VESSEL R.R.S. JOHN MURRAY, Cruise 4B/76

CRUISE PERIOD 15 - 25 April, 1976

PERSONNEL

IMER, Edinburgh
R.H.Bruce, SSO (Senior Scientist)
D.B.Hollis, HSO
A.W.G. John, HSO
A.J. Foubister, ASO

DAFS, Aberdeen
J.M.Davies, SSO
D.M.Finlayson, SSO
I.M. Davies, SO
S.J. Hay, SO

All personnel were present for the duration of the cruise.

ITINERARY

All times are GMT.

See also the attached sketch charts, tow lists and station lists.

14 April		Took over from scientific personnel from previous cruise; prepared and tested equipment.
15 April	11.20	Departed Aberdeen. Set course for centre of FLEX square (see Fig. 1).
	12.00	Started continuous logging of surface temperature, salinity, chlorophyll and nitrate using non-toxic pumped sea-water supply from 3m depth. This logging was maintained throughout the cruise whenever the ship was underway.
	13.00	Bridge started taking half-hourly navigational and hourly meteorological observations which were continued while the ship was at sea.
	13.30-13.55	Calibrated HSLE flowmeters at 5 knots.
	17.00-17.20	Station 0: Reversing water bottle casts (3 depths) as calibration check for UOR T & S sensors.
	17.23	Started UOR Tow 1 and CPR Tow 1. Proceeded at 9 knots along IN-OUT line ILSW. (See Fig. 1).
16 April	04.29	Recovered CPR and UOR.
	04.30-07.27	Station 9A: (centre of FLEX square) 2 HSLE oblique plankton hauls 1 LHPR oblique plankton haul Reversing water-bottle casts (9 depths). Large volume water samples.
	07.30	Set course for position of sediment-trap mooring laid on previous cruise.
	08.20-/	

08.20- Recovered mooring and re-laid it closer to
10.00 Station 9.
10.00 Set course for SW corner of FLEX square.
11.00- UOR Tow 2 and CPR Tow 2
14.00
14.10- Station 1A: Reversing water-bottle cast
14.30 (9 depths).
14.30 Set course for position of sediment-trap mooring laid on previous cruise.
15.00- Mooring recovered and re-laid.
15.36

UOR SURVEY IA (Fig. 3)

15.40 Set course along LEG 1 of FLEX grid (see Fig. 2).
16.07- UOR Tow 3 and CPR Tow 3
21.30
21.45- Station 2A: Reversing water-bottle cast
22.04 (9 depths)
22.52 Set course along LEG 2 of FLEX grid.
22.55 Started UOR Tow 4 and CPR Tow 4A
23.10 UOR not undulating correctly.
23.30 Recovered UOR for investigation.
23.40 Carried on with CPR Tow 4B along LEG 2.

17 April 04.00 CPR recovered because of deteriorating weather (westerly, Force 7-8), speed reduced to 6-7 knots.
04.30 Set course for Stavanger for shelter from forecast Force 8-9 gales.
09.06- Hove-to to take large volume water samples.
09.30 Heavy swell from west.
22.00 Arrived Stavanger.

18 April 16.50 Departed Stavanger
20.00 Set course at 9 knots for NE corner of FLEX square. Wind and swell subsided.

19 April 07.35- Station 8A: Light attenuation profile
08.55 Water samples for C^{14} expt.
Reversing water-bottle cast (8 depths).
Large volume water sample

UOR SURVEY IB (Fig. 3)

Proceeded along LEG 7 of FLEX grid.
09.06- UOR Tow 5 and CPR Tow 5
14.34
14.45- Station 7A: Reversing water-bottle casts
15.00 (9 depths).
15.00- Proceeded along LEG 6 of FLEX grid, but thick fog, and uncertainty about the reliability of the radar, forced a speed reduction of 2-3 knots - too slow for towing CPR or UOR.

20 April 09.00
09.27- Station 6A: Light attenuation profile
10.50 Reversing water-bottle cast (9 depths).
Large volume water samples from 5 depths.

HSLE SURVEY (Fig. 5)

11.00 /

	11.00	Visibility improved slightly to allow safe 5 knots; started regular ½ hourly HSLE hauls along LEG 5.
	12.25	HSLE net torn
	14.00-21.47	Net replaced; resumed ½ hourly hauls.
	22.17-22.39	Station 5A: Reversing water-bottle cast (9 depths).
	23.00-	Proceeded along LEG 4 of FLEX grid taking
21 April	03.52	½ hourly HSLE hauls
	04.00	Set course for sediment-trap mooring.
	05.10	Mooring sighted promptly in spite of fog which reduced visibility to <200 yds.
	05.45	Mooring recovered.
	08.00	Sediment traps re-laid ½ mile from JONSDAP mooring No. 95, having searched in vain for JONSDAP mooring No. 91.
	09.10-10.45	Station 9B: Reversing water-bottle cast (9 depths). Large volume water samples from 2 depths. 1 LHPR haul
	11.00	Resumed ½ hourly HSLE hauls along LEG 4.
	16.50-17.15	Station 4A: Reversing water-bottle cast (9 depths).
	18.00-	Proceeded along LEG 3 of FLEX grid taking ½
22 April	03.48	hourly HSLE hauls.
	04.40-05.00	Station 3A: Reversing water-bottle cast (9 depths).
	05.30-	Proceeded along LEG 2 of FLEX grid taking
	08.16	½ hourly HSLE hauls.
	08.30-08.55	Hove-to to take light attenuation profile, and water samples from 5 depths for C^{14} experiments.
	09.00-15.45	Resumed ½ hourly HSLE hauls along LEG 2.
	16.32-16.50	Station 2B: Reversing water-bottle cast (9 depths).
	17.03-	Proceeded along LEG 1 of FLEX grid taking
23 April	03.19	½ hourly HSLE hauls.
	03.45-06.00	Station 1B: Reversing water-bottle cast (9 depths). Recovered and re-laid sediment trap mooring. Large volume water samples. (Much oil-related activity in vicinity)

UOR SURVEY II (Fig. 4)

06.40	Started UOR Tow 6 and CPR Tow 6. Proceeded northwards along LEG 1 at 8½ knots.
09.27	Recovered CPR and UOR to investigate an undulation fault.
09.58	Started UOR Tow 7 (using spare UOR) and continued along LEG 1. Wind increased to northerly Force 6, reducing ship's speed to 7½ knots.
13.09	Recovered UOR.
13.23-/	

	13.23-13.48	Station 2C: Reversing water-bottle cast (9 depths).
	14.00	Started UOR Tow 8 and CPR Tow 7 Proceeded along LEG 2 of FLEX grid at 9½ knots with large following sea (wind Force 6-7).
	20.45	Recovered CPR and UOR
	20.29-21.50	Station 3B: Reversing water-bottle cast (9 depths).
	21.30	Started CPR Tow 8 Proceeded along LEG 3 of FLEX grid at 4-7 knots into heavy head sea (wind Force 7). Too rough for UOR.
24 April	07.00	Recovered CPR.
	07.29-08.36	Station 4B: Light attenuation profile Large volume water samples Reversing water-bottle cast (8 depths).
	08.39	Started UOR Tow 9 and CPR Tow 9. Proceeded along LEG 4 of FLEX grid at 9 knots with heavy following sea.
	15.00	Recovered CPR and UOR.
	15.22-15.42	Station 5B: Reversing water-bottle cast (9 depths)
	16.00	Headed north along LEG 5 of FLEX grid; heavy head seas reduced speed to 3-4 knots (wind Force 7). Too rough for UOR and CPR.
	20.15	Ship's engine trouble; suspected cracked sump. Set course for Aberdeen.
25 April	15.00	Arrived Aberdeen. Ship's engineers worked on engine.
26 April		On stand-by in Aberdeen; engine repairs continued.
27 April	08.30	Ship expected to be ready to sail by evening but lack of time (ship due in Newcastle on 30 April) and bad weather forecast (Force 7-8 northerly) forced decision to terminate cruise.
	13.00	Equipment unloaded.

OBJECTIVES

See Cruise Programme IMER/FLEX/3/76.

PROCEDURES AND METHODS

As outlined in the Cruise Programme, but with the following modifications:

1. Weather conditions forced departures from the planned regular alternations of UOR and HSLE surveys and stations (See also following section.)

2.1 Sampling from 50,70 and 90m depths was omitted.

3.3, 3.4 N^{15} experiments were carried out more frequently than the planned once/grid.

5. No comparative tows of the LHPR and the German multiple opening/closing net were taken.

6.2 The 6 hourly met.observations were transmitted via a U.K./

U.K. shore station to the U.K. Met. Office.

EQUIPMENT AND OTHER PROBLEMS

1. Weather

a) UOR Survey IA was abandoned after completing Legs 1 and 2 because of rough seas. 45 hours of towing time were lost while running to Stavanger for shelter and returning to the survey area.

b) UOR Survey IB, which started from the NE corner of the FLEX square and followed the grid in reverse, was abandoned after completing Leg 7 only, because of very poor visibility. Dense fog (coupled with doubt about the reliability of the radar) made unsafe (and hence prevented) all over-the-side operations for 18 hours.

c) Forecast northerly gales (together with lack of time) influenced the decision not to sail again for the FLEX square after completing engine repairs, but instead to terminate the cruise in Aberdeen on 27 April.

