SOUTHAMPTON OCEANOGRAPHY CENTRE

CRUISE REPORT No. 10

RRS *DISCOVERY* CRUISE 228
21 MAY-28 JUN 1997

The Fluxes at AMAR Experiment:
FLAME

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1997

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ABSTRACT

The principle objectives of the cruise were to study the physical, geochemical and biological dispersion of the neutrally-buoyant hydrothermal plume overlying the Rainbow hydrothermal field on the Mid-Atlantic Ridge, near 36°15'N; to investigate the interacting processes active within the dispersing plume; to better constrain the source of active venting on the seabed; and to quantify the physical, geochemical and biological fluxes to the water column on the segment scale. A secondary objective was to better constrain the source of strong dissolved methane concentrations which had been observed previously in the FAMOUS segment further north. An additional objective, which evolved during the course of the cruise programme, was to investigate the dispersion of vent-larvae through hydrothermal plumes along a section of the MAR extending from the Rainbow area to the previously known Lucky Strike hydrothermal field at 37°17'N. Initially, a series of hydrographic CTD stations were occupied, complete with a lowered Acoustic Doppler Current Profiler (L-ADCP) to provide instantaneous measurements of prevailing current directions with depth in the water column. This was coupled with a suite of deep-tow CTD tow-yo sections using the hydrothermal plume instrument BRIDGET. This preliminary data set yielded an understanding of the nature of plume dispersion which was then utilised to target further water column sampling using a combination of further CTD hydrocasts for water column samples, in situ filtration of particles for mineralogical, geochemical and microbiological investigations and RMT 1+8 Net trawls for biology. The strategy was largely successful and the neutrally buoyant plume, which was revealed to be dispersing under topographic control, was traced to a distance of greater than 50km down-stream. As the programme progressed a grid of closely spaced (0.5 nautical miles) orthogonal survey lines were occupied across the suspected site of venting, yielding a resolution of closest approach to the source of better than 200m. Finally at Rainbow, a suite of 8 current-meter moorings were deployed around the vent-site to monitor long-term (>12 month) fluxes of physical parameters including suspended particulate material away from the site of venting. In addition to sampling at Rainbow, 6 CTD stations were occupied in the southern portion of the FAMOUS segment and RMT 1+8 Net Trawls were completed in the Southern AMAR, AMAR, FAMOUS, North FAMOUS and Lucky Strike segments as well as in the non-transform discontinuity (NTD) offset immediately to the south of the Lucky Strike segment.

KEYWORDS

AMAR, AZORES TRIPLE JUNCTION, BIOGEOCHEMISTRY, BRIDGET, CRUISE 228 1997, CTD OBSERVATIONS, *DISCOVERY*/RRS, FAMOUS, FLAME, HYDROTHERMAL ACTIVITY, HYDROTHERMAL FIELD, HYDROTHERMAL FLOW, L-ADCP, LUCKY STRIKE, MID ATLANTIC RIDGE, PLUME DYNAMICS, PROJECT, RAINBOW, RMT

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H.R.	Hebson	A/B
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S.E.M.	Carter	Steward
E.	Percival	Steward
A.M.	Bridge	Motorman

ITINERARY

Departed:	Vigo, Spain	21 May 1997
Port-call:	Ponta Delgada, Azores	24 June 1997
Arrived:	Vigo, Spain	28 June 1997

OBJECTIVES

The objectives of the cruise were three-fold:

(1) To investigate the multidisciplinary (physical, geochemical and biological) processes and fluxes associated with the Rainbow hydrothermal plume, 36°15'N, Mid-Atlantic Ridge.

(2) To constrain the nature and source of venting in the FAMOUS segment near 36°30'N, Mid-Atlantic Ridge.

(3) To investigate the role of hydrothermal plumes in the dispersal of vent-larvae from one vent site to another between Rainbow (36°15'N) and Lucky Strike, (37°17'N, Mid-Atlantic Ridge).

NARRATIVE

The scientific party for RRS *Discovery* Cruise 228 assembled in Vigo, Spain between Sun. 18th and Tues. 20th May 1997 to board scientific equipment and prepare laboratory space. The RRS *Discovery* sailed from Vigo at 0906 local time (0706z) on Weds. 21st May, 1997 and best possible speed was set for the work area on the Mid-Atlantic Ridge. During Thursday 22nd, Friday 23rd and Saturday 24th May the ship's speed was reduced due to adverse weather plus, briefly, to enable repairs to the ship's electric motors. Best possible speed was regained on Sunday 25th May and RRS *Discovery* arrived on station east of the MAR on Monday 26th May (Julian Day 146).

Initially a BRIDGET test-dip was completed at 36°00'N 33°00'W (1315-1425z) followed by a background CTD cast at the same site commencing 1456z. Although CTD and lowered ADCP data were collected succesfully no bottles were found to have fired upon recovery at 1823z. Passage was set for the MAR rift-valley but a brief test deployment of the CTD was also carried out *en route* at 36°03'N 33°27'W between 2116z and 2135z. At 2312z a CTD station was commenced at 36°05'N astride a sill leading into the eastern end of the non-transform discontinuity (NTD) which hosts the Rainbow hydrothermal area, between the South AMAR and AMAR segments. The CTD was completed at 0115z on Tues. 27th May and the *Discovery* was then repositioned to commence a BRIDGET tow-yo along bearing 060° from 36°11'N 34°00'W (0322z) and ending at 36°18'N 33°43'W (1131z). Upon recovery of BRIDGET, an IFREMER CTD cast was attempted at 36°18'N 33°51'W (1306-1313z) but this had to be abandoned due to a failure of the CTD conducting cable. Upon retermination of the cable the station was successfully occupied commencing 1557z. After recovery of the IFREMER CTD (1836z) the *Discovery* was repositioned at 36°13'N 33°54'W for an RVS CTD station (2027z-2312z). Two further RVS CTD stations were then occupied during Weds.28th May at 36°14'N 33°56'W (0054-0359z) and 36°16'N 33°53'W (0448-0720z). Upon completion, a further BRIDGET line was

then commenced (0827z) following course 060° from 36°16'N 33°53'W to 36°23'N 33°36'W (2053z). During Thurs. 29th May another suite of three RVS CTD stations were occupied at 36°03'N 34°08'W (0027-0258z), 36°16'N 33°58'W (0452-0722z) and 36°16'N 34°03'W (0810-1037z). This was followed by a further BRIDGET deployment from 36°11'N 33°57'W to 36°20'N 33°47'W (1145-2356z). Friday 30th May saw completion of a further three RVS CTD stations at 36°21'N 33°47'W (0116-0344z), 36°19'N 33°45'W (0420-0636z) and 36°18'N 33°43'W (0706-0931z) followed by a final long-line BRIDGET tow-yo from 36°15'N 33°52'W to 36°22'N 33°36'W (1042-1938z). Following this the RMT 1+8 Nets were flushed through for pre-conditioning and then trawled through the Rainbow offset from 36°21'N 33°44'W (commencing 2157z) to 36°08'N 34°04'W where the nets were recovered at 0942z on Saturday May 31st. Toward the end of this deployment Clean A.C. power for the ship was briefly lost (0628-0646z). Following the RMT 1+8 Net deployments an IFREMER CTD station was occupied at 36°16'N 33°50'W (1213-1500z) followed by a Stand-Alone Pump (SAP) station at 36°14'N 33°53'W (1618-2145z) followed by a further IFREMER CTD station at 36°14'N 33°50'W which commenced at 2240z and was recovered inboard at 0113z on Sunday June 1st.

A further set of three RVS CTD stations were then occupied at 36°15'N 33°54'W (0236-0459z), 36°00'N 33°00'W (0940-1226z) and 36°17'N 33°54'W (1812-2048z) followed by a high resolution BRIDGET survey between 36°14'N 33°52'W and 36°19'N 33°55'W which commenced at 2136z and was completed at 0645z on Monday June 2nd. Following this survey, an IFREMER CTD station was occupied at 36°13'N 33°49'W (0830-1100z) followed by a SAP station at 36°16'N 33°50'W (1154-1703z) and then another IFREMER CTD station at 36°12'N 33°46'W (1807-2015z).

Following the above, the RMT 1+8 Nets were redeployed (2219z) and trawled from 36°22'N 33°38'W to 36°10'N 33°54'W where they were recovered at 0835z on Tuesday 3rd June. Following the net deployments an RVS CTD station was occupied at 36°12'N 33°43'W (1018-1256z) after which all science was temporarily suspended due to bad weather. During this time the CTD conducting cable was reterminated for a second time (1718-2018z) upon completion of which science was recommenced with a further RVS CTD station at 36°14'N 33°53'W (2018-224z). Upon recovery the ship was repositioned and the RVS CTD redployed at 36°16'N 33°53'W (2346z). The purpose of this deployment was to occupy a 12 hour yo-yo station at this location; the RVS CTD was recovered in-board at 1158z on Weds. 4th June.

A suite of three IFREMER CTD stations were then occupied at 36°13'N 33°45'W (1325-1602z), 36°16'N 33°43'W (1724-2000z) and 36°16'N 33°45'W (2106-2347z). On Thurs. 5th June two further RVS CTD stations were occupied. The first was at 36°14'N 33°50'W (0135-0420z). The second station was a tow-yo conducted directly over the JASON vent-site at a speed of approximately 0.5kts. The CTD was deployed at 36°13'N 33°53'W (0525z) and recovered at 1350z from 36°15'N 33°57'W. Immediately upon recovery all further science was suspended once more due to bad weather. Accordingly, course was set to sail west of the MAR rift valley toward a reference background station in the open NW Atlantic Ocean, off-axis.

Improved weather allowed that an RVS CTD station be occupied in the western basin of the N.Atlantic on Friday 6th June at 36°32'N 34°45'W (0756-1046z). Improving weather then allowed course to be set back to the MAR rift-valley at Rainbow where a SAP station was occupied (1720-2225z) at 36°15'N 33°55'W. Following the SAP station the RMT 1+8 Nets were redployed on Sat. 7th June and trawled from 36°26'N 33°43'W to 36°11'N 33°51'W (0011-1044z). Upon recovery, a further SAP station was occupied at 36°14'N 33°54'W (1158-1711z) followed by an RVS CTD station occupied at 36°11'N 33°51'W (1925-2140z). BRIDGET was then redeployed at 36°19'N 33°52'W (2306) and tow-yo'd to 36°09'N 33°57'W where it was recovered at 0741z on Sun.8th June. After repositioning of the ship, BRIDGET was then

redeployed at 36°11'N 33°46'W and tow-yo'd to 36°22'N 33°53'W (0900-1740z). Upon recovery of the BRIDGET vehicle an RVS CTD station was occupied at 36°14'N 33°54'W (1912-2147z) followed by an IFREMER CTD station which was deployed at the same location at 2248z and recovered in-board at 0131z on Mon.9th June.

Following these CTD casts a SAP station was occupied at 36°14'N 33°50'W (0244 - 0820) followed by an RMT 1+8 net trawl from 36°11'N 34°00'W to 35°55'N 34°11'W (1210-2251z) followed by a further RMT 1+8 net trawl on Tues.10th June from 35°55'N 34°10'W to 35°37'N 34°15'W (0022-1058z). Upon completion of the net trawls two IFREMER CTD stations were occupied, at 36°12'N 33°55'W (1620-1849z) and 36°16'N 33°58'W (2027-2356z). On Weds. 11th June a SAP station was occupied at 36°13'N 33°46'W (0225-0735z). An RVS CTD station was then occupied at 36°14'N 33°48'W (0829-1122z) followed by an IFREMER CTD station at 36°15'N 33°54'W (1223-1511z). At 1550z the BRIDGET deep-tow was deployed (36°18'N 33°52'W) and towed southwest along course 202° as far as 36°16'N 33°53'W where the survey had to be abandoned due to a fault on the deep-tow conducting cable (1852z). Upon recovery a SAP station was occupied, commencing at 36°17'N 33°53'W. Deployment was commenced at 2121z and all equipment was recovered in-board at 0245z on Thurs.12th June. Upon recovery an RVS CTD station was occupied at 36°15'N 33°54'W (0309-0558z) followed by an IFREMER CTD station at 36°15'N 33°53'W (0649-0924z). A further SAP station was then occupied, also at 36°15'N 33°53'W (1043-1601z) after which a wire test was completed upon the freshly re-terminated deep-tow conducting cable (1650-1829z). A further two IFREMER CTD stations were then occupied at 36°16'N 33°43'W (1829-2112z) and at 36°14'N 33°47'W (2202-0045z, Fri.13th June).

Following these IFREMER CTD stations BRIDGET was redeployed at 36°17'N 33°52'W and tow-yo'd along course 204° as far as 36°10'N 33°56'W (0137 - 0926). Upon completion of this line the ship was repositioned and BRIDGET was redeployed at 36°18'N 33°53'W where it was then tow-yo'd, on course 202°, to 36°12'N 33°56'W (1052-1810z). Next the ship was repositioned once more and BRIDGET was redeployed at 36°15'N 33°58'W at 1905z. BRIDGET was then tow-yo'd along course 113° as far as 36°14'N 33°56'W where the survey had to be abandoned due to a fault with the BRIDGET CTD system (2314z). Upon replacement with the spare (TOBI) CTD the line was reoccupied on Sat.14th June from 36°15'N 33°57'W to 36°14'N 33°55'W where the vehicle had to be recovered once more for further instrumental repairs (0002-0247z). An IFREMER CTD station was occupied at 36°14'N 33°54'W (0259-0523z) after which the repaired BRIDGET vehicle was redeployed to complete the proposed survey line on course 113° from 36°14'N 33°56'W to 36°13'N 33°52'W (0606-1152z). The ship was then re-positioned and a further, parallel BRIDGET survey line was run, along course 114° from 36°15'N 33°58'W to 36°14'N 33°52'W (1250-1852z). Upon completion of these surveys an RVS CTD station was occupied at 36°06'N 33°41'W (2030-2230z).

On Sun.15th June another RVS CTD station was occupied at 36°14'N 33°54'W (0005-0251z) followed by an IFREMER CTD station at exactly the same location (0306-0540z). A series of 4 current meter moorings were then deployed at 36°17'N 33°51 'W (0904-1021z), at 36°16'N 33°54'W (1125-1215z), at 36°17'N 33°54'W (1319-1456z) and at 36°16'N 33°53'W (1548-1704z). A SAP station was then occupied at 36°14'N 33°54'W (1800-2324z) followed by an IFREMER CTD station which was deployed at the same location at 2340z and recovered inboard at 0159z on Mon. June 16th. A final SAP station was then occupied at 36°14'N 33°55'W (0243-0804z) before the remaining four current meter moorings were deployed at 36°14'N 33°51'W (0847-0954z), at 36°12'N 33°49'W (1032-1122z), at 36°15'N 33°54'W (1244-1339z) and at 36°25'N 33°39'W (1544-1646z). Upon completion of the mooringd eployments a long BRIDGET survey line was occupied extending north along course 021°, away from the Rainbow area and into the adjacent AMAR segment. BRIDGET was deployed at

1905z at 36°11'N 33°45'W and recovered inboard at 36°28'N 33°39'W at 0652z on Tues. 17th June, the fifth anniversary of Discovery sailing from Viana do Castelo following her extension.

Two IFREMER CTD stations were then occupied at 36°18'N 33°48'W (0824-1121z) and at 36°20'N 33°44'W (1241-1538z) followed by an RVS CTD station further north, just beyond the northernmost mooring, at 36°26'N 33°39'W (1648-1912z). This represented the final science station at Rainbow during RRS *Discovery* Cruise 228.

Next, the RMT 1+8 nets were deployed at 36°23'N 33°41'W and trawled north along course 016° through the entire length of the AMAR segment as far as 36°44'N 33°33'W where they were recovered inboard at 0626z on Weds.18th June. Upon completion of the net trawl, a suite of three IFREMER CTD casts were occupied in the southern extent of the FAMOUS segment, at 36°34'N 33°24'W (0844-1128z), at 36°36'N 33°23'W (1229-1505z) and at 36°40'N 33°21'W (1607-1815z). A further set of RMT 1+8 net trawls was then commenced (1926z) continuing through the entire length of the FAMOUS segment along course 020° from 36°32'N 33°23'W to 36°54'N 33°13'W where the nets were recovered at 0626z on Thurs. 19th June. A further set of three IFREMER CTD stations were then occupied in the southern portion of the FAMOUS segment, at 36°32'N 33°25'W (0952-1210z), at 36°35'N 33°28'W (1315-1518z) and at 36°31'N 33°26'W (1616-1830z). Upon completion of these CTD stations two back-to-back RMT 1+8 net trawls were conducted through the North FAMOUS segment and into the NTD off-set which continues through to the southern end of the Lucky Strike segment. The first trawl (36°58'N 33°00'W to 37°07'N 32°41'W) was deployed at 2204z and recovered at 0715z on Fri.20th June after the third and final net had failed to close. The nets were subsequently redeployed at 0850z and trawled from 37°02'N 32°40'W to 37°07'N 32°14'W where they were recovered inboard at 1920z.

A pair of IFREMER CTD stations were then occupied close to the southern wall of the southern Lucky Strike NTD at 37°06'N 32°26'W (2100-2312z; Fri.20th June) and at 37°02'N 32°31'W (0005-0203; Sat.21st June). Upon completion of this final IFREMER CTD station of the cruise a final RMT 1+8 net trawl was conducted through the length of the Lucky Strike segment along course 018° from 37°06'N 32°21'W to 37°27'N 32°13'W (0333-1356z). After a third and final re-termination of the CTD conducting cable (1530-1732z) an RVS CTD station was occupied directly above the lava lake that hosts the known Lucky Strike hydrothermal field, at 37°18'N 32°17'W (1732-1918z). A final long BRIDGET tow-yo was then completed which commenced immediately north of the known Lucky Strike hydrothermal field at 37°19'N 32°16'W (1943z) and passed south directly over the vent-site and then west into the adjacent NTD offset, at the southern end of the segment, to 37°02'N 32°40'W where the BRIDGET vehicle was recovered at 1745z on Sun. 22nd June. Course was then made back to the known Lucky Strike vent-field for an engineering trial of the new PLASMA instrument at 37°18'N 32°17'W (2015-2340z). Upon recovery, steaming commenced back toward Ponta Delgada. On Mon. 23rd June a final scientific station was occupied at 37°27'N 29°49'W where the RVS CTD was lowered to 1000m to provide intercalibration of the spare CTD unit and also to provide an opportunity to cleanse the new 30L Niskin bottles prior to trace metal clean storage.

RRS *Discovery* Cruise 228 docked at Ponta Delgada at 0900z on Tues. June 24 where the majority of the scientific party disembarked together with scientific gear for the related MAST-III "AMORES" submersible cruises: FLORES and MARVEL. The ship sailed again at 1630z on transit to Vigo where the cruise was successfully completed at 0700z on Sat. June 28th. The ship's track followed by RRS *Discovery* during Cruise 228 (excluding transits East of the Azores) is shown in Figure 1. A diary of events is given as Appendix A.

(C.German)

SCIENTIFIC REPORTS

1. BRIDGET Operations.

1.a) Introduction.

The BRIDGET deep-tow system is a deep-tow CTD+sensor unit for the identification, investigation and sampling of hydrothermal plumes which has been developed jointly between the University of Cambridge and Southampton Oceanography Centre, under the umbrella of the NERC's BRIDGE programme.

Instrument preparation was carried out at SOC and the Bullard Laboratories, University of Cambridge. Modifications were made to the deep-tow to add 150 kg of ballast to improve stability, in the form of plastic coated lead weights. New brackets were added to carry two Challenger Oceanic Systems stand alone pumps (SAPs) and a pressure case for the electronics of an optical sensor string was also added. This sensor string, developed at Bullard Laboratories, is described later in this section.

Bulkhead connectors on the BRIDGET electronics pressure cases were replaced, after some unreliability was experienced on an earlier cruise (CD95), and new cables prepared.

The BRIDGET deep-tow carried the following sensors and samplers:

- FSI Micro CTD Ser. No. 1327 (BRIDGET CTD)
- FSI Micro CTD Ser. No. 1359 (TOBI CTD borrowed as a spare)
- Chelsea Instruments Alphatracka Transmissometer 25 cm. pathlength.
- Chelsea Instruments Aquatracka nephelometer.
- SeaTech Light Scattering Sensor (LSS)
- J.W.A. ZAPS (zero-angle photospectrometer) manganese sensor.

- Challenger Oceanic Stand Alone Pumps (two units)
- General Oceanics 12 position rosette pylon (modified) equipped with 12 x 2.5 litre Niskin bottles.

- Simrad Mesotech Acoustic Altimeter (500 metre range).
- Dual clinometer attitude sensor and flux gate magnetometer compass unit

1.b) Narrative

During the cruise a total of 17 tows were made, and are briefly described below;

BGT 01 A test deployment to 500 metres to check BRIDGET and Sensor String pressure case and connector seals.

BGT 02 First survey tow, aborted after 7 hours and 17 km run, due to fault with micro CTD. Later investigation indicated that an internal lithium cell powering the CTD memory had made poor contact in its holder, erasing operational constants in memory. Six water bottles were fired during the tow. During this tow SAP pump 1 was pumped for 11 mins 20 secs. The pumping was aborted due to the failure of the CTD. Note: rosette sequence began at bottle 2 for this cast.

BGT 03 Prior to this deployment the TOBI CTD was fitted to BRIDGET plus the required interface electronics. The ZAPS sensor was removed from the frame

due to a galvanic reaction between the ZAPS sensor and the SAP pump. This reaction occurred during the operation of the SAP on BGT 02, which caused pitting of the end caps on both devices. 35 km covered during a 12 hour tow. 12 water bottles fired and good sensor data acquired. Note: rosette sequence began at bottle 2 for this cast.

BGT 04 36 km covered, 13 hour tow. 12 bottles fired and good sensor data. Note: rosette sequence began at bottle 2 for this cast.

BGT 05 This line continued the track of the aborted BGT 02. 20 km tow over a nine hour period. 12 bottles fired. Note: rosette sequence began at bottle 2 for this cast.

BGT 06 Low speed detailed survey covering 9km in a 9 hour tow. 12 bottles fired. Note: rosette sequence began at bottle 2 for this cast.

BGT 07 12 km tow over 8 hours. 7 water bottles fired. Note: rosette sequence began at bottle 2 for this cast.

BGT 08 16 km tow over 8 hours. 12 bottles fired. The LSS sensor string was removed for repairs during this run. Note: rosette sequence began at bottle 2 for this cast.

BGT 09 BRIDGET tow aborted after three hours due to rapid degradation of the modem link. Electrical testing of cable on deck indicated a short circuit from coax ground to cable armouring. Cable reterminated.

BGT 10 Reoccupation of BGT 09 line. 10 km run in 9 hours. 12 bottles fired. SAP pump 1 was operated for 10 mins in a detected plume. No problems were encountered with pump end cap erosion.

BGT 11 9 km run in 7 hours. 12 bottles fired. SAP pump 1 operated for 10 mins and pump 2 operated for 5 mins.

BGT 12 The BRIDGET FSI micro CTD re-programmed and replaced on frame. Tow aborted after 3 hours due to failure of CTD.

BGT 13 CTD replaced with spare (TOBI) unit and redeployed. This run was aborted 2 hours later when power fluctuations were noticed on the deck supply unit. Vehicle recovered and internal connectors and external leads checked. Fault probably due to a loose connector.

BGT 14 5km run in 6 hours. 12 bottles fired.

BGT 15 7km run in 6 hours. 12 bottles fired.

BGT 16 The BRIDGET FSI micro CTD was replaced on the frame in addition to the TOBI CTD. 28 km run in 18 hours. 12 bottles fired. The two FSI CTDs were fitted to BRIDGET during this run to compare data quality. The BRIDGET CTD (Ser. No. 1327) stopped communicating after 2 hours 30 mins and only began transmitting again during ascent (1500m). A new lead was prepared for the next deployment.

BGT 17 During a 23 hour survey 52 km. were covered. All 12 bottles were fired. The BRIDGET CTD completed the line without data dropout, and it was assumed that the new cable had solved it's unreliability problem. Both CTDs were fitted to enable comparisons of data quality to be made.

1.c) Appraisal.

Deployment and recoveries were carried out in good conditions throughout the majority of the cruise. The BRIDGET tow plate was bent during one run by an excessive side load transmitted through the slip-ring swivel assembly, however no damage was caused to the swivel. The tow cable required retermination once during the cruise.

Sensors on BRIDGET overall performed well, however we describe below the known weaknesses of the present suite of instruments.

The BRIDGET CTD failed to operate once due to suspected poor contacts in its internal memory back up battery and two failures were caused by a pressure induced loss of contact within the "pie connector". Steps were taken, described earlier, so that this unit is now believed to be reliable. We were fortunate to have a second CTD available for BRIDGET, kindly loaned by Ian Rouse from the TOBI deep-tow project. Purchase of a second unit for BRIDGET should be a high priority.

The Challenger Oceanics SAPs units were not used extensively after the initial corrosion problem was found, as a precautionary measure, to prevent possible corrosion/damage to other sensors. As the units are self powered by internal batteries, optical isolation of the control lines from BRIDGET should prevent a recurrence of this problem. A new end cap for the SAPs tube is required to replace the corroded cap.

The Chelsea Instruments Aquatracka nephelometer gave a sinusoidal signal when passing through a temperature gradient. The Chelsea Instruments Alphatracka transmissometer exhibited a signal offset proportional to ambient pressure at depth. These problems will be brought to the manufacturers attention.

Throughout the cruise, the BRIDGET deep-tow completed 17 survey lines, covering a total distance of 250 km.

(R.Kirk, S. Riches, M.Rudnicki, C.German)

1.d) Data Processing.

Post-collection processing of BRIDGET data consists of two steps. First, ship's navigation is appended to the .ctd data file. Second, a wire log file is used in conjunction with the ship's navigation and BRIDGET depth to calculate the slant range and thus the position of BRIDGET during the tow.

During D228, these tasks were accomplished by the following C shell script:

```
#!/bin/csh
#
#
# script to process BRIDGET data following a tow-yo
#
#     stage 1: get and prepare ship's navigation and wirelog files
#
#
one_second -C/rvs/raw_data/gps_4000 -O./navigation/GPS_4000_60.ctd -
N60 -S$1 -E$2
#
#
rvstoascii -I/rvs/raw_data/winch -O./navigation/wirelog.dat -S$1 -E$2
-T1 -F2:0,2 -N2 -D60 -V
#
```

```
#     stage 2: Merge RVS ship's navigation into the BRIDGET files
#
mergenav -N./navigation/GPS_4000_60.ctd -C./to_be_processed -V
#
#     stage 3: Now compute the BRIDGET position by backtracking the
#                  BRIDGET slant range along the ship's track
#
mergeslant -N./navigation/GPS_4000_60.ctd -C./to_be_processed -
W./navigation/wirelog.dat -O0.0 -L -F4 -V
#
#     stage 4: final clearup
#
mv ./to_be_processed/*.ctd ./processed
#
#     stage 5: Now sort out the events files
#
events -E./to_be_processed -C./processed
mv ./to_be_processed/* ./processed
#
```

Stage 1.

Before merging with the BRIDGET data files, it is necessary to convert the RVS winch and ship's navigation files into a form suitable for the BRIDGET programs. The program one_second is used to resample the resulting subset file at the interval specified by the -N option. Here, -N60 is used to resample the RVS level C format navigation file at 1 minute intervals. This provides a sensible number of navigation data to work with. The time parameters are entered on the script command line *e.g.* `./process 1997-156-10:11:34 1997-156-19:34:15` (format YYYY-DDD-HH:MM:SS).

Winch wire out data is extracted from the RVS winch data file using `rvstoascii`. This program converts Level C format data files to ascii over a specified time range. The command line options used here are -I, the input ctd filename; -O, the output ascii filename; -S$1, E$2, the start and end file times; -T1 which specifies the YYYY-DDD-HH:MM:SS format for the time field in the ascii data file, -F2:0,2 which specifies that two fields are to be converted - fields 0 (time) and 2 (wireout); -N2 which specifies that a dataline should only be written if the wireout data is valid; -D60 which sets the decimation factor *i.e.* take every n data points; and -V which specifies verbose operation.

The result of stage 1 is two files: a BRIDGET format file of ship's navigation (GPS_4000_60.ctd), sampled every minute, and an ascii format file of wire out (wirelog.dat), sampled every 2 minutes consisting of time and wireout fields.

Stage 2.

Ship's navigation is merged into the raw BRIDGET data files using the program `mergenav`. The command line specifies a navigation file (-N option), and a directory of raw BRIDGET data files (-C option). `mergenav` has the capability to add ship's navigation to all the raw BRIDGET files residing in the directory specified by the -C option. Two data fields, ships_lat and ships_lon will be appended to the BRIDGET data files.

Stage 3.

BRIDGET position is calculated and merged into the BRIDGET data file by `mergeslant`. The command line specifies a navigation file (-N option), a directory of navigated BRIDGET files (-C option), a wireout file (-W option), a wireout-sea surface offset (-O option). Here -L specifies linear interpolation between wireout data points, -F4 sets the time format as YYYY-DDD-HH:MM:SS and -V sets verbose operation.

Stage 4.

Once navigated, the BRIDGET data files are moved to the ./processed directory.

Stage 5.

The events files can now be reprocessed using the `events` program. -E specifies the directory for the events file(s) and -C specifies the directory for the corresponding BRIDGET data files. After processing, the `_pro.events` files are moved to the ./processed directory.

The end result of the BRIDGET data processing is to produce files with both the ship's position and the calculated BRIDGET position merged in with the tow-yo data. Such files are now suitable for trackline plotting and section drawing.

(M.Rudnicki)

2. RVS CTD Operations.

Thirty nine CTD stations were occupied during the cruise (see Table 1). Stations CTD01 and CTD31 were taken to the East and the West of the ridge as background stations with Station CTD14 a repeat of CTD01. Station CTD02 was a short cast to test the Rosette sampler and was not logged. Station CTD03 and its repeat CTD36 were on a sill to the East of Rainbow segment.

The remaining stations up to and including CTD37 were all in the Rainbow segment. Of these, Station CTD18 was a 12 hour time-series with the CTD cycled (yo-yo'ed) up and down between the bottom and 1500m. Station CTD20 was a tow-yo with the ship steaming at 0.5 knots in a westward direction. The CTD was yo-yoed between the bottom and 1700m.

Station CTD38 was on a sill to the North of the segment and CTD39 at Lucky Strike.

Table 1. RVS CTD Stations
(Note all parameters are when the CTD is at the bottom of the cast)

CTD	Year Day	Water Depth (m)	Latitude	Longitude
1	146.677	2636	36° 00.00' N	33° 00.00' W
3	146.999	1777	36° 05.77' N	33° 41.05' W
4	147.899	2438	36° 12.83' N	33° 54.50' W
5	148.100	3230	36° 14.40' N	33° 56.27' W
6	148.243	2399	36° 15.77' N	33° 53.21' W
7	149.075	2803	36° 02.74' N	34° 04.67' W
8	149.261	2343	36° 16.44' N	33° 58.36' W
9	149.386	2277	36° 16.04' N	34° 03.47' W
10	150.101	2660	36° 21.11' N	33° 47.14' W
11	150.223	2301	36° 19.16' N	33° 44.80' W
12	150.344	2657	36° 17.90' N	33° 42.55' W
13	152.151	2393	36° 14.63' N	33° 53.69' W
14	152.448	2395	36° 00.00' N	32° 59.90' W
15	152.811	2515	36° 16.78' N	33° 53.89' W
16	154.479	2387	36° 12.01' N	33° 46.16' W
17	154.894	2001	36° 13.76' N	33° 52.55' W
18	155.048	2391	36° 15.71' N	33° 53.18' W
19	156.120	2487	36° 13.74' N	33° 50.61' W
20	156.270	1928	36° 13.45' N	33° 52.91' W
21	156.284	1947	36° 13.46' N	33° 53.17' W
22	156.280	1985	36° 13.57' N	33° 53.29' W
23	156.309	1992	36° 13.58' N	33° 53.42' W
24	156.323	2021	36° 13.63' N	33° 53.61' W
25	156.339	2111	36° 13.74' N	33° 53.87' W
26	156.359	2216	36° 13.97' N	33° 54.14' W
27	156.390	2486	36° 14.15' N	33° 54.59' W
28	156.427	2636	36° 14.41' N	33° 55.10' W
29	156.471	2925	36° 14.77' N	33° 55.45' W
30	156.518	3054	36° 15.01' N	33° 56.02' W
31	157.386	2643	36° 32.21' N	33° 54.37' W
32	158.848	2211	36° 10.75' N	33° 50.99' W
33	159.846	2460	36° 14.16' N	33° 54.31' W
34	162.414	3158	36° 13.79' N	33° 47.63' W
35	163.178	2381	36° 14.66' N	33° 53.72' W
36	165.8935	1967	36° 05.60' N	33° 40.96' W

37	166.0538	2472	36° 14.24' N	33° 54.26' W
38	168.7439	2634	36° 26.24' N	33° 38.83' W
39	172.7634	1695	37° 17.44' N	32° 17.00' W

A new RVS Stainless Steel CTD frame was used to allow 30 litre Niskin bottles to be deployed together with a lowered ADCP. The CTD was deployed from the amidships gantry and hauled via the 10T winch. Weather conditions were such that deployment and recovery were straightforward except on one occassion when the conditions required lines attached to the frame to control the package on recovery.

The following instruments were fitted to the underwater package:

- Neil Brown Mk IIIc CTD with a Beckman dissolved oxygen sensor. CTD data frequency is 25 Hz;
- 12 x 30 litre Niskin bottles on a GO 1016 intelligent rosette;
- 2 SIS digital reversing thermometers;
- Simrad altimeter for near bottom navigation;
- SeaTech 25 cm Transmissometer;
- Nephelometer, Chelsea Instruments Mk II Aquatracka (Turbidity);
- SeaTech Light Scattering Sensor (LSS);
- Self contained RDI Acoustic Doppler Current Profiler (LADCP)

Because of the size of the bottles only even numbered locations on the rosette were used. The bottles were numbered 2-24 accordingly. The digital thermometer was fitted to bottle number 2.

The electrical termination on the conducting cable was redone 5 times during the cruise for birdcaging, break in conductivity and for a different termination in bad weather. The LADCP compass gave information on the rotation of the package. After the cable had been shortened the rotation was much reduced. The rotation was further reduced by fitting a conducting swivel between the cable and the frame.

Problems were encountered with the firing of the bottles on casts CTD01, 18, 34 and 36. The first was traced to a failure in the constant power module, the second to an exhausted battery pack. The short life of later batteries was traced to a leakage of seawater into the conducting cable around the swivel

All sensors on the CTD worked well throughout the cruise with only very short periods (a few seconds in most cases) of bad data.

The LADCP was operated in bottom track mode for all casts except CTD07 when it operated in water track mode, the former using a ping frequency of 2s and the latter a frequency of 1s. The instrument was provided with a battery already in place and 3 spares. The first battery started at a voltage of 47.6V and was changed before CTD16, having dropped in voltage to 43.0V. Its performance was satisfactory. The second battery failed 7 hours into CTD 18, beginning the cast at 46.1V before deployment and ending at below 43V upon recovery, rising after 30 mins to 44.2V. There was difficulty "waking" the instrument at the end of the cast. A third battery was employed for casts CTD19-CTD36. During CTD36 the instrument failed about an hour into the

cast and never recovered. The battery voltage before the cast was 44.5V and 43.9V at the end. It took several minutes to "wake" the instrument up. A fourth battery was used for casts CTD37-39. The LADCP failed at the bottom of CTD39. Again, the instrument was difficult to wake up, even though the battery had a reasonable voltage. It awoke after the lead from the power supply to the instrument was cleaned.

During CTD36-38 a time gain of exactly 1 minute was observed on the instrument clock. In general the clock lost at least a second per day and was checked before and after every cast. The data required about 20 minutes to be downloaded from the instrument to the PC. This time was doubled, of course, for CTD07, which was performed in water-tracked mode.

(K.Richards, MM.Lam, P.Taylor, J.Wynar)

3. IFREMER CTD Operations

All operations were conducted using a 16 bottle rosette frame onto which was mounted a PASH6000 pylon and an *in situ* analyzer (AIS). Seafloor detection was ensured using a weight hanging from a spring-loaded switch. These three systems were interfaced to a Seabird Electronics SBE 9+. The rosette frame was hung on the coaxial seacable using a simple shackle. The other end of the seacable was connected into the SBE 11+ deck unit, itself interfaced to an IBM PC for real-time data storage and display of the upcast and downcast data. A Sea Tech LSS 6000 nephelometer was mounted on the SBE9/11+, in association with the usual C, T, P sensors. The 16 bottles were filled during the upcast at different levels in the plume visualized by the Sea Tech LSS 6000 nephelometer.

For a typical hydrocast, the rosette was lowered in the water column at 40m/min or less to the deepest point. There, the depths of the 16 bottle closures were chosen using the data displayed on the screen. During the upcast (20m/min), bottles were closed without stopping the winch. When all 16 bottles had been closed, the winch was hauled at 40m/min. From deployment to recovery, for a 2500m water column, the entire operation lasted typically 3h. Afterwards, the sample bottle file was extracted from the CTD data. That file lists the depth and other oceanographic parameters at which the samples were collected.

(J-L.Charlou, J.Knoëry)

4. RMT 1+8M Midwater Trawls.

Many of the MAR hydrothermal sites have high density populations of bresiliid shrimp. Very little is known about the reproductive patterns and larval dispersal of these animals. The objectives of the trawling programme were: (1) to investigate the midwater distribution of the early life history stages; (2) to compare this with the previous (1995) data from Broken Spur; and (3) to determine the abundance and composition of the existing bathypelagic community.

Ten tows were made with the RMT1+8M midwater trawl system. Each tow consisted of three pairs of nets (RMT1 and RMT8) fished consecutively at the plume depth range previously established at the Rainbow site (2000-2200m). The net system incorporated an altimeter (with an effective range of 300m) and a transmissometer. The net monitor operated faultlessly but two hauls were contaminated by shallower material because the release gear failed to close the net before it was hauled back to the surface.

It had been intended that most of the effort would be targeted at the Rainbow site. The first three tows at this site failed, however, to take any bresiliid larvae and it was

concluded that further work there would yield little extra information. Consequently the positions for the later tows were designed to survey the MAR regions within operational range. To this end two tows were made at South AMAR, and one each at FAMOUS, North FAMOUS, North FAMOUS/Lucky Strike offset, South Lucky Strike and Lucky Strike itself. The Rainbow site depth range was targeted at all sites where this was practicable. At Lucky Strike the middle of the three tows was fished across the summit of the hydrothermal site whose minimum depth is approximately 1560m. The depth range targeted for this net was therefore 1500-1900m (at the summit of the site the net came within 30m of the bottom) and 1900-2100m for the first and third nets.

