FFIU/Oppdrag 2775

Godkjent
Horten, 5 mai 1993

Jarl Johnsen
avd sjef

SIZEX 92 - PROPAGATION LOSS STUDIES - DATA REPORT.

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FFI/RAPPORT-93/2002

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NORWEGIAN DEFENCE RESEARCH ESTABLISHMENT (NDRE)
FORSVARETS FORSKNINGSINSTITUTT (FFI)

POST OFFICE BOX 25
N-2007 KJELLER, NORWAY

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE
(when data entered)

REPORT DOCUMENTATION PAGE

1) PUBL/REPORT NUMBER	2) SECURITY CLASSIFICATION	3) NUMBER OF PAGES
FFI/RAPPORT-93/2002	UNCLASSIFIED	50
1a) JOB REFERENCE	2a) DECLASSIFICATION/DOWNGRADING SCHEDULE	
FFIU/Oppdr 2775		

4) TITLE
SIZEX 92 - PROPAGATION LOSS STUDIES - DATA REPORT.

5) NAMES OF AUTHOR(S) IN FULL (surname first)

ENGELSEN, Ingjald

6) DISTRIBUTION STATEMENT

Distribution limited.
(Spredning begrenset i h t Sikkerhetsinstruksen)

7) INDEXING TERMS

IN ENGLISH:	IN NORWEGIAN:
a) Underwater acoustics	a) Undervannsakustikk
b) Propagation loss	b) Transmisjonstap
c) Marginal Ice Zone	c) Marginal issone
d) Barents Sea	d) Barentshavet
	e)

THESAURUS REFERENCE:

8) ABSTRACT (continue on reverse side if necessary)

A seasonal ice zone experiment, SIZEX 92, was conducted in the Barents Sea East of Hopen in the beginning of March 1992. The main objective of the experiment was to validate the SAR observations of the ice edge and the ice structure by comparison with in situ observations from ships, helicopter and aircraft. A programme of acoustic measurements in the marginal ice zone and outside the ice edge, was included in the programme. Measurements of ambient noise in the marginal ice zone and the study of propagation loss across the ice edge and across the polar front was carried out from a number of different platforms: ships, helicopter and aircraft. The report presents the results of the propagation loss measurements with aircraft deployed sonobuoys as receivers. Both broad band and narrow band CW sources were used and the results show good agreement between the two types of sources. It is also evident that the ice cover increases the propagation loss compared to a path in open water.

9) DATE	AUTHORIZED BY	POSITION
5 May 1993	This page only Karl Johnsen K Johnsen	Head of division

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE
(when data entered)

FFI-B-22-1982

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SIZEX 92 - PROPAGATION LOSS - DATA REPORT

SUMMARY

A seasonal ice zone experiment, SIZEX 92, was conducted in the Barents Sea east of Hopen in the beginning of March 1992. The main objective of the experiment was to validate the SAR observations of the ice edge and the ice structure by comparison with in situ observations from ships, helicopter and aircraft. A programme of acoustic measurements in the marginal ice zone and outside the ice edge, was included in the programme. Measurements of ambient noise in the marginal ice zone and the study of propagation loss across the ice edge and across the polar front was carried out from a number of different platforms: ships, helicopter and aircraft. The report presents the results of the propagation loss measurements with aircraft deployed sonobuoys as receivers. Both broad band and narrow band CW sources were used and the results show good agreement between the two types of sources. It is also evident that the ice cover increases the propagation loss compared to a path in open water.

1 INTRODUCTION

A post launch ERS-1 experiment was carried out in the Barents Sea in the first two weeks of March 1992. Several acoustic programmes, ambient noise measurements and propagation loss studies were included in this experiment. The acoustic experiments were coordinated with the collection of environmental parameters obtained from meteorological and oceanographic measurements and SAR images. The latter provided ice parameters such as ice concentration,ice type and ice kinematics and were used to identify areas where the experiments were located. The objectives are to correlate the acoustic data with the environmental data. The ERS-1 SAR data obtained during the experiment offers a unique opportunity to study variable ice conditions, eddies, surface waves, tidal currents and icebergs, all of which have a significant influence on the ambient noise and sound propagation characteristics.

SIZEX 92 was an international cooperation where the main participants were the Nansen Environmental and Remote Sensing Center (NERSC) in Bergen, Norwegian Defence Researh Institute (NDRE) in Horten, Defence Research Agency (DRA) in UK and Scott Polar Research Institute in UK. A description of the planned acoustic programme was presented in the Experiment Plan (Johannessen et al., 1991). A narrative of events and location of the various phases of the experiment have been reported in several cruise reports (Lane, 1992, Haigh,1992, Engelsen 1992 and Sandven et al. 1993).

This report describes the transmission loss measurements carried out on March 6 and presents the results of the analysis based on the data recorded on the P-3 aircraft. Broad band transmission loss data is presented in chapter 3 whilst the narrow band CW data is delt with in Chapter 4. A limited amount of environmental data is given in chapter 5. Chapter 6 offers some comments and conclusions.

2 EXPERIMENT SCHEDULE

A description of the planned acoustic programme was presented in the experiment plan (Johannessen et al., 1991). Due to changing weather and ice conditions and also due to the condition of the measuring equipment, the plan had to be revised and updated continually. The details of the experiment is described in various post-exercise cruise reports. (Johannessen et al. 1993, Engelsen 1992, Haig et al. 1992, Lane 1992, Turner 1992).

2.1 Participating units

The field programme of SIZEX 92 was carried out east of Hopen in the Barents Sea using three surface vessels supported by P-3 aircraft from the Royal Norwegian Airforce operating from Andøya airport. The participating vessels were:

- R/V POLARSYSSEL, an icebreaker suitable for operations within the MIZ. This vessel carried out a number of tasks such as oceanographic and meteorological measurements, ice observations and deployment of acoustic receiving equipment. It carried a helicopter for deployment of sonobuoys and for carrying out airial observations over the ice.

- R/V H U SVERDRUP II, a research vessel used for deployment of acoustic sources and for oceanographic measurements in the open ocean.

- R/V HÅKON MOSBY, open ocean research vessel for supporting oceanographic work.

2.2 Propagation experiment

Two types of acoustic experiments were carried out during SIZEX 92: Propagation loss experiment and ambient noise measurements. The propagation loss was measured using an ARGO projector deployed from H U SVERDRUP II operating south of the ice edge. Two tonal frequencies were transmitted: 188 Hz and 200 Hz. The signals were received on an array consisting of 6 hydrophones deployed through holes in an icefloe. This deployment was carried out from R/V POLARSYSSEL and was completed by 0100z on 6 March at position 77^0 17.0N, 030^0 14.5E. The ARGO sound source was deployed from H U SVERDRUP II at 0946z on 6 March in a position close to the ice edge. The SVERDRUP remained manoeuvering approximately in the same position until 0340 on 7 March when it started a tow-track south away from the ice edge. At 0900 on 8 March the SVERDRUP turned around and headed back towards the ice edge. The maximum distance to the ice array at this point was 185 km. The sound source was turned off at 2035z on 8 March due to power failure. This marked the end of the propagation experiment.

In addition to the sonobuoys in the ice array, a number of other sonobuoys were also deployed in the area, partly close to the ice edge, partly in the open ocean south of the ice edge and partly in leads in the ice. This sonobuoy pattern is shown in figure 2.3. The positions and deployment times for these buoys are given in table 2.1.

NOTE: The P-3 flight log provides both a "buoy drop position" and an "A/C position". Usually the buoy drop position, which is calculated based on the speed and altitude of the aircraft, is supposed to be the more accurate. However, we were informed by the air crew that if the two positions differed by more than 2 n miles, the A/C positions should be used instead as this indicated an error in the computing system. This was indeed the case for many of the drop positions during this sortie, and the A/C positions were used accordingly.

The ice array was monitored aboard the POLARSYSSEL for the duration of the operation of the sound source. In addition the P-3 also monitored the sonobuoys in the ice array as well as the other sonobuoys deployed in the area. This monitoring went on until 1630z on 6 March when the aircraft had to break off and start the return flight to the base.

In addition to and as a supplement to the CW experiment described above, a limited experiment using SUS charges and desensitised sonobuoys was conducted in the same area and at the same time in order to obtain some broad band transmission loss data. 6 desensitised sonobuoys (2 of which were uncerviceable) were deployed with the helicopter from the POLARSYSSEL. 20 SUS charges Mk 82 were dropped from the P-3 A/C, depth setting 18 meters. For some unknown reason only 11 of these charges detonated properly. The positions of the desensitised sonobuoys and SUS charges are shown in figure 2.4. Only the positions of the serviceable buoys and the SUS charges with a complete detonation are shown.

The data tapes from the POLARSYSSEL and from the P-3 flight have been sent to DRA for processing and data analysis. Copies of the P-3 data tapes have been retained at NDRE for processing of the shot data. In addition some processing has also been carried out on the CW data from the ice array as well as from the other sonobuoys in the area. This report covers the results of the NDRE analysis.

3 BROAD BAND MEASUREMENTS WITH SUS CHARGES

It was originally planned to deploy the desensitised sonobuoys as well as the SUS charges from the P-3 aircraft. But the desensitised buoys intended for this operation never turned up at Andøya airfield. Fortunately the POLARSYSSEL had been supplied with a small number of desensitised buoys (40 dB attenuation) and it was desided to deploy these with the helicopter. Due to very limited visibility this deployment could not be carried out until after 1200z on March 6. 6 desensitised sonobuoys Type AN/SSQ 41B were deployed on a north-south line some 18 km to the east of POLARSYSSEL. The hydrophone depth was set to 18 meters. Two of the sonobuoys appeared to be unserviceable while the others provided good data.

Following the deployment of the sonobuoys, the P-3 went in and dropped a total of 20 SUS Mk 82 charges set to a depth of 18 meters. 4 charges were dropped in leads in the ice in the vicinity of sonobuoy 21, 4 were dropped on an east-west course along the ice edge, while the remainder were dropped along a north-south line some 6 km east of the desensitised sonobuoys. As mentioned in chapter 2, only 11 of the charges detonated with full force, while the remainder had a very week signal level 25 to 30 dB below the expected level. The reasaon for this failure is not known, but it appears as if only the percussion cap has detonated and not the main charge.

Table 3.1 shows the deployment times and positions of the desensitised sonobuoys. The drop times and positions for the SUS charges are given in table 3.2. The positions of the sonobuoys and the charges are shown in figure 2.4.

3.1 Data recording and analysis

The data from the desensitised sonobuoys as well as from the regular sonobuoys were recorded on analog 1 inch tapes with the 28 track twin acoustic recording system aboard the P-3 aircraft. 16 tracks are available on each recorder for sonobuoy signals which means that

32 sonobuoys can be monitored simultaniously. The receiving system was calibrated on returning to base after the sortie. An RF signal is transmitted simultaniously on all RF channels at 3 different levels at a signal frequency of 100 Hz. The calibration signal is recorded on all sonotracks of the recorder. The procedure is known as "Linepost" calibration.

As it had been previously agreed that DRA should be provided with the original data tapes, a copy of all the A/C tapes were made. All the data analysis at NDRE has been made using these tape copies. The quality of the data on the copies were checked against the original data, it appears that the errors are insignificant.

The shot data was analysed in the laboratory using a Honeywell 28 track tape machine and a Bruel & Kjaer digital frequency analyser. The received energy from each shot is computed in 1/3 octave frequency bands. The operation of the analyser is based on digital filtering, detection and averaging. Each shot is processed by the analyser which gives an output in dB relative to 1 µv for each 1/3 octave band. This voltage is the computed root mean square value (rms) and thus related to the sound pressure at the hydrophone by applying the hydrophone sensitivity. The analyser was used in its linear averaging/max hold mode. In order to calculate the energy in each frequency band the rms value must be multiplied with the time constant of the averaging processor. In order to obtain correct results the time constant must be about 10 times the duration of the received shot signal.

The computation of the transmission loss (TL) will then be as follows:

Voltage level at hydrophone:	RL-120-G
Pressure level at hydrophone:	RL-120-G-S
Energy at hydrophone:	RL-120-G-S+T
Energy at hydrophone/Hz:	RL-120-G-S+T-10log Δf

Transmission loss: $TL=SL-(RL-120-G-S+T-10\log \Delta f)$

where

RL = received level in dB rel 1µv

G = system gain in dB

S = hydrophone sensitivity in dBv rel 1 µPa

T = analyser time constant: 12 dB (16 seconds)

Δf = 1/3 octave band width

SL = source level of Mk 82 SUS

In most cases the signal to noise level was high and the noise could be disregarded. In cases where the level of signal plus noise is 1 to 8 dB higher than the ambient noise, it is necessary to compensate for the noise. This is achieved by calculating the S/N ratio from the measured values of S+N and N from the expression below:

S/N = 10 log (antilog [(S+N)/N/10)-1]

This relationship is shown in figure 3.1.

The true signal level is then obtained by adding N and S/N (all numbers in this computation are in dB).

If the (S+N)/N is less than 1 in any 1/3 octave band the value is omitted.

The analysis system is shown in figure 3.2. In order to compensate for the the frequency response of the sonobuoy, an equaliser is connected in front of the frequency analyser. This is further commented upon in the calibration section.

Source levels for the Mk 82 charges detonated at a nominal depth of 18 meters (60 feet) and for frequencies above 630 Hz are those used by Gaspin and Schuler (1971). For frequencies below 630 Hz a combination of Gaspin and Schulers values with the results of Chapman (1988) have been used. The source levels used are included in table 3.3.

3.2 Calibration

The sonobuoys used in the broadband propagation loss experiment was modified AN/SSQ 41B with a sensitivity reduction of 40 dB. Unfortunately individual calibrations for these buoys were not available and generic calibration curves for the standard SSQ 41B's were used (Figure 3.3). The frequency response of these buoys are 15 log f. In order to facilitate the analysis work an equaliser network was developed with a frequency response equal to -(15 log f) In this way the overall response of the system will be constant over the frequency range 10 to 3000 Hz.

A socalled "linepost" calibration of the receiving and recording system was performed upon return of the flight. The reference point of the sonobuoy calibration curve is 116 ± 2 dB rel 1 μPa which is equivalent to 19 kHz frequency deviation of the RF frequency. Three calibration levels are used: 10, 19 and 75 kHz which corresponds to a change in level of 5.6 and 11.9 dB respectively. The calibration signals are recorded on all the sonotracks of the A/C receiving system and upon replay provides the necessary gain adjustment for each individual channel. This adjustment is included in table 3.4.

3.3 Propagation loss results

Propagation losses from each explosive charge to the four receiving sonobuoys have been computed in 1/3 octave frequency bands from 12.5 Hz to 3150 Hz as outlined in section 3.1. The results are given in tables 3.6 through 3.9 for sonobuoys 5, 21, 22 and 24 respectively. The tables also give the ranges between shots and receivers. The ranges are computed from the sonobuoy and shot positions as given in tables 3.1 and 3.2.

Shots numbers 2, 3 and 4 are all within the ice cover. Shots numbers 5, 6, 7 and 8 are deployed along the ice edge, while the remainder of the shots have been deployed along a north-south line out to a distance of approximately 56 km from the ice edge. The ice edge shots caused overloading of sonobuoy no 5 as the distances in these cases were very short. In some cases the signal to noise levels were too low to yield useful results and the spaces in the tables are left blank.

In figures 3.4 through 3.7 the propagation losses have been plotted as a function of range for 5 selected frequencies 31.5, 100, 315, 1000 and 3150 Hz. The figures also give an indication on what parts of the transmission path is covered by ice and what part lies in open water. The receiving sonobuoy is located at zero range, and the distances to the SUS charges are given in km. Spreading law curves for 15, 17 and 20 times the logarithm to the range are included. 20 log r represents spherical spreading.

