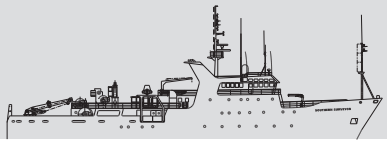

MARINE
NATIONAL FACILITY

2010 program

RV *Southern Surveyor*

voyageplan
SS01-2010

PINTS – primary Productivity induced by Nitrogen and Iron in the Tasman Sea.

Role of iron and other micronutrients in controlling primary productivity in the Tasman Sea: bioavailability, biogeochemical cycling and sources

Itinerary

Mobilise Sydney 0800hrs, Thursday 21st January, 2010
Depart Sydney 1000hrs, Friday 22nd January, 2010
Arrive Hobart 1900hrs, Monday 15th February, 2010
Demobilise Hobart 0800hrs, Tuesday 16th February, 2010

CSIRO

Principal Investigators

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Scientific Objectives

Macro- and micronutrients, mainly iron and nitrate, control oceanic primary productivity, phytoplankton community composition and subsequently carbon uptake and generation of radiatively important gases for climate. Assessing key underlying processes that control primary productivity and carbon export to the ocean's interior such as micro and macro-nutrient bioavailability is required to fully understand the ocean role in controlling climate change and improve modelling approaches. Indeed, data allowing an accurate modelling of iron bioavailability in the oceans is sparse. Although large dust deposition from eastern Australia to the ocean may occur, the Tasman Sea presents a region of great contrast: northern waters are nutrient poor while southern waters are nutrient rich, but low in iron. Consequently, the input of iron via dust to the northern and southern regions may influence nutrient uptake, primary production and nitrogen fixation.

The proposed research voyage will study iron bioavailability, sources and its biogeochemical cycling in the surface waters of the Tasman Sea, along with the role of other micronutrients. Our proposed voyage track will provide measurements on the effect of variable sources of iron (Australian continental dust, shelf sediments) on iron biogeochemistry. Results from this voyage will also provide modellers at CMAR with a key dataset to predict the biological control of the oceans on climate. This project will develop new methods for measuring iron bioavailability (e.g. iron dependent bioreporter) and limitation (e.g. photophysiological parameters) in the ocean, with potentially wide application to the growth of Australian and international marine research.

The main hypothesis of this project is that iron and other micronutrients are critical drivers of primary production in the Tasman Sea. In turn, the scale of primary production is instrumental in determining the biological uptake of CO_2 and fixation of carbon in surface waters.

Specific objectives with name of PIs involved in brackets:

1. Conduct zonal and meridional transects traversing the Tasman Sea to gain an understanding of the transport mechanisms influencing dust supply and its importance: a) as a source of iron and b) to link iron supply to nitrogen cycling in northern and southern waters (Bowie, Butler, Law, Ellwood);

2. Test iron-dependent bioreporter(s) as tools to measure iron bioavailability in the Tasman Sea (Hassler);

3. Characterise the iron biogeochemical cycling, chemical speciation, sources and potential control on primary productivity in the Tasman Sea (Law, Ellwood, Hassler, Doblin, Bowie);

4. Evaluate macronutrient limitation (e.g., nitrogen) of primary production and strategies to circumvent it (e.g., nitrogen fixation) (Law, Ellwood);

5. Investigate the role of other micronutrients in primary production and species composition. For example, the effect molybdenum and copper availability has on nitrogen-fixation by investigating the distribution of molybdenum and copper isotopes in the natural plankton community north and south of the Tasman Front (Butler, Ellwood, Bowie, Hassler, Doblin);

6. Undertake plankton incubation experiments to look at the influence of pCO_2 or sources (e.g. Dust and organic matter) on nutrient uptake (Law, Ellwood, Hassler).

Voyage Objectives

This voyage proposes two set of activities: transect stations and process stations (see Figure 1).

The transects conducted during this project will allow mapping of important biogeochemical parameters, whereas process stations will provide information about (i) the main factors controlling biological stocks and activities and (ii) the vertical distribution of the parameters measured during the transects in the whole water column. The information gathered at the process stations will be critical to identifying key parameters and processes driving the control of primary productivity by macro- and micro-nutrients, as well as pointing the sources and cycling of iron.

