Sound Measurement Procedures Manual

NPCS - 1

State of Oregon
Department of
Environmental
Quality

REVISION RECORD

INSTRUCTIONS FOR USE: All revisions of this manual will be numbered to assure each manual holder that he has received all revisions. The date and initials of the person inserting revisions to the manual should be entered on this revision record opposite the appropriate revision number. If the sequence is broken, copies of the missing revisions may be requested from the Noise Control Section.

Rev. No.	Date Inserted	Initials	
1.	4-30-74	JH	[illegible]
2.	8-16-74	JH	[illegible]
3.	11-25-74	NT	[illegible]
4.	8-27-76	JH	EQC Amendments
5.	5-6-83	JH	EQC Amendments
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FOREWORD

The Sound Measurement Procedures Manual has been prepared to specify the equipment to be used and the procedures to be followed when measuring environmental noise. The procedures established in the manual, when carefully followed, will ensure that the noise readings obtained are accurate, will support enforcement action, and aid in reducing environmental noise.

The scope of this manual includes industrial noise, commercial noise, noise from races and racetracks, noise from public roads and ambient noise measurements. Individual motor vehicle noise measurements are covered in a separate manual.

The objective of the manual is to establish procedures to implement the provisions of the Environmental Quality Commission. Further, if the practices and procedures herein are adhered to, the result will be a uniform enforcement program which will accomplish the intent of the Legislature and fulfill the Commission's responsibility under ORS Chapter 467.

Office of the Administrator
Air Quality Control Division
Department of Environmental Quality

TABLE OF CONTENTS

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

Policy

1.1.1 The Department of Environmental Quality, through the Noise Pollution Control Section shall establish a noise measurement program to implement the laws and regulations applying to environmental noise.

1.1.2 The Noise Pollution Control Section shall be responsible for the conformity of environmental noise measurement.

1.1.3 This manual contains procedures for the Noise Pollution Control Section, and all other persons taking environmental noise measurements. Guidance is provided in the "Comments".

1.2 Authority

Statutory and administrative law governing authority to the guidance and direction contained in the following sources:

a. Oregon Revised Statutes, Chapter 467, Sections 467.010, 467.020, 467.030, 467.040, 467.050, 467.990.

b. Oregon Administrative Rules, Chapter 340, Division 35, Department of Environmental Quality.

Instruments and Training

1.3.1 Specific requirements for instruments and personnel are defined under procedure manual, Noise Pollution Control Section - 2, Requirements for Sound Measuring Instruments and Personnel.

CHAPTER 2

INSTRUMENTATION

Sound Level Meters

The specifications for sound level meters (SLM) are defined in manual Noise Pollution Control Section (NPCS-2) Requirements for Sound Measuring Instruments and Personnel. The minimum meter required is a Type II as defined by American National Standard Institute Number S1.4-1971.

2.2 Accessories

The minimum accessories shall be a windscreen and an acoustically coupled calibrator.

Comment: Additional accessories that have been found to be valuable in gathering data are tabulated below:

(1) Noise data forms
(2) Clipboard
(3) Tripod
(4) Wind meter
(5) Sling psychrometer
(6) Screwdriver
(7) Spare batteries
(8) Watch with sweep second hand or digital equivalent

Tape Recorders and Level Recorders

Recording systems shall conform to NPCS-2.

Comment: The recording system should be able to duplicate the measurements as taken in the field. For tape recorders, a table of frequency response tolerances is given in SAE standards. Graphic level recorder systems standards are also described in the manual.

Octave Band Filter Sets

The octave band filter sets shall be those defined in NPCS-2.

Comment: These sets may either be integral to a sound level meter or they may be a separate piece of equipment.

Special Study Instruments

Comment: In some instances, special types of equipment may be found to be useful in studying a noise problem. The Department has several specialized noise instruments to be used in study situations. These instruments include a random noise generator, a loud speaker system, and a one-third octave band filter set.

One-Third Octave Band Filter Sets

The one-third octave band filter sets shall be those defined in NPCS-2.

Comment: These sets may be integral to a sound level meter or they may be a separate piece of equipment. Sets shall contain the preferred one-third octave band filters.

Impulse Meters

Impulse meters shall be those defined in NPCS-2.

Comment: These meters are integral to some Type I precision sound level meters set for a peak unweighted response. Blasting impulse noise is measured on a standard Type I or Type II meter set to the "C" weighting scale and the "SLOW" dumping response.

CHAPTER 3

INSTRUMENT CALIBRATION

General

All types of sound level meters shall be field calibrated immediately prior to use, using the procedures described in the factory instruction manual.

Battery Check

Batteries in both the meter and the calibrator shall be checked before calibration.

Instrument Calibration

The instrument shall be set to the correct level range, weighting scale and meter response. The calibrator shall be placed on the microphone of the meter. The output indicated on the meter shall then be adjusted to the correct calibration level.

Annual Calibration

Within a year prior to use, each sound level meter, including octave band filter and calibrator, shall receive a laboratory calibration in accordance with the manufacturer's specifications. This calibration shall be traceable to the National Bureau of Standards.

Comment: An inspection label may be attached to each instrument set to determine when the calibration was performed.

CHAPTER 4

ENVIRONMENTAL NOISE MEASUREMENT

4.1 Application

This chapter applies to ambient measurements, noise emissions from industrial facilities, and commercial facilities, and to ambient noise limits from motor vehicles. Individual motor vehicle noise measurements, airports and racetracks are covered in separate manuals.

4.1.2 Persons selected to measure environmental noise shall meet the requirements of NPCS-2 Requirements for Sound Measuring Instruments and Personnel.

Site Selection

4.2.1 The measurement location shall be at any point, no more than 25 feet from the noise sensitive building where the noise level is generally greatest, as illustrated in Figure 4-1.

If the noise sensitive building is closer than 25 feet from the property line, the measurement location shall be at any point on the property line, providing it is no more than 25 feet from the building, or at any other point within the noise sensitive property no more than 25 feet from the noise sensitive building, wherever the noise level is generally greatest, as illustrated in Figure 4-2. For any measurement, sound reflective surfaces shall not be closer than 10 feet from the measurement point.

Comment: Sound reflective surfaces do not include trees, shrubs, hedges or other vegetation.

Comment: Measurements for noise sensitive property on which the noise sensitive building lies within 10 feet of the noise sensitive property line may require sound level projection techniques described in 4.8 of the manual.

Equipment Set-Up

4.3.1 The sound level meter or microphone, either hand held or placed on a tripod, shall be 4 feet or more above the ground or floor surface.

4.3.2 Comment: A microphone extension cable may be used in areas where accessibility is difficult. Example: Changes in ground elevation, reflective surfaces, height or source or receiver.

Figure 4-1 Measurement Point 25 Feet From Building

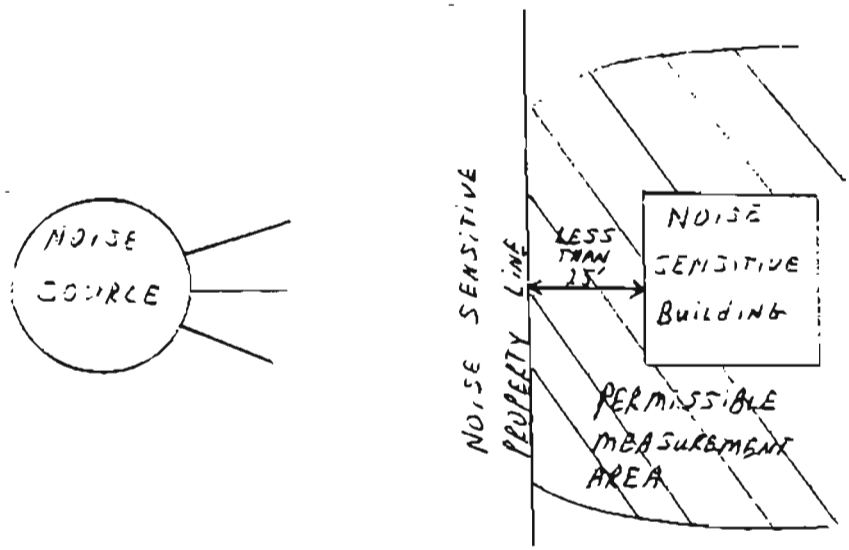


Figure 4-2 Measurement Point on Property Line

Instrument Calibration and Battery Check

4.4.1 Refer to Chapter 3 of NPCS-1 for instructions.

Noise Level Measurements

4.5.1 Comment: That information and data submitted to the Department should be recorded on Forms NPCS-4 and NPCS-5 as shown in Figure 4-3 and Figure 4-5, or on forms approved in writing by the Department.

