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RV CALANUS

24 APRIL – 2 MAY 1986

COMBINED IOS WORMLEY, IOS BIDSTON, UNIVERSITY OF EDINBURGH AND SMBA DUNSTAFFNAGE INSTRUMENT TESTING AND EVALUATION TRIALS.

TRIALS REPORT NO. 1

CRUISE REPORT NO. 184
1986

NATURAL ENVIRONMENT RESEARCH COUNCIL
INSTITUTE OF OCEANOGRAPHIC SCIENCES

INSTITUTE OF OCEANOGRAPHIC SCIENCES

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When citing this document in a bibliography the reference should be given as follows:-

GAUNT, D.I. *et al* 1986 RV *Calanus:* 24 April - 2 May 1986. Combined IOS Wormley, IOS Bidston, University of Edinburgh and SMBA Dunstaffnage instrument testing and evaluation trials. Trials Report No. 1. *Institute of Oceanographic Sciences, Cruise Report*, No. 184, 26pp.

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WORMLEY

RV CALANUS

24 April - 2 May 1986

Combined IOS Wormley, IOS Bidston,
University of Edinburgh and SMBA Dunstaffnage
instrument testing and evaluation trials.
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Trials Co-ordinator

D.I. Gaunt

CRUISE REPORT NO. 184

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1 BOX CORER

The IOS box corer is a relatively compact example of this type of deep sea corer, designed to retrieve a short wide core with good preservation of the sediment/water interface. The device has a central box section 30 cm, square by 120 cm long, but the handling frame generally restricts penetration into the sediment to <70 cm.

The corer has twin closing shovels operating in a scissor mode, and is deployed with the shovels open and run into the sediment at low speed (0.25 m/sec). A commercial lifeboat no-load release maintains the shovels open on descent and releases them on penetration, so that the shovels are closed to capture the core before the corer is withdrawn from the sediment. The no-load release is a simple device, but is liable to pre-trigger if descent is not smooth.

IOS Report 106, "The IOS box corer: its design development, operation and sampling" by R D Peters et al, describes experience with the corer up to 1980. Since 1980 the box corer has been used extensively by the IOS Chemistry Group and its university collaborators on several deep sea cruises.

The success of the corer in retrieving good sediment/water interfaces has resulted in a demand for its cores for a variety of geochemical solid phase and pore water studies. In such circumstances corer failure causes problems for efficient programming of scientific work on board. This is especially the case when working in deep water where up to 5 hours of ship time are necessary for a complete box corer run. Since coring on "RRS Discovery" is carried out aft, relatively large excursions are transmitted down the warp to the corer, and the resulting yo-yo effect can cause pre-trip of the no-load release at any point during descent.

In 1985 it was decided to overcome the pre-trip problem by re-designing the corer release mechanism. The solution developed was to use a purpose designed release operated by a modified retractor, fired by a standard IOS 10 k Hz acoustic control system. It was envisaged that as well as solving the pre-trigger problem this would have the additional advantage of permitting faster descent speeds and allow a tilt indicator to be incorporated into the acoustic package attached to the corer.

This new equipment was completed early in 1986 and before use on the "RRS Discovery" Cruise 160 (summer 86) a trial test was required to evaluate the re-designed system.

BOX CORER TRIALS

The equipment was loaded onto "Calanus" on 20 May, and several wire tests of the acoustic package, and the combined acoustic/mechanical release assembly (all without the corer) were made in the Firth of Lorne on the afternoon of 21 May. This was possible by courtesy of Mr Matthew Collins (Department of Geology University of Glasgow) who had the ship for a dredging operation that day.

A successful test of the complete system was made with "Calanus" alongside the SMBA pontoon and a core of the coarse sediment of the dock was recovered. On 21 May "Calanus" moved into Lock Etive, and the first core was taken in the shallow water of Aird's Bay (60 metres). It became clear that the standard 2 minute safety period of the release was too long for coring work because of the drift of the ship while the corer was on the bottom. This core was spoilt by tilt on pull out as was clearly indicated by the tilt sensor.

Following this, the electronics were modified to switch within one minute of transmission (Roy Bowers SMBA had joined us for the day to observe the corer operation and his help with the electronic circuit modifications was appreciated) and three cores were taken successfully from depths of 70-130 metres in the first deep basin of Loch Etive above Bonawe Quarry. Sub-cores of each core were taken for Dr N B Price (Grant Institute of Geology University of Edinburgh) who has a long standing research interest in the sediments of Loch Etive.

In view of the satisfactory progress on the 21st, a further arrangement with Dr Price was activated. He had a requirement for near-interface samples and for sub-cores with which to commission an inert atmosphere pore water squeezing system.

"Calanus" returned to Loch Etive on 22 May and Dr Price and two co-workers joined the ship from Taynuilt Pier. The day was spent coring at the standard Edinburgh University stations in Aird's Bay and the deep basins above Bonawe Quarry. Five in all were taken, but one was lost on deck due to the shovels opening while loading the corer in the deck frame. The remaining 4 cores were sub-sampled by the Edinburgh University team.