The following activities will be conducted onboard the Southern Surveyor to meet our scientific objectives:

1- Regular CTD profile down to 1000 m at each station to characterise physical oceanography (temperature, salinity, dissolved O2, transmissivity and fluorescence). In addition water will be sampled for macro-nutrient analysis (MNF Hydrochemist), Particulate organic carbon (POC) and nitrate (PON), and phytoplankton characterisation. Phytoplankton characterisation includes:

a) floristic information: measured mainly back in the laboratory using microscopy, high-performance liquid chromatoghraphy and flow cytommetry. Sample will be fixed or stored in liquid until analysis.

b) physiological information such as primary productivity and photosynthetic health, measured onboard using FRRF, PhytoPAM, spectroscopic analysis and 14C incubations.

At process stations (See Figure 1) deep CTD casts to the bottom (> 3000-4000 m) will be done to gain more information on the physical oceanography.

2 Trace metal sampling using a) a titanium rosette equipped with 12 10L Niskin X bottles at each station and b) line deployed overboard (see Figure 1, voyage track).

The water collected will be manipulated in a clean environment either under laminar flow or in one of the two clean room vans set up on board.

Using the trace metal (TM) clean rosette water will be sampled at several depths at all stations. In addition, deep casts will be done at process stations (down to 3000 – 4000 m). Water collected will be used to measure the following parameters:

– Dissolved trace elements (Fe and Al using Flow injection and others such as Cd, Zn, Co, Mn, Pb, etc using ICP-MS techniques).

– Iron chemical speciation using electrochemical approach

– Iron bioavailability using iron-dependent cynobacterial bioreporter

– Large sample volumes (10L) for iron and copper isotopes and isolation of natural organic matter

– Set up incubation at depth of Chlorophyll maximum to determine iron bioavailability, dust impact and primary productivity for natural phytoplankton community

– Nutrients at the naomolar levels

At various stations a weighted hose will be deployment over the side of the vessel to collect large volume of surface water, mainly to measure underway parameters, set up on-deck incubation at process stations and collect water for further culturing work. This water will be used in on-deck incubation to measure response of phytoplankton to ocean acidification, primary productivity, nitrogen fixation, dust impact and iron bioavailability.

3 Deployment of McLane pumps (at 4 depths) to measure parameters that require the filtration of large volume (up to 100L). The filters collected will be used to measure particulate materials – including trace metals, carbon and biogenic silicate.

4 Dust collection using a high-volume sampler set up on the monkey island. Filters are analysed by ICP-MS to assess metal solubility and fluxes associated with dust deposition.

The procedure associated with the deployments of the trace metal clean rosette, upper ocean pumping and McLane pumps are outlined below (Appendixes 1 and 2) and these procedures will be discussed with personnel at sea in due time. Outline of on-deck incubations are also outline in the Appendix 5. For more details about the measurements associated with this oceanographic voyage please refer to the original proposal.

All these operations are required for the success of this project. The most critical one is sampling trace metal clean water using the TM Rosette. For this reason, this operation was the subject of a trial at sea during SS04-2009. On deck-incubations are also an essential activity at process stations that are required to understand critical processes that drives the interaction between phytoplankton productivity and biodiversity and nutrients. For that purpose, sampling of large volumes of water using a line overboard is rapid and personnel-efficient (only 1 person required for sampling). The use of the McLane pumps will allow the measurement of the in-situ stochoimetric ratios of particles (including phytoplankton) and are thus important to understand the dynamic of this marine system. Finally, the sampling of atmospheric dust should also be regarded as a priority as it has been demonstrated that dust supply is important in that region and it could induce phytoplankton bloom; yet little is known on the trace elements that can potentially be released and their subsequent biological effect associated with the dust deposition in the Tasman Sea.

The order of deployments at transect stations will be:

- CTD rosette
- Trace metal clean Rosette
- McLane Pumps
- Hose deployment at incubation and process stations

TM rosette will be deployed using the CTD winch and operated using the side A-frame. The McLane pumps will be deployed using towed body winch off the stern deck using the stern A-frame. TM rosette will use Dynex (4000 m, 6 mm) and the McLane pump will use sheathed wire (2050 m). A plastic line will be deployed overboard to sample water from 30 m depth using double diaphragm Teflon pump and compressed air from the ship. Water will be pumped into a laminar flow cabinet in the general lab. In the laminar flow cabinet polypropylene taps will be installed to provide a large volume of unfiltered and filtered water (0.2 µm).

