ENVIRONMENT AGENCY

National acoustics group report 1

A field guide for Agency staff operating the SIMRAD EY500 portable scientific echosounder.

2nd Draft 3rd August 1999

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Contents

1. INTRODUCTION

1.1 Background

This manual has been produced by members of the national acoustics group (NAG) and represents the first in a series of outputs designed to promote co-ordination and consistency in Agency hydroacoustic surveys. It is designed as a field guide for Agency staff operating the SIMRAD EY500 portable scientific echosounder. It should be simplistic enough for the newcomer to EY500 to be able to set up and run a mobile hydroacoustic survey with some knowledge of the supporting theory. It should act as guidance for standardisation of survey procedures providing a concise list of settings and recommendations that can be used as a quick reference guide in the field.

This manual condenses 5 years of practical experience of surveying fish populations using Simrad hardware and software for surveying large rivers and stillwaters throughout England and Wales. This document should be used as a companion to the manufacturers instruction manual and not act as a substitute for it.

1.2 Further reading

For more information on hydroacoustic surveying please refer to the following sources:
Simrad EY500 Portable Scientific Echosounder Instruction Manual.
R&D Note 196 - Hydroacoustic methods of fish surveys – An overview of hydroacoustic use in UK
R&D Note 329 - Hydroacoustic methods of fish surveys – A Field manual
R&D Note 374 – Acoustic size versus real size relationships for common species of fish.
Urick, R.J. 1983. Principles of Underwater Sound for Engineers. 3rd edition. McGraw-Hill, New York. 389pp.
MacLennan, D.N & Simmonds, E.J. Fisheries Acoustics. Chapman and Hall. London. 325pp.

2. EQUIPMENT

For system familiarisation refer to instruction manual – Sect 1. In addition to this information, the following points should be considered:

2.1 Transducers

2.1.1 Types

4^0 x 10^0 is the most commonly transducer type at present used with the EY500 system.
Other types in use are 2.5^0 x 10^0 and 7^0 Circular. Refer to Appendix 1 for current operators.
All transducers are of split beam design and operate at 120kHz.

2.1.2 Positioning

For horizontal sounding the direction arrow on the transducer face should point upwards and for vertical sounding forwards. Current guidelines suggest positioning the transducer as far away as possible from sources of noise (outboard, generator), ideally1m in front of the boat and up to 1m below the surface. For alternative arrangements, refer to Simrad

instruction manual section 3. Appropriate methods for achieving maximum acoustic coverage is essential for acoustic surveying (See R&D note 329 p.24). Experience indicates that where possible rotators should be used when insonifying horizontally in shallow water. See Appendix 1 for designs in current use.

2.2 Survey vessel design

Key points to consider are:

Minimising noise from hull
Lateral stability – e.g. catamaran
Load bearing capacity
Suitability for slow speed
Reducing cavitation noise from propeller
Shelter for equipment and operator

NB Appendix 1. lists current vessels in use.

2.3 Transceiver power source

Refer to section 1 & 2 of Simrad instruction manual.

- Generators and inverters - Need to be checked with an oscilloscope for electrical spiking and field tested. 110V inverters tend to produce more spiking than 240V inverters. Current inverters in use are listed in Appendix1.
- Uninterrupted Power Supply (UPS) should be used (and field tested) If spiking occurs from generators or inverters
- DC input voltage should be between 10&40V.
- Test batteries with a drop tester and recharge when voltage is below 11Volts.
- Typical current drain of working EY500 echosounder is 1.5A.
- Calculate total current drain of all equipment, and possible upgrades, on power source.
- Select power source that gives power in excess of total current drain.

2.4 Transceiver connections

Cable connection between EY500 and computer should be less than 0.5m. Simrad currently recommend shielded type (Black Box corporation).

2.5 Printer

- Optional during surveying (but will reduce ping rate)
- Only 2 types can be used with EY500 (refer to manual)
- Useful for pre-survey and calibration.
- Tend not to be used during the main survey as this will reduce echosounder ping rate and sampling volume.
- Use standard parallel printer cable.

2.6 Computer

See Simrad Instruction manual section 1 (System familiarisation) for minimum PC specification. It is recognised that computer processor speed is a determining factor in echosounder ping rate. Standard PC specification for Agency use is currently under discussion. It is recommended that new computer purchases for use with Simrad EY500 should be discussed with the National Acoustic Group.

2.7 GPS

Any GPS with a RS232 output (fitted to the 9 pin COM1 terminal on the computer) can be used. Experience using differential GPS has caused some files to "hang" when analysed, if the GPS output is interrupted. Analysing echograms with Ep500 V5.4 or later should overcome this issue.

- Check NMEA output configuration, baud rate and parity (Refer to Navigation Menu – Simrad)
- Connect to COM1 port.

2.8 Multiplexing (MUX)

Multiplexing allows for multiple transducers to be used at once, such as scanning left and right banks simultaneously in mobile river surveys, or vertical and horizontal sounding simultaneously in mobile lake surveys. The EY500 echosounder controls the multiplexing unit, which switches sounding between transducers (up to 4). Data is stored with the file extension according to the transducer number. This technique has not been explored fully within the Agency and at present requires development.

The following hardware are required:

MP500 multiplexing unit
PCMCIA port as 2nd parallel port (LPT2) where required (e.g. in most portable PC's)
2nd Parallel connection lead

Wiring:
Refer to Simrad instruction manual.

Note when multiplexing ping rate is the reciprocal of the number of transducers in use, i.e. halved when 2 transducers are used. An alternative is to link 2 separate EY500 units with a junction box and run the systems in EXT Trig mode to synchronise the trigger pulse. The advantage of using this latter method is that no loss of ping rate occurs.

3. SURVEY CHECKLIST

The following equipment is required to carry out a full hydroacoustic survey using the Simrad EY500 echosounder:

Surveying:

EY500 Transceiver unit
Power supply – Batteries/ generator
Power cables
Transducer(s)
Transducer mount
Rotator, power supply and cables*
PC to transceiver cable
Parallel printer cable*
Printer & paper*
Printer power supply and cable*
PC
PC power supply and cable
PC Screen and cables*
GPS and connection lead*
Differential unit and lead*
Thermometer
Voltmeter*
Continuity tester*
Spare fuses (EY500: 4amp Transceiver board, 10amp power supply,+ plugs, invertors, leads)
Toolkit
Instruction manual, field manual & field notebook.
Protective cases – preferably waterproof
Spare batteries for instruments
Torches, spare bulbs/ batteries

For calibration:
Calibration sphere
Washing up liquid
Monofilament line
Roach pole or equivalent
Tape measure
Rotator frame/ mount*

* Optional items

4. MENU DESCRIPTION AND INTERPRETATION

This section supplements the Simrad instruction manual and should not be considered as a replacement for its use. Note that parameters are entered using the cursor buttons.

