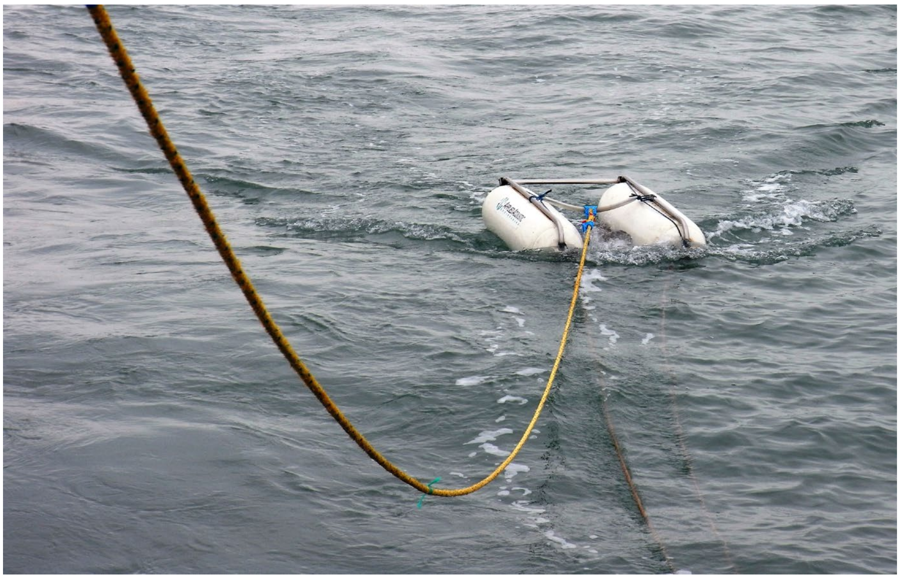
South Coast and Eastern English Channel Synthesis – Geophysical Survey Cruise Report

Marine Geoscience Programme

Open Report OR/10/052

MEPF Ref. 09/P92



BRITISH GEOLOGICAL SURVEY
MARINE GEOSCIENCE PROGRAMME.
OPEN REPORT OR/10/052
MEPF Ref. 09/P92

South Coast and Eastern English Channel Synthesis – Geophysical Survey Cruise Report.

N. Smart[1], S.R. Ritson[1] and J.W.C. James[2]

[1] British Geological Survey
Loanhead, Edinburgh
EH20 9AU

[2] British Geological Survey
Nicker Hill
Keyworth, Nottingham
NG12 5GG

Keywords

Surface tow boomer, sidescan sonar, survey, English Channel, Dungeness, Beachy Head

Front cover

Surface tow boomer deployed astern of the FPV Watchful. Picture by Nick Smart.

Bibliographical reference

SMART, N. RITSON, S R. AND JAMES, J W C. South Coast and Eastern English Channel Synthesis Project – Geophysical Survey Cruise Report. *British Geological Survey Open Report*, OR/10/052. 36 pp.

Keyworth, Nottingham British Geological Survey 2010

BRITISH GEOLOGICAL SURVEY

The full range of Survey publications is available from the BGS Sales Desks at Nottingham, Edinburgh and London; see contact details below or shop online at www.geologyshop.com

The London Information Office also maintains a reference collection of BGS publications including maps for consultation.

The Survey publishes an annual catalogue of its maps and other publications; this catalogue is available from any of the BGS Sales Desks.

The British Geological Survey carries out the geological survey of Great Britain and Northern Ireland (the latter as an agency service for the government of Northern Ireland), and of the surrounding continental shelf, as well as its basic research projects. It also undertakes programmes of British technical aid in geology in developing countries as arranged by the Department for International Development and other agencies.

The British Geological Survey is a component body of the Natural Environment Research Council.

British Geological Survey offices

Keyworth, Nottingham NG12 5GG

☎ 0115-936 3241 Fax 0115-936 3488
e-mail: sales@bgs.ac.uk
www.bgs.ac.uk
Shop online at: www.geologyshop.com

Murchison House, West Mains Road, Edinburgh EH9 3LA

☎ 0131-667 1000 Fax 0131-668 2683
e-mail: scotsales@bgs.ac.uk

London Information Office at the Natural History Museum (Earth Galleries), Exhibition Road, South Kensington, London SW7 2DE

☎ 020-7589 4090 Fax 020-7584 8270
☎ 020-7942 5344/45 email: bgslondon@bgs.ac.uk

Forde House, Park Five Business Centre, Harrier Way, Sowton, Exeter, Devon EX2 7HU

☎ 01392-445271 Fax 01392-445371

Geological Survey of Northern Ireland, Colby House, Stranmillis Court, Belfast BT9 5BF

☎ 028-9038 8462 Fax 028-9038 8461

Maclean Building, Crowmarsh Gifford, Wallingford, Oxfordshire OX10 8BB

☎ 01491-838800 Fax 01491-692345

Columbus House, Greenmeadow Springs, Tongwynlais, Cardiff, CF15 7NE

☎ 029–2052 1962 Fax 029–2052 1963

Parent Body

Natural Environment Research Council, Polaris House, North Star Avenue, Swindon, Wiltshire SN2 1EU

☎ 01793-411500 Fax 01793-411501
www.nerc.ac.uk

Foreword

This report describes a geophysical survey cruise undertaken by the British Geological Survey (BGS). The survey covered an area offshore between Newhaven and Dungeness on the south coast of England on board the FPV Watchful, the 18m x 7.8m fisheries patrol vessel of the Sussex Sea Fisheries District Committee (SSFDC). The survey comprised a grid of parallel and cross lines run with surface tow boomer (STB) and sidescan sonar (SSS). In total 353 line kilometres of survey were completed. The survey was undertaken over a period of 10 days from the 8th March to the 17th March 2010.

Three BGS staff and three SSFDC crew members (Appendix 1), were on board the vessel during the survey. Ceri James, based at BGS Keyworth, was the Party Chief and survey geologist responsible for fulfilling the MALSF survey requirements. He also organised the hire and simultaneous running of a C-MAX sidescan sonar. Nick Smart and Simon Ritson, from BGS Marine Operations, Loanhead, Edinburgh were responsible for preparing, setting up and running the survey equipment. Nick Smart was the lead Surveyor, responsible for organising transport, insurance, hiring equipment, SSS interfacing and QINSy/Coda setup and running. Simon Ritson was the electrical engineer and was responsible for high voltage (HV) operations, interfacing and Coda acquisition operation. During the survey these roles and responsibilities often crossed depending on the nature of the task at hand. Funding for the survey was provided by the Marine Aggregate Levy Sustainability Fund (MALSF). Additional funding was provided by BGS for the hire of the C-MAX Sidescan sonar.

Acknowledgements

This work was funded by the Marine Aggregate Levy Sustainability Fund (MALSF) and commissioned by the Marine Environment Protection Fund (MEPF) as project MEPF Ref 09/P92.

The authors would like thank the skipper of the FPV Watchful, Charlie Hubbard and the crew Mark Hayes and Alberto Kavadellas who contributed to the survey their considerable expert local knowledge of the waters and conditions, which was invaluable. Their assistance during mobilisation, particularly with regard to the sidescan sonar winch and block, demobilisation and launch/recovery of survey equipment was extremely helpful. Their hospitality and expertise were greatly appreciated throughout the survey and facilitated a successful and enjoyable cruise. Rob Clarke the SSFDC Senior Fishery Officer was of great help in organising the project and putting us in touch with appropriate people. Michael Wilson, BGS engineer, was on board during mobilisation and was the onshore BGS contact. Thanks must also be paid to Les Ford of Sonar Equipment Services, Great Yarmouth with regard to sidescan sonar repairs and operation and hire of alternative surface tow boomer and hydrophone.

Disclaimer

This report is available at www.alsf-mepf.org.uk

Client Contact Details

Marine Aggregate Levy Sustainability Fund (MALSF)
Commissioned by the Marine Environment Protection Fund (MEPF)
C/o Cefas, Pakefield Road, Lowestoft, Suffolk, NR33 0HT

Background to the Aggregate Levy Sustainability Fund (ALSF)

In 2002 the Government imposed a levy on all primary aggregates production (including marine aggregates) to reflect the environmental costs of winning these materials. A proportion of the revenue generated was used to provide a source of funding for research aimed at minimising the effects of aggregate production. This fund, delivered through Defra, is known as the ALSF; marine is one element of the ALSF. Further information on the ALSF is available at http://alsf.defra.gov.uk/

Governance

The Defra-chaired MALSF Steering Group develops the commissioning strategy and oversees the delivery arrangements of the Fund.

Contents

FIGURES

1 Introduction

The MALSF have funded two regional environmental characterisation (REC) studies in the English Channel: the South Coast REC (James et al, 2010) and the Eastern English Channel Marine Habitat Map (EECMHM) (James et al, 2007). In 2009 the MALSF awarded a contract to a consortium led by the British Geological Survey (BGS) to provide a synthesis of the results of these two REC studies and fill gaps in the geographical coverage by extending the synthesis area to include the coastal platform from Newhaven to the east past Beachy Head to Dungeness.

The survey described in this report was designed to extend the geophysical survey coverage of the EECMHM (Figure 1) to the coast to match the adjacent South Coast REC coverage and enable an integrated dataset to be produced for the whole of the Synthesis area.

For planning and operational purposes a survey plan grid of around 600 km was devised. This was an aspirational figure based on good weather throughout the survey period with no operational problems. The planning grid also included lines within the EECMHM area for inclusion if time was available. In total 353 kilometres of survey were completed and provided a coverage which enabled a practical interpretation of the geology between Beachy Head and Dungeness to be undertaken.

The survey was carried out using a BGS owned surface tow boomer (STB), simultaneously with a hired C-MAX CM2 sidescan sonar (SSS) system. During the planning stages for the survey the inclusion of a multibeam system was considered but the logistics of mounting a multibeam on the Watchful was deemed too complicated and prohibitive within the survey budget.

This report provides a review of the survey procedures and outcomes.

.

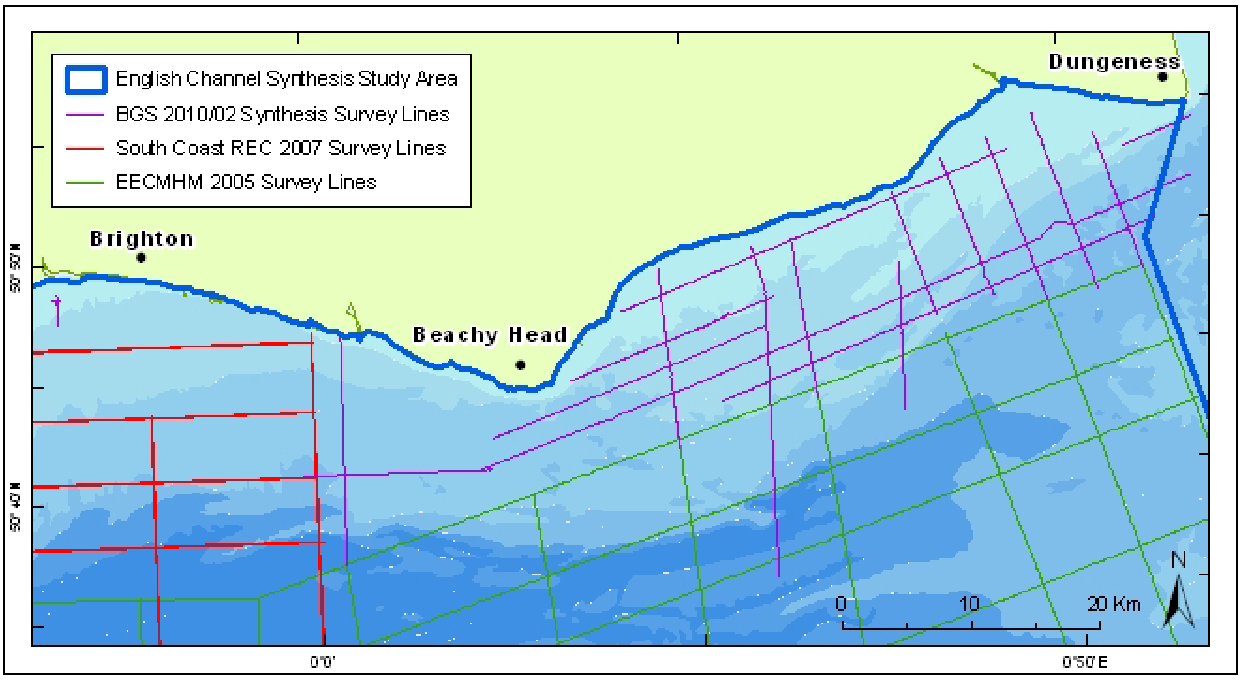


Figure 1 Survey track lines for 2010/02 Synthesis survey and surveys for the South Coast REC 2007 and EECMHM 2005.

2 Survey

2.1 MOBILISATION

The mobilisation of the surface tow boomer (STB), hydrophone and sidescan sonar (SSS) was undertaken on the 8th – 9th of March 2010 by Nick Smart, Simon Ritson, Michael Wilson and Ceri James with the aid of the FPV Watchful crew at Shoreham harbour.

STB equipment, including hydrophones and acquisition software were loaded into a hire van at BGS Marine Operations, Loanhead on Friday 5th of March 2010. The journey down to Shoreham was completed on Sunday the 7th of March 2010,

A C-MAX CM2 DF (100/325kHz) sidescan sonar towfish (www.cmaxsonar.com), CM2 portable winch plus charger box, CM2 counting block, CM2 Sonar Transceiver Unit and laptop with MaxView software were hired from Sonar Equipment Services (SES) Great Yarmouth. This equipment was delivered directly to SSFDC on Thursday the 4th of March 2010. This enabled Charlie Hubbard, the FPV Watchful skipper, to mount the CM2 portable winch and CM2 counting block on the Watchful prior to mobilisation which commenced at 0800 on Monday 8th March at Shoreham Harbour. Due to the confined space onboard the vessel most equipment was placed on the aft deck whilst the wheelhouse was fitted out with the survey equipment.

2.1.1 Wheelhouse layout

The wheelhouse layout is shown below in Figures 2 and 3.