At process stations the following activities will be carried out:

Day 0 to 1 (24 hours)
- – Shallow CTD – characterize water column
- – TM cast shallow – water from DCM
- – Line overboard – collect water for incubations ~ 8 hours pumping time

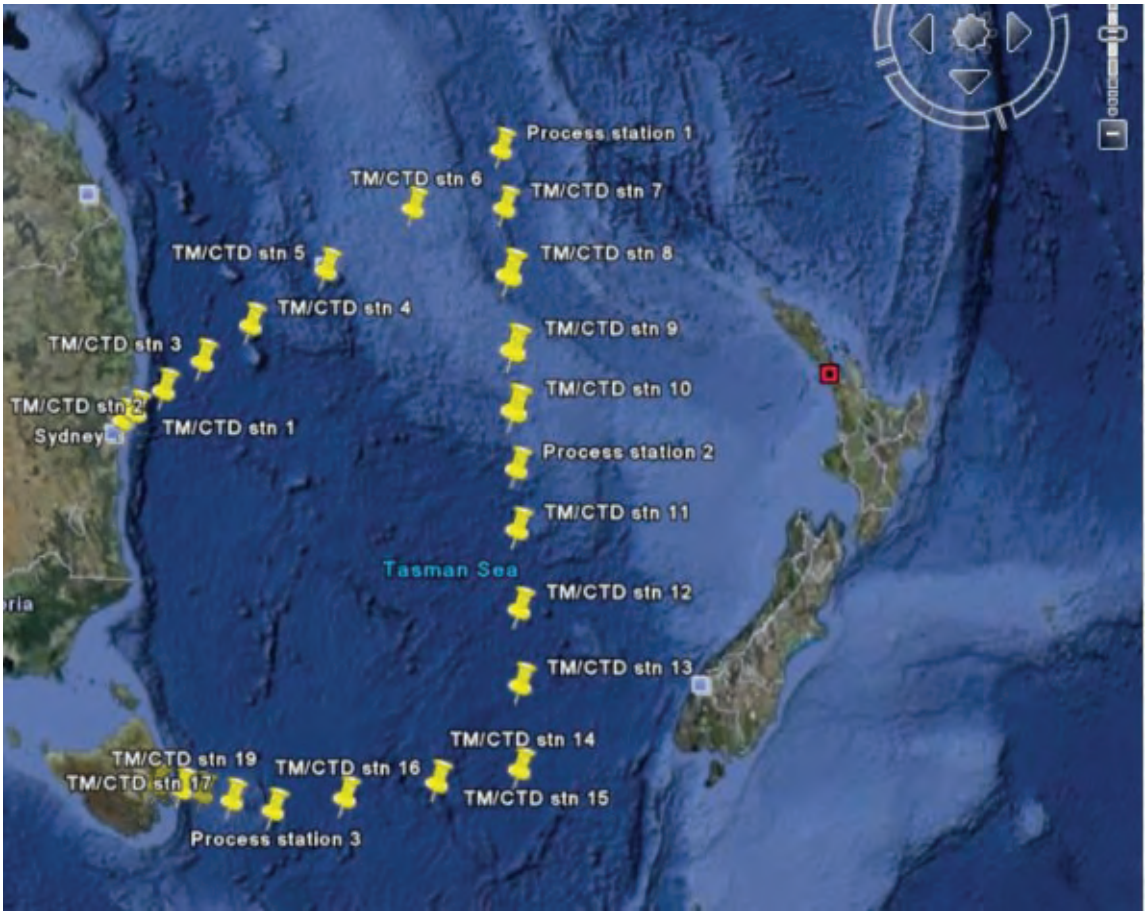
Day 1 to 3 (48 hours)
- – TM casts 0-3000 m 6 casts to various depths
- – McLane pumps 0-1500+ m - deploy between TM casts
- – Deep CTD

