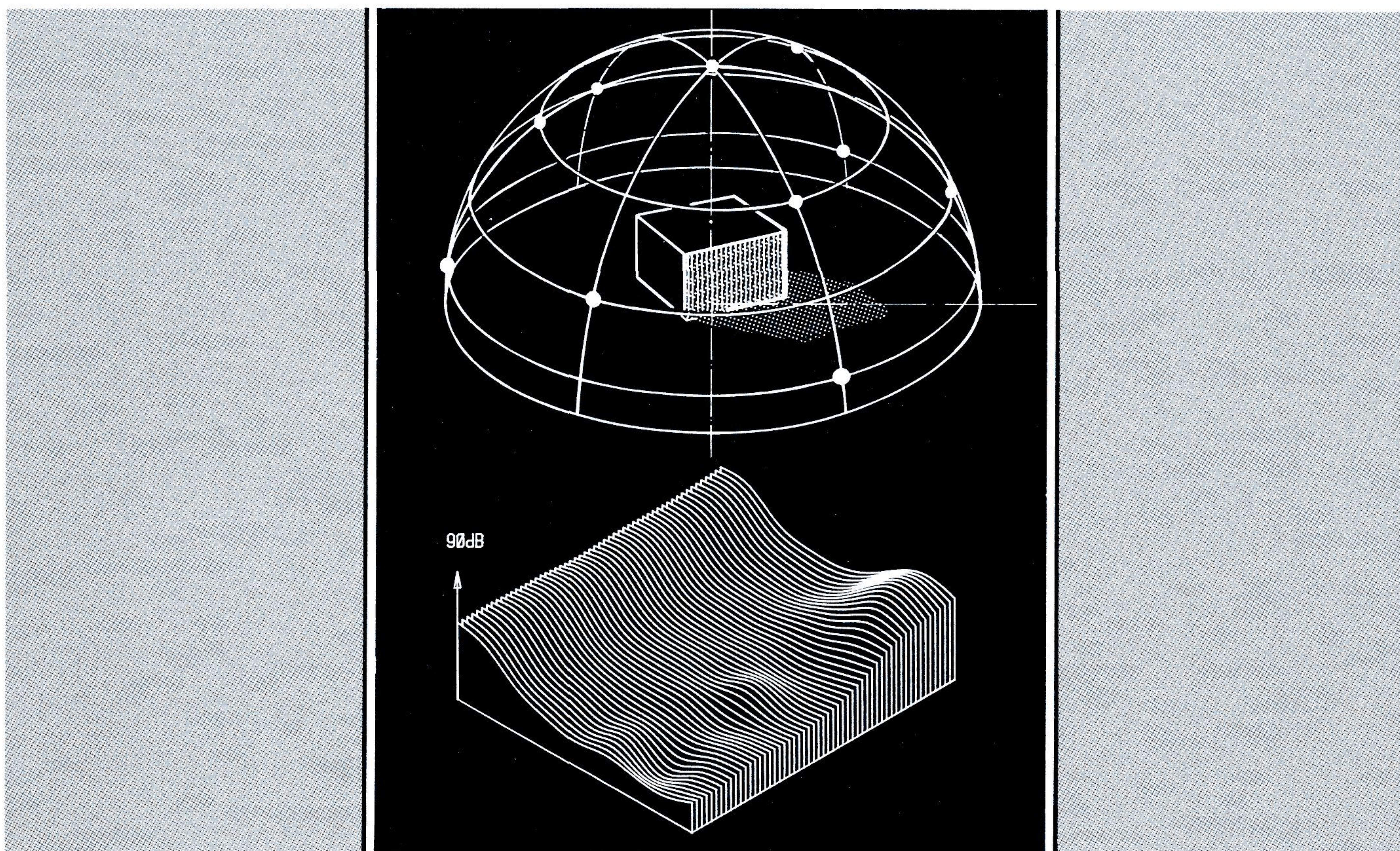




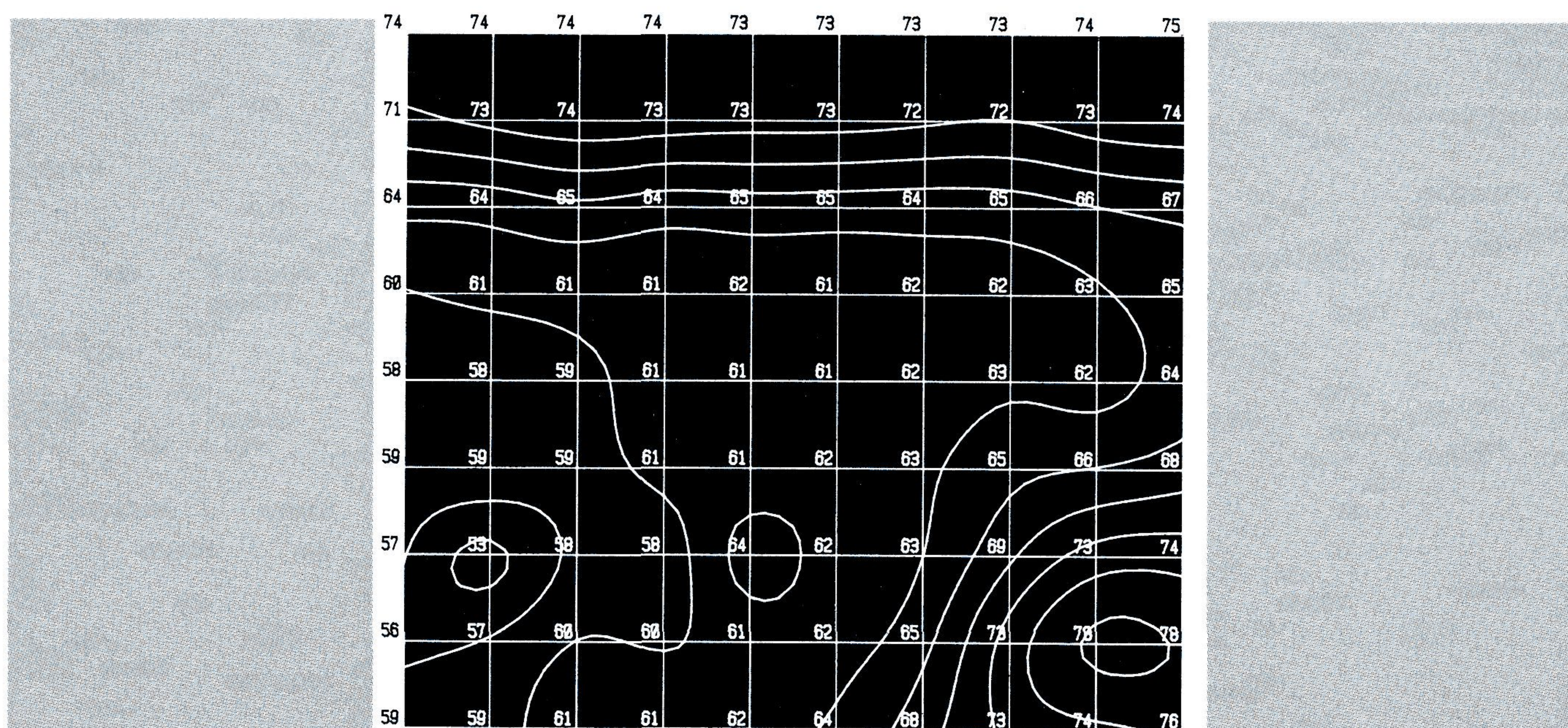
Brüel & Kjær

application notes

Software Package WW 9038



**for the Sound Intensity Analysing System Type 3360
or the Digital Frequency Analyzer Type 2131**



Software Package WW 9038 for the Sound Intensity Analysing System Type 3360 or the Digital Frequency Analyzer Type 2131

by Erik Mikkelsen, Brüel & Kjær

1. Introduction

The software package WW 9038 can be used with the Sound Intensity Analysing System Type 3360 for both sound intensity mapping and sound pressure mapping (noise mapping), and for calculation of sound power from either sound intensity or sound pressure measurements. With the Digital Frequency Analyzer Type 2131, the programs can be used for mapping of sound pressure and for calculation of sound power from sound pressure measurements.

WW 9038 can be delivered in HPL or BASIC 2.0 for use with the HP 9816, HP 9826 or HP 9836 desktop calculators. The programs are stored on a minidisc and require approximately 32 Kbytes user-memory. A list of the available program options is given in Appendix A and an example of a complete system is given in Appendix B.

The intensity or pressure maps can be made as numerical values, as three-dimensional plots and as equal intensity or equal pressure contours. The maps can be made for a selected 1/3 octave frequency band or for a specified frequency range, with or without A-weighting.

The sound power programs can be used to determine the sound power based on sound pressure measurements in a semi-anechoic room according to ISO 3745 and ANSI S1.35 (precision methods). The programs can also be used to determine the sound power based on sound intensity measurements in ordinary rooms, even in the presence of stationary background noise. As of yet no standards exist for sound power determination based on sound intensity measurements (spring 1983).

The programs allow the measurement surface to be specified as a number of segments of different areas or as a hemisphere divided into a number of sectors where the sector widths are specified by the operator.

2. Mapping Programs

The following programs are available for sound intensity or sound pressure mapping:

INPUT:	Input of data from the Digital Cassette Recorder Type 7400
CATALOG:	List of data stored on the program disc.
LIN-INTP:	Linear interpolation
LOG-INTP:	Logarithmic interpolation
DATA-MAP:	Numeric data mapping
CONT-MAP:	Contour mapping
3D-PLOT:	3-dimensional plot
3D-DEMO:	3-dimensional demonstration program
DUMP-PLT:	Dump plot from screen to printer

Before using the programs, the sound intensity or sound pressure spectra are recorded on the Digital Cassette Recorder Type 7400. Using the INPUT program the data is then transferred to the program disc. Then one of the two interpolation programs LIN-INTP or LOG-INTP is selected. After interpolation the programs DATA-MAP, CONT-MAP, 3D-PLOT or 3D-DEMO can be chosen.

2.1. Recording of Data

The Digital Cassette Recorder Type 7400 provides a convenient storage for the intensity spectra (Fig.1). One cassette can contain more than 1200 1/3 octave spectra. When recordings are performed in the field, the analyzer and the Type 7400 can be powered from a commercially available inverter, which may, for example, be connected to a car battery.

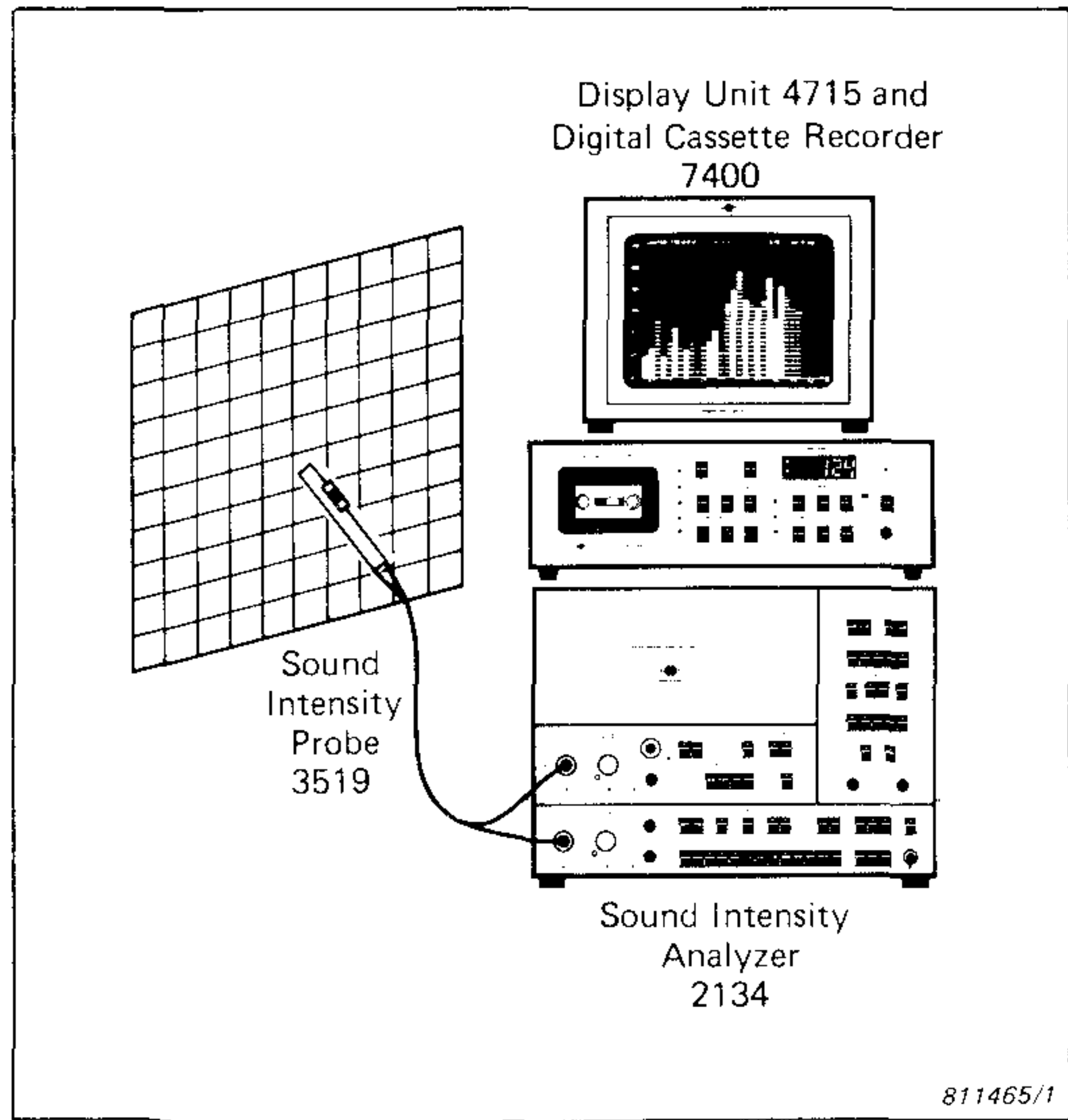


Fig.1. Data storage on Digital Cassette Recorder Type 7400

The data should be recorded as 1/3 octave spectra on the Type 7400 in the following order:

2n+1	3n
n+1	2n
1	n

The first measurement can be stored in any file on the Type 7400. The maximum number of rows and columns used in the plot is limited to 10, but any number of rows and columns can be recorded on the Type 7400.