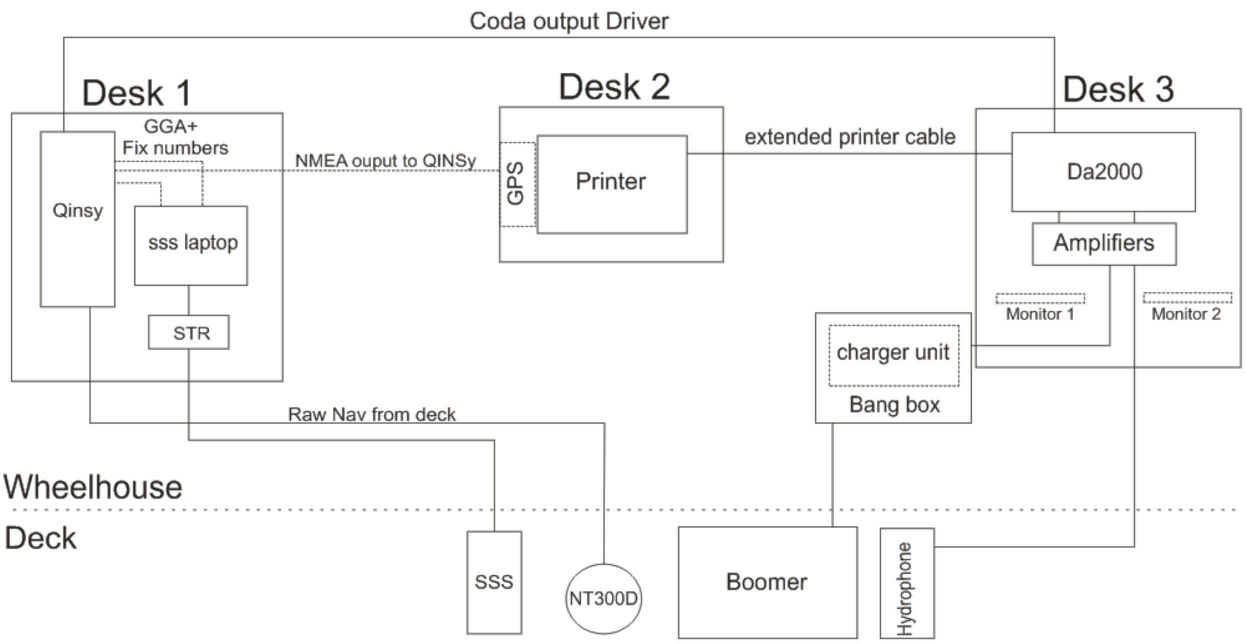


Figure 2 Diagram showing the wheelhouse layout of survey equipment.

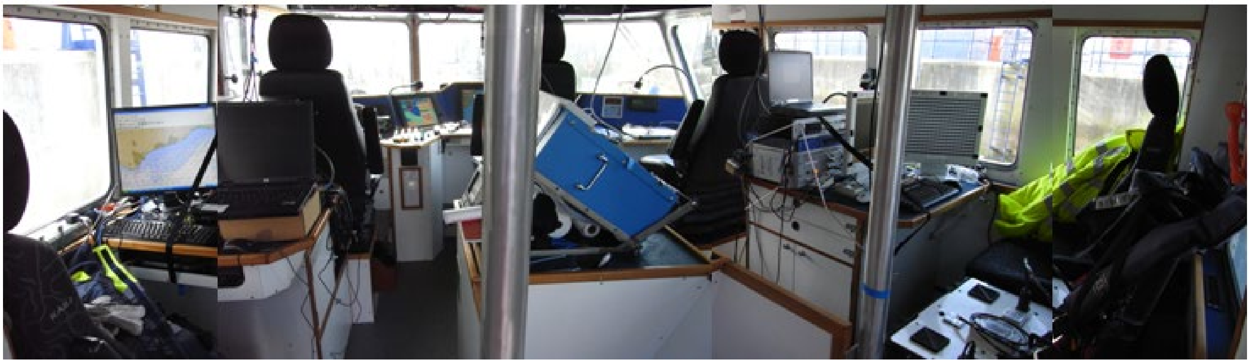


Figure 3 Photograph of the wheelhouse layout.
Desk 1 on left, Desk 2 in centre, Desk 3 on right.

To maintain order, the bang box, charger unit, amplifiers and Coda DA2000 system were all kept to one side of the wheelhouse, this way all the cables concerned were kept together. Cables connecting equipment on opposing sides of the wheelhouse were run through plastic pipes along the ceiling. Using this method ensured major access points were maintained.

2.1.2 Deck layout

Because the STB, SSS and hydrophone were deployed from the aft deck, careful consideration had to be taken in order to avoid the possibility of items of equipment interfering with each other during launch and recovery. Appendix 2 shows the layback diagram. Figure 4 shows the deck layout:

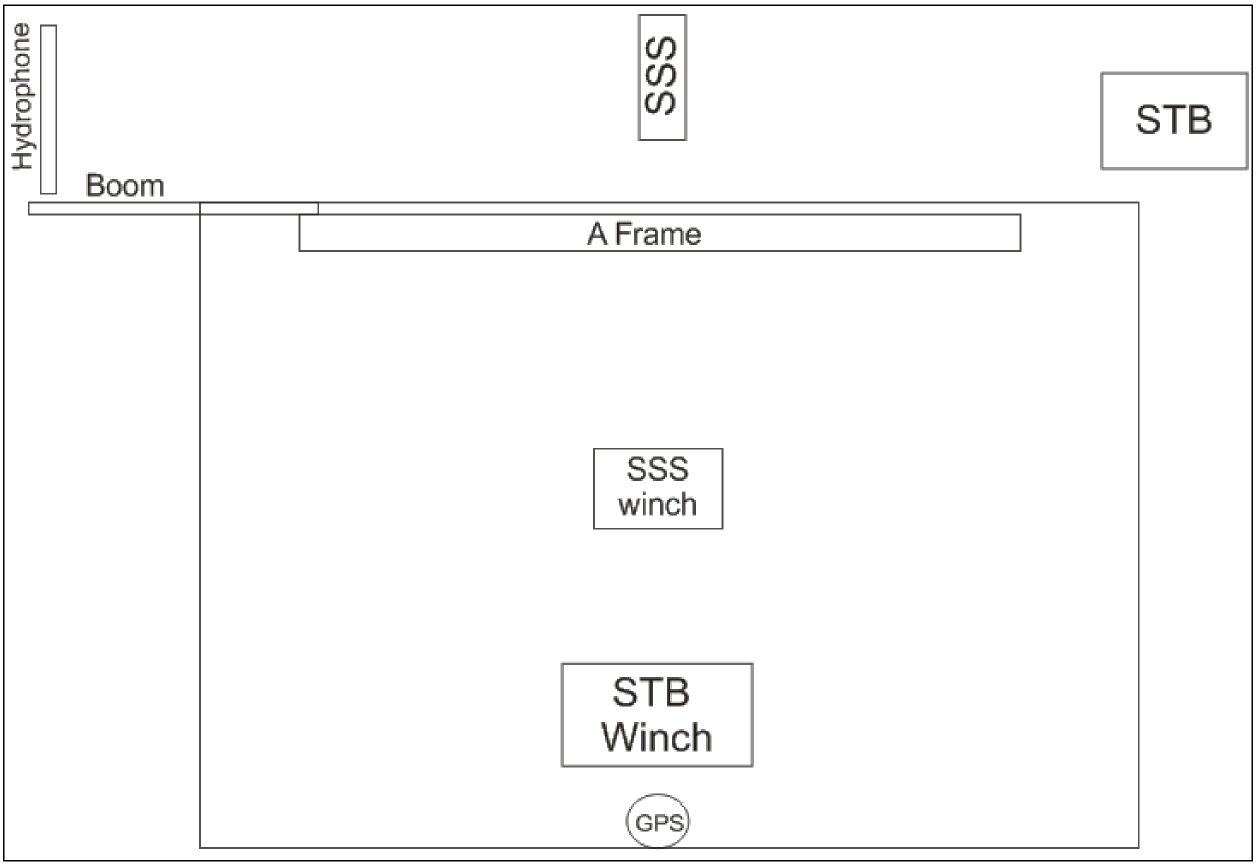


Figure 4 Deck layout of survey equipment.
SSS = sidescan sonar, STB = surface tow boomer.

2.1.3 Launch and recovery

The A frame on the aft deck housed two hanging blocks, these comprised the counting block for the SSS and a block that the Watchful provided for the STB tow rope (Figure 5). The SSS CM2 winch was mounted to the deck by the Watchful crew on a timber frame to provide a base for the winch along the centreline of the vessel. This lined up the SSS cable with the counting block on the centre of the A frame. The SSS towfish was deployed by launching directly astern of the vessel whilst paying out cable from the winch.

There were some initial setup issues with the SSS which delayed mobilisation. The CM2 has a feature which enables the angle of the transducer heads to be moved between 10° and 20°. This is achieved by rotating a circular dial on the fish. However, upon assembly this dial was detached, seemingly missing a securing screw. Upon further inspection the transducer heads seemed to have a lot of ‘play’ in them. This was later attributed to an angled metal rod that runs through the middle of the fish being hyper-extended, reducing its angle, and therefore failing to keep the heads under tension.

A new dial and metal rod were ordered from SES and arrived the next day, 9th of March, for fitting. This was done by BGS personnel. A further issue was the DC connector on the transceiver unit, which supplied 42V DC to the towfish. The orientation of the transceiver unit seemed to affect power output to the fish. It would not output power when laid in the normal horizontal position on the desk. To solve the problem, the unit was placed on its side for the duration of the survey. The issue was put down to a faulty connection within the unit

There were also cabling issues from the CM2 counting block to the CM2 laptop - the cable provided was not long enough and had to be extended.

Many of the problems associated with the SSS were attributed to the maintenance and previous use of this particular unit. The towfish had evidently hit the sea bed many times, as it was covered in scrapes; it is likely that repeatedly hitting the sea bed could be responsible for the loosening of the tension dial. When adjusting the transducer head angles further evidence of the towfish hitting the sea bed was uncovered as grating was evident, due to the sand within the towfish.

A boom, provided by BGS, was extended from the starboard side of the vessel to run the 10m multichannel SIG hydrophone away from the ship’s wake (Figure 5). The boom was securely fastened to the base of the A frame using ratchet straps, these aided in quick launch/recovery. The boom was angled downward towards the water surface for optimum hydrophone performance. The hydrophone was looped through the boom and tied off on deck during deployment until the boom was secured, whereupon the hydrophone was released. This method helps avoid the hydrophone tangling with the vessel propellers.

The STB was towed on the port side of the vessel. The STB was launched through the centre of the A frame using a launch/recovery rope from the forward most winch (Figure 4). Then using two tow ropes attached to the STB frame, the tension was adjusted to pull the STB out from the centreline of the vessel, to the port side, to avoid the wash. This was achieved by applying tension to the starboard rope whilst slacking off the port rope. These two ropes were secured to a cleat on the port side of the deck. Care was taken not to place tension on the STB cable, this was achieved by adjusting tow rope tension.

Figure 5 Left: BGS boom and hydrophone.
Right: SSS counting pulley and STB block on A frame. SSS winch on deck.

All deck cables were run thorough auxiliary doors connecting the deck to the wheelhouse. The doors were part of a storage cupboard that could be accessed from the wheelhouse and the deck, making it ideal for cable routing as the main access door could be kept shut. A suitable distance was maintained between the signal and power cables for the STB to avoid crosstalk.

Power to all equipment was provided by an 80kVA generator, which in turn provided 240V, 12V and 24V supply. The CM2 portable winch was powered by a charger box, provided by Sonar Equipment Services. This charged during the day, whilst also providing power, and ran off the mains voltage.

The Trimble NT300D GPS antenna was erected 8.2m forward of the A frame and 0.4m starboard of the centreline of the vessel. The antenna cable was run through into the wheelhouse where the control unit was mounted on Desk 2 (Figure 2 & 3). The output from the control unit was fed into QINSy as described in the QINSy setup section.

2.1.4 QINSy setup

Navigation data were fed into the software package QINSy 8.0 (www.qinsy.nl). Prior to mobilisation QINSy was set up with the appropriate inputs and outputs for each piece of equipment. Line coordinates were also entered and displayed, ready for survey.

During the setting up of QINSy there was only one issue of note. At first when the fix numbers and GGA string were set up to output to the CM2 laptop there was an issue with a conflict between USB drivers for the mouse and data input drivers. This was solved by restarting the QINSy machine.

Coda was set up during mobilisation for the STB calibration; the settings are described in the survey section (2.3) of this report.

All systems were up and running by 1800 on the 9th March 2010.

2.2 STB CALIBRATION

For quality control purposes BGS were requested by the MALSF to perform calibration tests of the surface tow boomer (STB) system prior to and at the end of the survey. This was to confirm that boomer data was consistent throughout the duration of the survey and that the unit was operating within expected ranges.

2.2.1 Pre-cruise

The first calibration test was carried out on Monday 8th March 2010 at Shoreham harbour, once the equipment had been mobilised on to the survey vessel. The plate under test was the BGS owned Applied Acoustics Engineering AA300 plate (s/n 2080050). Section 2.2.2 of the report details the trials undertaken on Thursday 18th March after the conclusion of the project. This involved a repeat test for the BGS plate and additional tests on another AA300 plate, which was hired from Sonar Equipment Services (SES) during the course of the survey.

A brand new calibrated hydrophone (Neptune D70) was hired from GSE Rentals, Aberdeen, for use in all the trials.

The D70 hydrophone was suspended exactly 1 metre below the plate for these tests. The output pulses were captured using a PicoScope PC oscilloscope on a laptop allowing easy digitising and printing of the results. The PicoScope operation was verified visually by viewing shots on a Philips PM3382 oscilloscope to confirm similar displays.

The surface tow boomer and hydrophone were deployed as per survey operations. Crosstalk between the boomer and hydrophone cables was minimised by maintaining as much separation between the cables as the routing into the vessel wheelhouse would allow. The CSP-2400 power supply was set to a 10 second trigger via a Coda DA2000 unit.

For the majority of the survey, the surface tow boomer was operated on the high frequency setting, running at 100J. The system was occasionally run on the low frequency setting or at either 50J or 200J in an attempt to improve data quality, but ultimately was switched back to the 100J/high frequency settings. Details of these changes can be found in Appendix 3 – Survey Log. The resulting graphs from the pre-cruise tests are shown in Figures 6 -9.

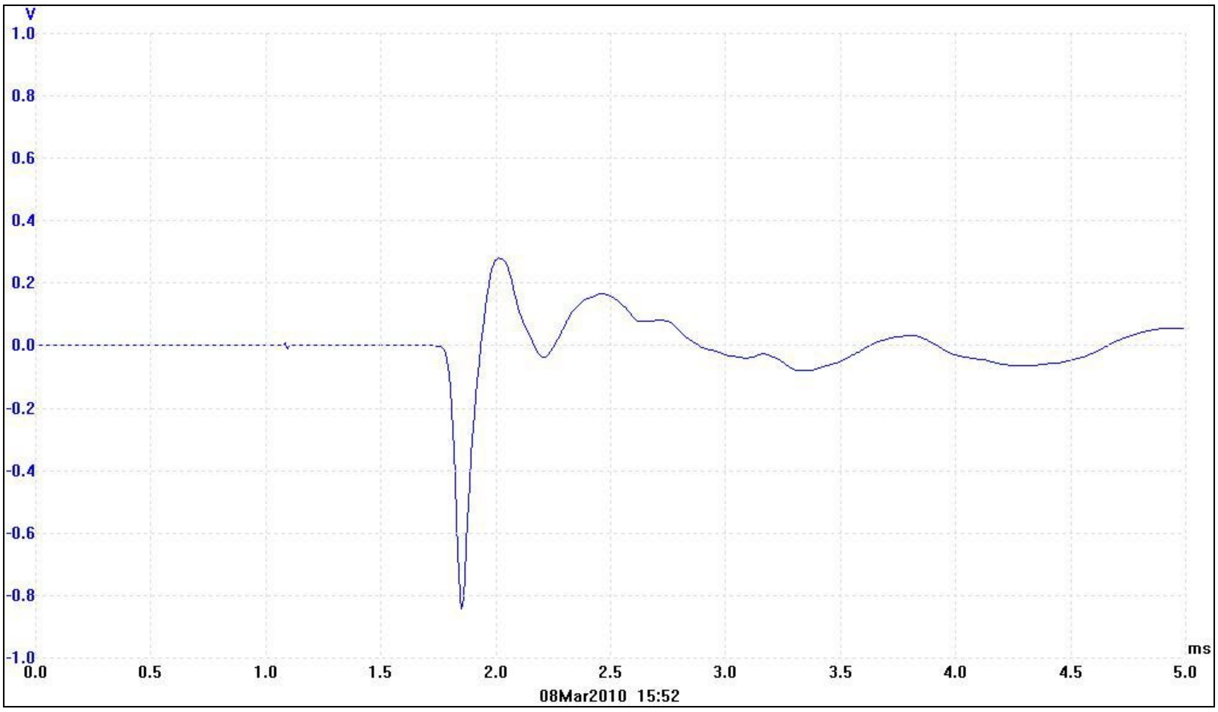


Figure 6 BGS AA300 Plate at 100J. Scale: +/- 1V. 08/03/2010 – pre-cruise.