4.5.2 Weather Conditions

a. The wind speed and direction shall be determined before measurements are taken and recorded on a form. Measurements shall not be taken when the wind speed exceeds 10 mph. The sound level meter windscreen shall always be installed on the microphone while taking measurements.

b. The relative humidity may be determined for the time measurements are taken. Measurements shall not be taken when precipitation affects results.

Comment: Measurements may be taken when the ground is wet if the readings are not influenced by motor vehicle tire noise on wet pavement.

c. Comment: The barometric pressure has an effect on the calibration level of most calibrators. This effect is usually small but can introduce some error under very low atmospheric pressure conditions or at high elevations. Typically no correction is needed at elevations below 2,000 feet. Above 2,000 feet elevation, the manufacturers correction factor must be applied to the instrument during calibration.

4.5.3 Determination of Meter Speed

a. Comment: The "FAST" meter speed is used for sounds of an essentially continuous nature. This speed is such that the indication instrument attains its final reading in approximately 0.2 seconds. In general, the "FAST" meter is used where meter fluctuations do not exceed 3 dB, or where the meter is required to follow fast changes in level such as an automobile or aircraft pass-by measurements.

b. Comment: The "SLOW" meter speed is used for sounds where the noise level fluctuates by + or - 3 dB and meter variations make the instrument display unreadable. The slower action of the meter provides an averaging effect that is helpful in measuring sounds of a rapidly varying nature or of low frequencies. However, for a noise pulse of 0.5 second duration, such a meter will typically read 2 to 6 dB low. It is not satisfactory for measuring intermittent sounds.

4.5.4 "A" Weighting Scale Measurements

Comment: Maximum noise level measurements with the "A" network weighting scale are taken with the sound level meter switched to the "A" network per the manufacturer's instructions. The meter must be properly positioned with respect to the noise source per the manufacturer's instructions. Information and data taken during the measurements should be recorded on Form NPCS-4 or equivalent as shown in Figure 4-3.

4.5.5 Statistical Noise

Comment: The statistical noise level is that noise level exceeded a stated percentage of the time. An $L_{10} = 65$ dBA means that in any consecutive 60 minute period of the day 65 dBA is equalled or exceeded only 10% of the time, or for a total of 6 minutes. Several procedures are in use by the Department to determine statistical noise levels and other methods may be approved in writing from the Department. Three acceptable procedures to determine the statistical noise level are presented in Section 6 of this Chapter. Information and data taken during the measurements should be recorded on Form NPCS-10-1 or equivalent as shown in Figure 4-9. Statistical calculations can be carried out on Forms NPCS-10-2 and NPCS-10-3 and should be summarized in "L" terminology on Form NPCS-4. An example of a completed Form NPCS-4 is presented in Figure 4.4.

4.5.6 Ambient Noise Determination

Comment: The ambient noise level is a composite of sounds from many sources near and afar. As the ambient noise level will be compared to the noise level with the source included in any consecutive 60 minute period, it is important that data is obtained in time periods of interest during the day and also both the week and

the weekend to obtain data which are representative. It is also important to note that the data must be taken without emphasis on either noise peaks or unusual quiet.

Measurements should not be taken in weather conditions which may create a bias in the data. Wet streets or snow accumulations could bias the data unless these conditions are typical for the community.

Measurements should be made at least at several appropriate locations within the sampling area under consideration. Measurements should be made randomly in the sense that each location and each sampling time has the same chance of being sampled and that the selection of any one factor in no way influences the choice of another. Measurements should be made on at least three separate days.

The ambient statistical noise levels obtained or predicted with the noise source in question operating, should include all noises generated by that source. This may include such sources as increased motor vehicle traffic noise, safety warning device noise, and other sounds that may be exempted from the rules due to other considerations.

Procedures to determine the L_{10} and L_{50}, statistical noise levels are presented in Section 6 of this Chapter. Information and data taken during the measurements should be recorded on Form NPCS-4 or equivalent as shown in Figure 4-4.

4.5.7 Octave Band Noise Measurement

Octave band noise measurements shall be made on an octave band frequency analyzer per document NPCS-2, Requirements for Sound Measuring Instruments and Personnel.

Comment: Octave band sound pressure levels may be measured in the same manner as the "A" weighting scale measurements, except that the octave band filters shall be used in place of the "A" weighting network. Information and data taken during the measurements should be recorded on Form NPCS-5 or equivalent as shown in Figure 4.5. An example of a completed form NPCS-5 is presented in Fig. 4-6.

4.5.8 Tape Recording

Comment: Tape recording of the noise and a calibration signal is optional. The tape recorder system must conform to the specifications defined in document NPCS-2 Requirements for Sound Measuring Instruments and Personnel.

4.5.9 One-Third Octave Band Noise Measurement

One-third octave band noise measurements shall be made on a one-third octave band frequency analyzer per document NPCS-2, Requirements for Sound Measuring Instruments and Personnel.

Comment: One-third octave band sound pressure levels may be measured in the same manner as the "A" weighting scale measurements, except that the one-third octave band filter shall be used in place of the "A" weighting network. Information and data taken during the measurements should be recorded on form NPCS-29 or equivalent as shown in Figure 4-7. An example is shown in Figure 4-8.

4.5.10 Impulse Measurements

Impulse measurements shall be made on meters per document NPCS-2, Requirements for Sound Measuring Instruments and Personnel. Impulse sound pressure levels are to be taken with the meter set to the linear unweighted scale with the peak detector circuit engaged for unweighted (dB) impulse measurements. For "C" weighted (dBC) impulse measurements the meter is set to the "C" weighting scale and the meter speed is set to the "SLOW" damping response.

Comment: Information and data should be recorded on Form NPCS-4 or equivalent as shown in Figure 4-3. An example of a completed form is presented in Figure 4-4.