2. Ship's Equipment

a) Engine trouble (cracked sump on starboard engine) caused UOR Survey II to be abandoned during Leg 5, and the ship to leave the survey area to return to port 5 days early.

b) Doubt about the reliability of the radar increased the time lost due to poor visibility.

c) Poor reception of the weather maps on the facsimile receiver, because the correct crystal was lacking, made technical planning more difficult, perhaps leading to excessive caution.

3. Equipment supplied by IOS, Barry.

a) Several of the reversing themometers were faulty, and others gave slightly variable or inaccurate readings. All should be checked and re-calibrated.

b) The precision depth recorder could not be made to function correctly. However, the bridge echo-sounder provided adequate depth information.

4. DAFS Equipment.

a) One HSLE net was badly torn while towing, causing 2 hours sampling time to be lost before a spare could be fitted.

b) Small amounts of potential data were missed by the continuous flow equipment because of occasional electrical and water-flow problems. Post-cruise checks/

checks and comparisons are required to correct for possible calibration shifts.

5. IMER Equipment.

a) UOR

Potential data or samples were lost in the following circumstances:

System Limitations

(i) UOR tows were cancelled on three occasions (Survey I, Leg 2 and Survey II, Legs 3 and 5) when head seas reduced the ship's speed below the minimum towing speed of 7 knots.

Undulator Faults

(i) UOR2 failed to undulate at the start of Tow 4. The cause of the fault could not be positively identified, but a drop of water and a slightly loose gear were found in the generator. After renewing the generator shaft seals and tightening the gear, operation was satisfactory.

(ii) UOR2 stopped undulating during Tow 6 about half way along Leg 1. The cause of the fault has not been conclusively identified, but shorting due to a drop of water in the generator or dirty brushes in the wing-drive unit are possibilities.

(iii) UOR3 performed mis-shapen undulations during Tows 7-9 due to a faulty pressure transducer (damaged by accidental over-pressurizing during the previous cruise).

Plankton Sampling Mechanism Fault

(i) During Tow 8, the silk-transport rate was slow because the pinch rollers were set too slack - operator error.

Data Logging Faults

The overall data return was poor (~ 40%) due to a number of independent faults.

(i) The ODAS logger was unreliable throughout, because of electronic and tape-transport faults which proved difficult to identify and eliminate.

(ii) The salinity sensor apparently started to leak during Tow 1, rendering all subsequent salinity data invalid.

(iii)/

(iii)ODAS 2 was badly flooded at the start of Tow 6 - operator error.

(iv) The MATR logger produced poor quality recordings during Tow 9; cause unknown.

RESULTS AND CONCLUSIONS

Bad weather and engine trouble combined to reduce the effectiv time in the FLEX area from the planned 14 days to 6 days. As a consequence the coverage of the FLEX grid was reduced from the 4 surveys planned (two each with UOR/CPR and HSLE) to two partial surveys with UOR/CPR (each covering about ½ the grid, although rather disjointedly) and one partial survey with the HSLE (covering about 2/3rds of the grid). Acquisition of STD data by the UOR/CPR was further reduced by about 50% by data-logging faults. Of the 36 station occupations planned only 16 were worked. Engine trouble also prevented us from carrying out the planned comparative plankton hauls and exchange of inter-calibration samples with R.V. METEOR and R.V. ANTON DOHRN, and from servicing the sediment-trap mooring at Station 1 before returning to port.

Nevertheless, the sampling was sufficient to obtain a reasonable impression of conditions during the start of the phyto-plankton bloom. Initially, (16 April), before the first stormy period, there was a weak thermocline between about 30 and 60 m separating surface water at 6.4-6.5^{o}C from bottom water at 6.2-6.3^{o}C. Chlorophyll concentrations were fairly low with maximum values of 1.0-1.6 mg Chl$\underline{a}$/m^{3} near the surface and back-ground values of 0.2-0.4 mg Chl$\underline{a}$/m^{3} below 60m. During the calm period (19-20 April) following the storm, the thermocline intensified, with surface temperatures rising to 6.8-7.0^{o}C and the temperature gradient extending from 10 - 60m.

Chlorophyll concentrations, which were down to 0.7 mg Chl$\underline{a}$/m^{3} at Station 8 immediately after the storm, increased in magnitude and variability during the next few days. The first significant phytoplankton patch to be detected by any FLEX participants was observed on 20 April in the vicinity of Station 5. It had an extent of 10km and appeared to be associated with a minor hydrographic feature. On entering the patch surface temperature increased from 6.8 to 7.2^{o}C, chlorophyll concentration from 1 to 2 mg Chl$\underline{a}$/m^{3} and nitrate concentration fell from 5 to 1 µg atom/litre. Surface chlorophyll values around 2 mg Chl$\underline{a}$/m^{3} became general over the next 3 days, with frequent peaks over 3 mg Chl$\underline{a}$/m^{3}, the cruise maximum of 4.5 mg Chl$\underline{a}$/m^{3} being observed near Station 3 on the 23 April. Thus the spring bloom was well underway before we had to leave the FLEX area prematurely on 24 April.

Date: 3.8.76

Prepared by: R.H.Bruce

Approved by: R.S. Glover

REGULAR CIRCULATION - CRUISES

Internal

Glover
Longhurst
Robinson
Heath
Plymouth File (2)

External

NERC

Foxton

IOS

Edwards (BODS)

RVB

Stobie

IOS (Bidston)

Cartwright

DAFS (Aberdeen)