Three of the 29 RMT8s took a single bresiliid larva, one at the FAMOUS/S.Lucky Strike offset and two at South Lucky Strike (one of the RMT1s also took a single specimen at this location). This is in marked contrast to their ubiquitous distribution at Broken Spur. All four were superficially similar and are tentatively assigned to *Chorocaris fortunata*. The Lucky Strike samples provided the closest approach during the programme to a vent site with previously identified populations of bresiliid shrimp; the lack of any captures here is particularly surprising. It should be noted that in common with other northern sites on the MAR, the Rainbow vent emissions are high in methane and relatively low in reduced sulphide. Previous investigations have shown an abundance of vent mussels (*Bathymodiolus* sp.) at these more shallow, northern sites. Mussels contain both methane and thiosulphate-oxidising endosymbiotic bacteria and are therefore better suited to this type of chemical environment. This contrasts with the high densities of vent shrimp, particularly *Rimicaris exoculata*, at the deeper southern sites (TAG 26°N; Snakepit 23°N). *Rimicaris* feeds mainly on free-living sulphur oxidising vent bacteria. Our findings are consistent with this distribution pattern of shrimp- and mussel-dominated vents along the ridge. The low frequency of *?C.fortunata* larvae in the water column at FAMOUS/Lucky Strike is consistent with its less abundant, secondary consumer role in mussel-dominated habitats, where it feeds on their faeces and pseudofaeces.

The bathypelagic populations at all the sites were very consistent in their faunal composition. The biomass was considerably higher than at the (deeper) Broken Spur site. The fishes comprised mainly *Gonostoma bathyphilum*, *Cyclothone* sp., melamphaeids and occasional alepocephalids (mainly juveniles). Crustaceans dominated the faunas, particularly the decapods *Ephyrina*, *Systellaspis braueri*, *Parapasiphaea*, *Hymenodora* and *Sergia*. Euphausiids were represented by *Thysanopoda* sp. and *Bentheuphausia*, mysids by *Gnathophausia* spp. and *Boreomysis* and amphipods by *Scypholanceola* and *Cyphocaris*. Nemertine worms were consistently present, as was the medusa *Atolla*. *Pyrosoma* was taken regularly everywhere except at the Rainbow site. More detailed analysis of the samples will be undertaken ashore.

The firm conclusion to be drawn from the samples is that bresiliid larvae are not as widely dispersed in the area as had been anticipated. It is not yet clear whether this reflects a seasonal or geographic pattern. Further sampling in August 1997 (MARVEL Cruise) may clarify the situation; planned submersible observations will also establish whether there are any significant numbers of adults at the Rainbow site.

(P.Herring, D.Dixon, B.Boorman, D.White, D.Pond)

5.*In Situ* Filtration Operations.

5.a) "Stand Alone" Pumps (SAPs).

Four RVS Stand Alone Pumps (SAPs) were deployed a total of ten times at Station 13193 (Rainbow). Sampling sites and depths were selected based on nephelometer

data from previous RVS CTD, IFREMER CTD, or BRIDGET deployments. SAPs were clamped in pairs (1 for geochemistry, 1 for microbiology, approximately 1 meter apart) at separations of 25 or 50 m apart on a plastic coated wire suspended below either the trawl wire (preliminary stern deployments) or the CTD conducting cable (preferred midships deployments). The wire was weighted with either a plastic coated 100kg weight or with Ti-housed acoustic releases being tested for the later mooring deployments (see following section). A pinger was attached when water depth required accurate knowledge of the height of the SAPs off-bottom. For the first two SAP stations, the pumps were deployed off the stern of the ship, on 480 m of plastic coated wire below the trawl wire. Bad weather first required that we "trawl" the SAPS at ca. 0.5kts for SAP01 and then delayed several subsequently scheduled deployments. The decision was then made to switch to the midships winch, at which point 200 m of plastic coated wire were cut from the aft drum and spooled on the starboard side, to be hung below the conducting cable used for the CTDs. A two hour delay time and two hour pumping time were used for all deployments. The SAPS operations went very smoothly and were completed in roughly 5 hours from arrival on station. A summary of all SAP deployments and sampling is appended in chart form as Appendix B.

i) Sampling - Geochemistry (SOC/URI).

RVS Pumps 1 and 3 (Serial Nos. SAP007 and SAP006) were loaded with 293 mm diameter 1 µm Nuclepore filters for particulate trace metal and radiochemistry sampling. In addition, two housings containing 3.3-inch MnO_2 filter cartridges (5 µm) were connected in series between the filter housing and the flow meter, for sampling of dissolved thorium isotopes. The plumbing of the cartridge holders was incorrect on SAP01 but was corrected for all subsequent deployments.

All filter handling (loading and sampling) was done in a laminar flow bench in the RVS "clean lab" container and SAP filter heads were covered with plastic bags whenever they were outside the container. On recovery, the filter heads were brought to the container where they were connected to a vacuum pump to remove excess residual seawater. Next, on removing the top of the filter head, the filter was rinsed under vacuum with approximately 100 mL Milli-Q water (MQW). From most filters, a small (approx. 2 cm^2) piece of the filter was cut, using an acid-cleaned glass knife, for mineralogy/probe studies. This filter stub was then placed in a plastic petri dish, inside a plastic bag which was back-filled with argon and then vacuum sealed. The sealed sample and bag were then placed in an outer ziploc bag and frozen. The remainder of the filter was folded into eighths after rinsing then double-bagged and frozen. A new filter was then loaded and the filter head reassembled, ready for the next deployment.

MnO_2 cartridges were rinsed briefly with MQW (to remove "sawdust" from when they were cut from 10 inch cartridges) before use. The cartridge holders were also rinsed, and filled with MQW prior to deployment. The cartridges were placed in the filled cartridge holders on deck immediately prior to screwing the holders onto the SAP heads, to minimize the amount of air in the plumbing. On recovering the SAPS the cartridges were removed, allowed to drip dry for approximately 10 seconds, placed in ziploc bags, and refrigerated (mainly just because it was a convenient place to store them, not out of necessity). All probe samples were returned direct to SOC. Filters and cartridges were shipped to URI for radiochemical analyses prior to return to SOC for trace metal analyses.

ii) Sampling - Microbiology (UC Galway).

RVS Pumps 2 and 4 (Serial Nos. SAP010 and SAP009) were loaded with 293 mm diameter 0.2 µm pore-size Cellulose Acetate filters for microbiology sampling. When assessing the performance of SAPS, it should be noted that the filters used for

microbiological purposes have a smaller pore size (0.2 μm) than those used for geochemistry (1 μm) and, thus, exhibit a lower mean flow rate.

The primary objective of studies to be carried out on material obtained on these filters is to investigate the structure of microbial communities associated with hydrothermal plumes by means of nucleic acid (non-culture) based methods.

All filter handling (loading and sampling) was done in the "clean lab" container, and the filter heads were covered with plastic bags whenever they were outside the container. On recovery, the filter heads were brought to the container where, upon removal of the top of the filter head, the filter was folded into eighths using alcohol-sterilised tweezers, and then bagged in sterile plastic bags. As preservative, 50 ml of 40% Glycerol was added to each sample. The bags were heat-sealed and then stored at -50°C. A new filter was then loaded and the filter head reassembled, ready for the next deployment. From the filters obtained from deployments SAP09 and SAP10, a small (approx. 4 cm^2) piece of the filter was cut, using an acid-cleaned glass knife, for microbe/particle association studies using Electron Microscopy. This piece was placed in a sterile plastic bag and 3% Glutaraldehyde was added as preservative. The bag was heat-sealed and then stored at -50°C. Following the cruise, all samples were shipped to UC Galway for analysis.

iii) Sampling - Biology (PML).

For deployments SAP09 and SAP10, Pump 2 (RVS SAP010) was deployed with a 30 mm Nitex mesh, for sampling planktonic larvae, in place of the 0.2 mm cellulose acetate filter. Upon recovery, the filter head was brought to the container, where the top of the filter head was removed. The bottom-half of the filter head, containing the Nitex mesh was then brought to the Chemistry laboratory where the Nitex filter was cut in half. One half was placed in a plastic bag, preserved with 10% Formalin, sealed and stored at 4°C for subsequent onshore Scanning Electron Microscope examination. The other half of each filter was also placed in a plastic bag, preserved with 95% Ethanol or 5M NaCl, sealed and stored at -20°C for subsequent onshore DNA analysis. The aim of the two preservatives is to establish their suitability for incorporation into the PLASMA instrument (an autonomous larval sampler) for molecular analysis of planktonic larvae. A preliminary microscopic examination of some of the particulate material on these filters, using phase contrast microscopy, revealed mainly inorganic particles, some of which were aggregated. There was also the occasional diatom frustule, indicative of a photic-zone origin. Following the cruise, samples were shipped to PML for analysis.

5.b) "(No longer)Stand Alone" Pumps mounted on BRIDGET.

Two SAPs were fitted to the frame of BRIDGET for Cruise D228 to enable informed sampling activated in real-time during BRIDGET tow-yos in response to real-time nephelometer, transmissometer and light-scattering sensor data. 293 mm diameter 1 μm pore-size Nuclepore filters were used for particulate metal sampling. On BGT01, which was a test dip for some new pressure cases, filters were loaded simply to make sure they would not split if the filter heads were not prefilled with water. These filters were saved as blanks. On BGT02, Pump 1 (the front pump) was turned on for approximately 11 minutes - at the end of this time communications were lost with the CTD and BRIDGET was recovered. For fear that the pumping had something to do with the demise of the CTD, the pumps were not deployed again until BGT09. The pumps were not turned on during BGT09, so the same filters were left on for BGT10. During BGT10, Pump 1 was turned on for 10 minutes, and pumped 106.2 L. However Pump 2, which was never turned on during BGT09 or 10, recorded 181 L pumped! Unfortunately, pump readings were not taken between BGT09 and BGT10,

so it is not known how much of this "spurious pumping" occured on each deployment, nor how much of the Pump 1 volume is attributable to the pumping period. During BGT11, Pump 1 was turned on for 10 minutes (50.2 L), and Pump 2 for 6 minutes (194 L). Again, it appears that the tow-yo motion of hauling and veering BRIDGET must be sufficient to force a flow of water through the filters and against the flow-meters which are positioned downstream. A pair of filters was also loaded on the pumps throughout BRIDGET Tows 12-15 - the pumps were never turned on during these runs, but Pump 1 recorded 69.6 L and Pump 2 197.2 L.

BRIDGET filters were handled in the same way as SAPS geochemistry samples. Probe samples were cut from BGT02 Pump 1, BGT10 Pump 1, and BGT11 Pump 1. All BRIDGET samples were returned to SOC for future analysis.

(H.Edmonds, J.D.O'Brien, D.Dixon, C.German)

6. Mooring Deployments.

Eight moorings where deployed. The position of each mooring is given in Table 2. Each mooring has Aanderaa current meters at a nominal 2300, 2100 and 1800m water depth, being below, at and above the expected plume height, respectively. Each current meter has temperature and pressure sensors. LSS were fitted to the 2100m current meter on each mooring. Mooring A has a fourth current meter at 1000m water depth to monitor the flow above the median valley. Each mooring is fitted with an Oceano acoustic release transponder positioned 100m above the bottom.

The moorings were layed in 2 days (Days 166 and 167) by deploying the buoyancy first over the stern of the ship with the ship steaming into wind (predominantly eastwards). The weight was released when the ship was at the required location. All moorings were monitored to the seabed and then checked to confirm the height and verticality of the release.

The Bosun and crew of the RRS Discovery are particularly acknowledged for their proficiency in completing this important portion of the cruise programme.

(K.Richards, P.Taylor, J.Wynar)

Mooring	Latitude	Longitude	Water Depth
A	36° 17.20' N	33° 53.96' W	2440
B	36° 16.27' N	33° 52.98' W	2450
C	36° 13.60' N	33° 50.68' W	2400
D	36° 16.57' N	33° 54.14' W	2520
E	36° 17.30' N	33° 51.09' W	2890
F	36° 25.41' N	33° 38.68' W	2650
G	36° 14.66' N	33° 54.02' W	2410
H	36° 11.83' N	33° 47.98' W	2450

Table 2. Mooring positions and water depth

7. Water Column Sampling.

7.a) Rn-222 Sampling.

The purpose of analysing ^{222}Rn on this cruise was in conjunction with helium isotopes to provide age constraints for the plume studies carried out at the Rainbow hydrothermal site and hence allow reaction rates within the plume to be determined. The radon was measured using the method of Mathieu et al. (1988). The sample was collected in evacuated 20L Pyrex bottles and stripped using helium. The radon was collected on activated charcoal columns held at -70°C in an isopropanol bath and then transferred to a scintillation vial by heating to 450°C. Radon activities were then counted using a scintillation counter,

In order to obtain a comprehensive set of samples, twelve 20L Pyrex bottles, four radon stripping boards and six scintillation counters were utilised. In this way it was possible to sample and analyse a full suite of twelve water samples collected with the 30L Go Flo bottles on the RVS CTD rosette from selected casts. A total of 11 CTD casts were sampled, ten from the Rainbow area and one from Lucky Strike.

(M.Cooper, M.Rudnicki)

7.b) He-3 Sampling.

Helium (^3He) is a key dissolved tracer used extensively in hydrothermal plume studies. It is enriched in hydrothermal fluids and inert, so that it can be utilized as a passive tracer of dilution and dispersion. For practical reasons, helium analyses cannot be performed on board. They will be performed on shore within the next two months (July and August 1997) by mass spectrometry at the Commissariat à l'Energie Atomique (CEA Saclay, Orme des Merisiers, Gif-sur-Yvette) under the responsibility of P. Jean-Baptiste.

Sea water destined for ^3He analyses is sampled in copper tubes fixed to aluminum rails and sealed with metal clamps. In total, 340 samples from both IFREMER and RVS CTDs (Conductivity-Temperature-Depth) have been taken for Helium analyses. 264 samples were taken at the Rainbow site, mostly coupled with Radon sampling. The remainder of the samples were taken at the FAMOUS and Lucky Strike stations.

(A-M.LeClerc)

7.c) Methane Sampling.

For CH_4 measurement, deep seawater was collected from the Niskin bottles of the RVS and IFREMER rosettes. Samples for CH_4 analysis on board the ship were rapidly drawn by gravity into 125 mL glass bulbs fitted with teflon stopcocks at either end. The bulbs were filled from below and allowed to overflow vertically to about one third of their volume in order to avoid trapping air bubbles.

7.d) Manganese Sampling.

Unfiltered samples were collected from the RVS rosette (30L Niskin with teflon coated springs, except bottle 4, 8, 12, and 20 with rubber springs), from the IFREMER rosette (8L Niskin, with silastic tubing), or from BRIDGET (2.5L Niskin, rubber springs). The 250mL samples are held in HDPE bottles acid-cleaned prior to use. These samples were acidified to pH <1 using 1mL conc. HCl per litre of sample. Acidification took place under a laminar flow hood. These samples will be analyzed at

the shore laboratory (IFREMER DRO/GM, Joel R. Knoery) and the data will be reported as total dissolvable manganese (TDM).

7.e) Barium Sampling.

All barium samples have a corresponding manganese sample. Barium samples (500 were collected) are also unfiltered, they are held in 30mL HDPE bottles. The samples have been acidified using 50µL HNO_3 per sample and this operation was carried out under the laminar flow hood.

7.f) Sulfide Sampling.

Unfiltered samples were drawn in polyethylene syringes and analyzed using the fluorimetric method of Radford-Knoery et al. (1997).

7.g) Dissolved Oxygen Sampling.

In order to flag improperly closed bottles, dissolved oxygen was analyzed on samples collected by the RVS rosette and the IFREMER rosette. Samples were drawn in iodine flasks, treated with manganese sulfate and alkaline iodide solutions. The flasks were then stoppered with a ground glass stopper until analysis, within 8 hrs. of sample collection.

7.h) Silicate Sampling.

In order to flag improperly closed bottles, dissolved silicic acid, silicate, was sampled using 60mL HDPE bottles. The samples were stored at ambient temperature until analysis in the container laboratory, always within 48h of sampling.

(J-L.Charlou, J.Knoëry, J-P.Donval)

7.i) Salinity Sampling.

During Cruise 228, *in situ* water column salinity measurements were made using four different CTD instruments on three different frames:

• Neil-Brown Mk.IIIc on the RVS CTD-frame

• Sea-Bird SBE 9/11plus on the IFREMER CTD-frame (the conductivity sensor of this instrument was changed after station 13193-62-HYD11)

• 2 different FSI MicroCTD systems on the BRIDGET tow-yo instrument; the first one being used on BRIDGET tows 2, 9-12, 16,17 and the second one on tows 3-8, 13-17 (both CTDs were deployed simultaneously on tows 16, 17)

To calibrate these instruments, seawater samples for shipboard salinity analysis were taken routinely throughout the cruise. A total of 479 200ml water samples were collected from all stations except BGT01, BGT09, BGT12, BGT13, CTD01, CTD02, CTD34, HYD05 and HYD08. Due to the fact that rosette bottles were shared, most samples have been taken at or near the plume-depth although enough samples are available to calibrate all the sensors throughout full ocean depth.

(A.Thurnherr)

7.j) Particle Size Distribution Sampling.

A total of four hundred and thirty three samples were collected for particle size distribution analysis from twenty-two RVS CTD casts, thirteen IFREMER hydrocasts and eleven BRIDGET tows. 100mL-200mL samples of unfiltered seawater were taken into particle-free LDPE 500mL bottles, with rinsing, and allowed to equilibrate to room temperature in the laboratory (10-12 hours) before commencing analysis. Details of the analytical method are given in Section 9.d) below.

(D.Green, D.Pond)

7.k) Microbiological Sampling.

Water column samples, (50 mL), were collected from the Niskin bottles of selected deployments of the RVS CTD, IFREMER CTD (HYD) and BRIDGET instruments for subsequent enumeration (Total Counts) and sizing of microorganisms by epifluorescent optical microscopy. These samples were collected in an effort to determine the numbers of microorganisms present in various locations in the plume and at various distances from the plume source. Upon recovery of the instruments on deck, 50 mL water samples were collected in 50 mL tissue culture flasks and, as preservative, 2 mL of 40% Formaldehyde (final conc. 2%) was added. All samples were then stored at 4°C for the duration of the cruise. Following the cruise, all samples were shipped to UC Galway for analysis. The deployment numbers for each instrument from which samples were obtained are as follows:

Instrument	*Deployment No.*
RVS CTD	03, 06, 20-30, 37
IFREMER CTD	03, 04, 05, 06, 07, 11
BRIDGET	02, 03, 07, 15

(J.D.O'Brien)

7.l) Organic Geochemistry.

A key question regarding the nutrition of MAR vent ecosystems is the importance of surface derived material which sediments to the deep ocean. As vents are located in regions characterised by low primary production, this material has previously been considered to be unimportant. However.....this may not be the case!

Surface-layer particulate fatty acid samples were taken from the microplankton maxima (as determined by light scattering sensors located on the various CTD systems) which varied from depths of 48-75 m (Table 3). For the deep-water samples, insufficient quantities of seawater were available for analysis from a single depth, so aliquots were pooled from a number of CTD or Hydrocast (HYD) bottles (Table 3). In addition, during two BRIDGET transects above the Rainbow hydrothermal vent plume, seawater was sampled from the non-toxic supply (approximate depth, 3 m, Table 4). All particulate fatty acid samples were pre-screened with 200 μm nylon mesh and filtered onto ashed GF/F filters and stored in chloroform:methanol (2:1, v/v) at -50°C.

(D.Pond)

Table 3 Samples taken from RVS CTD and IFREMER HYD stations.

Station	Sample depth (m) (samples in brackets were pooled)	Volume filtered (L)
CTD 03	63	10
	200	10
	1398	10
	1800	10
	1934	10
CTD 06	51	10
	(2101, 2126, 2151, 2175, 2200)	50
CTD 09	48	10
	(1399, 1699, 2000, 2277)	40
CTD 13	50	10
	(2000, 2099, 2200, 2301)	40
CTD 15	62	10
	(1900, 2000, 2100, 2199, 2300)	50
CTD 17	52	10
	(1600, 1800, 1900, 1949)	40
CTD 19	50,	10
	(2050, 2108, 2149, 2200)	40
CTD 31	75	10
	(2000, 2100, 2200, 2400)	40
CTD 32	50	10
	(1976, 1951, 2000, 2102)	40
CTD 33	(2139, 2147, 2146, 2139, 2136, 2137, 2125)	60
CTD 37	52	10
HYD 02	(1975, 2000, 2050, 2075, 2100, 2145, 2175, 2225)	30
HYD 03	(1970, 2010, 2050, 2090, 2140, 2170, 2210, 2250, 2290, 2330)	40
HYD 04	(2000, 2050, 2075, 2100, 2125, 2757, 2200, 2300)	40
HYD 06	(1900, 1950, 1975, 2000, 2025, 2050, 2075, 2100, 2125, 2150, 2175, 2200)	50

Table 4. Samples taken from the non-toxic pumped seawater supply.

Transect 1	Position	Volume filtered (L)
NON-TOXIC SUPPLY	38 11.92 N 33 59.99 W	10
NON-TOXIC SUPPLY	36 13.11 N 33 57.76 W	10
NON-TOXIC SUPPLY	36 14.79 N 33 53.72 W	10
NON-TOXIC SUPPLY	36 15.55 N 33 50.30 W	10
NON-TOXIC SUPPLY	36 18.58 N 33 46.16 W	10
Transect 2		
NON-TOXIC SUPPLY	36 11.56 N 33 55.90 W	10
NON-TOXIC SUPPLY	36 11.82 N 33 53.79 W	10
NON-TOXIC SUPPLY	36 12.66 N 33 51.10 W	10
NON-TOXIC SUPPLY	36 14.52 N 33 47.51 W	10
NON-TOXIC SUPPLY	36 16.87 N 33 41.64 W	10

8. Shipboard Data Processing.

8.1) CTD System.

i) Data capture.

CTD data were passed from the CTD Deck Unit to the Level A (acquisition) dedicated microcomputer. In real time the data were median despiked and averaged to one second values. Some pressure spikes still remained in the pressure 1 second averaged data although these were only 2-3 per cast. Data were then passed to Level B (logging) and C (processing).

This was the first use of the RVS MkIIIc CTD. Two problems arose with the data logging. The level A had difficulty in coping with the 25 Hz data frequency, leading to serial overruns and Level A crashes. The latter resulted in loss of data on station CTD03 (approximately 30 mins). Unfortunately the PC backup file was also accidentally deleted. On subsequent casts the Level A system was monitored and crashes dealt with when they occurred by stopping the winch and rebooting the system.

The second problem was that the bottle fires were not picked up by the RVS computer system. To overcome this, the exact firing time was written down and a file created with these times to merge with the 10s averaged CTD data. The technique produced satisfactory results but an automated system is required.

ii) Data processing.

CTD data were processed using Pstar. The following execs were applied to each cast:

`ctdexec0` data read into a pstar formatted file

Output file: `ctd`**`nnn`**`.raw` (where **`nnn`** refers to cast number)

`ctdexec1` data calibrated from engineering units using manufacturers calibration figures specified in the file deepctd.cal. The calibration constants are given in the header of each file. The Neil Brown CTD was last

calibrated by General Oceanics on 21 April 1997. The CTD will be recalibrated post cruise. Salinity spikes were minimised by adjusting the temperature lag constant deltat. A value of deltat = 0.26 was used.

remaining pressure spikes removed

data averaged to 10 seconds

Output files: `ctdnnn.du, ctdnnn.10s`

`ctdexec2` potential density referenced to 2000m calculated

only downcast data retained

Output file: `ctd228nnn.down`

`ctdexec3` variables plotted from CTD cast

`ctdexec4` salinity recalibrated using bottle data (see section 9). A constant offset of + 0.019 psu was applied. There was an indication that above 500m depth there was a dependence on pressure/temperature increasing the offset to +0.025 psu at the surface. No correction for this temperature dependence was applied on the cruise.

potential density recalculated

Output file: `ctd228nnn.1hz`

`ctdexec5` running mean despiking applied to salinity

data sorted with respect to pressure

data averaged over 2 decibar intervals

new variables potemp, sigma0 (referenced to the surface), potmp2, sigma2 (referenced to 2000m) and depth calculated

Output file: `ctd228nnn.2db`

(K.Richards, MM.Lam)

8.b) Lowered ADCP.

The raw data from the instrument were processed in two different ways: firstly making use of the software developed by Eric Firing to produce absolute velocities in the water column, and secondly, using PSTAR execs modified from ones developed by Brian King to extract absolute velocities from bottom-tracked data.

i) Water column data.

On PC:

`scanbb` run on raw instrument data `d228nnn.000`.

provides time of up and down cast and ensemble range of up and down cast. Latter information put into `dnnn.cnt`, along with latitude and longitude.

`loadbb` run using control file `dnnn.cnt`
creates CODAS database
output files: `dnnn*.blk`

These files were sent to a SUN workstation to be processed further.

On SUN:

`mkblkdir` run using `mkblkdir.cnt` to convert CODAS files to SUN format files
output files: `dnnns*.blk`

`domerge` run on SUN formatted `dnnns*.blk` files using `merge__.cnt` and `proc.dat` which contains information on the time of the up and downcasts (from `scanbb`) and the water depth (obtained from CTD data).

`do_abs.m` run in MATLAB to produce plots of the absolute velocity in the entire water column. Requires GPS data from the navigation file.

There was difficulty merging with the CTD data.

ii) Bottom-tracked data.

On PC:

`bblist` RS software used to produce ascii files from raw instrument data. We output 27 variables: ensemble number, year, month, day, hour, minutes, seconds, BTrb1(bottom-tracked range beam 1), Btrb2, BTrb3, BTrb4, BTvelE (bottom-tracked velocity east), BTvelN, BTvelv (vertical), BTvelEr (error), BT%b1 (bottom-tracked percent good beam 1), BT%b2, BT%b3, BT%b4, VE, VN, VV, VEr (last 4 are profile velocities), %1, %2, %3, %4 (last 4 are profile percent goods).
output files: `dnnnbt.pre`

ON SUN:

`bt_pre.m` MATLAB routine which reads in the `dnnnbt.pre` files, adds bin number to the first column of the dataset.
output files: `dnnnbt.asc`

`lexec0` PSTAR exec which converts `dnnnbt.asc` files to PSTAR format. Present version does not output the percent goods of beams 2-4 for either bottom-tracked data or profile data.
output files: `dnnnbt.pst`

An error in this exec produced incorrect velocities the first time the data was processed.

`lexec1.pre` used to determine depth of cast from CTD data except for CTD18/20.

`lexec1` swaps absent data values to pstar values, converts ranges and speeds from original units, makes ranges>356 absent, makes range equal the average of the 4 beam ranges, calculates bin depth, converts time to seconds, calculates water speed over ground, fixes water depth.
output files: `d228nnn.bt`

`lexec2` gets CTD file for cast and calculates depth, merges depth and pressure, produces absolute bin depths. lexec18 and lexec200 used for casts CTD18 and CTD20
output files: `d228nnn.bt`

`plist` used to determine the cycle number of the bottom of the cast.
output files: `d2280nnn.bt`

`pcopya` used to reduce the number of cycles in the output file to below 10000, and to divide the data for casts CTD18 and CTD20 into their separate down and up casts.
output files: `d2280nnn.bt`

`lexec20.pre` used on cast CTD20 to determine depth for each up and down.

`lexec3` Works out height of bins above bottom, selects bins within 500m of bottom, sorts and averages, applies magnetic correction (here equal to -14).
output files: `d228nnn.av`

(MM.Lam, K.Richards)

8.c) Hull mounted ADCP.

The hull mounted ADCP was switched on on Day 153. Data were logged on a PC and transferred to the RVS computer system. The data were archived but not processed on the cruise. This will be done subsequent to the cruise.

Initial checks of the PC time showed the PC clock to be keeping good time, to within less than half a second. On Day 167 a difference of 3 seconds was noted between the PC time and GMT. After that the PC time was checked on a daily basis and reset when necessary. The time difference was variable being as much as 48 seconds on Day 170.

(K.Richards)

9. Shipboard Analyses.

9.a) Salinity Measurements.

Laboratory analysis of all samples was performed using an Ocean Scientific International AUTOSAL Model 8400A*. However, due to initial temperature stability problems in the stable laboratory (main deck) analytical data for samples from stations HYD01, BGT02, CTD03, CTD04, CTD05, CTD06 have had to be discarded. The AUTOSAL was subsequently moved to the controlled temperature laboratory (laboratory deck) where an ambient temperature of 24±1°C could be maintained. The water bath temperature was set to 24°C.

For each water sample, salinity was measured until the standard deviation of three consecutive measurements was below 0.001psu (maximum allowed standard deviation for single measurements was 0.0005psu).

The AUTOSAL itself was periodically re-standardised approximately every 75 samples with IAPSO Standard Seawater (34.994psu).

(A.Thurnherr)

9.b) Dissolved Tracers.

All hydrocast (HYD) CTD data were archived on the IFREMER IBM PC for processing in the shore laboratory using the latest (post-cruise) calibration files supplied by SBE for the temperature and conductivity sensors. Preliminary processed data files from two casts were also transferred to A.Thurnherr for comparison with the RVS CTD data.

All shipboard analytical instruments were placed in the IFREMER mobile van fixed on the deck of the *Discovery*. Dissolved oxygen, silicate, hydrogen sulfide and methane concentrations were measured after each cast along the cruise in the three studied segments: AMAR, FAMOUS and LUCKY STRIKE. The real time analysis of the dissolved CH_4 tracer in deep waters made possible the tracking, delineating, and mapping of the hydrothermal plumes, in addition to nephelometric data.

i) Dissolved oxygen.

Dissolved oxygen was determined on 125mL samples using the conventional Winkler method. Titration and endpoint detection was carried out using a platinum rod electrode connected to a Metrohm Titrino apparatus.

ii) Silicate.

Silicate was determined using the silico-molybdate blue complex. The analyses were conducted on a Technicon AutoAnalyzer II. Samples were poured in the auto-sampler cups and subjected to the chemical reaction. The absorbance was determined at 880 nm and recorded on a paper chart recorder. The instrument was calibrated before and after each set of 12 or 16 samples, as well as in the middle. The instrument response was linear from 0 to 20µM.

iii) Sulfide analyses.

Dissolved sulfide quenches the fluorescence of fluorescein mercuric acetate solutions. Using this chemical reaction, and a Flow Injection Analysis apparatus, samples were analyzed as soon as possible after collection. Depending on the depth at which the sample was collected (and the time hauling the rosette back on deck) and the speed of sampling around the rosette, all samples were analyzed within 4 hours of bottle closure. Because of the reactivity of dissolved sulfide, analyses were only attempted where the nephelometry anomalies were large. Concentrations observed range between non detectable and 10nM. The concentrations observed follow the nephel anomaly.
A prototype of a sulfide sensor was lowered using the rosette frame in each of the hydrocasts in the vicinity of the likely location of the south-Amar (Rainbow) hydrothermal site conducted after hydrocast HYD 09. The detector signal remained insensitive to pressure effects, suggesting that the sensor design is good, and that sulfide concentrations at low nephels are too low to be detected by the AIS. It should be noted that sulfide concentrations at low nephels are too low to be detected using the bench top apparatus.

iv) Methane analyses.

CH_4 analyses were performed immediately on board in the IFREMER clean mobile laboratory by the modified method of Swinnerton et al. (1962), as described by Charlou et al. (1988, 1991) and Charlou and Donval (1993). The CH_4 analysis was performed on board the ship by using an equipment set up in a portable clean air-conditioned van, permitting dissolved CH_4 analysis every 10 minutes, 24 hours a day. The trapping method (Swinnerton et al., 1962; Scranton and Brewer, 1977; Lilley et al., 1983; Charlou et al., 1987, 1988, 1991, 1993) was chosen in this study, and

allowed us to work on small sample volumes of just 125 mL. The glass bulb was placed on the extraction line. Dissolved CH_4 was extracted from the seawater by stripping with purified helium and then trapping it on an activated charcoal trap placed in a cryocool at -80°C. After the stripping/trapping operation, CH_4 was desorbed from the activated charcoal by heating the trap at 100°C and injected into the chromatographic column placed in the 100°C heated oven of a DELSI instrument chromatograph equipped with a flame ionization detector. Peaks were recorded and integrated on an ICR-1-B Shimadzu integrator. For calibration of the gas chromatograph, Air Liquide/Alfagaz CH_4 standards (2.8 ppmv +/- 2% and 10 ppmv +/- 2%, both in pure helium) were injected through calibrated loops to the detector at appropriate time intervals. Known amounts of CH_4 injected into the stripping/trapping line, following the same steps as those used in seawater sample analysis permitted a good standardization. Blanks were run between samples. A 3% standard deviation was obtained for surface samples containing around 45 nL/L. The detection limit of the method is 0.5 nL CH_4 per liter of seawater. Taking into account the precision of the calibration, blank corrections, and reproducibility, the precision is better than 3% within a CH_4 concentration range of 10 - 500 nL/L. The Atlantic background concentration is close to 10 nL/L. However, previous results show that the lowest values observed along the axis of the Mid-Atlantic Ridge are closer to 15 nL/L. This value can be considered as background for the areas (AMAR and FAMOUS) studied in detail during the FLAME cruise.

v) Preliminary results for CH_4.

CH_4 is known to be a good indicator of hydrothermal activity and can also be produced during other processes occurring along the Mid-Atlantic Ridge. We know that above active hydrothermal areas, such as SnakePit (23°N) or at TAG (26°N), the CH_4/Mn and CH_4/nephel ratios are generally relatively low. In contast, high CH_4/Mn values are found in many areas along the MAR, indicative of active serpentinization processes, as observed at the eastern and western intersections of the 15°20'N Fracture Zone within the axial valley of the Mid Atlantic Ridge (Charlou et al., 1991; Charlou et al., 1996; Charlou et al., submitted).

750 samples were collected from BRIDGET, the RVS CTD-rosette and the IFREMER CTD-rosette and analysed on board the ship during the cruise. The CH_4 anomalies are in good agreement with nephelometric signals found in the AMAR area. However, CH_4 is a more sensitive and peristent sensor, which permits one to locate residual plume signatures in areas where a nephelometer may give no deviation. Examples of this feature were demonstrated during this cruise from all of the AMAR, FAMOUS and Lucky Strike segments:

* *AMAR segment - Rainbow plume.* Twenty six hydrocasts were conducted with the IFREMER CTD/Rosette in this area, where an intense plume was previously found from neplelometric data and from CH_4 and Mn anomalies. CH_4 data were well correlated with nephelometric data at all stations. The CH_4 plume is entrained by currents to the north east and contour the east basin before exiting into the north of the segment. Intense anomalies of CH_4 are found in stations HYD-12, 13, 17 (up to 5µL/L), as also observed in samples collected by the RVS CTD and BRIDGET in the same area. These CH_4 results indicate hydrothermal fluids are emitted between 2000 and 2100 m in this area, which will be studied in detail by the submersible *Nautile* during the FLORES cruise (July 6 to August 9, 1997).

* *FAMOUS segment.* Six IFREMER CTD-rosette stations were conducted in the southern portion of the FAMOUS segment, along the west wall and in the south of the basin, where high CH_4 anomalies were found during previous cruises. During the FAZAR cruise, a vertical hydrocast station in the middle of the south basin showed a CH_4 anomaly up to 250 nL/L between 2000 and 2700m depth. Dynamic hydrocasts

conducted during the HEAT cruise confirmed the presence of an important CH_4 enrichment along the west wall and in the south of the basin. All CTDs conducted during the FLAME cruise confirm the previous observations. The HYD-26 station permitted to locate precisely the area emitting large quantities of CH_4 (anomalies of up to 1µL/L were detected). During all these operations, the nephelometry profile remained very flat while the measured dissolved CH_4 concentrations were high, indicating that CH_4 is probably issued in this area from ultramafic outcrops placed on the west wall, as previously observed in many other areas along the Mid-Atlantic Ridge (Charlou et al., 1996).

* *Lucky Strike segment.* Two IFREMER hydrocasts were conducted south of the Lucky Strike segment, close to the FAZAR-HY-21 and HEAT-HC-01 stations. A CH_4 anomaly of 300 nL/L was found to be present on the 1750m isobath. The two stations FLAME HYD-01 and 02 conducted during thie FLAME cruise in the west and the north west do not, alone, permit one to find the origin of the CH_4 plume in this area. More investigation with more CTD hydrocasts will be necessary in this area. The absence of nephelometric signals tends to show, as observed in the south FAMOUS area, that CH_4 is again probably issued from serpentinized ultramafic outcrops. Above the active Lucky Strike hydrothermal field, a CH_4 anomaly of 1µL/L was found at 1645m depth (RVS CTD39). Again, no strong nephelometer signal was found at this location, demonstrating the superior sensitivity of dissolved CH_4 analyses.

Acknowledgements. The French scientific party enjoyed sailing on the RRS *Discovery*. The pleasant working atmosphere, the splendid accomodations, and the excitement of surveying an hydrothermally active area certainly played an important role. We thank the crew, officers and other scientists manning this great ship for making FLAME so successful. The entire scientific program was orchestrated with great efficiency, thanks to C. German's management. We are very grateful that he mustered the delivery of a 1030mbar high pressure, even if it took two weeks to actually get it!

(J-L.Charlou, J.Knoëry, J-P.Donval, H.Pellé, J-Y.Landuré)

9.c) ZAPS *in situ* dissolved Mn sensor development.

The prototype instrument, developed and manufactured under patent agreement by John Wheaton Associates Ltd., was intended for real-time in-situ measurements based on a continuous flow method (Klinkhammer, 1994). N,N-diethylaniline (DEA) is oxidised by potassium periodate in the presence of manganese to produce N,N,N',N'-tetraethylbenzidine (Hirayama and Unohara, 1984). Manganese concentration is derived as a function of the decrease in the DEA concentration. However, fitted to BRIDGET on deployment 05-BGT-02 at site 13193 (Rainbow), the SOC ZAPS probe failed to produce any significant signal deflection despite pronounced responses from the BRIDGET nephelometer, transmissometer and light scattering sensor, all of which indicated that a significant hydrothermal plume had been intercepted.

Continuing a study started at the Southampton Oceanography centre (SOC) with Stuart Holland from John Wheaton Associates Ltd. (Holland, 1997), parameters affecting the reagents and reaction kinetics were investigated. These included sample preparation, pH, reagent concentrations and reaction time. Samples were taken from RVS CTDs: 06, 12, 14, 16, 20-30, 37 and 39 (CTD01 at site 13198/Lucky Strike) and in many cases mixed to provide a suitable stock with which to evaluate the effects of altering a single variable. Ambient water was collected from bottles fired at depths well above a plume as detected by optical sensors, and also from stations outside the rift valley. This ambient water was then used to generate a background signal against which plume-sample signals could be compared.

The methodology developed by the end of the cruise was to accurately add potassium periodate (KIO_4) and hydrochloric acid (HCl) solutions to seawater samples immediately prior to analysis. A coil of tubing was incorporated between the DEA cartridge and the detector, allowing a reaction time of approximately ten minutes. The cartridge containing KIO_4 within a polymethylmethacrylate resin was not used. In other respects the method was similar to that described by Klinkhammer (1994). Heating and storage of samples treated with KIO_4/HCl prior to analysis, as described by Hirahama and Unohara (1984), reduced the magnitude of the signal deflection. The DEA signal was generally noisy and was found to be affected by motion, particuarly any sudden movement of the cartridge. In many cases, colour visibly developed in the tubing coil. This was thought to be due to the synthesis of N,N,N',N'-tetraethylbenzidine or, possibly, the presence of reduced iodine species.

