1 OF 3

AD A
110878

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO. AD-A110 878	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) A Comparison of Acoustic and Visual Determination of Cavitation Inception on a Model Propeller		5. TYPE OF REPORT & PERIOD COVERED THESIS
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) PRESTERO, MARK G.		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Masschusetts Institute of Technology Cambridge, MA		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS CODE 031 NAVAL POSTGRADUATE SCHOOL MONTEREY, CALIFORNIA 93940		12. REPORT DATE June 1979
		13. NUMBER OF PAGES 221
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)	LEVEL	15. SECURITY CLASS. (of this report) UNCLAS
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)
Naval Engineering
Acoustic Detection
Cavitation Noise
Demodulated Analysis

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

SEE REVERSE

82

DD FORM 1473 EDITION OF 1 NOV 68 IS OBSOLETE
(Page 1) S/N 0102-014-6601

AD A110878

DTIC FEB 1 2 1982

ABSTRACT

Although acoustic detection of cavitation inception has been shown to agree
relatively well with visual detection, acoustic methods have generally not been
used to detect cavitation inception during cavitation testing of model propellers.
In addition, it has been suggested that noise measurements on model propellers
be made at high frequencies to more properly represent the full scale noise. In
this thesis, three different methods of acoustic detection were investigated.
Two of these methods, the measurement of high frequency one-third octave band
levels and the analysis of the complete noise spectrum between 10 and 50 kHz,
met with some success, but were not equivalent to the capability of a visual
detection method. The third method used, the demodulated analysis of high
frequency cavitation noise, gave excellent agreement with visually determined
results.

A COMPARISON OF

ACOUSTIC AND VISUAL DETERMINATION OF CAVITATION INCEPTION

ON A MODEL PROPELLER

by

LCDR Mark G. Prestero, USN

B.S., College of the Holy Cross
(1967)

SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE
DEGREE OF
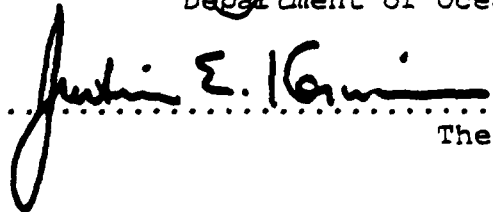
OCEAN ENGINEER

and for the degree of

MASTER OF SCIENCE IN NAVAL ARCHITECTURE
AND MARINE ENGINEERING

at the

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
June 1979

© 1979 Mark G. Prestero

Signature of Author..
Department of Ocean Engineering
June, 1979

Certified by..
Thesis Supervisor

Accepted by..
Chairman, Department Committee
on Graduate Students

A COMPARISON OF

ACOUSTIC AND VISUAL DETERMINATION OF CAVITATION INCEPTION

ON A MODEL PROPELLER

by

MARK G. PRESTERO

Submitted to the Department of Ocean Engineering on 11 May
1978, in partial fulfillment of the requirements for the
degrees of Ocean Engineer and Master of Science in Naval
Architecture and Marine Engineering.

ABSTRACT

Although acoustic detection of cavitation inception has
been shown to agree relatively well with visual detection,
acoustic methods have generally not been used to detect
cavitation inception during cavitation testing of model
propellers. In addition, it has been suggested that noise
measurements on model propellers be made at high frequencies
to more properly represent the full scale noise. In this
thesis, three different methods of acoustic detection were
investigated. Two of these methods, the measurement of high
frequency one-third octave band levels and the analysis of the
complete noise spectrum between 10 and 50 kHz, met with some
success, but were not equivalent to the capability of a
visual detection method. The third method used, the demodulated
analysis of high frequency cavitation noise, gave excellent
agreement with visually determined results.

Thesis Supervisor: Professor J.E. Kerwin
Title: Professor of Naval Architecture

ACKNOWLEDGEMENTS

help of this group, I would not have been able to perform this experiment. But there is one last group, my wife Linda, and Christopher, Timothy and Katherine, without whose continuing support, understanding and personal sacrifices, neither this experiment, nor any part of this education would have been successful.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

I. INTRODUCTION

Since the first observation of cavitation associated with marine propellers was reported by Reynolds in 1873, a number of unwanted effects, including loss of propeller efficiency, erosion of propeller surfaces, excitation of hull vibrations, and generation of noise, have been identified and studied. Because of these detrimental effects, it has been, and continues to be, desirable to predict the cavitation performance of a propeller design before the expensive full scale propeller is built. With no exact analytical approach available for predicting the full scale cavitation performance of a propeller, the testing of scale models has been used to aid in cavitation prediction in the propeller design process.

For the model test to properly represent the full scale, it is necessary for similarity conditions be satisfied. For propeller cavitation testing, this amounts to using a geometrically similar propeller operating in a flow which matches the wake where the full scale propeller operates. With these conditions met, it is assumed that cavitation performance for similar values of cavitation index,

$$\sigma = \frac{p - p_V}{\frac{1}{2}\rho \, U_\infty^2}$$

and advance coefficient,

$$J = \frac{V_a}{nD}$$

will be the same for the model and full scale propeller.
But this assumption is not precisely correct, and scale
effects, which arise from the inability to satisfy all
hydrodynamic, thermodynamic and other microscopic similarity
requirements, are encountered. These scale effects are
usually eliminated by means of empirically or theoretically
determined corrections.

In general, the procedure for conducting a model test for
determining cavitation inception performance is to operate
the model propeller in a variable pressure water tunnel,
downstream of a device which produces the desired wake at the
plane of the propeller. A water and propeller speed combination
are chosen to give the desired value of advance coefficient.
Water pressure is changed to change the cavitation index
until cavitation is visually observed to either begin or to
cease, depending upon the criterion used at the particular
test facility. This process is then repeated for several
different values of advance coefficient. The final result is
a curve of inception cavitation index, σ_i, versus advance
coefficient.

Although visual observation is the usual method for
determining the presence or absence of cavitation, it is not
the only available means. It is possible to use the detection
of cavitation-generated noise to determine, or to assist
visually determining, the inception of cavitation. Good
correlation between acoustic and visual inception determination
has been reported (Lehman, 1964). It has also been reported

that "numerous" facilities use an acoustic technique for
this purpose (ITTC, 1978), but the details of these methods
were not available. It is proposed for this investigation
to consider several different schemes for detecting cavitation-
generated noise as a method for inception determination, and
to compare acoustically-determined inception data with visual
observations of inception for a model propeller.

II. BACKGROUND

The sound generated by cavitation comes primarily from the growth and collapse of the cavitation bubbles. The theoretical energy spectrum for the sound generated by a single bubble has been shown to contain maxima at frequencies which correspond to the reciprocal of the time required for the growth and collapse of the bubble (Fitzpatrick and Strasberg, 1959). Experimental investigations into the spectrum of cavitation noise have found that the shape of the measured spectrum resembles the theoretical spectrum quite closely (Ross, 1976; Strasberg, 1977).

Strasberg also notes that the peak of the observed spectra move toward lower frequencies as the cavitation becomes more severe. The larger maximum size of the bubbles in the more developed cavitation corresponds to the observed peak at a lower frequency. Ross points out that the energy radiated per collapse is proportional to the product of the collapse pressure and the maximum bubble volume. So, when cavitation becomes more severe, and a larger number of bubbles,which also have a greater diameter, are produced, the amount of sound energy radiated becomes greater, the magnitude of the peak in the spectrum increases, and the frequency of the peak becomes lower. If the various spectra are non-dimensionalized in the manner of Fitzpatrick and Strasberg, the spectra for different degrees of cavitation intensity all agree well with the non-dimensionalized theoretical spectrum (Strasberg, 1977).

Continuing on with the scheme given by Strasberg, if the propeller diameter is used for the non-dimensionalizing length scale instead of the maximum bubble radius, a similarity condition for relating frequencies of interest between a model and a full scale propeller is obtained. For a given ratio of maximum bubble radius to propeller diameter (which can be interpreted as a measure of relative cavitation intensity), the non-dimensional frequency of the peak in the cavitation noise spectrum will remain invariant between different length scales. It should then be possible to compare cavitation noise measurements made at a given actual frequency on a full scale propeller with measurements made at the same non-dimensional frequency on a model propeller, so long as other similarity requirements are satisfied. For example, with the submarine propeller cavitation noise measurements used by Strasberg (1977), assuming that the full scale measurements were made at a submergence depth of 200 feet, the model measurements were made at an ambient pressure of 1 atmosphere, the same fluid was used in each case, and the length scale ratio was 8, the ratio between the frequency of interest with the model (f_M) to the frequency of interest with the full scale propeller (f_P) is:

$$\frac{f_M}{f_P} = \frac{D_P}{D_M} \cdot \left(\frac{P_M}{P_P} \right)^{\frac{1}{2}}$$

$$= 8 \cdot (34 \div 234)^{\frac{1}{2}} = 3.05$$

So, for cavitation noise measurements, the frequency of interest in model scale is about three times the full scale frequency for equivalent severity of cavitation in the two cases.

There are several considerations about the model cavitation noise which this concern with frequency alone does not show:

1) The size of the cavitation bubbles for the model will be one eighth the actual size of the full scale bubbles and might, consequently, be too small to see

2) At the same distance from the propeller as in model measurements (assuming the distances are large enough to avoid near field effects) the sound pressures, $\tilde{p}$, would have the ratio of

$$\frac{\tilde{p}_M}{\tilde{p}_P} = \frac{p_M}{p_P} \times \frac{D_M}{D_P}$$

$$= \frac{34}{234} \times \frac{1}{8} = 1.3 \times 10^{-2}$$

or approximately 35 db lower for the model, if the non-dimensionalization of Strasberg (1977) is used with the same bandwidth, distance and non-dimensional frequency.

3) The actual cavitation does not, in general, occur uniformly for all angular positions for all blades.

Operation of the propeller in a non-uniform wake causes variations of inflow velocity seen by the propeller which are periodic, with a frequency that corresponds to once per revolution. This periodic flow variation causes the inception,

growth, decrease, and disappearance of cavitation to occur in
a periodic fashion on a given blade. For a given average level
of cavitation intensity, the amplitude of the cavitation noise
will vary over one propeller revolution. This change in
amplitude will have two effects - it will shift the peak
frequency of the noise spectrum over the time span of one
revolution of the propeller, and it will vary the amplitude
of the noise spectrum.

If all blades of the propeller are the same, the
amplitud modulation of the noise occurs at blade passing
rate - once for each blade for each revolution of the shaft.
Since the blades are generally not identical, one blade will
usually begin to cavitate ahead of the others, and the
modulation of the noise will occur, in addition, at the shaft
rate (Strasberg, 1946; Ross, 1976).

It is intended, then, to investigate the use of these
two aspects of cavitation noise, frequency scaling and
amplitude modulation, either independently or together, as a
means of detecting cavitation inception on a model propeller.
It is expected that this approach would have certain advantages
as a part of the process for predicting full scale cavitation
performance:

(1) Visual determination of inception is very dependent
upon a number of conditions outside the test tunnel for
repeatable results. Lighting conditions, as well as the
location and visual acuity of the observer, can have a

substantial effect upon the outcome of a test. With an appropriate criteria for determining cavitation inception from acoustically obtained data, this sort of variation could be eliminated.

(2) For many ships, cavitation inception determination for the full scale propeller is accomplished using acoustic information. An acoustic method on model scale would more closely approximate the full scale test.

(3) Based upon bubble size considerations, an acoustic method might be able to detect the presence of cavitation bubbles before they are visible.

But there are disadvantages associated with using acoustic information for this purpose:

(1) The equipment to make the acoustic measurements is substantially more expensive than that needed for the visual determination of inception. For a very large length scale ratio, the frequency of interest at the model scale might become so high that the normal analysis equipment for acoustic measurements would not be usable, or the level of the acoustic signal from cavitation noise might be too low to be detected.

(2) If it is used alone, an acoustic method would appear to be less useful to the designer, since the method would not directly identify the type of cavitation causing the noise. The steps necessary to improve the cavitation performance of an unsatisfactory design would be less clear.

III. EXPERIMENTAL PROCEDURE

A. Equipment Setup

Experiments were conducted in the MIT Variable Pressure Water Tunnel, which has a 20 in square closed jet test section with a length of 54 in. All four walls of the test section have a 16 in by 44.5 in plexiglass viewing window insert. The propeller is located at the vertical and horizontal centerlines of the test section, and is driven by an upstream propeller shaft.

The propeller used for this test was the David Taylor Naval Ship Research and Development Center (DTNSRDC) model 3927, which had a diameter of 10.8 in and had seven blades. The tapered hub of the propeller had a maximum diameter of 2.8 in, which required the use of an adapter to provide a smooth transition between the 2.375 in diameter of the propeller shaft housing and the hub. Figure 1 shows this adapter. The propeller was installed on the shaft with no hub fairwater cap, leaving the mounting capscrew and lockwasher exposed.

Attached to the shaft housing 20 in upstream of the plane of the propeller was the holder for the screen which generated the desired wake at the propeller. The design of this screen used a scheme proposed by McCarthy (1963) as a starting point. The details of this process are given in Appendix A.

The wake prescribed for testing this propeller is
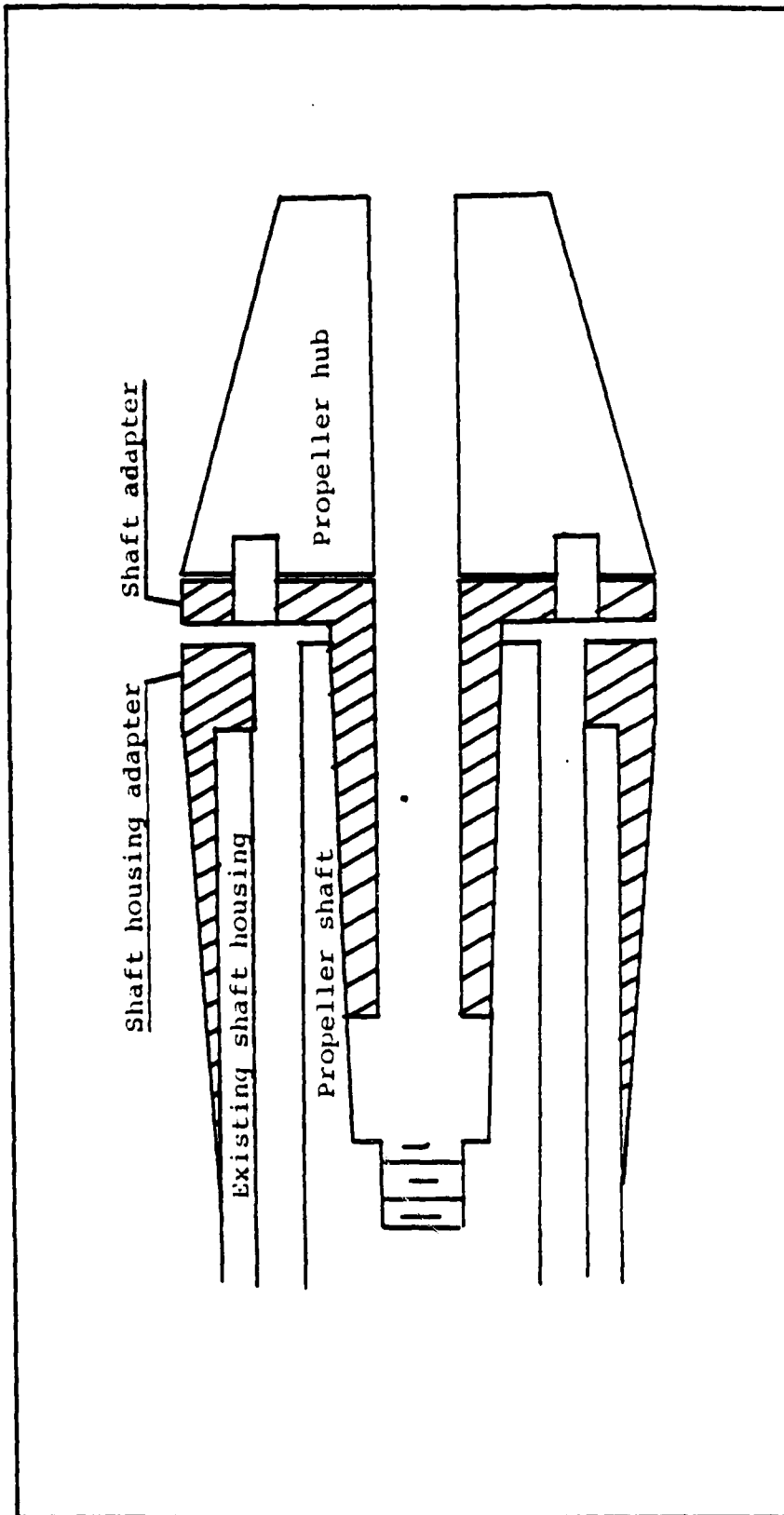
Shaft Adapter Fittings
Figure 1

axisymmetric, with a specific radial distribution of longitudinal velocity. For the first variation of the wake, the velocity distribution was measured along a diameter on a diagonal, but at the radii where the values of longitudinal velocity were given. The values for the two radii were averaged and compared to the specified values. An error of less than 10-12% was considered acceptable.

During the initial testing of the propeller it was discovered that face cavitation would occur behind the supports of the wake screen holder. This indicated a velocity increase as the propeller blade entered the region downstream of the supports, and was attributed to boundary layer viscous effects as the flow passed the wake screen holder supports. At the same time it was noted that modulation of the cavitation noise for other than this face cavitation was not detectable with the equipment being used. This indicated that a severe, once per revolution, velocity defect was desirable. This defect was achieved by using screen material to make the topmost support much thicker and tapered. No effort was made to maintain the same circumferential mean wake. The final wake screen used is shown in the photographs in figures 2A and 2B. Figure 3 shows the results of the wake survey made with a 1 in square grid, in a plane 2.5 in downstream of the blade root leading edge, but with the propeller removed, after the upper support was altered. The diagonal line indicates where the initial screen velocity measurements were made, as well as the data from the final
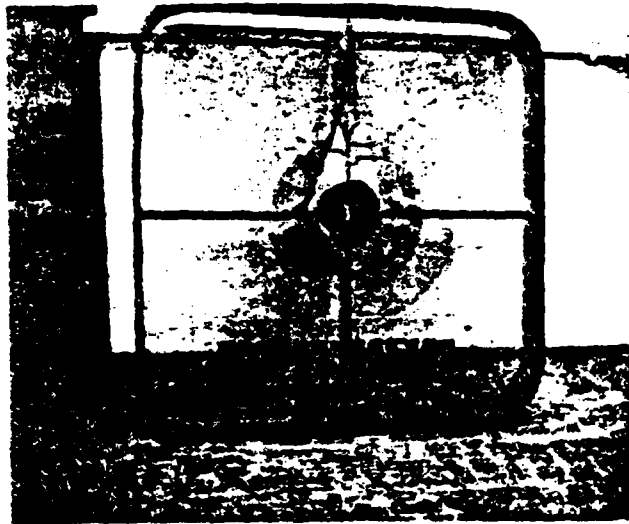
Final Wake Screen - Looking Downstream
Figure 2A
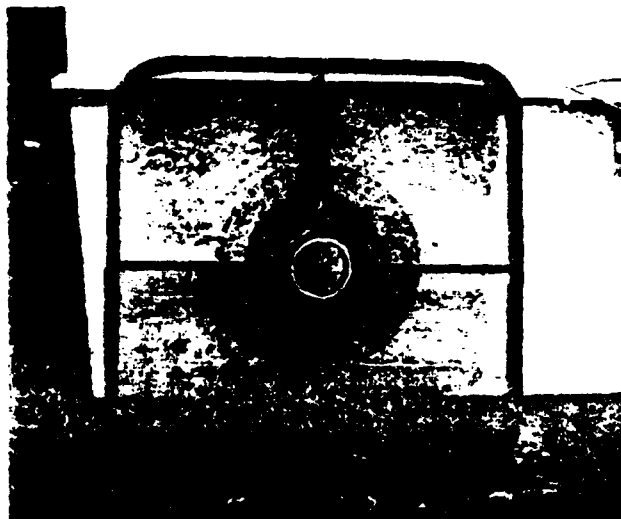
Final Wake Screen - Looking Upstream
Figure 2B
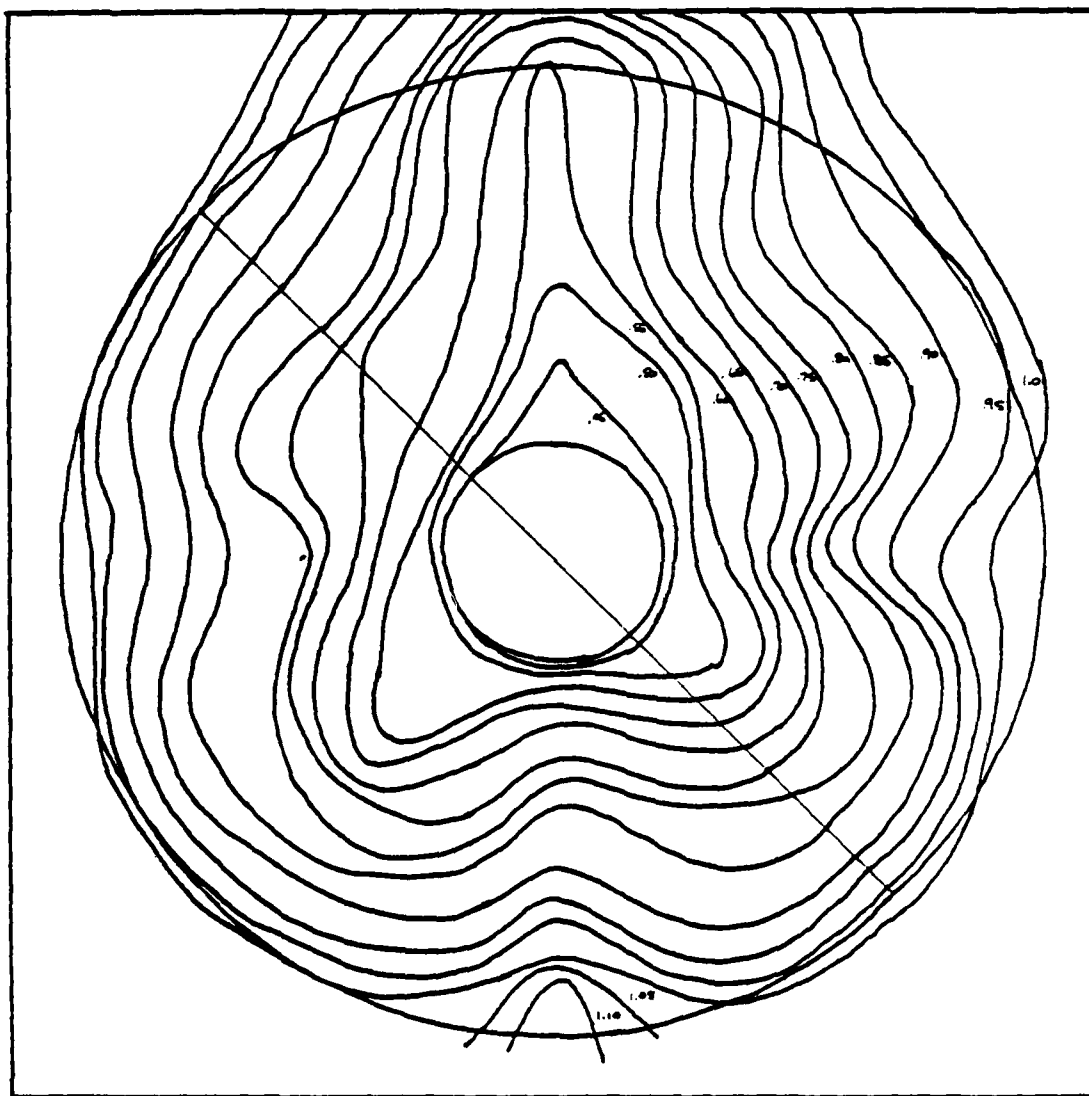
Wake Profile
Looking Upstream
Figure 3

screen velocity measurements, for comparison with the
prescribed wake were taken. A plot, comparing the actual and
prescribed velocities is shown in figure 4.

Two sensors were used at different times to obtain the
acoustic signal. The first, an accelerometer, was a Brüel &
Kjaer (B&K) type 4344. The characteristics of this
accelerometer are shown in table 1. The accelerometer was
mounted directly to one of the viewing windows, as close to
the center as possible, using a cyanoacrylate adhesive.
The other sensor, a minature hydrophone, was a B&K type 3103.
The principal characteristics of this hydrophone are given in
table 2. The hydrophone was mounted in the viewing window
as shown in figure 5, 2.5 in downstream of the leading edges
of the propeller blades. A schematic diagram of the
arrangement of the test section is shown in figure 6.

The methods of processing of the signal from the sensor
are shown in figures 7A and 7B. In configuration 7A, the
Ithaco 4213 filter was used as a band pass filter for one-
third octave bands, with the level indicated on the B&K type
2607 measuring amplifier as the output. The other
configuration used a Federal Scientific Model UA-15A
Ubiquitous Spectrum Analyzer coupled to a model 1015
Spectrum Averager, which, in turn, drove an X-Y plotter
to provide an output.

With the spectrum analyzer providing the output, two
set-ups were used. The first was to obtain the complete
spectrum of the cavitation noise to 50 kHz, the upper
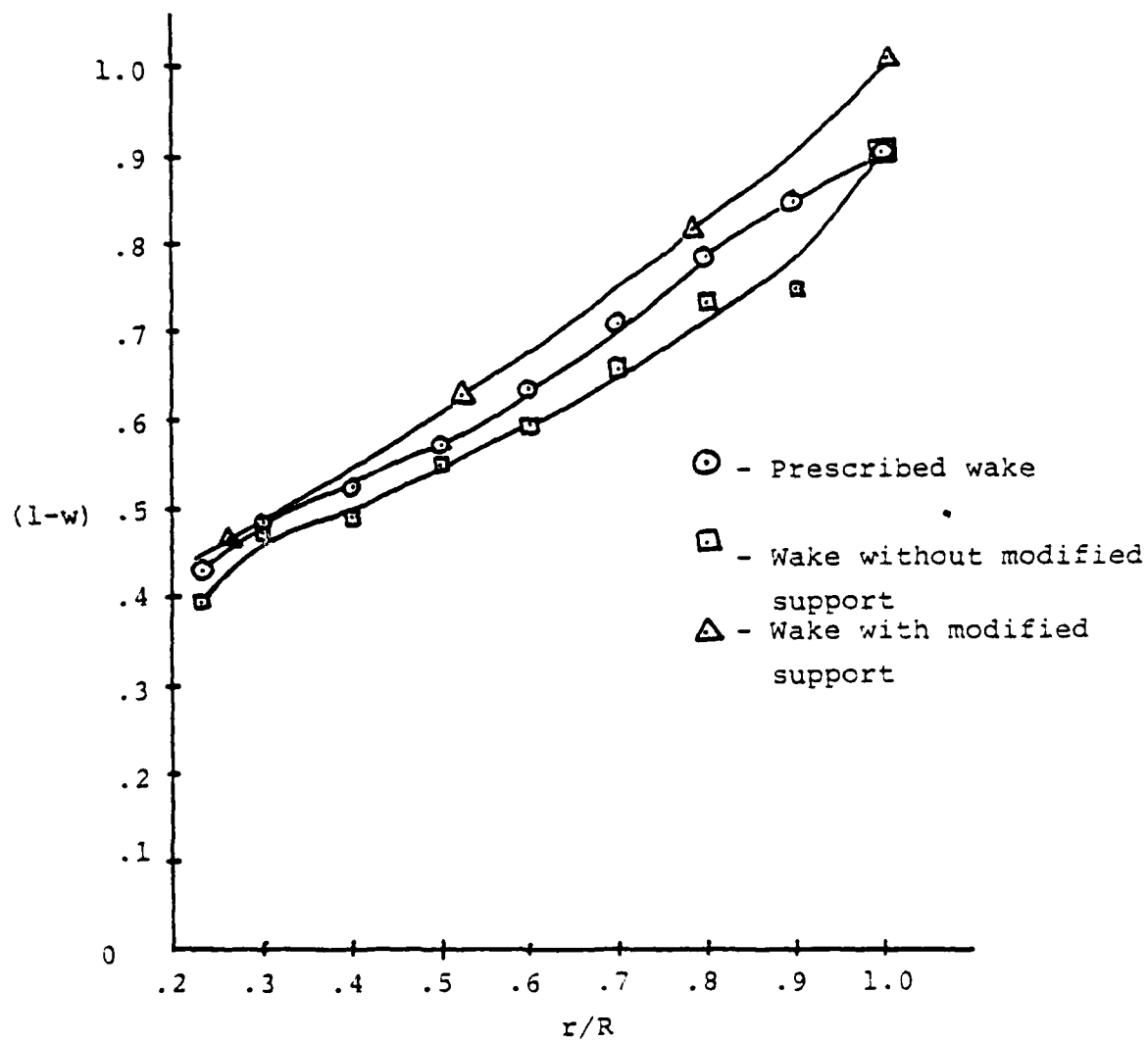
Wake Fraction versus Non-Dimensional Radius

Figure 4

Table 1

Accelerometer Characteristics

Type: B&K 4344   Serial Number: 475507

Reference sensitivity at 50 Hz at 23 $^{\circ}$C and including cable

   capacitance of 106 pF:

  Voltage sensitivity: 0.308 mV/ms^{-2} or 3.02 mV/g

  Charge sensitivity: 0.344 pC/ms^{-2} or 3.37 pC/g

Capacitance (including cable): 1116 pF

Weight: 22 gm   Undamped natural frequency: 121 KHz

Frequency response:
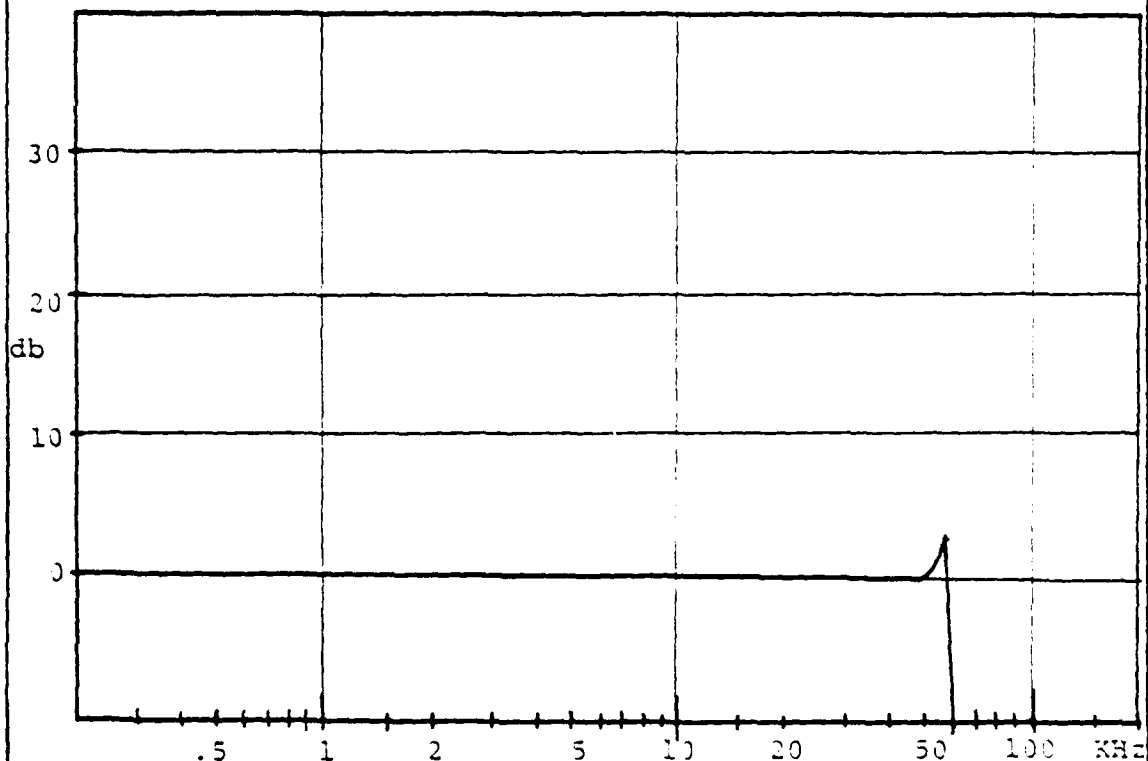
Table 2

Hydrophone Characteristics

Type: B&K 8103   Serial Number: 636764

Reference sensitivity at 250 Hz at 23 °C including 6m
    integral cable:

  Open circuit sensitivity:

        Voltage sensitivity: -211.6 db re 1V/μPa

                                - 91.6 db re 1V/Pa or 26.3 μV per
                                        Pa

                                -111.6 db re 1V per μbar

        Charge sensitivity: 91.5×10^{-3} pC per Pa

  Capacitance: 3480 pF

Frequency response:
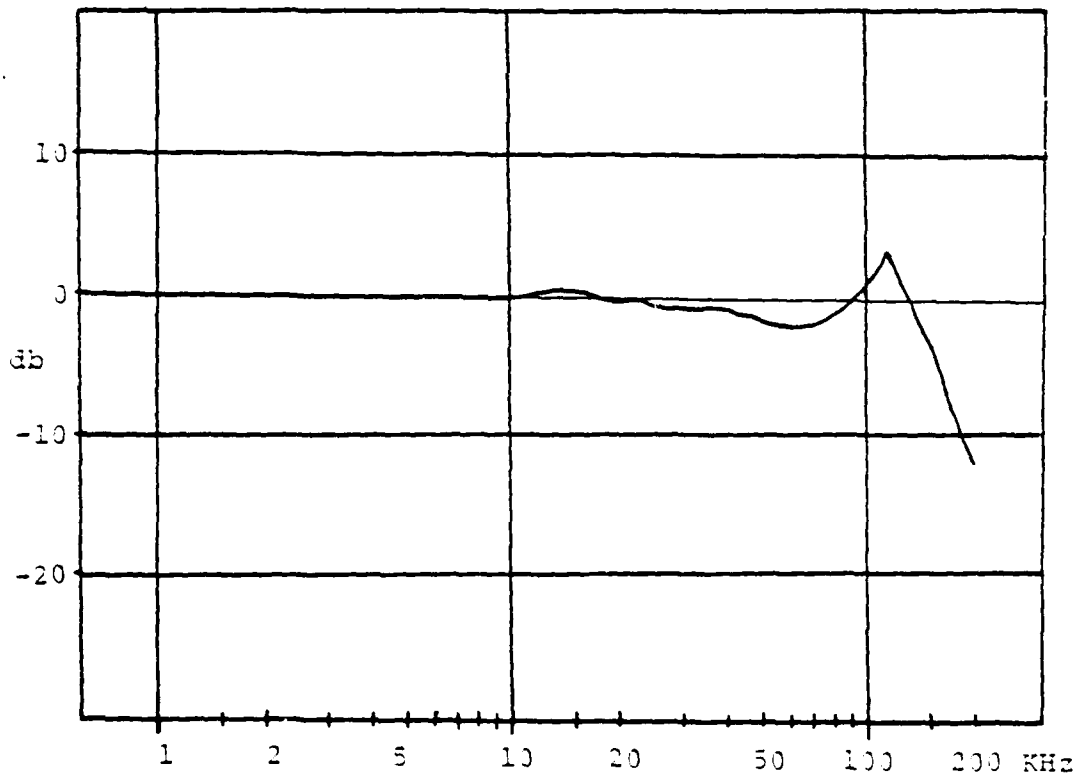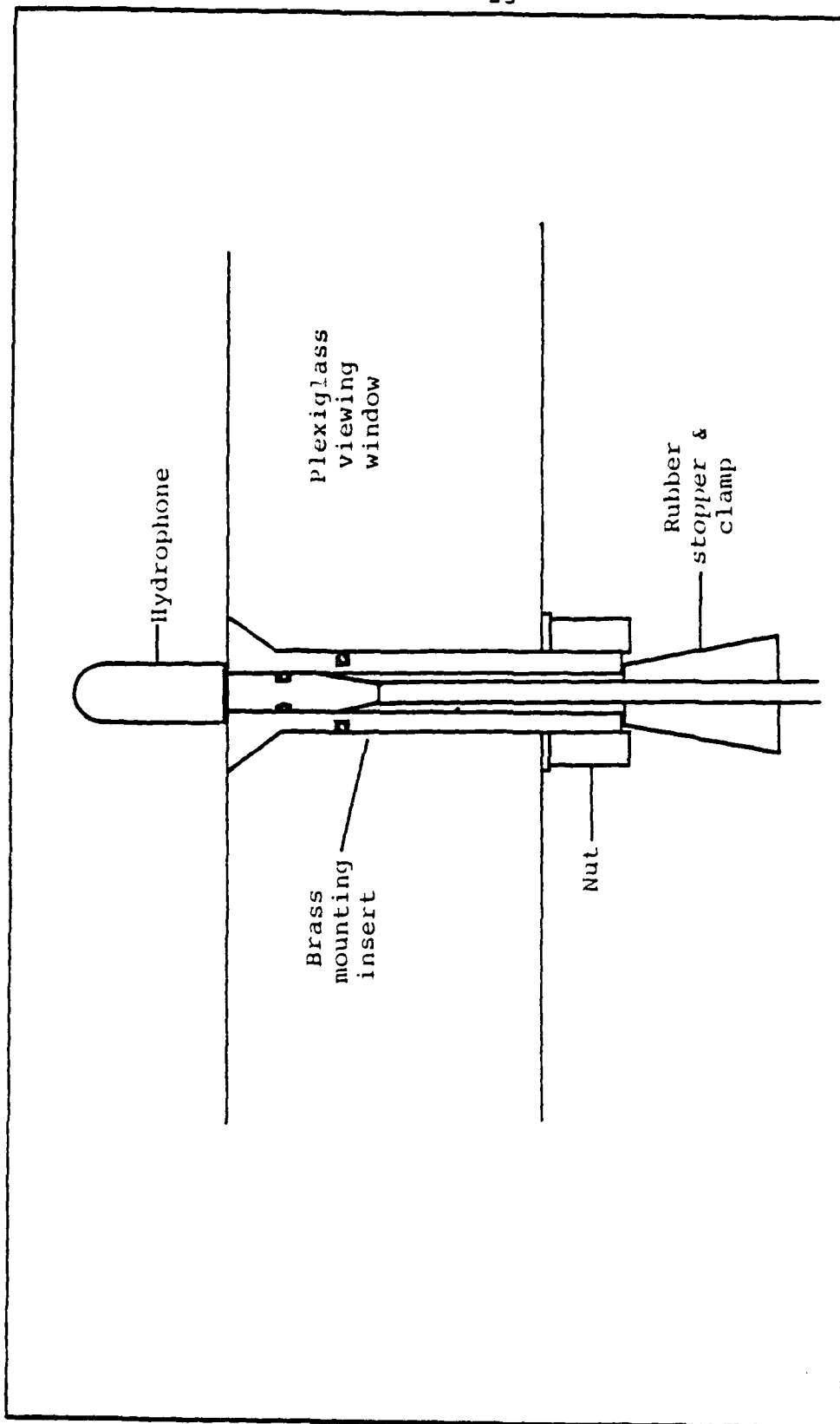
Hydrophone Mounting
Figure 5
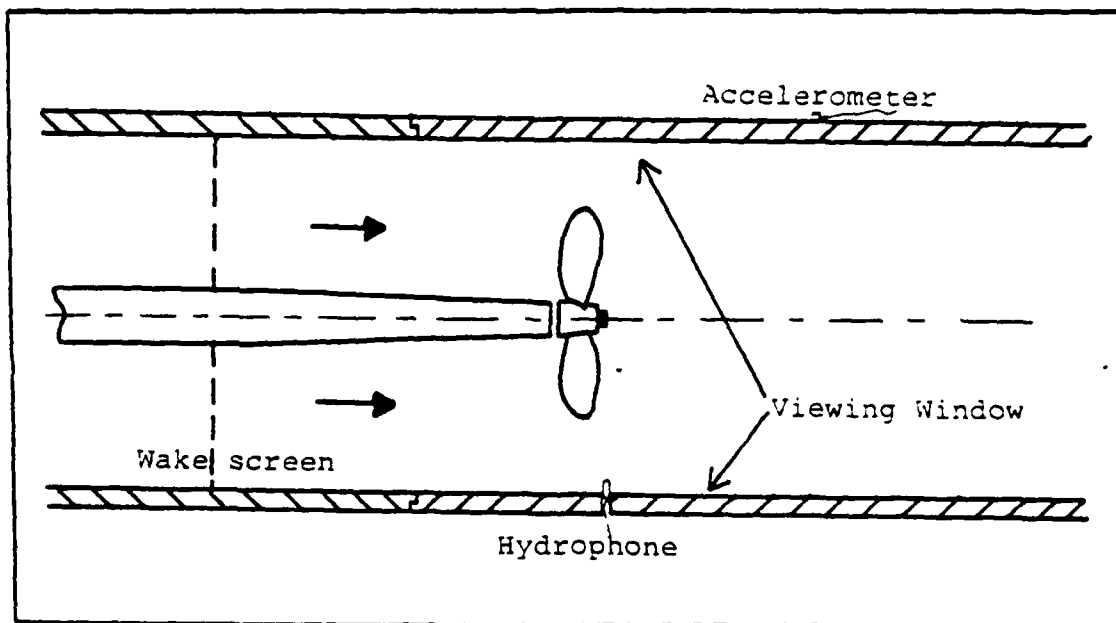
Arrangement of tunnel test section

Figure 6
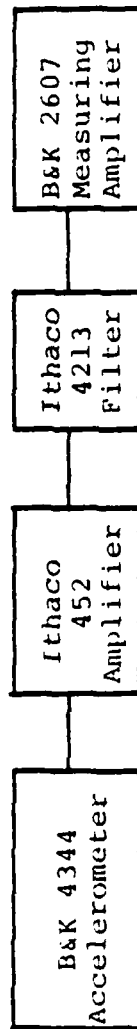
Figure 7A
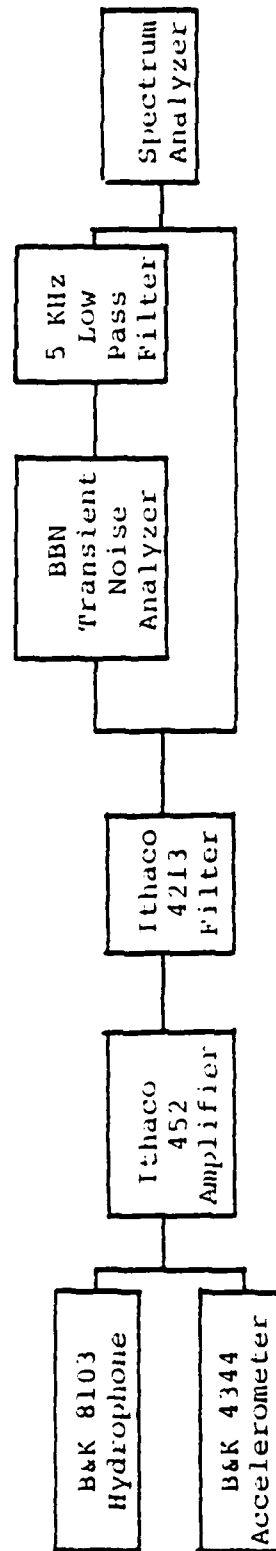
Figure 7B

frequency limit of the spectrum analyzer. In this case, the 4213 filter was used as a 10 kHz high pass filter to prevent the large amount of noise below 10 kHz, little of which was considered to be cavitation related, from overdriving the analysis equipment and preventing a good representation of the high frequency noise. For this analysis, 128 spectra were averaged to provide the output.

The second setup was intended to detect the cavitation by the presence of modulation of the high frequency noise, so that some form of demodulation was required. Demodulation of the signal was performed by passing it first through the Bolt, Beranek and Newman (BBN) Transient Signal Analyzer, which squared the signal, and then through a 5 kHz low pass filter and into the spectrum analyzer. For this setup, the 4213 filter was used either as a 20 kHz high pass filter or a 50-63 kHz band pass filter, so that only the high frequency, cavitation-related noise was being analyzed. (It was necessary to use high frequencies to obtain good results with this method of demodulation.) The spectrum analyzer was used on the 0-500 Hz range, and 32 spectra were averaged to obtain the output.

B. Calibration

It was not intended to attempt to measure the absolute levels of the cavitation noise, so a calibration of the level of the signal was not performed. In addition, a calibration of the frequency display of the spectrum analyzer was not

performed. Consequently, many of the spectra of the
demodulated signal do not have peaks at the proper
frequencies. But, because the peaks generally showed the
proper spacing, this error in the display was not considered
significant.

C. Test Procedure

The conventional test procedure of maintaining constant
free stream velocity and propeller speed, and varying static
pressure was used for this testing. This technique kept the
frequency of interest for the demodulated analysis constant
for a given test run.

Since it was not possible to determine the air content
of the tunnel water, it was decided to perform the acoustic
and. visual cavitation inception determinations concurrently.
Thus variations in air content would affect visual and
acoustic results equally.

Prior to beginning data recording for a series of data
points, the water was drained from the test section and the
propeller was operated in air at about 1000 RPM. At this
time, tare loadings for the thrust and torque load cells were
recorded and the height of the manometer column was recorded
as a no flow condition zero. The test section was refilled
with water, an initial atmospheric pressure reading was
recorded, and testing began.

For each data point, the following sequence was
followed:

(1) A nominal flow speed and propeller RPM were selected to give the desired value of J, and tunnel conditions were adjusted to these values. The flow speed chosen was such that cavitation inception would occur after tunnel static pressure was reduced from atmospheric pressure, but before the pressure was so low that air coming out of solution would begin to cause absorption of the high frequency acoustic signal or to obscure the propeller from view (250-300 mm Hg).

(2) Tunnel static pressure was set to atmospheric pressure. Room air and tunnel water temperatures, and amplifier gain and filter settings were recorded, and the first set of data taken. This data included tunnel static pressure, manometer height, propeller RPM, thrust and torque readings, and the acoustic data, either the one-third octave level or the spectral analysis. A visual observation of the propeller was made using a strobe light triggered by a once per revolution signal from the propeller shaft. A variable triggering delay on the light allowed the observation of all blades at all points in the propeller rotation. The large viewing windows enabled viewing the propeller under conditions of both back and front lighting, from both up and downstream using the one strobe light.

(3) Tunnel static pressure was lowered, and another set of data recorded. This process was continued until cavitation inception had been observed both visually and acoustically.

The sequence above was then repeated at the selected

values of advance coefficient needed to produce the curve of
cavitation index at inception versus advance coefficient.
At the end of a day's testing, the water was drained from the
test section. The propeller was operated in air, tare
loadings, atmospheric pressure and no-flow manometer height
were once again recorded. All raw data recorded is contained
in Appendix B.

IV. DATA REDUCTION

Reduction of the data for obtaining propeller parameters was accomplished using a program written for a TI-59 programmable hand calculator. This program performed the following functions:

(1) Determined the changes in tare loadings, atmospheric pressure and no-flow manometer height between the beginning and end of a series of test runs. A linear interpolation, based upon run number of a series, was then used to determine the value of these parameters for each run.

(2) Air and water temperatures were used to determine the vapor pressure of water at the two temperatures (p_{vw} and p_{va}). The vapor pressure of water at the room air temperature was used to correct the reading of the mercury column which was used for indication of tunnel static pressure, since this reading (p) was actually static pressure minus the vapor pressure of water at room temperature. Tunnel water temperature was also used to determine its density, ρ, and kinematic viscosity, ν.

(3) Tabulated values for the conversion from manometer height to velocity for the range of values encountered in a given test were entered and stored. They were then used in a linear interpolation to determine flow speed.

(4) For each value of static pressure where data was recorded during the test, the following calculations were made:

(a) Manometer height was entered, corrected
for the no-flow zero and converted to flow speed,
U_∞, in feet per second.

(b) Static pressure reading, p, was entered.
To this value the vapor pressure of water at room
temperature, p_{va}, was added to give the true static
pressure at the tunnel axis:

$$p_{stat} = p + p_{va}$$

(c) Propeller RPM was entered and converted to
revolutions per second, n.

(d) Propeller thrust reading was entered and
corrected for the tare loading. A correction for
the change in thrust from the pressure differential
between tunnel static pressure and atmospheric
pressure acting across the 1.317 in diameter
propeller shaft was then applied to give the actual
thrust, T. The thrust coefficient

$$K_T = \frac{T}{\rho n^2 D^4}$$

where D is the propeller diameter, was then calculated.

(e) This value of K_t was used to determine
the advance coefficient, J, from the open water test
results provided for this propeller, This value
was entered and stored for later use.

(f) For the first pressure increment for each
test, the measured torque was then entered, where

it was corrected for the tare loading to give
measured torque, Q, and a torque coefficient,

$$K_Q = \frac{Q}{\rho n^2 D^5}$$

was calculated. The open water test results
were entered with this value of K_Q to verify that
the J obtained in the previous step was reasonable.
The value of J obtained from the thrust identity
was used for the cavitation inception curve. In
addition, at this step, the 0.7 radius Reynolds
number,

$$R = \frac{c_{0.7} \times (V_a^2 + (0.7\pi nD)^2)^{\frac{1}{2}}}{\nu}$$

where V_a is the average inflow velocity seen at the
propeller (calculated from J) and $c_{0.7}$ was the
blade chord at the 0.7 radius, was calculated.

(g) Finally, the cavitation number,

$$\sigma = \frac{P_{stat} - P_{vw}}{\frac{1}{2}\rho U_\infty^2}$$

Once the data was reduced, and a value of J and σ could
be assigned to each data run, it was necessary to determine
which run represented the cavitation index at inception, σ_i,
for each value of J. The criteria used to define inception
are as follows:

(1) Visual observation - Hub vortex cavitation had a
different criterion from all other types. For it, the

appearance of a trail of bubbles from the vicinity of the hub

was used as the criterion. For other types of cavitation, the

criterion was to have a steady occurrence of that type of

cavitation on more than one blade. Steady occurrence meant

that the cavitation was present on each revolution of the

propeller at one location, but not necessarily throughout

the entire revolution.

(2) One third octave band level - the arbitrary db

level displayed on the measuring amplifier meter was plotted

against decreasing cavitation index as shown in figure 8.

The value of σ which corresponded to the curve after the "knee"

being 3 db above the extension of the curve before the knee

was taken as σ_i.

(3) Spectral analysis, complete spectrum - an increase

of 3 db from the level at atmospheric pressure across the

40-50 kHz portion of the spectrum was taken as the criteria.

The three spectra in figures 9, 10 and 11 correspond to a

fixed J, 0.51, and three different values of σ: that for

atmospheric pressure, σ_i for acoustically determined inception

and σ_i for acoustically determined inception, respectively.

The differences between these spectra are very slight and

tend to make the determination of inception difficult and

rather arbitrary. For this reason, this method was abandoned

in favor of using the demodulated analysis.