2 AUTO-RETRACTOR

The IOS acoustic release system, used on all sub-surface moorings and sea bed instrumented capsules, is operated by either pyros or retractors.

Pyros are a one shot throw away device and retractors after firing have to be opened and fitted with a new internal assembly. To reduce the possibility of operator error and to ensure that a system will be available if ICI stop producing the gas piston used in the retractor design, an AUTO-RETRACTOR has been designed. The auto-retractor provides operators with a recockable device that can be used for over 500 operations without breaking any pressure seals. Recocking takes 30 seconds and the standard retractor plastic parts fit the new design.

The auto-retractor can be used in place of puffas/fuses for pre-deployment wire testing, and is designed to fire in air and to a depth of 6000 metres. The energy to retract the piston is obtained initially from an external spring and below depths of 300 metres from the hydrostatic pressure acting on the piston face.

The auto-retractor can be fitted with a four pin plug giving a normal closed (opens on firing) switch facility, that can be used as an acoustic indicator.

A test mooring was deployed from Calanus on 12 December 1985 in the deep hole (Lynn of Morvern) to observe the long term corrosion problems of the alloy 825 piston with the titanium 125 case material.

For further information contact Dennis Gaunt IOS Wormley

See Appendix III (page 21) for IOS Bidston pressure/firing report

AUTO-RETRACTOR TRIALS

The acoustic transmission and receiving system was set up on "Calanus" on 20 May, and although it was the intention to use the Nagrofax facsimile recorder, problems arose with the attenuation control and it was decided to use the valve Mufax.

The ship was being used by SMBA on the 21 May, but an opportunity arose at the end of Matthew Collins' dredging operation to move to the Auto-retractor test mooring position. The mooring was interegated and the acoustic beacon switched within 2 minutes of transmission. It was too late to attempt a recovery, and after monitoring the beacon until it timed out, the ship returned to the pontoon.

On the 23 May "Calanus" returned to the mooring position where wire testing of various acoustic releases and auto-retractors was carried out at depths of 180 metres. All of these tests were satisfactory , the auto-retractors giving a 100 per cent operational return.

The test mooring beacon was switched on at 1400 hours, and responded immediately to the release signal, by 1405 hours, the release had passed through the firing sequence, but there was no indication that the anchor had been released. The release firing sequence was operated seven times but the mooring failed to part. At 1700 hours it was decided to return to the pontoon and prepare for a drag attempt on the following day.

The ship was required for a NERC/SMBA council inspection on the morning of the 24 May (a demonstration of the box corer and the acoustic system was arranged for the Council members). The test mooring was not reached until 1230 hours. On interegating the mooring there was no response from the acoustic beacon. The transmission system was tested and found to be in working order. Several positions were tried with intensive transmission periods, however there was no response from the mooring beacon. There were two possible explanations;

1 The mooring had been held down by weed (a known problem in the test area) and had been dragged free by the over-night tides.

2 The batteries had run flat.

Of these two alternatives the former was the most likely and it was decided to carry out an acoustic search of the area. The search continued until 1730 hours when it was abandoned. Due to the priority of the remaining trials and the loss of a days work due to south westerly gales no further attempt was made to locate the mooring.

See Appendix 1

3 THE ACOUSTIC DOPPLER CURRENT PROFILER

The profiler is built around a microcomputer based on the RCA 1802 CMOS microprocessor. This controls the sonar transceiver operation and calculates the mean Doppler frequency of the received signal using digital signal processing. After processing the Doppler frequency data, together with the backscatter strength, TVG parameters, spot compass reading, and time information are written to a Sea Data logger.

Trials of the complete system, with free fall deployment and acoustic release of the ballast frame, were required in it's designed for environment. It was also a requirement to measure the backscatter signal in the area.

ACOUSTIC DOPPLER CURRENT PROFILER TRIALS

The current meter rig was a modified "Teleost" frame, used at IOS Bidston for tide gauge deployment. It was deployed in a free fall mode in a water depth of 78 m, 1.58 miles from Lady Rock in the Lynn of Morvern.

It was intended to recover the rig on 31 May but the ship was unable to sail due to south westerly gales and poor visibility. The weather had improved on 1 June and the rig was recovered without any problems by 1020 BST.

The Doppler sonar was configured to record the North and East components of current in ten 6.3 m high cells, every 12 minutes. The preliminary data analysis showed that the instrument had functioned correctly and the backscatter signal returns were high.

Peter Foden)
Bob Spencer) IOS Bidston
Dave Platt)

4 MARK AND RECAPTURE AMPHIPOD TRAP

One way in which food is supplied to the deep sea floor is in the form of carcases of large organisms previously swimming in the water above. As soon as these carcases reach the sea floor, they attract large numbers of scavengers which devour the flesh with great speed, even a large dolphin only lasting a few days.