Propagation losses as a function of frequency are given in figures 3.8 through 3.11 for the 4 receiving sonobuoys respectively. Table 3.10 shows the appropriate distances between shots and receivers. Figure 3.9 shows the results for buoy no 21 which is deployed in the ice. It is apparent that there is an optimum frequency of minimum loss. At short distances, 5 to 10 km, the optimum frequency is seen to lie between 25 and 50 Hz, while for the longer distances the optimum frequency is increased to the range of 100 to 200 Hz. The same tendency is seen in the results for the other sonobuoys: Short distances means lower optimum frequencies than longer distances.

4 NARROW BAND MEASUREMENTS WITH CW PROJECTOR

In the CW experiment an ARGO projector was deployed from H U SVERDRUP II at about 0910 on 6 March, as reported by Lane (1992) and Burt (1993). Prior to this time an ice array had been deployed by POLARSYSSEL in position 77^{0}17 N, 30^{0}13 E. Figure 2.2 shows the configuration of the array. As a supplement to the array a number of ordinary sonobuoys were deployed from P-3 aircraft starting at about 1000z. 6 serviceable buoys SSQ 905 F-size and 3 SSQ 57B A-size buoys were deployed from the A/C. In addition the POLARSYSSEL helikopter also deployed two serviceable SSQ 57B's. The deployment pattern is shown in figure 2.3, while table 2.1 gives deployment times and positions for the ordinary sonobuoys.

During the first phase of the experiment SVERDRUP was required to remain stationary for about 15 hours just south of the ice edge. In order to do so she had to keep manouevering with her main engines running. Also POLARSYSSEL was manouevering during the first part of the experiment. At about 1300z the main engines of the POLARSYSSEL were stopped. Good data were obtained in the time periode between 1300z and 1630z when the aircraft had to return to base. Contact with the sonobuoys were occasionally lost during during short periodes when the aircraft made the SUS charge run between 1430z and 1530z.

The P-3 aircraft monitored all the sonobuoys including the 6 ice array buoys during the time it remained in the area. For reasons explained above the most useful data was obtained in the time periode from 1300z to 1630z.

DRA has the main responsibility for the analysis of the CW data. However, as a supplement, a limited analysis has also been performed at NDRE in order to make a comparison between the shot data and CW data.

4.1 Data recording and analysis

The data recording and calibration have been discussed in chapter 3. Data analysis was performed using the instrumentation shown in figure 4.1. An ONO SOKKI CF 920 FFT analysis system was used to obtain the average received levels of the transmitted tonal frequencies 188 Hz and 200 Hz. An averaging time of 1 min. was used. In order to obtain sufficient signal to noise ratio a bandwidth of 0.13 Hz was used.

Where the signal to noise ratio falls below about 8 dB corrections were applied according to figure 3.1. Cases were the signal to noise ratios falls below about 2 dB were disregarded.

Figure 4.2 shows an example of the frequency spectrum display on the scope of the analyser and is representative for the majority of the analysed samples.

The SUS charge experiment was carried out in the time periode 1430z to 1530z and the CW samples were therefore consentrated around the same time periode. It was also important to select time periodes were the aircraft was in good contact with all the sonobuoys in the field. Data processing was carried out at the following times: 1400, 1445, 1520, 1602 and 1628.

At the time of the data analysis the exact source level of the projector for the two frequencies used was not known. A SL of 160 dB ref 1 μPa at 1 meter was therefore assumed for both frequencies. Minor variations in source level with aspect and time was observed. In order to obtain more accurate figures for the propagation losses, corrections for SL variations will have to be applied.

4.2 Calibration

The sonobuoys used for receiving the CW signals were of 3 different types: SSQ 57A, SSQ 57B and SSQ 905. 57A's and 57B's are identical except that the 57B's have been calibrated. Unfortunately the calibration curves were not available at Andøya airforce base. We have therefore been oblidged to use the generic calibration curve which is shown in figure 4.3. This buoy has a frequency response of 15 log f over the frequency range 10 to 3000 Hz. As explained in chapter 3.2 this frequency response has been compensated by an equalising network which make the response of the analysis system independent of frequency over the stated frequency range. The 905 is a UK calibrated F-size buoy. For these buoys calibrations were available and were used for calculating the buoy sensitivity. The equalising network was not in use during the processing of the 905 data.

The gain for each individual rcording track was determined as explained in chapter 3.2. The gain adjustment is given in table 3.4. where the equaliser was used and in table 3.5 with no equaliser connected.

4.3 Propagation loss results

Propagation losses have been calculated for all the sonobuoys in the ice array as well as for the independent sonobuoys in the ice, at the ice edge and in the open water. As explained in section 4.1 the calculations were performed at 5 different times using an averaging time of 1 min. The results have been tabulated and are shown in table 4.1. The depth of each sonobuoy as well as the average range between source and receiver are also given. The ranges from H U SVERDRUP II to the sonobuoy receivers are given in table 4.2 in the time periode 1400 to 1700. The ranges are based on positions of the HUS at these times as reported by Lane 1992 (DRA Cruise Report). These positions are shown in table 4.3.

TRANSMISSION LOSS

EXPERIMENT SIZEX 92
DATE 6 MARCH 92
SOURCE ARGO PROJECTOR
FREQUENCY 188 HZ and 200 HZ
SOURCE LEVEL 160 dB ref 1 μPa

				188 Hz					200 Hz					
	Sonobuoy		Average	Time					Time					
No	Type	Depth	range km	1400	1445	1520	1602	1628	1400	1445	1520	1602	1628	Comments
9	57A	18 m	24.0		81.2	82.8	78.9	82.5		80.6	82.1	83.9	79.9	Ice array
11	"	38 "?	"	83.5	79.9	72.3	79.6	83.1	80.6	77.2	71.6	72.3		" "
15	"	18 "	"	80.3	80.6	79.4	77.4	80.0	77.7	78.6	78.8	79.8	79.7	" "
13	"	38 "	"	75.6	72.7	73.4	74.8	74.4	74.6	72.4	72.4	70.5	72.8	" "
29	"	18 "	"	83.0	84.5	85.9	84.1	84.6	81.3	81.8	83.7	86.8	85.7	" "
27	"	38 "	"	72.9	70.7	71.6	72.3	71.8	72.6	69.9	70.8	68.2	71.0	" "
14	57B	18 m	40.4		79.9	86.7		82.4		81.6	84.6		87.2	In ice
19	"	18 "	42.6	78.2	80.4	90.3	78.7	81.5	82.3	77.2	87.8	79.4	81.7	" "
26	"	18 "	23.7		76.4	79.1	71.5	74.1		72.2	73.3	71.7	71.9	" "
17	"	18 "	6.6	63.7	63.3	62.1	59.1	65.3	56.1	58.7	60.9	66.0	62.9	Ice edge
18	"	18 "	13.5	63.3	74.6	64.6	67.3	68.2	63.6	67.5	62.3	70.3	67.7	" "
2	905	18 "	5.1	62.1	63.3	75.3	62.0	69.6	59.3	62.8	60.5	60.8	62.4	" "
10	"	18 "	14.8	63.6	65.3	63.0	61.9	61.3	67.0	58.5	65.6	57.7	59.1	Open water
58	"	18 "	33.5	75.2	66.7	65.2	76.2	67.4	68.1	75.9	62.9	69.9	71.1	" "
53	"	18 "	47.9	80.5	72.5	80.6	71.2	79.4	73.1	76.2	73.7	71.8	72.9	" "
82	"	18 "	65.9	77.1	74.4	82.9	76.9	68.3	76.3	73.5	79.8	73.6	72.1	" "
30	"	18 "	84.4	74.7	81.4	80.1	82.9	72.8	80.6	75.0	75.7	74.0	70.9	" "

Table 4.1 CW Propagation Loss Results

Figure 4.4 gives a plot of the propagation losses as a function of range. Both frequencies are presented. The bars show the maximum and minimum values as well as the mean for the 5 measurement periodes mentioned above. In general there is god agreement between the propagation losses for the the two frequencies, but it appears that in most cases the loss at 188 Hz is 1 to 3 dB higher than at 200 Hz. The averaging time is probably too short to determine whether this discrepancy is real or not.

There is some uncertainty regarding the validity of the values obtained from buoy 11 in the ice array. In contrast to the other buoys in the ice array the noise output from this buoy shows extremly high levels at low frequencies which indicates that the noise source is nonacoustic. There is also some uncertainty as to the hydrophone depth of this buoy. When the system was deployed the hydrophone appeared to get stuck at a depth less than the 38 meters it was supposed to be deployed at. The person responsible for the deployment recollects that this was later corrected, but there is still some uncertainty. After about 1600z this buoy became completely unserviceable and was replaced by buoy 31 from 7 March at 1400z. The propagation loss values for buoy 11 are included in table 4.1 but must be regarded with some reservations.

Two separate bars represents the propagation loss to the ice array. One for the 18 meter hydrophones 9, 15 and 29, and one for the 38 meter hydrophones 13 and 27. The difference in average levels between the two hydrophone depths is seen to be about 10 dB. The results does not even show an overlap between the two depths.

The results are further dicussed in chapter 6.

5 ENVIRONMENTAL DATA

The P-3 aircraft deployed 7 serviceable AXBT buoys in the operating area during the operation. Deployment times and positions are given in table 5.1. The AXBT positions are shown in the map of figure 2.3. The temperature profiles have been converted to sound speed profiles using a constant salinity of 35 pr.m. The profiles are presented in figure 5.1. AXBT no 3 showed obvious errors and were discarded.

R/V Håkon Mosby made a CTD run parallel to the open water sonobuoy line the night of March 6. These CTD positions are shown in the map of figure 2.3. The sound velocity section of this run is presented in figure 5.2. A sharp sound velocity gradient at a depth which varies between 50 and 100 meters provides a strong surface duct. The higher frequencies will be trapped in the duct while some leakage out of the duct must be expected for the lower frequencies (below about 50 Hz).

CTD and XBT measurements were also carried out from H U SVERDRUP II during the acoustic experiment and will be reported by DRA.

SAR images from swath D17 were available from the following dates: March 2, 5, 8 and 11. Figure 2.3 shows part of this image which covers the area where the acoustic experiment took place. Although the SAR image shows the ice conditions on March 5, one day prior to the acoustic experiment, it is considered that the image is fairly representative also for the conditions on March 6 as the ice edge did not move very much in this periode.

The processing and analysis of the SAR data has been reported by Stein Sandven (1992) at NERSC. Additional measurements of environmental data such as windfield, currents and in situ ice conditions were carried out from "POLARSYSSEL" and will be reported by NERSC.

6 DISCUSSION OF RESULTS AND CONCLUSIONS

Results of the broad band experiment have been presented in figures 3.4 through 3.11 and in tables 3.6 through 3.9. Figures 3.8 through 3.11 show clearly a minimum propagation loss in the frequency range 100 to 250 Hz in most cases. Only at very short range the optimum frequency is shifted down to the region below 100 Hz. As discussed in chapter 5, a very strong surface duct prevailed in the area during the experiment. The depth of the duct was in places as shallow as 40 meters. Frequencies with wavelengths twice the depth of the duct (or more) will be trapped in the duct, while for lower frequencies som leakage out of the duct and subsequent interaction with the bottom must be expected. This will result in increased losses for lower frequencies.

The increase in propagation loss at higher frequencies can partly be attributed to absorption loss. However ,this is not sufficient to explain the measured difference in propagation loss for for middle and high frequencies. As an example the measured difference in propagation loss for buoy 24 at frequencies 315 and 3150 Hz respectively is seen to be 20 dB. at a range of 40 km, while the absorption loss at 3150 Hz is about 12 dB. The balance must therefore be due to some other mechanism. Surface scattering could be considered in this context. The extent of the scattering will depend on wind speed and sea state. At the present time these environmental data are not available.

Figures 3.4 through 3.7 show the propagation loss as a function of range for 5 selected frequencies. In accordance with figures 3.8 through 3.11, a minimum loss is found for frequencies 100 and 315 Hz. It is seen that when the propagation path is in an area with open water the propagation loss for these frequencies corresponds to a spreading law of 15 to 17 log r(range). On the other hand when the propagation path is partly or completely under the ice cover, the propagation loss corresponds to a spreading law of 17 to 20 log r. It is therefore a significant increase in propagation loss due to the ice cover.

The results of the CW propagation is shown in figure 4.4. In order to compare the results of the two experiments, the 200 Hz CW data and the 200 Hz 1/3 octave data from the broad band experiment has been plotted in figure 6.1. The data points shown for sonobuoys 21, 22 and 24 are from the shots near the ice edge (not far from the position of H U SVERDRUP II). For buoy 5 which is located not far from HUS all the data points are included.

The results show very good agreement between the two types of experiments. The propagation loss to buoy 5 from the shots fired from positions within the ice (no 2, 3 and 4) show somewhat less loss than for shots fired at the ice edge to a receiver in the ice (buoy 21). The reason for this discrepancy is not clear at the moment. It is clearly evident that the propagation loss for an open water path corresponds closely to a spreading law of 15 to 17 log r, while for a path under ice the loss is increased to correspond to a spreading law of 17 to 20 log r. The difference in propagation loss for deep and shallow receivers in the ice array has been commented on in chapter 4.

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Buoy no	Buoy type SSQ	Drop plat-form	Drop time	Area type	Location	Note
2	905	A/C	1009.00	Ice edge	77°06.35 N, 30°20.41 E	OK
10	905	"	1011.37	Open water	76°56.33 N, 30°21.01 E	OK
58	905	"	1014.15	" "	76°46.21 N, 30°21.15 E	OK
53	905	"	1016.28	" "	76°38.31 N, 30°31.29 E	OK
82	905	"	1018.42	" "	76°28.48 N, 30°30.58 E	OK
63	905	"	1020.50	" "	76°18.58 N, 30°31.06 E	Def
30	905	"	1129.22	" "	76°18.49 N, 30°33.11 E	OK
17	57-B	"	1052.07	" "	77°06.16 N, 30°14.51 E	OK
18	57-B	"	1055.11	Grease ice	77°09.48 N, 30°49.54 E	OK
19	57-B	"	1108.31	In lead	77°24.36 N, 29°38.15 E	OK
26	57-B	Helo	1350.58	" "	77°15 N, 31°00 E	OK
14	57-B	"	1419.29	" "	77°25 N, 31°00 E	OK

Table 2.1 <u>Positions and deployment times for ordinary sonobuoys</u>

Buoy no	Buoy type SSQ	Drop plat-form	Drop tid	Area type	Location	Note
22	41-B	"	1243.16	Open water	76°35 N, 31°00 E	OK
24	41-B	"	1307.03	" "	76°45 N, 31°00 E	OK
16	41-B	"	1331.50	" "	76°55 N, 31°00 E	Def
5	41-B	"	1332.14	" "	77°05 N, 31°00 E	OK
23	41-B	"	1350.38	In lead	77°15 N, 31°00 E	Def
21	41-B	"	1419.17	" "	77°25 N, 31°00 E	OK