4.1 Operation menu

Ping Mode NORMAL – Normal operation
REPLAY to run replay files after collection (See Disk menu for replay collection)
EXT.TRIG – External trigger used for linking two EY500 systems

NB. Ping rate determined by range, printing and processor speed. No on-line facility for accurate measurement of ping rate (ping per sec). See 5.4 for rough guide on ping rate determination.

Ping Auto Start Used for remote operation (counters) not used for mobile surveying.
Ping interval Set to 0 for fastest speed (Pings on return echo). Used fixed rate for calibration (See Lobe notes). Currently no standard Agency ping rate beyond recommendation to ping as fast as possible. However, 10 pings per second has been widely used by other scientific sonars in mobile surveys

4.2 Display menu

Colour Set LIGHT
Event Marker User defined

Only displays information on printer (running at time of survey) Refer to instruction manual on how to generate event.

Echogram Speed 1:1 (at maximum ping rate) Does not affect processing or ping rate.
Echogram ON to display echogram on screen.

Echogram Menu: TRANSD. NO: 1(Unless multiplexing, then set to no. on use)

RANGE: User defined

Set to maximum width of bank/depth of bottom established from pre-survey. Do not change range during survey, hence requirement to know range before start of survey.

RANGE START: 2m

No Agency standard. Suggest 4m minimum to eliminate near field effect. Beam is very small at close range. For the purposes of depth measurement the operator may prefer to set this to 0m in vertical surveys.

AUTO RANGE Off (For vertical see instruction manual)
BOTTOM RANGE User defined

Width/depth of bottom echogram

BOTTOM RANGE START User defined

Sets upper start depth for bottom echogram relative to detected bottom depth. e.g. Bottom range = 5m, Bottom range start =4m will show detail of 4m above bottom and 1m below bottom detected. Important that detected bottom is true bottom, hence applicable to situations where a good bottom echo is likely, such as vertical surveys of stillwaters. Bottom presentation can be useful in detecting targets close to the bottom, however the margin value in the layer menu would have to be set to 0m for their analysis.

BOTTOM RANGE PRES Off

Bottom detail covers 20% of echogram. This option helps to discriminate "bottom" (e.g. near boundary) targets from the bed/bank boundary. Target discrimination can be improved by reducing beam width compensation and using short pulse lengths. Further investigations required.

SUB BOTTOM GAIN 0

Possible geological application – no fisheries use.

PRESENTATION	Normal
TVG	40 log R – To display single targets
SCALE LINES	User defined (10 typical)
BOT. DET. LINE	User defined (On - Draws bottom)
LAYER LINES	User defined (On to see superlayer)
INTERGRATION LINE	Off – for surveying

Can be used in calibration to determine Sa value

TS COLOUR MIN -50db

Lowest TS (single target) visible on screen. NB Display window range is 36 dB. (Max TS is –14dB if Min TS set to –50dB)

SV COLOUR MIN -80db

Min threshold for integrated energy displayed. Can be used to determine background noise level (See 5.3)

4.3 Printer Menu

Use of printer menu affects ping rate and hence sample volume. The printer can be used during calibration and pre-survey, but not normally during the main survey. If required see suggested settings below:

Navig. Interval	60	
Event Marker	OFF	
Annotation	ON	(Or use a notebook instead)
Naut.Mile Marker	OFF	
TS Distribution	OFF	
Integr. Tables	OFF	
Echogram Speed	1:1	
Echogram	SLAVE	
Echogram Menu	Set the same as Display Menu.	

4.4 Transceiver Menu

NB - Along= Vert= Y Athw=Horiz=X.

A directory of transducer par files can be constructed to enable access to historical survey settings. Within DOS, take EY500 .PAR file, and rename to appropriate survey. Set up library of .PAR files in windows for each transducer or survey. Otherwise set parameters as below:

Mode	ACTIVE	Normal operation mode
	PASSIVE	For system test (See 4.14 - test menu) and setting TS Min level (See 5.1 - pre survey notes/ 4.8 - TS detection menu)
	TEST	Diagnostic – not used
Trans Type	User defined	Typically EL 4.0*10 (Y axis by X axis)
Trans Depth	User defined	0m for Horizontal survey. Use the depth in water for vertical
Trans Sequence	OFF	(Unless MUX – Refer to Instruction manual)
Absorption Coef.	User defined	Adjust for Salinity (4dbKm for 0 salinity) See Appendix 4 for sound absorption.
Pulse length	MEDIUM	as standard. (0.3ms)

A short pulse length can be used at close range (<50m) where greater resolution is required (e.g. noisy conditions/ high fish density/ close to boundary). Long pulse lengths are good for deep vertical work, but can cause shadowing and can cause problems in defining range.

Band width	WIDE	or AUTO as standard

NB. Do not combine short pulse length with narrow bandwidth. Need to calibrate for each pulse length/ bandwidth combination.

Max.Power	63W	NB Do not change.
2-Way Beam Angle	See spec sheet supplied with transducer	
Sv Trands Gain	From calibration (7.4)	
TS Trans Gain	From calibration (7.4)	
Angle Sens. Along	Use default Simrad value (38 for 4*10 transducer)	
Angle Sens Athw	Use default Simrad value (15 for 4*10 transducer)	
3 dB Beamw.Along	See spec sheet supplied with transducer	
3 dB Beamw.Athw	See spec sheet supplied with transducer	
Alongship Offset	0	(Relates angle off centre position of boat)
Athw.ship Offset	0	(Relates angle off centre position of boat)

4.5 Bottom Detection Menu

This menu is mainly used for vertical sounding, or where a clear bottom detection is possible (e.g canal wall)

Min Depth	0	As standard
Max Depth	User defined	Reset to value close to real depth

If maximum depth default (900m) is used bottom detection algorithm continues to look for bottom and slows ping rate. In horizontal sounding where pelagic analysis is used set Max depth to 0 to switch off menu.

Min Depth Alarm	Optional – Useful in vertical surveys/ boat safety!
Max Depth Alarm	Optional – Useful if pre survey not possible, uncertain about range.
Bottom Lost Alarm	Alarm when bottom detection is lost (important if recording surface locked).
Min Level	-50dB for hard bed, -60dB for soft bed. In situ experimentation required.

4.6 Log Menu

Sets calculation interval updated to TS detection menu. Can use to check ping rate in field by timing duration between log intervals against set number of pings eg. Time between update of histograms in TS detection menu for a fixed number of pings.

Mode: This sets the interval between calculation of Sa and TS values. One of the following options must be chosen in order to get Sa/ TS tables and for the TS distribution chart to be active (TS DETECTION menu 4.8).

PING - updates after set no pings
TIME - updates after set time (See instruction manual)
DISTANCE (See instruction manual)

Ping Interval e.g. 100 – updates after 100 pings

Time Interval e.g. 60 Sec -system updated every minute.