One of the most important scavengers are shrimp-like organisms called amphipods, an example of which is shown in Fig 1. These have very well developed mcuth parts and are often 1-10 mm long but can be up to 300 mm in the same areas. At present their significance in the deep sea ecosystem can not be determined however, as it is not possible to capture them quantitively in trawls, sledges or in baited traps. If the area from which they are drawn to a trap, is known however, their abundance could be calculated and the significance of this particular energy flow could be assessed.

The object of the mark and recapture experiment is to determine the distance an amphipod can swim in order to reach a piece of bait and from this information and other simple trapping experiments, the abundance of these scavengers can be calculated.

The procedure is that amphipods will be captured in the trap without feeding them. These animals will then be dyed so that they can be distinguished from the rest of the population. Once dyed they will then be moved (trap 1) a known distance (30-600 m) from the original capture rig. In the meantime a second trap (trap 2) which is part of the original rig is opened to expose some bait. The dyed amphipods are released (trap 1) and will swim to trap 2 if they are within range. By varying the distance between the release site (trap 1) and recapture site (original rig), information will be obtained on their foraging range and hence an estimate of their abundance can be made.

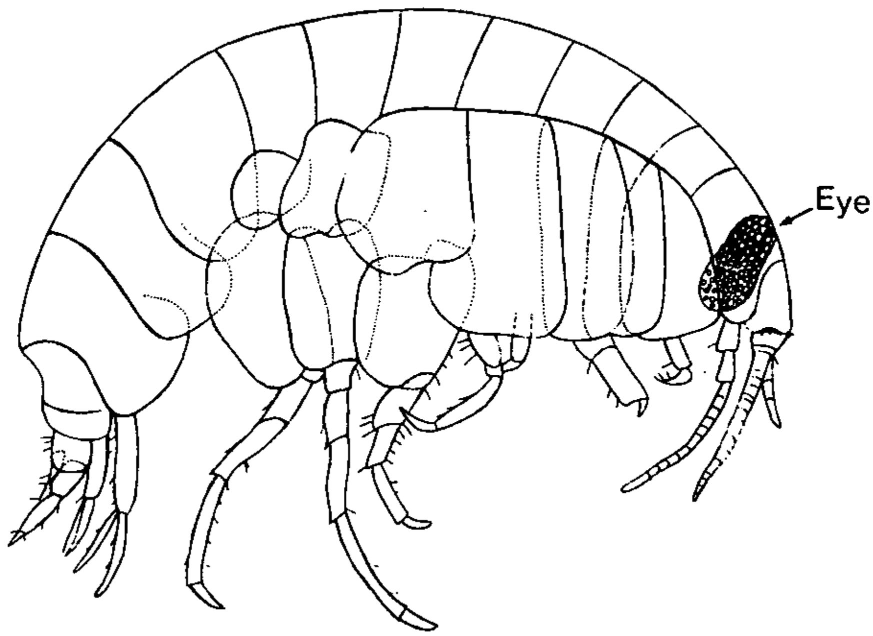

Fig 1 ORCHOMENE LIMODES - An Amphipod

The Amphipod trap is due to be operated by the French manned submersible 'Cayana' at depths of 1500/2000 m on the Porcupine Seabight, during August 86. To ensure the reliability of the overall design prior to deployment from the French ship "le Suroit" the following trials were carried out.

1 Mechanical operation of the amphipod marking and dispersal system (trap 1) and associated valves to be operated by the submersible.

2 Mechanical operation of the amphipod recapture system (trap 2) submersible operation.

3 Operation of the seawater/dye pump-timer system (in conjunction with 1).

4 Operation of the timer initiated 'Auto-retractor' to release the anchor weight.

5 Submersible operated release of the anchor weight.

6 Negative and positive buoyancy of the rig.

7 Techniques of rig deployment and recovery.

8 Use of the anchor weight alignment jig for repeated rig operations.

MARK AND RECAPTURE AMPHIPOD TRAP TRIALS

To check the operation of the trap on the sea bed a diving team was used to operate the valves and carry out the tasks that the submersible would have to undertake. SMBA restricted the depth to a maximum of 10 m for the type of work the divers would be carrying out.

After several delays due to south westerly gales the trap was deployed in a free fall mode in Ardmucknish Bay, the depth as recorded by the divers was 6 m.

DIVE PLAN

1 Diver 1 down rig buoy line, diver 2 down ballast buoy line, lay weight on sea bed and swim to rig.

2 Attach ballast buoy line to rig with shackle and wire.

3 Check pump is working, if necessary clear airlocks.

4 Close valve A.

5 Open valve B.

6 Observe flow of dye into trap 1.

7 Observe collapse of reservoir.

8 Remove trap 1 retaining pin.

9 Pull trap 2 opening handle and observe trap 2 opens immediately.

10 Lift trap 1 clear of rig.

11 Hold trap 1 horizontally, open lid and purge trap by horizontal movement.

12 Drop trap 1 back in rig, do not fix.

13 Release operates automatically OR operate manual release.

14 Retrieve ballast pin.

15 Divers surface up ballast line.

16 Diver 2 to take photographs at all stages of the operation.

DIVERS REPORT

All operations were successfully carried out, apart from the following comments regarding steps 6, 11 and 13.