In the recording process, the number of recorded spectra can easily be checked by watching the current file number displayed on the Type 7400 (each file corresponds to one spectrum). All recorded spectra can be read back continuously to the analyzer, enabling a quick manual check of the data.

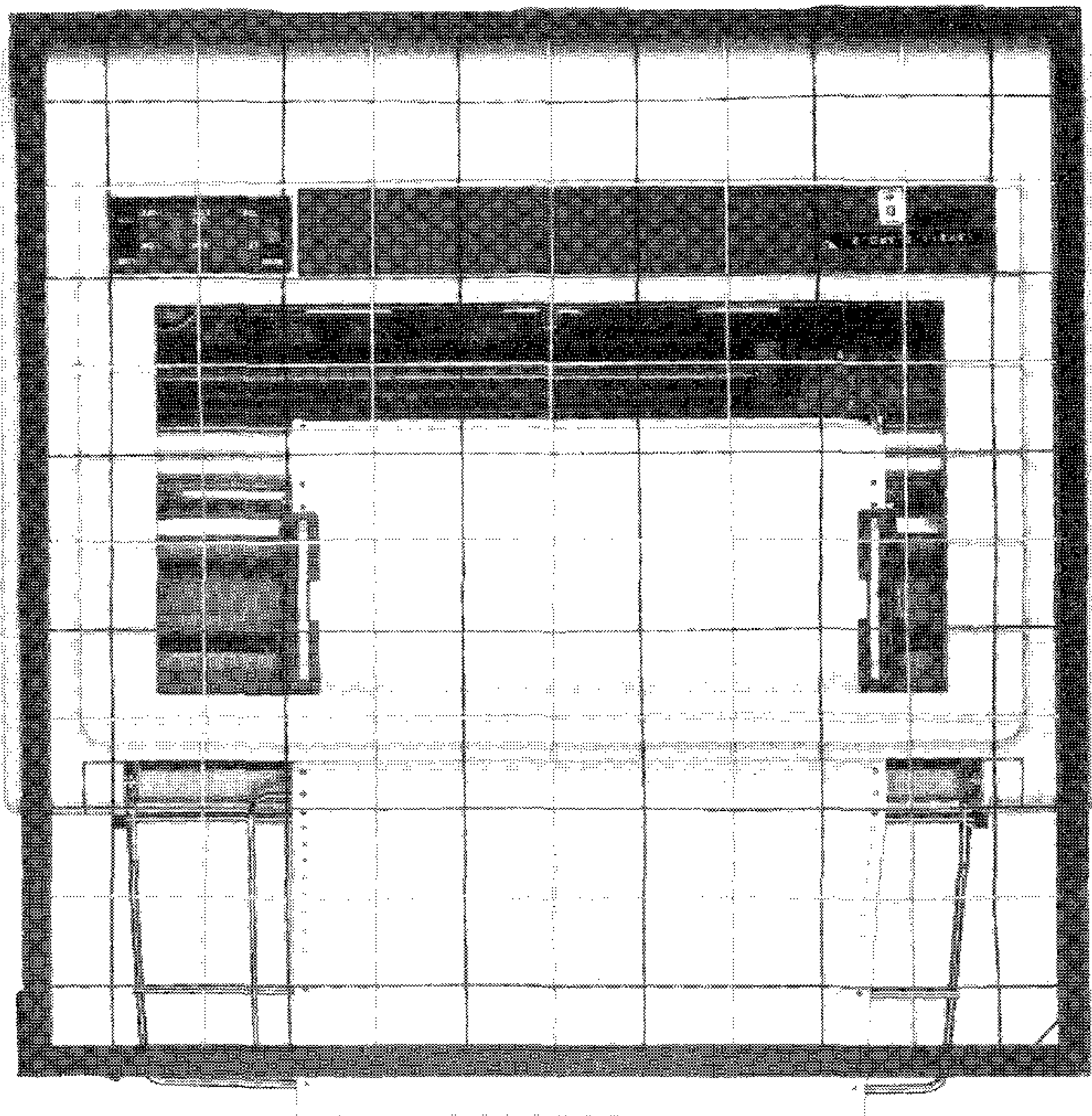


Fig.2. Grid used over a line printer for indication of the measurement locations

During the measurements a grid can be used for easy location of the measurement points. This is illustrated in Fig.2 where a grid is placed on top of a line printer. Instead of measuring at single points the measurements can be performed as space averages over small areas by sweeping the probe or the microphone over the areas with Linear Averaging selected on the analyzer.

In the laboratory, the data recorded on the Type 7400 or a part of the data can be transferred to the calculator and stored on the program disc using the program INPUT (Fig.3).

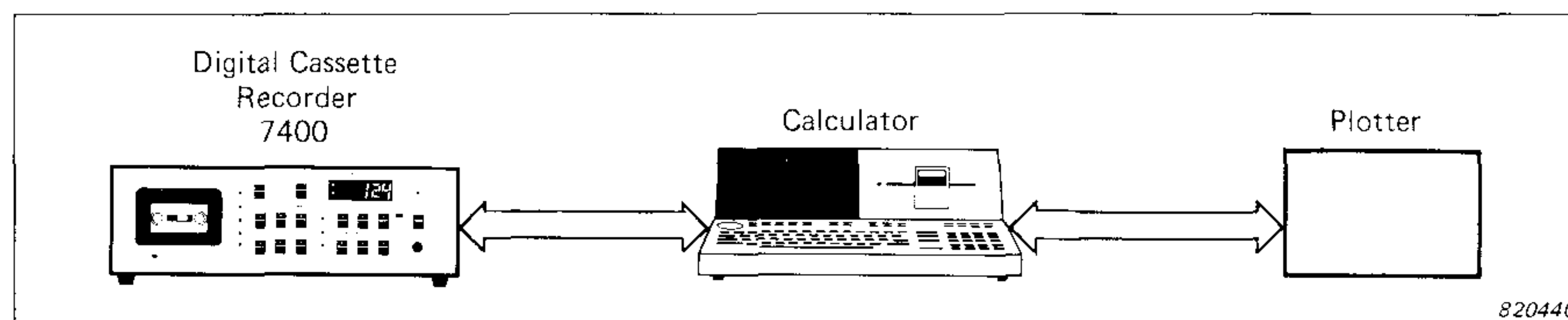


Fig.3. Instrumentation for plotting intensity or pressure maps

The program CATALOG can be used to give a list of the data stored on the program disc (files 1–12):

PREVIOUS RECORDINGS ON FILES 1–12:

FILE NO. 1: DEMO 1:
LINE PRINTER
FILE NO. 2: DEMO 1A:
CONTROL BUTTONS
FILE NO. 3: DEMO 2:
CAR ENGINE COVER
FILE NO. 4: ***EMPTY***
FILE NO. 5: ***EMPTY***
FILE NO. 6: ***EMPTY***
FILE NO. 7: ***EMPTY***
FILE NO. 8: ***EMPTY***
FILE NO. 9: ***EMPTY***
FILE NO. 10: ***EMPTY***
FILE NO. 11: ***EMPTY***
FILE NO. 12: ***EMPTY***

On delivery the above-listed data in files 1–3 is included as demonstration examples.

2.2. Interpolation

To obtain smooth lines in the plots, a spatial interpolation is performed.

One of the two interpolation programs LIN-INTP (linear interpolation) or LOG-INTP (logarithmic interpolation) is selected. The programs perform a Cubic Spline Interpolation (third-degree polynomials with the minimum curvature are computed by iteration between the measured datapoints; the adjacent polynomials are joined with continuous first and second derivatives). The linear interpolation is an interpolation in Watts, the logarithmic interpolation is an interpolation in dBs. The results will always be presented in dBs.

The logarithmic interpolation procedure should normally be used for sound pressure mapping or for sound intensity mapping when only “positive” or “negative” intensity levels are present in the data (“positive” intensity indicates that the measured intensity was incident on the front of the probe and “negative” intensity indicates that the measured intensity was incident on the rear of the probe). However, when both “positive” and “negative” intensity levels are present, the logarithmic interpolation will often give an overshoot around the area where the intensity direction changes. In this case the linear interpolation procedure is preferable.

The interpolation can be performed for a selected 1/3 octave frequency band or for a specified frequency range, with or without A-weighting.

The number of steps in the interpolation procedure can be selected by the operator. If 1 step is selected, no interpolation is performed. If 2 steps are selected, 1 extra data point is generated between all measured points. If 3 steps are selected, 2 extra data points are generated and so on.

The maximum number of steps depends on the number of measured data points and the memory size of the calculator. For approximately 64 Kbytes user-memory or more, 8 steps are possible for 10×10 measured data points. The total number of points after interpolation will in this case be: $(7 \times 9 + 10) \times (7 \times 9 + 10) = 73 \times 73$ points. For approximately 32 Kbytes user-memory, 5 steps are possible for 10×10 measured data points, giving a total number: $(4 \times 9 + 10) \times (4 \times 9 + 10) = 46 \times 46$ points.

2.3. Plot of Intensity or Pressure Maps

After interpolation the intensity or pressure maps can be plotted on a digital plotter or on the screen of the calculator. If a graphics printer is connected to the calculator, all plots made on the screen can be dumped to the printer using the program DUMP-PLT.

2.3.1. Data Mapping

The program DATA-MAP makes a numerical plot of the measured data, rounded to the nearest dB.

Fig.4 shows an example of the A-weighted intensity levels from 90 measurement locations over a line printer. Each grid point corresponds to a measurement point (or a measurement area).

74	74	74	74	73	73	73	73	74	75	
71	73	74	73	73	73	72	72	73	74	
64	64	65	64	65	65	64	65	66	67	DEMO 1:
60	61	61	61	62	61	62	62	63	65	LINE PRINTER
58	58	59	61	61	61	62	63	62	64	SOUND INTENSITY
59	59	59	61	61	62	63	65	66	68	6 mm MIC. SPACER
57	53	58	58	64	62	63	69	73	74	A-WEIGHTED RANGE:
56	57	60	60	61	62	65	73	78	78	400 Hz - 10000 Hz
59	59	61	61	62	64	68	73	74	76	REF. LEVEL: 30 dB

830210

Fig.4. Data map of intensity levels from a line printer

2.3.2. Three-Dimensional Plot

With the program 3D-PLOT either the "positive" or "negative" intensity or the sound pressure can be represented in a 3-dimensional plot. The operator can select the observation corner and the viewing angle for the plot as well as a base-line level which is the lowest level in the plot.

Fig.5 shows a 3-dimensional plot of the A-weighted intensity levels measured over the line printer from the previous example. The high intensity levels along the edge 4 to 3 correspond to the paper transport opening, the high levels near corner 2 correspond to the area around the control buttons.

The program package includes a demonstration program 3D-DEMO. This program draws a number of 3D-plots with different viewing angles on the screen. Thereafter the pictures are continuously shown on the screen. The number of pictures (maximum 10) are selected by the operator who can also control how fast the pictures are changed. The demonstration program can be used for selecting a suitable viewing angle for a 3-dimensional plot. The motion can be stopped and the current picture can be dumped to the printer using the program DUMP-PLT.

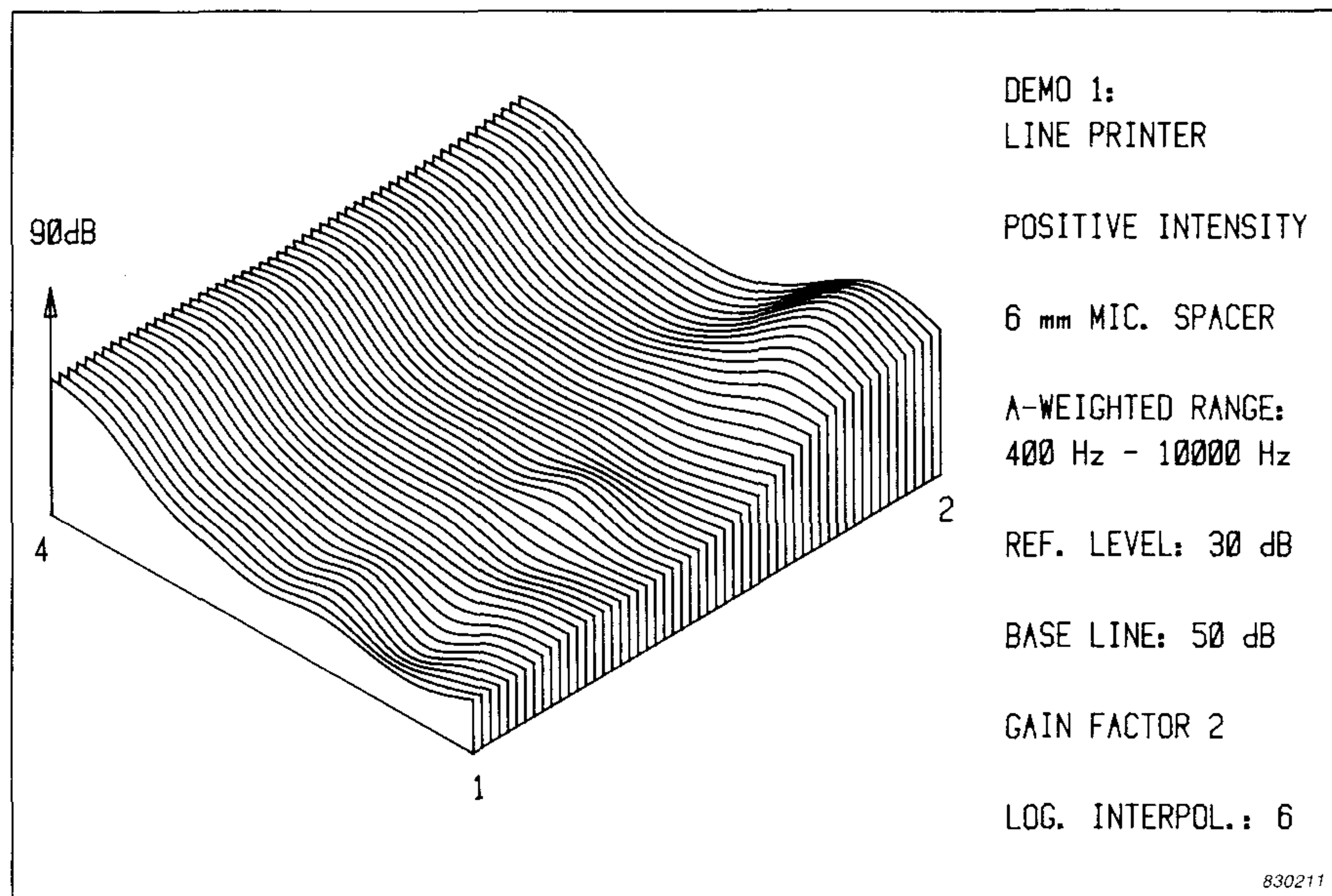


Fig.5. Three-dimensional plot of intensity levels from line printer

The demonstration program can only be used if more than approximately 80 Kbytes user-memory is available. 5 pictures require approximately 96 Kbytes user-memory on the HP 9816/26 and approximately 144 Kbytes on the HP 9836. 10 pictures require approximately 176 Kbytes user-memory on the HP 9816/26 and approximately 272 Kbytes on the HP 9836.