DEPARTMENT OF ENVIRONMENTAL QUALITY

File _____

SOUND PRESSURE LEVEL DATA SHEETS

County

SOURCE _____ BY

_____ DATE

_____ SHEET

_____

COMPLAINANT _____

_____

COMPLAINT DATE _____

INSTRUMENTATION		
EQT	TYPE	SERIAL
SLM		
MIC		
FLTR		
CAL		
Windscreen ON OFF		

Time	Bat. Ck.	Cal. dB	°F dry bulb	°F wet bulb	% RH	Press. mm Hg	Wind mph	Wind Direct

Measurement Position	Meter Fast/Slow	A Scale	C Scale	Linear Scale	L_1	L_{10}	L_{50}	Peak Impulse

Comments _____

_____

_____

_____

Form NPCS-4

INSTRUMENT SET-UP
CHECK-OFF LIST

- ☐ Site Selection
- ☐ SLM Position
- ☐ Battery Check
- ☐ Calibration Adjustment
- ☐ Wind Below 10 MPH
- ☐ Humidity Below 95%
- ☐ Windscreen

1. Days of Operation
   - A. Mon. - Fri.
   - B. Mon. - Sat.
   - C. Mon. - Sun.
2. Time of Operation
   - A. 8 a.m. - 5 p.m.
   - B. _ a.m. - _ p.m.
3. Number of Shifts
   - A. One
   - B. Two
   - C. Three
4. Distance from Receiver to source _____feet.
5. Visibility to Source
   - A. Direct _____
   - B. Hill or Berm
   - C. Trees _____
   - D. Other _____
6. Zoning
   - A. Residance _____
   - B. Plant or Facility _____
7. Who came first?
   - A. Residance...Date _____
   - B. Plant or Facility _____
8. Petition Submitted
   - A. Yes... Number _
   - B. No

SKETCH OF MEASUREMENT SITE AND SOURCE

REVERSE SIDE FORM NPCS-4
FIGURE 4-3

NPCS-4

DEPARTMENT OF ENVIRONMENTAL QUALITY

SOUND PRESSURE LEVEL DATA SHEETS

File Industry

County Multnomah

SOURCE Oregon Paving Co.
1000 SE 101st, Portland
Rock crusher

BY C. M. Sroka

DATE 6/6/74

SHEET 1/2

COMPLAINANT Mr. Eastland
155 SE Millman Dr, Portland

COMPLAINT DATE 5/10/74

INSTRUMENTATION		
EQT	TYPE	SERIAL
SLM	GR 1565B	
MIC	GR	
FLTR		
CAL	GR 1562	Del [illegible]
Windscreen (ON) OFF		

Time	Bat. Ck.	Cal. dB	°F dry bulb	°F wet bulb	% RH	Press. mm Hg	Wind mph	Wind Direct
1:45p	✓	114	67	51	29	—	0.5	W

Measurement Position	Meter Fast/Slow	A Scale	C Scale	Linear Scale	L_1	L_{10}	L_{50}	Peak Impulse
1	fast	78		85				106
2	fast				79	75	70	

Comments An occasional bus or truck; ambient noise without crusher operating is 51-57 dBA.

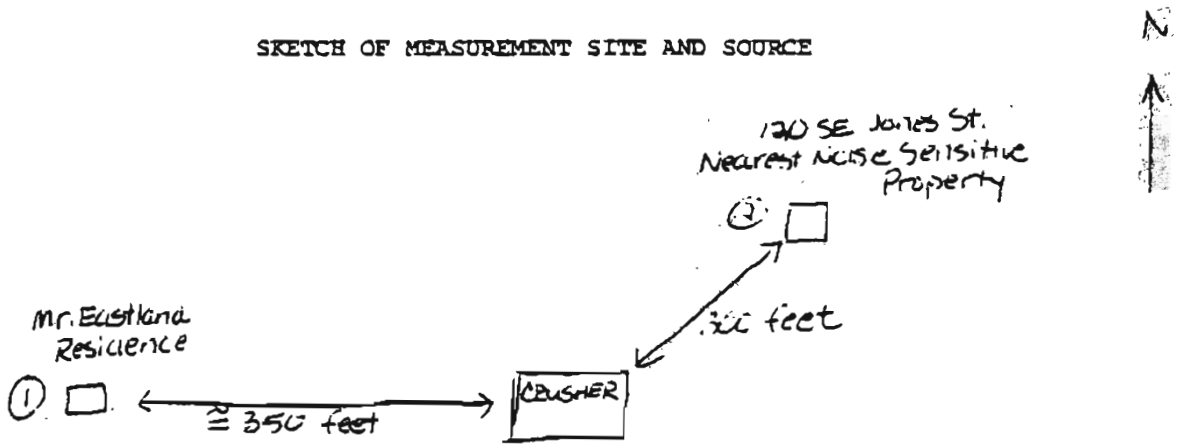
Example Form NPCS-4

INSTRUMENT SET-UP
CHECK-OFF LIST

- ☑ Site Selection
- ☑ SLM Position
- ☑ Battery Check
- ☑ Calibration Adjustment
- ☑ Wind Below 10 MPH
- ☑ Humidity Below 95%
- ☑ Windscreen

1. Days of Operation
   - (A) Mon. - Fri.
   - B. Mon. - Sat.
   - C. Mon. - Sun.
2. Time of Operation
   - A. 8 a.m. - 5 p.m.
   - (B) 6 a.m. - 9 p.m.
3. Number of Shifts
   - A. One
   - (B) Two
   - C. Three
4. Distance from Receiver to source 300-350 feet.
5. Visibility to Source
   - (A) Direct _____
   - B. Hill or Berm _____
   - C. Trees _____
   - D. Other _____
6. Zoning
   - (A) Residence _____
   - B. Plant or Facility _____
7. Who came first?
   - (A) Residence...Date _____
   - B. Plant or Facility
8. Petition Submitted
   - (A) Yes... Number 300 Sig?
   - B. No

SKETCH OF MEASUREMENT SITE AND SOURCE



Example Form NPCS-4
Figure 4-4 REVERSE SIDE FORM

DEPARTMENT OF ENVIRONMENTAL QUALITY

SOUND PRESSURE LEVEL DATA SHEETS

File _____

County _____

SOURCE _____

BY

DATE _____

SHEET 1

COMPLAINANT _____

COMPLAINT DATE _____

INSTRUMENTATION		
EQT	TYPE	SERIAL
SLM		
MIC		
FLTR		
CAL		
Windscreen ON OFF		

Time	Bat. Ck.	Cal. dB	°F dry bulb	°F wet bulb	% RH	Press. mm Hg	Wind mph	Wind Direct

Position	Fast/ Slow	A Scale	Lin. Scale	31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz

Comments _____

Form NPCS-5
Figure 4-5

NPCS-5

INSTRUMENT SET-UP
CHECK-OFF LIST

- ☐ Site Selection
- ☐ SLM Position
- ☐ Battery Check
- ☐ Calibration Adjustment
- ☐ Wind Below 10 MPH
- ☐ Humidity Below 95%
- ☐ Windscreen

1. Days of Operation
   - A. Mon. - Fri.
   - B. Mon. - Sat.
   - C. Mon. - Sun.
2. Time of Operation
   - A. 8 a.m. - 5 p.m.
   - B. _ a.m. - _ p.m.
3. Number of Shifts
   - A. One
   - B. Two
   - C. Three
4. Distance from Receiver to source _____feet.
5. Visibility to Source
   - A. Direct _____
   - B. Hill or Berm _____
   - C. Trees _____
   - D. Other _____
6. Zoning
   - A. Residence _____
   - B. Plant or Facility _____
7. Who came first?
   - A. Residence...Date _____
   - B. Plant or Facility _____
8. Petition Submitted
   - A. Yes... Number _____
   - B. No

SKETCH OF MEASUREMENT SITE AND SOURCE

FIGURE 4-5
REVERSE SIDE FORM NPCS-5

DEPARTMENT OF ENVIRONMENTAL QUALITY

SOUND PRESSURE LEVEL DATA SHEETS

File Industry

County Lane

SOURCE Sam's Sawmill
1200 East Road
Eugene

BY LCVR - GCS

DATE 4/27/74

SHEET 1 / 1

COMPLAINANT Mr. Ed Jones
100 North St., Eugene

COMPLAINT DATE April 19, 1974

INSTRUMENTATION		
EQT	TYPE	SERIAL
SLM	G.R. 1933	2250 1591
MIC	G.R.	[illegible]
FLTR	G.R.	1250
CAL	G.R. [illegible]	[illegible]
Windscreen ON OFF		

Time	Bat. Ck.	Cal. dB	°F dry bulb	°F wet bulb	% RH	Press. mm Hg	Wind mph	Wind Direct
3:40 pm	OK	114	67	51	47	—	4	W
4:07 pm	OK	114.0						

Position	Fast/ Slow	A Scale	Lin. Scale	31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
1	S	47	63	55	55	54	54	50	44	38	30	[illegible]

Comments Measurements taken during "blower" operation. Readings taken from 3:51 through 4:02 pm.