Dist. Interval Set within NAVIGATION menu

Distance Set within NAVIGATION menu

NB. If using printer during survey, do not set intervals too short as layer information tables are produced at the end of every log interval. This has the affect of reducing printed echogram information.

4.7 Layer Menu

See instruction manual for description of layers. Only one can be be defined as the superlayer. This is conventionally set as layer 1.

Super Layer User defined

Needs to be set at a value between 1 and 10 to retain TS detection display features, e.g. histogram and fish behaviour window.

Layer-1-10 Menu(s) Type: OFF/SURFACE/BOTTOM/PELAGIC See options below:

Horizontal sounding: Use PELAGIC mode where no bottom detection is needed – most riverine mobile surveys.
Use SURFACE lock if a consistently good bank echo exists. This then minimises need for redefining bottom during post processing.
Use with margin setup.

Vertical sounding: SURFACE lock (data analysed above hard bottom). Range Set to width/depth

Range Start 0

Margin Margin above bottom that is discounted from analysis. (1m standard)

NB. A higher margin is required where poor bottom detection is expected or bottom is soft. Setting margin to 0 is likely to include bottom detail, hence requiring the operator to redefine the bottom during post processing. This can be very time consuming, but can lead to more robust results in marginal applications.

Sv Threshold -80dB – Threshold for integration (-70 to –80dB, check appearance on echogram)

4.8 TS Detection menu

Min Value -50dB

NB. This value represents the smallest target size that can be detected anywhere within the beam. The practical application in setting an appropriate minimum TS level for surveying is explained in section 5.1 (The Pre-survey)

Min Echo Length 0.8 standard

Reflected targets between 0.8 and 1.4 times the transmitted echo length are thus recorded

Max Echo length 1.4 standard.

Max Gain Compensation 3.0 (standard)
Reduce value to artificially reduce beam size to increase accuracy. Use to detect small targets close to bed in vertical mode.

Max Phase Deviation 4.0 (standard)

NB This is a measure of standard deviation over 4 phase steps. Increase to 6 for small targets - to discriminate between targets of the same size in different places. Need to test effect of changes in maximum phase deviation on single target detection – further work required.

4.9 Disk Menu

Log	ON to begin survey when happy with settings
Max. File Size	1 Mb as standard
Drive	C
Directory	\directory name (Need to create directory prior to survey)
Replay File Name	See instruction manual
Replay Forever	See instruction manual

Disk/Telegram Menu
For all telegrams see Table 1 page 62 in Operations Section in instruction manual.

Sample range	Set to max range when collecting replay data
Status	Off
Parameter	On
Annotation	On - User defined
Navigation	On* - User defined
Depth	On
Ech	On
Echo trace	On
SV	Off
Sample Angle	Off*
Sample Power	Off*
Sample SV	Off*
Sample TS	Off*
Vessel Log	On
Layer	On
Integrator	On
TS Distribution	On

(*Turn on for collecting replay data.)

Disk/Echogram Menu

Range	Set to beyond anticipated max depth/ range
Range Start:	1m to reduce near field effect
Auto Range	Off – See instruction manual
Bottom range	See DISPLAY\ECHOGRAM menu 4.2
Bottom range start:	See DISPLAY\ECHOGRAM menu 4.2
No. Main Val	250
No. Bottom Val	75 (unless horizontal pinging in pelagic mode, then set to 0)
TVG	20LogR Always (Allows subsequent integration, but is essential for all post processing)

4.10 Serial Comm Menu

This menu is only used in conjunction with Lobe calibration program. Used for storing data to a separate PC. It can also be used to access EY data remotely, e.g. from a fish counter.

Serial/Telegram Menu

Format	BINARY
Modem Control	OFF
Remote Control	ON
Status	OFF
Parameter	OFF
Annotation	OFF
Navigation	OFF
Depth	OFF
Echogram	OFF
Echo-Trace	OFF

Sv	OFF
Vessel-Log	OFF
Layer	OFF
Integrator	OFF
TS Distribution	OFF

Serial/ Usart Menu

For output/data transmission using RS232 port. Values are user defined for all, e.g.:

Baudrate	9600
Bits Per Char.	8
Stop Bits	1
Parity	None

Serial/ Echogram Menu Set as Disk\Echogram menu.

4.11 Annotation Menu

This facility is only useful when running a printer. A good note book is probably of more use (& quicker).

4.12 Navigation Menu

Set values depending on GPS spec. (See appropriate GPS manual) e.g. default settings for NMEA 0183 navigation telegrams:

Navig Input	Serial
Start Sequence	$GPGLL
Separation Char.	002L
Stop Character	000D
First Field No.	2
No. Of Fields	4
Speed Input	MANUAL/ SERIAL (GPS) – This is correct option is required if LOG menu MODE is set to speed
Manual Speed	Knots (User defined if MANUAL SPEED INPUT chosen)
Baudrate	4800
Bits Per Char.	8
Stop Bits	1
Parity	None

4.13 Utility Menu

Beeper	User defined
Status Messages	On
Date	yy.mm.dd
Time	hh.mm.ss
Password	0
Default Setting	No
Language	English
Sound Velocity	- See. Appendix 3 e.g.1468ms-1 @ 15.5^{0}C and 0% Salinity
COM1/COM2	Switch OFF for GPS use, ON for Lobe calibration

4.14 Test Menu

Message
Transceiver - Check that noise isn't in detection range (ie. >-80db)

Amplitude measure is a good test of system = -55 +/- 2dB. For stable transducer and cables value should be the same when connected/disconnected to EY500 transceiver box. This is good practice (See Sect 5.1, pre-survey notes). System noise measured in passive mode; should be between –130dB and –140dB under normal circumstances. If this value approaches –100dB, results are likely to be hampered. This situation could also be a result of a noisy environment (wind/ rain/ suspended material etc.) or poor kit setup/ damage/ electrical interference. Check wiring/ connections/ try alternative power source/ look for damage to gear. Consider surveying in better conditions if limiting.

Scope	– use for calibration to look at pulse in dB re.1W at transducer terminals.
Version	The version of EY500 in use
Counter	Indicates CPU activity. (Zero. Indicates that the CPU is fully utilised or not running, a high no. indicates that there is CPU time left)
Simrad	SIMRAD USE ONLY

5. DATA COLLECTION

5.1 The Pre-survey

It is recommended that all hydroacoustic survey programs include a pre-survey. This is carried out to establish the most appropriate settings required for EY500 data collection and familiarise the operator(s) with the site.

General site familiarity – depths, obstacles, hazards, locks, establish best time to conduct survey (e.g. consider weed growth)
Optimising transducer position
Optimising survey route & direction
Temperature – set speed of sound (See Appendix 3)

Acoustic familiarisation:
System noise levels
Set minimum TS detection value
Determine ping rate (Specialised applications)
Depth/ Range variation
Bottom type

Create directory for data collection. e.g. c:\Trent1
Explore historical records for species, fish behaviour etc.