Parrish

ADDITIONAL CIRCULATION FOR FLEX CRUISES

Met.Office

White

NMFS

Marak

DAFS

Steele
Baird
J. Davies

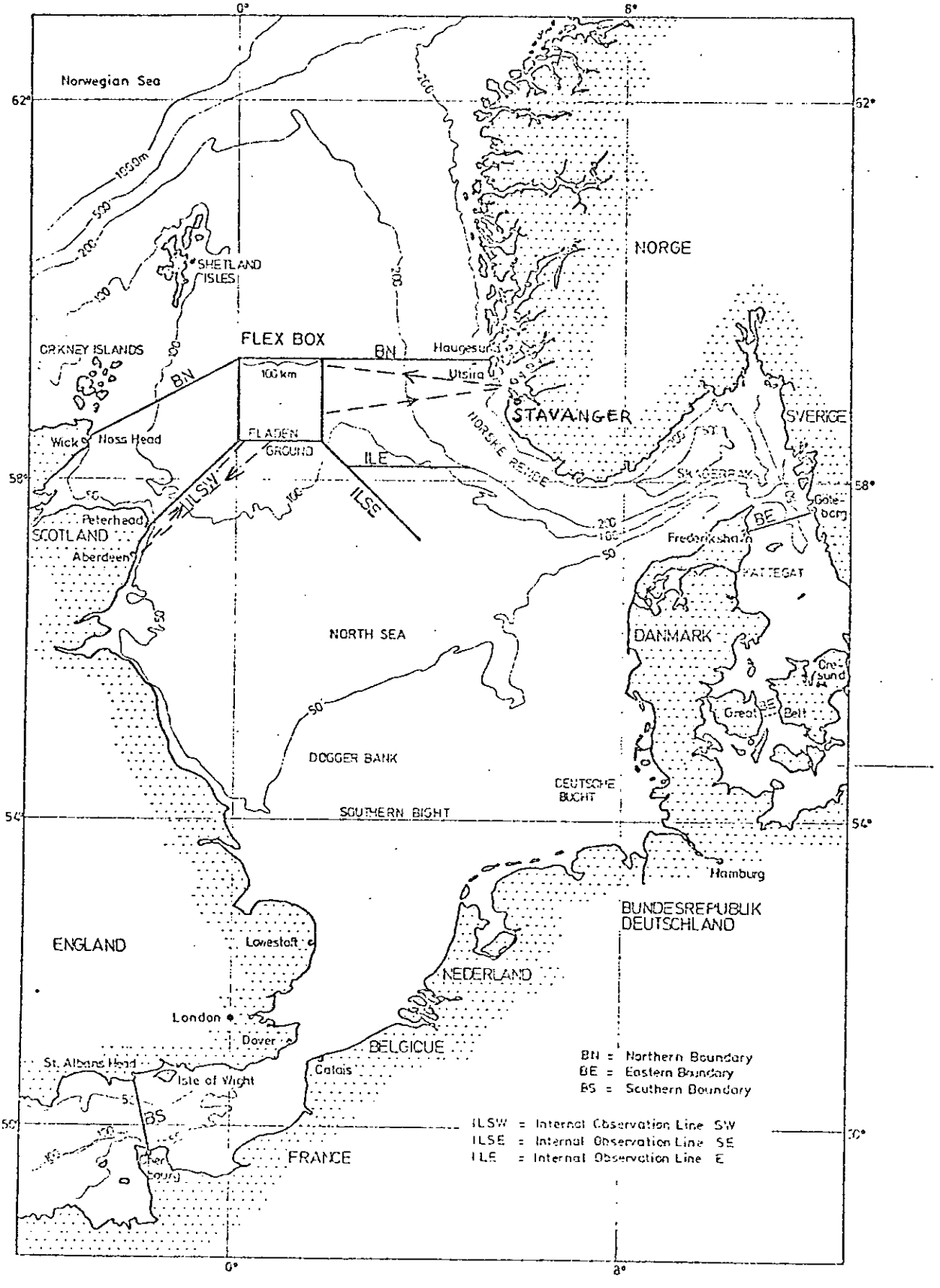
IMER

Williams
Bruce
Aiken
John
Hollis
Foubister
Wood
Hiby
Bottrell
Reid

FLEX Data Centre

Schulze

Fig.1 Observation Lines and Areas in JONSDAP 76



— — → — — R.R.S. JOHN MURRAY

FLEX- BOX- GRID

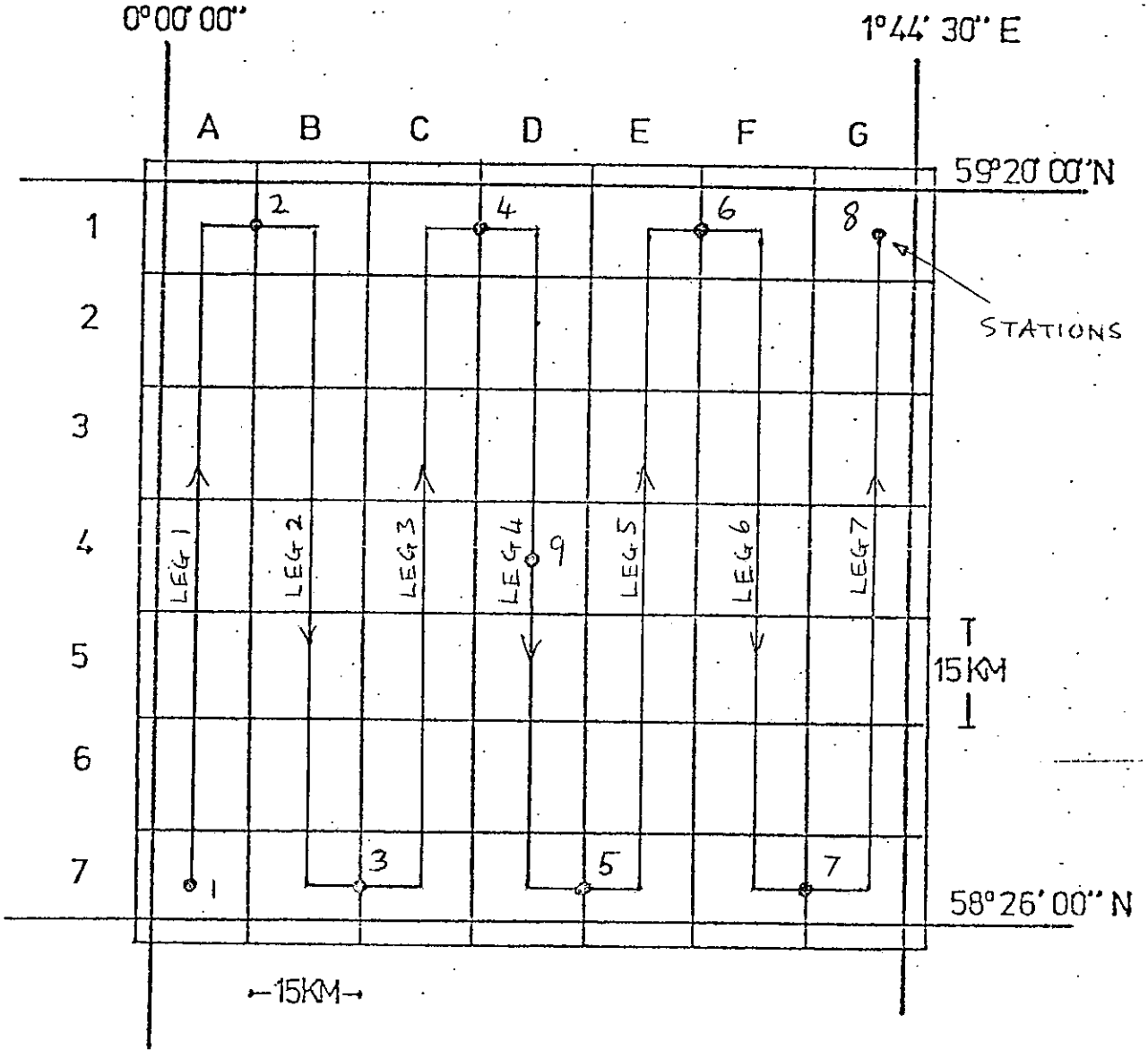
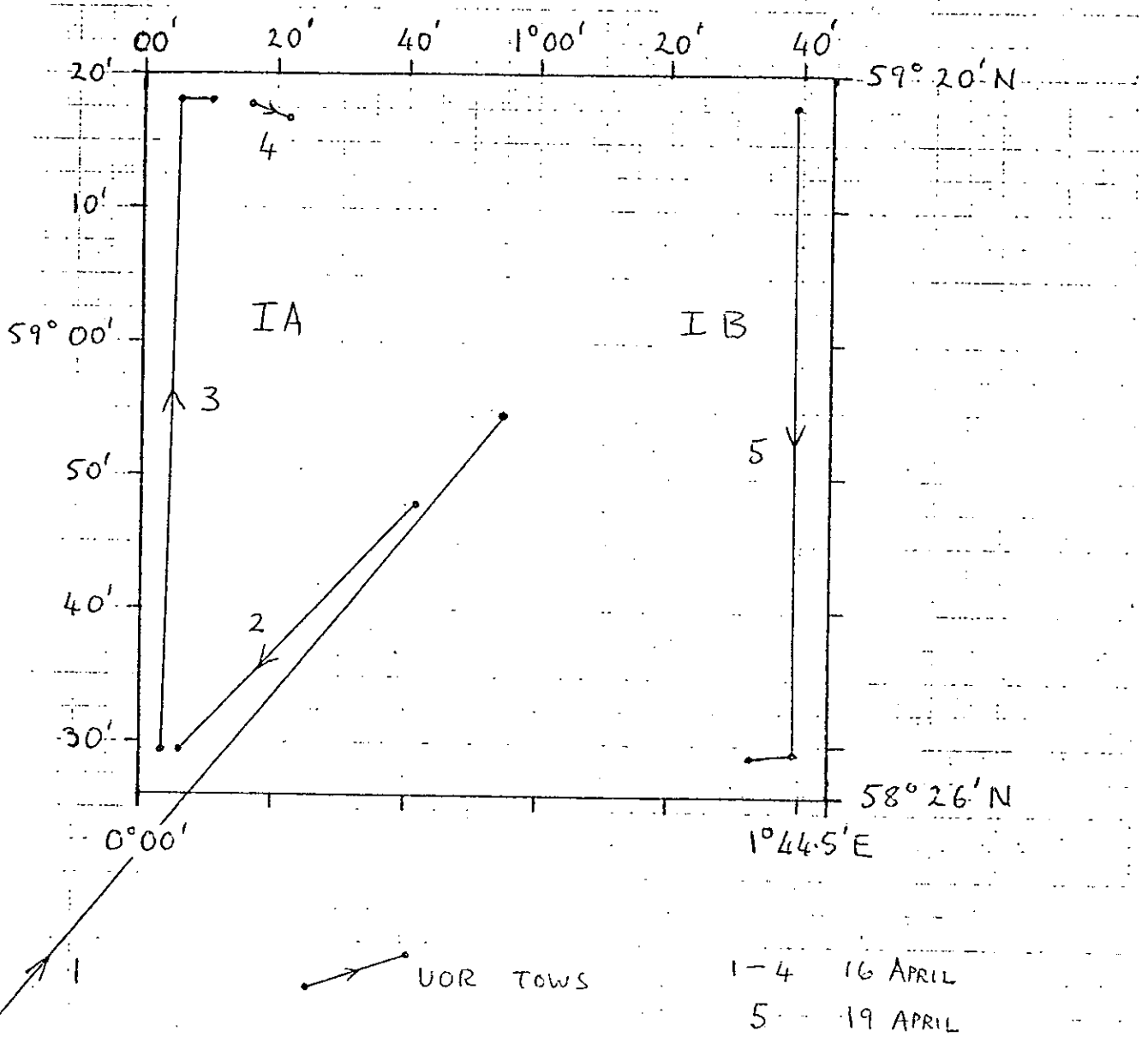