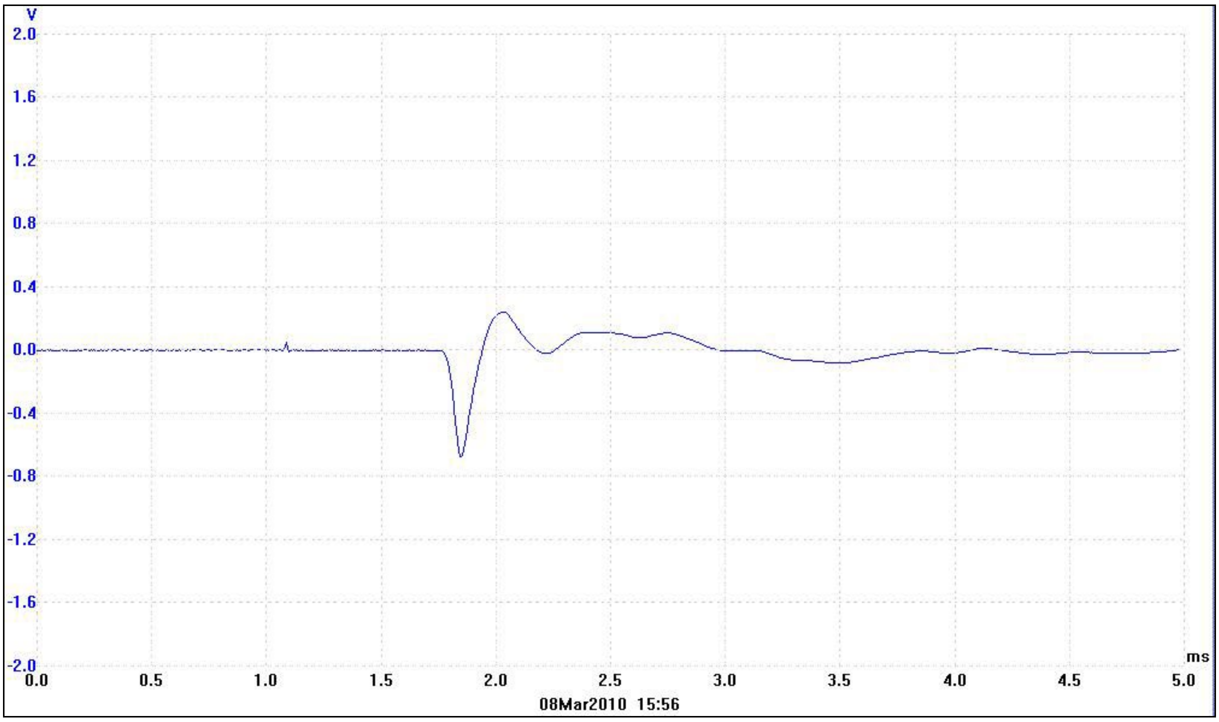


Figure 7 BGS AA300 Plate at 100J. Scale: +/- 2V. 08/03/2010 – pre-cruise.

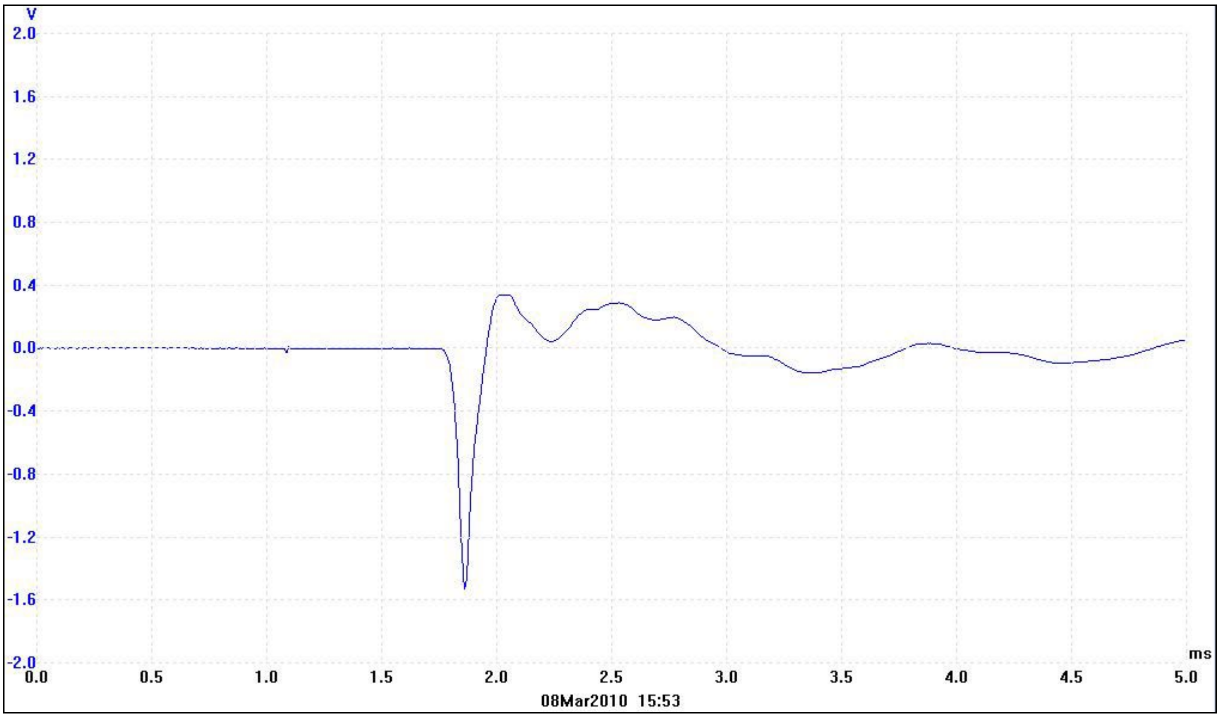


Figure 8 BGS AA300 Plate at 200J. Scale: +/- 2V. 08/03/2010 – pre-cruise.

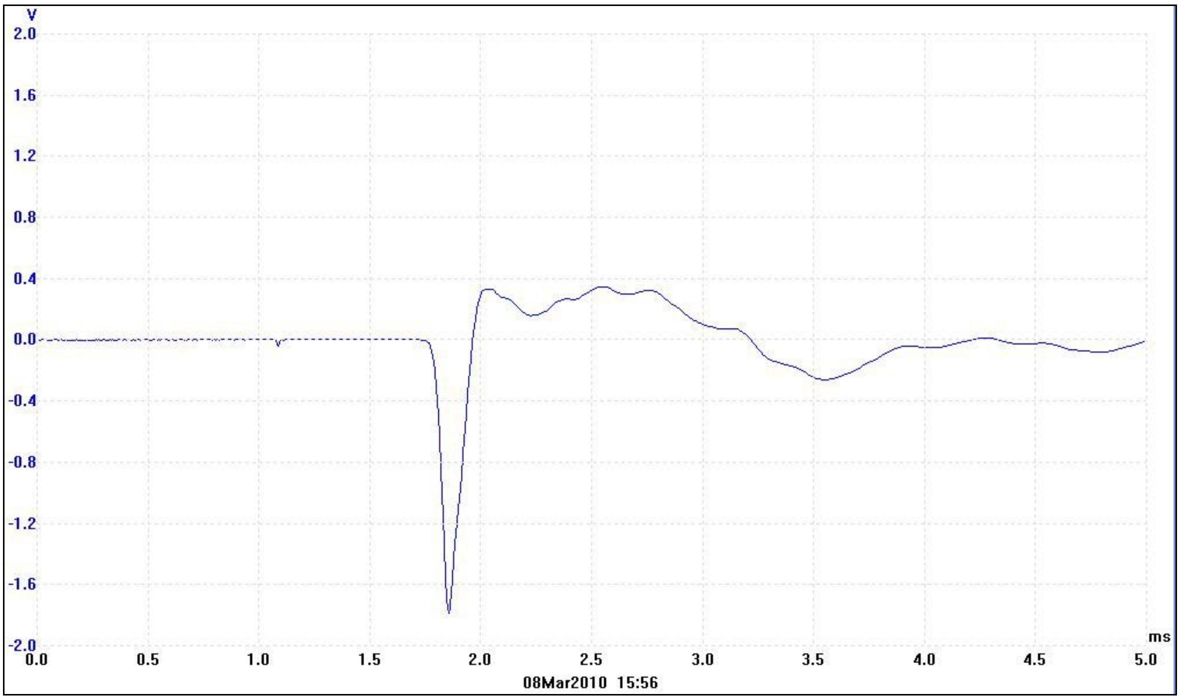


Figure 9 BGS AA300 Plate at 300J. Scale: +/- 2V. 08/03/2010 – pre-cruise.

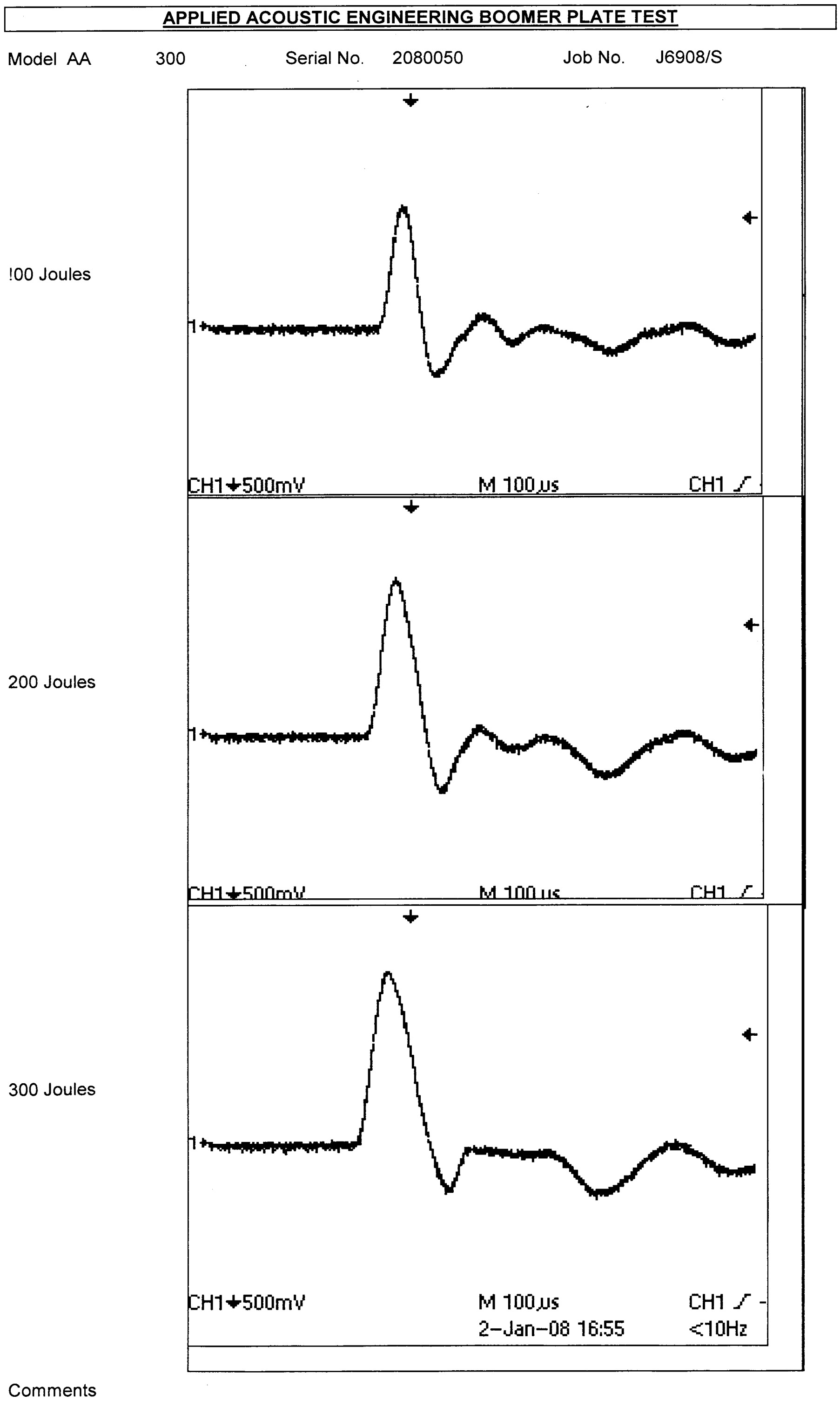


Figure 10 Calibration data for the hired Sonar Equipment Services boomer (provided by SES pre-cruise)

Figure 10 shows a scanned image of the calibration data provided by Applied Acoustic Engineering on the delivery of the AA300 plate in January 2008. The pulses shown here have the correct orientation; the hydrophone hired from GSE had reversed electrical connections.

2.2.2 Post-cruise

These tests were carried out after the completion of the survey cruise on the 18th March, using the same configuration and calibrated hydrophone as the pre-cruise test. In addition, a second boomer plate was tested. This was another Applied Acoustics AA300 plate which was brought in mid-way through the survey at the request of the Science Party Chief. The results from both tests are almost identical and are shown in Figures 11 – 18.