Table 3.1 <u>Positions and deployment times for desensitised sonobuoys</u>

SUS no	Drop time	Area type	Location	Note
1		In lead	$77^{0}30$ N $30^{0}59$ E	Defective
2	1433	" "	$77^{0}30$ N $31^{0}00$ E	OK
3	1443	" "	$77^{0}27$ N $31^{0}04$ E	OK
4	1557	" "	$77^{0}23$ N $31^{0}05$ E	OK
5	1514	By ice edge	$77^{0}07$ N $31^{0}24$ E	OK
6	1515	" "	$77^{0}06$ N $31^{0}15$ E	OK
7	1515	" "	$77^{0}05$ N $31^{0}00$ E	OK
8	1516	" "	$77^{0}04$ N $30^{0}50$ E	OK
9	1522	Open water	$77^{0}03$ N $31^{0}15$ E	OK
10	1523	" "	$77^{0}01$ N $31^{0}15$ E	Weak
11	1524	" "	$76^{0}58$ N $31^{0}15$ E	OK
12	1524	" "	$76^{0}55$ N $31^{0}15$ E	OK
13	1525	" "	$76^{0}52$ N $31^{0}15$ E	Weak
14	1526	" "	$76^{0}49$ N $31^{0}15$ E	Weak
15	1527	" "	$76^{0}46$ N $31^{0}15$ E	Weak
16	1527	" "	$76^{0}43$ N $31^{0}15$ E	Weak
17	2528	" "	$76^{0}40$ N $31^{0}15$ E	Weak
18	1528	" "	$76^{0}37$ N $31^{0}15$ E	Weak
19	1529	" "	$76^{0}35$ N $31^{0}15$ E	OK
20	1530	" "	$76^{0}32$ N $31^{0}15$ E	Weak

Table 3.2 <u>Positions and deployment times for SUS charges</u>

Freq Hz	12.5	16	20	25	31.5	40	50	63	80
SL dB	214.6	211.8	210.3	210.2	208.1	207.4	206.0	206.1	204.7
Freq Hz	**100**	**125**	**160**	**200**	**250**	**315**	**400**	**500**	**630**
SL dB	203.5	202.5	201.3	200.3	199.3	198.3	197.4	196.4	195.2
Freq Hz	**800**	**1000**	**1250**	**1600**	**2000**	**2500**	**3150**	**4000**	
SL dB	193.7	192.5	191.8	190.6	188.4	186.2	184.4	183.1	

Table 3.3 <u>Source levels for SUS MK 82 at 18 m detonation depth</u>

Track no	FORWARD 10 KHz	19 KHz	75 KHz	AFT 10 KHz	19 KHz	75 KHZ
9	-10.4	-4.7	+ 7.1	-10.5	-4.9	+ 7.0
10	-11.3	-5.6	+ 6.2	-11.0	-5.3	+ 6.6
11	- 7.7	-2.1	+ 9.7	- 7.5	-1.9	+10.0
12	- 9.8	-4.3	+ 9.7	-10.0	-4.4	+ 7.5
13	- 7.6	-2.1	+ 9.8	- 8.0	-2.3	+ 9.6
14	- 7.5	-1.9	+10.0	- 7.6	-2.0	+ 9.9
15	- 7.8	-2.2	+ 9.7	- 7.7	-2.1	+ 9.8
16	- 8.8	-3.2	+ 8.7	- 9.1	-4.4	+ 8.4
17	- 8.1	-2.6	+ 9.3	- 7.9	-2.3	+ 9.6
18	- 9.1	-3.6	+ 8.3	- 9.3	-3.8	+ 8.1
19	- 7.9	-2.3	+ 9.5	- 8.2	-2.6	+ 9.2
20	-12.7	-7.0	+ 4.7	-12.7	-7.1	+ 4.7
21	- 6.7	-1.2	+10.6	- 6.5	-0.9	+11.0
22	- 7.4	-1.7	+10.1	- 7.6	-2.0	+ 9.9
25	- 8.6	-3.1	+ 8.8	- 8.6	-3.1	+ 8.8
26	- 7.9	-2.2	+ 9.7	- 7.5	-1.9	+10.0

Table 3.4 <u>Calibration of P-3 receiving system with equaliser</u>

Track no	FORWARD 10 KHz	19 KHz	75 KHz	AFT 10 KHz	19 KHz	75 KHz
9	-21.0	-15.4	-3.4	-20.7	-15.1	-3.2
10	-21.4	-15.8	-3.9	-21.7	-16.1	-4.2
11	-17.9	-12.3	-0.4	-18.2	-12.6	-0.7
12	-20.5	-14.9	-3.0	-20.3	-14.7	-2.7
13	-18.4	-12.8	-0.9	-18.0	-12.4	-0.5
14	-18.1	-12.5	-0.6	-17.9	-12.3	-0.4
15	-18.2	-12.6	-0.7	-18.2	-12.6	-0.7
16	-19.5	-13.9	-2.0	-19.2	-13.6	-1.7
17	-18.3	-12.8	-0.9	-18.5	-13.0	-1.1
18	-19.9	-14.2	-2.3	-19.6	-14.0	-2.1
19	-18.7	-13.1	-1.2	-18.3	-12.7	-0.8
20	-23.2	-17.6	-5.7	-23.1	-17.5	-5.6
21	-17.0	-11.4	+0.6	-17.2	-11.6	+0.3
22	-18.1	-12.4	-0.5	-17.7	-12.1	-0.2
25	-19.1	-13.5	-1.6	-19.0	-13.4	-1.6
26	-18.0	-12.3	-0.4	-18.2	-12.6	-0.7

Table 3.5 <u>Calibration of P-3 receiving system without equaliser</u>

TRANSMISSION LOSS

BUOY NO	5					
DATE	6 - 3 - 92					
LOCATION	East of Hopen					
BANDWIDTH	1/3 octave					
NO OF SAMPLES	6					
SHOT NO	2 ice	3 ice	4 ice	11 open w	12 open w	19 open w
TIME	1433.12	1443.49	1456.44	1524.13	1525.00	1530.13
RANGE	46.3 km	40.8 km	33.4 km	14.3 km	19.5 km	55.9 km
FREQUENCY Hz						
12.5	89.8	89.2	98.1	72.2	72.3	82.4
16	88.3	87.2	91.9	73.4	71.8	81.1
20	87.7	88.5	90.5	71.5	70.7	80.1
25	88.7	92.0	87.4	70.4	75.2	82.9
31.5	85.0	83.2	82.6	64.2	70.3	87.3
40	83.8	81.9	80.0	63.8	67.4	82.5
50	80.8	82.6	79.9	63.6	66.0	76.4
63	81.9	83.7	77.4	65.4	67.1	75.4
80	79.6	79.9	74.9	64.8	66.5	71.7
100	77.5	78.7	74.1	64.8	68.1	71.7
125	75.5	75.7	73.4	64.9	67.5	71.4
160	78.0	77.5	74.2	65.5	66.0	69.7
200	78.0	76.4	74.9	66.9	67.8	69.4
250	81.3	77.8	75.5	68.8	68.3	72.9
315	83.3	81.5	77.6	69.7	69.4	72.1
400	78.4	78.6	77.1	71.2	70.9	75.3
500	85.4	86.5	83.2	72.3	72.5	76.0
630	90.1	85.3	85.2	73.7	73.5	78.4
800	87.9	87.5	86.9	74.2	73.7	82.1
1000	88.8	89.7	88.2	75.7	75.6	83.3
1250	92.5	92.8	91.2	78.5	76.6	85.4
1600	95.6	98.3	95.1	81.0	78.7	89.8
2000	97.5	102.5	98.9	81.9	81.9	93.1
2500	96.7	103.7	101.9	83.7	83.7	97.2
3150	97.5	104.0	104.0	88.5	86.2	99.9

Table 3.6 Broad Band Propagation Loss to Sonobuoy 5.

TRANSMISSION LOSS

BUOY NO	21
DATE	6 - 3 - 92
LOCATION	East of Hopen
BANDWIDTH	1/3 octave
NO OF SAMPLES	11

SHOT NO	2 ice	3 ice	4 ice	5 ice e	6 ice e	7 ice e	8 ice e	9 o.w.	11 o.w.	12 o.w.	19 Open w
TIME	1432.46	1443.23	1456.22	1514.53	1515.46	1516.47	1517.05	1523.12	1524.39	1525.25	1530.40
RANGE	9.8 km	4.6 km	5.0 km	34.6 km	37.0 km	37.0 km	40.4 km	41.3 km	49.8 km	55.2 km	93.0 km
FREQUENCY Hz											
12.5	72.4	66.9	70.6	97.5	97.1	95.0	103.6	105.0			
16	70.0	63.0	62.5	96.0	94.7	92.3	100.8	104.6			
20	68.4	60.6	61.4	95.0	93.9	91.7	100.0	101.6			
25	66.4	59.8	61.2	100.3	93.7	91.5	97.6	101.2	102.5	103.6	
31.5	65.5	59.8	61.0	91.4	93.1	91.2	93.5	94.0	94.8	97.0	96.9
40	65.6	61.4	61.8	92.1	89.3	88.0	90.6	91.6	92.8	92.6	95.1
50	64.1	59.2	65.9	87.0	90.3	86.3	88.0	90.4	91.3	90.8	92.7
63	68.3	65.5	66.0	89.0	88.8	86.1	87.4	90.3	91.0	89.7	93.3
80	68.6	67.0	66.2	87.7	87.0	87.8	85.0	87.4	87.5	90.4	92.8
100	65.2	65.9	68.1	85.4	84.6	84.4	85.2	84.3	86.3	86.4	90.1
125	70.6	68.0	69.2	82.3	81.6	79.8	85.6	83.6	82.7	83.7	89.1
160	71.8	68.5	70.2	85.0	85.4	80.1	84.6	84.2	85.0	87.1	90.6
200	72.0	69.8	70.6	84.7	84.6	81.7	84.1	83.7	86.6	85.5	89.7
250	73.7	73.7	74.7	87.7	84.8	83.4	84.4	85.9	88.8	87.9	92.3
315	75.5	76.7	75.6	86.0	86.1	84.2	86.5	87.6	89.1	87.2	92.5
400	77.7	76.6	77.6	90.9	86.9	84.6	88.6	88.1	91.1	90.5	94.4
500	83.6	80.1	80.8	93.8	90.3	87.3	88.3	89.7	90.8	90.1	96.6
630	84.6	82.0	79.9	91.7	88.7	90.1	93.2	89.6	90.4	92.5	97.7
800	84.4	81.5	81.0	92.7	92.5	89.0	93.5	92.8	92.9	92.8	98.6
1000	83.5	81.9	82.5	93.7	91.6	92.4	93.4	95.4	93.8	96.9	100.0
1250	84.6	82.8	82.8	97.6	93.7	95.9	99.8	95.7	95.1	102.8	105.0
1600	84.8	82.6	82.6	102.6	99.3	101.4	104.3	103.4	102.6	104.4	
2000	84.8	83.2	84.2	107.2	101.4	103.2	111.4	105.4	110.2	111.4	
2500	85.5	82.0	86.7	110.2	106.9	105.0	112.0	112.0	112.0	112.0	
3150	87.2	82.2	87.8		107.2						

Table 3.7 <u>Broad Band Propagation Loss to Sonobuoy 21</u>

TRANSMISSION LOSS

BUOY NO 22
DATE 6 - 3 - 92
LOCATION East of Hopen
BANDWIDTH 1/3 Octave
NO OF SAMPLES 10

SHOT NO	3 ice	4 ice	5 ice e	6 ice e	7 ice e	8 ice e	9 o.w.	11 o.w.	12 o.w.	19 open w
TIME	1444.26	1457.21	1515.06	1515.56	1516.58	1517.11	1523.15	1524.27	1525.06	1530.21
RANGE	96.3 km	88.5 km	60.7 km	57.6 km	55.6 km	52.4 km	51.6 km	43.3 km	38.3 km	6.1 km
FREQUENCY Hz										
12.5	96.9	104.5	88.4	92.8	87.6	83.8	92.1	78.5	77.9	71.6
16	92.9	105.1	87.9	91.8	85.7	86.5	91.0	83.7	79.0	70.3
20	93.0	107.0	87.1	91.3	85.5	86.3	91.0	85.3	79.2	69.6
25	95.9	103.1	89.0	93.5	88.2	91.2	91.2	79.9	81.8	70.2
31.5	91.9	97.8	90.1	93.8	92.3	87.2	87.2	81.7	78.8	68.7
40	91.8	94.7	90.3	92.7	85.7	87.0	88.0	80.8	79.3	67.3
50	93.7	94.4	84.6	83.3	82.2	81.0	83.0	77.5	77.7	68.2
63	93.9	91.7	84.5	81.6	80.2	81.9	81.2	78.3	76.3	69.7
80	91.8	90.9	80.4	80.6	77.6	78.3	76.4	76.4	68.5	69.5
100	89.9	88.5	77.8	77.0	74.1	77.3	76.3	75.2	74.1	69.5
125	90.9	86.3	78.9	75.8	75.6	75.2	74.3	74.6	73.4	70.1
160	92.3	86.9	75.5	73.6	75.6	76.2	74.0	73.1	71.3	70.3
200	92.3	86.9	75.3	75.3	75.6	74.4	74.8	73.3	72.4	71.4
250	93.4	89.0	76.7	76.0	75.9	74.0	76.7	71.9	73.6	69.7
315	94.6	93.0	79.1	77.2	76.6	74.7	77.7	74.9	76.1	72.0
400	95.9	94.4	78.0	78.8	78.5	79.7	78.2	75.6	75.0	73.0
500	94.4	92.7	80.0	79.7	80.8	79.9	78.2	78.7	77.2	73.5
630	96.5	94.9	82.2	81.4	81.3	81.4	81.6	79.4	78.9	76.2
800	96.2	97.0	85.3	87.0	84.0	83.1	84.5	81.1	81.8	76.2
1000	98.8	99.2	86.3	87.8	85.2	85.9	84.1	83.9	84.2	77.8
1250	102.5	103.5	87.8	88.7	88.4	87.8	88.2	84.5	85.6	78.9
1600	106.3	110.9	91.6	92.3	91.2	91.2	91.2	88.0	87.3	80.6
2000	106.4	113.3	95.1	96.2	95.1	92.7	94.1	92.1	91.1	82.1
2500	105.8		98.5	97.9	98.5	95.8	96.5	92.1	92.1	84.4
3150	106.1		102.1	103.6	103.1	103.1	101.3	97.3	93.9	85.7

Table 3.8 Broad Band Propagation Loss to Sonobuoy 22

TRANSMISSION LOSS

BUOY NO 24
DATE 6 - 3 - 92
LOCATION East of Hopen
BANDWIDTH 1/3 octave
NO OF SAMPLES 11

