ANALYSES OF
STRONG MOTION EARTHQUAKE ACCELEROMETERS

VOLUME IV - FOURIER AMPLITUDE SPECTRA
PARTS Q, R, AND S
ACCELEROMETERS IIQ233 TO IIQ243, IIQ244 TO IIQ254,
AND IIQ255 TO IIQ273

REPORT NO. EERL 74-104

A REPORT ON RESEARCH CONDUCTED UNDER A
GRANT FROM THE NATIONAL SCIENCE FOUNDATION

PASADENA, CALIFORNIA
OCTOBER, 1974
CALIFORNIA INSTITUTE OF TECHNOLOGY
EARTHQUAKE ENGINEERING RESEARCH LABORATORY

ANALYSES OF
STRONG MOTION EARTHQUAKE ACCELEROGRAMS

Volume IV - Fourier Amplitude Spectra
Parts Q, R and S
Accelerograms IQ233 to IQ243, IR244 to IR254,
and IS255 to IS273

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ABSTRACT

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PREFACE TO VOLUME IV, PARTS Q, R, AND S

This report, Volume IV, Parts Q, R, and S, Report No. EERL 74-104, is part of the Volume IV series presenting Fourier spectrum curves calculated from corrected strong-motion accelerograms including measurements in structures as well as at ground sites. We continue here with records from the San Fernando, California, earthquake of February 9, 1971. The analysis of records from this earthquake appeared first in Volume IV, Part C, Report No. EERL 73-101, and this report presents the last of the San Fernando spectra, from the following locations:

1. 14724 Ventura Boulevard, Los Angeles (3 records)
2. 1760 N. Orchid Avenue, Hollywood (3 records)
3. 9100 Wilshire Boulevard, Beverly Hills (2 records)
4. 800 W. First Street, Los Angeles (3 records)
5. 222 Figueroa Street, Los Angeles (2 records)
6. 6464 Sunset Boulevard, Los Angeles (2 records)
7. 6430 Sunset Boulevard, Los Angeles (1 record)
8. 1900 Avenue of the Stars, Los Angeles (2 records)
9. 234 Figueroa Street, Los Angeles (2 records)
10. 533 S. Fremont Avenue, Los Angeles (2 records)
11. 6200 Wilshire Boulevard, Los Angeles (3 records)
12. 3440 University Avenue, Los Angeles (3 records)
13. 1177 Beverly Drive, Los Angeles (1 record)
14. 5900 Wilshire Boulevard, Los Angeles (3 records)
15. 3435 Wilshire Boulevard, Los Angeles (1 record)**
16. 3550 Wilshire Boulevard, Los Angeles (1 record)
17. 5260 Century Boulevard, Los Angeles (3 records)
18. 930 Hilgard Avenue, Los Angeles (1 record)
19. 11661 San Vicente Boulevard, Los Angeles (2 records)
20. 15433 Ventura Boulevard, Los Angeles (1 record)

*For reasons of economy and convenience in the size of the reports, it has been thought desirable to combine three parts into one report.

**The original address of this building, when the instruments were first installed, was 3411 Wilshire Boulevard.
The uncorrected versions of these records appeared in Volume I, Parts Q, R, and S, Report Nos. EERL 73-22, 73-23, and 73-24, and the plotted corrected accelerations, velocities, and displacements were included in Volume II, Parts Q and R, Report No. EERL 74-56, and Volume II, Part S, Report No. EERL 74-57. These Volume II corrections included a long period cut-off of 8 seconds for all the 35-mm film records in this issue instead of the standard cut-off period of approximately 15 seconds. This includes all the records in this issue. The results published here reflect this altered low-frequency limit most clearly in the log-log plots where the Fourier amplitude spectrum in general commences falling off at a frequency of $f = 0.125$ cps ($\log f = -0.90$) instead of a $f = 0.07$ cps ($\log f = -1.15$).

A number of very low amplitude accelerograms have been eliminated from the processing of Volume II and on, reflecting the expectation that the resulting displacements would be dominated by noise. None of the records in Parts Q, R, and S are included in this group of accelerograms.

A comparative study of ground level and roof records using Volume II corrected accelerations, velocities, and displacements brought to light the following facts regarding the time scales of the three records obtained from the building at 1760 N. Orchid Avenue in Hollywood. In Volume I, Part Q, a description can be found, on page 3, of the way in which the time scales were chosen for the records obtained at the ground, 12th, and 23rd floors. The ground floor record time marks were faint and intermittent, but an estimate could be made of the average film transport speed of 1.67 cm/sec.
The 12th floor record time marks could be digitized directly. There were no time marks on the 23rd floor record and a typical speed of 1.62 cm/sec was used. The investigation described in Volume II, Parts Q and R, has shown that the ground and 12th floor records match perfectly and that a more probable film speed for the 23rd floor record is 1.585 cm/sec, a reduction of 2.2%. This implies the following corrections for the three components of this record, Q238, in this report: All frequencies are to be decreased by 2.2%, or the multiplicative factor 0.978, while their logarithms are to be reduced by the value 0.0097.