(4) Spectral analysis, demodulated signal - it was

assumed that the presence of a sharp peak ("line") at shaft

rate frequency indicated one blade cavitating, and that a

$U_\infty = 16$ fps
1150 rpm

$J = .681$

31.5-40 KHz

40-50 KHz

50-63 KHz
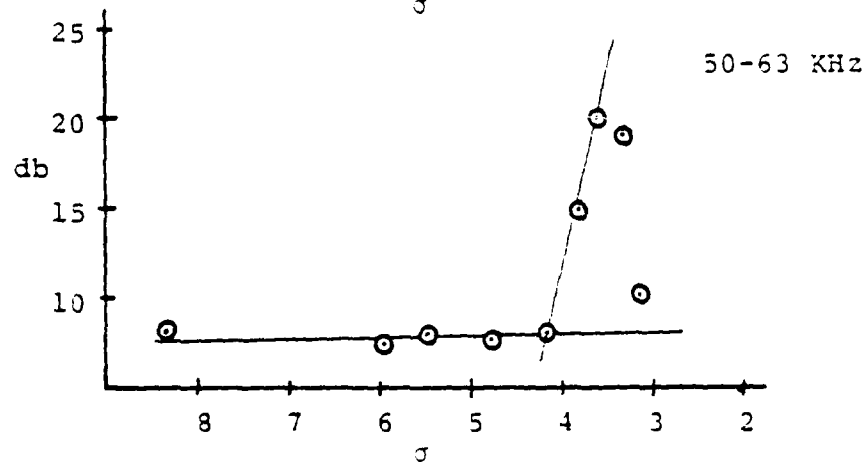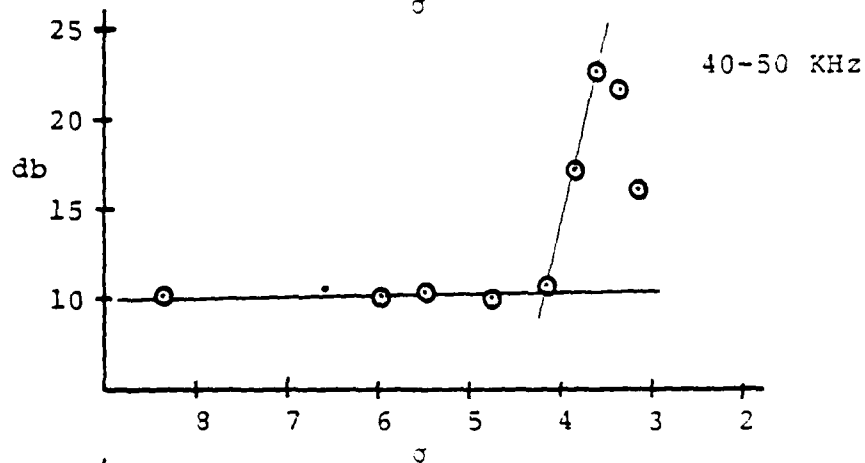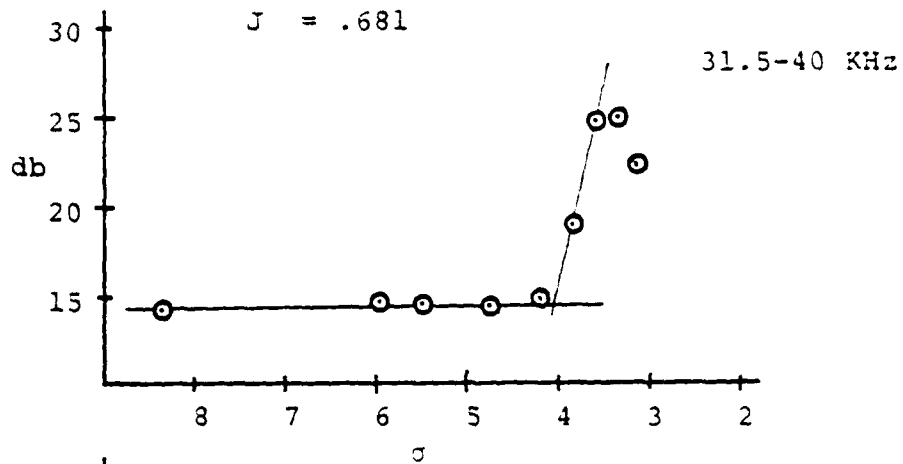
Typical One-Third Octave Band Levels vs. Cavitation Index
Figure 8
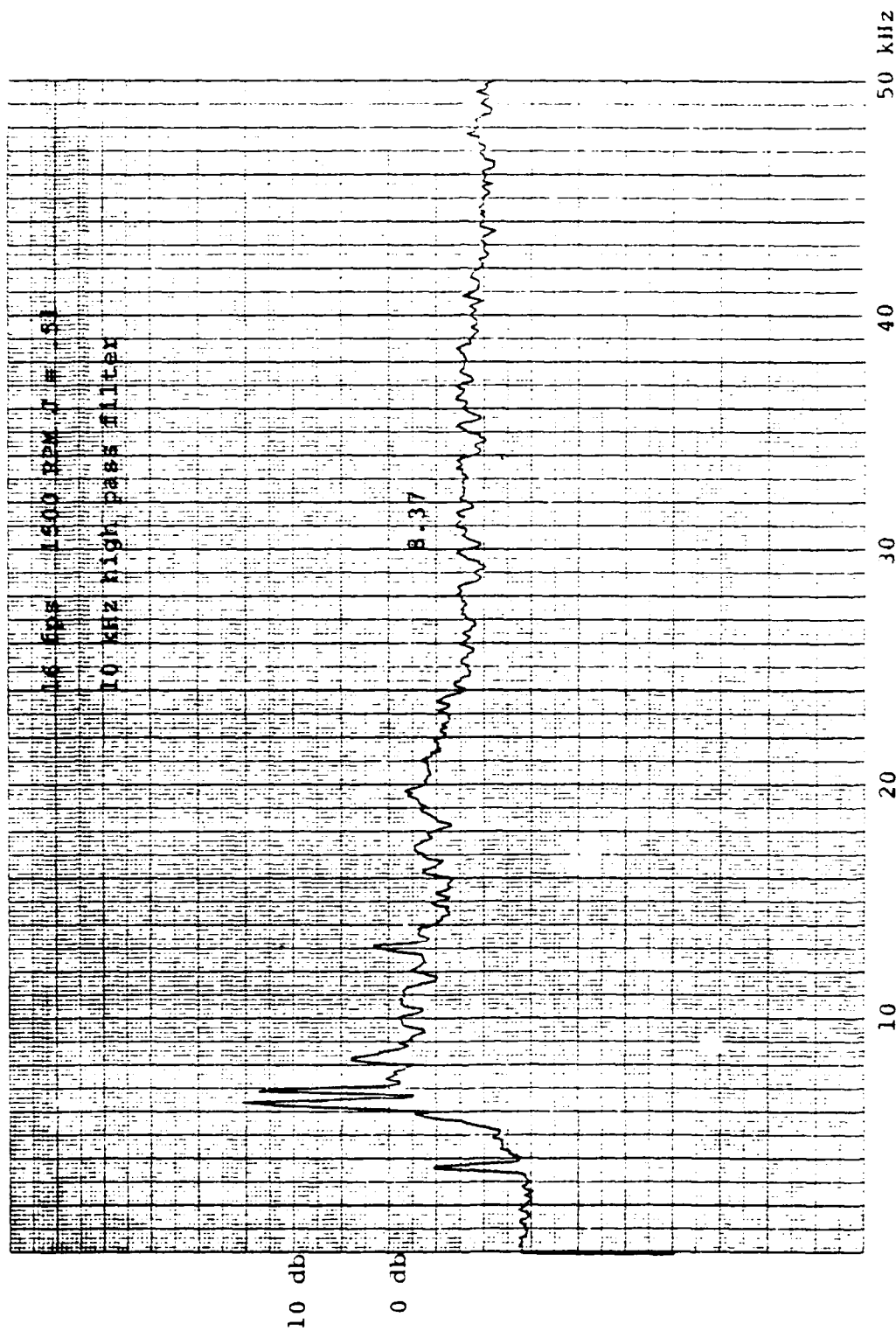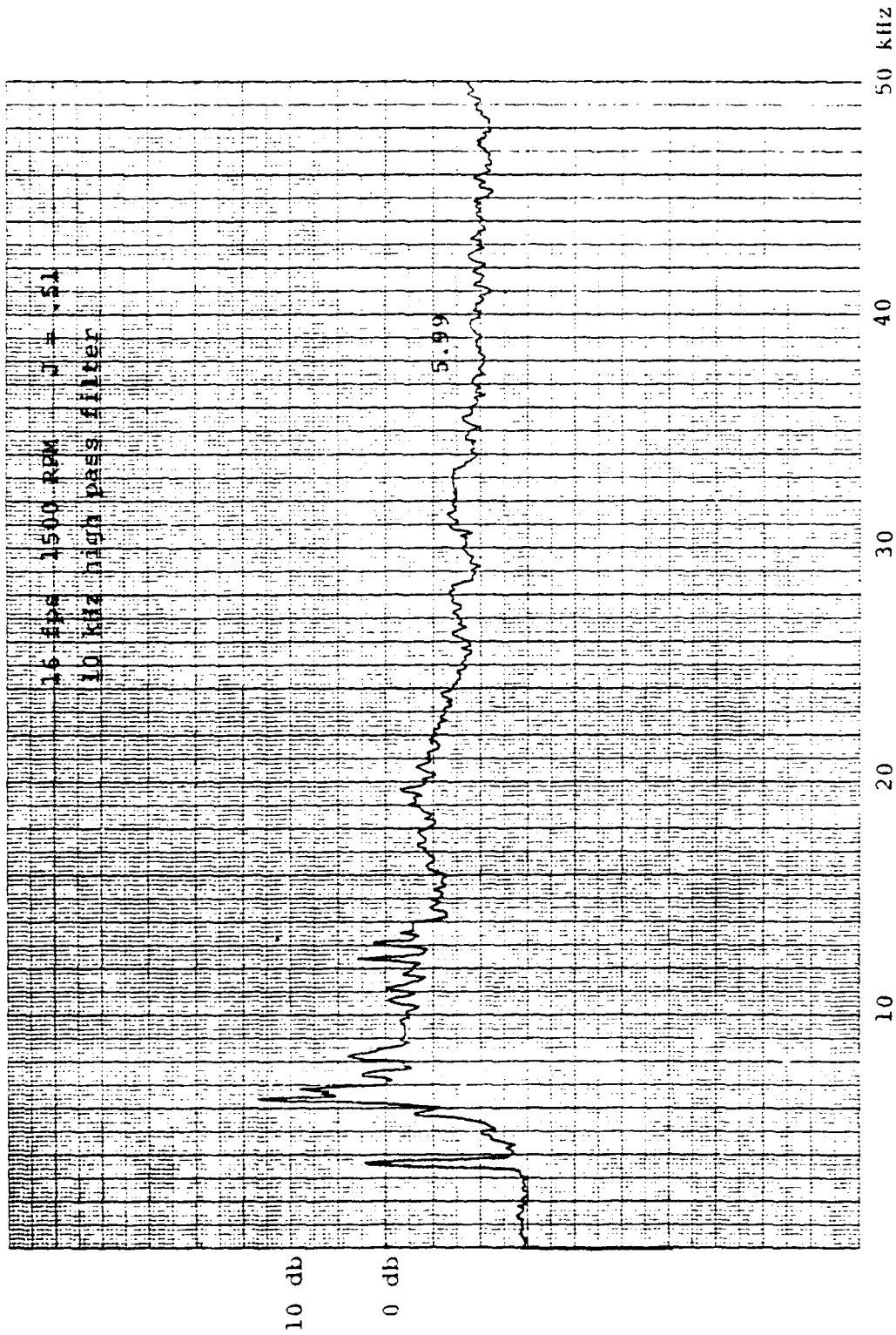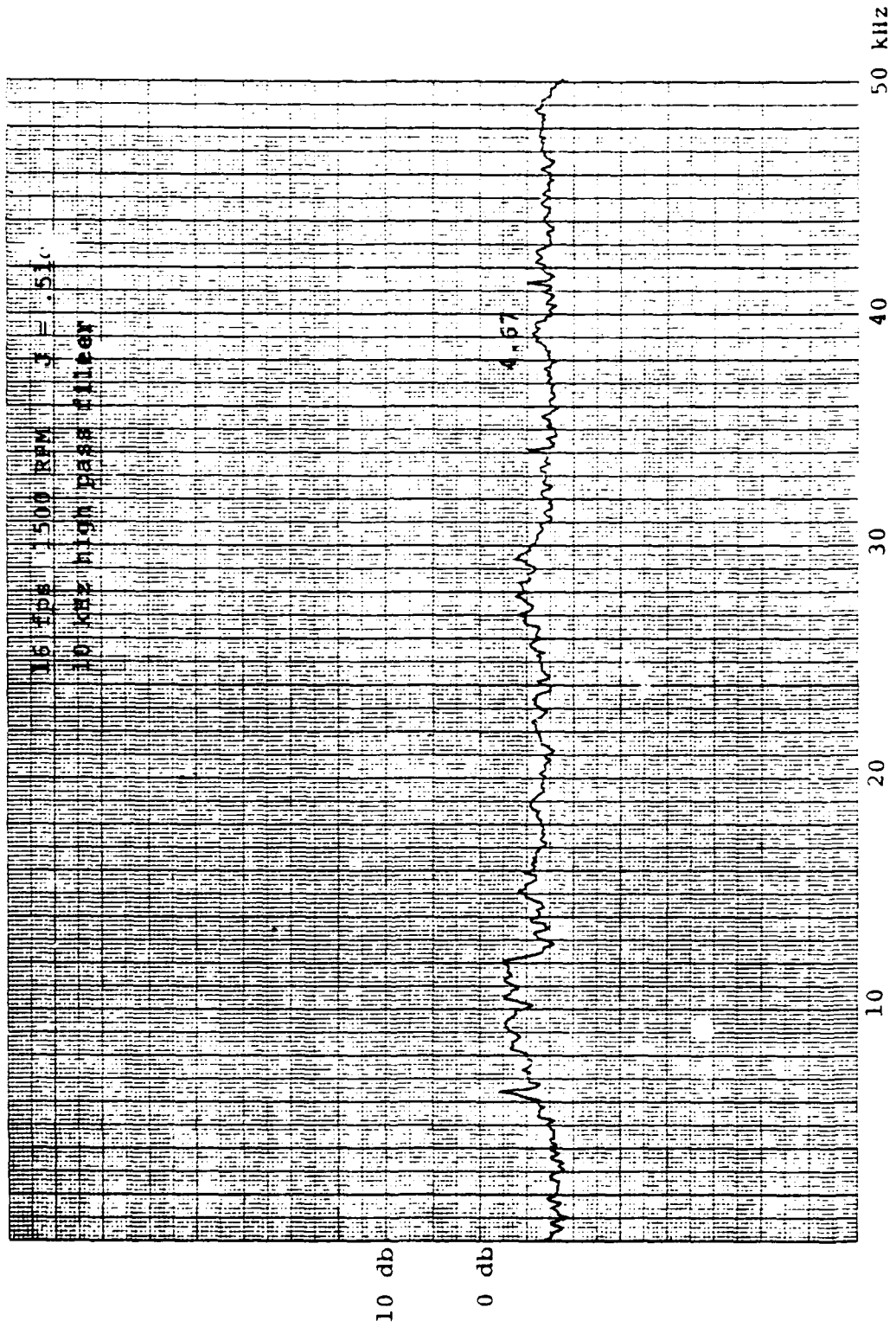
Figure 9

Figure 10

Figure 11

line at blade rate (number of blades times shaft rate)
indicated all blades were cavitating (despite the possibility
of the blade rate line merely being a harmonic of the shaft
rate line). The inception criteria for this analysis was
first taken to be the presence of lines at both shaft rate
and blade rate which were at least 3 db above the general
trend of the noise. A subsequent and less stringent criteria
finally adopted was to require the presence of a line 3 db
above the noise at blade rate frequency, with other lines
present at shaft rate spacing to verify that cavitation was
causing the line. Typical demodulated spectra are shown in
figures 12 and 13.

For each test, the value of σ_i obtained was plotted
against J to produce the cavitation inception curve. The
two different inception criteria for the demodulated signal
analysis were plotted on the same graph, but with
contrasting symbols and curves.
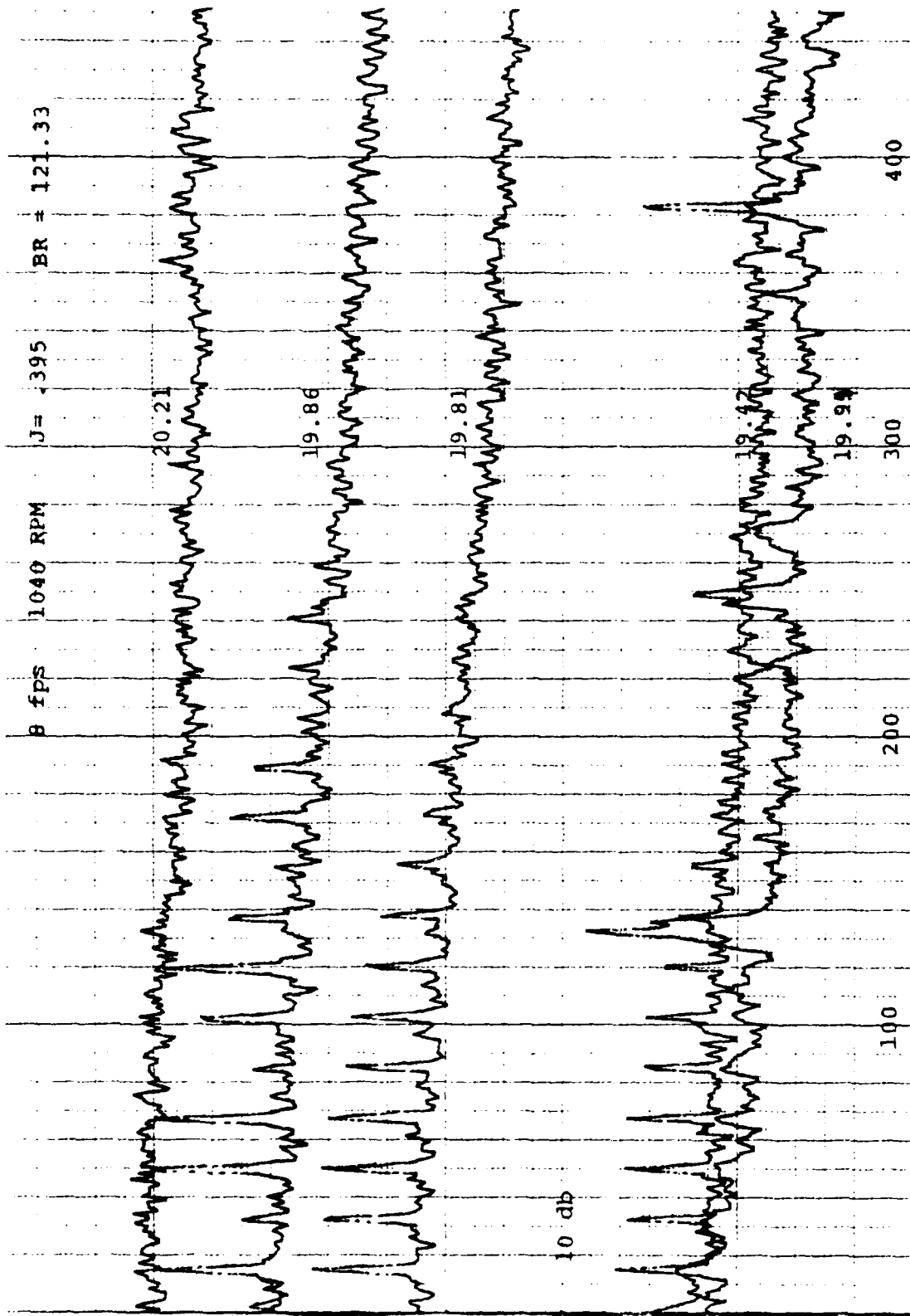
Figure 12
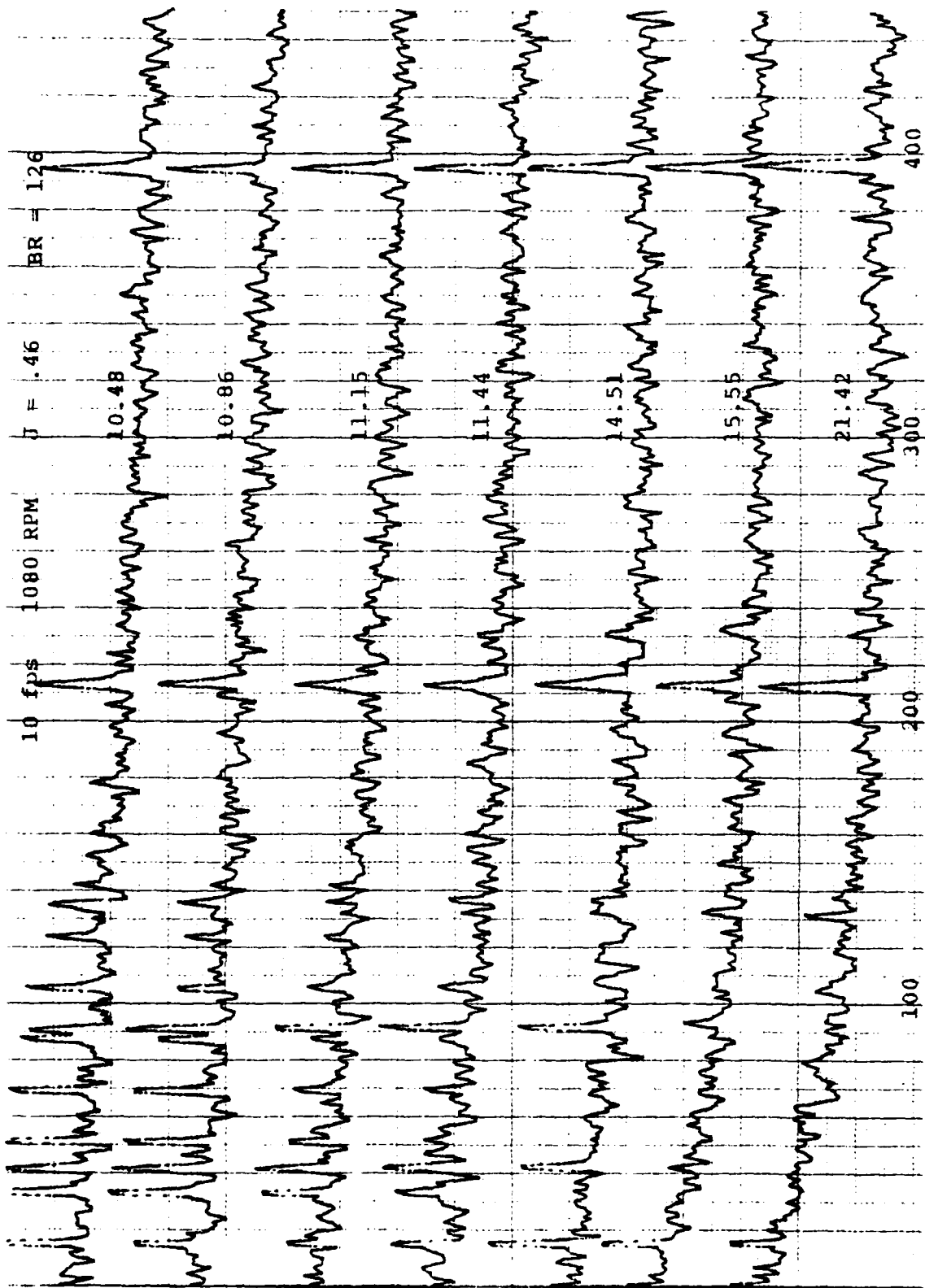
Figure 13

V.   RESULTS AND DISCUSSION

Curves of σ_i versus J for the visual and acoustic cavitation inception determinations are presented in figures 14 through 18. The comparison of acoustic and visual determinations for the one-third octave acoustic level measurements (figures 14 and 15) show a reasonably good agreement between the acoustically determined curve and the portion of the visually determined curve corresponding to the back bubble cavitation. However, tip vortex and leading edge face cavitation do not appear to be detected acoustically with the setup used.

Comparing the acoustic and visual results for the demodulated analysis of the acoustic signal figures 16, 17 and 18 shows a much better agreement for all types of cavitation, except for hub vortex cavitation. The results of the demodulated analysis of the 50-63 kHz band (figure 17) agrees almost exactly with the visually determined results for both of the inception criteria used with the acoustic analysis. The demodulated analysis of the acoustic signal above 20 kHz (figure 18) shows cavitation inception occurring at a higher value of σ for tip vortex cavitation than for the visual results, and at about equivalent values of σ for leading edge cavitation. The less stringent criteria for acoustically determined inception shows cavitation occurring at a higher value of σ than the more stringent criteria.

The two sets of results presented use different acoustic sensors. For the one-third octave level measurements,

Figure 14

Visually Determined
Cavitation Inception
(Upper screen holder
support unmodified)

O - Tip Vortex

△ - Back cavitation
    (bubble)

□ - Leading Edge Face
    Cavitation
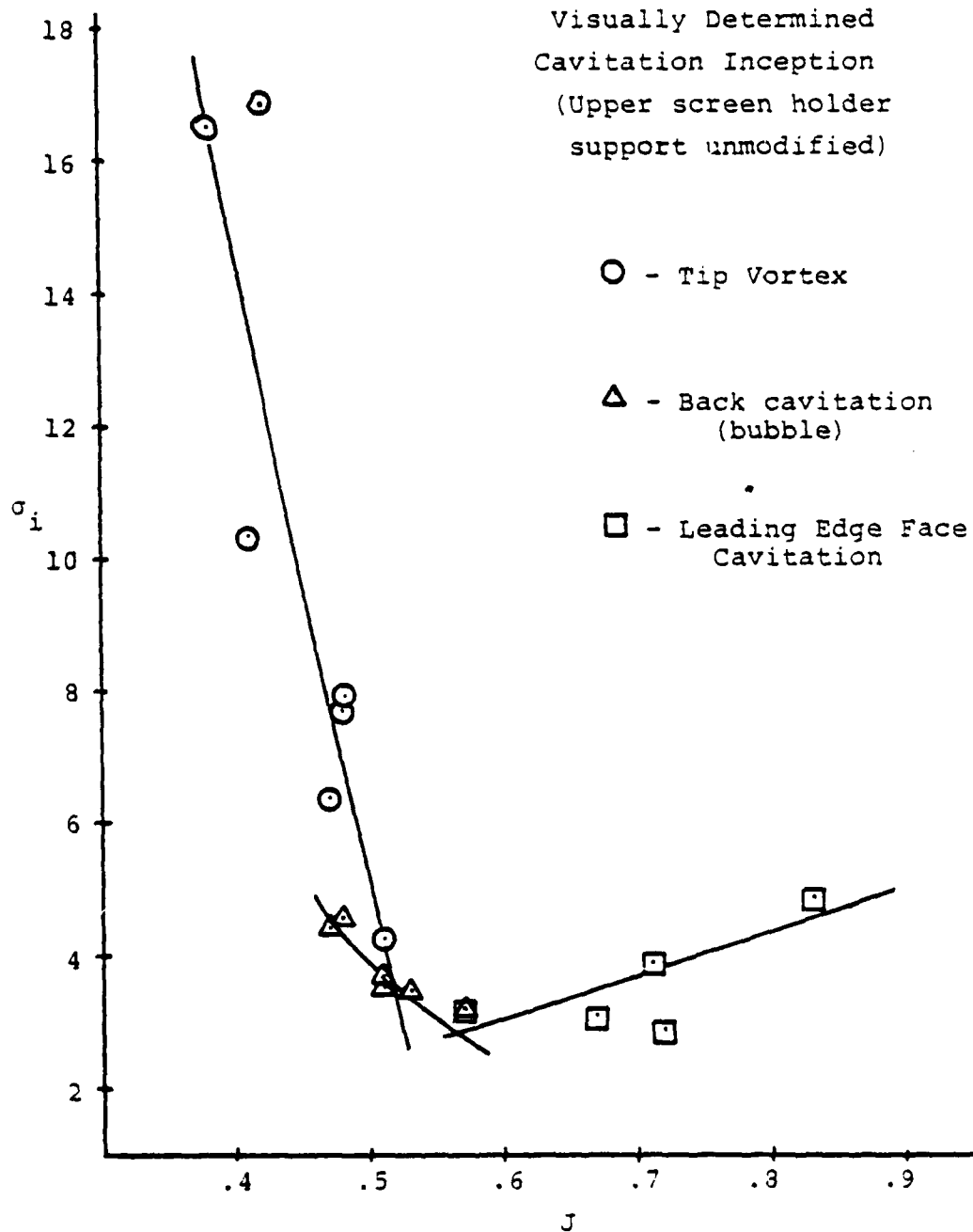
Figure 15

Acoustically Determined
Cavitation Inception
(Inception based upon one-
third octave band level.
Data point is average over
three bands - 30 to 60 KHz)

Figure 16

Visually Determined
Cavitation Inception

Figure 17

Acoustically Determined
Cavitation Inception
(Demodulated analysis of
signal passed through 20 KHz
high pass filter)

⊙ -• 3 db at blade rate
       and shaft rate

▣ - 3 db at blade rate
       with other lines at
       shaft rate spacing

Figure 18

Acoustically Determined
Cavitation Inception
(Demodulated analysis of
one-third octave band centered
at 56.12 KHz)

⊙ - 3 db at blade rate
and shaft rate

⊡ - 3 db at blade rate
with other lines at
shaft rate spacing

the accelerometer was used; but the demodulated analysis
presented used the hydrophone, since it was felt that the
higher usable frequency for the hydrophone was necessary.
However, a test run at J=0.62 (run number 2 of 4 March) was
performed to compare the acoustic information obtained from
the two sensors. Examples of the demodulated spectra from
the two sensors for a given σ are shown in figures 19
(hydrophone) and 20 (accelerometer). Except for the equipment
gain adjustments needed to accomodate the different
sensitivities of the sensors, the spectra are almost
identical, indicating that either sensor was usable for an
acoustic detection method.

It was expected that the curves of σ_i versus J would
show good agreement between the acoustic and visually
determined cavitation inception, and these results confirm
this. It was also expected that the acoustically determined
inception would anticipate (occur at a higher value of σ)
the visually determined inception. This, in general, did not
occur.

The higher value of σ at acoustically determined
inception is based upon bubble size considerations. It was
first assumed that the minimum bubble diameter which could
be detected visually under the conditions of a propeller
cavitation test was 0.001 in. This size was then taken to be
the maximum diameter ($2R_1$) of a bubble in the calculation
shown by Strasberg (1977) for the total lifetime of the cavity,

$$T = 2.7 \ R_1 \ \sqrt{\sigma/P_o}$$
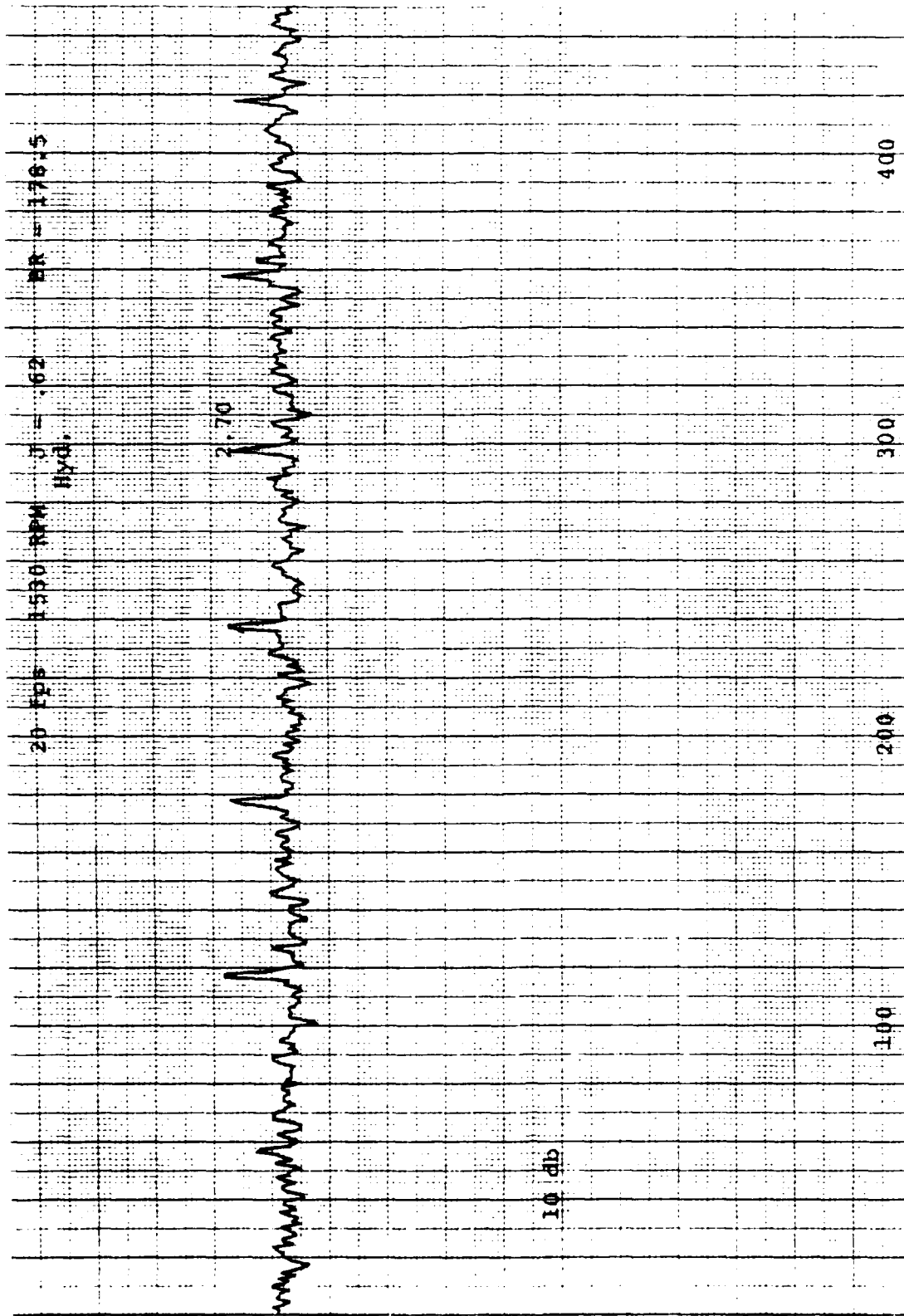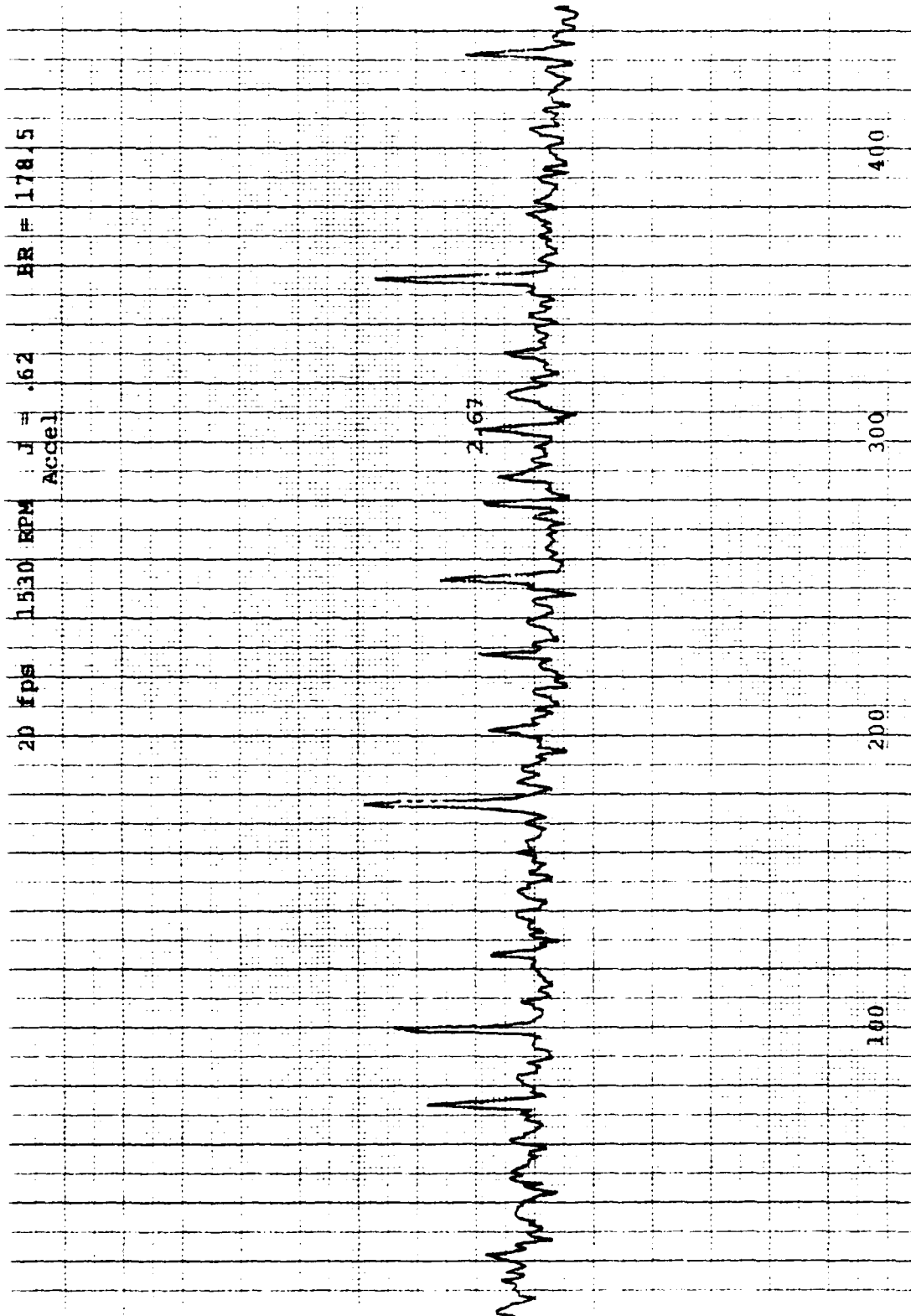
Figure 19

Figure 20

where c and P_O were taken to be representative of the
conditions in a cavitation test, $c = 1.93$ lb-sec^2/ft^4,
$P_O = 400$ mm Hg, or 1114 lb/ft^2. Under these conditions,
$T = 5.62 \times 10^{-4}$ sec, which corresponds to a frequency peak,
f_p, in the cavitation noise spectrum of 17 kHz. With P_O
equal to atmospheric pressure, $f_p = 24.5$ kHz. Since the
frequency used for this analysis was much higher than these,
it was felt that the detection of inception would occur at a
higher value of σ.

Two possible explanations for the observed result not
being in agreement with the prediction come to mind. The
first is that the existence of scale effects (affecting the
frequency scaling), due particularly to compressibility,
surface tension and viscous effects, were not taken into
account. If this caused the discrepancy, the use of high
frequency acoustic information to anticipate visual inception
determination would not be a workable scheme. However, if the
expected acoustic signal was present, but was not detectable
with the method or equipment used here, then anticipating the
visual inception determination is possible, so long as the
appropriate changes are made.

If the 0.001 in diameter bubble mentioned above is used
with Strasberg's non-dimensionalization for acoustic power,
the ratio of the power output with the spectral peak at 56 kHz
to that with the just barely visible bubble are given by,

$$\frac{\overset{\cdot}{P}_{acoustic}}{\overset{\cdot}{P}_{visual}} = \frac{D_a}{D_v} = \frac{f_v}{f_a} = \frac{17}{56} = 0.304$$

or about 10 db. Thus, without considering the noise present
or the increased absorption of the high frequency signal,
10 db of gain are required to have an equal acoustic signal
with the two conditions. When these other considerations
are included, it becomes obvious that increasing the gain of
the signal or decreasing the level of noise, or both, is
needed. The dramatic change between the inception information
obtainable with a one-third octave analysis and that
obtainable with the demodulated analysis tends to verify this.

By using an acoustic sensor which had some degree of
directivity, either by using an array of hydrophones or by
using some sort of reflector, an increase in the signal
to noise ratio could be expected. Problems encountered
with the instrumentation used could be corrected:

(1) There was no account taken of the changes in
absorption that occurs as air bubbles grow when the pressure
is reduced in the test section. The use of a calibrated
reference signal in the frequency range of interest would
enable correction of the acoustic signal levels for absorption.

(2) The combination of spectrum analyzer and X-Y
plotter used required about three minutes to produce a paper
copy of the demodulated spectrum, and the concurrent acoustic
and visual cavitation inception determination extended this
time span to the range of four to five minutes. Thus, for
each value of static pressure for a given J, about four
minutes were required, and the time required to produce each
data point on the σ_i versus J curve was about thirty minutes.

Because of time constraints on the availability of the test facilities and equipment, and the time required for each data point, two factors added to the inaccuracies in the results. First, each data point represented only one test at that value of J. Second, the steps in tunnel static pressure used were on the order of 25 mm Hg. This represents an error of 2 units of cavitation index at a tunnel flow speed of 6 feet per second or 0.3 units at 16 feet per second.

A more rapid analysis of the demodulated spectrum would make the method less time-consuming.

(3) During the time required for the spectrum analysis and averaging, tunnel flow speed and static pressure and propeller RPM would tend to drift on the order of one to five percent. The cumulative effects of these changes would also affect the accuracy of the analysis by causing variations (although slight) in the frequency of interest and by affecting the values of σ and J for the test run.

VI. CONCLUSIONS

Strasberg (1977) points out that "it is not possible
to estimate the inception cavitation number of the prototype
from model measurements without using empirically or
theoretically determined scale factors." However, the results
here show that it is possible to determine the cavitation
inception performance of a model propeller by acoustic means
at least as accurately as by visual means, as long as an
adequate system for detecting the noise from all types of
cavitation was available. And although the acoustically
determined inception would require the same scale factors
mentioned by Strasberg to predict full scale inception, the
use of an acoustic inception determination technique for
model tests does have advantages.

First, where full scale inception measurements are
made acoustically, an acoustic measurement technique for
the model would eliminate any scale effect that would occur
between model and full scale measurements caused by visual
observation on the model and acoustic determination on the
full scale propeller. Although the results indicate that for
the propeller tested here this scale effect would be small,
the test of a different propeller, with a different length
scale might show a greater difference between acoustic and
visual results.

Second, displaying the spectrum of the demodulated
cavitation noise signal gives a more definitive criteria for
inception than visual methods, as expected.

VII. REFERENCES

Pitzpatrick, H.M. Strasberg, M.	1959	"Hydrodynamic Sources of Sound," David Taylor Model Basin (DTMB) Report 1269 (Reprinted from the First Symposium on Naval Hydrodynamics
Lehman, A.F.	1964	"Some Cavitation Observation Techniques for Water Tunnels and a Description of the Oceanics Tunnel," Proc. of Symposium on Cavitation Research Facilities and Techniques, American Society of Mechanical Engineers.
McCarthy, J.H.	1963	"A Method of Wake Production in Water Tunnels," DTMB Report 1785.
Pope,A Harper, J.J.	1966	Low Speed Wind Tunnel Testing, John Wiley & Sons, Inc., New York.
Rose, J.D., Jr.	1969	"IBM-7090 Computer Program for Design Calculations of Wake Screens," David Taylor Naval Ship Research and Development Center Hydrodynamics Laboratory Technical Note 59.
Ross, D.	1976	Mechanics of Underwater Noise, Pergamon Press, Elmsford, New York.
Strasberg, M.	1946	"The Development of Cavitation Noise by Model Propellers," DTMB Report 543.
Strasberg, M.	1977	"Propeller Cavitation Noise: Thirty Years of Research," in Noise and Fluids Engineering, presented at the ASME Winter Meeting.

Appendix A

Details of the Wake Screen Design

The method developed by McCarthy (1963) and adapted into a FORTRAN program by Rose (1969) attempts to determine the value of the non-dimensional resistance coefficient for a grid,

$$K = \frac{\Delta p}{\frac{1}{2}\rho w_o^2} \qquad (1)$$

where Δp is the local static pressure drop across the screen grid and w_o is the local velocity normal to the grid. McCarthy points out that an empirical estimate for K for a given screen laid over a support screen is given by

$$K = 0.78 \frac{s}{(1-s)^2} + K_s \qquad (2)$$

where: s, the solidity ratio for the screen =

   $MD(2-MD)$

   M is the number of wires per inch in the mesh

   D is the diameter of the wire in inches

   K_s is the resistance coefficient for the support
   screen

The program written by Rose requires that the test section area be subdivided into smaller areas, A_i, with a flow velocity, V_i, associated with each area, which is the average velocity for the subdivision. The overall velocity average is then calculated,

$$V_{avg} = \frac{\Sigma \ A_i V_i}{\Sigma \ A_i} \qquad (3)$$

Then, for each area, the resistance coefficient, K_i, is calculated as follows:

(1) The integration constant, γ_o, from McCarthy's solution is determined from the area having the maximum average velocity, V_{max}, which is assumed to have the resistance coefficient, K_s, for the support screen only:

$$\gamma_o = \frac{1}{N} \left\{ \frac{(2+K_s-\chi_s)^2}{\chi_s+1} \right\}^{1/3} \left\{ \frac{V_{max}}{V_{avg}} - 1 \right\} + \chi_s - \frac{1}{6(K_s+1)} \qquad (4)$$

$$\text{where} \qquad \chi_s = (1+K_s)^{\frac{1}{2}}$$
$$N = 1.02$$

(2) For each area, A_i, with its associated V_i, K_i is determined by solving the following equation for K_i:

$$\frac{V_i}{V_{avg}} = 1 + \left\{ \gamma_o-\chi_i- \frac{1}{6(K_i+1)} \right\} \ N \left\{ \frac{\chi_i+1}{(2+K_i+\chi_i)^2} \right\}^{1/3} \qquad (5)$$

$$\text{where} \qquad \chi_i = (1+K_i)^{\frac{1}{2}}$$
$$N = 1.02$$

(3) Once K_i is determined for each area, the last step is to account for the deflections of the streamlines by the changes in velocity caused by the wake screen. This is done by an iterative procedure which adjusts the areas, A_i, until the volume flow rate at the screen is equal to the volume flow rate at the propeller (this assumes that the screen is within

one tunnel diameter of the propeller, and it uses an empirical
constant, α). The result is a correction to the actual screen
area for each subdivision.

For this experiment, this program was adapted for use
with a TI-59 programmable hand calculator. The test section
was divided into four areas, each with its associated velocity,
as shown in Table A-1. These areas and velocities were based
upon the desired circumferential mean wake information provided
for the velocities over the propeller disk, and an estimate for
the average velocity outside that area. For each area, K_i and
the area correction, ΔA_i, were determined from the program.

At this point Rose's method and the one used here
become different. When a large number of screens with different
meshes and wire diameters are available, having a screen
available with the proper resistance coefficient enables the
final wake screen to be assembled by piecing together the
correct screens on the support screen. But here, the desired
screens were not all available, so an alternative had to be
developed.

The alternative was based on an interpretation of
information given in Pope and Harper (1966) on turbulence
generation by screens in wind tunnels. This text indicates
that the cumulative effect of several layers of screens was
additive. This seemed to be supported by the empirical
formula for K in equation (2), where the effect of the support
screen and the wake producing screen are added. It was

Table A-1

Wake Characteristics

Area Designation	Range of r/R	A_i	V_i	$A_{i\ cor}$	r/R corr	K_{req}
1	∞ - 1.0	308.39	.97	317.86	∞ -.946	0.4612
2	1.0-0.7	46.72	.817	44.51	.946-.641	0.9462
3	.7-.5	21.99	.636	18.78	.641-.454	1.756
4	.5-.23	18.06	.510	14.01	.454-.23	2.531

felt that, even though Pope and Harper note that the effect of the screens was additive only if they did not touch, assuming that the effect was additive would be satisfactory for a first approximation.

Thus, the desired initial K_i values were obtained by using several layers of two different screens. The characteristics of these screens are listed in Table A-2, and the actual K_i for the screens used is listed in Table A-1. The was screen was then assembled, with the pieces of screen wired onto the support screen with pieces of 0.020 in stainless steel wire. A wake survey conducted with the Laser Doppler Anemometer was performed along the diagonal line shown in figure 3 previously.

The determination of velocities in the wake was done with the propeller removed from the shaft. The longitudinal flow speeds were determined in the plane 2.5 in downstream of the propeller blade leading edges. The results of this and all other wake surveys performed are contained in Appendix B.1. The results for this initial screen are plotted in figure A-1.

From the plot of non-dimensional velocity versus non-dimensional radius, r/R, it was possible to determine the average velocities actually obtained for each of the subdivided areas used, since the wake was to be axisymmetric. From the actual values of V_i, equations (4) and (5) were then used to determine the actual K_i obtained from the screen used for each area, shown in Table A-3. At this point it was

Table A-2

Screen Characteristics

Mesh, M	Wire Diameter, D	Solidity ratio, s	$K-K_s$
8×8	0.020 in	.2944	.4612
18×18	0.012 in	.3853	.7956

Table A-3

Comparison of Installed and Measured K Values

Area	K_{req}	K_{inst}	ΔK_{inst}	K_{meas}	ΔK_{meas}	ΔK ratio
1	0.4612	0.4612	–	0.4612	–	–
2	0.9462	0.9224	0.4612	1.1813	0.7201	1.560
3	1.756	1.7179	0.7954	2.4197	1.2384	1.557
4	2.531	2.5134	0.7954	4.106	1.6863	2.120

assumed that the calculated drag associated with the support
screen was correct, and the remaining screen layers could
be adjusted to develop the desired wake.

Still assuming that the effect of multiple layers of
screen material was additive, the measured increase in K_i for
each increment of screen material was determined (ΔK_i in Table
A-3). In each case, the ratio of measured ΔK_i to installed
ΔK_i was determined. The results of these calculations were
interpreted as follows:

(1) In area 2, the same material as that found in 1 was
added, and the increase in K was 1.56 times greater than
that expected from the simple addition of resistance
coefficients.

(2) Comparing measured results for areas 3 and 4, the
increase from adding another layer of the same material
was 1.36 ($\frac{1.6863}{1.2384}$ = 1.36) times greater than the expected
result.

(3) The apparent effect of adding the screen of area 3
onto that of area 2 was 1.56 greater than expected.

(4) Thus, an average increase in the resistance
coefficient from adding layers of screen material was
felt to be on the order of 1.5 times the expected result.
In terms of the screen material available, this meant that the
3×3×.020" screen material would be used for all screen layers,
with each added layer having 1.5 times the resistance
coefficient of the single layer. Table A-4 shows the
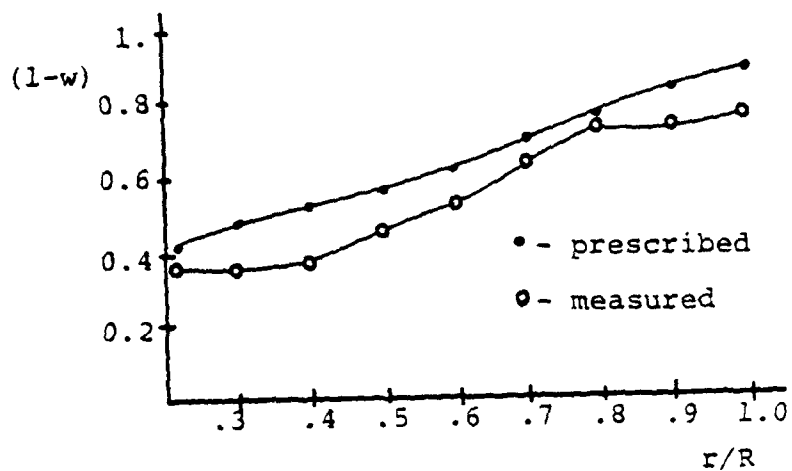
Wake Survey - Initial Wake Screen

Figure A-1
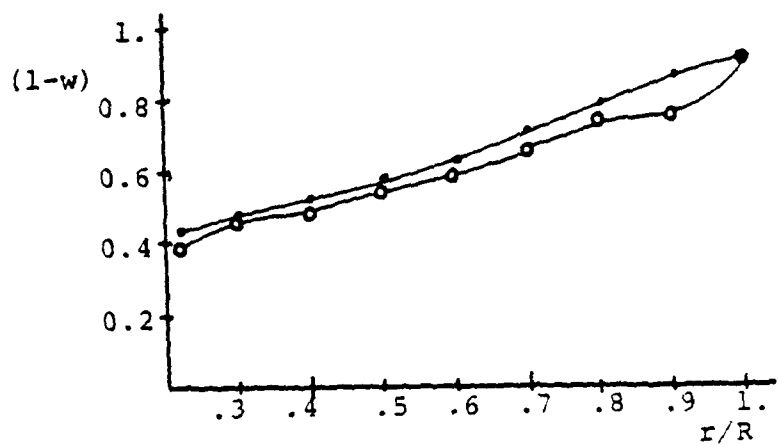
Wake Survey - Final Wake Screen

Figure A-2

calculated $K_{installed}$ values for the four wake screen areas
compared to the required K values, where

$$K_{calc} = K_s + 1.5K_{screen}$$

This screen was assembled as noted previously, and another
wake survey was made at the same points as before.

The results of this survey are shown graphically in
figure A-2. The low velocity seen at the outer radii
correspond to the use of a screen giving higher than the
required value of K in area 2. Lacking a screen with a
small enough K to correct this discrepancy, this wake was
considered to be acceptable.