SHOT NO	2 ice	3 ice	4 ice	5 ice e	6 ice e	7 ice e	8 ice e	9 o.w.	11 o.w.	12 o.w.	19 open w
TIME	1433.38	1444.14	1457.10	1514.55	1515.45	1516.46	1516.59	1523.02	1524.16	1524.55	1529.49
RANGE	83.0 km	77.8 km	70.2 km	42.6 km	38.7 km	36.1 km	34.3 km	33.3 km	25.9 km	20.4 km	20.0 km
FREQUENCY Hz											
12.5	93.1	103.8	107.4	75.2	76.7	76.5	74.5	77.3	73.1	72.1	76.3
16	94.2	101.4	103.4	75.9	77.0	76.6	75.4	78.8	76.5	79.5	74.7
20	93.0	99.7	103.4	76.2	77.9	79.5	78.8	78.8	80.4	74.5	74.4
25	94.3	100.6	100.2	78.6	80.7	85.7	79.2	80.4	80.0	74.1	76.8
31.5	93.1	96.2	94.9	78.6	81.0	81.4	77.1	82.6	76.2	71.1	80.3
40	92.0	94.4	94.7	79.9	79.3	79.0	76.1	82.2	73.7	70.1	79.1
50	91.3	93.2	94.6	81.7	77.6	77.4	74.0	80.2	71.0	68.1	74.3
63	92.4	95.6	90.8	80.7	77.4	78.4	75.2	77.7	73.1	69.3	77.8
80	89.9	90.9	87.8	77.7	76.6	76.3	73.9	74.4	72.6	67.4	75.2
100	86.5	87.0	85.6	77.2	75.1	74.7	73.2	75.8	73.7	70.2	73.3
125	87.7	88.7	85.2	74.7	75.6	75.2	72.8	74.5	73.4	70.8	74.4
160	87.3	88.4	85.8	74.8	73.2	73.5	73.1	74.0	71.2	70.0	73.7
200	88.0	88.8	84.4	73.7	71.4	72.2	70.8	73.5	71.8	70.4	72.9
250	92.7	91.8	87.6	73.9	72.6	75.5	73.0	72.6	71.6	72.2	73.4
315	92.5	89.4	86.8	75.0	74.1	75.4	73.7	74.0	72.5	72.7	74.7
400	92.1	90.1	87.2	76.3	75.7	76.3	74.9	76.1	75.1	73.6	75.6
500	93.1	90.0	88.1	79.6	78.7	78.7	78.0	78.6	78.1	76.4	77.6
630	96.3	92.3	89.9	80.1	80.8	80.4	78.9	78.8	77.9	77.3	79.8
800	95.6	92.7	90.0	82.2	81.3	80.2	80.3	79.9	80.0	77.3	80.7
1000	98.3	98.0	94.3	85.0	83.7	83.7	80.8	81.7	81.3	80.1	81.9
1250	103.4	102.4	104.6	86.4	85.1	84.5	84.0	83.9	81.6	81.6	81.8
1600	104.4	109.0	106.2	88.8	86.7	86.7	86.2	84.8	83.8	82.7	84.2
2000	106.4	110.6	109.0	92.0	90.2	89.3	88.0	88.7	85.1	85.0	77.4
2500	105.9	110.3	112.0	92.8	92.8	92.0	90.8	89.0	87.8	86.3	79.8
3150	106.7	111.2	113.0	96.5	96.7	96.5	95.5	94.9	90.0	88.2	82.0

Table 3.9 Broad Band Propagation Loss to Sonobuoy 24

Buoy no Shot no	5	21	22	24
2	46.3 km	9.8 km		83.0 km
3	40.8 "	4.6 "	96.3 km	77.8 "
4	33.4 "	5.0 "	88.5 "	70.2 "
5		34.6 "	60.7 "	42.6 "
6		37.0 "	57.6 "	38.7 "
7		37.0 "	55.6 "	36.1 "
8		40.4 "	52.4 "	34.3 "
9		41.3 "	51.6 "	33.3 "
11	14.3 km	49.8 "	43.3 "	25.9 "
12	19.5 "	55.2 "	38.3 "	20.4 "
19	55.9 "	93.0 "	6.1 "	20.0 "

Table 3.10 Distances between shots and sonobuoy receivers

Sonobuoy No	Type	1400 km	1430 km	1500 km	1600 km	1700 km	Average km
14	57B	38.48	39.18	41.44	41.12	42.47	40.4
19	"	41.18	42.16	43.12	42.83	44.65	42.6
26	"	21.85	22.35	24.75	24.46	25.48	23.7
17	"	6.14	6.82	6.57	6.37	8.04	6.6
18	"	11.82	12.16	14.56	14.29	15.13	13.5
2	905	4.06	4.92	5.45	5.17	6.98	5.1
10	"	16.68	15.91	13.75	14.08	12.6	14.8
58	"	35.38	34.54	32.52	32.85	31.25	33.5
53	"	49.79	48.90	47.05	47.38	45.69	47.9
82	"	67.79	66.90	65.03	65.36	63.68	65.9
30	"	86.25	85.35	83.50	83.83	82.14	84.4
Ice array		22.33	23.30	24.77	24.45	26.23	24.0

Table 4.2 Distances between HUS and sonobuoy receivers

Time	Latitude	Longitude	Depth
0915	77.055^{0}N	30.43 ^{0}E	216 m
0930	77.065^{0}N	30.45 ^{0}E	220 "
1300	77.065^{0}N	30.438^{0}E	220 "
1330	77.085^{0}N	30.513^{0}E	211 "
1345	77.080^{0}N	30.495^{0}E	215 "
1400	77.090^{0}N	30.485^{0}E	222 "
1415	77.090^{0}N	30.496^{0}E	214 "
1430	77.082^{0}N	30.502^{0}E	213 "
1500	77.065^{0}N	30.442^{0}E	221 "
1600	77.068^{0}N	30.443^{0}E	210 "
1700	77.053^{0}N	30.472^{0}E	218 "

Table 4.3 Positions of H U SVERDRUP II on March 6 (From DRA cruise report: Lane 1992)

Buoy no	Buoy type SSQ	AXBT no	Drop time	Area type	Location	Note
14	36	1	1033.12	" "	76^{0}29.08 N, 30^{0}31.54 E	OK
16	36	2	1041.37	" "	76^{0}49.08 N, 30^{0}32.22 E	OK
12	36	3	1050.16	Ice edge	77^{0}08.52 N, 30^{0}31.22 E	OK
14	36	4	1108.31	In lead	77^{0}24.36 N, 29^{0}38.15 E	OK
16	36	5	1526.50	Open water	76^{0}44.33 N, 31^{0}15.51 E	OK
12	36	6	1534.10	" "	76^{0}35.26 N, 31^{0}14.25 E	OK
16	36	7	1543.14	Ice edge	77^{0}05.46 N, 30^{0}28.58 E	OK

Table 5.1 <u>Positions and deployment times for AXBT buoys</u>

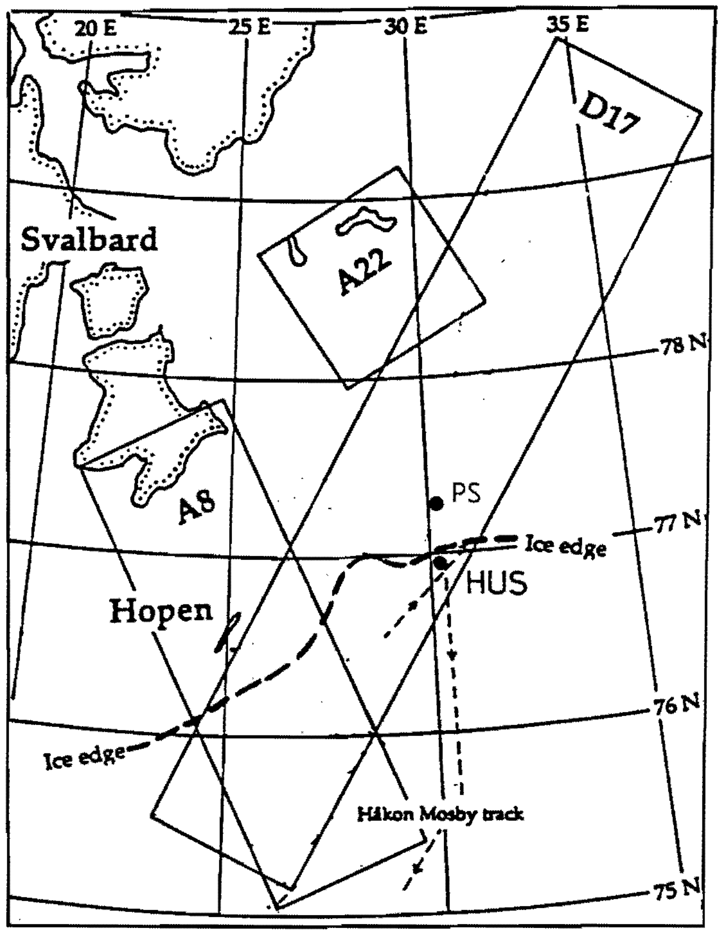


Figure 2.1 Map of experiment area

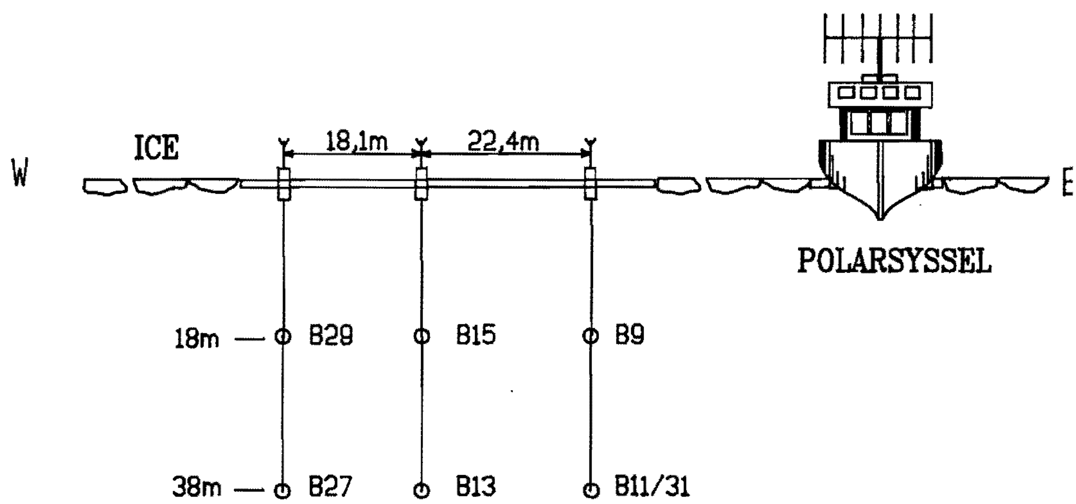


Figure 2.2 Geometry of ice array

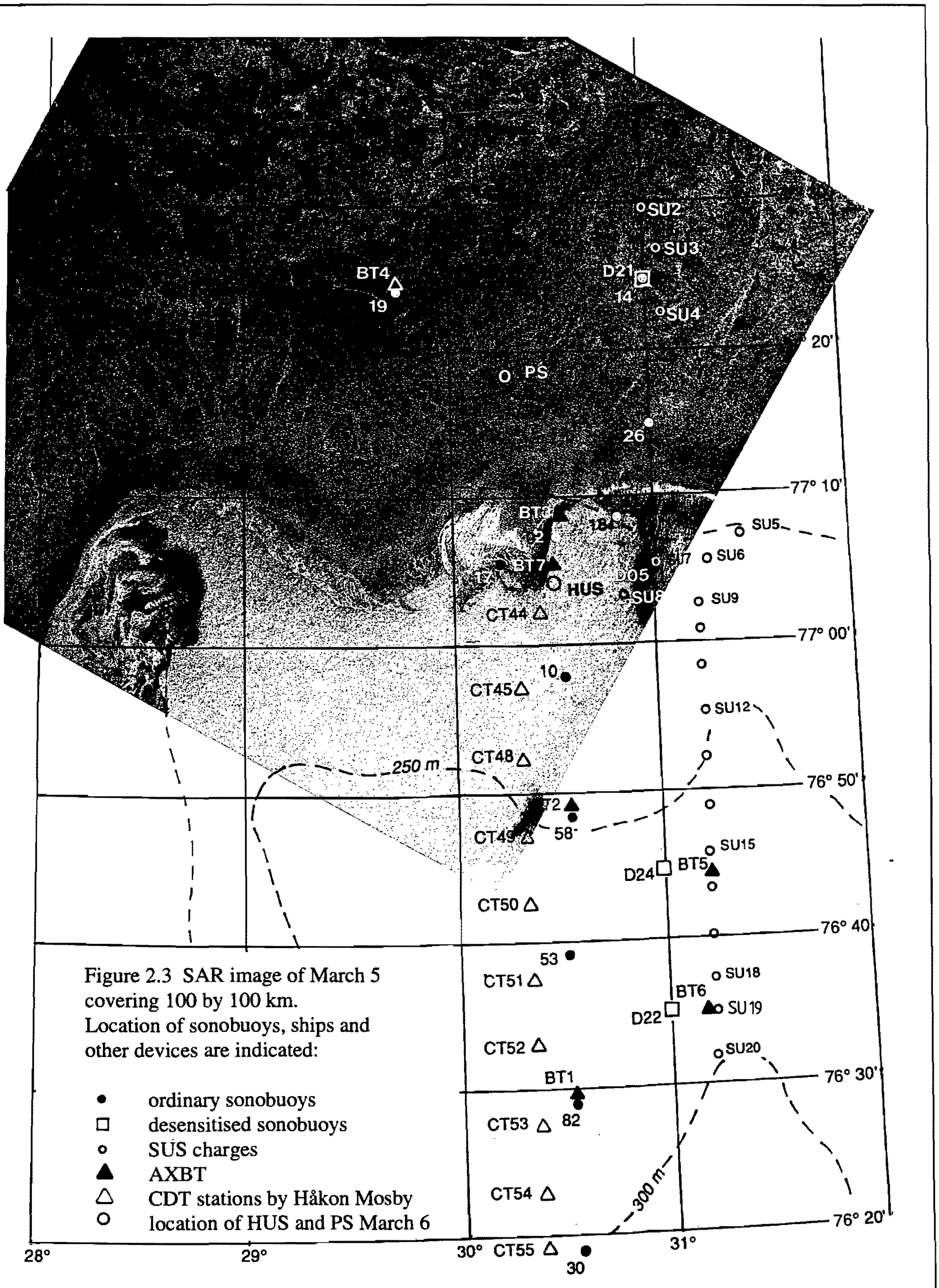


Figure 2.3 SAR image of March 5 covering 100 by 100 km.
Location of sonobuoys, ships and other devices are indicated:

- ● ordinary sonobuoys
- □ desensitised sonobuoys
- ○ SUS charges
- ▲ AXBT
- △ CDT stations by Håkon Mosby
- ○ location of HUS and PS March 6