5.1.1 Testing for system noise levels

To check that electronics, transducer and cable are functioning correctly the following tests are recommended:

i) With EY500 system in passive mode (Transceiver menu) acceptable system noise levels should be between –130dB and –140dB. This value can be found in the test menu \transceiver option.

ii) The amplitude value in the above menu should be the same with transducer connected or disconnected. This is a measure of cable and transducer stability.

5.1.2 Setting min TS detection value

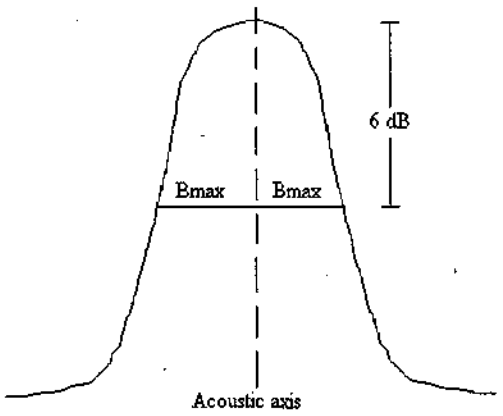
The acoustic environment of a site will limit the extent to which the smallest targets can be detected. Sections within the survey site may vary in respect to background noise levels, which will determine the minimum size of targets that can be detected. For general routine surveying –50dB is used as a default minimum TS detection value. On occasions the operator may wish to detect targets with a TS < -50dB. The following instructions accurately determine the minimum size of target that can be detected *in situ*:

i) Set Transceiver menu\Mode\PASSIVE

ii) Display menu TS colour Min. SET LEVEL APPROPRIATE TO RANGE.
e.g. max survey range is 25m. Adjust TS colour Min to level where noise appears at limit of required survey range**. This will be noted as the grey end of the TS spectrum appearing. Ideally this should be tested throughout the full length of the site, under similar flow and weather conditions to the planned survey.

iii) Apply 3:1 (10dB) noise ratio (for info see R&D note 196 Section 8 p.125-127) e.g. from ii) assume TS Colour min is –80dB = noise level. Therefore given the logarithmic scale used with decibels subtract 10dB to give a 3:1 noise ratio (now –70dB in this example).

iv) Apply value from iii) into following formula
TS detection level= (TS min-6)-2*Bmax
NB Agency standard for Bmax(maximum gain compensation) = 3.
e.g. –70dB = (TS min-6)-2*3
For this example setting TS min to –58dB will ensure detection of targets anywhere in beam to this level. However targets as small as –70dB will be detected close to the acoustic axis.



NB Bmax = maximum gain compensation
(3.0 default in TS detection menu)

v) Once decided the min value must be entered in the TS DETECTION menu (MIN VALUE)

** DIAGRAM REQUIRED HERE TO DEMONSTRATE

5.1.3 Determining ping rate

Determining ping rate gives an indication of the volume sampled and is important when comparing acoustic datasets. i.e. If ping rate is doubled, twice as much data are collected

Referring to 4.6 (Log menu) the procedure can be explained in the following example:

Set ping interval in Log menu to 600 and mode to ping. If log update interval is timed at exactly 60 seconds (requires operator to manually time how often histogram is updated in TS detection menu) this equates to a ping rate of 10 pings per second.

NB A ping rate of 10 pings sec^{-1} can usually be achieved in most freshwater Agency applications, with a processor of 166μHz or greater. However, this depends on range

5.1.4 Bottom type

Determine whether bottom will give strong echo/ whether bottom information is collected in Disk/echogram menu. Need to consider how data will be processed (i.e. pelagic or surface locked – the latter requiring bottom detection).

6. SURVEY PROTOCOL FOR DIFFERENT WATER BODIES

(Desired conditions/ characteristics)

6.1 Mobile River

>20m width
>2m depth
4-5 kph^{-1} boat speed
Laminar flow – Steady flow, no turbulence, avoiding entrained air (e.g. weirs)
Well defined channel with limited macrophyte growth (timing)
Survey June to October
Boat noise and roll should be minimised
Survey between 1 hour after sunset to 1 hour before sunrise
Survey both banks (upstream and downstream)
Avoid periods of high rainfall, high flow and high winds
Avoid full moon/ aim to conduct surveys around new moon if possible.
Repeat surveys conducted, where possible, under same time, date and environmental conditions.

6.2 Fixed Location - River

As in 6.1, also consider:
Site selection where bed profile matches acoustic beam pattern (undulating bed profile not suitable)
Good (permitted) 24hr access
Know species present
In conjunction with mobile survey for TS distribution data.

6.3 Mobile Stillwater

>1ha
>20m width
>2m depth for horizontal surveying, >15m deep for vertical surveys
4-5 kph^{-1} boat speed
Survey June to October (timing should avoid excessive macrophyte growth)
Boat noise and roll should be minimised

Survey between 1 hour after sunset to 1 hour before sunrise
Avoid periods of high rainfall and high winds
Avoid full moon
Repeat surveys conducted, where possible, under same time, date and environmental conditions.
Survey length >3*√ Area for one vertical or horizontal run.
If< 15m deep: 1 x vertical and 2 x horizontal runs in opposing directions.
If >15m deep: consider more vertical sounding

6.3 Fixed Location - Stillwater

Suitable for smaller lakes, or clear areas within heavily weeded sites.

Additional information on survey protocol can be found in R&D Note 196 or by guidance given by National Acoustic Group.

7. EY500 CALIBRATION

7.1 Summary

This section should be used as an aid to calibration, particularly in the field. It is designed to offer concise short-cuts to calibration, without having to relate to the full manufacturers manual. You may find it useful to laminate certain sections for use in the field. These instructions do not replace the full manufacturers manual, which should be kept on hand to assist with any specific problems, should they occur.

- It is advisable that you are familiar with Section 2 "Installation, system test and calibration" of the Simrad manual prior to any field work.

- Calibration should be an integral part of your survey design.

- Routine calibration as part of each survey is advised.

- It is recommended that equipment is re-calibrated with every 5°C change in water temperature.

- Two methods of on-axis calibration are available with the Simrad EY 500.

  These are: A manual method, which requires the standard EY500 hardware, with printer.

A semi-automated method called "The Lobe", which requires the standard EY500 hardware and an additional pc or laptop with DOS and the LOBE.EXE programme.

- The Lobe offers an easier method of Ts calibration.

- A pan and tilt unit is extremely useful for assisting with the centring on axis of the target sphere.