A similar situation, although not resolved as readily, occurred with the two records S271 and S272, at 11661 San Vicente Boulevard, Los Angeles, the 5th and 11th floors. Neither of these records had a time mark trace, and an average film speed of 1.62 cm/sec was used for the Volume I, Part S, uncorrected data. However, subsequent Volume II analysis of these records has shown that a good fit of the corrected velocity in the vertical direction could be obtained if the 11th floor record was extended with respect to the 5th floor record by 4.03%, i.e., by increasing the time coordinates of the 11th floor record by this percentage. No absolute time rate is available though, because of the three records available within two miles of this site, at 945 Tiverton (2 records) and 930 Hilgard, not one had an operating time mark trace. In all cases the corrected vertical velocity can be used to obtain relative film speeds by selecting appropriate peaks, and the 4.03% fluctuation above is the largest discrepancy between any two records. Because it is impossible at
this stage to determine the true time rates, no change has been made to the values of the frequencies in this issue. For investigators interested in consistency in this building, the values of the frequencies for record number IIS272 may be decreased by 4.03%.

A separate section included in this report entitled "High Frequency Amplitude Errors in Digitized Strong Motion Accelerograms" describes the results of a recent investigation of high frequency noise generated by the digitizing process. Frequencies from several to 25 Hz have been studied, and figures have been included to indicate clearly the extent to which Fourier amplitudes have been affected within this range.
NOTES ON THE VOLUME IV SERIES

Description of the Four Volumes of the Project. The series of reports in Volume I present "uncorrected" digitized and plotted strong-motion earthquake accelerograph data, while the series in Volume II present corrected digitized data prepared so that the maximum information over the widest practicable frequency range would be available. The corrections include long period filtering ensuring to the greatest extent possible a uniform type of baseline adjustment and an instrument correction to account for the high frequency response characteristics of the accelerograph transducer.

The Volume III series presents earthquake response spectrum curves calculated from the corrected accelerograms of Volume II, while the Volume IV series contains Fourier amplitude spectra calculated by the Fast Fourier Transform algorithm. An extensive introduction was prepared for Volume IV, Part A, Report No. EERL 72-100, where details of the methods used can be found together with examples of applications to various problems of earthquake engineering and strong-motion seismology. That introduction should also serve as a basic summary of background information for users of the data.

Contents of the Various Parts. The specific records whose "uncorrected" digitized versions appeared in Part A of Volume I are included subsequently with their analyses in Part A of Volume II, III, and IV. This arrangement has been maintained throughout the whole series. In Part C of Volume IV, Report No. EERL 73-101, we began the presentation of Fourier spectra analysis for the unusually important series of accelerograms obtained during the San Fernando
earthquake of February 9, 1971, and Part S contains the last of the San Fernando records. In Part T a return is made to those records received during the years 1933 to 1968, which continue into Parts U and V. Parts W and X contain the records from the Lytle Creek, California, earthquake of Sept. 12, 1970, and Part Y contains the records of the Borrego Mountain, California, earthquake of April 8, 1968, not already included in Parts A and B. Part Y marks the conclusion of the current digitizing and analysis project.

Component Directions. A description of the component direction nomenclature for the records was given in Volume II, Part B, Report No. EERL 72-50. Consistent with this, the component direction where it appears in this report refers to the direction of the transducer pendulum motion for the trace to be deflected "up" on the record when viewed in the normal way with time increasing from left to right. The direction of true ground acceleration is opposite to this pendulum motion. The spectral calculations of Volume IV, however, are concerned with the amplitude spectrum only and the particular component sense is thus immaterial.

Assessment of Long Period Errors. A separate section in Volume II, Part G, Report No. EERL 73-52, entitled "Current Assessment of Long Period Errors" describes the results of a recent investigation of long period displacements calculated from recorded accelerations. During the course of this study it became evident that the procedures for preparation of 70-mm and, to a lesser extent, 35-mm film records from the San Fernando earthquake of February 9, 1971, introduced spurious excitations at periods close to the duration
of the sectional enlargements. These effects have been removed from all of the 70- and 35-mm film records by filtering with a long period limit of 8 seconds rather than the standard cut-off period of 16 seconds in the Volume II correction procedure. The following list of Caltech reference numbers indicates the records from the San Fernando earthquake included in Volume I, Parts C through S, that have been processed with the cut-off period of 8 seconds:

- Parts G, H, I, K, N, Q, R, S: All records in these parts.
- Part J: Records J142 and J145 through J150.
- Part L: Records L166, L167, L168; L172 through L175.
- Part M: Records M176, M177, M178; M180 through M184.
- Part O: Records O198 through O201; O206, O208, O210.
- Part P: Records P231 and P232.

A decision was also made at the same time to eliminate a number of very low amplitude accelerograms from further processing (Volume II and on) reflecting the expectation that the resulting displacement records will be dominated by noise. Their Caltech reference numbers are as follows:

- H127; I140; J151, J152; K153 through K156, K161 through K165; O202, O203, O209, O211, O212; P224 through P230.

**Description of the Figures and Tables.** For each component in the following pages the Fourier amplitude spectrum is presented in two forms - a linear plot and a log-log plot. Details concerning identification are given at the top of each plot. The second line gives the name, date, and time of occurrence of the earthquake; the third
line is comprised of two labels, the observation station and the component processed. The Roman numeral "IV" in the first identification label indicates that the results pertain to the fourth stage of data processing, i.e., Volume IV of Fourier spectra of accelerogram records already corrected for baseline adjustment and instrument response. The letter following the Roman numerals indicates the part of Volume II to which the processed record belongs. The three-digit number completing the first label is the Caltech Reference Number for the given earthquake record in Volume I, right-adjusted in a three-digit numerical field. The second label is a string of three numbers separated by periods; the first number gives the year in which the earthquake occurred; the second is the serial number of the record as it was received at the Caltech Earthquake Engineering Research Laboratory during that year; and the last number indicates whether it was a main event or an aftershock (sequentially numbered, the main event starting from zero). On the linear spectrum plot, the data lying above the 95 percent confidence level may be considered relevant to that degree. The spectra have been plotted up to a frequency of 25 cyc/sec on linear and logarithmic scales, corresponding to the capabilities of the instrumentation and data processing methods used.