Day 3 to 4 (24 hours)
- – Finish Incubation experiments etc

Day 4 leave site to transect station

Voyage Track

The following figure shows the voyage track. It consist of 20 transect stations (TM/CTD) and 3 process stations. Sampling at transect stations will require 3 hours, whereas operations at process stations will require 4 days (please see above). The voyage track consists of 4 transects:
– Transect 1: from Sydney to Process station 1
– Transect 2: from Process station 1 to Process station 2
– Transect 3: from Process station 2 to Process station 3
– Transect 4: from Process station 3 to Hobart



Time Estimates

25 days at sea are required to complete the above transect. Ship time will be used as described below. One contingency day for bad weather at sea is scheduled.

Date 22/1/2010. Transect 1. Undertake 6 TM/CTD McLane pump stations

Leg 1	Lat	Long	Transit distance (NM)	Transit time (hr) @ 11 kt	On-station time (hr)	Date and time
Sydney						22/01/2010 – 12:00
TM/CTD Stn 1	33°54'7.04"S	151°37'40.08"E	21	2	3	22/01/2010 – 16:54
TM/CTD Stn 2	33°39'2.03"S	152°42'15.89"E	58	5	3	23/01/2010 – 1:10
TM/CTD Stn 3	33°17'37.90"S	154° 8'50.19"E	75	7	3	23/01/2010 – 11:00
TM/CTD Stn 4	32°49'11.40"S	155°56'6.34"E	94	9	3	23/01/2010 – 22:32
TM/CTD Stn 5	32° 2'27.02"S	158°40'34.92"E	147	13	3	24/01/2010 – 14:54
TM/CTD Stn 6	31° 3'33.94"S	161°49'19.05"E	172	16	3	25/01/2010 – 9:32
Process stn 1	30° 0'0.00"S	165° 0'0.00"E	177	16		26/01/2010 – 1:38

Note: location of CTD1 will depend on the bathymetry as it required 1000m +. This station will be a toolbox station and be used to check deployment procedures and test pieces of equipment.

Date 30/1/2010. Transect 2. Undertake 4 TM/CTD McLane pump stations

Leg 2	Lat	Long	Transit distance (NM)	Transit time (hr) @ 11 kt	On-station time (hr)	Date and time
Process stn 1	30° 0'0.00"S	165° 0'0.00"E				30/01/2010 1:38
TM/CTD Stn 7	31°36'54.22"S	164°34'54.44"E	99	9	3	30/01/2010 13:38
TM/CTD Stn 8	33°30'35.55"S	164° 4'49.66"E	111	10	3	31/01/2010 2:43
TM/CTD Stn 9	35°29'22.69"S	163°32'50.76"E	120	11	3	31/01/2010 16:38
TM/CTD Stn 10	37° 1'56.30"S	163° 3'27.58"E	99	9	3	1/02/2010 4:38
Process stn 2	38°26'12.70"S	162°41'22.37"E	85	8		1/02/2010 12:21

Date 5/2/2010. Transect 3. Undertake 6 TM/CTD McLane pump stations

Leg 3	Lat	Long	Transit distance (NM)	Transit time (hr) @ 11 kt	On-station time (hr)	Date and time
Process stn 2	38°26'12.70"S	162°41'22.37"E				5/02/2010 12:21
TM/CTD Stn 11	39°57'36.36"S	162°10'52.48"E	98	9	3	6/02/2010 0:16
TM/CTD Stn 12	41°57'49.27"S	161°31'51.00"E	123	11	3	7/02/2010 14:27
TM/CTD Stn 13	43°51'36.50"S	160°51'23.49"E	114	10	3	8/02/2010 3:49
TM/CTD Stn 14	46° 0'0.00"S	160° 0'0.00"E	130	12	3	8/02/2010 18:38
TM/CTD Stn 15	46° 1'16.10"S	156°49'23.77"E	134	12	3	9/02/2010 9:49
TM/CTD Stn 16	45°57'27.35"S	153°19'40.76"E	146	13	3	10/02/2010 2:05
Process stn 3	45°51'25.13"S	150°52'50.16"E	103	9		10/02/2010 11:27