2.3.3. Contour Mapping

With the program CONT-MAP the equal intensity or equal pressure contour lines can be plotted. A base-line level can be selected for the contours (all levels below the base-line level will not appear in the plot) and the level between the contour lines can be selected by the operator.

Fig.6 shows an example of a contour map plotted on the screen of an HP 9826 and then dumped to a graphics printer. The equal-contours of the A-weighted intensity levels over a line printer are shown (same data as in the previous examples).

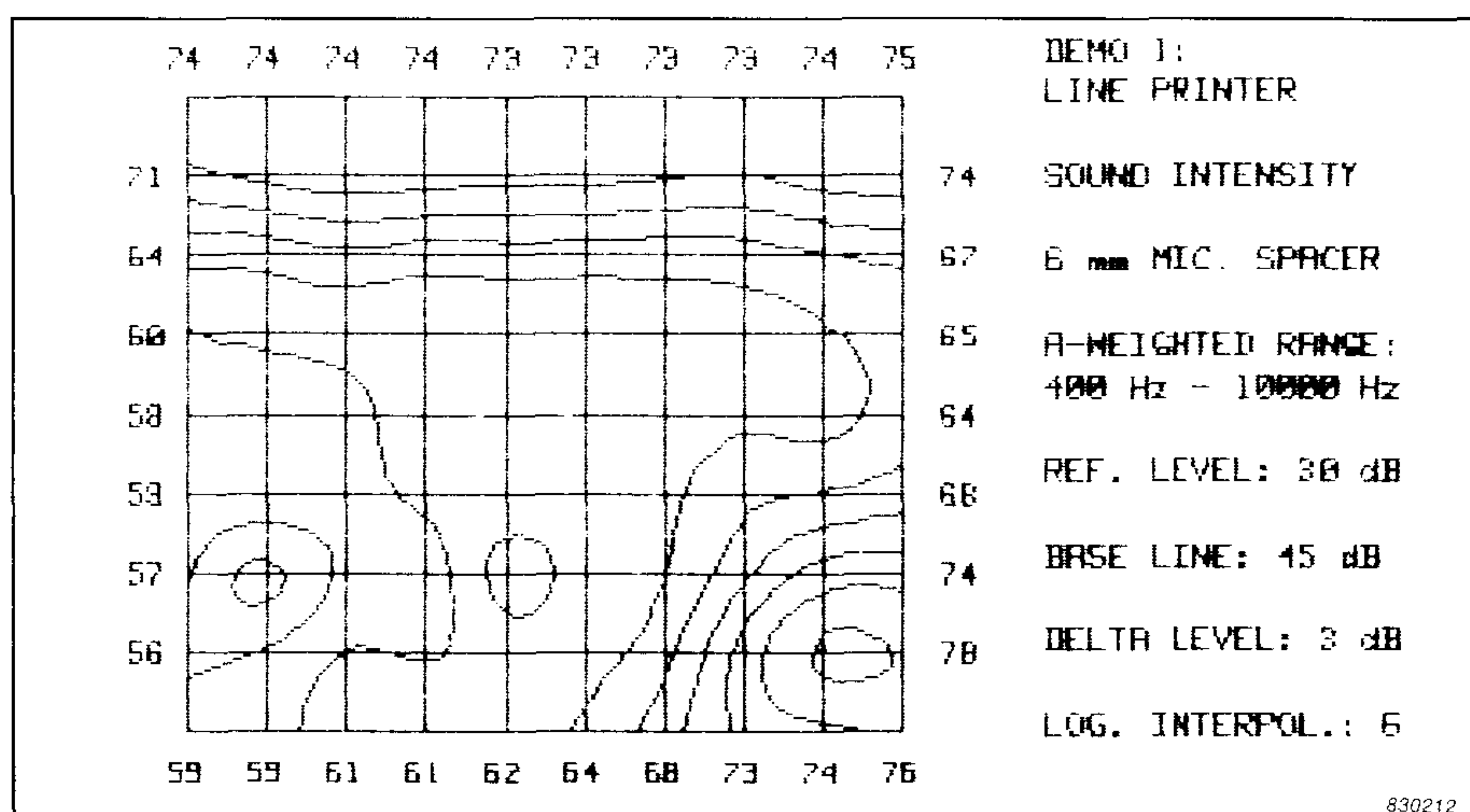


Fig.6. Equal intensity contour map of a line printer. The map was plotted on the screen and dumped to a graphics printer

If a digital plotter is used, the contour maps can be made in three colours: one colour for the data grid, another colour to designate regions of "positive" levels and a third colour to designate "negative" levels. If a plotter with three or more pens is used, the three different colours will be selected automatically. If a plotter with one or two pens is used, the plot can still be made in three colours by manual change of pens (the plotter stops for a few seconds every time a new pen is selected).

When a digital plotter is used, it is also possible to obtain a numerical plot of the measured data on the contour plot. An example of this is shown in Fig.7.

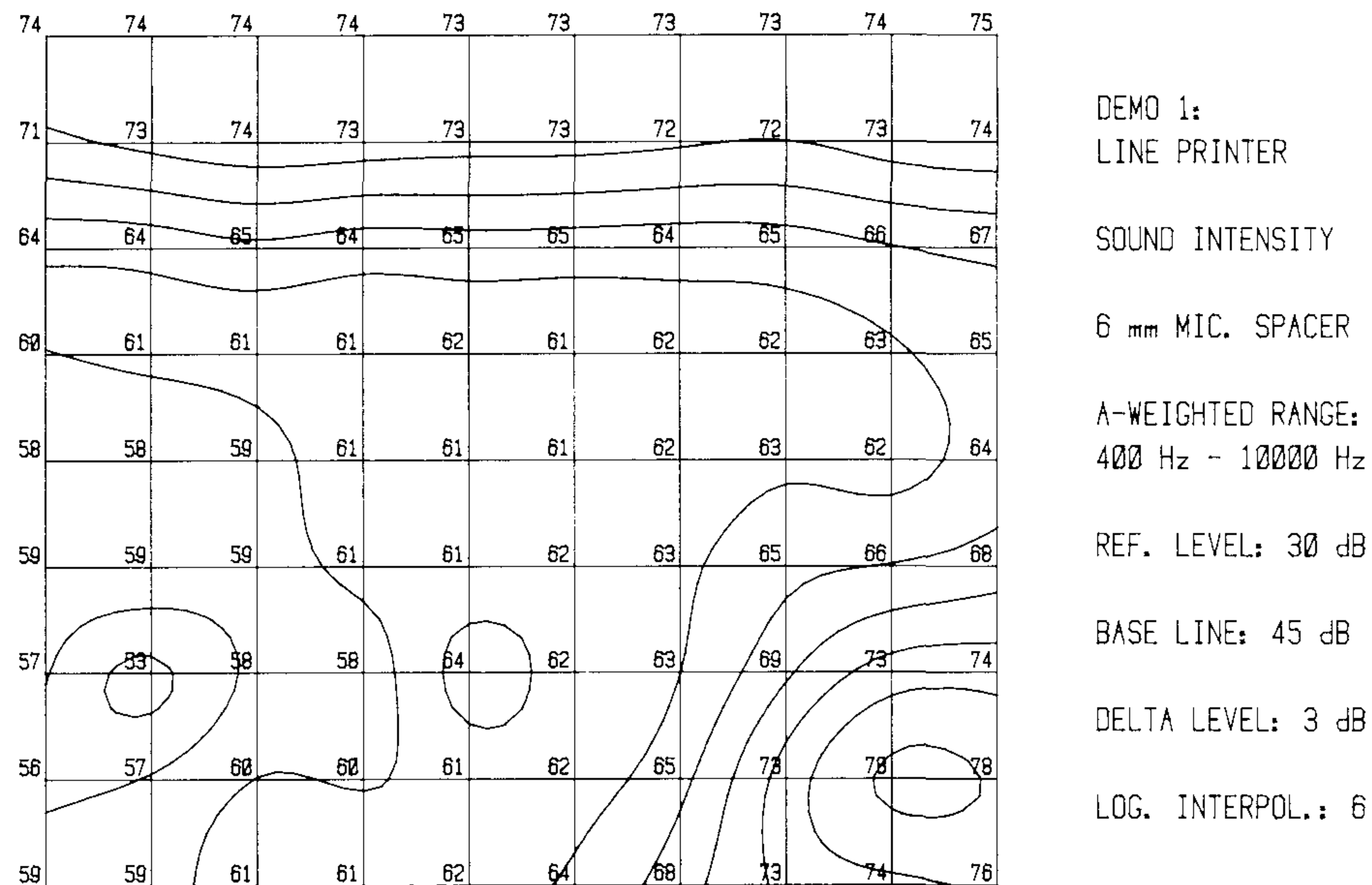


Fig.7. Equal intensity contour map of a line printer. The measured levels are shown on the contour map

The “negative” contours may be drawn as dashed lines on the plotter, or every second line may be drawn dashed. This can often be helpful when identifying the individual contour lines. An example is seen in Fig.8 showing the A-weighted intensity levels from the area around the control buttons of the line printer (same data as before, but only using 4×4 measurement points from the lower right corner).

