated. This is typically caused by the presence of other sources of excitation besides the specified input. The measure of what is "good" coherence is dependent upon usage of the transfer function. Good estimates of modal damping from transfer functions require coherence values of $\gamma^2 \cong 0.9$ or better. On the otherhand, demonstration of relative dependence of two components of an earthquake's accelerogram require only a coherence value of $\gamma^2 \cong 0.5$ or better.[1] Other things to consider when evaluating coherence is that a sufficient number of averages should be taken and the input power should be sufficiently high to produce a reliable coherence value. Considering the data processed, $\gamma^2 < 0.8$ in the resonant frequencies ranging up to 20 Hz and $\gamma^2 < 0.5$ in the higher frequency ranges was judged as indicating modes with considerable response due to external sources such a rattling, i.e., lack of causality between seismic input motion and cabinet response motion.

Using these various tools as rattling indicators, analysis of the six records indicated that there was a considerable amount of rattling in most of the cabinet responses. However, malfunctions were only recorded in two of the five tests in which cabinet rattling was indicated.

Considering all of the evidence collected as a result of the seismic qualification test survey, it was concluded that, even though there was significant high frequency cabinet rattling in some qualification tests, a conclusive correlation between that phenomenon and the occurrence of functional anomalies could not be made. Primarily, this was due to the fact that the excitation wave form at the time of anomalous occurrences could not be recovered from the existing test records.

To address this problem, a series of tests were performed on a very limited set of electrical devices. The following sections describe the selection process, test setup, and results.

4. TEST SPECIMEN

The following subsections outline the philosophy of test item selection and describes the physical characteristics of each of the six relays tested.

4.1 Basis for Selection

Because the overall objective of this study was to investigate the relative significance of rattling phenomena in seismic qualification, the philosophy of testing was based on the attempt to investigate a bounding test scenario. Test specimens were selected for their probable susceptibility to a rattling environment, their typical use in nuclear plant safety systems, and, if possible, their general use throughout the nuclear industry. Rather than test a wide variety of components, multiple items of a few types were selected to provide some statistical confidence in the test data. This allowed the focus of attention to be placed upon: (a) the detailed characterization of the failure mechanisms involved and (b) quantification of the devices' sensitivity in measurements typically made in seismic testing.

The electrical devices were selected on the following basis:

1. One hundred nuclear power plant electrical equipment seismic qualification test reports were reviewed to identify electrical devices that most prevalently indicated anomalous behavior during seismic excitation.
2. The test data for susceptible devices was evaluated to identify devices that indicated anomalies in the presence of excitations having frequency content beyond the normal seismic range.
3. The devices selected were representative of devices commonly used in nuclear power plants.

4.2 Specimen Description

Using the defined selection criteria, electrical relays exhibiting contact chatter were the prime candidates for this testing. Additionally, other sources[4] have indicated relays as critical components in plant safety yet having relatively low seismic capacity. Commonly used industrial-type relays from two manufacturers, typically used in the control or auxiliary relay functions in nuclear safety systems, were selected. Six relays, three of General Electric manufacture and three from Westinghouse, were tested simultaneously. Table 2 describes these relays.

4.3 Receiving Inspection

Upon receipt at Wyle Laboratories, and prior to any testing, the test specimens were visually examined for evidence of damage which may have been incurred in shipping. Specimen identification information was checked with the shipping documents for conformity. Results of the visual examination, together with specimen identification information, were recorded on the appropriate test data sheets. There was no visible evidence of damage to the test specimens upon receipt at Wyle Laboratories. The test specimens were described as General Electric 230 Vac Relay, Part CR120B06003 and Westinghouse 120 Vac Relay, Part AR660.

Table 2. Test specimen description

Device Description	Manufacturer	Model	Coil Voltage (Vac)	Number of Poles	Dimensions (in.)	Weight (lb)
Relay	GE	CR120B	230	6	4.5 x 2.38 x 3.5	1.5 lb
Relay	Westinghouse	AR6A	120	6	6 x 4.09 x 3.875	2.3 lb

5. TEST PROCEDURE

Details concerning the physical layout of the tests, parameters modeled, and excitation used are given below. In addition to these descriptions, testing philosophy is also included, where appropriate.

5.1 Mounting

The test items were mounted on a fixture as shown in Figure 1. The mounting screws were Number 10 for Westinghouse and Number 8 for GE relays. The mounting screws were tightened so that the relays were held firmly on the fixture. The fixture was fabricated from 1-in. thick plates and welded to the test table. Figures 2 and 3 picture the actual setup.

The tests were performed on Wyle Laboratories' biaxial seismic test table, G-machine, and single axis vibration table, F-machine. The seismic G-machine table is 100-in. square and is capable of 12-in. double amplitude displacement horizontally and 9-in. double amplitude displacement vertically. The seismic machine has a load rating in excess of 10,000 lb. The F-machine has a load capacity of 200 lb at 5 g's and double amplitude displacement up to 4 ft.

5.2 Electrical Monitoring

Electrical monitoring was designed to obtain data on (a) occurrence of contact chatter or change of state, (b) chatter duration and number of chatter events during each test, (c) level and frequency at which chatter occurred, and (d) the effects of contact chatter on other devices connected to it.

It was recognized that relay chatter, by itself, may or may not present a problem to nuclear plant safety depending upon the systems to which the relay is connected. With this in mind, an effort was made to characterize, in detail, the relay response and to determine the relay's response effect on other electrical devices to which it could be connected. Three off-table relays were selected to monitor this sensitivity to chatter initiated from each of the two on-table designs tested. The off-table selection represented devices with different coil sizes and, thus, possibly offering different sensitivities to on-table relay chatter. Table 3 lists each off-table device and the on-table relay to which it was connected.

All tests were initially conducted with the test specimens in the de-energized state, which was selected because recent fragility tests by other

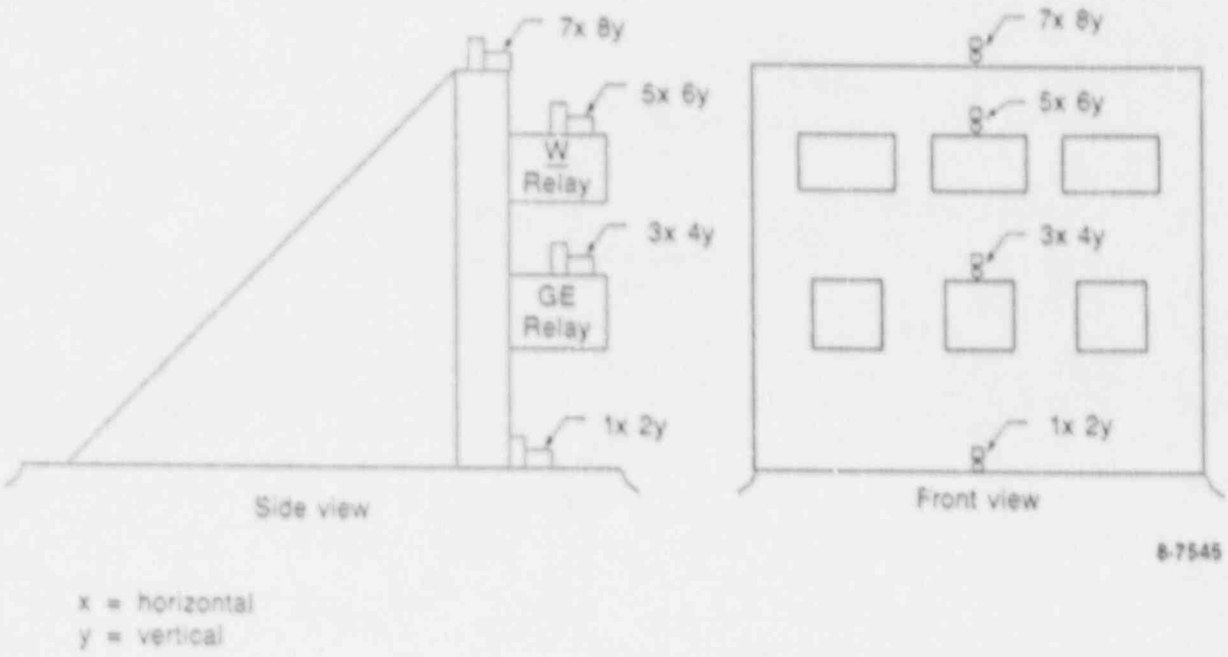

Figure 1. Test fixture and response acceleration location.

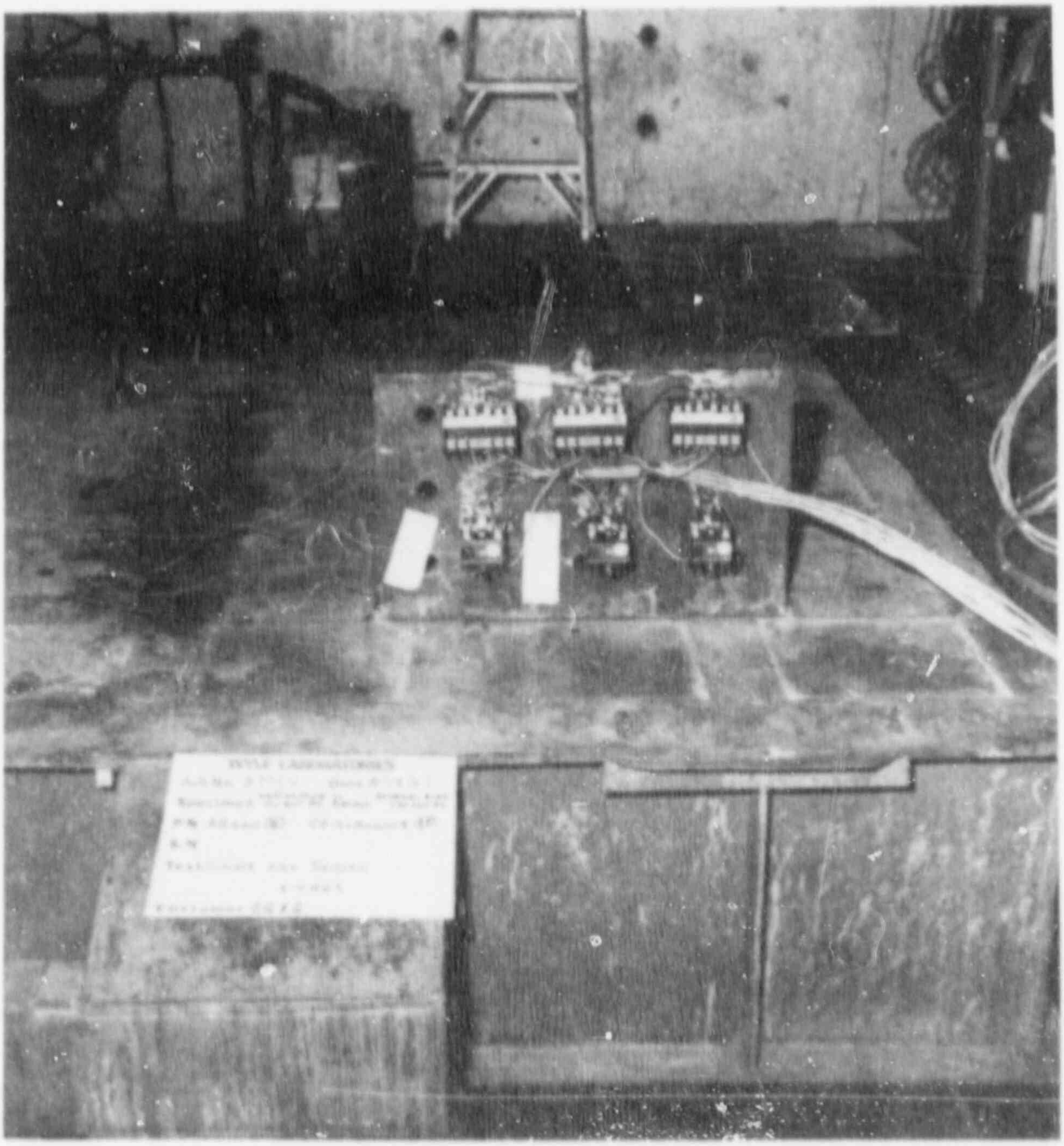

Figure 2. Test setup on the G-machine.

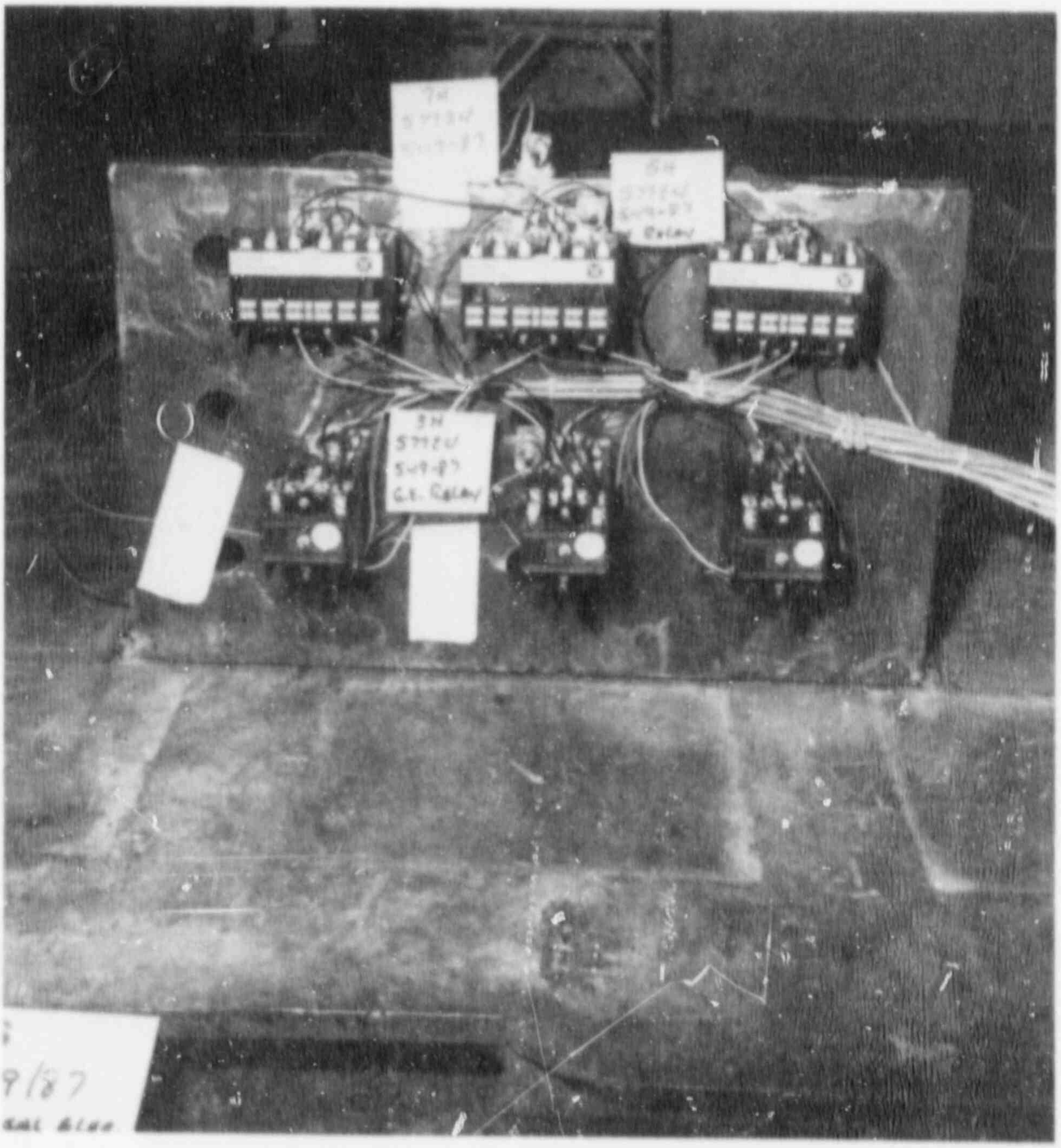

Figure 3. Accelerometer locations.

Table 3. On- and off-table relay arrangement

On-Table Relay Manufacturer	Off-Table Device Manufacturer	Model	Coil Voltage Vac
GE	Cutler Hammer	D40RB Series 2A	120
GE	GE	CR120B	230
GE	Allen Bradley	Size 1 Starter	120
Westinghouse	Cutler Hammer	D40RB	120
Westinghouse	Westinghouse	AR6A	120
Westinghouse	Allen Bradley	Size 1 Starter	120

researchers[5] have indicated this configuration to be most susceptible to chatter. If contact chatter occurred during a test, the same test was repeated with the test specimen energized. The off-table relays were energized through the on-table relays during all testing. These contact configurations represent the worst case scenario, since normally closed (NC) contacts require less inertial force to cause contact chatter. Normally open (NO) contacts typically have a significant gap which must be traversed and, therefore, require a higher inertial force to initiate chatter or state changes than NC contacts.

5.3 Accelerometer Arrangement

Table and relay response was measured by accelerometers at four locations. The table response was measured and controlled with two accelerometers mounted at the base of the test fixture in the vertical and horizontal directions. Fixture response was measured by accelerometers mounted on top in the horizontal and vertical directions. Relay responses were measured by accelerometers mounted on the relay casing of one Westinghouse and one GE relay. These also measured horizontal and vertical response. Record of these responses offered measurement of any local response in table, fixture, or relays. The positions of these accelerometers are shown in Figure 1 and the test setup photographs (Figures 2 and 3). The accelerometer data was recorded on analog FM tape and also monitored by computer.

5.4 Excitation Wave Forms

The shake table excitations used in this program consisted of: (a) low level resonance search tests to aid in the detection of any resonant response frequency in the test, and (b) high level random and swept sine tests to actually achieve the chatter g-levels. Additional high level amplification check tests were performed to more accurately define the relay chatter spectra discussed in Section 6.4. The random tests were performed to best replicate waveforms expected in an earthquake-excited, cabinet-rattling environment. Generalized broadband excitation was divided into low (<15 Hz), high (15 to 100 Hz), and composite (3 to 100 Hz) frequency content bands to evaluate the effect of dynamic excitations on the cabinet device (relay) that are outside the range expected for purely seismic motion. High level swept sine tests were performed to augment the random test results by providing a more definitive picture of the frequency response of the table, fixture, and relay casings.

5.4.1 Resonance Search. The resonance search consisted of a low level sinusoidal sweep test (0.2 g's) of the relays mounted on the test fixture in the horizontal (x) and vertical (y) directions (see Figure 1) to determine the response of the test specimens and fixture in the desired frequency band of 1 to 100 Hz. The sweep rate of 1/2 octave per min was employed in this frequency range on the G-machine test table.

5.4.2 Random Excitation. The seismic fragility tests were conducted uniaxially using random motion that was amplitude-controlled in one-third octave bandwidths from 1.25 to 100 Hz. This input signal was synthesized with a bank of parallel one-third octave filters with individual output attenuators adjusted to meet the required response spectra shapes. The tests were conducted in three separate frequency bands; low, high, and a combination of these frequency bands. Because of the large number of test runs, 10-second duration strong motion waveforms were used to reduce fatigue effects. The strong motion segment of the excitation was preceded by a 2 to 3 second ramp-up and followed by a 3 to 4 second ramp-down.

Analyses of the test motions were accomplished with a response spectrum analyzer. The analyses were performed and plotted at one-sixth octave frequency intervals up to 100 Hz. Response spectra were plotted at damping values of 1, 2, and 3% of critical.

Figures 4, 5, and 6 show the specified test levels for this program. The criterion used in meeting the test levels was that the amplified portion of the response spectra of the table acceleration (calculated with 2% damping) envelopes the g-levels indicated in these three figures. The dashed lines in Figure 4 illustrate the corresponding levels of the

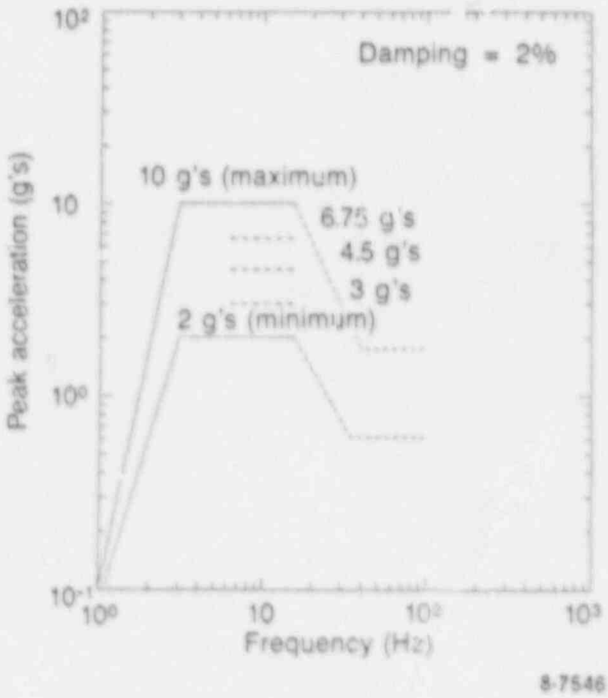

Figure 4. Low frequency RRS.

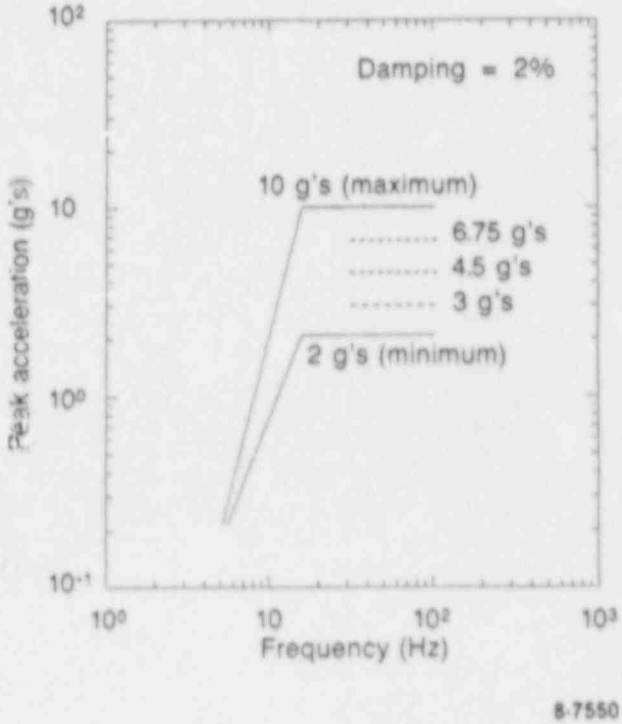

Figure 5. High frequency RRS.

xxx

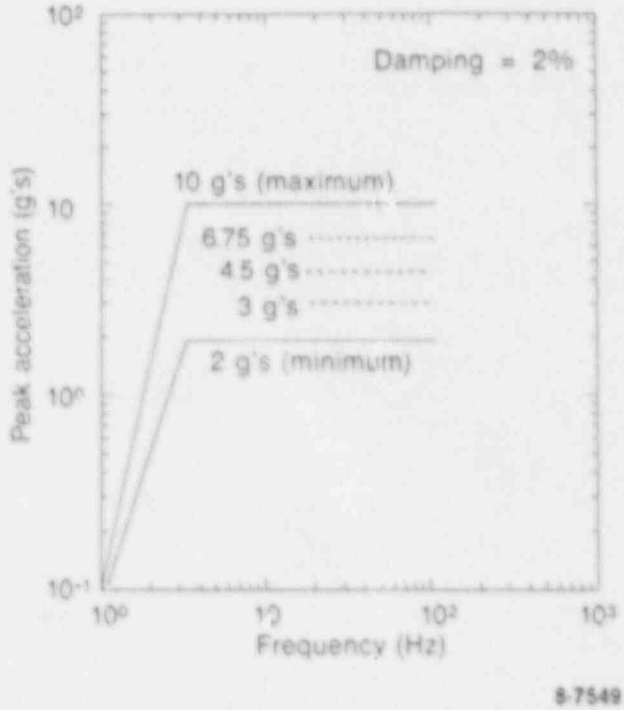

Figure 6. Composite frequency band RRS.

ZPA [illegible] maintained, as close as possible, in [illegible] range testing.

5.4.3 Single Axis Sine Sweep Excitation. The test specimens were simultaneously subjected to uniaxial sine sweep excitations in the horizontal (x) and vertical (y) directions indicated in Figure 1. The F-machine was used to sweep through the frequency range from 4 to 100 Hz (see Figures 7 and 8). Each test began with the specimen in the de-energized state and maintained in this state for the test duration. If a chatter event occurred during the test, the same test was repeated with the relay in the energized state. The sweep rate was approximately one octave per min. The acceleration level for each sweep was increased until component malfunction occurred. The acceleration and frequency of excitation at which specimen malfunction occurred during the sweep was recorded. Data from this set of tests were used to develop the chatter zone spectra discussed in Section 6.4.

5.4.4 High g-Level Sine Sweep Amplification Check. Initially, modal amplification of the F-machine table, fixture, or relays was not expected to affect the test results significantly since all modal frequencies seemed to be quite high. However, the chatter spectra developed from the swept sine tests pointed out a need for determining any modal response amplification of the fixture or relays in the 60 to 100 Hz frequency range. Therefore, high g-level swept sine tests were performed to quantify the modal response amplifications so that such amplifications could be considered in the chatter zone spectra. These tests are documented in Revision A of the test report.

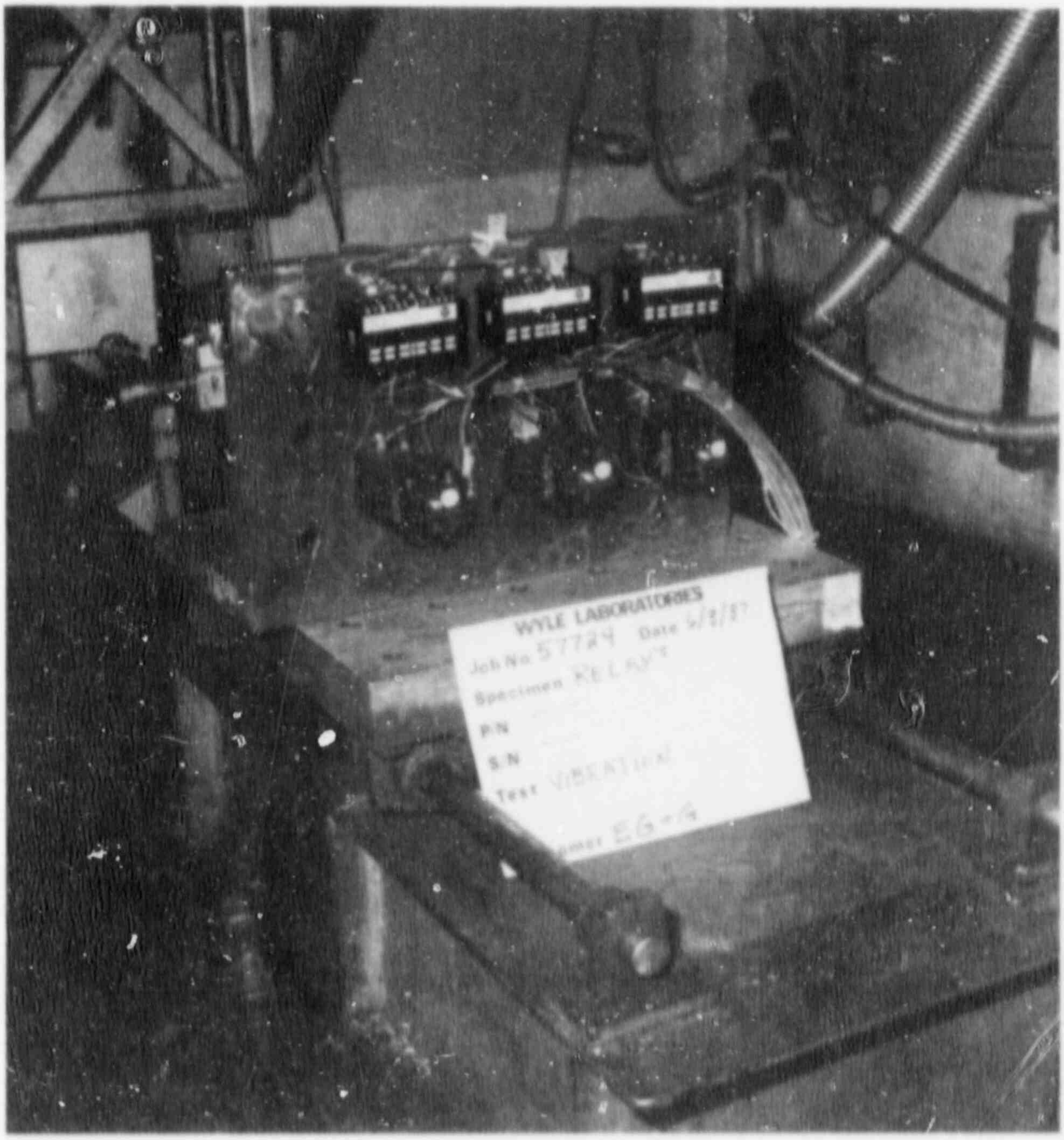

Figure 7. Horizontal sine sweep test setup on the F-machine.

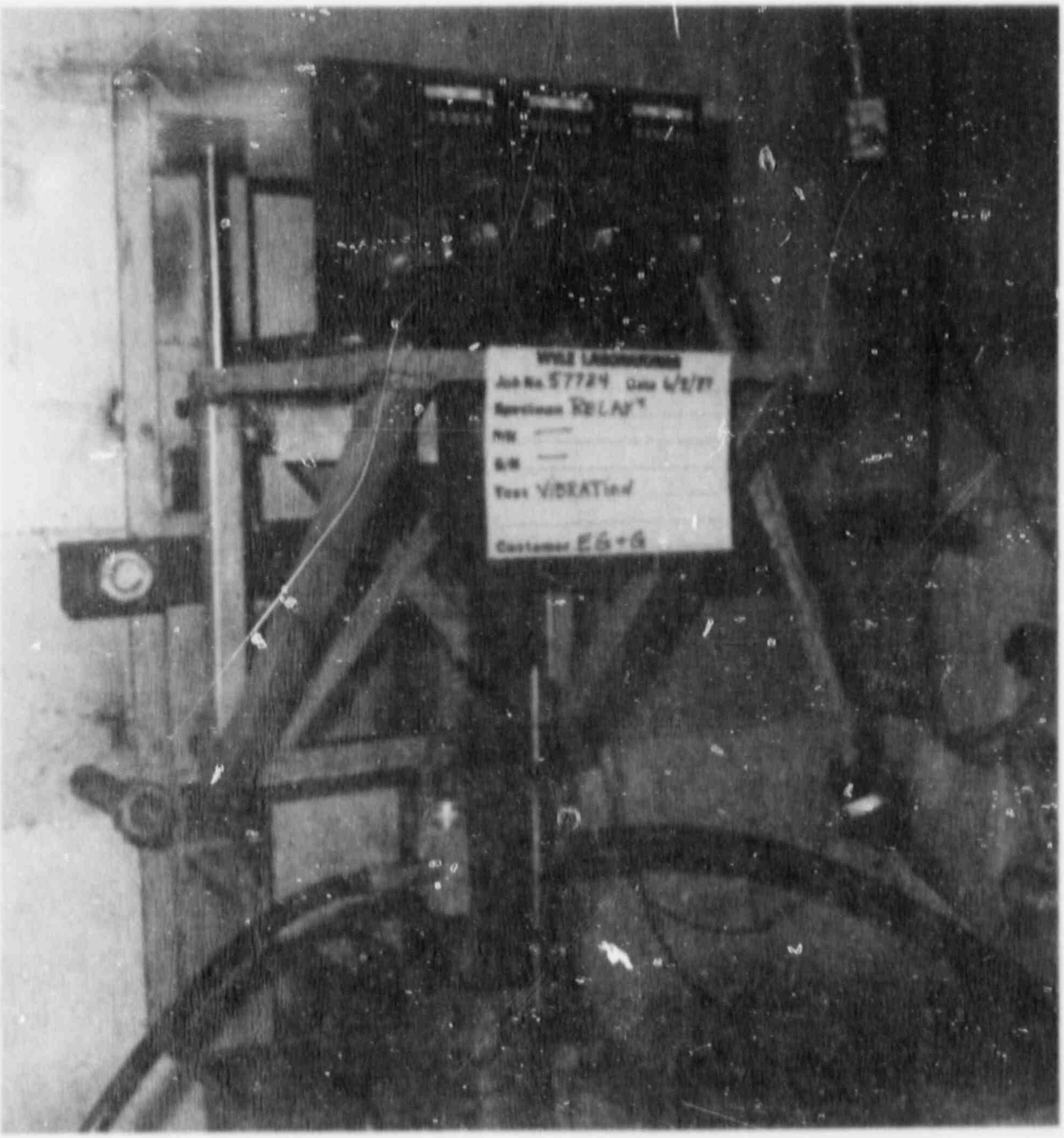

Figure 8. Vertical sine sweep test setup on the F-machine.

6. TEST RESULTS

The following sections describe the actual sequence of tests performed, discuss the results of each set of tests, and offer some observations on relay chatter characteristics encountered in the various tests.

6.1 Test Sequence

The test log and list of test and control equipment as well as detailed data sheets are presented in Appendix C of the test report. The test program was performed in the following sequence with the resulting data located in the indicated portions of the test report:

1. Calibration of the test table for low, high, and composite frequency band excitations in the horizontal directions
2. Resonance search on G-machine (App. D)
3. Random excitation in the low frequency range in the horizontal direction (Runs 1-6; App. E)
4. Random excitation in the high frequency range in the horizontal direction (Runs 7-11; App. E)
5. Composite frequency band random excitation in the horizontal direction. (Runs 12-17; App. E)
6. Random excitation in the low frequency range in the vertical direction (Runs 18 to 20; App. E)
7. Random excitation in the high frequency range in the vertical direction (Runs 21 to 33; App. E)
8. Composite frequency band random excitation in the vertical direction (Runs 24 to 28; App. E)
9. Detailed sine sweep testing in the horizontal (Runs. 29 to 36; App. G) and the vertical (Runs 37 to 41; App. G) directions in the frequency range 4 to 100 Hz
10. Repeat of step IX at higher g-levels (Runs 27 and 28; App. E)
11. High level sine sweep amplification check on the F-machine (Rev. A; App. H).

A summary of the simultaneous excitation of the GE and Westinghouse relays with random excitation (Runs 1 to 28) and swept sine (Runs 29 to 41) tests is shown in Table 4.

6.2 Resonance Search

The results of the resonance search on the G-machine are presented in Appendix D of the test report as transmissibility plots between response and control accelerometer readings. A uniaxial resonance search was performed in the horizontal, x-, and vertical, y-axes. The search consisted of a sine sweep from 1 to 100 Hz using a low excitation level of 0.2 g's at ~1/2 octave per min. During the resonance search, the relays were in the de-energized state. The results of the search indicate that the first resonance in the horizontal direction was 70 Hz (GE relay) and the first resonance in the vertical direction took place at 60 Hz. The vertical resonance source is somewhat unclear but response on the GE relay is the highest of all measurement points.

6.3 Uniaxial Random Test

As is indicated in Table 4 and discussed previously, the random tests were performed simultaneously on both relay types over various frequency ranges, uniaxially in one horizontal and the vertical direction, and at various excitation levels.

The test excitation levels were controlled by means of a response spectrum analyzer. Therefore, the g-levels shown in Table 4 for the random tests, indicate the levels in the amplified portion of the response spectrum for the control accelerometer record at the base of the test fixture. It must be noted that table response to the specified control levels is not easily maintained around natural frequencies encountered in the test. Thus, the peak g-levels indicated are approximations to the actual peak accelerations encountered on the relays themselves. Also, because of the nature of the random signal, peak-to-ZPA ratios as high as those indicated in Figure 4 could not be maintained even though a concerted effort was made to maintain as low a ZPA as possible and still maintain the requested peak g-levels on the response spectra. This method of excitation measurement was selected, however, because of its prevalence in seismic qualification and thus, its usability as a comparison parameter. Additionally, acceleration responses on the relay casing were recorded and analyzed.

The uniaxial random test data are included in Appendix E of the test report. As previously stated, the first phase of random excitation testing

Table 4. Test run summary

Test Description	Peak[a] Level (g's)	Relay[b] States	Horizontal Direction Excitation Frequency Range, Hz: 3 to 15	15 to 100	3 to 100	4 to 100	15 to 70	Vertical Direction Excitation Frequency Range, Hz: 3 to 15	15 to 100	3 to 100	4 to 100
Random	2.0	De-energized	1,1-1	7	12						
Random	3.0	De-energized	2	8	13						
Random	4.5	De-energized	3	9	14			18	21	24	
Random	6.75	De-energized	4	10	15			19	22	25	
Random	10.0	De-energized	5[c]	11,11-1,11-2	16[c]			20	23,23-1	26	
Random	12.0	De-energized		27							
Random	15.0	De-energized		28							
Random	10.0	Energized	6		17						
Swept sine	1.0	De-energized				33					
Swept sine	1.5	De-energized				32[c]					
Swept sine	2.0	De-energized				31[c]					40
Swept sine	2.5	De-energized				30[c]					39[c]
Swept sine	3.0	De-energized				29[c]					38[c]
Swept sine	3.5	De-energized				34[c]					37[c]
Swept sine	4.0	De-energized					35[c]				
Swept sine	3.5	Energized				36					41

a. Peak g definitions: Random - Amplified portion of the TRS from the control accelerometer.
Swept sine - Approximate peak table input motion.

b. Refers to both GE and W relays.

c. Chatter occurred on at least one on-table relay during this test.

consisted of uniaxial excitation in the horizontal direction, which was parallel to the relay contact line of action (the direction most likely to cause chatter), with peak acceleration in the low frequency range of 3 to 15 Hz. During this phase, relays were in the de-energized state and the maximum spectral acceleration level was gradually increased from 2 to 10 g's at 2% damping. The response spectral levels are also included in Appendix E of the test report for comparison purposes. No sign of chatter or other malfunction was noticed until spectral acceleration levels reached 10 g's in Run 5. The first chatter was detected on the normally-closed contacts of all relays. Subsequently, the on-table relays were energized and the 10 g-level random excitation test rerun and no chatter was detected.

Next, the random tests were repeated with de-energized relays and filtered input such that the amplified portion of the TRS ranged from 15 to 100 Hz. Excitation levels were incrementally raised until peak spectral accelerations of 15 g's were reached with no chatter detected. Then the test sequence was repeated with excitation having frequency content in the composite frequency range, 3 to 100 Hz. Again, chatter occurred only at the 10 g-level in Run 16. This excitation was repeated after energizing the on-table relays and, as was the case of the 3 to 15 Hz excitation, no chatter was detected.

Runs 18 through 26, summarized in Table 4, shows that a similar procedure was performed with excitations in the vertical direction of the shake table. This corresponds to exciting the relays in a direction orthogonal to the orientation of the contact action. No contact chatter was encountered during any of this series of random excitation tests which included peak g-levels to 10 g's.

While these tests did indicate the comparative influence of high and low frequency broadband excitation on relay chatter, the characterization of the chatter mechanism, in general, required a closer look at the waveforms causing chatter. With this in mind, the accelerometer records from the relay body responses during Runs 5 and 16 were evaluated closely in the time domain. Acceleration time histories were integrated to yield velocity and displacement histories in the time periods of the tests when chatter occurred in the relays. Comparison of these time history records with chatter event records proved quite interesting.

Figures 9 and 10 indicate a typical comparison of acceleration, velocity, and displacement response on the casing of one of the relays tested in relation to specific chatter event times of both the GE and Westinghouse relays. This particular record documents the response of one of the GE relays but the response of the Westinghouse relay was quite similar. In Figure 10 a chatter event initiated on the GE relay is indicated by a measured voltage pulse labeled *GE*, while a chatter event initiated on the Westinghouse relay is indicated by a voltage pulse labeled *W*. All of the chatter events during test runs 5 and 16 are summarized in Table 5, listing the chatter event time, identification of the chattering relay type and the acceleration, velocity, and displacement determined from the simultaneous measurement of both the GE and Westinghouse relay casing responses at the monitored time of chatter.

Examination of the acceleration, velocity, and displacement time histories in Figures 9 and 10 indicates that chatter is most closely correlated with a directional change in casing displacement after a sustained period of relatively constant acceleration (a period of relatively constant slope on the velocity curve as indicated by the boxed regions in Figure 10). As observed in Figure 9, peak accelerations are not as clearly correlated with chatter. In fact, a closer look at the relay casing response shows that the relay contact rebound causes a much higher acceleration response in the relay, but does not induce further chatter. While there are some exceptions to the rule, it appears that a strong correlation exists between chatter and a limiting average velocity change extended over a duration of 20 to 50 ms for these specific relays. In other words, a minimum sustained acceleration extended over a long enough duration, coinciding with a change in casing response direction seems to cause the chatter. Examination of Table 5 shows that chatter of a given relay design is also dependent upon the direction of acceleration. The GE relay here typically chatters with a positive average acceleration while the Westinghouse relay chatters with a negative average acceleration applied. This is due to the particular arrangement of the moving and stationary contacts within each relay, giving further evidence that contact inertia plays an important part in relay chatter.

A close look at Tables 4 and 5 points out that conclusions concerning the effects of high frequency content on relay chatter may be different depending upon the parameter on which the conclusion is based. Comparison of the chatter levels of Runs 5, 11, and 16 in Table 4 seems to indicate that, when the peak g-levels of the response spectra are compared, frequency content >15 Hz does not

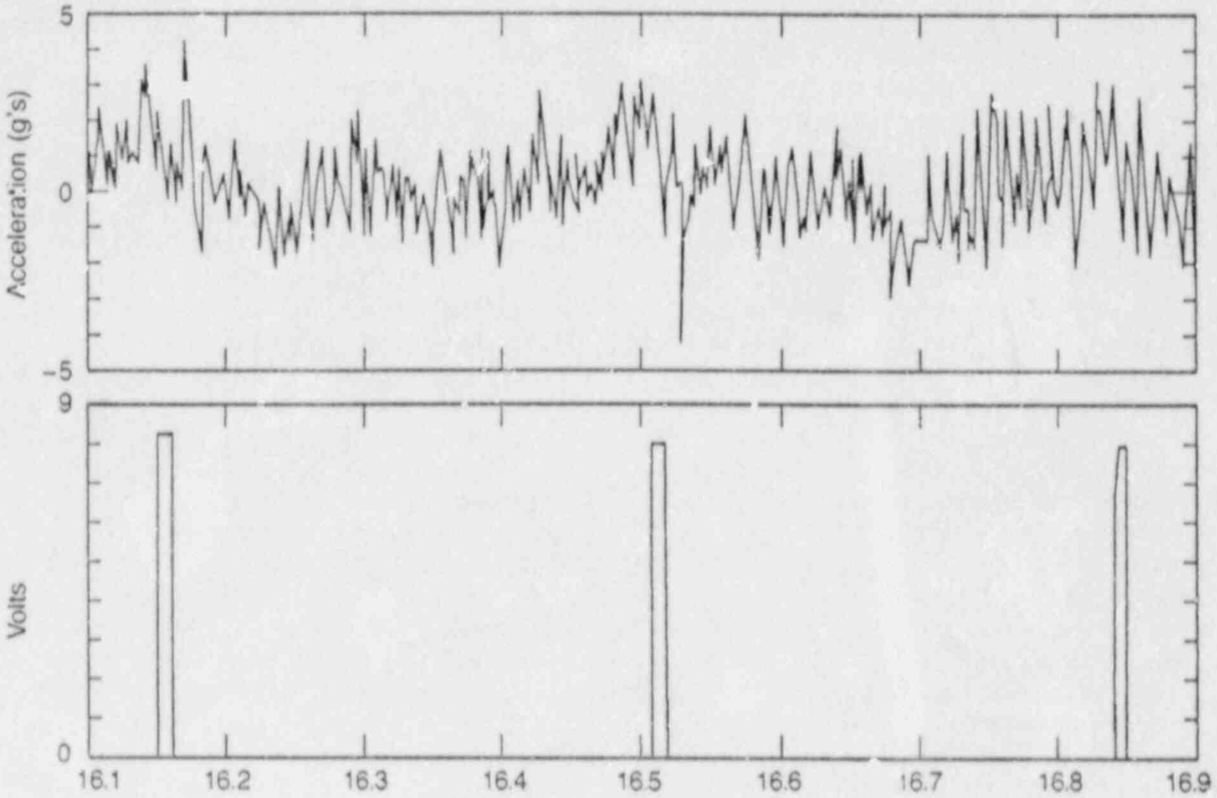

Figure 9. Acceleration response on GE relay during recorded chatter events.

induce chatter nor does it reduce the chatter acceleration limit when added to the low frequency excitation. *Examination of Table 5 shows, however, that when the sustained accelerations at inception of chatter are compared in Runs 5 (low frequency) and 16 (composite frequency range), a notable decrease in the chatter causing acceleration level occurs, when higher frequency content is added to the low frequency excitation.* In this particular case the reduction factor is ~50% and affects both relay types.

6.4 Swept Sine Test

In an effort to more clearly characterize the frequency dependence of the relay chatter, uniaxial swept sine tests in the 4 to 100 Hz range were performed on the relays as summarized in Table 4 and detailed in Appendix G of the test report. The peak g-levels indicated are the control limits which were supplied to the shake table controller and intended to be maintained throughout each sweep. The sweep function used in each of the tests was plotted against time to determine the excitation frequency at the recorded time of chatter on the relays. As indicated in the table, chatter occurred when the de-energized relays were excited in the horizontal direction at g-levels of 1.5 g's or greater. This echoes Figure 9, results of the random tests indicating that relays are less susceptible to chatter when excited in a direction orthogonal to the relay's contact line of action. As with the random tests, when the relays were energized no chatter occurred.

Figures 11 and 12 plot the results of the horizontal swept sine tests by indicating the g-levels versus frequency at which chatter occurred during the tests for the instrumented GE and Westinghouse relays. These data were compiled by correlating the chatter records of all six on-table relays with the table response acceleration recorded. Note that the chatter spectrum for each manufacturer's relay consists of a lower bound envelope of data taken from the three on-table relays of the same manufacturer.

The chatter spectra indicatd two areas of frequency sensitivity. The Westinghouse relays showed sensitivity at <15 Hz and in the 45 to 85 Hz range. The GE relays also chattered in the zone <15 Hz and then had an upper frequency sensitivity range of 60 to 85 Hz. For the sine sweep tests, accelerometers were

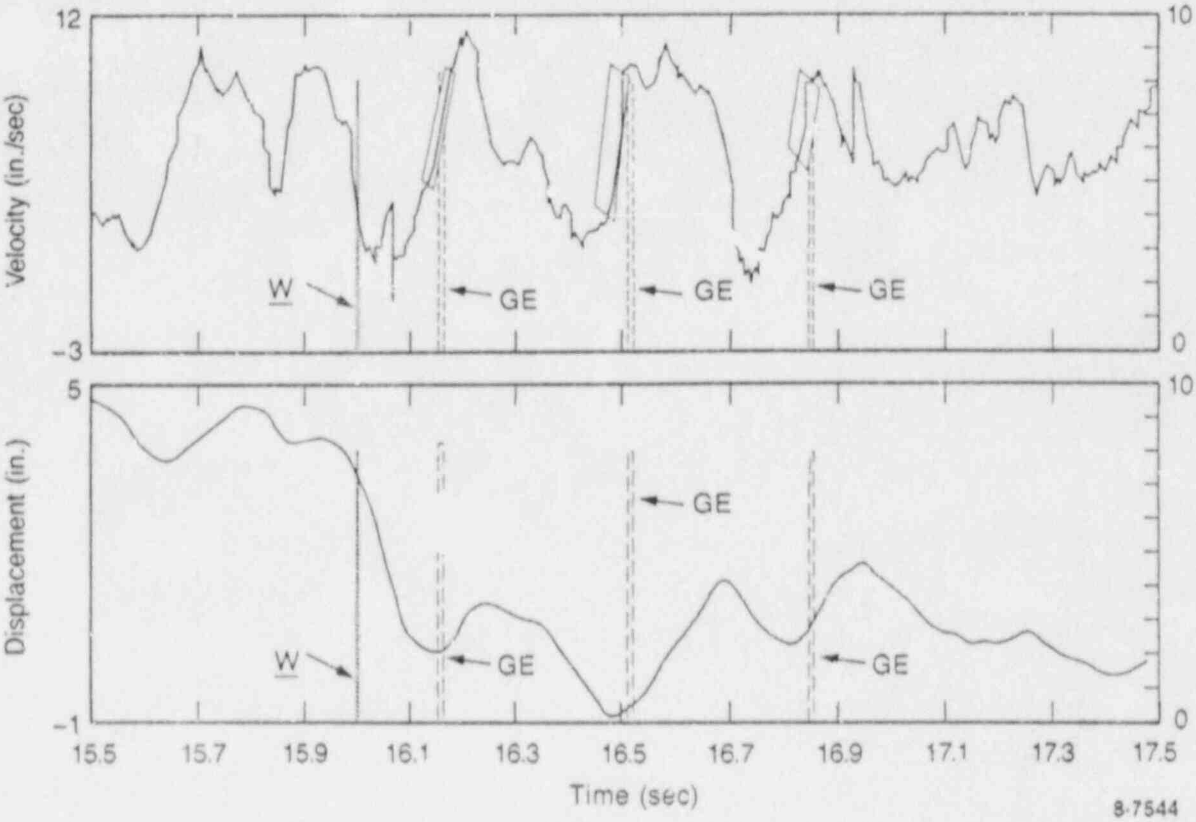

Figure 10. Velocity and displacement of the GE relay during recorded chatter events.

only mounted on the table. Amplification compensation was subsequently made by determining transmissibility functions (peak response to peak input acceleration ratios versus frequency) from additional high g-level swept sine tests documented in Revision A of the test report in which accelerometers were mounted as illustrated in Figure 1. The transmissibility information was applied to the peak table acceleration data within the lower bound chatter envelopes in Figures 11 and 12. This produced the cross-hatch shaded regions enveloping the average peak relay casing accelerations when chatter occurred at the indicated excitation frequencies. The acceleration level at the top of the fixture is also plotted in the upper frequency ranges to give a comparison of relative amplification of the fixture and relays. Both relays exhibit some resonance amplification in the upper frequency range. The sensitivities below 15 Hz, however, reflect those mechanisms within the relays themselves. Note that the minimum chatter levels of the Westinghouse relays are ~50% higher than those of the GE relays in the low frequency range but lower in the high frequency range.

Comparison of the swept sine and random test results shows lower sensitivity of the relays during the swept sine tests. The reason for this difference seems clear when the mechanism causing chatter, discussed in the previous section, is considered. It is expected that the swept sine test could more easily achieve the minimum sustained acceleration over the required duration to induce chatter than the rather broad-banded signal employed in the random tests.

6.5 Chatter Characterization

The functionality of a relay is not only based upon the susceptibility of that relay to chatter but also upon the relay's response effects upon connecting electrical equipment. An effort was made in these tests to provide some insight into the relays' characteristic responses and their effects on other equipment. Since the on-table relays were wired to off-table relays of three different coil sizes, some

Table 5. Waveform characterization at time of chatter

Test Run Number	Chattering Relay Type	Test Time at Chatter (sec)	Relay Instantaneous Dynamic Response at Chatter Time: General Electric Relay			Westinghouse			Chattering Relay Sustainted Ave. Acceleration (g's)
			Acceleration (g's)	Velocity (in/sec)	Displacement (in.)	Acceleration (g's)	Velocity (in/sec)	Displacement (in.)	
5	GE	8.232	4.2	20	.4	5.9	23	.4	2.7
5	W	10.068	-5	-30	4.6	-6	-25	5.1	-2.9
5	W	14.919	-6.8	-22	5.2	-8.2	-20	5.2	-3.6
5	W	17.065	-5.5	-18	3.8	-6.0	-18	3.6	-3.3
16	GE	13.483	1.6	11	-.6	2.1	-9	-1.4	1.4
16	GE	16.151	2.0	8	.4	2.5	8	1	1.5
16	GE	16.508	3.0	10	-.6	3.6	15	.6	1.6
16	GE	16.842	3.2	9	.7	3.5	8	1.4	1.7
16	W	11.152	-1.1	-22	-1	-2	-22	-1	-1.2
16	W	15.996	-0.8	3	3.4	-1	0	3.0	-2.1

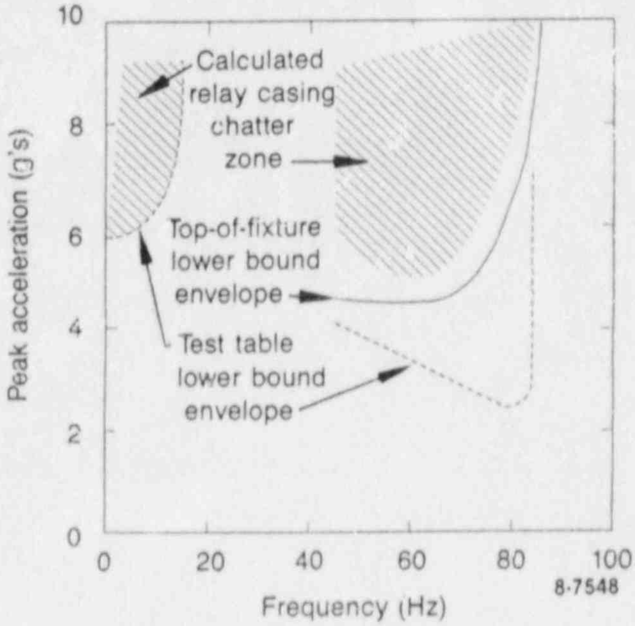

Figure 11. Contact chatter zone from excitation in the horizontal direction for Westinghouse relay.

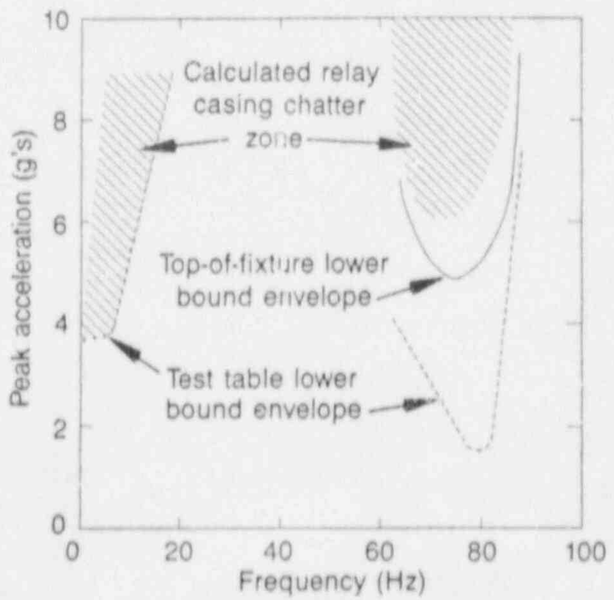

Figure 12. Contact chatter zone from excitation in the horizontal direction for GE relay.

evaluation could be made concerning interaction functionality.

Table 6 summarizes this evaluation by presenting a distribution of chatter durations for both on- and off-table relays for different types of excitation. The total number of chatter events in a given duration, for a given excitation (swept sine horizontal, swept sine vertical, and random horizontal), and a given relay type have been tabulated in this table. Note that the off-table relays connected to on-table relays 1 through 3 correspond to ever increasing relay coil sizes. The swept sine tests are considerably longer in duration than the random tests and thus produce many more chatter events. To normalize this disparity, the total number of events are divided by the total duration of tests considered (Table 6). The normalized number (events/s) in the parentheses is obtained for the on-table relays.

On-table relay chatter event durations ranged from 2 to 20 ms with 30 to 50% of the events having a duration of 5 to 10 ms. When excited in the direction orthogonal to the contact action (vertical direction), random excitation of equivalent levels to those applied parallel to contact action (horizontal) did not cause chatter. Swept sine tests in this direction, however, did cause chatter with event durations ranging from 2 to 10 ms with 30% of the events occurring in the 2 to 5 ms duration range.

Almost all off-table relays exhibited some chatter at some time during the tests in response to the chatter of the corresponding on-table relay. The preponderance of the off-table chatter occurred in the relays having the lightest coil while the second highest number of occurrences were exhibited in relays having the strongest coil.

From these data, the causality between on-table chatter duration and off-table duration is not precisely defined but it can easily be seen that off-table relays are exhibiting *longer* chatter durations than the corresponding on-table relays. One explanation might be that this result is caused by the occurrence of multiple short duration electrical pulses being emitted from the on-table relays in close enough succession to appear as a much longer pulse to the off-table relay, in comparison to its characteristic response time. A second possibility might be that the pulsing emulates an alternating current to the off-table coil which induces a longer chatter duration in that relay. If this is indeed the case, the equipment qualification of relays should include measurement of the time interlude between line pulses to the relays or other such sensitive devices to which it is intended to interface.

Table 6. Distribution of relay chatter events

Chatter Duration (ms)		2 to 5	5 to 10	10 to 20	20 to 40	40 to 80	>80
On-table							
S.S.[b] Horizontal	W	1015 (0.7)[a]	1502 (1.0)	683 (0.5)			
	GE	853 (0.6)	1876 (1.3)	1114 (0.8)			
S.S. Vertical	W	162 (1.5)	20 (0.2)				
	GE	101 (0.09)	48 (0.04)				
Random Horizontal	W	3 (0.15)	5 (0.25)	7 (0.35)			
	GE	2 (0.10)	4 (0.20)	2 (0.10)			
Off-table							
S.S. Horizontal	W1 & G1	189	113	397	203	63	31
	W2 & G2	8					
	W3 & G3	120	114	162	499	96	65
S.S. Vertical	W1 & G1	41	14	27	22	2	
	W2 & G2						
	W3 & G3						
Random Horizontal	W1 & G1	1			1		
	W2 & G2						
	W3 & G3	2			3		

a. Numbers in parenthesis indicate number of chatter events/s averaged over all tests applicable to each category.

b. S.S. - Swept sine tests.

7. DISCUSSION OF RESULTS AND CONCLUSIONS

The results of this research effort have not only provided information addressing the effects of in-structure generated motion in electrical cabinets, but have also provided insight into the fragility levels of relays and their effects on other equipment. The prime concern here, however, is the evaluation of the effects of rattling.

At the start of this research study, it was thought that the determination of whether rattling was a problem requiring special attention could be addressed by: (a) determining if significant rattling effects in cabinets really existed and (b) whether their presence offered detrimental effects upon the functionality of safety related electrical devices in those cabinets.

Analysis of the Wyle Laboratories equipment seismic qualification records pointed out that high frequency response spectral acceleration at device locations did occur and that some functional anomalies did occur during testing. Detailed frequency domain evaluation of six selections of the one hundred qualification records that included power spectral density calculations of cabinet input and response confirmed that significant high frequency response was present. Also, coherence functions of the input and response of certain cabinets indicated that, while some frequency ranges were quite coherent (i.e. the response was caused by the presumed input) other frequency ranges indicated a considerable amount of noise which could be attributed to rattling. Causality between anomalies and rattling could not be well established, because even though most of the qualification records which were studied in detail involved a rattling environment, anomalies only occurred during some of the tests. Thus, while the rattling environment may be there, the effect on functionality most likely depends on the dynamic characteristics of the specific devices involved.

As stated previously, the most prevalent anomaly found in the qualification tests was relay chatter. It has also been widely believed that relay functionality offers typically low seismic capacity. Therefore, relays were good electrical devices for evaluation of functionality in a rattling environment. Dynamic characteristics of the excitation could be controlled and the response closely monitored for cause-and-effect.

Observation of relay response to this series of tests indicated several characteristics which affirm results of testing done by others and new facets of the response mechanisms not documented previously. Relays with normally closed contacts tended to be more susceptible to chatter than relays with normally open contacts. Energized relays indicated no chattering at relatively high test g-levels. Excitation of the relays in directions orthogonal to the contact line-of-action required higher excitation g-levels to induce chatter than excitations parallel to the contact orientation.

Testing of these relays under random excitation also produced some results which have not been previously reported. Since the primary measure of seismic qualification of equipment in the past has been the comparison of the TRS and the RRS, response spectral acceleration was initially used in this study as the measure of relay excitation level. In the comparison of chatter response with this measure using low, high, and the combination of low and high frequency excitations, levels of response spectral acceleration at which relay chatter occurred were not degraded by the additional presence of high frequency excitation. However, the characterization of the mechanism causing relay chatter pointed out a critical difference in these results which may have considerable bearing upon whether rattling should be seriously considered in qualification testing.

The detailed evaluation of relay casing response indicated that relay chatter was most closely correlated to sustained acceleration for a certain duration rather than peak acceleration. The relays seemed to be able to withstand much higher acceleration peaks without chattering. Contact rebound accelerations were a good example of this. No chatter was reinitiated when contact rebound induced high acceleration peaks in the casing response. However, when sustained accelerations beyond a limiting value occurred over a long enough duration corresponding with a directional change in displacement, chatter typically began.

Thus, a critical difference in results is apparent, depending upon whether response spectra or sustained acceleration criteria is used to measure the level of input excitation to these relays. In considering acceleration response spectra, which is a measure of peak accelerations in a component's response, there appears to be no reduction in seismic response levels causing chatter in relays when significant high frequency content (such as from rattling) is added to existing low frequency (less than 15 Hz) seismic excitation. However, sustained accelerations reduced acceleration values to chatter by approximately 50% in tests on these particular relays (see Table 5). Obviously, there is a correlation between peak acceleration levels applied to the relay and incidences of chatter because the sustained acceleration level, which appears to be the most causal parameter, has a correlation with peak accelerations. However, the degree of correlation between peak acceleration and chatter is unknown and, due to the limited scope of testing here, not reliably defined.

The swept sine tests indicate that the sensitivity of relays to chatter in the low frequency range (<15 Hz), which was demonstrated by Holman, et al,[5] also occurs in the high frequency ranges. While it appears that broad-banded excitation in these higher frequency ranges does not readily induce chatter, more narrow-banded waveforms (such as swept sine) in these frequency ranges do. This phenomenon is consistent with the dynamic characterization of the chatter mechanism discussed previously.

Relay chatter and its subsequent effects on interfacing electrical equipment is a failure mode which requires some consideration beyond the recommended present qualification test procedures and which broadly affects important assumptions in commercial plant seismic probabilistic risk assessments (PRA's). Bley et al.,[6] in their recent paper on the impact of relay chatter on nuclear plant risk, have stated that: "Although most PRAs have assumed that equipment malfunction due to relay chatter will be fully recovered, Lambert[7] and others have expressed concern that recovery of some circuits may require difficult diagnosis and that operator performance may be severely degraded by high [emotional] stress levels following the earthquake." This statement is in reference to the typical seismic PRA procedure in the past of essentially neglecting the effects of relay chatter in the calculation of safety system reliability since chatter was not considered to adversely affect the relay, and no adverse effects on components in the chattering relay's circuits were known at the time. This test data indicates that there *can* be adverse effects to a chattering relay's circuit and that this PRA procedure should be reconsidered.

Test results here indicate that secondary relays controlled by chattering relays are induced to chatter and for longer durations than the controlling relays. Possible causes for this increase in duration could be that pulse sequences in close enough succession would appear as a single, long-duration pulse to subsequent relays or that alternating current could affect the relay coil. This increased chattering duration in secondary relays could cause relay contact state changes long enough to fail some safety systems.

Presently, equipment seismic qualification criteria require registering chatter durations only in excess of 2 ms. In light of these test results, some consideration should also be given in seismic qualification to the relationship between interfacing system response time, the occurrence of critical length chatter durations, and the time interval between those chatter incidents.

Seismic PRAs of commercial nuclear plants have, to date, typically neglected chatter in relays as a failure event in their safety systems. This test data, though limited in scope question this assumption because increased contact duration in secondary relays could cause safety system failure. This, coupled with the fact that some safety related circuits with auxiliary relays are not easily reset when chatter occurs, highlights the need for more research in this area of concern.

A summary of these test results provides the following insight to qualification testing in the seismic-induced rattling environment:

1. The rattling environment is indeed real in some equipment qualification tests of cabinets.
2. There are analytical tools available which can offer some qualitative measure of the existence of cabinet in-structure generated motion outside the normal seismic range of interest. Comparisons of table input and device location output response spectra is one such set of tools. Comparisons of the transfer function between the two locations and its corresponding coherence function can offer some additional insight into the phenomenon.
3. The existence of rattling does not necessarily mean that a cabinet supported device is going to malfunction during seismic excitation. Dynamic characteristics of the device of concern must be considered as well as the possibility of any narrow-banded frequency characteristics in the rattling environment.
4. Depending upon the device functional mechanisms, there may be dynamic characteristics, which better reflect functional operability than the commonly used peak acceleration parameter, inferred from the comparison of test response spectra to

required response spectra. In this limited testing, levels of sustained acceleration seemed more critical than peak acceleration response.

5. Instances of relay interaction infer that seismic qualification testing should base its chatter measurement requirements on the joint considerations of relay chatter duration, time intervals between chatter incidents, and response characteristics of interfacing equipment.

Items 4 and 5 above are preliminary in nature because of the limited set of electrical devices tested here. The significant implication is that response spectra, which is presently used as a measure of excitation level for devices in seismic qualification by IEEE 344, may not be the proper measurement. Relay interaction is also a significant finding affecting not only equipment qualification methods but also assumptions used in the seismic PRAs. Consideration of these findings should be factored into future research testing in order to address these issues from a much broader scope of testing and uncover new areas where research should be performed.

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13. ABSTRACT (200 words or less)

The Idaho National Engineering Laboratory (INEL) has been conducting a research study to assist the United States Nuclear Regulatory Commission (USNRC) in determining susceptibility of electrical devices to in-structure generated motion sometimes present in electrical cabinets. In Phase I of this study, a survey of past seismic qualification tests conducted at Wyle Laboratories on various electrical and control equipment housed in nuclear grade cabinets was taken to identify components which experienced a rattling environment. The INEL has used several different methods to reduce that data and has determined the existence of a number of device anomalies in the presence of high frequency cabinet response to earthquake-type excitation motion. However, causality between the high frequency content and the malfunctions could not be conclusively confirmed. Phase II of the study consisted of shake table testing for the most prevalent malfunction discovered in the survey, relay chatter, with excitation frequency content in the seismic range and higher. This report will document the results of Phase I and II of the study. Insight into the susceptibility of electrical devices to rattling and characterization of relay chatter mechanisms offers guidance in addressing rattling effects during qualification.

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IN-STRUCTURE GENERATED MOTION DATA EVALUATION AND TESTING FOR EG&G IDAHO

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ABSTRACT

The report presents a study performed by Wyle Laboratories for EG&G Idaho, Inc. to determine susceptibility of electrical devices to the high-frequency in-structure generated motion.

The study was conducted in two main phases:

1. Evaluation of existing test data related to seismic qualification of various electrical and control equipment used in Nuclear Power Plants.

2. Limited testing of selected typical electrical equipment (relays) to demonstrate its susceptibility to low and high frequency excitation.

Review and analysis of 100 selected qualification test reports demonstrated that contact chatter is one of the most common device anomalies. These anomalies are clearly related with excitation levels, but the reports give no conclusive evidence to correlate contact chatters with the frequency contents of the equipment response.

An analysis of six selected sets of acceleration time histories demonstrated substantial motion and energy of response acceleration in the high frequency range, while input motion generally showed a downward trend at the high frequency range.

Uniaxial random and sine sweep testing of two types of relays, Westinghouse AR6A and General Electric CR120B, were performed at various excitation levels and frequency ranges, and in different directions of excitation. Good repeatability of the test results were achieved in spite of the limited number of test specimen. The results of the test clearly demonstrate sensitivity of the contact chatter to the frequency contents of excitation (see, for example, Figures 6-1 and 6-2). All test specimens exhibited contact chatter not only in a traditional low frequency, seismic range, but in a high frequency range 50 to 80 Hz.

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1.0 INTRODUCTION

1.1 Purpose

The seismic qualification testing of safety class equipment typically assumes that the equipment primarily responds in a linear fashion. Theoretically this implies that for an input excitation over a specified frequency band, the excited component will only contain frequency response in that band. Seismic floor spectra typically have dynamic amplification in the frequency range of 3 - 15 Hz. Therefore, a linear structure thus excited would not be expected to respond dynamically above that frequency range. However, a nonlinear structure could induce additional frequency response, both within the range of frequency content of the input as well as outside of that frequency range. Rattling of the structure is a good example of this nonlinearity.

This effectively presents a problem only for particular testing scenarios, albeit, a common one. Often times, testing of a support cabinet, and the devices which might be used in it are tested in separate qualification tests. This is typically due to retrofitting different devices into the cabinet from those used in the original qualification test. While the effect of rattling on the cabinet itself is addressed in the original qualification test, the Required Response Spectrum (RRS) for the retrofitted device may not necessarily consider amplified frequency content above 33 Hz. This may be due to the RRS for the device being derived by analysis using table motion and a linear model for the cabinet or it may be due to testing the retrofitted device only in the frequency range below 33 Hz. Depending upon the device's characteristics and functionality requirements, neglecting excitation frequencies above 33 Hz raises the question of whether the component is qualified seismically, since rattling can introduce frequencies in the cabinet at frequencies higher than 33 Hz.

The present study has focused upon determining if the problem exists in electrical cabinets, if there are electrical devices which are susceptible to such rattling, and to provide some guidance for qualification testing which would adequately and feasibly address this concern.

The main objective of the program was to detect frequency and mechanisms associated with the contact chatter and other functional anomalies in a variety of electrical control devices.

The program was divided into two main tasks:

1. Evaluation of existing test data related to seismic qualification of various electrical and control equipment used in Nuclear Power Plants.

2. Limited testing of selected typical electrical equipment (relays) to demonstrate its susceptibility to low and high frequency excitation.

1.2 Summary

Review and analysis of 100 selected qualification test reports demonstrated that contact chatter is one of the most common device anomalies. These anomalies are clearly related with excitation levels, but the reports give no conclusive evidence to correlate contact chatters with the frequency contents of the equipment response.

An analysis of six selected sets of acceleration time histories demonstrated substantial motion and energy of response acceleration in the high frequency range, while input motion generally showed a downward trend at the high frequency range.

Uniaxial random and sine sweep testing of two types of relays, Westinghouse AR6A and General Electric CR120B, were performed at various excitation levels and frequency ranges, and in different directions of excitation. Good repeatability of the the test results were achieved in spite of the limited number of test specimen. The results of the test clearly demonstrate sensitivity of the contact chatter to the frequency contents of excitation (see, for example, Figures 6-1 and 6-2). All test specimens exhibited contact chatter not only in a traditional low frequency, seismic range, but in a high frequency range around 80 Hz.

2.0 REVIEW AND ANALYSIS OF EXISTING TEST QUALIFICATION PROGRAM

2.1 Approach

One hundred test reports were selected from the seismic qualification programs conducted at both the Norco and Huntsville facilities of Wyle Laboratories in the last few years. These reports addressed the seismic qualification of typical electrical equipment used in Nuclear Power Plants. The reports were reviewed and their data evaluated in order to establish general behavior of the control equipment under typical seismic excitation.

A format was developed for summarizing the pertinent seismic qualification test data. This form contains the description of equipment, anomalies, tests performed and equipment response amplification at frequencies higher than 33 Hz.

Appendix A contains a typical summary form used to collect the data and the table that summarizes the pertinent data.

A brief physical description of the cabinet tested is listed in the column marked "structure" while electrical devices of interest in the cabinet during the test are described under the "component" column. Tests performed on the structure and maximum zero period acceleration (ZPA) g levels are subsequently listed. Next a description of any anomalies which occurred during the test is given. An indicator of frequency response of the cabinet above 33 Hz was measured as a percent increase in amplitude above the amplitude at 33 Hz.

2.2 Findings

The summary indicated that a wide range of cabinet size and functionality had been tested. Correspondingly, a wide range of electrical devices were supported in the cabinets. Input ZPA g levels ranged from 0.1 to 25 g's. Cabinet response of elevated device locations showed amplification above the 33 Hz frequency amplitude in about 85% of the cabinets tested in the survey. Amplification increased up to 2300% for frequencies above 33 Hz.

Supported devices exhibiting anomalous behavior included: a meter, relays, switches, circuit breakers, starter, a circuit card, a pressure switch, and an indicating light. Relays, switches, and circuit breakers made up the majority of the devices where anomalous behavior occurred. The anomalous behavior included: contact chatter, breaker trip, output change (on the circuit card), short circuit on the indicator light, erroneous readings of the meter, spurious signals, and contact bouncing. Contact chatter was typically monitored and recorded for durations of 2 msec and greater. Sources of the rattling determined in this survey were loose cabinet doors and loose device-mounting connectors.

This review showed equipment response amplification at frequencies higher than 33 Hz and demonstrated that electromechanical devices are more sensitive to seismic motion than components without moving parts. Thirty of the hundred reports reviewed detected anomalies, and twenty-nine of them were related to device operability. Twenty-five of the anomalies were contact chatter, change of state, or bouncing.

Notably, most of the qualification programs reviewed were conducted with random multifrequency motion and designed to demonstrate that the specimen meets its acceptance criteria. The instrumentation monitored the occurrence of the device anomaly during the test but did not record the time at which the anomaly occurred or the corresponding component response frequency. Furthermore, most of the evaluated reports traditionally addressed equipment performance at "seismic frequency range" or below 33 Hz. Therefore, the recorded data at frequencies above 33 Hz are far from perfect being influenced by test equipment and control system noise. In some cases, the filtering of so-called high frequency noise camouflaged the real high frequency components of the equipment response.

The review gives possible identification, but does not give conclusive proof of causal effect between rattling and anomalies.

3.0 ANALYSIS OF SELECTED TIME HISTORIES

3.1 Approach

Six records of input/response time histories were selected from a pool of available time histories for detailed computerized analysis. The selection was based on the character of time histories, comparison between input and output motions, and performance of tested equipment, especially in the high frequency range. Location of response accelerometers and availability of data tapes with non-filtered time histories were also taken into consideration.

Table 3-1 presents six selected records from the identified reports. Each record consists of input acceleration time history from control accelerometer located at the test table close to the support of the test specimen (Accelerometer No. 1) and response acceleration time history from selected location. Location of the response (and corresponding accelerometer number) was selected based on performance of the tested equipment. Only one run from each report in the study was selected for detailed evaluation; the run number is also presented in Table 3-1.

Each record set consists of shake table input spectra (based on control accelerometer reading) and the cabinet response spectra at specified location (based on corresponding response accelerometer reading). Thirty-second input and response acceleration time histories are also presented in each record, as well as time histories for only five-second duration to show more details of the time histories. All the above information was gathered from selected test reports. Based on this information, new quantities were derived using VAMP software on the in-house computer PDP-11. First of all, each thirty-second time histories were divided into six five-second time histories and an average time history was created. Then the FFT analysis of input and response acceleration was performed and PSD of the input and response acceleration were calculated. Finally, coherence, transmissibility and transfer function between input, X, and response, Y, acceleration were calculated as follows:

Coherence is the amplitude of the cross-power spectrum squared divided by the product of the two autospectra ($|XY^*|^2/|X|^2|Y|^2$).

Transmissibility is the spectrum of a response divided by the spectrum of the input (Y/X).

Transfer function was calculated by dividing the cross-power spectrum of the response and the input by the autospectrum of the input ($|XY|/|XX^*|$).

In these definitions autospectrum means a spectrum multiplied by its conjugate (XX^*), while conjugate of a spectrum (X^*) is a spectrum with the signs of the imaginary parts reversed.

Table 3-1

Time History Records Description

Record No.	Report No. (See App. A)	Accelerometer No. Input	Response	Run No.
1	NOR01	1	7	11
2	NOR07	1	5	12
3	NOR08	1	7	6
4	NOR15	1	15	44
5	NOR37	1	21	15
6	NOR47	1	3	16

No "filtering" or "smoothing" was used. The initial data and results of calculation of a total of 13 plots are presented graphically in Appendix B in the following order:

1. Shake table input spectra and the cabinet response spectra. (2 plots)

2. Thirty second input and response time histories. (2 plots)

3. Input and response time histories for five second duration to present more details of the time histories. (2 plots)

4. FFT analysis of input and response accelerations. (2 plots)

5. PSD of input and response accelerations. (2 plots)

6. Coherence between input and response acceleration. (1 plot)

7. Transmissibility between input and response acceleration. (1 plot)

8. Transfer function between input and response acceleration. (1 plot)

3.2 Findings

Comparisons of response spectra and time histories show that amplification of acceleration at elevated device locations reached significantly higher levels at the upper frequencies when compared to input acceleration levels at the test table. FFT and PSD serve to characterize the only input and response motion as a function of frequency. Obviously, due to motion amplification in tested equipment, the acceleration amplitude and PSD for response motion is higher than those for input motion. But the more important fact is that both acceleration and PSD for the response motion indicate substantial motion and energy in the higher frequency range, while input motion generally shows a downward trend at frequencies above 15 Hz.

Coherence, transmissibililty and transfer function between input motion and response at elevated device locations are characterized by how much of a given response is due to an input motion and how much of it is generated by some other source, such as rattling. Selected records exhibit coherence values close to unity at most frequency regions.

4.0 TEST SPECIMEN

4.1 Basis for Selection

The electrical device selection for this program was based on the following:

1) One hundred nuclear power plant electrical equipment seismic qualification test reports were reviewed to identify electrical devices that are most susceptible to seismic events.

2) The test data for susceptible devices was evaluated to identify devices that were more sensitive to the frequency of input motion.

3) The devices selected were representative of devices commonly used in nuclear power plants.

4) Two models of the devices were selected for testing per EG&G request. Three devices of each model were subjected to this test program.

4.2 Specimen Description

Table 4-1 lists the electrical devices which were tested in this program.

Table 4-1

Test Specimen Description

Device Description	Mfgr.	Model No.	Coil Voltage	No. Poles	Dimension	Weight
Relay	GE	CR120B	230 VAC	6	4.5"x2.38"x35"	1.5 lb
Relay	Westinghouse	AR6A	120 VAC	6	6"x4.09"x3.875"	2.3 lbs

5.0 TEST PROCEDURE

5.1 Mounting

The test specimen were mounted on a rigid fixture as shown in Figure 5-1. The mounting screws were No. 10 for Westinghouse and No. 8 for GE relays. The mounting screws were tightened so that the relays were held firmly on the fixture. The fixture was fabricated from one-inch thick plates and welded to the test table during the test.

The tests were performed on Wyle Laboratories' biaxial seismic test "G-machine" and single axis vibration "F-machine". The seismic "G-machine" table is 100 inches square and is capable of 12-inches double amplitude displacement horizontally and 9-inches double amplitude displacement vertically. The seismic machine has a load rating in excess of 10,000 lbs. The vibration "F-machine" has a load capacity of 200 lbs at 5 g's and double amplitude displacement up to 4 feet.

5.2 Electrical Monitoring

Electrical monitoring was designed to obtain data on a) occurrence of contact chatter or change of state, b) chatter duration and number of chatters during each test, c) level and frequency at which chatter occurred and d) the effects of contact chatter on other devices connected to it.

Relays were selected as the devices connected to contact of the specimens. The relays used in the program were grouped into "on-table" and "off-table" in order to distinguish between the specimen and the test set up components. On-table relays referred to the specimens. Off-table relays were part of the test set up. Off-table relays were selected to represent typical relays used in nuclear power plants. Table 5-1 lists each off-table relay and the on-table relay to which it is connected to.

Each test started with the test specimen in the de-energized position and held in that position during the test. This position was selected since the only significant force acting on the contact was table input excitation. If contact chatter or change of state occurred during a test, the same test was repeated with the test specimen energized. The off-table relay was energized during all testing. These contact configurations represent the worst case scenario, since closed contact requires less force to cause contact chatter. Open contact needs to travel more and, hence, needs more force to cause contact chatter or change of state than closed contact. Figures 5-2 and 5-3 show the set up for monitoring contact chatter/change of state.

5.3 Accelerometer Arrangement

One test table mounted accelerometer was used for control and monitoring of the input motion. Three accelerometers were mounted on the top of the test fixture and on one of each GE and Westinghouse relay to monitor fixture and specimen response. The location of these accelerometers are shown in Figure 5-1 and test setup photographs (Photographs 5-1, 5-2). The accelerometer data was recorded on analog FM tape and also monitored by computer.

Table 5-1

On- and Off-Table Relay Arrangement

On-Table Relay	Mfgr.	Model No.	Coil Voltage
GE	Cutler Hammer	D40RB Series 2A	120 VAC
GE	GE	CR120B	230 VAC
GE	Allen Bradley	Size 1 Starter	120 VAC
Westinghouse	Cutler Hammer	D40RB	120 VAC
Westinghouse	Westinghouse	AR6A	120 VAC
Westinghouse	Allen Bradley	Size 1 Starter	120 VAC

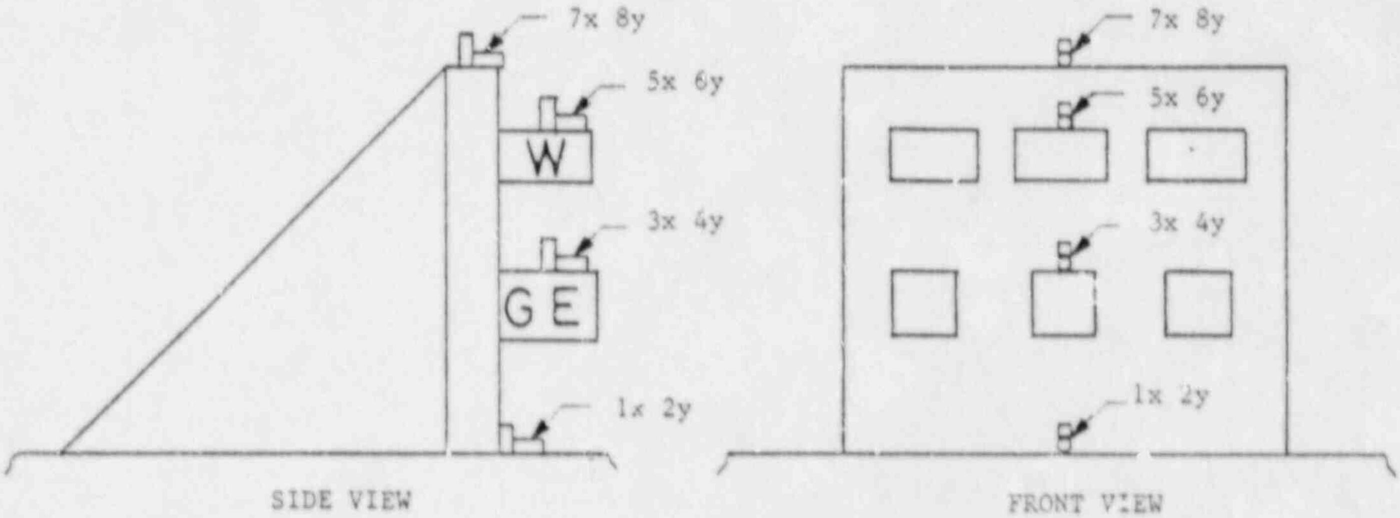


Figure 5-1
TEST FIXTURE AND RESPONSE ACCELERATION LOCATION

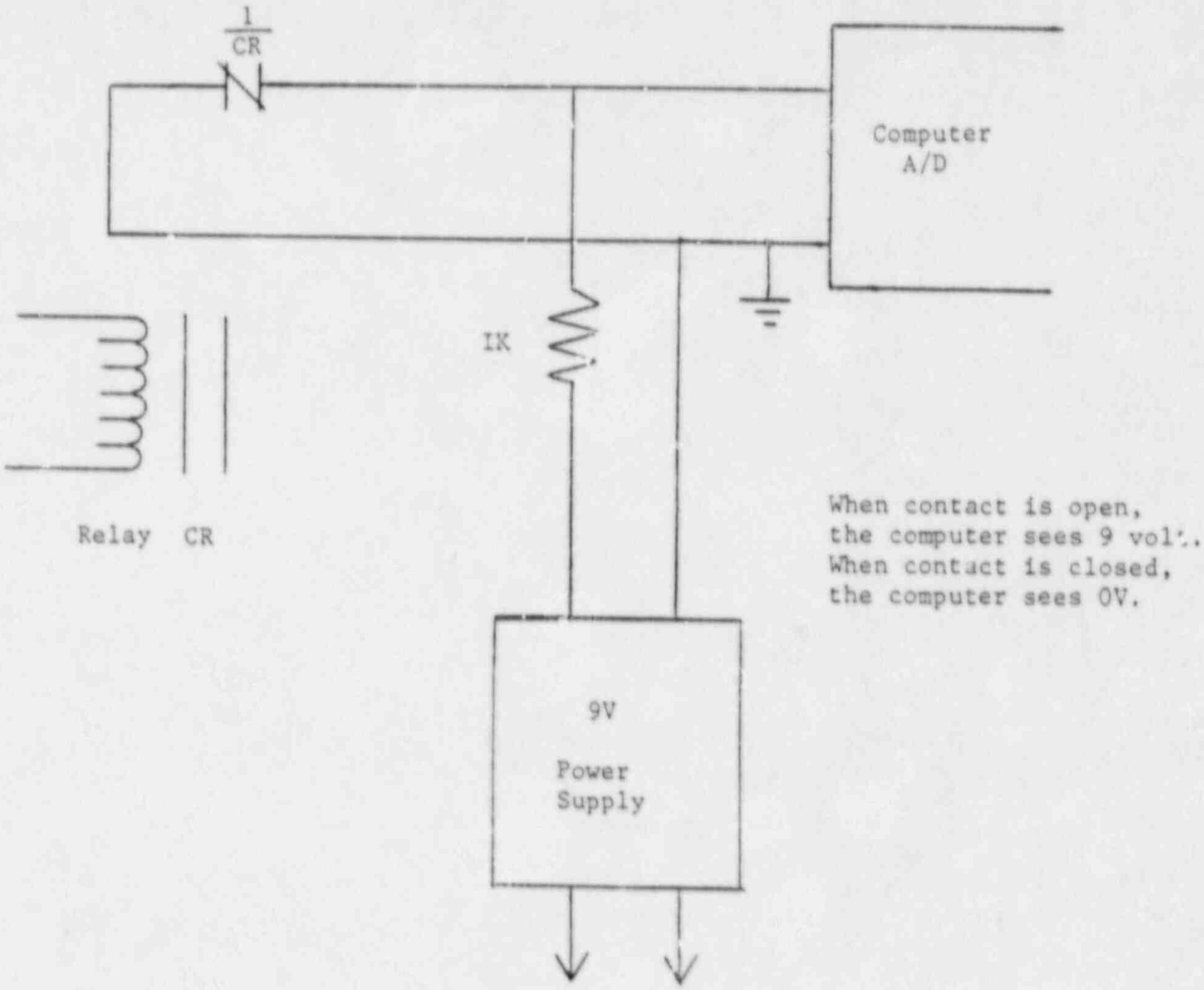


Figure 5-2
TYPICAL CHATTER DETECTION TEST SETUP

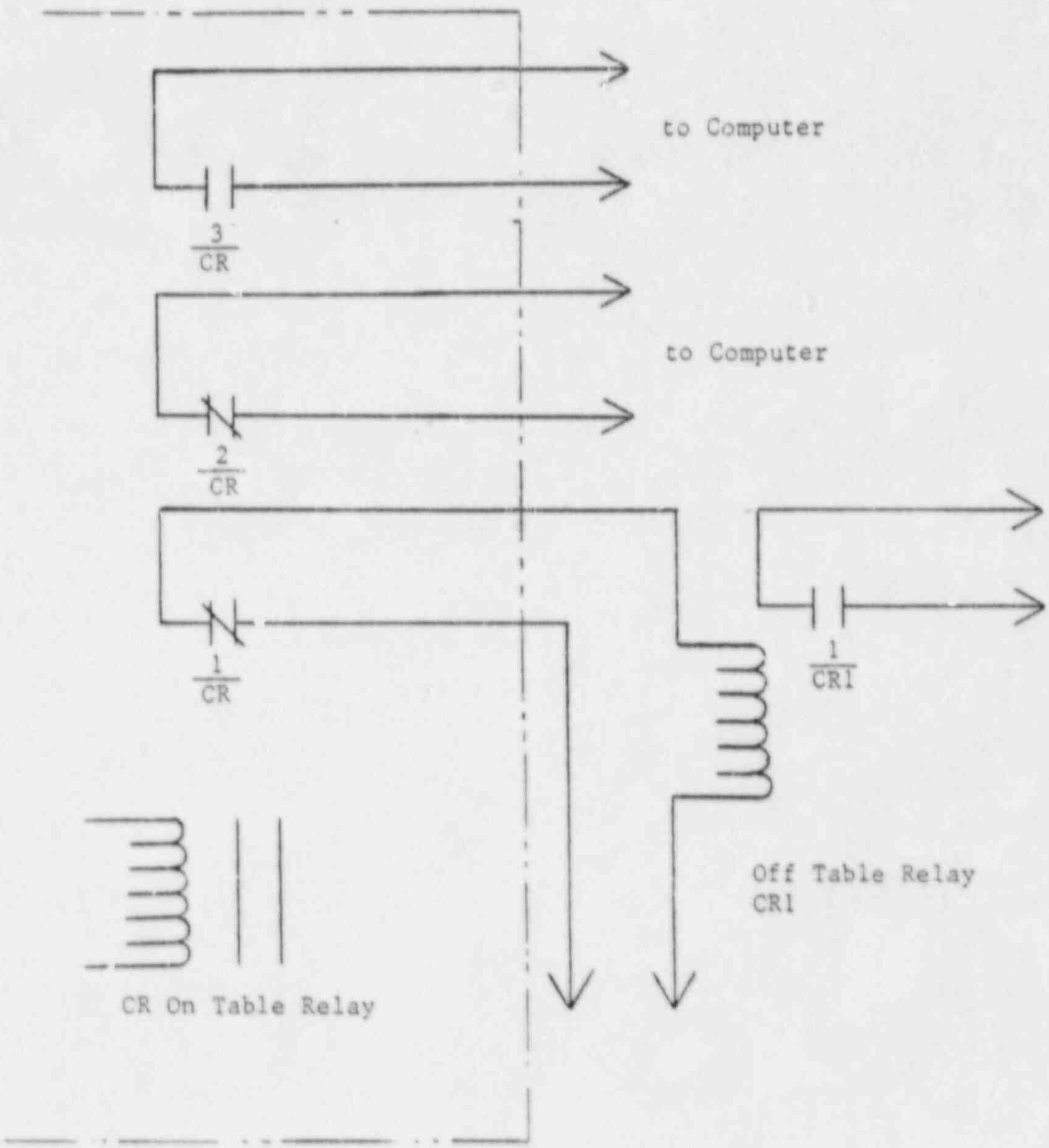
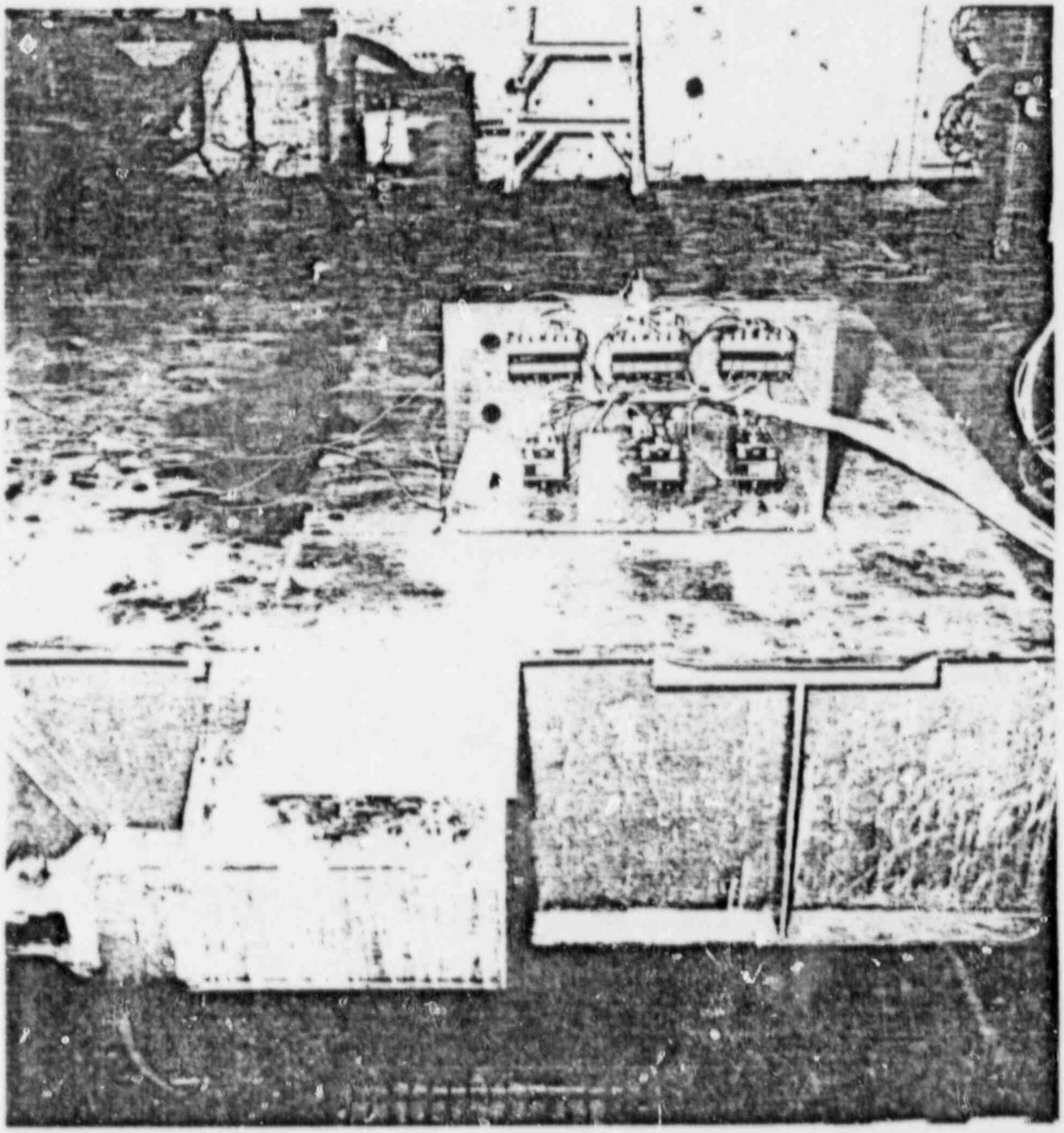
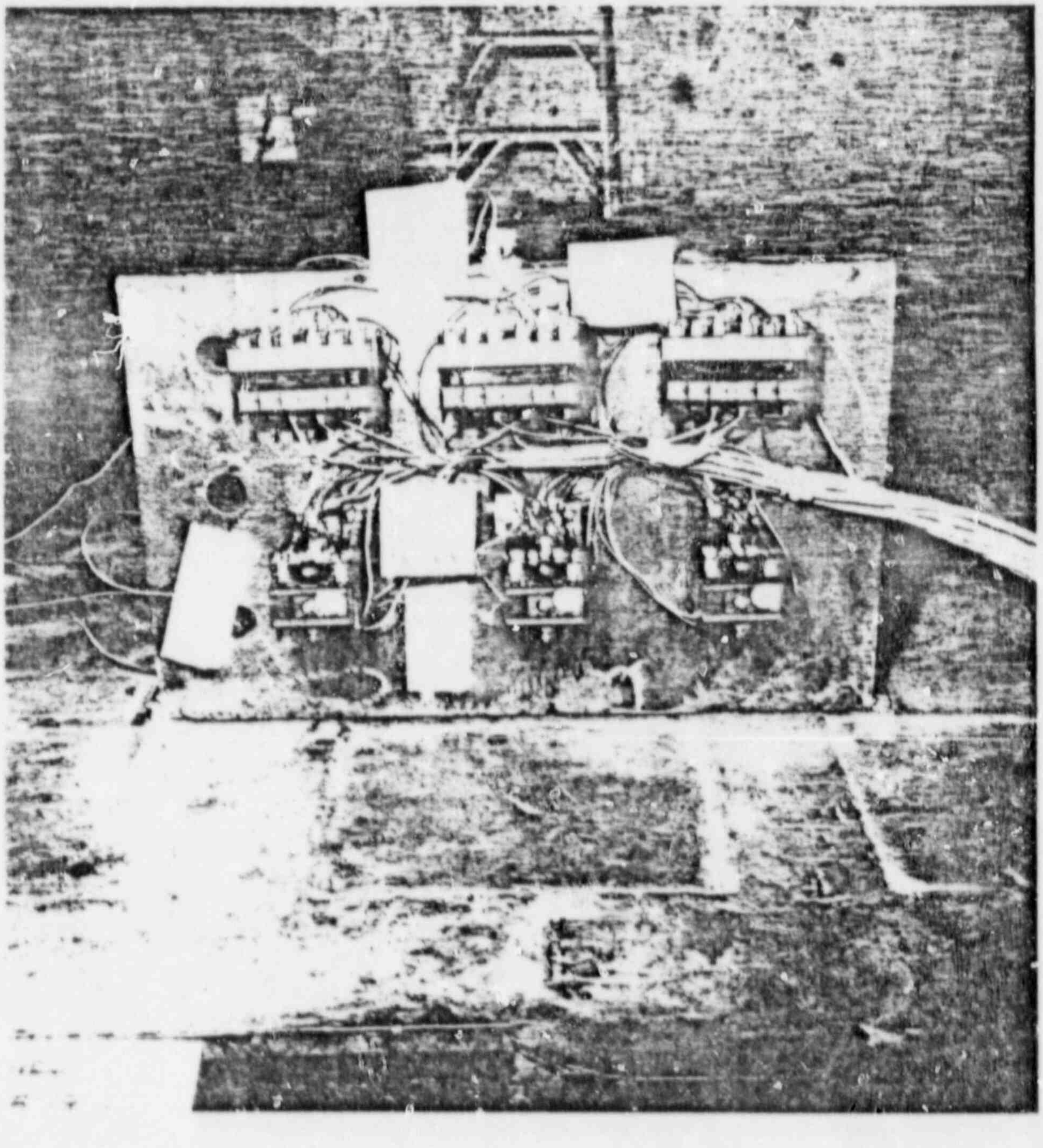


Figure 5-3
TYPICAL ON- AND OFF-TABLE TEST SETUP
FOR CHATTER DETECTION



Photograph 5-1

Test Setup



Photograph 5-2

Accelerometer Locations

5.4 Resonance Search

The resonance search consisted of a low level sinusoidal sweep test (0.2 g) in the horizontal (x) and vertical (y) directions to determine the response of the test specimen and fixture in the desired frequency band of 1 to 100 Hz. The sweep rate of 1/2 octave per minute was employed in this frequency range.

5.5 Random Excitation

The seismic fragility test was conducted uniaxially using random motion which was amplitude-controlled in one-third octave bandwidths from 1.25 to 100 Hz. This input signal was synthesized with a bank of parallel one-third octave filters with individual output attenuators adjusted to meet the required response spectra shapes. The test was conducted in three separate frequency bands; low, high and broad band frequencies. Due to the number of test runs, 10 second duration strong-motion waveforms were used to reduce fatigue effects. The strong motion portion of the excitation was preceded by a 2-3 second "ramp-up" and followed by a 3-4 second "ramp-down".

Figures 5-4, 5-5 and 5-6 show the specified test level for this program. The primary criteria used in meeting the test level was the ZPA portion of the response spectrum for "high frequency" excitation and the peak of the response spectrum for "low frequency" excitation.

Analyses of the test motions were accomplished with a response spectrum analyzer. The analyses were performed and plotted at one-sixth octave frequency intervals from 1.0 to 100 Hz. Response spectrum was plotted at damping values of 1, 2 and 3 percent.

5.6 Single Axis Sine Sweep Excitation

The test specimens were subjected to uniaxial sine sweep excitations in two directions, selected horizontal and vertical, from 2.5 to 100 Hz on the "G-machine" test table and at the frequency range from 4 - 100 Hz on the "F-machine" test table (Photographs 5-3 and 5-4). Each test was started with the specimen in the de-energized position and held in this position for the test duration. If a chatter or change of state ocurred during the test, the same test was repeated with the relay in the energized position. The sweep rate was approximately one octave per minute. The acceleration was increased until component malfunction occured. The acceleration and frequency of excitation at which specimen malfunction occurred was recorded.

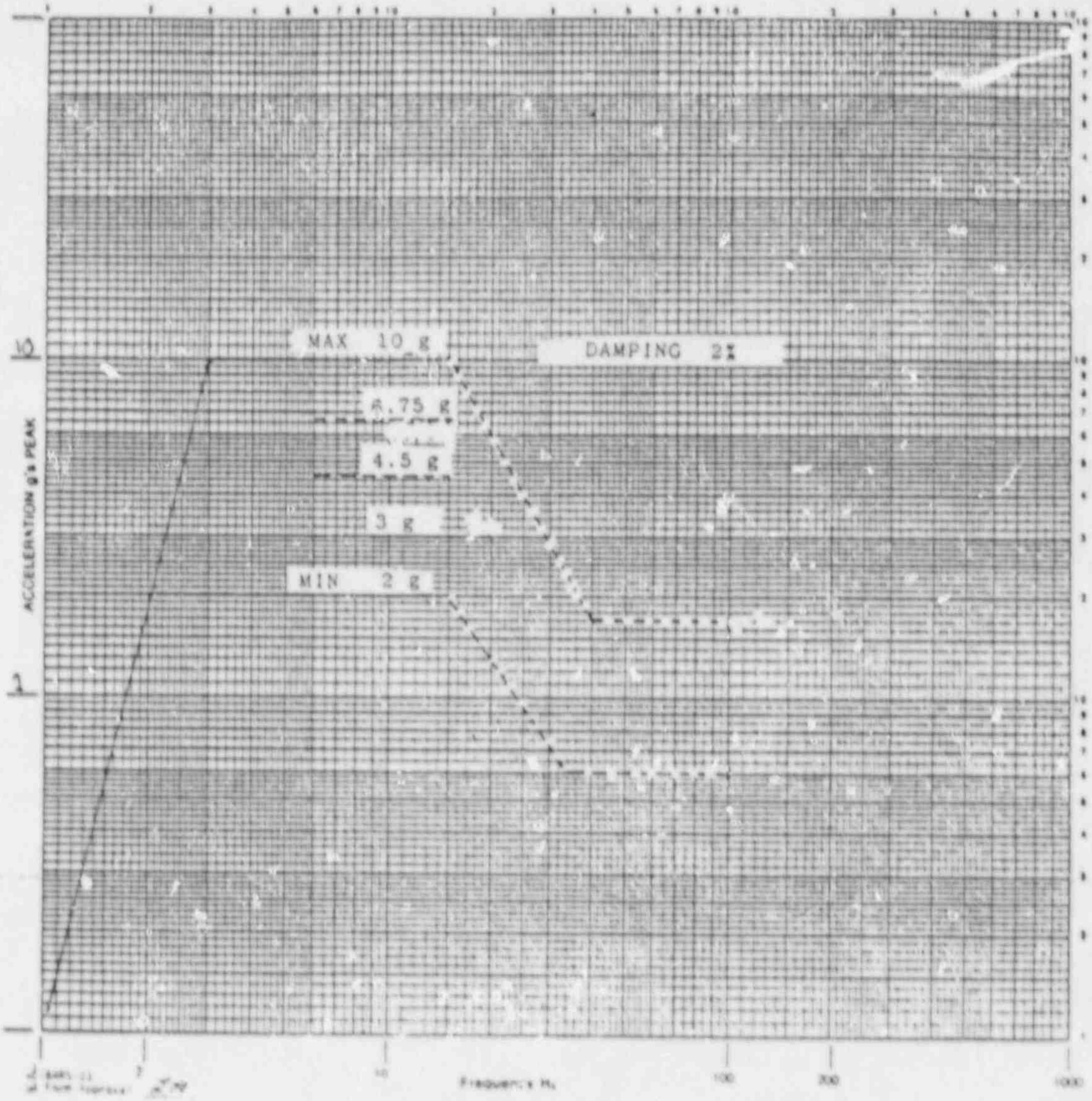


Figure 5-4
LOW FREQUENCY RRS

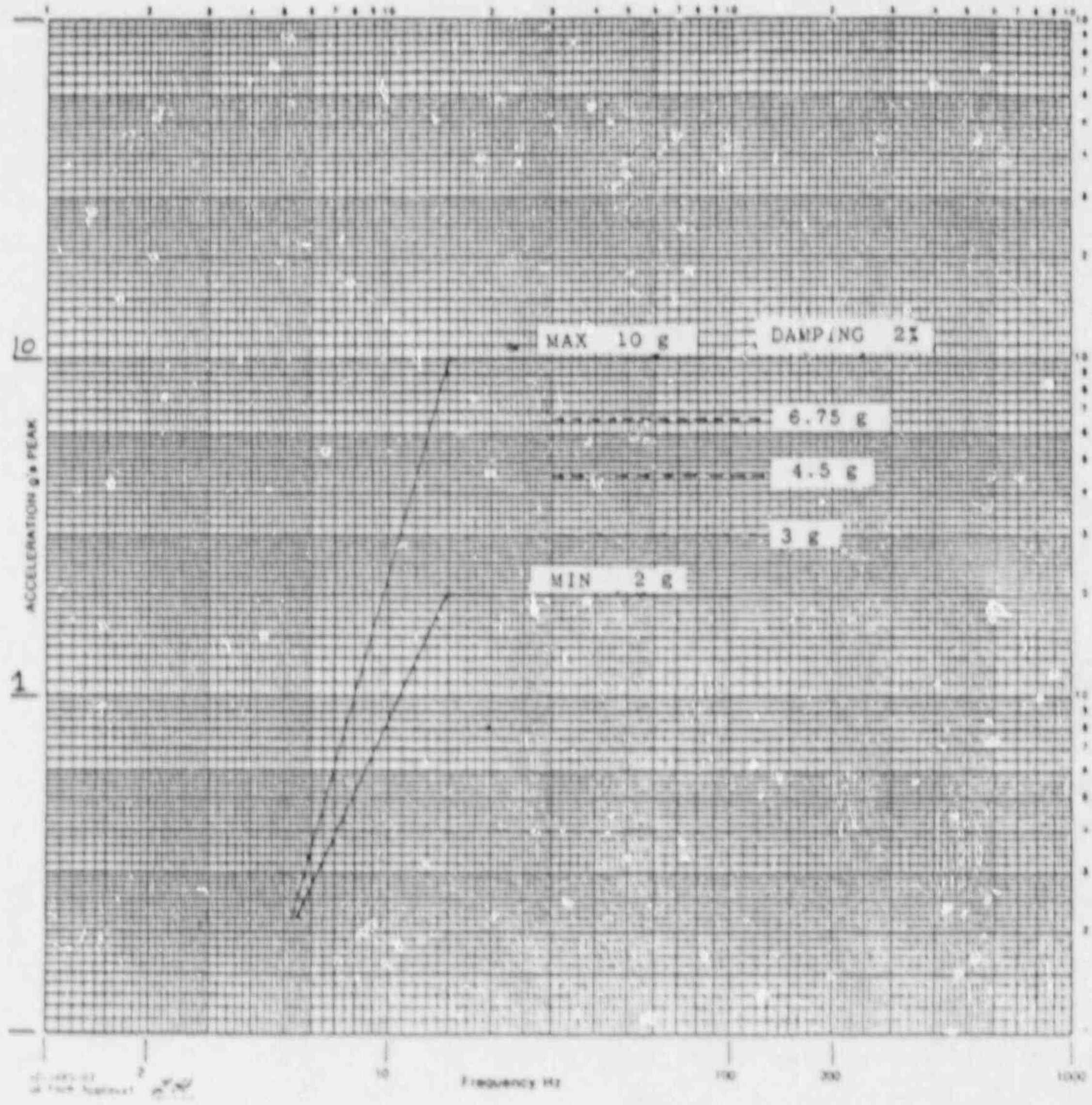


Figure 5-5
HIGH FREQUENCY RRS

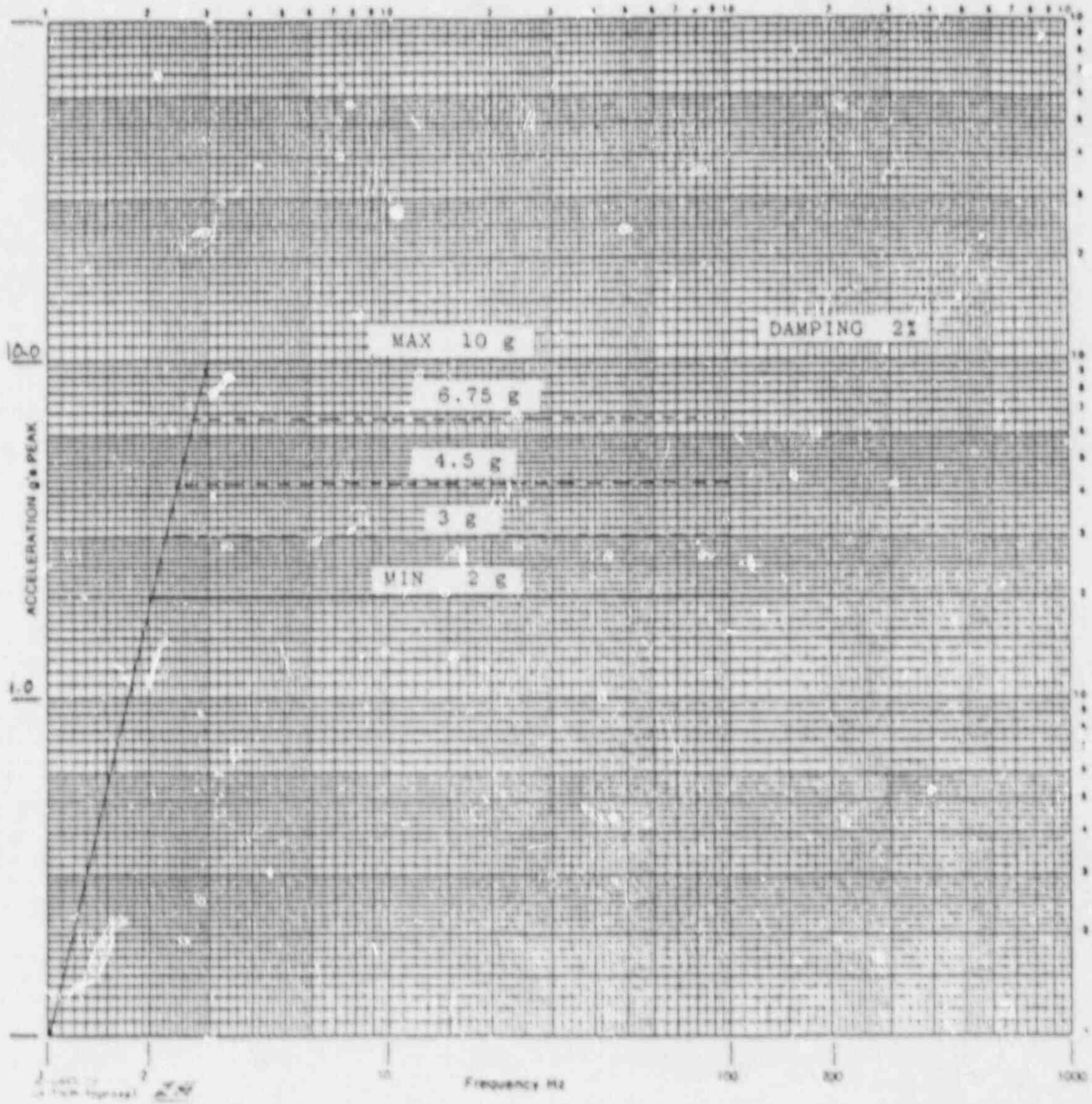
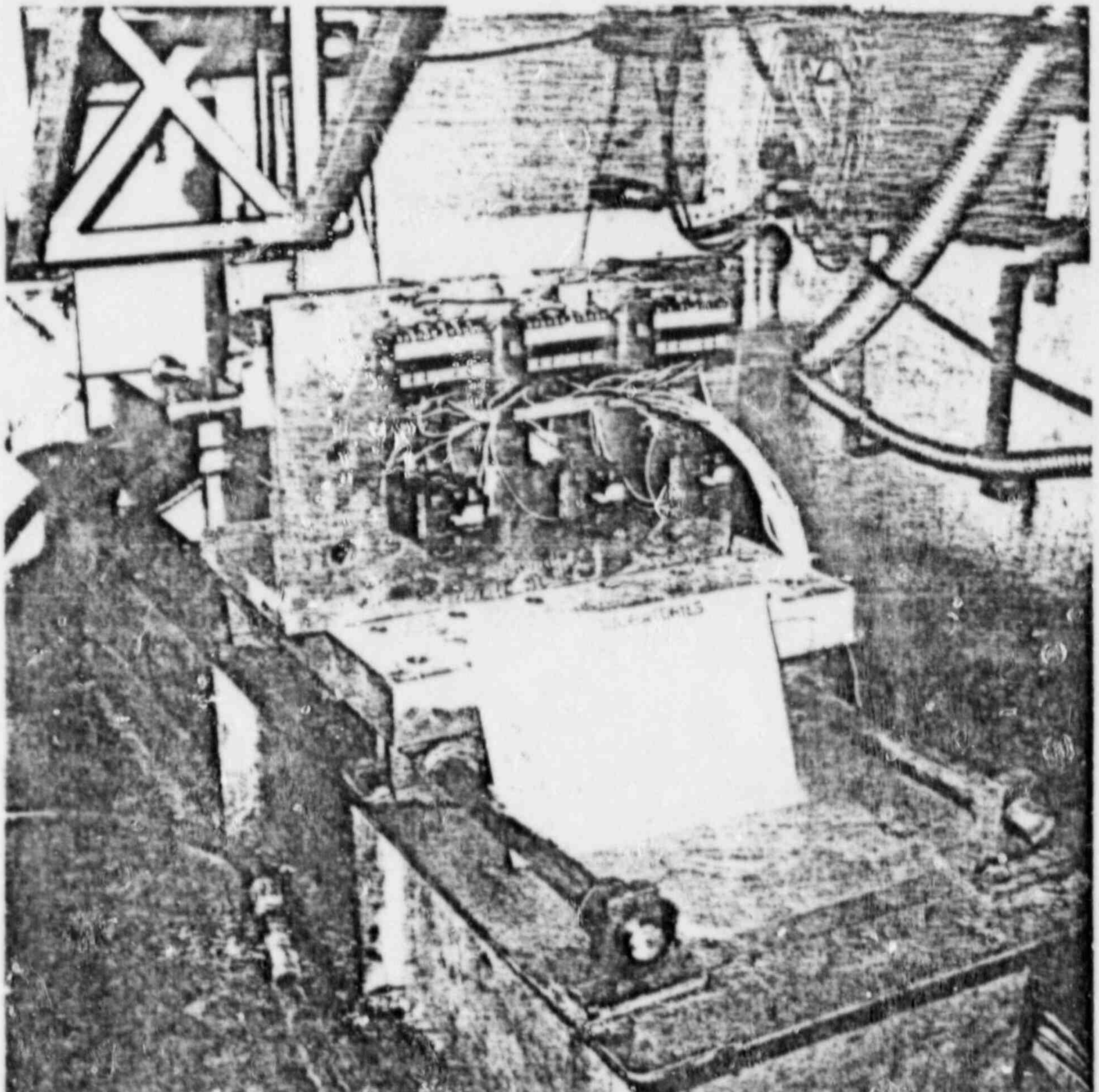
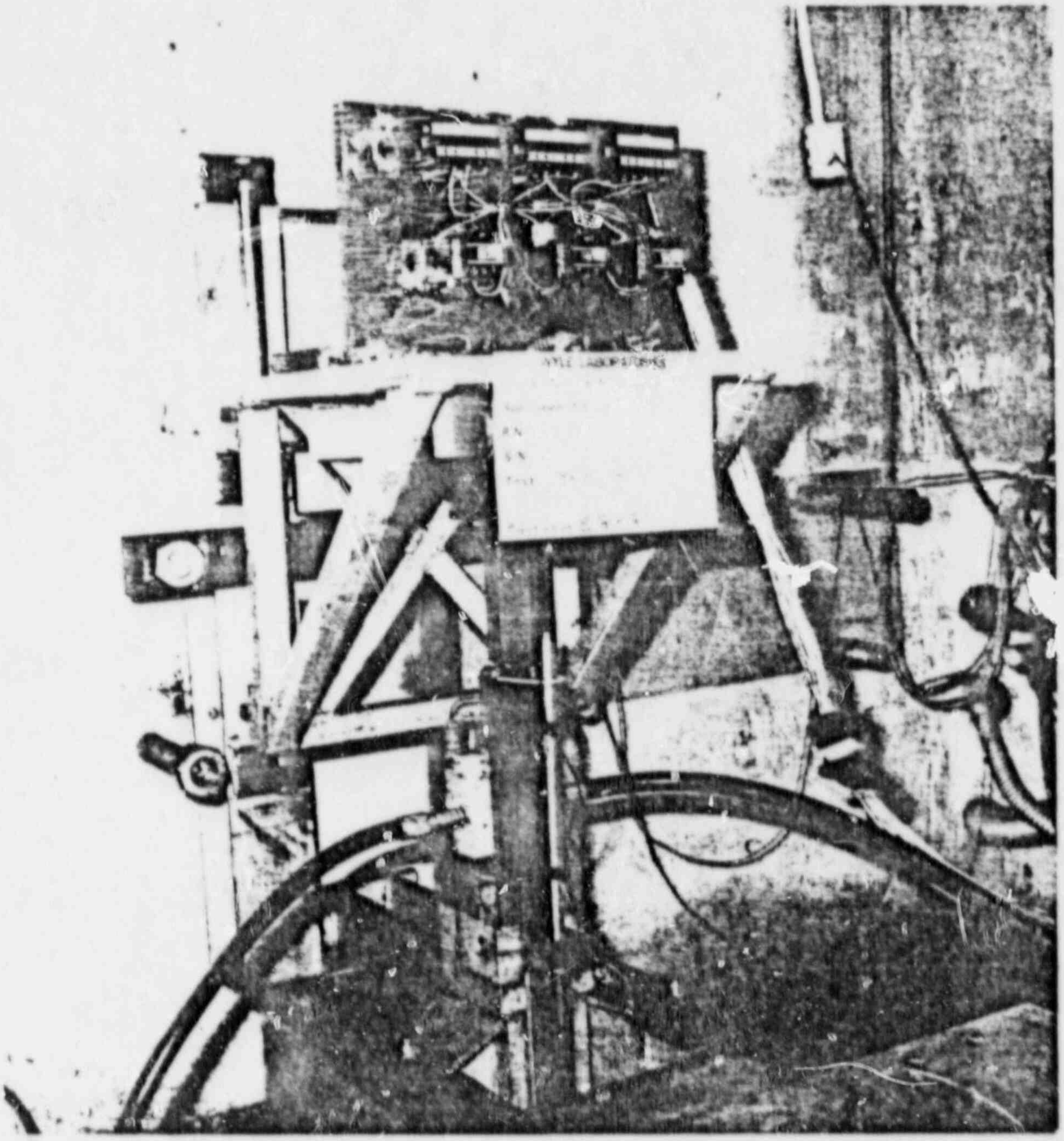


Figure 5-6
BROADBAND RRS



Photograph 5-3

Horizontal Sine Sweep Test Setup



Photograph 5-4

Vertical Sine Sweep Test Setup

6.0 TEST RESULTS

6.1 Receiving Inspection

Upon receipt at Wyle Laboratories, and prior to any testing, the test specimens were visually examined for evidence of damage which may have been incurred in shipping. Specimen identification information was checked with the shipping documents for conformity. Results of the visual examination, together with specimen identification information, were recorded on the appropriate test data sheets.

There was no visible evidence of damage to the test specimens upon receipt at Wyle Laboratories.

The test specimens were described as General Electric 230 Volt AC Relay, Part No. CR120B06003 and Westinghouse 120 Volt AC Relay, Part No. AR660. Four relays of each type have been received.

Receiving inspection data sheets are included in Appendix C.

6.2 Test Sequence

Test log, list of test and control equipment are presented in Appendix C, as well as detailed data sheets. The test program was performed in the following main steps:

1. Calibration of the test table for low, high and broadband frequency excitations in the horizontal directions.

2. Resonance search.

3. Random excitation at low frequency range in the vertical direction (Run Nos. 18-20).

4. Random excitation at high frequency range in the vertical direction (Run Nos. 21-33).

5. Broadband frequency random excitation in the vertical direction (Run Nos. 24-28).

6. Detailed sine sweep testing in the horizontal (Run Nos. 29-36) and the vertical (Run Nos. 37-41) directions in the frequency range 4 - 100 Hz.

A description of the first 28 runs is summarized in Table 6-1. For the following run description, see Table 6-2.

Table 6-1

Test Sequence with Run Numbers

	Peak g Level	Relay Status	HORIZONTAL DIRECTION Frequency Range, Hz 3-15	15-100	3-100	VERTICAL DIRECTION Frequency Range, Hz 3-15	15-100	3-100
Table Calibration		N/A	+	+	+	+	+	+
Resonance Search	.2	D	+	+	+	+	+	+
Random Excitation	2.0	D	1,1-1	7	12	-	-	-
	3.0	D	2	8	13	-	-	-
	4.5	D	3	9	14	18	21	24
	6.75	D	4	10	15	19	22	25
	10.0	D	5	11, 11-1, 11-2	16	20	23, 23-1	26
	12.0	D	-	27	-	-		-
	15.0	D	-	28	-	-		-
	10.0	E	6	-	17	-	-	-
Sine Sweep	2.50	D		2.5 - 50 Hz		-	-	-
	2.0	D		50 - 100 Hz		-	-	-
	2.5	D		2.5 - 100 Hz		-	-	-
	2.5	E		2.5 - 100 Hz		-	-	-

Note: * - Numbers in the table present run number
D - De-energized relay status
E - Energized relay status

Table 6-2

Sine Sweep Test Numbers

DIRECTION			FRONT-TO-BACK								VERTICAL				
Run No.			33	32	31	30	29	34	35	36	40	39	38	37	41
Acceleration Peak g's			1.0	1.5	2.0	2.5	3.0	3.5	4.0	3.5	2.0	2.5	3.0	3.5	3.5
WESTINGHOUSE	W1	NC			9	153	166	728	154		29		3	29	
		NO						12							
	W2	NC				2	8	665	122				7	24	
		NO													
	W3	NC						744	449				23	96	
		NO													
	Off-table	W1				35	33	48	18					5	
		W2													
		W3						434	208						
GENERAL ELECTRIC	G1	NC		30	148	238	266	820	53			16	48	85	
		NO													
	G2	NC		14	103	202	1089	209							
		NO													
	G3	NC					568	103							
		NO													
	Off-table	G1		35	63	121	28	451	37		5	16	46	34	
		G2													
		G3						386	28						

Note: The table shows the number of chatters in each test.
All runs, except Nos. 36 and 41, are in the de-energized state.
Frequency range of 4 - 100 Hz applied to all runs, except for Run 35 which ranged 15 - 70 Hz.

6.3 Resonance Search

The results of the resonance search are presented in Appendix D as transmissibility plots between response and control accelerometer readings. A uniaxial resonance search was performed in the horizontal x and vertical y axes. The search consisted of a sine sweep from 1 to 100 Hz using a low excitation level of 0.2 g at approximately 1/2 octave per minute. During the resonance search, the relays were in the de-energized state. The results of the search do not indicate any resonance of the test fixture up to 60 Hz. The first resonance in the horizontal direction was recorded at 70 Hz, and the first resonance in the vertical direction took place at 60 Hz.

6.4 Uniaxial Random Test

The results of uniaxial random tests are presented in Appendix E. As previously stated, the first phase of testing consisted of uniaxial excitation in the horizontal direction at peak acceleration occurring at the low frequency range from 3 to 15 Hz. During this phase, the relays were in the de-energized state and the maximum acceleration level was gradually increased from 2 to 10 g's at 2% damping. No sign of chatter or other malfunction was noticed during the first four levels of the test. But when the acceleration reached 10 g's (Run No. 5), the first chatter was recorded on the normally-closed contacts of all relays. For ten seconds of excitation, all Westinghouse relays exhibited three chatters for a duration of 5-20 milliseconds. Each of the GE relays exhibited one chatter with a duration of 2-20 milliseconds. It is worth to notice that all relays of the same model exhibited chatter during this time period, but this time period was different for the different models. When the relays where energized, the chatter was effectively blocked. High frequency excitation from 15 to 100 Hz did not cause any chatter even at the highest acceleration level of 10 g's.

Broadband excitation from 3 to 100 Hz caused relay chatter only when the response acceleration level reached 10 g's at 2% damping. The character of relay chatter was quite similar to previously recorded low frequency excitation. And, again, no chatter was recorded for relays in the energized position.

The uniaxial random testing in the vertical direction was initiated from a medium accleration level of 4.2 g's which did not produce any chatter during testing in the horizontal direction. No chatter was recorded in the excitation level up to 10 g's in low, high and broadband frequency ranges. Even acceleration levels up to 15 g's applied in the vertical direction at high frequency ranges (see Run Nos. 27, 28) did not cause any relay chatter.

Relay chatter usually occurred 20-30 msec after acceleration spike in the time history. (It is worth to notice that some even higher acceleration spikes did not produce any chatter.) Off-table relay response, if any, immediately follow the corresponding relay chatter with time delay up to 10 msec. Rebound acceleration was recorded in about 10-20 msec after the chatter occurrence. Extended time history plots in Appendix E present these effects in greater detail. For selected Runs No. 4, 5, 15 and 16, acceleration time histories of response accelerometer Nos.

3 and 5 (mounted on GE and Westinghouse relays correspondingly) were double integrated and, thus, velocity and displacement time histories were denerated. These time histories are also presented in Appendix E. A clear indication of time correlation between chatter occurrence and table velocity is contact chatter happening simultaneously with the peak velocity.

6.5 Sinusoidal Sweep Test

A sinusoidal sweep test was performed initially on the "G-machine" in the frequency range from 2.5 to 100 Hz in the horizontal direction. No chatter was recorded for relays in the de-energized state at a peak acceleration of 2.0 g's and for relays in the energized state at a peak acceleration of 2.5 g's. However, the peak acceleration of 2.5 g's caused substantial relay chatter in the de-energized state (see Appendix F).

All Westinghouse relays exhibited substantial chatter of NC contacts in the frequency range from 4 to 7 Hz. No noticeable acceleration peak was recorded which caused contact chatter, but rebound acceleration was recorded in about 10-20 msec following chatter occurrence. Off-table relay response follows the corresponding contact chatter with a delay of about 10 msec.

The General Electric relays, Nos. 2 and 3, exhibited contact chatter from 10 to 40 sec into testing and then from 50 sec to the end of the test. No contact chatter was observed for relay No. 1. The relation between contact chatter, acceleration time history and performance of the off-table relays was identical to what was obtained for the Westinghouse relays.

As one can see from recorded data plots, the sine sweep excitation on the "G-machine" exhibits high noise level and distortion of sinusoidal shape of the signal. Therefore, the test specimens were installed on the "F-machine" to perform a more definite sinusoidal sweep test.

Detailed records of the sinusoidal sweep test performed on the "F-machine" are presented in Appendix G. All test data are recorded as function of the test duration. In order to correlate the test results with the excitation frequency, several "frequency vs. time" plots are included in Appendix G.

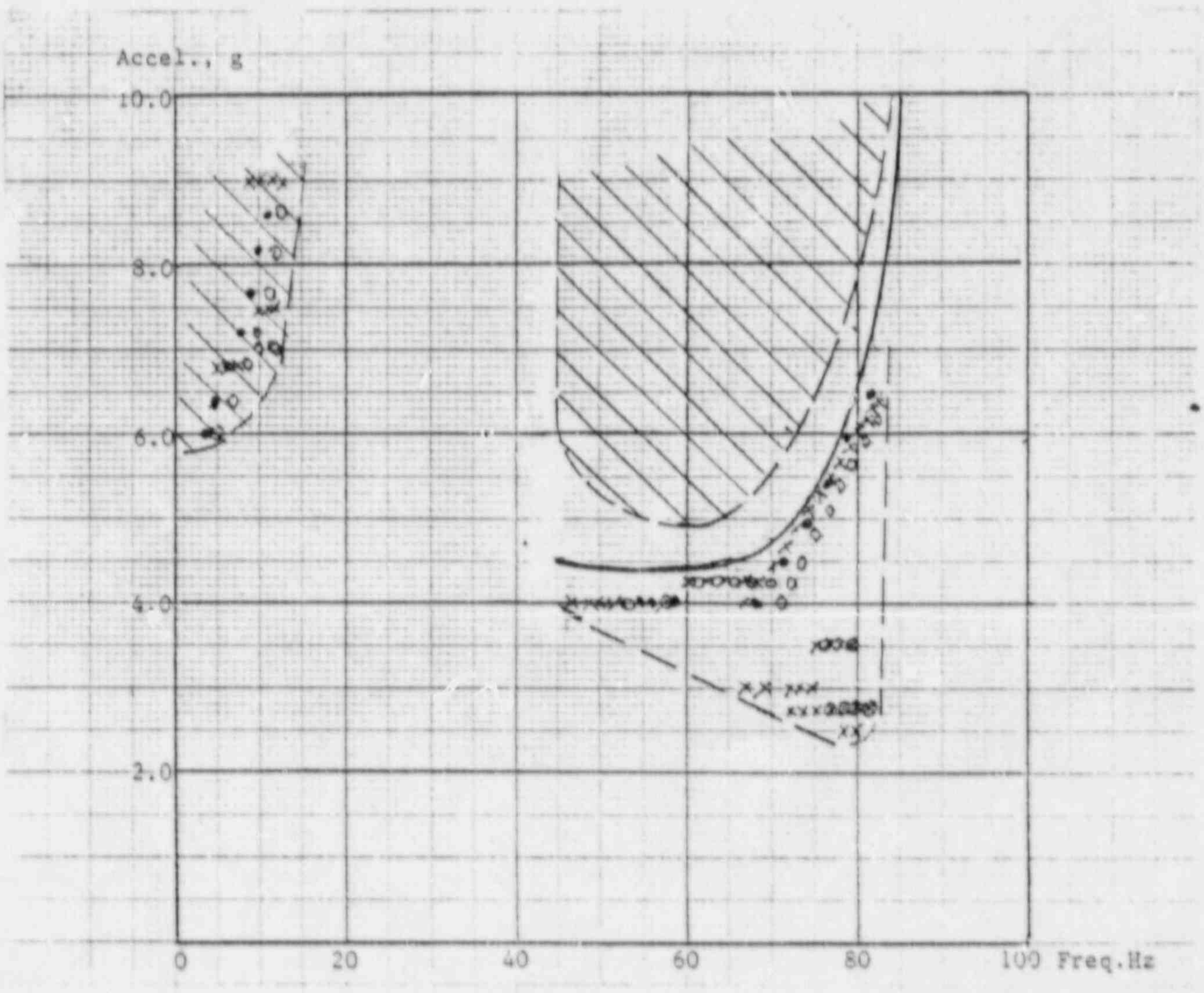
The records show contact chatter, the time of occurrence, and the corresponding frequency and excitation level. The results of the sinusoidal test are summarized in Table 6-2. The table presents a matrix showing correlation of relay contact chatters with the relay model, specimen number, type of contact (normally-open or normally-closed) and contact state, direction of excitation and specified excitation level. It is important to notice that peak acceleration in Table 6-2 is specified value. The real acceleration at any given time may deviate from the specified value and, therefore, has to be taken from acceleration time history plots presented in Appendix C.

No chatter has been recorded at excitation level of 1 g applied in the horizontal, front-to-back direction in the frequency range from 4.0 to 100 Hz (Run No. 33). With increasing test levels to 1.5 g, NC contact of one GE relay started to chatter (Run No. 32). Further increase of the test level caused more and more substantial chatter of NC contacts of all the tested relays. At maximum test levels of 3.5 g, a total of 5975 contact chatters were recorded (Run No. 34). Because most of the relay chatters occurred below 15 Hz and above 60 Hz, the frequency range of 15 -70 Hz was examined at a higher test level of 4.0 g's (Run No. 35). The sinusoidal sweep at 3.5 g's did not cause any contact chatter on the relays in the energized position (Run No. 36).

Sinusoidal sweep applied in the vertical direction caused substantially fewer contact chatters (Run Nos. 37-40). Even the highest test excitation level of 3.5 g's (Run 37) generated quite modest, short duration chatter in the Westinghouse relays and contact chatter in only one GE relay. And, again, the relays showed no indication of contact chatter while in the energized state.

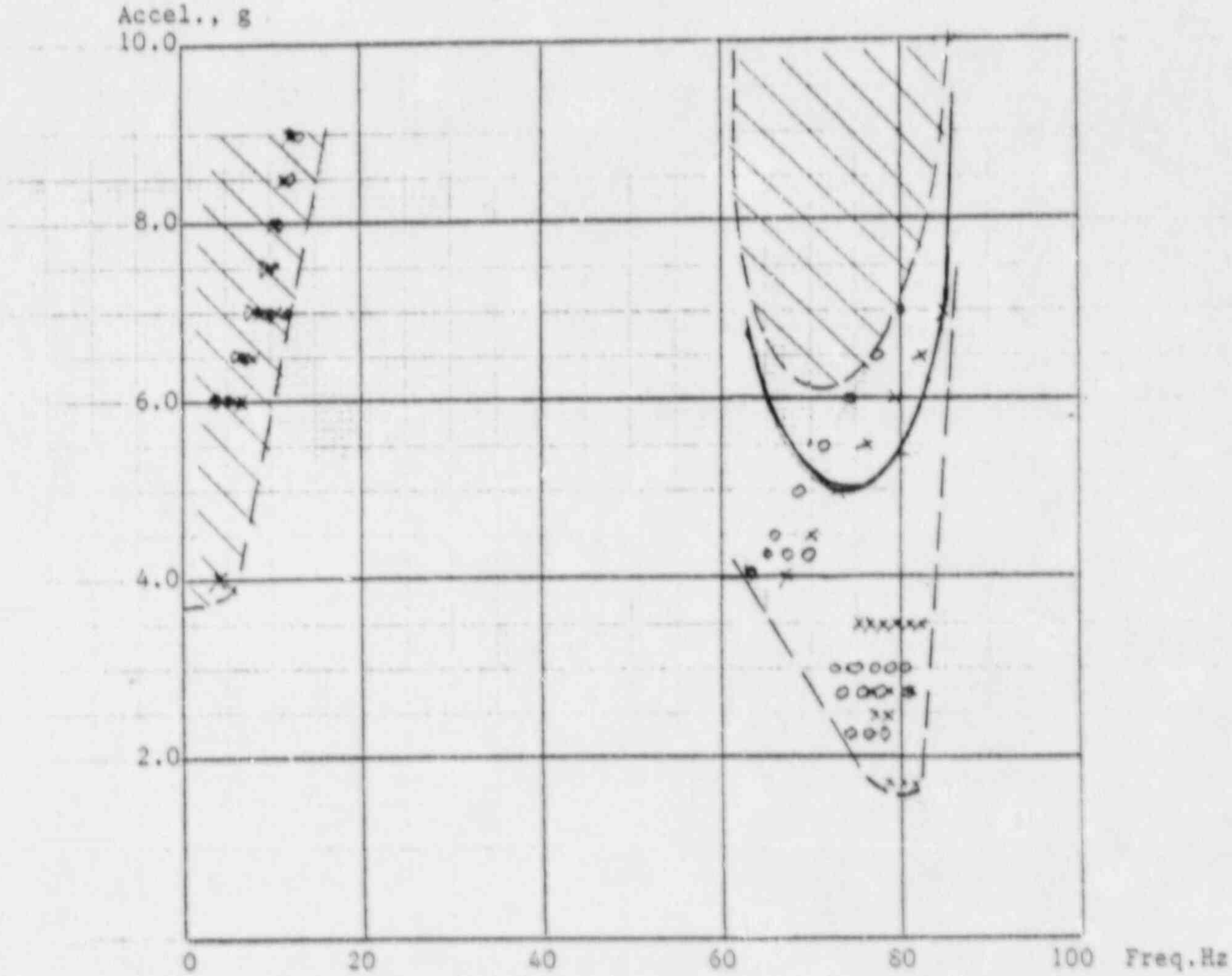
Figures 6-1 and 6-2 show contact chatter zones for Westinghouse and GE relays as a function of table excitation level and frequency contents of the excitation. The figures clearly present a very important phenomenon. Both Westinghouse and General Electric relays exhibited contact chatter, not only in the traditional low frequency range, but in the high frequency range 50 to 80 Hz. The contact chatter at the high frequency was recorded for all test specimens in the horizontal, front-to-back direction. Vertical table excitations of 3.0 g and higher caused chatter in the Westinghouse relays at frequencies near 50 Hz. Only one of the GE relays exhibited contact chatter in the frequency range of 80 to 90 Hz when the vertical excitation level reached 2.5 g.

Response of the off-table relays were similar to the previously recorded random test and sine sweep on the "G-machine". Extended time histories and records in Appendix G present these data in greater detail.



×, o, • - test table acceleration points
\\\\\\ - calculated relay acceleration level
—— - book end fixture acceleration level

Figure 6-1
CONTACT CHATTER ZONE FOR WESTINGHOUSE RELAY



x, o, ● - test table acceleration points
\\\\\ - calculated relay acceleration level
—— - book-end fixture acceleration level

Figure 6-2
CONTACT CHATTER ZONE FOR GE RELAY

6.6 Evaluation of the Test Table and Relay Responses on "F-Machine"

To further evaluate the response characteristics, a detailed evaluation of the "F-Machine" table/relay interface has been performed. During this evaluation, sine sweeps from 4 to 100 Hz at acceleration levels of 1 g and 3 g were applied to the table and acceleration time histories were recorded of control accelerometer 1 and response accelerometers 3, 5 and 7. These time histories are presented in Appendix H. Based on the test results, transmissibility functions were computed and presented in Figures 6-3, 6-4 and 6-5 for 1 g and 3 g excitation levels. The transmissibility data indicate:

- The test table has first resonance at 84 to 85 Hz (see Figure 6-5).

- The Westinghouse relay has first resonance at 55 to 57 Hz (see Figure 6-4).

- The General Electric relay exhibited a first resonance at approximately 75 Hz (see Figure 6-3).

It is important to notice that higher excitation levels lead to smaller amplification caused by nonlinear damping in the table supports, table/relay interface and relays themselves. Response frequency shift can also be explained by increasing damping in the system with the rise of the excitation level.

The next step of the data evaluation was computation of the response acceleration levels of Westinghouse and General Electric relays caused by input excitation previously recorded for Run Nos. 29 through 35. The response level at a particular frequency was calculated as the product of the measured table acceleration times the transmissibility at that frequency. The plots of the calculated responses are presented in Appendix H. The plots for the General Electric relay are marked "Acc-3*"; the plots for the Westinghouse relays are marked with "Acc-5*". The calculated transmissibility functions were used to evaluate the chatter area as a function of the acceleration level at the relays themselves. These areas shown in Figures 6-1 and 6-2 as shaded zones were defined as the product of table acceleration times the appropriate transmissibility values. The solid lines in Figures 6-1 and 6-2 depict the acceleration level at the top of the book end fixture. This level is defined as the product of the table acceleration times transmissibility between accelerometers 7 and 1 at 3 g excitation level.

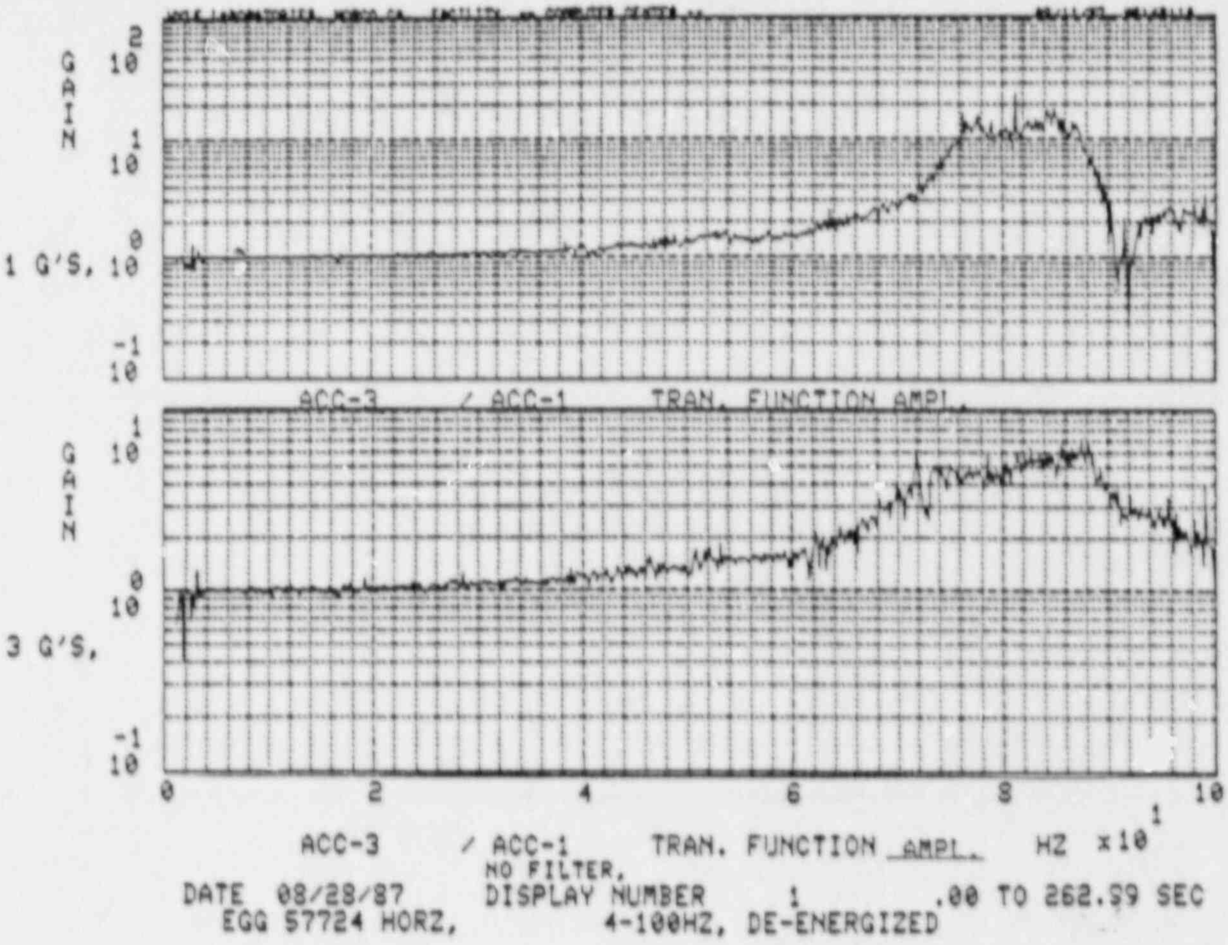


Figure 6-3
Transmissibility Plot for GE Relay

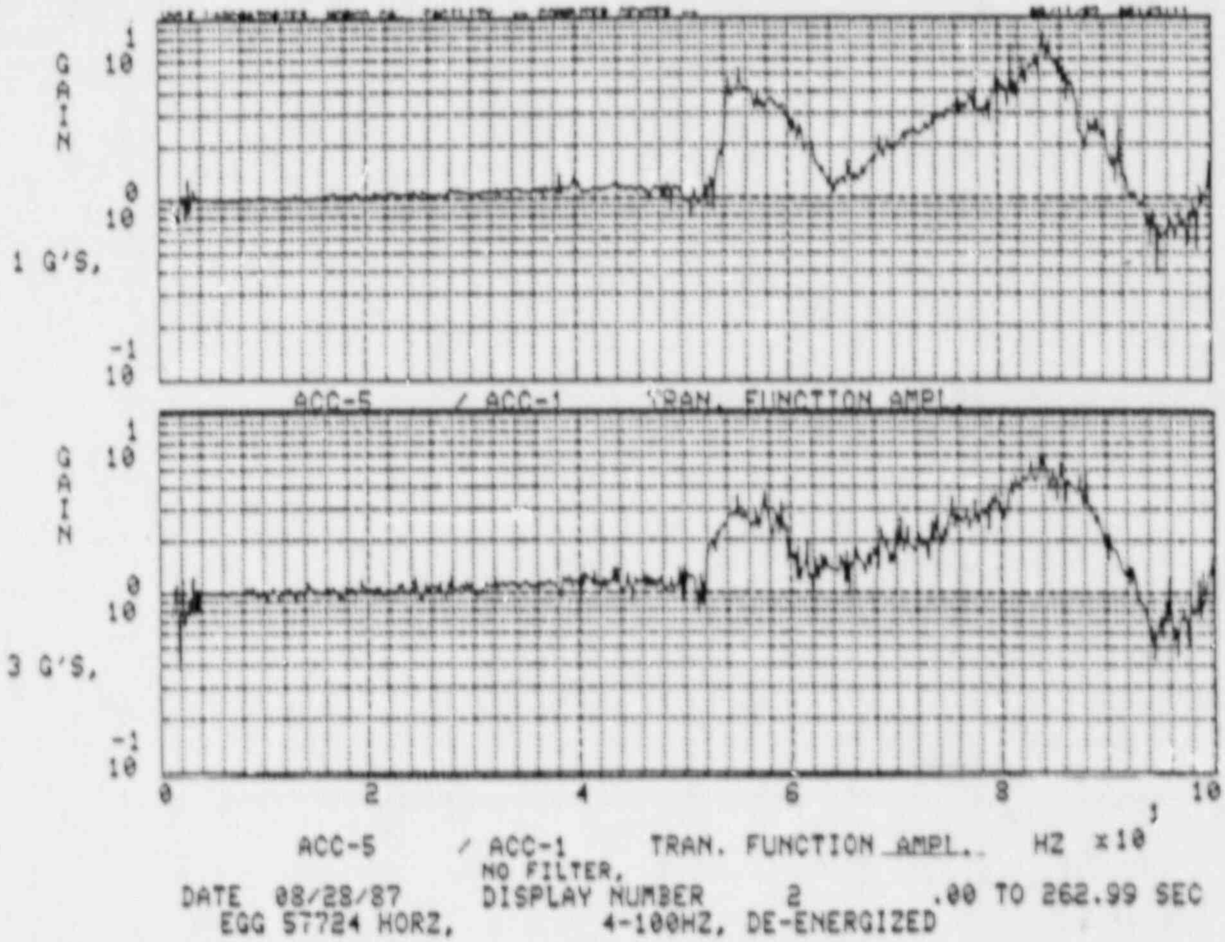


Figure 6-4
Transmissibility Plot for Westinghouse Relay

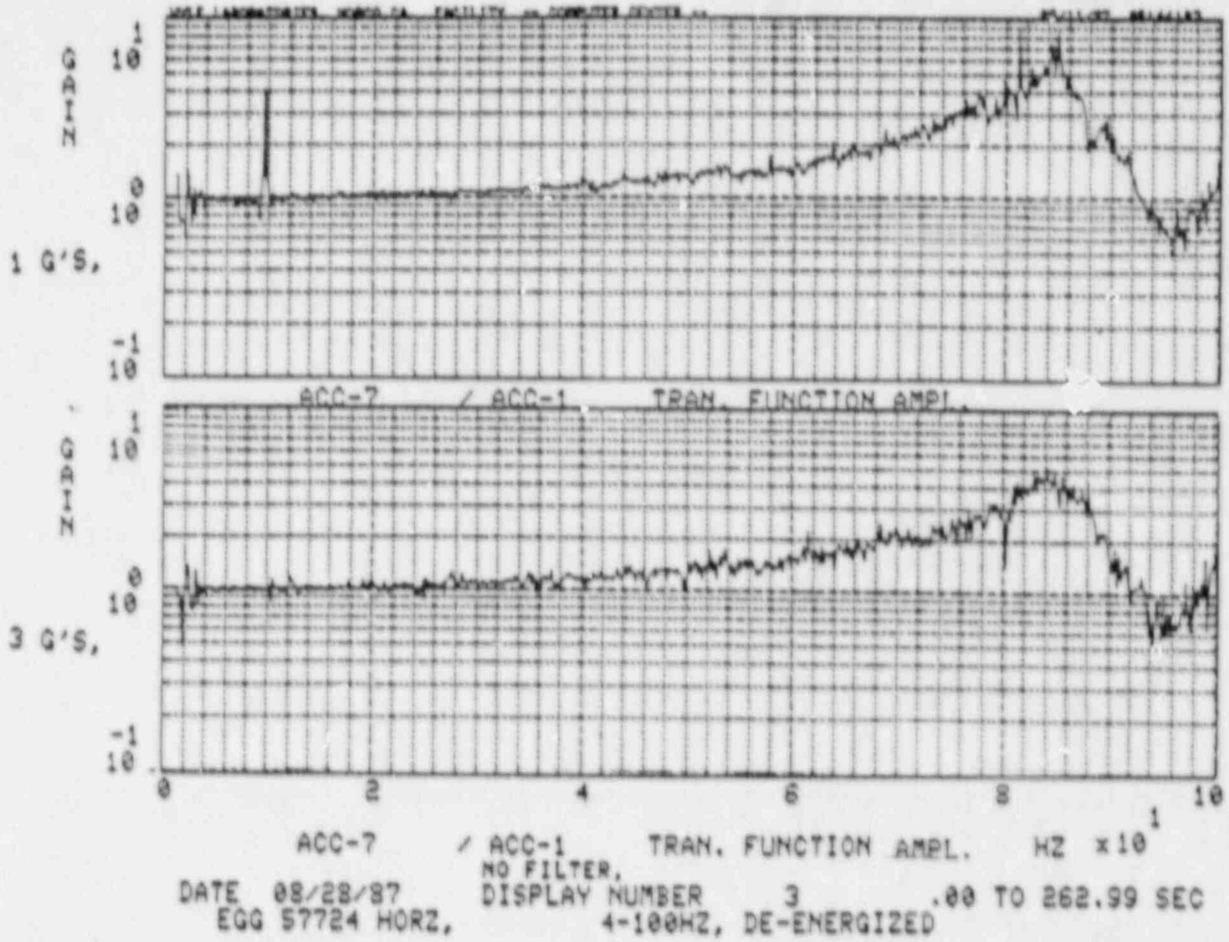


Figure 6-5
Transmissibility Plot for Test Table/Book End Fixture

7.0 GENERALIZED TEST RESULTS

None of the relays showed any contact chatter while energized. It indicates that contact chatter is caused by armature movement rather than local response of contact elements. Most of the chatter affiliated with the normally-closed (NC) relay contacts also prove the cause of chatter to be armature movement.

The contact chatter level was substantially higher in the horizontal direction than vertical. Contact chatter usually caused rebound acceleration of the relay.

While random excitation of 10 g's in the frequency range from 3 to 15 Hz initiated contact chatter, the same acceleration in the frequency range from 15 to 100 Hz did not cause any chatter. Chatter was recorded when broadband random excitation of 10 g's in the frequency range from 3 to 100 Hz was applied, but obviously the low frequency portion of the excitation caused the chatter.

The sinusoidal sweep test in the horizontal direction indicates frequency dependency of contact chatter. Both relay models in the study exhibited contact chatter not only in the traditional low frequency range below 15 Hz, but in the high frequency range 50 to 80 Hz. This phenomenon may be partially associated with the relay's resonances at 55 to 57 Hz for the Westinghouse relay, at 72 to 77 Hz for the GE relay, as well as the table/fixture resonance at 85 Hz.

Even so, the study was limited to only two different relay models and three specimens per model; good level of repeatability was achieved and a clear frequency sensitivity of relay contact chatter has been demonstrated.

8.0 REFERENCES

8.1 EG&G Idaho, Inc., Puvchase Order No. C87-101208 dated February 16, 1987.

8.2 Wyle Laboratories Test Plan No. 4477 for Seismic Fragility Testing of Electrical Components for EG&G Idaho, dated May 6, 1987.

8.3 Wyle Laboratories Quality Assurance Manual No. 380, Revision F, dated March 1, 1986.

8.4 STI VAMP Operator's Manual, Version 5A, dated June 18, 1984.

APPENDIX A

SUMMARY OF TEST QUALIFICATION REPORTS

INDEX KEY HSV 101

EG&G 57714

DATE 2/18/85

Page 1 of 2

SPECIMEN (Name, Structure Type, Size, Weight, Structure Characteristics):

15 KV METALCLAD SWITCHGEAR UNIT, 36W X 94D X 100H AND WEIGHING 3500 LBS., CONTAINING 4 DOOR-MOUNTED GE RELAYS, 1 DOOR-MOUNTED SWITCH, AND A 15 KV CIRCUIT BREAKER. DOOR HAD 4 HINGES AND 2 LATCHES.

DEVICE DESCRIPTION, LOCATION, ANOMALIES:

CONTACT CHATTER OF DOOR-MOUNTED RELAYS AND SPURIOUS OPENING OF 15 KV CIRCUIT BREAKER DURING TEST WHEN DOOR OPENED (5TH INCREASED LEVEL TEST AFTER SSE). ACCELEROMETERS 1, 2, AND 3 WERE LOCATED ON THE DOOR NEAR THE RELAYS AND 13, 14, AND 15 WERE LOCATED ON THE CIRCUIT BREAKER.

TEST PROGRAM SUMMARY:

TRIAXIAL RANDOM, MULTIFREQUENCY TESTING (5 OBE's, 1 SSE, AND 5 INCREASED LEVEL TESTS) WAS PERFORMED WITH THE CIRCUIT BREAKER CYCLED DURING THE SSE AND INCREASED LEVEL TESTS.

TEST LEVEL:

HORIZ. SSE TRS ZPA .75 TO 2.0 } SSE TEST FOLLOWED BY 5 INCREMENTALLY

VERT. SSE TRS ZPA .60 TO 2.0 } INCREASED LEVEL TESTS

NUMBER AND LOCATION OF IN-STRUCTURE ACCELEROMETERS, AND AVAILABILITY OF TRS PLOTS IN TEST REPORT:

16 IN-STRUCTURE ACCELEROMETERS; TRS PLOTS OF ALL ACCELEROMETERS FROM SSE AND 4TH INCREASED LEVEL TEST.

IN-STRUCTURE RESPONSE SPECTRA AT HIGHEST FREQUENCY VS RESPONSE SPECTRA AT 33 Hz EXPRESSED AS A PERCENTAGE:

TEST	ACCEL NO.	S_A (Highest Frequency)	S_A (33 Hz)	$\frac{S_A(H.F.) - S_A(33\ Hz)}{S_A(33\ Hz)} \times 100\%$
SSE	1FB	12.0	8.1	48%
	2SS	2.3	2.6	-12%
	3V	1.8	2.4	-25%
	13FB	9.0	2.8	221%
	14SS	6.6	7.0	-6%
	15V	12.5	4.7	166%
4TH INCR. LEVEL	1FB	49.0	23.0	113%
	2SS	6.3	7.8	-19%
	3V	4.9	4.6	7%
	13FB	10.3	5.6	84%
	14SS	12.5	9.2	36%
	15V	14.2	8.7	63%

TAPE AVAILABILITY: WYLE HSV HAS TAPES.

TABLE I

INDEX KEY	SPECIMEN DESCRIPTION		TEST PROGRAM							REMARKS
				SSE TRS ZPA LEVELS		ANOMALIES				
	Structure	Component	Test Description	Vertical	Horiz.	Component	Description	Location	Max. % Amp at F.	
NOR01	7 Bay, 22 cubical 150"x36"x90"H cabinet	Control and instrumentation devices	Biaxial multifrequency motion	0.7	1.3	N/A	N/A	N/A	166% at 70 Hz	See Record No. 1.
NOR02	3 bay cabinet	Control and instrumentation	Biaxial multifrequency random motion	0.75	0.8	N/A	N/A	N/A	133% at 50 Hz	
NOR03	Small enclosures	Various electronic and electro-mechanical components	Biaxial multifrequency random motion	36	20	N/A	N/A	N/A	% at 45 Hz	The specimen was subjected to a shock impact at 45 Hz. The amplification was 441% However, the amplification in 70 to 100 Hz range varied from 290% to 361%.
NOR04	Enclosure 24"x1.8"x12"	Various electronic and electro-mechanical components and cables	Biaxial multifrequency random motion	0.9	0.8	N/A	N/A	N/A	36% at 100 Hz	

TABLE 1 (cont.)

INDEX KEY	SPECIMEN DESCRIPTION		TEST PROGRAM							REMARKS
				SSE TRS ZPA LEVELS		ANOMALIES				
	Structure	Component	Test Description	Vertical	Horiz.	Component	Description	Location	Max. % Amp at F.	
NOR05	Cabinet 30"x25"x21" 150 lbs	Relays, transformer, motor	Biaxial multifrequency random motion.	0.7	0.6	N/A	N/A	N/A	400% at 52 Hz	
NOR06	Cabinet 60"x48"x48" 600 lbs	Transformer and cables	Biaxial multifrequency random motion	1.1	1.7	N/A	N/A	N/A	20% at 40 Hz	
NOR07	Large cabinet with two doors	Control devices, fuse, fuse block, cables	Biaxial multifrequency random motion	1.0	0.9	N/A	N/A	N/A	108% at 44 Hz	See Record No. 2.
NOR08	3 bay cabinet 140"x76"x9"	Control and Instrumentation devices. Instrumentation were mounted on two of the bay doors.	Biaxial multifrequency random motion	1.5	1.0	N/A	N/A	N/A	160% at 80 Hz	See Record No. 3.

TABLE I (cont.)

INDEX KEY	SPECIMEN DESCRIPTION		TEST PROGRAM							REMARKS
				SSE TRS ZPA LEVELS		ANOMALIES				
	Structure	Component	Test Description	Vertical	H	Component	Description	Location	Max. % Amp at F.	
NOR09	2 bay cabinet 70"x40"x90"	Control and instrumentation devices. Some devices mounted on the doors	Biaxial multifrequency random motion	0.15	0.18	N/A	N/A	N/A	112% at 90 Hz	
NOR10	Cabinet 60"x24"x60"	Control and instrumentation devices and transformer. Some devices mounted on the door.	Biaxial multifrequency random motion	0.13	0.7	N/A	N/A	N/A	83% at 100 Hz	
NOR11	4 bay, 4 door cabinet 140"x40"x90"	Control and instrumention indicating lights. Meter installed on the doors	Biaxial multifrequency random motion	13	7	meter	loose screws	on the door	171% at 30 Hz	An indicating frequency meter showed 60 Hz at the completion of the test when the cabinet was de-energized. It was concluded that two screws were loose.

TABLE 1 (cont.)

INDEX KEY	SPECIMEN DESCRIPTION		TEST PROGRAM							REMARKS
				SSE TRS ZPA LEVELS		ANOMALIES				
	Structure	Component	Test Description	Vertical	Horiz.	Component	Description	Location	Max. % Amp at F.	
NOR12	Cabinet 70"x70"x95"	Control and instrumentation devices. Some mounted on the door	Biaxial multifrequency random motion	0.7	1.5	N/A	N/A	N/A	--	Responses at F > 33 Hz were equal or less than the responses at 33 Hz.
NOR13	3 bay cabinet 150"x40"x9"	Control instrumentation, indicating lights. Lights, recorders mounted on the doors	Biaxial multifrequency random motion	5.0	2.4	N/A	N/A	N/A	160% at 70 Hz	
NOR14	2 bay cabinet 100"x40"x90"	Control instrumentation, indicating lights. Lights and switches mounted on both doors	Biaxial multifrequency random motion	2.6	2.1	N/A	N/A	N/A	375% at 87 Hz	

TABLE 1 (cont.)

INDEX KEY	SPECIMEN DESCRIPTION		TEST PROGRAM							REMARKS
				SSE TRS ZPA LEVELS		ANOMALIES				
	Structure	Component	Test Description	Vertical	Horiz.	Component	Description	Location	% Amp at Max. F.	
NOR15	Three bay motor control center 60"x21"x90" 3250 lbs	Eight controllers; twelve different relays, panel mounted	Biaxial multifrequency random motion	2.4	2.5	selected relays	bouncing, contact chatter	top of the cabinet	322% at 18 Hz	Comprehensive study of MCC under various load conditions. Amplification at F > 33 Hz did not occur. See Record No. 4.
NOR16	2 cabinets 36"x36"x18" and 18"x18"x12"	Control, instrumentation and indicating lights	Biaxial multifrequency random motion	7.5	17	light	did not operate	on the door	752% at 30 Hz	
NOR17	2 bay cabinets 60"x30"x90"	Control and instrumentation devices mounted inside the cabinet	Biaxial multifrequency random motion	1.8	2.5	N/A	N/A	N/A	328% at 100 Hz	
NOR18	2 small cabinets 24"x36"x12"	Control and instrumentation devices. Some devices mounted on the door	Biaxial multifrequency random motion	2	3	N/A	N/A	N/A	252% at 90 Hz	

TABLE I (cont.)

INDEX KEY	SPECIMEN DESCRIPTION		TEST PROGRAM							REMARKS
				SSE TRS ZPA LEVELS		ANOMALIES				
	Structure	Component	Test Description	Vertical	Horiz.	Component	Description	Location	Max. % Amp at F.	
NOR19	Cabinet 30"x30"x96" three control panels with doors	Control and instrumentation devices installed inside and on the front plate of the cabinet	Biaxial multifrequency random motion	2.8	2.4	N/A	N/A	N/A	538% at 100 Hz	
NOR25	Cabinet 150"x40"x90" 6000 lbs (2 cabinets)	Control devices installed inside and on the wall of the cabinet	Biaxial multifrequency random motion	4.6	1.5	N/A	N/A	N/A	223% at 100 Hz	
NOR21	Switchgear cabinet 40"x30"x50"	Control and power switching devices	Biaxial multifrequency random motion	.58	0.5	N/A	N/A	N/A	--	Responses at F > 33 Hz were equal or less than the response at 33 Hz.
NOR22	Cabinet 70"x30"x30"	Control, electronic components and a large transformer. The transformer is in 35x30x30 cubical. Some components installed in the door.	Biaxial multifrequency random motion	2.5	2.5	N/A	N/A	N/A	42% at 100 Hz	

TABLE 1 (cont.)

INDEX KEY	SPECIMEN DESCRIPTION		TEST PROGRAM							REMARKS
				SSE TRS ZPA LEVELS		ANOMALIES				
	Structure	Component	Test Description	Vertical	Horiz.	Component	Description	Location	Max. % Amp at F.	
NOR23	3 cabinets 1) 35"x35"x80" 875 lbs 2) 40"x40"x80" 975 lbs 3) 50"x30"x55"	Electrical, electronic and mechanical devices installed inside the cabinets	Biaxial multifrequency random motion	3.0	2.0	N/A	N/A	N/A	2300% at 100 Hz	
NOR24	Cabinet 40"x40"x80" 975 lbs	Electrical, electronic and control components installed inside the cabinet	Biaxial multifrequency random motion	4.0	1.8	N/A	N/A	N/A	900% at 100 Hz	
NOR25	4 small cabinets 1) 36"x20"x10" 2) 36"x24"x20" 3) 15"x36"x20" 4) 36"x30"x10"	Electrical switches, control components mounted inside the cabinet	Biaxial multifrequency random motion	12.0	12.0	N/A	N/A	N/A	--	Responses at F > 33 Hz were equal or less than response at 33 Hz.
NOR26	4 bay cabinet	Computer subassemblies	Biaxial multifrequency random motion	2.6	2.2	door, latches T-block	deformed and fractured	on door and inside cabinet	250% at 100 Hz	

TABLE 1 (cont.)

INDEX KEY	SPECIMEN DESCRIPTION		TEST PROGRAM							REMARKS
				SSE TRS ZPA LEVELS		ANOMALIES				
	Structure	Component	Test Description	Vertical	Horiz.	Component	Description	Location	Max. % Amp at F.	
NOR27	Mounting frame 25"x15"x15"	Signal isolator assemblies. Each assembly has electrical and electronic components	Biaxial multifrequency random motion	3.6	21.0	N/A	N/A	N/A	136% at 56 Hz	
NOR28	Small enclosure 24"x15"x20"	16 PCB are mounted inside. Push button and key board mounted on the wall of the enclosure	Biaxial multifrequency random motion	7.5	6.5	N/A	N/A	N/A	63% at 47 Hz	
NOR29	2 cabinets 1) 20"x20"x10" 2) 50"x20"x15"	Electrical electronic components lights and meters. mechanical components	Biaxial multifrequency random motion	15.5	10.5	N/A	N/A	N/A	237% at 100 Hz	Structural damage of the motor starter caused by test machine malfunction.
NOR30	Motor starter enclosure 24"x20"x10"	Control devices, relay, and contactor	Biaxial multifrequency random motion	9.0	25.0	N/A	N/A	N/A	37% at 100 Hz	

TABLE I (cont.)

INDEX KEY	SPECIMEN DESCRIPTION		TEST PROGRAM							REMARKS
				SSE TRS ZPA LEVELS		ANOMALIES				
	Structure	Component	Test Description	Vertical	Horiz.	Component	Description	Location	Max. % Amp at F.	
NOR31	Small enclosure 20"x20"x10"	Differential pressure switches	Biaxial multifrequency random motion	6.0	4.0	N/A	N/A	N/A	229% at 55 Hz	
NOR32	MCC cabinet 25"x30"x15"	Relays and contactors indicating lights	Biaxial multifrequency random motion	5.0	4.0	relay	contact chatter	mounted inside	77% at 44 Hz	
NOR33	Cabinet 60"x40"x90"	Relay, switches transformer and electronic components	Biaxial multifrequency random motion	7.0	3.0	relay	contact chatter	contact inside	314% at 80 Hz	
NOR34	Two Cabinet 1) local motor controller wall mounted 2) Battery charger cabinet	Lights, switches motor starters and electronic components	Biaxial multifrequency random	1) 5.4 2) 3.8	1) 3.8 2) 2.6	N/A	N/A	N/A	1) 77% at 45 Hz 2) 253% at 100 Hz	

TABLE 1 (cont.)

INDEX KEY	SPECIMEN DESCRIPTION		TEST PROGRAM							REMARKS
				SSE TRS ZPA LEVELS		ANOMALIES				
	Structure	Component	Test Description	Vertical	Horiz.	Component	Description	Location	Max. % Amp at F	
NOR 35	Cabinet 3 bays	Terminal blocks	Biaxial multifrequency random motion	0.4	0.6	N/A	N/A	N/A		Responses at F > 33 Hz were equal or less than response at F > 33 Hz.
NOR 36	Cabinet wall mounted	Component list not available (electronics)	Biaxial multifrequency random motion	7.0	5.4	N/A	N/A	N/A	146% at 50 Hz	
NOR 37	Generator control cabinet 4 bays	Transformers, switches, control devices	Random multifrequency motion	15.0	7.0	N/A	N/A	N/A	76% at 60 Hz	Cabinet structure was damaged. No component anamolies. See Record No. 5.
NOR 38	Starter cabinet	Component list not available. Pictures show door mounted transfer switches.	Random multifrequency motion	0.5	0.65	N/A	N/A	N/A	--	Responses at F > 33 Hz were equal or less than response at F > 33 Hz.

TABLE 1 (cont.)

INDEX KEY	SPECIMEN DESCRIPTION		TEST PROGRAM							REMARKS
				SSE TRS ZPA LEVELS		ANOMALIES				
	Structure	Component	Test Description	Vertical	Horiz.	Component	Description	Location	Max. % Amp at F.	
NOR39	Display panel	Component list not available. Picture shows door mounted transfer switches	Biaxial multifrequency random motion	9.0	9.0	N/A	N/A	N/A	40% at 100 Hz	
NOR40	Rack with fifteen digital multiplexers	Electronic	Single axis random motion	1.8	1.6	N/A	N/A	N/A	--	Responses at F > 33 Hz were equal or less than response at F > 33 Hz.
NOR41	Power supply cabinet	Relays contactors electronic components	Biaxial multifrequency random motion	0.32	0.75	N/A	N/A	N/A	39% at 40 Hz	
NOR42	Cabinet	Contactor, time delay relay, test switch, terminal block, fuse block, fuse	Biaxial multifrequency random motion	3.3	2.7	N/A	N/A	N/A	46% at 45 Hz	

TABLE 1 (cont.)

INDEX KEY	SPECIMEN DESCRIPTION		TEST PROGRAM							REMARKS
				SSE TRS ZPA LEVELS		ANOMALIES				
	Structure	Component	Test Description	Vertical	Horiz.	Component	Description	Location	Max % Amp. at F.	
NOR43	Two door cabinet	Rotary relay time delay relay fuse fuse block resistors terminal blocks	Biaxial multifrequency random motion	3.0	4.0	relay	contact chatter	on the back panel	350% at 44 Hz	
NOR44	Switch gear cabinet	Contactors, under/over voltage relays door mounted lights and switches	Biaxial multifrequency random motion	1.0	0.8	N/A	N/A	N/A		Responses at F > 33 Hz were equal or less than response at 33 Hz
NOR45	Two cabinets 1) Analyzer cabinet	Contactors, relays, P-switch, S-valve, flow-meter, valves, electronic components	Biaxial multifrequency random motion	5.0	5.6	N/A	N/A	N/A		Responses at F > 33 Hz were equal or less than response at 33 Hz
	2) Control cabinet	Relays, electronic components, transformer, fuse holder, fuse	Biaxial multifrequency random motion	4.0	5.0	N/A	N/A	N/A		Responses at F > 33 Hz were equal or less than response at 33 Hz

TABLE I (cont.)

INDEX KEY	SPECIMEN DESCRIPTION		TEST PROGRAM							REMARKS
				SSE TRS ZPA LEVELS		ANOMALIES				
	Structure	Component	Test Description	Vertical	Horiz.	Component	Description	Location	Max. % Amp at F.	
NOR46	Cabinet	Switches	Biaxial multifrequency random motion and fragility	0.9	0.8	switch	contact chatter	not known	--	The chatter occurred during fragility test Responses at F > 33 Hz were equal or less than response at 33 Hz
NOR47	Cabinet and display panel	Electrical and electronic components solid state relay, fuse blocks, fuse ho' 'er	Biaxial multifrequency random motion	0.6	1.2	N/A	N/A	N/A	127% at 70 Hz	See Record No. 6.
NOR48	3 bays cabinet	Door mounted protective relays and indicating lights	Biaxial multifrequency random motion	0.7	0.6	N/A	N/A	N/A	92% at 54 Hz	
NOR49	Two panels	Circuit breaker, motor starter, rotary relay, time delay relay, terminal blocks	Biaxial multifrequency random motion	4.0	4.0	N/A	N/A	N/A	84% at 56 Hz	

TABLE 1 (cont.)

INDEX KEY	SPECIMEN DESCRIPTION		TEST PROGRAM							REMARKS
				SSE TRS ZPA LEVELS		ANOMALIES				
	Structure	Component	Test Description	Vertical	Horiz.	Component	Description	Location	Max. % Amp at F.	
NOR30	Telephone switching	Electronic PCB	Single axis resonance search Single axis time history motion	3.2	6.0	N/A	N/A	N/A	--	Responses at F > 33 Hz were equal or less than response at 33 Hz
HSV101	Switchgear cabinet 36"x94"x100" 3500 lbs	Relays, switch and 15KV circuit breaker. The relays and switch were door mounted	Triaxial random multi-frequency motion	2.0	2.0	1) relay 2) 15KV circuit breaker	contact chatter spurious opening	door inside cabinet	221*	*Maximum response amplification at highest frequency (F = 100 Hz)
HSV102	2 wall mounted panels 1) 24"x10"x30" 2) 30"x14"x42"	Relay, switches indicating lights Relays, switches and indicating light door mounted.	Biaxial multifrequency random motion	3.9	4.0	relays	contact chatter	door	138*	The contact chatter was alleviated by welding 2 reinforcement angles to rear of the enclosure and adding a subpanel mounting stud to the rear of the enclosure at center of the subpanel.
HSV103	2 wall mounted panels 1) 21"x70"x30" 2) 26"x3"x62"	Circuit breaker panel. The circuit breaker panel was mounted in the back of the enclosure with 3 angle brackets	Biaxial multifrequency random motion	6.0	6.0	circuit breaker	opened	circuit breaker panel	65*	

TABLE 1 (cont.)