Date 13/2/2010. Transect 4. Undertake 6 TM/CTD McLane pump stations

Leg 3	Lat	Long	Transit distance (NM)	Transit time (hr) @ 11 kt	On-station time (hr)	Date and time
Process stn 3	45°51'25.13"S	150°52'50.16"E				13/02/2010 11:27
TM/CTD Stn 17	44°55'52.33"S	149°38'30.76"E	76	7	3	13/02/2010 21:21
TM/CTD Stn 18	44°12'38.80"S	148°44'46.99"E	56	5	3	14/02/2010 5:27
TM/CTD Stn 19	43°36'48.04"S	148° 1'14.74"E	47	4	3	14/02/2010 12:43
Hobart	43° 3'40.72"S	147°23'40.26"E	44	4		14/02/2010 16:43

Southern Surveyor Equipment

Scientific equipment:

- Simrad EA500 sounder for bottom detection (12Hz)
- ADCP-measures current vector beneath the vessel
- Packard Tri-Carb Beta counter

Laboratory and other Facilities:

- General purpose laboratory (include fume hoods, fridge and freezer)
- Controlled temperature laboratory – SST to be adjusted weekly
- Hydrochemistry laboratory
- Wet laboratory/CTD room
- Fish laboratory/Geosciences laboratory
- Fish sorting room
- Photographic/preservation laboratory
- Blast freezer
- Walk in Freezer
- Distilled and ROS water supply
- Non-toxic seawater supply to incubators/labs
- Fresh water
- Acid storage
- Air compressor

Winches, A-frames and Crane:

- CTD/Hydro winches
- Hydrographic A-frame
- Towed body winch
- Block for McLane pumps which can accept shackle couplings

Data product – all data product offered by the MNF are requested.

Specialised equipment and services requiring some additional support:

- Conductivity, Temperature and depth profiling (CTD):
- CTD (seabird SBE 911 plus)
- Rosette (24 x 10 L Niskin bottles)
- Spare CTD with bottles
- Transmissometer (to 6000m depth)
- Profiling fluorometer (6000 m depth)
- Light PAR (to 5000 m depth)
- Dissolved oxygen (to 6000 m depth)
- Lowered ADCP (to 6000 m depth)

Specialised equipment and services that require extensive additional support:

Chemical Analysis:

- Salinity (calibration CTD), Oxygen (calibration CTD), Nitrate+Nitrite, Nitrite, reactive silicate, ortho-phosphate on 57 casts (24 samples)
- Underway fluorometer
- Radiation sensors

User Equipment

- Scientific equipment:
- FRRF (Cliff/Boyd)
- Phyto and/or WaterPAM (Doblin/Boyd)
- Microscope (Doblin/Hassler)
- Nano-nutrients analyser (Law/Boyd)
- Flow injection (Bowie)
- Voltammeter (Ellwood)
- Reduction Detector (Law)
- Dust/atmosphere sampler (Butler/Boyd)
- Masterflex pp pump (Trull/Hassler)
- Zooplankton net (Hassler/Doblin)

Water sampling equipment:

- Trace metal CTD rosette and bottles (Ellwood) and 4000 m Kelvar (Ellwood). Needs to be spliced and spooled on SS winch.
- Trace-metal clean tow-fish/compressor with Taps and Tees and tubing (Law/Boyd/Ellwood)
- Trace metal Block (Boyd/Bowie)
- In situ McLane pumps and hydrowire (Bowie/Boyd)
- 4000 m Kevlar line (Dynex, Ellwood)
- 2000m sheathed hydrowire from SAZ-11 mooring (Bowie/Trull)

Laboratory and other Facilities:

- CSIRO clean van
- ANU clean van
- Deionized water supply with new cartridges (Bowie/Butler/Ellwood)
- Laminar flow benches x3(Hassler/Ellwood/Bowie/Butler)
- Filtration units (POC/PON/Chlorophyll) (Hassler/Doblin/Butler/Trull)
- Gas cylinders and regulators, N2 for trace metals (Hassler/Bowie/Law) CO_2/air mix (Boyd/Law)
- Liquid N_2 – dewars x4(Hassler/Doblin/Ellwood/Butler)

Incubation:

- 4 deckboard temperature-controlled incubators (Forecastle deck) (Law/Boyd/Ellwood) 3x NIWA and 1 x 1x 1m2 ANU
- Temp and light data logger (3, Hassler)
- Perturbation incubation units and photosythetron (lab-based) (Hassler/ Doblin) ^{55}Fe and ^{14}C
- A deck layout of the large equipment (van and on-deck incubators) is shown in Appendix 3.

