LIGO-T880006-00-R

COMMENTS ON THE DOCUMENT TITLED "Preliminary Seismic Survey of the Livingston LIGO Site" WRITTEN BY Warren Johnson, Donald Stevenson and Kyle Clevenger AND RECOMMENDATIONS ABOUT THE LIVINGSTON SITE

WRITTEN BY: Yekta Gürsel, Fred Raab, Peter Saulson, Robert Spero

November 11, 1988

I. Introduction

In this document we will review the manuscript prepared by Warren Johnson, Donald Stevenson and Kyle Clevenger which describes the seismic survey done at the Livingston site in the light of our past experiences and the original data about the other sites. The section headings closely follow the ones given in their paper. Our recommendations are presented in the conclusion section.

II. Calibration

Before the survey the authors calibrated the moving magnet seismometer using its calibration coil. They found that the seismometer response has a deficiency in the vertical response above 30 Hz. The horizontal response was about the same as the vertical one below this frequency, but it deviated from the vertical response radically above this frequency.

In the past we have used a moving magnet type seismometer. We determined that the best way of calibrating it was to physically shake it and read its output as a function of the shaking velocity. The shaking velocity was independently determined by either using an optical read-out or by using an accelerometer. The calibration coil was used in the field just before and just after a measurement to verify that the field-handling did not alter the seismometer response. It is recommended that these data are calibrated in the same manner.

On page 5 of the document, the authors alter the instrument response function by multiplying it by a single pole high frequency roll-off function to fit the observed behavior. They state that the correction for the amplifier roll-off was not included because it made the fit worse. The amplifier roll-off should be included. If the fit got worse, this means the model for the given behavior was inaccurate.

On page 6 the authors state that one way of explaining the behavior described above is to assume that the magnets that are attached to the proof mass are a significant fraction of the total proof mass and they are attached to it with a compliant mount. Given the facts that the proof mass has a mass of 5 Kg and the seismometer is of recent manufacture I doubt that the magnets are that heavy. The new technology rare-earth magnets are extremely strong and light weight compared to old alnico magnets. The manufacturer should be consulted to test this hypothesis.

III. Noise Floor of the Measurements

The authors determined the noise floor of the *instruments* by locking the mass and then measuring the output noise from the system. This way of noise floor measurement is not satisfactory. A very good way of determining the noise floor is to isolate the seismometer and then measure the output noise. The seismometer can be isolated both horizontally and vertically down to 1 Hz quite easily. We have accomplished this by suspending the seismometer by a long (5 feet) section of surgical tubing. One then reads the output of the system with the same settings that are used in the field. The electronic noise can be determined by terminating the input of the amplifier with a resistor which has the same value as the read-out coil output impedance.

IV. Ground Placement

The horizontal and the vertical seismometers were buried in different ways. The horizontal one is in a shallow (about 1 foot deep) hole, but soil is packed all around it. The vertical one appears to be in a four feet deep hole, but the soil does not cover its top surface. Further more it seems to be covered with a thinner piece of plywood.

Although there are data about the fact that the aircraft tend to cause vertical vibrations in the ground rather than horizontal ones (the Glasgow seismic survey team noticed this also), these differences in burial might explain why the vertical seismometer was more sensitive in picking up the passing aircraft noise. The soil all around the horizontal seismometer was probably a good sound insulator, but the vertical one had a nice channel covered by a thin drumhead which carried the sound waves to the seismometer.

These devices are very prone to acoustic pickup. Both of the pits should be filled with sound absorbing foam. Also, the seismometers should be placed at the same depth. It might be a good idea to put two horizontal (or two vertical) seismometers at different depths to see whether that makes a difference in the observed ground motion.

V. Data Acquisition

The authors used a spectrum analyzer in the field to analyze and record the data. They also recorded the data on a FM instrumentation recorder but this data were not analyzed.

The problem with this arrangement is that the spectrum analyzer is not a good device to look at transient phenomena. The seismic survey includes all forms of acts which cause the crust of the earth to move. To determine the cause of the motion one must have access to the signals in the time domain. Another problem is that these instruments are very power hungry and this shortens the observation time. Unless continuous power is available it will not be possible to take data for a whole day at a given location. Carrying power generating equipment does not solve the problem either since they produce noise themselves. Ideally one should take data for at least a week at a given location to get an idea of what the typical motions are.

The instrumentation should be capable of acquiring data simultaneously from all of the sensors placed at a given location. Since the analog tape recorder that was used was recording both of the seismometers, the data recorded by it should be available for analysis. It is probably a good idea to carry a portable weather station to the field to get an objective idea of the prevailing meteorological conditions. The output of these instruments should also be recorded on the analog recorder.

VI. Locations and Times

The are two creeks passing through the site. The authors do not indicate what the size of the water flow is in these creeks. They also did not take data near any one of those. During rainy season the creeks might carry enough water flow to cause *significant seismic* noise.

VII. Variation

The authors state that the ground noise showed no obvious variation during a measurement section except for the occasional passing truck. Their measurement section was too short to reach this conclusion. They should have taken data for the whole day. In the original Edwards data, the noise level goes down by a factor of four at 1 Hz between 4 o'clock and 5 o'clock in the morning compared to the noise level in the early evening. Incidentally, during those hours the Edwards site is 80 times quieter than the Livingston site at 1 Hz. This does not seem to be such a trivial difference.

The larger noisy episodes in the high-frequency sections of the spectra can only be resolved by examining the time domain signal. The authors claim that since the horizontal isolation is much more important for a LIGO than vertical isolation and since most of the noisy episodes are due to airborne sound that does not couple to the horizontal seismic motion, such noise is of less effect. The horizontal isolation is much more important for a LIGO but it is also much easier to accomplish since vibration isolators like rubber stacks are much softer in the shear direction. The vertical isolation is the one that is difficult to get at low frequencies.

VIII. Wind Noise

The authors state that the high frequency wind noise that was observed when the seismometers were placed directly under a tree vanished when the sensors were moved away from the tree. This fact was also observed by the British seismic survey team in an indirect way. They placed their sensors always away from the trees and they did not see any effect due to the wind shaking the trees.

Another conclusion in this section is that the wind noise is not significant for a typical day at this site. This may not be quite true when one considers the fact that a LIGO will have several buildings that are about 50 feet high. If the ground is prone to motion (it seems to be that way at 1-3 Hz), the building itself may couple the wind to the ground and may cause excessive noise.

There is a rather puzzling conclusion about the effects of strong winds. The authors state that there was a strong subjective wind, but the data from the fire tower somehow were not consistent with their subjective impression. But on page 11, they say that the fire tower was 20 miles away and they took the data from 10:24 to 10:58. The fire tower wind data were collected at 13:20 which is three hours after they took the data. I do not see any reason why the winds should be the same 20 miles away and three hours later especially when a hurricane was coming towards them. On page 17, they also say that the fire tower is 15 miles away which contradicts the figure given on page 11.

IX. Remarks

The authors state that the ground motion seen at the Livingston Site was up to 100 times smaller than what they measured on their lab floor which was a concrete slab resting directly on the ground. This is hardly surprising if their lab is in a university building. In such an environment there are many things that are shaking the ground.

The measurements made at the old observatory at Clinton seems to indicate that the part of the slab that is above the ground is acting like a lever arm which amplifies the motion. The base of the slab does not do this of course, so it has less horizontal motion.

The most interesting feature of this site is the observed large motion in the frequency range from 1 to 3 Hz. This motion does appear to be linked to a local property of the ground. We propose that this is wind induced motion of the ground and the ground moves with large amplitudes at this location because of the underlying soil structure. In a smaller extent the ocean may also be a cause of this, but we think wind is the more likely culprit. The support for this comes from the British seismic survey. In that survey they did examine a site which had excessive motion at about 3 Hz. This was a clay filled buried valley and they conclude that it was the wind that was driving it. The following is taken directly from that document:

"The effect of amplification of ground motion by deposits of unconsolidated materials is a well known phenomenon in earthquake seismology. Studies in the San Francisco Bay region (Borcherdt, et al, 1975) have indicated that the effects of amplified ground shaking are expected least for sites underlain by bedrock, intermediate for sites underlain by alluvium (largely silt, sand and gravel), and greatest for sites underlain by bay mud (largely clay and silt)."

The authors note that the Livingston site is underlain by 40,000 feet of alluvial deposits. The wind is probably coupling in through the trees continuously and globally to cause the whole region to move at 1 to 3 Hz and at lower frequencies. From their data it seems that the when the winds die down the low frequency spectra do not change appreciably. The explanation for this is that the low frequency motion is caused by the winds on global scale which moves the whole area. The measurements of local winds will not give an indication of this phenomenon.

The authors also note that the Livingston site is 10 times noisier than the other sites at 1 to 3 Hz. It is actually much worse than that. As I indicated before, the Edwards site is 80 times quieter than the Livingston site at late hours of the night. The Edwards site is not the quietest of all sites that are available. They say that the Livingston site is quieter at higher frequencies, and the quietness at higher frequencies is more desirable. We note that higher frequencies are extremely easy to isolate, it is the low frequencies in the 1 to 3 Hz region which are most difficult to get rid of.

XI. Conclusion

On the basis of this data which is in much better condition than the data we have on the Edwards and Cherryfield sites we see no reason to drop the Livingston site from further consideration as a LIGO site at this time. However, as we outlined above we do have a number of technical concerns. One in particular is possibly a very serious concern -- the very large noise level below 3 Hz which is about five times larger than the corresponding noise level at the Caltech Laboratory. Although this is likely to be outside the signal band of the first (and maybe even all subsequent) LIGO receivers, the large amount of noise could cause difficult demands on the dynamic range of the holding servos.

There are other non-linear effects as well. These include the nonlinear effects in the mechanical systems that up-convert this noise into a noise in the interferometer bandwidth, the non-linearities in the optical read-out which up-convert the large excursions in the mass positions into high frequency noise that also falls in the interferometer bandwidth. This large motion can also interfere with the low frequency gravitational wave searches through varying gravitational gradients. We do not know how to evaluate these effects at the present time.

We know that if there were not any non-linearities, the site would be quite acceptable as a LIGO site since it has good noise level at high frequencies and it is possible to reduce the lower frequency noise to the required levels by using isolation stacks.

Another issue which needs resolution is the effect of the imported noise to the site since relatively tall buildings and other vibration producing machinery will be installed on the sites. Since the ground is prone to motion at low frequencies at this site, the wind noise coupling to the ground through the building might be an important noise source and it may be larger than the intrinsic seismic noise of the site.

We appreciate the urgency of resolving this question. We plan to make a few measurements that will cover an extended period of time like a week at the Caltech laboratory and the at the JPL research facility in the Edwards Air Force Base which will show the effect of the wind coupling to ground through buildings. The necessary equipment for this is already in our possession.

After the measurements in California has been completed we plan to ship this equipment to Maine to get an idea of how the Maine site is like. We expect that these measurements will be completed in a month and their results will be included in our upcoming report about site seismicity which is due on December 15, 1988.

In summary we do not know for sure that this site is any worse than any of the other sites since we do not know how to assess the importance of the low frequency noise at the present time. The measurements planned might be able to help us in resolving this issue in the near future.

BATCH START

STAPLE
OR
DIVIDER

LIGO-T880068-00-R

Preliminary Seismic Survey of the Livingston LIGO Site

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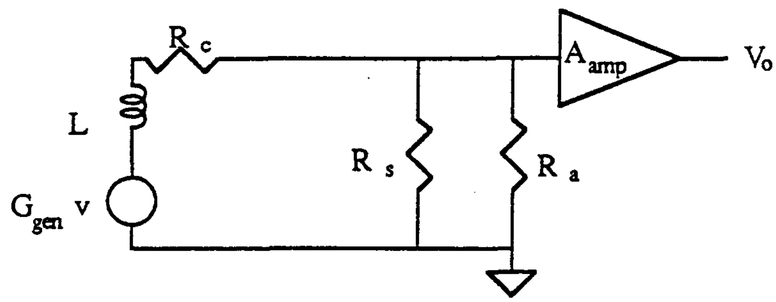
October 22, 1988

The equivalent circuit for the sensor-amplifier combination is



Most of the damping of the proof-mass is provided by the net input resistance of the amplifier. The bare input resistance $\mathbf{R_a}$ = 20 kΩ of the amplifier is reduced by a shunting damping resistor $\mathbf{R_s}$ placed on the amplifier circuit board. Thus the net input resistance is $\mathbf{R_{in}} = (R_a^{-1}+R_s^{-1})^{-1}$. The shunting resistor R_s was chosen to be 7400 Ω, the value calculated to make the net damping coefficient **h** = 0.70 of critical. The net input resistance was checked, with an impedance bridge, to have the value 5450 kΩ, in good agreement with expectation. This causes the input voltage to the amplifier to be smaller, by the factor $A_{div} = R_{in}/(R_{in} + R_c)$, than the voltage $G_{gen}v$ generated by the velocity. The coil inductance L, estimated at 5 Henries, is too small to have an effect at these frequencies.

Vertical Calibration

The calibration procedure used the manufacturer's calibration coil, which is a second coil mounted on the framework and inside another magnet attached to the proof-mass. We put known sinusoidal currents through the vertical seismometer's calibration coil, using a voltage V_{gen} in series with a net resistance R_{cal}. We can then calculate the resulting force from the manufacturer's value for the coil-magnet motor constant G_{mot} = 0.1975 Newton/Amp. If the proof-mass were a free mass, then the magnitude of its velocity v(f) would be $v_{fm}(f)$

$$v_{fm}(f) \equiv \frac{G_{mot}\left(\frac{V_{gen}}{R_{cal}}\right)}{2\pi f M} \tag{1}$$

and the amplifier output voltage V_o will be

$$V_o(f) = A_{amp}\, A_{div}\, G_{gen}\, v(f) \tag{2}$$

were surprised to discover that the response to the ground velocity is essentially identical, requiring only that the ground velocity $v_{gr}(f)$ be substituted for $v_{fm}(f)$ in combining eqs. (2) and (3).

$$v_{fm}(f) \rightarrow v_{gr}(f) \qquad (4)$$

This can be shown from the equations of motion, where v(f) becomes the velocity difference between the ground and the proof mass.

The expected and measured values are in excellent agreement below about 30 Hz, which means that the amplifier response and the sensor coil parameters are completely consistent with the calibration coil parameters. One calibration point was taken in the field (9/7) on each seismometer to verify that the lab calibration was still valid. We therefore are confident of the correctness of the instrument response below 30 Hz.

Above 30 Hz there is a deficiency in the vertical response that grows with frequency. The true cause for this deficiency is unknown. Talking to the service personnel at Geotech was not helpful. At one time we had thought that it was due to the sensor coil inductance causing an enhanced voltage divider effect, but this explanation fails quantitatively : the inductance is too small by an order of magnitude. We conjecture that there is some connection to the much greater deviation found when the seismometer is used in the horizontal configuration.

We have chosen to take the calibration procedure at face value, and so have altered the instrument response function by multiplying it by a single pole hi frequency rolloff function $H_{hi}(f)$:

$$H_{do}(f) \longrightarrow H_{do}(f)\,H_{hi}(f) \equiv \frac{H_{do}(f)}{\sqrt{1+(f/f_{hi})^2}} \qquad (5)$$

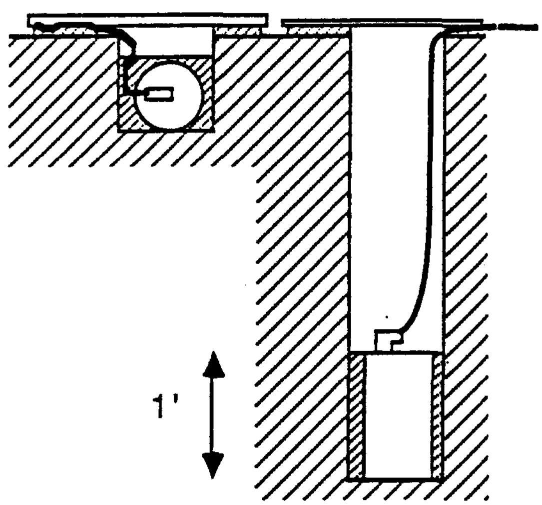
where $f_{hi} = 46$ Hz provides a reasonable fit. (The correction for the amplifier rolloff was not included because it made the fit worse.) This is shown in the graph above as the line labeled "fit". Of course, to correct the measured voltages, we divided them by this combined response function to give the best estimate of the true ground velocity. This correction increases the reported values for motion above 30 Hz by at most a factor of 2 at 100 Hz.

Noise Floor of the Measurements

The noise floor of the instruments was apparently not reached during any of the ground noise measurements. We evaluated it by locking the proof-mass and measuring the output noise of the amplifier. This was not really satisfactory in the laboratory, where it was easy to see many peaks at the vibration frequencies of nearby machinery. In the field, the ground was much quieter, and a spectrum was taken with the mass locked (see Appendix : Calibration Data). It was found to be nearly the same as the spectrum when the sensor coil was detached from the amplifier, shown as AMPNOISE in figure 26B of Appendix : Ground Noise Spectra. This is a reasonable indication of the displacement noise floor for the vertical seismometer at all frequencies and the horizontal seismometer below 30 Hz.

Ground Placement

All placements of the seismometers in the ground were the same. A hydraulic-motor driven auger, 9" in diameter, was used to dig holes in the sandy clay soil. The seismometers, cylinders 6.5" dia by 12" long were arranged as shown:



The depth of both units was determined by the necessity to level them to within 4 degrees of the nominal orientation. Soil was packed around them till it was firm to the hand. The cable was buried in soil for 8"-12" after it emerged from the hole. A piece of plywood covered each hole, flush with the surrounding ground. Scratching the cable outside the hole produced no visible microphonics.

to-fm converters were used so that the dynamic range of the recording should be about 55 dB. We have not looked at any of this data because the analyzer acquired data has given a reasonably consistent picture. This tape is being kept as an archive, if any further analysis is desired.

Locations and Times

Measurements were recorded on disk at five locations on the forested tract of land in Livingston Parish owned by Cavenham Forest Industries. On the following page is a marked copy of the USGS quad map (Satsuma, LA) that locates these sites.

August 31

Sites A & B : two locations within 50 yards of the Livingston (Fire) Lookout Tower. This was a dry run, done without the computer, so data could not be converted to displacements or corrected for instrument response. The raw data plots are not included in this report.

September 7 (Data filenames start with T)

Site C : a site where the trees were set back perhaps 40' from the gravel road, so that the seismometers could be out in the open, away from tree roots. It is about 1600 meters east of the eastern pipeline right-of-way and about 1300 meters north of the power line. The subjective wind speed was "moderate", meaning some breeze could be felt near the ground, and there was modest movement at the tops of the trees, but not of the lower branches. The wind speed recorded at the Livingston Fire Tower was 4 mph at 13:30, and 3 mph at 15:15. Data was collected from 17:15 to 17:40 Central Daylight Time. 1-5B

Site D : a site on the east pipeline right-of-way, which is owned by Shell. This right-of-way was supposed to have a CO_2 pipeline on the west side and a 48" dia Shell crude oil pipeline 30' or 40' east in the middle of the right-of-way. When we looked closely, we found signs indicating a third pipeline another 40' east of the crude oil line. The crude oil pipeline was operating at a normal flow rate. The seismometers were placed 15' west of the CO_2 pipeline or about 45' to 55' west of the crude oil line, and about 20' east of the tree line. The horizontal seismometer axis was E-W, or perpendicular to the N-S pipelines. The subjective wind speed was "calm", meaning no perceptible breeze at ground level and no visible movement of the tops of the trees. Data collected from 19:59 to 20:37. 6B-10B

September 8 (Data filenames start with U)

Site D again. The crude oil pipeline was off. A few cows walked by about 100' from the seismometers, during the first 15-20 minutes of data collection. Subjective wind speed was "strong", because the lower tree branches were occasionally moving several feet. Data collected from 10:26 to 11:13. 11B-12B

Site E : two hundred meters west of site D, where the two gravel roads cross, which put it half way to the other pipeline right-of-way. The seismometers were under the branches of a pine tree, about 10' from its trunk. Horizontal axis was E-W. Subjective wind still "strong". Fire tower recorded wind velocity as 5 mph at 13:30. Data was collected from 13:03 to 13:39. The crude oil pipeline was still off. 14B + 15B

Site E' : across the road from site E, which got the seismometers out from under the trees, about 20' away from the nearest one. Subjective wind was down slightly. Data was collected on tape from 14:51 to 15:13, computer data till 15:34. The pipeline log shows that flow was stopped at 6:30 and reestablished at 15:05 (about three hours later than we had been told). An operator estimated it might typically take 5-10 minutes for flow to be reestablished. 16+17B

Site F : directly under the power lines, which makes it about 40' to the tree line. This site is 1800 meters east of the Shell pipeline. The recreational vehicle was closer to the seismometers, perhaps 60 yards away. Subjective wind "calm". Data from 17:17 to 17:35. 18+19B

Measurements were also made on the Idlewild Plantation (farm), an LSU agricultural research station and the site of the defunct LSU optical observatory. This is about 2 miles SE of Clinton LA. According to soil experts on the Louisiana Geological Survey, the soil there is looser and more sandy than near Livingston, with a deeper water table; perhaps the ground noise would be different. This area is also about three times farther from Interstate 10 than the Livingston area.

September 9 (Data filenames start with V)

Site G : in an open field at the Idlewild farm, about 1/2 mile north of the observatory, using the usual ground placement. The subjective wind was "very strong", strong enough to gently rock the recreational vehicle. It was sunny and clear, but a hurricane was some hundreds of miles south and heading towards us; it arrived the next day as an ordinary rain storm. (The Livingston fire tower, about 20 miles SE of here, recorded 6 mph at 13:20, not consistent with our subjective impression. The reason is unknown.) Data were collected from 10:24 to 10:58. 20+21B

Results

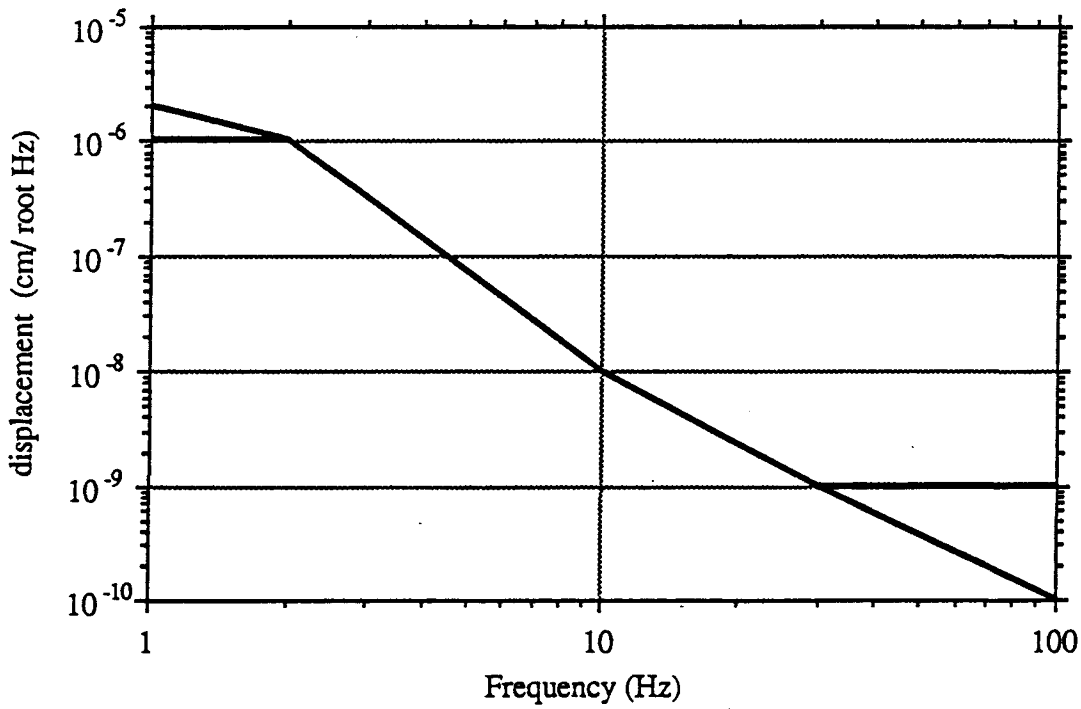
Typical Spectra

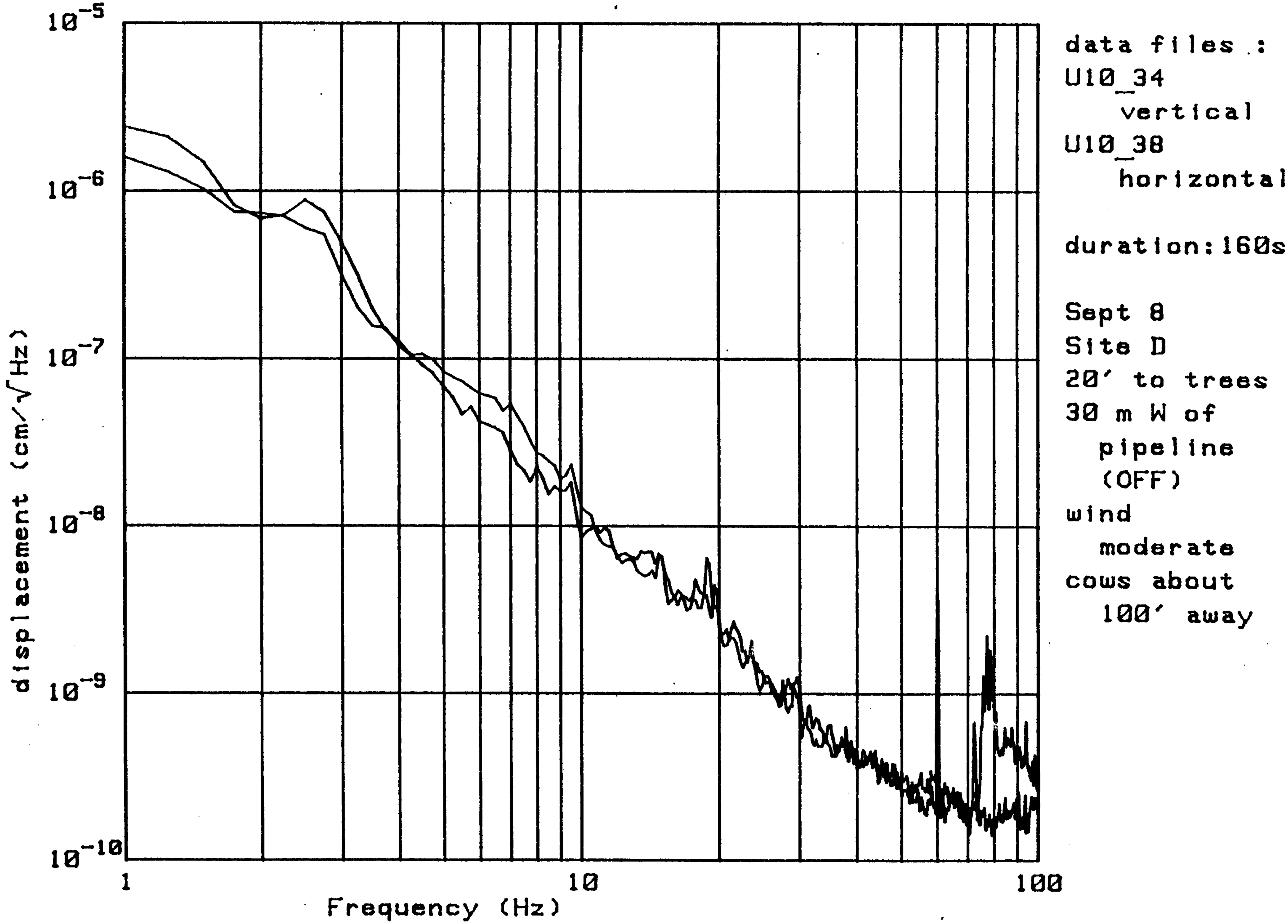
The raw spectrum of the amplifier output, as recorded, is proportional to a slightly distorted spectrum of the ground velocity. A typical one is shown on a following page.

The distortions of the raw power spectrum were corrected by dividing each frequency bin by the frequency dependent instrument response and the noise bandwidth. We then converted this to a displacement spectrum and plotted its square root. The page following the raw spectrum shows this corrected and converted spectrum for the same data set.

All of the data stored on disk appears among the 26 plots in the Appendix : Ground Noise Spectra.