INDEX KEY	SPECIMEN DESCRIPTION		TEST PROGRAM							REMARKS
				SSE TRS ZPA LEVELS		ANOMALIES				
	Structure	Component	Test Description	Vertical	Horiz.	Component	Description	Location	Max. % Amp at F.	
HSV104	2 wall mount 1 panels 1) 14"x6"x19" 33 lbs 2) 28"x12"x47" 225 lbs	Relay, contactors time relay. Relay mounted on 4 subpanel	Biaxial multifrequency random motion	0.4	0.9	N/A	N/A	N/A	43*	* Maximum response amplification at highest frequency (F = 100 Hz)
HSV105	Wall mounted panel 32"x10"x50" 285 lbs	Circuit breaker control relay mounted on subpanels	Triaxial multifrequency random motion	3.2	3.1	N/A	N/A	N/A	132	
HSV106	MCC cabinet 40"x20"x104" 1600 lbs	Starters, circuit breakers, and transformer mounted on panels	Biaxial multifrequency random	1.5	2.5	contactor	contact chatter	upper left rear corner	31	
HSV107	MCC cabinet 34"x20"x91" 2000 lbs	Starters and 1.5KVA transformer	Triaxial multifrequency random motion	5.0	2.5	contactor	contact chatter	mounted inside panel	46	
						relay	contact chatter			

TABLE 1 (cont.)

INDEX KEY	SPECIMEN DESCRIPTION		TEST PROGRAM							REMARKS
				SSE TRS ZPA LEVELS		ANOMALIES				
	Structure	Component	Test Description	Vertical	Horiz.	Component	Description	Location	Max. % Amp at F.	
HSV108	MCC cabinet 40"x20"x92" and 1120 lbs	Starter and circuit breaker	Triaxial multifrequency random motion	4.1-4.0	2.5	N/A	N/A	N/A	112*	*Maximum response amplification at highest frequency (F = 100 Hz)
HSV109	Cabinet 66"x36"x84" 3500 lbs	Front surface mounted, switches, meters, and indicating lights	Triaxial multifrequency random motion	3.5	2.0	N/A	N/A	N/A	9*	
HSV110	4 bay cabinet 104"x82"x104" 9000 lbs	High ampere circuit (2000 ampere) and door mounted switches and indicating lights	Pseudo triaxial multi-frequency random motion	1.2	0.9	circuit breaker	contact chatter	inside	129*	
						under voltage and sequence relay	contact chatter	door		
HSV111	4 bay cabinet 212"x68"x90" 17000 lbs	Circuit breakers door mounted switches, lights, relays and 6.9KVA transformer	Biaxial multifrequency random motion	1.4	1.5	circuit breaker	contact chatter	inside cabinet	375*	

TABLE I (cont.)

INDEX KEY	SPECIMEN DESCRIPTION: Structure	SPECIMEN DESCRIPTION: Component	TEST PROGRAM: Test Description	SSE TRS ZPA LEVELS: Vertical	SSE TRS ZPA LEVELS: Horiz.	ANOMALIES: Component	ANOMALIES: Description	ANOMALIES: Location	Max. % Amp at F.	REMARKS
HSV112	Cabinet 32"x14"x90" 1000 lbs	30 and 60 ampere circuit breaker, 100 ampere fusible switches	Biaxial multifrequency random and triaxial multifrequency random motion	3.5	3.9	N/A	N/A	N/A	--	Responses at F > 33 Hz were less than response at F > 33 Hz.
HSV113	Cabinet 36"x18"x80" 700 lbs	Door mounted relays	Triaxial multifrequency random motion	0.63	0.62	N/A	N/A	N/A	68*	*Maximum response amplification at highest frequency (F = 100 Hz)
HSV114	Wall mounted panel 52"x30"x48" 820 lbs	Switches and fuses	Triaxial multifrequency random motion	0.5	0.6	N/A	N/A	N/A	729*	
HSV115	2 cabinets	Terminal block	Triaxial multifrequency random motion	4.8	1.8				87*	
	1) Termination cabinets 24"x36"x84" 600 lbs					N/A	N/A	N/A		
	2) Relay cabinet 30"x23"x90" 1100 lbs	Terminal block and relay mounted on subpanels and attached to the side walls				relay	contact chatter	subpanel		

TABLE I (cont.)

INDEX KEY	SPECIMEN DESCRIPTION		TEST PROGRAM							REMARKS
				SSE TRS ZPA LEVELS		ANOMALIES				
	Structure	Component	Test Description	Vertical	Horiz.	Component	Description	Location	Max. % Amp at F.	
HSV116	2 cabinets		Triaxial multifrequency random motion	1.1	1.1				147*	*Maximum response amplification at highest frequency (F= 100 Hz)
	1) 43"x28"x58" 600 lbs	Electric motor, pump pressure switch, circuit breaker				N/A	N/A	N/A		
	2) 54"x36"x78" 1200 lbs	Relays, circuit breakers terminal blocks, controllers, meters, transformers				relay	contact chatter	subpanel		
HSV117	3 MCC cabinet 1) 90"x20"x90" 1800 lbs 2) 40"x20"x90" 1500 lbs 3) 20"x20"x90" 900 lbs	Starters, circuit breakers and transformer	Triaxial multifrequency random motion	0.6	0.5	N/A	N/A	N/A	0*	
HSV118	MCC cabinet 30"x20"x92" 2875 lbs	Starters, circuit breakers, door mounted switch and relay	Triaxial multifrequency random motion	4.4	2.3	starter	contact chatter	upper section of MCC	109*	

TABLE I (cont.)

INDEX KEY	SPECIMEN DESCRIPTION		TEST PROGRAM							REMARKS
				SSE TRS ZPA LEVELS		ANOMALIES				
	Structure	Component	Test Description	Vertical	Horiz.	Component	Description	Location	Max. % Amp at F.	
HSV119	Wall mounted panel 36"x12"x60" and detectors	Relay, power supply switches detectors and sirens	Triaxial multifrequency random motion	0.9	1.1	N/A	N/A	N/A	44*	*Maximum response amplification at highest frequency (F = 100 Hz)
HSV120	2 Bay switchgear 72"x38"x100" 3450 lbs	High ampere circuit breakers, relay, transformer and switches	Triaxial multifrequency random motion	3.6	2.0	N/A	N/A	N/A	75*	
HSV121	2 cabinets 1) 2 bay MCC cabinet 60"x20"x110" 1170 lbs 2) 3 bay MCC cabinet 60"x20"x110" 1730 lbs	Relays, circuit breakers, starters, ground fault relays	Triaxial multifrequency random motion	1.7	1.7	circuit breakers	contact chatter	inside cabinet	117*	

TABLE 1 (cont.)

INDEX KEY	SPECIMEN DESCRIPTION		TEST PROGRAM							REMARKS
				SSE TRS ZPA LEVELS		ANOMALIES				
	Structure	Component	Test Description	Vertical	Horiz.	Component	Description	Location	Max. % Amp at F.	
HSV122	High voltage starter cabinets 40"x36"x92" 1600 lbs	Power and current transformers, relays, contactors, switches, and meter	Biaxial multifrequency random motion	0.4	0.4	N/A	N/A	N/A	24*	*Maximum response amplification at highest frequency (F = 100 Hz)
HSV123	Panel 16"x8"x24" 70 lbs	Contactors, control relays, transformer	Triaxial multifrequency random motion	0.8	1.0	N/A	N/A	N/A	5*	
HSV124	3 panels 1) AC panel board 40"x12"x62" 410 lbs 2) DC switch-board 70"x50"x90" 2660 lbs 3) AC panel board 35"x12"x70" 410 lbs	Circuit breakers, door mounted relay, meters, switches AC panels wall mounted DC panels base mounted	Triaxial multifrequency random motion	0.9	1.5	N/A	N/A	N/A	213*	

TABLE I (cont.)

INDEX KEY	SPECIMEN DESCRIPTION: Structure	SPECIMEN DESCRIPTION: Component	TEST PROGRAM: Test Description	SSE TRS ZPA LEVELS: Vertical	SSE TRS ZPA LEVELS: Horiz.	ANOMALIES: Component	ANOMALIES: Description	ANOMALIES: Location	Max. % Amp at F.	REMARKS
HSV125	3 cabinets 1) 3 bay cabinet 90"x20"x90" 1800 lbs 2) 2 bay cabinet 40"x20"x90" 1500 lbs 3) cabinet 20"x20"x90" 800 lbs	Starters, circuit breaker, distributor, transformer	Triaxial multifrequency random motion	0.8	0.9	N/A	N/A	N/A	14*	*Maximum response amplification at highest frequency (F = 100 Hz)
HSV126	Cabinet 26"x90"x90" 2150 lbs	Door mounted switches, relays, time delay relay, and 1200A circuit breaker	Biaxial multifrequency random motion	1.1	0.6	switch	contact chatter	door	89*	
HSV127	Cabinet 58"x48"x90" 2225 lbs	Printed circuit board, power supply, relays and connector		1.4	1.0	N/A	N/A	N/A	159*	

TABLE 1 (cont.)

INDEX KEY	SPECIMEN DESCRIPTION		TEST PROGRAM							REMARKS
				SSE TRS ZPA LEVELS		ANOMALIES				
	Structure	Component	Test Description	Vertical	Horiz.	Component	Description	Location	Max. % Amp at F.	
HSV128	Control panel 112"x24"x84" 2500 lbs	Front surface mounted meter, switches, indicating light, annunciator, and control relays	Triaxial multifrequency random motion	3.0	1.3	Indicating light	Short circuit	Front surface	35*	*Maximum response amplification at highest frequency (F = 100 Hz)
HSV129	Distribution panel 38"x24"x90" 2000 lbs	Terminal blocks fuses, switches	Biaxial multifrequency random motion	.8	1.2	N/A	N/A	N/A	14*	
HSV130	Battery charger cabinet 46"x36"x75" 2500 lbs	Door mounted switches, meter, lights, and front surface mounted breakers subpanels with relays	Triaxial multifrequency random motion	4.0	3.0	N/A	N/A	N/A	24*	
HSV131	Relay cabinet 72"x88"x82"	Door mounted relays and internally mounted potential transformers	Biaxial multifrequency random motion	1.0	2.0	relay under voltage	contact chatter	door	1775*	

TABLE I (cont.)

INDEX KEY	SPECIMEN DESCRIPTION		TEST PROGRAM							REMARKS
				SSE TRS ZPA LEVELS		ANOMALIES				
	Structure	Component	Test Description	Vertical	Horiz.	Component	Description	Location	Max. % Amp at F.	
HSV132	Control panel 60"x36"x72" 2000 lbs	Relays, isolation devices, power supply	Biaxial multifrequency random motion	0.7	1.2	N/A	N/A	N/A	600*	*Maximum response amplification at highest frequency (F = 100 Hz)
HSV133	2 bay MCC cabinet 40"x20"x90" 1100 lbs	Starters and circuit breaker	Biaxial multifrequency random motion	0.7	0.7	N/A	N/A	N/A	92*	
HSV134	Switchgear cabinet 36"x132"x90" 5800 lbs	Door mounted relay, ground detectors, switches, meters	Biaxial multifrequency random motion	0.8	1.6	over current relay	chatter	door	380*	
HSV135	Relay cabinet 50"x30"x90" 1100 lbs	Relays, fuses and terminal block	Biaxial multifrequency random motion	.16	.20	N/A	N/A	N/A	32*	
HSV136	Cabinet 74"x24"x91" 1300 lbs	Door mounted relay, switches meters, lights and inside rear panel mounted current transformer contactor, relay	Biaxial multifrequency random motion	1.7	1.6	contactor relay	contact chatter contact chatter	rear panel rear panel	436*	

TABLE I (cont.)

INDEX KEY	SPECIMEN DESCRIPTION: Structure	SPECIMEN DESCRIPTION: Component	TEST PROGRAM: Test Description	SSE TRS ZPA LEVELS: Vertical	SSE TRS ZPA LEVELS: Horiz.	ANOMALIES: Component	ANOMALIES: Description	ANOMALIES: Location	Max. % Amp at F.	REMARKS
HSV137	3 bay MCC cabinet 70"x20"x92" 1500 lbs	Relays, circuit breaker, contactor, and relay panel	Biaxial multifrequency random motion	0.5	1.1	N/A	N/A	N/A	--	Responses at $F > 33$ Hz were less than response at $F > 33$ Hz.
HSV138	Distribution cabinet 98"x20"x92" 2000 lbs	Motor starter, circuit breaker, relay	Biaxial multifrequency random motion	4.0	2.0	motor starter relay	contact chatter contact chatter	inside cabinet	6*	*Maximum frequency amplification at highest frequency ($F = 100$ Hz)
HSV139	2 bay switchgear cabinet 72"x97"x90"	Door mounted relays, lights switches, and subpanel mounted switches relays, transformer, and a 1200A circuit breaker	Pseudo triaxial multifrequency random motion	1.2	0.7	under frequency relay	contact chatter	door	235*	

TABLE 1 (cont.)

INDEX KEY	SPECIMEN DESCRIPTION		TEST PROGRAM							REMARKS
				SSE TRS ZPA LEVELS		ANOMALIES				
	Structure	Component	Test Description	Vertical	Horiz.	Component	Description	Location	Max. % Amp at F.	
HSV140	Control console 156"x66"x162" 3750 lbs	Switches, lights	Biaxial multifrequency random motion	0.4	1.2	N/A	N/A	N/A	350*	*Maximum response amplification at highest frequency (F = 100 Hz)
	Interface cabinet 168"x24"x72" 3450 lbs	Rack - mounted power supplies								
HSV141	Control cabinet 57"x30"x97" 2000 lbs	Circuit card racks, power supply, controller, circuit breaker and relay	Biaxial multifrequency random motion	0.3	1.0	circuit card	output changed	rack	237*	
HSV142	Relay panel 36"x18"x48" 500 lbs	Selector switches, pushbutton switches relay	Biaxial multifrequency random motion	0.7	0.8	N/A	N/A	N/A	148*	
HSV143	Cabinet 72"x24"x92" 1000 lbs	Vertical channel mounted relays	Biaxial multifrequency random motion	.9	1.1	N/A	N/A	N/A	31*	

TABLE 1 (cont.)

INDEX KEY	SPECIMEN DESCRIPTION		TEST PROGRAM							REMARKS
				SSE TRS ZPA LEVELS		ANOMALIES				
	Structure	Component	Test Description	Vertical	Horiz.	Component	Description	Location	Max. % Amp at F.	
HSV144	Cabinet 24"x30"x84"	Rack mounted signal conditioning, power supply and alarm units	Biaxial multifrequency random motion	0.6	1.8	N/A	N/A	N/A	44*	*Maximum response amplification at highest frequency (F = 100 Hz)
HSV145	Panel 24"x4"x24" 40 lbs wall mounted	Alarm control	Biaxial multifrequency random motion	1.2	1.8	N/A	N/A	N/A	115*	
HSV146	Two cabinets 1) 36"x12"x48" 350 lbs	Relays, power supplies, terminal block mounted on subpanel and attached to the enclosure	Biaxial multifrequency random motion	4.0	5.0	pressure switch	contact chatter	subpanel	413*	
						relay	contact chatter	door		
						circuit breaker	breaker was tripped	subpanel		
	2) 36"x12"x48" 350 lbs	Door mounted relay, meter switch, and subpanel mounted circuit breaker, pressure switch, transformer								

TABLE 1 (cont.)

INDEX KEY	SPECIMEN DESCRIPTION		TEST PROGRAM							REMARKS
				SSE TRS ZPA LEVELS		ANOMALIES				
	Structure	Component	Test Description	Vertical	Horiz.	Component	Description	Location	Max. % Amp at F.	
HSV147	Cabinet 45"x10"x62" 1000 lbs	Subpanel mounted relays, isolation devices, terminal blocks	Biaxial multifrequency random motion	0.5	0.8	N/A	N/A	N/A	10*	*Maximum response amplification at highest frequency (F = 100 Hz)
HSV148	Panel 60"x12"x48" 700 lbs	Subpanel mounted relay, terminal block, contactors, voltage adjuster, temperature controller	Biaxial multifrequency random motion	0.7	0.9	N/A	N/A	N/A	219*	
HSV149	Cabinet 58"x46"x97" 3000 lbs	Door mounted switch, meter, lights, and subpanel mounted relays, timers circuit cards and 1600A circuit breaker, transformer	Biaxial multifrequency random motion	0.9	1.0	relay	contact chatter	subpanel	58*	

TABLE 1 (cont.)

INDEX KEY	SPECIMEN DESCRIPTION		TEST PROGRAM							REMARKS
				SSE TRS ZPA LEVELS		ANOMALIES				
	Structure	Component	Test Description	Vertical	Horiz.	Component	Description	Location	Max. % Amp at F.	
HSV150	Cabinet 72"x18"x72" 1000 lbs	Door mounted switches, lights, and subpanel mounted undervoltage and under-frequency monitors, relays, and isolation devices	Biaxial multifrequency random motion	1.0	1.0	N/A	N/A	N/A	71*	*Maximum response amplification at highest frequency (F = 100 Hz)

APPENDIX B

ACCELERATION TIME HISTORY PLOTS

RECORD NO. 1

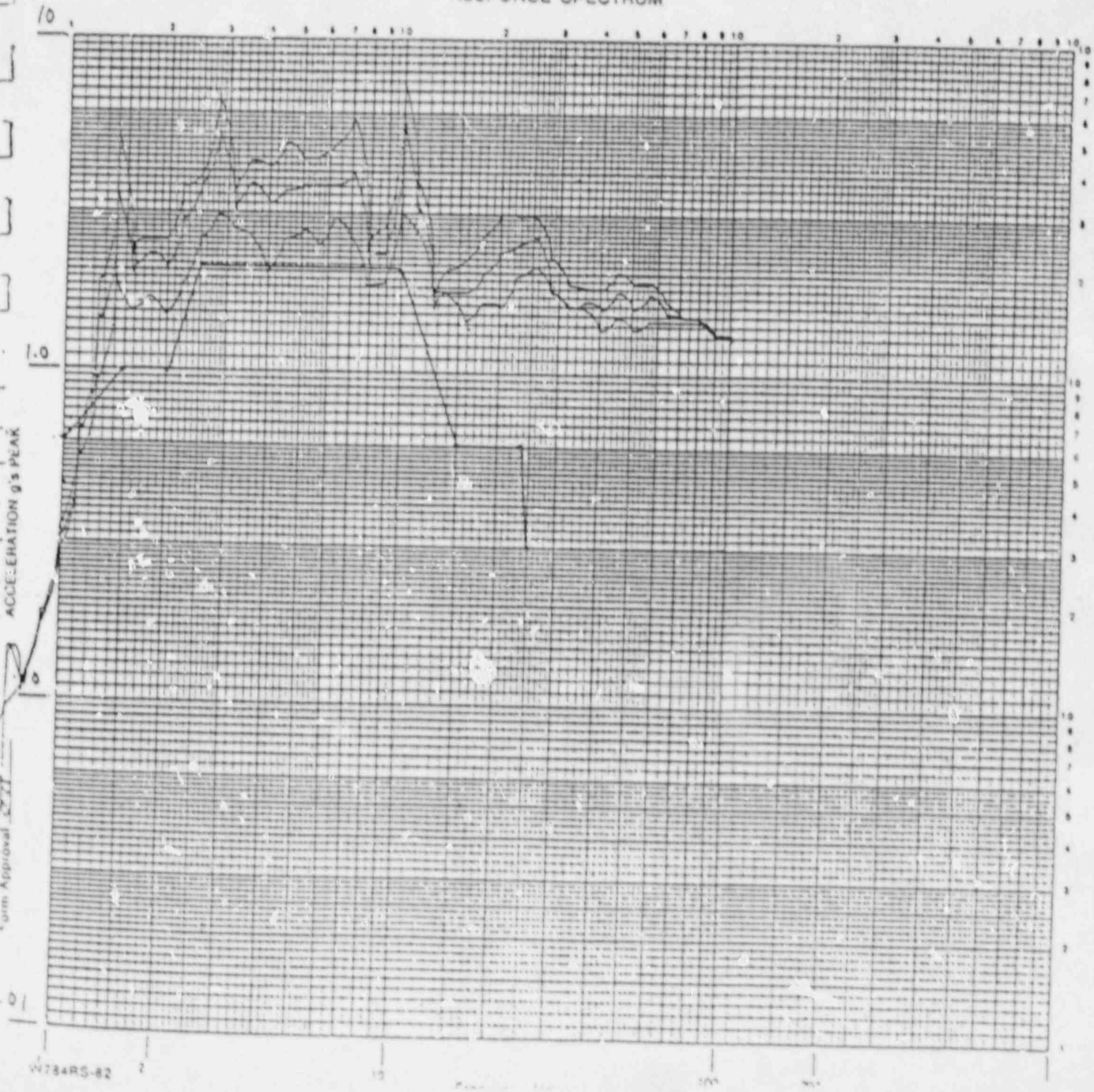
Specimen 125V DC DISTRIBUTION SWITCHBOARD Axis of Test X - Y

Accel. No. 1 Axis HORIZ Control (✓) Response ( ) OBE ( ) SSE (✓) OBE ( )

Full Scale 10 g Damping 1, (2), 5 % Run No. 11

Operator GRETERMAN Engineer C.C. Lu

RESPONSE SPECTRUM



Form Approval

W784RS-82

RECORD NO. 1

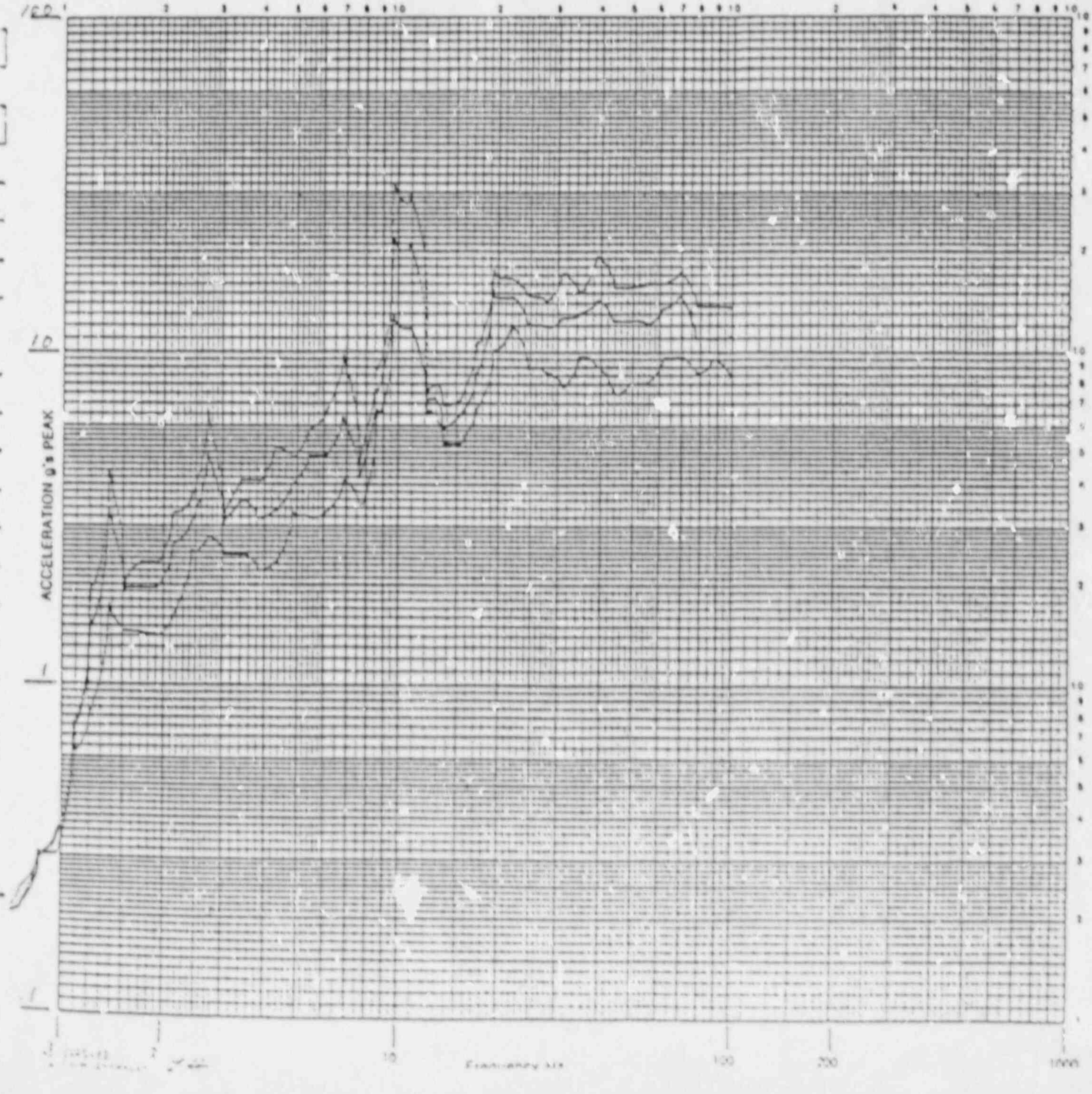
Specimen 125 V DC Distribution Switch Boards Axis of Test X-Y

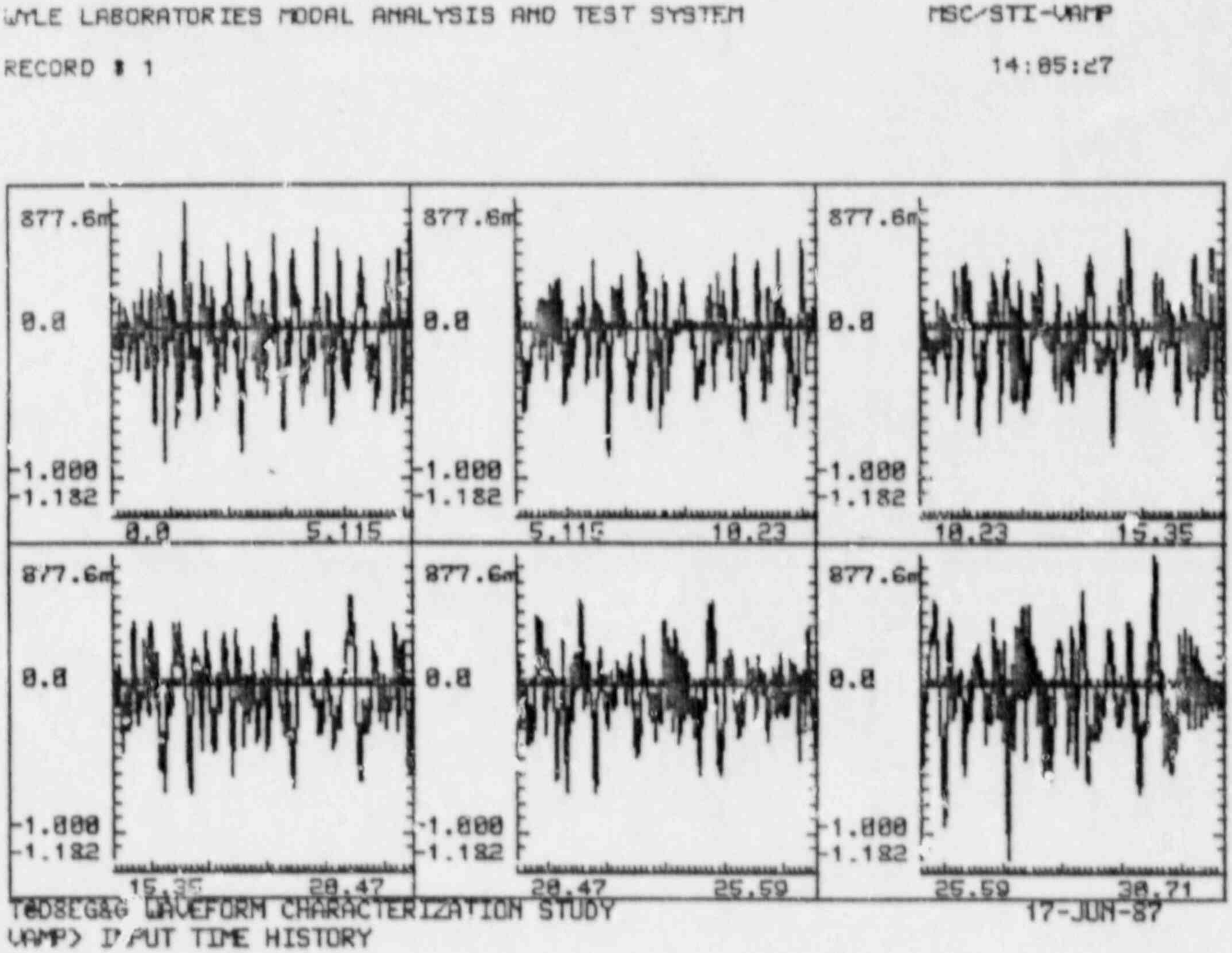
Accel. No. 7 Axis X Control ( ) Response (✓) OBE ( ) SSE (✓) DBE ( )

Full Scale 100 g Damping 1, 2, 5 % Run No. 11

Operator Gruterman Engineer C C Lu

RESPONSE SPECTRUM

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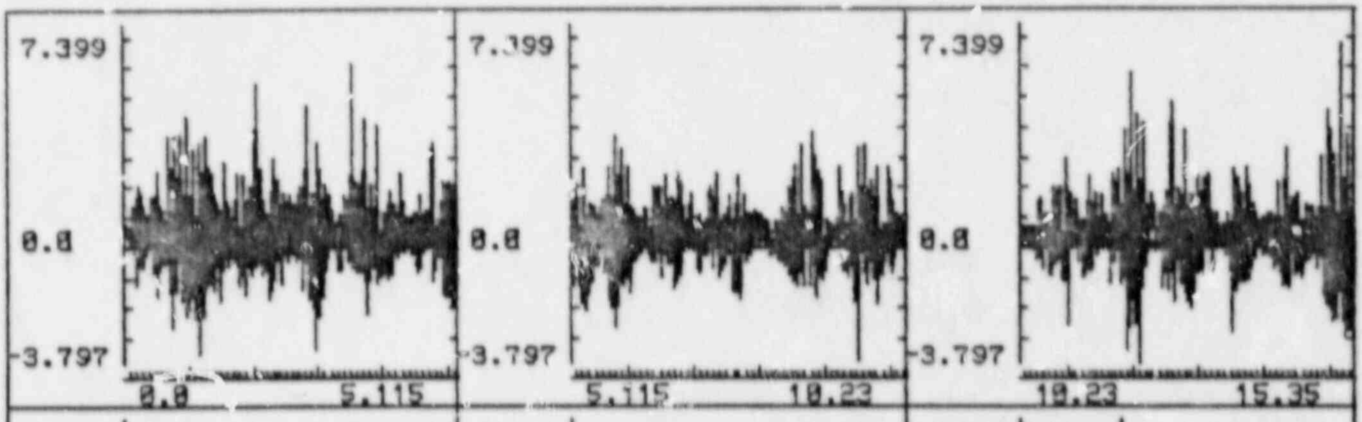
25.59
30.71
T0D8EG&G WAVEFORM CHARACTERIZATION STUDY
17-JUN-87
VAMP> INPUT TIME HISTORY

WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM MSC/STI-VAMP

RECORD # 1 14:07:48

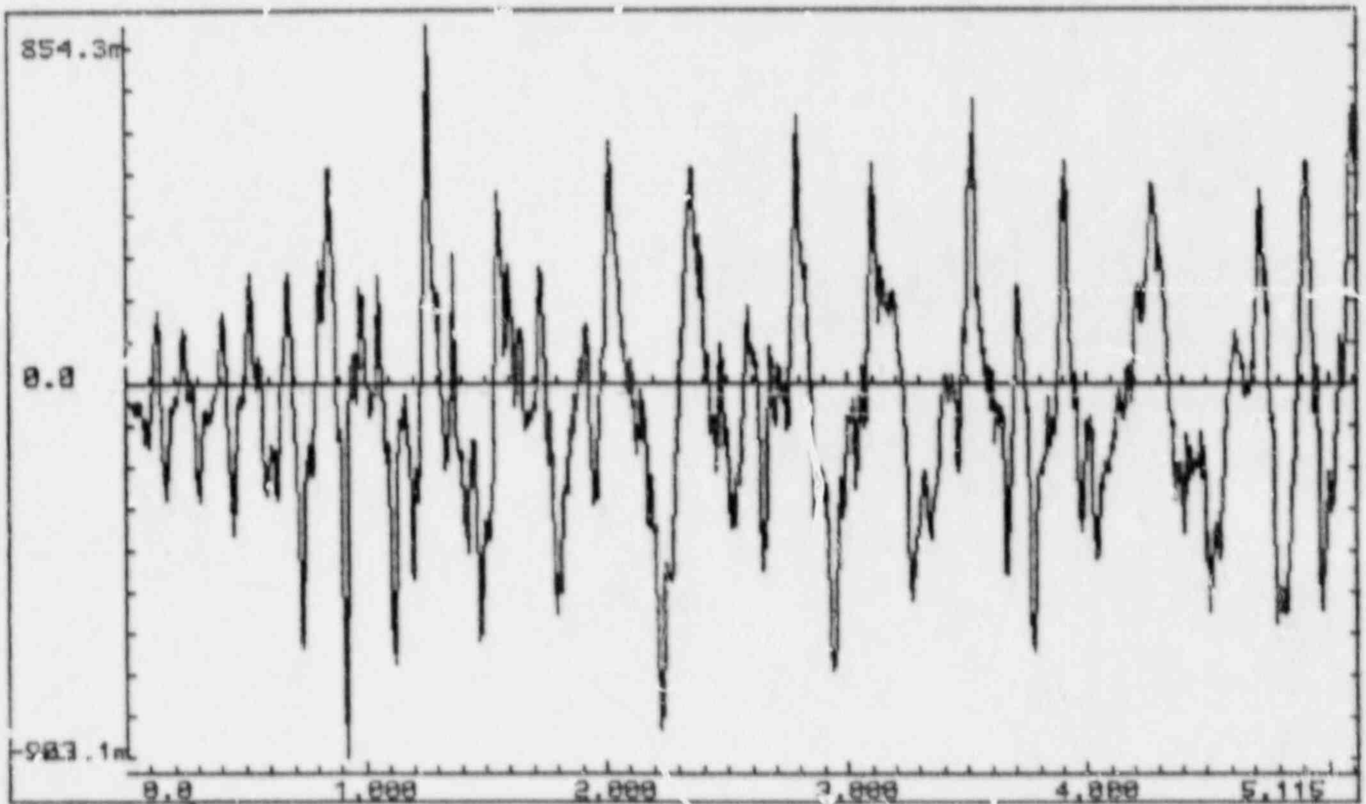


T0D8EG&G WAVEFORM CHARACTERIZATION STUDY 17-JUN-87

VAMP> RESPONSE TIME HISTORY

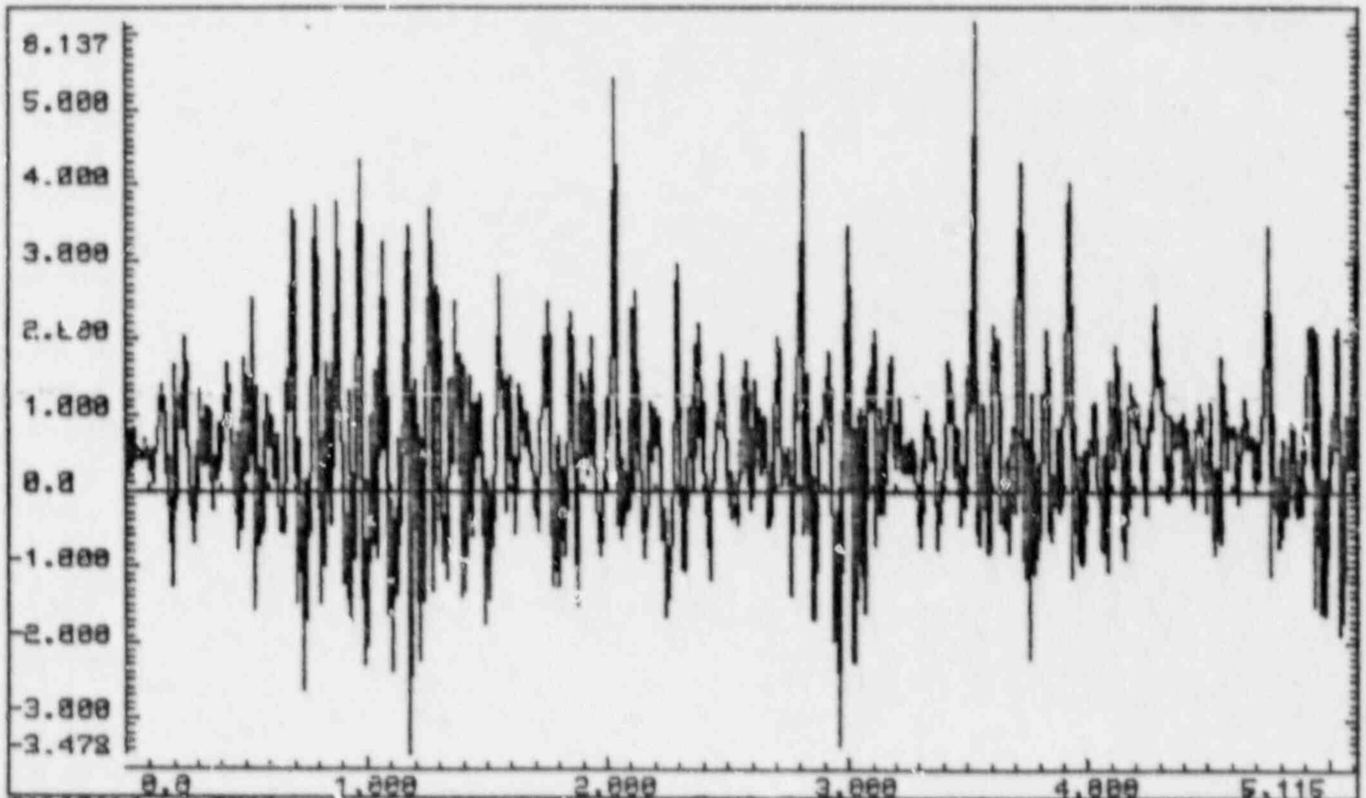
WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM MSC/STI-VAMP

RECORD # 1 14:16:43



WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM MSC/STI-VAMP

RECORD # 1 14:17:42



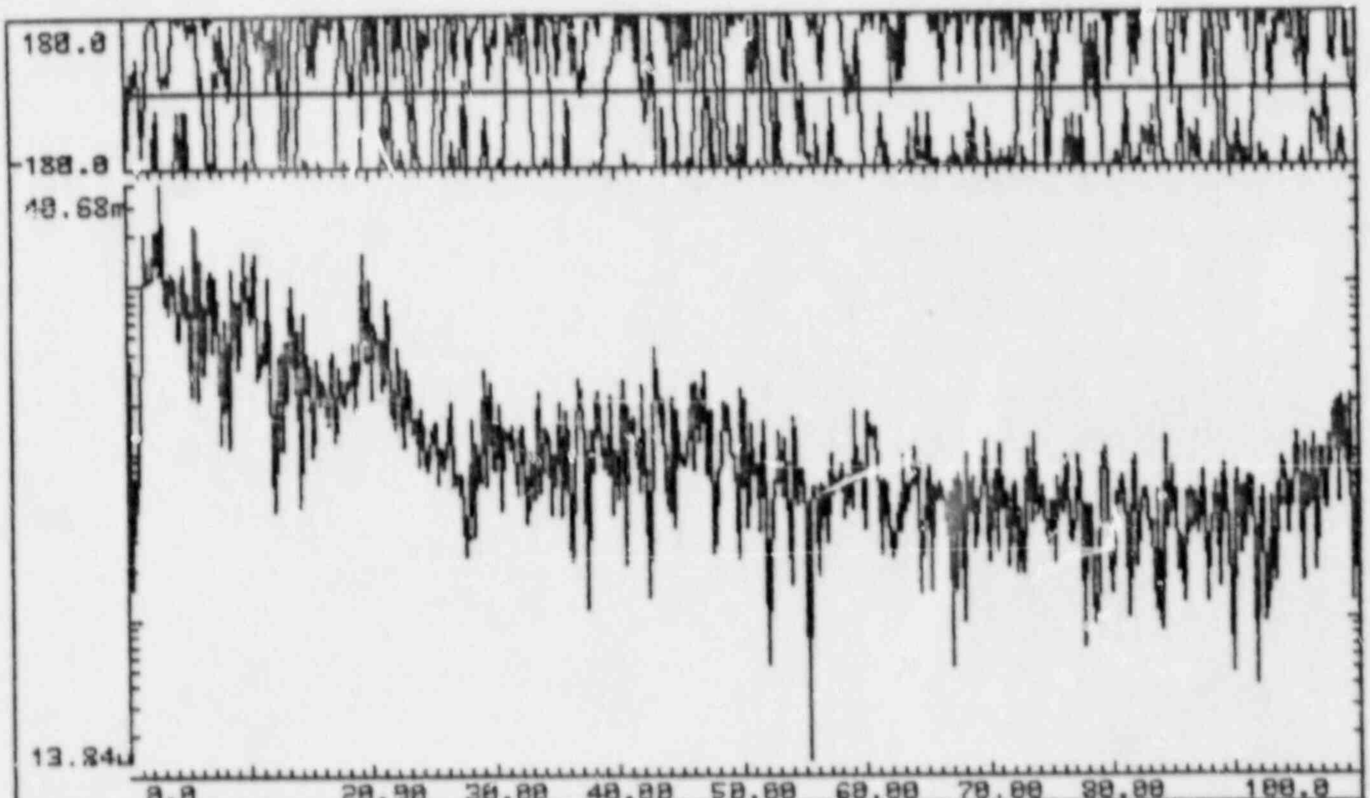
T0D8EG&G WAVEFORM CHARACTERIZATION STUDY 17-JUN-87

VAMP> RESPONSE

WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM MSC/STI-VAMP

RECORD # 1 14:28:58

FFT



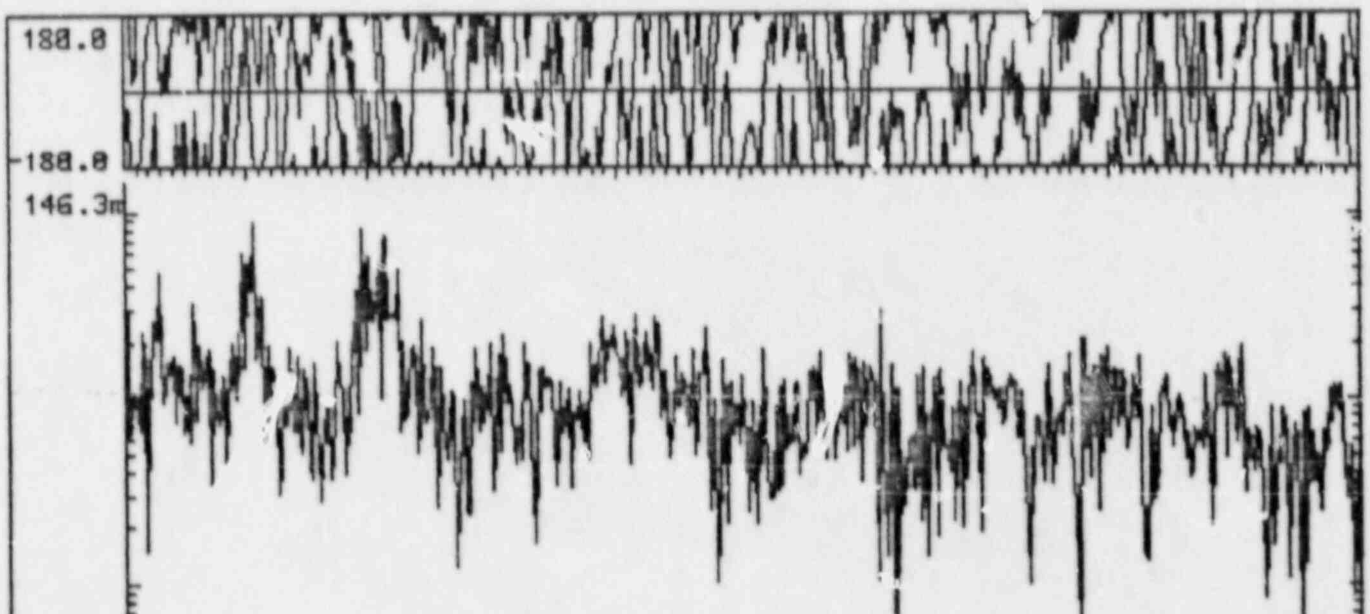
T@DSEG&G WAVEFORM CHARACTERIZATION STUDY 17-JUN-87

VAMP> INPUT

WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM MSC/STI-VAMP

RECORD # 1 4:23:55

FFT

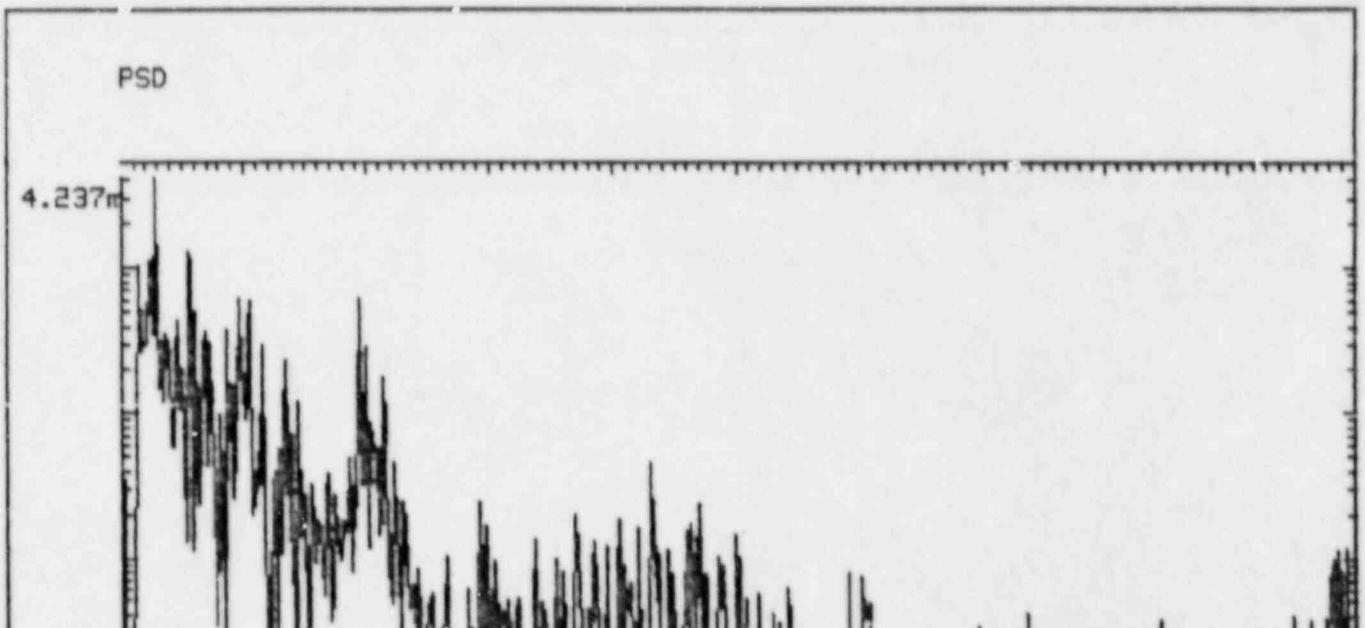


T&G&G WAVEFORM CHARACTERIZATION STUDY 17-JUN-87

VAMP> RESPONSE

WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM MSC/STI-VAMP

RECORD # 1 14:28:55

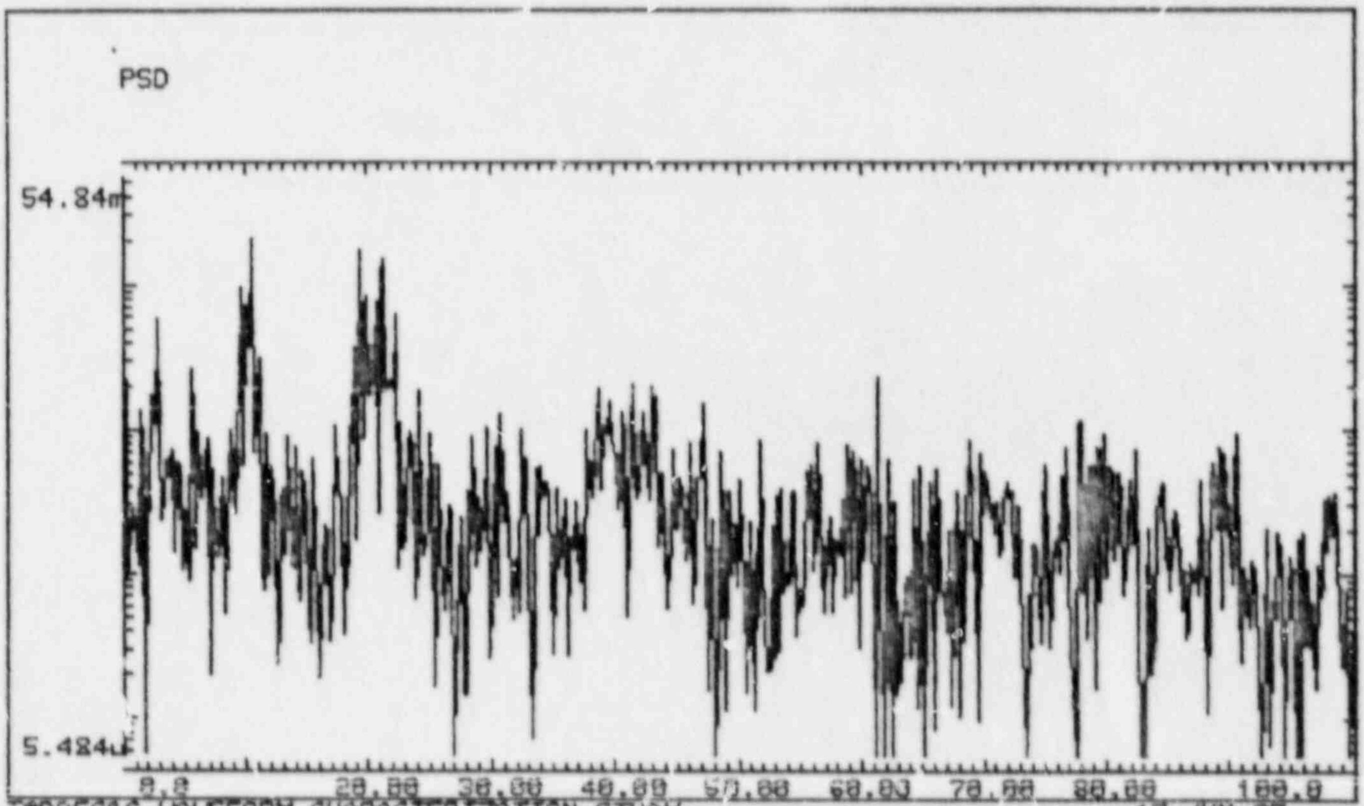


T&D8EG&G WAVEFORM CHARACTERIZATION STUDY 17-JUN-87

VAMP> INPUT

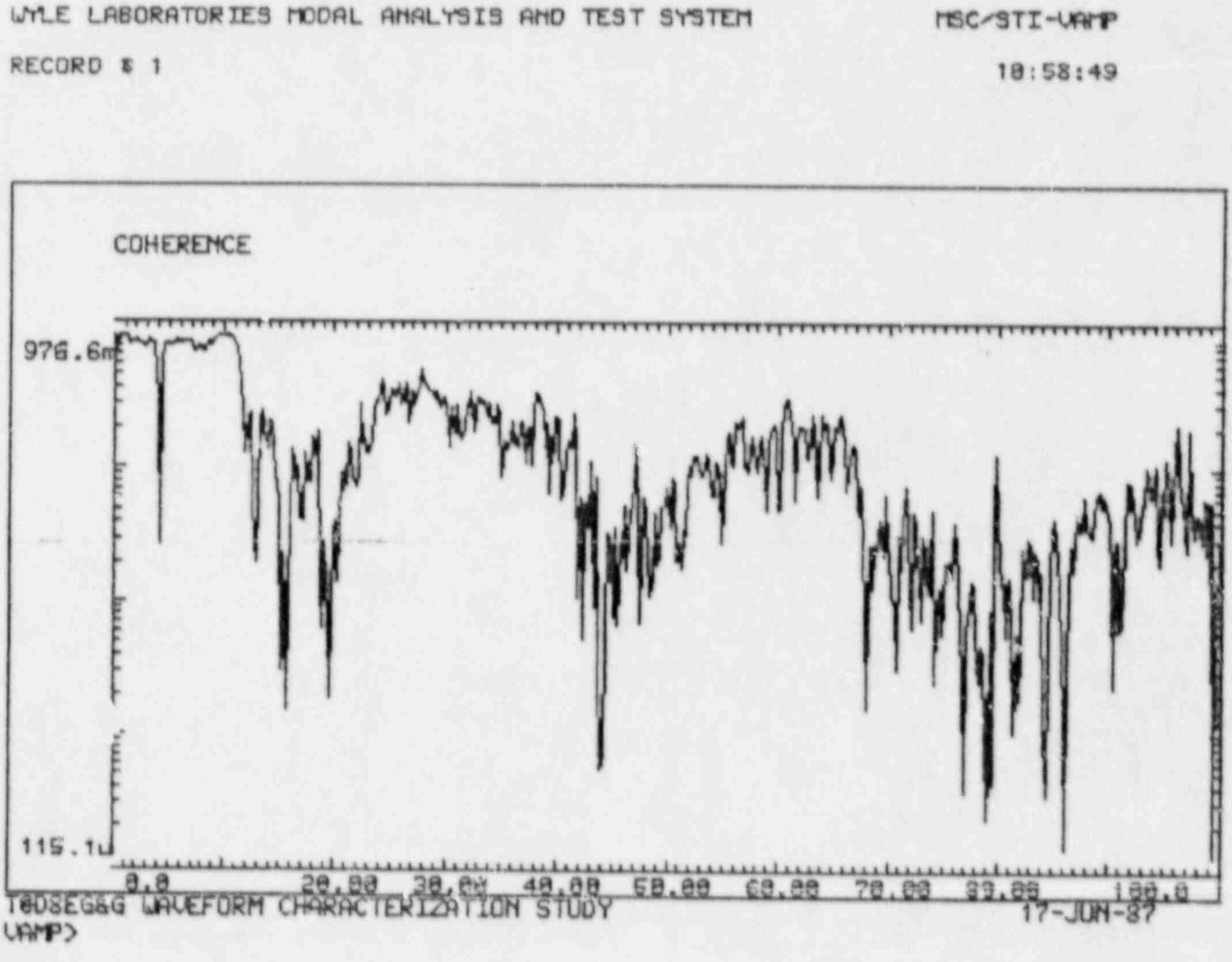
WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM MSC/STI-VAMP

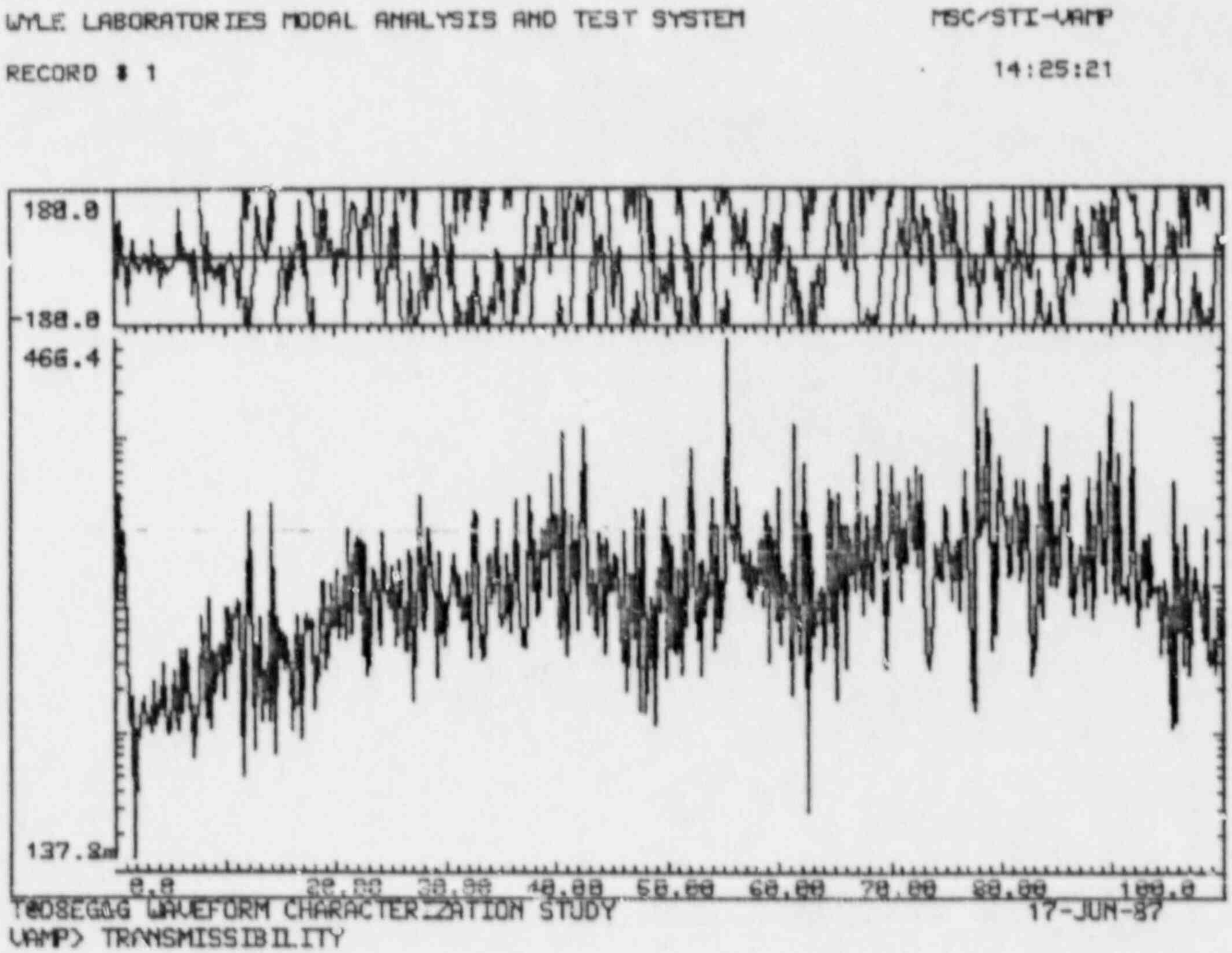
RECORD # 1 14:27:37



T008EG&G WAVEFORM CHARACTERIZATION STUDY 17-JUN-87

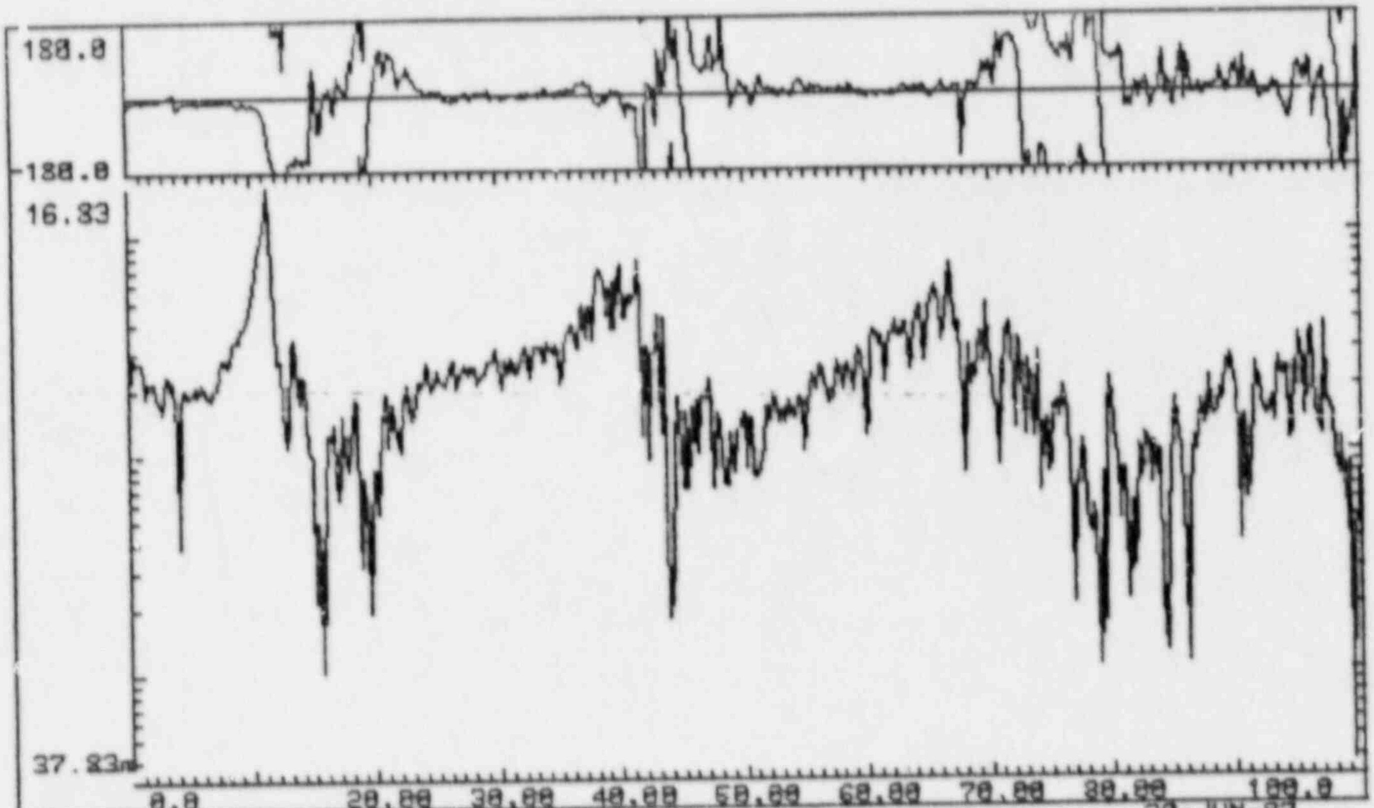
VAMP> RESPONSE


WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM
MSC/STI-VAMP
RECORD # 1
18:58:49
COHERENCE
976.6m
115.1u
0.0
20.00
30.00
40.00
50.00
60.00
70.00
80.00
100.0
T0DSEG&G WAVEFORM CHARACTERIZATION STUDY
17-JUN-87
VAMP>


WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM
MSC/STI-VAMP
RECORD # 1
14:25:21
180.0
-180.0
466.4
137.2m
0.0
20.00
30.00
40.00
50.00
60.00
70.00
80.00
100.0
T@DSEG&G WAVEFORM CHARACTERIZATION STUDY
17-JUN-87
VAMP> TRANSMISSIBILITY

WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM MSC/STI-VAMP

RECORD # 1 15:11:36



T@DSEG&G WAVEFORM CHARACTERIZATION STUDY 20-JUN-87

VAMP> TRANSFER FUNCTION

RECORD NO. 2

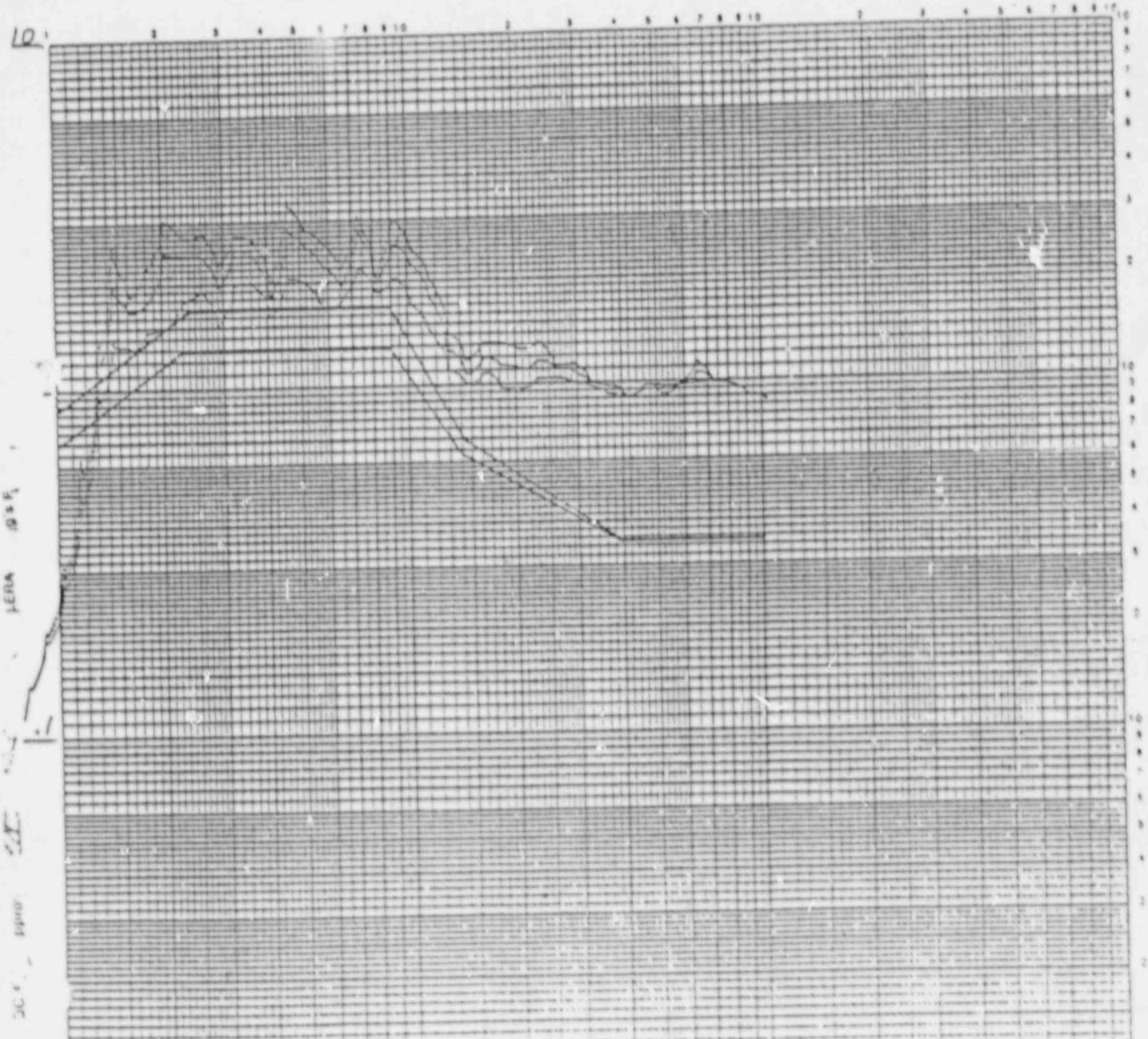
Specimen ENGINE CONTROL PANEL Axis of Test X-Y

Accel. No. 1 Axis HORIZ Control (✓) Response ( ) OBE ( ) SSE (✓) OBE ( )

Full Scale 10 g Damping 2,5,5,3 % Run No. 12

Operator GREIERMAN Engineer

RESPONSE SPECTRUM



RECORD NO. 2

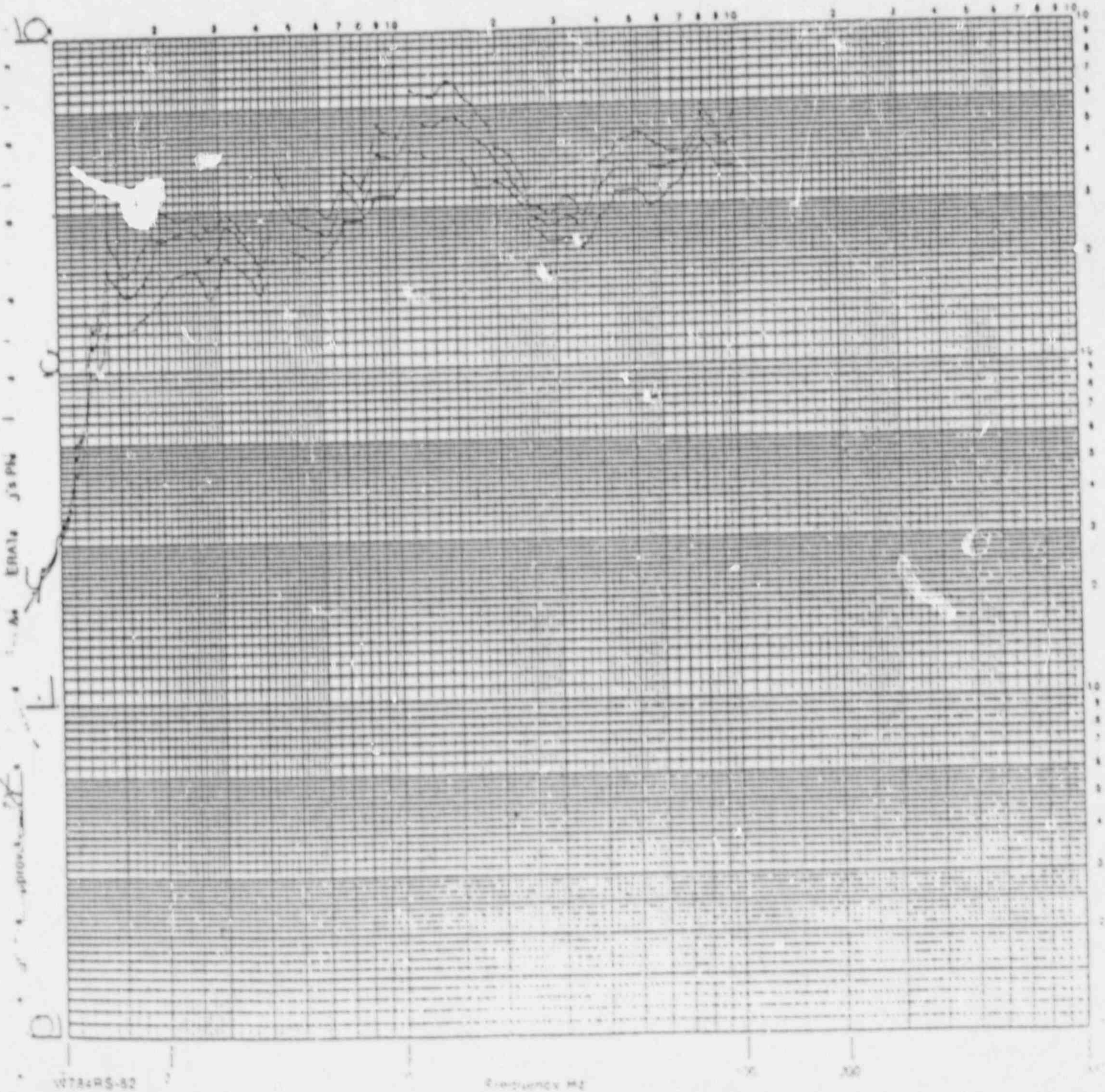
Specimen Engine Control Panel Axis of Test X-Y

Accel. No. 5 Axis X Control ( ) Response (✓) OBE ( ) SSE (✓) DBE ( )

Full Scale 10 g Damping 2 3 5 % Run No. 12

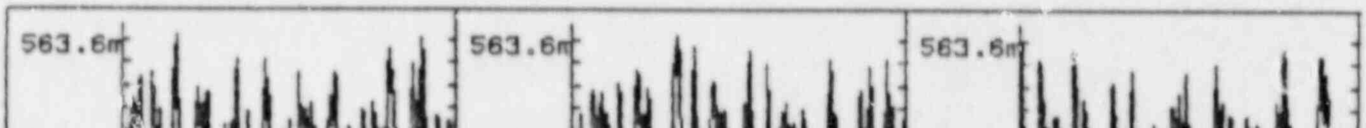
Operator GRETERMAN Engineer [illegible]

RESPONSE SPECTRUM



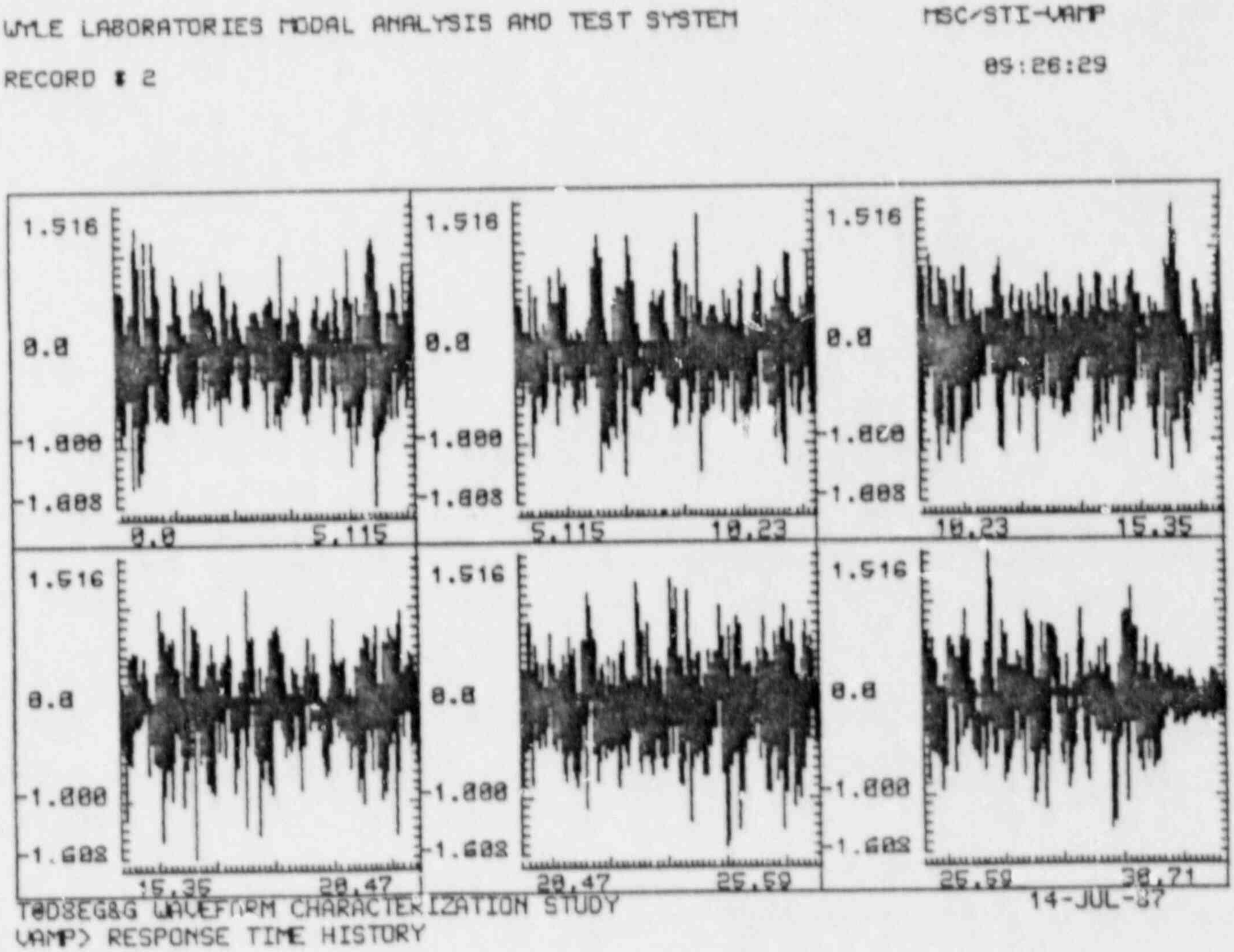
WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM MSC/STI-VAMP

RECORD # 2 09:23:50



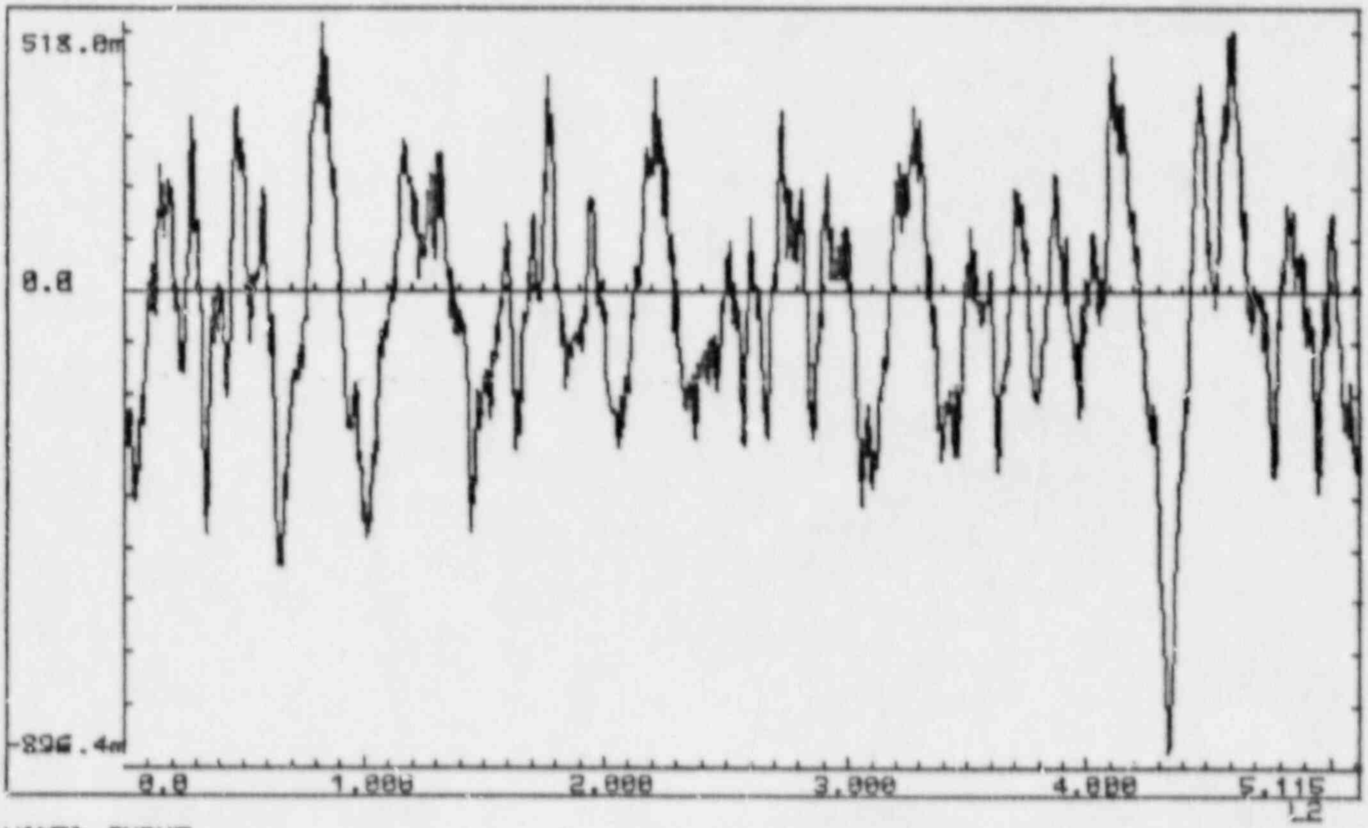
T0D8EG&G WAVEFORM CHARACTERIZATION STUDY 14-JUL-87

VAMP> INPUT TIME HISTORY


WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM
MSC/STI-VAMP
RECORD # 2
05:26:29
1.516
0.0
-1.000
-1.608
0.0
5.115
10.23
15.35
15.36
20.47
25.59
30.71
T@DSEG&G WAVEFORM CHARACTERIZATION STUDY
14-JUL-87
VAMP> RESPONSE TIME HISTORY

WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM MSC/STI-VAMP

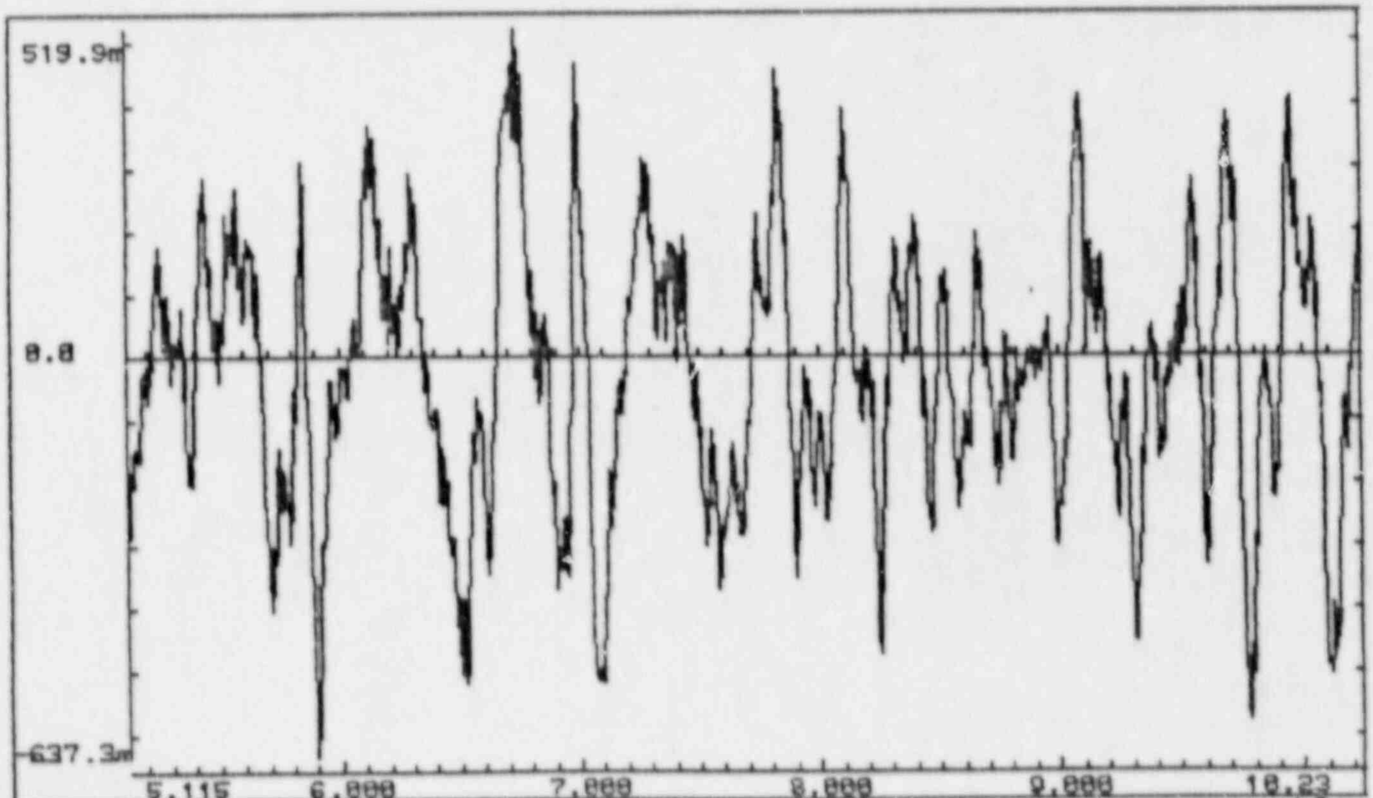
RECORD # 2 09:21:49



VAMP> INPUT

WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM MSC/STI-VAMP

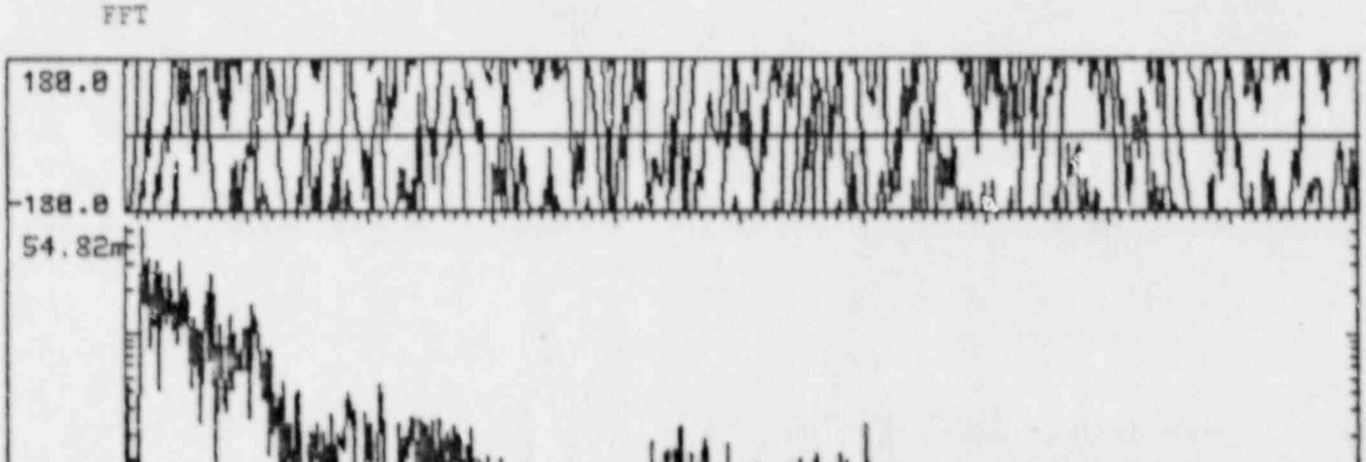
RECORD # 2 09:22:45



VAMP> RESPONSE

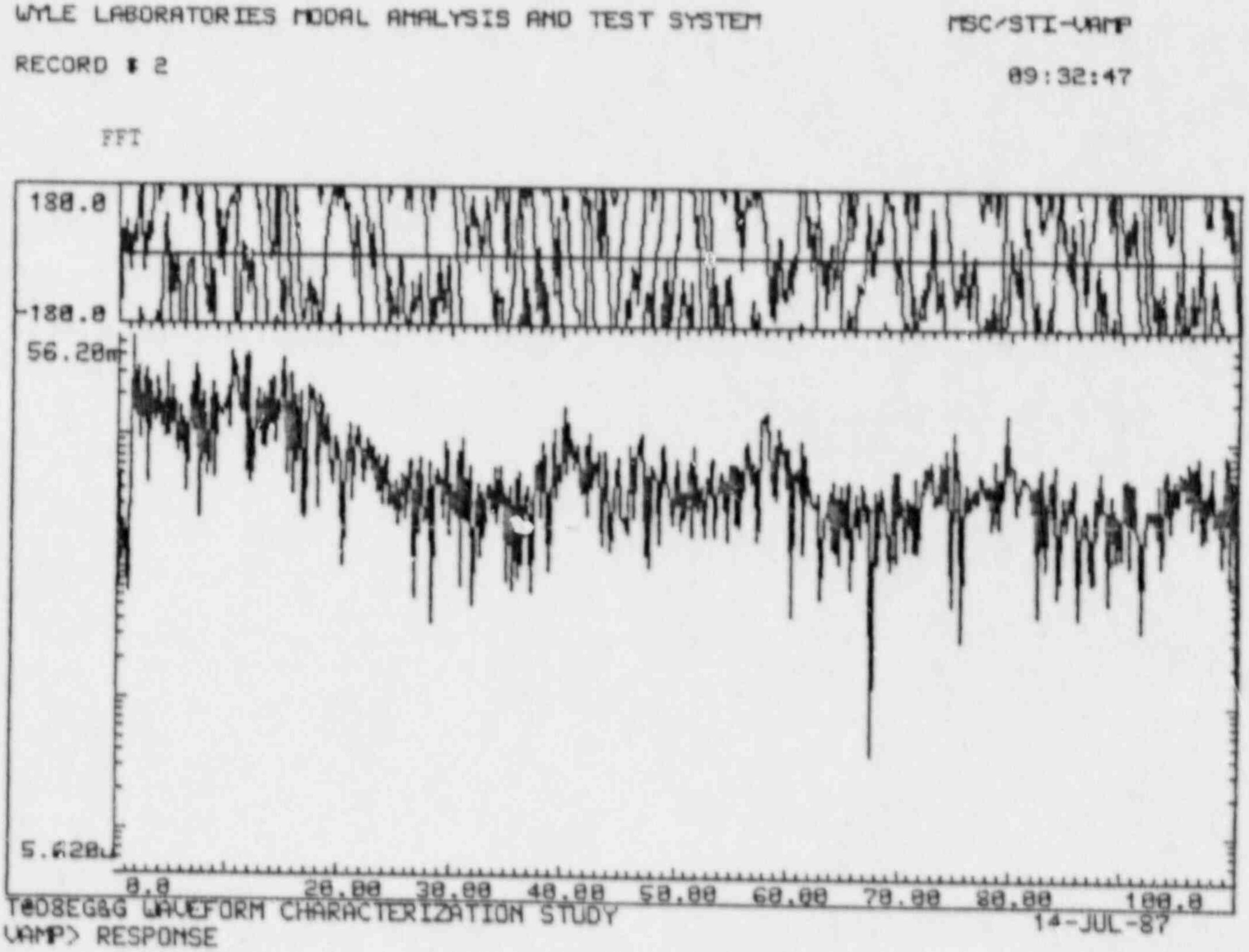
WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM　　MSC/STI-VAMP

RECORD # 2　　09:30:31



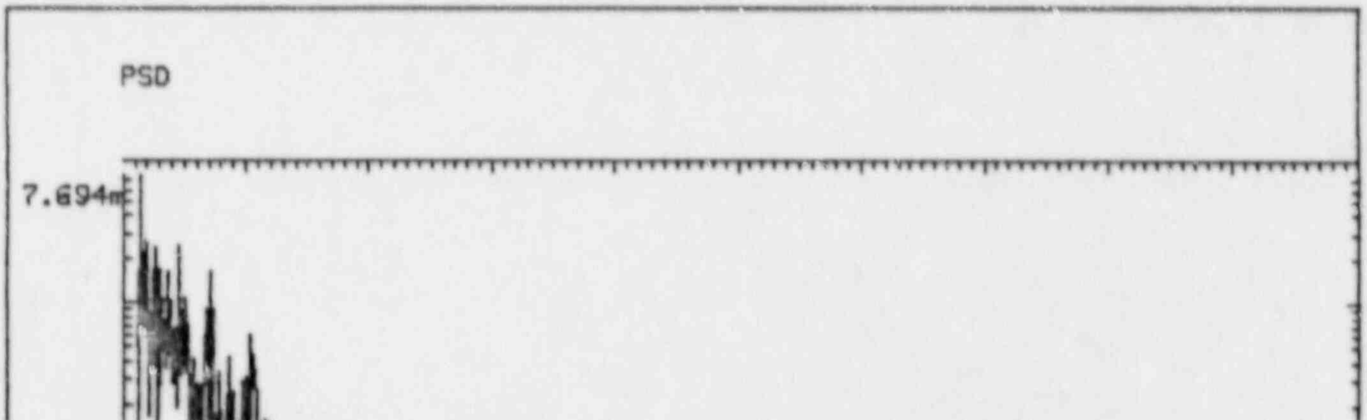
T0DSEG&G WAVEFORM CHARACTERIZATION STUDY　　14-JUL-87

VAMP> INPUT


WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM
MSC/STI-VAMP
RECORD # 2
09:32:47
FFT
180.0
-180.0
56.20m
5.620u
0.0
20.00
30.00
40.00
50.00
60.00
70.00
80.00
100.0
T@D8EG&G WAVEFORM CHARACTERIZATION STUDY
14-JUL-87
VAMP> RESPONSE

WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM MSC/STI-VAMP

RECORD # 2 09:33:53

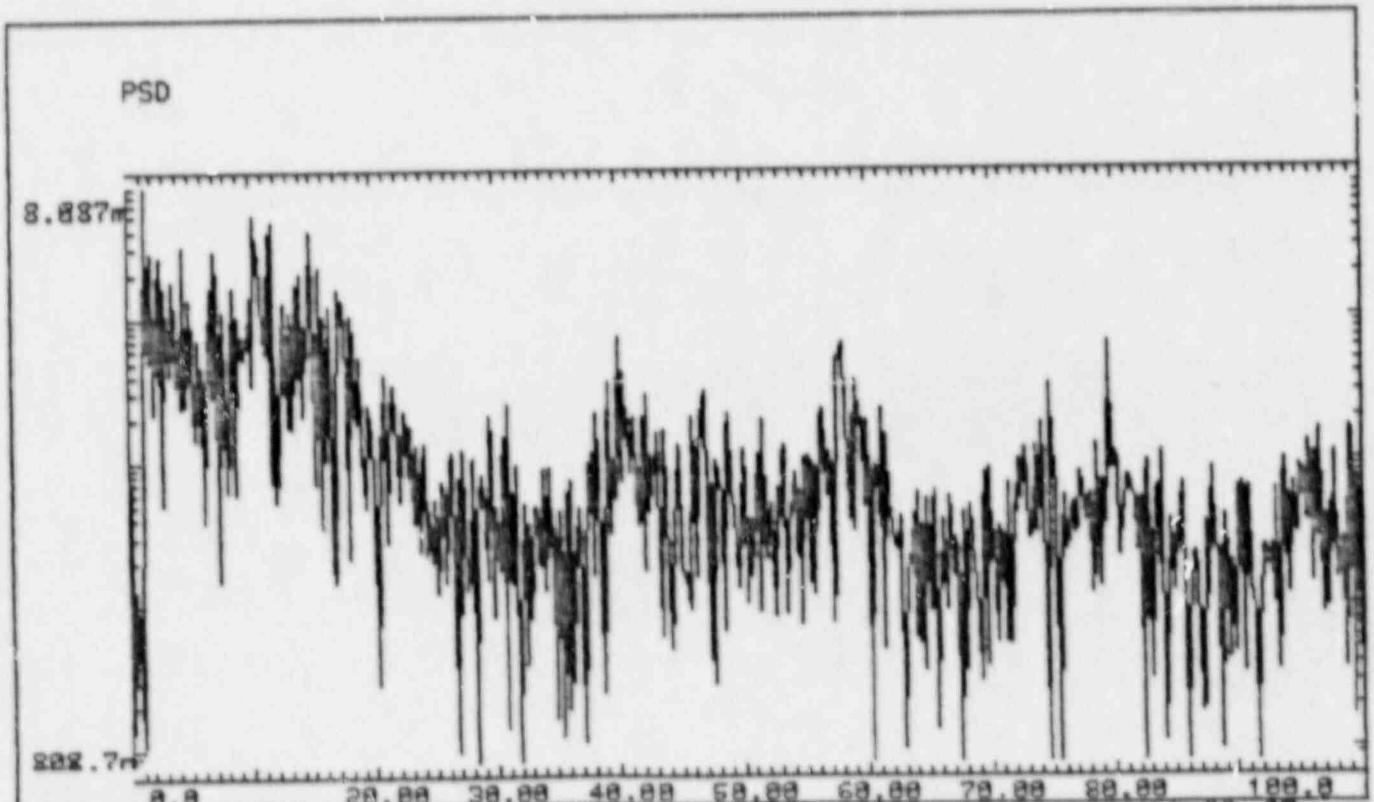


T@DSEG&G WAVEFORM CHARACTERIZATION STUDY 14-JUL-87

VAMP> INPUT

WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM MSC/STI-VAMP

RECORD # 2 09:34:40

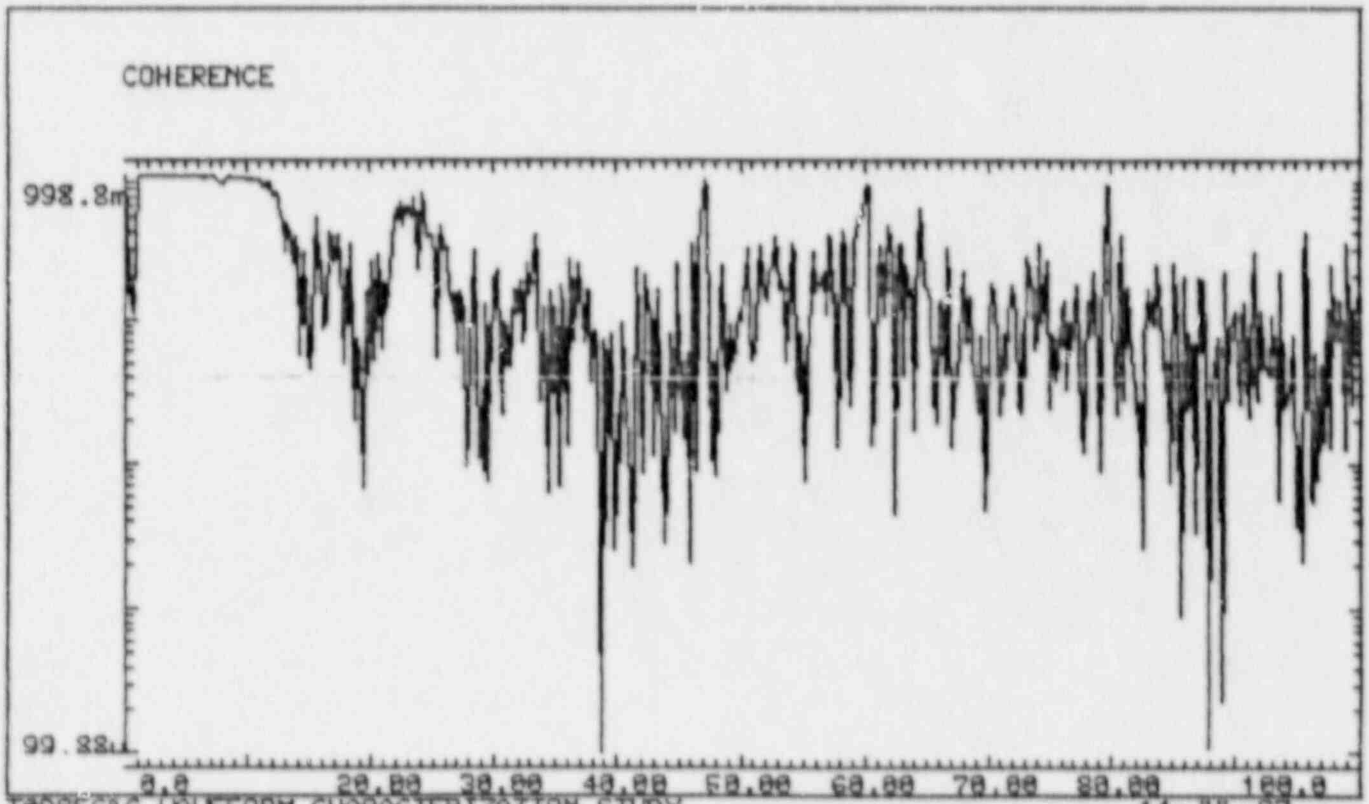


T@DSEG&G WAVEFORM CHARACTERIZATION STUDY 14-JUL-87

VAMP> RESPONSE

WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM MSC/STI-VAMP

RECORD # 2 09:42:19

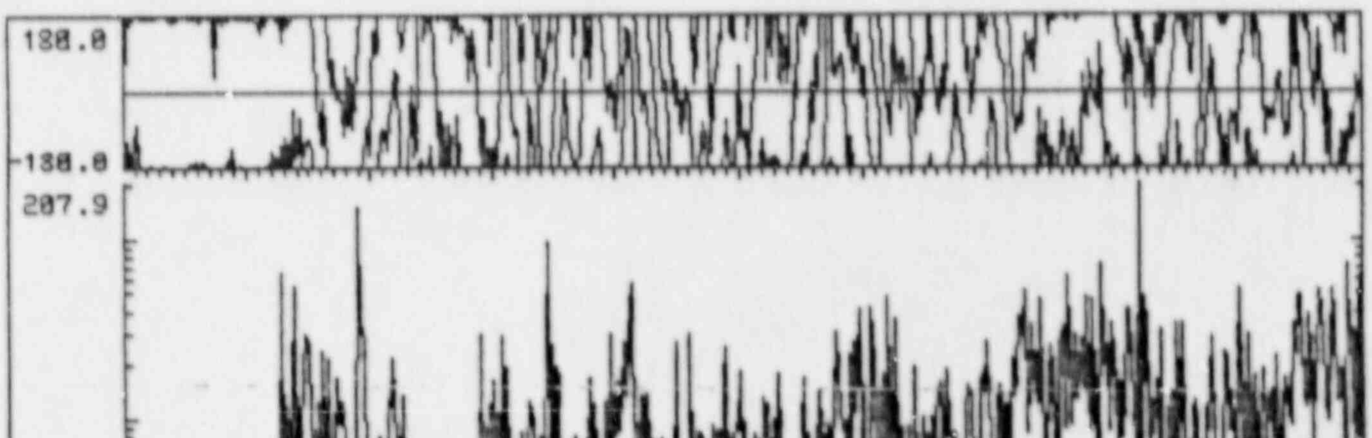


T0DSEG&G WAVEFORM CHARACTERIZATION STUDY 14-JUL-87

VAMP>

WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM　　MSC/STI-VAMP

RECORD # 2　　09:35:58

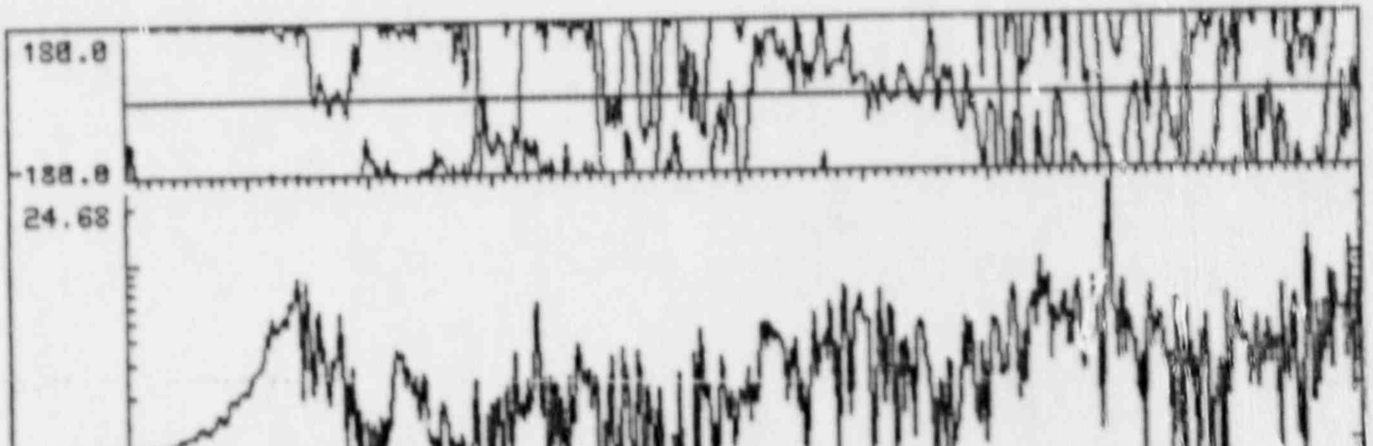


T@DSEG&G WAVEFORM CHARACTERIZATION STUDY　　14-JUL-87

VAMP> TRANSMISSIBILITY

WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM MSC/STI-VAMP

RECORD # 2 09:43:17



T@D8EG&G WAVEFORM CHARACTERIZATION STUDY

VAMP> TRANSFER FUNCTION

RECORD NO. 3

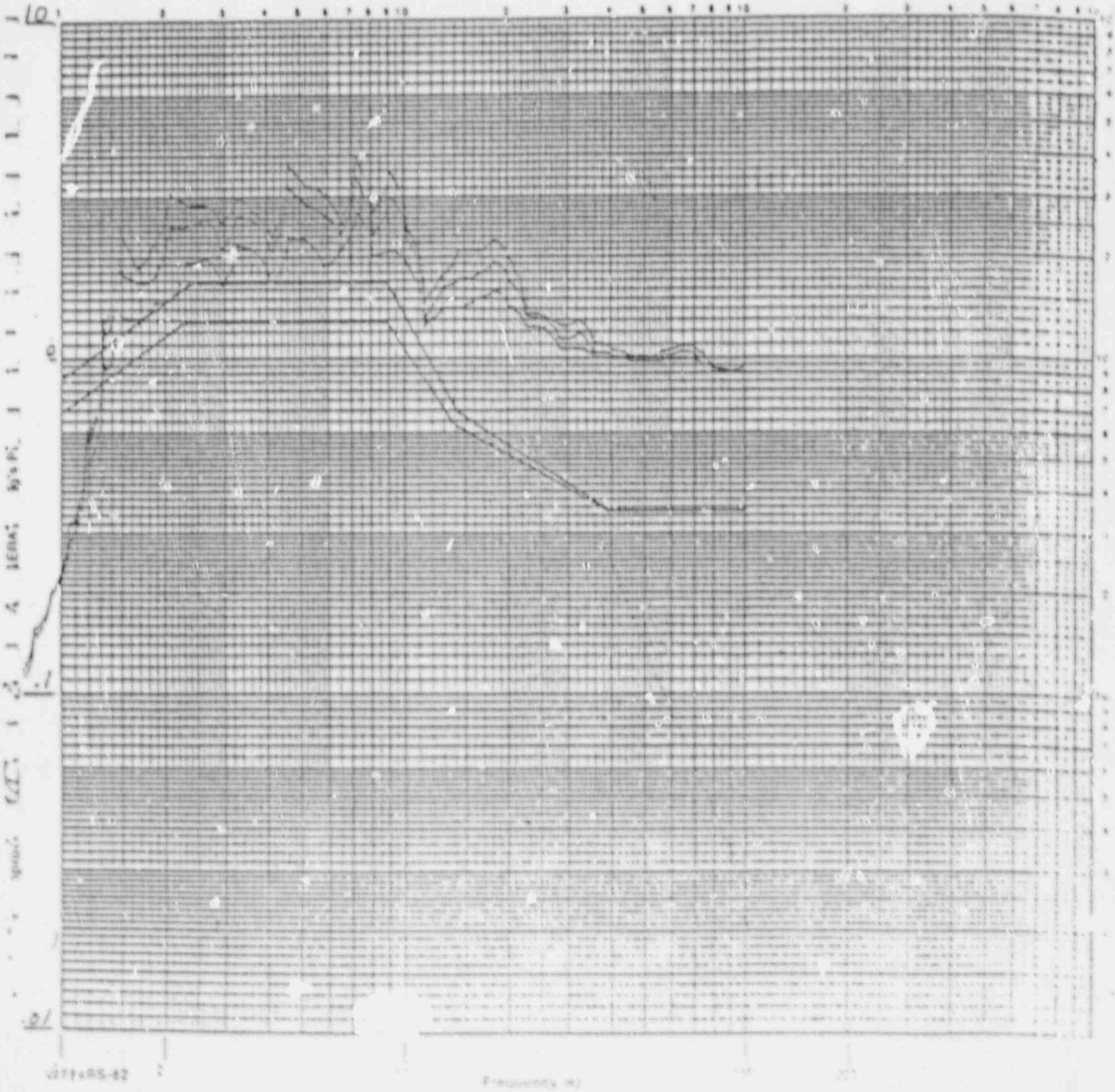
Specimen GENERATOR CONTROL PANEL Axis of Test X-Y

Accel. No. 1 Axis HORIZ Control (✓) Response ( ) OBE ( ) SSE (✓) OBE

Full Scale 10 g Damping 2,5,5,3 % Run No. 6

Operator GRETERMAN Engineer

RESPONSE SPECTRUM



RECORD NO. 3

Specimen Generator Control Panel A... X-Y

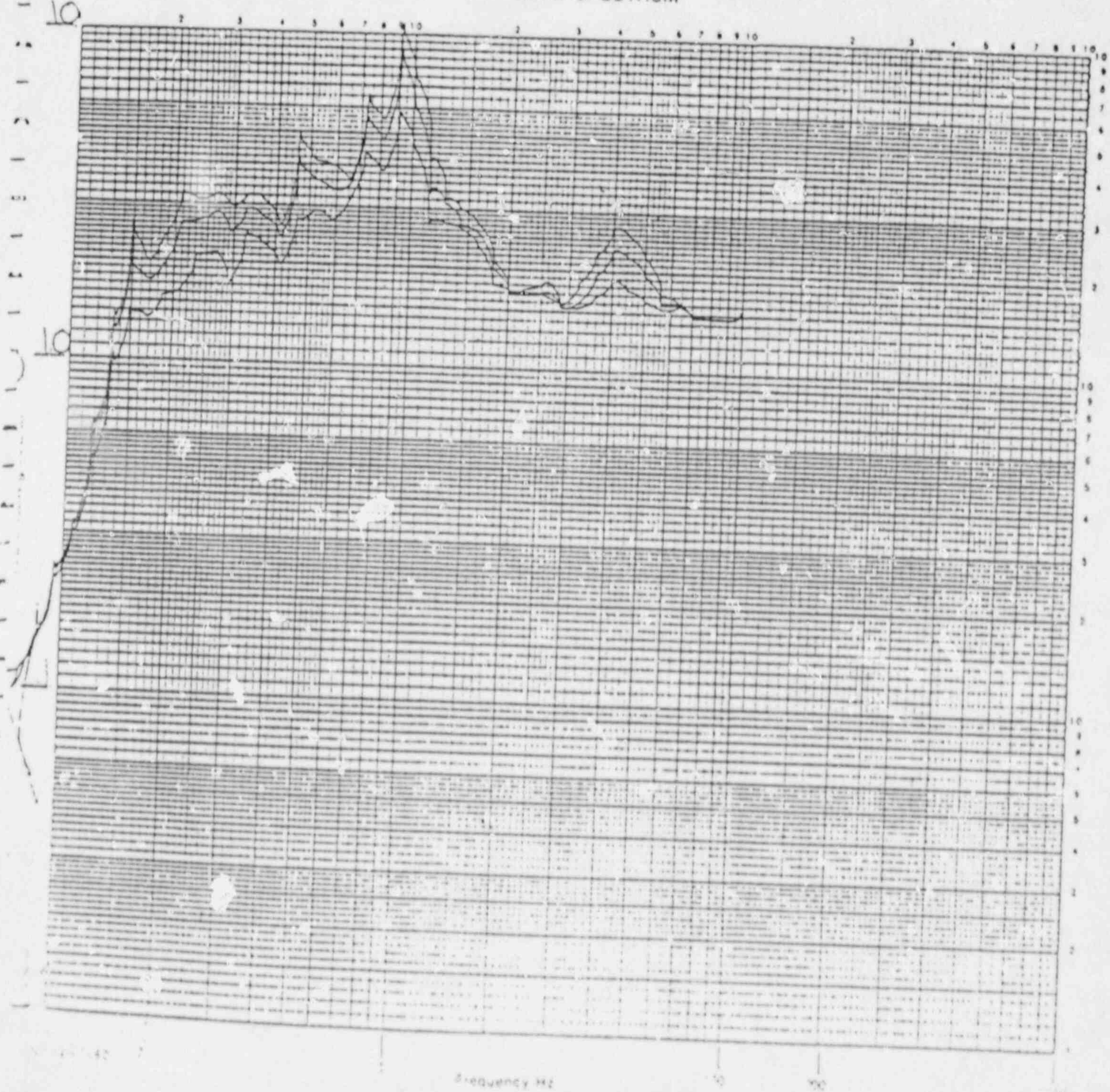
Accel. No. 7 Axis X Control ( ) Response (✓) OBE ( ) (✓) OBE ( )

Full Scale 10 g Damping 2 3 5 %

Run No. 6

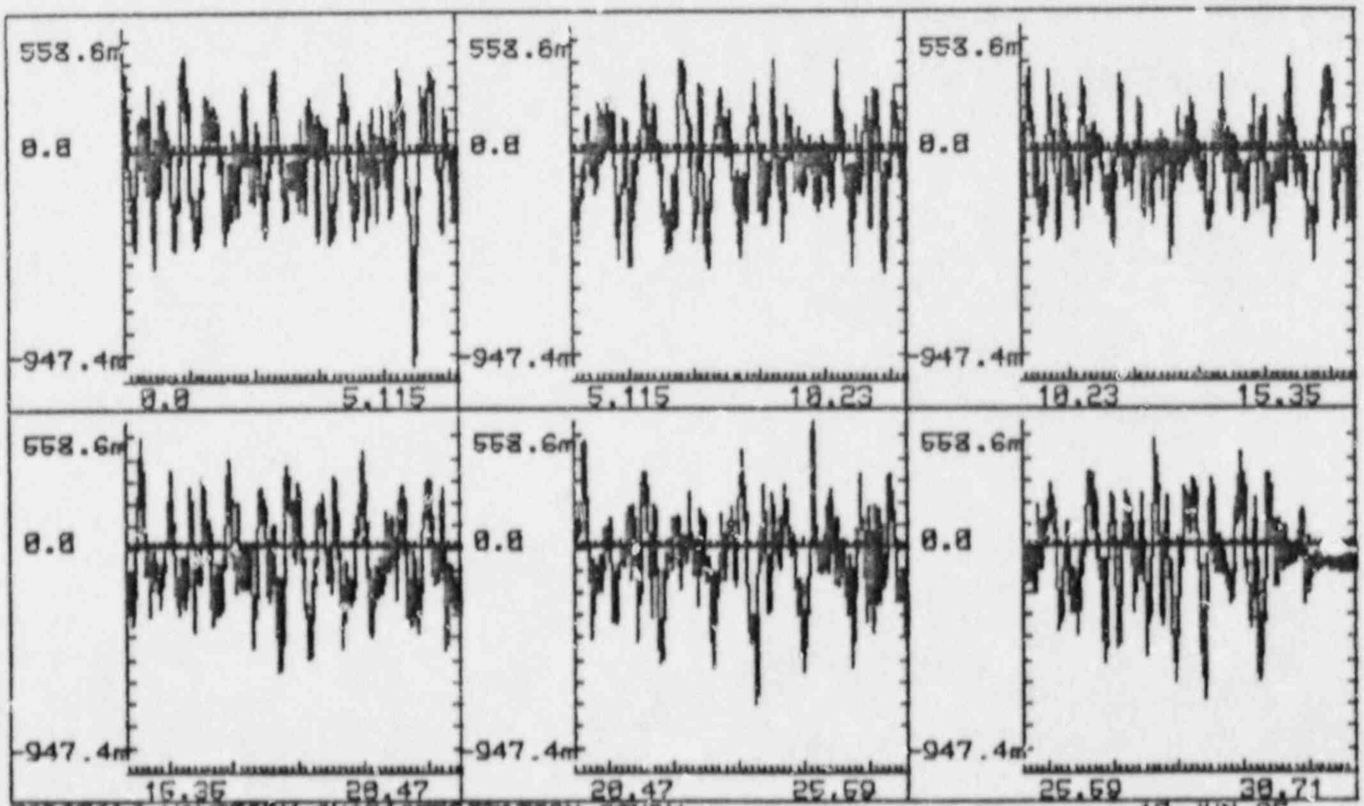
Operator BREITERMAN Engineer

RESPONSE SPECTRUM



WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM MSC/STI-VAMP

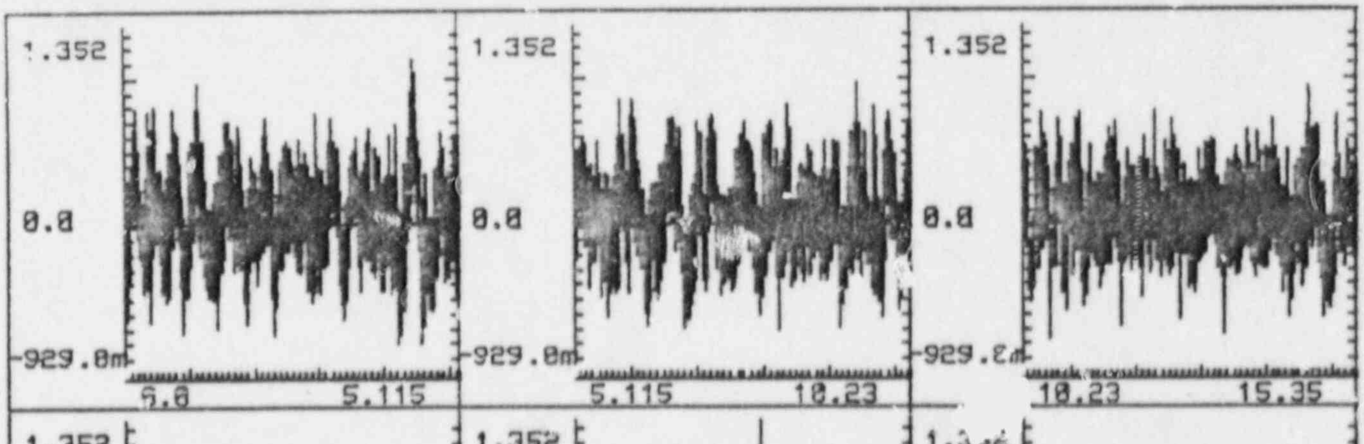
RECORD # 3 11:16:03



T#D8EG&G WAVEFORM CHARACTERIZATION STUDY 17-JUN-8?
VAMP> INPUT TIME HISTORY

WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM MSC/STI-VAMP

RECORD # 3 11:54:48

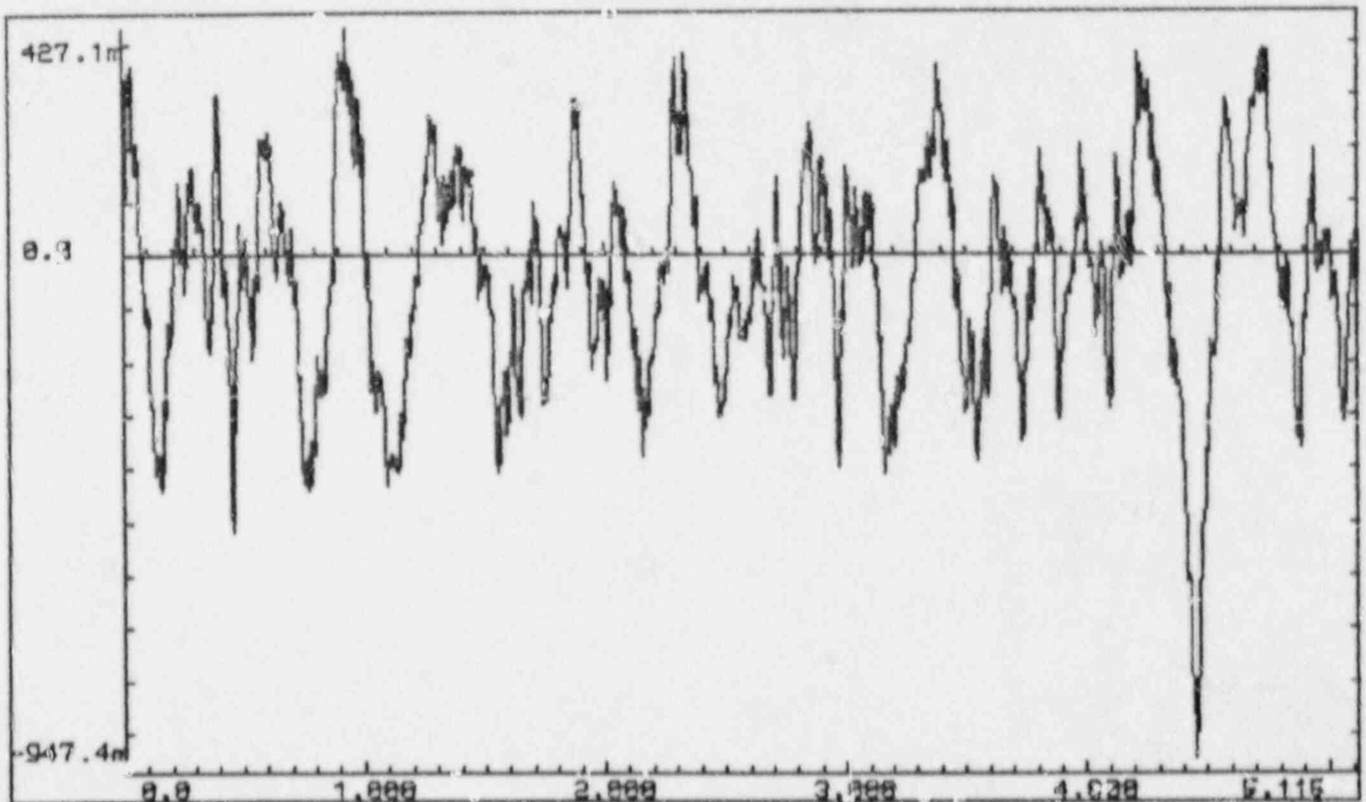


T@D8EG&G WAVEFORM CHARACTERIZATION STUDY 17-JUN-87

VAMP> RESPONSE TIME HISTORY

WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM MSC/STI-VAMP

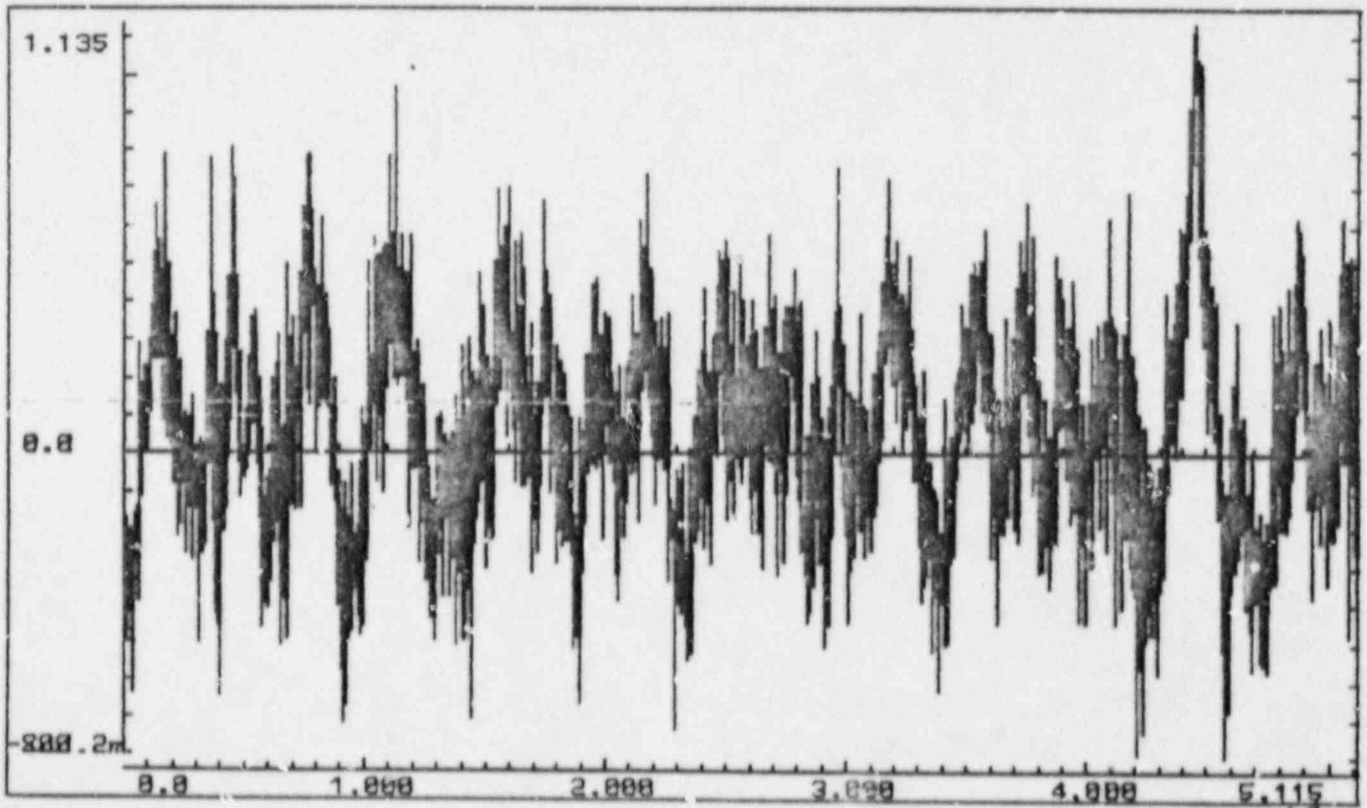
RECORD # 3 12:00:16



VAMP> INPUT

WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM MSC/STI-VAMP

RECORD # 3 12:14:19

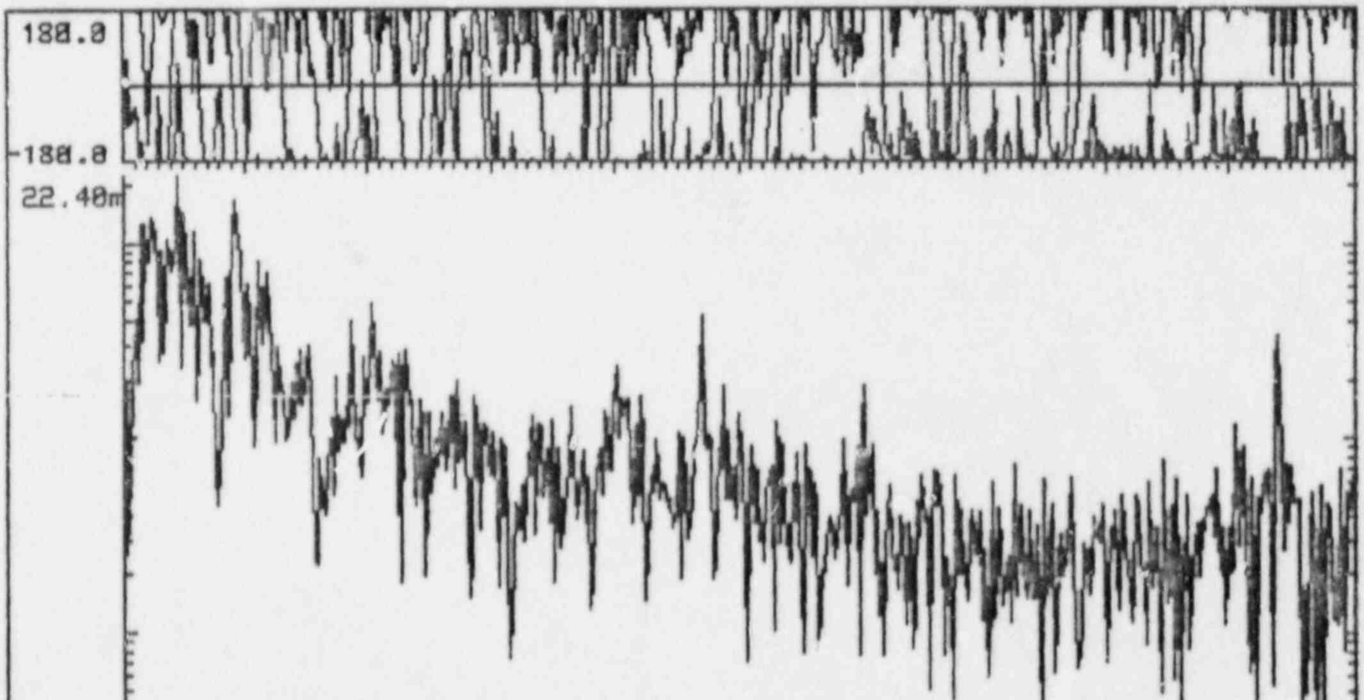


VAMP> RESPONSE

WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM MSC/STI-VAMP

RECORD # 3 13:14:00

FFT



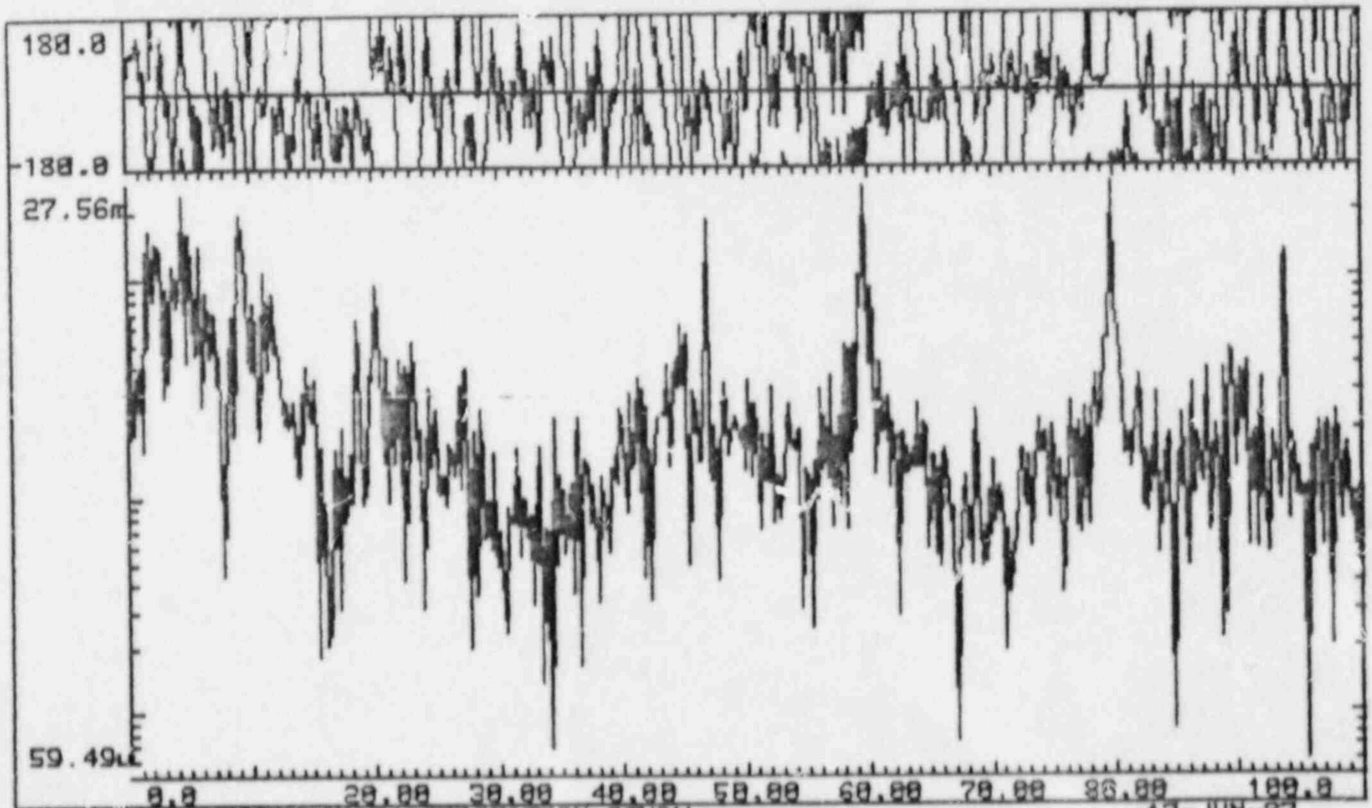
T@D8EG&G WAVEFORM CHARACTERIZATION STUDY 17-JUN-87

VAMP> INPUT

WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM MSC/STI-VAMP

RECORD # 3 13:12:49

FFT

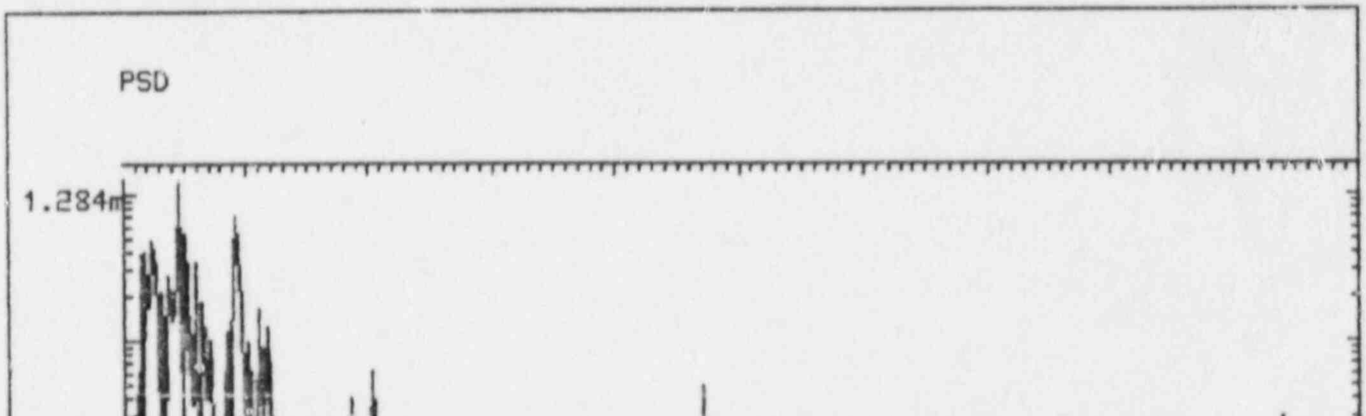


T@D8EG&G WAVEFORM CHARACTERIZATION STUDY 17-JUN-87

VAMP> RESPONSE

WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM MSC/STI-VAMP

RECORD # 3 13:17:29

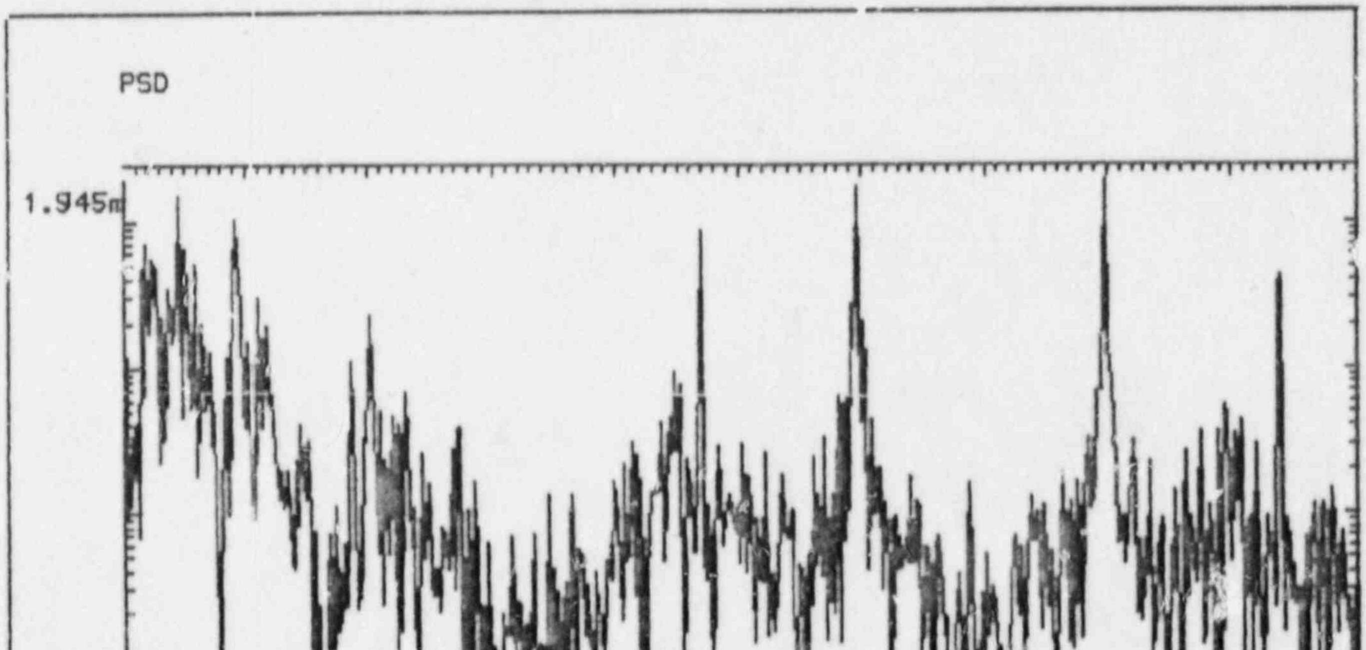


T@D8EG&G WAVEFORM CHARACTERIZATION STUDY 17-JUN-87

VAMP> INPUT

WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM MSC/STI-VAMP

RECORD # 3 13:18:40

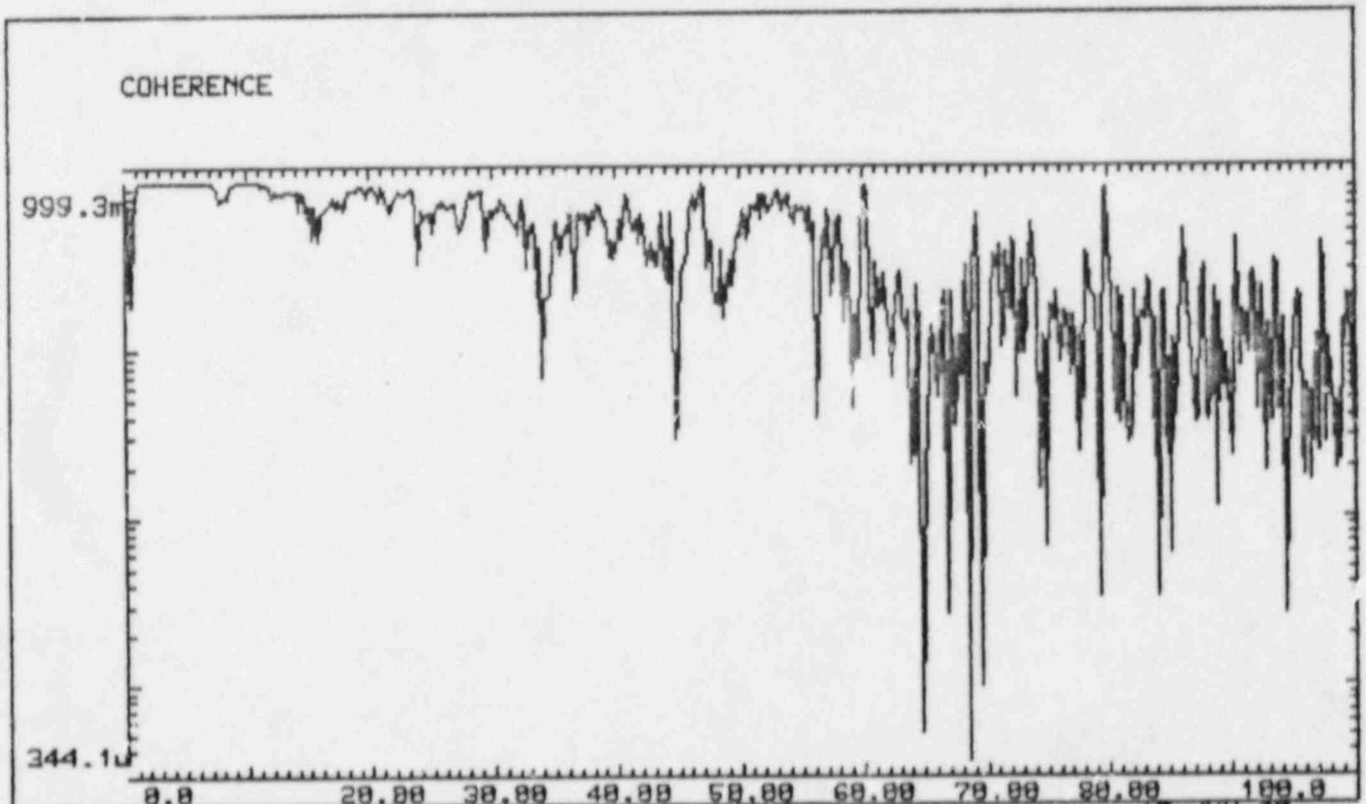


T@D8EG&G WAVEFORM CHARACTERIZATION STUDY 17-JUN-87

VAMP> RESPONSE

WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM MSC/STI-VAMP

RECORD # 3 13:34:22

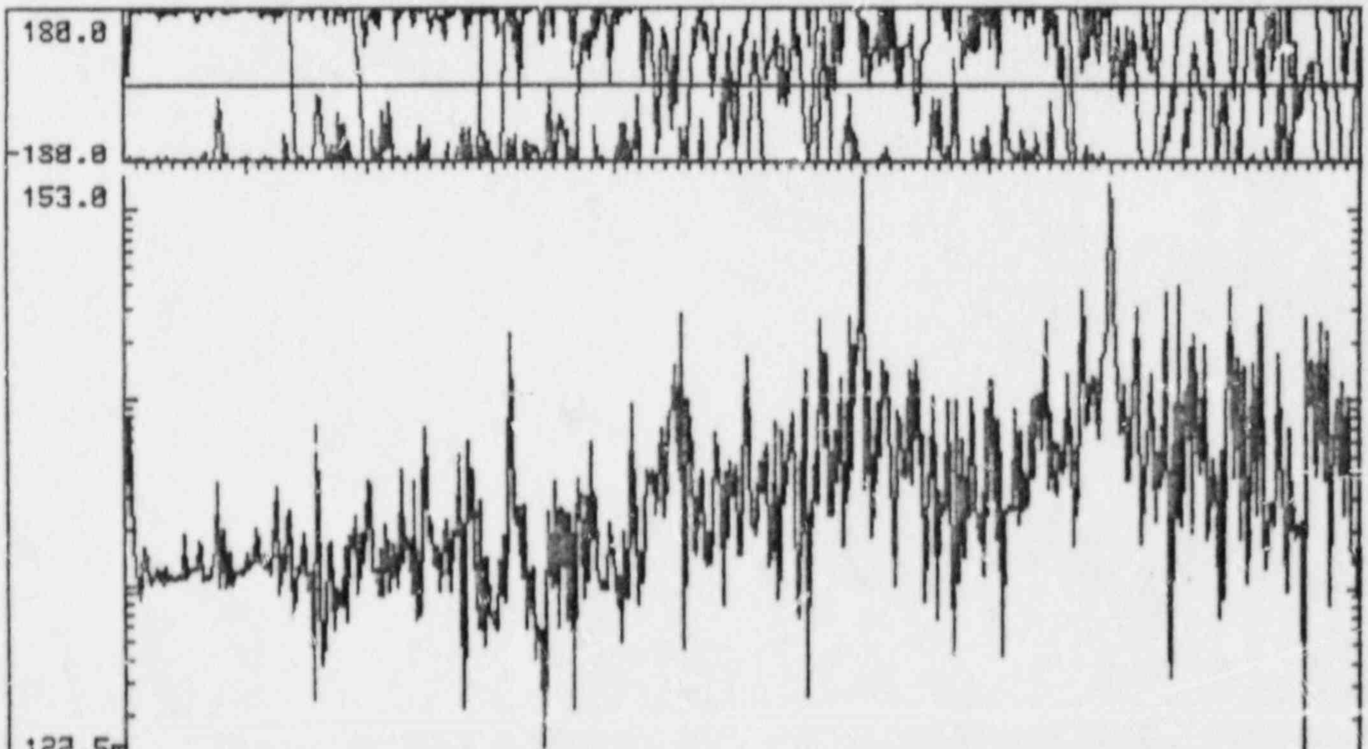


T@D8EG&G WAVEFORM CHARACTERIZATION STUDY 17-JUN-87

VAMP>

WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM MSC/STI-VAMP

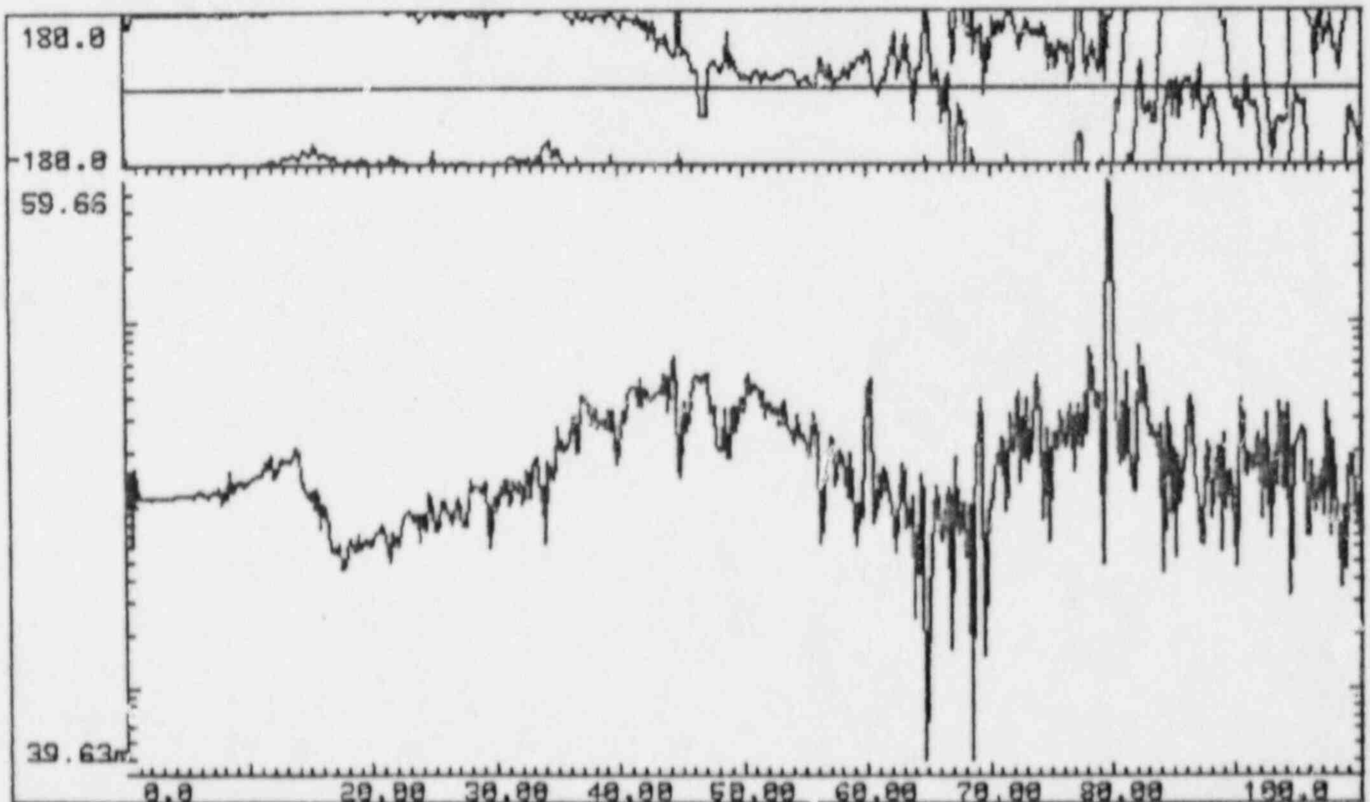
RECORD # 3 13:20:00



VAMP> TRANSMISSIBILITY

WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM MSC/STI-VAMP

RECORD # 3 13:30:34



T0D8EG&G WAVEFORM CHARACTERIZATION STUDY 17-JUN-87

VAMP> TRANSFER FUNCTION

RECORD NO. 4

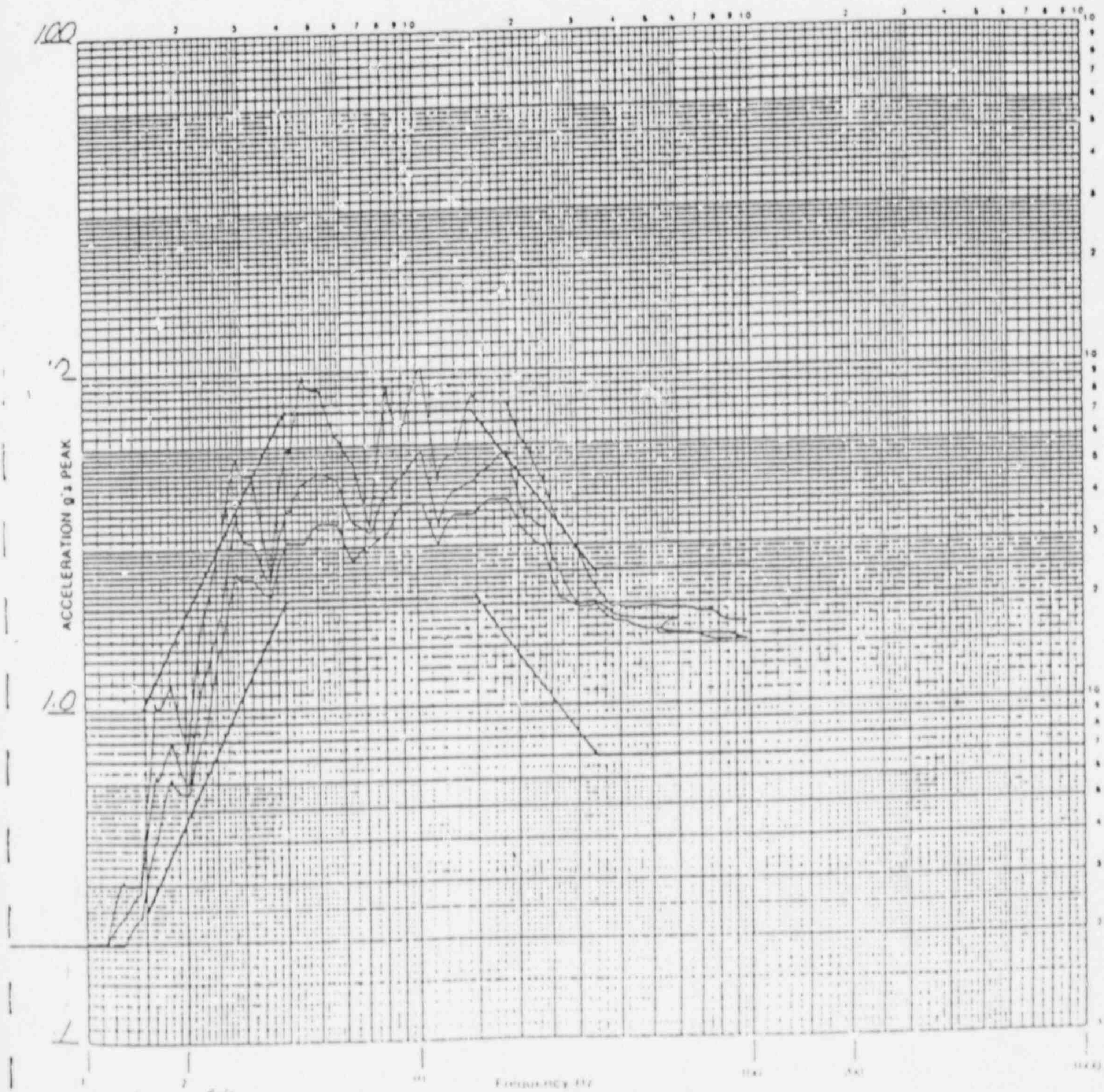
Specimen MOTOR CONTROL CENTER Axis of Test X-Y

Accel. No. 1 Axis HORIZ Control (✓) Response ( ) OBE ( ) SSE ( ) DBE ( )

Full Scale 100 g Damping 5, 1, 3 % Run No. 44

Operator GRETERMAN Engineer [signature] 3RD LEVEL 30 HZ

RESPONSE SPECTRUM



RECORD NO. 4

Specimen MOTOR CONTROL UNIT Axis of Test X-Y

Accel. No. 15 Axis X Control ( ) Response (✓) OBE ( ) SSE ( ) DBE ( )

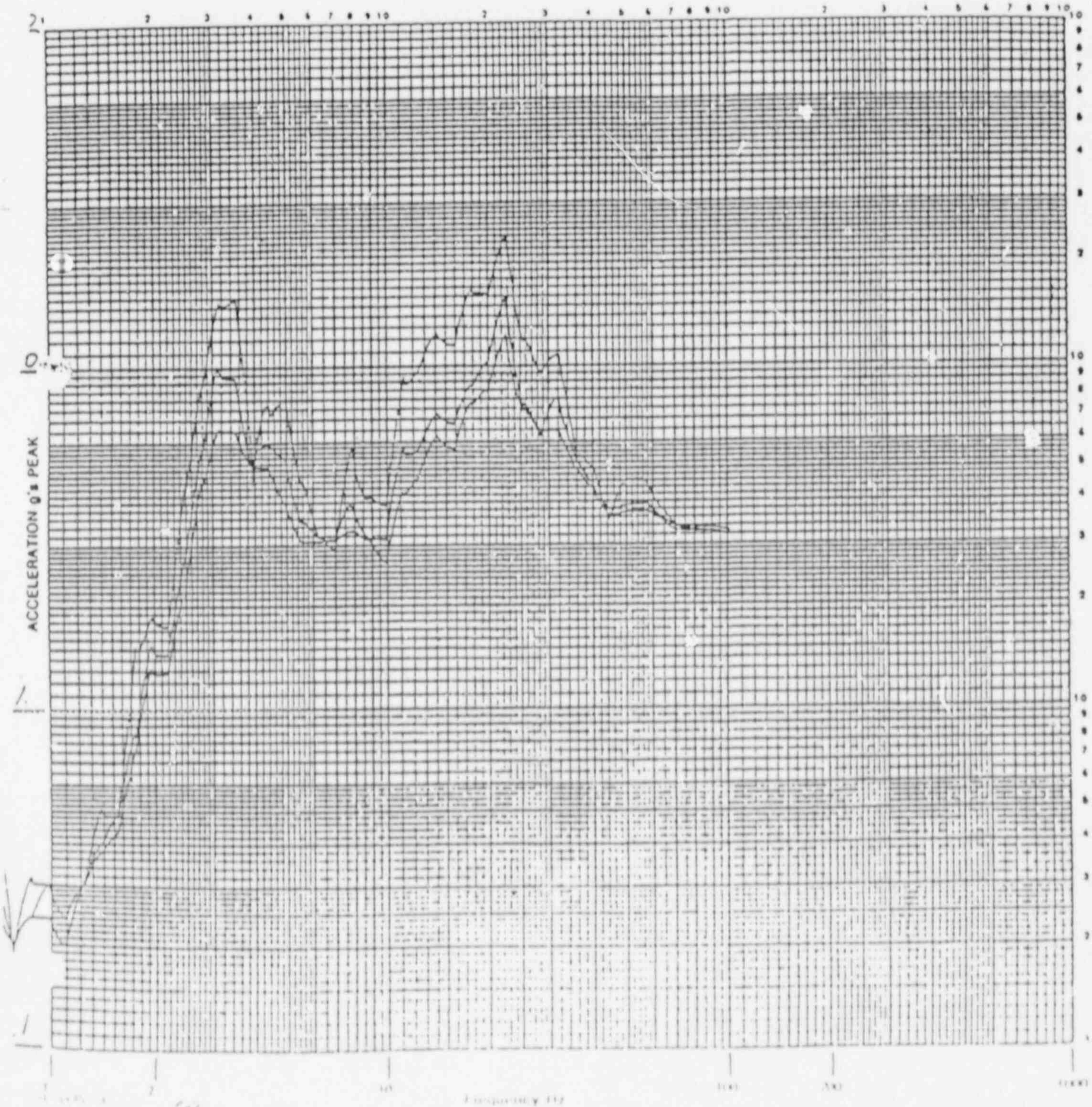
Full Scale 190 g Damping 5, 1, 3 %

Run No. 44

3RD LEVEL 30HZ Lo-PASS

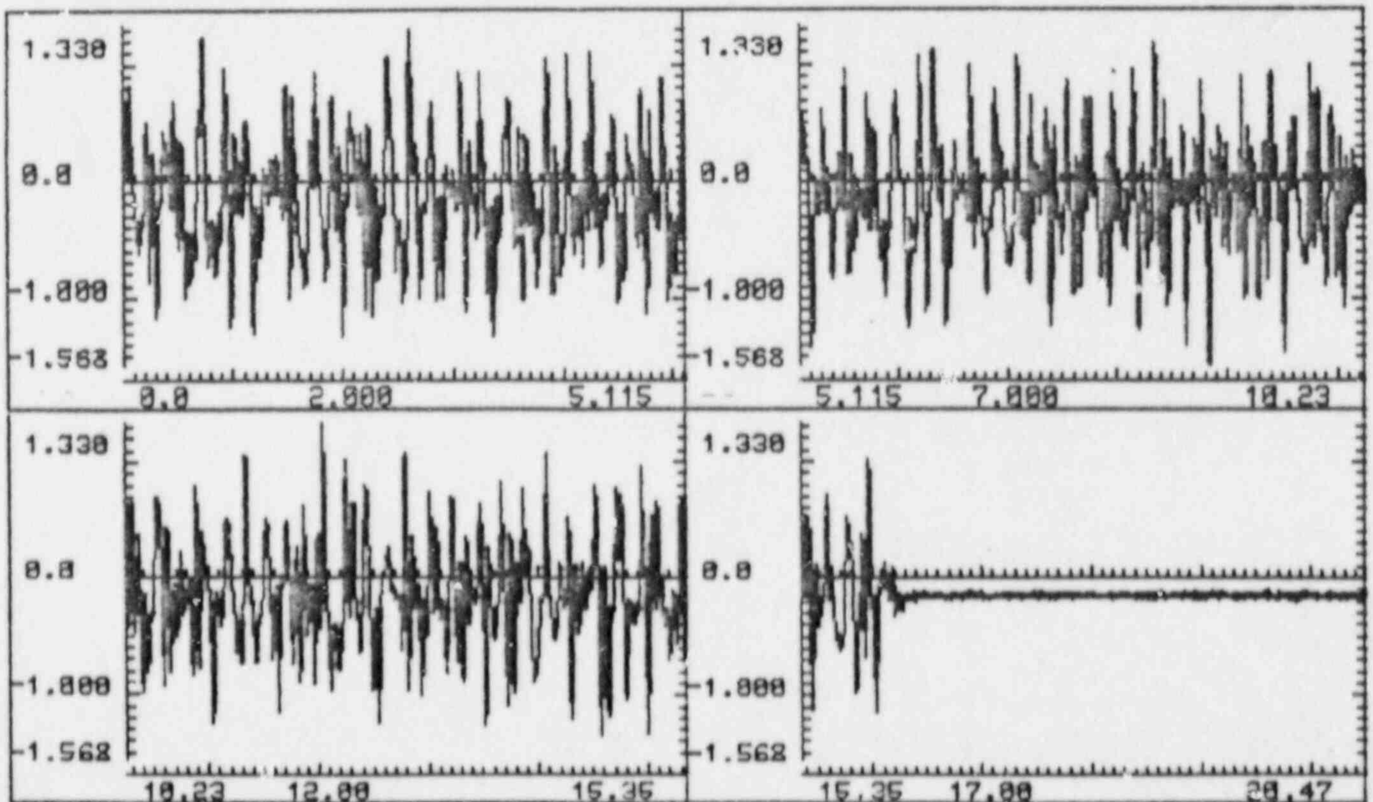
Operator [signature] Engineer [signature]