Special Requests

Prior to voyage:

- Control of contamination sources on deck outside Wet Lab – any possible steps to reduce water pouring off the Forecastle Deck; general maintenance and painting of exposed metal surfaces in the Wet Lab and vicinity.
- Position to secure 3 gas cylinders (size G) close to the NIWA on deck incubators.
- Allow room on CTD winch for 4000 m Dynex cable
- Wash decks and winches with freshwater and then plastic wrap winches to be used to deploy the TM rosette and the McLane pumps.
- Packard TriCarb (scintillation counter) freshly calibrated and operational.
- Use of radioisotopes 14C, 55Fe and 3H (request to be submitted separately).

On Mobilisation day:

- Kevlar line needs to be spliced and spooled onto SS (need to identify who will be doing it)
- Sheathed Hydro wire needs to be spooled onto SS
- Crane for lifting containers onto the vessel to be organised by science party.
- Clean vans should be connected for electricity, freshwater (ROS) and seawater
- On-deck incubators should be connected to seawater input/ output (garden hose and fitting to incubators provided by users), they would require UPS (temperature controller).
- Working at height will sporadically occur for dust sampling (monkey island, Butler/Boyd) – specific safety procedure will be considered.

At sea:

Daily email link to receive MODIS and BlueLink images from CSIRO (Drs. Richard Matear and Ken Ridgeway to send to Christel Hassler email on Southern Surveyor)

Specific requests associated with trace metal clean work-refer to Appendix 4. These include control on grey water and relocation of usual smoking areas as smoking has to be avoided in sampling and experimental areas (see Appendix 4).

Personnel List

Christel Hassler	UTS	Chief Scientist - Biological Oceanographer
Michael Ellwood	ANU	PI - Chemical Oceanographer
Claire Thompson	ANU	Chemical Oceanographer/student
Edward Butler	CSIRO	PI - Chemical Oceanographer
Eike Breitbarth	NIWA/Otago	Chemical Oceanographer
Ros Watson	CSIRO	Chemical Oceanographer
Cliff Law	NIWA	PI - Biological Oceanographer
Robert van Hale	NIWA/Otago	Chemical Oceanographer
Martina Doblin	UTS	PI - Biological Oceanographer
Gabriel Shaw	UTS	Oceanographer/student
Karl Forcey	CMAR-MNF	MNF Electronics Support
Alicia Navidad	CMAR-MNF	MNF Hydrochemistry Support
Sue Reynolds	CMAR-MNF	MNF Hydrochemistry Support
Hiski Kippo	CMAR-MNF	MNF Computing Support
Don McKenzie	CMAR-MNF	MNF Voyage Manager

As per AMSA requirements for additional berths on Southern Surveyor, the following personnel are designated as System Support Technicians and are required to carry their original AMSA medical and AMSA Certificate of Safety Training on the voyage:

Name	**AMSA Certificate of Safety Training No.**
Don McKenzie	AS02764
Karl Forcey	BB02062
Hiski Kippo	AS02377
Alicia Navidad	AS04836

This voyage plan is in accordance with the directions of the Marine National Facility Steering Committee for the Research Vessel Southern Surveyor.