Finally, samples from 13198-CTD01 at Lucky Strike were measured. Those from within the hydrothermal plume, as identified by the nephelometer anomalies and dissolved methane and radon analyses, clearly produced larger deflections than those outside. Given the relatively low TDM analyses reported from the Lucky Strike plume previously, this indicates significant progress with the SOC ZAPS *in situ* Mn probe.

(D.Green, C.German)

9.d) Particle Size Distribution Measurements.

Measurements of particle abundance and size distribution were made on-board using a Spectrex Corporation PC-2000 Laser Particle Counter. Samples were typically conducted approximately ten hours after sampling because previous studies (CD95, CD97a) had indicated that analyses of cold non-equilibrated samples led to exsolution of dissolved gases leading to erroneously high concentrations of coarse-grained material being indicated by the LPC.

Although more than four hundred analyses were completed, two further problems were encountered with the LPC during the cruise. The first, which manifested itself as an upward shift in particle size distribution, was shown to be caused by stray, natural light reaching the detector and was overcome by covering the instrument or by analysing outside daylight hours. The second was that some samples containing a total number of particles greater than that low enough for coincident counting to be considered insignificant, yielded higher values after dilution with Milli-Q Water (MQW). This was thought to be due to cell membranes rupturing as a result of the reduction in osmolality of the fluid. This indicates a severe limitation of the instrument - particularly (e.g.) in near-surface marine environments which are likely to be dominated by organic rather than inorganic suspended particulate phases - in contrast to typical hydrothermal plumes.

(D.Green, D.Pond)

9.e) Chromosomes: Molecular cytogenetics.

i) Objective.

As a supplement to the molecular investigation to be carried out on adult vent shrimps and their larvae, a chromosome study was commenced with the intention of using a range of cytogenetic markers, viz. chromosome number, karyotype composition and the chromosomal location of specific DNA sequences (as revealed by *in situ* hybridisation), as indicators of phylogenetic relationships within and between species groups. The ideal material for cytogenetic analysis, because of the high intrinsic rate of cell division, is male gonad or embryo/larval tissues. Given that the adult stages of vent shrimp are sedentary and only found in close proximity to hydrothermal vents, and

given the low abundance of their larvae in the water column (see Section 4: *Midwater Trawl Results*, above), it was decided to develop a cytogenetics method generally applicable to deep-sea crustaceans, which could then be applied to the gonadal tissues of adult vent shrimps when these became available during the subsequent *Nautile* dives (MARVEL cruise; August-September 1997).

ii) Animals and tissue types.

Two species of bathypelagic carid prawns were selected for investigation: *Hymenodora gracilis* and *Systellaspis debilis*. Two tissue types: gills and female gonad (Note no sexually mature males were identified) were removed from freshly collected specimens and treated as follows:

iii) Methods.

- The tissues were finely minced in cold, filtered sea water using dissection scissors and needles. It was noted that the tissues, particularly the gonad, were rich in lipids and care was taken to remove as much of this potential contamination as possible during the tissue processing stage.

- The tissue fragments were held in 0.08% colchicine (Sigma), a mitotic spindle inhibitor, for 4-5 h, at 4°C.

- Ten minutes each in 3:1, 1:1 and 1:3 mixtures of Seawater:0.075M KCl, at 4°C.

- Fixed in cold, freshly made, 3:1 ethanol:acetic acid (Carnoy's fixative), 3 changes over 1 h.

- Slide making: a few pieces of tissue, each approx. 1 mm cubes, were placed in a clean watch glass together with 5 volumes of 60% acetic acid.

The slides were then left for 5 min. by which time the tissues had become translucent and could be seen, under a binocular microscope, to be sloughing cells at their margins. At this stage, the tissues were teased apart using mounted needles, and diluted with a few drops of 60% acetic acid. Finally, drops of this single cell suspension were placed onto a clean microscope slide on a hotplate (40°C), using a pasteur pipette, and left for a few seconds before moving the drops to another position on the slide surface. By repeating this operation, this produced a series of concentric circles of cell nuclei. Finally, the slides were examined for metaphases using low-medium power magnification on a phase contrast microscope.

iv) Results.

A few partially spread metaphase plates were identified but overall (for both tissue types: gill and female gonad) the cell division rate was extremely low, with a mitotic index estimated to be in the order of 1:50,000 - 1:100,000 cells.

v) Conclusions.

This finding is consistent with the low rates of productivity which are characteristic of the bathypelagic fauna in this part of the Atlantic Ocean (P. Herring, *pers. comm.*), and may indicate that, when not feeding, these organisms are in a state of virtual diapause. As far as future cytogenetic investigatons are concerned, the well spread nature of the cell nuclei, particularly those from the basal cells in the gill tissue, bodes well for future studies of hydrothermal-vent shrimps, where the metabolic rate/cell division rate is expected to be significantly higher than in these bathypelagic species. However, before embarking on any lengthy cell processing method in future, it is recommended that the tissues first be examined using a simple squash technique: fixation in Carnoy's fixative,

followed by staining with aceto-orcein (Gurr's). In this way, the frequency of dividing cells could be determined for specimens in advance.

(D.Dixon)

10. Shipboard Computing.

The following data was logged by the ABC computing system;

Speed	Chernikeff log
Gyro	Ships gyro
Position	Trimble GPS 4000 receiver
Position	Ashtech GPS GG24 receiver
Position	Ashtech GPS 3DF receiver
ADCP	
Winch	Seametrics

Data was recorded for the following periods;

adcp:	97 153 19:00:40	97 173 16:16:47
ctd_12c:	97 142 15:37:29	97 174 11:49:28
ea500d1:	97 141 07:32:21	97 175 06:00:00
gps_4000:	97 141 06:52:27	97 175 09:00:00
gps_ash:	97 142 16:42:56	97 175 09:00:00
gps_glos:	97 141 06:52:29	97 175 09:00:00
gyro:	97 141 06:52:24	97 175 09:00:00
log_chf:	97 141 06:52:29	97 175 09:00:00
winch: 97 141 14:47:16		97 174 15:07:50

Final navigation data was produced by using the output from the Ashtech GG24 GPS receiver (gps_glos) with corrected dead-reckoning used to fill in the gaps when there was no output from the receiver.

The CTD data was processed by the "pstar" suite of programs by others.

Navigation data was taken for BRIDGET processing.

A VT100 style terminal was setup to provide a continuous display of position, speed and heading. This will eventually be replaced by a series of permanently mounted displays throughout the scientific areas of the ship, a prototype of which was under development during the cruise.

The most serious problem encountered was the unreliability and subsequent failure of the Sparc20 workstation. This workstation has in past months borne the majority of the data processing on it as its speed far exceeds that of any of the other workstations. It also acted as the file server for user data and its disks had to be removed to another machine early on in the cruise.

There were also some problems with the interface between the CTD and the logging system. On a number of occasions it would hangup and require a manual reset. On two of these resets it provided an incorrect timestamp to the CTD data. These were later corrected by comparing the CTD pressure with that of the winch cable out.

Final data was backed up onto an optical disk.

(M.Beney)

11. Scientific Instrumentation.

The Simrad EA500 echo sounder was run continuously during the cruise using the fish transducer and performed well. It was routinely used for instrument monitoring near the sea bed. The RDI 150Khz VM ADCP was used in water tracking mode and gave no problems, producing good profiles down to 250m. Surface data (fluo, trans, temp & salinity) together with met. data were collected and logged on the ship's computer system. Apart from the replacement of a Didcot par light sensor, no problems were encountered. The Chernikeff log reads low and will require replacement/recalibration at the next port call. No problems were encountered with any other systems.

(P.Taylor, J.Wynar)

12. Scientific Engineering.

12.a) General.

i) Overside operations.

The overside operations of the cruise comprised:

- BRIDGET Tows.
- RMT 1+8M Nets.
- RVS CTD Frame with Qty 12 off 30L Niskin Bottles.
- IFREMER CTD Frame with Qty 16 0ff 8L Niskin Bottles.
- SAPs Deployments
- Mooring Deployments.
- Plasma Instrument Trials.

ii) Winches.

For all overside operations except moorings work, all deployments were carried out using either the Stern or Starboard Gantries with both the 10T and 20T Winch Systems being utilised extensively.

iii) Deployment schedules.

The original cruise plan was to carry out operations in 12hr periods of:

- 1 off Bridget Tow
- 1 off RMT 1+8 Net Tow, 1 off CTD/HYD
- 2 off HYD/CTD, 1 off SAPs

This would have involved at least one wire change per 24hr period, each taking between 1 and 1,5hrs.

NB: The 20T Winch System on Discovery does not allow for two cables to be run through the system simultaneously.

By re-scheduling the order of operations the total number of wire changes was reduced to a minimum, thus reducing the possible scientific time lost whilst carrying out this operation.

12.b) Deployment Details.

i) BRIDGET Tows.

These were carried out over the stern of the vessel, the vehicle being towed using the Rochester Deep Tow Conducting Cable, Type SC0010372PO00. It was found

necessary to reterminate the cable due to a mechanical breakdown of the conductors; approximately 20m of cable being cropped and a new termination fitted.

ii) RMT Nets.

Carried out over the stern of the vessel, the Tapered Trawl wire being used. Deployment/Recovery was carried out using Qty 2 off 3T SWL Deck winches (net assy's) and Qty 1 off 2T SWL Deck Winch for recovery of the weight bar assy.

iii) RVS CTDs and IFREMER Hydrocasts.

Both operations were carried out over the stbd side of the vessel using the 10T Winch System with 10mm dia (Nom) Rochester Conducting Wire, Type 1-H-375A.

Initially the IFREMER type cable termination was used, this being replaced with the standard RVS termination when, due to deteriorating weather, the IFREMER members on board could not guarantee the safe working of their termination for anticipated snatch loads greater than 2T.

It was necessary to crop a total of 300m from the cable in the early stage of the cruise due to the outer armouring of the cable 'bird caging', this being caused primarily by the unsymmetrical configuration of modern CTD packages resulting in rotation of the package and twists being trapped in the wire.

Following these initial problems with the CTD wire, it was agreed to fit and extensively trial new conducting swivels recently purchased by RVS.

Swivel Details:
Manufacturer: IEC Corporation, Austin, Texas.
Model: IEL-SVL-04.
Ser. No's: 2-15-95-V104 & 3-13-95-V267-796

The first swivel used failed after three deployments due to damage occurring to the pressure compensating hose covering one of the electrical connecting leads. Further investigation revealed that the damage was caused by the supporting shackle, there being insufficient distance between the cable exit from the body and the shackle attachment clevis thus allowing chafing to occur between the shackle and lead.

The second unit was modified by the addition of a protective re-inforced tubing sleeve, placed over the lead. This appeared to be successful. The unit failed after 16 casts, however, failure being due to corrosion of the "as supplied" electrical JSP type connectors.

NB: These type of connectors are known to be susceptible to corrosion/ingress of water.

Both swivels are to be repaired and modified to incorporate leads having "Bulgin" connectors fitted, these being the type normally used by RVS for this type of application.

The use of the swivels would also appear to have to allow the cable to "spin-out" any inherent twist trapped within the system, thus preventing further damage being caused. **This would indicate that with regular use of the swivels in the system, the effective life of the CTD cables could be increased significantly.**

iv) Stand Alone Pumps (SAPs).

The initial deployment of the SAPs was carried out over the stern, the SAPs being clamped onto 6mm dia plastic coated wire, 480m in length; this being attached to the end of the Tapered Trawl Warp. The OTD Double Barrelled Winch was used for deployment of the plastic coated wire.

NB: The SAPs are generally deployed over the stbd side of the vessel; the plastic coated wire being wound onto one of the 3T deck winches. Due to the commitment of all suitable deck winches to both the Discovery and Charles Darwin this preferred method of deployment was not possible for Cruise D228.

Following an initial recovery in inclement weather, the possibility of deployment over the stbd side using one of the auxiliary winches mounted on the stbd gantry for the plastic coated wire was investigated; the plastic coated wire then being suspended from the CTD wire utilising a mechanical swivel. Due to the more limited winch drum capacity, it was necessary to reduce the plastic coated wire in length to 250m (500m being the length originally requested by the PSO at the cruise planning meeting).

v) Moorings Deployment.

These were carried out over the stern using the OTD Double Barrel Winch, with them being secured off to the deck for the addition of the instrumentation.

vi) Plasma Instrument Trials.

The plasma instrument frame was deployed over the stbd side and suspended from the CTD cable using a mechanical swivel with a steel weight suspended below to give the added mass necessary to assist in the operation of the winch system.

12.c) Equipment Failures.

i) Aft Crane, Stbd.

Failure of the hydraulic fail safe system operating solenoid occurred during the first mooring deployment. The port crane was used as a back-up whilst repairs were being undertaken with no loss to scientific time. No other equipment failures occurred.

(A.Poole, D.Dunster, D.Turner)

SUMMARY

RRS *Discovery* Cruise 228 was an extremely successful cruise which investigated hydrothermal plume processes at three separate hydrothermal locations along the Mid-Atlantic Ridge near the Azores Triple Junction; at Rainbow, Southern FAMOUS and Lucky Strike. Continuing evidence of different styles of venting were identified at all three locations in good preparation for continuing research in these areas during the forthcoming *Nautile* dives to these areas under the related MAST III "AMORES" campaigns later in 1997 - "FLORES" and "MARVEL".

At Rainbow an extremely strong hydrothermal plume was detected along the western flank of Rainbow Ridge near 36°14'N 33°54'W. Physical Oceanographic investigations, coupled with *in situ* nephelometry and shipoboard analyses for dissolved methane have revealed a plume, perhaps the strongest of its kind in the N.Atlantic, which is dispersed under topographic control and which can be traced continuously for a distance of up to 50km downstream. Strategic sampling has been

completed along the flow-direction of the plume for mineralogy, geochemistry and microbiology. Net trawls of the same plume have revealed an apparent complete absence of vent-shrimp larvae from this plume. A series of current meter/nephelometer moorings have been deployed in and around the vent-field which will provide a 12-month time-series study of the variability and flux of hydrothermal products away from the vent-site and into the N.Atlantic Ocean on a segment (10-30km) scale. In the southern FAMOUS segment evidence was obtained for a second plume rich in methane but without associated nephelometer signals, indicating a source different from conventional hydrothermal balck smokers. It is likely that this area is dominated, instead, by alteration of ultramafic rocks. Similar signals were also seen close to the southern end of the Lucky Strike segment, and quite discrete from the previously known Lucky Strike hydrothermal field. RMT 1+8 Net trawls were completed through all of the South AMAR, AMAR, FAMOUS, North FAMOUS and Lucky Strike segments as well as the non-transform discontinuity (NTD) offsets at Rainbow (southern AMAR segment) and at south Lucky Strike. Despite this extensive coverage, comparable to that achieved with TOBI during the HEAT cruise (CD89) in 1994, no abundant catches of vent-shrimp larvae were obtained from hydrothermal plume height. In total, the cruise achieved 17 BRIDGET tow-yos plus two long tow-yo CTD deployments where weather conditions required. A further 28 vertical hydrocasts were achieved using the RVS CTD together with 28 hydrocasts using the IFREMER CTD. A total of 10 sets of RMT 1+8 Net trawls were completed and the Stand Alone Pumps were also deployed 10 times. 8 long-term current meter deployments were made on the seabed and, finally, a preliminary engineering test dip of the new molecular biology PLASMA instrument was completed in preparation for the subsequent *Nautile* programme "MARVEL" (August-September, 1997)

ACKNOWLEDGEMENTS

It is my great pleasure as PSO to offer thanks to Capt. Keith Avery and the officers and crew of RRS *Discovery* Cruise 228 for their excellence, professionalism and good-humoured hard work. Capt. Avery's experience and helpful advice, particularly during the early "marginal weather" stages of the cruise, were particularly appreciated. The officers were helpful at all times - one might even say "MAGNIFICENT" - and the engineers again performed to the high levels one has come to expect (both on and off-duty!). Particular thanks go to Greg Lewis and the deck crew for a safe and enjoyable trip made all the more successful by the rapid and efficient deployment of the current meter moorings at Rainbow - without which our secondary science objectives at FAMOUS and Lucky Strike would have been jeopardised. Thanks also to Eddie Staite and the catering team for another superb cruise - for morale to remain so high on such a long cruise reflects extremely well on his team.

The scientific team were greatly indebted to the hardwork and professionalism of the RVS Scientific personnel under the leadership of Tony Poole who made every possible effort to ensure fast, safe and smooth delivery of the scientific operations requested. Finally, I thank my fellow scientists for an enjoyable and stimulating cruise. We achieved a lot, we learnt a lot and now we have several years to work out what it all means. But maybe first we deserve to rest a little. Thank you.

RRS *Discovery* Cruise 228 "FLAME" was funded jointly by the BRIDGE programme of the NERC, UK (BRIDGE Grant 85) and by EC MAST-III Contract MAST3-CT95-0040 "AMORES" (Co-ordinateur: D.Desbruyeres, IFREMER, France). The "FLAME" cruise represents the first part of a three-fold European campaign to the hydrothermal areas of the SW Azores region in 1997 and is followed by two *Nautile* submersible expeditions "FLORES" (July-Aug.) and "MARVEL" (Aug.-Sept.).

(C.German)

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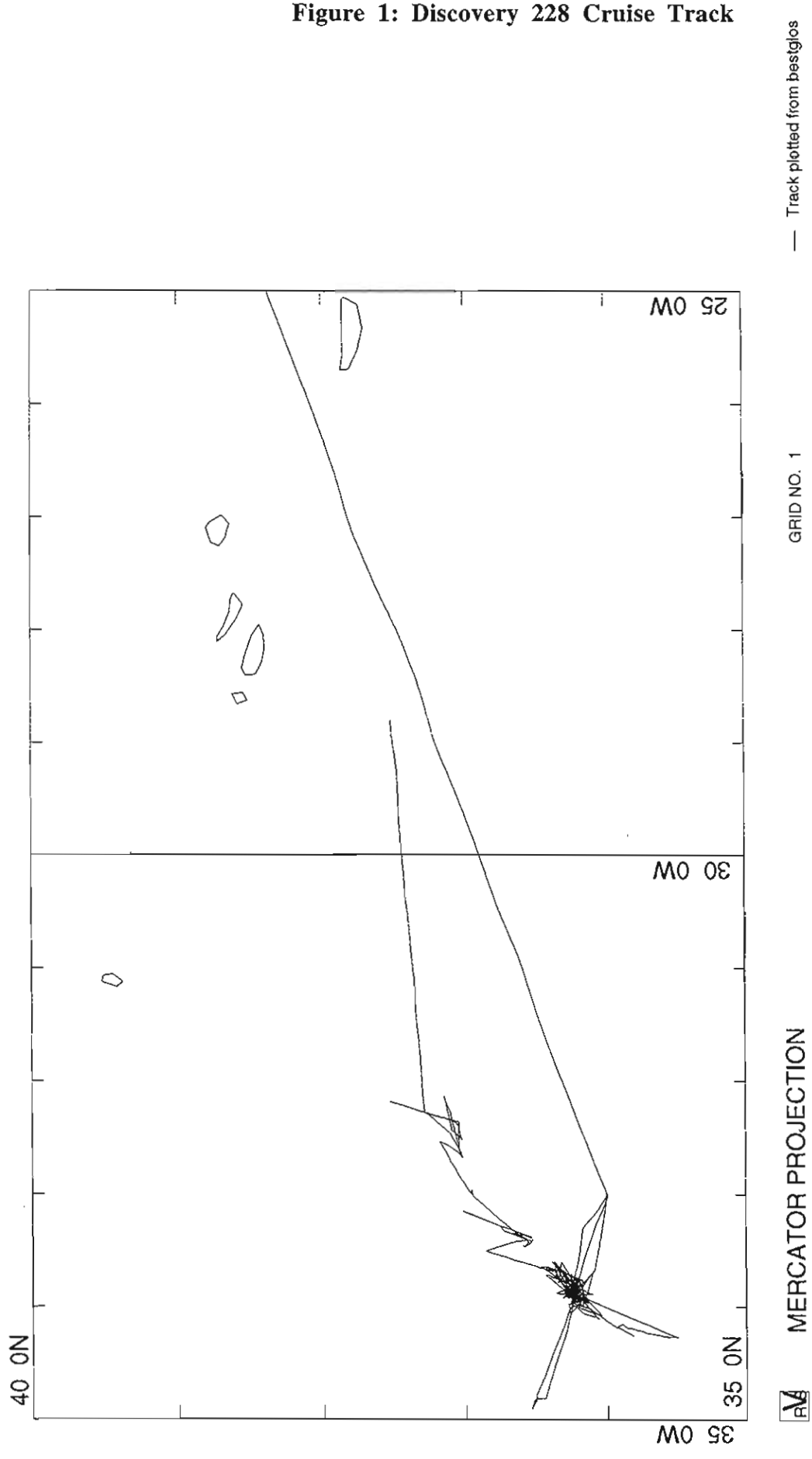
Figure 1: Discovery 228 Cruise Track



Appendix A: Diary of Events

Key to Abbreviations:

BGT: BRIDGET HYD: IFREMER CTD CTD: RVS CTD
RMT: RMT 1+8 Nets SAP: Stand Alone Pumps MOR: Moorings
PLS: PLASMA

MONDAY 19TH MAY :
Loading Scientific equipment.
TUESDAY 20TH MAY :
Continue loading scientific equipment, scientists join ship. Familiarization completed.
WEDNESDAY 21ST MAY:
Clear of berth 0906. Whilst the gangway was being lifted the crane caught the aft hydraulic cylinder and guard of the starboard gantry roller. The cover was straightened by RVS technicians. Best Possible speed set for working area.
THURSDAY 22ND MAY :
Speed reduced due to adverse weather.
FRIDAY 23RD MAY :
Still on reduced speed.
SATURDAY 24TH MAY :
Speed increased during 8 to 12 watch to Best Possible.
1934 to 2052 Reduced speed due to repairs to electric motors.
SUNDAY 25TH MAY:
Best possible speed towards working area.

DISCOVERY STATION 13193

MONDAY 26TH MAY:
1315 36 00N 33 00.1W #01-BGT01 launched for test.
1426 BGT01recovered.
1456 - 1823 35 59.9N 33 00W #02-CTD01.
2116 - 2135 36 03N 33 27W. #03-CTD02 test deployment.
2312-0115 36 05N 33 41W #04-CTD03.
TUESDAY 27TH MAY:
0322 - 1131 36 11N 34 00W #05-BGT02 deployed CO 060.
1306 - 1313 36 18N 33 51W HYD deployment: cable failure.
1557 -1836 36 17N 33 51W #06-HYD01 station.
1945 - 1955 36 13N 33 53W CTD outboard and inboard. Station aborted due to incorrect position.
2027 - 2312 36 13N 33 54W #07-CTD04.
WEDNESDAY 28TH MAY:
0054 - 0359 36 14N 33 56W #08-CTD05.
0448 - 0720 36 16N 33 53W #09-CTD06.
0827 - 2053 36 12N 34 00W #10-BGT03 deployed: Co 060.
THURSDAY 29TH MAY:
0027 - 0258 36 03N 34 08W #11-CTD07.
0452 - 0722 36 16N 33 58W #12-CTD08.
0810 - 1037 36 16N 34 03W #13-CTD09.
1145 - 2356 36 11N 34 57W 14-BGT04 deployed. Co. NEasterly.
FRIDAY 30TH MAY:
0116 - 0344 36 21N 33W #15-CTD10.
0420 - 0636 36 19N 33 45W #16-CTD11.
0706 - 0931 36 18N 33 43W #17-CTD12.
1042 - 1938 36 15N 33 52W #18-BGT05 deployed. Co 061.
2157 - 2216 RMT net flushed through.
2230 - 0942 36 22N 33 44W #19-21 RMT01-03 deployed. Co 237.
SATURDAY 31ST MAY:

0628 to 0646 Clean A.C. power lost.
1213 - 1500 36 16N 33 50W #22-HYD02.
1618 - 2145 36 14N 33 53W #23-SAP01.
2240 - 0113 36 14N 33 50W #24-HYD03.

SUNDAY 1st JUNE:

0236 - 0459 36 15N 33 54W #25-CTD13.
0940 - 1226 36 00N 33 00W #26-CTD14.
1812 - 2048 36 17N 33 54W #27-CTD15.
2136 - 0645 #28-BGT06 survey Co. 333.

MONDAY 2nd JUNE:

0830 - 1100 36 13N 33 49W #29-HYD04.
1154 - 1703 36 16N 33 50W #30-SAP02.
1807 - 2015 36 12N 33 46W #31-HYD05.
2219 - 0835 36 23N 33 37W #32-34 RMT04-06 Co. 227.

TUESDAY 3rd JUNE:

1018 - 1256 36 12N 33 43W #35-CTD16. Science suspended, bad weather.
1718 - 2018 CTD wire being reterminated from HYD to CTD.
2018 - 2246 36 14N 33 53W #36-CTD17.
2346 - 1158 36 16N 33 53N #37-CTD18; 12 hour station.

WEDNESDAY 4rd JUNE:

1325 - 1602 36 13N 33 45W #38-HYD06.
1724 - 2000 36 16N 33 43W #39-HYD07.
2106 - 2347 36 16N 33 45W #40-HYD08.

THURSDAY 5th JUNE:

0135 - 0420 36 14N 33 50W #41-CTD19.
0525 - 1350 36 14N 33 53W #42-CTD20-30.
1400 Science suspended, bad weather.

FRIDAY 6TH JUNE:

0756 - 1046 36 32N 34 45W #43-CTD31.
1720 - 2225 36 15N 33 55W #44-SAP03.

SATURDAY 7th JUNE:

0011 - 1044 36 26N 33 43W #45-47 RMT07-09 Co. 202.
1158 - 1711 36 14N 33 54W #48-SAP04.
1925 - 2140 #49-CTD32.
2306 - 0741 36 19N 33 52W #50-BGT07 survey. Co. 204.

SUNDAY 8th JUNE:

0900 - 1740 36 11N 33 46W #51-BGT08 survey Co. 331.
1912 - 2147 36 14N 33 54W #52-CTD33.
2248 - 0131 36 14N 33 54W #53-HYD09.

MONDAY 9TH JUNE:

0244 - 0820 36 14N 33 50W #54-SAP05.
1210 - 2251 36 11N 34 00W #55-57 RMT10-12 Co.194.

TUESDAY 10th JUNE:

0022 - 1058 35 55N 34 10W #58-60 RMT13-15 Co.196.
1620 - 1849 36 12N 33 55W #61-HYD10.
2027 - 2356 36 16N 33 58W #62-HYD11.

WEDNESDAY 11TH JUNE:

0225 - 0735 36 13N 33 46W #63-SAP06.
0829 - 1122 36 14N 33 48W #64-CTD34.
1223 - 1511 36 15N 33 54W #65-HYD12.
1550 -1852 36 18N 33 52W #66-BGT09 survey. Co.202. Survey abandoned due to cable failure.
2121 - 0245 36 17N 33 53W #67-SAP07

THURSDAY 12TH JUNE:

0309 - 0558 36 15N 33 54W #68-CTD35.
0649 - 0924 36 15N 33 53W #69-HYD13.
1043 - 1601 36 15N 33 53W #70-SAP08.
1650 - 1829 36 16N 33 43W Wire test.

1829 - 2112 36 16N 33 43W #71-HYD14.
2202 - 0045 36 14N 33 47W #72-HYD15.

FRIDAY 13TH JUNE:

0137 - 0926 36 17N 33 52W #73-BGT10 survey. Co. 204.
1052 - 1810 36 18N 33 53W #74-BGT11 survey. Co. 202.
1905 - 2314 36 15N 33 58W #75-BGT12 survey. Co.113. Survey abandoned, BRIDGET to be repaired.

SATURDAY 14TH JUNE:

0002 - 0247 36 15N 33 57W #76-BGT13 survey. Survey abandoned BRIDGET to be repaired.
0259 - 0523 36 14N 33 54W #77-HYD16.
0606 - 1152 36 14N 33 57W #78-BGT14 survey. Co. 113.
1250 - 1852 36 17N 33 58W #79-BGT15 survey. Co.114.
2030 - 2230 36 06N 33 41W #80-CTD36.

SUNDAY 15TH JUNE:

0005 - 0251 36 14N 33 54W #81-CTD37.
0306 - 0540 36 14N 33 54W #82-HYD17.
0730 to 1730 #83-86 Deploying Moorings (MOR E, D, A & B).
1800 - 2324 36 14N 33 54W #87-SAP09.
2340 - 0159 36 14N 33 54W #88-HYD18.

MONDAY 16TH JUNE:

0243 - 0804 36 14N 33 55W #89-SAP10.
0846 to 1647 #90-93 Deploying Moorings (MOR C, H, G & F).
1905 - 0652 36 11N 33 46W #94-BGT16 survey. Co.021.

TUESDAY 17TH JUNE: The fifth anniversary of Discovery sailing from Viana Do Castelo.

0824 - 1121 38 18N 33 48W #95-HYD19.
1241 - 1538 36 20.5N 33 44W #96-HYD20.
1648 - 1912 36 26N 33 39W #97-CTD38.

DISCOVERY STATION 13194

1958 - 0626 36 23N 33 41W #01-03 RMT01-03 Co.016.

WEDNESDAY 18TH JUNE:

DISCOVERY STATION 13195

0844 - 1128 36 34N 33 24W #01-HYD01.
1229 - 1505 36 36N 33 23W #02-HYD02.
1607 - 1815 36 40N 33 21W #03-HYD03.

DISCOVERY STATION 13196

1926 - 0626 36 32N 33 23W #01-03 RMT01-03 Co. 020.

THURSDAY 19TH JUNE:

DISCOVERY STATION 13195 (Contd).

0952 - 1210 36 32N 33 25W #04-HYD04.
1315 - 1518 36 35N 33 28W #05-HYD05.
1616 - 1830 36 31N 33 26W #06-HYD06.

DISCOVERY STATION 13197

2204 - 0715 36 58N 33 00W #01-03 RMT01-03. At 0440 the bridge was informed that the 3rd net had failed and the trawl was being hauled.

FRIDAY 20TH JUNE:

DISCOVERY STATION 13198

0850 - 1920 37 02N32 40W #01-03 RMT01-03 Co. 076.
2100 - 23012 37 06N 32 26W #04-HYD01.

SATURDAY 21ST JUNE:

0005 - 0203 37 02N 32 31W #05-HYD02.
0333 - 1356 37 06N 32 21W #06-08 RMT04-06 Co. 018.
1530 to 1732 Reterminating conducting cable.
1732 - 1918 37 18N 32 17W #09-CTD01.
1943 - 1647 37 19N 32 16W #10-BGT01 survey. Co. various.

SUNDAY 22ND JUNE:

2015 - 2340 37 18N 32 17W #11-PLS01 trials. Commenced steaming towards Ponta Delgada.

MONDAY 23RD JUNE:

DISCOVERY STATION 13199

1040 - 1154 37 27N 29 49W #01-CTD01. Science completed.

Appendix B: SAP Operations Summary

D228 - Sta. 13193 Date 31/5/97 Series **23-SAP01**

Water Depth 2738 m Lat 36°14.56-16.02'N Long 33°53.05-53.60'W
(could not hold stn, had to steam to north at 0.5 knots)

Pumps 1&3 1µm Nuclepores for radiochem and metals, + Mn cartridges for dissolved radiochem
Pumps 2&4 0.2 µm cellulose nitrate for microbiology

	SAP 1	SAP 2	SAP 3	SAP 4
Pump depth (m)	2150	2150	2100	2100
Vol Pumped (L)	920.9	344.4	1541.9	368.5

Neph Data: tgt. CTD06 - neph peak between 2100 and 2200 m
Pump 1: brown covering, quite dark when folded, probe sample taken
Pump 2: brown covering of particulate material
Pump 3: brown covering, quite dark when folded, probe sample taken
Pump 4: brown covering of particulate material
NOTE: MnO2 cartridges not plumbed correctly for this deployment

D228 - Sta. 13193 Date 2/6/97 Series **30-SAP02**

Water Depth 2500 m Lat 36°15.42'N Long 33°50.44'W

Pumps 1&3 1µm Nuclepores for radiochem and metals, + Mn cartridges for dissolved radiochem
Pumps 2&4 0.2 µm cellulose nitrate for microbiology

	SAP 1	SAP 2	SAP 3	SAP 4
Pump depth (m)	2150	2150	2100	2100
Vol Pumped (L)	984.4	364.7	1280.2	347.5

Neph Data: tgt. HYD02 - neph. peak between 2100 and 2200m
Pump 1: filter blew out, saved as blank
Pump 2: very light dusting of particulates, occasional large black particles
Pump 3: filter blew out, saved as blank
Pump 4: very light dusting of particulates, occasional large black particles

D228 - Sta. 13193 Date 6/6/97 Series **44-SAP03**

Water Depth 2677 m Lat 36°14.46'N Long 33°55.04'W

Pumps 1&3 1µm Nuclepores for radiochem and metals, + Mn cartridges for dissolved radiochem
Pumps 2&4 0.2 µm cellulose nitrate for microbiology

	SAP 1	SAP 2	SAP 3	SAP 4
Pump depth (m)	2050	2050	2025	2025
Vol Pumped (L)	773.2	1181.7	734.4	328.5

Neph Data: tgt. CTD29 downcast (tow-yo sect. w. of Rainbow R.)
Pump 1: green-brown, with a few larger black particles, probe sample taken
Pump 2: split filter, green-brown coating of material
Pump 3: green-brown, with a few larger black particles, probe sample taken
Pump 4: green-brown coating of material

D228 - Sta. 13193 Date 7/6/97 Series **48-SAP04**

Water Depth 2490 m Lat 36°14.29'N Long 33°54.07'W

Pumps 1&3 1µm Nuclepores for radiochem and metals, + Mn cartridges for dissolved radiochem
Pumps 2&4 0.2 µm cellulose nitrate for microbiology

	SAP 1	SAP 2	SAP 3	SAP 4
Pump depth (m)	2135	2135	2110	2110
Vol Pumped (L)	610.6	648.0	545.2	642.8

Neph Data: tgt. CTD27 downcast (tow-yo sect. w. of Rainbow R.)
Pump 1: see no. 3 - but not quite as dark, probe sample taken
Pump 2: small tear in filter, heavy covering of dark brown particulate material
Pump 3: really dark overall, brown/black, fine-grained, probe sample taken
Pump 4: small tear in filter, heavy covering of brown particulate material

Appendix B: SAP Operations Summary

D228 - Sta. 13193 Date 9/6/97 Series **54-SAP05**

Water Depth 2628 m Lat 36°13.71'N Long 33°49.81'W

Pumps 1&3 1µm Nuclepores for radiochem and metals, + Mn cartridges for dissolved radiochem
Pumps 2&4 0.2 µm cellulose nitrate for microbiology

	SAP 1	SAP 2	SAP 3	SAP 4
Pump depth (m)	2025	2025	2000	2000
Vol Pumped (L)	582.4	457.4	662.2	333.5

Neph Data: tgt. HYD03 - neph peaks at bottles 10&11, 2033 and 1993 m
Pump 1: v. dark, green-brown, lg. flaky aggregates, probe samples from both
Pump 2: brown coating of particulate material
Pump 3: see no. 1 - lost some part. material from both to SAP heads
Pump 4: brown/dark brown coating of particulate material

D228 - Sta. 13193 Date 11/6/97 Series **63-SAP06**

Water Depth 2445 m Lat 36°12.29'N Long 33°46.42'W

Pumps 1&3 1µm Nuclepores for radiochem and metals, + Mn cartridges for dissolved radiochem
Pumps 2&4 0.2 µm cellulose nitrate for microbiology

	SAP 1	SAP 2	SAP 3	SAP 4
Pump depth (m)	1940	1940	1915	1915
Vol Pumped (L)	693.2	1194.6	772.8	338.6

Neph Data: tgt. HYD05 - small neph. peaks between 1900 and 1950m
Pump 1: Both 1&3 lt. br. (but dark in tone - blk. not grn.), fine-grained
Pump 2: split filter, light coating of material
Pump 3: probe samples taken from both 1&3
Pump 4: light coating of material

D228 - Sta. 13193 Date 12/6/97 (began 11/6) Series **67-SAP07**

Water Depth 2396 m Lat 36°15.83'N Long 33°52.83'W

Pumps 1&3 1µm Nuclepores for radiochem and metals, + Mn cartridges for dissolved radiochem
Pumps 2&4 0.2 µm cellulose nitrate for microbiology

	SAP 1	SAP 2	SAP 3	SAP 4
Pump depth (m)	2150	2150	2125	2125
Vol Pumped (L)	900.2	N/A	753.2	322.0

Neph Data: tgt. site of CTDs 06/18 (and SAP01)- plume seen 1st time, not 2nd
Pump 1: darker overall than no. 3, but fewer lg. particles, probe sample taken from both
Pump 2: not deployed, timer malfunction
Pump 3: filter may not have been seated quite right? lt. brn, quite a lot of dk. particles
Pump 4: light brown coating, some black particles

D228 - Sta. 13193 Date 12/6/97 Series **70-SAP08**

Water Depth 2393 m Lat 36°15.36'N Long 33°43.06'W

Pumps 1&3 1µm Nuclepores for radiochem and metals, + Mn cartridges for dissolved radiochem
Pumps 2&4 0.2 µm cellulose nitrate for microbiology

	SAP 1	SAP 2	SAP 3	SAP 4
Pump depth (m)	2200	2200	2175	2175
Vol Pumped (L)	681.6	949.0	817.0	315.4

Neph Data: tgt. HYD07 - small neph. peaks between 2150 and 2200m
Pump 1: light in overall color & coverage, some dk flecks, probe sample taken
Pump 2: filter split, light covering of particulate material
Pump 3: darker & w/more lg. particles than no. 1, probe sample taken
Pump 4: heavier covering of slightly darker material than pump 2

Appendix B: SAP Operations Summary

D228 - Sta. 13193 Date 15/6/97 Series **87-SAP09**

Water Depth 2375 m Lat 36°14.42'N Long 33°53.92'W

Pumps 1&3 1µm Nuclepores for radiochem and metals, + Mn cartridges for dissolved radiochem
Pump 2 30 µm mesh for biology, Pump 4 0.2 µm cellulose nitrate for microbiology

	SAP 1	SAP 2	SAP 3	SAP 4
Pump depth (m)	2100	2100	2075	2075
Vol Pumped (L)	829.4	2646.2	514.2	319.9

Neph Data: tgt. BGT15 - 165/17:00, neph >1.75 V 2000-2200 m
Pump 1: GREAT, v. dk, but filter split - looks to have happened late? probe sample taken
Pump 2: substantial amounts of particulate material present
Pump 3: VERY dark, lots of larger (0.5-1mm) black aggregates, probe sample taken
Pump 4: very heavy covering of dark particulate material, EM sample taken

D228 - Sta. 13193 Date 16/6/97 Series **89-SAP10**

Water Depth 2508 m Lat 36°14.01'N Long 33°54.55'W

Pumps 1&3 1µm Nuclepores for radiochem and metals, + Mn eartridges for dissolved radiochem
Pump 2 30 µm mesh for biology, Pump 4 0.2 µm cellulose nitrate for microbiology

	SAP 1	SAP 2	SAP 3	SAP 4
Pump depth (m)	2100	2100	2075	2075
Vol Pumped (L)	783.2	2683.0	1196.0	356.2