Most of these ground noise spectra are fairly similar. We would summarize them with the following graph of the "typical spectrum" :





10^{-5}
10^{-6}
10^{-7}
10^{-8}
10^{-9}
10^{-10}
displacement (cm/√Hz)
1
10
100
Frequency (Hz)
data files :
U10_34
vertical
U10_38
horizontal
duration:160s
Sept 8
Site D
20′ to trees
30 m W of
pipeline
(OFF)
wind
moderate
cows about
100′ away

was (fortuitously) off for part of the data taking, so that we have data to isolate its effects. Some data were taken next to it when it was both on (graphs 6B-10B) and off (graphs 11B-12B). When the crude oil was flowing, the ground noise next to the pipeline increased by factors up to 30 for a band of frequencies centered near 7 Hz, but had no effect above 10 Hz. At a distance of 200 meters, the crude oil flow increased the noise by a factor of 10 in a narrower band at 7 Hz (see graphs 16B-17B). At a distance of 1800 meters its effects were undetectable. This is clearly a source of noise that one would like to avoid. More measurements will be needed to be certain how close one can be and not see this source.

When the crude oil line is off, the spectra near the other pipelines resembled spectra far away from them. We conclude that the other pipelines, which are gas pipelines, were not a significant source of noise.

Wind Noise

Comparison of the many spectra at the Livingston site seems to show rather little effect due to the local wind : on Sept 8 the wind was subjectively "strong" during the middle of the day and calm later, but the spectra do not show systematic differences with wind speed (factoring out the effect of the crude oil pipeline). The one case that seems to show a wind effect is a comparison of graphs 14B and 17B; by moving the seismometers out from under a tree, the noise above 30 Hz was reduced significantly, which implies that this type of wind generated noise is easy to avoid.

The one caution in evaluating the effect of wind is that our subjective evaluation of wind speed may be too low, and so we may not have data representative of really windy days. The wind measurement at the Fire Tower that afternoon was 5 mph, which does not sound like "strong". The Fire Tower measurement is objective and certainly much more reliable. Our conclusion then is that wind noise is not significant for a typical day at the Livingston site. The data we collected represents the conditions for 80% of the year, because the Fire Tower wind speed exceeded 5 mph on only 74 days in 1987 (see the Appendix : Wind Speed Records).

In contrast, the data taken on Sept 9 at Idlewild (site G) do seem to show a systematic effect due to the wind. The spectra are 3 or 4 times higher (for f > 4 Hz) than the previous day and the subjective wind was much stronger. We might conclude that : 1) the wind had passed the threshold where it makes a significant contribution. The ambiguity comes from the Fire Tower measurement of 6 mph for that day. Several alternate conclusions might then be drawn : 2) the wind was different at the Fire Tower, which is 15 miles away, and the local wind was still the cause for the increased motion, or 3) the Fire Tower wind measure should be trusted (our subjective measure of wind speed is very unreliable), hence we should look for alternate explanations of the greater motion at this different site on this different day. The data is insuffícent to chose among these alternatives.

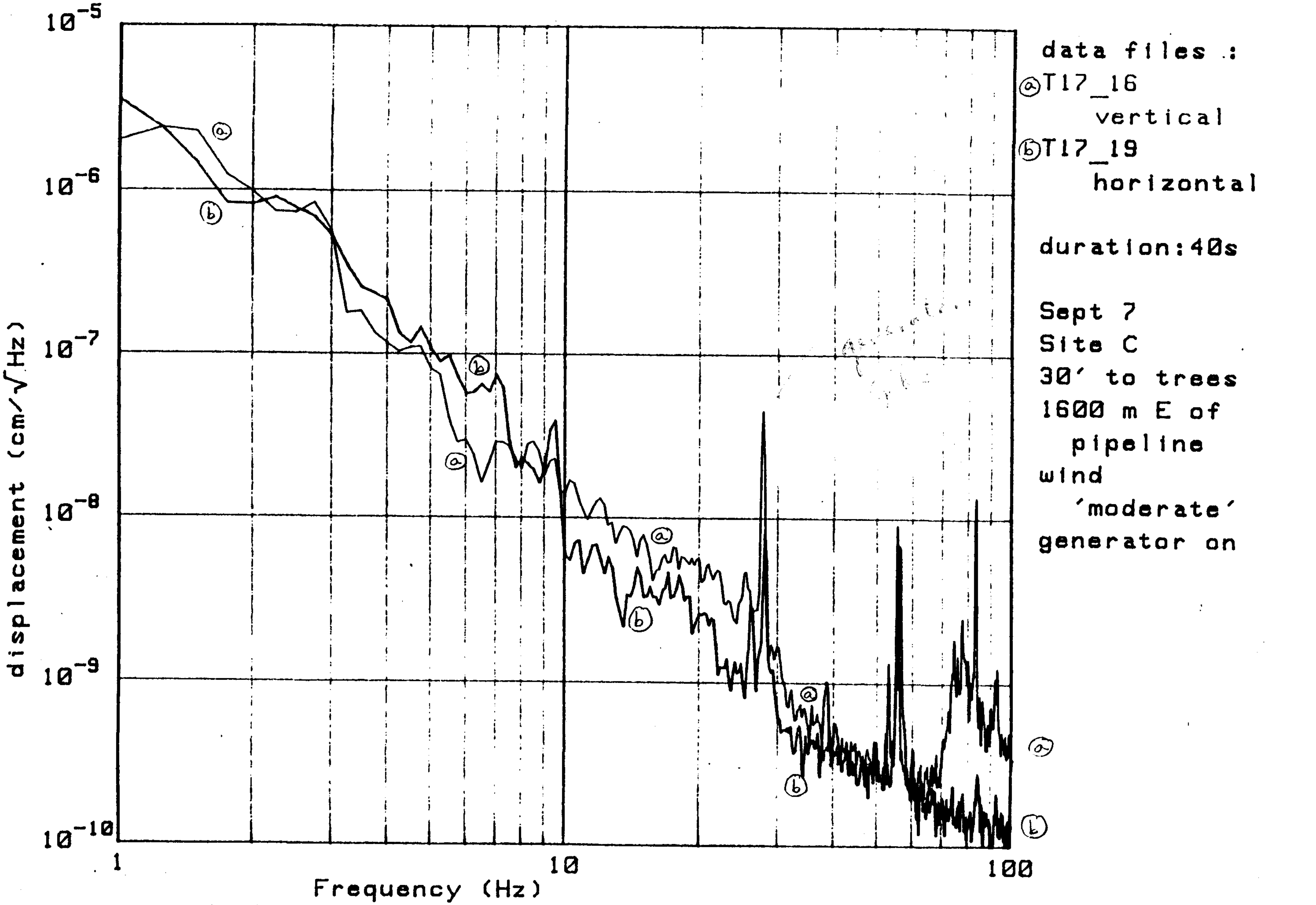
Appendix : Ground Noise Spectra

This appendix contains 26 graphs of converted and corrected spectra of the ground noise motion, numbered from 1B to 26B. (Graphs 1A through 26A are the raw data and are not included in this report.) This is all of the data acquired with the digital signal analyzer.

The letter in the data filename specifies the day that the data were taken (see Locations and Times), and the numbers in the filename give the hour and minute (CDT) that the particular average was started.

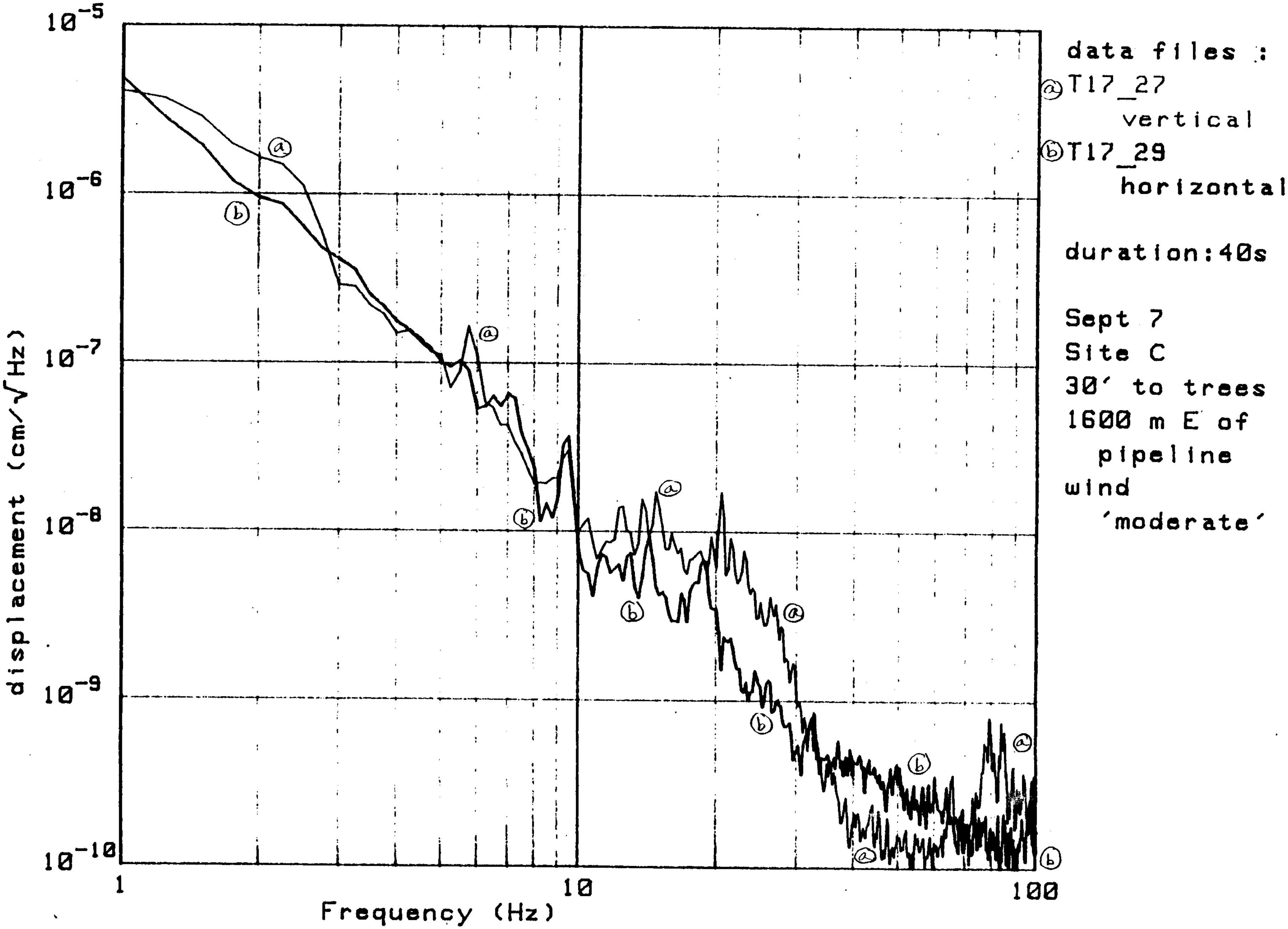
It may be difficult to distinguish between the vertical and the horizontal seismometer traces if the following are a black and white copies of the original graphs.

1B



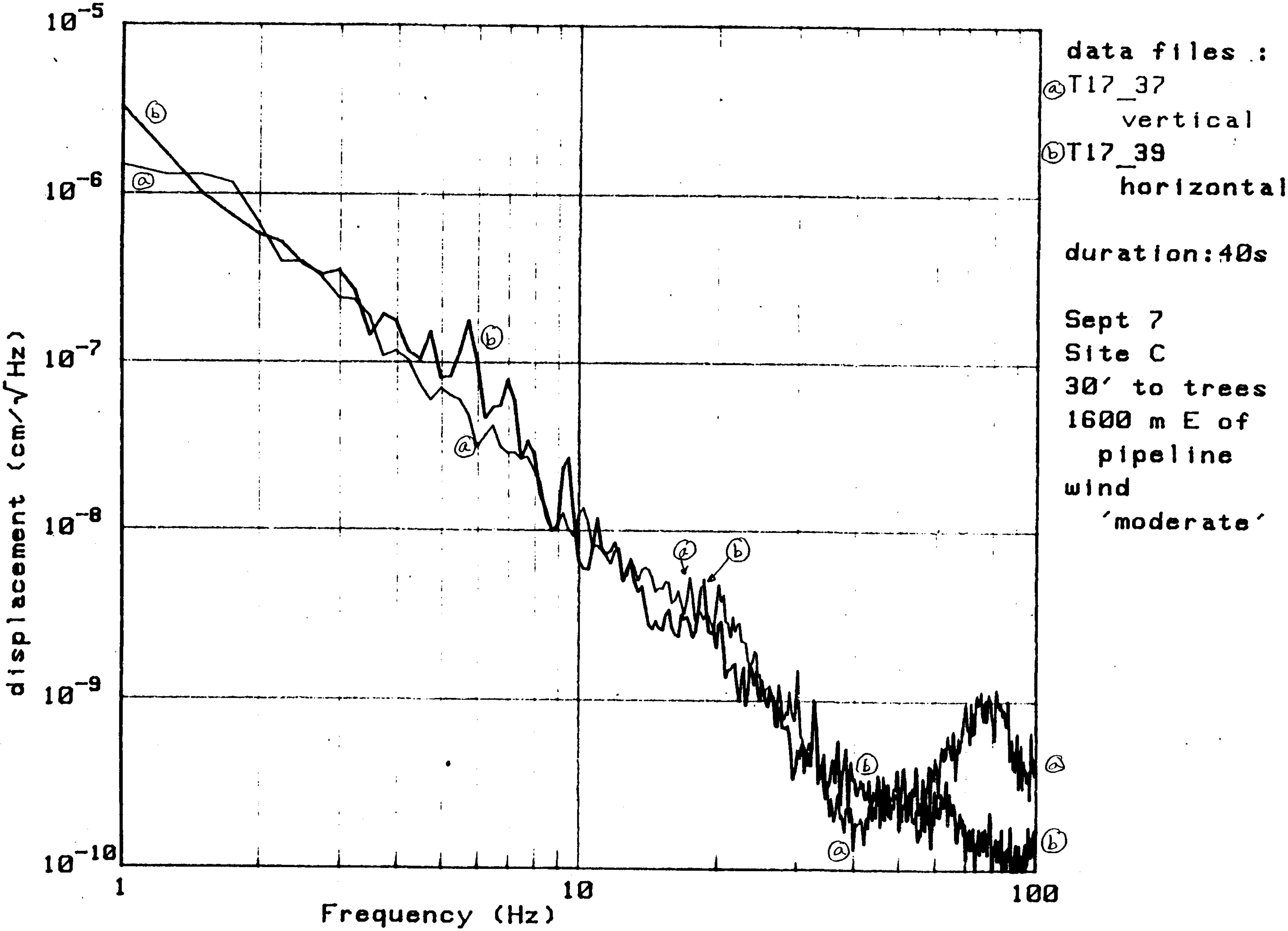
data files :
ⓐT17_16
vertical
ⓑT17_19
horizontal
duration:40s
Sept 7
Site C
30′ to trees
1600 m E of
pipeline
wind
′moderate′
generator on
displacement (cm/√Hz)
Frequency (Hz)
10^-5
10^-6
10^-7
10^-8
10^-9
10^-10
1
10
100

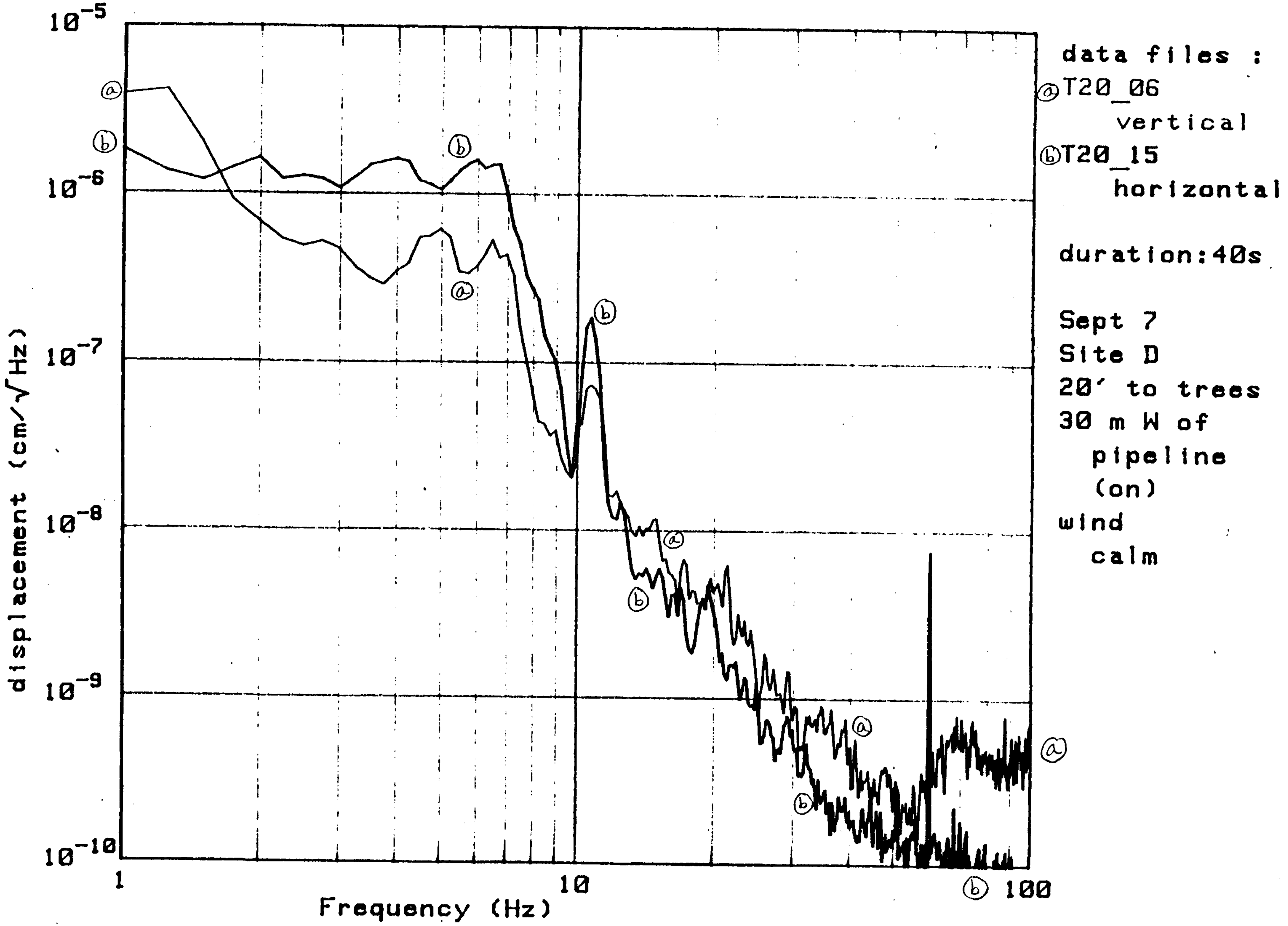
3B



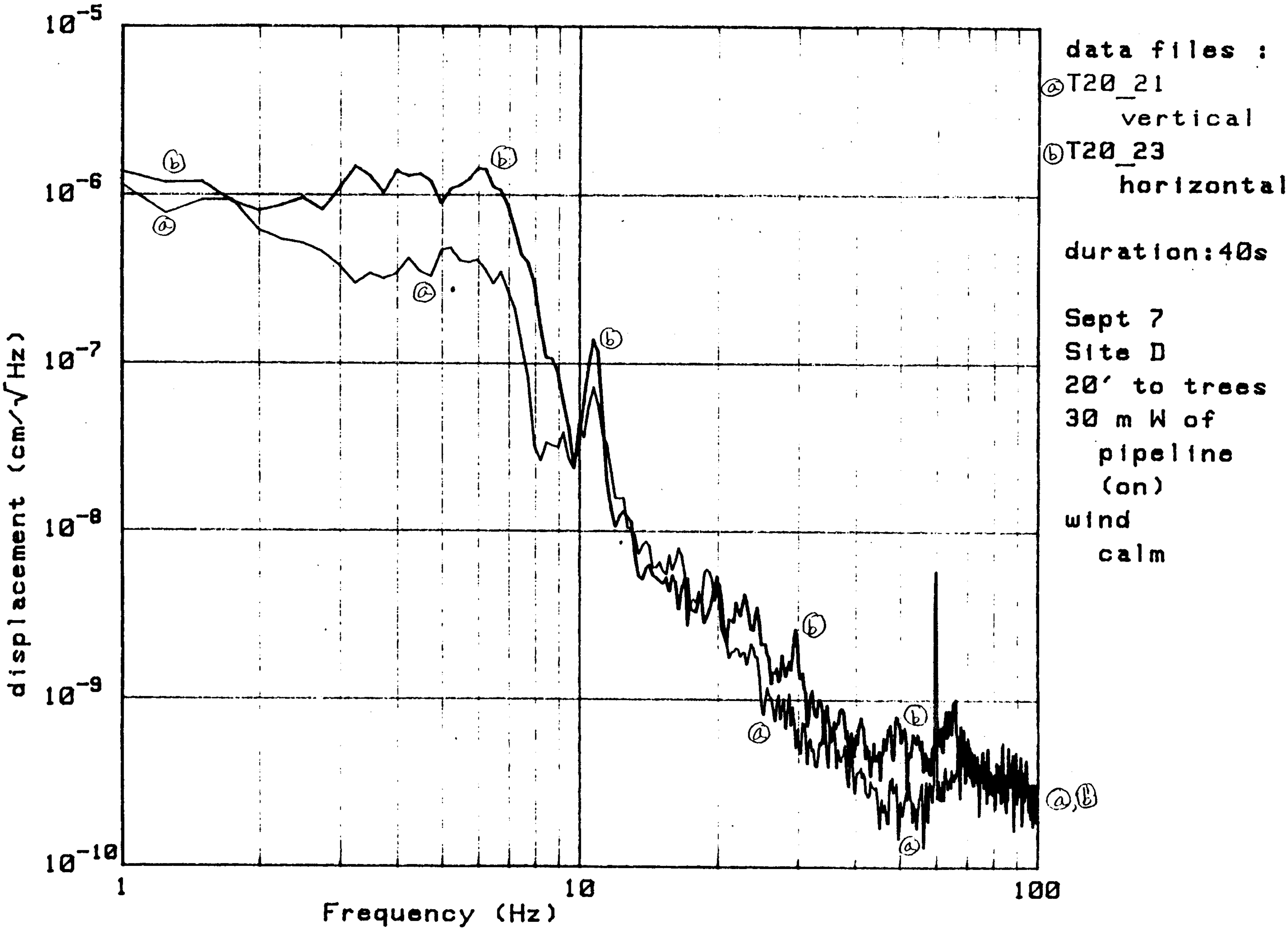
displacement (cm/√Hz)
10^-5
10^-6
10^-7
10^-8
10^-9
10^-10
1
10
100
Frequency (Hz)
data files :
ⓐ T17_27
vertical
ⓑ T17_29
horizontal
duration:40s
Sept 7
Site C
30′ to trees
1600 m E of
pipeline
wind
′moderate′

5B


10^{-5}
10^{-6}
10^{-7}
10^{-8}
10^{-9}
10^{-10}
displacement (cm/√Hz)
1
10
100
Frequency (Hz)
data files :
ⓐT17_37
vertical
ⓑT17_39
horizontal
duration:40s
Sept 7
Site C
30′ to trees
1600 m E of
pipeline
wind
′moderate′

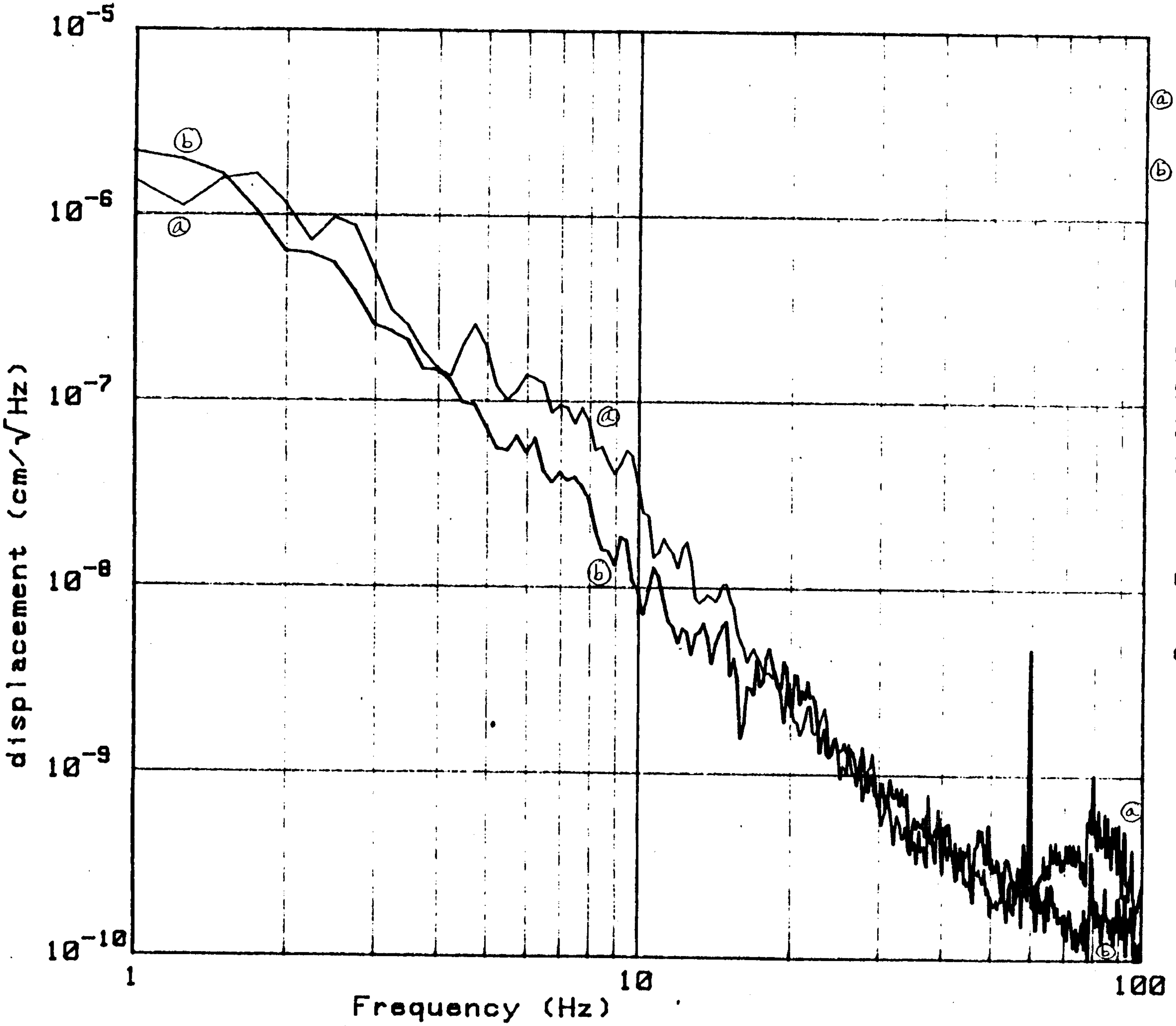


10^{-5}
10^{-6}
10^{-7}
10^{-8}
10^{-9}
10^{-10}
displacement (cm/√Hz)
1
10
100
Frequency (Hz)
data files :
ⓐT20_06
vertical
ⓑT20_15
horizontal
duration:40s
Sept 7
Site D
20′ to trees
30 m W of
pipeline
(on)
wind
calm



displacement (cm/√Hz)
10^-5
10^-6
10^-7
10^-8
10^-9
10^-10
1
10
100
Frequency (Hz)
data files :
ⓐ T20_21
vertical
ⓑ T20_23
horizontal
duration:40s
Sept 7
Site D
20' to trees
30 m W of
pipeline
(on)
wind
calm