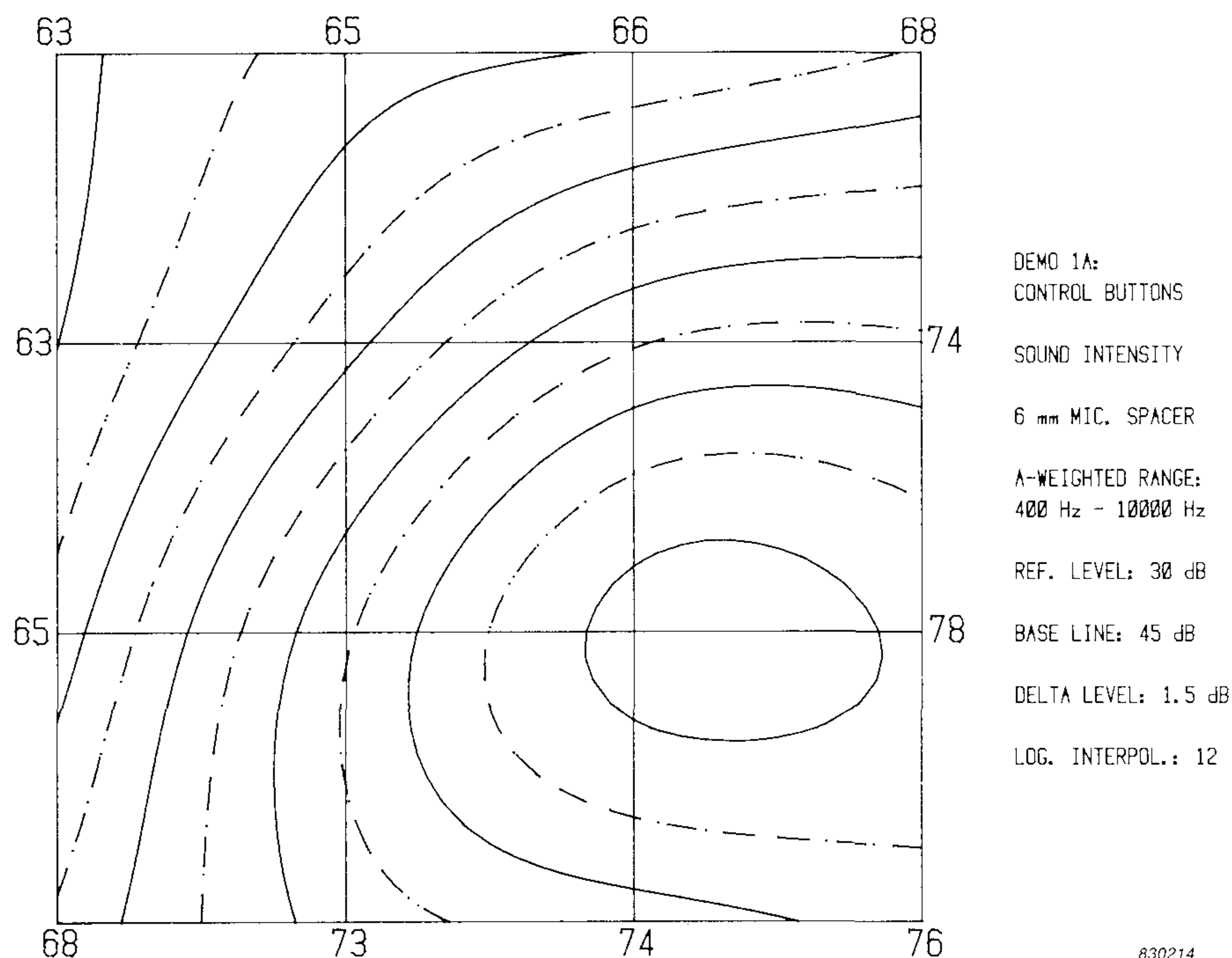
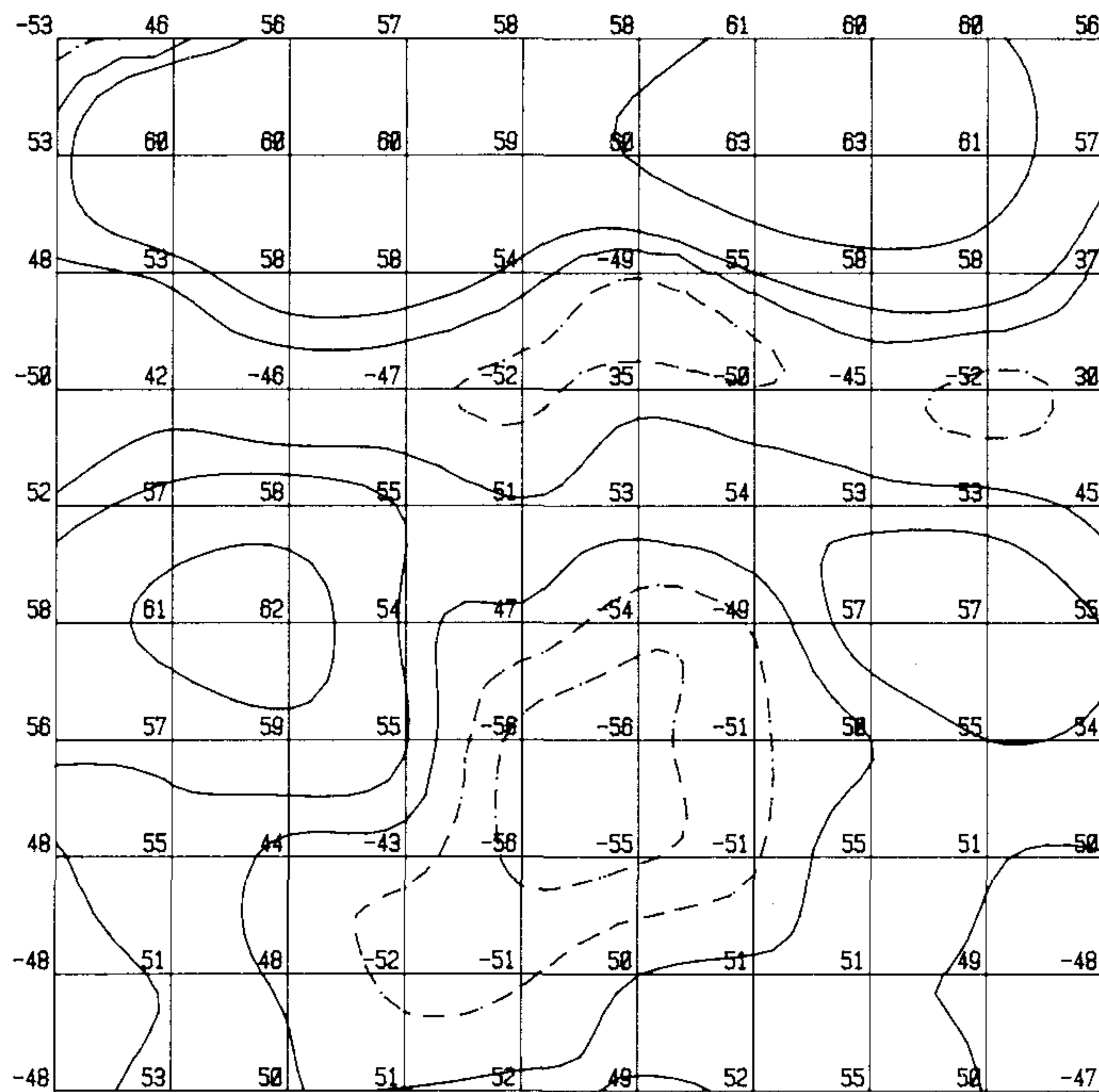


Fig.8. Equal intensity contour map of the area around the control buttons of the line printer

2.3.4. Examples

Examples of intensity maps measured over the engine cover of a van are shown in Figs.9 and 10. The measurements are described in the B & K Application Note “Sound Intensity Measurements Inside a Motor Vehicle”.