RESPONSE SPECTRUM



WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM MSC/STI-VAMP

RECORD # 4 11:26:39

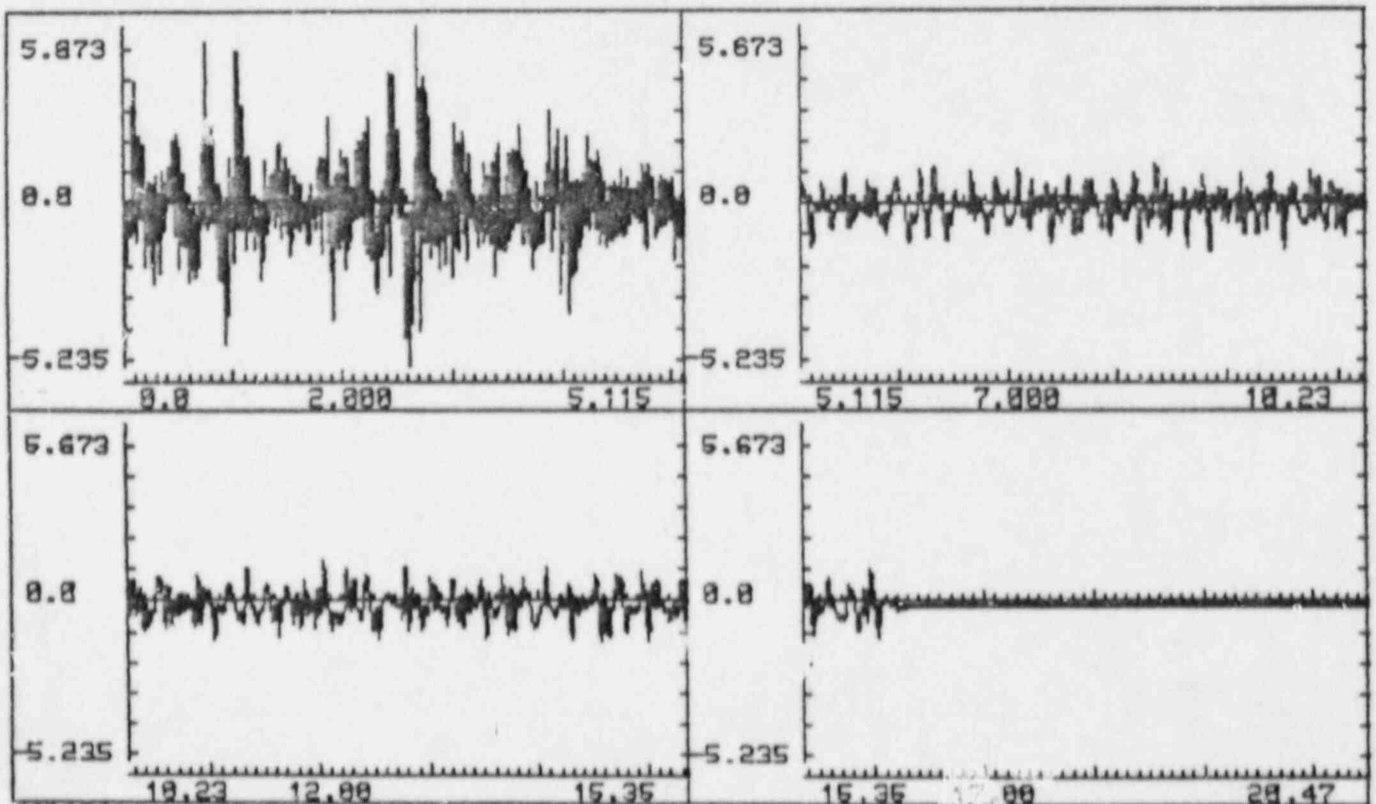


T@D8EG&G WAVEFORM CHARACTERIZATION STUDY 20-JUN-87

VAMP> INPUT TIME HISTORY

WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM MSC/STI-VAMP

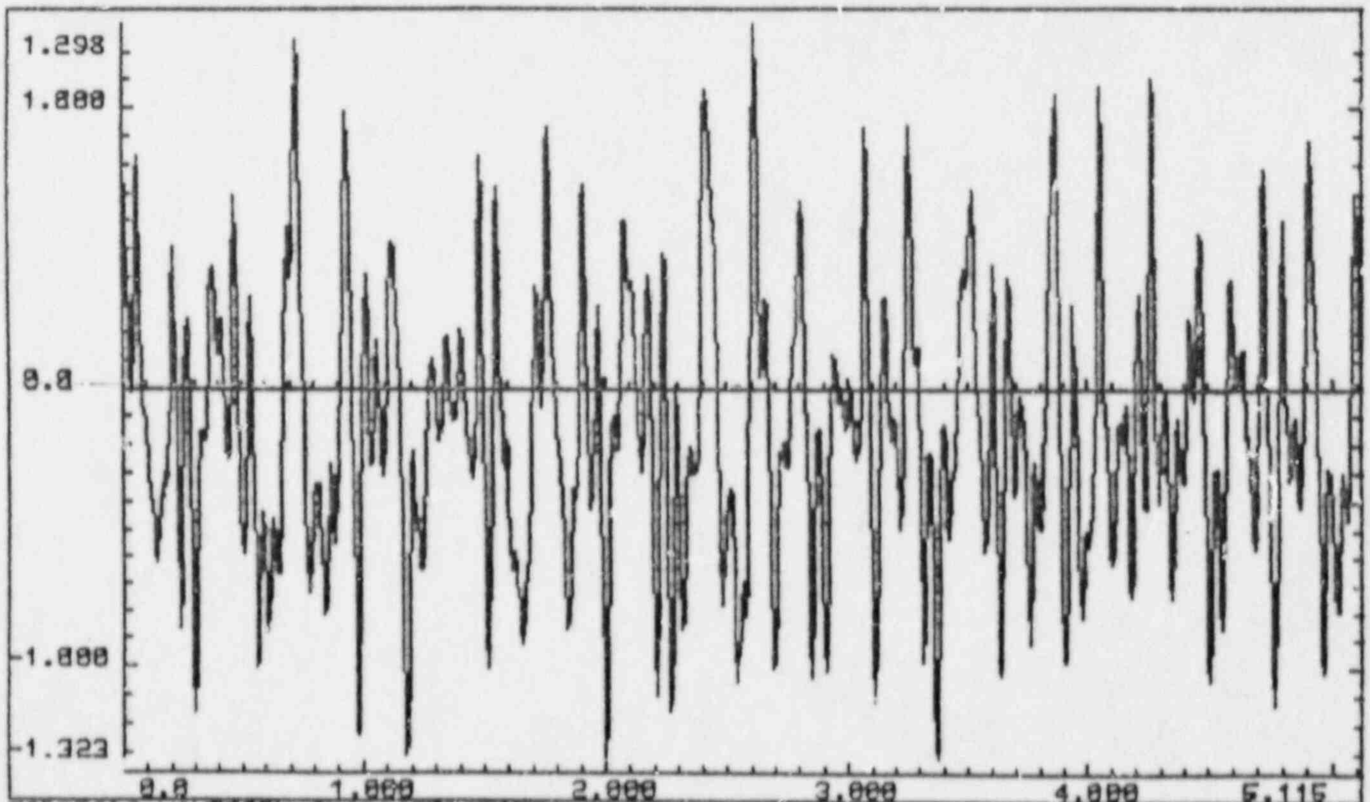
RECORD # 4 11:22:25



?08EG&G WAVEFORM CHARACTERIZATION STUDY 20-JUN-87
VAMP> RESPONSE TIME HISTORY

WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM MSC/STI-VAMP

RECORD # 4 11:15:43

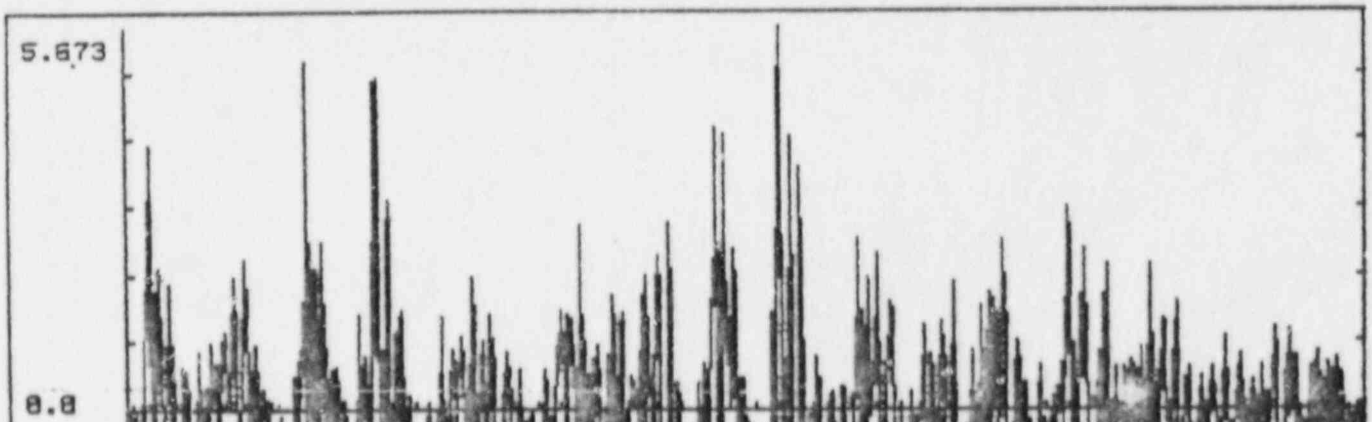


T@D8EG&G WAVEFORM CHARACTERIZATION STUDY 28-JUN-87

VAMP> INPUT

WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM MSC/STI-VAMP

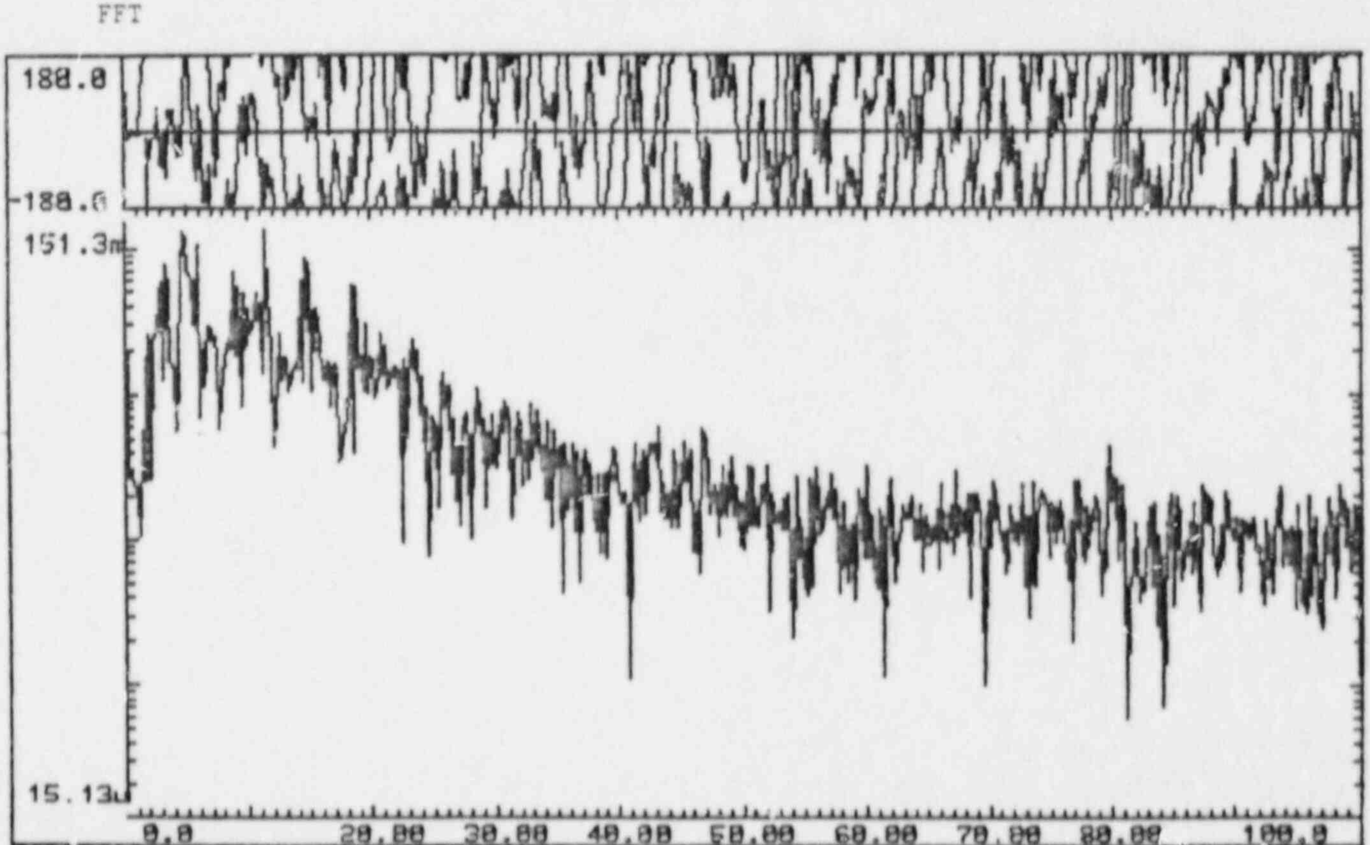
RECORD # 4 11:14:58



VAMP> RESPONSE

WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM MSC/STI-VAMP

RECORD # 4 11:45:07

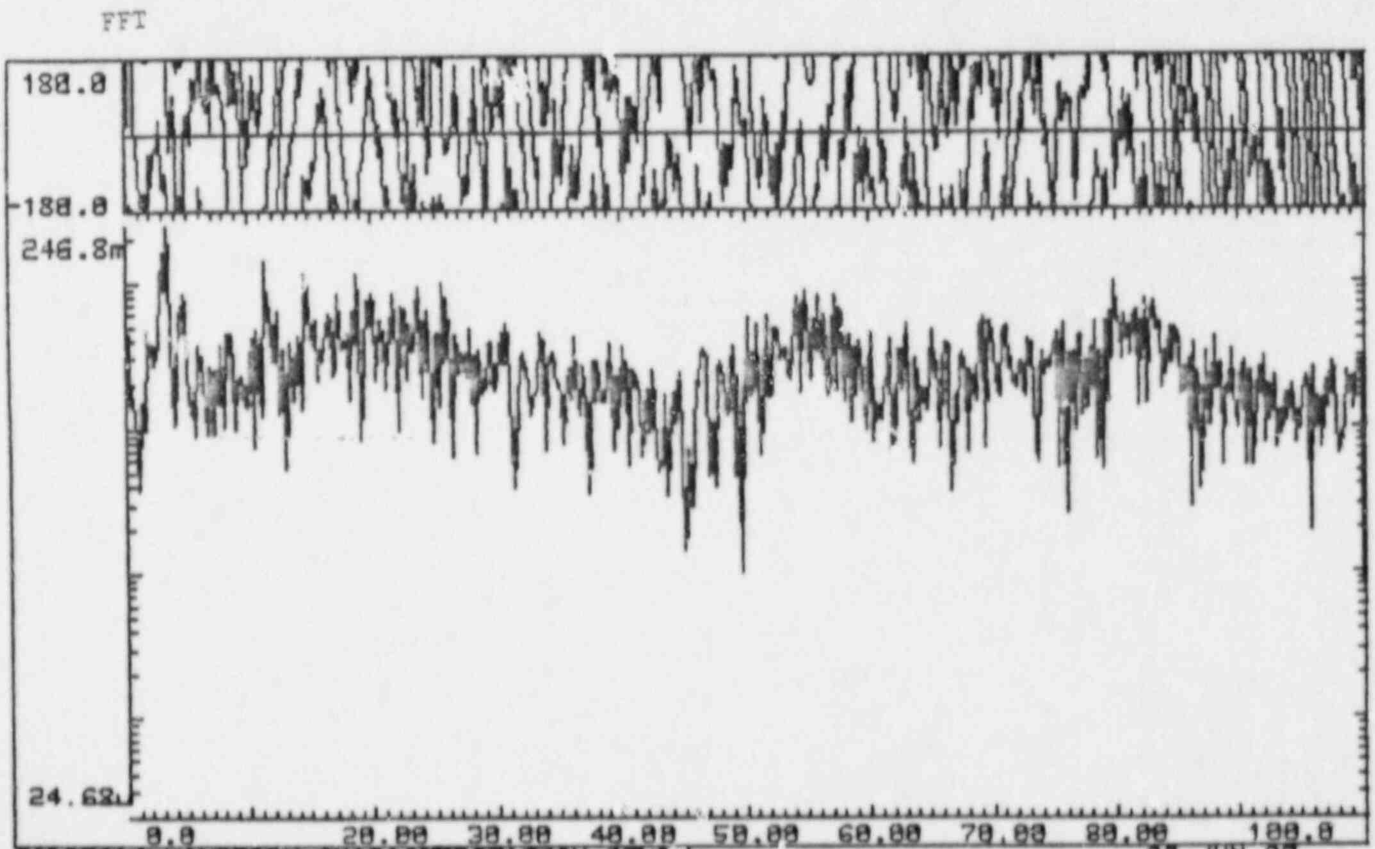


T@D8EG&G WAVEFORM CHARACTERIZATION STUDY 28-JUN-87

VAMP> INPUT

WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM MSC/STI-VAMP

RECORD # 4 11:43:35

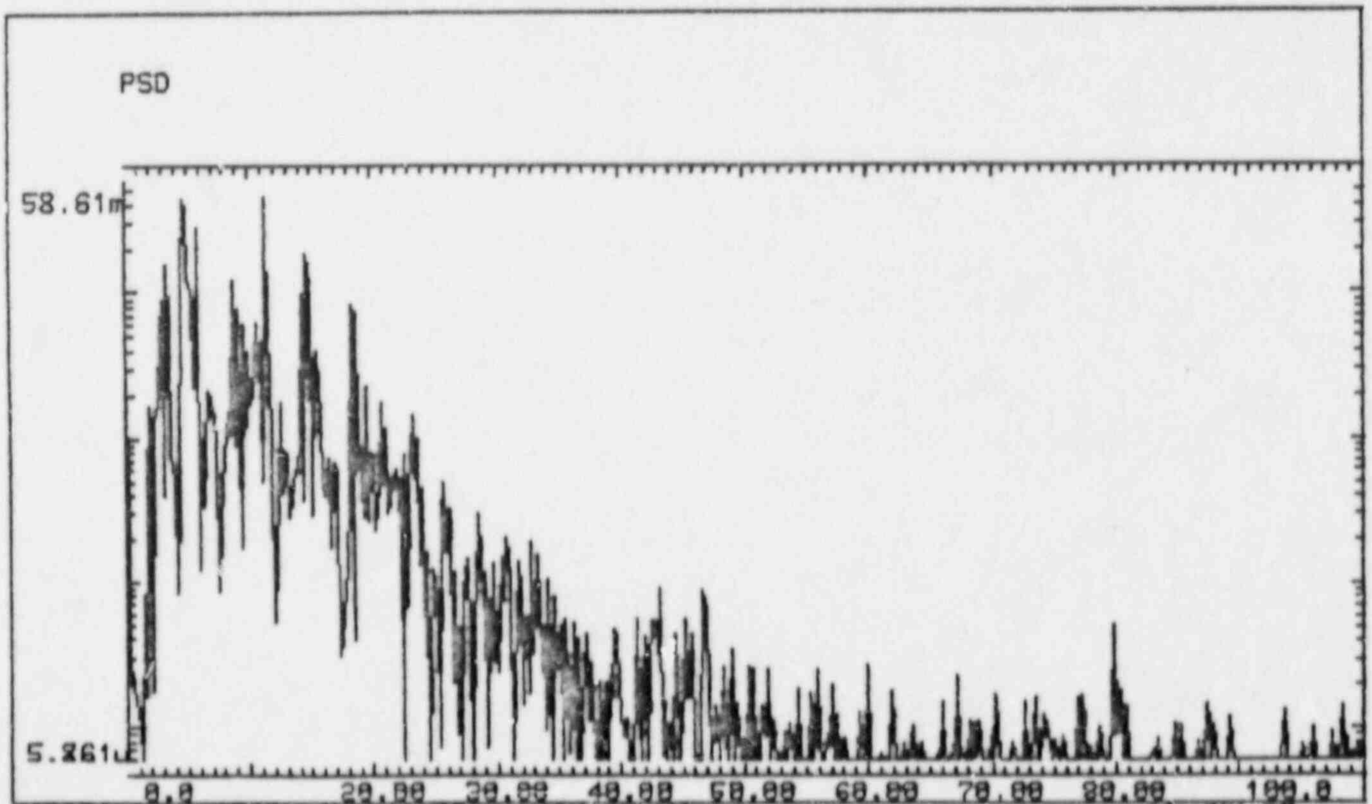


T608EG&G WAVEFORM CHARACTERIZATION STUDY 20-JUN-87

VAMP> RESPONSE

WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM MSC/STI-VAMP

RECORD # 4 11:46:07

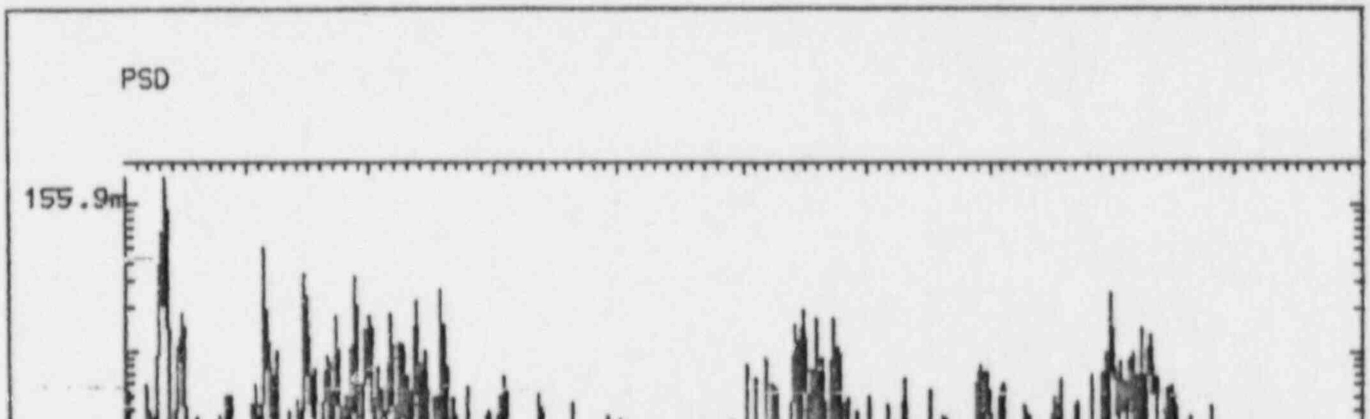


T008EG&G WAVEFORM CHARACTERIZATION STUDY 20-JUN-87

VAMP> INPUT

WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM MSC/STI-VAMP

RECORD # 4 11:44:29

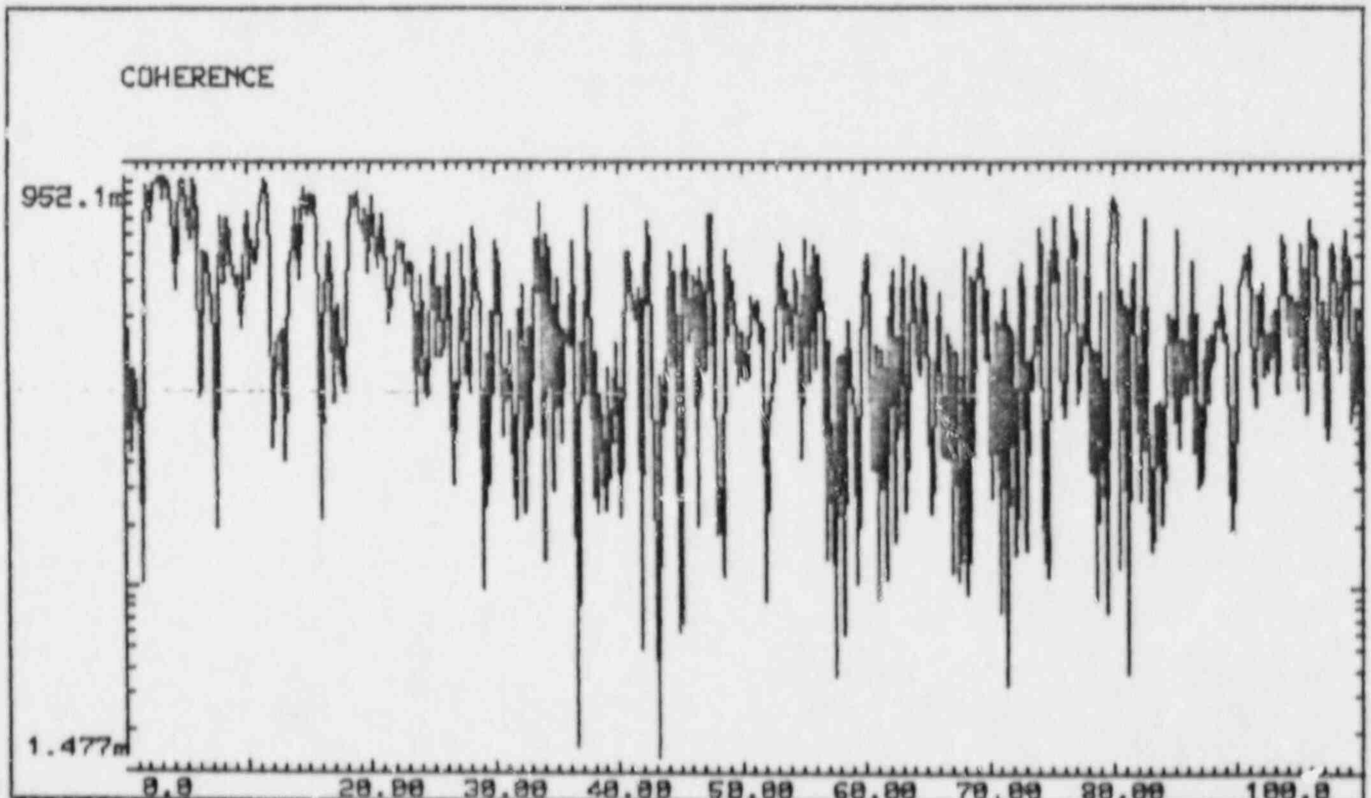


T0D8EG&G WAVEFORM CHARACTERIZATION STUDY 20-JUN-87

VAMP> RESPONSE

WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM MSC/STI-VAMP

RECORD # 4 11:52:04

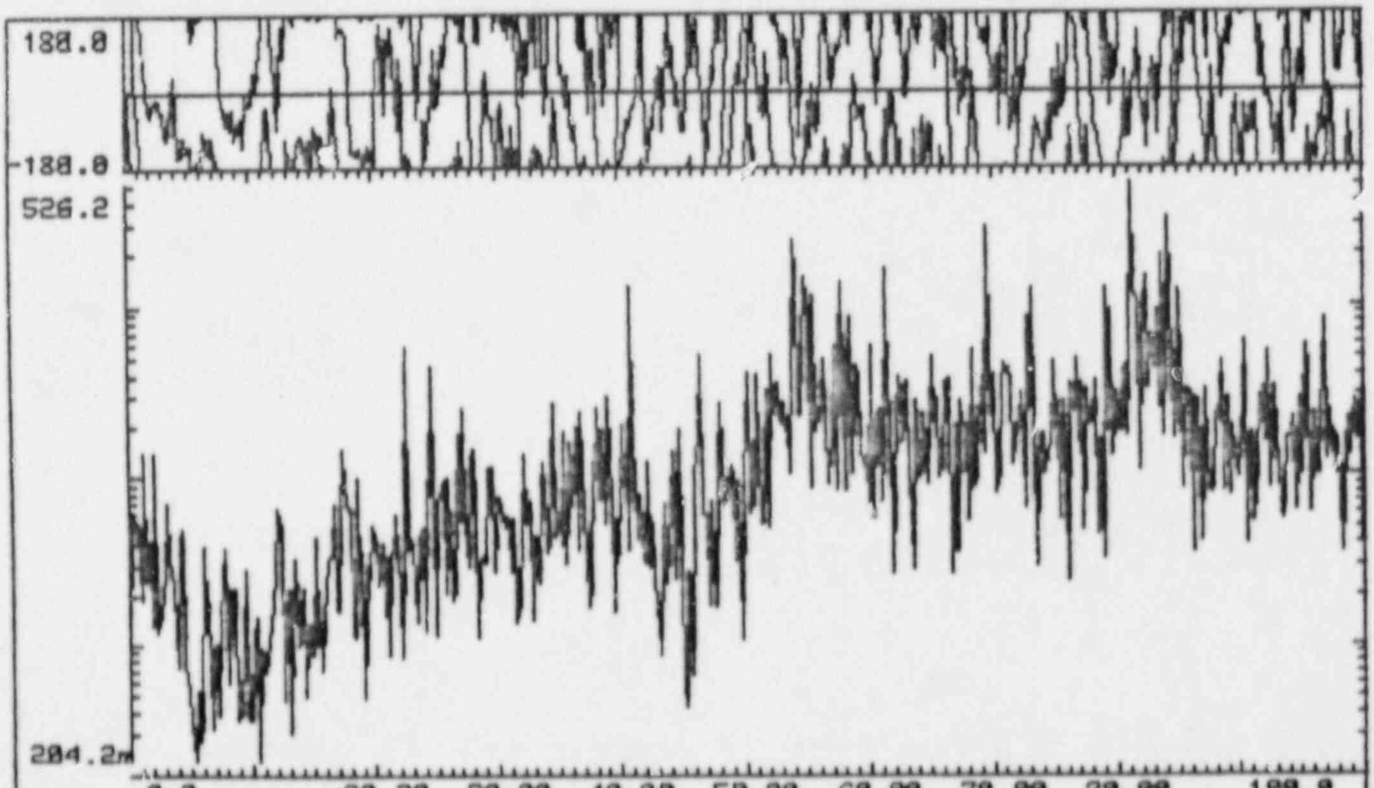


TED&EG&G WAVEFORM CHARACTERIZATION STUDY 20-JUN-87

VAMP>

WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM MSC/STI-VAMP

RECORD # 4 11:47:47

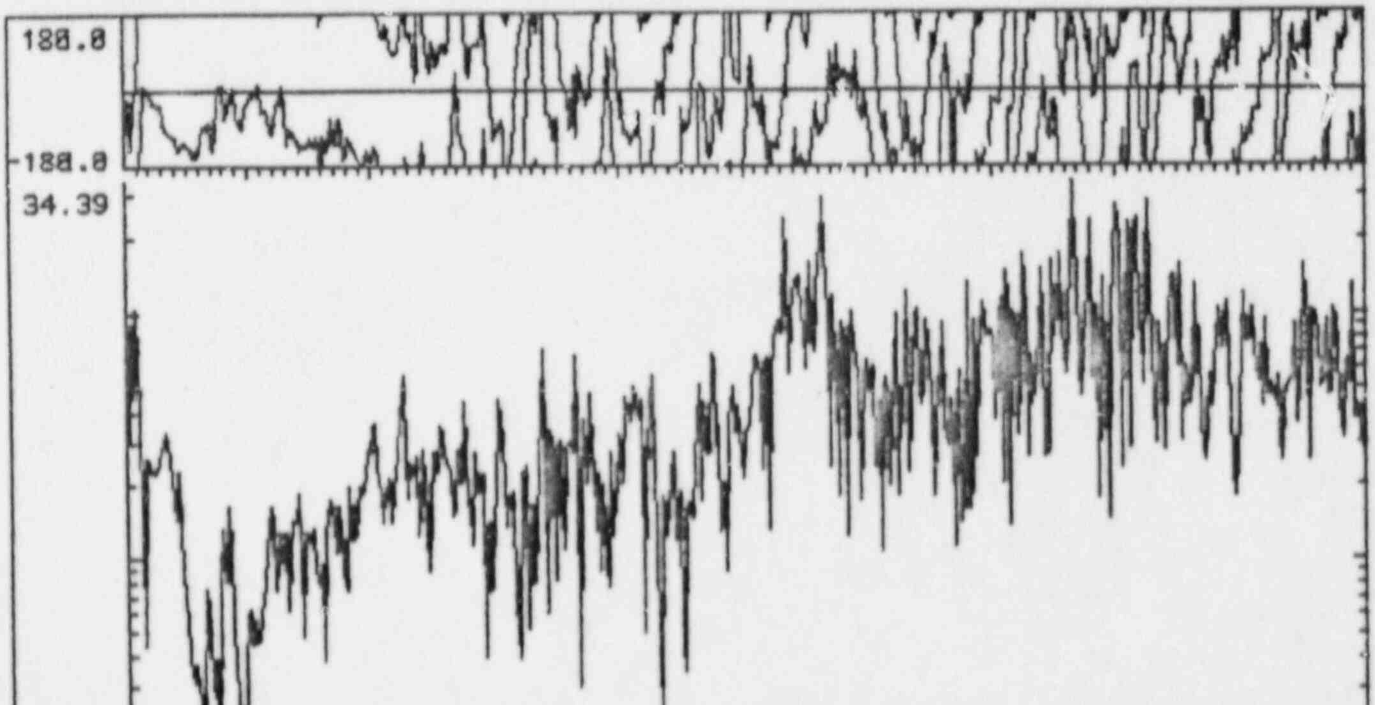


T#J8EG&G WAVEFORM CHARACTERIZATION STUDY 28-JUN-87

VAMP> TRANSMISSIBILITY

WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM MSC/STI-VAMP

RECORD # 4 11:52:41



T@D8EG&G WAVEFORM CHARACTERIZATION STUDY 20-JUN-87

VAMP> TRANSFER FUNCTION

RECORD NO. 5

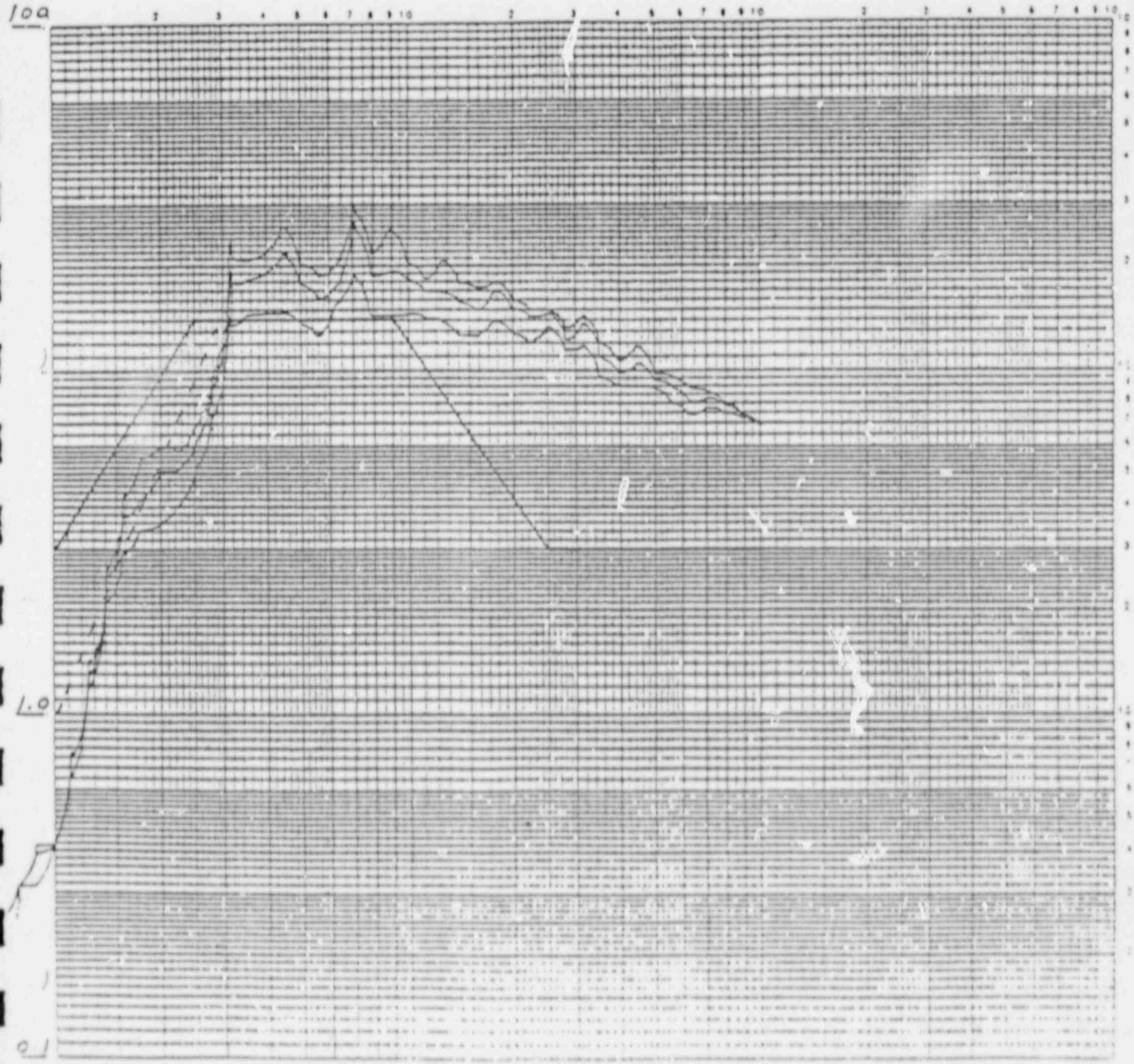
Specimen GENERATOR CONTROL PANEL Axis of Test X-Y

Accel. No. 1 Axis HORIZ Control (✓) Response ( ) OBE ( ) SSE (✓) DBE ( )

Full Scale 100 g Damping 2, 5, (3) % Run No. 15

Operator GRETERMAN Engineer [illegible]

RESPONSE SPECTRUM



RECORD NO. 5

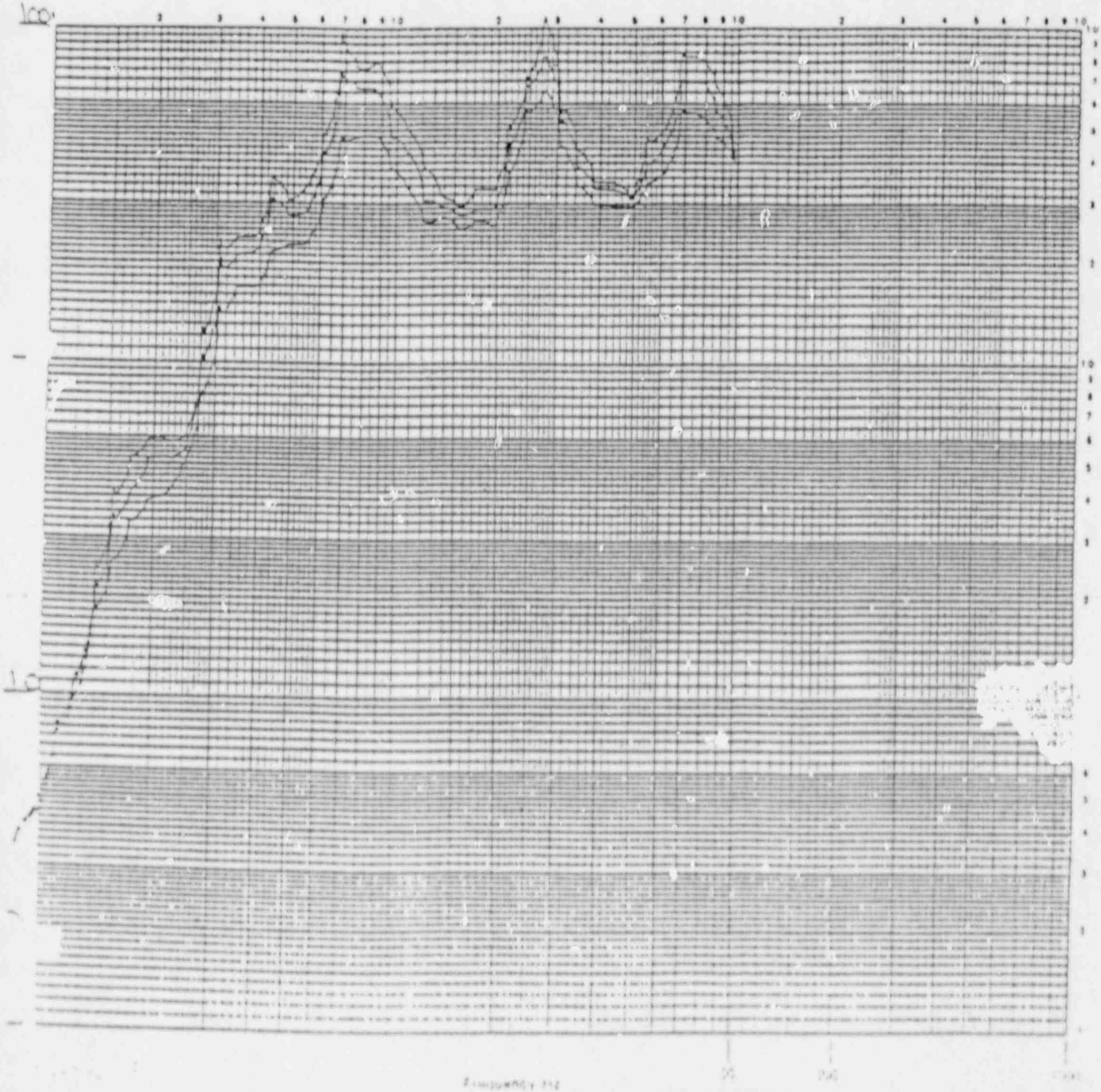
Specimen Generator Control Panel Axis of Test X-Y

Accel. No. 21 Axis X Control ( ) Response (✓) OBE ( ) SSE (✓) DBE ( )

Full Scale 100 g Damping 2,3,5 % Run No. 15

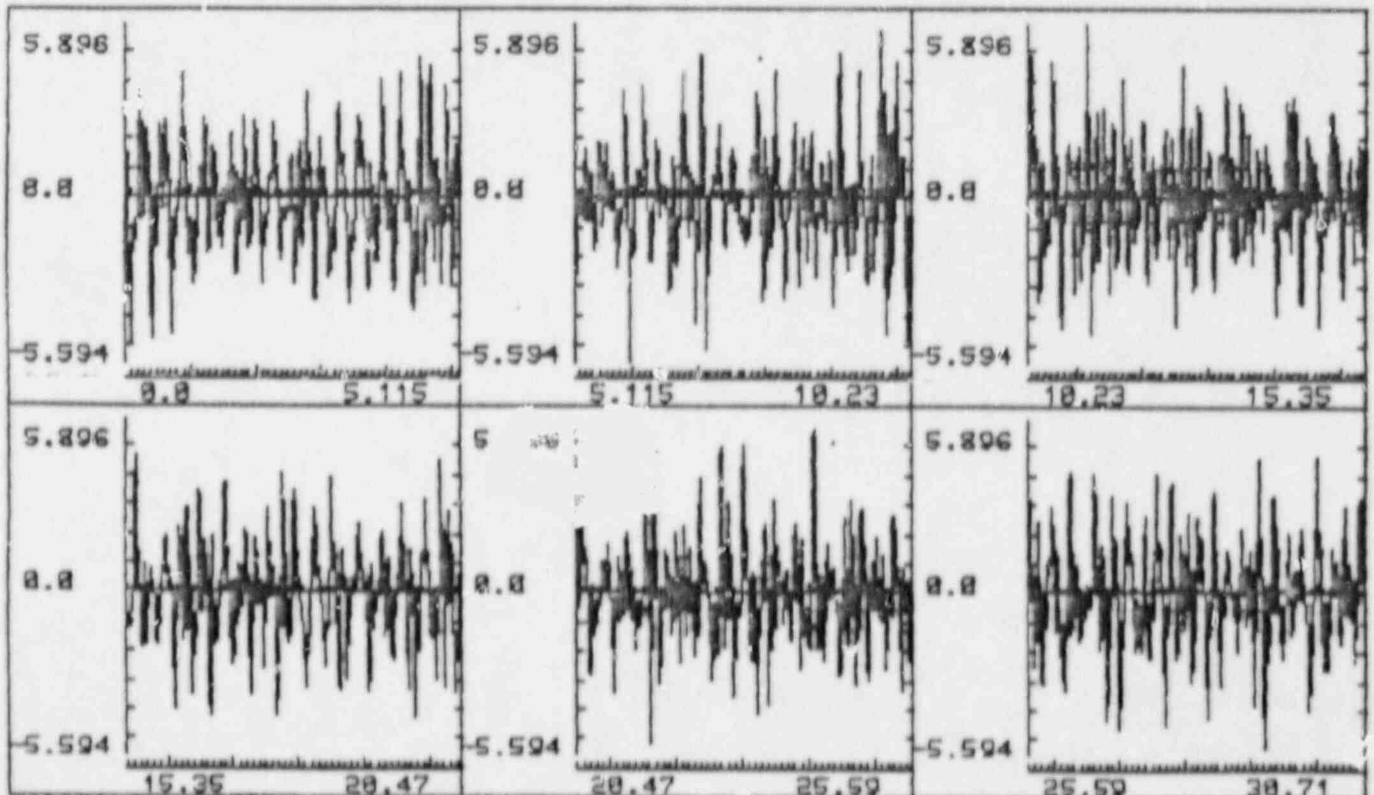
Operator Jm Engineer JHJ

RESPONSE SPECTRUM



WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM MSC/STI-VAMP

RECORD # 5 09:56:31

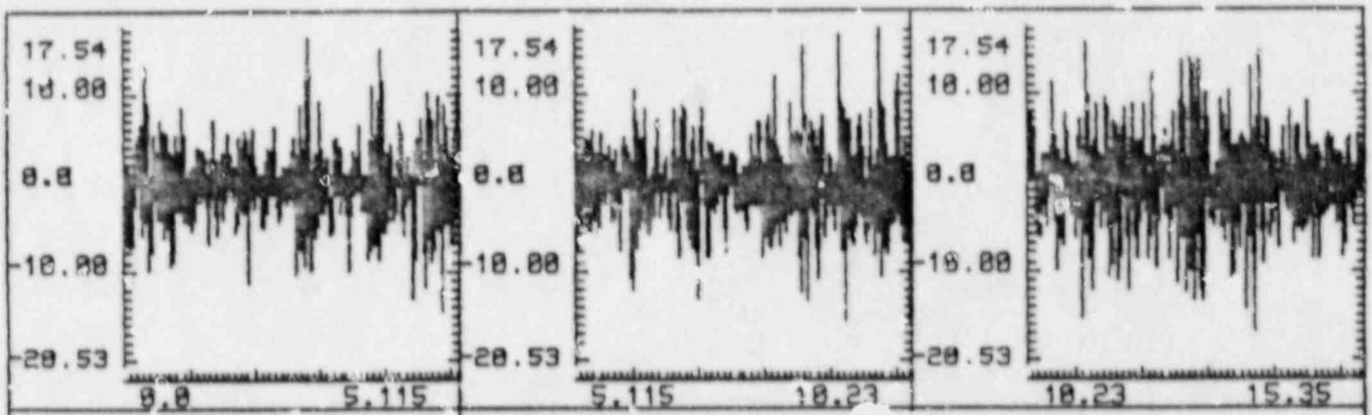


T008EG&G WAVEFORM CHARACTERIZATION STUDY 14-JUL-87

VAMP> INPUT TIME HISTORY

WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM MSC/STI-WAMP

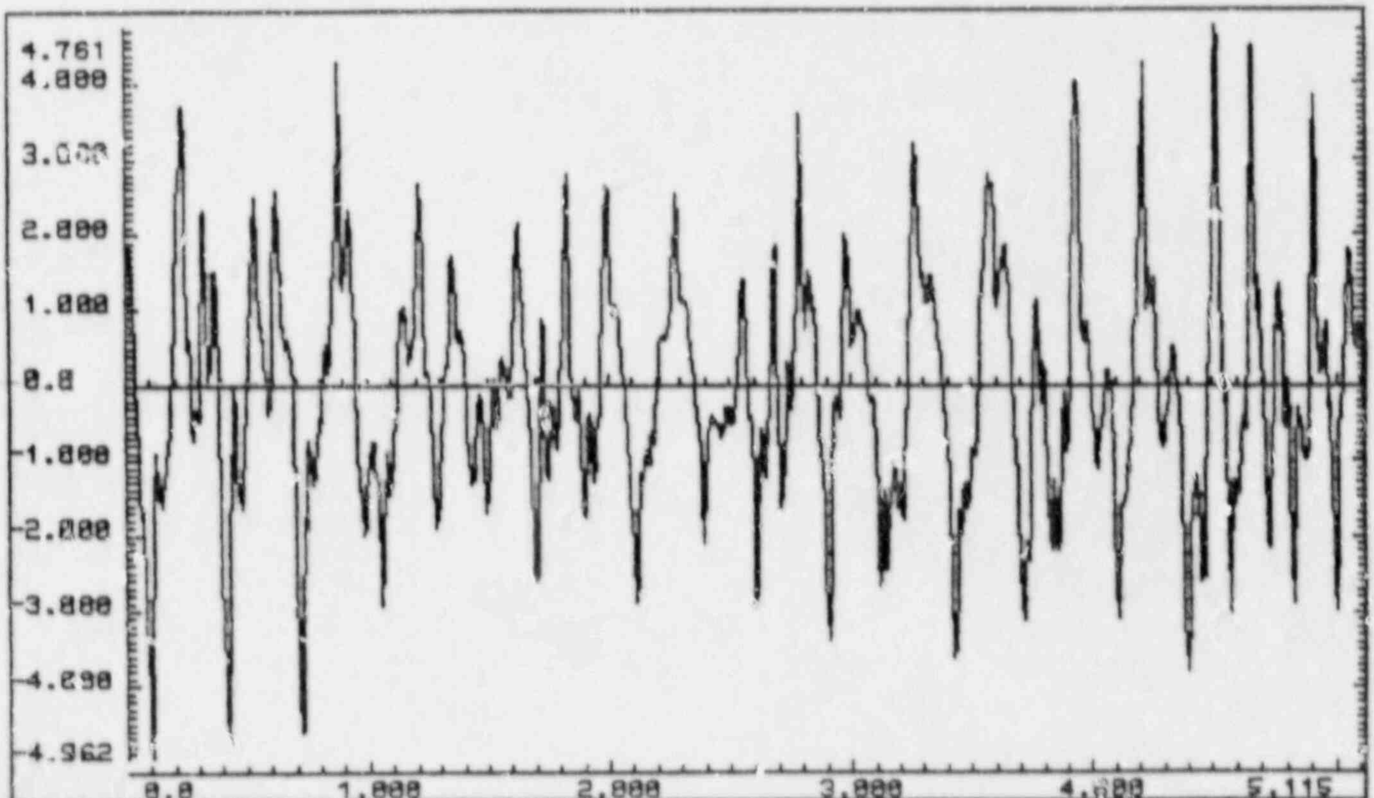
RECORD # 5 09:58:39



TIME HISTORY

WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM MSC/STI-VAMP

RECORD # 5 09:54:34

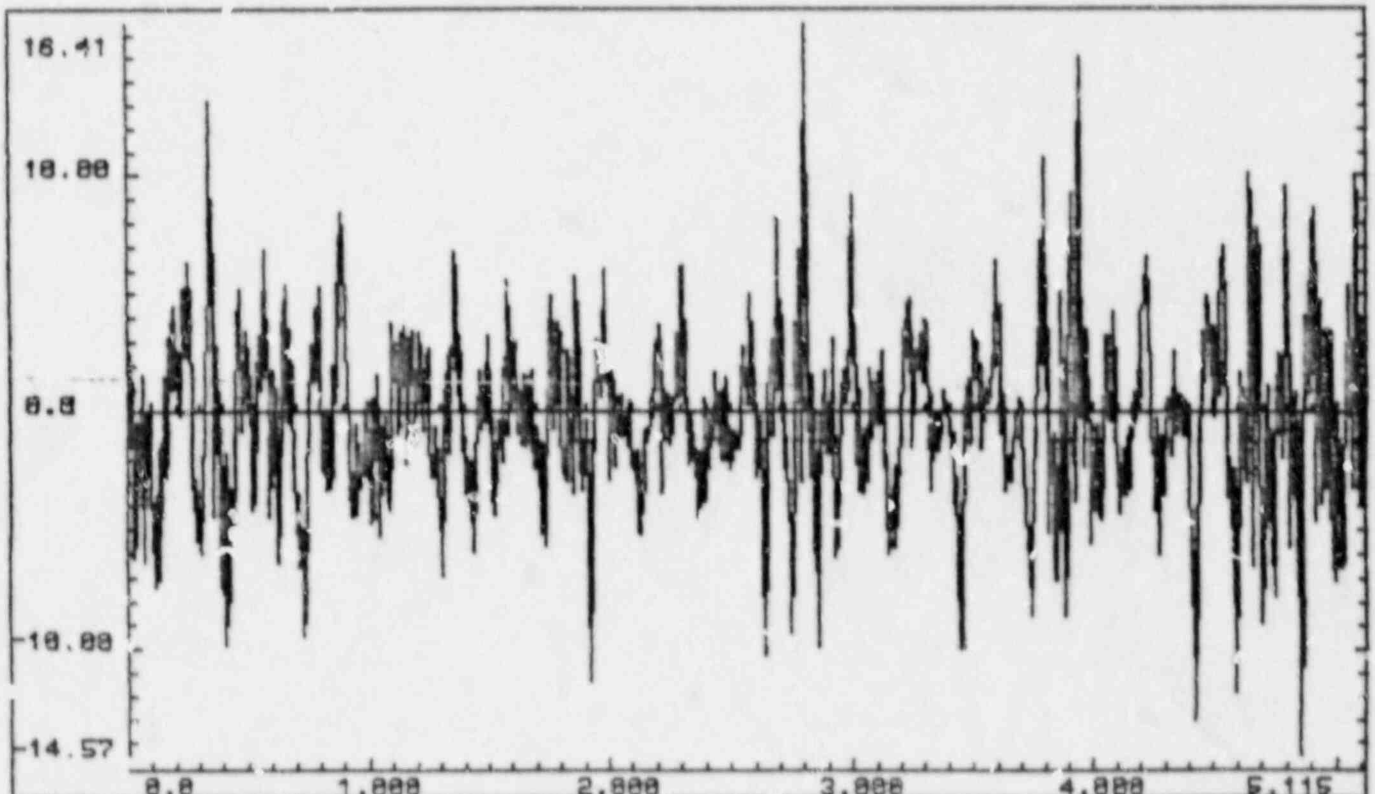


T@08EG&G WAVEFORM CHARACTERIZATION STUDY 14-JUL-87

VAMP> INPUT

WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM MSC/STI-VAMP

RECORD # 5 09:55:44

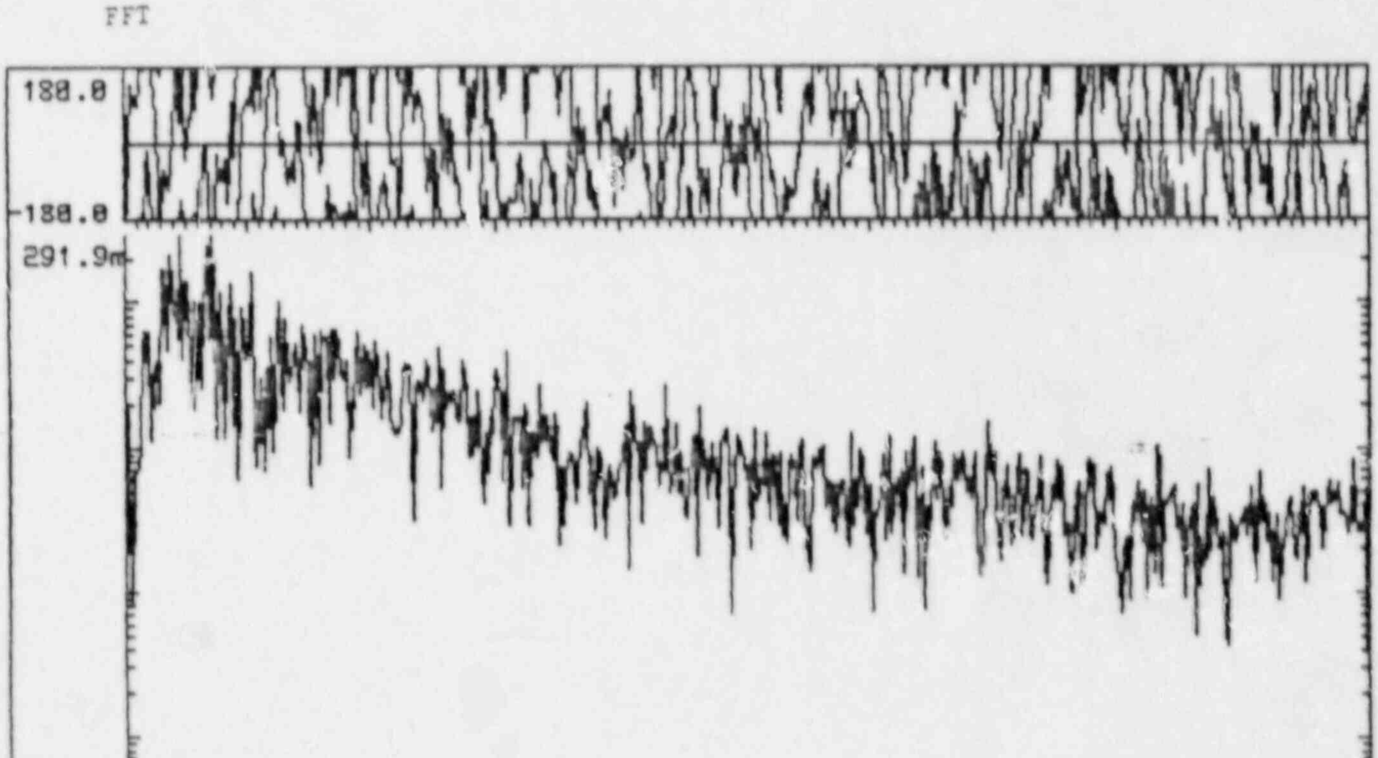


T0DSEG&G WAVEFORM CHARACTERIZATION STUDY 14-JUL-87

VAMP> RESPONSE

WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM MSC/STI-VAMP

RECORD # 5 10:02:29

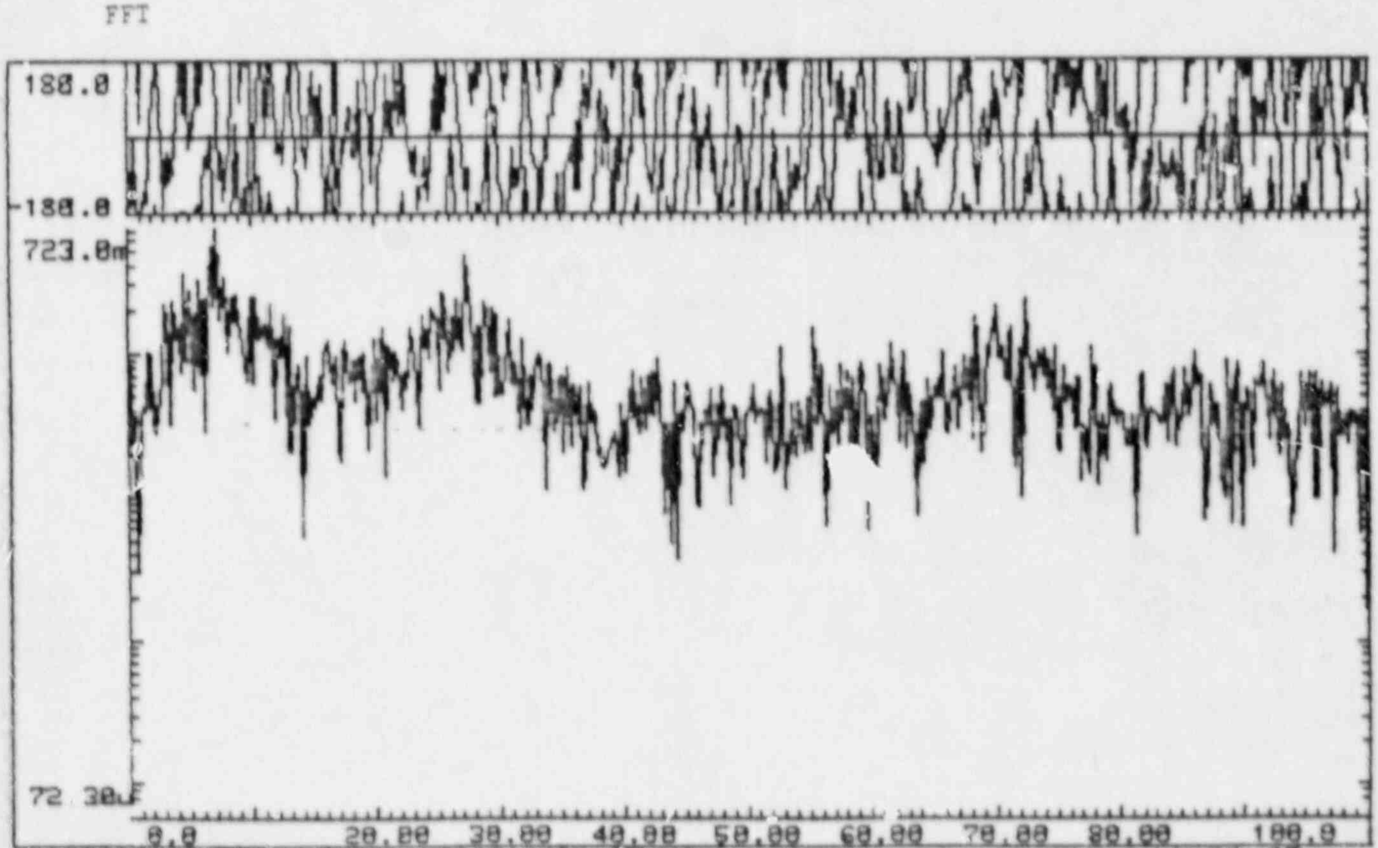


T00SEG&G WAVEFORM CHARACTERIZATION STUDY 14-JUL-87

VAMP> INPUT

WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM MSC/STI-VAMP

RECORD # 5 18:03:32

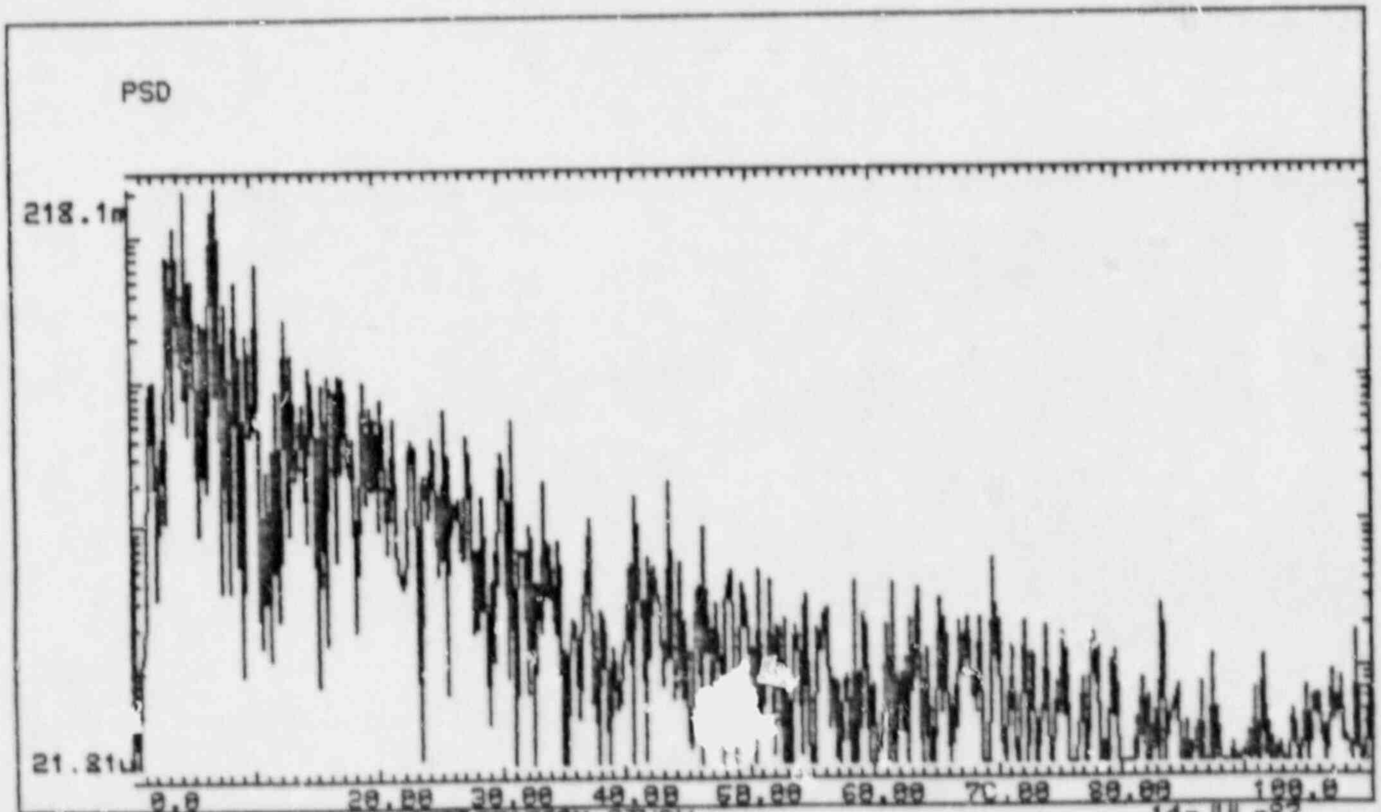


T0D8EG&G WAVEFORM CHARACTERIZATION STUDY 14-JUL-87

VAMP> RESPONSE

WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM MSC/STI-VAMP

RECORD # 5 10:06:02

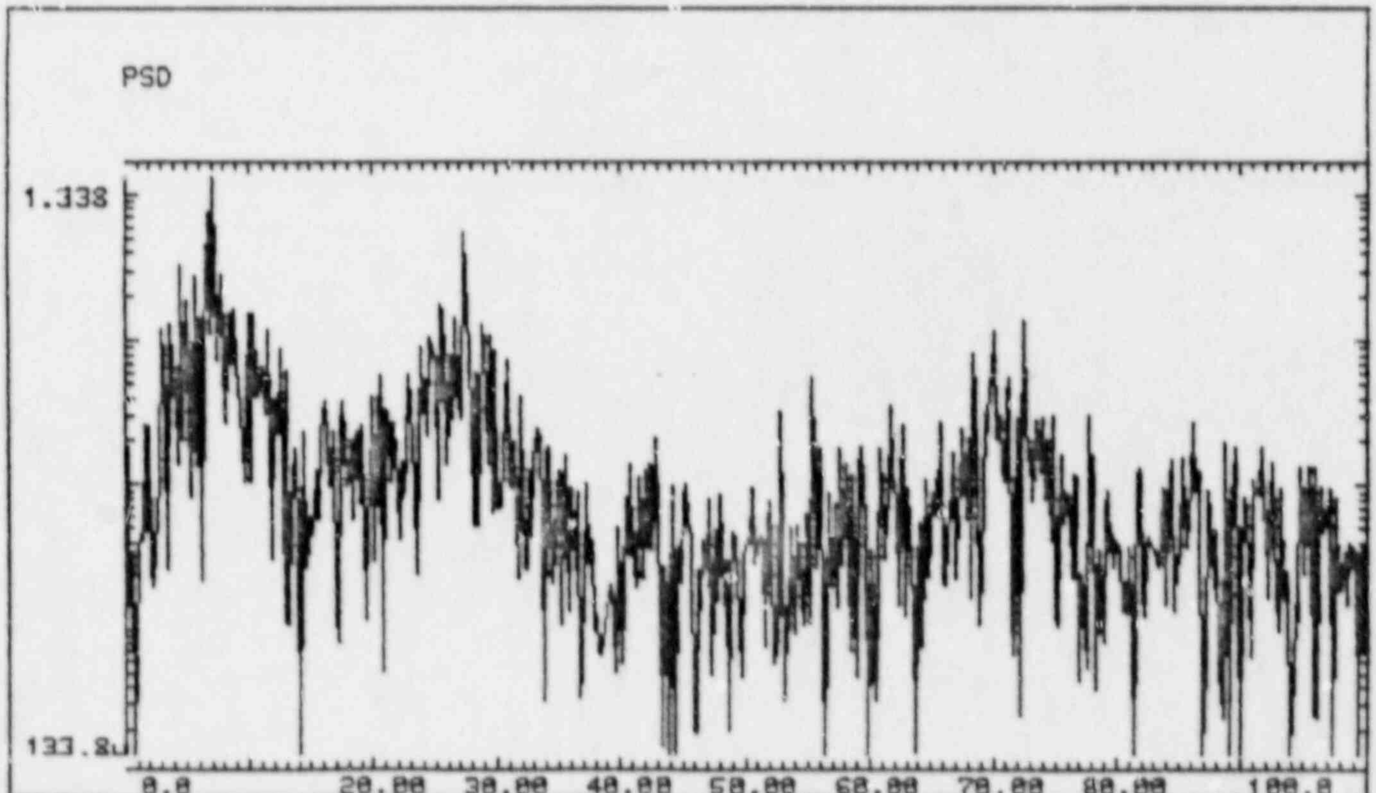


T@D8EG&G WAVEFORM CHARACTERIZATION STUDY 14-JUL-87

VAMP> INPUT

WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM MSC/STI-VAMP

RECORD # 5 10:06:51

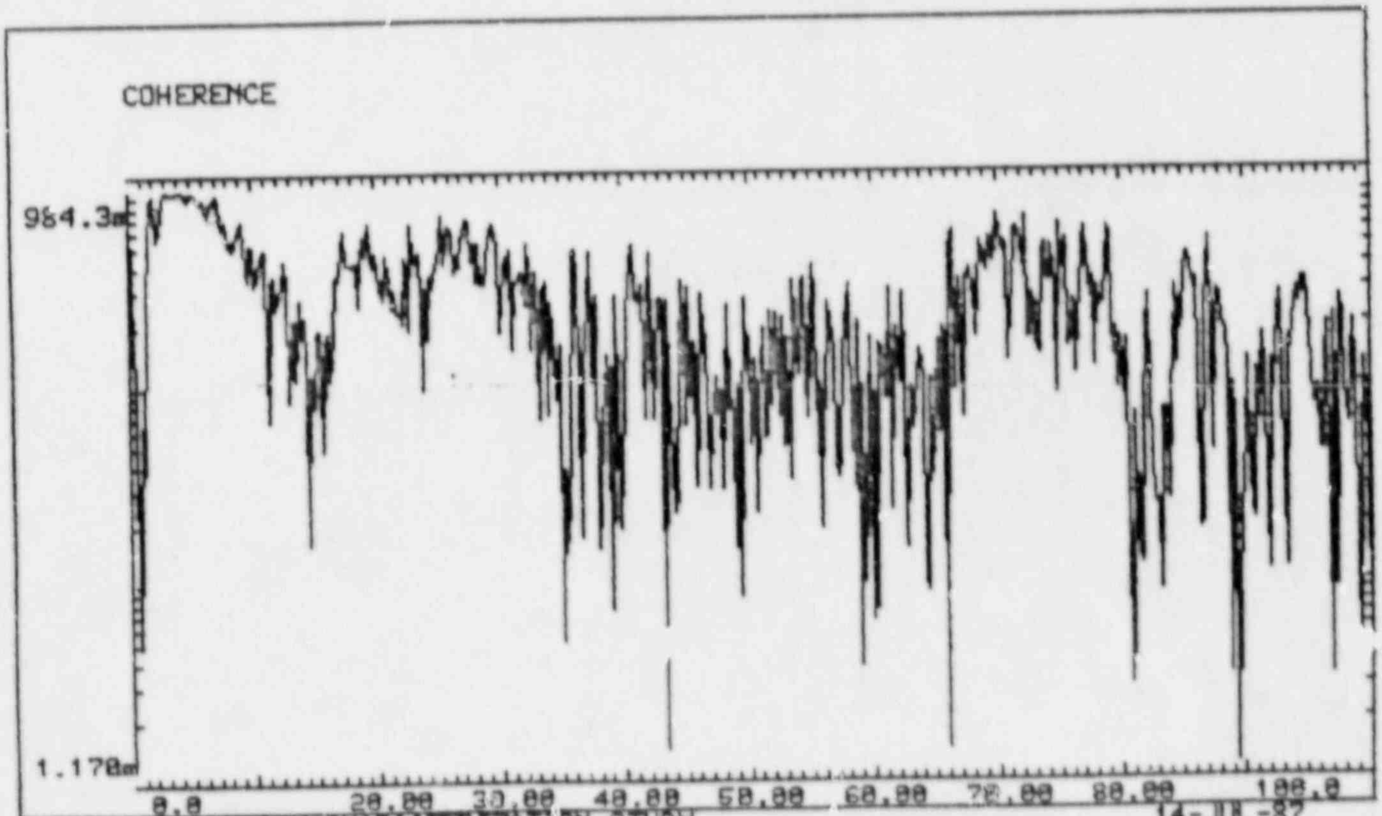


T0D3EG&G WAVEFORM CHARACTERIZATION STUDY 14-JUL-87

VAMP> RESPONSE

WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM　　MSC/STI-VAMP

RECORD # 5　　10:14:03

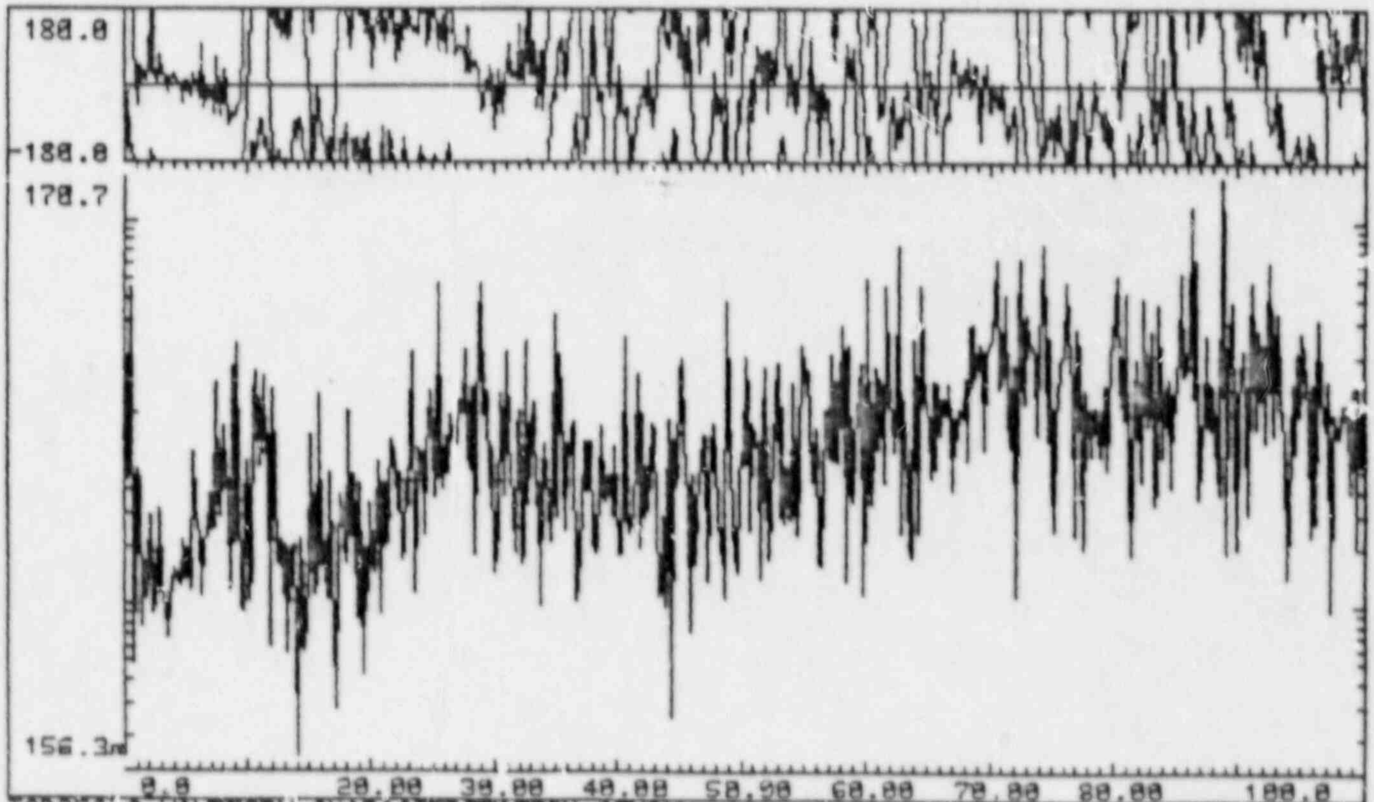


T@D8EG&G WAVEFORM CHARACTERIZATION STUDY　　14-JUL-87

VAMP>

WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM MSC/STI-VAMP

RECORD # 5 10:04:55

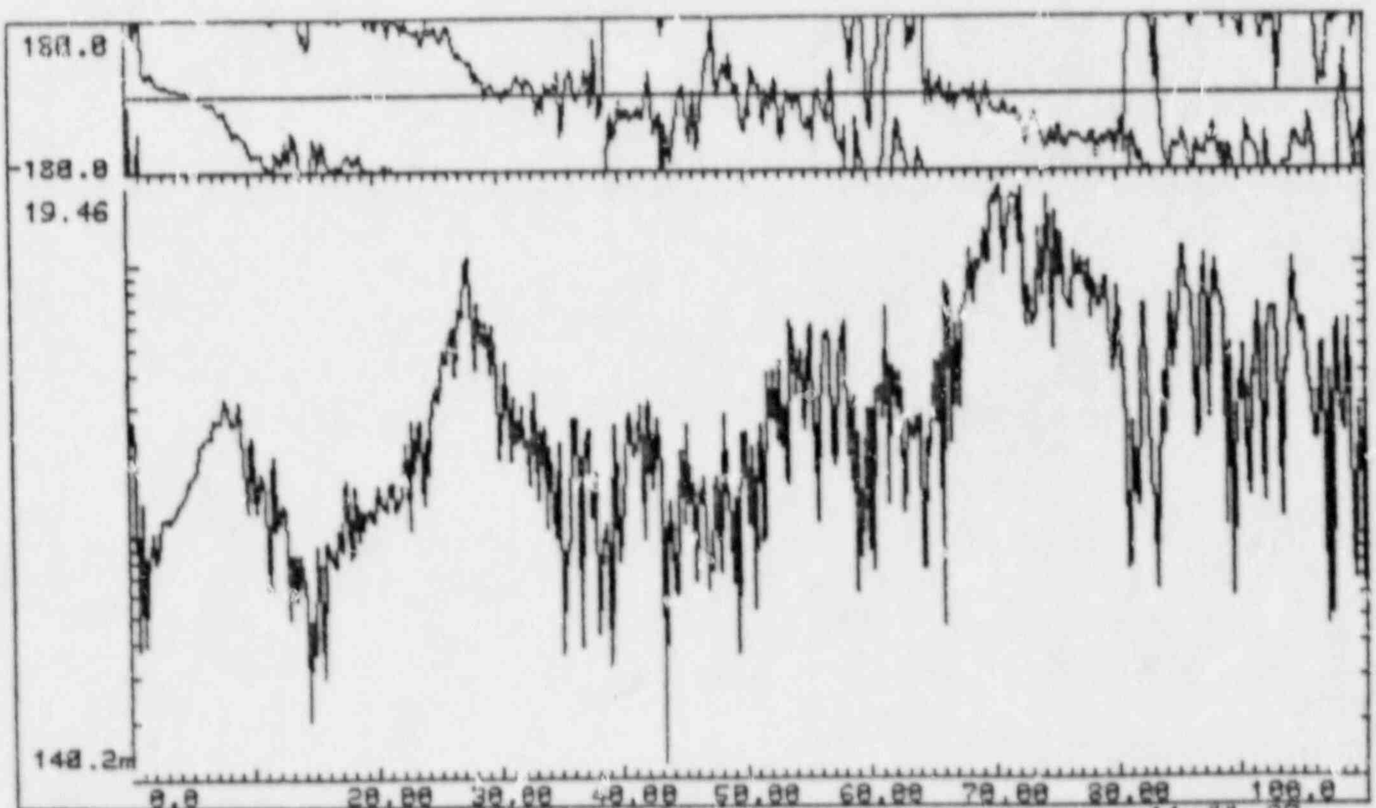


T@D8EC..G WAVEFORM CHARACTERIZATION STUDY 14-JUL-87

VAMP> TRANSMISSIBILITY

WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM MSC/S[illegible]T-VAMP

RECORD # 5 10:14:53



T@D8EG&G WAVEFORM CHARACTERIZATION STUDY 14-JUL-87

(AMP) TRANSFER FUNCTION

RECORD NO. 6

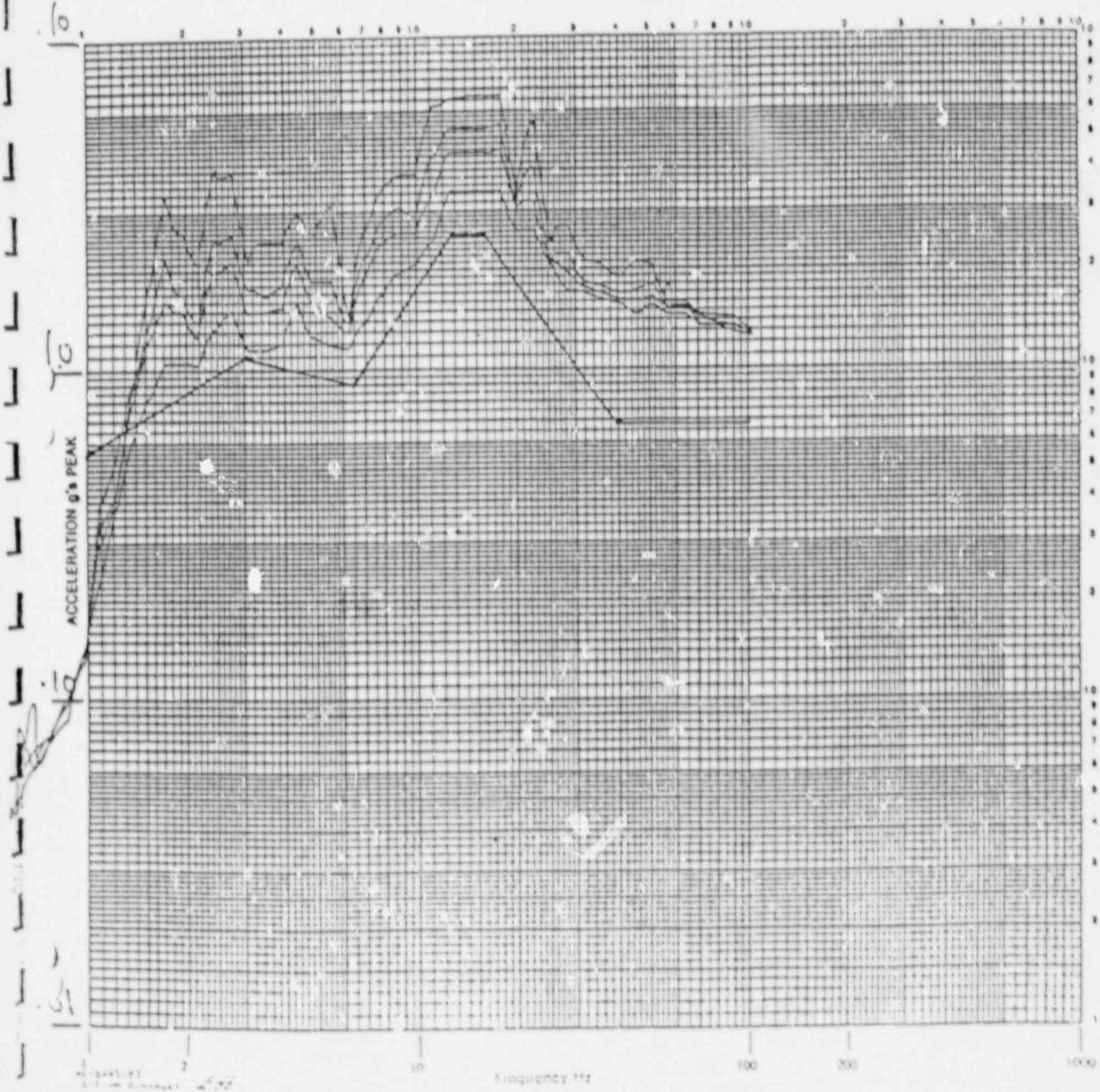
Specimen PANEL & ELEC. COMPONENTS Axis of Test Z

Accel. No. 1 Axis HORIZ Control (✓) Response ( ) OBE ( ) SSE (✓) DDE ( )

Full Scale 10 g Damping 1, 2, 3, (5) % Run No. 16

Operator GRETERMAN Engineer C. C. Lo

RESPONSE SPECTRUM



RECORD NO. 6

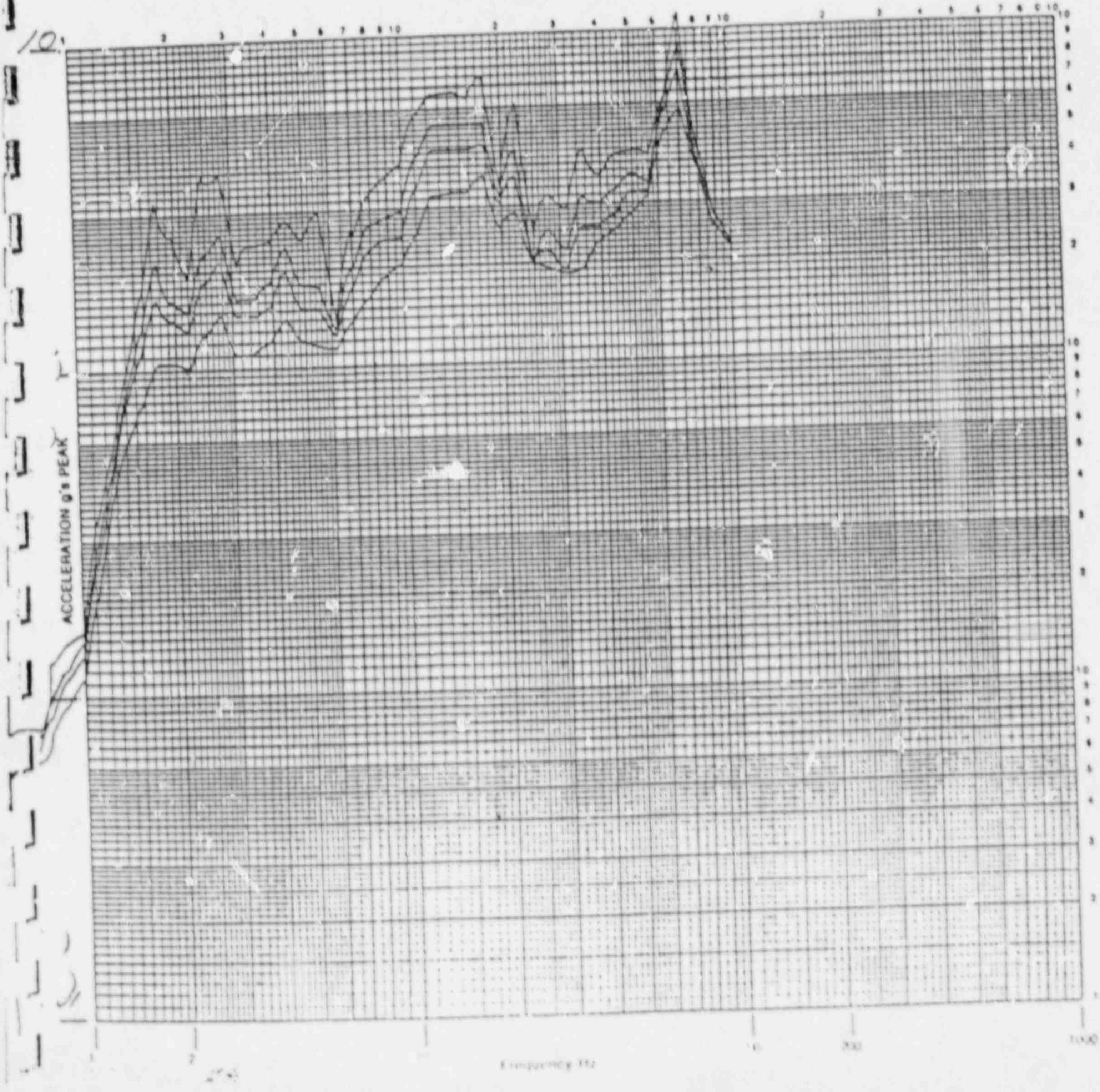
Specimen PANEL & ELEC COMPONETS Axis of Test Z-Y

Accel. No. 3 Axis HORIZ Control ( ) Response (✓) OBE ( ) SSE (✓) DBE ( )

Full Scale 10 g Damping (2,3,(5)% Run No. 16

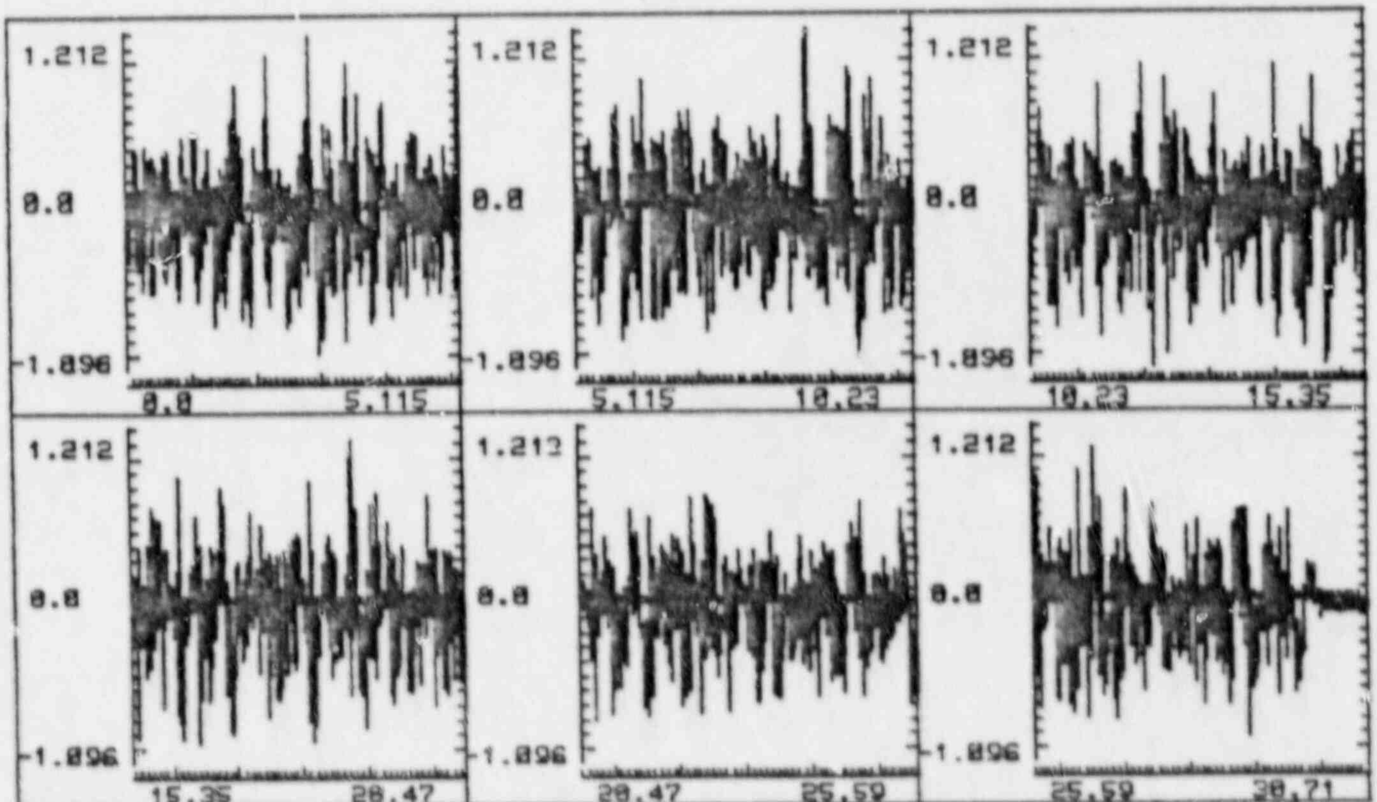
Operator SPETERMAN Engineer C C L

RESPONSE SPECTRUM



WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM MSC/STI-VAMP

RECORD # 6 08:45:45

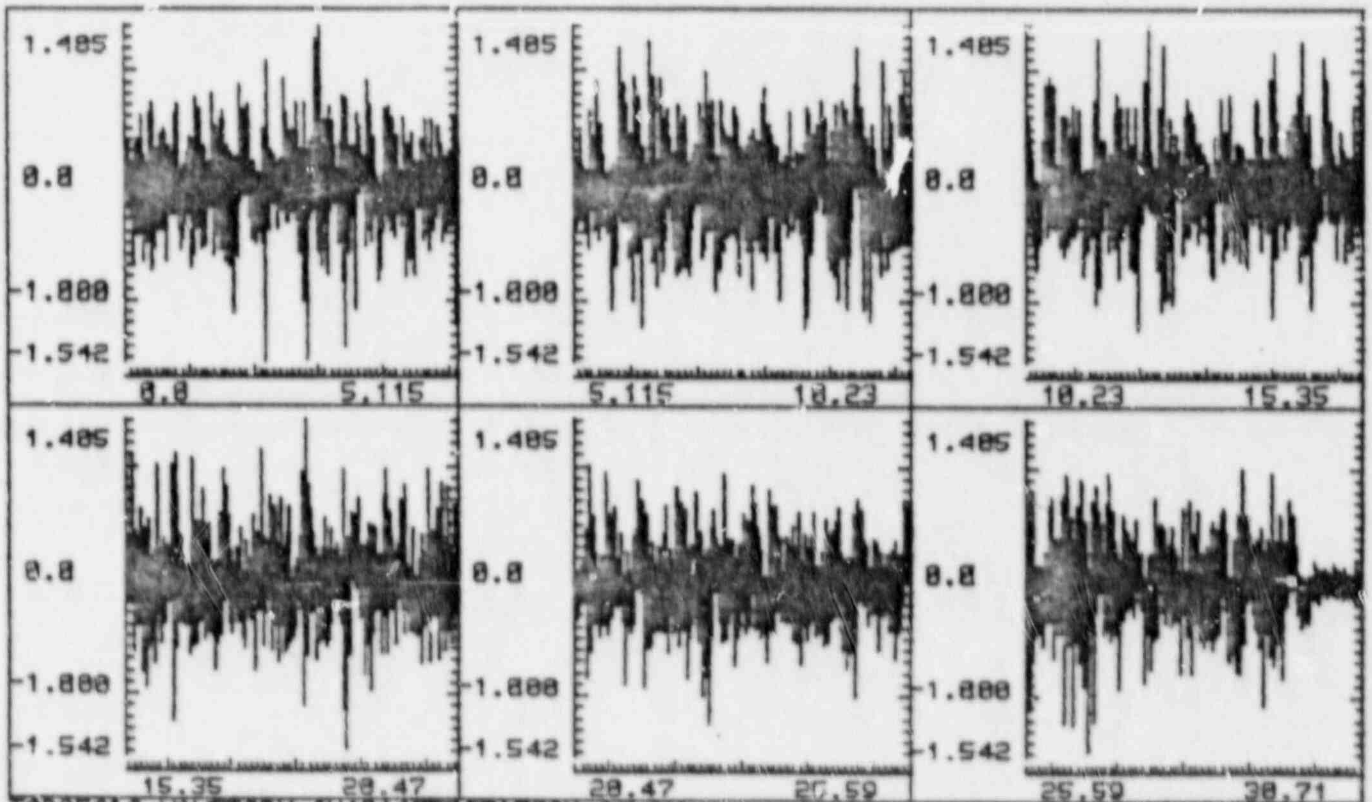


T@D8EG&G WAVEFORM CHARACTERIZATION STUDY 20-JUN-87

VAMP> INPUT

WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM MSC/STI-VAMP

RECORD # 6 08:48:28

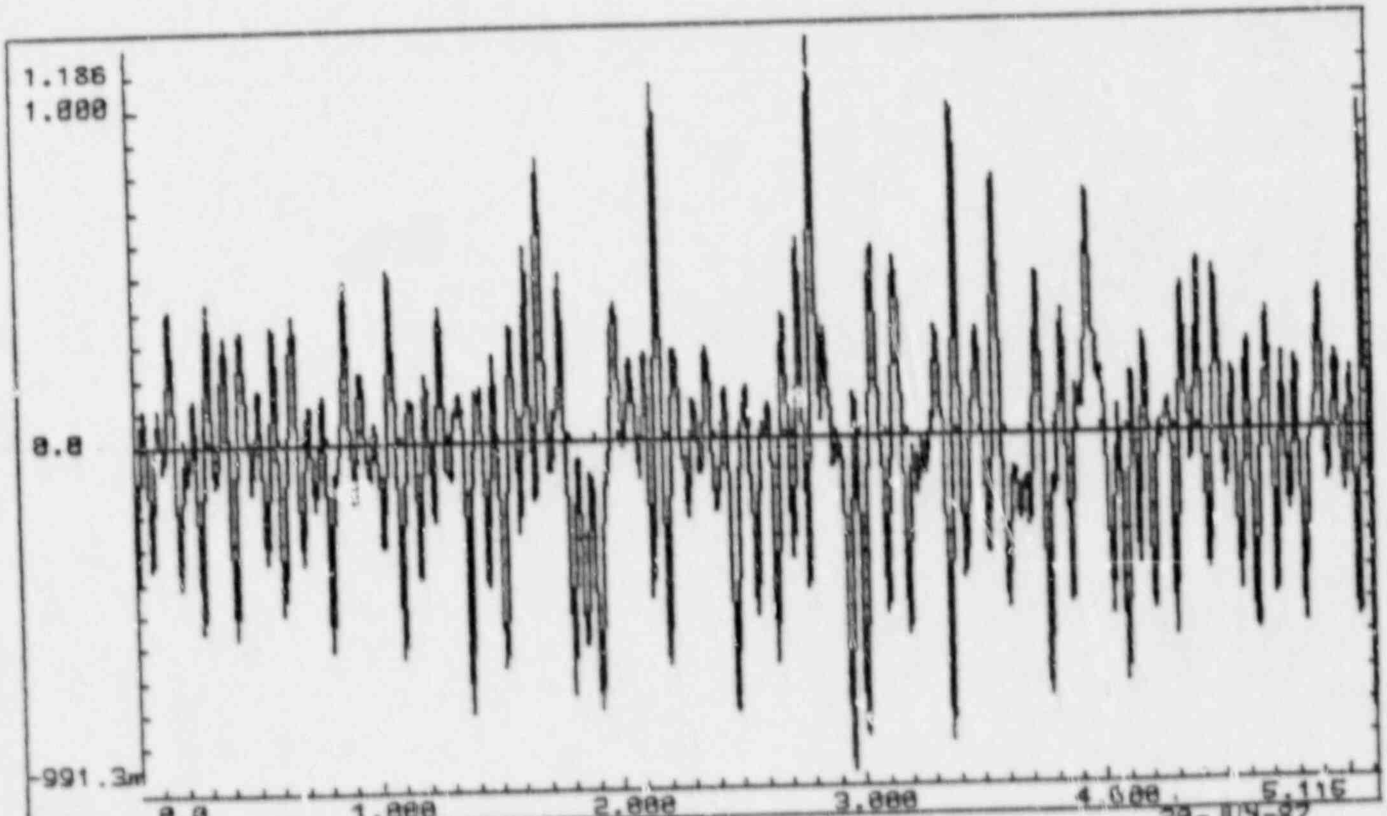


T0DSEG&G WAVEFORM CHARACTERIZATION STUDY 20-JUN-87

VAMP> RESPONSE

WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM MSC/STI-VAMP

RECORD # 6 08:44:47

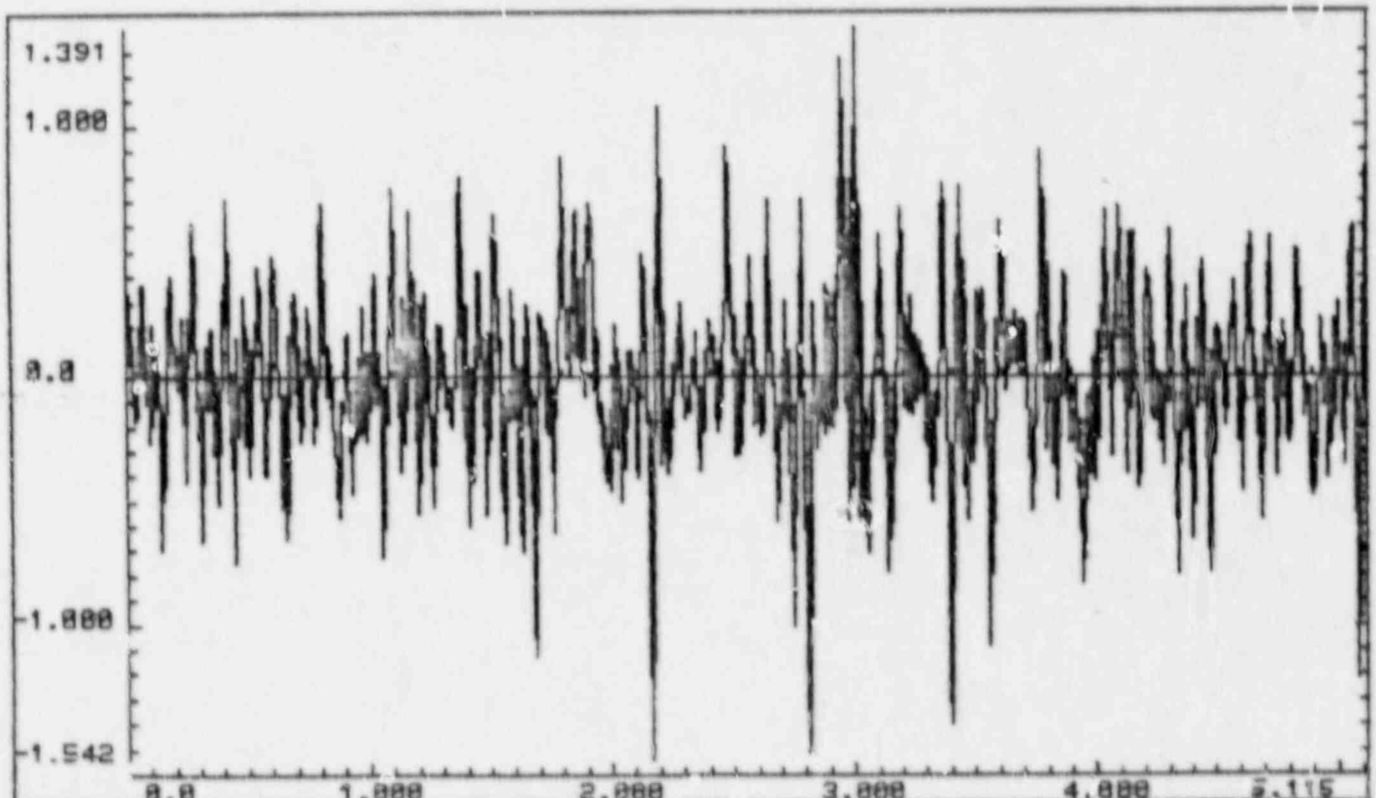


T@DSEG&G WAVEFORM CHARACTERIZATION STUDY 28-JUN-87

VAMP> INPUT

WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM MSC·STI-VAMP

RECORD # 6 08:44:33

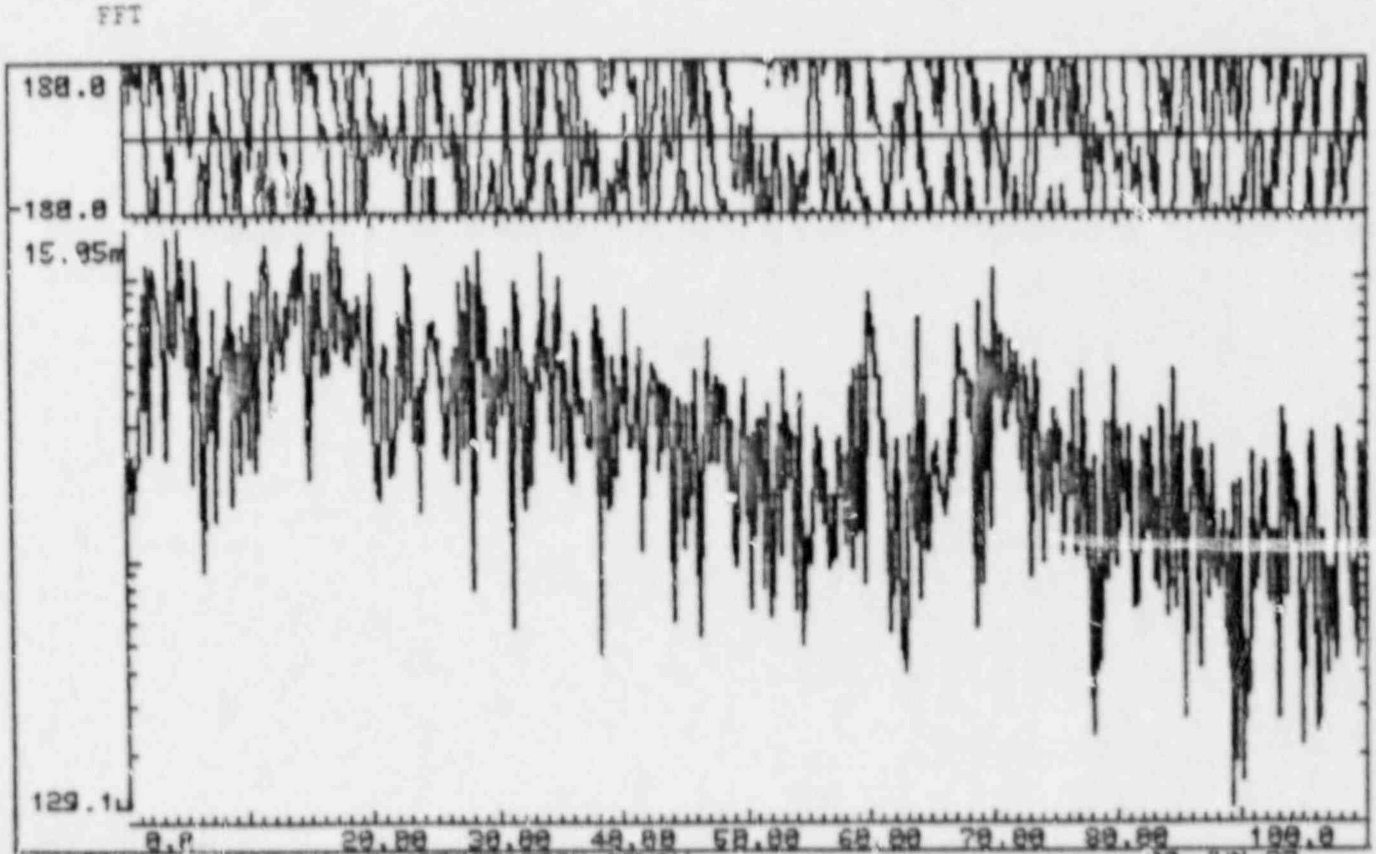


T@08EG&G WAVEFORM CHARACTERIZATION STUDY 20-JUN-87

VAMP> RESPONSE

WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM MSC/STI-VAMP

RECORD # 6 09:53:03

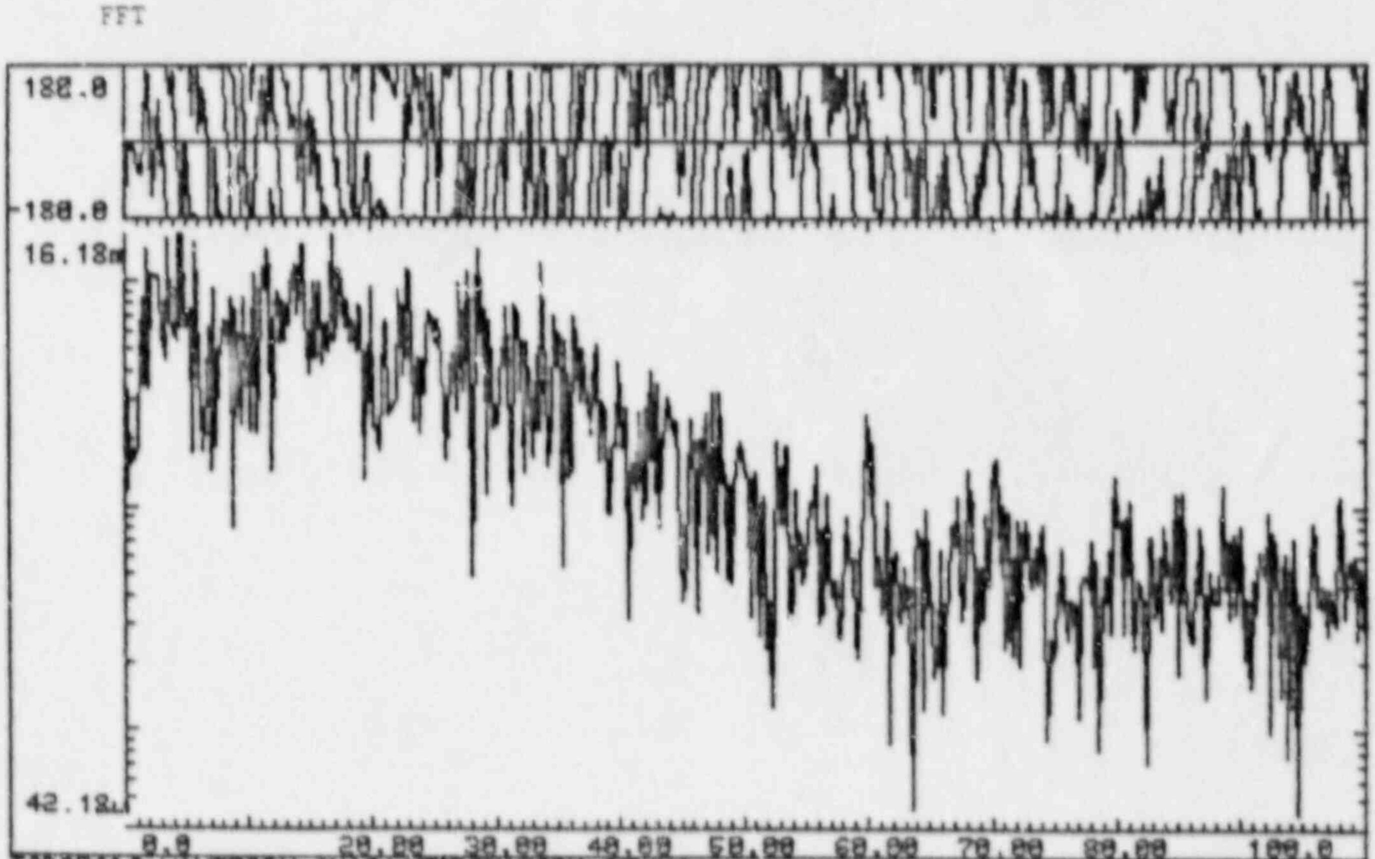


T00SEG&G WAVEFORM CHARACTERIZATION STUDY 20-JUN-87

VAMP> INPUT

WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM MSC/STI-VAMP

RECORD # 6 09:54:53

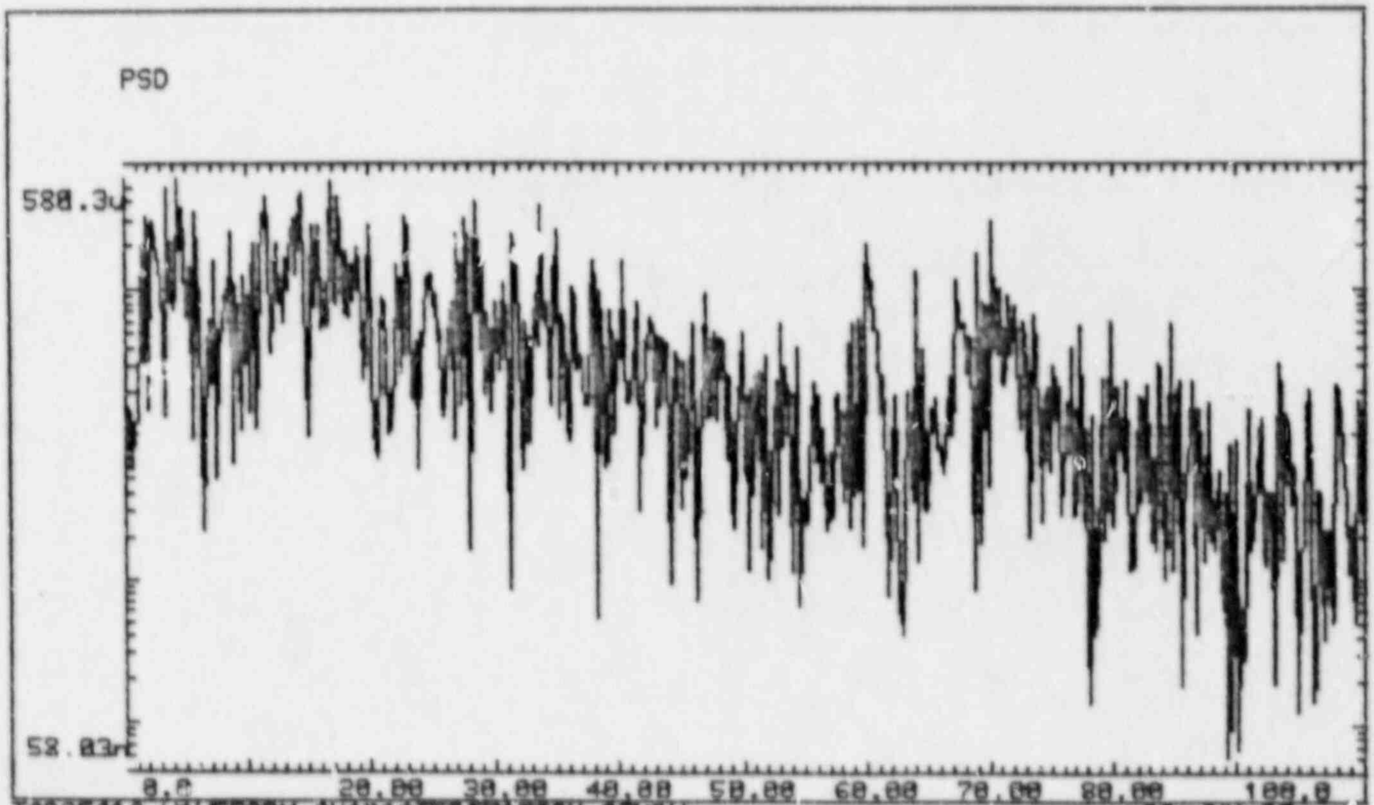


T@)8EG&G WAVEFORM CHARACTERIZATION STUDY 28-JUN-87

(AMP) RESPONSE

WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM MSC/STI-VAMP

RECORD # 6 09:54:09

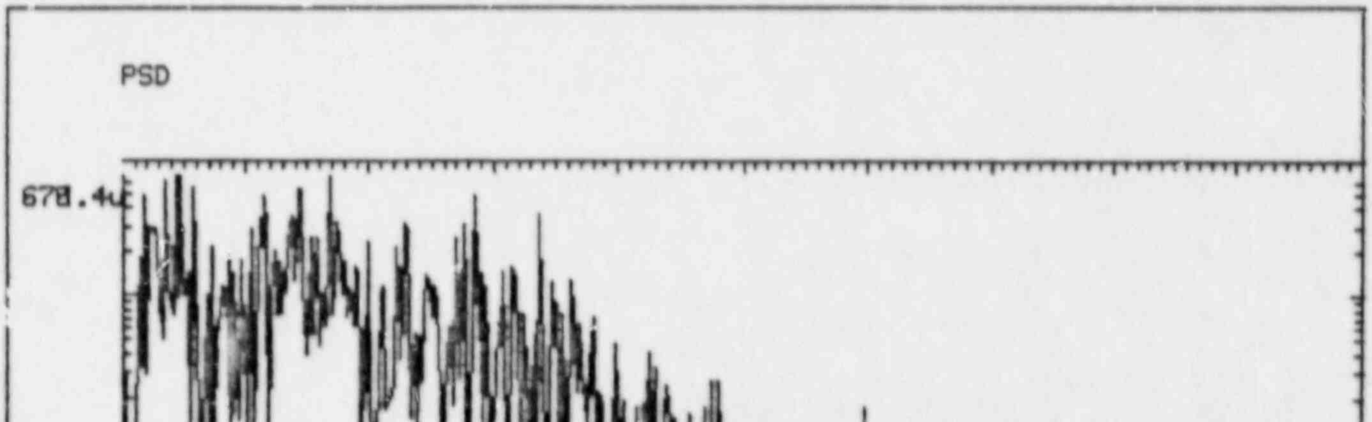


T008EG&G WAVEFORM CHARACTERIZATION STUDY 28-JUN-87

VAMP> INPUT

WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM MSC/STI-VAMP

RECORD # 6 09:55:58

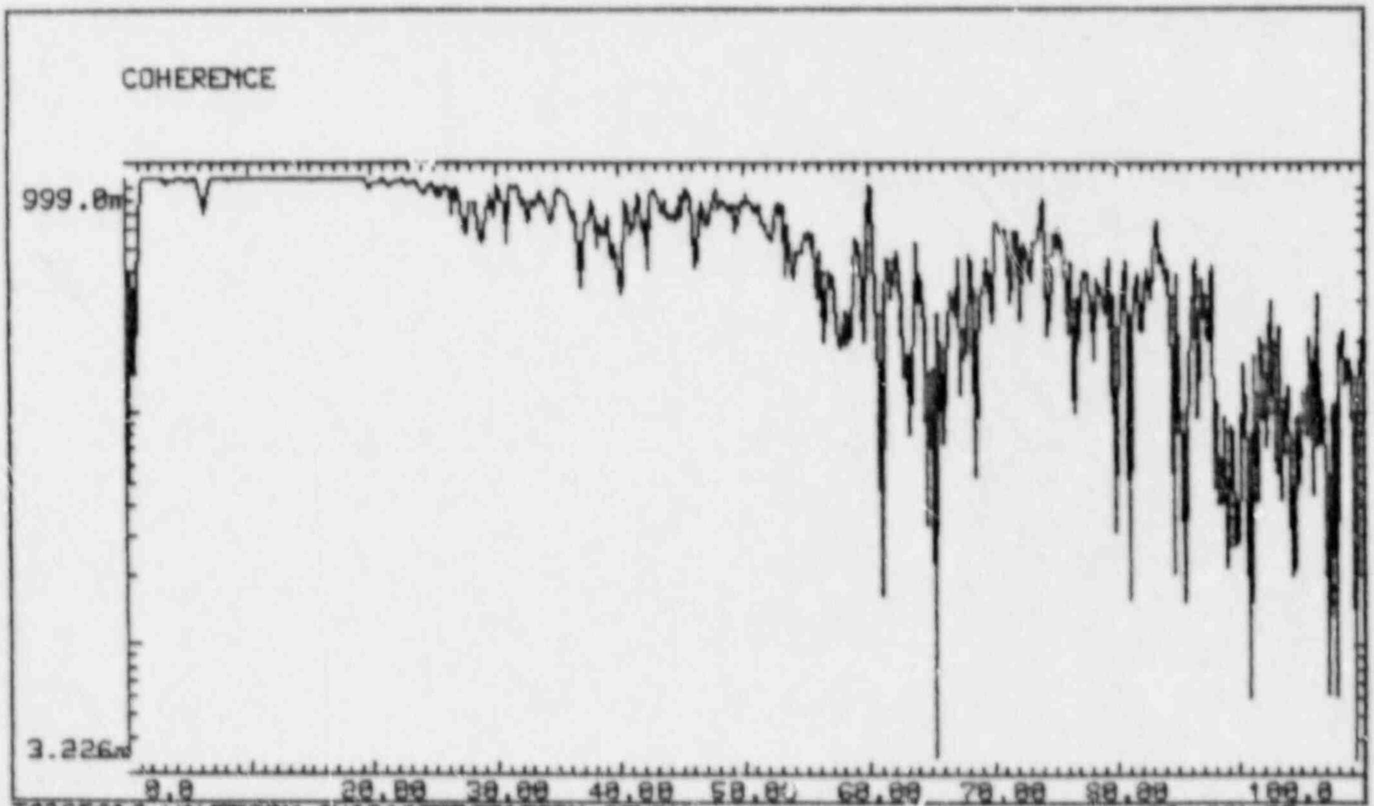


T@OSEG&G WAVEFORM CHARACTERIZATION STUDY 28-JUN-87

VAMP> RESPONSE

WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM MSC/STI-VAMP

RECORD # 6 09:02:55

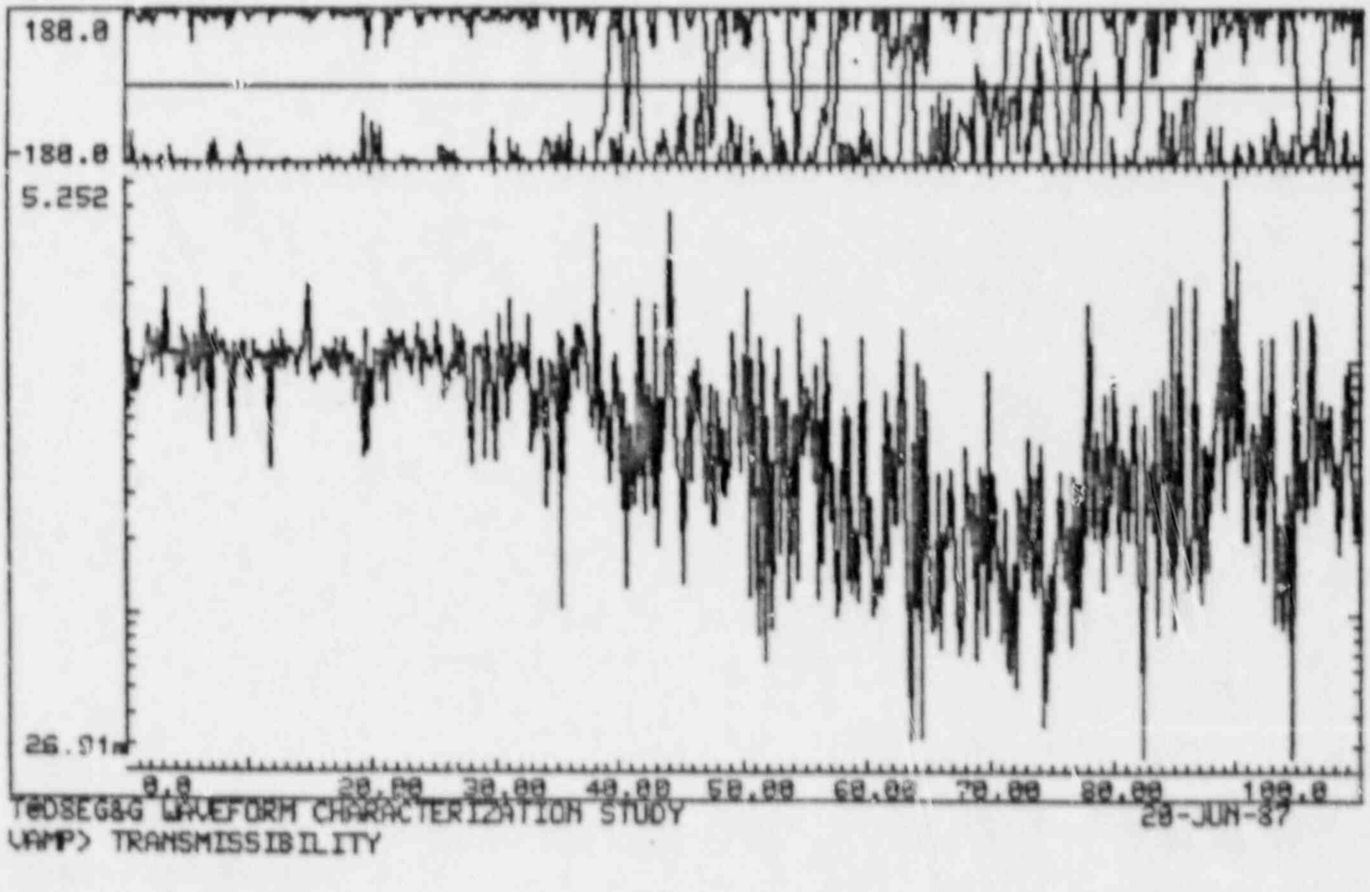


T@DSEG&G WAVEFORM CHARACTERIZATION STUDY 20-JUN-87

VAMP>

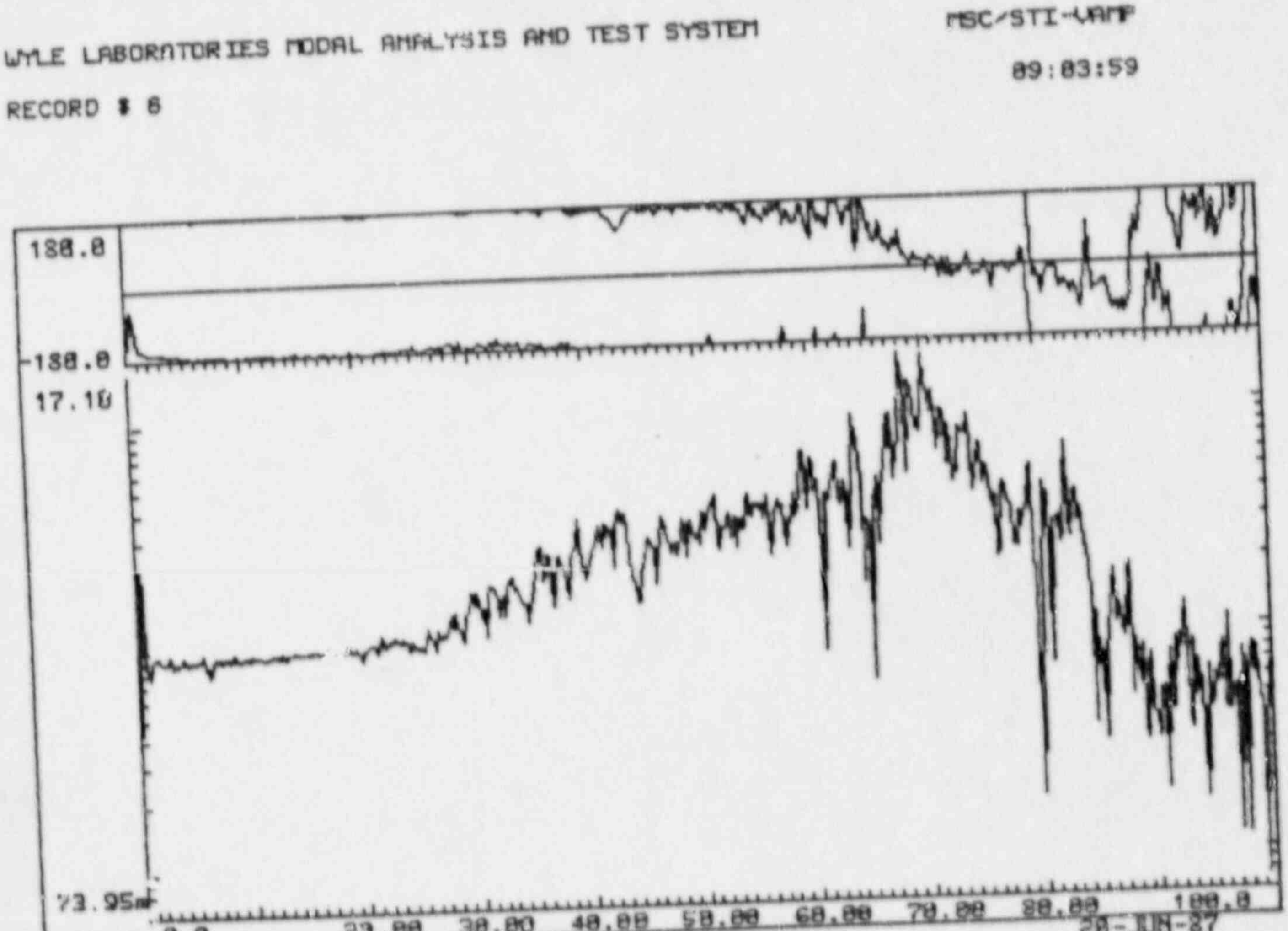
WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM MSC/STI-VAMP

RECORD # 6 09:56:33



T@DSEG&G WAVEFORM CHARACTERIZATION STUDY 20-JUN-87

VAMP> TRANSMISSIBILITY


WYLE LABORATORIES MODAL ANALYSIS AND TEST SYSTEM
MSC/STI-VAMP
09:03:59
RECORD # 6
180.0
-180.0
17.10
73.95m
0.0
20.00
30.00
40.00
50.00
60.00
70.00
80.00
100.0
28-JUN-87
T@DSEG&G WAVEFORM CHARACTERIZATION STUDY
VAMP> TRANSFER FUNCTION

APPENDIX C

TEST LOG AND DATA SHEETS

WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

DATA SHEET

Customer E. G. & G. Job No. 57724

Date 5-15-87

Specimen 230 VOLT AC RELAY

RECEIVING INSPECTION

No. of Specimens Received: 4

Record identification information exactly as it appears on the tag or specimen:

Manufacturer GENERAL ELECTRIC

Part Numbers CR120B0600?

How does identification information appear: (name plate, tag, painted, imprinted, etc.)

Serial Numbers:*

Examination: Visual, for evidence of damage, poor workmanship, or other defects, and completeness of identification.

Inspection Results: There was no visible evidence of damage to the specimens unless noted below.

* If additional space is required for serial numbers, use an additional page, or reference first functional test data sheet (if applicable).

Inspected By [signature]

Sheet No. ____ of ____

Approved [signature] Date: 5/15/87

W-614

WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

DATA SHEET

Customer E. G. & G. Job No. 57724

Date 5-15-87

Specimen 120 VOLT AC RELAY

RECEIVING INSPECTION

No. of Specimens Received: 4

Record identification information exactly as it appears on the tag or specimen:

Manufacturer WESTINGHOUSE

Part Numbers AR660

How does identification information appear: (name plate, tag, painted, imprinted, etc.)

Serial Numbers:*

Examination: Visual, for evidence of damage, poor workmanship, or other defects, and completeness of identification.

Inspection Results: There was no visible evidence of damage to the specimens unless noted below.

* If additional space is required for serial numbers, use an additional page, or reference first functional test data sheet (if applicable).

Inspected By [signature]

Sheet No. of

Approved [signature] Date: 5/15/87

W-614

QA Form Approval

WYLE LABORATORIES

WYLE LABORATORIES TEST LOG SHEET

Job Number 57724 — Test Title SINGLE AXIS SEISMIC. — Log Page 1 Of

Customer EG & G — Test Item Elec. COMPONENTS — Test Engineer

Date 5-17-87 — Serial No. — Test Area F-10

USE A SEPARATE LOG SHEET FOR EACH TEST TITLE OR TEST ITEM

Time Start	Time Comp.	Action and Remarks	Entered by
0715		START CALIBRATION FOR TEST. 10 SEC. TEST RUNS.	B.Y.
	1500	LOW & HIGH LEVEL COMPLETE	B.S.
5-18-87			
0855		RESUME CALIBRATION.	B.Y.
	1430	FINISHED.	B.Y.
1430		MOUNTE SPECIMENTS AND READY FOR TEST.	B.Y.
	1700	READY.	B.Y.
5-19-87			
0800		OPEN TEST SITE AND WARM UP SHAKERS.	B.Y.
	0810	COMPLETED.	B.Y.
0817		START XAXIS RES. SEARCH 1-10 CHZ. .20. RANDOM 1/2 OCT. SETTING 1.50	B.S.
	0832	COMPLETE	B.Y.
0913	0914	START RUN#1 LOW FREQ. 5TH SETTING. X-AXIS. 1ST LEVEL. DE-EN.	B.Y.
0943	0944	RUN#1-1 LOW FREQ 5TH SETTING. X-AXIS. 1ST LEVEL. RE-RUN DE-EN.	B.Y.
1025	1026	RUN#2 LOW FREQ 4TH SETTING. X-AXIS. 2ND LEVEL DE-EN.	B.Y.
1031	1032	RUN#3 LOW FREQ. 3RD SETTING. X-AXIS. 3RD LEVEL DE-EN	B.Y.
1038	1039	RUN#4 LOW FREQ 2ND SETTING. X-AXIS. 4TH LEVEL DE-EN	B.Y.
1044	1045	RUN#5 " " 1ST " X-" 5TH LEVEL DE-EN. CHATTER.	B.Y.
1129	1130	RUN#6 " " 1ST " " " 5TH LEVEL ENERGIZED	B.S.

W-648-B Q.C. Form Approval [illegible]

WYLE LABORATORIES

WYLE LABORATORIES TEST LOG SHEET

Job Number 57724 | Test Title Single Axis Seismic | Log Page 2 Of

Customer EG & G. | Test Item Elec. Components | Test Engineer

Date 5-19-87 | Serial No. | Test Area F-10

USE A SEPARATE LOG SHEET FOR EACH TEST TITLE OR TEST ITEM

Time Start	Time Comp.	Action and Remarks	Entered by
1320	1321	START HIGH FREQ X-AXIS. 5TH SETTING. 1ST LEVEL DE-EN. RUN # 7	BY.
1328	1329	RUN #8 HIGH FREQ X-AXIS 4TH SETTING. 2ND LEVEL DE-EN.	BY
1337	1338	RUN #9 " " " " 3RD " 3RD " DE-EN.	BY.
1348	1349	RUN #10 " " " " 2ND " 4TH " DE-EN.	BY.
1358	1359.	RUN #11 " " " " 1ST " 5TH " DE-EN. NO GOOD 80HZ'S	BY.
N/O	1411	RUN #11-1 " " " " 1ST " 5TH " DE-EN TAPE RECORDER	BY
1425	1426	RUN #11-2 " " " " 1ST " 5TH " DE-EN	BY.
1438	1439	START RUN #12 BROAD BAND FREQ X-AXIS. 5TH SET. 1ST LEVEL DE-EN	BY.
1445	1446	RUN #13 BROAD " " X-AXIS. 4TH SET 2ND LEVEL DE-EN.	BY.
1451	1452	RUN #14 " " " " 3RD SET 3RD LEVEL DE-EN	BY
1523	1524	RUN #15 " " " " 2ND SET 4TH LEVEL DE-EN.	BY.
1529	1530	RUN #16 " " " " 1ST " 5TH LEVEL DE-EN. CHATTER	BY.
1552	1553	RUN #17 " " " " 1ST " 5TH " ENERGIZED	BY
1605		SINE SWEEP AT 2G'S. 2.5-100HZ. X-AXIS. DE-EN.	BY.
	1636.	COMPLETED.	BY
5-20-87 0832		SINE SWEEP 2.5-100HZ @ 2 G's X-AXIS. DE-EN.	BY.
	0836	STOP AT 50HZ.	BY.
0853		RESUME SWEEP AT 50HZ 2G'S. DE-EN.	BY
	0854	COMPLETE	BY

W-648-B Q.C. Form Approval FJF

Report No. 57724

WYLE LABORATORIES

WYLE LABORATORIES TEST LOG SHEET

Job Number 57724 | Test Title Single Axis | Log Page 3 Of

Customer EG. & G. | Test Item Elec. Components | Test Engineer

Date 5-20-87 | Serial No. | Test Area F-10

USE A SEPARATE LOG SHEET FOR EACH TEST TITLE OR TEST ITEM

Time Start	Time Comp.	Action and Remarks	Entered by
0900		Start ~~second~~ Sine Sweep. 2.5-100Hz. @ 2.5G. X-Axis. DE-EN.	BY
	0916	Complete 1 Channel Chatter.	BY.
0935		Re-Run at Higher Level 2.5-100 Hz @ 2.5G. X-Axis. DE-EN.	BY
	0940	Complete.	BY.
1048		Start Sine Sweep Second Run 2.5-100Hz @ 2.5G. X-Axis. Energized.	BY.
	1054	Complete	BY.
5-26-87			
1300		Start Vert Cal. for. Single Axis Seismic.	BY.
	1700	Finish Later.	BY
5-27-87			
0640		Resume Cal. Low Freq Done, High Freq Complete, Broad Band.	BY.
	1055	Completed.	BY.
1055		Mount Specimen.	BY.
	1200	Ready	BY.
1434		Start Res. Search 1-100Hz. .2G. Y-Axis. DE-EN.	BY.
	1449	Completed	BY
1613	1614	Start Run #18 3rd Level Y-Axis. DE-EN. Low Freq	BY
1621	1622	Run #19 4th Level Y-Axis. DE-EN.	BY
1628	1629	Run #20 5th Level Y-Axis. DE-EN.	BY.

W-643-B Q.C. Form Approval [illegible]

Report No. 57724

Page No. C-5

WYLE LABORATORIES

WYLE LABORATORIES TEST LOG SHEET

Job Number 57724   Test Title SINGLE AXIS SEISMIC   Log Page 4 Of

Customer EG&G   Test Item ELEC. COMPONENTS   Test Engineer

Date 5-29-87   Serial No.   Test Area F-10

USE A SEPARATE LOG SHEET FOR EACH TEST TITLE OR TEST ITEM

Time Start	Time Comp.	Action and Remarks	Entered by
0952	0953	RUN #21 HIGH FREQ LEVEL 3RD LEVEL Y-AXIS. DE-EN.	BJ
1020	1021	RUN #22 " " 4TH LEVEL Y-AXIS. " "	BJ
1028	1029	RUN #23 " " 5TH LEVEL " " " "	BJ
1036	1037	RUN #23-1 " " 5TH LEVEL " " " "	BJ
1044	1045	START RUN #24 BROAD BAND. 3RD LEVEL Y-AXIS. DE-EN.	BJ
1053	1054	RUN #25 BROAD BAND 4TH LEVEL Y-AXIS. DE-EN.	BJ
1103	1104	RUN # 26 " " 5TH LEVEL " " " "	BJ
1403	1404	START HIGH FREQ 6TH LEVEL RG'S X-AXIS. DE-EN. RUN #27	BJ
1410	1411	RUN #28 7TH LEVEL 15G'S. X AXIS. DE-EN.	BJ
	1415	COMPLETED ALL SEISMIC TESTING	
6/1/87	8-1600	SET-UP ON F-MACH FOR SINE SWEEP'S	PK
6/2/87			
0800		CHECK INSTR LINE'S FOR COMPUTER	PK
1100		SWEEP 4-100 HZ 3g's RUN # 29	PK
1315		VERIFIED LINES BETWEEN F-3 AND COMPUTER	PK
1330		SWEEP 4-100 HZ. 2.5g RUN # 30	PK
14:08		RUN # 31, 2.0g	PK
1435		RUN # 32, 1.5g	PK
1517		RUN # 33, 1.0g	PK

W-648-B Q.C. Form Approval   JJ

WYLE LABORATORIES

WYLE LABORATORIES TEST LOG SHEET

Job Number 57724 Test Title ViB. Log Page ___ Of ___

Customer EG+G Test Item RELAY's Test Engineer P. Knoll

Date 6/2/87 Serial No. ——— Test Area E-3

USE A SEPARATE LOG SHEET FOR EACH TEST TITLE OR TEST ITEM

Time Start	Time Comp.	Action and Remarks	Entered by
1600		RUN # 34, 3.5g's	PK
6/3/87			
0843		RUN # 35, HORIZ. 15-70 HZ. 4.0g DE-ENERG.	PK
1013		RUN # 36, 4-100 HZ. 3.5g ENERGIZED	PK
1334		RUN # 37, 4-100 HZ VERT. 3.5g DE-ENERG.	PK
1353		RUN # 38, 3.0g's " "	PK
1417		RUN # 39, 2.5g's " "	PK
1438		RUN # 40, 2.0g's " "	PK
1516		RUN # 41, 3.5g's ENERGIZED	PK

W-648-B Q.C. Form Approval FH

WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

TEST TITLE SINGLE AXIS SEISMIC

CUSTOMER EG&G Job No. 57724 Date 5-17-87

Specimen ELECTRIC COMPONENTS Technician GRETERMAN

Part No. SEE REC. INSP. Serial No. SEE REC. INSP. Engineer P. Bzur

EQUIPMENT	MANUFACTURER	MODEL NO.	RANGE	WYLE NO.	CALIBRATION LAST	CALIBRATION DUE	ACCY.
ACCELEROMETER	UNHOLTZ DICKIE	7SD21	0-1000g's	9049	5-4-87	8-4-87	± 2%
ACCELEROMETER	UNHOLTZ DICKIE	7SD21	0-1000g's	9054	5-4-87	8-4-87	± 2%
ACCELEROMETER	UNHOLTZ DICKIE	7SD21	0-1000g's	8289	3-16-87	6-16-87	± 2%
ACCELEROMETER	UNHOLTZ DICKIE	7SD21	0-1000g's	8876	3-10-87	6-10-87	± 2%
ACCELEROMETER	UNHOLTZ DICKIE	7SD21	0-1000g's	8744	4-13-87	7-13-87	± 2%
ACCELEROMETER	UNHOLTZ DICKIE	7SD21	0-1000g's	8874	4-2-87	7-2-87	± 2%
ACCELEROMETER	UNHOLTZ DICKIE	7SD21	0-1000g's	8928	3-16-87	6-16-87	± 2%
ACCELEROMETER	UNHOLTZ DICKIE	7SD21	0-1000g's	8565	4-13-87	7-13-87	± 2%
CHARGE AMPLIFIER	UNHOLTZ DICKIE	SERIES 11	0-1000g's	8189	4-21-87	10-25-87	± 2%
CHARGE AMPLIFIER	UNHOLTZ DICKIE	SERIES 11	0-1000g's	9408	4-21-87	10-25-87	± 2%
CHARGE AMPLIFIER	UNHOLTZ DICKIE	SERIES 11	0-1000g's	9411	4-21-87	10-25-87	± 2%
CHARGE AMPLIFIER	UNHOLTZ DICKIE	SERIES 11	0-1000g's	9412	4-21-87	10-25-87	± 2%
CHARGE AMPLIFIER	UNHOLTZ DICKIE	SERIES 11	0-1000g's	9435	4-21-87	10-25-87	± 2%
CHARGE AMPLIFIER	UNHOLTZ DICKIE	SERIES 11	0-1000g's	31408	4-21-87	10-25-87	± 2%
CHARGE AMPLIFIER	UNHOLTZ DICKIE	SERIES 11	0-1000g's	9151	12-5-86	6-7-87	± 2%
CHARGE AMPLIFIER	UNHOLTZ DICKIE	SERIES 11	0-1000g's	31491	12-5-86	6-7-87	± 2%
VISICORDER	HONEYWELL	1912	18 CHANNEL	9690	3-19-87	9-20-87	± 2%

QA Form Approval [signature]

W614D-82

Where applicable, the listed test equipment has been calibrated using standards which are traceable to the National Bureau of Standards. Certificates and reports of all calibrations are retained in the Wyle Laboratories QA files and are available for inspection upon request.

WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

TEST TITLE SINGLE AXIS SEISMIC

CUSTOMER EG & G Job No. 57724 Date 5-17-87

Specimen ELECTRIC COMPONENTS Technician GREIERMAN

Part No. SEE REC. INSP. Serial No. SEE REC. INSP. Engineer [signature]

EQUIPMENT	MANUFACTURER	MODEL NO.	RANGE	WYLE NO.	CALIBRATION LAST	CALIBRATION DUE	ACCY.
X-Y RECORDER	HEWLETT PACKARD	7044A	X = 30"/SEC. Y = 20"/SEC.	8163	PRIOR TO	USE	± 1%
X-Y RECORDER	HEWLETT PACKARD	7044A	X = 30"/SEC. Y = 20"/SEC.	7348	PRIOR TO	USE	± 1%
TIME CLOCK	STANDARD	S-60	0-60SEC. 0-60MIN.	6857	2-16-87	8-16-87	± .2SEC.
OSCILLOSCOPE	LEADER	LBO514A	DUAL TRACE	9622	PRIOR TO	USE	± 1%
COMPUTER	VARIAN MINI	V-77-600	N/A	8951	SYSTEM CA	LIBRATION	

QA Form Approval [initials]

W614D-82

Where applicable, the listed test equipment has been calibrated using standards which are traceable to the National Bureau of Standards. Certificates and reports of all calibrations are retained in the Wyle Laboratories QA files and are available for inspection upon request.

WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

TEST TITLE SINGLE AXIS SEISMIC

CUSTOMER EG & G Job No. 57724 Date 5-17-87

Specimen ELECTRIC COMPONENTS Technician GREIERMAN

Part No. SEE REC. INSP. Serial No. SEE. REC. INSP. Engineer P. [illegible]

EQUIPMENT	MANUFACTURER	MODEL NO.	RANGE	WYLE NO.	CALIBRATION LAST	CALIBRATION DUE	ACCY.
EXCITER HYD.	TEAM CORP.	W3000	12"D.A. 30,000 FORCE lbs	—	—	—	N/A
EXCITER HYD.	TEAM CORP.	W1800	10"D.A. 18,000 FORCE lbs	—	—	—	N/A
EXCITER HYD.	TEAM CORP.	W1800	10"D.A. 18,000 FORCE lbs	—	—	—	N/A
SERVO CONTROLLER /AMPLIFIER	MC FADDEN	152 A	—	—	PRIOR TO	USE	N/A
SERVO CONTROLLER /AMPLIFIER	MC FADDEN	152 A	—	—	PRIOR TO	USE	N/A
SERVO CONTROLLER /AMPLIFIER	MC FADDEN	152 A	—	—	PRIOR TO	USE	N/A
EQUALIZER SHAPER	TRACOR	822	1.25 TO 10 HZ	31574	PRIOR TO	USE	N/A
SPECTRUM SHAPER	BRUEL & KJAER	123	12.5 TO 40 KHZ	31570	PRIOR TO	USE	N/A
X-Y RECORDER	HEWLETT PACKARD	7005 B	X = 30"/SEC. Y = 20"/SEC.	8640	PRIOR TO	USE	± 1%
ELECTRONIC VOLTMETER	BRUEL & KJAER	2416	.01 TO 1000 VOLTS	5504	2-4-87	6-5-87	± .1%
TAPE RECORDER	HEWLETT PACKARD	3924 B	14 CHANNEL	31265	PRIOR TO	USE	± 1%
AMPLITUDE SERVO /MONITOR	SPECTRAL DYNAMICS	SD105 A	—	31306	PRIOR TO	USE	± 1%
SWEEP OSCILLATOR	SPECTRAL DYNAMICS	SD104A-5	5HZ TO 50KHZ	7996	4-27-87	11-1-87	± 2%
OSCILLOSCOPE	LEADER	LBO514A	DUAL TRACE	9621	PRIOR TO	USE	± 30%
LOG CONVERTER	SPECTRAL DYNAMICS	SD112-1	N/A	1572	PRIOR TO	USE	± 1%
TRACKING FILTER	SPECTRAL DYNAMICS	SD1012 B	N/A	31643	PRIOR TO	USE	± 1%
TAPE RECORDER	HEWLETT PACKARD	3955	14 CHANNEL	31565	PRIOR TO	USE	± 1%

QA Form Approval [illegible]
W614D-82

Where applicable, the listed test equipment has been calibrated using standards which are traceable to the National Bureau of Standards. Certificates and reports of all calibrations are retained in the Wyle Laboratories QA files and are available for inspection upon request.

APPENDIX D

TRANSMISSIBILITY PLOTS

Page No.

WYLE LABORATORIES

DYNAMICS SECTION
VIBRATION TEST DATA SHEET

Job No. 57724
Sheet ______ of ______

Customer EG & G
Specimen ELECTRICAL COMPONENTS
P/N SEE REC. INSP.
S/N SEE REC. INSP.

Date	Time	Axis	Temp (°F)	SINUSOIDAL Freq. (HZ)	SINUSOIDAL Disp. ("DA)	SINUSOIDAL Accel. (±G)	Test Time (Min.)	Comments
1987	NOTED	NOTED	AMB	1-100	—	.2	*	ONE SINE SWEEP 1-100HZ - .2G PK @ APPROX 1/2 OCTAVE
								PER MINUTE, IN EACH AXIS. ONE AXIS HORIZ. AND
								ONE AXIS VERT.
5-19	0817	X	AMB	1-100	—	.2		START SINE SWEEP. DE-ENERGIZED. [initials]
	0831						14 MINS.	COMPLETED. [initials]
5-27	1434	Y	AMB	1-100	—	.2		START SINE SWEEP. DE-ENERGIZED. [initials]
	1448						14 MINS.	COMPLETED. [initials]

W589 QA Form Approval [initials]

Signed: [signature]

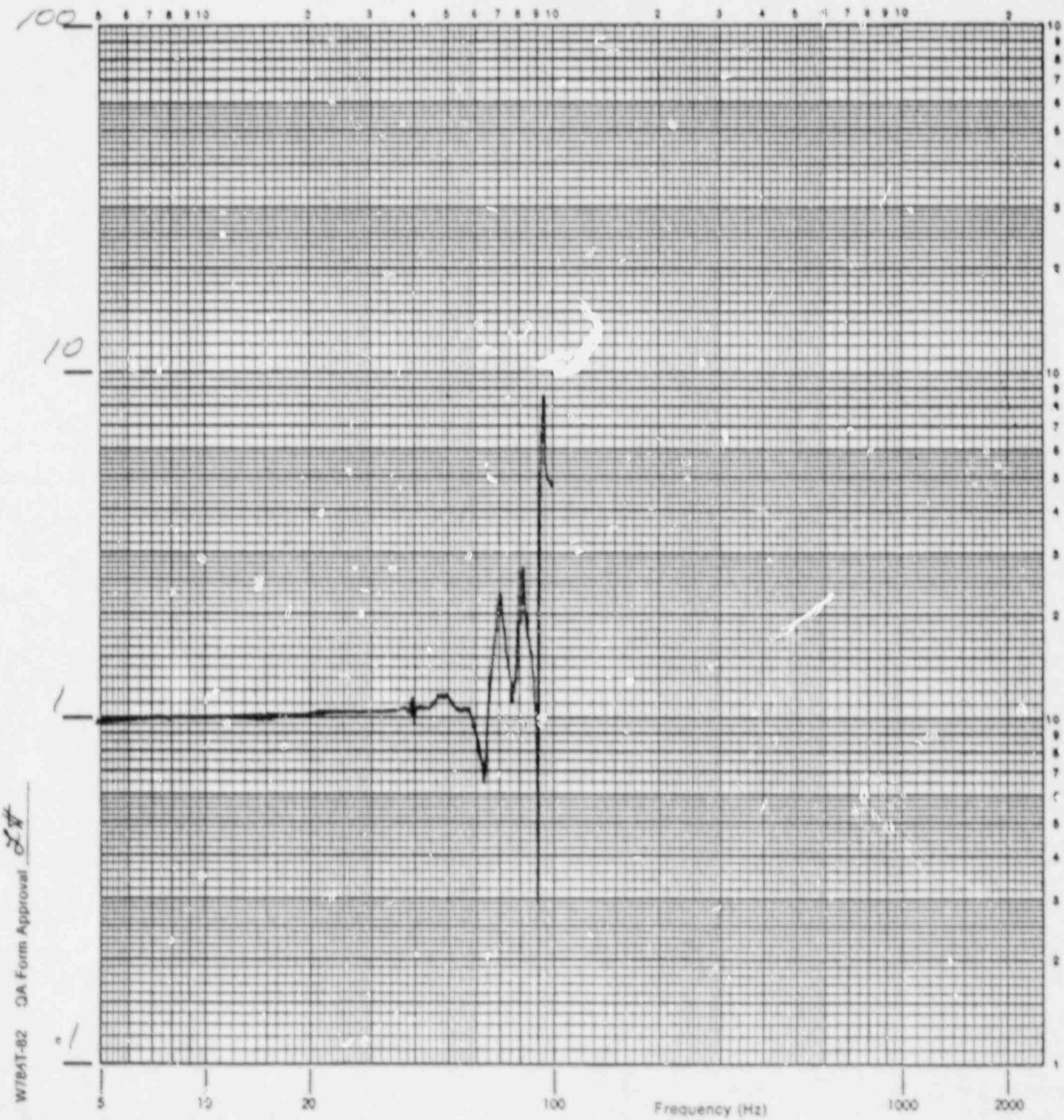
WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

CUSTOMER EG+G Job No. 57724 Date 5-19-87

Specimen ELECTRICAL COMPONENTS Test Axis X Accel. No. 3/1

Operator GRETERMAN Engineer [signature] Full Scale 100 G

TRANSMISSIBILITY



W784T-82 QA Form Approval

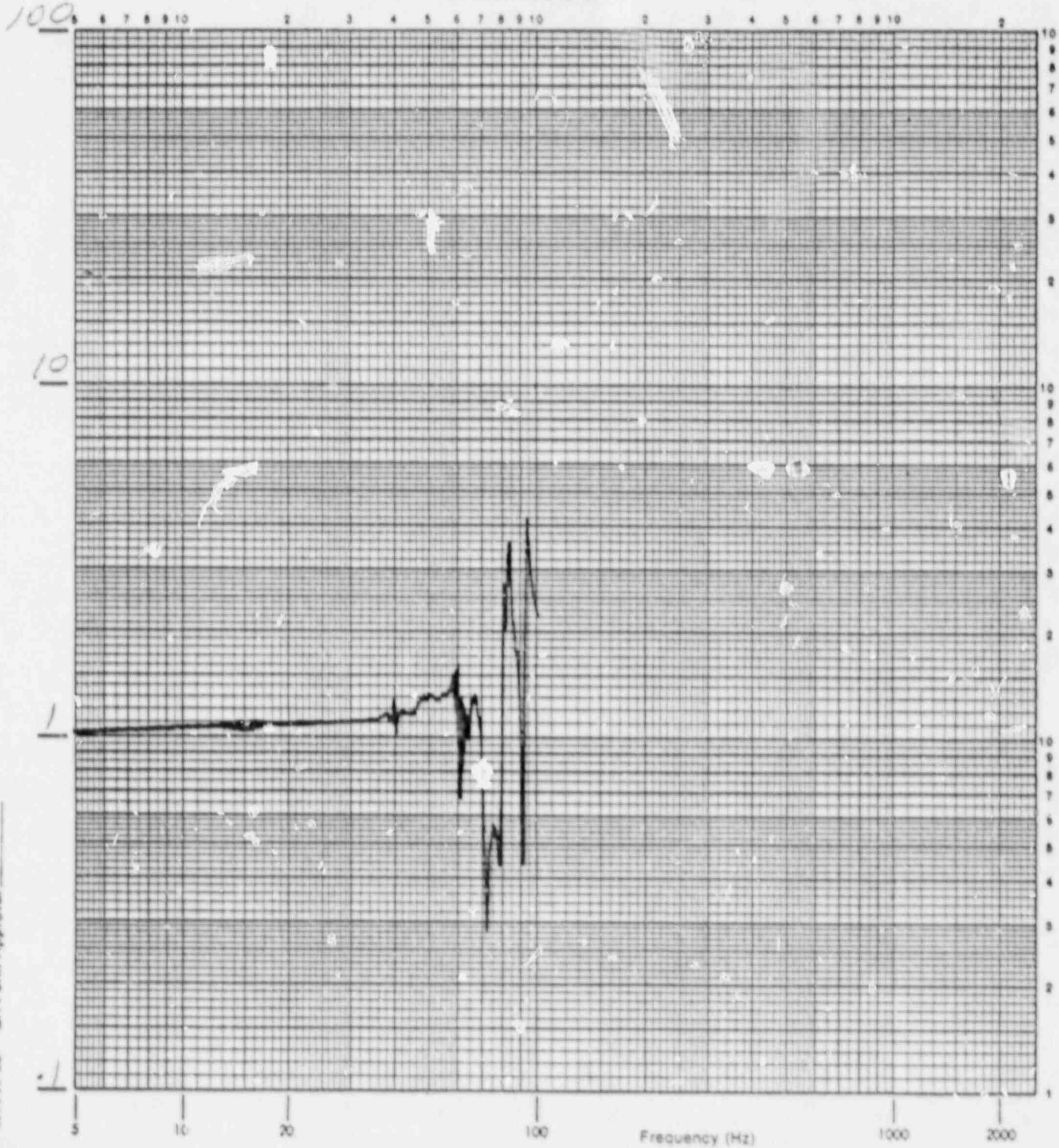
WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

CUSTOMER E G + G Job No. 57724 Date 5-19-87

Specimen ELECTRICAL COMPONENTS Test Axis X Accel. No. 5/1

Operator GREITERMAN Engineer [signature] Full Scale 100 G

TRANSMISSIBILITY



W784T-82 QA Form Approval

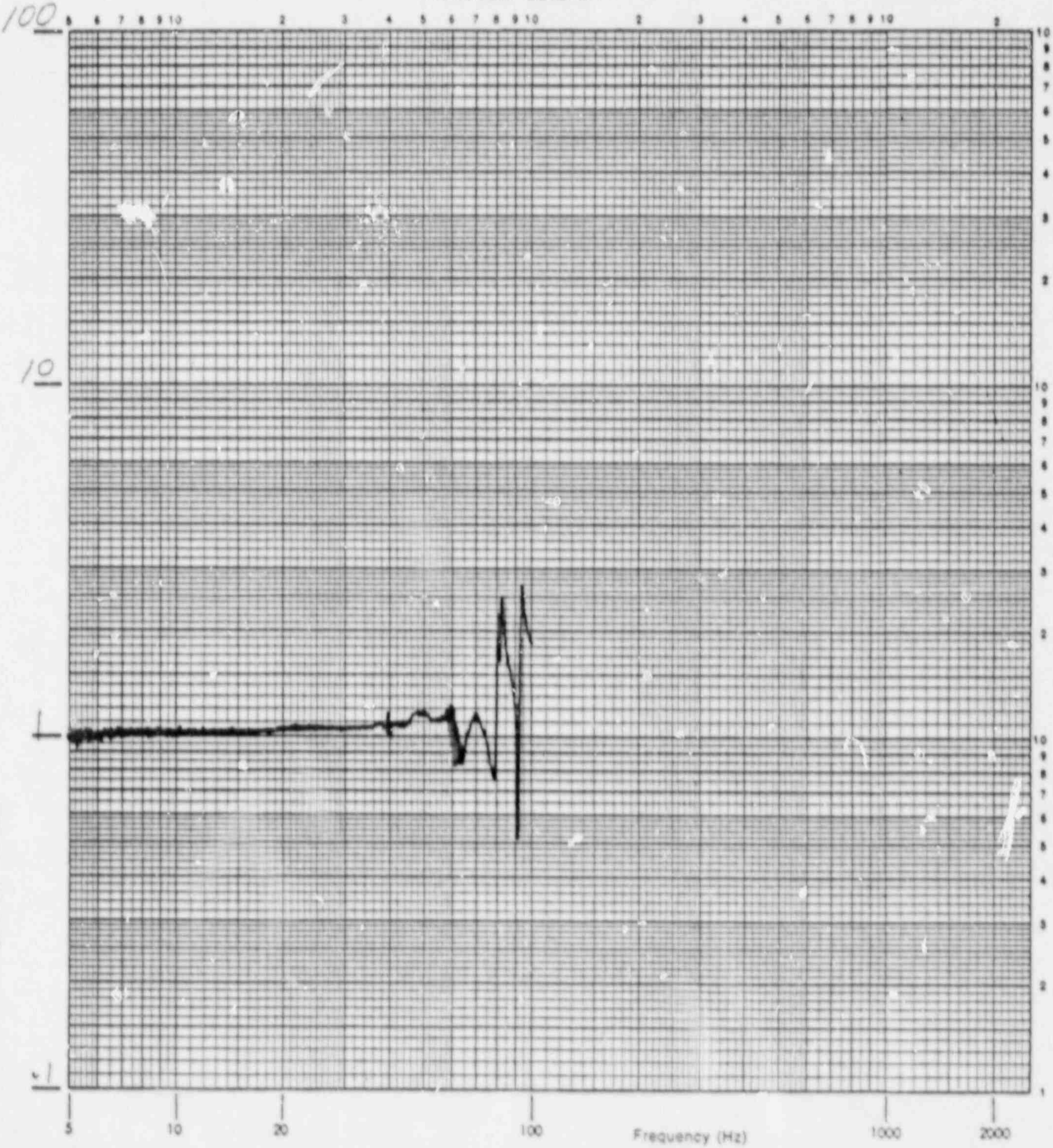
WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

CUSTOMER E G + G Job No. 57724 Date 5-19-87

Specimen ELECTRICAL COMPONENTS Test Axis X Accel. No. 7/1

Operator GREIERMAN Engineer [signature] Full Scale 100 g

TRANSMISSIBILITY



W784T-82 QA Form Approval [initials]

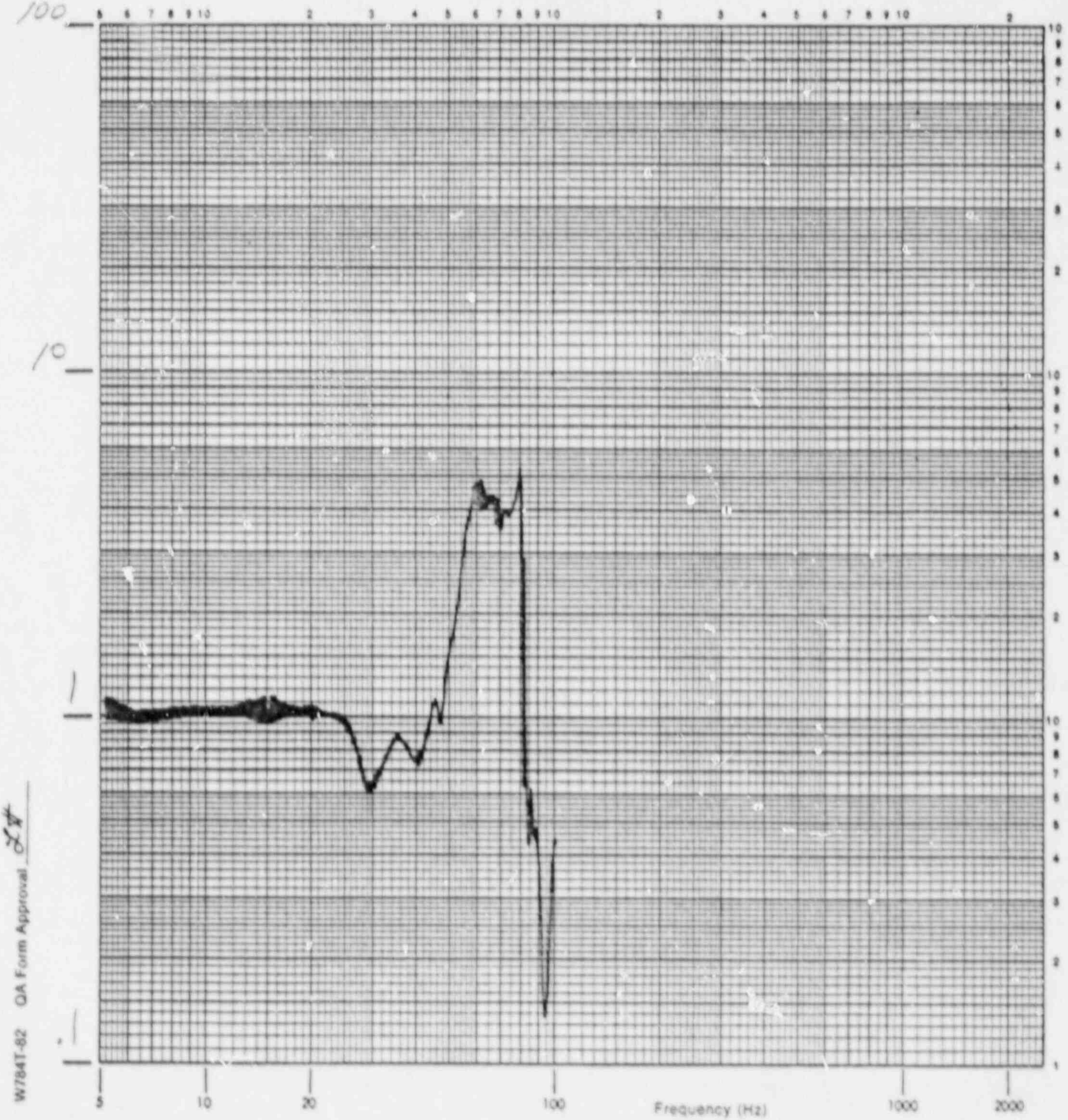
WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

CUSTOMER E G + G Job No. 57724 Date 5-27-87

Specimen ELECTRICAL COMPONENTS Test Axis Y Accel. No. 4/2

Operator GRETERMAN Engineer P. Kruck Full Scale 100 G

TRANSMISSIBILITY



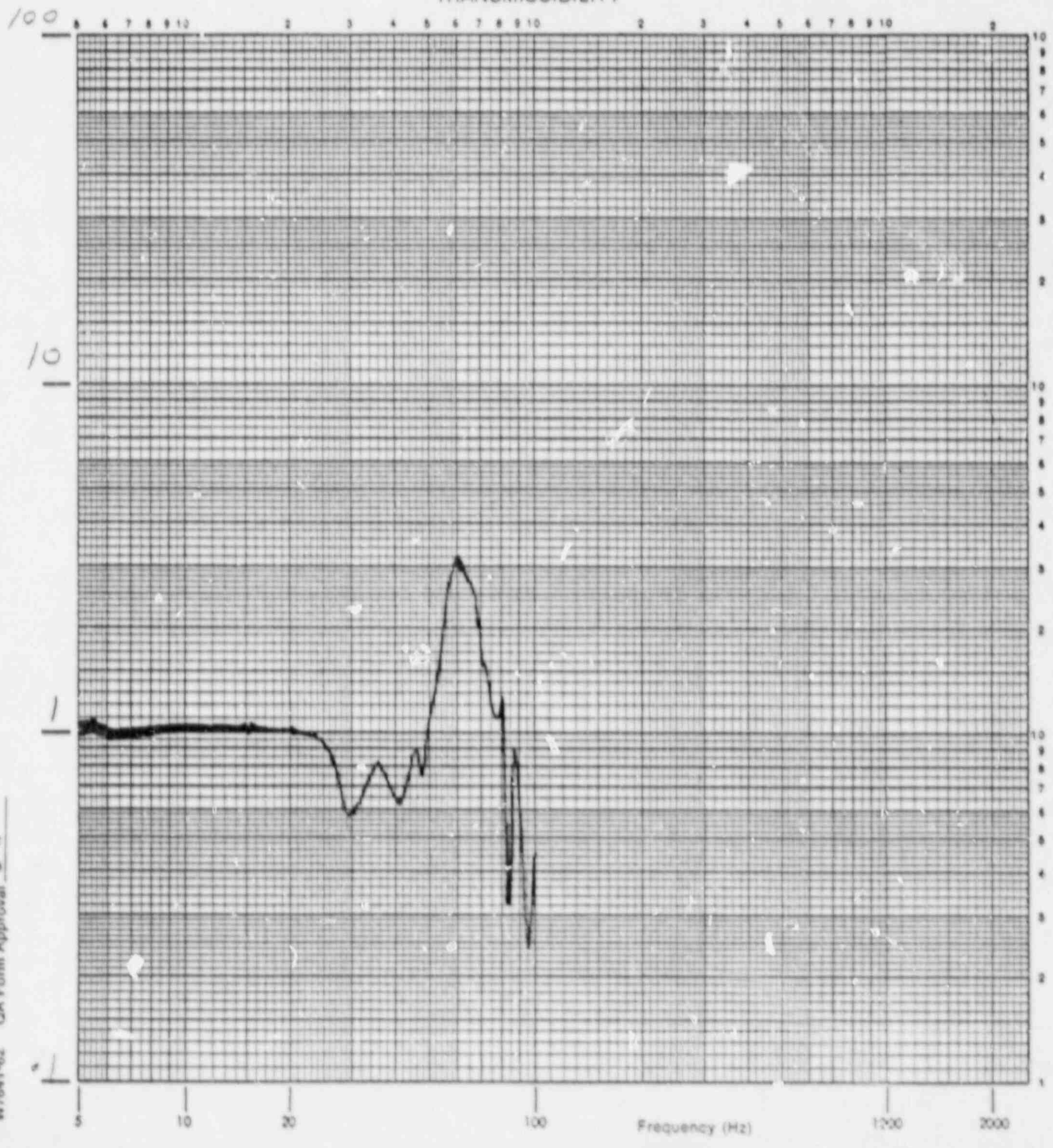
W784T-82 QA Form Approval LT

CUSTOMER EG+G Job No. 57724 Date 5-27-87

Specimen ELECTRICAL COMPONENTS Test Axis Y Accel. No. 6/2

Operator BREITERMAN Engineer [signature] Full Scale 100 G

TRANSMISSIBILITY



W784T-82 QA Form Approval [initials]

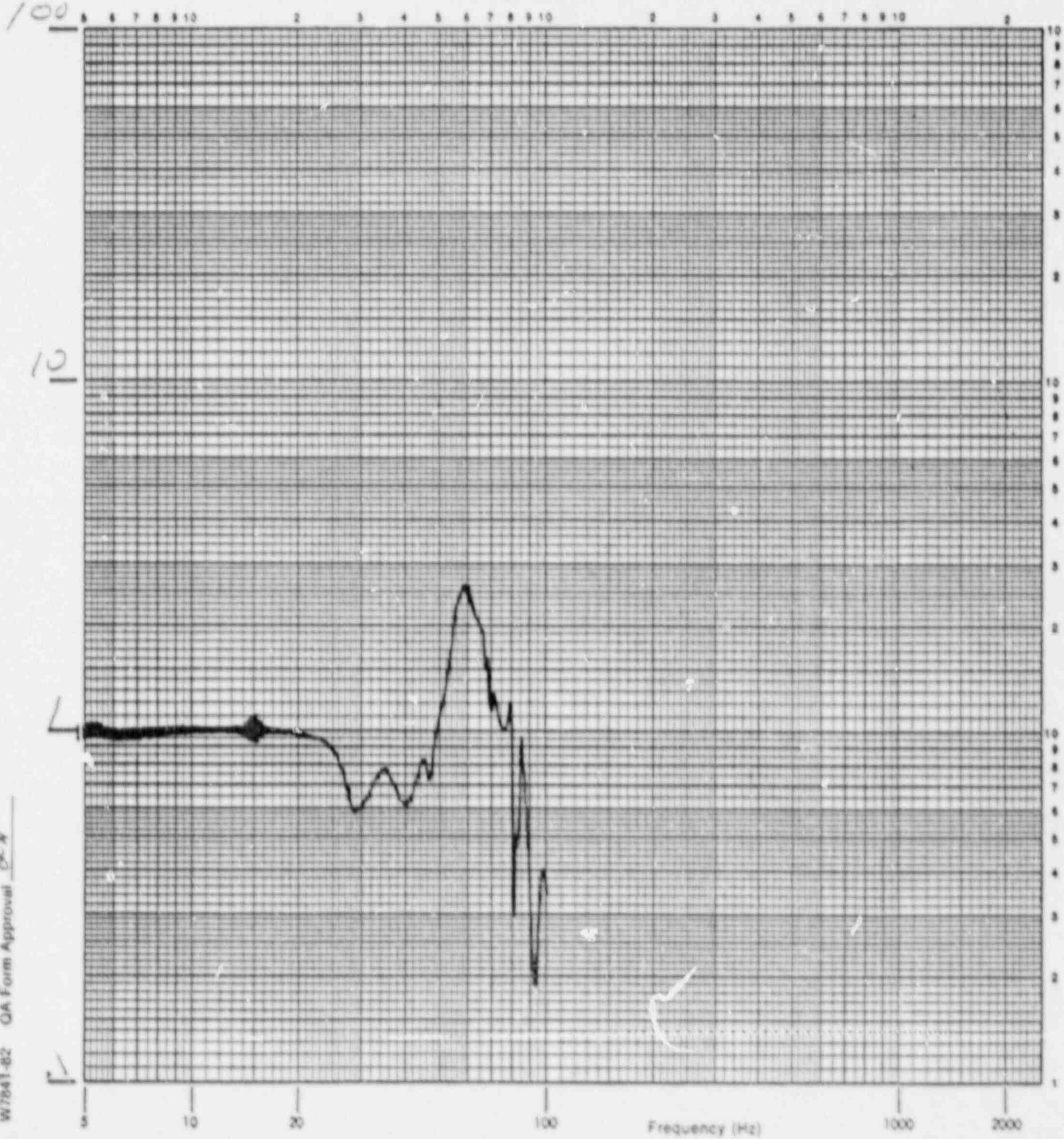
WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

CUSTOMER E G + G Job No. 57724 Date 5-22-87

Specimen ELECTRICAL COMPONENTS Test Axis Y Accel. No. 8/2

Operator GREFERMAN Engineer P. Krull Full Scale 100 G

TRANSMISSIBILITY



W7841-82 QA Form Approval ZW

APPENDIX E

RANDOM TEST RECORDS

Report No. 57724

Page No. E-2

WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

DATA SHEET

TEST TITLE SINGLE AXIS SEISMIC Date 5-19-87

Customer EG & G Job No. 57724

Specimen ELECTRICAL COMPONENTS Technician GREIERMAN

Part No. SEE RECV. INSP. Serial No. SEE RECV. INSP. Engineer [illegible]

DATE	TIME PER RUN	AXIS	TEST FREQ	COMMENTS
1987	14 SEC.	X	LEVELS	SPECIMEN'S WERE IN THE DE-ENERGIZED
				STATE UNTIL CHATTER OCCURRED THEN
				SPECIMEN'S WERE TESTED IN THE ENERGIZED
				STATE. EACH TEST RUN WAS APPROX 14
				SECONDS.
5-19	0914 14 SEC.	X	LOW FREQ 1ST	RUN #1 - DE-ENERGIZED. (COMPUTER MALFUNCTION) BG
5-19	0944 14 SEC.	X	LOW FREQ 1ST	RUN #1-1 - DE-ENERGIZED. BG
5-19	1026 14 SEC.	X	LOW FREQ 2ND	RUN #2 - DE-ENERGIZED. BG
5-19	1032 14 SEC.	X	LOW FREQ 3RD	RUN #3 - DE-ENERGIZED. BG
5-19	1037 14 SEC.	X	LOW FREQ 4TH	RUN #4 - DE-ENERGIZED. BG
5-19	1045 14 SEC.	X	LOW FREQ 5TH	RUN #5 - DE-ENERGIZED (CHATTER.) BG
5-19	1150 14 SEC.	X	LOW FREQ 5TH	RUN #6 - ENERGIZED. BG
5-19	1321 14 SEC.	X	HIGH FREQ 1ST	RUN #7 - DE-ENERGIZED. BG
5-19	1329 14 SEC.	X	HIGH FREQ 2ND	RUN #8 - DE-ENERGIZED. BG
5-19	1338 14 SEC.	X	HIGH FREQ 3RD	RUN #9 - DE-ENERGIZED BG
5-19	1344 14 SEC.	X	HIGH FREQ 4TH	RUN #10 - DE-ENERGIZED BG
5-19	1354 14 SEC.	X	HIGH FREQ 5TH	RUN #11 (DID NOT REACH TEST LEVEL) BG
5-19	1411 14 SEC.	X	HIGH FREQ 5TH	RUN #11-1 (NO TAPE RECORDING) BG
5-19	1426 14 SEC.	X	HIGH FREQ 5TH	RUN #11-2 DE-ENERGIZED. BG
5-19	1437 14 SEC.	X	BROAD BAND FREQ 1ST	RUN #12 - DE-ENERGIZED. BG
5-19	1446 14 SEC.	X	BROAD BAND FREQ 2ND	RUN #13 - DE-ENERGIZED. BG
5-19	1452 14 SEC.	X	BROAD BAND FREQ 3RD	RUN #14 - DE-ENERGIZED. BG
5-19	1524 14 SEC.	X	BROAD BAND FREQ 4TH	RUN #15 - DE-ENERGIZED. BG
5-19	1540 14 SEC.	X	BROAD BAND FREQ 5TH	RUN #16 - DE-ENERGIZED (CHATTER) BG
5-19	1553 14 SEC.	X	BROAD BAND FREQ 5TH	RUN #17 - ENERGIZED. BG

QC Form Approval [illegible]

SHEET 1 OF ____

WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

DATA SHEET

TEST TITLE SINGLE AXIS SEISMIC Date 5-27-87

Customer EG&G Job No. 57724

Specimen ELEC. COMPONENTS Technician GRETERMAN

Part No SEE RECV. INSP. Serial No. SEE RECV. INSP. Engineer DK

DATE	TIME PER RUN	AXIS	TEST FREQ	COMMENTS
1987	14 SEC.	Y	LEVEL	
5-27	1610 14 SEC.	Y	LOW FREQ 3RD	RUN #18 DE-ENERGIZED. G.G.
5-27	1622 14 SEC.	Y	LOW FREQ 4TH	RUN #19 DE-ENERGIZED. G.G.
5-27	1629 14 SEC.	Y	LOW FREQ 5TH	RUN #20 DE-ENERGIZED. G.G.
5-28	0950 14 SEC.	Y	HIGH FREQ 3RD	RUN #21 DE-ENERGIZED. G.G.
5-28	1021 14 SEC.	Y	HIGH FREQ 4TH	RUN #22 DE-ENERGIZED G.G.
5-28	1028 14 SEC.	Y	HIGH FREQ 5TH	RUN #23 DID NOT MAKE TEST LEVEL G.G.
5-28	1037 14 SEC.	Y	HIGH FREQ 5TH	RUN #23-1 DE-ENERGIZED. G.G.
5-28	1045 14 SEC.	Y	BROAD BAND FREQ 3RD	RUN #24 DE-ENERGIZED. G.G.
5-28	1058 14 SEC.	Y	BROAD BAND FREQ 4TH	RUN #25 DE-ENERGIZED G.G.
5-28	1104 14 SEC.	Y	BROAD BAND FREQ 5TH	RUN #26 DE-ENERGIZED. G.G.
5-28	1402 14 SEC.	X	HIGH LEVEL FREQ	RUN #27 17g ZPA DE-ENERGIZED G.G.
5-28	1511 14 SEC.	X	HIGH LEVEL FREQ	RUN #28 15g ZPA DE-ENERGIZED G.G.

