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Institute of
Oceanographic Sciences
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INTERNAL DOCUMENT No. 335

The ADOX Experiment: mooring design and implementation
ADOX Technical Report 1991-1993

I Waddington

1994

Natural Environment Research Council

INSTITUTE OF OCEANOGRAPHIC SCIENCES
DEACON LABORATORY

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Wormley
Godalming
Surrey GU8 5UB UK
Tel +44-(0)428 684141
Telex 858833 OCEANS G
Telefax +44-(0)428 683066

DOCUMENT DATA SHEET

AUTHOR	PUBLICATION DATE
WADDINGTON, I	1994

TITLE

The ADOX Experiment: mooring design and implementation. ADOX Technical Report 1991-1993.

REFERENCE

Institute of Oceanographic Sciences Deacon Laboratory, Internal Document, No. 335, various pagination. (Unpublished manuscript)

ABSTRACT

The design and implementation of ADOX moorings, as a cooperative venture between IOSDL and MAFF Lowestoft.

Full depth and mid-water moorings deployed in the southwest Indian Ocean and Southern Ocean as a contribution to the WOCE Programme.

The detail design and supply of components and assemblies for the full depth moorings with methodology of deployment.

The calibration and setting up of Äanderaa current meters and temperature profile loggers with methods and examples.

The document is prepared as an historical record and as a guide to techniques employed in the preparation and operation of full ocean depth moorings at IOSDL.

KEYWORDS

ISSUING ORGANISATION

Institute of Oceanographic Sciences
Deacon Laboratory
Wormley, Godalming
Surrey GU8 5UB. UK.

Director: Colin Summerhayes DSc

Telephone Wormley (0428) 684141
Telex 858833 OCEANS G.
Facsimile (0428) 683066

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ADOX Technical File

IOSDL Mooring design and implementation

I Waddington

1991 -1993

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ADOX Technical File

1.Mooring Design and Layouts

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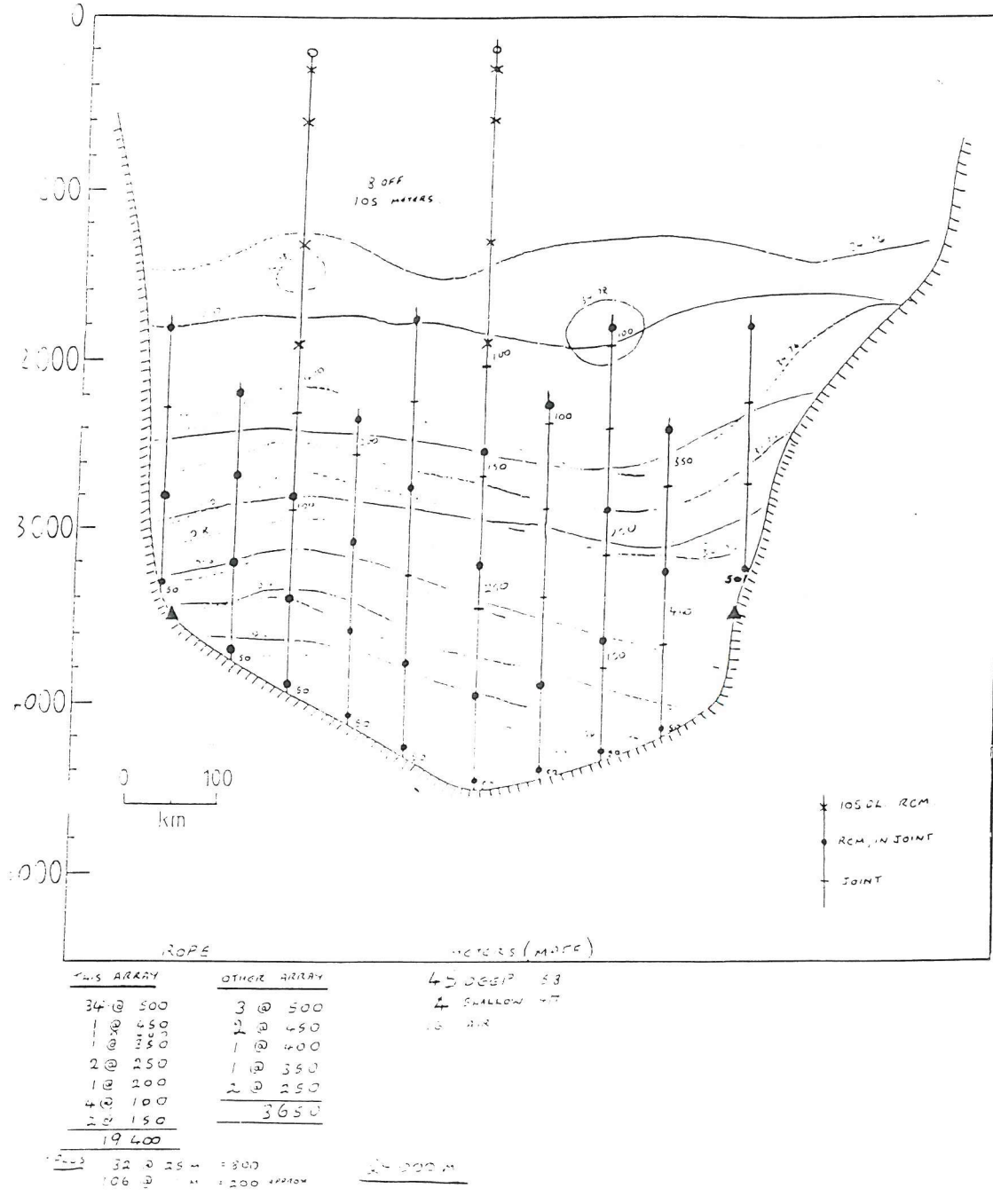
Mooring Design Process

IOSDL is to extend MAFF Lowestoft moorings C & F of the Crozet Kerguelen mooring array,midwater current moorings,to full depth subsurface moorings.

Mr J Read,MAFF,supplied sketch details of the moorings and expected topography for IOSDL mooring design of the extended moorings and for discussion of mooring deployment techniques of all MAFF moorings.A preliminary informal meeting was held at IOSDL between J Read ,I Waddington and Dr J W Gould on 22nd Jan 1992.A proposed joint working scheme incorporating elements of the CR201 SWINDEX was evolved.

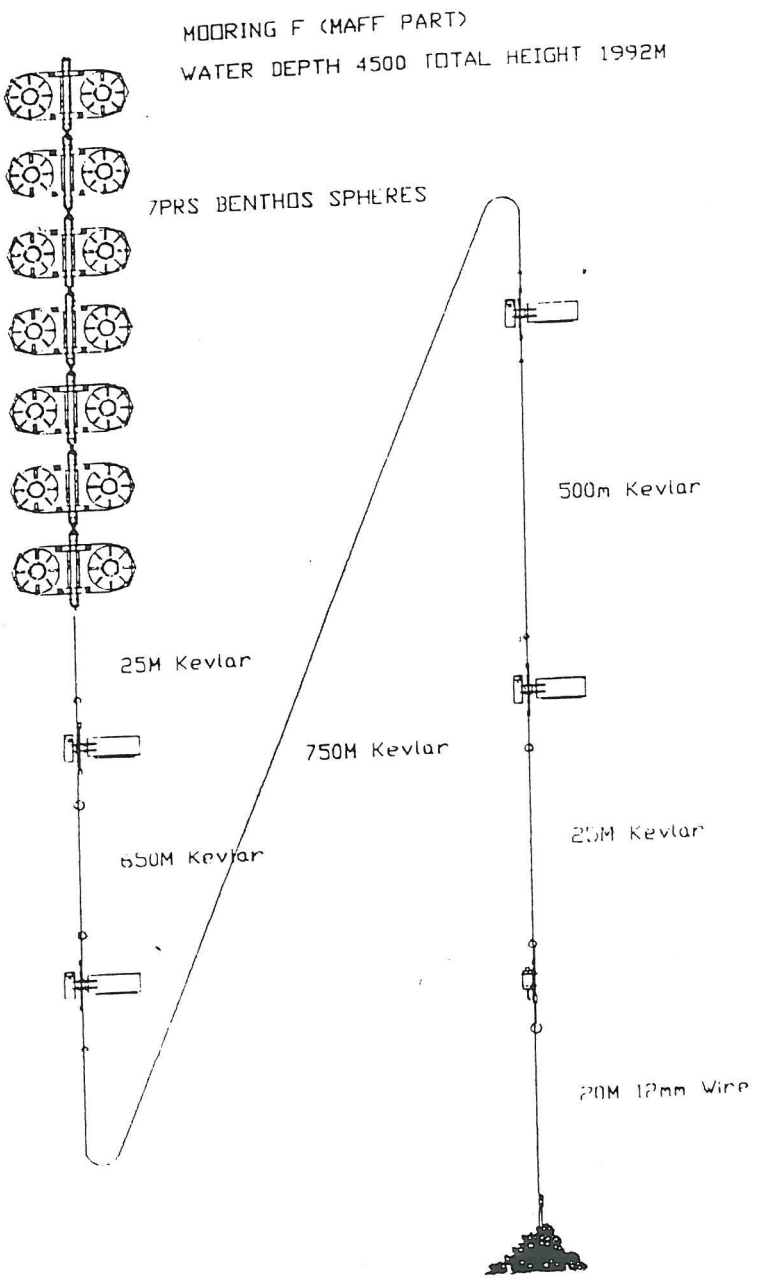
Crozet/Kerguelen Mooring Array

As received at IOSDL 14-ii--1992



MAFF Mooring General Diagram

As received 22-i-1992



IOSDL extension to MAFF Moorings

From detailed discussions on aspects of mooring design and materials a sketch scheme was evolved at IOSDL to create the MAFF moorings as full depth moorings.

IOSDL will be providing the extended section on top of the MAFF section and also providing the modified anchor to acoustic release components.

A sketch outline along with components allocation was forwarded to MAFF,J Read, for discussion/approval.

MAFF accepted the proposal and further detail design was commenced.Reference was made to IOSDL moorings of similar design and duration to establish a reliable known approach.

Historical comparison to IOSDL moorings.

The mooring design compares to Mooring 400,a full depth mooring in 5444m water depth.Deployed for a one year duration at Great Meteor East ,31 29N 24 44W Sept 1985 to September 1986.Mooring Log 351-400,Cruise reports 180 and 241.

Mooring 400 was subjected to currents of 50 cm/sec and apparent knock down of the subsurface sphere was in the region of 30 to 50m,Unpublished report Packwood circa 1988.
It was apparent that as marine growth became established on the jacket wire and upper fibre lines the mooring performance was improved ie knockdown of the subsurface float decreased.This can be attributed to the hairy fairing effect of the growth reducing strumming of the system,thus reducing drag.

The ADOX moorings are different to Mooring 400 in that the sphere is at greater depth and back up buoyancy is included.
The back up buoyancy will act to stiffen the lower 1000m of the mooring in the lower current region.Thus the steel sphere will create greater tension in the line than seen in Mooring 400.Thus overall the ADOX moorings will be stiffer than Mooring 400 which should yield a marginal gain in reducing sphere knock down.

Mooring 400 was recovered after the one period and all items examined for fouling,corrosion and abrasion of the mooring and current meter components.

Marine Fouling

Marine fouling was observed to extend throughout the length of the polypropylene coated mooring wire.The fouling was of the simple strand like growth,similar to Hydroids,varying in length from 5mm to 30mm from bottom to top.No evidence of any damage to the coating or the internal wire was observed.

The steel sphere was coated on one upper side with a similar fouling growth to the wire section.This appears to indicate that the sphere stabilised in the flow with the growth occuring more on the downstream side.The underside of the buoy had compartively little growth.

The current meters in the upper 1500m of the water column had fouling around the rotor arches and some small fouling on the vane surfaces.The ADOX units will therefore have additional anti fouling on the rotor arch shortly before deployment.This should inhibit growth substantially.

Corrosion

There was insignificant corrosion on the steel sphere and mooring wire connections,some corrosion was apparent at the lower end of the steel sphere chain.This could be attributed to the stainless mooring swivel having some electrolytic effect in close proximity to this chain end.The ADOX chain has been increased in diameter from the 13mm of Mooring 400 to 5/8" to provide an increase in material, the chain will preferentially corrode when in close contact with the mooring swivel.

The current meters and acoustic releases had no corrosion.Preparation of these items was carefully carried out prior to deployment with Greases and sealants liberally applied.

Abrasion

No evidence of abrasion was seen throughout the length of the mooring.

Moorings C and F

Mooring C
Water depth.3950m **MAFF mooring height.**1188m.

Current meter depths from surface.
300m,600m,1300m,2000m. IOSDL.
2750m,3400m,3900m. MAFF

Mooring F
Water depth.4500m **MAFF mooring height.**1992m.

Current meter depths from surface.
300m,600m,1300m,2000m. IOSDL.
2550m,3950m,4450m. MAFF

The mooring design incorporates all of the MAFF section from the acoustic release to the top of the MAFF glass sphere buoyancy package this has the IOSDL section attached above,extending to the 300m depth.

To enhance recovery a further package of glass buoyancy is placed above the MAFF package giving sufficient additional buoyancy to recover the mooring should the steel sub surface sphere be lost.

The anchor to acoustic release section is given some compliance with the inclusion of a nylon anchor line.This acts as a shock absorber on anchor bottoming out and also as a tow line should the mooring require positioning after streaming.

Deployment

As the design evolved it became apparent that this mooring with high buoyancy and anchor loading was not suitable for anchor first deployment.The mooring lines would see excessive loading in the static mode and with induced dynamic loadings in excess of twice the static load,due to ship pitch.
Thus the mooring deployment has to be buoy first with the anchor free fall last.

MAFF moorings are all to be buoy first and so the extended moorings will use the same deployment techniques thus simplifying deck equipment.

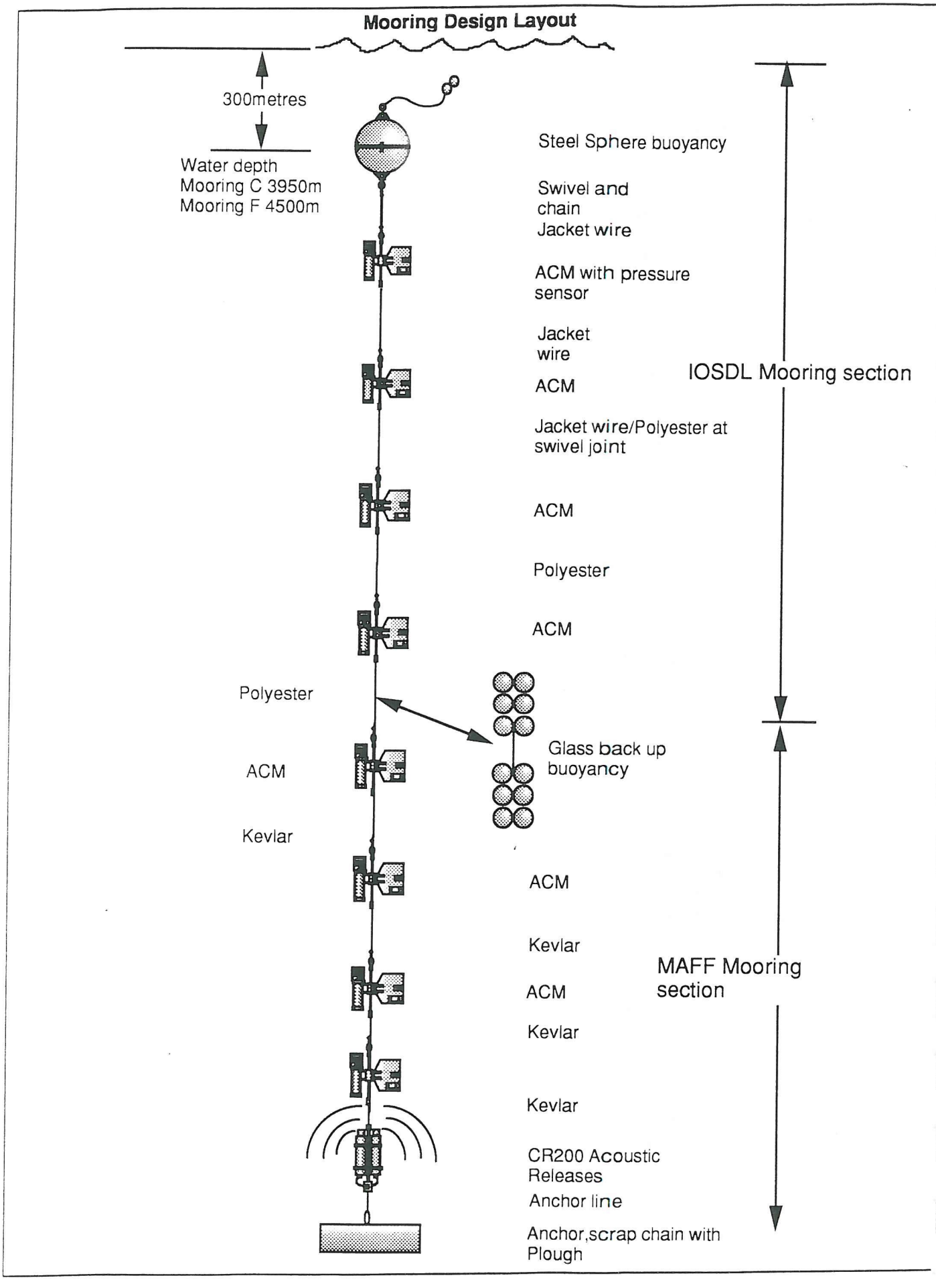
Acoustic Releases

On the 22nd June a joint cruise planning meeting was held at the James Rennel Centre where Greg Philips offered the MAFF two CR200 releases to add to the moorings giving duplication of electronics on each mooring.This method adopted as standard at IOSDL was accepted by MAFF and Greg Philips will provide the necessary components.