Table A-4

Final Screen Resistance Coefficients

Area	K_{req}	K added	K_{calc}
1	0.4612		0.4612
2	0.9462	0.4612	1.148
3	1.756	0.4612	1.836
4	2.531	0.4612	2.523

APPENDIX B

Raw Data

The following pages of this section contain the propeller operating conditions data sheets, the graphs of sound level versus cavitation index for one-third octave level measurements, and the X-Y plotter outputs for the demodulated spectra and for the analysis of the complete spectrum. Since, in some cases, the recorded data may not be completely clear as to what is being presented, some clarifying explanations are presented here.

Wake survey data - For tables B-1 and B-2, the velocity used to obtain (1-w) is the $V_{\infty avg}$ calculated from the 6,7,and 8 inch radial positions. For table B-3, the velocity used is the velocity from the manometer height, 12.0 fps.

One-third octave band level - The conversion factors for T to thrust and Q to torque for this series of tests and for the data of sections B.5, B.6 and B.7 are on the data sheet for run number 1. In these and all subsequent data sheets the first number in the "GAIN CHANGE" column refers to the code number for the amplifier shown in the upper section, the second number gives the setting to which the selector was changed. In the "REMARKS" column for this section only are three numbers which refer to the displayed

level on the measuring amplifier meter for the 31.5-40 kHz band, the 40-50 kHz band, and the 50-63 kHz band, respectively. For all sections of the appendix this column also contains the visual inception determinations as follows: any visual inception determination will have a * , together with a TV for tip vortex cavitation, HV for hub vortex cavitation, LEPF for leading edge pressure face cavitation, LESF for leading edge suction face cavitation, BB or BACK for back bubble or back cavitation. The points plotted on the plots of db versus σ are the arbitrary level from the measuring amp meter. The top plot is the 31.5-40 kHz level, the middle is the 40-50 kHz level, and the bottom is the 50-63 kHz level.

Demodulated Analysis - The conversion factors for thrust and torque for these two sections are on the first data sheet for the 20 kHz high pass signal. On these and all plots from the X-Y plotter, 10 db is represented by 20 of the smallest divisions (2 cm total). For the plots in these two sections, the first plot made was the one at the bottom of the page. For each subsequent plot, the zero setting for the X-Y plotter was placed 2 cm higher (10 db). Unless noted on the associated data sheet, no gain adjustments were made. On these and all subsequent

plots the number typed in beside a particular curve
is the value of the cavitation index associated with
that plot.

Table B-1

Wake Survey Data -
Initial Wake Screen

R	θ	Scale		Volts	(1-w)
		Hor.	Vert.		
8	135	11.74	91.60	.831,.831,.831	-
7	135	13.08	89.80	.837,.837,.837	-
6	135	14.43	88.01	.827,.827,.827	-
5.4	135	15.24	86.93	.690,.693,.692	.827
4.86	135	15.97	85.96	.637,.638,.637	.762
4.32	135	16.69	84.99	.622,.623,.623	.745
3.78	135	17.42	84.02	.546,.546,.547	.653
3.24	135	18.15	83.05	.443,.440,.443	.529
2.70	135	18.87	82.08	.361,.366,.365	.436
2.16	135	19.60	81.11	.280,.284,.293	.338
1.62	135	20.33	80.14	.269,.268,.270	.321
1.24	135	20.84	79.46	.298,.294,.296	.354
1.24	315	24.18	75.00	.328,.331,.330	.394
1.62	315	24.69	74.32	.339,.341,.343	.408
2.16	315	25.42	73.35	.365,.362,.360	.433
2.70	315	26.15	72.38	.408,.407,.407	.427
3.24	315	26.87	71.41	.443,.443,.443	.530
3.78	315	27.60	70.44	.540,.539,.540	.645
4.32	315	28.33	69.47	.623,.622,.622	.744
4.86	315	29.05	63.50	.633,.634,.632	.757
5.4	315	29.78	67.53	.759,.771,.770	.917
6	315	30.59	66.45	.844,.844,.844	-
7	315	31.94	64.66	.839,.841,.838	-
0	0	22.51	77.28	-	-

1 Volt = 20.805 ft/sec

$V_{\infty avg}$ = .836 V = 17.4 ft/sec

Table B-1 (Continued)

Comparison With Prescribed Wake
Initial Wake Screen

r/R	$(1-w)_{avg}$	$(1-w)_{req}$	Error
1.	.872	.903	-.03
0.9	.759	.846	-.10
0.8	.745	.784	-.05
0.7	.649	.710	-.09
0.6	.529	.636	-.17
0.5	.461	.573	-.19
0.4	.385	.528	-.27
0.3	.365	.488	-.25
0.23 ·	.374	.431	-.13

Table B-2

Wake Survey Data -
Final Wake Screen
(Unmodified upper support)

R	θ	Scale		Volts	(1-w)
		Hor.	Vert.		
8	135	11.74	91.60	.836,.837,.837	-
7	135	13.08	89.80	.833,.835,.338	-
6	135	14.43	88.01	.836,.836,.837	-
5.40	135	15.24	86.93	.741,.739,.739	.883
4.86	135	15.97	85.96	.617,.617,.618	.737
4.32	135	16.69	84.99	.603,.602,.601	.718
3.78	135	17.42	84.02	.529,.526,.523	.625
3.24	135	18.15	83.05	.477,.476,.477	.567
2.70	135	18.87	82.08	.441,.441,.443	.525
2.16	135	19.60	81.11	.406,.407,.406	.485
1.62	135	20.33.	80.14	.391,.390,.395	..468
1.24	135	20.84	79.46	.272,.288,.287	.332
1.24	315	24.13	75.00	.379,.379,.379	.459
1.62	315	24.69	74.32	.404,.404,.400	.483
2.16	315	25.42	73.35	.418,.416,.415	.499
2.70	315	26.15	72.38	.480,.478,.479	.574
3.24	315	26.87	71.41	.514,.516,.517	.618
3.78	315	27.60	70.44	.575,.579,.578	.693
4.32	315	28.33	69.47	.621,.623,.623	.745
4.86	315	29.05	68.50	.630,.629,.631	.754
5.40	315	29.78	67.53	.762,.769,.769	.919
0	0	22.51	77.28		

$$V_{\infty avg} = .836 \ V = 17.4 \ \text{ft/sec}$$

Table B-2 (Continued)

Comparison With Prescribed Wake
Final Wake Screen
(Unmodified upper support)

r/R	$(1-w)_{avg}$	$(1-w)_{req}$	Error
1.0	.901	.903	-.003
0.9	.746	.846	-.118
0.8	.732	.784	-.066
0.7	.659	.710	-.072
0.6	.593	.636	-.068
0.5	.550	.573	-.040
0.4	.491	.528	-.070
0.3	.475	.488	-.027
0.23	.395	.431	-.083

Table B-3

Wake Survey Data -

Final Wake Screen
(Modified upper support)

y	z	Scale		Volts	Speed	(1-w)
		Hor.	Vert.			
6	1	37.91	75.84	.646	13.44	1.12
	0		78.38	.687	14.29	1.19
	-1		80.92	.656	13.65	1.14
5	-3	36.00	86.00	.633	13.17	1.10
	-2		83.46	.546	11.36	.95
	-1		80.92	.513	10.67	.89
	0		78.38	.597	12.42	1.04
	1		75.84	.578	12.03	1.0
	2		73.30	.601	12.50	1.04
	3		70.76	.648	13.48	1.12
4	4	34.10	68.22	.655	13.63	1.14
	3		70.76	.505	10.51	.88
	2		73.30	.470	9.78	.81
	1		75.84	.462	9.61	.80
	0		78.38	.543	11.30	.94
	-1		80.92	.501	10.42	.87
	-2		83.46	.478	9.94	.83
	-3		86.00	.506	10.53	.88
	-4		88.54	.556	11.57	.96
3	-4	32.19	88.54	.516	10.74	.89
	-3		86.00	.507	10.55	.88
	-2		83.46	.438	9.11	.76
	-1		80.92	.407	8.47	.71
	0		78.38	.483	10.05	.84
	1		75.34	.411	8.55	.71
	2		73.30	.410	8.53	.71
	3		70.76	.460	9.57	.80
	4		68.22	.549	11.42	.95

Table B-3 (Continued)

y	z	Scale		Volts	Speed	(1-w)
		Hor.	Vert.			
2	5	30.29	65.68	.656	13.65	1.14
	4		68.22	.476	9.90	.83
	3		70.76	.455	9.47	.79
	2		73.30	.363	7.55	.63
	1		75.84	.287	5.97	.50
	0		78.38	.355	7.39	.62
	-1		80.92	.334	6.95	.58
	-2		83.46	.369	7.68	.64
	-3		86.00	.469	9.76	.81
	-4		88.54	.434	9.03	.75
	-5		91.08	.430	8.95	.75
1	-6	28.38	93.62	.459	9.55	.80
	-5		91.08	.340	7.07	.59
	-4		88.54	.370	7.70	.64
	-3		86.00	.370	7.70	.64
	-2		83.46	.269	5.60	.47
	-1		80.92	.259	5.39	.45
	1		75.84	.266	5.53	.46
	2		73.30	.357	7.43	.62
	3		70.76	.450	9.36	.78
	4		68.22	.480	9.99	.83
	5		65.68	.645	13.42	1.12
	6		63.14	.657	13.67	1.14
0	6	26.48	63.14	.690	14.36	1.20
	5		65.68	.673	14.00	1.17
	4		68.22	.556	11.57	.96
	3		70.76	.480	9.99	.83
	2		73.30	.394	8.20	.68
	-2		83.46	.257	5.35	.45
	-3		86.00	.289	6.01	.50
	-4		88.54	.297	6.18	.51
	-5		91.08	.290	6.03	.50
	-6		93.62	.400	3.32	.69

Table B-3 (Continued)

y	z	Scale Hor.	Vert.	Volts	Speed	(1-w)
-1	-6	24.58	93.62	.491	10.22	.85
	-5		91.08	.360	7.49	.62
	-4		88.54	.354	7.36	.61
	-3		86.00	.355	7.39	.62
	-2		83.46	.329	6.84	.57
	-1		80.92	.273	5.68	.47
	1		75.84	.308	6.41	.53
	2		73.30	.359	7.47	.62
	3		70.76	.401	8.34	.70
	4		68.22	.484	10.07	.84
	5		65.68	.638	13.27	1.11
	6		63.14	.659	13.71	1.14
-2	5	22.67	65.68	.646	13.44	1.12
	4		68.22	.486	10.11	.84
	3		70.76	.444	9.24	.77
	2		73.30	.317	6.60	.55
	1		75.84	.329	6.84	.57
	0		78.38	.346	7.20	.60
	-1		80.92	.377	7.84	.65
	-2		83.46	.366	7.61	.63
	-3		86.00	.438	9.11	.76
	-4		88.54	.438	9.11	.76
	-5		91.08	.483	10.05	.84
-3	-4	20.77	88.54	.500	10.40	.87
	-3		86.00	.476	9.90	.83
	-2		83.46	.430	8.95	.75
	-1		80.92	.405	8.43	.70
	0		78.38	.504	10.49	.87
	1		75.84	.447	9.30	.77
	2		73.30	.455	9.47	.79
	3		70.76	.457	9.51	.79
	4		68.22	.517	10.76	.90

Table B-3 (Continued)

y	z	Scale		Volts	Speed	(1-w)
		Hor.	Vert.			
-4	4	18.86	68.22	.629	13.09	1.09
	3		70.76	.495	10.30	.86
	2		73.30	.459	9.55	.80
	1		75.84	.492	10.24	.85
	0		78.38	.481	10.01	.83
	-1		80.92	.438	9.11	.76
	-2		83.46	.501	10.42	.87
	-3		86.00	.507	10.55	.88
	-4		88.54	.602	12.52	1.04
-5	-3	16.96	86.00	.648	13.48	1.12
	-2		83.46	.572	11.90	.99
	-1		80.92	.523	10.88	.91
	0		78.38	.552	11.48	.96
	1		75.84	.632	13.15	1.10
	2		73.30	.618	12.86	1.07
	3		70.76	.648	13.48	1.12
-6	1	15.05	75.84	.648	13.48	1.12
	0		78.38	.686	14.27	1.19
	-1		80.92	.651	13.54	1.13
-6.5	-6.5	14.10	94.89	.651	13.54	1.13
-6	-6	15.05	93.62	.653	13.59	1.13
-5.5	-5.5	16.01	92.35	.666	13.86	1.15
-5	-5	16.96	91.08	.6	13.67	1.14

$U_{nominal}$ = 12 fps   1 Volt = 20.305 fps

Coordinates are in inches.   (1-w) is based on 12 fps

DATA SHEET

RUN NO __1/9__
DATE __2/25/79__

U_{nom} __10__   RPM __950__ J_{nom} __.51__   Shaft rate _____

(Taps: 6/5 blue)   Blade rate _____

Ithaco amp① __+60__ db; Filter: Hi pass _____   Trans Anal

Lo pass _____   ② _____ db

Measuring   Input atten③ __0.1 V__ ~~db~~ Meas amp __X__   (# of
Equipment: Output gain④ __x 1__ ~~db~~ Spect anal. ___ spectra___)

Temperature: (Start) water __78__ air __75__ Reynolds number:

(End)   __78__   __75__

Thrust in lbs = $T \times 0.200$ Torque in ft-lbs = $\frac{Q}{12}$

MAN	STAT	RPM	T	Q	GAIN CHANGE	K_T	J	C	J	REMARKS
11	B+L 769.5	1006	-2	10.5						TARE
										db
										31.5- 40- 50· 40 · 50 63
371	399	951	260	101						15 11 8.5
370	365	954	258	101.5						15 0.8 8
370	343	953	257	101.5						15 9.5 6
369	325	953	257	101.5						13 7 5
372	300	953	248	10.5						0.5 5 4
371	272	953	242	101.5						5 4 9.3
370	228	955	230	100						16.3 11.5 10.8

DATA SHEET

RUN NO **2/9**

DATE **7/25**

U_{nom} **10**   RPM **1200** J_{nom} **.458**   Shaft rate _____

(Taps: 6/5 blue)   Blade rate _____

Ithaco amp① **+80** db; Filter: Hi pass _____   Trans Anal

Lo pass _____   ②_____ db

Measuring Equipment: Input atten③ **0.3V** db   Meas amp **X**   (# of

Output gain④ **x1** db   Spect anal. ___ spectra___)

Temperature: (Start) water **78** air **75**   Reynolds number:

(End) **78**   **75**   **7.6×10⁵**

MAN	STAT	RPM	T	Q	GAIN CHANGE	K_T	J		REMARKS		
370	787	1202	616	182.5		.24	.41	22.52	17.5	13.2	16
372	620	1205	596	183		.243		17.62	17	12	9
370	592	1202	596	183.5				16.92	16.6	12	9
370	564	1203	590	183				16.11	16.4	11.6	8.5
371	538	1203	588	183.5				15.32	15.7	11.0	7.8
369	578	1203	586	183.5				14.53	15.6	11.0	7.8
370	484	1204	582	183				13.81	15.6	11.2	7.8
370	460	1204	580	184				13.12	15.6	11	7.5
371	425	1204	576	184				12.07	16	11	7.5
369	396	1205	572	184				11.31	17	12	9
369	363	1505	568	183.5				10.35	16.2	12.2	6 ✱
369	353	1505	566	183.5				10.07	15.6	11.2	9.5
370	312	1505	566	184				9.72	14.6	10.5	9
370	319	1505	562	183.5					10	6	7
370	291	1206	556	183					1	1	5

DATA SHEET

RUN NC 3/9

DATE 2/25

U$_{nom}$ 16   RPM 1300   J$_{nom}$ .378   Shaft rate _____

(Taps: 6/5 blue)   Blade rate _____

Ithaco amp① +80 db;Filter: Hi pass _____ Trans Anal

Lo pass _____   ②_____ db

Measuring   Input atten③ 0.3 U db Meas amp X   (≠ of

Equipment: Output gain④ ×1 db Spect anal. ___ spectra___)

Temperature: (Start) water 78 air 75 Reynolds number:

(End)   78   75   8.19×10⁵

MAN	STAT	RPM	T	Q	GAIN CHANGE		K$_T$	J	C	REMARKS		
370	783	1300	762	221			.255	.38	22.49	19	15	12
371	665	1300	744	220.5	1	+70				13.2	9	6.5
371	606	1297	734	219.5						.13	9	6.5
370	578	1299	734	220						13	9.2	7
371	559	1299	730	220						13.2	9	6.2
370	535	1300	732	221						13.4	9.1	7
371	509	1301	730	221						13.5	9	6.3
371	483	1302	728	221.5						13	8.6	6
371	460	1302	724	221.5						13.5	8	5.4
371	436	1300	718	221						12.6	8.2	6
370	409	1300	714	220.5						11.9	7.6	5.8

DATA SHEET

RUN NO $4/9$

DATE $2/95$

U_{nom} 16 RPM 1650 J_{nom} $.746$ Shaft rate _____

(Taps: 6/5 blue)

Blade rate _____

Ithaco amp① $+60$ db; Filter: Hi pass _____ Trans Anal

Lo pass _____   ② _____ db

Measuring   Input atten③ $.3V$ db Meas amp X (# of

Equipment: Output gain④ $\times 1$ db Spect anal. ___ spectra___)

Temperature: (Start) water 78 air 75 Reynolds number:

(End) 78 75 6.86×10^5

MAN	STAT	RPM	T	Q	GAIN CHANGE		K_T	J		REMARKS			
917	747	1650	174	72			0.09	0.72	8.30	13.4	8.1	6	
909	699	1050	170	72.5					7.54	13.6	8.1	6.1	
909	658	1050	160	71.5					7.29	13.1	8.8	6.2	
912	611	1050	156	72					6.82	13	8.8	6.3	
911	577	1050	154	71.5					6.45	13.5	9	6.6	
911	546	1050	150	72.5					6.10	13.4	9	6.3	
912	521	1050	144	71.5					5.81	13.7	9.2	7	
912	488	1050	140	72					5.44	13.5	9.1	7.2	
~~912~~	~~488~~	~~1050~~	1										
912	455	1050	138	72.5					5.07	13.8	9.2	7.1	
911	415	1050	132	72.0					4.62	4.2	10	7.2	
912	389	1050	128	72.0					4.33	15	107	7.9	
912	364	1050	124	71.5					4.05	17	13	0.5	
913	321	1050	114	70.5	1	+50			3.56	14	116	r	
913	300	1050	106	70.0					3.32	15.4	13	54	π
906	260	1050	100	69.5	1	+60				8	3	20	tilt
					Measured by Lewis								

DATA SHEET

RUN NO 5/9

DATE 3/25

U_{nom} 16   RPM 1150 J_{ncm} .681   Shaft rate _____

(Taps: 6/5 blue)   Blade rate _____

Ithaco amp① +60 / +50 db; Filter: Hi pass _____ Trans Anal

Lo pass _____   ②_____ db

Measuring Equipment: Input atten③ 0.3V db Meas amp X   (# of

Output gain④ x1 db Spect anal. ___ spectra___)

Temperature: (Start) water 78 air 75   Reynolds number:

(End)   78   75 7.46×10^5

MAN	STAT	RPM	T	Q	GAIN CHANGE		K_T	J	J	REMARKS		
912	747	1150	290	104.5			0.125	0.67	8.35	4.2	10	7.9
912	680	1150	278	104.5						144	10.1	7.5
913	616	1150	270	104.0						145	10.3	7.7
913	571	1150	262	103.5					5.94	146	9.9	7.2
912	538	1150	262	104.5						145	10	7.3
911	491	1150	260	105					5.48	145	10.2	7.3
911	460	1150	252	105						145	10	7.6
911	425	1150	246	104.5					4.74	142	10	7.5
912	375	1150	238	104					4.7	149	10.6	8
915	346	1150	236	104.5					3.83	1520	17	15.5
912	324	1150	230	103.5	1	+50			3.60	149	12.5	9.9
912	303	1150	222	103					336	29	11.5	9
912	285	1150	218	102.5					3.16	124	6	0
911	256	1151	204	101.5	1	+80				14	9	5.5

DATA SHEET

RUN NO __6/9__

DATE __2/25__

U_{nom} __1/6__   RPM __1250__ J_{nom} __0.627__   Shaft rate _____

(Taps: 6/5 blue)   Blade rate _____

Ithaco amp① __+60__ db;Filter: Hi pass _____   Trans Anal

Lo pass _____   ② _____ db

Measuring   Input atten③ __0.3__ db Meas amp __X__   (# of

Equipment: Output gain④ __X1__ db Spect anal. ___ spectra___)

Temperature: (Start) water __78__ air __75__   Reynolds number:

(End)   __78__   __75__   __8 05 × 10⁵__

MAN	STAT	RPM	T	Q	GAIN CHANGE	K_T	J	J	REMARKS
913	749	1250	414	139			0.151	0.605	8.37	15c 11.0 8.9
913	669	1250	400	138.5					.7.47	148 10.6 8.9
912	587	1250	390	139.5						15 10.9 8.6
910	530	1250	384	139.0					5.93	148 10.7 8.7
912	493	1250	380	140						14.8 10.7 8.1
913	459	1250	372	139					5.11	14× 10.6 8.5
913	415	1250	364	135						14.9 10.8 8.8
913	384	1250	36c	138.5					4.27	15.0 11c 8.6
912	335	1250	354	138.5	1	+50			3.72	13.2 1c 8.5
913	3c0	1250	346	137.5					3.39	138 1c 8.2
912	274	1250	334	136					3.c3	7.3 <0 <0
							observed by ____			

DATA SHEET

DATE 2/25

U_{nom} 16   RPM 1350 J_{nom} 0.580   Shaft rate _____

(Taps: 6/5 blue)   Blade rate _____

Ithaco amp① +60 db;Filter: Hi pass _____   Trans Anal

Lo pass _____   ②_____ db

Measuring   Input atten③ 0.3V db Meas amp X   (# of
Equipment: Output gain④ X1 db Spect anal. ___ spectra___)

Temperature: (Start) water 78 air 75   Reynolds number:

(End)   78   75 8.66×10^5

MAN	STAT	RPM	T	Q	GAIN CHANGE	K_T	J	c	REMARKS		
912	748	1350	578	76.5		0.171	0.57	8.37	15	11.1	9.0
911	653	1350	530	176					15	11.1	9.0
912	575	1350	522	76.5					149	11.0	9.0
913	525	1350	514	176				5.85	149	11.1	9.0
911	482	1350	510	176					149	11.0	8.7
911	448	1350	500	175.5					148	10.8	3.8
911	406	1350	498	176				4.53	4.6	105	5.3
910	373	1350	494	76				4.16	15.2	115	9.0
913	356	1350	488	175.5				3.95	185	44	11.7 8U
912	332	1350	482	175	1 +50			3.69	12.4	9	7.3
912	310	1350	478	174.5				3.44	12.9	9	7.5
913	289	1350	466	173.5				3.20	10.6	49	40

DATA SHEET

RUN NO **8/9**

DATE **2/25**

U$_{nom}$ **16**   RPM **1510**   J$_{nom}$ **C.519**   Shaft rate _____
(Taps: 6/5 blue)

Blade rate _____

Ithaco amp① **+60** db;Filter: Hi pass _____   Trans Anal

Lo pass _____   ② _____ db

Measuring Equipment: Input atten③ **0.3V** db Meas amp **X**   (# of

Output gain④ **X1** db Spect anal. ___ spectra ___)

Temperature: (Start) water **78** air **75**   Reynolds number:

(End)   **78**   **75**   **9.62×10⁵**

MAN	STAT	RPM	T	Q	GAIN CHANGE		K_T	J	J	REMARKS		
912	749	1510	784	248			0.195	0.51	8.38	149	10.9	8.7
911	658	1509	770	248						14.8	10.9	8.6
912	614	1570	766	248						14.7	10.9	8.5
911	567	1510	754	241						14.7	10.6	8.7
911	519	1510	750	241					5.80	14.7	10.8	8.4
913	486	1510	744	241						14.7	10.5	8.4
913	451	1570	738	241						14.5	10.4	8.0
912	422	1510	736	241.5					4.70	44	101	7.8
911	378	1510	730	241.5					4.21	154	110	82
913	345	1510	718	240					3.83	19	146	118
912	320	1510	712	239	1	+50			3.55	12	7	3.6
912	287	1510	698	242.5					3.18	10.5	5	1
910	267	1510	662	240	1	+60				1	20	20
									descend by autables			

DATA SHEET

RUN NO 9/9
DATE 2/25

U_{nom} __16__   RPM __1710__ J_{nom} __0.458__ Shaft rate _____

(Taps: 6/5 blue)   Blade rate _____

Ithaco amp ① __+60__ db; Filter: Hi pass _____   Trans Anal

Lo pass _____   ② _____ db

Measuring   Input atten ③ __0.3V__ db Meas amp __X__   (# of
Equipment: Output gain ④ __X1__ db Spect anal. ___ spectra___)

Temperature: (Start) water __78__ air __75__ Reynolds number:

(End) __78__ __75__ 1.085×10^6

MAN	STAT	RPM	T	Q	GAIN CHANGE		K_T	J	J	REMARKS		
911	750	1710	1128	337			0.219	0.47	8.40	15	10.9	8.5
912	690	1710	1118	337						15	10.9	9.0
910	618	1710	1110	337					6.92	14.9	10.6	8.5
911	577	1710	1104	336					6.45	14.6	10.5	8
911	542	1710	1100	336.5					6.06	14.5	10.4	8
912	509	1710	1096	336.0						14.5	10.0	7.8	TV ✗
909	478	1710	1088	336.5					5.35	14.0	9.4	7.0
912	439	1710	1080	334.5					4.89	14.4	9.8	6.6	Ench ✗
911	400	1710	1070	335	1	+50			4.46	30	15	11 ✗
12	BAR 762.7		-2	11.5						TARE		

DATA SHEET

RUN NO __1__

DATE __2/26__

U_{nom} __16__   RPM __1710__ J_{nom} __.458__   Shaft rate _____

(Taps: 6/5 blue)   Blade rate _____

Ithaco amp ① __+6c__ db; Filter: Hi pass _____   Trans Anal

Lo pass _____   ② _____ db

Measuring Equipment: Input atten ③ __0.3V__ db   Meas amp __X__   (# of

Output gain ④ __X1__ db   Spect anal. ___ spectra___)

Temperature: (Start) water __82__ air __75__   Reynolds number:

(End) __83__ __75__ 1.10×10^6

MAN	STAT	RPM	T	Q	GAIN CHANGE		K_T	J	ε	REMARKS		
12	763.7		-2	11.5			0.216	0.48	8	TARE		
912	747	1710	1112	338.0			0.216	0.48	8.31	13.7	8.6	7.1
913	713	1710	1108	338						13	9.1	7.5
912	674	1710	1104	338.5						13.4	9.2	7.4
912	645	1710	1100	337.5					7.16	13.2	9.1	7.1
912	624	1710	1096	337.5						13.1	9.1	7.1
912	597	1710	1092	335.5						13.4	9.3	7.2
911	565	1710	1090	335.0						13.0	9.0	7.0
912	530	1710	1086	335.0					5.87	13.9	9.9	6.8
912	501	1710	1086	335.5						13.8	9.3	6.1
912	470	1710	1078	334.5					5.19	12.4	7.0	4.7
912	440	1710	1070	333.0						11.8	6.9	3
910	412	1710	1066	333.5	1	+50			4.55	13.8	3.5	5.3
912	382	1710	1060	334.0	1	+40			4.20	11.4	7.0	4.0
911	351	1710	1046	338.0					3.86	12.6	7	5

DATA SHEET

RUN NO __3__
DATE __2/26__

U$_{nom}$ __m__   RPM __1900__ J$_{nom}$ __.515__ Shaft rate _____

(Taps: 6/5 blue)   Blade rate _____

Ithaco amp① __+50__ db;Filter: Hi pass __—__   Trans Anal

                              Lo pass __—__   ② __—__ db

Measuring   Input atten③ __0.3V__ db Meas amp __x__   (# of
Equipment: Output gain④ __x1__ db Spect anal. ___ spectra___)

Temperature: (Start) water __83__ air __75__   Reynolds number:

             (End)   __85__   __75__   __1.23 x 10^6__

MAN	STAT	RPM	T	Q	GAIN CHANGE		K$_T$	J		REMARKS		
1465	715	1900	1220	378			.255	.38	~~23.43~~	8.2	4.2	1.9
1405	685	1900	1220	378.5						8.8	4.2	2
1406	650	1900	1210	378.0					4.63	8.9	4.9	2.1
1404	626	1900	1208	377.0					4.45	9.3	5.0	2
1405	602	1900	1204	377.0					4.27	12.0	6.3	3.3
1403	572	1900	1200	378.5					4.06	16	12.2	3.3
1404	542	1900	1192	376.0	1	+40			3.84	9.6	6.5	6.5
1405	519	1900	1190	377.5					3.68	11.0	8.5	7.2
1404	496	1900	1188	377.0					3.51	13	10.1	8.5
1402	471	1900	1178	378.0					3.34	14	10.5	8.2
1403	442	1900	1158	385					3.13	13.2	9.2	7

DATA SHEET

RUN NO __3__

DATE __2/26__

U_{nom} __20__   RPM __1800__ J_{nom} __.543__ Shaft rate __—__

(Taps: 6/5 blue)   Blade rate __—__

Ithaco amp① __+50__ db; Filter: Hi pass _____ Trans Anal

Lo pass _____   ② _____ db

Measuring   Input atten③ __0.30__ ~~db~~ Meas amp __∝__   (# of
Equipment: Output gain④ __x1__ ~~db~~ Spect anal. ___ spectra___)

Temperature: (Start) water __83__ air __75__ Reynolds number:

(End)   __85__   __75__   __1.16×10⁶__

MAN	STAT	RPM	T	Q	GAIN CHANGE		K_T	J	σ	REMARKS		
1403	715	1800	1040	325.0			.183	.53	5.09	7.4	3.0	0.5
1402	691	(1800)	1036	325.5					˙	7.6	3.1	0.5
1402	643	1800	1038	325.5					4.58	7.9	3.0	0.5
1402	607	1800	1034	326.0					4.32	7.5	3.1	0.2
1401	568	1800	1016	326.0					4.04	12.6	7.1	3.8
1404	543	1800	1010	325.0					3.85	18.8	15.2	14.6
1404	527	1800	1004	304.5	1	+40			3.73	9.6	7.0	5.8
1403	506	1800	1006	325.0					3.59	10.5	8.0	6.3
1405	489	1800	1000	324.0					3.46	11.4	8.5	7.7
1406	469	1800	970	320.5					3.31	11.7	9.0	7.9
1404	445	1800	978	323.0					3.14	12.1	8.9	7.0
1406	426	1800	966	322.5					3.00	12.1	7.9	5.0

DATA SHEET

RUN NO __4__

DATE __2/26__

U_{nom} __20__   RPM __1340__   J_{nom} __0.73__   Shaft rate _____

(Taps: 6/5 blue)   Blade rate _____

Ithaco amp① __+50__ db; Filter: Hi pass _____   Trans Anal

Lo pass _____   ② _____ db

Measuring   Input atten③ __0.3 V__ ~~db~~ Meas amp __X__   (# of
Equipment: Output gain④ __X1__ ~~db~~ Spect anal. ___ spectra___)

Temperature: (Start) water __85__ air __75__   Reynolds number:

(End) __88__ __76__   __8.84×10⁵__

MAN	STAT	RPM	T	Q	GAIN CHANGE		K_T	J	J	REMARKS		
1410	714	1340	302	118.6			.695	.71	5.06	10.0	6.0	36
1402	688	1339	304	118.5						10.1	6.0	3.7
1401	662	1339	304	120.0					4.72	10.0	6.0	3.9
1401	632	1340	296	118.5					4.50	10.3	6.5	39
1410	593	1340	286	118.0					4.19	11.4	7.1	48
1406	569	1340	286	119.0					4.03	13.9	9.2	76
1402	546	1340	284	119.0					3.88	17.5	14	125
1407	526	1340	289	118.0					3.72	20	17.0	157
1409	500	1340	270	116.5	1	+40			3.53	11.7	89	76
1403	472	1340	278	120.0					3.34	12.0	9.1	3.
1409	442	1340	254	115.0					3.11	11.5	8.7	7
1408	425	1340	253	117						10.9	7.7	5.3

DATA SHEET

RUN NO __5__

DATE __2/26__

U_{nom} __70__   RPM __1150__ J_{nom} __.851__   Shaft rate _____

(Taps: 6/5 blue)   Blade rate _____

Ithaco amp① __+50__ db;Filter: Hi pass __—__   Trans Anal

Lo pass __—__   ② __—__ db

Measuring Equipment: Input atten③ __0.3V__ ~~db~~ Meas amp __7__   (≠ of

Output gain④ __×1__ ~~db~~ Spect anal. ___ spectra___)

Temperature: (Start) water __88__ air __76__   Reynolds number:

(End) __90__ __78__   __7.72×10⁵__

MAN	STAT	RPM	T	Q	GAIN CHANGE		x_T	J	σ	REMARKS			
1407	722	1150	58	51.0			.024	.83	5.13	12.5	7.3	5.9	
1408	685	1150	50	49.5					4.86	12.8	88	66	BPF
1413	655	1151	40	48.5					4.63	13.1	9.1	66	
1405	618	1150	34	46.5					4.39	13.7	9.6	7.1	
1406	579	1150	32	46.5					4.10	154	109	8.1	
1407	550	1150	24	45.0					3.89	15.4	14.5	154	
1399	521	1151	26	46.5	1	+40			3.70	10.6	7.2	63	
1403	491	1151	16	44.5					3.48	15.2	7.2	7.5	
1409	474	1150	12	45					3.34	12.4	9.3	7.9	
1405	441	1150	8	45						11.2	8.1	6	
11	BAR 760.0		8	12.5						TARE			

DATA SHEET

RUN NO ___1___

DATE ___2/27___

U_{nom} ___10___   RPM ___1200___ J_{nom} ___.41___   Shaft rate ___—___

(Taps: 6/5 blue)

Blade rate ___—___

Ithaco amp① ___+70___ db; Filter: Hi pass ___—___   Trans Anal

Lo pass ___—___   ② _____ db

Measuring   Input atten③ _0.3V_ ~~db~~ Meas amp _X_   (# of
Equipment: Output gain④ _X1_ ~~db~~ Spect anal. ___ spectra___)

Temperature: (Start) water __87__ air __77__ Reynolds number:

(End)   __87__   __77__ 8.32×10^5

MAN	STAT	RPM	T	Q	GAIN CHANGE		K_T	J	η	REMARKS		
17	BAR 757.1		2	9.5						TARE		
373	770	1200	610	181			0.238	0.42	22.08	7.1	3.6	0.2
374	736	1500	602	180						8.0	3.1	0.1
373	657	1200	596	180.5						8.0	3.5	0
374	615	1500	590	180.5					17.53	8.3	3.7	0.1
374	592	1200	586	180						8.1	3.0	0
374	566	1500	582	180						7.9	3.1	0
373	543	1200	580	180					15.49	7.9	3.1	<0
373	520	1500	578	180						7.6	2.8	<0
373	501	1200	576	180	1	+30			14.27	13.4	13.3	10.2
373	477	1200	572	180					13.58	15.2	12.5	9.7
371	453	1200	570	180						16.1	13.2	9.8
373	433	1200	568	180						15.3	13.2	9.6
373	405	1200	562	179.5					11.52	14.1	11.5	10.5
374	376	1200	555	179.5						10	6	7.5
373	345	1200	552	178.5						<0	<0	6
373	321	1200	548	178.5						<0	<0	2

DATA SHEET

RUN NO __2__

DATE __2/27__

U_{nom} __16__   RPM __1710__ J_{nom} __.458__   Shaft rate __—__

(Taps: 6/5 blue)   Blade rate __—__

Ithaco amp① __+60__ db;Filter: Hi pass _____   Trans Anal

Lo pass _____   ② _____ db

Measuring   Input atten③ __0.3 V__ ~~db~~ Meas amp __X__   (≠ of
Equipment: Output gain④ __X 1__ ~~db~~ Spect anal. ___ spectra___)

Temperature: (Start) water __87__ air __77__   Reynolds number:

(End)   __87__   __77__   __1.19×10⁶__

MAN	STAT	RPM	T	Q	GAIN CHANGE		K_T	J	J	REMARKS
914	736	1710	1112	331.5			.213	.48	8.17	13.9 9.4 7.9
912	699	1710	1106	331.5						13.7 9.2 6.9
914	661	1710	1098	331						13.6 9.0 6.3
914	630	1710	1092	331						13.4 8.9 6.0 ᵀⱽ
912	595	1710	1099	331						13.5 8.6 6.0
~~915~~	~~552~~	~~1710~~								1
914	578	1710	1086	331						13.6 8.2 5.5
915	552	1710	1084	331.5						11.9 7.3 4.6
914	534	1710	1082	331.5						12.4 7.9 5.1
915	505	1710	1078	331						11.9 6.8 3.2
912	476	1710	1074	331						16.6 5.6 2
914	451	1710	1070	330.5						16.6 5.9 2
915	441	1710	1068	330.5						13.2 8.8 6
914	430	1710	1066	330	1	+50				7.1 3.5 0 ²ᴬᶜ
914	410	1710	1062	330						18 13.2 12
914	739	1710	1114	332.5	1	+60				12.4 8.1 6.0
	BAR									
13	756.4		14	11						TARE

16 fps
1150 RPM
J = .681

16 fps
1150 RPM
J = .580

16 fps
1510 RPM
J = .319

10 fps
1900 RPM
J = 1.315

DATA SHEET

RUN NO __5__

DATE __3/35__

U_{nom} __8__   RPM __1040__ J_{nom} __.375__ Shaft rate __17.33__

(Taps: 6/5 blue)   Blade rate __121.33__

Ithaco amp① __+50__ db; Filter: Hi pass __2×10^4__ Trans Anal

Lo pass __10×10^5__   ② __-15__ db

Measuring   Input atten③ __-30__ db Meas amp ____ (# of

Equipment: Output gain④ __+10__ db Spect anal. __X__ spectra __32__)

Temperature: (Start) water __82__ air __76__   Reynolds number:

(End) __52__ __76__   __7.63×10^5__

Thrust in lbs = $T \times 0.1$ Torque in ft lbs = $\frac{Q}{12}$

MAN	STAT BAR	RPM	T	Q	GAIN CHANGE		K_T	J		REMARKS
12	753.8		-4	10						TARE
246	760	1043	978	145			.254	.395	33.70	7-1
250	653	1042	950	145					29.75	-2
252	587	1043	928	145					25.32	
251	561	1040	916	144.5					24.29	-3
248	534	1041	912	144.5					23.40	-4
248	507	1042	916	145.5					22.21	-5
249	480	1043	910	145.5					20.92	-6
249	457	1043	900	45.5	2	-25			19.91	8-1
248	439	1045	906	146.5					18.75	
248	444	1043	902	145.5					19.42	-2 PASS
248	453	1045	908	146.5					19.81	-3 PASS
247	452	1040	896	145					19.86	-4 PASS
247	460	1044	908	145.5					20.21	-5 PASS

DATA SHEET

RUN NO 6

DATE 3/25

J_{nom} 8   RPM 975 J_{nom} C.4   Shaft rate 16.25
(Taps: 6/5 blue)   Blade rate 113.75

Ithaco amp① +50 db; Filter: Hi pass $2x10^4$ Trans Anal

Lo pass $10x10^5$ ② -10 db

Measuring   Input atten③ -30 db Meas amp ___   (# of
Equipment: Output gain④ +10 db Spect anal. X_ spectra 32)

Temperature: (Start) water 82 air 76   Reynolds number:
             (End)   83   74 $7.14 x 10^5$

MAN	STAT	RPM	T	Q	GAIN CHANGE	K_T	J	⊂	REMARKS
243	757	975	832	124.5		.247	.4	3403	9-1
244	536	976	778	125.5				23.92	-2
243	402	973.	736	124.5				17.95	-3
242	298	970	706	124				13.30	-4

DATA SHEET

RUN NO __7__

DATE __3/25__

U_{nom} __10__   RPM __1215__ J_{nom} __0.4__   Shaft rate __20.25__

(Taps: 6/5 blue)   Blade rate __141.75__

Ithaco amp① __+50__ db;Filter: Hi pass __2x10⁴__ Trans Anal

Lo pass __10x10⁵__   ② __-15__ db

Measuring   Input atten③ __-30__ db Meas amp ___   (# of

Equipment: Output gain④ __+10__ db Spect anal. _X_   spectra 32)

Temperature: (Start) water __83__ air __74__ Reynolds number:

(End)   __83__   __73__   __7.95x10⁵__

MAN	STAT	RPM	T	Q	GAIN CHANGE		K_T	J	U	REMARKS
369	750	1215	1570	187.5			.244	.405	21.53	10-1
370	670	1215	1248	188					19.21	-2
370	700	1215	1360	188					20.08	-3
368	717	1215	1369	188					20.69	-4
369	725	1215	1362	188					20.86	-5

DATA SHEET

RUN NO __8__
DATE __3/25__

U$_{nom}$ __10__   RPM __1150__   J$_{nom}$ __0.42__ Shaft rate __17.17__
(Taps: 6/5 blue)

Blade rate __134.17__

Ithaco amp① __+50__ db; Filter: Hi pass __2×10^4__ Trans Anal

Lo pass __10×10^5__   ② __-15__ db

Measuring   Input atten③ __-30__ db Meas amp ____   (# of
Equipment: Output gain④ __+10__ db Spect anal. __X__ spectra __32__

Temperature: (Start) water __83__ air __73__   Reynolds number:

(End)   __83__   __73__   __7.55×10^5__

MAN	STAT	RPM	T	Q	GAIN CHANGE		K$_T$	J	J	REMARKS
369	758	1151	1168	165			.235	.43	21.76	11(-1
370	642	1152	1080	166					18.34	-2
369	675	1151	1080	165					19.35	-3
370	612	1154	1072	166					17.47	-4 ＊NV
370	601	1151	1062	165					17.15	-5
370	583	1150	1056	165					16.63	-6

DATA SHEET

RUN NO __9__

DATE __3/25__

U_{nom} __8__   RPM __915__ J_{nom} __.425__   Shaft rate __15.25__

(Taps: 6/5 blue)   Blade rate __106.75__

Ithaco amp ① __+50__ db; Filter: Hi pass __2×10^4__ Trans Anal

Lo pass __10×10^5__   ② __-15__ db

Measuring   Input atten ③ __-30__ db Meas amp ____   (# of

Equipment: Output gain ④ __+10__ db Spect anal. __X__   spectra __32)__

Temperature: (Start) water __83__ air __73__   Reynolds number:

(End)   __83__   __73__   __6.0×10^5__

MAN	STAT	RPM	T	Q	GAIN CHANGE	K_T	J	τ	REMARKS
247	766	915	766	108		.237	.43	33.59	12-1
249	470	918	632	108				20.65	-2
249	385	917	608	108				16.55	
252	334	919	596	108				14.76	-3

DATA SHEET

RUN NO __1C__

DATE __3/25__

U_{nom} __10__   RPM __1080__ J_{nom} __0.45__ Shaft rate __18__

(Taps: 6/5 blue)   Blade rate __126__

Ithaco amp① __+50__ db;Filter: Hi pass __2×10^4__ Trans Anal

Lo pass __10×10^5__   ② __-20__ db

Measuring   Input atten③ __-30__ db Meas amp ___   (# of

Equipment: Output gain④ __+10__ db Spect anal. __X__ spectra __32__

Temperature: (Start) water __83__ air __73__ Reynolds number:

(End)   __83__   __73__   __7.08×10^5__

MAN	STAT	RPM	T	Q	GAIN CHANGE		K_m	J	τ	REMARKS
371	750	1077	916	140			.224	.46	21.42	13-1
370	545	1080	872	141					15.55	-2
370	509	1080	862	141					14.51	-3
369	402	1078	836	141					11.44	-4
369	392	1080	836	141					11.15	-5
369	382	1079	832	141					10.86	-6
370	370	1081	832	141.5					10.48	-7

DATA SHEET

RUN NO ___11___

DATE ___3/25___

U_{nom} ___12___   RPM ___1225___ J_{nom} ___0.475___ Shaft rate ___20.42___

(Taps: 6/5 blue)   Blade rate ___42.92___

Ithaco amp① ___+50___ db; Filter: Hi pass ___2×10^4___ Trans Anal

Lo pass ___10×10^5___   ② ___-30___ db

Measuring   Input atten③ ___-20___ db Meas amp ___   (# of

Equipment: Output gain④ ___+10___ db Spect anal. __X__ spectra 32)

Temperature: (Start) water ___83___ air ___73___ Reynolds number:

(End)   ___83.5___   ___73___   ___8.07×10^5___

MAN	STAT	RPM	T	Q	GAIN CHANGE	K_T	J	J	REMARKS
521	740	1225	1136	172			.213	.48	14.78	14-1
521	558	1228	1086	174					11.11	-2
527	535	1224	1058	171					10.51	-3
526	523	1224	1058	171.5					10.30	-4

DATA SHEET

RUN NO 12

DATE 3/25

U~nom~ 16   RPM 1550   J~nom~ 0.5   Shaft rate 25.83

(Taps: 6/5 blue)

Blade rate 180.83

Ithaco amp① + 50 db; Filter: Hi pass 2×10^4 Trans Anal

Lo pass 10×10^5 ② -30 db

Measuring Equipment: Input atten③ -20 db Meas amp ___ (# of

Output gain④ +10 db Spect anal. X spectra 32)

Temperature: (Start) water 83.5 air 73   Reynolds number:

(End)   83.5   73 1.02×10^6

MAN	STAT	RPM	T	Q	GAIN CHANGE	K_T	J	σ	REMARKS
912	715	1546	1666	257.5		.199	.51	7.96	15-1

DATA SHEET

RUN NO __13__

DATE __3/25__

U_{nom} __12__ RPM __1175__ J_{nom} __0.5__ Shaft rate __19.58__

(Taps: 6/5 blue) Blade rate __137.08__

Ithaco amp① __+50__ db; Filter: Hi pass __2×10⁴__ Trans Anal

Lo pass __10×10⁵__ ② __-25__ db

Measuring Input atten③ __-30__ db Meas amp ___ (# of

Equipment: Output gain④ __+10__ db Spect anal. _x_ spectra③②)

Temperature: (Start) water __83.5__ air __73__ Reynolds number:

(End) __83.5__ __73__ __7.74×10⁵__

MAN	STAT	RPM	T	Q	GAIN CHANGE	K_T	J	J	REMARKS
527	739	1173	984	156		.203	.50	14.60	16-1
528	418	1174	904	154	.			8.17	
530	469	1175	920	154				9.15	-2 *4U
527	452	1174	910	154				8.86	-3
530	431	1175	898	153.5				8.39	-4
526	417	1175	908	154.5				8.15	-5

DATA SHEET

RUN NO __14__

DATE __3/25__

U_{nom} __12__   RPM __1100__ J_{nom} __0.525__ Shaft rate __18.33__

(Taps: 6/5 blue)

Blade rate __128.33__

Ithaco amp ① __+50__ db; Filter: Hi pass __2x10⁴__ Trans Anal

Lo pass __10x10⁵__   ② __-25__ db

Measuring   Input atten ③ __-30__ db Meas amp ____   (# of

Equipment: Output gain ④ __+10__ db Spect anal. __X__ spectra __32__)

Temperature: (Start) water __83.5__ air __73__ Reynolds number:

(End)   __84__   __73__   __7.28×10⁵__

MAN	STAT	RPM	T	Q	GAIN CHANGE		K_T	J	J	REMARKS
529	738	1101	804	159			.188	.52	14.53	17-1
529	410	1101	716	129					8.00	-2
528	384	1101	710	129					7.49	-3
528	363	1100	700	129					7.07	-4
527	332	1101	700	159.5					6.47	-5
528	319	1101	694	129					6.30	-6

DATA SHEET

RUN NO 15

DATE 3/25

U_{nom} 12   RPM 1050 J_{nom} 0.55   Shaft rate 17.5

(Taps: 6/5 blue)   Blade rate 22.5

Ithaco amp① +50 db;Filter: Hi pass $2x10^4$ Trans Anal

Lo pass $10x10^5$ ② -25 db

Measuring   Input atten③ -30 db Meas amp ___   (# of

Equipment: Output gain④ +10 db Spect anal. x__ spectra 32)

Temperature: (Start) water 84 air 73 Reynolds number:

(End)   84   73 $6.99x10^5$

MAN	STAT	RPM	T	Q	GAIN CHANGE	K_T	J	J	REMARKS
526	739	1052	696	114		.178	.56	14.64	18 -1
526	405	1051	606	114				7.95	-2
526	305	1051	580	114				5.94	-3
526	273	1051	574	114				5.30	-4
524	249	1051	568	114				4.84	-5 + 4v
523	225	1049	556	113				4.37	-6

DATA SHEET

RUN NO __16__

DATE __3/25__

U_{nom} __16__ RPM __1350__ J_{nom} __0.575__ Shaft rate __22.5__

(Taps: 6/5 blue)

Blade rate __157.5__

Ithaco amp① __+ 50__ db; Filter: Hi pass __2×10⁴__ Trans Anal

Lo pass __10×10⁵__ ② __-25__ db

Measuring
Equipment:

Input atten③ __-30__ db Meas amp ___ (# of

Output gain④ __+10__ db Spect anal. __X__ spectra32)

Temperature: (Start) water __84__ air __73__ Reynolds number:

(End) __84.5__ __73__ __9.09×10⁵__

MAN	STAT	RPM	T	Q	GAIN CHANGE		$\bar{K}_T$	J	σ	REMARKS
919	712	1351	1080	176.5			.169	.57	7.62	19-1
914	600	1348	1034	174					6.40	-2
911	566	1348	1030	175	2 3	-30 -20			6.04	-3
911	541	1350	1030	176					5.76	-4
907	329	1349	970	175.52	-40				3.55	-5

<u>DATA SHEET</u>   RUN NO __17__

DATE __3/25__

U$_{nom}$ __16__   RPM __1300__ J$_{nom}$ __0.6__   Shaft rate ~~30~~ __31.67__

(Taps: 6/5 blue)   Blade rate __151.67__

Ithaco amp① __+50__ db; Filter: Hi pass __2×10^4__ Trans Anal

Lo pass __10×10^5__   ② __-30__ db

Measuring   Input atten③ __-20__ db Meas amp ___   (# of

Equipment: Output gain④ __+10__ db Spect anal. _X_ spectra 32)

Temperature: (Start) water __84.5__ air __73__   Reynolds number:

(End)   __85__   __73__   __8.77×10^5__

MAN	STAT	RPM	T	Q	GAIN CHANGE		K_T	J	J	REMARKS
909	717	1300	938	157			.158	.59	7.76	20-1
916	577	1299	886	155					6.13	-2
916	531	1300	8.78	156					5.62	-3
914	504	1303	878	157					5.37	-4
911	481	1305	878	158					5.08	-5
913	457	1300	856	155.5					4.74	-6

DATA SHEET

RUN NO __18__

DATE __3/25__

U_{nom} __16__ RPM __1250__ J_{nom} __0.625__ Shaft rate __20.83__

(Taps: 6/5 blue)

Blade rate __145.83__

Ithaco amp① __+50__ db; Filter: Hi pass __2x10^4__ Trans Anal

Lo pass __10x10^5__ ② __-30__ db

Measuring Equipment: Input atten③ __-20__ db Meas amp ___ (# of

Output gain④ __+10__ db Spect anal. __X__ spectra③②)

Temperature: (Start) water __85__ air __73__ Reynolds number:

(End) __85.5__ __73__ __8.56x10^5__

MAN	STAT	RPM	T	Q	GAIN CHANGE		K_T	J		REMARKS
919	713	250	784	137.5			.143	.62	7.87	21-1
919	409	1250	706	136.5					4.47	-2
918	397	1253	716	139					4.34	-3
912	386	1251	710	137.5	3	-30			4.24	-4
911	371	1250	706	138					4.08	-5
909	344	1251	704	138	2 3	-35 -30			3.78	-6
915	318	1251	698	138	1	+40			3.46	22-1
912	307	1251	690	137					3.35	-2
910	292	1251	674	137					3.19	-3
913	272	1250	660	136					2.95	-4

DATA SHEET

RUN NO 19

DATE 3/25

U$_{nom}$ 16   RPM 1200   J$_{nom}$ 0.65   Shaft rate 20

(Taps: 5/5 blue)