FIGURE 2

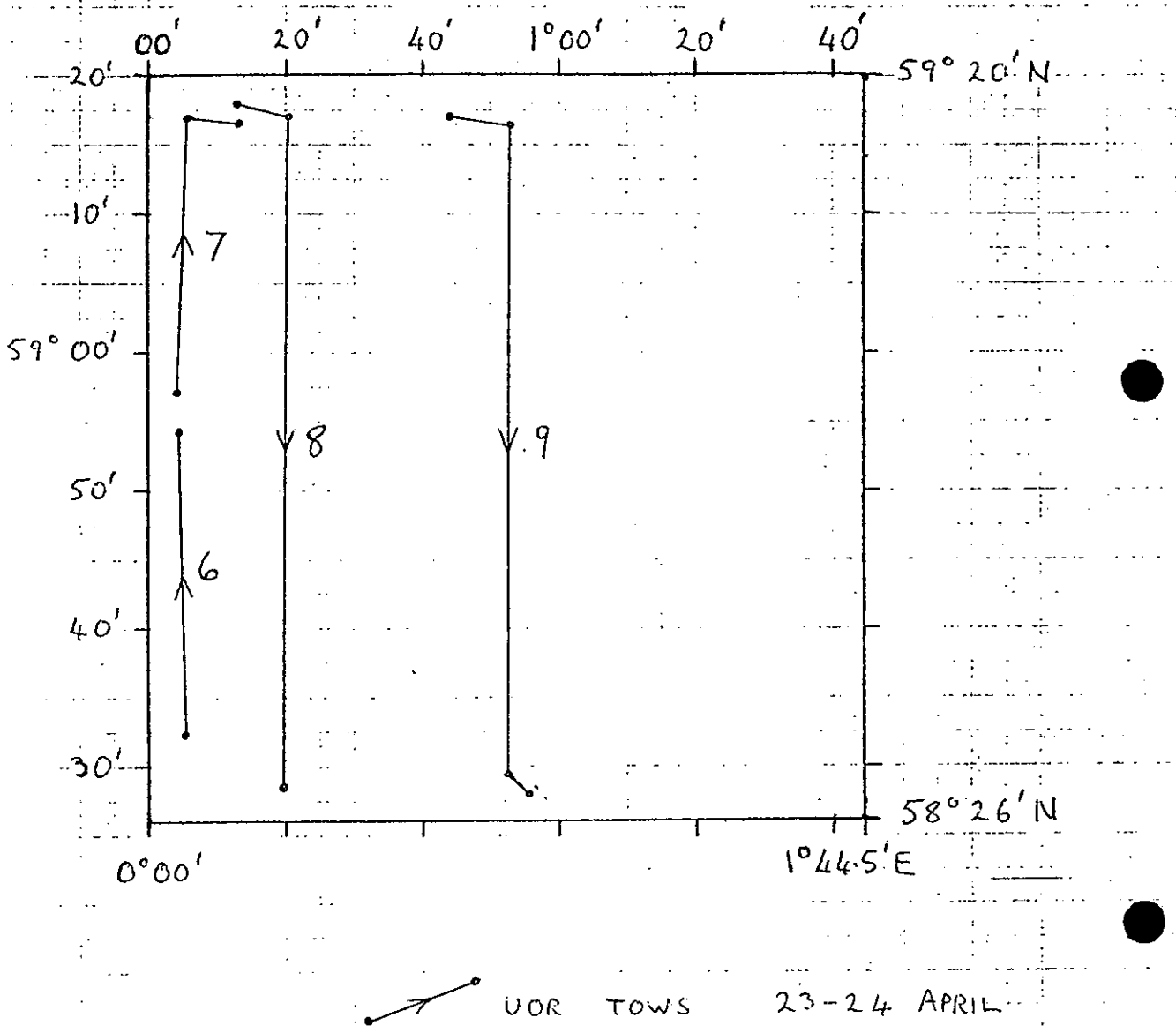
FLEX BOX



UOR SURVEYS IA AND IB

FIGURE 3

FLEX BOX



UOR SURVEY II

FIGURE 4

UOR TOW LIST (page 1 of 3)

UOR Tow No.	Location	Action	Date	Time (GMT)	Position Lat.N	Position Long.	Dist. towed (n. miles)	No.of Undula-tions	Av.Und. Leng. (n. miles)	Depth Range (m)	Silk No.	Av.Silk Trans. rate (miles/ div.)	Tape No.	Comments
1	ILSW →	Shoot Haul	15 Apr 16 Apr	17.23 04.29	57°37.6' 58°54.6'	1°13.0'W 0°54.9'E	101	75	1.35	10-58	F3/ UOR/1	1.17	ODAS F3/2	UTV2/ODAS2. All plankton samples valid. Some intermittently faulty STD recording, mostly towards end of tow, but ~3/4 recoverable. Validity of all S data uncertain
2	Sta.9 → Sta.1	Shoot Haul	" "	11.00 14.00	58°48.0' 58°29.4'	0°42.0'E 0°05.9'E	26	18	1.44	8-58	F3/ UOR/2	1.14	ODAS F3/3	All plankton samples & T/D data valid, but salinit sensor faulty - no valid S data.
3	FLEX grid Leg 1	Shoot A/C Haul	" " "	16.07 21.12 21.30	58°29.0' 59°18.0' 59°17.9'	0°03.4'E 0°05.4'E 0°10.3'E	52	36	1.44	8-58	"	1.19	ODAS F3/5	All plankton samples valid. Some intermittently faulty recording, but ~ 4/5 T/D data recoverable. No valid S data
4	FLEX grid Leg 2	Shoot Haul	" "	22.55 23.30	59°17.8' 59°16.8'	0°16.0'E 0°21.7'E	3	0	-	-	"	-	ODAS F3/6	No undulations

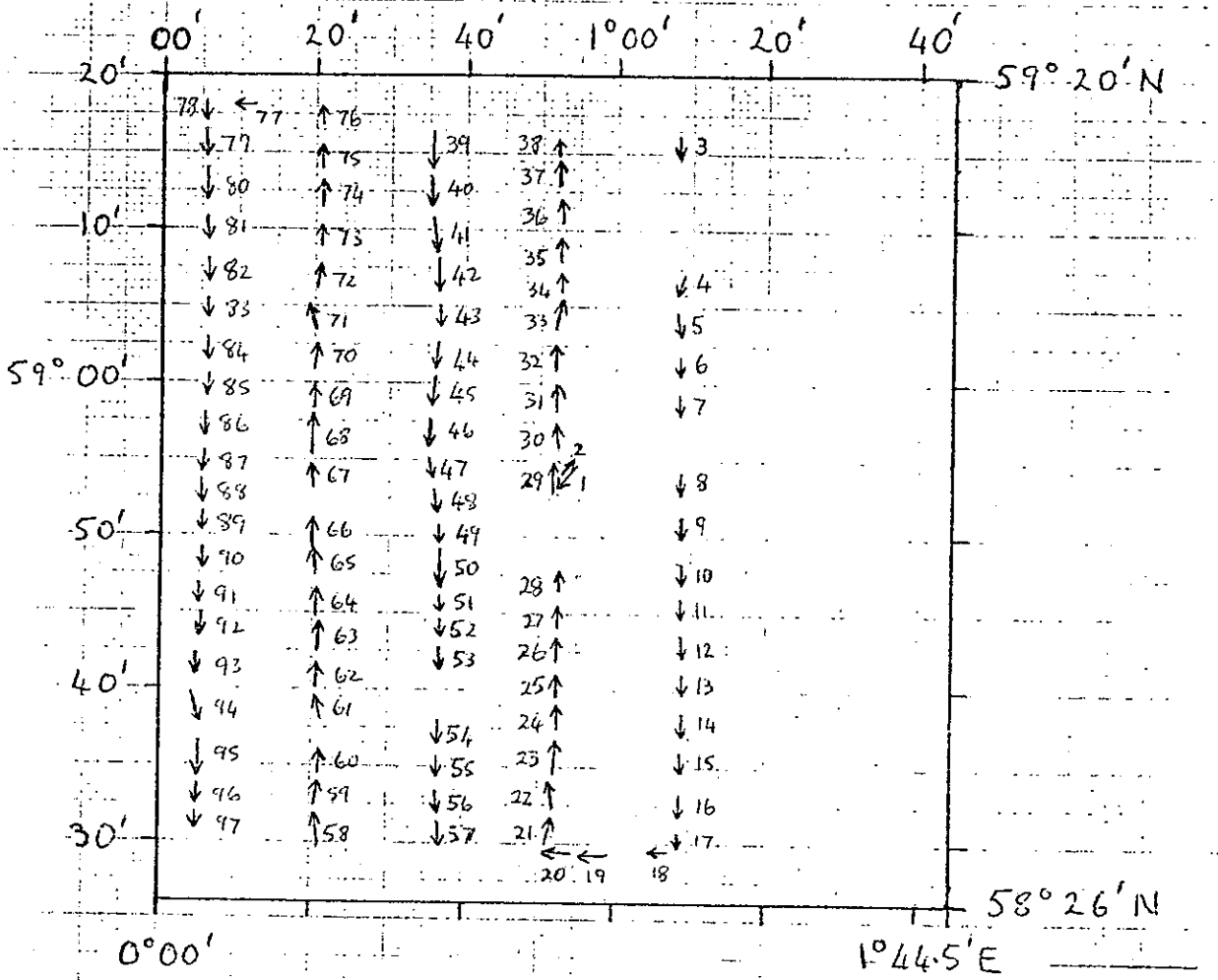
UOR TOW LIST (page 2 of 3)

UOR Tow No.	Location	Action	Date	Time (GMT)	Position Lat.N	Position Long.	Dist. towed (n. miles)	No.of Undula-tions	Av.Und. Leng. (n. miles)	Depth Range (m)	Silk No.	Av.Silk Trans. rate (miles/ div.)	Tape No.	Comments
5	FLEX grid Leg 7	Shoot A/C Haul	19 Apr " "	09.06 14.10 14.34	59°17.6' 58°29.3' 58°29.1'	1°39.2'E 1°39.1'E 1°32.7'E	51	36	1.42	8-60	F3 UOR/3	1.16	ODAS F3/12	All plankton samples valid. Intermittent recording fault makes validity of most of S/T data doubtful; ½ D data recoverable.
6	FLEX grid Leg 1	Shoot Haul	23 Apr "	06.40 09.27	58°32.3' 58°54.1'	0°05.2'E 0°04.5'E	22	12	1.83	?	"	1.20	ODAS F3/17	All plankton samples valid. ODAS flooded at start of tow, hence no STD data.
7	FLEX grid Leg 1 (contd.)	Shoot A/C Haul	" " "	09.58 12.30 13.09	58°57.1' 59°17.0' 59°15.6'	0°04.3'E 0°05.4'E 0°12.9'E	24	13	1.85	?	F3/ UOR/4	1.82	"	UTV3/ODAS2. All plankton samples valid. No STD data (ODAS flooded at start of previous tow.
8	FLEX grid Leg 2	Shoot A/C Haul	" " "	14.00 14.30 19.45	59°18.1' 59°17.0' 58°28.5'	0°12.7'E 0°20.5'E 0°19.7'E	53	29	1.83	23-56	"	5.6	MATR F3/ UOR/1	UTV3/MATR. Validity of plankton samples uncertain - silk transport rate low. All T/D data valid.