Christel Hassler
Chief Scientist

Appendix

Appendix 1: Deployment procedure for the TM rosette

TM rosette deployment and retrieval

Deployment

1. Couple rosette to computer and charge/program
2. Load bottles onto rosette
3. Cock Niskin bottles, with plastic shroud still attached
4. Move rosette to deployment area
5. Spool Kevlar line through bocks etc and attached to rosette
6. Remove cover just prior to deployment
7. Deploy rosette by spooling and swing out on side A-frame
8. Lower rosette to desired depth

Retrieval

1. Spool Kevlar line
2. Once rosette is at deck level, move A-frame in and land the rosette onto plastic pallet
3. Place cover over rosette and remove Kevlar line
4. Remove Niskin bottles, bag upon removal and transfer to clean container
5. Hose-down rosette with fresh water
6. Couple rosette to computer, download deployment information and then charge
7. Move rosette to storage area

Cocking rosette bottles prior to deployment

Appendix 2
– Deployment procedure for the McLane pumps

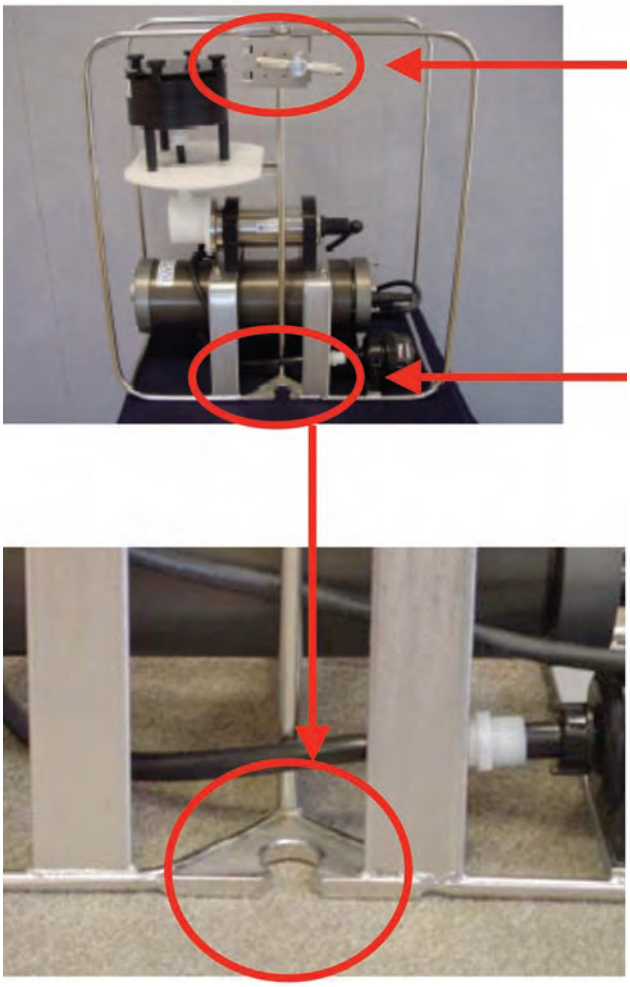
McLane pump deployment and retrieval

Deployment

- Spool hydrowire through blocks etc and attached weights (~100 kg)
- Deploy weight by paying out ~50 m of wire
- Move wire close to side of vessel
- Attach lower McLane pump clamp to hydrowire (see figures below)
- Lift McLane pump (~50 kg) and locate lower pin through eye on pump – requires three people
- Do up upper clamp on pump – third person job while 1 and 2 hold pump
- Attach pressure sensor to hydrowire – determines the pump depth
- Move hydrowire away from vessel and then lower to desired depth – need to monitor amount of wire out.

Retrieval

- Spool hydrowire
- Once pump is at deck level move hydrowire close to vessel
- Undo upper clamp – persons 1 and 2 hold pump while the third person undoes clamp
- Lift pump off lower clamp
- Remove lower clamp
- Spool hydrowire and bring weights onboard



Upper clamp.
Swings open

Lower attachment point. Eye fits over pin of clamp attached to hydrowire. Lower clamp is like the upper clamp and swings open.