6 On opening valve B the dye started to enter trap 1. The dye seemed to enter slowly and there was a definite boundary layer between the dye and the sea water. Dye was seen escaping around the edges of the lid. When the reservoir was empty (completely deflated), trap 1 was about half full of dye. The dye continuing to escape around the lid.

11 Because of the above problem, trap 1 was only about a quarter full of dye when it was taken out of the rig. The dye which was left escaped almost immediately the lid was opened so an effective 'purging' by horizontal movement was not possible.

13 The automatic release had been set to operate three quarters of an hour after deployment of the rig (half an hour after the divers entered the water). The release failed to operate and after waiting five minutes the divers returned to the surface as agreed. After discussions with the surface team, the divers returned to the rig and successfully operated the manual release.

RESULTS AND CONCLUSIONS

All the objectives other than (1,3,4) were satisfactorily achieved, with regards to these three objectives.

1 Fresh water had been used (mistakenly) as the simulated dye carrier and its lower density (compared to sea water) contributed to the incomplete filling of trap 1. The lid of the trap requires to be effectively sealed against dye leakage.

3,4 The electronic timer unit failed to work when installed in the rig. Further study of the timer design, followed by rigorous electrical and mechanical testing, would appear to be necessary in view of the limited facilities on board Le Suroit.

Diving Team

S Oxer	IOS Wormley
C Grier	SMBA
C Cumley	SMBA

5 DIVERS TIME/DEPTH RECORDING LOG

The "Diverlog" divers data recorder is designed to aid divers, and those responsible for their activities. It provides a hard copy record of the various aspects of a divers underwater programme.

Strapped to a divers forearm, the instrument records a depth/time profile, together with manually entered event marks. In addition depth, time underwater, and time of any surface interval are displayed to the diver, thus providing all the information needed for decompression calculations. After surfacing the instrument is connected to a strip chart recorder, to provide a hard copy.

The unit on test was a prototype manufactured by Harding Signals Ltd, New Zealand, and loaned to IOS by the Department of Scientific and Industrial Research.

Diving Co-operation (Sally Oxer IOS Wormley)
(Crawford Grier SMBA)
(Dave Flatt Bidston)

It was intended that several diving exercises would be carried out during the trials period, however diving was severely restricted by the south westerly gales. One joint dive was carried out on 30 April 1986, diving from the SMBA slipway. The object of the dive was to carry out two transects under one of the SMBA fish trap rafts, taking photographs every few metres to determine any variations in the sea bed.

This was the first open water use of the new IOS Wormley Nikonos V camera with a flash unit. The flash had been used only once before in the wave tank but the batteries did not have enough power left in them for the flash work at full efficiency. New batteries must be used each time the flash is required.

DIVING CO-OPERATION TRIALS REPORT

Although the "Diverlog" had been used on previous occasions with some success, the inbuilt Ni-Cd batteries had run flat. The unit had been fully charged prior to transport to Dunstaffnage but for some reason the charge was not held. All attempts at re-charging the unit failed. Both the Wormley and Bidston electronics personnel could not ascertain the cause of the fault, as the unit was sealed, and there was no circuit diagram for guidance.

A full report has been sent to DSIR New Zealand.

For further information contact Sally Oxer (Diver)

6 SPHERICAL ACOUSTIC RELEASE UNITS

The Bidston spherical pinger/release units have been modified to improve their performance, an acoustic indicator has been added to give a visual record of the position of the release cycle. Changes have also been made to the receiver side of the circuitry, in view of the past experience with shallow water deployments. The main improvement has been to gate the transmitter on and off for a predetermined time this enables the receiver to listen unhindered by the many reflections experienced in shallow water. This means that in 'quiet' periods good communication over a long distance can be obtained. A great help in bad sea conditions.

TRIAL RESULTS

A test mooring was layed on 28 April 1986 ccnsisting of an anchor weight attached to the release by a short strop, this was held vertical by several plastic trawl floats (sub-surface). There was then a polypropylene warp to a large surface float with a 10 metre recovery line attached. The first mooring had two new sets of pingers and an early one (S07). At a distance of half a mile communications with the pingers was good although the trace was a little noisy.

The chart recording device was a converted Nagrofax recorder driven by a standard MK 4 Tracker unit. At a distance of one mile it was hard to see the Nagrofax trace and there seemed to be a fault with the overside transducer. (A light weight Dolphin fitted with a ceramic ring).

Going to a position diametrically opposite the original position, communication was still difficult and was not helped by a strong tide that tended to put the Dolphin cable at a shallow angle to the surface and point the transducer away from the mooring position.