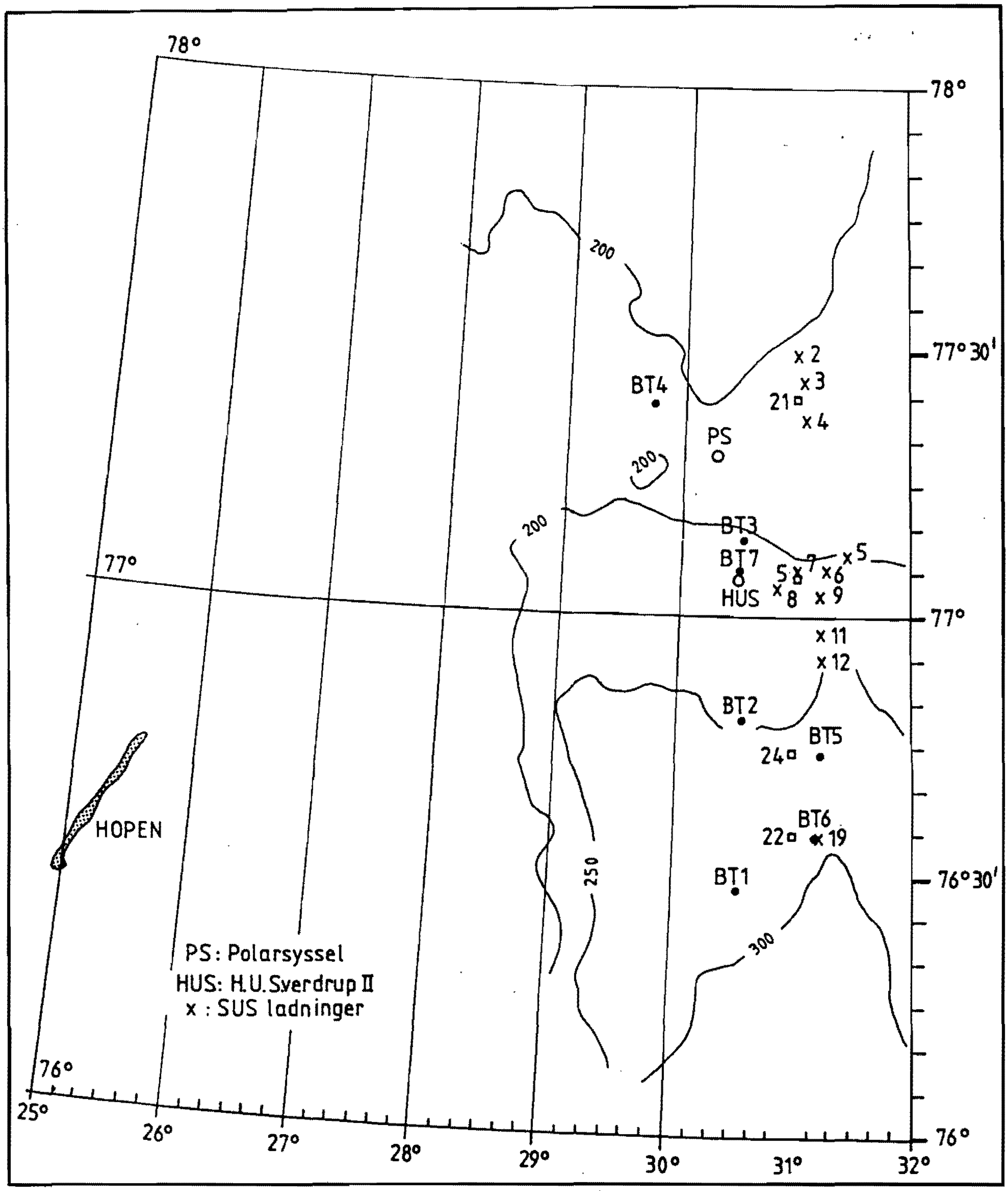


Figure 2.4 <u>Positions of densitised sonobuoys and SUS charges.</u>

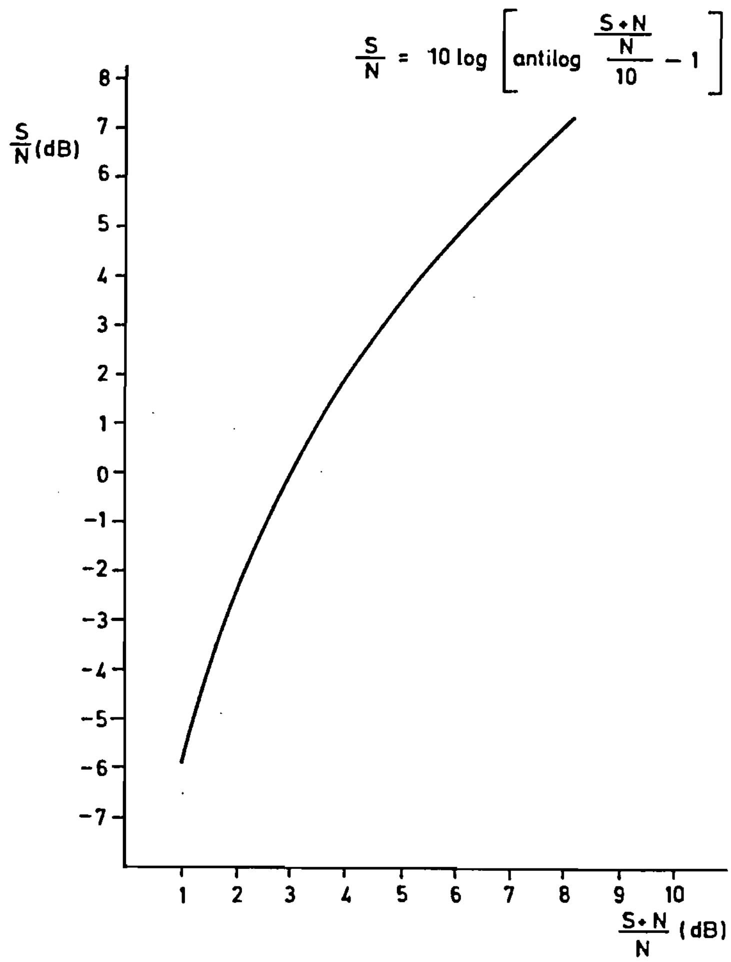


Figure 3.1 <u>Correction curve for signal to noise ratio</u>

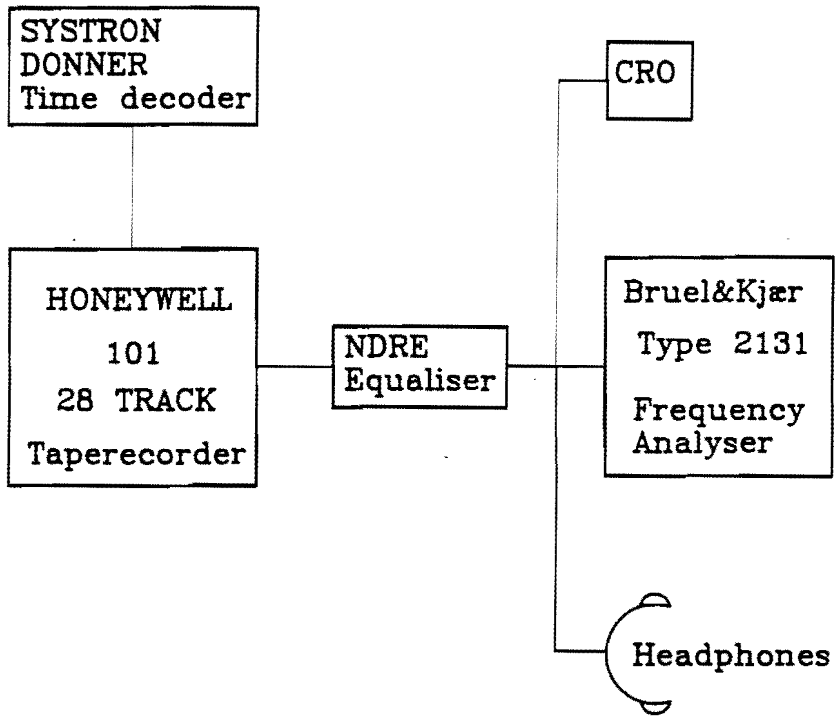


Figure 3.2 Block diagram of data analysis system for shot data

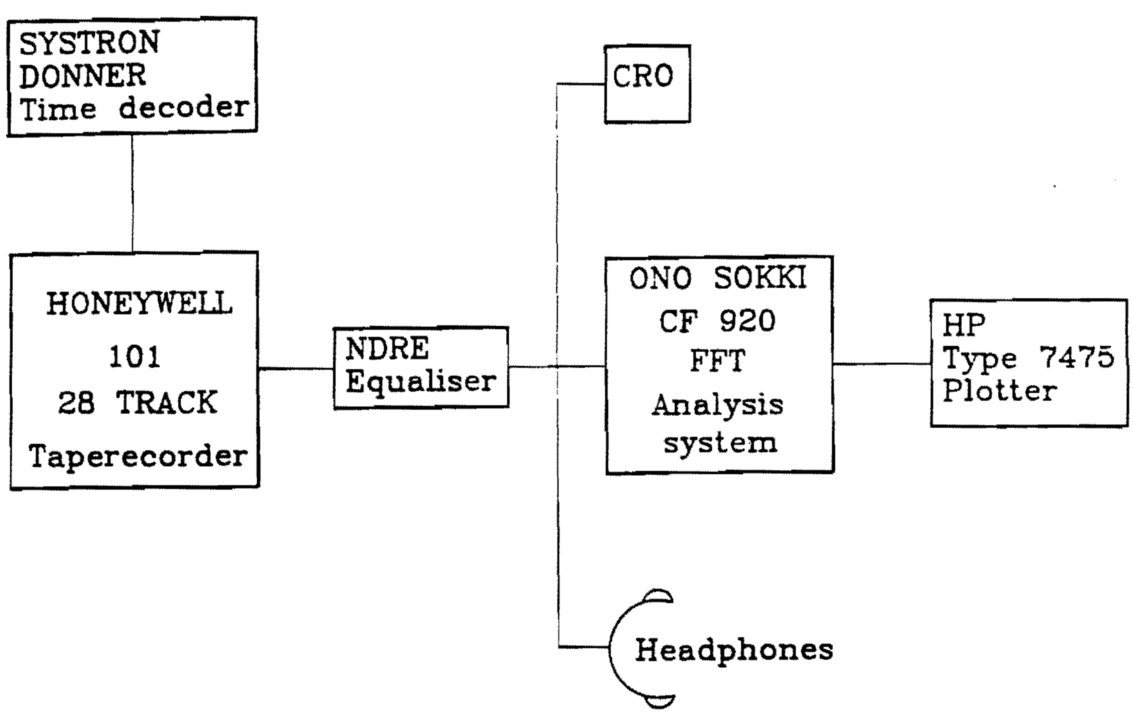


Figure 4.1 Block diagram of data analysis system for CW data

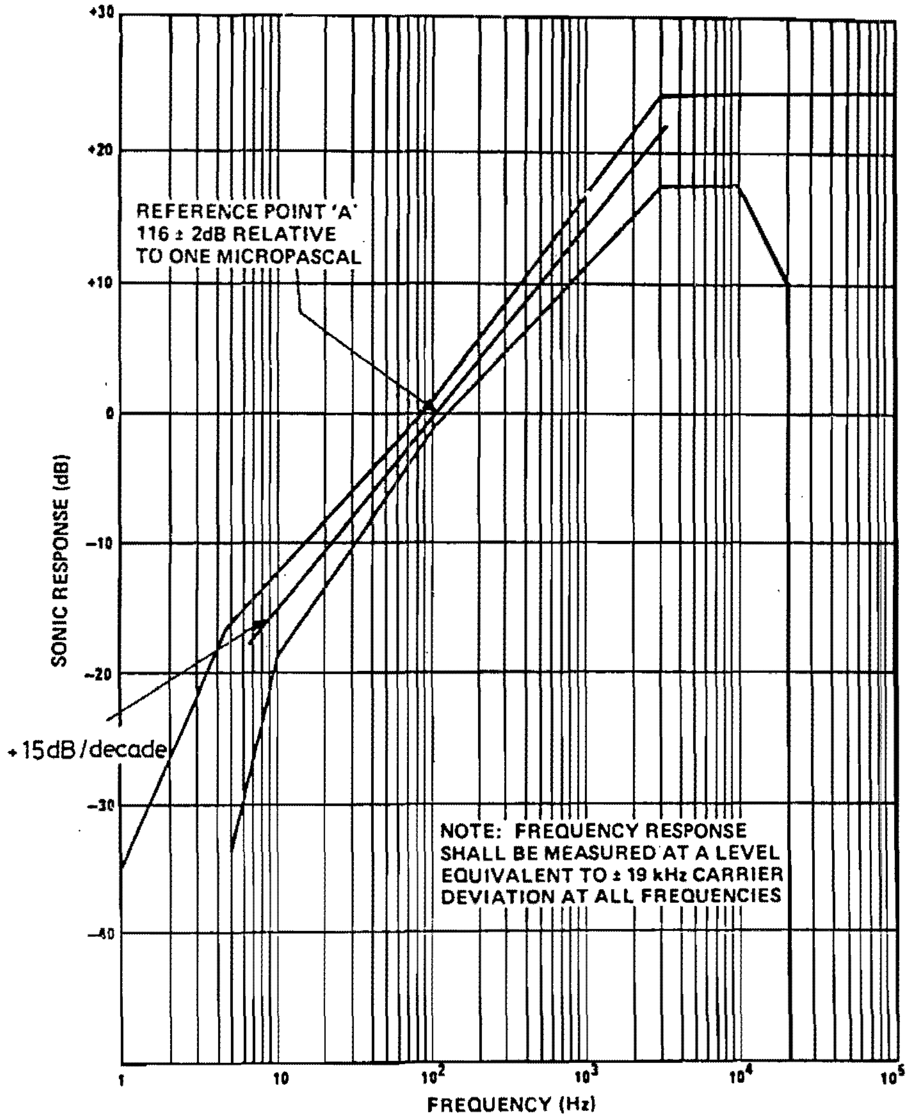


Figure 3.3 Frequency response for sonobuoy AN/SSQ-41B

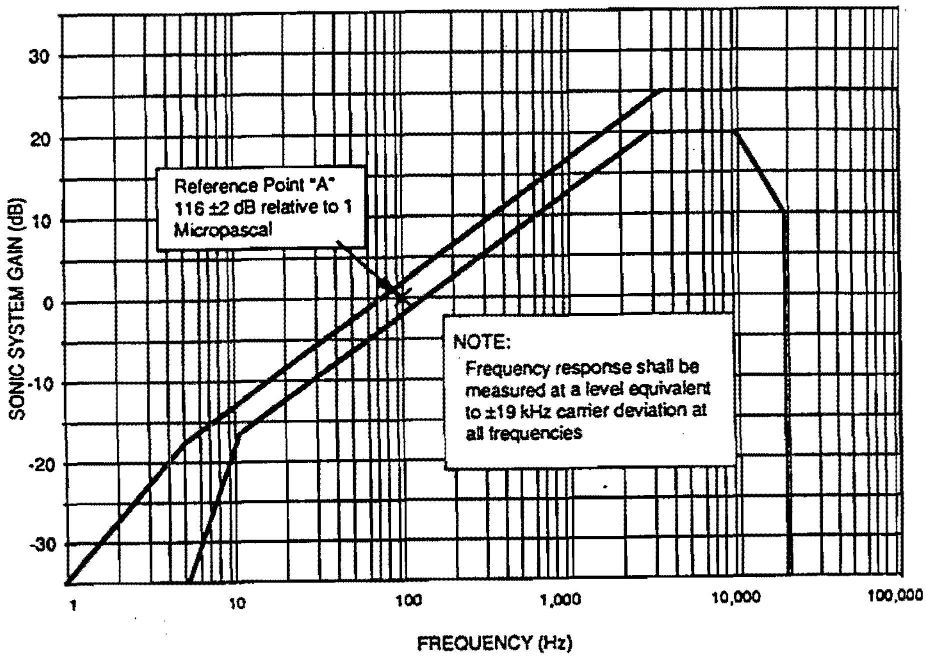