Current Meters

IOSDL has prepared current meters to the standard of the IOSDL Southern Ocean SWINDEX array units,thus giving good quality calibrations for ;Rotor,compass,temperature and pressure(where fitted) and check values for conductivity(where fitted).See ADOX Technical File 3.

The current meters are all of Aanderaa manufacture and are to be deployed as new instruments.Rigorous testing was carried out throughout calibration and bench tests carried out for duration and reliability. SeeADOX Technical File 3.


Mooring Design Layout
300metres
Water depth
Mooring C 3950m
Mooring F 4500m
Steel Sphere buoyancy
Swivel and chain
Jacket wire
ACM with pressure sensor
Jacket wire
ACM
Jacket wire/Polyester at swivel joint
ACM
Polyester
ACM
Polyester
Glass back up buoyancy
ACM
Kevlar
ACM
Kevlar
ACM
Kevlar
Kevlar
CR200 Acoustic Releases
Anchor line
Anchor,scrap chain with Plough
IOSDL Mooring section
MAFF Mooring section

Static Mooring Loads

Derived from DESIGN Spreadsheet,old Ability.

Mooring C

Main Buoyancy	651 kg	Total buoyancy in system	1163 kg
Anchor air weight	1653 kg	Mooring hold up	490 kg
Anchor hold down	300 kg	Back up recovery buoyancy	100kg
Total 17" spheres	20.5		

IOSDL Mooring Section

Buoyancy	651 kg	Instrument load	194 kg	OA buoyancy	457 kg
Tension in wire	845 kg	GS of wire	2250kg	GS of polyester	3190 kg
SF under steel sphere in position		2.7	SF at top of polyester	5	

MAFF mooring section

Buoyancy glass	508 kg	Instrument load	194 kg	
Tension in kevlar	Glass + OA Buoyancy	IOSDL+Instrument load	1159 kg	GS of kevlar 10mm 4510 kg
SF under glass spheres in position		3.89		

Mooring F

Main Buoyancy	651 kg	Total buoyancy in system	1163 kg
Anchor air weight	1699 kg	Mooring hold up	495 kg
Anchor hold down	300 kg	Back up recovery buoyancy	100kg
Total 17" spheres	22		

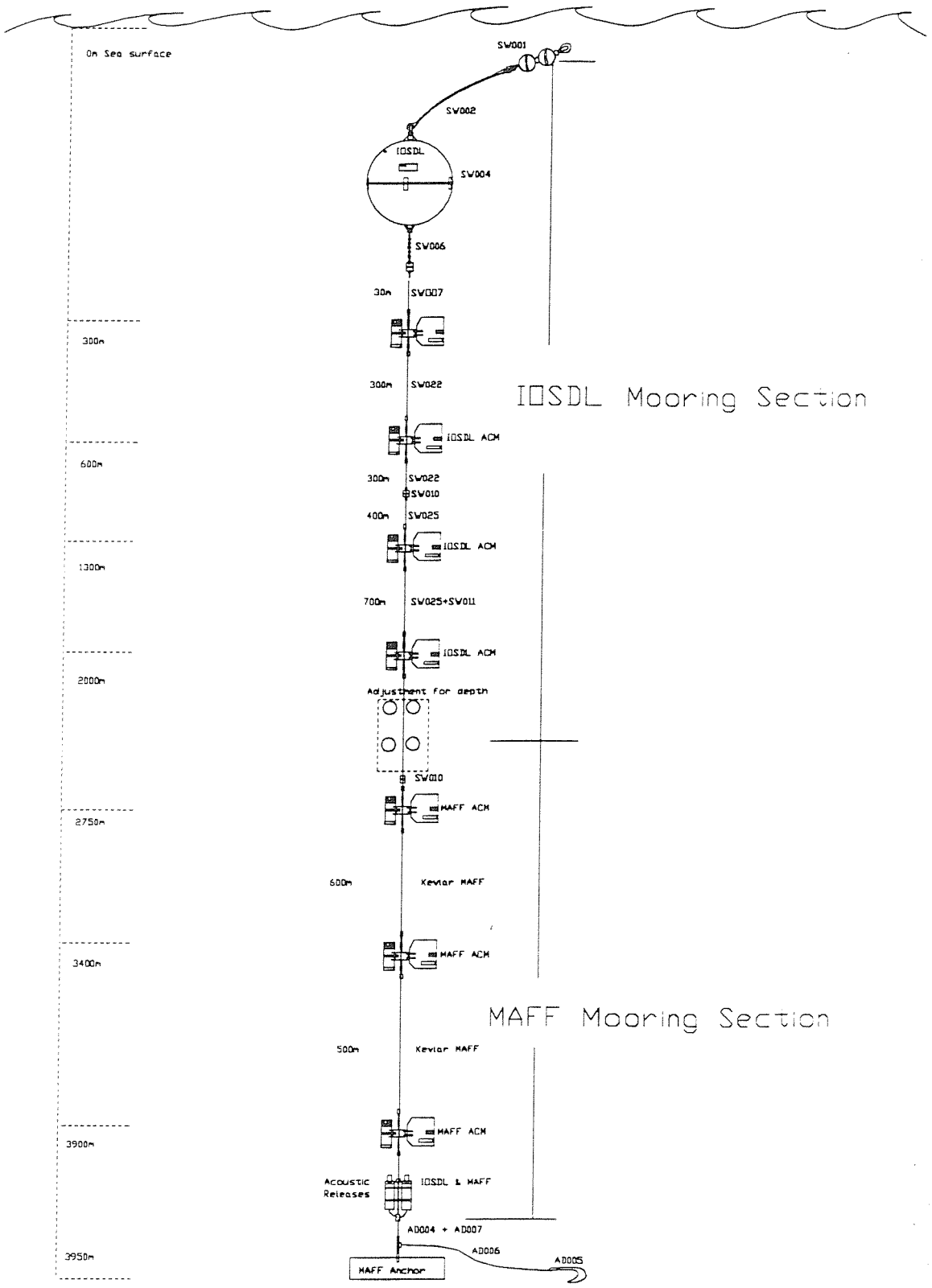
IOSDL Mooring Section

Buoyancy	651 kg	Instrument load	194 kg	OA buoyancy	457 kg
Tension in wire	845 kg	GS of wire	2250kg	GS of polyester	3190 kg
SF under steel sphere in position		2.7	SF at top of polyester	5	

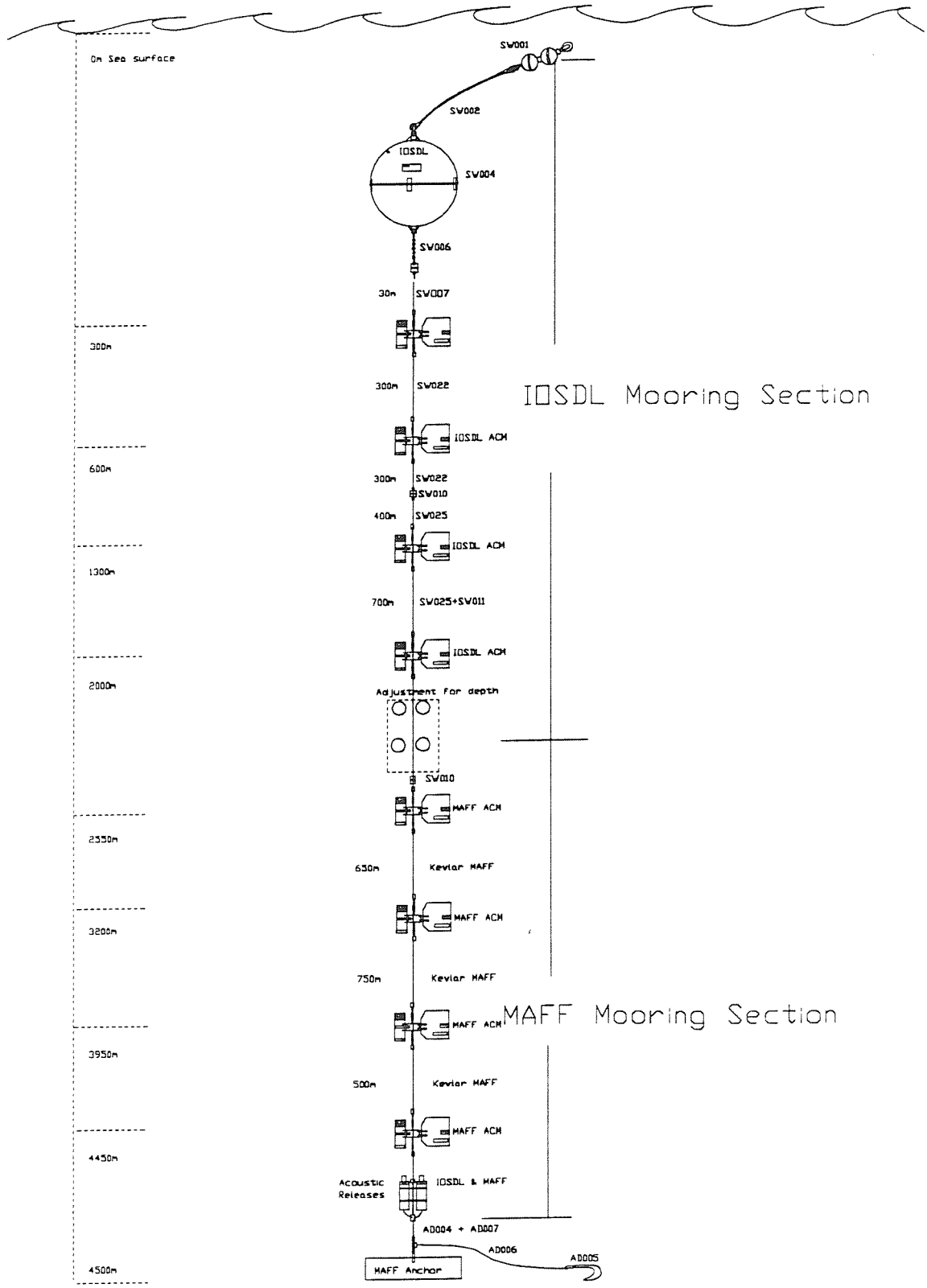
MAFF mooring section

Buoyancy glass	558 kg	Instrument load	237 kg	
Tension in kevlar	Glass + OA Buoyancy	IOSDL+Instrument load	1159 kg	GS of kevlar 10mm 4510 kg
SF under glass spheres in position		3.6		

Mooring C Design



Mooring F Design



ADOX Technical File

2.Mooring Hardware

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Mooring Lines

Jacket 6mm wire

Jacket steel wire is to be used in the top 1000m of the water column as a precaution against fish bite.The wire is coated with polypropylene to prevent corrosion.This wire has survived for one year deployments in the Faeroe and Great Meteor regions and has been recycled to 3 years exposure.

The wire is a 6mm diameter 7x19 galvanised construction,produced as a special item with no internal grease.The wire is then coated,by extrusion,with polypropylene to a thickness of 1mm,thus increasing the overall diameter to 8mm.
The coating is smooth and as such acts to reduce drag and strumming of the mooring wire.

IOSDL has previously obtained supplies from British Wire Ropes,later Bristol Wire Ropes.Estimates for production were obtained from several manufacturers to the IOSDL specification.
Midland Wire Cordage,MWC offered a favourable price on the specification and provided a sample to IOSDL for testing.The sample was pressure tested with the ends sealed to 3000 psi for 5 days with no ingress of water.
Bending and load tests were carried out indicating the material to be up to specification.

The heat shrink shroud material was obtained from Ampliversal and was tested for sealing,adhesion and durability in the laboratory.
A termination suitable for IOSDL and RVS was manufactured by MWC to IOSDL specifications and fitted to a test length for load testing.

RVS were to deploy one year moorings for PML,Dr R D Pingree,which IOSDL was to design and specify. The opportunity to field trial the wire using these deployments was taken and all the wires were manufactured by MWC for this.
Trials were carried out on the wire onboard RRS Charles Darwin Cruise 66,Mar-April 1992 proving the wire suitable.Plymouth Marine Laboratory Cruise Report RRS Charles Darwin 66/92.

Supplier. Midland Wire Cordage Ltd. Orchard Works,Arthur St,Redditch,Worcestershire,B98 8LJ

Type. Steel wire rope 6mm dia,7x10 Galvanised,preformed,tensile 1770 N/mm to BS 302/1987.
Manufactured with no grease.Impregnated with blue polypropylene to 8mm o.d. B.L.2350 kg.
To be supplied on drums for cutting and measuring at IOSDL.
Termination.MW 12-12-91 special product.
Shroud.AMH 1-727120-2.AM-Black Medium Wall Tubing with sealant.Cut to length at IOSDL.Ampliversal UK

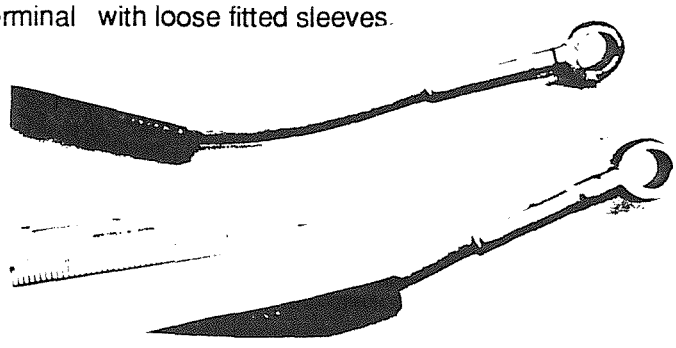
The lengths required for ADOX are 30m x 4 and 300m x 4.These were cut and measured from stock drums at IOSDL and returned to MWC for swaging of the end terminations.Each end of the wires was accessible and fitted with a heat shrink boot,loosely slipped onto the wire.

Mooring Wire Preparation

On return from swaging at MWRC the terminations were inspected and found satisfatory.