Blade rate 140

Ithaco amp① +40 db; Filter: Hi pass 2x10^4 Trans Anal

Lo pass 10x10^5 ③ -20 db

Measuring Equipment:
Input atten③ -20 db Meas amp ___ (# of

Output gain④ +10 db Spect anal. X spectra 32

Temperature: (Start) water 85.5 air 73   Reynolds number:

(End) 86   73   8.25x10^5

MAN	STAT	RPM	T	Q	GAIN CHANGE		K$_T$	J	J	REMARKS
9.13	715	1202	684	122			.135	.64	7.45	23-1
9.13	466	1200	600	118.5					5.14	-2
9.14	453	1204	600	120					4.65	-3
9.10	385	1200	586	119.5					4.24	-4
9.12	370	1199	580	119.5					4.06	
9.16	355	1201	574	119.5					3.57	
9.14	346	1201	568	119.5	2	-30 -10			3.71	-5
9.17	334	1199	560	118.5	3	-20			3.63	24-1
9.17	318	1200	560	118.5					3.45	-2
9.14	293	1199	550	118					3.18	-3
9.13	274	1200	534	117.5					2.97	-4

DATA SHEET

RUN NO __20__

DATE __3/25__

U_{nom} __'6__   RPM __1150__ J_{nom} __0.675__   Shaft rate __9.17__

(Taps: 6/5 blue)   Blade rate __134.17__

Ithaco amp① __+50__ db; Filter: Hi pass __2×10^4__   Trans Anal

Lo pass __10×10^5__   ② __-30__ db

Measuring   Input atten③ __-20__ db Meas amp ___   (# of
Equipment: Output gain④ __+10__ db Spect anal. __x__ spectra 32)

Temperature: (Start) water __86__ air __73__   Reynolds number:

(End)   __87__   __72.7__   __7.98×10^5__

MAN	STAT	RPM	T	Q	GAIN CHANGE		K_T	J	?	REMARKS
915	714	1151	556	102.5			.130	.67	7.91	25-1
918	A70	1152	480	101.5					5.15	-2
916	423	1150	468	101.5					4.63	-3
915	388	1150	460	101.5					4.24	-4
913	365	1150	454	102					3.99	-5
916	345	1149	440	101	2	-40			3.75	26-1
915	335	1149	440	101					3.64	-2
915	327	1149	435	101					3.55	-3
913	312	1150	438	101	1	+40			3.37	-4
915	300	1150	426	100.5					3.25	-5
915	282	1148	414	100					3.05	-6 (2 sets)

DATA SHEET

RUN NO 21

DATE 3/25

U$_{nom}$ 16   RPM 1100   J$_{nom}$ 0.7   Shaft rate 18.33

(Taps: 6/5 blue)   Blade rate 173.33

Ithaco amp① +50 db; Filter: Hi pass 2x10^4 Trans Anal

Lo pass 10x10^5 ② -30 db

Measuring   Input atten③ -20 db Meas amp ___ (# of
Equipment: Output gain④ +10 db Spect anal. X spectra 32)

Temperature: (Start) water 87 air 72.7 Reynolds number:

(End)   87.4   72.7   7.85x10^5

MAN	STAT	RPM	T	Q	GAIN CHANGE		K$_T$	J	C	REMARKS
917	714	1100	430	84.5			.107	.69	7.86	27-1
918	394	1100	340	84.5					4.27	-2
918	353	1100	326	84	4	+40			3.81	-3
917	319	1101	326	85	2	-40			3.44	-4
921	302	1100	308	83					3.23	-5

<u>DATA SHEET</u>   RUN NO 22

DATE 3/25

U_nom 16   RPM 1070   J_nom 0.72   Shaft rate 17.83
(Taps: 6/5 blue)   Blade rate 124.83

Ithaco amp① +50 db;Filter: Hi pass 2×10⁴ Trans Anal

Lo pass 10×105   ② -30 db

Measuring   Input atten③ -30 db Meas amp ___ (# of
Equipment: Output gain④ +16 db Spect anal. X spectra 32)

Temperature: (Start) water 87.4 air 72.7 Reynolds number:

(End)   88   72.5   7.67 ×105

MAN	STAT	RPM	T	Q	GAIN CHANGE		K_T	J	J	REMARKS
912	714	1071	366	75			.092	.72	7.91	25-1
913	386	1070	270	74.5					4.51	-2
911	354	1068	266	74.5	1	+40			3.85	-3
912	343	1071	264	74.5					3.73	-4 * LEAF

DATA SHEET

RUN NO **23**

DATE **3/25**

U_{nom} __16__   RPM __1640__ J_{nom} __.75__   Shaft rate __17.33__

(Taps: 6/5 blue)   Blade rate __121.33__

Ithaco amp① __+40__ db; Filter: Hi pass __5x10⁴__ Trans Anal

Lo pass __10x10⁵__   ② __-30__ db

Measuring Equipment: Input atten③ __-20__ db Meas amp ___ (# of

Output gain④ __+10__ db Spect anal. __X__ spectra __32__)

Temperature: (Start) water __88__ air __72.5__ Reynolds number:

(End)   __88__   __72.5__   __7.46x10⁵__

MAN	STAT	RPM	T	Q	GAIN CHANGE	K_T	J	J	REMARKS
97	716	1039	286	64.5		.076	.74	7.87	29-1
914	463	1040	230	64.5				5.05	-2
914	397	1640	206	64.5				4.3	-3
916	366	1640	200	64.8				3.95	-4
914	341	1042	192	65				3.68	-5
916	356	1042	195	65				3.84	-6
914	454	1641	224	64.5				4.95	30-1
915	455	1641	224	64.52	-20			4.96	-2
16	BAR 750.3		20	12					TARE

DATA SHEET

RUN NO __2__

DATE __3/26__

U$_{nom}$ __16__   RPM __975__   J$_{nom}$ __C.80__   Shaft rate __16.25__

(Taps: 6/5 blue)   Blade rate __113.75__

Ithaco amp① __+40__ db;Filter: Hi pass __$\frac{2}{5}$×10⁴__ Trans Anal

Lo pass __10×10⁵__   ② __-20__ db

Measuring
Equipment: Input atten③ __-20__ db Meas amp ___ (# of

Output gain④ __+10__ db Spect anal. __X__ spectra 32)

Temperature: (Start) water __87__ air __77__   Reynolds number:

(End)   __87.7__   __77__   __2.07×10⁵__

MAN	STAT	RPM	T	Q	GAIN CHANGE	K_T	J	$\mathcal{J}$	REMARKS
919	713	977	142	44.5		.043	.79	7.78	33-1
914	483	975	86	45				5.25	-2
910	475	976	86	45				5.20	-3
912	465	976	82	44.5				5.07	-4
916	453	976	86	45				4.92	-5
915	437	975	78	44				4.75	-6
915	423	974	68	44				4.59	-7 ✱LEFT