QC Form Approval

SHEET 2 OF 2

WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

CUSTOMER EG & G Job No. 57724 Date 5-19-87

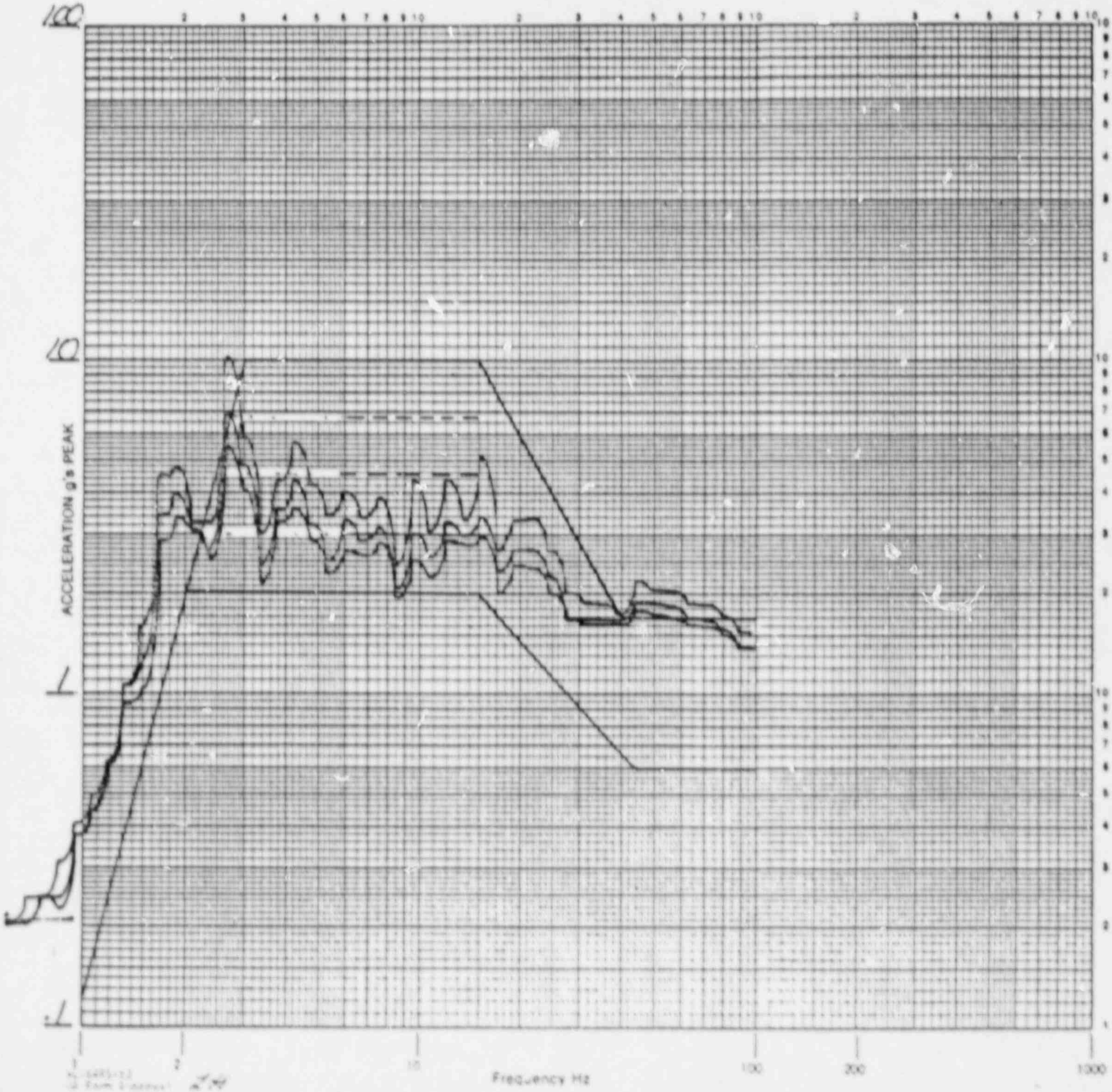
Specimen ELECTRICAL COMPONENTS Axis of Test X

Accel. No. 1 Axis HORIZ Control (✓) Response ( ) OBE ( ) SSE ( ) DBE ( )

Full Scale 100 g Damping 1,(2%),3 % Run No. LOW FREQUENCY RUN # 1-1

Operator GRETERMAN Engineer [signature]

RESPONSE SPECTRUM



WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

CUSTOMER EG+G Job No. 57724 Date 5-19-87

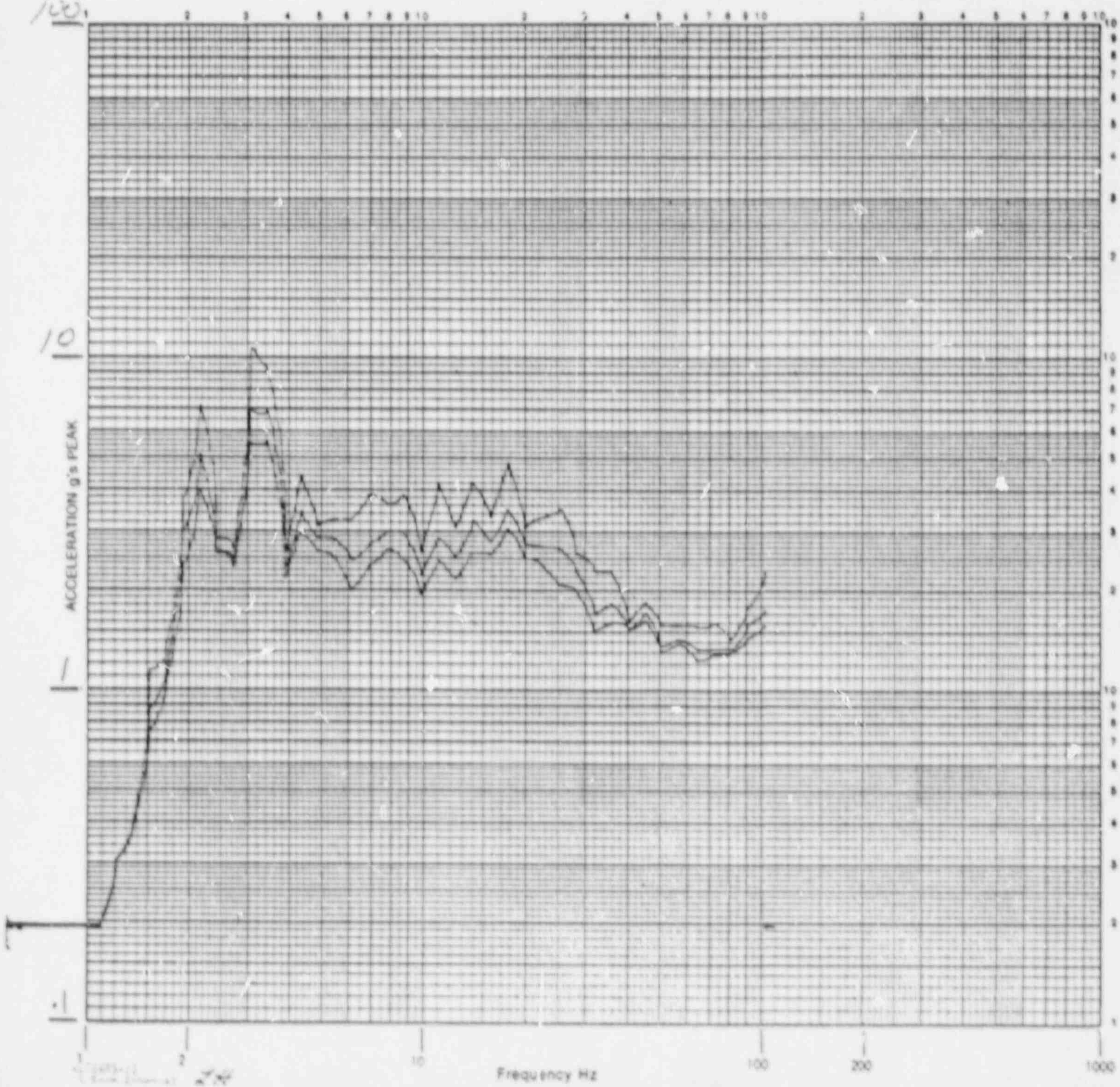
Specimen RELAY Axis of Test X

Accel. No. 3 Axis ____ Control ( ) Response (✓) OBE ( ) SSE ( ) DBE ( )

Full Scale 100 g Damping 1, (2), 3 % Run No. 1-1

Operator BG Engineer [signature]

RESPONSE SPECTRUM



WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

CUSTOMER E G + G Job No. 57724 Date 5-19-87

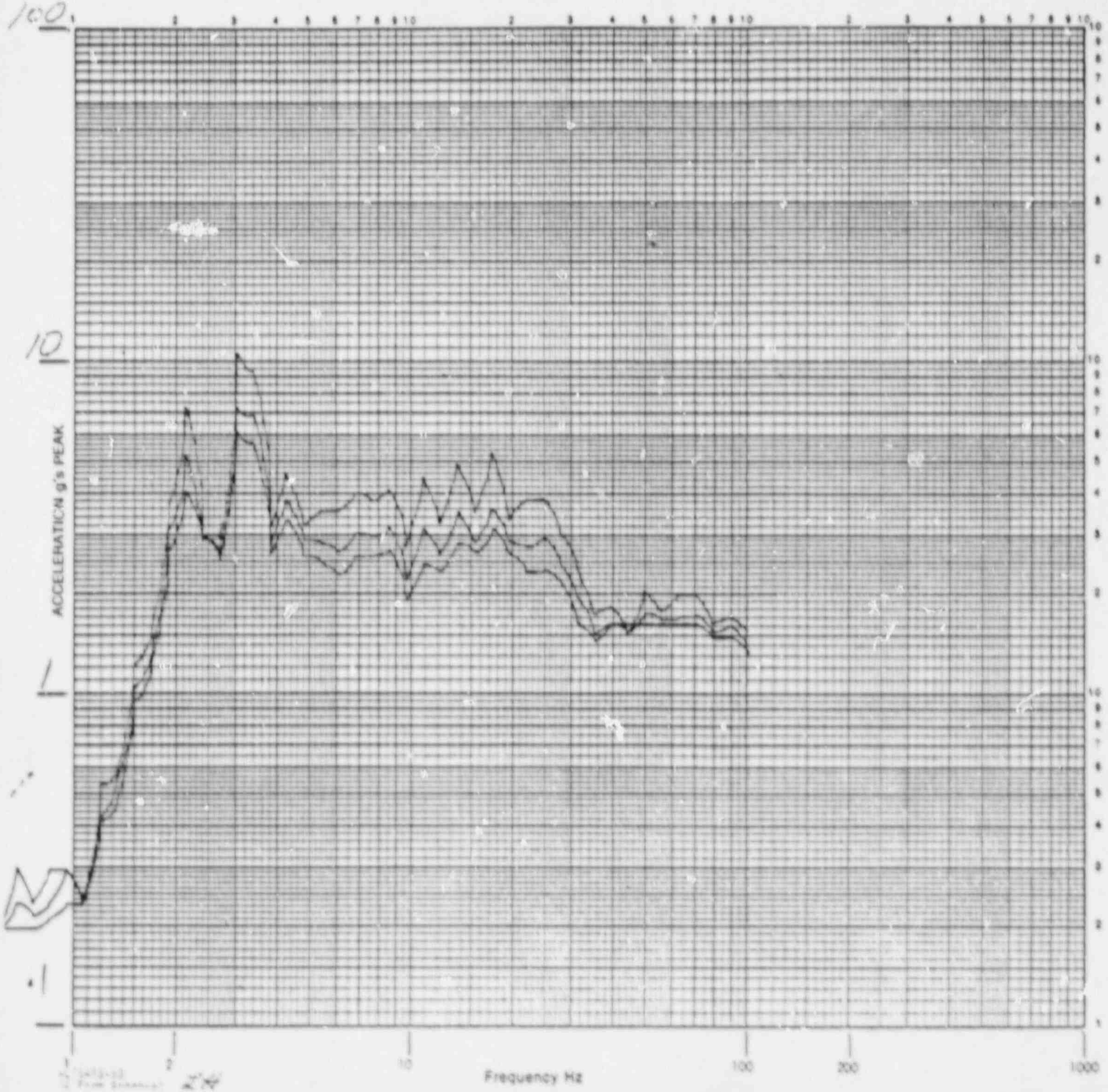
Specimen RELAY Axis of Test X

Accel. No. 5 Axis ____ Control ( ) Response (✓) OBE ( ) SSE ( ) DBE ( )

Full Scale 100 g Damping 1, (2), 3 % Run No. 1-1

Operator BG Engineer P. Brunel

RESPONSE SPECTRUM



CUSTOMER E G + G Job No. 57724 Date 5-19-87

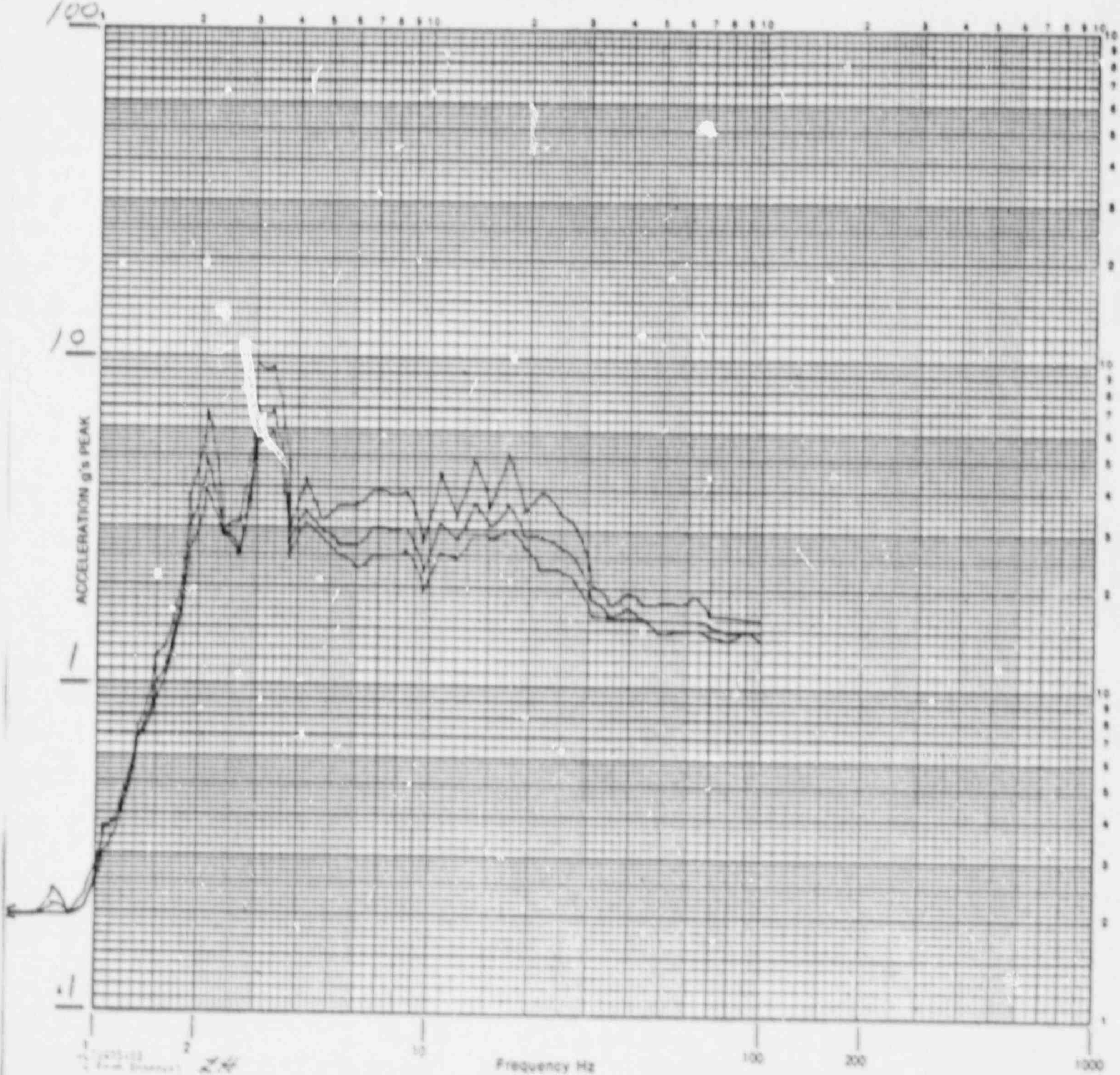
Specimen RELAY Axis of Test X

Accel. No. 7 Axis ______ Control ( ) Response (✓) OBE ( ) SSE ( ) DBE ( )

Full Scale 100 g Damping 1, (2), 3 % Run No. 1-1

Operator BG Engineer R. Kruu

RESPONSE SPECTRUM



WYLE LABORATORIES,NORCO,CA. FACILITY CHATTER AND PULSE ANALYSIS PROGRAM 05/19/87 09:44:18 HOURS PAGE 1

START TIME= 0.0000 STOP TIME= 22.152

TEST NAME=EGG 57724, F/B AXIS, 1ST LEVEL, RUN 1-1
TEST DATE=05/19/87 9:41:21 HOURS

CHANNEL ID	CHANNEL NUMBER	FIRST CHATTER	LAST CHATTER	STATE CHANGE	NUMBER OF CHATTER FAILURES PER TIME LENGTH 2.00-5.00	5.00-10.0	10.0-20.0	20.0-40.0	40.0-80.0	>80.0	TOTAL
W1-NC	2			0	NO CHATTER						
W1-NO	3			0	NO CHATTER						
W2-NC	4			0	NO CHATTER						
W2-NO	6			0	NO CHATTER						
W3-NC	7			0	NO CHATTER						
W3-NO	8			0	NO CHATTER						
G1-NC	10			0	NO CHATTER						
G1-NO	11			0	NO CHATTER						
G2-NC	12			0	NO CHATTER						
G2-NO	13			0	NO CHATTER						
G3-NC	14			0	NO CHATTER						
G3-NO	15			0	NO CHATTER						
W1-OT-NO	16			0	NO CHATTER						
W2-OT-NO	17			0	NO CHATTER						
W3-OT-NO	18			0	NO CHATTER						
G1-OT-NO	19			0	NO CHATTER						
G2-OT-NO	20			0	NO CHATTER						
G3-OT-NO	21			0	NO CHATTER						
	22			0	NO CHATTER						
										TOTAL=	0

WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

CUSTOMER EG & G Job No. 57724 Date 5-19-87

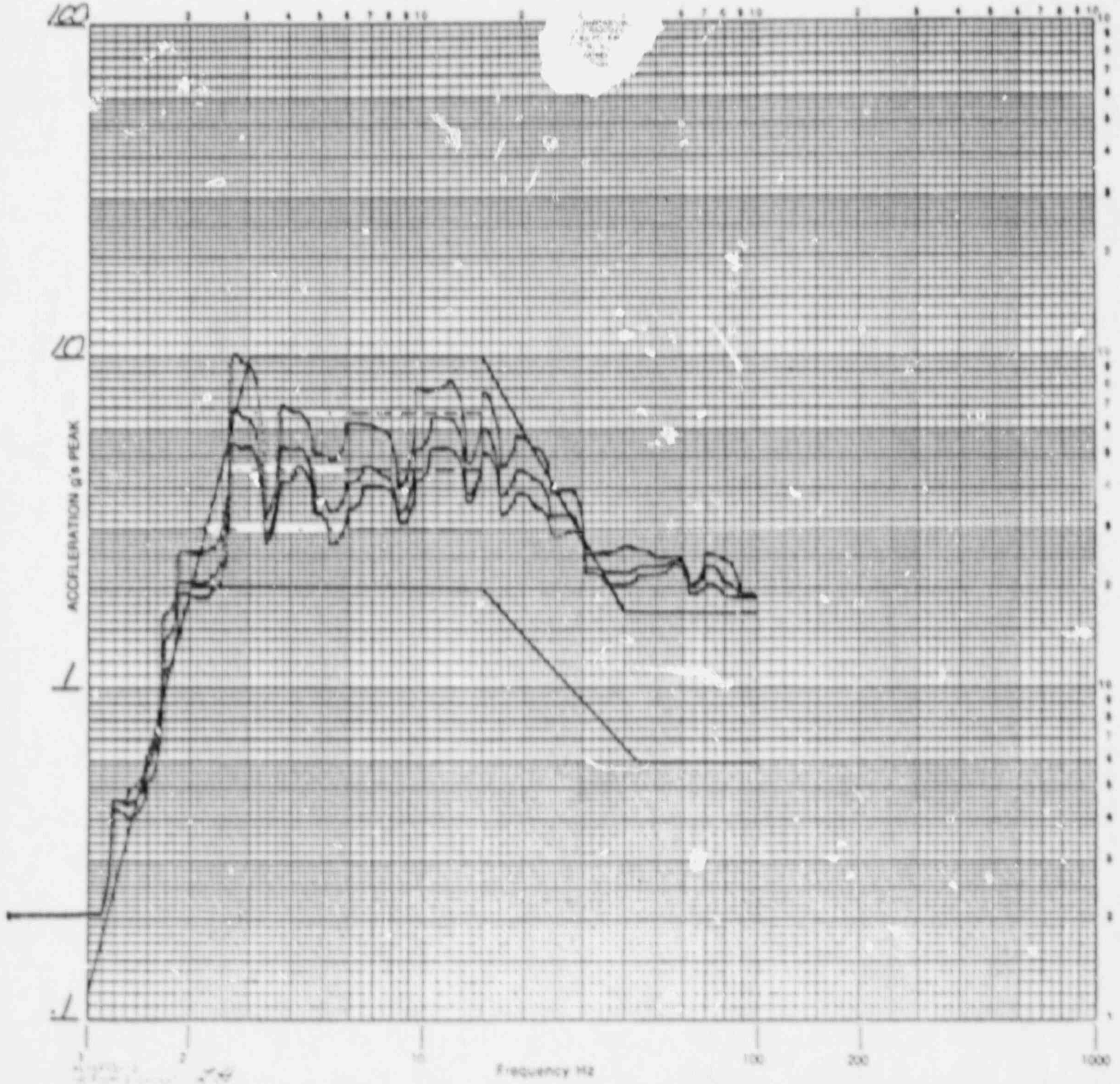
Specimen ELECTRICAL COMPONENTS Axis of Test X

Accel. No. 1 Axis Horiz Control (✓) Response ( ) OBE ( ) SSE ( ) DBE ( )

Full Scale 100 g Damping 1,(2%),3 % Run No. Low Frequency Run # 2

Operator C.R. Freedman Engineer

RESPONSE SPECTRUM



WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

CUSTOMER E G + G Job No. 57724 Date 5-19-87

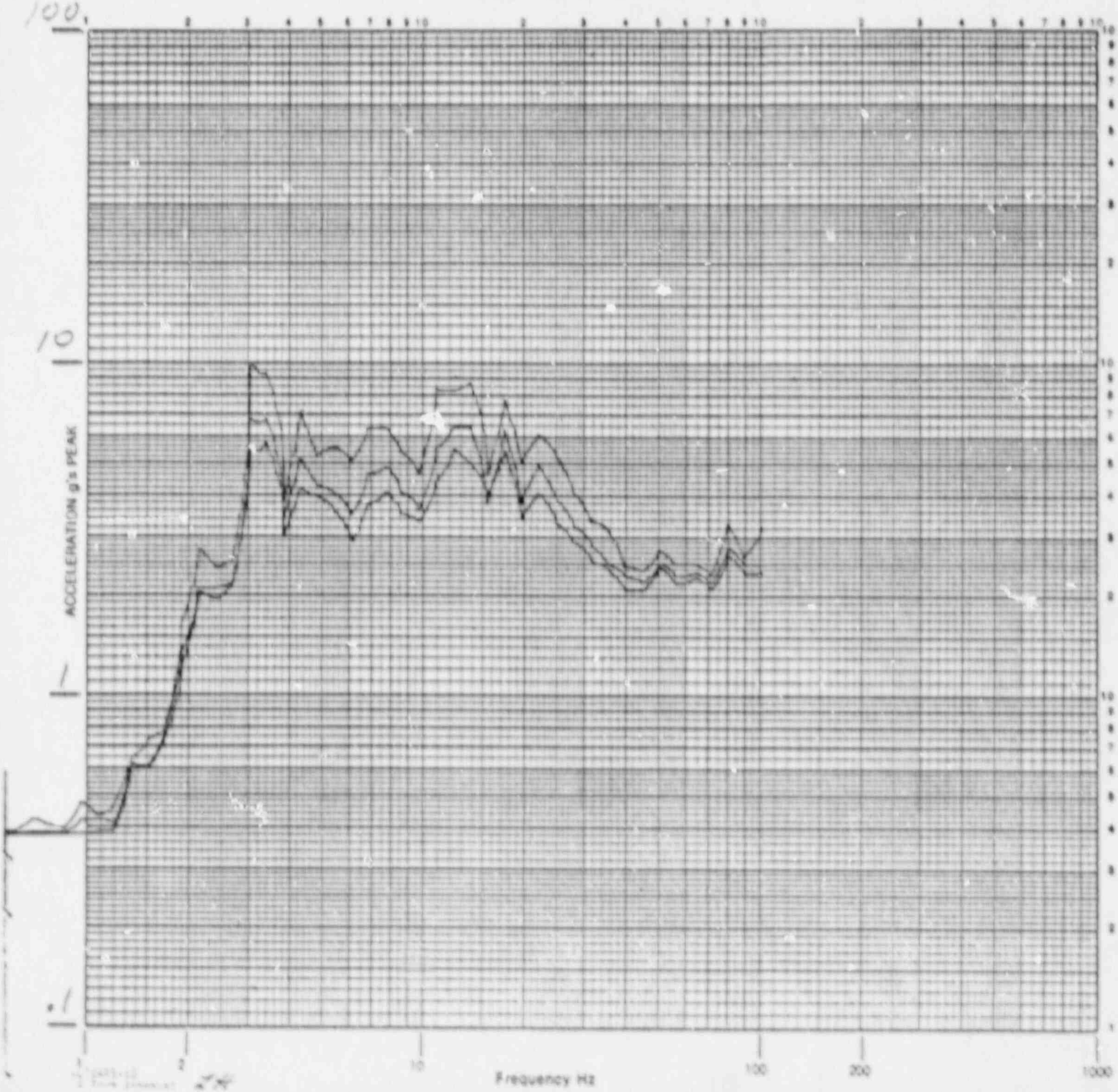
Specimen RELAY Axis of Test X

Accel. No. 3 Axis Control ( ) Response ( ) OBE ( ) SSE ( ) DBE ( )

Full Scale 100 g Damping 1, (2), 3 % Run No. 2

Operator BG Engineer [signature]

RESPONSE SPECTRUM



WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

CUSTOMER E G + G Job No. 57724 Date 5-19-82

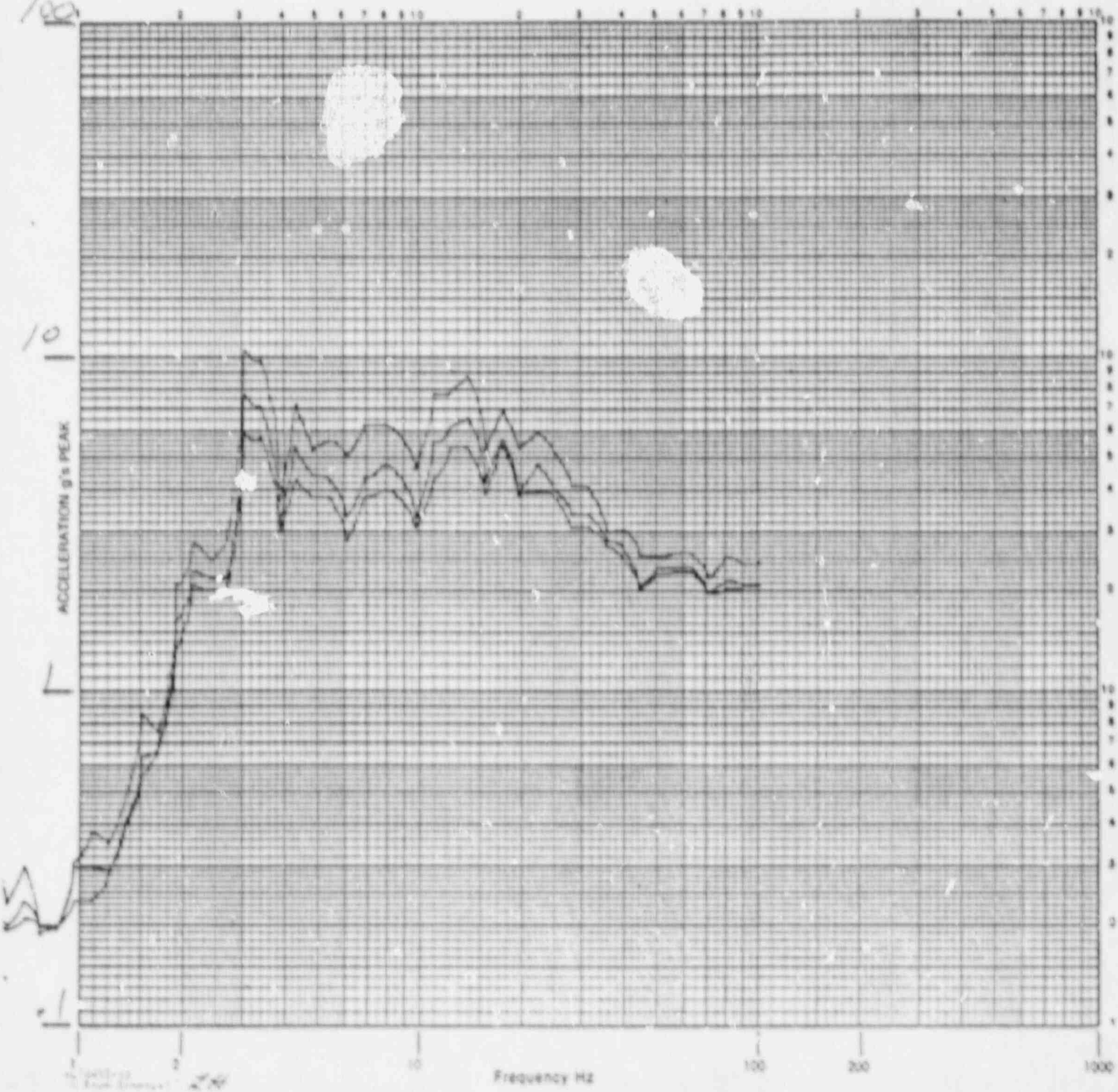
Specimen RELAY Axis of Test

Accel. No. 5 Axis Control ( ) Response (✓) OBE ( ) SSE ( ) DBE ( )

Full Scale 100 g Damping 1, (2), 3 % Run No. 2

Operator BG Engineer R. Bull

RESPONSE SPECTRUM



WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

CUSTOMER E G & G Job No. 57724 Date 5-19-87

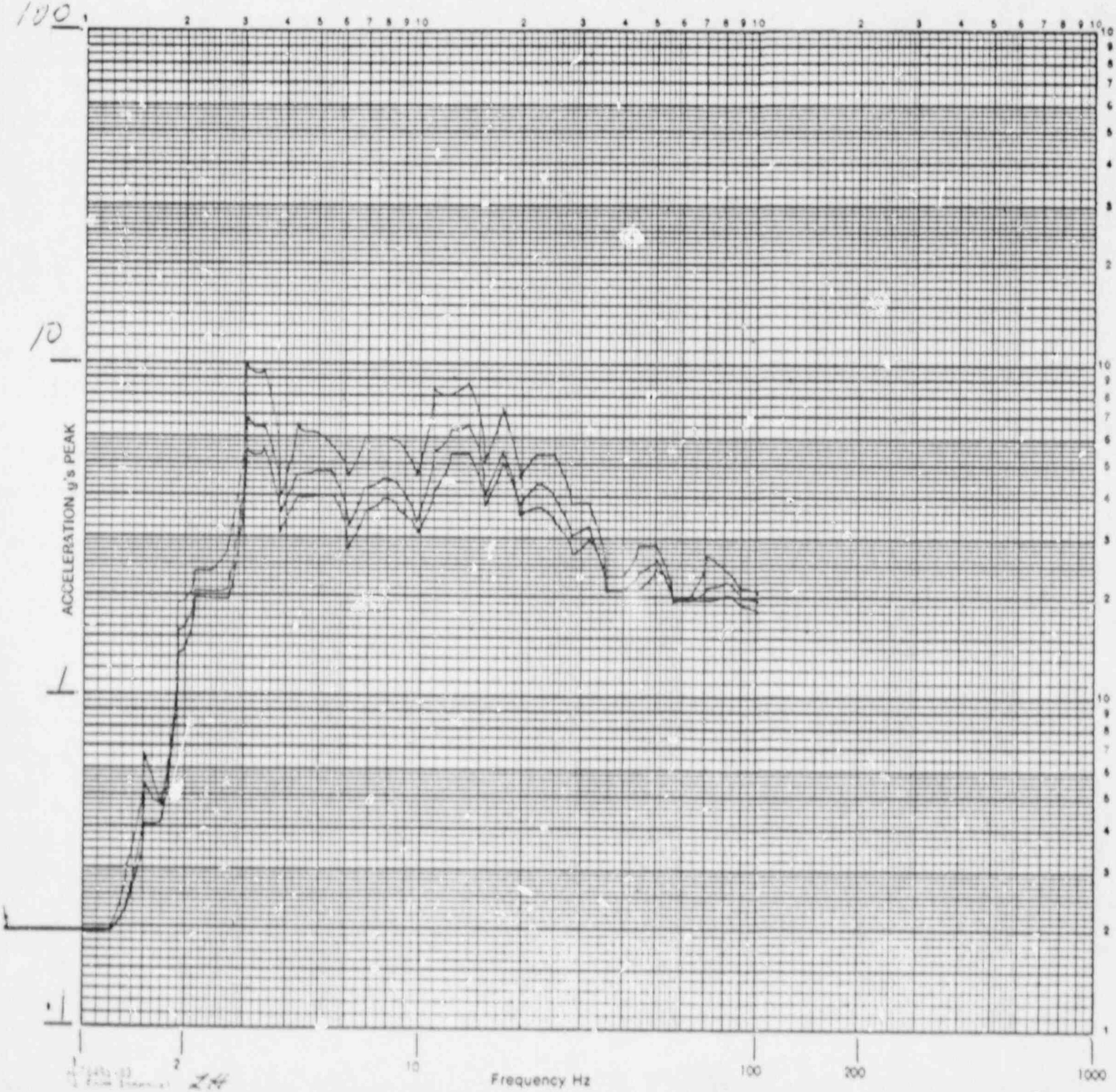
Specimen RELAY Axis of Test

Accel. No. 7 Axis Control ( ) Response (✓) OBE ( ) SSE ( ) DBE ( )

Full Scale 100 g Damping 1, (2), 3 %   Run No. 2

Operator BG Engineer P. Briel

RESPONSE SPECTRUM



WYLE LABORATORIES,NORCO,CA. FACILITY CHATTER AND PULSE ANALYSIS PROGRAM 05/19/87 10:26:27 HOURS PAGE 1

START TIME= 0.0000 STOP TIME= 23.400

TEST NAME=EGG 57724, F/B AXIS, 2ND LEVEL. RUN 2
TEST DATE=05/19/87 10:23:43 HOURS

CHANNEL ID	CHANNEL NUMBER	FIRST CHATTER	LAST CHATTER	STATE CHANGE	NUMBER OF CHATTER FAILURES PER TIME LENGTH 2.00-5.00	5.00-10.0	10.0-20.0	20.0-40.0	40.0-80.0	>80.0	TOTAL
W1-NC	2			0	NO CHATTER						
W1-NO	3			0	NO CHATTER						
W2-NC	4			0	NO CHATTER						
W2-NO	6			0	NO CHATTER						
W3-NC	7			0	NO CHATTER						
W3-NO	8			0	NO CHATTER						
G1-NC	10			0	NO CHATTER						
G1-NO	11			0	NO CHATTER						
G2-NC	12			0	NO CHATTER						
G2-NO	13			0	NO CHATTER						
G3-NC	14			0	NO CHATTER						
G3-NO	15			0	NO CHATTER						
W1-OT-NO	16			0	NO CHATTER						
W2-OT-NO	17			0	NO CHATTER						
W3-OT-NO	18			0	NO CHATTER						
G1-OT-NO	19			0	NO CHATTER						
G2-OT-NO	20			0	NO CHATTER						
G3-OT-NO	21			0	NO CHATTER						
	22			0	NO CHATTER						
										TOTAL=	0

WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

CUSTOMER EG & G Job No. 57724 Date 5-19-87

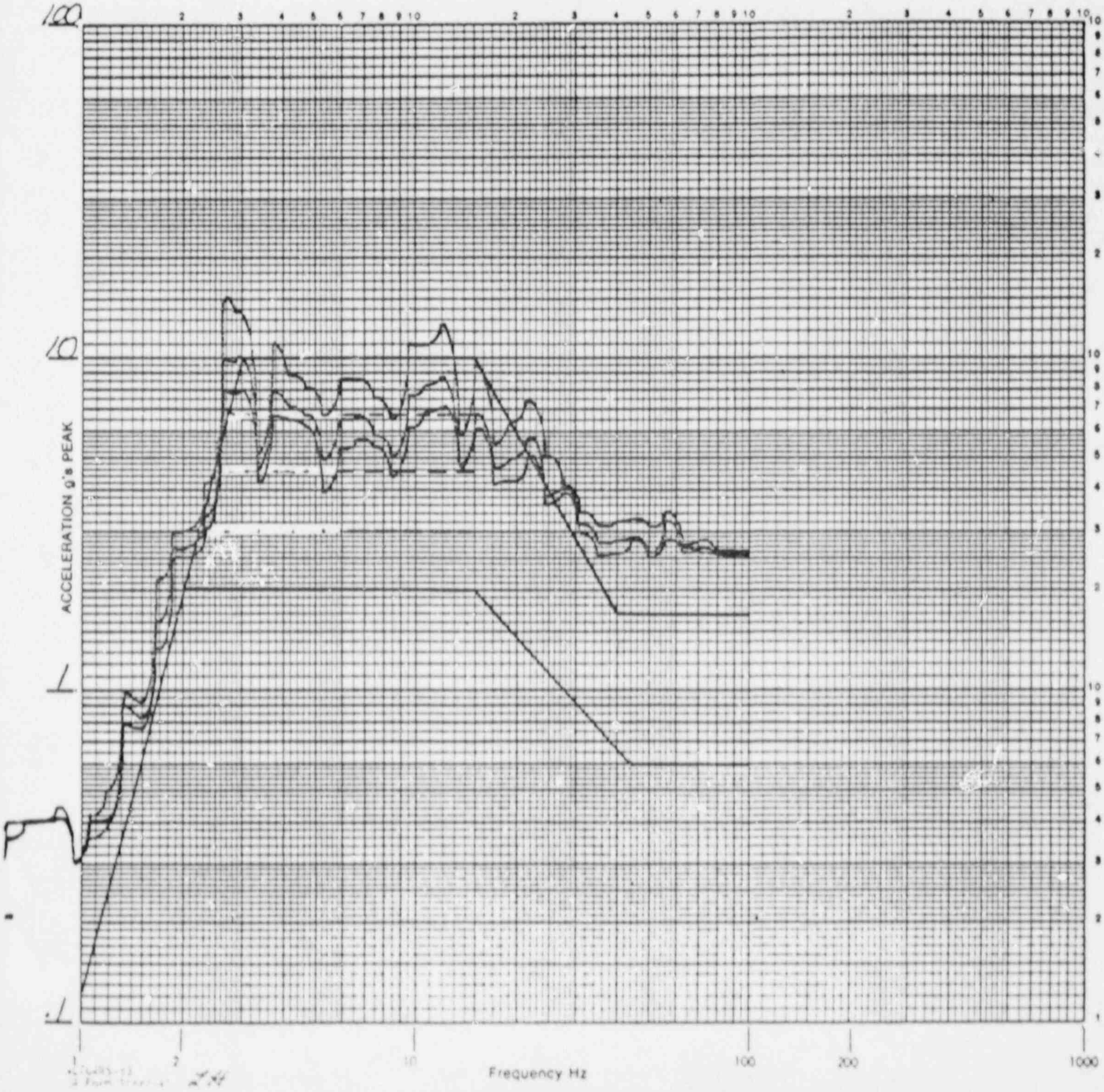
Specimen ELECTRICAL COMPONENTS Axis of Test X

Accel. No. 1 Axis HORIZ Control (✓) Response ( ) OBE ( ) SSE ( ) DBE ( )

Full Scale 100 g Damping 1,(2%),3 % Run No. LOW FREQUENCY RUN #3

Operator GRETZELMAN Engineer

RESPONSE SPECTRUM



WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

CUSTOMER EG+G Job No. 57724 Date 5-19-87

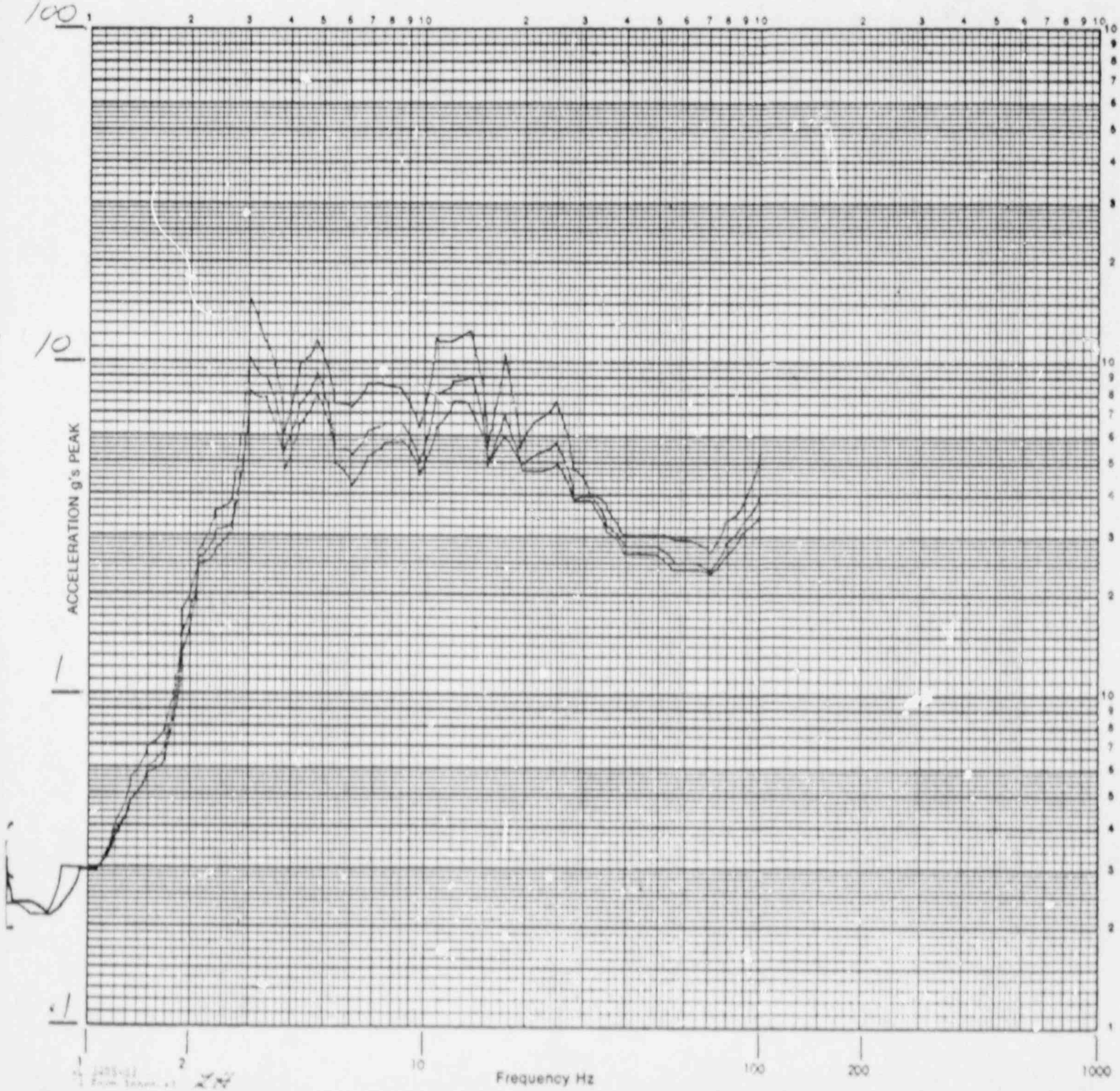
Specimen RELAY Axis of Test X

Accel. No. 3 Axis ____ Control ( ) Response (✓) OBE ( ) SSE ( ) DBE ( )

Full Scale 100 g Damping 1, (2), 3 % Run No. 3

Operator BG Engineer R. Kaul

RESPONSE SPECTRUM



CUSTOMER E G + G Job No. 57724 Date 5-19-87

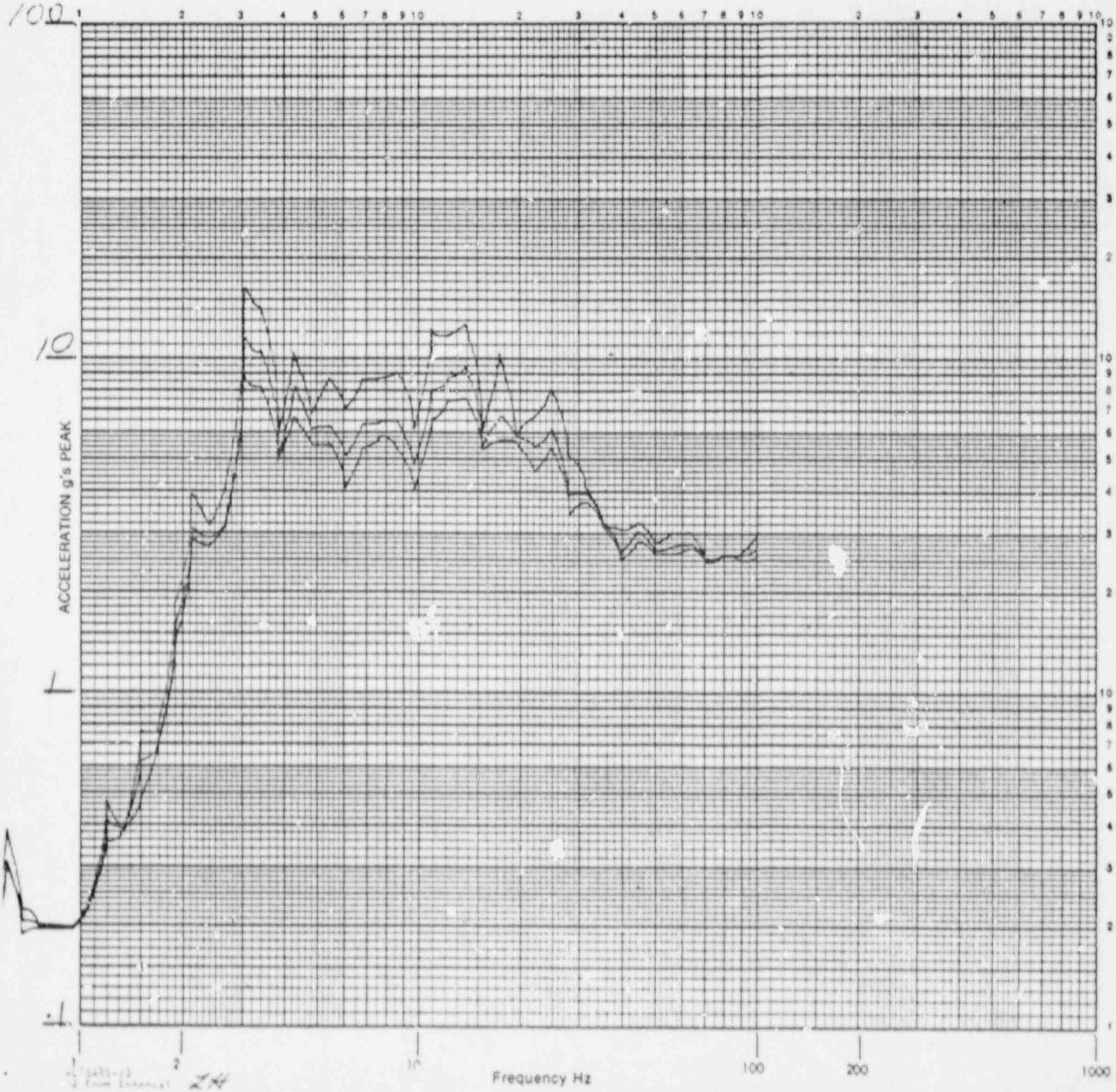
Specimen RELAY Axis of Test

Accel. No. 5 Axis Control ( ) Response (✓) OBE ( ) SSE ( ) DBE ( )

Full Scale 100 g Damping 1,(2),3 % Run No. 3

Operator BG Engineer [signature]

RESPONSE SPECTRUM



WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

CUSTOMER EG+G Job No. 57724 Date 5-19-87

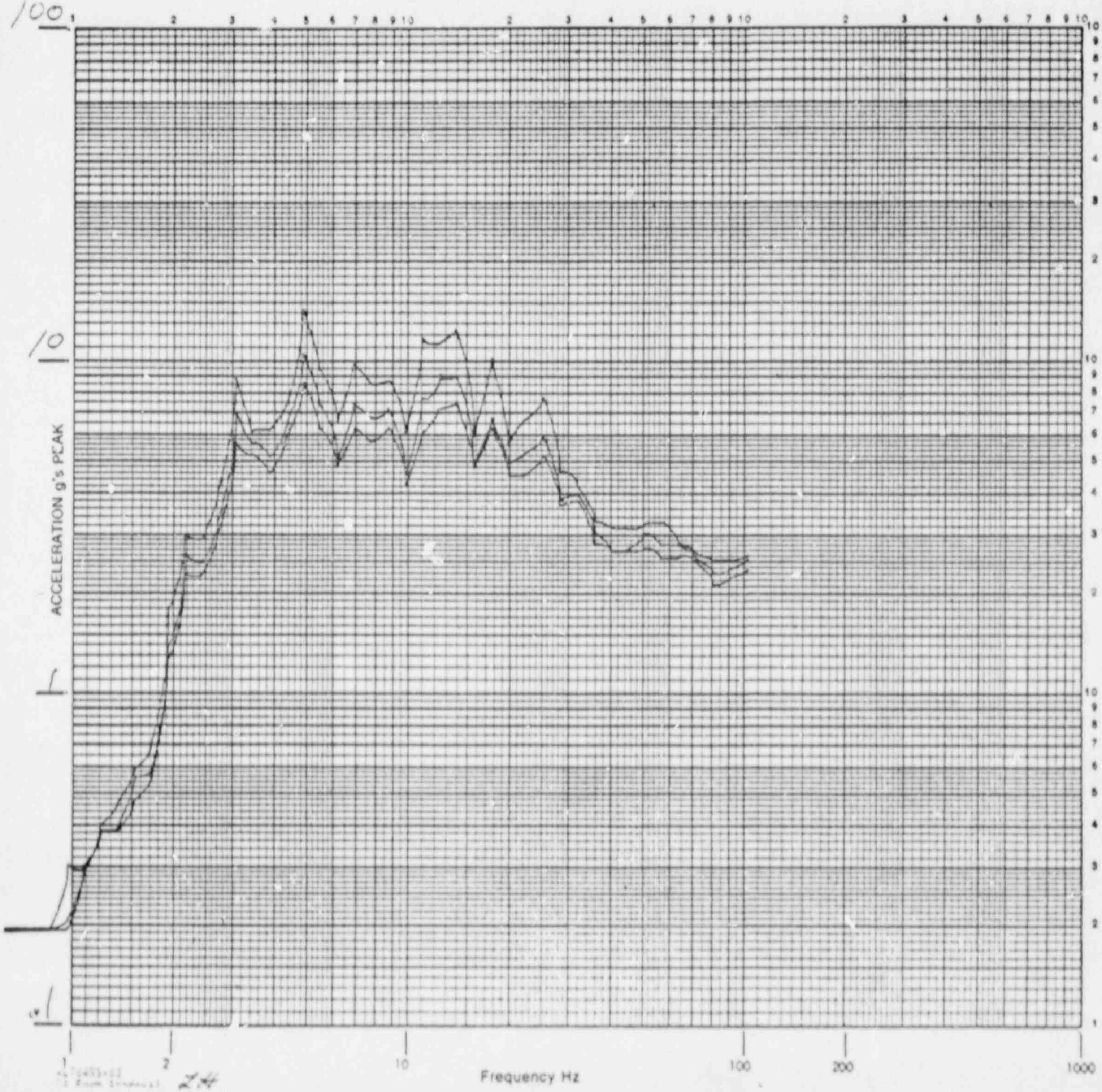
Specimen RELAY Axis of Test X

Accel. No. 7 Axis ____ Control ( ) Response (✓) OBE ( ) SSE ( ) DBE ( )

Full Scale 100 g Damping 1,(2),3 % Run No. 3

Operator BG Engineer [signature]

RESPONSE SPECTRUM



WYLE LABORATORIES,NORCO,CA. FACILITY   CHATTER AND PULSE ANALYSIS PROGRAM   05/19/87 10:33:10 HOURS   PAGE 1

START TIME= 0.0000   STOP TIME= 24.648

TEST NAME=EGG 57724, F/B AXIS, 3RD LEVEL, RUN 3
TEST DATE=05/19/87 10:30:23 HOURS

CHANNEL ID	CHANNEL NUMBER	FIRST CHATTER	LAST CHATTER	STATE CHANGE	NUMBER OF CHATTER FAILURES PER TIME LENGTH 2.00-5.00	5.00-10.0	10.0-20.0	20.0-40.0	40.0-80.0	>80.0	TOTAL
W1-NC	2			0	NO CHATTER						
W1-NO	3			0	NO CHATTER						
W2-NC	4			0	NO CHATTER						
W2-NO	6			0	NO CHATTER						
W3-NC	7			0	NO CHATTER						
W3-NO	8			0	NO CHATTER						
G1-NC	10			0	NO CHATTER						
G1-NO	11			0	NO CHATTER						
G2-NC	12			0	NO CHATTER						
G2-NO	13			0	NO CHATTER						
G3-NC	14			0	NO CHATTER						
G3-NO	15			0	NO CHATTER						
W1-OT-NO	16			0	NO CHATTER						
W2-OT-NO	17			0	NO CHATTER						
W3-OT-NO	18			0	NO CHATTER						
G1-OT-NO	19			0	NO CHATTER						
G2-OT-NO	20			0	NO CHATTER						
G3-OT-NO	21			0	NO CHATTER						
	22			0	NO CHATTER						
										TOTAL=	0

WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

CUSTOMER EG & G Job No. 57724 Date 5-19-87

Specimen ELECTRICAL COMPONENTS Axis of Test X

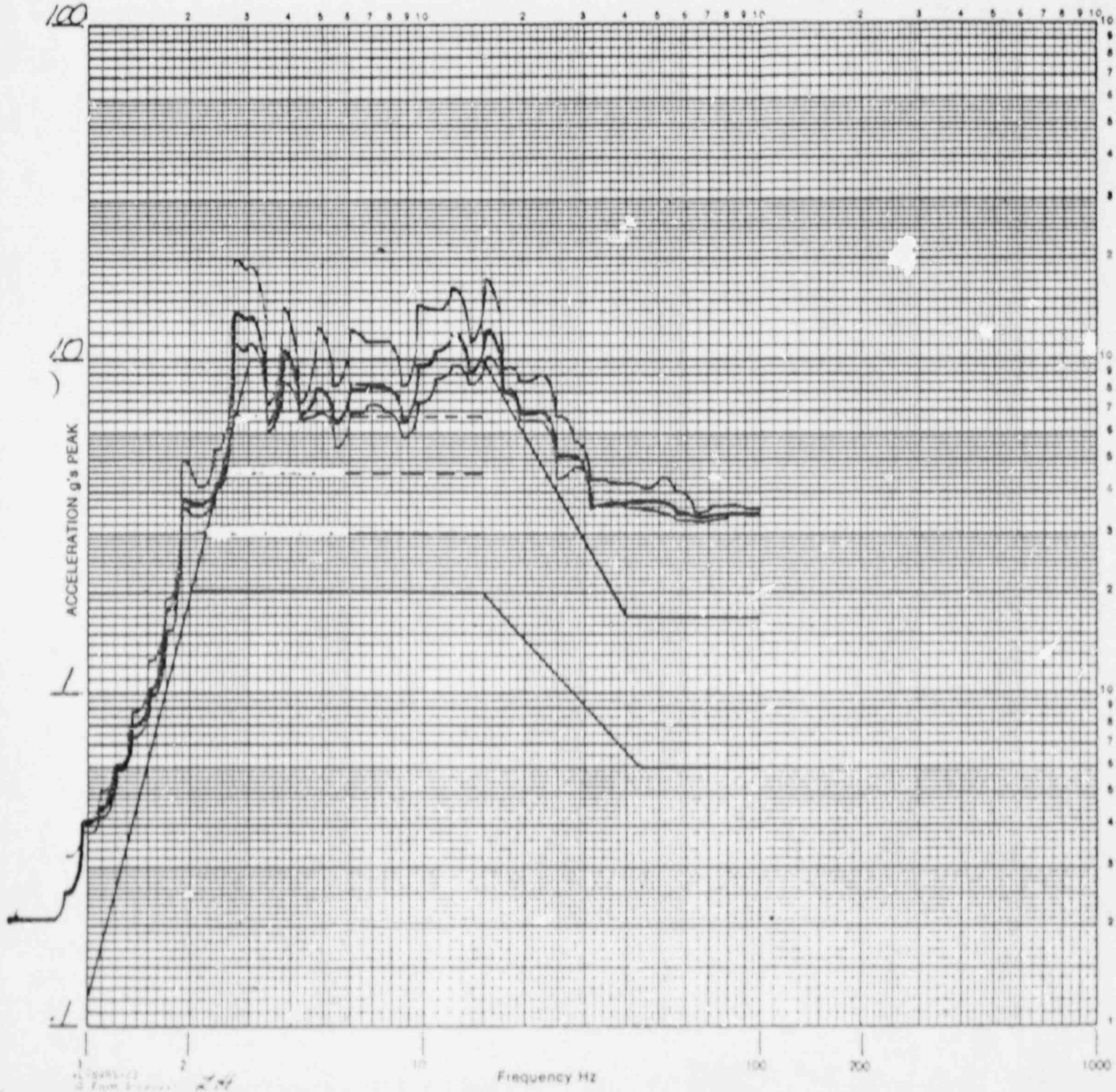
Accel. No. 1 Axis HORIZ Control (✓) Response ( ) OBE ( ) SSE ( ) DBE ( )

Full Scale 100 g Damping 1,(2%),3 %

Run No. LOW FREQUENCY RUN #4

Operator GREERMAN Engineer JL

RESPONSE SPECTRUM



WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

CUSTOMER E G + G Job No. 57724 Date 5-19-87

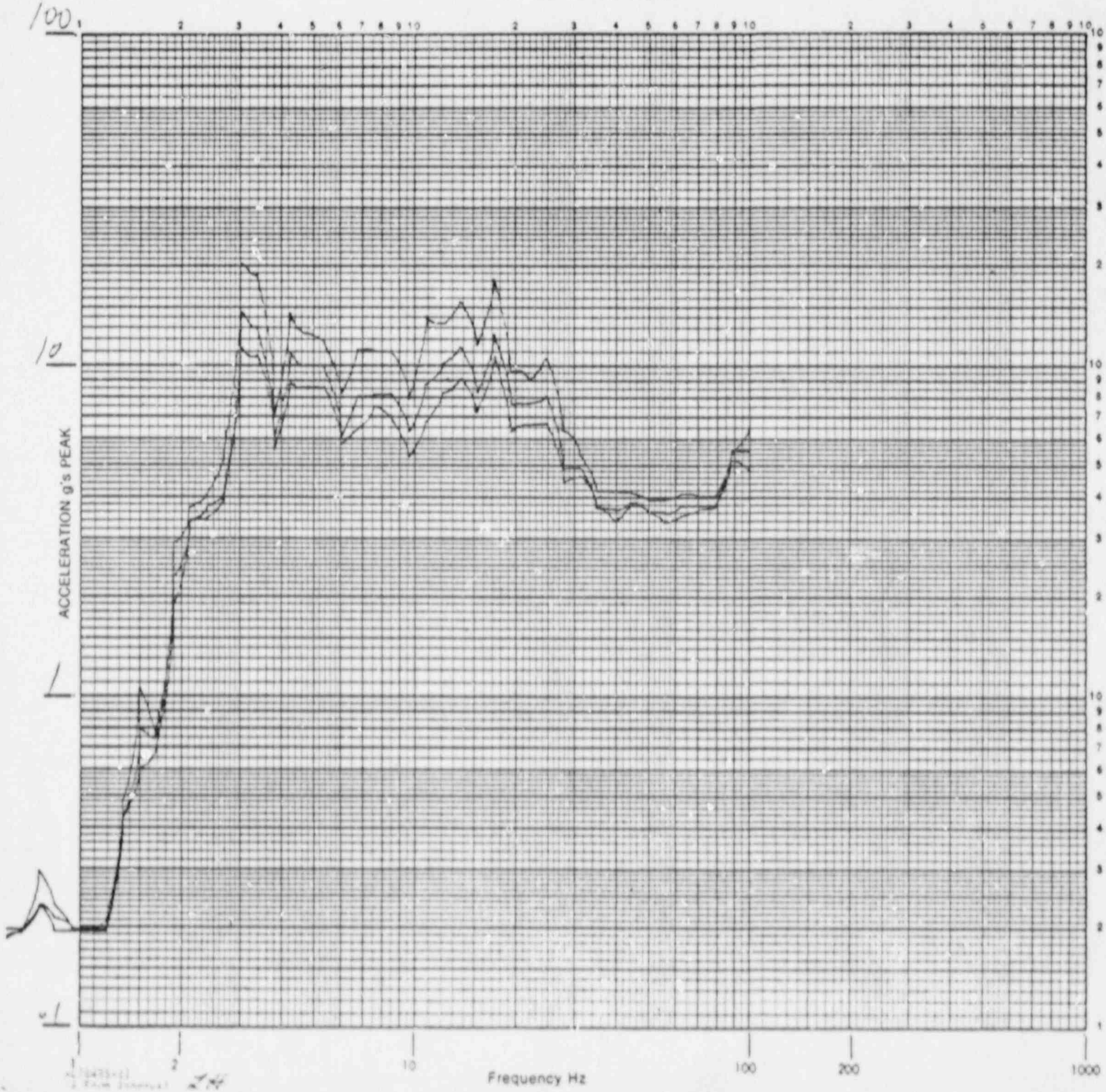
Specimen RELAY Axis of Test X

Accel. No. 3 Axis ____ Control ( ) Response (✓) OBE ( ) SSE ( ) DBE ( )

Full Scale 100 g Damping 1,(2), 3 % Run No. 4

Operator BG Engineer D. Kuhl

RESPONSE SPECTRUM



WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

CUSTOMER E G + G Job No. 57724 Date 5-19-87

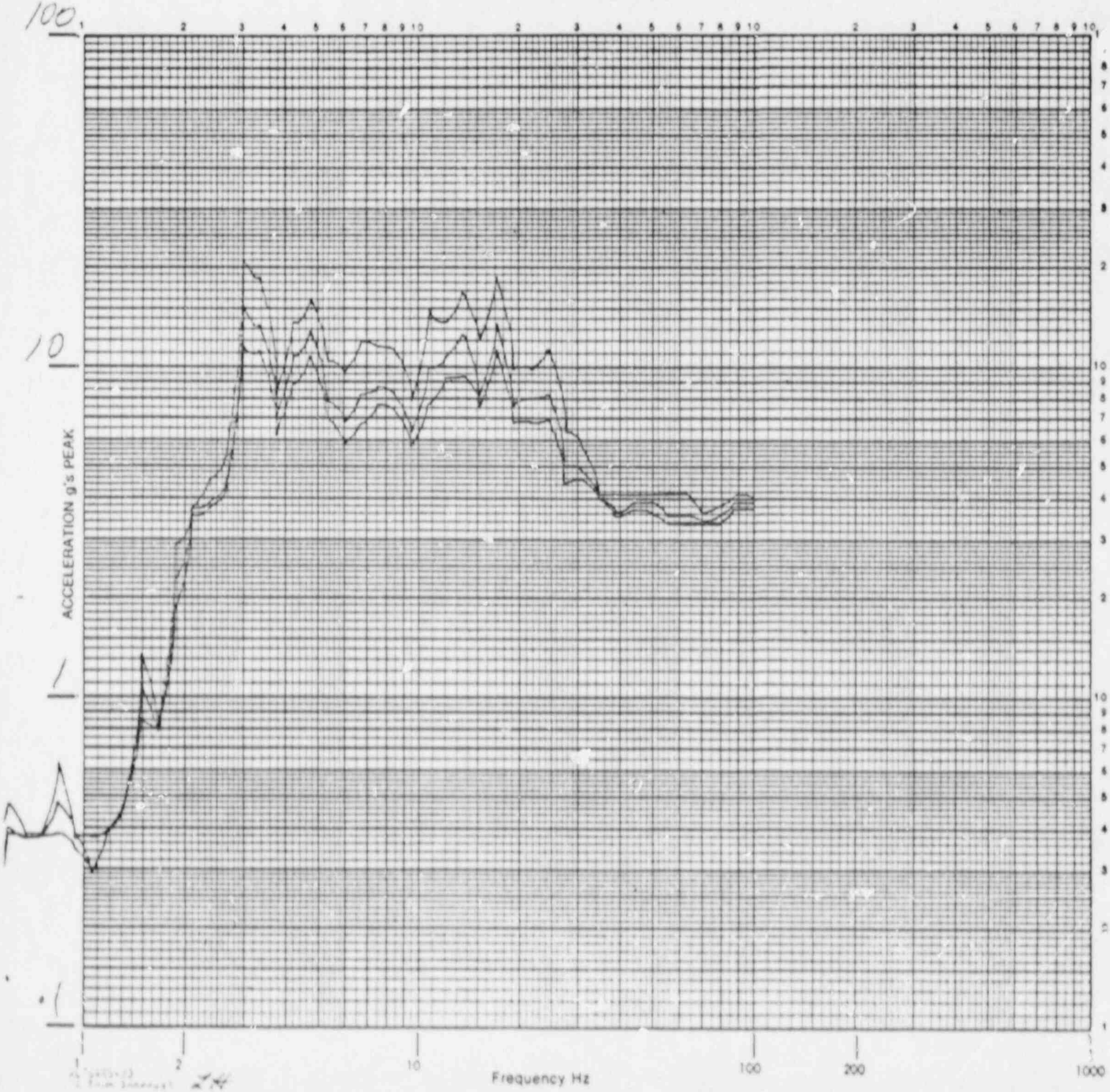
Specimen RELAY Axis of Test

Accel. No. 5 Axis Control ( ) Response ( ) OBE ( ) SSE ( ) DBE ( )

Full Scale : Damping 1, (2), 3 % Run No. 4

Operator BG Engineer [signature]

RESPONSE SPECTRUM



WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

CUSTOMER E G + G Job No. 57724 Date 5-19-87

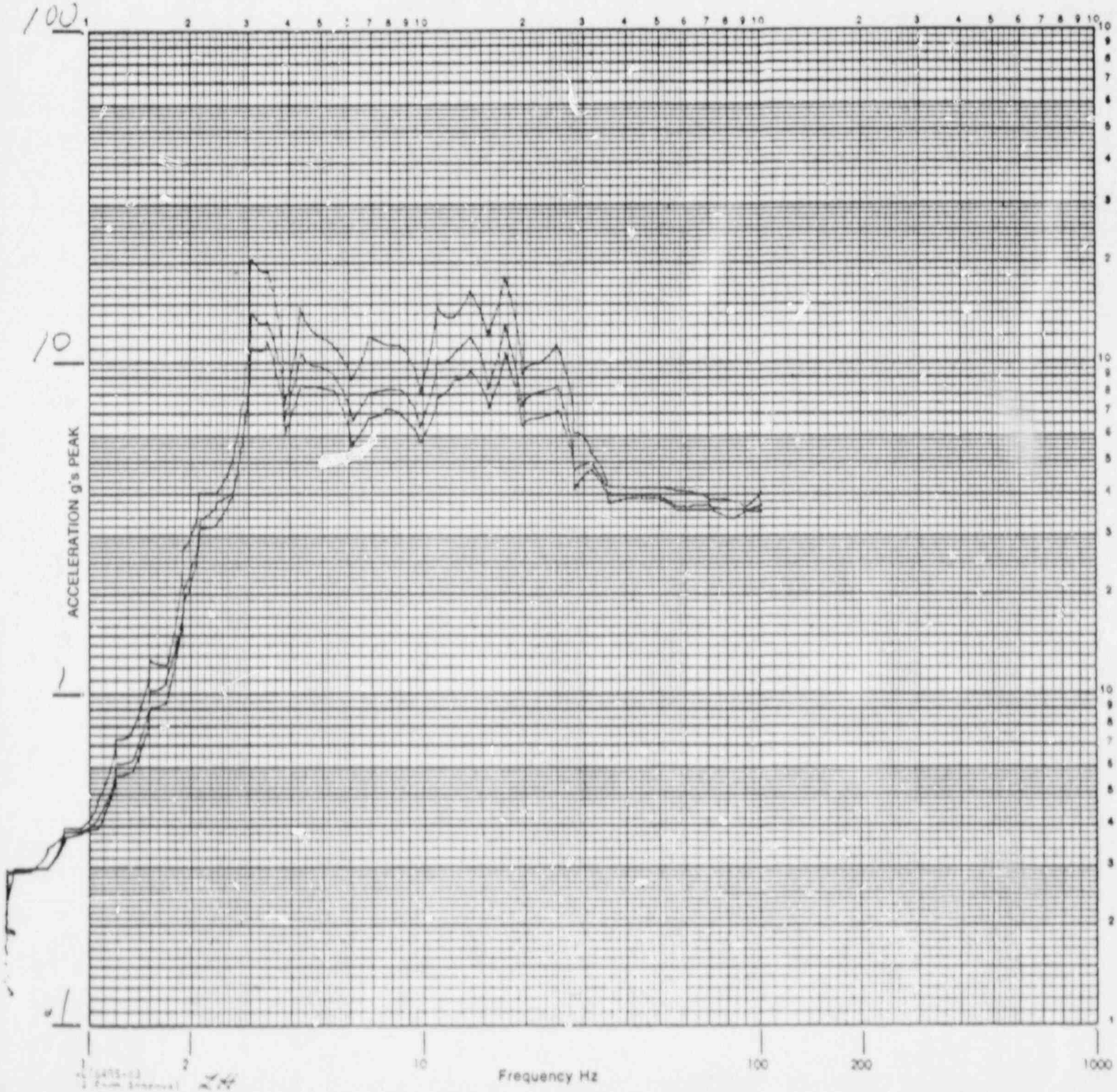
Specimen RELAY Axis of Test X

Accel. No. 7 Axis Control ( ) Response (✓) OBE ( ) SSE ( ) DBE ( )

Full Scale 100 g Damping 1,(2),3 % Run No. 4

Operator BG Engineer D. Buell

RESPONSE SPECTRUM



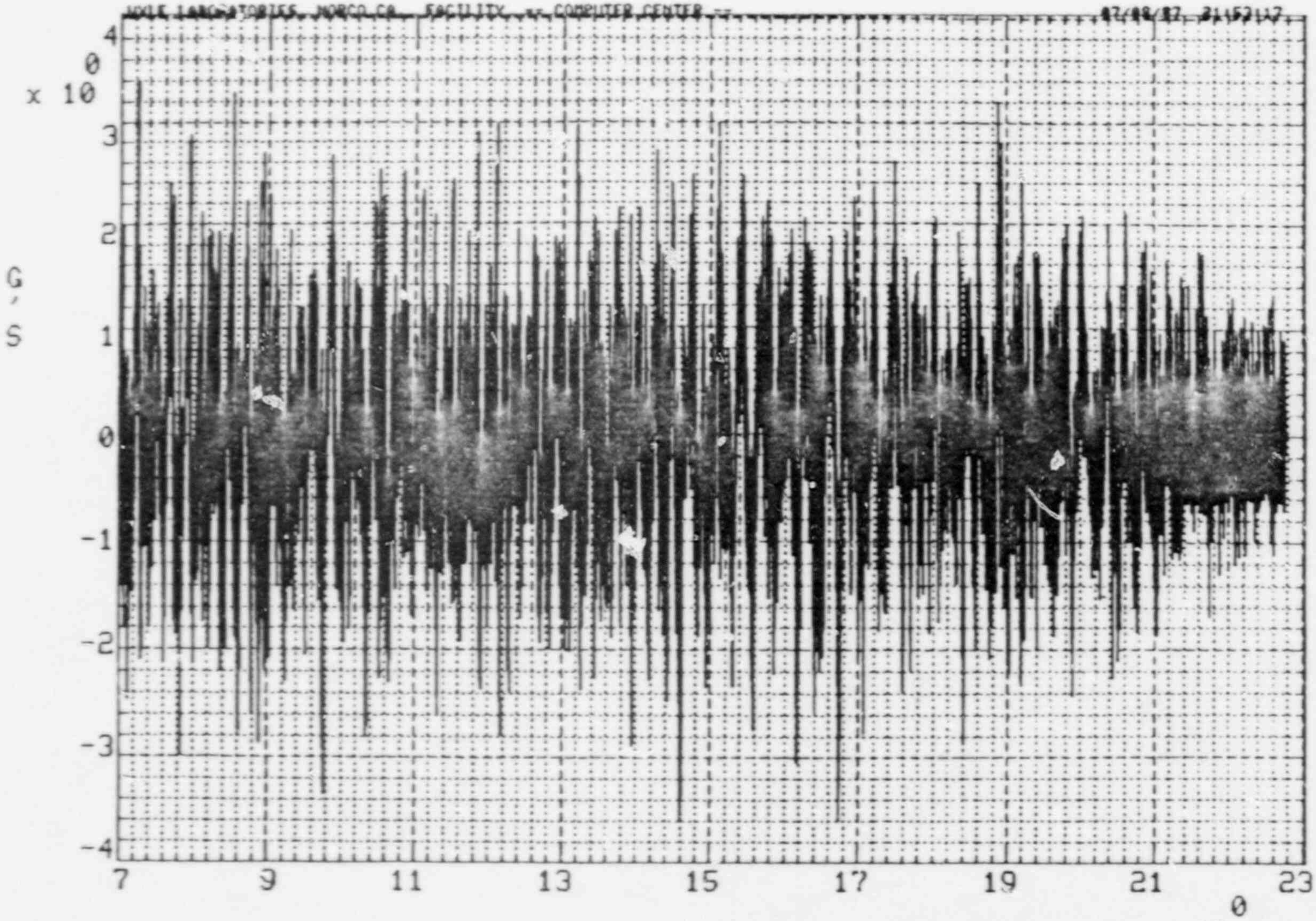
24

WYLE LABORATORIES,NORCO,CA. FACILITY   CHATTER AND PULSE ANALYSIS PROGRAM   05/19/87 11:41:35 HOURS   PAGE 1

START TIME= 0.0000   STOP TIME= 22.776

TEST NAME=EGG 57724, F/B AXIS, 4TH LEVEL, RUN 4
TEST DATE=05/19/87 10:37:10 HOURS

CHANNEL ID	CHANNEL NUMBER	FIRST CHATTER	LAST CHATTER	STATE CHANGE	NUMBER OF CHATTER FAILURES PER TIME LENGTH 2.00-5.00	5.00-10.0	10.0-20.0	20.0-40.0	40.0-80.0	>80.0	TOTAL
W1-NC	2			0	NO CHATTER						
W1-NO	3			0	NO CHATTER						
W2-NC	4			0	NO CHATTER						
W2-NO	6			0	NO CHATTER						
W3-NC	7			0	NO CHATTER						
W3-NO	8			0	NO CHATTER						
G1-NC	10			0	NO CHATTER						
G1-NO	11			0	NO CHATTER						
G2-NC	12			0	NO CHATTER						
G2-NO	13			0	NO CHATTER						
G3-NC	14			0	NO CHATTER						
G3-NO	15			0	NO CHATTER						
W1-OT-NO	16			0	NO CHATTER						
W2-OT-NO	17			0	NO CHATTER						
W3-OT-NO	18			0	NO CHATTER						
G1-OT-NO	19			0	NO CHATTER						
G2-OT-NO	20			0	NO CHATTER						
G3-OT-NO	21			0	NO CHATTER						
	22			0	NO CHATTER						
										TOTAL=	0

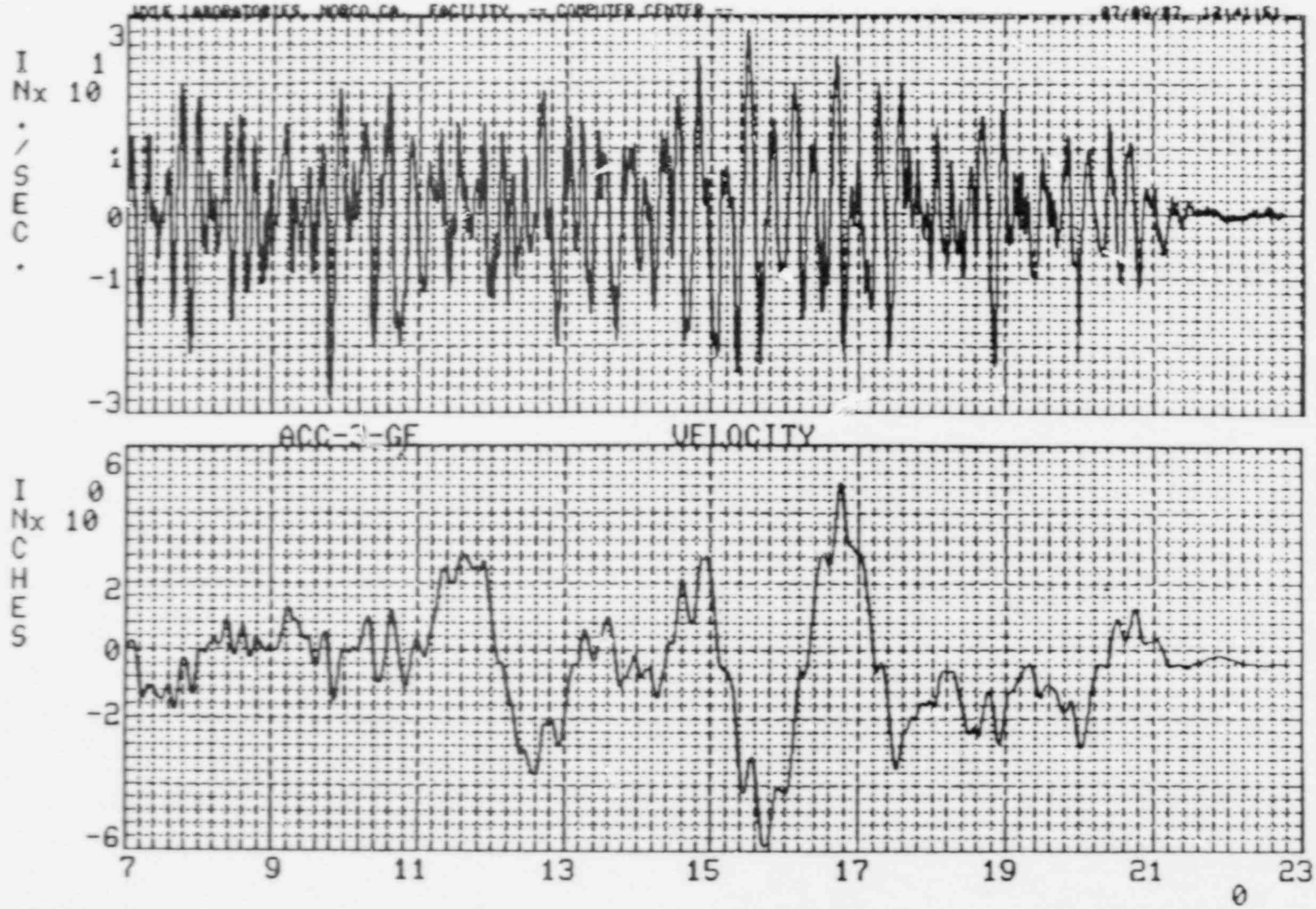


ACC-3-GE TIME HISTORY SEC x 10^0

NO FILTER, 1000.00 SPS, TREND REMOVAL ON,

DATE 05/19/87 DISPLAY NUMBER 10 7.00 TO 22.78 SEC

EGG 57724, F/B AXIS, 4TH LEVEL, RUN 4

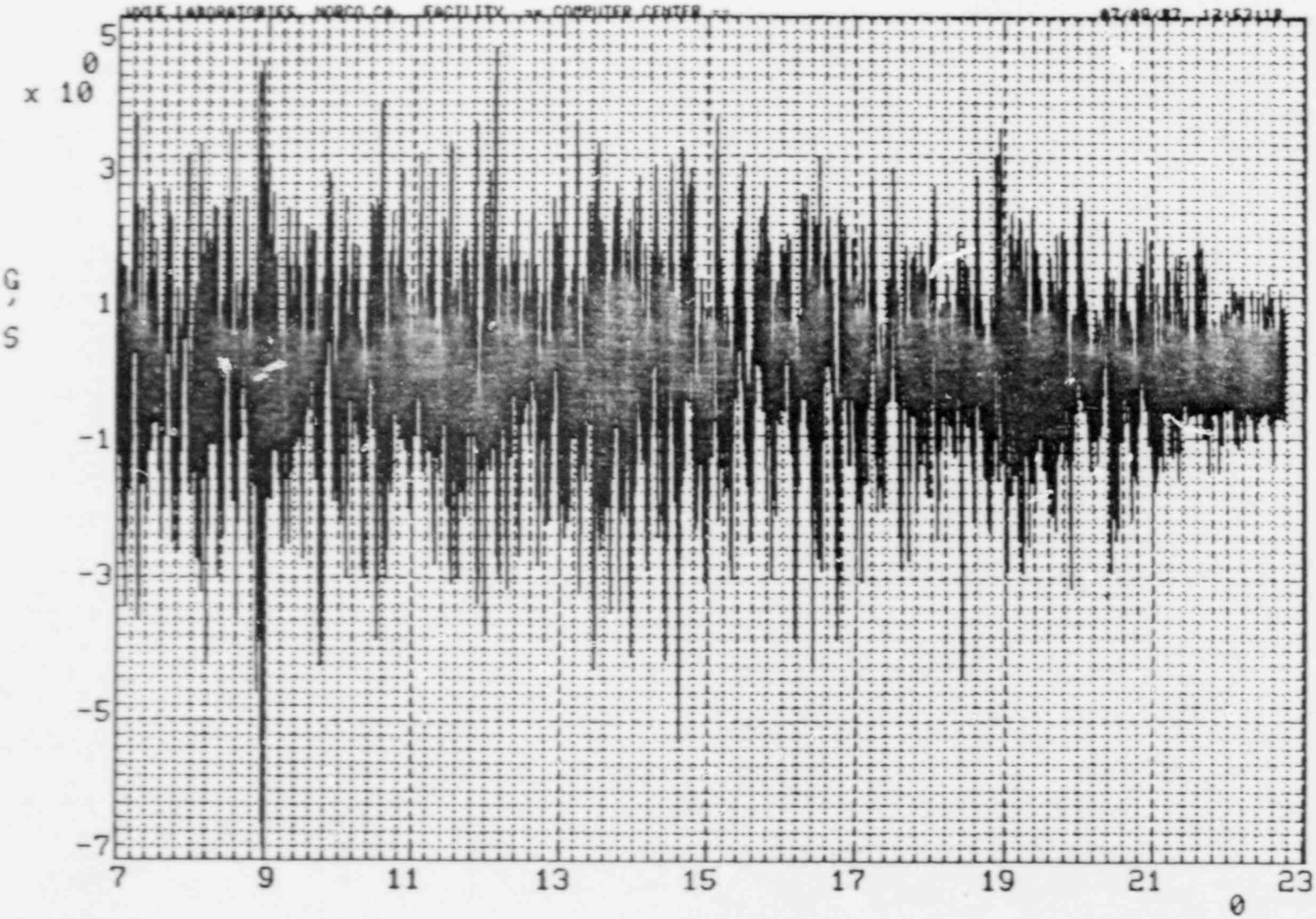


ACC-3-GE DISPLACEMENT SEC x 10^0

NO FILTER, 1000.00 SPS, TREND REMOVAL ON,

DATE 05/19/87 DISPLAY NUMBER 6 7.00 TO 22.77 SEC

EGG 57724, F/B AXIS, 4TH LEVEL, RUN 4

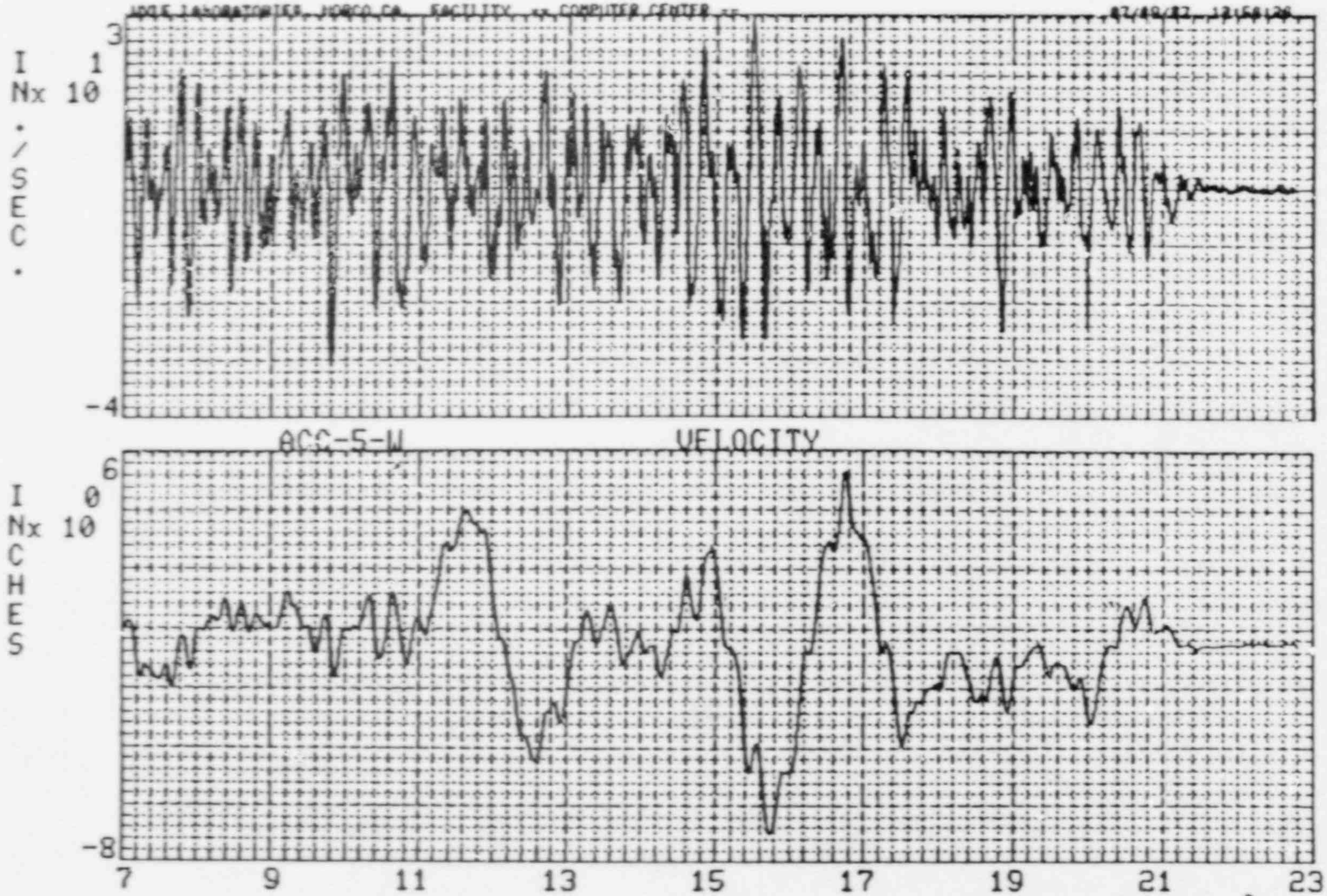


ACC-5-W TIME HISTORY SEC x 10^0

NO FILTER, 1000.00 SPS, TREND REMOVAL ON,

DATE 05/19/87 DISPLAY NUMBER 7 7.00 TO 22.78 SEC

EGG 57724, F/B AXIS, 4TH LEVEL, RUN 4



ACC-5-W DISPLACEMENT SEC x 10^0

NO FILTER, 1000.00 SPS, TREND REMOVAL ON,

DATE 05/19/87 DISPLAY NUMBER 8 7.00 TO 22.77 SEC

EGG 57724, F/B AXIS, 4TH LEVEL, RUN 4

WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

CUSTOMER E G & G Job No. 57724 Date 5-19-87

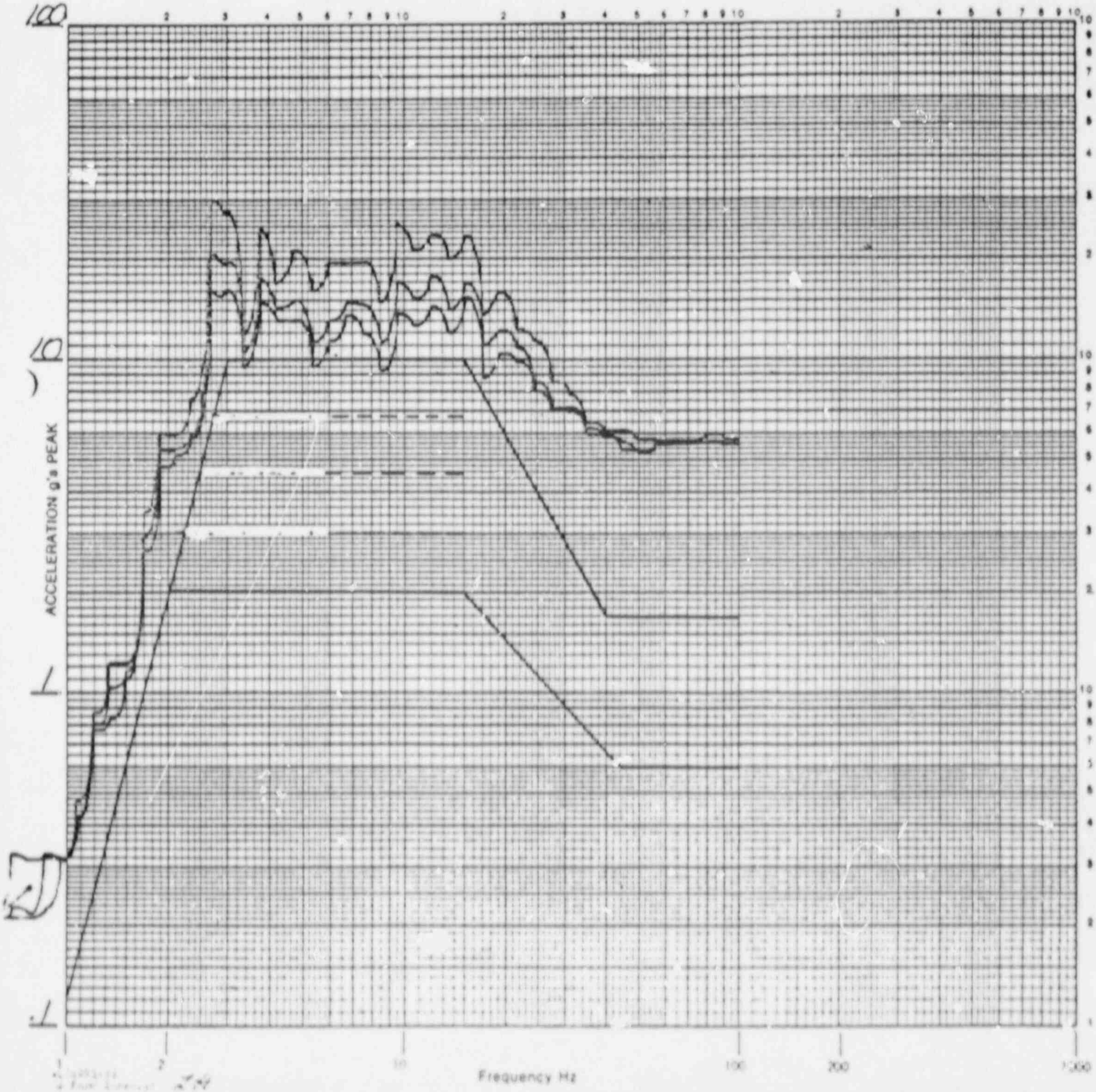
Specimen ELECTRICAL COMPONENTS Axis of Test X

Accel. No. 1 Axis HORIZ Control (✓) Response ( ) OBE ( ) SSE ( ) DBE ( )

Full Scale 100 g Damping 1,(2%),3 % Run No. LOW FREQUENCY RUN #5

Operator GREIERMAN Engineer [illegible]

RESPONSE SPECTRUM



Report No. 57724

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WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

CUSTOMER EG+G Job No. 57724 Date 5-19-87

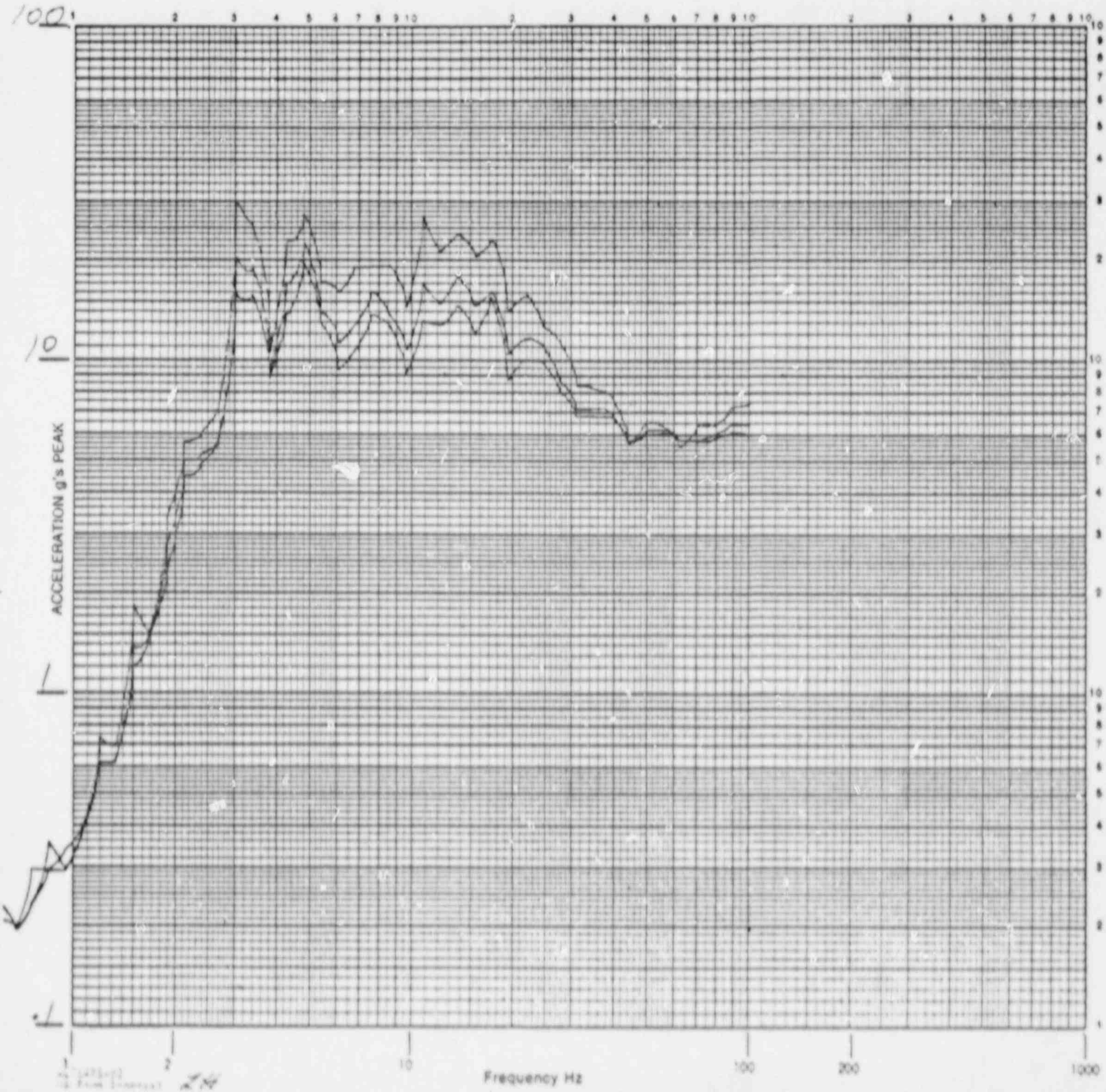
Specimen RELAY Axis of Test X

Accel. No. 3 Axis ____ Control ( ) Response (✓) OBE ( ) SSE ( ) DBE ( )

Full Scale 100 g Damping 1,(2),3 % Run No. 5

Operator BG Engineer D. Kim

RESPONSE SPECTRUM



WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

CUSTOMER E G+G Job No. 57724 Date 5-19-87

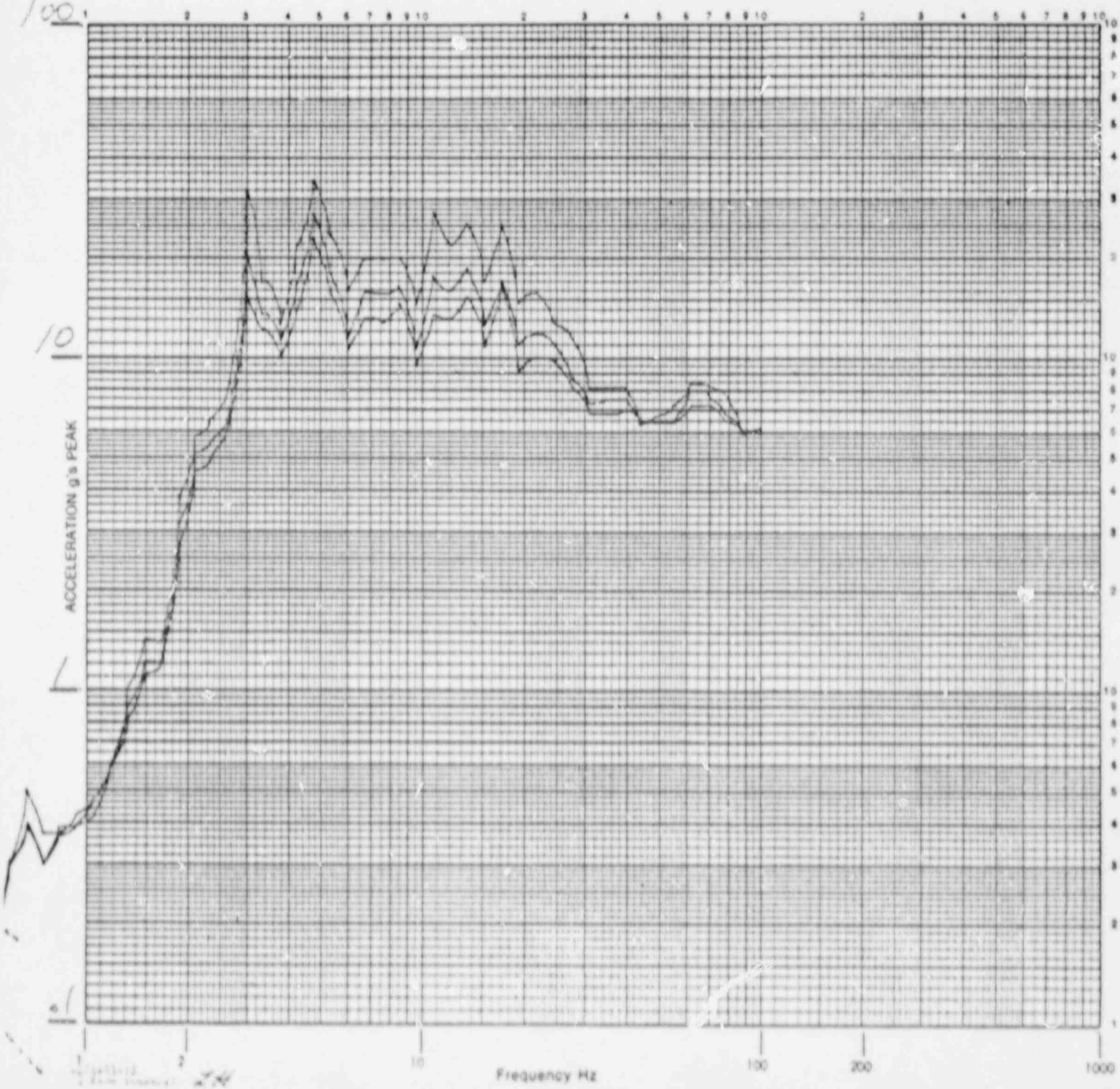
Specimen RELAY Axis of Test X

Accel. No. 5 Axis ____ Control ( ) Response (✓) OBE ( ) SSE ( ) DBE ( )

Full Scale 100 g Damping 1,(2),3 % Run No. 5

Operator BG Engineer R. Keill

RESPONSE SPECTRUM



WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

CUSTOMER EG+G Job No. 57724 Date 5-19-87

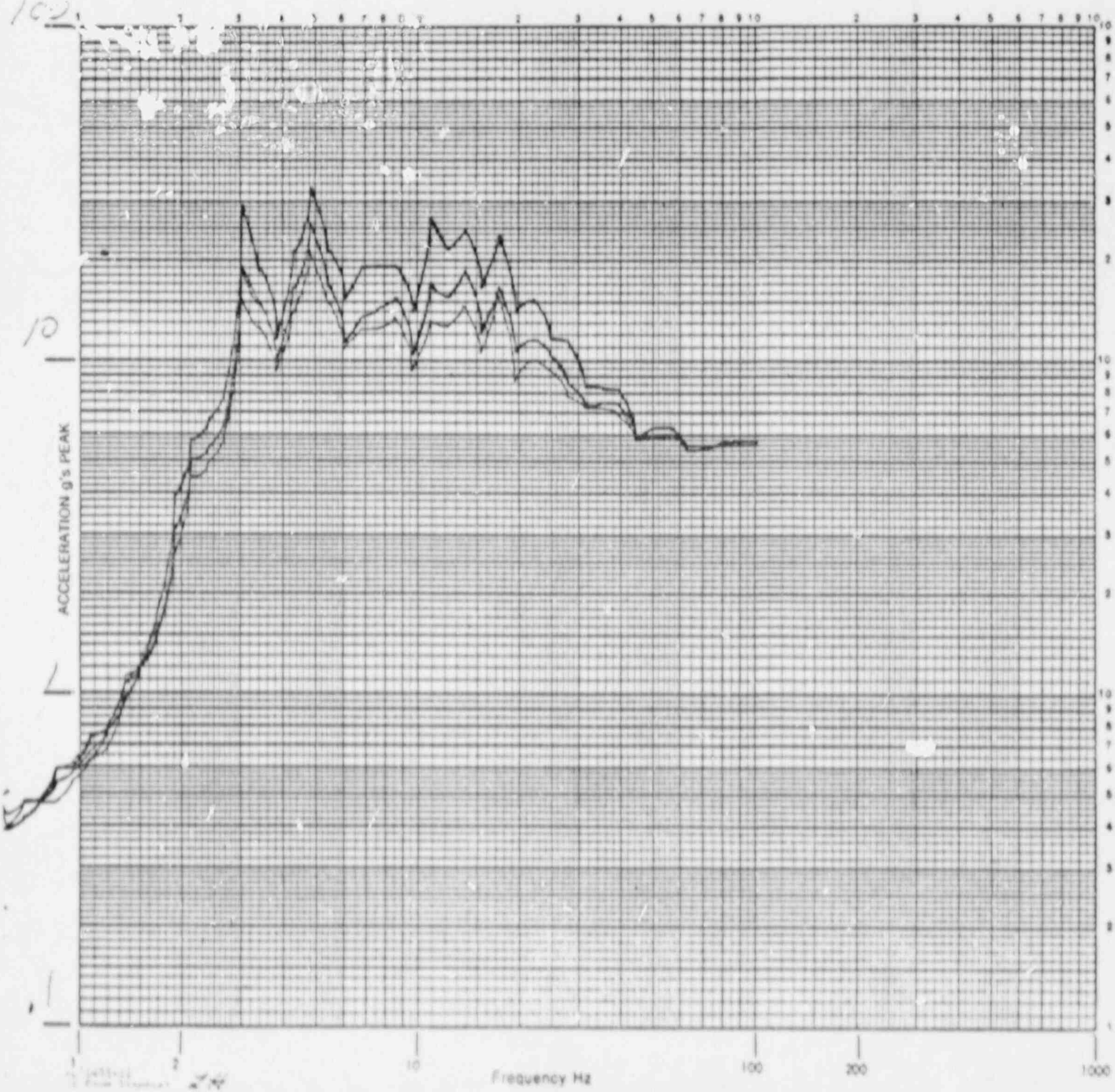
Specimen RELAY Axis of Test X

Accel. No. Z Axis Control ( ) Response (✓) OBE ( ) SSE ( ) DBE ( )

Full Scale 100 g Damping 1(2),3 % Run No. 5

Operator BG Engineer R. Brown

RESPONSE SPECTRUM

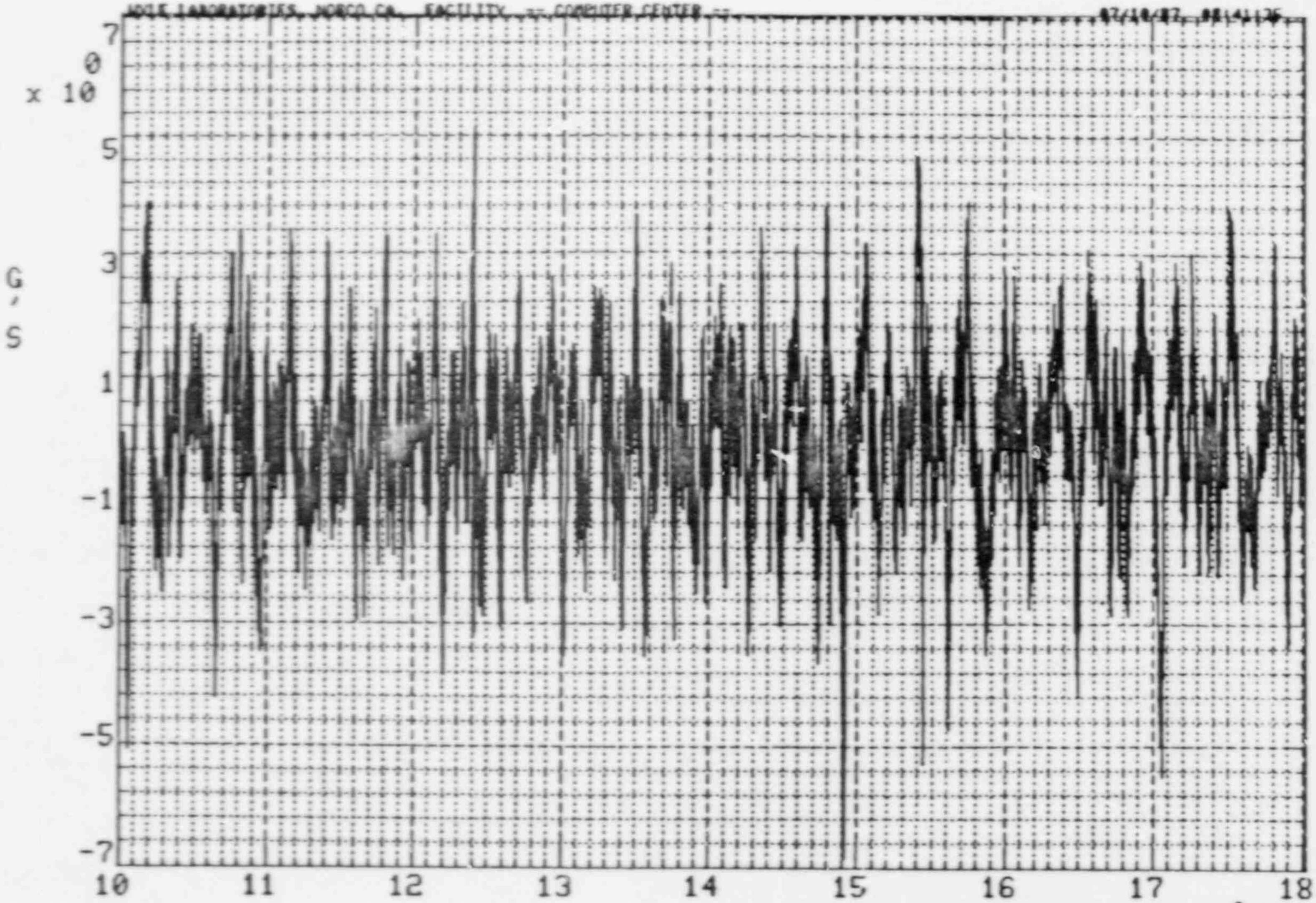


WYLE LABORATORIES,NORCO,CA. FACILITY CHATTER AND PULSE ANALYSIS PROGRAM 05/19/87 11:10:07 HOURS PAGE 1

START TIME= 0.0000 STOP TIME= 23.712

TEST NAME=EGG 57724, F/B AXIS, 5TH LEVEL, RUN 5
TEST DATE=05/19/87 10:43: 9 HOURS

CHANNEL ID	CHANNEL NUMBER	FIRST CHATTER	LAST CHATTER	STATE CHANGE	NUMBER OF CHATTER FAILURES PER TIME LENGTH 2.00-5.00	5.00-10.0	10.0-20.0	20.0-40.0	40.0-80.0	>80.0	TOTAL
W1-NC	2	10.069	17.078	0	0	1	2	0	0	0	3
W1-NO	3			0	NO CHATTER						
W2-NC	4	10.069	17.078	0	0	1	2	0	0	0	3
W2-NO	6			0	NO CHATTER						
W3-NC	7	10.065	17.078	0	0	0	3	0	0	0	3
W3-NO	8			0	NO CHATTER						
G1-NC	10	8.237	8.242	0	1	0	0	0	0	0	1
G1-NO	11			0	NO CHATTER						
G2-NC	12	8.233	8.250	0	0	0	1	0	0	0	1
G2-NO	13			0	NO CHATTER						
G3-NC	14	8.234	8.249	0	0	0	1	0	0	0	1
G3-NO	15			0	NO CHATTER						
W1-OT-NO	16	14.932	17.097	0	1	0	0	1	0	0	2
W2-OT-NO	17			0	NO CHATTER						
W3-OT-NO	18	10.078	17.103	0	0	0	0	2	0	0	2
G1-OT-NO	19			0	NO CHATTER						
G2-OT-NO	20			0	NO CHATTER						
G3-OT-NO	21	8.242	8.276	0	1	0	0	1	0	0	2
	22			0	NO CHATTER						
										TOTAL=	18

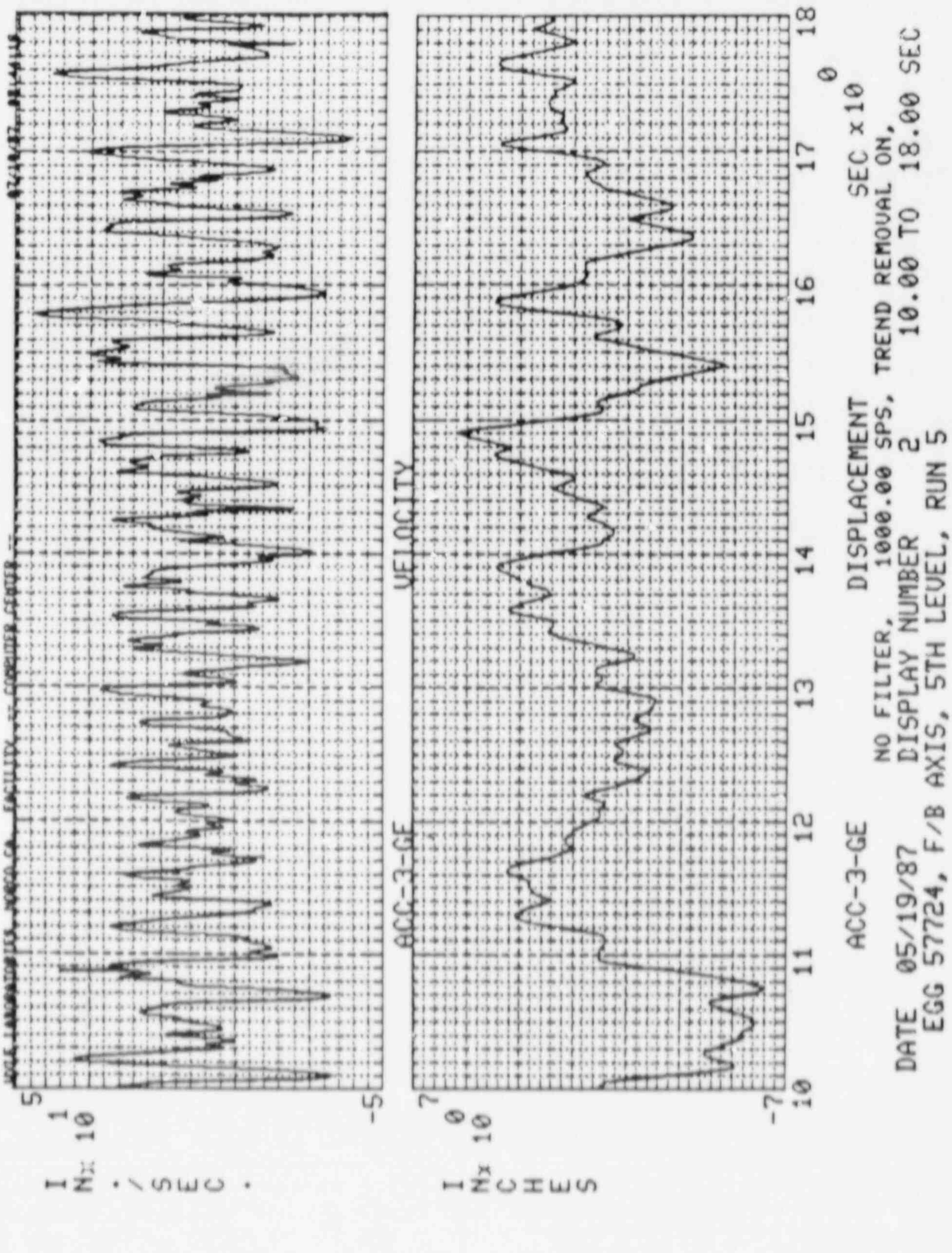


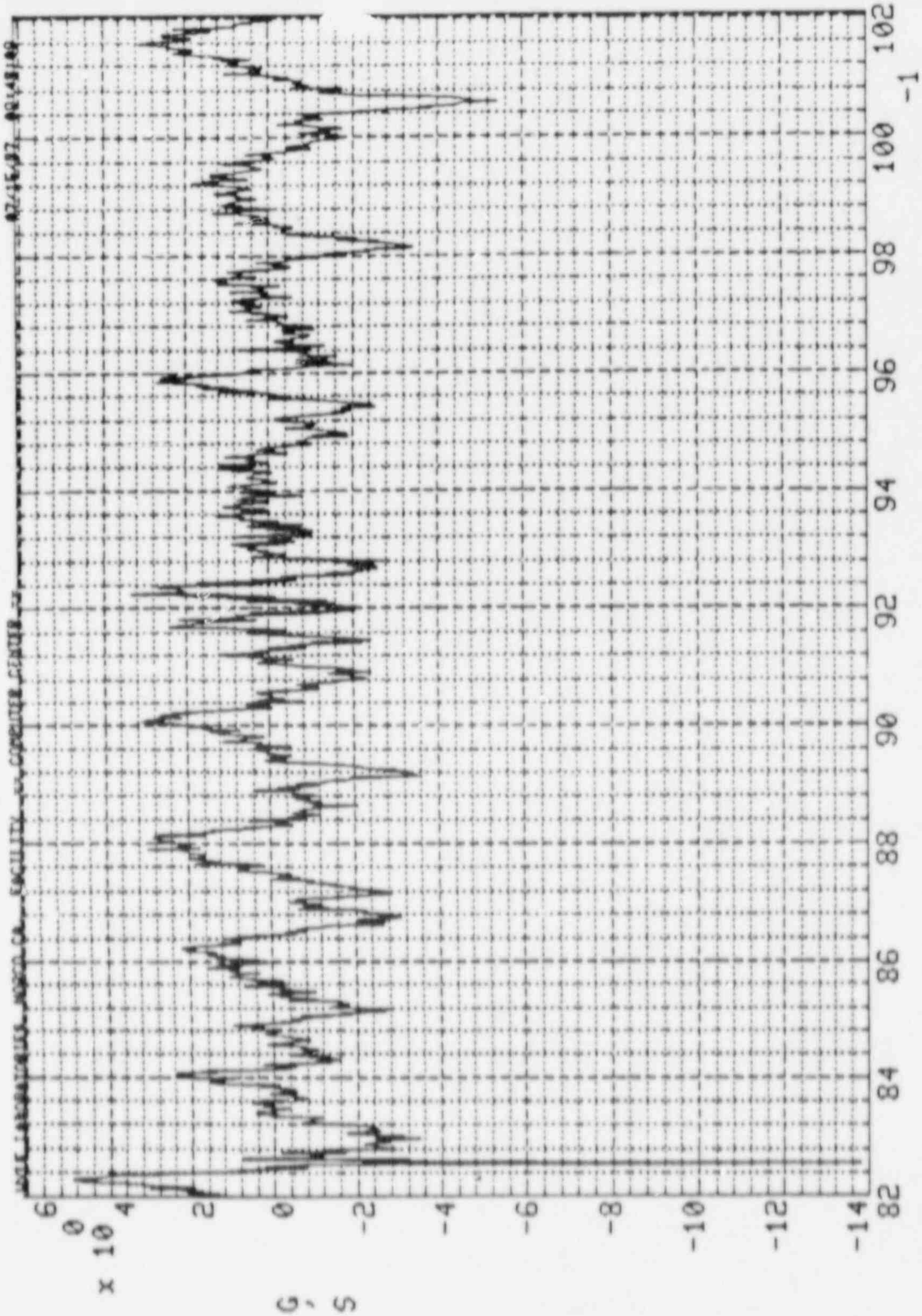
ACC-3-GE TIME HISTORY SEC x10^0

NO FILTER, 1000.00 SPS, TREND REMOVAL ON,

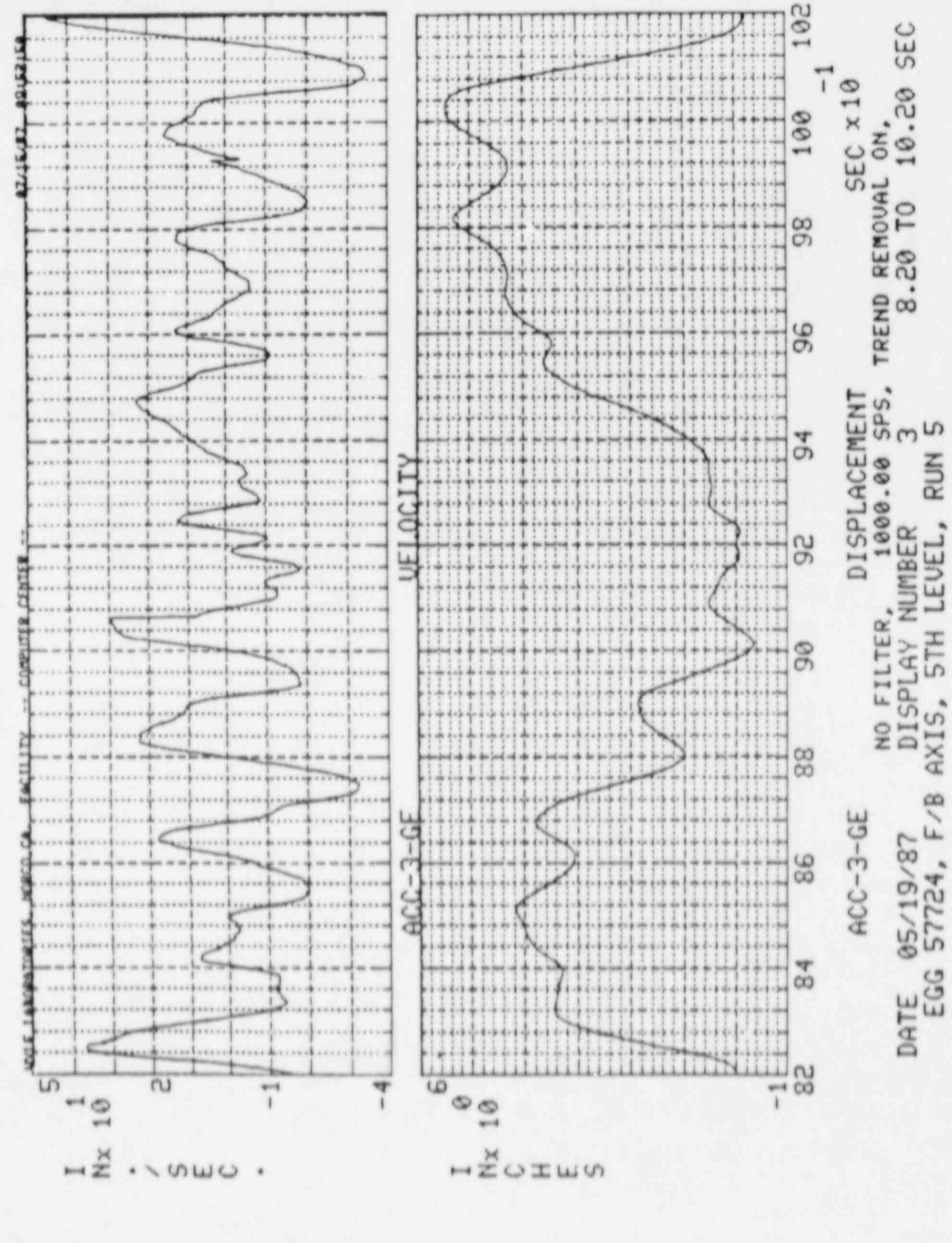
DATE 05/19/87 DISPLAY NUMBER 1 10.00 TO 18.00 SEC

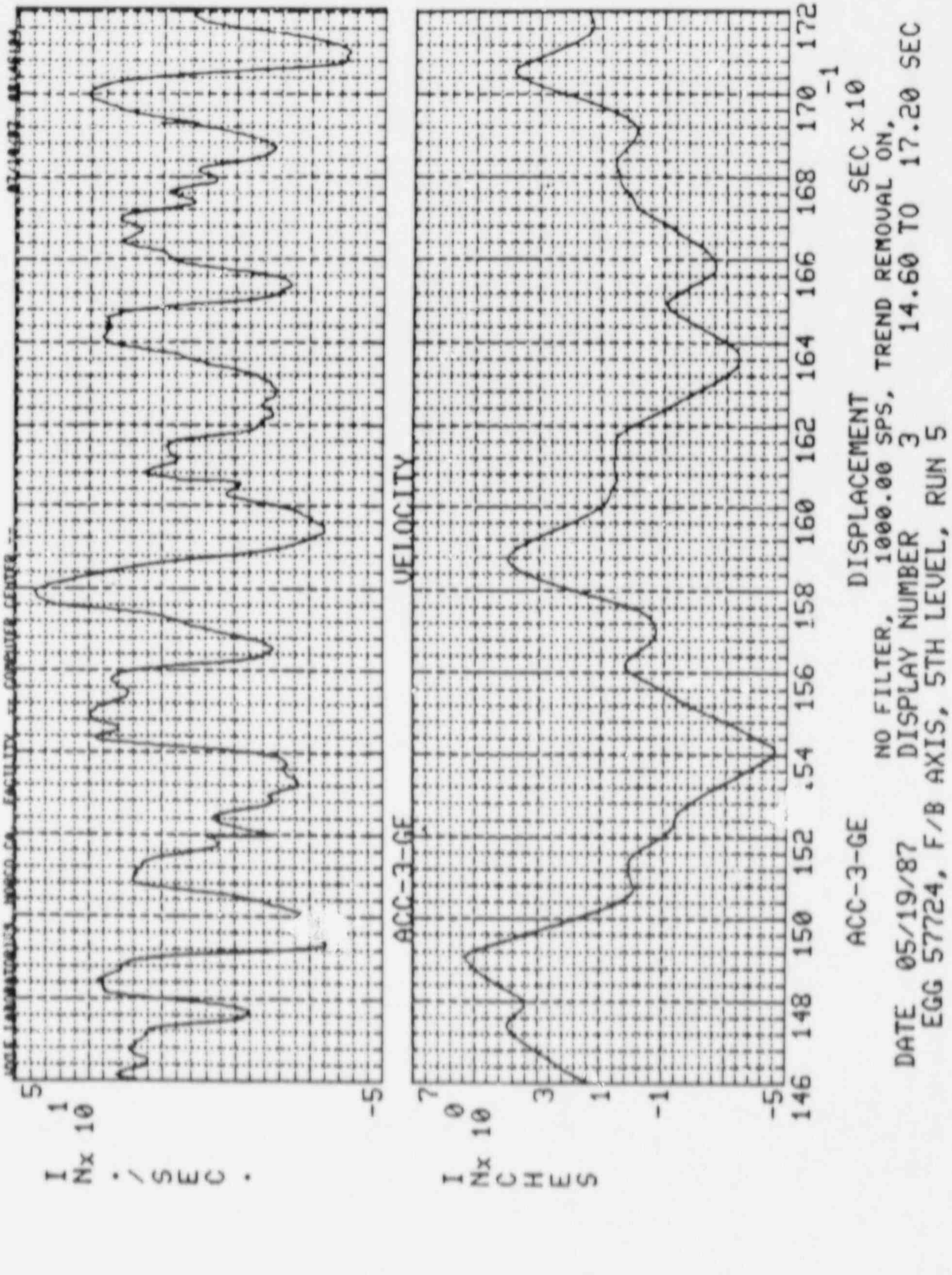
EGG 57724, F/B AXIS, 5TH LEVEL, RUN 5

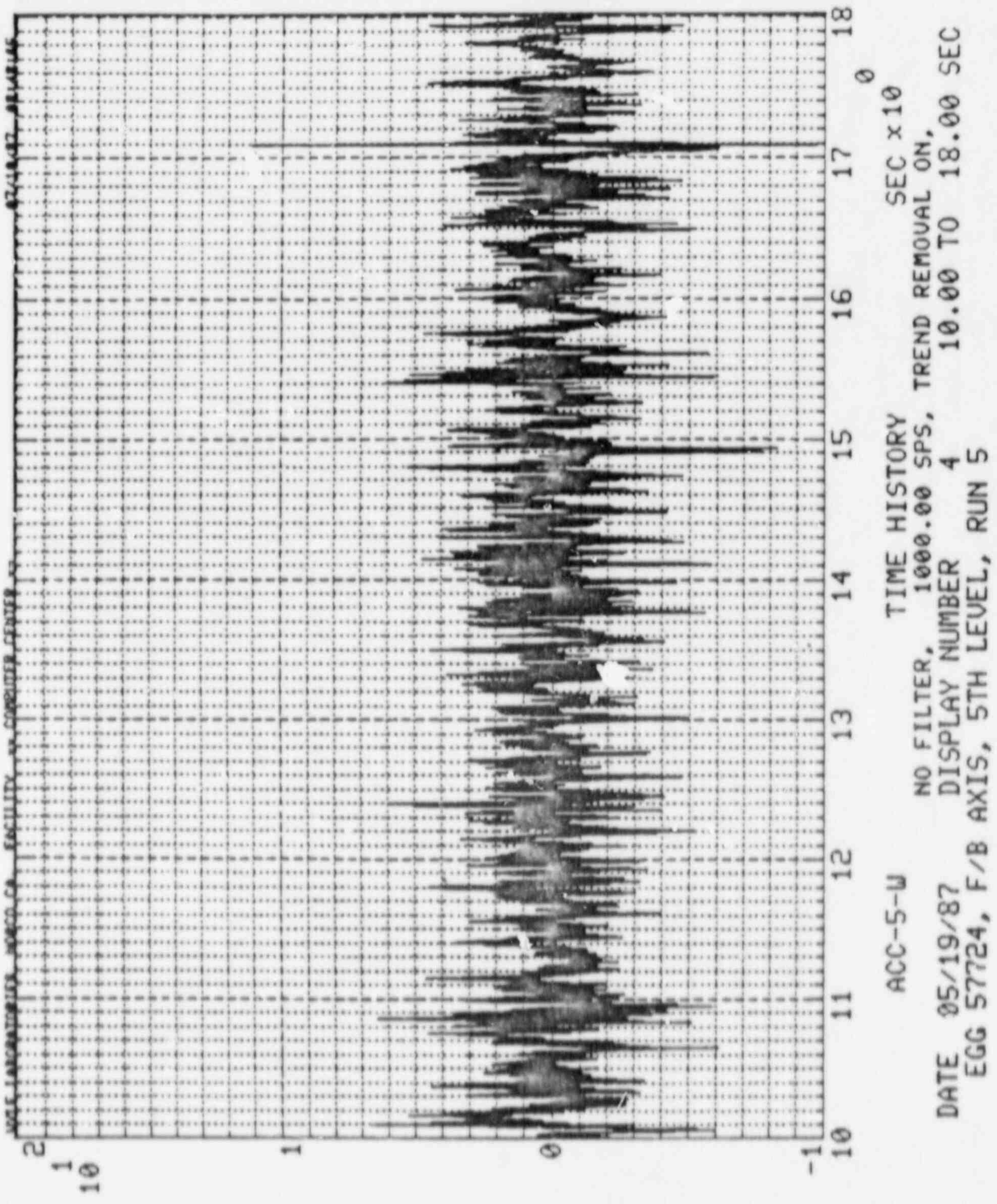

VELOCITY
ACC-3-GE
IN./SEC. x10^1
INCHES x10^0
5
-5
7
-7
10
11
12
13
14
15
16
17
18
SEC x10^0
ACC-3-GE DISPLACEMENT
NO FILTER, 1000.00 SPS, TREND REMOVAL ON,
DATE 05/19/87 DISPLAY NUMBER 2 10.00 TO 18.00 SEC
EGG 57724, F/B AXIS, 5TH LEVEL, RUN 5

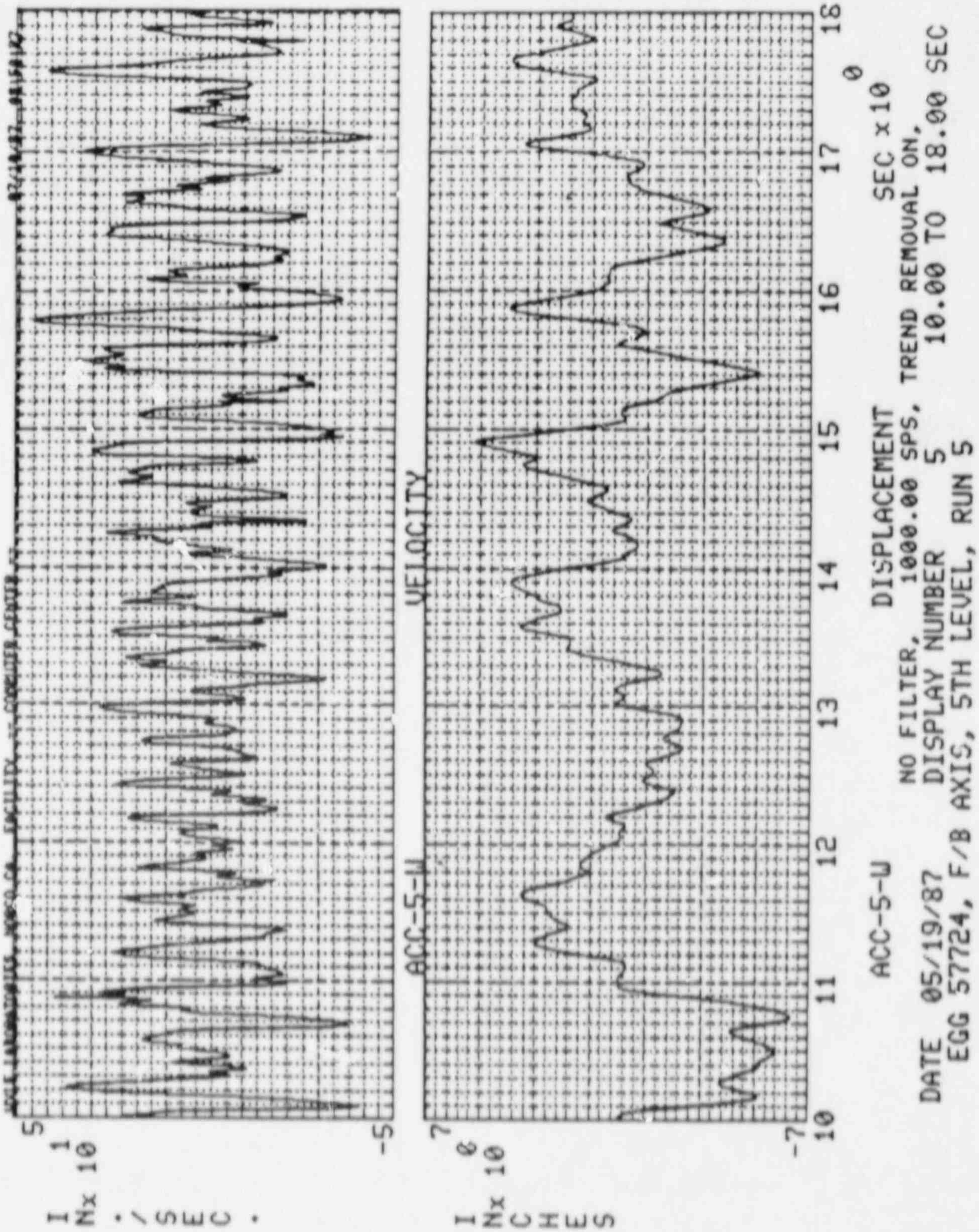


ACC-3-GE TIME HISTORY
NO FILTER, 1000.00 SPS, TREND REMOVAL ON,
DATE 05/19/87 DISPLAY NUMBER 2 8.20 TO 10.20 SEC
EGG 57724, F/B AXIS, 5TH LEVEL, RUN 5


VELOCITY
ACC-3-GE
IN./SEC. x 10^1
5
2
-1
-4
INCHES x 10^0
6
0
-1
82
84
86
88
90
92
94
96
98
100
102
SEC x 10^-1
ACC-3-GE DISPLACEMENT
NO FILTER, 1000.00 SPS, TREND REMOVAL ON,
DATE 05/19/87 DISPLAY NUMBER 3 8.20 TO 10.20 SEC
EGG 57724, F/B AXIS, 5TH LEVEL, RUN 5

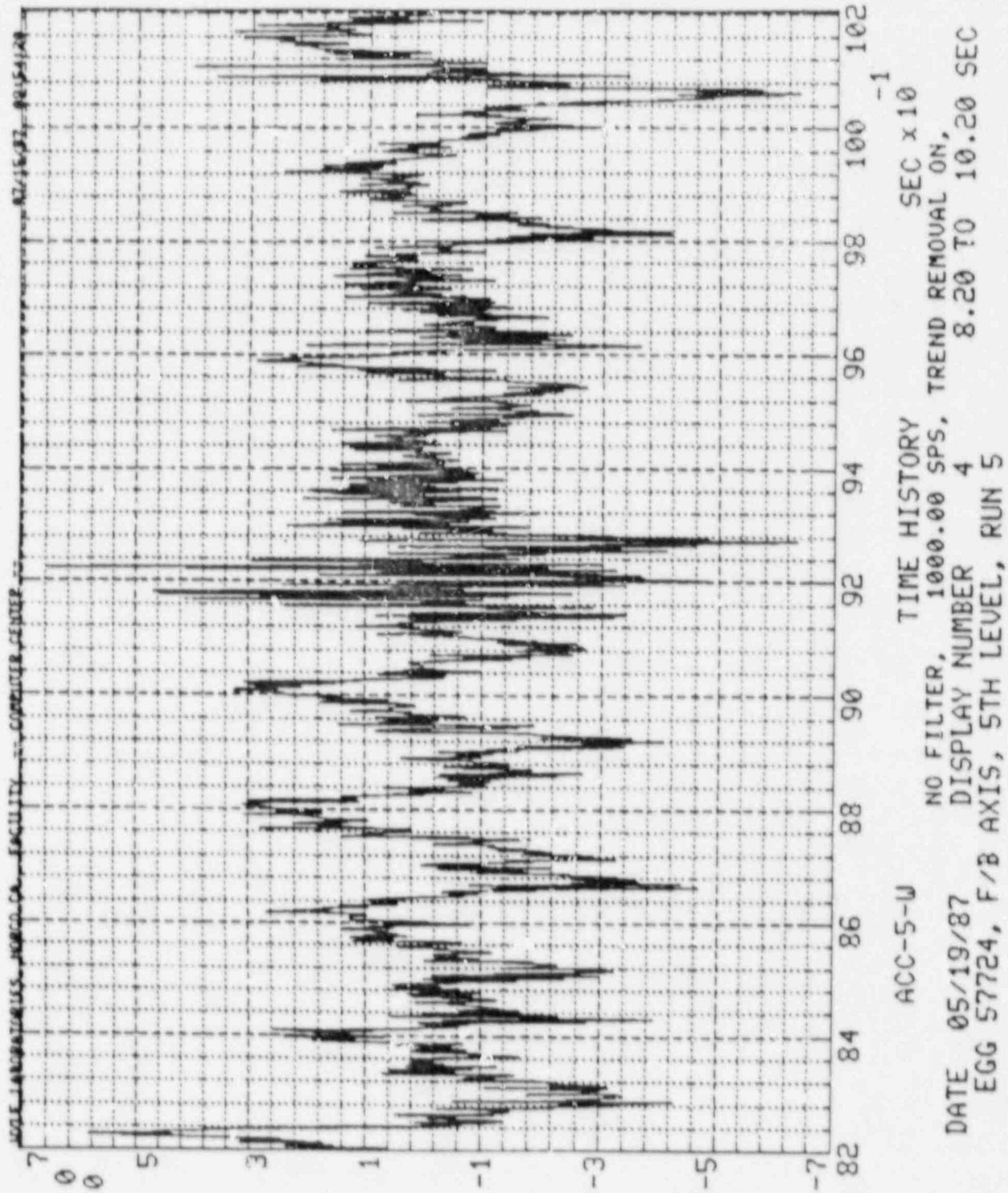

ACC-3-GE DISPLACEMENT
NO FILTER, 1000.00 SPS, TREND REMOVAL ON,
DATE 05/19/87 DISPLAY NUMBER 3 14.60 TO 17.20 SEC
EGG 57724, F/B AXIS, 5TH LEVEL, RUN 5
VELOCITY
ACC-3-GE
SEC x10 -1
INx 10 1 /SEC
INx 10 0 CHES
146 148 150 152 154 156 158 160 162 164 166 168 170 172
5 -5
7 3 1 -1 -5

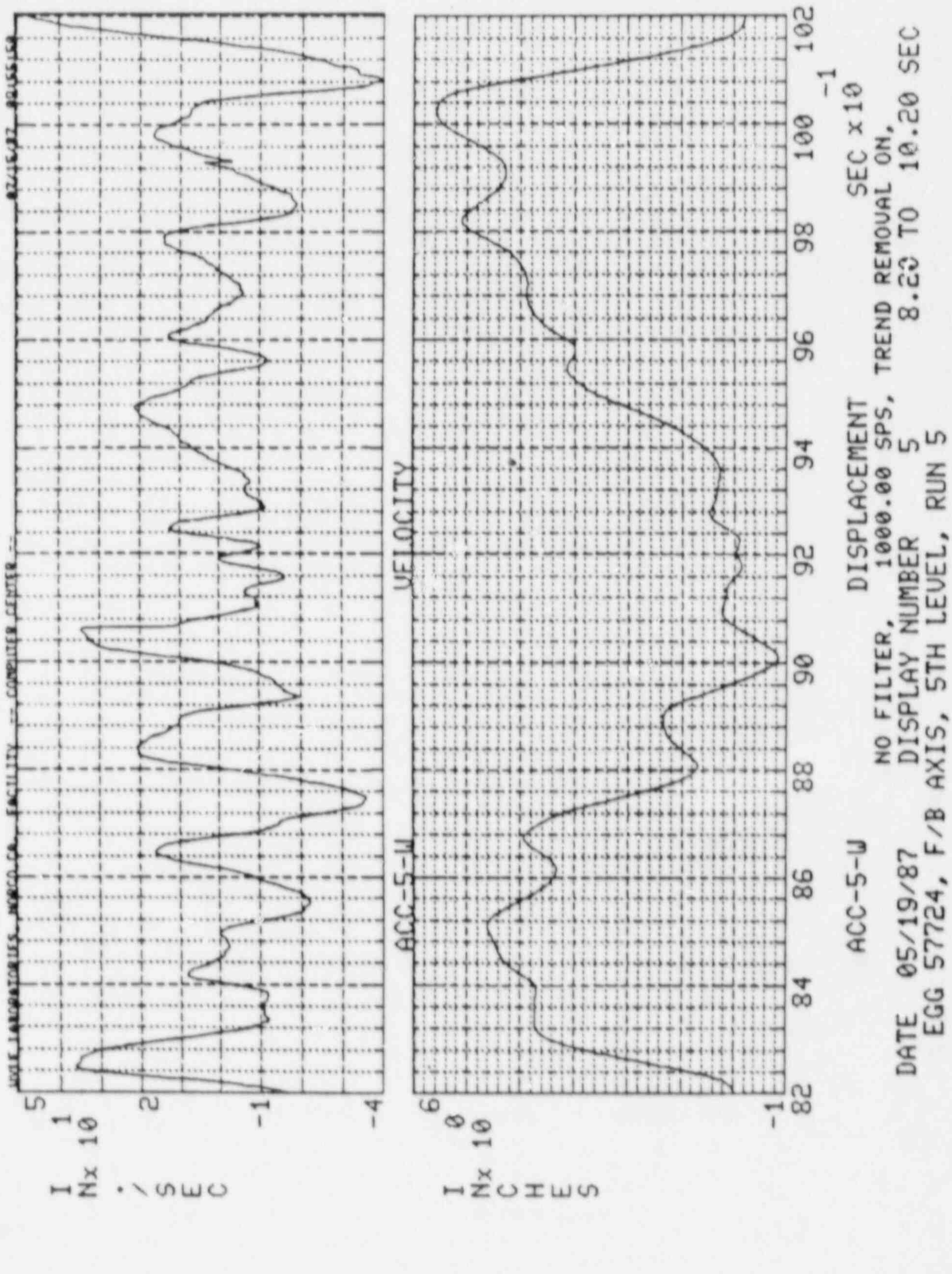

G's x 10^1
2
1
0
-1
10
11
12
13
14
15
16
17
18
SEC x 10^0
ACC-5-W
TIME HISTORY
DATE 05/19/87 NO FILTER, 1000.00 SPS, TREND REMOVAL ON,
DISPLAY NUMBER 4
10.00 TO 18.00 SEC
EGG 57724, F/B AXIS, 5TH LEVEL, RUN 5

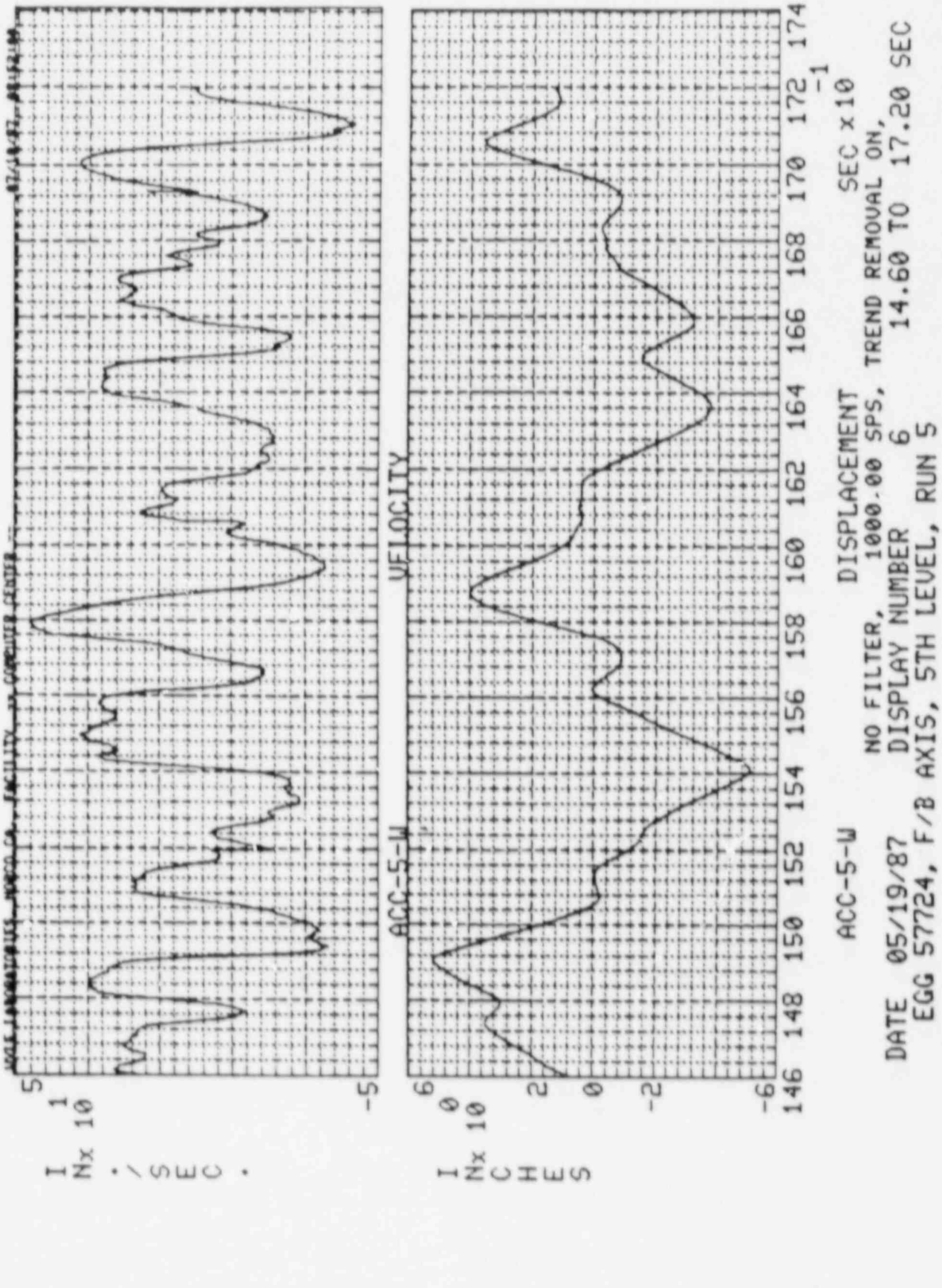

VELOCITY
INCHES/SEC x 10^1
5
-5
DISPLACEMENT
INCHES x 10^0
7
-7
10
11
12
13
14
15
16
17
18
SEC x 10^0
ACC-5-U
ACC-5-U NO FILTER, 1000.00 SPS, TREND REMOVAL ON,
DATE 05/19/87 DISPLAY NUMBER 5 10.00 TO 18.00 SEC
EGG 57724, F/B AXIS, 5TH LEVEL, RUN 5

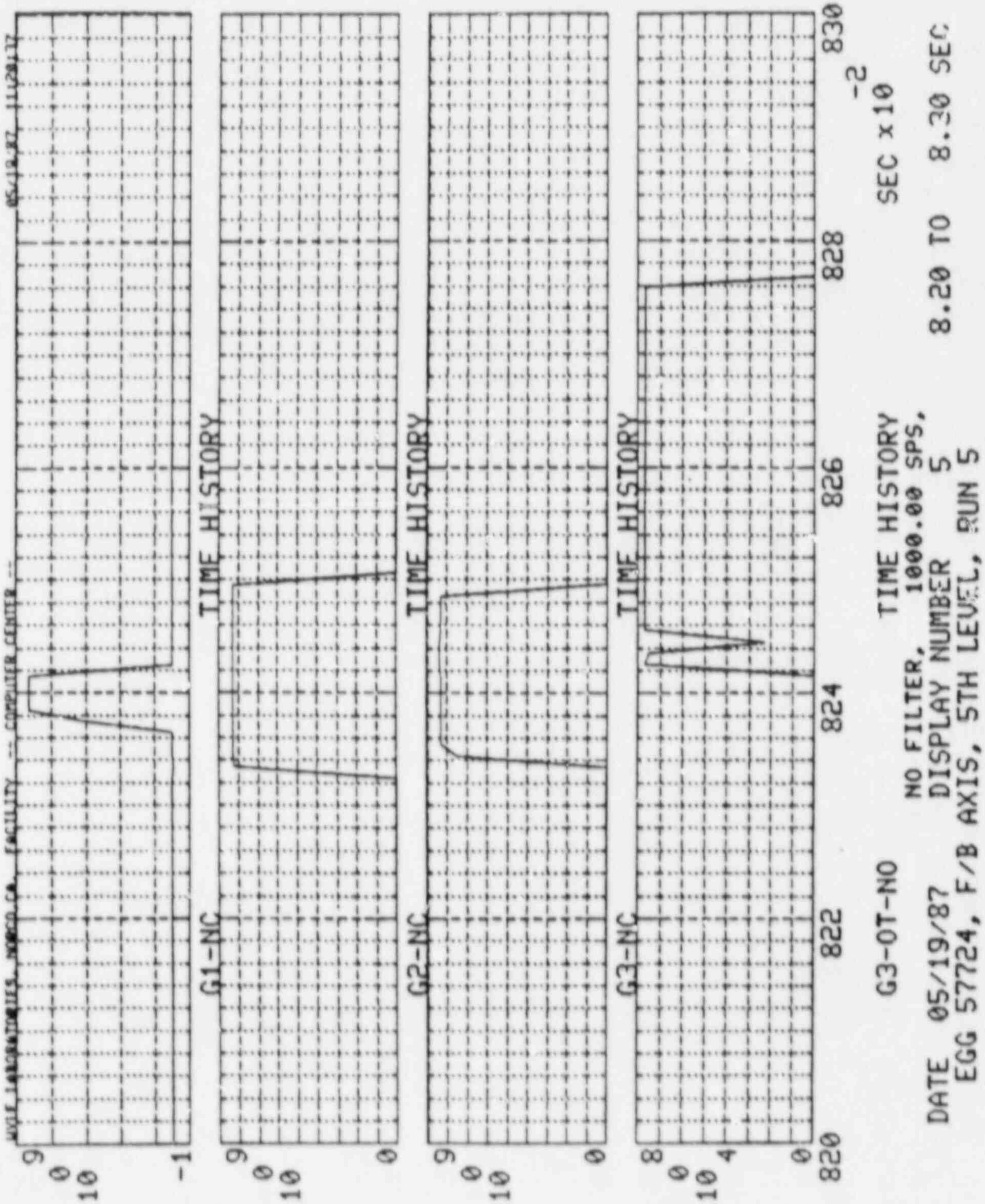
Report No. 57724

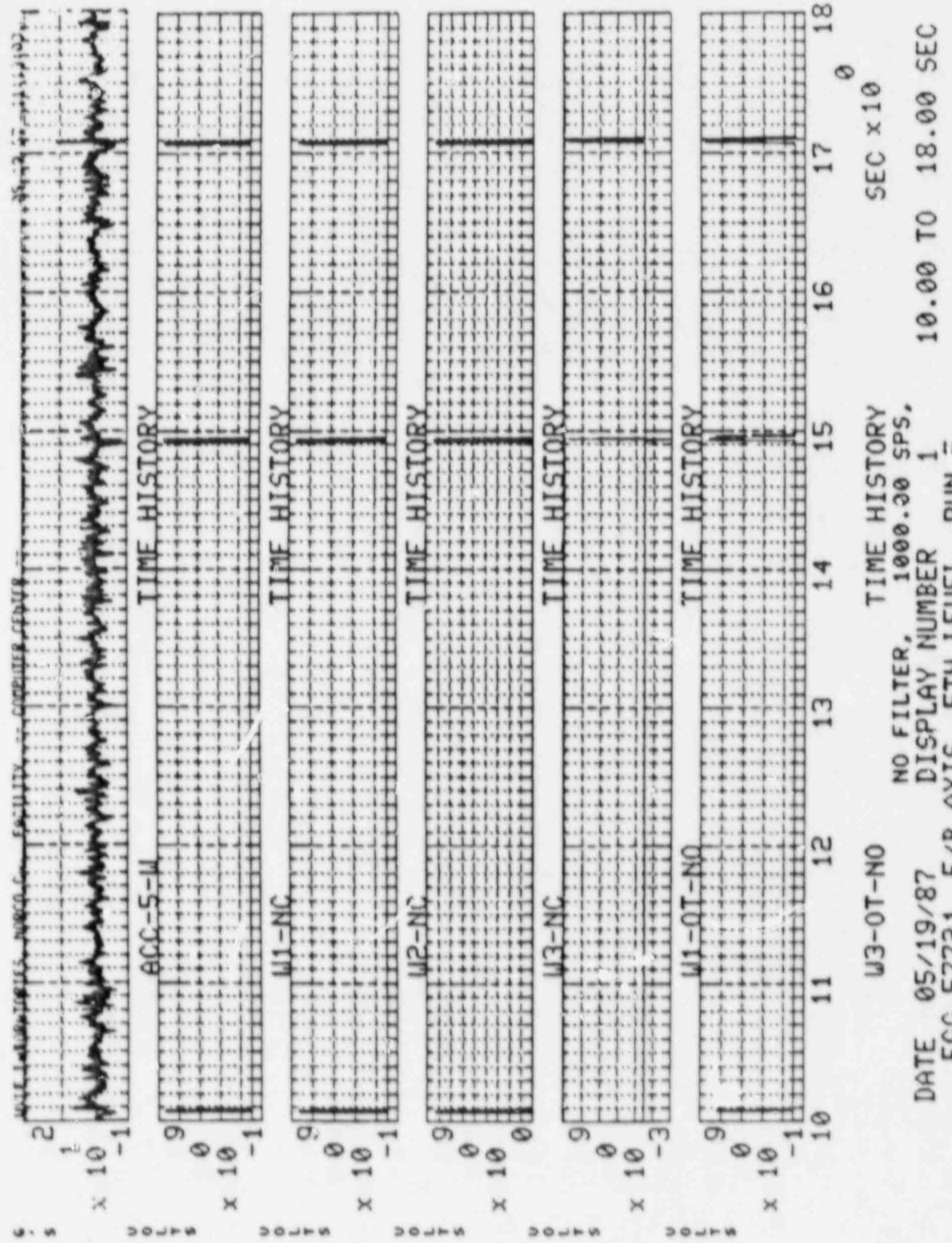
Page No. E-38a

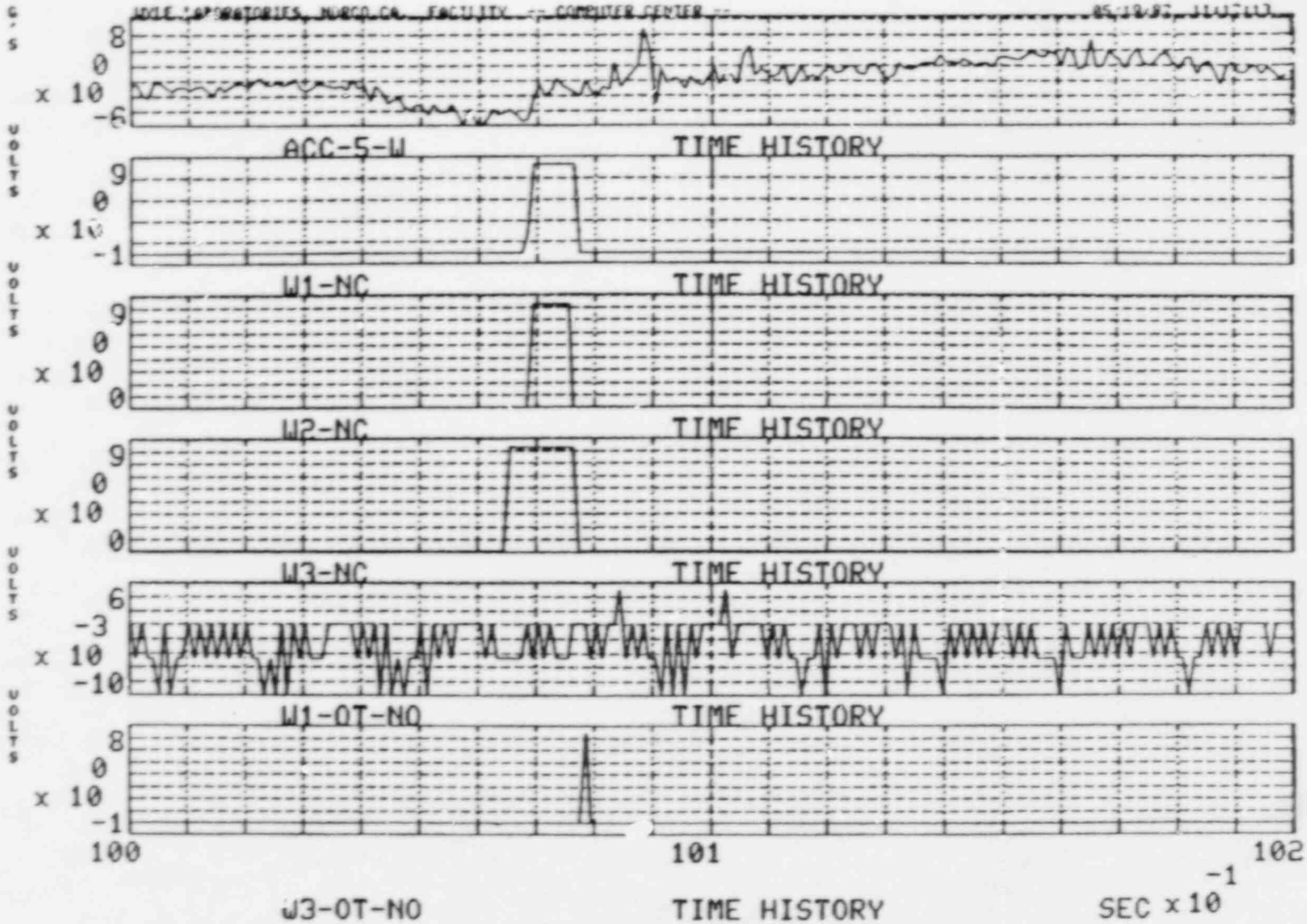



VELOCITY
ACC-5-W
IN/SEC x 10^1
INCHES x 10^0
82
84
86
88
90
92
94
96
98
100
102
ACC-5-W
DISPLACEMENT
SEC x10^-1
NO FILTER, 1000.00 SPS, TREND REMOVAL ON,
DATE 05/19/87 DISPLAY NUMBER 5 8.20 TO 10.20 SEC
EGG 57724, F/B AXIS, 5TH LEVEL, RUN 5


ACC-5-W
VELOCITY
INCHES x 10^0
IN./SEC. x 10^1
SEC x 10^-1
ACC-5-W DISPLACEMENT
NO FILTER, 1000.00 SPS, TREND REMOVAL ON,
DATE 05/19/87 DISPLAY NUMBER 6 14.60 TO 17.20 SEC
EGG 57724, F/B AXIS, 5TH LEVEL, RUN 5


WYLE LABORATORIES, NORCO CA. FACILITY -- COMPUTER CENTER --
G1-NC TIME HISTORY
G2-NC TIME HISTORY
G3-NC TIME HISTORY
VOLTS x 10
820 822 824 826 828 830
SEC x 10^-2
G3-OT-NO NO FILTER, TIME HISTORY 1000.00 SPS,
DATE 05/19/87 DISPLAY NUMBER 5 8.20 TO 8.30 SEC
EGG 57724, F/B AXIS, 5TH LEVEL, RUN 5

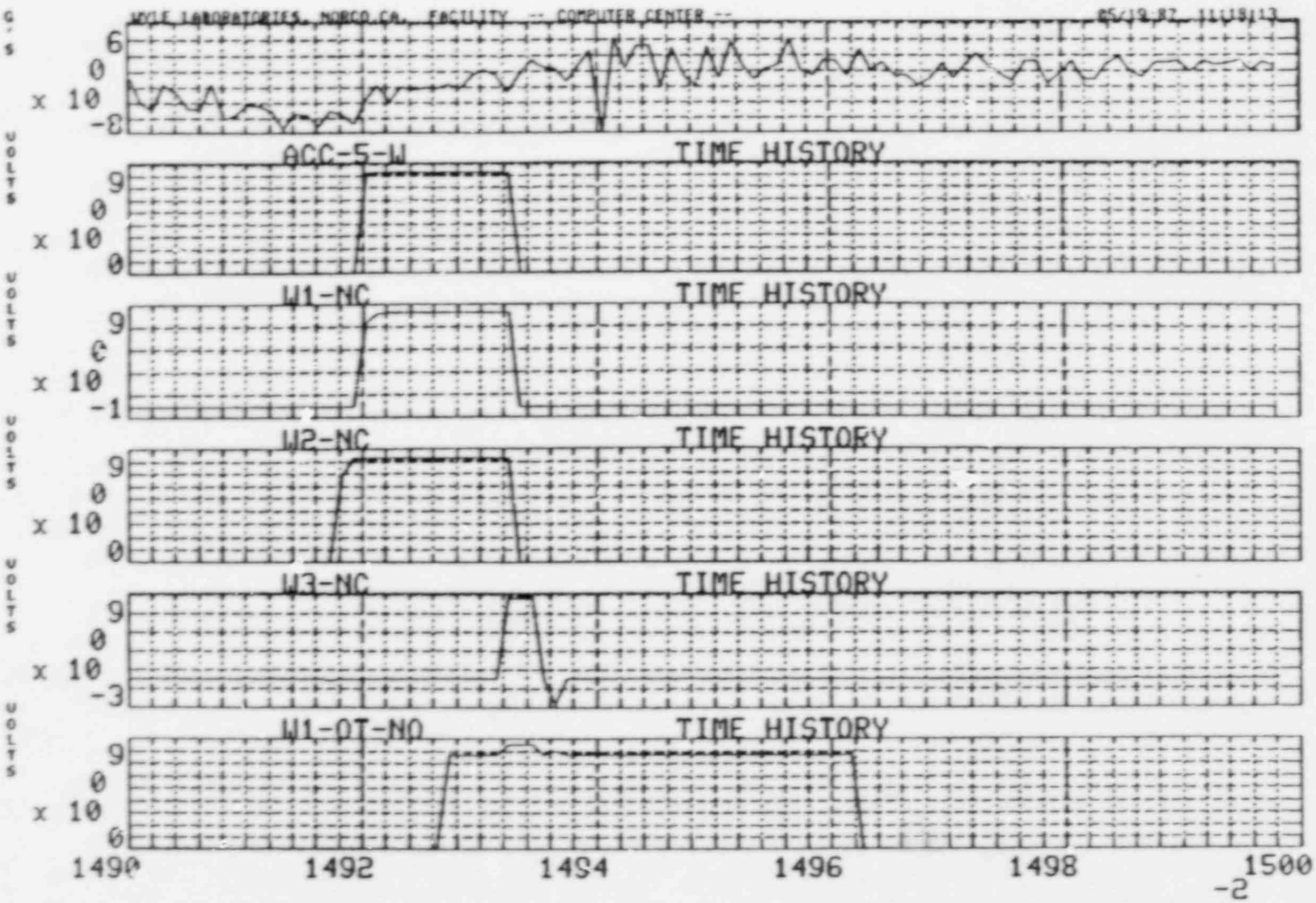

ACC-5-W
W1-NC
W2-NC
W3-NC
W1-OT-NO
TIME HISTORY
SEC x10
W3-OT-NO
TIME HISTORY
NO FILTER, 1000.00 SPS, 10.00 TO 18.00 SEC
DATE 05/19/87 DISPLAY NUMBER 1
EGG 57721, F/B AXIS, 5TH LEVEL, RUN 5



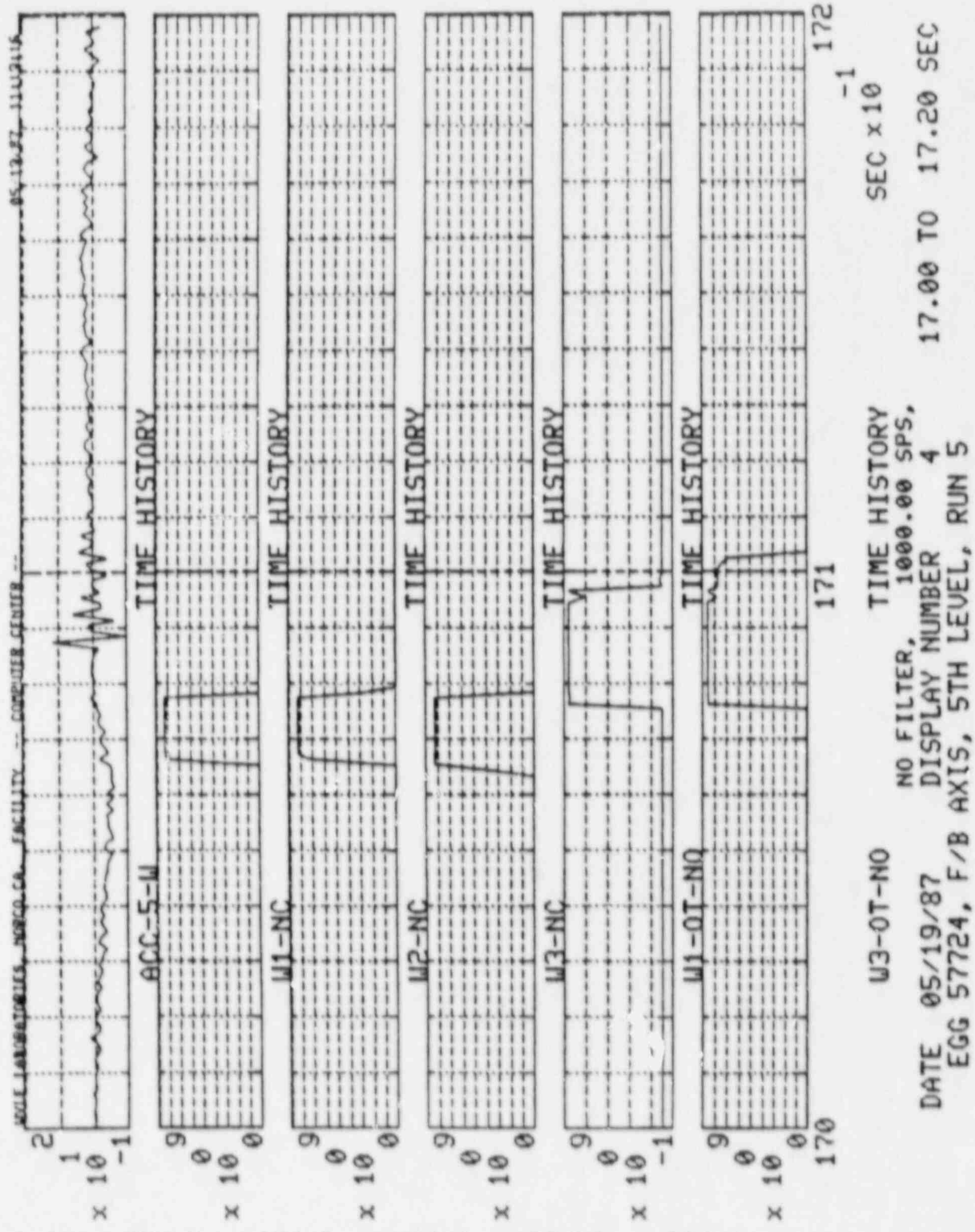
NO FILTER, 1000.00 SPS,

DATE 05/19/87 DISPLAY NUMBER 2 10.00 TO 10.20 SEC

EGG 57724, F/B AXIS, 5TH LEVEL, RUN 5



W3-OT-NO TIME HISTORY SEC x 10^-2
NO FILTER, 1000.00 SPS,
DATE 05/19/87 DISPLAY NUMBER 3 14.90 TO 15.00 SEC
EGG 57724, F/B AXIS, 5TH LEVEL, RUN 5


ACC-5-W TIME HISTORY
W1-NC TIME HISTORY
W2-NC TIME HISTORY
W3-NC TIME HISTORY
W1-OT-NO TIME HISTORY
170
171
172
SEC x 10^-1
W3-OT-NO TIME HISTORY
NO FILTER, 1000.00 SPS, 17.00 TO 17.20 SEC
DATE 05/19/87 DISPLAY NUMBER 4
EGG 57724, F/B AXIS, 5TH LEVEL, RUN 5

CUSTOMER EG & G Job No. 57724 Date 5-19-87

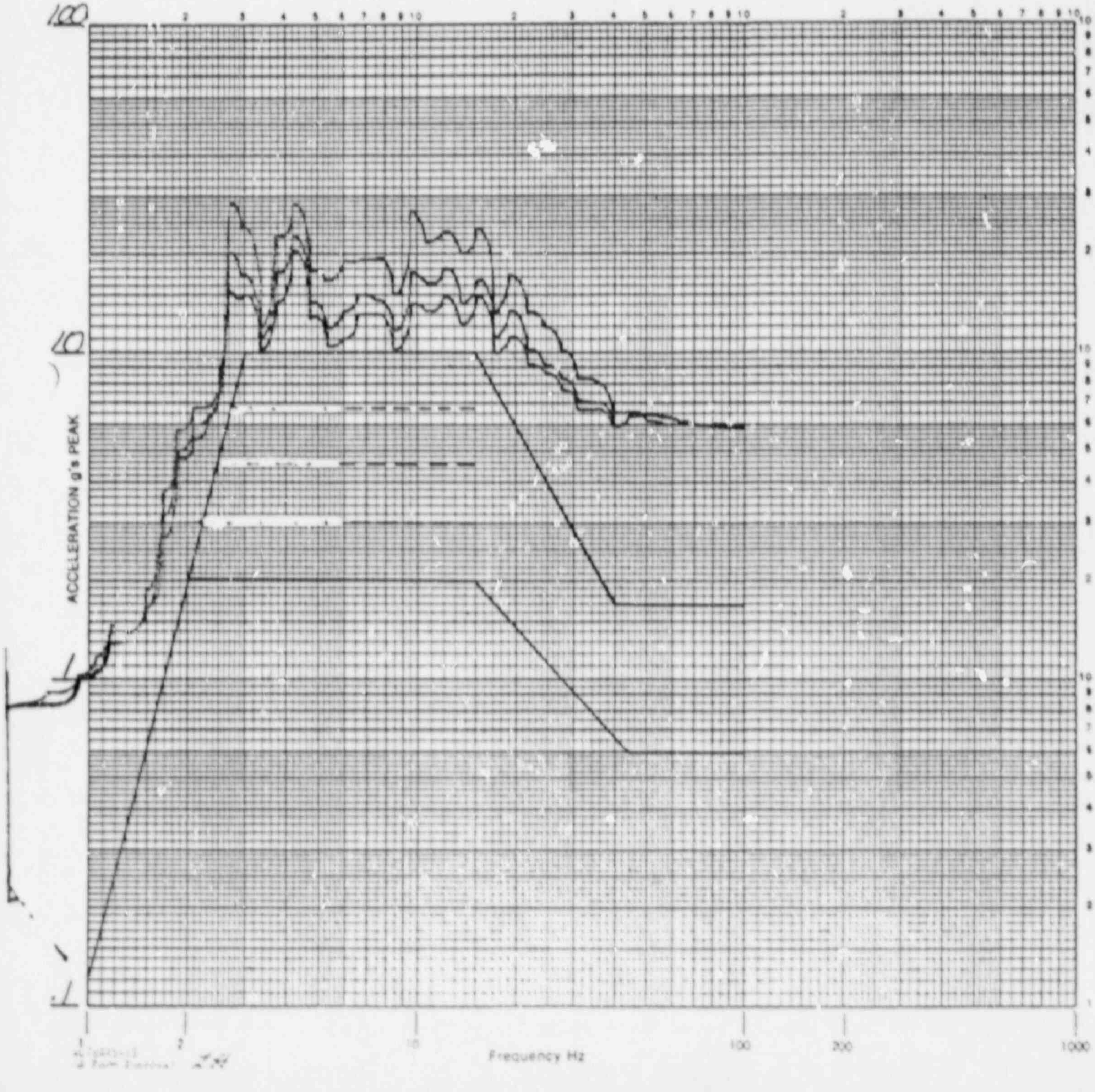
Specimen ELECTRICAL COMPONENTS Axis of Test X

Accel. No. 1 Axis HORIZ Control (✓) Response ( ) OBE ( ) SSE ( ) DBE ( )

Full Scale 100 g Damping 1,(2%),3 % Run No. LOW FREQUENCY RUN #6

Operator BREIERMAN Engineer [signature]

RESPONSE SPECTRUM



WYLE LABORATORIES,NORCO,CA. FACILITY   CHATTER AND PULSE ANALYSIS PROGRAM   05/19/87 11:31:19 HOURS   PAGE 1

START TIME= 0.0000   STOP TIME= 21.216

TEST NAME=EGG 57724, F/B AXIS, 5TH LEVEL, RUN 6, ENERGIZED
TEST DATE=05/19/87 11:28:11 HOURS

CHANNEL ID	CHANNEL NUMBER	FIRST CHATTER	LAST CHATTER	STATE CHANGE	NUMBER OF CHATTER FAILURES PER TIME LENGTH 2.00-5.00	5.00-10.0	10.0-20.0	20.0-40.0	40.0-80.0	>80.0	TOTAL
W1-NC	2			0	NO CHATTER						
W1-NO	3			0	NO CHATTER						
W2-NC	4			0	NO CHATTER						
W2-NO	6			0	NO CHATTER						
W3-NC	7			0	NO CHATTER						
W3-NO	8			0	NO CHATTER						
G1-NC	10			0	NO CHATTER						
G1-NO	11			0	NO CHATTER						
G2-NC	12			0	NO CHATTER						
G2-NO	13			0	NO CHATTER						
G3-NC	14			0	NO CHATTER						
G3-NO	15			0	NO CHATTER						
W1-OT-NO	16			0	NO CHATTER						
W2-OT-NO	17			0	NO CHATTER						
W3-OT-NO	18			0	NO CHATTER						
G1-OT-NO	19			0	NO CHATTER						
G2-OT-NO	20			0	NO CHATTER						
G3-OT-NO	21			0	NO CHATTER						
	22			0	NO CHATTER						
										TOTAL=	0

WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

CUSTOMER EG & G Job No. 57724 Date 5-19-87

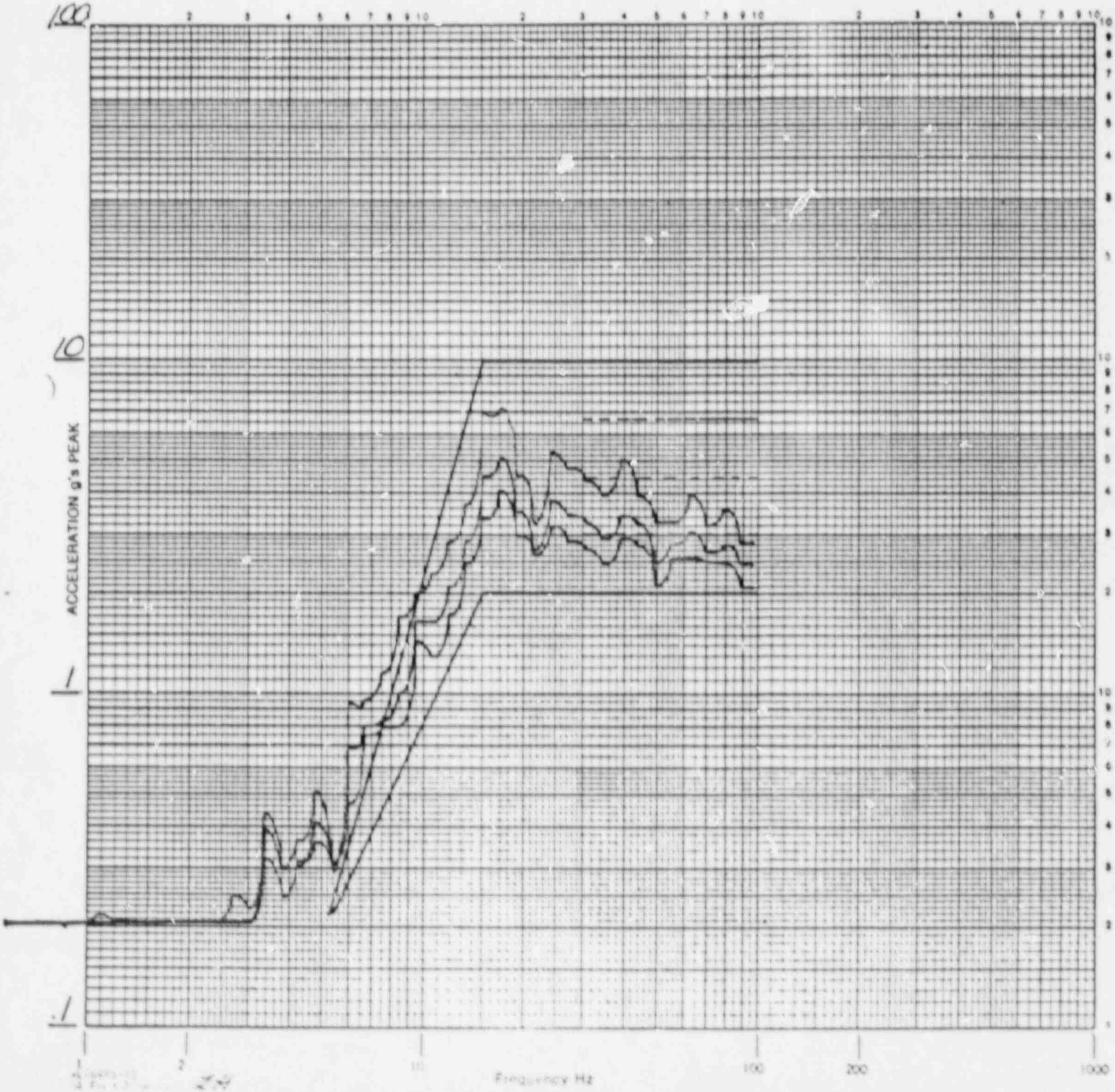
Specimen ELECTRONIC COMPONENTS Axis of Test X