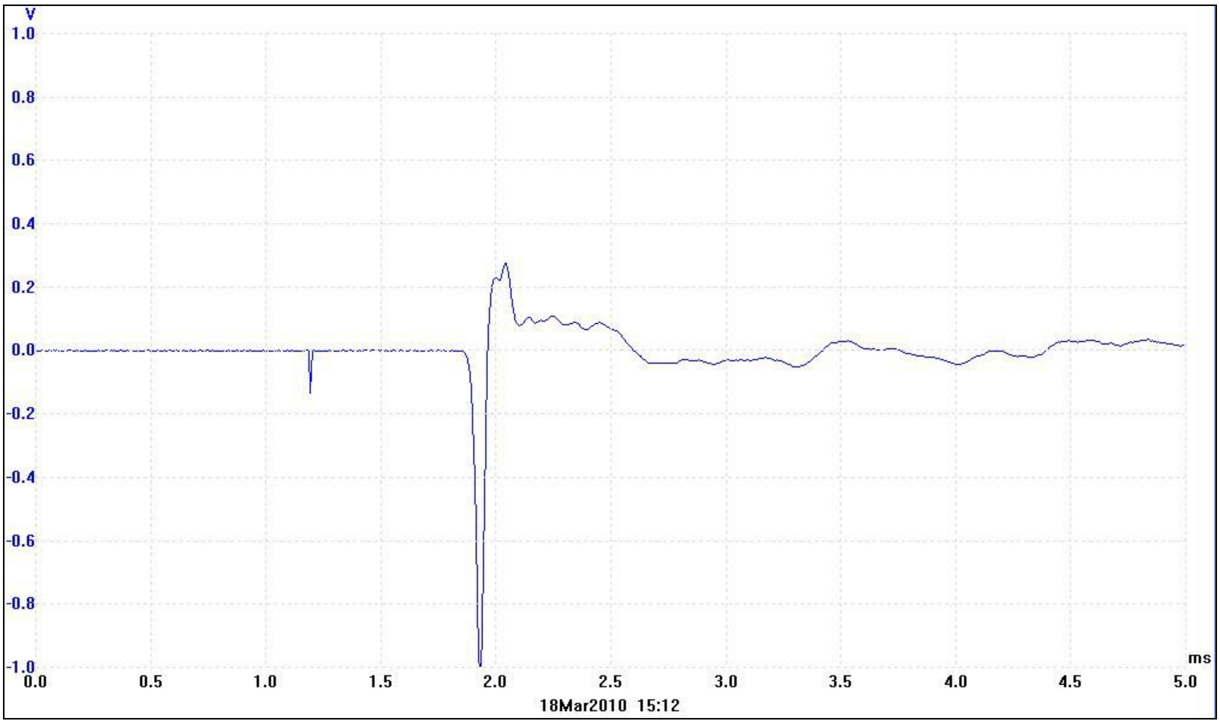


Figure 11 BGS AA300 plate at 100J. Scale: +/- 1V. 18/03/2010 – post-cruise.

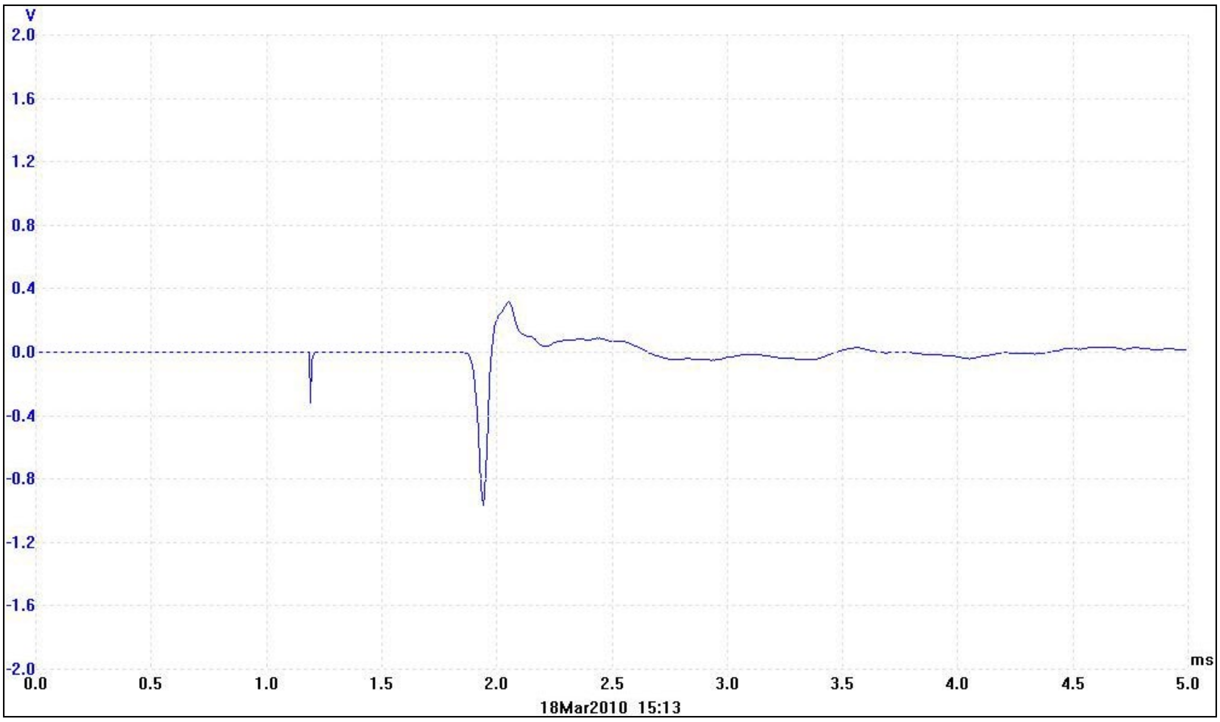


Figure 12 BGS AA300 plate at 100J. Scale: +/- 2V. 18/03/2010 – post-cruise.

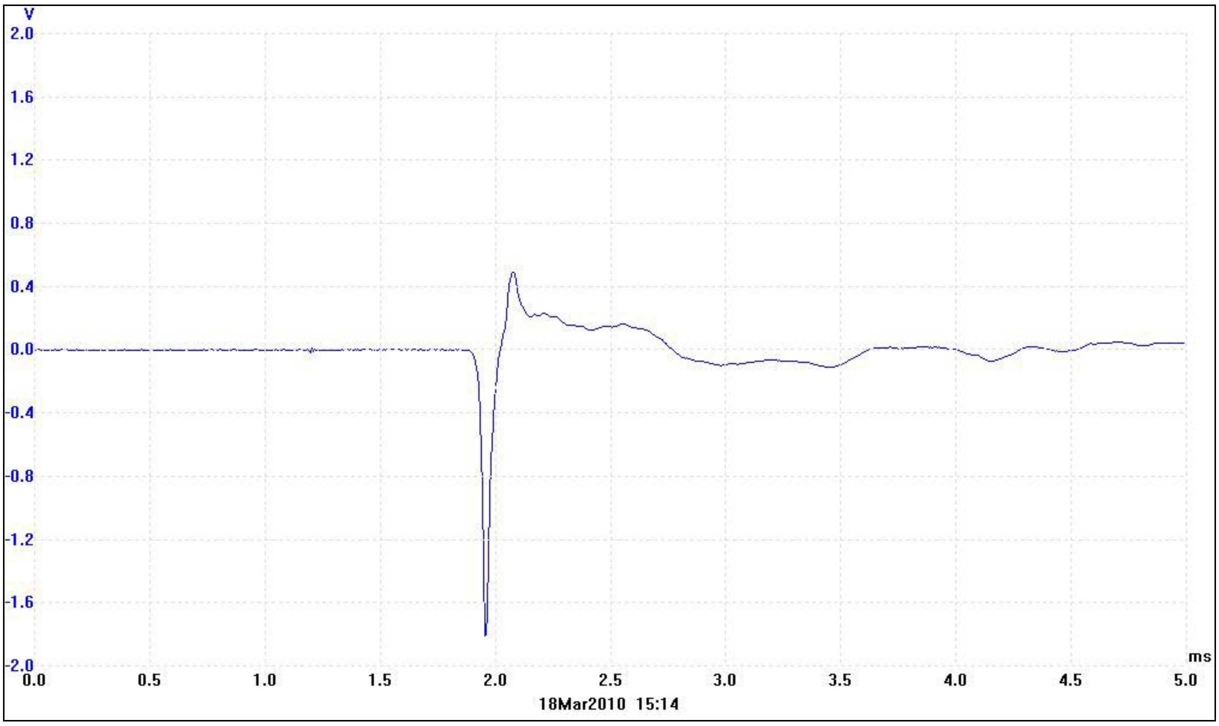


Figure 13 BGS AA300 plate at 200J. Scale: +/- 2V. 18/03/2010 – post-cruise.

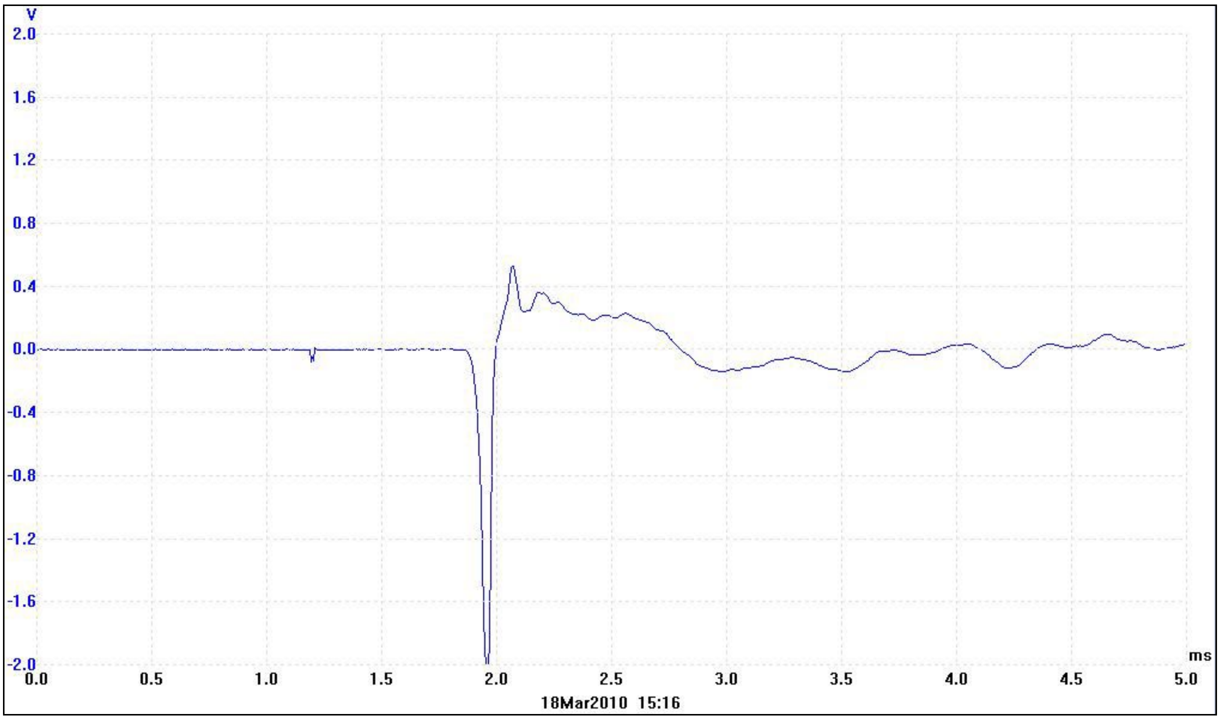


Figure 14 BGS AA300 plate at 300J. Scale: +/- 2V. 18/03/2010 – post-cruise.