Neph Data: tgt. the "Jason site"
Pump 1: pale overall, a few dark specks
Pump 2: small amounts of particulate material present
Pump 3: darker than no. 1, but sm. pt. of edge appeared not sealed, hence lg. vol.
Pump 4: light covering of light brown particulate material

Appendix C: Operations Log

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	Time (z)	J.Day	Ship	Lat.	Ship	Long	Water	Speed	Hdg.	Station	Series	Opern.	Wire	Instr.	Horiz.	Comment			
2			Deg.	Min.	Deg.	Min.	Depth						Out	Depth	Range				
3																			
4	12:57	146	35	59.98	33	00.13	2617	0.0		13193						Hove to			
5																			
6	13:05									13193	01	**BGT 01**				PES Fish deployed			
7	13:15	146	36	00.13	33	00.01	2610	0.3	023.9	13193	01	**BGT 01**	0			BRIDGET in water			
8	13:26	146	36	00.17	32	59.95	2612	0.4	026.4	13193	01	**BGT 01**	250			Lowering			
9	13:32	146	36	00.20	32	59.92	2538	0.4	025.3	13193	01	**BGT 01**	500			At depth			
10	14:07	146	36	00.43	32	59.69	2448	0.6	024.1	13193	01	**BGT 01**	500			Start hauling			
11	14:25	146	36	00.55	32	59.49	2354	0.3	030.8	13193	01	**BGT 01**				On deck			
12																			
13																			
14	14:50	146	36	00.00	33	00.00	2620	0.3		13193	02	**CTD 01**				Hove to			
15	14:56	146								13193	02	**CTD 01**				In water, lowering			
16	16:14	146	35	59.92	33	00.02	2632			13193	02	**CTD 01**				On bottom			
17	16:20	146								13193	02	**CTD 01**				Up to 100m off			
18										13193	02	**CTD 01**				Bottles not firing			
19	17:15									13193	02	**CTD 01**				Off bottom			
20	17:54	146	35	59.93	33	00.25	2617			13193	02	**CTD 01**	1000			Firing still failed			
21	18:20	146	35	59.92	33	00.32	2613		031.0	13193	02	**CTD 01**	0			On deck			
22																			
23	21:18	146	36	03.15	33	26.83	3400			13193	03	**CTD 02**				In water (test)			
24	21:40	146	36	03.15	33	26.83	3400			13193	03	**CTD 02**				On deck (worked!)			
25																.			
26	23:12	146	36	05.74	33	40.96	2008	0.4	350.7	13193	04	**CTD03**				Hove to, in water			
27	00:05	147								13193	04	**CTD03**				At bottom			
28	01:12	147	36	05.74	33	40.96				13193	04	**CTD03**				On deck			
29																			
30	03:07	147						0.50		13193	05	**BGT 02**				Hove to on stn.			
31							(Bow Thrust.)			13193	05	**BGT 02**							
32	03:19	147								13193	05	**BGT 02**				Deploying string			
33	03:21	147	36	10.95	33	59.68	3003	0.85	052.0	13193	05	**BGT 02**				BRIDGET in water			
34	03:30	147	36	11.05	33	59.35	2945	1.40	062.0	13193	05	**BGT 02**	297	297	0	Reduced spd.			
35	03:45	147	36	11.18	33	59.12	3653	0.49	047.4	13193	05	**BGT 02**	594	577	141				
36	04:00	147	36	11.35	33	58.77	3003	0.75	053.3	13193	05	**BGT 02**	1038	1000	278	Fire Bottle 1			
37	04:15	147	36	11.47	33	58.54	3018	0.55	053.0	13193	05	**BGT 02**	1486	1456	297				
38	04:20	147								13193	05	**BGT 02**	1500	1500	0	ZAPS gain set to 1900 (0.88 volts)			
39	04:30	147	36	11.62	33	58.30	3063	1.00	059.3	13193	05	**BGT 02**	1933	1905	328	Speed increase 1.5Kn			
40	04:45	147	36	11.87	33	57.68	3077	1.55	055.6	13193	05	**BGT 02**	2363	2083	1116				
41	05:00	147	36	12.10	33	57.10	3112	1.40	053.7	13193	05	**BGT 02**	2802	2233	1693				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
42	05:15	147	36	12.32	33	56.52	3190	1.68	055.2	13193	05	BGT 02	3258	2427	2174				
43	05:30	147	36	12.54	33	55.94	3078	1.74	052.8	13193	05	BGT 02	3695	2664	2560				
44	05:45	147	36	12.78	33	55.40	2685	1.60	042.3	13193	05	BGT 02	4130	2905	2936				
45	05:51	147	36	12.91	33	55.21	2642	1.58	040.1	13193	05	BGT 02	4319	3000	3107	Haul up @ 30m/m			
46	06:00	147	36	13.10	33	54.95	2541	1.51	045.8	13193	05	BGT 02	4081	2727	3036				
47	06:15	147	36	13.40	33	54.43	2292	1.50	048.5	13193	05	BGT 02	3626	2295	2807				
48	06:30	147	36	13.68	33	53.93	2148	1.70	052.7	13193	05	BGT 02	3162	1983	2463				
49	06:45	147	36	13.94	33	53.48	2082	1.90	060.7	13193	05	BGT 02	2721	1715	2112	Veer Down @30m/m			
50	07:00	147	36	14.20	33	52.90	2008	1.40	064.6	13193	05	BGT 02	3153	2232	2227				
51	07:05	147	36	14.31	33	52.69	1991	1.60	063.9	13193	05	BGT 02	3289	2117	2517	Haul up @30m/m, ZAPS Gain Inc. to 2000 , Sig. = 0.92			
52	07:15	147	36	14.46	33	52.37	2054	1.60	064.7	13193	05	BGT 02	3021	1905	2345				
53	07:24	147	36	14.62	33	52.01	2097	1.60	066.0	13193	05	BGT 02	2799	1705	2220	Veer Down @30m/m			
54	07:30	147	36	14.73	33	51.82	2127	1.66	067.3	13193	05	BGT 02	2946	1815	2320				
55	07:37	147	36	14.91	33	51.57	2209	1.67	074.1	13193	05	BGT 02	3153	1970	2462	Haul up @30m/min			
56	07:45	147	36	14.99	33	51.24	2276	1.96	074.4	13193	05	BGT 02	2930	1744	2354				
57	07:47	147								13193	05	BGT 02	2884	1701	2329	Veer down @ 30m/min			
58	07:57	147								13193	05	BGT 02	3171	1974	2482	Haul up @30m/min			
59	08:00	147	36	15.21	33	50.69	2425	1.19	073.6	13193	05	BGT 02	3086	1912	2422				
60	08:10	147								13193	05	BGT 02	2806	1696	2235	Veer down @ 30m/min			
61	08:15	147	36	15.41	33	50.13	2520	1.87	074.5	13193	05	BGT 02	2921	1796	2304				
62	08:30	147	36	15.71	33	49.51	2620	1.67	073.6	13193	05	BGT 02	3369	2042	2680	also fired bottle 2			
63	08:34	147								13193	05	BGT 02			0	Fired bottle 3			
64	08:45	147	36	15.95	33	48.90	2873	1.58	069.3	13193	05	BGT 02	3830	2297	3065				
65	08:46	147								13193	05	BGT 02			0	Fired bottle 4			
66	08:50	147	36	16.02	33	48.67	2800			13193	05	BGT 02	3996	2400	3195	Hauling @ 30			
67	08:58	147	36	16.15	33	48.42				13193	05	BGT 02			0	SAP1 ON			
68	09:00	147	36	16.19	33	48.33		1.28	070.2	13193	05	BGT 02	3695	2157	3000				
69	09:01	147								13193	05	BGT 02		2150	#NUM!	Bottle 5 Fired			
70	09:04	147								13193	05	BGT 02		2100	#NUM!	Bottle 6 Fired			
71	09:05	147								13193	05	BGT 02	3454	2061	2772	CTD Stopped			
72	09:09	147								13193	05	BGT 02				SAP1 Stopped			
73	09:15	147	36	16.49	33	47.81	2789	1.60	065.3	13193	05	BGT 02	3308			CTD has Lost Calibrations			
74	09:20	147								13193	05	BGT 02	3200			Winch Stopped			
75	09:24	147								13193	05	BGT 02	3196			Attempting Re-cal of CTD			
76	09:30	147	36	16.71	33	47.15	2859	1.76	070.1	13193	05	BGT 02	3196						
77	09:35	147	36	16.82	33	47.96	2869	1.80	071.7	13193	05	BGT 02	3196			Haul in @ 30m/min to recover			
78	10:30	147	36	17.71	33	44.52	2477	1.45	070.1	13193	05	BGT 02	1800			System off			
79	11:00	147	36	18.12	33	42.97	2455	1.75	070.5	13193	05	BGT 02	604			Still hauling			
80	11:30	147								13193	05	BGT 02				On Deck			
81	11:40	147																	
82																			
83	16:08	147	36	17.62	33	50.74	3034			13193	06	HYD 01				In water			

Appendix C: Operations Log

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
84	17:40	147	36	17.84	33	50.72	3096			13193	06	**HYD 01**		3096		CTD on bottom			
85										13193	06	**HYD 01**		3098		Bottle 1			
86										13193	06	**HYD 01**		2800		2			
87										13193	06	**HYD 01**		2600		3			
88										13193	06	**HYD 01**		2400		4			
89										13193	06	**HYD 01**		2300		5			
90										13193	06	**HYD 01**		2200		6			
91										13193	06	**HYD 01**		2250		7			
92										13193	06	**HYD 01**		2200		8			
93										13193	06	**HYD 01**		2100		9			
94										13193	06	**HYD 01**		2050		10			
95										13193	06	**HYD 01**		2000		11			
96										13193	06	**HYD 01**		1950		12			
97										13193	06	**HYD 01**		1900		13			
98										13193	06	**HYD 01**		1700		14			
99										13193	06	**HYD 01**		1500		15			
100										13193	06	**HYD 01**		500		16			
101	18:35	147	36	17.79	33	50.79				13193	06	**HYD 01**				CTD In-board			
102																			
103	20:15	147	36	12.87	33	54.49	2321	-0.05	025.0	13193	07	**CTD 04**				Hove to in water			
104	21:39	147	36	12.86	33	54.50	2453			13193	07	**CTD 04**				On bottom			
105	23:11	147	36	12.86	33	24.50	2453			13193	07	**CTD 04**				CTD In-board			
106																			
107	00:21	148	36	14.40	33	56.43	3224	0.39	043.5	13193	08	**CTD 05**				Hove to			
108	00:53	148	36	14.39	33	56.31	3200	0.67	357.0	13193	08	**CTD 05**				In water			
109	02:24	148								13193	08	**CTD 05**				On bottom			
110	04:02	148								13193	08	**CTD 05**				CTD In-board			
111																			
112	04:48	148	36	15.68	33	53.17	2380	0.34	009.5	13193	09	**CTD 06**				In water			
113	05:51	148	36	15.79	33	53.21	2343	0.10	008.6	13193	09	**CTD 06**				On bottom			
114	07:18	148	36	15.84	33	53.10				13193	09	**CTD 06**				On deck			
115																			
116	08:19	148	36	11.95	33	00.05				13193	10	**BGT 03**				On station, turning			
117	08:27									13193	10	**BGT 03**				Deploying string			
118	08:30	148	36	11.92	33	59.96	3200	0.49	039.7	13193	10	**BGT 03**	28						
119	08:45	148	36	11.87	33	59.69		0.99	032.1	13193	10	**BGT 03**	423	422	29				
120	09:00	148	36	11.98	33	59.53	3150	0.95	017.8	13193	10	**BGT 03**	815	798	166				
121	09:15	148	36	12.15	33	59.36	2945	0.77	027.1	13193	10	**BGT 03**	1233	1192	315				
122	09:30	148	36	12.29	33	59.18	2969	0.61	026.9	13193	10	**BGT 03**	1678	1626	414	incr spd to 1.5 kts			
123	09:45	148	36	12.61	33	58.82	3005	1.48	034.8	13193	10	**BGT 03**	2136	1934	907				
124	10:00	148	36	12.81	33	58.44	2944	1.29	036.1	13193	10	**BGT 03**	2585	2226	1314				
125	10:15	148	36	13.01	33	57.95	3009	1.22	036.7	13193	10	**BGT 03**	3059	2549	1691				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
126	10:30	148	36	13.24	33	57.56	3154	1.26	036.7	13193	10	BGT 03	3485	2844	2014				
127	10:34	148	36	13.26	33	57.43				13193	10	BGT 03	3591	2923	2086	Haul up @30m/min			
128	10:45	148	36	13.37	33	57.10	3130	1.44	036.9	13193	10	BGT 03	3252	2515	2062				
129	11:00	148	36	13.57	33	56.57	3197	1.30	031.4	13193	10	BGT 03	2816	2040	1941				
130	11:12	148	36	13.71	33	56.14	3083	1.18	025.3	13193	10	BGT 03	2423	1700	1727	Fire water bottle no.1 @ 1700mtrs Temp = 4.7462deg.C			
131	11:13	148								13193	10	BGT 03	2450	1730	1735	Veer down @30m/min			
132	11:15	148	36	13.74	33	56.06	3036	1.32	026.0	13193	10	BGT 03	2485	1781	1733				
133	11:30	148	36	14.06	33	55.62	2823	1.53	030.3	13193	10	BGT 03	2910	1993	2120				
134	11:45	148	36	14.30	33	55.04	2596	1.33	032.0	13193	10	BGT 03	3310	2226	2450				
135	12:00	148	36	14.53	33	54.56	2500	1.20	030.5	13193	10	BGT 03	3752	2516	2783				
136	12:15	148	36	14.72	33	54.08	2415	1.17	026.9	13193	10	BGT 03	4180	2872	3037				
137	12:19	148	36	14.77	33	53.97	2405	1.03	026.4	13193	10	BGT 03	4312	3000	3097	Haul @30m/min			
138	12:30	148	36	14.84	33	53.69	2302	0.93	012.0	13193	10	BGT 03	4000	2776	2880				
139	12:45	148	36	15.09	33	53.30	2244	1.59	016.4	13193	10	BGT 03	3550	2437	2581				
140	13:00	148	36	15.38	33	52.87	2261	1.27	025.9	13193	10	BGT 03	3085	2089	2270				
141	13:15	148	36	15.57	33	52.39	2270	1.50	024.1	13193	10	BGT 03	2628	1728	1980				
142	13:19	148	36	15.61	33	52.25	2282			13193	10	BGT 03	2517	1700	1856	Veer @30m/min			
143	13:30	148	36	15.78	33	51.95	2299	1.81	024.4	13193	10	BGT 03	2844	1997	2025				
144	13:33	148								13193	10	BGT 03		2110		Bottle 2 fired			
145	13:34	148								13193	10	BGT 03		2119		Bottle 3 fired			
146	13:34	148								13193	10	BGT 03		2132		Bottle 4 fired			
147	13:35	148								13193	10	BGT 03	2985	2150	2071	Haul @30m/min			
148	13:36	148								13193	10	BGT 03		2117		Bottle 5 fired			
149	13:45	148	36	15.96	33	51.52	2354	1.62	024.6	13193	10	BGT 03	2692	1908	1899				
150	13:54	148								13193	10	BGT 03	2415	1701	1714	Veer @30 m/min			
151	14:00	148	36	16.18	33	51.10	2498	1.75	024.2	13193	10	BGT 03	2554	1845	1766				
152	14:06	148								13193	10	BGT 03		2017		Bottle 6 fired			
153	14:07	148								13193	10	BGT 03		2035		Bottle7 fired, Alt =260 mtrs			
154	14:15	148	36	16.40	33	50.72	2632	1.66	024.9	13193	10	BGT 03	2988	2240	1978	Haul @ 30m/min.			
155	14:30	148	36	16.55	33	50.32	2691	1.59	030.1	13193	10	BGT 03	2525	1875	1691				
156	14:38	148	36	16.69	33	50.12	2766	1.77	029.5	13193	10	BGT 03	2288	1691	1541	Veer @ 30m/min.			
157	14:45	148	36	16.77	33	49.89	2600	1.83	030.2	13193	10	BGT 03	2485	1885	1619				
158	15:00	148	36	16.96	33	49.48	2790	1.64	030.2	13193	10	BGT 03	2928	2237	1889	incr spd to 2 kts			
159	15:15	148	36	17.22	33	48.96	2796	1.89	032.9	13193	10	BGT 03	3395	2516	2279				
160	15:20	148	36	17.34	33	48.78	2716	1.91	034.6	13193	10	BGT 03	3562	2616	2418	Haul @30m/min			
161	15:30	148	36	17.42	33	48.46	2635	1.98	036.2	13193	10	BGT 03	3294	2289	2369				
162	15:45	148	36	17.67	33	47.86	2724	1.96	021.2	13193	10	BGT 03	2816	1791	2173				
163	15:49	148	36	17.76	33	47.70	2696	1.82	031.0	13193	10	BGT 03	2720	1700	2123	Veer @30m/min			
164	16:00	148	36	17.95	33	47.38	2685	1.78	033.2	13193	10	BGT 03	2992	1986	2238				
165	16:15	148	36	18.15	33	46.96	3031	1.73	033.6	13193	10	BGT 03	3439	2352	2509				
166	16:27	148	36	18.39	33	46.53	3067	1.99	036.2	13193	10	BGT 03	3806	2587	2792	Haul @ 30m/min.			
167	16:30	148	36	18.44	33	46.45	3059	1.86	037.5	13193	10	BGT 03	3728	2468	2794				

Appendix C: Operations Log

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
168	16:45	148	36	18.71	33	45.85	2733	1.91	040.3	13193	10	BGT 03	3261	2013	2566				
169	16:57	148	36	18.95	33	45.33	2253	1.93	040.1	13193	10	BGT 03	2882	1696	2330	Veer @30m/min			
170	17:00	148	36	18.98	33	45.25	2196	1.84	041.0	13193	10	BGT 03	2923	1744	2346				
171	17:15	148	36	19.28	33	44.63	22xx?	2.07	040.7	13193	10	BGT 03	3364	1994	2709				
172	17:30	148	36	19.54	33	44.05	2409	1.89	046.1	13193	10	BGT 03	3787	2285	3020				
173	17:35	148	36	19.62	33	43.82	2433	1.78	045.6	13193	10	BGT 03	3938	2401	3121	Haul @30m/min			
174	17:45	148	36	19.71	33	43.46	2514	1.76	045.3	13193	10	BGT 03	3694	2401	2807				
175	17:46	148								13193	10	BGT 03	3663	2150	2966	Fired bottle 8			
176	17:48	148								13193	10	BGT 03	3583	2100	2903	Fired bottle 9			
177	17:51	148								13193	10	BGT 03	3507	2048	2847	Fired bottle 10			
178	18:00	148	36	19.93	33	42.86	2580	1.90	044.0	13193	10	BGT 03	3240	1868	2647				
179	18:09	148	36	20.09	33	42.48	2635	2.02	042.0	13193	10	BGT 03	2984	1695	2456	Veer @30m/min.			
180	18:15	148	36	20.20	33	42.24	2678	1.86	040.0	13193	10	BGT 03	3165	1843	2573				
181	18:29	148	36							13193	10	BGT 03	3611	2103	2935	Fired bottle 11			
182	18:30	148	36	20.48	33	41.57	2765	1.85	039.6	13193	10	BGT 03	3620	2114	2939				
183	18:45	148	36	20.75	33	40.92	2678	1.76	040.4	13193	10	BGT 03	4092	2358	3344				
184	18:53	148	36	20.87	33	40.62	2697	1.68	040.3	13193	10	BGT 03	4343	2498	3553	Haul @30m/min			
185	19:00	148	36	20.98	33	40.36	2707	1.66	040.6	13193	10	BGT 03	4166	2323	3458				
186	19:15	148	36	21.30	33	39.76	2674	1.93	040.6	13193	10	BGT 03	3699	1984	3122				
187	19:30	148	36	21.67	33	39.09	2581	2.21	039.6	13193	10	BGT 03	3227	1681	2755				
188	19:30	148	36		33					13193	10	BGT 03		1676		fired bottle 12 &			
189	"									13193	10	BGT 03				haul @40m/min			
190	19:45	148	36	21.92	33	38.48	2390	2.03	039.5	13193	10	BGT 03	2626	1369	2241				
191	20:00	148	36	22.29	33	37.87	2364	1.82	039.7	13193	10	BGT 03	2001	1049	1704				
192	20:15	148	36	22.62	33	37.29	2268	1.65	035.6	13193	10	BGT 03	1359	764	1124				
193	20:30	148	36	22.90	33	36.83	2568	1.57	028.8	13193	10	BGT 03	771	528	562				
194	20:50	148	36		33					13193	10	BGT 03	0	0	0	At surface			
195	20:55	148	36	23.48	33	36.12	1960	1.74	066.7	13193	10	BGT 03	0	0	0	On deck			
196																			
197	00:20	149	36	02.44	34	04.74	2817			13193	11	CTD 07				Hove to			
198	00:27	149								13193	11	CTD 07				In water			
199	01:50	149	36	02.73	34	04.70				13193	11	CTD 07				On bottom			
200	03:00	149	36	02.69	34	04.75	2877			13193	11	CTD 07				Out of water			
201																			
202	04:55	149	36	16.34	33	58.35	2343			13193	12	CTD 08				In water			
203	06:15	149								13193	12	CTD 08				At bottom			
204	07:20	149	36	16.49	33	58.44				13193	12	CTD 08				On deck			
205																			
206	08:09	149	36	16.03	34	03.43				13193	13	CTD09				In water			
207	09:16	149								13193	13	CTD09				On bottom			
208	10:36	149	36	16.05	34	03.45				13193	13	CTD09				On deck			
209																			

Appendix C: Operations Log

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
210	11:45	149	36	11.37	33	57.05				13193	14	BGT04				BRIDGET in water			
211	12:00	149	36	11.29	33	56.88	2958	0.66	043.3	13193	14	BGT04	344	349					
212	12:15	149	36	11.43	33	56.67	2957	0.75	037.1	13193	14	BGT04	628	634					
213	12:30	149	36	11.48	33	56.29	2980	0.85	048.4	13193	14	BGT04	1029	999	247				
214	12:45	149	36	11.56	33	56.03	2809	0.65	049.0	13193	14	BGT04	1457	1419	331				
215	12:55	149	36	11.56	33	55.82	3140	0.70	050.1	13193	14	BGT04	1738	1700	361	Bottle 1 fired. Temp = 4.6946 deg.C.			
216	13:00	149	36	11.57	33	55.73	3150	0.72	049.4	13193	14	BGT04	1902	1843	470				
217	13:15	149	36	11.60	33	55.47	2860	0.64	050.2	13193	14	BGT04	2319	2267	488				
218	13:30	149	36	11.64	33	55.26	2787	0.69	050.0	13193	14	BGT04	2736	2683	536				
219	13:41	149	36	11.63	33	55.06	2707	0.40	051.3	13193	14	BGT04	3057	3011	528	Haul @30 m/min			
220	13:45	149	36	11.63	33	55.01	2661	0.68	050.6	13193	14	BGT04	2947	2909	472	Haul @40 m/min			
221	14:00	149	36	11.62	33	54.76	2544	0.60	050.2	13193	14	BGT04	2335	2287	471				
222	14:15	149	36	11.68	33	54.50	2435	0.81	050.6	13193	14	BGT04	1730	1658	494	Veer @40m/min			
223	14:30	149	36	11.72	33	54.19	2301	0.70	042.6	13193	14	BGT04	2266	2202	535				
224	14:40	149	36	11.75	33	54.02	2232	0.52	047.6	13193	14	BGT04	2649	2605	481	Haul at 40m/min.			
225	14:45	149	36	11.77	33	53.97	2195	0.57	044.3	13193	14	BGT04	2455	2404	498	Increase speed to 1 knot over ground.			
226	15:00	149	36	11.83	33	53.68	2155	0.68	042.8	13193	14	BGT04	1883	1810	519				
227	15:03	149	36		33					13193	14	BGT04	1750	1695	435	Veer @ 40m/min.			
228	15:15	149	36	11.99	33	53.37	2088	0.77	043.6	13193	14	BGT04	2224	2133	630	Haul at 40m/min.			
229	15:27	149	36	12.04	33	53.14	2042	0.79	049.2	13193	14	BGT04	1804	1688	636	Veer @ 40m/min.			
230	15:30	149	36	12.06	33	53.09	2051	0.87	049.2	13193	14	BGT04	1875	1800	525				
231	15:35	149	36	12.09	33	52.96				13193	14	BGT04			0	Incr spd to 1.5 kts o/g			
232	15:36	149	36	12.12	33	52.90	2019	0.79	049.2	13193	14	BGT04	2153	2055	642	Haul @ 40m/min.			
233	15:43	149	36	12.12	33	52.73	2034	0.84		13193	14	BGT04			0	at way point, passing it and beginning turn			
234	15:45	149	36	12.12	33	52.73	2036	0.79	050.6	13193	14	BGT04	1802	1698	603	Veer @ 40m/min.			
235	15:53	149	36	12.19	33	52.54	2052	0.66	042.8	13193	14	BGT04	2093	1976	690	Haul @ 40m/min.			
236	16:00	149	36	12.18	33	52.41	2059	0.54	043.9	13193	14	BGT04	1838	1720	648	Veer @ 40m/min.			
237	16:08	149	36	12.27	33	52.28	2062	1.10	031.9	13193	14	BGT04	2060	1940	693	Haul @ 40m/min.			
238	16:13	149	36	12.37	33	52.17	2069	0.95	042.8	13193	14	BGT04	1839	1720	651	Veer @ 40m/min.			
239	16:15	149	36	12.39	33	52.13	2066	1.03	044.0	13193	14	BGT04	1863	1726	701				
240	16:23	149	36	12.46	33	51.88	2079	0.93	049.5	13193	14	BGT04	2196	1995	918	Haul @ 40m/min.			
241	16:30	149	36	12.50	33	51.68	2107	0.92	049.2	13193	14	BGT04	1926	1714	878	Veer @ 40m/min.			
242	16:39	149	36	12.59	33	51.43	2196	1.02	050.4	13193	14	BGT04	2254	2005	1030	Haul @ 40m/min., fired bottle 2, slight nephel anomaly			
243	16:45	149	36	12.62	33	51.26	2237	0.87	051.1	13193	14	BGT04	2052	1783	1016				
244	16:47	149	36	12.63	33	51.19	2243	0.87	049.5	13193	14	BGT04	1971	1692	1011	Veer @ 40m/min.			
245	16:58	149	36	12.74	33	50.93	2316	0.95	050.8	13193	14	BGT04	2376	2074	1159				
246	17:00	149	36	12.75	33	50.86	2318	0.86	051.0	13193	14	BGT04	2321	1989	1196				
247	17:07	149	36	12.80	33	50.66	2360	0.92	046.0	13193	14	BGT04	2004	1698	1064	Veer @ 40m/min			
248	17:15	149	36	12.88	33	50.44	2407		046.6	13193	14	BGT04	2327	2001	1188				
249	17:22	149	36	12.91	33	50.27	2452	0.96	044.0	13193	14	BGT04	2542	2195	1282	Haul @ 40m/min.			
250	17:24	149	36	12.99	33	50.23	2472	0.78	042.6	13193	14	BGT04	2446	2098	1258	Bottle 3 fired			
251	17:30	149	36	12.96	33	50.07	2506	0.76	042.1	13193	14	BGT04	2243	1910	1176				

Appendix C: Operations Log

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
252	17:36	149	36	13.03	33	49.95	2554	0.94	038.6	13193	14	BGT04	2005	1698	1066	Veer @ 40m/min.			
253	17:45	149	36	13.16	33	49.17	2654	1.04	035.9	13193	14	BGT04	2369	2029	1223				
254	17:46	149	36	13.17	33	49.67	2669	0.99	036.4	13193	14	BGT04	2410	2050	1267	Bottle 4 fored			
255	17:47	149	36	13.20	33	49.64	2678	1.02	036.5	13193	14	BGT04	2469	2100	1298	Bottle 5 fired			
256	17:55	149	36	13.27	33	49.45	2726	0.92	036.7	13193	14	BGT04	2790	2395	1431	Haul @ 40m/min.			
257	18:00	149	36	13.32	33	49.33	2767	0.78	038.3	13193	14	BGT04	2634	2244	1379				
258	18:02	149	36	13.33	33	49.28	2787	0.74	037.2	13193	14	BGT04	2533	2150	1339	Fired bottle 6			
259	18:06	149	36	13.32	33	49.28	2787	0.71	037.2	13193	14	BGT04	2634	2244	1379				
260	18:10	149	36	13.37	33	49.04	2878	1.35	028.6	13193	14	BGT04	2207	1827	1238	Inc. to 2 kts			
261	18:15	149	36	13.49	33	48.94	2908	1.64	027.5	13193	14	BGT04	2042	1665	1182	Veer @ 40m/min			
262	18:30	149	36	13.87	33	48.49	3140	1.36	029.4	13193	14	BGT04	2633	2040	1665				
263	18:33	149	36	13.94	33	48.40	3135	1.44	030.6	13193	14	BGT04	2763	2143	1744				
264	18:34	149	36	13.96	33	48.33	3135	1.35	030.6	13193	14	BGT04	2814	2185	1773				
265	18:45	149	36	14.21	33	48.10	3237	1.68	037.0	13193	14	BGT04	3237	2440	2127				
266	19:00	149	36	14.52	33	47.51	2970	1.42	044.3	13193	14	BGT04	3858	2755	2701				
267	19:13	149	36	14.71	33	47.09	2870	1.36	044.2	13193	14	BGT04	4343	3040	3102	Haul @ 40 m/min.			
268	19:15	149	36	14.77	33	46.99	2840	1.36	044.7	13193	14	BGT04	4220	2918	3049				
269	19:30	149	36	14.99	33	46.51	2508	1.56	047.8	13193	14	BGT04	3673	2363	2812				
270	19:38	149	36	15.12	33	46.17	2666	1.73	049.2	13193	14	BGT04	3326	2054	2616	Bottle 10 fired			
271	19:45	149	36	15.27	33	46.86	2615	1.48	052.0	13193	14	BGT04	3049	1831	2438				
272	19:50	149	36	15.30	33	45.70	2694	1.53	052.3	13193	14	BGT04	2839	1701	2273	Veer @ 40m/min.			
273	20:00	149	36	15.47	33	45.22	2919	1.59	052.0	13193	14	BGT04	3247	2000	2558				
274	20:15	149	36	15.62	33	44.70	2989	1.30	052.8	13193	14	BGT04	3853	2527	2909				
275	20:20	149	36	15.65	33	44.53	2987	1.35	045.6	13193	14	BGT04	4069	2719	3027	Haul @ 40 m/min.			
276	20:30	149	36	15.75	33	44.24	2729	1.38	045.4	13193	14	BGT04	3734	2407	2855				
277	20:40	149	36	15.88	33	43.90	2730	1.54	041.2	13193	14	BGT04	3374	2120	2625	winch slowed to 10 m/min (checking mechanics)			
278	20:41	149	36		33					13193	14	BGT04			0	back to 40 m/min			
279	20:45	149	36	16.00	33	43.64	2629	1.67	041.8	13193	14	BGT04	3167	1969	2481				
280	20:55	149	36	16.18	33	43.24	2538	1.66	042.1	13193	14	BGT04	2760	1643	2218	Veer @ 40m/min.			
281	21:00	149	36	16.26	33	43.05	2469	1.86	041.6	13193	14	BGT04	2938	1771	2344				
282	21:15	149	36	16.54	33	42.45	2224	1.50	042.6	13193	14	BGT04	3545	2189	2788				
283	21:30	149	36	16.75	33	41.95	2153	1.54	041.3	13193	14	BGT04	4052	2590	3116	Haul @ 40m/min.			
284	21:43	149	36	16.96	33	41.50	2075	1.51	041.5	13193	14	BGT04	3566	2150	2845				
285	21:45	149	36	16.99	33	41.47	2127	1.53	041.4	13193	14	BGT04	3485	2084	2793				
286	21:58	149	36	17.27	33	40.95	2037	1.95	041.4	13193	14	BGT04	2936	1690	2401	Veer @ 40m/min.			
287	22:00	149	36	17.30	33	40.85	2035	1.74	041.1	13193	14	BGT04	2981	1741	2420				
288	22:15	149	36	17.64	33	40.27	2092	1.91	045.3	13193	14	BGT04	3556	2067	2894				
289	22:19	149	36	17.73	33	40.11	2086	1.77	045.6	13193	14	BGT04	3707	2150	3020	Hauling @ 40m/min.			
290	22:30	149	36	17.91	33	39.68	2024	1.64	045.2	13193	14	BGT04	3276	1772	2755				
291	22:34	149	36	17.98	33	39.53	2008	1.82	045.0	13193	14	BGT04	3111	1666	2627	Bottle 12 fired.			
292	22:45	149	36	18.15	33	39.07	2006	1.75	044.7	13193	14	BGT04	2673	1432	2257				
293	23:00	149	36	18.49	33	38.41	2090	1.75	045.1	13193	14	BGT04	2046	1072	1743				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
294	23:15	149	36	18.77	33	37.37	2022	1.66	044.4	13193	14	BGT04	1418	776	1187				
295	23:30	149	36	19.05	33	37.21	2010	1.65	044.8	13193	14	BGT04	813	512	632				
296	23:45	149	36	19.35	33	36.74	3173	1.59	045.2	13193	14	BGT04	191	173	81				
297	23:56	149								13193	14	BGT04			0	On deck			
298																			
299	01:15	150	36	21.17	33	46.98				13193	15	CTD10				in water			
300	02:26	150	36	21.11	33	47.14	2661			13193	15	CTD10				on bottom			
301	03:44	150	36	21.05	33	47.01				13193	15	CTD10				on deck			
302																			
303	04:22	150	36	19.18	33	44.76	2296			13193	16	CTD11				in water			
304	05:22	150	36		33					13193	16	CTD11				on bottom			
305	06:35	150	36	19.41	33	44.93				13193	16	CTD11				on deck			
306																			
307	07:07	150	36	17.75	33	42.77				13193	17	CTD12				in water			
308	08:16	150	36		33					13193	17	CTD12				on bottom			
309	09:32	150	36	17.90	33	42.34	2608			13193	17	CTD12				on deck			
310																			
311	10:42	150	36		33					13193	18	BGT05				String in			
312	10:44	150	36		33					13193	18	BGT05				in water			
313	10:45	150	36	14.53	33	52.24	2075	1.06	56.1	13193	18	BGT05	60						
314	11:00	150	36	14.57	33	51.94	2741			13193	18	BGT05	607	633	#NUM!				
315	11:15	150	36	14.57	33	51.71	2158	0.43	40.9	13193	18	BGT05	1155	1155	0				
316	11:28	150	36	14.63	33	51.51	2209	0.50	28.8	13193	18	BGT05	1710	1702	165	Bott. 1 fired T=4.4783°			
317	11:30	150	36	14.94	33	51.47	2214	0.63	27.6	13193	18	BGT05	1795	1785	189				
318	11:40	150	36	14.72	33	51.31	2245	0.47	30.7	13193	18	BGT05	2202	2166	397	Bottle 2 fired Haul @ 40m/min.			
319	11:41	150	36		33					13193	18	BGT05	2160	2128	370	Bottle 3 fired			
320	11:42	150	36		33					13193	18	BGT05	2101	2064	393	Bottle 4 fired			
321	11:43	150	36		33					13193	18	BGT05	2061	2000	498	Bottle 5 fired			
322	11:45	150	36	14.76	33	51.23	2281	0.43	30.3	13193	18	BGT05	2000	1950	444	Bottle 6 fired			
323	11:50	150	36	14.82	33	51.13	2294	0.50	30.6	13193	18	BGT05	1747	1707	372	Veer @ 40m/min.			
324	12:00	150	36	14.89	33	51.03	2370	0.43	31.3	13193	18	BGT05	2114	2060	475				
325	12:03	150	36	14.84	33	50.97	2347	0.48	29.3	13193	18	BGT05	2250	2200	472	Haul @40m/min			
326	12:05	150	36	14.88	33	50.96	2374	0.33	29.6	13193	18	BGT05	2218	2150	545	Incr spd to 1.5 kts o/g			
327	12:15	150	36	15.02	33	50.80	2395	0.84	29.8	13193	18	BGT05	1824	1761	475				
328	12:16	150	36	15.03	33	50.79	2408	0.74	28.8	13193	18	BGT05	1785	1700	544	Veer @40m/min			
329	12:30	150	36	15.26	33	50.52	2471	0.77	35.2	13193	18	BGT05	2312	2137	882				
330	12:34	150	36	15.32	33	50.44	2491	0.67	39.8	13193	18	BGT05	2472	2270	979	Haul @40m/min			
331	12:45	150	36	15.43	33	50.25	2513	0.49	40.8	13193	18	BGT05	2056	1876	841				
332	12:48	150	36	15.46	33	50.20	2515	0.56	40.9	13193	18	BGT05	1937	1733	865	Veer @40m/min			
333	13:00	150	36	15.60	33	49.90	2531	0.79	40.0	13193	18	BGT05	2363	2130	1023				
334	13:08	150	36	15.70	33	49.72	2563	0.59	40.7	13193	18	BGT05	2675	2407	1167	Haul @ 40m/min.			