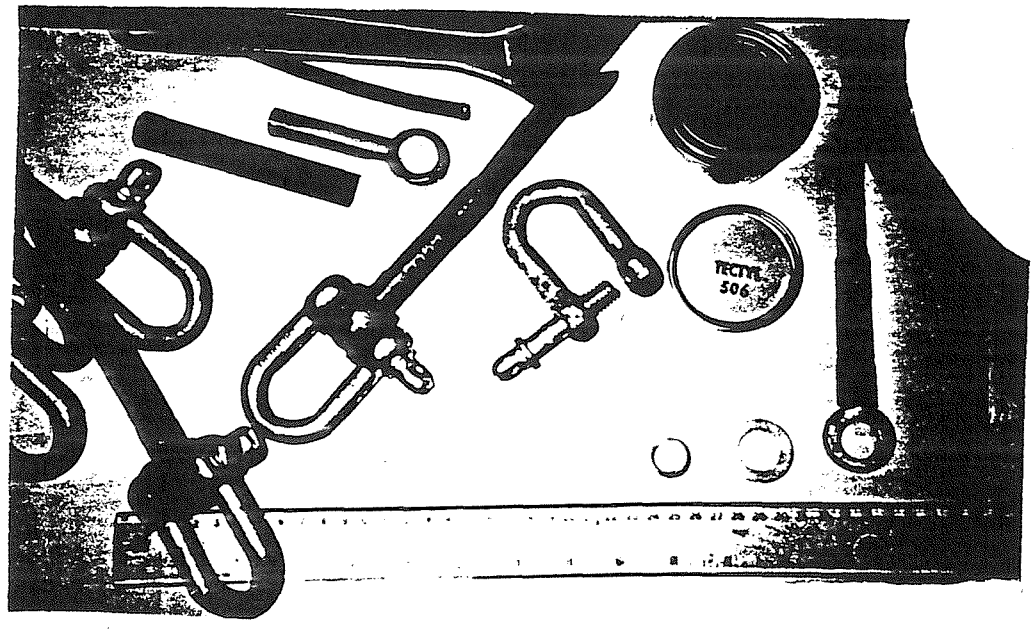
1.Heat shrink shrouds. The wire and terminal was thoroughly degreased for 250mm from the terminal.The shroud was then slid along the wire and over the swage terminal.Using a hot air gun fitted with a deflector the shroud was heated from the terminal end progressing slowly and evenly to the wire end to shrink the terminal evenly onto the wire.Sealant could be seen to extrude from the shroud completing the shrinking process.

Mooring wire swaged terminal with loose fitted sleeves.



2.Polypropylene Bushes. Bushes are fitted within the swage terminal eye to reduce abrasion and corrosion.The terminal eye is liberally coated with TECTYL 506 both externally and internally within the eye.With the coating still wet the bushes are inserted and the outer washers fitted.The coating provides a watertight barrier within the bush and acts a location to hold the bush and washers in place.

Component parts of Mooring wire termination.



Shipping

The wires need to be treated carefully when shipping to prevent damage to the polypropylene coating.The 30metre wires are secured in coils and shipped in cardboard boxes.The 300m wires are wound onto smooth finished wooden drums,wrapped with strurdy polythene.The drums and boxes used are low cost disposable items which can be disposed of on completion of the mooring,thus saving return freight.

Synthetic Lines

Fibre lines are used below 1000m water depth where fish bite is minimal.The line chosen for the IOSDL section is polyester,which is also to be used in the SWINDEX array.This gives a reasonable cost return per metre and has been used at IOSDL for several years.IOSDL has acquired historical data through usage of polyester lines which can be used to better estimate stretch over the long term deployments for a given mooring loading and/or configuration.

Most major European manufacturers produce lines suitable for this application and were approached for quotations and specifications.Marlow Ropes Ltd.offered favourable prices and delivery for the specification required.

Suppiier. Marlow Ropes Ltd. South Rd,Hailsham,East Sussex.BN27 3JS
Type. Marlowbraid polyester,10mm dia,white,GS 3760 kg.

Stretch Allowance.
The calculated tension in the Polyester line is 1159kg,the stretch expected is 5% plus 3% for initial settling in of the line.
Stretch Measuring.
All the lines were reeled and measured at IOSDL.At sea a representative quantity of lines will be stretched overside using a suitable weight and measured with the metre wheel of the Double Barrel Capstan mooring winch.
Lengths Required.

Length	Cut	Total	Part Number
50m	46m	4 off	AD002
100m	92m	8 off	SW008
200m	184m	1 off	SW024
300m	276m	2 off	SW011
400m	368m	4 off	SW025
500m	460m	2 off	SW012

Splicing

All the splices were done at IOSDL by Sterling Aldridge.
A splice was produced by Sterling using the Marlow reccomended proceedure,This splice was tested at RVS to ensure its integrity and to observe the splice performance at the thimble when under load.

Mooring Line Testing

The mooring lines were taken to RVS Barry and load tested with the RVS test bed.Tests were carried out by K M Goy and S Aldridge,25-vi-1992.

Line type	Splices	Test Load	Comments
1.Marlow 10mm SPB Two samples tested.	Spliced each end Aanderaa One end coated on each.	1.5 tonne (0.5 GS)	No movement in splices Thimbles secure under load.
2.Liros 12mm Br/Br Two samples tested.	As above	2 tonne	As above
3.Marlow KT3 8mm One sample tested.	IOSDL splice/factory splice	2 tonne	No movement in the IOSDL splice Some movement at factory splice

The splice load tests indicated the IOSDL splice adequate to be adequate for the expected tensions.The thimbles retained their position and on relaxation of the tension,the thimbles remained tight within the spliced eyes.

Superthane Splice Coating

Superthane Abrasion Resistant Coating is a liquid,water thinnable,plastic type coating.Its primary use is in coating tow lines to reduce external abrasion to the fibres.
IOSDL has been experimenting with the material as a protective coating for umbilical cables,MAST 1,and as a splice lock and coating,PML drifting buoys and short term moorings.
The end terminations of mooring lines can experience significant abrasion on deployment and with subsequent shackle corrosion can become contaminated with rust products.
The material adheres well to Polyester braids and when thinned with water penetrates to the core of the lines bonding the fibres together and sealing the line from the ingress of abrasive contaminants.
The end terminations of all the fibre lines are dipped in a thinned solution of Superthane for 15 minutes and then removed to drain vertically with the thimble at the lower position.The termination is allowed to dry for 12 hours at which time the Superthane has set sufficiently to allow the splice to be handled.
The finished protection extends from the thimble 300mm along the line,completely covering the splice.

Test coatings were load tested,page iv,to ensure the Superthane did not adversly effect the splice strength.

Nylon Thimbles

The Polyester 10mm mooring line is terminated around a solid nylon thimble manufactured by Aanderaa Instruments.This thimble has been load tested to 2 tonnes with minimal distortion,Aug 1990,and has completed a 20 month mooring deployment with no significant signs of wear.FI Array 1992-1993.
The thimble accepts a 1/2" Dee shackle pin which is used as standard for these mooring types.

Supplier. W.S.Ocean Systems,Unit 4,Omni Business Centre,Alton,Hants.GU34 2QD.
Type. Thimble for spindle end piece,Part no.935021.

Nylon Anchor Line

A compliant 20 metre section,Part no AD004, is inserted below the Acoustic Release assembly to act as a tow line when positioning the mooring and also as a shock absorber to prevent the release over running the line as the anchor reaches the sea floor.
The line is measured,spliced and coated with Superthane at IOSDL.
The thimble used is a BS 16mm Heart type,hot dip galvanised,suitable for steel wire.
A test sample spliced each end with thimbles was produced for testing to 2 tonne at RVS,C Washington.

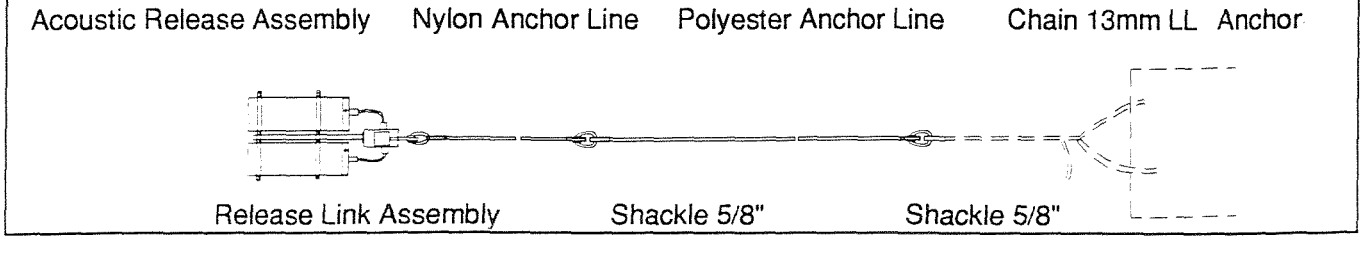
Supplier. English Braids Ltd,Spring Lane,Malvern,Worcestershire.WR14 1AL.
Type. Anchorline 16mm diameter,nylon,8 plait,GS 5300 kg(dry)

Polyester Anchor line

A negatively buoyant 25 metre section of heavy duty polyester braid is inserted beneath the Nylon Anchor line and above the anchor riser chain.This acts as a rugged connector between the Anchor Line and the chain.The line acts a buffer between the abrasive chain and the relatively soft fibre of the Nylon.
The line is connected to the chain with a single shackle thus reducing the chance of overshoot tangling.
The thimble used is a BS 14mm Heart type,hot dip galvanised,suitable for steel wire.

Supplier. English Braids Ltd,Spring Lane,Malvern,Worcestershire.WR14 1AL.
Type. Braid on Braid 14mm diameter,GS 4000 kg.

IOSDL anchor section.



Recovery/Handling Line

IOSDL has for many years used one product for recovery and handling lines,STURDEE split film polypropylene.The line is competitively priced,robust and reliable.
The line is purchased in bulk and cut and spliced at IOSDL.Each end is spliced with a large soft eye.

Supplier. Marlow Ropes Ltd. South Rd,Hailsham,East Sussex.BN27 3JS
Type. Sturdee,20mm diameter,3 strand,GS 6210 kg.

Mooring line Shipping. Lines in excess of 100m are to be shipped on disposable lightweight wooden drums,all shorter lines are to be shipped in disposable cardboard cartons.

Chains,Shackles,Swivels

Shipping. All chains,shackles and swivels are to be shipped in heavy duty wooden mooring crates.

Mooring Chains

There are two sizes of chain used in the moorings,13mm long link and 5/8" long link.Thes chain sizes are chosen for the load application and the corrosion expected.

13mm Chain. The chain is used for glass sphere attachment,anchor riser chain and as the drag anchor chain.The chain is purchased in bulk and cut to suit the application at IOSDL and onboard ship.The chain is easily cut using wire rod cutters which are carried as standard mooring tools.
Supplier. JW Chains Quarry rd,Dudley Wood,Dudley,West Midlands.DY2 0ED
Type. 1/2 x 6 MS Long link,Galvanised

5/8" Chain. The chain is used as a thresher chain beneath the subsurface buoy .Previous deployments have used 13mm chain.However it has been noted that there appeared to be increased corrosion at the stainless swivel end of the chain,possibly by electrolytic action.This corrosion is acceptable for a one year deployment but the rate of corrosion could not be forecast for a two year deployment.It was therefore decided to increase the chain size for safety.

The chain is purchased in bulk and cut to length at IOSDL.Cutting the chain can be done by oxy-acetylene torch or by a cutting wheel.Cutting by hack saw is time consuming but can be done onboard ship.
Supplier. JW Chains Quarry rd,Dudley Wood,Dudley,West Midlands.DY2 0ED
Type. 5/8 x 6 MS Long link,Galvanised

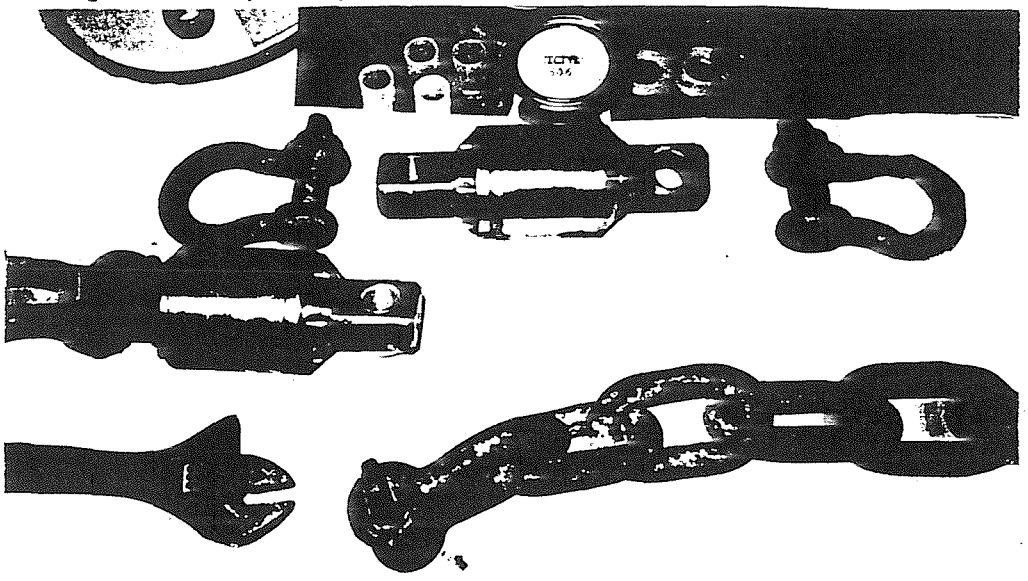
Stainless Steel Swivels

The units used for two year moorings are Stainless Steel-Pressure balanced units manufactured for IOSDL. The swivels are stainless steel 316 bodies with roller and ball race turning components sealed in oil.The oil is pressure balanced using a pressure transmitting membrane and is operable to 6000 metres.
The turning force under load is small,1 ft/lb at 1500 kg,allowing free movement of the wires and lines.

The swivels for these moorings are all recycled units from the 20 month Faeroe Iceland Array.IOSDL OIG workshops dismantled and inspected all parts,any worn parts being discarded,and reassembled and checked the units.The proceedure evolved for reassembly calls for all components exposed to sea water to be coated with TECTYL 506.This coating is applied within all threads and enclosed surfaces to prevent crevice corrosion.

Bushes and Washers are fitted to the shackle end holes to isolate the stainless and galvanised steel components from each other.The bushes,washers and all the swivel surfaces are coated with TECTYL 506 before assembly.The swivel assemblies are overcoated with Weather-X for shipping and storage.

Stainless Mooring swivel.Component parts and chain assembly.



Shackles and Links

All the shackles and links in the moorings are proven components for one year deployments.

1/2" BS Dee Shackles. The shackles are 1/2" body with 1/2" screw pin.Hot dip galvanised.SWL 800 kg.These shackles are used to join all mooring lines in the upper section.

5/8" Green Pin Alloy Bow.5/8" screw pin size,galvanised.SWL 2 tonne.These shackles are used in the buoy chain assembly and anchor riser assembly.

1/2" BS Reevable Links.1/2" body,pear shaped,hot dip galvanised.SWL 1 tonne.Used throughout the mooring line for stopping off.

5/8" Weldless Sling links.5/8"body,pear shaped,hot dip galvanised.SWL 4.2 tonne.Used in the buoy chain assembly for stopping off.

1/2"Commercial Dee Shackles.1/2" body,1/2" screw pin.These are used as glass sphere mounting shackles.

Buoyancy

Steel Spheres

The main buoyancy of the moorings is a 1.3m steel sphere manufactured by IOSDL.The units are recycled and refurbished to IOSDL standard.

Shipping. The spheres are transported on IOSDL steel buoy stands,suitable for craneage and fork lifting.

Type.IOSDL 1.3m diameter,buoyancy 637 kg,air weight 318 kg,O/A diameter 1219mm.
Serial numbers 92B,RV1.

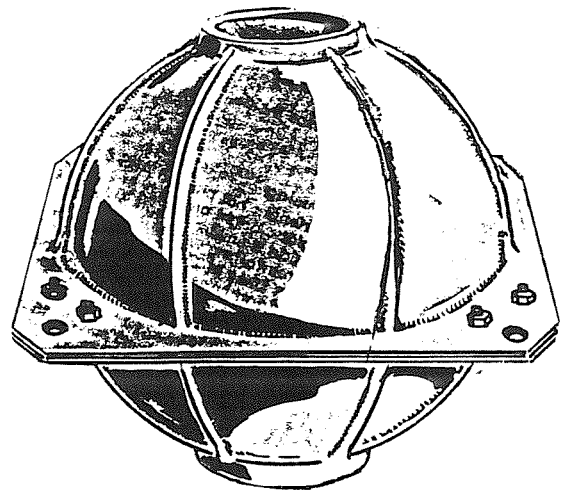
Glass Spheres

Twenty two glass spheres are required for the IOSDL mooring section,to act as back up buoyancy should the steel sphere fail.
On competetive tender the order was placed for Benthos spheres encased in OCEANO hard hats.
These units require drilling to accept 1/2" Commercial Dee shackle pins for chain mounting.