7.2 Introduction

The calibration technique chosen should reflect the survey design as far as practically possible and should be conducted in situ, preferably just before the start of the survey to optimise accurate data

collection. Routine calibration has indicated that the target strength of the sphere is relatively stable under similar environmental conditions in the same water system. However, notable changes in water temperature (± 5°C) between surveys should facilitate re-calibration. A calibration should be conducted for each survey type, ie. horizontal or vertical and between different water systems.

7.2.1 Prior to calibration

Calculate the minimum distance in which the standard target must be placed in order to prevent errors from near field calibration. The recommended range for sphere placement is twice the Rayleigh distance. This distance will dictate where calibrations can be undertaken.

Rayleigh distance = L^2/λ therefore:

Where:

L = the longest face of the transducer (m)

$\lambda = C/f$

C = speed of sound in water (ms^{-1}) (See Appendix 3)

f = frequency of transducer (Hz)

Calibration range = $2 \times [L^2/(c/f)]$

NB. The measurement of L is <u>not</u> the full length of an elliptical transducer, but the length of the encased ceramics. These can be seen as the dark area on the transducer face. For example L for a $4^{\circ}x10^{\circ}$ elliptical transducer is c. 0.25m, giving a Rayleigh distance of approximately 5m, hence the calibration sphere should be placed at 10m. The Rayleigh distance will be greater for a $2^{\circ}x10^{\circ}$ transducer. It will govern at what range or depth the standard target should be placed for horizontal or vertical calibration, but all calibrations should ideally be undertaken at working depths and ranges as far as practically possible.

7.3 Calibration techniques

The principles for calibrating horizontally and vertically are basically the same, but will require different hardware to enable the centring of the standard target in the beam. Windy conditions can cause problems during calibration in centring the sphere within the beam, particularly with the manual technique and should be avoided. However, calibration using the Lobe program is less problematical under windy conditions because the software will take account of any movement of the sphere.

7.3.1 Vertical calibration

The Simrad manual Section 2, pg7 demonstrates a system of winches, which can be utilised from a boat for vertical calibration. In practice, centring of the target sphere using winches can be difficult. The procedure is made easier if the sphere is held stationary with three lines and the transducer is mounted on an electric pan a tilt unit which can be used to focus the beam onto the sphere. Operators have also found it useful, when surveying deep lakes that the calibration procedure is conducted on fixed moorings or jetties to provide a stable platform for maintaining the target sphere position.

7.3.2 Horizontal calibration

Most rivers in the UK are not deep enough to adequately calibrate vertically and therefore a horizontal technique should be applied. A pan and tilt unit is almost essential for horizontal calibration in the field. It is useful to note that by aiming the transducer face towards deep water

surface reflections can be reduced. However, this can be eliminated in most situations by limiting the range of the echogram around the target (See note on Layer menu in this section).

7.4 Calibration procedures

Always complete a calibration report (example end of this chapter?) during each procedure, it acts as a check list for each calibration step.

- record the water temperature

- read the sound speed and absorption coefficient from section 4 "Theory of Operation" (p.18 & 19) in the simrad instruction manual. For freshwater, set the speed of sound using the table in Appendix 3.

- read the target strength of the calibration sphere from Simrad Instruction manual Sect 7. p.9

- It is good practice at each calibration to cross check the noise and amplitude of the internal oscillator (Simrad manual section 2 pg 6)

7.4.1 Centring of the target sphere

EY500 MENU DESCRIPTIONS FOR CALIBRATION

OPERATION MENU

Ping Mode:	normal
Ping interval:	1.0 sec. (0 secs may work better on slower processors)
Noise margin:	0dB

DISPLAY MENU

Colour Set:	light
Event Marker:	off
Echogram Speed:	1:1
Echogram:	on
Echogram Menu/ Transducer No.:	1
Range:	Select a range beyond your target sphere (normally 10m,15m or 25m) (Sphere needs to be placed towards the end of this range to avoid to avoid problem of not having deep water to point transducer)
Range start:	0m
Auto range:	off
Bot. Range start:	0m
Bot. Range Pres.:	Off
Sub. Bottom Gain:	0.0dB/m
Presentation:	normal
TVG:	40logR (20logR if you intend to use integrated data.)
Scale lines:	makes it easier to set calibration range in the layer menu
Bot. Det. Line:	off

Layer lines:	on
Integration lines:	off (useful to have on during manual calibration)
Ts Colour min.:	-60dB*
Sv Colour min.:	-70dB**

NB. * Check noise thresholds in Transceiver Menu/Mode/passive for 40logR
** Check noise thresholds in Transceiver Menu/Mode/passive for 20logR

See Noise Thresholds in Section 5.1.1

PRINTER MENU/
ECHOGRAM MENU – same values as for DISPLAY/Echogram (above)

Disable printer menu, unless calibrating manually for Sv. (see Simrad manual Sec. 2 pg 16)

TRANSCEIVER MENU

Ensure all the settings from previous calibrations/surveys are recorded.

Mode:	active
Transducer type:	Select the type from the list.
Transducer sequence:	off
Transducer depth:	0.0m
Absorption Coef.:	4dBkm (default for freshwater)
Pulse Length:	medium (separate calibration for each pulse length is required)
Bandwidth:	wide
Max. Power:	63w (manufacturer set for 120kHz – do not change)
2-way Beam Angle:	-21.6 (Specific value for each transducer-read from manufacturers data sheet)
Sv Transd. Gain:	Use defaults prior to calibration
Ts Transd. Gain:	Use defaults prior to calibration
Angle Sens. Along:	38* (Check with manufacturer for correct value for your transducer)
Angle Sens. Athw.:	15* (Check with manufacturer for correct value for your transducer)
3dB Beamw. Along:	4.4 (Specific value for each transducer-read from manufacturers data sheet)
3dB Beamw. Athw.:	9.0 (Specific value for each transducer-read from manufacturers data sheet)
Alongship Offset:	0.0dg
Athw.ship Offset:	0.0dg

* Defaults for a 4 x 10^0 elliptical transducer

BOTTOM DETECTION MENU

Not required for calibration
LOG MENU

Mode:	ping
Ping interval:	100

LAYER MENU

Super Layer: 1

Layer-1 Menu/

Type:	Surface (vertical pinging)
	Pelagic (horizontal pinging)
Range:	Width of layer around target sphere (as narrow as practically possible 0.5m – 1m)
Range start:	Set initially 0.5m shorter than the range of the sphere.
Margin:	0.0m
Sv threshold:	-60dB

All the other layers should be turned off.

TS DETECTION SUBMENU

Min. value:	-50dB (check noise thresholds in 5.1.1, 5.1.2)
Min. echo length:	0.8
Max. echo length:	1.5
Max. gain comp.:	3
Max. phase dev.:	4

DISK MENU

Disabled for the purpose of calibration. It may be useful for some calibrations to be stored as replay files (see Simrad Instruction manual Sect 3, 2.10.1) for practice outside field conditions. Stored echograms of the reference target can be used as a cross-check calibration in echo processing EP 500. (see SecXX Post processing pg XXX- to be produced) Simrad advise that this practise is not adopted and that calibration is carried out using the Lobe program (See 7.7)

SERIAL COM. MENU

Utilised for the Lobe Calibration only, see below.