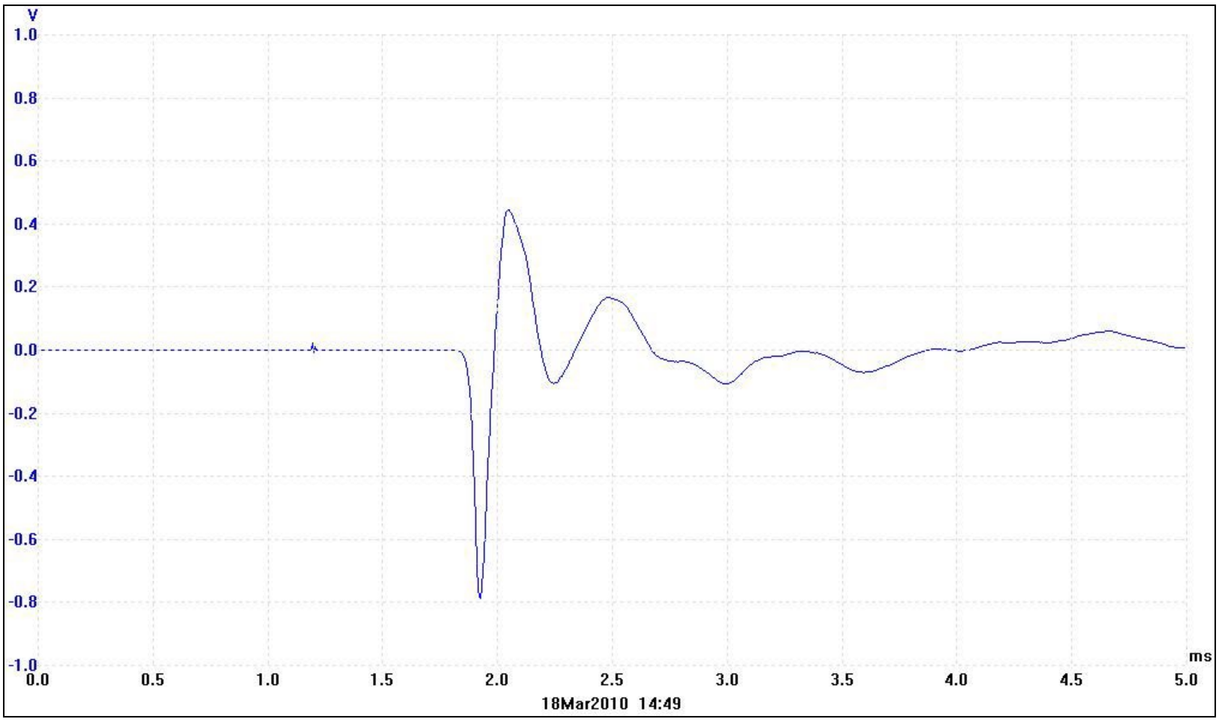


Figure 15 SES AA300 plate at 100J. Scale: +/- 1V Scale. 18/03/2010 – post-cruise

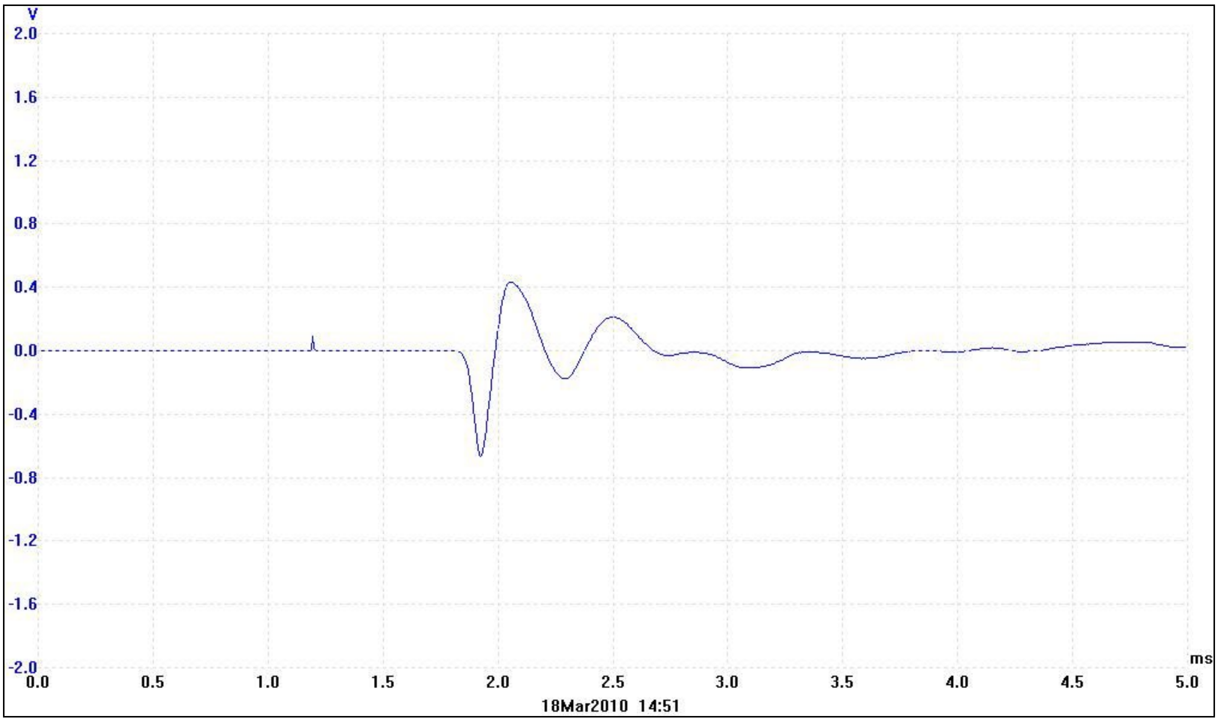


Figure 16 SES AA300 plate at 100J. Scale: +/- 2V Scale. 18/03/2010 – post-cruise

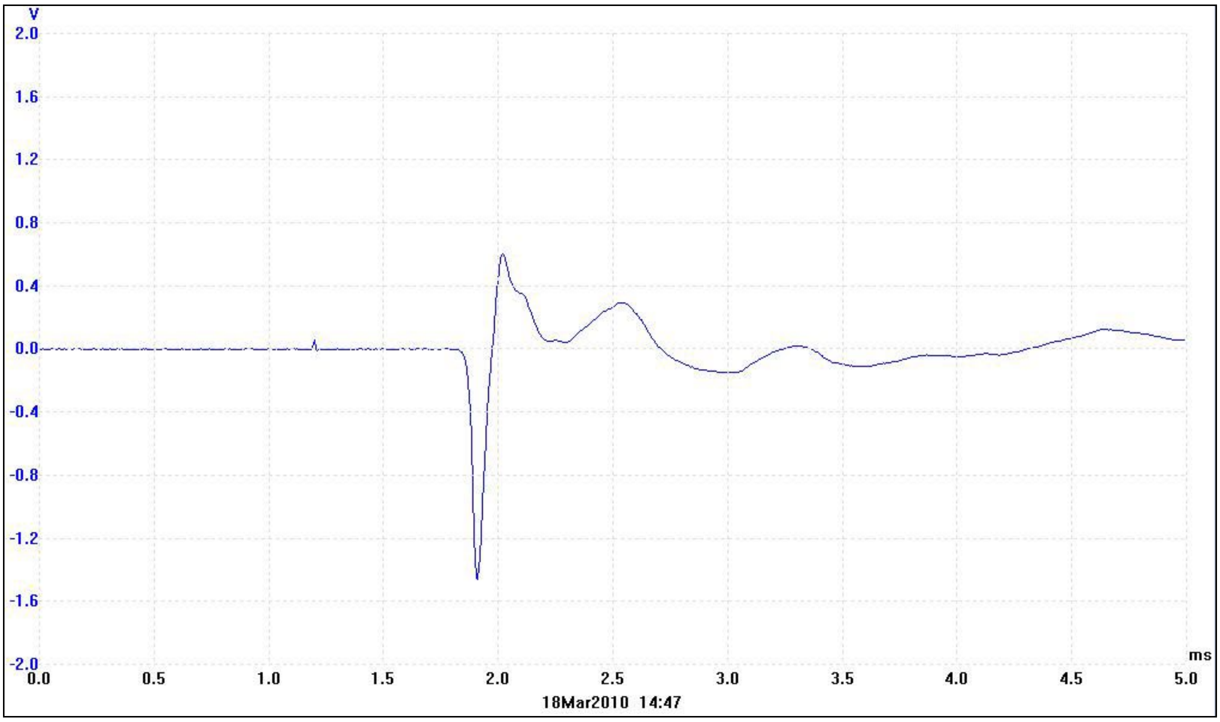


Figure 17 SES AA300 plate at 200J. Scale: +/- 1V Scale. 18/03/2010 – post-cruise

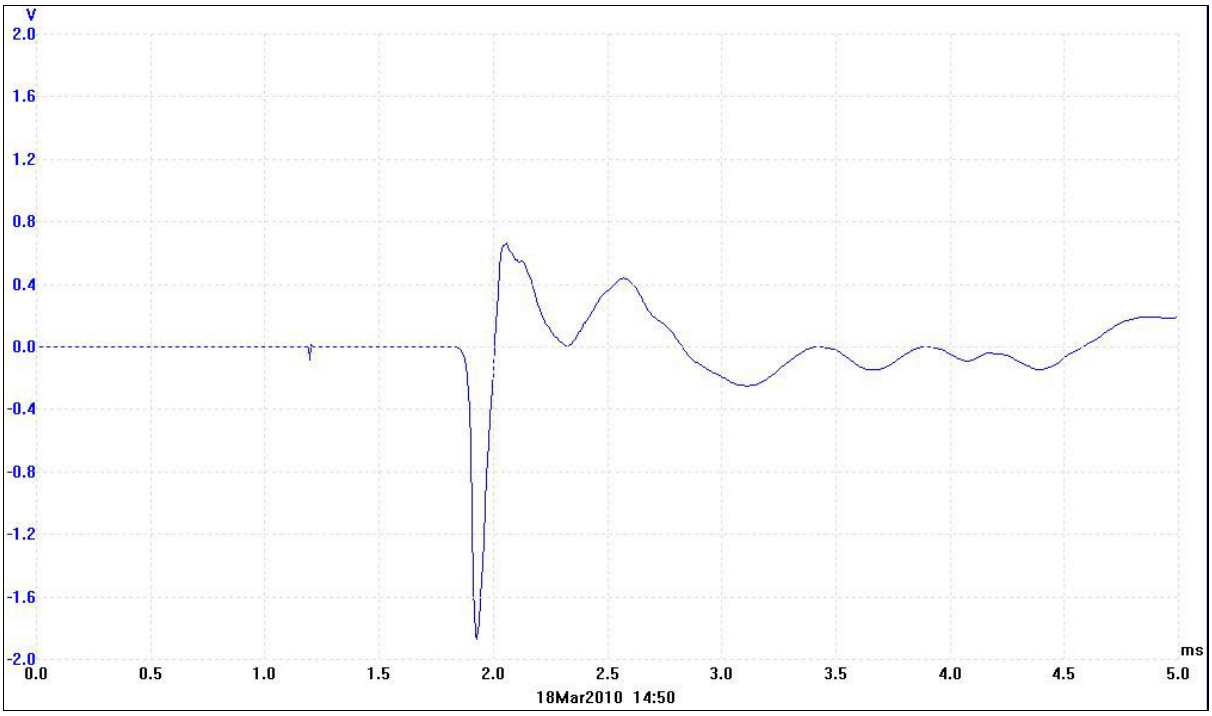


Figure 18 SES AA300 plate at 300J. Scale: +/- 1V Scale. 18/03/2010 – post-cruise

2.2.3 Post-cruise tank test

An in house discussion was carried out due to the concerns about the 5ms pulse width. It was during these discussions that a concern was raised about the shape of the pulse in the original tests. After consulting Applied Acoustics (www.appliedacoustics.com) a further pulse test was carried out by BGS Marine Operations staff at Loanhead in the test tank. The results showed no issue with the boomer operation.

The following figures are screen shots of the pulse at 100J, 200J and 300J on high and low frequency settings:

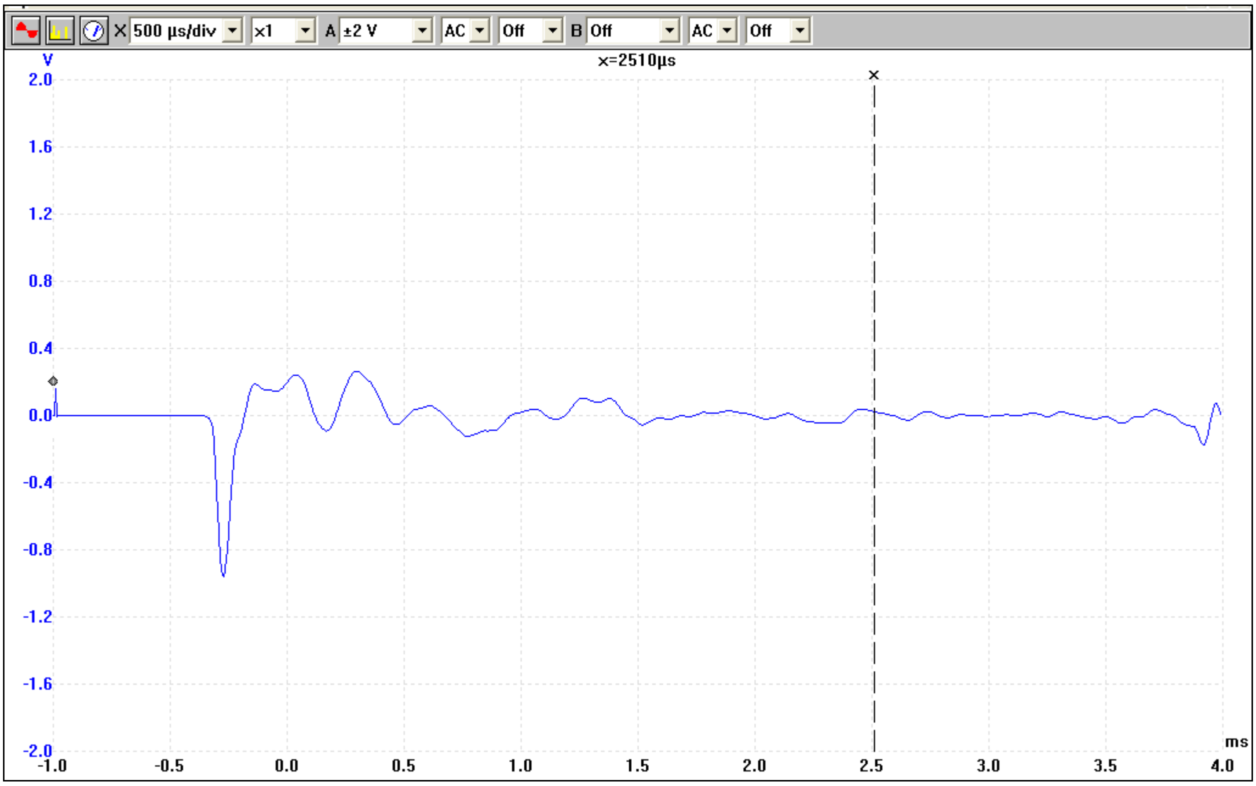


Figure 19 BGS boomer pulse test at 100J. High frequency. Scale: ±2V and 500µs/div.

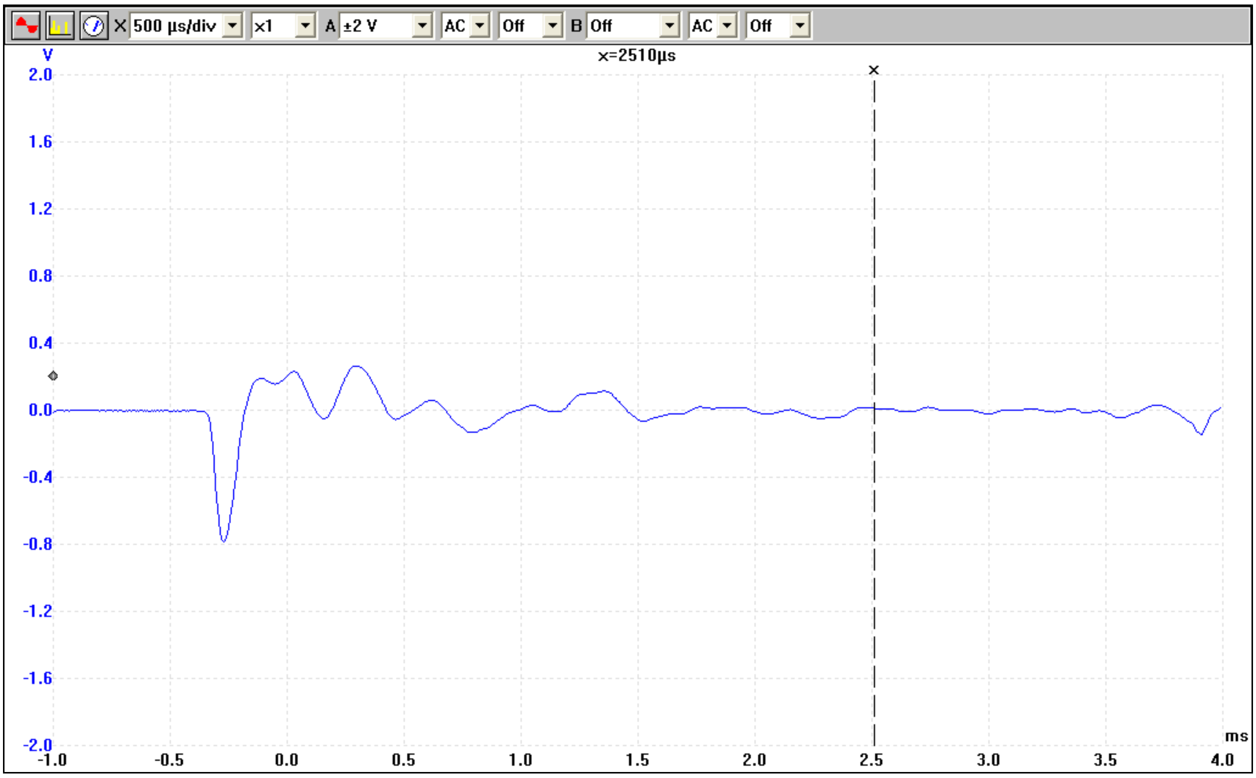


Figure 20 BGS boomer pulse test at 100J. Low frequency. Scale: ±2V and 500µs/div.