Example Form NPCS-5
Figure 4-6

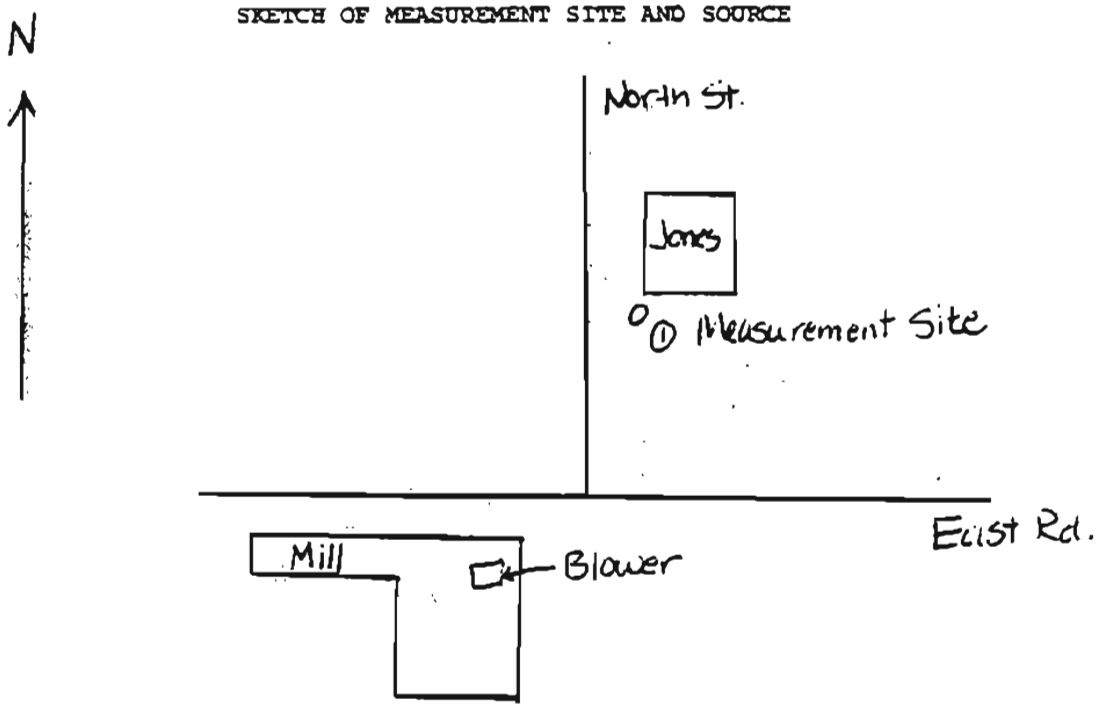
NPCS-5

INSTRUMENT SET-UP
CHECK-OFF LIST

- [x] Site Selection
- [x] SLM Position
- [x] Battery Check
- [x] Calibration Adjustment
- [x] Wind Below 10 MPH
- [x] Humidity Below 95%
- [x] Windscreen

1. Days of Operation
   - A. Mon. - Fri.
   - (B) Mon. - Sat.
   - C. Mon. - Sun.
2. Time of Operation
   - A. 8 a.m. - 5 p.m.
   - (B) 8 a.m. - 4 p.m.
3. Number of Shifts
   - A. One
   - (B) Two
   - C. Three
4. Distance from Receiver to source ≈300 feet.
5. Visibility to Source
   - A. Direct X
   - B. Hill or Berm
   - C. Trees
   - D. Other
6. Zoning
   - A. Residence X
   - B. Plant or Facility
7. Who came first?
   - (A) Residence...Date 1952
   - B. Plant or Facility
8. Petition Submitted
   - A. Yes... Number
   - (B) No

SKETCH OF MEASUREMENT SITE AND SOURCE



Example Form NPCS-5
Figure 4-6
REVERSE SIDE OF FORM

DEPARTMENT OF ENVIRONMENTAL QUALITY

1/3 OCTAVE BAND DATA SHEET

File

County _____

SOURCE _____ BY _____

_____ DATE

_____ SHEET

_____

COMPLAINANT _____

_____

COMPLAINT DATE _____

INSTRUMENTATION		
EQT	TYPE	SERIAL
SLM		
MIC		
FLTR		
CAL		

Windscreen ON OFF

Time	Bat. Ck.	Cal. dB	°F dry bulb	°F wet bulb	% RH	Press. mm Hg	Wind mph	Wind Direct

PREFERRED CENTER FREQUENCIES FOR 1/3 OCTAVE BANDS

osition	Lin. Scale	20 Hz	25 Hz	30 Hz	40 Hz	50 Hz	63 Hz	80 Hz	100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz
osition	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000	6300	8000	10,000	12,500

omments _____

_____

_____

_____

Figure 4-7 Form NPCS-29

NPCS-29

DEPARTMENT OF ENVIRONMENTAL QUALITY

1/3 OCTAVE BAND DATA SHEET

I+C

File NP-ABC Lumber

County Coos

SOURCE ABC Lumber Co.
1000 "F" St.
Coos Bay, OR

BY B. Hammon

DATE 9-18-81

COMPLAINANT Mr. Joe Smith
1245 "D" St., Coos Bay

COMPLAINT DATE 9-16-81

INSTRUMENTATION		
EQT	TYPE	SERIAL
SLM	B+K 2209	396472
MIC	B+K 4145	311347
FLTR	B+K 1618	923111
CAL	B+K 4220	376042
MAG TAPE	B+K 7003	704619
Windscreen	(ON)	OFF

Time	Bat. Ck.	Cal. dB	°F dry bulb	°F wet bulb	% RH	Press. mm Hg	Wind mph	Wind Direct
2:00 PM	✓	124.0	66°	PARTLY CLOUDY			4-6	SW
3:10 PM	✓	124.0	69°	"			2-4	"

PREFERRED CENTER FREQUENCIES FOR /3 OCTAVE BANDS

Position	Lin. Scale	20 Hz	25 Hz	30 Hz	40 Hz	50 Hz	63 Hz	80 Hz	100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz
1	70	58	60	59	58	59	60	59	59	58	57	56	54	52	51

Position	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000	6300	8000		
1	50	48	46	45	53	43	41	40	40	37	38	36	37	32	28

Comments SAMPLE TAKEN 2:13 TO 2:35 PM PDT. PRIMARY IS A LARGE SAW. PRODUCES WHINE IN 1250 Hz. BAND

NPCS-29

4.6 Statistical Noise Level Calculations

4.6.1 Hand Sample Method (Comment)

a. For this method use forms NPCS-10-1, NPCS-10-2, and NPCS-10-3 as shown in Figures 4-9 through 4-11 or equivalent.

b. Perform a short noise survey to determine the approximate range of sound levels produced by the noise source being investigated. Enter the approximate high and low noise levels as well as the central tendency on form NPCS-10-1. Use the minimum and maximum sound levels and the table at the back-bottom of form NPCS-10-1 to estimate the minimum number of good sound samples needed to be taken from the source in question. For example, in Figure 4-12 the noise varied from a high of approximately 67 dBA to a low of 61 dBA. This is a 6 dBA variation. The table on NPCS-10-1 indicates that a minimum of 132 good readings needs to be taken.