Supplier. OCEANO Instruments UK Ltd. 9 Broompark,Granton Park Ave,Industrial Est,Edinburgh
Type. Glass sphere 17",2040-17V,Tested.Fitted into OCEANO Hyper 6 hard hat.
Shipping. The spheres are shipped in the manufacturers disposable cardboard cartons.

Glass sphere assembly for ADOX

2040-17V



Hyper 6 Hard hat.

Pick up Buoys

Pick up buoys are used on the mooring recovery line to buoy up the recovery line when the mooring is released.The buoys then keep the recovery line clear of the subsurface as it rises and buoy the line at the surface.
IOSDL has used commercial fishing floats for this purpose.However catastrophic flooding has occured with a recent batch from one manufacturer,experienced by IOSDL and PML.
The purchase of these floats was conducted on the most historically reliable units available,not on cost.

Supplier. Bridport Gundry Marine
Type. Pantherplast float,11" diameter,8.5kg buoyancy,working depth 500m,Centre hole.

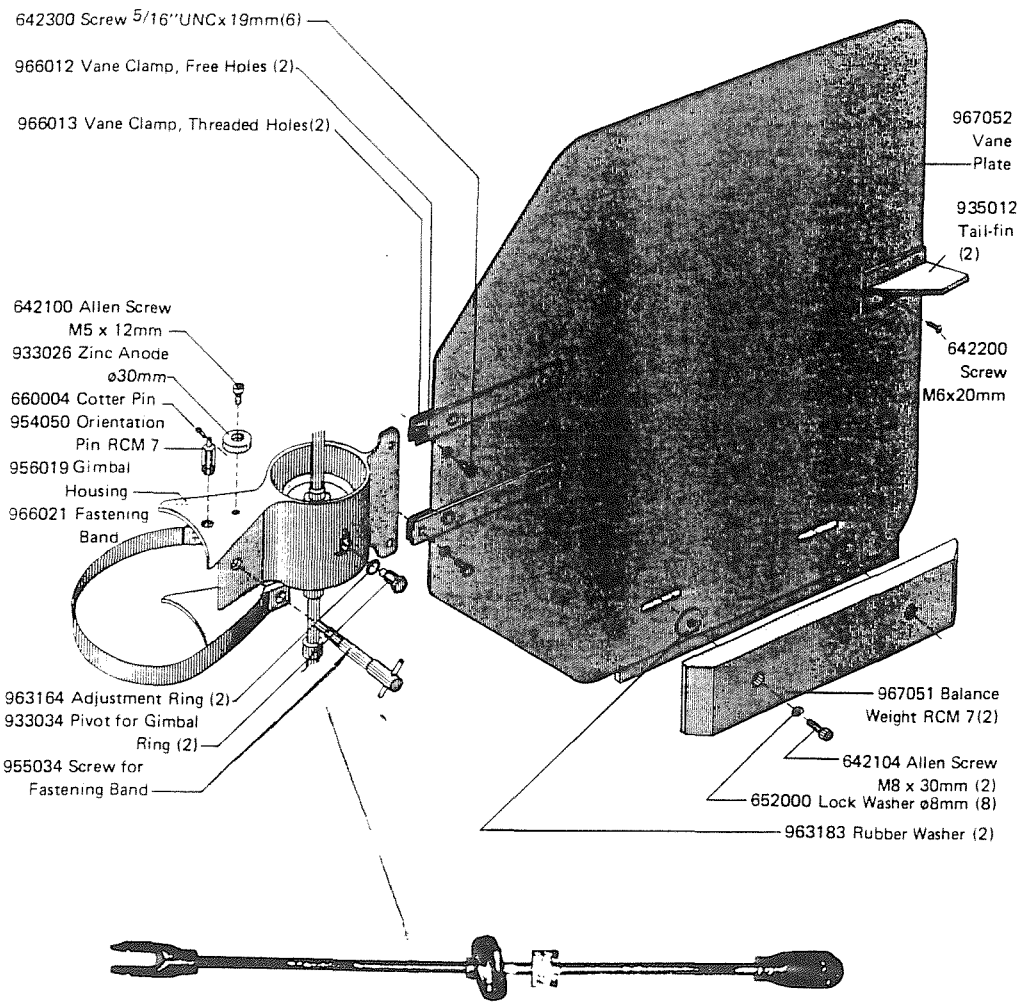
Aanderaa Current Meter Vanes

The current meters are all of the RCM7 and RCM8 types.These units were supplied to IOSDL without Spindles,part no.3115,as IOSDL does not use this reduced length pattern.This is due to interference from mooring components on the adjacent compass.

Stainless steel spindles,part no.971207,are to be used from IOSDL stock.These are of increased length and have been used successfully by IOSDL for 1 year moorings.It should be noted that these spindles have been superceded by Titanium units manufactured by IOSDL to increase duration to 2 years.

All the spindles were dismantled to their component parts and inspected for wear and corrosion.All suspect parts were rejected.
There were suffucient parts,in sets as we did not wish to mix partsand thus perhaps induce corrosion,to assemble the 8 required units.

Vane assembly.



Assembly of Vanes

The spindles were stripped of all manufactures paint and three coats of Hypalon rubber applied to seal the surfaces.The ball races were all cleaned and new balls fitted as required,a minimal number actually needed replacement.
The end forks were refitted with the threads sealed with TECTYL 506 to inhibit crevice corrosion.
The completed spindle assemblies were then overcoated with TECTYL 506 as a protective surface coat.

The RCM7 and 8 Gimbal housings,Part no.956019,were new as received from the manufacturer.Corrsion has been noted in the threads of this assembly and so all components were dismantled and threads and surfaces coated with TECTYL 506.
The Spindle assembly and the Gimbal housings were then assembled together with the pivots overcoated with TECTYL.The pivots were locked in place with PVC coated wire rather than the manufacturers supplied stainless steel,this has been seen to corrode.

Shipping

The units were then assembled with their current meters and air balanced,all parts were numbered and the units disassembled as sets for shipping.

Note:1.All threads and surfaces on the vane plate metal parts will need to be sealed with TECTYL 506 on assembly onboard Discovery.

2.Recheck the spindle coatings and overcoat as necessary with TECTYL 506.

ADOX Technical File

3.Aanderaa Current Meters

Index

Current Meter Specifications

IOSDL is to supply the current meters for the extended moorings C and F.The depths and sensor configurations are;

Depth	Mooring C & Mooring F				
300m	Aanderaa RCM 7.	Operating depth 2000m		6 channel digital recording	
	Sampling Interval	60 minutes	Vector Sampling	50 times per sample period	
	Channel 1	Reference	Channel 2	Temperature	Low range -2.46 to +21.48C
	Channel 3	Not used	Channel 4	Pressure	0-3000 psi
	Channel 5 & 6	Current Speed and Direction			
600m	Aanderaa RCM 7.	Operating depth 2000m		6 channel digital recording	
	Sampling Interval	60 minutes	Vector Sampling	50 times per sample period	
	Channel 1	Reference	Channel 2	Temperature	Low range -2.46 to +21.48C
	Channel 3	Conductivity 30 to 40 mmhos	Channel 4	Temperature	Special range +2 to +10C
	Channel 5 & 6	Current Speed and Direction			
1300m	Aanderaa RCM 8.	Operating depth 6000m		6 channel digital recording	
	Sampling Interval	60 minutes	Vector Sampling	50 times per sample period	
	Channel 1	Reference	Channel 2	Temperature	Low range -2.46 to +21.48C
	Channel 3	Not used	Channel 4	Temperature	Special range +1 to +7C
	Channel 5 & 6	Current Speed and Direction			
2000m	Aanderaa RCM 8.	Operating depth 6000m		6 channel digital recording	
	Sampling Interval	60 minutes	Vector Sampling	50 times per sample period	
	Channel 1	Reference	Channel 2	Temperature	Low range -2.46 to +21.48C
	Channel 3	Not used	Channel 4	Temperature	Special range 0 to +6C
	Channel 5 & 6	Current Speed and Direction			

Current Meter Allocation

The current meters were selected from the WOCE purchase stock and modified to the required sensor configurations at IOSDL.

Depth	Mooring C	Mooring F
300m	**Ser.10855**	**Ser.10856**
600m	**Ser.10854**	**Ser.10862**
1300m	**Ser.10113**	**Ser.9967**
2000m	**Ser.9969**	**Ser.9968**

Sensor Modification

All the sensors used are standard Aanderaa sensors modified for "Special"ranges at IOSDL.

Special Range Temperatures.

IOSDL Marine Physics Group has fitted the special range temperature to Channel 4 which enhances the accuracy of the instrument for a given reduced range.Ranges were proposed by S G Alderson,internal memo 28-iv-1992.

This is achieved by connecting terminals 4 and 14 on the electronic board and fitting selected high grade resistors between terminals 34 and 14b,34 and 15b.A Basic program has been written,S Watts RVS 1990, which is used to accurately determine the resistor values required for a specified range.Determination carried out by K M Goy 29-iv-1992.

Range deg.C	**R 14b Ohms**	**R 15b Ohms**
+2 to +10	633	546
+1 to +7	500	395
0 to +6	514	387

The resistors used are Precision Metal Film with a resistance tolerance of +/- 15 ppm/degree C ,ambient temperature range -55 to +155C ,power rating 0.125W.Careful selection of resistor values is carried out to obtain the best match to the theoretical values above.
The resistors are carefully soldered to the tags on the board and the range checked by substituting an accurate Vishay resistance box for the thermistor.The box resistance is varied to known thermistor resistances,corresponding to the desired range,establishing correct range selection and performance.

Conductivity Ranges

A conductivity range was suggested,S G Alderson internal memo 28-iv-1992,for the current meters at 600m which is also to be included in the SWINDEX current meter array.
The range and lower point are determined using the Aanderaa factory formulae ;

Total conductivity range required 10 mmho/cm

$$\text{Range mmho/cm} = \frac{1000}{WR5 + 1000} \times 90.5$$

Where WR5 is a resistor between terminals 18 and 17 on the current meter electronic board,value in ohms.

Lower range point required 30mmho/cm

$$\text{Lower range point} = \frac{1000}{WR6} \times 90.5$$

Where WR6 is a resistor between terminals 14 and 17 on the current meter electronic board,value in ohms.

The resistors used are Precision Metal Film with a resistance tolerance of +/- 15 ppm/degree C ,ambient temperature range -55 to +155C ,power rating 0.125W.Careful selection of resistor values is carried out to obtain the best match to the theoretical values above.
The resistors are carefully soldered to the tags on the board and the range checked by placing a wire loop connected to an accurate Vishay resistance box through the conductivity cell.The box resistance is varied to simulate conductivity values,corresponding to the desired range,establishing correct range selection and performance.

The most suitable resistore values are WR5 = 8450 ohms WR6 = 3160 ohms

These give a Lower point = 29.93 ohms and a range of 10.01 ohms.

Current Meter Calibrations

All the sensors are calibrated at IOSDL by Marine Physics staff using established techniques and standards. A spreadsheet was developed to enhance presentation,archiving and data processing has for 1992 and calibration sheets in this document are in this format.
M Hartman and K M Goy.

Temperature Calibrations

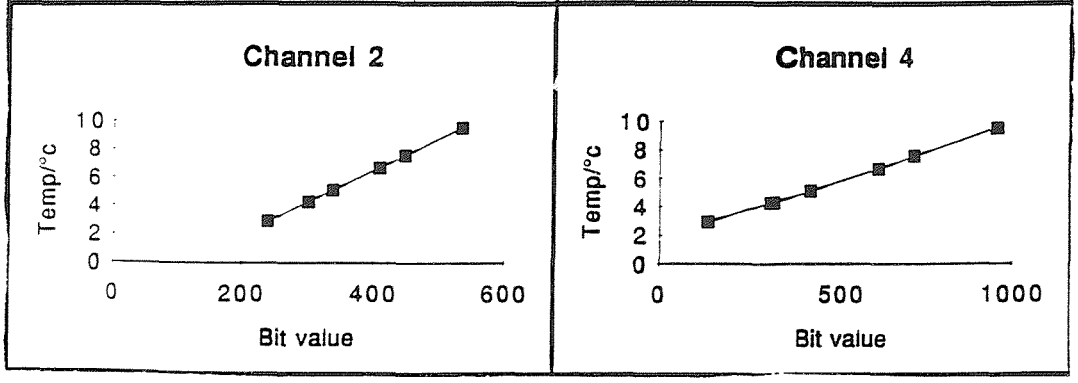
IOSDL calibrates temperature sensors by immersing the current meter completely in a controlled,well stirred temperature bath and varying this bath through the expected temperature range.With the bath at a stable temperature the temperature is measured using an ASL Ac F25 precision digital thermometer.The current meter is externally triggered from a Printer 2860 and the current meter values noted.This technique simulates the instrument in the ocean and thus all components which may have an effect on calibration are subjected to temperature change.

The calibration is controlled manually and progress is monitorred as the temperature is changed,this has been found to be most effective in identifying defective units before an invalid calibration is produced.
An example of a calibration is given below

Temperature Calibration.Current Meter Ser.10854. Temperature Ch 2 & Ch 4

Date	Site	Range	Operator	Standard			
Sep-92	IOSDL	2 to 10°c	GOY	F25			
T/°c	T(cal)/°c	Channel 2	Channel 4	Calc. Ch.2	Ch.2 Error	Calc. Ch.4	Ch.4 Error
2.908	2.905106	240	136	2.892	0.013	2.898	0.007
4.287	4.283031	302	308	4.289	-0.006	4.285	-0.002
5.078	5.07343	337	406	5.078	-0.004	5.076	-0.003
6.696	6.690235	409	607	6.700	-0.009	6.697	-0.007
7.557	7.550619	447	713	7.556	-0.005	7.552	-0.002
9.535	9.527254	534	957	9.516	0.012	9.521	0.007

	Slope	Intercept	F25 Calibration Coefficients		
			C	B	A
CHANNEL 2	2.253E-2	-2.51475	9.10E-6	9.99E-1	-5.12E-4
CHANNEL 4	8.067E-3	1.80093			



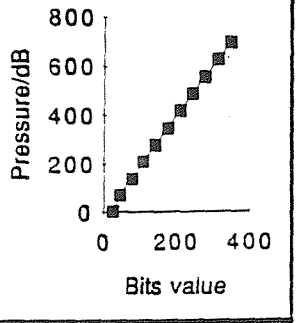
Pressure Calibrations

Pressure sensors are calibrated at IOSDL by Marine Physics Staff using a Budenberg 10543/280L Deadweight Tester.The tester is connected to the pressure transducer stem using an adaptor developed by IOSDL OIG workshops,R Peters 1992.Pressure is varied on the sensor from 0 psi,ambient air,through the expected pressure range with current meter output values monitorred on a Printer 2860.Values are noted at stable pressure values both on increasing and decreasing pressure to establish the calibration and also to monitor any hysterisis of the sensor.

An example of a calibration is given below

Pressure Calibration.Current Meter Ser.10856.Sensor range 0 to 3000 psi.Calibration Range 0 to 1000 psi.

Date	Pressure		Reading	Calculated	Error
Oct-92	PSI	dBars	Bits	Pressure dB	dB
Site	0	0	26	24.415899	-24.4159
IOSDL	100	68.9708	46	65.690128	3.280672
Range/PSI	200	137.9416	77	129.66518	8.276418
0 to 3000	300	206.9124	110	197.76766	9.144741
Operator	400	275.8832	144	267.93385	7.949353
GOY	500	344.854	179	340.16375	4.690253
Standard	600	413.8248	214	412.39365	1.431153
BUD	700	482.7956	248	482.55983	0.235765
Sensor No	800	551.7664	282	552.72602	-0.95962
501	900	620.7372	317	624.95592	-4.21872
	1000	689.708	351	695.12211	-5.41411



Slope	Intercept
2.06371	-29.2406

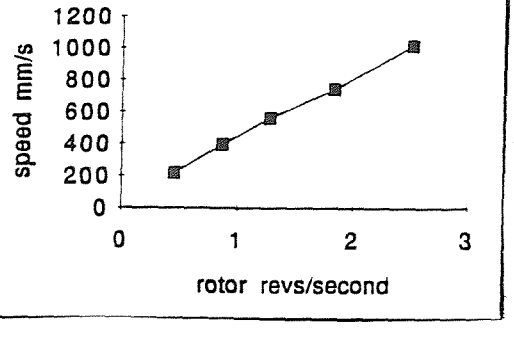
Rotor Calibration

Rotor calibrations are carried out in the IOSDL tow tank with the instruments being towed in water at at controlled speeds.The tow speed is accurately monitorred and rotor response is determined at steady state tow speeds.Rotor revolutions are counted using a Hall effect diode mounted on the top cap of the current meters.Rotor threshold,the lowest tow speed at which the rotor responds,is determined.
Tow speeds for ADOX are from threshold,typically 12 to 20 mm/sec, up to 1000 mm/sec.