**Frequency Transfer Functions.** This report presents many spectra of accelerograms recorded simultaneously at different locations in the same structure, for example, the basement, mid-height, and roof levels of a tall building. At present, it is planned to calculate frequency transfer functions involving smoothing and calculating the ratio of two such spectra in supplementary reports.
Acknowledgments. The cooperative efforts of many people are essential in the preparation of a series of reports of this kind and we have been fortunate in the quality of staff that has carried out the various details with special care and attention. We should like to express our appreciation to Mr. Vincent Lee for his assistance with many details of computer programming, to Miss Barbara Turner and Miss Sharon Vedrode for the care taken over typing and editing, to the staff of the Willis H. Booth Computing Center for their continued help with all aspects of the computing process, and to the staff of the Caltech Graphic Arts Facilities for very efficient work on publication details. The whole project has been made possible by the continued support of the National Science Foundation, supplemented in an important way by contributions from the Earthquake Research Affiliates Program of the California Institute of Technology.

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HIGH FREQUENCY AMPLITUDE ERRORS IN DIGITIZED STRONG MOTION ACCELEROGRAMS

The strong motion accelerograms generated by the San Fernando, California, earthquake provide an unprecedented opportunity to study high frequency ground motion, both because of the large number of accelerograms available for this earthquake and because of the favorable instrumental response in the frequency band of interest. We are currently studying the excitation and propagation characteristics of Fourier amplitudes of acceleration at 0.5, 1.0, 2.0, 4.0, 8.0, and 16.0 Hz for 95 San Fernando earthquake accelerograms, utilizing the data presented in Volume IV of the series "Strong Motion Earthquake Accelerograms" prepared by the Earthquake Engineering Research Laboratory of the California Institute of Technology.

In the course of our investigation, we have encountered high frequency noise generated by the digitizing process. Quite generally, this digitizing noise can affect the amplitudes in much of the high frequency band, which we loosely consider to be several to 25 Hz, 25 Hz being the maximum resolvable frequency with the existing routine processing techniques (Trifunac et al, 1973). In view of the potential significance that such noise may have on both seismological and engineering analyses of high frequency Fourier amplitudes of acceleration, we report separately here our present assessment of this problem.

The amplitude errors applicable to the series "Strong Motion Earthquake Accelerograms" have been described by Trifunac et al (1973). Five "accelerogram" data sets were derived from five
independent digitizations of the same straight line; the mean of the
data sets serves as a baseline with which to correct the five data
sets for systematic errors of the digitizing machine. The remaining
error was a nearly normally distributed random error with a standard
deviation of one digital point (\(\frac{1}{312}\) cm).

The straight line length was 60 cm, and the experiment was
designed to represent a 30-second AR-240 accelerogram, recorded
on 12-inch wide paper and digitized without enlargement. In fact,
the length of the experimental line in centimeters has no intrinsic
physical significance; it is only its length in seconds, defined relative
to the actual accelerogram of interest, that is important. For the
estimation of high frequency noise, this length-to-time conversion
is fixed by the necessity of having the sampling rate in pts/sec for
the actual accelerogram equal to the sampling rate in pts/sec for
the experimental line. The estimate of high frequency noise in the
actual accelerogram, of course, will depend in addition on any
difference between the length in seconds of the actual accelerogram
and the normalized length in seconds of the experimental line.

In our investigation of high frequency ground motion, we have
used a 15-second sample of data beginning with the direct shear
arrival. Because the routine digitizing process employs variable
sampling rates, the determination of an average sampling rate is
somewhat arbitrary. The noise estimates given below and in Figure 1
are based on a sampling rate of 56 points/sec. This value corresponds
to a point spacing of 0.018 seconds, which is the average of four
median values determined from cumulative frequency distributions of
successive points in the first 20 seconds of four accelerograms for which digitizing noise is dominant at 16 Hz. These distributions are displayed in Figure 3, and we shall return to them and the influence of the variable sampling rate scheme at the conclusion of this correspondence. The 60 cm experimental line length was digitized with approximately 1,000 points (Trifunac et al., 1973) and when considered to be digitized at 56 pts/sec corresponds to an 18-second blank accelerogram. We consider the noise estimates of this 18-second blank to be an adequate measure of the expected noise in the 15-second sample of acceleration data.

The Fourier amplitude of the random error obtained in the analysis of the experimental line are plotted against frequency in radians per centimeter of line length in Figure 7 of Trifunac et al. (1973). For a line length-time conversion of 3.3 cm/sec and a data sensitivity of 7.6 cm/g, Figure 1 gives the expected digitizing noise range in Fourier amplitudes of acceleration for the frequency band 1-25 Hz to be expected from a 15-second accelerogram digitized at 56 pts/sec. A data sensitivity of 7.6 cm/g is that of an original AR-240 accelerogram and is also that of RFT-250 and SMA-1 accelerograms in the form to be digitized, that is, with a 4x photographic enlargement.