11B

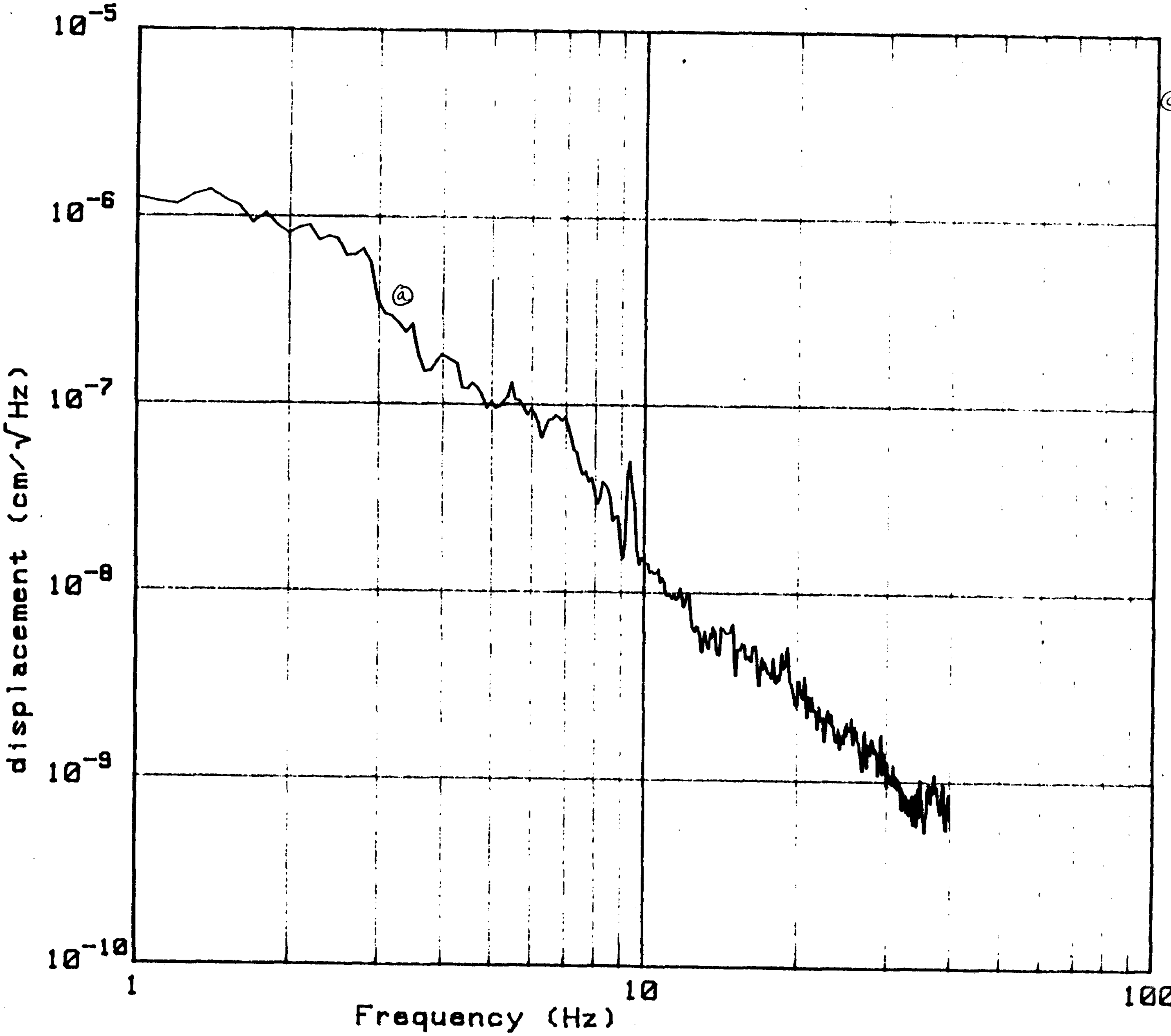


data files :
ⓐU10_29
vertical
ⓑU10_31
horizontal

duration:40s

Sept 8
Site D
20′ to trees
30 m W of
pipeline
(OFF)
wind
moderate
cows about
100′ away

13B

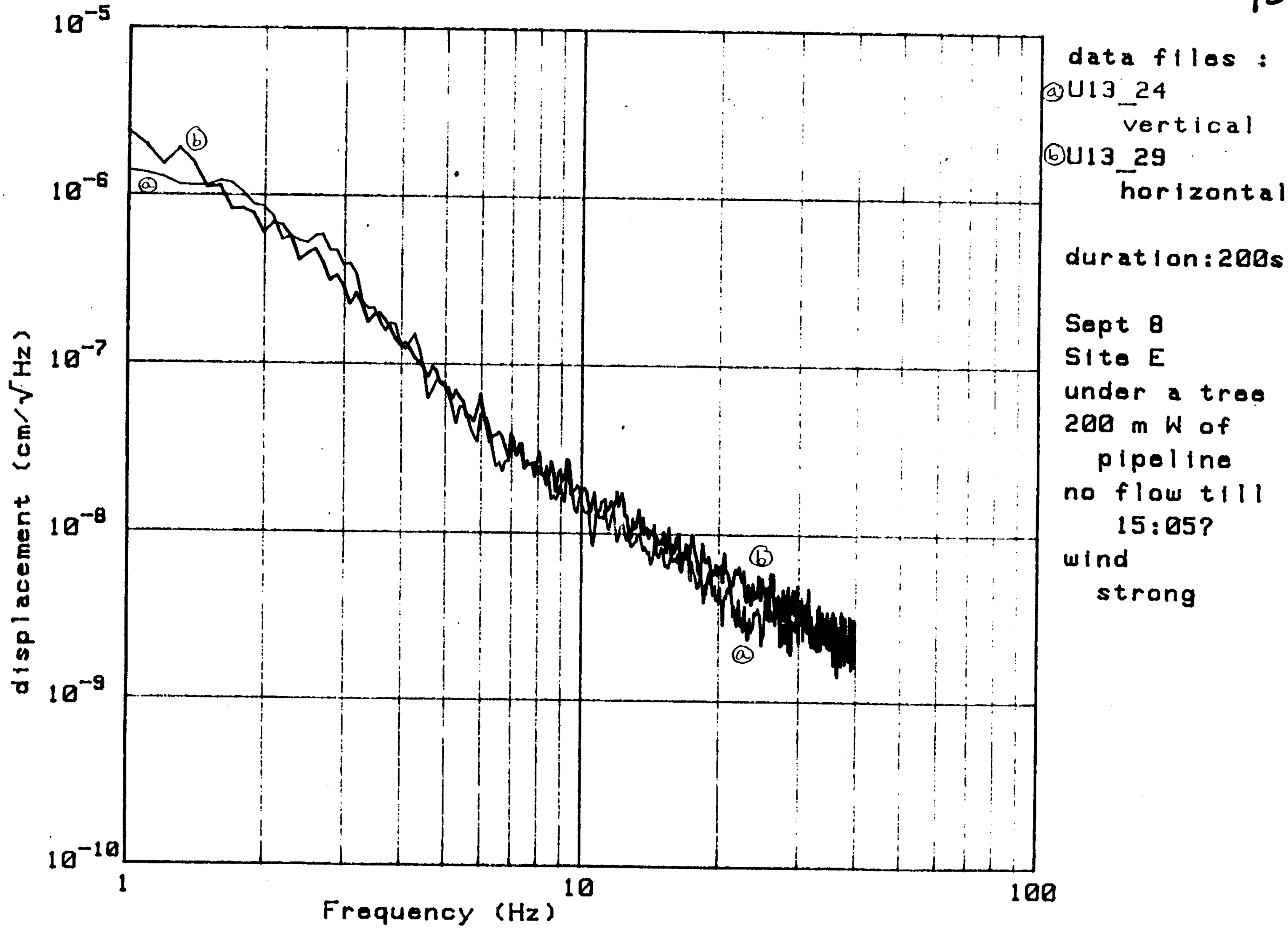


data files :
@U10_47
vertical

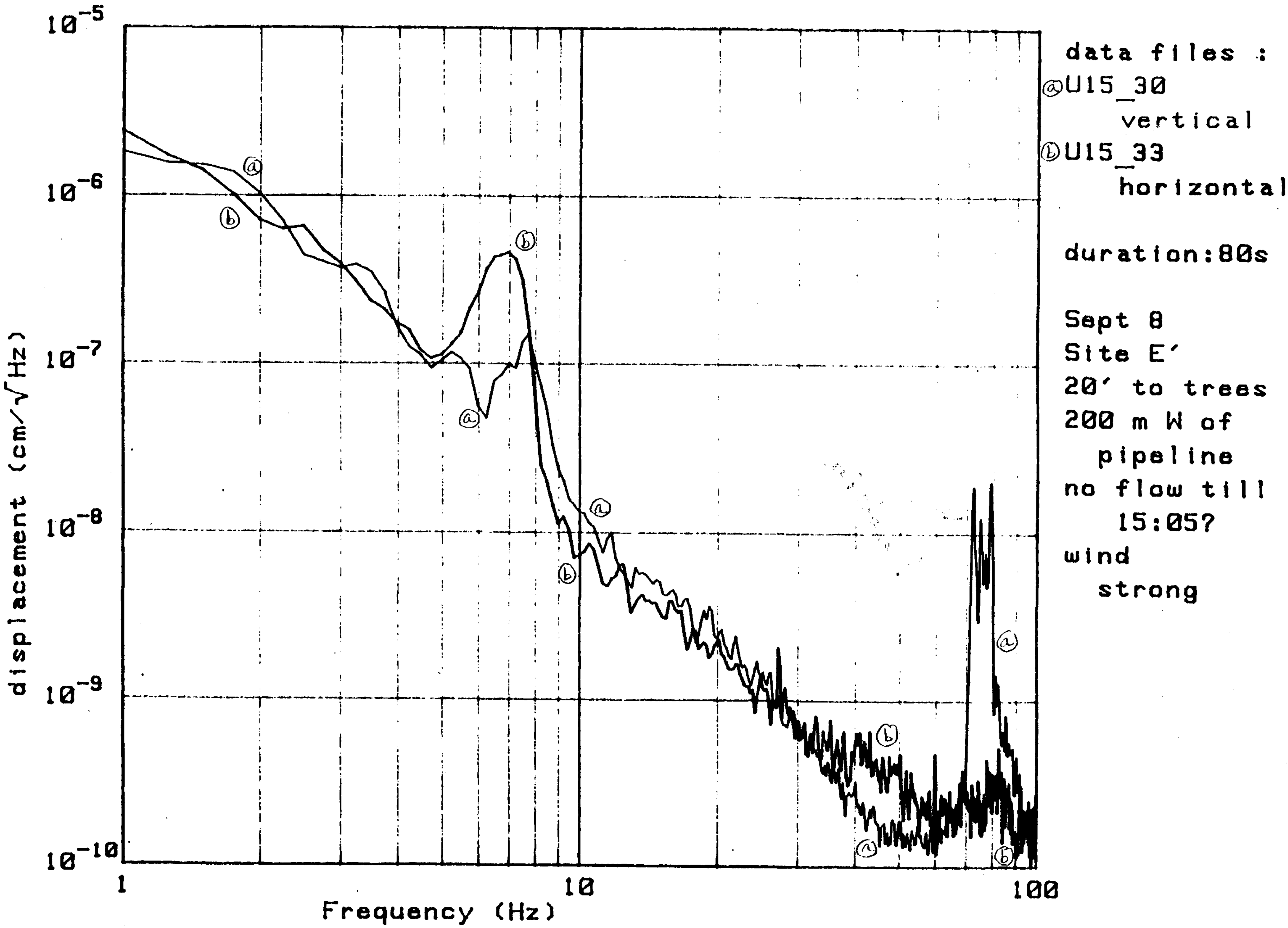
duration:200s

Sept 8
Site D
20′ to trees
30 m W of
pipeline
(OFF)
wind
moderate
cows about
100′ away

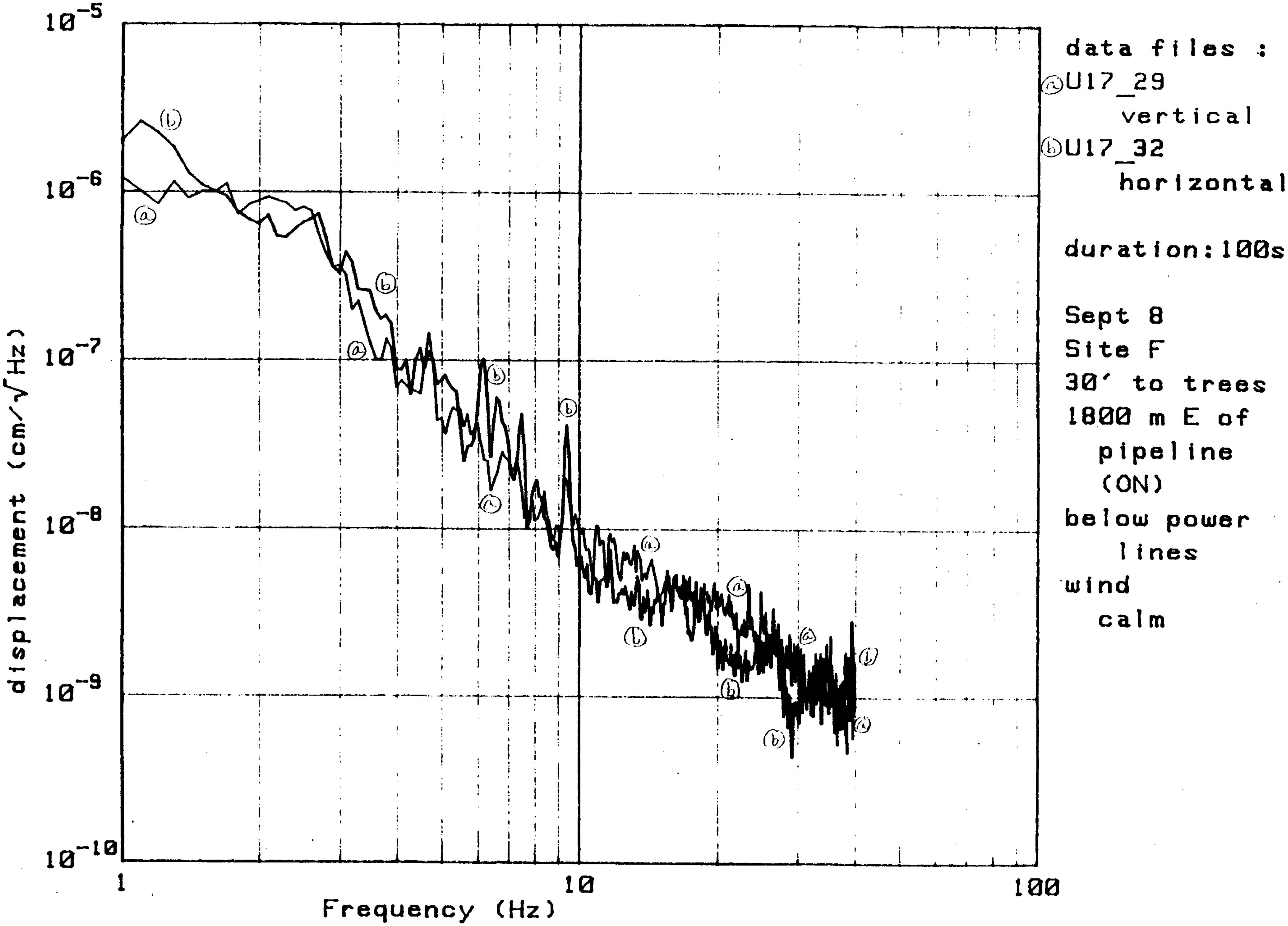
15B



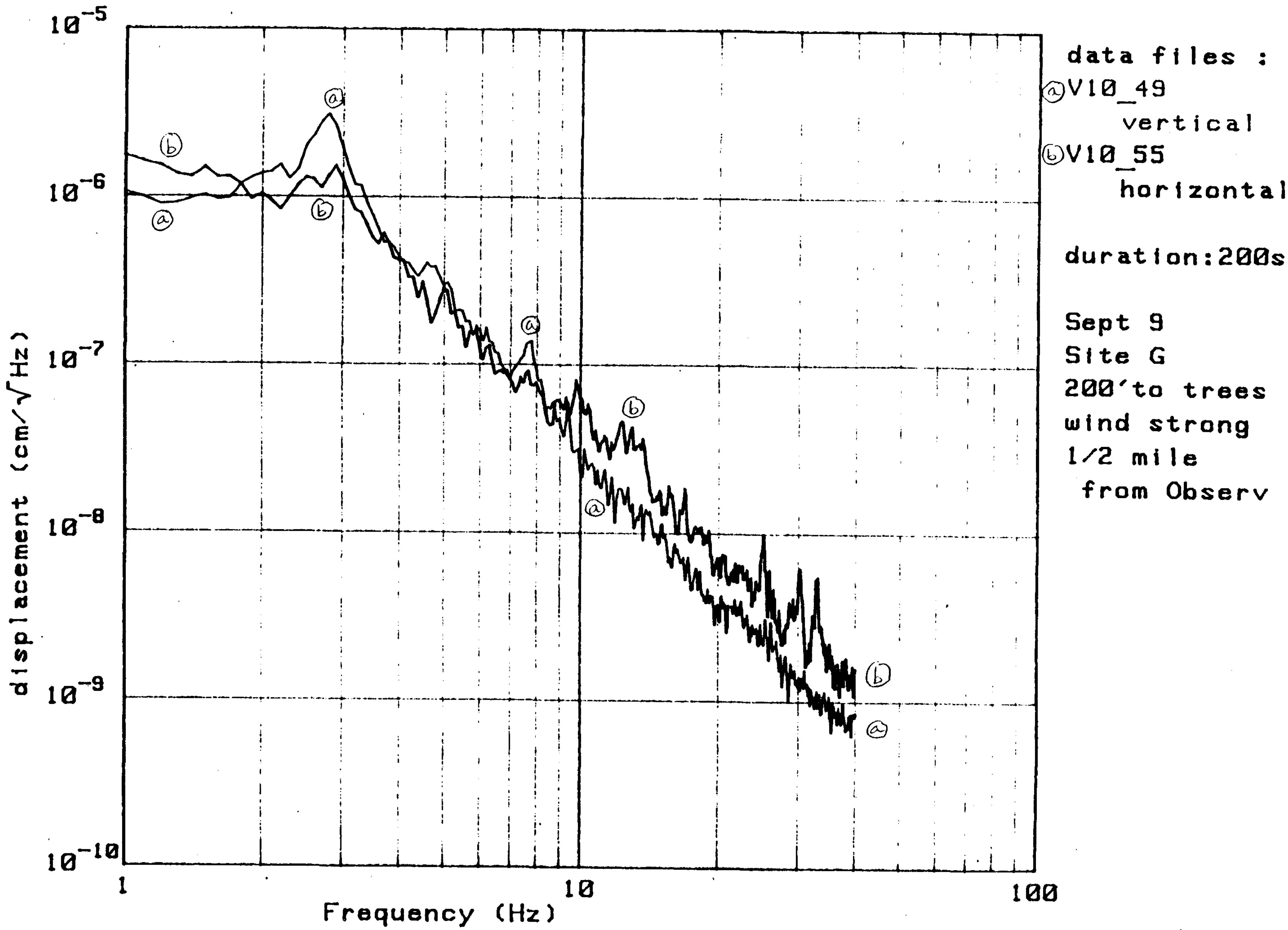
10^-5
10^-6
10^-7
10^-8
10^-9
10^-10
displacement (cm/√Hz)
1
10
100
Frequency (Hz)
a
b
data files :
ⓐU13_24
vertical
ⓑU13_29
horizontal
duration:200s
Sept 8
Site E
under a tree
200 m W of
pipeline
no flow till
15:05?
wind
strong


10^-5
10^-6
10^-7
10^-8
10^-9
10^-10
displacement (cm/√Hz)
1
10
100
Frequency (Hz)
a
b
data files :
a U15_30
vertical
b U15_33
horizontal
duration:80s
Sept 8
Site E′
20′ to trees
200 m W of
pipeline
no flow till
15:05?
wind
strong

19B

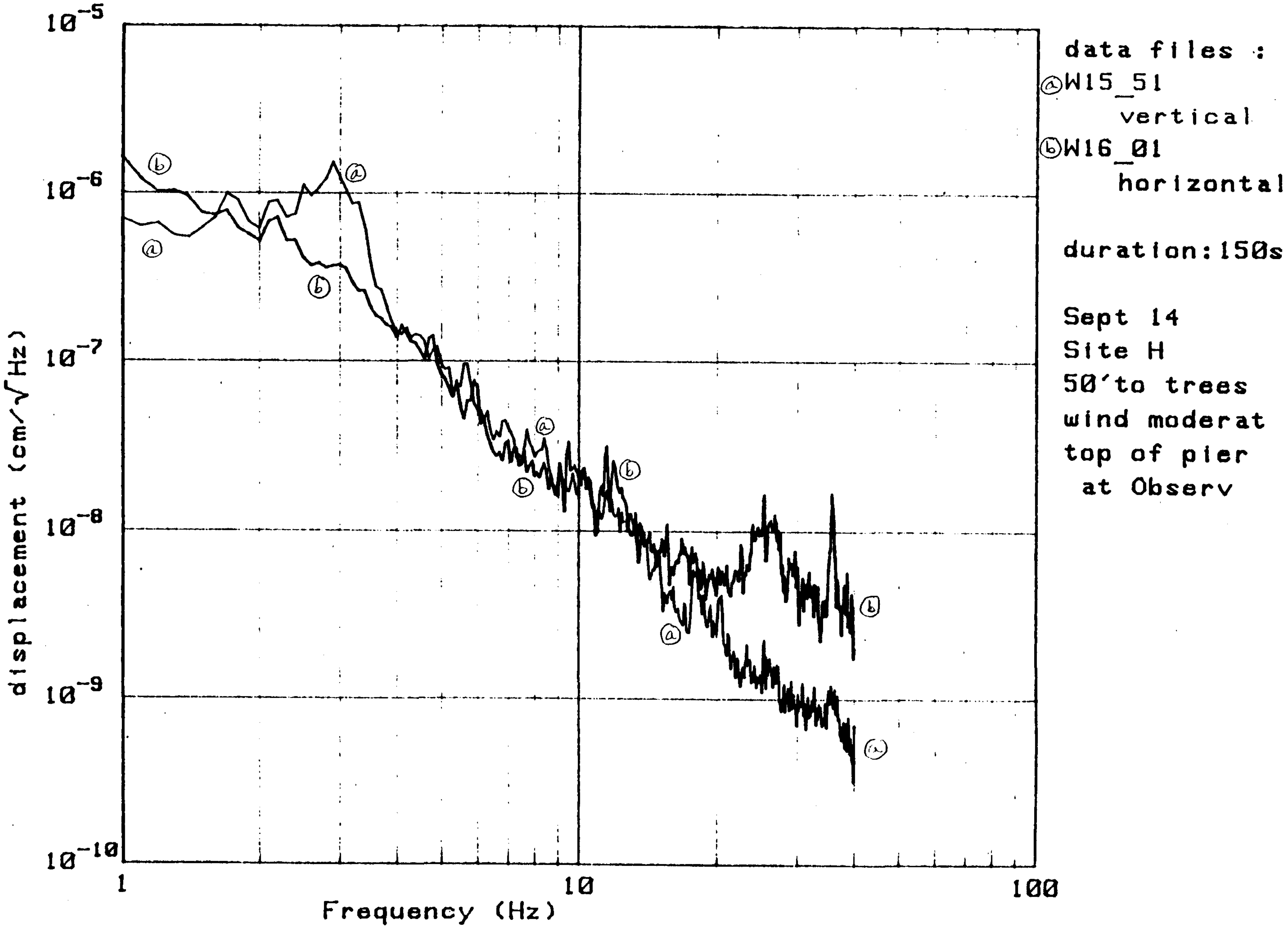


10^{-5}
10^{-6}
10^{-7}
10^{-8}
10^{-9}
10^{-10}
1
10
100
Frequency (Hz)
displacement (cm/√Hz)
data files :
ⓐU17_29
vertical
ⓑU17_32
horizontal
duration:100s
Sept 8
Site F
30′ to trees
1800 m E of
pipeline
(ON)
below power
lines
wind
calm



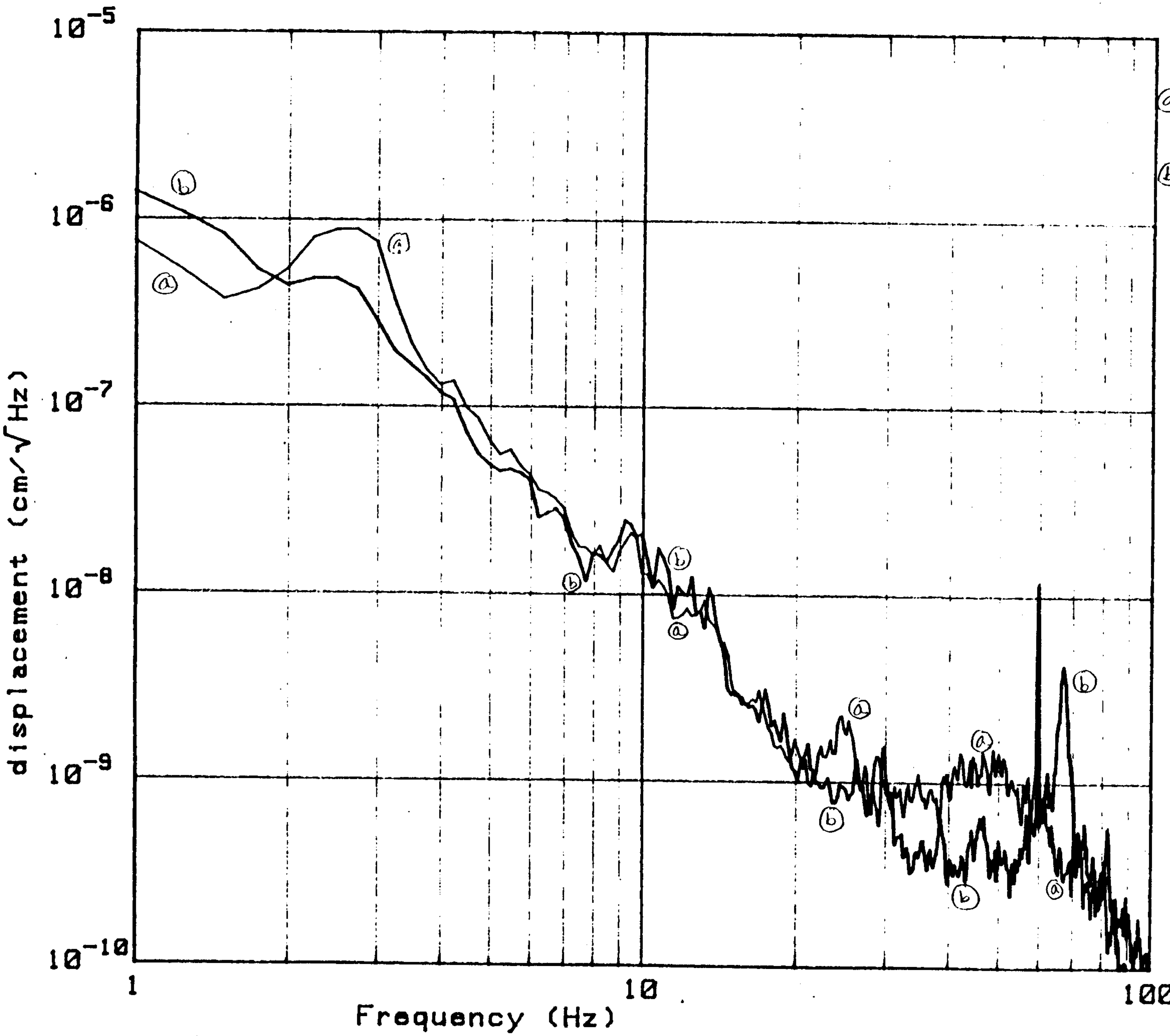
displacement (cm/√Hz)
10^-5
10^-6
10^-7
10^-8
10^-9
10^-10
1
10
100
Frequency (Hz)
data files :
ⓐ V10_49
vertical
ⓑ V10_55
horizontal
duration:200s
Sept 9
Site G
200′to trees
wind strong
1/2 mile
from Observ

23B



10^{-5}
10^{-6}
10^{-7}
10^{-8}
10^{-9}
10^{-10}
displacement (cm/√Hz)
1
10
100
Frequency (Hz)
data files :
ⓐW15_51
vertical
ⓑW16_01
horizontal
duration:150s
Sept 14
Site H
50'to trees
wind moderat
top of pier
at Observ