An example of a calibration is given below

Rotor Calibration.Current Meter Ser.10856.Calibration Range 214.5mm/sec to 1020.5 mm/sec

RCM	10856	Calibration Spreadsheet
RCM No.	Mean rotor	Carriage
10856	revs/sec	speed mm/s
Date	0.4561978	214.5
28/9/92	0.8650737	394
Operator	1.267703	561.9
MCH.GOY	1.823347	739.6
Threshold	2.513806	1020.5
12.0	Slope	Intercept
mm/s	384.791	53.078



Compass Calibration

The RCM 7 and 8 current meters use fixed coefficients in the internal calibration formulaes.At IOSDL the compasses are checked for errors from the theoretical values.Error offset is equalised about each side of the theoretical values by adjusting the compass position on the mounting plate.
The later series of current meters are fitted with a Rotor counter switch type 3240 which detects the rotor revolutions using a Hall effect sensor.This arrangement causes the compass to be offset dependent on the rotor position.
Calibration is carried out to minimise this effect.
An example of a calibration is given below

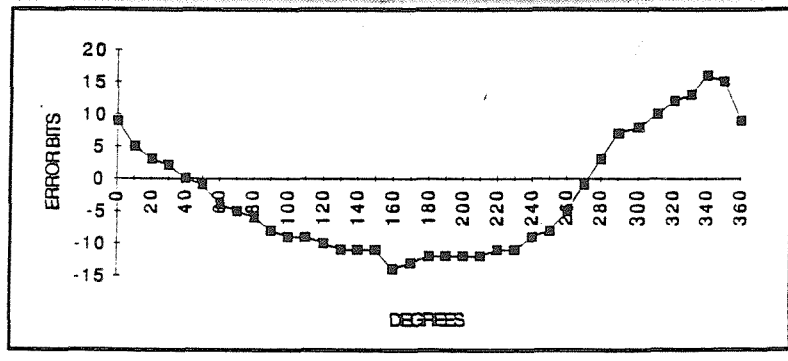
Compass calibration.Current meter Ser.10854.

Institute of Oceanographic Sciences
Deacon Laboratory
Marine Physics Dept.
Aanderaa Compass Calibration

Calibration Date	13/10/92
ACM Serial No.	10854
Comp. Ser. No.	18645
Calibration Site	IOSDL
Operator	MCH

Degrees	Reading	Perfect	Error	Degrees	Reading	Perfect	Error
0	9	0	9	190	528	540	-12
10	33	28	5	200	556	568	-12
20	60	57	3	210	585	597	-12
30	87	85	2	220	614	625	-11
40	114	114	0	230	643	654	-11
50	141	142	-1	240	673	682	-9
60	167	171	-4	250	702	710	-8
70	194	199	-5	260	734	739	-5
80	221	227	-6	270	766	767	-1
90	248	256	-8	280	799	796	3
100	275	284	-9	290	831	824	7
110	304	313	-9	300	861	853	8
120	331	341	-10	310	891	881	10
130	358	369	-11	320	921	909	12
140	387	398	-11	330	951	938	13
150	415	426	-11	340	982	966	16
160	441	455	-14	350	1010	995	15
170	471	484	-13	360	9	0	9
180	500	512	-12				

Dead band				Cardinal Points			
Degrees	Reading	Perfect	Error	Degrees	Reading	Perfect	Error
355	1020	1011	9	0	6	0	6
356	1023	1014	9	90	247	256	-9
357	2	1017	9	180	500	512	-12
			0	270	766	767	-1



Vector Averaging of Current Speed and Direction

Rotor revolutions and compass direction are sampled every 12 seconds during the set sample interval.The data is combined to represent a current vector,the magnitude derived from rotor revolutions and direction from the compass reading.The current vector is resolved into East-West and North-South Components which are successively added and stored.At the end of the sample period the resulting average vector and its angle are calculated internally and stored to the DSU.

Current Meter Testing and Preparation

Performance of the current meters is monitorred throughout the calibration proceedures.Subsequent to sucessfull calibrations being produced further tests are carried out.

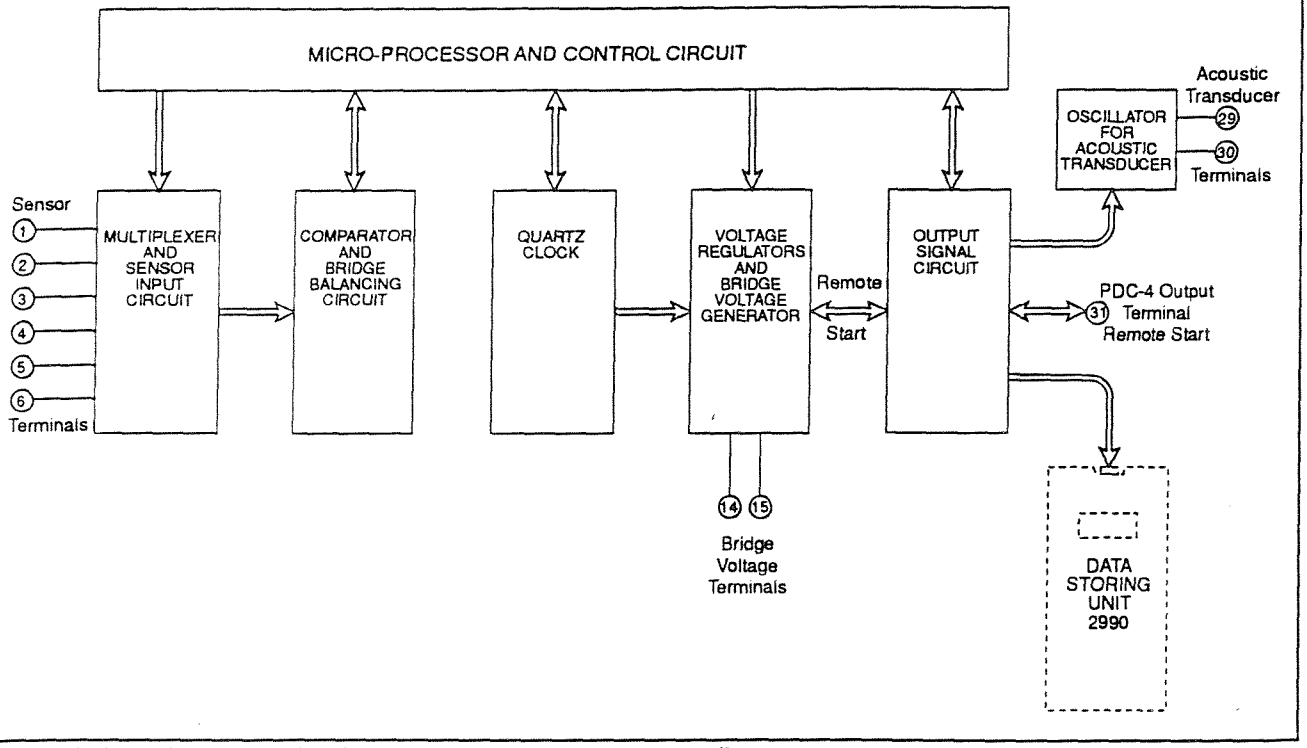
Time keeping and data recording

The current meter is controlled by a Quartz crystal clock unit with a quoted accuracy of +-2 seconds a day over a temperature range of 0 to 20 C.The main electronics battery pack is a custom built Lithium pack,L9-10.
The Data storage unit is an EEPROM unit,part no 2990E,with an internal clock,quoted accuracy +- 2 seconds a day -10 to 45 C,giving real time information which is recorded.Storage capacity 262,137 12 bit words.
The unit is powered by the main battery pack when the current meter is switched on and powered by an internally fitted Lithium AA cell,life time quoted at 7 years.

The current meters are set up in the laboratory to sample at the deployment interval,fitted with the deployment battery pack.Voltages and current drain are measured from the battery pack with the current meter in its quiescent and sampling states.
The Data storage unit,DSU, is cleared of all data and the clock reset.
The current meters are started at accurately known times and run for several days on the bench with rotors turning.
Timing of the samples is noted on the DSU read out and any internal clock drift determined.

On completion of the test the end time,last data cycle time and battery pack voltages are noted.
The DSU is then removed and downloaded to a PC using the Aanderaa reading program,P3059.The data is then analysed for correct current meter and DSU operation.

Block diagram of Current meter Electronic Sampling and Data Logging,Aanderaa Handbook page 3-03.



On completion of the tests the Data storage unit is reset and all test data erased.
The current meter is switched off and the main battery disconnected.

Pressure case Seals

All the O ring seals and faces are checked and greased.Units with Conductivity cells are pressure tested to the deployment depth as evidence of leakage from these sensors has been noted.

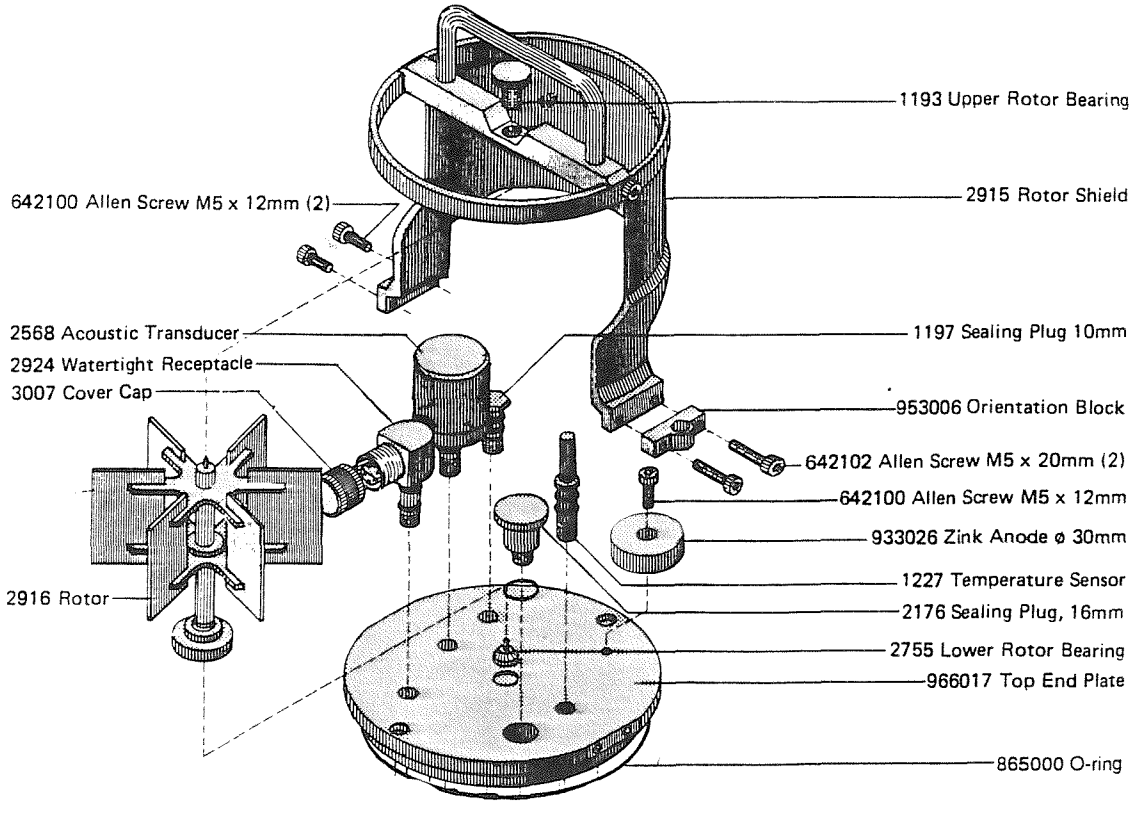
Corrosion protection

IOSDL does not use the Acoustic transducer,Part no.2568,as this provides no usable function in deep ocean,long term applications.Similarily the water tight receptacle,Part no.2924,is used only for calibration and operational checks.This part is removed on completion of all tests and the orifice sealed with Sealing plug,Part no.1197.

All the stainless steel external screws are removed and the threads coated with TECTYL 506 to act as a sealer.This inhibits crevice corrosion caused by sea water trapped within the threads.The screws are then replaced and excess TECTYL ,forced from the threads,brushed evenly around the screw head.

A new Zinc anode,Part no.933026,is fitted to the top end plate.

Illustration of parts removed and protected.Aanderaa handbook 8.15



Shipping

The current meter is shipped purged with Nitrogen Grade N 4.8 (Zero) and sealed.This is to maintain a dry atmosphere within the pressure case.

The Aanderaa supplied shipping cases are used for all transport operations.

ADOX Technical File

4.Mooring Sub assemblies

Index

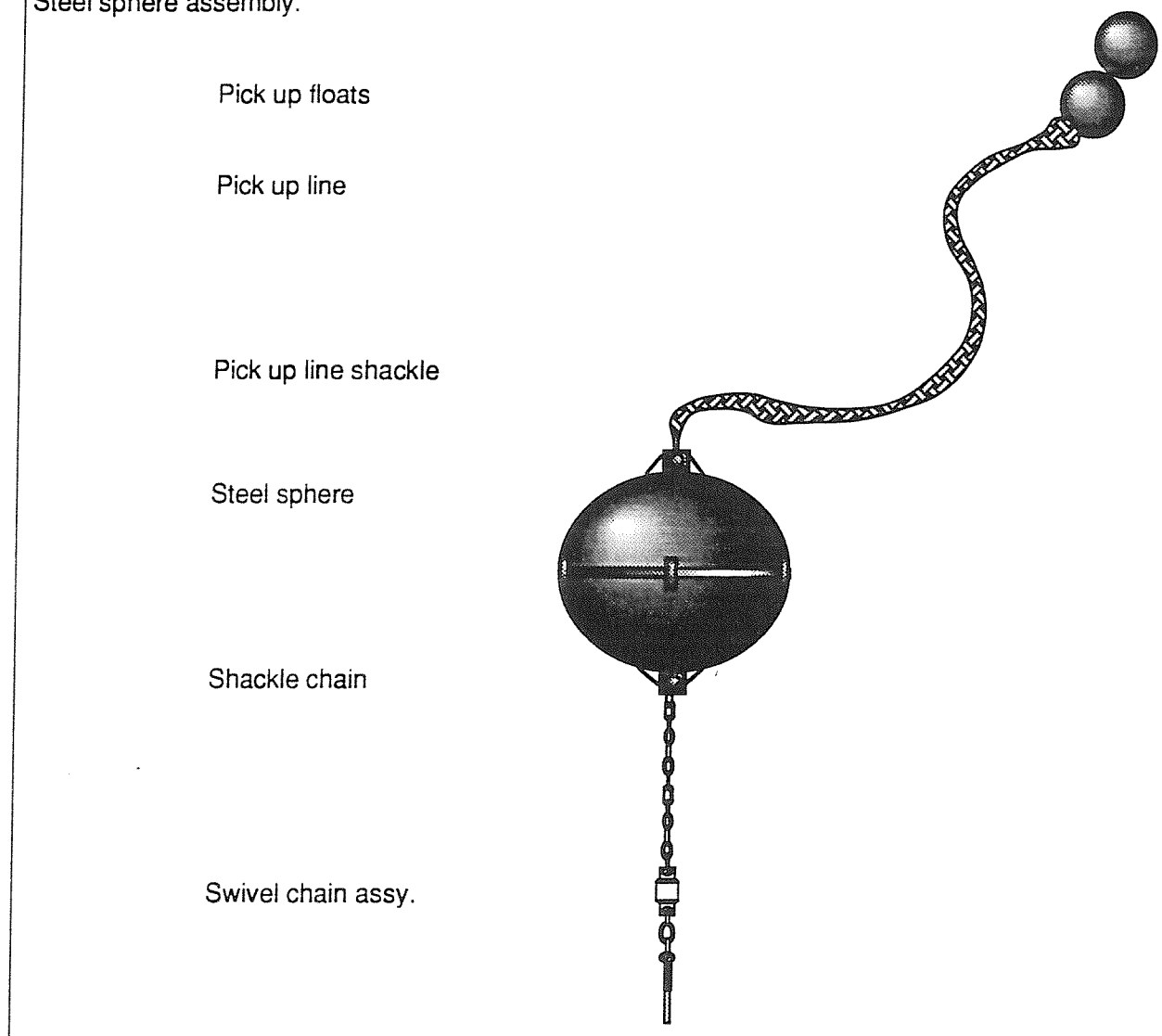
Steel Sphere Assembly

The steel sphere is the main buoyancy of the system.If we consider the all the hardware associated with the sphere,but not including the mooring line,as an assembly the parts list is;

Pick up floats	SW001	2	Pantherplast 11" dia
Buoy 1.3m dia steel	SW004	1	IOSDL pattn.
Pick up line	SW002	1	15m 22mm STURDEE 3 strand
Pick up line shackle	SW003	1	5/8" Bow Green pin Alloy
Shackle chain	SW005	1	5/8" Bow Green pin Alloy
Swivel and chain assy.	SW006	2	S/S IOSDL swivel,5/8"chain & shackles
Cable ties	SW033	6	RS 543-349 or RS TY525 MXR

The assembly is put together onboard immediately before deployment.The buoy is positioned adjacent to the stern on its stand.All shackles tightened and seized with cable ties.