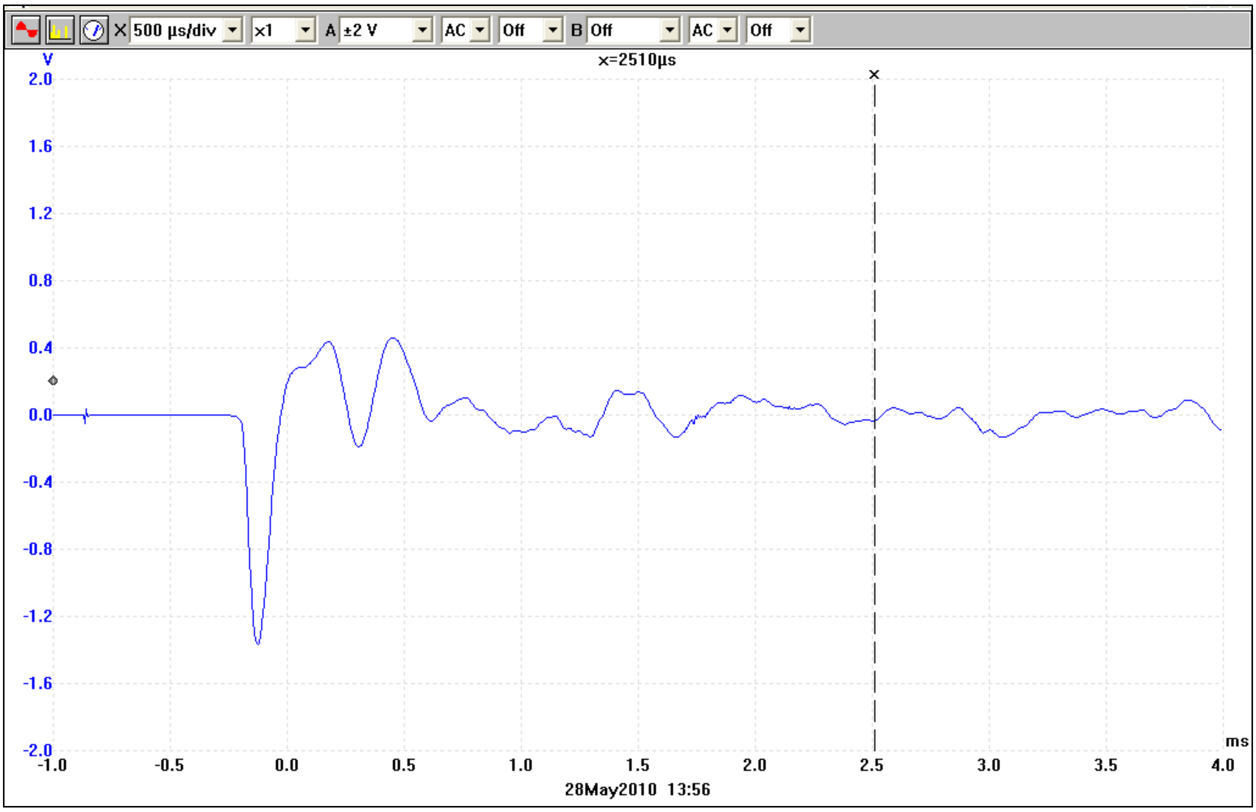


Figure 21 BGS boomer pulse test at 200J. High frequency. Scale: ±2V and 500µs/div.

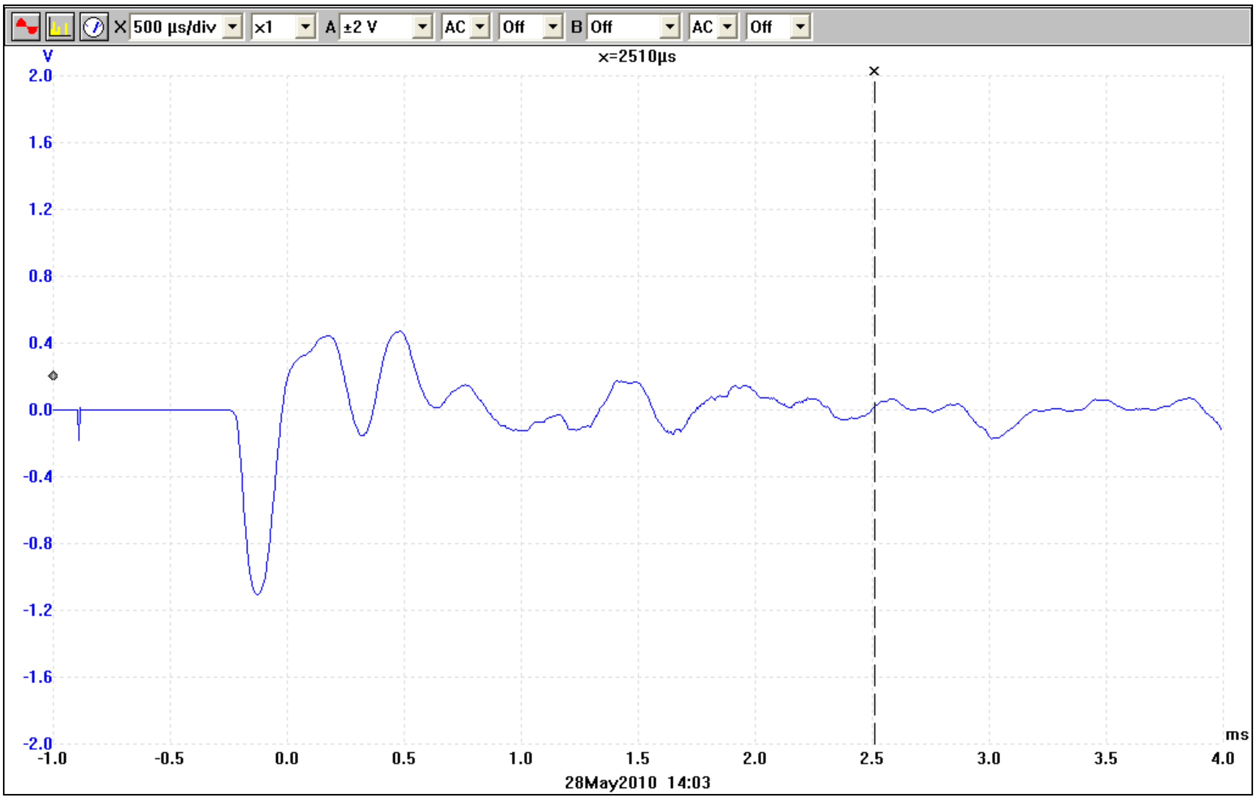


Figure 22 BGS boomer pulse test at 200J. Low frequency. Scale: ±2V and 500µs/div.

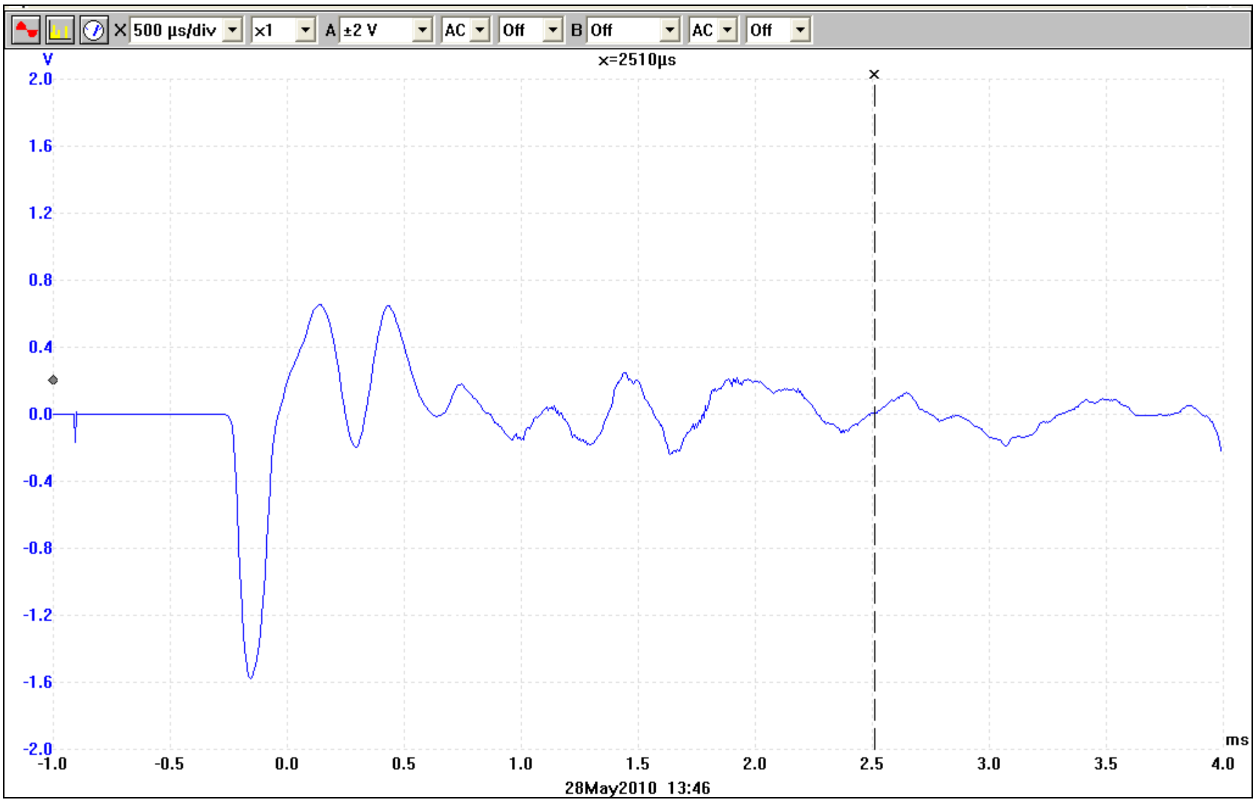


Figure 23 BGS boomer pulse test at 300J. High frequency. Scale: ±2V and 500µs/div.

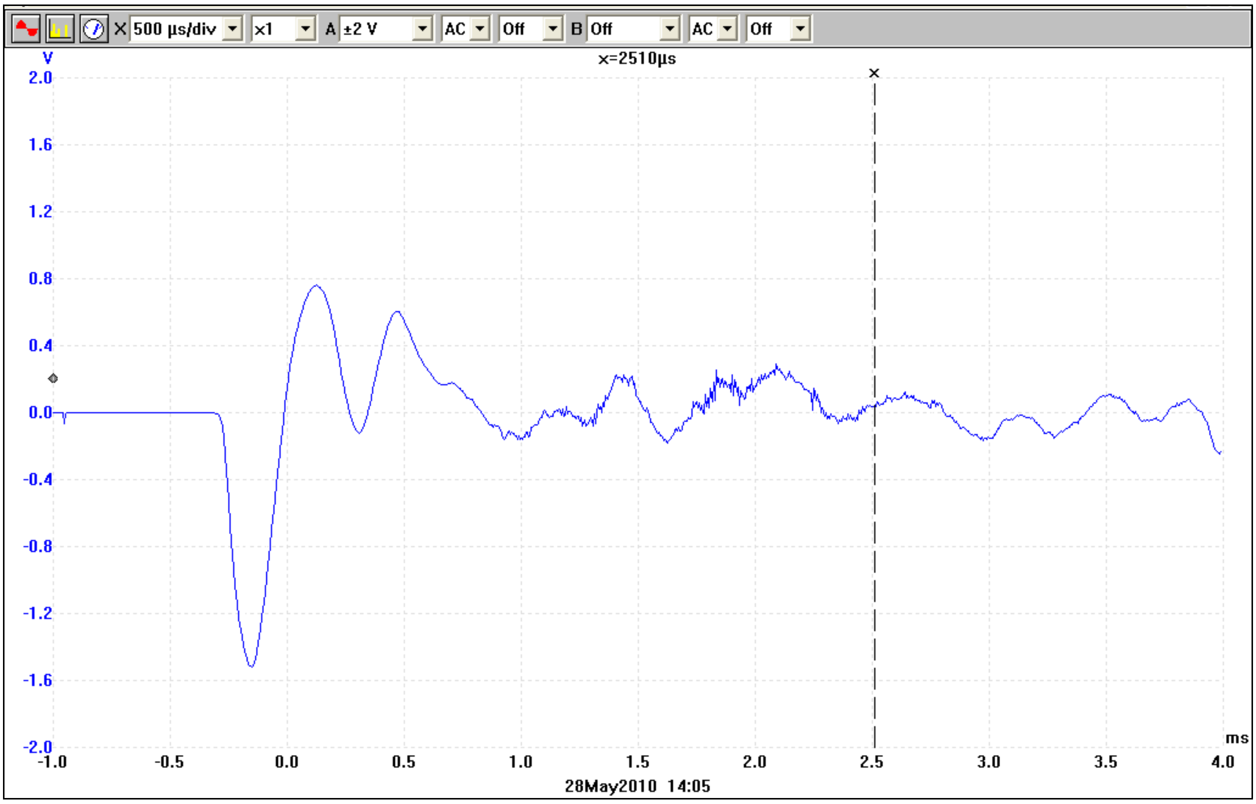


Figure 24 BGS boomer pulse test at 300J. Low frequency. Scale: ±2V and 500µs/div.

2.2.4 Equipment details

D70 Hydrophone serial number:	20555
Hydrophone sensitivity:	-198dB re 1V/µPa
Hydrophone depth:	1m below plate
HV Power Supply (CSP2400D) s/n	2030405
BGS AA300 plate s/n	2080050
SES AA300 plate s/n	B727
Plate depth:	180mm
Water Type:	Salt

2.3 SURVEY SETTINGS

2.3.1 QINSy settings

Inputs

GGA from NT300D: COM 1 with PPS at 9600 8N1.

Outputs

GGA to Coda: Coda output driver, 9600 8N1

Fix number to CM2 laptop (COM 6), 9600 8N1, every 5 minutes.

GGA to CM2 laptop (COM 5), 9600 8N1.

The GGA string, sent to Coda from QINSy, was originally decoded by Coda as UTM zone 30N and was set up to display WGS84 Lat/Long. Raw QINSy nav text files are in WGS84 Lat/Long. The survey area is in UTM zone 31N therefore the Coda data was subsequently converted to UTM zone 31N using corrected navigation files, these were produced by replaying the QINSy database files for each line in UTM zone 31N, these files were then formatted and applied in Coda.

A GGA string plus fix numbers was also sent to the CM2 sidescan, this was in WGS84 Lat/Long.

2.3.2 Coda project settings:

Many of the settings within Coda were varied throughout the survey. Changes were recorded in the log book and will be discussed further on in this report. The initial project settings were as follows.

Project folder: Southcoast

<u>Open Acquisition:</u>

- Channel 1 only
- Trigger A
- ±5V
- Seismic
- Custom SBP
- Sample freq = 12,000Hz
- Samples/Ping = 1800
- Start delay = 0 ms
- Total Sweep time = 150 ms.

<u>Filters:</u>

Filter 1 – Low Pass

- From: Sensor
- To: End of Data
- Frequency design parameters: Cut off: 2000Hz
- Filter order 2.

Filter 2 – High Pass

- From: Sensor
- To: End of Data
- Frequency design parameters: Cut off: 800Hz
- Filter order 2.

Filter 3 – Band Pass

- From: Sensor
- To: Seabed +0.0ms
- Frequency design parameters: Low cut off = 1800Hz, High cut off = 2000Hz
- Filter order 2.

TVG – TVG line made up of 4 points, applied to all channels from the minimum displayed value.