The Dolphin was changed for an ordinary overside transducer fitted with a ceramic ring and an impedance matching choke. This also gave poor results.

The mooring was recovered and on returning to the pontoon both the Dolphin and the overside transducer were examined. The cables were found to have electrical 'shorts' at the tracker unit end (shorts in this case meaning resistances in the order of <1M ohm instead of the usual infinite resistance).

In both cases the short was found to be in the Plessey connector to the tracker unit. These were replaced with new ones and the performance of the acoustic transducers was restored. Trouble had also been encountered with the Marsh and Marine cable on the matching choke. The connector had been leaking and was sealed using self-amalgamating tape. The mooring was deployed on 29 April 1986 with another pair of new pingers and (S06).

The results from these acoustics was mixed. One of the new pingers would not switch at all and S06 was difficult to switch from release state to beacon state. The other new pinger operated well and could be seen stepping through it's release cycle.

When the mooring was recovered S06 was still in it's release mode and the new pinger which had not switched on was still off.

The mooring was replaced with three older pingers S14, S15 and S17. All three units operated at a distance of one mile although difficulty was had in hearing the transmission from the pingers sometimes. This was thought to be due to the poor position of the overside transducer due to the strong current. The unit which had failed to operate was examined and found to have a faulty battery connection, this was rectified and the unit gave good results in a later deployment. The results of these trials are being evaluated to determine the effect of the changes made to the spherical pingers.

For further information contact Peter Foden IOS Bidston.

7 THE NAGROFAX CHART RECORDER

The Nagrofax is a small chart recorder designed for displaying weather charts.It is small and light and ideal for use as an acoustic display unit. There are however problems in synchronising the chart scan with the incoming acoustic signal. Origninally the Nagrofax was modified by IOS Wormley to be 'tuned in' manually with a set of switched resistors and a fine control by a variable resistor. This was satisfactory for a short period but then the trace would begin to drift and would continue to do so. This meant that the fine control had to be continually adjusted. There was no way of knowing for sure if the slope of the trace was due to relative movement of the signal source and the ship or to the chart recorder drift.

It became obvious that:

1) The display must run continuously, for as long as the operator requires it, often in excess of 2 hours.

2) The trace must be capable of being synchronised to any of the standard periods without fine adjustments, or any appreciable delay (or drift with time) over the period range 0.9 to 1.18 seconds, in steps of 0.02 seconds.

A conversion board that incorporated the above requirements was developed at Bidston and two Nagrofaxes were converted for trial on the "Calanus".
Briefly the modification involves using a crystal time-base to lock the motor drive to the correct frequency for the desired period range. The current drive to the motor must also be varied as the motor speed changes, this is catered for by means of switched resistors.

NAGROFAX TRIAL RESULTS

During the second week of the trials the Nagrofax's were used for monitoring the Bidston spherical pingers, the acoustic doppler current profiler, and the Wormley test mooring. Both of the modified units performed well with no drifting over periods of several hours. The conversion helps the operator to keep track of several pingers at the same time, which would have been difficult with the original conversion.

ACKNOWLEDGEMENTS

We would like to thank all those concerned both on the run up to the trials and to the period after it, and also to take this opportunity of thanking all of the ships personnel for their excellent co-operation and help. The facilities available at SMBA both in terms of workshop and ship use provide an essential part in the testing of equipment prior to use for scientific work.It also is an excellent training ground for all of the NERC/University sea going personnel allowing exchange of ideas and techniques.

APPENDIX 1

Auto-retractor test mooring (recovery)

Oban Coast Guards informed IOS Wormley that an object had been recovered by a local fisherman from the shore of Seal Island on 10 June 1986. SMBA, were informed and Jim Watson kindly negotiated for the return of the gear, and took it to the SMBA Laboratory for safe keeping. Subsequently the recovered gear was identified as the auto-retractor test mooring.

On inspection of the system it was obvious that the mooring bottom end had suffered from being dragged on the sea bed, presumably in shallow water. The Marsh and Marine rubber connectors had been torn off, and also the two auto-retractors, however the acoustic release was still working and in good condition. The ceramic ring transducer rubber housing had lost all of it's oil but there was no penetration of sea water into the housing. The release was opened on return to Wormley and found to be in good condition internally. Although the mechanical release had suffered from dragging it was still operational and there was no evidence of malfunction of any of the levers. The complete release is suitable for further use.

It is obvious that the mooring did not part from the anchor on the 23 May 1986 although the release system had functioned correctly. A check was carried out to ascertain the positive buoyancy available to bring the mooring to the surface.

Freshwater

Sub-surface buoy + Wire and shackles	=	+27 kg (60 lbs)
Acoustic release (Titanium)	=	-9 kg (20 lbs)
		------
		18 kg (40 lbs)

This figure of 18 kg is twice the recommended buoyancy required for pop up systems, therefore, there is a possibility that the new auto-retractors are not operating immediately. It is possible that the piston O ring is bedding into the piston (with time) and the operating spring has not sufficient force. This is not a problem in deeper water as the hydrostatic force on the piston is considerable.