Steel sphere assembly.



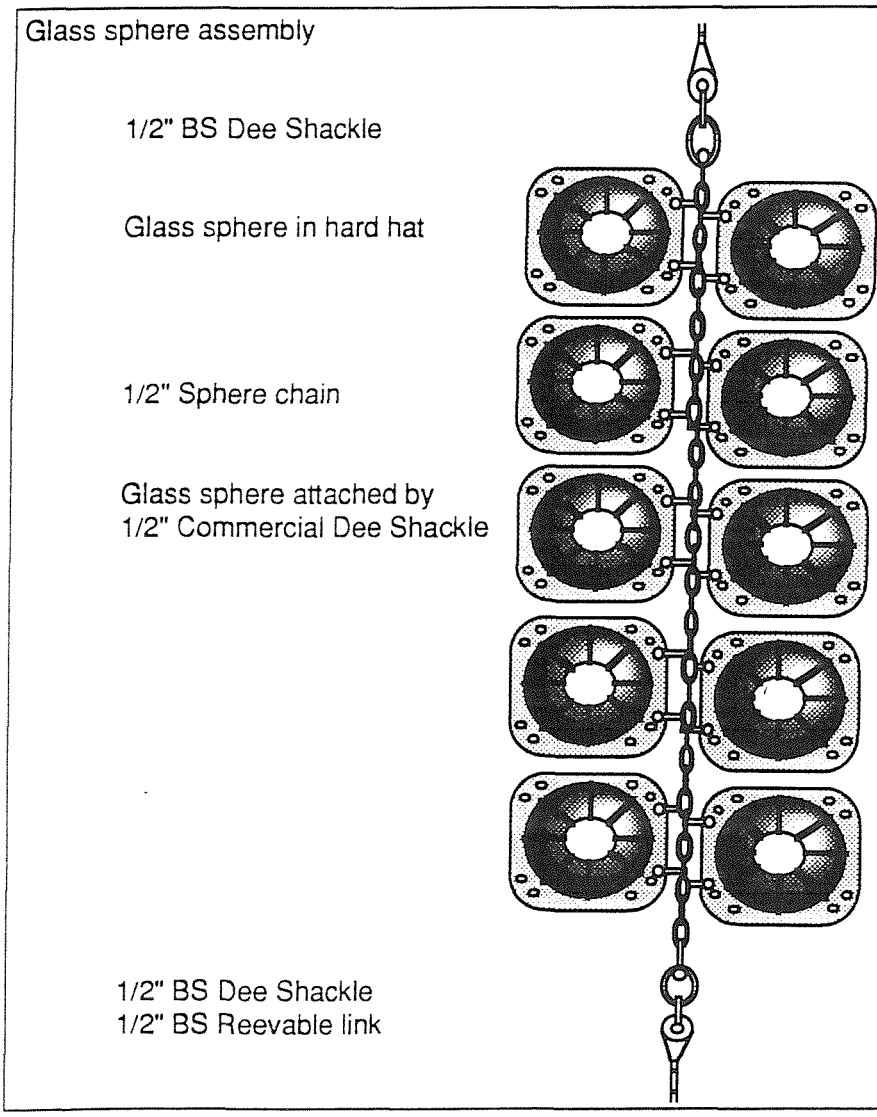
Glass Sphere Assembly

The IOSDL spheres are to be shackled to a section of 1/2" long link chain.Each sphere is secured with two Commercial pattern 1/2" Dee shackles.The sphere hard hats are drilled,13mm,to take the shackle pins.The shackles are passed through the chain and secured by the pins to the hard hats.All the shackle pins are greased with DCMC heavy duty chain grease and seized with cable ties.Each end of the chain has a 1/2" BS Dee shackle fitted with the lower end having a 1/2" reevable link included.The upper end utilises the reevable link already in the mooring line which is used to stop off.

The parts required are;

Shackle Dee 1/2"	SW016	2	BS 1/2" Dee
Reevable link 1/2"	SW017	1	BS 1/2" Reevable(Pear shape)
Glass sphere 17"	SW028	10	2040-17V in Hyper 6 Hard hat
Sphere chain assembly	SW029	1	2.5m 1/2" long link galvanised
Glass sphere shackle 1/2"	SW032	20	Commercial 1/2" Dee Galvanised
Cable ties	SW033	22	RS 543-349 or RS TY525 MXR

Glass sphere assembly



Anchor Assembly

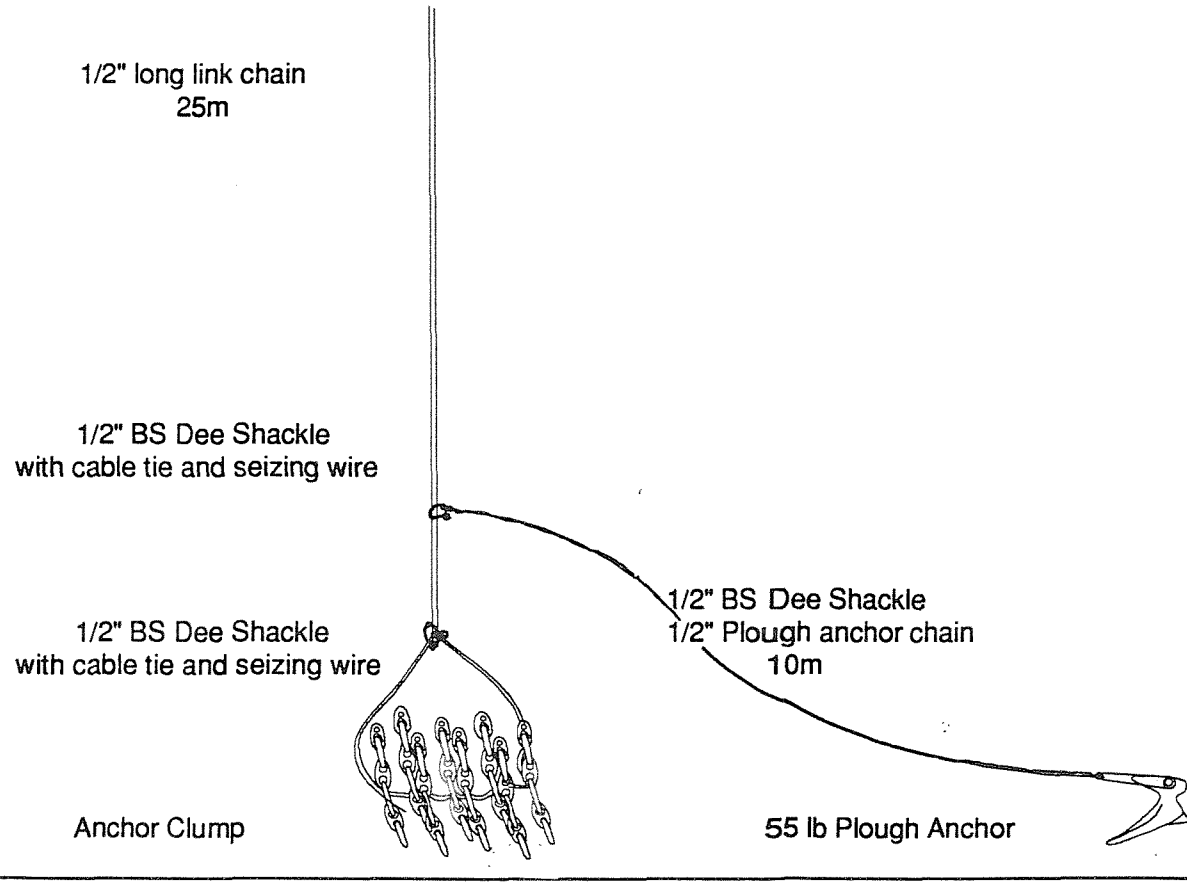
The anchor assembly is to be provided by IOSDL and MAFF.
MAFF is to provide the scrap anchor chain clump.IOSDL to provide all chains and shackles.

The anchor assembly is designed as an IOSDL standard high current mooring,this being a requirement to provide a weak link at the IOSDL section and an anchor requirement to hold the mooring on position when subjected to possible iceberg drag at the subsurface.ADOX Technical file 1.

The parts required are;

Plough anchor 55 lb		AD005	1	Plough anchor Galvanised
Plough anchor chain		AD006	1	10m 1/2" long link galvanised
Anchor chain 13mm	25m	AD007	1	25m 1/2" long link galvanised
Shackle Dee 1/2"		SW016	4	BS 1/2" Dee
Reevable link 1/2"		SW017	1	BS 1/2" Reevable(Pear shape)
Cable ties		SW033	4	RS 543-349
Seizing wire		No part	4	Galvanised Fencing 3mm

ADOX Anchor assembly.



ADOX Technical File

5.Required parts and Loading

Index

ADOX Mooring Hardware Parts List

IOSDL is to supply all the parts for the extension of moorings C and F Crozet/Kerguelen Array.The list below is parts required plus line adjustment.

Item	Part No	Total	Value	Package
Mooring wire 6mm Jkt 300m	SW022	4	1200	4 reels
Mooring wire 6mm Jkt 30m	SW007	4	1200	1 carton(d)
Mooring line 10mm poly 368m	SW025	4	800	4 reels
Mooring line 10mm poly 184m	SW024	1	100	1 reel
Mooring line 10mm poly 460m	SW012	2	500	2 reels
Mooring line 10mm poly 276m	SW011	2	300	2 reels
Mooring line 10mm poly 46m	AD002	1	20	1 carton(a)
Mooring line 10mm poly 92m	SW008	1	45	1 reel
Mooring line 10mm poly 46m	AD002	3	75	1 carton(a)
Mooring line 10mm poly 92m	SW008	7	350	7 reels
Mooring line 12mm poly 10m	AD001	6	120	1 carton(b)
Mooring line 12mm poly 30m	AD003	1	25	1 carton(b)
Pick up floats	SW001	4	40	1 carton(c)
Buoy 1.3m dia steel	SW004	2	4000	Onboard
Pick up line	SW002	2	20	1 carton(c)
Pick up line shackle	SW003	2	6	M box 3
Shackle chain	SW005	2	6	M box 3
Swivel and chain assy.	SW006	2	800	M box 3
In line swivel assy.	SW010	4	1400	M box 3
Shackle Dee 1/2"	SW016	100	100	M box 3
Reevable link 1/2"	SW017	30	30	M box 3
Glass sphere 17"	SW028	20	7000	Onboard
Sphere chain assembly	SW029	2	30	M box 3
Sphere stand	ST001	2	200	Onboard
Mooring line 14mm poly 25m	SW030	6	150	1 carton(d)
Mooring line 16mm nylon 20m	AD004	2	80	1 carton(a)
Plough anchor 55 lb	AD005	2	200	Loose items
Plough anchor chain	AD006	2	25	Cardboard barrel
Anchor chain 13mm 25m	AD007	2	75	Cardboard barrel
Stopper chain 5/8"	AD008	1	30	M box 3
Stopper shackles 1/2"	AD009	10	10	M box 3
Stopper shackles 3/4" pin	AD010	3	15	M box 3
Stopper shackles 1" pin	AD011	3	24	M box 3
Mooring wire 10m(spares)	AD012	2	30	1 carton(a)
Polypropylene line 18mm 200m	No part	1	100	1 reel
Glass sphere shackle 1/2"	SW032	50	25	M box 3
Mooring wire bushes	SW021	16	16	M box 3
Winch rope Polypropylene 50m	No part	1	45	1 carton(e)

Loading for Southern Ocean Cruises

ADOX equipment will be loaded in three shipments.

1.Departing onboard Discovery from Barry South Wales.**Load list ADBSW.**
Steel buoyancy spheres,Glass buoyancy spheres,Nitrogen bottles,Pyros.

2.Departing IOSDL by hire container.**Load list ADR1A**
Mooring Hardware,Double barrel winch and associated parts,SWINDEX spare lines,Deck tools and handling equipment.

3.Departing MAFF Lowestoft by container.**Load list ADR1B**
Instrumentation,deck control equipment,personal gear.

Equipment identification.

All **mooring hardware** is identified by a series of part numbers.There are two main series AD prefix which is ADOX only and SW prefix which are parts common to SWINDEX and ADOX.
Parts Lists have been drawn up indicating item,part number,number off,value and package identification.
It is proposed to weigh items for loading both for container freight and for positioning onboard Discovery.

Ancilliary equipment,tools,test equipment,winch etc will be identified by description,number off,value and package identification.Weights and sizes will be obtained for container freight and positioning onboard Discovery.

Current Meters and hardware,will be identified by manufacturers serial number, type and value. Packaging for current meters will be in two parts,current meter logger and current meter vane assembly each with corresponding serial numbers.

Current Meter test equipment,will be identified by description,serial number,value and package identification..

Acoustics equipment,should follow the same format as for Current meters and test equipment.

Personal gear will need to be identified by description,value and packaging.But not labelled as Personal.