UOR TOW LIST (page 3 of 3)

UOR Tow No.	Location	Action	Date	Time (GMT)	Position Lat.N	Position Long.	Dist. towed (n. miles)	No.of Undula-tions	Av.Und. Leng. (n. miles)	Depth Range (m)	Silk No.	Av.Silk Trans. rate (miles/ div.)	Tape No.	Comments
9	FLEX grid Leg 4	Shoot A/C A/C Haul	24 Apr " " "	08.39 09.14 14.35 15.00	59°16.9' 59°16.5 58°29.5' 58°28.1'	0°43.8'E 0°52.4'E 0°52.5'E 0°55.5'E	54	32	1.68	23-56	F3/ UOR/4	1.46	MATR F3/ UOR/1	All plankton samples valid. MATR recording intermittently of poor quality, bu ~2/3 of T/D dat probably recover able.

FLEX BOX



↗ HSLE HAULS

FIGURE 5

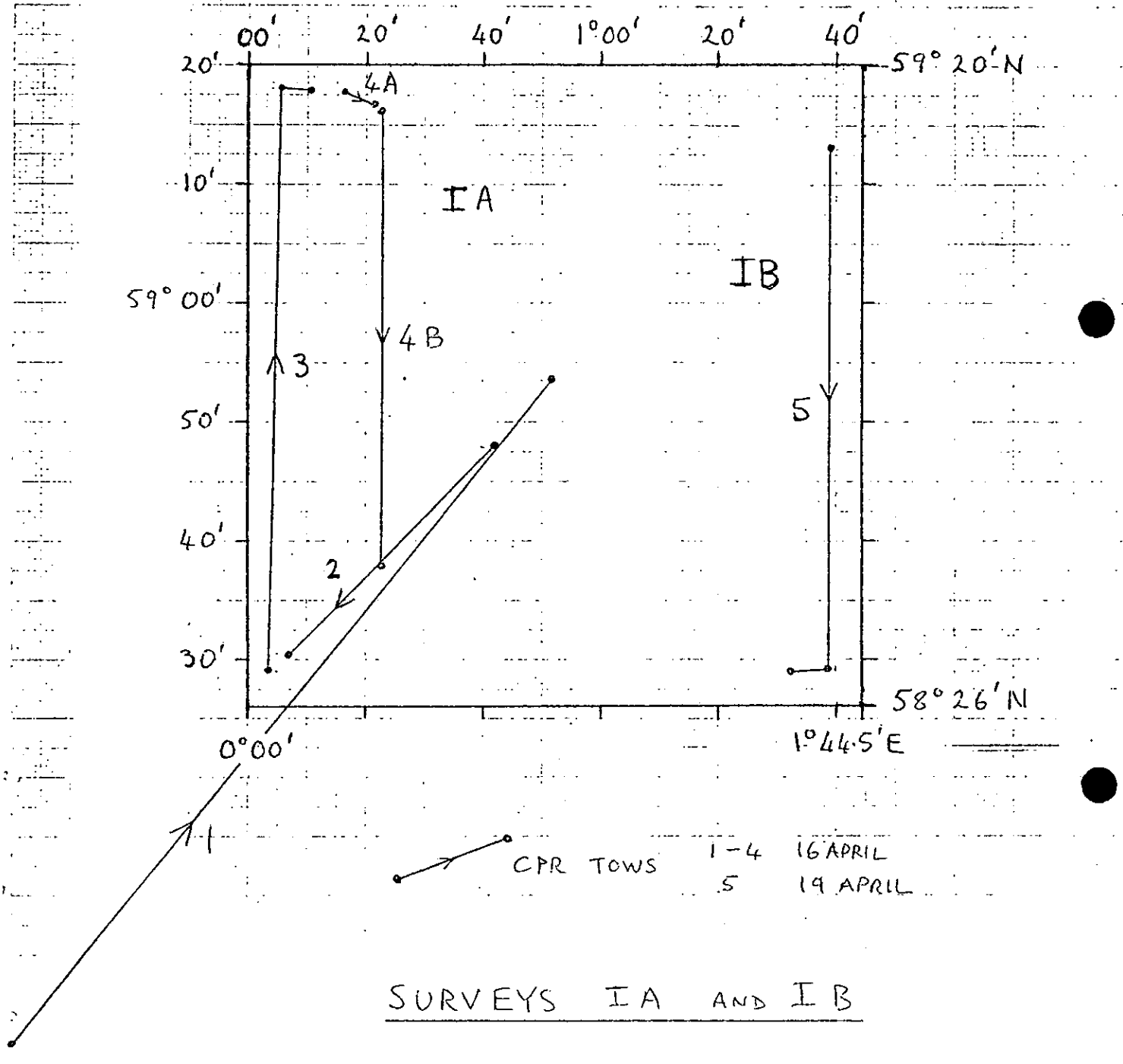
HSLE HAULS (page 1 of 2)

Haul No.	Date	Starting Time (GMT)	Duration of Haul (mins.)	Starting - Position Lat. N	Long. E	Finishing - Position Lat. N	Long. E
F3/1	16 April	04.40	20	58°54.6'	0°54.9'	58°53.2'	0°52.2'
2	"	05.10	20	58°53.2'	0°52.2'	58°54.5'	0°53.7'
3	20 April	12.10	15	59°16.1'	1°08.1'	59°14.9'	1°08.2'
4	"	14.00	10	59°07.0'	1°08.8'	59°05.8'	1°08.1'
5	"	14.30	15	59°04.5'	1°08.2'	59°03.2'	1°08.4'
6	"	15.00	15	59°01.8'	1°08.5'	59°00.5'	1°08.5'
7	"	15.30	15	58°59.3'	1°08.5'	58°58.0'	1°08.5'
8	"	16.30	15	58°54.1'	1°08.7'	58°52.8'	1°08.7'
9	"	17.00	15	58°51.3'	1°08.7'	58°49.9'	1°08.7'
10	"	17.30	?	58°48.2'	1°08.7'	?	?
11	"	18.00	15	58°46.0'	1°08.8'	58°44.8'	1°08.8'
12	"	18.30	15	58°43.5'	1°08.8'	58°42.1'	1°09.0'
13	"	19.00	15	58°41.1'	1°09.0'	58°39.8'	1°09.0'
14	"	19.30	15	58°38.5'	1°09.0'	58°37.1'	1°08.9'
15	"	20.00	15	58°35.9'	1°08.8'	58°34.8'	1°08.9'
16	"	20.30	15	58°33.2'	1°08.6'	58°31.8'	1°08.6'
17	"	21.00	18	58°30.8'	1°08.6'	58°29.7'	1°08.6'
18	"	21.30	17	58°29.4'	1°07.3'	58°29.4'	1°04.9'
19	"	23.00	22	58°29.2'	0°59.6'	58°29.2'	0°55.9'
20	"	23.30	24	58°29.4'	0°54.7'	58°29.5'	0°51.0'
21	21 April	00.00	24	58°29.9'	0°51.0'	58°31.7'	0°51.9'
22	"	00.30	24	58°32.2'	0°52.0'	58°34.1'	0°51.7'
23	"	01.00	26	58°34.6'	0°52.1'	58°36.8'	0°52.3'
24	"	01.33	23	58°37.4'	0°52.4'	58°38.9'	0°52.3'
25	"	02.05	17	58°39.6'	0°52.3'	58°41.1'	0°52.4'
26	"	02.33	17	58°41.9'	0°52.4'	58°43.4'	0°52.4'
27	"	03.00	20	58°44.0	0°52.4'	58°45.5'	0°52.4'
28	"	03.30	22	58°46.3'	0°52.5'	58°47.8'	0°52.5'
29	"	11.00	25	58°52.8'	0°52.1'	58°54.9'	0°52.2'
30	"	11.35	17	58°55.8'	0°52.3'	58°57.4'	0°52.1'
31	"	12.00	20	58°58.2'	0°51.9'	58°59.9'	0°51.9'
32	"	12.30	21	59°00.9'	0°51.8'	59°02.6'	0°52.0'
33	"	13.03	22	59°03.6'	0°52.1'	59°05.5'	0°52.4'
34	"	13.33	16	59°06.1'	0°52.4'	59°07.2'	0°52.4'
35	"	14.00	18	59°08.0'	0°52.4'	59°09.4'	0°52.4'
36	"	14.30	20	59°10.5'	0°52.4'	59°12.0'	0°52.3'
37	"	15.00	15	59°12.9'	0°52.2'	59°14.1'	0°52.2'
38	"	15.30	15	59°14.9'	0°52.1'	59°15.4'	0°52.0'
39	"	18.00	25	59°16.4'	0°35.3'	59°14.0'	0°35.2'
40	"	18.30	?	59°13.5'	0°35.1'	?	?
41	"	19.00	20	59°10.8'	0°35.6'	59°08.6'	0°35.9'
42	"	19.30	15	59°08.3'	0°36.1'	59°06.5'	0°36.2'
43	"	20.00	15	59°05.1'	0°36.4'	59°03.8'	0°36.4'
44	"	20.30	20	59°02.6'	0°36.1'	59°01.0'	0°35.9'
45	"	21.02	?	59°00.6'	0°35.8'	?	?
46	"	21.30	24	58°57.6'	0°35.2'	58°55.9'	0°35.1'
47	"	22.00	20	58°55.2'	0°35.1'	58°53.8'	0°35.6'
48	"	22.30	18	58°53.1'	0°35.8'	58°51.6'	0°36.3'
49	"	23.00	23	58°50.7'	0°36.4'	58°49.7'	0°36.5'
50	"	23.30	20	58°49.2'	0°36.6'	58°46.8'	0°36.8'