25B



data files :
(a) W16_27
vertical
(b) W16_31
horizontal

duration:60s

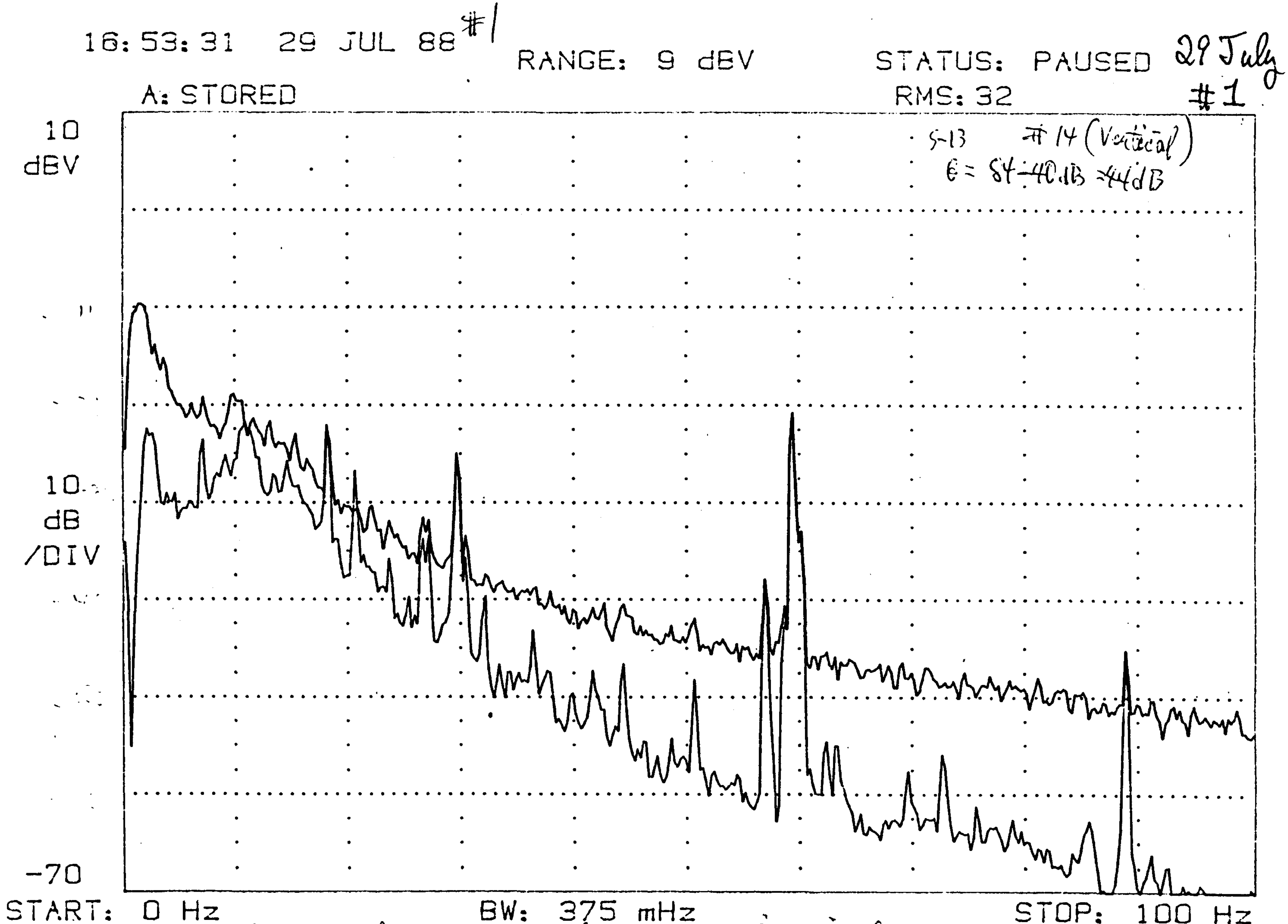
Sept 14
Observatory
on slab by
telescope

wind
moderate

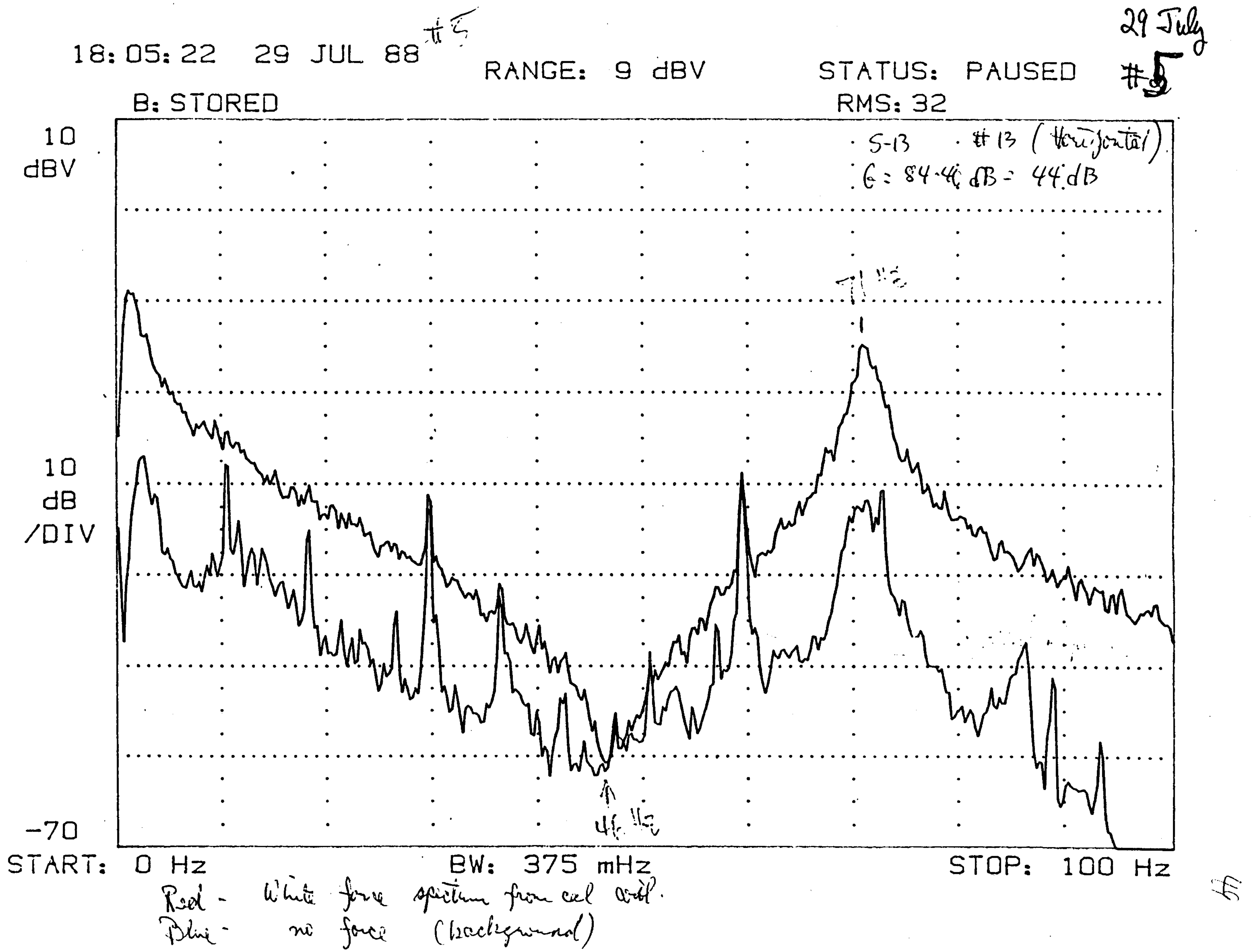
Appendix : Calibration Spectra

Four raw data graphs of calibration spectra. They were used to compare the response of the horizontal seismometer to the response of the vertical seismometer, when the proof mass was excited by a random force with a flat spectrum.

The fifth graph is the raw noise spectra, in the field, when the proof masses were locked.



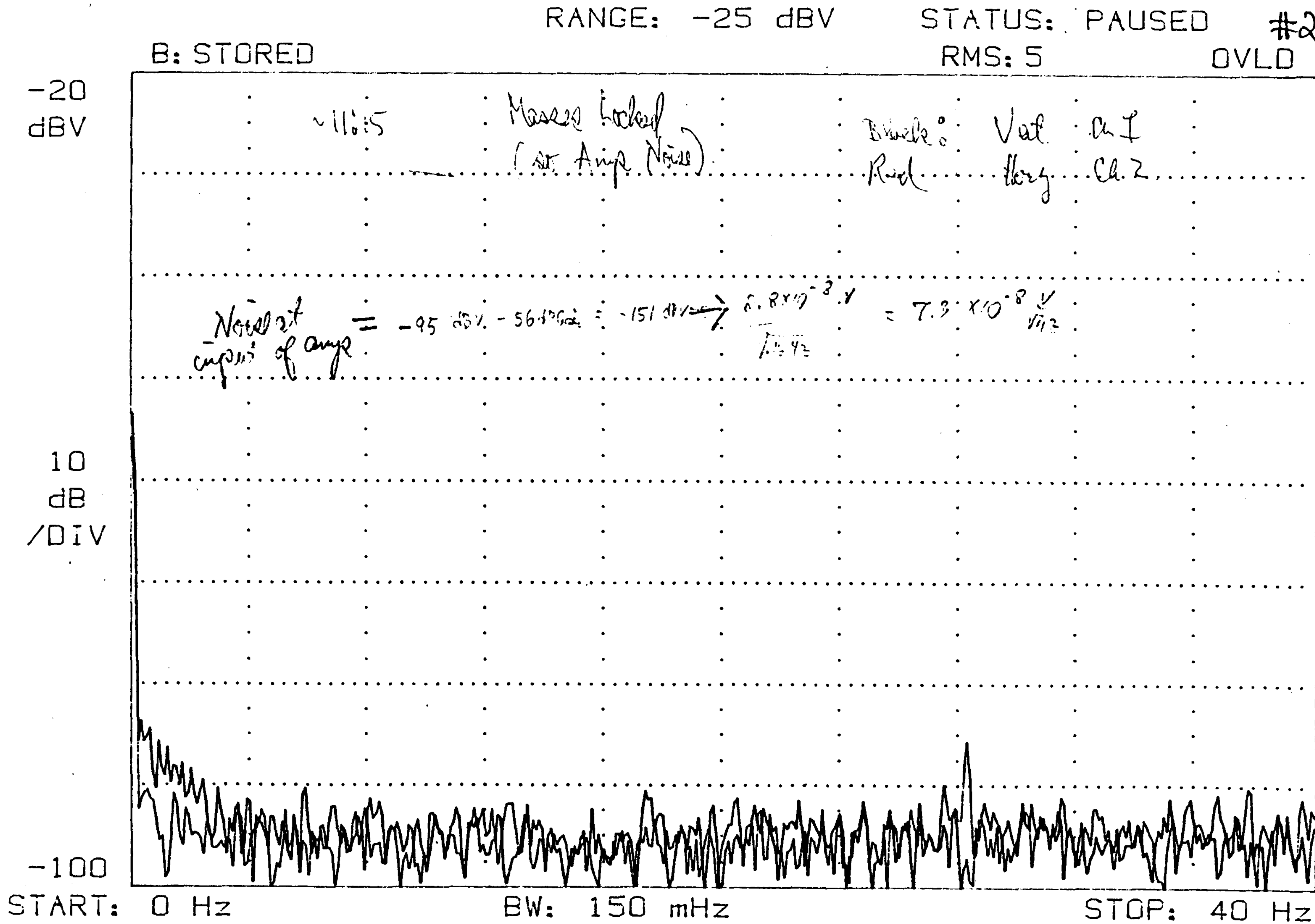
Red - Response when Cal Coil is driven by white noise from FFT (0 dB Atten.)
Blue - " with no driving (background)



18:05:22 29 JUL 88
RANGE: 9 dBV
STATUS: PAUSED
29 July
#5
B: STORED
RMS: 32
10
dBV
S-13 #13 (Horizontal)
71 Hz
10
dB
/DIV
-70
46 Hz
START: 0 Hz
BW: 375 mHz
STOP: 100 Hz
Red - White force spectrum from coil
Blue - no force (background)

Sept 8 #2

8 Sept #2



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Appendix : Local Wind Data

One years worth of data from the Livingston Fire Lookout Tower, courtesy of Cyril LeJuene of the Lousiana Department of Agriculture and Forestry. These anemometers are a type used on forest lookout towers around the entire country; Mr. LeJuene believes that the US Forest Service originated the instrument,the recording protocol, and the calibration chart.

Louisiana Department of Agriculture & Forestry
Office of Forestry
Post Office Box 8
Clinton, Louisiana
70722-0008
(504) 683-5862

BOB ODOM
COMMISSIONER

MICHAEL P. METY
STATE FORESTER

September 1, 1988

Dr. Warren Johnson
Department of Physics
Louisiana State University
Baton Rouge, Louisiana 70803

Dear Dr. Johnson:

We have enclosed the weather information that you requested for Livingston parish. The monthly reports are for calendar year 1987 and the data includes the wind speed for each day of that year.

Although the heading of each page lists Springville as the station, these measurements were actually taken at Livingston Fire Tower. And although the time of the entries is listed as 1300, the data is measured at 1:00 P.M. Central Standard Time and at 2:00 P.M. Central Daylight Time.

As we discussed, these wind speeds are used for determining fire danger and are corrected to represent wind speed at twenty feet above the ground instead of the one hundred foot level at which the anemometer is actually located.

If the Louisiana Department of Agriculture and Forestry, Office of Forestry can be of further assistance, please contact us.

Cyril E. LeJeune

CYRIL E. LeJEUNE - DISTRICT FORESTER

FIRE DANGER RECORD -- NATION

DIST 10 PARISH -LIVINGSTON STATION -SPRINGVILLE MONTH/YEAR 01/87 TIME :

DAY #	DRY TEMP	WET TEMP	REL HUM	HERB STG	FINE FUEL	RAIN IN	BU YEST	DRY FACT	BU TODAY	ADJ FUEL	WIND SPD	SPRED IN	CLASS DY	FIRES #	ACRES #	SIG 7 #	MILES #
1	50	45	68	1	13	0	7	1	8	20	3	6	2	0	0	0	0
2	50	45	68	1	13	0	8	1	9	20	2	5	2	0	0	0	0
3	58	53	72	1	14	0	9	1	10	20	10	13	3	0	0	0	0
4	47	45	86	1	21	1.67	2	0	2	30	4	1	1	0	0	0	0
5	54	45	48	1	9	0	2	2	4	17	2	8	2	0	0	0	0
6	64	51	39	1	6.5	0	4	3	7	14	0	9	2	0	0	0	0
7	66	60	71	1	12	0	7	1	8	20	1	4	1	0	0	0	0
8	60	55	73	1	12	0	8	1	9	20	1	4	1	0	0	0	0
9	68	62	71	1	12	0	9	1	10	20	5	8	2	0	0	0	0
10	49	44	67	1	14	0.20	10	1	11	20	10	13	3	0	0	0	0
11	45	38	51	1	10	0	11	1	12	18	4	10	3	0	0	0	0
12	50	42	49	1	9	0	12	2	14	15	2	10	3	0	0	0	0
13	53	48	69	1	13	0	14	1	15	19	1	4	1	0	0	0	0
14	50	49	93	1	22	0.52	6	0	6	30+	0	1	1	0	0	0	0
15	58	55	83	1	17	0	6	0	6	23	1	1	1	0	0	0	0
16	57	56	94	1	22	0.88	3	0	3	30	2	1	1	0	0	0	0
17	53	53	100	1	30+	0.95	1	0	1	30+	3	1	1	0	0	0	0
18	70	70	100	1	30+	1.41	0	0	0	30+	5	1	1	0	0	0	0
19	45	39	57	1	12	0	0	1	1	21	5	6	2	0	0	0	0
20	44	39	63	1	13	0	1	1	2	21	2	3	1	0	0	0	0
21	36	36	100	1	30+	1.04	0	0	0	30+	4	1	1	0	0	0	0
22	47	41	59	1	12	1.05	0	1	1	21	8	8	2	0	0	0	0
23	49	39	37	1	8.5	0	1	2	3	17	4	10	3	0	0	0	0
24	60	55	73	1	12	0	3	1	4	21	3	4	1	0	0	0	0
25	47	45	86	1	21	0.47	3	0	3	30	6	1	1	0	0	0	0
26	46	40	58	1	12	0	3	1	4	21	10	10	3	0	0	0	0
27	55	45	43	1	8.5	0	4	2	6	16	7	17	3	0	0	0	0
28	65	60	75	1	14	0	6	1	7	20	4	7	2	0	0	0	0
29	73	62	53	1	7.5	0	7	2	9	16	9	19	3	2	8	1	7
30	67	55	45	1	8	0	9	2	11	16	6	15	3	0	0	2	28
31	63	50	38	1	6.5	0	11	3	14	13	2	12	3	1	6	1	20
TOTALS						TOTAL RAIN= 8.19								3	14	4	55

TOTAL RAINFALL = 8.19 SIGNAL 7'S = 4 SIGNAL 7 MILES = 55

AVER TEMP = 55 AVER HUMIDITY = 67 HIGH TEMP = 73 LOW TEMP = 36

NUMBER OF CLASS DAYS

13 CLASS 1 DAYS
8 CLASS 2 DAYS
10 CLASS 3 DAYS
0 CLASS 4 DAYS
0 CLASS 5 DAYS

FIRE DANGER RECORD -- NATIONAL SYSTEM

DIST 10 PARISH -LIVINGSTON STATION -SPRINGVILLE MONTH/YEAR 03/87 TIME

DAY #	DRY TEMP	WET TEMP	REL HUM	HERB STG	FINE FUEL	RAIN IN	BU YEST	DRY FACT	BU TODAY	ADJ FUEL	WIND SPD	SPRED IN	CLASS DY	FIRES #	ACRES #	SIG7 #	MILES #
1	61	52	54	1	8.5	0	2	2	4	17	9	15	3	0	0	0	0
2	61	52	54	1	8.5	0	4	2	6	17	3	9	2	0	0	0	0
3	67	54	41	1	7.5	0	6	2	8	16	4	12	3	0	0	0	0
4	66	50	29	1	5.5	0	8	3	11	14	4	14	3	4	20.50	0	0
5	67	50	26	1	5.5	0	11	3	14	13	2	12	3	4	28	0	0
6	68	54	38	1	6.5	0	14	3	17	13	9	25	4	0	0	0	0
7	54	52	88	1	19	0.40	12	0	12	26	1	1	1	0	0	0	0
8	56	54	88	1	19	0.60	6	0	6	26	2	1	1	0	0	0	0
9	70	58	48	1	7	0	6	2	8	14	1	9	2	0	0	0	0
10	64	55	56	1	9	0	8	2	10	16	4	12	3	0	0	0	0
11	45	43	85	1	21	0.05	10	0	10	29	4	1	1	0	0	0	0
12	56	46	44	1	9.5	0	10	2	12	18	7	13	3	0	0	0	0
13	62	49	37	1	6.5	0	12	3	15	15	3	11	3	0	0	0	0
14	67	54	41	1	7.5	0	15	2	17	15	11	22	4	1	7	0	0
15	70	62	64	1	9.5	0	17	2	19	17	2	8	2	1	4	0	0
16	75	64	55	1	9.5	0	19	2	21	16	15	26	4	2	19	0	0
17	65	65	100	1	30+	0.10	21	0	21	30	11	1	1	0	0	0	0
18	71	61	56	1	8	2.32	1	2	3	17	2	8	2	0	0	0	0
19	73	60	46	1	7	0	3	2	5	15	4	12	3	0	0	0	0
20	75	60	40	1	6	0	5	3	8	14	5	16	3	1	10	0	0
21	79	63	40	1	6	0	8	3	11	14	2	11	3	0	0	0	0
22	75	62	47	1	7	0	11	2	13	13	1	10	3	0	0	0	0
23	75	65	58	1	8	0	13	2	15	15	21	34	4	0	0	0	0
24	67	52	34	1	6	1.60	2	3	5	15	1	8	2	0	0	0	0
25	72	55	31	1	5	0	5	3	8	11	4	19	3	0	0	0	0
26	73	59	42	1	6	0	8	3	11	14	7	20	4	0	0	0	0
27	73	62	53	1	7.5	0.13	10	2	12	16	2	10	3	0	0	0	0
28	77	63	45	1	7	0	12	2	14	13	4	16	3	0	0	0	0
29	65	65	100	1	30+	0.07	14	0	14	30+	3	1	1	0	0	0	0
30	41	39	84	1	18	0.70	6	0	6	26	9	3	1	0	0	0	0
31	51	40	34	1	7	0	6	2	8	14	6	18	3	0	0	1	30
TOTALS	TOTAL RAIN= 5.97													13	88.5	1	30

TOTAL RAINFALL = 5.97 SIGNAL 7'S = 1 SIGNAL 7 MILES = 30

AVER TEMP = 66 AVER HUMIDITY = 53 HIGH TEMP = 79 LOW TEMP = 41

NUMBER OF CLASS DAYS

6 CLASS 1 DAYS
5 CLASS 2 DAYS
15 CLASS 3 DAYS
5 CLASS 4 DAYS
0 CLASS 5 DAYS

FIRE DANGER RECORD -- NATIONAL SYSTEM

DIST 10 PARISH -LIVINGSTON STATION -SPRINGVILLE MONTH/YEAR 05/87 TIME

DAY #	DRY TEMP	WET TEMP	REL HUM	HERB STG	FINE FUEL	RAIN IN	BU YEST	DRY FACT	BU TODAY	ADJ FUEL	WIND SPD	SPRED IN	CLASS DY	FIRES #	ACRES #	SIG 7 #	MILES #
1	85	69	44	2	10	0	56	3	59	13	3	14	3	4	50	0	0
2	84	72	56	2	12	0	59	2	61	15	5	14	3	1	25	0	0
3	88	73	49	2	11	0	61	3	64	13	1	10	3	0	0	0	0
4	82	75	72	2	15	0	64	1	65	18	1	6	2	0	0	0	0
5	82	74	69	2	14	2.19	4	2	6	20	1	4	1	0	0	0	0
6	81	73	68	2	14	0	6	2	8	20	2	5	2	0	0	0	0
7	73	70	78	2	17	0.20	6	1	7	23	1	3	1	0	0	0	0
8	80	71	64	2	13	0	7	2	9	20	1	4	1	0	0	0	0
9	85	70	47	2	11	0.03	9	3	12	18	7	13	3	0	0	0	0
10	76	72	82	2	19	0	12	1	13	25	1	1	1	0	0	0	0
11	80	70	61	2	13	0.40	8	2	10	20	1	4	1	0	0	0	0
12	82	75	72	2	15	0	10	1	11	23	1	1	1	0	0	0	0
13	79	71	68	2	15	2.09	1	1	2	24	1	1	1	0	0	0	0
14	83	72	59	2	12	0	2	2	4	21	2	3	1	0	0	0	0
15	84	73	59	2	12	0	4	2	6	20	4	7	2	0	0	0	0
16	80	72	68	2	14	0	6	2	8	20	2	5	2	0	0	0	0
17	84	74	62	2	12	0	8	2	10	20	4	7	2	0	0	0	0
18	86	75	60	2	13	0	10	2	12	20	1	4	1	0	0	0	0
19	82	75	57	3	17	0	12	2	14	22	1	1	1	0	0	0	0
20	87	75	57	3	17	0	14	2	16	22	1	1	1	0	0	0	0
21	88	75	55	3	17	0	16	2	18	22	1	1	1	0	0	0	0
22	87	77	64	3	18	0.08	18	2	20	24	3	3	1	0	0	0	0
23	76	73	87	3	26	1.67	3	0	3	30+	6	1	1	0	0	0	0
24	75	74	95	3	29	0.25	3	0	3	30+	2	1	1	0	0	0	0
25	86	77	67	3	19	0	3	2	5	27	3	1	1	0	0	0	0
26	81	75	76	3	21	1.12	1	1	2	30	4	1	1	0	0	0	0
27	84	74	62	3	18	0	2	2	4	27	5	1	1	0	0	0	0
28	86	74	57	3	17	0	4	2	6	23	5	4	1	0	0	0	0
29	84	75	66	3	19	0	6	2	8	26	3	6	2	0	0	0	0
30	85	73	56	3	17	0	8	2	10	23	5	4	1	0	0	0	0
31	86	75	60	3	18	0	10	2	12	26	7	2	1	0	0	0	0
TOTALS						TOTAL RAIN= 8.03								5	75	0	0

TOTAL RAINFALL = 8.03 SIGNAL 7'S = 0 SIGNAL 7 MILES = 0

AVER TEMP = 83 AVER HUMIDITY = 64 HIGH TEMP = 88 LOW TEMP = 73

NUMBER OF CLASS DAYS

21 CLASS 1 DAYS
6 CLASS 2 DAYS
4 CLASS 3 DAYS
0 CLASS 4 DAYS
0 CLASS 5 DAYS

FIRE DANGER RECORD -- NATIONAL SYSTEM

DIST 10 PARISH -LIVINGSTON STATION -SPRINGVILLE MONTH/YEAR 07/87 TIME

DAY #	DRY TEMP	WET TEMP	REL HUM	HERB STG	FINE FUEL	RAIN IN	BU YEST	DRY FACT	BU TODAY	ADJ FUEL	WIND SPD	SPRED IN	CLASS DY	FIRES #	ACRES #	SIG7 #	MILES #
1	74	74	100	3	30+	0.11	3	0	3	30+	9	1	1	0	0	0	0
2	85	79	77	3	21	0.60	2	1	3	30	2	1	1	0	0	0	0
3	89	79	64	3	18	0	3	2	5	27	1	1	1	0	0	0	0
4	87	80	74	3	20	0.12	3	1	4	27	3	1	1	0	0	0	0
5	88	81	74	3	20	0.40	3	1	4	21	2	1	1	0	0	0	0
6	73	72	95	3	30+	0.18	3	0	3	30+	5	1	1	0	0	0	0
7	74	73	95	3	30+	0.24	3	0	3	30+	2	1	1	0	0	0	0
8	80	77	87	3	25	0.25	3	1	4	30	1	1	1	0	0	0	0
9	86	78	70	3	20	0.12	3	1	4	27	2	1	1	0	0	0	0
10	89	79	64	3	19	0	4	2	6	26	0	1	1	0	0	0	0
11	90	77	55	3	16	0	6	3	9	23	1	1	1	0	0	0	0
12	90	80	65	3	18	0	9	2	11	26	2	1	1	0	0	0	0
13	89	78	61	3	18	0	11	2	13	25	1	1	1	0	0	0	0
14	87	78	67	3	19	0	13	2	15	25	3	1	1	0	0	0	0
15	86	73	54	3	17	0	15	2	17	22	2	3	1	0	0	0	0
16	90	75	50	3	15	0	17	3	20	21	3	4	1	0	0	0	0
17	88	76	58	3	17	0	20	2	22	21	2	3	1	0	0	0	0
18	87	75	57	3	17	0	22	2	24	21	1	2	1	0	0	0	0
19	92	79	56	3	16	0	24	3	27	21	2	3	1	0	0	0	0
20	91	77	53	3	15	0	27	3	30	20	1	4	1	0	0	0	0
21	78	78	100	3	30+	0.80	10	0	10	30+	1	1	1	0	0	0	0
22	83	80	83	3	22	0.70	6	1	7	29	1	1	1	0	0	0	0
23	84	79	80	3	22	0	7	1	8	29	2	1	1	0	0	0	0
24	89	79	64	3	18	0	8	2	10	26	1	1	1	0	0	0	0
25	89	79	64	3	18	0	10	2	12	26	2	1	1	0	0	0	0
26	91	80	62	3	17	0	12	2	14	22	1	2	1	0	0	0	0
27	87	79	70	3	20	0.47	8	1	9	26	1	1	1	0	0	0	0
28	92	78	53	3	15	0	9	3	12	22	1	2	1	0	0	0	0
29	90	81	68	3	18	0.39	8	2	10	26	2	1	1	0	0	0	0
30	91	82	68	3	18	0	10	2	12	26	1	1	1	0	0	0	0
31	89	80	68	3	19	0.42	8	2	10	26	1	1	1	0	0	0	0