The replacement mooring has retractors with increased spring force.

APPENDIX II

Experience with the redesigned Box Corer system on "RRS Discovery" Cruises 159 and 160 (June/July 1986)

An opportunity arose to test the new box corer release on Cruise 159. The system which was succesfully tested in Loch Etive was run with a standard IOS 10 kHz acoustic beacon 100 m above the corer to measure the run into the sea floor. A good core was obtained from a water depth of 5400 m, and sampled for various geochemical purposes by the scientific party. It was found that the acoustic release package on the corer did not return a bottom echo, presumably because the transmitted signal was absorbed by the corer itself.

The new box corer system was run on a routine basis on Cruise 160, where a number of geochemical investigations of near-surface sediment pore waters were an important component of the scientific work. The first run failed, when only a single firing pulse was transmitted from the ship with the corer in the sediments. Subsequently the charging time of the relay firing capacitor was decreased, and at least two firing pulses were transmitted to the corer. A total of nine further box cores were taken without any problems from water depths between 4500 and 5500 m. This success was of considerable benefit to the scientific programme.

For further details see IOS Cruise Reports for Cruises 159 and 160.

APPENDIX III

Using Auto-retractors with series 200 Acoustic Releases
The following report was prepared by Peter Foden (IOS Bidston)

The Auto-retractor is a very useful form of release system when compared to the "Pyro-lease" or the conventional ICI retractor system. It is simple to use and can be re-cocked after recovery and ready for use again in a few minutes.

They are convenient to send abroad by air or sea transport where problems can be experienced in obtaining clearance for pyrotechnic releases. Auto-retractors do have the disadvantage of being initially more expensive than the standard form of release, although there are no disposable parts to replace, and the pressure seals do not have to be broken. The other disadvantage is that they are not directly compatible with the series 200 release system.

The purpose of this report is to indicate how auto-retractors can be used with the minimum of modifications to the release circuitry.

The main problem with using auto-retractors is the voltage required to operate it and the length of time the voltage is applied. A typical series 200 release delivers a pulse of 9 volts for about 60 ms. Due to the tolerance of the relays and the capacitors used to fire the relay, this can be as low as 20 ms. This is sufficient to fire a Pyro but not enough to fire an auto-retractor. Before the auto-retractors can be used with the IOS release system some important points must be considered:-

1) The current required by the solenoid is higher than that required by a Pyro. The resistance of the connector leads is no longer negligible and care must be taken to ensure that the Marsh and Marine/Impulse leads and bulkhead connectors are in good condition and the contact pins are clean. Ccntact resistance must be kept to a minimum.

2) The firing current is required for a longer period. This is because the operation of an auto-retractor is by Ledex rotary solenoid, which physically releases the internal lever assembly and allows the pressure piston to retract. This takes time and current so the relay operating the solenoid must be closed for a longer period.

3) To help overcome the problem of contact resistance the battery voltage should be raised from the standard 9V. This enables slight increases in contact resistance due to wear and tear to be tolerated.

4) Due to the inductive nature of the solenoid a large spike is induced when the supply to the solenoid is broken. In order to preserve the contacts of the relay a spark suppressor must be fitted. A 1N4007 was found to be effective in quelling the spike. Care must be taken to ensure that the diode is connected the correct way round ie the positive end of the diode (cathode) is connected to the positive supply.

Three auto-retractors were supplied to Bidston in May 1986 and with the co-Operation of staff at Wormley they were tested in the 10,000 PSI pressure vessel to determine any problems associated with firing from the series 200 release modified as in 4.

The battery supply was a standard Alkaline 9V package make up of Duracel MN1500 type cells, the relay had been substituted by the more robust Hellerman-Deutsch (HDS12 HC1B 62) and an extra 1000 uF 16V in parallel with C31 on the relay board. (This is a standard modification on Bidston ceramic ring releases, used for current meter moorings).

The three auto-retractors were pressurised from 1000 PSI to 9000 PSI in steps of 1000 PSI. The auto-retractors were fired at pressure and the wave form across the solenoid monitored with a storage oscilloscope. A typical output can be seen in Fig 2. There is a fast rise time at the start of the pulse and then a drop in voltage and a distinct dip when the solenoid is beginning to move. After the solenoid has stopped moving the voltage reduces to a plateau value of about 6.8V. When the relay contact releases there is a negative excursion whilst the solenoid dissipates it's stored charge. The high voltage spike can be seen clamped at approximately 0.6V whilst the coil discharges itself.

In the example shown the relay contact is closed for about 68 ms, and the wave form ends after 119 ms. The negative going spike just after the beginning of the wave form is caused by slight contact bounce in the relay and is present in all the wave forms observed at different pressures and so the wave form shown in Fig 2 is representative of the solenoid operation.