HSLE HAULS (page 2 of 2)

Haul No.	Date	Starting Time (GMT)	Duration of Haul (mins.)	Starting - Position Lat. N	Long. E	Finishing - Position Lat. N.	Long. E
F3/51	22 April	00.00	22	58°46.0'	0°36.7'	58°45.3'	0°36.9'
52	"	00.30	18	58°44.6'	0°36.9'	58°43.5'	0°36.9'
53	"	01.00	18	58°42.7'	0°36.9'	58°41.4'	0°36.9'
54	"	02.00	20	58°38.0'	0°36.6'	58°36.6'	0°36.5'
55	"	02.30	19	58°35.7'	0°36.4'	58°34.4'	0°36.6'
56	"	03.00	19	58°33.4'	0°36.6'	58°32.1'	0°36.7'
57	"	03.30	18	58°31.4'	0°37.0'	58°29.9'	0°37.0'
58	"	05.34	21	58°29.8'	0°21.0'	58°31.8'	0°20.6'
59	"	06.07	18	58°32.4'	0°20.6'	58°33.9'	0°20.9'
60	"	06.32	16	58°34.4'	0°20.9'	58°34.8'	0°20.7'
61	"	07.30	17	58°38.8'	0°21.4'	58°39.2'	0°20.6'
62	"	08.00	16	58°40.2'	0°20.6'	58°43.1'	0°25.3'
63	"	09.00	15	58°42.4'	0°20.7'	58°44.3'	0°20.8'
64	"	09.30	14	58°44.7'	0°20.5'	58°46.4'	0°23.4'
65	"	10.02	13	58°47.5'	0°20.3'	?	?
66	"	10.30	15	58°50.2'	0°20.1'	58°51.2'	0°20.0'
67	"	11.00	18	58°53.2'	0°20.1'	58°54.7'	0°19.9'
68	"	11.30	25	58°54.7'	0°19.7'	58°58.0'	0°19.9'
69	"	12.00	18	58°58.3'	0°19.9'	58°59.8'	0°20.0'
70	"	12.30	19	59°00.9'	0°20.0'	59°01.1'	0°19.6'
71	"	13.00	20	59°03.6'	0°20.2'	59°05.1'	0°19.4'
72	"	13.30	15	59°06.2'	0°20.4'	59°07.6'	0°20.6'
73	"	14.00	16	59°08.9'	0°20.8'	59°10.2'	0°20.8'
74	"	14.30	20	59°11.5'	0°20.9'	59°13.2'	0°20.9'
75	"	15.00	15	59°14.1'	0°20.9'	59°15.5'	0°20.9'
76	"	15.30	15	59°16.8'	0°20.9'	59°17.9'	0°20.8'
77	"	17.03	18	59°18.2'	0°12.2'	59°18.1'	0°09.6'
78	"	17.30	16	59°18.8'	0°17.6'	59°17.2'	0°05.5'
79	"	18.00	15	59°17.4'	0°05.6'	59°18.6'	0°05.5'
80	"	18.30	15	59°14.0'	0°05.6'	59°11.9"	0°05.6'
81	"	19.00	15	59°10.8'	0°05.7'	59°09.4'	0°05.8'
82	"	19.30	15	59°08.0'	0°05.8'	59°06.6'	0°05.8'
83	"	20.00	15	59°05.4'	0°05.9'	59°04.2'	0°05.9'
84	"	20.30	17	59°02.9'	0°05.9'	59°01.5'	0°05.9'
85	"	21.00	18	59°00.4'	0°05.8'	58°59.1'	0°05.7'
86	"	21.30	16	58°58.0'	0°05.7'	58°56.6'	0°05.5'
87	"	22.00	15	58°55.5'	0°05.4'	58°54.2'	0°05.2'
88	"	22.30	15	58°52.9'	0°05.2'	58°52.6'	0°05.4'
89	"	23.00	14	58°51.5'	0°05.4'	58°50.4'	0°05.3'
90	"	23.30	16	58°49.1'	0°05.3'	58°47.9'	0°05.2'
91	23 April	00.00	20	58°46.8'	0°05.0'	58°45.6'	0°05.0'
92	"	00.33	17	58°44.9'	0°05.2'	58°43.4'	0°05.0'
93	"	01.00	20	58°42.3'	0°04.7'	58°40.9'	0°04.8'
94	"	01.30	20	58°38.8'	0°04.7'	58°38.3'	0°05.1'
95	"	02.03	17	58°36.5'	0°05.3'	58°33.2'	0°04.1'
96	"	02.30	18	58°34.8'	0°05.1'	58°33.1'	0°04.8'
97	"	03.00	19	58°31.8'	0°04.3'	58°31.0'	0°04.9'

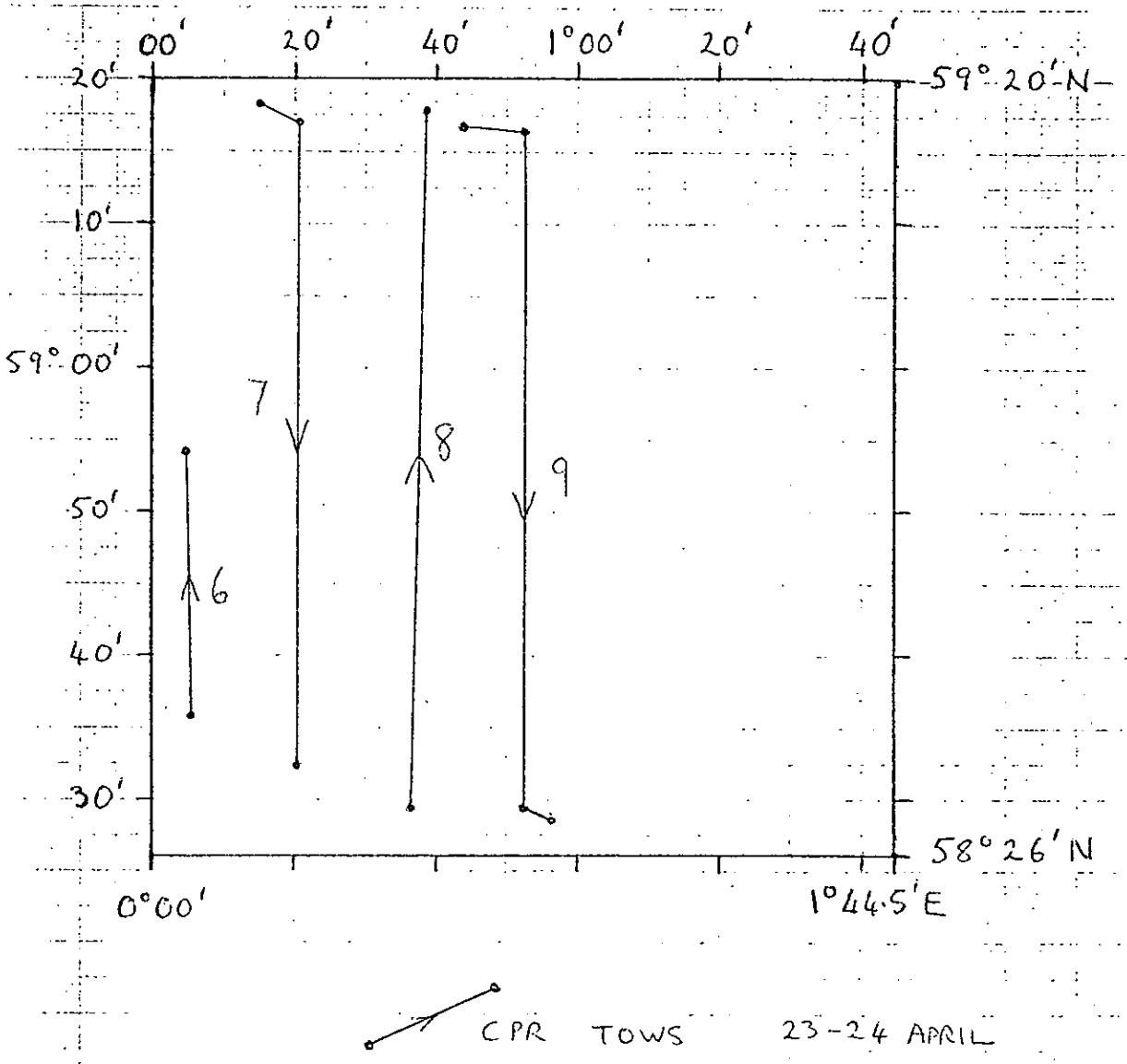
FLEX BOX



SURVEYS IA AND IB

FIGURE 6

FLEX BOX



SURVEY II

FIGURE 7

CPR TOW LIST (page 1 of 2)