Appendix C: Operations Log

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
335	13:15	150	36	15.73	33	49.58	2600	0.50	40.7	13193	18	BGT05	2423	2150	1117				
336	13:27	150	36	15.81	33	49.29	2597	0.63	40.0	13193	18	BGT05	1948	1691	967	Veer @ 40m/min.			
337	13:30	150	36	15.84	33	49.21	2439	0.78	40.1	13193	18	BGT05	2048	1805	968				
338	13:45	150	36	15.99	33	48.86	2854	0.47	41.4	13193	18	BGT05	2695	2373	1277				
339	13:51	150	36	16.02	33	48.72	2819	0.49	40.8	13193	18	BGT05	2928	2615	1317	Haul @40m/min			
340	14:00	150	36	16.07	33	48.73	2782	0.84	33.7	13193	18	BGT05	2589	2254	1274	Increase speed to 2 knots.			
341	14:11	150	36	16.27	33	48.21	2779	1.53	33.3	13193	18	BGT05	2096	1691	1238	Veer @40m/min			
342	14:15	150	36	16.34	33	48.08	2758	1.66	33.5	13193	18	BGT05	2235	1775	1358				
343	14:30	150	36	16.63	33	47.61	2828	1.11	35.1	13193	18	BGT05	2839	2152	1852				
344	14:45	150	36	16.81	33	47.22	2872	1.14	34.9	13193	18	BGT05	3443	2681	2160	Haul @40m/min			
345	15:00	150	36	17.03	33	46.83	2909	1.22	38.0	13193	18	BGT05	2894	2127	1962				
346	15:12	150	36	17.26	33	46.45	2655	1.46	51.0	13193	18	BGT05	2454	1690	1779	Veer @ 40m/min.			
347	15:15	150	36	17.29	33	46.39	2632	1.53	50.3	13193	18	BGT05	2508	1780	1767				
348	15:30	150	36	17.55	33	45.73	2365	1.60	50.6	13193	18	BGT05	3118	2057	2343				
349	15:45	150	36	17.77	33	45.15	2210	1.49	53.6	13193	18	BGT05	3705	2415	2810				
350	15:54	150	36	17.88	33	44.85	2238	1.53	53.4	13193	18	BGT05	4051	2656	3059	Haul @ 40m/min			
351	16:00	150	36	17.94	33	44.64	2271	1.47	47.1	13193	18	BGT05	3816	2405	2963				
352	16:15	150	36	18.28	33	44.03	2394	2.03	51.0	13193	18	BGT05	3241	1841	2667				
353	16:19	150	36	18.38	33	43.83	2575	2.09	51.4	13193	18	BGT05	3068	1692	2559	Veer @ 40m/min			
354	16:30	150	36	18.62	33	43.25	2341	2.58	51.3	13193	18	BGT05	3474	1850	2940				
355	16:45	150	36	18.91	33	42.45	2620	2.34	53.3	13193	18	BGT05	4077	2033	3534				
356	17:00	150	36	19.18	33	41.70	2534	1.94	52.3	13193	18	BGT05	4640	2291	4035	Haul @ 40m/min			
357	17:15	150	36	19.37	33	41.13	2458	1.63	45.0	13193	18	BGT05	4172	2015	3563				
358	17:30	150	36	19.63	33	40.64	2505	1.72	40.1	13193	18	BGT05	3578	1880	3044				
359	17:42	150	36	19.95	33	40.22	2281	1.82	39.4	13193	18	BGT05	3075	1699	2563	Veer @ 40m/min.			
360	17:45	150	36	20.02	33	40.10	2226	2.01	41.9	13193	18	BGT05	3165	1802	2602				
361	18:00	150	36	20.32	33	39.56	2286	1.89	42.4	13193	18	BGT05	3742	2206	3023	Haul @ 40m/min			
362	18:11	150	36	20.51	33	39.20	2372	1.56	42.8	13193	18	BGT05	3304	1870	2724	Fired bottle 7			
363	18:15	150	36	20.56	33	39.04	2258	1.77	42.7	13193	18	BGT05	3154	1800	2590	Fired bottle 8			
364	18:18	150	36		33					13193	18	BGT05		1730		Fired bottle 9			
365	18:18	150	36	20.65	33	38.89	2255	1.78	42.5	13193	18	BGT05	2988	1727	2438	Fired bottle 10			
366	18:24	150	36	20.76	33	38.70	2213	1.80	42.6	13193	18	BGT05	2765	1600	2255	Fired bottle 11			
367	18:30	150	36	20.89	33	38.51	2241	1.74	42.7	13193	18	BGT05	2542	1470	2074				
368	18:33	150	36	20.94	33	38.39	2250	1.83	42.4	13193	18	BGT05	2417	1400	1970	Fired bottle 12			
369	18:45	150	36	21.25	33	37.89	2289	2.11	42.6	13193	18	BGT05	1923	1079	1592				
370	19:00	150	36	21.65	33	37.25	2228	2.00	42.9	13193	18	BGT05	1322	730	1102				
371	19:15	150	36	22.02	33	36.63	2414	2.04	43.5	13193	18	BGT05	707	433	559				
372	19:30	150	36	22.35	33	36.08	2506	1.71	41.8	13193	18	BGT05	115	104	49	System off			
373	19:42	150								13193	18	BGT05				On deck			
374																			
375																			

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
376	21:58	150	36		33					13193	19	RMT01				Preliminary Launch			
377	22:33									13193	19-21	RMT01-3				RMT1+8M in the water			
378	23:00	150	36	21.19	33	44.50				13193	19-21	RMT01-3							
379	23:30	150	36	20.61	33	45.58				13193	19-21	RMT01-3			1107				
380	00:00	151	36	19.98	33	46.85				13193	19-21	RMT01-3			1997				
381	00:15	151	36	19.63	33	47.42				13193	19-21	RMT01-3			2364				
382	00:30	151	36	19.34	33	47.42				13193	19-21	RMT01-3			2652				
383	00:36	151	36	19.21	33	48.22				13193	19	RMT01	3560	2201	2798	Net 1 Open			
384	01:00	151	36	18.75	33	49.03				13193	19	RMT01			3003				
385	01:30	151	36	18.12	33	50.17				13193	19	RMT01			3216				
386	02:00	151	36	17.47	33	51.35				13193	19	RMT01			3401				
387	02:36	151	36	16.94	33	52.63				13193	20	RMT02	3767	2180	3072	Net 2 Open			
388	03:00	151	36	16.44	33	53:40				13193	20	RMT02			3067				
389	03:30	151	36	15.79	33	54.60				13193	20	RMT02			3147				
390	04:00	151	36	15.11	33	55.75				13193	20	RMT02			3401				
391	04:36	151	36	14.29	33	57.32				13193	21	RMT03	4129	2028	3597	Net 3 Open			
392	05:00	151	36	13.75	33	58.34				13193	21	RMT03			3765				
393	05:30	151	36	13.06	33	59.70				13193	21	RMT03			3896				
394	06:00	151	36	12.24	34	01.21				13193	21	RMT03			0				
395	06:15	151	36	08.60	34	04.20				13193	21	RMT03			0				
396	06:40	151								13193	21	RMT03			0	Net 3 Closed			
397	??:??	151								13193	21	RMT03				Power failure:closing time estimated			
398	09:42	151								13193	21	RMT03			0	RMT 1+8M Inboard			
399																			
400	12:10	151	36	15.51	33	50.51	2515			13193	21	HYD 02				CTD in water			
401	13:33	151	36	15.55	33	50.75	2482			13193	21	HYD 02				CTD at seafloor			
402										13193	21	HYD 02		2499		Bottle 1			
403										13193	21	HYD 02		2400		Bottle 2			
404										13193	21	HYD 02		2225		Bottle 3			
405										13193	21	HYD 02		2175		Bottle 4			
406										13193	21	HYD 02		2145		Bottle 5			
407										13193	21	HYD 02		2100		Bottle 6			
408										13193	21	HYD 02		2075		Bottle 7			
409										13193	21	HYD 02		2050		Bottle 8			
410										13193	21	HYD 02		2000		Bottle 9			
411										13193	21	HYD 02		1975		Bottle 10			
412										13193	21	HYD 02		1950		Bottle 11			
413										13193	21	HYD 02		1900		Bottle 12			
414										13193	21	HYD 02		1800		Bottle 13			
415										13193	21	HYD 02		1700		Bottle 14			
416										13193	21	HYD 02		1500		Bottle 15			
417										13193	21	HYD 02		1000		Bottle 16			

Appendix C: Operations Log

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
418	14:41	151	36	15.99	33	50.91	Surface			13193	21	HYD 02		0		CTD on deck			
419																			
420	16:14	151	36		33					13193	22	SAP 01				Commencing SAPs deployment			
421	16:18	151	36		33					13193	22	SAP 01				Zeroed SAP wire			
422	16:20	151	36		33					13193	22	SAP 01				Pinger on @ 25m			
423	16:27	151	36		33					13193	22	SAP 01				SAP 1 on @ 50m			
424	16:34	151	36		33					13193	22	SAP 01				SAP 2 on below SAP 1			
425	16:40	151	36		33					13193	22	SAP 01				SAP 3 @ 100m			
426	16:44	151	36		33					13193	22	SAP 01				SAP 4 on below SAP 3			
427	16:57	151	36		33					13193	22	SAP 01				end of blue cable at 480 m			
428	17:00	151	36	14.56	33	53.05	2438	0.76	340.6	13193	22	SAP 01	0			Finished deploying SAPs, zero trawl wire			
429	17:35	151	36	14.95	33	53.16	2523	1.31	342.1	13193	22	SAP 01	1243						
430	17:45	151	36	15.03	33	53.11	2202	1.06	342.9	13193	22	SAP 01	1690			Stopped wire for pinger fix			
431	18:00	151	36	15.28	33	53.16	2249	1.36	338.6	13193	22	SAP 01	1690			waiting for deeper water			
432	18:14	151	36	15.30	33	53.09	2237	0.02	354.3	13193	22	SAP 01	1690			Pumps starting, lowering to 1720			
433	18:15	151	36		33					13193	22	SAP 01	1720			stopped at 1720m			
434	18:16	151	36	15.28	33	53.05	2324	0.12	354.2	13193	22	SAP 01	1720			paying out another 25m			
435	18:17	151	36	15.28	33	53.04	2227	0.19	350.3	13193	22	SAP 01	1745			stopped winch			
436	18:20	151	36	15.31	33	53.02	2235	1.10	337.9	13193	22	SAP 01	1770			At 1770m w/o			
437	18:30	151	36	15.45	33	53.10	2279	0.79	333.1	13193	22	SAP 01	1770						
438	19:00	151	36	15.60	33	53.07	2350	0.63	325.1	13193	22	SAP 01	1770						
439	19:30	151	36	15.72	33	53.27	2248	0.41	326.8	13193	22	SAP 01	1770						
440	20:00	151	36	15.92	33	53.47	2204	0.58	328.4	13193	22	SAP 01	1770						
441	20:14	151	36	16.02	33	53.60	2549	0.64	326.8	13193	22	SAP 01	1770			Pumping stopped			
442	20:15	151	36	16.02	33	53.62	2489	0.33	323.9	13193	22	SAP 01	1770			Start hauling			
443	20:45	151	36	16.21	33	53.85	2504	0.68	325.4	13193	22	SAP 01	399						
444	21:01	151								13193	22	SAP 01				Started recovery			
445	21:34	151								13193	22	SAP 01				SAPs 3&4 I/bd			
446	21:44	151								13193	22	SAP 01				SAPs 1&2 i/bd			
447	21:45	151								13193	22	SAP 01				Finished SAPs			
448																			
449	22:29	151	36	13.68	33	49.91	2612			13193	24	HYD03				In water			
450	22:59	151	36	13.68	33	49.91				13193	24	HYD03				On bottom			
451		151								13193	24	HYD03		2613		Bottle 1			
452		151								13193	24	HYD03		2400		Bottle 2			
453		151								13193	24	HYD03		2330		Bottle 3			
454		151								13193	24	HYD03		2290		Bottle 4			
455		151								13193	24	HYD03		2250		Bottle 5			
456		151								13193	24	HYD03		2210		Bottle 6			
457		151								13193	24	HYD03		2170		Bottle 7			
458		151								13193	24	HYD03		2140		Bottle 8			

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
459		151								13193	24	HYD03		2090		Bottle 9			
460		151								13193	24	HYD03		2050		Bottle 10			
461		151								13193	24	HYD03		2010		Bottle 11			
462		151								13193	24	HYD03		1970		Bottle 12			
463		151								13193	24	HYD03		1930		Bottle 13			
464		151								13193	24	HYD03		1860		Bottle 14			
465		151								13193	24	HYD03		1720		Bottle 15			
466		151								13193	24	HYD03		1600		Bottle 16			
467	01:08	152	36	13.78	33	49.95				13193	24	HYD03				On deck			
468																			
469	02:36	152	36	14.59	33	53.76	2340	0.5	333	13193	25	CTD 13				In water			
470	03:37	152	36	14.65	33	53.72	2331	0.3	337	13193	25	CTD 13				On bottom			
471	04:59	152	36		33					13193	25	CTD 13				On deck			
472																			
473	09:41	152	36	00.02	33	00.00	2570	0.0	327	13193	26	CTD 14				In water			
474	11:05	152	36	59.96	33	00.02	2634	0.2	326	13193	26	CTD 14				At bottom			
475	12:25	152	36		33					13193	26	CTD 14				On deck			
476																			
477	18:15	152	36	16.69	33	53.78		-0.9	321	13193	27	CTD 15				In water			
478		152									27	CTD 15				At bottom			
479	20:45	152	36	16.81	33	53.87	2440	0.6	316	13193	27	CTD 15				On deck			
480																			
481	21:33	152								13193	28	BGT 06				String o/b			
482	21:36	152	36	13.83	33	52.04	2050	0.4	356	13193	28	BGT 06	0	0	0	BGT in water			
483	21:45	152	36	13.85	33	52.05		0.7	332	13193	28	BGT 06	210	241	BX	Veer @ 30m/min			
484	22:00	152	36	14.02	33	52.17	2047	0.7	330	13193	28	BGT 06	598	659	BX				
485	22:15	152	36	14.11	33	52.20	2063	0.9	338	13193	28	BGT 06	1032	1083	BX				
486	22:30	152	36	14.25	33	52.26	2034	0.7	343	13193	28	BGT 06	1492	1530	BX				
487	22:36	152	36	14.28	33	52.27	2042	0.8	335	13193	28	BGT 06	1658	1700	BX	Bott#1 T=4.6012			
488	22:45	152	36	14.34	33	52.29	2037	0.6	335	13193	28	BGT 06	1942	2002	BX	Haul @ 40m/min			
489	22:53	152	36	14.39	33	52.32	2046	0.5	328	13193	28	BGT 06	1668	1700	BX	Veer @ 40m/min			
490	23:00	152	36	14.45	33	52.41	2036	0.7	335	13193	28	BGT 06	1899	1950	BX	Haul @ 40m/min			
491	23:06	152	36	14.52	33	52.42	2030	0.7	333	13193	28	BGT 06	1681	1700	BX	Veer @ 40			
492	23:13	152	36	14.56	33	52.48	2025	0.9	336	13193	28	BGT 06	1925	1990	BX	Haul @ 40			
493	23:15	152	36	14.58	33	52.49	2032	0.7	337	13193	28	BGT 06	1953	1963	BX				
494	23:22	152	36	14.63	33	52.49	2040	0.6	335	13193	28	BGT 06		1700	BX	Veer @ 40			
495	23:28	152	36	14.71	33	52.51	2080	0.7	329	13193	28	BGT 06	1901	1932	BX	Haul @ 40			
496	23:30	152	36	14.71	33	52.52	2080	0.6	333	13193	28	BGT 06	1860	1860	BX				
497	23:35	152	36	14.75	33	52.55	2084	0.7	334	13193	28	BGT 06	1675	1690	BX	Veer @ 40			
498	23:44	152	36	14.84	33	52.68	2028	0.5	332	13193	28	BGT 06	2028	2042		Haul @ 40			
499	23:45	152	36	14.86	33	52.68	2180	0.3	331	13193	28	BGT 06	1989	1992					
500	23:53	152	36	14.89	33	52.75	2198	0.7	342	13193	28	BGT 06	1693	1698		Veer @ 40			

Appendix C: Operations Log

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
501	00:00	153	36	14.95	33	52.72	2217	0.6	344	13193	28	BGT 06	1945	1998	53				
502	00:03	153	36	14.97	33	52.68	2218	0.5	345	13193	28	BGT 06	2034	2112	78	Haul @ 40			
503	00:15	153	36	15.09	33	52.60	2222	1.3	328	13193	28	BGT 06	1679	1698	19	Veer @ 40			
504	00:27	153	36	15.23	33	52.75	2290	0.7	327	13193	28	BGT 06	2167	2177	10	Haul @ 40			
505	00:30	153	36	15.26	33	52.78	2250	0.5	329	13193	28	BGT 06	2078	2090	12				
506	00:39	153	36	15.34	33	52.84	2250	0.6	329	13193	28	BGT 06	1706	1700	-6	Veer @ 40			
507	00:45	153	36	15.38	33	52.88	2254	0.7	329	13193	28	BGT 06	1890	1912	22				
508	00:51	153	36	15.41	33	52.91	2274	0.7	340	13193	28	BGT 06	2186	2190	4	Haul @ 40			
509	01:00	153	36	15.50	33	52.98	2286	0.6	335	13193	28	BGT 06	1889						
510	01:05	153	36	15.55	33	52.98	2330	0.6	333	13193	28	BGT 06	1685	1699	14	Veer @ 40			
511	01:15	153	36	15.63	33	53.03	2341	0.5	334	13193	28	BGT 06	2066	2100	34				
512	01:18	153	36	15.64	33	53.05	2351	0.6	330	13193	28	BGT 06	2205	2218	13	Haul @ 40			
513	01:30	153	36	15.75	33	53.19	2389	0.8	332	13193	28	BGT 06	1748	1728	-20				
514	01:31	153	36	15.76	33	53.21	2396	0.8	332	13193	28	BGT 06	1706	1700	-6	Veer @ 40			
515	01:45	153	36	15.90	33	53.31	2383	0.7	332	13193	28	BGT 06	2223	2218	-5	Haul @ 40			
516	02:00	153	36	16.02	33	53.37	2406	0.6	331	13193	28	BGT 06	1710	1700	-10	Veer @ 40			
517	02:11	153	36	16.12	33	53.44	2423	0.7	332	13193	28	BGT 06	2258	2295	37	Haul @ 40			
518	02:15	153	36	16.15	33	53.44	2425	0.7	333	13193	28	BGT 06	2175	2184	9				
519	02:27	153	36	16.25	33	53.53	2503	0.6	333	13193	28	BGT 06	1693	1700	7	Veer @ 40			
520	02:30	153	36	16.26	33	53.55	2474	0.7	331	13193	28	BGT 06	1764	1815	51				
521	02:45	153	36	16.36	33	53.61	2495	0.8	329	13193	28	BGT 06	2358	2393	35	Haul @ 40			
522	03:00	153	36	16.42	33	53.65	2502	0.7	330	13193	28	BGT 06	1741	1778	37				
523	03:02	153	36	16.44	33	53.64	2500	0.7	332	13193	28	BGT 06	1671	1700	29	Veer @ 40			
524	03:15	153	36	16.53	33	53.75	2502	0.3	333	13193	28	BGT 06	2167	2242	75				
525	03:19	153	36	16.55	33	53.77	2510	0.5	327	13193	28	BGT 06	2333	2390	57	Haul @ 40			
526	03:30	153	36	16.64	33	53.81	2507	0.6	331	13193	28	BGT 06	1910	1902	-8				
527	03:35	153	36	16.71	33	53.79	2490	0.4	335	13193	28	BGT 06	1672	1700	28	Veer @ 40			
528	03:45	153	36	16.76	33	53.85	2509	0.8	327	13193	28	BGT 06	2012	2066	54				
529	03:53	153	36	16.83	33	53.92	2418	0.8	325	13193	28	BGT 06	2350	2394	44	Haul @ 40			
530	04:00	153	36	16.88	33	54.02	2407	0.8	327	13193	28	BGT 06	2135	2140	5				
531	04:11	153	36	16.98	33	54.09	2400	0.8	330	13193	28	BGT 06	1706	1702	-4	Veer @ 40			
532	04:15	153	36	17.05	33	54.10	2416	0.9	328	13193	28	BGT 06	1862	1900	38				
533	04:29	153	36	17.15	33	54.18	2391	0.8	332	13193	28	BGT 06	2339	2372	33	Haul @ 40			
534	04:30	153	36	17.16	33	54.17	2394	0.7	329	13193	28	BGT 06	2313	2320	7				
535	04:45	153	36	17.32	33	54.25	2374	0.8	329	13193	28	BGT 06	1711	1697		Veer @ 40			
536	04:52	153	36	17.39	33	54.30	2371	0.7	331	13193	28	BGT 06	1917	1950	0	Fire Bottle 2			
537	04:53	153	36	17.40	33	54.31	2368	0.5	329	13193	28	BGT 06	1947	2000		Fire Bottle 3			
538	04:55	153	36	17.40	33	54.32	2356	0.6	329	13193	28	BGT 06	2025	2050		Fire Bottle 4			
539	05:00	153	36	17.47	33	54.36	2295	0.7	331	13193	28	BGT 06	2236	2289	23	Haul @ 40			
540	05:15	153	36	17.65	33	54.41	2234	0.9	329	13193	28	BGT 06	1719	1700	25	Veer @ 40			
541	05:30	153	36	17.81	33	54.53	2180	0.8	327	13193	28	BGT 06	2237	2230		Haul @ 40			
542	05:43	153	36	17.95	33	54.67	2050	0.5	326	13193	28	BGT 06	1708	1697		Veer @ 40			

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
543	05:45	153	36	17.98	33	54.68	2095	0.7	324	13193	28	BGT 06	1729	1740		X'd Way Point			
544	05:49	153	36	18.03	33	54.74	1968	0.9	326	13193	28	BGT 06	1915	1902		Haul @ 40			
545	05:52	153	36		33					13193	28	BGT 06				Bottle 5 Fired			
546	05:53	153	36		33					13193	28	BGT 06				Bottle 6 Fired			
547	05:53	153	36		33					13193	28	BGT 06				Bottle 7 Fired			
548	05:53	153	36		33					13193	28	BGT 06				Bottle 8 Fired			
549	05:53	153	36		33					13193	28	BGT 06				Bottle 9 Fired			
550	05:54	153	36		33					13193	28	BGT 06				Bottle 10 Fired			
551	05:54	153	36		33					13193	28	BGT 06				Bottle 11 Fired			
552	05:55	153	36	18.09	33	54.75	1928	0.8	322	13193	28	BGT 06	1732	1717		Bottle 12 Fired			
553	06:00	153	36	18.16	33	54.80	1872	0.8	325	13193	28	BGT 06	1510	1500					
554	06:30	153	36	18.60	33	55.18	1637	1.0	325	13193	28	BGT 06	263	243		Nr. surface			
555	06:45	153								13193	28	BGT 06				On deck			
556																			
557	08:29	153	36	12.51	33	48.92	2574			13193	29	HYD04				In water			
558	09:51	153	36	12.58	33	48.77	2646			13193	29	HYD04				On bottom			
559		153								13193	29	HYD04		2646		Bottle 1			
560		153								13193	29	HYD04		2400		Bottle 2			
561		153								13193	29	HYD04		2300		Bottle 3			
562		153								13193	29	HYD04		2200		Bottle 4			
563		153								13193	29	HYD04		2157		Bottle 5			
564		153								13193	29	HYD04		2125		Bottle 6			
565		153								13193	29	HYD04		2100		Bottle 7			
566		153								13193	29	HYD04		2075		Bottle 8			
567		153								13193	29	HYD04		2050		Bottle 9			
568		153								13193	29	HYD04		2000		Bottle 10			
569		153								13193	29	HYD04		1950		Bottle 11			
570		153								13193	29	HYD04		1900		Bottle 12			
571		153								13193	29	HYD04		1850		Bottle 13			
572		153								13193	29	HYD04		1800		Bottle 14			
573		153								13193	29	HYD04		1500		Bottle 15			
574		153								13193	29	HYD04		1000		Bottle 16			
575	10:59	153	36	12.58	33	48.60				13193	29	HYD04				On deck			
576																			
577	11:40	153								13193	30	SAP02				Commence deplopment			
578	12:07	153								13193	30	SAP02				SAPs 1&2 @ 50m			
579	12:15	153								13193	30	SAP02				SAPs 3&4 @ 100m			
580	12:35	153	36	15.65	33	50.40		0.5	291	13193	30	SAP02	56	436		SAPs & 480m blue away			
581	13:00	153	36	15.58	33	50.45			294	13193	30	SAP02	824	1204					
582	13:27	153	36	15.46	33	50.50	2561		293	13193	30	SAP02	1719	2099		Wire stopped			
583	13:40	153	36	15.42	33	50.44	2951		312	13193	30	SAP02	1720	2100		Pumping started			
584	14:10	153	36	15.48	33	50.47		0.6	303	13193	30	SAP02	1720	2100					

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	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
585	14:40	153	36	15.60	33	50.47	2512	0.9	305	13193	30	SAP02	1720	2100					
586	15:10	153	36	15.73	33	50.68	2482	0.4	304	13193	30	SAP02	1720	2100					
587	15:40	153	36	15.74	33	50.70	2464	0.3	305	13193	30	SAP02	1720	2100		Pumping stopped			
588	16:10	153	36	15.74	33	50.70	2465	0.6	303	13193	30	SAP02	1720	2100		Start hauling			
589	16:30	153								13193	30	SAP02	0	380		At top of blue wire			
590	16:54	153								13193	30	SAP02				SAPs 3&4 out			
591	17:02	153								13193	30	SAP02				SAPs 1&2 out			
592																			
593	18:07	153	36	12.33	33	46.40				13193	31	HYD 05				CTD in water			
594	19:24	153	36	12.32	33	46.52				13193	31	HYD 05				CTD at bottom			
595	20:13	153	36	12.45	33	46.64				13193	31	HYD 05				CTD on deck			
596																			
597	22:20	153	36	21.93	33	38.29		2.4	256	13193	32	RMT04	0			Nets outboard			
598	23:00	153						2.4		13193	32	RMT04	1100	750	805				
599	23:30	153						2.2		13193	32	RMT04	2001	1150	1638				
600	24:00	153	60	20.30	33	40.64		2.0		13193	32	RMT04	3049	1652	2563				
601	00:00	153	36	20.30	33	40.64		2.0		13193	32	RMT04	3049	1652	2563				
602	00:30	154	36	19.36	33	41.75		2.0	244	13193	32	RMT04	4169	2200	3541	Net 1 open			
603	01:00	154	36	18.48	33	42.76				13193	32	RMT04	4360	2130	3804				
604	01:35	154	36	17.64	33	44.08				13193	32	RMT04	4249	2112	3687				
605	02:00	154	36	17.14	33	44.95		1.9	245	13193	32	RMT04	4128	2129	3537				
606																			
607	02:30	154	36	16.41	33	45.99				13193	33	RMT05	4071	2117	3477	Net 2 open			
608	03:00	154	36	15.54	33	47.00		1.9	240	13193	33	RMT05	4071	2051	3517				
609	03:30	154	36	14.70	33	47.93		2.2	240	13193	33	RMT05	4061	2065	3497				
610	04:00	154	36	13.88	33	48.88			241	13193	33	RMT05	4061	2063	3498				
611																			
612	04:30	154	36	13.05	33	49.90		2.2		13193	34	RMT06	4061	2063	3498	Net 3 open			
613	05:00	154	36	12.24	33	51.10		2.2		13193	34	RMT06	4061	2070	3494				
614	05:30	154	36	11.56	33	52.20		2.2	236	13193	34	RMT06	4061	2079	3488				
615	06:00	154	36	10.74	33	53.20			236	13193	34	RMT06	4061	2105	3473				
616	06:23	154	36	10.17	33	53.89				13193	34	RMT06	3633	2000	3033	Closing signal sent			
617		154									34	RMT06				Failed to close?			
618	08:30	154								13193	34	RMT06				All inboard			
619																			
620	10:17	154	36	11.92	33	46.27		0.5	003	13193	35	CTD16				CTD In water			
621	11:28	154										CTD16				On bottom			
622	12:56	154										CTD16				CTD inboard			
623																			
624																			
625	13:00	154	ded due to bad weather.																
626																			

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
627	20:17	154								13193	36	CTD17				CTD in water			
628	21:27	154								13193	36	CTD17				On bottom			
629	22:44	154	36	13.95	33	52.47	2000	0.3	264	13193	36	CTD17				CTD inboard			
630																			
631	23:48	154	36	15.78	33	53.08	2397	0.7	261	13193	37	CTD18				CTD in water			
632																			
633	01:08	155	36	15.69	33	53.18	2397			13193	37	CTD18				At Bottom			
634	01:35	155	36	15.72	33	53.20	2390			13193	37	CTD18				At 1500m			
635	01:57	155	36	15.71	33	53.12	2394			13193	37	CTD18				At Bottom			
636	02:23	155	36	15.71	33	53.03	2386			13193	37	CTD18				At 1500m			
637	02:46	155	36	15.69	33	53.00	2405			13193	37	CTD18				At Bottom			
638	03:12	155	36	15.66	33	53.06	2355			13193	37	CTD18				At 1500m			
639	03:35	155	36	15.71	33	53.01	2374			13193	37	CTD18				At Bottom			
640	04:01	155	36	15.66	33	53.18	2380			13193	37	CTD18				At 1500m			
641	04:25	155	36	15.65	33	53.27	2371			13193	37	CTD18				At Bottom			
642	04:48	155	36	15.70	33	53.24	2381			13193	37	CTD18				At 1500m			
643	05:11	155	36	15.70	33	53.24	2354			13193	37	CTD18				At Bottom			
644	05:35	155	36	15.70	33	53.25	2379			13193	37	CTD18				At 1500m			
645	05:59	155	36	15.68	33	53.27	2375			13193	37	CTD18				At Bottom			
646	06:24	155	36		33					13193	37	CTD18				At 1500m			
647	06:46	155	36	15.74	33	53.28	2362			13193	37	CTD18				At Bottom			
648	07:12	155	36	15.73	33	53.25	2378			13193	37	CTD18				At 1500m			
649		155	36		33					13193	37	CTD18				At Bottom			
650	07:59	155	36	15.70	33	53.20	2383			13193	37	CTD18				At 1500m			
651	08:22	155	36	15.68	33	53.26	2385	0.5	275	13193	37	CTD18				At Bottom			
652	08:47	155	36	15.73	33	53.21	2382	-0.1	275	13193	37	CTD18				At 1500m			
653	09:10	155	36	15.69	33	53.26	2377	0.1	275	13193	37	CTD18				At Bottom			
654	09:37	155	36	15.71	33	53.24		0.1		13193	37	CTD18				At 1500m			
655	10:01	155	36	15.73	33	53.21		0.2		13193	37	CTD18				At Bottom			
656	10:24	155	36	15.76	33	53.23		0.1		13193	37	CTD18				At 1500m			
657	10:47	155	36	15.79	33	53.21	2399	0.1	270	13193	37	CTD18				At Bottom			
658	11:57	155	36	15.92	33	53.16	2400	0.4	269	13193	37	CTD18				Out of water			
659																			
660	13:25	155	36	13.25	33	44.61	2595			13193	38	HYD06				CTD in water			
661	14:51	155	36	13.08	33	44.85	2595			13193	38	HYD06				At bottom			
662	16:00	155	36	13.10	33	44.80	2607			13193	38	HYD06				CTD inboard			
663																			
664	17:25	155	36	15.71	33	43.08				13193	39	HYD07				CTD in water			
665	18:55	155	36	15.47	33	43.07				13193	39	HYD07				At bottom			
666	20:00	155	36	15.44	33	43.03				13193	39	HYD07				CTD inboard			
667																			
668	21:06	155	36	15.63	33	45.41				13193	40	HYD08				CTD in water			

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	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
669	22:32	155	36	15.68	33	45.54				13193	40	**HYD08**				At bottom			
670	23:44	155	36	15.71	33	45.60				13193	40	**HYD08**				CTD inboard			
671																			
672	01:35	156	36	13.65	33	50.73				13193	41	**CTD19**				CTD in water			
673	02:52	156	36	13.73	33	50.65				13193	41	**CTD19**				At bottom			
674	04:21	156								13193	41	**CTD19**				CTD inboard			
675																			
676	05:26	156	36	13.47	33	52.84	1944	-0.3	316	13193	42	**CTD20**				CTD in water			
677	06:28	156	36	13.45	33	52.91	1950			13193	42	**CTD20**		1926		10m off: Bottle 2			
678	06:31	156	36		33					13193	42	**CTD20**				50m off; moving			
679	06:34	156	36	13.45	33	53.00	1946			13193	42	**CTD20**				Start to haul			
680	06:39	156	36	13.44	33	53.08	1940	0.9	290	13193	42	**CTD21**		1700		At 1700m			
681	06:50	156	36	13.46	33	53.16	1944	1.0	293	13193	42	**CTD21**		1938		10m off: Bottle 4			
682	06:58	156	36	13.54	33	53.20	1949	1.1	296	13193	42	**CTD22**		1700		At 1700m			
683	07:08	156	36	13.57	33	53.29	1984	1.0	288	13193	42	**CTD22**		1983		10m off			
684	07:16	156	36	13.57	33	53.38	2003	1.0	293	13193	42	**CTD23**		1700		At 1700m			
685	07:25	156	36	13.59	33	53.42	2006	0.9	290	13193	42	**CTD23**		1987		10m off			
686	07:28	156	36	13.59	33	53.45	2009	0.9	294	13193	42	**CTD23**		1924		Bottle #6			
687	07:35	156	36	13.58	33	53.44	2013	0.5	295	13193	42	**CTD24**		1700		At 1700m			
688	07:45	156	36	13.62	33	53.61	2040	0.9	293	13193	42	**CTD24**				10m off			
689	07:55	156	36	13.64	33	53.76	2084	1.4	299	13193	42	**CTD25**		1672		At 1700m			
690	08:08	156	36	13.75	33	53.90	2149	1.4	300	13193	42	**CTD25**				10m off			
691	08:12	156	36	13.79	33	53.91	2173	1.0	300	13193	42	**CTD25**		1969		Bottle 8			
692	08:21	156	36	13.84	33	53.99	2189	1.4	300	13193	42	**CTD26**		1700		At 1700m			
693	08:36	156	36	13.99	33	54.17	2260	1.2	295	13193	42	**CTD26**		2215		10m off			
694	08:39	156	36	14.02	33	54.24	2295	1.1	297	13193	42	**CTD26**		2170		Bottle 10			
695	08:52	156	36	14.02	33	54.28	2330	0.8	297	13193	42	**CTD26**		2150		Bottle 12			
696	08:59	156	36	14.08	33	54.42	2440	1.2	297	13193	42	**CTD27**		1700		At 1700m			
697	09:21	156	36	14.15	33	54.59	2501	0.9	297	13193	42	**CTD27**		2485		10m off			
698	09:32	156	36	14.15	33	54.56	2492	0.8	286	13193	42	**CTD27**		2210		Bottle 14			
699	09:36	156	36	14.11	33	54.69	2513	0.9	288	13193	42	**CTD27**		2102		Bottle 16			
700	09:37	156	36	14.20	33	54.73	2524	1.2	288	13193	42	**CTD27**		2004		Bottle 18			
701	09:43	156	36	14.20	33	54.86	2543	1.1	295	13193	42	**CTD27**		1944		Bottle 20			
702	09:50	156	36	14.28	33	54.98	2576	0.9	295	13193	42	**CTD28**		1700		At 1700m			
703	10:14	156	36	14.41	33	55.11	2648	0.9	297	13193	42	**CTD28**		2638		10m off			
704	10:31	156	36	14.51	33	55.21	2722	0.9	296	13193	42	**CTD28**		2060		Bottle 22			
705	10:34	156	36	14.57	33	55.23	2747	0.3		13193	42	**CTD28**		2020		Bottle 24			
706	10:48	156	36	14.63	33	55.28	2780	1.0	294	13193	42	**CTD29**		1700		At 1700m			
707	11:19	156	36	14.76	33	55.45	2935	0.9	290	13193	42	**CTD29**		2925		10m off			
708	11:49	156	36	14.98	33	55.73	3001	0.7	295	13193	42	**CTD30**		1700		At 1700m			
709	12:26	156	36	15.04	33	56.02	3046	0.9	288	13193	42	**CTD30**		3058		10m off			
710	13:47	156	36	14.95	33	56.63	3207	0.6	293	13193	42	**CTD30**		CTD on Deck:-		God stops play.			