An observational encounter with the presence of high frequency noise is illustrated in Figure 2. Here the Fourier amplitude of acceleration at 16 Hz for the previously described 15-second sample of San Fernando accelerograms at sites south of the epicenter is plotted against epicentral distance (R). With considerable scatter,
the amplitude data fall off monotonically with $R$ out to 60-70 km. Beyond this distance, the amplitude data define a constant level independent of further increases in $R$, strongly suggesting the presence of noise. The solid curve is based on an amplitude decay law of 

$$\frac{\tilde{a}_o}{R} e^{-\frac{\pi f R}{Q \beta}},$$

with frequency $f = 16$ Hz, shear-wave velocity $\beta = 3.2$ km/sec, and quality factor $Q = 325$; $\tilde{a}_o$ is the appropriate amplitude scaling.

The expected noise levels are indicated by the hatched areas. Those for the AR-240, RFT-250, and SMA-1 accelerograms have been taken directly from Figure 1. That for the older "standard" accelerographs has been obtained with the appropriate difference in sensitivity between this instrument and 7.6 cm/g.

It is clear from Figure 2 that Fourier acceleration amplitudes at 16 Hz for the San Fernando earthquake are at the noise level for $R \geq 60$ km and, moreover, that the predominant source of this noise is random digitizing error corresponding to 1 digital unit. This latter result is the same as that obtained in similar comparative studies of long-period errors (Hanks, 1973, 1975; Trifunac and Lee, 1974). In the course of our investigation of Fourier amplitudes of acceleration for the San Fernando earthquake at 0.5, 1.0, 2.0, 4.0, 8.0, and 16.0 Hz, digitization noise was a factor only at 16 Hz. At 8 Hz, the data at distances out to 150 km are well above the noise level and describe a fairly well-defined decay with increasing $R$, in reasonable agreement with the same theoretical amplitude decay given in Figure 2.
Interestingly, Fourier amplitudes of acceleration at 16 Hz and 
R ≥ 60 km are not significantly greater when the sample length
includes the whole record. This apparent anomaly stems from the
variable sampling rate with time on the accelerogram. Table 1
gives the mean sampling rate, the first 20 seconds median sampling
rate, and record length in seconds for four accelerograms whose
cumulative sampling interval counts in the first 20 seconds are
displayed in Figure 3. The average sampling rate for the accelerograms
at L171 and P220 is barely adequate to recover 16 Hz amplitudes
uniformly throughout the record (whether signal or noise).
Given that 20 seconds of these records are sampled at a rate con-
siderably greater than the average rate, it follows that much of the
remainder of these records are sampled at a rate less than the 32^+
points/sec necessary to recover 16 Hz amplitudes. In short, the
sampling rate elsewhere in these two records is not sufficient to
generate the otherwise expected digitizing noise at 16 Hz.

For the accelerograms at sites N191 and O206, the average
sampling rate is substantially above 32^+ pts/sec, and, indeed, whole
record spectral amplitudes at 16 Hz are somewhat greater than the
15-second sample spectral amplitudes, although not so large as
would be expected on the basis of their record length alone. Even
in these cases, Table 1 indicates that significant fractions of these
records were probably not sampled at 32^+ pts/sec.

The variable sampling rate is related to the signal character
as a function of time. High amplitude, high frequency samples, such
as those accompanying the main energy group, deserve and clearly
get more dense sampling than lower amplitude, lower frequency signals of the coda. This process is nearly optimal for recovering observable signal at high frequencies, while at the same time not generating noise continuously throughout the record. On the other hand, true noise estimates are thus dependent on the extent of record digitized at or above a certain sampling rate, and some care must be exercised in its determination.

We feel that Figure 1 is generally representative of the high frequency digitizing noise to be expected in the bulk of the San Fernando accelerograms. In view of the actual variations in record length and median sample rate for these records, as well as the variations of sampling rate within these accelerograms, it also seems clear, however, that Figure 1 should not be taken too literally, unless careful attention is paid to these parameters in the particular accelerogram of interest. We recommend that signal amplitudes less than a factor of two greater than the upper limit of noise in Figure 1 be regarded as processing-generated noise. With these considerations in mind and with an additional allowance for other data sensitivities, Figure 1 may be taken as generally representative of the high frequency digitizing noise to be expected for accelerograms of the series "Strong Motion Earthquake Accelerograms."

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REFERENCES


Table 1

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<tr>
<th>Accelerograph Site¹</th>
<th>Sampling Rate Whole Record Average pts/sec</th>
<th>Sampling Rate First 20 Seconds² pts/sec</th>
<th>Record Length sec</th>
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<td>L171</td>
<td>35.5</td>
<td>47.6</td>
<td>32.5</td>
</tr>
<tr>
<td>N191</td>
<td>47.5</td>
<td>66.7</td>
<td>70.2</td>
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<tr>
<td>O206</td>
<td>47.5</td>
<td>66.7</td>
<td>52.8</td>
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<td>P220</td>
<td>39.3</td>
<td>47.6</td>
<td>60.9</td>
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¹ "Strong Motion Earthquake Accelerograms" identification number.
² Median value
NOISE RANGE FOR AR 240
RFT 250 AND SMA 1 ACCELEROGRAPHS

FOURIER AMPLITUDE, cm/sec

FREQUENCY, Hz
Figure 3
INDEX OF EARTHQUAKE RECORDS
VOLUME IV, PARTS Q, R, AND S

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EARTHQUAKE DATA

The San Fernando, California, Earthquake of February 9, 1971, 0600 PST; epicenter, 34°24.7'N, 118°24.0'W;* maximum intensity, XI; revised magnitude (Mₗ), 6.4; depth, 13.0 km.