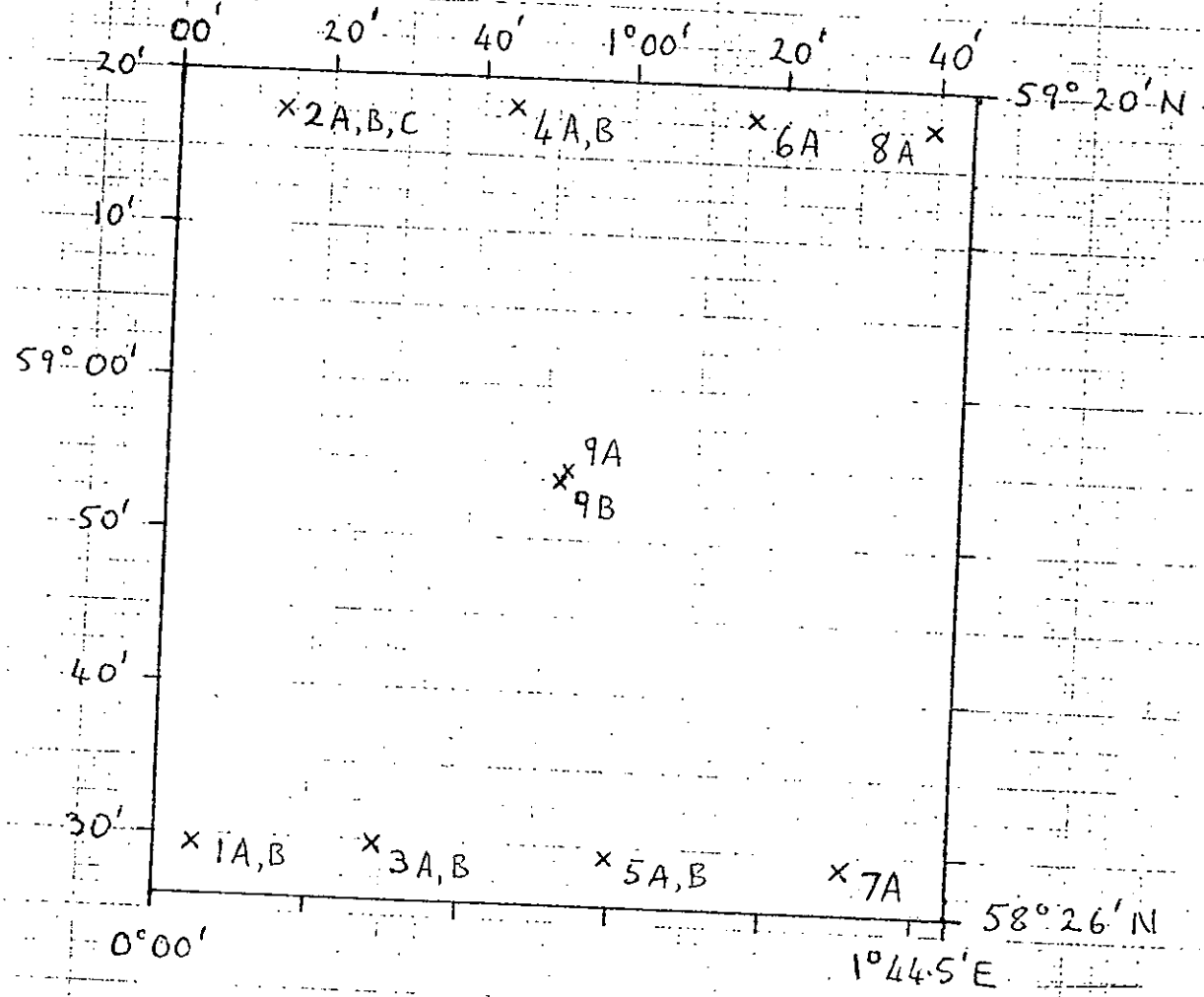
CPR Tow No.	Location	Action	Date	Time (GMT)	Position Lat. N	Position Long.	Silk No.	MATR Tape No.	Distance towed (n.miles)	Silk transport rate (Miles/Div.)	Comments
1	ILSW →	Shoot	15 April	18.20	57°47.9'	1°00.4'W	F3/CPR/1	F3/CPR/1	88	5.6	Plankton sampl and T/D data valid througho
		Haul	16 April	04.23	58°53.5'	0°52.0'E					
2	Sta. 9 →	Shoot	"	11.09	58°48.0'	0°42.0'E	"	"	25	6.8	"
	Sta.1	Haul	"	13.52	58°30.4'	0°07.4'E					
3	FLEX grid	Shoot	"	16.13	58°29.0'	0°03.4'E	"	F3/CPR/2	52	6.5	"
	Leg 1	A/C	"	21.12	59°18.0'	0°05.4'E					
		Haul	"	21.24	59°17.9'	0°10.3'E					
4A	FLEX grid	Shoot	"	23.05	59°17.8'	0°16.0'E	"	"			"
	Leg 2	Haul	"	23.20	59°16.8'	0°21.7'E			42	6.7	Towing speed reduced by hea seas to ~ 6 knots towards end of tow.
4B	"	Shoot	"	23.40	59°16.4'	0°22.5'E					
		Haul	17 April	04.00	58°37.8'	0°22.7'E					
5	FLEX grid	Shoot	19 April	09.25	59°13.1'	1°39.5'E	F3/CPR/2	F3/CPR/3			Plankton sampl
	Leg 7	A/C	"	14.10	58°29.3'	1°39.1'E			47	5.3	and T/D data valid througho
		Haul	"	14.28	58°29.1'	1°32.7'E					
6	FLEX grid	Shoot	23 April	07.05	58°35.8'	0°05.3'E	F3/CPR/2	F3/CPR/3	19	6.8	Plankton sampl
	Leg 1	Haul	"	09.20	58°54.1'	0°04.5'E					and T/D data valid througho
7	FLEX grid	Shoot	"	14.10	59°18.2'	0°17.6'E	"	"	47	5.5	"
	Leg 2	A/C	"	14.30	59°17.0'	0°20.5'E					
		Haul	"	19.35	58°32.4'	0°20.3'E					

CPR TOW LIST (page 2 of 2)

CPR Tow No.	Location	Action	Date	Time (GMT)	Position Lat. N	Position Long.	Silk No.	MATR Tape No.	Distance towed (n. miles)	Silk transport rate (Miles/Div.)	Comments
8	FLEX grid Leg 3	Shoot	23 April	21.30	58°29.4'	0°36.6'E	F3/CPR/2	F3/CPR/4	49	8.4	Silk transport rate slow (because towing speed reduced t 4-7 knots by head seas) making validity of plankton samples uncertai T/D data valid throughout.
		Haul	24 April	07.00	59°18.0'	0°38.7'E					
9	FLEX grid Leg 4	Shoot	"	09.00	59°16.8"	0°43.7'E	"	"	54	6.3	Plankton samples and T/D data valid throughout
		A/C	"	09.14	59°16.5'	0°52.4'E					
		A/C	"	14.35	58°29.5'	0°52.5'E					
		Haul	"	14.50	58°28.5'	0°56.1'E					

Total 423

FLEX BOX



× HYDRO-STATIONS

FIGURE 8

HYDRO-STATION LIST (p.1 of 2)