Accel. No. 1 Axis Horiz Control (✓) Response ( ) OBE ( ) SSE ( ) DBE ( )

Full Scale 100 g Damping (2%),3 % Run No HIGH FREQUENCY RUN #7

Operator GREIERMAN Engineer [signature]

RESPONSE SPECTRUM



START TIME= 0.0000   STOP TIME= 21.528

TEST NAME=EGG 57724, F/B AXIS, 1ST LEVEL HI FREQ. RUN 7, DENERGIZED
TEST DATE=05/19/87 13:18:18 HOURS

CHANNEL ID	CHANNEL NUMBER	FIRST CHATTER	LAST CHATTER	STATE CHANGE	NUMBER OF CHATTER FAILURES PER TIME LENGTH 2.00-5.00	5.00-10.0	10.0-20.0	20.0-40.0	40.0-80.0	>80.0	TOTAL
W1-NC	2			0	NO CHATTER						
W1-NO	3			0	NO CHATTER						
W2-NC	4			0	NO CHATTER						
W2-NO	6			0	NO CHATTER						
W3-NC	7			0	NO CHATTER						
W3-NO	8			0	NO CHATTER						
G1-NC	10			0	NO CHATTER						
G1-NO	11			0	NO CHATTER						
G2-NC	12			0	NO CHATTER						
G2-NO	13			0	NO CHATTER						
G3-NC	14			0	NO CHATTER						
G3-NO	15			0	NO CHATTER						
W1-OT-NO	16			0	NO CHATTER						
W2-OT-NO	17			0	NO CHATTER						
W3-OT-NO	18			0	NO CHATTER						
G1-OT-NO	19			0	NO CHATTER						
G2-OT-NO	20			0	NO CHATTER						
G3-OT-NO	21			0	NO CHATTER						
	22			0	NO CHATTER						
										TOTAL=	0

WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

CUSTOMER EG & G Job No. 57724 Date 5-19-87

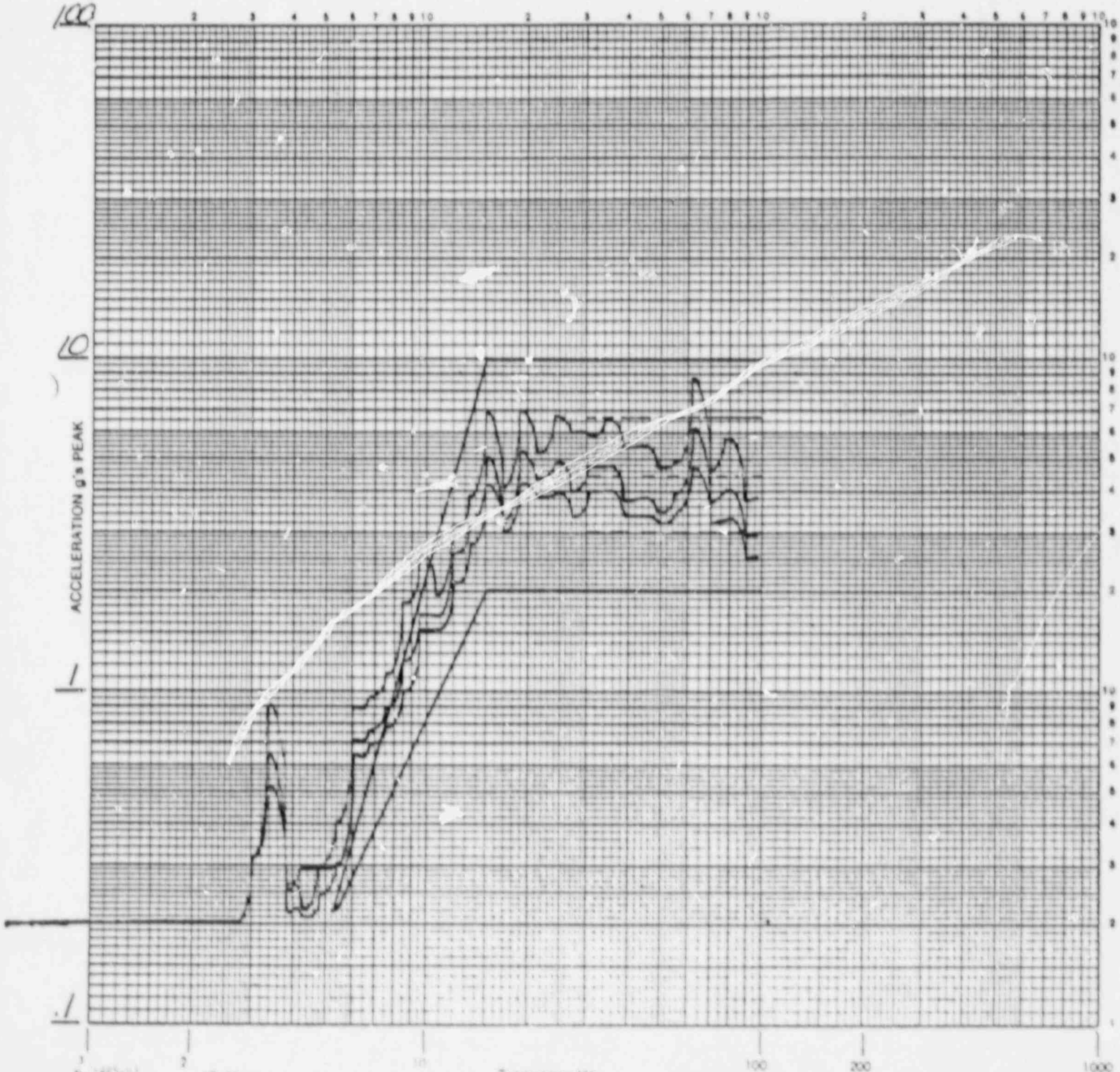
Specimen ELECTRONIC COMPONENTS Axis of Test X

Accel. No. 1 Axis HORIZ Control (✓) Response ( ) CBE ( ) SSE ( ) DBE ( )

Full Scale 100 g Damping 1,(2%),3 % Run No HIGH FREQUENCY Run #8

Operator BREIERMAN Engineer [initials]

RESPONSE SPECTRUM



WYLE LABORATORIES,NORCO,CA. FACILITY CHATTER AND PULSE ANALYSIS PROGRAM 05/19/87 13:31:18 HOURS PAGE 1

START TIME= 0.0000 STOP TIME= 21.840

TEST NAME=EGG 57724, F/B AXIS, 2ND LEVEL HI FREQ. RUN 8, DENERGIZED
TEST DATE=05/19/87 13:27:26 HOURS

CHANNEL ID	CHANNEL NUMBER	FIRST CHATTER	LAST CHATTER	STATE CHANGE	NUMBER OF CHATTER FAILURES PER TIME LENGTH 2.00-5.00	5.00-10.0	10.0-20.0	20.0-40.0	40.0-80.0	>80.0	TOTAL
W1-NC	2			0	NO CHATTER						
W1-NO	3			0	NO CHATTER						
W2-NC	4			0	NO CHATTER						
W2-NO	6			0	NO CHATTER						
W3-NC	7			0	NO CHATTER						
W3-NO	8			0	NO CHATTER						
G1-NC	10			0	NO CHATTER						
G1-NO	11			0	NO CHATTER						
G2-NC	12			0	NO CHATTER						
G2-NO	13			0	NO CHATTER						
G3-NC	14			0	NO CHATTER						
G3-NO	15			0	NO CHATTER						
W1-OT-NO	16			0	NO CHATTER						
W2-OT-NO	17			0	NO CHATTER						
W3-OT-NO	18			0	NO CHATTER						
G1-OT-NO	19			0	NO CHATTER						
G2-OT-NO	20			0	NO CHATTER						
G3-OT-NO	21			0	NO CHATTER						
	22			0	NO CHATTER						
										TOTAL=	6

CUSTOMER EG & G Job No. 57724 Date 5-19-87

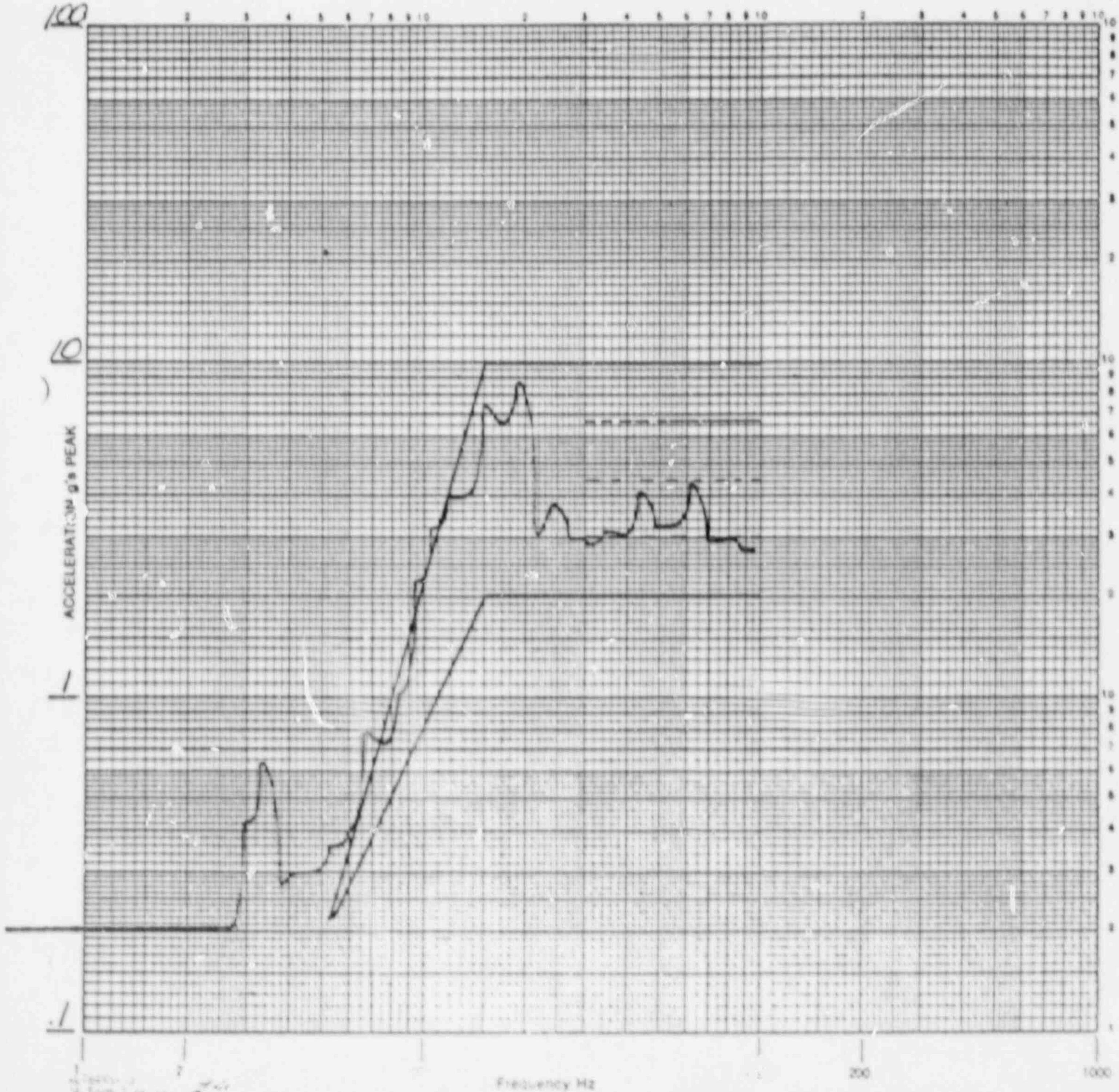
Specimen ELECTRONIC COMPONENTS Axis of Test X

Accel. No. 1 Axis HORIZ Control (✓) Response ( ) OBE ( ) SSE ( ) DBE ( )

Full Scale 100 g Damping 1,(2%),3 % Run No HIGH FREQUENCY Run # 9

Operator GRÉTERMAN Engineer [illegible]

RESPONSE SPECTRUM



WYLE LABORATORIES,NORCO,CA. FACILITY CHATTER AND PULSE ANALYSIS PROGRAM 05/19/87 13:39:33 HOURS PAGE 1

START TIME- 0.0000 STOP TIME- 20.904

TEST NAME-EGG 57724, F/B AXIS, 3RD LEVEL HI FREQ. RUN 9, DENERGIZED
TEST DATE-05/19/87 13:37:23 HOURS

CHANNEL ID	CHANNEL NUMBER	FIRST CHATTER	LAST CHATTER	STATE CHANGE	NUMBER OF CHATTER FAILURES PER TIME LENGTH 2.00-5.00	5.00-10.0	10.0-20.0	20.0-40.0	40.0-80.0	>80.0	TOTAL
W1-NC	2			0	NO CHATTER						
W1-NO	3			0	NO CHATTER						
W2-NC	4			0	NO CHATTER						
W2-NO	6			0	NO CHATTER						
W3-NC	7			0	NO CHATTER						
W3-NO	8			0	NO CHATTER						
G1-NC	10			0	NO CHATTER						
G1-NO	11			0	NO CHATTER						
G2-NC	12			0	NO CHATTER						
G2-NO	13			0	NO CHATTER						
G3-NC	14			0	NO CHATTER						
G3-NO	15			0	NO CHATTER						
W1-OT-NO	16			0	NO CHATTER						
W2-OT-NO	17			0	NO CHATTER						
W3-OT-NO	18			0	NO CHATTER						
G1-OT-NO	19			0	NO CHATTER						
G2-OT-NO	20			0	NO CHATTER						
G3-OT-NO	21			0	NO CHATTER						
	22			0	NO CHATTER						
										TOTAL-	0

WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

CUSTOMER EG & G Job No. 57724 Date 5-19-87

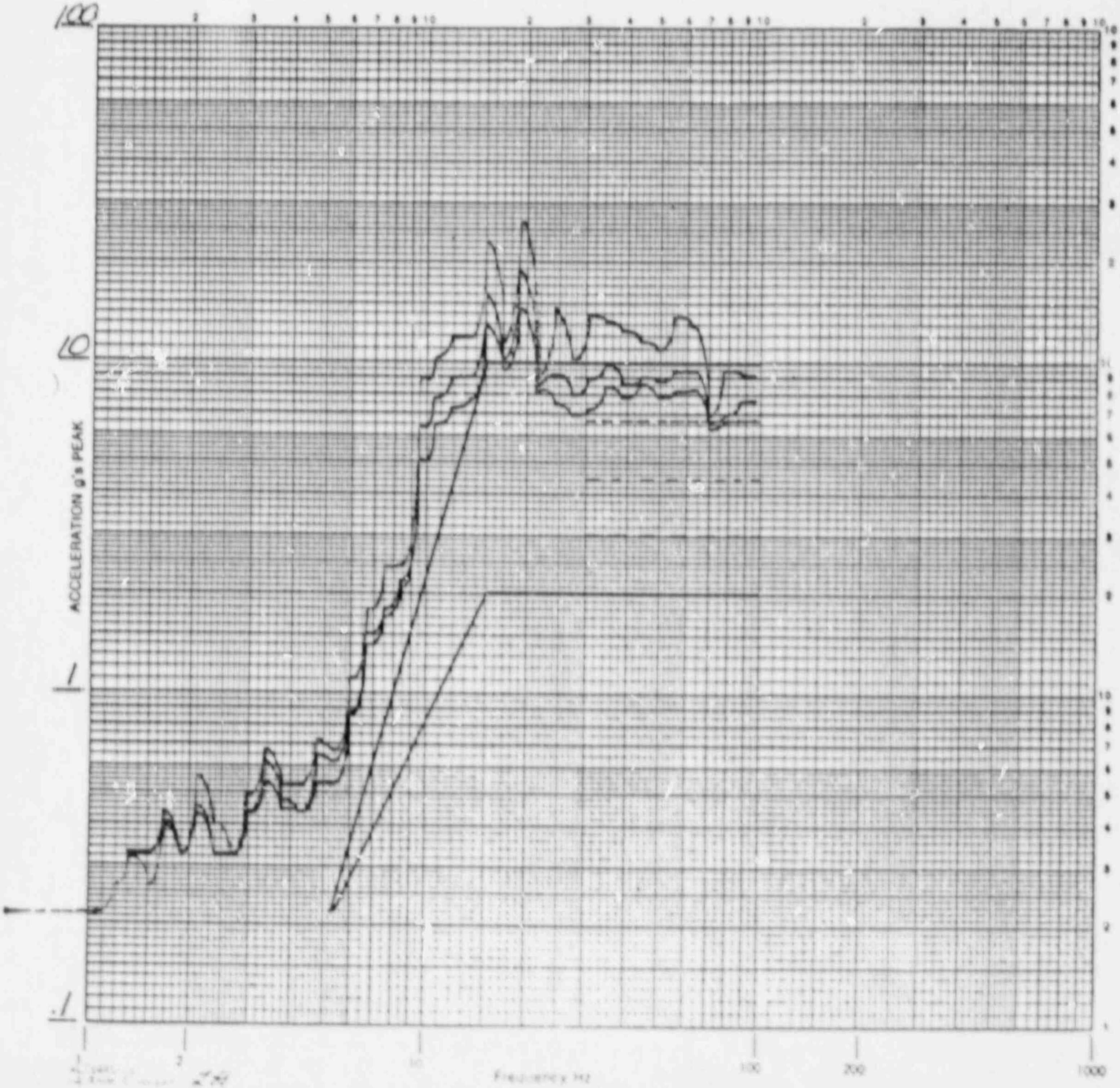
Specimen ELECTRONIC COMPONENTS Axis of Test X

Accel. No. 1 Axis Horiz Control (✓) Response ( ) OBE ( ) SSE ( ) DBE ( )

Full Scale 100 g Damping 1, (2%), 3 % Run No HIGH FREQUENCY Run #10

Operator Breiterman Engineer [initials]

RESPONSE SPECTRUM



START TIME- 0.0000 STOP TIME- 19.656

TEST NAME-EGG 57724, F/B AXIS, 4TH LEVEL HI FREQ. RUN 10,DENERGIZED
TEST DATE-05/19/87 13:45:57 HOURS

CHANNEL ID	CHANNEL NUMBER	FIRST CHATTER	LAST CHATTER	STATE CHANGE	NUMBER OF CHATTER FAILURES PER TIME LENGTH 2.00-5.00	5.00-10.0	10.0-30.0	20.0-40.0	40.0-80.0	>80.0	TOTAL
W1-NC	2			0	NO CHATTER						
W1-NO	3			0	NO CHATTER						
W2-NC	4			0	NO CHATTER						
W2-NO	6			0	NO CHATTER						
W3-NC	7			0	NO CHATTER						
W3-NO	8			0	NO CHATTER						
G1-NC	10			0	NO CHATTER						
G1-NO	11			0	NO CHATTER						
G2-NC	12			0	NO CHATTER						
G2-NO	13			0	NO CHATTER						
G3-NC	14			0	NO CHATTER						
G3-NO	15			0	NO CHATTER						
W1-OT-NO	16			0	NO CHATTER						
W2-OT-NO	17			0	NO CHATTER						
W3-OT-NO	18			0	NO CHATTER						
G1-OT-NO	19			0	NO CHATTER						
G2-OT-NO	20			0	NO CHATTER						
G3-OT-NO	21			0	NO CHATTER						
	22			0	NO CHATTER						
										TOTAL-	0

CUSTOMER EG & G Job No. 57724 Date 5-19-87

Specimen ELECTRONIC COMPONENTS Axis of Test X

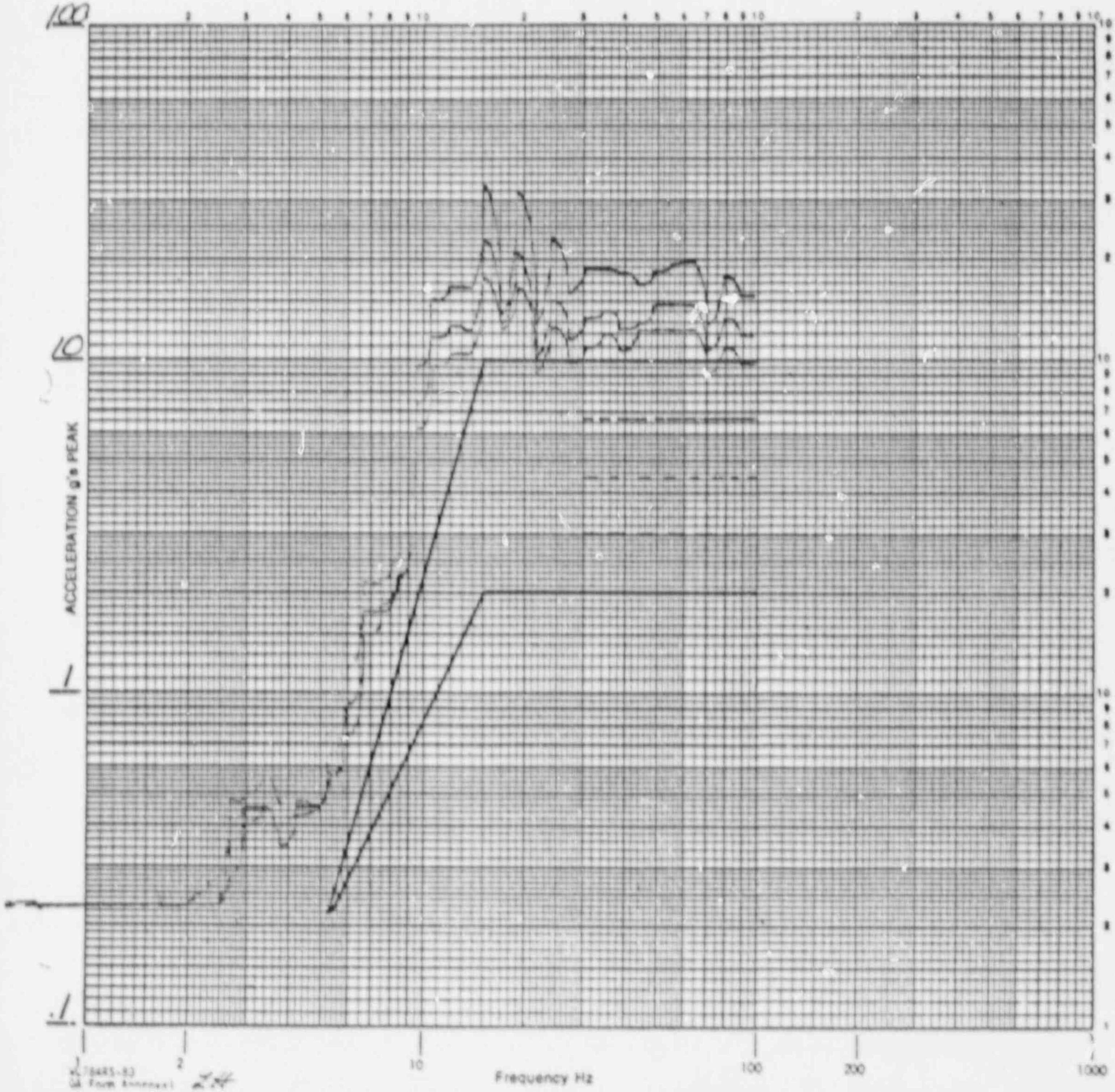
Accel. No. 1 Axis HORIZ Control (✓) Response ( ) OBE ( ) SSE ( ) DBE ( )

Full Scale 100 g Damping 1,(2%),3 %

Run No HIGH FREQUENCY RUN #11-2

Operator BETTERMAN Engineer

RESPONSE SPECTRUM



WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

CUSTOMER EG+G Job No. 57724 Date 5-19-87

Specimen RELAY Axis of Test X

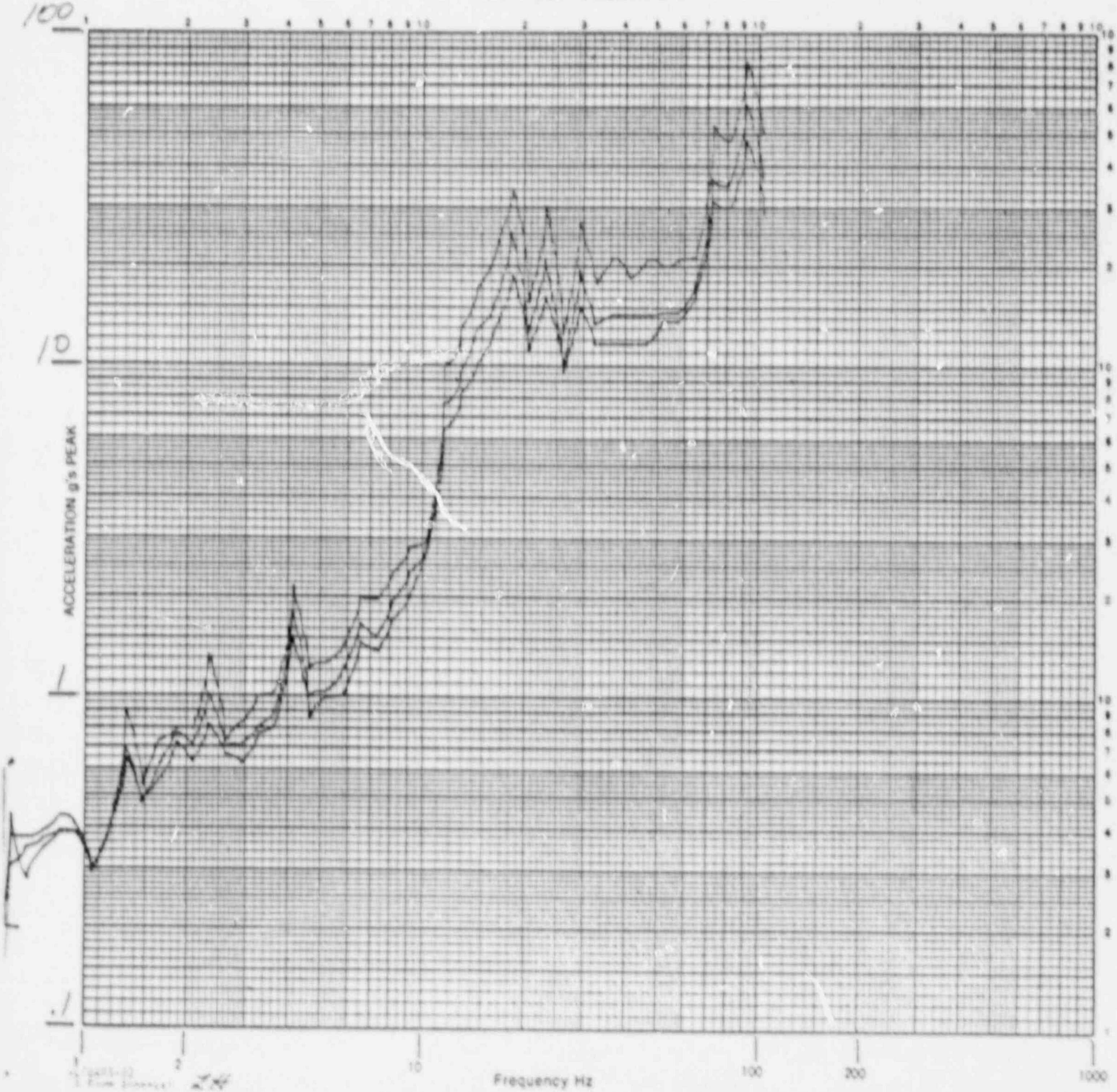
Accel. No. 3 Axis ____ Control ( ) Response (✓) OBE ( ) SSE ( ) DBE ( )

Full Scale 100 g Damping 2 % Run No. 11-2

Operator BG Engineer R Kellum

LEVEL 5
HIGH FREQ.

RESPONSE SPECTRUM



WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

CUSTOMER EG+G Job No. 57724 Date 5-19-87

Specimen RELAY Axis of Test X

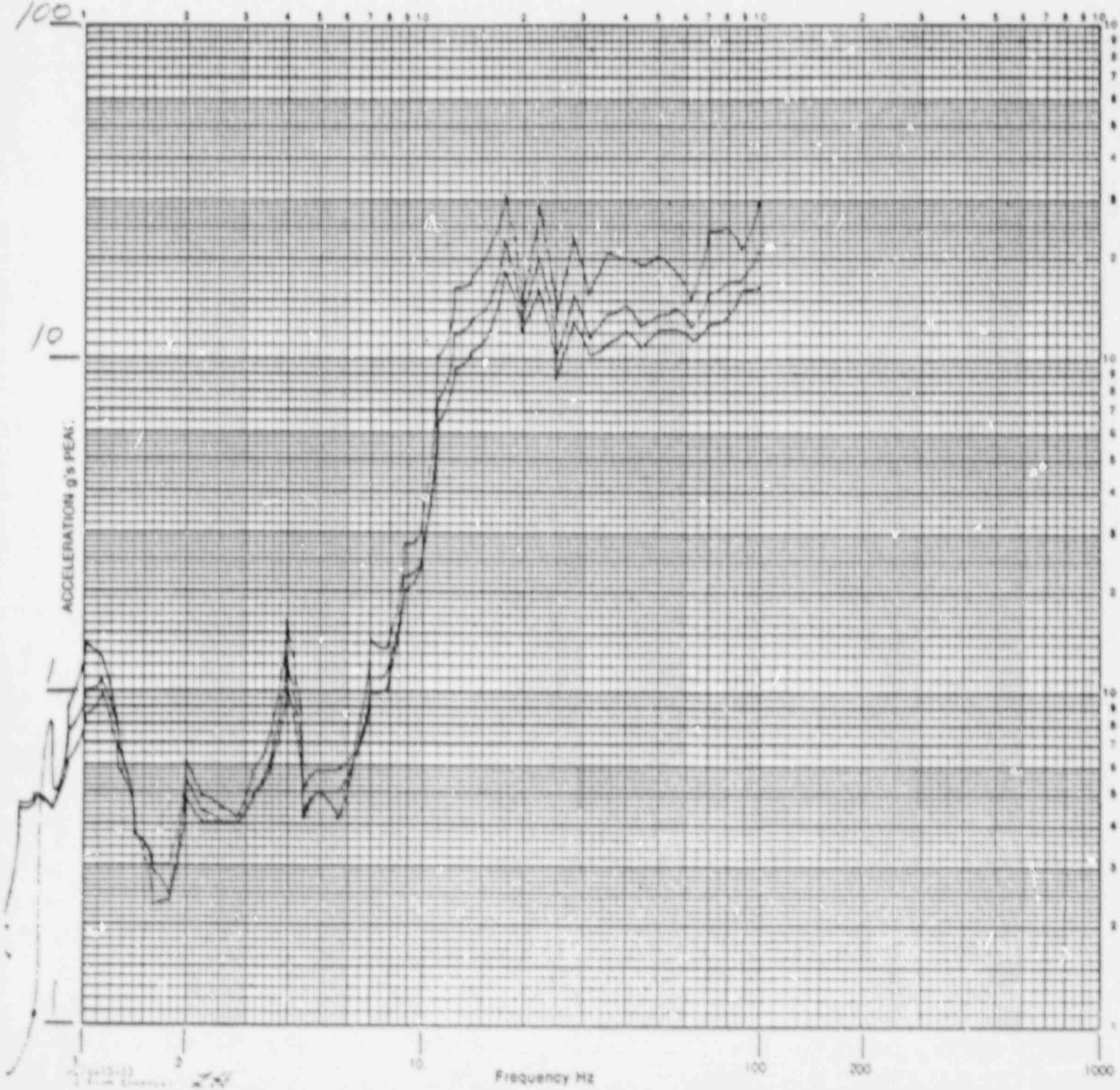
Accel. No. 5 Axis Control ( ) Response (✓) OBE ( ) SSE ( ) DBE ( )

Full Scale 100 g Damping 2 % Run No. 11-2

Operator BG Engineer D. Krull

Level 5 HIGH FREQ.

RESPONSE SPECTRUM



WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

CUSTOMER EG+G Job No. 57724 Date 5-19-87

Specimen RELAY Axis of Test X

Accel. No. 7 Axis ____ Control ( ) Response (✓) OBE ( ) SSE ( ) DBE ( )

Full Scale 100 g Damping 2 %

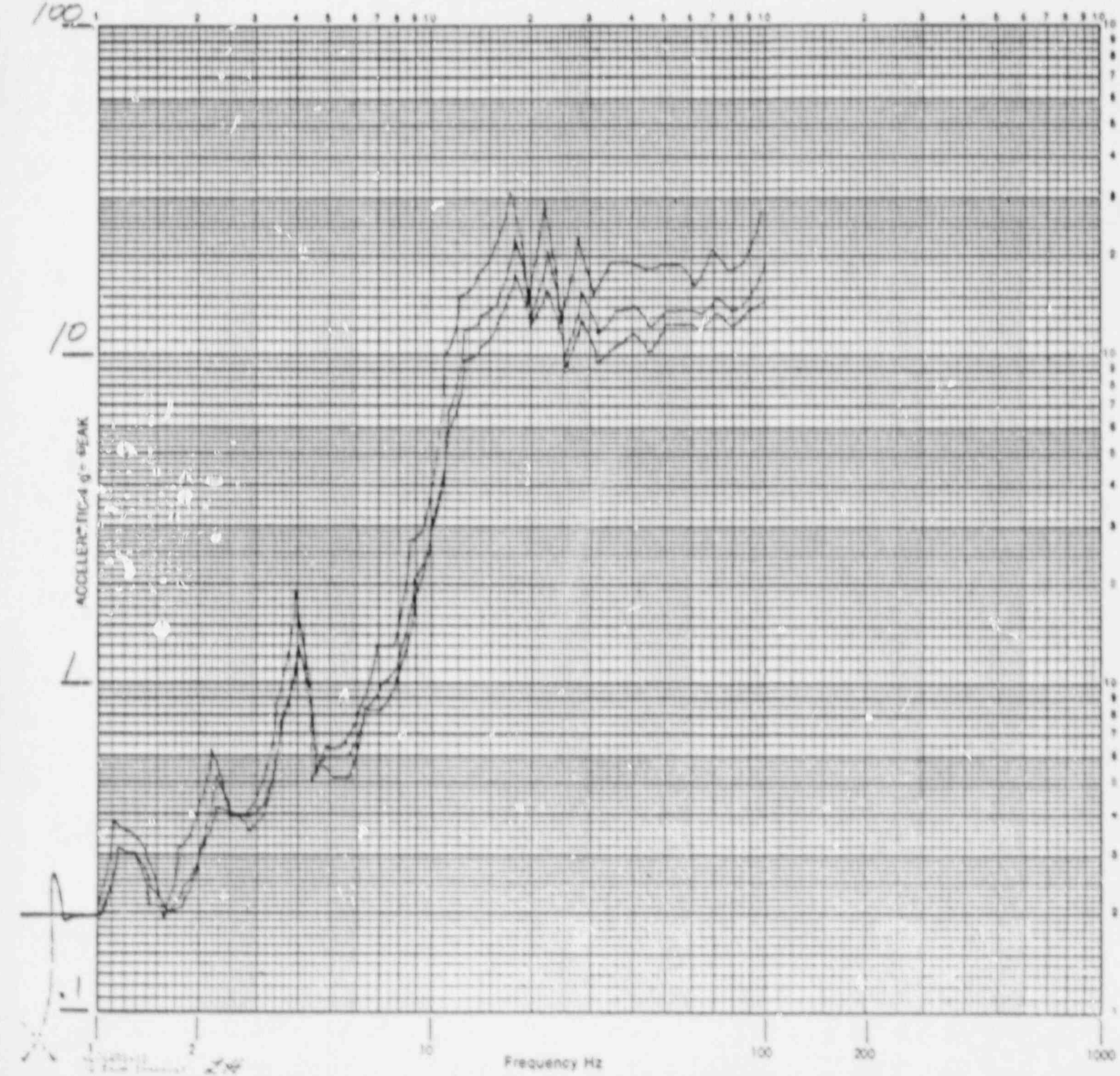
Run No. 11-2

Operator BG Engineer [signature]

Level 5

HIGH FREQ.

RESPONSE SPECTRUM



WYLE LABORATORIES,NORCO,CA. FACILITY   CHATTER AND PULSE ANALYSIS PROGRAM   05/19/87 14:26:19 HOURS   PAGE 1

START TIME= 0.0000   STOP TIME= 21.216

TEST NAME=EGG 57724, F/B AXIS, 5TH LEVEL HI FREQ. RUN 11-2, DENERGIZED
TEST DATE=05/19/87 14:21:49 HOURS

CHANNEL ID	CHANNEL NUMBER	FIRST CHATTER	LAST CHATTER	STATE CHANGE	NUMBER OF CHATTER FAILURES PER TIME LENGTH 2.00-5.00	5.00-10.0	10.0-20.0	20.0-40.0	40.0-80.0	>80.0	TOTAL
W1-NC	2			0	NO CHATTER						
W1-NO	3			0	NO CHATTER						
W2-NC	4			0	NO CHATTER						
W2-NO	6			0	NO CHATTER						
W3-NC	7			0	NO CHATTER						
W3-NO	8			0	NO CHATTER						
G1-NC	10			0	NO CHATTER						
G1-NO	11			0	NO CHATTER						
G2-NC	12			0	NO CHATTER						
G2-NC	13			0	NO CHATTER						
G3-NC	14			0	NO CHATTER						
G3-NO	15			0	NO CHATTER						
W1-OT-NO	16			0	NO CHATTER						
W2-OT-NO	17			0	NO CHATTER						
W3-OT-NO	18			0	NO CHATTER						
G1-OT-NO	19			0	NO CHATTER						
G2-OT-NO	20			0	NO CHATTER						
G3-OT-NO	21			0	NO CHATTER						
	22			0	NO CHATTER						
										TOTAL=	0

WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

CUSTOMER EG & G Job No. 57724 Date 5-19-87

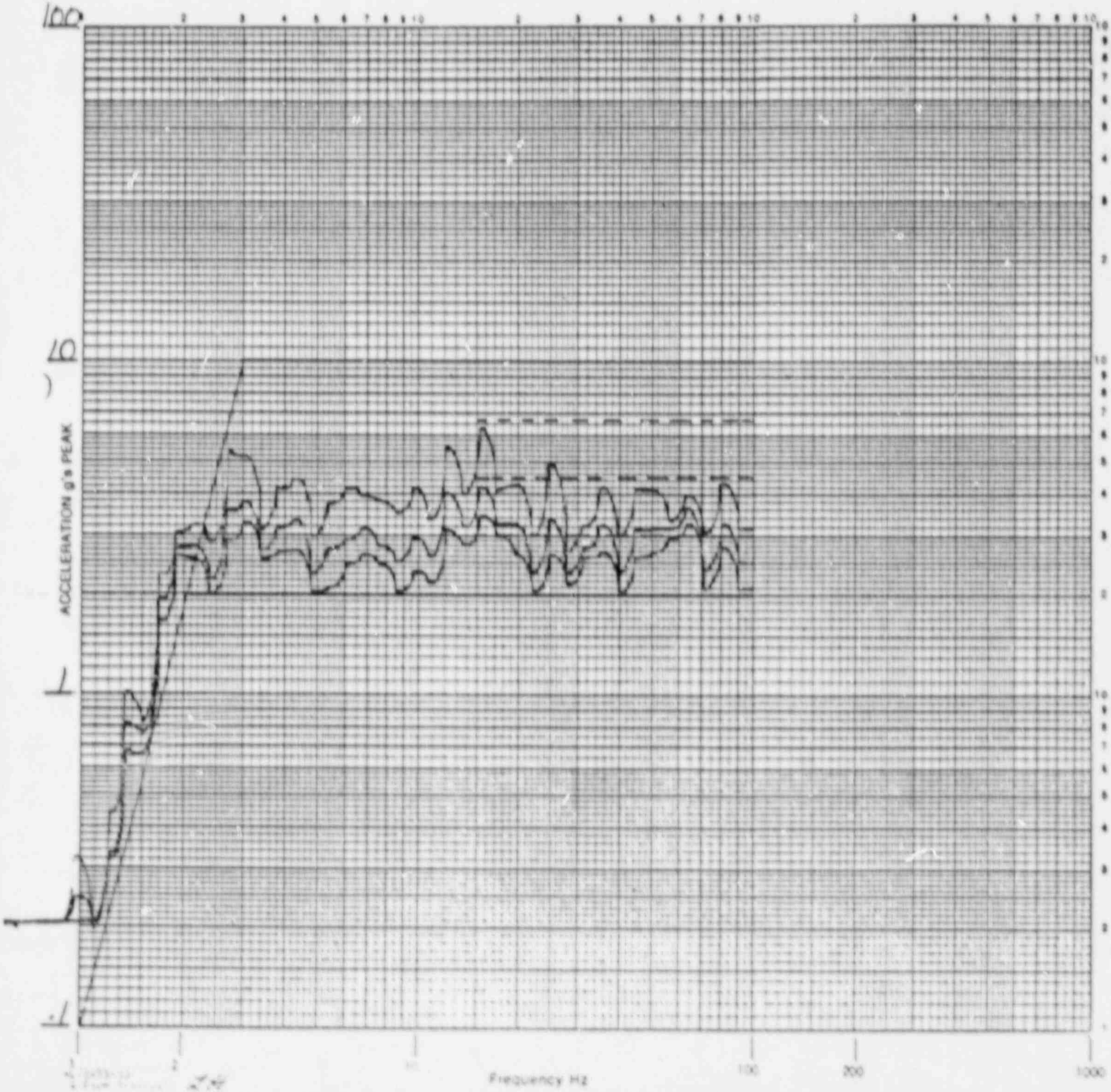
Specimen ELECTRONIC COMPONENTS Axis of Test X

Accel. No. 1 Axis HORIZ Control (✓) Response ( ) OBE ( ) SSE ( ) OBE ( )

Full Scale 100 g Damping 1,(2%),3 % Run No BROAD BAND FREQUENCY RUN #12

Operator GRETERMAN Engineer

RESPONSE SPECTRUM



WYLE LABORATORIES,NORCO,CA. FACILITY CHATTER AND PULSE ANALYSIS PROGRAM 05/19/87 14:42:45 HOURS PAGE 1

START TIME- 0.0000 STOP TIME- 20.280

TEST NAME-EGG 57724, F/B, 1ST LEVEL BROAD BAND, RUN 12, DEENERGIZED
TEST DATE-05/19/87 14:38:22 HOURS

CHANNEL ID	CHANNEL NUMBER	FIRST CHATTER	LAST CHATTER	STATE CHANGE	NUMBER OF CHATTER FAILURES PER TIME LENGTH 2.00-5.00	5.00-10.0	10.0-20.0	20.0-40.0	40.0-80.0	>32.0	TOTAL
W1-NC	2			0	NO CHATTER						
W1-NO	3			0	NO CHATTER						
W2-NC	4			0	NO CHATTER						
W2-NO	6			0	NO CHATTER						
W3-NC	7			0	NO CHATTER						
W3-NO	[illegible]			0	NO CHATTER						
G1-NC	[illegible]			0	NO CHATTER						
G1-NO	[illegible]			0	NO CHATTER						
G2-NC	12			0	NO CHATTER						
G2-NO	13			0	NO CHATTER						
G3-NC	14			0	NO CHATTER						
G3-NO	15			0	NO CHATTER						
W1-OT-NO	16			0	NO CHATTER						
W2-OT-NO	17			0	NO CHATTER						
W3-OT-NO	18			0	NO CHATTER						
G1-OT-NO	19			0	NO CHATTER						
G2-OT-NO	20			0	NO CHATTER						
G3-OT-NO	21			0	NO CHATTER						
	22			0	NO CHATTER						
										TOTAL-	0

CUSTOMER EG & G Job No. 57724 Date 5-19-87

Specimen ELECTRONIC COMPONENTS Axis of Test X

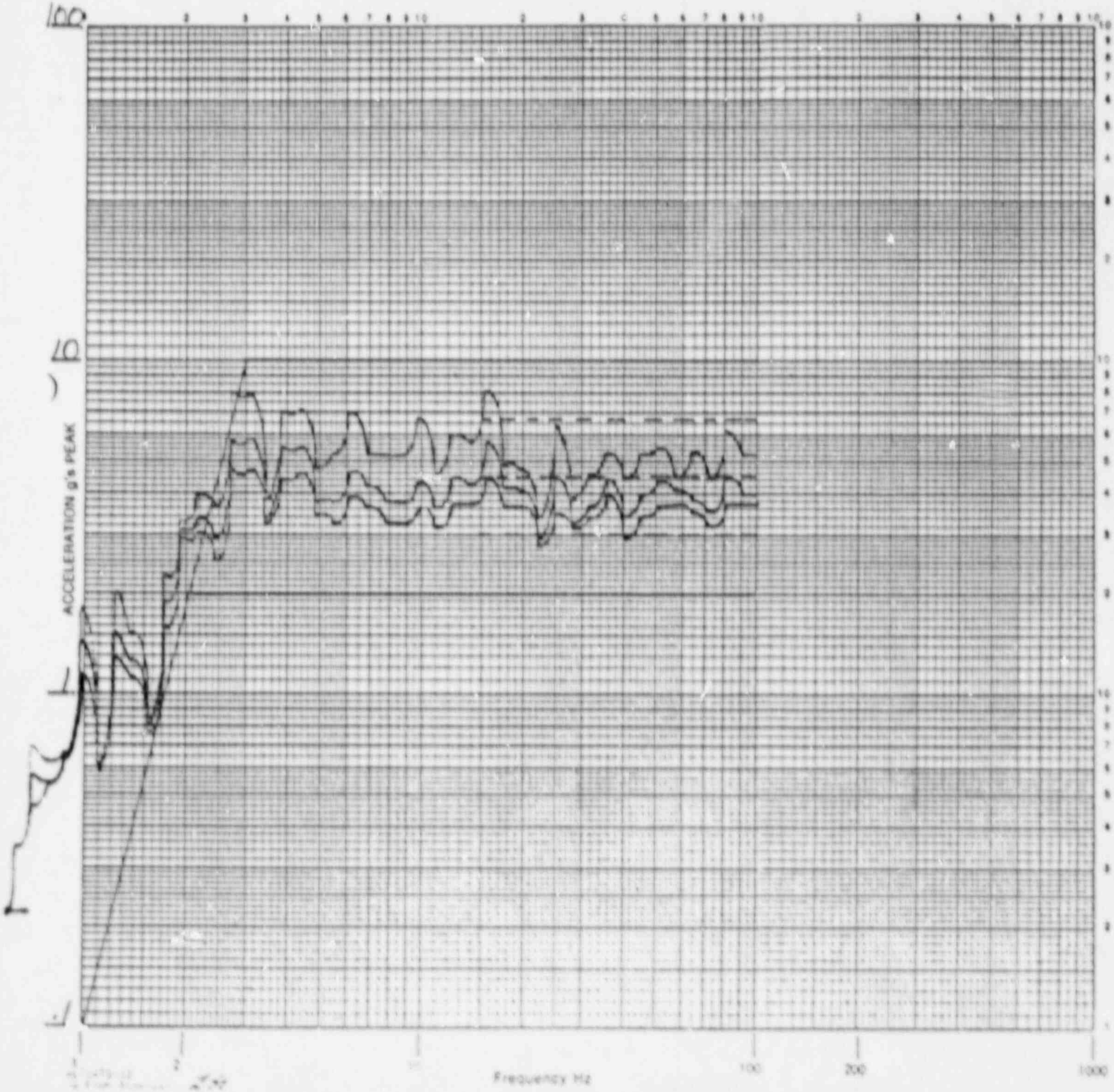
Accel. No. 1 Axis HORIZ Control (✓) Response ( ) OBE ( ) SSE ( ) DBE ( )

Full Scale 100 g Damping 1,(2%),3 %

Run No. BROAD BAND FREQUENCY RUN #13

Operator GEERMAN Engineer [illegible]

RESPONSE SPECTRUM



WYLE LABORATORIES,NORCO,CA. FACILITY   CHATTER AND PULSE ANALYSIS PROGRAM   05/19/87 14:48:28 HOURS   PAGE 1

START TIME= 0.0000   STOP TIME= 20.904

TEST NAME=EGG 57724, F/B, 2ND LEVEL BROAD BAND,RUN 13,DE-ENERGIZED
TEST DATE=05/19/87   14:45:26 HOURS

CHANNEL ID	CHANNEL NUMBER	FIRST CHATTER	LAST CHATTER	STATE CHANGE	NUMBER OF CHATTER FAILURES PER TIME LENGTH 2.00-5.00	5.00-10.0	10.0-20.0	20.0-40.0	40.0-80.0	>80.0	TOTAL
W1-NC	2			0	NO CHATTER						
W1-NO	3			0	NO CHATTER						
W2-NC	4			0	NO CHATTER						
W2-NO	5			0	NO CHATTER						
W3-NC	7			0	NO CHATTER						
W3-NO	8			0	NO CHATTER						
G1-NC	10			0	NO CHATTER						
G1-NO	11			0	NO CHATTER						
G2-NC	12			0	NO CHATTER						
G2-NO	13			0	NO CHATTER						
G3-NC	14			0	NO CHATTER						
G3-NO	15			0	NO CHATTER						
W1-OT-NO	16			0	NO CHATTER						
W2-OT-NO	17			0	NO CHATTER						
W3-OT-NO	18			0	NO CHATTER						
G1-OT-NO	19			0	NO CHATTER						
G2-OT-NO	20			0	NO CHATTER						
G3-OT-NO	21			0	NO CHATTER						
	22			0	NO CHATTER						
										TOTAL=	0

CUSTOMER EG & G Job No. 57724 Date 5-19-87

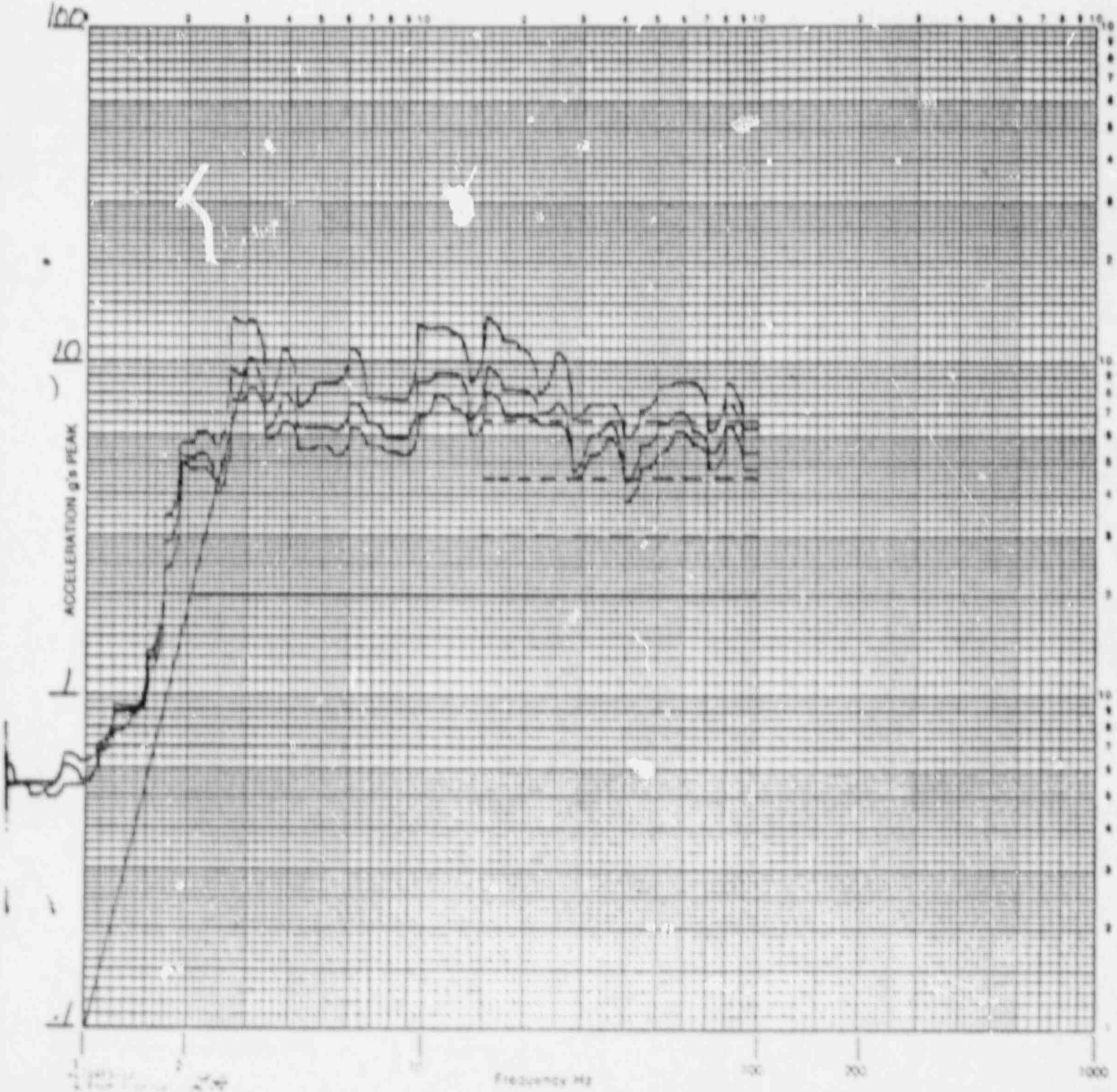
Specimen ELECTRONIC COMPONENTS Axis of Test X

Accel. No. 1 Axis Horiz Control (✓) Response ( ) OBE ( ) SSE ( ) DBE ( )

Full Scale 100 g Damping 1,(2%),3 % Run No. BROAD BAND FREQUENCY RUN # 14

Operator BRETERMAN Engineer

RESPONSE SPECTRUM



START TIME= 0.0000   STOP TIME= 20.904

TEST NAME=EGG 57724, F/B, 3RD LEVEL BROAD BAND,RUN 14,DE-ENERGIZED
TEST DATE=05/19/87 14:51:11 HOURS

CHANNEL ID	CHANNEL NUMBER	FIRST CHATTER	LAST CHATTER	STATE CHANGE	NUMBER OF CHATTER FAILURES PER TIME LENGTH 2.00-5.00	5.00-10.0	10.0-20.0	20.0-40.0	40.0-80.0	>80.0	TOTAL
W1-NC	2			0	NO CHATTER						
W1-NO	3			0	NO CHATTER						
W2-NC	4			0	NO CHATTER						
W2-NO	6			0	NO CHATTER						
W3-NC	7			0	NO CHATTER						
W3-NO	8			0	NO CHATTER						
G1-NC	10			0	NO CHATTER						
G1-NO	11			0	NO CHATTER						
G2-NC	12			0	NO CHATTER						
G2-NO	13			0	NO CHATTER						
G3-NC	14			0	NO CHATTER						
G3-NO	15			0	NO CHATTER						
W1-OT-NO	16			0	NO CHATTER						
W2-OT-NO	17			0	NO CHATTER						
W3-OT-NO	18			0	NO CHATTER						
G1-OT-NO	19			0	NO CHATTER						
G2-OT-NO	20			0	NO CHATTER						
G3-OT-NO	21			0	NO CHATTER						
	22			0	NO CHATTER						
										TOTAL=	0

WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

CUSTOMER EG & G Job No. 57724 Date 5-19-87

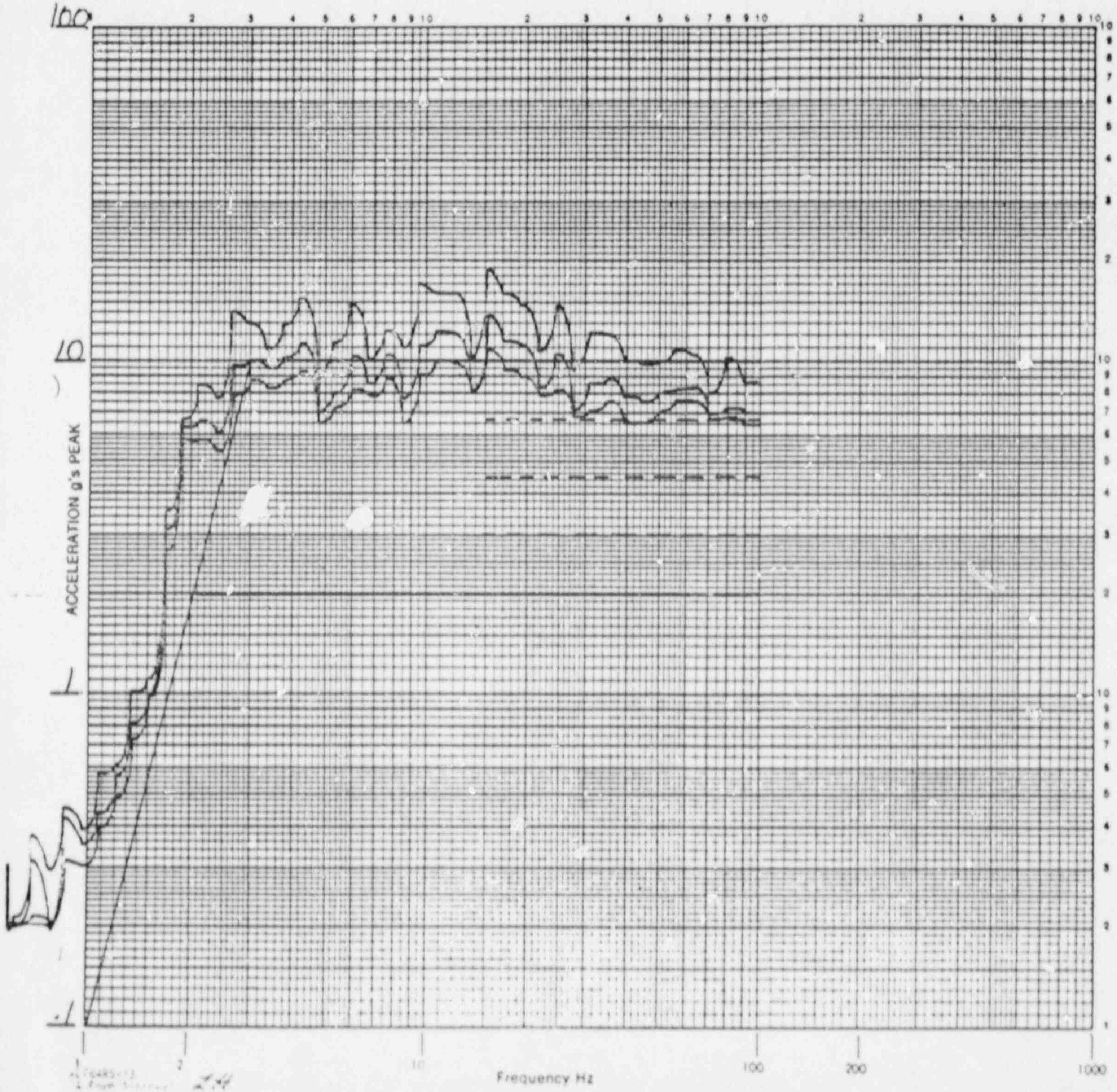
Specimen ELECTRONIC COMPONENTS Axis of Test X

Accel. No. 1 Axis Horiz Control (✓) Response ( ) OBE ( ) SSE ( ) DLE ( )

Full Scale 100 g Damping 1,(2%),3 % Run No. BROAD BAND FREQUENCY RUN # 15

Operator GREIFERMAN Engineer [signature]

RESPONSE SPECTRUM

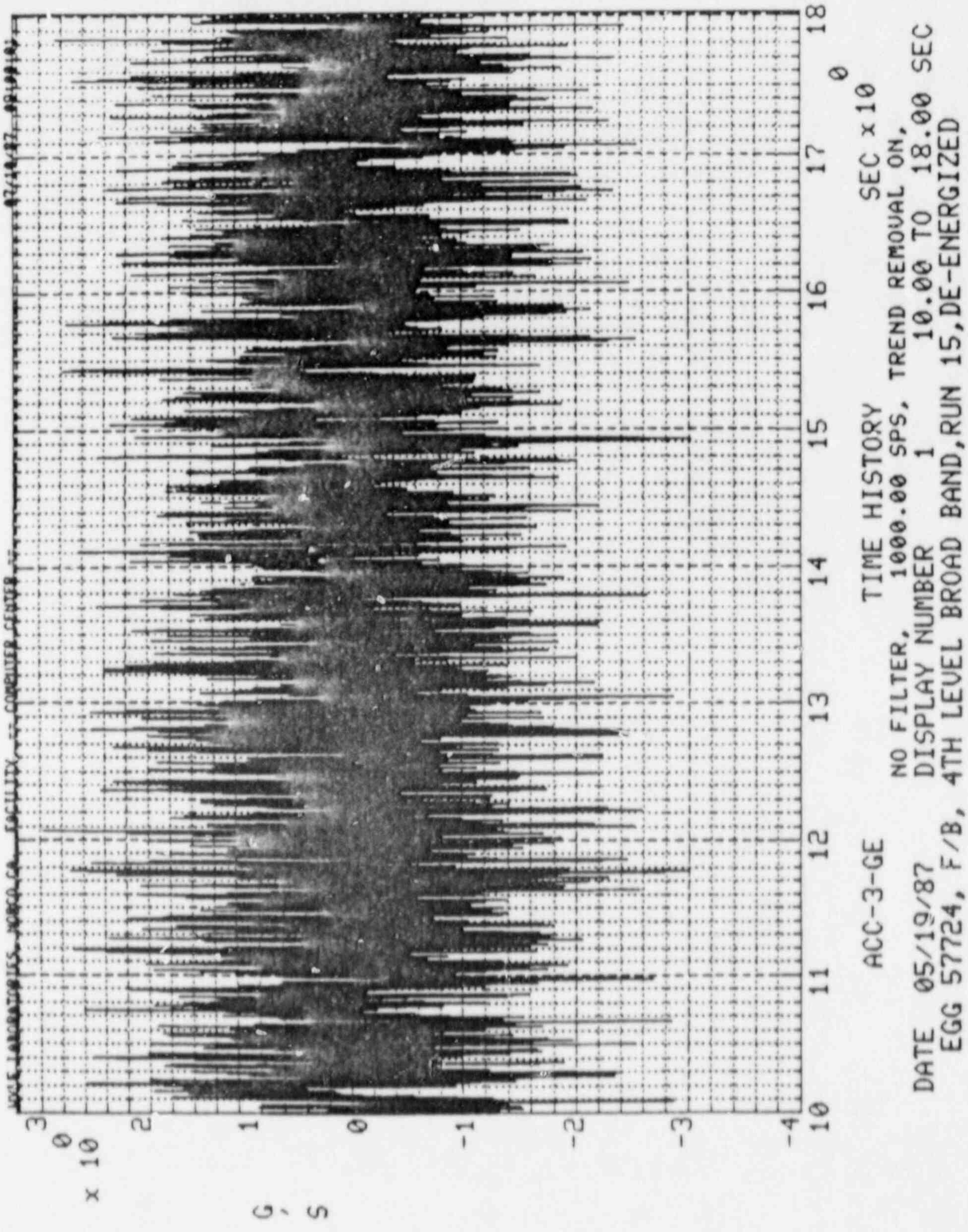


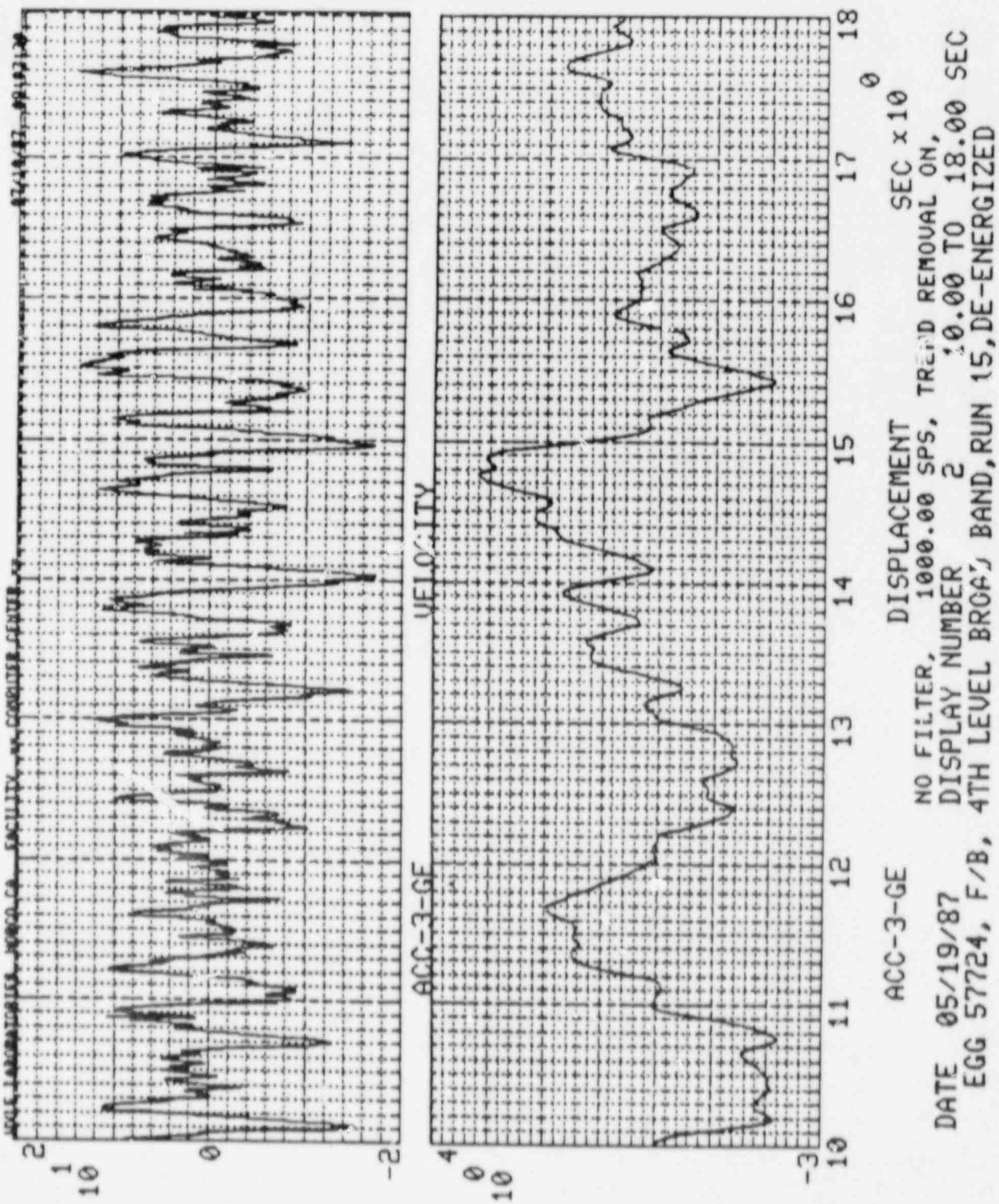
WYLE LABORATORIES,NORCO,CA. FACILITY   CHATTER AND PULSE ANALYSIS PROGRAM   05/19/87 15:24:26 HOURS   PAGE 1

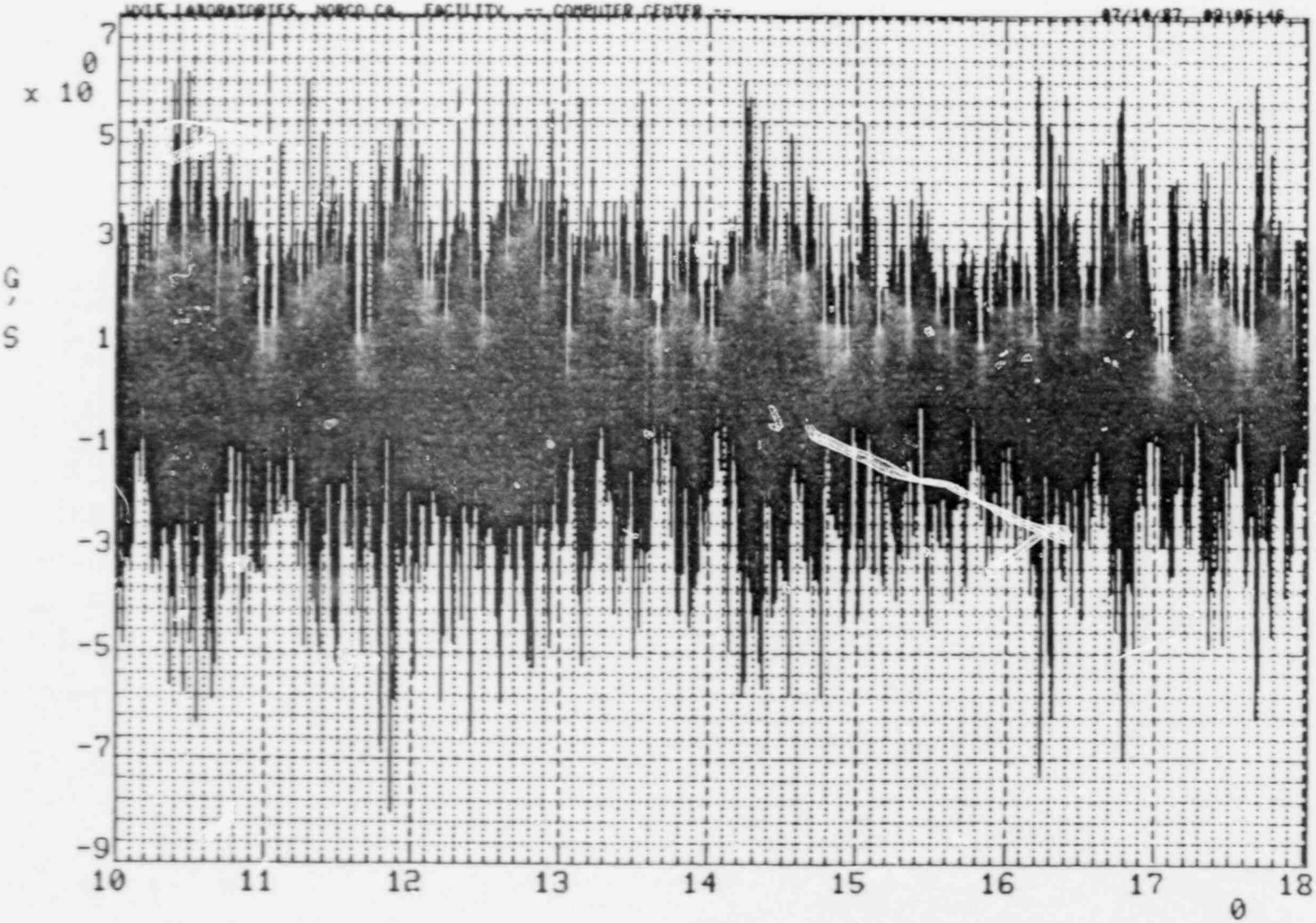
START TIME= 0.0000   STOP TIME= 21.216

TEST NAME=EGG 57724, F/B, 4TH LEVEL BROAD BAND,RUN 15,DE-ENERGIZED
TEST DATE=05/19/87   15:21:38 HOURS

CHANNEL ID	CHANNEL NUMBER	FIRST CHATTER	LAST CHATTER	STATE CHANGE	NUMBER OF CHATTER FAILURES PER TIME LENGTH 2.00-5.00	5.00-10.0	10.0-20.0	20.0-40.0	40.0-80.0	>80.0	TOTAL
W1-NC	2			0	NO CHATTER						
W1-NO	3			0	NO CHATTER						
W2-NC	4			0	NO CHATTER						
W2-NO	6			0	NO CHATTER						
W3-NC	7			0	NO CHATTER						
W3-NO	8			0	NO CHATTER						
G1-NC	10			0	NO CHATTER						
G1-NO	11			0	NO CHATTER						
G2-NC	12			0	NO CHATTER						
G2-NO	13			0	NO CHATTER						
G3-NC	14			0	NO CHATTER						
G3-NO	15			0	NO CHATTER						
W1-OT-NO	16			0	NO CHATTER						
W2-OT-NO	17			0	NO CHATTER						
W2-OT-NO	18			0	NO CHATTER						
G1-OT-NO	19			0	NO CHATTER						
G[illegible]-OT-NO	20			0	NO CHATTER						
G[illegible]-OT-NO	21			0	NO CHATTER						
	22			0	NO CHATTER						
										TOTAL=	0


WYLE LABORATORIES NORCO,CA. FACILITY -- COMPUTER CENTER --
G'S x 10^0
3
2
1
0
-1
-2
-3
-4
10
11
12
13
14
15
16
17
18
SEC x 10^0
ACC-3-GE TIME HISTORY
NO FILTER, 1000.00 SPS, TREND REMOVAL ON,
DATE 05/19/87 DISPLAY NUMBER 1 10.00 TO 18.00 SEC
EGG 57724, F/B, 4TH LEVEL BROAD BAND,RUN 15,DE-ENERGIZED


ACC-3-GE VELOCITY
IN./SEC. x10 1
ACC-3-GE DISPLACEMENT
INCHES x10 0
SEC x10 0
DATE 05/19/87 NO FILTER, 1000.00 SPS, TREND REMOVAL ON,
DISPLAY NUMBER 2 10.00 TO 18.00 SEC
EGG 57724, F/B, 4TH LEVEL BROAD BAND, RUN 15, DE-ENERGIZED

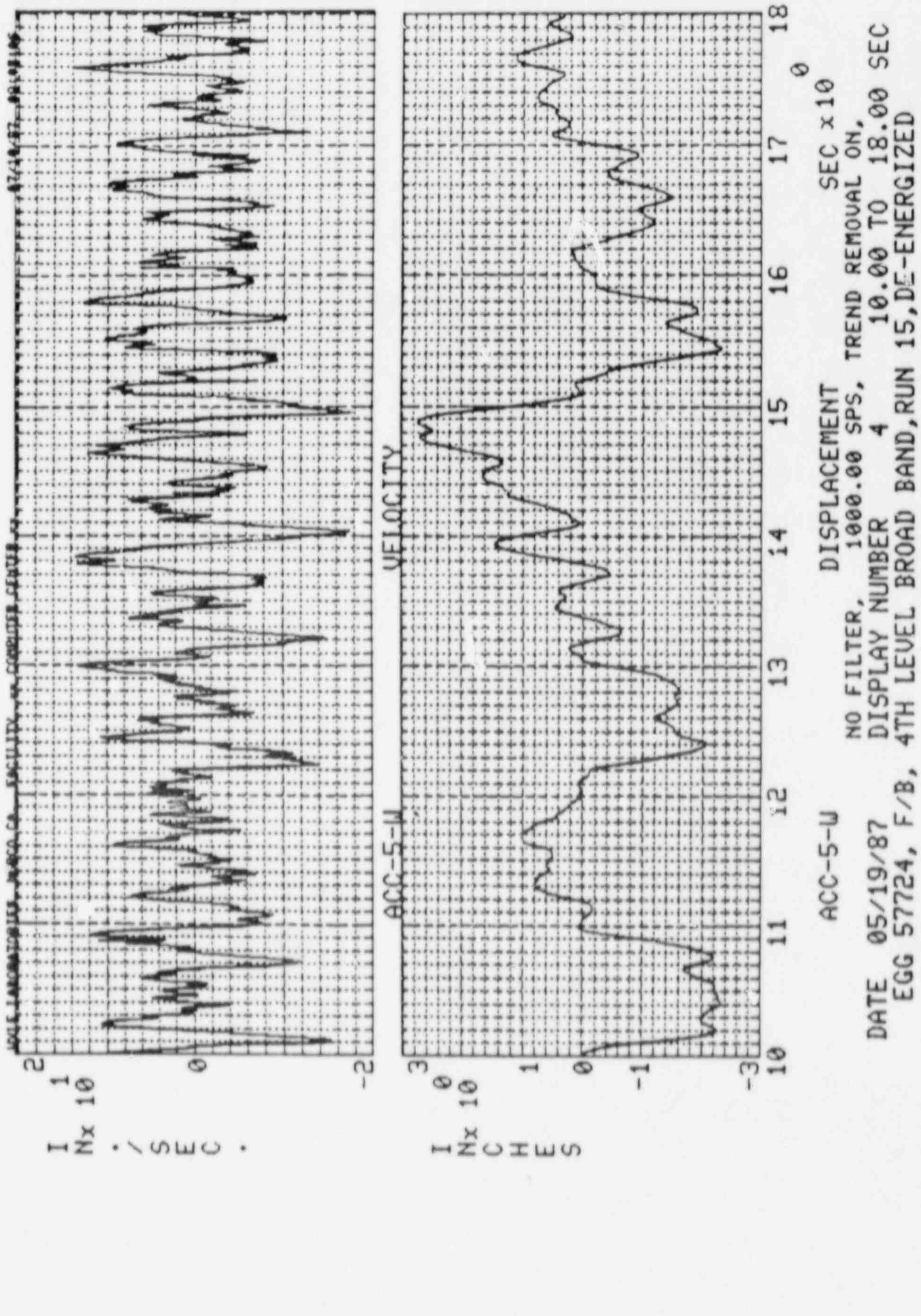


ACC-5-W TIME HISTORY

NO FILTER, 1000.00 SPS, TREND REMOVAL ON,

DATE 05/19/87 DISPLAY NUMBER 3 10.00 TO 18.00 SEC

EGG 57724, F/B, 4TH LEVEL BROAD BAND, RUN 15, DE-ENERGIZED


VELOCITY
IN/SEC x 10^1
DISPLACEMENT
INCHES x 10^0
SEC x 10^0
ACC-5-W
NO FILTER, 1000.00 SPS, TREND REMOVAL ON,
DATE 05/19/87 DISPLAY NUMBER 4 10.00 TO 18.00 SEC
EGG 57724, F/B, 4TH LEVEL BROAD BAND,RUN 15,DE-ENERGIZED

WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

CUSTOMER EG & G Job No. 57724 Date 5-19-87

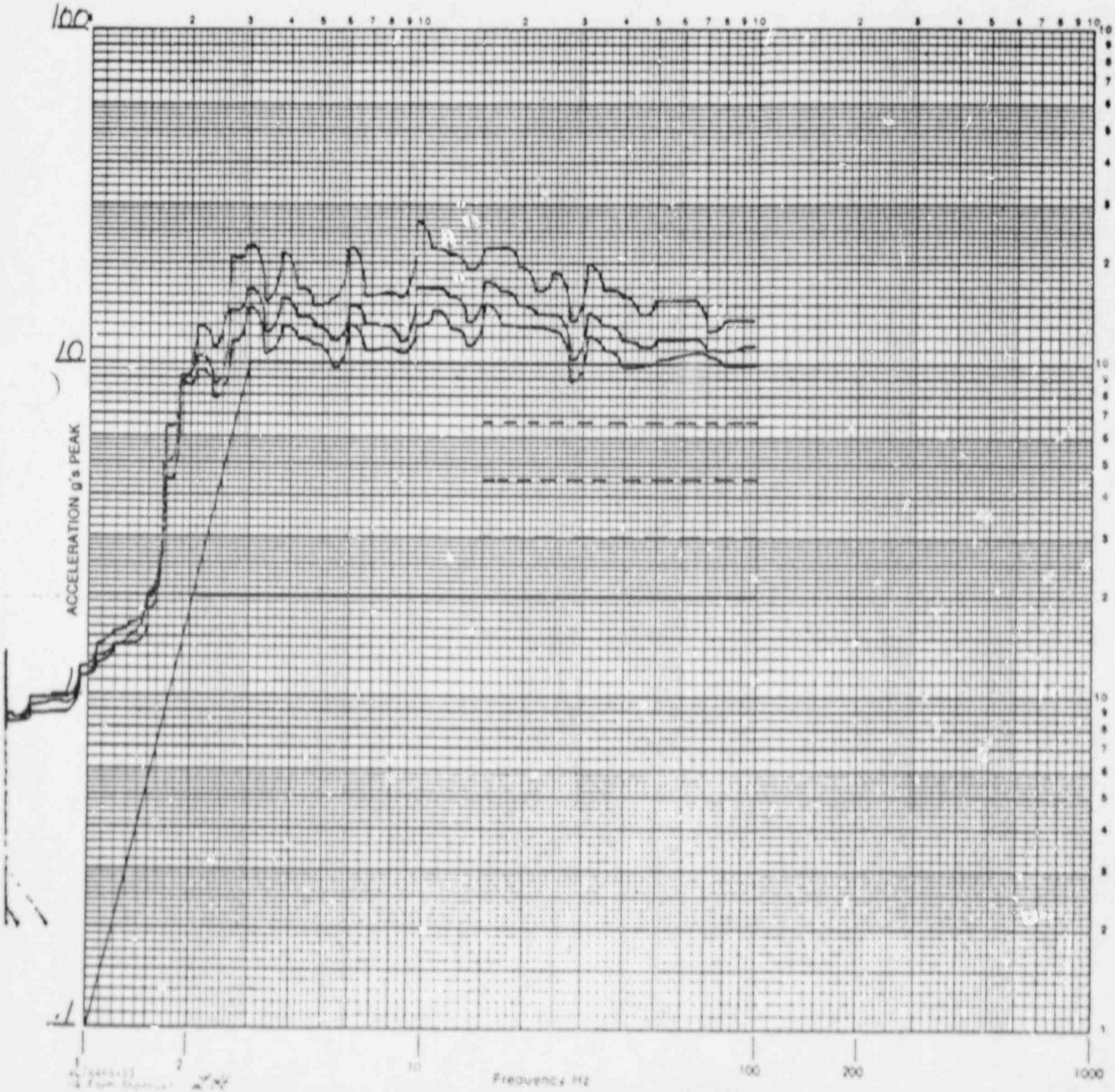
Specimen ELECTRONIC COMPONENTS Axis of Test X

Accel. No. 1 Axis LONG Control (✓) Response ( ) OBE ( ) SSE ( ) DBE ( )

Full Scale 100 g Damping 1,(2%),3 % Run No. BROAD BAND FREQUENCY RUN # 16

Operator GREERMAN Engineer

RESPONSE SPECTRUM



CUSTOMER EG+G Job No. 57724 Date 5-19-87

Specimen RELAY Axis of Test X

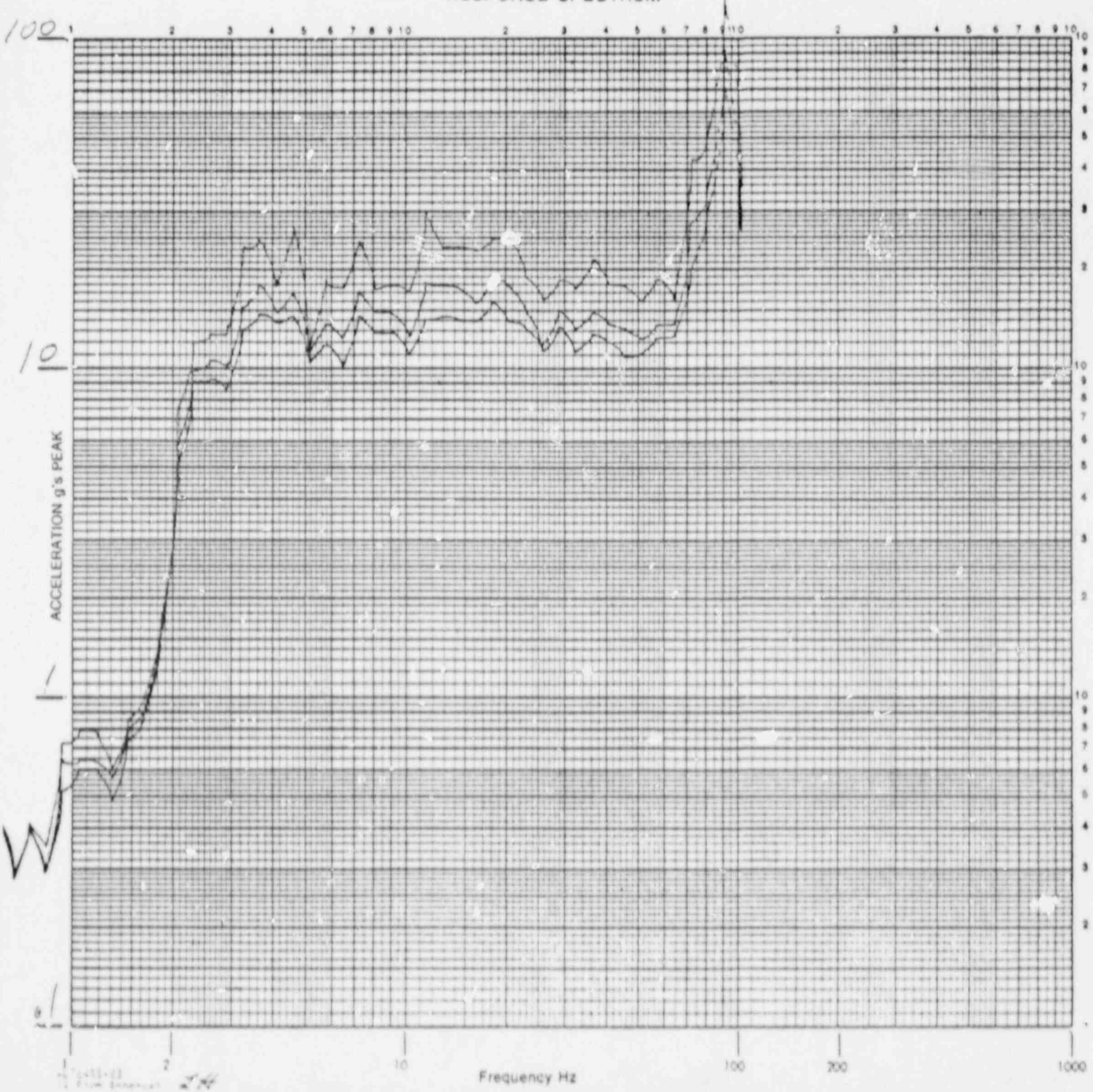
Accel. No. 3 Axis ______ Control ( ) Response (✓) OBE ( ) SSE ( ) DBE ( )

Full Scale 100 g Damping 2 % Run No. 16

Operator BE Engineer D. Kuller

Level 5
BROAD BAND

RESPONSE SPECTRUM



CUSTOMER EG+G Job No. 57724 Date 5-19-87

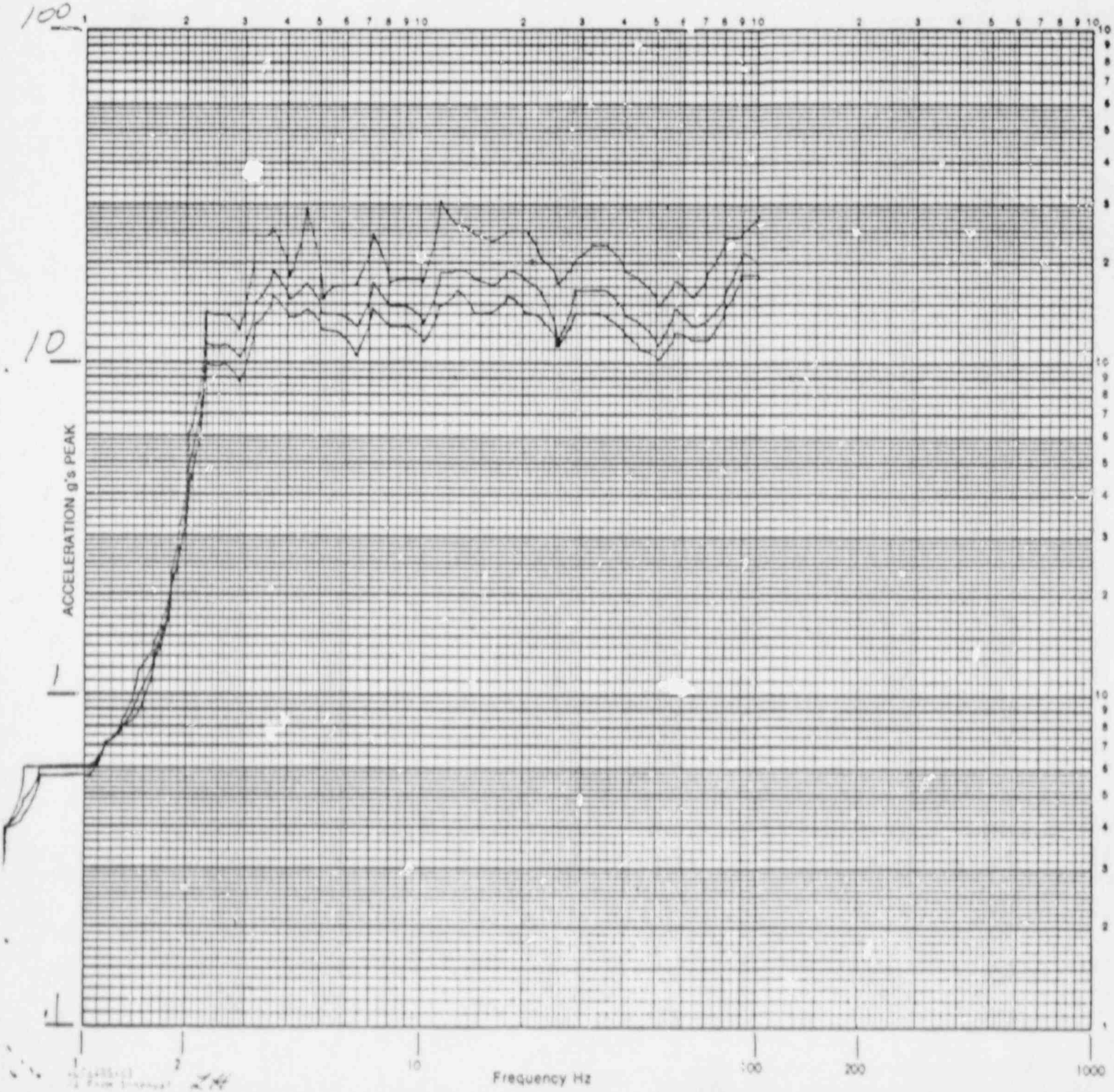
Specimen RELAY Axis of Test X

Accel. No. 5 Axis ___ Control ( ) Response (✓) OBE ( ) SSE ( ) DBE ( )

Full Scale 100 g Damping 2 %   Run No. 16

Operator BG Engineer P. Kgaur   Level 5 BROAD BAND

RESPONSE SPECTRUM



WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

CUSTOMER EG+G Job No. 57724 Date 5-19-87

Specimen RELAY Axis of Test X

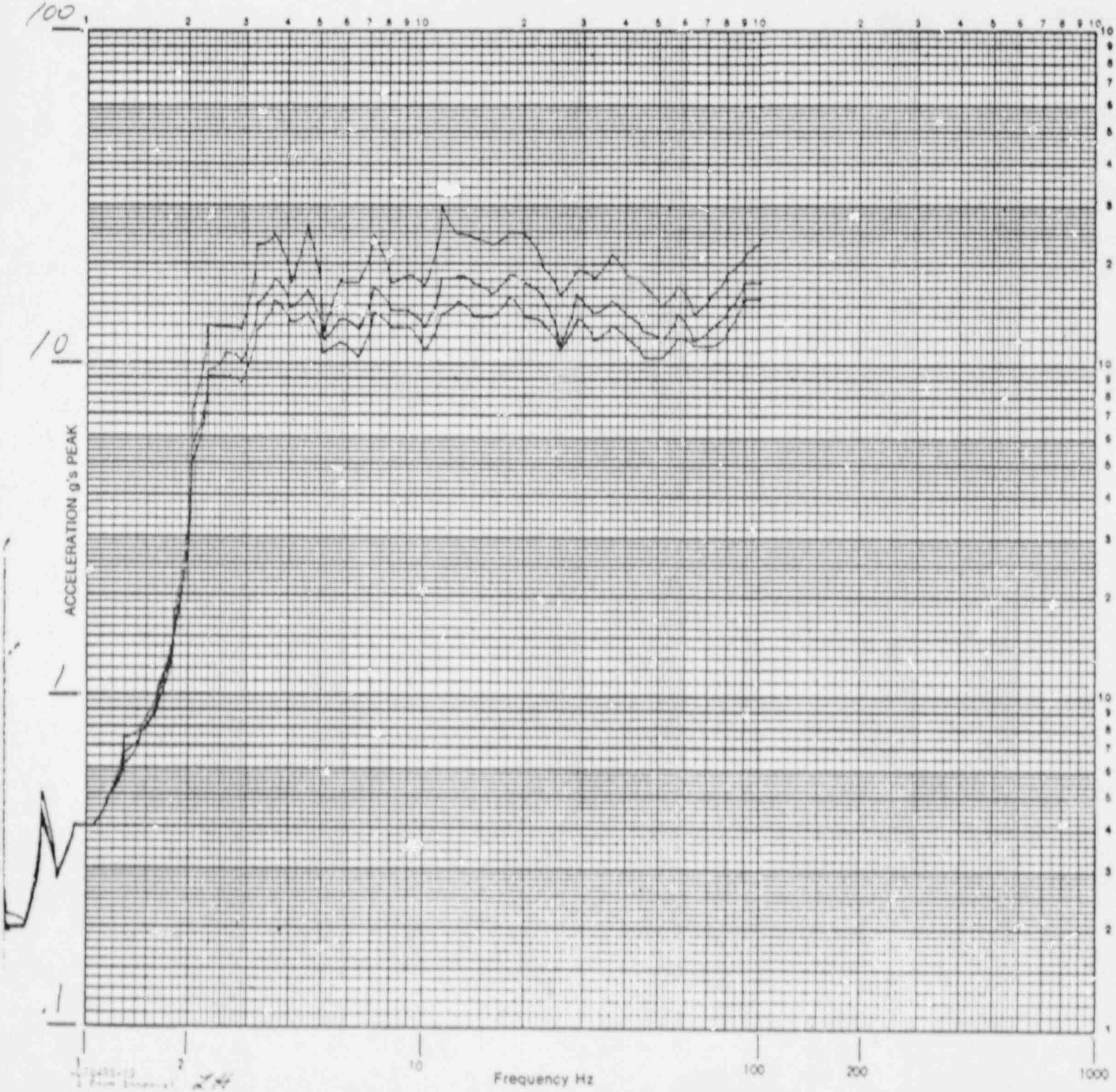
Accel. No. 7 Axis Control ( ) Response (✓) OBE ( ) SSE ( ) DBE ( )

Full Scale 100 g Damping 2 % Run No. 16

Operator BG Engineer [signature]

Level 5
BROAD BAND

RESPONSE SPECTRUM

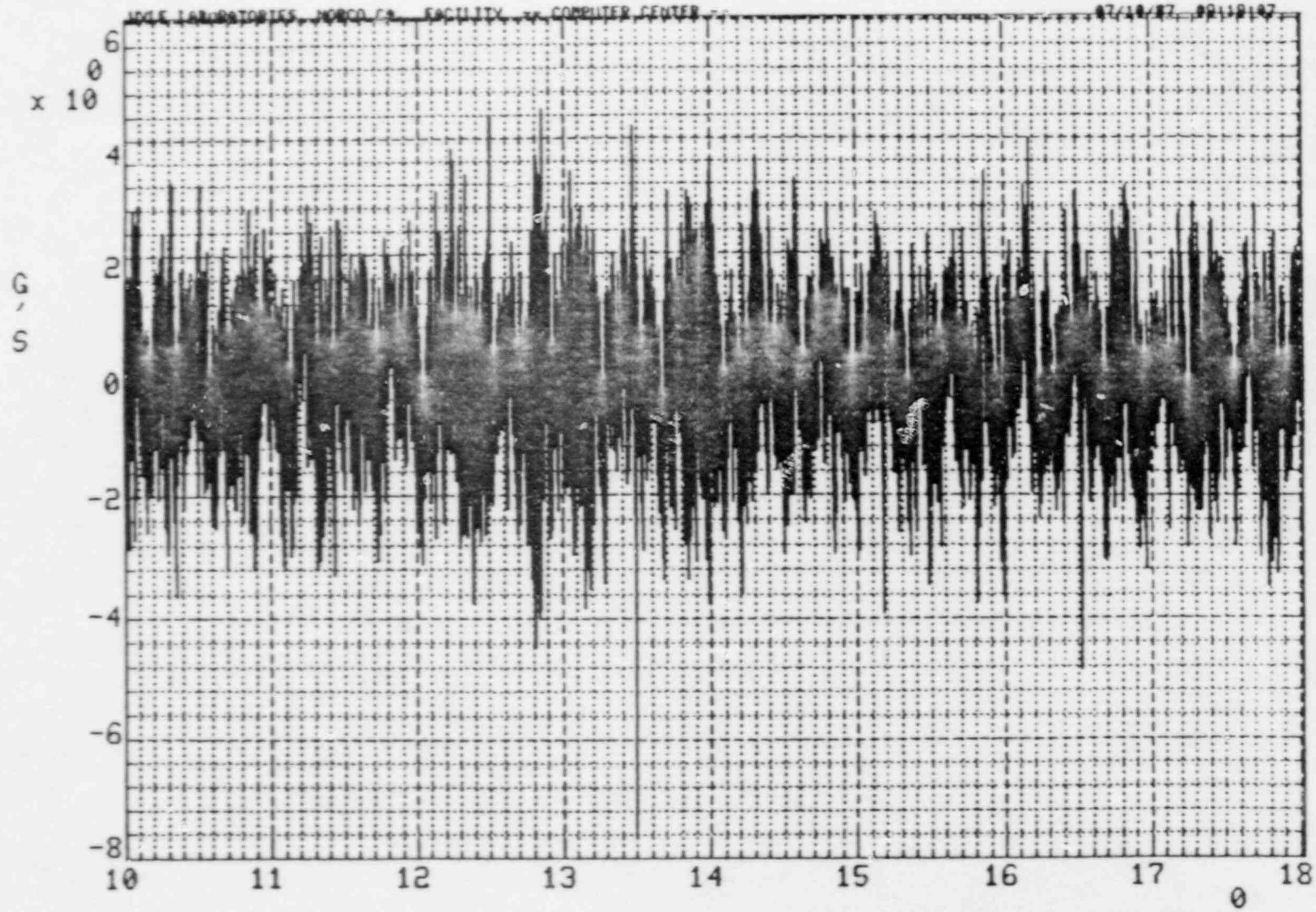


WYLE LABORATORIES,NORCO,CA. FACILITY CHATTER AND PULSE ANALYSIS PROGRAM 05/19/87 15:32:16 HOURS PAGE 1

START TIME= 0.0000 STOP TIME= 22.776

TEST NAME=EGG 57724, F/B, 5TH LEVEL BROAD BAND,RUN 16,DE-ENERGIZED
TEST DATE=05/19/87 15:29: 8 HOURS

CHANNEL ID	CHANNEL NUMBER	FIRST CHATTER	LAST CHATTER	STATE CHANGE	NUMBER OF CHATTER FAILURES PER TIME LENGTH 2.00-5.00	5.00-10.0	10.0-20.0	20.0-40.0	40.0-80.0	>80.0	TOTAL
W1-NC	2	11.152	16.002	0	1	1	0	0	0	0	2
W1-NO	3			0	NO CHATTER						
W2-NC	4	11.153	16.001	0	2	0	0	0	0	0	2
W2-NO	6			0	NO CHATTER						
W3-NC	7	11.151	16.002	0	0	2	0	0	0	0	2
W3-NO	8			0	NO CHATTER						
G1-NC	10			0	NO CHATTER						
G1-NO	11			0	NO CHATTER						
G2-NC	12	13.483	16.850	0	0	4	0	0	0	0	4
G2-NO	13			0	NO CHATTER						
G3-NC	14	16.510	16.513	0	1	0	0	0	0	0	1
G3-NO	15			0	NO CHATTER						
W1-OT-NO	16			0	NO CHATTER						
W2-OT-NO	17			0	NO CHATTER						
W3-OT-NO	18	16.008	16.012	0	1	0	0	0	0	0	1
G1-OT-NO	19			0	NO CHATTER						
G2-OT-NO	20			0	NO CHATTER						
G3-OT-NO	21			0	NO CHATTER						
	22			0	NO CHATTER						
										TOTAL=	12

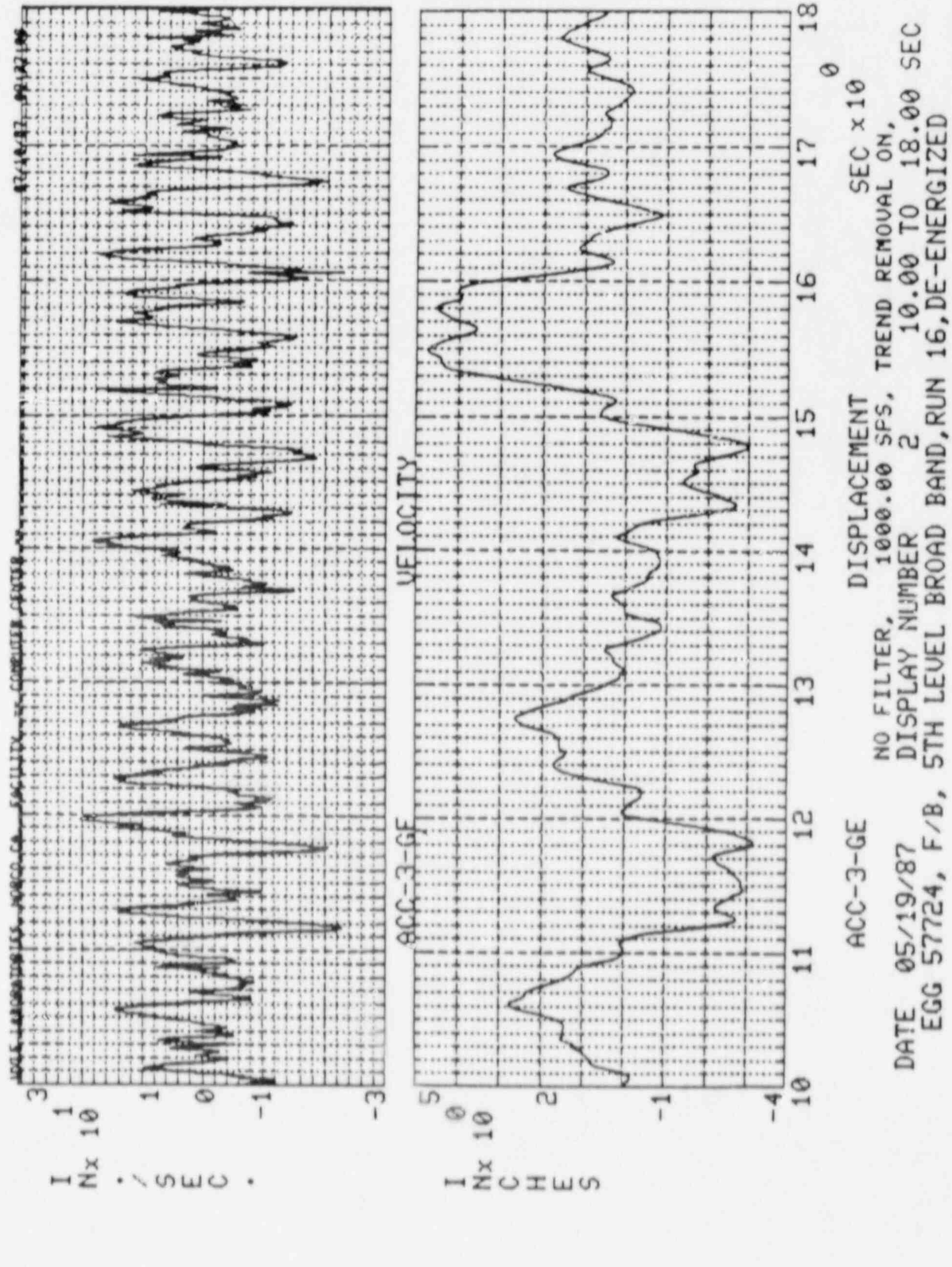


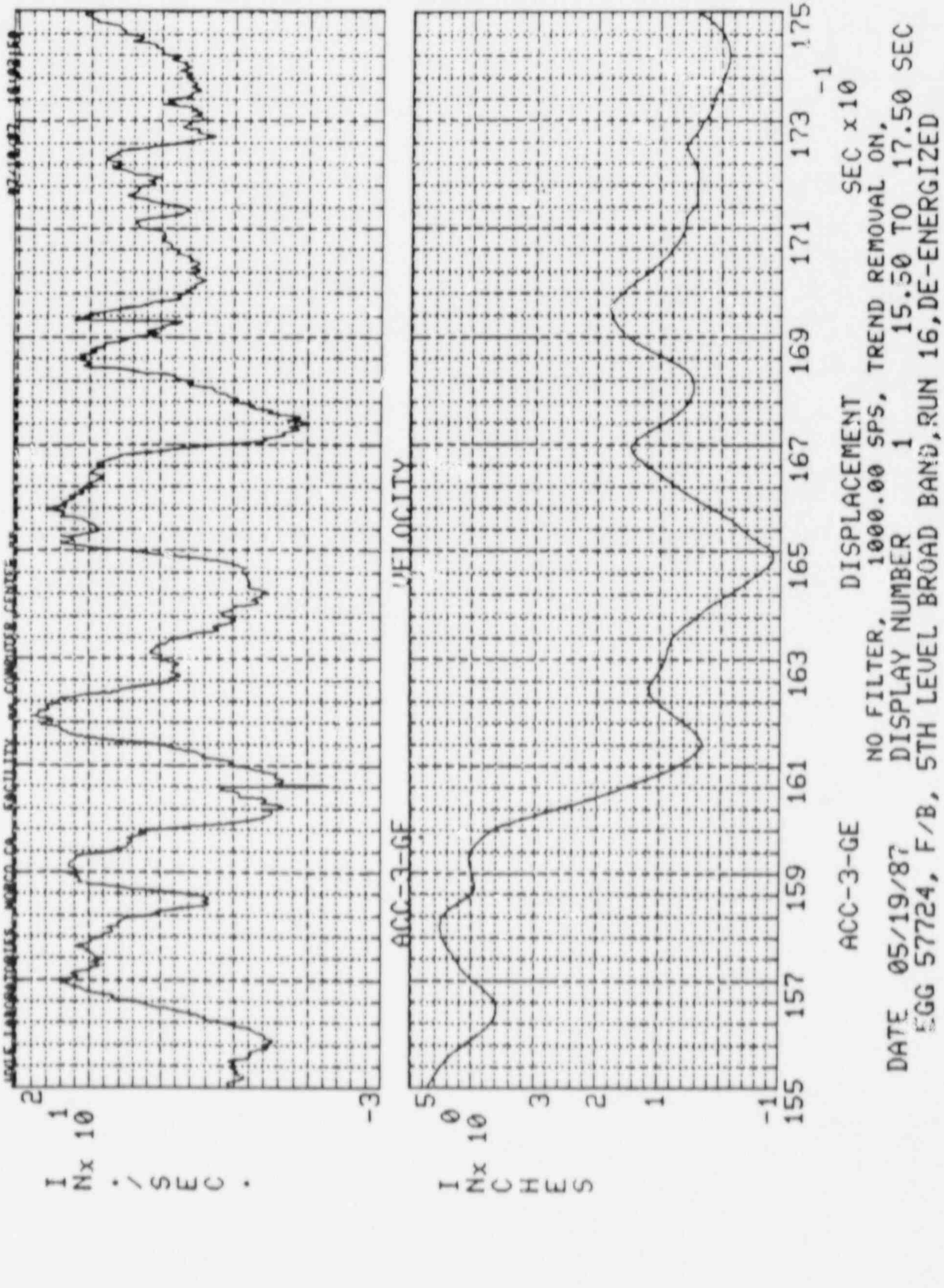
ACC-3-GE TIME HISTORY SEC x 10

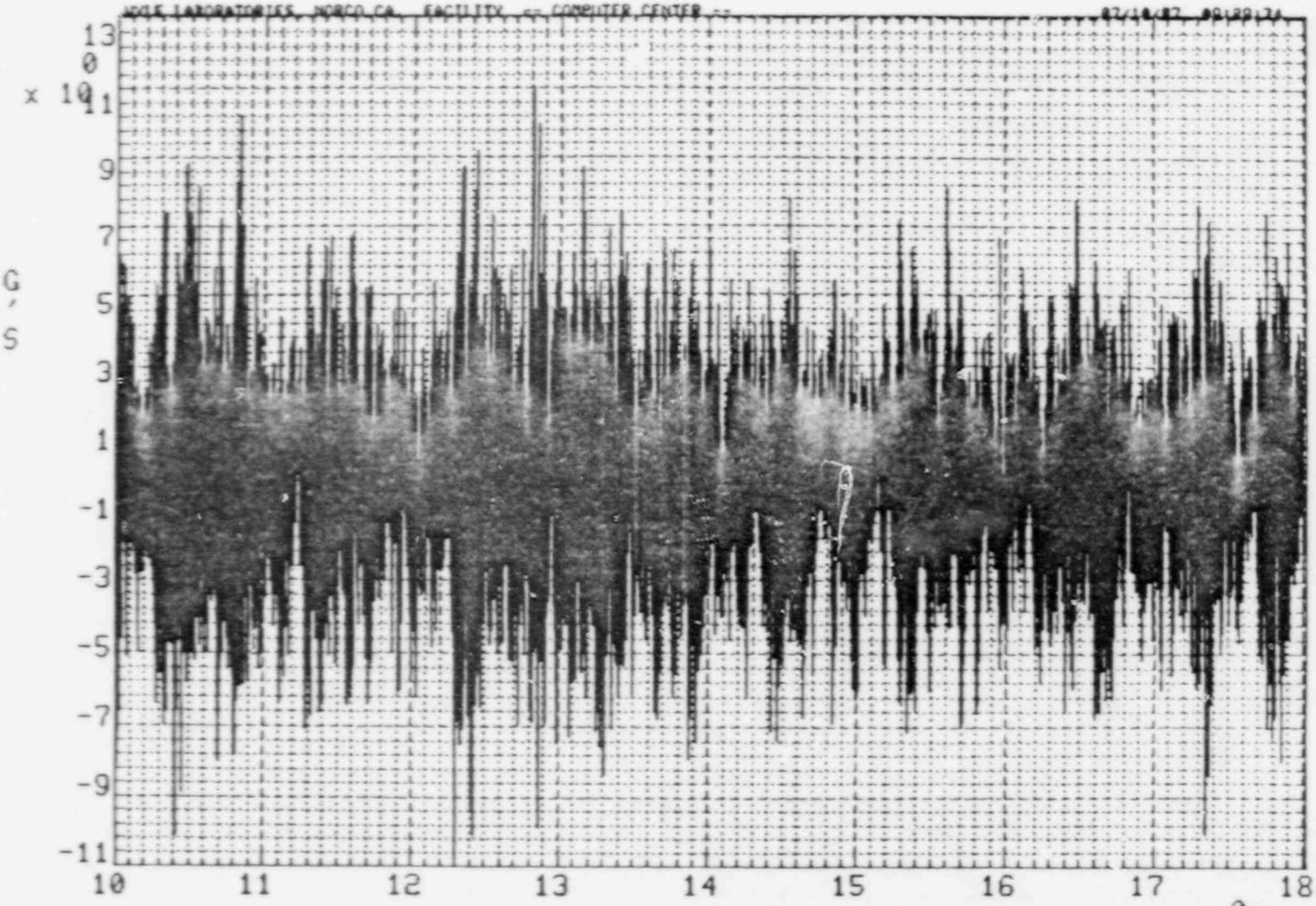
NO FILTER, 1000.00 SPS, TREND REMOVAL ON,

DATE 05/19/87 DISPLAY NUMBER 1 10.00 TO 18.00 SEC

EGG 57724, F/B, 5TH LEVEL BROAD BAND, RUN 16, DE-ENERGIZED


ACC-3-GE VELOCITY
IN/SEC x10^1
INCHES x10^0
ACC-3-GE DISPLACEMENT SEC x10^0
DATE 05/19/87 NO FILTER, 1000.00 SPS, TREND REMOVAL ON,
DISPLAY NUMBER 2 10.00 TO 18.00 SEC
EGG 57724, F/B, 5TH LEVEL BROAD BAND,RUN 16,DE-ENERGIZED


VELOCITY
DISPLACEMENT
ACC-3-GE
INx10 1 /SEC.
INx10 0 INCHES
SEC x10 -1
155 157 159 161 163 165 167 169 171 173 175
ACC-3-GE
NO FILTER, 1000.00 SPS, TREND REMOVAL ON,
DATE 05/19/87 DISPLAY NUMBER 1 15.50 TO 17.50 SEC
EGG 57724, F/B, 5TH LEVEL BROAD BAND, RUN 16, DE-ENERGIZED

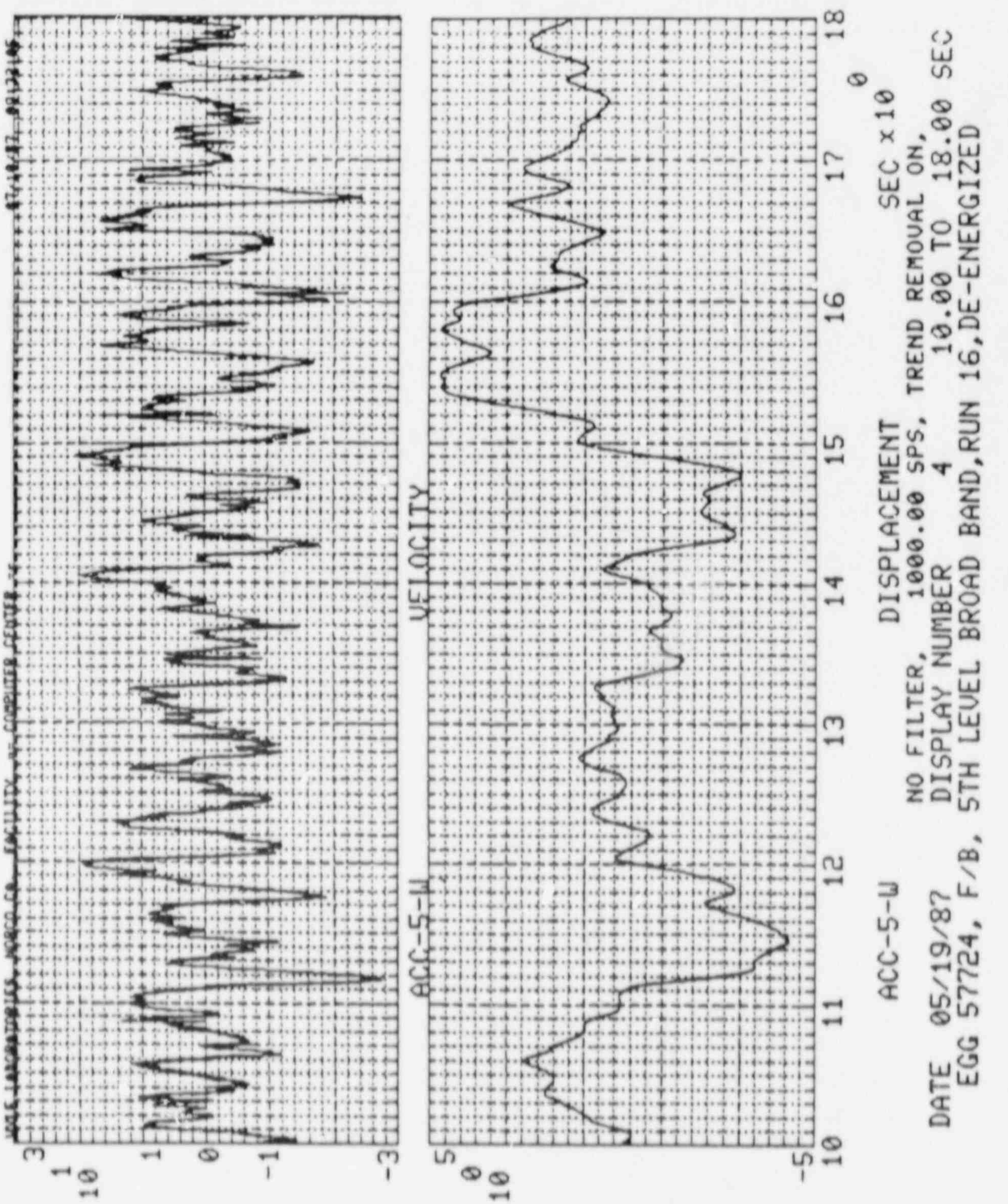


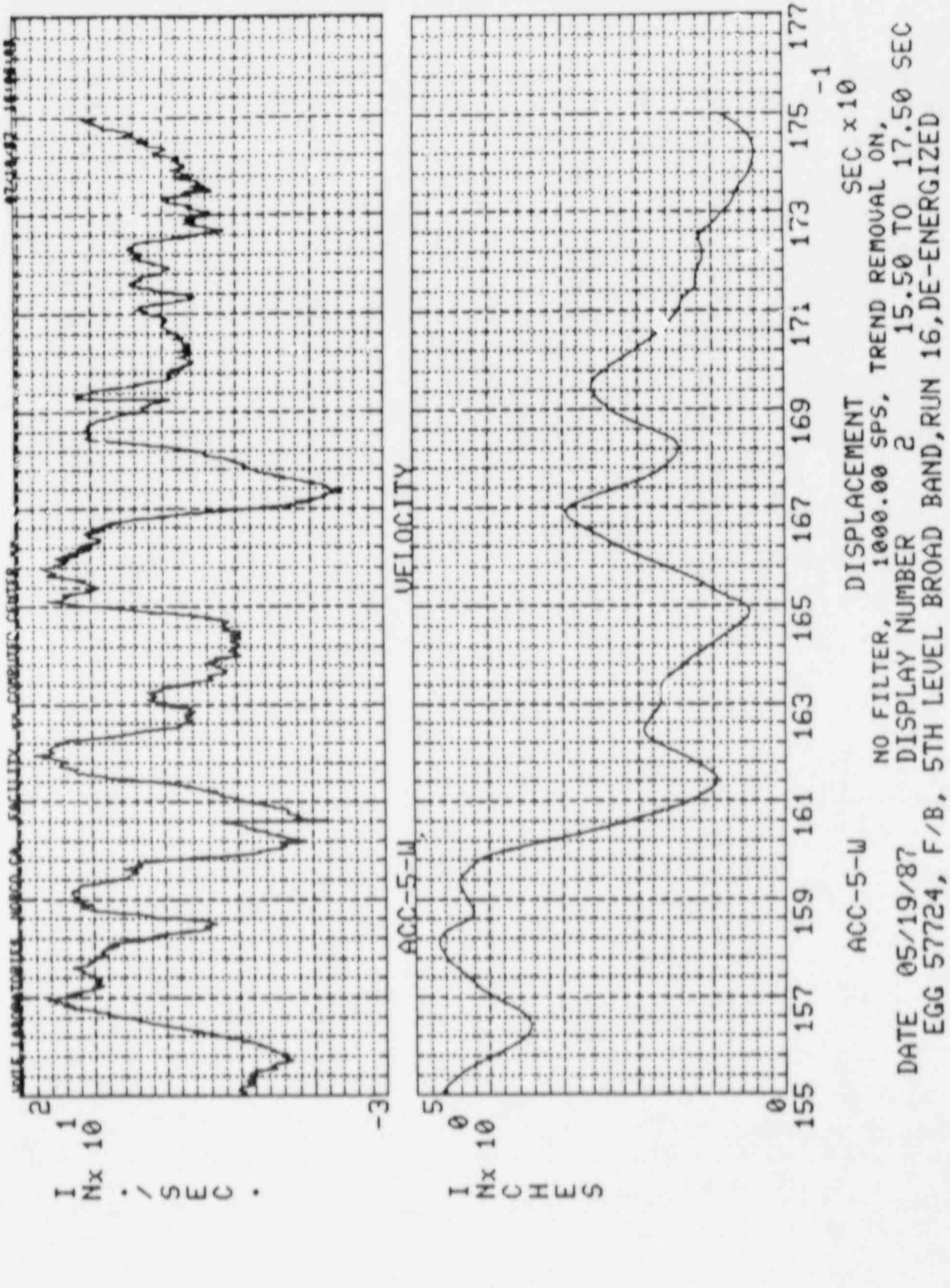
ACC-5-W TIME HISTORY SEC x 10^0

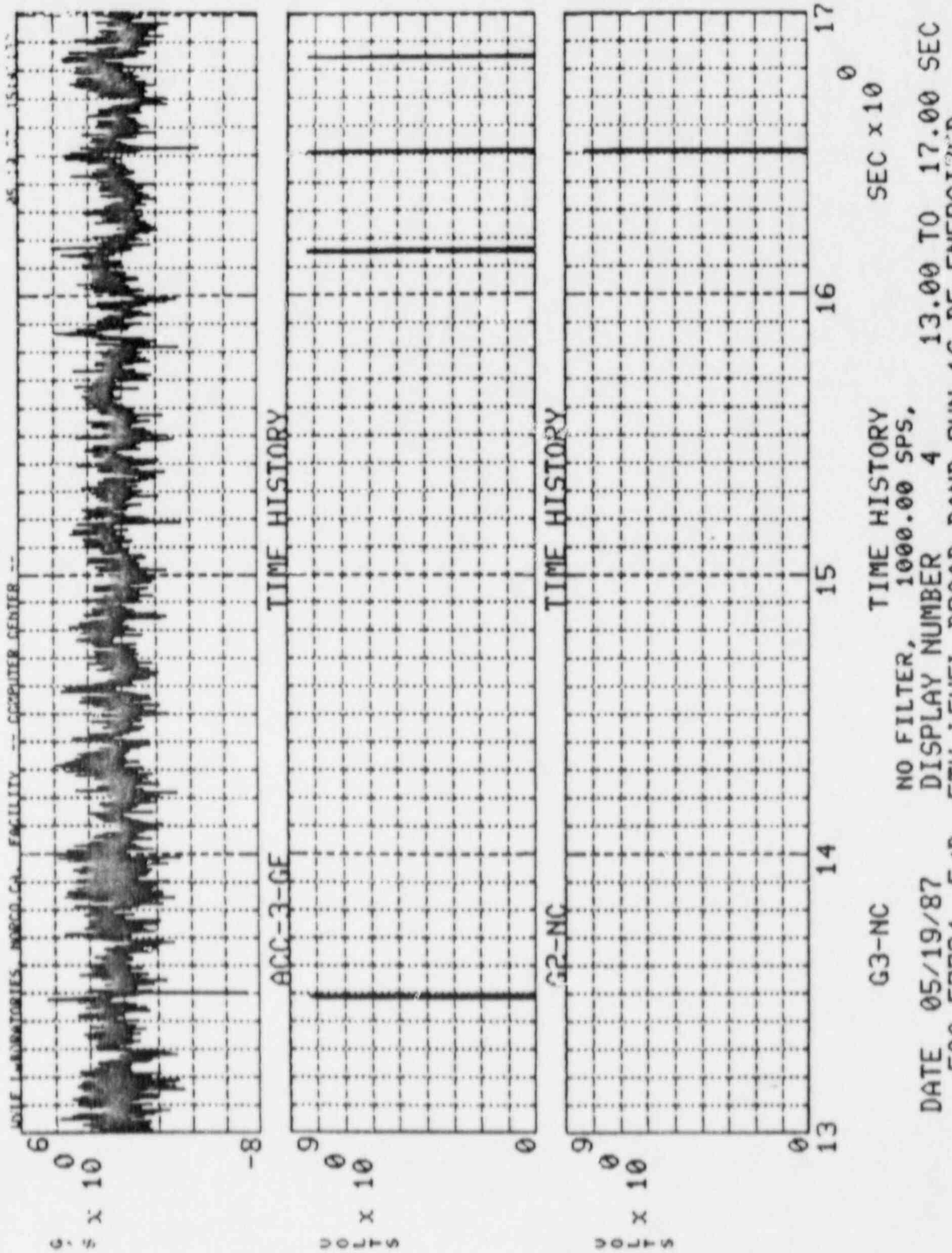
NO FILTER, 1000.00 SPS, TREND REMOVAL ON,

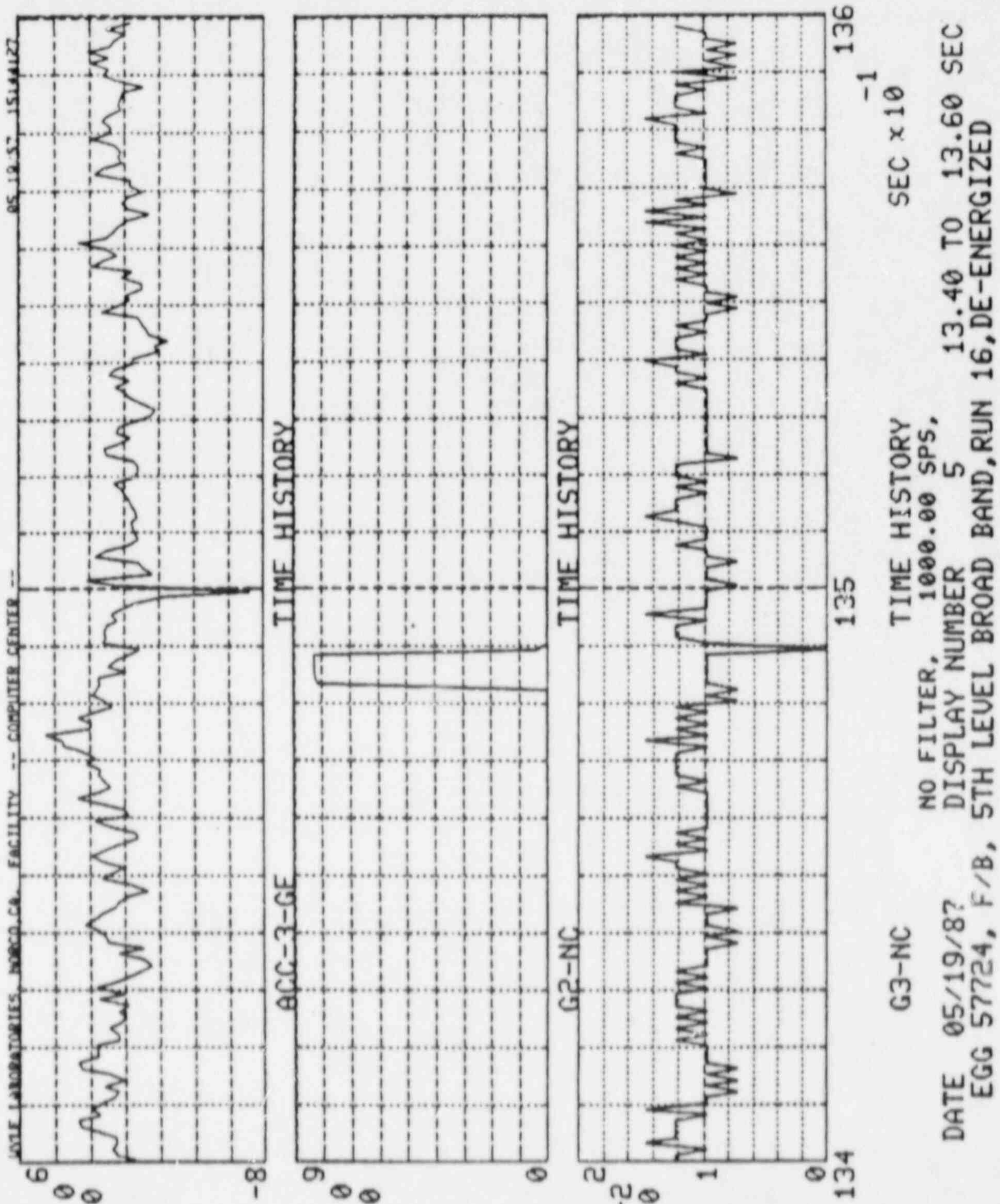
DATE 05/19/87 DISPLAY NUMBER 3 10.00 TO 18.00 SEC

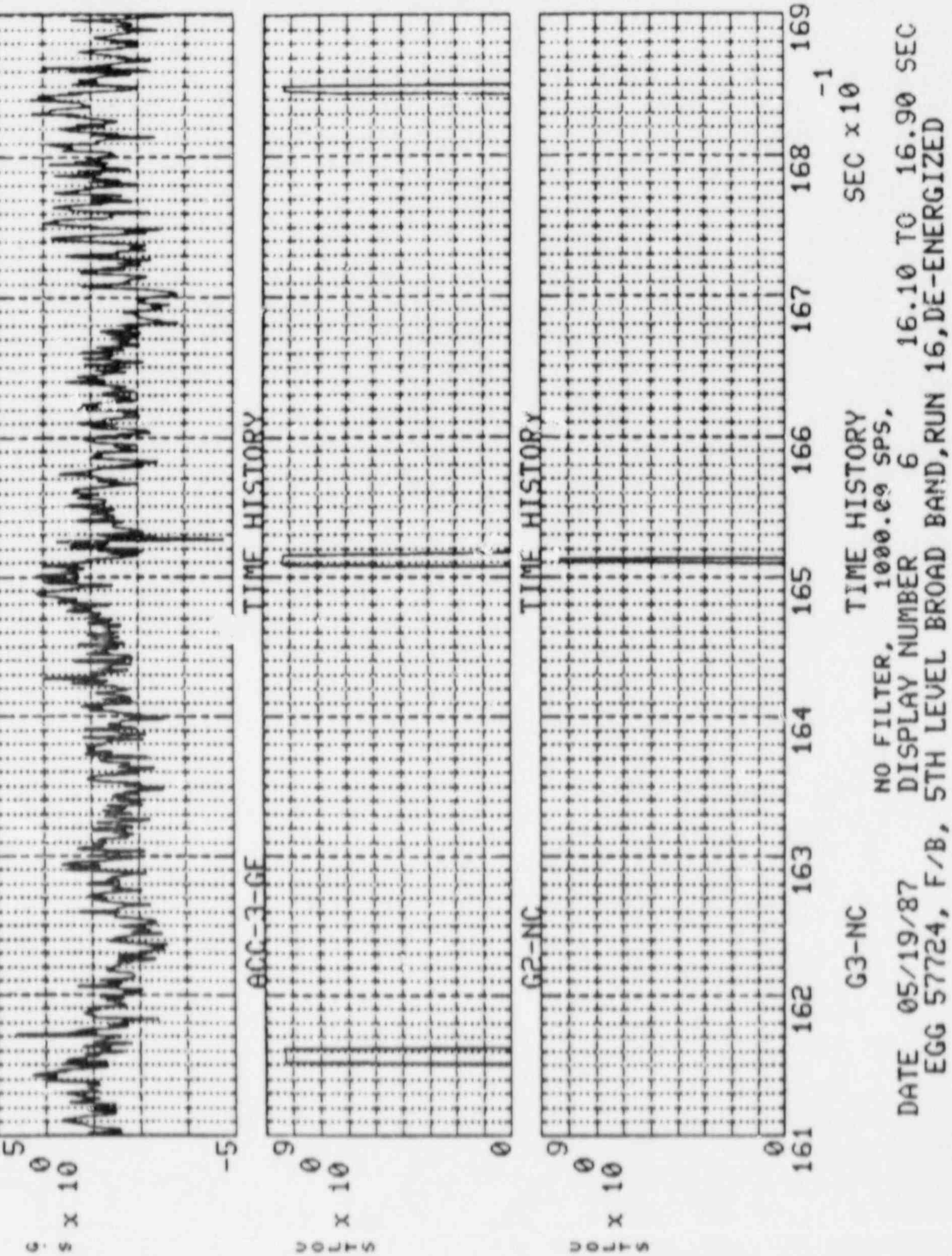
EGG 57724, F/B, 5TH LEVEL BROAD BAND, RUN 16, DE-ENERGIZED

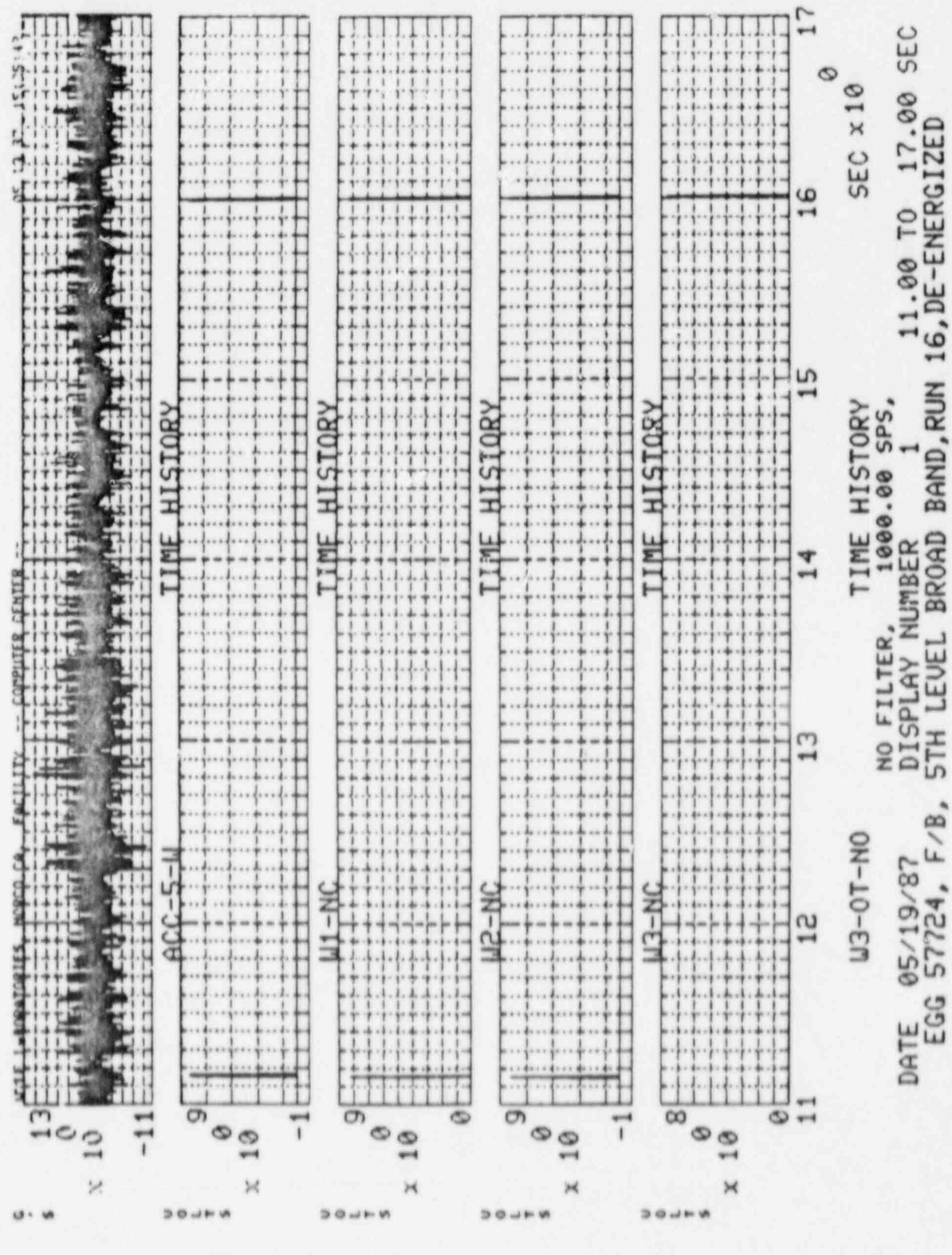

VELOCITY
ACC-5-W
INCHES x 10^0
IN./SEC. x 10^1
ACC-5-W DISPLACEMENT SEC x 10^0
NO FILTER, 1000.00 SPS, TREND REMOVAL ON,
DATE 05/19/87 DISPLAY NUMBER 4 10.00 TO 18.00 SEC
EGG 57724, F/B, 5TH LEVEL BROAD BAND, RUN 16, DE-ENERGIZED

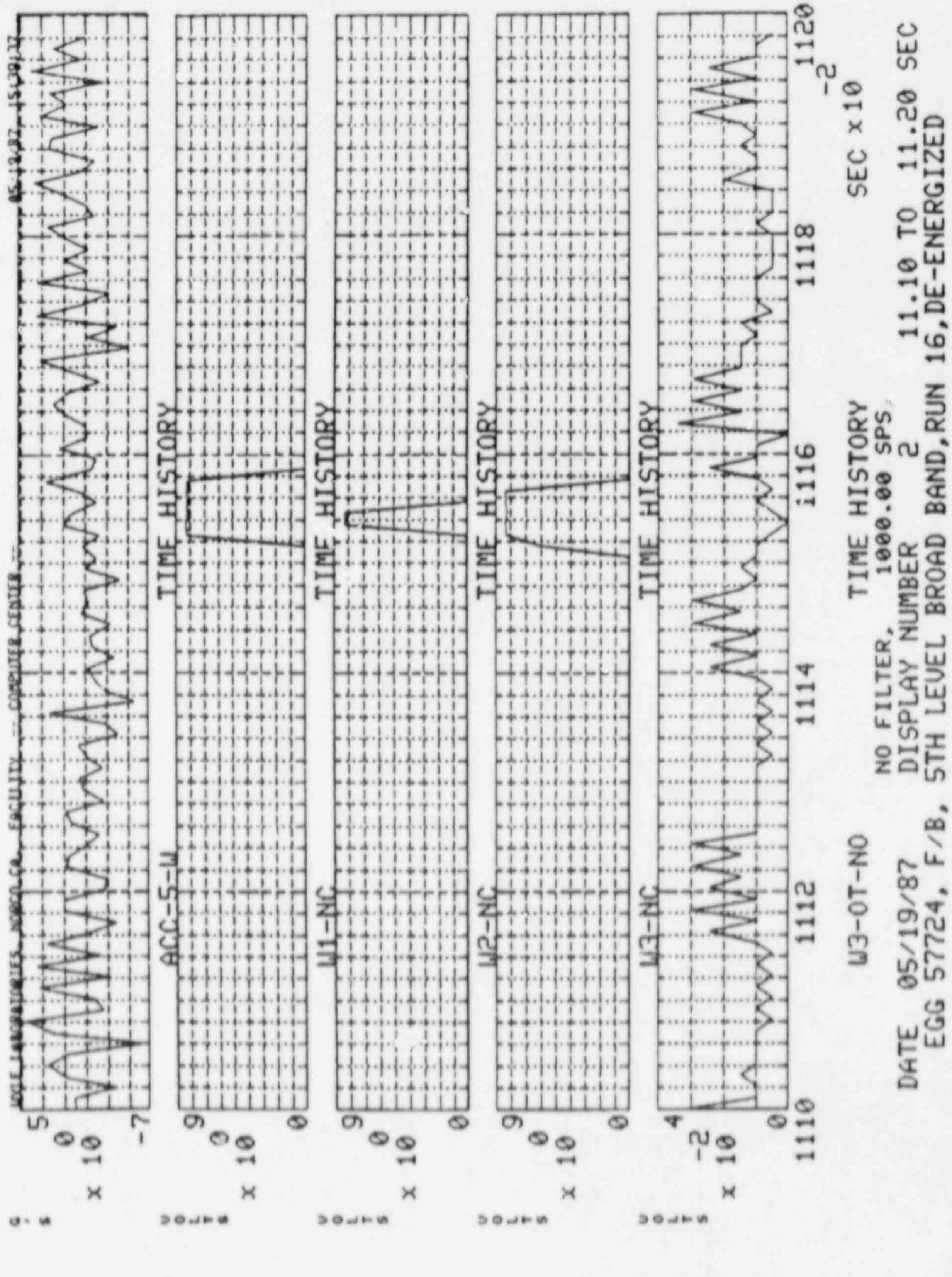

INCHES/SEC x10^1
2
-3
INCHES x10^0
5
0
VELOCITY
ACC-5-W
155
157
159
161
163
165
167
169
171
173
175
177
DISPLACEMENT
SEC x10^-1
ACC-5-W
NO FILTER, 1000.00 SPS, TREND REMOVAL ON,
DATE 05/19/87
DISPLAY NUMBER 2
15.50 TO 17.50 SEC
EGG 57724, F/B, 5TH LEVEL BROAD BAND, RUN 16, DE-ENERGIZED

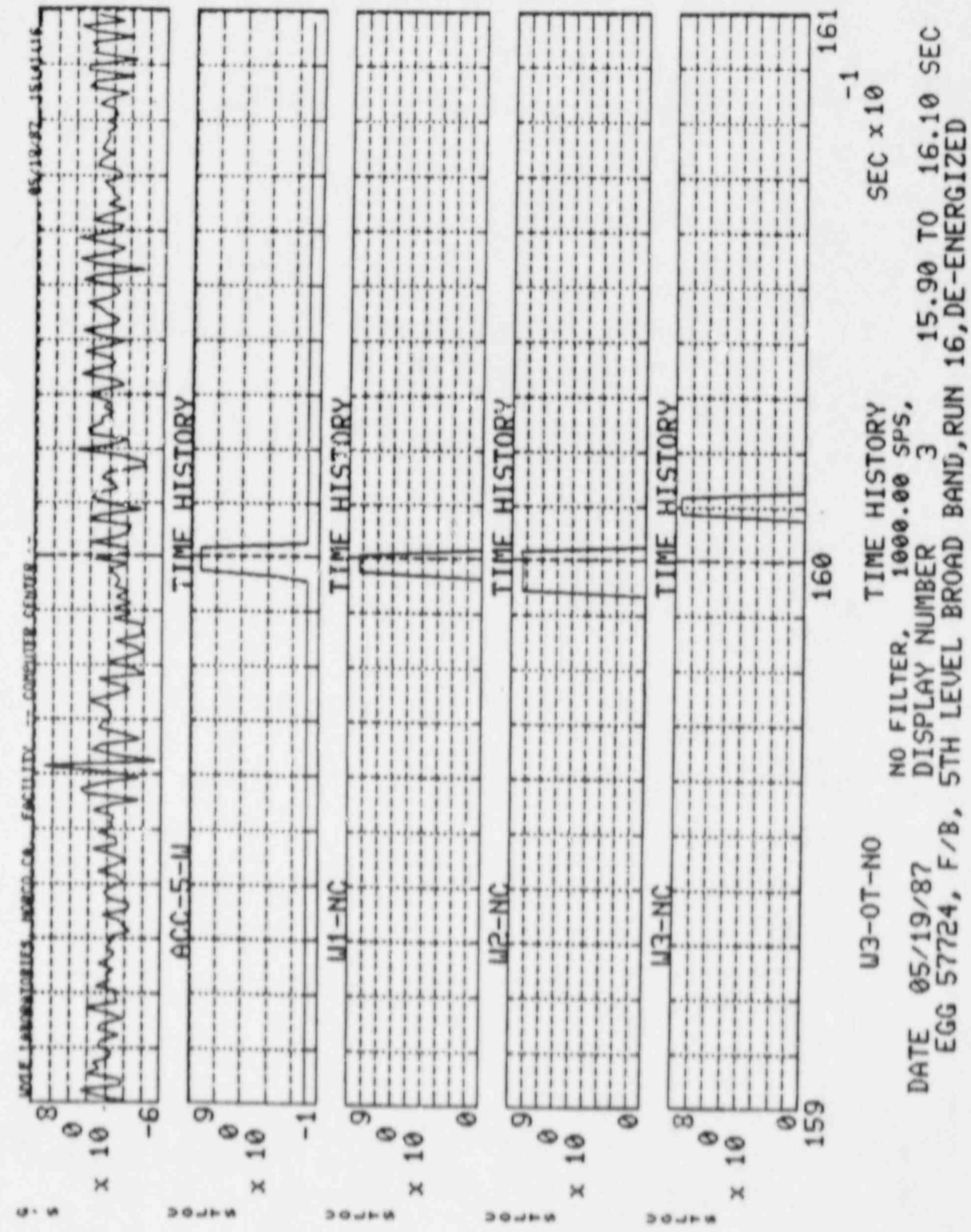

WYLE LABORATORIES NORCO CA. FACILITY -- COMPUTER CENTER --
G's x 10
9
0
-8
ACC-3-GE
TIME HISTORY
VOLTS x 10
9
0
G2-NC
TIME HISTORY
VOLTS x 10
9
0
13
14
15
16
17
SEC x 10
0
G3-NC
TIME HISTORY
NO FILTER, 1000.00 SPS,
DATE 05/19/87 DISPLAY NUMBER 4 13.00 TO 17.00 SEC
EGG 57724, F/B, 5TH LEVEL BROAD BAND,RUN 16,DE-ENERGIZED

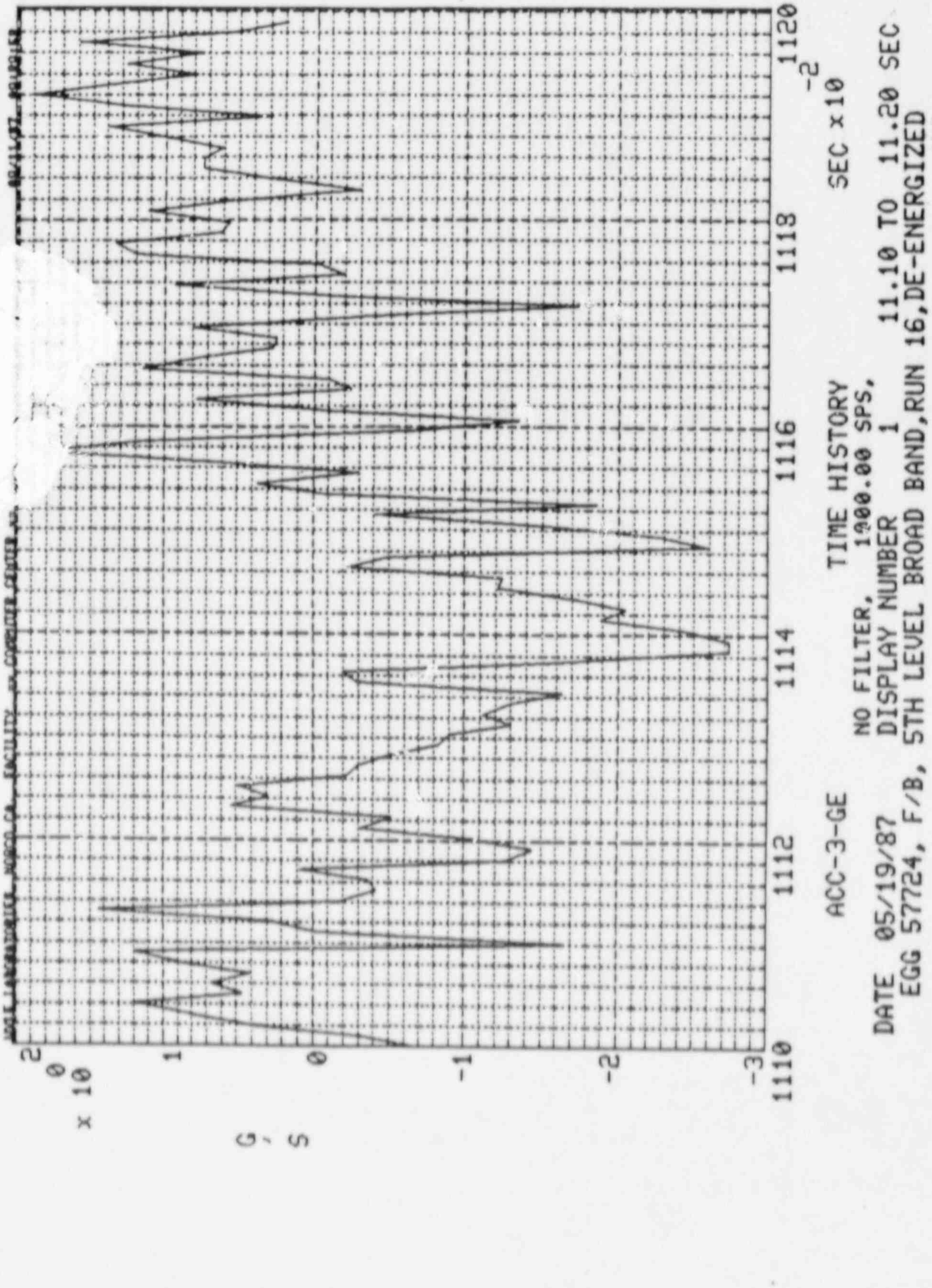

WYLE LABORATORIES, NORCO,CA. FACILITY -- COMPUTER CENTER -- 05.12.57 15:44:27
G3-NC TIME HISTORY
ACC-3-GE TIME HISTORY
G2-NC TIME HISTORY
G'S x 10
VOLTS x 10
VOLTS x 10
134
135
136
SEC x 10^-1
G3-NC
NO FILTER, 1000.00 SPS,
DISPLAY NUMBER 5
13.40 TO 13.60 SEC
DATE 05/19/87
EGG 57724, F/B, 5TH LEVEL BROAD BAND,RUN 16,DE-ENERGIZED

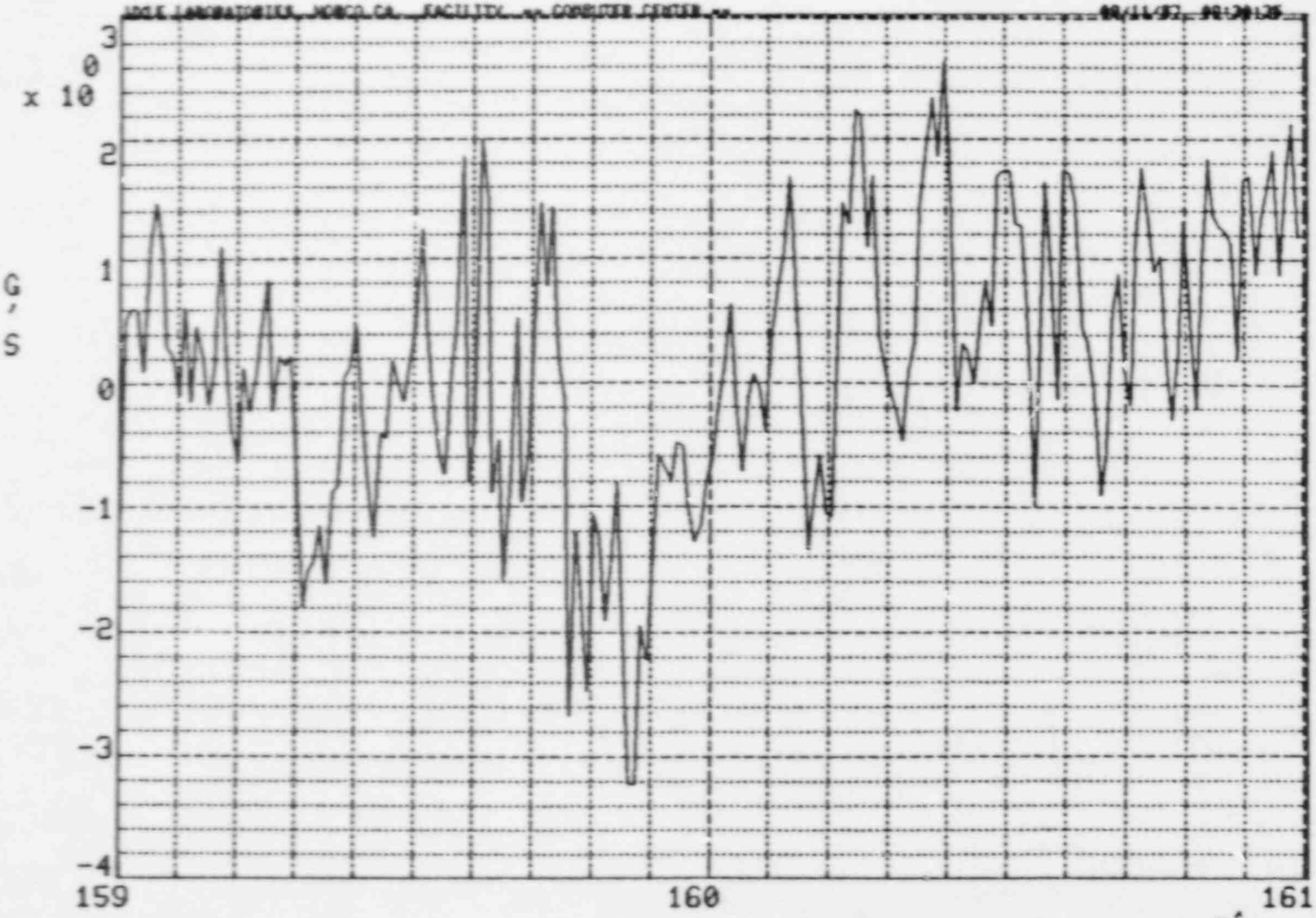

G3-NC TIME HISTORY
ACC-3-GE TIME HISTORY
G2-NC TIME HISTORY
G's x 10
VOLTS x 10
VOLTS x 10
5
0
-5
9
0
9
0
161
162
163
164
165
166
167
168
169
SEC x 10
-1
DATE 05/19/87
NO FILTER, 1000.00 SPS, 16.10 TO 16.90 SEC
DISPLAY NUMBER 6
EGG 57724, F/B, 5TH LEVEL BROAD BAND, RUN 16, DE-ENERGIZED


ACC-5-W
TIME HISTORY
W1-NC
TIME HISTORY
W2-NC
TIME HISTORY
W3-NC
TIME HISTORY
G'S x 10^0
VOLTS x 10^0
11
12
13
14
15
16
17
SEC x 10^0
W3-OT-NO
TIME HISTORY
NO FILTER, 1000.00 SPS,
DATE 05/19/87 DISPLAY NUMBER 1 11.00 TO 17.00 SEC
EGG 57724, F/B, 5TH LEVEL BROAD BAND, RUN 16, DE-ENERGIZED


ACC-5-W
W1-NC
W2-NC
W3-NC
TIME HISTORY
G'S x 10
VOLTS x 10
1110
1112
1114
1116
1118
1120
SEC x10^-2
W3-OT-NO
TIME HISTORY
NO FILTER, 1000.00 SPS
DISPLAY NUMBER 2
DATE 05/19/87
11.10 TO 11.20 SEC
EGG 57724, F/B, 5TH LEVEL BROAD BAND, RUN 16, DE-ENERGIZED


WYLE LABORATORIES NORCO CA. FACILITY -- COMPUTER CENTER -- 05/19/87 15:41:16
ACC-5-W TIME HISTORY
W1-NC TIME HISTORY
W2-NC TIME HISTORY
W3-NC TIME HISTORY
159
160
161
SEC x10 -1
W3-OT-NO NO FILTER, 1000.00 SPS, TIME HISTORY
DATE 05/19/87 DISPLAY NUMBER 3 15.90 TO 16.10 SEC
EGG 57724, F/B, 5TH LEVEL BROAD BAND, RUN 16, DE-ENERGIZED


ACC-3-GE
TIME HISTORY
DATE 05/19/87
NO FILTER, 1900.00 SPS,
DISPLAY NUMBER 1
11.10 TO 11.20 SEC
EGG 57724, F/B, 5TH LEVEL BROAD BAND, RUN 16, DE-ENERGIZED
G'S x 10^0
SEC x10^-2
1110
1112
1114
1116
1118
1120
2
1
0
-1
-2
-3



ACC-3-GE TIME HISTORY

NO FILTER, 1000.00 SPS,

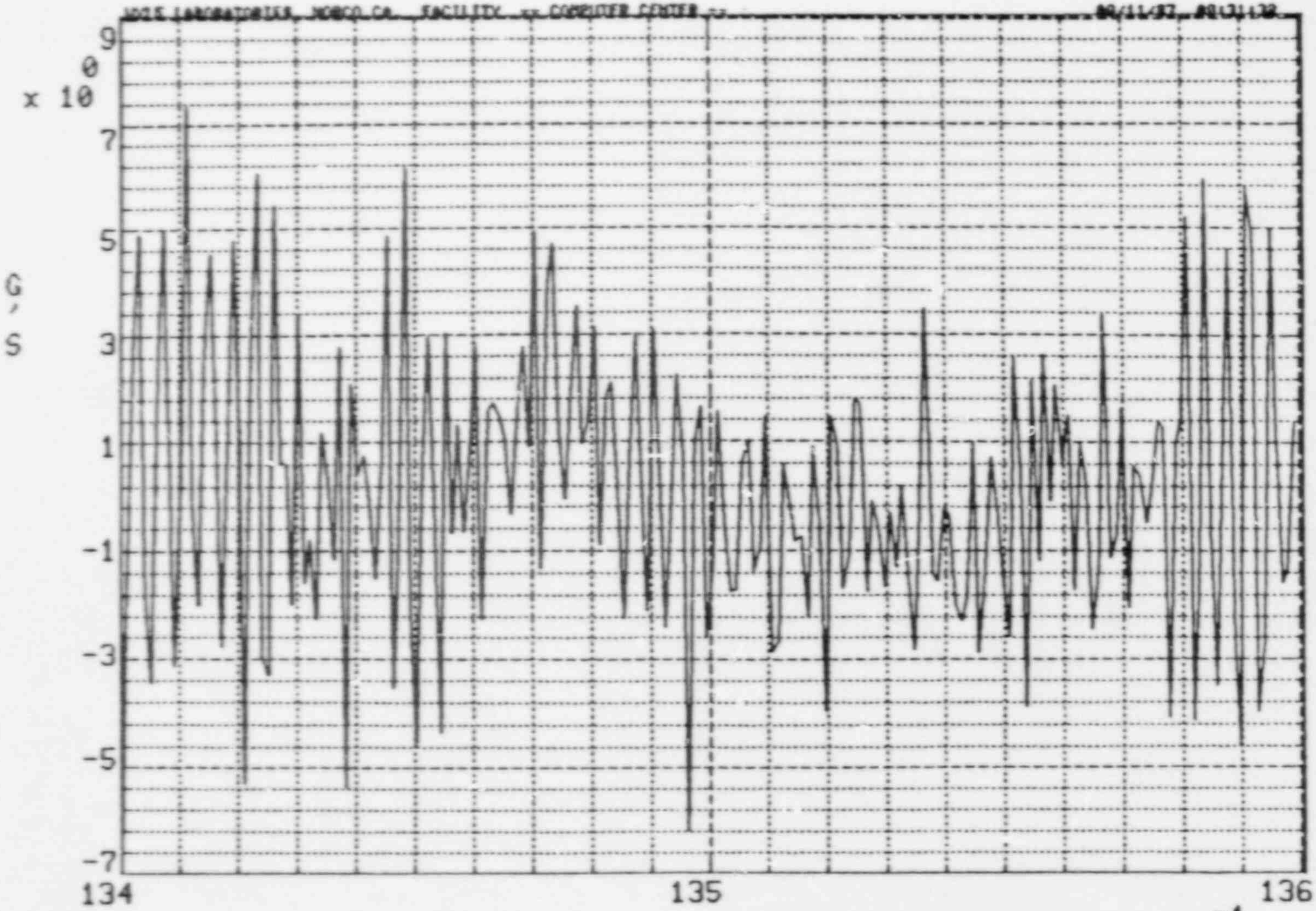
DATE 05/19/87 DISPLAY NUMBER 2 15.90 TO 16.10 SEC

EGG 57724, F/B, 5TH LEVEL BROAD BAND, RUN 16, DE-ENERGIZED

Report No. 57724

Page No. 87b

Revision A



ACC-5-W TIME HISTORY SEC x 10

NO FILTER, 1000.00 SPS,

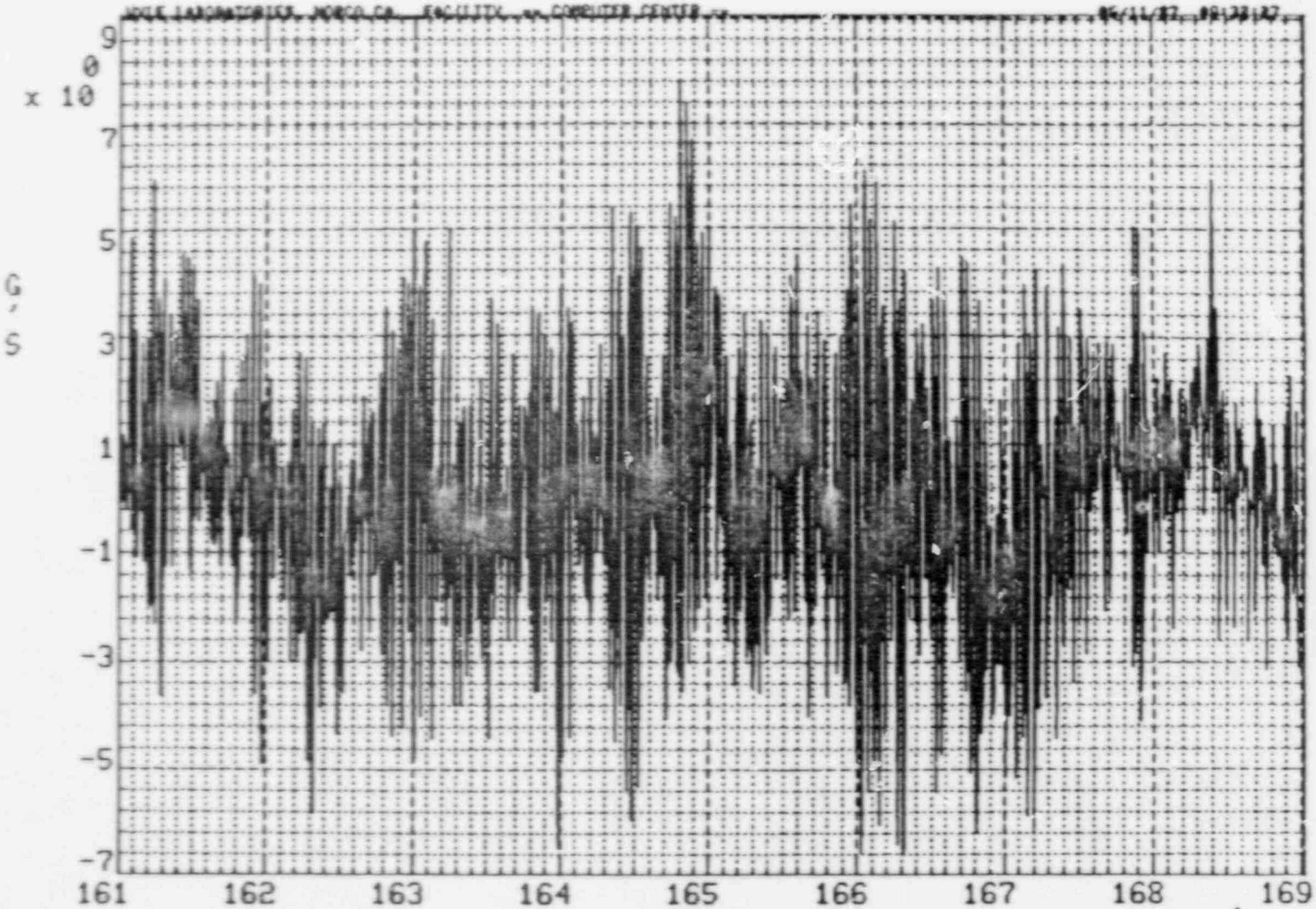
DATE 05/19/87 DISPLAY NUMBER 3 13.40 TO 13.60 SEC

EGG 57724, F/B, 5TH LEVEL BROAD BAND,RUN 16,DE-ENERGIZED

Report No. 57724

Page No. E-87c

Revision A



ACC-5-W TIME HISTORY SEC x 10^{-1}

NO FILTER, 1000.00 SPS,

DATE 05/19/87 DISPLAY NUMBER 4 16.10 TO 16.90 SEC

EGG 57724, F/B, 5TH LEVEL BROAD BAND, RUN 16, DE-ENERGIZED

WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

CUSTOMER EG & G Job No. 57724 Date 5-19-87

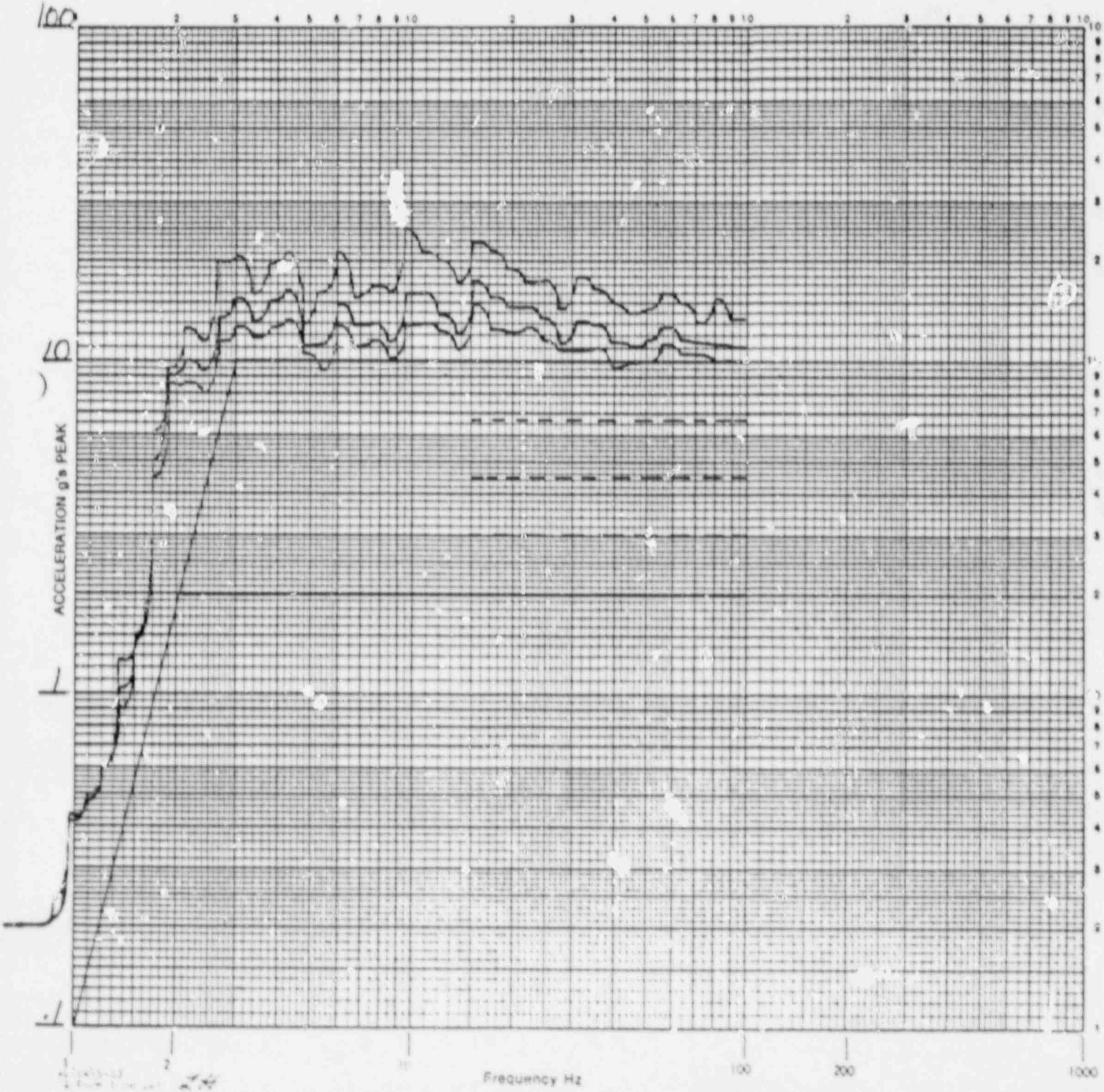
Specimen ELECTRONIC COMPONENTS Axis of Test X

Accel. No. 1 Axis Horiz Control (✓) Response ( ) OBE ( ) SSE ( ) DBE ( )

Full Scale 100 g Damping 1,(2%),3 % Run No. BROAD BAND FREQUENCY RUN#17

Operator GREIERMAN Engineer [illegible]

RESPONSE SPECTRUM



WYLE LABORATORIES,NORCO,CA. FACILITY CHATTER AND PULSE ANALYSIS PROGRAM 05/19/87 15:54:23 HOURS PAGE 1

START TIME= 0.0000 STOP TIME= 17.784

TEST NAME=EGG 57724, F/B, 5TH LEVEL BROAD BAND,RUN 17, ENERGIZED
TEST DATE=05/19/87 15:50:27 HOURS

CHANNEL ID	CHANNEL NUMBER	FIRST CHATTER	LAST CHATTER	STATE CHANGE	NUMBER OF CHATTER FAILURES PER TIME LENGTH 2.00-5.00	5.00-10.0	10.0-20.0	20.0-40.0	40.0-80.0	80.0	TOTAL
W1-NC	2			0	NO CHATTER						
W1-NO	3			0	NO CHATTER						
W2-NC	4			0	NO CHATTER						
W2-NO	6			0	NO CHATTER						
W3-NC	7			0	NO CHATTER						
W3-NO	8			0	NO CHATTER						
G1-NC	10			0	NO CHATTER						
G1-NO	11			0	NO CHATTER						
G2-NC	12			0	NO CHATTER						
G2-NO	13			0	NO CHATTER						
G3-NC	14			0	NO CHATTER						
G3-NO	15			0	NO CHATTER						
W1-OT-NO	16			0	NO CHATTER						
W2-OT-NO	17			0	NO CHATTER						
W3-OT-NO	18			0	NO CHATTER						
G1-OT-NO	19			0	NO CHATTER						
G2-OT-NO	20			0	NO CHATTER						
G3-OT-NO	21			0	NO CHATTER						
	22			0	NO CHATTER						
										TOTAL=	0

WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

CUSTOMER EG & G Job No. 57724 Date 5-27-87

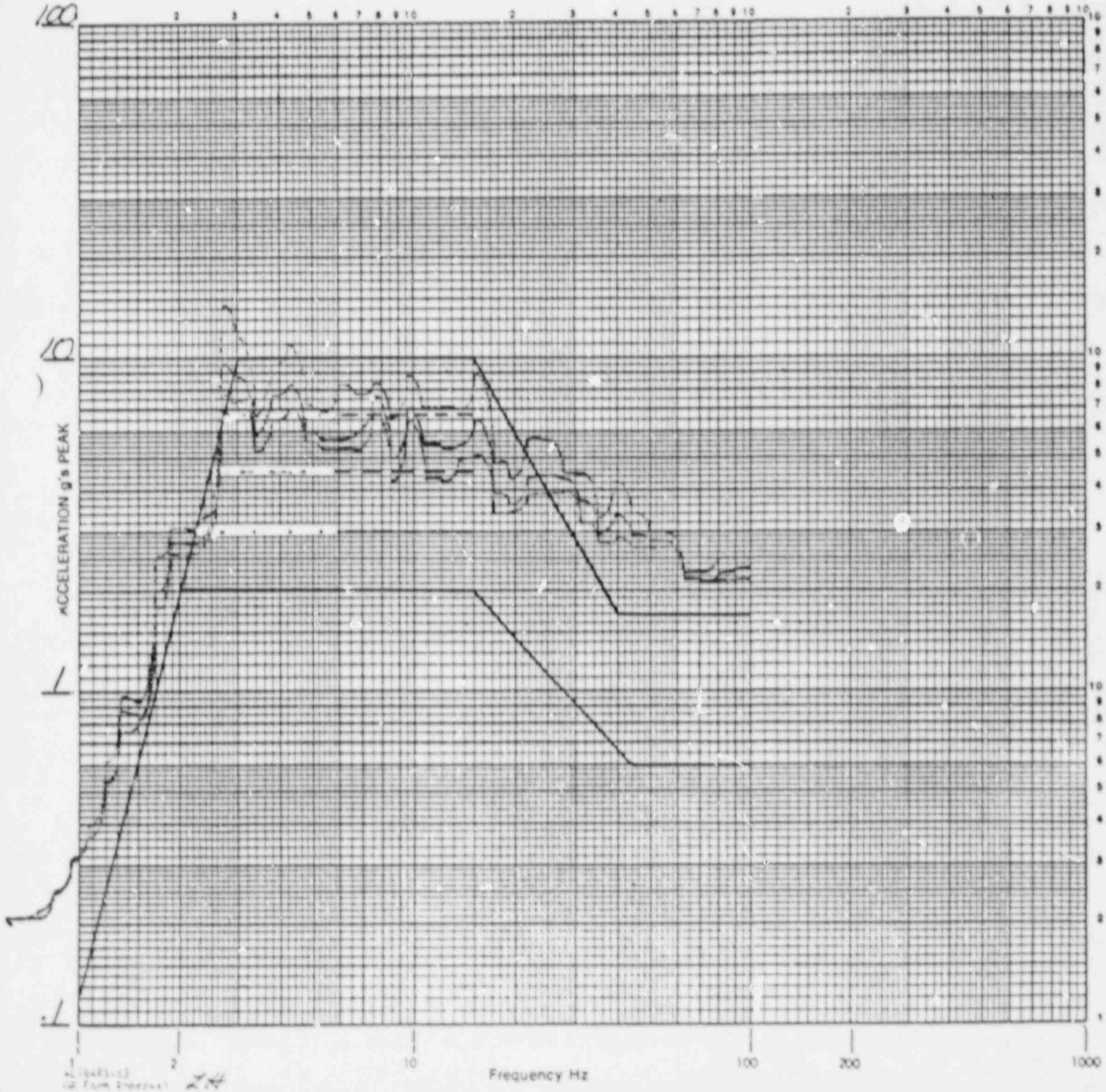
Specimen ELECTRICAL COMPONENTS Axis of Test V