ANNOTATION AND NAVIGATION MENUS

Not utilised during calibration

UTILITY MENU

Used for the Lobe calibration only, see below.

TEST MENU Not utilised during calibration

7.5 Manual calibration

TS measurement

- Select the TS-DETECTION MENU
- Ensure the target is in the centre of the beam (TS Detection submenu)
- TS compensated and TS un-compensated should be the same

- Use the TS compensated value as the measured TS

- If the measured TS is different from the TS of the sphere calculate a new TS transducer gain.

$$\text{New transd. Gain} = \text{Old transd. Gain} + \frac{\text{TS measured} - \text{TS sphere}}{2}$$

- Replace the TS Transducer gain in the TRANSCEIVER MENU with the New transducer gain and check that the measured TS in the TS DETECTION MENU is the same as the known value of the sphere. Repeat if necessary.

7.6 Sa measurement

Often the TS measurement is sufficient for calibration and the Sv Transd. Gain in the TRANSCEIVER MENU can be the same value as the calculated TS Transd Gain. However, for a more accurate figure the calibration procedure for Sa should follow the instructions shown in the Simrad manual Sec 2 pg 16 (ref P2260/E). This is particularly important if integration is to used. A printer must be connected to output integrator tables. (NB S.Hughes, NCFC, can distribute spreadsheet to estimate this)

7.7 Lobe calibration

(This technique is considered the most accurate for calibrating the EY500 echosounder and is the recommended option, of the range given here)

Ensure you are using Lobe V 5.0 (17/1/95) from the Utilities disc.

7.7.1 Equipment: a) Normal EY500 set up for manual calibration.
b) an extra pc with the lobe program on (EY500 not required)
c) 9 pin female to female (check your own serial port requirements) wired 2,3,5 on the lobe pc to 3,2,5 on the EY500 pc. (See below)
d) calibration report sheet

Lobe pc serial port 9 pin female		EY500 pc serial port 9 pin female
2	----------	3
3	----------	2
5	----------	5

7.7.2 Operating procedure

1. Ensure you have a record of your current calibration data from the Transceiver menu on a calibration report sheet.

2. Connect the two PCS via the serial ports.

3. Switch on the EY500 and centre the calibration sphere (calibration page 11, manual P2473E).

4. On the EY500 pc check: UTILITY MENU that the com1/com2 switch=ON

SERIAL TELEGRAM MENU that Remote=ON, Format=Binary.

5. Start the Lobe program by clicking on **lobe.exe** in windows File Manager/ windows explorer. You will be given an instruction page.

6. On the Lobe pc press **F2** to enter the **RS232 Menu.**

7. On the EY500 pc check: **SERIAL USART MENU-** The parameters set here need to be the same as those for the Lobe pc. Make a note of ; **baud rate, bits per character, stop bits** and **parity** and ensure that these parameters are the same in the **RS232 Menu** on the Lobe pc. The left or right arrow key will amend each line. The up and down arrows allow you to move within the menu. Once you have set each parameter press **ENTER**. If your connections are correct a small rotating forward slash will be observed in the bottom right hand corner of the **RS232 Menu** and you will be reminded of the function keys on the bottom line.

8. **Press F3** to enter the **RECORD MENU**. Delete the Comment String and enter your own. Use the down arrow to enter details in the **RECORD MENU** window:

File: Chose a file name relating to the calibration (up to16 characters)
Transceiver:
TS (dB): The TS of your sphere at current temp./sound speed
Depth (m): The range of the sphere

Check that the depth (range) of the sphere is ±10% and the TS is ±4dB of the values measured in the TS DETECTION MENU on the EY500 pc. If not, change the depth in the RECORD MENU and adjust the Transducer Gain in the EY500 TRANSCEIVER MENU. ***If the depth (range) and TS values are outside these limits the LOBE programme will not function.***

•

Once you have adjusted the above parameters press RETURN. **Wait approx. 30 secs** and the lobe will set up a detection window and start to collect data.

9. Move the sphere to ensure you have sufficient hits in each quadrant, aim for about 100 data sets. This may take a couple of minutes. The LOBE programme may stop collecting data if the shere is moved excessively and the thresholds are exceeded. It will restart collecting data once the target settles within the thresholds again.

10. Once you have enough data press **RETURN** to stop recording. If you do not have sufficient data sets it will not allow you to fit the data (next stage).

11. **Press F4** to reveal the transducer pattern (view window). If this does not appear to follow the typical transducer shape then the data points require examination. (Refer to manual sect 7 p.21).

12. **Press F5** to enter the **FIT MENU** and fit the collected data. The number of iterations will be shown accumulating in the bottom right hand corner of the **FIT MENU** window. When at least 50 have been reached press **RETURN**. If you require more iterations press F6 then **RETURN** to accept.