The table on NPCS-10-1 is designed to give an acceptable statistical confidence in the L_{10} and L_{50} noise level. For determining the L_1 noise level with confidence or for more complex noise sources, more noise samples than indicated in the table may be necessary.

c. Record the noise levels in dBA on Form NPCS-10-1 at five second intervals, at ten second intervals, or at fifteen second intervals. An example of such a measurement is presented in Figure 4-12. Note any unusual activity from the noise source in question. Also indicate all external or extraneous noise sources which may contaminate the noise reading. Examples include sounds from passing vehicle traffic and aircraft. The sound readings associated with these external sources will not be included in the statistical noise level calculations. If external sounds contaminate the measurements for a significant amount of time, it may be necessary to conduct the survey during a period of the day in which these other sources are absent or quieter.

d. Using Form NPCS-10-2, tally the recorded noise levels in 1 dBA increments as the example shows in Figure 4-13. Record on NPCS-2 only those sound levels which are legitimately associated with the source in question, ignoring all other contaminating sound levels.

In the "Number of Readings" column, sum the total readings at each dBA level. Using the "Number Greater Than" column, calculate the number of readings taken that are greater than each particular level. For example, in Figure 4-13 there are no readings greater than 74 dBA, hence the "Number Greater Than " is zero. There is one reading taken at a level greater than 73 dBA, and three (1 plus 2) readings greater than 72 dBA.

The percent greater than (% Greater Than) column contains the statistical percent for each dBA level. The percent is calculated by dividing the numbers in the "Number Greater Than" column by the total number of readings times 100. For example, the percent of 73 dBA is calculated as (1/194) x 100 = 0.5%, and the percent at 72 dBA is (3/194) x 100 = 1.5%.

e. Using Form NPCS-10-3, the dBA levels versus the "percent greater than" numbers are plotted. An example of this is shown in Figure 4-14.

From the resulting graph, the statistical noise level at any required percentage may be found. For example, the L_{50} and L_{10} are found to be 63 dBA and 66 dBA, respectively. Note that a normalized or randomly varying noise source will result in a straight line when plotted on form NPCS-10-3.

f. The results from the statistical survey are then summarized on form NPCS-4 (see Figure 4-4). On the back of NPCS-4 a sketch of the measurement site should be drawn.

g. A typical noise survey will require approximately 20 minutes of measuring to record the required number of samples at a 5-second sample interval. However, the noise standards for industrial and commercial noise sources (OAR 340-35-035) are specified for a one-hour (60 minute) period. Therefore, the noise investigator must ensure that the noise survey represents sounds that are typical of a full 60-minute operation of the noise source. If the source significantly changes its operation for the remainder of the hour, it is recommended that a full 60 minutes of samples are measured and recorded for the statistical analysis.

h. The documentation of the L_1 statistical noise level is often better accomplished by the "time above" method. For noise sources that operate for a short period of time at a constant sound level, an accurate determination of the L_1 noise level can be determined by measuring the total amount of time the noise source operates in a one-hour period. If

the source operates for a period of 36 seconds or greater within the hour (but less than 6 minutes), then the L_1 is equal to the measured noise level. If the source operates for 6 minutes or more during the hour, then the measured level is the L_{10} statistical noise level.

4.6.2 Noise Exposure Counter or Monitor Method

Comment: Statistical noise levels may be obtained through the use of several commercially designed devices that sample and classify the data.

4.6.3 Programmable Calculator Method

Comment: The noise staff of the Department has developed a program to calculate statistical noise levels on a Wang 600 series programmable calculator. This method will digitally make the necessary calculations after the analog noise data has been converted to digital data. As this method is specialized to the Department's facilities, it will not be presented here. A complete explanation of the method and program listing is on file at the Department in Manual NPCS-22, Analysis of Ambient Noise with the Wang 600 Series Programmable Calculator.

DEPARTMENT OF ENVIRONMENTAL QUALITY

STATISTICAL NOISE SURVEY

SOURCE: _____ DATE:

_____ BY:

MEASUREMENT SITE: _____ COUNTY: _____

_____ SHEET: /

Time	Bat.	Calibration dB	F dry bulb	F wet bulb	%RH	Press. mm Hg.	Wind MPH	Wind direct.

INSTRUMENTATION		
EQUT	TYPE	SERIAL
SLM		
MIC		
CAL		

WINDSCREEN: ON OFF

~ Range of Noise: Hi _____ dBA Low _____ dBA Central Tend. _____ dBA

Start Time: _____ Sample Interval: 5 10 15 seconds

DATA POINTS	SOUND PRESSURE LEVEL dBA					
1 - 6						
7 - 12						
13 - 18						
19 - 24						
25 - 30						
31 - 36						
37 - 42						
43 - 48						
47 - 54						
55 - 60						
61 - 66						
67 - 72						
73 - 78						
79 - 84						
85 - 90						
91 - 96						
97 - 102						
103 - 108						
109 - 114						
115 - 120						
121 - 126						
127 - 132						

Figure 4-9
Form NPCS-10-1

Note: See back for the minimum number of samples.
Indicate all missing data points and give an explanation.

NPCS-10-1

6/76

133 - 138						
139 - 144						
145 - 150						
151 - 156						
157 - 162						
163 - 168						
169 - 174						
175 - 180						
181 - 186						
187 - 192						
193 - 198						
199 - 204						
205 - 210						
211 - 216						
217 - 222						
223 - 228						
229 - 234						
235 - 240						
241 - 246						
247 - 252						
253 - 258						
259 - 264						
265 - 270						
271 - 276						
277 - 282						
283 - 288						
289 - 294						
295 - 300						
301 - 306						
307 - 312						
313 - 318						
319 - 324						
325 - 330						
331 - 336						

Figure 4-9
Reverse Side Form NPCS-10-1

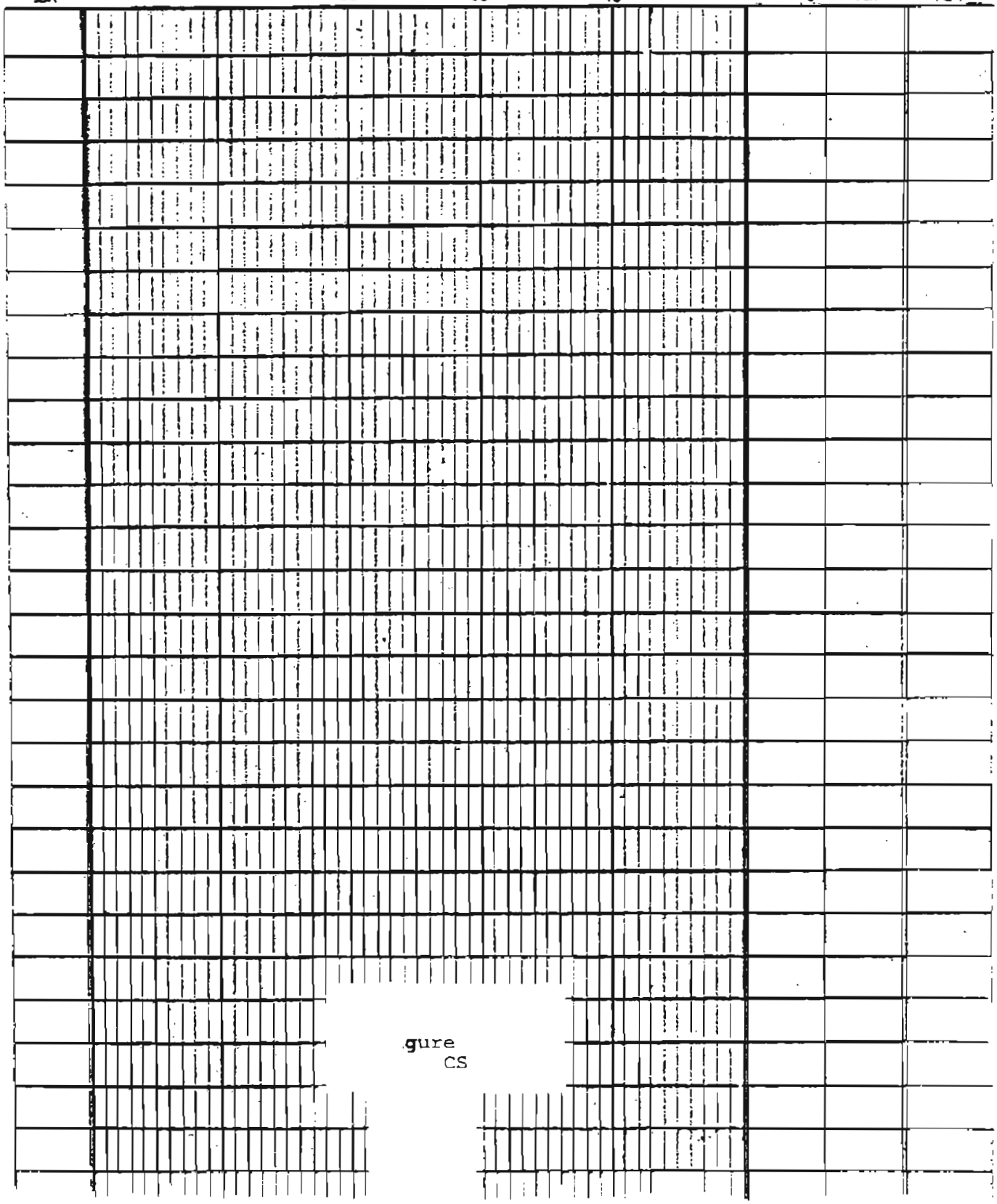
Maximum - Minimum Levels (difference in range)													
0-8	9	10	11	12	13	14	15	16	17	18	19	20	21
132	138	174	210	246	288	336	384	438	498	558	618	684	756
Minimum Number "Good" Samples													