ADOX Mooring Hardware Parts List
Load List ADR1A
Shipping from IOSDL by Container 1 of 2

Item	Part No	Total	Value	Package	Weight Total kg
3.Mooring line 10mm poly 368m	SW025	4	800	4 reels*	128
4.Mooring line 10mm poly 184m	SW024	1	100	1 reel*	18
5.Mooring line 10mm poly 460m	SW012	2	500	2 reels*	76
6.Mooring line 10mm poly 276m	SW011	2	300	2 reels*	48
8.Mooring line 10mm poly 92m	SW008	1	45	1 reel*	11
10.Mooring line 10mm poly 92m	SW008	7	350	7 reels*	77
16.Pick up line shackle	SW003	2	6	M box 3*	227
17.Shackle chain	SW005	2	6	M box 3*	
18.Swivel and chain assy.	SW006	2	800	M box 3*	
19.In line swivel assy.	SW010	4	1400	M box 3*	
20.Shackle Dee 1/2"	SW016	100	100	M box 3*	
21.Reevable link 1/2"	SW017	30	30	M box 3*	
23.Sphere chain assembly	SW029	2	30	M box 3*	
27.Plough anchor 55 lb	AD005	2	200	Loose items*	48
28.Plough anchor chain	AD006	2	25	Cdbd barrel*	75
29.Anchor chain 13mm 25m	AD007	2	75	Cdbd barrel*	
30.Stopper chain 5/8"	AD008	1	30	M box 3*	
31.Stopper shackles 1/2"	AD009	10	10	M box 3*	
32.Stopper shackles 3/4" pin	AD010	3	15	M box 3*	
33.Stopper shackles 1" pin	AD011	3	24	M box 3*	
35.Polypropylene line 18mm 200m	No part	1	100	1 reel*	25
36.Glass sphere shackle 1/2"	SW032	50	25	M box 3*	
37.Mooring wire bushes	SW021	16	16	M box 3*	

IOSDL to ship 9695 Pounds Sterling IOSDL to ship 506 kilos IOSDL to ship 8 cu metres

SWINDEX and ADOX Deck Equipment

Item	Part no	Total	Value	Package	Weight Total kg 1.Drum
stands Blue steel	DE001	3	300	Loose items* 30	
2.Cleats Blue steel	DE002	3	150	M Box 3	
3.Tackles Stainless Steel	DE003	2	200	M Box 3	
4.Bolt cutters HUBA	DE004	1	180	Loose item	10
5.Crow bar 1.5m length	DE005	1	50	Loose item	10
6.Mooring Sheave with side lugs	DE006	1	300	Loose item*	62
7.Mooring Sheave 5" centre	DE007	2	400	Loose item*	152
10.Tool kit Green Steel Box	DE010	1	1000	Tool box A*	40
13.Bolt cutters FELCO C5	DE013	1	200	Tool box A	
14.Winch Double Barrel with Power Pack	DBC1	1	38000	Loose item*	
15.Storage winch on base	DBC2	2	10000	..*	
16.Metering Sheave on base	DBC3	1	300	..*	
17.Divertor Sheave on base	DBC4	1	200	..*	
18.Storage winch steel drums	DBC5	4	800	..*	
19.Storage winch drum stands	DBC6	4	400	..*	
20.Steel deck channels(cable tray)	DBC7	2	100	..*	54
21.Steel deck channels(hydraulic hose)	DBC8	1	50	..*	
23.Stopper shackles 5/8" pin	---------	8	24	M box 3	
24.BOSS hook S6	---------	4	120	M box 3	
25.No Load Hook,Admiralty patt.	---------	1	50	M box 3	
26.Nylon tow line 16mm 10m length	---------	1	30	M box 3	

IOSDL to ship 51850 Pounds Sterling

Load List ADR1A continued
SWINDEX Parts List
Required items total List SWR92 **2 of 2**

Item	Part no	Total	Value	Package	Weight Total kg
3.Pick up line shackle 5/8	SW003	8	24	M Box 1*	180
5.Shackle chain 5/8	SW005	8	24	M Box 1*	
6.Swivel and chain assy	SW006	8	3200	M Box 1*	
10.In line swivel assy	SW010	8	3000	M Box 1*	
16.Shackle Dee 1/2"	SW016	250	250	M Box 2*	
17.Reevable link1/2"	SW017	100	100	M Box 2*	

Spare parts and adjustment List SWS92

Item	Part no	Total	Value	Package	Weight
4.Mooring wire 100m	SW008	2	200	2 reels *	24
5.Mooring wire 200m	SW009	2	400	2 reels *	48
6.Polyester line 300m	SW011	4	600	4 reels *	96
7.Polyester line 500m	SW012	2	500	2 reels *	76
11.Shackle Dee 1/2"	SW016	100	100	M Box 2*	
12.Reevable link1/2"	SW017	50	50	M Box 2*	
15.Mooring wire 300m	SW022	2	600	2 reels *	72
16.Mooring wire 400m	SW023	2	800	2 reels *	96
18.Polyester line 200m(LIROS)	SW024	3	300	3 reels *	54
19.Polyester line 400m	SW025	2	400	2 reels *	64
20.Polyester line 100m	SW026	7	350	7 reels *	84
23.Sphere chain assembly	SW029	1	15	M Box 2*	
24.Shackle 13mm Commercial	SW032	50	5	M Box 2*	

ADOX Mooring Hardware Parts List
Load list **ADR1B**
Shipping from MAFF by Container **1 of 2**

Equipment to be shipped to MAFF by IOSDL transport.

Item	Part No	Total	Value	Package	Weight Total kg
1.Mooring wire 6mm Jkt 300m	SW022	4	1200	4 reels	144
2.Mooring wire 6mm Jkt 30m	SW007	4	120	1 carton(d)	39
7.Mooring line 10mm poly 46m	AD002	1	20	1 carton(a)	27
9.Mooring line 10mm poly 46m	AD002	3	75	1 carton(a)	
11.Mooring line 12mm poly 10m	AD001	6	120	1 carton(b)	11
12.Mooring line 12mm poly 30m	AD003	1	25	1 carton(b)	
13.Pick up floats	SW001	4	40	1 carton(c)	15
15.Pick up line	SW002	2	20	1 carton(c)	
25.Mooring line 14mm poly 25m	SW030	6	150	1 carton(d)	39
26.Mooring line 16mm nylon 20m	AD004	2	80	1 carton(a)	
34.Mooring wire 10m(spares)	AD012	2	30	1 carton(a)	
38.Winch rope Polypropylene50m	No part	1	45	1 carton(e)	20
39.Cable ties	SW033	200	8	AL box 01	
40.Mooring wire 6mm jkt 30m	SW007	2	60	1 carton (f)	20
41.Polypropylene line 18mm 40m	No part	1	40	1 carton (f)	
42.Consumables(tapes/grease etc)	(see attached list)		247	Al box 01	

SWINDEX Parts List
Required items total List SWR92

Item	Part no	Total	Value	Package	Weight
18.Thermistor logger mount	SW018	2	200	AL box 01 *	34
30.Cable ties	SW033	1000	30	AL box 01 *	

Spare parts and adjustment List SWS92

Item	Part no	Total	Value	Package	Weight
14.Mooring wire bushes	SW021	20	20	AL Box 01*	
25.Cable ties	SW033	300	10	AL box 01*	

ADOX Instrumentation

Item	Serial no	Total	Value	Package	Weight kg
1.Current Meter RCM 7	10855	1	4200	Current box	14
2.Current Meter RCM 7	10856	1	4200	..	14
3.Current Meter RCM 7	10854	1	4200	..	14
4.Current Meter RCM 7	10862	1	4200	..	14
5.Current Meter RCM 8	10113	1	4400	..	15
6.Current Meter RCM 8	9967	1	4400	..	15
7.Current Meter RCM 8	9969	1	4400	..	15
8.Current Meter RCM 8	9968	1	4400	..	15
9.Vane RCM7	AD01	1	700	Vane box 2	12
10.VaneRCM7	AD02	1	700	Vane box 2	12
11.VaneRCM7	AD03	1	700	Vane box 3	12
12.VaneRCM7	AD04	1	700	Vane box 3	12
13.VaneRCM8	AD05	1	700	Vane box 1	14
14.VaneRCM8	AD06	1	700	Vane box 1	14
15.VaneRCM8	AD07	1	700	Vane box 2	14
16.VaneRCM8	AD08	1	700	Vane box 1	14
17.Computer Amstrad including Printer & including DSU reader.		1	1800	Computer box 1	25

ADOX Mooring Hardware Parts List Continued
Load list **ADR1B**
Shipping from MAFF by Container **2 of 2**

Item	Part No	Total	Value	Package	Weight Total kg
18.Computer Amstrad including Printer (As Spare unit)	1	1200		Computer box 2	25
19.Computer ELONEX S3642	1	2000		3 cdbd cartons	30
20.Multimeter	1	180		black case	
21.Video Camera Panasonic 1000	1	1000		black case	5
22.Video tape 180 VHS	10	35		black case	1
23.Video tape VHS C	10	35		black case	1
25.Current meter spares kit (contents on seperate list)	1	1151		Al box 02	1
26.Current meter vane spares (contents on seperate list)	1	357		Al box 02	1
27.Nitrogen cylinder Valves	1	50		Al box 02	
29.Tape Reader Aanderaa	1	3500		Wooden	5
30.Printer Aanderaa	1	1150		black case	1
31.Printer Paper Rolls	5	10		black case	

SWINDEX and ADOX Mooring Hardware Parts List
Load list **ADBSW**
Shipping from Barry South Wales onboard RRS Discovery **1 of 1**

Shipped under supervision of R Bonner.

Item	Part No	Total	Value	Package	Weight Total kg
ADOX					
14.Buoy 1.3m dia steel	SW004	2	4000	Onboard	1274
22.Glass sphere 17"	SW028	20	7000	Onboard	500
24.Sphere stand	ST001	2	200	Onboard	50
SWINDEX					
4.Sphere steel 1.3m dia	SW004	8	16000	Onboard	5096
29.Sphere stand	ST001	2	200	Onboard	50
ADOX & SWINDEX					
27.Nitrogen cylinders.SizeF.	none	2	50	Onboard	30

ADOX Mooring Hardware Parts List

This is **total equipment** to be shipped from UK,IOSDL shipment List IOSDL(ADR1A),shipment list MAFF(ADR1B).Items listed as onboard shipped from Barry onboard RRS Discovery on departure UK.

Item	Part No	Total	Value	Package	Weight Total kg
1.Mooring wire 6mm Jkt 300m	SW022	4	1200	4 reels	144
2.Mooring wire 6mm Jkt 30m	SW007	4	120	1 carton(d)	39
3.Mooring line 10mm poly 368m	SW025	4	800	4 reels*	128
4.Mooring line 10mm poly 184m	SW024	1	100	1 reel*	18
5.Mooring line 10mm poly 460m	SW012	2	500	2 reels*	76
6.Mooring line 10mm poly 276m	SW011	2	300	2 reels*	48
7.Mooring line 10mm poly 46m	AD002	1	20	1 carton(a)	27
8.Mooring line 10mm poly 92m	SW008	1	45	1 reel*	11
9.Mooring line 10mm poly 46m	AD002	3	75	1 carton(a)	
10.Mooring line 10mm poly 92m	SW008	7	350	7 reels*	77
11.Mooring line 12mm poly 10m	AD001	6	120	1 carton(b)	11
12.Mooring line 12mm poly 30m	AD003	1	25	1 carton(b)	
13.Pick up floats	SW001	4	40	1 carton(c)	15
14.Buoy 1.3m dia steel	SW004	2	4000	Onboard	
15.Pick up line	SW002	2	20	1 carton(c)	
16.Pick up line shackle	SW003	2	6	M box 3*	227
17.Shackle chain	SW005	2	6	M box 3*	
18.Swivel and chain assy.	SW006	2	800	M box 3*	
19.In line swivel assy.	SW010	4	1400	M box 3*	
20.Shackle Dee 1/2"	SW016	100	100	M box 3*	
21.Reevable link 1/2"	SW017	30	30	M box 3*	
22.Glass sphere 17"	SW028	20	7000	Onboard	
23.Sphere chain assembly	SW029	2	30	M box 3*	
24.Sphere stand	ST001	2	200	Onboard	
25.Mooring line 14mm poly 25m	SW030	6	150	1 carton(d)	39
26.Mooring line 16mm nylon 20m	AD004	2	80	1 carton(a)	
27.Plough anchor 55 lb	AD005	2	200	Loose items*	48
28.Plough anchor chain	AD006	2	25	Cdbd barrel*	75
29.Anchor chain 13mm 25m	AD007	2	75	Cdbd barrel*	
30.Stopper chain 5/8"	AD008	1	30	M box 3*	
31.Stopper shackles 1/2"	AD009	10	10	M box 3*	
32.Stopper shackles 3/4" pin	AD010	3	15	M box 3*	
33.Stopper shackles 1" pin	AD011	3	24	M box 3*	
34.Mooring wire 10m(spares)	AD012	2	30	1 carton(a)	
35.Polypropylene line 18mm 200m	No part	1	100	1 reel*	25
36.Glass sphere shackle 1/2"	SW032	50	25	M box 3*	
37.Mooring wire bushes	SW021	16	16	M box 3*	
38.Winch rope Polypropylene50m	No part	1	45	1 carton(e)	20
39.Cable ties	SW033	200	8	AL box 01	
40.Mooring wire 6mm jkt 30m	SW007	2	60	1 carton (f)	20
41.Polypropylene line 18mm 40m	No part	1	40	1 carton (f)	
42.Consumables(tapes/grease etc)	(see attached list)		247	Al box 01	

Items indicated * are to be shipped with ADOX equipment in container with DBC winch to Capetown.

Total value this page	18220 Pounds Sterling	IOSDL to ship 9695 Pounds
Total weight this page	1048 kilograms	IOSDL to ship 506 kilos
Total volume this page	12 cu metres	IOSDL to ship 8 cu metres
Total value this page for MAFF shipment	8525 Pounds Sterling	
Total weight this page for MAFF shipment	542 kilograms	
Total volume this page for MAFF shipment	4 cu metres	

SWINDEX and ADOX Deck Equipment

This is total equipment to be shipped from UK,IOSDL shipment list IOSDL(ADR1A),shipment list MAFF(ADR1B).Items listed as onboard shipped from Barry onboard RRS Discovery on departure UK.

Item	Part no	Total	Value	Package	Weight Total kg 1.Drum
1.Deck stands Blue steel	DE001	3	300	Loose items*	30
2.Cleats Blue steel	DE002	3	150	M Box 3	
3.Tackles Stainless Steel	DE003	2	200	M Box 3	
4.Bolt cutters HUBA	DE004	1	180	Loose item	10
5.Crow bar 1.5m length	DE005	1	50	Loose item	10
6.Mooring Sheave with side lugs	DE006	1	300	Loose item*	62
7.Mooring Sheave 5" centre	DE007	2	400	Loose item*	152
8.Current meter stand	DE008	2	200	Loose items	34
9.Cargo net Blue polyprop	DE009	3	600	Loose items	48
10.Tool kit Green Steel Box	DE010	1	1000	Tool box A*	40
11.Current meter bench stand	DE011	9	180	AL box 01	
12.Bench Pallets wooden	DE012	10	100	Loose items	65
13.Bolt cutters FELCO C5	DE013	1	200	Tool box A	
14.Winch Double Barrel with Power Pack	DBC1	1	38000	Loose item*	
15.Storage winch on base	DBC2	2	10000	..*	
16.Metering Sheave on base	DBC3	1	300	..*	
17.Divertor Sheave on base	DBC4	1	200	..*	
18.Storage winch steel drums	DBC5	4	800	..*	
19.Storage winch drum stands	DBC6	4	400	..*	
20.Steel deck channels(cable tray)	DBC7	2	100	..*	54
21.Steel deck channels(hydraulic hose)	DBC8	1	50	..*	
22.Stopper chain 13mm(high tensile)	---------	1	25	Loose item	15
23.Stopper shackles 5/8" pin	---------	8	24	M box 3	
24.BOSS hook S6	---------	4	120	M box 3	
25.No Load Hook,Admiralty patt.	---------	1	50	M box 3	
26.Nylon tow line 16mm 10m length	---------	1	30	M box 3	
27.Fold down steel cages	---------	3	90	Onboard	
28.Cargo net polypropylene	---------	3	240	Loose items	45

Total value this page 54094 Pounds Sterling IOSDL to ship 51850Pounds
Total weight this page kilograms IOSDL to ship kilos
Total volume this page cu metres IOSDL to ship cu metres
Total value this page for MAFF shipment Pounds Sterling
Total weight this page for MAFF shipment kilograms
Total volume this page for MAFF shipment cu metres

ADOX Consumables Aluminium box 01

Consumables.ADOX.

1.PVC tape	8	8	AL Box 01	34
2.Telcohesive	1	5	..	
3.Switch cleaner	1	3	..	
4.Polythene string	1	5	..	
5.Gear and chain grease	2	10	..	
6.Seizing wire	1	10	..	
7.Galv Thimbles 16mm	9	12	..	
8.Vaseline	2	5	..	
9.Duct tape Silver	2	5	..	
10.Marker tape Black/Yellow	1	5	..	
11.Silastoseal	1	3	..	
12.Cutters C7	2	70	..	
13.Spanners 8"	3	15	..	
14.Rigging kit	1	25	..	
15.Repair laquer ACM	3	15	..	
16.Tectyl 506	7	35	..	
17.Araldite	1	3	..	
18.Fibre glass tape	1	5	..	
19.Kimwipe Blue rolls	3	4	..	
20.Wipes	2	4	Al box 02	

ADOX Current Meter Spares

Item	Serial no	Total	Value	Package
1.Rotor S type	2916	2	60	ADOX CM Spares
2.DSU 2990E	2378	1	670	..
3.Compass	971248	1	213	..
4.O ring RCM8	865001	2	2	..
5.O ring RCM7	865000	3	3	..
6.O ring 10mm plug	861002	10	10	..
7.O ring 16mm plug	863001	3	3	..
8.Sealing plug 16mm	972176	3	30	..
9.Sealing plug 10mm	971197	4	24	..
10.Lower rotor bearing	972755	3	19	..
11.Upper rotor bearing	971193	1	7	..
12.Thermistor	971227	1	49	..
13.Conductivity wrench	934064	2	8	..
14.C clamp wrench	913003	1	3	..
15.Battery pack A1M	----------	1	50	..
16.Battery DSU	----------	1	Installed in item 2	..