TOTALS TOTAL RAIN= 4.8 0 0 0 0

TOTAL RAINFALL = 4.8 SIGNAL 7'S = 0 SIGNAL 7 MILES = 0

AVER TEMP = 86 AVER HUMIDITY = 70 HIGH TEMP = 92 LOW TEMP = 73

NUMBER OF CLASS DAYS

31 CLASS 1 DAYS
0 CLASS 2 DAYS
0 CLASS 3 DAYS
0 CLASS 4 DAYS
0 CLASS 5 DAYS

FIRE DANGER RECORD -- NATIONAL SYSTEM

DIST 10 PARISH -LIVINGSTON STATION -SPRINGVILLE MONTH/YEAR 09/87 TIME

DAY #	DRY TEMP	WET TEMP	REL HUM	HERB STG	FINE FUEL	RAIN IN	BU YEST	DRY FACT	BU TODAY	ADJ FUEL	WIND SPD	SPRED IN	CLASS DY	FIRES #	ACRES #	SIG7 #	MILES #
1	80	72	68	3	19	0	2	2	4	27	4	1	1	0	0	0	0
2	85	72	73	3	18	0	4	2	6	27	3	1	1	0	0	0	0
3	86	68	39	3	15	0	6	3	9	23	1	2	1	0	0	0	0
4	87	73	51	3	17	0	9	2	11	23	3	3	1	0	0	0	0
5	85	73	56	3	17	0	11	2	13	23	1	1	1	0	0	0	0
6	83	74	65	3	19	0	13	2	15	25	0	1	1	0	0	0	0
7	87	74	54	3	17	0	15	2	17	22	2	3	1	0	0	0	0
8	88	75	55	3	17	0	17	2	19	22	5	6	2	0	0	0	0
9	89	77	58	3	17	0	19	2	21	21	3	4	1	0	0	0	0
10	88	78	64	3	18	0	21	2	23	24	2	2	1	0	0	0	0
11	76	74	91	3	29	0	23	0	23	30	3	1	1	0	0	0	0
12	86	77	67	3	19	2.05	2	2	4	27	2	1	1	0	0	0	0
13	86	75	60	3	18	0	4	2	6	26	3	1	1	0	0	0	0
14	88	75	55	3	17	0	6	2	8	23	2	2	1	0	0	0	0
15	86	76	63	3	18	0	8	2	10	26	1	1	1	0	0	0	0
16	82	79	88	3	25	0	10	1	11	29	3	1	1	0	0	0	0
17	86	80	77	3	21	0	11	1	12	29	2	1	1	0	0	0	0
18	75	75	100	3	30+	0.86	5	0	5	30+	0	1	1	0	0	0	0
19	80	78	91	3	28	0.96	1	0	1	30+	2	1	1	0	0	0	0
20	80	68	54	3	17	0	1	2	3	24	3	3	1	0	0	0	0
21	80	69	57	3	17	0	3	2	5	24	2	2	1	0	0	0	0
22	83	71	55	3	17	0	5	2	7	23	3	3	1	0	0	0	0
23	78	64	46	3	17	0	7	2	9	26	4	1	1	0	0	0	0
24	78	65	49	3	17	0	9	2	11	23	4	1	1	0	0	0	0
25	78	65	49	3	17	0	11	2	13	22	0	2	1	0	0	0	0
26	79	67	53	3	18	0	13	2	15	25	2	1	1	0	0	0	0
27	81	73	68	3	19	0	15	2	17	25	3	1	1	0	0	0	0
28	80	74	75	3	21	0	17	1	18	28	2	1	1	0	0	0	0
29	80	74	75	3	21	0	18	1	19	28	1	1	1	0	0	0	0
30	76	63	48	3	11	0	19	2	21	21	6	7	2	0	0	0	0
TOTALS		TOTAL RAIN=	3.87											0	0	0	0

TOTAL RAINFALL = 3.87 SIGNAL 7'S = 0 SIGNAL 7 MILES = 0

AVER TEMP = 83 AVER HUMIDITY = 63 HIGH TEMP = 89 LOW TEMP = 75

NUMBER OF CLASS DAYS

28 CLASS 1 DAYS
2 CLASS 2 DAYS
0 CLASS 3 DAYS
0 CLASS 4 DAYS
0 CLASS 5 DAYS

FIRE DANGER RECORD -- NATIONAL SYSTEM

DIST 10 PARISH -LIVINGSTON STATION -SPRINGVILLE MONTH/YEAR 11/87 TIME

DAY #	DRY TEMP	WET TEMP	REL HUM	HERB STG	FINE FUEL	RAIN IN	BU YEST	DRY FACT	BU TODAY	ADJ FUEL	WIND SPD	SPREAD IN	CLASS DY	FIRES #	ACRES #	SIG 7 #	MILES #
1	78	60	33	2	10	0	35	3	38	15	9	19	3	3	20	0	0
2	80	67	50	2	12	0	38	2	40	18	3	9	2	14	181	0	0
3	80	68	54	2	12	0	40	2	42	16	4	12	3	4	12	0	0
4	74	68	77	2	17	0	42	1	43	19	2	5	2	1	2	0	0
5	80	65	44	2	10	0	43	3	46	16	6	15	3	10	28.75	2	50
6	67	50	26	2	11	0	46	3	49	14	3	12	3	17	63.25	0	0
7	73	65	65	2	15	0	49	1	50	19	5	8	2	6	58	0	0
8	74	69	78	2	17	0	50	1	51	18	3	10	3	2	5	0	0
9	70	70	100	2	30+	.40	32	0	32	29	2	1	1	0	0	0	0
10	49	46	80	2	23	.12	31	0	31	26	5	2	1	0	0	0	0
11	55	45	43	2	14	0	31	2	33	17	6	12	3	0	0	0	0
12	59	47	33	2	12	0	33	2	35	17	3	9	2	1	20	0	0
13	60	50	48	2	13	0	35	2	37	17	3	9	2	0	0	0	0
14	69	63	72	2	17	0	37	1	38	20	7	10	3	0	0	1	50
15	75	70	78	2	17	0	38	1	39	20	11	15	3	4	160	0	0
16	77	72	79	2	17	.04	39	1	40	19	17	19	3	0	0	0	0
17	67	55	45	2	13	2.00	3	2	5	21	3	4	1	0	0	0	0
18	65	53	44	2	13	0	5	2	7	20	2	5	2	0	0	0	0
19	65	53	44	2	13	0	7	2	9	20	4	7	2	0	0	0	0
20	62	50	41	2	13	0	9	2	11	20	3	6	2	0	0	0	0
21	59	44	24	2	11	0	11	3	14	17	2	8	2	6	102	0	0
22	70	59	51	2	13	0	14	2	16	19	3	6	2	4	38	1	45
23	73	64	61	2	14	0	16	2	18	19	2	5	2	3	7	1	20
24	74	67	70	2	16	0	18	1	19	22	9	9	2	4	87	1	20
25	74	68	74	2	16	0	19	1	20	21	7	8	2	3	55	0	0
26	70	70	100	2	30+	.08	20	0	20	30	2	1	1	0	0	0	0
27	70	68	90	2	24	0	20	0	20	27	1	1	1	0	0	0	0
28	57	52	71	2	19	.56	9	1	10	26	3	1	1	0	0	0	0
29	56	49	60	2	16	0	10	1	11	26	1	1	1	0	0	0	0
30	61	52	54	2	14	0	11	2	13	19	8	11	3	0	0	0	0
TOTALS						TOTAL RAIN= 3.2								82	839	6	185

TOTAL RAINFALL = 3.2 SIGNAL 7'S = 6 SIGNAL 7 MILES = 185

AVER TEMP = 68 AVER HUMIDITY = 60 HIGH TEMP = 80 LOW TEMP = 49

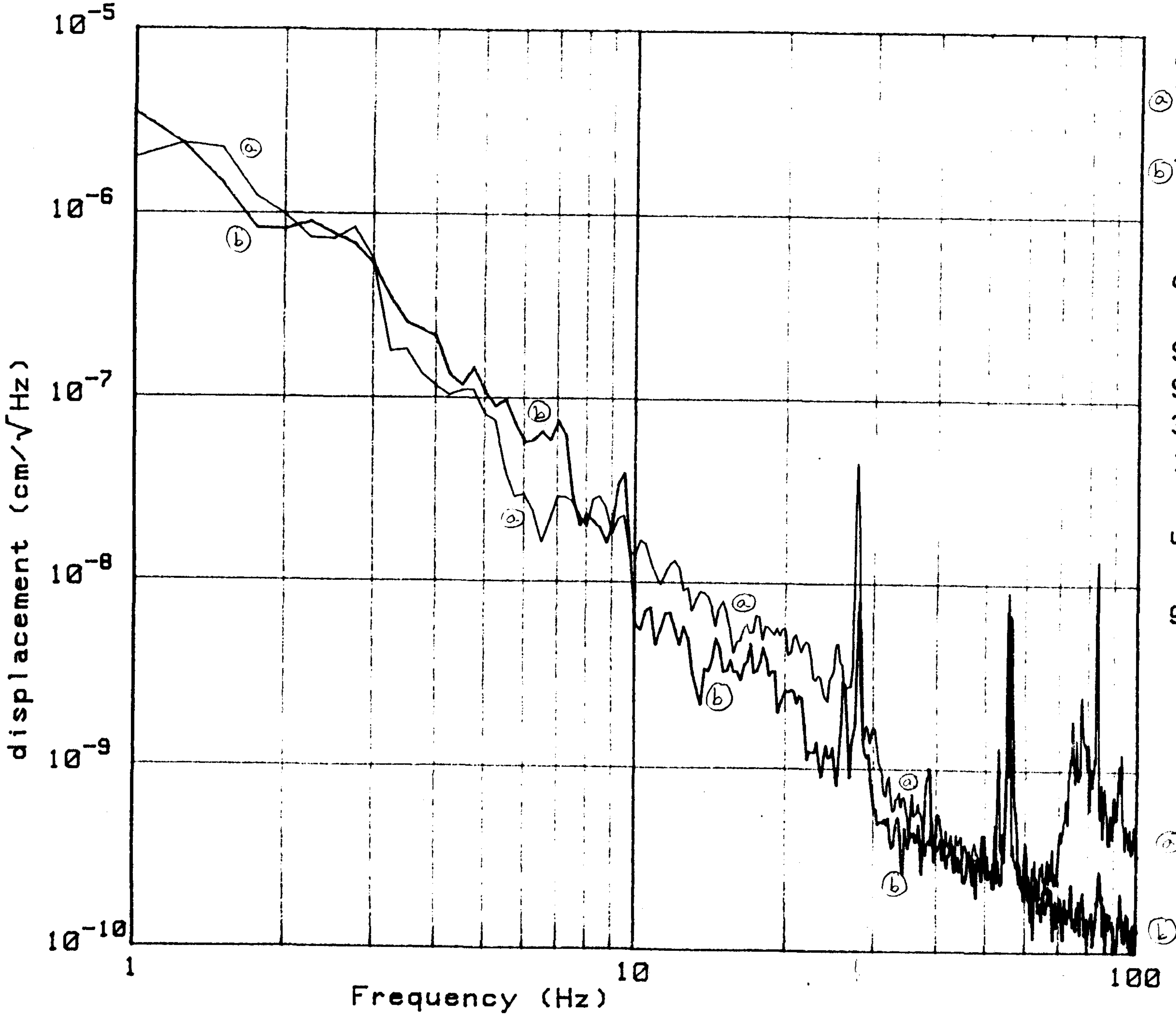
NUMBER OF CLASS DAYS

7 CLASS 1 DAYS
13 CLASS 2 DAYS
10 CLASS 3 DAYS
0 CLASS 4 DAYS
0 CLASS 5 DAYS

BATCH START

STAPLE
OR
DIVIDER

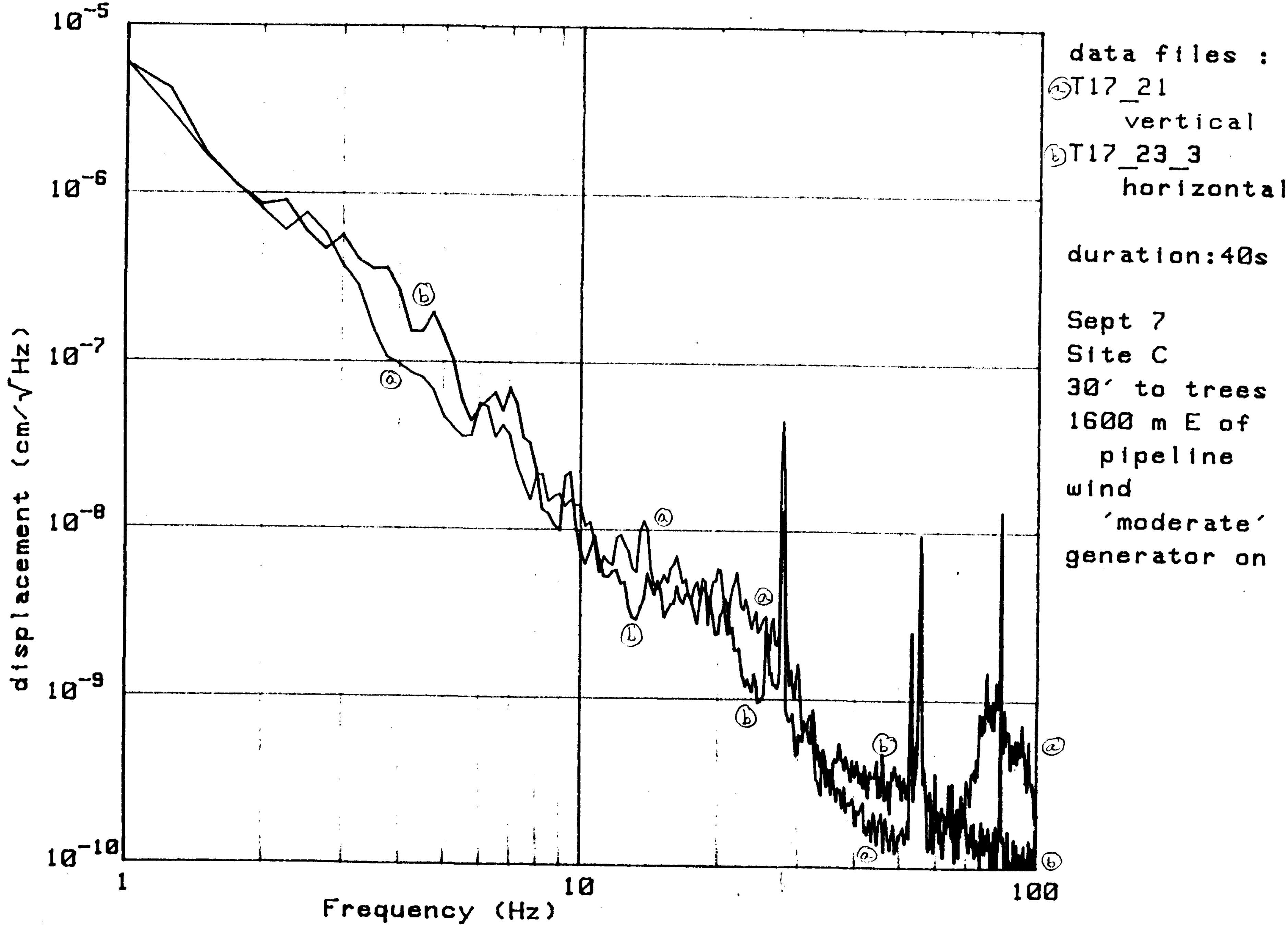
E Raab 1B



data files :
ⓐT17_16
vertical
ⓑT17_19
horizontal

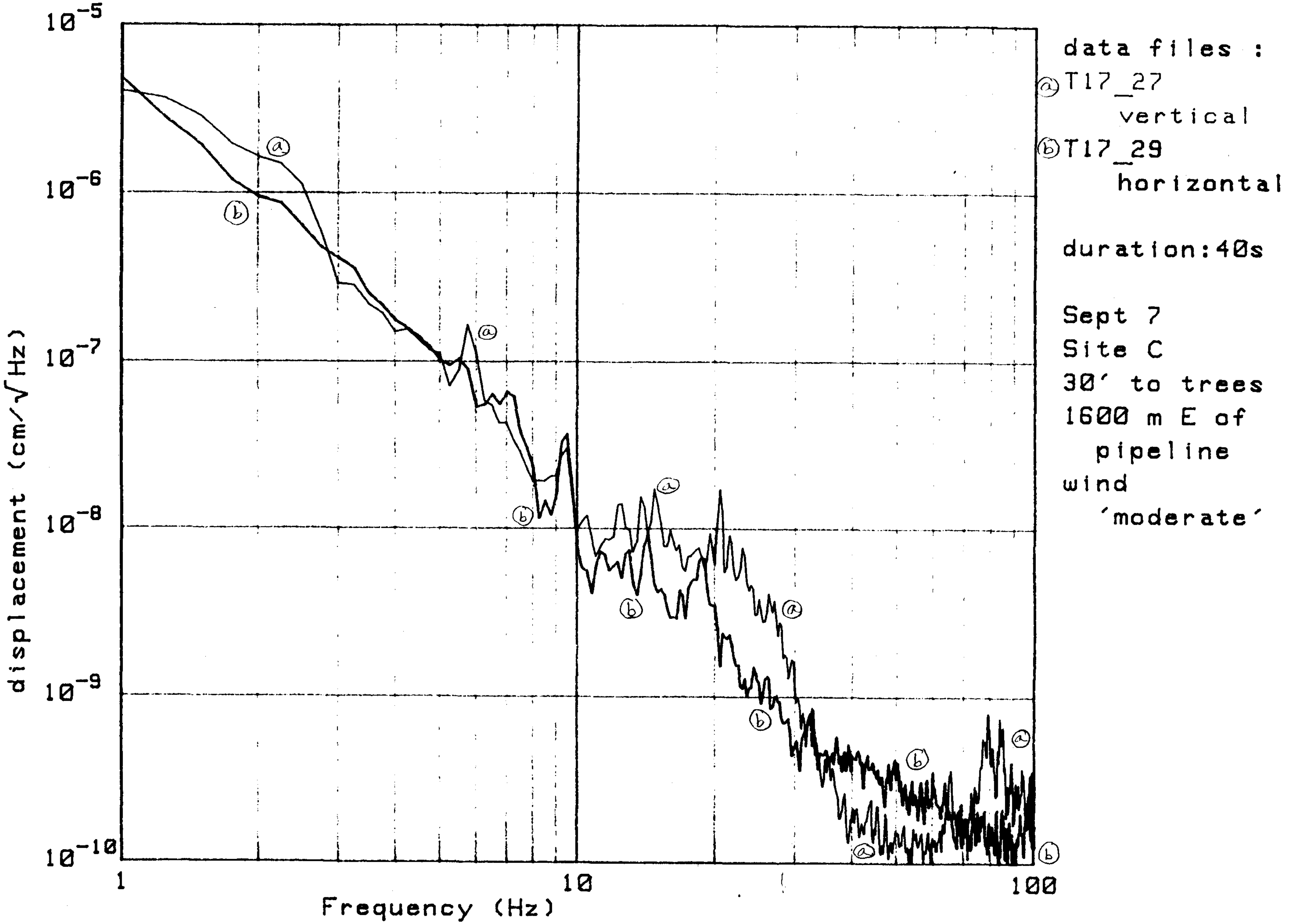
duration:40s

Sept 7
Site C
30' to trees
1600 m E of
pipeline
wind
'moderate'
generator on



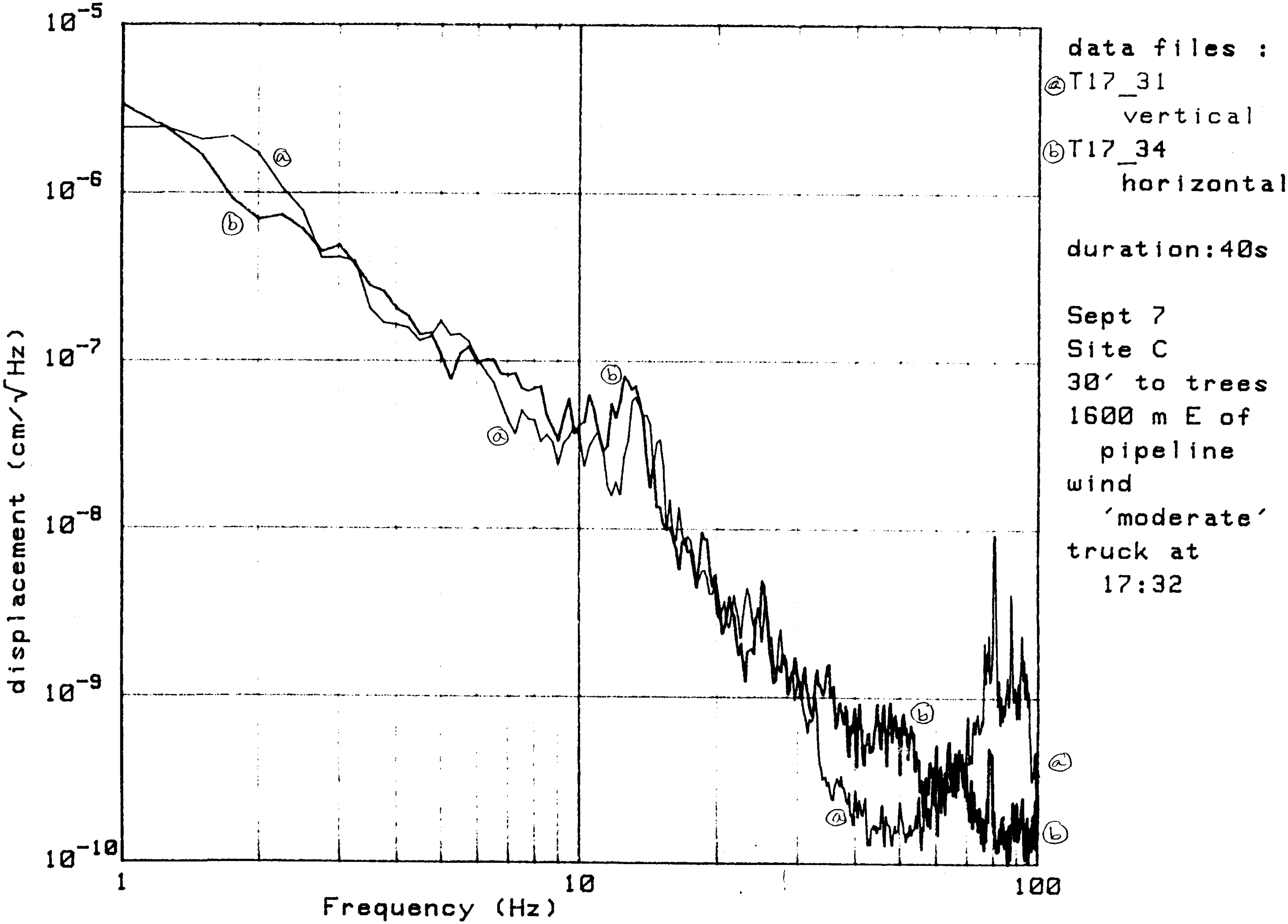
10^-5
10^-6
10^-7
10^-8
10^-9
10^-10
displacement (cm/√Hz)
1
10
100
Frequency (Hz)
a
b
data files :
a T17_21
vertical
b T17_23_3
horizontal
duration:40s
Sept 7
Site C
30′ to trees
1600 m E of
pipeline
wind
′moderate′
generator on

3B



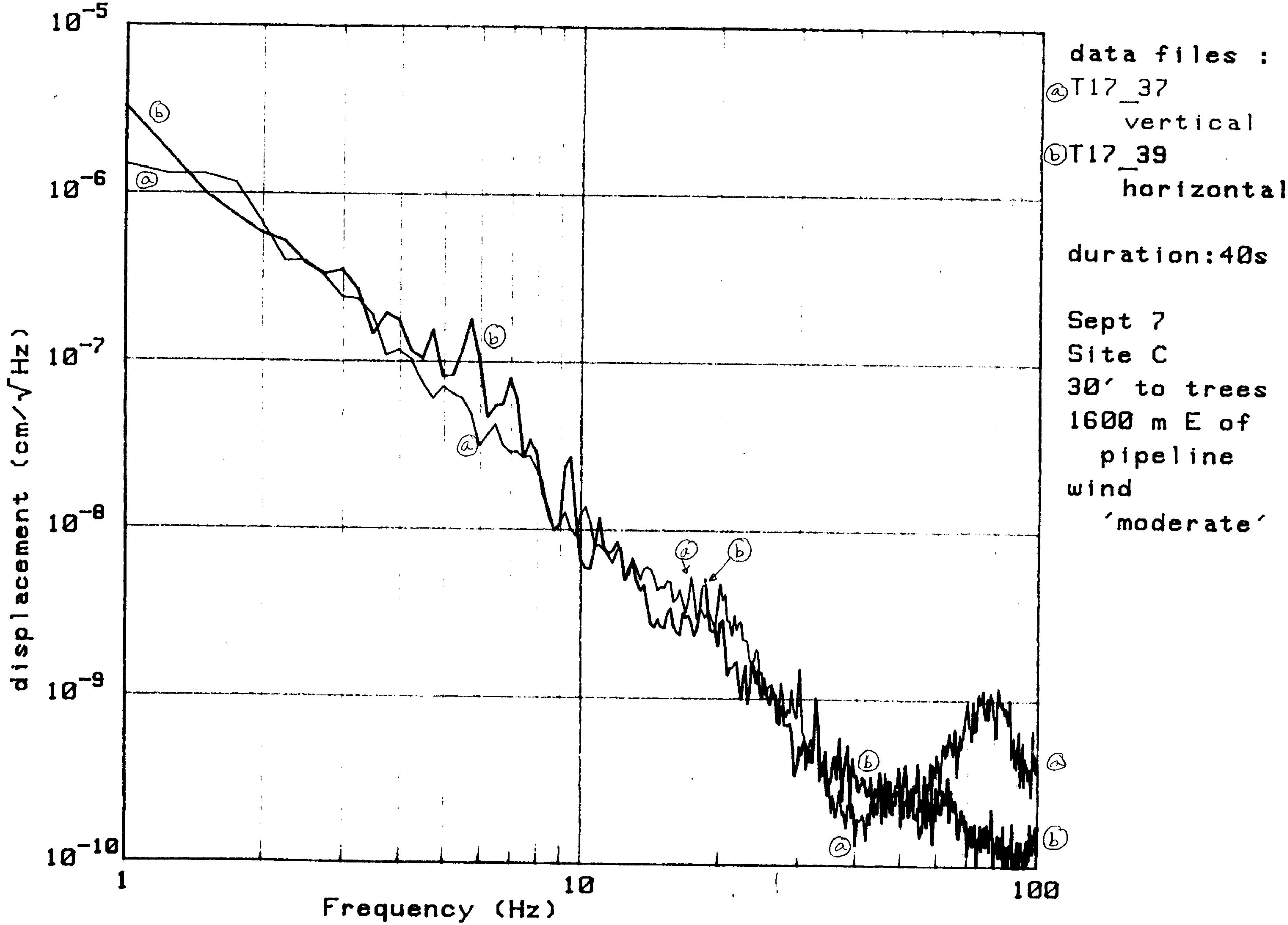
10^-5
10^-6
10^-7
10^-8
10^-9
10^-10
displacement (cm/√Hz)
1
10
100
Frequency (Hz)
data files :
ⓐT17_27
vertical
ⓑT17_29
horizontal
duration:40s
Sept 7
Site C
30′ to trees
1600 m E of
pipeline
wind
′moderate′