Appendix C: Operations Log

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
711																			
712	07:56	157	36	32.27	34	54.13	2580	0.6	305	13193	43	CTD31				CTD in water			
713	09:16	157	36	32.21	34	54.37	2645	0.0	314	13193	43	CTD31				CTD at bottom			
714	10:46	157	36	32.29	34	54.74	2533	0.5	318	13193	43	CTD31				CTD on deck			
715																			
716	16:15	157	36		33					13193	44	SAP03				On Station-Boat Drill			
717	17:20	157	36		33					13193	44	SAP03				Commence Deployment			
718	17:30	157	36		33					13193	44	SAP03				SAPS 1,2 on @25m			
719	17:38	157	36		33					13193	44	SAP03				SAPS 3,4 on @50m			
720	17:48	157	36	14.48	33	55.12	2677	0.2	318	13193	44	SAP03	4m			Cable attached, SAPS away			
721	18:35	157	36	14.51	33	55.09	2670	0.1	318	13193	44	SAP03	1876m			Winch stopped			
722	18:45	157	36	14.46	33	55.04	2658	0.7	307	13193	44	SAP03	1876m			Pump1 start			
723	20:54	157	36	14.47	33	55.27	2787	0.3	335	13193	44	SAP03	1876m			Pumping finished, commence hauling			
724	22:22	157								13193	44	SAP03				last pump off			
725	22:24	157								13193	44	SAP03				Pingers on deck			
726																			
727	00:16	158	36	25.92	33	42.97			199	13193	45	RMT07	61			Nets In water			
728	00:45	158	36	24.99	33	43.19			207	13193	45	RMT07	895						
729	01:00	158	36	24.63	33	43.38			225	13193	45	RMT07	1310	1040					
730	01:15	158	36	24.26	33	43.67			226	13193	45	RMT07	1772						
731	01:30	158	36	23.91	33	43.95			216	13193	45	RMT07	2222	1678					
732	01:45	158	36	23.43	33	44.20	2714		215	13193	45	RMT07	2706	1864	1971				
733	02:00	158	36	23.05	33	44.44			216	13193	45	RMT07	3101	2147	2238				
734	02:04	158	36	22.89	33	44.51			216	13193	45	RMT07	3216	2211	2335	Net 1 open			
735	02:15	158	36	22.61	33	44.66			215	13193	45	RMT07	3216	2138	2402				
736	02:34	158	36	22.08	33	44.87			215	13193	45	RMT07	3275	2136	2483				
737	02:45	158	36	21.78	33	45.01			215	13193	45	RMT07	3372	2169	2582				
738	03:00	158	36	21.37	33	45.21			215	13193	45	RMT07	3372	2119	2623				
739	03:30	158	36	20.42	33	45.72	2720		217	13193	45	RMT07	3546	2100	2857				
740	04:00	158	36	19.58	33	46.26			212	13193	45	RMT07	3553	2070	2888				
741	04:04	158	36	19.45	33	46.30			215	13193	46	RMT08	3553	2065	2891	Net 2 open			
742	04:30	158	36	18.60	33	46.59	3080		215	13193	46	RMT08	3553	2053	2900				
743	05:00	158	36	17.66	33	47.12			219	13193	46	RMT08	3553	2039	2910				
744	05:30	158	36	16.72	33	47.65			219	13193	46	RMT08	3553	2035	2912				
745	06:04	158	36	15.56	33	48.35	2807		219	13193	47	RMT09	3718	2035	3112	Net 3 open			
746	06:30	158	36	14.63	33	48.92				13193	47	RMT09	3834	2028	3254				
747	07:00	158	36	13.49	33	49.46				13193	47	RMT09	4048	2056	3487				
748	07:30	158	36	12.22	33	50.03			200	13193	47	RMT09	4238	2025	3723				
749	08:04	158	36	10.66	33	50.84				13193	47	RMT09	4547	2014	4077	Net 3 closed			
750																Nets on deck			
751																			
752	11:47	158	36		33					13193	48	SAP 04				On station			

Appendix C: Operations Log

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
753	11:50	158	36		33					13193	48	**SAP 04**				Commence deploying SAPs			
754	12:15	158	36		33					13193	48	**SAP 04**				All SAPs on wire			
755	12:25	158	36	14.13	33	54.45	2490	0.3	256	13193	48	**SAP 04**	0			200m blue cable out			
756	13:19	158	36	14.28	33	54.35	2409	0.3	242	13193	48	**SAP 04**	1960			Winch stopped			
757	13:50	158	36	14.29	33	54.07	2322	0.2	233	13193	48	**SAP 04**	1960			Pumps on			
758	14:20	158	36	14.12	33	54.20	2304	0.6	237	13193	48	**SAP 04**	1960			30 mins on			
759	14:50	158	36	14.00	33	54.25	2319	0.5	249	13193	48	**SAP 04**	1960			60 mins on			
760	15:20	158	36	14.12	33	54.27	2341	0.3	259	13193	48	**SAP 04**	1960			90 mins on			
761	15:54	158	36	14.11	33	54.16	2310	1.0	237	13193	48	**SAP 04**	1960			Pumps off			
762	16:45	158	36		33					13193	48	**SAP 04**				At blue cable			
763	16:57	158	36		33					13193	48	**SAP 04**				Start recovering Pumps			
764	17:11	158	36		33					13193	48	**SAP 04**				All done			
765																			
766	19:25	158	36	10.78	33	50.93	2172	0.3	259	13193	49	**CTD 32**				CTD in water			
767	20:20	158	36		33					13193	49	**CTD 32**				CTD at bottom			
768	21:39	158	36	10.74	33	50.99		0.0	268	13193	49	**CTD 32**				CTD on deck			
769																			
770	23:01	158								13193	50	**BGT 07**				String in water			
771	23:06	158								13193	50	**BGT 07**				BGT in water			
772	23:30	158	36	18.65	33	51.73	2650	0.4	222	13193	50	**BGT 07**	539	529	103				
773	23:45	158	36	18.34	33	51.72	2657	0.2	250	13193	50	**BGT 07**	1010	969	285				
774																			
775	00:00	159	36	18.06	33	51.93	2721	0.6	243	13193	50	**BGT 07**	1467	1392	463				
776	00:15	159	36	17.74	33	52.03	2727	1.1	252	13193	50	**BGT 07**	1916	1757	764				
777	00:30	159	36	17.46	33	52.17	2673	0.3	248	13193	50	**BGT 07**	2365	2151	983				
778	00:45	159	36	17.25	33	52.44	2628	0.5	254	13193	50	**BGT 07**	2817	2570	1154				
779	00:46	159	36	17.22	33	52.47	2626	0.5	251	13193	50	**BGT 07**	2851	2609	1149	Haul @ 40m/min.			
780	01:00	159	36	17.01	33	52.60	2605	0.6	249	13193	50	**BGT 07**	2310	2080	1005				
781	01:10	159	36	16.82	33	52.76	2536	0.8	235	13193	50	**BGT 07**	1924	1686	927	Veer @ 30m/min.			
782	01:15	159	36	16.72	33	52.84	2483	1.1	235	13193	50	**BGT 07**	2071	1801	1022				
783	01:30	159	36	16.41	33	52.98	2427	0.5	234	13193	50	**BGT 07**	2530	2227	1201				
784	01:40	159	36	16.24	33	53.03	2424	0.8	235	13193	50	**BGT 07**	2817	2502	1294	Haul @ 40m/min.			
785	01:45	159	36	16.11	33	53.06	2408	0.6	232	13193	50	**BGT 07**	2599	2280	1248				
786	02:00	159	36	15.82	33	53.21	2392	0.7	248	13193	50	**BGT 07**	1975	1700	1005	Veer @ 30m/min.			
787	02:15	159	36	15.62	33	53.46	2385	0.9	241	13193	50	**BGT 07**	2375	2085	1137	Bottle 1 fired			
788	02:25	159	36	15.45	33	53.63	2433	0.7	241	13193	50	**BGT 07**	2646	2298	1312	Haul @ 40m/min.			
789	02:30	159	36	15.37	33	53.72	2411	0.8	239	13193	50	**BGT 07**	2469	2115	1274				
790	02:42	159	36	15.14	33	53.82	2397	0.6	241	13193	50	**BGT 07**	1975	1690	1022	Veer @ 30m/min			
791	02:45	159	36	15.09	33	53.82	2400	1.0	225	13193	50	**BGT 07**	2030	1783	970				
792	03:00	159	36	14.75	33	53.96	2410	1.0	224	13193	50	**BGT 07**	2500	2132	1306	Bottle 2 fired			
793	03:08	159	36	14.51	33	54.04	2407	1.1	223	13193	50	**BGT 07**	2707	2300	1428	Haul @ 40m/min.			
794	03:15	159	36	14.41	33	54.04	2375	1.0	223	13193	50	**BGT 07**	2494	2074	1385				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
795	03:25	159	36	14.17	33	54.02	2294	1.0	229	13193	50	BGT 07	2063	1697	1173	Veer @ 30m/min.			
796	03:30	159	36	14.06	33	54.05	2257	0.9	242	13193	50	BGT 07	2180	1830	1185				
797	03:37	159	36	13.90	33	54.10	2241	0.9	244	13193	50	BGT 07	2406	2045	1268	Bottle 3 fired			
798	03:45	159	36	13.79	33	54.10	2216	0.7	246	13193	50	BGT 07	2650	2300	1316	Haul @ 40m/min.			
799	04:00	159	36	13.50	33	54.24	2228	0.8	250	13193	50	BGT 07	2086	1786	1078				
800	04:03	159	36	13.43	33	54.29	2242	0.7	261	13193	50	BGT 07	1994	1703	1037	Veer @ 30m/min.			
801	04:15	159	36	13.29	33	54.50	2345	0.7	260	13193	50	BGT 07	2366	2097	1096				
802	04:18	159	36	13.37	33	54.57	2376	0.8	254	13193	50	BGT 07	2452	2170	1142	Haul @ 40m/min.			
803	04:30	159	36	13.08	33	54.78	2499	1.2	249	13193	50	BGT 07	2009	1703	1066	Veer @ 30m/min.			
804	04:45	159	36	12.77	33	55.07	2550	1.2	233	13193	50	BGT 07	2440	2100	1242				
805	04:57	159	36	12.51	33	55.11	2582	1.0	232	13193	50	BGT 07	2781	2399	1407	Haul @ 40m/min.			
806	05:00	159	36	12.43	33	55.10	2590	0.9	232	13193	50	BGT 07	2650	2268	1371				
807	05:15	159	36	12.02	33	55.20	2690	1.0	234	13193	50	BGT 07	2053	1674	1189	Veer @ 30m/min.			
808	05:30	159	36	11.64	33	55.25	2799	1.1	232	13193	50	BGT 07	2491	2024	1452				
809	05:45	159	36	11.23	33	55.40	2851	1.3	250	13193	50	BGT 07	2931	2306	1809				
810	06:00	159	36	10.84	33	55.66	2852	1.0	248	13193	50	BGT 07	3364	2565	2177	Haul @ 40m/min.			
811	06:15	159	36	10.46	33	55.91	2772	1.3	249	13193	50	BGT 07	2791	1980	1967				
812	06:30	159	36	10.02	33	56.21	2632	1.1	250	13193	50	BGT 07	2164	1510	1550				
813	06:44	159	36	09.74	33	56.47	2619	1.0	259	13193	50	BGT 07	1685	1200	1183	Bottle 4 fired			
814	07:00	159	36	09.43	33	57.91	2697	1.3	274	13193	50	BGT 07	1072	792	722				
815	07:15	159	36	09.23	33	57.29	2815	1.1	284	13193	50	BGT 07	491	407	275				
816	07:19	159	36	09.20	33	57.43	2867	1.2	290	13193	50	BGT 07	318	297	114	Bottles 5 thru 12 fired.			
817	07:43	159								13193	50	BGT 07			0	BGT on deck			
818															0				
819	09:01	159	36	10.90	33	45.62	1739	0.2	336	13193	51	BGT 08			0	BGT in water			
820	09:16	159	36	11.03	33	45.56	1848	0.6	320	13193	51	BGT 08		300	#NUM!	Bottle #1 @ 300m			
821	09:30	159	36	11.19	33	45.66	1928	0.3	318	13193	51	BGT 08	574	578	#NUM!				
822	09:45	159	36	11.29	33	45.79	1978	0.5	319	13193	51	BGT 08	1008	1017	#NUM!				
823	09:50	159	36	11.31	33	45.80	2236	0.4	319	13193	51	BGT 08	1193	1200	#NUM!	Bottle #2 @ 1200m			
824	10:00	159	36	11.41	33	48.88	2216	0.7	325	13193	51	BGT 08	1492	1497	#NUM!				
825	10:15	159	36	11.61	33	46.00	2205	0.7	321	13193	51	BGT 08	1968	1964	125				
826	10:20	159	36	11.66	33	46.01	2210	0.7	324	13193	51	BGT 08		2145		Haul@40 (Sp.1.5kt)			
827	10:30	159	36	11.82	33	46.12	2234	1.0	321	13193	51	BGT 08	1765	1740	296	Veer @ 30			
828	10:45	159	36	12.10	33	46.34	2398	1.1	320	13193	51	BGT 08	2207	2025	878				
829	10:49	159	36	12.13	33	46.38	2413	1.0	321	13193	51	BGT 08	2267	2151	716	Haul @ 40			
830	11:00	159	36	12.36	33	46.56	2497	1.6	321	13193	51	BGT 08	1893	1689	855	Winch stopped			
831	11:06	159	36	12.49	33	46.68	2548	1.8	324	13193	51	BGT 08	1916	1690	903	Veer @ 30			
832	11:15	159	36	12.66	33	46.86	2723	1.4	324	13193	51	BGT 08	2201	1921	1074				
833	11:17	159	36	12.68	33	46.89	2734	1.3	322	13193	51	BGT 08	2244	1950	1110	Bottle 3			
834	11:19	159	36	12.72	33	46.93	2746	1.2	323	13193	51	BGT 08	2302	2000	1140	Bottle 4			
835	11:21	159	36	12.76	33	46.97	2755	1.4	322	13193	51	BGT 08	2361	2050	1171	Bottle 5			
836	11:23	159	36	12.84	33	46.99	2850	1.4	327	13193	51	BGT 08	2434	2100	1231	Bottle 6			

Appendix C: Operations Log

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
837	11:30	159	36	12.96	33	47.10	2870	1.3	329	13193	51	BGT 08	2635	2264	1348				
838	11:42	159	36	13.20	33	47.24	3041	1.0	327	13193	51	BGT 08	3006	2607	1497	Haul @ 40			
839	11:45	159	36	13.24	33	47.27	3044	1.1	326	13193	51	BGT 08	2916	2510	1484				
840	11:55	159	36	13.45	33	47.45	3068	1.6	329	13193	51	BGT 08	2495	2085	1370	Bottle 7			
841	11:58	159	36	13.49	33	47.50	3111	1.6	330	13193	51	BGT 08	2412	1993	1359	Bottle 8			
842	12:00	159	36	13.53	33	47.53	3122	1.3	328	13193	51	BGT 08	2342	1900	1369				
843	12:06	159	36	13.65	33	47.62	3131	1.4	332	13193	51	BGT 08	2115	1700	1258	Veer @ 30m/min			
844	12:15	159	36	13.88	33	47.77	3161	1.5	338	13193	51	BGT 08	2328	1860	1400				
845	12:23	159	36	14.10	33	47.92	3154	1.3	340	13193	51	BGT 08	2584	2051	1572	Bottle 9			
846	12:30	159	36	14.25	33	47.98	3144	1.4	339	13193	51	BGT 08	2773	2110	1799				
847	13:00	159	36	14.98	33	48.31	3121	1.3	338	13193	51	BGT 08	3681	2915	2248				
848	13:07	159	36	15.13	33	48.37	3040	1.3	335	13193	51	BGT 08	3877	3064	2376	Haul @ 40			
849	13:15	159	36	15.37	33	48.47	2989	1.8	335	13193	51	BGT 08	3588	2680	2386				
850	13:30	159	36	15.83	33	48.76	2872	1.5	328	13193	51	BGT 08	2963	2022	2166				
851	13:41	159	36	16.13	33	48.97	2859	1.6	322	13193	51	BGT 08	2512	1700	1849	Veer @ 30			
852	14:01	159	36	16.65	33	49.42	2903	1.5	323	13193	51	BGT 08	3099	2100	2279				
853	14:21	159	36	17.18	33	49.87	2803	1.6	325	13193	51	BGT 08	3728	2437	2821				
854	14:30	159	36	17.44	33	50.11	2996	1.7	322	13193	51	BGT 08	4050	2616	3092				
855	14:39	159	36	17.69	33	50.42	3068	1.7	322	13193	51	BGT 08	4437	2800	3442	Haul @ 40			
856	14:45	159	36	17.90	33	50.56	3023	2.0	330	13193	51	BGT 08	4270	2563	3415	Reduce to 1.5Kn			
857	15:00	159	36	18.31	33	50.88	2909	1.6	330	13193	51	BGT 08	3666	2078	3020				
858	15:15	159	36	18.65	33	51.10	2794	1.2	332	13193	51	BGT 08	3006	1814	2397				
859	15:21	159	36	18.79	33	51.24	2810	1.2	337	13193	51	BGT 08	2743	1700	2153	Veer @ 40			
860	15:30	159	36	19.03	33	51.38	2787	1.6	340	13193	51	BGT 08	3049	1989	2311				
861	15:45	159	36	19.45	33	51.57	2352	1.6	333	13193	51	BGT 08	3652	2455	2704				
862	15:53	159	36	19.65	33	51.73	2168	1.4	335	13193	51	BGT 08	3990	2750	2891	Haul @ 40			
863	16:00	159	36	19.79	33	51.80	2160	1.3	335	13193	51	BGT 08	3751	2536	2764				
864	16:16	159	36	20.18	33	51.98	2091	1.7	335	13193	51	BGT 08	3102	2100	2283	Bottle #10			
865	16:25	159	36	20.41	33	52.12	2125	1.9	334	13193	51	BGT 08	2711	1850	1982	Bottle #11			
866	16:30	159	36	20.51	33	52.16	2134	1.9	334	13193	51	BGT 08	2550	1737	1867				
867	17:03	159	36	21.17	33	52.51	2157	1.6	333	13193	51	BGT 08	1215	929	783				
868	17:30	159	36	21.73	33	52.82	2033	1.3	335	13193	51	BGT 08	153	139	64				
869	17:40	159	36		33					13193	51	BGT 08				BGT on deck			
870																			
871	19:12	159	36	14.15	33	54.26	2343	0.1	343	13193	52	CTD 33				In Water			
872	20:16	159	36	14.15	33	54.30	2378	0.6	325	13193	52	CTD 33				At Bottom			
873	21:46	159	36	14.04	33	54.27	2322	0.6	337	13193	52	CTD 33				Out			
874																			
875	22:48	159	36	14.10	33	54.36	2370			13193	53	HYD 09				In water			
876	00:15	160	36	14.31	33	54.36	2476			13193	53	HYD 09				At Bottom			
877	01:30	160	36	14.34	33	54.41	2450			13193	53	HYD 09				Out			
878																			

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
879	02:34	160								13193	54	SAP 05				On Station			
880	02:35	160								13193	54	SAP 05				Timer 1 Started			
881	02:36	160								13193	54	SAP 05				Timer 4 Started			
882	02:54	160								13193	54	SAP 05				Pumps 1,2 on @ 25m			
883	03:02	160								13193	54	SAP 05				Pumps 3,4 on @ 50m			
884	03:15	160	36	13.71	33	49.95	2628	0.6	345	13193	54	SAP 05	5			Cable Attached, lowering			
885	03:35	160	36	13.72	33	49.96	2623	0.0	342	13193	54	SAP 05	683			1 hr before pumping			
886	04:00	160	36	13.65	33	49.93	2625	0.0	351	13193	54	SAP 05	1664						
887	04:15	160								13193	54	SAP 05	1850			Winch Stopped			
888	04:35	160	36	13.71	33	49.81	2649	0.4	350	13193	54	SAP 05	1850			Pumping Started			
889	05:00	160	36	13.71	33	49.81	2655	0.4	338	13193	54	SAP 05	1850						
890	05:38	160	36	13.69	33	49.94	2630	0.3	324	13193	54	SAP 05	1850						
891	06:00	160	36	13.70	33	49.96	2619	0.4	331	13193	54	SAP 05	1850						
892	06:36	160	36	13.64	33	50.02	2605	0.4	345	13193	54	SAP 05	1850			Finished Pumping			
893	07:42	160								13193	54	SAP 05				At blue cable			
894	08:19	160								13193	54	SAP 05				All inboard			
895																			
896	12.10	160	36	11.34	33	59.65				13193	55-57	RMT1+8M			0	Nets in the water			
897	12.30	160	36							13193	55-57	RMT1+8M			0				
898	13.00	160	36	09.40	34	00.28	2713	2.5	196	13193	55-57	RMT1+8M	1327	842	1026				
899	13.30	160	36	08.15	34	00.65	2236	2.3	196	13193	55-57	RMT1+8M	2229	1284	1822	Bridge adjust waypoint			
900	14.00	160	36	07.08	34	01.30	3135	2.3	221	13193	55-57	RMT1+8M	3102	1842	2496	33deg 36 to 33deg 56			
901	14.26	160	36	06.29	34	02.17	2524	2.0	221	13193	55	RMT10	3906	2205	3224	NET 1 OPEN			
902	15.00	160	36	05.19	34	03.15	2662	2.0	210	13193	55	RMT10	4174	2126	3592				
903	15.30	160	36	04.11	34	03.95	2674	1.9	212	13193	55	RMT10	4174	2056	3633				
904	16.00	160	36	03.05	34	04.87	2786	2.2	213	13193	55	RMT10	4400	2077	3879				
905	16.26	160	36	02.18	34	05.76				13193	56	RMT11	4518	2093	4004	NET 2 OPEN			
906	17.00	160	36	01.04	34	06.81	2274	2.2	210	13193	56	RMT11	4518	2089	4006				
907	17.30	160	36	00.04	34	07.82	2241	2.4	210	13193	56	RMT11	4518	2105	3998				
908	18.00	160	36	58.98	34	08.66	2427	2.2	200	13193	56	RMT11	4401	2126	3853				
909	18.26	160	35	58.02	34	09.38	2307	2.2	203	13193	57	RMT12	4285	2165	3698	NET 3 OPEN			
910	19.00	160	35	57.08	34	10.22	2414	2.1	203	13193	57	RMT12	4131	2107	3553				
911	19.30	160	35	56.05	34	10.94	2322	2.3	186	13193	57	RMT12	4058	2075	3487	A/C 190			
912	20.00	160	35	54.87	34	11.41	2263	2.0	187	13193	57	RMT12	4058	2056	3499				
913	20.26	160			34					13193	57	RMT12	4058	2021	3519	NET 3 CLOSED			
914	22.55	160			34					13193	55	RMT12			0	ALL INBOARD			
915																			
916	00:24	161			34					13193	58	RMT13			0	NETS IN THE WATER			
917	00:29	161	35	54.98	34	10.12				13193	58	RMT13			0				
918	01:00	161	35	53.73	34	09.53				13193	58	RMT13	946	671	667				
919	01:30	161	35	52.72	34	10.10				13193	58	RMT13	1895	1232	1440	a/c 210			
920	02:00	161	35	52.00	34	10.81			200	13193	58	RMT13	2872	1955	2104				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
921	02:13	161	35	51.63	34	11.11			200	13193	58	RMT13	3289	2195	2449	NET 1 OPEN			
922	02:30	161	35	51.10	34	11.17			187	13193	58	RMT13	3289	2103	2529				
923	03:00	161	35	50.07	34	11.37	2488	2.3	196	13193	58	RMT13	3500	2063	2827				
924	03:30	161	35	48.96	34	11.81			200	13193	58	RMT13	3838	2126	3195				
925	04:00	161	35	47.93	34	12.22	2459		202	13193	58	RMT13	3838	2044	3248				
926	04:13	161	35	47.32	34	12.43				13193	59	RMT14	3838	2028	3258	NET 2 OPEN			
927	04:30	161	35	46.75	34	12.60				13193	59	RMT14	3838	2035	3254				
928	05:00	161	35	45.65	34	12.86		2.1	202	13193	59	RMT14	4098	2105	3516				
929	05:30	161	35	44.41	34	13.34				13193	59	RMT14	4249	2023	3737				
930	06:00	161	35	42.99	34	14.01				13193	59	RMT14	4659	2000	4208				
931	06:13	161	35	42.38	34	14.13				13193	59	RMT14	4786	2025	4336				
932	06:30	161	35	41.62	34	14.27				13193	60	RMT15	4786	2056	4322	NET 3 OPEN 06.13			
933	07:00	161	35	40.25	34	14.56	2735			13193	60	RMT15	4735	2105	4241				
934	07:30	161	35	38.95	34	14.86	2840	1.9	198	13193	60	RMT15	4697	2117	4193				
935	08:00	161	35	37.52	34	15.12	2900	2.3	199	13193	60	RMT15	4697	2093	4205				
936	08:13	161	35	36.89	34	15.29	2785	2.2	200	13193	60	RMT15	4697	2079	4212	NET 3 CLOSED			
937	10:58	161								13193	60	RMT15			0	NETS Inboard			
938																			
939	16:21	161	36	11.93	33	54.91	2643			13193	61	HYD 10				In Water			
940	17:34	161	36	11.91	33	55.13	2688			13193	61	HYD 10				At Bottom			
941	18:41	161	36	11.83	33	55.17	2728			13193	61	HYD 10				On Deck			
942																			
943	20:24	161	36	15.83	33	51.75	2320			13193	62	HYD 11				In Water			
944	21:54	161	36	15.69	33	51.63	2290			13193	62	HYD 11				At Bottom			
945	23:54	161	36		33					13193	62	HYD 11				On Deck			
946																			
947	02:14	162	36	12.33	33	46.17	2372	0.3	285	13193	63	SAP 06				On Station			
948	02:16	162	36		33					13193	63	SAP 06				Timer 1 on			
949	02:20	162	36		33					13193	63	SAP 06				Timer 4 on			
950	02:35	162	36		33					13193	63	SAP 06				1,2 on at 25m			
951	02:41	162	36		33					13193	63	SAP 06				3,4 on at 50m			
952	02:55	162	36	12.33	33	46.44	2445	0.0	288	13193	63	SAP 06	6			Cable on, Lowering			
953	03:34	162	36	12.31	33	46.42	2428	0.9	280	13193	63	SAP 06	1411						
954	04:16	162	36	12.29	33	46.42	2433	0.0	292	13193	63	SAP 06	1675			Start of Pumping			
955	05:16	162	36	12.37	33	46.44	2448	0.0	286	13193	63	SAP 06	1675			1hr of Pumping			
956	06:16	162	36	12.31	33	46.44	2442	0.4	292	13193	63	SAP 06	1675			Pumps off			
957	07:06	162	36	12.39	33	46.36	2501	0.0	287	13193	63	SAP 06	0			At Blue cable			
958	07:33	162	36	12.35	33	46.49	2642	0.4	284	13193	63	SAP 06				All in-board			
959																			
960	08:29	162	36	13.75	33	47.62	3143	0.1	305	13193	64	CTD 34				In water			
961	09:56	162	36	13.79	33	47.63	3153	0.7	305	13193	64	CTD 34				On bottom			
962	11:21	162	36	13.83	33	47.73	3155	0.2	276	13193	64	CTD 34				On deck			

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
963																			
964	12:23	162	36	15.15	33	53.85	2412			13193	65	HYD 12				In water			
965		162	36		33					13193	65	HYD 12				On bottom			
966		162	36		33					13193	65	HYD 12				On deck			
967																			
968	15:48	162								13193	66	BGT 09	NB: Back to BGT CTD here.			String in water			
969	15:50	162								13193	66	BGT 09				BGT in water			
970	16:15	162	36	17.02	33	52.02	2663	0.6	194	13193	66	BGT 09	577	583	#NUM!				
971	16:30	162	36	16.88	33	52.11	2625	0.5	203	13193	66	BGT 09	1173	1187	#NUM!				
972	16:45	162	36	16.80	33	52.25	2581	0.5	203	13193	66	BGT 09	1766	1792	#NUM!				
973	17:00	162	36	16.72	33	52.28	2536	0.4	197	13193	66	BGT 09	2360	2400	#NUM!				
974	17:01	162	36	16.72	33	52.29	2556	0.4	196	13193	66	BGT 09	2417	2460	#NUM!	Haul @ 40m/min.			
975	17:15	162	36	16.56	33	52.32	2491	0.8	195	13193	66	BGT 09	1860	1875	#NUM!				
976	17:19	162	36	16.51	33	52.35	2467	0.7	195	13193	66	BGT 09	1699	1699	0	Veer @ 30m/min			
977	17:30	162	36	16.35	33	52.43	2433	0.8	197	13193	66	BGT 09	2018	2000	269				
978	17:44	162	36	16.24	33	52.57	2399	0.7	196	13193	66	BGT 09	2431	2408	334	Haul @40m/mim.			
979	17:45	162	36	16.23	33	52.59	2398	0.6	197	13193	66	BGT 09	2398	2363	408	Comms poor!!			
980	17:55	162	36	16.18	33	52.67	2884	0.6	190	13193	66	BGT 09	1978	1969	188	Slowed haul to 30m/min.			
981	18:00	162	36	16.14	33	52.69	2392	0.6	190	13193	66	BGT 09	1855	1848	161				
982	18:05	162	36	16.40	33	52.74	2403	0.8	180	13193	66	BGT 09	1691	1693	#NUM!	Veer @ 30m/min.			
983	18:15	162	36	16.05	33	52.76	2369	1.0	164	13193	66	BGT 09	1972	1977	#NUM!				
984	18:26	162	36	15.85	33	52.75	2355	0.8	164	13193	66	BGT 09	2312	2306	166	Haul @ 40m/min.			
985	18:30	162	36	15.83	33	52.74	2350	0.8	164	13193	66	BGT 09	2176	2170	161				
986	18:35	162	36		33					13193	66	BGT 09	1973		1973	Winch stopped, comms poor.			
987	18:36	162	36		33					13193	66	BGT 09			0	Winch restarted			
988	18:45	162	36		33					13193	66	BGT 09			0				
989	19:48	162	36		33					13193	66	BGT 09			0	BGT on deck.			
990		162	36		33					13193	66	BGT 09			0	Deep-tow cable shorted			
991		162	36		33					13193	66	BGT 09			0	Re-terminating			
992																			
993	21:18	162	36		33					13193	67	SAP 07				On Station, Timer 1 On			
994	21:30	162	36	15.73	33	53.02	2392	0.1	48	13193	67	SAP 07				Commence Deployment			
995	21:37	162	36		33					13193	67	SAP 07				1 on at 25m			
996	21:42	162	36		33					13193	67	SAP 07				3,4 on at 50m			
997	21:55	162	36	15.78	33	53.03	2396	0.2	45	13193	67	SAP 07	1			Cable Attached, Lowering			
998	22:20	162	36	15.80	33	52.93	2385	0.2	67	13193	67	SAP 07	588						
999	22:58	162	36	15.68	33	52.99	2373	0.2	53	13193	67	SAP 07	1975			Winch Stopped			
1000	23:18	162	36	15.83	33	52.83	2363	0.7	51	13193	67	SAP 07	1975			Pumping Started			
1001	23:42	162	36	15.81	33	52.96	2386	0.0	115	13193	67	SAP 07	1975			1/2 hour in			
1002	00:12	163	36	15.87	33	52.88	2386	0.2	130	13193	67	SAP 07	1975			1 hr pumping			
1003	00:42	163	36	15.76	33	52.72	2342	0.7	270	13193	67	SAP 07	1975			1.5 hr pumping			
1004	01:18	163	36	15.81	33	52.88	2366	0.4	314	13193	67	SAP 07	1975			Pumping Ends			

Appendix C: Operations Log

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1005	01:25	163	36		33					13193	67	**SAP 07**				Start Hauling			
1006	02:17	163	36		33					13193	67	**SAP 07**				Blue Cable at Surface			
1007	02:37	163	36		33					13193	67	**SAP 07**				Pumps 3,4 off			
1008	02:42	163	36		33					13193	67	**SAP 07**				Pump1 off			
1009	02:43	163	36		33					13193	67	**SAP 07**				All in			
1010																			
1011	03:09	163	36	14.66	33	53.63	2292	0.8	292	13193	68	**CTD 35**				In water			
1012	04:19	163	36	14.64	33	53.71	2385	0.5	326	13193	68	**CTD 35**				On bottom (touched!)			
1013	05:59	163	36	14.54	33	53.79	2355	0.1	320	13193	68	**CTD 35**				On deck			
1014																			
1015	06:50	163	36	14.45	33	53.41	2188			13193	69	**HYD 13**				In water			
1016	08:42	163	36	14.56	33	53.25	2196			13193	69	**HYD 13**				On bottom			
1017	09:22	163	36	14.59	33	53.39	2289			13193	69	**HYD 13**				On deck			
1018																			
1019	10:36	163	36		33					13193	70	**SAP 08**				On Station, Timer 1 On			
1020	10:39	163	36		33					13193	70	**SAP 08**				Timer 4 Started			
1021	10:42	163	36		33					13193	70	**SAP 08**				Begin Deployment			
1022	10:52	163	36		33					13193	70	**SAP 08**				Pumps 1,2 on @ 25m			
1023	10:59	163	36		33					13193	70	**SAP 08**				Pumps 3,4 on @ 50m			
1024	11:09	163	36	15.40	33	43.06	2393	0.3	323	13193	70	**SAP 08**	0			Cable On, Lowering			
1025	11:36	163	36	15.41	33	43.11	2420	0.6	333	13193	70	**SAP 08**	776						
1026	12:07	163	36	15.49	33	43.08	2459	1.0	355	13193	70	**SAP 08**	2025			Cable Out, At Depth			
1027	12:36	163	36	15.36	33	43.06	2433	0.7	356	13193	70	**SAP 08**	2025			Pumping Starts			
1028	13:07	163	36	15.34	33	43.12	2424	0.4	17	13193	70	**SAP 08**	2025			30 mins in			
1029	13:36	163	36	15.36	33	43.11	2453	0.6	30	13193	70	**SAP 08**	2025			60 mins in			
1030	14:06	163	36	15.52	33	43.03	2432	0.4	29	13193	70	**SAP 08**	2025			90 mins in			
1031	14:39	163	36	15.49	33	43.21	2451	-0.1	71	13193	70	**SAP 08**	2025			Pumping ends			
1032	14:45	163								13193	70	**SAP 08**				Hauling started			
1033	16:01	163								13193	70	**SAP 08**				All in-board			
1034																			
1035	16:30	163														Commence wire test			
1036	18:00	163														Wire test completed			
1037																			
1038	18:26	163	36	15.77	33	48.05	2777			13193	71	**HYD 14**				In water			
1039	19:58	163	36	15.64	33	48.07	2802			13193	71	**HYD 14**				At bottom			
1040	21:10	163	36	15.71	33	47.94	2786			13193	71	**HYD 14**				On deck			
1041																			
1042	22:01	163	36	14.31	33	47.33	3106			13193	72	**HYD 15**				In water			
1043	23:29	163	36	14.36	33	47.48	3079			13193	72	**HYD 15**				At bottom			
1044	00:39	163	36	14.25	33	47.40	3064			13193	72	**HYD 15**				On deck			
1045																			

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1046	01:36	164	36		33					13193	73	BGT 10			0	String in water			
1047	01:39	164	36	16.76	33	52.07	2584	0.77	236	13193	73	BGT 10	13	10	8	BGT in water			
1048	01:45	164	36	16.68	33	52.07	2548	0.56	230	13193	73	BGT 10	143	142	17	Veer @ 30m/min			
1049	02:00	164	36	16.49	33	52.20	2476	1.03	250	13193	73	BGT 10	511	514	#NUM!				
1050	02:15	164	36	16.35	33	52.34	2419	0.58	263	13193	73	BGT 10	962	977	#NUM!				
1051	02:30	164	36	16.23	33	52.44	2399	0.61	257	13193	73	BGT 10	1431	1460	#NUM!				
1052	02:45	164	36	16.11	33	52.44	2361	0.65	261	13193	73	BGT 10	1877	1910	#NUM!				
1053	02:59	164	36	16.03	33	52.51	2350	0.76	266	13193	73	BGT 10	2282	2300	#NUM!	Haul @ 40m/min			
1054	03:00	164	36	16.02	33	52.52	2335	0.72	268	13193	73	BGT 10	2245	2260	#NUM!				
1055	03:15	164	36	15.91	33	52.64	2353	0.59	267	13193	73	BGT 10	1682	1689	#NUM!	Veer @ 30m/min			
1056	03:30	164	36	15.72	33	52.76	2348	0.78	263	13193	73	BGT 10	2140	2154	#NUM!				
1057	03:34	164	36	15.69	33	52.80	2351	0.52	251	13193	73	BGT 10	2264	2270	#NUM!	Haul @ 40m/min			
1058	03:45	164	36	15.56	33	52.86	2313	0.50	254	13193	73	BGT 10	1865	1855	193				
1059	03:48	164	36	15.50	33	52.86	2295	0.57	254	13193	73	BGT 10	1723	1700	281	Veer @ 30m/min			
1060	04:00	164	36	15.39	33	52.93	2257	0.59	269	13193	73	BGT 10	2028	2004	311	Bottle 1 Fired			
1061	04:01	164	36	15.38	33	52.93	2246	0.61	269	13193	73	BGT 10	2058	2050	181	Bottle 2 Fired			
1062	04:02	164	36	15.35	33	52.93	2244	0.55	269	13193	73	BGT 10	2118	2100	276	Bottle 3 Fired			
1063	04:08	164	36	15.29	33	53.01	2233	0.78	272	13193	73	BGT 10	2272	2255	277	Haul @40			
1064	04:15	164	36	15.19	33	53.06	2227	0.48	265	13193	73	BGT 10	2013	1989	310				
1065	04:22	164	36	15.11	33	53.10	2238	0.78	266	13193	73	BGT 10	1739	1700	366	Veer @ 30			
1066	04:30	164	36	15.00	33	53.19	2218	0.61	264	13193	73	BGT 10	1978	1942	376				
1067	04:34	164	36	14.95	33	53.23	2212	0.60	256	13193	73	BGT 10	2122	2084	400	Bottle 4 Fired			
1068	04:35	164	36	14.93	33	53.23	2210	0.46	255	13193	73	BGT 10	2153	2115	403	Bottle 5 Fired			
1069	04:37	164	36	14.90	33	53.23	2214	0.60	257	13193	73	BGT 10	2185	2144	421	Haul @ 40			
1070	04:39	164	36		33					13193	73	BGT 10			0	Winch Stopped			
1071	04:41	164	36	14.84	33	53.28	2209	0.56	257	13193	73	BGT 10	2138	2081	490	SAP1 on @ 2V nephs			
1072	04:45	164	36	14.79	33	53.29	2216	0.60	257	13193	73	BGT 10	2146	2080	528				
1073	04:50	164	36		33					13193	73	BGT 10			0	Veered 10m			
1074	04:51	164	36	14.68	33	53.34	2225	0.52	255	13193	73	BGT 10	2158	2079	579				
1075	05:00	164	36	14.53	33	53.41	2199	0.33	255	13193	73	BGT 10	1845	1765	537				
1076	05:02	164	36	14.51	33	53.42	2196	0.60	261	13193	73	BGT 10	1784	1697	550				
1077	05:15	164	36	14.31	33	53.56	2169	0.49	246	13193	73	BGT 10	2184	2062	720				
1078	05:15	164	36		33					13193	73	BGT 10	2183	2077	672				
1079	05:16	164	36	14.29	33	53.56	2179	0.51	244	13193	73	BGT 10	2215	2195	297				
1080	05:26	164	36	14.11	33	53.64	2135	0.68	247	13193	73	BGT 10	1825	1700	664	Veer @ 30			
1081	05:30	164	36	14.04	33	53.70	2134	0.63	246	13193	73	BGT 10	1933	1800	705				
1082	05:44	164	36	13.80	33	53.83	2152	0.46	244	13193	73	BGT 10	2357	2168	925	Haul @ 40			
1083	05:45	164	36	13.79	33	53.85	2139	0.49	243	13193	73	BGT 10	2326	2134	925				
1084	05:57	164	36	13.59	33	53.93	2112	0.58	247	13193	73	BGT 10	1861	1698	762	Veer @ 30			
1085	06:00	164	36	13.52	33	53.94	2127	0.78	247	13193	73	BGT 10	1949	1777	801				
1086	06:10	164	36	13.35	33	53.54	2155	0.41	241	13193	73	BGT 10	2260	2050	951	Bottle 8 Fired			
1087	06:12	164	36	13.34	33	54.11	2161	0.41	241	13193	73	BGT 10	2303	2097	952	Haul @ 40m/min			

Appendix C: Operations Log

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1088	06:15	164	36	13.28	33	54.14	2173	0.47	241	13193	73	BGT 10	2181	1979	917				
1089	06:23	164	36	13.14	33	54.15	2195	0.46	241	13193	73	BGT 10	1864	1700	765	Winch Stopped			
1090	06:26	164	36	13.08	33	54.18	2219	0.64	244	13193	73	BGT 10	1864	1700	765	Veer @ 30m/min			
1091	06:33	164	36	12.96	33	54.29	2242	0.45	230	13193	73	BGT 10	2055	1872	848				
1092	06:44	164	36	12.77	33	54.37	2306	0.58	229	13193	73	BGT 10	2330	2155	886	Haul @ 40m/min			
1093	06:45	164	36	12.76	33	54.37	2310	0.57	229	13193	73	BGT 10	2319	2100	984				
1094	06:55	164	36	12.56	33	54.47	2426	0.60	230	13193	73	BGT 10	1918	1697	894	Veer @ 30m/min			
1095	07:00	164	36	12.44	33	54.54	2454	0.50	230	13193	73	BGT 10	2067	1831	959				
1096	07:15	164	36	12.13	33	54.64	2563	0.51	228	13193	73	BGT 10	2545	2257	1176				
1097	07:16	164	36	12.11	33	54.64	2598	0.48	229	13193	73	BGT 10	2571	2280	1188	Haul @40m/min			
1098	07:30	164	36	11.84	33	54.72	2597	0.50	230	13193	73	BGT 10	2024	1753	1012				
1099	07:32	164	36	11.79	33	54.73	2674	0.47	235	13193	73	BGT 10	1979	1700	1013	Veer @ 30m/min			
1100	07:45	164	36	11.54	33	54.99	2626	0.43	231	13193	73	BGT 10	2392	2048	1236				
1101	08:00	164	36	11.26	33	55.11	2564	0.33	230	13193	73	BGT 10	2834	2458	1411				
1102	08:05	164	36	11.19	33	55.16	2585	0.32	231	13193	73	BGT 10	2985	2590	1484	Haul @ 40m/min			
1103	08:15	164	36	11.01	33	55.20	2692	0.43	231	13193	73	BGT 10	2576	2236	1279				
1104	08:30	164	36	10.75	33	55.38	2802	0.63	232	13193	73	BGT 10	1953	1682	993				
1105	08:39	164	36	10.59	33	55.56	2736	0.63	232	13193	73	BGT 10	1581	1338	842	Bottle 9 fired @ 6degC			
1106	08:45	164	36	10.49	33	55.69	2737	0.70	232	13193	73	BGT 10	1348	1159	688				
1107	08:49	164	36	10.41	33	55.72	2740	0.58	232	13193	73	BGT 10	1174	1013	593	Bottle 10 fired @ 8 deg.C			
1108	08:56	164	36	10.31	33	55.80	2739	0.43	232	13193	73	BGT 10	905	826	370	Bottle 12 fired @9deg.C			
1109	09:00	164	36	10.29	33	55.87	2722	0.51	232	13193	73	BGT 10	743	702	243				
1110	09:15	164	36	10.02	33	56.14	2632	0.84	231	13193	73	BGT 10	155	156	#NUM!				
1111	09:30	164													0	BRIDGET on deck.			
1112																			
1113	10:48	164								13193	74	BGT 11			0	String in water			
1114	10:52	164								13193	74	BGT 11				Bridget in water			
1115	11:00	164	36	17.96	33	52.56	2531	0.41	226	13193	74	BGT 11	167	175	#NUM!				
1116	11:16	164	36	17.74	33	52.67	2511	0.85	231	13193	74	BGT 11	585	585	0				
1117	11:30	164	36	17.52	33	52.82	2544	0.32	229	13193	74	BGT 11	1020	1031	#NUM!				
1118	11:45	164	36	17.39	33	52.88	2586	0.22	232	13193	74	BGT 11	1498	1509	#NUM!				
1119	12:00	164	36	17.28	33	52.94	2556	0.43	241	13193	74	BGT 11	1990	2004	#NUM!				
1120	12:15	164	36	17.18	33	53.11	2527	0.47	241	13193	74	BGT 11	2498	2495	122				
1121	12:16	164	36	17.17	33	53.12	2525	0.42	241	13193	74	BGT 11	2502	2533	#NUM!	Haul @40m/min			
1122	12:30	164	36	17.11	33	53.23	2516	0.51	225	13193	74	BGT 11	1994	2020	#NUM!				
1123	12:37	164	36	17.02	33	53.27	2518	0.66	227	13193	74	BGT 11	1705	1703	83	Veer @ 30 m/min			
1124	12:45	164	36	16.89	33	53.30	2521	0.66	205	13193	74	BGT 11	1907	1905	87				
1125	13:00	164	36	16.63	33	53.31	2474	0.41	229	13193	74	BGT 11	2353	2334	298				
1126	13:04	164	36	16.62	33	53.35	2467	0.42	230	13193	74	BGT 11	2473	2447	358	Haul @40m/min.			
1127	13:15	164	36	16.48	33	53.37	2458	0.61	237	13193	74	BGT 11	2048	2031	263				
1128	13:23	164	36	16.39	33	53.49	2503	0.65	236	13193	74	BGT 11	1728	1695	336	Veer @30m/min.			
1129	13:30	164	36	16.25	33	53.55	2505	0.70	237	13193	74	BGT 11	1925	1891	360				