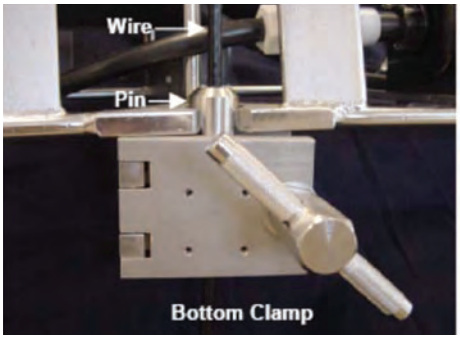


Figure 6-1: Bottom Clamp

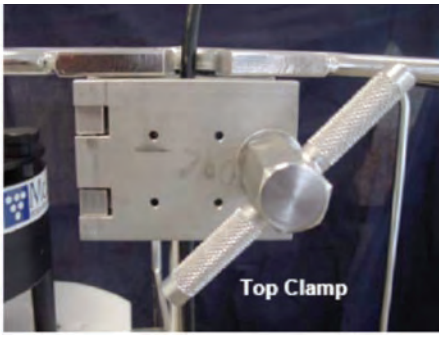
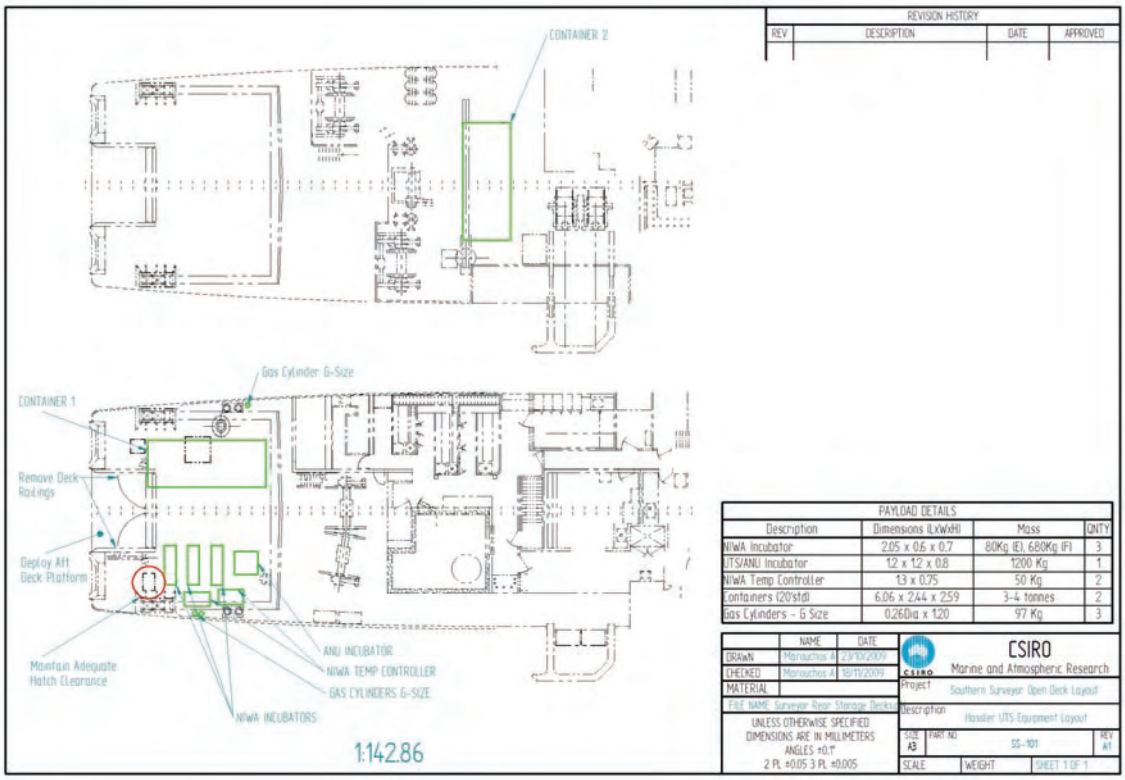


Figure 6-2: Top Clamp

Appendix 3 – Deck layout of large user equipment



Appendix 4 – General behaviour associated with trace metal clean work

All trace metal clean work is done using vinyl gloves that will be provided by the user on board

Be aware that everything your gloves touch might bring trace metal contamination – do not touch metallic parts and do not reuse

Absolutely no smoking next to trace metal sampling operations. Unfortunately, this means that the usual sheltered smoking areas (outside the Wet Lab on the Shelter Deck, and under the alcove on the Forecastle Deck, aft of the Lounge / Rec Room) will be out of bounds. New location of the smoking area will be discussed onboard.

Grey water will have to be discharged when no sampling is going on – typically the best time would be in between stations when underway fish is retrieved.

Appendix 5 – Schematic representation of on-deck incubations