4B



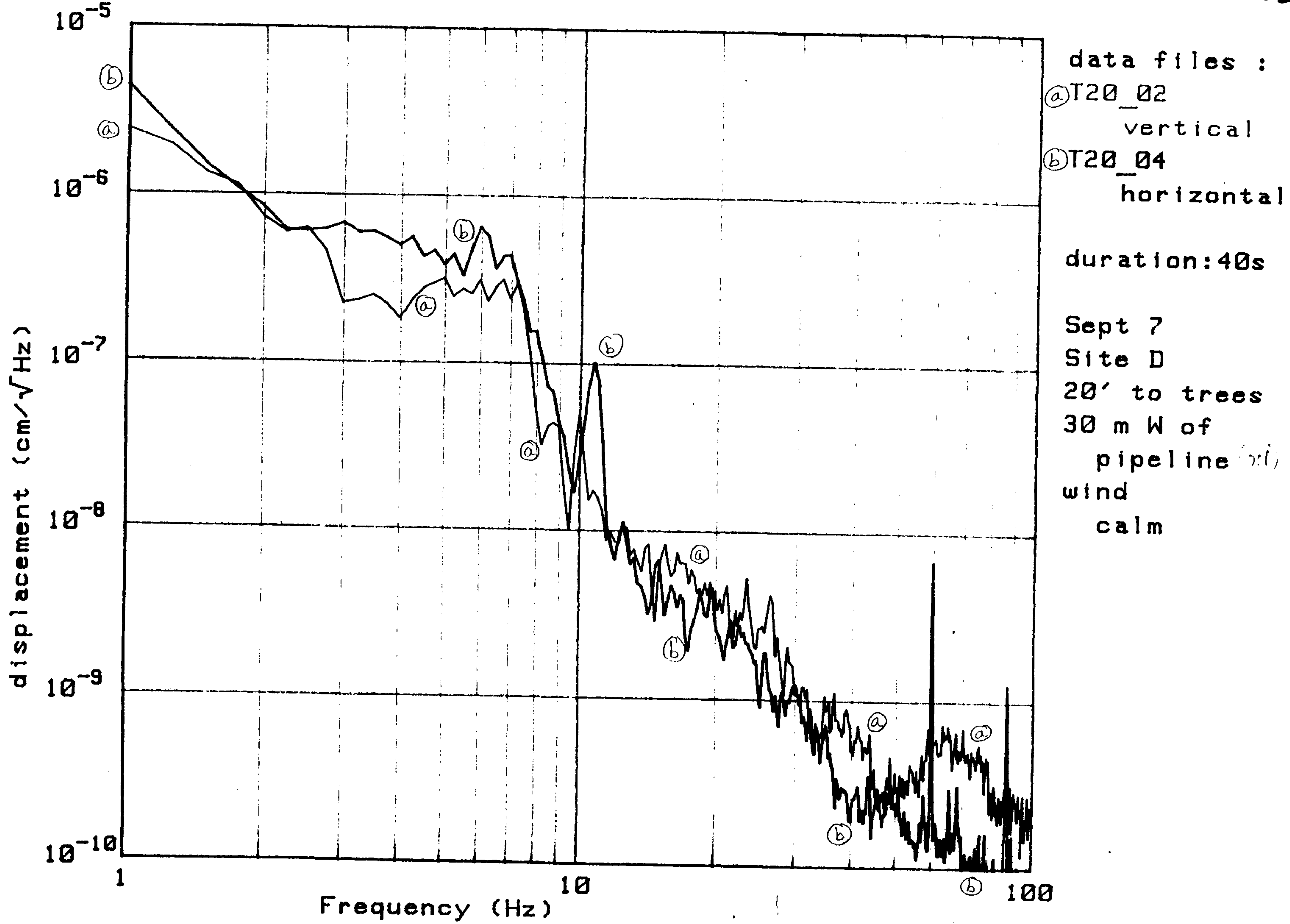
10^-5
10^-6
10^-7
10^-8
10^-9
10^-10
displacement (cm/√Hz)
1
10
100
Frequency (Hz)
a
b
data files :
ⓐT17_31
vertical
ⓑT17_34
horizontal
duration:40s
Sept 7
Site C
30′ to trees
1600 m E of
pipeline
wind
‘moderate’
truck at
17:32

5B

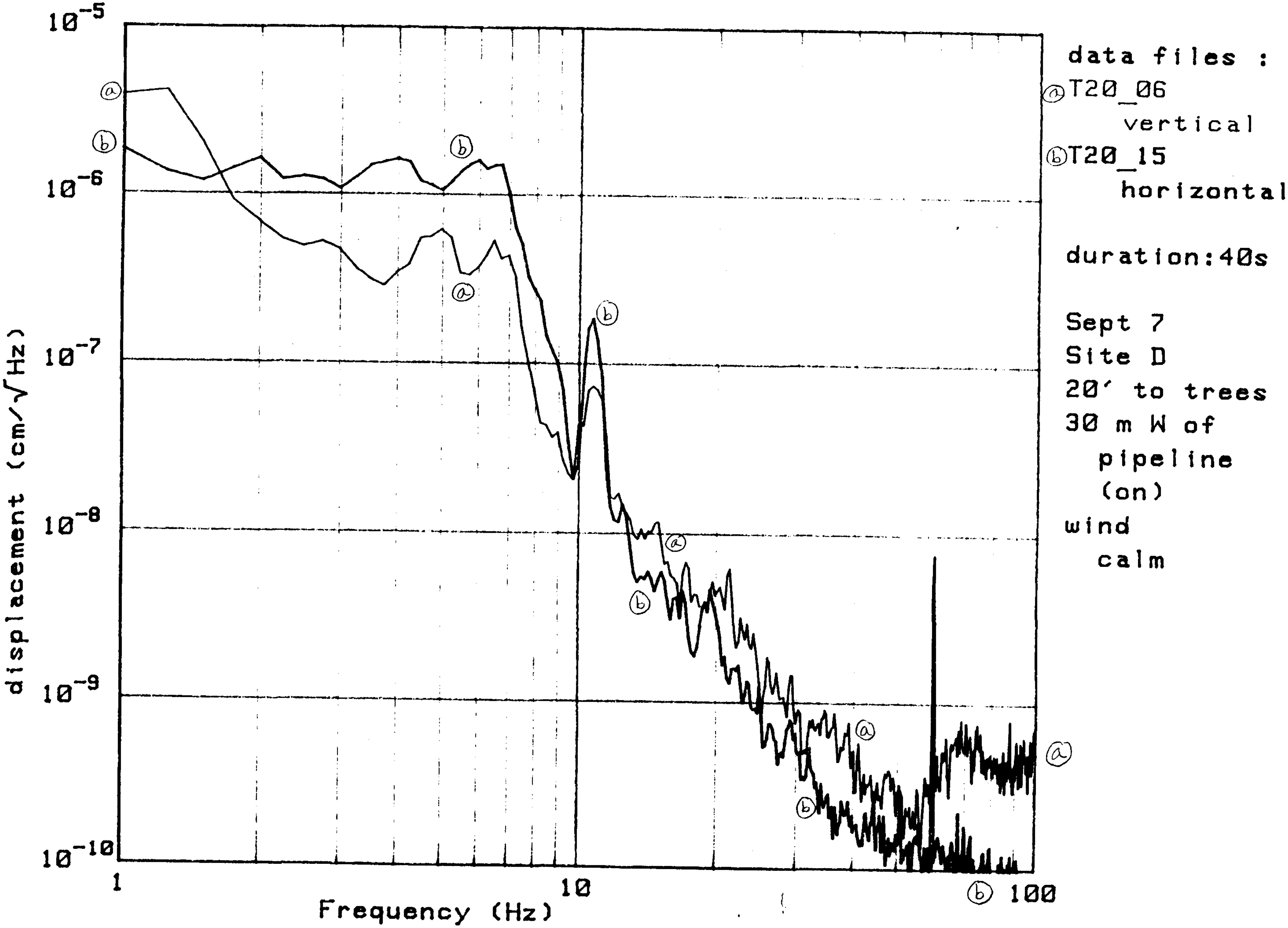


10^{-5}
10^{-6}
10^{-7}
10^{-8}
10^{-9}
10^{-10}
displacement (cm/√Hz)
1
10
100
Frequency (Hz)
a
b
data files :
ⓐT17_37
vertical
ⓑT17_39
horizontal
duration:40s
Sept 7
Site C
30′ to trees
1600 m E of
pipeline
wind
′moderate′

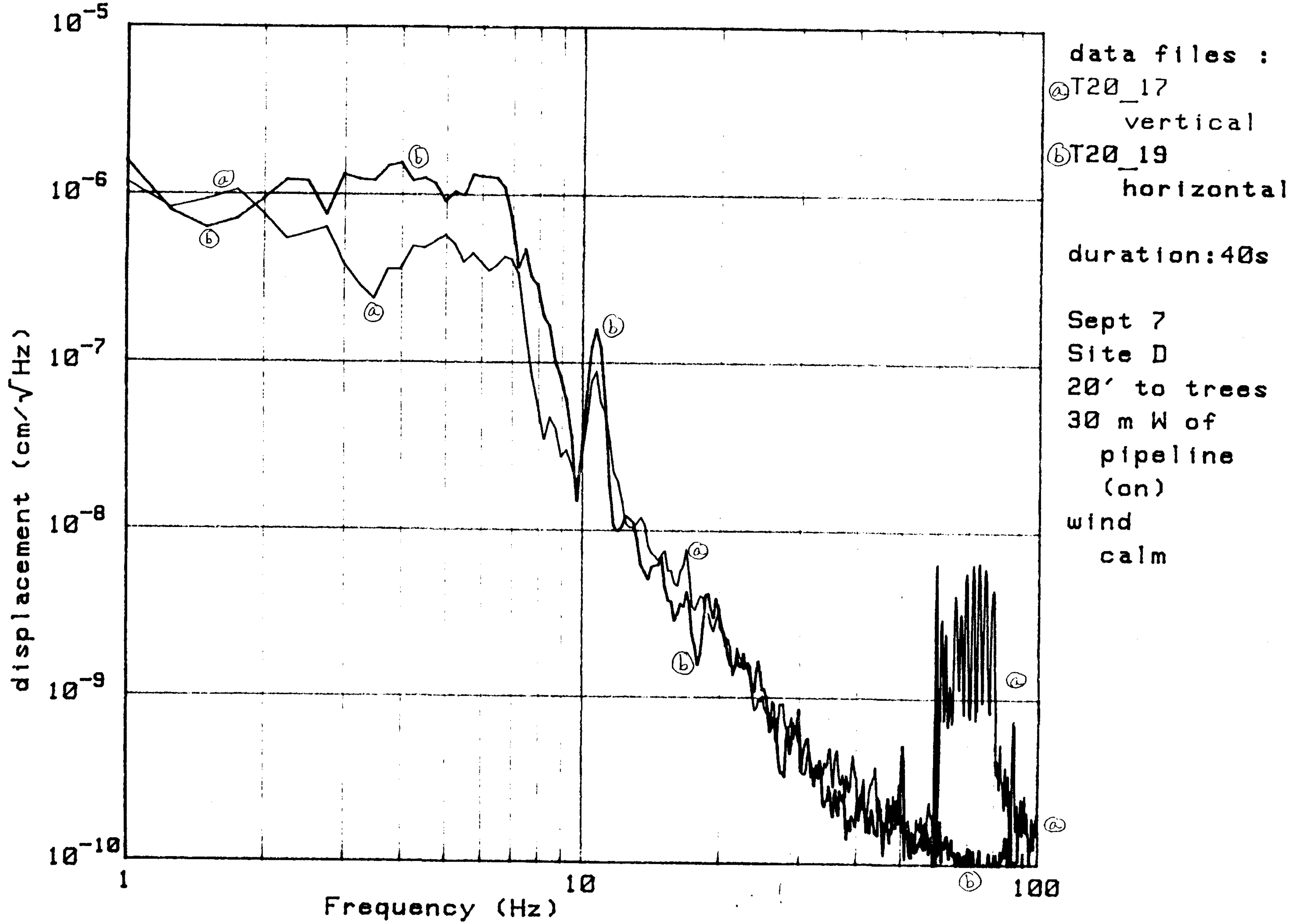
6B


10^-5
10^-6
10^-7
10^-8
10^-9
10^-10
displacement (cm/√Hz)
1
10
100
Frequency (Hz)
data files :
ⓐT20_02
vertical
ⓑT20_04
horizontal
duration:40s
Sept 7
Site D
20′ to trees
30 m W of
pipeline
wind
calm

7B

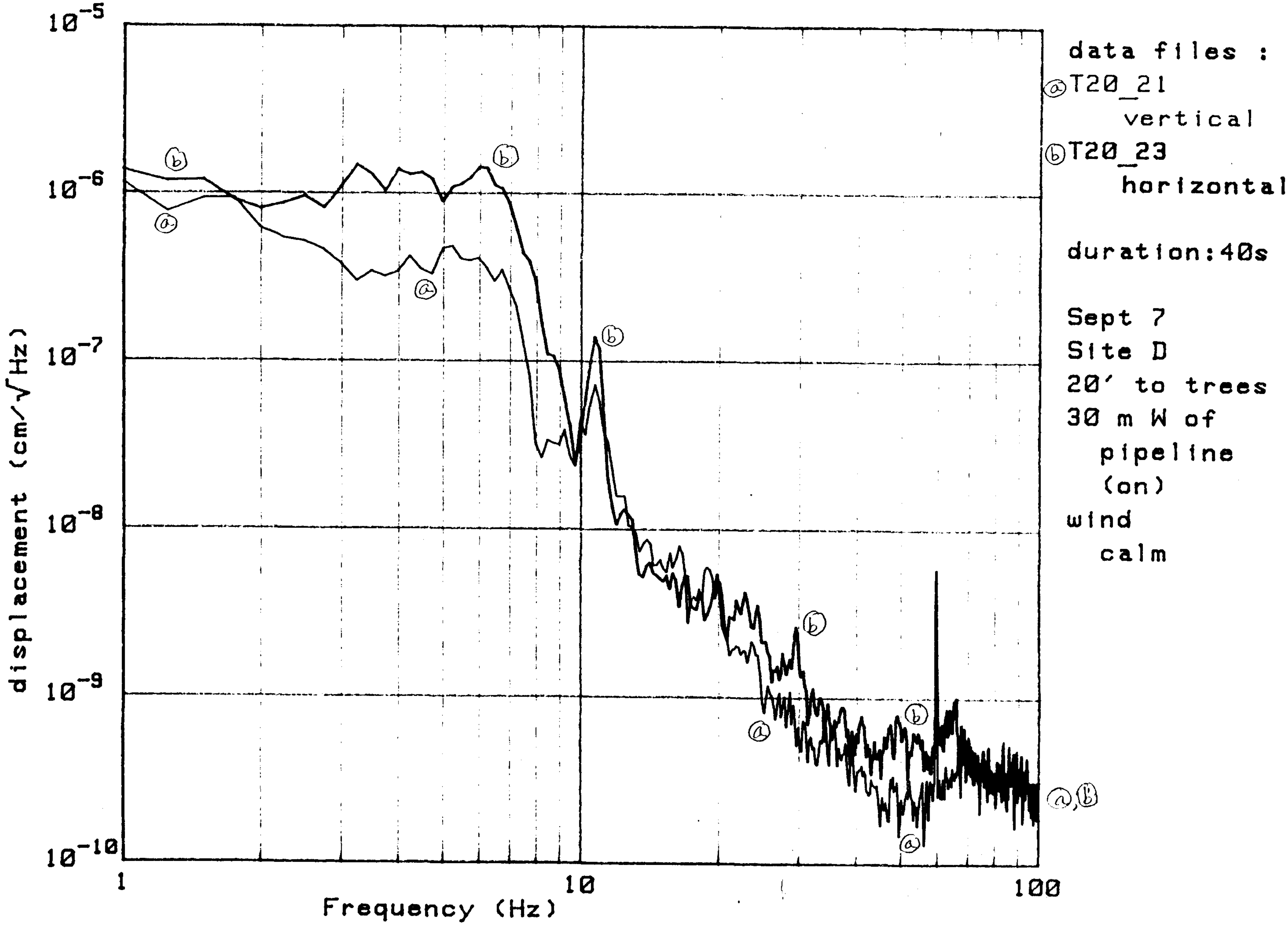


10^-5
10^-6
10^-7
10^-8
10^-9
10^-10
displacement (cm/√Hz)
1
10
100
Frequency (Hz)
data files :
ⓐ T20_06
vertical
ⓑ T20_15
horizontal
duration:40s
Sept 7
Site D
20′ to trees
30 m W of
pipeline
(on)
wind
calm

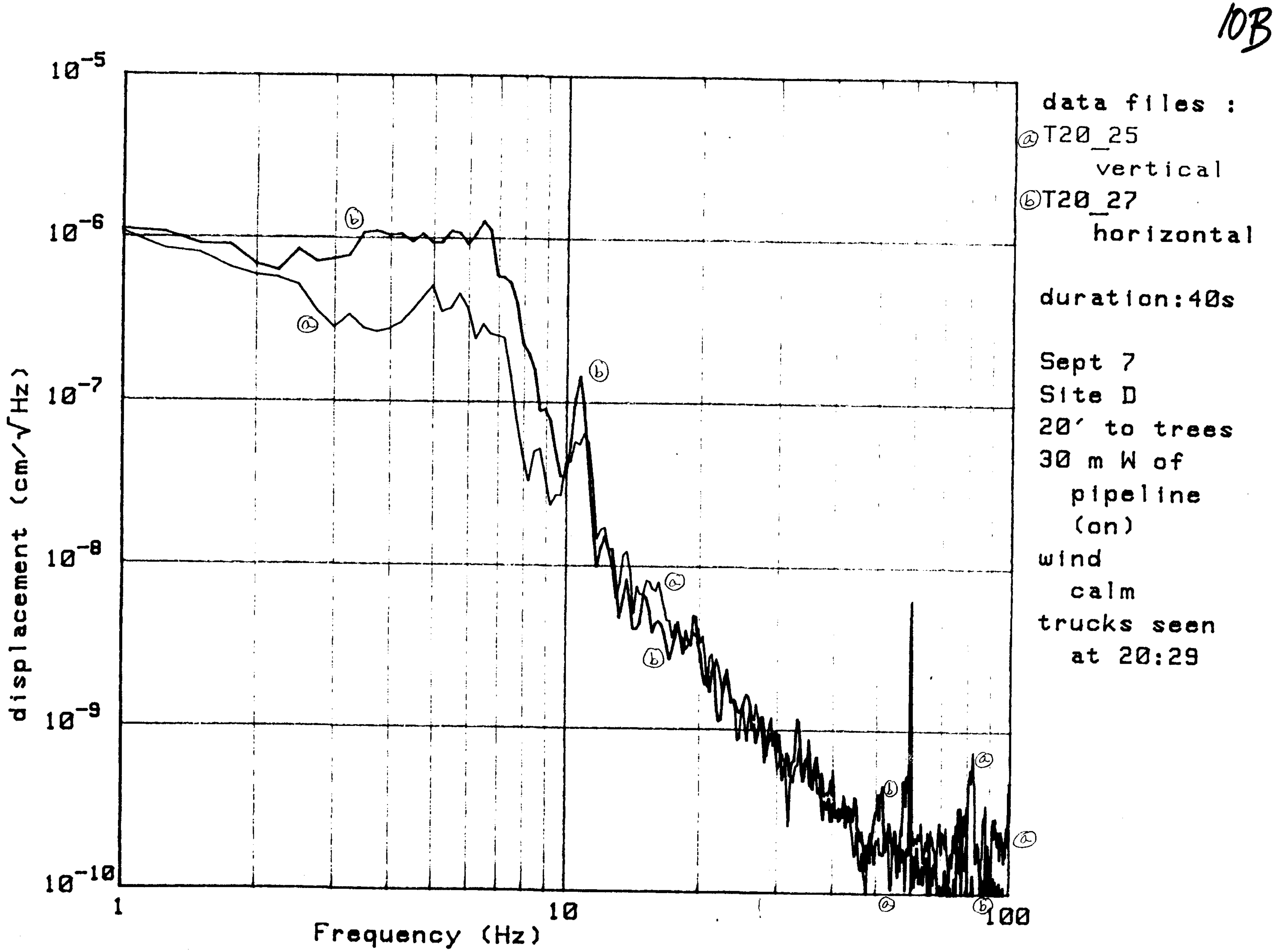


data files :
ⓐT20_17 vertical
ⓑT20_19 horizontal
duration:40s
Sept 7
Site D
20′ to trees
30 m W of pipeline (on)
wind calm
displacement (cm/√Hz)
Frequency (Hz)
10^-5
10^-6
10^-7
10^-8
10^-9
10^-10
1
10
100

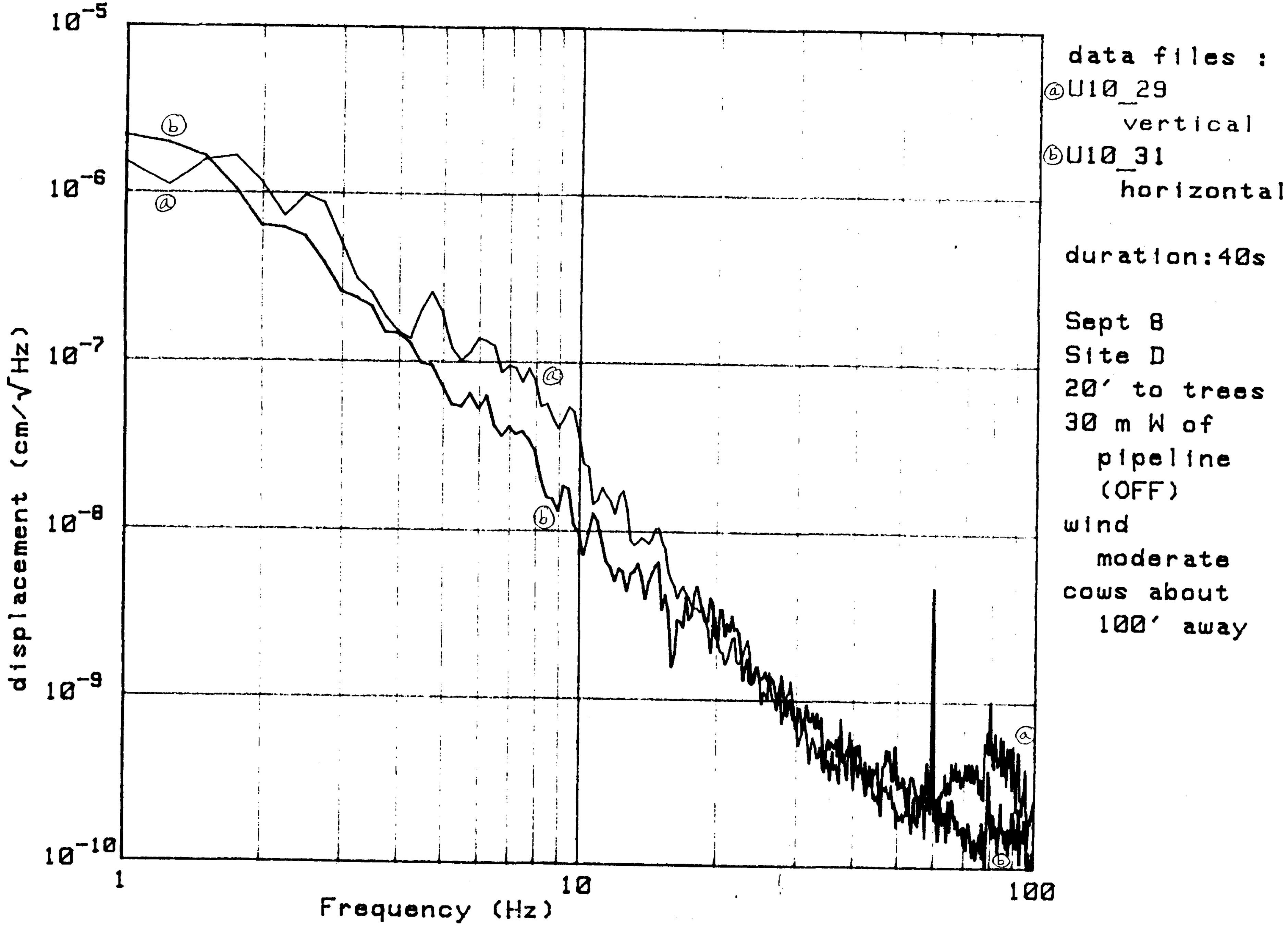
9B



displacement (cm/√Hz)
10^-5
10^-6
10^-7
10^-8
10^-9
10^-10
1
10
100
Frequency (Hz)
b
a
data files :
a T20_21
vertical
b T20_23
horizontal
duration:40s
Sept 7
Site D
20′ to trees
30 m W of
pipeline
(on)
wind
calm
a,b

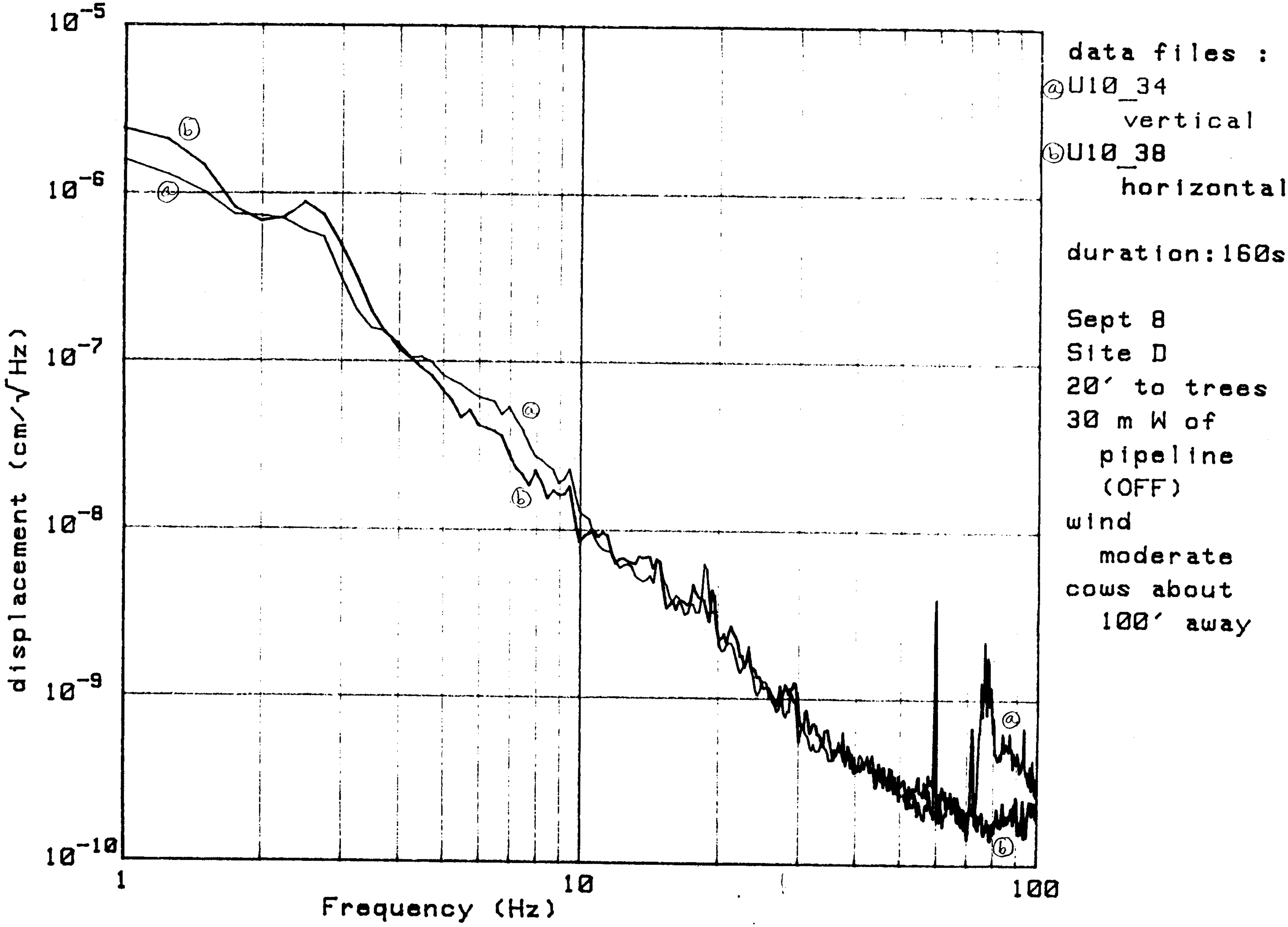

10B
10^-5
10^-6
10^-7
10^-8
10^-9
10^-10
displacement (cm/√Hz)
1
10
100
Frequency (Hz)
a
b
data files :
a T20_25
vertical
b T20_27
horizontal
duration:40s
Sept 7
Site D
20′ to trees
30 m W of
pipeline
(on)
wind
calm
trucks seen
at 20:29