3 Navigation

Navigation data was provided by the Trimble NT300D unit. This 12 channel unit, capable of 5Hz position update, provides standalone DGPS with its integrated beacon/receiver capable of sub meter accuracy.

Projection: UTM zone 31N

Reference Spheroid: WGS84

Time zone: GMT

Raw navigation values from QINSy, were in WGS84 lat/long. For Coda, navigation information is in UTM zone 31N meters.

Two navigation strings were sent from QINSy to the C-MAX laptop, one string contained fix numbers, whilst the other was a GGA string containing position in WGS84 lat/long.

The Trimble antenna was mounted on a threaded pole and zip tied to framework 8.2m forward of the A frame and 0.4m starboard of the centreline. It remained here throughout the survey with reasonable visibility to satellites. Throughout the survey there were several incidents with the GPS dropping out. This appeared to occur for no apparent reason but possibly because some satellites in certain constellations were blocked by the radar and mast of the vessel. Points where the GPS dropped out can be identified in the nav text files from QINSy, where particular lines have several 'parts' to them, each new part was created when QINSY was stopped and restarted due to a new database being created. QINSy were contacted after the survey about this stopping and restarting every time navigation information drops out, they have said the problem will be fixed for their next software release.

4 Geophysical Survey Equipment

4.1 SURFACE TOW BOOMER (STB)

The equipment associated with the STB used on this survey are listed below:

- AA300 boomer plate
- CSP-D 2400 power source
- Coda DA2000
- SIG hydrophone
- BGS amplifier
- Thermal printer
- PicoScope PC oscilloscope

50-200J was generated and supplied to the boomer plate from the CSP-D 2400. The STB, towed from the port side of the vessel (Figure 25), fired between 500ms-200ms consistently throughout the survey, never missing a shot. Firing rates were altered based on the sea bed type, depth and structure.

Reflections were picked up via the 10m multichannel SIG hydrophone towed from the starboard side of the vessel, 2-3 channels of a possible 7 were active, the channels used varied throughout the survey, channels 1-3 were used mostly, there were occasions however when channels were switched to 5-7. The hydrophone depth was varied using an electronic air pump when necessary.

The signal was fed through the BGS amplifier in which the gain, pre and post filter, was altered to optimise the output. The seismic data was fed into the Coda DA2000 system where filters and further gain controls, including time varying filter (TVF) and time varying gain (TVG), were applied to further optimise the image output. Filter settings etc can be found in the .set files within the folder structure. Analogue traces were printed out via the thermal printer with scale lines, fix numbers and positions added. Files were recorded in .cod format, the Coda proprietary file format.

Figure 25 BGS surface tow boomer (STB) deployed in water.

4.2 SIDESCAN SONAR (SSS)

The equipment associated with the sidescan sonar is listed below. Figure 26 shows the system on deck. All equipment was hired from Sonar Equipment Services (SES), Great Yarmouth.

- C-MAX CM2 towfish.
- CM2 sonar transceiver unit.
- CM2 portable winch.
- CM2 laptop with MaxView software.
- Charger box for winch power.
- Counting block.
- CM2 winch charging unit.

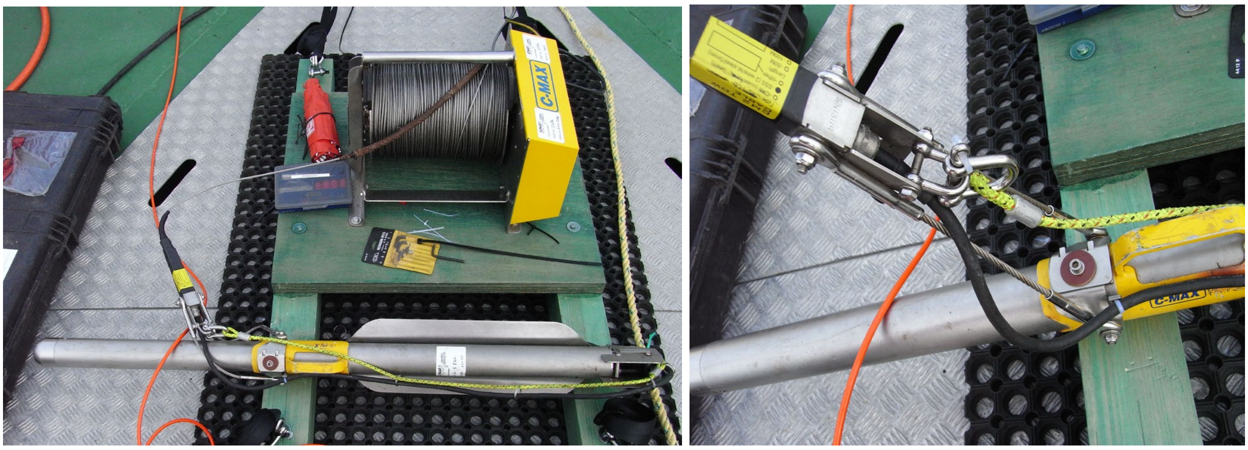


Figure 26 C-MAX CM2. Left – winch and towfish with wooden mounting frame. Right - towfish safety lanyard and towing bracket.

The CM2 is a true digital system, with the images being digitised in the towfish. Unlike sidescan sonars that rely on analogue towfish telemetry there is no loss of image quality in the cable. The transducers on the towfish are protected by wide wings. These also maintain pitch of the towfish and act as acoustic reflectors, primarily for the high frequency beams, cutting down the signal in the upper side lobes by 20dB. This significantly reduces interference by surface echoes in shallow water.

The transducers have a unique configuration that includes an additional pair of depressed short arrays that ensure good coverage directly below the towfish; these also act as an echo sounder to allow the towfish to measure altitude automatically, the value of which is displayed in the software (www.cmaxsonar.com).

The CM2 winch, which holds 300m of cable and weighs less than 50kg, was fixed to the deck via a pre-fabricated wooden frame. The winch was powered from a charger box inside the wheelhouse and was also supplied with a remote control which could be operated from inside the wheelhouse. This proved vital when running lines with varying depths as the altitude could be monitored and altered without moving away from the screen. The only issue with the winch came when feeding the cable back onto the winch, at times it struggled to spool correctly, a spooling device would solve this problem.

The dual frequency towfish was used on this project; it was operated at 325 kHz with a range normally set at 75m either side of the fish. A sonar transceiver unit interfaces the towfish to an external data acquisition computer via a USB link; it makes the sonar appear to the computer as a USB peripheral and also powers the fish.

The counting block proved a useful tool as it was able to monitor and display the amount of cable paid out astern of the vessel. This allowed the operator to make estimates of the horizontal distance of the fish behind the navigation reference point and manually input them into the MaxView software. The counting block was interfaced with the CM2 laptop via a RS232 link; however, a new cable had to be made up for this due to insufficient length.

The MaxView software is a basic package that runs on Microsoft Windows. A simple GGA string was built within QINSy and output to the MaxView via communication ports. Fix numbers were also required, these were again built in QINSy and had to follow the format of $Fxxxx<CR> where the fix number had to be 4 digits. Line coordinates could be entered into the software; however lines had to be added as they were run due to the order not being maintained, when a new line was added it was given priority in run order. The lines were only really necessary if a bitmap image chart was used, on which they would be displayed, however a bitmap for the survey area was not obtained. Sidescan records were saved as CM2 files, the C-MAX proprietary file format, they were then converted into XTF's using a CMA conversion program.

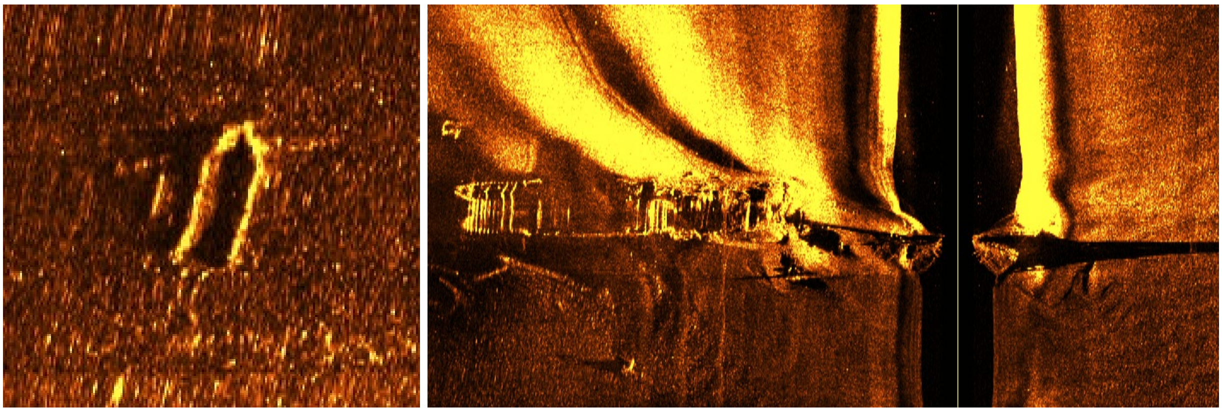


Figure 27 C-MAX sidescan sonar images of wrecks seen on survey lines.

5 Conclusion

For planning and operational purposes a survey plan grid of around 600 km was devised. This was an aspirational figure based on good weather throughout the survey period with no operational problems. In total 353 line kilometres were completed during the survey and although there was some weather downtime the sea state was remarkably good for March on a number of days. Survey time was maximised on these good days because the crew's knowledge and ship's radar enabled survey to continue in darkness late into the evening. This produced a reasonable survey grid coverage in the extension area between Beachy Head and Dungeness. Unfortunately the time lost to weather and issues with the survey equipment did not enable us to complete the planned grid west of Beachy Head.

The surface tow boomer generally provided good penetration and resolution at depths to >25 ms. However, particularly in Tertiary solid bedrock, there were issues with the immediate 5 ms of record beneath the sea bed. There was a consistently wide pulse width and ringing in this top section. For a habitat or archaeological survey, being able to resolve the immediate sub-sea bed is important. In those areas where Chalk bedrock lies at the surface, e.g. around Beachy Head, these issues are not so significant because the relatively wide pulse width would occur in the Chalk; although sediment filled channels should be resolved. However, between Beachy Head and Dungeness most of the sea bed is underlain by a thick cover of sand in banks that are parallel to the shore. The base of this sand unit was well resolved on the boomer records as were foresets within the unit but detail in the top of the unit was not generally well resolved.

The hire of an additional surface tow boomer from Sonar Equipment Services during the survey was undertaken to provide a comparison with the BGS surface tow boomer. However, the SES boomer produced similar results to the BGS boomer. These issues are being further investigated in house to determine a cause and possible solutions to reduce the pulse width and improve sub-sea bed resolution.

Aside from the sea bed pulse issue, all equipment worked well. The SSS, despite early setup problems, provided some interesting data and proved easy to use. The software however proved slightly limiting in its functions. For example, whilst the counting pulley was measuring layback, this value still had to be manually entered every time it changed. If the layback could be automatically updated within the software this would be of great advantage. However, for what the cruise required, it was ideal and C-MAX personnel were very helpful with any concerns or questions raised.

References

JAMES, J.W.C., COGGAN, R.A., BLYTH-SKYRME, V.J., MORANDO, A., BIRCHENOUGH, S.N.R., BEE, E., LIMPENNY, D.L., VERLING, E., VANSTAEN, K., PEARCE, B., JOHNSTON, C.M., ROCKS, K.F., PHILPOTT, S.L. AND REES, H.L. 2007. The Eastern English Channel Marine Habitat Map. Cefas Science Series Technical Report 139. (Lowestoft : Cefas). 190pp.

JAMES, J W C, PEARCE, B, COGGAN, R A, ARNOTT, S H L, CLARK, R, PLIM, J F, PINNION, J, BARRIO FRŐJAN, C, GARDINER, J P, MORANDO, A, BAGGALEY, P A, SCOTT, G, BIGOURDAN,N. 2010. The South Coast Regional Environmental Characterisation. British Geological Survey Open Report OR/09/51. 249pp.

www.alsf-mepf.org.uk/ Marine Environment Protection Fund

www.appliedacoustics.com Applied Acoustics A2201 and AA301 seismic sound source, boomer plates

www.bgs.ac.uk British Geological Survey

www.cmaxsonar.com C-MAX sonar - CM2 side scan sonar system

Appendix 1 Personnel

Party Chief: Ceri James

Surveyor: Nick Smart

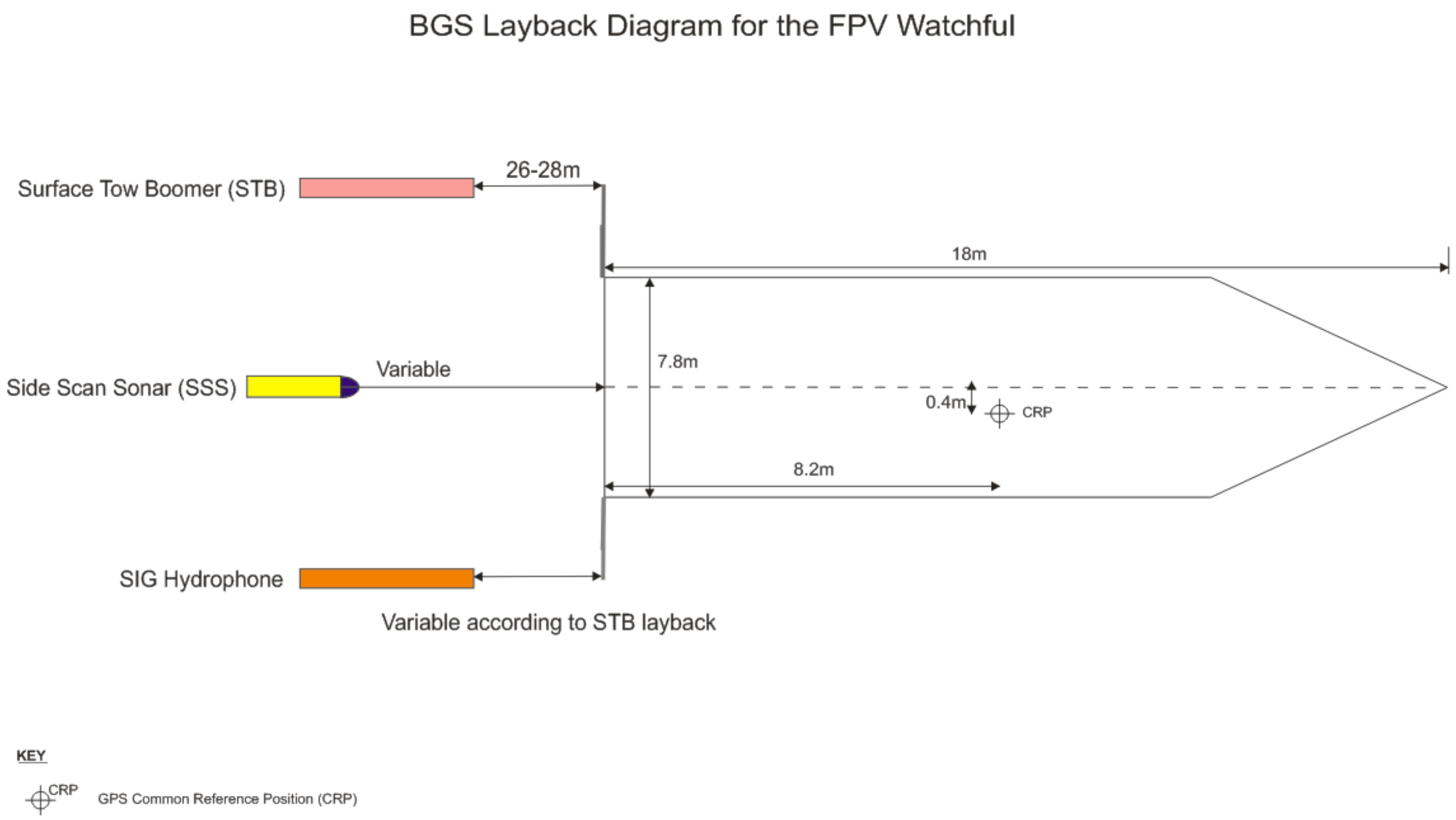
Electrical engineer: Simon Ritson

Wessex Archaeology representative: Stephanie Arnott (15^{th}-16^{th} March only)

Skipper: Charlie Hubbard

Crew: Mark Hayes and Alberto Kavadezlas

Appendix 2 Equipment Layback Diagram



2010_2_MALSF
MALSF South Coast and Eastern English Channel Synthesis Project

Appendix 3 Survey Log.