8 fps   1040 RPM   J= .395   BR = 121.33

20.21

19.86

19.81

19.9%

19.32

10 db

100   200   300   400

-139-

DATA SHEET   RUN NO _1_
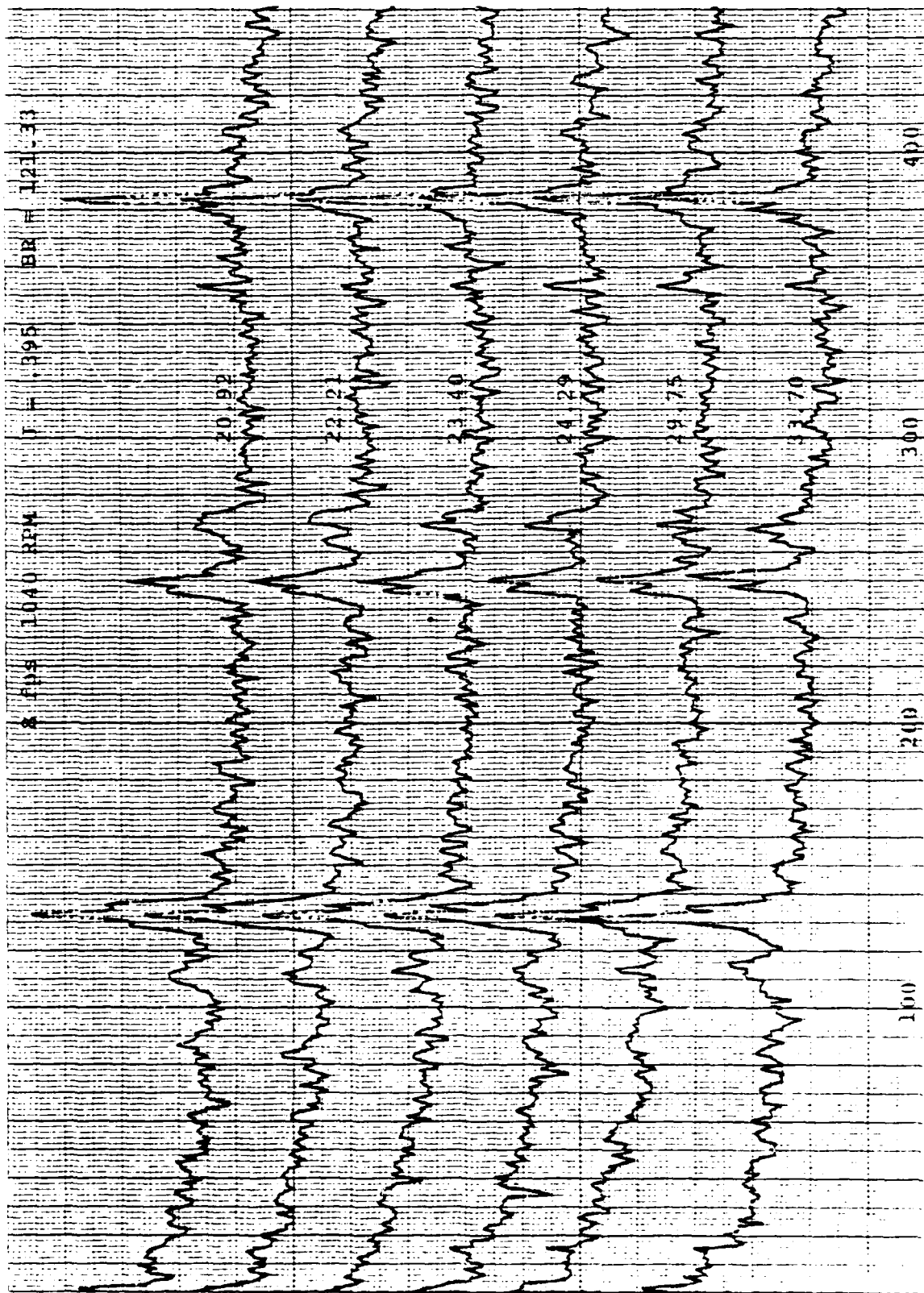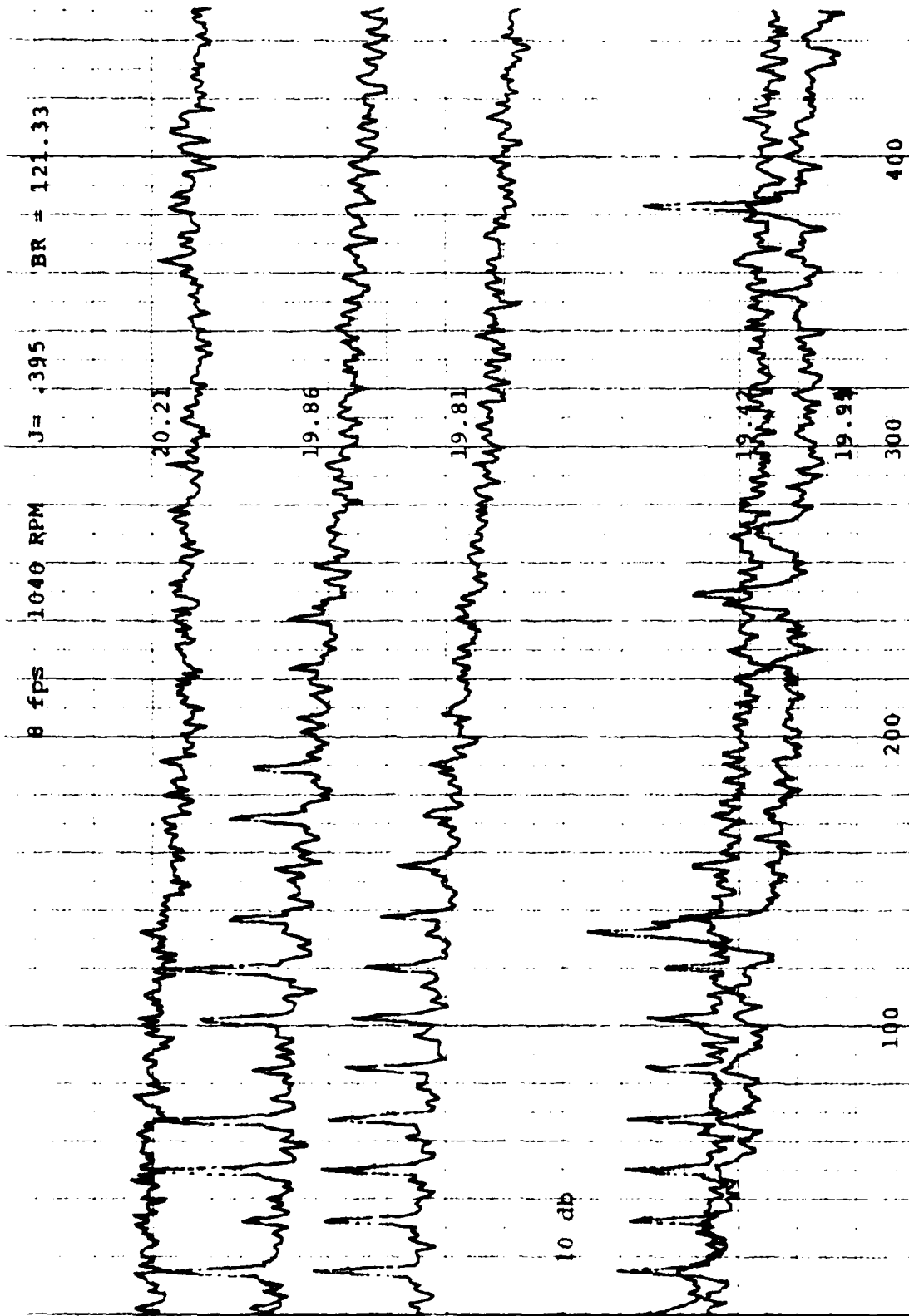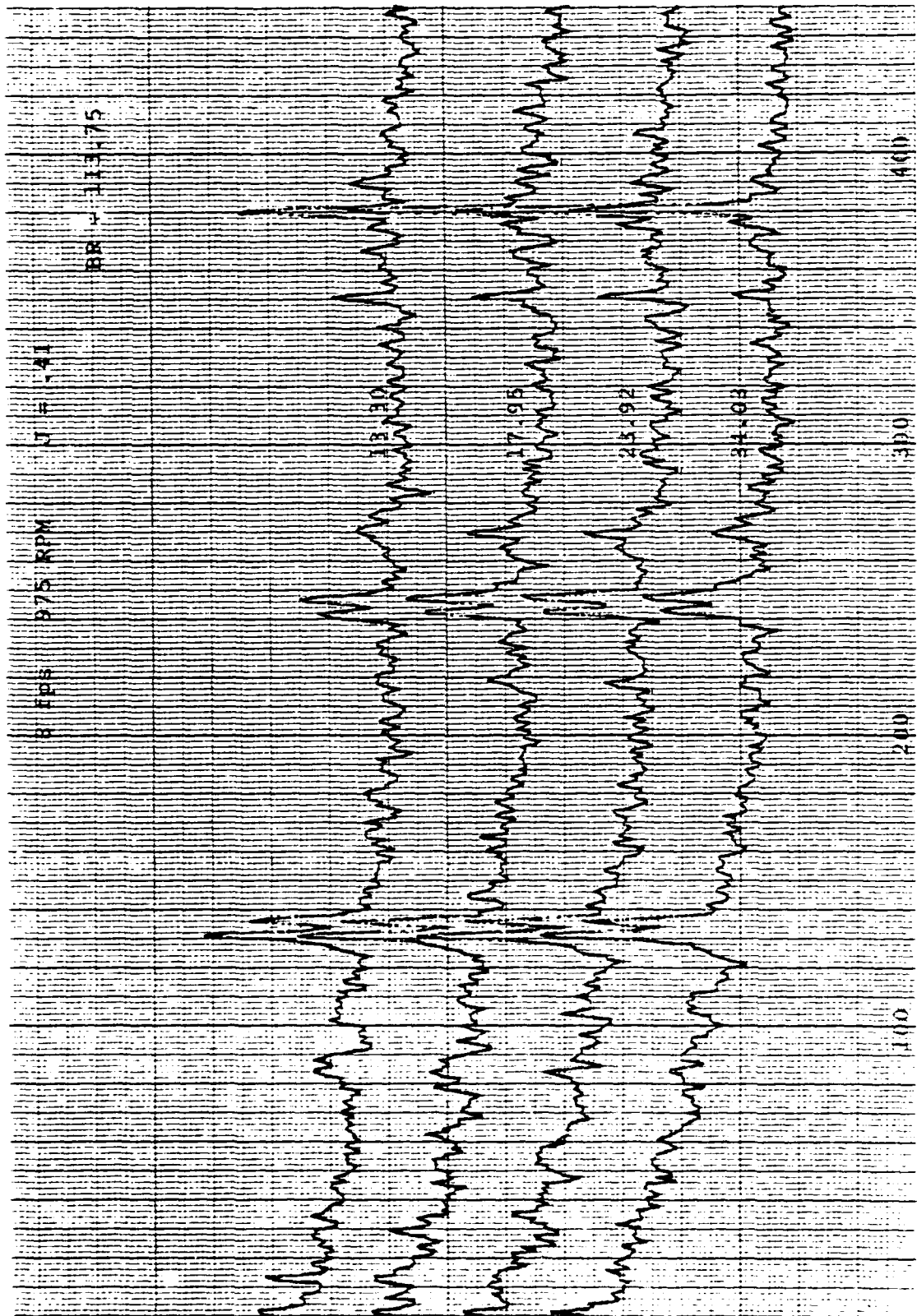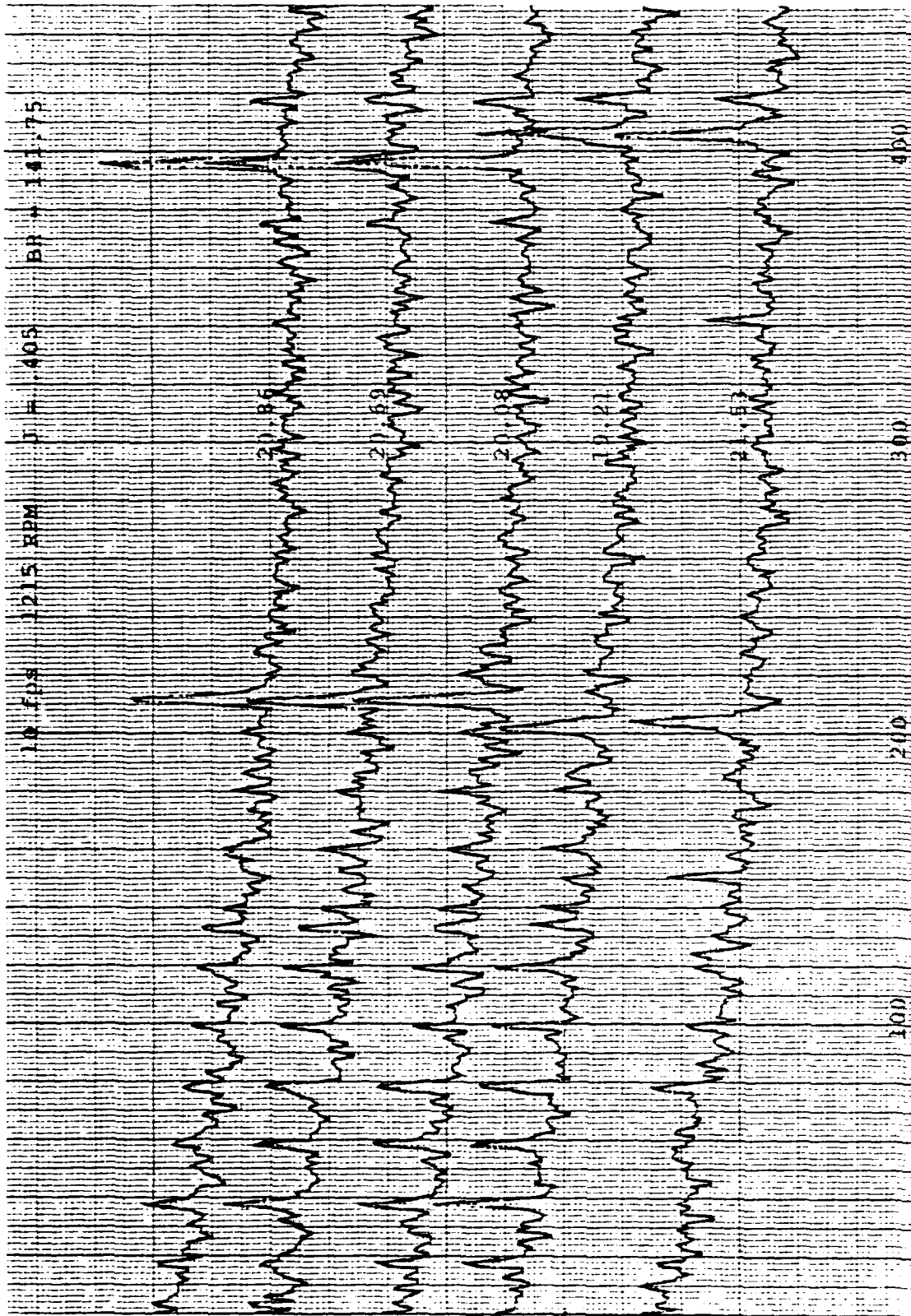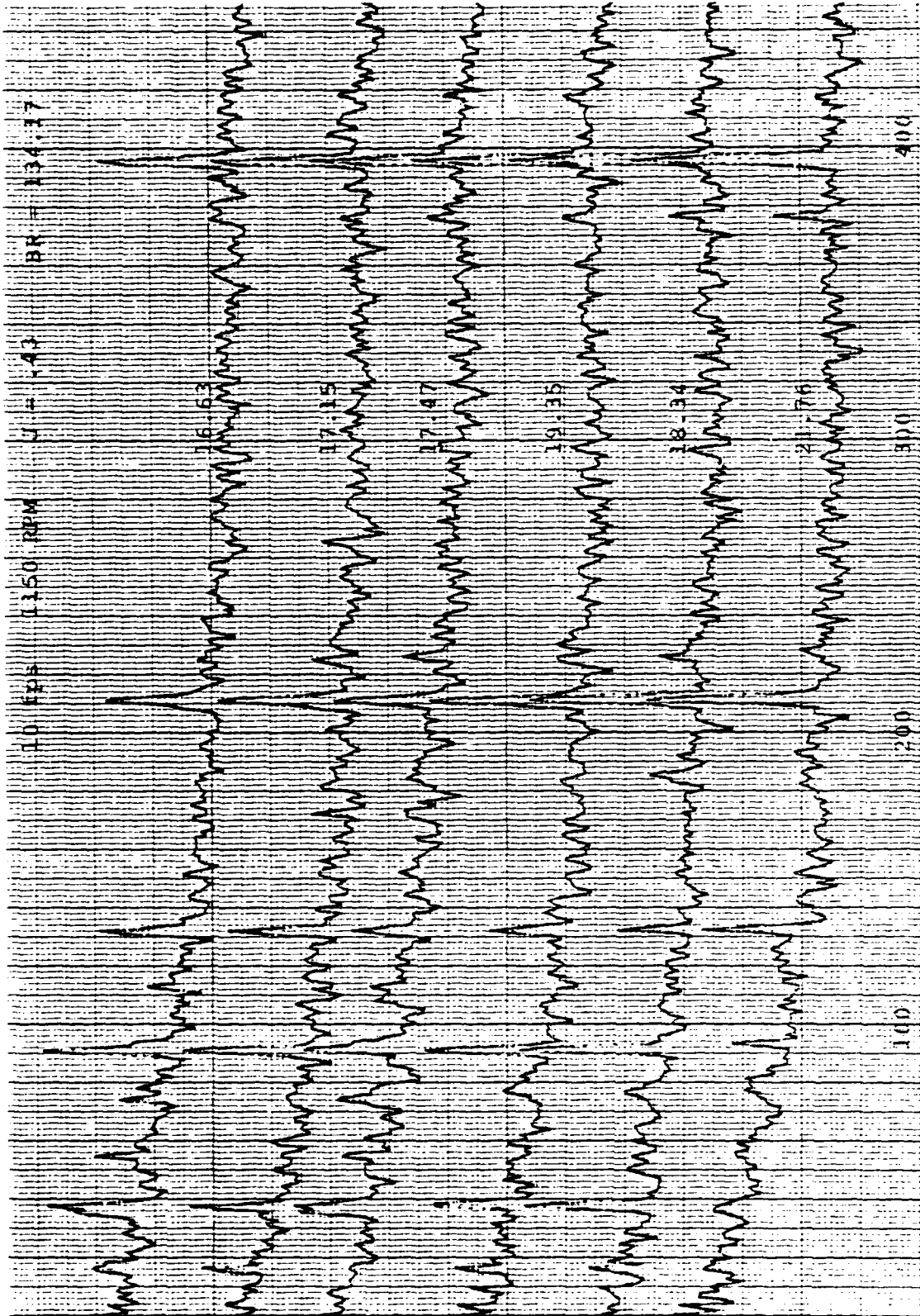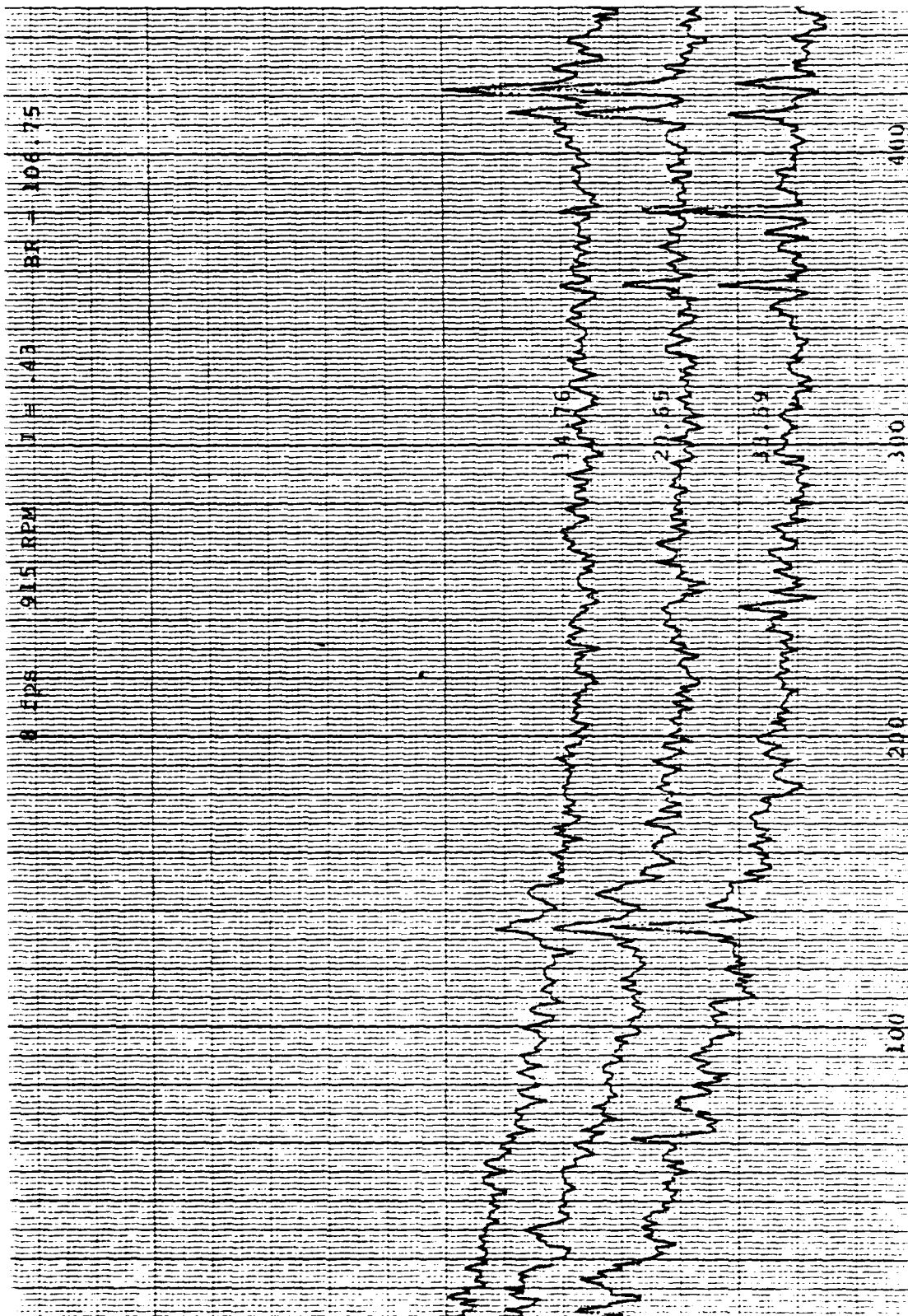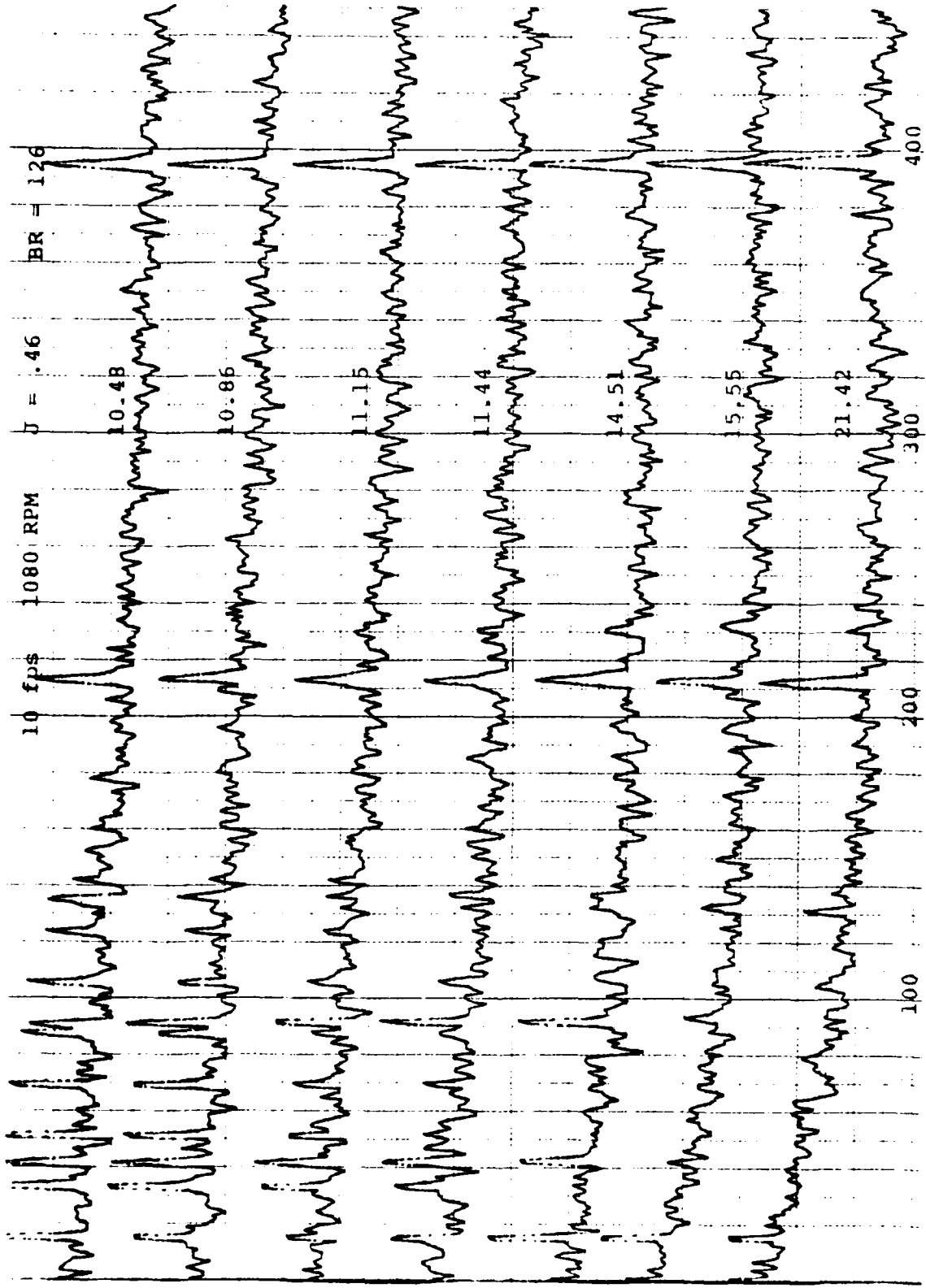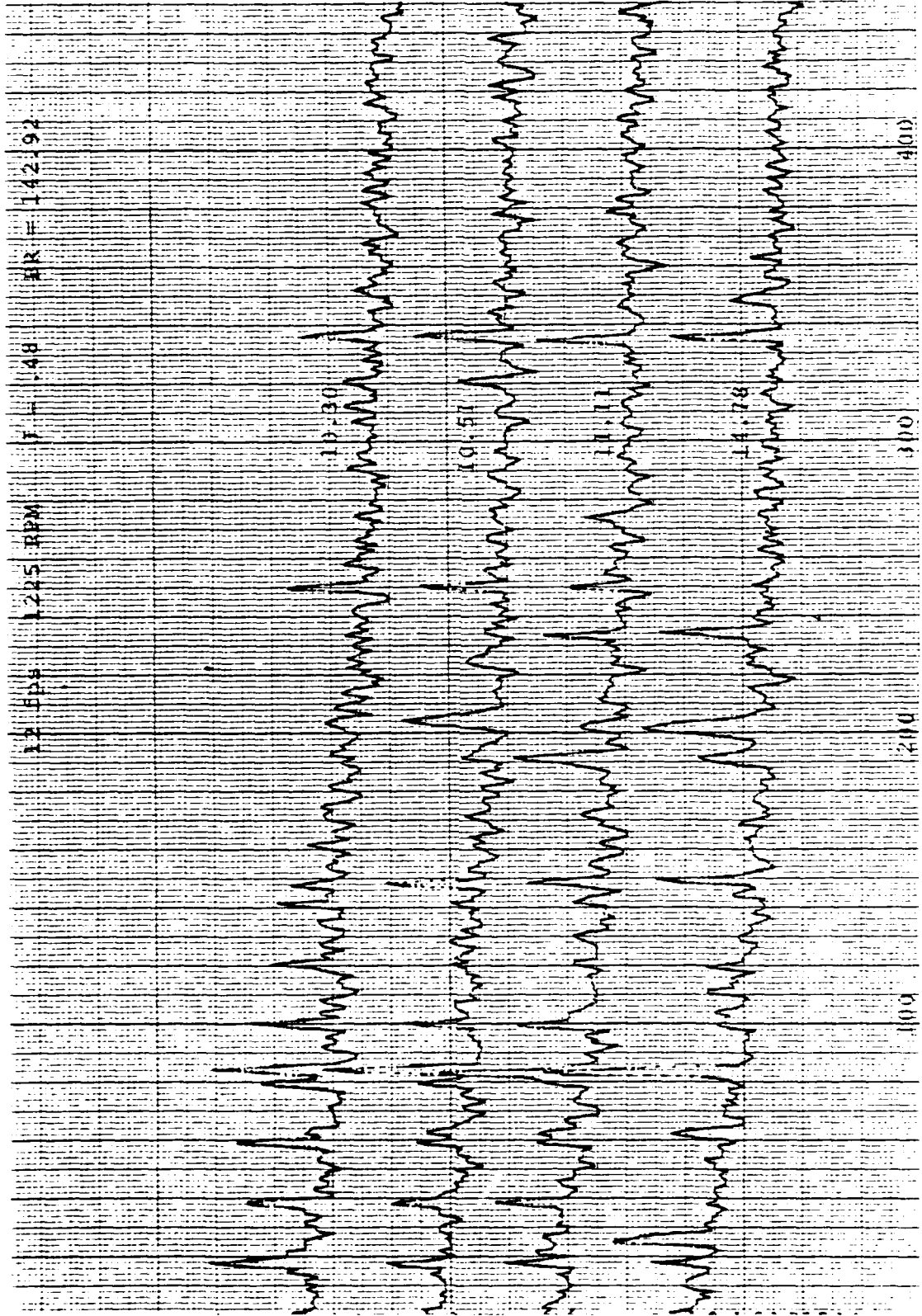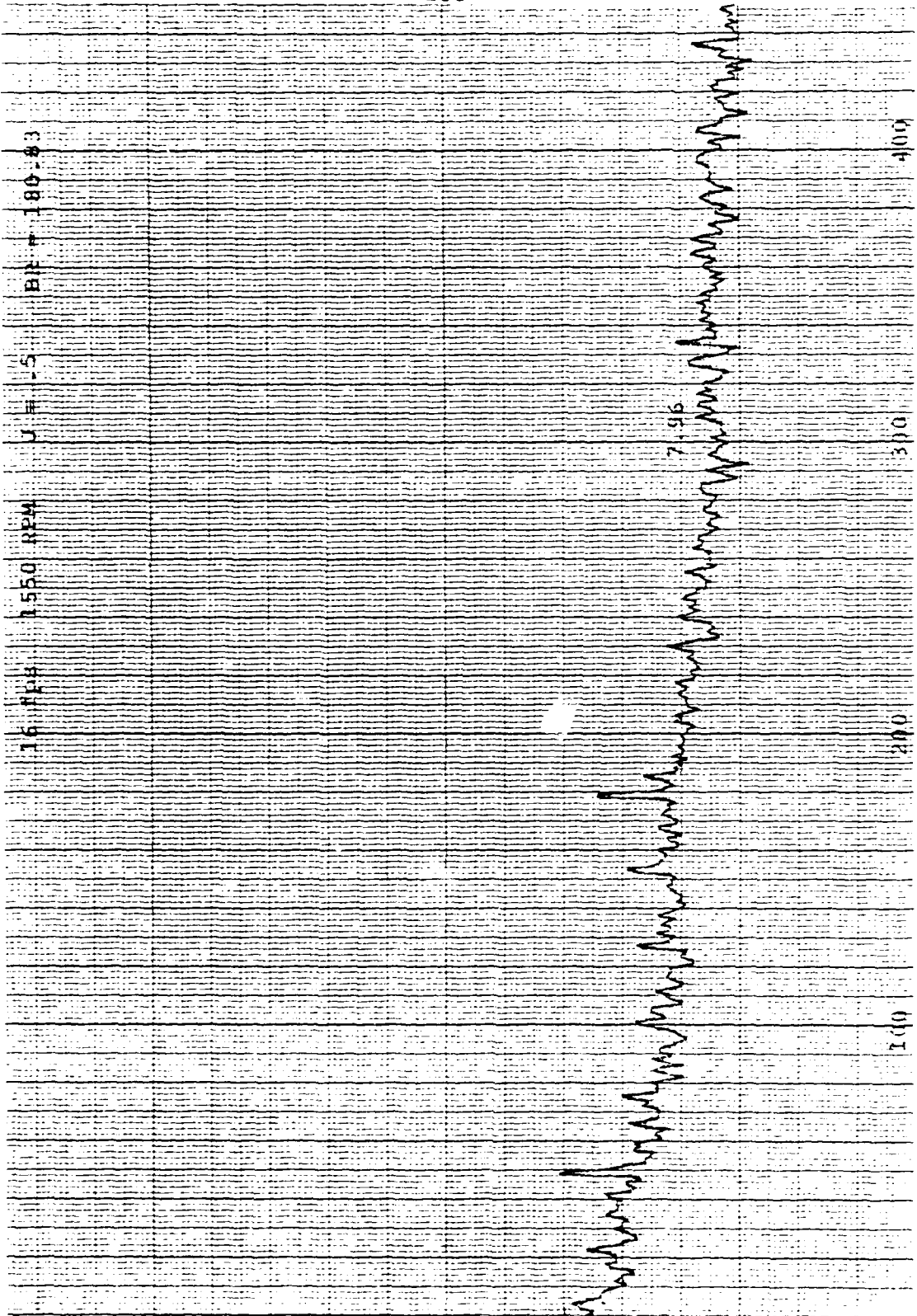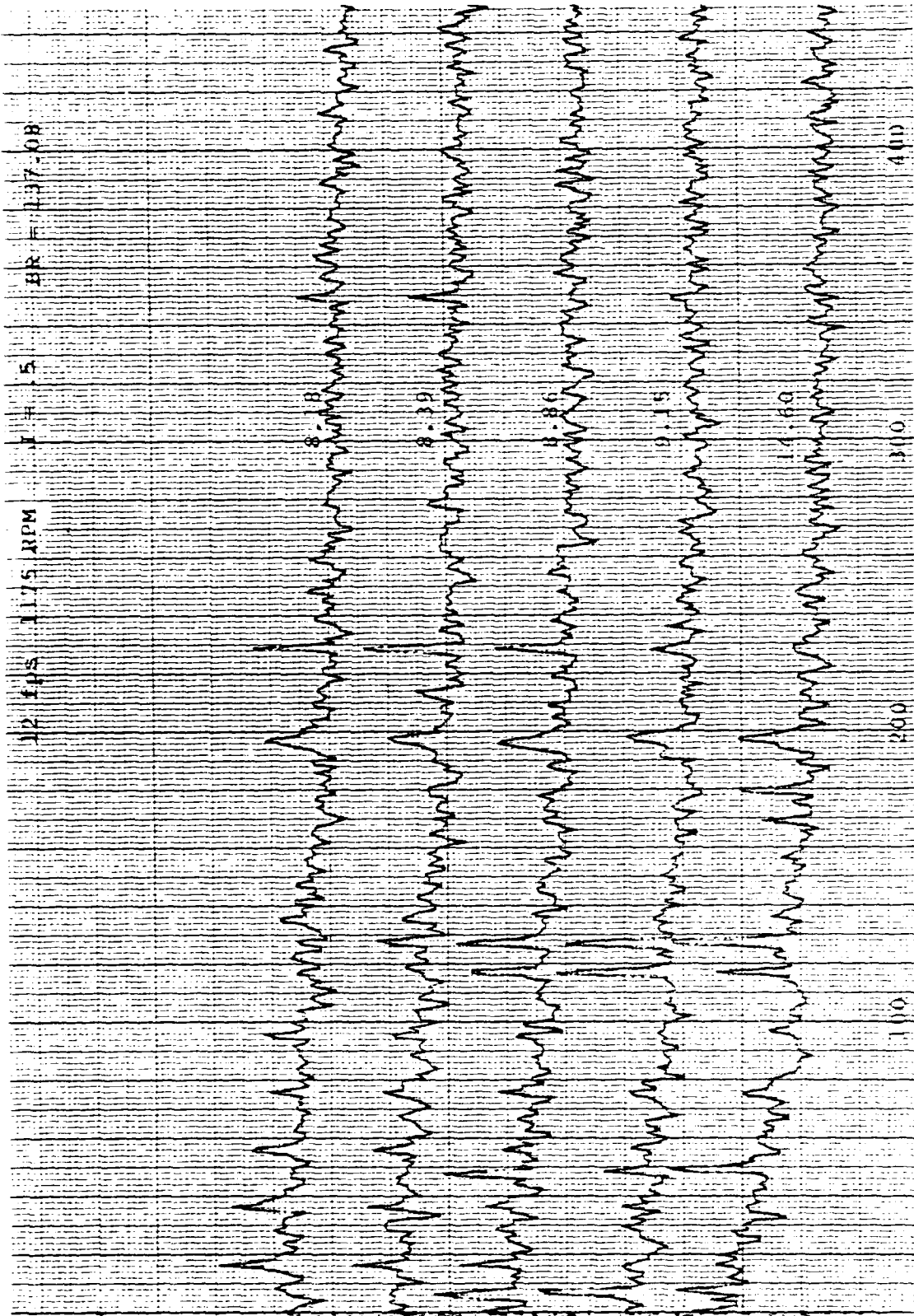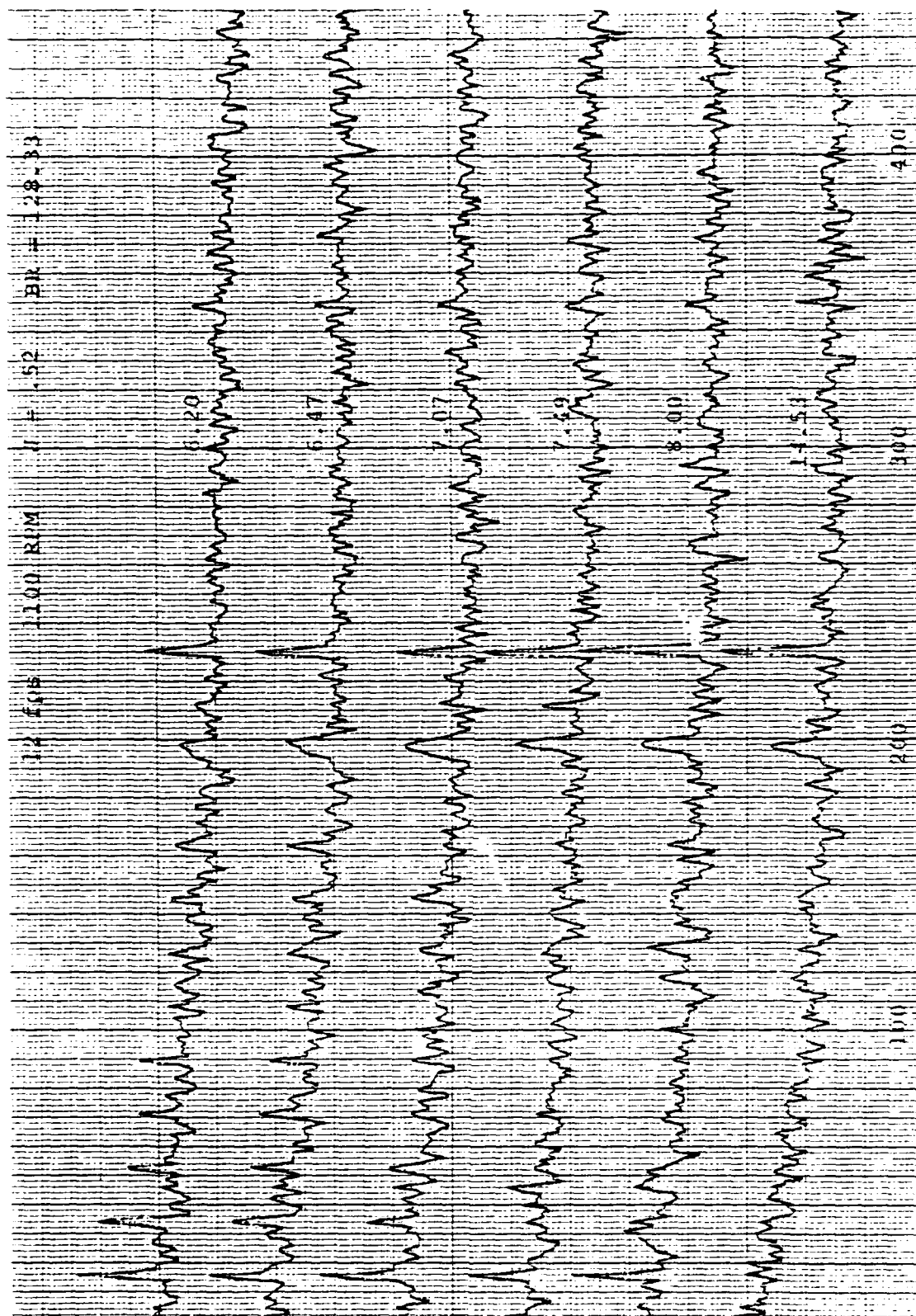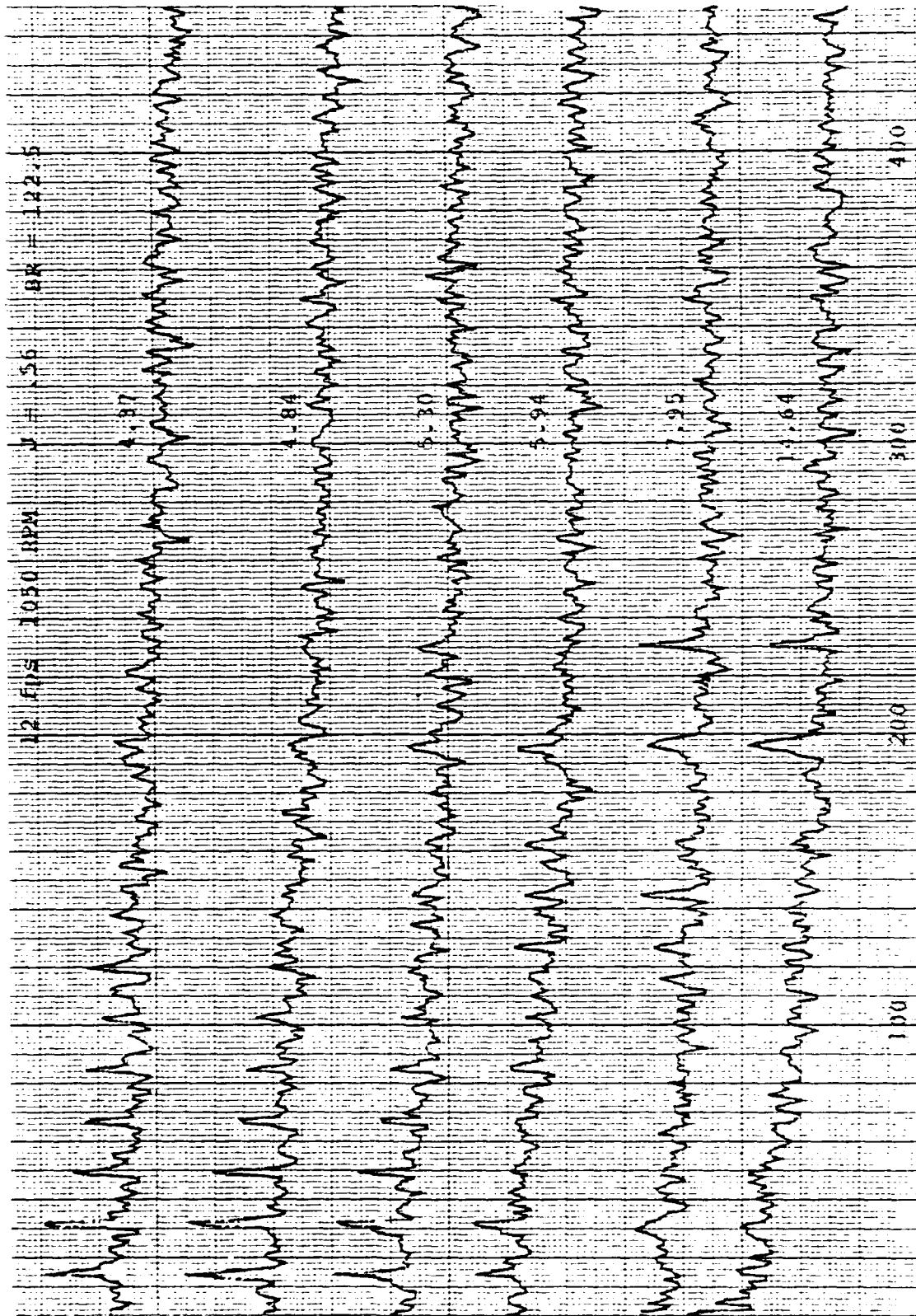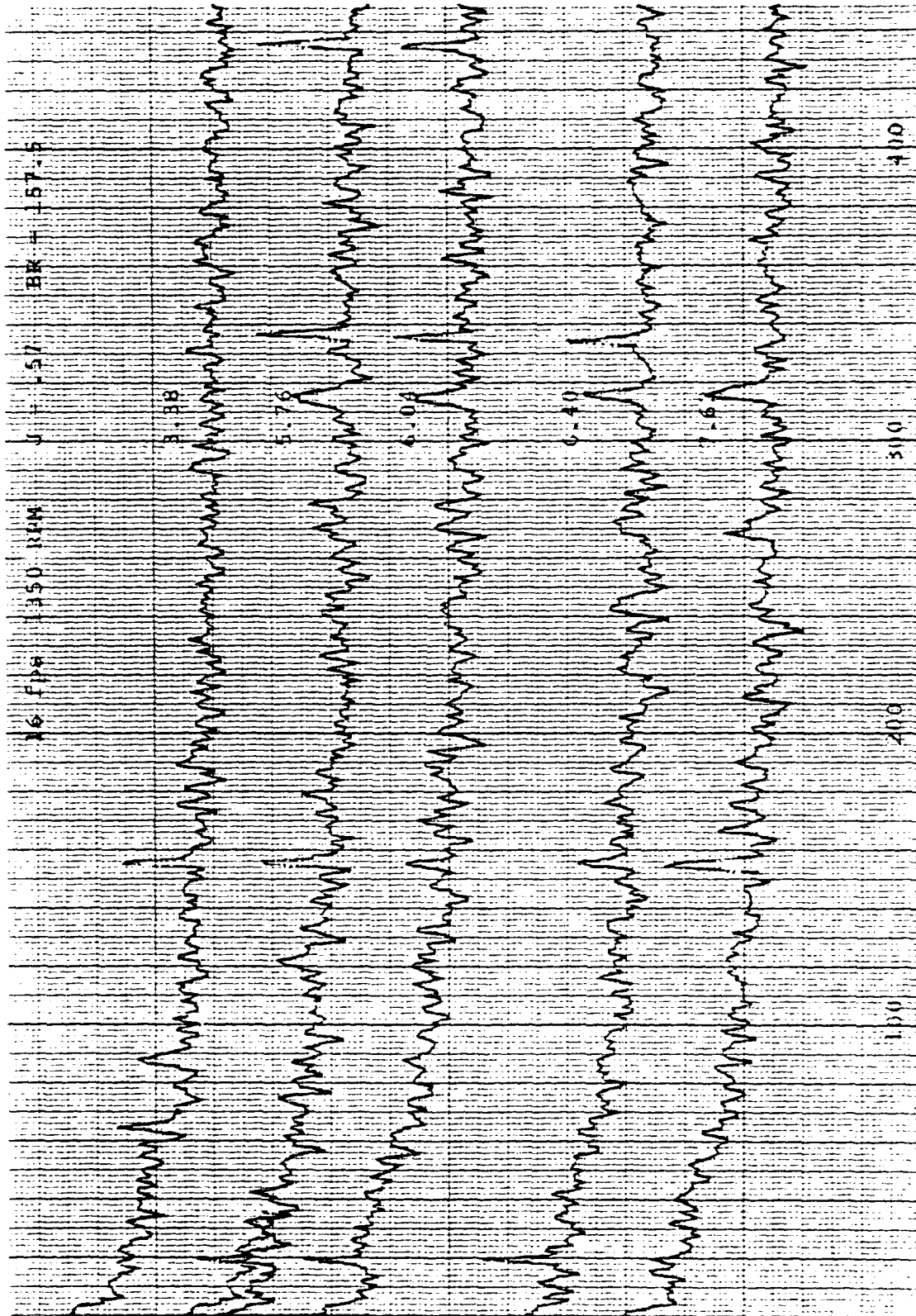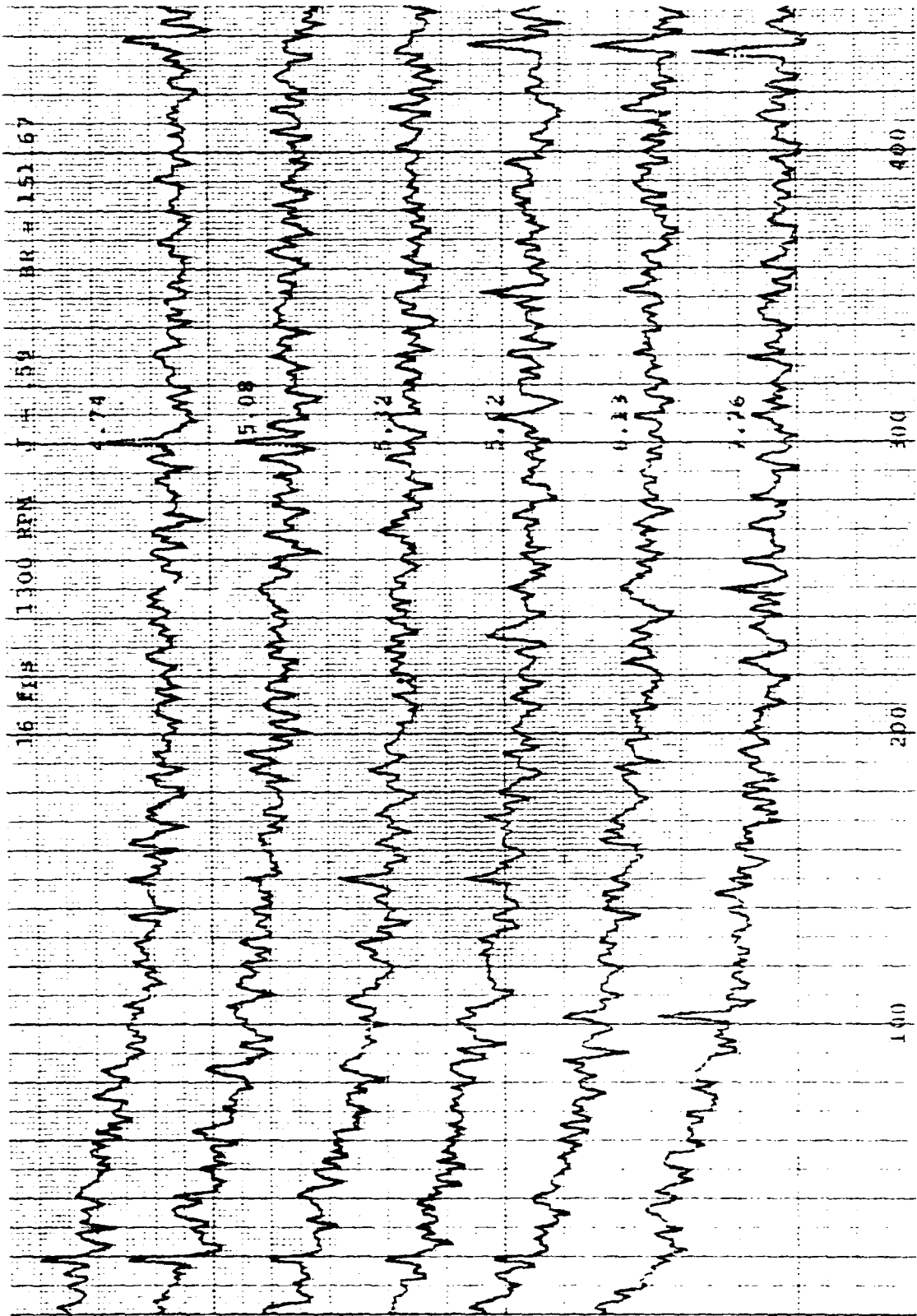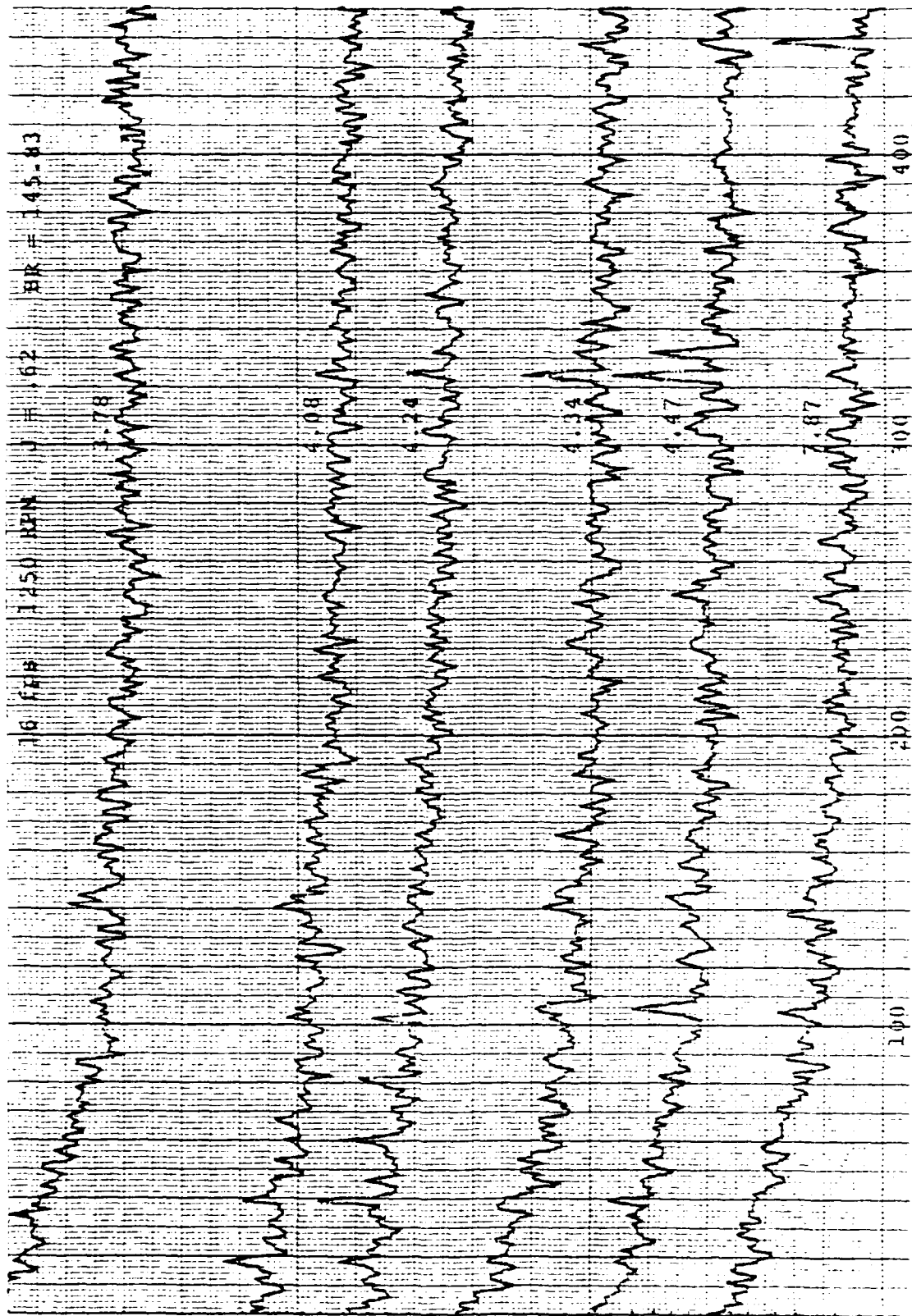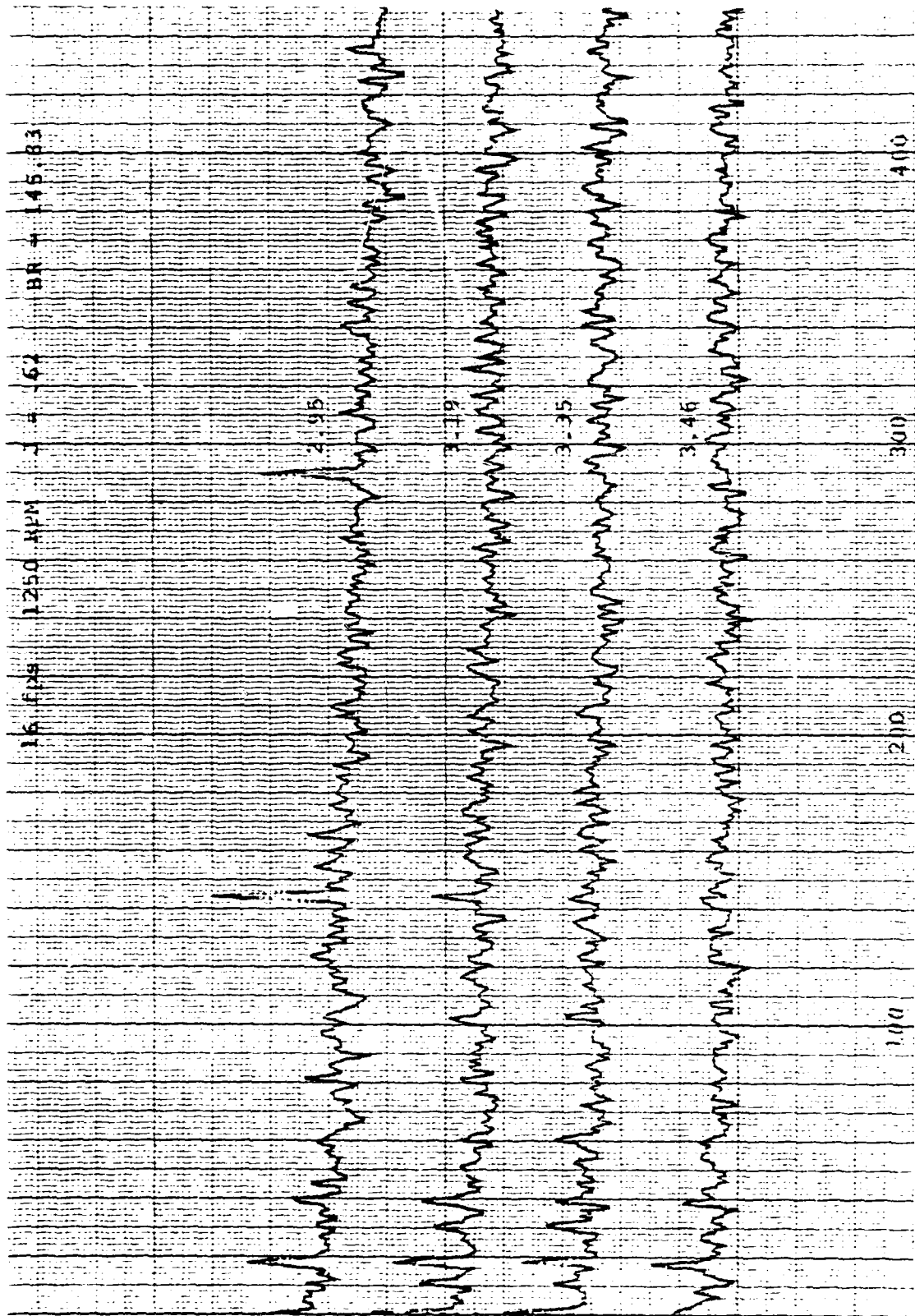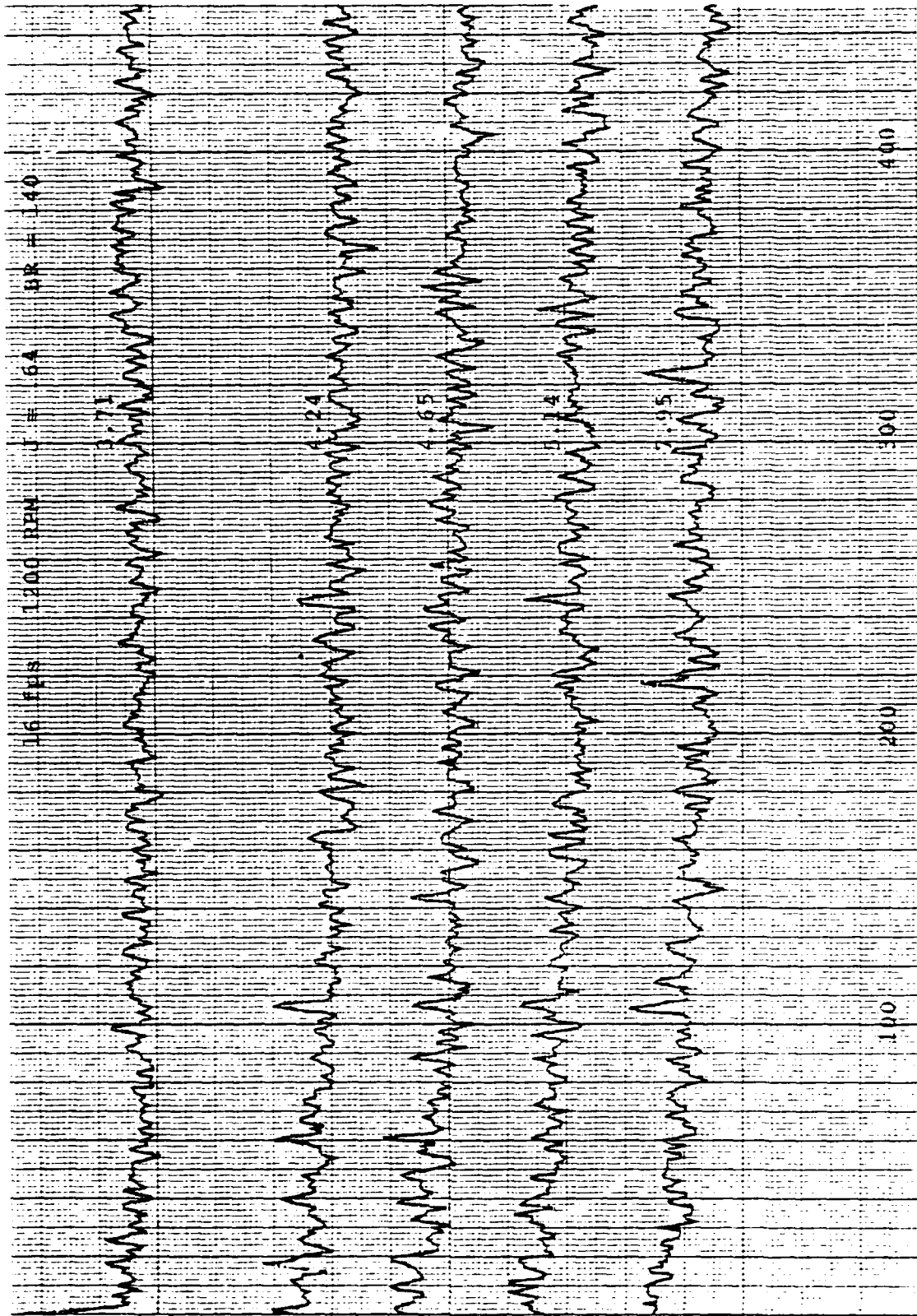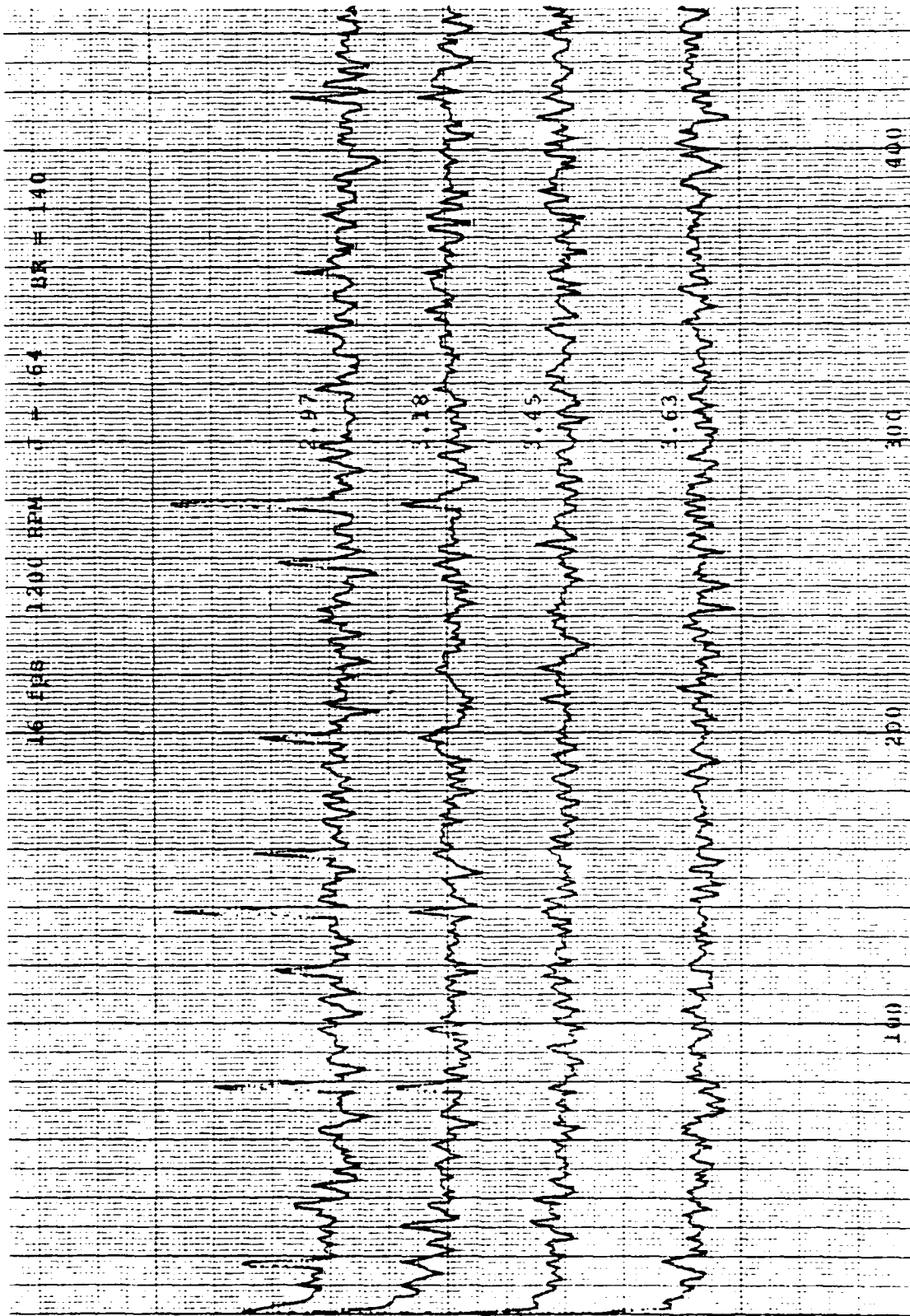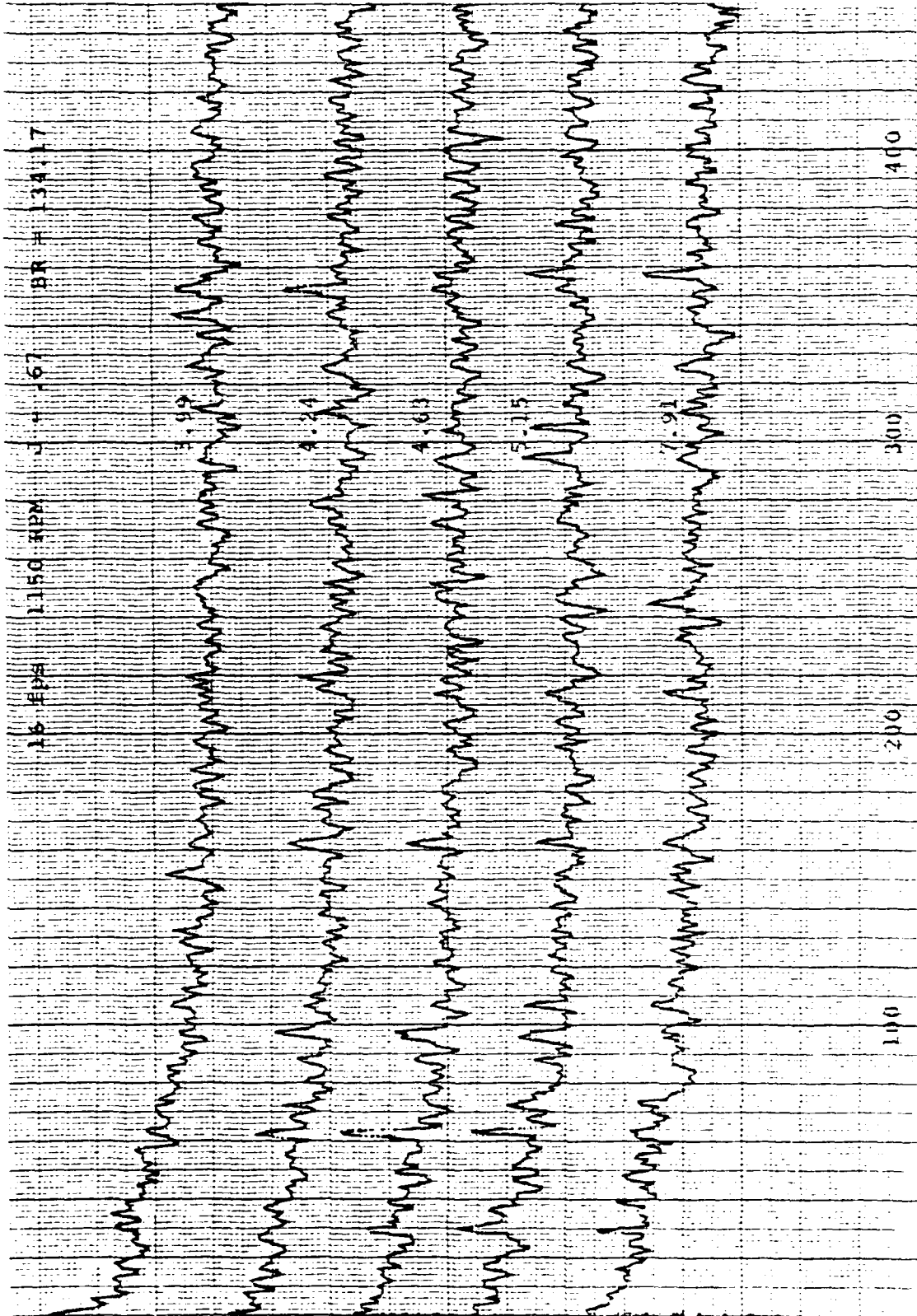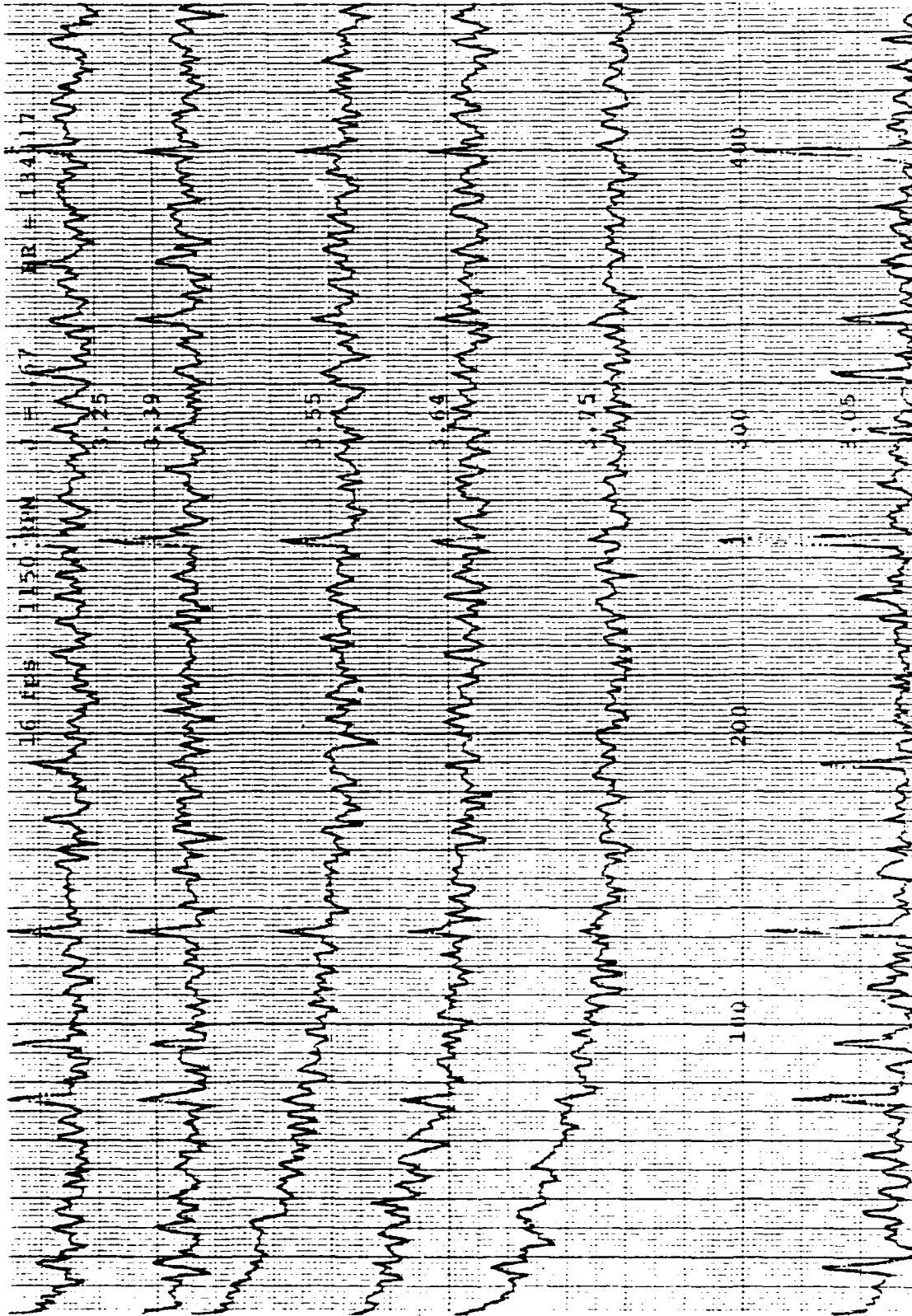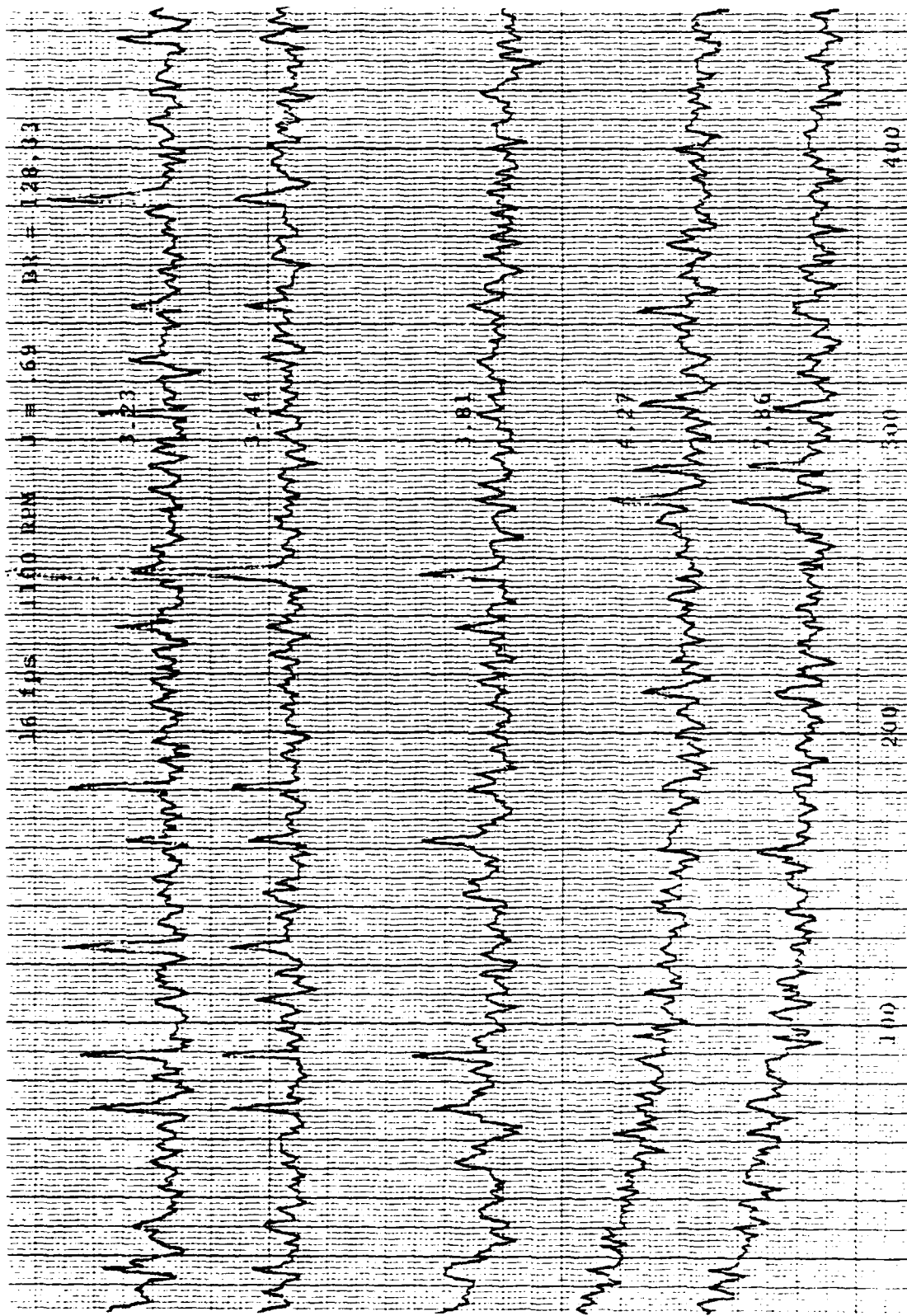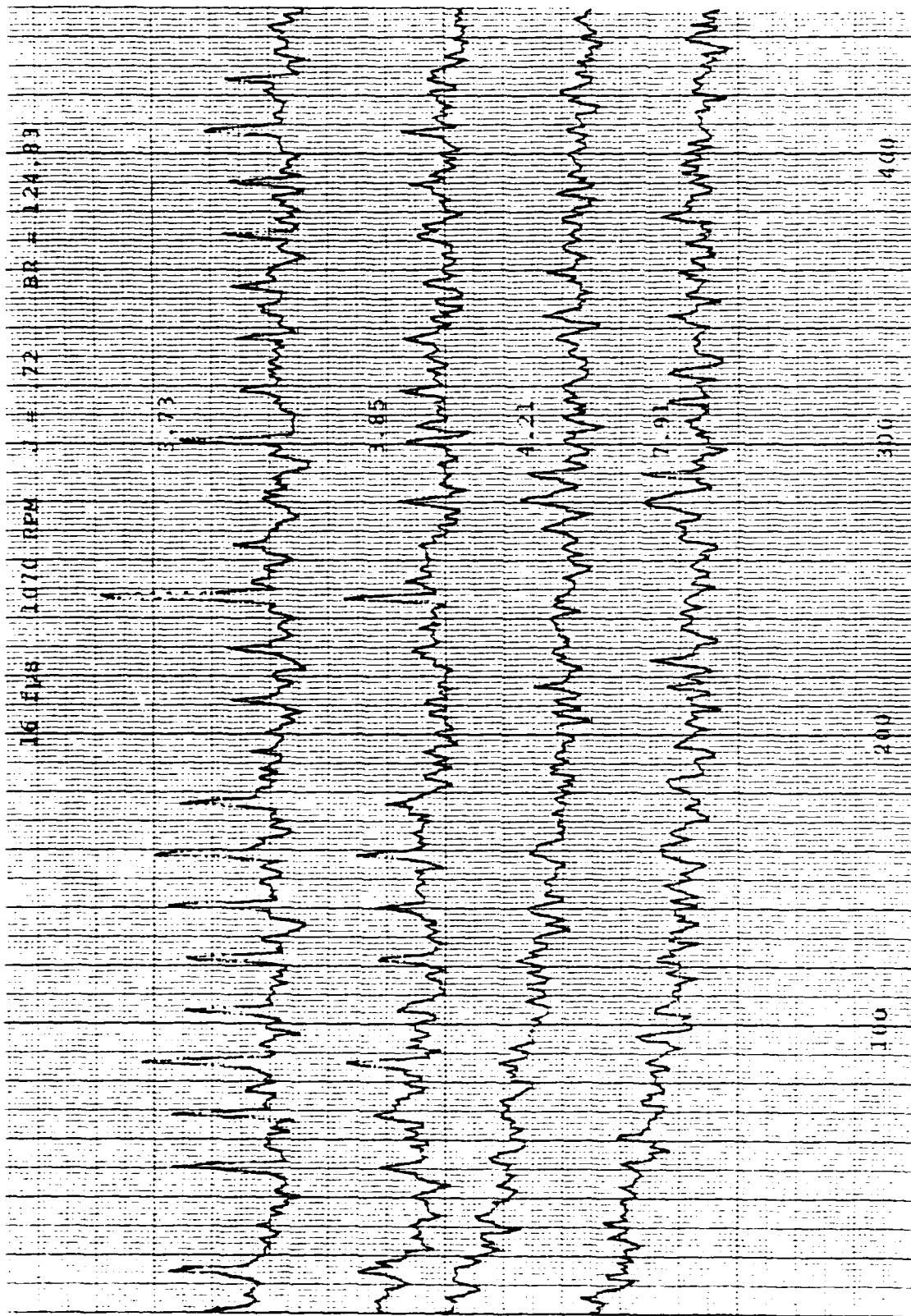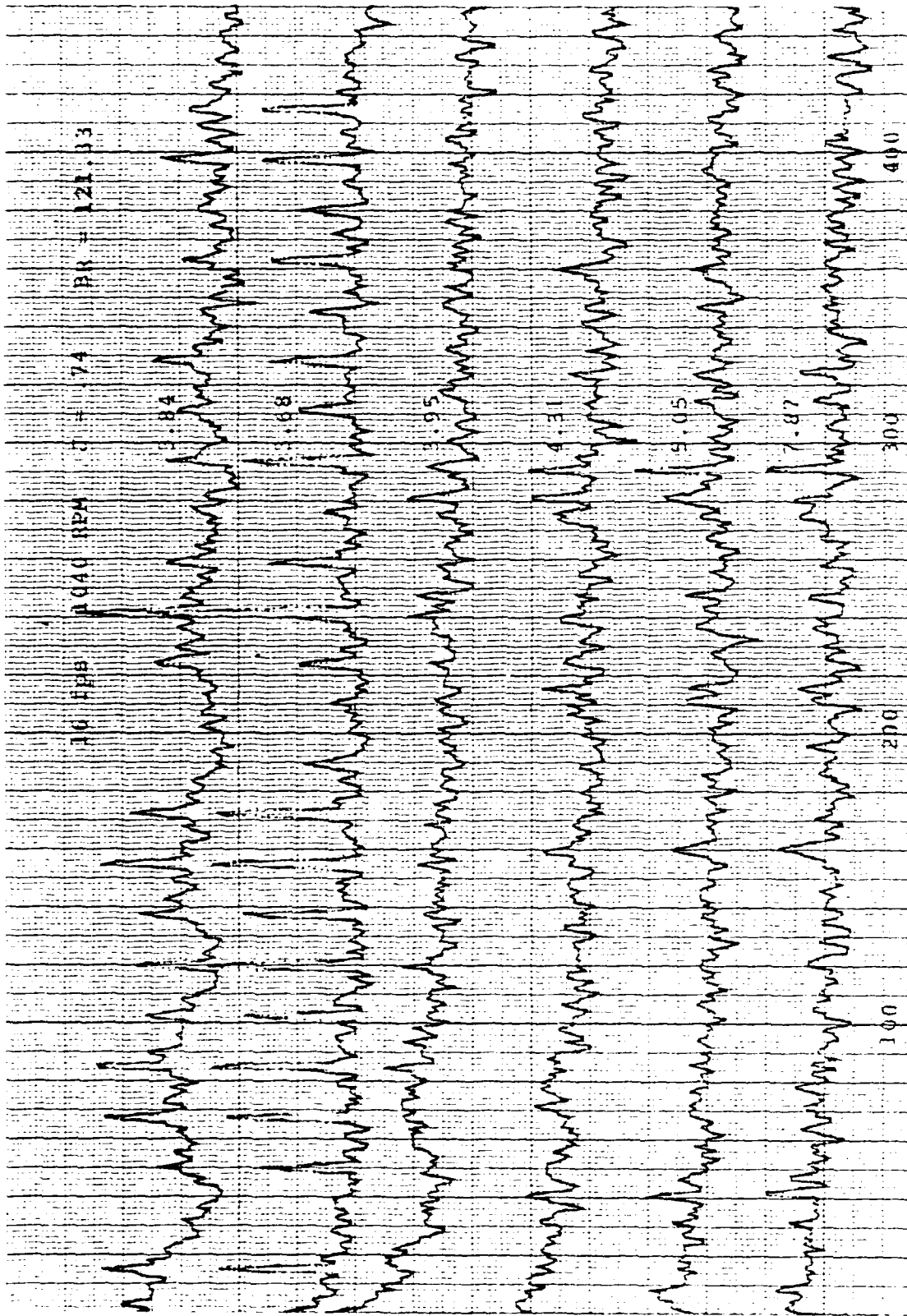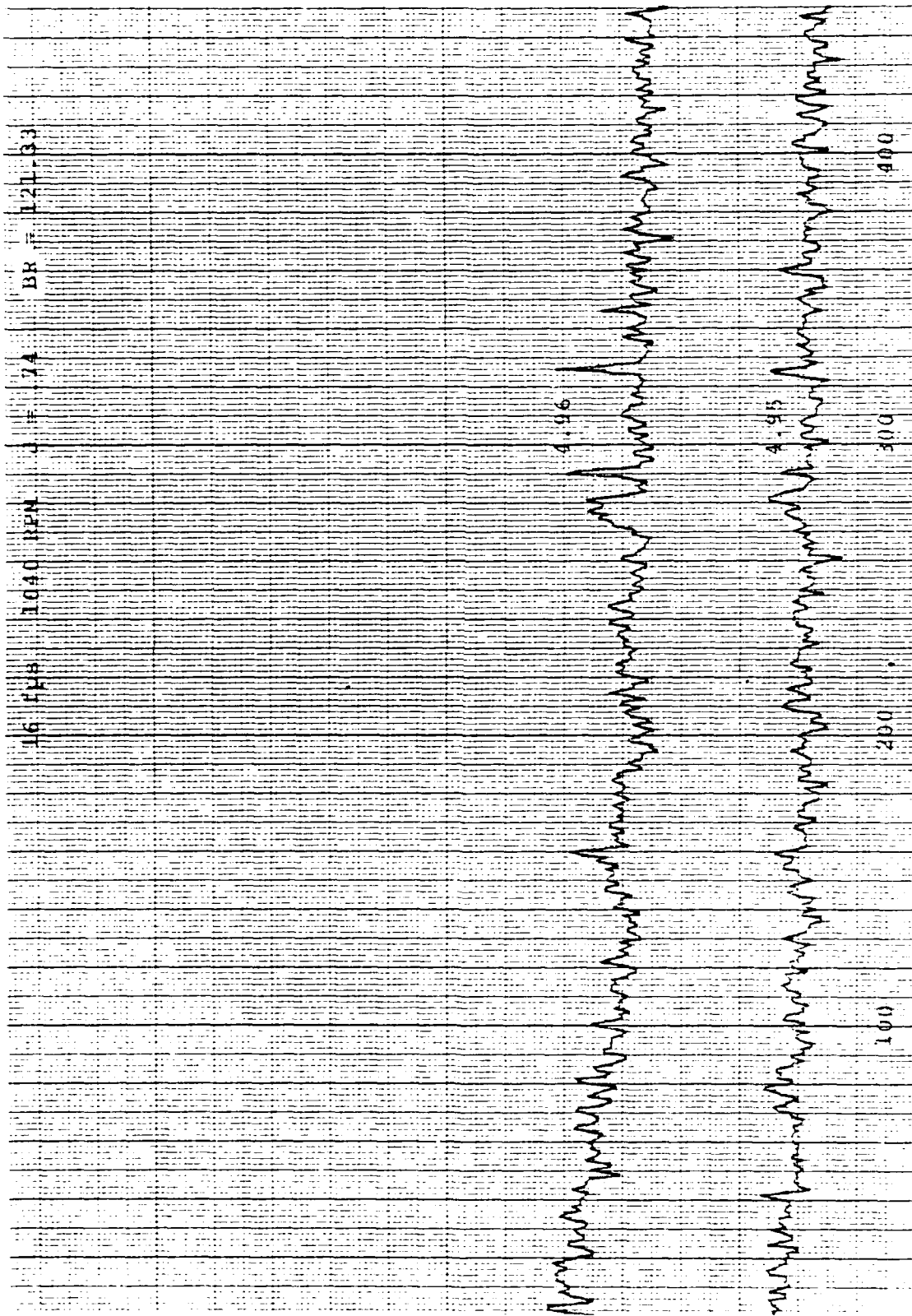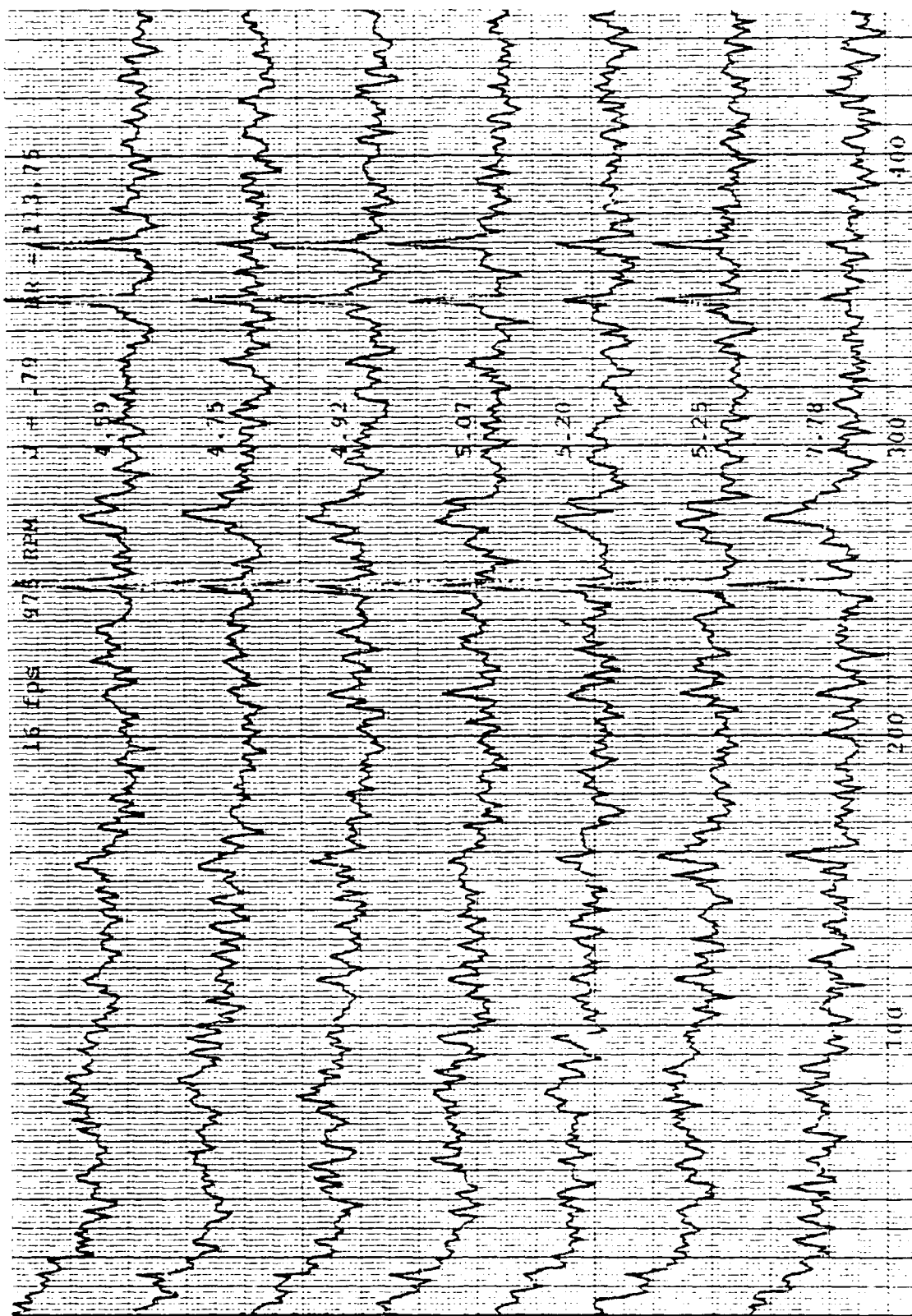
DATE _3/26_

J_nom _16_   RPM _104_   J_nom _0.75_   Shaft rate _17.33_

(Taps: 5/5 blue)   Blade rate _15.33_

Ithaco amp① _+40_ db; Filter: Hi pass _5×10^4_ Trans Anal

Lo pass _63×10^5_   ② _-15_ db

Measuring   Input atten③ _-20_ db Meas amp ___ (# of

Equipment: Output gain④ _+10_ db Spect anal. _λ_ spectra_32_

Temperature: (Start) water _85.5_ air _76_   Reynolds number:

(End)   _87_   _77_   _7.32×10^5_

Thrust 1 $T \times 0.1$

MAN	STAT	RPM	T	Q	GAIN CHANGE	K_T	J	J	REMARKS
2	Bar 750.9		0	15.0					TARE
9.7	471	(104)	214	65		.074	.74	5.11	31 -1
9.11	503	1043	228	66				5.51	-2
9.14	493	1040	224	65.5				5.35	-3
9.15	483	1041	222	66				5.26	-4
9.16	473	1040	216	65				5.14	-5
9.16	458	1041	216	65.5				4.98	-6
9.16	447	1041	214	65				4.55	33 -1
9.19	440	1042	212	65.5				4.76	-2
9.19	434	1041	206	65				4.69	-3
9.17	426	1041	205	65				4.62	-4
9.18	417	1041	204	65.5				4.51	-5 +LOFF
9.17	500	1041	230	65.5				5.44	-6
9.16	463	1042	224	66				5.03	-7

DATA SHEET   RUN NO __3__

DATE __3/26__

U$_{nom}$ __16__   RPM __975__ J$_{nom}$ __0.80__ Shaft rate __16.25__
(Taps: 6/5 blue)

Blade rate __113.75__

Ithaco amp① __+40__ db;Filter: Hi pass __5×10⁴__ Trans Anal

Lo pass __6.3×10⁵__   ② __-15__ db

Measuring   Input atten③ __-20__ db Meas amp ___ (# of
Equipment: Output gain④ __+10__ db Spect anal. _X_ spectra__32__)

Temperature: (Start) water __87.7__air __77.8__ Reynolds number:

(End)   __88.3__   __76.5__   __7.05×10⁵__

MAN	STAT	RPM	T	Q	GAIN CHANGE	K$_T$	J	J	REMARKS
913	523	975	166	44		.047	.79	5.71	34-1
916	486	976	96	45				5.58	
915	473	973	86	44				5.15	
916	455	975	88	44.5				4.94	-2
913	486	974	90	44				5.30	-3
915	507	972	92	44				5.52	-4
914	495	977	100	45				5.40	-5
912	483	974	94	44				5.27	-6
914	469	975	92	44.5				5.11	-7
912	459	973	86	44				5.01	35-1
911	464	975	84	44.5				5.07	-2
914	458	974	88	44				4.99	-3
910	448	974	82	44				4.90	-4
912	434	973	80	44				4.73	-5
910	416	973	76	44				4.54	-6 *LEPF

<u>DATA SHEET</u>   RUN NO __4__

                                                 DATE __3/26__

U_{nom} __16__   RPM __990__ J_{nom} __0.775__ Shaft rate __16.5__

(Taps: 6/5 blue)   Blade rate __115.5__

Ithaco amp① __+40__ db;Filter: Hi pass __5×10⁴__ Trans Anal

                              Lo pass __6.3×10⁵__   ② __-15__ db

Measuring   Input atten③ __-20__ db Meas amp ___   (# of
Equipment: Output gain④ __+10__ db Spect anal. __X__ spectra_32_

Temperature: (Start) water __88.3__air __76.5__ Reynolds number:

             (End)   __89__   __76__   __7.13×10⁵__

MAN	STAT	RPM	T	Q	GAIN CHANGE	K$_T$	J	σ	REMARKS
915	533	988	132	48.5		.052	.775	5.80	36-1
910	520	988	136	49				5.69	-2
915	505	992	130	49				5.49	
917	487	993	128	49.5				5.38	-3
914	471	990	116	48.5				5.12	-4
915	458	990	108	48				4.97	-5
918	441	992	108	48.5				4.76	-6
917	458	993	108	49.5				4.65	* LEPF