Figure 4.3 Frequency response for sonobuoy AN/SSQ-57A, -57B

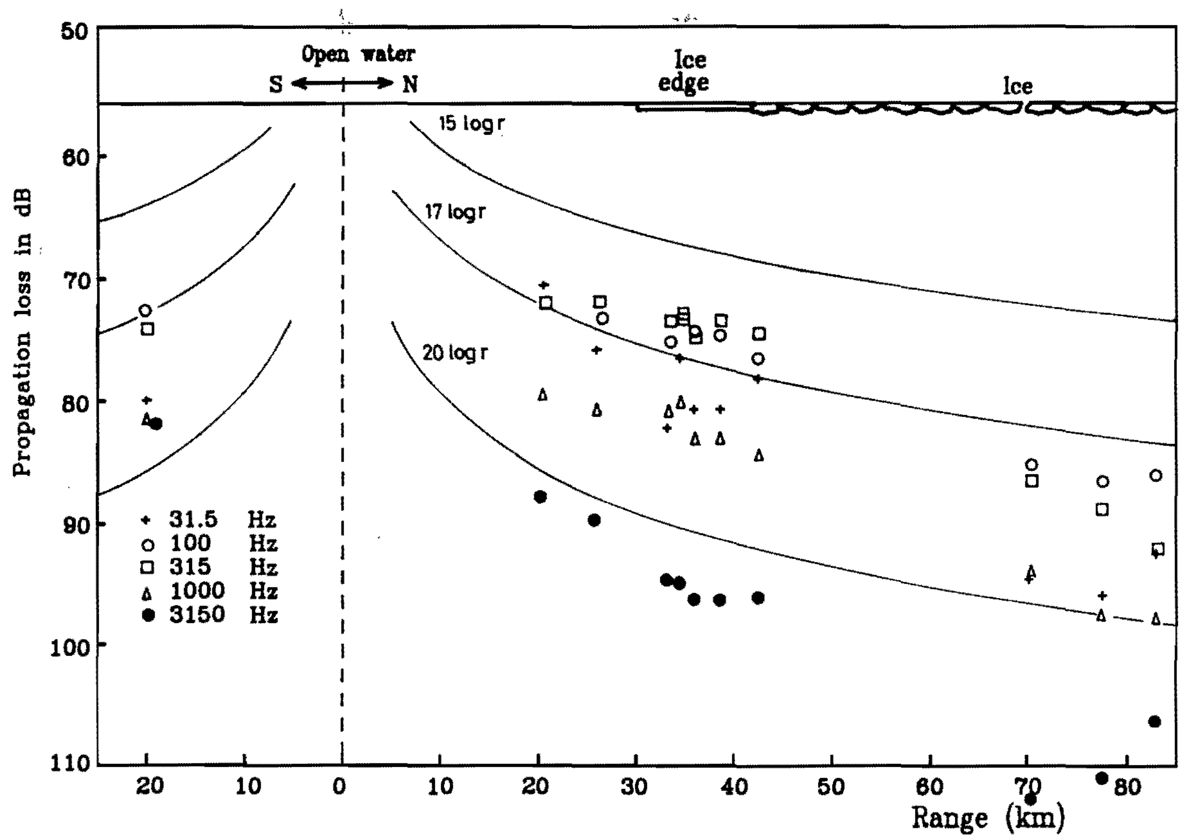


Figure 3.4 <u>Propagation loss to sonobuoy no 24</u>

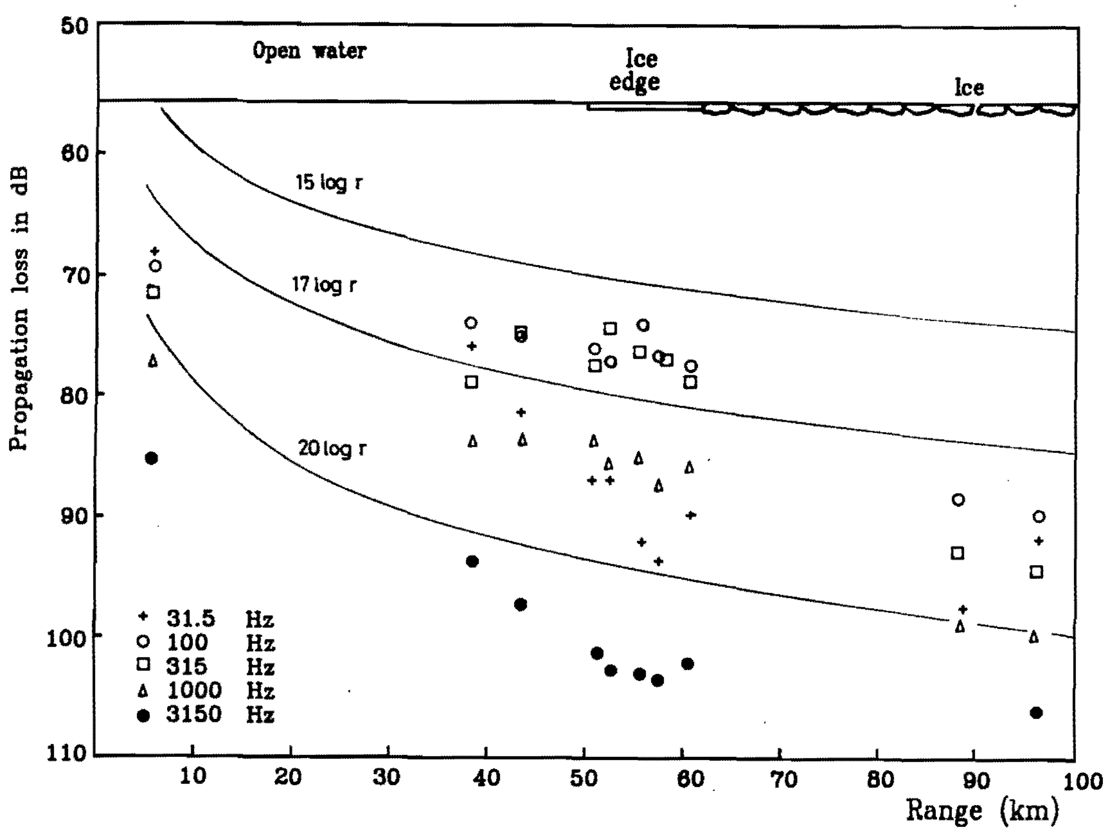


Figure 3.5 <u>Propagation loss to sonobuoy no 22</u>

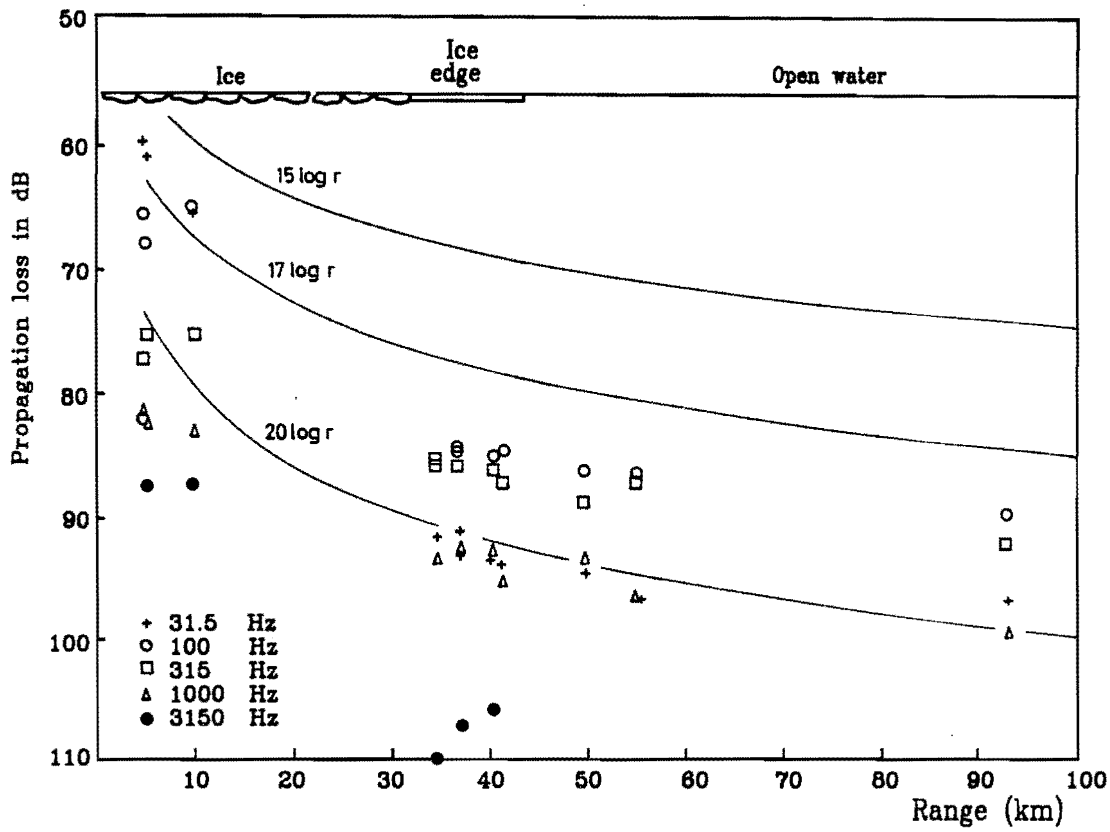


Figure 3.6 Propagation loss to sonobuoy no 21

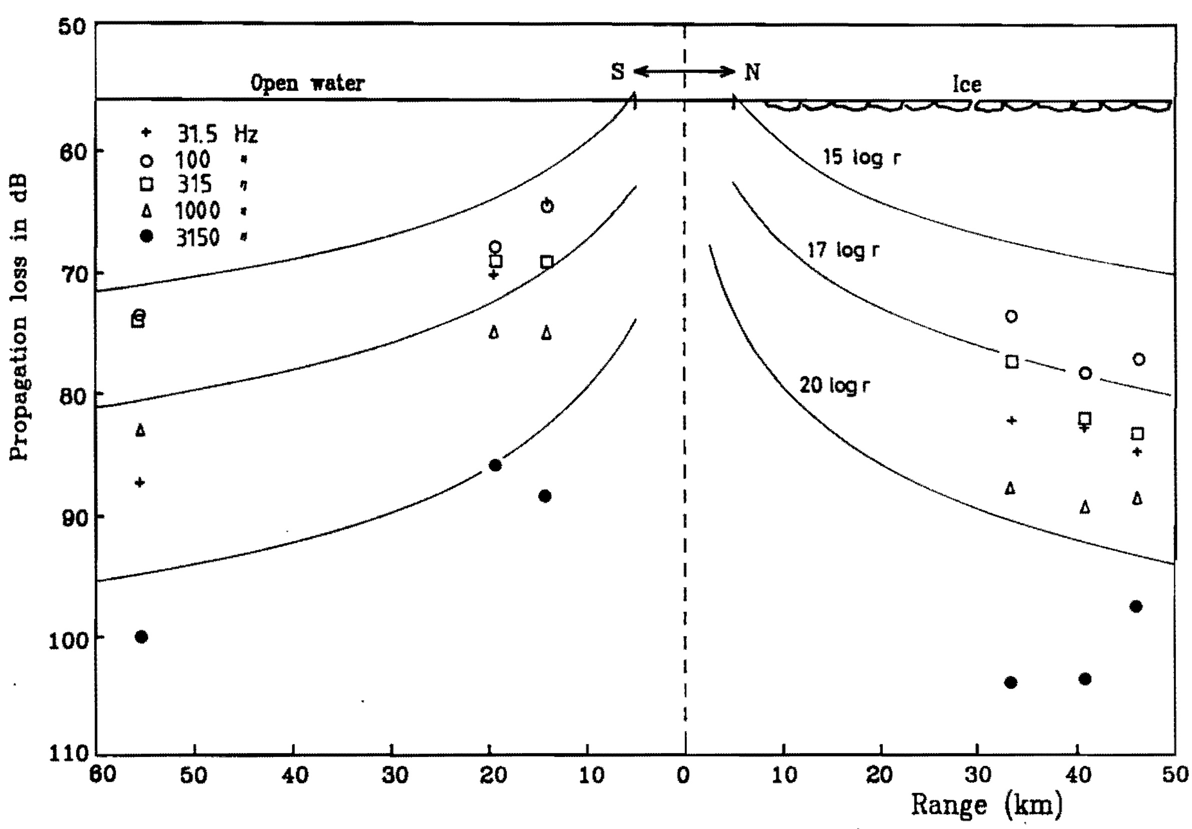


Figure 3.7 Propagation loss to sonobuoy no 5

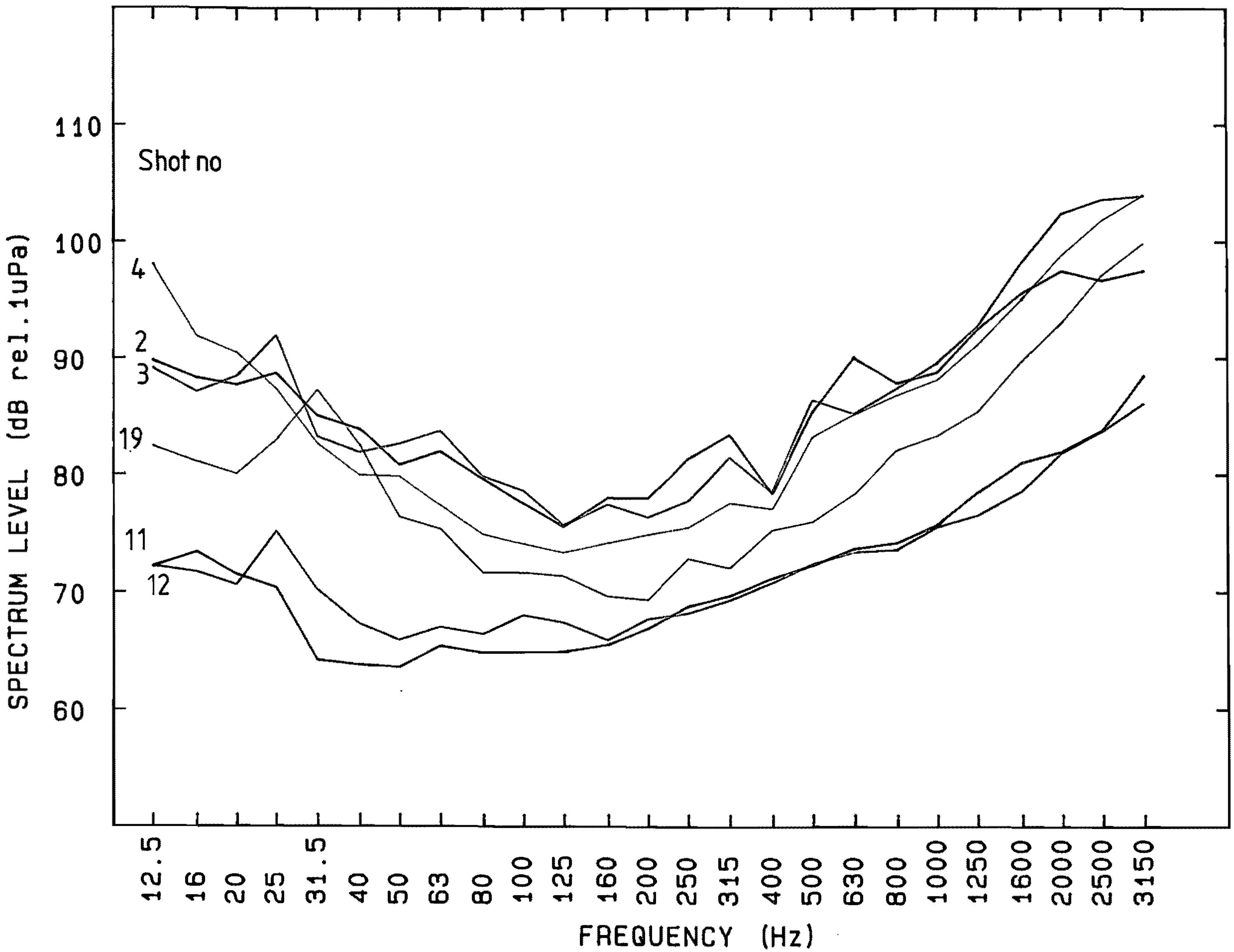


Figure 3.8 Propagation loss as a function of frequency B-5