Note: Indicate all missing data points and give an explanation. Additional data points may be needed to document an L_1 violation.

NPCS-10-1

DEPARTMEN OF ENVIRONMENTAL QUALITY
STATISTICAL COMPUTATION SHEE

te. _____ rce: _____ /



gure
CS

NPCS 2 6/76

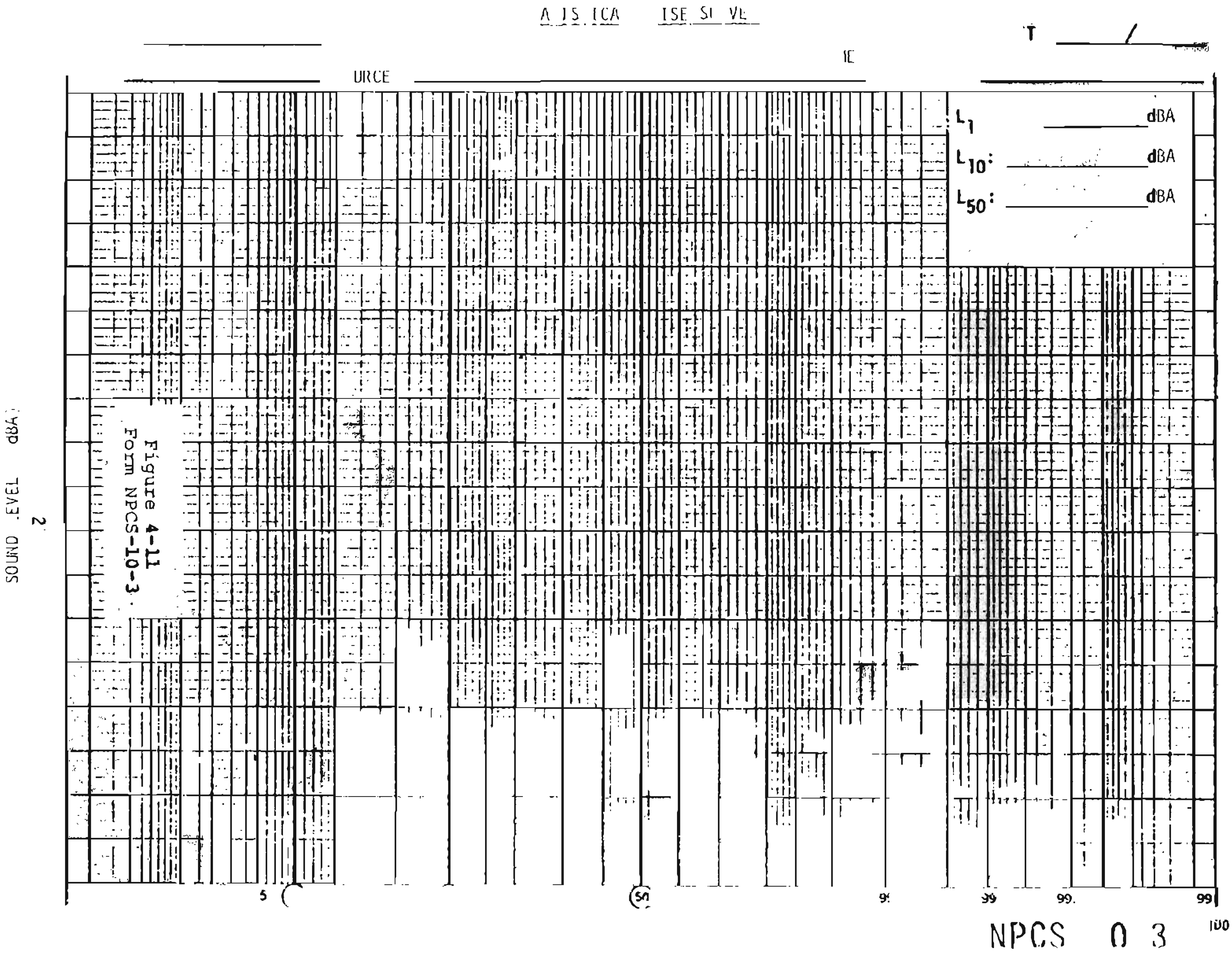


Figure 4-11
Form NPCS-10-3

SOURCE: ACME WOOD PRODUCTS INC. DATE: 9-16-81

1581 S.W. 76TH (DEBARKER, SAW, CHIPPER) BY: GTW

MEASUREMENT SITE: SITE 1, MR & MRS. JONES' NSP COUNTY: MULT.

1576 S.W. 76TH, PORTLAND SHEET: 2/4

Time	Bat.	Calibration dB	F dry bulb	F		Press. mm Hg.	Wind MPH	Wind direct.
1410	✓	114.0					0-5	NW
1515	✓	114.0					2-6	NW

INSTRUMENTATION		
EQUT	TYPE	SERIAL
SLM	GR 1565	12345
MIC	1"	
CAL	GR 1987	1790

WINDSCREEN (ON) OFF

~ Range of Noise: Hi 67 dBA Low 61 dBA Central Tend. 63 dBA

Start Time: 1420 PDT Sample Interval: (5) 10 15 seconds

DATA POINTS	SOUND PRESSURE LEVEL dBA					
1 - 6	65	63	62	61	64	65
7 - 12	63	61	65	CAR	CAR	64
13 - 18	63	62	70	65	63	62
19 - 24	70	62	DOG	64	63	61
25 - 30	62	63	63	61	67	67
31 - 36	TRUCK →	T	T	64	66	65
37 - 42	62	63	64	63	62	64
43 - 48	63	63	64	63	73 R	62
47 - 54	63	63	65	62	64	63
55 - 60	61	64	65	63	63	65
61 - 66	65	66	64	61	62	66
67 - 72	60	61	63	63	64	70
73 - 78	72	61	73 R	74 R	64	64
79 - 84	63	62	60	65	62	64
85 - 90	61	62	67	63	JET	JET →
91 - 96	JET	JET	65	64	64	64
97 - 102	70 R	63	64	63	62	65
103 - 108	66	65	66	62	64	63
109 - 114	64	64	62	63	65	64
115 - 120	64	67	63	64	DOG	DOG
121 - 126	65	66	67	64	66	69
127 - 132	69	CAR	CAR	63	66	64

Note: See back for the minimum number of samples. NPCS-10-1
Indicate all missing data points and give an explanation.