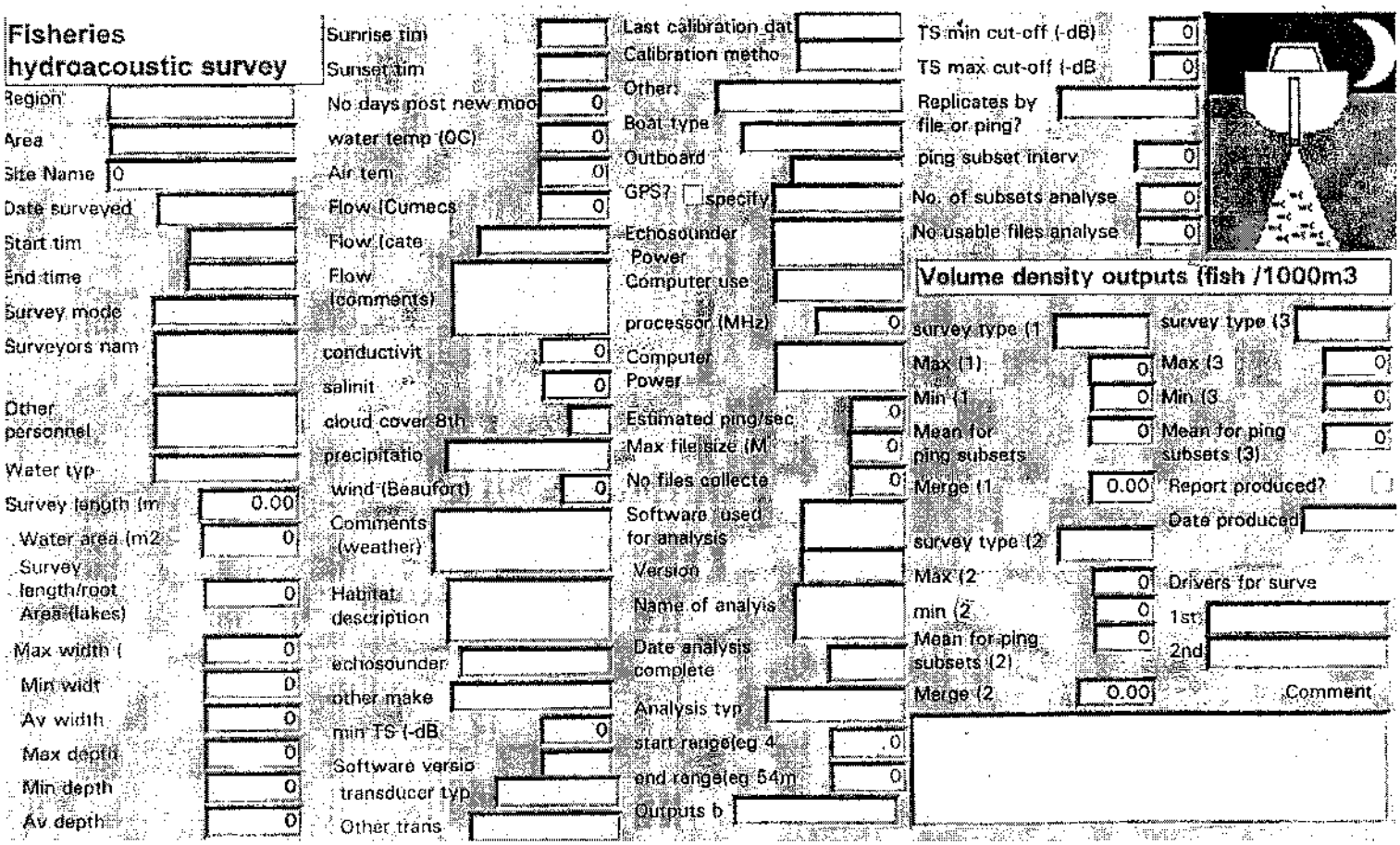
You will now be left with a whole host of useful figures in the **FIT MENU** which you should record on your calibration sheet for future reference.

13. Press **RETURN** once more and you will be asked if you want to "copy to the Transceiver menu" Remember it will overwrite existing data, if these are required make sure you have a note of them.

APPENDIX 1 - CURRENT OPERATOR DETAILS
(TO BE COMPLETED BY GROUP)

Name:	
Post title:	
Address:	
XT no.	
Mobile:	
e-mail:	
Application of gear:	
Transducers used	
MUX?	
Boat:	
Transducer mount arrangement:	
Power source:	
PC:	
Auxillary equipment used (GPS type, differential etc.)	
Environmental parameters:	

APPENDIX 2 – PROPOSED HYDROACOUSTIC SURVEY DATA RECORDING SHEET (FOR COLLATION BY NAG)



The above image is a copy of the form within the access database "hydroform.mdb"

- Many of the fields are created from combo boxes (options given).
- There are numerous fields, that may be used at a later date (once collated by NAG) to describe volume density outputs. There are also duplicate fields for the some characteristics (e.g. flow) it is suggested that all data is entered where available.
- A choice of outputs description is given, such as by file, subset interval, or merge
- Data may have been collected in the past in 40LogR before the recommendation to always collect 20LogR was made, so this option is given in one field.
- Date entries must be made with slash separators (e.g. 03/08/98)
- Time entries must be made with a semi-colon separator (e.g. 20:12)
- Although characters are missing on the example form shown above, they do appear on the computer screen
- A new "echosounder model" field has been added since this above image was imported.

An example of a completed form is shown on the following page.

An example of a completed form

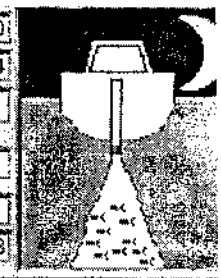
Fisheries
Hydroacoustic survey

Region	nwNorthWest
Area	North
Lake Name	Ennerdale 1
Date surveyed	19/08/96
Start time	21:30
End time	00:53
Survey mode	Combination
Surveyors name	Jon Hillary
	Mike Bell
Other personnel	
Water type	Stillwater
Survey length (m	5830.00
Water area (m2	29600
Survey length/root Area (lakes)	3.39
Max width (	3940
Min width	61.5
Av width	0
Max depth	44
Min depth	2
Av depth	0

Sunrise time	05:50
Sunset time	20:19
No. days post new moo	5
water temp (OC)	17.4
Air tem	17.7
Flow (Cumecs	0
Flow (calc	None
Flow (comments	
conductivit	
salinit	
cloud cover-8th	7
precipitatio	Light
wind (Beaufort)	2
Comments (weather)	Calm at start of survey, gusting at end.
Habitat description	Oligotrophic lake. Trout and Char present.
echosounder	SIMRAD
other make	
model	EY500
min TS (-dB	60
Software versio	5.0
transducer typ	4*10 degre
Other trans	

Last calibration dat	12/08/99
Calibration metho	Manual
Other	
Boat type	Dory
Outboard	2 stroke
GPS? ✓specify	Garmin GPS
Echosounder Power	Direct Battery
Computer use	Toshiba 110
processor (MHz)	50
Computer Power	Direct Battery
Estimated ping/sec	4
Max file size (M	1
No files collecte	10
Software used for analysis?	EP500
Version	5.2
Name of analyst	Jon Hillary
Date analysis complete	/11/97
Analysis typ	Surface
start range(eg 4	2
end range(eg 54m	44
Outputs b	Multiple targets

TS min cut-off (-dB)	50
TS max cut-off (-dB	14
Replicates by file or ping?	File
ping subset interv	
No. of subsets analyse	
No usable files analyse	8



Volume density outputs (fish /1000m3

survey type (1	vertical	survey type (3	
Max (1)	4	Max (3	0
Min (1	0.5	Min (3	0
Mean for ping subsets	0	Mean for ping subsets (3)	0
Merge (1	3.70	Report produced?	✓
		Date produced	01/11/97
survey type (2			
Max (2	0	Drivers for surve	
min (2	0	1st	Baseline date
Mean for ping subsets (2)	0	2nd	Rare/Cons spp. St
Merge (2	0.00		

Comment

1st in a series of 3 survey between 1996 and 1998 for baseline data and to quantify numbers of arctic char. Horizontal surveying was of little use due to deteriorating weather.