11B



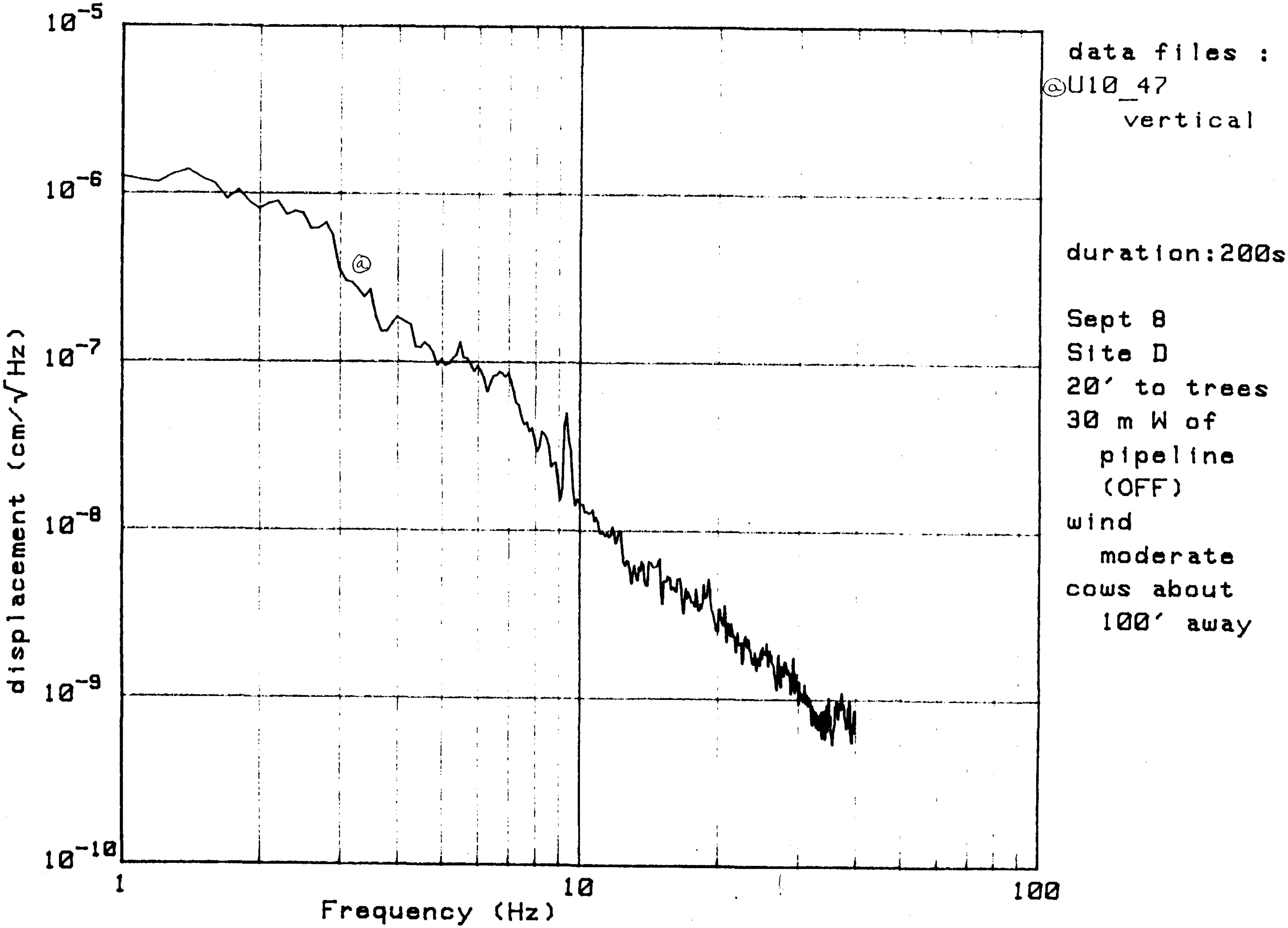
10^-5
10^-6
10^-7
10^-8
10^-9
10^-10
displacement (cm/√Hz)
1
10
100
Frequency (Hz)
data files :
ⓐU10_29
vertical
ⓑU10_31
horizontal
duration:40s
Sept 8
Site D
20′ to trees
30 m W of
pipeline
(OFF)
wind
moderate
cows about
100′ away

12B

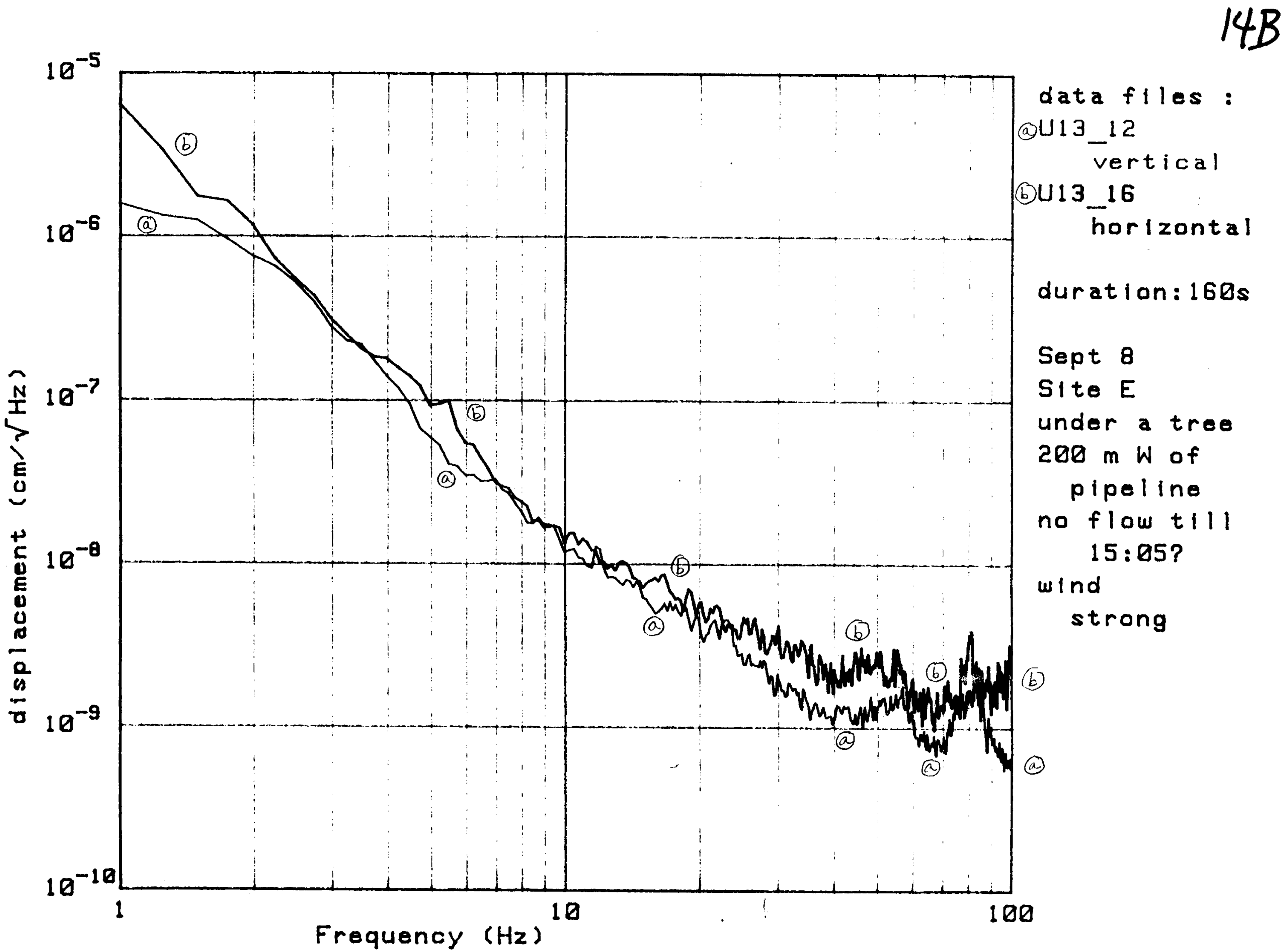


10^-5
10^-6
10^-7
10^-8
10^-9
10^-10
displacement (cm/√Hz)
1
10
100
Frequency (Hz)
a
b
data files :
a U10_34
vertical
b U10_38
horizontal
duration:160s
Sept 8
Site D
20′ to trees
30 m W of
pipeline
(OFF)
wind
moderate
cows about
100′ away

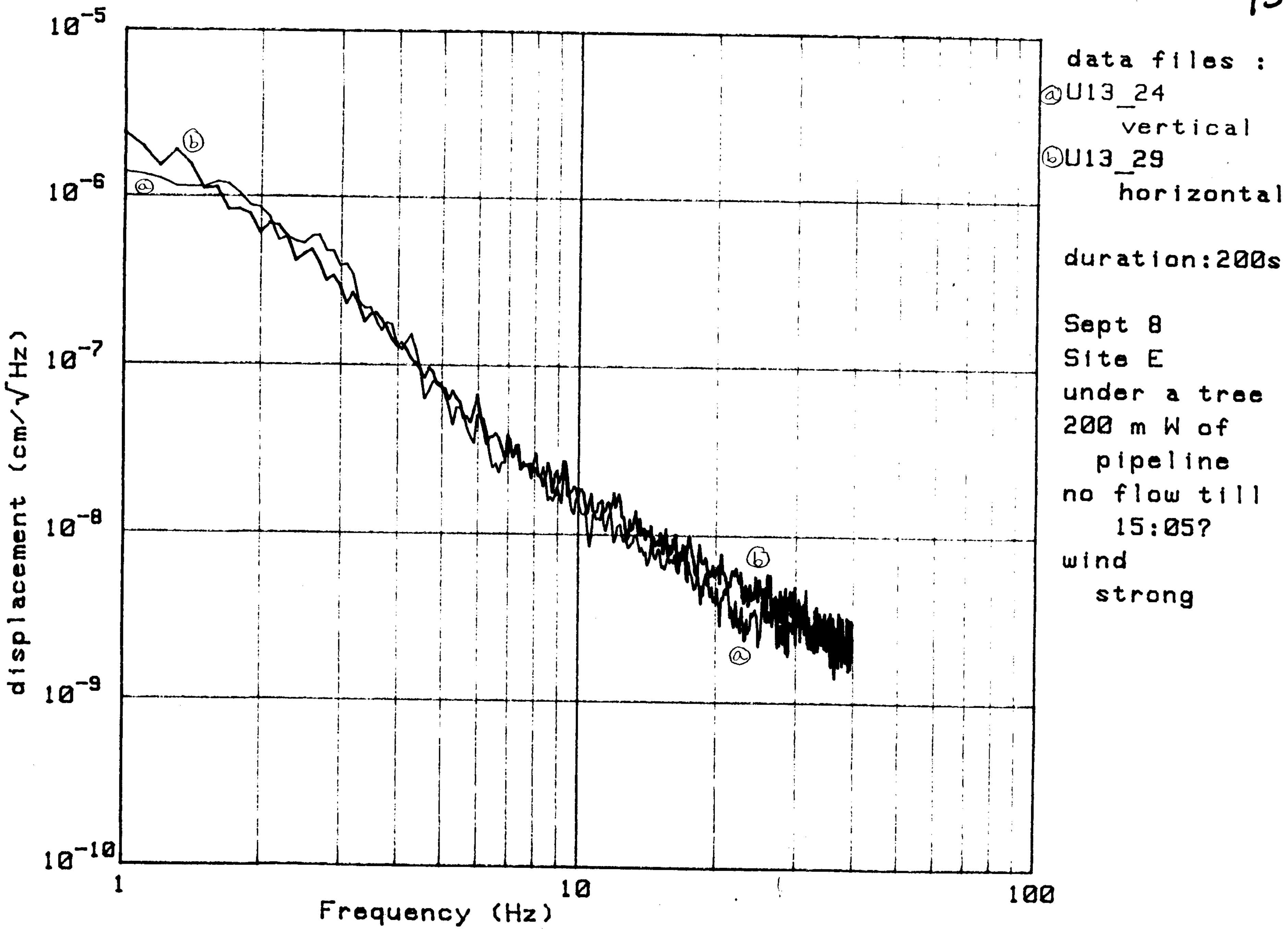
13B



displacement (cm/√Hz)
10^-5
10^-6
10^-7
10^-8
10^-9
10^-10
1
10
100
Frequency (Hz)
@
data files :
@U10_47
vertical
duration:200s
Sept 8
Site D
20' to trees
30 m W of
pipeline
(OFF)
wind
moderate
cows about
100' away

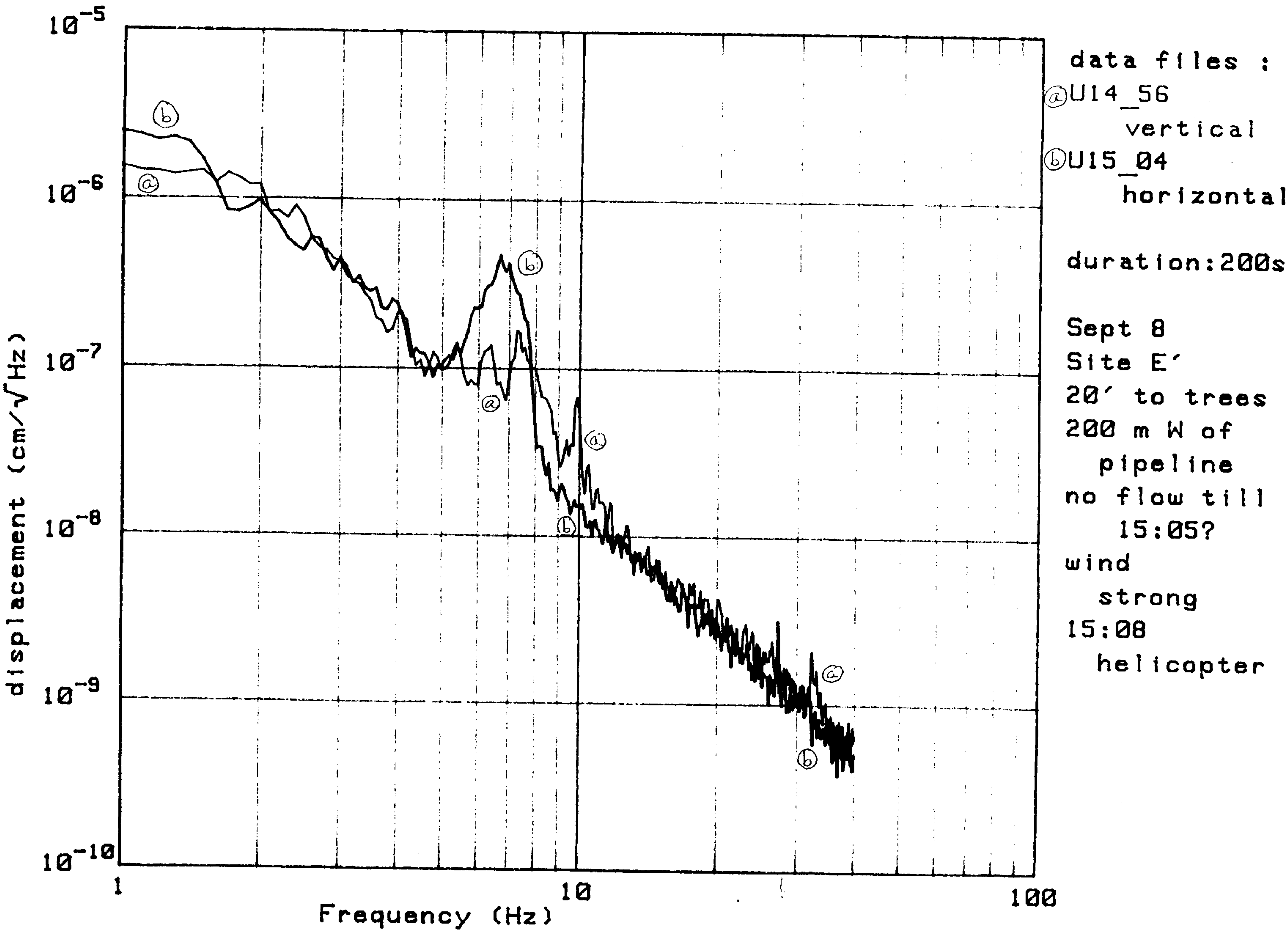

14B
10^-5
10^-6
10^-7
10^-8
10^-9
10^-10
displacement (cm/√Hz)
1
10
100
Frequency (Hz)
ⓐ
ⓑ
data files :
ⓐU13_12
vertical
ⓑU13_16
horizontal
duration:160s
Sept 8
Site E
under a tree
200 m W of
pipeline
no flow till
15:05?
wind
strong

15B

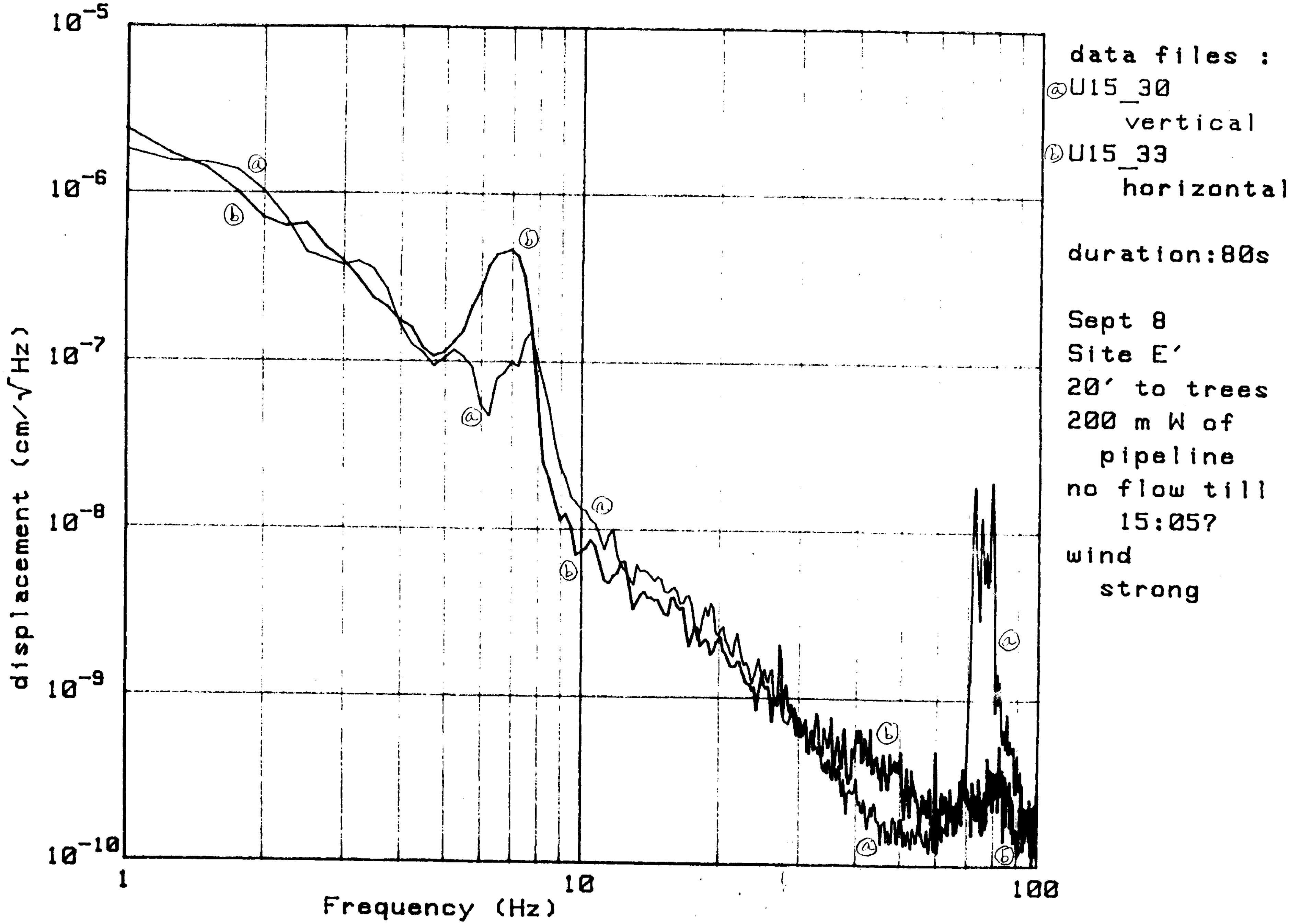


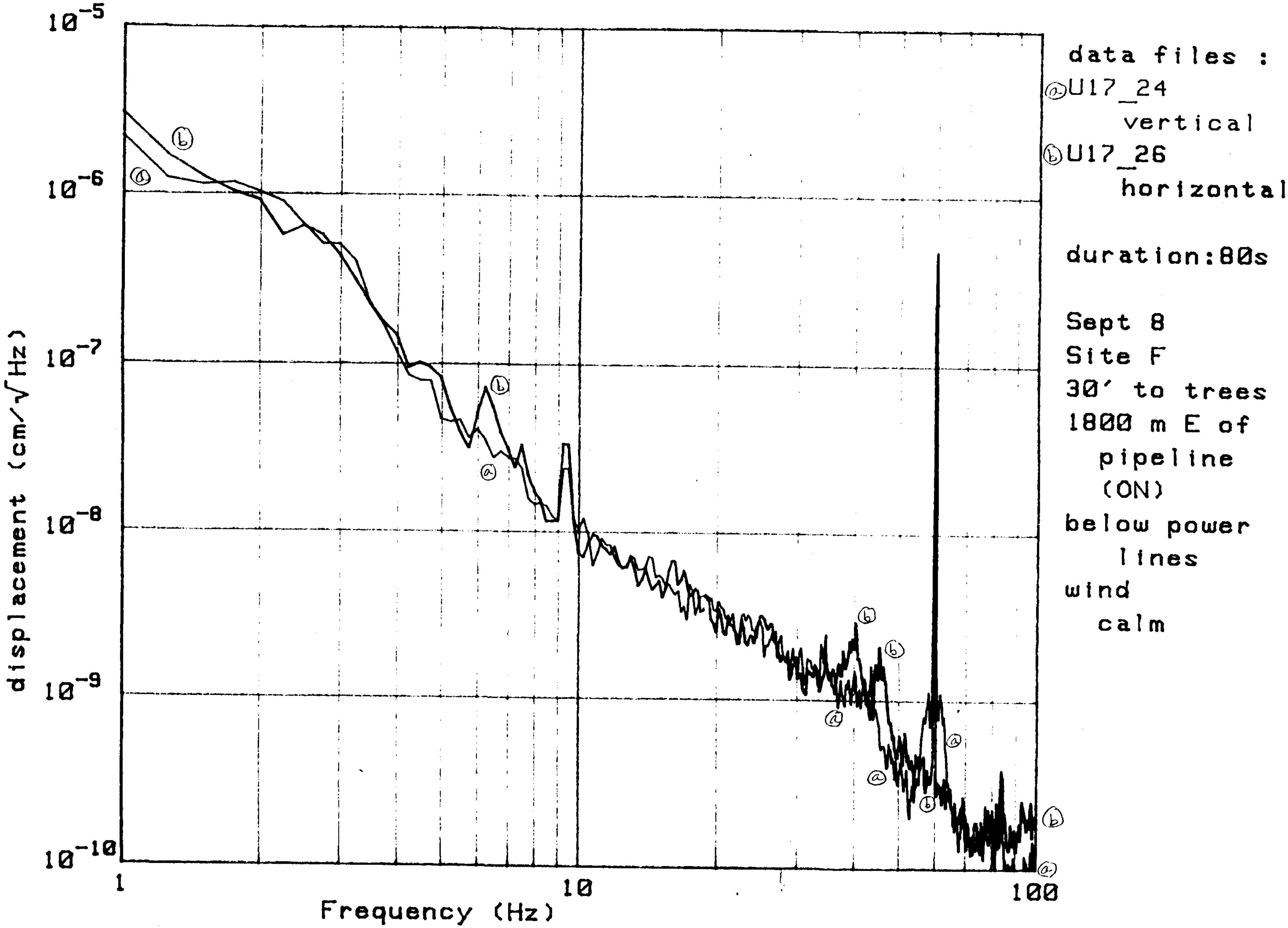
10^-5
10^-6
10^-7
10^-8
10^-9
10^-10
displacement (cm/√Hz)
1
10
100
Frequency (Hz)
ⓐ
ⓑ
data files :
ⓐU13_24
vertical
ⓑU13_29
horizontal
duration:200s
Sept 8
Site E
under a tree
200 m W of
pipeline
no flow till
15:05?
wind
strong

16B



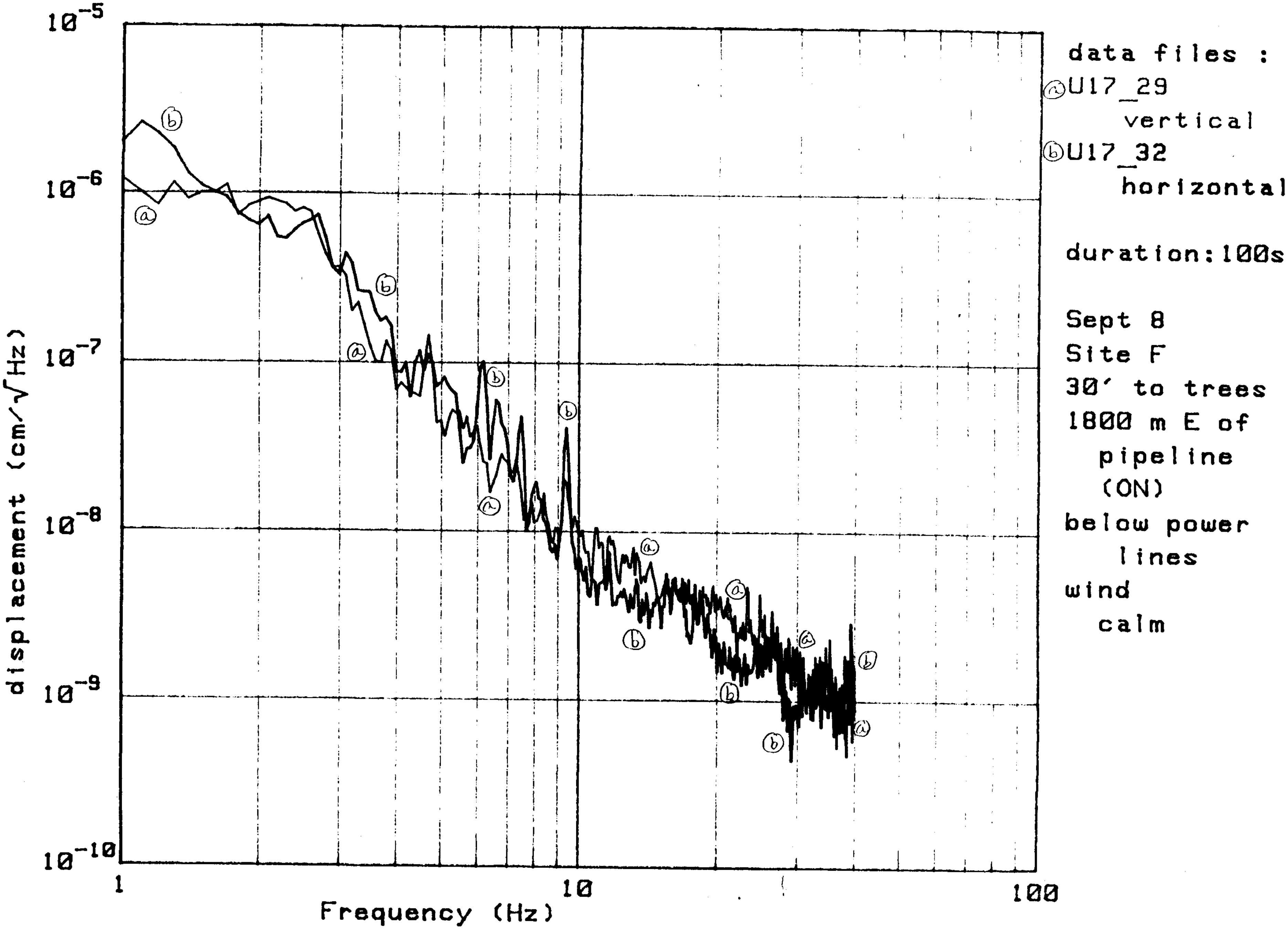
10^{-5}
10^{-6}
10^{-7}
10^{-8}
10^{-9}
10^{-10}
displacement (cm/√Hz)
1
10
100
Frequency (Hz)
a
b
data files :
a U14_56
vertical
b U15_04
horizontal
duration:200s
Sept 8
Site E′
20′ to trees
200 m W of
pipeline
no flow till
15:05?
wind
strong
15:08
helicopter


10^-5
10^-6
10^-7
10^-8
10^-9
10^-10
displacement (cm/√Hz)
1
10
100
Frequency (Hz)
data files :
ⓐU15_30
vertical
ⓑU15_33
horizontal
duration:80s
Sept 8
Site E′
20′ to trees
200 m W of
pipeline
no flow till
15:05?
wind
strong