6/76

133 - 138	63	66	65	64	63	66
139 - 144	62	63	65	64	63	64
145 - 150	64	64	65	66	62	64
151 - 156	66	63	68	63	63	63
157 - 162	62	63	64	63	63	62
163 - 168	63	65	64	62	63	68
169 - 174	← COMPLAINANT		TALKING →		64	61
175 - 180	63	63	63	64	63	65
181 - 186	64	61	61	BIRDS →	B	63
187 - 192	64	63	64	62	65	64
193 - 198	62	64	63	62	64	62
199 - 204	CAR	CAR	63	64	60	63
205 - 210	64	62	62	TRUCK →	T	T
211 - 216	T	T	T	63	64	64
217 - 222	69	63	65	63	65	63
223 - 228						
229 - 234						
235 - 240						
241 - 246						
247 - 252						
253 - 258						
259 - 264						
265 - 270						
271 - 276						
277 - 282						
283 - 288						
289 - 294						
295 - 300						
301 - 306						
307 - 312						
313 - 318						
319 - 324						
325 - 330						
331 - 336						

Maximum - Minimum Levels (difference in range)

0-8	9	10	11	12	13	14	15	16	17	18	19	20	21
132	138	174	210	246	288	336	384	438	498	558	618	684	756

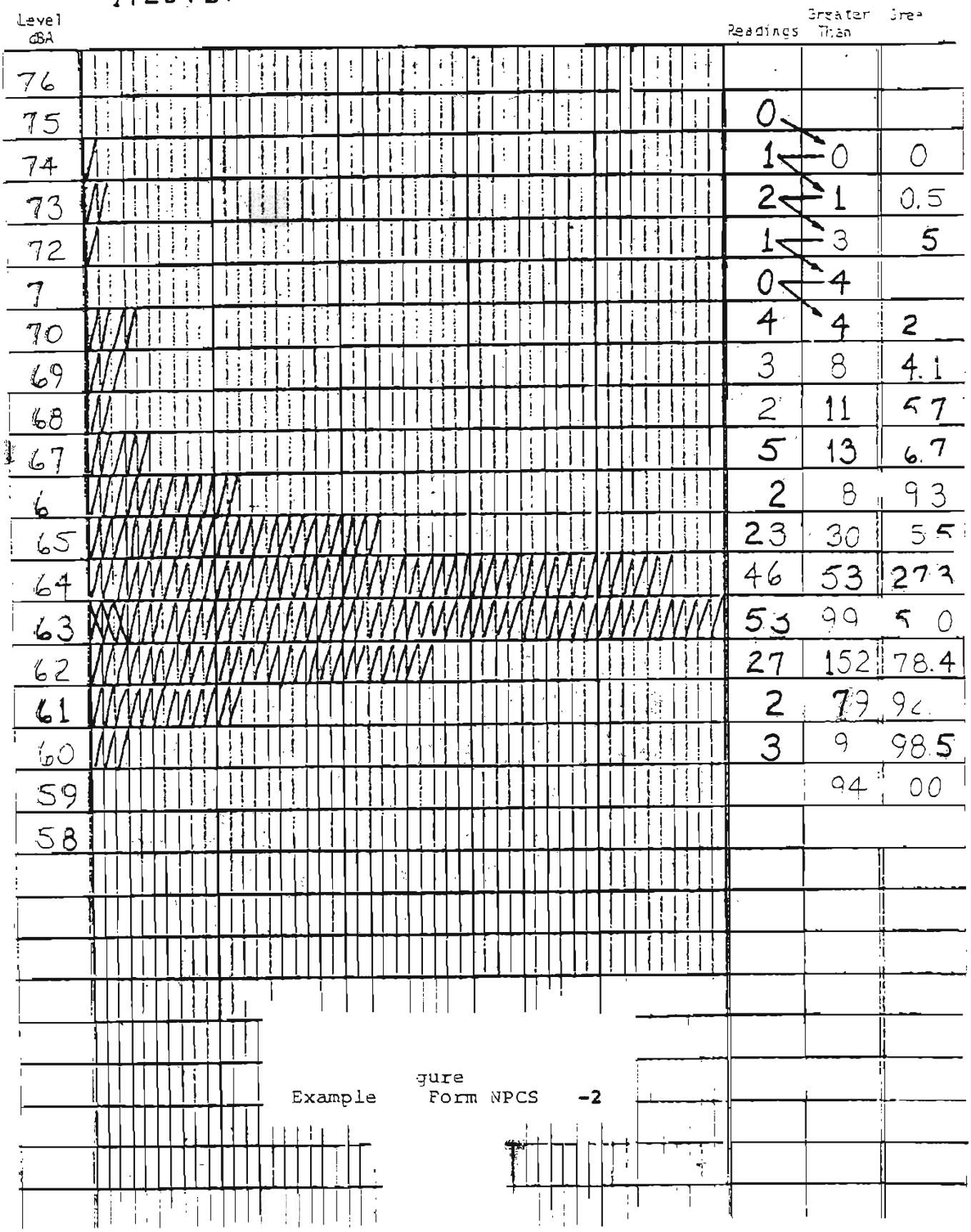
Minimum Number "Good" Samples

Additional data

NPCS-10-1

ICAL COMPI

Date 9-16-81 1420 PDT Source: ACME WOOD PRODUCTS INC. Sheet 3/4



Level dBA	Readings	Greater Than	Grea
76			
75	0		
74	1	0	0
73	2	1	0.5
72	1	3	5
7	0	4	
70	4	4	2
69	3	8	4.1
68	2	11	57
67	5	13	6.7
6	2	8	93
65	23	30	55
64	46	53	273
63	53	99	50
62	27	152	78.4
61	2	79	9[illegible]
60	3	9	98.5
59		94	00
58			