DEMO 2:
CAR ENGINE COVER

SOUND INTENSITY

12 mm MIC. SPACER

FREQ.: 315 Hz

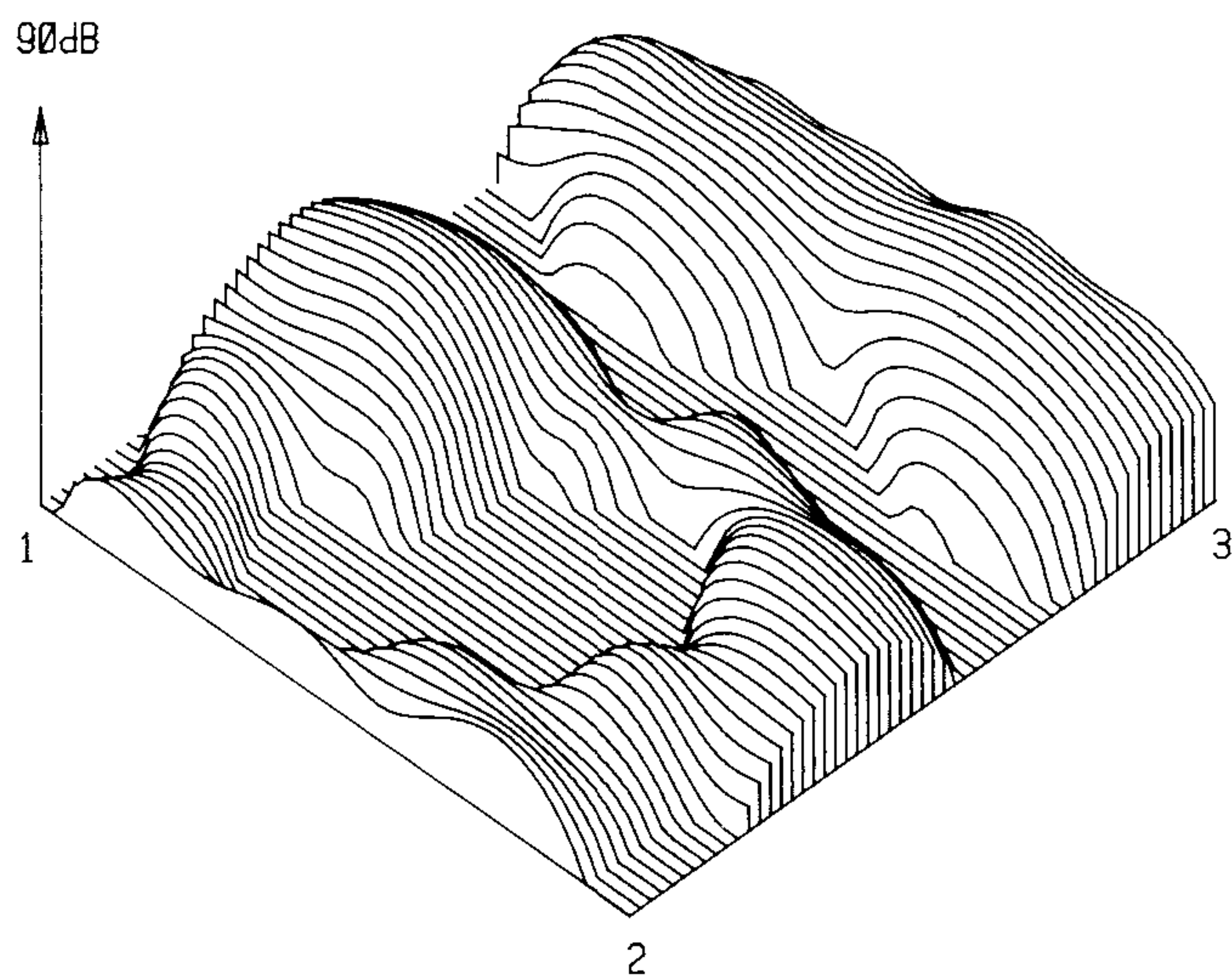
REF. LEVEL: 30 dB

BASE LINE: 50 dB

DELTA LEVEL: 5 dB

LIN. INTERPOL.: 6

830215



DEMO 2:
CAR ENGINE COVER

POSITIVE INTENSITY

12 mm MIC. SPACER

FREQ.: 315 Hz

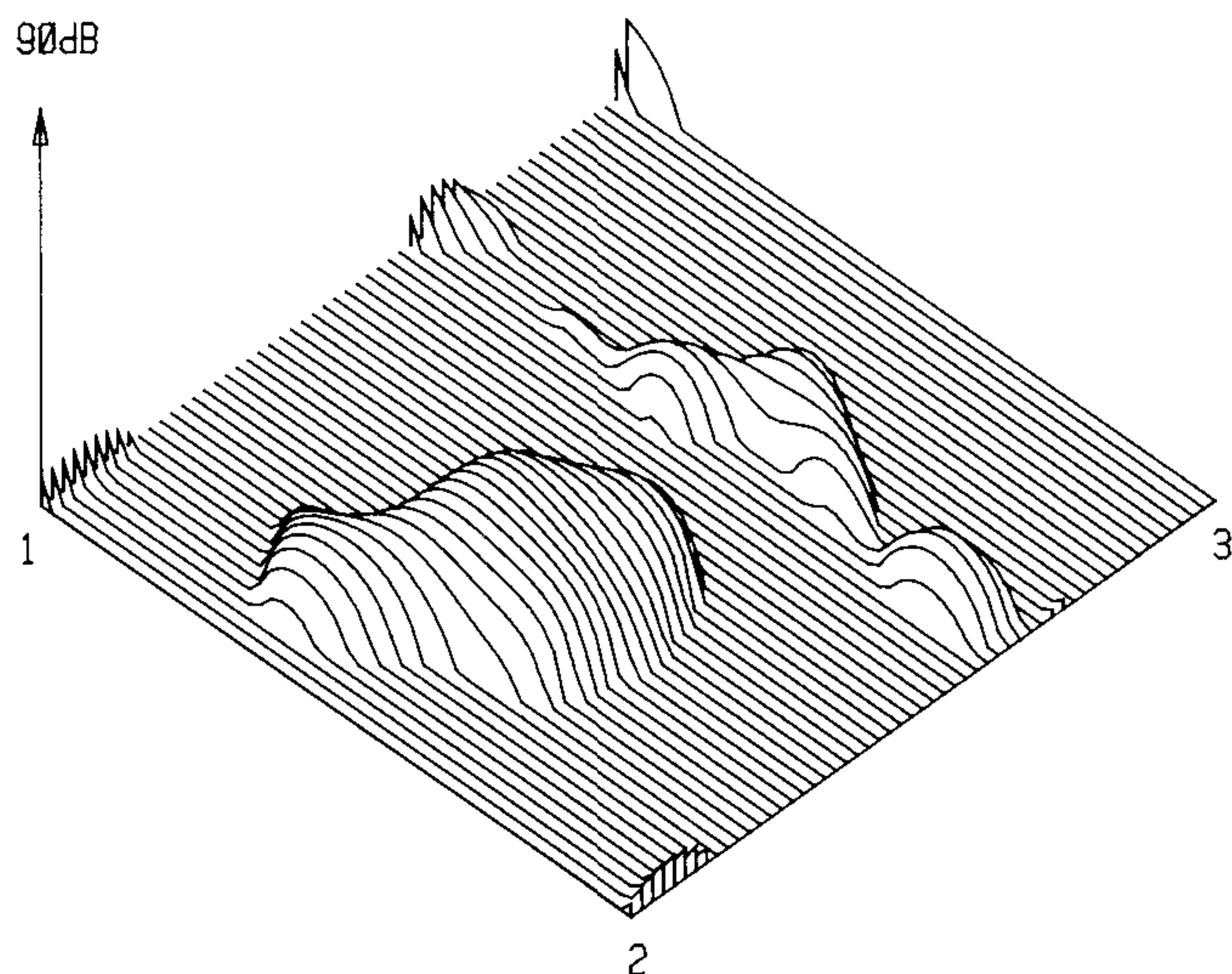
REF. LEVEL: 30 dB

BASE LINE: 45 dB

GAIN FACTOR 2.5

LIN. INTERPOL.: 6

830216



DEMO 2:
CAR ENGINE COVER

NEGATIVE INTENSITY

12 mm MIC. SPACER

FREQ.: 315 Hz

REF. LEVEL: 30 dB

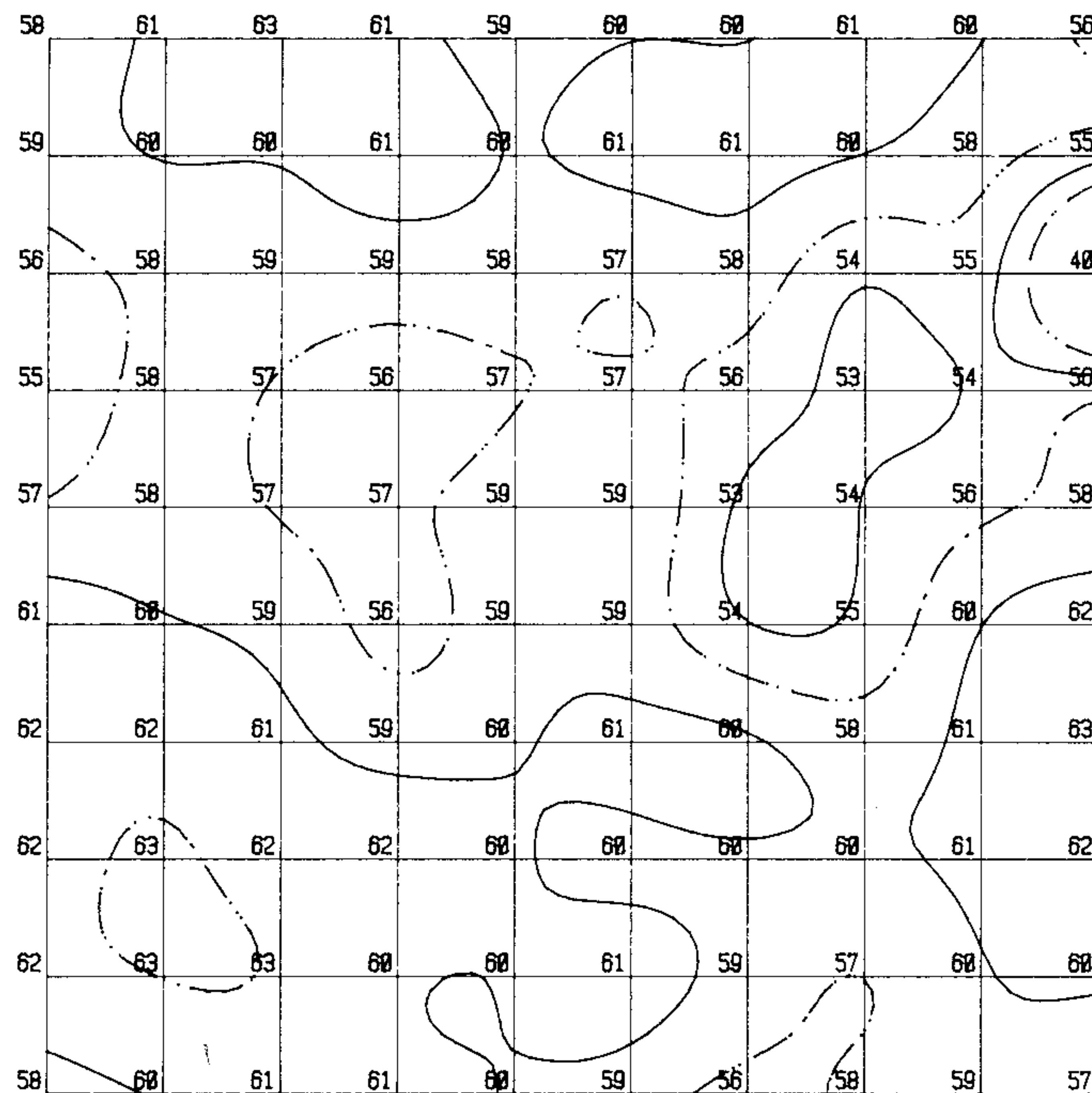
BASE LINE: 45 dB

GAIN FACTOR 2.5

LIN. INTERPOL.: 6

830217

Fig.9. Sound intensity maps for the 1/3 octave frequency band 315Hz measured over the engine cover of a van