ADOX Vane Spares

Item	Serial no	Total	Value	Package
Spindle assembly	3115	1	150	Al box 02
Cotterpin 5mm	660003	12	12	..
Cotterpin 4mm	6600017	4	2	..
Cotterpin 3mm	660004	4	2	..
Lock wire S/S 1m	----------	4	4	..
Tie bar and bushes IOSDL	----------	2	24	..
Pivot S/S	933034	4	16	..
Outer Ball race	934061	1	20	..
Tail fin assy.	935012	2	20	..
Fastening band	966021	2	80	..
Spindle pin	934026	2	3	..
Spindle anode	933024	2	10	..
Vane Plate RCM7/8 Grey	IOSDL	1	14	Packed Vane Box 3

ADOX Instrumentation

Item	Serial no	Total	Value	Package	Weight kg
1.Current Meter RCM 7	10855	1	4200	Current box	14
2.Current Meter RCM 7	10856	1	4200	..	14
3.Current Meter RCM 7	10854	1	4200	..	14
4.Current Meter RCM 7	10862	1	4200	..	14
5.Current Meter RCM 8	10113	1	4400	..	15
6.Current Meter RCM 8	9967	1	4400	..	15
7.Current Meter RCM 8	9969	1	4400	..	15
8.Current Meter RCM 8	9968	1	4400	..	15
9.Vane RCM7	AD01	1	700	Vane box 2	12
10.VaneRCM7	AD02	1	700	Vane box 2	12
11.VaneRCM7	AD03	1	700	Vane box 3	12
12.VaneRCM7	AD04	1	700	Vane box 3	12
13.VaneRCM8	AD05	1	700	Vane box 1	14
14.VaneRCM8	AD06	1	700	Vane box 1	14
15.VaneRCM8	AD07	1	700	Vane box 2	14
16.VaneRCM8	AD08	1	700	Vane box 1	14
17.Computer Amstrad including Printer including DSU reader.		1	1800	Computer box 1	25
18.Computer Amstrad including Printer (As Spare unit)		1	1200	Computer box 2	25
19.Computer ELONEX	S3642	1	2000	3 cdbd cartons	30
20.Multimeter		1	180	black case	
21.Video Camera		1	1000	black case	5
22.Video tape 180		10	35	black case	1
23.Video tape VHS C		10	35	black case	1
24.Electronic tool kit		1		Green T box	
25.Current meter spares kit (contents on seperate list)		1		Al box 02	
26.Current meter vane spares (contents on seperate list)		1	357	Al box 02	
27.Nitrogen cylinders.SizeF.		2	50	Onboard	30
28.Nitrogen cylinder Valves		1	50	Al box 02	
29.Tape Reader Aanderaa		1	3500	Wooden	5
30.Printer Aanderaa		1	1150	black case	1
31.Printer Paper Rolls		5	10	black case	

ADOX Technical File

6.Testing and Methods Darwin Cr 66

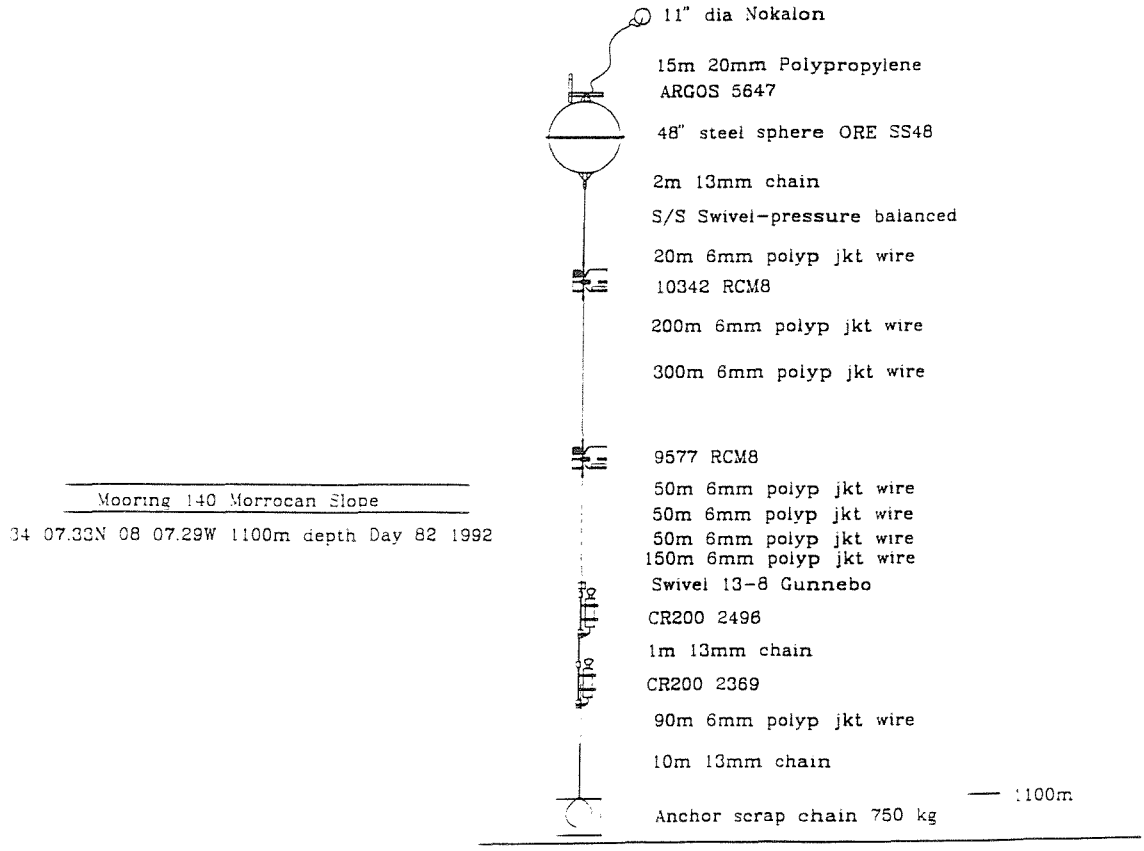
index

Charles Darwin Cruise 66
Moorings

The cruise was to deploy moorings for PML both in water depths from 288m to 3003m.The moorings were long,1 year plus,and short term,2 to 3 days,which presented IOSDL with the opportunity to test methods and materials for ADOX and SWINDEX moorings in the Southern Ocean.

IOSDL was to produce designs for the moorings as part of the RVS-IOSDL cooperation with RVS purchasing to the IOSDL specification.

Example of Shelf Slope Long term mooring.



Long Term Jacket Wire

The long term moorings along the shelf slopes all required polypropylene jacket wire from 1000m to the surface.IOSDL had tested a wire for the Southern Ocean which meets the specification of the previously used wire at considerably reduced cost.It was decided to specify this wire for the moorings.

Specification. Supplier.Midland Wire Cordage.Steel wire 6mm diameter,7 x 19,preformed,tensile 1770 N/m2 to BS 302/1987,impregnated with blue polypropylene to 8mm o.d.Terminations to IOSDL spec.MW 12-12-91. The heat shrink boots specified,AMH 1-727120-2,could not be obtained in the time availableand a substitute material,RS 399-748,was used.

Supply. The wires were supplied from MWC precut,terminated and with shrouds heat shrunk.The wires were delivered on good quality wooden drums and coils in bags.The transport packaging was of good quality and no ropes were damaged.

Handling onboard. The moorings were to be deployed buoy first using the RVS Bouble Barrel Capstan,DBC. This required the wires to be transferred from the suppliers drums onto the the storage drum of the DBC.The wires were placed on an IOSDL steel deck stand and wound through the DBC onto the storage drum.This then tensions the wire onto the storage drum correctly.This operation was easily carried out with the wire laying evenly onto the storage drum.
The mooring line joints required canvassing over as they were wound on,however canvas was not available and cloth rags were used.
On deployment it was clear that the rags wre not adequate to protect the wire from snagging on the shackle pins and the outer polypropylene jacket was damaged on two occasions.

Repairs were carried out to the damaged jacket,the method used has been used on the previous wire type successfully.
1.Thoroughly degrease the wire around the area of damage with a proprietary degreaser and dry with paper wipes.
2.Coat the damage with Dow Corning Silastoseal,extending the coating 10 cm along the wire on each side of the damage.
3.Overlay the Silastoseal with two layers of Telcohesive Self vulcanising tape.
4.Overlay the repair area with two layers of 3M 88 black insulating,extending the overlay 5cm either side of the self vulcanising.

The moorings used 30m wire lengths from the subsurface buoy to the top current meter.These were uncoiled on deck for hand deployment as the sphere was lifted into the water.A problem was encountered in that the wire tended to reform coils.These lengths were streched along the deck to form one large loop and as the buoy was deployed the wire could be controlled by hand and kept relatively straight.

The wire behaved and handled very much as the previous wire type and given adequate joint protection should be as effective.

Load Testing

The moorings were all deployed under low load buoy first methods.However moorings were towed onto position and the wire proved adequate in sea states up to force 8.As this configuration was similar to SWINDEX applications no further load trials were made.

Abrasion Resistance

During the deployments the wire had to pass around the DBC drums and through sheaves.No abrasion damage was seen on any wire.
Whilst towing the wire was subjected to abrasion on the ships stern where the deck is rounded over.No damge was noted in a 20 minute period.As a precaution the wire was protected by a canvas sheath for other tows and\or held off the deck as the situation allowed.

Terminations

The terminations and heat shrink boots gave no cause for concern.The terminals freely rotated around the winch barrels,with no damage to the boots.

Line lengths

The wires were supplied pre measured by MWC and the lengths appear satisfatory.It was not possible to establish accurate lengths onboard due to the deployment method.

Due to the design requirement for on site length adjustment there were more terminations on the storage drum than was desirable.This caused some slack turns when deploying and was partly reponsible for the two occasions of wire jacket damage.
It will be necessary to wind on these wires with a more even lay and less terminations on the drum to reduce this occurence.Using two storage drums and/or winches will certainly improve this,but will introduce the complication of changing drums/winches.

Reevable in line Links

The type used by RVS were the Crosby 1/2" Weldless Sling link.These are considerably larger than the type used by IOSDL and were used to improve stopping off.However due to this increase in size,capacity of the winch was decreased and when stopping off the lower/outboard shackle was used,yielding no significant advantage from the increased link size.

Shackles

The shackles were supplied to RVS from IOSDL stores and were of the 1/2" BS Dee type supplied by William Hankey.On previous occasions problems have been encountered on thread and pin tightness causing the shackle to be difficult to unscrew.This had been pointed out to the manufacturer and the majority of shckles from this batch were easy to unscrew.All the shackles were greased with BP high pressure grease before use.

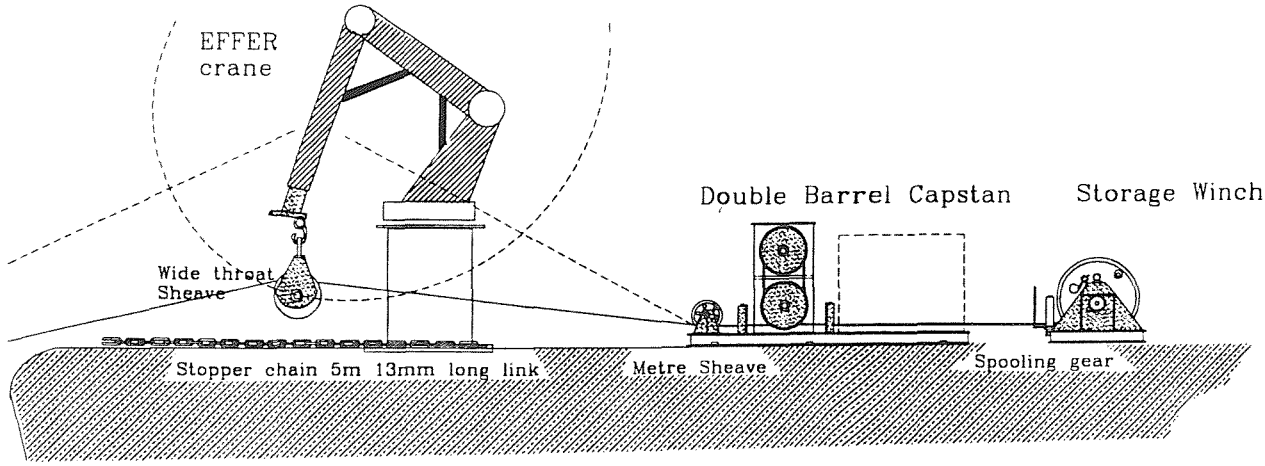
Deployment Methods

As trial for SWINDEX a deployment method for buoy first operations was evolved to improve control of the positioning of the mooring lines and equipment.

The EFFER cranes fitted aft on the Darwin were used to support the mooring deployment sheaves.Previously the A frame had been used with a block suspended within it.This method was adequate but always made recovering the outboard line for stopping off difficult ,as the A frame does not travel far enough inboard.

The EFFER cranes rated at 2 tonnes+ provide adequate strength to support a buoy first deployment and heve the advantage that they can be adjusted to suit most instrument configurations.Deployments were made with instrument configurations up to 4m in length.

Mooring Deployment Deck Layout. RRS Charles Darwin



Buoyancy Deployment

The operations required several types of buoyancy to be deployed.
Steel spheres were deployed using the A frame and Rexroth winch mounted on it.
Glass spheres were deployed using the EFFER crane and DBC.
Both methods worked well and will be suitable for SWINDEX.

Stopping off

Stopping off is achieved using a 5m 1/2" long link alloy load chain,GS 6 tonne,attached along the deck from the deck matrix.
The mooring sheave on the EFFER crane can be swung inboard and lowered near to the deck for chain insertion by BOSS S6 snap hook to the stopping off point.
The load is then transferred to the chain by DBC pay out.
To increase flexibility two BOSS hooks were shackled together which allowed the hooking point to be moved along the chain as required,quickly and easily.

Towing/Anchor Transfer

The moorings all required anchor free fall.Anchors were therefore always hung over the port quarter before commencement of operations.The anchor was held to a strong cleat by a cutting off rope.
The 10m riser chain could then be arranged around the stern onto the after deck and secured ready for attachment.

When transferring from the mooring line to the anchor chain,the mooring line was secured to the stopper by a strong polypropylene strop,20mm dia x 0.5m.This permits the anchor chain to be inserted whilst the mooring is secure at deck level.

Should towing be required to position the mooring,a chain security is added between the stopper chain and the mooring wire,this is placed such that should the cut off line fail the mooring is retained by the chain.

To transfer to the anchor the chain security is removed and the polypropylene strop cut away.The load tranfers to the anchor cut off strop.
When towing, the stopper chain can be lifted off the deck by EFFER crane to allow the mooring line to be clear of the deck.Care must be taken to minimise the crane extension and side loading.

Bad Weather Deployments

We were fortunate that we had bad weather on the very edge of workable conditions(F8)with which to test the deployment methods.No modifications to the methods are required in so far as the personnel involved on deck are experienced in the type of operation.

For Southern Ocean deployments safety lines along the deck at waist height and a chain on the deck would be required for safety harness attachment.
Deck mounted eye bolts are not suitable as personnel have the unpleasant habit of tripping over them.
The crane driver is exposed to the weather on the Darwin and if this is so on the Discovery then the driver will have to be brought down onto deck between crane operations.

Winching

The RVS DBC winch was used throughout the operations and was very reliable.IOSDL will be providing a similar DBC for the Southern Ocean which will be refurbished and fitted with a new electro-hydraulic power pack.It has been suggested that RVS mechanical personnel go to LEBUS when the winch is commisioned to get hands on experience before the winch is shipped to the Discovery.

A single storage winch was used on the cruise,this will be changed for the Southern Ocean with two storage winches being fitted.

Brook Road, Wormley, Godalming
Surrey, GU8 5UB,
United Kingdom
Telephone +44 (0) 428-684141
Facsimile +44 (0) 428-683066
Telex 858833 OCEANS G

Natural
Environment
Research
Council