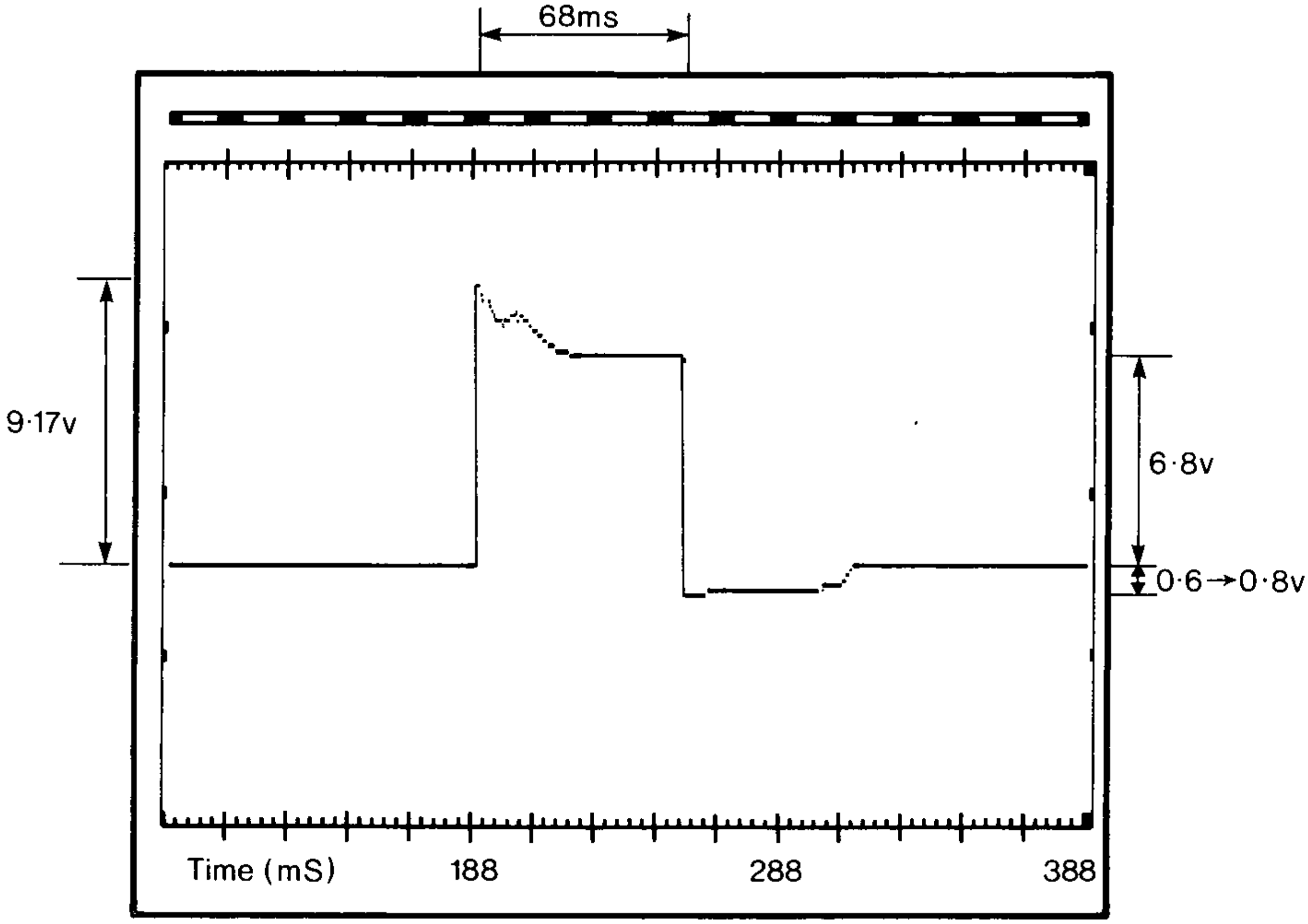

Fig 2: <u>AUTO-RETRACTOR TYPICAL FIRING CURVE</u>

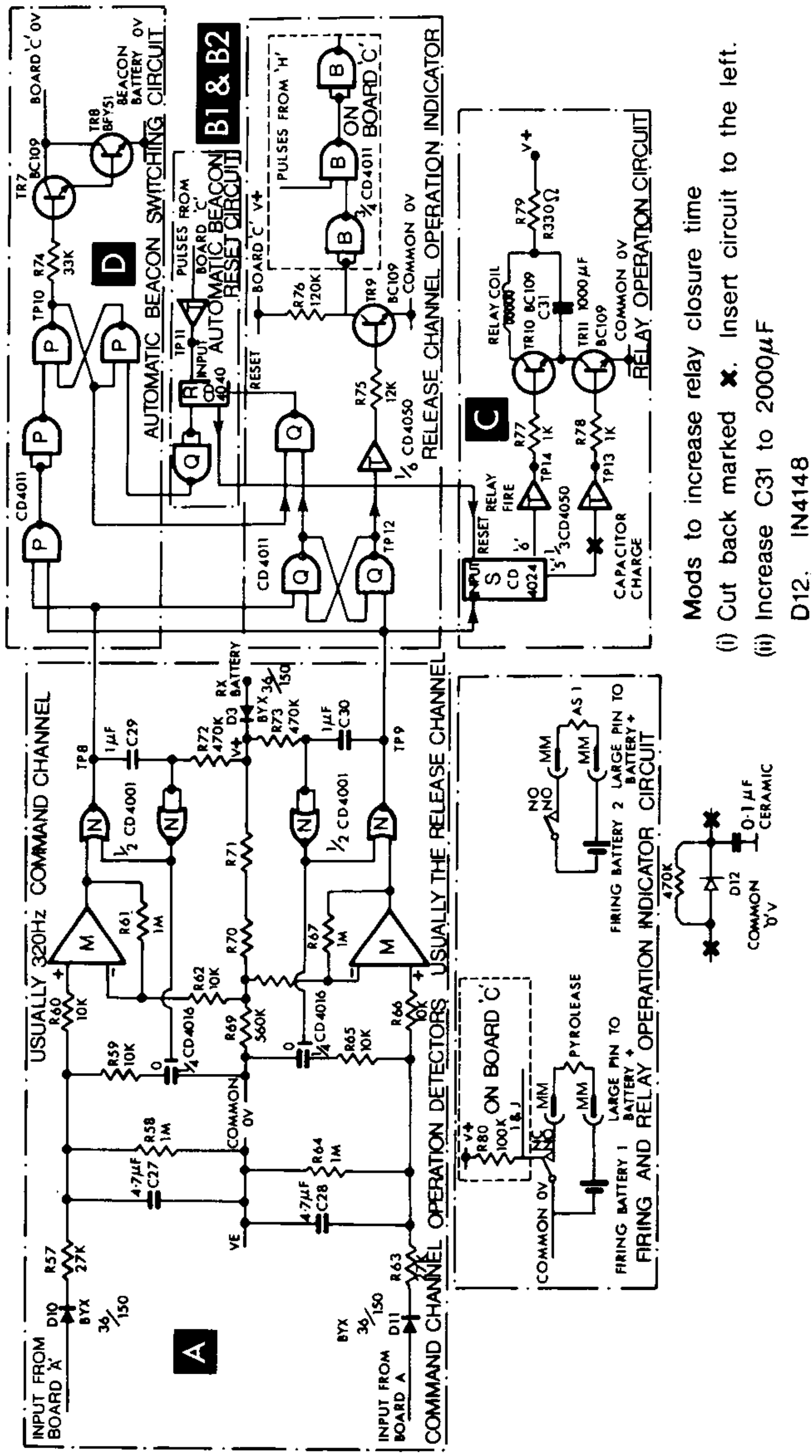

Fig 3: RL81 RELAY BOARD (MODIFIED) 12/11/84

It is interesting to note that one of the retractors exhibited a lengthening of the dip at the start of the wave form. This was thought to be caused by a slight stiffness caused by the piston moving against it's sealing 'o' ring. The stiffness was helped by a smear of vaseline on the piston shaft.

Out of the 30 or so firings that were carried out during the tests only once did an auto-retractor not fire and this was thought to be due to contact resistance. Crocodile clips were used to connect the relay leads to the pressure vessel lid input plug, after the misfire the crocodile leads were reapplied and the auto-retractor fired without any problem. This would indicate how carefully the problem of contact resistance should be considered.

The following recommendations are made based on the short time the auto-retractor has been available as field experience is obtained these guide lines may require to be updated.

A) Auto-retractors should be fired using a voltage at least twice as high as the standard release voltage ie a minimum of 18V. This will ensure that if there are slight increases in contact resistance the solenoid will still operate reliably.

B) The closure time of the relay should be as long as is practically possible. This can be achieved by first increasing the value of C31 by 1000 uF. The other method is to use a resistor, capacitor and a diode arrangement as in Fig 3. This design has been used for the Bidston "Spherical Pingers" and it gives a useful increase in relay closure time. This in conjunction with the extra capacitor can give closure times greater than 100 ms. It is not a good idea to arrange for the relay to remain closed permanently or for several minutes as it is possible for the solenoid to overheat and burn out.

C) A 1N4007 diode should be fitted across the solenoid, preferably inside the release so that if by accident the leads are transposed it will still fire it without forward biasing the diode and possibly destroying the solenoid.

An IOS Wormley release was modified to the above recommendations by Peter Foden, and has been deployed on a test mooring. The mooring was layed from the Seol Mara 22 July 1986 in the Lynn of Lorne, and is due to be recovered 28/29 October 1986.

Peter Foden
IOS Bidston
July 1986