DEMO 2:
CAR ENGINE COVER

SOUND INTENSITY

12 mm MIC. SPACER

A-WEIGHTED RANGE:
250 Hz - 5000 Hz

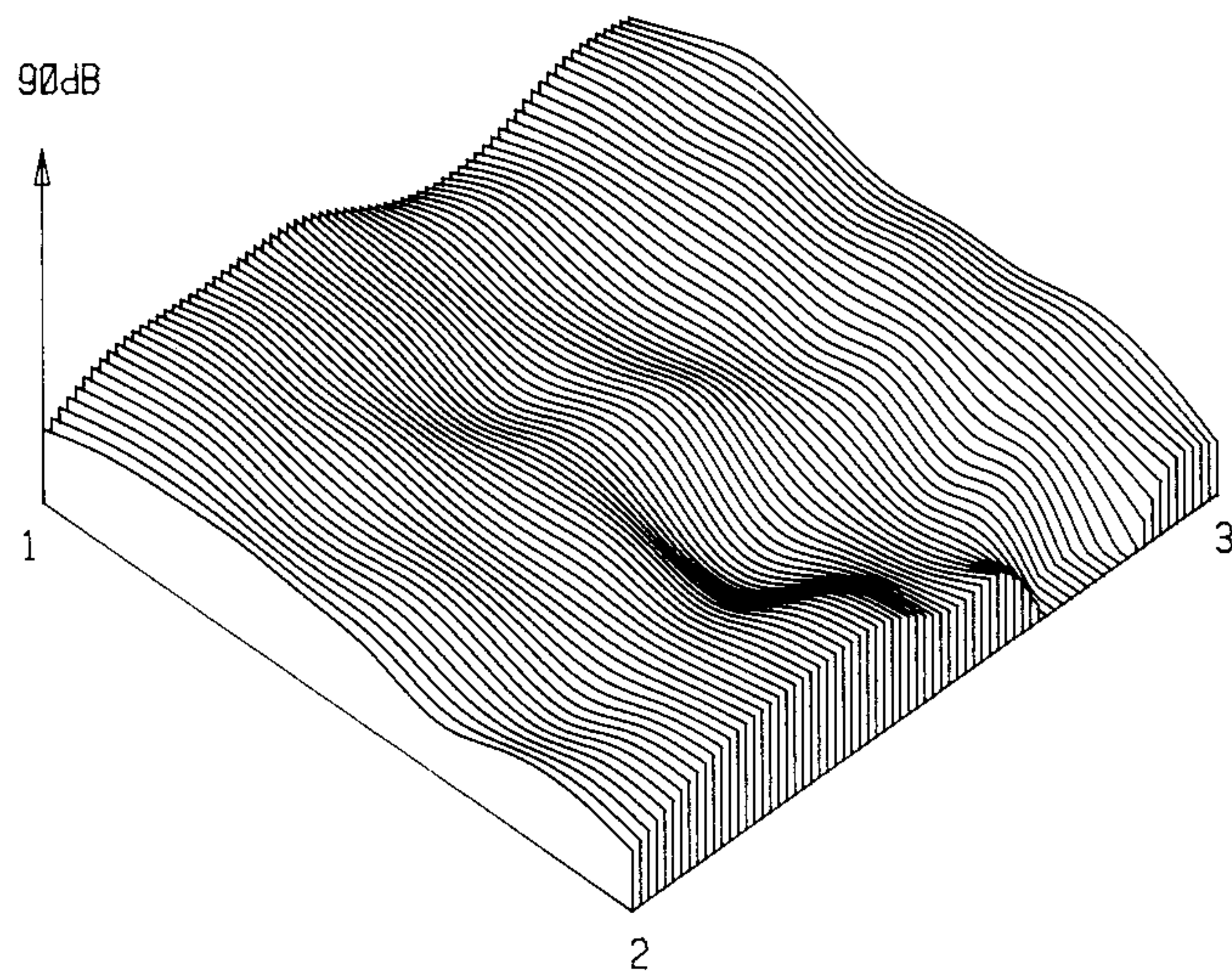
REF. LEVEL: 30 dB

BASE LINE: 50 dB

DELTA LEVEL: 3 dB

LOG. INTERPOL.: 8

830221



DEMO 2:
CAR ENGINE COVER

POSITIVE INTENSITY

12 mm MIC. SPACER

A-WEIGHTED RANGE:
250 Hz - 5000 Hz

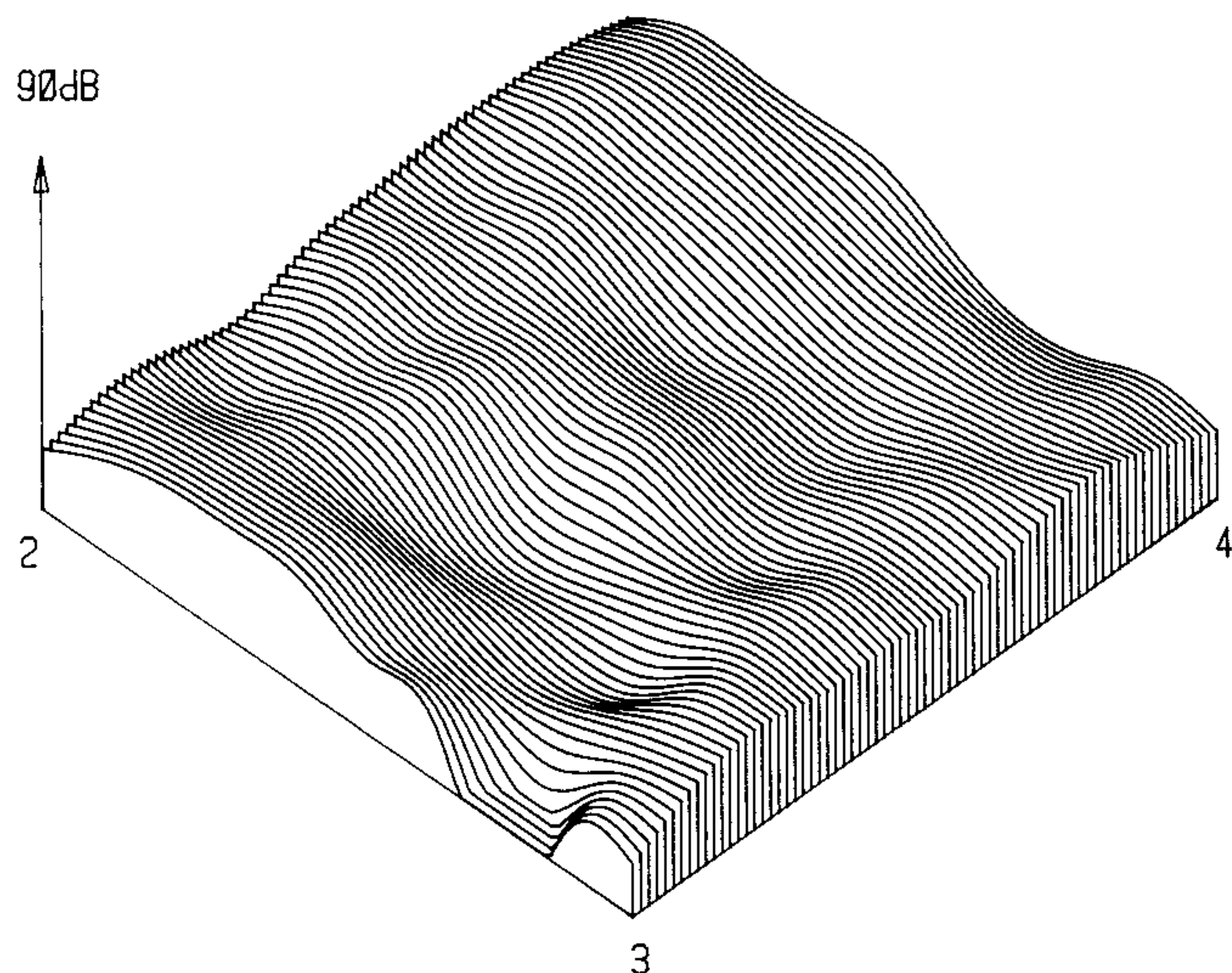
REF. LEVEL: 30 dB

BASE LINE: 50 dB

GAIN FACTOR: 2.5

LOG. INTERPOL.: 8

830220



DEMO 2:
CAR ENGINE COVER

POSITIVE INTENSITY

12 mm MIC. SPACER

A-WEIGHTED RANGE:
250 Hz - 5000 Hz

REF. LEVEL: 30 dB

BASE LINE: 50 dB

GAIN FACTOR: 2.5

LOG. INTERPOL.: 8

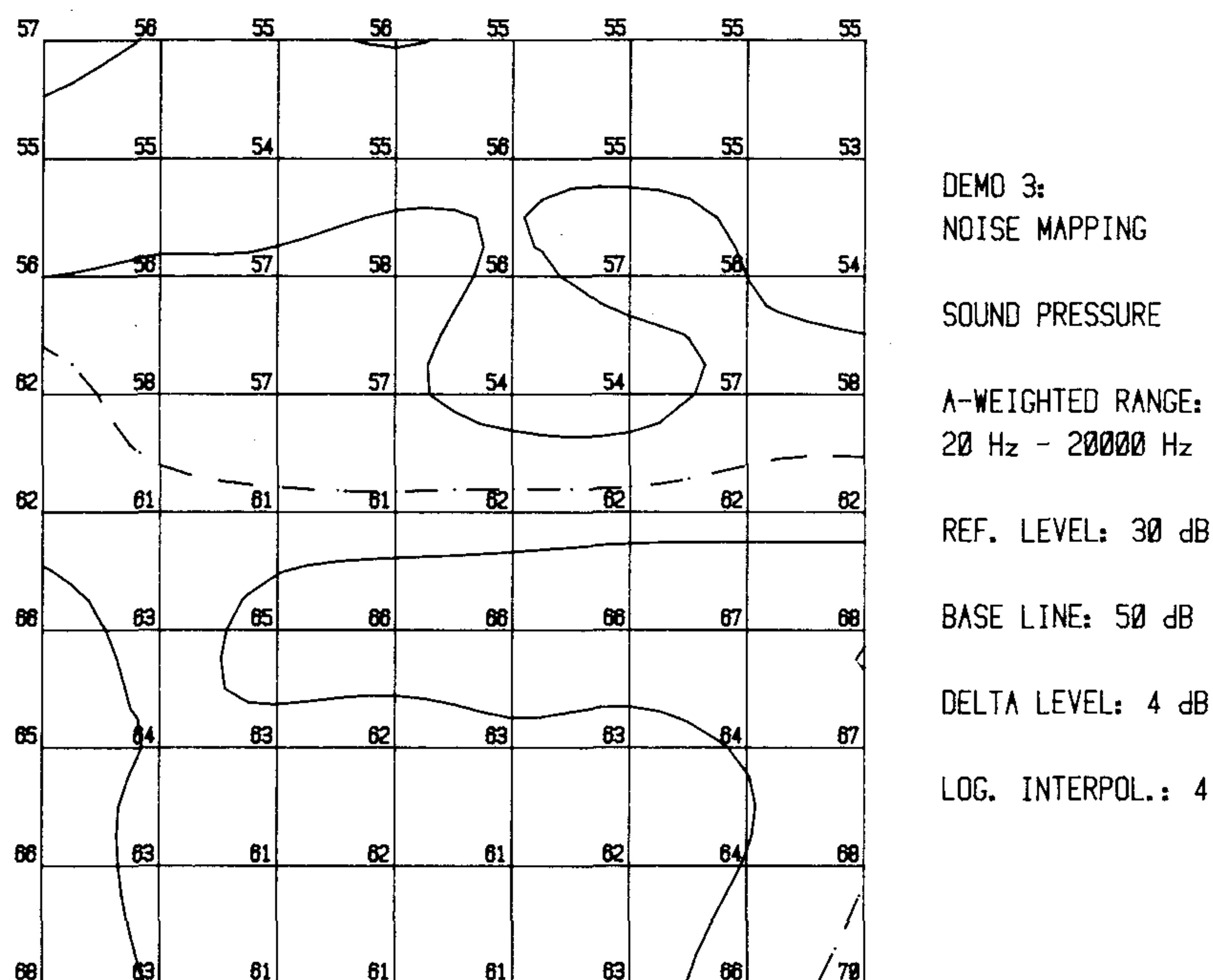
830218

Fig.10. Sound intensity maps for the A-weighted intensity levels, measured over the engine cover of a van

Fig.9 shows the intensity maps for the 1/3 octave frequency band 315 Hz. Both “positive” and “negative” intensity levels are present. Therefore the linear interpolation procedure has been selected using the guidelines described in section 2.2. In the contour map, the “negative” intensity levels are represented by dashed lines.

Fig.10 shows the intensity maps for the A-weighted levels in the frequency range 250 Hz – 5000 Hz. In this case all levels are positive, and therefore the logarithmic interpolation could be used. In the contour map, every second contour line is shown as dashed lines. The 3-dimensional plots are shown from two different viewing corners.

Fig.11 shows an example of contour mapping from sound pressure measurements (noise mapping).



830219

Fig.11. Example of equal pressure contour mapping (noise mapping)

3. Sound Power Programs

The following programs are available for sound power calculation from sound intensity or sound pressure measurements:

- RET-DISC: Retrieve data stored on the program disc.
- RET-7400: Retrieve data recorded on the Digital Cassette Recorder Type 7400
- MEAS-ANY: Measurements on any area.
- MEAS-HEM: Measurements on a hemisphere.
- CATALOG: List of data stored on the program disc.

The program RET-DISC is used for calculation of the total sound power spectrum from intensity or pressure spectra previously stored on the program disc (stored using INPUT from the mapping programs). CATALOG is used to give a list of the data stored on the program disc. RET-7400 is used for sound power calculation from spectra recorded on the Digital Cassette Recorder Type 7400.

The programs MEAS-ANY or MEAS-HEM are used for controlling measurements of sound intensity or sound pressure in a number of locations over a specified area or over a hemisphere and for calculation of the total sound power spectrum.

In the programs the frequency range for the sound power calculation is specified by the operator. If the calculation is based on sound intensity measurements the operator can also choose to compensate for the approximation error of the two-microphone technique at high frequencies. When compensation is applied, the approximation error shown in Fig.12 is assumed. The figure shows the maximum approximation error in the far field of a source, i.e. when wavefronts can be considered essentially plane.

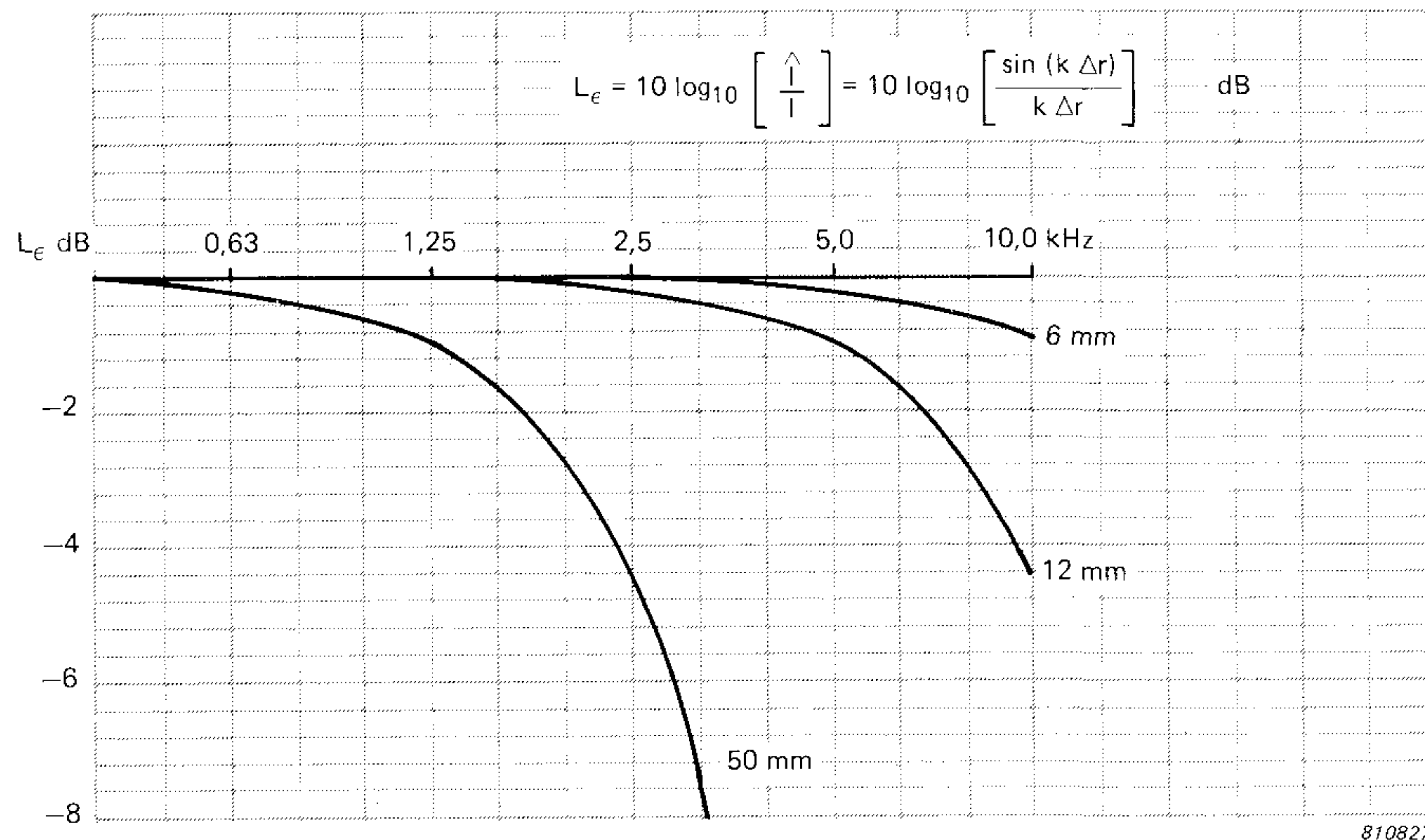


Fig.12. Approximation error, L_e , at high frequencies for the various spacers

Compensation for the approximation error is normally not necessary when the appropriate spacer has been selected, and it should only be used for far-field measurements. The actual approximation error is between zero and the values shown in Fig.12. The compensation can only be selected for the 6 mm and the 12 mm spacers.

Refer to the Type 3360 Product Data Sheet for details on the approximation error of the two-microphone technique.

3.1. Spectra Transferred from the Disc or the Type 7400

When the program RET-DISC is used, the spectra from a selected file number on the program disc are transferred to the calculator. The area per measurement position is specified by the operator.

When the program RET-7400 is used, 1/3 octave spectra recorded on the Digital Cassette Recorder Type 7400 are transferred to the calculator as groups of files (each file corresponds to one spectrum). A common area for all files can be specified by the operator. Alternatively the area per file can be specified for each group of files. Up to 500 spectra can be transferred for approximately 32 Kbytes user-memory or more.

When all the spectra have been transferred to the calculator, the sound power spectrum calculated over all measurement positions is shown on the screen of the analyzer (if connected). A print-out of the sound power spectrum in terms of numerical values and as a plot can be obtained. Also a print-out in terms of a table showing the linear and A-weighted sound intensity or sound pressure, the area, the linear and A-weighted sound power for each measurement position can be obtained.

Examples of print-outs from the programs RET-DISC and RET-7400 are shown on pages 12–13. The first example shows the total sound power spectrum calculated from 90 intensity measurements over a line printer (same measurements as in Figs.4–7). The next example shows the sound power spectrum from 16 measurements over the area around the control buttons of the printer.

3.2. Spectra Transferred from the Analyzer

In the program MEAS-ANY the measurement surface can be divided into a number of segments. For each segment the number of measurement positions and the area per measurement position can be specified by the operator.

In the program MEAS-HEM, the measurement surface is assumed to be a hemisphere. The hemisphere can be divided into a number of sectors. The radius of the hemisphere, the sector widths and the number of measurement positions in each sector are specified by the operator.

Fig.13 shows an example of a hemisphere with radius R , divided into four sectors with sector widths $0.3R$, $0.3R$, $0.3R$ and $0.1R$. The indicated measurement positions are the ten standardised positions recommended in the ISO standard 3745 for determination of sound power from sound pressure measurements in an anechoic chamber over a reflecting plane. The measurement positions are in this case selected so that the areas associated with all measurement positions are the same.

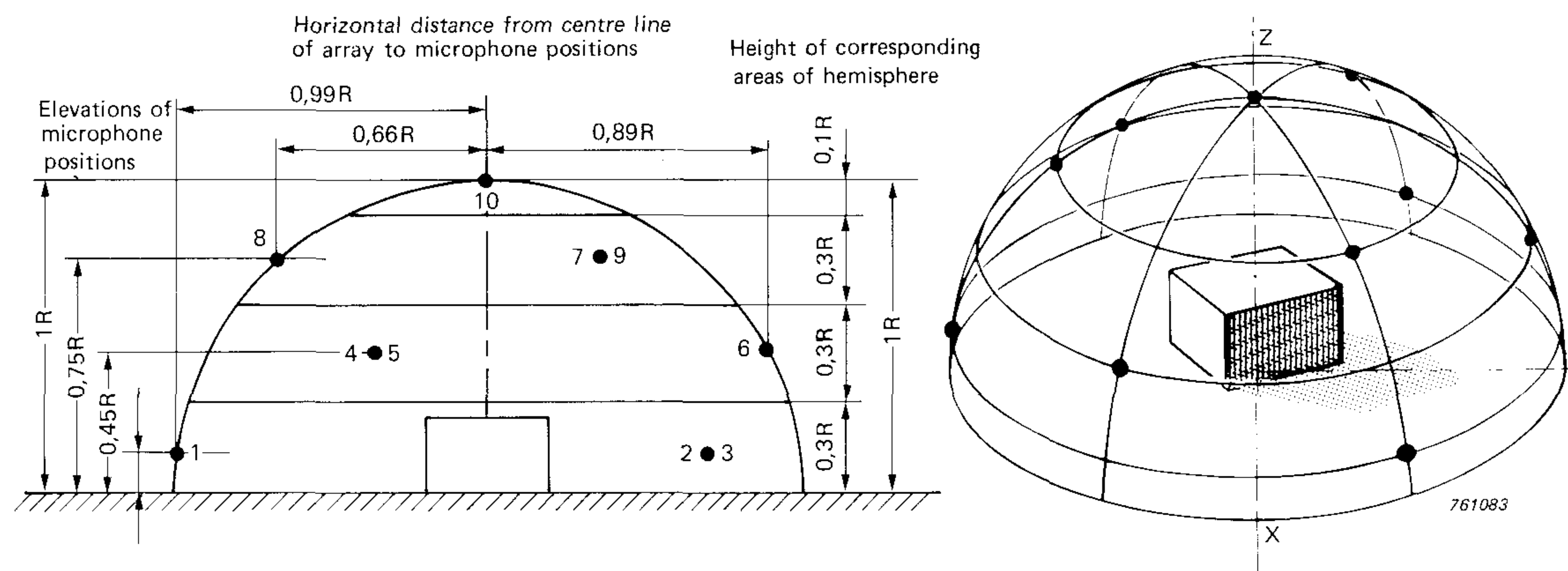


Fig.13. Microphone positions on the surface of a hemisphere as recommended by ISO 3745

When the parameters for the hemisphere have been entered, the measurement height and measurement radius for each sector are calculated and printed. An example corresponding to Fig.13 is shown in Table 1.