*Latest revised epicenter location.
REFERENCES (See additional list, page 274)


FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE  FEB 9, 1971 - 0600 PST
IVQ233 71.162.0 14724 VENTURA BOULEVARD, 1ST FLOOR, LOS ANGELES, CAL.  COMP S12W

LOG OF FOURIER AMPLITUDE SPECTRUM - CPM/SEC

LOG OF FREQUENCY - CPS
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE  FEB 9, 1971 - 0600 PST
IVQ233  71.162.0  14724 VENTURA BOULEVARD, 1ST FLOOR, LOS ANGELES, CAL.  COMP UP

LOG OF FOURIER AMPLITUDE SPECTRUM - CM/SEC

LOG OF FREQUENCY - CPS
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE  FEB 9, 1971 - 0600 PST
IVQ234  71.163.0  14724 VENTURA BOULEVARD, 6TH FLOOR, LOS ANGELES, CAL.  COMP S12W
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE  FEB 9, 1971 - 0600 PST
IVQ234    71.163.0    14724 VENTURA BOULEVARD, 6TH FLOOR, LOS ANGELES, CAL.  COMP N78W

FREQUENCY - CPS

FOURIER AMPLITUDE SPECTRUM - CM/SEC

---

95 PERCENT CONFIDENCE LEVEL
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE  FEB 9, 1971 - 0600 PST
IVQ234  71.163.0  14724 VENTURA BOULEVARD, 6TH FLOOR, LOS ANGELES, CAL. COMP UP
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE  FEB 9, 1971 - 0600 PST
IVQ235 71.164.0  14724 VENTURA BOULEVARD, PENTHOUSE, LOS ANGELES, CAL.  COMP S12W
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE  FEB 9, 1971 - 0600 PST
IVQ235  71.164.0  14724 VENTURA BOULEVARD, PENTHOUSE, LOS ANGELES, CAL.  COMP N76W

FOURIER AMPLITUDE SPECTRUM - CW/SEC

FREQUENCY - CPS

95 PERCENT CONFIDENCE LEVEL
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE  FEB 9, 1971 - 0600 PST
IVQ235  71.164.0  14724 VENTURA BOULEVARD, PENTHOUSE, LOS ANGELES, CAL.  COMP UP

95 PERCENT CONFIDENCE LEVEL
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE  FEB 9, 1971 - 0600 PST

IVQ235  71.164.0  14724 VENTURA BOULEVARD, PENTHOUSE, LOS ANGELES, CAL.  COMP UP

LOG OF FOURIER AMPLITUDE SPECTRUM - CM/SEC

LOG OF FREQUENCY - CPS
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE  FEB 9, 1971 - 0600 PST
IVQ236  71.165.0  1760 N. ORCHID AVENUE, GND FLOOR, HOLLYWOOD, CAL.  COMP UP

LOG OF FOURIER AMPLITUDE SPECTRUM - CM/SEC

LOG OF FREQUENCY - CPS
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE  FEB 9, 1971 - 0600 PST
IVQ237  71.166.0  1760 N. ORCHID AVENUE, 12TH FLOOR, HOLLYWOOD, CAL.  COMP SOUTH

LOG OF FREQUENCY - CPS

LOG OF FOURIER AMPLITUDE SPECTRUM - CM/SEC
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE  FEB 9, 1971 - 0600 PST

IVQ237  71.166.0  1760 N. ORCHID AVENUE, 12TH FLOOR, HOLLYWOOD, CAL.  COMP EAST

FOURIER AMPLITUDE SPECTRUM - CM/SEC

FREQUENCY - CPS

95 PERCENT CONFIDENCE LEVEL
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE
FEB 9, 1971 - 0800 PST
1760 N. ORCHID AVENUE, 12TH FLOOR, HOLLYWOOD, CAL. COMP UP

LOG OF FREQUENCY - CPS

LOG OF FOURIER AMPLITUDE SPECTRUM - CM/SEC
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE  FEB 9, 1971 - 0600 PST
IVQ239  71.168.0  9100 WILSHIRE BOULEVARD, BASEMENT, BEVERLY HILLS, CAL.  COMP SOUTH

FOURIER AMPLITUDE SPECTRUM - CM/SEC

FREQUENCY - CPS

95 PERCENT CONFIDENCE LEVEL
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE FEB 9, 1971 - 0600 PST

IVQ239 71.168.0 9100 WILSHIRE BOULEVARD, BASEMENT, BEVERLY HILLS, CAL. COMP EAST

LOG OF FOURIER AMPLITUDE SPECTRUM - CM/SEC

LOG OF FREQUENCY - CPS
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE FEB 9, 1971 - 0600 PST

LOG OF FOURIER AMPLITUDE SPECTRUM - CM/SEC

LOG OF FREQUENCY - CPS
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE  FEB 9, 1971 - 0600 PST

1Y0241  71.170.0  800 W. FIRST STREET, 1ST FLOOR, LOS ANGELES, CAL.  COMP N37E

FREQUENCY - CPS

95 PERCENT CONFIDENCE LEVEL

FOURIER AMPLITUDE SPECTRUM - CM/SEC
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE FEB 9, 1971 - 0600 PST
IVG241 71 170.0 800 W. FIRST STREET, 1ST FLOOR, LOS ANGELES, CAL. COMP UP