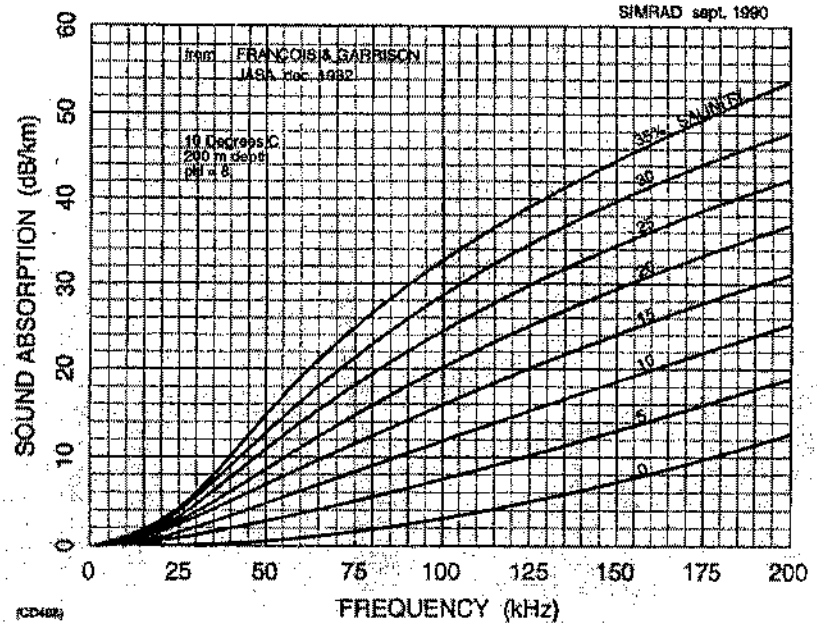
APPENDIX 3 – SPEED OF SOUND IN WATER

Speed of sound in freshwater (ms^{-1})
after Del Grosso & Mader (1972)
0-95^{0}C

Temp (^{0}C)	ms^{-1}	Temp (^{0}C)	ms^{-1}	Temp (^{0}C)	ms^{-1}
0.5	1405	10.5	1449	20.5	1484
1.0	1407	11.0	1451	21.0	1485
1.5	1410	11.5	1453	21.5	1487
2.0	1412	12.0	1455	22.0	1488
2.5	1415	12.5	1457	22.5	1490
3.0	1417	13.0	1459	23.0	1491
3.5	1419	13.5	1461	23.5	1493
4.0	1422	14.0	1462	24.0	1494
4.5	1424	14.5	1464	24.5	1495
5.0	1426	15.0	1466	25.0	1497
5.5	1428	15.5	1468	25.5	1498
6.0	1431	16.0	1469	26.0	1499
6.5	1433	16.5	1471	26.5	1501
7.0	1435	17.0	1473	27.0	1502
7.5	1437	17.5	1474	27.5	1503
8.0	1439	18.0	1476	28.0	1504
8.5	1441	18.5	1478	28.5	1506
9.0	1443	19.0	1479	29.0	1507
9.5	1445	19.5	1481	29.5	1508
10.0	1447	20.0	1482	30.0	1509

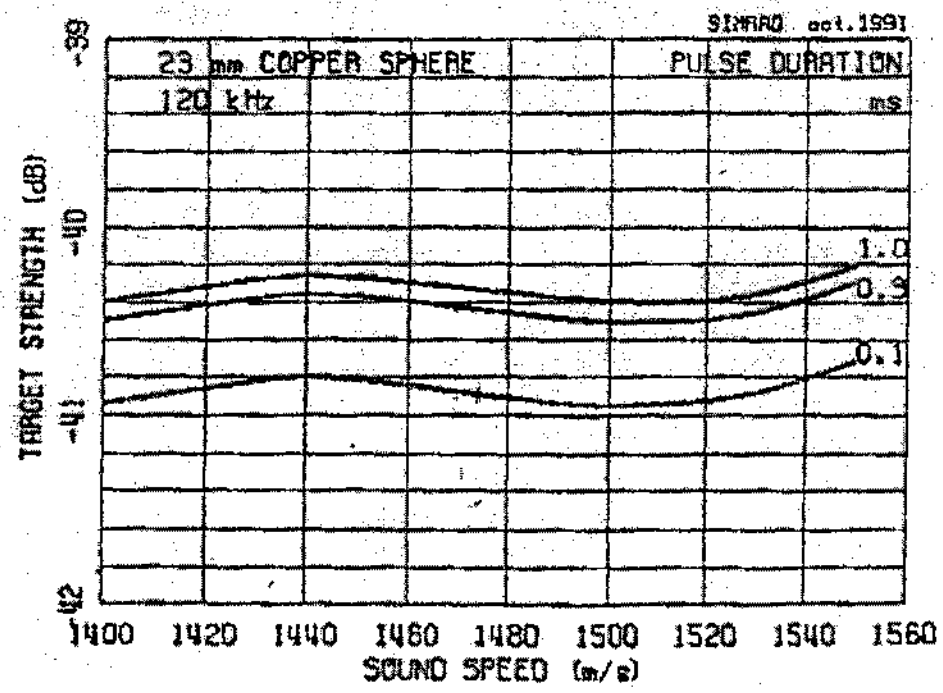
Values appropriate for horizontal sounding as taken near surface.
NB. Speed of sound is increases with depth, e.g. at 10m depth and 10^{0}C, speed of sound is increased by 0.161ms^{-1}

APPENDIX 4 – SOUND ABSORPTION



APPENDIX 5 – SIMRAD REFERENCE TARGET TS

pulse length 0.3ms – most commonly used.



APPENDIX 6 - Quick start up guide:

1) Check all connections:	Transducer to EY500 Computer to EY500 Power to EY500 Power to Computer GPS (if used) to COM1 (Computer)

2) Ensure transducer is submerged – (sounding in air will damage the transducer)

3) Power up EY500, GPS, then computer

4) Check you have a directory on the C:\ drive to store data (e.g. Lune1)
NB. You may need to re-start the computer after doing this to .....

5) Start EY500 programme

6) TRANSCEIVER menu-	Check that settings are correct Put MODE to PASSIVE
7) OPERATION menu	PING MODE to NORMAL
8) TEST menu	Check noise <-130dB
9) OPERATION menu	PING MODE to OFF
10) TRANSCEIVER menu-	Put MODE to ACTIVE
11) LAYER menu	Set Layer parameters to suit survey
12) DISPLAY menu	Set ECHOGRAM menu to suit survey
13) DISK menu	Change DIRECTORY name to that created earlier (e.g. \Lune1) Set ECHOGRAM menu to suit survey
14) UTILITY menu	Take water temp and enter SPEED OF SOUND(Appendix 2) COM1/COM2 switch OFF for GPS input.
14) OPERATION menu	PING MODE to NORMAL (Echogram should begin to scroll)
15) NAVIGATION menu	Check GPS data is being read (N &W coord's at bottom of screen)
16) TS DETECTION menu	Set min TS value (either to standard –50dB, or through procedure given in 5.1.2)
17) DISK menu	LOG on (Mb's should clock up in L hand corner of screen).