RADIUS OF HEMISPHERE: 1.00 M

SECT NO.	MEAS. POINTS	WIDTH [M]	HEIGHT [M]	RADIUS [M]
1	3	0.30	0.15	0.99
2	3	0.30	0.45	0.89
3	3	0.30	0.75	0.66
4	1	0.10	1.00	0.00

Table 1. Print-out of entered and calculated parameters (height and radius) for a hemisphere

In the programs, up to 200 measurement positions can be selected. The maximum number of positions depends on the selected frequency range and the memory size of the calculator. For approximately 64Kbytes user-memory or more, 200 measurement positions are possible for a frequency range covering 20 third-octave channels (2 decades). For approximately 32Kbytes user-memory, 80 measurement positions are possible for 20 third-octave channels.

In the programs, the 1/3 octave intensity or pressure spectrum for each measurement position is transferred to the calculator using "Digital-Output" on the analyzer or "Read-Out" on the Remote Indicating Unit ZH 0250 (included in the Sound Intensity Analysing System Type 3360).

During the measurements, the program counts the number of the entered spectra, and when a sector has been completed, the screen of the analyzer will light up for a few seconds (the Remote Indicating Unit ZH 0250 will indicate maximum level).

After each measurement an updated list of the overall linear and A-weighted intensity or pressure levels for all measured positions will appear on the screen. At any time it is possible to repeat part of the measurements.

When the measurements have been completed, the sound power spectrum calculated over all measurement positions is shown on the screen of the analyser. As in the programs RET-DISC and RET-7400, a print-out of the sound power spectrum and a table of the overall linear and A-weighted levels at each measurement position are available. New measurements can be made on the same measurement surface without re-entering the measurement parameters.

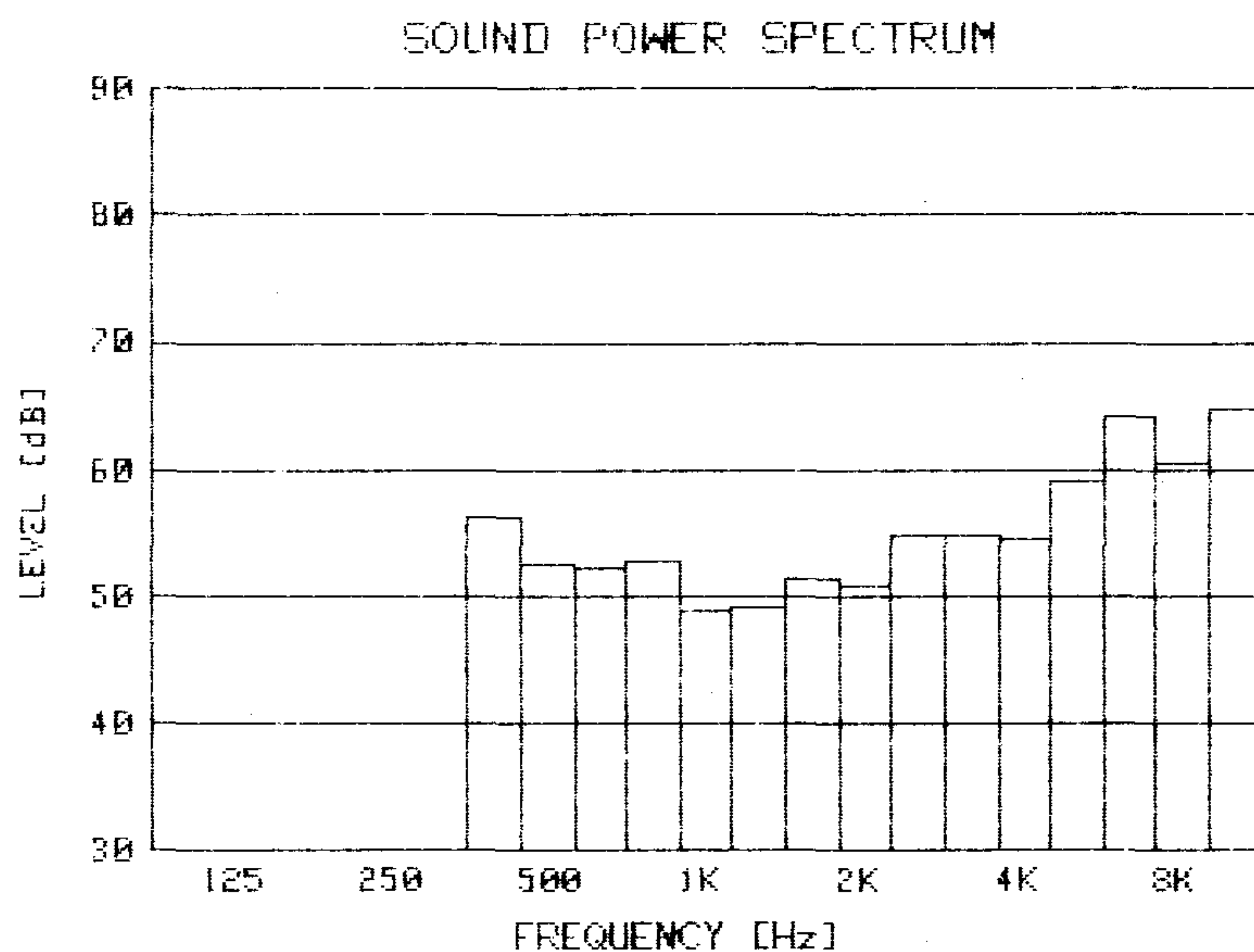
Examples of print-outs from the programs MEAS-ANY and MEAS-HEM are shown on pages 14–15. The first example shows the total sound power spectrum calculated from 18 intensity measurements in three sectors around a small pump. The next example shows the total sound power spectrum calculated from 10 sound pressure measurements around a small demo motor in a semi-anechoic room. The measurement surface is a hemisphere according to ISO 3745 (see Fig.13).

PROGRAM: RET-DISC
 DEMO 1: LINE PRINTER

TOTAL AREA: 0.900 M²
 MICROPHONE SPACER: 6 mm

SOUND POWER (CALC. FOR POS. 1 - 90)

FREQ. (Hz)	LEVEL (dB)	LEVEL (dBA)
400 Hz	56.4 dB+	51.6 dBA+
500 Hz	52.6 dB+	49.4 dBA+
630 Hz	52.2 dB+	50.3 dBA+
800 Hz	52.8 dB+	52.0 dBA+
1000 Hz	48.8 dB+	48.8 dBA+
1250 Hz	49.0 dB+	49.6 dBA+
1600 Hz	51.4 dB+	52.4 dBA+
2000 Hz	50.8 dB+	52.0 dBA+
2500 Hz	54.8 dB+	56.1 dBA+
3150 Hz	54.7 dB+	55.9 dBA+
4000 Hz	54.6 dB+	55.6 dBA+
5000 Hz	59.2 dB+	59.7 dBA+
6300 Hz	64.2 dB+	64.1 dBA+
8000 Hz	60.5 dB+	59.4 dBA+
10000 Hz	64.8 dB+	62.3 dBA+
TOTAL:	69.9 dB+	69.2 dBA+

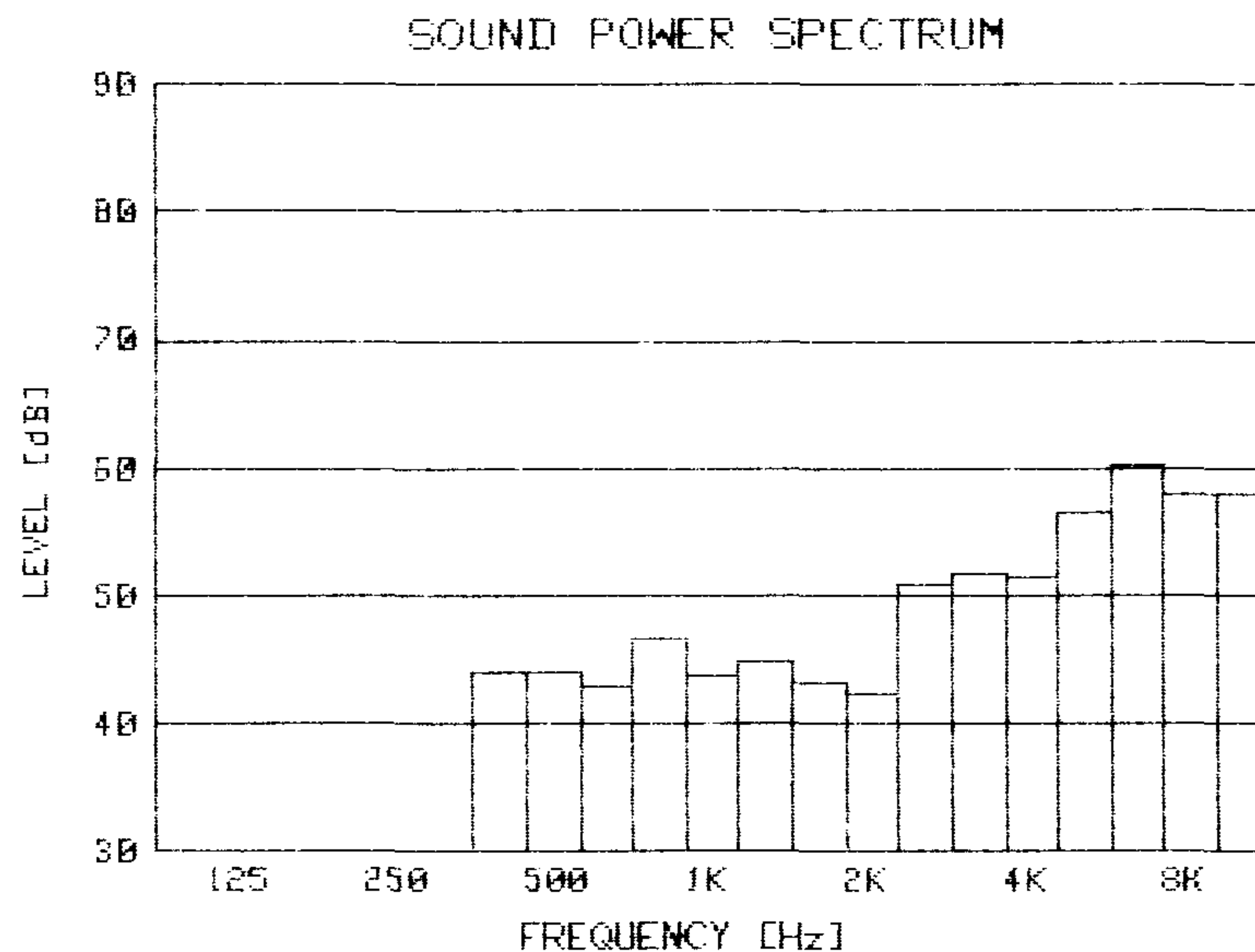


PROGRAM: RET-7400
 DEMO 1A: CONTROL BUTTONS

TOTAL AREA: 0.160 M²
 MICROPHONE SPACER: 6 mm

SOUND POWER (CALC. OVER 16 FILES)

FREQ. (Hz)	LEVEL (dB)	LEVEL (dBA)
400 Hz	43.9 dB+	39.1 dBA+
500 Hz	44.1 dB+	40.9 dBA+
630 Hz	43.0 dB+	41.1 dBA+
800 Hz	46.7 dB+	45.9 dBA+
1000 Hz	43.7 dB+	43.7 dBA+
1250 Hz	45.0 dB+	45.6 dBA+
1600 Hz	43.3 dB+	44.3 dBA+
2000 Hz	42.4 dB+	43.6 dBA+
2500 Hz	50.8 dB+	52.1 dBA+
3150 Hz	51.8 dB+	53.0 dBA+
4000 Hz	51.5 dB+	52.5 dBA+
5000 Hz	56.5 dB+	57.0 dBA+
6300 Hz	60.2 dB+	60.1 dBA+
8000 Hz	58.0 dB+	56.9 dBA+
10000 Hz	57.9 dB+	55.4 dBA+
TOTAL:	65.3 dB+	64.9 dBA+