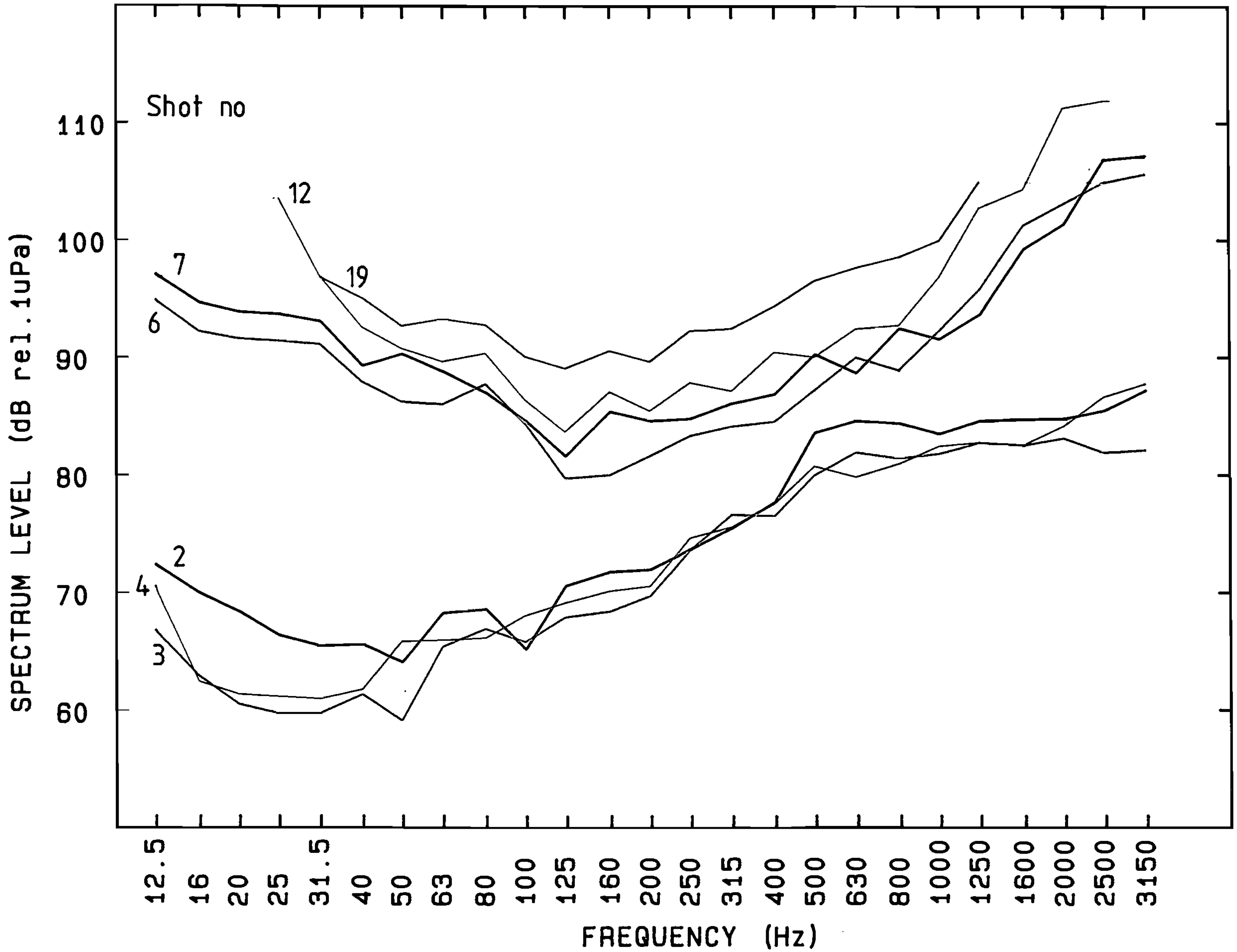


Figure 3.9 Propagation loss as a function of frequency B-21

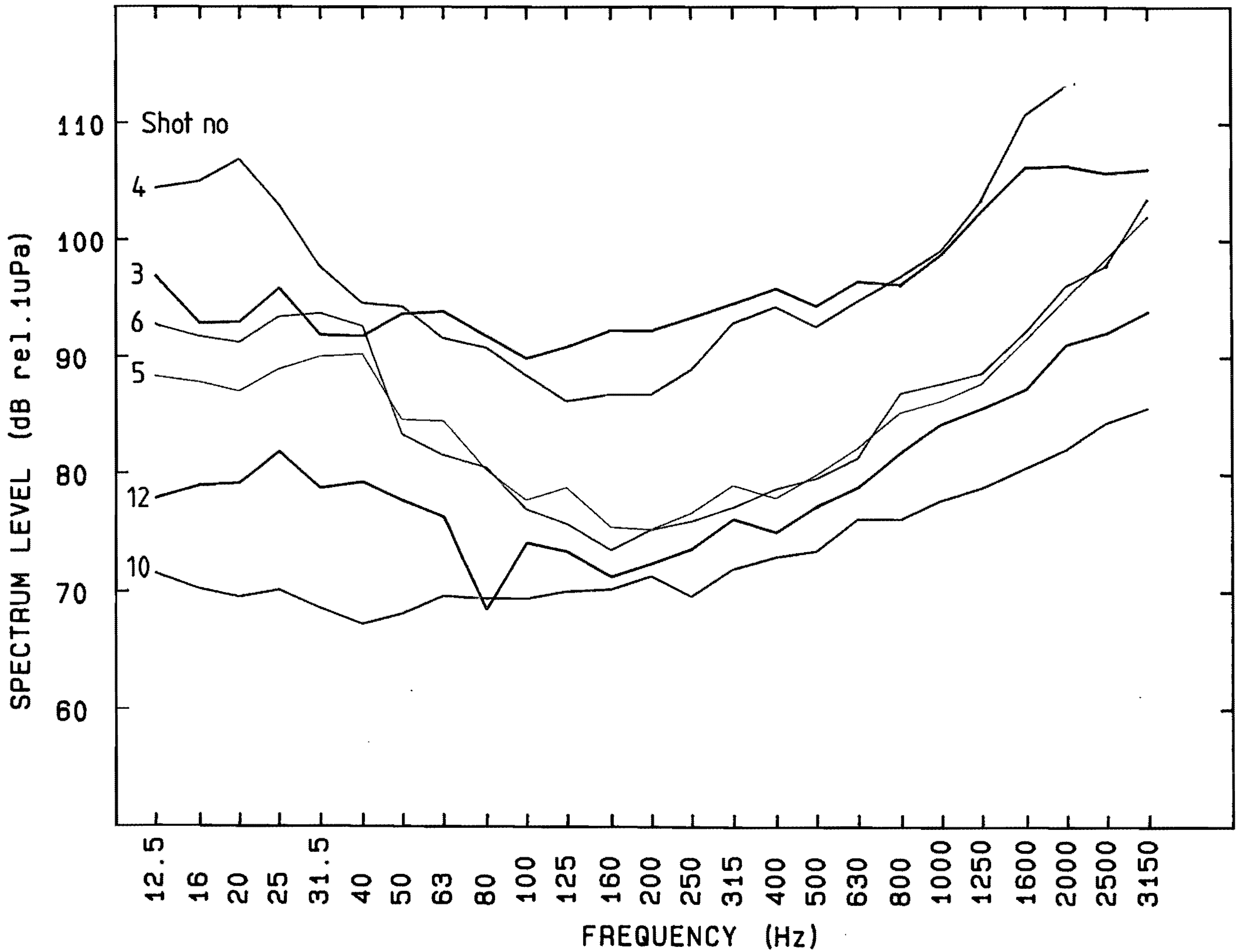


Figure 3.10 Propagation loss as a function of frequency B-22

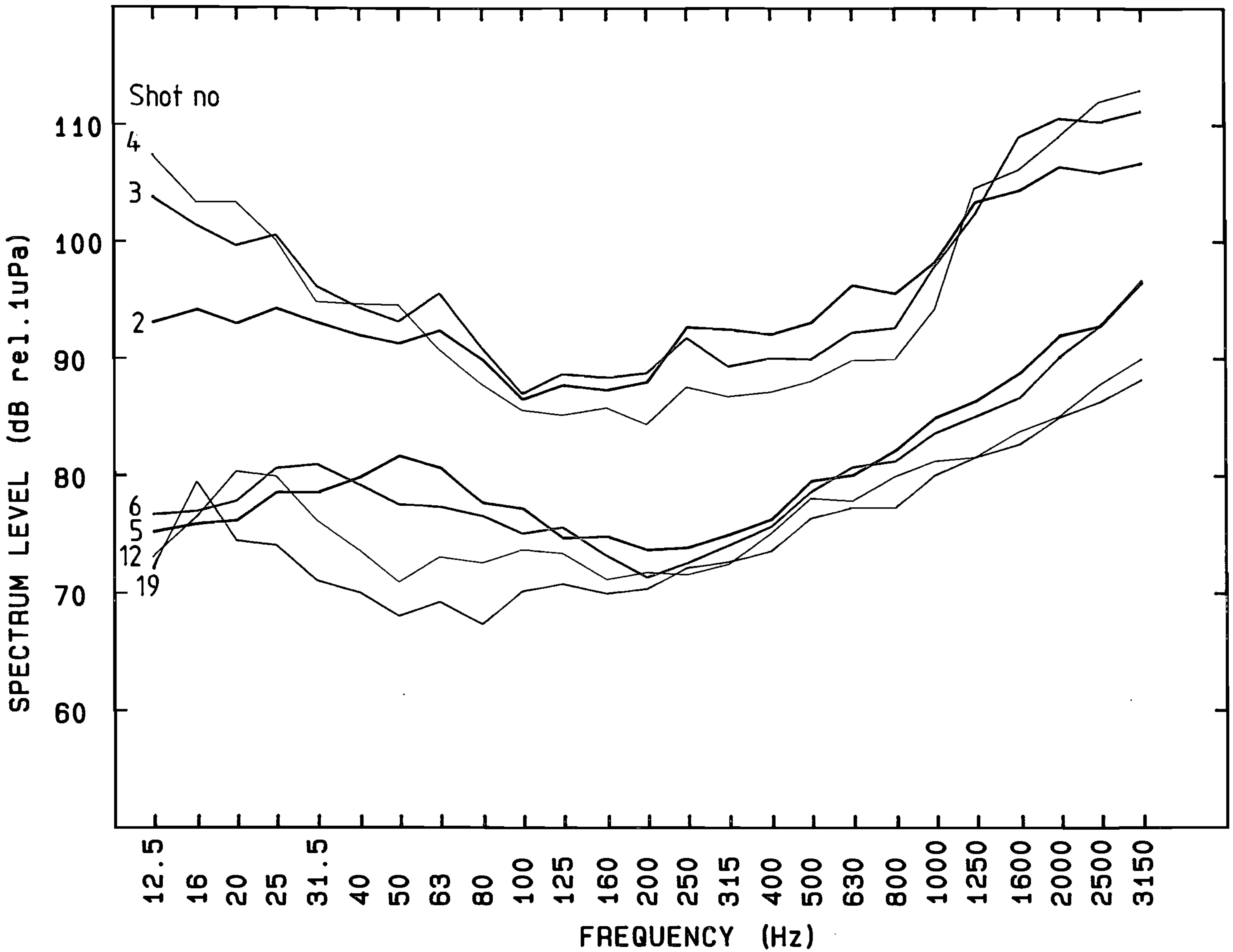
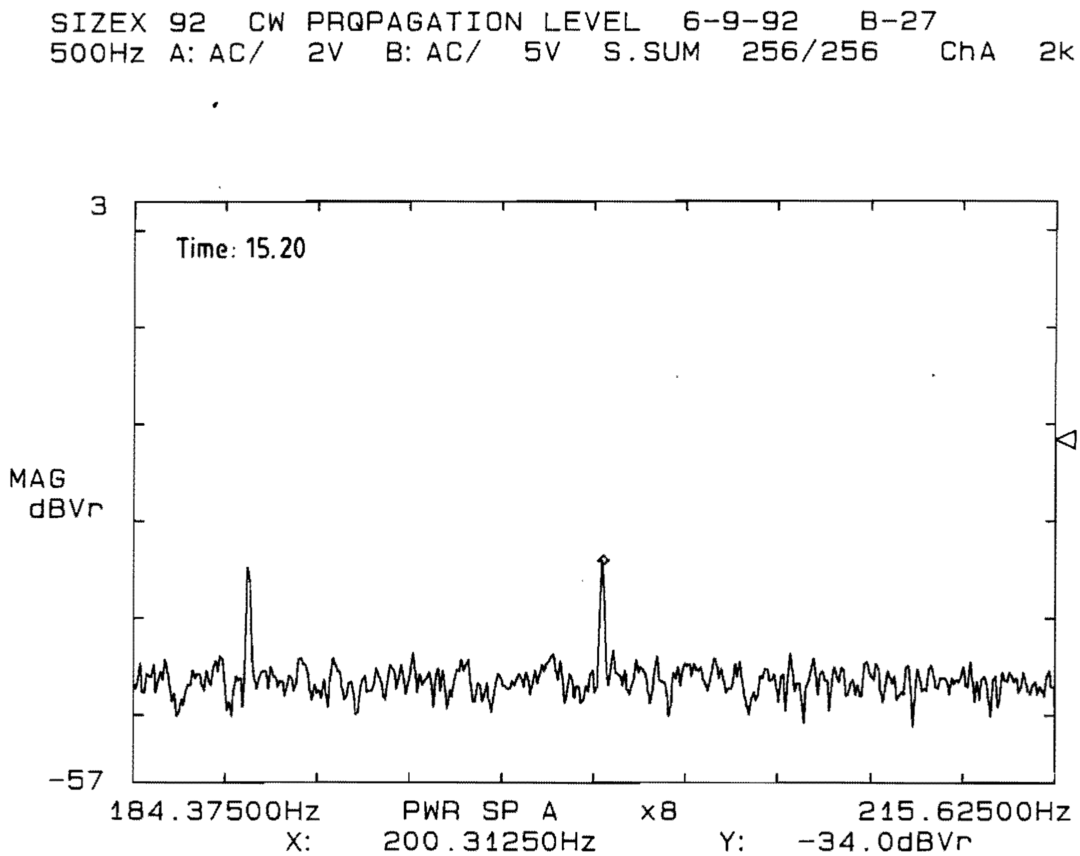


Figure 3.11 Propagation loss as a function of frequency B-24



SIZEX 92 CW PRQPAGATION LEVEL 6-9-92 B-27
500Hz A: AC/ 2V B: AC/ 5V S.SUM 256/256 ChA 2k

	PWR SPECTRUM	ChA	
1	188.28125Hz	-34.7dBVr	
2	200.31250	-34.0	
3	194.21875	-46.9	} Noise
4	206.71875	-43.6	