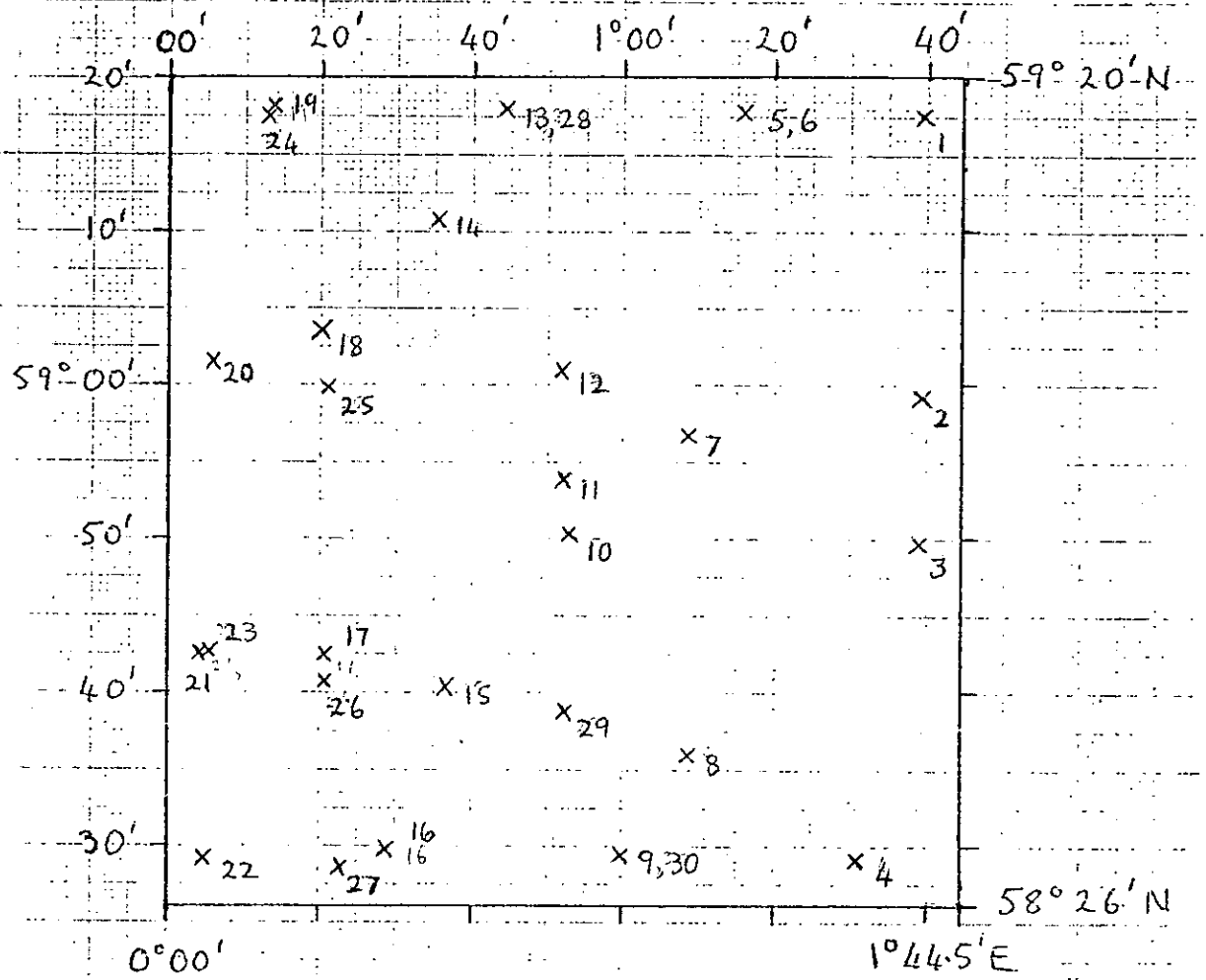
Station No.	Date	Messenger Time (GMT)	Position		Sounding (m)	Depths Sampled (m)	SAMPLE NUMBERS					PHYTOPLANKTON	
			Lat. N	Long.			Salinity	NO_3	Nutrients	Silicate	Chla	Reid	Gilibricht
0	15 Apr	17.10	57°38.1'	1°16.4'W	-	15,30,50	I	-	-	-	-	-	-
9A	16 "	06.43	58°54.3'	0°52.8'E	128	3,10,20,30,40, 60,80,100,110	I *12-14/2	+	1-9	1-9	+	FR115 -123	-
1A	16 "	14.24	58°29.4'	0°05.3'E	145	3,10,20,30,40, 60,80,100,130	I	+	10-18	10-18	+	FR124 -132	FG31-36 FG38-40
2A	16 "	22.00	59°17.7'	0°13.6'E	135	3,10,20,30,40, 60,80,100,120	I	+	19-27	19-27	+	FR133 -141	-
8A	19 Apr	08.29	59°17.6'	1°39.2'E	113	3,10,20,30,40, 60,80,100	I *15-17/2	+	28-35	28-35	+	FR142 -149	-
7A	19 "	14.58	58°29.1'	1°30.9'E	128	3,10,20,30,40, 60,80,100,115	I	+	36-44	36-44	+	FR150 -158	-
6A	20 Apr	10.05	59°17.8'	1°15.7'E	108	3,10,20,30,40, 60,80,100	I	+	45-52	45-52	+	FR159 -166	-
5A	20 "	22.33	58°29.3'	0°59.8'E	142	3,10,20,30,40, 60,80,100,130	I	+	53-61	53-61	+	FR167 -175	-
9B	21 Apr	09.28	58°53.9'	0°52.0'E	133	3,10,20,30,40, 60,80,100,120	I	+	62-70	62-70	+	FR176 -184	-
4A	21 "	17.05	59°18.1'	0°44.4'E	132	3,10,20,30,40, 60,80,100,120	I	+	71-79	71-79	+	FR185 -193	-
3A	22 Apr	04.55	58°29.8'	0°28.8'E	145	3,10,20,30,40, 60,80,100,130	I	+	80-88	80-88	+	FR194 -202	-
2B	22 "	16.50	59°18.1'	0°13.8'E	134	3,10,20,30,40, 60,80,100,120	I	+	89-97	89-97	+	FR203 -211	-
1B	23 Apr	03.54	58°29.1'	0°04.8'E	141	3,10,20,30,40, 60,80,100,130	I	+	98-106	98-106	+	FR212 -216, 218-221	FG41-49
2C	23 "	13.38	59°17.6'	0°12.9'E	132	3,10,20,30,40, 60,80,100,120	I	+	107-115	107-115	+	FR222 -230	-

HYDRO-STATION LIST (p.2 of 2)

Station No.	Date	Messenger Time (GMT)	Position Lat. N	Position Long.	Sounding (m)	Depths Sampled (m)	SAMPLE NUMBERS Salinity	NO_3	Nutrients	Silicate	Chla	PHYTOPLANKTON Reid	Gillbri
3B	23 Apr	20.42	58°28.5'	0°28.6'E	145	3,10,20,30,40, 60,80,100,130	I	+	116-124	116-124	+	FR231 -239	-
4B	24 Apr	08.22	59°18.1'	0°44.1'E	130	3,10,20,30,40, 60,80,100,120	I	+	125-133	125-133	+	FR240 -248	-
5B	24 "	15.36	58°29.6'	1°00.2'E	140	3,10,20,30,40, 60,80,100,120	I	+	134-142	134-142	+	FR249 -257	-

I Samples taken by IMER + Samples taken by DAFS * Intercalibration samples for NIOZ

FLEX BOX



× XBT CASTS

FIGURE 9

XBT CASTS

XBT NO.	Date	Time (GMT)	Position Lat.N.	Long.E	Depth (m)
1	19 April	08.49	59°17.6'	1°39.3'	113
2	"	11.03	58°59.3'	1°39.3'	121
3	"	13.06	58°49.7'	1°38.9'	99
4	"	14.57	58°29.1'	1°30.9'	128
5	20 April	10.10	59°17.8'	1°15.7'	109
6	"	12.00	59°17.7'	1°15.5'	106
7	"	16.06	58°56.7'	1°08.6'	121
8	"	20.00	58°35.9'	1°08.8'	135
9	"	22.30	58°29.3'	0°59.9'	138
10	21 April	04.20	58°50.3'	0°52.6'	122
11	"	09.25	58°53.9'	0°52.0'	128
12	"	13.30	59°00.9'	0°51.8'	117
13	"	17.05	59°18.1'	0°44.4'	132
14	"	19.08	59°10.8'	0°35.6'	155
15	22 April	01.40	58°40.3'	0°36.9'	134
16	"	05.03	58°29.8'	0°28.8'	147
17	"	09.01	58°42.4'	0°20.7'	135
18	"	13.02	59°03.6'	0°20.2'	134
19	"	16.50	59°18.1'	0°13.8'	133
20	"	20.40	59°01.5'	0°05.9'	140
21	23 April	01.00	58°42.3'	0°04.3'	144
22	"	04.05	58°29.1'	0°04.8'	143
23	"	08.10	58°42.7'	0°05.4'	?
24	"	13.38	59°17.6'	0°12.9'	134
25	"	16.25	58°59.8'	0°20.8'	?
26	"	18.40	58°40.6'	0°20.4'	135
27	"	21.00	58°28.5'	0°22.9'	145
28	24 April	08.22	59°18.1'	0°44.1'	129
29	"	13.40	58°38.7'	0°52.2'	132
30	"	15.43	58°29.6'	1°00.2'	140

LHPR HAULS

Haul No.	Location	Date	Starting Time (GMT)	Duration of Haul (Min.)	Starting Position Lat.N	Position Long.E	Sounding at Start(m)	Max.Depth Sampled (m)	No.of Samples
1	Sta.9A	16 April	05.40	30	58°54.5'	0°53.7'	128	120	20
2	Sta.9B	21 April	10.05	35	58°53.8'	0°52.4'	133	110	23