Accel. No. 1 Axis VERT Control (✓) Response ( ) OBE ( ) SSE ( ) DBE ( )

Full Scale 100 g Damping 1,(2%),3 % Run No. LOW FREQUENCY 18 3RD LEVEL

Operator GREIERMAN Engineer [signature]

RESPONSE SPECTRUM



START TIME= 0.0000 STOP TIME= 21.582

TEST NAME=EGG 57724 VERT., 3RD LEVEL, LO-FREQ, RUN 18 DE-ENERGIZED
TEST DATE=05/27/87 16: 5:46 HOURS

CHANNEL ID	CHANNEL NUMBER	FIRST CHATTER	LAST CHATTER	STATE CHANGE	NUMBER OF CHATTER FAILURES PER TIME LENGTH 2.00-5.00	5.00-10.0	10.0-20.0	20.0-40.0	40.0-80.0	>80.0	TOTAL
W1-NC	2			0	NO CHATTER						
W1-NO	3			0	NO CHATTER						
W2-NC	4			0	NO CHATTER						
W2-NO	6			0	NO CHATTER						
W3-NC	7			0	NO CHATTER						
W3-NO	8			0	NO CHATTER						
G1-NC	10			0	NO CHATTER						
G1-NO	11			0	NO CHATTER						
G2-NC	12			0	NO CHATTER						
G2-NO	13			0	NO CHATTER						
G3-NC	14			0	NO CHATTER						
G3-NO	15			0	NO CHATTER						
W1-OT-NO	16			0	NO CHATTER						
W2-OT-NO	17			0	NO CHATTER						
W3-OT-NO	18			0	NO CHATTER						
G1-OT-NO	19			0	NO CHATTER						
G2-OT-NO	20			0	NO CHATTER						
G3-OT-NO	21			0	NO CHATTER						
	22			0	NO CHATTER						
										TOTAL=	0

WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

CUSTOMER EG & G Job No. 57724 Date 5-27-87

Specimen ELECTRICAL COMPONENTS Axis of Test Y

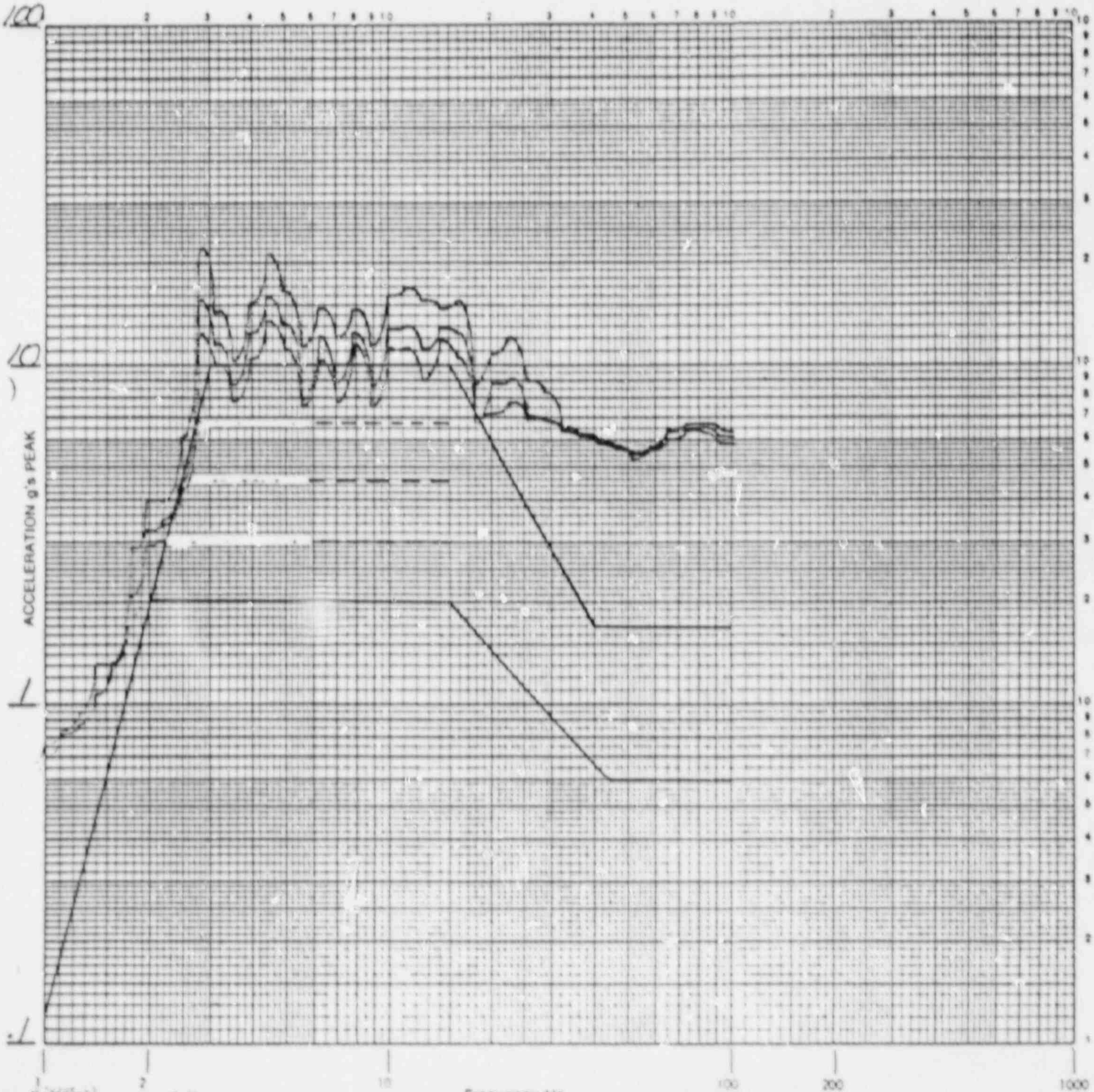
Accel. No. 1 Axis VERT Control (✓) Response ( ) OBE ( ) SSE ( ) DBE ( )

Full Scale 100 g Damping 1,(2%),3 %

Run No. LOW FREQUENCY/19 4TH LEVEL

Operator GREIERMAN Engineer

RESPONSE SPECTRUM



START TIME- 0.0000 STOP TIME- 34.989

TEST NAME-EGG 57724 VERT., 4TH LEVEL, LO-FREQ, RUN-19 DE-ENGERIZED
TEST DATE-05/27/87 16:17:52 HOURS

CHANNEL ID	CHANNEL NUMBER	FIRST CHATTER	LAST CHATTER	STATE CHANGE	NUMBER OF CHATTER FAILURES PER TIME LENGTH 2.00-5.00	5.00-10.0	10.0-20.3	20.0-40.0	40.0-80.0	>80.0	TOTAL
W1-NC	2			0	NO CHATTER						
W1-NO	3			0	NO CHATTER						
W2-NC	4			0	NO CHATTER						
W2-NO	6			0	NO CHATTER						
W3-NC	7			0	NO CHATTER						
W3-NO	8			0	NO CHATTER						
G1-NC	10			0	NO CHATTER						
G1-NO	11			0	NO CHATTER						
G2-NC	12			0	NO CHATTER						
G2-NO	13			0	NO CHATTER						
G3-NC	14			0	NO CHATTER						
G3-NO	15			0	NO CHATTER						
W1-OT-NO	16			0	NO CHATTER						
W2-OT-NO	17			0	NO CHATTER						
W3-OT-NO	18			0	NO CHATTER						
G1-OT-NO	19			0	NO CHATTER						
G2-OT-NO	20			0	NO CHATTER						
G3-OT-NO	21			0	NO CHATTER						
	22			0	NO CHATTER						
										TOTAL=	0

Report No. 57724

WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

CUSTOMER EG & G Job No. 57724 Date 5-27-87

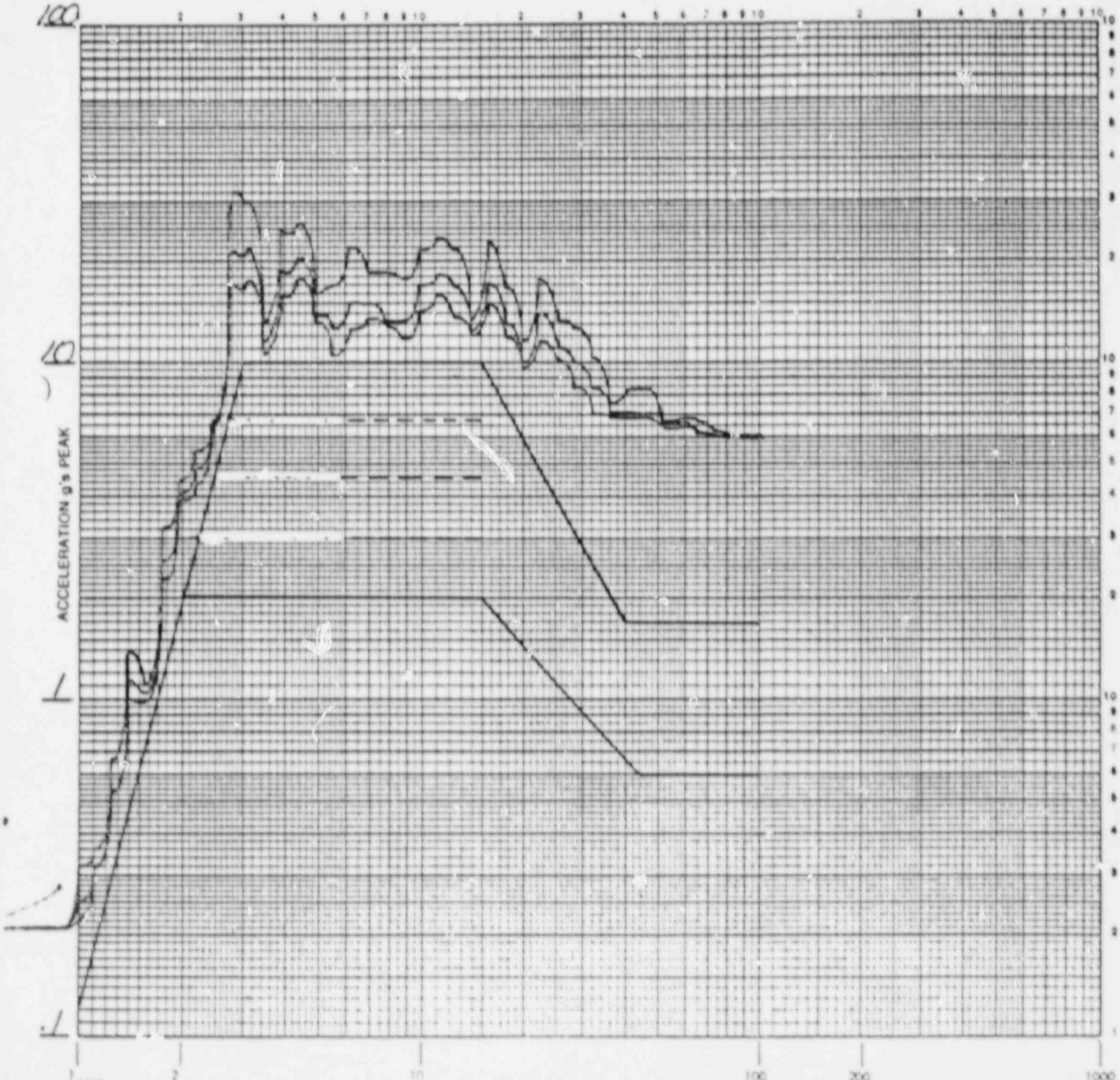
Specimen ELECTRICAL COMPONENTS Axis of Test Y

Accel. No. 1 Axis VERT Control (✓) Response ( ) OBE ( ) SSE ( ) DBE ( )

Full Scale 100 g Damping 1,(2%),3 % Run No. LOW FREQUENCY 20 5th LEVEL

Operator BREITERMAN Engineer

RESPONSE SPECTRUM



WYLE LABORATORIES,NORCO,CA. FACILITY CHATTER AND PULSE ANALYSIS PROGRAM 05/27/87 16:26:37 HOURS PAGE 1

START TIME= 0.0000 STOP TIME= 21.582

TEST NAME=EGG 57724 VERT., 5TH LEVEL, LO-FREQ, RUN-20 DE-ENERGIZED
TEST DATE=05/27/87 16:25:20 HOURS

CHANNEL ID	CHANNEL NUMBER	FIRST CHATTER	LAST CHATTER	STATE CHANGE	NUMBER OF CHATTER FAILURES PER TIME LENGTH 2.00-5.00	5.00-10.0	10.0-20.0	20.0-40.0	40.0-80.0	>80.0	TOTAL
W1-NC	2			0	NO CHATTER						
W1-NO	3			0	NO CHATTER						
W2-NC	4			0	NO CHATTER						
W2-NO	6			0	NO CHATTER						
W3-NC	7			0	NO CHATTER						
W3-NO	8			0	NO CHATTER						
G1-NC	10			0	NO CHATTER						
G1-NO	11			0	NO CHATTER						
G2-NC	12			0	NO CHATTER						
G2-NO	13			0	NO CHATTER						
G3-NC	14			0	NO CHATTER						
G3-NO	15			0	NO CHATTER						
W1-OT-NO	16			0	NO CHATTER						
W2-OT-NO	17			0	NO CHATTER						
W3-OT-NO	18			0	NO CHATTER						
G1-OT-NO	19			0	NO CHATTER						
G2-OT-NO	20			0	NO CHATTER						
G3-OT-NO	21			0	NO CHATTER						
	22			0	NO CHATTER						
										TOTAL=	0

Report No. 57724

CUSTOMER EG & G Job No. 57724 Date 5-27-87

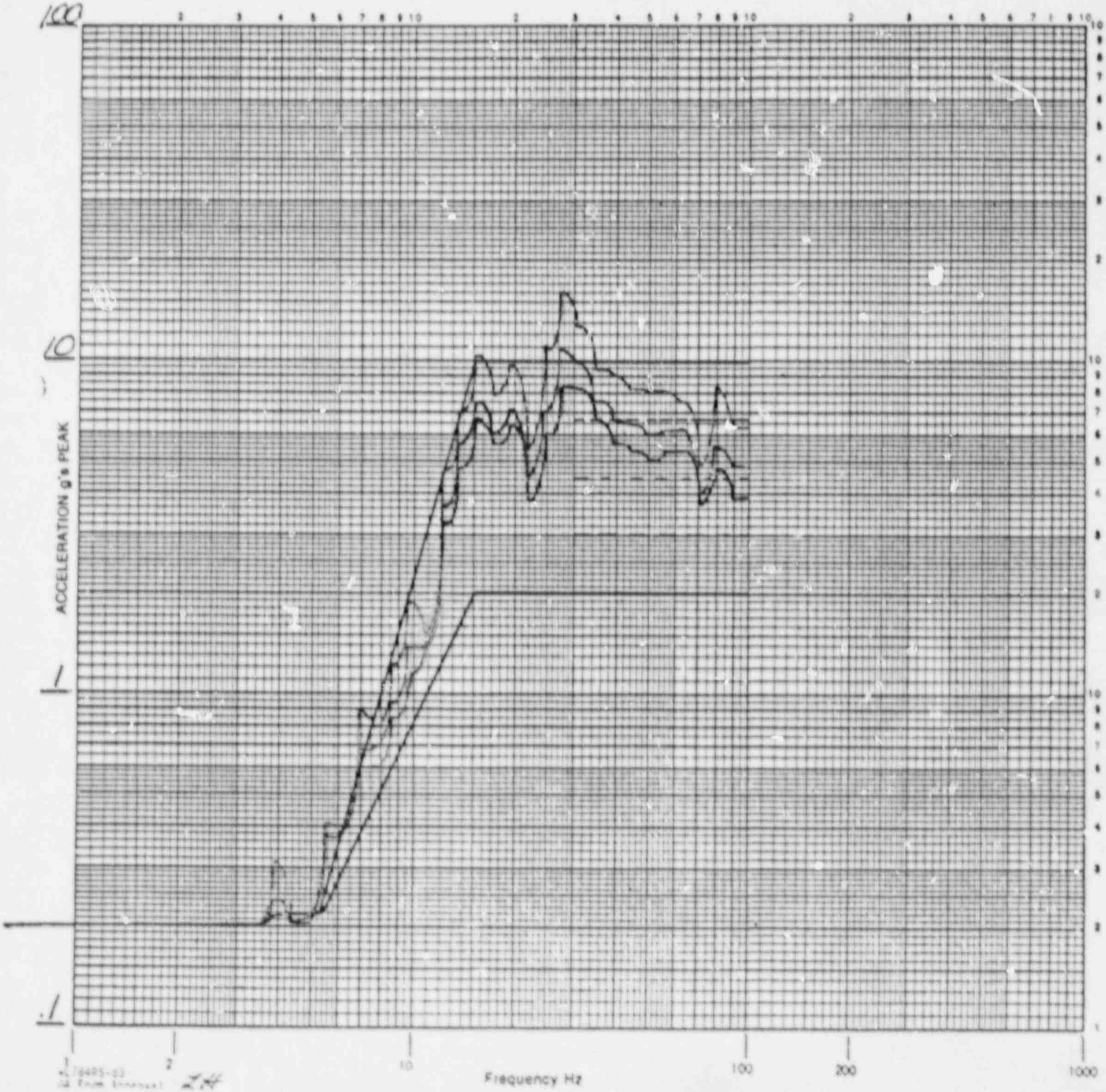
Specimen ELECTRONIC COMPONENTS Axis of Test Y

Accel. No. 1 Axis VERT Control (✓) Response ( ) OBE ( ) SSE ( ) OBE ( )

Full Scale 100 g Damping 1,(2%),3 % Run No HIGH FREQUENCY RUN # 21 3RD LEVEL

Operator BREIERMAN Engineer

RESPONSE SPECTRUM



WYLE LABORATORIES,NORCO,CA. FACILITY CHATTER AND PULSE ANALYSIS PROGRAM 05/28/87 09:50:37 HOURS PAGE 1

START TIME= 0.0000 STOP TIME= 20.601

TEST NAME=EGG 57724 VERT., 3RD LEVEL, HI-FREQ, RUN-21 DE-ENERGIZED
TEST DATE=05/28/87 9:48:47 HOURS

CHANNEL ID	CHANNEL NUMBER	FIRST CHATTER	LAST CHATTER	STATE CHANGE	NUMBER OF CHATTER FAILURES PER TIME LENGTH 2.00-5.00	5.00-10.0	10.0-20.0	20.0-40.0	40.0-80.0	>80.0	TOTAL
W1-NC	2			0	NO CHATTER						
W1-NO	3			0	NO CHATTER						
W2-NC	4			0	NO CHATTER						
W2-NO	6			0	NO CHATTER						
W3-NC	7			0	NO CHATTER						
W3-NO	8			0	NO CHATTER						
G1-NC	10			0	NO CHATTER						
G1-NO	11			0	NO CHATTER						
G2-NC	12			0	NO CHATTER						
G2-NO	13			0	NO CHATTER						
G3-NC	14			0	NO CHATTER						
G3-NO	15			0	NO CHATTER						
W1-OT-NO	16			0	NO CHATTER						
W2-OT-NO	17			0	NO CHATTER						
W3-OT-NO	18			0	NO CHATTER						
G1-OT-NO	19			0	NO CHATTER						
G2-OT-NO	20			0	NO CHATTER						
G3-OT-NO	21			0	NO CHATTER						
	22			0	NO CHATTER						
										TOTAL=	0

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WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

Report No. 57724

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CUSTOMER EG & G Job No. 57724 Date 5-27-87

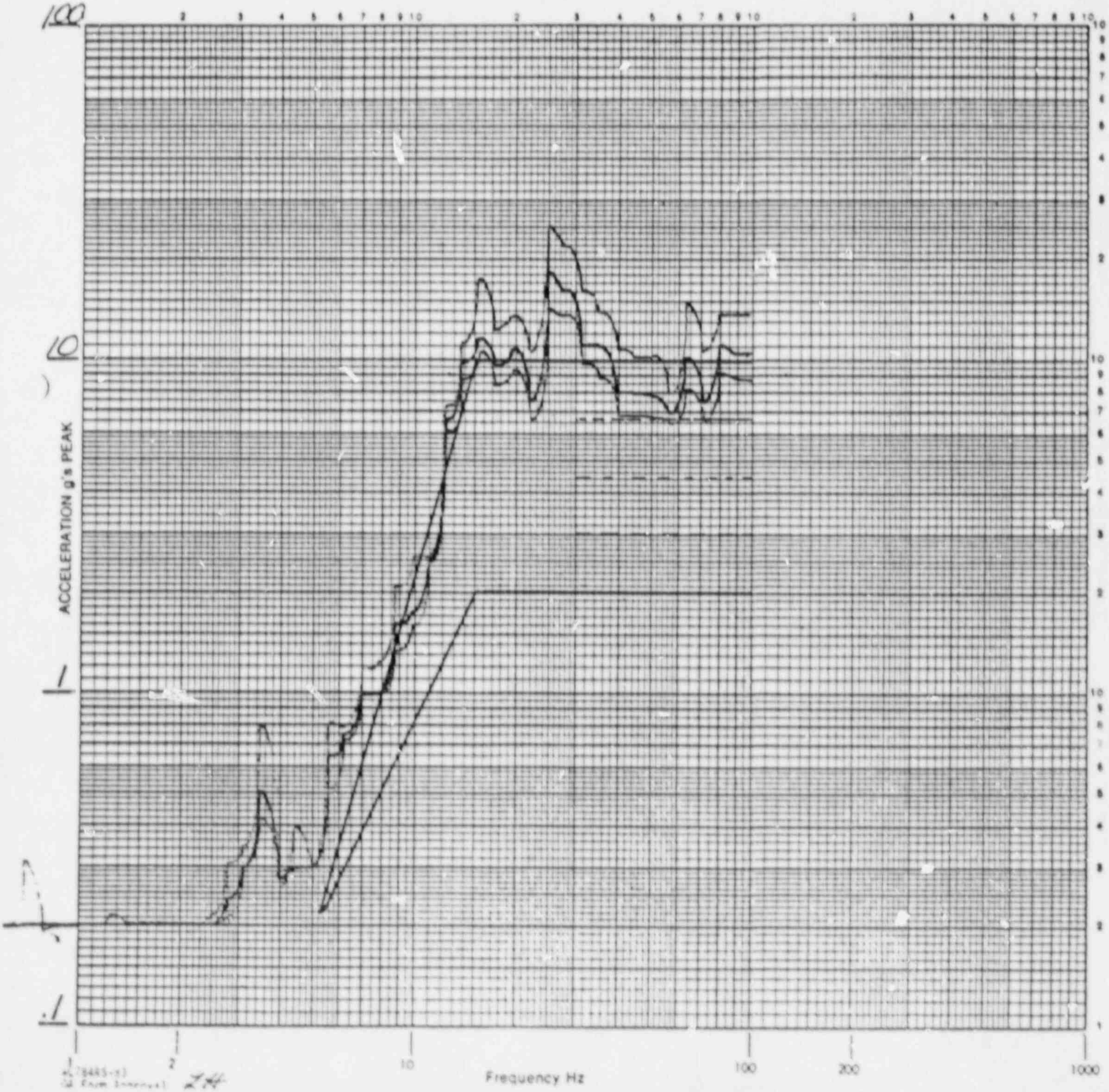
Specimen ELECTRONIC COMPONENTS Axis of Test Y

Accel. No. 1 Axis VERT Control (✓) Response ( ) OBE ( ) SSE ( ) DBE ( )

Full Scale 100 g Damping 1,(2%),3 % Run No HIGH FREQUENCY RUN #22 4TH LEVEL

Operator GREIERMAN Engineer [initials]

RESPONSE SPECTRUM



WYLE LABORATORIES,NORCO,CA. FACILITY   CHATTER AND PULSE ANALYSIS PROGRAM   05/28/87 10:20:06 HOURS   PAGE 1

START TIME= 0.0000   STOP TIME= 22.563

TEST NAME=EGG 57724 VERT., 4TH LEVEL, HI-FREQ, RUN-22 DE-ENERGIZED
TEST DATE=05/28/87 10:17:14 HOURS

CHANNEL ID	CHANNEL NUMBER	FIRST CHATTER	LAST CHATTER	STATE CHANGE	NUMBER OF CHATTER FAILURES PER TIME LENGTH 2.00-5.00	5.00-10.0	10.0-20.0	20.0-40.0	40.0-80.0	>80.0	TOTAL
W1-NC	2			0	NO CHATTER						
W1-NO	3			0	NO CHATTER						
W2-NC	4			0	NO CHATTER						
W2-NO	6			0	NO CHATTER						
W3-NC	7			0	NO CHATTER						
W3-NO	8			0	NO CHATTER						
G1-NC	10			0	NO CHATTER						
G1-NO	11			0	NO CHATTER						
G2-NC	12			0	NO CHATTER						
G2-NO	13			0	NO CHATTER						
G3-NC	14			0	NO CHATTER						
G3-NO	15			0	NO CHATTER						
W1-OT-NO	16			0	NO CHATTER						
W2-OT-NO	17			0	NO CHATTER						
W3-OT-NO	18			0	NO CHATTER						
G1-OT-NO	19			0	NO CHATTER						
G2-OT-NO	20			0	NO CHATTER						
G3-OT-NO	21			0	NO CHATTER						
	22			0	NO CHATTER						
										TOTAL=	0

WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

CUSTOMER EG & G Job No. 57724 Date 5-27-87

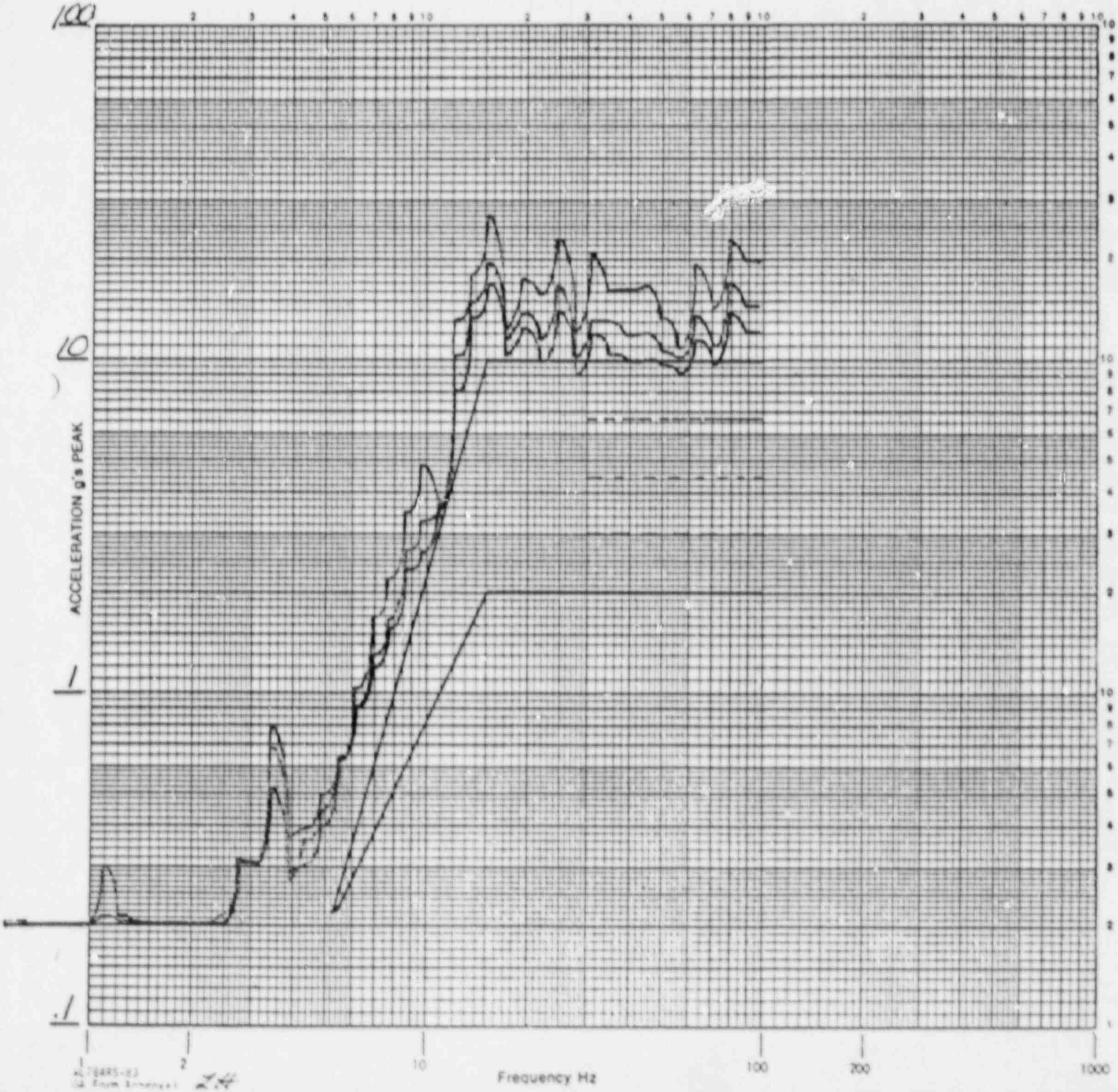
Specimen ELECTRONIC COMPONENTS Axis of Test Y

Accel. No. 1 Axis VERT Control (✓) Response ( ) OBE ( ) SSE ( ) DBE ( )

Full Scale 100 g Damping 1,(2%),3 % Run No HIGH FREQUENCY Run 23-4 5th LEVEL

Operator BREIERMAN Engineer

RESPONSE SPECTRUM



24

WYLE LABORATORIES,NORCO,CA. FACILITY CHATTER AND PULSE ANALYSIS PROGRAM 05/28/87 10:34:35 HOURS PAGE 1

START TIME= 0.0000 STOP TIME= 20.928

TEST NAME=EGG 57724 VERT., 5TH LEVEL, HI-FREQ, RUN-23-1 DE-ENERGIZED
TEST DATE=05/28/87 10:32:49 HOURS

CHANNEL ID	CHANNEL NUMBER	FIRST CHATTER	LAST CHATTER	STATE CHANGE	NUMBER OF CHATTER FAILURES PER TIME LENGTH 2.00-5.00	5.00-10.0	10.0-20.0	20.0-40.0	40.0-80.0	>80.0	TOTAL
W1-NC	2			0	NO CHATTER						
W1-NO	3			0	NO CHATTER						
W2-NC	4			0	NO CHATTER						
W2-NO	6			0	NO CHATTER						
W3-NC	7			0	NO CHATTER						
W3-NO	8			0	NO CHATTER						
G1-NC	10			0	NO CHATTER						
G1-NO	11			0	NO CHATTER						
G2-NC	12			0	NO CHATTER						
G2-NO	13			0	NO CHATTER						
G3-NC	14			0	NO CHATTER						
G3-NO	15			0	NO CHATTER						
W1-OT-NO	16			0	NO CHATTER						
W2-OT-NO	17			0	NO CHATTER						
W3-OT-NO	18			0	NO CHATTER						
G1-OT-NO	19			0	NO CHATTER						
G2-OT-NO	20			0	NO CHATTER						
G3-OT-NO	21			0	NO CHATTER						
										TOTAL=	0

CUSTOMER EG & G Job No. 57724 Date 5-27-87

Specimen ELECTRONIC COMPONENTS Axis of Test Y

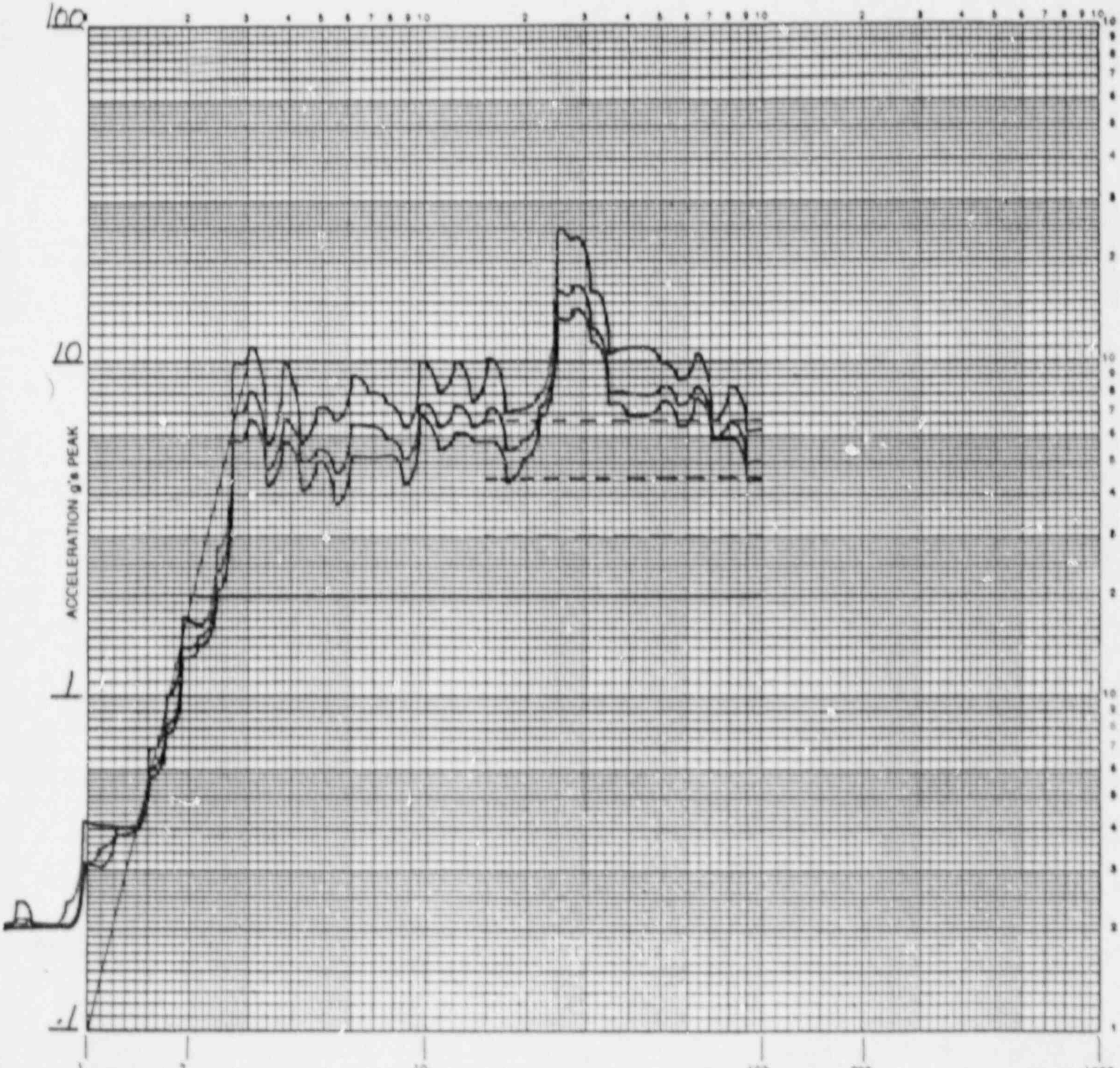
Accel. No. 1 Axis VERT Control (✓) Response ( ) OBE ( ) SSE ( ) DBE ( )

Full Scale 100 g Damping 1,(2%),3 %

Run No. BROAD BAND FREQUENCY 3RD LEVEL Run # 24

Operator GREVERMAN Engineer [signature]

RESPONSE SPECTRUM



24

START TIME- 0.0000   STOP TIME- 22.236

TEST NAME-EGG 57724 VERT, 3[illegible] LEVEL, BROAD BAND RUN-24 DE-ENERGIZED
TEST DATE-05/28/87   10:40:37 HOURS

CHANNEL ID	CHANNEL NUMBER	FIRST CHATTER	LAST CHATTER	STATE CHANGE	NUMBER OF CHATTER FAILURES PER TIME LENGTH 2.00-5.00	5.00-10.0	10.0-20.0	20.0-40.0	40.0-80.0	>80.0	TOTAL
W1-NC	2			0	NO CHATTER						
W1-NO	3			0	NO CHATTER						
W2-NC	4			0	NO CHATTER						
W2-NO	6			0	NO CHATTER						
W3-NC	7			0	NO CHATTER						
W3-NO	8			0	NO CHATTER						
G1-NC	10			0	NO CHATTER						
G1-NO	11			0	NO CHATTER						
G2-NC	12			0	NO CHATTER						
G2-NO	13			0	NO CHATTER						
G3-NC	14			0	NO CHATTER						
G3-NO	15			0	NO CHATTER						
W1-OT-NO	16			0	NO CHATTER						
W2-OT-NO	17			0	NO CHATTER						
W3-OT-NO	18			0	NO CHATTER						
G1-OT-NO	19			0	NO CHATTER						
G2-OT-NO	20			0	NO CHATTER						
G3-OT-NO	21			0	NO CHATTER						
										TOTAL-	0

Report No. 57724

WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

CUSTOMER EG & G Job No. 57724 Date 5-27-87

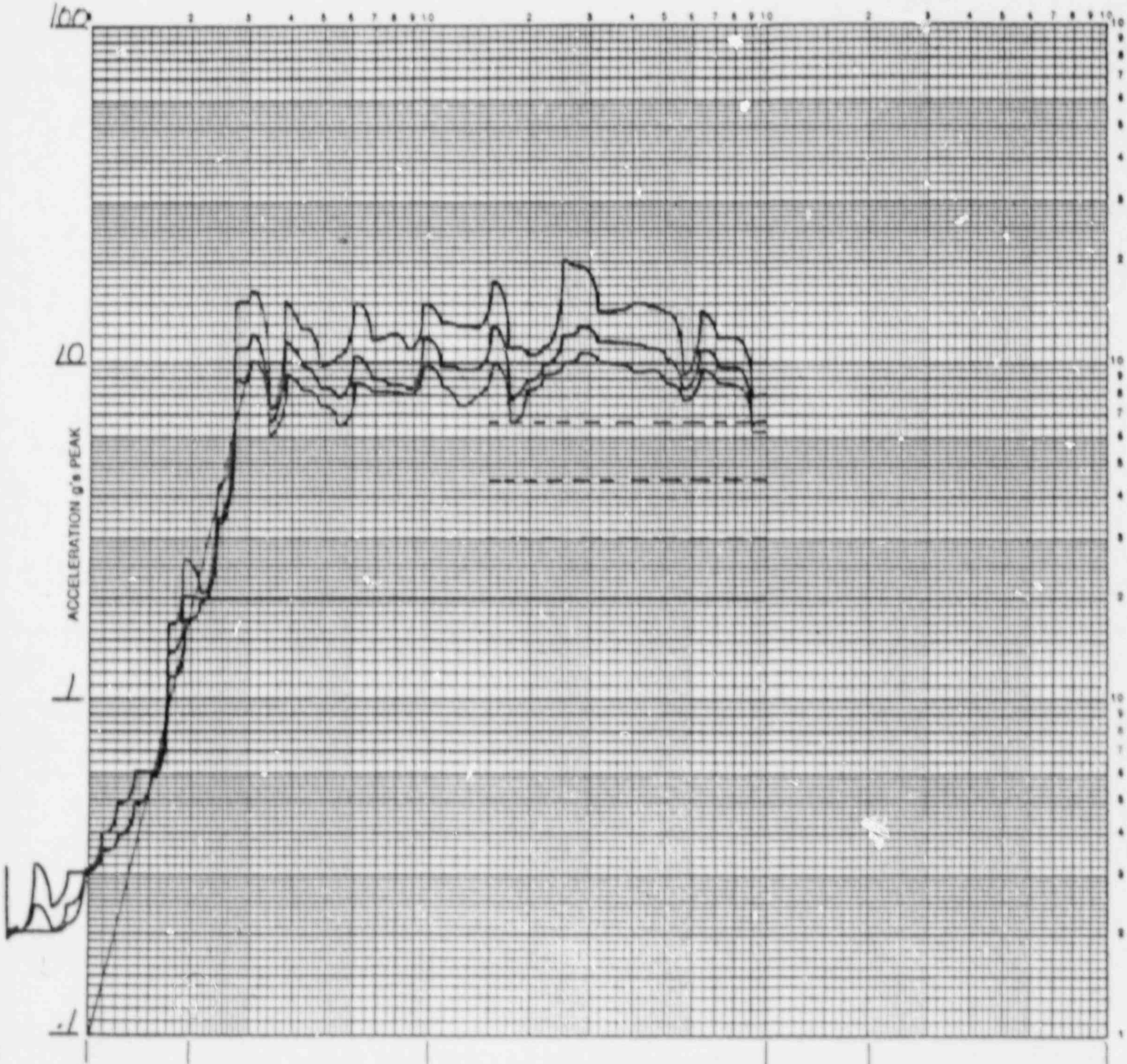
Specimen ELECTRONIC COMPONENTS Axis of Test Y

Accel. No. 1 Axis VERT Control (✓) Response ( ) OBE ( ) SSE ( ) DBE ( )

Full Scale 100 g Damping 1,(2%),3 % Run No. BROAD BAND FREQUENCY 4th LEVEL Run# 25

Operator GREIERMAN Engineer JK

RESPONSE SPECTRUM



WL 78485-83 ZH

START TIME= 0.0000 STOP TIME= 22.563

TEST NAME=EGG 57724 VERT, 4TH LEVEL, BROAD BAND RUN-25 DE-ENERGIZED
TEST DATE=05/28/87 10:50:36 HOURS

CHANNEL ID	CHANNEL NUMBER	FIRST CHATTER	LAST CHATTER	STATE CHANGE	NUMBER OF CHATTER FAILURES PER TIME LENGTH 2.00-5.00	5.00-10.0	10.0-20.0	20.0-40.0	40.0-80.0	>80.0	TOTAL
W1-NC	2			0	NO CHATTER						
W1-NO	3			0	NO CHATTER						
W2-NC	4			0	NO CHATTER						
W2-NO	6			0	NO CHATTER						
W3-NC	7			0	NO CHATTER						
W3-NO	8			0	NO CHATTER						
G1-NC	10			0	NO CHATTER						
G1-NO	11			0	NO CHATTER						
G2-NC	12			0	NO CHATTER						
G2-NO	13			0	NO CHATTER						
G3-NC	14			0	NO CHATTER						
G3-NO	15			0	NO CHATTER						
W1-OT-NO	16			0	NO CHATTER						
W2-OT-NO	17			0	NO CHATTER						
W3-OT-NO	18			0	NO CHATTER						
G1-OT-NO	19			0	NO CHATTER						
G2-OT-NO	20			0	NO CHATTER						
G3-OT-NO	21			0	NO CHATTER						
										TOTAL=	0

CUSTOMER EG & G Job No. 57724 Date 5-27-87

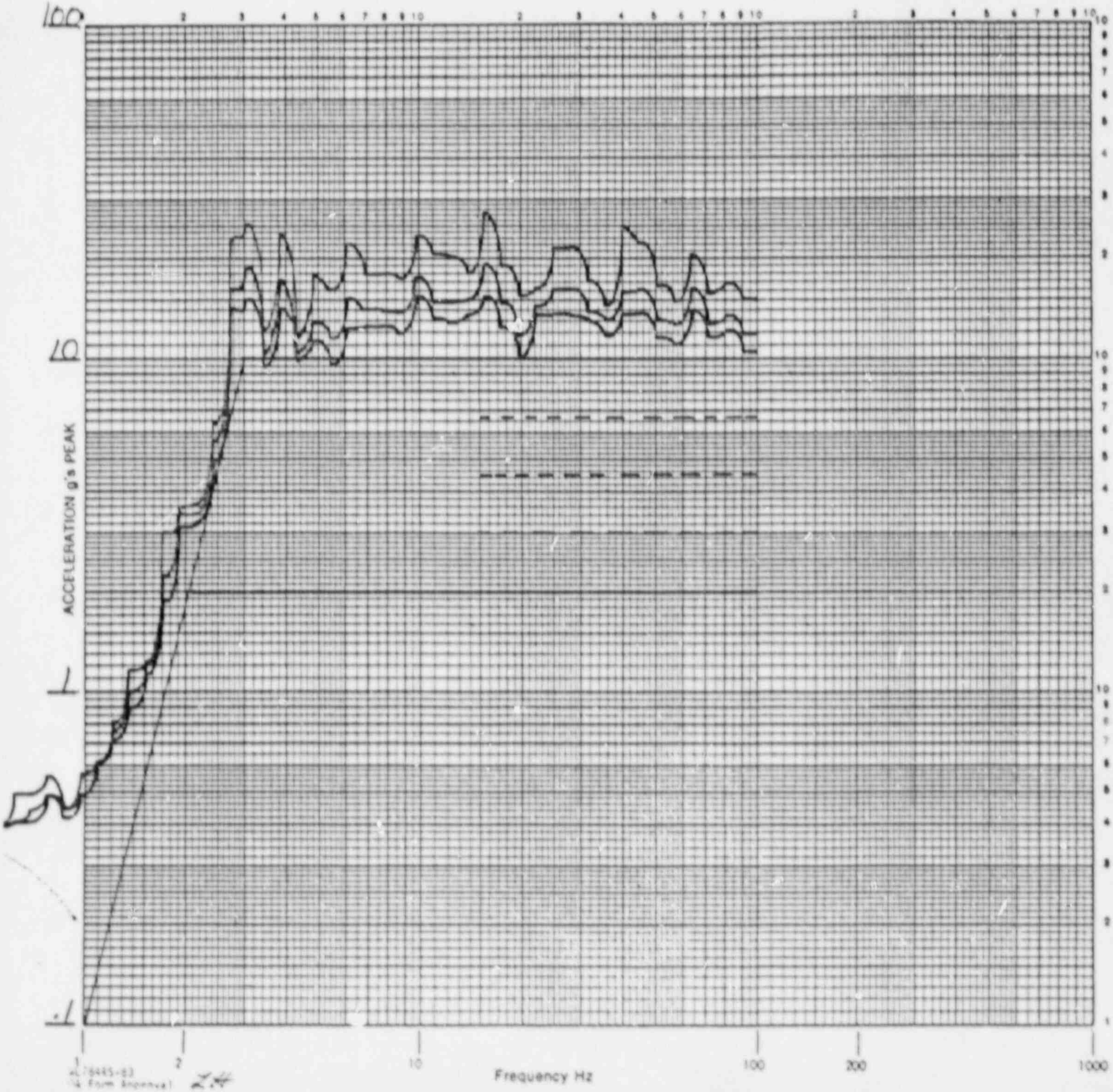
Specimen ELECTRONIC COMPONENTS Axis of Test Y

Accel. No. 1 Axis VERT Control (✓) Response ( ) OBE ( ) SSE ( ) DBE ( )

Full Scale 100 g Damping 1,(2%),3 % Run No. BROAD BAND FREQUENCY 5th LEVEL Run# 26

Operator C. PETERMAN Engineer [signature]

RESPONSE SPECTRUM



WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

CUSTOMER E G & G Job No. 57224 Date 5-28-87

Specimen RELAY Axis of Test VERT

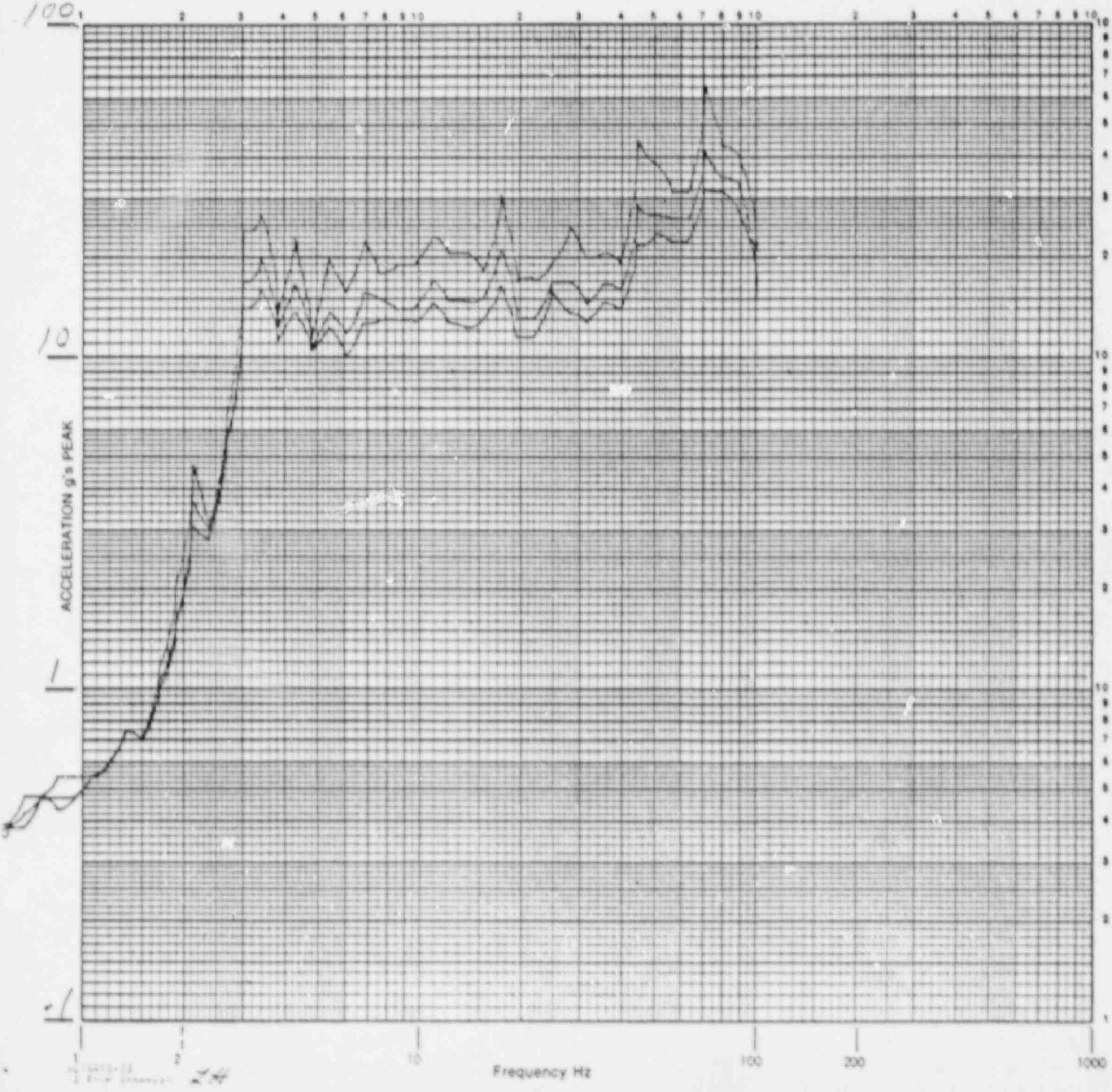
Accel. No. 4 Axis ______ Control ( ) Response (✓) OBE ( ) SSE ( ) DBE ( )

Full Scale 100 g Damping 1,(2),3 % Run No. 26

Operator BG Engineer R. Kriley

Level 5
BROAD BAND

RESPONSE SPECTRUM



WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

CUSTOMER E G + G Job No. 57724 Date 5-28-87

Specimen RELAY Axis of Test VERT

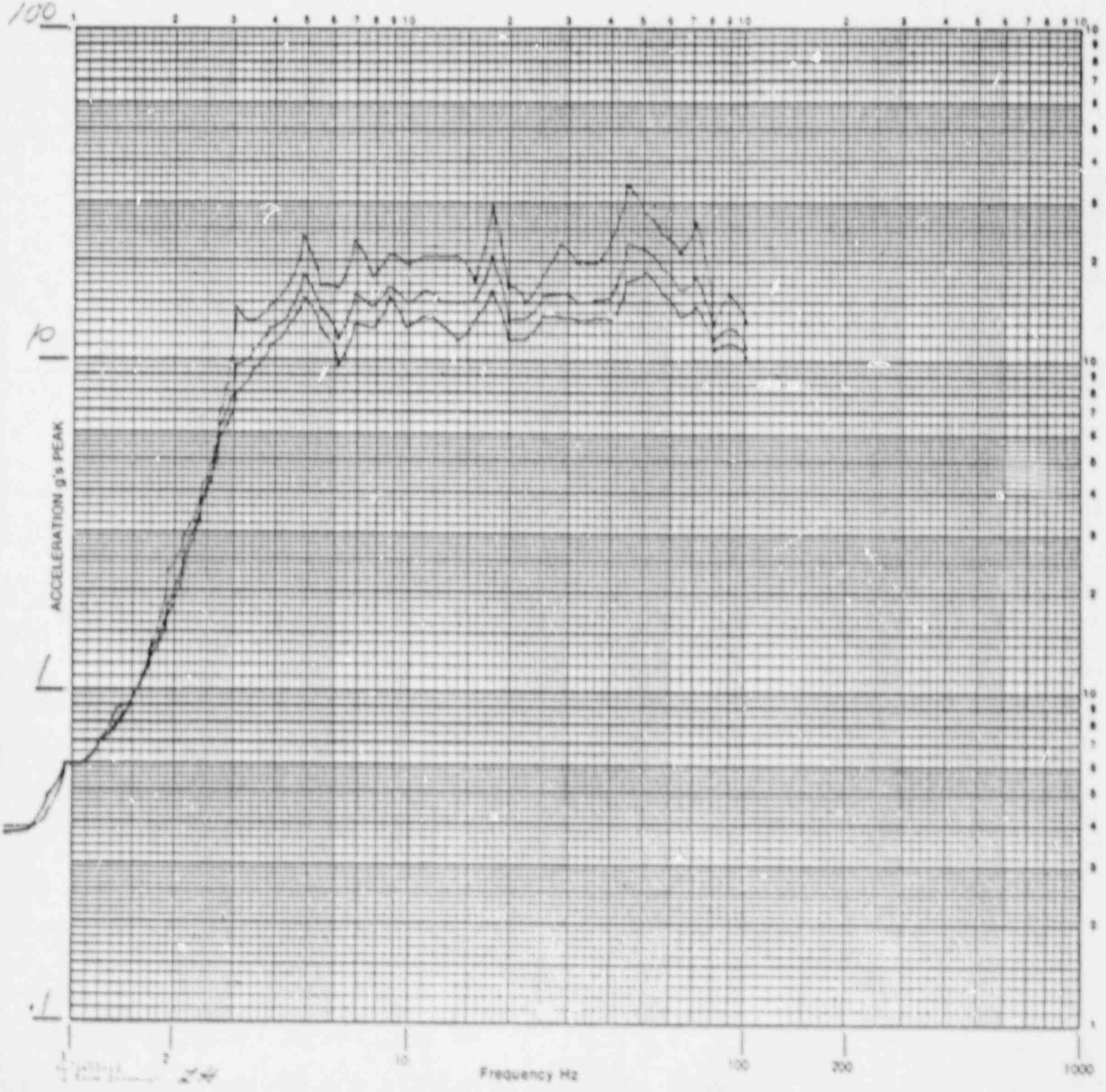
Accel. No. 6 Axis ______ Control ( ) Response (✓) OBE ( ) SSE ( ) DBE ( )

Full Scale 100 g Damping 1, (2), 3 % Run No. 26

Operator BG Engineer R. Kaun

Level 5
BROAD BAND

RESPONSE SPECTRUM



WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

CUSTOMER E G + G Job No. 57724 Date 5-28-87

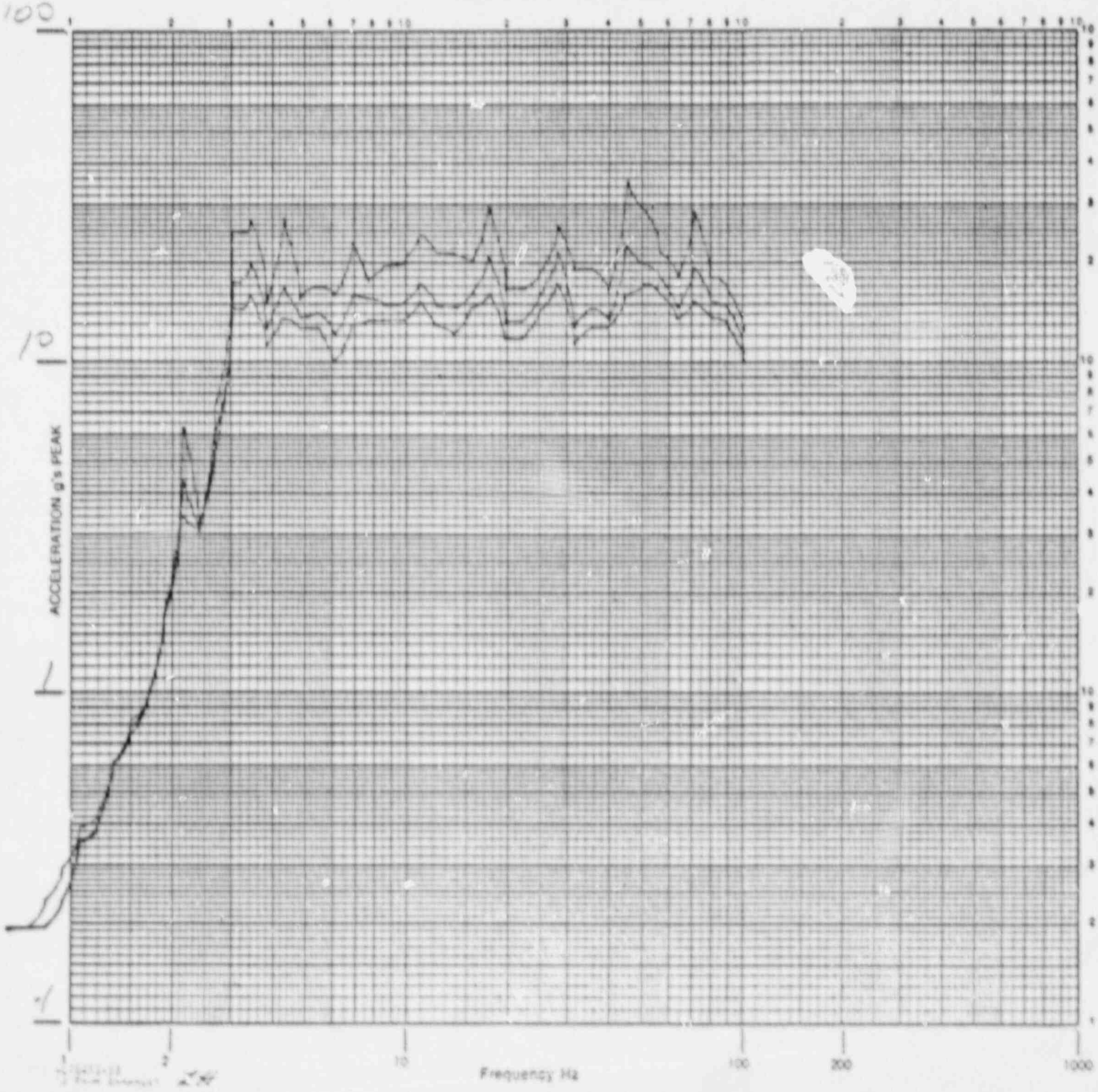
Specimen RELAY Axis of Test VERT

Accel. No. 8 Axis ______ Control ( ) Response (✓) OBE ( ) SSE ( ) DBE ( )

Full Scale 100 g Damping 1,(2),3 % Run No. 26

Operator BG Engineer P. Kruse Levels BROAD BAND

RESPONSE SPECTRUM



START TIME= 0.0000 STOP TIME= 22.563

TEST NAME=EGG 577244 VERT, 5TH LEVEL, BROAD BAND RUN-26 DE-ENERGIZED
TEST DATE=05/28/87 10:58:31 HOURS

CHANNEL ID	CHANNEL NUMBER	FIRST CHATTER	LAST CHATTER	STATE CHANGE	NUMBER OF CHATTER FAILURES PER TIME LENGTH 2.00-5.00	5.00-10.0	10.0-20.0	20.0-40.0	40.0-80.0	>80.0	TOTAL
W1-NC	2			0	NO CHATTER						
W1-NO	3			0	NO CHATTER						
W2-NC	4			0	NO CHATTER						
W2-NO	6			0	NO CHATTER						
W3-NC	7			0	NO CHATTER						
W3-NO	8			0	NO CHATTER						
G1-NC	10			0	NO CHATTER						
G1-NO	11			0	NO CHATTER						
G2-NC	12			0	NO CHATTER						
G2-NO	13			0	NO CHATTER						
G3-NC	14			0	NO CHATTER						
G3-NO	15			0	NO CHATTER						
W1-OT-NO	16			0	NO CHATTER						
W2-OT-NO	17			0	NO CHATTER						
W3-OT-NO	18			0	NO CHATTER						
G1-OT-NO	19			0	NO CHATTER						
G2-OT-NO	20			0	NO CHATTER						
G3-OT-NO	21			0	NO CHATTER						
										TOTAL=	0

WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

CUSTOMER EG & G Job No. 57724 Date 5-27-87

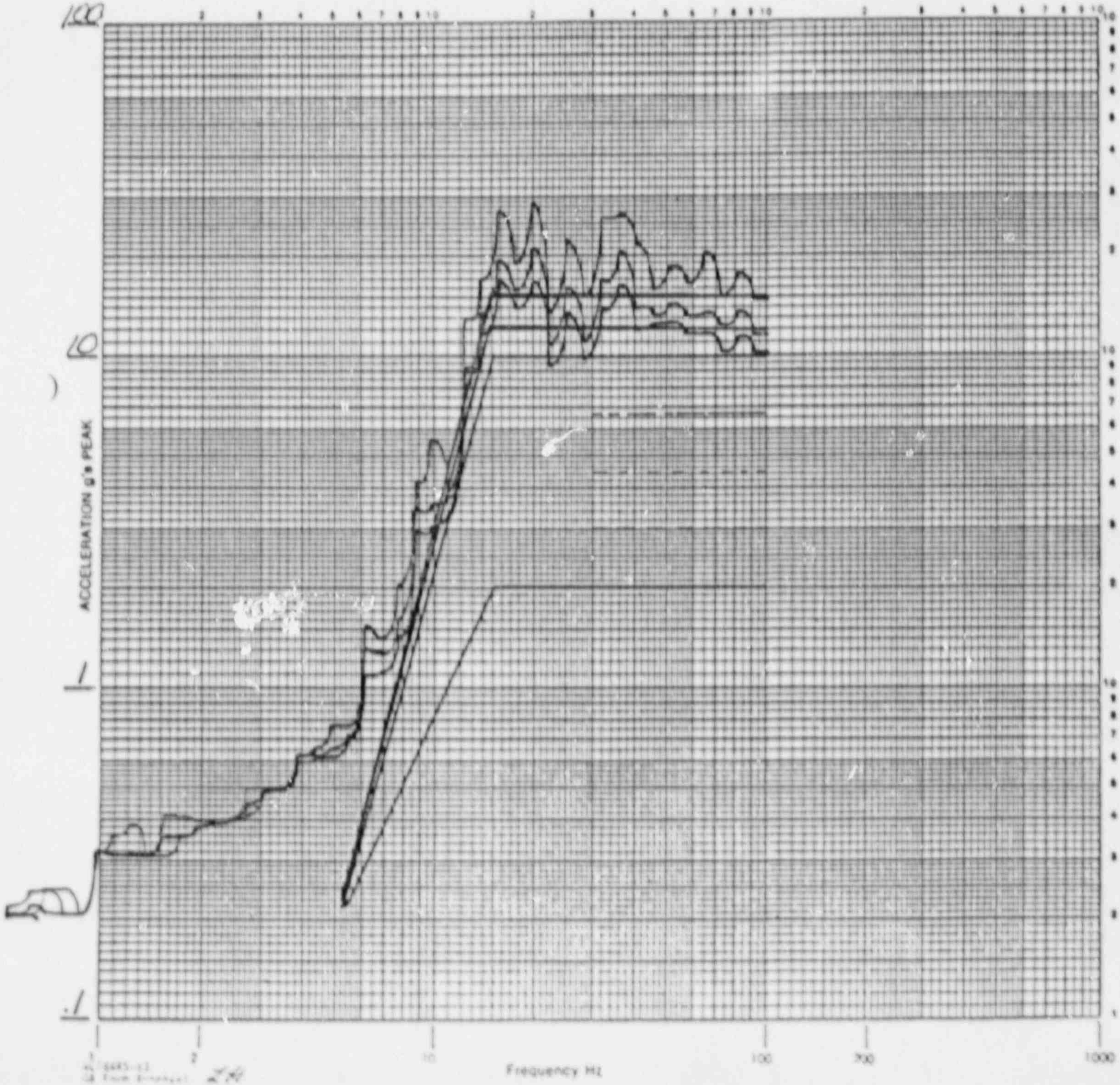
Specimen ELECTRONIC COMPONENTS Axis of Test X

Accel. No. 1 Axis Hor 7 Control (✓) Response ( ) OBE ( ) SSE ( ) DBE ( )

Full Scale 100 g Damping (2%),3 % Run No HIGH FREQUENCY RUN #27

Operator [illegible] Engineer [illegible]

RESPONSE SPECTRUM



START TIME- 0.0000 STOP TIME- 21.582

TEST NAME=EGG 57724 F/B, 6TH LEVEL, HI-FREQ, RUN-27 DE-ENERGIZED
TEST DATE=05/28/87 13:41:18 HOURS

CHANNEL ID	CHANNEL NUMBER	FIRST CHATTER	LAST CHATTER	STATE CHANGE	NUMBER OF CHATTER FAILURES PER TIME LENGTH 2.00-5.00	5.00-10.0	10.0-20.0	20.0-40.0	40.0-80.0	>80.0	TOTAL
W1-NC	2			0	NO CHATTER						
W1-NO	3			0	NO CHATTER						
W2-NC	4			0	NO CHATTER						
W2-NO	6			0	NO CHATTER						
W3-NC	7			0	NO CHATTER						
W3-NO	8			0	NO CHATTER						
G1-NC	10			0	NO CHATTER						
G1-NO	11			0	NO CHATTER						
G2-NC	12			0	NO CHATTER						
G2-NO	13			0	NO CHATTER						
G3-NC	14			0	NO CHATTER						
G3-NO	15			0	NO CHATTER						
W1-OT-NO	16			0	NO CHATTER						
W2-OT-NO	17			0	NO CHATTER						
W3-OT-NO	18			0	NO CHATTER						
G1-OT-NO	19			0	NO CHATTER						
G2-OT-NO	20			0	NO CHATTER						
G3-OT-NO	21			0	NO CHATTER						
										TOTAL-	0

CUSTOMER EG & G Job No. 57724 Date 5-27-87

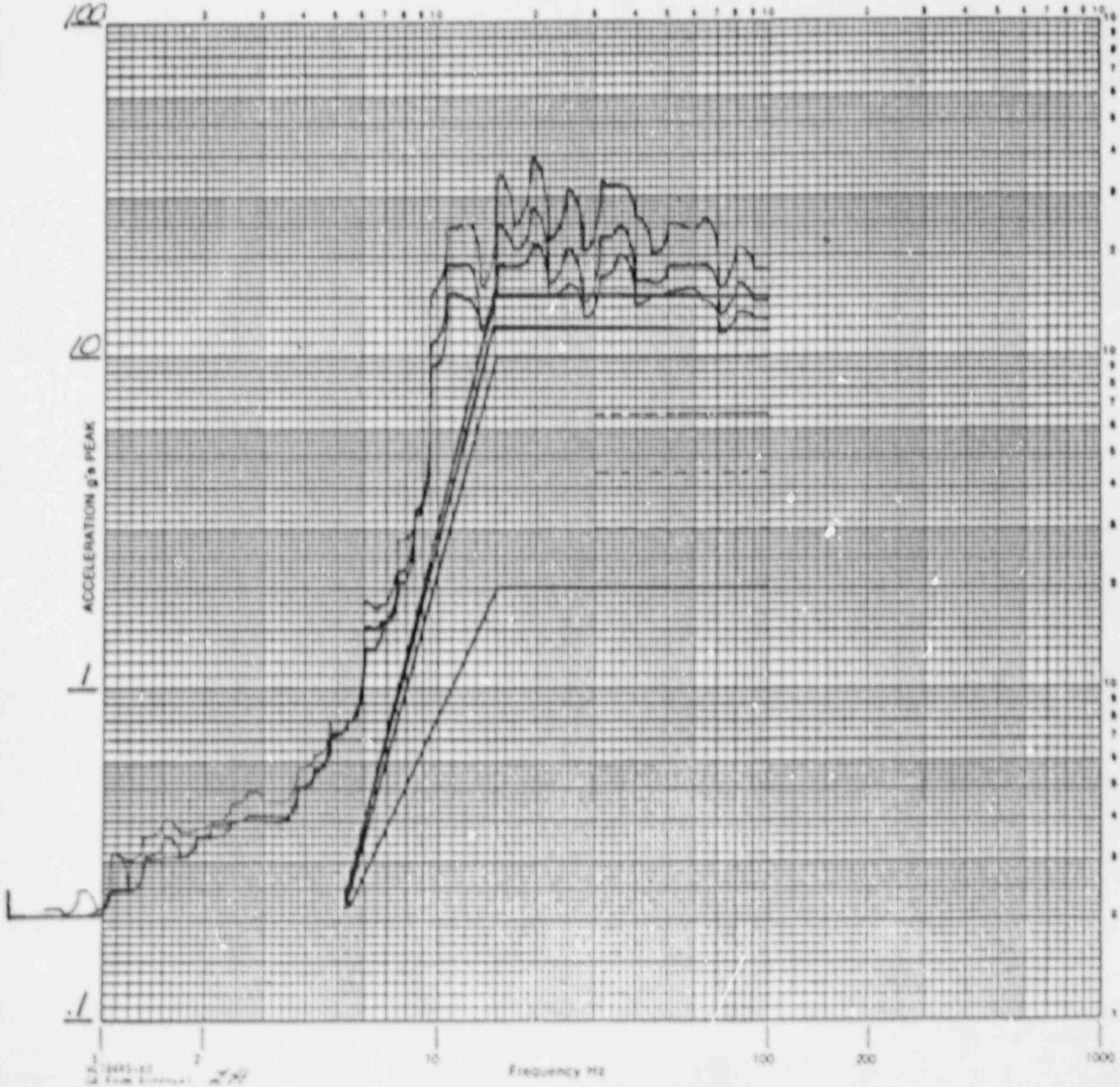
Specimen ELECTRONIC COMPONENTS Axis of Test X

Accel. No. 1 Axis Horiz Control (✓) Response ( ) OBE ( ) SSE ( ) DBE ( )

Full Scale 100 g Damping 1,(2%),3 % Run No HIGH FREQUENCY Run #28 7TH LEVEL

Operator BRETERMAN Engineer

RESPONSE SPECTRUM



WYLE LABORATORIES,NORCO,CA. FACILITY CHATTER AND PULSE ANALYSIS PROGRAM 05/28/87 14:11:42 HOURS PAGE 1

START TIME= 0.0000 STOP TIME= 21.582

TEST NAME=EGG 57724 F/B, 7TH LEVEL, HI-FREQ, RUN-28 DE-ENERGIZED
TEST DATE=05/28/87 14: 9: 6 HOURS

CHANNEL ID	CHANNEL NUMBER	FIRST CHATTER	LAST CHATTER	STATE CHANGE	NUMBER OF CHATTER FAILURES PER TIME LENGTH 2.00-5.00	5.00-10.0	10.0-20.0	20.0-40.0	40.0-80.0	>80.0	TOTAL
W1-NC	2			0	NO CHATTER						
W1-NO	3			0	NO CHATTER						
W2-NC	4			0	NO CHATTER						
W2-NO	6			0	NO CHATTER						
W3-NC	7			0	NO CHATTER						
W3-NO	8			0	NO CHATTER						
G1-NC	10			0	NO CHATTER						
G1-NO	11			0	NO CHATTER						
G2-NC	12			0	NO CHATTER						
G2-NO	13			0	NO CHATTER						
G3-NC	14			0	NO CHATTER						
G3-NO	15			0	NO CHATTER						
W1-OT-NO	16			0	NO CHATTER						
W2-OT-NO	17			0	NO CHATTER						
W3-OT-NO	18			0	NO CHATTER						
G1-OT-NO	19			0	NO CHATTER						
G2-OT-NO	20			0	NO CHATTER						
G3-OT-NO	21			0	NO CHATTER						
	22			0	NO CHATTER						
										TOTAL=	0

Report No. 57724
Page No. E-114

APPENDIX F

SINE SWEEP RECORDS ON "G-MACHINE"

WYLE LABORATORIES

DYNAMICS SECTION
VIBRATION TEST DATA SHEET

Job No. 51164
Sheet 1 of

Customer EG & G.
Specimen Electrical Components P/N See Rec. Insp. S/N See Rec. Insp.

Date	Time	Axis	Temp (°F)	SINUSOIDAL Freq. (HZ)	Disp. ("DA)	Accel. (±G)	Test Time (Min.)	Comments
987	NOTED	NOTED	AMB	NOTED	—	NOTED	*	SINE SWEEP 2.5 TO 100 HZ APPROX ONE OCTAVE PER MINUTE, IN EACH AXIS. TEST LEVEL WAS INCREASED UNTIL COMPONENT MALFUNCTION OCCURS.
5-19	1605	X	AMB	2.5-100	—	2G.		START SINE SWEEP. DE-ENERGIZED.
	1611						6 MINS.	COMPLETED.
5-20	0832	X	AMB	2.5-50		2G.		START SINE SWEEP. DE-ENERGIZED.
	0836						4 MIN.	STOP AT 50 HZ AND REVIEW COMPUTER DATA.
5-20	0853	X	AMB	50-100	—	2G.		RESUME SWEEP. DE-ENERGIZED.
	0855						2 MINS.	COMPLETED.
5-20	0910	X	AMB	2.5-100	—	2.4		START SINE SWEEP. DE-ENERGIZED.
	0916						6 MIN.	COMPLETED. 1 CHANNEL OF CHATTER.
5-20	0935	X	AMB	2.5-100	—	2.5		START SINE SWEEP. DE-ENERGIZED.
	0941						6 MIN.	COMPLETED. CHATTER.
5-20	1048	X	AMB	2.5-100	—	2.5		START SINE SWEEP. ENERGIZED.
	1054						6 MIN.	COMPLETED.

WYLE LABORATORIES,NORCO,CA. FACILITY CHATTER AND PULSE ANALYSIS PROGRAM 05/20/87 08:43:39 HOURS

START TIME= 0.0000 STOP TIME= 253.42

TEST NAME=EGG 57724, F/B, 2.0G'S,SINE SWEEP, 2.5-50 HZ. DE-ENERGIZED
TEST DATE=05/20/87 8:29: 3 HOURS

CHANNEL ID	CHANNEL NUMBER	FIRST CHATTER	LAST CHATTER	STATE CHANGE	NUMBER OF CHATTER FAILURES PER TIME LENGTH 2.00-5.00	5.00-10.0	10.0-20.0	20.0-40.0	40.0-80.0	>80.0	TOTAL
W1-NC	2			0	NO CHATTER						
W1-NO	3			0	NO CHATTER						
W2-NC	4			0	NO CHATTER						
W2-NO	6			0	NO CHATTER						
W3-NC	7			0	NO CHATTER						
W3-NO	8			0	NO CHATTER						
G1-NC	10			0	NO CHATTER						
G1-NO	11			0	NO CHATTER						
G2-NC	12			0	NO CHATTER						
G3-NO	13			0	NO CHATTER						
G3-NC	14			0	NO CHATTER						
G3-NO	15			0	NO CHATTER						
W1-OT-NO	16			0	NO CHATTER						
W2-OT-NO	17			0	NO CHATTER						
W3-OT-NO	18			0	NO CHATTER						
G1-OT-NO	19			0	NO CHATTER						
G2-OT-NO	20			0	NO CHATTER						
G3-OT-NO	21			0	NO CHATTER						
	22			0	NO CHATTER						
										TOTAL=	0

WYLE LABORATORIES,NORCO,CA. FACILITY   CHA..ER AND PULSE ANALYSIS PROGRAM   05/19/87 08:55:57 HOURS   PAGE 1

START TIME= 0.0000   STOP TIME= 54.282

TEST NAME=EGG 57724, F/B, 2.0G'S,SINE SWEEP, 50-100 HZ. DE-ENERGIZED
TEST DATE=05/20/87   8:51:34 HOURS

CHANNEL ID	CHANNEL NUMBER	FIRST CHATTER	LAST CHATTER	STATE CHANGE	NUMBER OF CHATTER FAILURES PER TIME LENGTH 2.00-5.00	5.00-10.0	10.0-20.0	20.0-40.0	40.0-80.0	>80.0	TOTAL
W1-NC	2			0	NO CHATTER						
W1-NO	3			0	NO CHATTER						
W[illegible]-NC	4			0	NO CHATTER						
W[illegible]-NO	6			0	NO CHATTER						
W[illegible]-NC	7			0	NO CHATTER						
W[illegible]-NO	8			0	NO CHATTER						
G1-NC	10			0	NO CHATTER						
G1-NO	11			0	NO CHATTER						
G[illegible]-NC	12			0	NO CHATTER						
G[illegible]-NO	13			0	NO CHATTER						
G[illegible]-NC	14			0	NO CHATTER						
[illegible]-NO	15			0	NO CHATTER						
W[illegible]-OT-NO	16			0	NO CHATTER						
W[illegible]-OT-NO	17			0	NO CHATTER						
W[illegible]-OT-NO	18			0	NO CHATTER						
G1-OT-NO	19			0	NO CHATTER						
[illegible]-OT-NO	20			0	NO CHATTER						
[illegible]-OT-NO	21			0	NO CHATTER						
	22			0	NO CHATTER						
										TOTAL=	0

Report No. 57724

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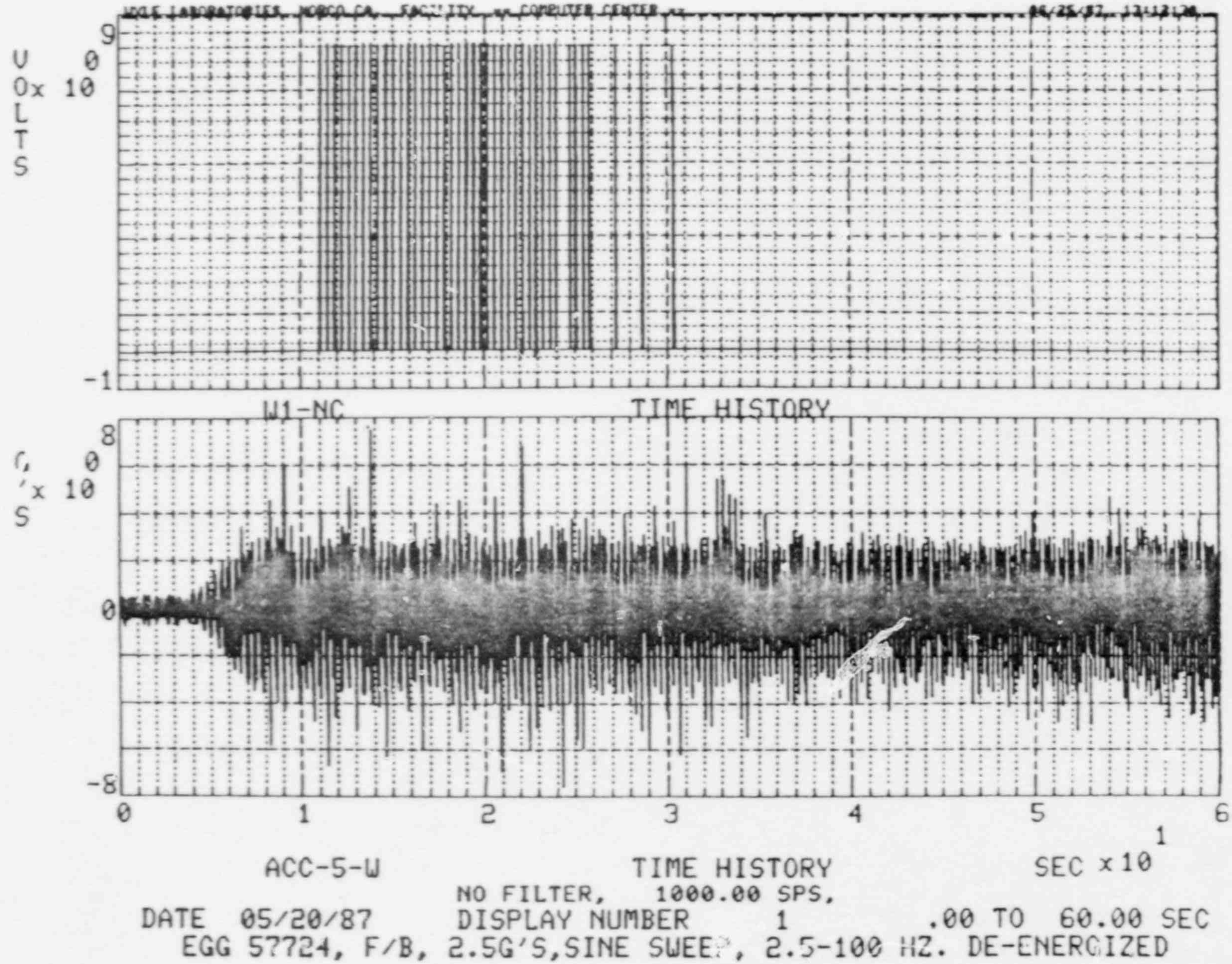
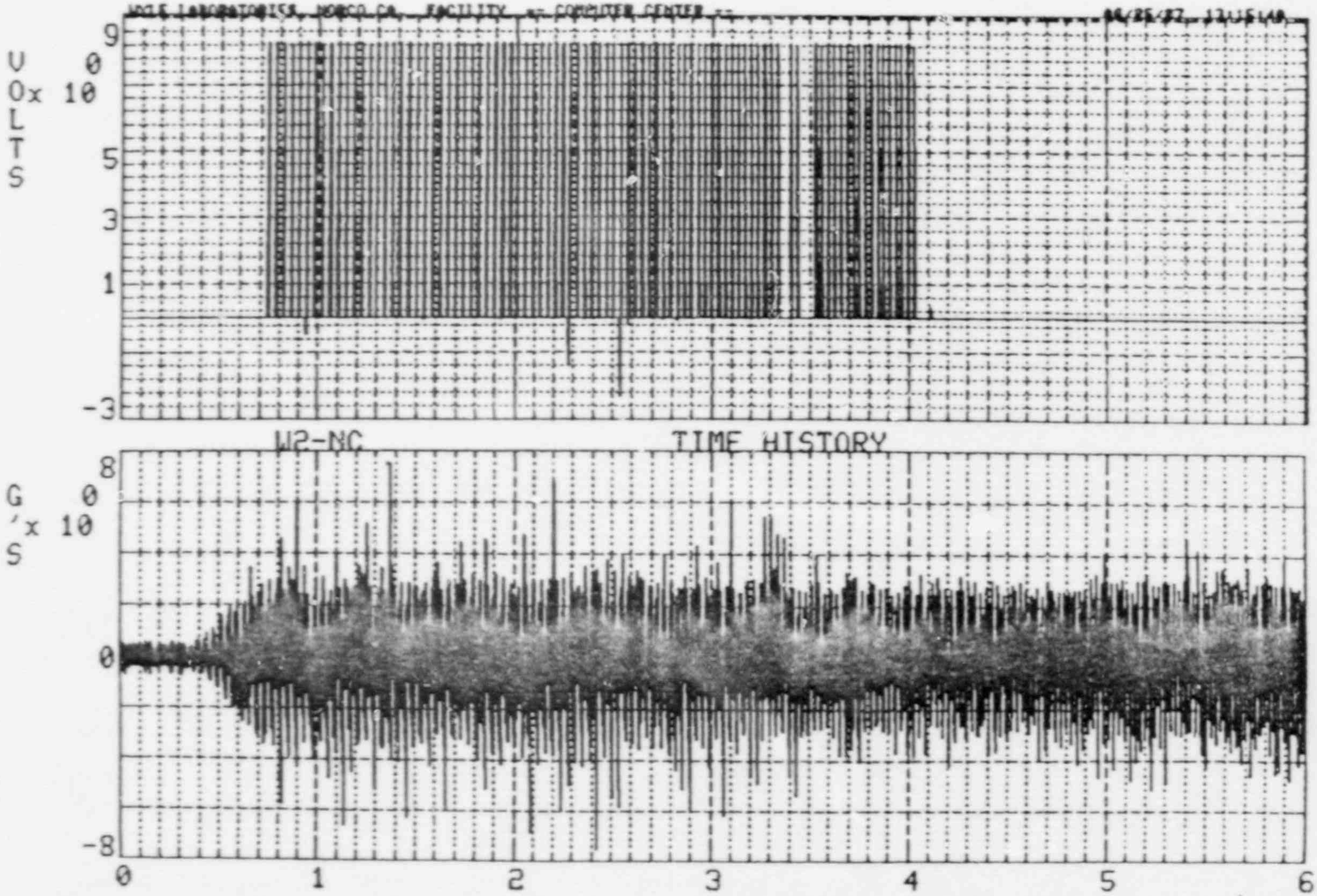
START TIME= 0.0000 STOP TIME= 335.18

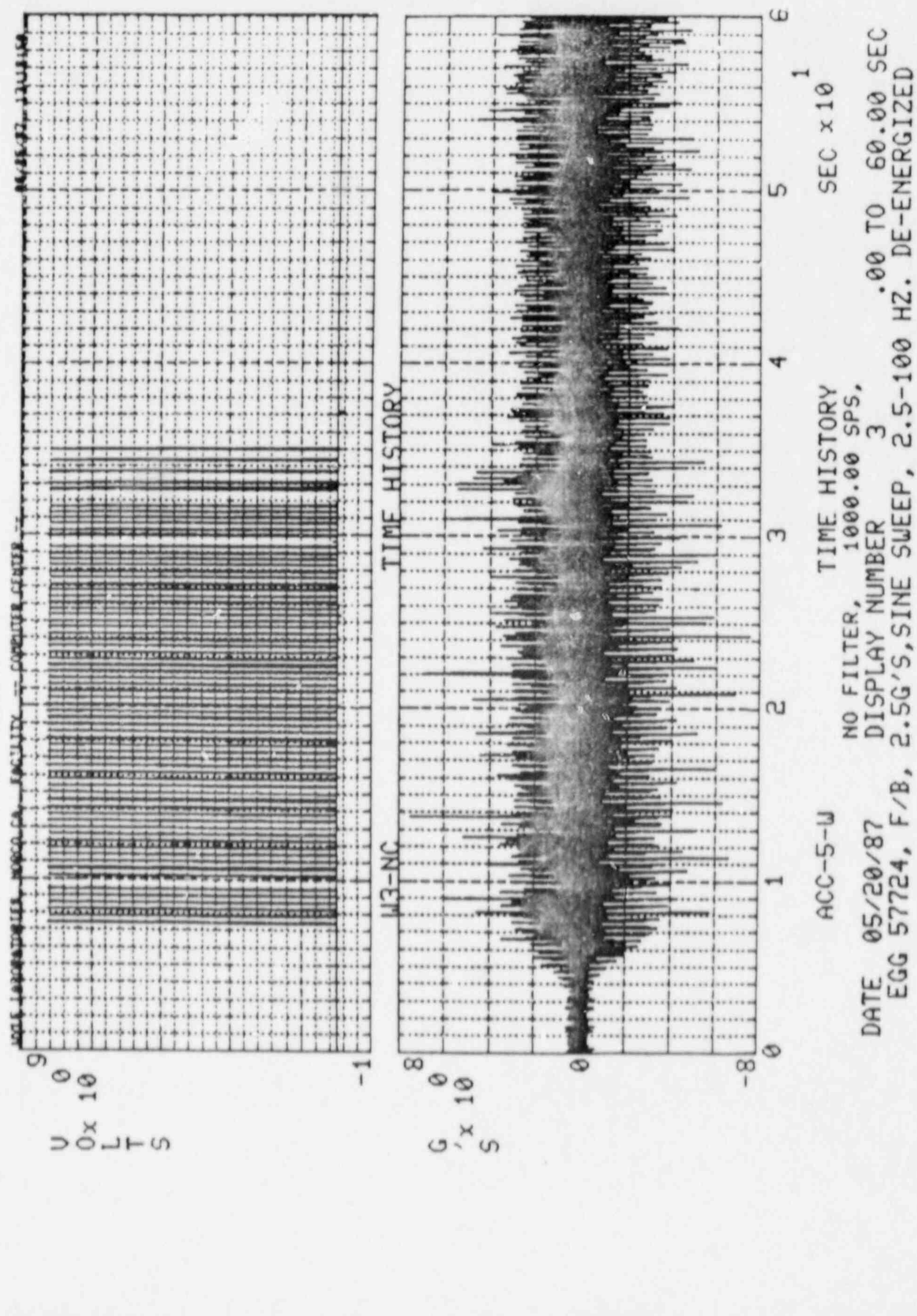
TEST NAME=EGG 57724, F/B, 2.5G'S,SINE SWEEP, 2.5-100 HZ. DE-ENERGIZED
TEST DATE=05/20/87 9:31:45 HOURS

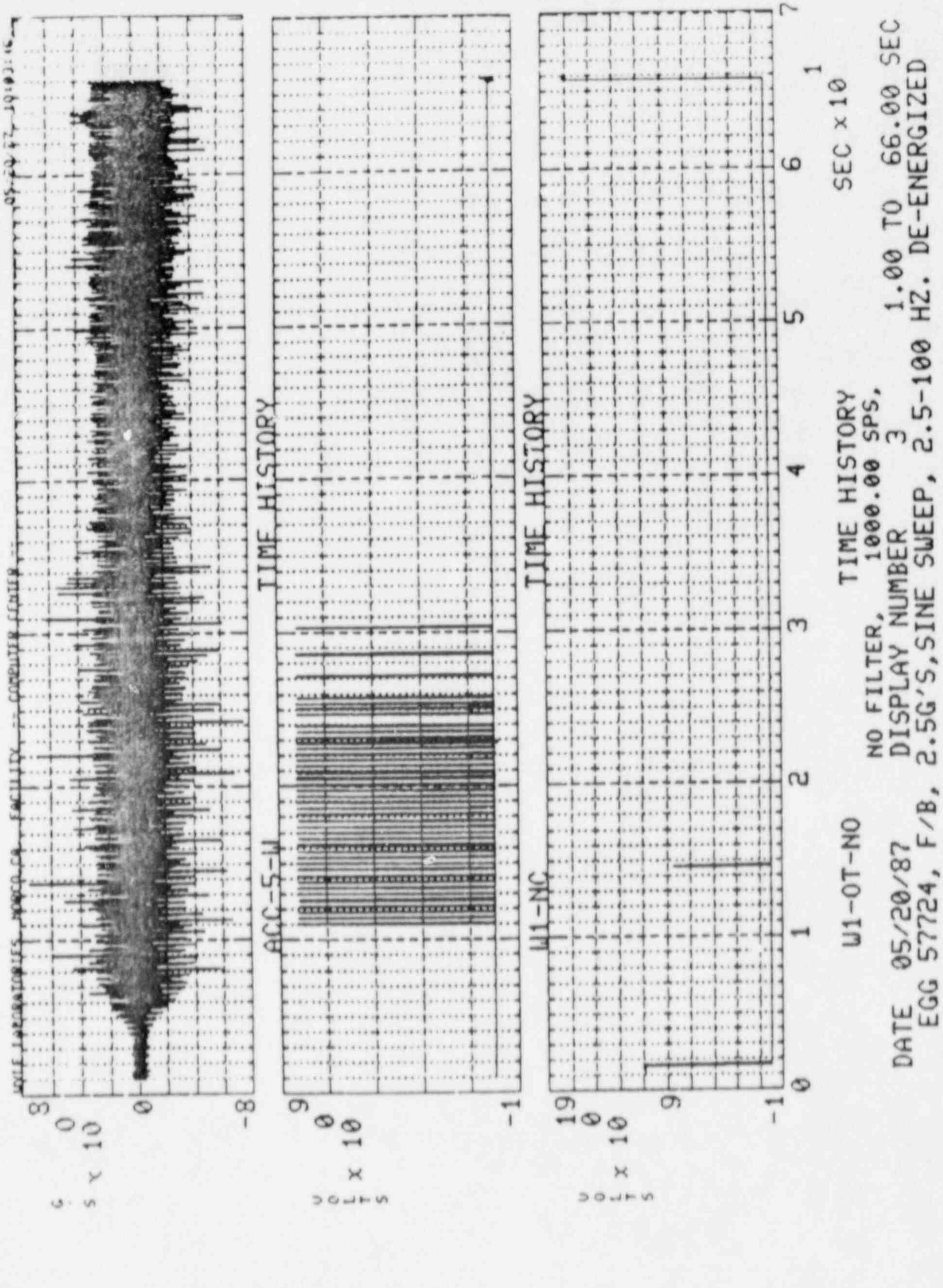
CHANNEL ID	CHANNEL NUMBER	FIRST CHATTER	LAST CHATTER	STATE CHANGE	NUMBER OF CHATTER FAILURES PER TIME LENGTH 2.00-5.00	5.00-10.0	10.0-20.0	20.0-40.0	40.0-80.0	>80.0	TOTAL
W1-NO	2	10.934	30.324	0	7	29	5	0	0	0	41
W1-NO	3			0	NO CHATTER						
[illegible]	4	7.399	40.272	0	10	38	41	0	0	0	89
[illegible]	6			0	NO CHATTER						
[illegible]	7	7.397	34.971	0	12	34	21	0	0	0	67
[illegible]	8	65.689	71.086	0	0	0	0	0	0	2	2
G1-NO	10			0	NO CHATTER						
G1-NO	11			0	NO CHATTER						
[illegible]	12	9.990	64.816	0	13	20	112	0	0	0	145
[illegible]	13			0	NO CHATTER						
[illegible]	14	9.991	59.327	0	27	39	28	0	0	0	94
[illegible]	15			0	NO CHATTER						
[illegible]-OT-NO	16	1.635	65.688	0	0	0	0	0	0	2	2
[illegible]-OT-NO	17			0	NO CHATTER						
[illegible]-OT-NO	18	1.635	29.298	0	1	0	0	0	0	41	42
[illegible]-OT-NO	19			0	NO CHATTER						
[illegible]-OT-NO	20			0	NO CHATTER						
[illegible]-OT-NO	21	1.635	55.698	0	4	1	0	0	0	39	44
	22			0	NO CHATTER						
										TOTAL=	526

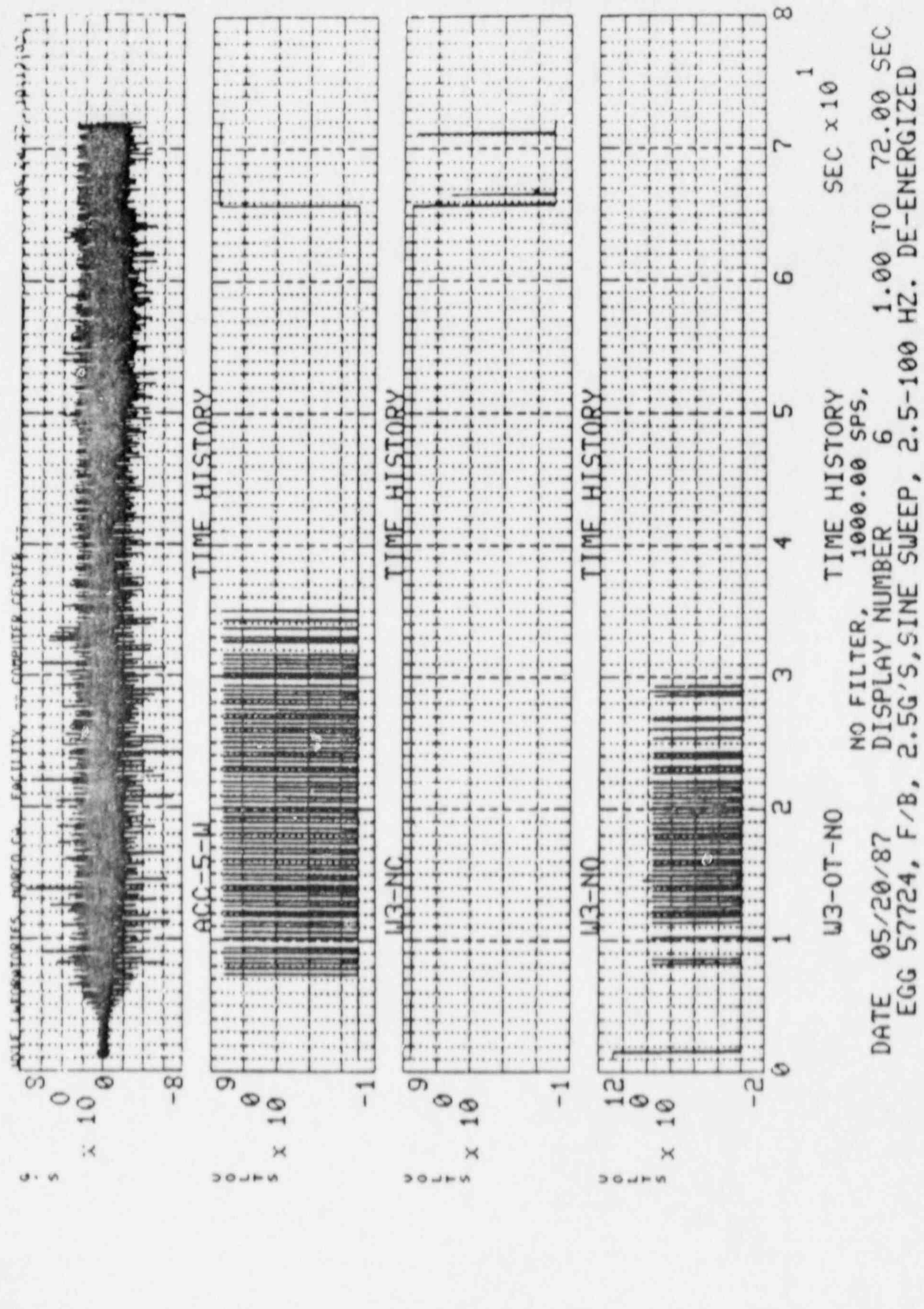

WYLE LABORATORIES, NORCO CA. FACILITY COMPUTER CENTER
VOLTS x 10
9
0
-1
W1-NC
TIME HISTORY
G'S x 10
8
0
-8
0
1
2
3
4
5
6
ACC-5-W
TIME HISTORY
SEC x 10 1
NO FILTER, 1000.00 SPS,
DATE 05/20/87 DISPLAY NUMBER 1 .00 TO 60.00 SEC
EGG 57724, F/B, 2.5G'S,SINE SWEEP, 2.5-100 HZ. DE-ENERGIZED

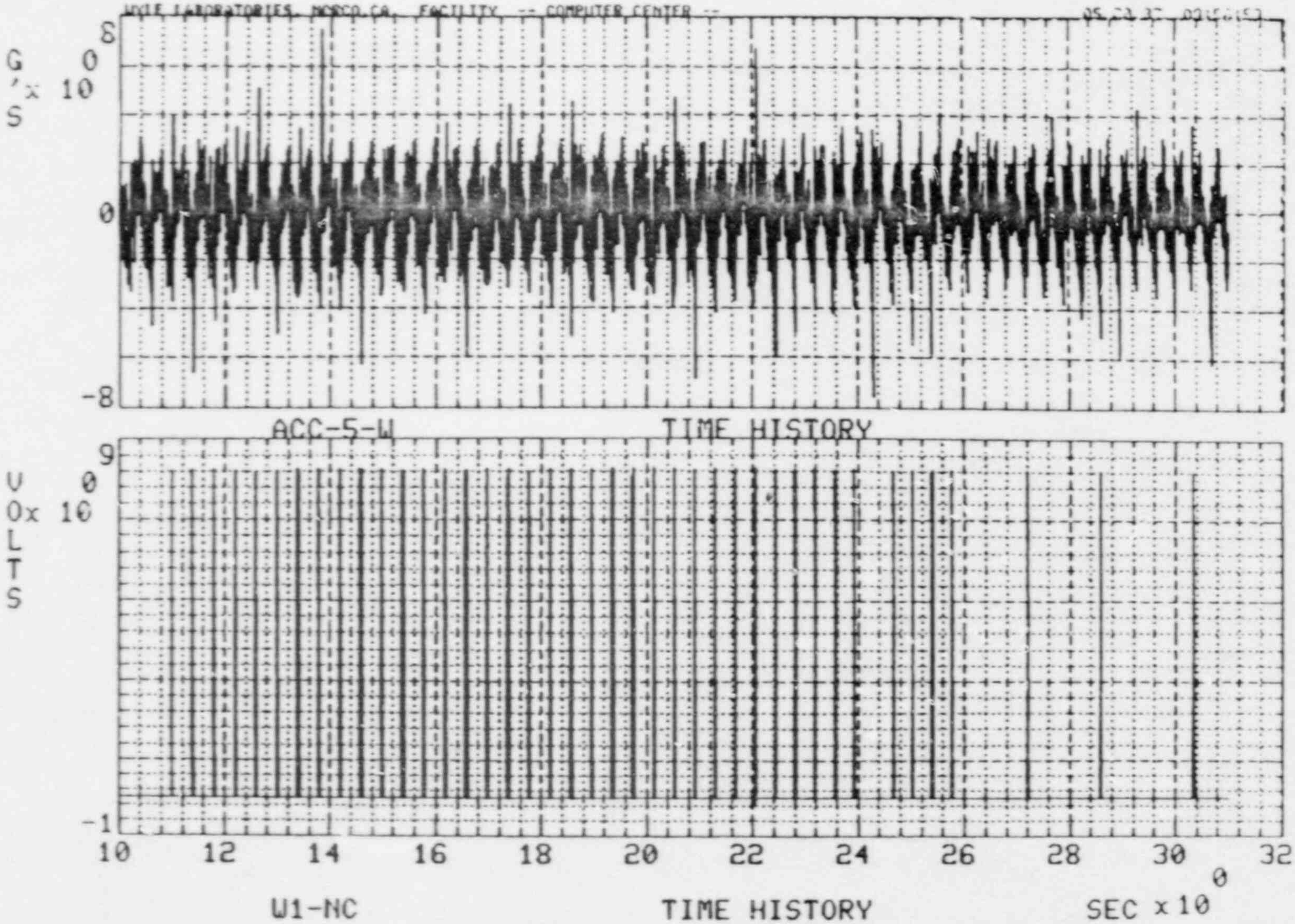


ACC-5-W TIME HISTORY SEC x 10^1
NO FILTER, 1000.00 SPS,
DATE 05/20/87 DISPLAY NUMBER 2 .00 TO 60.00 SEC
EGG 57724, F/B, 2.5G'S,SINE SWEEP, 2.5-100 HZ. DE-ENERGIZED

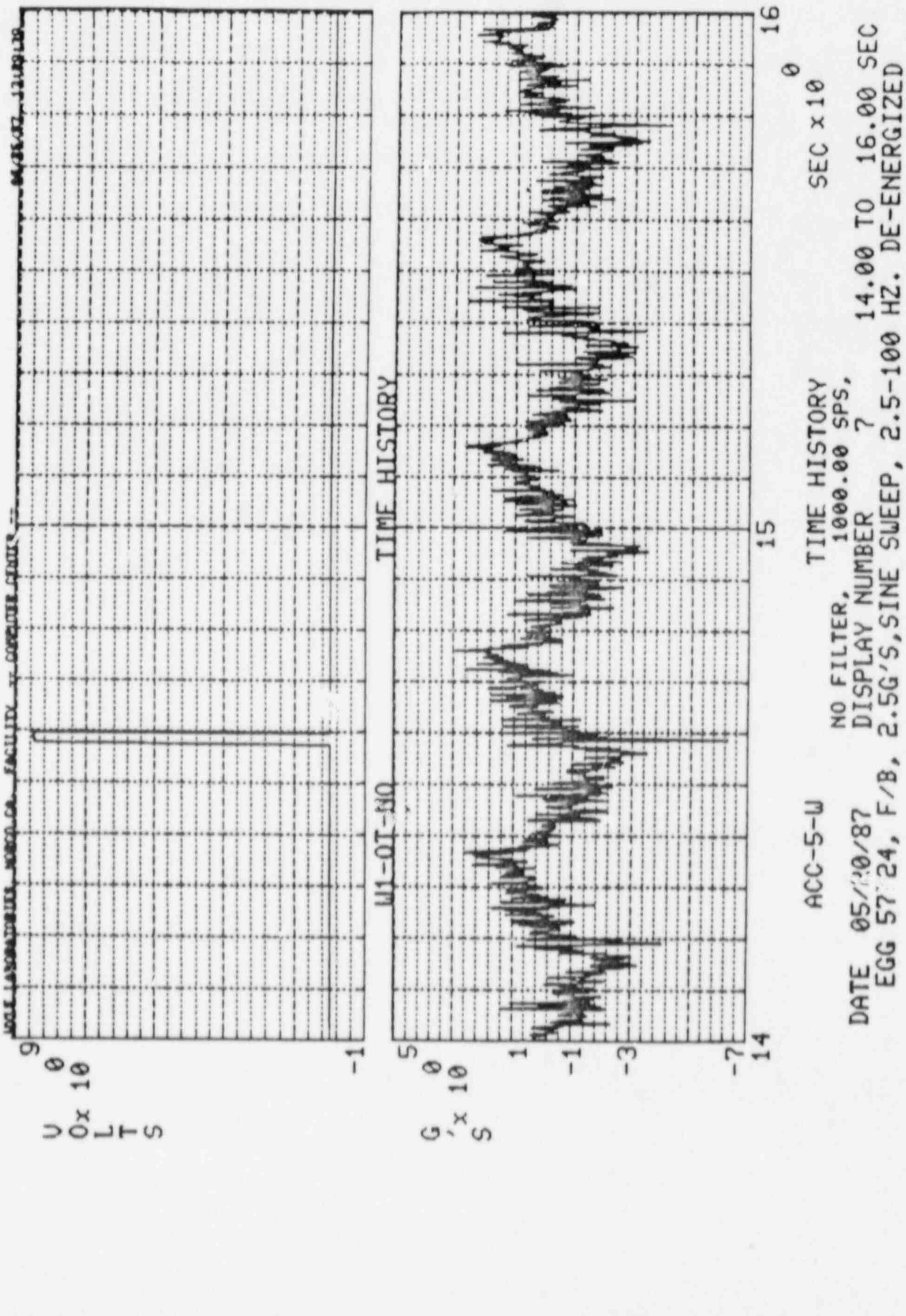

TIME HISTORY
W3-NC
VOLTS x 10^0
G'S x 10^0
SEC x 10^1
ACC-5-W
TIME HISTORY
DATE 05/20/87
NO FILTER, 1000.00 SPS,
DISPLAY NUMBER 3
.00 TO 60.00 SEC
EGG 57724, F/B, 2.5G'S,SINE SWEEP, 2.5-100 HZ. DE-ENERGIZED

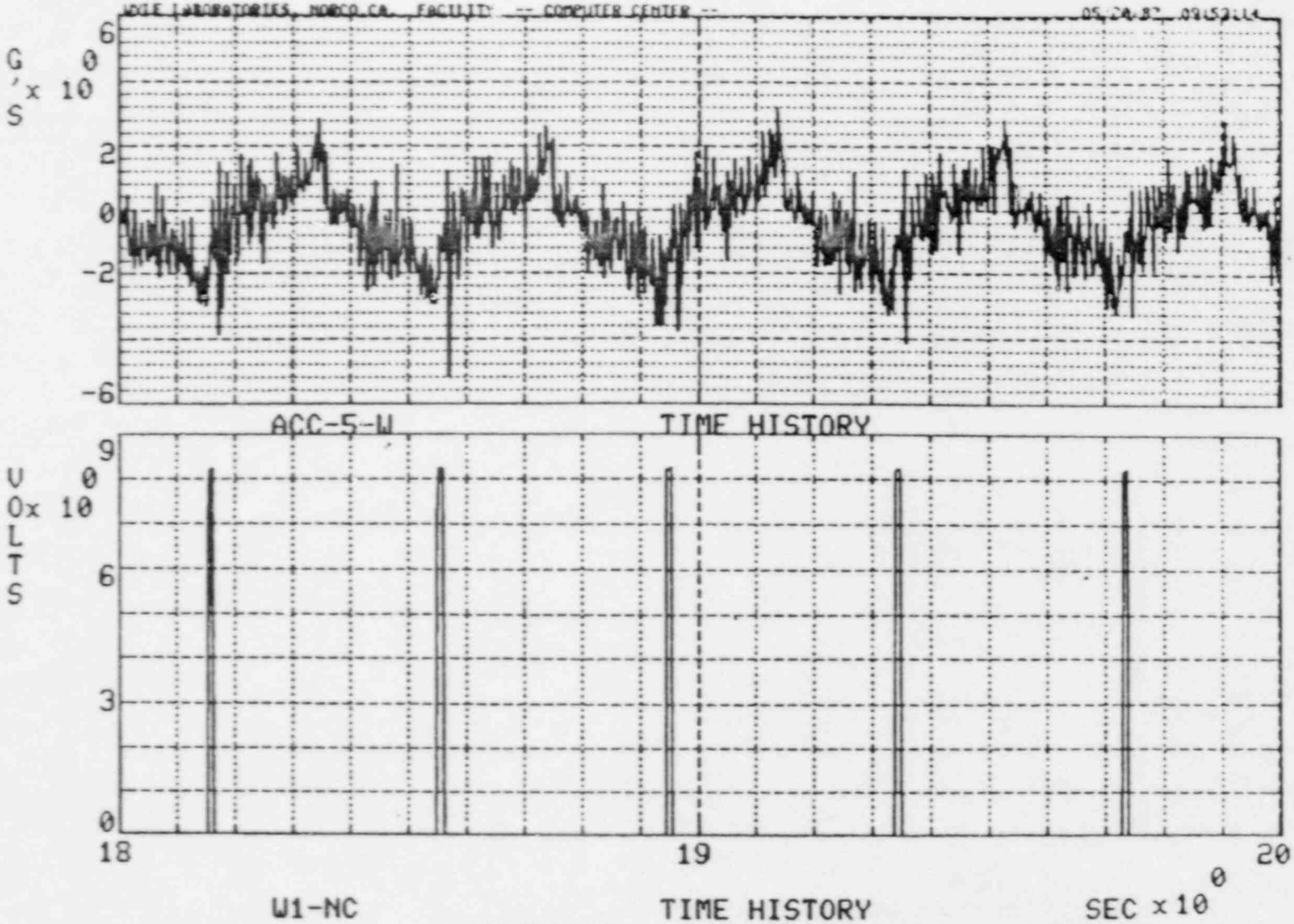

TIME HISTORY
ACC-5-W
TIME HISTORY
W1-NC
TIME HISTORY
W1-OT-NO
NO FILTER, 1000.00 SPS,
DATE 05/20/87 DISPLAY NUMBER 3 1.00 TO 66.00 SEC
EGG 57724, F/B, 2.5G'S,SINE SWEEP, 2.5-100 HZ. DE-ENERGIZED
SEC x 10
G'S x 10
VOLTS x 10
VOLTS x 10


ACC-5-W
TIME HISTORY
W3-NC
TIME HISTORY
W3-NO
TIME HISTORY
SEC x 10
W3-OT-NO TIME HISTORY
DATE 05/20/87 NO FILTER, 1000.00 SPS, 1.00 TO 72.00 SEC
DISPLAY NUMBER 6
EGG 57724, F/B, 2.5G'S, SINE SWEEP, 2.5-100 HZ. DE-ENERGIZED

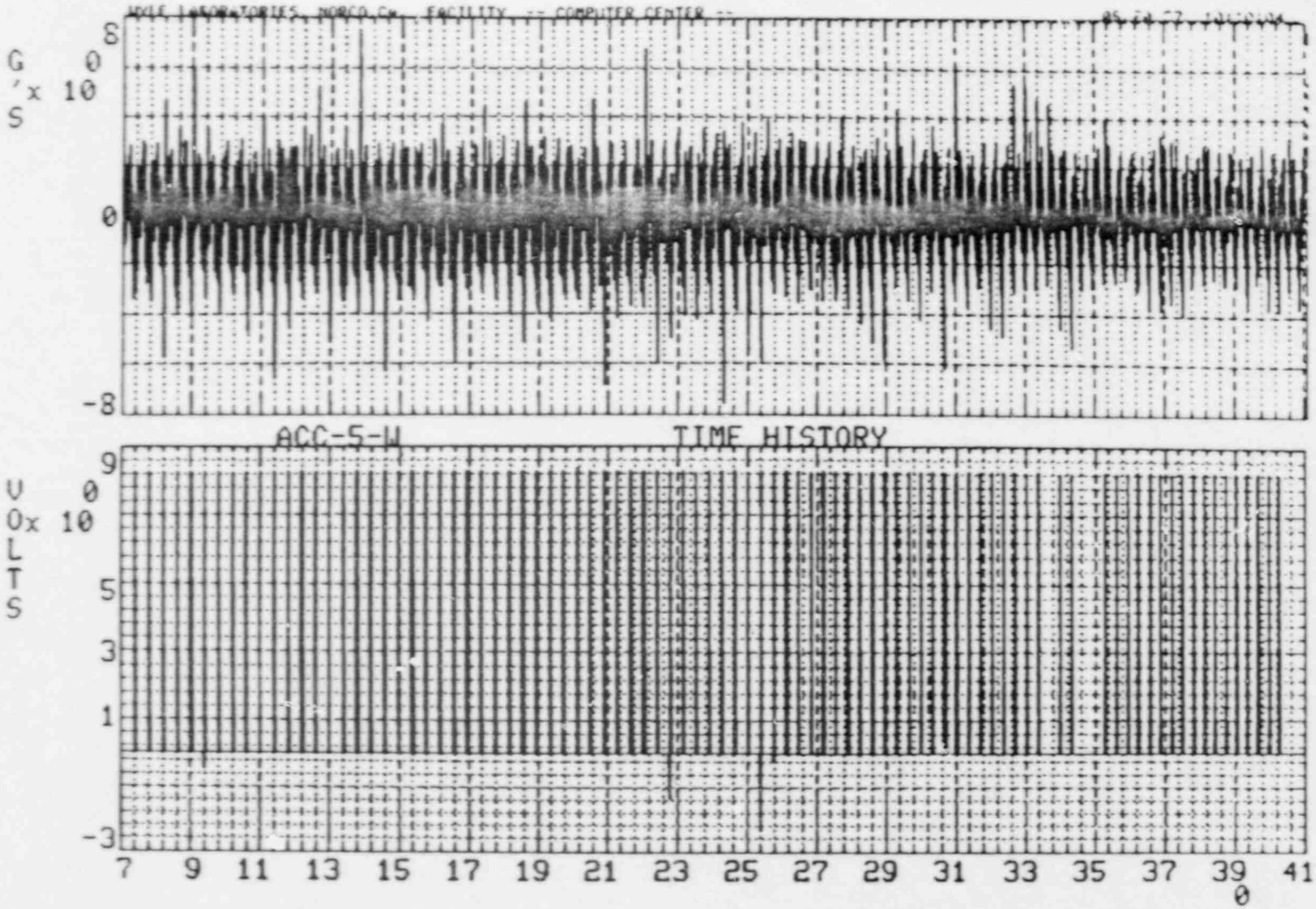


NO FILTER, 1000.00 SPS,
DATE 05/29/87 DISPLAY NUMBER 1 10.00 TO 31.00 SEC
EGG 57724, F/B, 2.5G'S,SINE SWEEP, 2.5-100 HZ. DE-ENERGIZED


VOLTS x 10^0
G'S x 10^0
SEC x 10^0
TIME HISTORY
W1-OT-NO
ACC-5-W
NO FILTER, 1000.00 SPS,
DISPLAY NUMBER 7
TIME HISTORY
14.00 TO 16.00 SEC
2.5G'S, SINE SWEEP, 2.5-100 HZ. DE-ENERGIZED



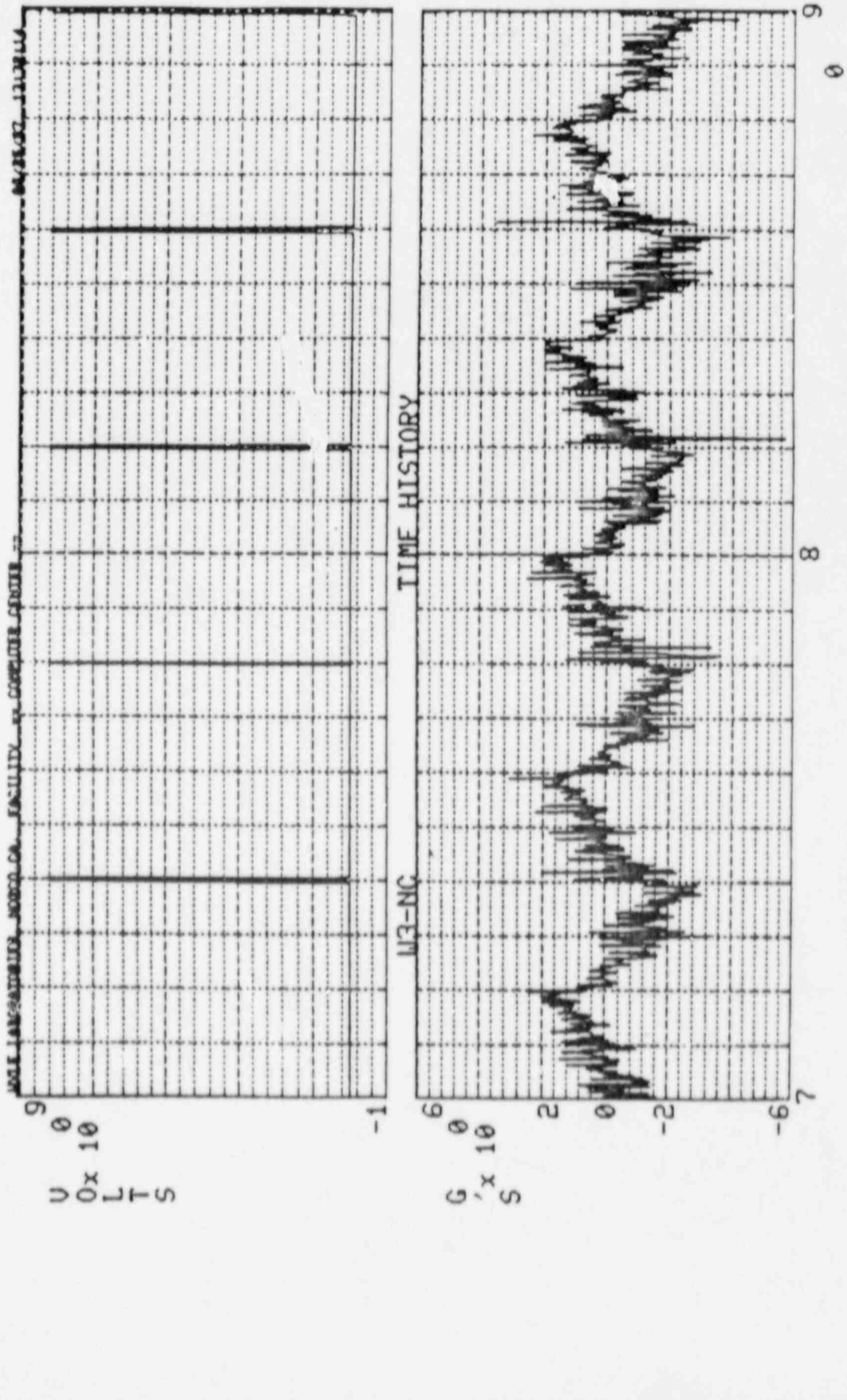
NO FILTER, 1000.00 SPS,
DATE 05/20/87 DISPLAY NUMBER 2 18.00 TO 20.00 SEC
EGG 57724, F/B, 2.5G'S,SINE SWEEP, 2.5-100 HZ. DE-ENERGIZED



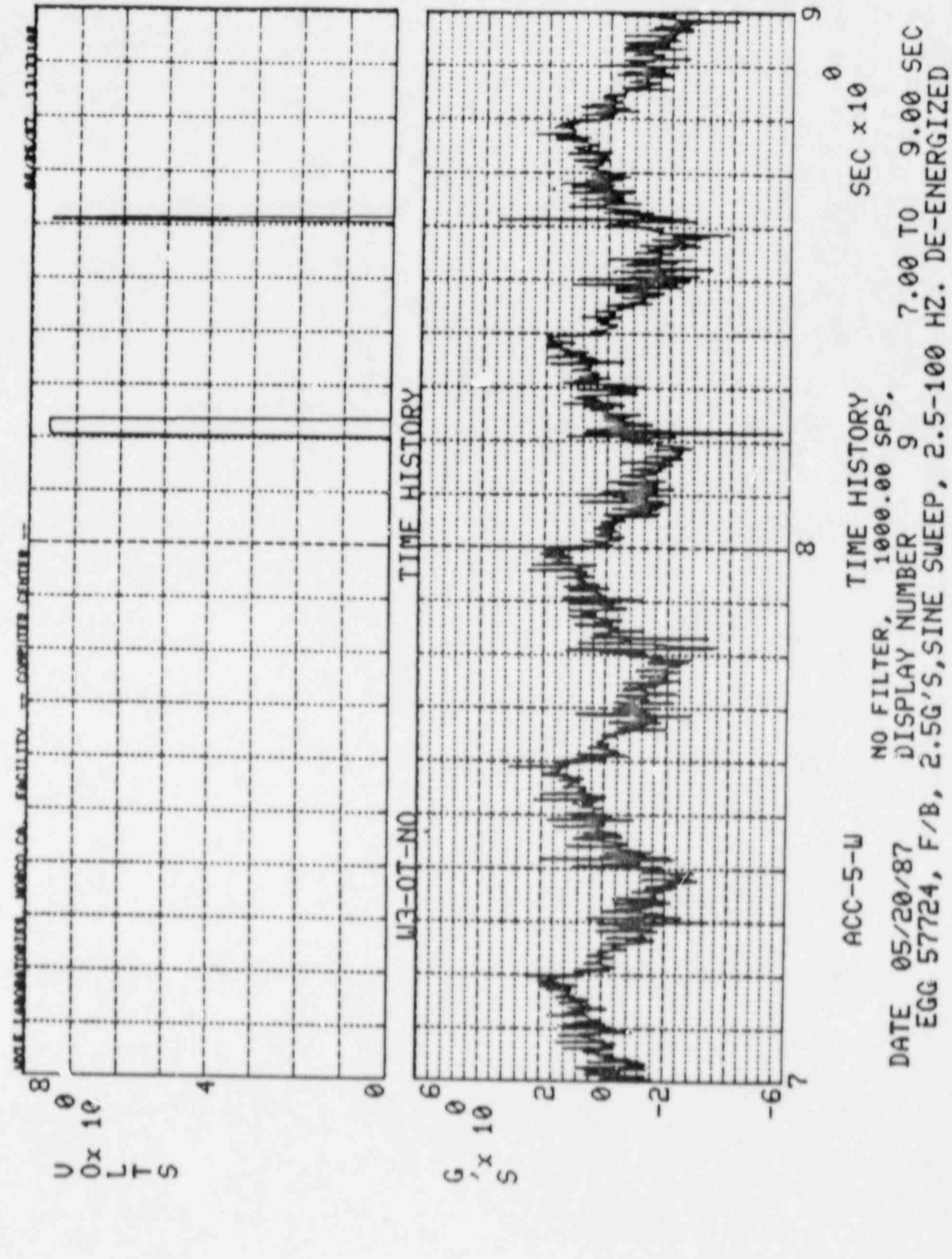
NO FILTER, 1000.00 SPS,

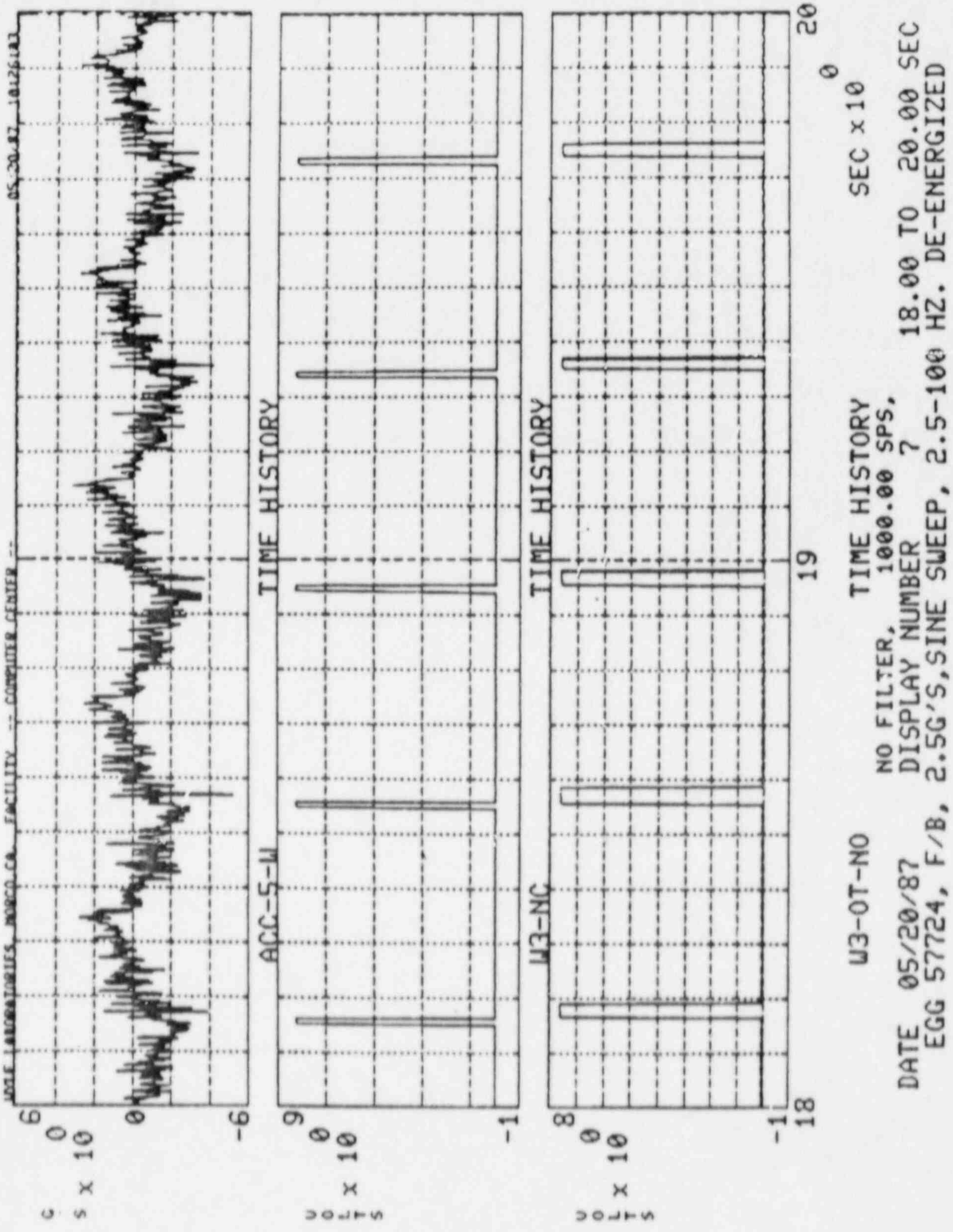
DATE 05/20/87 DISPLAY NUMBER 4 7.00 TO 41.00 SEC

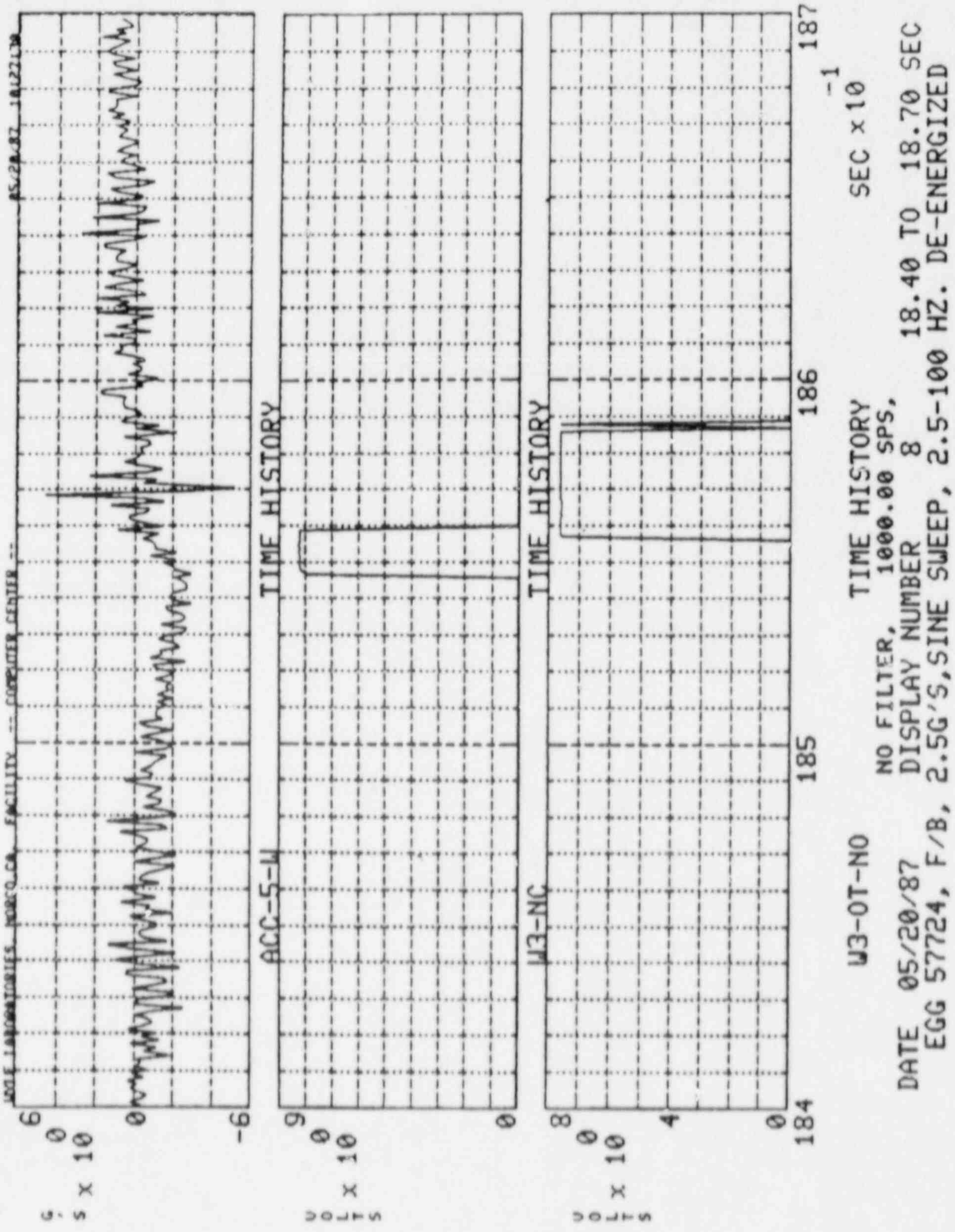
EGG 57724, F/B, 2.5G'S,SINE SWEEP, 2.5-100 HZ. DE-ENERGIZED

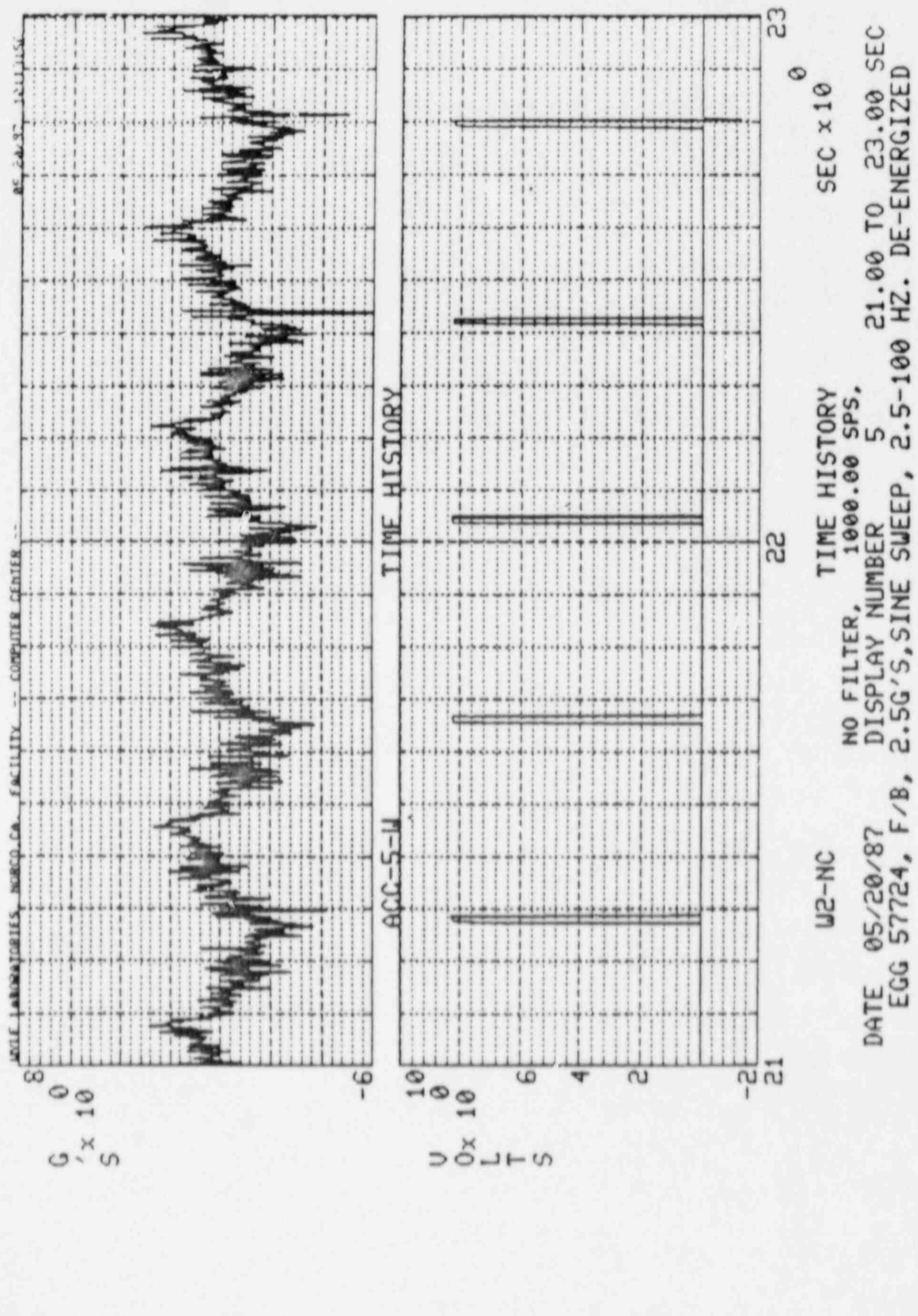


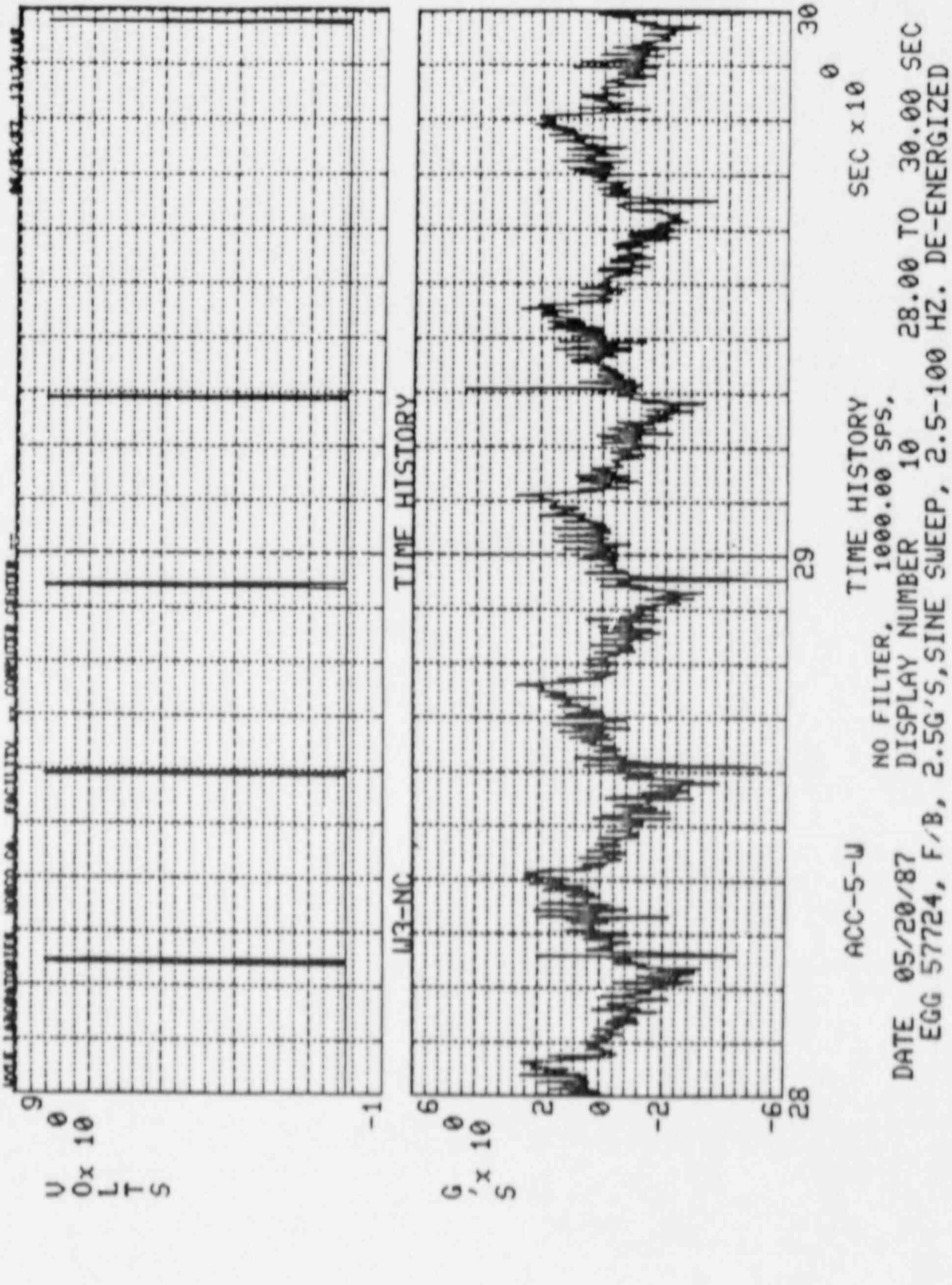
ACC-5-W TIME HISTORY
NO FILTER, 1000.00 SPS,
DATE 05/20/87 DISPLAY NUMBER 8 7.00 TO 9.00 SEC
EGG 57724, F/B, 2.5G'S,SINE SWEEP, 2.5-100 HZ. DE-ENERGIZED

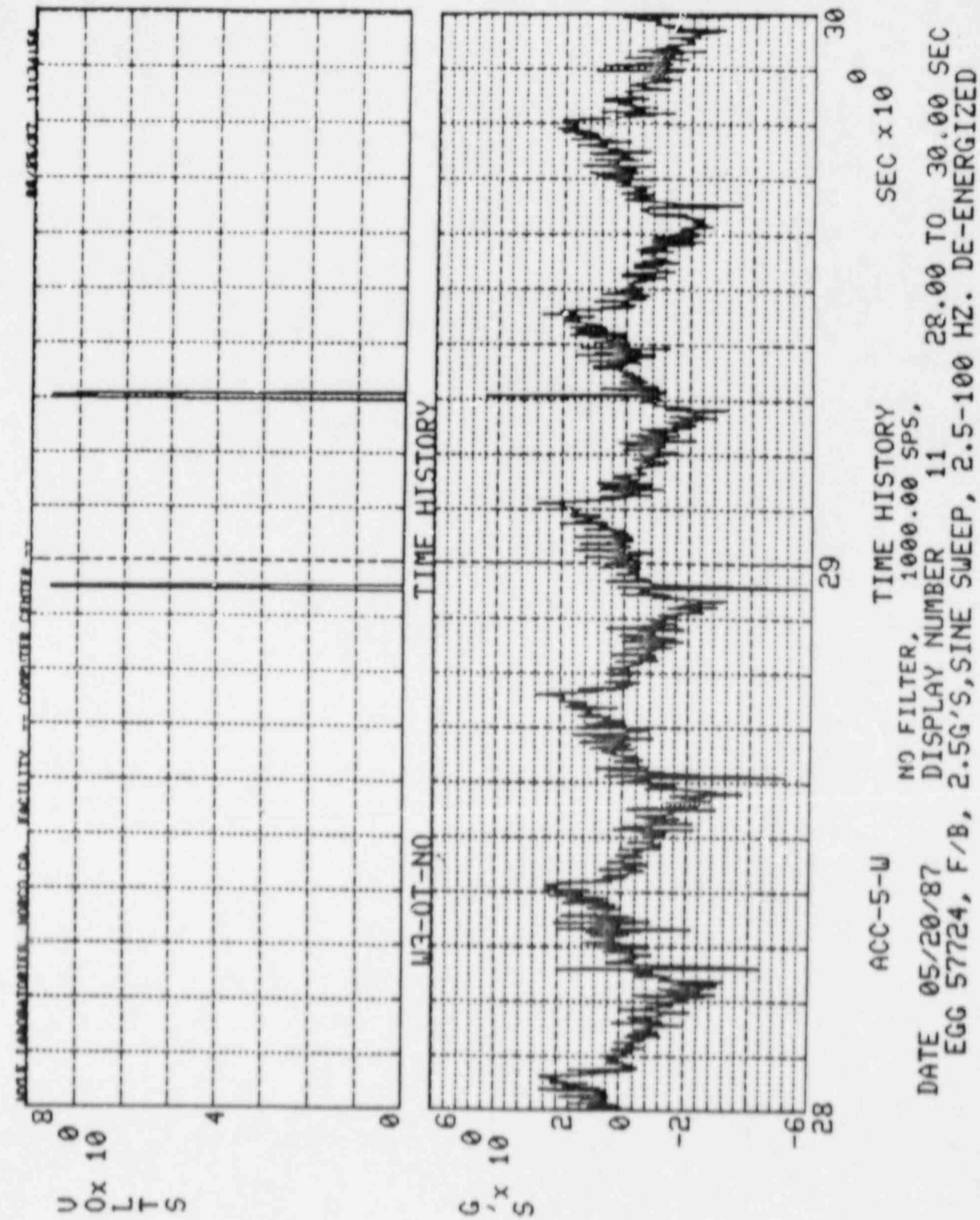

VOLTS x10^0
8
4
0
G'S x10^0
6
2
0
-2
-6
7
8
9
W3-OT-NO
TIME HISTORY
SEC x10^0
ACC-5-W
TIME HISTORY
DATE 05/20/87
NO FILTER, 1000.00 SPS,
DISPLAY NUMBER 9
7.00 TO 9.00 SEC
EGG 57724, F/B, 2.5G'S,SINE SWEEP, 2.5-100 HZ. DE-ENERGIZED

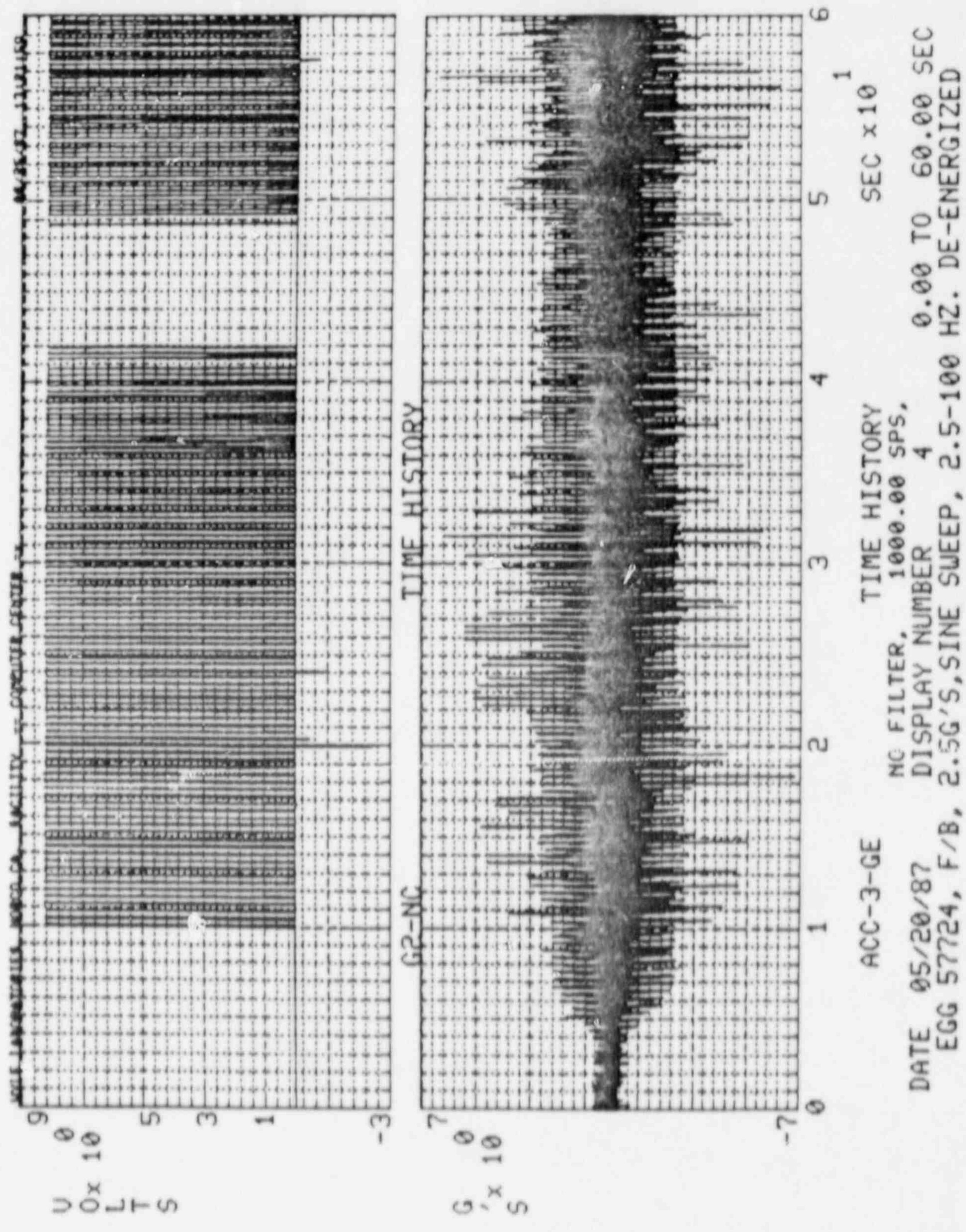

G's x 10^0
6
0
-6
ACC-5-W
TIME HISTORY
VOLTS x 10^0
9
-1
W3-NC
TIME HISTORY
VOLTS x 10^0
8
-1
18
19
20
SEC x 10^0
W3-OT-NO
TIME HISTORY
DATE 05/20/87
NO FILTER, 1000.00 SPS, 18.00 TO 20.00 SEC
DISPLAY NUMBER 7
EGG 57724, F/B, 2.5G'S,SINE SWEEP, 2.5-100 HZ. DE-ENERGIZED

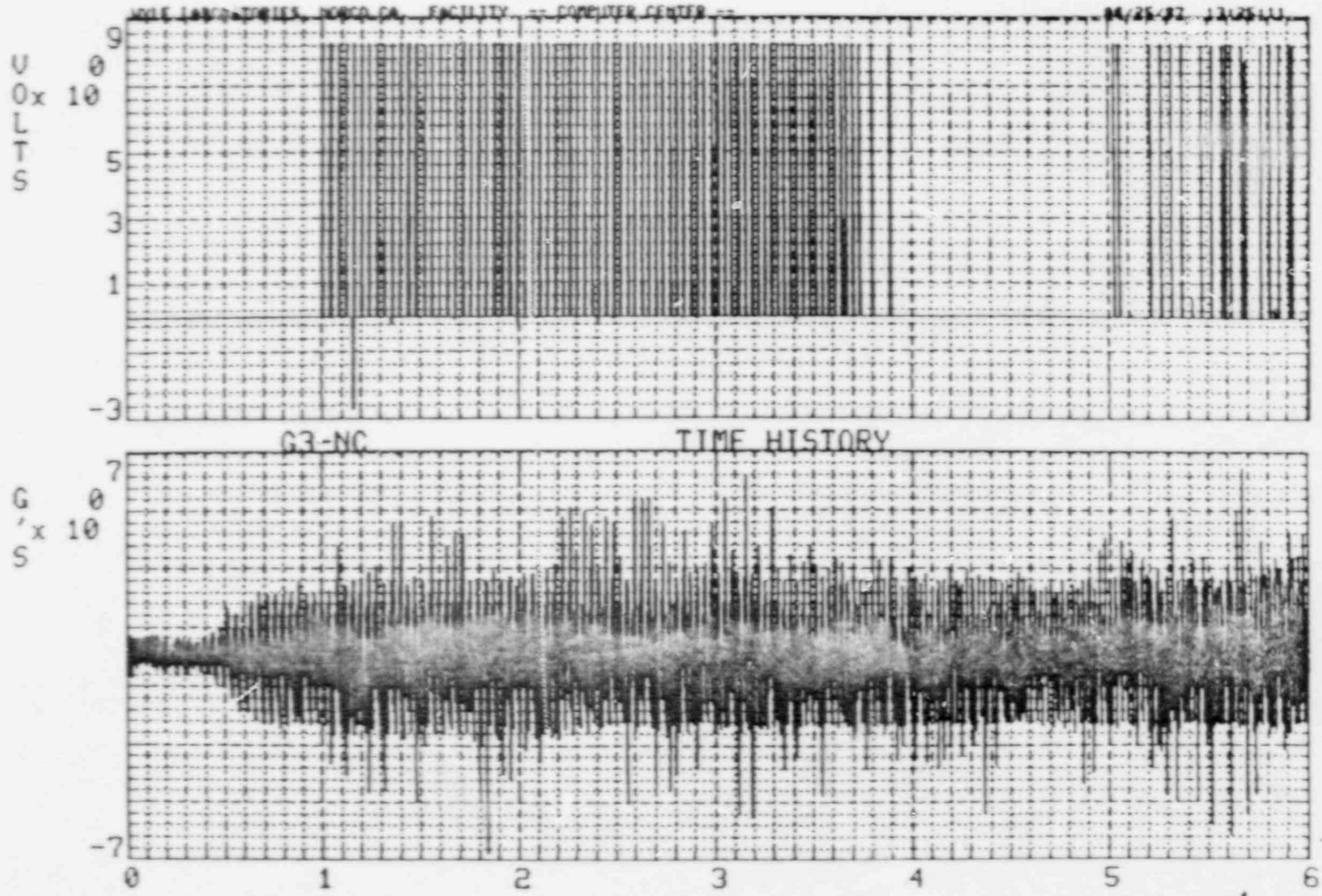

G'S x 10 0
6
0
-6
ACC-5-W TIME HISTORY
VOLTS x 10 0
9
0
W3-NC TIME HISTORY
VOLTS x 10 0
8
4
0
184
185
186
187
SEC x 10 -1
W3-OT-NO TIME HISTORY
NO FILTER, 1000.00 SPS,
DATE 05/20/87 DISPLAY NUMBER 8 18.40 TO 18.70 SEC
EGG 57724, F/B, 2.5G'S,SINE SWEEP, 2.5-100 HZ. DE-ENERGIZED


W2-NC
TIME HISTORY
NO FILTER, 1000.00 SPS, 21.00 TO 23.00 SEC
DATE 05/20/87 DISPLAY NUMBER 5
EGG 57724, F/B, 2.5G'S,SINE SWEEP, 2.5-100 HZ. DE-ENERGIZED
ACC-5-W
TIME HISTORY
G'S x 10^0
VOLTS x 10^0
SEC x 10^0
21
22
23
8
-6
10
6
4
2
-2


TIME HISTORY
W3-NC
VOLTS x 10^0
G'S x 10^0
SEC x 10^0
ACC-5-W
NO FILTER, 1000.00 SPS,
TIME HISTORY
DATE 05/20/87
DISPLAY NUMBER 10
28.00 TO 30.00 SEC
EGG 57724, F/B, 2.5G'S,SINE SWEEP, 2.5-100 HZ. DE-ENERGIZED


VOLTS x 10^0
G'S x 10^0
W3-OT-NO
TIME HISTORY
SEC x 10^0
ACC-5-W
NO FILTER, 1000.00 SPS,
TIME HISTORY
DATE 05/20/87
DISPLAY NUMBER 11
28.00 TO 30.00 SEC
EGG 57724, F/B, 2.5G'S, SINE SWEEP, 2.5-100 HZ. DE-ENERGIZED


VOLTS x 10^0
G'S x 10^0
G2-NC
TIME HISTORY
SEC x 10^1
DATE 05/20/87
ACC-3-GE
NO FILTER,
DISPLAY NUMBER 4
TIME HISTORY
1000.00 SPS,
0.00 TO 60.00 SEC
EGG 57724, F/B, 2.5G'S,SINE SWEEP, 2.5-100 HZ. DE-ENERGIZED

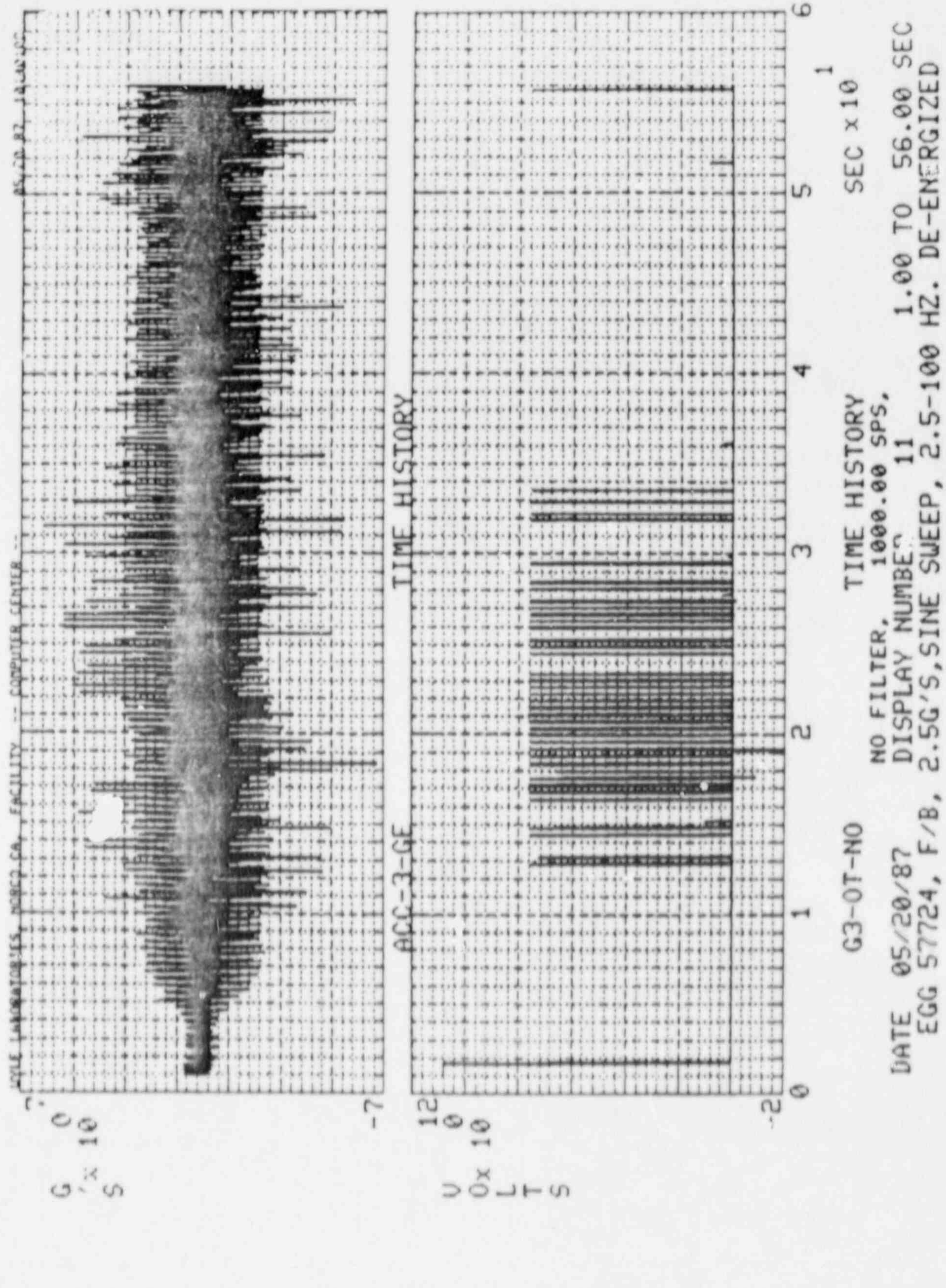


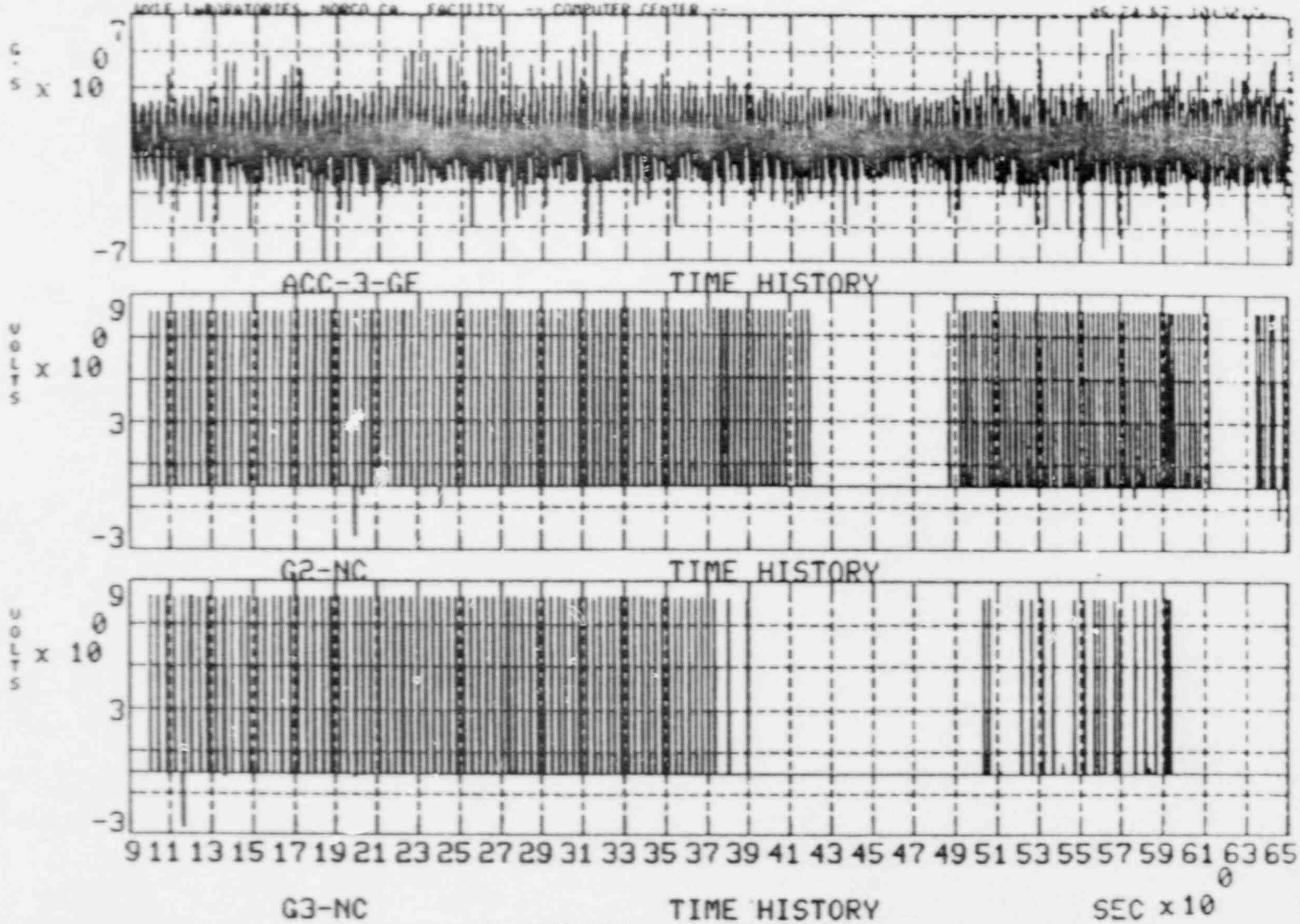
ACC-3-GE TIME HISTORY SEC x 10[1]

NO FILTER, 1000.00 SPS,

DATE 05/29/87 DISPLAY NUMBER 5 0.00 TO 60.00 SEC

EGG 57724, F/B, 2.5G'S, SINE SWEEP, 2.5-100 HZ. DE-ENERGIZED

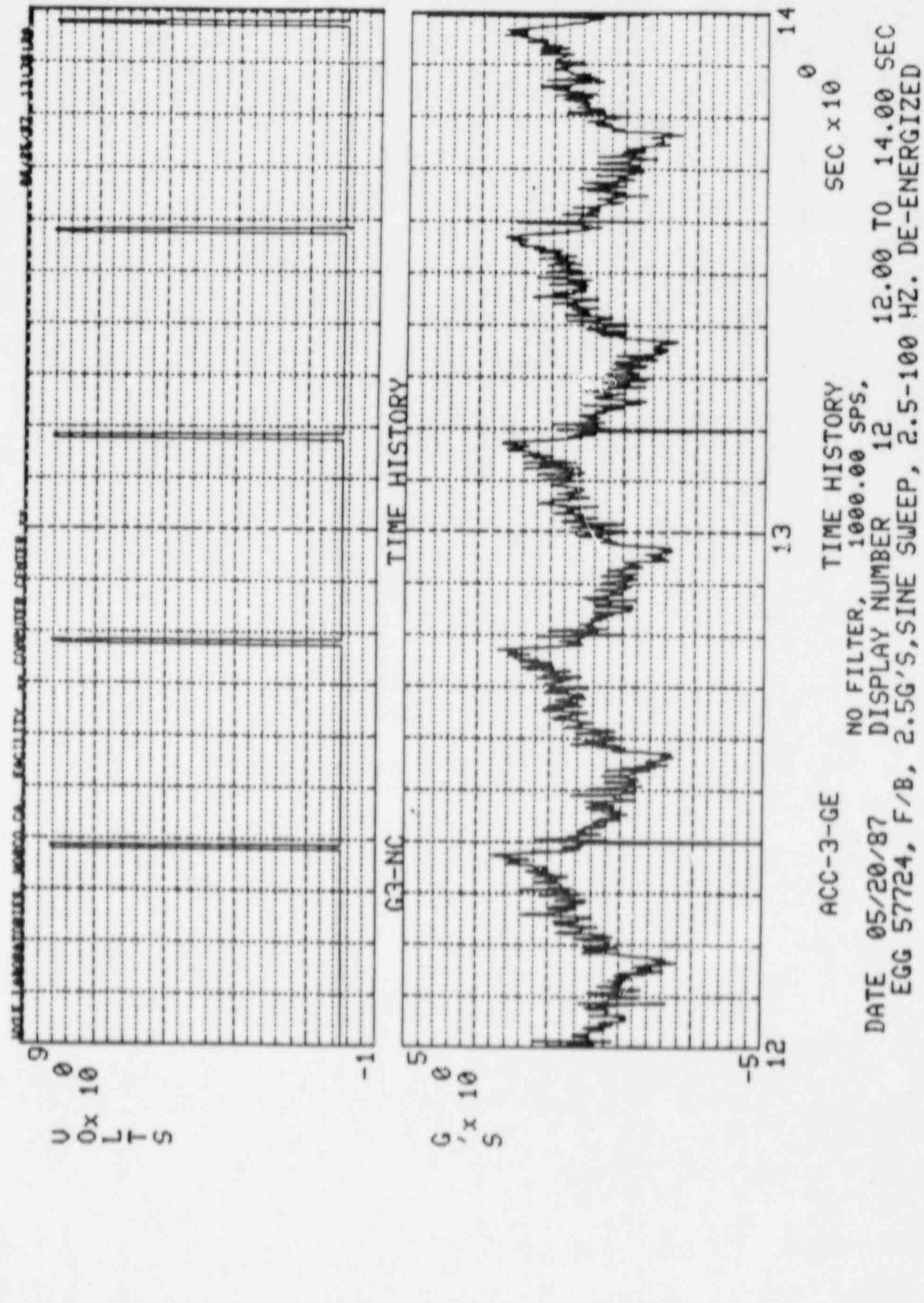

WYLE LABORATORIES NORCO CA. FACILITY --- COMPUTER CENTER ---
G'S x 10^0
VOLTS x 10^0
ACC-3-GE TIME HISTORY
SEC x 10^1
G3-OT-NO TIME HISTORY
DATE 05/20/87 NO FILTER, 1000.00 SPS, 1.00 TO 56.00 SEC
DISPLAY NUMBER 11
EGG 57724, F/B, 2.5G'S, SINE SWEEP, 2.5-100 HZ. DE-ENERGIZED

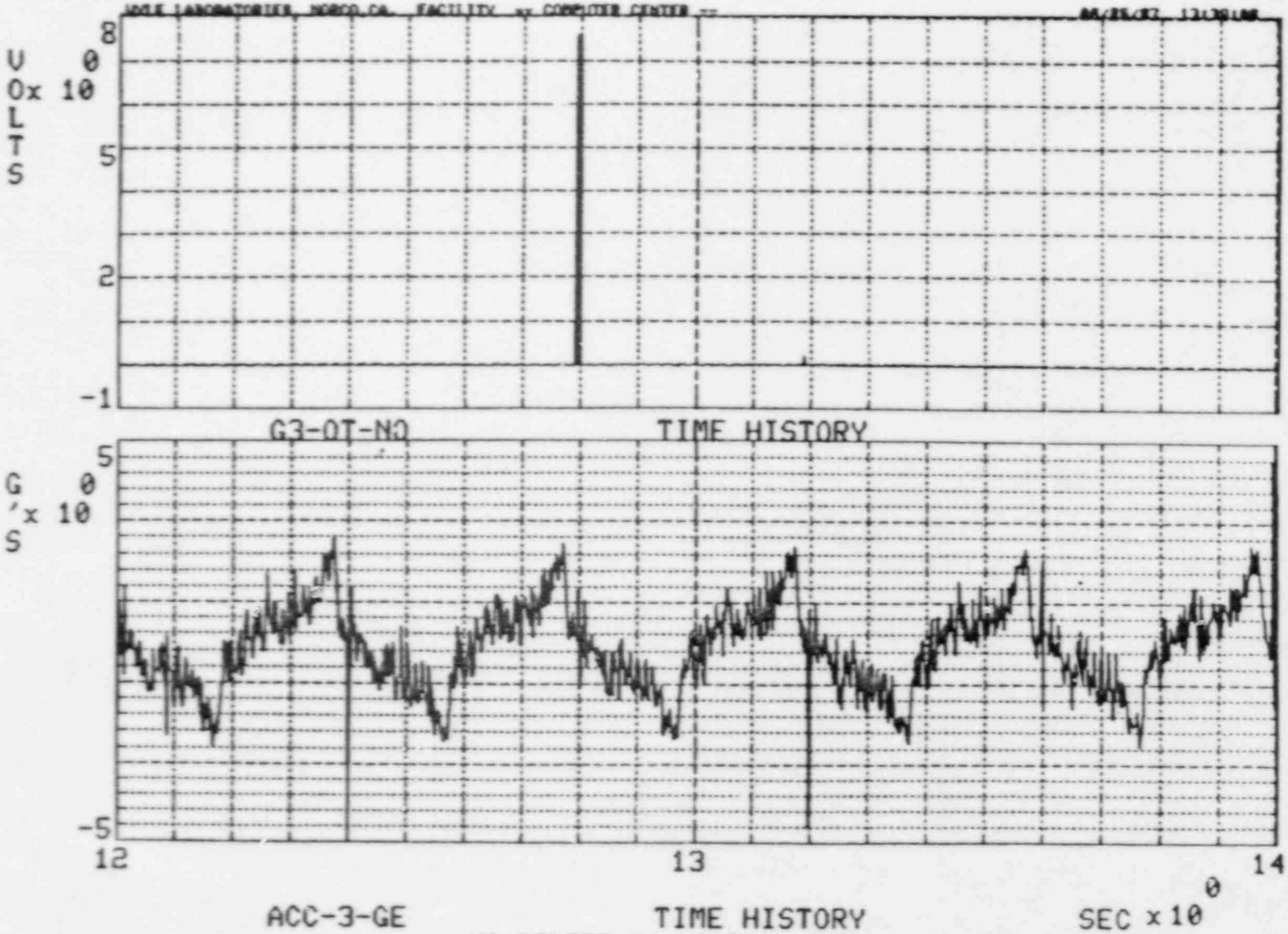


NO FILTER, 1000.00 SPS,

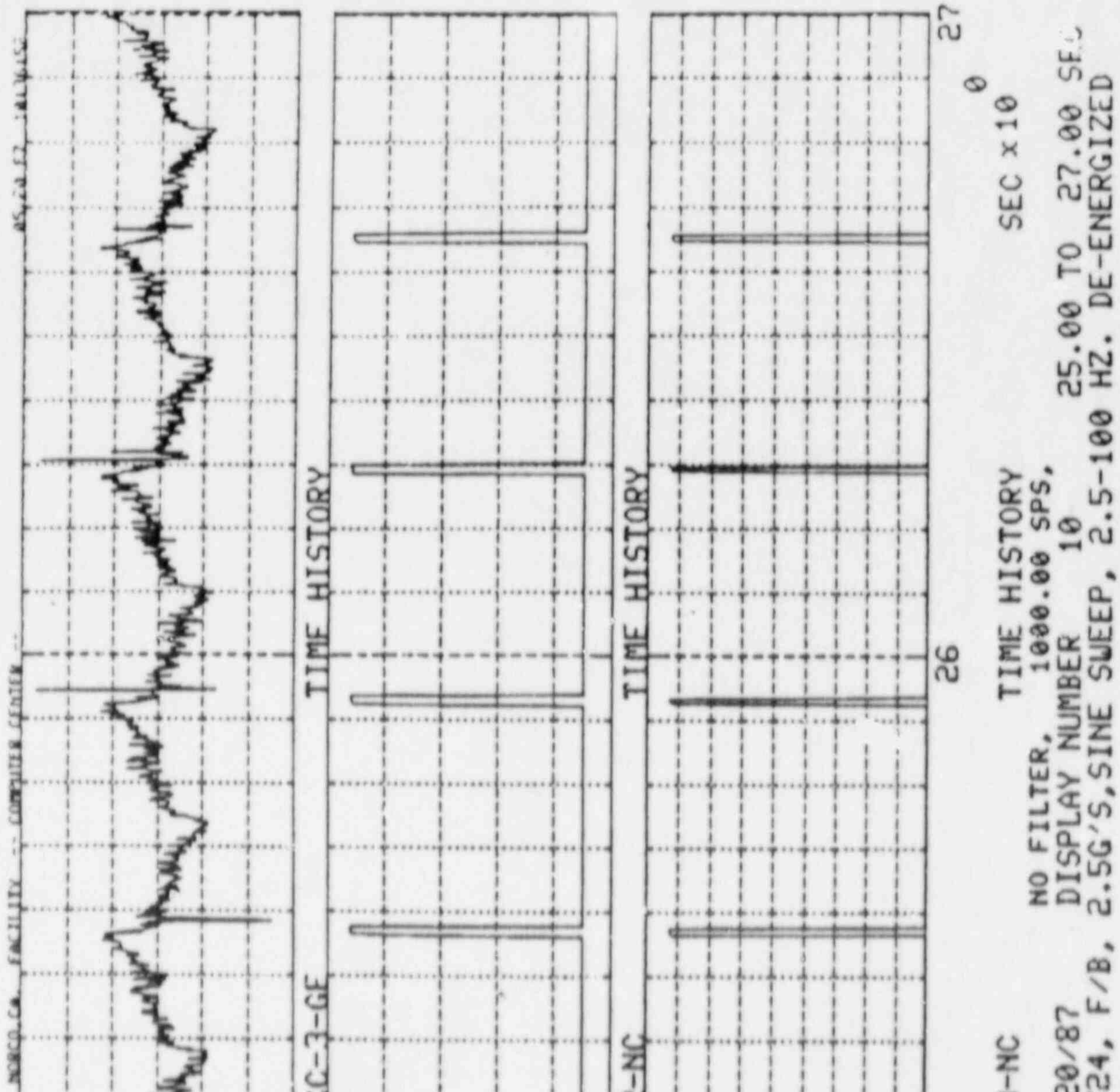
DATE 05/20/87 DISPLAY NUMBER 9 9.00 TO 65.00 SEC

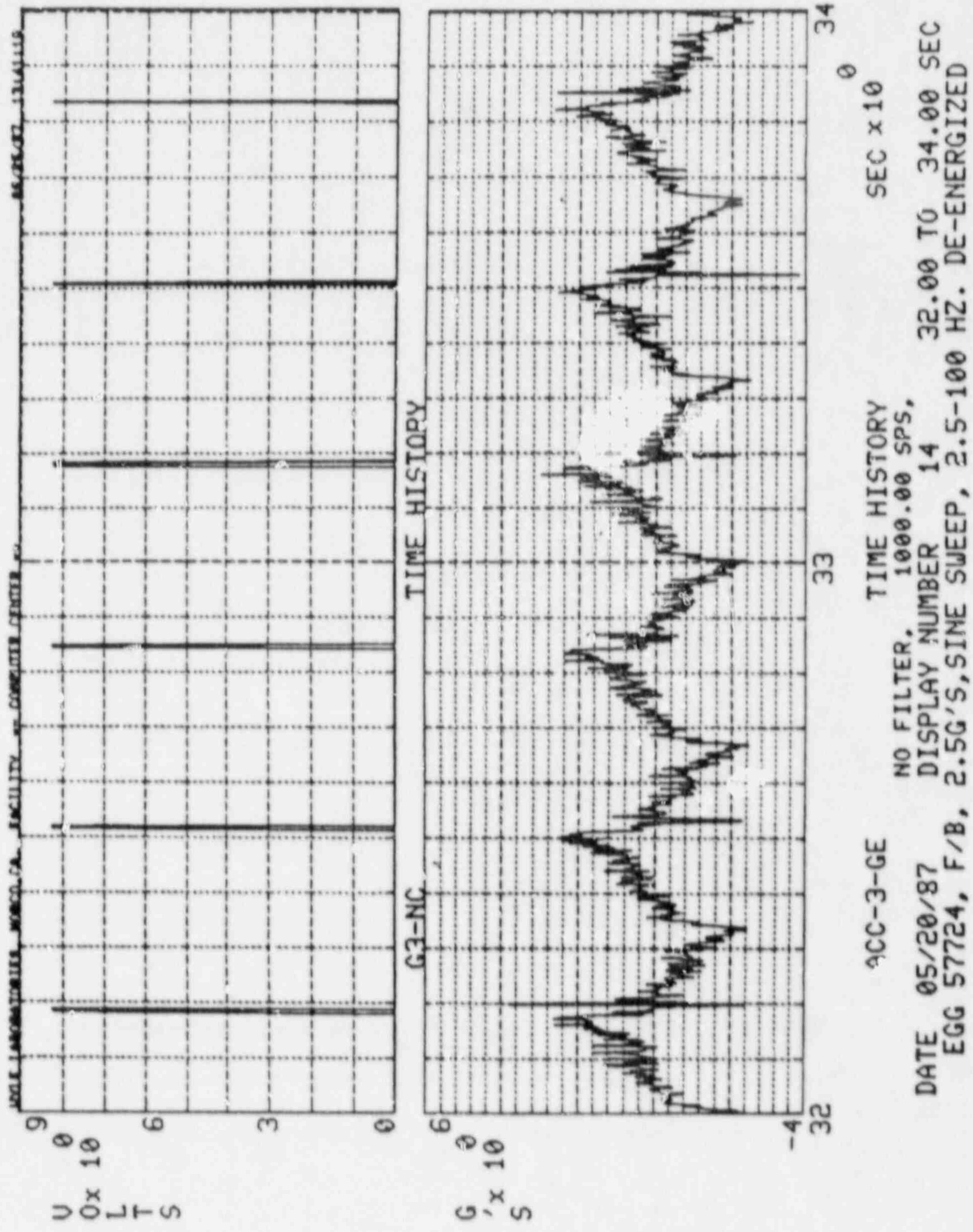
EGG 57724, F/R, 2.5G'S, SINE SWEEP, 2.5-100 HZ. DE-ENERGIZED

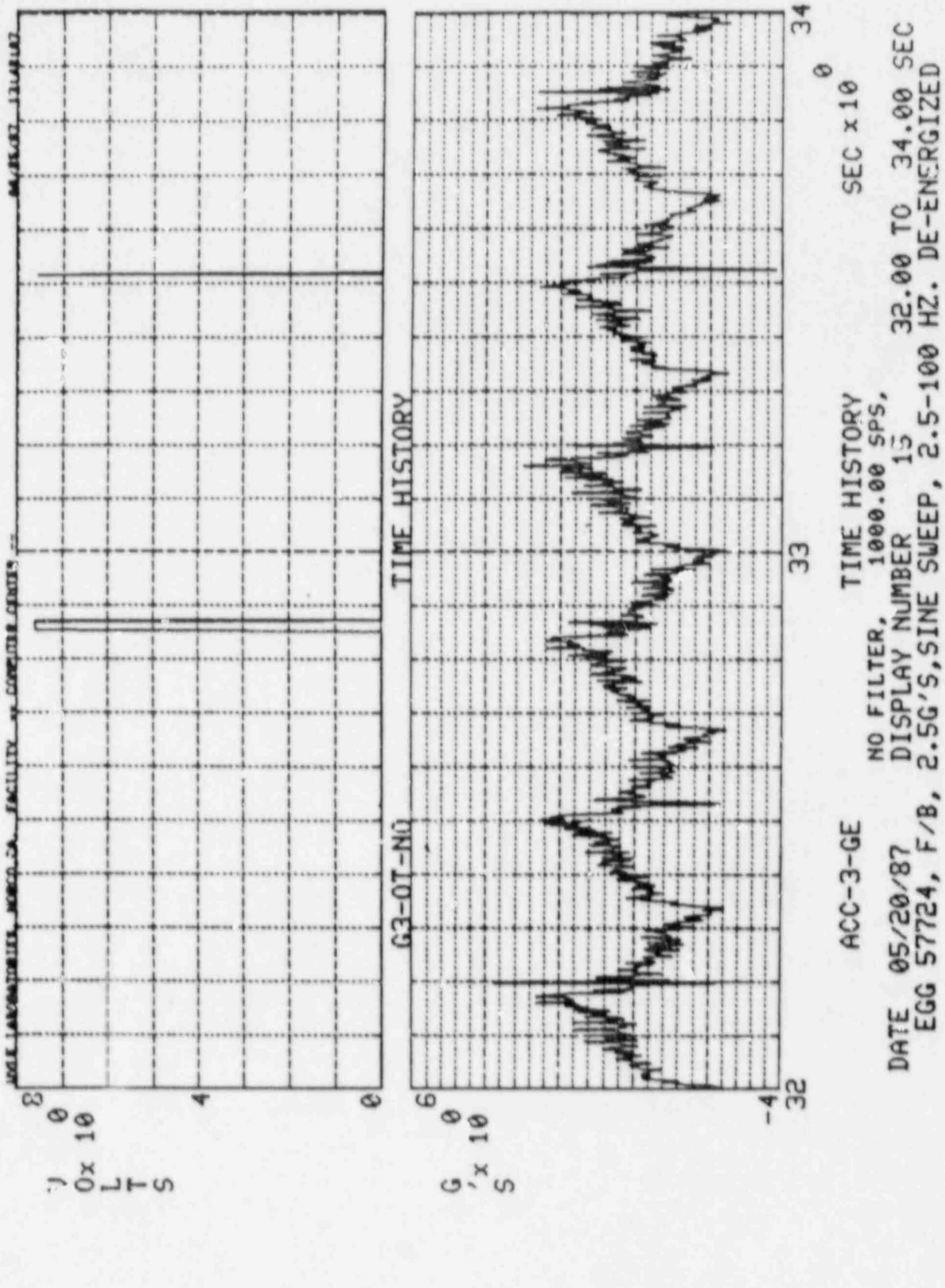

VOLTS x 10^0
9
-1
G'S x 10^0
5
-5
12
13
14
SEC x 10^0
TIME HISTORY
G3-NC
ACC-3-GE
TIME HISTORY
NO FILTER, 1000.00 SPS, 12.00 TO 14.00 SEC
DATE 05/20/87
DISPLAY NUMBER 12
EGG 57724, F/B, 2.5G'S,SINE SWEEP, 2.5-100 HZ. DE-ENERGIZED



NO FILTER, 1000.00 SPS,
DATE 05/20/87 DISPLAY NUMBER 13 12.00 TO 14.00 SEC
EGG 57724, F/B, 2.5G'S,SINE SWEEP, 2.5-100 HZ. DE-ENERGIZED


G3-NC
TIME HISTORY
DATE 05/20/87
NO FILTER, 1000.00 SPS,
DISPLAY NUMBER 10
25.00 TO 27.00 SEC
EGG 57724, F/B, 2.5G'S,SINE SWEEP, 2.5-100 HZ. DE-ENERGIZED
ACC-3-GE
TIME HISTORY
G2-NC
TIME HISTORY
SEC x 10
25
26
27
6
0
-6
9
-1
9
0


VOLTS x 10^0
9
6
3
0
G'S x 10^0
6
-4
32
33
34
SEC x 10^0
G3-NC
TIME HISTORY
9CC-3-GE
TIME HISTORY
NO FILTER, 1000.00 SPS, 32.00 TO 34.00 SEC
DISPLAY NUMBER 14
DATE 05/20/87
EGG 57724, F/B, 2.5G'S, SINE SWEEP, 2.5-100 HZ. DE-ENERGIZED


TIME HISTORY
G3-OT-NO
VOLTS x 10^0
G'S x 10^0
8
4
0
6
-4
32
33
34
SEC x 10^0
ACC-3-GE
TIME HISTORY
NO FILTER, 1000.00 SPS, 32.00 TO 34.00 SEC
DATE 05/20/87 DISPLAY NUMBER 15
EGG 57724, F/B, 2.5G'S,SINE SWEEP, 2.5-100 HZ. DE-ENERGIZED

WYLE LABORATORIES,NORCO,CA. FACILITY   CHATTER AND PULSE ANALYSIS PROGRAM   05/20/87 11:02:25 HOURS   PAGE 1

START TIME= 0.0000   STOP TIME= 3[illegible].67

TEST NAME=EGG 57724 F/B, 2.5G'S,SINE SWEEP, 2.5-100 HZ. ENERGIZED
TEST DATE=05/20/87   10:47: 5 HOURS

CHANNEL ID	CHANNEL NUMBER	FIRST CHATTER	LAST CHATTER	STATE CHANGE	NUMBER OF CHATTER FAILURES PER TIME LENGTH 2.00-5.00	5.00-10.0	10.0-20.0	20.0-40.0	40.0-80.0	>80.0	TOTAL
W1-NO	2			0	NO CHATTER						
W1-NO	3			0	NO CHATTER						
W2-NO	4			0	NO CHATTER						
W2-NO	6			0	NO CHATTER						
W3-NO	7			0	NO CHATTER						
W3-NO	8			0	NO CHATTER						
G1-NO	10			0	NO CHATTER						
G1-NO	11			0	NO CHATTER						
G2-NO	12			0	NO CHATTER						
G2-NO	13			0	NO CHATTER						
G3-NO	14			0	NO CHATTER						
G3-NO	15			0	NO CHATTER						
W1-OT-NO	16			0	NO CHATTER						
[illegible]-OT-NO	17			0	NO CHATTER						
[illegible]-OT-NO	18			0	NO CHATTER						
[illegible]-OT-NO	19			0	NO CHATTER						
[illegible]-OT-NO	20			0	NO CHATTER						
[illegible]-OT-NO	21			0	NO CHATTER						
	22			0	NO CHATTER						
										TOTAL=	0

APPENDIX G

SINE SWEEP RECORDS ON "F-MACHINE"

Page No.

WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

DYNAMICS SECTION
VIBRATION TEST DATA SHEET

Job No. 37724
Sheet 1 of ____

Customer E.G.&G. Specimen ELECTRICAL COMPONENTS P/N SEE REC. INSP. S/N SEE REC. INSP.

Date	Time	Axis	Temp (°F)	SINUSOIDAL Freq (HZ)	Disp ("DA)	Accel. (±G)	Test Time (Min.)	Comments	
1987	NOTED	NOTED	AMB	NOTED	—	NOTED	*	SINE SWEEP 2.5 TO 100 HZ APPROX ONE OCTAVE PER	
								MINUTE, IN EACH AXIS. TEST LEVEL WAS INCREASED UNTIL	
								COMPONENT MALFUNCTION OCCURS.	
5-19	1605	X	AMB	2.5-100	—	2G.		START SINE SWEEP. DE-ENERGIZED.	BB
	1611						6 MINS.	COMPLETED.	BB
5-20	0832	X	AMB	2.5-50	—	2G.		START SINE SWEEP. DE-ENERGIZED.	BB
	0836						4 MIN.	STOP AT 50 HZ AND REVIEW COMPUTER DATA.	BB
5-20	0853	X	AMB	50-100	—	2G.		RESUME SWEEP. DE-ENERGIZED.	BB
	0855						2 MINS.	COMPLETED.	BB
5-20	0910	X	AMB	2.5-100	—	2.4		START SINE SWEEP. DE-ENERGIZED.	BB
	0916						6 MIN.	COMPLETED. 1 CHANNEL OF CHATTER.	BB
5-20	0935	X	AMB	2.5-100	—	2.5		START SINE SWEEP DE-ENERGIZED.	BB
	0941						6 MIN.	COMPLETED. CHATTER.	BB
5-20	1048	X	AMB	2.5-100	—	2.5		START SINE SWEEP. ENERGIZED.	BB
	1054						6 MIN.	COMPLETED.	BB
6-2	1100	X	AMB	4-100	—	3G.		START SINE SWEEP. RUN #29 DE-ENERGIZED.	BB
	1106						6 MIN.	COMPLETED.	BB
6-2	1330	X	AMB	4-100	—	2.5		START SINE SWEEP. RUN #30 DE-ENERGIZED.	BB
	1336						6 MIN.	COMPLETED.	BB
6-2	1408	X	AMB	4-100	—	2.0		START SINE SWEEP. RUN #31 DE-ENERGIZED.	BB
	1414						6 MIN.	COMPLETED.	BB

W589 QA Form Approval LH

Signed: P Brown

WYLE SC[illegible]IC SERVICES & S[illegible]EMS
LABORATORIES GROUP

DYNAMICS SECTION
VIBRATION TEST DATA SHEET

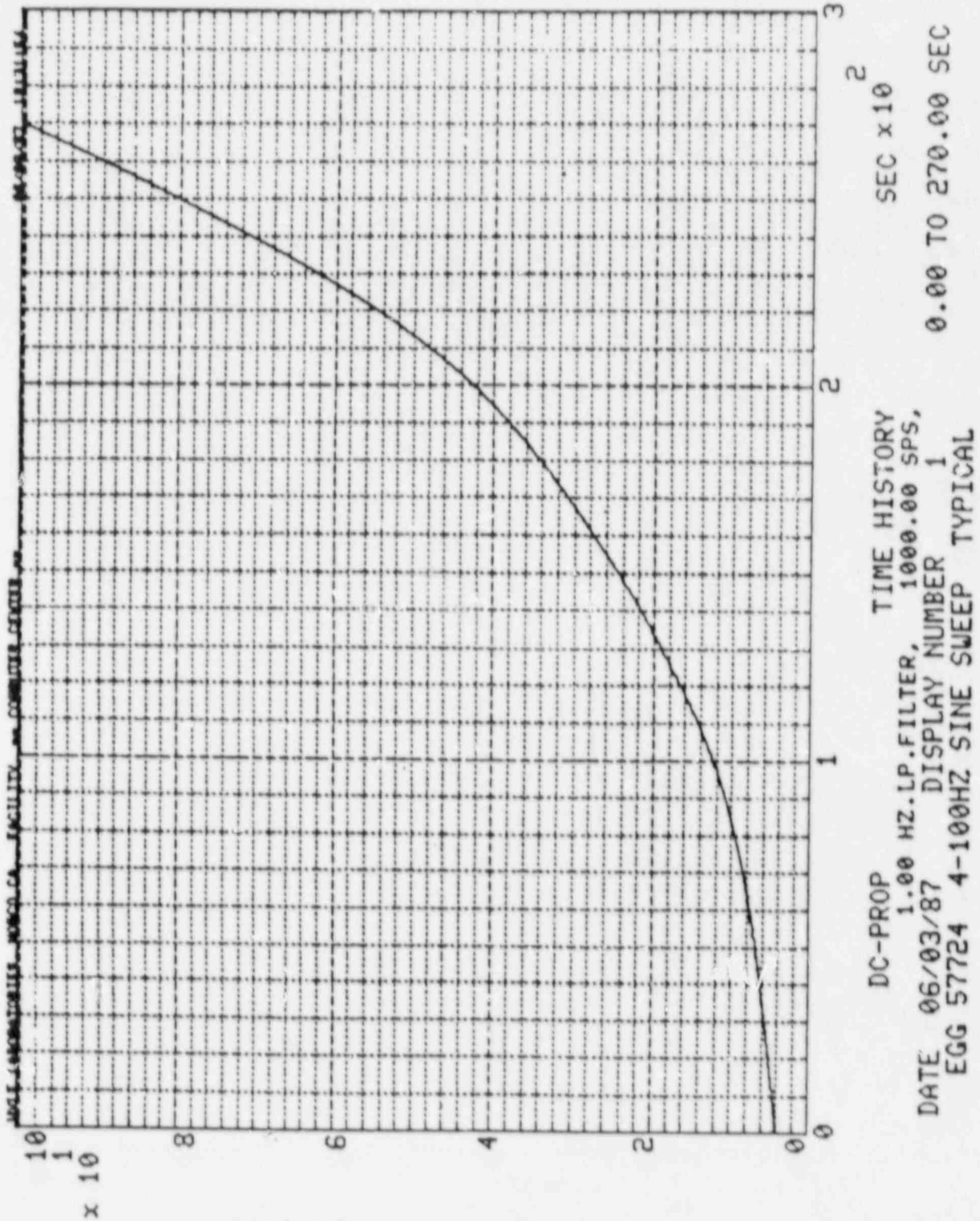
Job No. 57724
Sheet 2 of

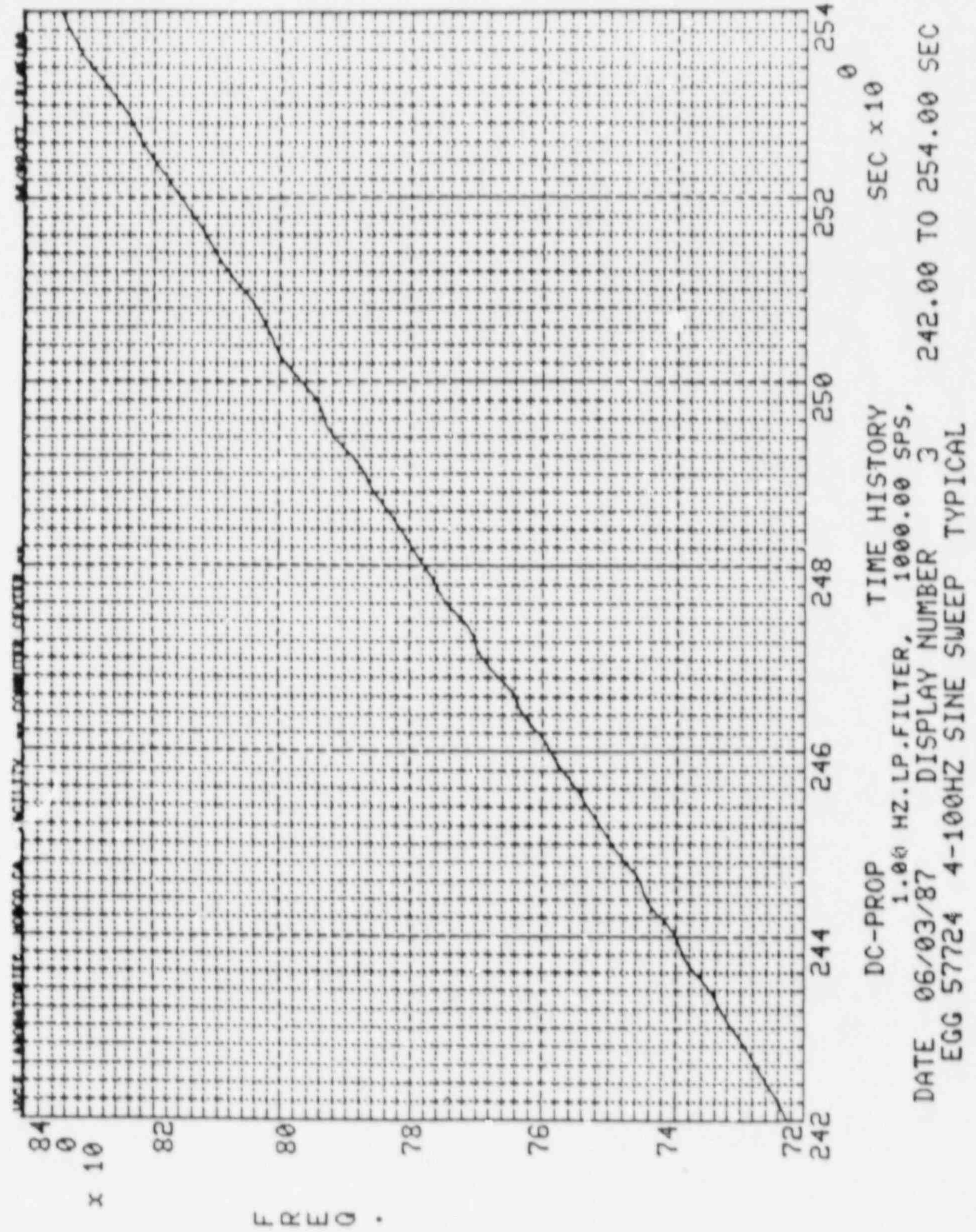
Customer EG&G Specimen ELECTRICAL COMPONENTS P/N SEE REC. INSP. S/N SEE REC. INSP.

Date	Time	Axis	Temp (°F)	SINUSOIDAL Freq. (HZ)	Disp. (″DA)	Accel. (±G)	Test Time (Min.)	Comments
1987	NOTED	NOTED	AMB	NOTED	—	NOTED		
6-2	1435	X	AMB	4-100	—	1.5		START SINE SWEEP. RUN #32 DE-ENERGIZED. BL.
	1441						6 MIN.	COMPLETED. BL.
6-2	1517	X	AMB	4-100	—	1a		START SINE SWEEP. RUN #33 DE-ENERGIZED BL.
	1523						6 MIN.	COMPLETED. BL.
6-2	1600	X	AMB	4-100	-	3.5		START SINE SWEEP. RUN #34 DE-ENERGIZED. BL.
	1606						6 MIN.	COMPLETED. BL.
6-3	0843	X	AMB	15-20	—	4		START SINE SWEEP. RUN #35 DE-ENERGIZED. BL.
	0849						6 MIN.	COMPLETED. BL.
6-3	1013	X	AMB	4-100	—	3.5		START SINE SWEEP. RUN #36 ENERGIZED. BL.
	1019						6 MIN.	COMPLETED. BL.
6-3	1334	Y	AMB	4-100	—	3.5		START SINE SWEEP. RUN #37 DE-ENERGIZED. BL.
	1340						6 MIN.	COMPLETED. BL.
6-3	1353	Y	AMB	4-100	—	3		START SINE SWEEP. RUN #38 DE-ENERGIZED. BL.
	1359						6 MIN.	COMPLETED. BL.
6-3	1417	Y	AMB	4-100	—	2.5		START SINE SWEEP. RUN #39. DE-ENERGIZED BL.
	1423						6 MIN.	COMPLETED. BL.
6-3	1438	Y	AMB	4-100	—	2		START SINE SWEEP. RUN #40 DE-ENERGIZED BL.
	1444						6 MIN.	COMPLETED. BL.
6-3	1516	Y	AMB	4-100	—	3.5		START SINE SWEEP. RUN #41 ENERGIZED. BL.
	1522						6 MIN.	COMPLETED. BL.

W589 QA Form Approval [illegible]

Signed: [signature]

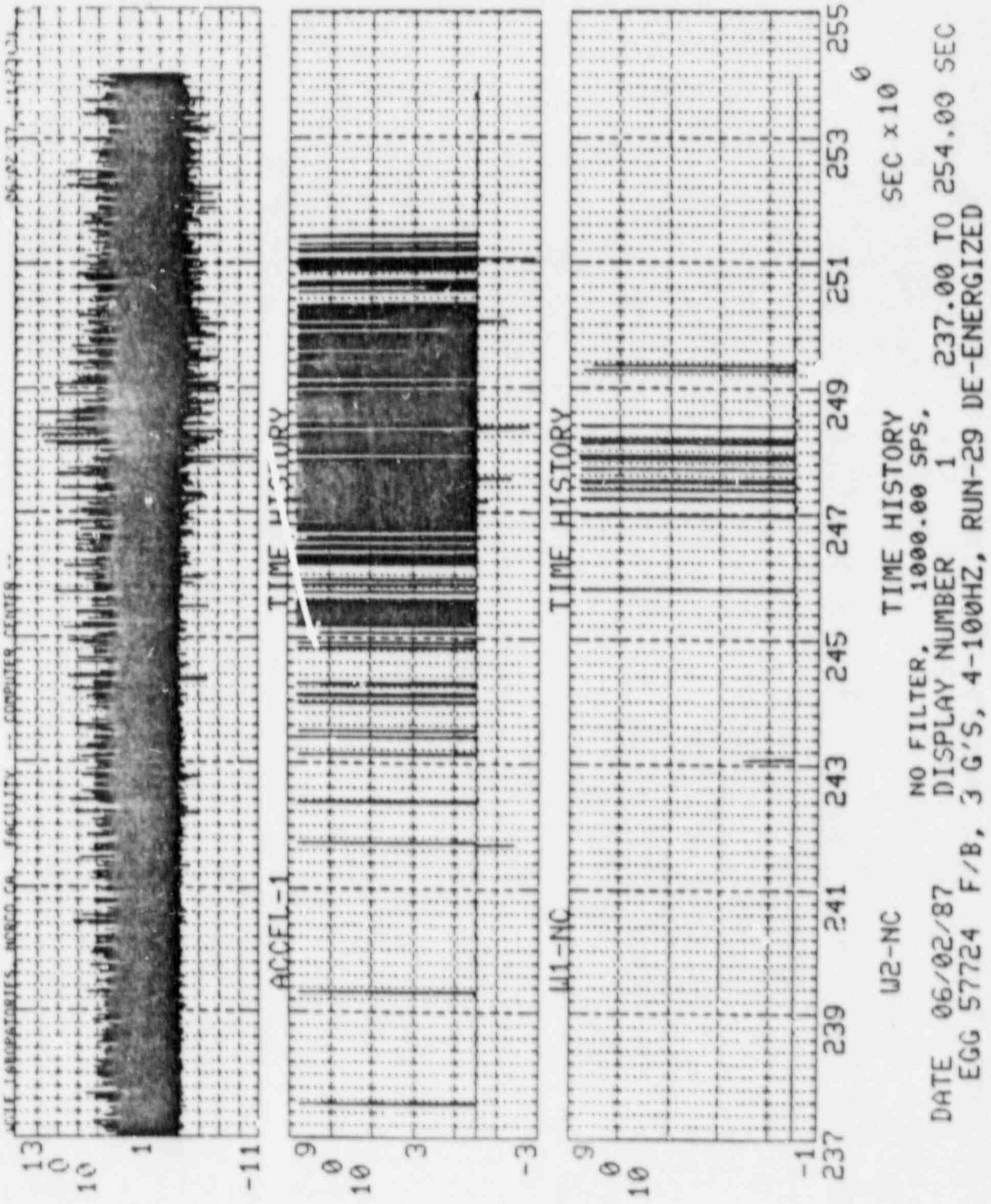

FREQ.
x 10^1
10
8
6
4
2
0
0
1
2
3
SEC x 10^2
DC-PROP TIME HISTORY
1.00 HZ.LP.FILTER, 1000.00 SPS,
DATE 06/03/87 DISPLAY NUMBER 1
EGG 57724 4-100HZ SINE SWEEP TYPICAL
0.00 TO 270.00 SEC

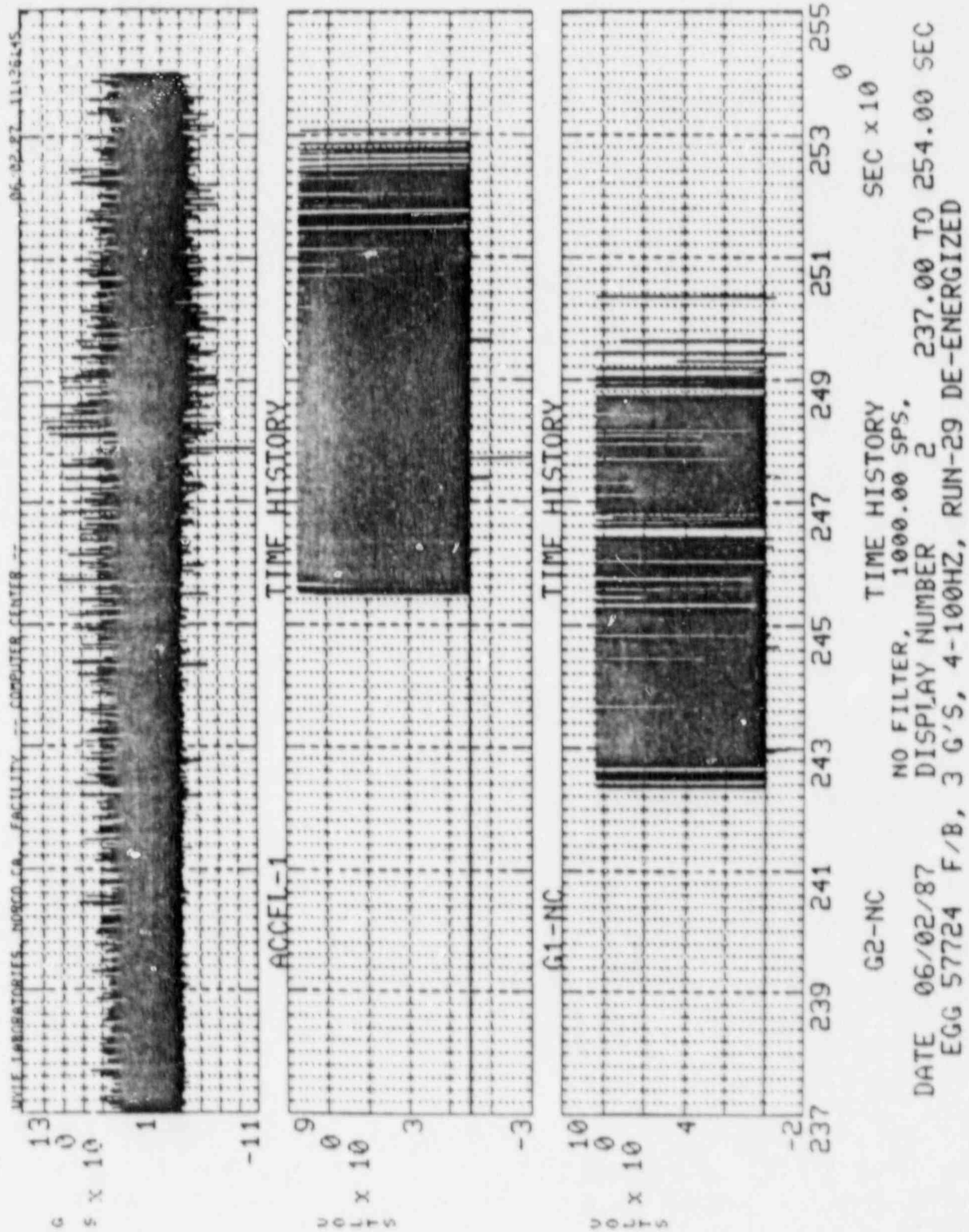

FREQ. x 10^0
84
82
80
78
76
74
72
242
244
246
248
250
252
254
SEC x10^0
DC-PROP TIME HISTORY
1.00 HZ.LP.FILTER, 1000.00 SPS,
DATE 06/03/87 DISPLAY NUMBER 3 242.00 TO 254.00 SEC
EGG 57724 4-100HZ SINE SWEEP TYPICAL

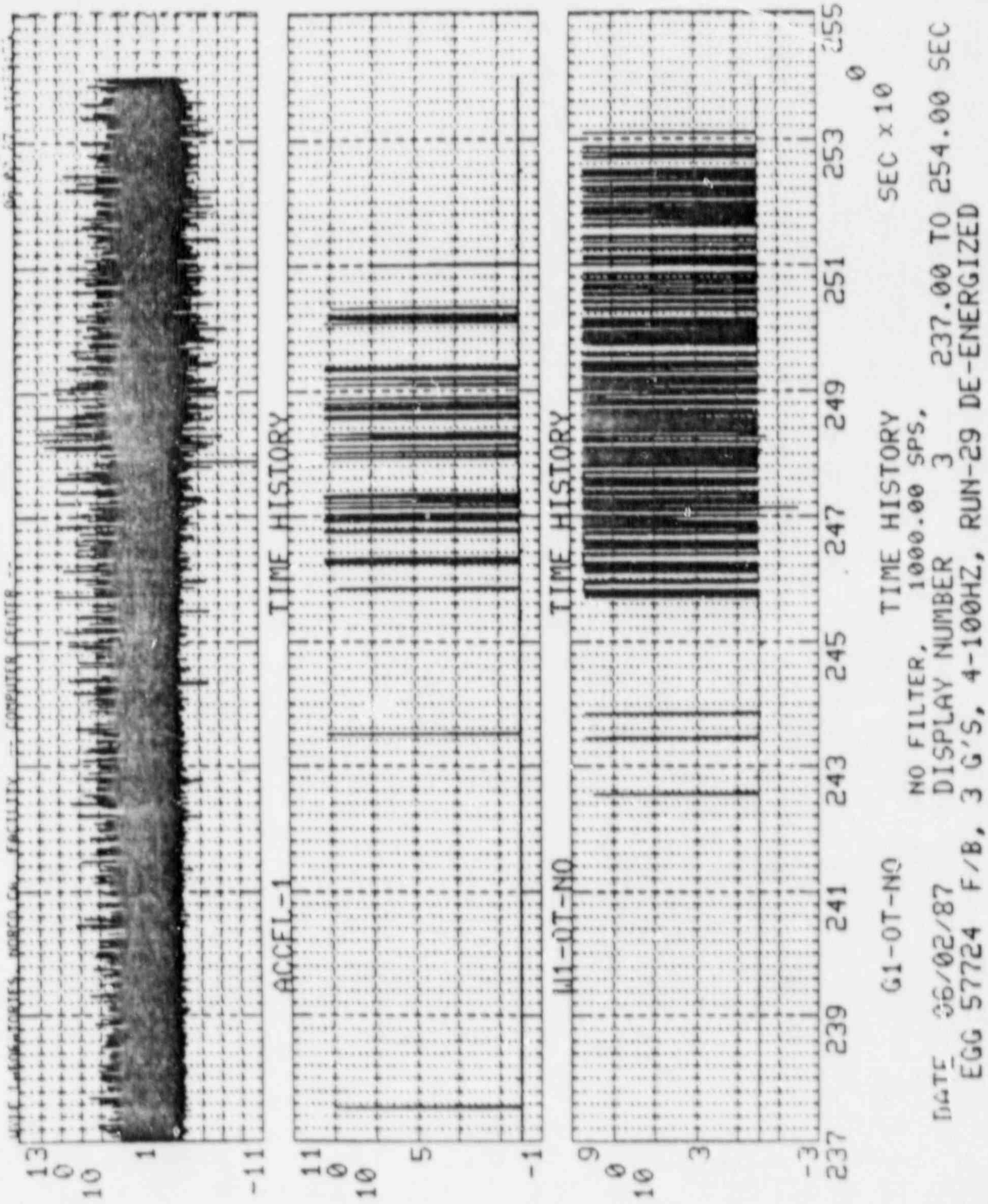
START TIME= 0.0000   STOP TIME= 265.73

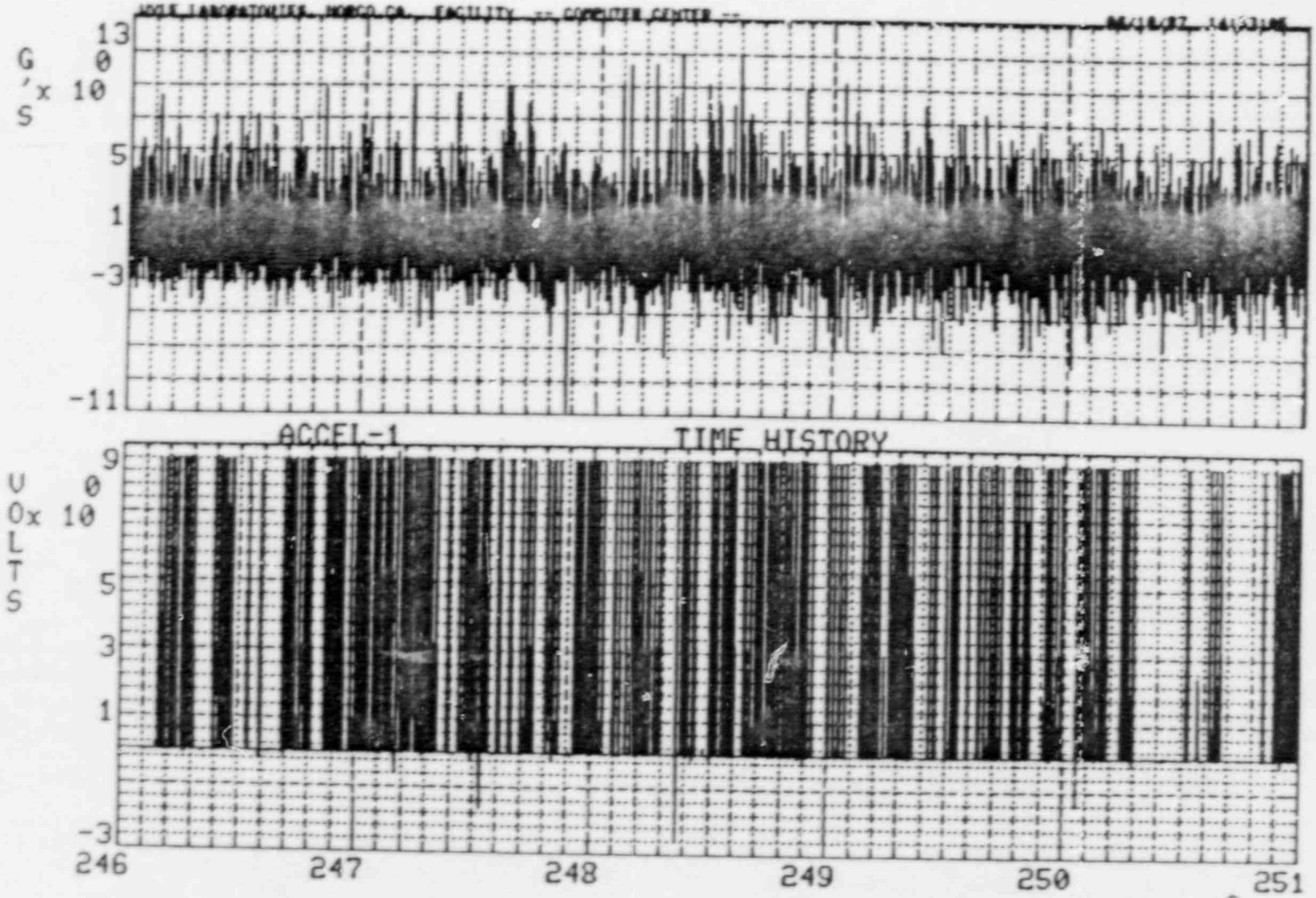
TEST NAME-EGG 57724 F/B, 3 G'S, 4-100HZ, RUN-29 DE-ENERGIZED
TEST DATE-06/02/87 11: 4:20 HOURS

CHANNEL ID	CHANNEL NUMBER	FIRST CHATTER	LAST CHATTER	STATE CHANGE	NUMBER OF CHATTER FAILURES PER TIME LENGTH 2.00-5.00	5.00-10.0	10.0-20.0	20.0-40.0	40.0-80.0	>80.0	TOTAL
W1-NC	3	237.531	251.431	0	93	72	1	0	0	0	166
W1-NO	4			0	NO CHATTER						
W2-NC	5	245.769	249.337	0	8	0	0	0	0	0	8
W2-NO	6			0	NO CHATTER						
W3-NC	7			0	NO CHATTER						
W3-NO	8			0	NO CHATTER						
G1-NC	9	245.491	253.075	0	44	219	3	0	0	0	266
G1-NO	10			0	NO CHATTER						
G2-NC	11	242.356	250.350	0	101	101	0	0	0	0	202
G2-NO	12			0	NO CHATTER						
G3-NC	13			0	NO CHATTER						
G3-NO	14			0	NO CHATTER						
W1-OT-NO	15	237.537	250.996	0	17	8	8	0	0	0	33
W2-OT-NO	16			0	NO CHATTER						
W3-OT-NO	17			0	NO CHATTER						
G1-OT-NO	18	242.542	253.987	0	15	19	54	22	12	6	128
G2-OT-NO	19			0	NO CHATTER						
G3-OT-NO	20			0	NO CHATTER						
										TOTAL=	803

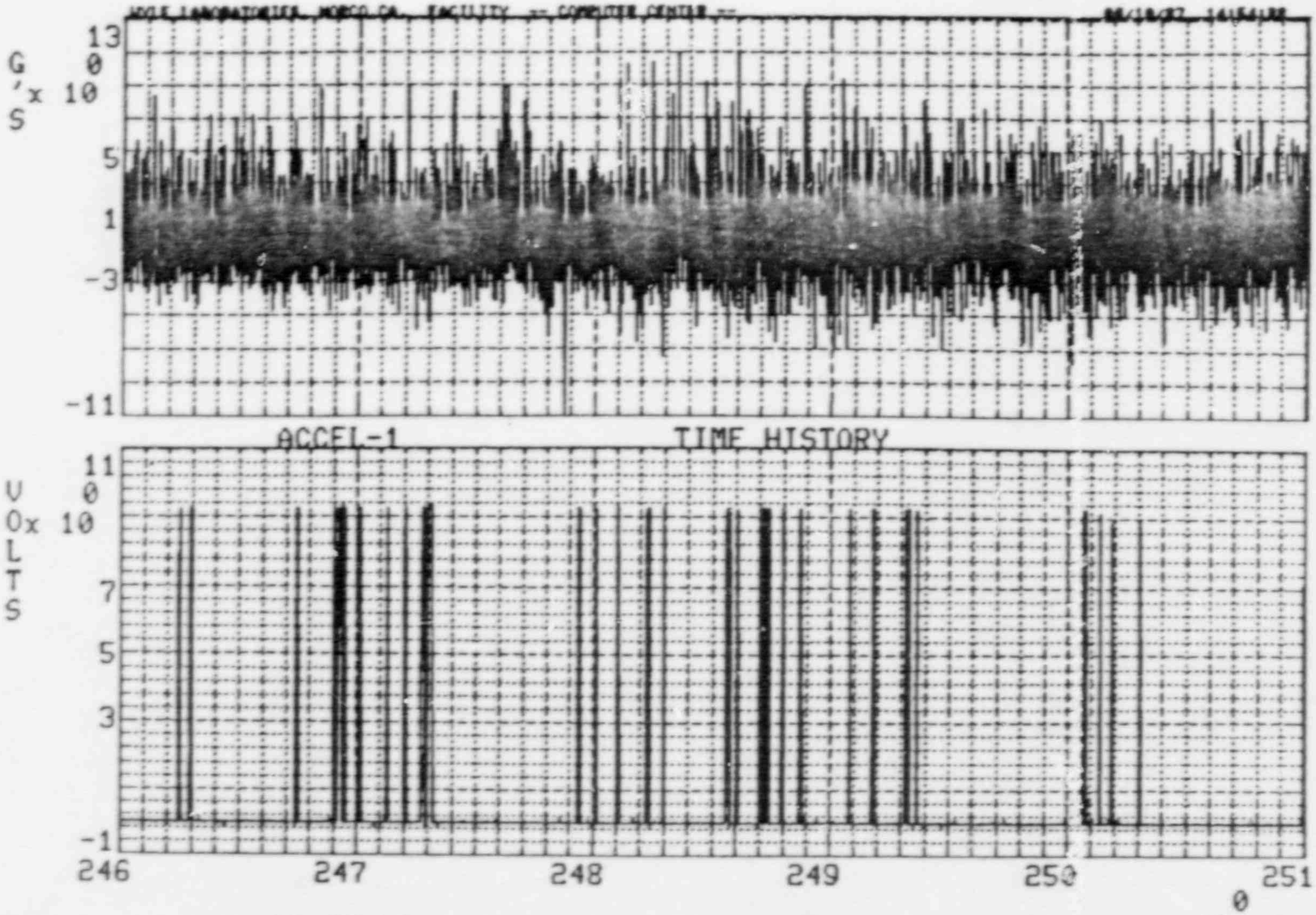

ACCEL-1
TIME HISTORY
W1-NC
TIME HISTORY
G'S x 10
VOLTS x 10
VOLTS x 10
237
239
241
243
245
247
249
251
253
255
SEC x 10
W2-NC
TIME HISTORY
DATE 06/02/87
NO FILTER, 1000.00 SPS,
DISPLAY NUMBER 1
237.00 TO 254.00 SEC
EGG 57724 F/B, 3 G'S, 4-100HZ, RUN-29 DE-ENERGIZED


ACCEL-1
TIME HISTORY
G1-NC
TIME HISTORY
G2-NC
TIME HISTORY
NO FILTER, 1000.00 SPS, 237.00 TO 254.00 SEC
DATE 06/02/87 DISPLAY NUMBER 2
EGG 57724 F/B, 3 G'S, 4-100HZ, RUN-29 DE-ENERGIZED
SEC x 10
237
239
241
243
245
247
249
251
253
255


ACCEL-1
TIME HISTORY
W1-OT-NO
TIME HISTORY
G1-OT-NO TIME HISTORY
NO FILTER, 1000.00 SPS, 237.00 TO 254.00 SEC
DATE 06/02/87 DISPLAY NUMBER 3
EGG 57724 F/B, 3 G'S, 4-100HZ, RUN-29 DE-ENERGIZED
SEC x 10
237 239 241 243 245 247 249 251 253 255



W1-NC TIME HISTORY
NO FILTER, 1000.00 SPS,
DATE 06/02/87 DISPLAY NUMBER 2 246.00 TO 251.00 SEC
EGG 57724 F/B, 3 G'S, 4-100HZ, RUN-29 DE-ENERGIZED

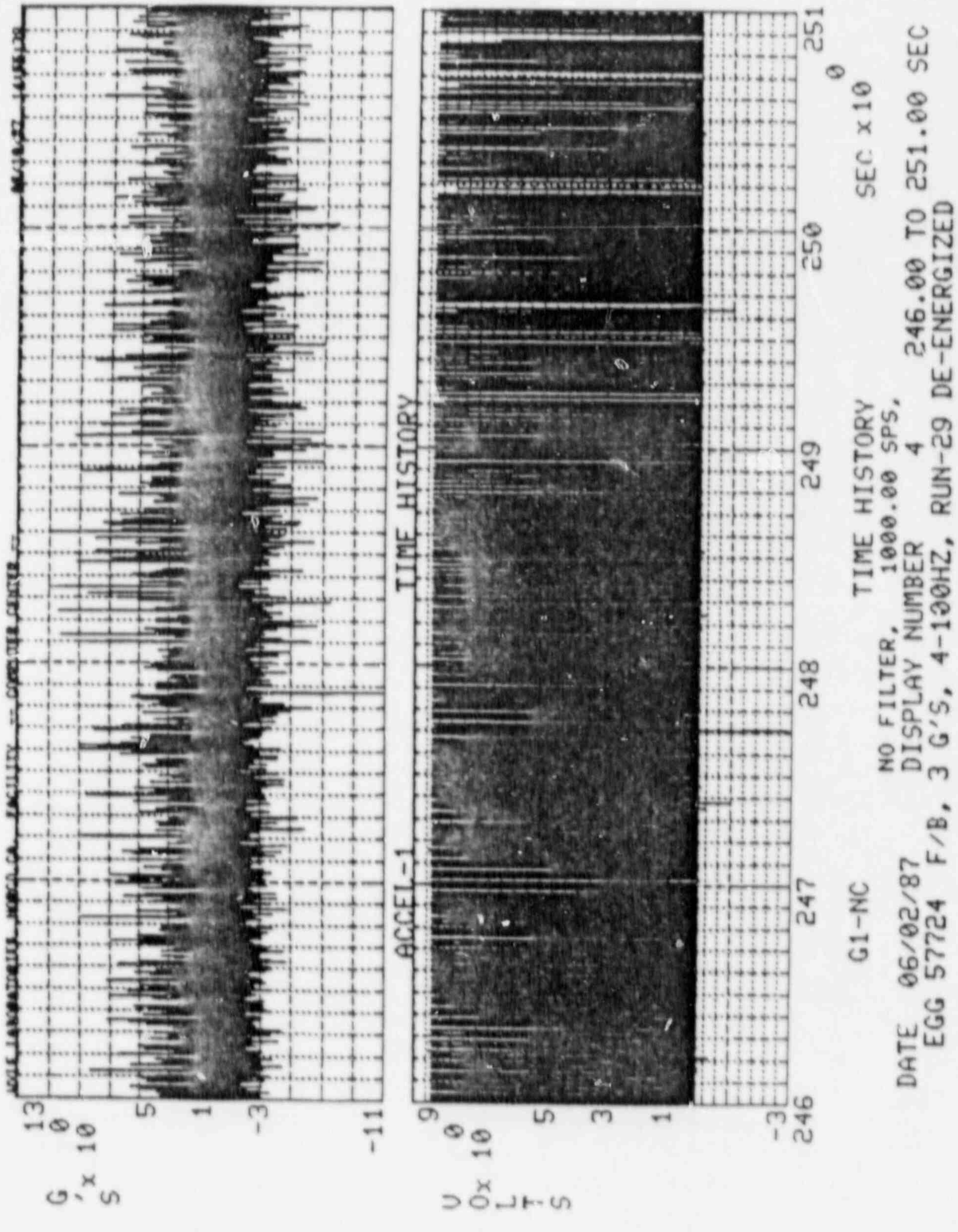


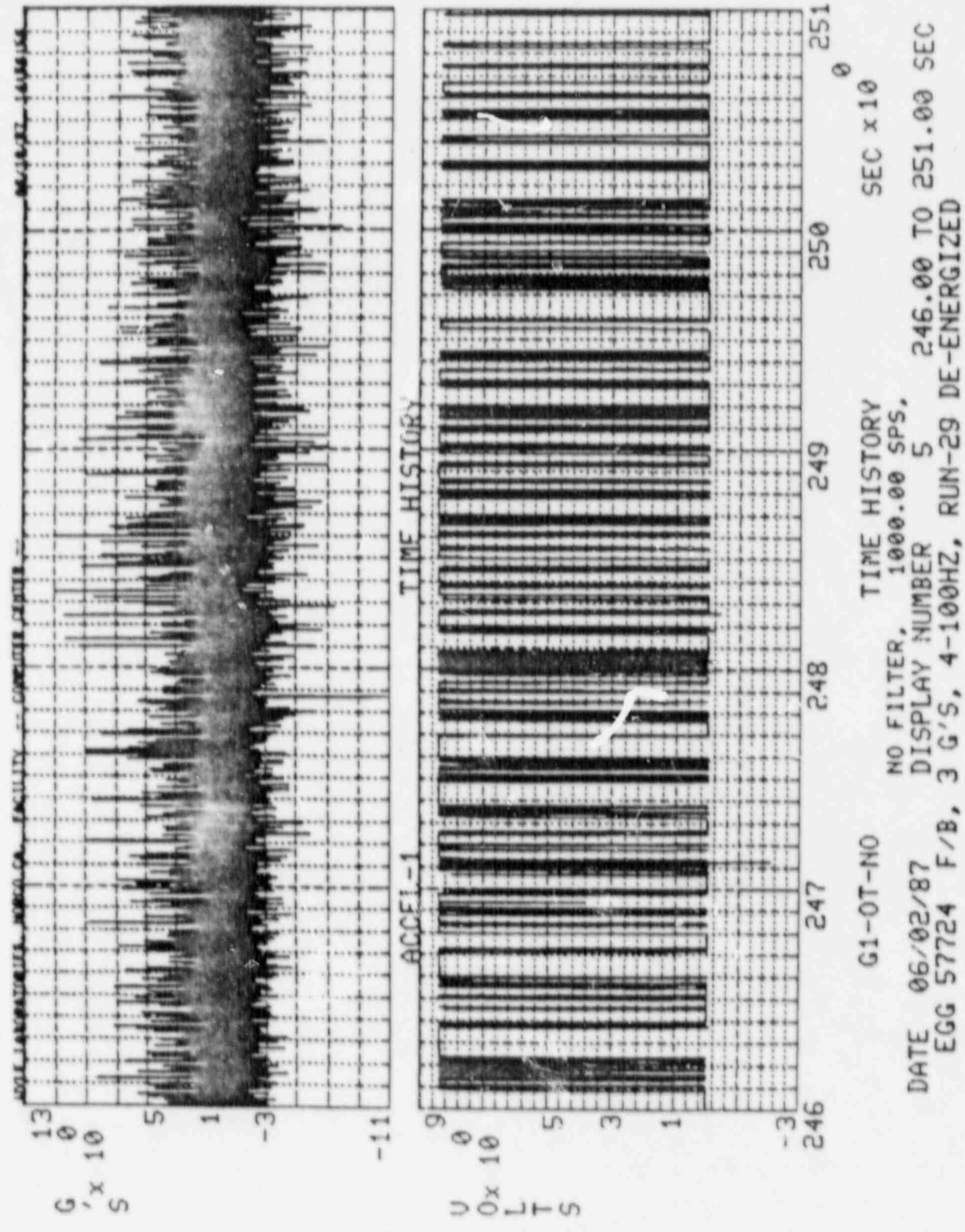
W1-OT-NO TIME HISTORY SEC x 10^0

NO FILTER, 1000.00 SPS,

DATE 06/02/87 DISPLAY NUMBER 3 246.00 TO 251.00 SEC

EGG 57724 F/B, 3 G'S, 4-100HZ, RUN-29 DE-ENERGIZED

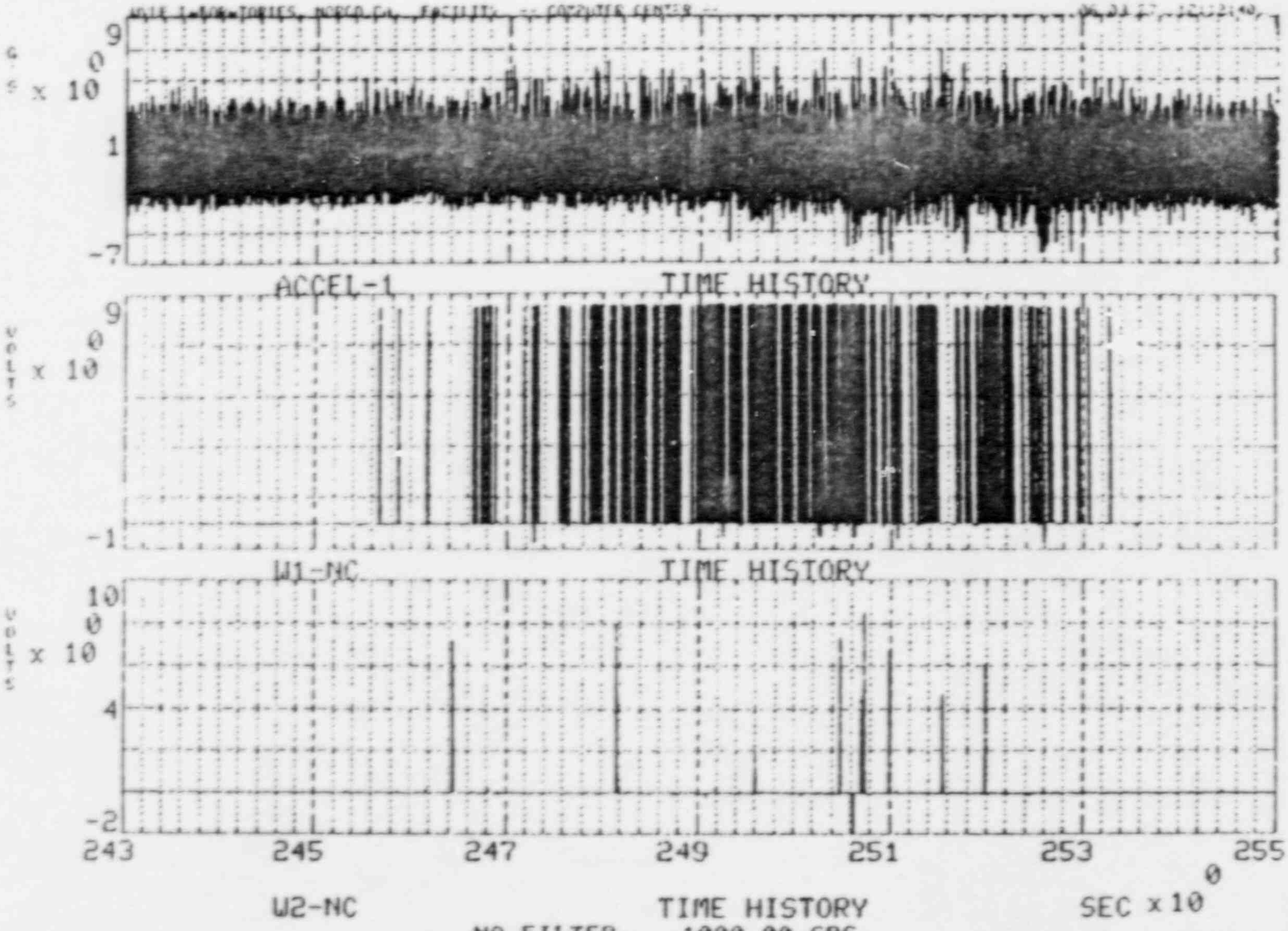

ACCEL-1
TIME HISTORY
G's x 10^0
VOLTS x 10^0
SEC x 10^0
G1-NC
TIME HISTORY
NO FILTER, 1000.00 SPS,
DATE 06/02/87 DISPLAY NUMBER 4 246.00 TO 251.00 SEC
EGG 57724 F/B, 3 G'S, 4-100HZ, RUN-29 DE-ENERGIZED


G'S x 10^0
VOLTS x 10^0
ACCEL-1
TIME HISTORY
13
5
1
-3
-11
9
5
3
1
-3
246
247
248
249
250
251
SEC x 10^0
G1-OT-NO
NO FILTER, 1000.00 SPS,
TIME HISTORY
DATE 06/02/87
DISPLAY NUMBER 5
246.00 TO 251.00 SEC
EGG 57724 F/B, 3 G'S, 4-100HZ, RUN-29 DE-ENERGIZED

START TIME- 0.0000 STOP TIME- 266.42

TEST NAME-EGG 57724 F/B, 2.5 G'S, 4-100HZ, RUN-30 DE-ENERGIZED
TEST DATE-06/02/87 13:37:37 HOURS

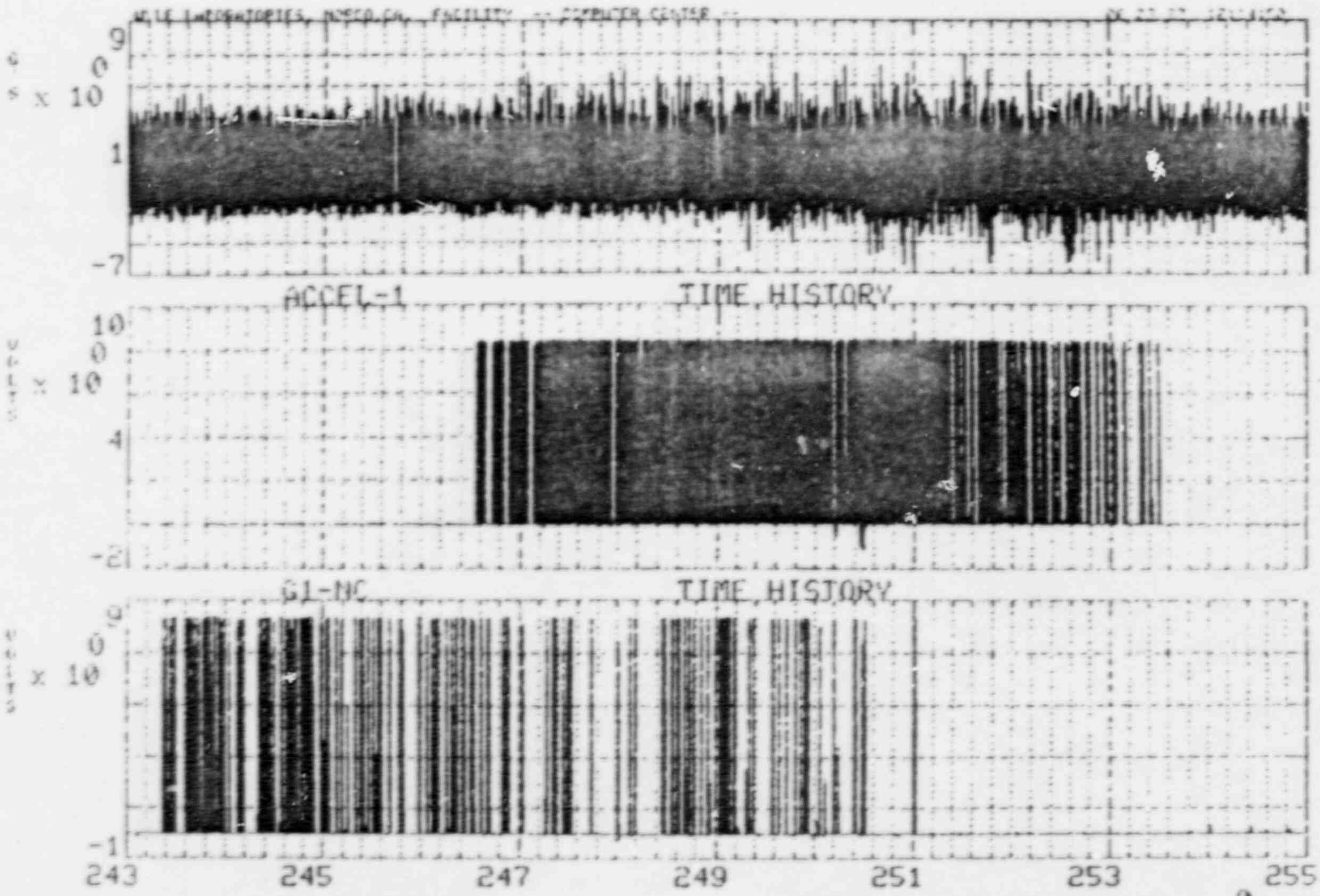
CHANNEL ID	CHANNEL NUMBER	FIRST CHATTER	LAST CHATTER	STATE CHANGE	NUMBER OF CHATTER FAILURES PER TIME LENGTH 2.00-5.00	5.00-10.0	10.0-20.0	20.0-40.0	40.0-80.0	>80.0	TOTAL
W1-NC	3	245.667	253.278	0	94	58	1	0	0	0	153
W1-NO	4			0	NO CHATTER						
W2-NC	5	246.437	251.983	0	2	0	0	0	0	0	2
W2-NO	6			0	NO CHATTER						
W3-NC	7			0	NO CHATTER						
W3-NO	8			0	NO CHATTER						
G1-NC	9	246.558	253.490	0	58	180	0	0	0	0	238
G1-NO	10			0	NO CHATTER						
G2-NC	11	243.370	251.014	0	76	27	0	0	0	0	103
G2-NO	12			0	NO CHATTER						
G3-NC	13			0	NO CHATTER						
G3-NO	14			0	NO CHATTER						
W1-OT-NO	15	246.759	252.679	0	18	7	10	0	0	0	35
W2-OT-NO	16			0	NO CHATTER						
W3-OT-NO	17			0	NO CHATTER						
G1-OT-NO	18	246.664	254.066	0	12	10	60	21	15	3	121
G2-OT-NO	19			0	NO CHATTER						
G3-OT-NO	20			0	NO CHATTER						
										TOTAL=	652



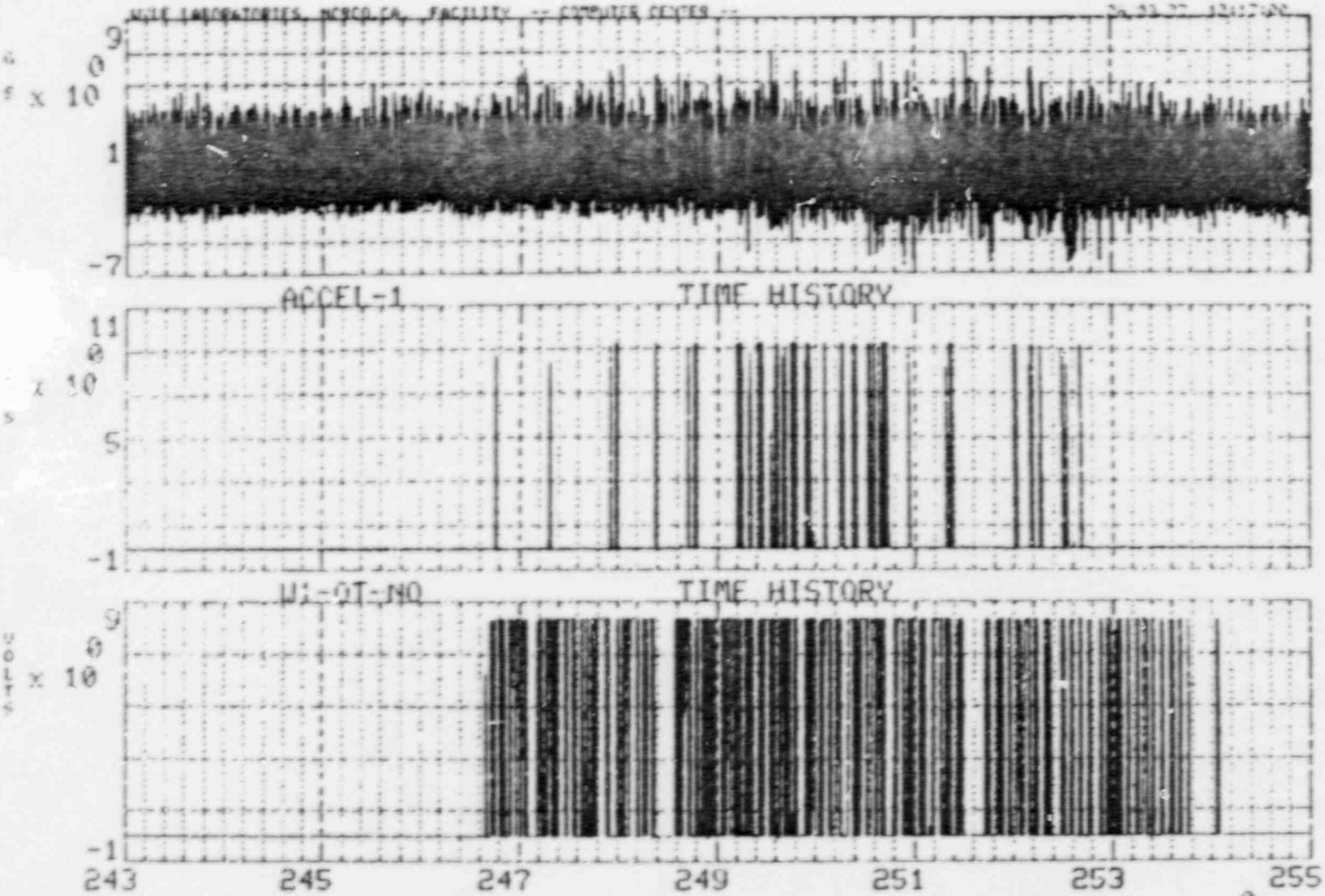
NO FILTER, 1000.00 SPS.

DATE 06/02/87 DISPLAY NUMBER 1 243.00 TO 255.00 SEC

EGG 57724 F/B, 2.5 G'S, 4-100HZ, RUN-30 DE-ENERGIZED



NO FILTER, 1000.00 SPS,
DATE 06/02/87 DISPLAY NUMBER 2 243.00 TO 255.00 SEC
EGG 57724 F/B, 2.5 G'S, 4-100HZ, RUN-30 DE-ENERGIZED



G1-OT-NO TIME HISTORY SEC x 10^0

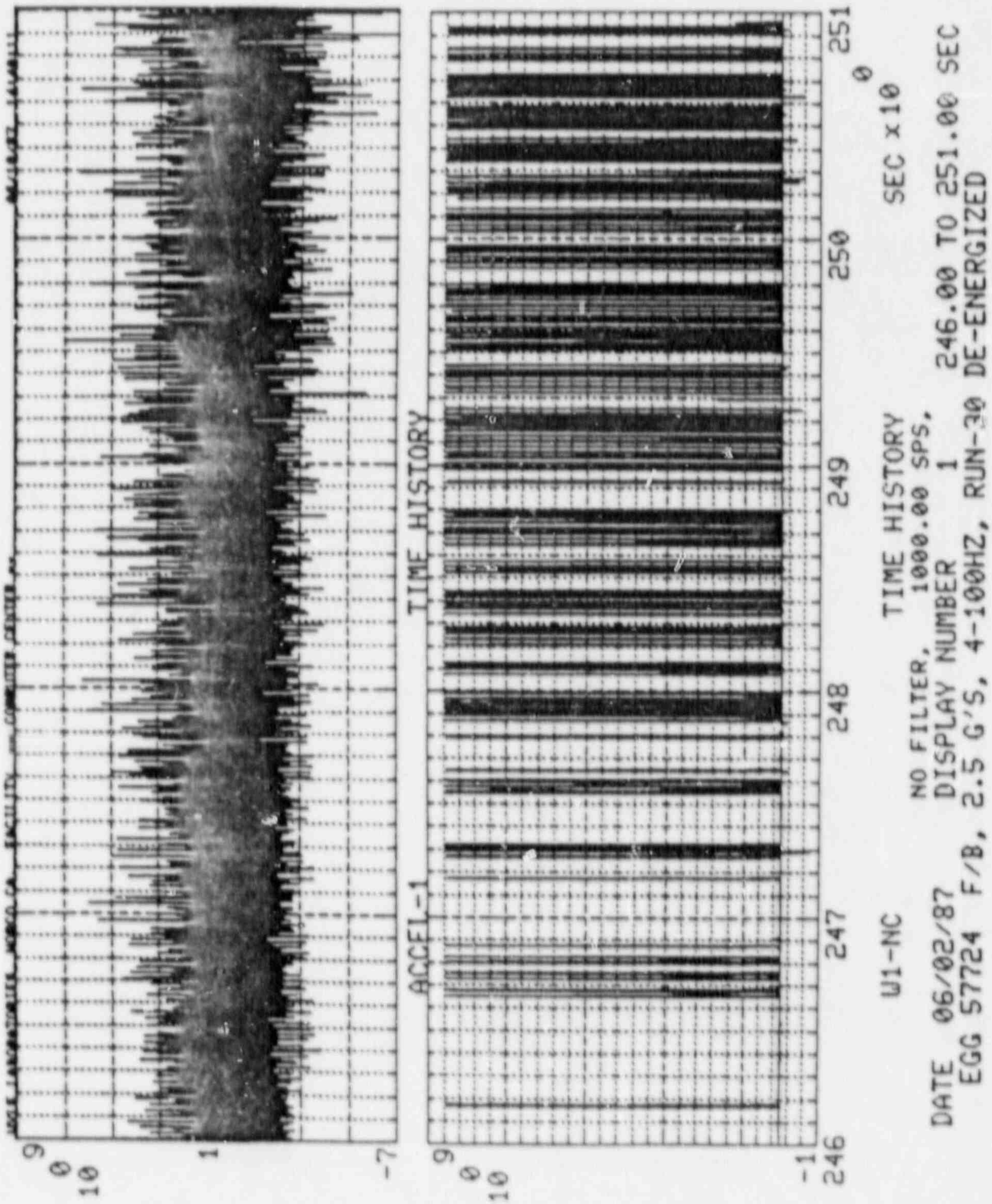
NO FILTER, 1000.00 SPS,

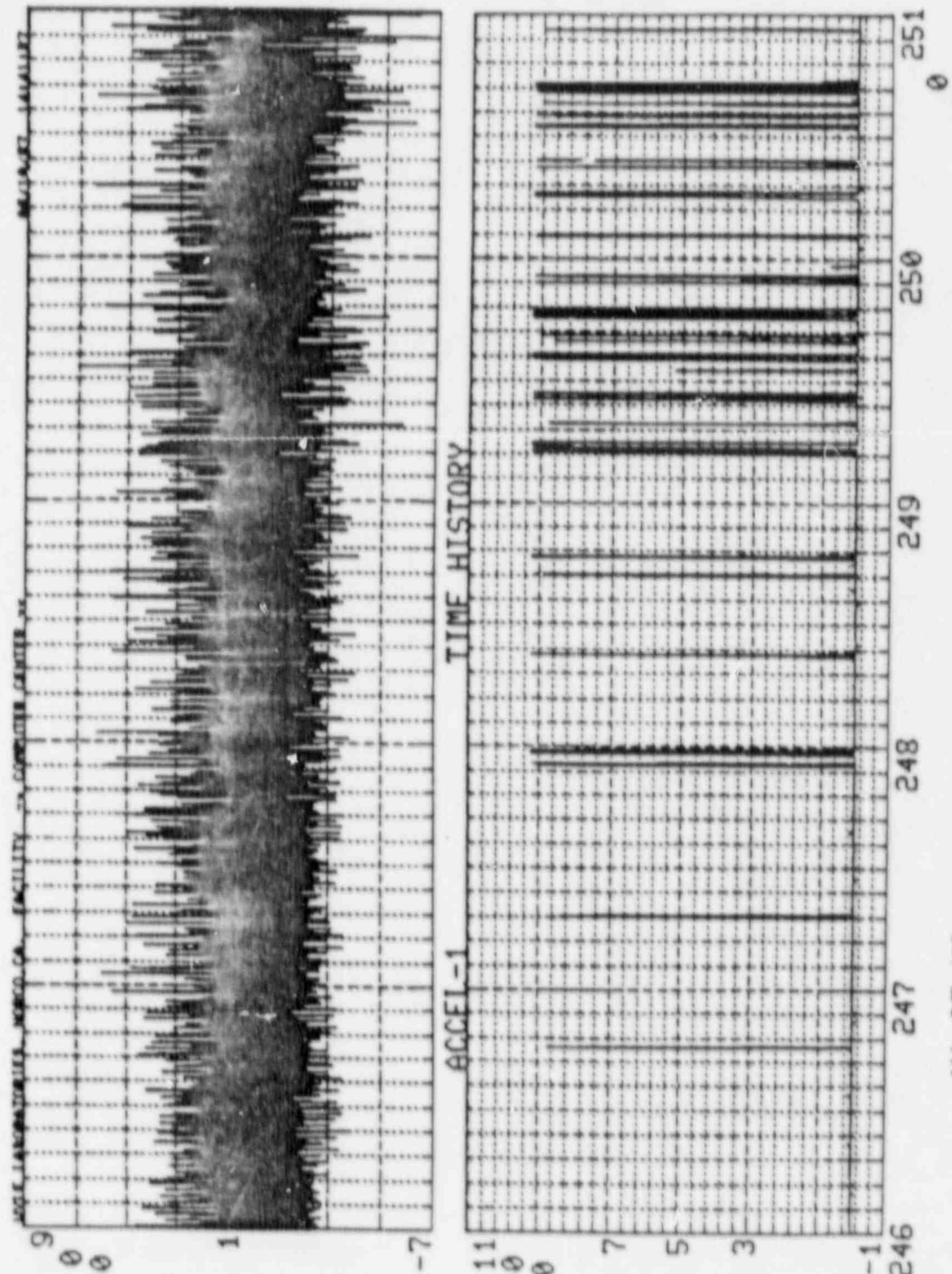
DATE 06/02/87 DISPLAY NUMBER 3 243.00 TO 255.00 SEC

EGG 57724 F/B, 2.5 G'S, 4-100HZ, RUN-30 DE-ENERGIZED

Report No. 57724

Page No. G-17


G'S x10^0
VOLTS x10^0
9
1
-7
9
-1
246
247
248
249
250
251
SEC x10^0
ACCEL-1
TIME HISTORY
W1-NC
TIME HISTORY
NO FILTER, 1000.00 SPS,
DATE 06/02/87 DISPLAY NUMBER 1
246.00 TO 251.00 SEC
EGG 57724 F/B, 2.5 G'S, 4-100HZ, RUN-30 DE-ENERGIZED

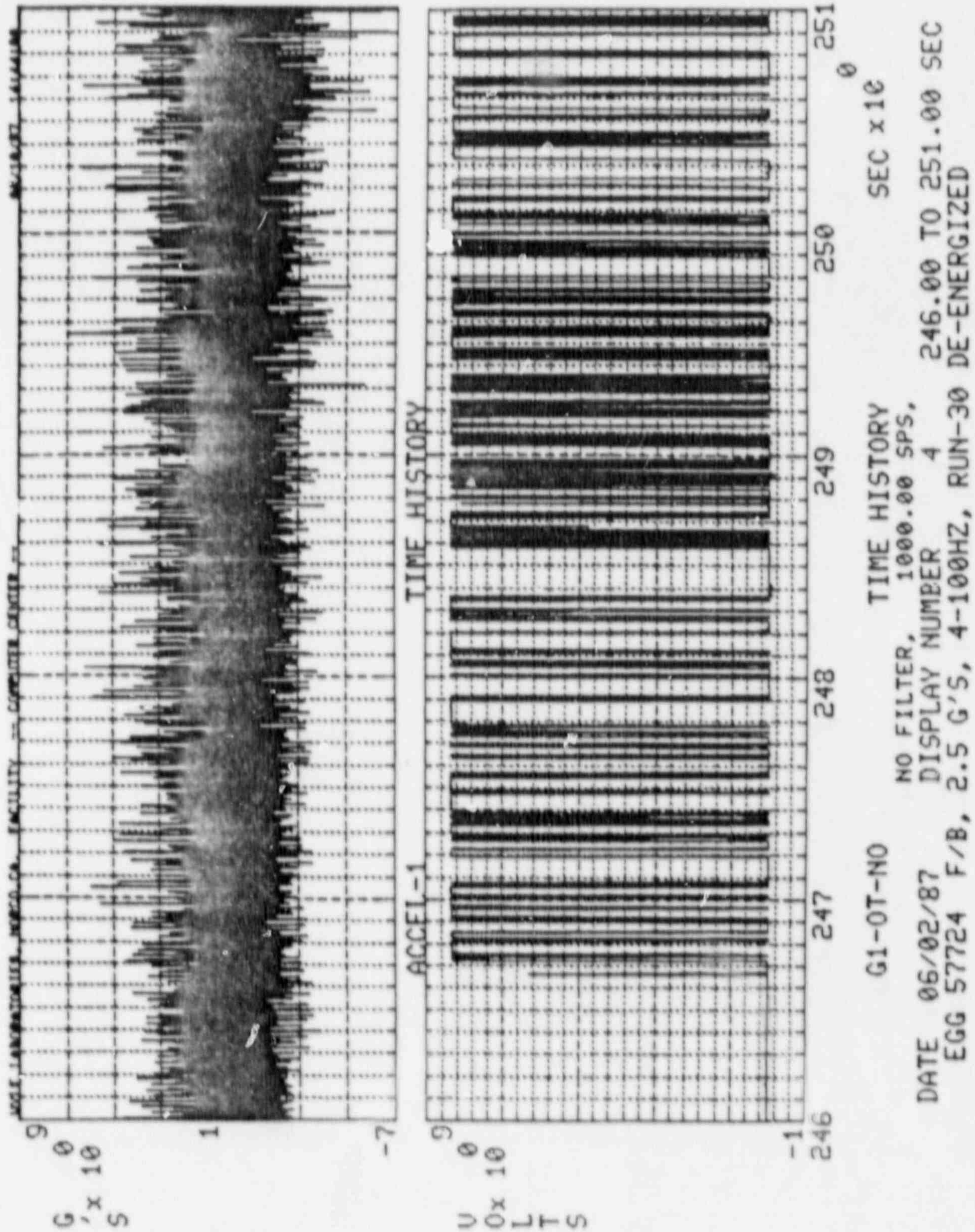


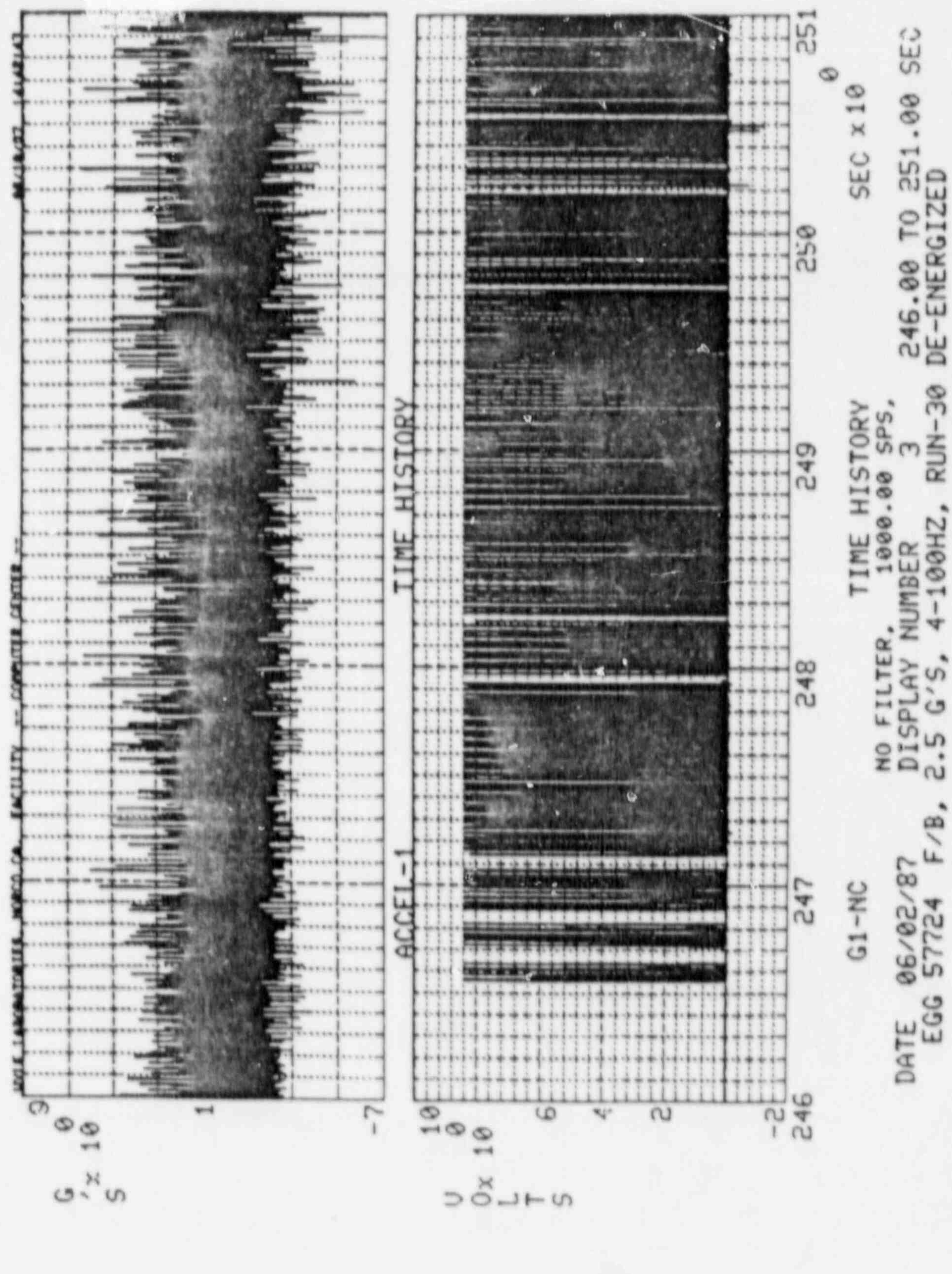
W1-OT-NO TIME HISTORY

DATE 06/02/87 NO FILTER, 1000.00 SPS, 246.00 TO 251.00 SEC

DISPLAY NUMBER 2

EGG 57724 F/B, 2.5 G'S, 4-100HZ, RUN-30 DE-ENERGIZED


G's x 10^0
VOLTS x 10^0
ACCEL-1
TIME HISTORY
9
1
-7
9
-1
246
247
248
249
250
251
SEC x 10^0
G1-OT-NO
TIME HISTORY
NO FILTER, 1000.00 SPS, 246.00 TO 251.00 SEC
DATE 06/02/87 DISPLAY NUMBER 4
EGG 57724 F/B, 2.5 G'S, 4-100HZ, RUN-30 DE-ENERGIZED

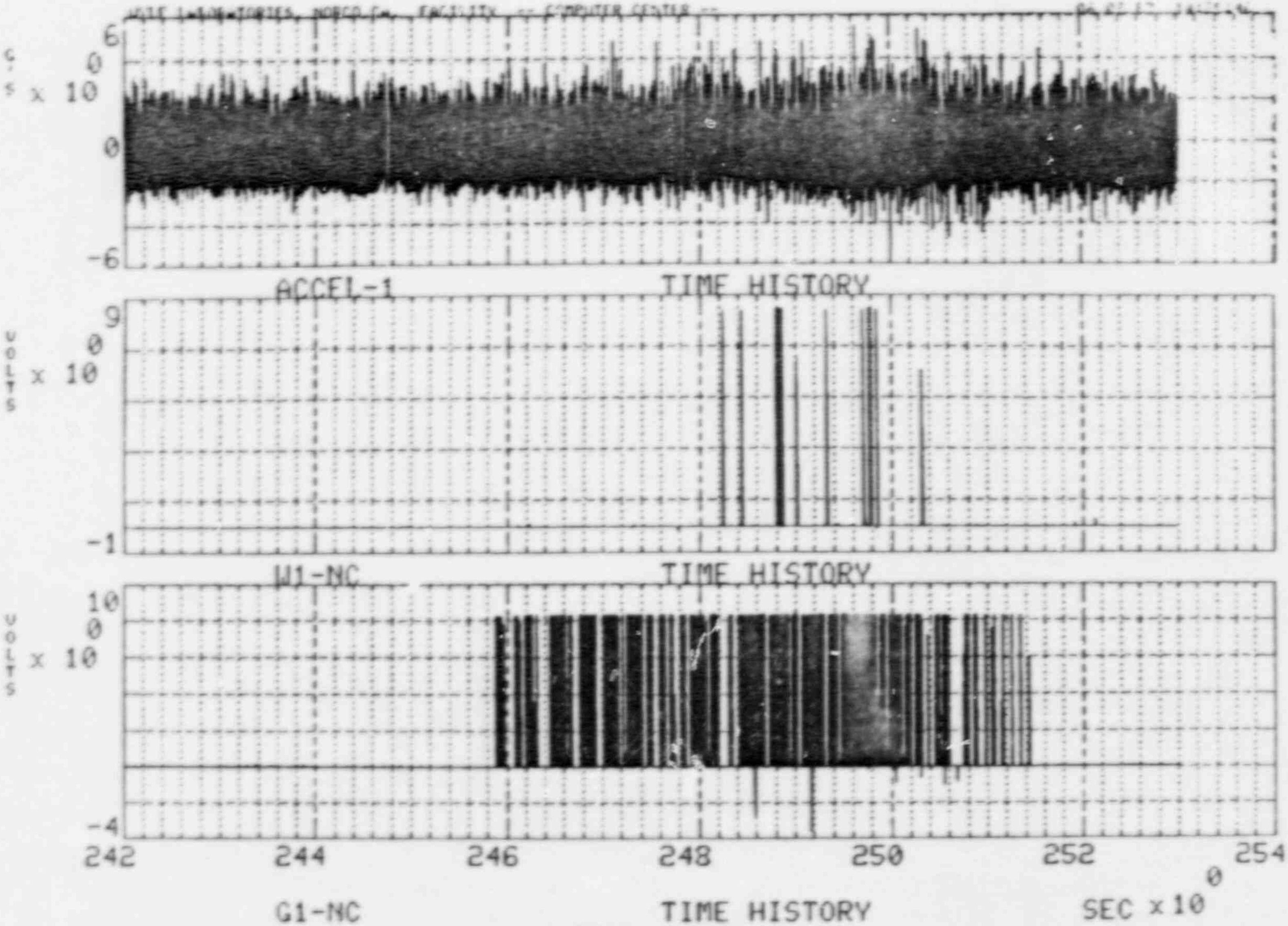

ACCEL-1
TIME HISTORY
G's x 10^0
VOLTS x 10^0
9
1
-7
10
6
4
2
-2
246
247
248
249
250
251
SEC x 10^0
G1-NC
TIME HISTORY
DATE 06/02/87
NO FILTER, 1000.00 SPS, 246.00 TO 251.00 SEC
DISPLAY NUMBER 3
EGG 57724 F/B, 2.5 G'S, 4-100HZ, RUN-30 DE-ENERGIZED

WYLE LABORATORIES,NORCO,CA. FACILITY CHATTER AND PULSE ANALYSIS PROGRAM 06/02/87 14:18:11 HOURS PAGE 1

START TIME= 0.0000 STOP TIME= 265.05

TEST NAME=EGG 57724 F/B, 2.0 G'S, 4-100HZ, RUN-31 DE-ENERGIZED
TEST DATE=06/02/87 14: 8:45 HOURS

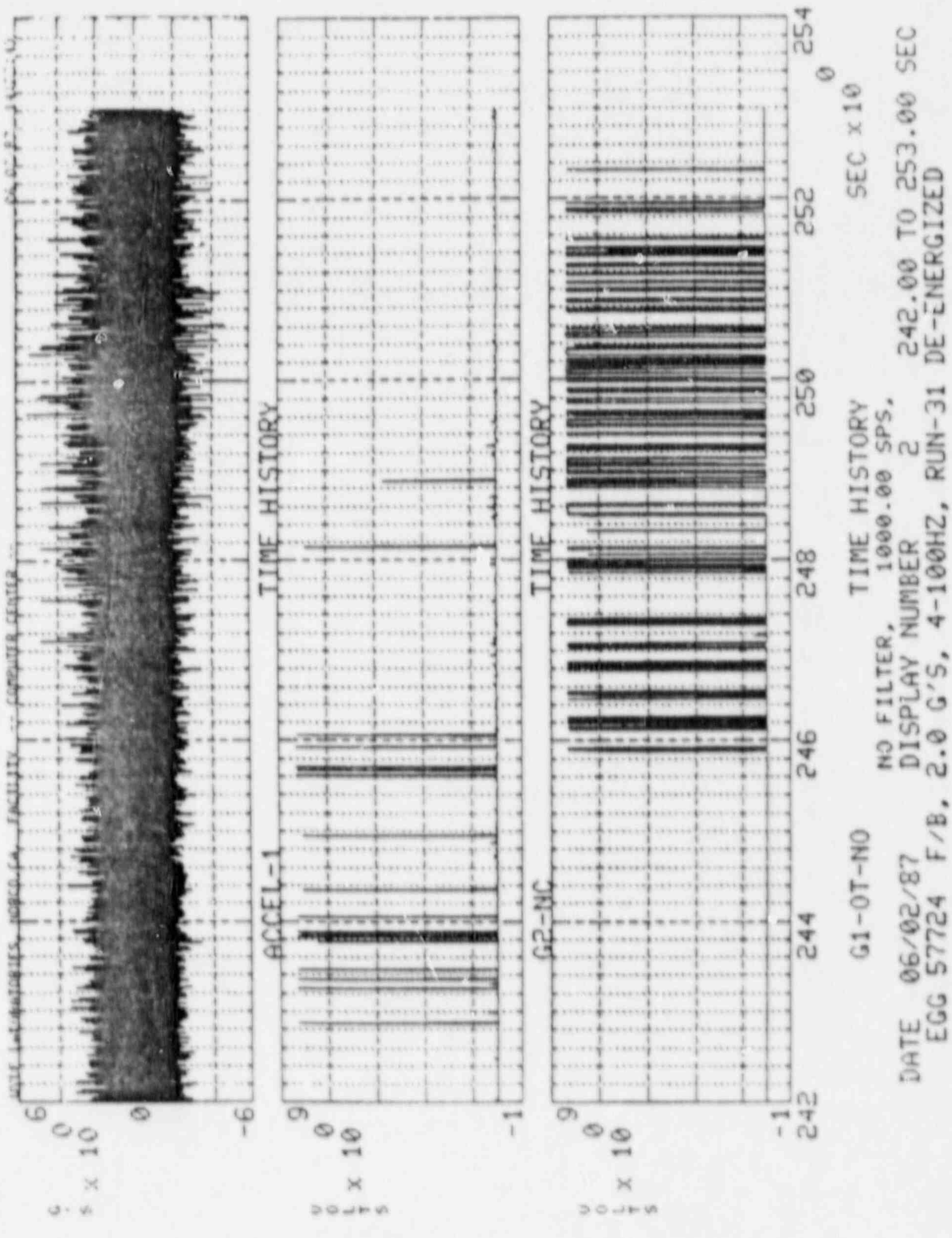
CHANNEL ID	CHANNEL NUMBER	FIRST CHATTER	LAST CHATTER	STATE CHANGE	NUMBER OF CHATTER FAILURES PER TIME LENGTH 2.00-5.00	5.00-10.0	10.0-20.0	20.0-40.0	40.0-80.0	>80.0	TOTAL
W1-NC	3	248.242	250.314	0	9	0	0	0	0	0	9
W1-NO	4			0	NO CHATTER						
W2-NC	5			0	NO CHATTER						
W2-NO	6			0	NO CHATTER						
W3-NC	7			0	NO CHATTER						
W3-NO	8			0	NO CHATTER						
G1-NC	9	245.889	251.427	0	94	54	0	0	0	0	148
G1-NO	10			0	NO CHATTER						
G2-NC	11	242.869	248.879	0	14	0	0	0	0	0	14
G2-NO	12			0	NO CHATTER						
G3-NC	13			0	NO CHATTER						
G3-NO	14			0	NO CHATTER						
W1-OT-NO	15			0	NO CHATTER						
W2-OT-NO	16			0	NO CHATTER						
W3-OT-NO	17			0	NO CHATTER						
G1-OT-NO	18	245.894	252.322	0	14	5	15	17	11	1	63
G2-OT-NO	19			0	NO CHATTER						
G3-OT-NO	20			0	NO CHATTER						
										TOTAL=	234



NO FILTER, 1000.00 SPS,

DATE 06/02/87 DISPLAY NUMBER 1 242.00 TO 253.00 SEC

EGG 57724 F/B, 2.0 G'S, 4-100HZ, RUN-31 DE-ENERGIZED

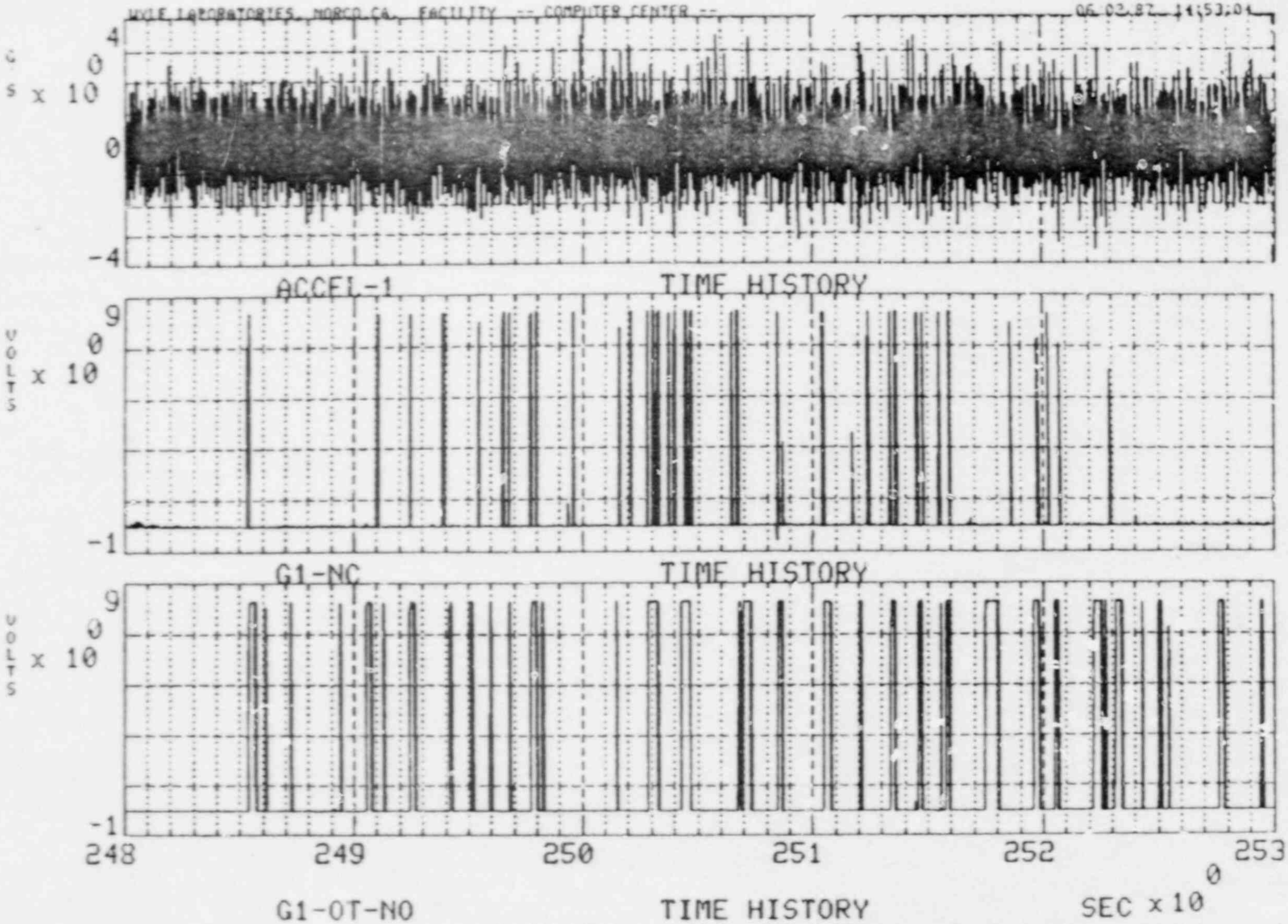

WYLE LABORATORIES, NORCO CA. FACILITY -- COMPUTER CENTER --
G'S x 10^0
6
0
-6
ACCEL-1 TIME HISTORY
VOLTS x 10^0
9
-1
G2-NC TIME HISTORY
VOLTS x 10^0
9
-1
242
244
246
248
250
252
254
SEC x 10^0
G1-OT-NO TIME HISTORY
NO FILTER, 1000.00 SPS,
DATE 06/02/87 DISPLAY NUMBER 2 242.00 TO 253.00 SEC
EGG 57724 F/B, 2.0 G'S, 4-100HZ, RUN-31 DE-ENERGIZED

WYLE LABORATORIES,NORCO,CA. FACILITY CHATTER AND PULSE ANALYSIS PROGRAM 06/02/87 14:46:21 HOURS PAGE 1

START TIME- 0.0000 STOP TIME- 267.44

TEST NAME-EGG 57724 F/B, 1.5 G'S, 4-100HZ, RUN-32 DE-ENERGIZED
TEST DATE-06/02/87 14:35:33 HOURS

CHANNEL ID	CHANNEL NUMBER	FIRST CHATTER	LAST CHATTER	STATE CHANGE	NUMBER OF CHATTER FAILURES PER TIME LENGTH 2.00-5.00	5.00-10.0	10.0-20.0	20.0-40.0	40.0-80.0	>80.0	TOTAL
W1-NC	3			0	NO CHATTER						
W1-NO	4			0	NO CHATTER						
W2-NC	5			0	NO CHATTER						
W2-NO	6			0	NO CHATTER						
W3-NC	7			0	NO CHATTER						
W3-NO	8			0	NO CHATTER						
G1-NC	9	248.533	252.287	0	27	3	0	0	0	0	30
G1-NO	10			0	NO CHATTER						
G2-NC	11			0	NO CHATTER						
G2-NO	12			0	NO CHATTER						
G3-NC	13			0	NO CHATTER						
G3-NO	14			0	NO CHATTER						
W1-OT-NO	15			0	NO CHATTER						
W2-OT-NO	16			0	NO CHATTER						
W3-OT-NO	17			0	NO CHATTER						
G1-OT-NO	18	248.540	252.952	0	11	5	7	9	3	0	35
G2-OT-NO	19			0	NO CHATTER						
G3-OT-NO	20			0	NO CHATTER						
										TOTAL-	65



NO FILTER, 1000.00 SPS,

DATE 06/02/87 DISPLAY NUMBER 1 248.00 TO 253.00 SEC

EGG 57724 F/B, 1.5 G'S, 4-100HZ, RUN-32 DE-ENERGIZED

START TIME= 0.0000 STOP TIME= 263.68

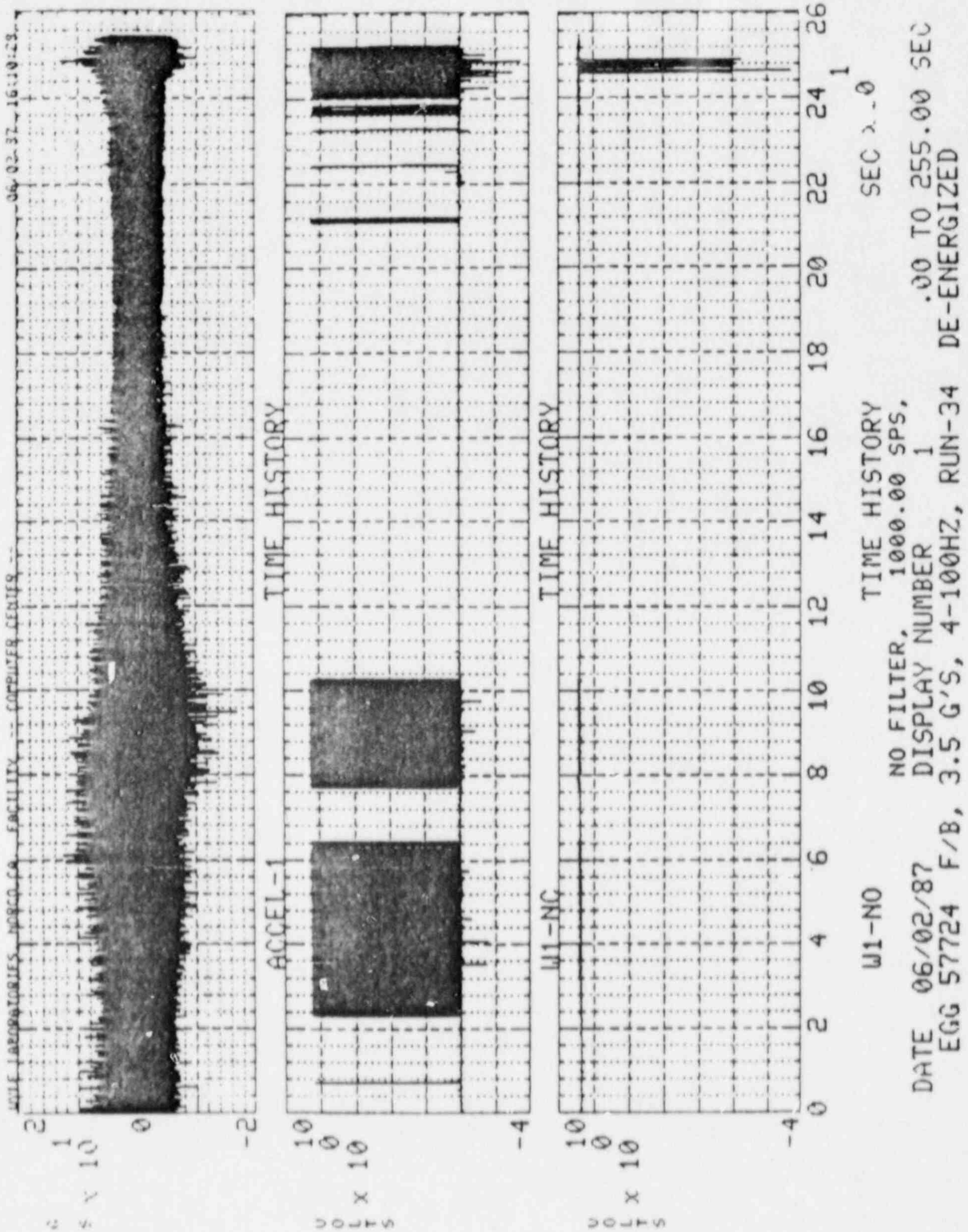
TEST NAME=EGG 57724 F/B, 1.0 G'S, 4-100HZ, RUN-33 DE-ENERGIZED
TEST DATE=06/02/87 15:17:12 HOURS

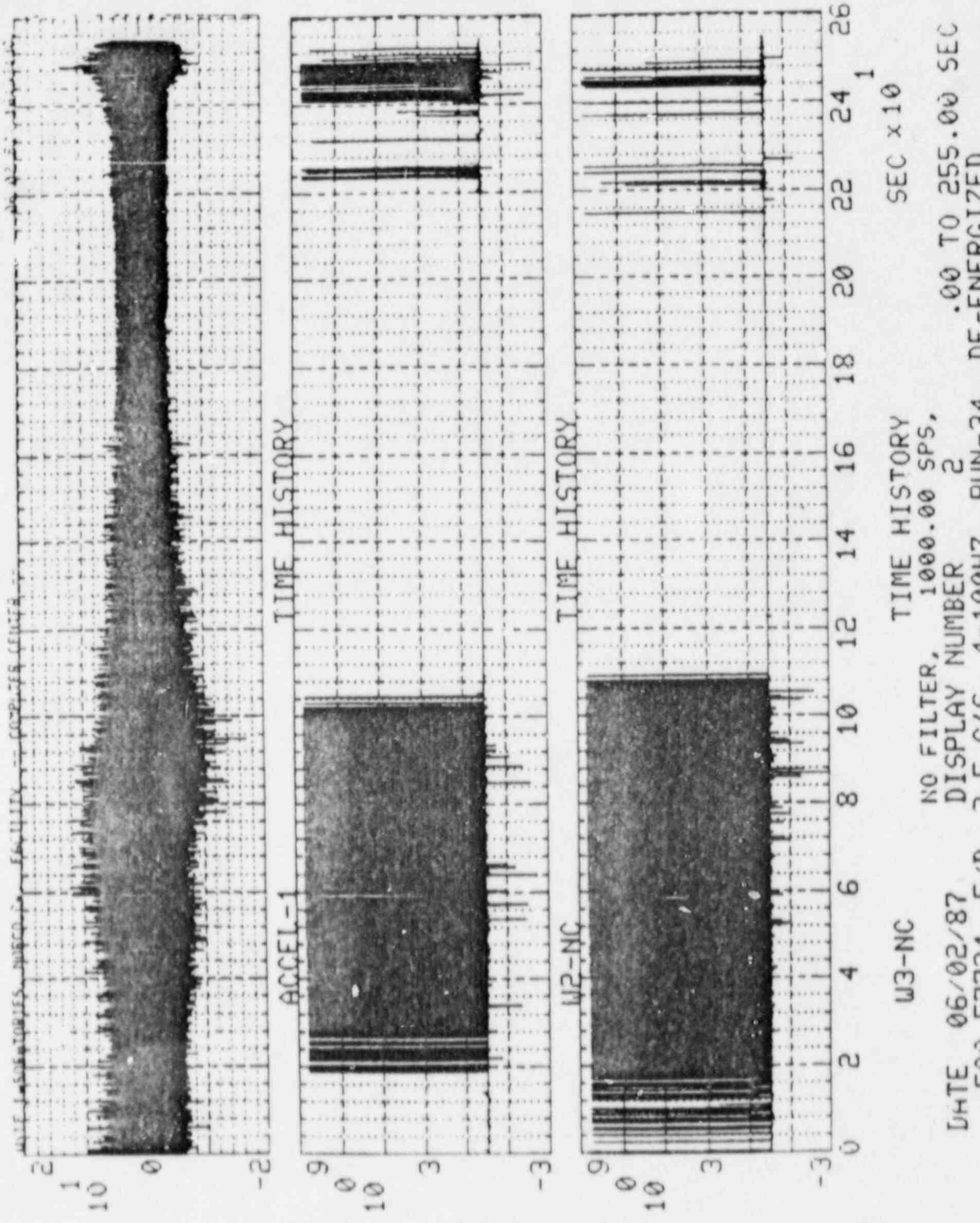
CHANNEL ID	CHANNEL NUMBER	FIRST CHATTER	LAST CHATTER	STATE CHANGE	NUMBER OF CHATTER FAILURES PER TIME LENGTH 2.00-5.00	5.00-10.0	10.0-20.0	20.0-40.0	40.0-80.0	>80.0	TOTAL
W1-NC	3			0	NO CHATTER						
W1-NO	4			0	NO CHATTER						
W2-NC	5			0	NO CHATTER						
W2-NO	6			0	NO CHATTER						
W3-NC	7			0	NO CHATTER						
W3-NO	8			0	NO CHATTER						
G1-NC	9			0	NO CHATTER						
G1-NO	10			0	NO CHATTER						
G2-NC	11			0	NO CHATTER						
G2-NO	12			0	NO CHATTER						
G3-NC	13			0	NO CHATTER						
G3-NO	14			0	NO CHATTER						
W1-OT-NO	15			0	NO CHATTER						
W2-OT-NO	16			0	NO CHATTER						
W3-OT-NO	17			0	NO CHATTER						
G1-OT-NO	18			0	NO CHATTER						
G2-OT-NO	19			0	NO CHATTER						
G3-OT-NO	20			0	NO CHATTER						
										TOTAL=	0

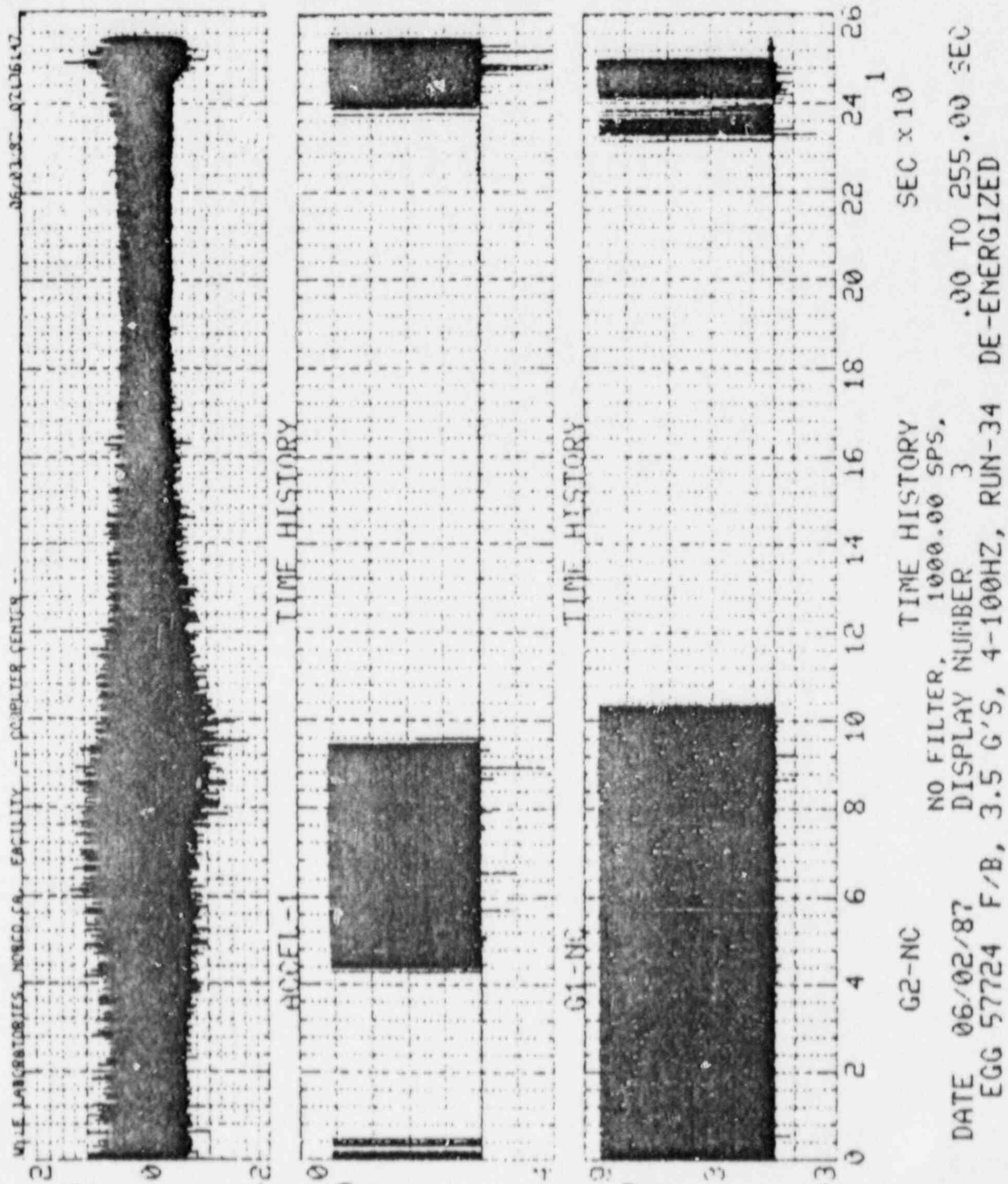
START TIME= 0.0000 STOP TIME= 265.73

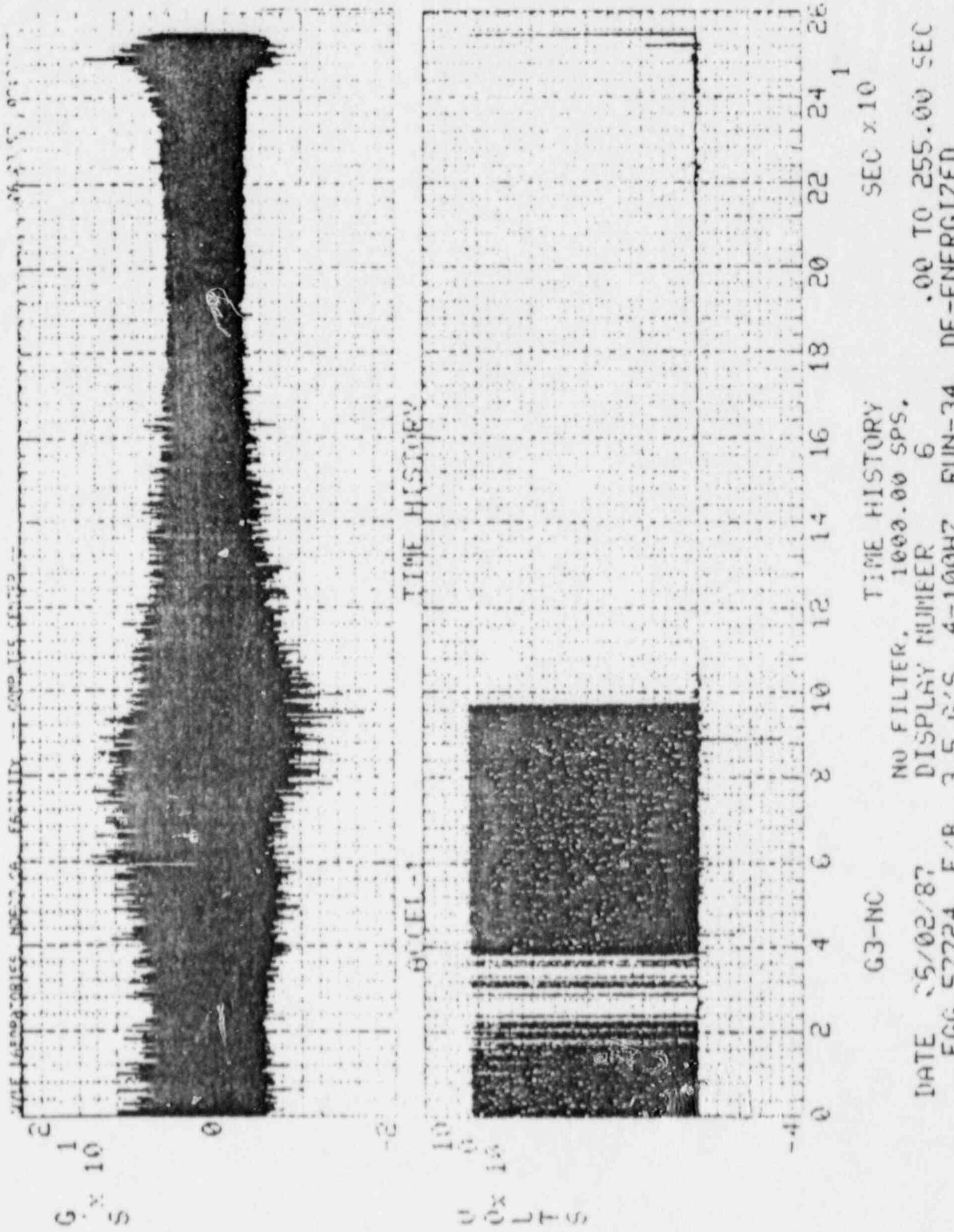
TEST NAME=EGG 57724 F/B, 3.5 G'S, 4-100HZ, RUN-34 DE-ENERGIZED
TEST DATE=06/02/87 15:41:44 HOURS

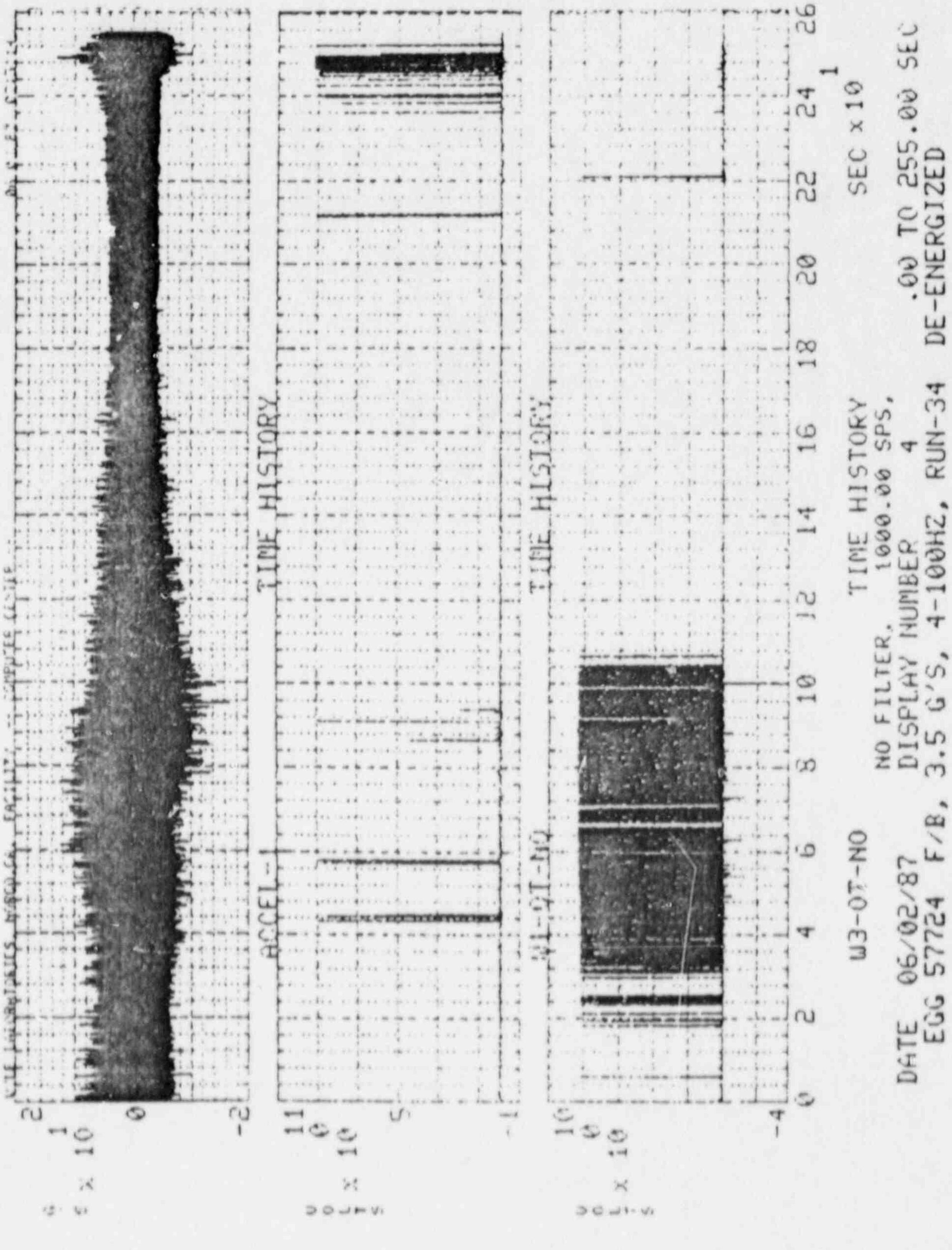
CHANNEL ID	CHANNEL NUMBER	FIRST CHATTER	LAST CHATTER	STATE CHANGE	NUMBER OF CHATTER FAILURES PER TIME LENGTH 2.00-5.00	5.00-10.0	10.0-20.0	20.0-40.0	40.0-80.0	>80.0	TOTAL
W1-NC	3	7.172	252.271	0	253	455	20	0	0	0	728
W1-NO	4	245.795	248.930	0	12	0	0	0	0	0	12
W2-NC	5	18.953	252.564	0	139	311	215	0	0	0	665
W2-NO	6			0	NO CHATTER						
W3-NC	7	.283	248.843	0	90	313	341	0	0	0	744
W3-NO	8			0	NO CHATTER						
G1-NC	9	.398	254.691	0	112	658	50	0	0	0	820
G1-NO	10			0	NO CHATTER						
G2-NC	11	.149	249.971	0	126	299	664	0	0	0	1089
G2-NO	12			0	NO CHATTER						
G3-NC	13	.154	254.529	0	65	229	274	0	0	0	568
G3-NO	14			0	NO CHATTER						
W1-OT-NO	15	43.138	251.890	0	25	6	14	3	0	0	48
W2-OT-NO	16			0	NO CHATTER						
W3-OT-NO	17	5.979	220.548	0	48	58	93	234	1	0	434
G1-OT-NO	18	.409	254.711	0	62	48	198	130	22	21	481
G2-OT-NO	19			0	NO CHATTER						
G3-OT-NO	20	.659	93.709	0	61	50	64	208	3	0	386
										TOTAL=	5975

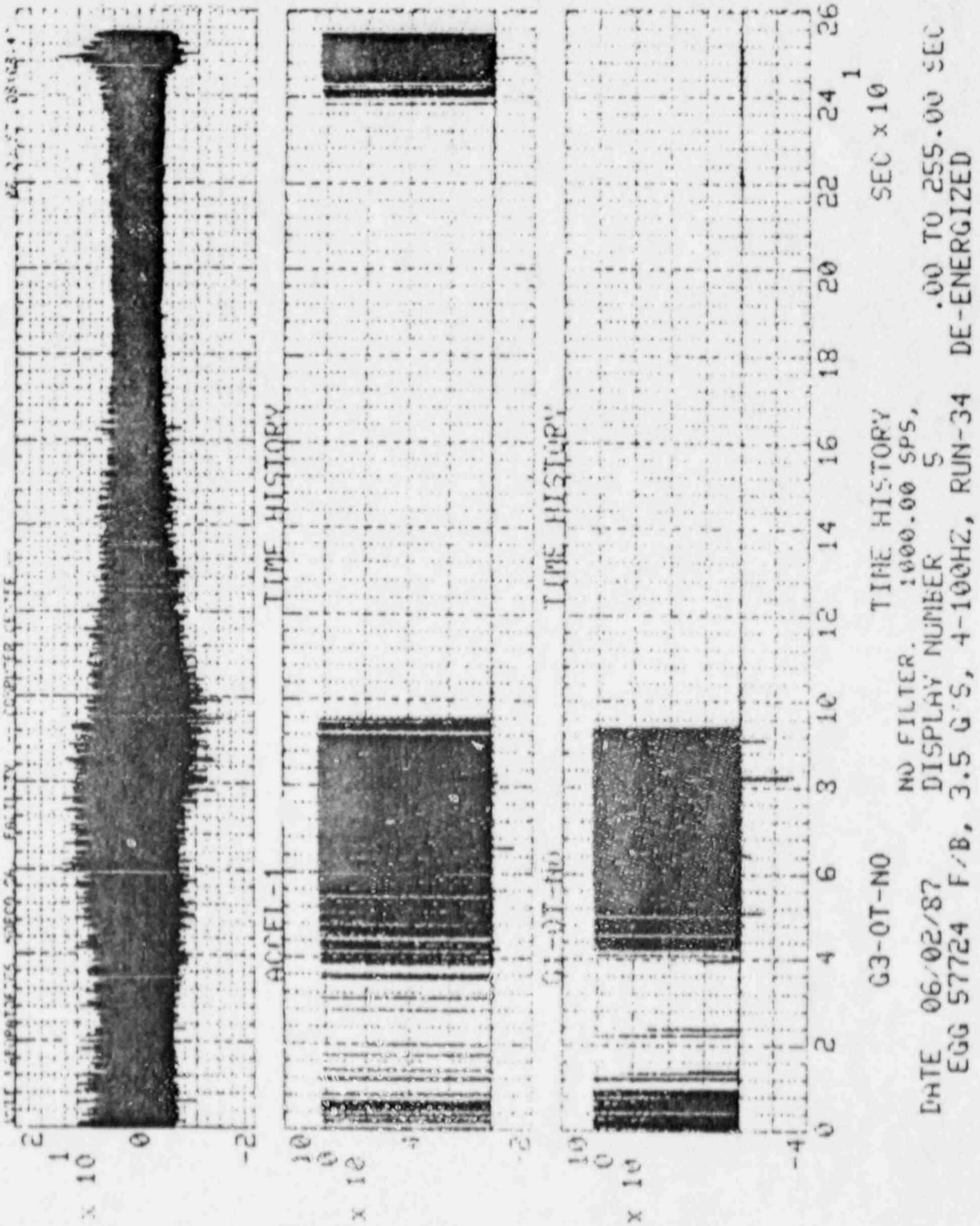

W1-NO
ACCEL-1
TIME HISTORY
W1-NC
TIME HISTORY
W1-NO TIME HISTORY
NO FILTER, 1000.00 SPS, .00 TO 255.00 SEC
DISPLAY NUMBER 1
DATE 06/02/87
EGG 57724 F/B, 3.5 G'S, 4-100HZ, RUN-34 DE-ENERGIZED
VOLTS
0 2 4 6 8 10 12 14 16 18 20 22 24 26

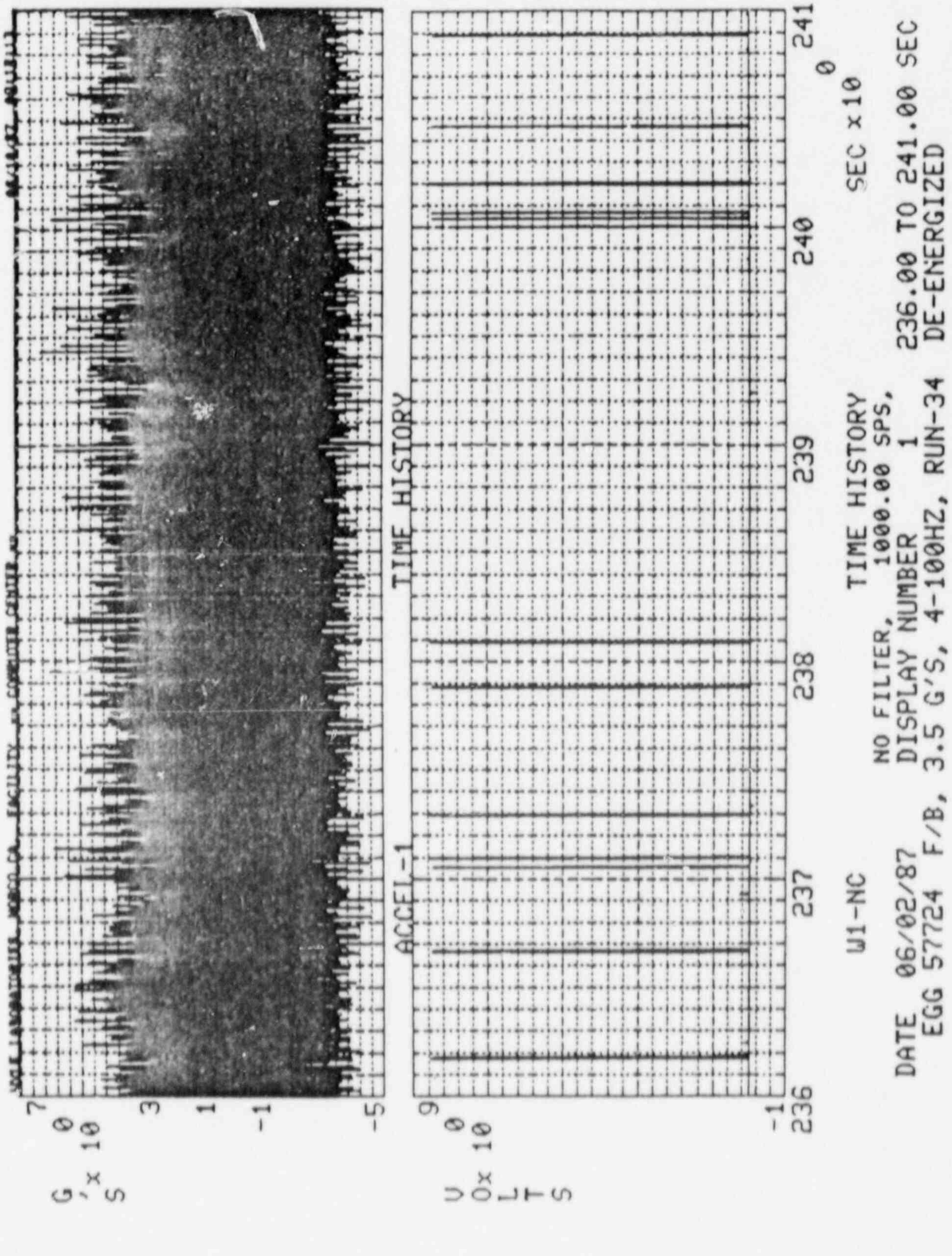

ACCEL-1 TIME HISTORY
W2-NC TIME HISTORY
G'S x 10 1
VOLTS x 10 0
VOLTS x 10 0
SEC x10 1
W3-NC
TIME HISTORY
NO FILTER, 1000.00 SPS, .00 TO 255.00 SEC
DATE 06/02/87 DISPLAY NUMBER 2
EGG 57724 F/B, 3.5 G'S, 4-100HZ, RUN-34 DE-ENERGIZED

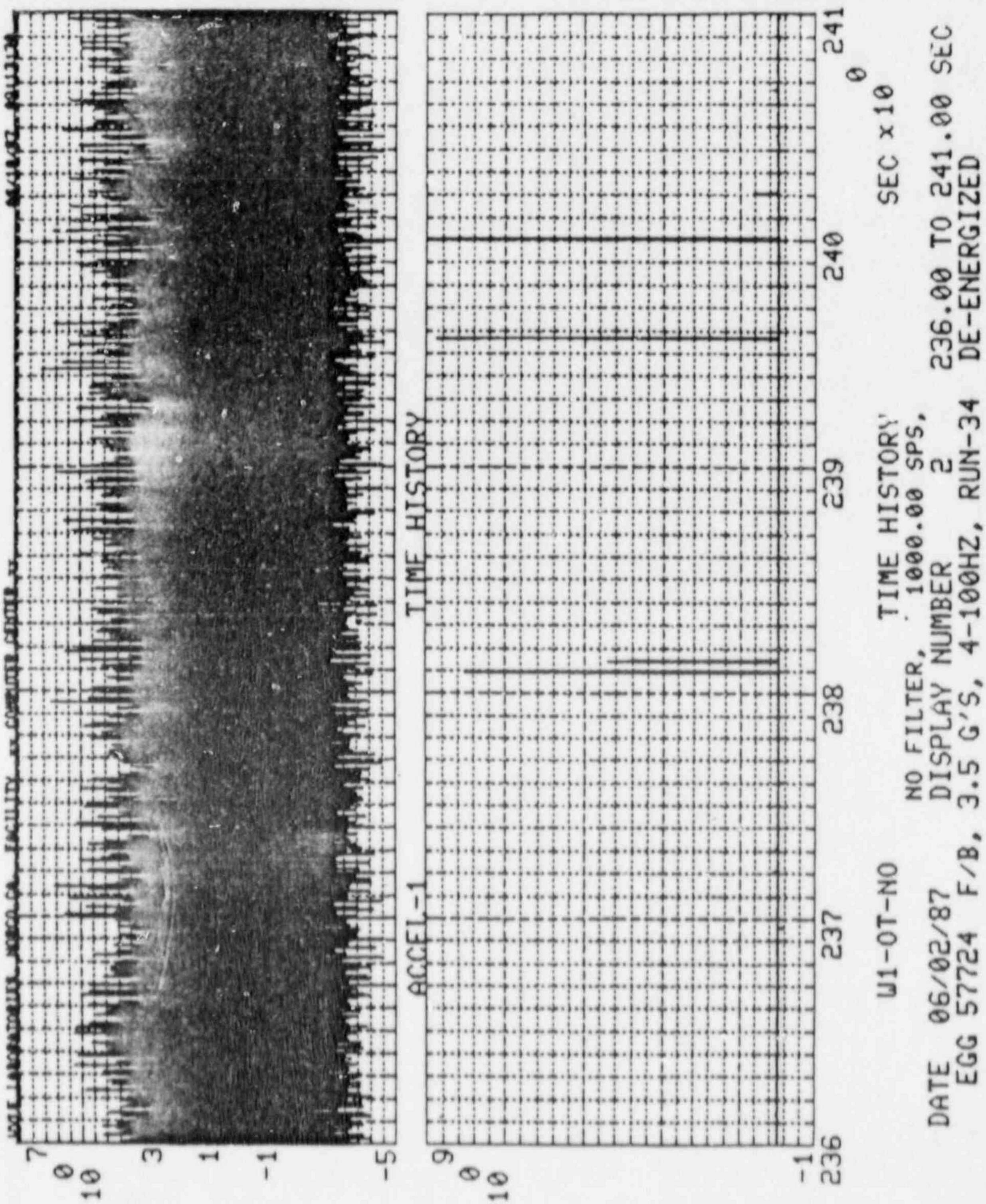

WYLE LABORATORIES, NORCO,CA. FACILITY -- DOPPLER CENTER --
TIME HISTORY
ACCEL-1
TIME HISTORY
G1-NC
G2-NC
TIME HISTORY
DATE 06/02/87
NO FILTER, 1000.00 SPS,
DISPLAY NUMBER 3
.00 TO 255.00 SEC
EGG 57724 F/B, 3.5 G'S, 4-100HZ, RUN-34 DE-ENERGIZED
SEC x 10 1
0
2
4
6
8
10
12
14
16
18
20
22
24
26

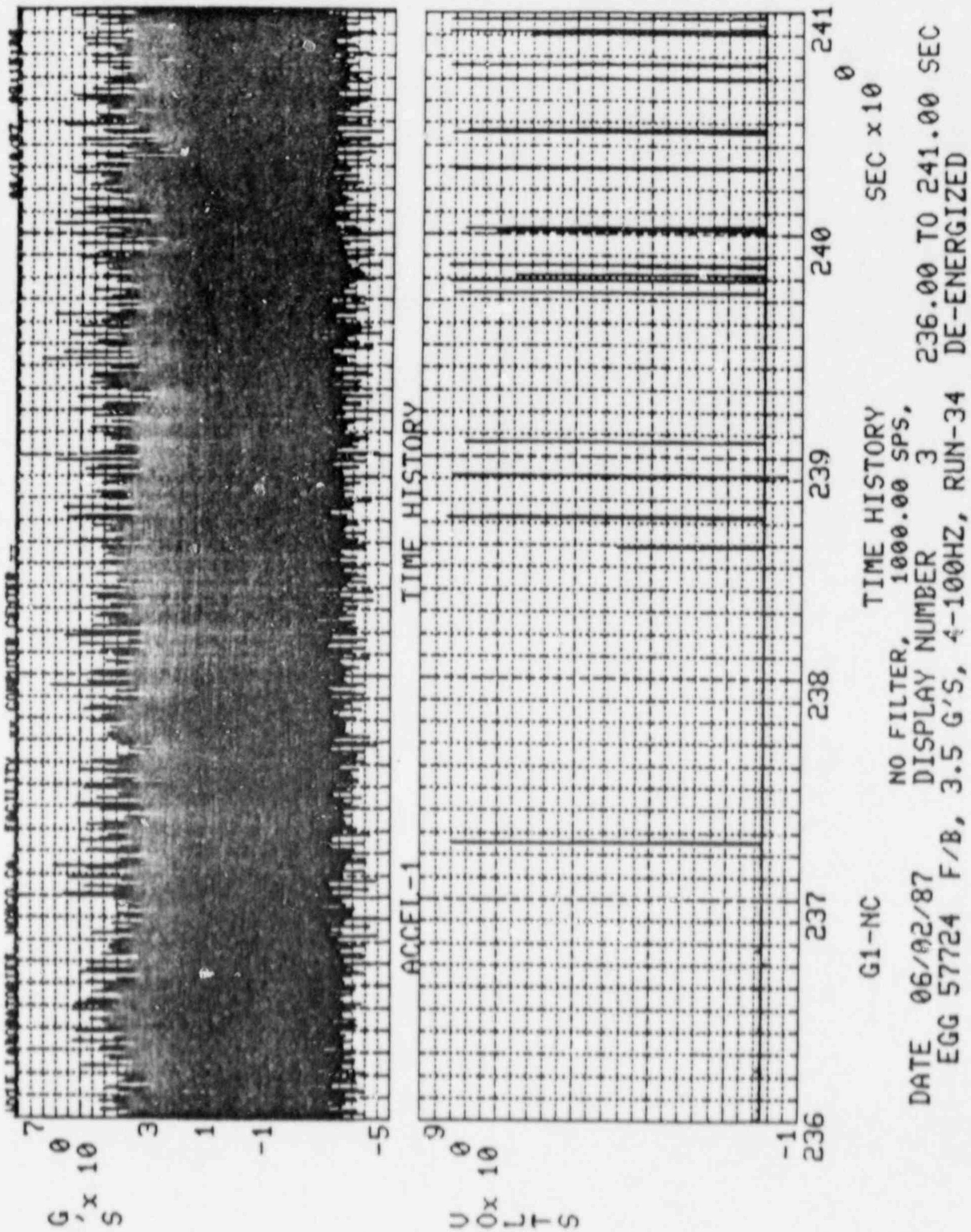

TIME HISTORY
G3-NC
TIME HISTORY
SEC x 10
NO FILTER, 1000.00 SPS. .00 TO 255.00 SEC
DISPLAY NUMBER 6
EGG 57724 F/B, 3.5 G'S, 4-100HZ, RUN-34 DE-ENERGIZED

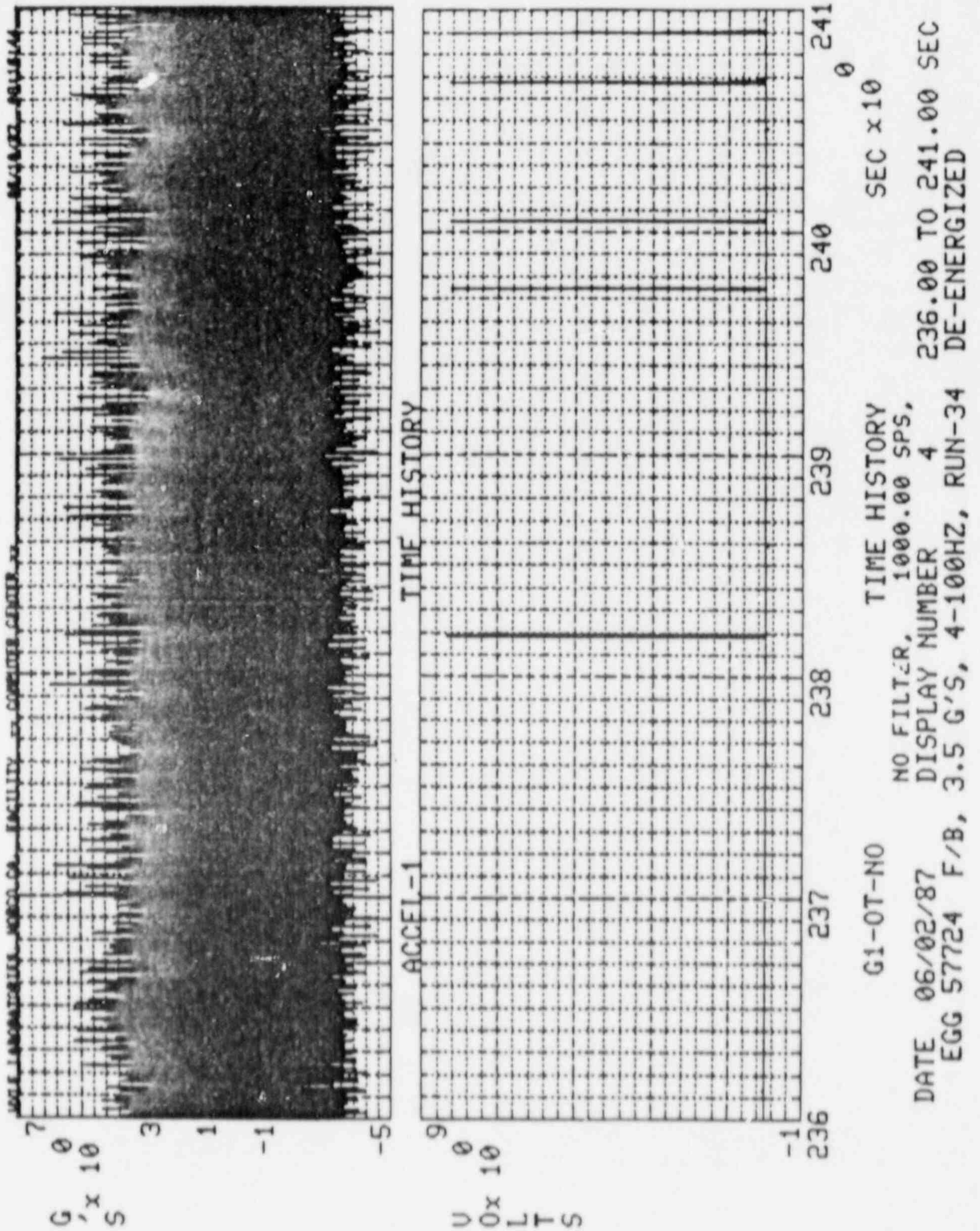

ACCEL-1
TIME HISTORY
W1-OT-NO
TIME HISTORY
SEC x 10 1
W3-OT-NO TIME HISTORY
NO FILTER, 1000.00 SPS,
DATE 06/02/87 DISPLAY NUMBER 4 .00 TO 255.00 SEC
EGG 57724 F/B, 3.5 G'S, 4-100HZ, RUN-34 DE-ENERGIZED


ACCEL-1
TIME HISTORY
TIME HISTORY
SEC x 10 1
G3-OT-NO
TIME HISTORY
NO FILTER. 1800.00 SPS,
DISPLAY NUMBER 5
DATE 06/02/87
EGG 57724 F/B, 3.5 G'S, 4-100HZ, RUN-34
.00 TO 255.00 SEC
DE-ENERGIZED


TIME HISTORY
ACCEL-1
G's x10^0
VOLTS x10^0
7
3
1
-1
-5
9
-1
236
237
238
239
240
241
SEC x10^0
W1-NC
DATE 06/02/87
EGG 57724 F/B, 3.5 G'S, 4-100HZ, RUN-34
NO FILTER, 1000.00 SPS,
DISPLAY NUMBER 1
TIME HISTORY
236.00 TO 241.00 SEC
DE-ENERGIZED


G'S x 10^0
7
3
1
-1
-5
VOLTS x 10^0
9
-1
ACCEL-1
TIME HISTORY
236
237
238
239
240
241
SEC x 10^0
W1-OT-NO
TIME HISTORY
DATE 06/02/87
NO FILTER, 1000.00 SPS,
DISPLAY NUMBER 2
236.00 TO 241.00 SEC
EGG 57724 F/B, 3.5 G'S, 4-100HZ, RUN-34
DE-ENERGIZED


ACCEL-1
TIME HISTORY
G1-NC
TIME HISTORY
NO FILTER, 1000.00 SPS,
DISPLAY NUMBER 3
236.00 TO 241.00 SEC
DATE 06/02/87
EGG 57724 F/B, 3.5 G'S, 4-100HZ, RUN-34
DE-ENERGIZED
SEC x 10 0
236
237
238
239
240
241
G'S x 10 0
VOLTS x 10 0
7
3
1
-1
-5
9
-1

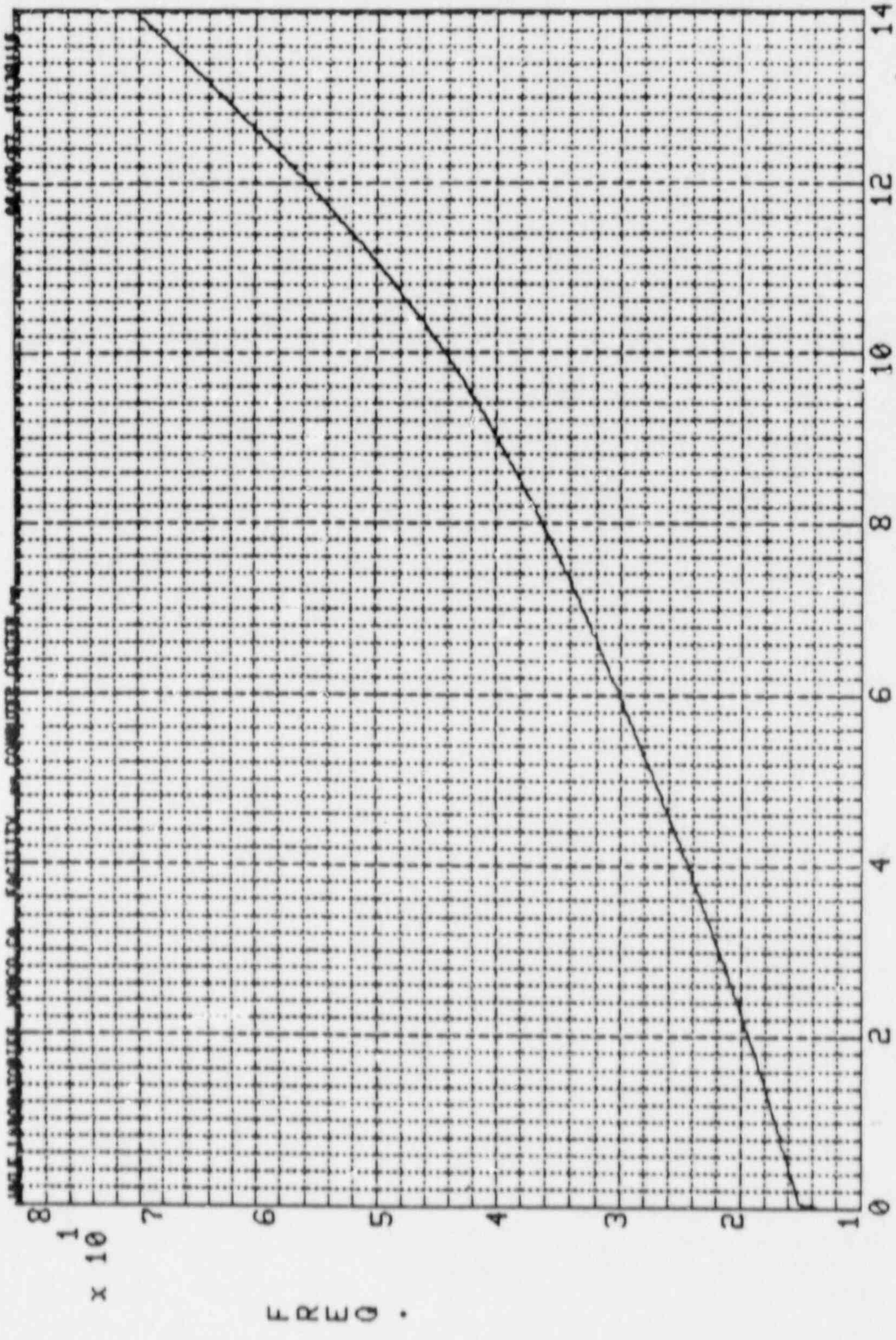

ACCEL-1
TIME HISTORY
G'S x10^0
VOLTS x10^0
7
3
1
-1
-5
9
-1
236
237
238
239
240
241
SEC x10^0
G1-OT-NO
TIME HISTORY
DATE 06/02/87
NO FILTER, 1000.00 SPS, 236.00 TO 241.00 SEC
DISPLAY NUMBER 4
EGG 57724 F/B, 3.5 G'S, 4-100HZ, RUN-34 DE-ENERGIZED

WYLE LABORATORIES,NORCO,CA. FACILITY   CHATTER AND PULSE ANALYSIS PROGRAM   06/03/87 08:49:20 HOURS   PAGE 1

START TIME= 0.0000   STOP TIME= 141.25

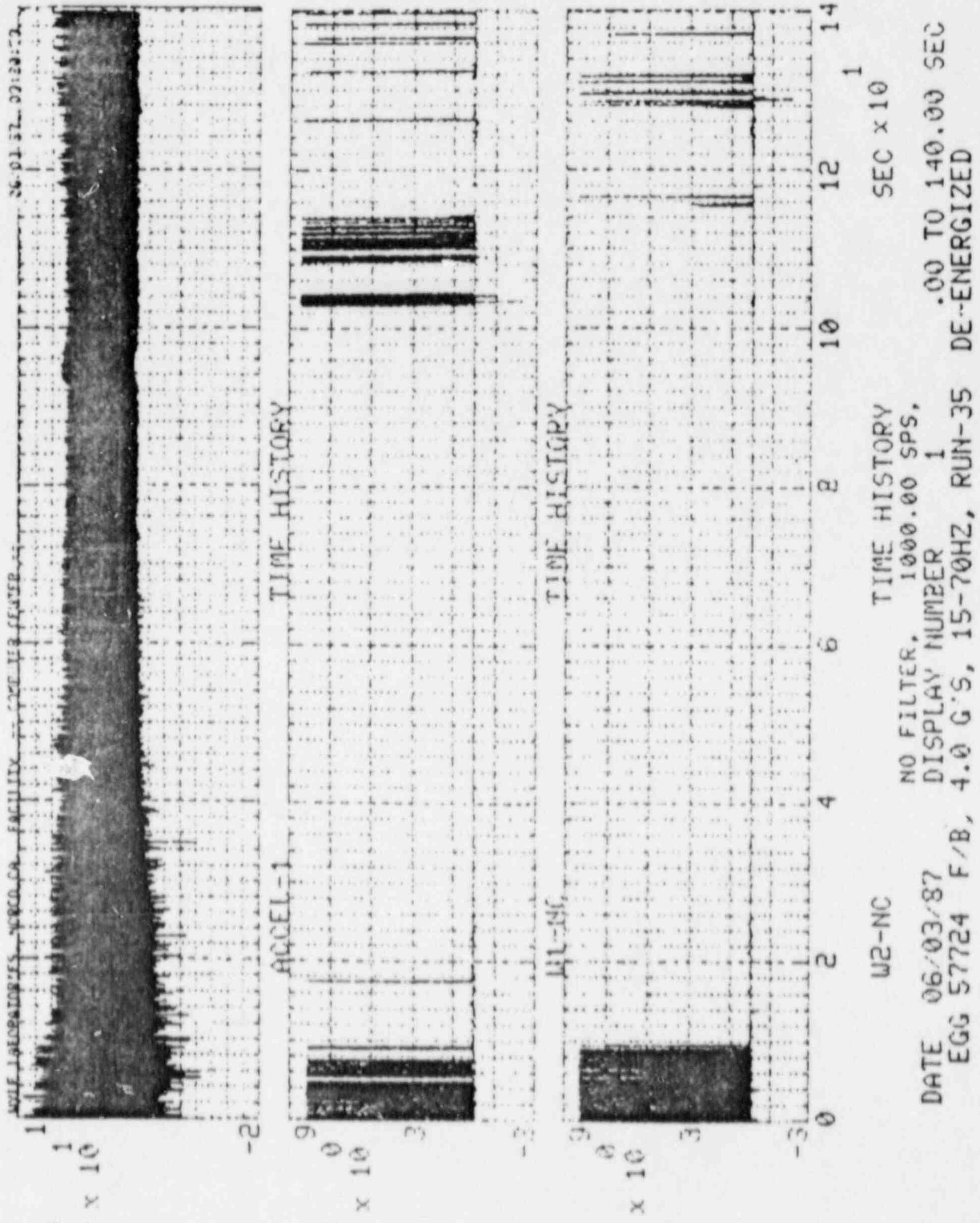
TEST NAME=EGG 57724 F/B, 4.0 G'S, 15-70HZ, RUN-35 DE-ENERGIZED
TEST DATE=06/03/87 8:43: 3 HOURS

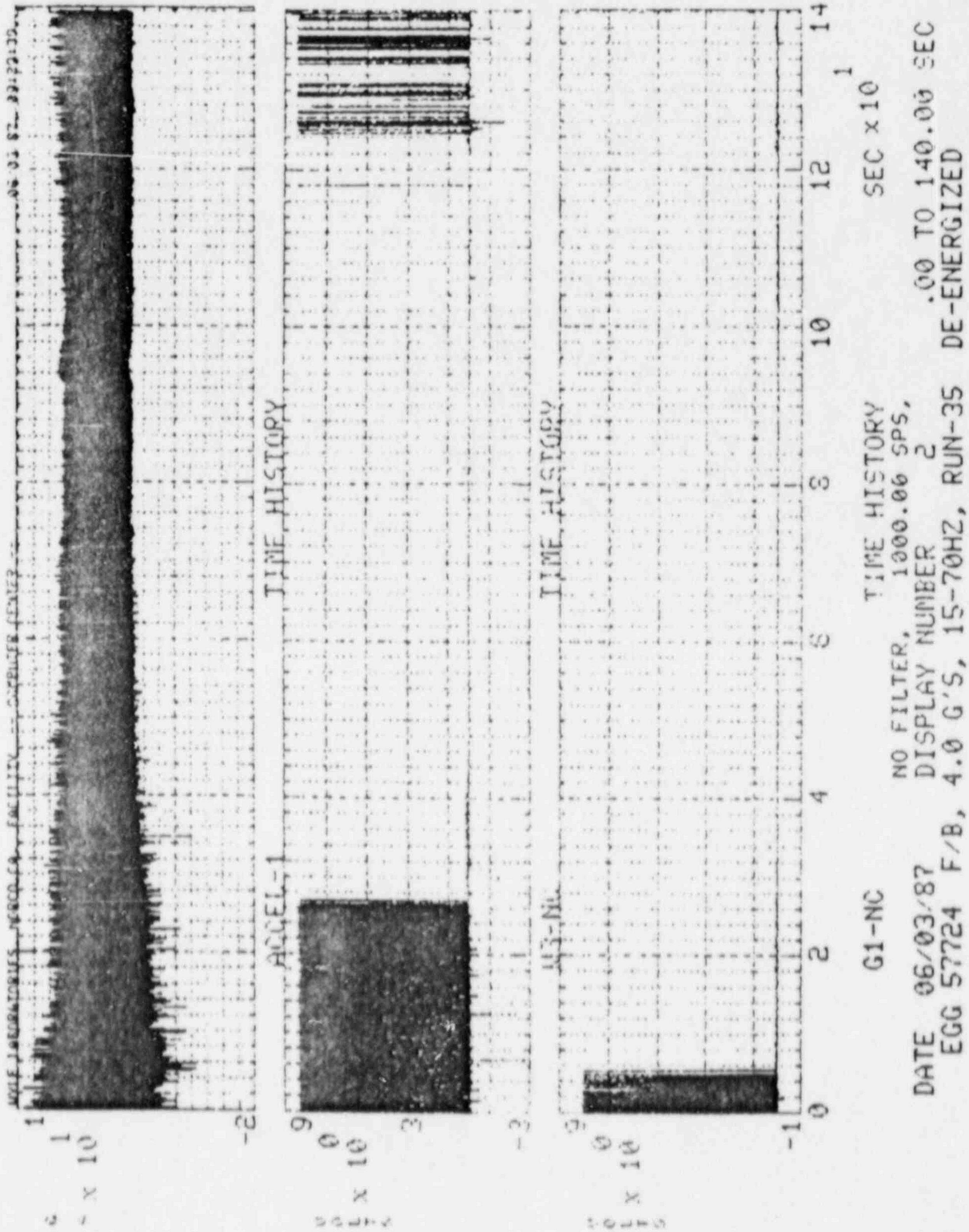
CHANNEL ID	CHANNEL NUMBER	FIRST CHATTER	LAST CHATTER	STATE CHANGE	NUMBER OF CHATTER FAILURES PER TIME LENGTH 2.00-5.00	5.00-10.0	10.0-20.0	20.0-40.0	40.0-80.0	>80.0	TOTAL
W1-NC	3	.052	139.601	0	101	53	0	0	0	0	154
W1-NO	4			0	NO CHATTER						
W2-NC	5	.051	136.960	0	59	63	0	0	0	0	122
W2-NO	6			0	NO CHATTER						
W3-NC	7	.050	139.673	0	167	177	105	0	0	0	449
W3-NO	8			0	NO CHATTER						
G1-NC	9	.019	5.391	0	45	8	0	0	0	0	53
G1-NO	10			0	NO CHATTER						
G2-NC	11	.016	139.902	0	57	29	123	0	0	0	209
G2-NO	12			0	NO CHATTER						
G3-NC	13	.018	7.822	0	34	69	0	0	0	0	103
G3-NO	14			0	NO CHATTER						
W1-OT-NO	15	.880	128.979	0	11	1	6	0	0	0	18
W2-OT-NO	16			0	NO CHATTER						
W3-OT-NO	17	.007	125.301	0	1	0	2	48	92	65	208
G1-OT-NO	18	.162	9.333	0	4	4	25	4	0	0	37
G2-OT-NO	19			0	NO CHATTER						
G3-OT-NO	20	.031	6.882	0	10	6	3	9	0	0	28
										TOTAL=	1381

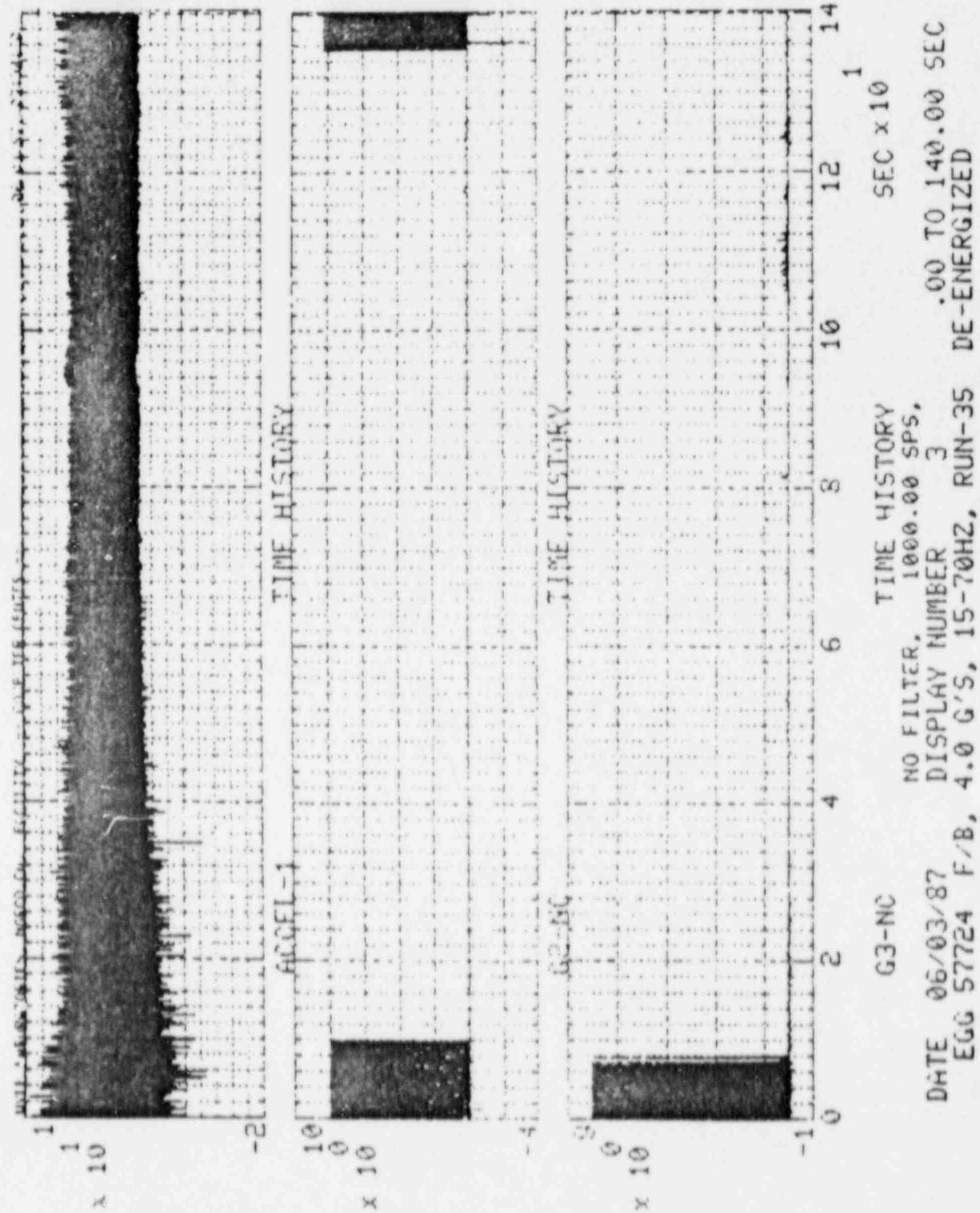


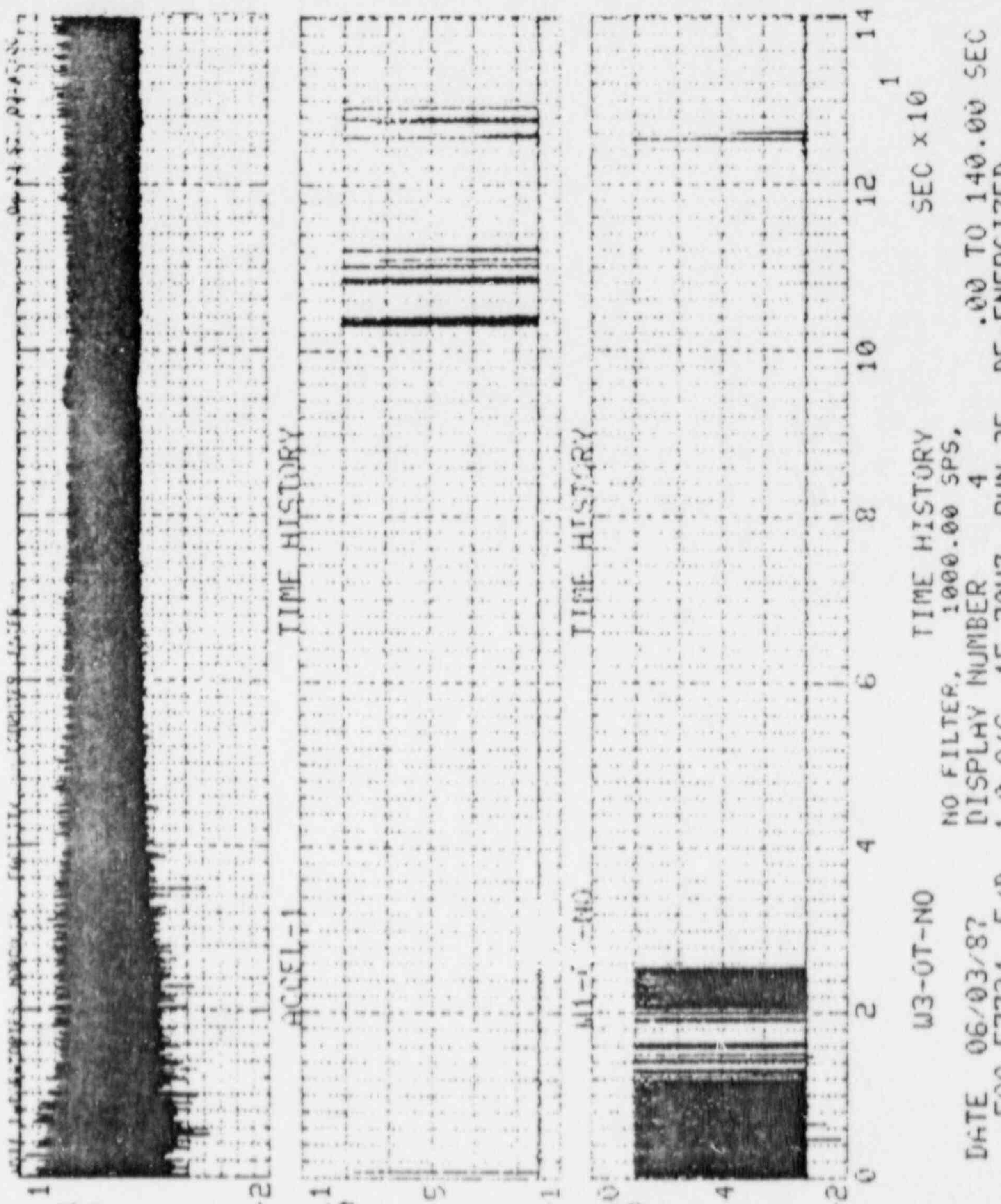
SEC x 10^1

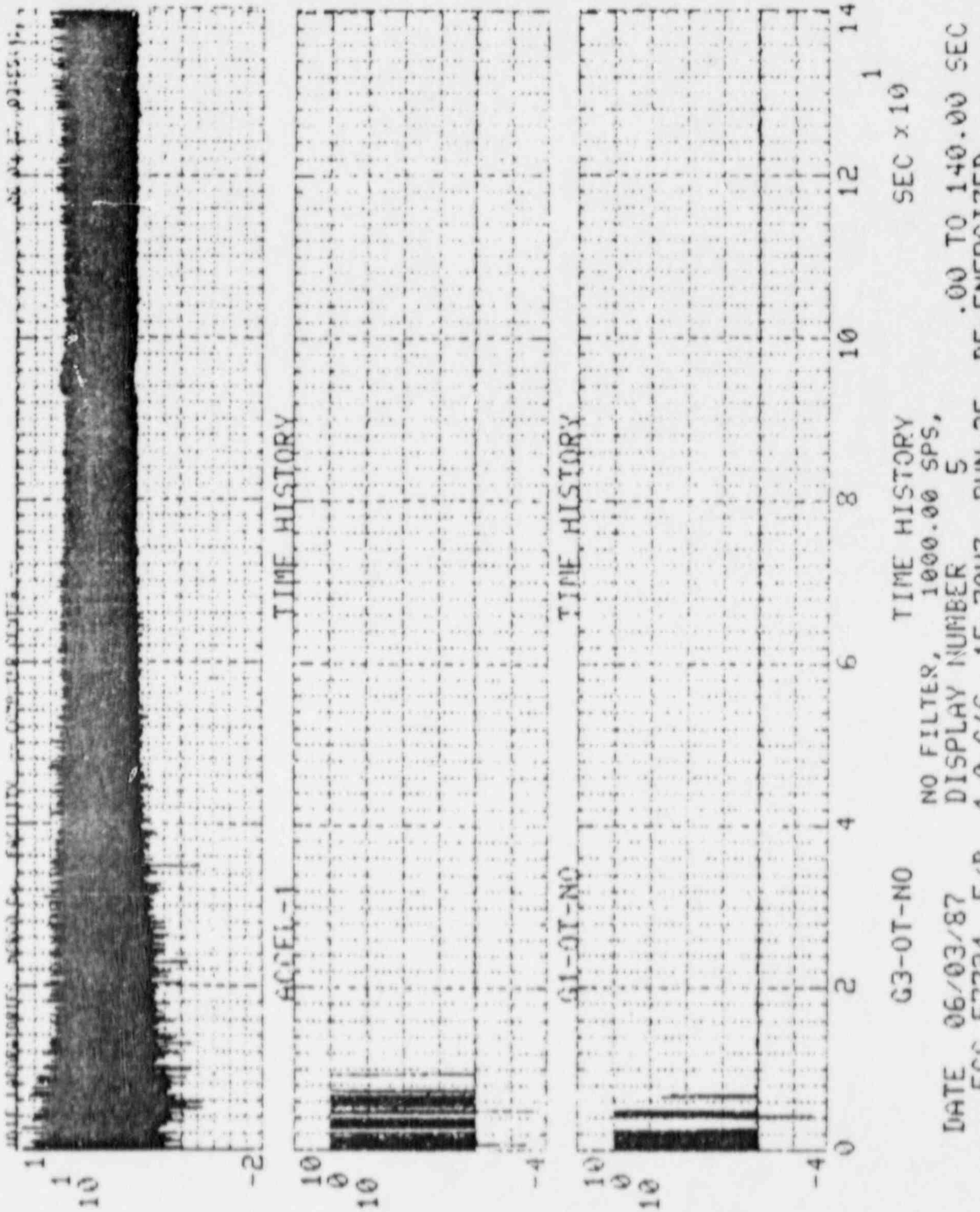
DC-PROP TIME HISTORY
1.00 HZ.LP.FILTER, 1000.00 SPS, 0.00 TO 140.00 SEC
DATE 06/03/87 DISPLAY NUMBER 1
EGG 57724 15-70HZ SINE SWEEP TYPICAL