FOURIER AMPLITUDE SPECTRUM - CM/SEC

FREQUENCY - CPS

95 PERCENT CONFIDENCE LEVEL
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE  FEB 9, 1971 - 0600 PST
IVQ241  71.170.0  600 W. FIRST STREET, 1ST FLOOR, LOS ANGELES, CAL.  COMP UP

![Fourier Amplitude Spectrum](image)
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE  FEB 9, 1971 - 0600 PST
IVQ242  71.171.0  800 W. FIRST STREET, 16TH FLOOR, LOS ANGELES, CAL.  COMP N53W

FOURIER AMPLITUDE SPECTRUM - CM/SEC

FREQUENCY - CPS

95 PERCENT CONFIDENCE LEVEL
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE  FEB 9, 1971 - 0600 PST
IVQ242  71.171.0  800 W. FIRST STREET, 16TH FLOOR, LOS ANGELES, CAL.  COMP UP

FOURIER AMPLITUDE SPECTRUM - CM/SEC

FREQUENCY - CPS

95 PERCENT CONFIDENCE LEVEL
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE  FEB 9, 1971 - 0600 PST
IVQ243 71.172.0  800 W. FIRST STREET, 33RD FLOOR, LOS ANGELES, CAL.  COMP N53W

FREQUENCY - CPS

95 PERCENT CONFIDENCE LEVEL
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE FEB 9, 1971 - 0600 PST

IVR244 71.174, 222 FIGUEROA STREET, 1ST FLOOR, LOS ANGELES, CAL. COMP N53W

FOURIER AMPLITUDE SPECTRUM - CM/SEC

FREQUENCY - CPS

95 PERCENT CONFIDENCE LEVEL
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE, FEB 9, 1971, 0600 PST
IVR244, 71.174, 222 FIGUEROA STREET, 1ST FLOOR, LOS ANGELES, CAL.

LOG OF FREQUENCY - CPS
LOG OF FOURIER AMPLITUDE SPECTRUM - CM/SEC
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE  FEB 9, 1971  0600 PST
IVA244  71.174,  222 FIGUEROA STREET, 1ST FLOOR, LOS ANGELES, CAL.  COMP UP

FOURIER AMPLITUDE SPECTRUM - CM/SEC

FREQUENCY - CPS

95 PERCENT CONFIDENCE LEVEL
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE    FEB 9, 1971 - 0600 PST
IVR245  71.173,  222 FIGUEROA STREET, 20TH FLOOR, LOS ANGELES, CAL.,  COMP S37W

FOURIER AMPLITUDE SPECTRUM - CM/SEC

FREQUENCY - CPS

95 PERCENT CONFIDENCE LEVEL
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE  FEB 9, 1971 - 0600 PST
IVA246  71.192.  6464 SUNSET BOULEVARD, BASEMENT, LOS ANGELES, CAL. COMP UP

FREQUENCY - CPS
0  5  10  15  20  25
0  10  20  30  40  50
FOURIER AMPLITUDE SPECTRUM - CM/SEC

95 PERCENT CONFIDENCE LEVEL
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE, FEB 9, 1971 - 0600 PST
1404, SUNSET BOULEVARD, 12TH FLOOR, LOS ANGELES, CAL.

LOG OF FREQUENCY - CPS

LOG OF FOURIER AMPLITUDE SPECTRUM - CM/SEC
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE FEB 9, 1971 - 0600 PST
IVA247 71.193  6464 SUNSET BOULEVARD, 12TH FLOOR, LOS ANGELES, CAL. COMP UP

FOURIER AMPLITUDE SPECTRUM - CM/SEC

FREQUENCY - CPS

95 PERCENT CONFIDENCE LEVEL
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE  FEB 9, 1971 - 0600 PST
IVR248 71.194. 6430 SUNSET BOULEVARD, 1ST FLOOR, LOS ANGELES, CAL.  COMPU UP

LOG OF FOURIER AMPLITUDE SPECTRUM - CM/SEC

LOG OF FREQUENCY - CPS
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE FEB 9, 1971 - 0800 PST
IVR249 71.196, 1900 AVENUE OF THE STARS, BASEMENT, LOS ANGELES, CAL. COMP N44E

FOURIER AMPLITUDE SPECTRUM - CM/SEC

FREQUENCY - CPS

95 PERCENT CONFIDENCE LEVEL
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE  FEB 9, 1971 - 0600 PST
IVA249  71.196,  1900 AVENUE OF THE STARS, BASEMENT, LOS ANGELES, CAL.  COMP NUE
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE  FEB 9, 1971 - 0600 PST
IVR249  71.196.  1900 AVENUE OF THE STARS, BASEMENT, LOS ANGELES, CAL.  COMP SYGE

FREQUENCY - CPS
0  5  10  15  20  25
0  10  20  30  40  50  60

FOURIER AMPLITUDE SPECTRUM - CM/SEC

85 PERCENT CONFIDENCE LEVEL
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE   FEB 9, 1971 - 0600 PST
IVA249    71.196.  1900 AVENUE OF THE STARS, BASEMENT, LOS ANGELES, CAL.  COMP UP