Example gure Form NPCS -2

NPCS 2

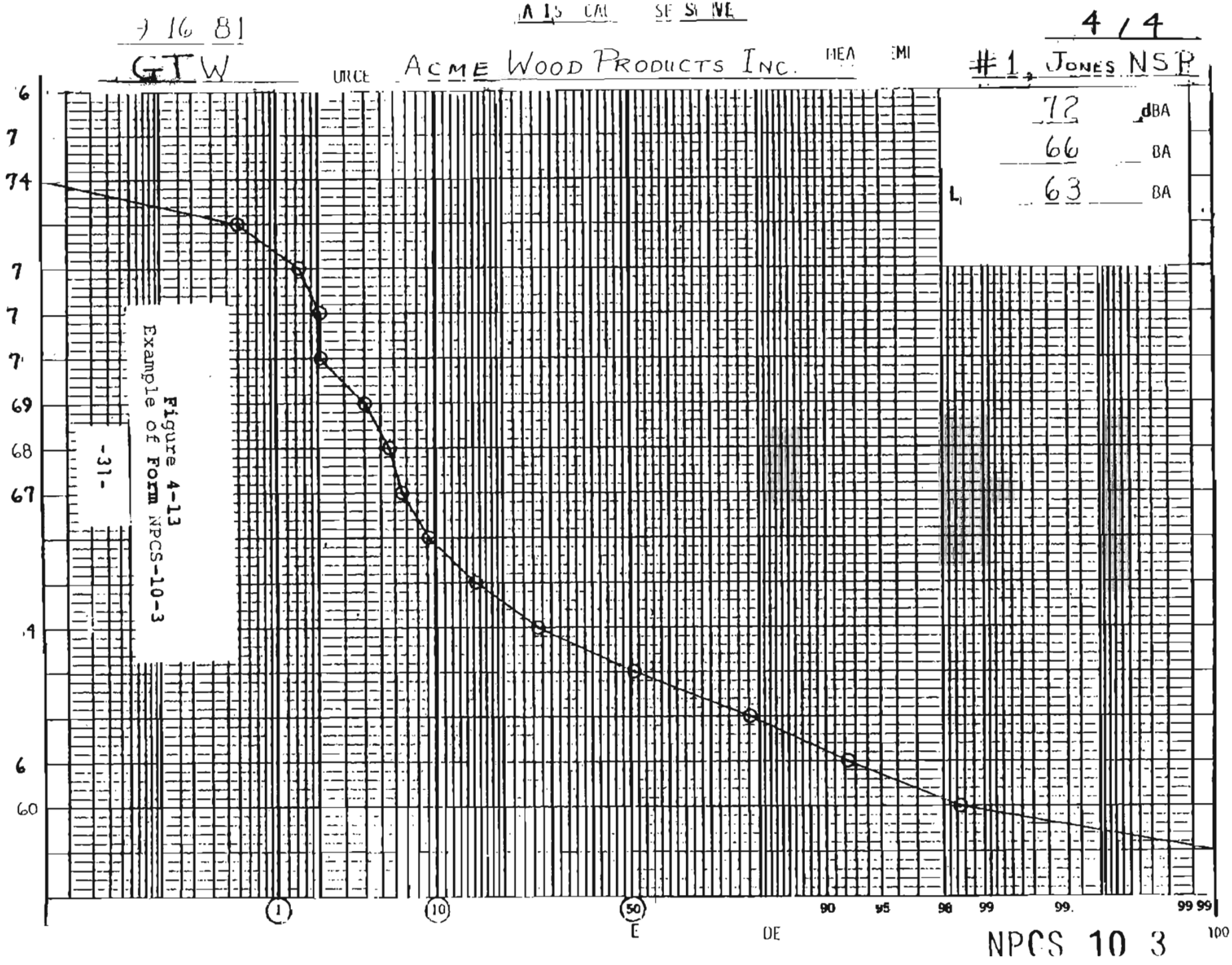


Figure 4-13
Example of Form NPCS-10-3

4.8.1 Point Source

Comment: The sound pressure level at a point r feet from a point source can be calculated from a sound pressure level measurement at a point r_o feet from the point source using the following equation:

$$SPL = SPL_o - 20 \log (r/r_o)$$

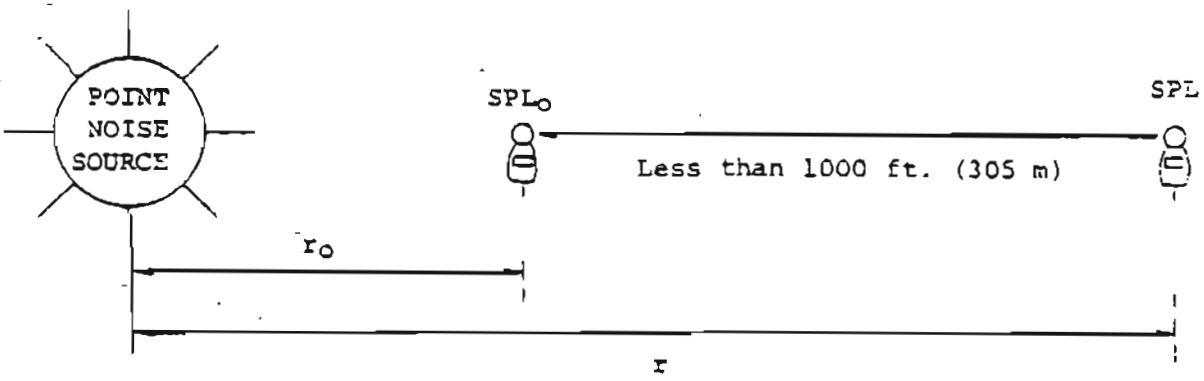
where:

SPL = sound pressure level at r feet from the source.

SPL_o = sound pressure level at r_o feet from the source. Note that r_o is a reference distance and that the distance r is always greater than r_o. The point r_o must be in the far field of the source.

Figure 4-15 illustrates a point source, such as an industrial site, and the distance at which the measurement SPL_o is taken and the distance where the required level, SPL is needed.

This projection technique is applicable only if the distance between r and r_o is less than 1000 feet. This projection technique should be used only when it is not practical to make a sound pressure level reading at r.



SOUND LEVEL ADJUSTMENT WITH DISTANCE

FIGURE 4-15

4.8.2 Line Source

Comment: The sound pressure level at a point r feet from a line source can be calculated from a sound pressure level measurement at a point r_o feet from the line source using the following equation:

$$SPL = SPL_o - 10 \log (r/r_o)$$

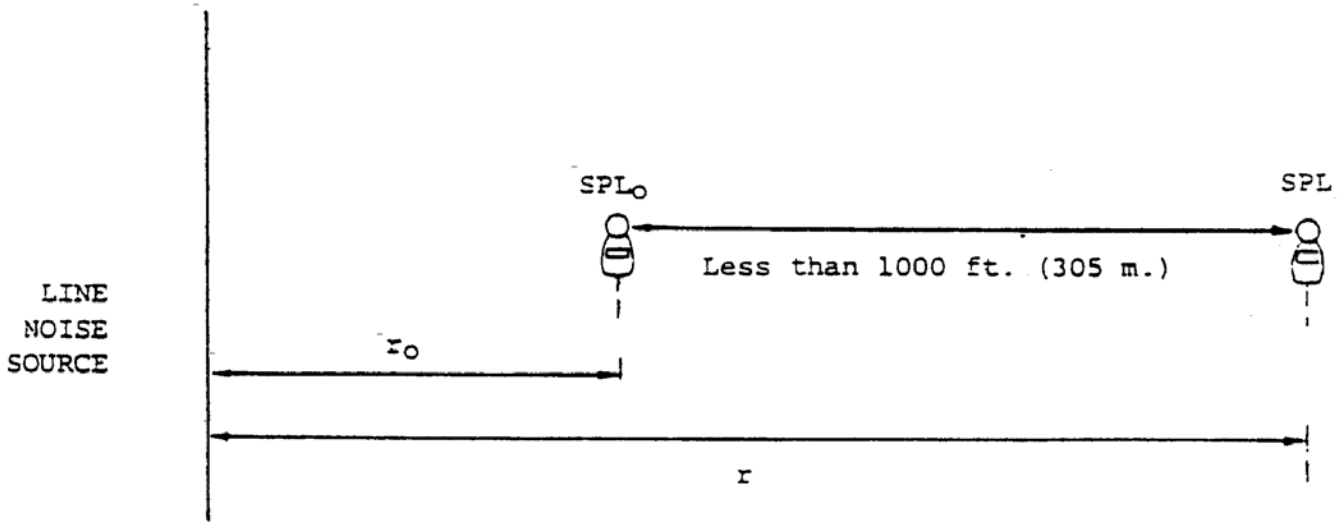
where:

SPL = sound pressure level at r feet from the source.

SPL_o = sound pressure level at r_o feet from the source. Note that r_o is a reference distance and that the distance r is always greater than r_o. The point r_o must be in the far field of the source.

Figure 4-16 illustrates a line source, such as a highway with closely spaced moving vehicles, and the distance at which the measurement, SPL_o is taken and the distance where the required level SPL is needed.

This projection technique is applicable only if the distance between r and r is less than 1000 feet. This projection technique should be used only when it is not practical to make a sound pressure level reading at point r.



LINE NOISE SOURCE DISTANCE ADJUSTMENT

FIGURE 4-16