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	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1130	13:45	164	36	16.10	33	53.70	2522	0.49	219	13193	74	BGT 11	2380	2341	429				
1131	13:47	164	36	16.80	33	53.70	2511	0.51	217	13193	74	BGT 11	2452	2411	447	Haul @ 40m/min.			
1132	14:00	164	36	15.85	33	53.71	2533	0.55	213	13193	74	BGT 11	1954	1890	496				
1133	14:05	164	36	15.76	33	53.68	2502	0.51	222	13193	74	BGT 11	1731	1681	413	Veer @ 30 m/min			
1134	14:15	164	36	15.63	33	53.76	2508	0.76	240	13193	74	BGT 11	2013	1963	446				
1135	14:30	164	36	15.39	33	53.97	2509	0.61	234	13193	74	BGT 11	2487	2385	705				
1136	14:33	164	36	15.32	33	54.00	2669	0.51	234	13193	74	BGT 11	2579	2467	752	Haul @40m/min			
1137	14:40	164	36	15.23	33	54.03	2467	0.51	234	13193	74	BGT 11	2299	2176	742	bottle 1 fired, winch stopped and lowered 5m			
1138	14:41	164	36	15.21	33	54.05	2466	0.58	234	13193	74	BGT 11	2302	2185	725	Pump 1 ON			
1139	14:43	164	36		33					13193	74	BGT 11			0	up 10 m			
1140	14:45	164	36	15.18	33	54.09	2302	0.68	235	13193	74	BGT 11	2302	2178	745	stopped at 2302m, then down 5 m			
1141	14:51	164	36	15.03	33	54.17	2457	0.63	235	13193	74	BGT 11	2307	2171	780	Pump 1 OFF, haul @40m/min			
1142	15:00	164	36	14.88	33	54.22	2438	0.54	234	13193	74	BGT 11	1977	1854	686				
1143	15:04	164	36	14.81	33	54.27	2447	0.57	235	13193	74	BGT 11	1829	1705	662	Veer @30m/min			
1144	15:15	164	36	14.63	33	54.38	2472	0.63	233	13193	74	BGT 11	2170	2019	795				
1145	15:27	164	36	14.44	33	54.45	2488	0.32	232	13193	74	BGT 11	2528	2356	917	Haul @40m/min.			
1146	15:30	164	36	14.40	33	54.47	2477	0.30	232	13193	74	BGT 11	2407	2237	889				
1147	15:44	164	36	14.16	33	54.57	2479	0.93	236	13193	74	BGT 11	1845	1700	717	Veer @ 30m/min.			
1148	15:45	164	36	14.13	33	54.58	2510	0.85	237	13193	74	BGT 11	1880	1722	754				
1149	16:00	164	36	13.81	33	54.75	2490	0.83	235	13193	74	BGT 11	2324	2074	1049	Bottle 2 fired			
1150	16:02	164	36	13.76	33	54.78	2489	0.77	235	13193	74	BGT 11	2389	2125	1092	Winch stopped SAPS 2 on.			
1151	16:04	164	36		33					13193	74	BGT 11			0	Veer Slowly			
1152	16:08	164	36	13.62	33	54.82	2498	0.72	233	13193	74	BGT 11	2471	2165	1191	SAPS 2 off.			
1153	16:15	164	36	13.49	33	54.83	2509	0.57	235	13193	74	BGT 11	2691	2370	1275				
1154	16:16	164	36	13.47	33	54.84	2512	0.61	236	13193	74	BGT 11	2719	2399	1280	Haul @ 40m/min.			
1155	16:30	164	36	13.28	33	54.85	2490	0.45	254	13193	74	BGT 11	2167	1908	1027				
1156	16:37	164	36	13.20	33	54.92	2537	0.88	255	13193	74	BGT 11	1895	1702	833	Veer @ 30m/min.			
1157	16:45	164	36	13.10	33	55.08	2623	0.96	253	13193	74	BGT 11	2138	1960	854				
1158	17:00	164	36	12.93	33	55.29	2664	0.72	243	13193	74	BGT 11	2593	2421	929	Haul @ 40m/min.			
1159	17:09	164	36	12.78	33	55.35	2692	0.75	241	13193	74	BGT 11	2261	2100	838	Bottle 3 fired			
1160	17:14	164	36	12.72	33	55.40	2675	0.88	242	13193	74	BGT 11	2059	1900	793	Bottle 4 fired			
1161	17:15	164	36	12.70	33	55.42	2681	0.82	241	13193	74	BGT 11	2006	1850	776				
1162	17:19	164	36	12.66	33	55.48	2698	0.77	240	13193	74	BGT 11	1856	1700	745	Bottle 5 fired			
1163	17:24	164	36	12.55	33	55.53	2759	0.92	242	13193	74	BGT 11	1629	1500	635	Bottle 6 fired			
1164	17:29	164	36	12.47	33	55.61	2789	1.03	241	13193	74	BGT 11	1424	1300	581	Bottle 7 fired			
1165	17:30	164	36	12.46	33	55.62	2792	1.05	242	13193	74	BGT 11	1398	1248	630				
1166	17:34	164	36	12.38	33	55.69	2828	1.13	241	13193	74	BGT 11	1218	1100	523	Bottle 8 Fired			
1167	17:43	164	36	12.24	33	55.82	2905	1.11	241	13193	74	BGT 11	856	800	305	Bottle 9 Fired			
1168	17:49	164	36	12.15	33	55.86	2947	1.08	242	13193	74	BGT 11	626	600	179	Bottle 10 Fired			
1169	17:55	164	36	12.06	33	55.94	3135	1.08	241	13193	74	BGT 11	387	400	#NUM!	Bottle 11 fired			
1170	18:00	164	36	11.98	33	56.06	3139	1.30	242	13193	74	BGT 11	200	200	0	Bottle 12 fired			
1171	18:10	164								13193	74	BGT 11				BRIDGET on deck.			

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	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1172																			
1173	19:04	164	36		33					13193	75	BGT12				String into water.			
1174	19:05	164	36	15.19	33	58.30	2880	0.65	116	13193	75	BGT12				BGT in water			
1175	19:15	164	36	15.08	33	58.13	2906	0.40	100	13193	75	BGT12	234	238	#NUM!				
1176	19:30	164	36	14.97	33	57.93	2967	0.42	102	13193	75	BGT12	763	770	#NUM!				
1177	19:45	164	36	14.84	33	57.71	3031	0.47	069	13193	75	BGT12	1360	1358	74				
1178	20:00	164	36	14.72	33	57.44	3052	0.65	054	13193	75	BGT12	1970	1943	325				
1179	20:15	164	36	14.67	33	57.12	3194	0.49	054	13193	75	BGT12	2613	2549	575				
1180	20:28	164	36	14.54	33	56.97	3207	0.39	055	13193	75	BGT12	3182	3120	625				
1181	20:30	164	36	14.54	33	56.96	3212	0.41	049	13193	75	BGT12	3146	3088	601				
1182	20:45	164	36	14.38	33	56.75	3223	0.32	034	13193	75	BGT12	2515	2445	589				
1183	21:00	164	36	14.36	33	56.58	3223	0.37	029	13193	75	BGT12	1838	1814	296				
1184	21:03	164	36	14.35	33	56.58	3225	0.64	029	13193	75	BGT12	1714	1700	219				
1185	21:15	164	36	14.34	33	56.38	3227	0.76	031	13193	75	BGT12	2067	2059	182				
1186	21:30	164	36	14.30	33	56.22	3227	0.66	030	13193	75	BGT12	2516	2515	71				
1187	21:45	164	36	14.31	33	56.02	3200	0.60	031	13193	75	BGT12	2956	2953	133				
1188	21:51	164	36	14.28	33	55.92	3194	0.50	027	13193	75	BGT12	3141	3138	137	Haul @ 40			
1189	22:03	164	36	14.26	33	55.78	2922	0.68	025	13193	75	BGT12	2714	2700	275				
1190	22:13	164	36		33					13193	75	BGT12			0	CTD has died			
1191	22:15	164	36	14.15	33	55.64	2858	0.47	026	13193	75	BGT12	2210		2210	Recovering			
1192	23:15	164	36		33					13193	75	BGT12			0	BGT in board			
1193																			
1194	00:00	165	36		33					13193	76	BGT13				String in water			
1195	00:03	165	36	14.62	33	56.83	3214	1.01	041	13193	76	BGT13				BGT in water			
1196	00:16	165	36	14.51	33	56.65	3222	0.84	042	13193	76	BGT13	318	317	25	Veer @ 30			
1197	00:30	165	36	14.43	33	56.40	3229	0.82	044	13193	76	BGT13	691	687	74				
1198	00:41	165	36	14.33	33	56.36	3229	0.61	007	13193	76	BGT13	1022	1024	#NUM!	Veer @ 40			
1199	00:46	165	36	14.31	33	56.34	3230	0.83	006	13193	76	BGT13	1230	1256	#NUM!				
1200	01:00	165	36	14.37	33	56.27	3190	0.90	046	13193	76	BGT13	1799	1819	#NUM!				
1201	01:15	165	36	14.26	33	56.03	3206	0.91	057	13193	76	BGT13			0				
1202	01:21	165								13193	76	BGT13			0	Power fluctuations			
1203		165								13193	76	BGT13			0	Deck unit turned off, on.			
1204	01:25	165								13193	76	BGT13			0	Continuing problems			
1205	01:30	165	36	14.23	33	55.83	2938	0.88	041	13193	76	BGT13	2642		2642	Recovering BGT.			
1206	02:00	165	36	14.09	33	55.36	2775	1.00	057	13193	76	BGT13	1460		1460				
1207	02:15	165	36	13.96	33	55.16	2635	1.13	056	13193	76	BGT13	850		850				
1208	02:35	165								13193	76	BGT13			0	BGT in board			
1209																			
1210	03:00	165	36	14.27	33	53.50	2154			13193	77	HYD 16				CTD in water			
1211	04:10	165	36	14.34	33	53.57	2244			13193	77	HYD 16				CTD at bottom			
1212	05:20	165	36	14.34	33	53.75	2245			13193	77	HYD 16				CTD on deck			
1213																			

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1214	06:00	165								13193	78	BGT14			0	String in water			
1215	06:04	165	36	14.37	33	56.51	3225	0.90	060	13193	78	BGT14			0	BRIDGET in water			
1216	06:30	165	36	14.33	33	56.39	3227	0.90	046	13193	78	BGT14	839	850	#NUM!				
1217	06:45	165	36	14.26	33	56.12	3228	1.00	070	13193	78	BGT14	1497	1458	339				
1218	07:00	165	36	14.22	33	55.54	3153	1.20	070	13193	78	BGT14	2055	2043	222				
1219	07:15	165	36	14.21	33	55.40	2896	1.10	087	13193	78	BGT14	2666	2649	301				
1220	07:18	165	36	14.19	33	55.36	2870	1.10	091	13193	78	BGT14	2824	2804	335	Haul @40m/min.			
1221	07:30	165	36	14.12	33	55.30	2798	0.80	094	13193	78	BGT14	2375	2350	344				
1222	07:45	165	36	14.14	33	55.38	2722	0.80	071	13193	78	BGT14	1780	1776	119				
1223	07:47	165	36	14.11	33	55.36	2774	0.70	071	13193	78	BGT14	1701		1701	veer @30m/min			
1224	08:00	165	36	14.02	33	55.21	2652	0.80	070	13193	78	BGT14	2100	2098	92				
1225	08:13	165	36	13.91	33	55.07	2621	-0.10	059	13193	78	BGT14	2514	2503	235	Haul @40m/min			
1226	08:15	165	36	13.89	33	55.07	2615	0.00	064	13193	78	BGT14	2445	2432	252				
1227	08:30	165	36	13.88	33	54.93	2584	0.99	043	13193	78	BGT14	1855	1841	227				
1228	08:34	165	36	13.93	33	54.89	2566	0.73	050	13193	78	BGT14	1685	1697	#NUM!	Veer @ 30m/min.			
1229	08:45	165	36	13.89	33	54.76	2531	0.75	055	13193	78	BGT14	2106	2123	#NUM!				
1230	08:54	165	36	13.89	33	54.68	2436	0.43	061	13193	78	BGT14	2477	2500	#NUM!	Haul @ 40m/min.			
1231	09:00	165	36	13.85	33	54.61	2409	0.56	058	13193	78	BGT14	2259	2281	#NUM!				
1232	09:14	165	36	13.46	33	54.26	2315	0.60	055	13193	78	BGT14	1683	1695	#NUM!	Veer @ 30m/min			
1233	09:30	165	36	13.66	33	54.24	2228	0.57	058	13193	78	BGT14	2150	2155	#NUM!				
1234	09:31	165	36	13.68	33	54.23	2221	0.65	057	13193	78	BGT14	2194	2207	#NUM!	Haul @ 40m/min			
1235	09:45	165	36	13.61	33	54.04	2154	0.77	055	13193	78	BGT14	1693	1682	193	Veer @ 30m/min			
1236	10:00	165	36	13.51	33	53.90	2103	-0.01	074	13193	78	BGT14	2121	2133	#NUM!				
1237	10:01	165	36	13.52	33	53.90	2105	0.49	075	13193	78	BGT14	2150	2165	#NUM!	Haul @ 40m/min			
1238	10:13	165	36	13.46	33	53.70	2057	0.86	049	13193	78	BGT14	1700	1688	202	Veer @30m/min			
1239	10:15	165	36	13.47	33	53.66	2049	0.88	050	13193	78	BGT14	1752	1743	177				
1240	10:24	165	36	13.40	33	53.50	2023	0.18	053	13193	78	BGT14	2035	2029	156	Haul @ 40m/min			
1241	10:30	165	36	13.39	33	53.45	2015	0.68	044	13193	78	BGT14	1823	1812	200				
1242	10:33	165	36	13.39	33	53.40	1995	0.78	041	13193	78	BGT14	1696	1680	232	Veer @ 30m/min			
1243	10:43	165	36	13.44	33	53.22	1953	0.49	056	13193	78	BGT14	1973	1952	287	Haul @ 40m/min			
1244	10:45	165	36	13.42	33	53.19	1950	0.38	056	13193	78	BGT14	1913	1895	262				
1245	10:50	165	36	13.39	33	53.11	1951	0.69	056	13193	78	BGT14	1709	1692	240	Veer @ 30m/min			
1246	10:58	165	36	13.34	33	52.97	1960	0.67	055	13193	78	BGT14	1930	1903	322	HAUL @40m/min			
1247	11:01	165	36	13.31	33	52.89	1959	0.47	058	13193	78	BGT14	1810	1788	281	Bottle 1 fired			
1248	11:06	165	36	13.29	33	52.86	1955	0.32	059	13193	78	BGT14	1618	1600	241	Bottle 2 fired			
1249	11:12	165	36	13.22	33	52.79	1949	0.41	061	13193	78	BGT14	1388	1375	190	Bottle 3 fired			
1250	11:15	165	36	13.19	33	52.78	1949	0.31	061	13193	78	BGT14	1273	1254	219				
1251	11:16	165	36	13.17	33	52.76	1948	0.49	058	13193	78	BGT14	1220	1200	220	Bottle 4 fired			
1252	11:21	165	36	13.12	33	52.63	1942	0.81	048	13193	78	BGT14	1021	1000	206	Bottle 5 fired			
1253	11:26	165	36	13.15	33	52.55	1933	0.88	052	13193	78	BGT14	818	800	171	Bottle 6 fired			
1254	11:28	165	36	13.17	33	52.51	1939	0.81	052	13193	78	BGT14	721	700	173	Bottle 7 fired			
1255	11:30	165	36	13.16	33	52.47	1933	0.87	053	13193	78	BGT14	676	650	186				

Appendix C: Operations Log

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1256	11:31	165	36	13.15	33	52.43	1931	0.85	053	13193	78	BGT14	620	600	156	Bottle 8 fired			
1257	11:34	165	36	13.16	33	52.40	1934	0.83	053	13193	78	BGT14	517	500	131	Bottle 9 fired			
1258	11:36	165	36	13.16	33	52.34	1956	0.92	053	13193	78	BGT14	417	400	118	Bottle 10 fired			
1259	11:42	165	36	13.16	33	52.20	1975	0.78	044	13193	78	BGT14	206	200	49	Bottle 11 fired			
1260	11:45	165	36	13.17	33	52.16	1992	0.68	033	13193	78	BGT14	100	100	0	Bottle 12 fired			
1261	11:51	165	36	13.23	33	52.06	2022	0.73	028	13193	78	BGT14	0	0	0	On Deck			
1262																			
1263	12:49	165								13193	79	BGT15				String in water			
1264	12:51	165								13193	79	BGT15				BGT in water			
1265	13:00	165	36	15.34	33	57.46	2910	0.70	075	13193	79	BGT15	219	212	55				
1266	13:15	165	36	15.44	33	57.62	2805	0.56	045	13193	79	BGT15	596	600	#NUM!				
1267	13:30	165	36	15.45	33	57.30	2781	0.78	059	13193	79	BGT15	1039	1012	235				
1268	13:45	165	36	15.34	33	57.06	2844	0.73	055	13193	79	BGT15	1506	1477	294				
1269	14:00	165	36	15.26	33	56.80	2876	0.84	049	13193	79	BGT15	1965	1921	414				
1270	14:05	165														Incr. veer to 40			
1271	14:15	165	36	15.21	33	56.55	2909	0.85	058	13193	79	BGT15	2522	2471	505				
1272	14:20	165	36	15.22	33	56.48	2907	0.79	057	13193	79	BGT15	2712	2666	497	Haul @ 40			
1273	14:30	165	36	15.08	33	56.37	2946	0.64	057	13193	79	BGT15	2333	2282	485				
1274	14:45	165	36	15.01	33	56.14	2998	0.83	055	13193	79	BGT15	1758	1700	448	Veer @ 40			
1275	15:00	165	36	14.92	33	55.80	3020	0.82	057	13193	79	BGT15	2394	2294	685				
1276	15:15	165	36	14.84	33	55.60	2952	1.33	039	13193	79	BGT15	3018	2900	836				
1277	15:19	165	36	14.88	33	55.51	2894	1.00	049	13193	79	BGT15	3144	3030	839	Haul @ 40			
1278	15:30	165	36	14.84	33	55.30	2835	0.77	063	13193	79	BGT15	2725	2599	819				
1279	15:45	165	36	14.70	33	55.02	2658	0.95	066	13193	79	BGT15	2130	1992	754				
1280	15:53	165	36	14.64	33	54.85	2592	1.03	065	13193	79	BGT15	1807	1673	683	Veer @ 40			
1281	16:00	165	36	14.57	33	54.68	2537	1.05	079	13193	79	BGT15	2070	1927	756				
1282	16:15	165	36	14.41	33	54.39	2455	1.03	080	13193	79	BGT15	2623	2409	1038				
1283	16:19	165	36	14.31	33	54.31	2414	0.92	077	13193	79	BGT15	2791	2552	1130	Haul @ 40			
1284	16:30	165	36	14.17	33	54.13	2313	0.72	071	13193	79	BGT15	2360	2084	1107				
1285	16:42	165	36	14.09	33	53.95	2226	1.05	053	13193	79	BGT15	1900	1696	856				
1286	16:49	165	36		33					13193	79	BGT15		2016	#NUM!	Bottle 1 fired			
1287		165	36		33					13193	79	BGT15			0	Bottle 2 fired			
1288	16:51	165	36	14.08	33	53.74	2154	0.95	052	13193	79	BGT15	0	2079	#NUM!	Bottle 3 fired			
1289	16:52	165	36	14.08	33	53.72	2151	0.94	052	13193	79	BGT15	2284	2104	889	Bottle 4 fired			
1290	16:52	165	36		33					13193	79	BGT15		2125	#NUM!	Bottle 5 fired			
1291	16:56	165	36	14.09	33	53.64	2144	0.94	059	13193	79	BGT15	2467	2300	892	Haul @ 40			
1292	17:00	165	36	14.09	33	53.58	2116	0.96	068	13193	79	BGT15	2356	2198	848	Bottle 6 fired. Stopped			
1293	17:01	165	36		33					13193	79	BGT15			0	Haul @ 30			
1294	17:03	165	36		33					13193	79	BGT15		2156	#NUM!	Bottle 7			
1295	17:05	165	36		33					13193	79	BGT15		2101	#NUM!	Bottle 8			
1296	17:06	165	36		33					13193	79	BGT15		2060	#NUM!	Bottle 9			
1297	17:07	165	36		33					13193	79	BGT15		2038	#NUM!	Bottle 10			

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1298	17:09	165	36	14.01	33	53.40				13193	79	BGT15	2141	1980	815	Out of Plume			
1299	17:12	165	36		33					13193	79	BGT15			0	Haul @ 40			
1300	17:16	165	36	13.98	33	53.29	2077	0.87	064	13193	79	BGT15	1882	1736	727				
1301	17:18	165	36	13.98	33	53.26	2077	0.99	064	13193	79	BGT15	1825	1698	669	Veer @ 40			
1302	17:25	165	36		33					13193	79	BGT15			0	Slow to 30			
1303	17:26	165	36		33					13193	79	BGT15		2046	#NUM!	Bottle 11 fired			
1304	17:28	165	36		33					13193	79	BGT15		2100	#NUM!	Haul @ 40			
1305	17:30	165	36	13.95	33	53.04	2034	1.00	067	13193	79	BGT15	2170	2040	740				
1306	17:31	165	36		33					13193	79	BGT15		2024	#NUM!	Bottle 12 fired			
1307	17:40	165	36	13.90	33	52.86	1958	0.95	066	13193	79	BGT15	1770	1680	557	Veer @ 40			
1308	17:49	165	36		33					13193	79	BGT15			0	Slow to 20			
1309	17:51	165	36	13.85	33	52.66	1982	0.99	067	13193	79	BGT15	2126	2040	599	Haul @ 20			
1310	18:00	165	36	13.79	33	52.51	1992	0.95	067	13193	79	BGT15	1818	1718	595	@ Waypoint			
1311	18:15	165	36	13.71	33	52.18	2022	1.02	066	13193	79	BGT15	1211	1114	475				
1312	18:30	165	36	13.63	33	51.84	2091	1.03	066	13193	79	BGT15	583	540	220				
1313	18:50	165	36		33					13193	79	BGT15			0	BGT on deck			
1314																			
1315	20:30	165	36	05.63	33	40.92	1949	0.55	015	13193	80	CTD36				In water			
1316	21:27	165	36	05.59	33	40.96	1943	0.43	020	13193	80	CTD36				At bottom			
1317	22:28	165	36	05.76	33	41.05	1917	0.16	015	13193	80	CTD36				On deck			
1318																			
1319	00:05	166	36	14.10	33	54.12	2299	0.8	044	13193	81	CTD 37	0	0	0	In water			
1320	01:18	166	36	14.24	33	54.26	2408	0.7	041	13193	81	CTD 37				On Bottom			
1321	02:49	166	36	14.17	33	54.02	2285	0.6	025	13193	81	CTD 37				On Deck			
1322																			
1323	03:05	166	36	14.10	33	54.12	2226				82	HYD 17				In water			
1324	04:22	166	36	14.24	33	54.26	2330				82	HYD 17				On Bottom			
1325	05:45	166	36	14.17	33	54.02					82	HYD 17				On Deck			
1326																			
1327	09:04	166	36	16.86	33	51.69	2646	0.6	057	13193	83	MORE				Start Deployment			
1328	09:05	166	36		33					13193	83	MORE				Current meter 1			
1329	09:27	166	36		33					13193	83	MORE				Current meter 2			
1330	09:37	166	36		33					13193	83	MORE				Current meter 3			
1331	09:59	166	36		33					13193	83	MORE				Release			
1332	10:21	166	36	17.30	33	51.09	2890			13193	83	MORE				Anchor away			
1333																			
1334	11:25	166	36	16.25	33	54.71	2630	0.5	041	13193	84	MORD				Start Deployment			
1335	11:26	166	36		33					13193	84	MORD				Current meter 1			
1336	11:47	166	36		33					13193	84	MORD				Current meter 2			
1337	11:57	166	36		33					13193	84	MORD				Current meter 3			
1338	12:05	166	36		33					13193	84	MORD				Release			
1339	12:13	166	36	16.57	33	54.14	2520			13193	84	MORD				Anchor away			

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	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1340																			
1341	13:19	166	36	16.61	33	55.41	2217	0.6	069	13193	85	MOR A				Start Deployment			
1342	13:20	166	36		33					13193	85	MOR A				Current meter 1			
1343	13:58	166	36		33					13193	85	MOR A				Current meter 2			
1344	14:10	166	36		33					13193	85	MOR A				Current meter 3			
1345	14:20	166	36		33					13193	85	MOR A				Current meter 4 & Release			
1346	14:56	166	36	17.20	33	53.96	2420			13193	85	MOR A				Anchor away			
1347																			
1348	15:48	166	36		33					13193	86	MOR B				Start Deployment			
1349	15:50	166	36		33					13193	86	MOR B				Current meter 1			
1350	16:04	166	36		33					13193	86	MOR B				Current meter 2			
1351	16:17	166	36		33					13193	86	MOR B				Current meter 3 & release			
1352	17:04	166	36		33					13193	86	MOR B				Anchor away			
1353																			
1354	17:59	166	36		33					13193	87	SAP 09				1st timer on			
1355	18:01	166	36		33					13193	87	SAP 09				Last timer on			
1356	18:10	166	36		33					13193	87	SAP 09				SAPS 1&2 on @ 25m			
1357	18:20	166	36		33					13193	87	SAP 09				SAPS 3&4 on @ 50m			
1358	18:31	166	36	14.37	33	54.04	2375	0.6	074	13193	87	SAP 09	1			Cable attached, lowering			
1359	19:00	166	36	14.42	33	53.95	2371	0.4	072	13193	87	SAP 09	800						
1360	19:30	166	36	14.45	33	53.95	2409	0.5	082	13193	87	SAP 09	1925			Winch stopped			
1361	19:59	166	36	14.42	33	53.92	2359	0.6	085	13193	87	SAP 09	1925			Pumping starts			
1362	20:30	166	36	14.36	33	53.96	2348	0.2	073	13193	87	SAP 09	1925			30 mins in			
1363	21:00	166	36	14.43	33	53.98	2380	0.7	095	13193	87	SAP 09	1925			1 hr in			
1364	21:30	166	36	14.37	33	53.88	2353	0.2	084	13193	87	SAP 09	1925			1.5 hr In			
1365	22:01	166	36	14.38	33	53.94	2353	0.2	085	13193	87	SAP 09	1925			Pumping Ends			
1366	23:02	166	36		33					13193	87	SAP 09				End of Cable			
1367	23:17	166	36		33					13193	87	SAP 09				3,4 on deck			
1368	23:23	166	36		33					13193	87	SAP 09				1,2 on deck			
1369	23:24	166	36		33					13193	87	SAP 09				Finished			
1370																			
1371	23:43	166	36	14.19	33	53.87	2235			13193	87	HYD 18				In water			
1372	00:54	167	36	14.21	33	53.85	2307			13193	88	HYD 18				At Bottom			
1373	01:57	167	36	14.00	33	53.00				13193	88	HYD 18				On Deck			
1374																			
1375	02:44	167								13193	89	SAP 10				Timer 1 on, Weight in Water			
1376	02:48	167								13193	89	SAP 10				Last Timer On			
1377	02:50	167								13193	89	SAP 10				SAPS 1,2 on at 25m			
1378	02:57	167								13193	89	SAP 10				SAPS 3,4 on at 50m			
1379	03:08	167	36	13.99	33	54.39	2508	0.2	050	13193	89	SAP 10	1			Cable Attached, Lowering			
1380	04:00	167	36		33					13193	89	SAP 10	1925			At Depth			
1381	04:44	167	36	14.01	33	54.55	2517	0.6	069	13193	89	SAP 10	1925			Pumping Starts			

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1382	05:14	167	36	14.02	33	54.49	2461	0.2	064	13193	89	SAP 10	1925			30 min pumping			
1383	05:44	167	36	13.98	33	54.48	2452	0.1	086	13193	89	SAP 10	1925			1 hr pumping			
1384	06:14	167	36	13.94	33	54.47	2474	0.6	080	13193	89	SAP 10	1925			1.5 hr pumping			
1385	06:48	167	36	14.04	33	54.51	2497	0.2	076	13193	89	SAP 10	1925			Pumping ends, begin hauling			
1386	07:39	167								13193	89	SAP 10	1925			Cable Up			
1387	07:55	167								13193	89	SAP 10	1925			3, 4 on deck			
1388	08:02	167								13193	89	SAP 10	1925			1, 2 on deck			
1389	08:03	167								13193	89	SAP 10	1925			Weight in board			
1390																			
1391	08:47	167	36	13.70	33	51.61	2150	0.4	089	13193	90	MOR C				Start deployment			
1392	08:49	167								13193	90	MOR C				CM1			
1393	09:05	167								13193	90	MOR C				CM2			
1394	09:13	167	36	13.64	33	51.17	2228			13193	90	MOR C				CM3+release			
1395	09:35	167	36	13.60	33	50.68	2400			13193	90	MOR C				Weight away			
1396	09:54	167	36	13.59	33	50.56				13193	90	MOR C				On bottom			
1397																			
1398	10:32	167	36	11.81	33	48.70	2445	0.2	095	13193	91	MOR H				Start deployment			
1399	10:34	167								13193	91	MOR H				CM1			
1400	10:48	167	36	11.75	33	48.43	2405	0.5	097	13193	91	MOR H				CM2			
1401	10:58	167	36	11.72	33	48.27	2381			13193	91	MOR H				CM3+release			
1402	11:22	167	36	11.83	33	47.98	2450			13193	91	MOR H				Weight away			
1403																			
1404	12:44	167	36	14.92	33	55.37	2860	0.8		13193	92	MOR G				Start deployment			
1405	12:45	167	36		33					13193	92	MOR G				CM1			
1406	13:04	167	36	14.89	33	54.95	2676	0.9	094	13193	92	MOR G				CM2			
1407	13:13	167	36	14.77	33	54.69	2574	1.0	108	13193	92	MOR G				CM3+release			
1408	13:39	167	36	14.66	33	54.02	2410	0.7	134	13193	92	MOR G				Weight away			
1409																			
1410	15:44	167	36	25.81	33	39.65	2494	1.1	128	13193	93	MOR F				Start deployment			
1411	15:45	167	36		33					13193	93	MOR F				CM1			
1412	15:59	167	36	25.57	33	39.46	2552	0.8	124	13193	93	MOR F				CM2			
1413	16:08	167	36	25.49	33	39.40	2556	0.7	121	13193	93	MOR F				CM3			
1414	16:13	167	36		33					13193	93	MOR F				Release			
1415	16:46	167	36	25.41	33	38.68	2650			13193	93	MOR F				Weight away			
1416																			
1417																			
1418	19:02									13193	94	BGT16				String in water			
1419	19:04	167	36	11.00	33	45.44	1832	0.9	035	13193	94	BGT16				BGT in water			
1420	19:15	167	36	11.19	33	45.44	1917	0.7	019	13193	94	BGT16	261	257	45.519				
1421	19:30	167	36	11.38	33	45.47	1983	0.5	004	13193	94	BGT16	714	710	75.472				
1422	19:45	167	36	11.59	33	45.49	2043	0.6	030	13193	94	BGT16	1179	1170	145.4				

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	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1423	20:00	167	36	11.83	33	45.41	2084	0.2	040	13193	94	BGT16	1684	1651	331.75				
1424	20:09	167	36	11.95	33	45.30	2095	0.8	044	13193	94	BGT16	2075	2022	465.98	Haul @ 40m/min. Inc speed to 1.5 knots			
1425	20:16	167	36	12.12	33	45.24	2358	1.0	040	13193	94	BGT16	1792	1699	569.79				
1426	20:30	167	36	12.40	33	45.12				13193	94	BGT16		2121	#NUM!				
1427	20:31	167	36	12.50	33	45.02	2308	0.8	031	13193	94	BGT16	2404	2169	1036.7				
1428	20:42	167	36	12.77	33	44.89	2610	1.0	026	13193	94	BGT16	1994	1694	1051.9	Veer @ 40m/min.			
1429	20:45	167	36	12.85	33	44.85	2604	1.2	026	13193	94	BGT16	2106	1770	1141.2				
1430	20:50	167	36	12.97	33	44.81	2595	1.1	027	13193	94	BGT16	2300	1933	1246.4	Bottle 1 fired.			
1431	21:00	167	36	13.22	33	44.76	2593	1.0	027	13193	94	BGT16	2698	2275	1450.4				
1432	21:02	167	36	13.24	33	44.75	2591	1.0	027	13193	94	BGT16	2750	2313	1487.5	Haul @ 40m/min.			
1433	21:15	167	36	13.57	33	44.63	2674	1.0	031	13193	94	BGT16	2208	1748	1349				
1434	21:16	167	36	13.61	33	44.60	2686	1.0	032	13193	94	BGT16	2156	1698	1328.6	Veer @ 40m/min.			
1435	21:23	167	36	13.79	33	44.50	2755	1.2	035	13193	94	BGT16	2434	1926	1488.2				
1436	21:30	167	36	13.96	33	44.44	2928	1.0	034	13193	94	BGT16	2928	2172	1963.6				
1437	21:39	167	36	14.14	33	44.37	2914	0.8	034	13193	94	BGT16	3094	2518	1797.9	Haul @ 40m/min.			
1438	21:45	167	36	14.27	33	44.31	2912	0.9	035	13193	94	BGT16	2844	2269	1714.6				
1439	22:00	167	36	14.63	33	44.15	2929	1.1	037	13193	94	BGT16	2273	1747	1454.1				
1440	22:01	167	36	14.66	33	44.12	2935	1.1	037	13193	94	BGT16	2222	1701	1429.6	Veer @ 40m/min.			
1441	22:14	167	36		33					13193	94	BGT16		2120	#NUM!	CTD2 Alive			
1442	22:15	167	36	14.99	33	43.89	2721	1.0	037	13193	94	BGT16	2740	2126	1728.5	CTD2 Dead			
1443	22:30	167	36	15.38	33	43.78	2744	0.9	037	13193	94	BGT16	3332	2656	2011.9				
1444	22:35	167	36	15.47	33	43.71	2740	0.9	036	13193	94	BGT16	3532	2837	2103.9	Haul @ 40m/min.			
1445	22:45	167	36	15.69	33	43.62	2737	0.9	040	13193	94	BGT16	3129	2453	1942.5				
1446	22:58	167	36	15.97	33	43.46	2537	1.0	040	13193	94	BGT16	2595	2003	1649.9	Bottle 3 fired			
1447	22:59	167	36	16.00	33	43.44	2548	1.1	040	13193	94	BGT16	2534	1955	1612.2	Bottle 4 fired			
1448	23:00	167	36	16.01	33	43.43	2575	1.0	040	13193	94	BGT16	2513	1908	1635.5				
1449	23:07	167	36	16.14	33	43.30	2588	1.1	036	13193	94	BGT16	2233	1701	1446.7				
1450	23:15	167	36	16.33	33	43.20	2532	0.9	035	13193	94	BGT16	2578	2043	1572.3				
1451	23:30	167	36	16.63	33	43.03	2415	1.0	032	13193	94	BGT16	3189	2605	1839.5	Haul @ 40 m/min.			
1452	23:45	167	36	17.02	33	42.90	2450	1.2	032	13193	94	BGT16	2602	2007	1656				
1453	23:54	167	36	17.23	33	42.82	2374	1.2	032	13193	94	BGT16	2255	1699	1482.7	Veer @ 40m/min.			
1454																			
1455	00:00	168	36	17.39	33	42.75	2477	1.3	031	13193	94	BGT16	2494	1911	1603				
1456	00:01	168	36	17.42	33	42.73	2421	1.1	033	13193	94	BGT16	2555	1960	1639	Bottle 5 fired			
1457	00:15	168	36	17.81	33	42.62	2652	1.0	034	13193	94	BGT16	3067	2400	1910	Haul @ 40m/min.			
1458	00:30	168	36	18.11	33	42.49	2668	1.1	043	13193	94	BGT16	2472	1851	1638				
1459	00:35	168	36	18.25	33	42.43	2700	1.2	043	13193	94	BGT16	2259	1681	1509	Veer @40m/min			
1460	00:44	168	36	18.49	33	42.29	2704	1.3	042	13193	94	BGT16	2598	1960	1705	Bottle 6 fired			
1461	00:45	168	36	18.52	33	42.29	2706	1.4	043	13193	94	BGT16	2638	1990	1732				
1462	01:02	168	36	18.97	33	42.09	2679	1.1	043	13193	94	BGT16	3313	2506	2167				
1463	01:03	168	36	19.00	33	42.08	2675	1.1	042	13193	94	BGT16	3350	2536	2189	Haul @ 40m/min			
1464	01:15	168	36	19.27	33	41.95	2599	1.1	047	13193	94	BGT16	2888	2098	1985				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1465	01:27	168	36	19.59	33	41.75	2711	1.5	046	13193	94	BGT16	2443	1702	1753	Veer @ 40m/min			
1466	01:30	168	36	19.67	33	41.69	2595	1.5	044	13193	94	BGT16	2562	1804	1819				
1467	01:36	168	36	19.86	33	42.56	2620	1.3	042	13193	94	BGT16	2802	1971	1992	Bottle 7 Fired			
1468	01:45	168	36	20.08	33	41.38	2786	1.1	042	13193	94	BGT16	3167	2273	2205				
1469	01:51	168	36	20.21	33	41.38	2745	0.9	026	13193	94	BGT16	3439	2549	2309	Haul @ 40m/min			
1470	02:00	168	36	20.34	33	41.31	2774	0.9	025	13193	94	BGT16	3124	2284	2131				
1471	02:15	168	36	20.69	33	41.21	2755	1.4	033	13193	94	BGT16	2526	1875	1693				
1472	02:20	168	36	20.83	33	41.15	2752	1.3	034	13193	94	BGT16	2324	1700	1585	Veer @ 40m/min			
1473	02:28	168	36	21.04	33	41.06	2745	1.4	033	13193	94	BGT16	2611	1970	1714	Bottle 8 Fired			
1474	02:30	168	36	21.08	33	41.05	2687	1.3	032	13193	94	BGT16	2663	2014	1742				
1475	02:45	168	36	21.45	33	40.96	2683	1.0	035	13193	94	BGT16	3280	2568	2041	Haul @ 40m/min			
1476	03:00	168	36	21.75	33	40.87	2721	1.2	048	13193	94	BGT16	2860	2226	1796				
1477	03:15	168	36	22.06	33	40.59	2659	1.3	048	13193	94	BGT16	2278	1713	1502	Veer @ 40m/min			
1478	03:22	168	36	22.25	33	40.46	2625	1.2	042	13193	94	BGT16	2560	1970	1635	Bottle 9 Fired			
1479	03:30	168	36	22.39	33	40.35	2618	1.1	042	13193	94	BGT16	2871	2252	1781				
1480	03:38	168	36	22.58	33	40.29	2589	0.9	038	13193	94	BGT16	3217	2603	1890	Haul @ 40m/min			
1481	03:41	168	36	22.62	33	40.28	2605	0.9	037	13193	94	BGT16	3158	2538	1879	Bottle 10 Fired			
1482	03:45	168	36	22.69	33	40.29	2611	0.8	042	13193	94	BGT16	3005	2418	1784				
1483	04:00	168	36	23.00	33	40.15	2604	1.1	040	13193	94	BGT16	2384	1926	1405				
1484	04:07	168	36	23.15	33	40.09	2601	1.3	040	13193	94	BGT16	2132	1700	1287	Veer @ 40m/min			
1485	04:15	168	36	23.33	33	39.99	2571	1.1	039	13193	94	BGT16	2431	1956	1444				
1486	04:30	168	36	23.71	33	39.85	2615	1.1	039	13193	94	BGT16	3008	2438	1762				
1487	04:33	168	36	23.80	33	39.82	2628	1.3	040	13193	94	BGT16	3123	2535	1824	Haul @ 40m/min			
1488	04:46	168	36	24.14	33	39.71	2611	1.2	043	13193	94	BGT16	2626	1979	1726				
1489	04:53	168	36	24.35	33	39.62	2621	1.1	047	13193	94	BGT16	2347	1700	1618	Veer @ 40m/min			
1490	05:00	168	36	24.51	33	39.54	2634	1.3	051	13193	94	BGT16	2564	1956	1658				
1491	05:15	168	36	24.87	33	39.33	2639	1.2	052	13193	94	BGT16	3187	2437	2054				
1492	05:19	168	36	25.02	33	39.27	2652	1.0	053	13193	94	BGT16	3363	2584	2152	Haul @ 40m/min			
1493	05:30	168	36	25.25	33	39.17	2608	1.3	027	13193	94	BGT16	2952	2153	2020				
1494	05:32	168	36	25.35	33	39.16	2607	1.1	026	13193	94	BGT16	2869	2050	2007	Bottle 11 Fired			
1495	05:34	168	36	25.42	33	39.16	2587	1.2	025	13193	94	BGT16	2788	1970	1973	Bottle 12 Fired			
1496	05:45	168	36	25.79	33	39.11	2557	1.2	024	13193	94	BGT16	2367	1576	1766				
1497	05:52	168	36		33					13193	94	BGT16		1470	#NUM!	CTD2 Begins Working			
1498	06:00	168	36	26.34	33	39.03	2528	1.4	024	13193	94	BGT16	1779	1090	1406				
1499	06:15	168	36	26.93	33	38.89	2521	1.6	024	13193	94	BGT16	1177	668	969				
1500	06:31	168	36	27.58	33	38.74	2590	1.3	024	13193	94	BGT16	560	342	443				
1501	06:51	168								13193	94	BGT16			0	BGT on deck			
1502	06:53	168								13193	94	BGT16				All in-board			
1503																			
1504	08:25	168	36	17.56	33	47.64	2869			13193	95	HYD 19				CTD in water			
1505	09:51	168	36	17.58	33	47.53	2864			13193	95	HYD 19				CTD at bottom			
1506	11:20	168	36	17.62	33	47.48	2878			13193	95	HYD 19				CTD on deck			