FOURIER AMPLITUDE SPECTRUM - CM/SEC

FREQUENCY - CPS

95 PERCENT CONFIDENCE LEVEL
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE  FEB 9, 1971 - 0600 PST

IVA249  71.196.  1900 AVENUE OF THE STARS, BASEMENT, LOS ANGELES, CAL.  COMP UP

LOG OF FOURIER AMPLITUDE SPECTRUM - CM/SEC

LOG OF FREQUENCY - CPS

-2.2  -2  -1.8  -1.6  -1.4  -1.2  -1  -0.8  -0.6  -0.4  -0.2  0  0.2  0.4  0.6  0.8  1  1.2  1.4  1.6  1.8  2
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE    FEB 9, 1971 - 0600 PST
I VR250    71.197.  1900 AVENUE OF THE STARS, 29TH FLOOR, LOS ANGELES, CAL.  COMP N44E

FREQUENCY - CPS

FOURIER AMPLITUDE SPECTRUM - CM/SEC

95 PERCENT CONFIDENCE LEVEL
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE   FEB 9, 1971 - 0600 PST
IVA250  71197, 1900 AVENUE OF THE STARS, 29TH FLOOR, LOS ANGELES, CAL.  COMP 546E

FOURIER AMPLITUDE SPECTRUM - CM/SEC

FREQUENCY - CPS

95 PERCENT CONFIDENCE LEVEL
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE  FEB 9, 1971 - 0600 PST
IVA250  71.197.  1900 AVENUE OF THE STARS, 29TH FLOOR, LOS ANGELES, CAL.  COMP UP

FOURIER AMPLITUDE SPECTRUM - CM/SEC

FREQUENCY - CPS

95 PERCENT CONFIDENCE LEVEL
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE    FEB 9, 1971 - 0600 PST

IVR251  71.198.  234 FIGUEROA STREET, BASEMENT, LOS ANGELES, CAL.  COMP N37E

FREQUENCY - CPS

FOURIER AMPLITUDE SPECTRUM - CM/SEC

95 PERCENT CONFIDENCE LEVEL
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE    FEB 9, 1971 - 0600 PST
IBR251    71.198. 234 FIGUEROA STREET, BASEMENT, LOS ANGELES, CAL. COMP S53E

Fourier Amplitude Spectrum - cm/sec

Frequency - CPS

95 percent confidence level
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE  FEB 9, 1971 - 0600 PST
IVR252  71.199,  234 FIGUEROA STREET, ROOF, LOS ANGELES, CAL.  COMP N37E

Log of Fourier Amplitude Spectrum - cm/sec

Log of Frequency - CPS
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE  FEB 9, 1971 - 0600 PST
IVR252  71.199,  234 FIGUEROA STREET, ROOF, LOS ANGELES, CAL. COMP S53E
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE FEB 9, 1971 - 0600 PST
535 S. FREMONT AVENUE, BASEMENT, LOS ANGELES, CA.

LOG OF FREQUENCY - CPS

LOG OF FOURIER AMPLITUDE SPECTRUM - CM/SEC

1  0  -1  -2
1  0  -1  -2
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE FEB 9, 1971 - 0600 PST

IVA253 71.200  535 S. FREMONT AVENUE, BASEMENT, LOS ANGELES, CAL.  COMP 560W

FOURIER AMPLITUDE SPECTRUM - CM/SEC

FREQUENCY - CPS

95 PERCENT CONFIDENCE LEVEL
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE  FEB 9, 1971 - 0600 PST
IVR253  71.200.  535 S. FREMONT AVENUE, BASEMENT, LOS ANGELES, CAL.  COMP 560W
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE FEB 9, 1971 - 0600 PST
IVR253 71.200 535 S. FREMONT AVENUE, BASEMENT, LOS ANGELES, CAL. COMP UP

LOG OF FOURIER AMPLITUDE SPECTRUM - CM/SEC

LOG OF FREQUENCY - CPS
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE  FEB 9, 1971 - 0600 PST
IVA254  71.201.  535 S. FREMONT AVENUE, 6TH FLOOR, LOS ANGELES, CAL  COMP S60W

FOURIER AMPLITUDE SPECTRUM - CM/SEC

FREQUENCY - CPS

95 PERCENT CONFIDENCE LEVEL
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE  FEB 9, 1971 - 0600 PST
IVA254  71.201  535 S. FAEMONT AVENUE, 6TH FLOOR, LOS ANGELES, CAL  COMP S80W

LOG OF FOURIER AMPLITUDE SPECTRUM - CM/SEC

LOG OF FREQUENCY - CPS
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE  FEB 9, 1971 - 0600 PST

IVS255  71.178,  6200 WILSHIRE BOULEVARD, GROUND FLOOR, LOS ANGELES, CAL.  COMP N82W

FOURIER AMPLITUDE SPECTRUM - CM/SEC

95 PERCENT CONFIDENCE LEVEL

FREQUENCY - CPS
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE  FEB 9, 1971 - 0600 PST
IVS255  71,178.  6200 WILSHIRE BOULEVARD, GROUND FLOOR. LOS ANGELES, CAL.  COMP N82W
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE FEB 9, 1971 0600 PST
6200 WILSHIRE BOULEVARD 10TH FLOOR LOS ANGELES CAL.