W2-NC
TIME HISTORY
ACCEL-1
TIME HISTORY
W1-NC
TIME HISTORY
SEC x 10
DATE 06/03/87
NO FILTER, 1000.00 SPS, .00 TO 140.00 SEC
DISPLAY NUMBER 1
EGG 57724 F/B, 4.0 G'S, 15-70HZ, RUN-35 DE-ENERGIZED


ACCEL-1
TIME HISTORY
TIME HISTORY
SEC x 10^1
G1-NC
TIME HISTORY
DATE 06/03/87
NO FILTER, 1000.00 SPS,
DISPLAY NUMBER 2
.00 TO 140.00 SEC
EGG 57724 F/B, 4.0 G'S, 15-70HZ, RUN-35 DE-ENERGIZED


TIME HISTORY
ACCEL-1
TIME HISTORY
SEC x 10
G3-NC
TIME HISTORY
NO FILTER, 1000.00 SPS, .00 TO 140.00 SEC
DATE 06/03/87 DISPLAY NUMBER 3
EGG 57724 F/B, 4.0 G'S, 15-70HZ, RUN-35 DE-ENERGIZED


TIME HISTORY
ACCEL-1
TIME HISTORY
W3-OT-NO
TIME HISTORY
SEC x 10
NO FILTER, 1000.00 SPS, .00 TO 140.00 SEC
DISPLAY NUMBER 4
DATE 06/03/87
EGG 57724 F/B, 4.0 G'S, 15-70HZ, RUN-35 DE-ENERGIZED


G'S x 10^1
10^0
-2
ACCEL-1 TIME HISTORY
10^0 x 10
-4
G1-OT-NO TIME HISTORY
10^0 x 10
-4
0
2
4
6
8
10
12
14
SEC x 10^1
G3-OT-NO TIME HISTORY
DATE 06/03/87 NO FILTER, 1000.00 SPS, .00 TO 140.00 SEC
DISPLAY NUMBER 5
EGG 57724 F/B, 4.0 G'S, 15-70HZ, RUN-35 DE-ENERGIZED

START TIME= 0.0000 STOP TIME= 300.62

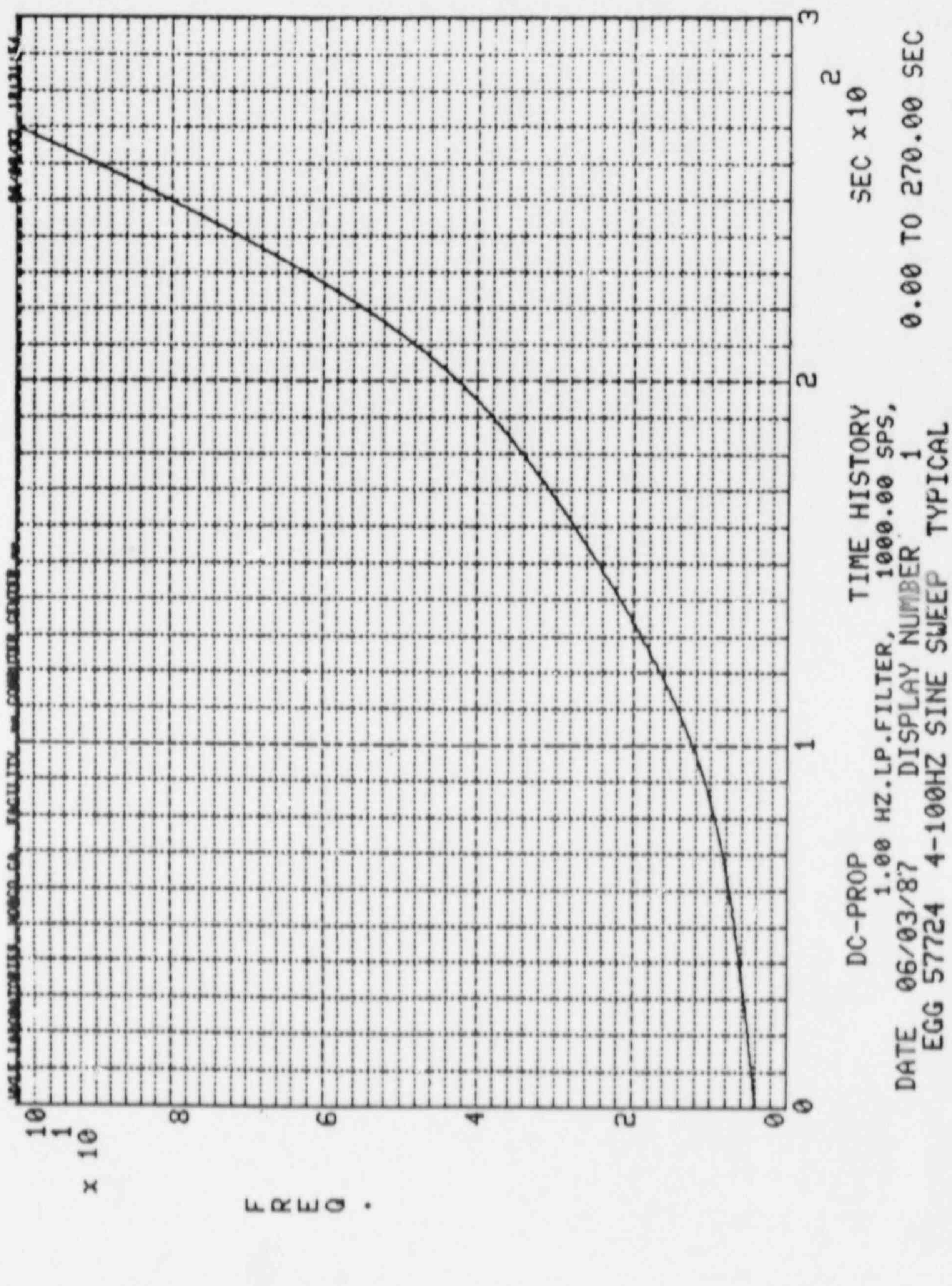
TEST NAME=EGG 57724 F/B, 3.5 G'S, 4-100HZ, RUN-36 ENERGIZED
TEST DATE=06/03/87 10:13:28 HOURS

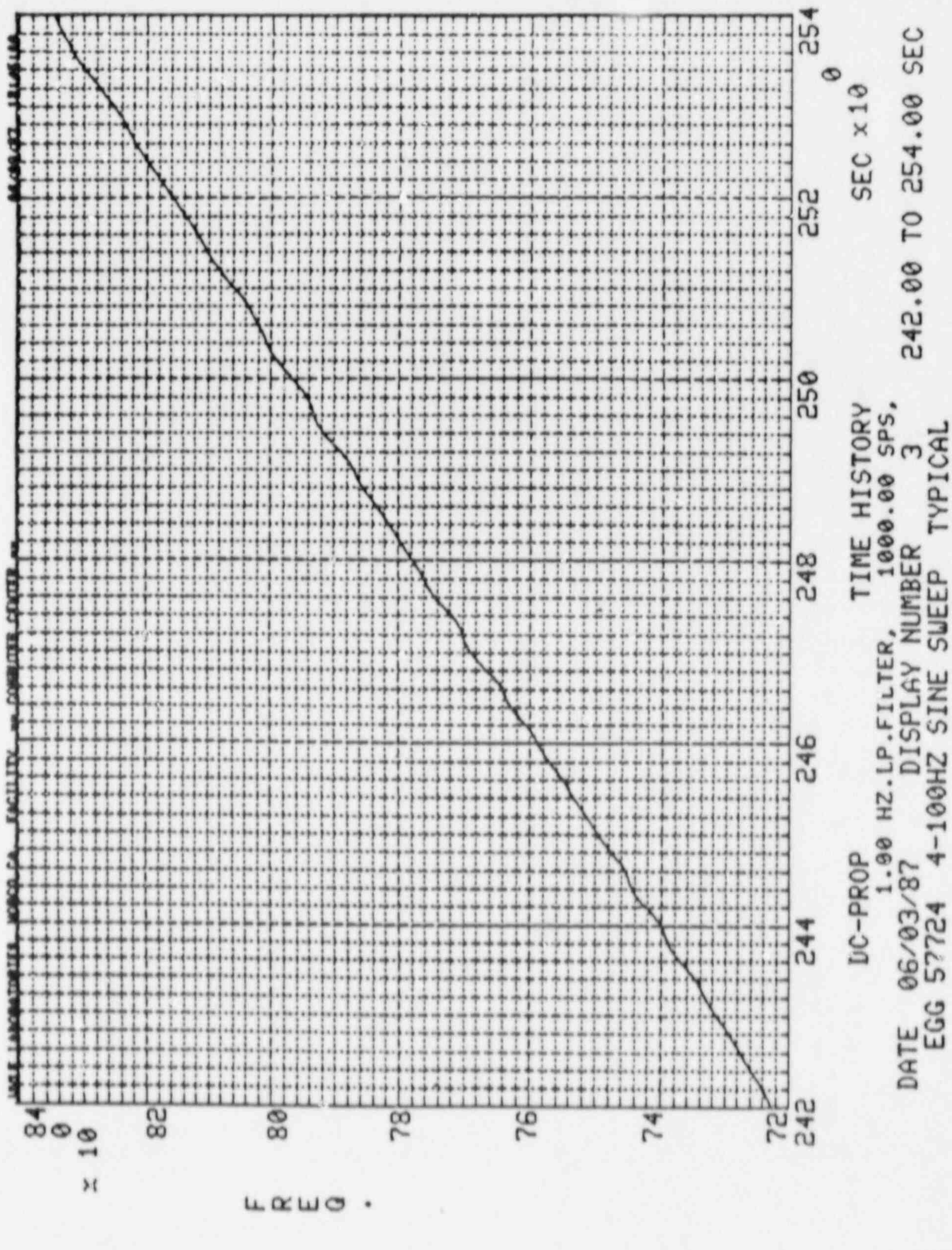
CHANNEL ID	CHANNEL NUMBER	FIRST CHATTER	LAST CHATTER	STATE CHANGE	NUMBER OF CHATTER FAILURES PER TIME LENGTH 2.00-5.00	5.00-10.0	10 0-20.0	20.0-40.0	40.0-80.0	>80.0	TOTAL
W1-NC	3			0	NO CHATTER						
W1-NO	4			0	NO CHATTER						
W2-NC	5			0	NO CHATTER						
W2-NO	6			0	NO CHATTER						
W3-NC	7			0	NO CHATTER						
W3-NO	8			0	NO CHATTER						
G1-NC	9			0	NO CHATTER						
G1-NO	10			0	NO CHATTER						
G2-NC	11			0	NO CHATTER						
G2-NO	12			0	NO CHATTER						
G3-NC	13			0	NO CHATTER						
G3-NO	14			0	NO CHATTER						
W1-OT-NO	15			0	NO CHATTER						
W2-OT-NO	16			0	NO CHATTER						
W3-OT-NO	17			0	NO CHATTER						
G1-OT-NO	18			0	NO CHATTER						
G2-OT-NO	19			0	NO CHATTER						
G3-OT-NO	20			0	NO CHATTER						
										TOTAL=	0

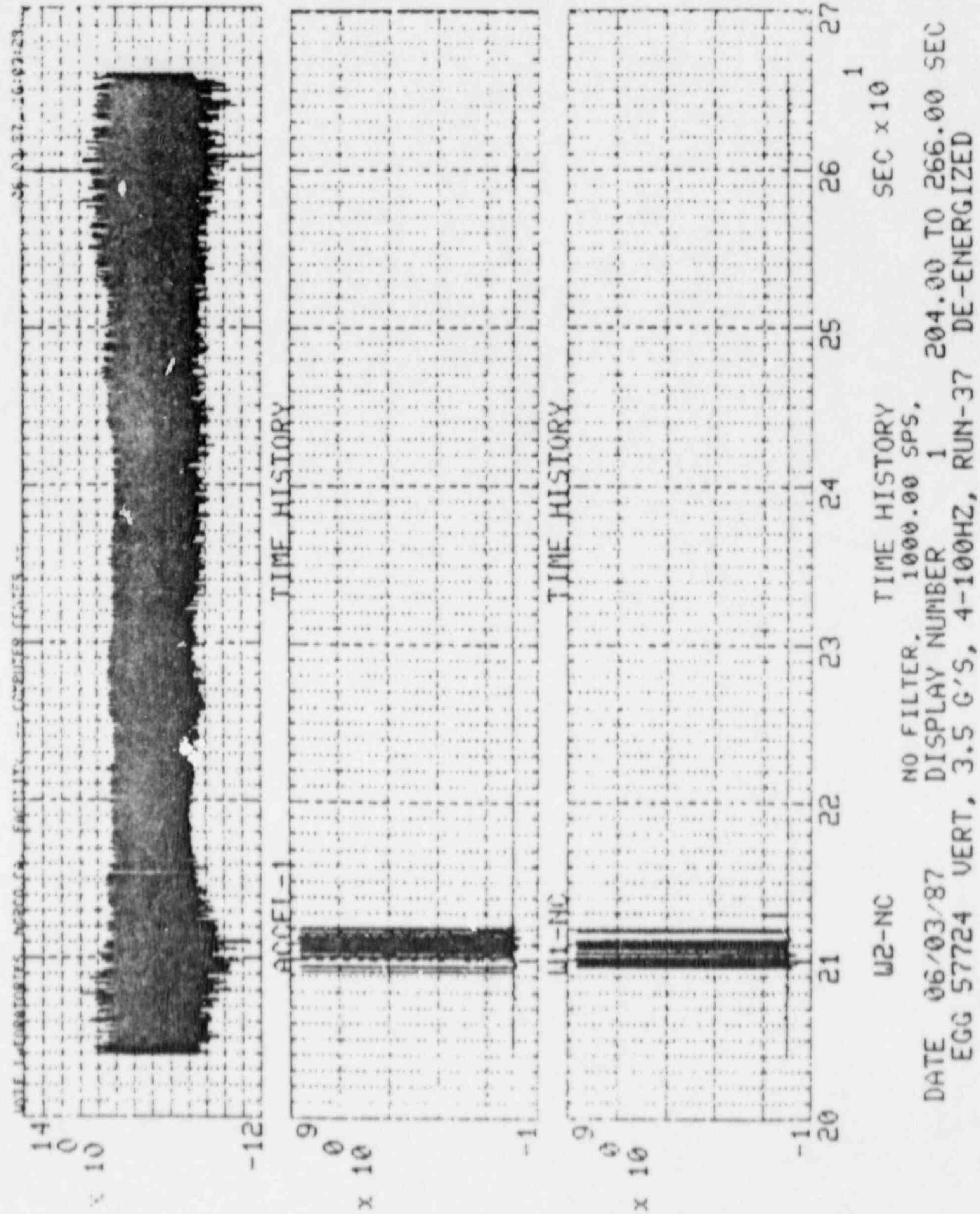
START TIME= 0.0000 STOP TIME= 281.12

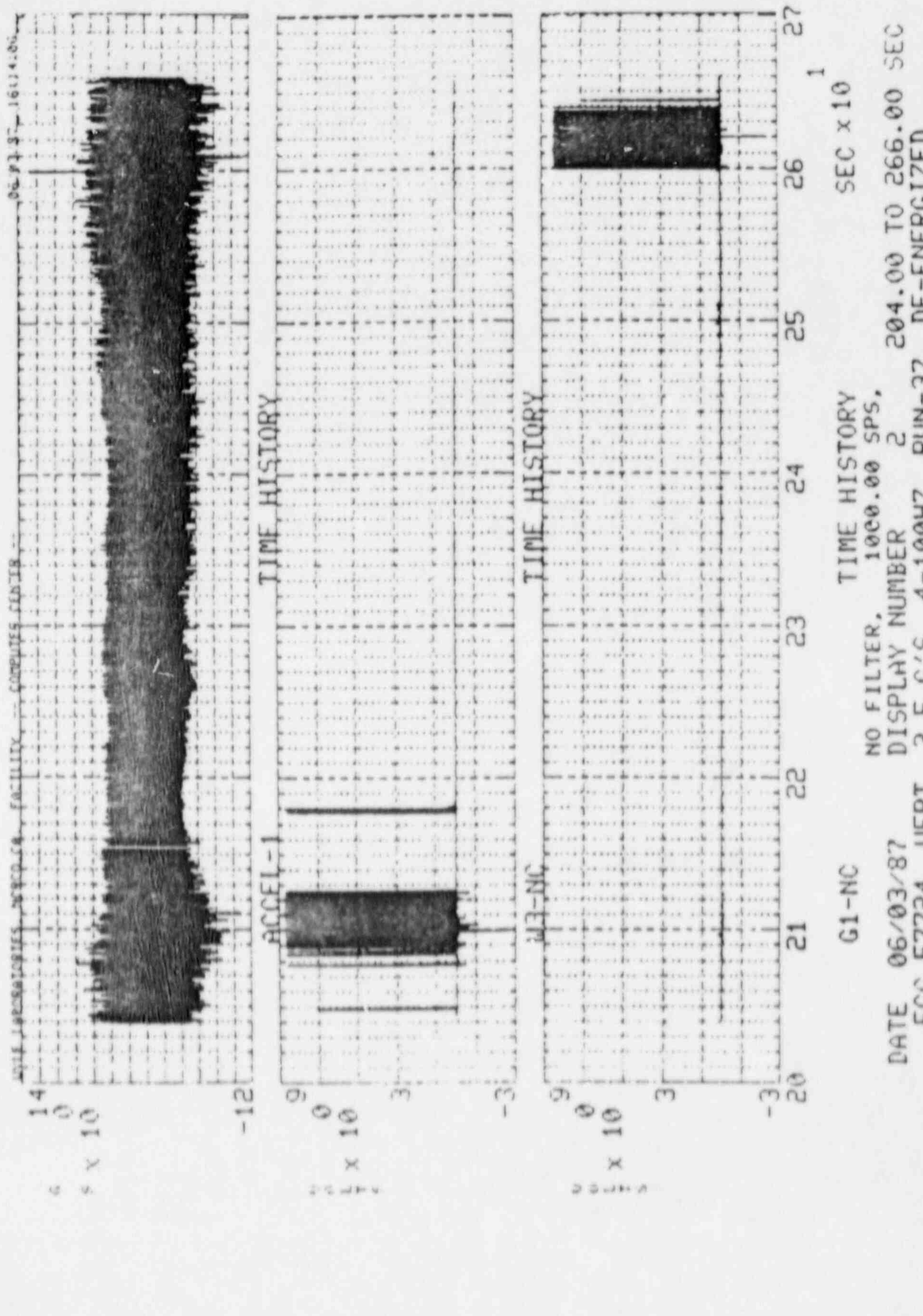
TEST NAME=EGG 57724 VERT, 3.5 G'S, 4-100HZ, RUN-37 DE-ENERGIZED
TEST DATE=06/03/87 13:34:31 HOURS

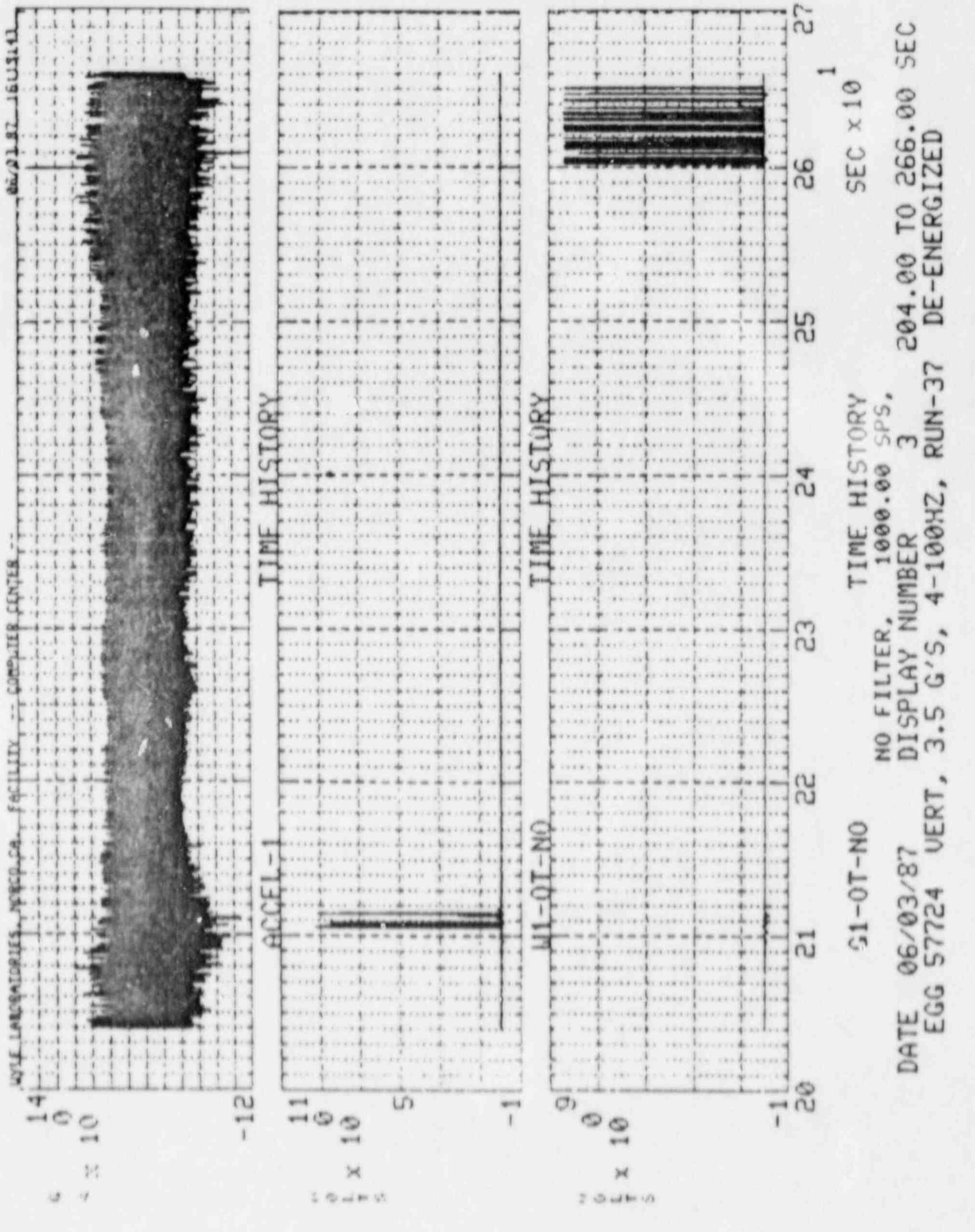
CHANNEL ID	CHANNEL NUMBER	FIRST CHATTER	LAST CHATTER	STATE CHANGE	NUMBER OF CHATTER FAILURES PER TIME LENGTH 2.00-5.00	5.00-10.0	10.0-20.0	20.0-40.0	40.0-80.0	>80.0	TOTAL
W1-NC	3	269.255	212.021	0	26	3	0	0	0	0	29
W1-NO	4			0	NO CHATTER						
W2-NC	5	209.614	212.045	0	23	1	0	0	0	0	24
W2-NO	6			0	NO CHATTER						
W3-NC	7	204.848	217.951	0	81	15	0	0	0	0	96
W3-NO	8			0	NO CHATTER						
G1-NC	9	259.872	264.412	0	50	35	0	0	0	0	85
G1-NO	10			0	NO CHATTER						
G2-NC	11			0	NO CHATTER						
G2-NO	12			0	NO CHATTER						
G3-NC	13			0	NO CHATTER						
G3-NO	14			0	NO CHATTER						
W1-OT-NO	15	210.546	211.491	0	5	0	0	0	0	0	5
W2-OT-NO	16			0	NO CHATTER						
W3-OT-NO	17			0	NO CHATTER						
G1-OT-NO	18	260.133	265.116	0	11	0	13	9	1	0	34
G2-OT-NO	19			0	NO CHATTER						
G3-OT-NO	20			0	NO CHATTER						
										TOTAL=	273

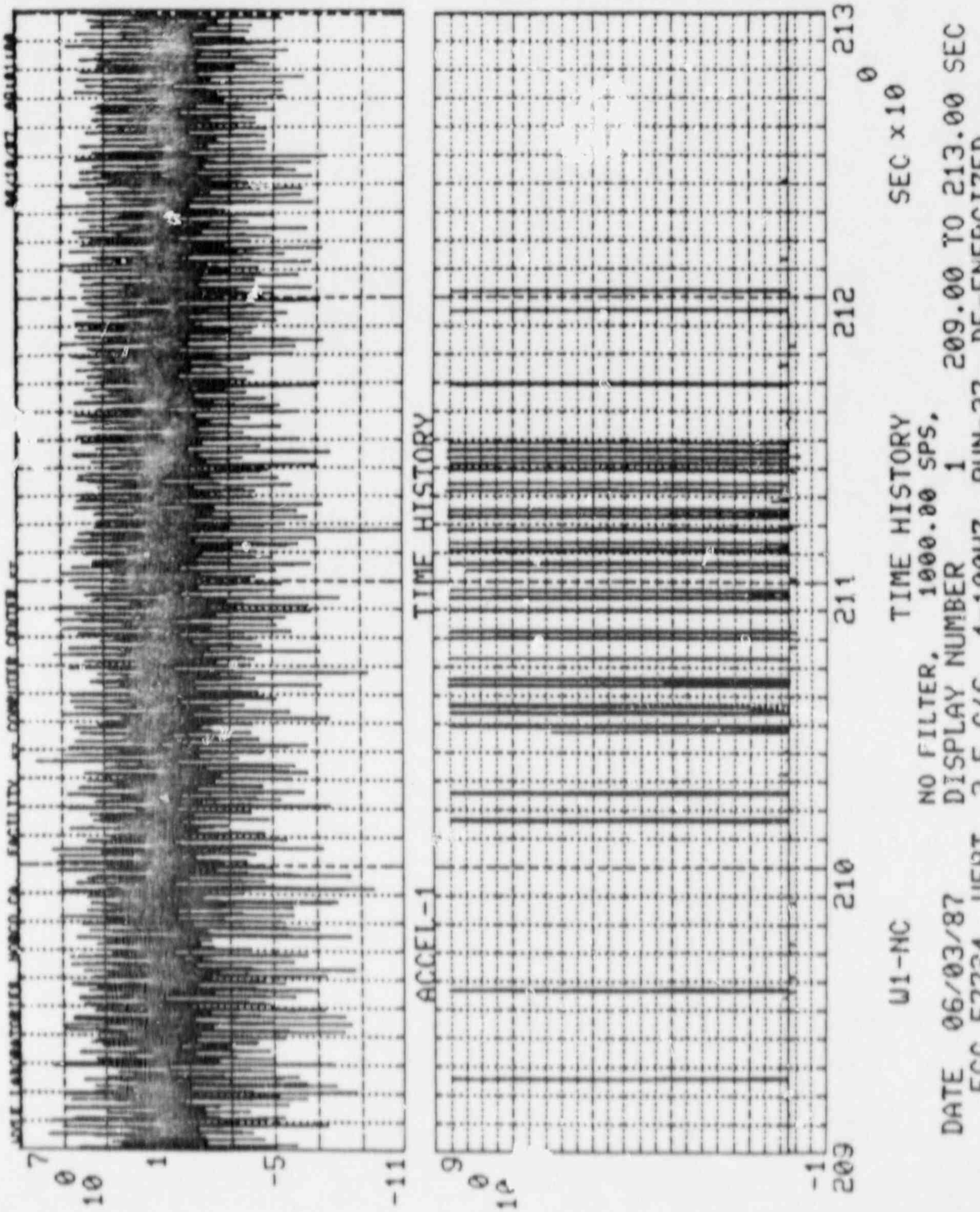

DC-PROP TIME HISTORY
1.00 HZ.LP.FILTER, 1000.00 SPS,
DATE 06/03/87 DISPLAY NUMBER 1
EGG 57724 4-100HZ SINE SWEEP TYPICAL
0.00 TO 270.00 SEC
SEC x 10^2
FREQ.
x 10^1
0
2
4
6
8
10
1
3

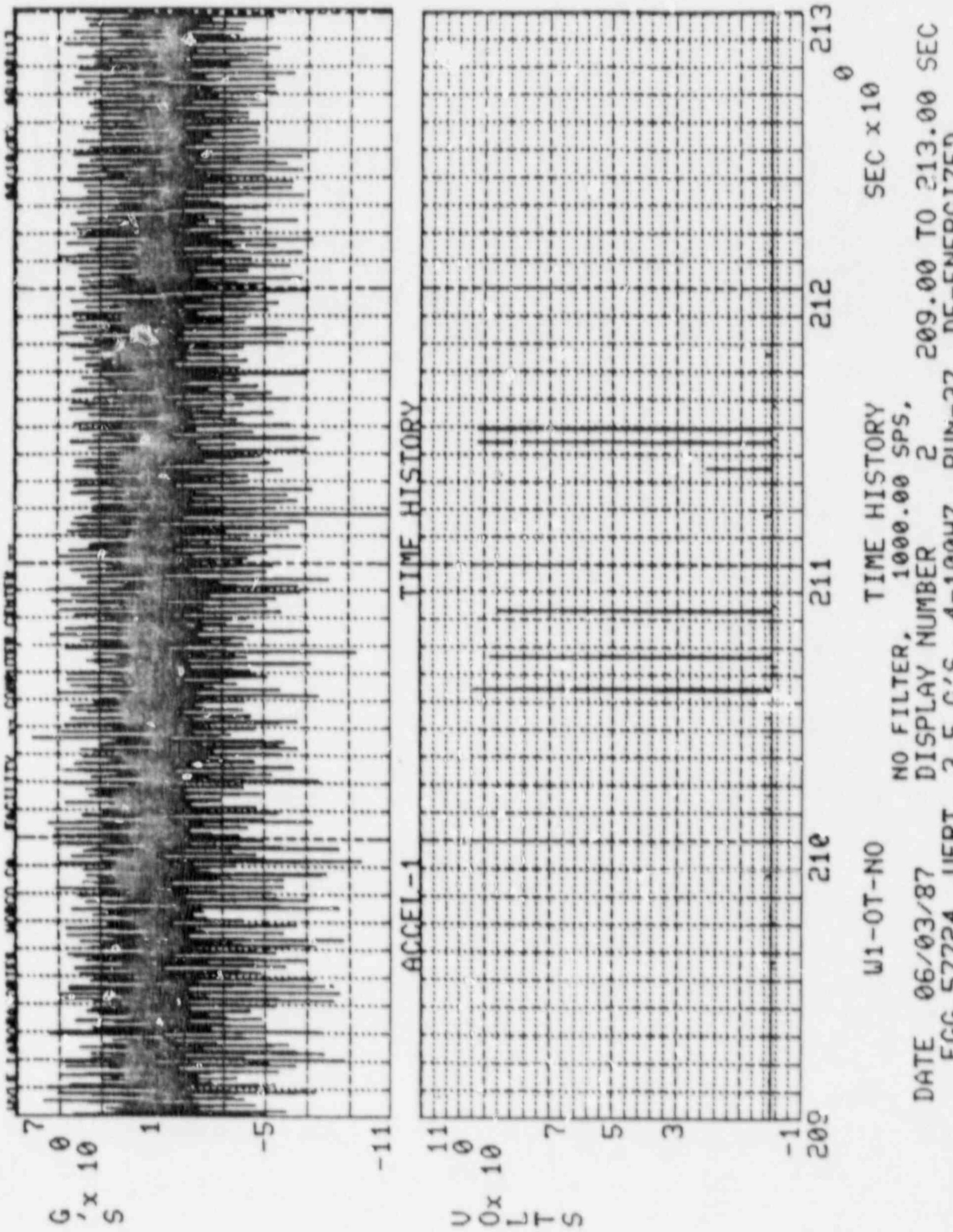

FREQ. x 10^0
84
82
80
78
76
74
72
242
244
246
248
250
252
254
SEC x 10^0
DC-PROP TIME HISTORY
1.00 HZ.LP.FILTER, 1000.00 SPS,
DATE 06/03/87 DISPLAY NUMBER 3 242.00 TO 254.00 SEC
EGG 57724 4-100HZ SINE SWEEP TYPICAL

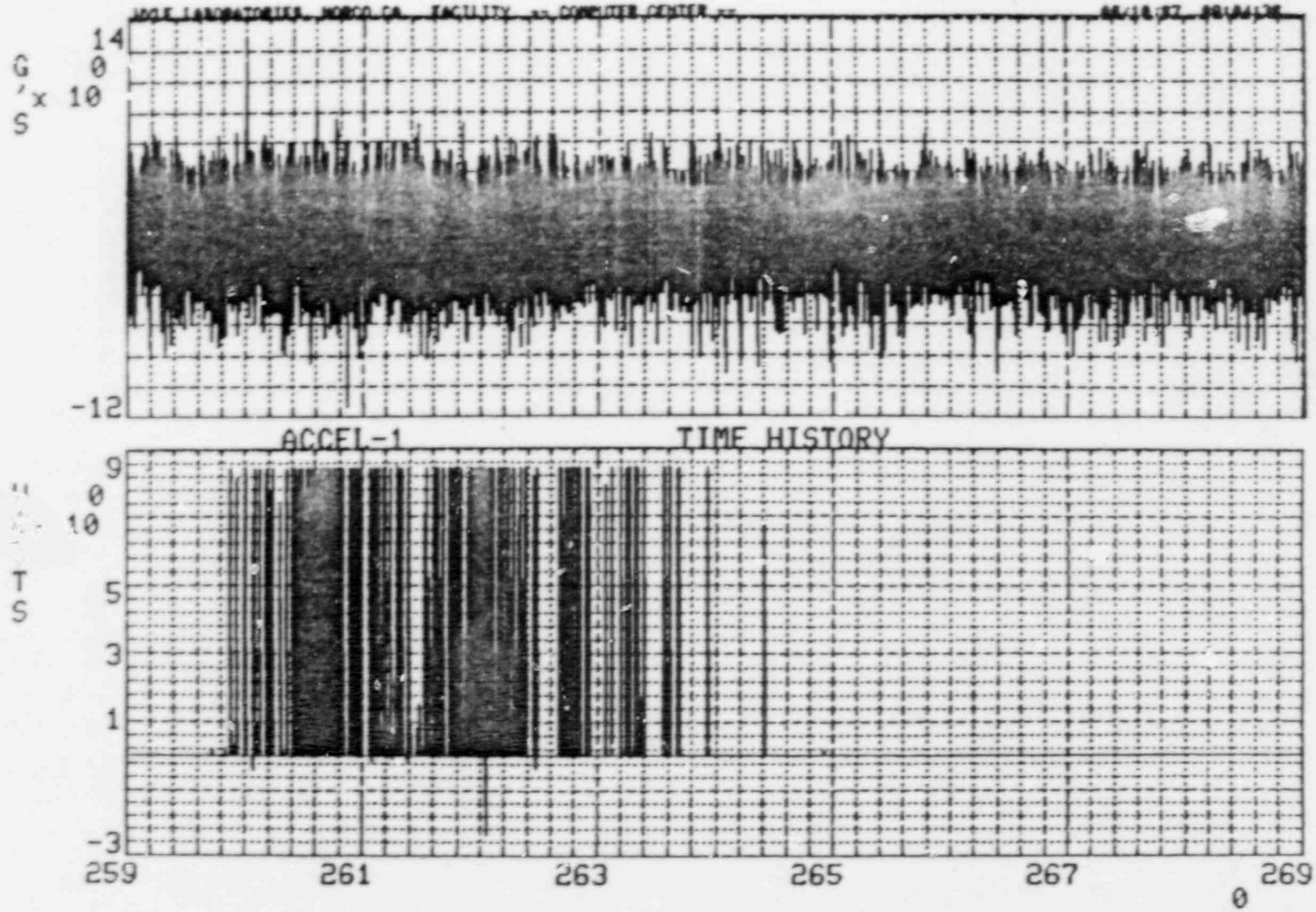

ACCEL-1 TIME HISTORY
W1-NC TIME HISTORY
W2-NC TIME HISTORY
NO FILTER, 1000.00 SPS, 204.00 TO 266.00 SEC
DATE 06/03/87 DISPLAY NUMBER 1
EGG 57724 VERT, 3.5 G'S, 4-100HZ, RUN-37 DE-ENERGIZED
SEC x 10 1
VOLTS x 10


G'S x 10^0
14
-12
9
3
-3
ACCEL-1
TIME HISTORY
W3-NC
TIME HISTORY
20
21
22
23
24
25
26
27
SEC x 10^1
G1-NC
TIME HISTORY
NO FILTER, 1000.00 SPS,
DISPLAY NUMBER 2
DATE 06/03/87
204.00 TO 266.00 SEC
EGG 57724 VERT, 3.5 G'S, 4-100HZ, RUN-37
DE-ENERGIZED


WYLE LABORATORIES, NORCO CA. FACILITY -- COMPUTER CENTER -- 06/03/87 16:13:43
ACCEL-1 TIME HISTORY
W1-OT-NO TIME HISTORY
SEC x 10 1
G1-OT-NO TIME HISTORY
NO FILTER, 1000.00 SPS,
DATE 06/03/87 DISPLAY NUMBER 3 204.00 TO 266.00 SEC
EGG 57724 VERT, 3.5 G'S, 4-100HZ, RUN-37 DE-ENERGIZED


TIME HISTORY
ACCEL-1
G's x 10^0
VOLTS x 10^0
SEC x 10^0
209
210
211
212
213
7
1
-5
-11
9
-1
W1-NC TIME HISTORY
DATE 06/03/87 NO FILTER, 1000.00 SPS, 209.00 TO 213.00 SEC
DISPLAY NUMBER 1
EGG 57724 VERT, 3.5 G'S, 4-100HZ, RUN-37 DE-ENERGIZED


G'S x 10^0
VOLTS x 10^0
ACCEL-1
TIME HISTORY
SEC x10^0
209
210
211
212
213
W1-OT-NO
TIME HISTORY
DATE 06/03/87
NO FILTER, 1000.00 SPS, 209.00 TO 213.00 SEC
DISPLAY NUMBER 2
EGG 57724 VERT, 3.5 G'S, 4-100HZ RUN-37 DE-ENERGIZED

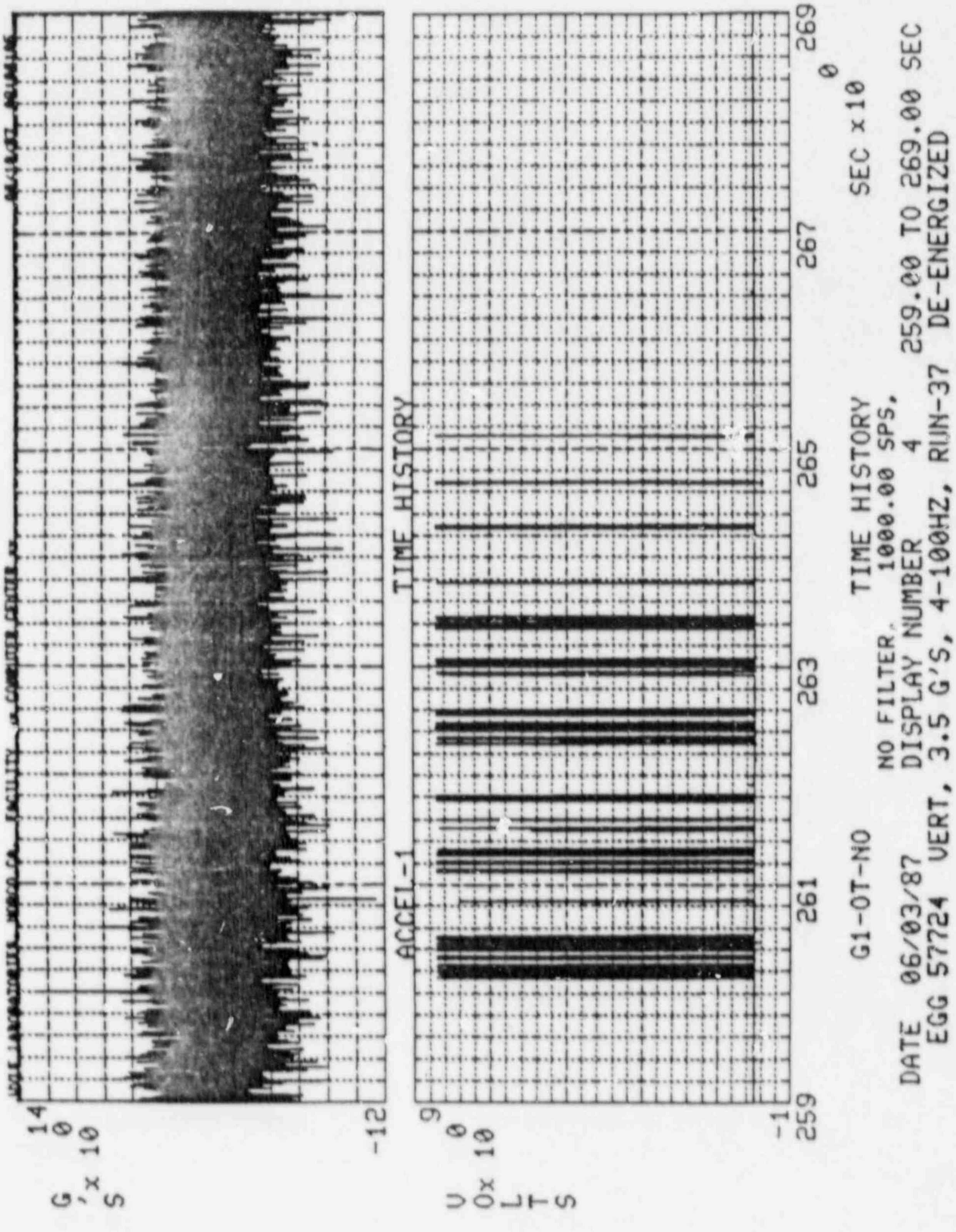


G1-NC TIME HISTORY

NO FILTER, 1000.00 SPS,

DATE 06/03/87 DISPLAY NUMBER 3 259.00 TO 269.00 SEC

EGG 57724 VERT, 3.5 G'S, 4-100HZ, RUN-37 DE-ENERGIZED


ACCEL-1 TIME HISTORY
G'S x 10^0
14
-12
VOLTS x 10^0
9
-1
259
261
263
265
267
269
SEC x 10^0
G1-OT-NO TIME HISTORY
NO FILTER. 1000.00 SPS, 259.00 TO 269.00 SEC
DATE 06/03/87 DISPLAY NUMBER 4
EGG 57724 VERT, 3.5 G'S, 4-100HZ, RUN-37 DE-ENERGIZED

WYLE LABORATORIES,NORCO,CA. FACILITY   CHATTER AND PULSE ANALYSIS PROGRAM   06/03/87 14:10:26 HOURS   PAGE 1

START TIME= 0.0000   STOP TIME= 281.12

TEST NAME=EGG 57724 VERT, 3.0 G'S, 4-100HZ, RUN-38 DE-ENERGIZED
TEST DATE=06/03/87 13:53:41 HOURS

CHANNEL ID	CHANNEL NUMBER	FIRST CHATTER	LAST CHATTER	STATE CHANGE	NUMBER OF CHATTER FAILURES PER TIME LENGTH 2.00-5.00	5.00-10.0	10.0-20.9	20.0-40.0	40.0-80.0	>80.0	TOTAL
W1-NC	3	208.536	210.312	0	3	0	0	0	0	0	3
W1-NO	4			0	NO CHATTER						
W2-NC	5	208.797	209.648	0	7	0	0	0	0	0	7
W2-NO	6			0	NO CHATTER						
W3-NC	7	208.323	210.461	0	22	1	0	0	0	0	23
W3-NO	8			0	NO CHATTER						
G1-NC	9	258.511	262.089	0	35	13	0	0	0	0	48
G1-NO	10			0	NO CHATTER						
G2-NC	11			0	NO CHATTER						
G2-NO	12			0	NO CHATTER						
G3-NC	13			0	NO CHATTER						
G3-NO	14			0	NO CHATTER						
W1-OT-NO	15			0	NO CHATTER						
W2-OT-NO	16			0	NO CHATTER						
W3-OT-NO	17			0	NO CHATTER						
G1-OT-NO	18	258.516	262.891	0	15	10	10	10	1	0	46
G2-OT-NO	19			0	NO CHATTER						
G3-OT-NO	20			0	NO CHATTER						
										TOTAL=	127

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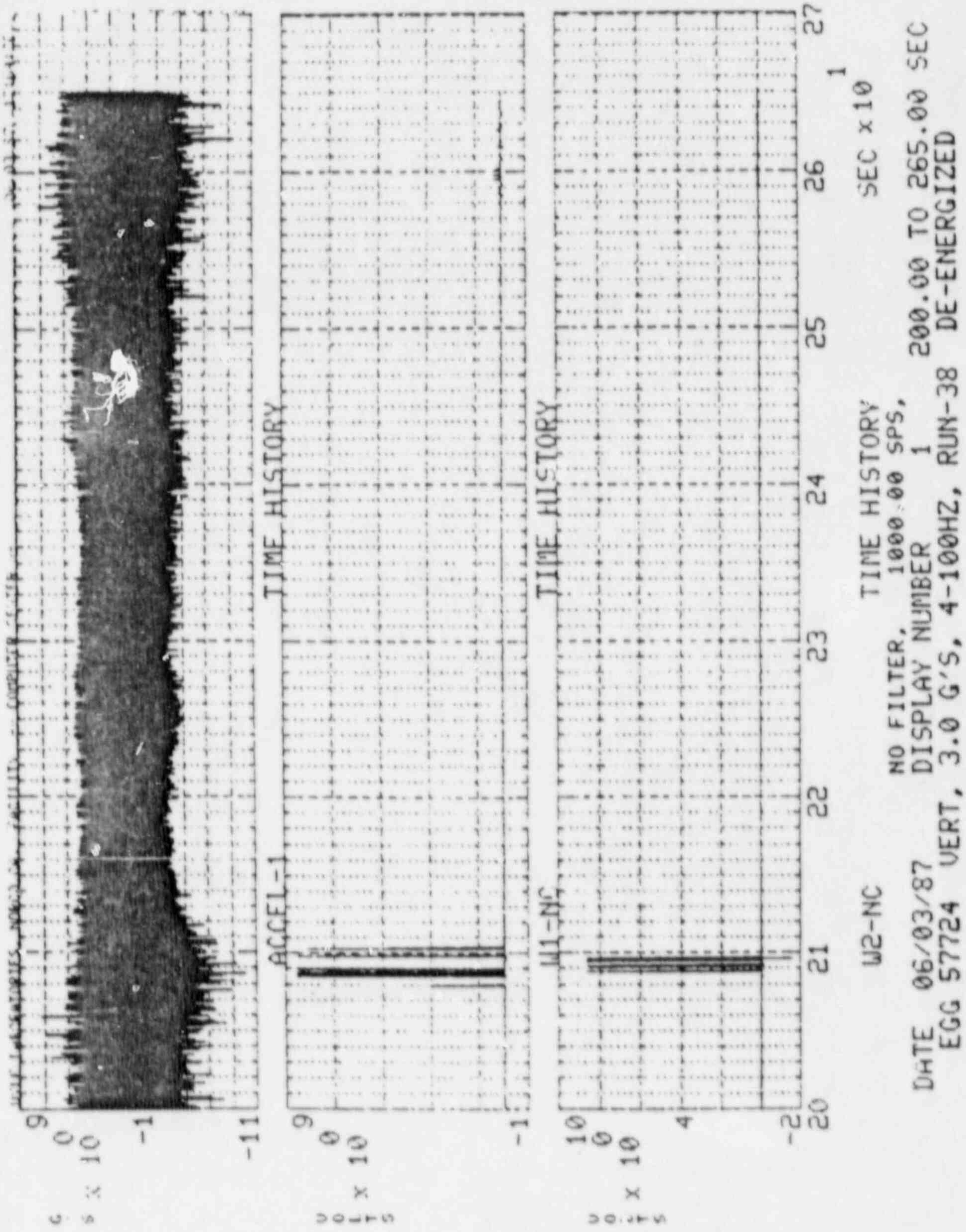
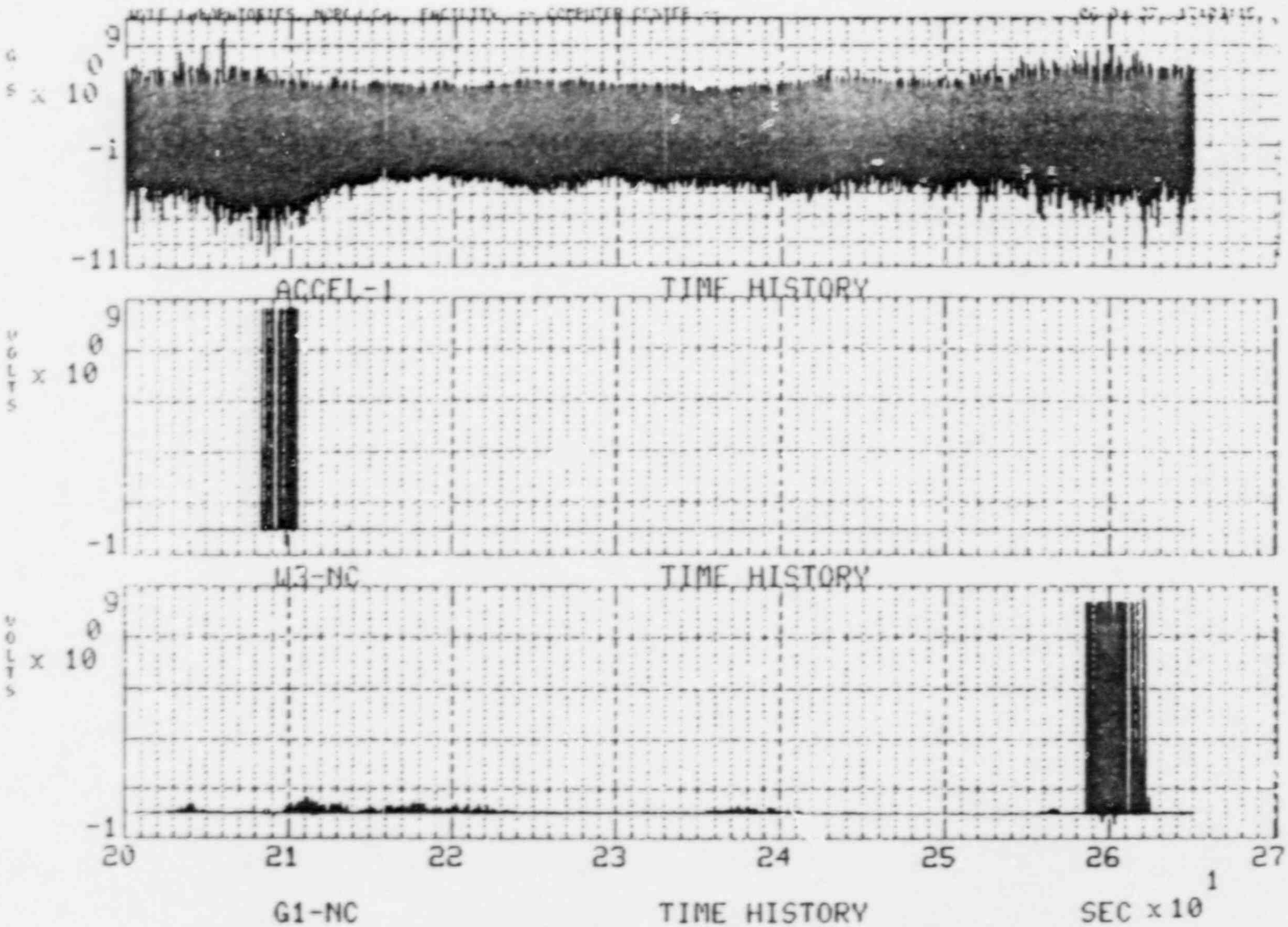
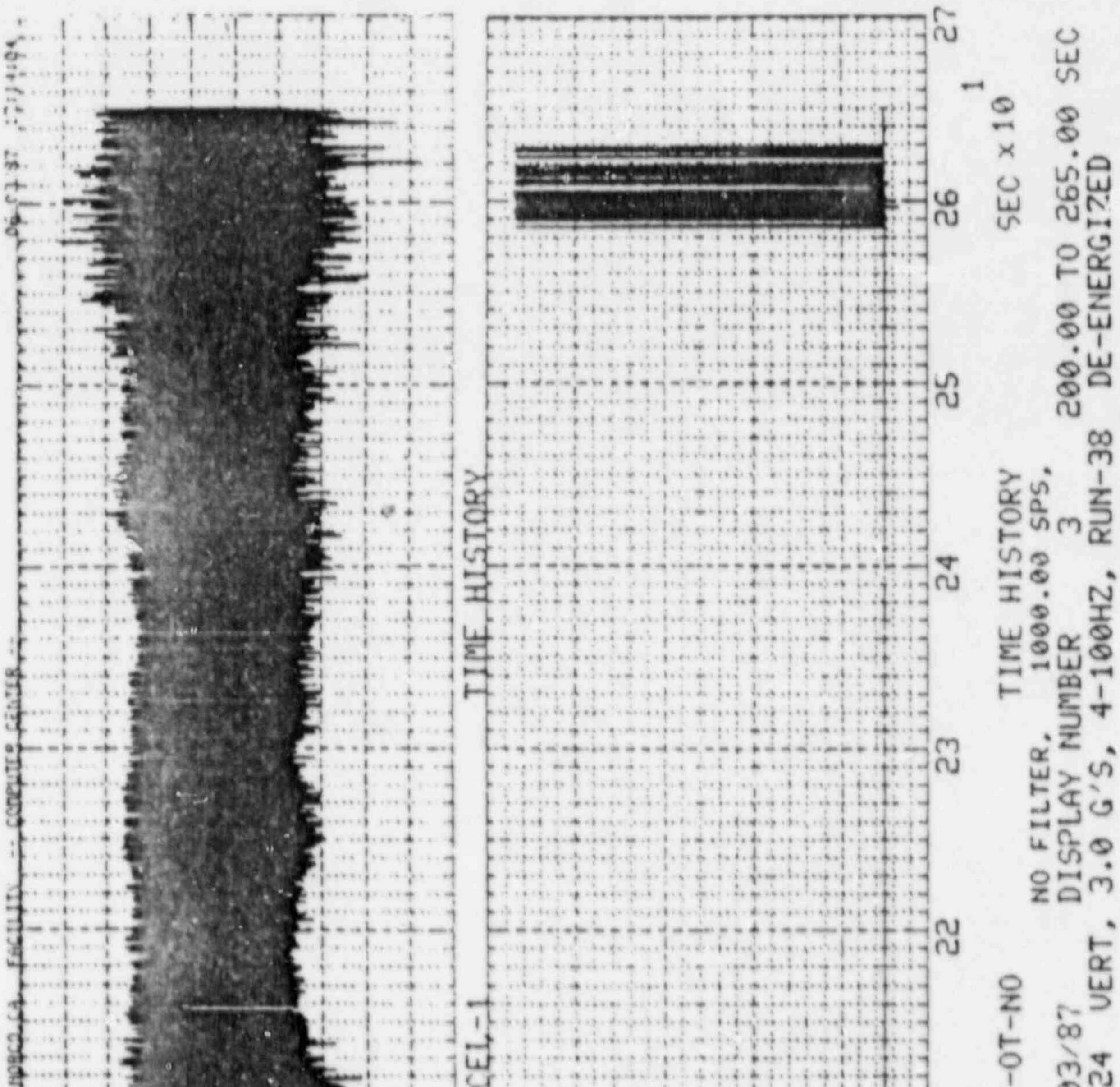
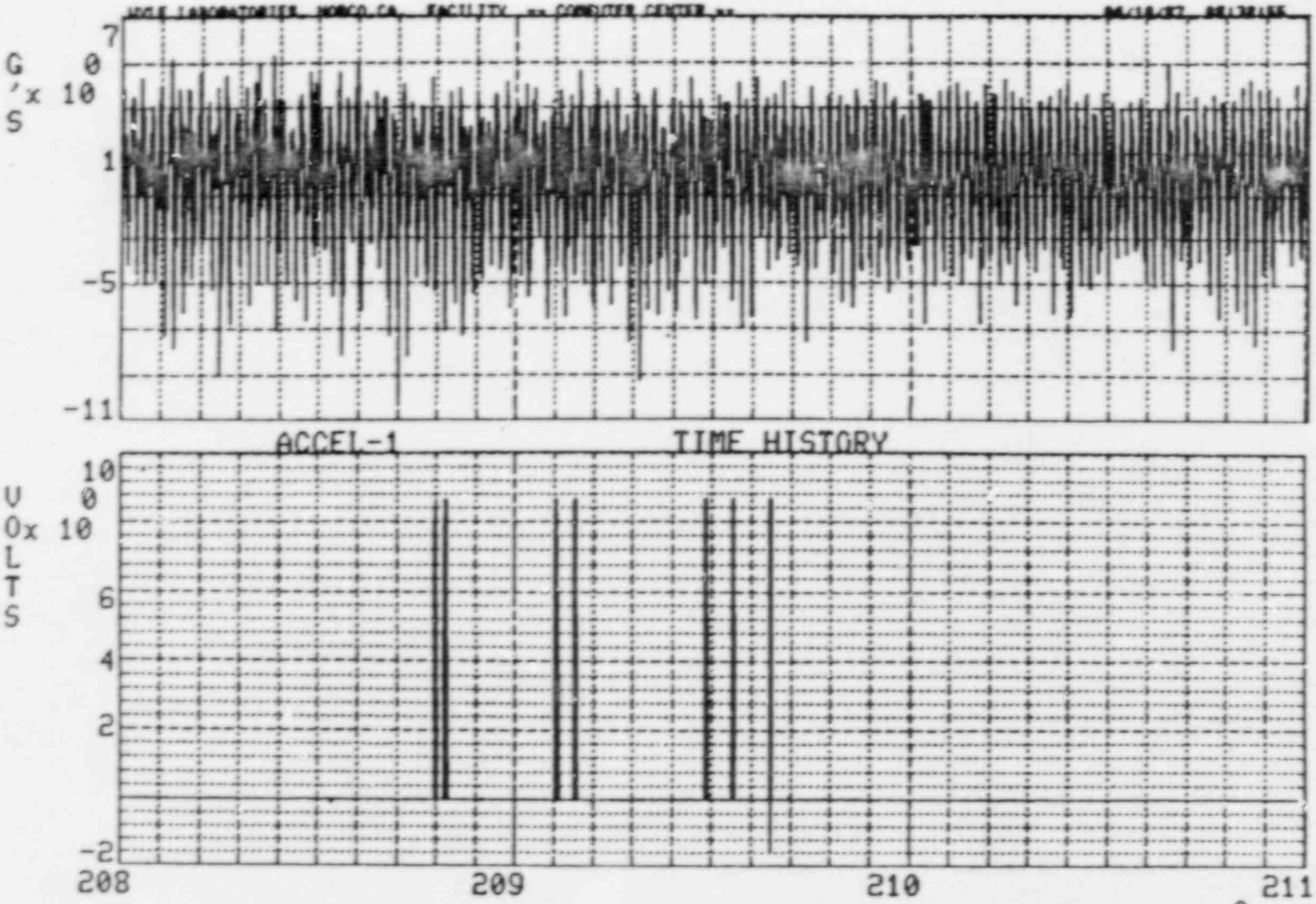

TIME HISTORY
TIME HISTORY
ACCEL-1
W1-NC
W2-NC
SEC x 10
TIME HISTORY
NO FILTER, 1000.00 SPS, 200.00 TO 265.00 SEC
DATE 06/03/87 DISPLAY NUMBER 1
EGG 57724 VERT, 3.0 G'S, 4-100HZ, RUN-38 DE-ENERGIZED



NO FILTER, 1000.00 SPS,
DATE 06/03/87 DISPLAY NUMBER 2 200.00 TO 265.00 SEC
EGG 57724 VERT, 3.0 G'S, 4-100HZ, RUN-38 DE-ENERGIZED


G1-OT-NO
TIME HISTORY
ACCEL-1
NO FILTER, 1000.00 SPS,
DATE 06/03/87 DISPLAY NUMBER 3
EGG 57724 VERT, 3.0 G'S, 4-100HZ, RUN-38 DE-ENERGIZED
200.00 TO 265.00 SEC
SEC x 10 1
G'S x 10 0
VOLTS x 10 0
20 21 22 23 24 25 26 27

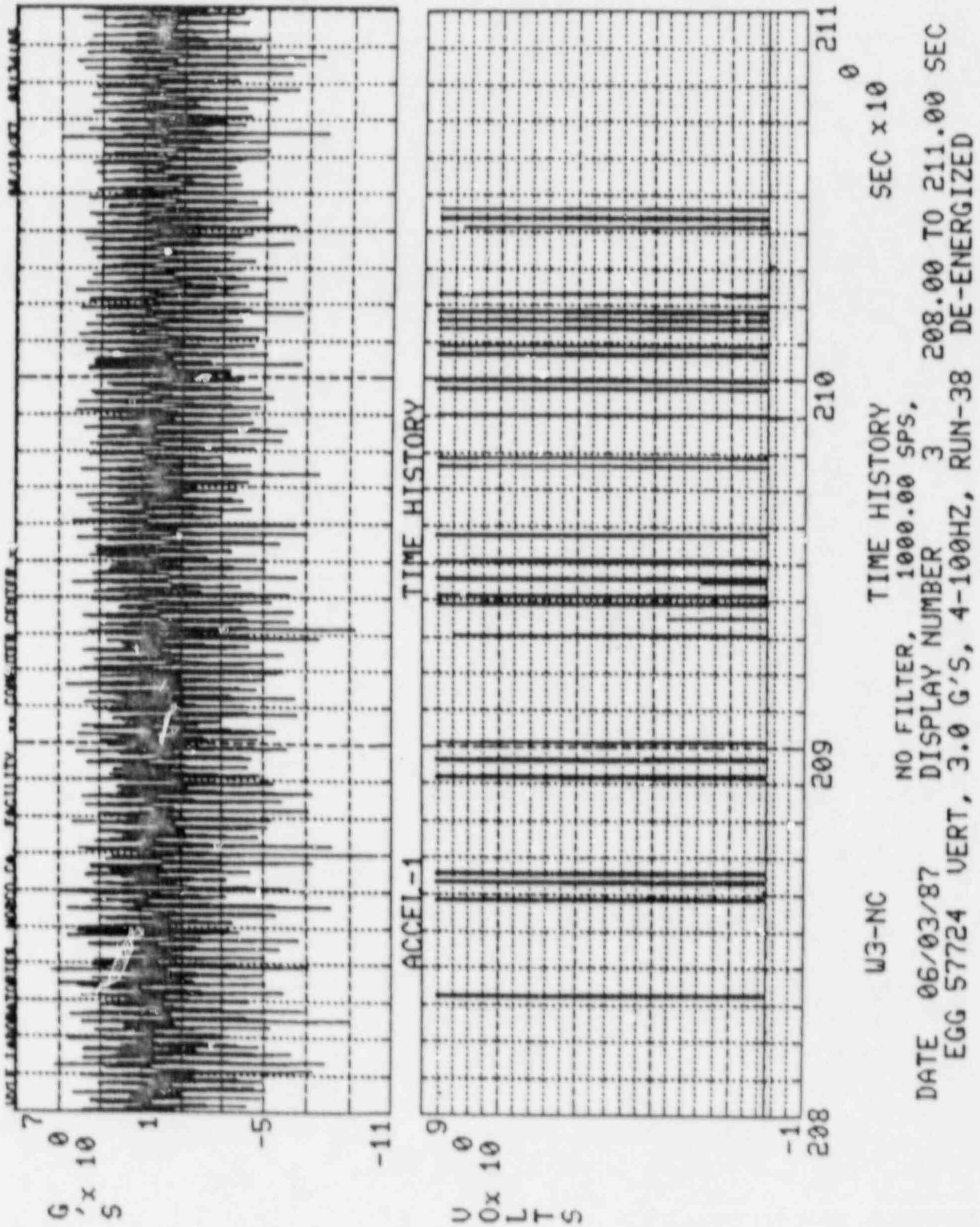


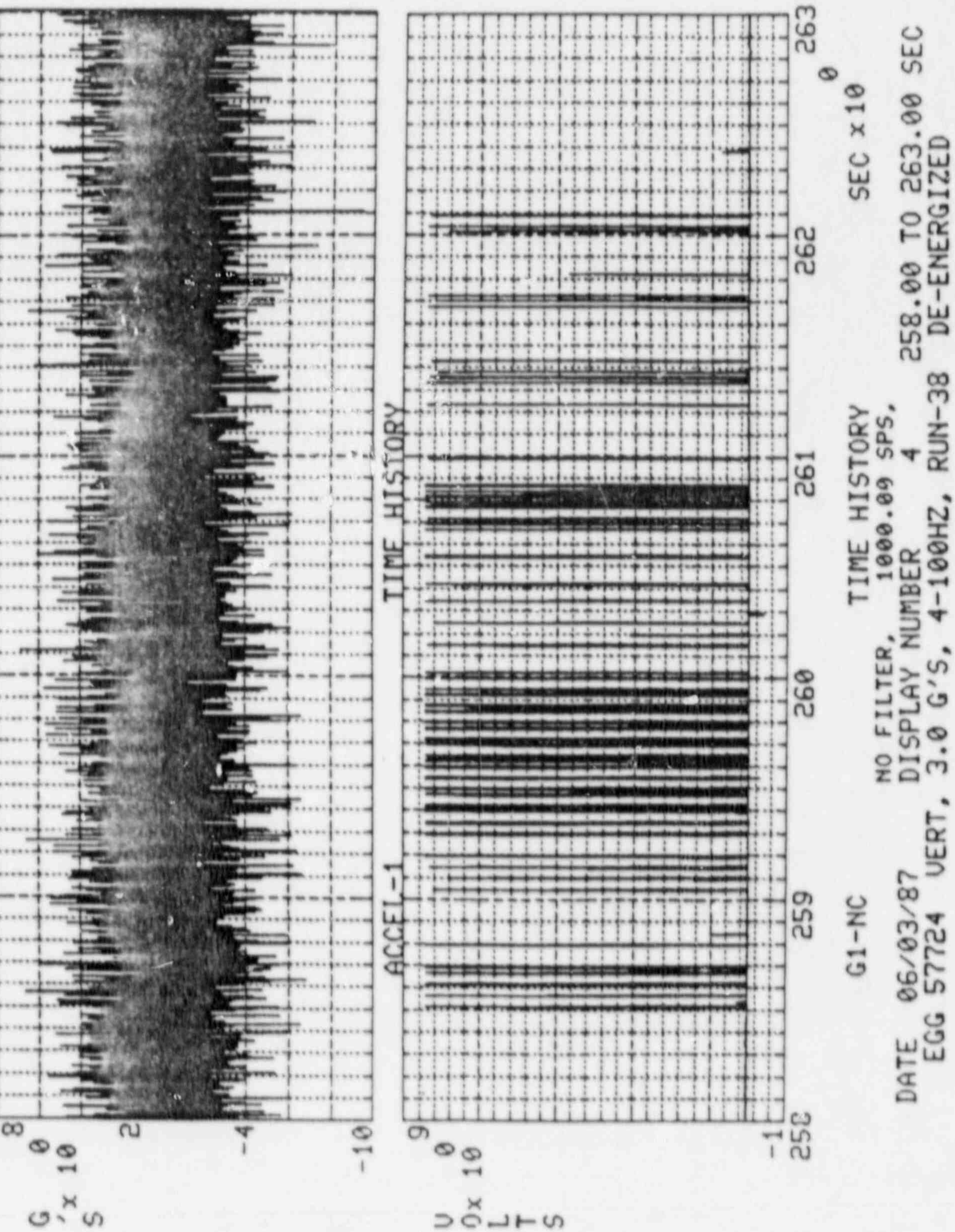
W2-NC TIME HISTORY

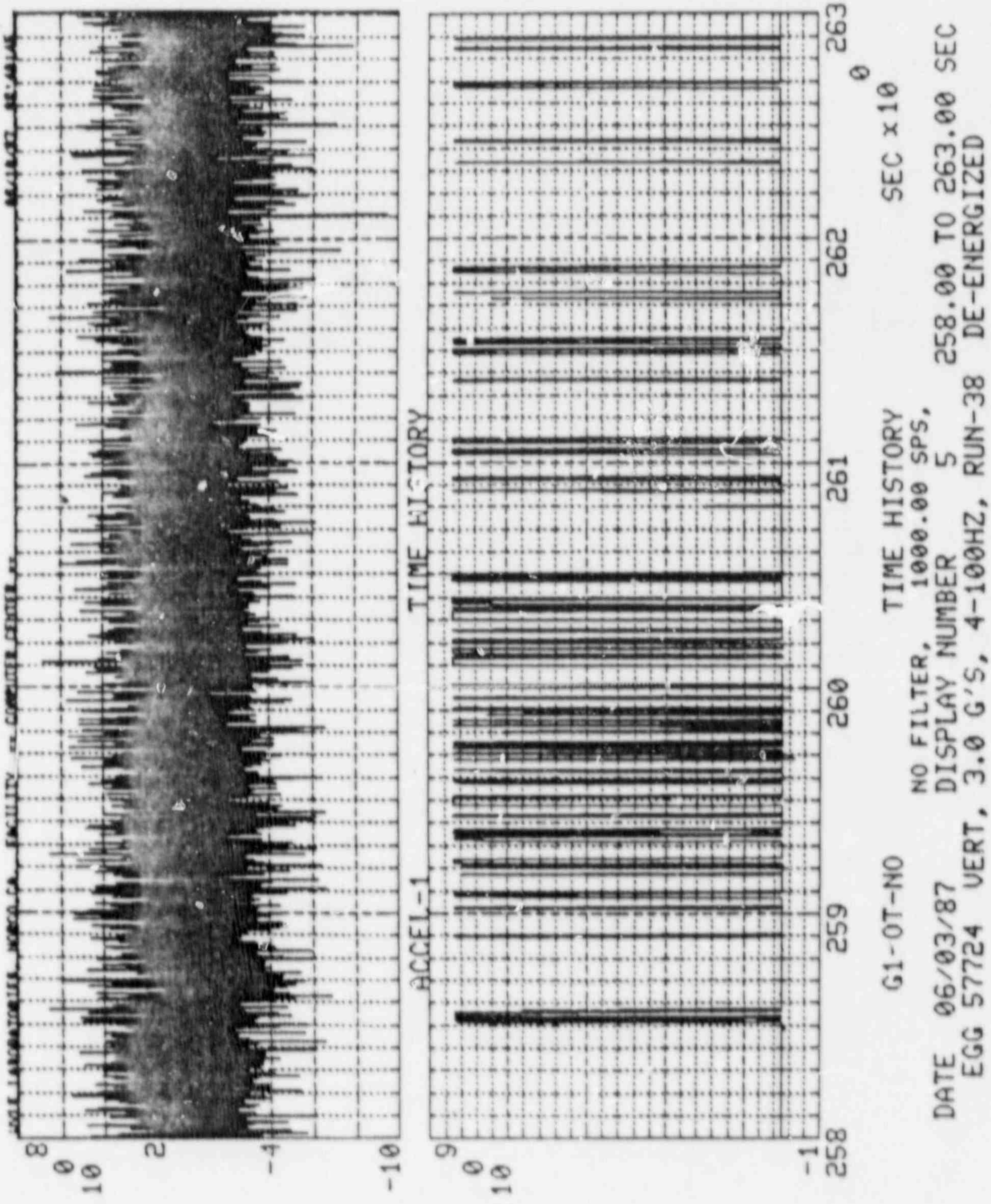
NO FILTER, 1000.00 SPS,

DATE 06/03/87 DISPLAY NUMBER 2 208.00 TO 211.00 SEC

EGG 57724 VERT, 3.0 G'S, 4-100HZ, RUN-38 DE-ENERGIZED


TIME HISTORY
ACCEL-1
W3-NC
TIME HISTORY
NO FILTER, 1000.00 SPS,
DATE 06/03/87 DISPLAY NUMBER 3 208.00 TO 211.00 SEC
EGG 57724 VERT, 3.0 G'S, 4-100HZ, RUN-38 DE-ENERGIZED
SEC x 10^0
G'S x 10^0
VOLTS x 10^0
208
209
210
211
7
1
-5
-11
9
-1


G'S x10^0
8
2
-4
-10
VOLTS x10^0
9
-1
258
259
260
261
262
263
SEC x10^0
ACCEL-1
TIME HISTORY
G1-NC
TIME HISTORY
DATE 06/03/87
NO FILTER, 1000.00 SPS,
DISPLAY NUMBER 4
258.00 TO 263.00 SEC
EGG 57724 VERT, 3.0 G'S, 4-100HZ, RUN-38
DE-ENERGIZED


G1-OT-NO
NO FILTER, 1000.00 SPS,
TIME HISTORY
DATE 06/03/87
DISPLAY NUMBER 5
258.00 TO 263.00 SEC
EGG 57724 VERT, 3.0 G'S, 4-100HZ, RUN-38 DE-ENERGIZED
ACCEL-1
TIME HISTORY
G'S x 10^0
VOLTS x 10^0
SEC x10^0
8
2
-4
-10
9
-1
258
259
260
261
262
263

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START TIME= 0.0000   STOP TIME= 260.44

TEST NAME=EGG 57724 VERT, 2.5 G'S, 4-100HZ, RUN-39 DE-ENERGIZED
TEST DATE=06/03/87 14:17:55 HOURS

CHANNEL ID	CHANNEL NUMBER	FIRST CHATTER	LAST CHATTER	STATE CHANGE	NUMBER OF CHATTER FAILURES PER TIME LENGTH 2.00-5.00	5.00-10.0	10.0-20.0	20.0-40.0	40.0-80.0	>80.0	TOTAL
W1-NC	3			0	NO CHATTER						
W1-NO	4			0	NO CHATTER						
W2-NC	5			0	NO CHATTER						
W2-NO	6			0	NO CHATTER						
W3-NC	7			0	NO CHATTER						
W3-NO	8			0	NO CHATTER						
G1-NC	9	257.419	260.511	0	16	0	0	0	0	0	16
G1-NO	10			0	NO CHATTER						
G2-NC	11			0	NO CHATTER						
G2-NO	12			0	NO CHATTER						
G3-NC	13			0	NO CHATTER						
G3-NO	14			0	NO CHATTER						
W1-OT-NO	15			0	NO CHATTER						
W2-OT-NO	16			0	NO CHATTER						
W3-OT-NO	17			0	NO CHATTER						
G1-OT-NO	18	257.899	260.520	0	6	4	3	3	0	0	16
G2-OT-NO	19			0	NO CHATTER						
G3-OT-NO	20			0	NO CHATTER						
										TOTAL=	32

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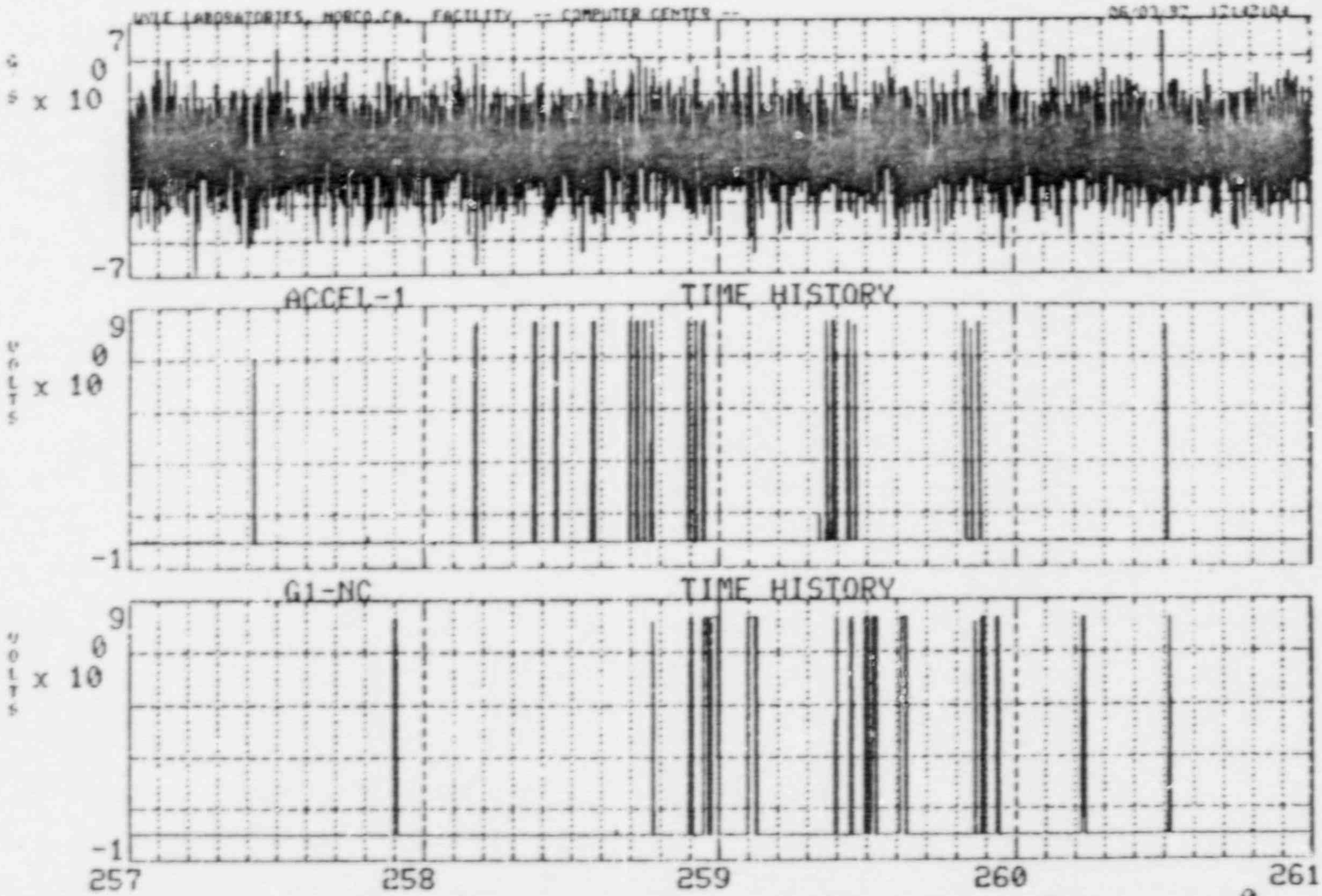


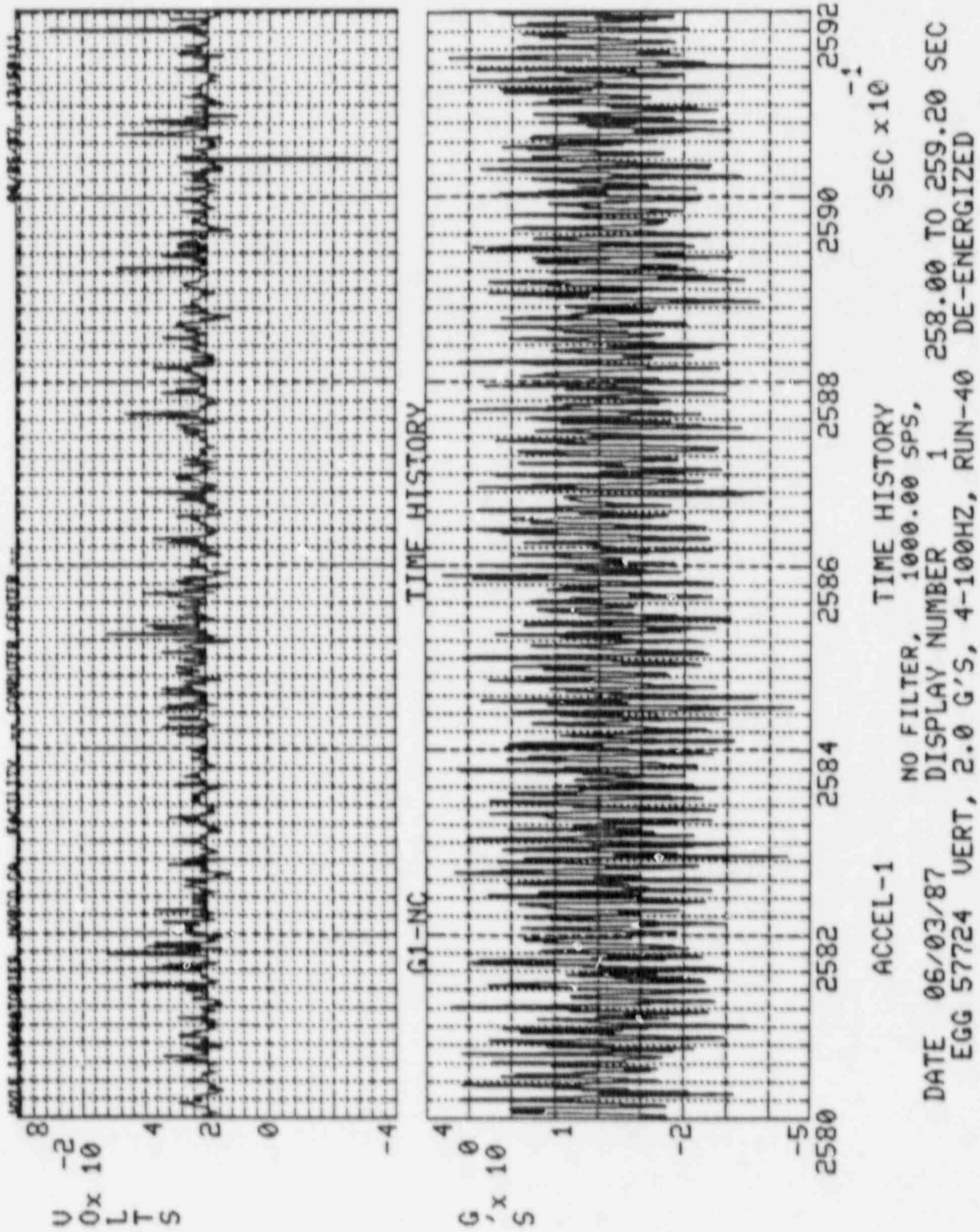
G1-OT-NO TIME HISTORY SEC x 10^0
NO FILTER, 1000.00 SPS,
DATE 06/03/87 DISPLAY NUMBER 1 257.00 TO 261.00 SEC
EGG 57724 VERT, 2.5 G'S, 4-100HZ, RUN-39 DE-ENERGIZED

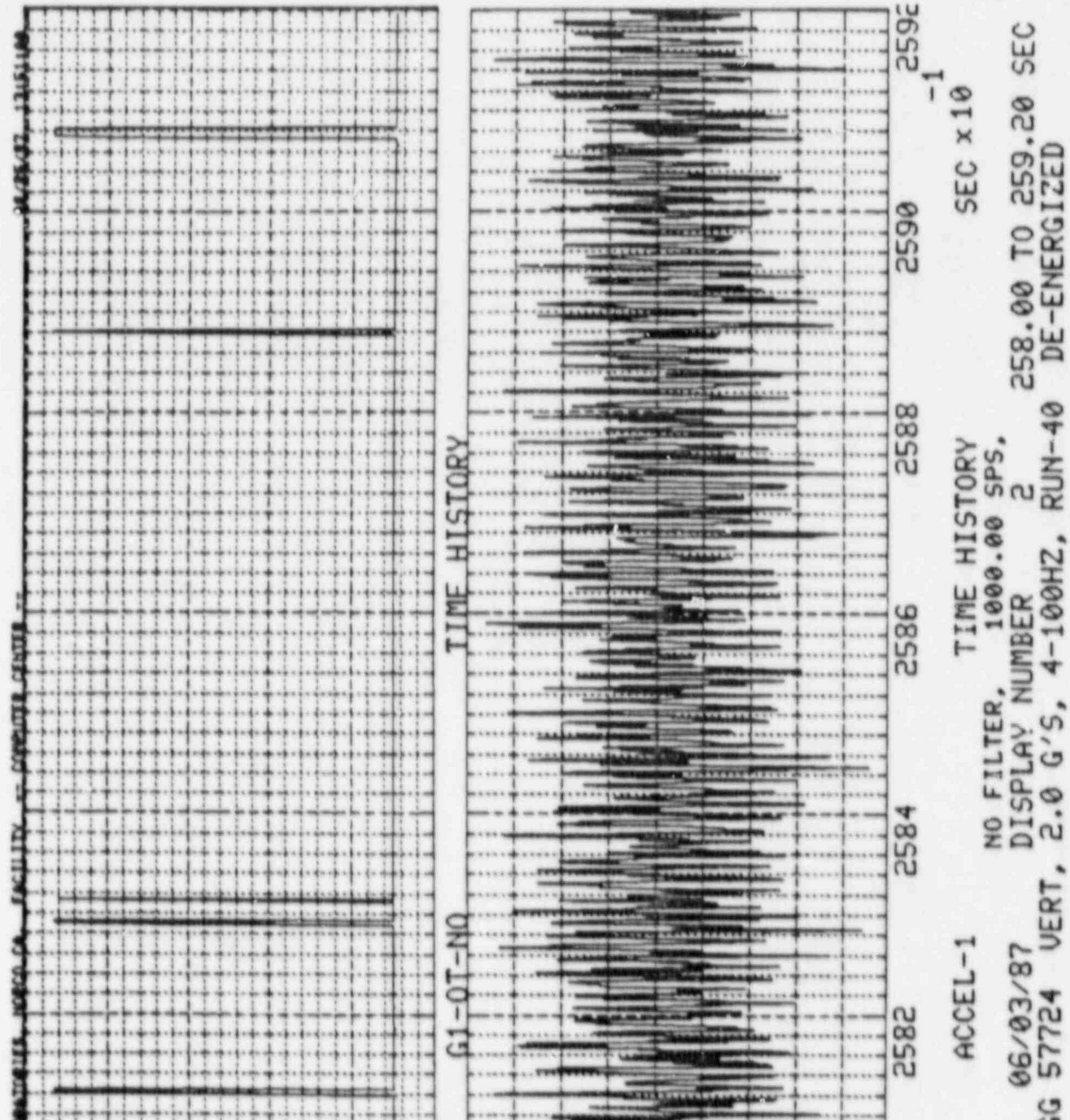
WYLE LABORATORIES,NORCO,CA. FACILITY CHATTER AND PULSE ANALYSIS PROGRAM 06/03/87 14:48:18 HOURS PAGE 1

START TIME= 0.0000 STOP TIME= 276.68

TEST NAME=EGG 57724 VERT, 2.0 G'S, 4-100HZ, RUN-40 DE-ENERGIZED
TEST DATE=06/03/87 14:38:44 HOURS

CHANNEL ID	CHANNEL NUMBER	FIRST CHATTER	LAST CHATTER	STATE CHANGE	NUMBER OF CHATTER FAILURES PER TIME LENGTH 2.00-5.00	5.00-10.0	10.0-20.0	20.0-40.0	40.0-80.0	>80.0	TOTAL
W1-NC	3			0	NO CHATTER						
W1-NO	4			0	NO CHATTER						
W2-NC	5			0	NO CHATTER						
W2-NO	6			0	NO CHATTER						
W3-NC	7			0	NO CHATTER						
W3-NO	8			0	NO CHATTER						
G1-NC	9			0	NO CHATTER						
G1-NO	10			0	NO CHATTER						
G2-NC	11			0	NO CHATTER						
G2-NO	12			0	NO CHATTER						
G3-NC	13			0	NO CHATTER						
G3-NO	14			0	NO CHATTER						
W1-OT-NO	15			0	NO CHATTER						
W2-OT-NO	16			0	NO CHATTER						
W3-OT-NO	17			0	NO CHATTER						
G1-OT-NO	18	258.120	259.083	0	4	0	1	0	0	0	5
G2-OT-NO	19			0	NO CHATTER						
G3-OT-NO	20			0	NO CHATTER						
										TOTAL=	5


TIME HISTORY
G1-NC
VOLTS x 10^-2
G'S x 10
SEC x10^-1
ACCEL-1
TIME HISTORY
NO FILTER, 1000.00 SPS, 258.00 TO 259.20 SEC
DATE 06/03/87 DISPLAY NUMBER 1
EGG 57724 VERT, 2.0 G'S, 4-100HZ, RUN-40 DE-ENERGIZED


VOLTS x 10^0
G'S x 10^0
G1-OT-NO
TIME HISTORY
SEC x 10^-1
ACCEL-1 TIME HISTORY
NO FILTER, 1000.00 SPS,
DISPLAY NUMBER 2
DATE 06/03/87 258.00 TO 259.20 SEC
EGG 57724 VERT, 2.0 G'S, 4-100HZ, RUN-40 DE-ENERGIZED

START TIME= 0.0000 STOP TIME= 279.07

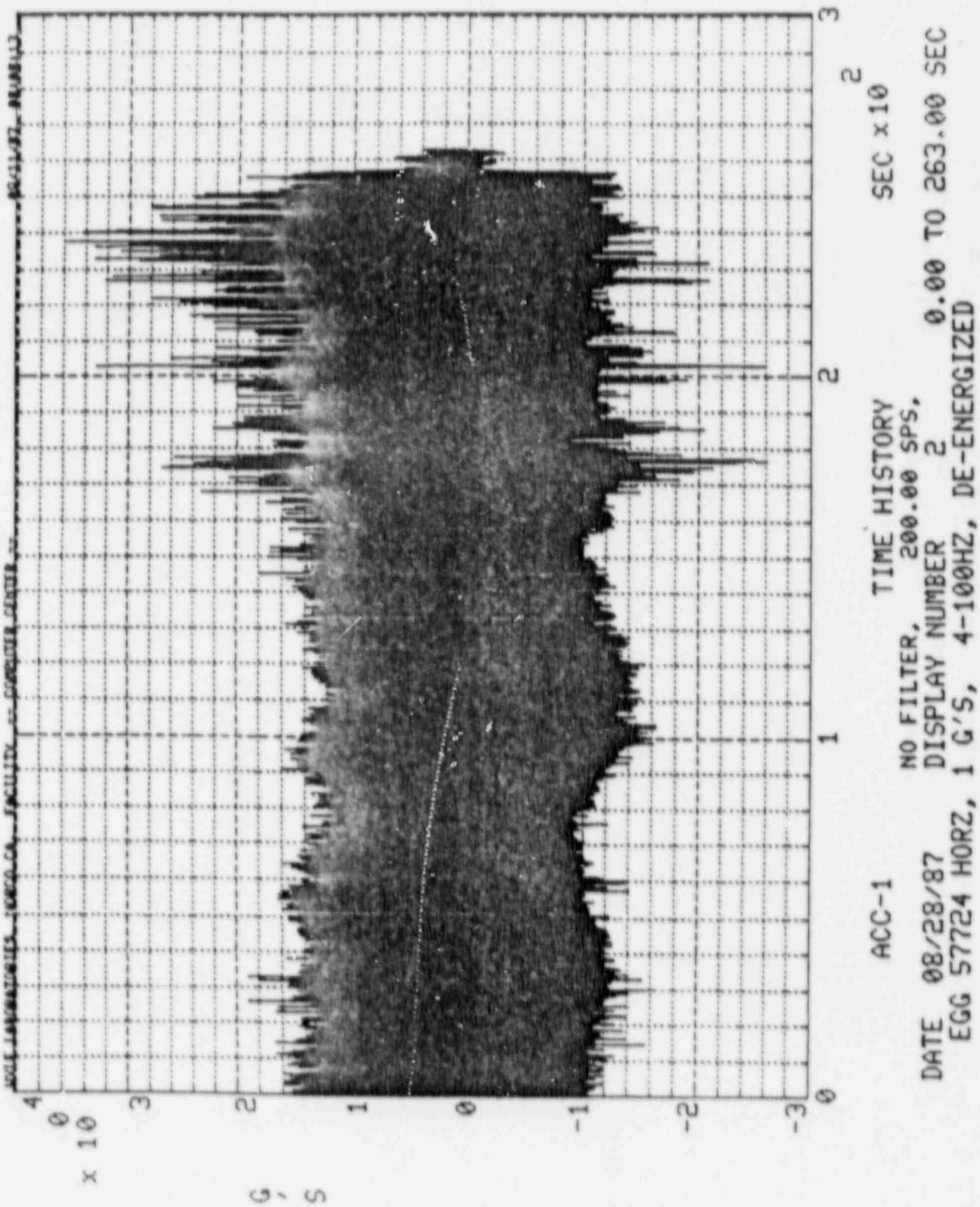
TEST NAME=EGG 57724 VERT, 3.5 G'S, 4-100HZ, RUN-41 ENERGIZED
TEST DATE=06/03/87 15:16:54 HOURS

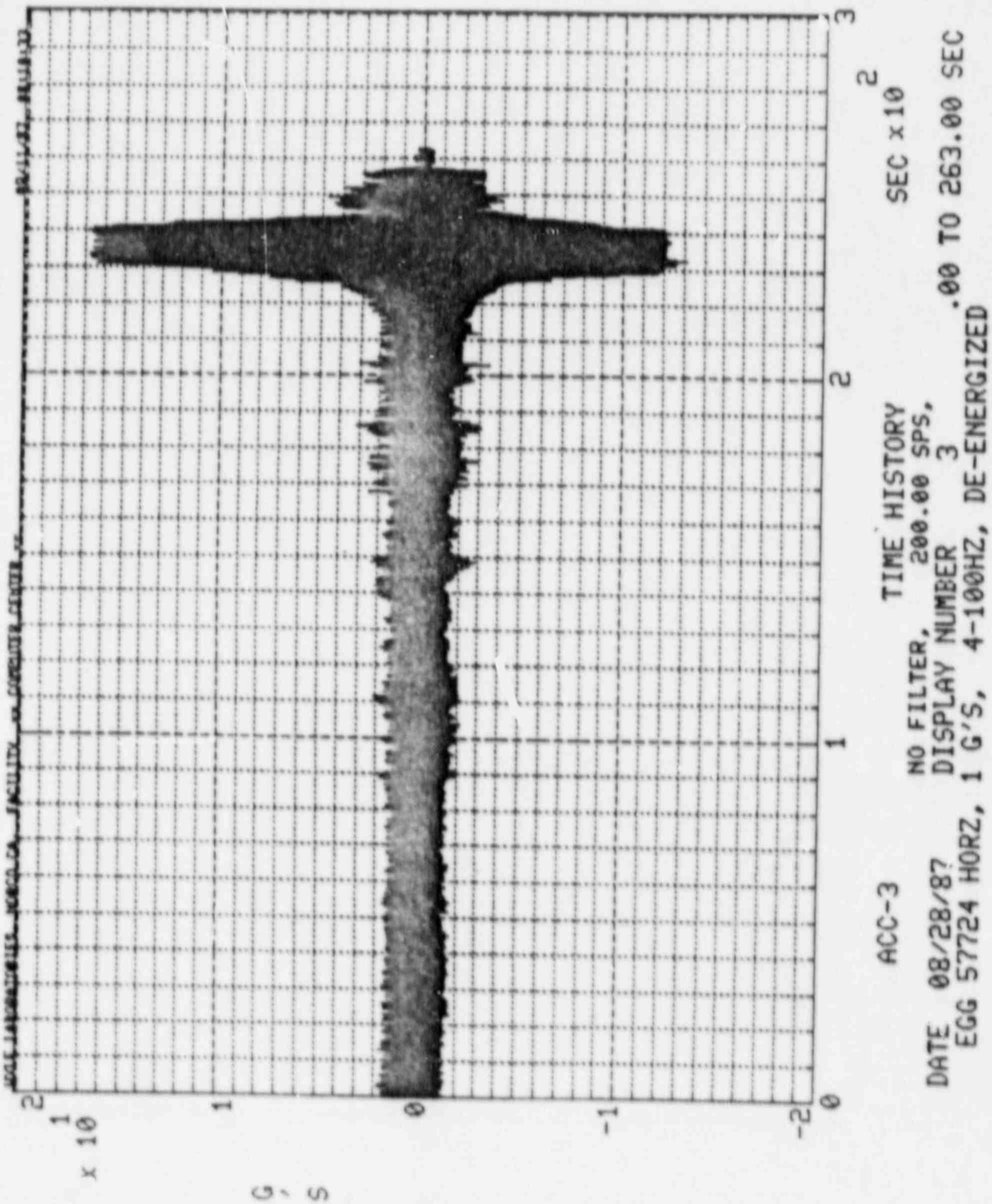
CHANNEL ID	CHANNEL NUMBER	FIRST CHATTER	LAST CHATTER	STATE CHANGE	NUMBER OF CHATTER FAILURES PER TIME LENGTH 2.00-5.00	5.00-10.0	10.0-20.0	20.0-40.0	40.0-80.0	>80.0	TOTAL
W1-NC	3			0	NO CHATTER						
W1-NO	4			0	NO CHATTER						
W2-NC	5			0	NO CHATTER						
W2-NO	6			0	NO CHATTER						
W3-NC	7			0	NO CHATTER						
W3-NO	8			0	NO CHATTER						
G1-NC	9			0	NO CHATTER						
G1-NO	10			0	NO CHATTER						
G2-NC	11			0	NO CHATTER						
G2-NO	12			0	NO CHATTER						
G3-NC	13			0	NO CHATTER						
G3-NO	14			0	NO CHATTER						
W1-OT-NO	15			0	NO CHATTER						
W2-OT-NO	16			0	NO CHATTER						
W3-OT-NO	17			0	NO CHATTER						
G1-OT-NO	18			0	NO CHATTER						
G2-OT-NO	19			0	NO CHATTER						
G3-OT-NO	20			0	NO CHATTER						
										TOTAL=	0

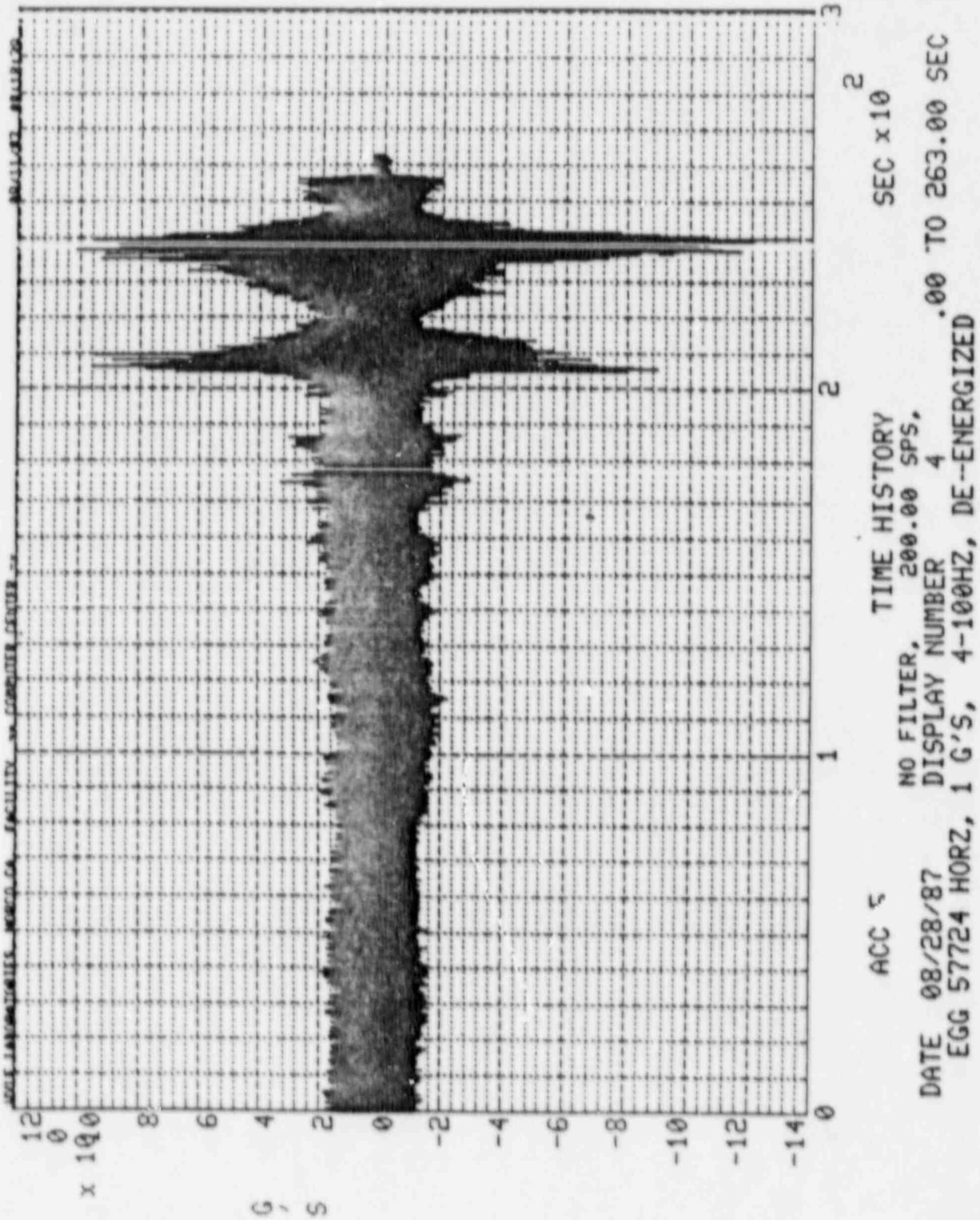
APPENDIX H

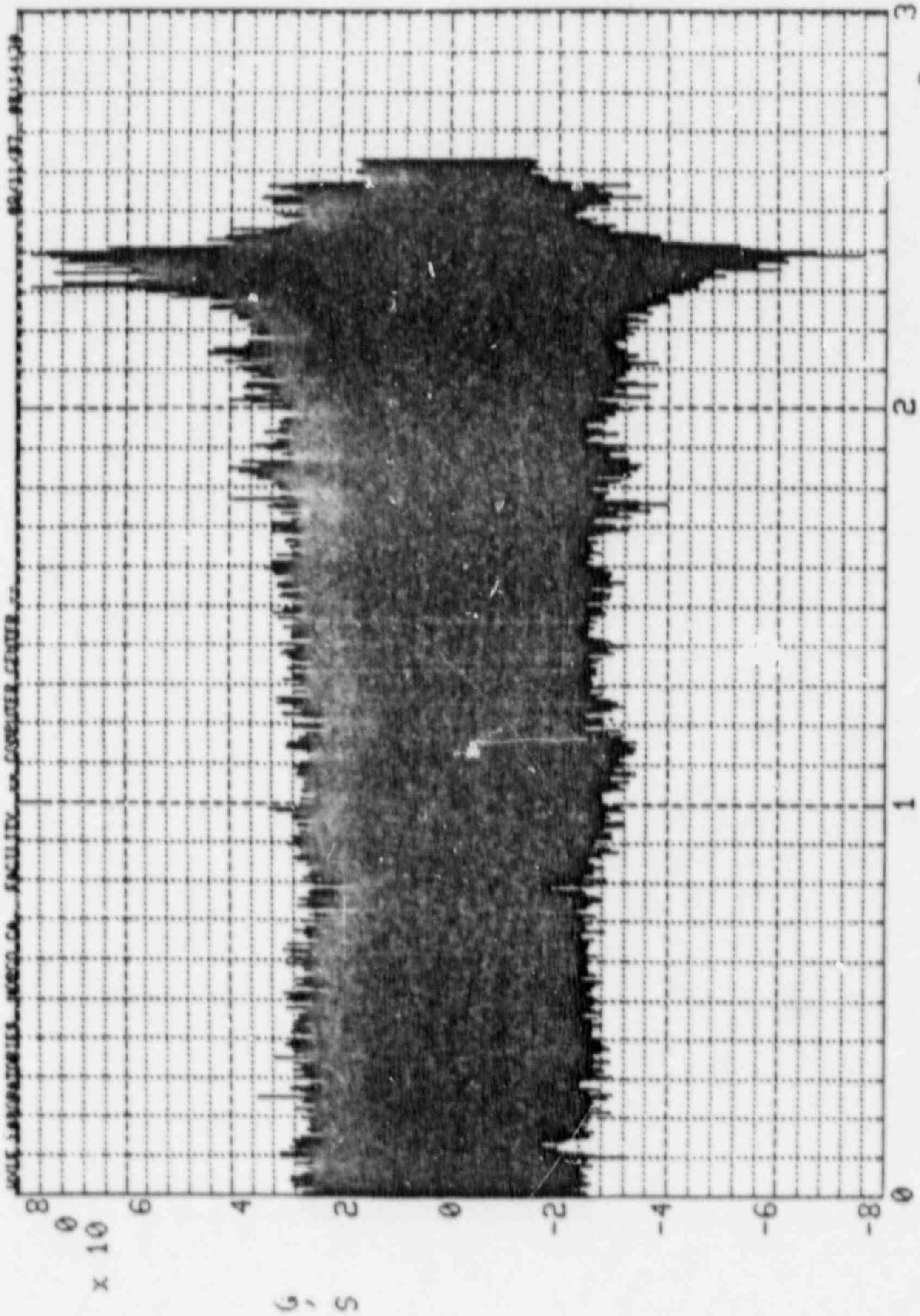
ACCELERATION TIME HISTORIES AND CALCULATED RESPONSES ON "F-MACHINE"

Page No.


ACC-1
TIME HISTORY
DATE 08/28/87
NO FILTER, 200.00 SPS,
DISPLAY NUMBER 2
0.00 TO 263.00 SEC
EGG 57724 HORZ, 1 G'S, 4-100HZ, DE-ENERGIZED
G's x 10^0
SEC x 10^2


ACC-3
TIME HISTORY
DATE 08/28/87 NO FILTER, 200.00 SPS, .00 TO 263.00 SEC
DISPLAY NUMBER 3
EGG 57724 HORZ, 1 G'S, 4-100HZ, DE-ENERGIZED
SEC x10^2
G'S x 10^1
0
1
2
3
-1
-2


ACC 5
TIME HISTORY
NO FILTER, 200.00 SPS, .00 TO 263.00 SEC
DATE 08/28/87 DISPLAY NUMBER 4
EGG 57724 HORZ, 1 G'S, 4-100HZ, DE-ENERGIZED
SEC x10^2
G'S x 10^0
12 10 8 6 4 2 0 -2 -4 -6 -8 -10 -12 -14
0 1 2 3

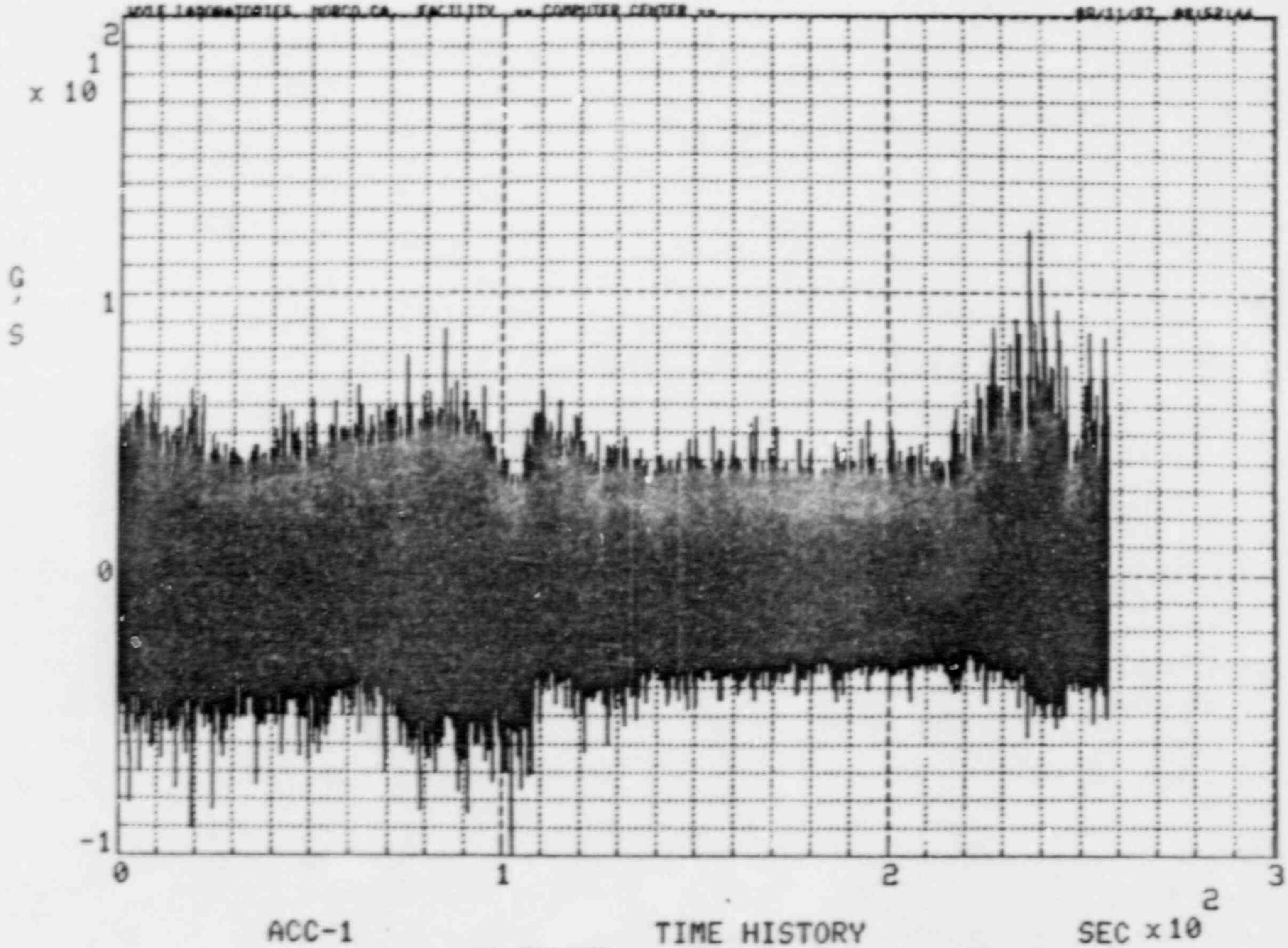


ACC-7 TIME HISTORY

DATE 08/28/87 NO FILTER, 200.00 SPS,

DISPLAY NUMBER 5

EGG 57724 HORZ, 1 G'S, 4-100HZ, DE-ENERGIZED .00 TO 263.00 SEC

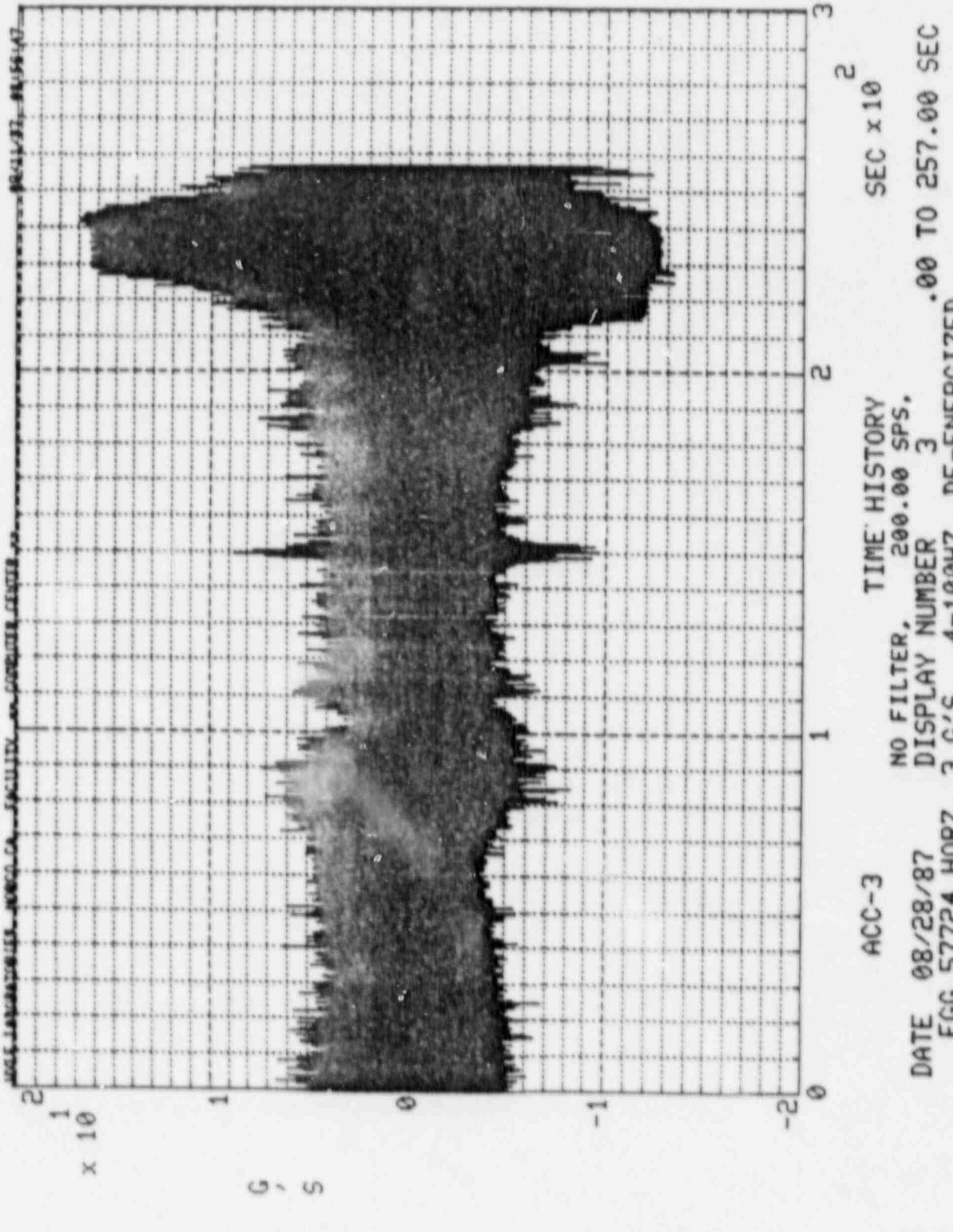


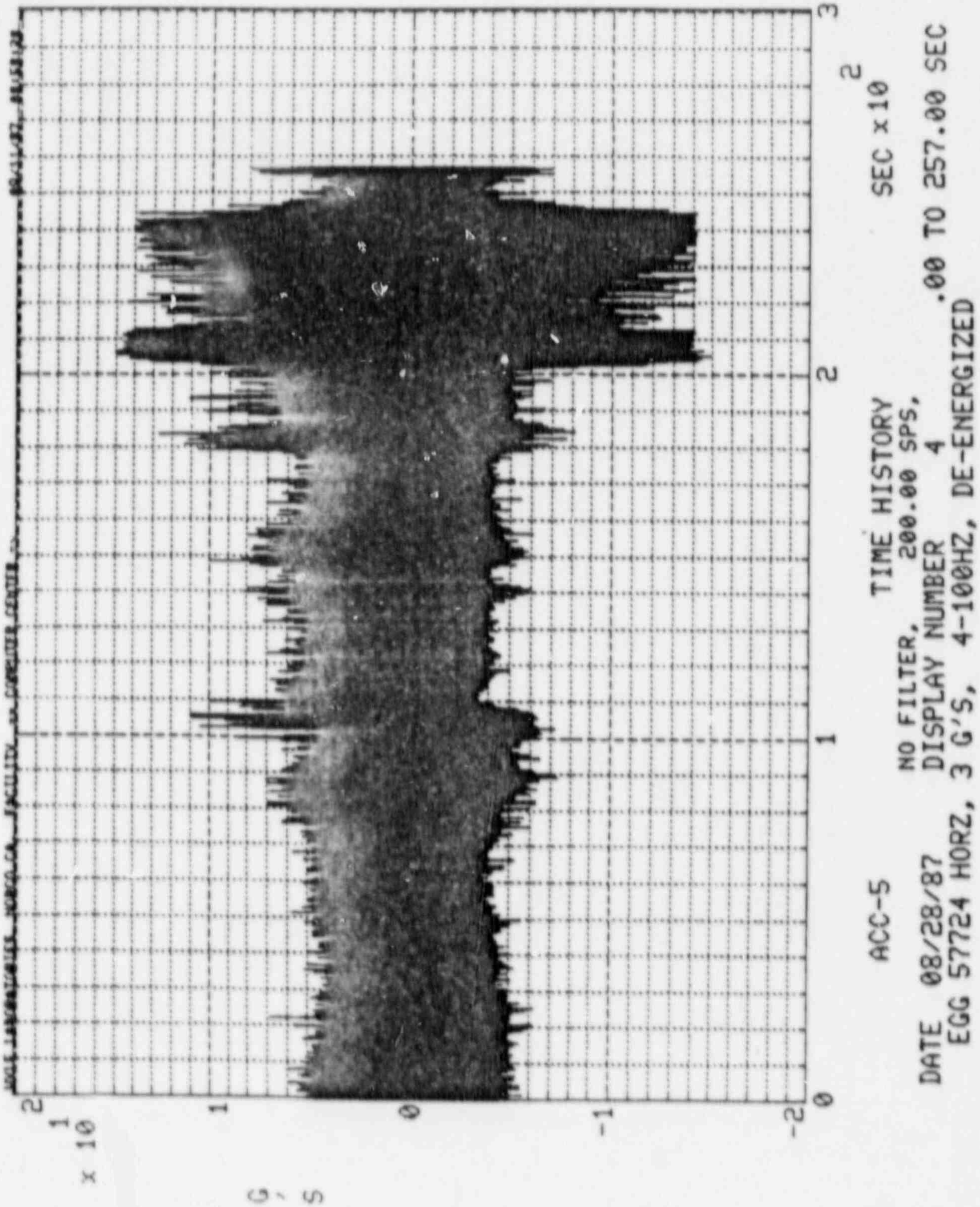
ACC-1 TIME HISTORY

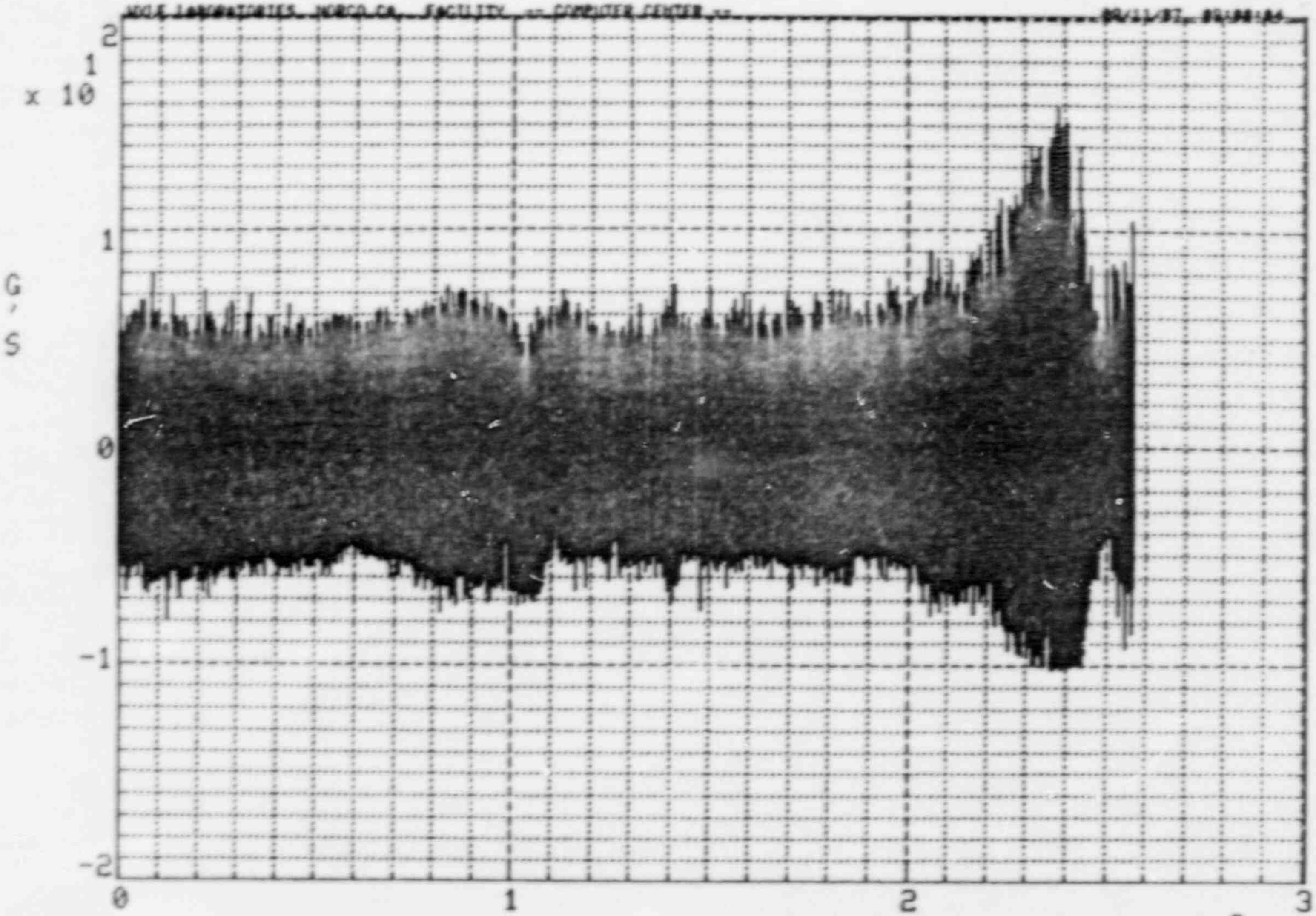
NO FILTER, 200.00 SPS,

DATE 08/28/87 DISPLAY NUMBER 2 0.00 TO 257.00 SEC

EGG 57724 HORZ, 3 G'S, 4-100HZ, DE-ENERGIZED


G'S
x 10^1
2
1
0
-1
-2
0
1
2
3
SEC x 10^2
ACC-3
NO FILTER,
TIME HISTORY
200.00 SPS.
DATE 08/28/87
DISPLAY NUMBER 3
EGG 57724 HORZ, 3 G'S, 4-100HZ, DE-ENERGIZED
.00 TO 257.00 SEC


TIME HISTORY
ACC-5
NO FILTER, 200.00 SPS,
DATE 08/28/87
DISPLAY NUMBER 4
EGG 57724 HORZ, 3 G'S, 4-100HZ, DE-ENERGIZED
.00 TO 257.00 SEC
SEC x 10^2
G'S x 10^1
0
1
2
3
-2
-1
0
1
2

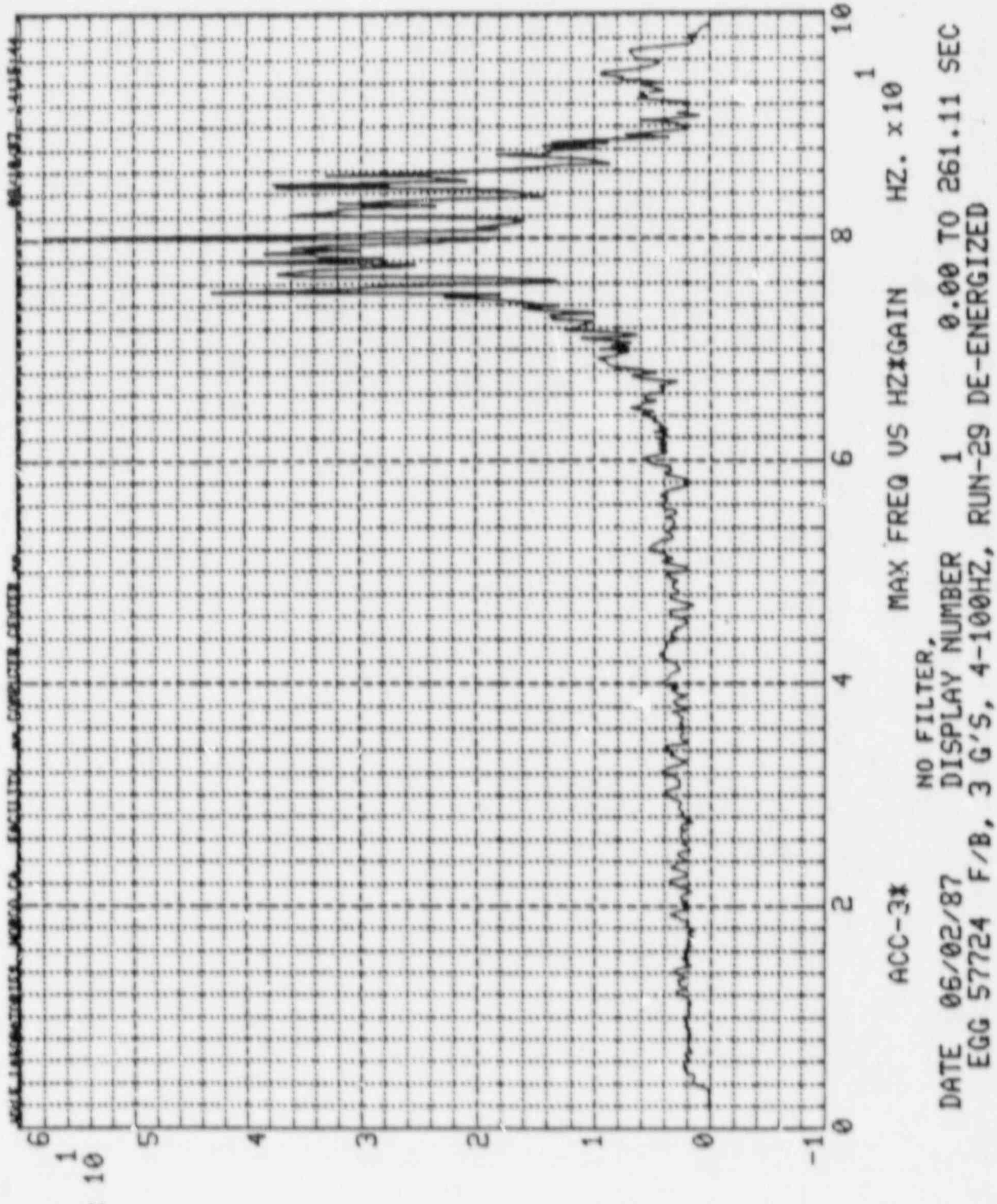


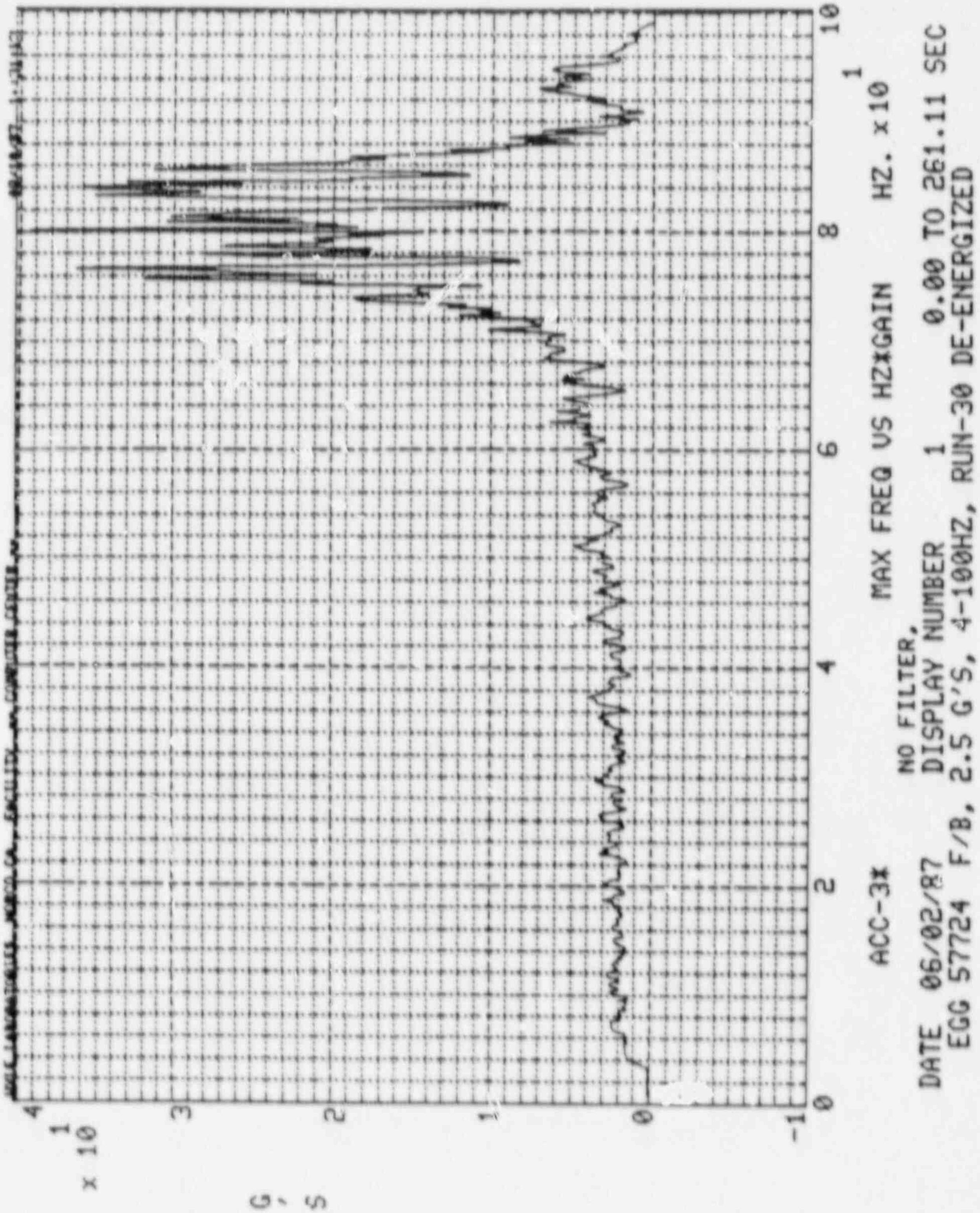
ACC-7 TIME HISTORY SEC x10^2

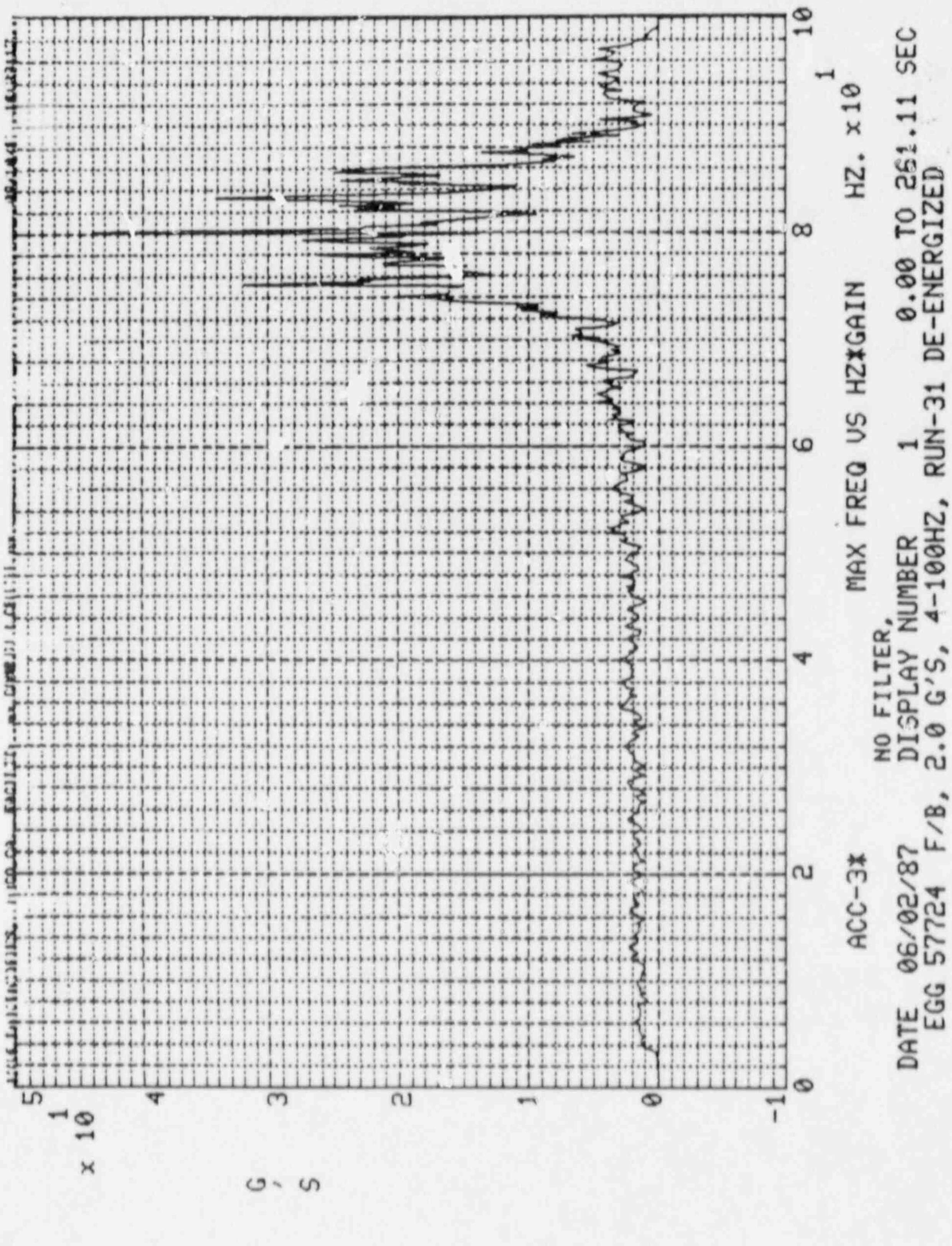
NO FILTER, 200.00 SPS,

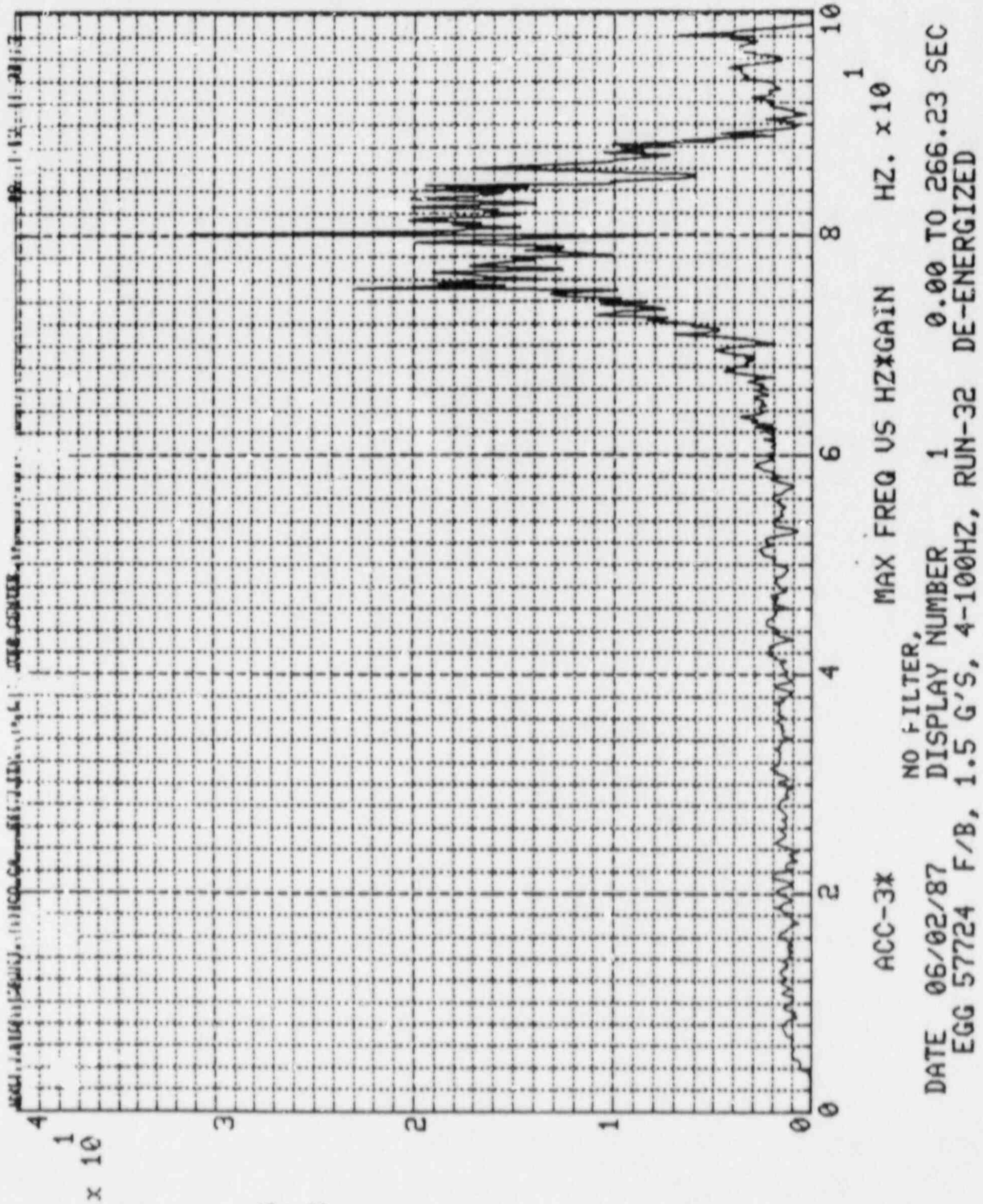
DATE 08/28/87 DISPLAY NUMBER 5 .00 TO 257.00 SEC

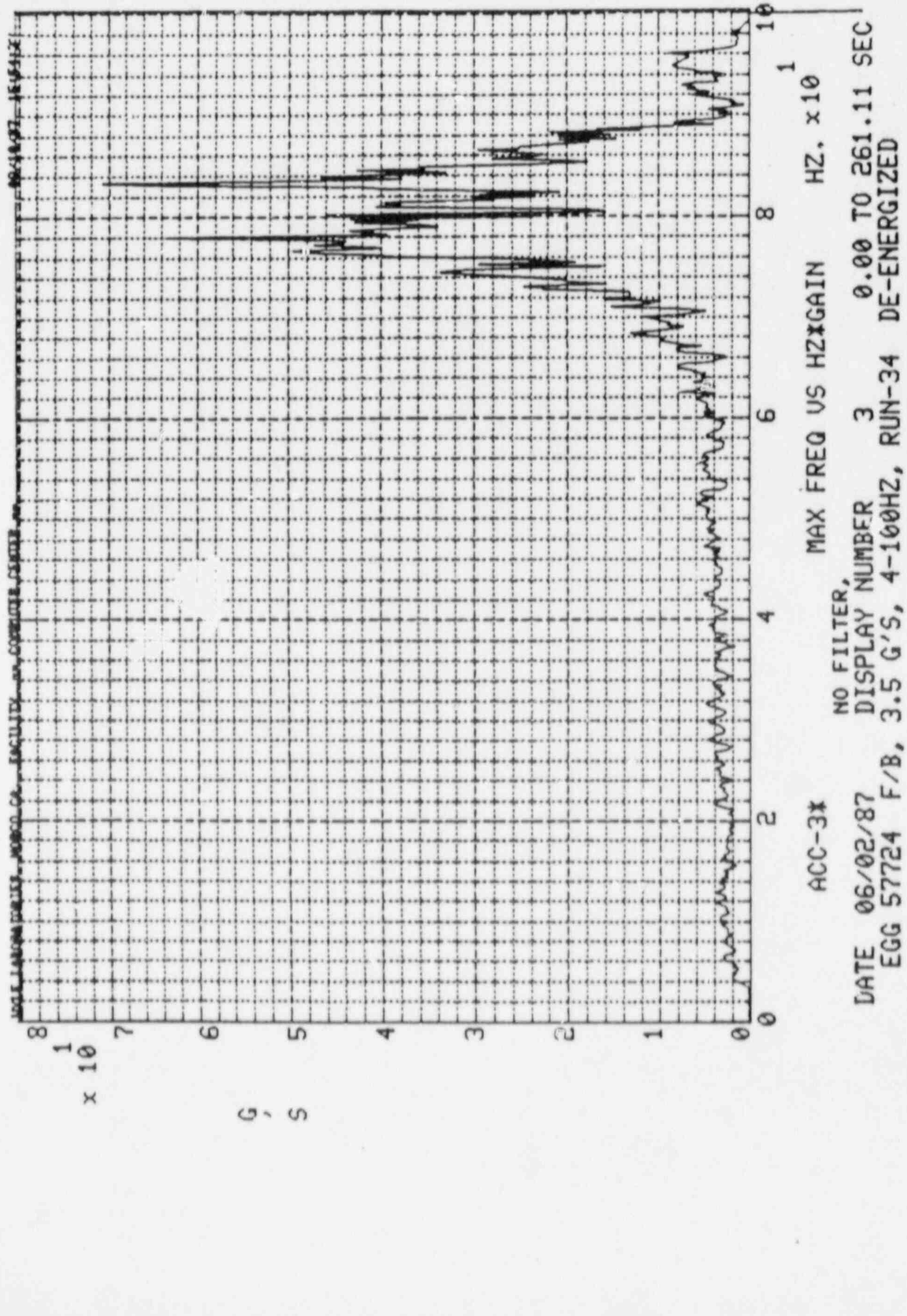
EGG 57724 HORZ, 3 G'S, 4-100HZ, DE-ENERGIZED

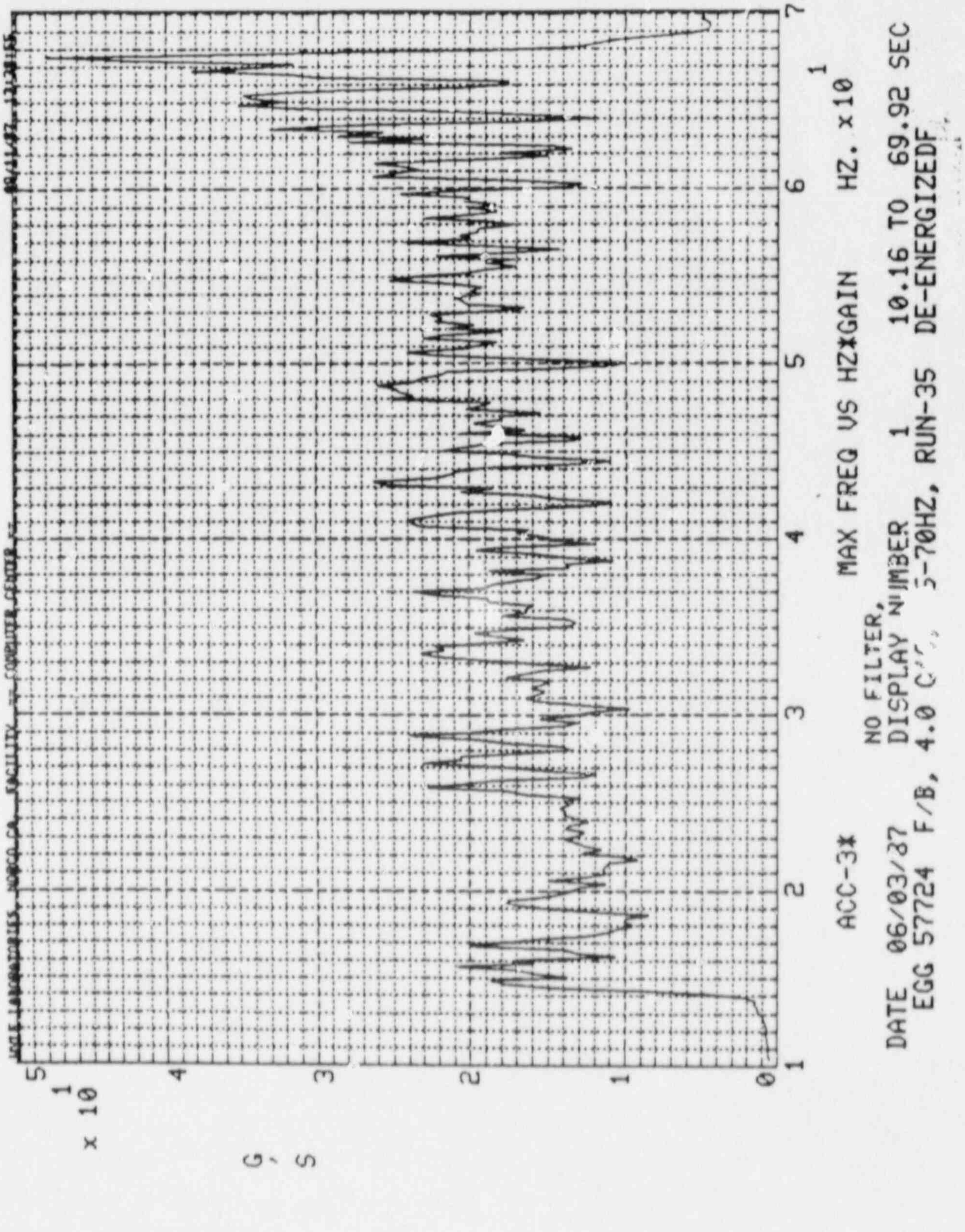

ACC-3*
MAX FREQ VS HZ*GAIN
HZ. x10^1
NO FILTER,
DATE 06/02/87
DISPLAY NUMBER 1
0.00 TO 261.11 SEC
EGG 57724 F/B, 3 G'S, 4-100HZ, RUN-29 DE-ENERGIZED
G/S
x 10^1
6
5
4
3
2
1
0
-1
0
2
4
6
8
10

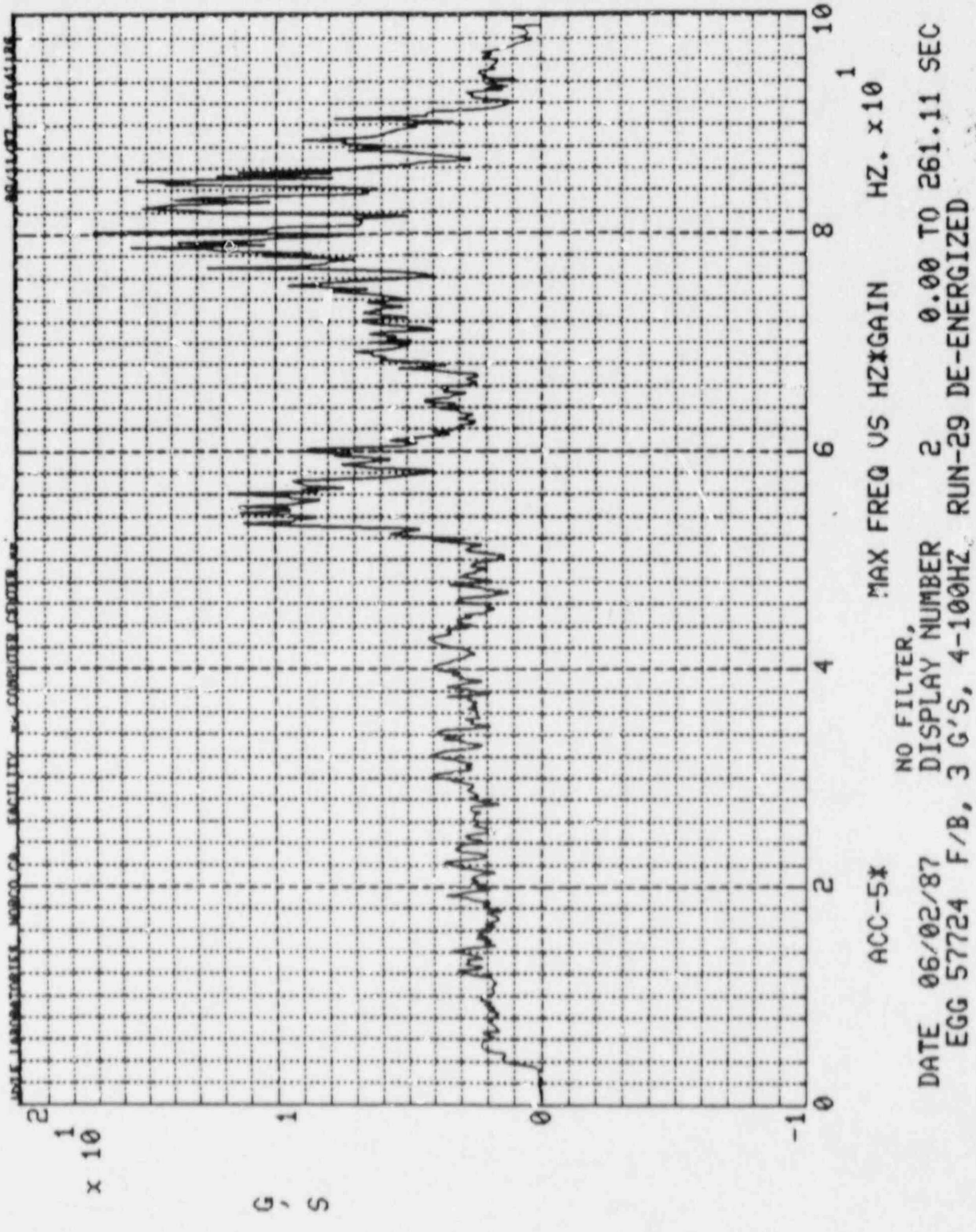

G'S x 10^1
4
3
2
1
0
-1
0
2
4
6
8
10
HZ. x10^1
ACC-3*
MAX FREQ VS HZ*GAIN
NO FILTER,
DATE 06/02/87
DISPLAY NUMBER 1
0.00 TO 261.11 SEC
EGG 57724 F/B, 2.5 G'S, 4-100HZ, RUN-30 DE-ENERGIZED

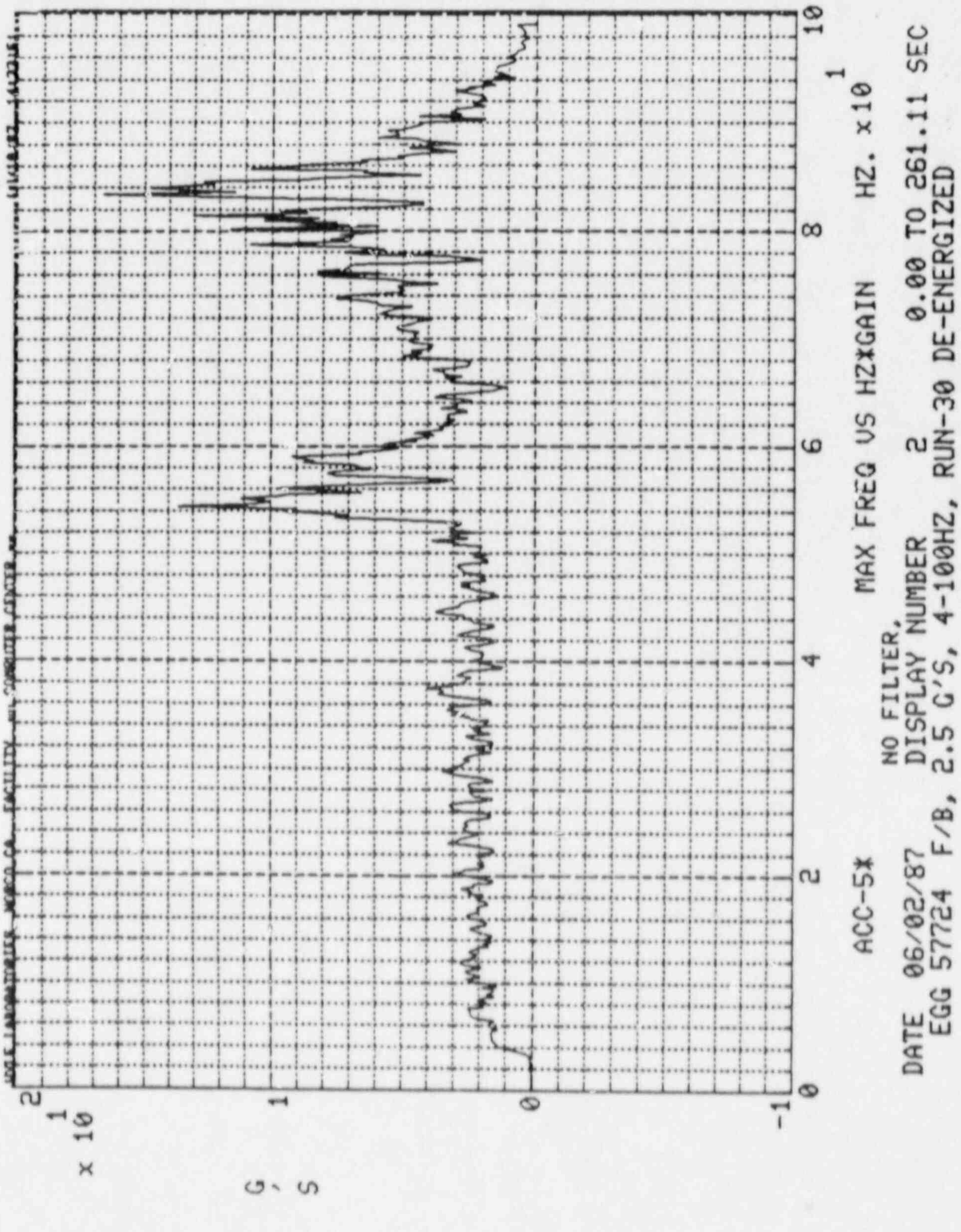

MAX FREQ VS HZ*GAIN
HZ. x10 1
G/S
x 10 1
ACC-3*
NO FILTER,
DATE 06/02/87
DISPLAY NUMBER 1
0.00 TO 261.11 SEC
EGG 57724 F/B, 2.0 G'S, 4-100HZ, RUN-31 DE-ENERGIZED

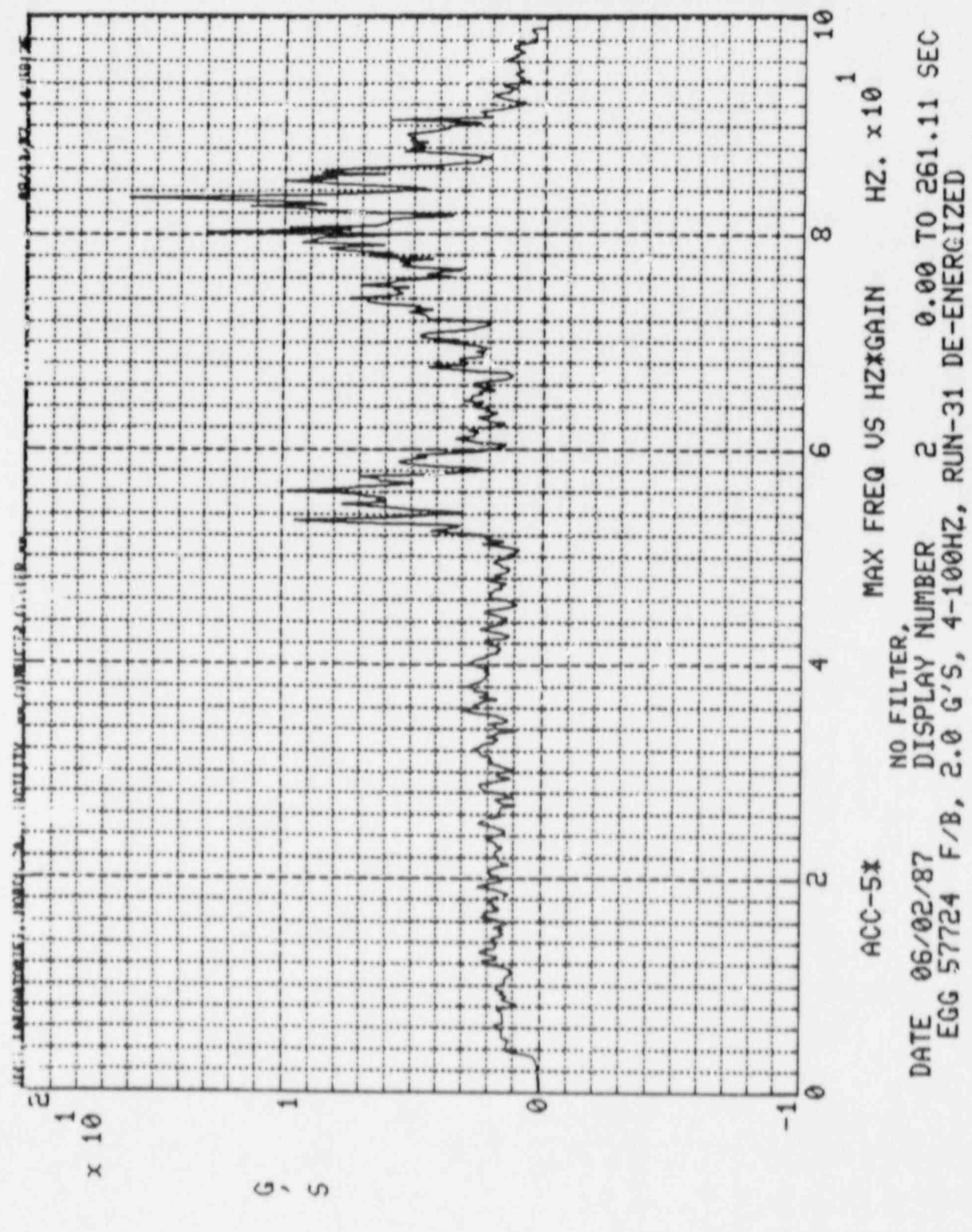

ACC-3*   MAX FREQ VS HZ*GAIN   HZ. x10^1
DATE 06/02/87   NO FILTER,   DISPLAY NUMBER 1   0.00 TO 266.23 SEC
EGG 57724 F/B, 1.5 G'S, 4-100HZ, RUN-32 DE-ENERGIZED
G's x 10^1
0
1
2
3
4
0
2
4
6
8
10

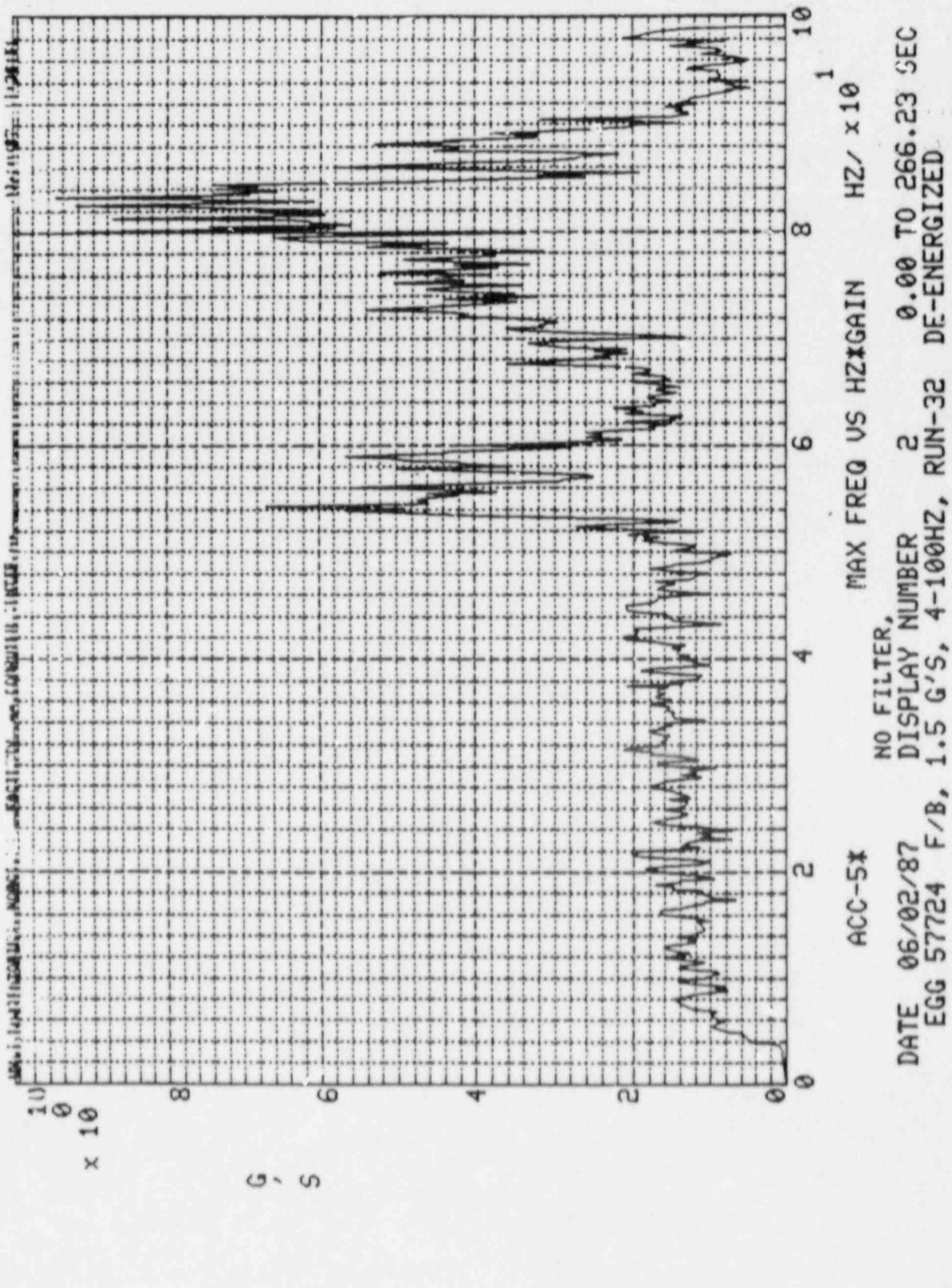

ACC-3*
NO FILTER,
MAX FREQ VS HZ*GAIN
DATE 06/02/87 DISPLAY NUMBER 3 0.00 TO 261.11 SEC
EGG 57724 F/B, 3.5 G'S, 4-100HZ, RUN-34 DE-ENERGIZED
HZ. x10 1
G'S x10 1
0 2 4 6 8 10
0 1 2 3 4 5 6 7 8

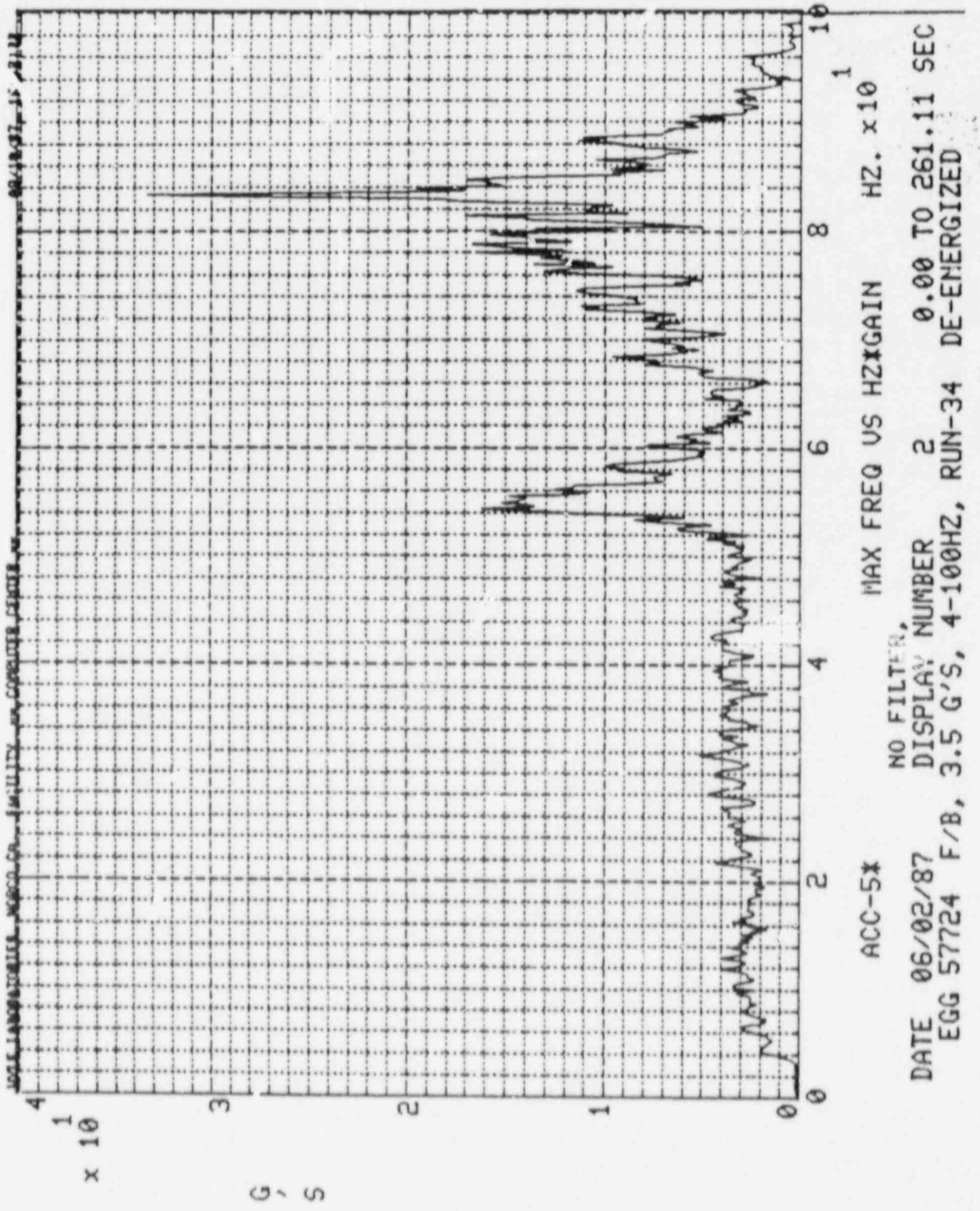

G/S x 10^1
HZ. x10^1
MAX FREQ VS HZ*GAIN
ACC-3*
NO FILTER,
DATE 06/03/87
DISPLAY NUMBER 1
10.16 TO 69.92 SEC
RUN-35
DE-ENERGIZED
EGG 57724 F/B, 4.0

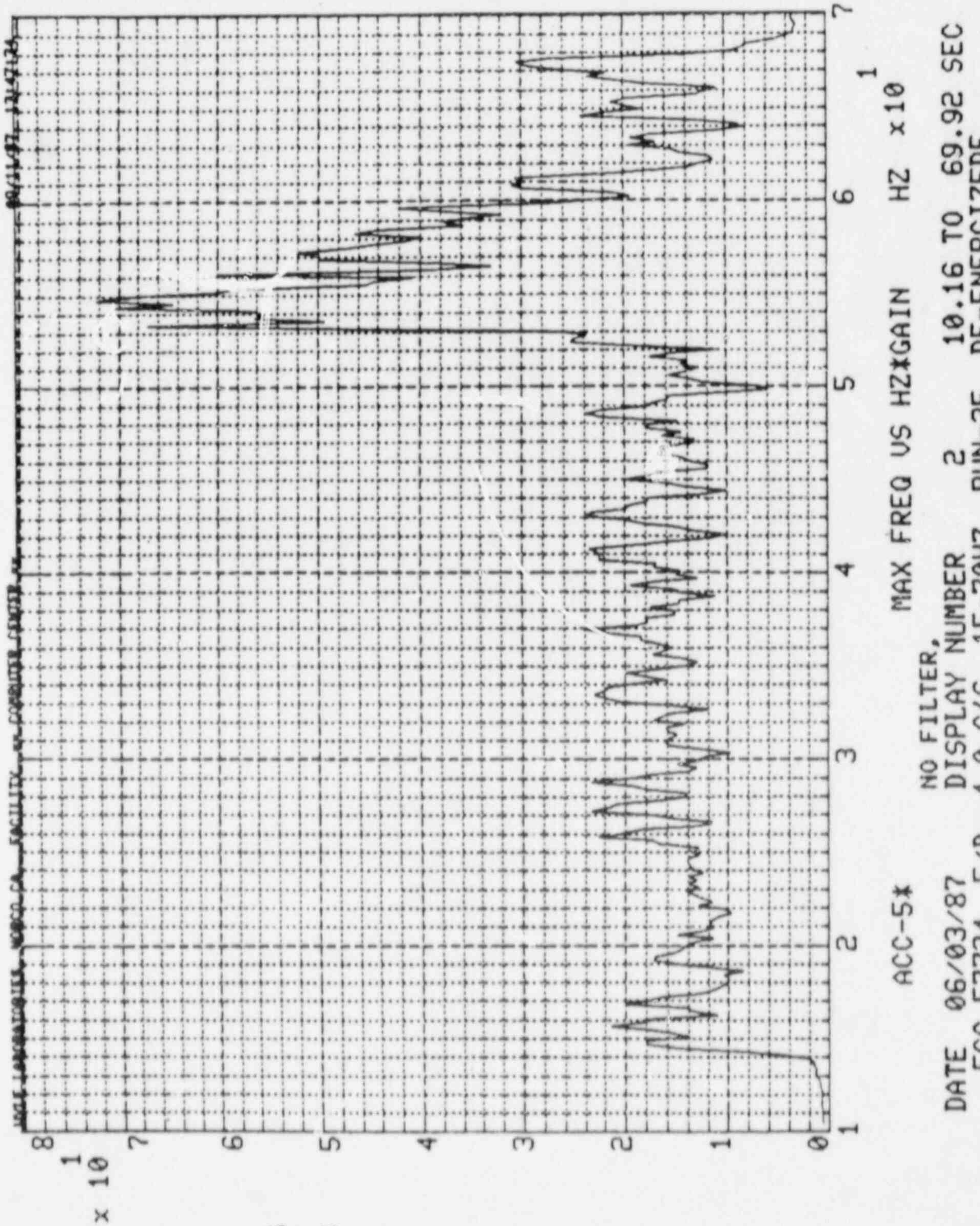

ACC-5*
NO FILTER,
MAX FREQ VS HZ*GAIN
HZ. x10 1
DATE 06/02/87
DISPLAY NUMBER 2
0.00 TO 261.11 SEC
EGG 57724 F/B, 3 G'S, 4-100HZ
RUN-29 DE-ENERGIZED
G/S
x 10 1
0
2
4
6
8
10
-1
1
2


ACC-5*
MAX FREQ VS HZ*GAIN HZ. x10^1
DATE 06/02/87 NO FILTER, DISPLAY NUMBER 2 0.00 TO 261.11 SEC
EGG 57724 F/B, 2.5 G'S, 4-100HZ, RUN-30 DE-ENERGIZED
G'S x 10^1
-1
0
1
2
0
2
4
6
8
10


ACC-5*
MAX FREQ VS HZ*GAIN
HZ. x 10^1
DATE 06/02/87
NO FILTER,
DISPLAY NUMBER 2
0.00 TO 261.11 SEC
EGG 57724 F/B, 2.0 G'S, 4-100HZ, RUN-31 DE-ENERGIZED
G'S
x 10^1
2
1
0
-1
0
2
4
6
8
10


ACC-5*
NO FILTER,
MAX FREQ VS HZ*GAIN
HZ/ x 10^1
DATE 06/02/87
DISPLAY NUMBER 2
0.00 TO 266.23 SEC
EGG 57724 F/B, 1.5 G'S, 4-100HZ, RUN-32 DE-ENERGIZED
G/S
x 10^0
0
2
4
6
8
10


ACC-5*
NO FILTER,
MAX FREQ VS HZ*GAIN
HZ. x10
DATE 06/02/87
DISPLAY NUMBER 2
0.00 TO 261.11 SEC
EGG 57724 F/B, 3.5 G'S, 4-100HZ, RUN-34 DE-ENERGIZED
G'S
x 10
0
2
4
6
8
10
1
3


ACC-5*
MAX FREQ VS HZ*GAIN
NO FILTER,
DATE 06/03/87 DISPLAY NUMBER 2 10.16 TO 69.92 SEC
EGG 57724 F/B, 4.0 G'S, 15-70HZ, RUN-35 DE-ENERGIZEDF
HZ x 10^1
G'S x 10^1
1
2
3
4
5
6
7
0
8