DATA SHEET

RUN NO __5__

DATE __3/26__

U_{nom} __16__   RPM __930__ J_{nom} __0.835__ Shaft rate _____

(Taps: 6/5 blue)   Blade rate _____

Ithaco amp① __+40__ db; Filter: Hi pass __5×10^4__ Trans Anal

Lo pass __6.3×10^5__   ② __-15__ db

Measuring   Input atten③ __-20__ db Meas amp ____   (≠ of

Equipment: Output gain④ __+10__ db Spect anal. __X__ spectra __32__)

Temperature: (Start) water __89__ air __76__   Reynolds number:

(End)   __89.3__   __75.9__   __6.91×10^5__

MAN	STAT	RPM	T	Q	GAIN CHANGE	K_T	J	:	REMARKS
916	530	930	8	29.5		.018	.83	5.75	37-1
95	502	932	4	29.5				5.44	-2
915	483	931	-2	29.5				5.23	-3
916	467	933	-8	30				5.05	-4
916	451	932	-14	29.5				4.87	-5
916	423	933	-18	30				4.56	* LEPF

DATA SHEET

RUN NO __6__

DATE __3/26__

U$_{nom}$ __16__   RPM __915__   J$_{nom}$ __0.85__   Shaft rate __15.25__

(Taps: 6/5 blue)   Blade rate __106.75__

Ithaco amp① __+40__ db;Filter: Hi pass __5×10⁴__ Trans Anal

Lo pass __6.3×10⁴__   ② __-15__ db

Measuring   Input atten③ __-20__ db Meas amp ____ (# of

Equipment: Output gain④ __+16__ db Spect anal. __x__ spectra②)

Temperature: (Start) water __89.3__ air __75.9__ Reynolds number:

(End)   __90__   __76.2__   __6.82×10⁵__

MAN	STAT	RPM	T	Q	GAIN CHANGE		K_T	J	J	REMARKS
911	612	917	8	26			.011	.84	6.70	38 -1
910	586	919	4	26					6.42	-2
913	560	916	-8	25.5					6"5.85	.-3 -4
915	538	917	-12	25.5					5.85	-4
914	516	917	-22	25					5.61	-5
914	495	915	-36	24.5					5.38	-6
914	477	914	-38	24.5					5.15	
913	464	913	-42	24					5.04	
913	451	911	-44	24					4.89	-7 ← LEFT

<u>DATA SHEET</u>   RUN NO _7_

DATE _3/26_

U$_{nom}$ _16_   RPM _1070_   J$_{nom}$ _0.72_   Shaft rate _17.83_

(Taps: 6/5 blue)   Blade rate _12483_

Ithaco amp① _+40_ db; Filter: Hi pass _5×10^4_ Trans Anal

Lo pass _6.3×10^4_   ② _-15_ db

Measuring   Input atten③ _-30_ db Meas amp ___ (# of

Equipment: Output gain④ _+10_ db Spect anal. _x_ spectra _30_

Temperature: (Start) water _90_ air _762_ Reynolds number:

(End)   _90.4_   _76.5_   _7.39×10^5_

MAN	STAT	RPM	T	Q	GAIN CHANGE	K_T	J		REMARKS
912	393	1071	278	75		.089	.71	4.24	3;-1
913	381	1070	270	74.5				4.16	-2
915	363	1070	268	74.5				3.89	-3 ALERT

DATA SHEET

RUN NO __8__

DATE __3/26__

U_{nom} __16__   RPM __1100__ J_{nom} __0.70__   Shaft rate __18.3__

(Taps: 6/5 blue)   Blade rate __128.33__

Ithaco amp① __+40__ db; Filter: Hi pass __5×10^4__ Trans Anal

Lo pass __6.3×10^4__   ② __-15__ db

Measuring   Input atten③ __-20__ db Meas amp ___   (# of

Equipment: Output gain④ __+10__ db Spect anal. ___ spectra___

Temperature: (Start) water __90.4__ air __76.5__   Reynolds number:

(End)   __90.6__   __76.7__   __8.01×10^5__

MAN	STAT	RPM	T	Q	GAIN CHANGE		K_T	J	$\cdot$	REMARKS
914	373	1099	334	84.5			.098	.70	4.01	40-1
916	362	1100	336	84.5					3.88	-2
916	347	1100	.332	84.5					3.71	✶ LEPF

DATA SHEET

RUN NO __9__

DATE __3/26__

U_{nom} __16__   RPM __1150__ J_{nom} __0.675__   Shaft rate __19.7__

(Taps: 6/5 blue)   Blade rate __134.7__

Ithaco amp① __+40__ db; Filter: Hi pass __$\leq 1\times10^4$__ Trans Aral

Lo pass __6.3×10^4__   ② __-15__ db

Measuring   Input atten③ __-80__ db Meas amp ___ (≠ of
Equipment: Output gain④ __+10__ db Spect anal. __X__ spectra32)

Temperature: (Start) water __90.6__ air __76.7__ Reynolds number:

(End)   __907__   __76.5__   __8.33×10^5__

MAN	STAT	RPM	T	Q	GAIN CHANGE	K_T	J	J	REMARKS
914	376	1151	466	102		.118	.67	4.05	41-1
916	359	1150	452	101.5				3.86	
914	357	1151	452	102				3.84	-2
916	330	1150	440	101				3.53	-3 * LCPS

DATA SHEET

RUN NO _10_
DATE _3/36_

U$_{nom}$ _16_   RPM _1200_ J$_{nom}$ _C65_ Shaft rate _20_
(Taps: 6/5 blue)   Blade rate _140_

Ithaco amp① _+40_ db; Filter: Hi pass _5×10⁴_ Trans Anal

Lo pass _6.3×10⁴_   ② _-15_ db

Measuring   Input atten③ _-20_ db Meas amp ___   (# of
Equipment: Output gain④ _+10_ db Spect anal. _X_ spectra _32_

Temperature: (Start) water _90.7_ air _76.5_ Reynolds number:
(End)   _91.1_   _77_   _8.88×10⁵_

MAN	STAT	RPM	T	Q	GAIN CHANGE	K$_T$	J		REMARKS
918	405	1202	600	121		.133	.64	4.36	42-1
914	395	1199	588	119.5				4.27	-2
910	382	1204	594	121				4.14	-3
915	367	1205	584	120.5				3.95	-4
911	321	1206	576	121.5				3.45	* LEPX

DATA SHEET

RUN NO __11__

DATE __3/26__

U~nom~ __16__   RPM __1250__   J~nom~ __0.625__   Shaft rate __2083__

(Taps: 6/3 blue)

Blade rate __14583__

Ithaco amp① __+40__ db; Filter: Hi pass __5×10^4__   Trans Anal

Lo pass __6.3×10^4__   ② __-15__ db

Measuring   Input atten③ __-20__ db Meas amp ___   (# of

Equipment: Output gain④ __+10__ db Spect anal. __X__ spectra③②)

Temperature: (Start) water __91.1__ air __77__ Reynolds number:

(End)   __91.6__   __77.5__   __9.22×10^5__

MAN	STAT	RPM	T	Q	GAIN CHANGE	K_T	J	⌐	REMARKS
917	456	1251	730	137.5		.143	.62	4.93	43-1
916	432	1251	722	137.5				4.67	-2
920	421	1250	712	137				4.53	-3
915	386	1250	706	137.5				4.16	-4
914	363	1251	704	137.5				3.91	-5
916	353	1251	706	137.5				3.79	-6
916	334	1252	700	137.5				3.58	44-1 ✱TV
919	316	1252	685	137.5				3.37	✱46
919	317	1253	685	137.5				3.38	-
919	309	1253	686	137				3.29	44-2

DATA SHEET

RUN NO 12
DATE 3/26

U$_{nom}$ 16   RPM 1300 J$_{nom}$ 0.6   Shaft rate 21.67
(Taps: 6/5 blue)   Blade rate 151.67

Ithaco amp① +46 db; Filter: Hi pass 5×10^4 Trans Anal

Lo pass 6.3×10^4 ② -15 db

Measuring   Input atten③ -20 db Meas amp ___   (# of
Equipment: Output gain④ +10 db Spect anal. X spectra 32)

Temperature: (Start) water 91.6 air 77.5 Reynolds number:

(End) 92 78 9.55×10^5

MAN	STAT	RPM	T	Q	GAIN CHANGE		K$_T$	J	J	REMARKS
916	462	1300	864	155.5			.155	.595	5.03	45-1
916	440	1299	856	155					4.78	-2
914	426	1299	850	155.5					4.63	-3 *TV

DATA SHEET

RUN NO 13

DATE 3/26

U_{nom} 16   RPM 1350 J_{nom} 0.575   Shaft rate 22.5
(Taps: 6/5 blue)

Blade rate 157.5

Ithaco amp① +40 db; Filter: Hi pass 5×10^4 Trans Anal

Lo pass 6.3×10^4 ② -15 db

Measuring   Input atten③ -20 db Meas amp ___   (# of
Equipment: Output gain④ +16 db Spect anal. λ   spectra 32)

Temperature: (Start) water 92 air 78   Reynolds number:

(End) 92.4 78.3 9.84×10^5

MAN	STAT	RPM	T	Q	GAIN CHANGE	K_T	J	∴	REMARKS
919	714	1350	1066	175		.165	.57	7.82	46-1°
918	689	1352	1060	175.5				7.55	-2
921	646	1350	1048	175				7.05	-3
918	607	1350	1040	174.5				6.64	-4
918	588	1351	1034	174.5				6.42	-5
921	559	1351	1030	175				6.08	-6
922	490	1350	1008	174.5				5.30	+BB/TV

DATA SHEET   RUN NO 14

DATE 3/26

U nom 12   RPM 1050   J nom 0.55   Shaft rate 17.5

(Taps: 5/5 blue)   Blade rate 122.5

Ithaco amp ① +50 db; Filter: Hi pass 5×10⁴ Trans Anal

Lo pass 6.3×10⁵   ② -30 db

Measuring   Input atten ③ -30/+30 db Meas amp ___ (# of

Equipment: Output gain ④ +20 db Spect anal. X spectra 32)

Temperature: (Start) water 92.4 air 78.3 Reynolds number:

(End)   92.6   79   7.85×10⁵

MAN	STAT	RPM	T	Q	GAIN CHANGE	K_T	J	J	REMARKS
516	488	1053	644	115		.177	.55	9.65	47-1
521	406	1054	612	114.5				7.90	47-2
526	344	1052	594	114.5				6.58	-3-2
516	314	1051	590	114.5				6.11	-3 *HV
516	275	1050	580	114				5.31	*TV
516	274	1052	576	114.5				5.29	-4

DATA SHEET

RUN NC __15__

DATE __3/26__

U$_{nom}$ __17__   RPM __11CC__   J$_{nom}$ __C.525__   Shaft rate __15.33__

(Taps: 6/5 blue)

Blade rate __128.33__

Ithaco amp① __+50__ db; Filter: Hi pass __5×10⁴__ Trans Anal

Lo pass __6.3×10⁴__   ② __-5__ db

Measuring   Input atten③ __-30__ db Meas amp ___ (# of

Equipment: Output gain④ __+10__ db Spect anal. __X__ spectra __32__

Temperature: (Start) water __92.6__ air __79__   Reynolds number:

(End)   __92.8__   __79__   __8.17×10⁵__

MAN	STAT	RPM	T	Q	GAIN CHANGE	K$_T$	J	J	REMARKS
S17	463	1099	740	129.5		.187	.58	9.11	✳ 48
S17	459	1099	738	129.5				9.05	48-1
S16	433	1098	726	129				8.84	-2
S16	410	1098	730	130				8.07	
S18	391	1099	750	129				7.65	-3
S16	359	1098	714	129				7.03	-4
S16	330	1100	704	129.5				6.44	-5
S16	303	1100	698	129.5				5.59	-6 ✳ TV

DATA SHEET

RUN NO 16
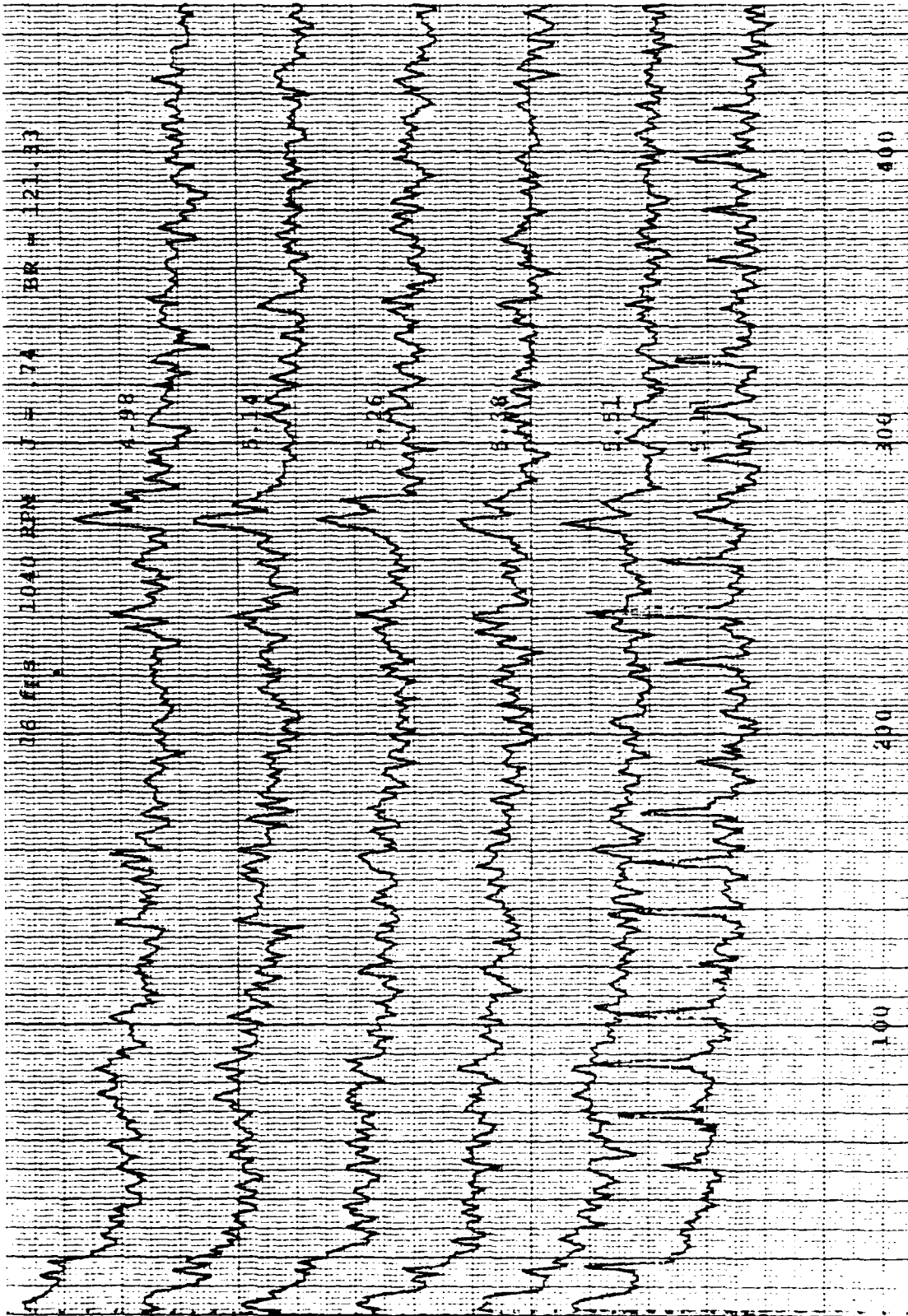DATE 3/56

J_{nom} 17   RPM 1.75 J_{nom} 0.5   Shaft rate 19.58
(Taps: 6/5 blue)   Blade rate 137.08
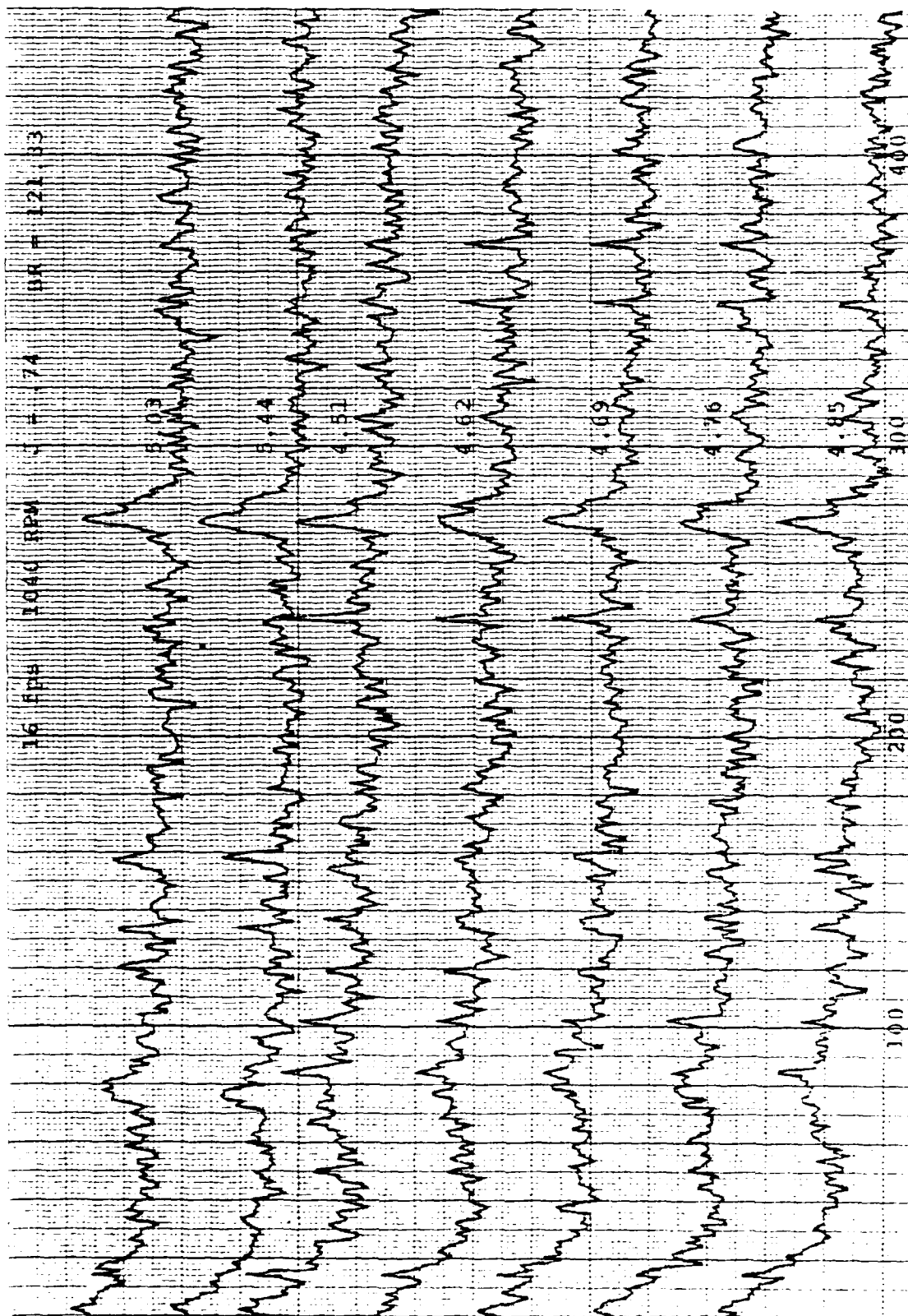
Ithaco amp① + 50 db;Filter: Hi pass 5×10^4 Trans Anal

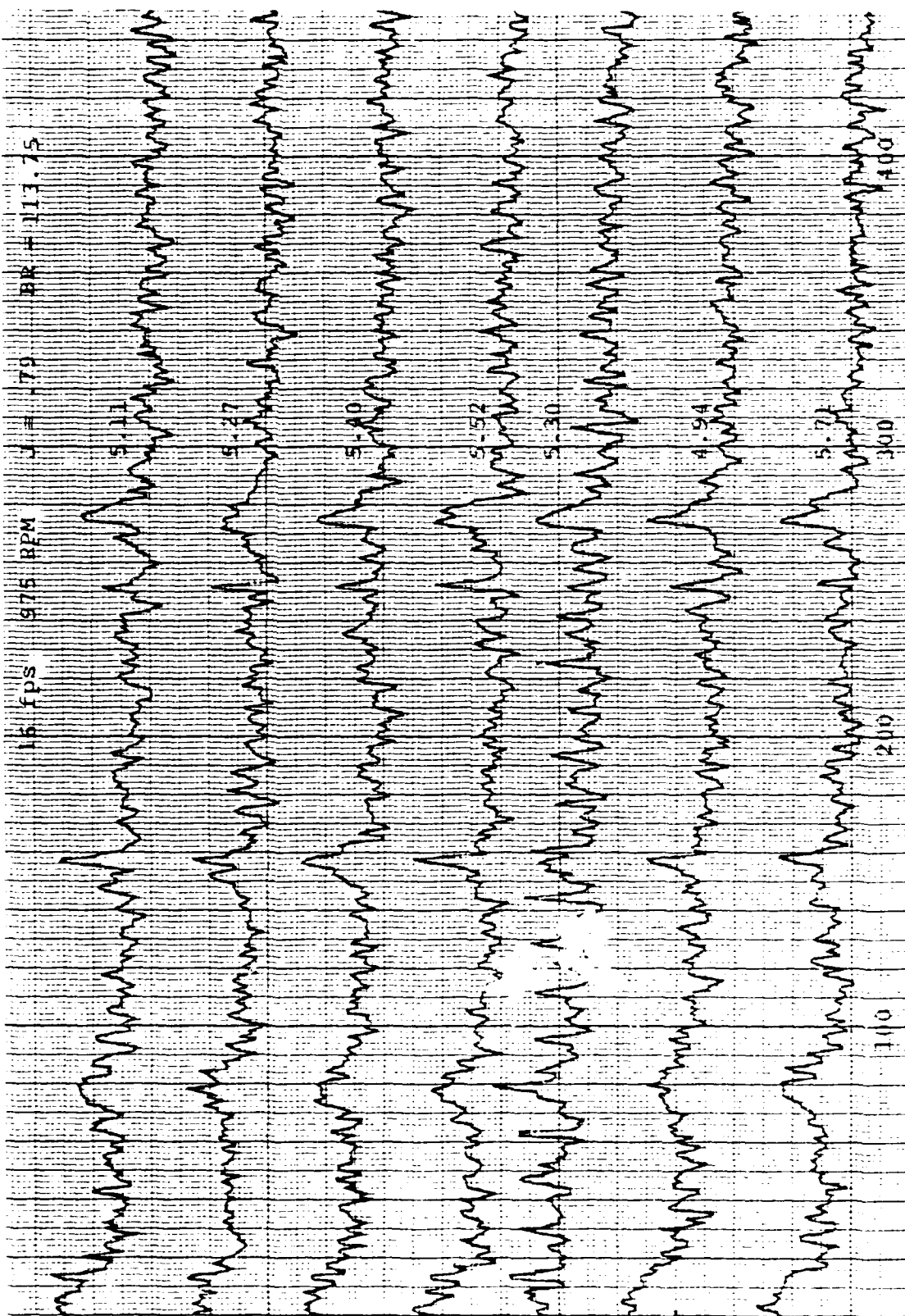Lo pass 6.3×10^4 ② -15 db

Measuring   Input atten③ -30 db Meas amp ___ (# of
Equipment: Output gain④ +10 db Spect anal. __X spectra 32)

Temperature: (Start) water 92.8 air 79   Reynolds number:

(End)   92.8   79.5 8.74×10^5

MAN	STAT	RPM	T	Q	GAIN CHANGE	K_T	J	J	REMARKS
521	567	1178	956	155		.201	.5	11.16	
520	530	1178	950	155.5				10.44	49-1
517	478	1173	928	154.5				9.44	-2
517	445	1174	918	154.5				8.77	-3 *HV
518	416	1172	908	154				8.16	-4
516	384	1173	902	154.5				7.54	-5
512	360	1172	899	152.5				7.11	-6
517	301	1173	876	154				5.84	-7
514	288	1173	876	154				5.61	*TV

DATA SHEET

RUN NO __17__

DATE __3/26__

U_{nom} __10/12__ (Taps: 6/5 blue)   RPM __1025/__ __1005__ J_{nom} __0.475__   Shaft rate __17.08/20.42__

Blade rate __1195.8/145.92__

Ithaco amp① __+50__ db; Filter: Hi pass __5x10⁴__   Trans Anal

Lo pass __6.3x10⁴__   ② __-15__ db

Measuring Equipment: Input atten③ __-30__ db Meas amp ____ (# of

Output gain④ __+10__ db Spect anal. __X__ spectra __32__)

Temperature: (Start) water __92.8__ air __79.5__ Reynolds number:

(End) __93__ __79.8__ __7.67x10⁵/9.06x10⁵__

MAN	STAT	RPM	T	Q	GAIN CHANGE		K_T	J	σ	REMARKS
366	449	1036	754	158			.214	.48	12.76	×1½ Lw
364	431	1053	722	124.5					12.32	50-1
520	465	1224	1048	171.5			.208	.48	9.14	
516	451	1225	1056	172.5					8.93	50-2 HW
517	399	1226	1042	173					7.86	-3
515	367	1227	1036	173					7.33	-4
515	341	1226	1056	173.5					6.70	-5 ×TV

DATA SHEET

RUN NO <u>18</u>

DATE <u>3/36</u>

U_{nom} <u>10</u>   RPM <u>1080</u>   J_{nom} <u>0.45</u>   Shaft rate <u>18</u>

(Taps: 6/5 blue)   Blade rate <u>106</u>

Ithaco amp① <u>+50</u> db; Filter: Hi pass <u>≤×10⁴</u>   Trans Anal

Lo pass <u>63×10⁴</u>   ②<u>-15</u>   db

Measuring   Input atten③ <u>-30</u> db Meas amp ___   (# of

Equipment: Output gain④ <u>+10</u> db Spect anal. <u>λ</u> spectra <u>32</u>

Temperature: (Start) water <u>93</u> air <u>79.8</u> Reynolds number:

(End)   <u>93.1</u>   <u>79.8</u>   <u>8.66×10⁵</u>

MAN	STAT	RPM	T	Q	GAIN CHANGE		K_T	J		REMARKS
376	536	1089	886	143			.219	.475	14.91	+HV
364	390	1080	858	141.5			.		11.11	S1-1
365	347	1076	816	140.5					9.83	-2
364	324	1077	812	40.5					9.17	
364	305	1083	822	142					8.6	-3 *TV

DATA SHEET

RUN NO <u>19</u>

DATE <u>3/26</u>

U_{nom} <u>8/10</u>   RPM <u>915/1150</u> J_{nom} <u>0.455</u> Shaft rate <u>5.25/19.7</u>

(Taps: 6/5 blue)

Blade rate <u>06.75/134.17</u>

Ithaco amp① <u>+50</u> db; Filter: Hi pass <u>5×10⁴</u> Trans Anal

Lo pass <u>6.3×10⁴</u>   ② <u>−15</u> db

Measuring   Input atten③ <u>−30</u> db Meas amp ___ (# of

Equipment: Output gain④ <u>+10</u> db Spect anal. <u>X</u> spectra <u>32</u>)

Temperature: (Start) water <u>93.1</u> air <u>798</u> Reynolds number:

(End)   <u>93.1</u>   <u>79.7</u>   <u>6.76×10⁵</u>

                                                                <u>8.48×10⁵</u>

MAN	STAT	RPM	T	Q	GAIN CHANGE	K_T	J	c	REMARKS
251	525	915	640	107			.227	45	22.61	*HV
213	345	915	604	108					15.17	52-1
370	471	1150	1026	163.5			.230	.44	13.33	-2
367	443	1150	1024	164.5					12.62	-3
360	460	1149	1057	164					13.38	-4
364	447	1145	1012	163					12.85	-5
363	433	1151	1026	165					13.47	-6 *TV

DATA SHEET

RUN NO $\mathcal{X}$

DATE 3/26

U_{nom} 8/10   RPM 975/1215 $_{nom}$ 0.40   Shaft rate 16.25/5c.25

(Taps: 6/5 blue)   Blade rate 13.75/141.75

Ithaco amp① +50 db;Filter: Hi pass 5×10^4 Trans Anal

Lo pass 6.3×10^4 ② -15 db

Measuring   Input atten③ -30 db Meas amp ___ (# of

Equipment: Output gain④ +10 db Spect anal. X spectra 32)

Temperature: (Start) water 93.1 air 79.7 Reynolds number:

(End) 93.2 79.2   7.19×10⁵/ 8.95×10⁵

MAN	STAT	RPM	T	Q	GAIN CHANGE	K_T	J	:	REMARKS
214	555	977	792	135.5		.242	.41	24.75	*HU
364	749	1216	1280	188		.240	.41	21.83	53-1
366	539	1215	1224	187.5				15.5	-2 *TU

DATA SHEET

RUN NO 21

DATE _____

U_{nom} __8__   RPM __1040__ J_{nom} __0.375__   Shaft rate __17.33__

(Taps: 6/5 blue)   Blade rate __51.33__

Ithaco amp① __+56__ db; Filter: Hi pass 5×10^4 Trans Anal

Lo pass 6.3×10^5 ② __-15__ db

Measuring   Input atten③ __-30__ db Meas amp ____   (# of
Equipment: Output gain④ __T10__ db Spect anal. __x__ spectra 32)

Temperature: (Start) water __93.2__ air __79.2__ Reynolds number:

(End)   __93.2__   __78.9__ 7.65×10^5

MAN	STAT	RPM	T	Q	GAIN CHANGE	K_T	J	C	REMARKS
244	584	1041	948	145.5		.252	.39	26.15	✱ HU
240	408	1043.	904	146				18.4	51-1
240	388	1043	900	146				17.47	-2
241	530	1042	938	146				23.99	
241	514	1041	926	145.5				23.25	-3
240	472	1042	926	146.5				21.35	-4
239	446	1042	912	145.5				20.57	-5
243	428	1041	910	145.5				19.8	✱ TU
	BAR								
16	754.6		26	13.5					TARE
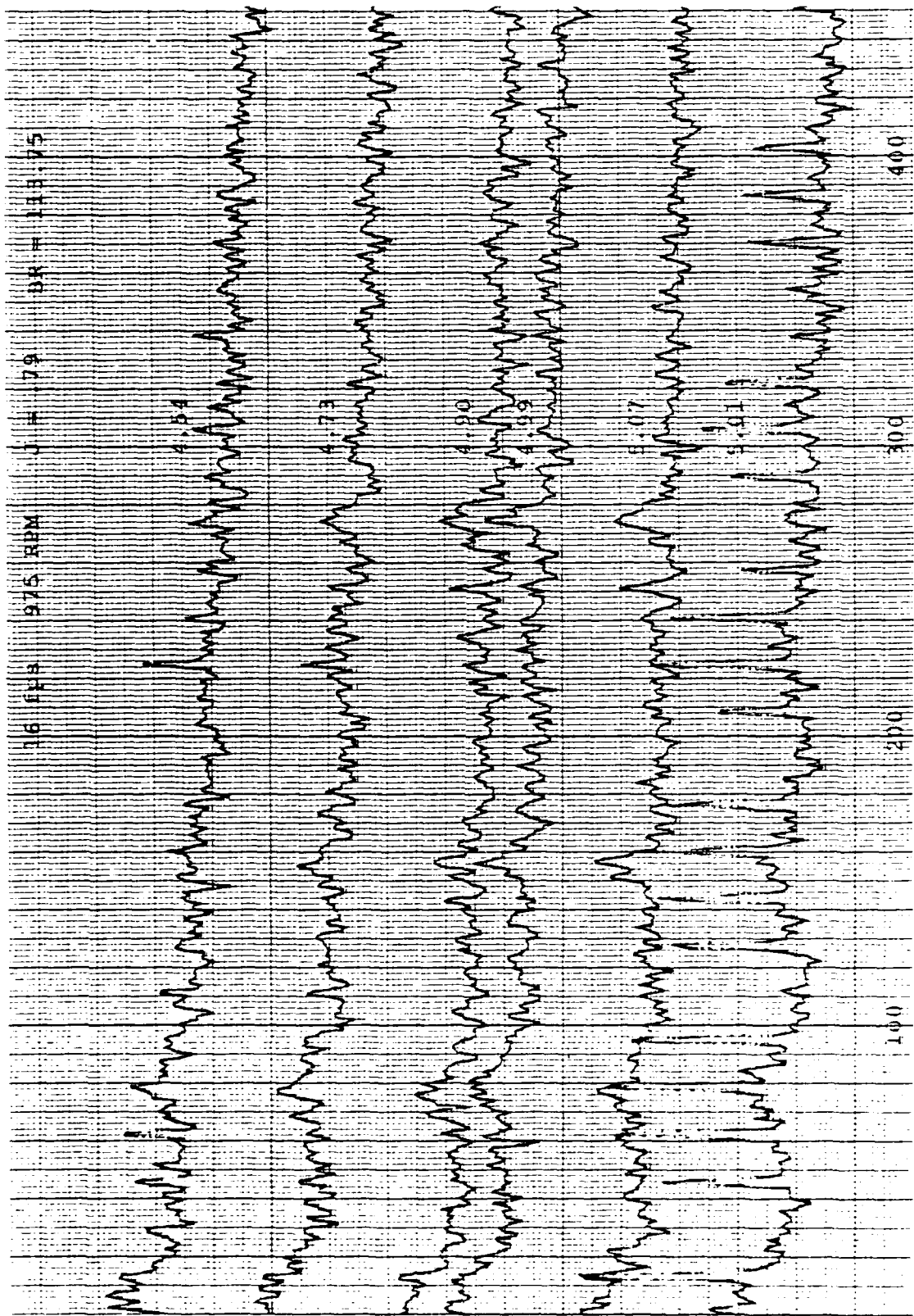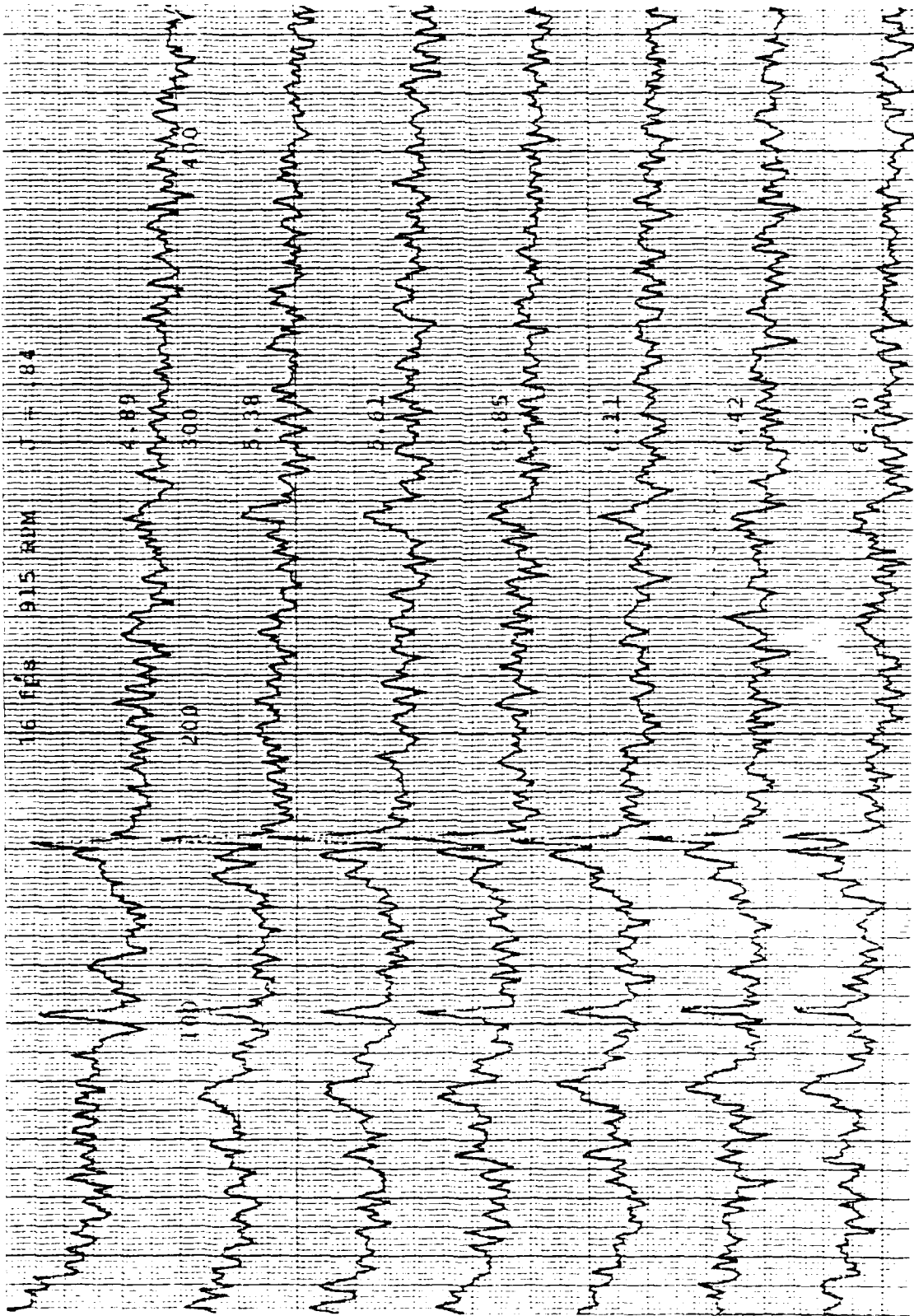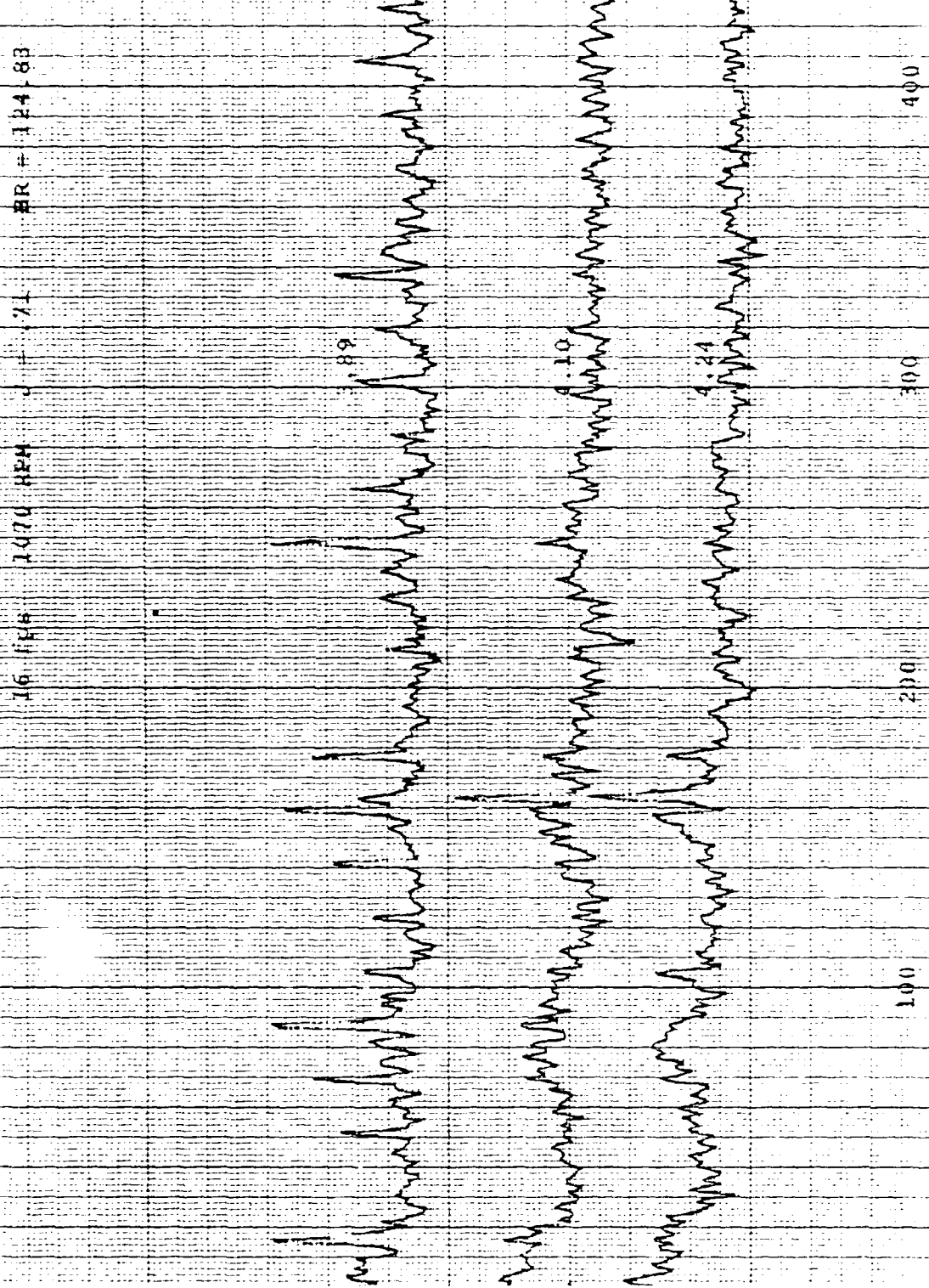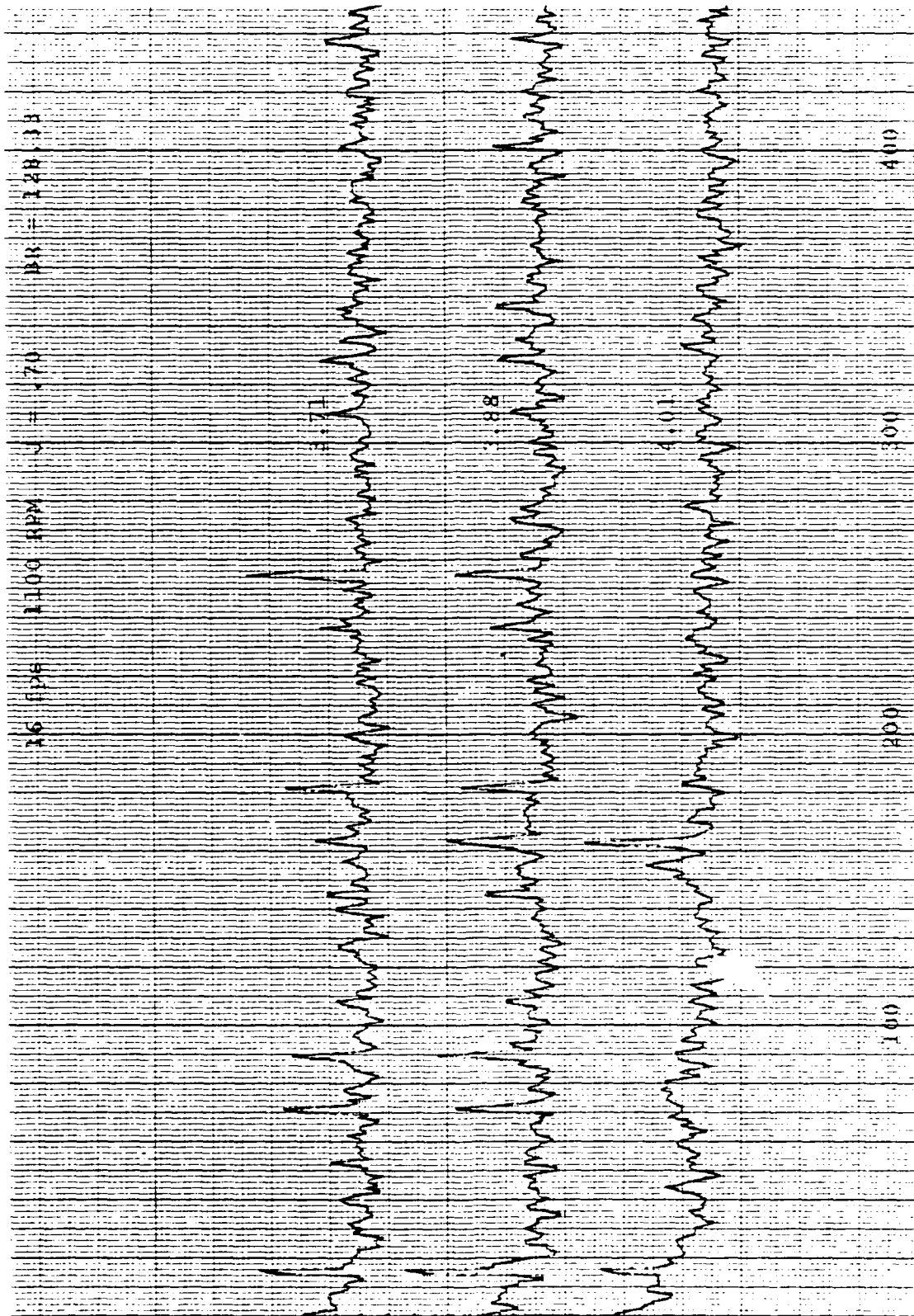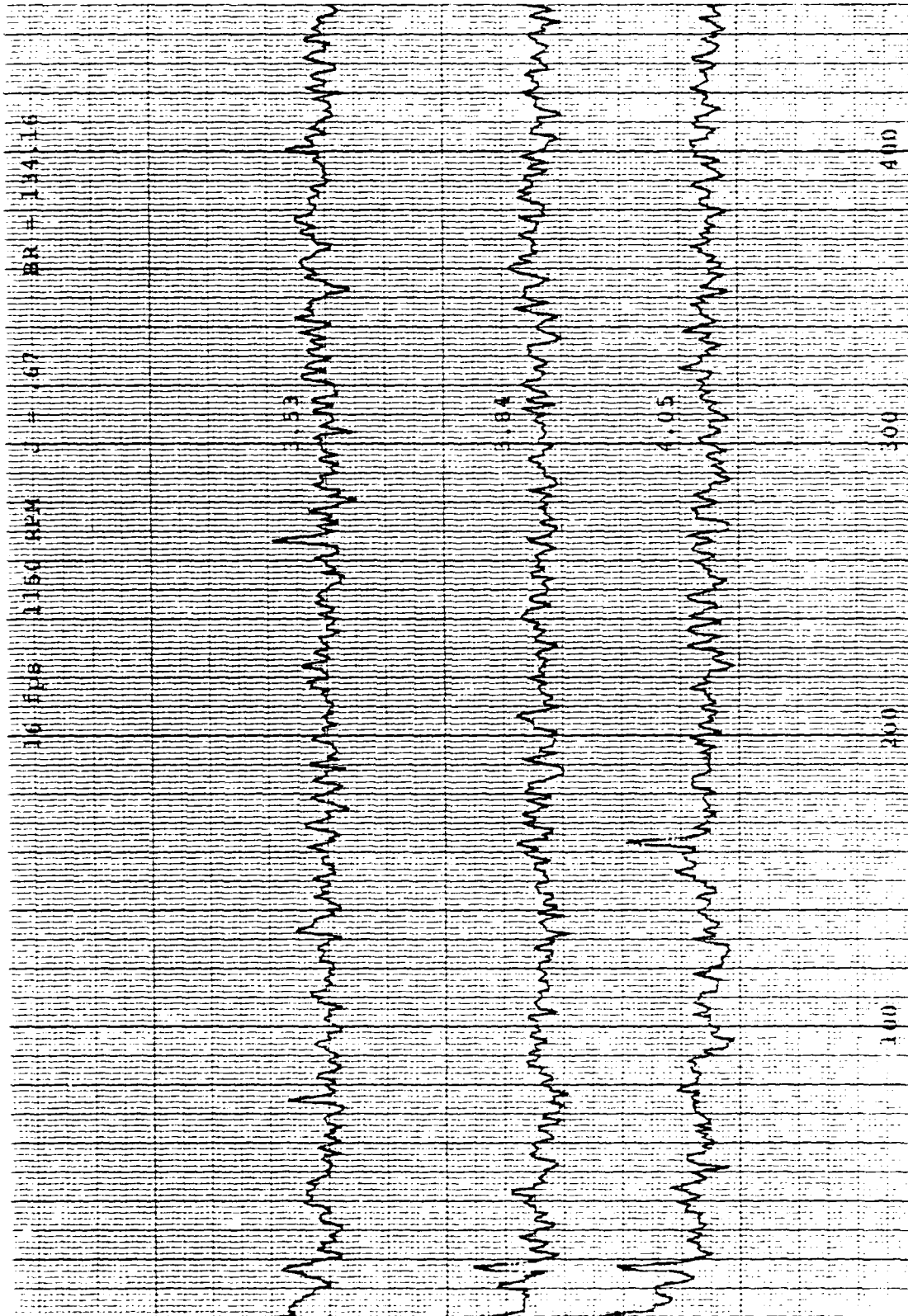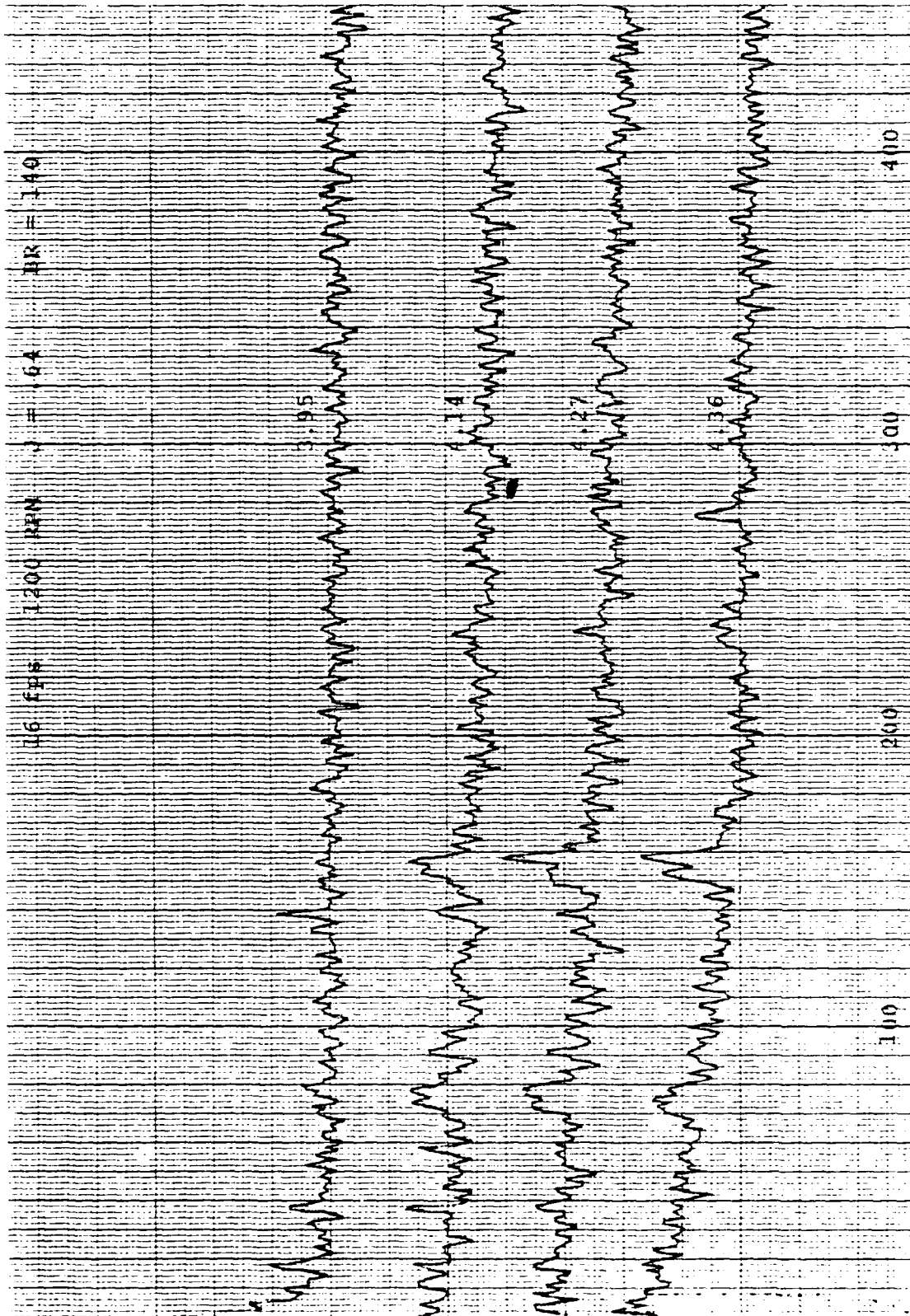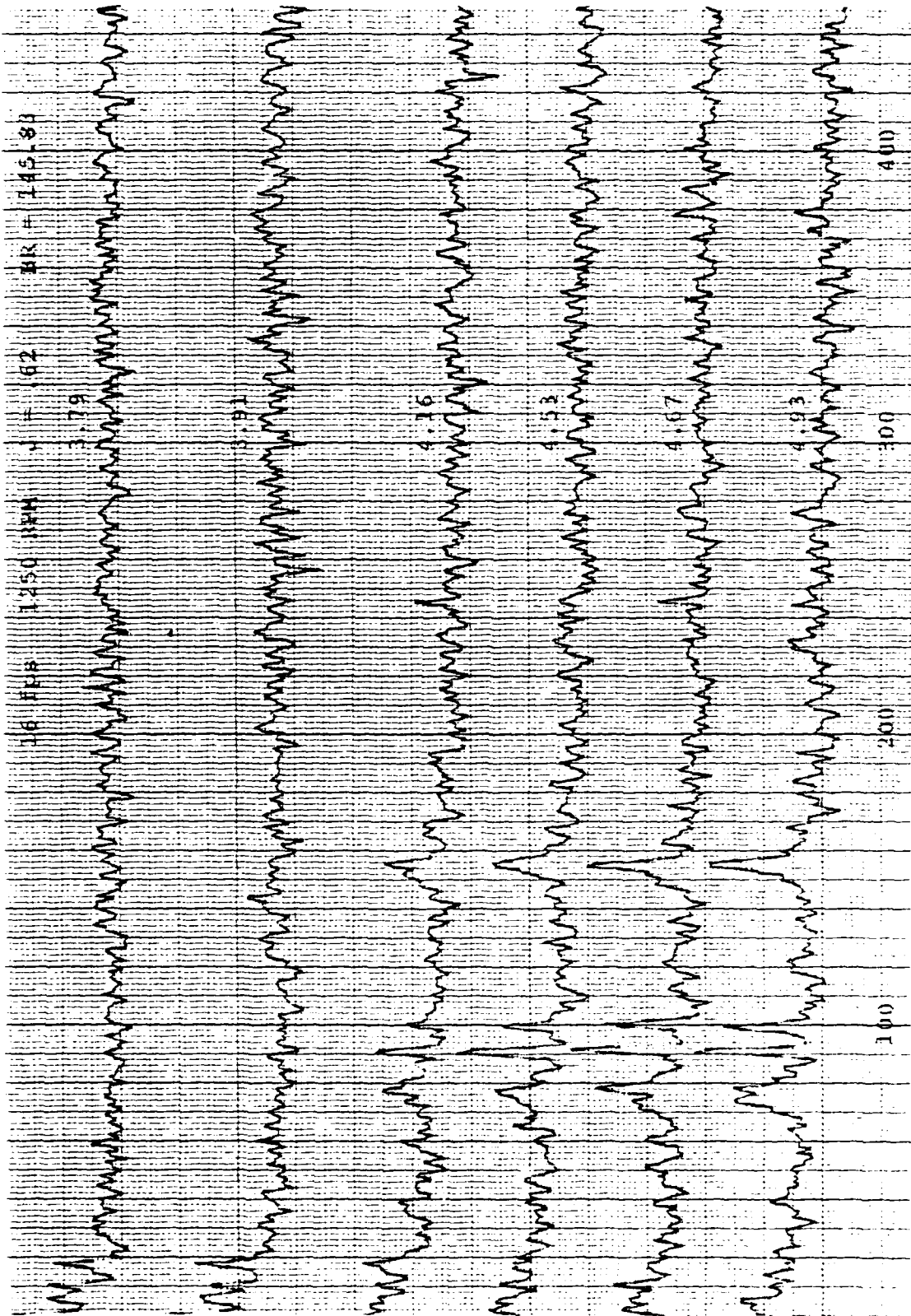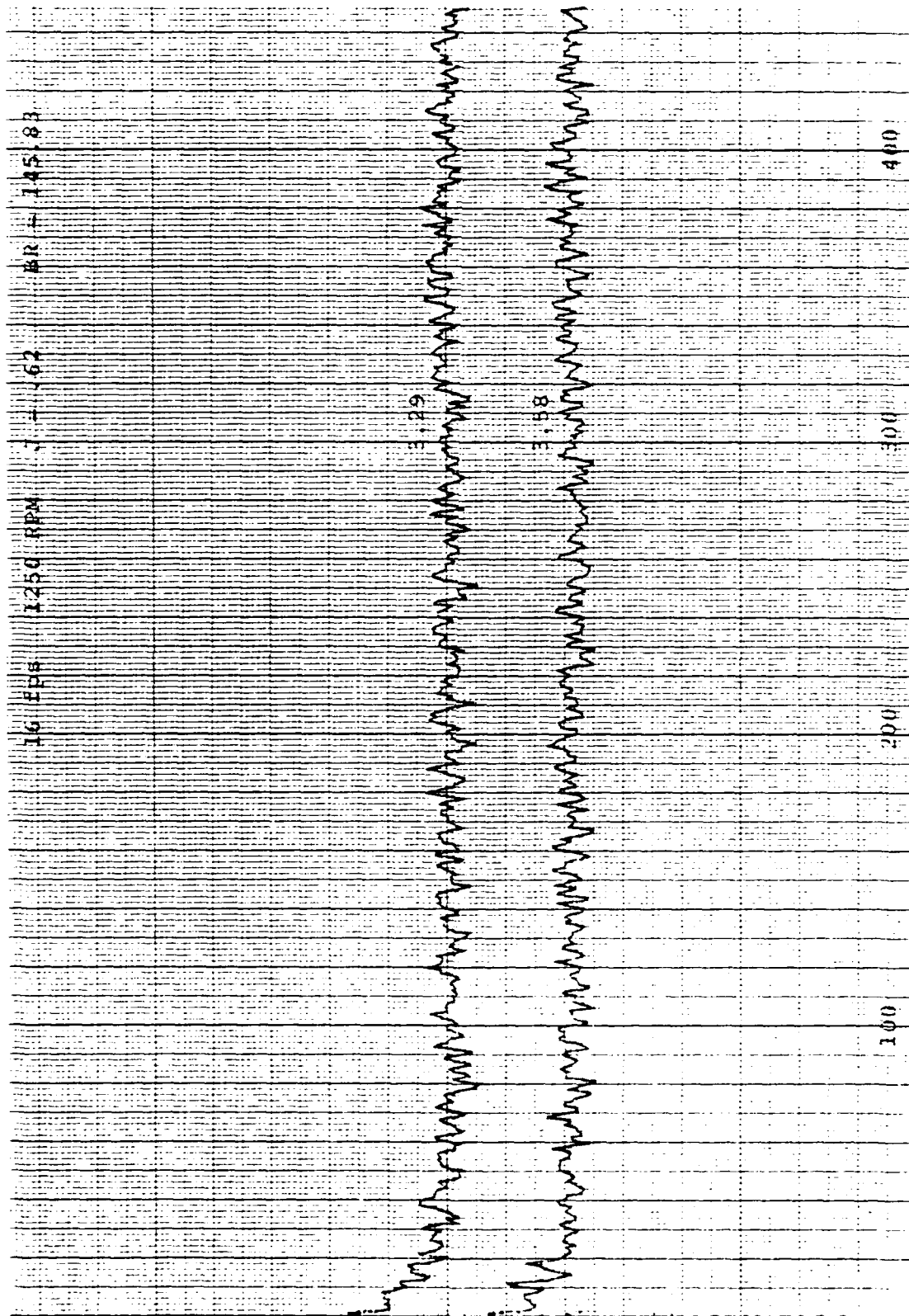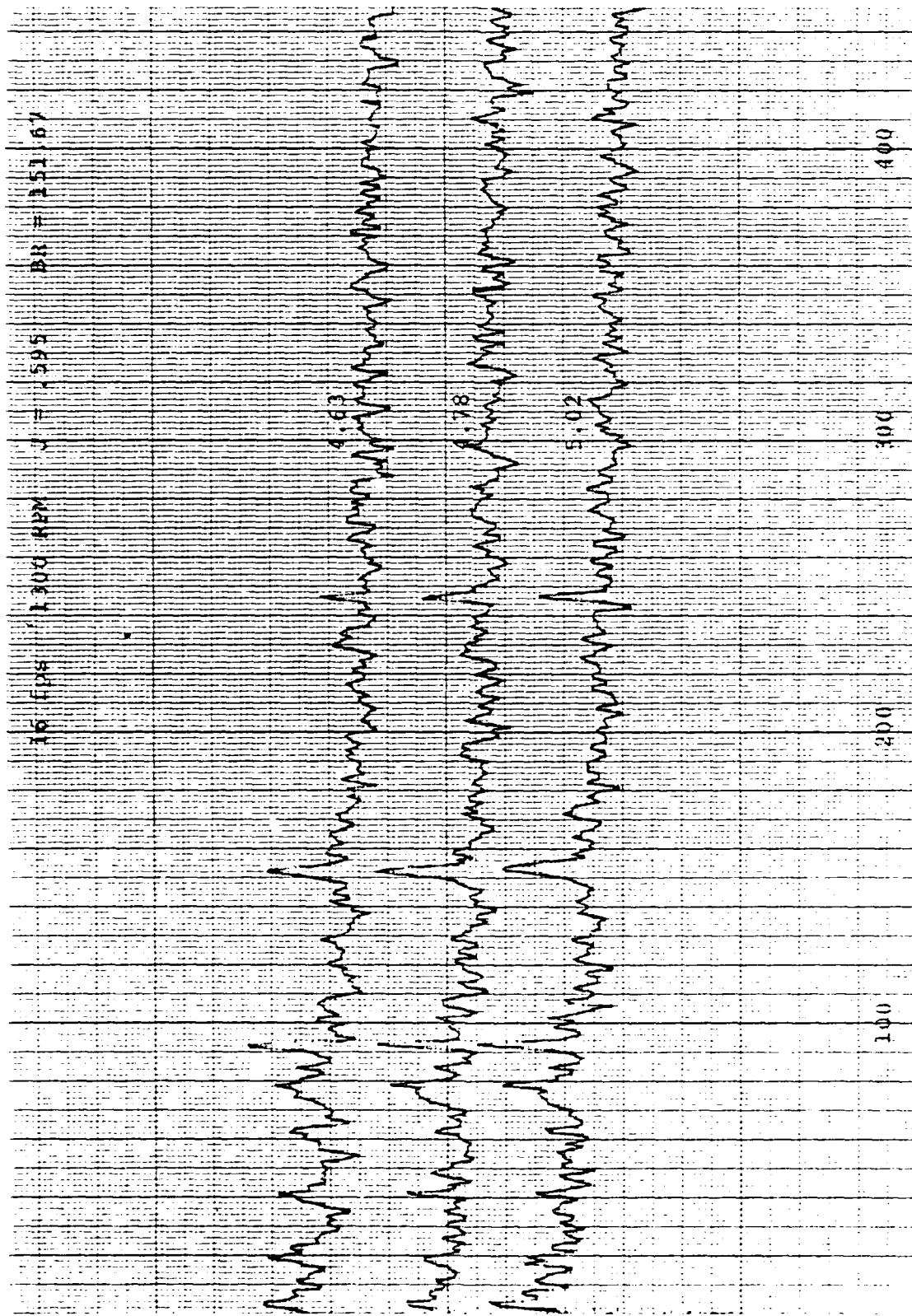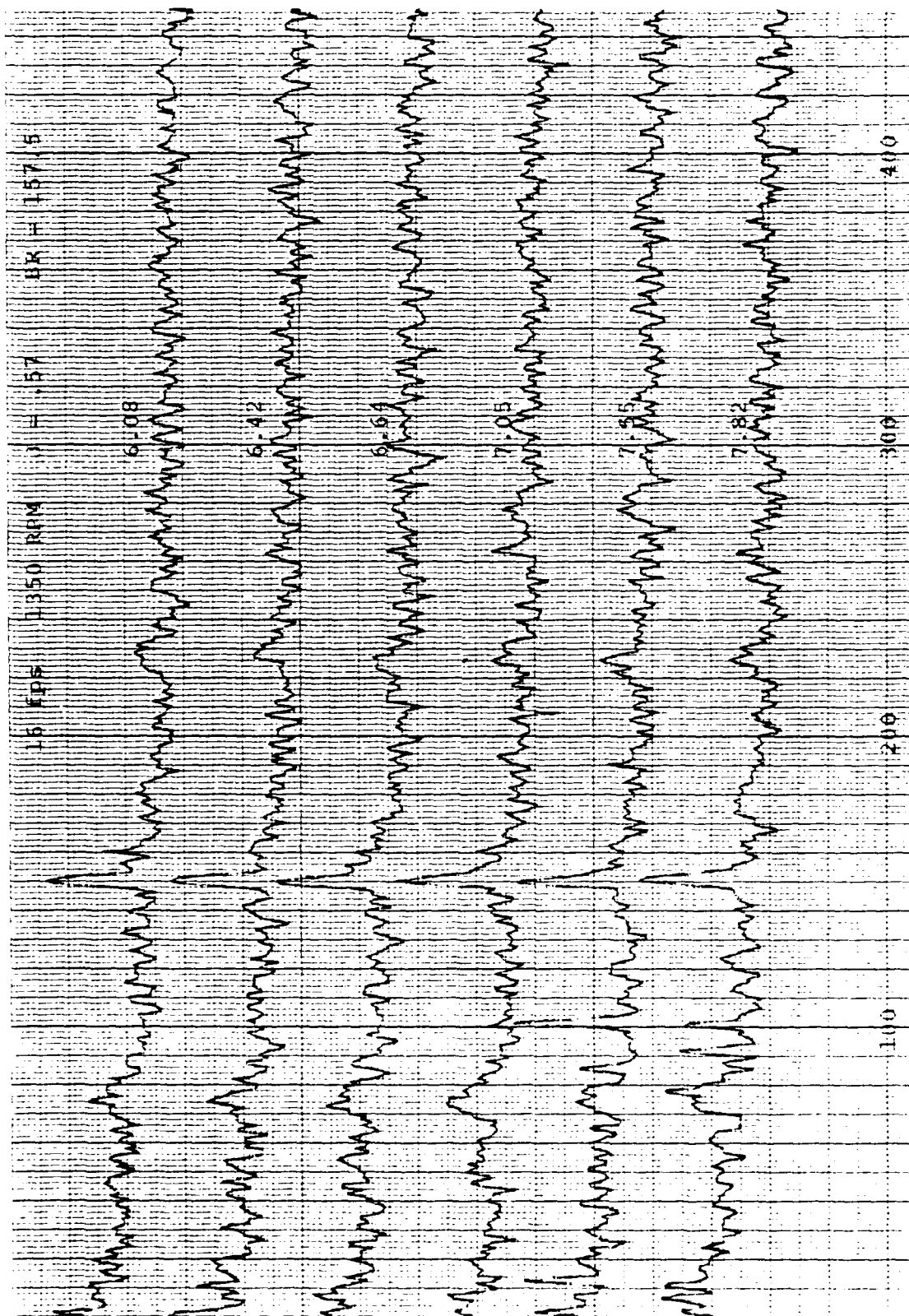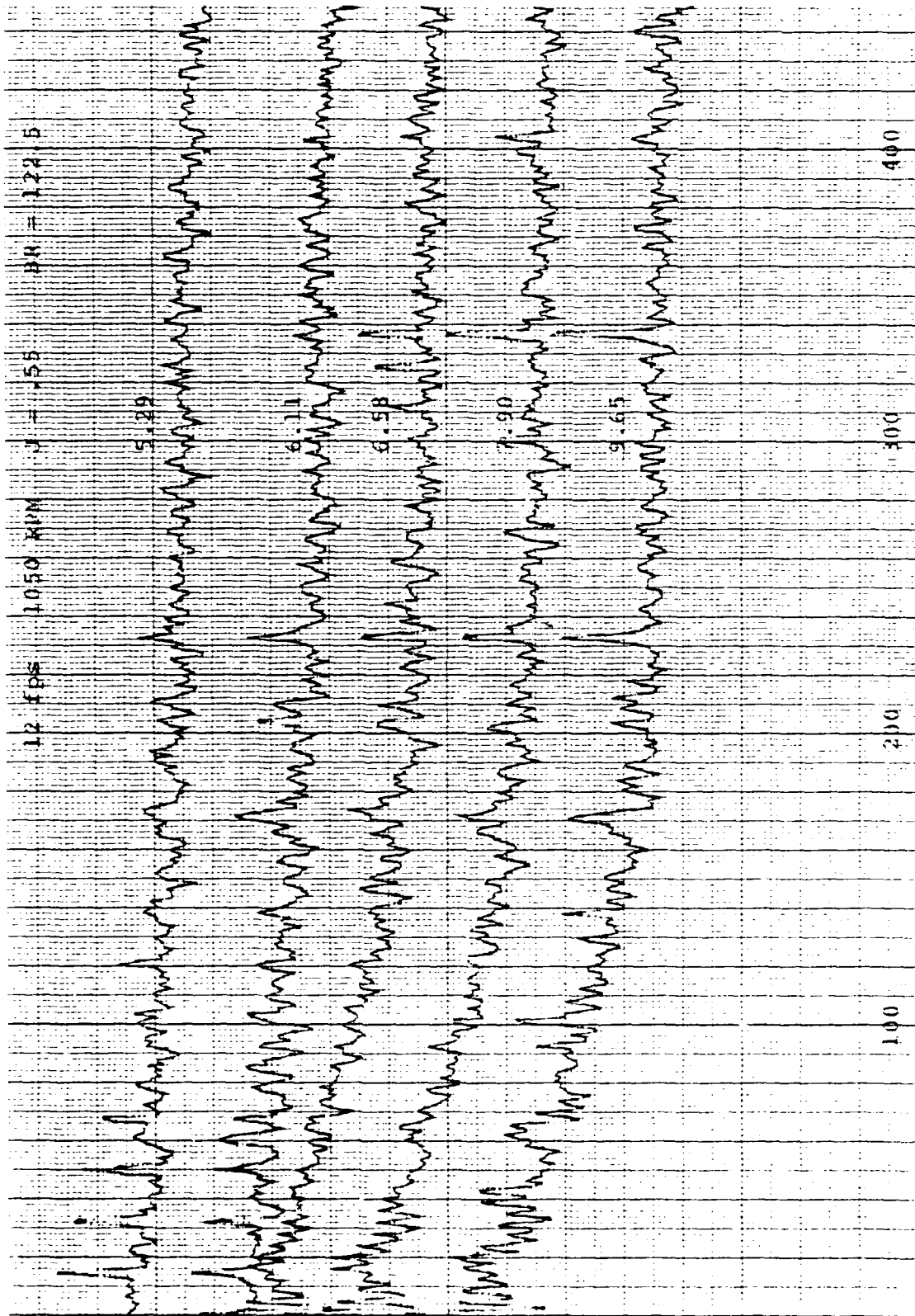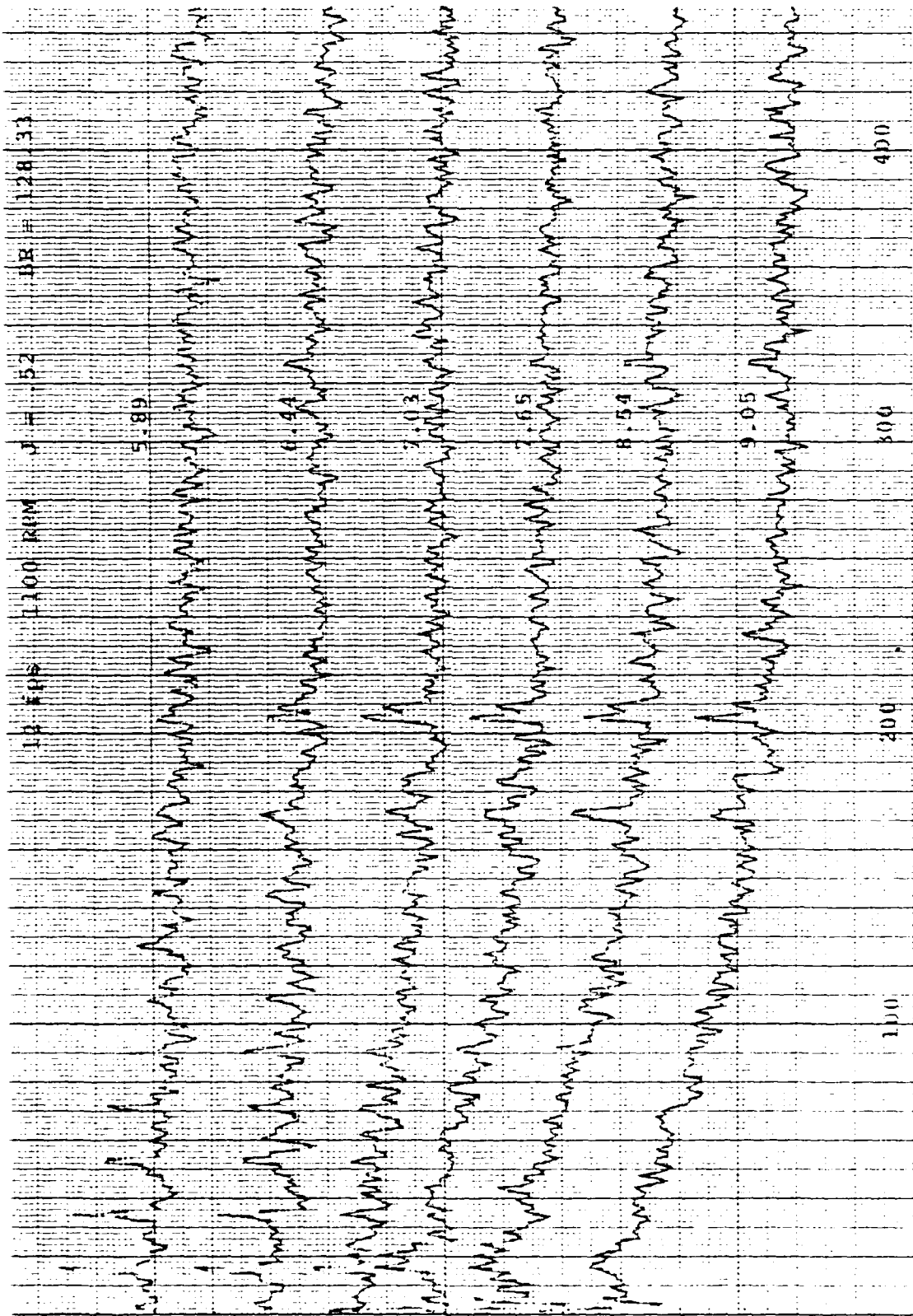
(Replacement page not available)
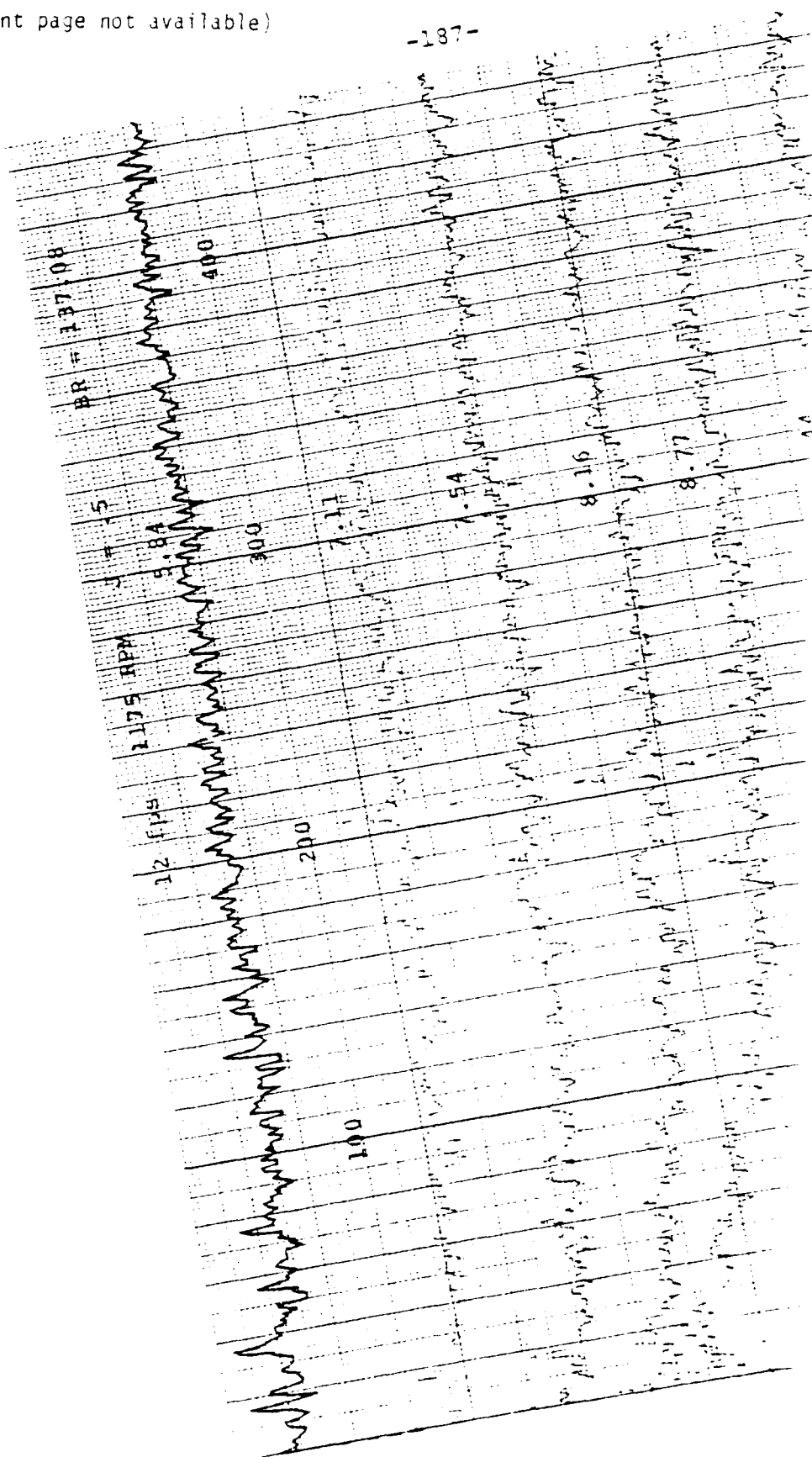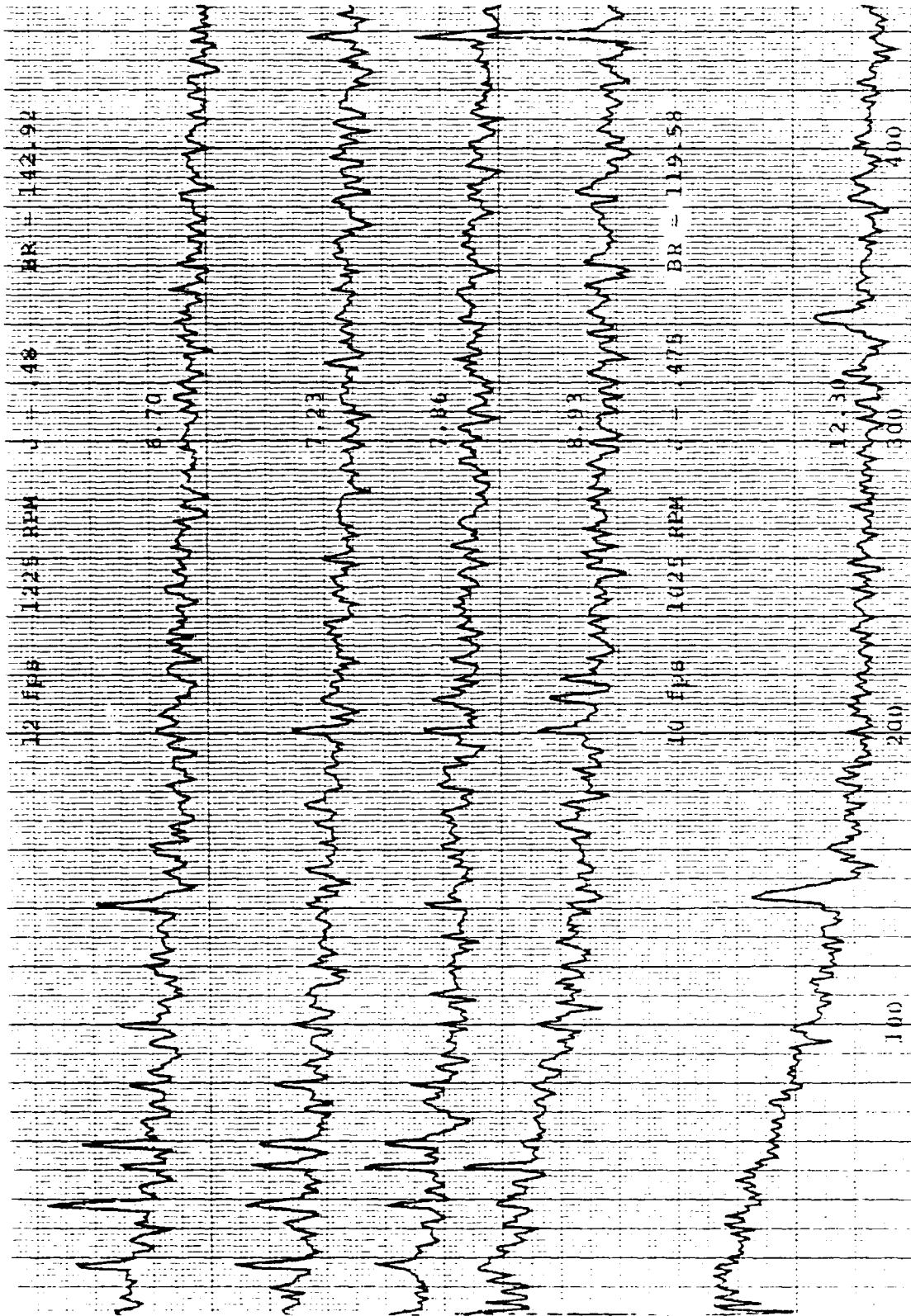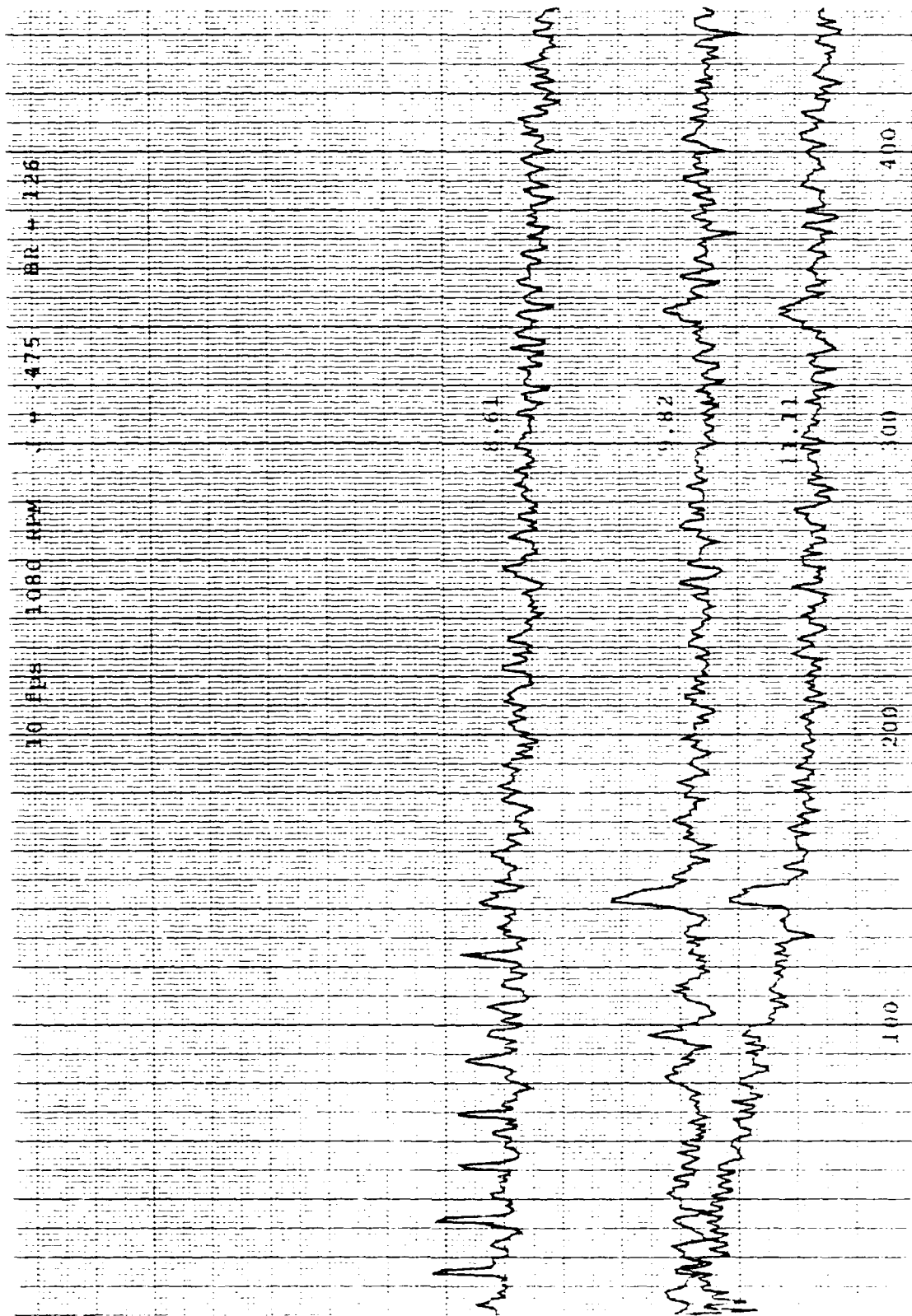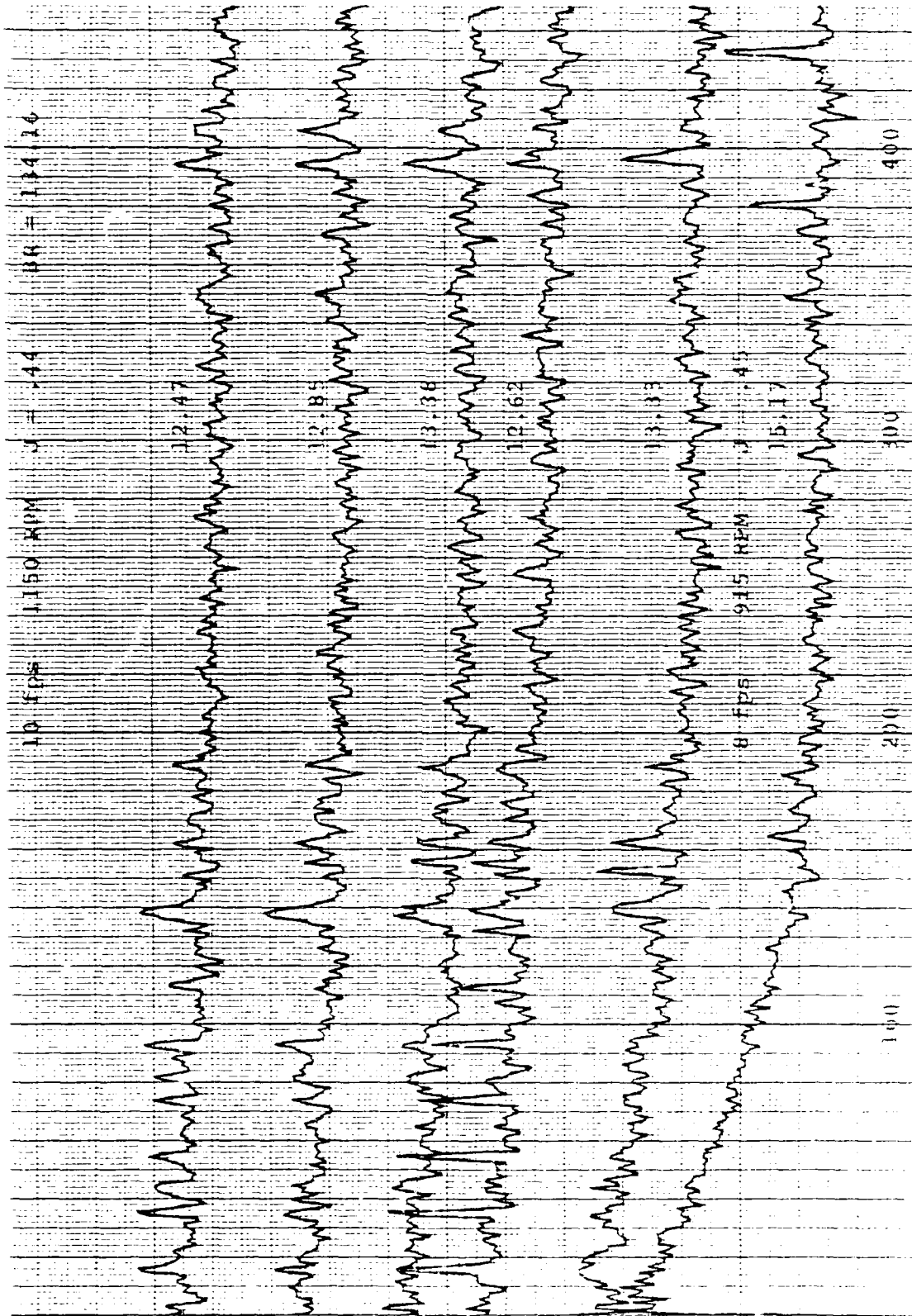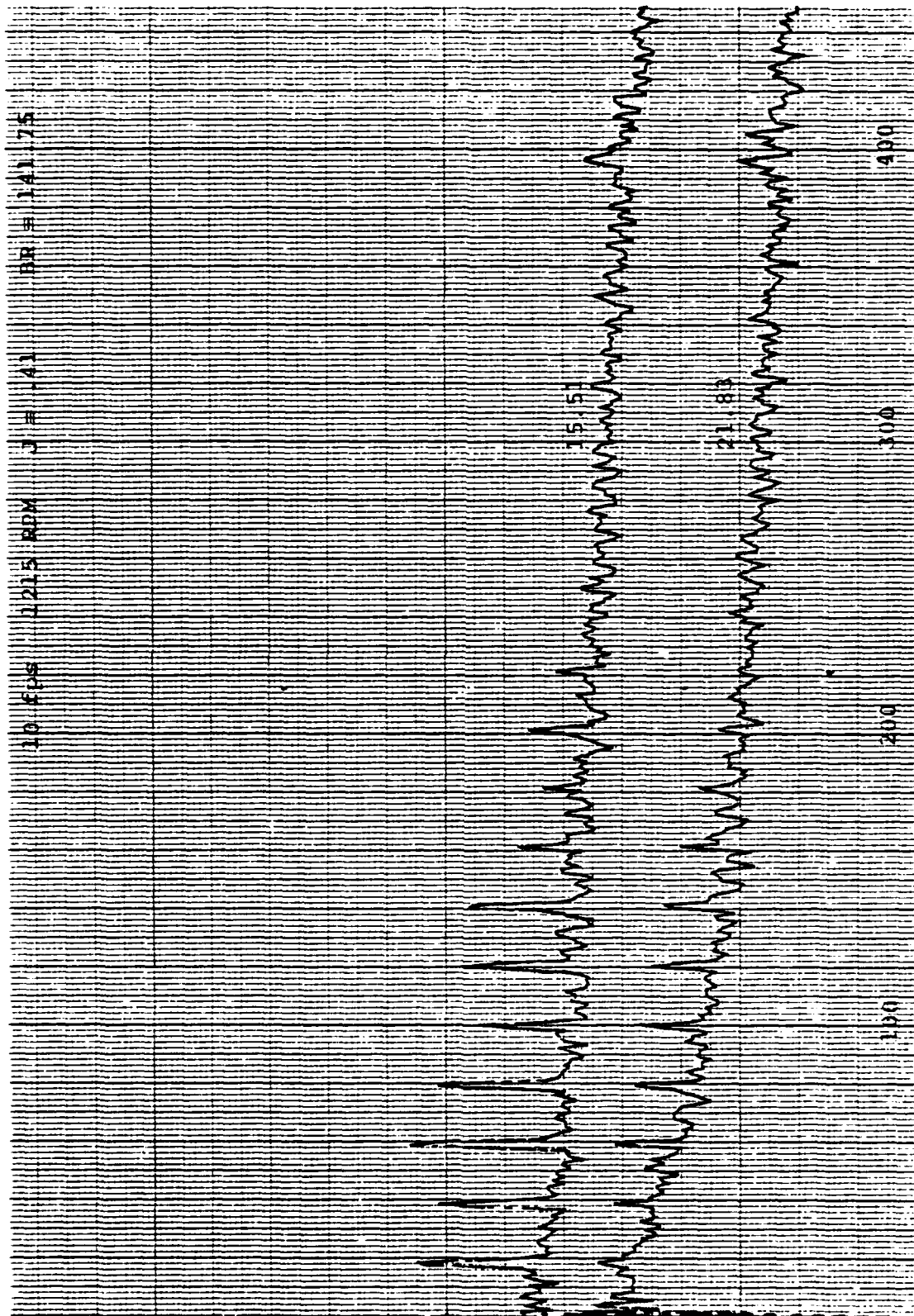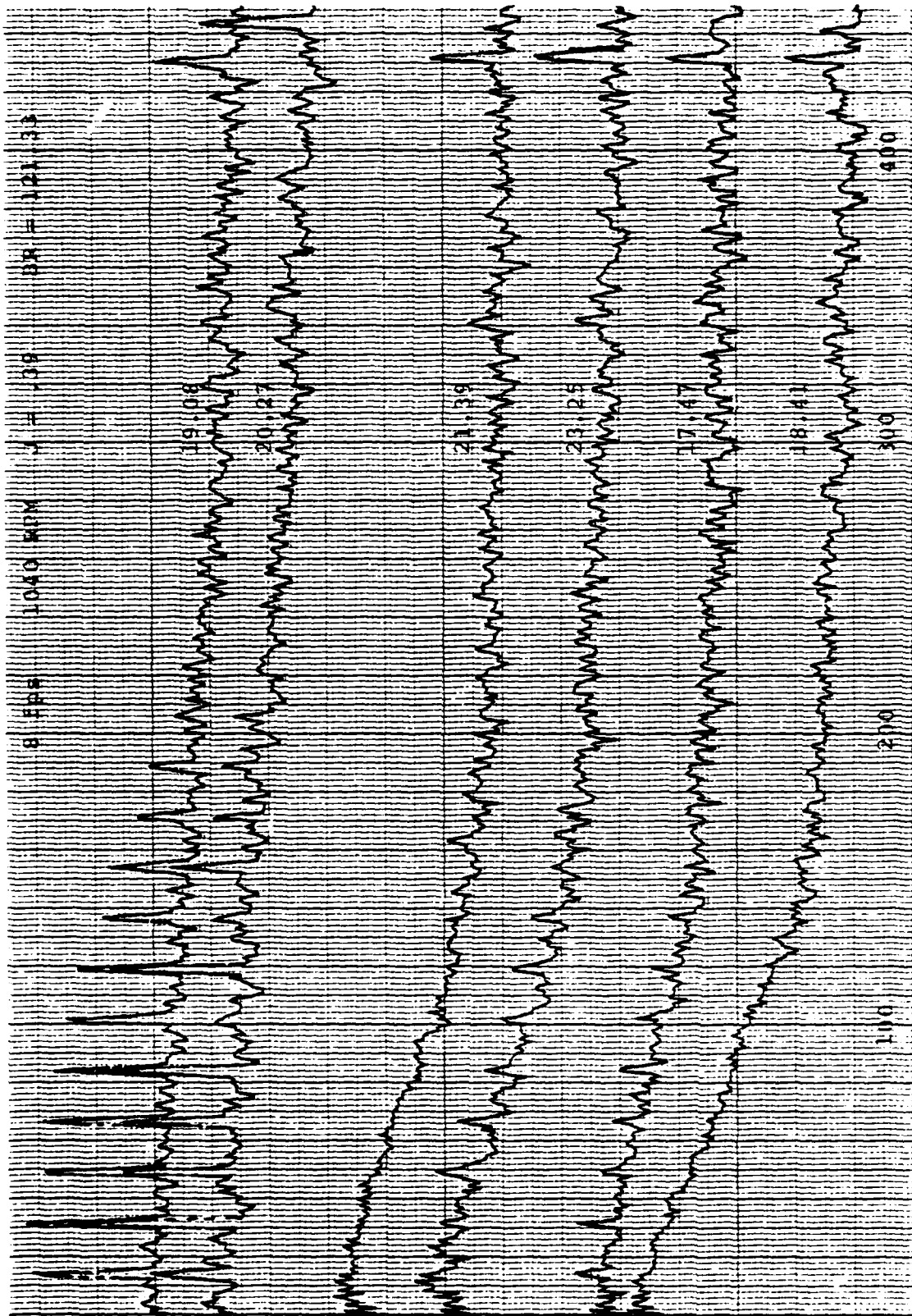
<u>DATA SHEET</u>

RUN NO <u>8</u>

DATE <u>3/4</u>

U$_{nom}$ <u>16</u>　　RPM <u>1200</u>　J$_{nom}$ <u>0.64</u>　Shaft rate <u>20</u>

(Taps: 6/5 blue)　　　　　　　　　　　　　　Blade rate <u>140</u>

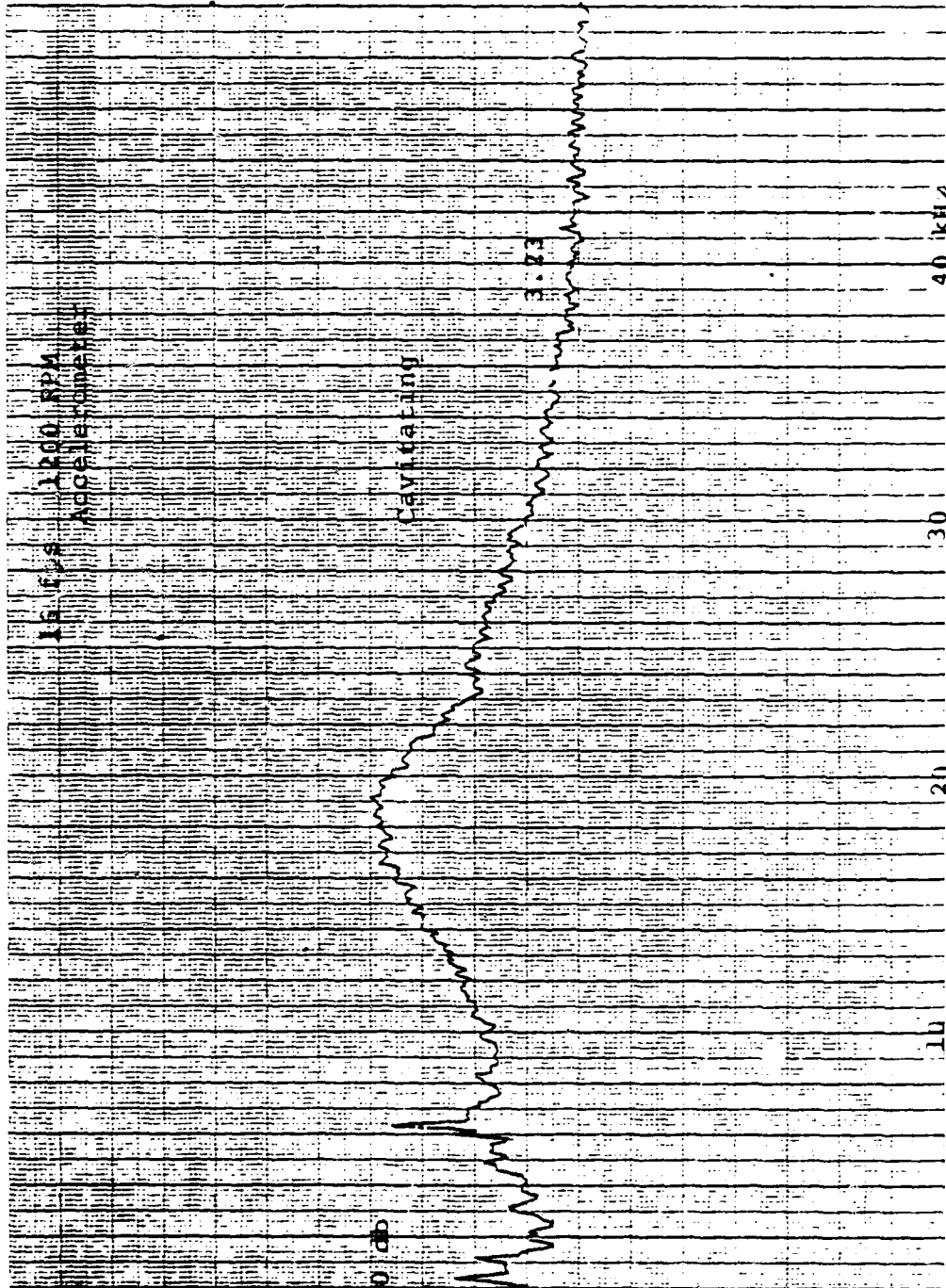Ithaco amp① <u>40</u> db;Filter: Hi pass <u>125</u>　Trans Anal

　　　　　　　　　　　　　Lo pass <u>10 x 10^5</u>　　② <u>—</u> db

Measuring　　　Input atten③ <u>-30</u> db Meas amp <u>___</u>　(# of

Equipment:　　Output gain④ <u>+20</u> db Spect anal. <u>X</u>　spectra 28)

Temperature: (Start) water <u>102</u> air <u>81</u>　Reynolds number:

　　　　　　　(End)　　　<u>105</u>　<u>82</u>　　<u>_____</u>

MAN	STAT	RPM	T	Q	GAIN CHANGE		K$_T$	J		REMARKS
914	310	1201							3.23	7-1 1¼d
908	747	1199							8.12	-2 ¼d
911	744	1199			1 3	-50 -20			8.12	8 accel
917	308	1200			1	40			3.23	9 accel
12	3AC 771.0		2	8						TARE

16 fps   1200 RPM
Hydrophone

8.12 - no visible cavitation
3.23 - steady tip vortex visible, audible
       back cavitation, visible intermittently

3.23
8.12

10   20   30   40 kHz

16 fps 1200 RPM
Accelerometer

No visible cavitation

8.12

0 db

0   10   20   30   40 kHz

DATA SHEET   RUN NO $\underline{2A}$

DATE $\underline{3/4}$

U$_{nom}$ $\underline{20}$ RPM $\underline{1530}$ J$_{nom}$ $\underline{0.62}$ Shaft rate $\underline{25.5}$

(Taps: 6/5 blue)   Blade rate $\underline{178.5}$

Ithaco amp① $\underline{+40}$ db;Filter: Hi pass $\underline{1 \times 10^4}$ Trans Anal

Lo pass $\underline{10 \times 10^5}$ ② $\underline{-25}$ db

Measuring   Input atten③ $\underline{-20}$ db Meas amp ___ (# of

Equipment: Output gain④ $\underline{+10}$ db Spect anal. $\underline{K}$ spectra$\underline{32}$)

Temperature: (Start) water $\underline{94}$ air $\underline{77}$ Reynolds number:

(End) $\underline{97}$ $\underline{77}$ $\underline{1.12 \times 10^6}$

accelerometer
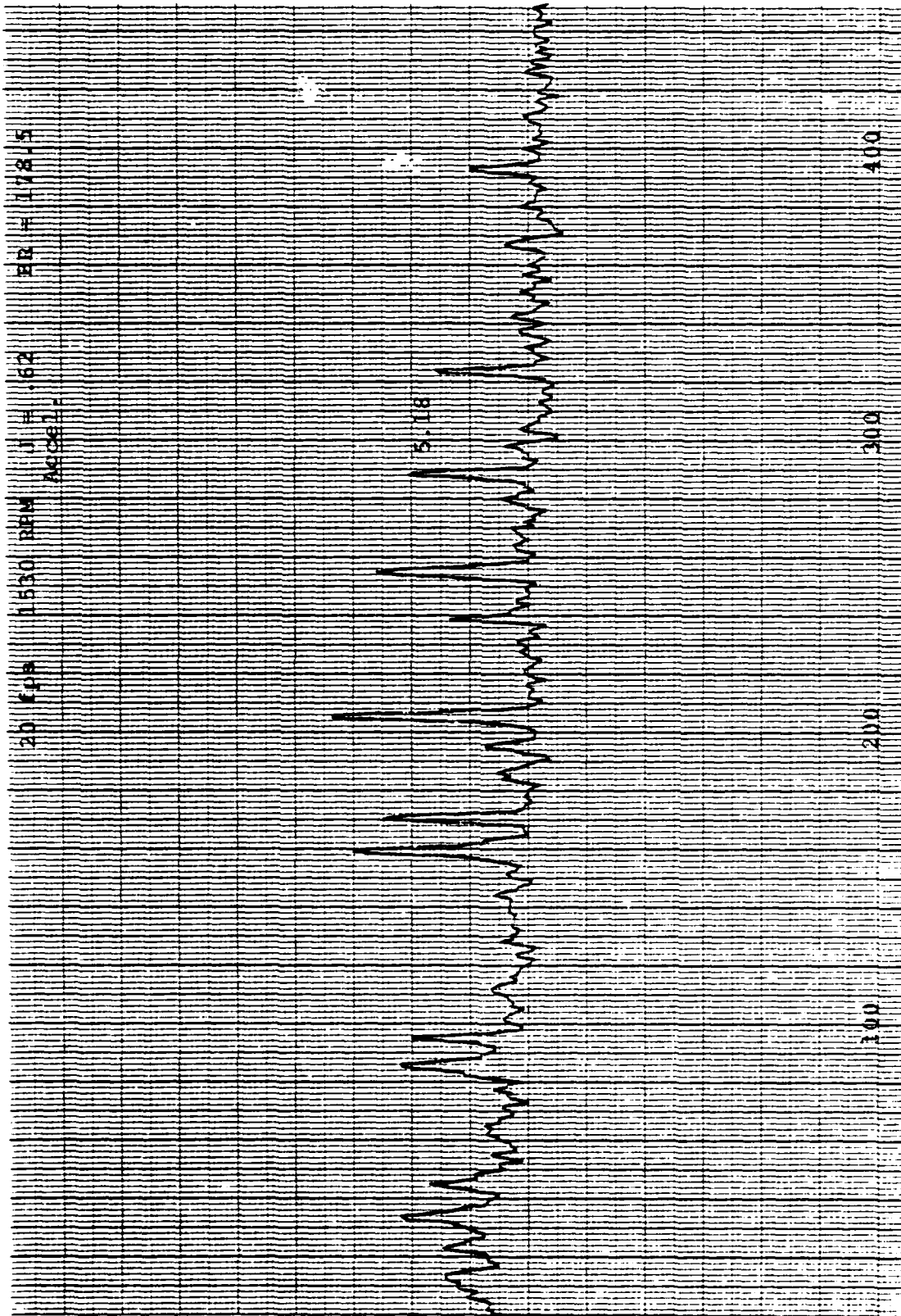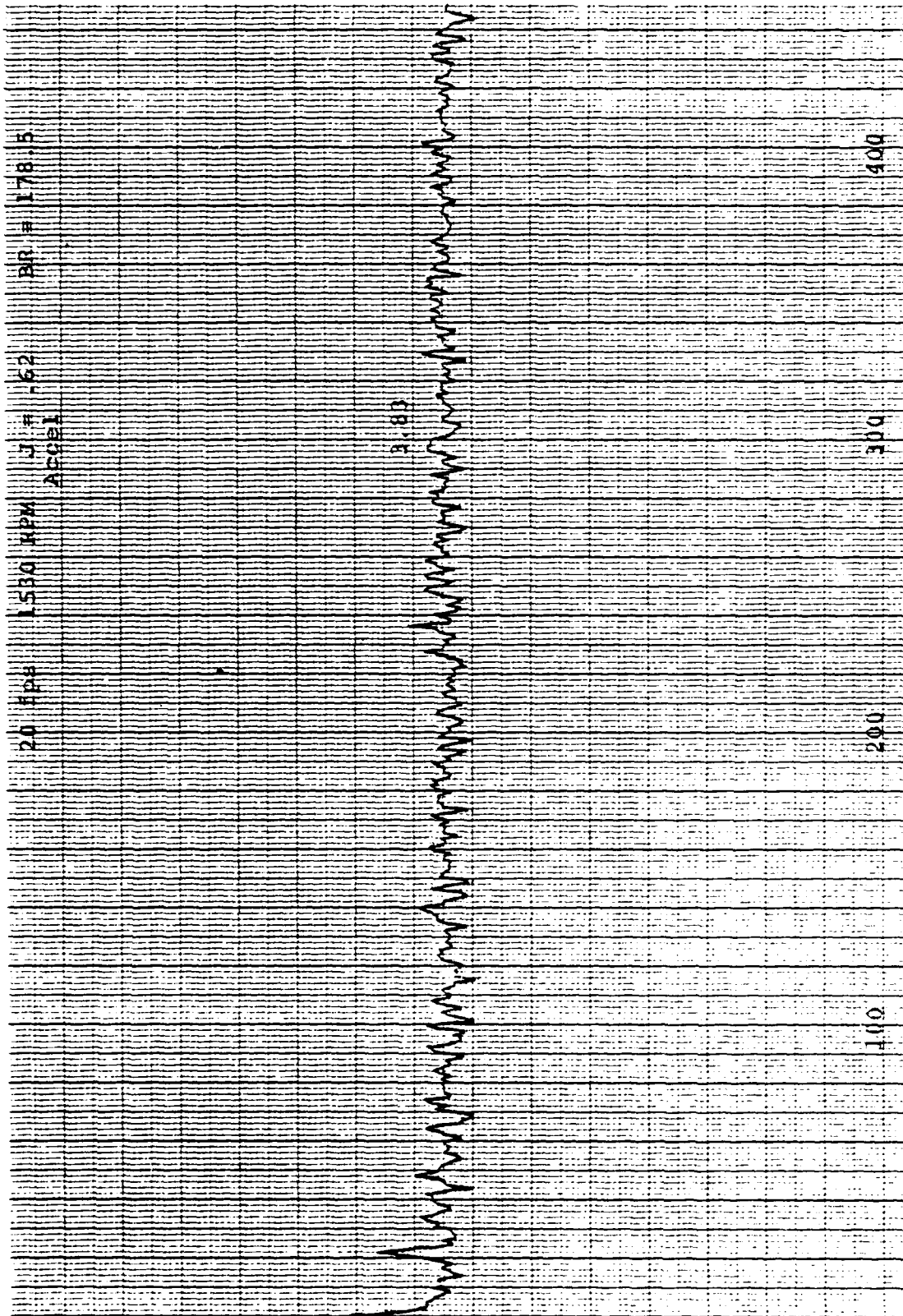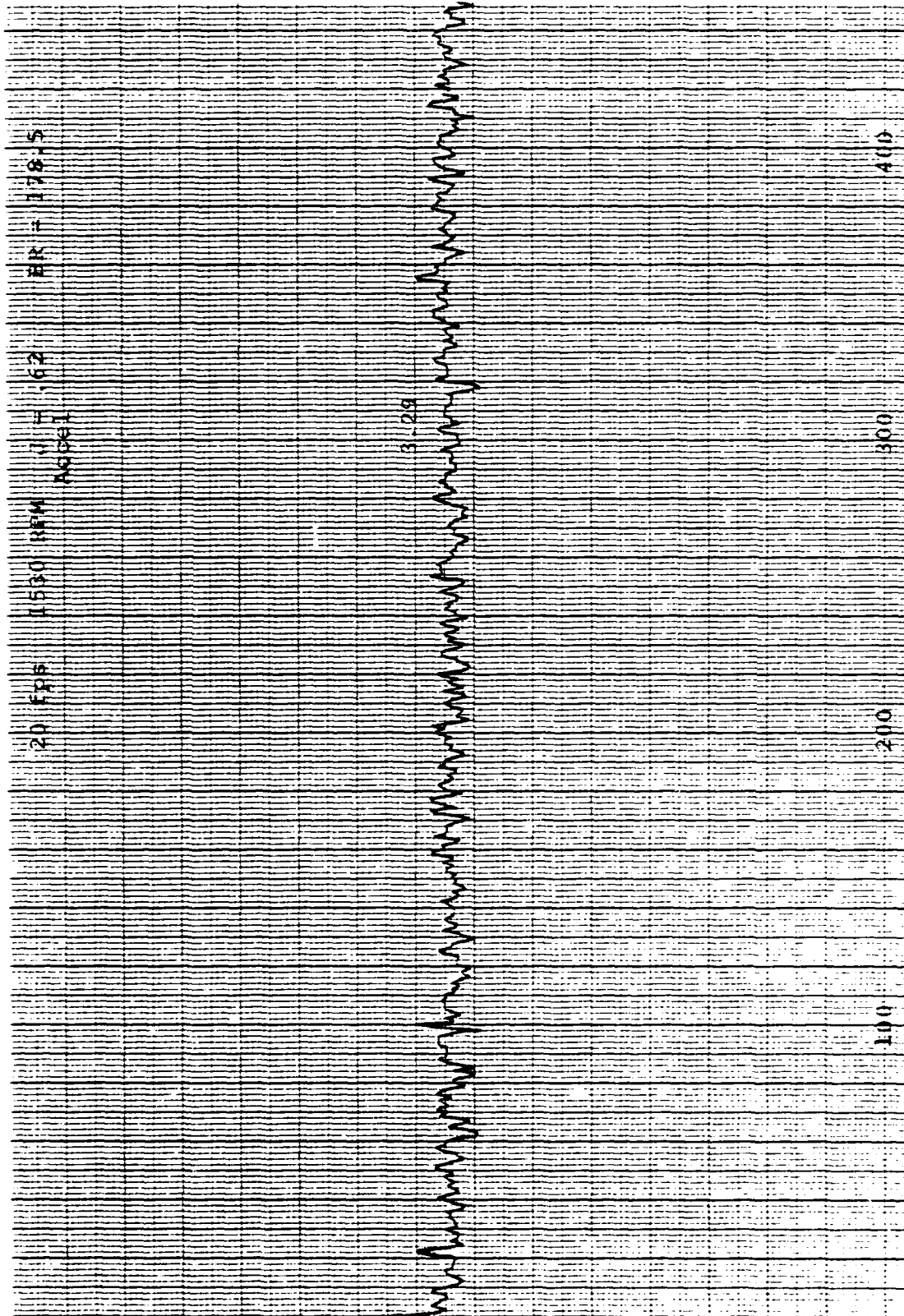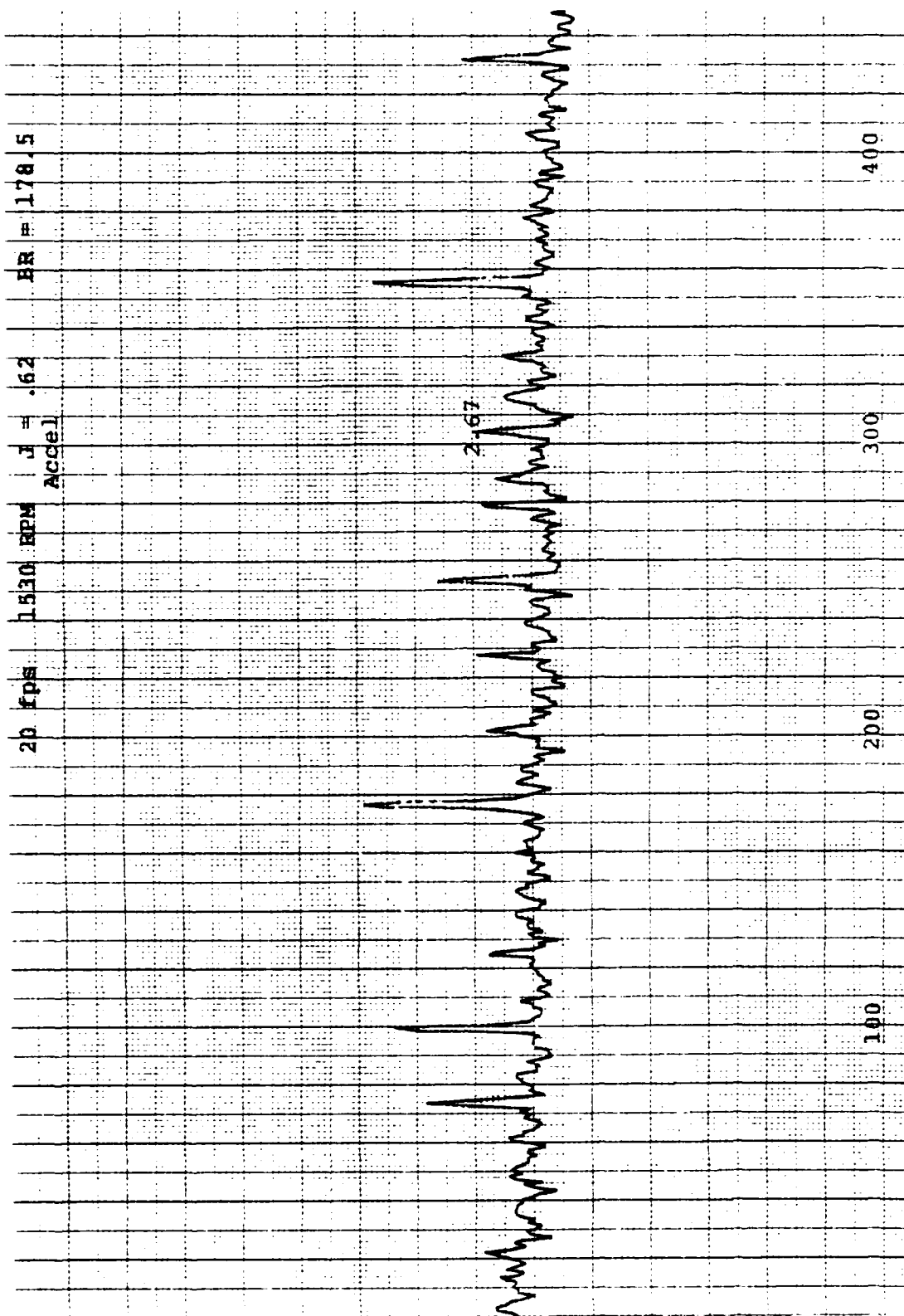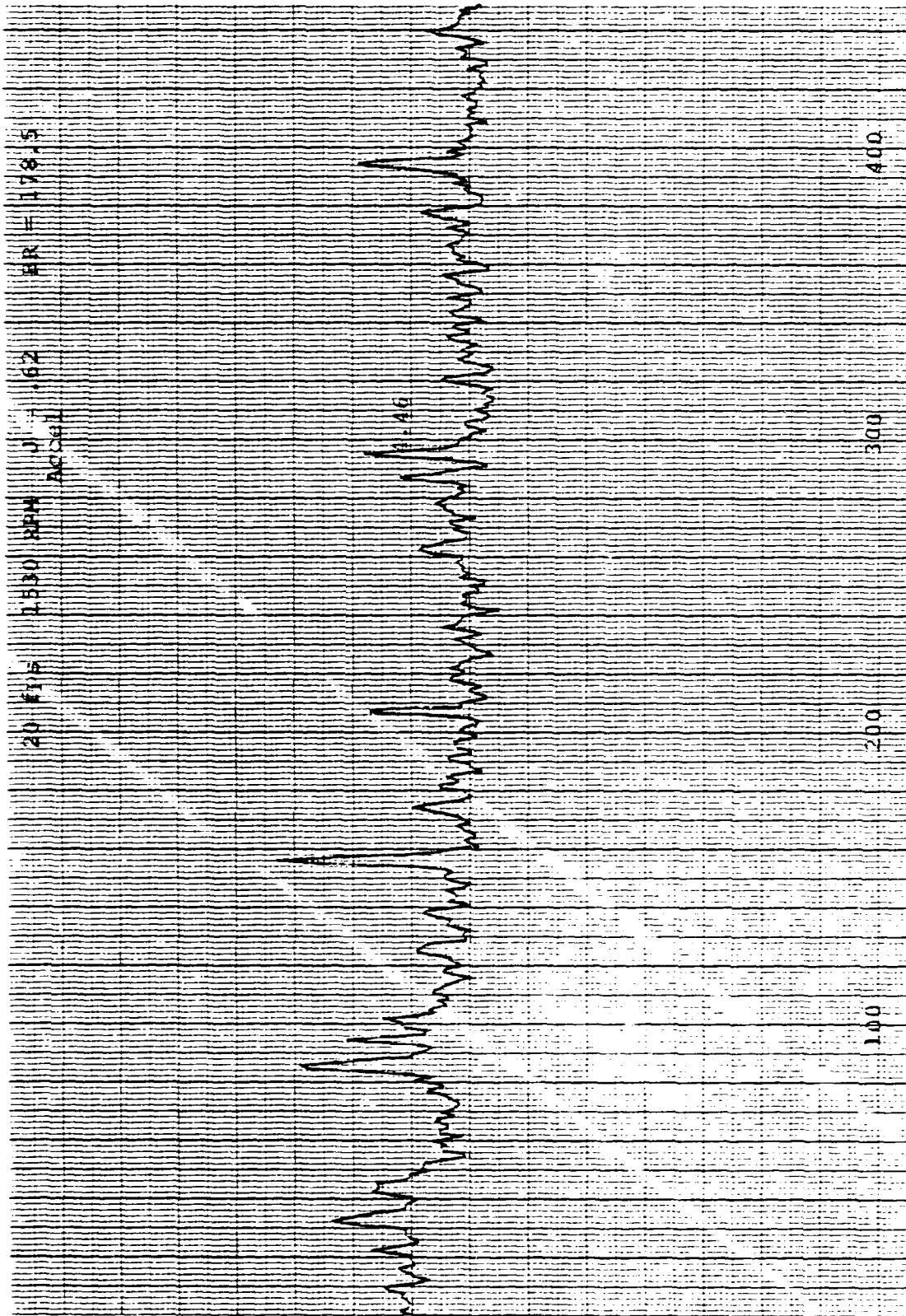
MAN	STAT BAR	RPM	T	Q	GAIN CHANGE		K_T	J	$\bar{c}$	REMARKS
12	775.7		0	11.5						TARE
									.	
1386	723	1530	594	198.5			.145	.62	5.18	335
1368	531	1530	576	200	$\frac{2}{4}$	$\frac{-30}{+30}$			3.83	345
1375	460	1535	552	197.5					3.29	375
1409	386	1533	512	191.5	3	-30			2.67	385
1391	626	1532	576	198.0	$\frac{2}{3}$	$\frac{-25}{-30}$			4.46	415

20 FPS   1530 RPM   .162   BR = 178.5
Accel   3.29   400   300   200   100

DATA SHEET

RUN NO 24

DATE 3/4

U_{nom} 20   RPM 1530 J_{nom} 0.62   Shaft rate 25.5

(Taps: 6/5 blue)   Blade rate 178.5

Ithaco amp① +40 db;Filter: Hi pass 1×10^4 Trans Anal

Lo pass 10×10^5 ② 0 db

Measuring   Input atten③ 0 db Meas amp ___ (# of

Equipment: Output gain④ +20 db Spect anal. X spectra 32)

Temperature: (Start) water 94 air 77   Reynolds number:

(End)   97   77 1.12×10^6

Hydrophone

MAN	STAT	RPM	T	Q	GAIN CHANGE		K_T	J	σ	REMARKS
1386	723	1530	594	198.5			.145	.62	5.18	32S
1388	529	1536	572	200	3	+50 -10			3.83	35S
1378	460	1529	526	192.5					3.29	36S
1395	386	1530	506	191	1	+60			2.70	39S
1421	134	1530	568	195.5					4.40	46S

-206-

DATA SHEET

RUN NO ¹

DATE 3/3
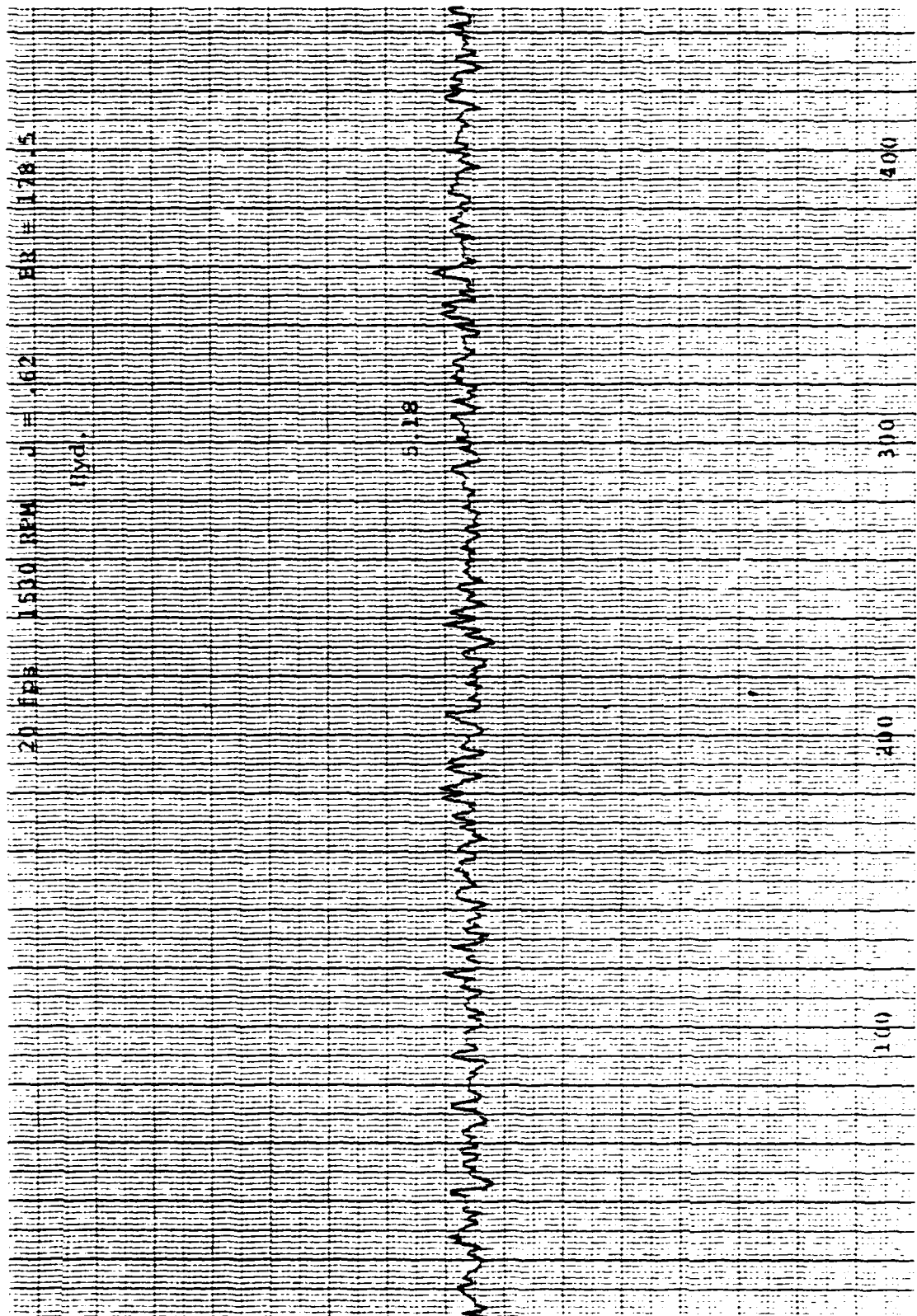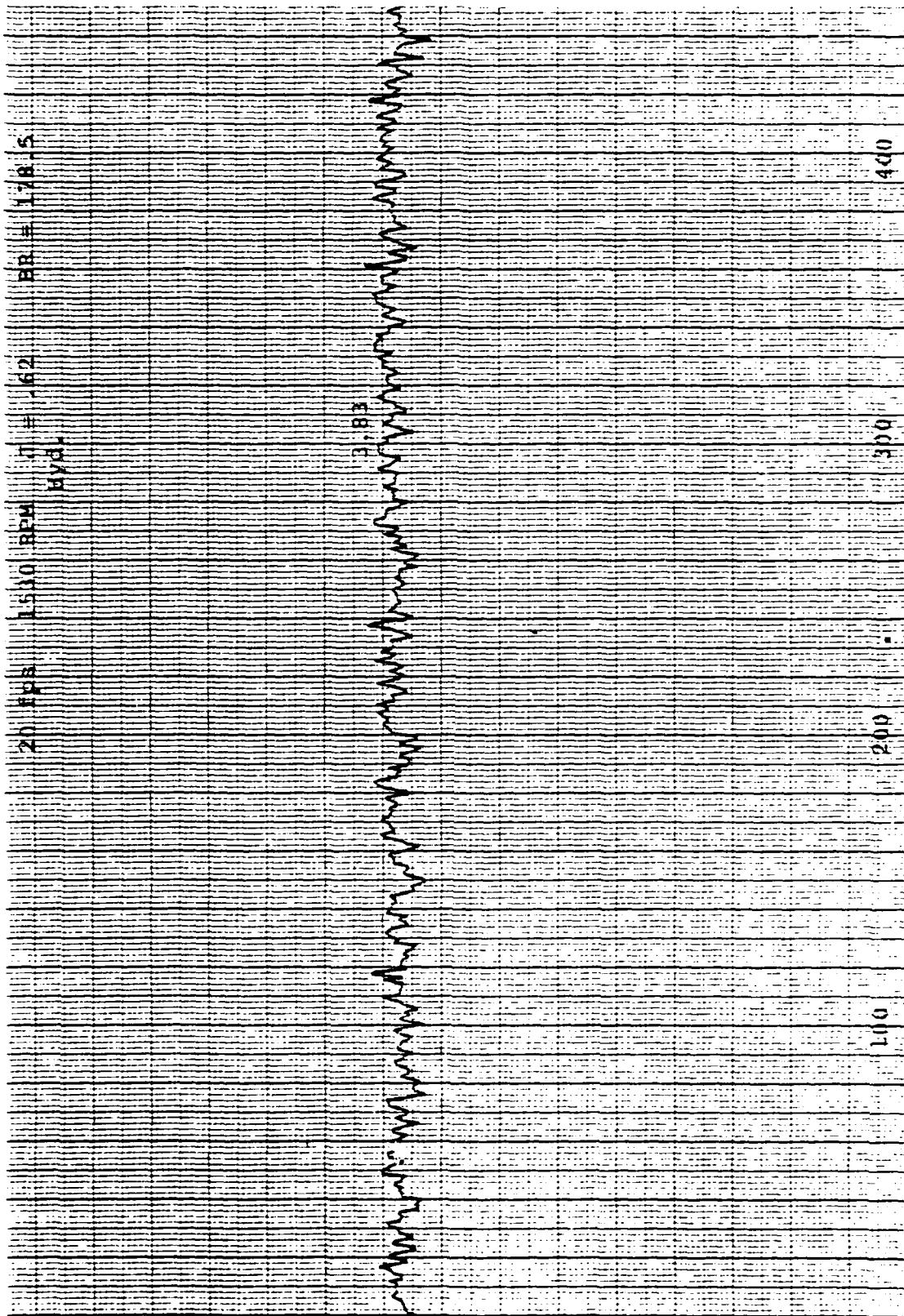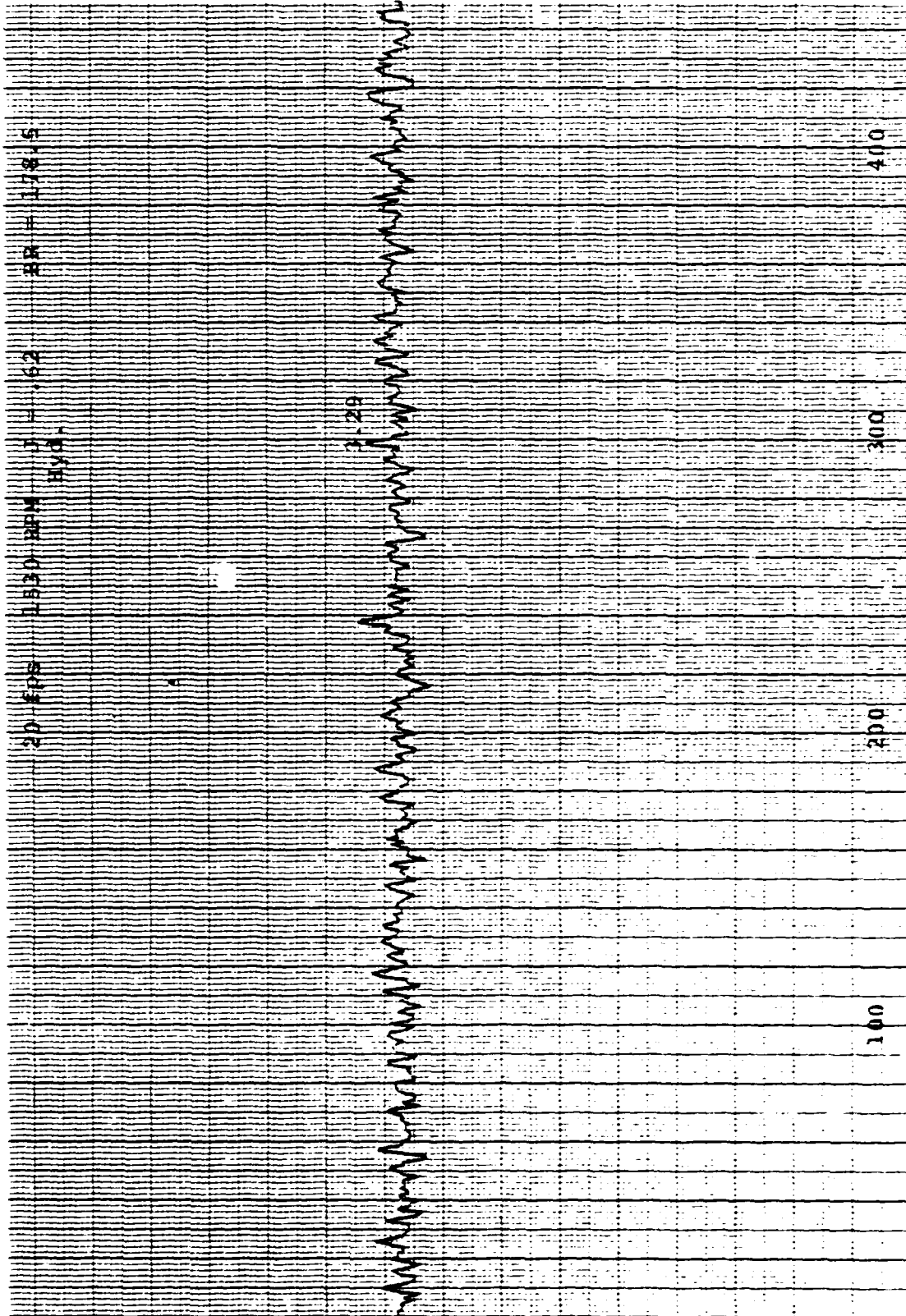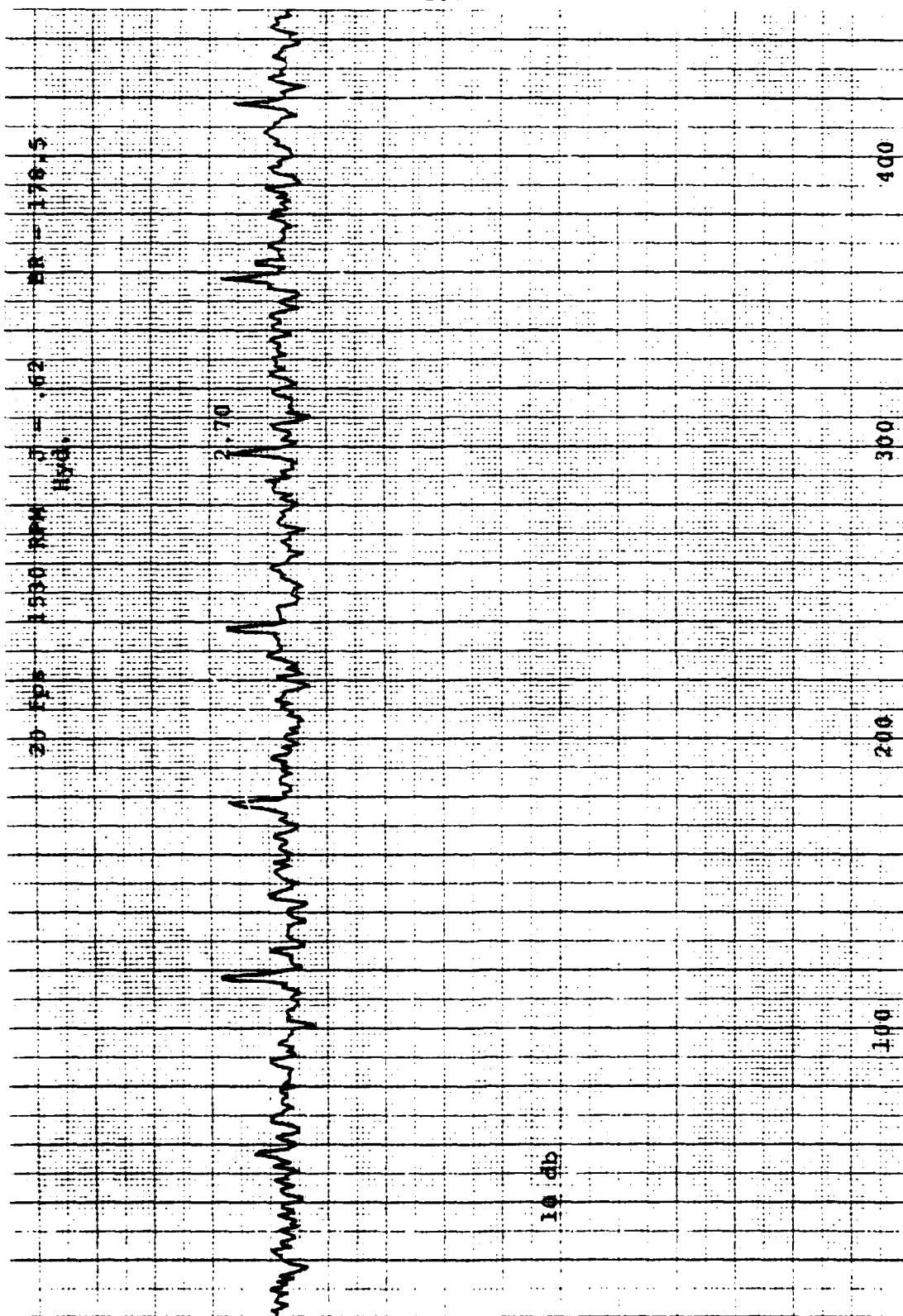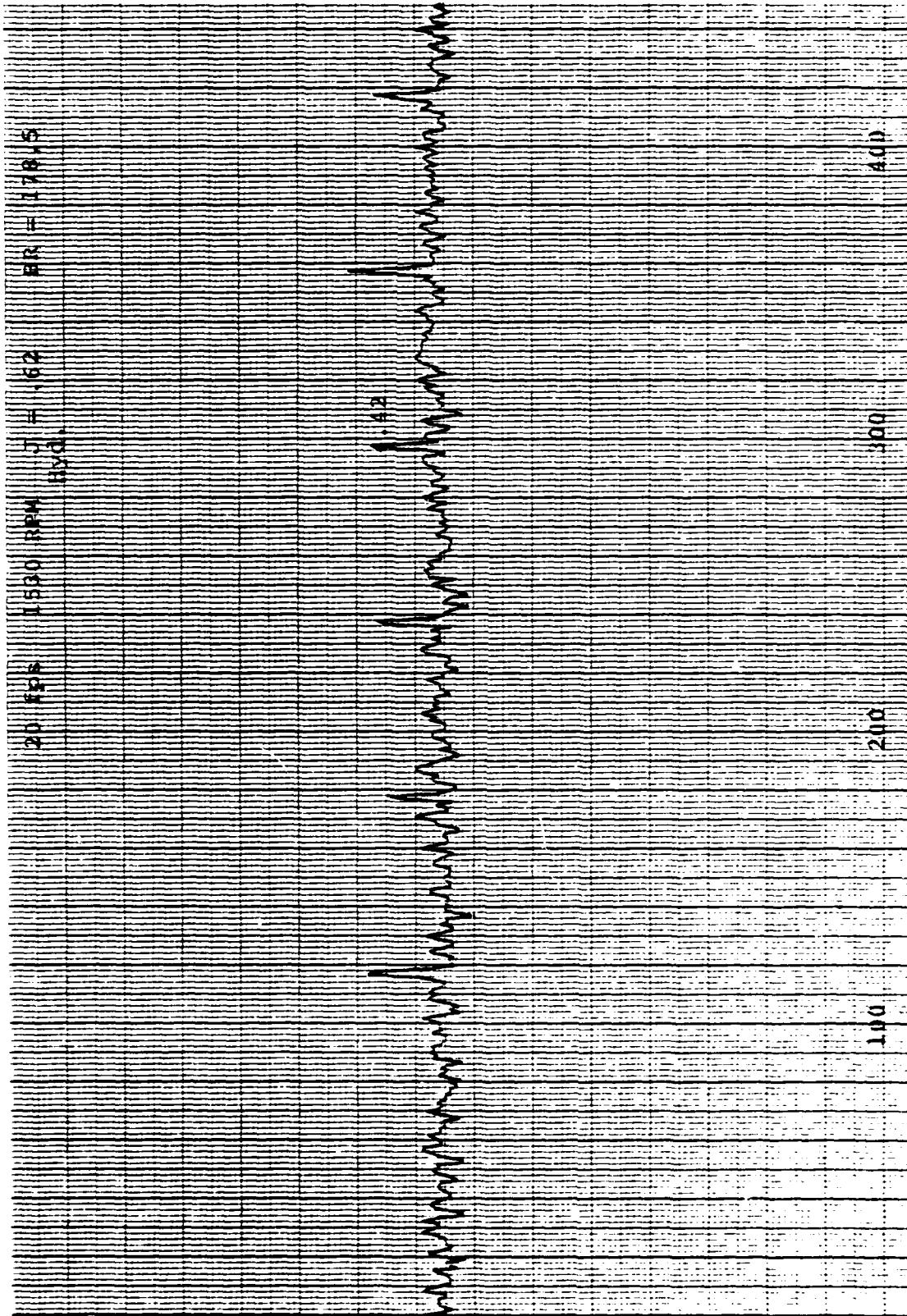
U_{nom} 16   RPM 1500 J_{nom} 0.50   Shaft rate 25

(Taps: 6/5 blue)   Blade rate 175

Ithaco amp① +40 db; Filter: Hi pass 1×10^4 Trans Anal

Lo pass 10×10^5 ② ___ db

Measuring   Input atten③ −10 db Meas amp ___   (# of

Equipment: Output gain④ +20 db Spect anal. x spectra 28)

Temperature: (Start) water 82 air 75   Reynolds number:

(End)   86   75   _____

Torque in pounds = T×0.2

MAN	STAT	RPM	T	Q	GAIN CHANGE		X_T	J	J	REMARKS
9,4	754	1500	770	236.5			.194	.51	8.37	9
9,6	655	1501	762	237.5					7.58	12
9,6	663	1501	760	237					7.33	13
9,6	632	1501	758	237.5					6.98	16
9,6	603	1501	752	237					6.66	17
9,4	573	1499	748	236.5					6.34	20
9,5	543	1500	748	237.5					5.99	21 ×TV
9,3	513	1500	740	237					5.67	24
9,0	479	1497	734	236					5.31	25
9,0	453	1501	758	238	1	+30			5.02	25
9,3	424	1500	728	236.5					4.67	29
9,3	390	1500	722	236					4.29	32
9,4	338	1500	714	235.5					3.70	33 ×63
9,4	295	1500	702	235	1	+40			3.22	36
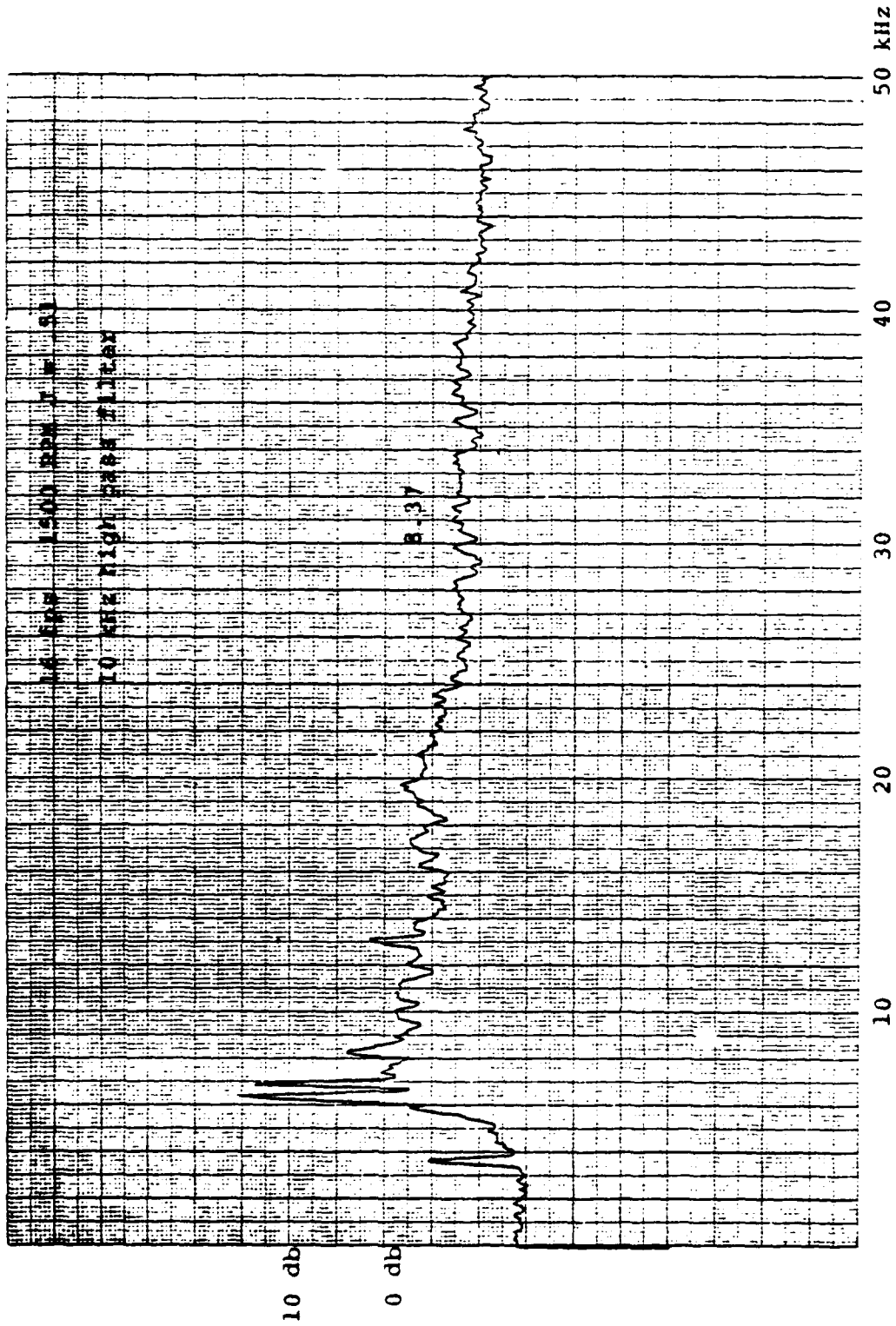
461510

K&E 10 X 10 TO THE CENTIMETER
KEUFFEL & ESSER CO.

14 Rpm 1500 RPM 1 = 81

10 kHz High Pass filter

B-37

10 db

0 db

10   20   30   40   50 kHz
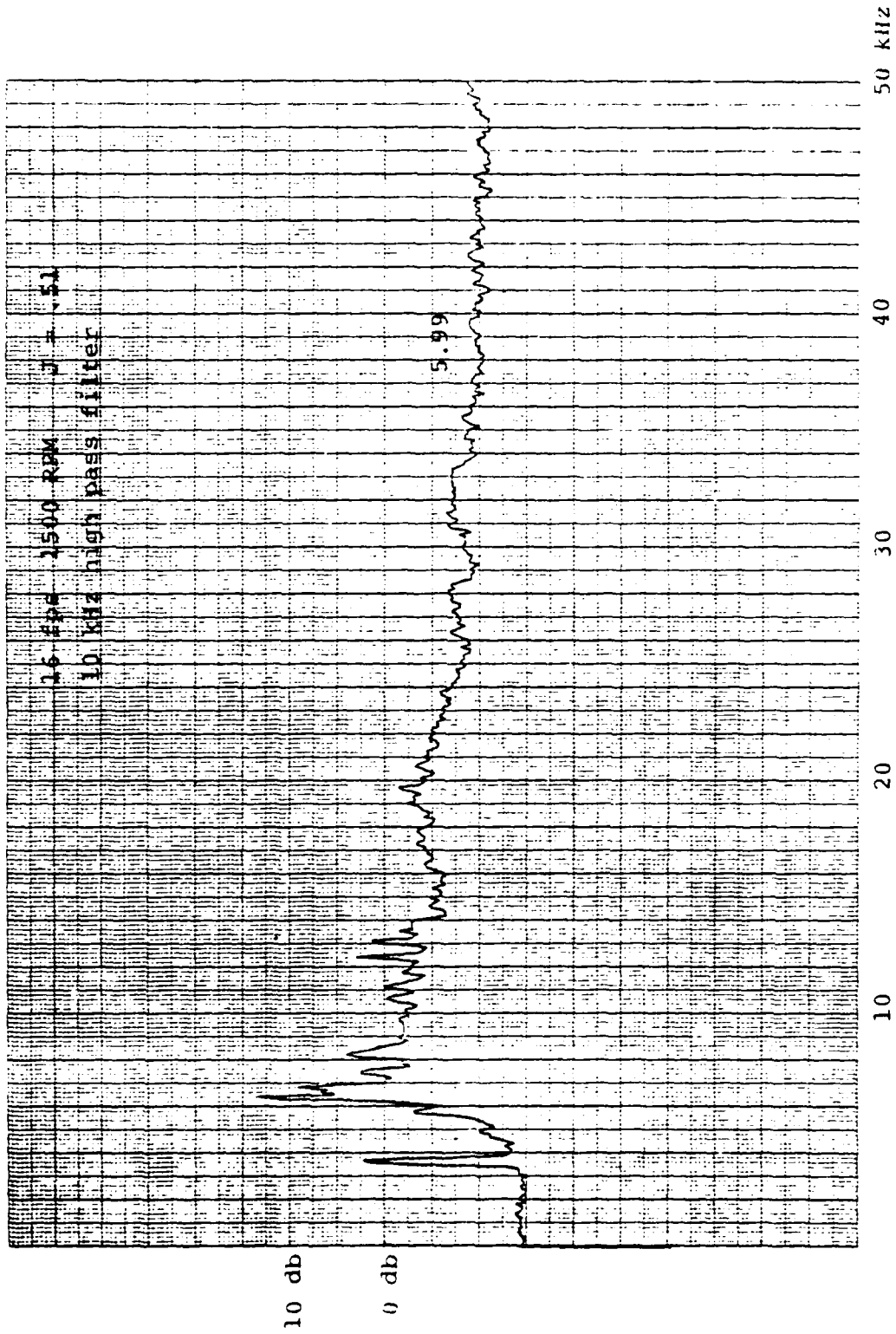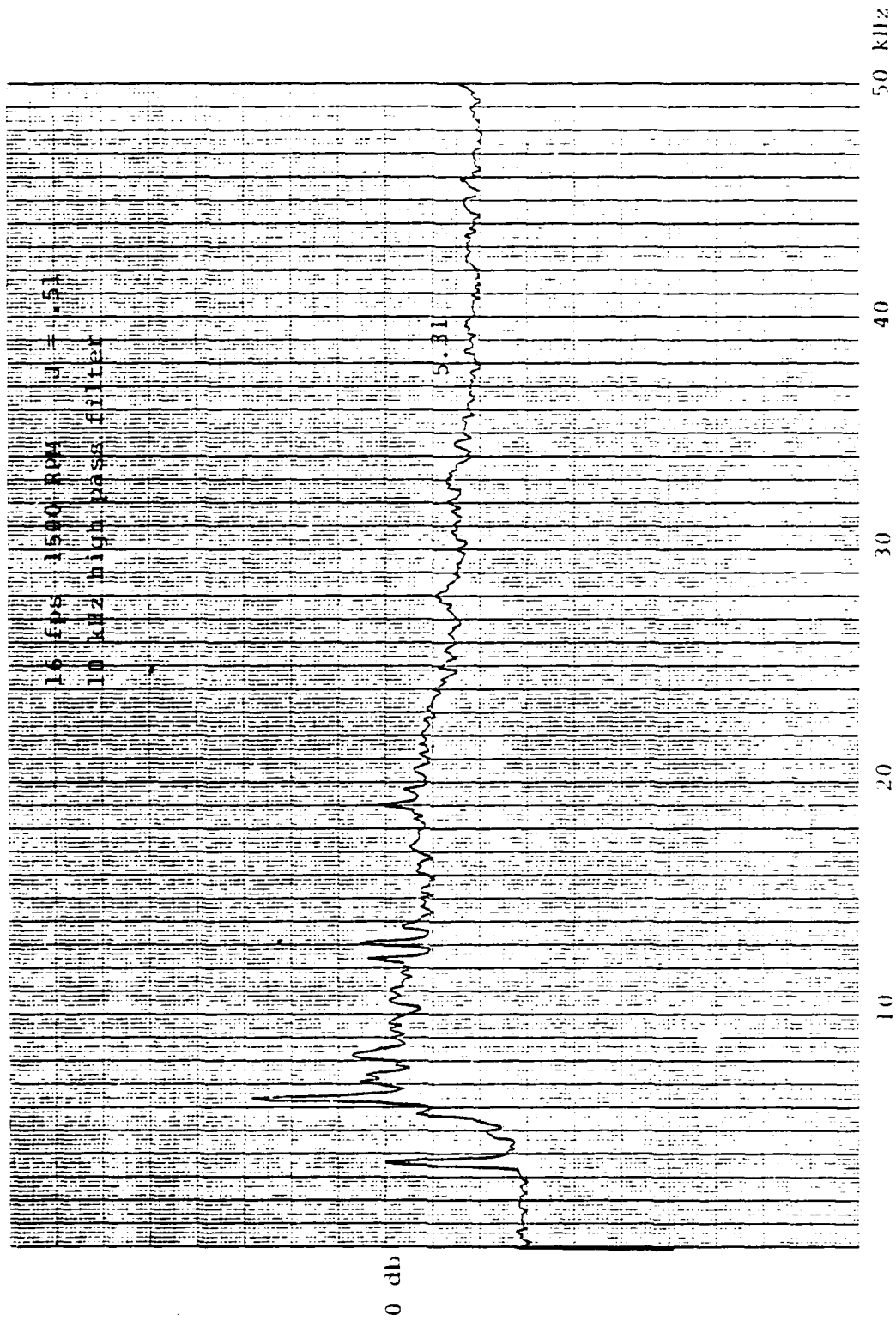
461510

16 fps 1500 RPM
10 kHz high pass filter

7.58

50 kHz

40

30

20

10

0 db

461510

16 fps 1500 RPM $J = .51$
10 kHz high pass filter

6.66

0 db

50 kHz

16 cps   1500 RPM   y = 1.51
10 kHz high pass filter

5.31

461510

K-E

0 db

10   20   30   40   50 kHz

1b fpe 1500 RPM J = .51
10 kHz high pass filter

5.02

0 db

50 kHz
40
30
20
10

461510

16 dps 1500 RPM J = .51

10 kHz high pass filter

4.29

0 db

10   20   30   40   50 kHz

461510

16 Eps 1500 RPM   J = .51

10 kHz high pass filter

3.22

0 db

10   20   30   40   50 kHz

DATE
ILMED

3-8