TOTAL AREA: 2.000 M²
SPACER: 12 mm, COMPENSATED

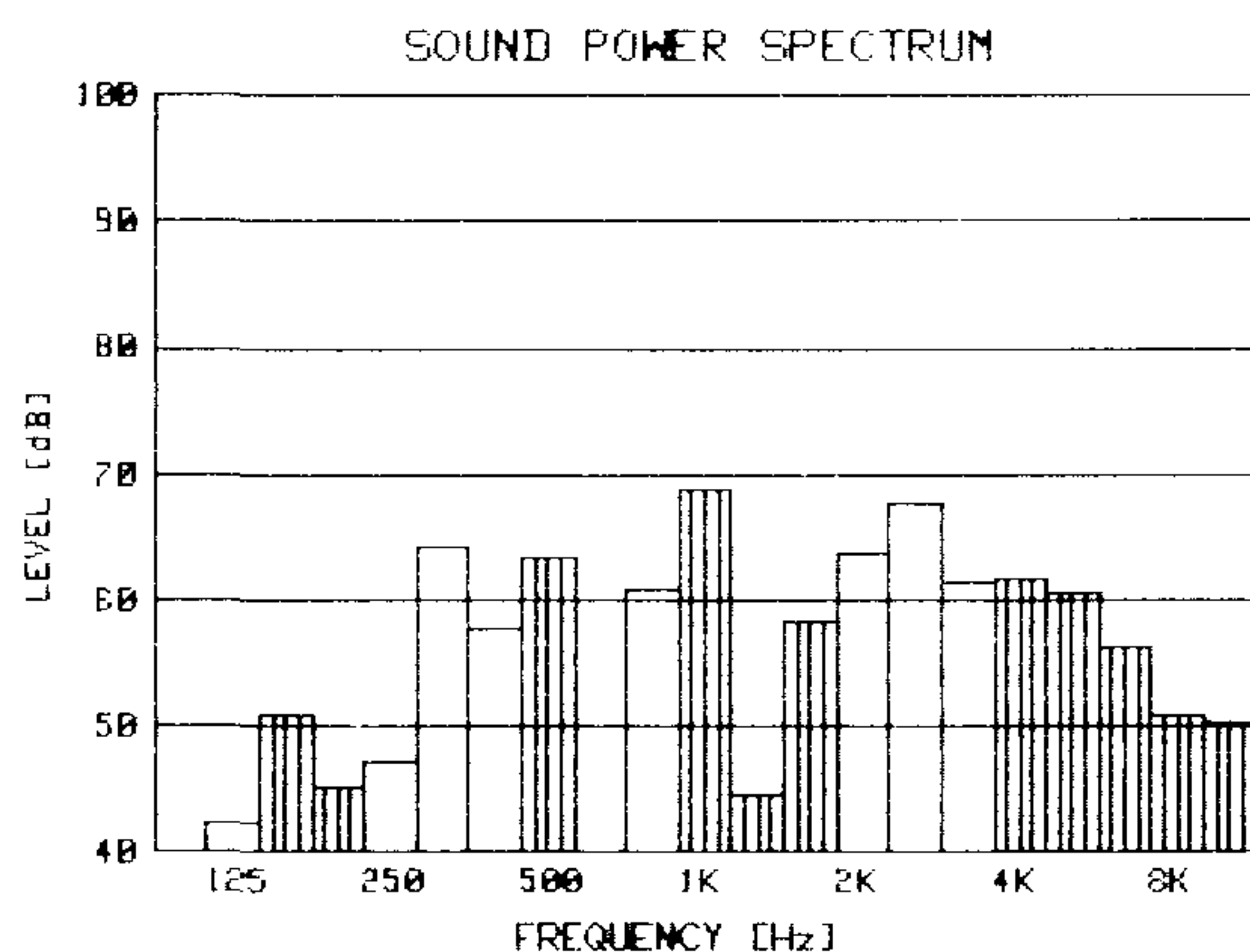
PROGRAM: MEAS-ANY
MEASUREMENTS ON PUMP

SEGM NO.	MEAS. POINTS	AREA/POINT [M ²]
1	8	0.100
2	8	0.100
3	2	0.200

POS NO.	INTENSITY (dB)	INTENSITY (dBA)	AREA (M ²)	SOUND POWER (dB)	SOUND POWER (dBA)
1	66.9 dB+	68.3 dBA+	0.100	56.9 dB+	58.3 dBA+
2	67.3 dB-	61.0 dBA+	0.100	57.3 dB-	51.0 dBA+
3	66.7 dB+	69.1 dBA+	0.100	56.7 dB+	59.1 dBA+
4	75.0 dB+	71.4 dBA+	0.100	65.0 dB+	61.4 dBA+
5	76.2 dB+	77.8 dBA+	0.100	66.2 dB+	67.8 dBA+
6	61.8 dB-	64.8 dBA-	0.100	51.8 dB-	54.8 dBA-
7	72.4 dB-	71.6 dBA-	0.100	62.4 dB-	61.6 dBA-
8	72.1 dB+	70.0 dBA+	0.100	62.1 dB+	60.0 dBA+
9	69.3 dB+	63.0 dBA+	0.100	59.3 dB+	53.0 dBA+
10	62.8 dB-	60.1 dBA-	0.100	52.8 dB-	50.1 dBA-
11	58.6 dB-	58.6 dBA-	0.100	48.6 dB-	48.6 dBA-
12	69.1 dB-	68.6 dBA-	0.100	59.1 dB-	58.6 dBA-
13	74.3 dB-	73.5 dBA-	0.100	64.3 dB-	63.5 dBA-
14	65.7 dB-	64.1 dBA-	0.100	55.7 dB-	54.1 dBA-
15	64.3 dB-	59.9 dBA-	0.100	54.3 dB-	49.9 dBA-
16	62.8 dB-	63.3 dBA-	0.100	52.8 dB-	53.3 dBA-
17	70.2 dB-	70.7 dBA-	0.200	63.2 dB-	63.7 dBA-
18	65.1 dB-	65.6 dBA-	0.200	58.2 dB-	58.6 dBA-

SOUND POWER (CALC. FOR POS. 1 - 18)

FREQ. (Hz)	LEVEL (dB)	LEVEL (dBA)
125 Hz	42.4 dB+	26.3 dBA+
160 Hz	51.0 dB-	37.6 dBA-
200 Hz	45.3 dB-	34.4 dBA-
250 Hz	47.2 dB+	38.6 dBA+
315 Hz	64.2 dB+	57.6 dBA+
400 Hz	57.6 dB+	52.8 dBA+
500 Hz	63.3 dB-	60.1 dBA-
630 Hz	59.9 dB+	58.0 dBA+
800 Hz	60.9 dB+	60.1 dBA+
1000 Hz	68.9 dB-	68.9 dBA-
1250 Hz	44.5 dB-	45.1 dBA-
1600 Hz	58.3 dB-	59.3 dBA-
2000 Hz	63.7 dB+	64.9 dBA+
2500 Hz	67.7 dB+	69.0 dBA+
3150 Hz	61.4 dB+	62.6 dBA+
4000 Hz	61.8 dB-	62.8 dBA-
5000 Hz	60.7 dB-	61.2 dBA-
6300 Hz	56.3 dB-	56.2 dBA-
8000 Hz	50.8 dB-	49.7 dBA-
10000 Hz	50.3 dB-	47.8 dBA-
TOTAL:	59.9 dB+	62.4 dBA+



RADIUS OF HEMISPHERE: 1.00 M
SOUND PRESSURE MEAS.

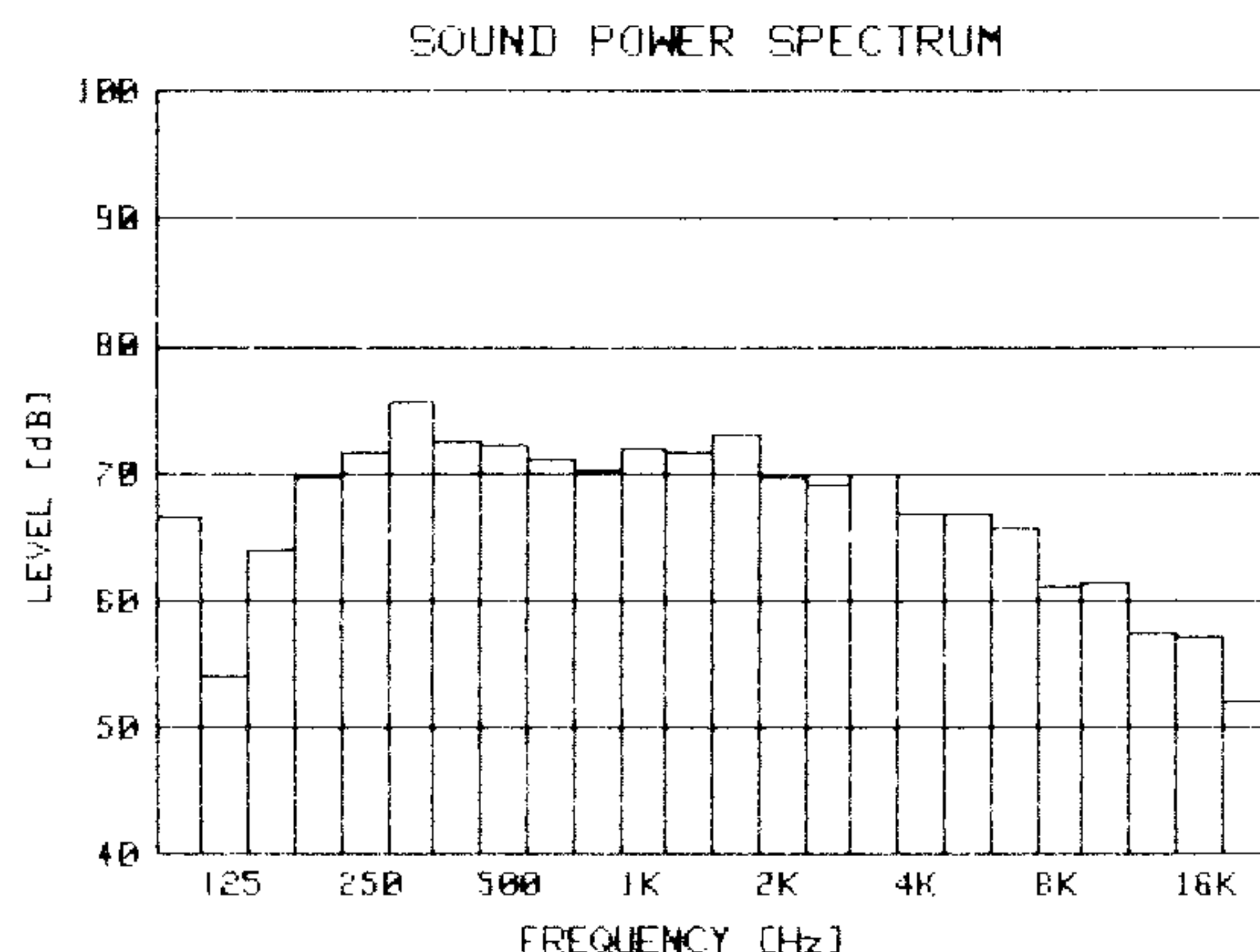
PROGRAM: MEAS-HEM
SMALL DEMO MOTOR

SECT NO.	MEAS. POINTS	WIDTH [M]	HEIGHT [M]	RADIUS [M]
1	3	0.30	0.15	0.99
2	3	0.30	0.45	0.89
3	3	0.30	0.75	0.66
4	1	0.10	1.00	0.00

POS NO.	SOUND PRESS. (dB)	SOUND PRESS. (dBA)	AREA (M ²)	SOUND POWER (dB)	SOUND POWER (dBA)
1	75.7 dB	73.9 dBA	0.628	73.7 dB	71.9 dBA
2	74.4 dB	71.8 dBA	0.628	72.4 dB	69.8 dBA
3	76.7 dB	74.6 dBA	0.628	74.7 dB	72.6 dBA
4	75.5 dB	74.0 dBA	0.628	73.5 dB	72.0 dBA
5	75.6 dB	73.9 dBA	0.628	73.6 dB	71.9 dBA
6	75.3 dB	74.0 dBA	0.628	73.3 dB	72.0 dBA
7	75.5 dB	74.1 dBA	0.628	73.5 dB	72.1 dBA
8	75.5 dB	74.6 dBA	0.628	73.5 dB	72.6 dBA
9	75.4 dB	74.1 dBA	0.628	73.4 dB	72.1 dBA
10	75.1 dB	73.8 dBA	0.628	73.1 dB	71.8 dBA

SOUND POWER (CALC. FOR POS. 1 - 10)

FREQ. (Hz)	LEVEL (dB)	LEVEL (dBA)
100 Hz	66.4 dB	47.3 dBA
125 Hz	54.1 dB	38.0 dBA
160 Hz	63.9 dB	50.5 dBA
200 Hz	69.6 dB	58.7 dBA
250 Hz	71.7 dB	63.1 dBA
315 Hz	75.7 dB	69.1 dBA
400 Hz	72.6 dB	67.8 dBA
500 Hz	72.3 dB	69.1 dBA
630 Hz	71.2 dB	69.3 dBA
800 Hz	70.2 dB	69.4 dBA
1000 Hz	72.0 dB	72.0 dBA
1250 Hz	71.7 dB	72.3 dBA
1600 Hz	73.2 dB	74.2 dBA
2000 Hz	69.8 dB	71.0 dBA
2500 Hz	69.2 dB	70.5 dBA
3150 Hz	69.9 dB	71.1 dBA
4000 Hz	67.0 dB	68.0 dBA
5000 Hz	66.9 dB	67.4 dBA
6300 Hz	65.6 dB	65.5 dBA
8000 Hz	61.1 dB	60.0 dBA
10000 Hz	61.6 dB	59.1 dBA
12500 Hz	57.6 dB	53.3 dBA
16000 Hz	57.2 dB	50.6 dBA
20000 Hz	52.1 dB	42.8 dBA
TOTAL:	83.5 dB	81.9 dBA



Appendix A

List of Available Program Options:

1. WW 9038 / WH 1471 HPL programs on a 5 1/4 in. disc (for HP 9826/36)
2. WW 9038 / WH 1472 BASIC 2.0 programs on a 5 1/4 in. disc (for HP 9826/36)
3. WW 9038 / WH 1473 HPL programs on a 3 1/2 in. disc (for HP 9816)
4. WW 9038 / WH 1474 BASIC 2.0 programs on a 3 1/2 in. disc (for HP 9816)

Appendix B

Example of a Complete System for Sound Intensity / Sound Pressure Mapping and Sound Power Calculation:

1. Type 3360 Sound Intensity Analysing System
(includes Remote Indicating Unit ZH 0250)
2. Type 7400 Digital Cassette Recorder
(includes Digital Tape Cassette QR 1009)
3. WW 9038 Sound Intensity Software Package
(includes Instruction Manual)
4. WQ 0218:

HP 9826A/opt 14 Calculator System with ROM-based HPL (hardloaded system)
At the moment (spring 1983) approximately 50 Kbytes user-memory is available with this option.

HP 2671G Graphics Printer
5. HP 7470A 2-pen Plotter
6. Two AO 0194 2-metre IEC cables
AO 0195 IEEE-IEC adaptor
HP 10833B 2-metre HP-IB cable

Optionally:

- | | |
|--------------|---------------------------------|
| QR 1010 | Digital Cassettes, pack of 10 |
| HP MD 550-01 | Mini Discs, pack of 10 |
| HP 92160M | Thermal Printer Paper, box of 4 |
| HP 98256A | 256 Kbyte RAM additional memory |

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