Figure 4.2 Frequency spectrum from buoy 27 showing 188 and 200 Hz tonois

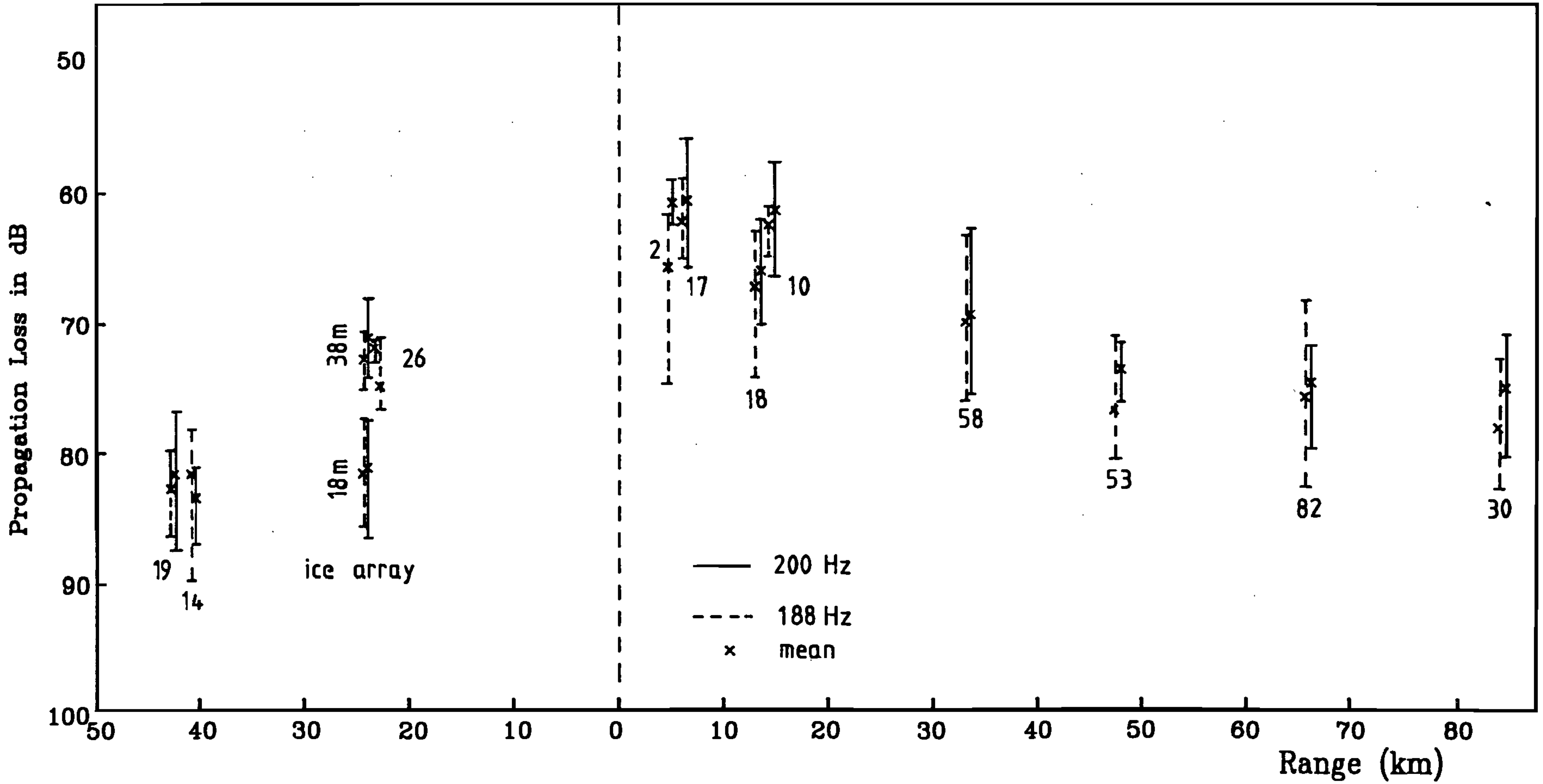


Figure 4.4 <u>CW Propagation Loss as a function of range</u>

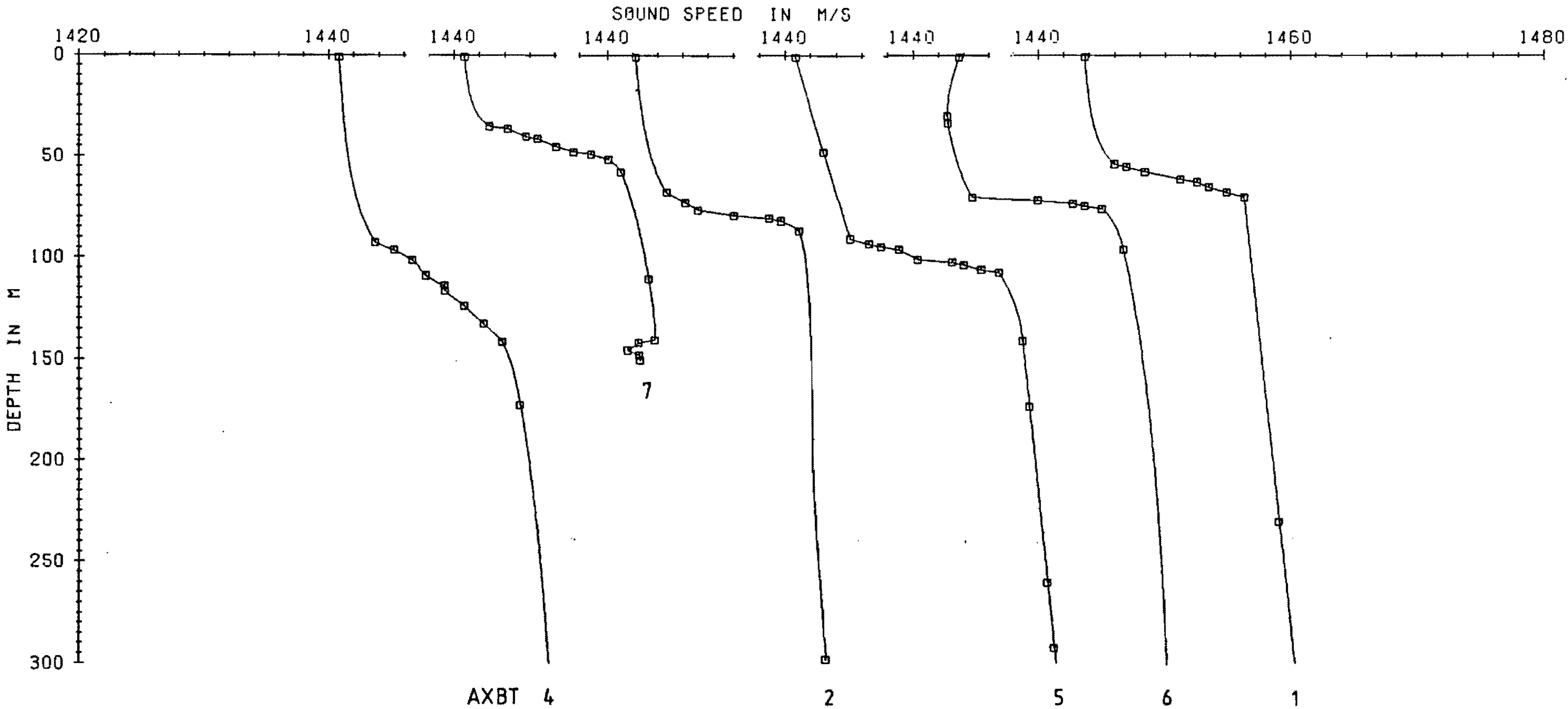
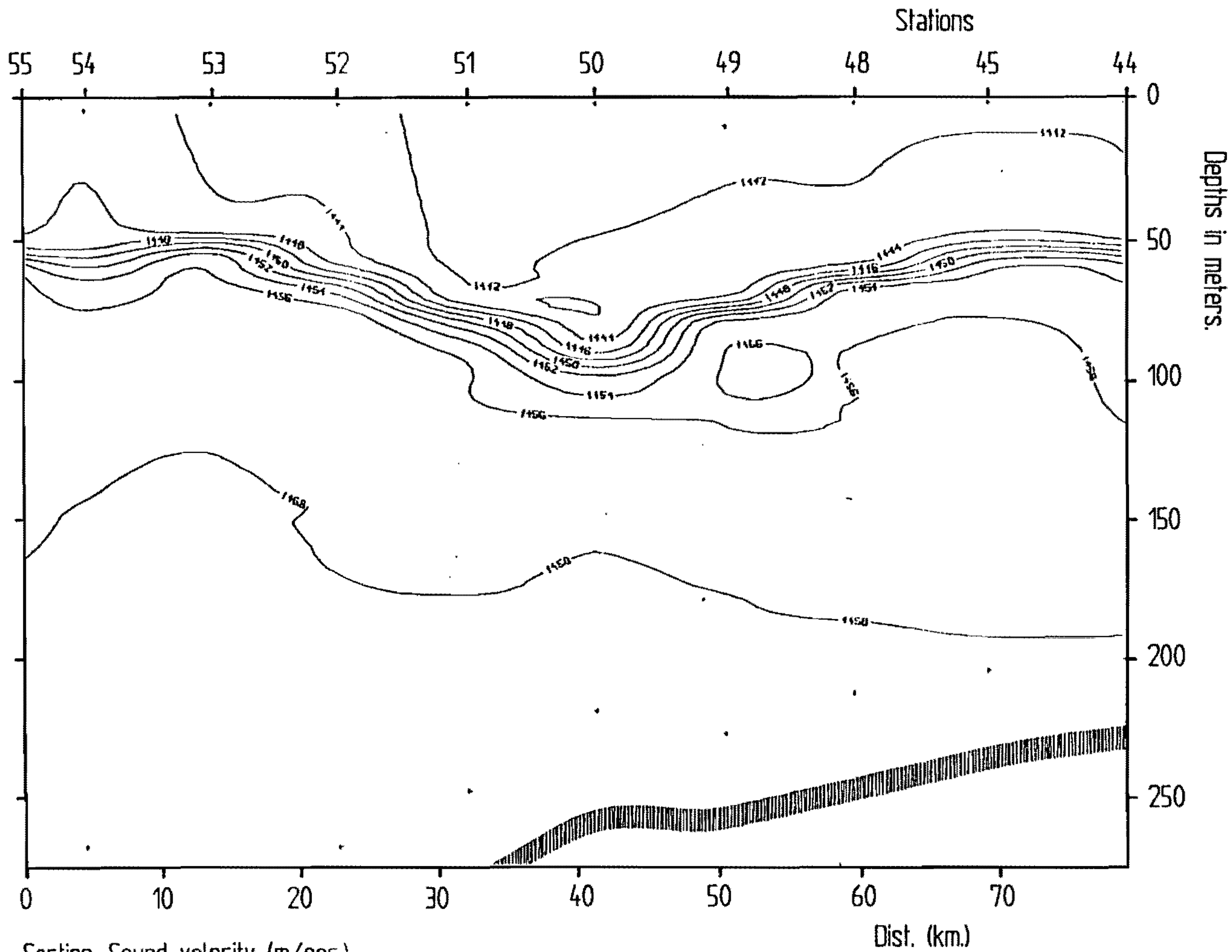


Figure 5.1 Sound speed profiles based on AXBT measurements.



Section: Sound velocity (m/sec.)
Time: Mar. 5:2053 - mar. 6: 230 1992
Pos: 76.33°N 30.41°E - 77.04°N 30.45°E

Figure 5.2 <u>Sound speed section based on CTD run by Håkon Mosby</u>

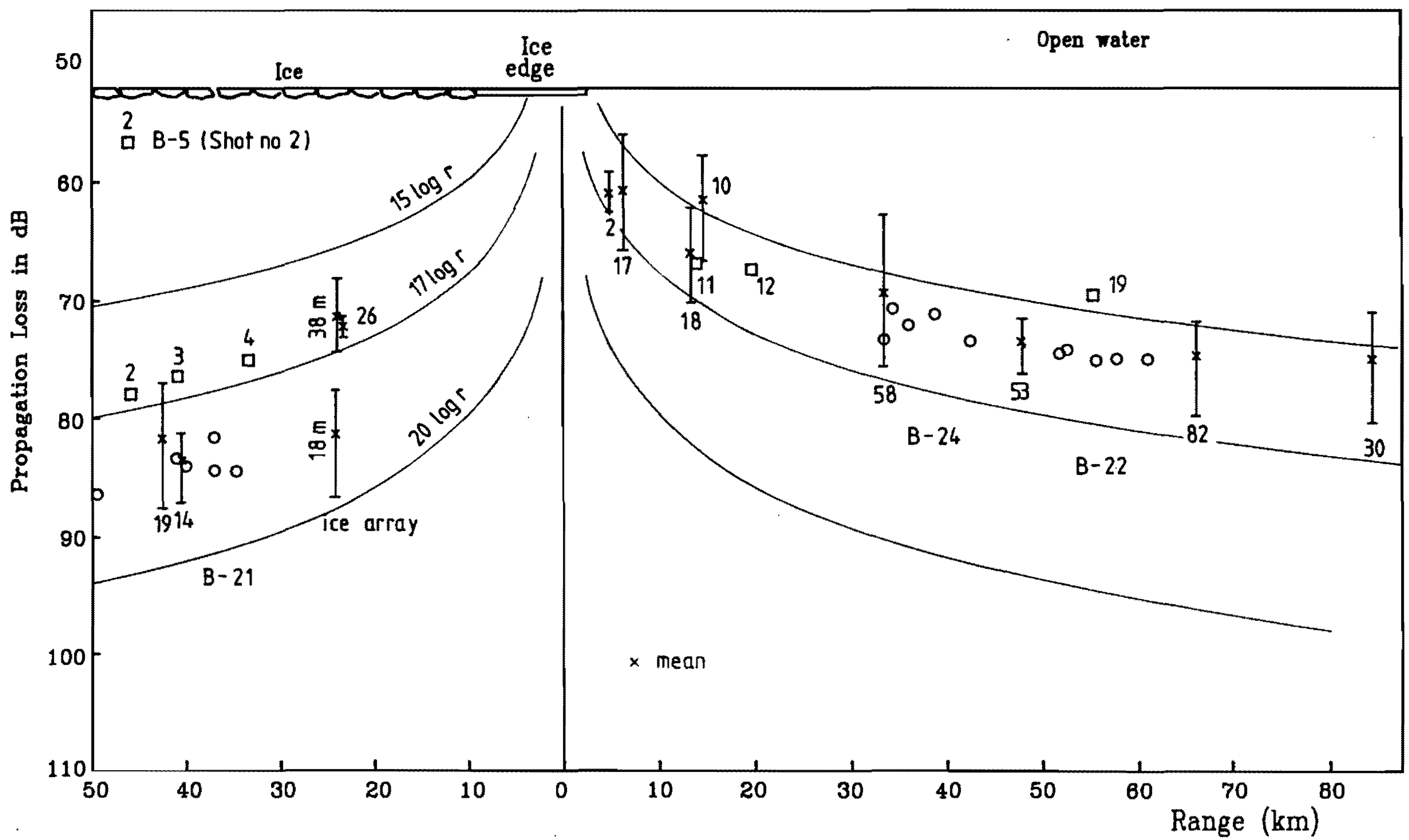


Figure 6.1 Propagation loss as a function of range. Frequency 200 Hz.

FFIU

VÅR REFERANSE: 924
TIL SENTRALSTABEN
GJENPART: FFI-BIBL (MED VEDLEGG)

OVERSENDELSE AV RAPPORTER

DATO:

RAPPORT TYPE (KRYSS AV)	RAPPORT NR	REFERANSE	RAPPORTENS DATO	
[X] IR [ ] TN [ ] RR	93/2002	FFIU/Oppdr 2775	5 mai 1993	
FYLLES BARE UT NÅR RAPPORTEN ER BESKYTTELSESGRADERT	RAPPORTENS BESKYTTELSESGRAD: UGRADERT		ANTALL EKS UTSTEDT: 20	ANTALL SIDER: 50
RAPPORTENS TITEL: SIZEX 92 - PROPAGATION LOSS STUDIES - DATA REPORT.		FORFATTER (E): ENGELSEN, Ingjald		
GODKJENT AV FORSKNINGSSJEF: Jarl Johnsen		GODKJENT AV DIREKTØREN: [signature]		

FORSLAG TIL EKSTERN FORDELING

ANTALL	EKS NR	TIL
2		Defence Research Agency Southwell, UK Portland, Dorset DT5 2JS Att: Dr G C Jackson
1		EASAM Ltd Lyon Way Frimley Rd, Camberley Surrey GU16 5EX, UK Att: Mr T Turner
1		Nansen Environmental Remote Sensing Centre Edv Griegsvei 3A N-5037 SOLHEIMSVIK
1		333 Skvadron Andøya
1		SFK/T-UVS
1		FO/E
1		KNM Tordenskjold/UVVS

FORDELT INTERNT

ANTALL	EKS NR	TIL
1		FFIS (VEDLAGT)
2		FFI-BIBL
1		FFIS Botnan
8		FFIU

TIL FORDELING VEDLEGGES:

ANTALL: NR:

FFI-K1

AVDELINGENE FORETAR INTERN FORDELING AV RAPPORTENE
AVDELINGENE FORESLÅR EKSTERN FORDELING AV RAPPORTENE
BENYTT BAKSIDEN OM NØDVENDIG