The following is a narrative of the 2010/02 survey day by day; the notes are taken from the log book which was maintained throughout the survey.

7th March

Arrive at Princes Marine Hotel, Shoreham.

8th March

0800: Commence mobilisation at Shoreham harbour.

1730: Drive to Eastbourne, Sovereign Harbour.

9th March

0930: Arrive at Sovereign Harbour, Watchful delayed in transit from Shoreham. Bad weather resulted in no survey.

Weather: wind = 22knts, wind dir = 030°, Air Temp = 3°C, 2m swell.

1030: Repairs to SSS completed.

1300: Equipment tests, leaving Sovereign Harbour, Systems up and running. Still issues with counting block, new cable made up.

1330: STB deployed to port side of vessel, hydrophone to starboard. Picoscope set to 100ms/div, ±5V.

Bang box firing at 300ms, 100J with a 100ms sweep.

1610: Sea state too poor for decent data, STB and hydrophone recovered. SSS deployed. Receiving backscatter of acceptable quality.

1630: SSS recovered.

1655: Heading back to Sovereign Harbour.

1800: Alongside Sovereign Harbour.

March 10th: Weather downtime all day, NE winds blowing force 5-6.

March 11th

0900: Sovereign harbour waiting for tide.

1115: Leave Harbour

Weather: wind = 20knts, wind dir = 030°, Air temp = 4°C, water temp = 7°C, swell = 0.9m, period = 6 sec.

1350: SOL 2 Dir = W-E (named line 1 in coda and QINSy txt files due to erroneous input). Line names were kept the same as the line plan names on request of Party Chief.

Fix numbers started at 1000 in QINSy due to the MaxView software needing a 4 digit number.

Channels 2-3 on hydrophone used.

1400: Hardcopy (H/C) output stopped due to power cable coming loose.

1410: Band pass changed to 800Hz – 2000Hz, minimal difference.

1423: Scale lines changed to repeat every 1000 lines.

Problems with Coda picking up the difference between direct path from the STB instead of the first return therefore difficult to pick the sea bed. Hence the threshold percentage was increased from 50 – 65%.

Band stop filter (filter 4) added. Sensor to Sea bed, 1800Hz – 2000Hz.

Band pass changed back to 1800Hz – 2000Hz.

This resulted in loss of data in the lower regions of the record.

1530: SSS deployed for tests. Lat/Long from QINSy set to output every 5 seconds (Fix number interval would later be changed to 300 seconds).

16m layback was manually applied in the MaxView software.

1617: Manual fix taken in QINSy (1030) to sync SSS to 5 min fix intervals.

1810: EOL 2, fix 1053.

1900: Alongside at Sovereign harbour.

March 12th

0800: Sovereign harbour.

Weather: wind speed = 12knts, wind dir = 290°, Sea temp = 7°C, Swell = 0.3m, period = 4 sec.

0815: Leaving for line 29.

0957: Boomer and SSS deployed, SOL 29, fix 1054. 75m range applied to SSS.

1012: H/C off briefly due to power cable being knocked.

Display cut to show 20-100ms.

Sandy seabed

Adjust low pass filter = 1000Hz

Adjust high pass filter = 2000Hz

This resulted in worse data, changed back to 2000Hz/1000Hz respectively.

High pass filter change from 1000Hz to 800Hz.

Nav dropping out at start of line

1125: EOL 29, fix 1070. All gear in and heading to Line 24.

Layback measured from antenna to STB = 26m. This was to be applied in Coda at request of Party Chief.

1211: SOL 24, fix 1071. STB and SSS deployed, layback of 26m and 23m applied respectively. Line started at intersection with line 3.

1230: Display changed = 20 – 80ms.

1243: Dog leg to avoid trawler.

1344: EOL 24 fix 1089.

1408: SOL 25, fix 1091.

Display changed to 30 – 100ms.

1519: Display changed to 20 – 100ms.

Fix 1105 on paper record; stop H/C output to changed firing rate.

Firing rate changed to 500ms, fix 1107.

Firing rate changed to 200ms, fix 1109.

1543: Nav dropout, QINSy restarted, manual fix taken = 1115.

1545: Restart fix taken = 1116

1603: EOL 25 fix 1120.

1623: SOL 26 fix 1121.

1706: counting block connection lost.

1755: FSV threshold changed to 55%

1815: EOL 26, fix 1144.

1842: SOL 28, fix 1145.

1854: Offline to avoid trawler.

1909: display start changed from 30 to 20ms

1931: display start changed from 20 to 0ms. Full display = 0-100ms.

2012: EOL 28, fix 1163.

2100: Alongside Sovereign harbour.

March 13th: Weather downtime, wind blowing NE at force 4-5.

March 14th

0830: en route to line 32.

Weather: wind speed = 16knts, wind dir = 260°, air temp = 8°C, Sea temp = 7°C, swell = 0.3m, period 5 sec.

0932: SOL 32, fix 1164.

Bang box set to 50J to start with for test purposes.

Boomer layback now 28m.

Channels 3-4 selected.

0943: Nav dropout, fix 1167.

QINSy restarted, fix 1168.

0959: SSS one fix behind due to Nav dropout, Fix number changed from 1170 – 1172 to sync with QINSy.

SSS remained a fix behind.

Fix 1174: fix output from QINSy to MaxView changed to 1 second to sync fix numbers between QINSy and MaxView.

Fix interval changed back to 300 sec.

Fix 1179: H/C off. Change firing rate (value not recorded), decided against result.

Fix 1180: H/C on. Change back to 200ms.

Fix 1181: Manual fix, H/C off to change sample freq to 20,000/3000Hz

1028: Fix 1183, H/C on.

Fix 1185: H/C off, change sample freq to 12000/1800Hz.

Fix 1186: H/C on.

Fix 1188: Bang box changed from 50 – 100J

Fix 1189: Bang box restarted at 100J.

1112: EOL 32, fix 1196.

1144: SOL 30, fix 1197. Display range set to 30 – 100ms due to water depth.

Settings: 100J, Sampling freq = 12000Hz, samples per ping = 1800Hz, 200ms firing rate.

Party Chief decided to extend line adding in a dogleg, Waypoint added in QINSy in an attempt to carry on recording, however recording still had to be stopped and restarted.

1321: EOL 30, fix 1216

1349: SOL Waypoint, fix 1217.

Fix 1223: EOL Waypoint.

1418: SOL 34, Fix 1224.

1540: low pass = 2000, high pass = 1000Hz

1550: Low pass = 2000, High pass = 800Hz.

Fix 1244: Bang box turned up to 200J

Fix 1245: Bang box restarted.

Fix 1251-52: Nav lost in QINSy.

1712: EOL 34, fix 1262.

1753: SOL 36, fix 1263

Bang box at 100J.

1936: EOL 36, fix 1284.

2045: Alongside at Sovereign harbour.

March 15th

0900: On station for line 10.

Weather: Wind speed = 16knts, wind dir = 310°, air temp = 6°C, sea temp = 7°C, swell = 0.2m, period = 4 sec.

Stephanie Arnott, geophysicist from Wessex Archaeology came on board to look at survey results and procedures as a representative for one of BGS' project partners.

0918: SOL 10, fix 1264.

Bang box at 100J, firing at 200ms.

The Party Chief and partner representative were concerned with the pulse width in the top of the record; this was estimated to be 4-5ms in width and was masking some of the data coming to the surface of the record, possibly put down to ringing or the hydrophone running too deep.

Fix 1274: Coda stopped, SSS and QINSy resumed. STB recovered for a plate check.

Fix 1281: STB back in the water after finding no sign of defects.

1059: Channel 4-5 used.

1400: EOL 10, fix 1323.

It was at this point in the survey that the decision was taken by the Party Chief to hire a new AA330 boomer and single channel hydrophone from SES. The aim of this was to see if there was a difference in the amount of ringing and the pulse width.

1424: SOL 4, fix 1324.

1510: EOL 4, fix 1334.

1659: SOL 5, fix 1335.

Fix 1336-1337, QINSy stopped and line named changed from 7 to 5 due to erroneous input.

1900: EOL 5, extended by 10nm into line 5. Fix 1361.

2030: Alongside at Sovereign Harbour.

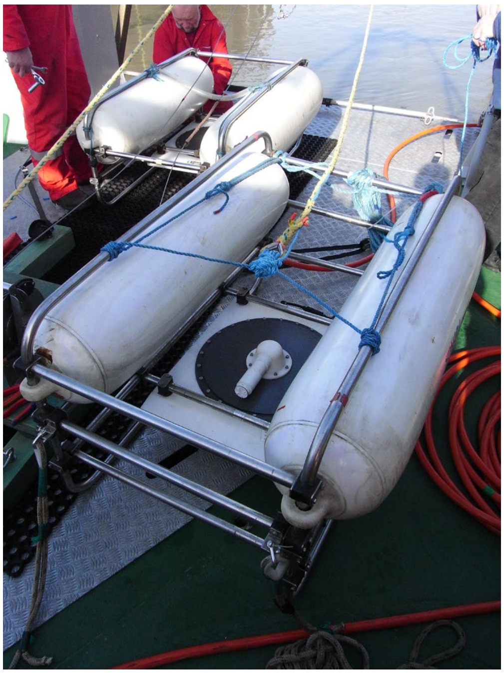


Figure 28 SES STB in the front of the picture with BGS STB in the rear.

March 16th

0800: Sovereign harbour.

The Wessex Archaeology representative was on board once again for quality control purposes.

0855: Pick up Sonar Equipment Services (SES) STB and hydrophone (Figure 28).

0950: On route to line 5 with the aim of rerunning to obtain a direct comparison of data. Line 5 renamed to line 5a.

1007: On station for deployment.

1018: SOL 5a with new SES STB and BGS (SIG) hydrophone.

Fix 1366, Ping rate changed to 330ms on recommendation of the Wessex Archaeology representative.

Fix 1370: H/C output off to change firing rate to 500ms.

Fix 1375: H/C output stopped, Coda recording stopped to replace hydrophone. The addition of the new boomer provided no substantial difference, the pulse width and ringing were still present in the data. Therefore the hydrophone was then replaced as described below.

Fix 1383: SSS only. QINSy recording stopped due to nav dropout.

Fix 1384: QINSy restarted.

With the new SES single channel hydrophone in the water, no signal was being picked up. This was later found to be caused by the incorrect connector being used, the type of which changes when switching between multi channel hydrophones and single channel hydrophones. Therefore the SIG hydrophone was reinstated.

1158: EOL 5a, fix 1389.

1200: Heading to line 9, returned firing rate to 330ms, BGS (SIG) hydrophone back in.

1259: SOL 9.

Firing rate = 330ms, power = 100J.

Fix 1417: Layback extended to try and minimise ringing. No real difference observed.

Fix 1420: At this point the hydrophone was measured at marked intervals to align with the STB as accurately as possible. However the SES STB seemed to ride deeper in the water than the BGS STB. The floats on the SES STB were smaller than the BGS STB yet were expected to hold a larger frame; as a result the floats were barely breaking the surface.

1531: EOL 9, fix 1424.

SES STB was recovered and the towing points were adjusted to help lift the nose of the STB up out of the water.

A layback of 33m was now applied in Coda.

1552: SOL 8, fix 1425.

Note: Points where the Nav in QINSy drops out comes through on the paper record at Fix 0.

Fix 1467-80: Manual fixes due to navigation dropping out repeatedly.

Fix 1487-91: H/C off due to printer cable being knocked. Needs to be reprinted.

2043: EOL 8, fix 1496.

2330: Alongside at Sovereign harbour.

The Wessex Archaeology representative left the survey.

During the tests with the new STB, attempts were made to pump more air into the hydrophone, this worked intermittently as there were issues with the pump/valve, this could have resulted in the hydrophone running too deep, however due to the angle of the boom, the hydrophone should have been running fairly close to the surface consistently.

March 17th

0925: Sovereign Harbour.

1134: SOL 42, fix 1497.

Hydrophone ‘layback’ extended, channels 3-4 used. SES STB still being used with BGS (SIG) hydrophone.

1350: EOL 42, fix 1525.

1428: SOL 21, fix 1526.

Fix 1543-45: Nav dropout.

1625: EOL 21.

At the end of the line a test was carried out to see if the engines contributed to any noise in the data. The engines were turned off at fix 1153, however very little difference was seen.

1641: SOL 7

1925: EOL 7

2030: BGS personnel dropped off at Eastbourne, the Watchful steamed back to Shoreham.

March 18th

Set off from Shoreham Harbour, a series of lines outside of the survey plan were designed, the aim of these lines was to cover a feature known as 'Mikes Mushroom'.

Note: The lines added maintained the numerical sequence, 43-46 within QINSy and Coda. Due to the short length of lines, all equipment remained in the water. For the SSS records, lines 43-46 are all in one file under line 43 as recording was not stopped between lines. QINSy was only sending fix numbers and position to the C-MAX software, so line numbers had to be entered manually, due to the short nature of the lines this proved too time consuming, hence three lines coming under one file. The raw navigation files, because they are from QINSy, maintain line numbering.

1300: Back at Shoreham harbour for final plate calibrations of both BGS and SES STBs and Demobilisation of all equipment.

15.30 Party Chief leaves with hired Sonar Equipment Services STB and C-MAX SSS

1620: BGS Marine Ops personnel en route to Peebles/Howgate.

20.00 Party Chief arrives at Lowestoft hotel

March 19th

02.00: BGS Marine Ops personnel arrive Peebles/Howgate.

09.30 Party Chief delivers hired equipment to Sonar Equipment Services, Great Yarmouth. Discusses quality of boomer records with Les Ford and provides him with digital Coda files.

15.00 Party Chief arrives BGS Keyworth