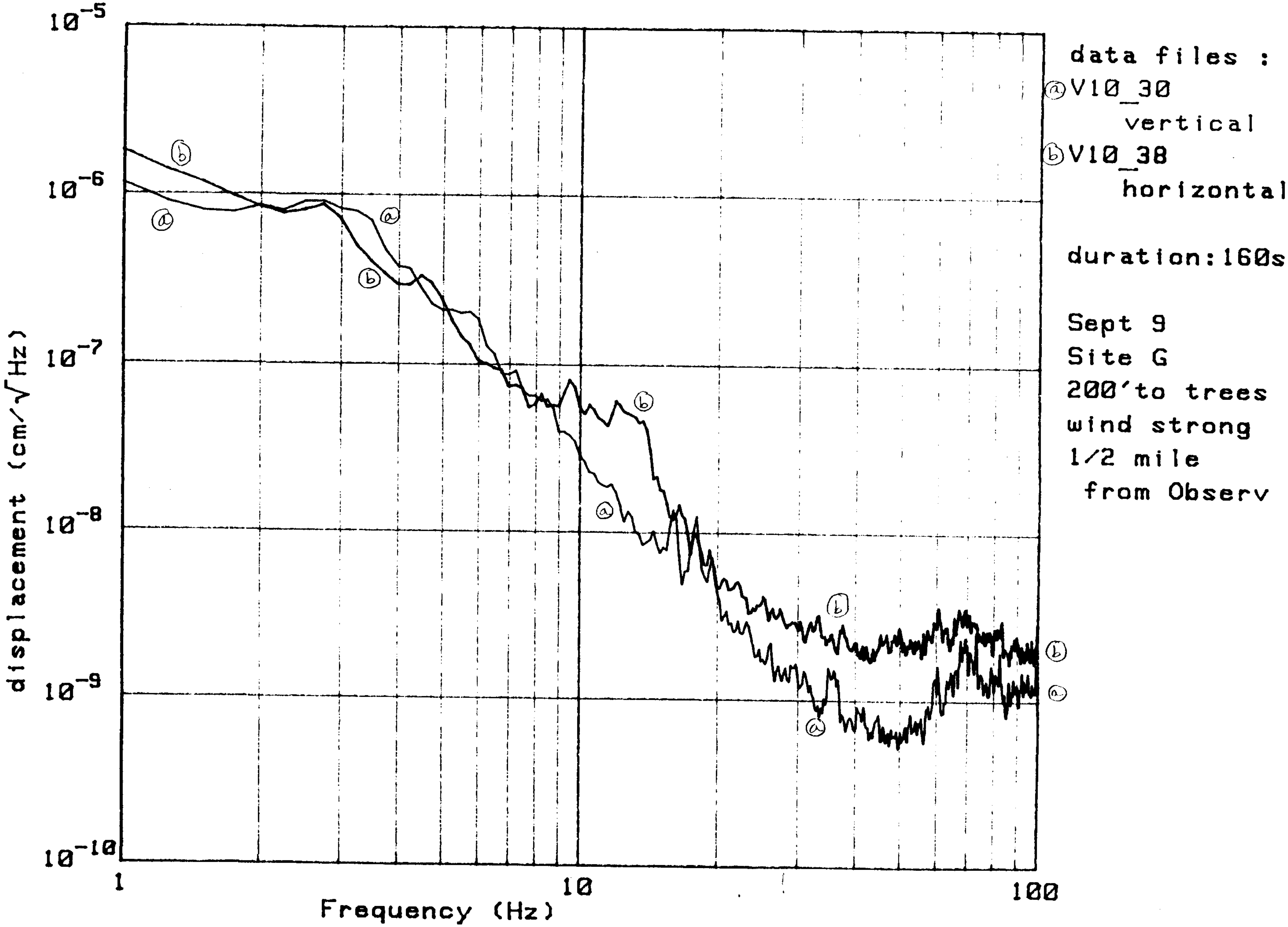
displacement (cm/√Hz)
10^{-5}
10^{-6}
10^{-7}
10^{-8}
10^{-9}
10^{-10}
1
10
100
Frequency (Hz)
data files :
ⓐ U17_24
vertical
ⓑ U17_26
horizontal
duration:80s
Sept 8
Site F
30' to trees
1800 m E of
pipeline
(ON)
below power
lines
wind
calm

19B

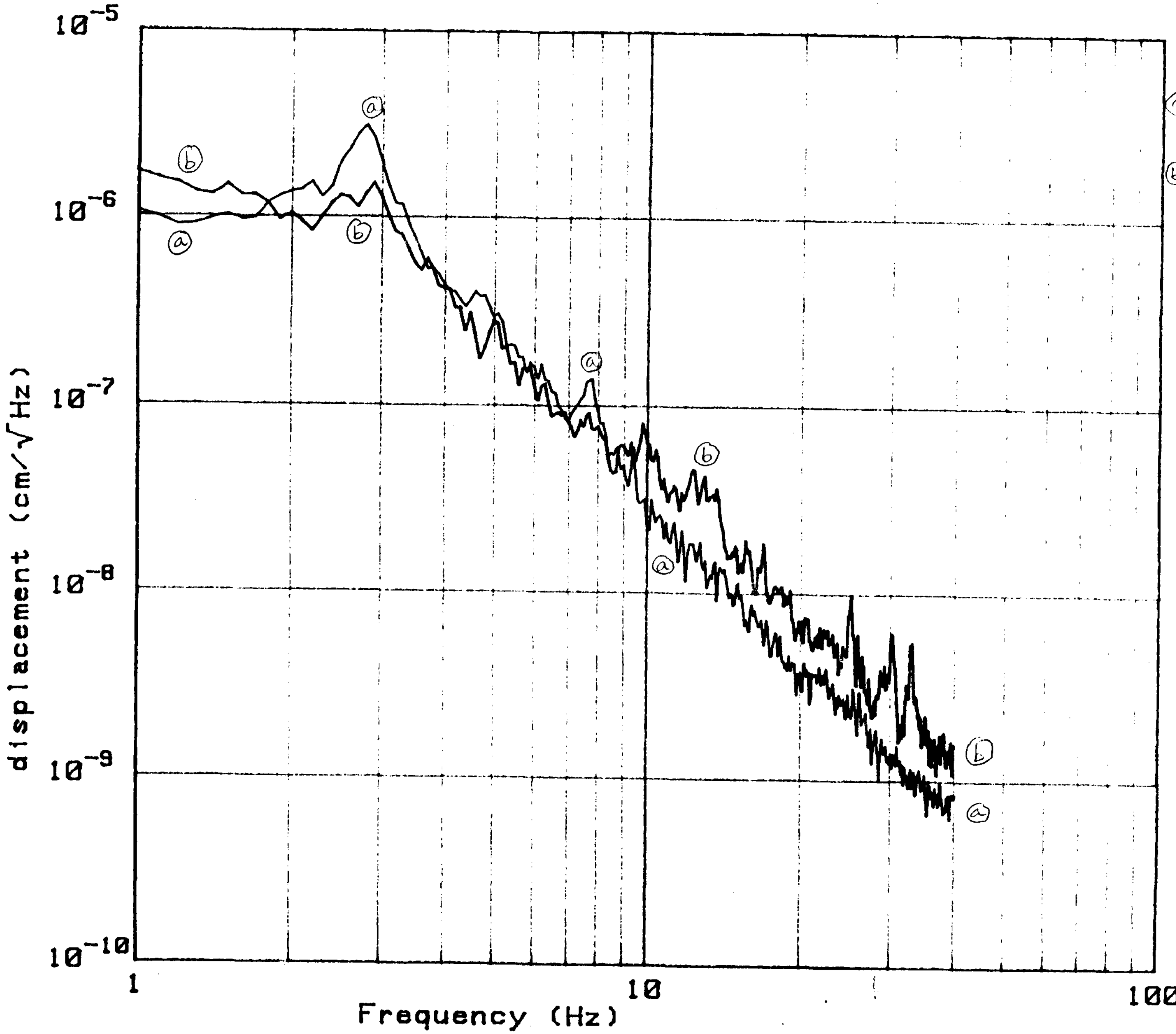


10^{-5}
10^{-6}
10^{-7}
10^{-8}
10^{-9}
10^{-10}
displacement (cm/√Hz)
1
10
100
Frequency (Hz)
ⓑ
ⓐ
data files :
ⓐU17_29
vertical
ⓑU17_32
horizontal
duration:100s
Sept 8
Site F
30′ to trees
1800 m E of
pipeline
(ON)
below power
lines
wind
calm

20B



displacement (cm/√Hz)
10^{-5}
10^{-6}
10^{-7}
10^{-8}
10^{-9}
10^{-10}
1
10
100
Frequency (Hz)
ⓐ
ⓑ
data files :
ⓐV10_30
vertical
ⓑV10_38
horizontal
duration:160s
Sept 9
Site G
200'to trees
wind strong
1/2 mile
from Observ

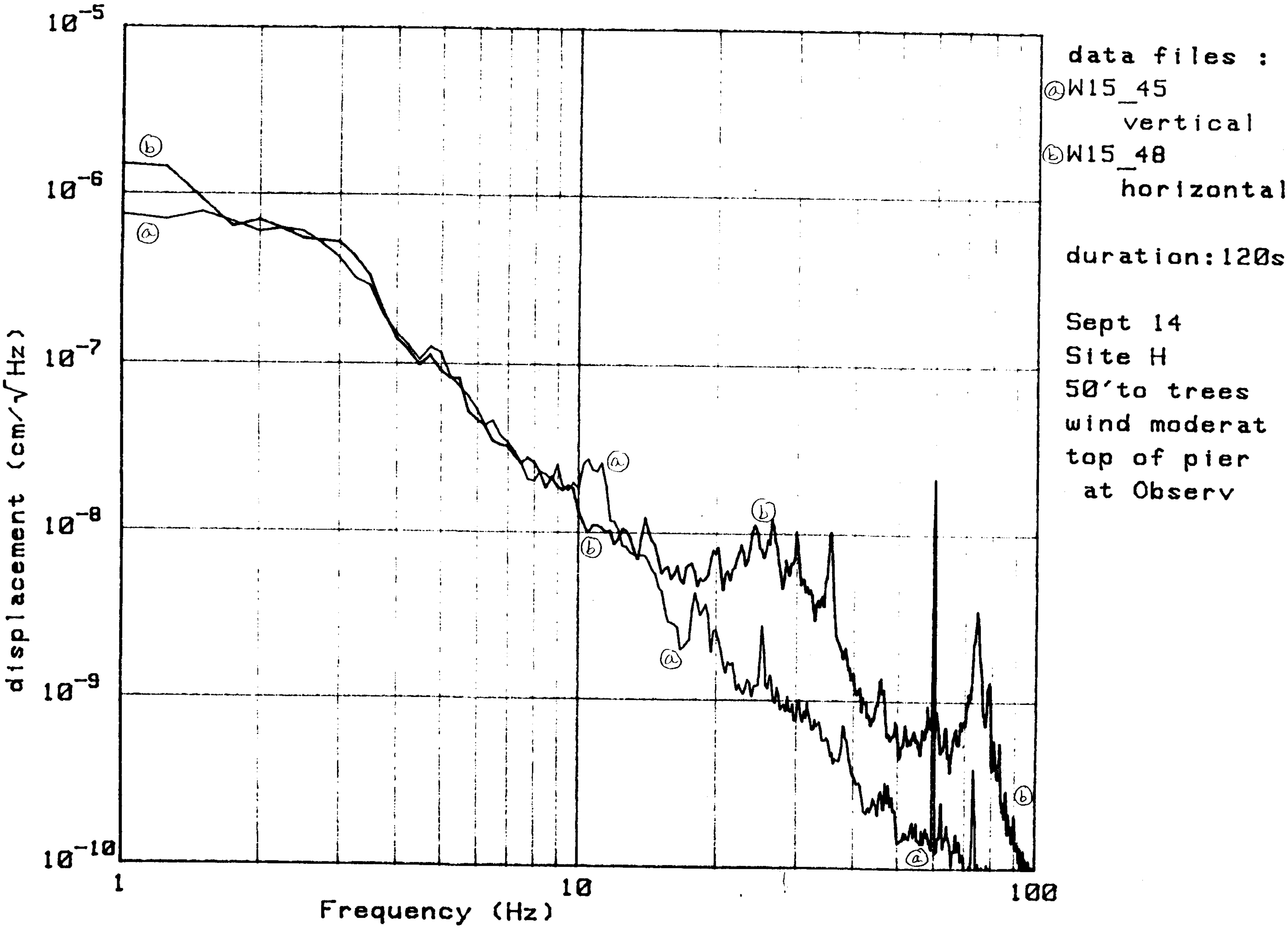


data files :
(a) V10_49
vertical
(b) V10_55
horizontal

duration:200s

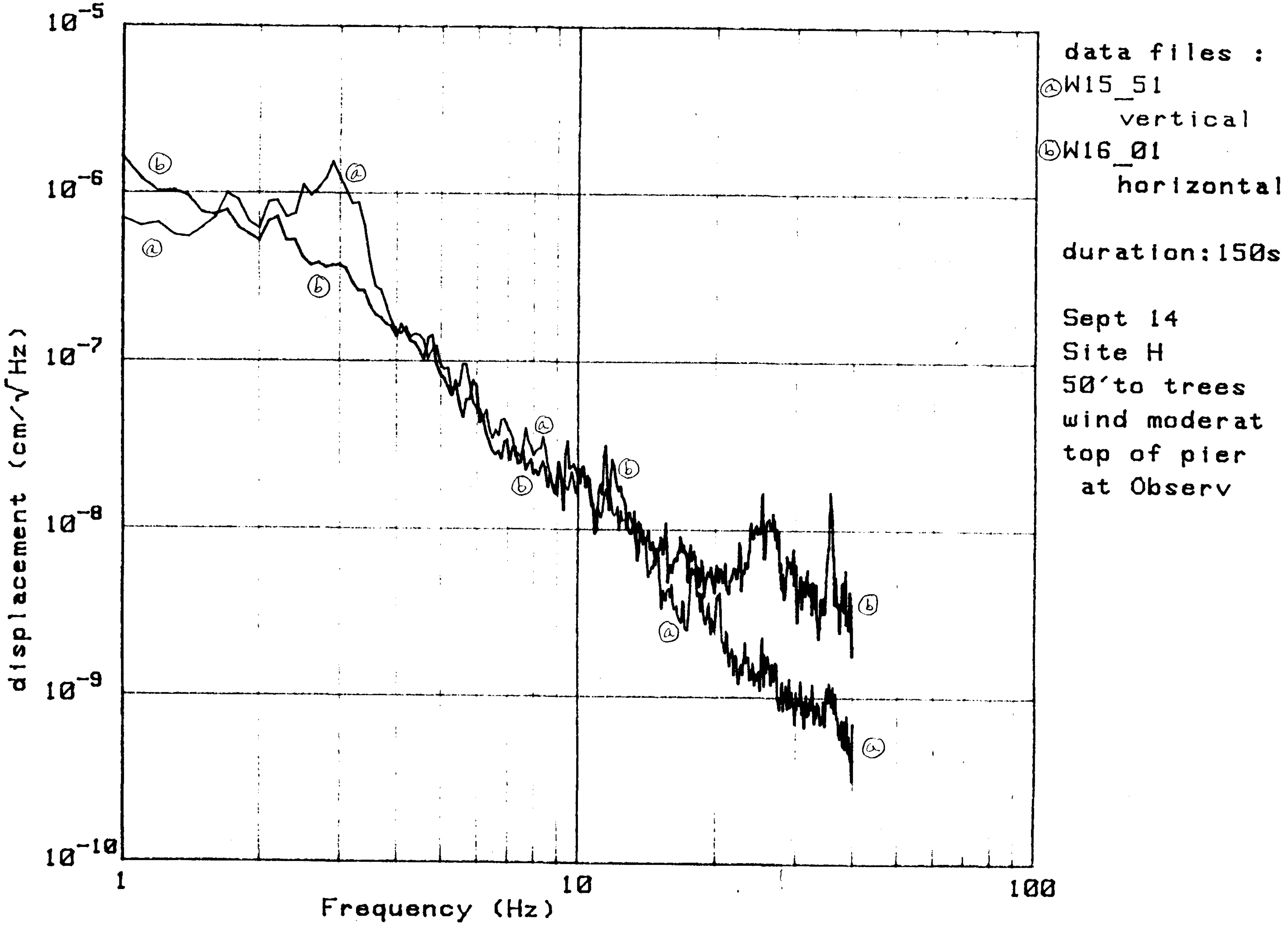
Sept 9
Site G
200' to trees
wind strong
1/2 mile
from Observ

22B



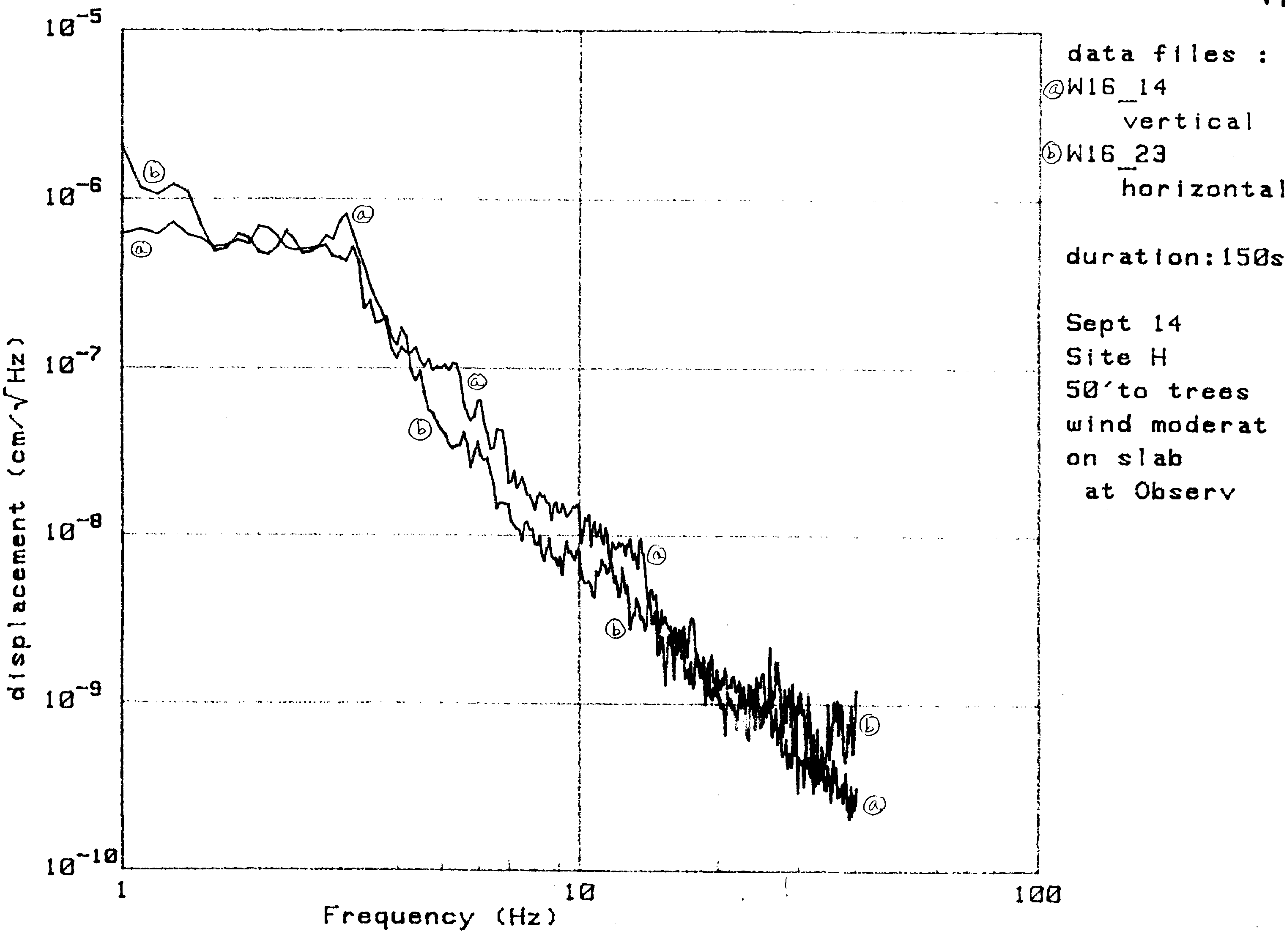
10^{-5}
10^{-6}
10^{-7}
10^{-8}
10^{-9}
10^{-10}
displacement (cm/√Hz)
1
10
100
Frequency (Hz)
ⓐ
ⓑ
data files :
ⓐW15_45
vertical
ⓑW15_48
horizontal
duration:120s
Sept 14
Site H
50'to trees
wind moderat
top of pier
at Observ

23B

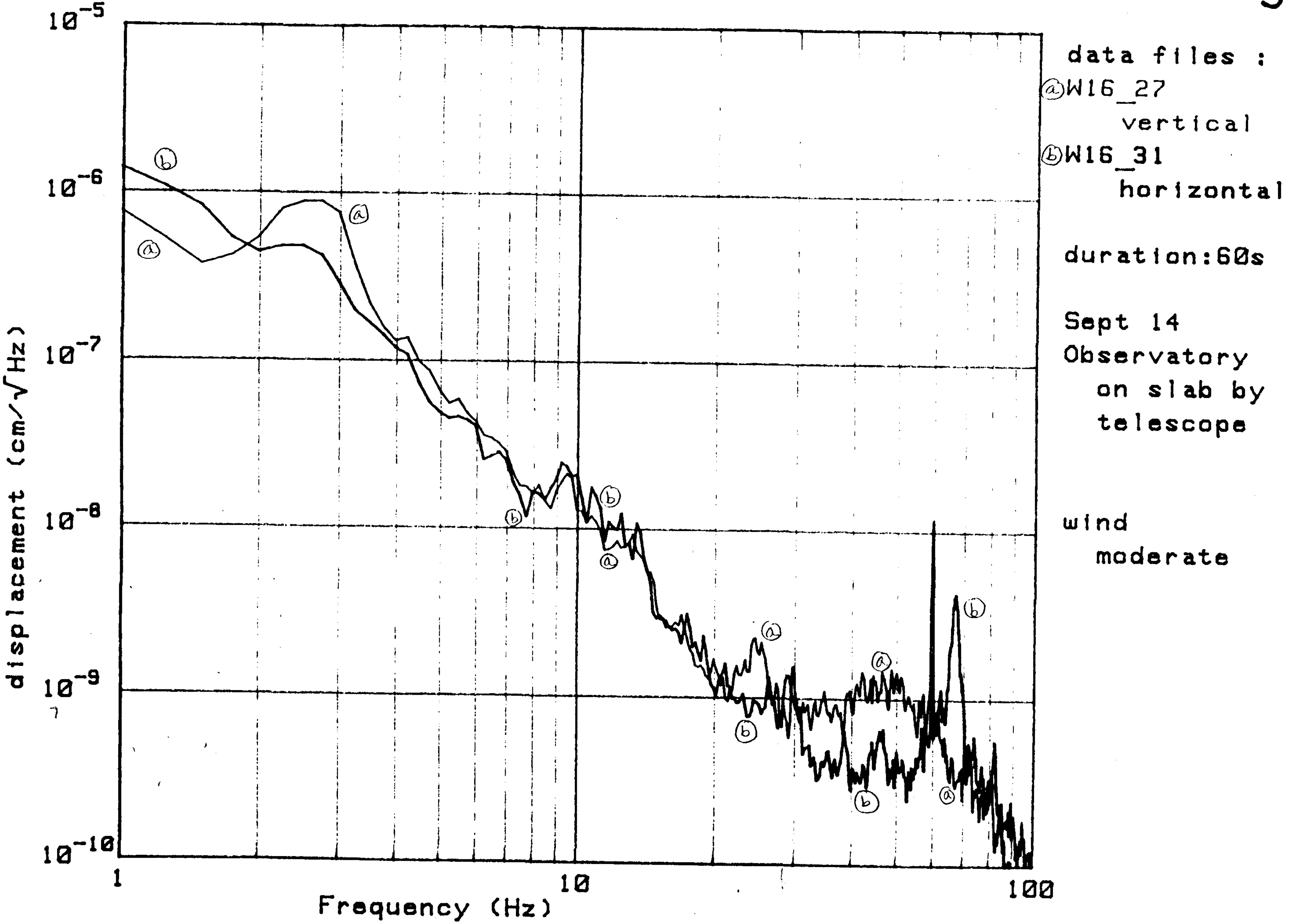


data files :
ⓐW15_51
vertical
ⓑW16_01
horizontal
duration:150s
Sept 14
Site H
50′to trees
wind moderat
top of pier
at Observ
displacement (cm/√Hz)
Frequency (Hz)
10^-5
10^-6
10^-7
10^-8
10^-9
10^-10
1
10
100

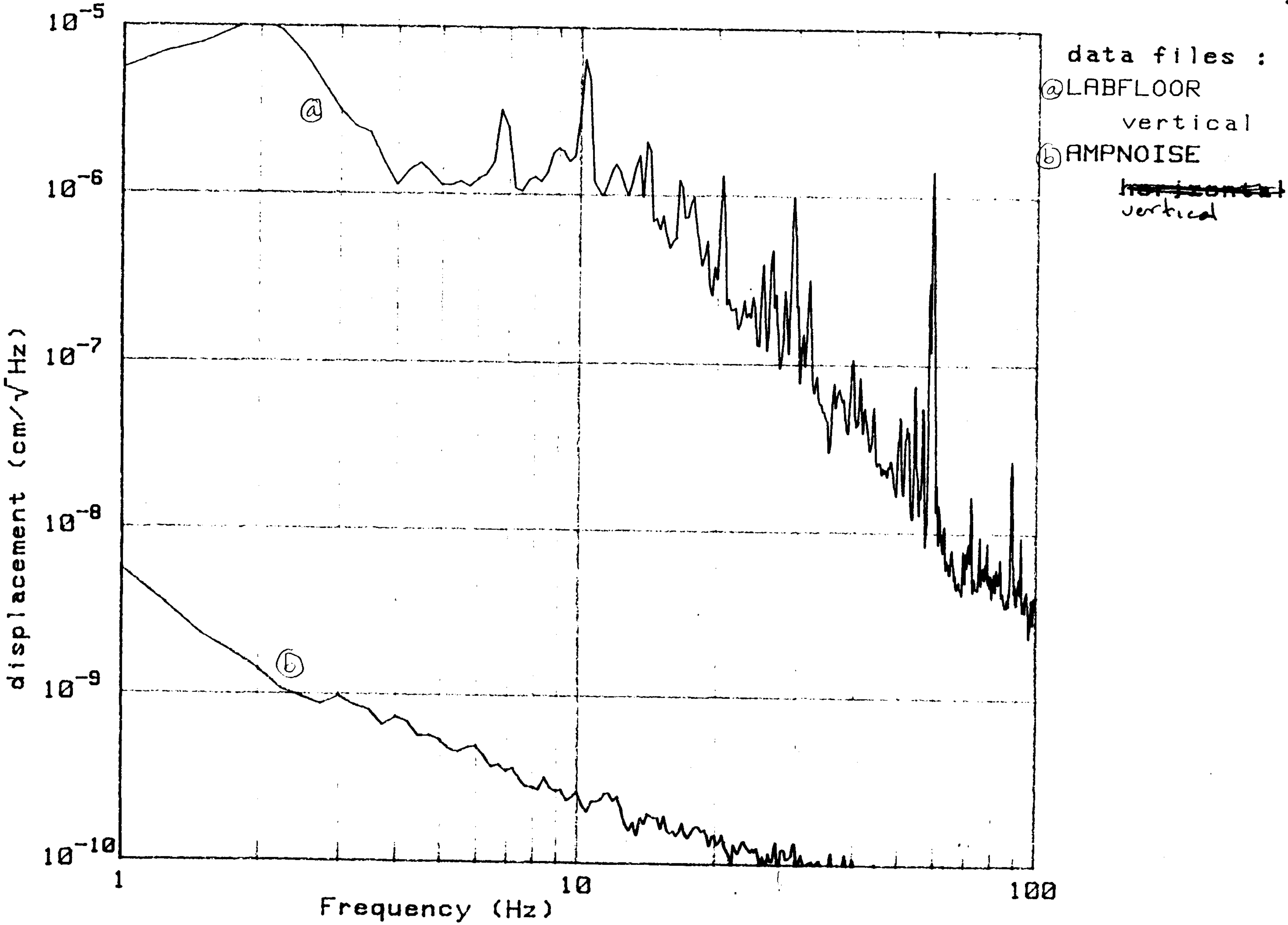
24B



10^-5
10^-6
10^-7
10^-8
10^-9
10^-10
displacement (cm/√Hz)
1
10
100
Frequency (Hz)
a
b
data files :
ⓐW16_14
vertical
ⓑW16_23
horizontal
duration:150s
Sept 14
Site H
50´to trees
wind moderat
on slab
at Observ



displacement (cm/√Hz)
Frequency (Hz)
10^-5
10^-6
10^-7
10^-8
10^-9
10^-10
1
10
100
data files :
ⓐW16_27
vertical
ⓑW16_31
horizontal
duration:60s
Sept 14
Observatory
on slab by
telescope
wind
moderate



data files :
@LABFLOOR
vertical
ⓑAMPNOISE
horizontal
vertical
@
ⓑ
10^-5
10^-6
10^-7
10^-8
10^-9
10^-10
displacement (cm/√Hz)
1
10
100
Frequency (Hz)