-169-
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE   FEB 9, 1971 - 0600 PST
1VS256  71.179.  6200 WILSHIRE BOULEVARD, 10TH FLOOR, LOS ANGELES, CAL.  COMP UP

95 PERCENT CONFIDENCE LEVEL
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE  FEB 9, 1971 - 0600 PST

IVS257  71.177.  6200 WILSHIRE BOULEVARD, 17TH FLOOR, LOS ANGELES, CAL.  COMP N82W

FREQUENCY - CPS

FREQUENCY - CM/SEC

95 PERCENT CONFIDENCE LEVEL
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE  FEB 9, 1971 - 0600 PST
IVS257 71.177. 6200 WILSHIRE BOULEVARD, 17TH FLOOR, LOS ANGELES, CAL. COMP UP

95 PERCENT CONFIDENCE LEVEL
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE  FEB 9, 1971 - 0600 PST

IVS257  71.177.  6200 WILSHIRE BOULEVARD, 17TH FLOOR, LOS ANGELES, CAL.  COMP UP
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE  FEB 9, 1971 - 0600 PST
IVS258  71.181.  3440 UNIVERSITY AVENUE, BASEMENT, LOS ANGELES, CAL.  COMP N29E

95 PERCENT CONFIDENCE LEVEL

FREQUENCY - CPS
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE FEB 9, 1971 - 0600 PST
IVS258 71.181. 3440 UNIVERSITY AVENUE, BASEMENT, LOS ANGELES, CAL. COMP UP

FOURIER AMPLITUDE SPECTRUM - CM/SEC

FREQUENCY - CPS

95 PERCENT CONFIDENCE LEVEL
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE, FEB 9, 1971 - 0600 PST
2240 UNIVERSITY AVENUE, 5TH FLOOR, LOS ANGELES, CAL. COMP NCSE

LOG OF FREQUENCY - CPS

LOG OF FOURIER AMPLITUDE SPECTRUM - CM/SEC
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE  FEB 9, 1971 - 0600 PST
IVS 259  71.180.  3440 UNIVERSITY AVENUE, 5TH FLOOR, LOS ANGELES, CAL.  COMP 561E

LOG OF FREQUENCY - CPS

LOG OF FOURIER AMPLITUDE SPECTRUM - CM/SEC
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE  FEB 9, 1971 - 0600 PST
IVS260  71.182,  3440 UNIVERSITY AVENUE, ROOF, LOS ANGELES, CAL.  COMP 561E

FOURIER AMPLITUDE SPECTRUM - CM/SEC

95 PERCENT CONFIDENCE LEVEL

FREQUENCY - CPS
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE    FEB 9, 1971 - 0600 PST
1V5260  71.182,  3440 UNIVERSITY AVENUE, ROOF, LOS ANGELES, CAL.  COMP S61E
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE  FEB 9, 1971 - 0600 PST
IVS261  71.163,  1177 BEVERLY DRIVE, BASEMENT, LOS ANGELES, CAL.  COMP NSSE

FREQUENCY - CPS

FOURIER AMPLITUDE SPECTRUM - CM/SEC

95 PERCENT CONFIDENCE LEVEL
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE  FEB 9, 1971 - 0600 PST

IVS261  71.183.  1177 BEVERLY DRIVE, BASEMENT, LOS ANGELES, CAL.  COMP N31W

LOG OF FOURIER AMPLITUDE SPECTRUM - CM/SEC

LOG OF FREQUENCY - CPS
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE  FEB 9, 1971 - 0600 PST
IVS262  71.18S.  5900 WILSHIRE BOULEVARD, 'B' PARKING LOT, LOS ANGELES, CAL.  COMP N83W

FOURIER AMPLITUDE SPECTRUM - CM/SEC

FREQUENCY - CPS

95 PERCENT CONFIDENCE LEVEL
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE  FEB 9, 1971 - 0600 PST

IVS262  71.185.  5900 WILSHIRE BOULEVARD, 'B' PARKING LOT, LOS ANGELES, CAL.  COMP 507W

LOG OF FREQUENCY - CPS

LOG OF FOURIER AMPLITUDE SPECTRUM - CM/SEC
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE  FEB 9, 1971 - 0600 PST

IVS262  71.185.  5900 WILSHIRE BOULEVARD, 'B' PARKING LOT, LOS ANGELES, CAL.  COMP UP

FREQUENCY - CPS

FOURIER AMPLITUDE SPECTRUM - CM/SEC

95 PERCENT CONFIDENCE LEVEL
FOURIER AMPLITUDE SPECTRUM OF ACCELERATION
SAN FERNANDO EARTHQUAKE    FEB 9, 1971 - 0600 PST
IVS263  71.184.  5900 WILSHIRE BOULEVARD, 16TH FLOOR, LOS ANGELES, CAL.  COMP UP

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71.187  3435 WILSHIRE BOULEVARD, 5TH BASEMENT, LOS ANGELES, CAL.  COMP SOUTH

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15433 VENTURA BOULEVARD, 7TH FLOOR, LOS ANGELES, CAL.
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IVS273  71.204.  15433 VENTURA BOULEVARD, 7TH FLOOR, LOS ANGELES, CAL.  COMP UP

![Fourier Amplitude Spectrum Plot]

-2.2  -2.1  -2.0  -1.9  -1.8  -1.7  -1.6  -1.5  -1.4  -1.3  -1.2  -1.1  -1.0  -0.9  -0.8  -0.7  -0.6  -0.5  -0.4  -0.3  -0.2  -0.1  0.0  0.1  0.2  0.3  0.4  0.5  0.6  0.7  0.8  0.9  1.0  1.1  1.2  1.3  1.4  1.5  1.6  1.7  1.8  1.9  2.0

LOG OF FREQUENCY - CPS

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