Appendix C: Operations Log

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1507																			
1508	12:41	168	36	20.49	33	44.52	2707			13193	96	**HYD 20**				CTD in water			
1509	14:04	168	36	20.57	33	44.79	2759			13193	96	**HYD 20**				CTD at bottom			
1510	15:31	168	36	20.52	33	44.51	2697			13193	96	**HYD 20**				CTD on deck			
1511																			
1512	16:48	168	36	26.27	33	38.97	2550			13193	97	**CTD 38**				CTD in water			
1513	17:52	168	36	26.25	33	38.83	2635			13193	97	**CTD 38**				CTD at bottom			
1514	19:12	168	36	26.28	33	38.69	2594	0.6	115	13193	97	**CTD 38**				CTD on deck			
1515																			
1516	20:03	168	36	23.15	33	40.96	2669		027	13194		**RMT01-03**				NETS IN THE WATER			
1517	20:30	168	36		33					13194			939	320	883				
1518	20:45	168	36		33					13194					0	A/c 010 degrees			
1519	21:00	168	36	25.92	33	40.08				13194			1865	900	1633				
1520	21:30	168	36	27.37	33	39.81				13194			2766	1373	2401	A/c to orig. waypoint			
1521	22:00	168	36	28.68	33	39.29				13194			3683	1830	3196				
1522	22:22	168	36	29.71	33	38.74				13194	01	**RMT01**	4362	2100	3823	NET 1 OPEN			
1523	22:45	168	36		33					13194	01	**RMT01**	4662	2110	4157				
1524	23:00	168	36	31.41	33	38.09				13194	01	**RMT01**	4813	2131	4316				
1525	23:30	168	36	32.78	33	37.56	2768	2.0	022	13194	01	**RMT01**	4813	2068	4346				
1526	00:00	169	36	34.15	33	37.07				13194	01	**RMT01**	4897	2072	4437				
1527	00:22	169	36	35.17	33	36.67				13194	02	**RMT02**	4897	2089	4429	NET 2 OPEN			
1528	01:00	169	36	36.81	33	36.14		2.0	014	13194	02	**RMT02**	4897	2150	4400				
1529	01:30	169	36	38.14	33	35.17		2.1	013	13194	02	**RMT02**	4770	2100	4283				
1530	02:00	169	36	39.60	33	35.30		2.1	027	13194	02	**RMT02**	4908	2050	4459				
1531	02:22	169	36	40.87	33	34.67		2.0	018	13194	03	**RMT03**	5054	2056	4617	NET 3 OPEN			
1532	03:00	169	36	42.35	33	34.02				13194	03	**RMT03**	5128	2051	4700				
1533	03:30	169	36	43.62	33	33.48				13194	03	**RMT03**	4996	2072	4546				
1534	03:41	169	36	44.03	33	33.34				13194	03	**RMT03**	4822	2044	4367	NET 3 CLOSED			
1535	06:26	169								13194	03	**RMT03**				All in-board			
1536																			
1537	08:44	169	36	34.00	33	24.04				13195	01	**HYD01**				In water			
1538	10:15	169	36	33.99	33	25.04				13195	01	**HYD01**				At bottom			
1539	11:30	169	36	34.04	33	24.00				13195	01	**HYD01**				On deck			
1540																			
1541	12:31	169	36	36.40	33	22.48				13195	02	**HYD02**				In water			
1542	13:55	169	36	36.52	33	22.64				13195	02	**HYD02**				At bottom			
1543	15:02	169	36	36.17	33	22.52				13195	02	**HYD02**				On deck			
1544																			
1545	16:08	169	36	39.50	33	21.05				13195	03	**HYD03**				In water			
1546	17:25	169	36	39.55	33	21.01				13195	03	**HYD03**				At bottom			
1547	18:13	169	36	39.50	33	20.93				13195	03	**HYD03**				On deck			
1548																			

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1549						STATIONB 13196: FAMOUS													
1550																			
1551	19:25	169	36	32.63	33	22.66				13196		RMT01-03				NETS IN THE WATER			
1552	20:00	169	36	34.22	33	22.04				13196					0				
1553	20:30	169	36		33					13196			1918	840	1724				
1554	21:00	169	36	37.29	33	20.68				13196			2849	1352	2508				
1555	21:30	169	36	38.52	33	20.11				13196			3788	1908	3272				
1556	21:45	169	36	39.13	33	19.82				13196	01	RMT01	4234	2188	3625	NET 1 OPEN			
1557	22:00	169	36	39.72	33	19.56				13196	01	RMT01	4363	2129	3808				
1558	22:30	169	36	41.03	33	18.98				13196	01	RMT01	4534	2077	4030				
1559	23:00	169	36		33					13196	01		4534	2065	4036				
1560	23:30	169	36	43.56	33	17.88				13196	01	RMT01	4534	2085	4026				
1561	23:45	169	36	44.15	33	17.65				13196	02	RMT02	4421	2070	3906	NET 2 OPEN			
1562																			
1563	00:00	170	36	44.77	33	17.34				13196	02	RMT02	4421	2084	3899				
1564	00:30	170	36	46.08	33	16.82				13196	02	RMT02	4421	2063	3910				
1565	01:00	170	36	47.41	33	16.21				13196	02	RMT02	4421	2011	3937				
1566	01:30	170	36	48.64	33	15.64				13196	02	RMT02	4593	2096	4087				
1567	01:46	170	36	49.28	33	15.31				13196	03	RMT03	4593	2105	4082	NET 3 OPEN			
1568	02:00	170	36	49.89	33	14.98				13196	03	RMT03	4593	2079	4096				
1569	02:30	170	36	51.15	33	14.46				13196	03	RMT03	4593	2072	4099				
1570	03:00	170	36	52.50	33	13.84				13196	03	RMT03	4711	2138	4198				
1571	03:30	170	36	53.65	33	13.22				13196	03	RMT03	4623	2105	4116				
1572	03:45	170	36	54.25	33	12.90				13196	03	RMT03	4623	2082	4128	NET 3 CLOSED			
1573																			
1574	09:51	170	36	31.74	33	25.77	2741			13195	04	HYD04				In water			
1575	11:12	170	36	31.68	33	24.66	2787			13195	04	HYD04				At bottom			
1576	12:10	170	36	31.75	33	24.69	2768			13195	04	HYD04				On deck			
1577																			
1578	13:13	170	36	35.30	33	27.73	2173			13195	05	HYD05				In water			
1579	14:22	170	36	35.58	33	27.80	2151			13195	05	HYD05				At bottom			
1580	15:16	170	36	35.30	33	27.91	2215			13195	05	HYD05				On deck			
1581																			
1582	16:16	170	36	33.08	33	25.76	2350			13195	06	HYD06				In water			
1583	17:26	170	36	33.16	33	25.91	2310			13195	06	HYD06				At bottom			
1584	18:23	170	36	33.28	33	25.74	2284			13195	06	HYD06				On deck			
1585																			
1586						NORTH FAMOUS SITE: 13197													
1587	22:10	170	36	58.07	32	59.56		2.1	052	13197		RMT01-03				NETS IN WATER			
1588	00:27	171	37	01.84	32	52.58	2819	1.9	042	13197	01	RMT01	4085	2100	3504	NET 1 OPEN			
1589	00:57	171	37	02.61	32	51.02	2845	2.2	051	13197	01		4600	2082	4102				
1590	01:27	171	37	03.36	32	49.42	2780	2.1	054	13197	01		4767	2058	4300				

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	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1591	01:57	171	37	04.08	32	47.87	2820	2.0	057	13197	01		4767	2025	4316				
1592	02:27	171	37	04.74	32	46.24	2970	2.0	055	13197	02	RMT02	4985	2117	4513	NET 2 OPEN			
1593	02:57	171	37	05.40	32	44.93	2878	1.8	042	13197	02		4815	2187	4290				
1594	03:30	171	37	06.28	32	43.46	2852	2.1	048	13197	02		4660	2140	4140				
1595	04:00	171	37	06.86	32	42.07		2.0	063	13197	02		4460	2129	3919				
1596	04:27	171	37	07.28	32	40.55	2994	1.9	057	13197	03		4395	2077	3873	SIGNAL SENT			
1597	04:35	171								13197						HAUL IN			
1598	07:15					NET 2 FAILED TO CLOSE										ALL INBOARD			
1599																			
1600																			
1601																			
1602	08:51	171	37	01.93	32	40.10			066	13198		RMT01-03				NETS IN WATER			
1603	11:00		37	03.35	32	33.14				13198	01	RMT01	3774	2180	3081	NET 1 OPEN			
1604	11:30		37	03.83		31.53			075	13198	01	RMT01	4035	2025	3490				
1605	12:00			04.11		29.67			075	13198	01	RMT01	4445	2000	3970				
1606	12:30			04.40		28.03	2792	1.9	074	13198	01	RMT01	4744	2161	4223				
1607	13:00	171	37	04.66	32	26.47		1.7	074	13198	02	RMT02	4440	2100	3912	NET 2 OPEN			
1608	13:30			04.90		24.88	2772	1.8	063	13198	02	RMT02	4440	2105	3909				
1609	14:00	171	37	05.40	32	23.39	2653	1.7	063	13198	02	RMT02	4440	2050	3938				
1610	14:30	171	37	05.84	32	21.62	2900	1.5	065	13198	02	RMT02	4646	2105	4142				
1611	15:00	171	37	06.23	32	19.86	2892	1.7	076	13198	03	RMT03	4708	2055	4236	NET 3 OPEN			
1612	15:30	171	37	06.40	32	18.34	2668	1.9	077	13198	03	RMT03	4670	2103	4170				
1613	16:00	171	37	06.56	32	17.05	2678	1.6	072	13198	03	RMT03	4342	2138	3779				
1614	16:30	171	37	06.79	32	15.74	2520	1.7	072	13198	03	RMT03	3979	2040	3416				
1615	17:00	171	37	07.44	32	14.39	2401	2.0	072	13198	03	RMT03	3979	2030	3422	NET 3 CLOSED			
1616	19:20														0	ALL IN			
1617																			
1618	20:59	171	37	06.09	32	26.04	2472			13198	04	HYD01				CTD in water			
1619	22:12	171	37	06.06	32	26.02	2463			13198	04	HYD01				CTD at bottom			
1620	23:02	171	37	06.11	32	26.02	2460			13198	04	HYD01				CTD on deck			
1621																			
1622	00:03	172	37	01.53	32	31.39	2355			13198	05	HYD02				CTD in water			
1623	01:15	172	37	01.65	32	31.34	2345			13198	05	HYD02				CTD at bottom			
1624	02:05	172	37	01.71	32	31.32	2350			13198	05	HYD02				CTD on deck			
1625																			
1626	03:33	172	37	06.25	32	20.88			016	13198	06	RMT04-06			0	NETS IN WATER			
1627	04:30	172	37		32					13198	06		1580	859	1326				
1628	05:00	172	37		32				007	13198	06		2502	1232	2178				
1629	05:30	172	37	11.19	32	19.61			016	13198	06		3335	1882	2753				
1630	05:44	172	37	11.76	32	19.38			016	13198	06	RMT04	3719	2103	3067	NET 1 OPEN			
1631	06:00	172	37	12.48	32	19.09				13198	06	RMT04	3898	1969	3364				
1632	06:30	172	37	13.88	32	18.59			021	13198	06	RMT04	4499	2030	4015				

Appendix C: Operations Log

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1633	07:00	172	37	15.24	32	18.08				13198	06	RMT04	4658	2000	4207				
1634	07:27	172	37	16.30	32	17.42				13198	07	RMT05	4370	1900	3935	NET 2 OPEN			
1635	08:00	172	37	17.72	32	16.85	1590	2.2	011	13198	07	RMT05	3904	1627	3549				
1636	08:30	172	37	19.14	32	16.45	1843	2.5	013	13198	07	RMT05	3492	1514	3147				
1637	09:00	172	37	20.48	32	16.04	2155			13198	07	RMT05	3660	1612	3286				
1638	09:30	172	37	21.79	32	15.47	2344	2.3	021	13198	08	RMT06	4119	1900	3655	NET 3 OPEN			
1639	10:00	172	37		32					13198	08	RMT06	4435	2117	3897				
1640	10:30	172	37	24.23	32	14.37	2765	2.2		13198	08	RMT06	4435	2105	3904				
1641	11:00	172	37	25.44	32	13.83	2860	2.0	016	13198	08	RMT06	4292	2063	3764				
1642	11:30	172	37	26.88	32	13.29	2929	2.3	017	13198	08	RMT06	4292	1850	3873	NET 3 CLOSED			
1643	13:56	172	37		32					13198	08	RMT06			0	ALL INBOARD			
1644																			
1645	17:31	172	37	17.54	32	16.53		0.2		13198	09	CTD01				In water			
1646	18:20	172	37	17.45	32	16.98	1654	0.7	048	13198	09	CTD01				At bottom			
1647	19:17	172	37	17.52	32	16.78	1705	0.6	043	13198	09	CTD01				On deck			
1648																			
1649	19:44	172	37	18.53	32	16.44		0.6	171.4	13198	10	BGT01			0	BRIDGET deployed.			
1650	20:00	172	37	18.36	32	16.54	1745	0.8	193	13198	10	BGT01	441	441	0				
1651	20:15	172	37	18.17	32	16.61	1685	0.6	194	13198	10	BGT01	874	869	93				
1652	20:30	172	37	18.00	32	16.71	1638	0.7	180	13198	10	BGT01	1307	1299	144				
1653	20:41	172	37	17.95	32	16.70	1627	0.6	176	13198	10	BGT01	1615	1607	161	Haul @ 40m/min.			
1654	20:45	172	37	17.89	32	16.71	1603	0.5	172	13198	10	BGT01	1445	1441	107				
1655	20:46	172	37	17.86	32	16.71	1627	0.5	172	13198	10	BGT01	1400	1391	158	Veer @ 40m/min			
1656	20:51	172	37	17.86	32	16.71	1631	0.4	172	13198	10	BGT01	1582	1580	80	Haul @ 40m/min.			
1657	20:56	172	37	17.84	32	16.74	1655	0.5	172	13198	10	BGT01	1400	1391	158	Veer @ 40m/min.			
1658	21:00	172	37	17.79	32	16.76	1654	0.5	171	13198	10	BGT01	1568	1566	79				
1659	21:01	172	37	17.79	32	16.76	1650	0.5	171	13198	10	BGT01	1589	1585	113	Haul @ 40m/min.			
1660	21:06	172	37	17.74	32	16.77	1651	0.6	172	13198	10	BGT01	1394	1390	106	Veer @ 30m/min.			
1661	21:11	172	37	17.68	32	16.77	1648	0.6	167	13198	10	BGT01	1573	1570	97	Haul @ 30m/min.			
1662	21:15	172	37	17.67	32	16.80	1658	0.5	167	13198	10	BGT01	1437	1436	54				
1663	21:16	172	37	17.66	32	16.81	1669	0.5	167	13198	10	BGT01	1398	1395	92	Veer @ 30m/min.			
1664	21:24	172	37	17.60	32	16.79	1727	0.5	167	13198	10	BGT01	1601	1595	138	Haul @ 30m/min.			
1665	21:30	172	37	17.54	32	16.82	1688	0.5	167	13198	10	BGT01	1402	1398	106	Veer @ 30m/min.			
1666	21:37	172	37	17.50	32	16.84	1694	0.5	167	13198	10	BGT01	1586	1580	138	Haul @ 30m/min,			
1667	21:43	172	37	17.44	32	16.84	1721	0.7	166	13198	10	BGT01	1403	1392	175	Veer @ 30m/min.			
1668	21:45	172	37	17.38	32	16.83	1651	0.8	168	13198	10	BGT01	1457	1440	222				
1669	21:53	172	37	17.28	32	16.84	1677	0.9	179	13198	10	BGT01	1677	1631	390	Haul @ 30m/min.			
1670	22:00	172	37	17.15	32	16.87	1567	1.0	188	13198	10	BGT01	1454	1379	461	Veer @ 30m/min.			
1671	22:10	172	37	16.98	32	16.96	1569	1.0	192	13198	10	BGT01	1757	1629	658	Haul @ 30m/min.			
1672	22:15	172	37	16.89	32	17.02	1586	1.1	188	13198	10	BGT01	1627	1484	667				
1673	22:18	172	37	16.84	32	17.02	1604	1.0	187	13198	10	BGT01	1549	1396	671	Veer @ 30m/min.			
1674	22:23	172	37	16.76	32	17.07	1658	1.1	187	13198	10	BGT01	1684	1512	741	Haul @ 30m/min.			

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	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1675	22:26	172	37	16.70	32	17.05	1779	1.1	187	13198	10	BGT01	1574	1393	733	Veer @ 30m/min.			
1676	22:30	172	37	16.62	32	17.09	1771	1.2	187	13198	10	BGT01	1664	1469	782	Haul @ 30m/min.			
1677	22:32	172	37	16.55	32	17.08	1768	1.2	191	13198	10	BGT01	1620	1396	822	Veer @ 30m/min.			
1678	22:37	172	37	16.46	32	17.10	1778	1.4	192	13198	10	BGT01	1739	1478	916	Haul @ 30m/min.			
1679	22:39	172	37	16.41	32	17.11	1770	1.3	196	13198	10	BGT01	1690	1398	950	Veer @ 30m/min.			
1680	22:45	172	37	16.26	32	17.18	1784	1.5	196	13198	10	BGT01	1873	1507	1112				
1681	22:52	172	37	16.06	32	17.24	1784	1.5	199	13198	10	BGT01	2085	1635	1294	Haul @ 30m/min.			
1682	22:59	172	37	15.88	32	17.33	1804	1.5	199	13198	10	BGT01	1896	1397	1282	Veer @ 30m/min.			
1683	23:00	172	37	15.85	32	17.34	1776	1.6	200	13198	10	BGT01	1924	1428	1289				
1684	23:12	172	37	15.54	32	17.49	1827	1.3	201	13198	10	BGT01	2304	1694	1562	Haul @ 30m/min.			
1685	23:15	172	37	15.49	32	17.50	1879	1.3	198	13198	10	BGT01	2207	1583	1538				
1686	23:21	172	37	15.34	32	17.52	1878	1.5	202	13198	10	BGT01	2005	1394	1441	Veer @ 30m/min.			
1687	23:30	172	37	15.07	32	17.62	1859	1.4	201	13198	10	BGT01	2265	1561	1641				
1688	23:39	172	37	14.82	32	17.65	1926	1.4	198	13198	10	BGT01	2516	1742	1815	Haul @ 30m/min.			
1689	23:45	172	37	14.69	32	17.71	1956	1.5	202	13198	10	BGT01	2330	1549	1741				
1690	23:51	172	37	14.43	32	17.74	2000	1.6	206	13198	10	BGT01	2159	1397	1646	Veer @ 30m/min.			
1691	00:00	173	37	14.24	32	17.88	2023	1.56	213	13198	10	BGT01	2448	1624	1832				
1692	00:04	173	37	14.15	32	17.95	1984	1.46	214	13198	10	BGT01	2602	1748	1927	Haul @ 30m/min			
1693	00:15	173	37	13.93	32	18.08	1973	1.21	213	13198	10	BGT01	2280	1488	1727				
1694	00:19	173	37	13.82	32	18.14	2005	1.37	214	13198	10	BGT01	2152	1400	1634	Veer @ 30m/min			
1695	00:30	173	37	13.54	32	18.28	2063	1.41	210	13198	10	BGT01	2466	1660	1824				
1696	00:42	173	37	13.23	32	18.42	2194	1.28	205	13198	10	BGT01	2836	1954	2055	Haul @ 30m/min			
1697	00:45	173	37	13.16	32	18.44	2189	1.22	205	13198	10	BGT01	2783	1887	2046				
1698	01:00	173	37	12.77	32	18.58	2209	1.38	203	13198	10	BGT01	2344	1510	1793				
1699	01:05	173	37	12.64	32	18.64	2232	1.35	204	13198	10	BGT01	2197	1402	1692	Veer @ 30 m/min			
1700	01:15	173	37	12.31	32	18.69	2200	1.33	198	13198	10	BGT01	2482	1613	1886				
1701	01:30	173	37	11.86	32	18.81	2307	1.15	197	13198	10	BGT01	2926	1881	2241				
1702	01:39	173	37	11.57	32	18.91	2306	1.08	197	13198	10	BGT01	3205	2091	2429	Haul @ 30m/min			
1703	01:45	173	37	11.44	32	18.93	2323	1.13	198	13198	10	BGT01	3058	1937	2366				
1704	02:00	173	37	10.99	32	19.18	2455	1.40	207	13198	10	BGT01	2626	1564	2109				
1705	02:10	173	37	10.73	32	19.29	2441	1.09	206	13198	10	BGT01	2337	1400	1871	Veer @ 30 m/min			
1706	02:15	173	37	10.61	32	19.39	2430	1.02	206	13198	10	BGT01	2452	1550	1900				
1707	02:30	173	37	10.19	32	19.48	2494	1.03	187	13198	10	BGT01	2919	1950	2172				
1708	02:45	173	37	09.81	32	19.55	2470	1.00	187	13198	10	BGT01	3343	2320	2407				
1709	02:46	173	37	09.79	32	19.56	2461	0.96	187	13198	10	BGT01	3378	2351	2426	Haul @ 40 m/min			
1710	03:00	173	37	09.47	32	19.63	2438	0.96	191	13198	10	BGT01	2816	1925	2055				
1711	03:15	173	37	09.11	32	19.75	2580	1.15	191	13198	10	BGT01	2229	1540	1611				
1712	03:20	173	37	09.01	32	19.78	2560	1.20	195	13198	10	BGT01	2038	1400	1481	Veer @ 30 m/min			
1713	03:30	173	37	08.71	32	19.88	2581	1.21	195	13198	10	BGT01	2342	1641	1671				
1714	03:45	173	37	08.29	32	20.06	2645	1.08	200	13198	10	BGT01	2817	1979	2005				
1715	04:00	173	37	07.93	32	20.28	2687	0.91	201	13198	10	BGT01	3285	2360	2285				
1716	04:05	173	37	07.83	32	20.33	2716	1.00	200.5	13198	10	BGT01	3428	2494	2352	Haul @ 40 m/min			

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	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1717	04:15	173	37	07.63	32	20.46	2742	0.84	197.9	13198	10	BGT01	3036	2156	2138				
1718	04:30	173	37	07.27	32	20.65	2817	1.13	185.1	13198	10	BGT01	2445	1712	1746				
1719	04:40	173	37	06.97	32	20.72	2785	1.21	181.3	13198	10	BGT01	2022	1400	1459	Veer @ 30 m/min			
1720	04:45	173	37	06.85	32	20.78	2805	1.33	180.4	13198	10	BGT01	2139	1505	1520				
1721	05:00	173	37	06.38	32	20.88	2912	1.32	181.8	13198	10	BGT01	2592	1817	1849				
1722	05:15	173	37	06.00	32	20.99	2904	1.19	182.4	13198	10	BGT01	3046	2198	2109				
1723	05:30	173	37	05.66	32	21.14	2894	0.85	183	13198	10	BGT01	3502	2624	2319				
1724	05:33	173	37	05.56	32	21.19	2858	0.88	183.1	13198	10	BGT01	3607	2722	2367	Haul @ 40 m/min			
1725	05:45	173	37	05.38	32	21.23	2795	0.86	178.5	13198	10	BGT01	3174	2368	2113				
1726	06:00	173	37	05.04	32	21.29	2792	1.06	181.4	13198	10	BGT01	2565	1916	1705				
1727	06:15	173	37	04.61	32	21.42	2766	1.27	188.7	13198	10	BGT01	1932	1404	1327	Veer @ 30 m/min			
1728	06:30	173	37	04.21	32	21.57	2774	1.39	192.2	13198	10	BGT01	2350	1718	1603				
1729	06:45	173	37	03.79	32	21.73	2785	1.24	190.6	13198	10	BGT01	2797	2051	1902				
1730	06:50	173	37	03.68	32	21.75				13198	10	BGT01			0	Slowed to 0.5 knots			
1731	06:56	173	37	03.49	32	21.79	2787	1.03	188.9	13198	10	BGT01	3136	2344	2083	Haul @ 40 m/min. Bridge not happy slowing with lots of wire out			
1732	07:00	173	37	03.42	32	21.78	2784	1.11	197.2	13198	10	BGT01	3016	2226	2035				
1733	07:15	173	37	03.03	32	21.94	2768	1.33	208.6	13198	10	BGT01	2405	1694	1707	Starting Turn			
1734	07:26	173	37	02.89	32	22.27	2774	1.63	275.2	13198	10	BGT01			0	Finished Turn			
1735	07:30	173	37	02.91	32	22.42	2788	1.63	274.8	13198	10	BGT01	1793	1298	1237				
1736	07:45	173	37	02.95	32	23.00	2789	1.45	272.3	13198	10	BGT01	1179	856	811	BGT Heading 275.			
1737	07:53	173	37	02.96	32	23.34	2789	1.63	272.6	13198	10	BGT01	851	605	598	Veer @ 30 m/min			
1738	08:00	173	37	02.91	32	23.58	2792	1.32	274	13198	10	BGT01	1050	815	662	Veer @ 40m/min.			
1739	08:15	173	37	02.88	32	24.01	2813	1.29	290	13198	10	BGT01	1638	1380	882	Back at Working Depth			
1740	08:30	173	37	02.93	32	24.43	2813	1.36	291	13198	10	BGT01	2238	1935	1124				
1741	08:45	173	37	03.00	32	24.83	2825	1.15	276	13198	10	BGT01	2869	2495	1416				
1742	08:52	173	37	02.98	32	25.07	2825	1.23	275	13198	10	BGT01	3171	2740	1596	Haul @ 40m/min.			
1743	09:00	173	37	02.98	32	25.32	2800	1.33	276	13198	10	BGT01	2849	2320	1654				
1744	09:12	173	37	02.98	32	25.80	2812	1.41	280	13198	10	BGT01	2361	1750	1585	Bottle 1 Fired			
1745	09:17	173	37	03.01	32	25.98	2821	1.35	281	13198	10	BGT01	2185	1563	1527				
1746	09:21	173	37	03.02	32	26.15	2829	1.37	280	13198	10	BGT01	2016	1408	1443	Veer @ 40m/min.			
1747	09:30	173	37	3.01	32	26.51	2850	1.51	280	13198	10	BGT01	2362	1650	1690				
1748	09:34	173	37	3.04	32	26.60	2854	1.44	281	13198	10	BGT01	2522	1750	1816	Bottle 2 Fired			
1749	09:45	173	37	3.06	32	27.12	2857	1.20	271	13198	10	BGT01	2972	2061	2141				
1750	10:00	173	37	3.05	32	27.72	2871	1.18	276	13198	10	BGT01	3580	2463	2598				
1751	10:08	173	37	3.07	32	27.98	2874	0.95	271	13198	10	BGT01	3920	2762	2782	Haul @ 40m/min.			
1752	10:15	173	37	3.05	32	28.19	2825	0.77	272	13198	10	BGT01	3651	2520	2642				
1753	10:31	173	37	3.06	32	28.78	2817	1.24	272	13198	10	BGT01	2999	1920	2304				
1754	10:36	173	37	3.10	32	28.97	2823	1.15	266	13198	10	BGT01	2789	1750	2172	Bottle 3 Fired			
1755	10:46	173	37	3.14	32	29.32	2890	0.97	261	13198	10	BGT01	2373	1470	1863				
1756	10:49	173	37	3.15	32	29.43	2893	1.04	259	13198	10	BGT01	2258	1404	1768	Veer @ 40m/min.			
1757	11:00	173	37	3.15	32	29.87	2931	0.94	246	13198	10	BGT01	2690	1750	2043	Bottle 4 Fired			
1758	11:05	173	37	3.13	32	30.02	2935	0.84	247	13198	10	BGT01	2901	1950	2148	Bottle 5 Fired			

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	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1759	11:15	173	37	3.08	32	30.31	2941	0.70	251	13198	10	BGT01	3316	2366	2323				
1760	11:26	173	37	3.07	32	30.59	2952	0.55	248	13198	10	BGT01	3756	2805	2498	Haul @ 40m/min.			
1761	11:30	173	37	3.10	32	30.69	2953	0.60	247	13198	10	BGT01	3569	2645	2396				
1762	11:45	173	37	3.17	32	31.03	2954	0.91	234	13198	10	BGT01	2985	2198	2020				
1763	12:00	173	37	3.06	32	31.59	2944	1.21	244	13198	10	BGT01	2374	1600	1754				
1764	12:03	173	37	3.05	32	31.73	2941	1.21	243	13198	10	BGT01	2266	1490	1707	Veer @ 40m/min			
1765	12:13	173	37	2.96	32	32.17	2947	1.50	247	13198	10	BGT01	2683	1750	2034	Bottle 6 fired			
1766	12:15	173	37	2.93	32	32.25	2949	1.45	247	13198	10	BGT01	2764	1798	2099				
1767	12:20	173	37	2.87	32	32.46	2962	1.13	249	13198	10	BGT01	2986	1950	2261	Bottle 7 fired			
1768	12:30	173	37	2.85	32	32.78	2951	1.02	258	13198	10	BGT01	3359	2250	2494				
1769	12:45	173	37	2.81	32	33.26	2744	1.36	265	13198	10	BGT01	3953	2763	2827				
1770	12:48	173	37	2.80	32	33.37	2740	1.24	261	13198	10	BGT01	4082	2850	2922	Haul @ 40 m/min			
1771	13:00	173	37	2.80	32	33.81	2872	1.29	269	13198	10	BGT01	3696	2403	2808				
1772	13:15	173	37	2.82	32	34.40	2861		277	13198	10	BGT01	3100	1862	2478				
1773	13:30	173	37	2.90	32	34.86	2774	1.26	277	13198	10	BGT01	2503	1531	1980				
1774	13:31	173	37	2.91	32	34.92	2775	1.17	277	13198	10	BGT01	2450	1502	1936	Veer @ 40 m/min			
1775	13:44	173	37	2.98	32	35.33	2637	1.22	258	13198	10	BGT01	2948	1950	2211	Bottle 8 fired			
1776	13:45	173	37	2.98	32	35.35	2638	1.20	259	13198	10	BGT01	2991	1989	2234				
1777	14:00	173	37	2.93	32	35.75	2594	1.10	258	13198	10	BGT01	3605	2632	2463				
1778	14:03	173	37	2.95	32	35.79	2597	1.08	258	13198	10	BGT01	3730	2789	2477	Haul @ 40 m/min			
1779	14:15	173	37	2.88	32	36.00	2594	1.00	257	13198	10	BGT01	3248	2473	2106				
1780	14:30	173	37	2.83	32	36.27	2609	1.38	257	13198	10	BGT01		2025	#NUM!				
1781	14:39	173	37	2.75	32	36.48	2520	1.31	257	13198	10	BGT01	2220	1746	1371	Bottle 9 fired			
1782	14:45	173	37	2.69	32	36.63	2523	1.28	257	13198	10	BGT01	1983	1551	1236				
1783	14:46	173	37	2.67	32	36.67	2522	1.13	257	13198	10	BGT01	1921	1500	1200	Veer @ 40 m/min			
1784	14:54	173	37	2.57	32	36.90	2509	1.32	257	13198	10	BGT01	2223	1750	1371	Bottle 10 fired			
1785	15:00	173	37	2.50	32	37.05	2570	1.31	257	13198	10	BGT01	2445	1917	1518				
1786	15:01	173	37	2.49	32	37.08	2541	1.38	258	13198	10	BGT01	2487	1950	1544	Bottle 11 fired			
1787	15:13	173	37	2.38	32	37.44	2613	1.03	258	13198	10	BGT01	2998	2388	1813	Stopped winch to prepare to oil cable on way in			
1788	15:15	173	37	2.38	32	37.47	2609	1.10	258	13198	10	BGT01	2998	2387	1814				
1789	15:23	173	37	2.28	32	37.65	2583	1.09	257	13198	10	BGT01	2998	2388	1813	Haul @40 m/min			
1790	15:30	173	37	2.22	32	37.82	2553	1.05	259	13198	10	BGT01	2744	2149	1706				
1791	15:36	173	37	2.16	32	37.96	2493	1.10	257	13198	10	BGT01	2519	1950	1595	Bottle 12 fired			
1792	15:45	173	37	2.07	32	38.21	2446	1.27	258	13198	10	BGT01	2175	1648	1419				
1793	16:00	173	37	1.93	32	38.67	2500	1.47	273.2	13198	10	BGT01	1584	1139	1101				
1794	16:15	173	37	1.85	32	39.22	2510	1.62	273.3	13198	10	BGT01	978	648	733				
1795	16:30	173	37	1.74	32	39.89	2588	1.83	272	13198	10	BGT01	385	250	293				
1796	17:45	173								13198	10	BGT01				BRIDGET inboard.			
1797																			
1798	20:15	173	37	17.49	32	16.78	1725		99	13198	11	PLS01	0	0	0	PLASMA DEPLOYED			
1799	21:03	173	37	17.51	32	16.76	1722		63	13198	11	PLS01	1226			First filter starts pumping			
1800	21:18	173	37	17.51	32	16.76	1713		44	13198	11	PLS01	1645			Depth reached.			

Appendix C: Operations Log

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1801	21:53	173	37	17.53	32	16.63	1677		50	13198	11	PLS01	1645			First filter closed, commence hauling @ 30m/min.			
1802	22:04	173	37	17.49	32	16.74	1742		51	13198	11	PLS01	1250			Second filter starts pumping.			
1803	22:10	173	37	17.50	32	16.72	1721		51	13198	11	PLS01	1145			Depth reached.			
1804	22:54	173	37	17.52	32	16.73	1718		75	13198	11	PLS01	1145			Second filter stops pumping.			
1805	22:57	173	37	17.55	32	16.74	1717		77	13198	11	PLS01	1145			Start hauling PLASMA to the surface.			
1806	23:40	173	37	17.51	32	16.75	1713	0.37	76.1	13198	11	PLS01	0	0		PLASMA on deck			
1807																			
1808	10:40	174	37	27.23	29	49.04	1724	0.58	109.3	13199	01	CTD01	0	0		CTD in water			
1809	11:09	174								13199	01	CTD01		1000		CTD @ 1000m			
1810	11:35	174	37	27.53	29	48.31	1669	-0.29	131.4	13199	01	CTD01				CTD inboard			